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St Aloysius' College

Quantitative Wind Assessment

Report Number 610.17552-R03

15 March 2018

PMDL Architecture
801 / 28-34 Clarke Street
CROWS NEST NSW 2065

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St Aloysius' College

Quantitative Wind Assessment

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
2 Lincoln Street
Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
+61 2 9427 8100 +61 2 9427 8200
sydney@slrconsulting.com www.slrconsulting.com

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.17552-R03-v1.0	15 March 2018	Dr Neihad Al-Khalidy	Dr Peter Georgiou	Dr Peter Georgiou

Executive Summary

SLR Consulting Australia (SLR) has been engaged by PMDL Architecture to prepare a quantitative wind impact assessment for the proposed refurbishment project of St Aloysius' College, specifically the Upper Pitt Street Main Campus.

The SLR wind study has focused on the following focused areas:

- Level 3 Roof Terrace & Level 4 Juana Mateo Roof Terrace
- Southern Facade Feature Opening
- Internal Zones Exposed to External Airflow
- Internal Bounded Zones Eastern Half

Wind speeds for the areas of interest have been quantified using Computational Fluid Dynamics (CFD) analysis.

Sydney Winds

The Sydney wind climate is characterised by dominant (prevailing) northeast, west, southeast and southerly winds. While northeast winds are the more common prevailing wind direction in summer (occurring typically as offshore land-sea breezes), southeast and south winds generally provide the strongest gusts during this period. West quadrant winds are common throughout winter (southwest to northwest) and provide the strongest winds over the course of the whole year.

Existing Wind Environment

Existing street level wind conditions in the vicinity of the site are likely to be close to the 16 m/s *"walking comfort"* criterion for some prevailing wind directions given the orientation of the site and the upstream shielding afforded to the site by surrounding buildings and vegetation.

Wind Impact of the Proposed Refurbishment – Base Case Condition assuming Fully Open Southern and Western Façade Louvres

In relation to the wind impact of the proposed development with the currently proposed building design (the "Base Case" condition), some internal areas have the potential to experience elevated wind speeds, in excess of the standard once per year standing comfort criteria (refer **Figure 15**).

This occurs mainly when …

- Prevailing winds align with building geometry conditions conducive to accelerated windflow, eg the southern façade feature opening will be exposed to stronger winds from the south (southwest to southeast).

- Winds will also be able to flow between various openings from the north (Upper Pitt Street building entry), west (Jeffreys Street), south and the overhead central void areas due to pressure differences.

Future Wind Impact of the Proposed Development with Reduced Southern and Western Façade Openings

- With the proposed building design and already planned and proposed landscaping, areas of interest will lie mostly within the "comfortable" seating criterion (refer **Figure 23**).

Executive Summary

SLR recommends the following:

- Implement operable louvres to the south and west facades. The louvres can therefore be fully closed during high wind conditions (refer **Figure 24**).

- Further away from the roof edges the windflow may have a slightly downward arc, where vertical type screening (eg via landscaping) would be the optimum windbreak solution. It is noted that the Level 3 Roof Terrace has variations in RL, with planting included on some of the elevated zones. A localised area of potentially elevated winds has been identified at the southwest corner of the Level 3 terrace (refer **Figure 25**) which would benefit from further analysis during the detailed design phase of the project.

- Retain the proposed 2.1 m parapet along the Level 3 and Level 4 roof terraces (refer **Figure 25**).

Table of Contents

TABLES

Table of Contents

FIGURES

APPENDICES

1 INTRODUCTION

SLR Consulting Australia (SLR) has been engaged by PMDL Architecture to prepare a quantitative wind impact assessment which will be submitted to the Department of Planning and Environment as part of the State Significant Development Application (SSDA) for the proposed redevelopment works at St Aloysius' College, Kirribilli.

Wind speeds for the site surrounds and upper level terraces have been quantified using Computational Fluid Dynamics (CFD).

1.1 Development Site

The site is located on the Milsons Point and Kirribilli peninsular on the lower North Shore in Sydney. The Upper Pitt Street Main Campus, at 47 Upper Pitt Street, accommodates various Secondary School and administration, as well as the Great Hall and Chapel, and comprises a multi-storey building constructed in stages in the 1960's to 1980's. The buildings are built up to the street frontage boundaries on three sides and enclose a central courtyard.

Opposite the main site on Upper Pitt Street is "Wyalla", housing the Year 11 and 12 campus and Dalton Hall, which comprises an indoor pool and sports facility. "Wyalla" is a heritage item dating from the 1880's, whilst Dalton Hall was completed within the last 10 years.

The Junior School campus is at 29 Burton Street and accommodates the year 3-6 students. The site contains the former Milsons Point Primary School, which is a heritage item, and newer buildings constructed in the 1990's and 2000's. **Figure 1** indicates the location of each of the three campuses relative to one another.

Figure 1 Site Location

Image: Nearmap July 2017

1.2 Surrounding Environment

The surrounding environment at each of the three campus locations is comprised predominately of residential developments in all directions which are a mixture of single and double-storey terraces as well as multi-storey apartment buildings. The northern approach ramps to the Sydney Harbour Bridge lie in close proximity to the west of the site.

1.3 Proposed Work

The relevant works include:

- Staged works to the Main Campus including a new infill building to the courtyard, multi-storey façade openings on the Jeffreys Street and Kirribilli Avenue side of the building, and the refurbishment of internal areas.

- Staged refurbishment of “Wyalla” to create more relevant teaching and learning facilities, including a small single storey addition to the eastern side of the existing heritage building.

- Staged works to the Burton Street campus, Junior School including additional level of teaching and learning plus a new semi-subterranean sports facility and associated landscaping.

2 AREAS OF INTEREST FOR WIND MODELLING

The SLR wind study has been focussing on the following areas:

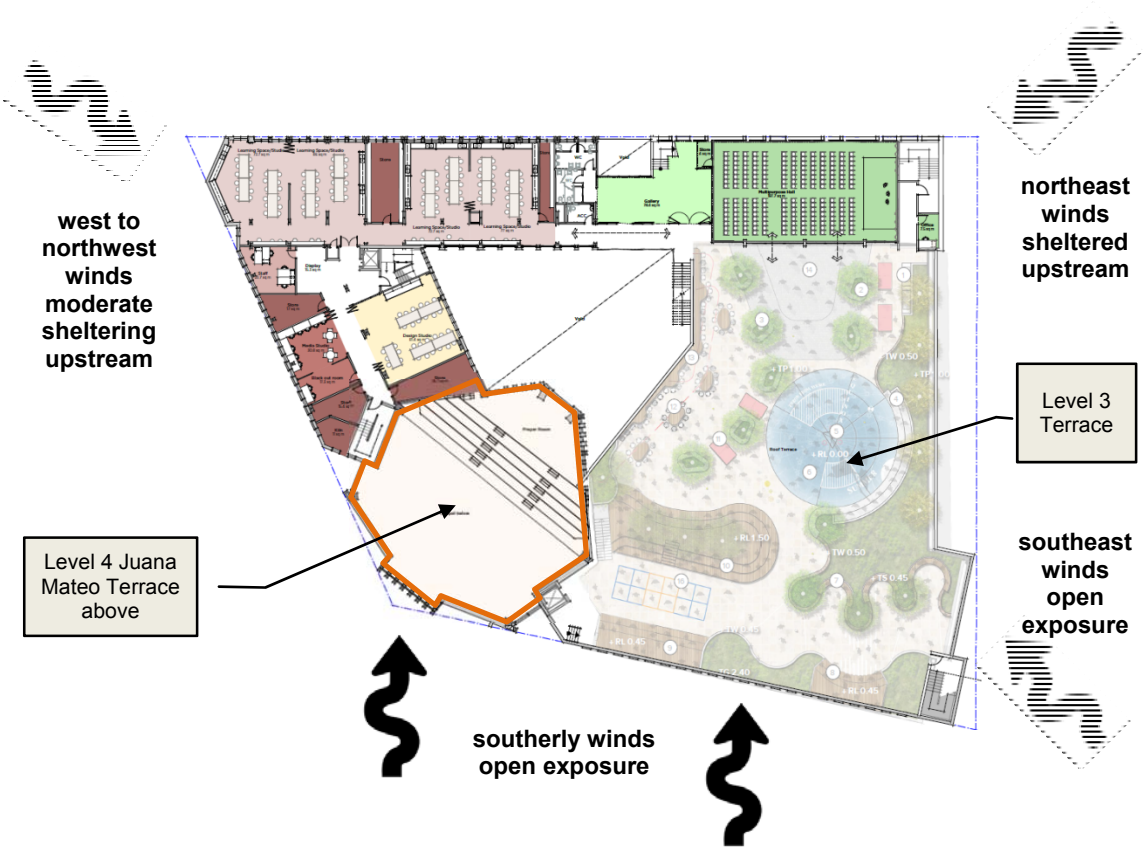
Level 3 Roof Terrace & Level 4 Juana Mateo Roof Terrace

A focal point for the Upper Pitt Street project is the Level 3 Roof Terrace (refer **Figure 2**) which features numerous "zones" for various activities involving short to long-term exposure. The adjacent Level 4 Juana Mateo Roof Terrace is also accessible. These spaces are used as follows:

- The Level 3 Roof Terrace will be used for school assemblies.
- The Level 3 Roof Terrace will also be used for school functions like Parents' functions and the annual New Years' Eve party.
- The Level 4 Juana Mateo Terrace is only rarely used, eg overflow for the annual New Years' Eve party.

There is a roof terrace on Level 5 located at the northwest corner of the building. Although this is not normally used as a publicly accessible area, information on wind speeds over this is provided in **Section 6.1** of this report.

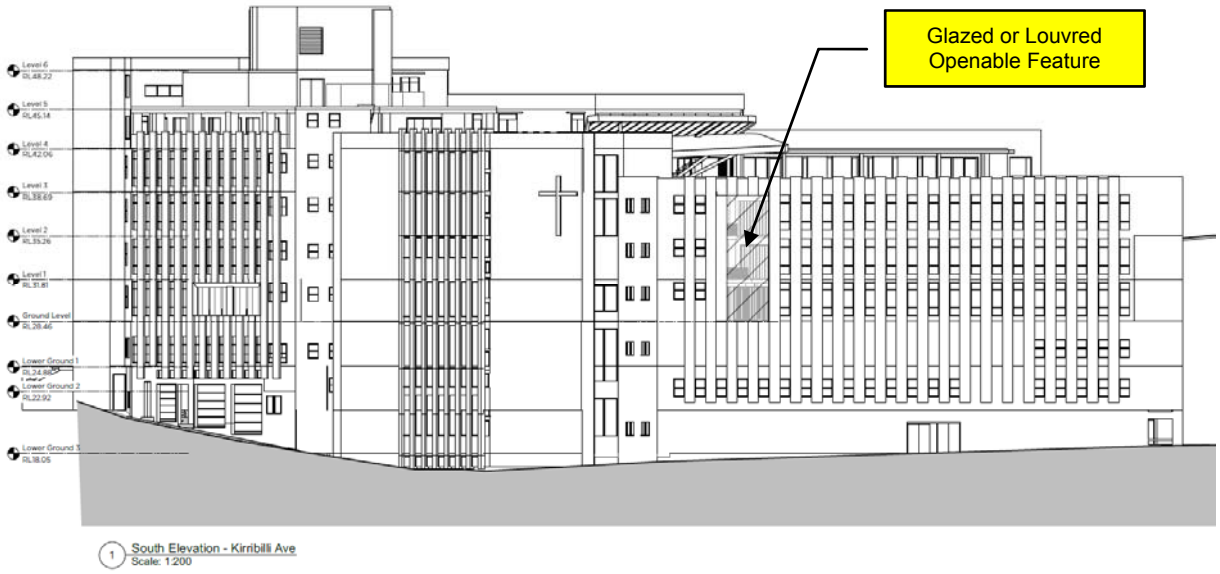
Figure 2 Level 3 Roof Terrace and Level 4 Juana Mateo Terrace



Southern Facade Feature Opening

The Upper Pitt Street proposal features a 3-storey glazed or louvred opening, which will be partially openable – refer **Figure 3**. Its location has been designed so that occupants of the building (on the Ground Floor, Level 1 and Level 2) can look towards the south from various internal areas straight out onto Sydney Harbour, Sydney Opera House and Sydney CBD.

Figure 3 Southern Façade Feature Glazed or Louvred Opening



Internal Zones Exposed to External Airflow

The design proposal features openings on the building's north, west and southern facades as well as centrally beneath the new canopy structures which allow airflow to enter and exit the internal areas of the site. These areas include walkways and areas where students, staff and visitors may congregate and be present for longer-term exposure activities (eg. standing).

Internal Bounded Zones Eastern Half

The refurbishment's central eastern façade areas have openable windows which have exposure to northeasterly winds over the open area between the College and the nearby Craiglea House. There will also be some exposure to southeasterly winds for these openable windows.

The potential to exploit these winds for internal natural ventilation is being explored, including input from the present wind study.

3 SYDNEY'S WIND CLIMATE

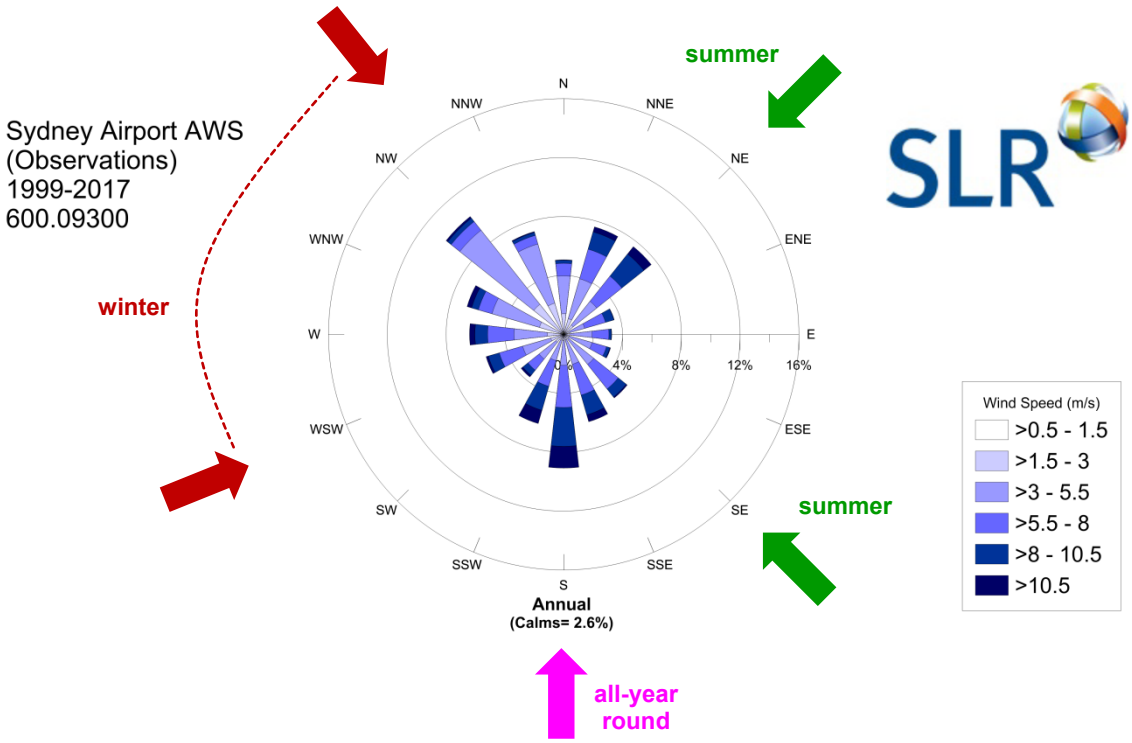
The data of interest in this study are the annual extreme, mean hourly wind speeds and largest gusts experienced throughout the year, how these winds vary with azimuth, and the seasonal break-up of winds into the primary Sydney wind seasons.

3.1 Seasonal Winds

In relation to key characteristics of the Sydney Region Wind Climate (refer **Figure 4** and seasonal wind roses provided in **Appendix A**) relevant to the wind impact assessment of the proposed development, we note that Sydney is affected by two primary wind seasons:

- Summer winds occur mainly from the northeast, southeast and south.
  - While northeast winds are the more common prevailing wind direction (occurring typically as offshore land-sea breezes), southeast and south winds generally provide the strongest gusts during summer.
- Winter/Early Spring winds occur mainly from the west and the south.
  - West quadrant winds (southwest to northwest) provide the strongest winds during winter and in fact for the whole year.

Figure 4 Annual Sydney Wind Rose (BoM Data 1999-2017)



The wind rose above shows the stronger winds in dark blue from the west, south, northwest and northeast.

