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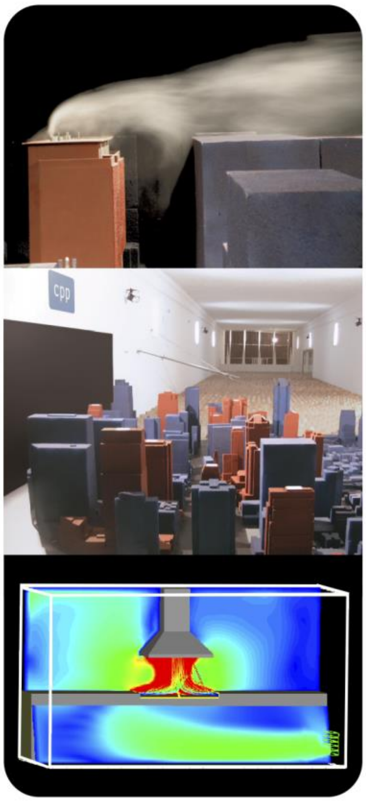
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Wind Assessment for:

20 Illawong Avenue

Sydney, NSW

Prepared for:

Midson

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Australia

March 2020

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DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
08/08/19	Draft report	TXE	JP	JP
24/02/20	Revised Drawings - Final	TXE	JP	JP
09/03/20	Conversion tables added	TXE		JP

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Midson to provide a review of wind impacts and design loads for the proposed redevelopment of 20 Illawong Avenue .

The development is located on Sydney's eastern coast, situated on a small escarpment above Tamarama Beach, Figure 1. The existing 7-storey building is to be modified by the addition of an extra level to accommodate two new penthouses, as well as the replacement of the eastern façade including new balconies and sliding doors. Advice is sought regarding wind comfort conditions on the new balconies and terraces, as well as design wind loads on architectural elements. The east elevation of the proposed design is shown in Figure 2.

