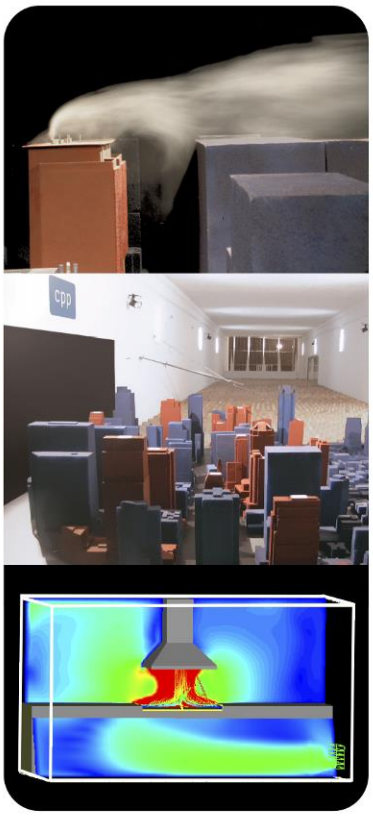
APPENDIX H

WIND IMPACT ASSESSMENT - CPP

CERMAK
PETERKA
PETERSEN

WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT



Wind Assessment for:

505-523 GEORGE STREET

Sydney, Australia

Prepared for:

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NSW 2022

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Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by Coombes Property Group and Mirvac to provide an opinion based assessment of the impact of the proposed development at 505-523 George Street, Sydney, on the pedestrian level local wind environment in and around the proposed development.

The site is located in the centre of Sydney CBD and is surrounded by medium to high rise buildings, Figure 1.

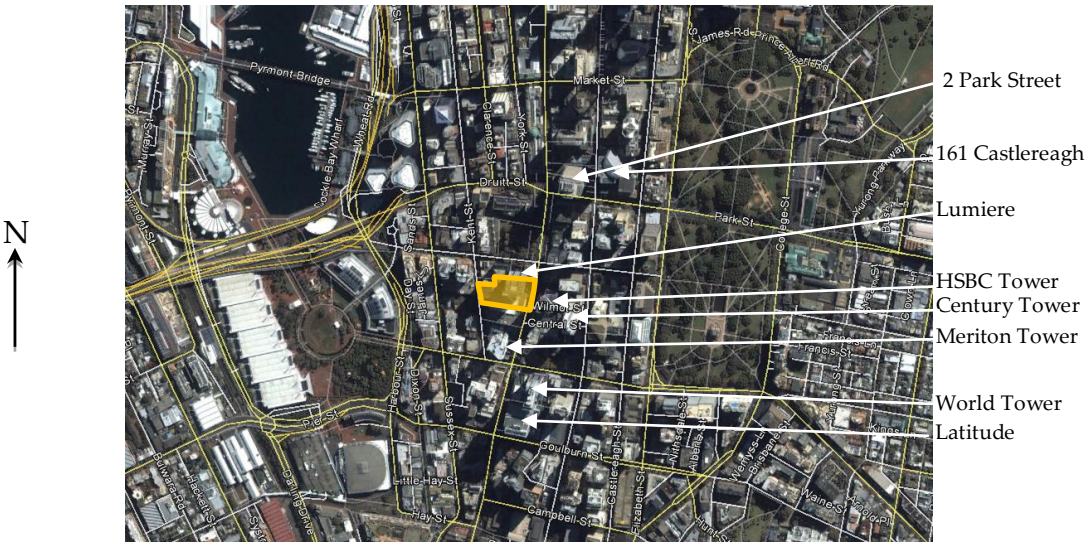

Figure 1 Location of the proposed development (Google Earth, 2013)

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 2013 have been used in this analysis, Figure 2. It is noted from Figure 2 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 larger the temperature differential between land and sea, the stronger the breeze.

Strong 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.