3.2 Wind Exposure at the Site – the "Local" Wind Environment

Close to the ground, the Sydney region wind patterns described above are modified by the local terrain, topography and built environment, which all influence the "local" wind environment. At the St Aloysius' College site, the following influences are present:

- To the northeast is a combination of near-field "urban" built exposure (low to medium-rise blocks) on slightly elevated topography relative to the site dropping to sea level (Neutral Bay) and then suburban terrain further afield.
- To the southeast is a combination of near-field "suburban" exposure (low rise buildings) and far-field "open" exposure generated by Sydney Harbour.
- To the south is a combination of near-field and lower elevation "open" exposure (Sydney Harbour) causing speed-up and far-field "heavily built-up" exposure generated by the Sydney CBD.
- To the west is a combination of varying near-field "urban" exposure (southwest to northwest) and then Lavender Bay and far-field "suburban" exposure (MacMahons Point).

4 WIND ACCEPTABILITY CRITERIA

4.1 Standard Local Government Criteria

The choice of suitable criteria for evaluating the acceptability of particular ground level conditions has been the subject of relatively recent research. The acceptability criteria that have been developed from this research and currently referenced by most Australian Local Government Development Control Plans have been summarised below in **Table 1**.

Table 1 Standard Local Government Wind Acceptability Criteria

Type of Criteria	Limiting Gust Wind Speed Occurring Once Per Year	Activity Concerned
Safety	24 m/s	Knockdown in Isolated Areas
	23 m/s	Knockdown in Public Access Areas
Comfort	16 m/s	Comfortable Walking
	13 m/s	Standing, Waiting, Window Shopping
	10 m/s	Dining in Outdoor Restaurant

The primary objectives relating to the above wind impact criteria are as follows:

- The general objective is for annual 3-second gust wind speeds to remain at or below the so-called 16 m/sec "Walking Comfort" criterion. Whilst this magnitude may appear somewhat arbitrary, its value represents a level of wind intensity which the majority of the population would find unacceptable for comfortable walking on a regular basis at any particular location.
- In many urban locations, either because of exposure to open water conditions or because of street "canyon" effects, etc, the 16 m/s "Walking Comfort" level may already be currently exceeded. In such instances a new development should ideally not exacerbate existing adverse wind conditions and, wherever feasible and reasonable, ameliorate such conditions.

It can be seen in **Table 1** that the recommended limiting wind speeds for spaces designed for activities such as seating, outdoor dining, etc., are lower (ie more stringent) than for "walking comfort".

4.2 Application of Standard Council Wind Criteria for the Current CFD Study

The criteria provided in **Table 1** should not be viewed as *"hard"* numbers as the limiting values were generally derived from subjective assessments of wind acceptability. Such assessments have been found to vary with the height, strength, age, etc, of the pedestrian concerned.

An additional factor for consideration is the *extent* of windy conditions: some relaxation of the above criteria may be acceptable for small areas under investigation provided the general site conditions satisfy the relevant criteria.

Finally, it is noted that the ground level wind acceptability criteria provided in **Table 1** have been stated in terms of the maximum **gust wind speed per annum** as it is the wind pressures associated with these gusts that people perceive as being acceptable or unacceptable whilst performing various activities.

Maximum wind gusts will differ from the corresponding mean wind speed modelled in the current CFD investigation (see Results Section of this report). For a normally distributed process it is reasonable to assume that the 2-3 second maximum gust may be up to 3.5 standard deviations above the mean. It is therefore conservative to assume that mean wind could be approximately half the magnitude of gust wind speeds given the level of wind turbulence expected at the proposed site.

The equivalent mean wind speed acceptability criteria for the CFD study are summarised in

Table 2 Equivalent Pedestrian Level Mean Wind Acceptability Criteria

Type of Criteria	Limiting MEAN Wind Speed Occurring Once Per Year	Activity Concerned	Impacts
Safety	12 m/s	Knockdown in Isolated Areas	People blown over by gusts
	11.5 m/s	Knockdown in Public Access Areas	Generally impedes progress, great difficulty with balance
Comfort	8 m/s	Comfortable Walking	Inconvenience felt when walking, umbrellas used with difficulty, wind noise on ears unpleasant
	6.5 m/s	Standing, Waiting, Window Shopping	Force of wind felt on body, hair disarranged.
	5 m/s	Dining in Outdoor Restaurant	Raises dust, and loose paper, clothing flaps

5 CFD MODELLING ASSUMPTIONS AND ANALYSIS

SLR has modelled the proposed development and the surrounds using specialised CAD and SpaceClaim software packages. This was then imported into ANSYS to prepare the model for solving.

The surrounding buildings and terrain have been simplified to reduce computational time. This includes the removal of all trees and vegetation, which means that the model can be considered slightly conservative as the addition of vegetation would typically reduce ground level wind speeds. The model was then moved to the specialised CFD software Fluent for computation.

Sydney's highest wind speeds come from the northeast, southeast, south and west (southwest to northwest). Of these, southerly and westerly winds have been identified as most critical to this project.

Ambient wind profiles have been created to simulate the annual maximum mean wind speeds from these directions utilising the Australian Wind Code (AS1170.2). This will be used to check the areas of interest for potential adverse wind areas.

5.1 Modelling

A 3D model of the development area and surrounding buildings was created from 3D and 2D AutoCAD files (supplied by PMDL Architects). Additional blocks were then added around the development site to an approximate radius of up to 500 m to give a more accurate result. The 3D model accounts for the site topography.

The 3D geometry for CFD Modelling is shown in **Figure 5**. A calculation domain of 2000 m length, 2000 m width and 600 m height was used for the CFD analysis.

Figure 5 3D Model of the Site and Surrounds

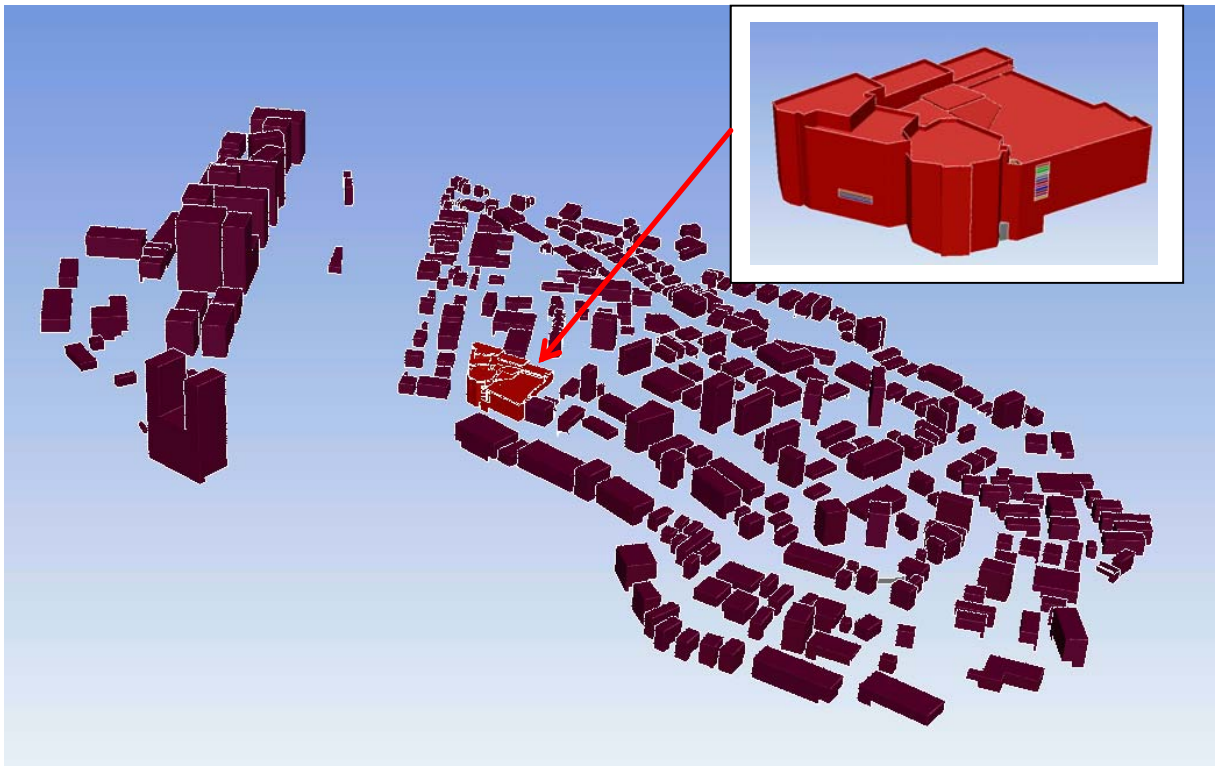
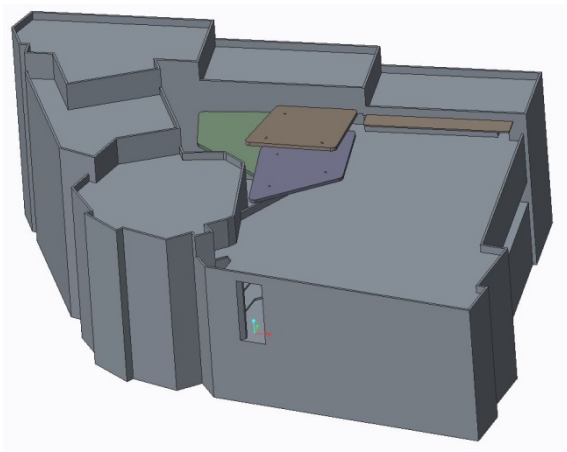


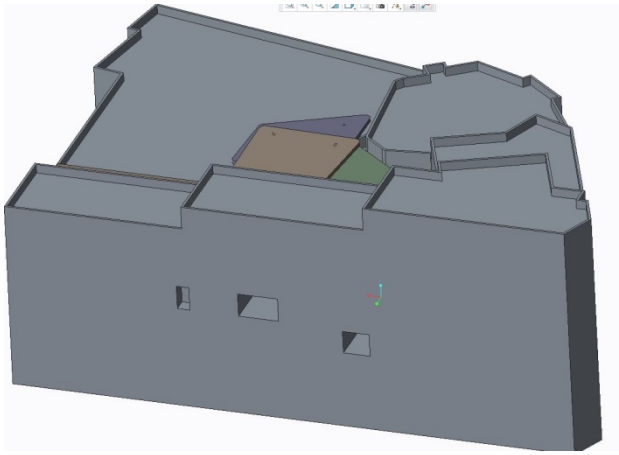
Figure 6 shows images from SLR's 3-D model of the Upper Pitt Street Main Campus component.

Figure 6 Upper Pitt Street Building CFD Model (note: ground level not shown)

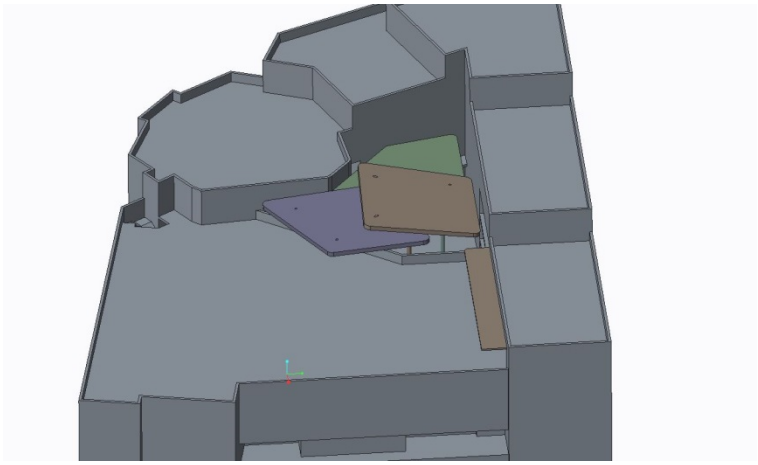
Perspective View from South



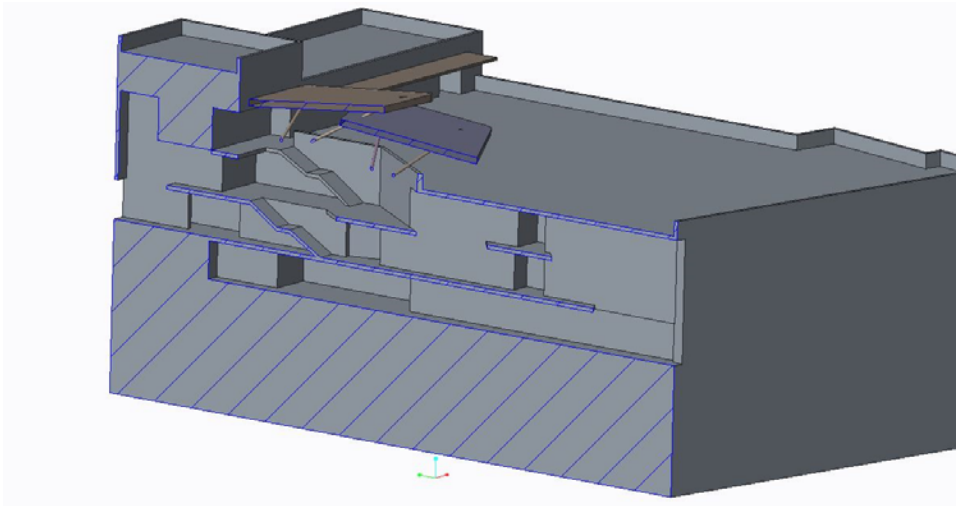
Perspective View from North



Perspective View from East



North-South Sectional Cut View (view from east)



5.2 Boundary Conditions

5.2.1 Wind Condition

The CFD study was undertaken to estimate the velocity and pressure profile during elevated wind conditions representing an annual exceedance probability. At the upwind free boundary inlet mean wind velocity profiles were derived from Bureau of Meteorology data and the Australian Wind Code AS1170.2 for Sydney's four prevailing wind directions. At the downwind and upper free boundaries constant pressure boundary conditions were applied.

The four key prevailing Sydney wind directions were modelled and the public locations were checked for any exacerbation of the current wind conditions caused by the proposed development. The modelled wind directions were:

- West Winds
- Northeast Winds
- South Winds
- Southwest Winds

The following velocity boundary conditions for the most critical westerly winds were used representing the mean wind speed with height with a 1 year return period.

- Height 10 m — Annual maximum mean wind speeds utilising AS1170.2 (eg 11.8 m/s for Westerly winds)
- Height 10-500 m — Mean wind velocity profile based on AS1170.2 (for the relevant direction)

5.2.2 Other Boundary Conditions

The following additional boundary conditions were used

- Turbulence quantities (kinetic energy and dissipation rate) were calculated from empirical relationships
- A wall function data group was used to avoid using a very fine mesh near the wall and improve turbulent flow simulation

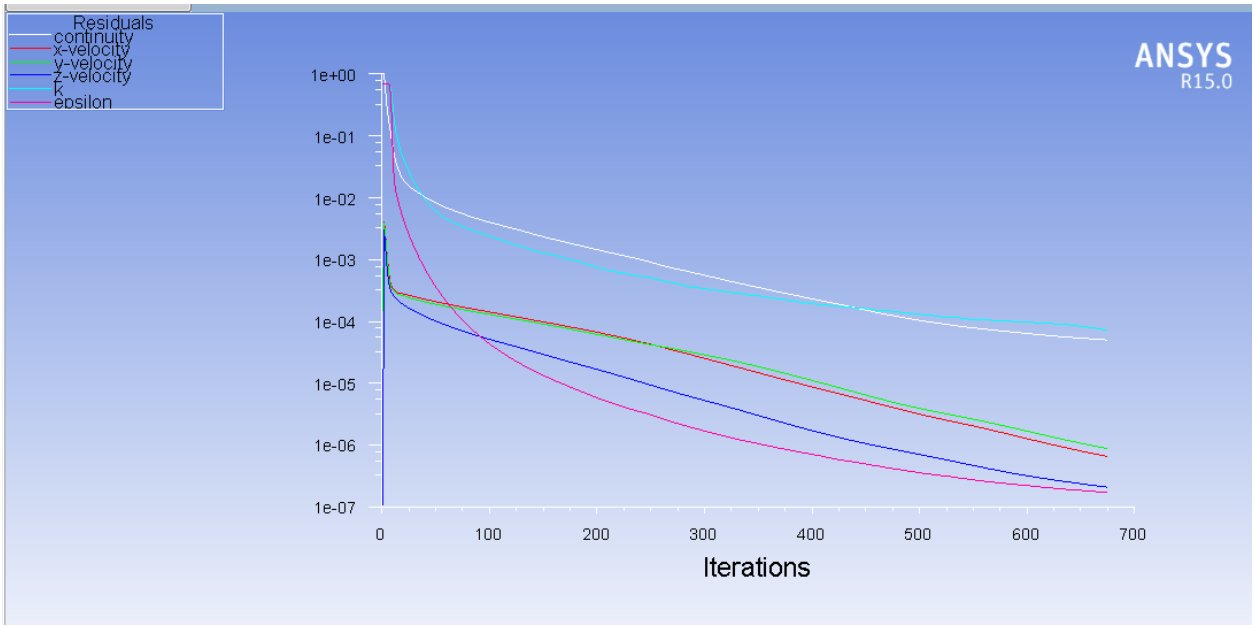
5.3 Discretization

The software package utilised in the current CFD analysis is the commercially available code Fluent. The CFD model solves continuity, energy and momentum equations in the computational domain to predict the steady state airflow inside and around the redevelopment.