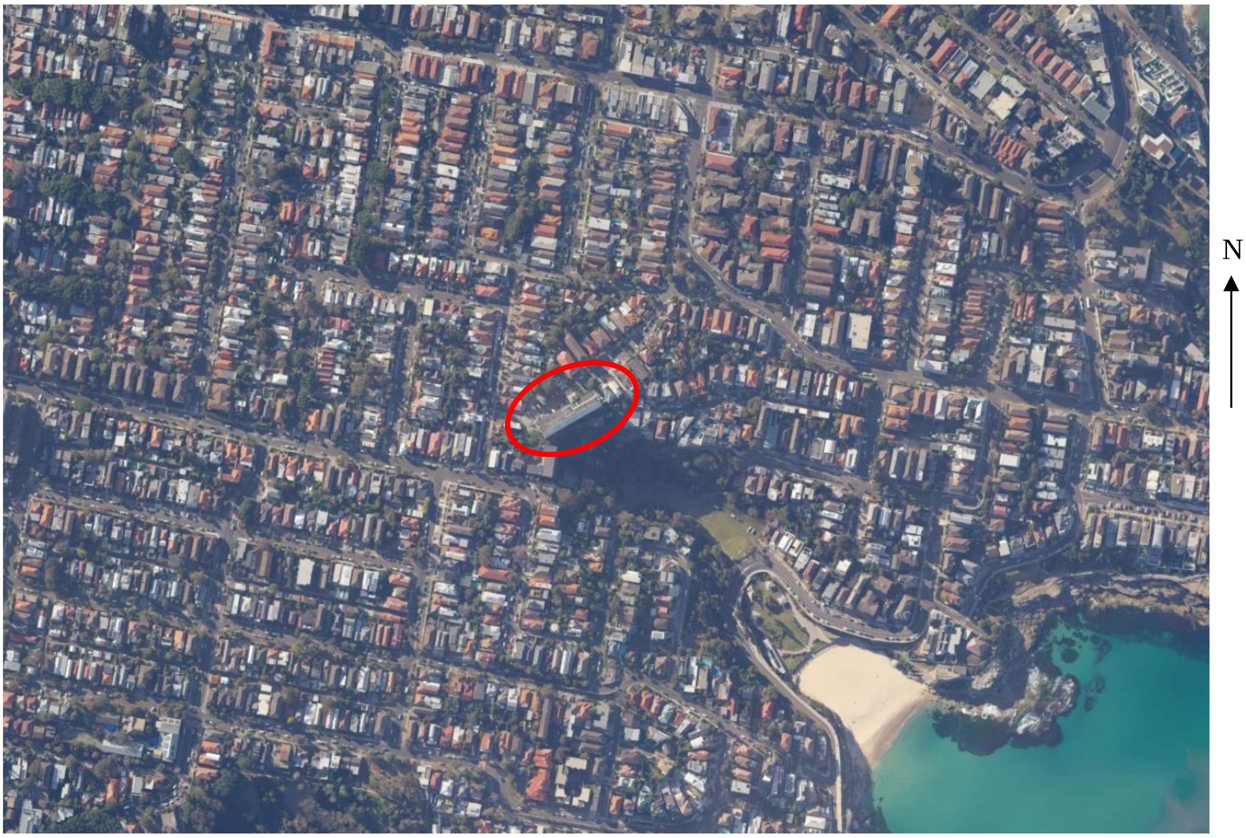


Figure 1: Aerial view of the proposed development site (Eagle View, 2018).

Figure 2: Proposed east elevation

2 PEDESTRIAN WIND COMFORT

2.1 Sydney Wind Climate

The proposed development lies approximately 10 km to the north-east of the Sydney Airport Bureau of Meteorology anemometer. 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 2017 have been used in this analysis. The wind rose for Sydney Airport is shown in Figure 3 and is considered to be representative of prevailing winds at the site. Strong prevailing winds are organised into three main groups which centre at about north-east, south, and west. Due to the unique location and topography of the site, the impact of south-easterly and easterly winds will also be important. This wind assessment is focused on these prevailing strong wind directions.