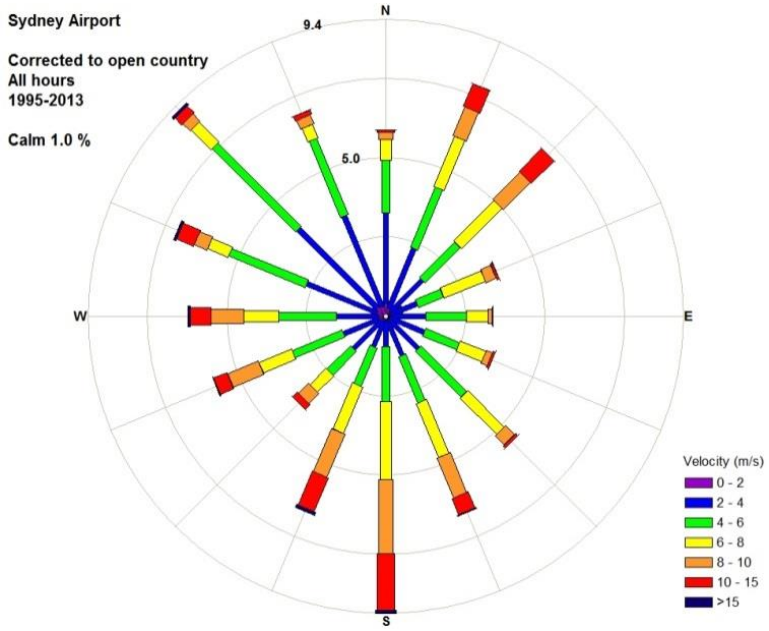

Figure 2: Annual wind rose of direction and speed for Sydney Airport

Wind Flow Mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 3; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward and sides of the building. In Figure 3 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.

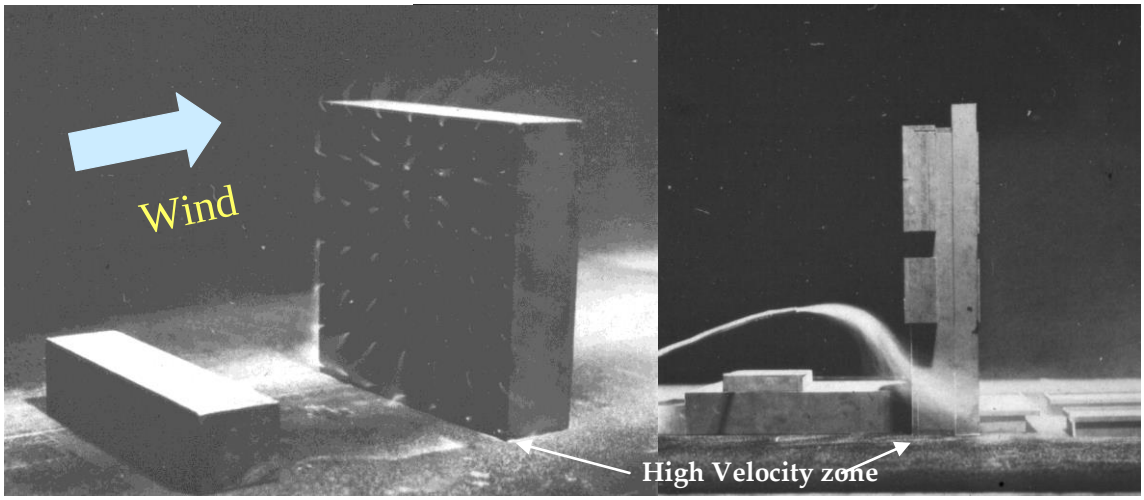

Figure 3: Flow visualisation around a tall building

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.

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 10 m/s along George Street as this is an active frontage, and 16 m/s along Kent Street. 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 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), 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 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 proposed development is situated to the south of the central business district, towards the north of the block bounded by Bathurst, George, Liverpool, and Kent Streets, Sydney, Figure 1. The block is towards the southern edge of the regular grid street pattern in this section of the city. The winds in this area are channelled along the streets with large exposed buildings bringing upper air flow to ground level.

The proposed development has a frontage of approximately 50 m on George Street and 35 m on Kent Street. The proposed development consists of an essentially prismatic tower with an irregular floor plan, Figure 4. The four-storey podium covers the entire site with a height of about 30 m above Kent Street, with the tower rising to about 260 m above ground level, Figure 5. The proposed tower setback from the podium edge is about 45 m from George Street, 6 m from Kent Street, 9 m to the south, and 12 m to the north, Figure 4. The proposed development is surrounded by many medium- to high-rise buildings. From a wind perspective the topography surrounding the site drops slightly to the south and west.