- For the current analysis mixed elements with a total 18,019,988 cells used to cover the computational domain. Solution Adaptation Technique is used to refine the mesh based on the results to obtain a more accurate solution with a lower cell count.
- A Realizable k-epsilon (rke) turbulence model was used for all analysed cases. The model can handle high pressure gradient and recirculation and provides a number of advantages over the standard k-epsilon model.
- A second order numerical scheme was used for discretization of pressure to obtain more accurate results.
- An iterative procedure was used to estimate the air velocity in terms of three directions, pressure profile and turbulence parameters. For the pressure velocity coupling a global solver based on a sophisticated COUPLE algorithm was employed.

Figure 7 shows that the normalised residuals of continuity, x-, y-, and z-velocity, k and epsilon were reduced between five and seven orders of magnitude demonstrating a valid solution.

Figure 7 Scaled Residual History – South Wind



6 CFD RESULTS AND DISCUSSIONS

6.1 Westerly (Winter) Winds

Figure 8 shows overall airflow velocities at various 2D horizontal sections above the ground. Velocity magnitudes are plotted on a colour coded scale between 0 m/s and 13.5 m/s. Dark blue represents still conditions at 0 m/s with red shading representing the strongest wind speeds.

The following conclusions can be reached from **Figure 8**:

- The CFD model captures the fluid flow characteristics in significant detail. Wind approaches the site from the west with a 10 m height mean wind speed of 11.8 m/s as per the given boundary condition. Wind is then accelerated near the edges of upstream buildings to approximately 13.0 m/s (refer **Figure 8A**), channels between buildings and stagnates and recirculates behind the buildings as expected.

Figure 9 shows the mean wind speeds at 1.5 m above floor of the Upper Pitt Street building. The refurbishment design features openings on the building's north, west and southern facades as well as centrally around the new canopy structures; this allows airflow to enter and exit the internal areas of the site. These areas include walkways and areas where students and staff and visitors may congregate and be present for longer-term exposure activities (eg seating and standing). The south and west façade louvres are assumed open for the base case scenario.

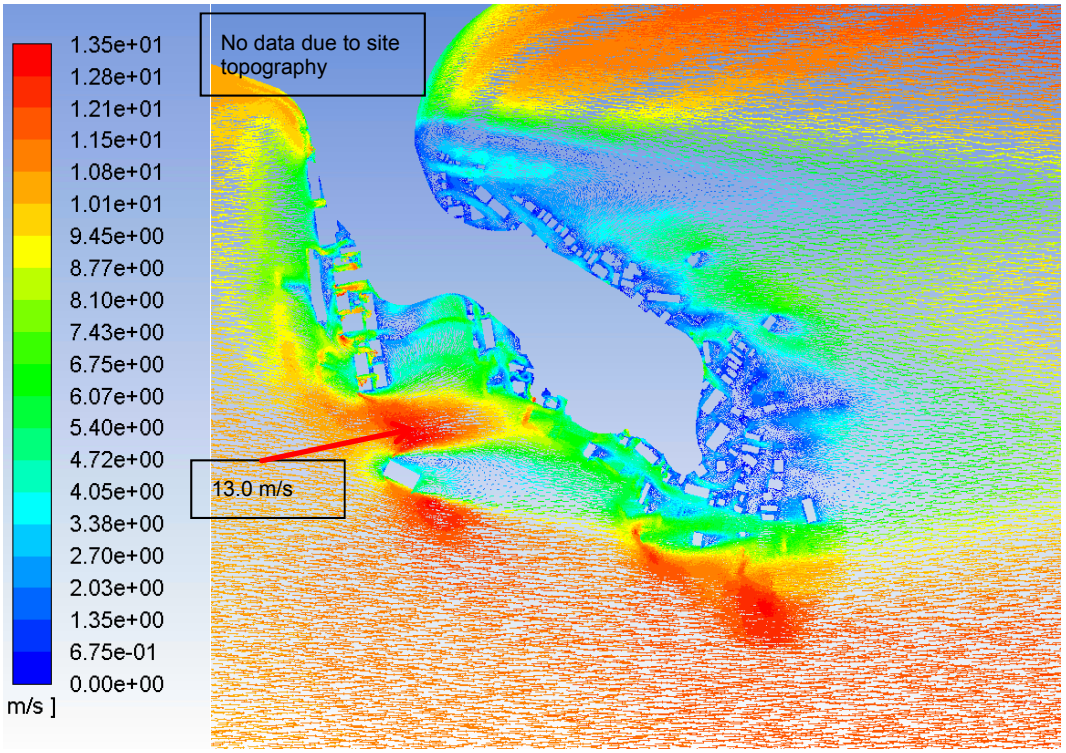
The following conclusions can be reached:

- The mean wind speed at Region B, **Figure 9B** is approximately 7.3 m/s. Corresponding gust strengths at this location will have magnitudes as high as 14.6 m/s thereby exceeding the comfort criteria for standing.
- The CFD results reveal wind recirculation inside the building.

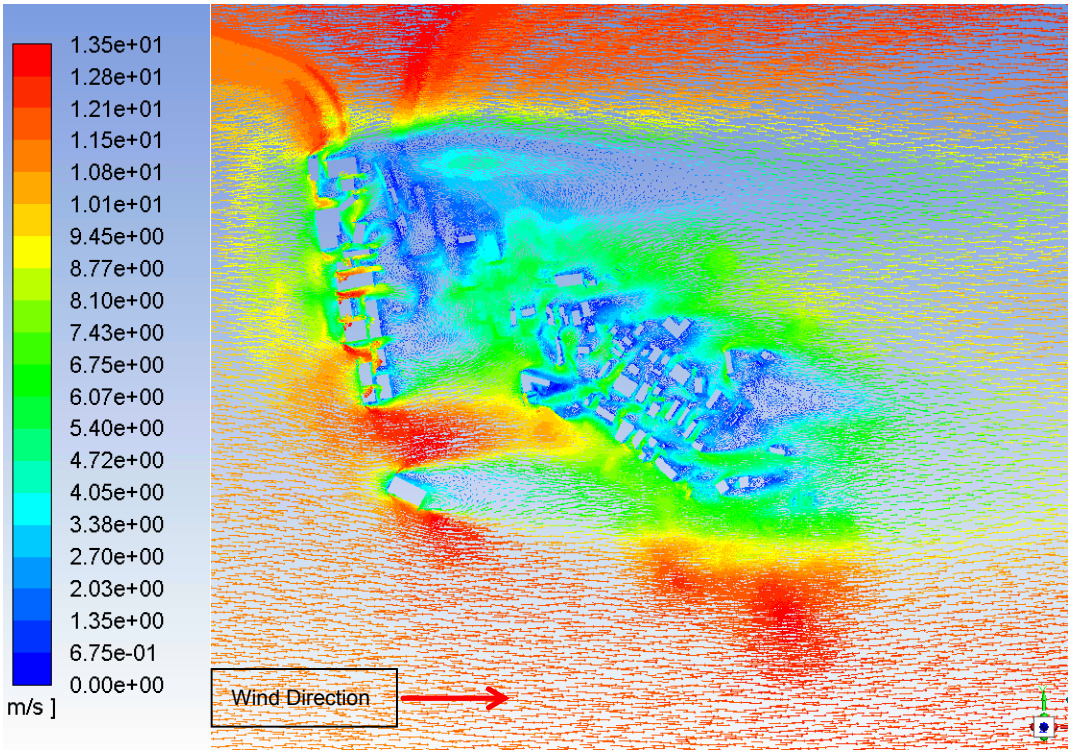
Results of simulations at 2D sections through roof terraces are shown in **Figure 10** to **Figure 12**. These figures show the mean airflow velocities on a colour coded scale between 0 m/s and 5 m/s. The following conclusions can be reached from the above figures:

- The proposed balustrade (2.1 m high) provides an acceptable shielding to most analysed areas of the Level 3 terrace.
- Roof terraces were shown to have the potential to experience wind speeds up to 4.6 m/s. Corresponding gust strengths at this location will have magnitudes as high as 9.2 m/s thereby satisfying the comfort criteria for seating.

Figure 8 Velocity Vector (m/s) at various 2D Sections – Westerly Wind



A:1.5 above Ground of the Computational Domain



B: Overall Flow Overview

Figure 9 Velocity Vector (m/s) at 1.5 m above Ground of Upper Pitt Street Building – Westerly Wind

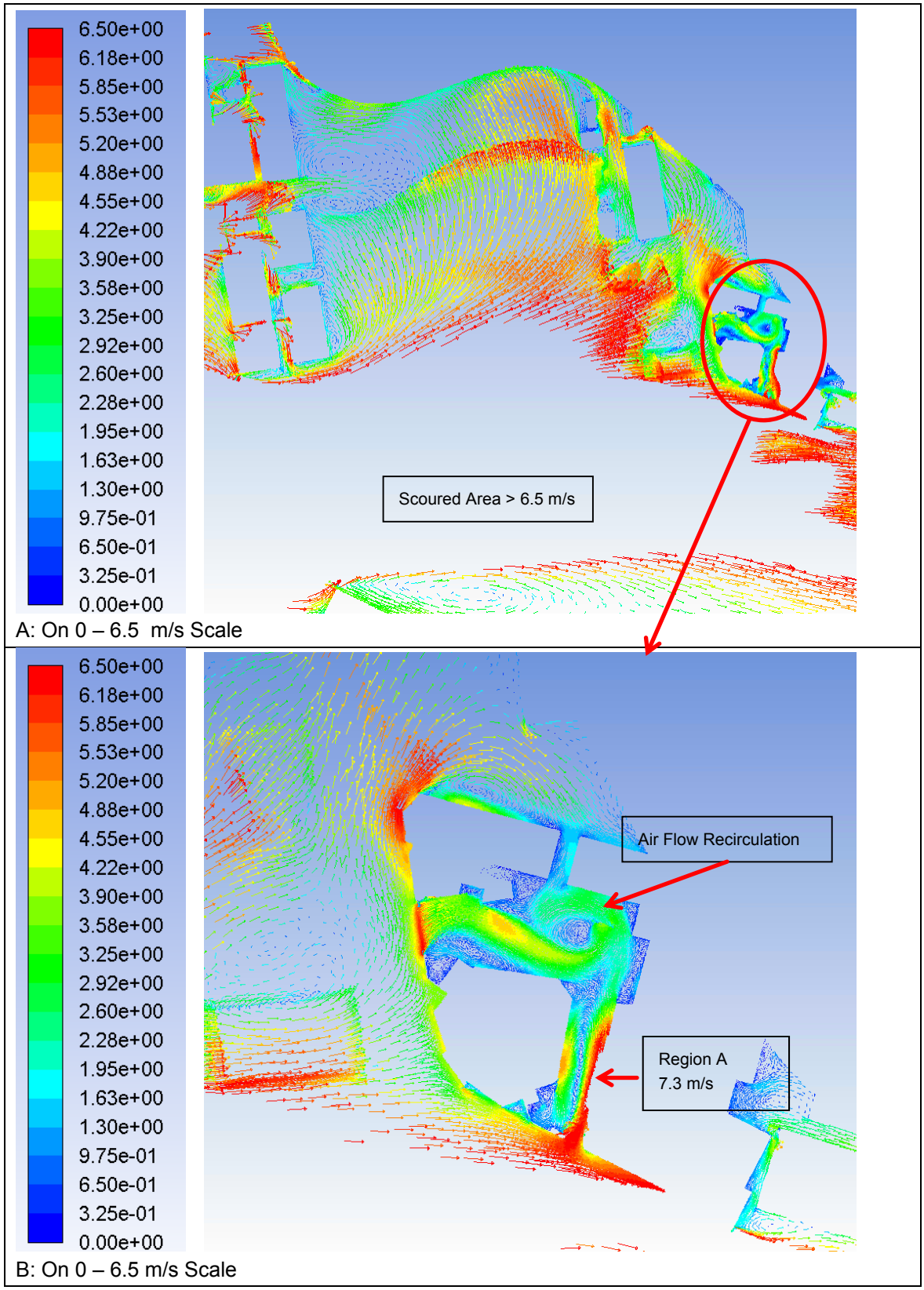
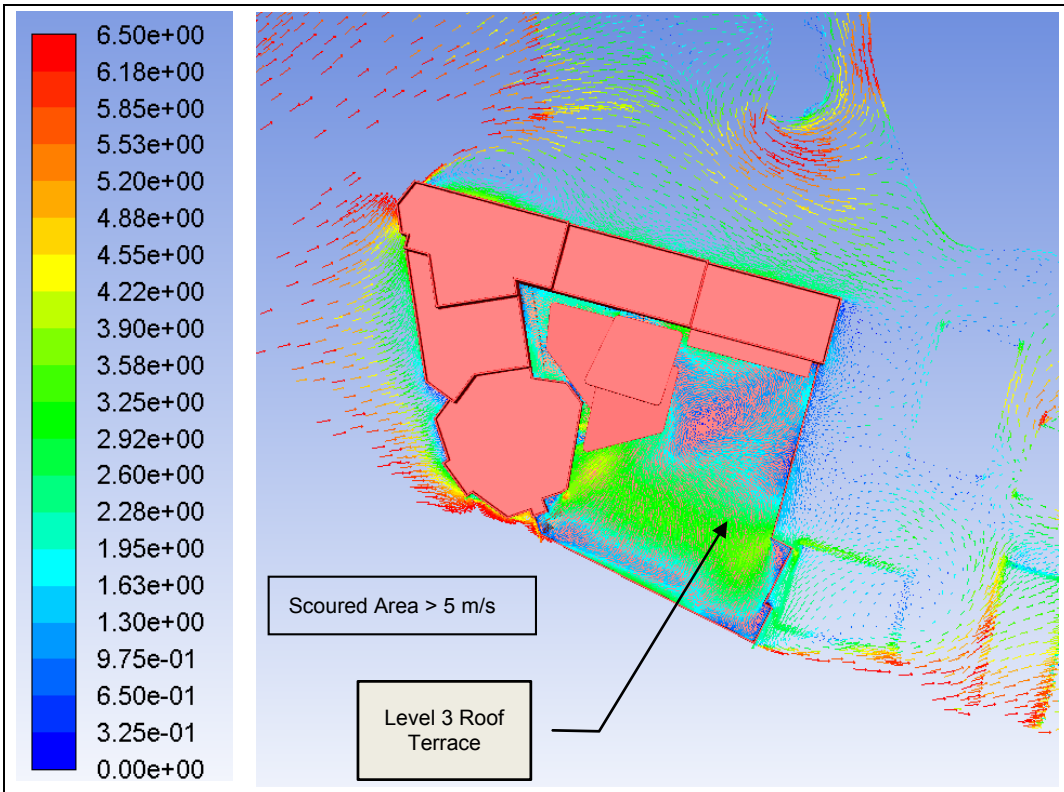
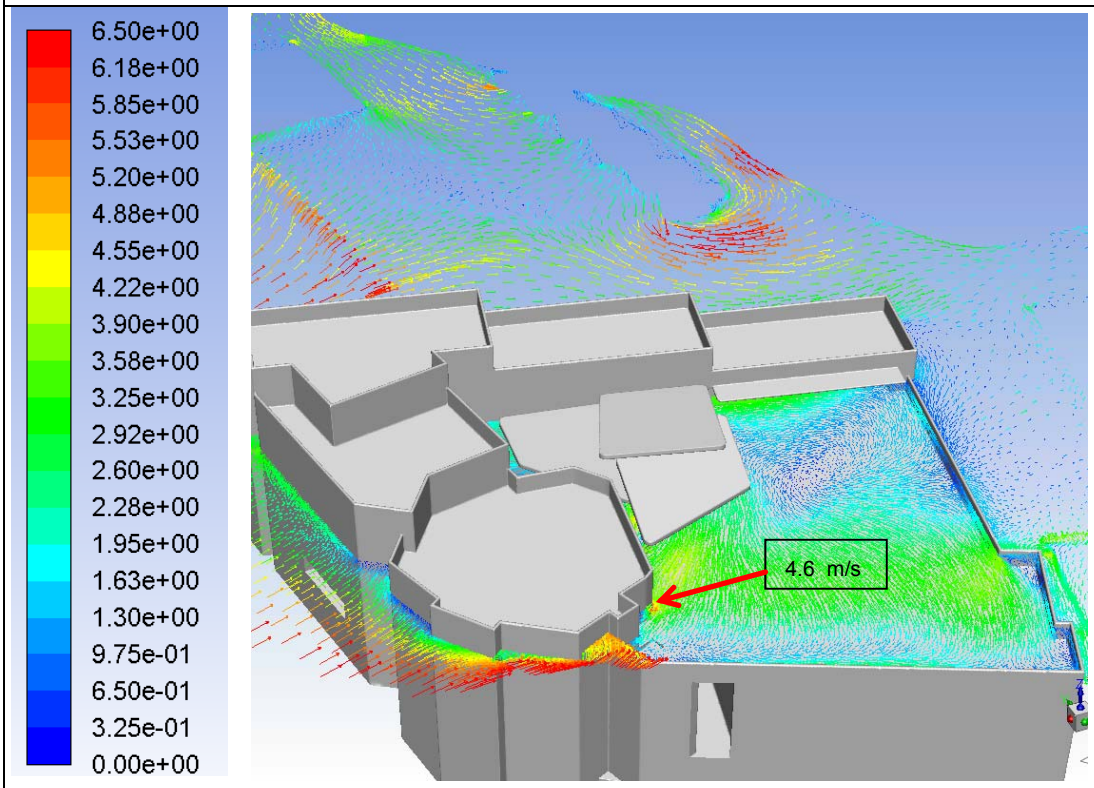