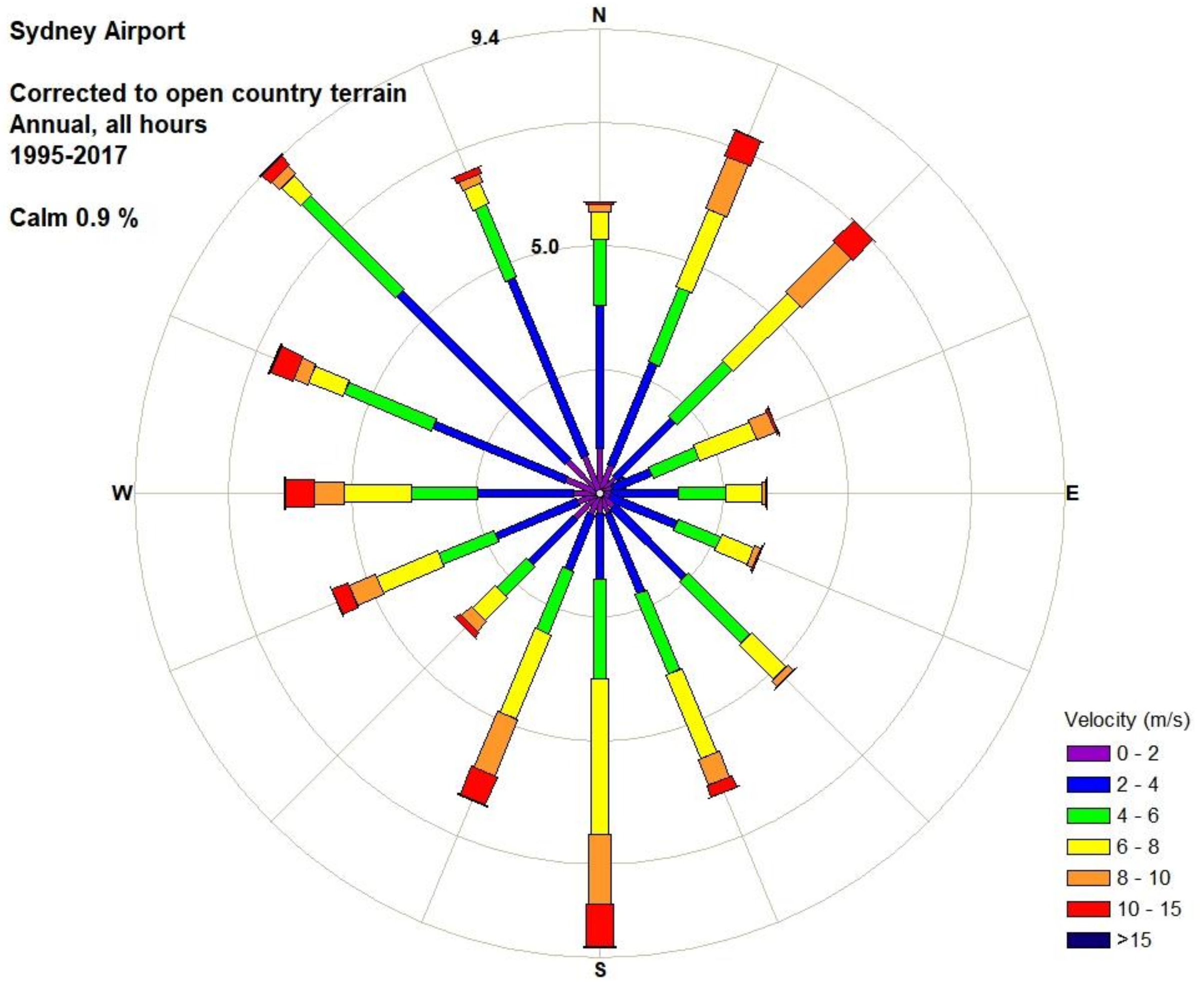


Figure 3: Wind rose for Sydney Airport.

2.2 Environmental Wind 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.

The wind assessment criteria that will be used in this study will be based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress/safety. 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. The level and severity of these comfort categories can vary based on individual preference, so calibration to the local wind environment for all wind directions is recommended when evaluating with Lawson ratings. Another benefit of these from a comfort perspective is that the 5% of the time event is appropriate for a precinct to develop a reputation from the general public.

Table 1: Pedestrian comfort criteria for various activities.

Comfort (max. 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/Safety (max. 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 an hourly 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.

2.3 Environmental Wind Assessment

The development site is situated on an escarpment overlooking Tamarama Beach, recessed between Bronte and Tamarama Headlands. The approach from the south-eastern quadrant is over open ocean. Topography slopes steeply upward approaching the site from the east and south-east and is relatively flat in all other directions. To the north, south, and west are regions of suburban development comprising mainly low-level buildings. Due to its relative size and location, the subject building will receive significant exposure to prevailing winds. The primary wind impacts will arise due to the interaction of the building massing with these wind directions. Several wind flow mechanisms such as downwash and channelling flow are described in Appendix 1, and the effectiveness of some common wind mitigation measures are described in Appendix 2.

The focus of this assessment are the east-facing external balconies on Ground Floor to Level 07, and the external terraces extending around the Level 08 penthouses, Figure 4.