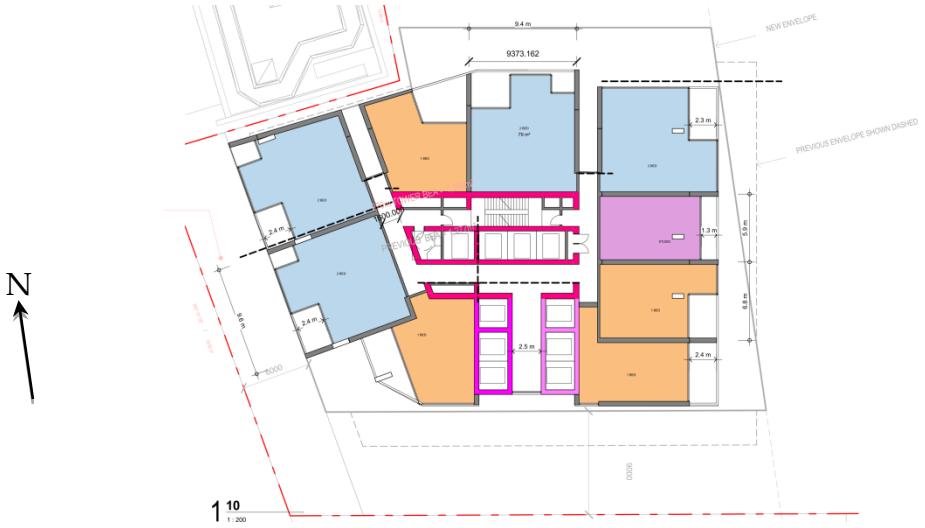

Figure 4: Low rise floor plan

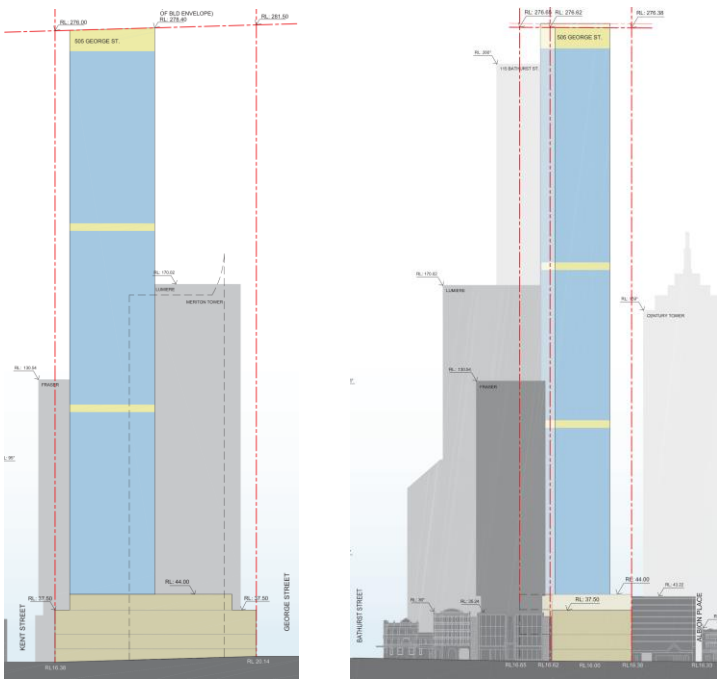

Figure 5: South (L) and West (R) elevation

Winds in such a complex cityscape tend to be channelled along the streets with local effects being dictated by exposed large buildings and local topography. This is known to be true of this area of the city where prevailing winds from the west and south are accelerated up the local topography and are brought to ground level in the form of downwash by the large exposed buildings including World Tower, Latitude Tower, Lumiere, 2 Park Street, Century Tower, and the HSBC building. With the proposed tower being taller than the surrounding buildings, but embedded in such complex flow, the local wind conditions around the site are generally expected to be similar to existing conditions. There are some exceptions at certain locations along Kent Street for winds from the south respectively, which are discussed more fully in this report.

Existing wind conditions in this section of the city are known to be relatively windy along George Street, particularly for winds from the south, which are accelerated up the slope and combined with the downwash generated by the upwind large buildings. Using the Lawson criteria these areas would be expected to be classified for 'pedestrian standing' or 'pedestrian walking' and pass the distress criterion. It is considered unlikely that the existing wind conditions would meet the City of Sydney (2012) DCP requirements for the once per annum maximum gust to not exceed 10 m/s along George Street. The area would be expected to be useable for café style pedestrian sitting activities for about 80% of the time.