Figure 10 Velocity Vector (m/s) at 1.5 m above Floor of Level 3 Roof Terrace – Westerly Wind

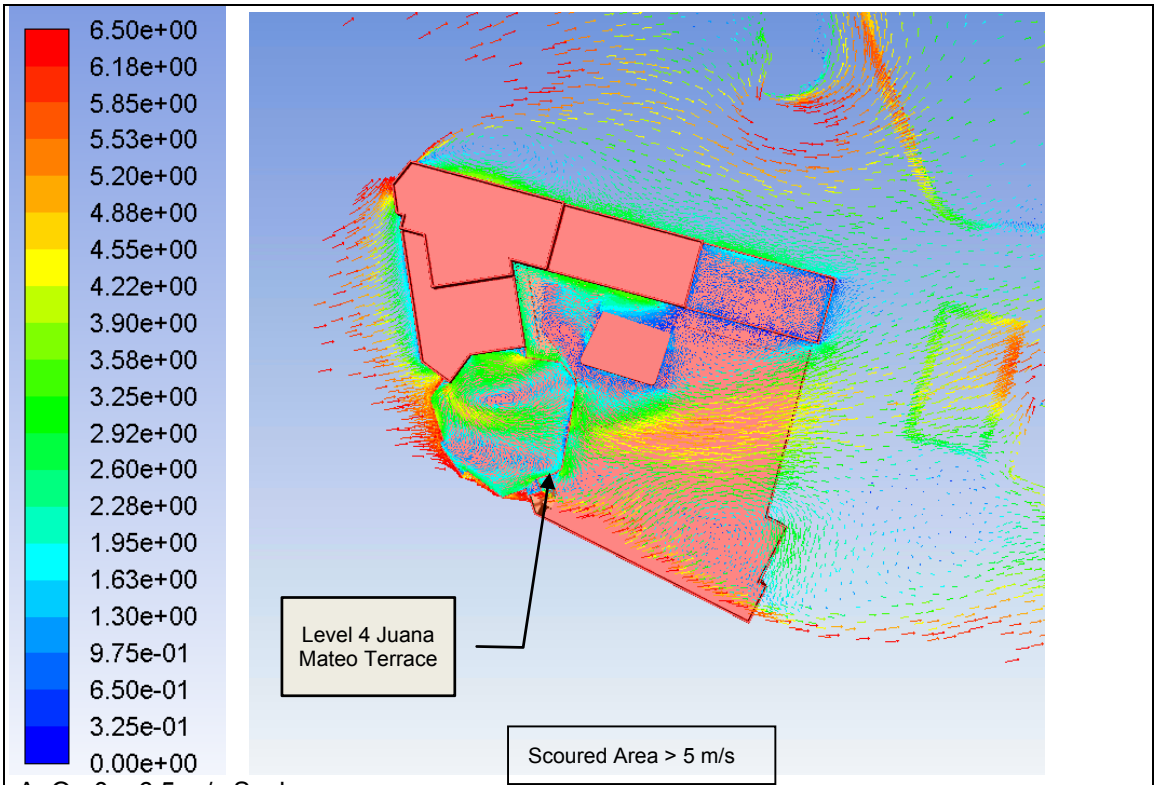


A: On 0-5 m/s Scale

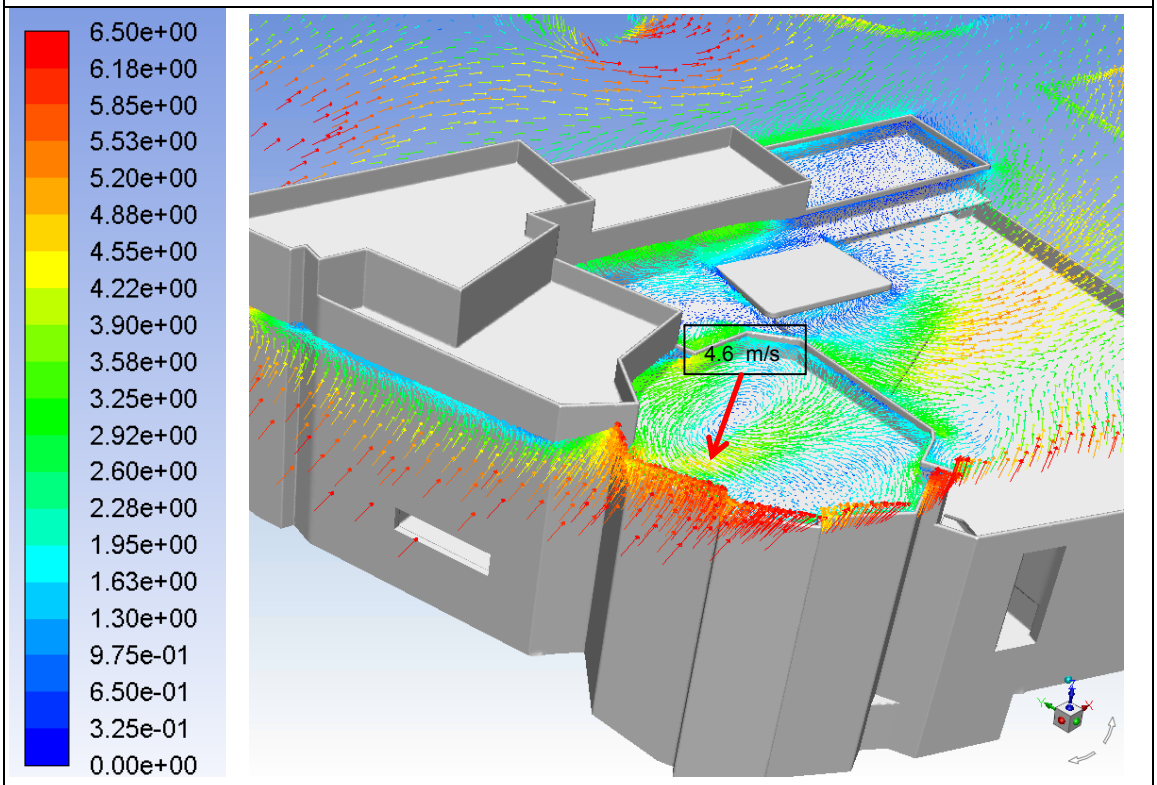


B: On 0 – 6.5 m/s Scale

Figure 11 Velocity Vector (m/s) at 1.5 m above Floor of Level 4 Roof Terrace – Westerly Wind

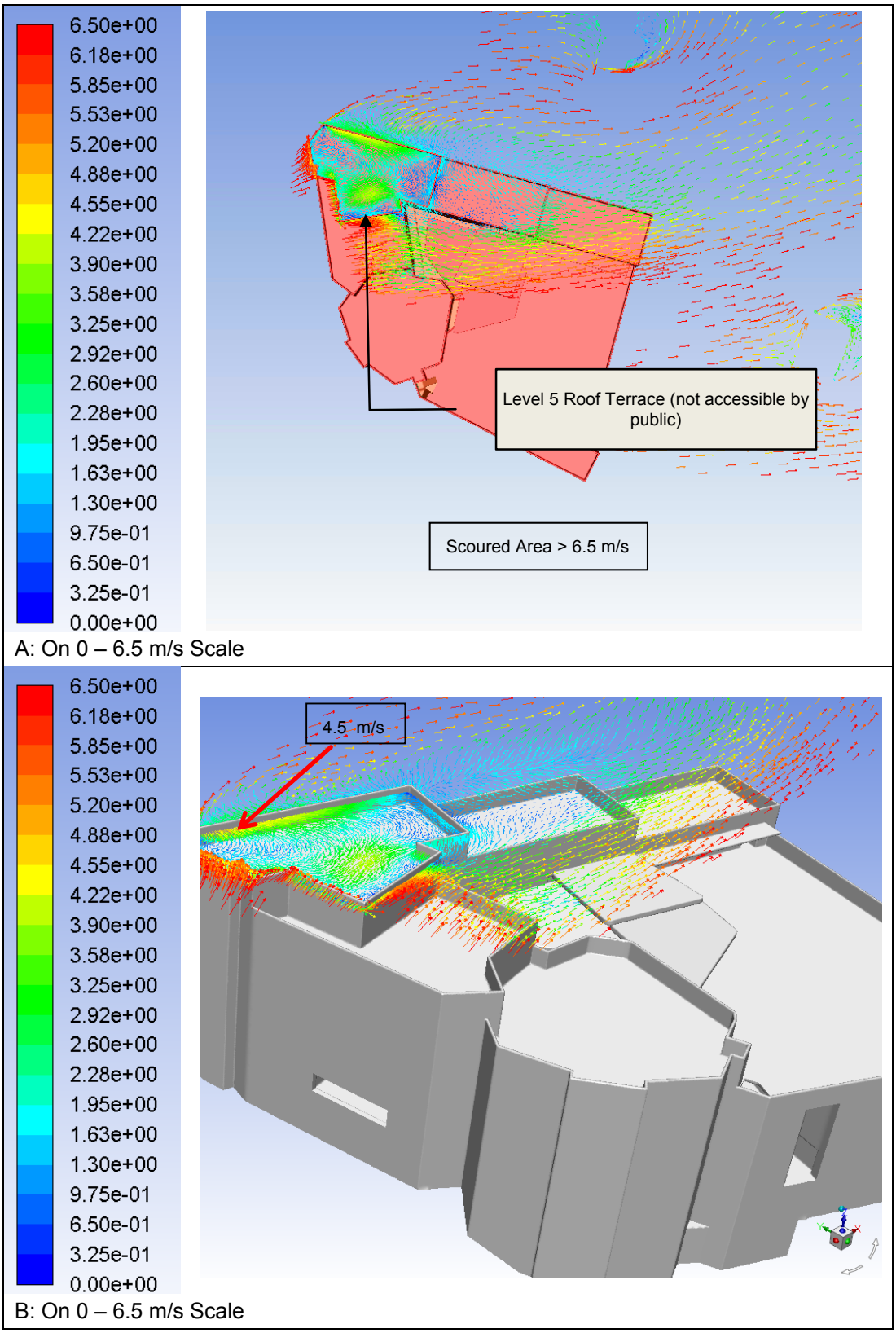


A: On 0 – 6.5 m/s Scale



B: On 0 – 6.5 m/s Scale

Figure 12 Velocity Vector (m/s) at 1.5 m above Floor of Upper Roof Terrace – Westerly Wind

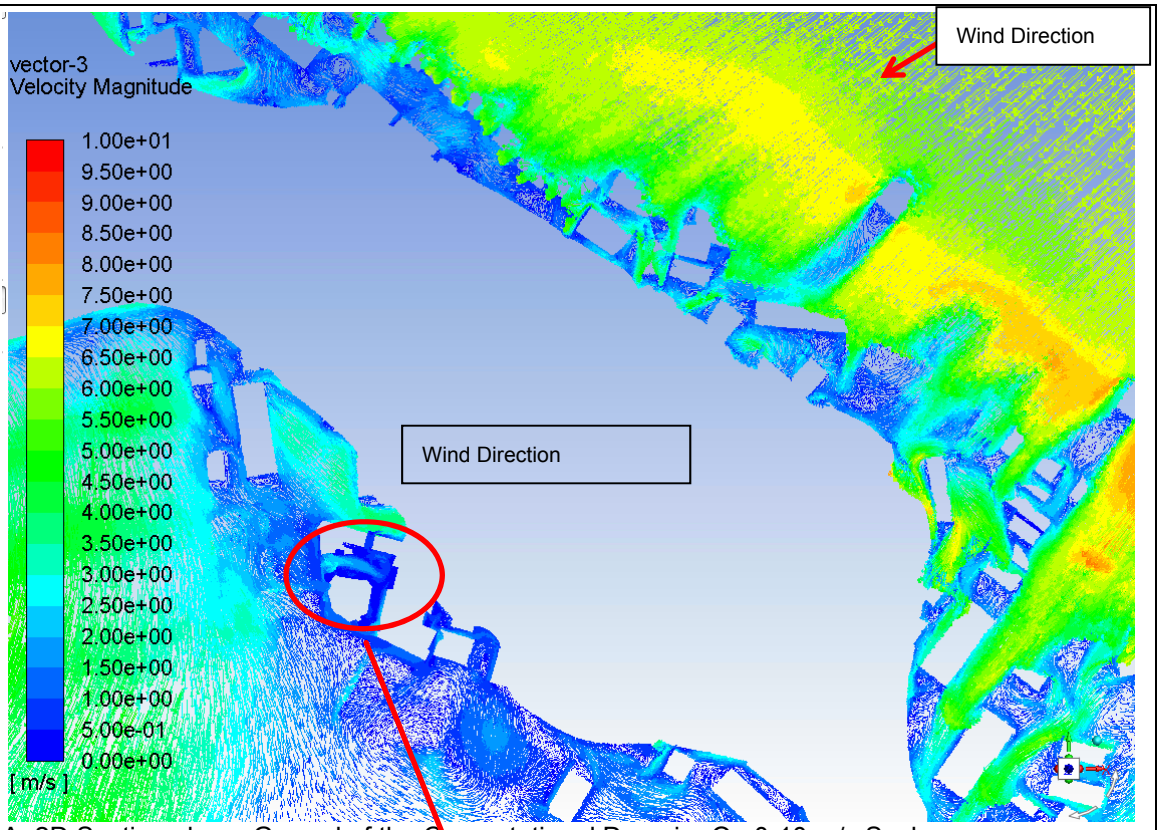


6.2 Northeast (Summer) Winds

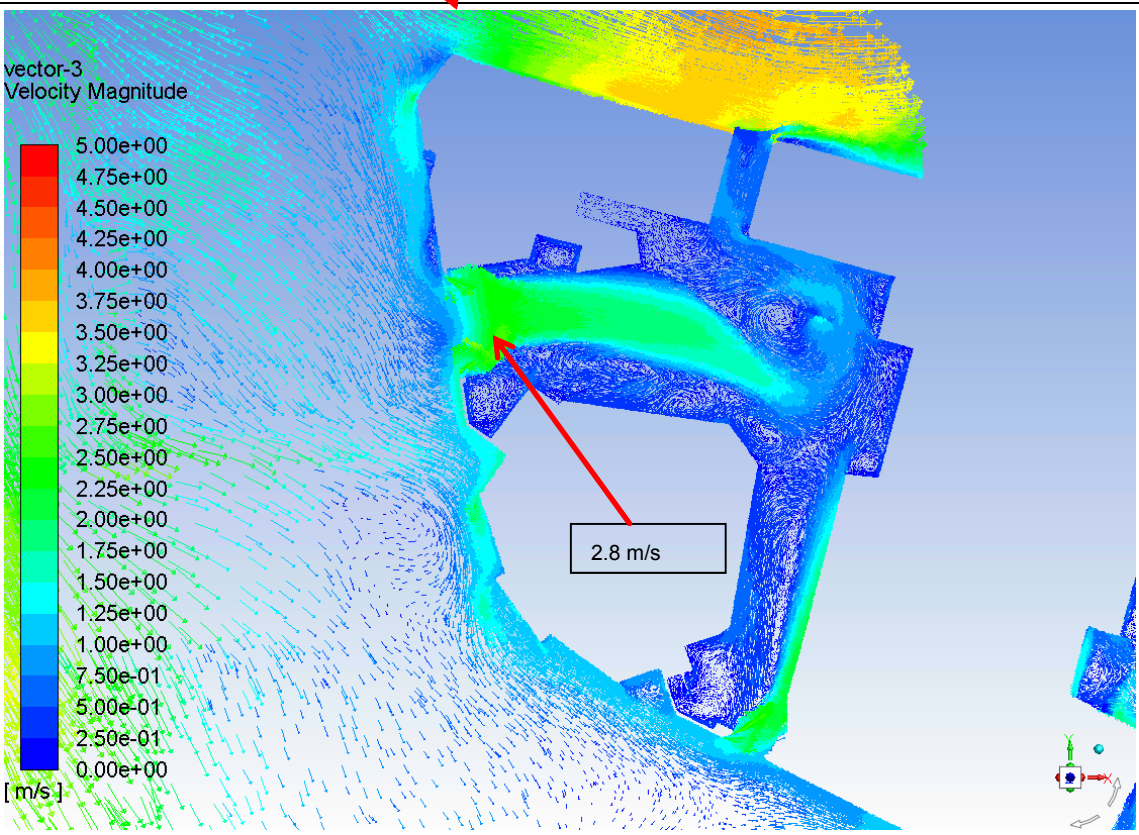
The results of the northeast wind simulations are presented in **Figure 13** and **Figure 14**. The following conclusions can be reached from these figures:

- A combination of near-field “urban” built exposure (low to medium-rise blocks) and elevated topography relative to the site dropping to sea level (Neutral Bay) and then suburban terrain further afield provide reasonable shielding from the northeast.
- The mean wind speed inside the building is 2.8 m/s (refer **Figure 13)**. Corresponding gust strengths at this location will have magnitudes as high as 5.6 m/s thereby satisfying the comfort criteria for seating.
- Roof terraces were shown to have the potential to experience wind speeds up to 2.5 m/s. Corresponding gust strengths at this location will have magnitudes as high as 5 m/s thereby satisfying the comfort criteria for seating.