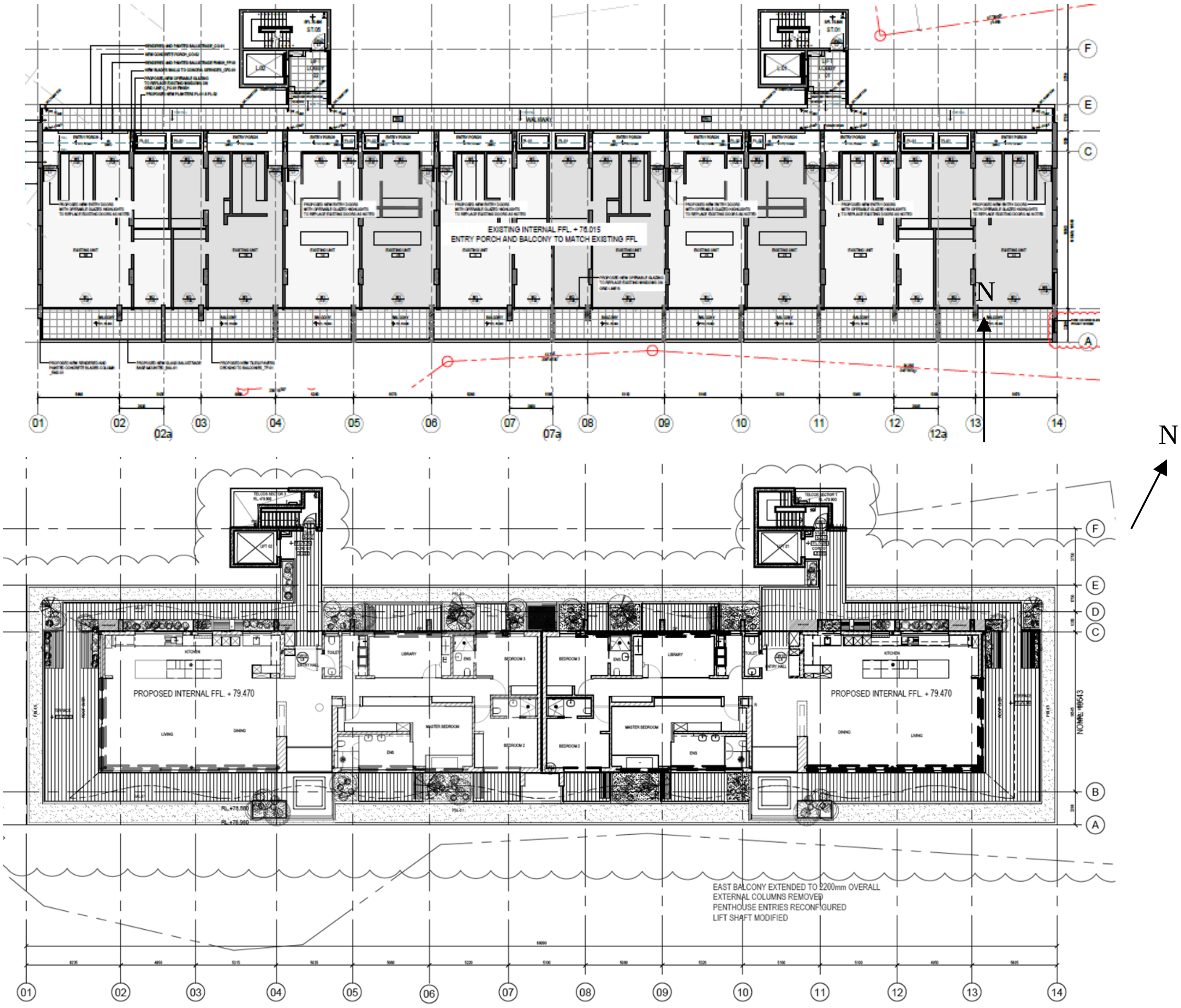


Figure 4: Level 07 (T) and Level 08 (B) floor plans

2.3.1 Winds from the north-east

Winds from the north-east will approach over the open region of Bondi Beach and across the adjacent headland before reaching the site. The orientation of the rectangular building planform will direct these winds along the eastern façade of the development, though some external areas will be affected as winds impinge on the building. In particular, stronger winds would be expected at the north-eastern corner balconies as winds accelerate around the building massing before moving parallel to the east and west facades. Due to the provision of privacy fin-type glazing on the east-facing balconies, these stronger conditions are likely to be restricted to a small area, and mostly calm conditions would be expected on the east-facing balconies further from the northern end.

On the northernmost sections of the Level 08 terrace, relatively strong conditions would be expected during wind from the north-east. This area is mostly exposed to incoming wind, which will be further accelerated as it moves around the building form. The east (bedroom) and south-facing terraces on this level will experience generally calm conditions due to the orientation of the building relative to the incoming wind and the protection provided by the sections of structure and landscaped areas.

2.3.2 Winds from the south and south-east

Winds from the south-east quadrant approach over a section of ocean and will be slightly accelerated by the local topography before reaching the subject building. These winds will impinge normal to the broad eastern façade. The strongest conditions would be expected near to the corners of the building as flow moves around it, while the balconies nearer to the centre of the façade would be calmer. In general, the balconies on Level 07 and below represent a small volume relative to the size of the façade, and the associated back-pressure will discourage high velocities through them. However, they may still be affected by strong gusts on windier days.

The corner terraces on Level 08 would be expected to experience windy conditions during winds from this direction, as flow is pushed around the building corners and across the recessed terrace. The protection from landscaped areas and dividers to the smaller terraces on this level will allow calmer areas to exist for these spaces. The west-facing terrace areas will be calm during winds from these directions.

2.3.3 Winds from the west

Winds from the west will impinge upon the subject development at an oblique angle, which will encourage flow to move around the building parallel to the western façade without generating higher velocities. The east-facing balconies on Level 07 and below are shielded from westerly winds and will be calm under these conditions. The majority of the east-facing Level 08 terrace areas will also be calm for the same reason, and the larger area on the northern side will be additionally protected by the separate lift core structure. Some of the west-facing terrace areas on this level will be impacted by these winds, though some protection would be provided by the dividers, landscaped areas, and lift core structures. Additionally, relatively strong conditions would be anticipated at the larger southern terrace area, which is somewhat exposed to winds from this direction. These winds will accelerate across the southern corners of the terrace as they are directed around the building massing.