From a wind engineering perspective, the main architectural difference between the proposed development and existing buildings is the additional approximately 240 m high tower.

Winds from the north-east

The proposed block is located to the south of the city and is therefore considered to be reasonably well protected from winds from the north-east crossing Sydney Harbour. In Sydney these winds occur on hot summer days and the hotter the weather the stronger the winds as the driving mechanism is due to the local pressure differential generated by the temperature gradient between land and sea. Because the winds are stronger on hotter days, they can bring welcome relief.

The general wind flow pattern in this area is governed by the larger buildings in the neighbouring blocks to the north-east combined with the open nature of Hyde Park. It is considered that the proposed building will have little impact on the wind conditions along George or Kent Street as a significant portion of the tower is in the wake of Lumiere, Century Tower, and the HSBC building for winds from the north-east. The higher exposed portion of the tower will induce downwash, but the orientation of the tower with the corner pointing to the north-east will reduce the amount of downwash. The expanse of podium to the north and east

will provide significant protection to the ground plane and the area is expected to remain suitable for pedestrian standing or walking, and pass the distress criterion.

Winds from the south

Winds from the south are currently channelled by the taller buildings along George Street. As Kent Street only extends to Liverpool Street to the south, there is insufficient distance for the wind to be channelled along Kent Street. The large residential tower at 569-581 George Street blocks the flow entering Kent Street. The location of the proposed tower on the site is expected to generate downwash discharging into Kent Street. The 6 m podium setback with the continuation to the existing Frasers tower to the north will assist in protecting Kent Street from downwash effects. Wind conditions along Kent Street are expected to get windier to the north of the former Judge's cottage at 529 Kent Street where the downwash is expected to impinge at ground level, but are still expected to be acceptable for pedestrian walking with reference to the Lawson comfort criterion. Wind conditions along George Street are expected to remain similar to the existing conditions due to the significant tower setback. Wind conditions along Albion Place to the south of the neighbouring site are expected to be similar to the current wind conditions, as the 9 m podium setback and the neighbouring 25 m wide rooftop will redirect the vertical downwash before reaching ground level.

Winds from the west

Winds from the west are channelled up Liverpool and Bathurst Streets by the upstream buildings. The proposed tower is located in the centre of the block so the majority of downwash will be directed across the podium roof rather than down to ground level on Kent Street. The 6 m tower setback and the proximity to the Frasers Tower and Lumiere are expected to slightly increase the wind flow along Bathurst Street and to a lesser extent Albion Place. The downwash mechanism is expected to cause some minor circulation of wind across Kent Street and the former Judge's cottage. Wind conditions along George Street are expected to remain similar to existing conditions. All locations impacted by the proposed tower are expected to remain suitable for pedestrian walking from a comfort perspective and meet the distress criterion.

Conclusions

Cermak Peterka Petersen Pty. Ltd. has provided an opinion based assessment of the impact on the local wind environment of the proposed development at 505 George Street, Sydney. Our summary assessment of the proposed redevelopment is as follows:

Wind conditions at pedestrian level areas around the proposed development are expected to be similar to those currently experienced in this area of the city, with slightly windier conditions expected along sections of Kent Street for certain wind directions, but calmer for others. When compared with the Lawson criterion, the areas are expected to be suitable for pedestrian standing or walking from a comfort perspective and pass the distress criterion. Like the majority of the city the wind climate would not be expected to meet the 'normal' or 'active frontage' criterion specified in City of Sydney (2012) in the existing or proposed configurations. Any intended outdoor dining areas along Kent Street, George Street, or Albion Place, would be expected to require varying levels of local amelioration to create suitable wind conditions. The podium roof is redirecting downwash from the tower and would not be considered suitable for resident access without a significant level of enclosure such as a courtyard style design, or located remote from the tower base. On a building of this size, it would be recommended that the wind conditions described in this report are confirmed and quantified through detailed environmental wind tunnel testing, which is recommended to occur during the preparation of subsequent planning applications.

References

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Melbourne, W.H., (1978), Criteria for environmental wind conditions, *J. Industrial Aerodynamics*, **3**, 241-249.