Figure 13 Velocity Magnitude (m/s) Coloured by Velocity Vector – Northeast Wind 1.5 m

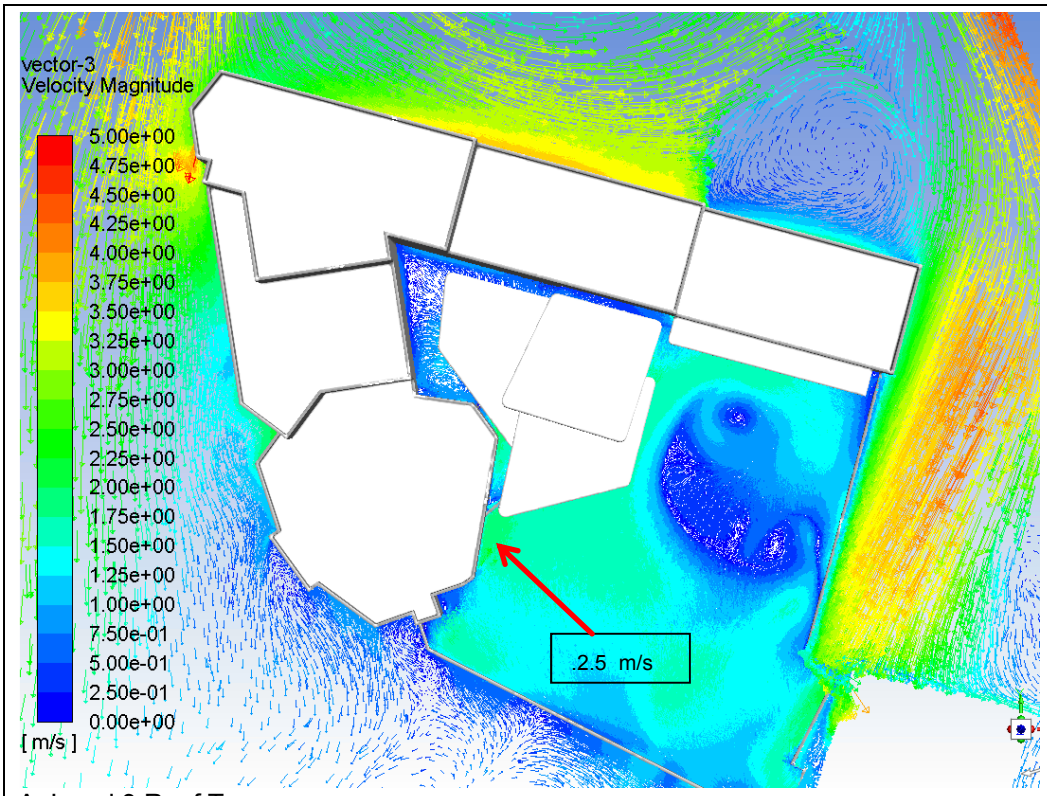


A: 2D Section above Ground of the Computational Domain- On 0-10 m/s Scale

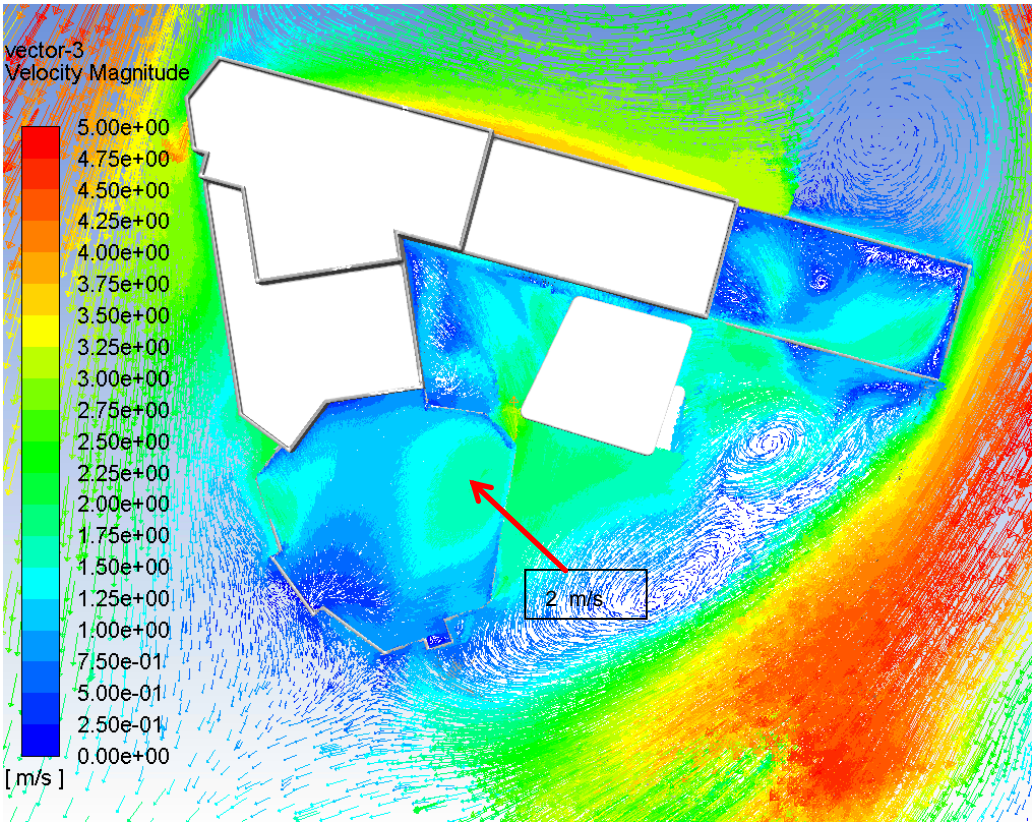


B: 2D Section on 1.5 m above ground of Upper Pitt Street Building - On 0 - 5 m/s Scale

Figure 14 Velocity Vector (m/s) at 1.5 m above Floor of Roof Terraces – Northeast Wind



A: Level 3 Roof Terrace



B: Level 4 Roof Terrace

6.3 Southerly (All-Year Round) Winds

The results of the south wind simulations are presented in **Figure 15** and **Figure 16**. The following conclusions can be reached from these figures:

- The maximum mean wind speed inside the building is 7.9 m/s (refer **Figure 15)**. Corresponding gust strengths at this location will have magnitudes as high as 15.8 m/s thereby potentially exceeding the comfort criteria for standing and approaching the comfort criteria for walking.
- Level 3 roof terraces were shown to have the potential to experience wind speeds up to 6.1 m/s. Corresponding gust strengths at this location will have magnitudes as high as 12.2 m/s thereby exceeding the comfort criteria for seating at one location shown in red in **Figure 16A**.
- The proposed balustrades (2.1 m high) provide an acceptable shielding to Level 4 roof terrace. Level 4 Roof terrace (**Figure 16B) was** shown to have the potential to experience wind speeds up to 4.2 m/s . Corresponding gust strengths at this location will have magnitudes as high as 8.4 m/s thereby satisfying the comfort criteria for seating.

Figure 17 reveals the airflow interaction between the Level 2 walkway and the open roof structure at a selected wind speed at a 2D vertical section inside the building. The maximum mean wind speed in the walkway is 5.6 m/s. Corresponding gust strengths at this location will have magnitudes as high as 11.2 m/s thereby satisfying the comfort criteria for standing.

Figure 15 Velocity Vector (m/s) at 1.5 m above Ground of Upper Pitt Street Building – Southerly Wind

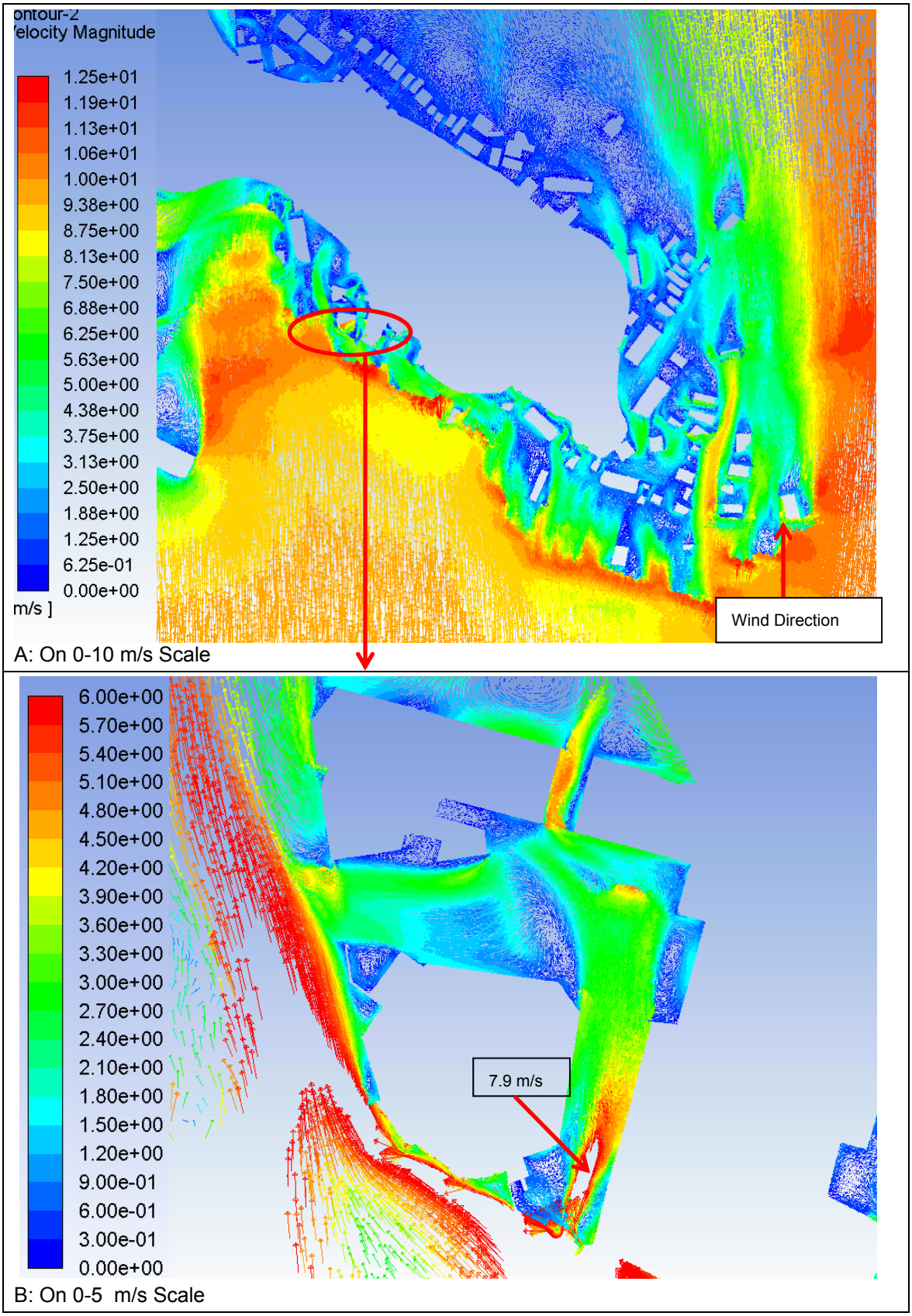


Figure 16 Velocity Vector (m/s) at 1.5 m above Floor of Roof Terraces – Southerly Wind