2.3.4 Summary and recommendations

For Level 7 and below, the privacy partitions and relative volume of the balconies will allow reasonably amenable conditions most of the time. Under the Lawson criteria, these areas are expected to be rated as suitable for Pedestrian Sitting and Standing. The balconies on the edges of the buildings may be affected by strong winds more often. The portion of time these balconies would be suitable for comfortable long-term and stationary activity could be increased by enclosing the space on one side as shown in Figure 5.

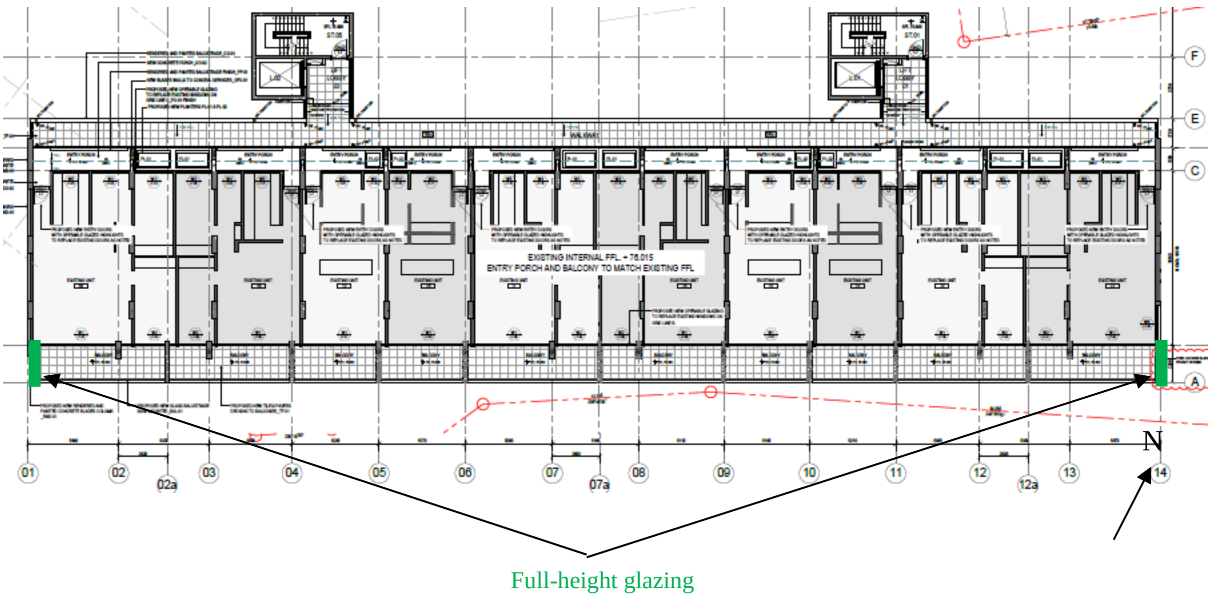


Figure 5: Plan indicating suggested mitigation for edge balconies – L07 and below

For the Level 08 terraces, conditions are likely to be slightly windier, particularly at the larger end terraces. These spaces are likely to fall into the Pedestrian Standing or Pedestrian Walking categories under the Lawson criteria. Due to the arrangement of the outdoor areas around the building, some calm areas are likely to exist for any prevailing wind direction. Increasing the height of the balustrade would be suggested to promote calmer conditions, particularly at the eastern corners areas. A suggested approach incorporating full-height glazed screens at these corners is shown in Figure 6. For all balconies and terraces on the development, the higher the balustrade, the better conditions will be. A minimum height of 1500 mm from finished floor level would be recommended.

These recommendations are not prescriptive and are provided from the perspective of improving the proportion of time comfortable conditions are available to residents. In general, residents will acclimatize to temporal and seasonal variation of winds and adapt their expectations and use of balconies accordingly.