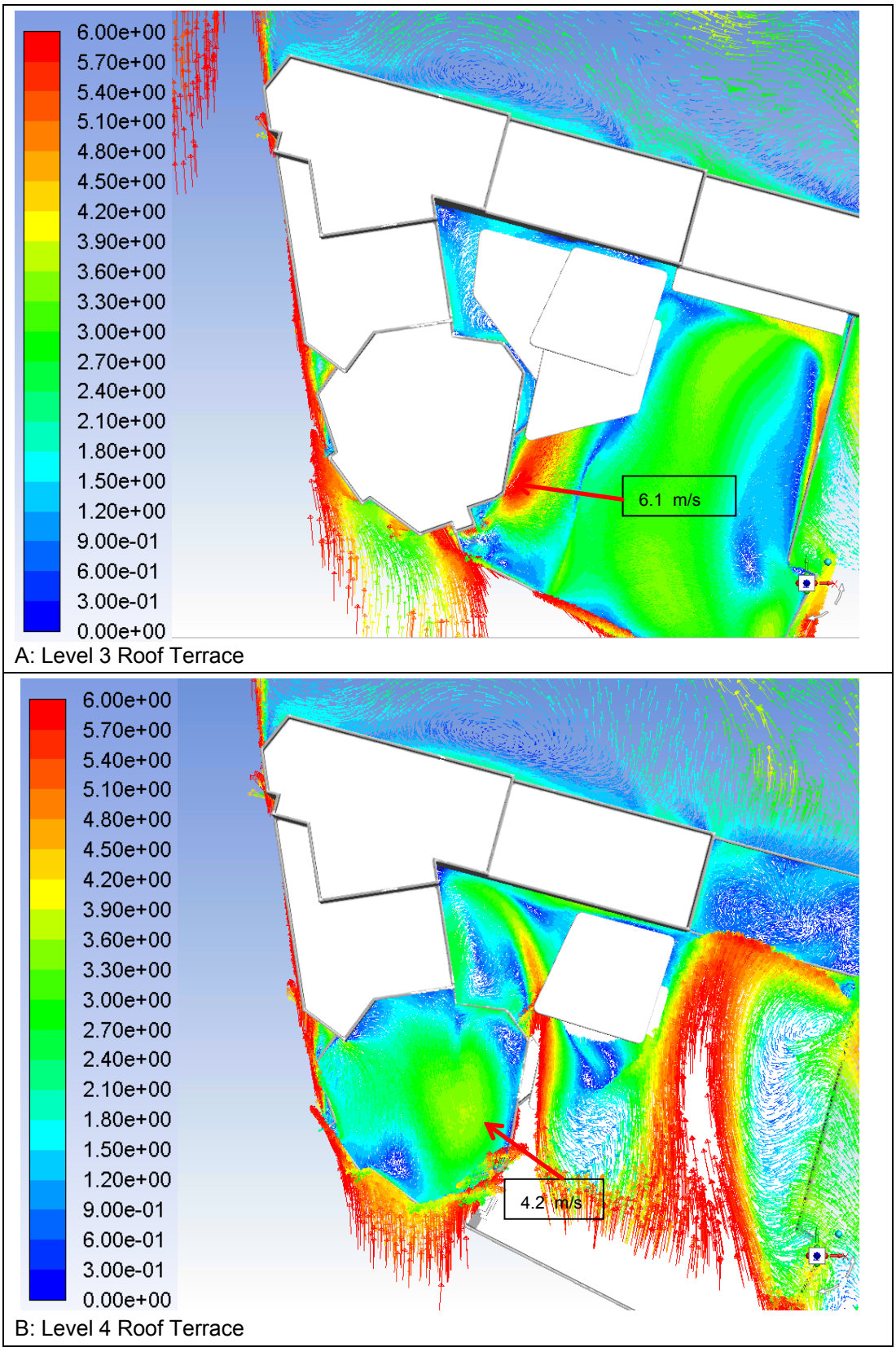
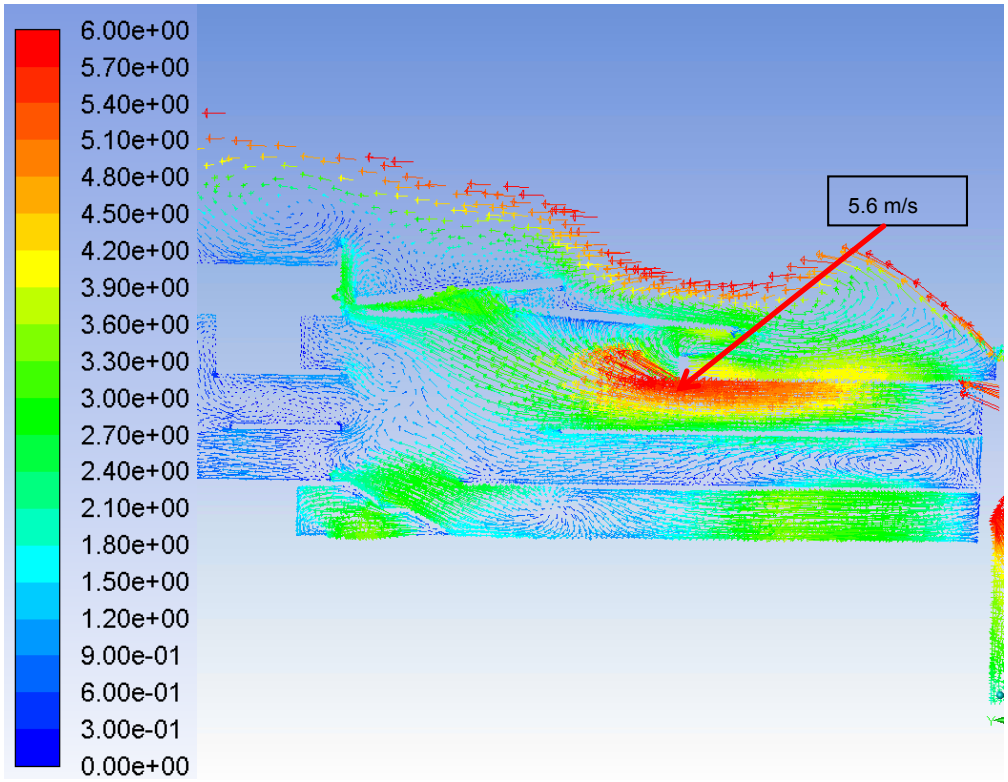
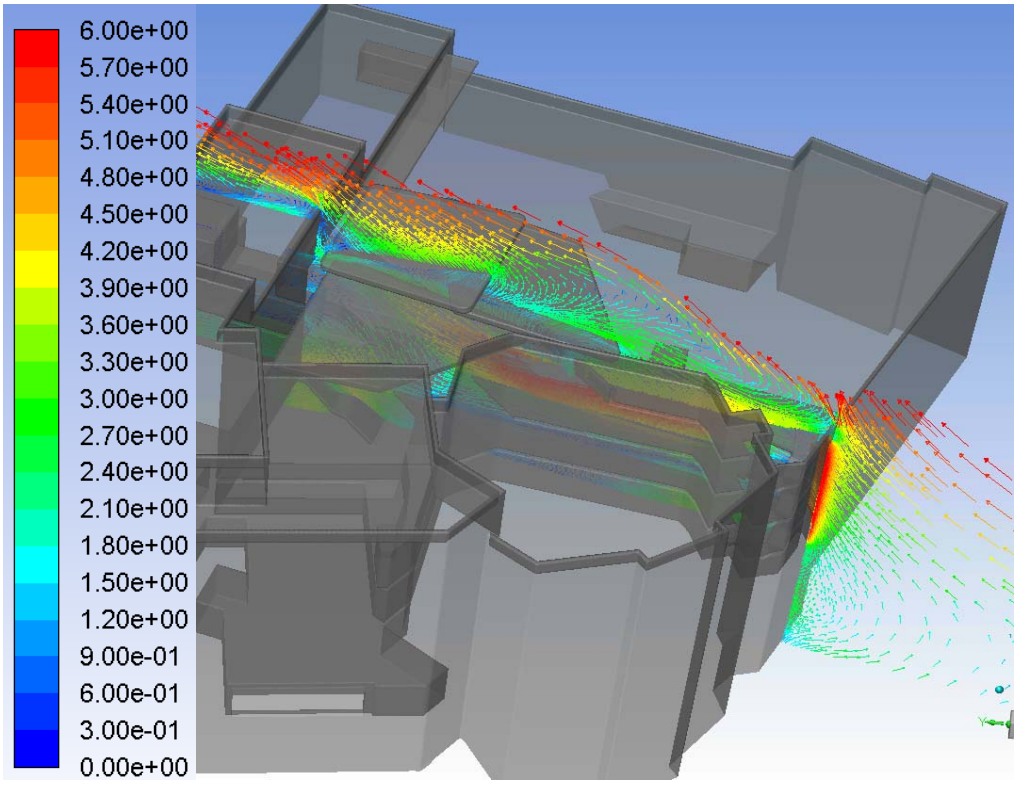


Figure 17 Velocity Vector (m/s) at various 2D Vertical Sections inside the Building – Southerly Wind



A: Level 3 Roof Terrace



B: Level 4 Roof Terrace

6.4 Northwest (Winter) Winds

The results of the northwest simulations are presented in **Figure 18** and **Figure 19**. The following conclusions can be reached from these figures:

- A combination of near-field “urban” built exposure (low to medium-rise blocks) and elevated topography relative to the site dropping to sea level and then suburban terrain further afield provide a reasonable shielding from the northwest.
- The maximum wind speed near one of the entrances is 5.2 m/s (refer **Figure 18)**. Corresponding gust strengths at this location will have magnitudes as high as 10.4 m/s thereby just exceeding the comfort criteria for seating.
- The proposed balustrades (2.1 m high) provide an acceptable shielding to Level 3 and roof terraces.

Figure 18 Velocity Vector (m/s) at 1.5 mm above Ground of Upper Pitt Street Building – Northwest Wind

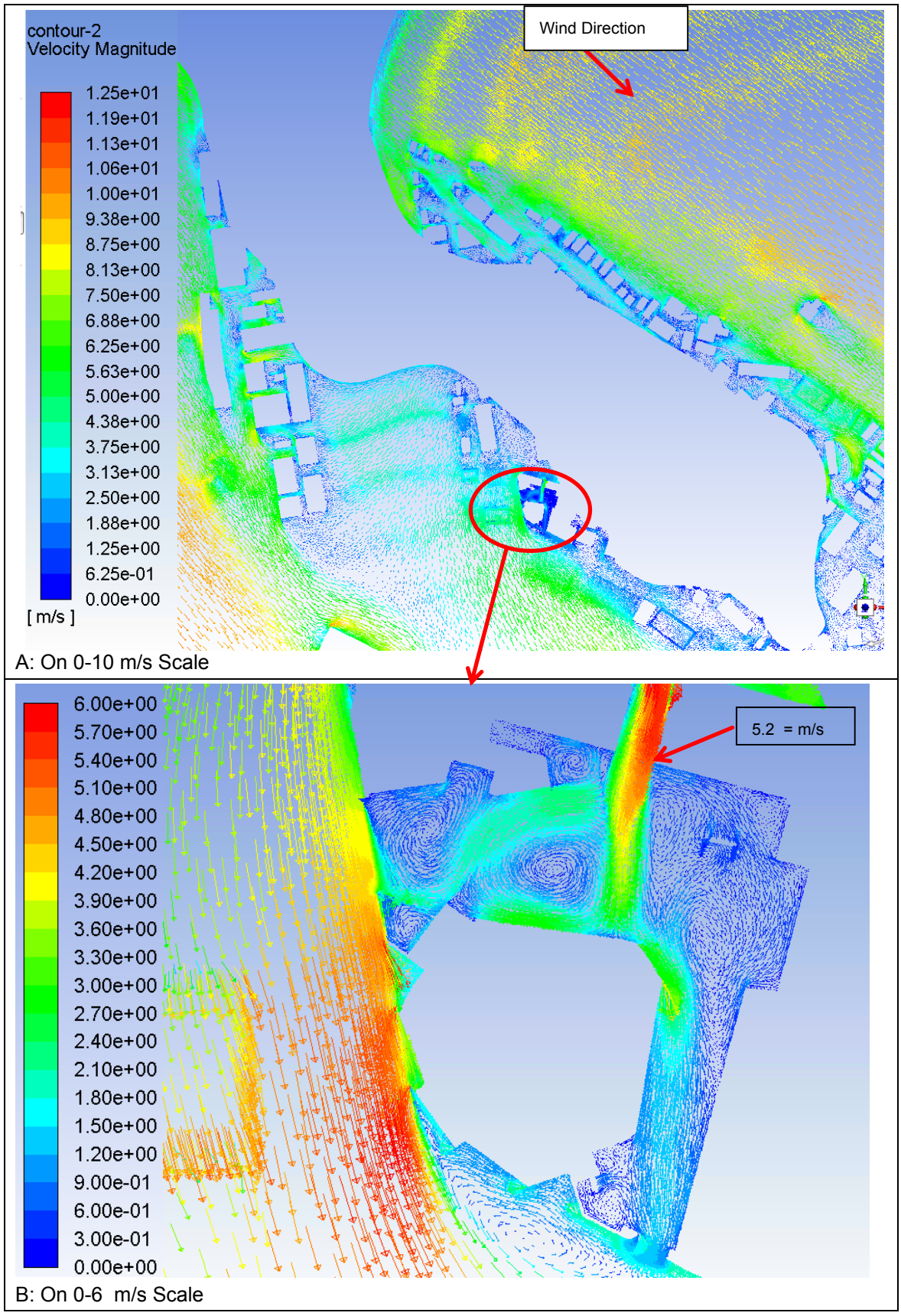
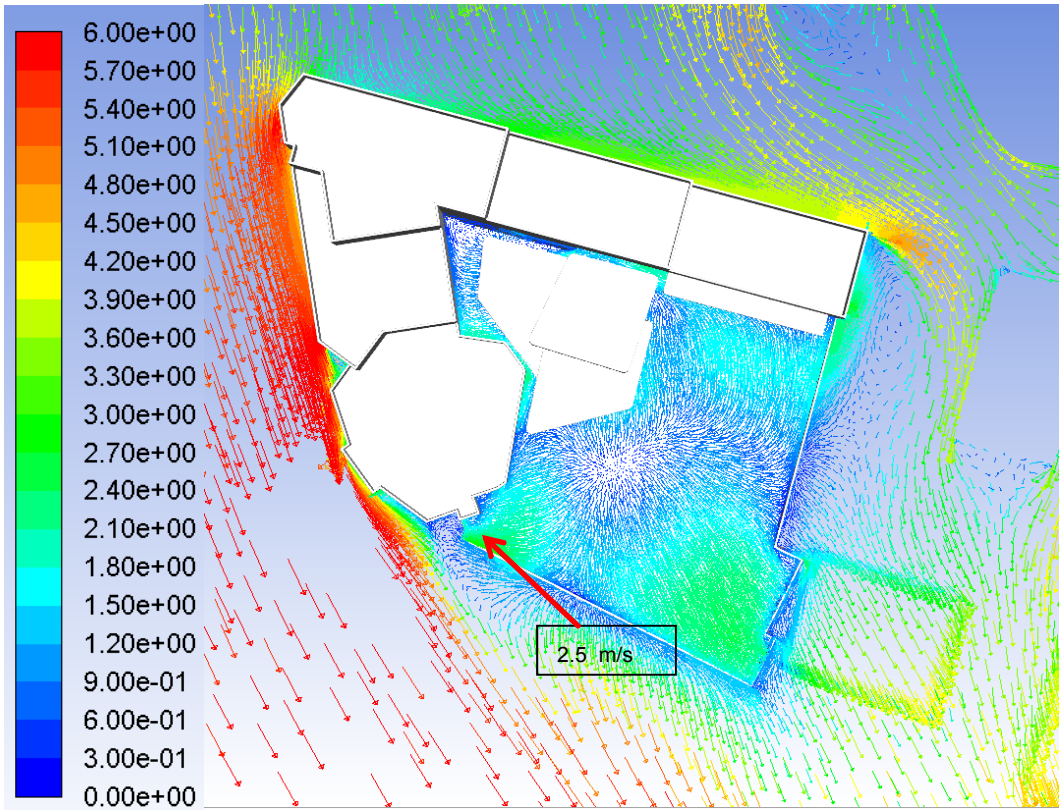
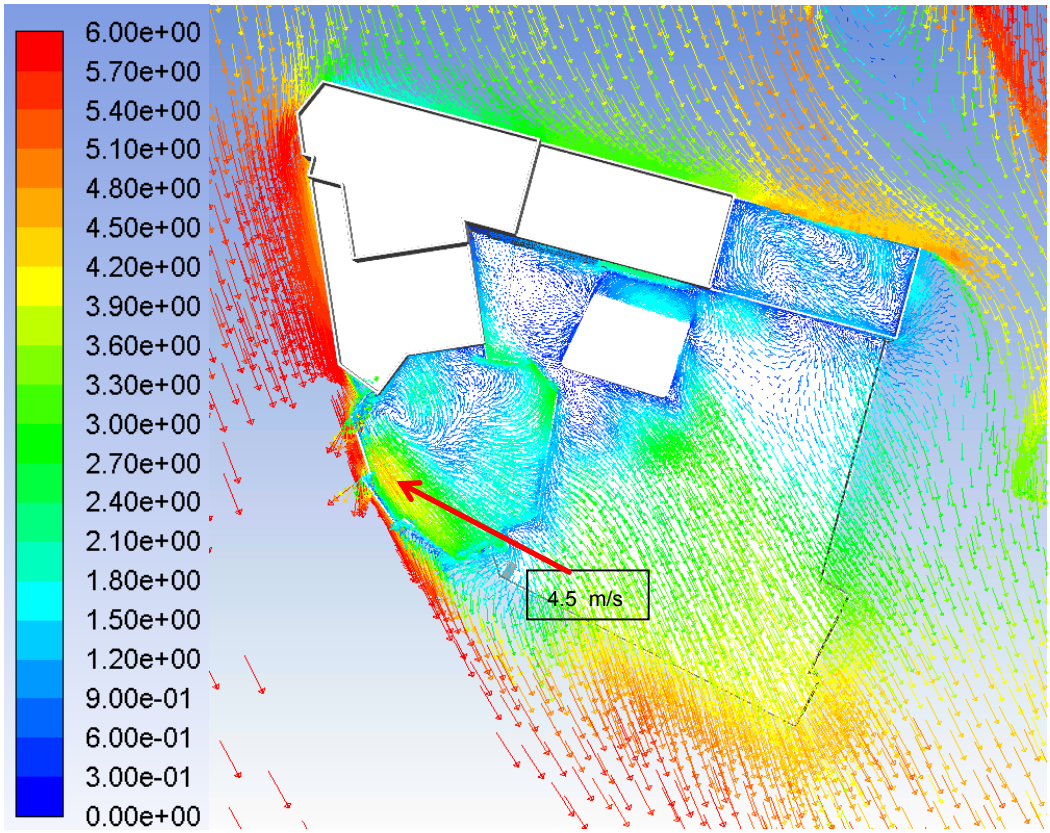


Figure 19 Velocity Vector (m/s) at 1.5 m above Floor of Roof Terraces – Northwest Wind



A: Level 3 Roof Terrace



B: Level 4 Roof Terrace

6.5 Southwest (Winter) Winds

The results of the southwest simulations are presented in **Figure 20** and **Figure 21**. The following conclusions can be reached from these figures:

- A combination of only modest near-field “urban” built exposure (low to medium-rise blocks) and the influence of the Sydney Harbour Bridge northern abutments dropping to sea level and then largely open exposure from Sydney Harbour provide modest shielding for the southwest.
- The mean wind speed inside the building is 7 m/s (refer **Figure 20)**. Corresponding gust strengths at this location will have magnitudes as high as 14 m/s thereby exceeding the comfort criteria for standing.
- The proposed balustrades (2.1 m high) provide an acceptable shielding to Level 3 and roof terraces.

Figure 20 Velocity Vector (m/s) at 1.5 mm above Ground of Upper Pitt Street Building – South Westerly Wind

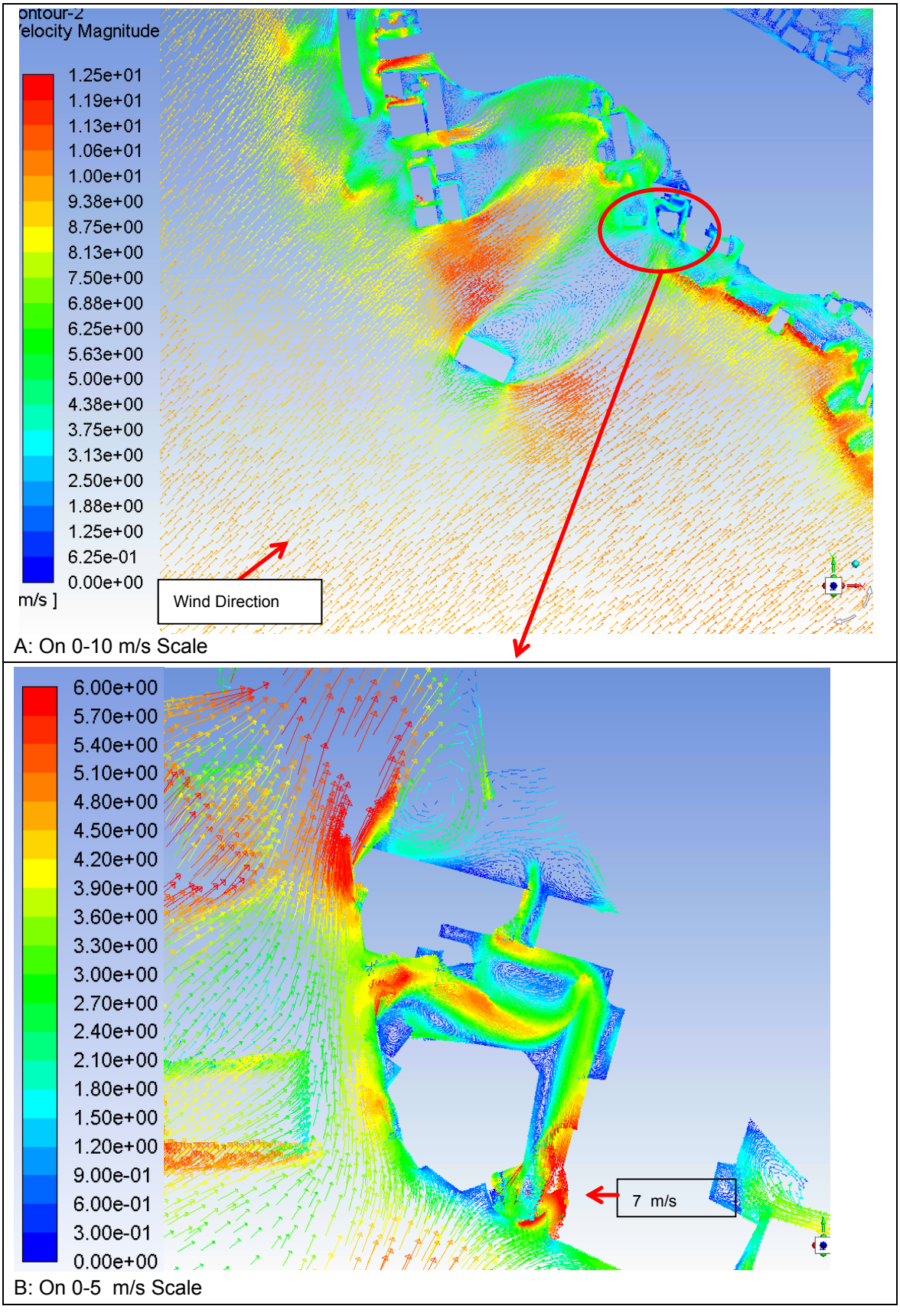
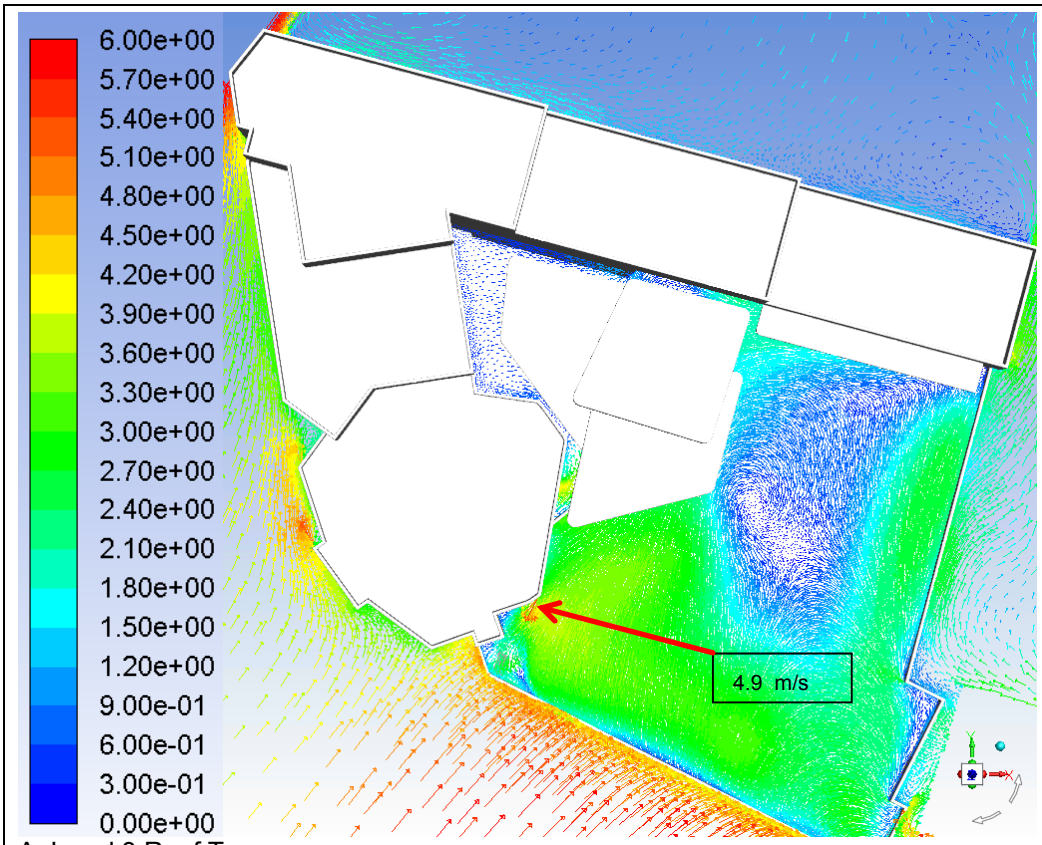
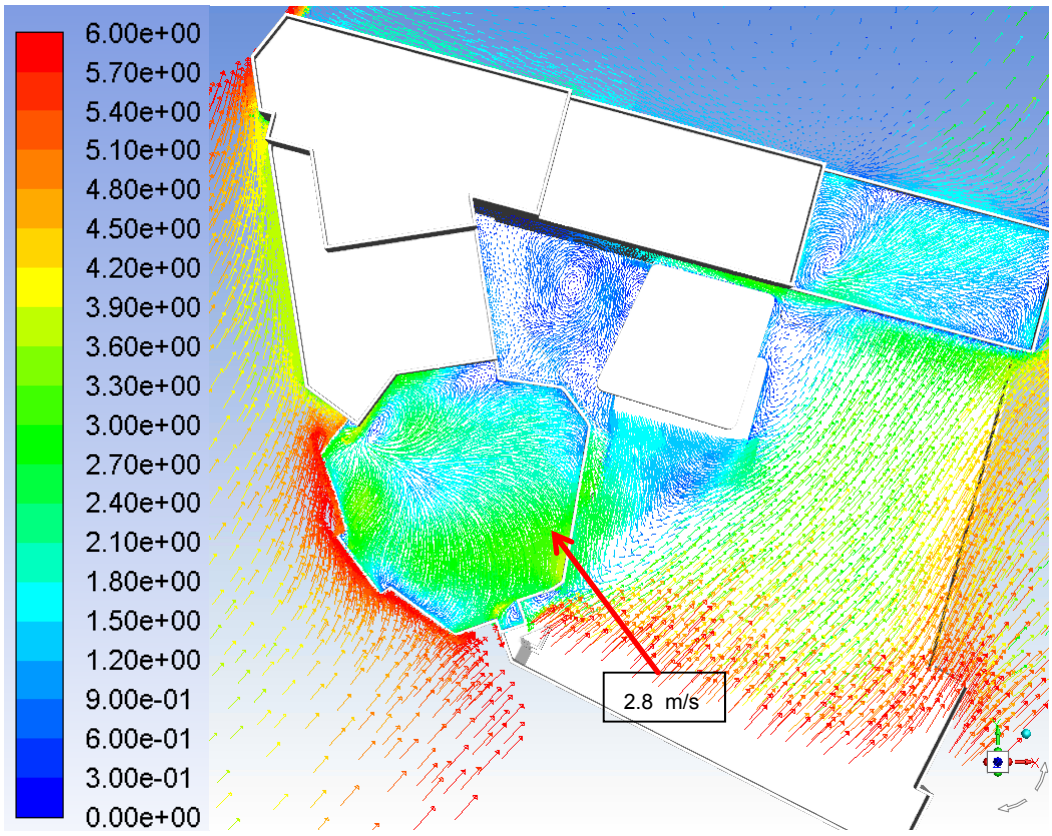


Figure 21 Velocity Vector (m/s) at 1.5 m above Floor of Roof Terraces – South Westerly Wind



A: Level 3 Roof Terrace



B: Level 4 Roof Terrace

6.5.1 Modification OPTION 1

Modification Option 1 involves reducing the south and west louvered openings by 50 % (refer **Figure 22**).

The results of the southwest simulations are presented in **Figure 23.**

The mean wind speed inside the building is reduced to 4.8 m/s. Corresponding gust strengths at this location will have magnitudes as high as 9.6 m/s thereby satisfying the comfort criteria for seating.

Figure 22 Proposed Openings – Modification Option 1

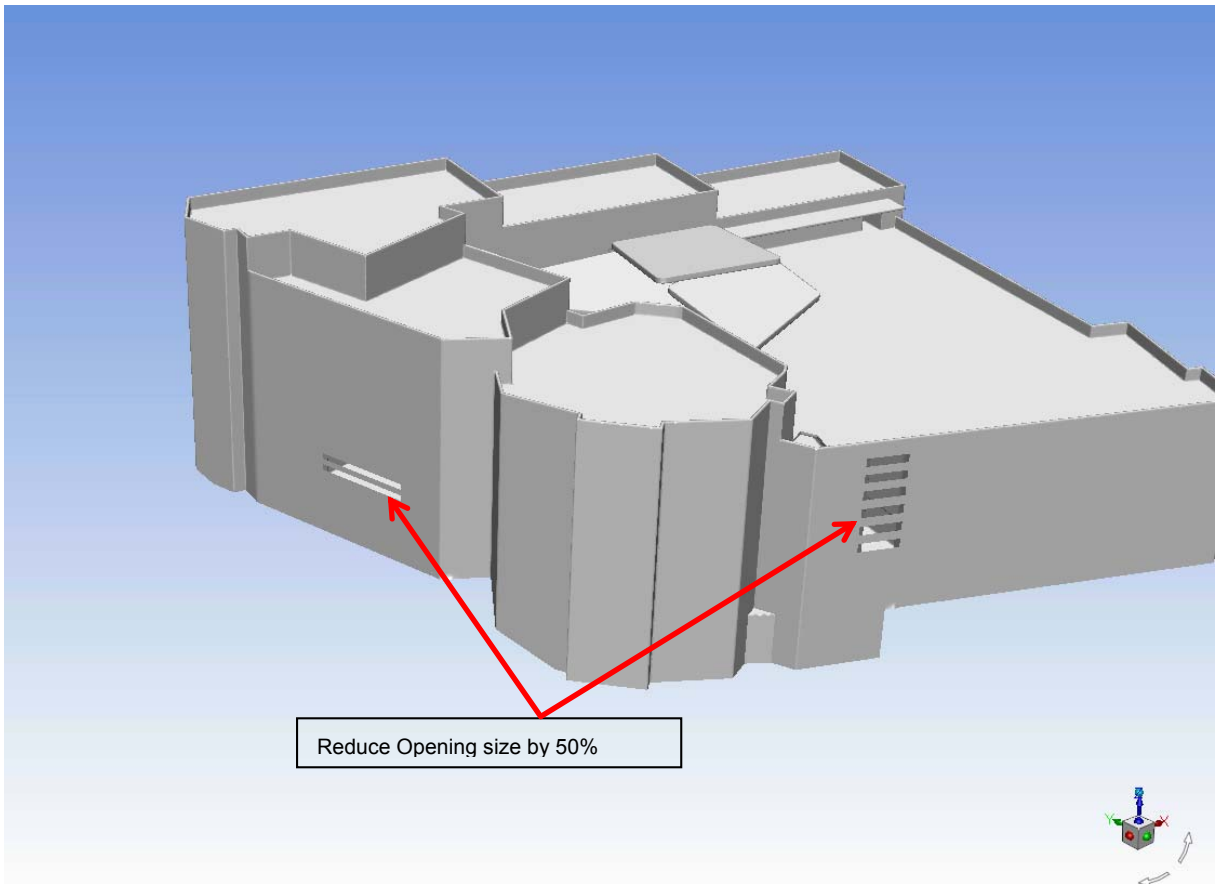
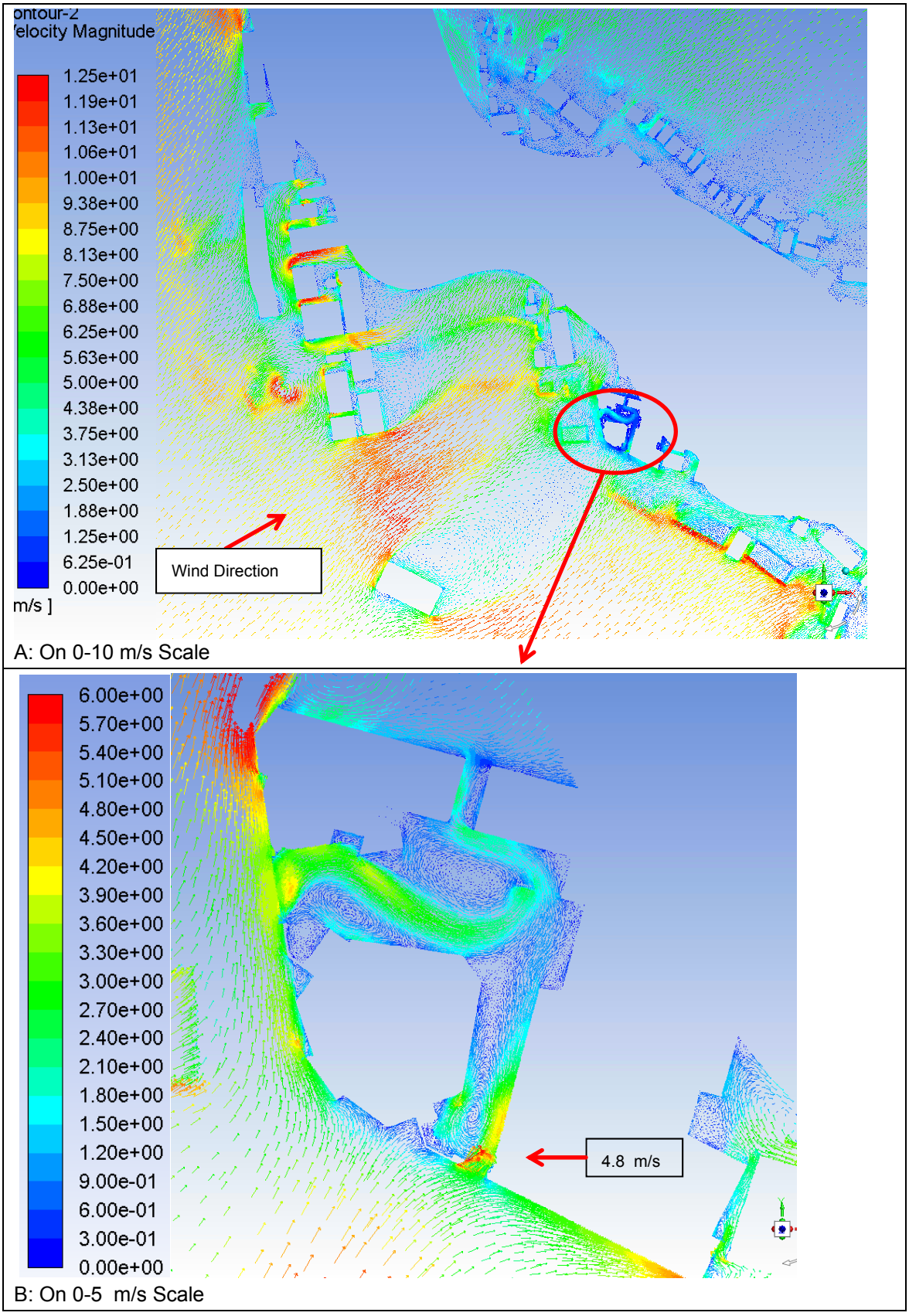


Figure 23 Velocity Vector (m/s) at 1.5 m above Ground of Upper Pitt Street Building – South Westerly Wind



7 WIND MITIGATION RECOMMENDATIONS

Section 6 provided guidance as to the areas where the adopted wind acceptability criterion had the potential to be exceeded and an indication as to the likely local optimum wind treatment strategy, ie whether the wind condition of interest is likely to arise from accelerating winds which require vertical windbreaks (such as landscaping) or downwash winds which require horizontal windbreaks (such as awnings, canopies).

Primary Wind Conditions of Concern

The wind conditions of primary concern:

- Prevailing winds align with building geometry conditions conducive to accelerated windflow, eg the southern façade feature opening will be exposed to stronger winds from the south (southwest to southeast).

- Winds will also be able to flow between various openings from the north (Upper Pitt Street building entry), west (Jeffreys Street), south and the overhead central void areas due to pressure differences.

- Both of roof terraces (Level 3 and Level 4) will be exposed to stronger winds from the south, less so from the west and less again for northeast winds.

SLR recommends the following:

- Implement operable louvres to the south and west facades. The louvres can therefore be closed during high wind conditions (refer **Figure 24**).
- Further away from the roof edges the windflow may have a slightly downward arc, where vertical type screening (eg via landscaping) would be the optimum windbreak solution. It is noted that the Level 3 Roof Terrace has variations in RL, with planting included on some of the elevated zones. A localised area of potentially elevated winds has been identified at the southwest corner of the Level 3 terrace (refer **Figure 25**) which would benefit from further analysis during the detailed design phase of the project.
- Retain the 2.1 m parapet along the Level 3 and Level 4 roof terraces (refer **Figure 25**).

Figure 24 Mitigation Recommendations – Louvered Facades

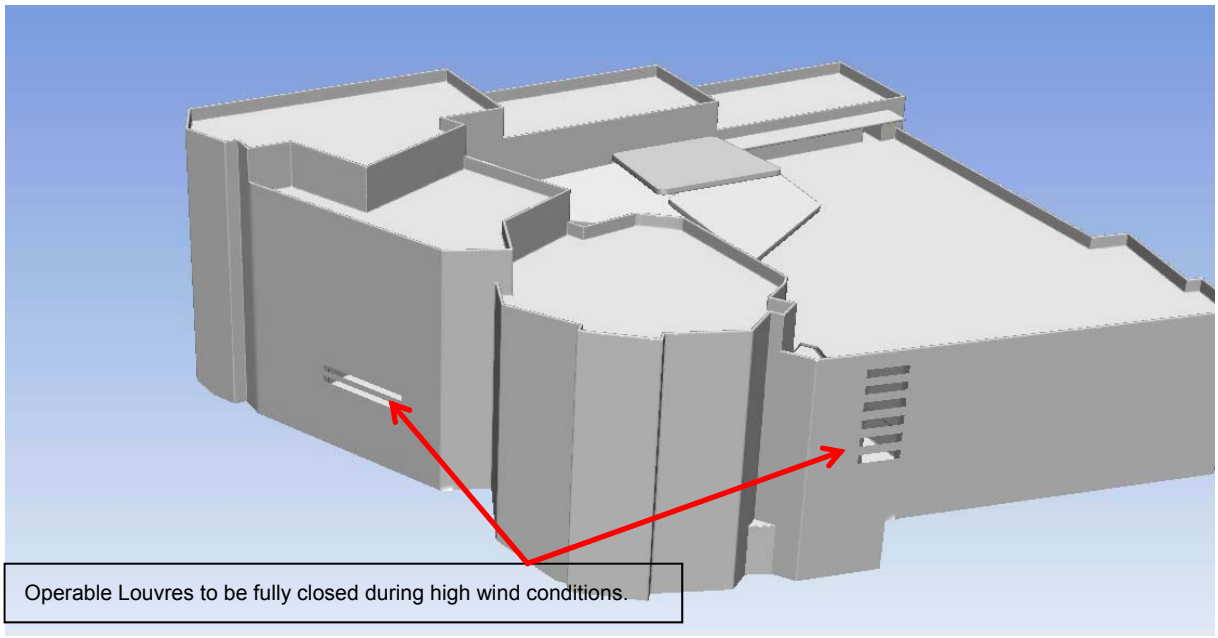
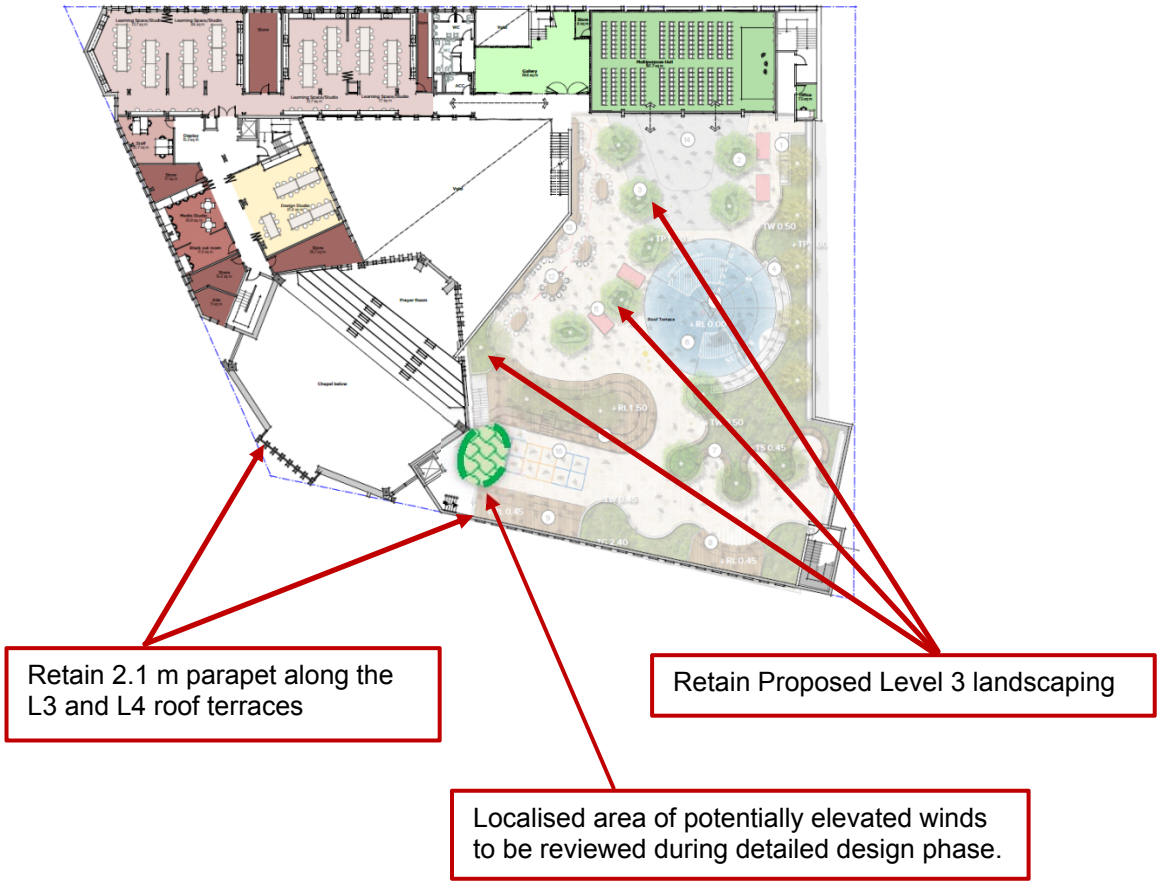


Figure 25 Mitigation Recommendations (Roof Terraces)



8 CONCLUSION

SLR Consulting Australia (SLR) has been engaged by PMDL Architecture to prepare a quantitative wind impact assessment which will be submitted to the Department of Planning and Environment as part of the State Significant Development Application (SSDA) for the proposed redevelopment works at St Aloysius' College, Kirribilli.

The SLR wind study focused on the following areas:

- Level 3 Roof Terrace & Level 4 Juana Mateo Roof Terrace
- Southern Facade Feature Opening
- Internal Zones Exposed to External Airflow
- Internal Bounded Zones Eastern Half

Wind speeds for the areas of interest have been quantified using Computational Fluid Dynamics (CFD).

Sydney Winds

The Sydney wind climate is characterised by dominant (prevailing) north-easterly, westerly and southerly winds. While northeast winds are the more common prevailing wind direction (occurring typically as offshore land-sea breezes), southeast and south winds generally provide the strongest gusts during summer. West quadrant winds (southwest to northwest and common throughout winter) provide the strongest winds for the whole year.

Local Wind Environment

At the St Aloysius' College site, the following influences are present:

- To the northeast is a combination of near-field "urban" built exposure (low to medium-rise blocks) on slightly elevated topography relative to the site dropping to sea level (Neutral Bay) and then suburban terrain further afield.
- To the southeast is a combination of near-field "suburban" exposure (low rise buildings) and far-field "open" exposure generated by the Sydney Harbour.
- To the south is a combination of near-field and lower elevation "open" exposure (Sydney Harbour) causing speed-up and far-field "heavily built-up" exposure generated by the Sydney CBD.
- To the west is a combination of varying near-field "urban" exposure (southwest to northwest) and then Lavender Bay and far-field "suburban" exposure (MacMahons Point).

Wind Impact of the Proposed Development – Base Case Condition assuming fully open Southern and Western Façade Features

In relation to the wind impact of the proposed development with the currently proposed building design (the "Base Case" condition), some internal area have the potential to experience elevated wind speeds, in excess of the standard once per year standing comfort criteria (refer **Figure 15**). This occurs mainly when …

- Prevailing winds align with building geometry conditions conducive to accelerated windflow, eg the southern façade feature opening will be exposed to stronger winds from the south (southwest to southeast).
- Winds will also be able to flow between various openings from the north (Upper Pitt Street building entry), west (Jeffreys Street), south and the overhead central void areas due to pressure differences.

Future Wind Impact of the Proposed Development with Reduced Southern and Western Façade Openings

- With the proposed building design and already planned and proposed landscaping, locations surrounding the site will lie mostly within the “comfortable” seating criterion (refer **Figure 23**).

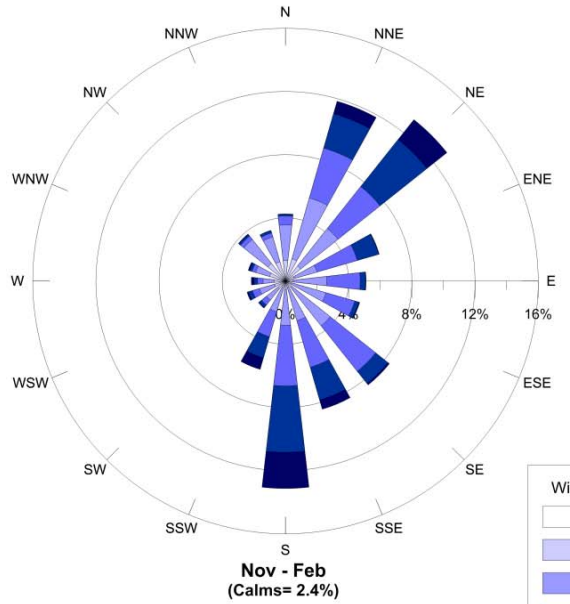
SLR recommends the following:

- Implement operable louvres to the southern and western facades. The louvres can therefore be closed during high wind conditions (refer **Figure 24**).
- Further away from the roof edges the windflow may have a slightly downward arc, where vertical type screening (eg via landscaping) would be the optimum windbreak solution. It is noted that the Level 3 Roof Terrace has variations in RL, with planting included on some of the elevated zones. A localised area of potentially elevated winds has been identified at the southwest corner of the Level 3 terrace (refer **Figure 25**) which would benefit from further analysis during the detailed design phase of the project.
- Retain the proposed 2.1 m parapet along the Level 3 and Level 4 roof terraces (refer **Figure 25**).

SYDNEY SEASONAL WIND ROSES

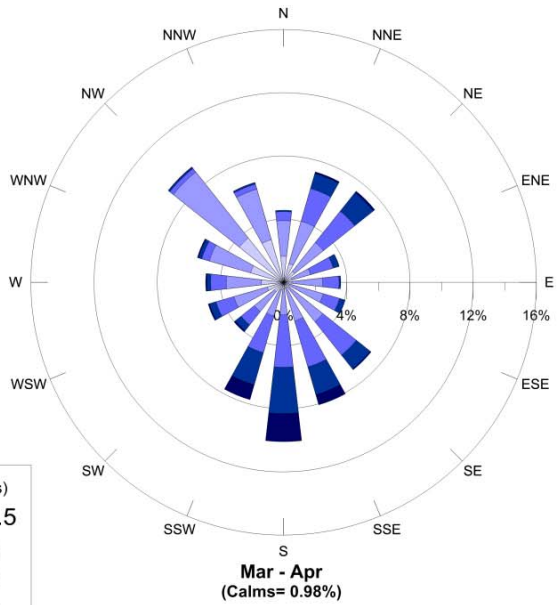
Sydney Airport AWS
(Observations)
1999-2017
600.09300

Summer

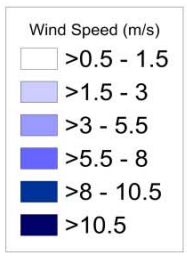


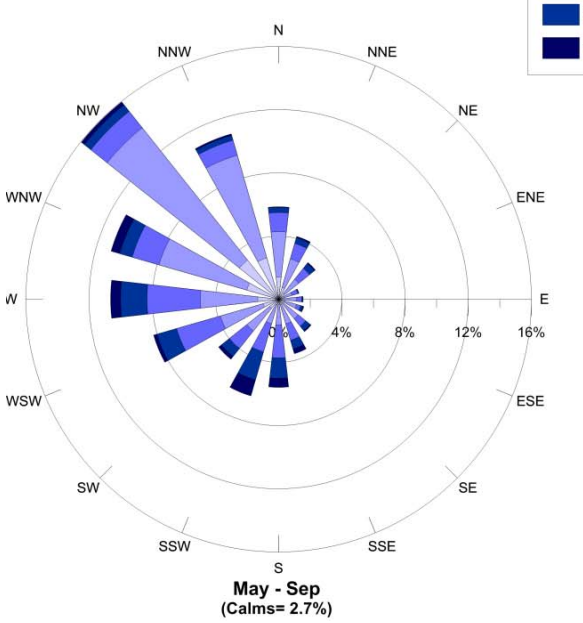
Nov - Feb
(Calms= 2.4%)

Autumn Transition



Mar - Apr
(Calms= 0.98%)

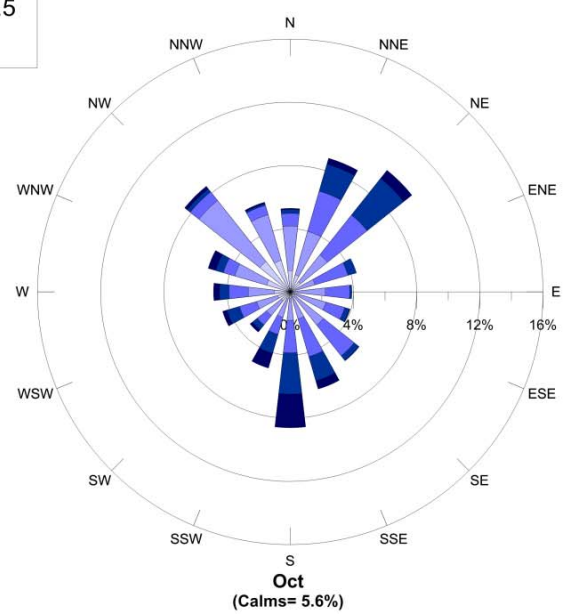




May - Sep
(Calms= 2.7%)

Winter/Early Spring

Late Spring Transition



Oct
(Calms= 5.6%)