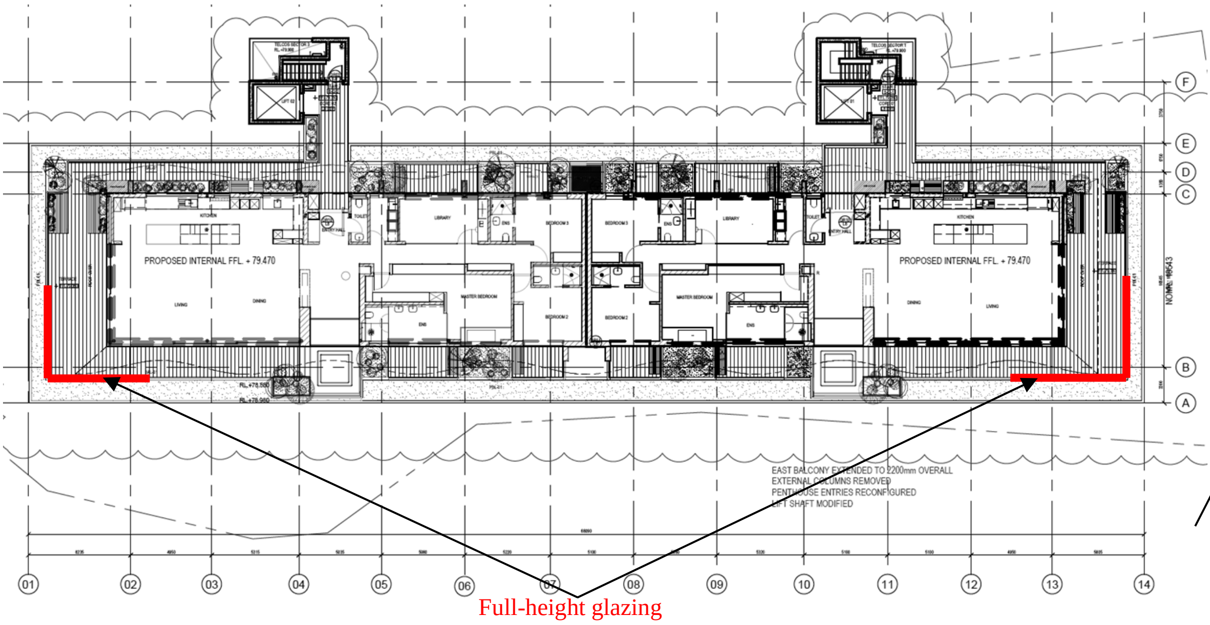


Figure 6: Suggested mitigation measures – Level 08

3 FAÇADE CLADDING LOADS

The methods described in Australian Standards (2011) have been used to estimate the design façade cladding pressures for the development. The code-based approach includes consideration of the local topography and surrounding terrain. The calculation parameters are summarised in Table 2. The resulting design wind pressures are shown marked up on the building elevations in Appendix 2. These pressures are suitable for the design of façade glazing, windows, and balcony doors. Additionally, the pressure loads on the penthouse roof are included.

For the design of the glazed balustrades, these pressures shown in Appendix 2 may be reduced by 40%.

Table 2: Calculation parameters as per AS1170.2 (2011)

Wind Region	A2
Basic Wind Speed	46 m/s
Terrain Category	2, 3
Return Period	1000 years
Internal Pressure Coefficient C_{pi}	-0.3
Local Pressure factor K_L	1.5

4 WIND INDUCED NOISE

Façade cladding and ancillary elements exposed to strong winds have the potential to generate noise. This may be related to whole-body vibration of panels or similar, tonal noise or whistling caused by air moving through porous elements or cracks/apertures, or rattling and isolated vibration of fittings. Prediction of these issues is difficult, as wind-related noise is a function of many variables including materiality, location, installation, and geometry. Large-scale issues can usually be addressed through robust design. For the primary façade components including glazing, balcony doors, and roof, the supplier should ensure that installed materials are capable of withstanding serviceability wind pressures without noticeable deformation or vibration. Serviceability pressures may be estimated by reducing those shown in Appendix 2 by 35%. For specific items or materials, more detailed information such as shop drawings, material properties, or prototypes would be required to assess the risk of wind-induced noise issues.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of expected environmental wind conditions for proposed new balconies and terraces on 20 Illawong Avenue . Reasonably amenable conditions are expected for the majority of the residential balconies, considering the coastal location and local topography. Advice for mitigation has been provided to improve conditions where appropriate, in particular near the building corners and on the larger Level 08 terraces. Design wind pressures suitable for the design of façade cladding and ancillaries have also been provided, including generic advice on wind-related noise issues.

6 REFERENCES

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.

Standards Australia (2011), Australian/New Zealand Standard, Structural Design Actions, Part 2: Wind Actions (AS/NZS1170 Pt.2).

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 7; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward corners and sides of the building. In Figure 7, 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 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 8 shows the wind at mid and upper levels on a building being 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.

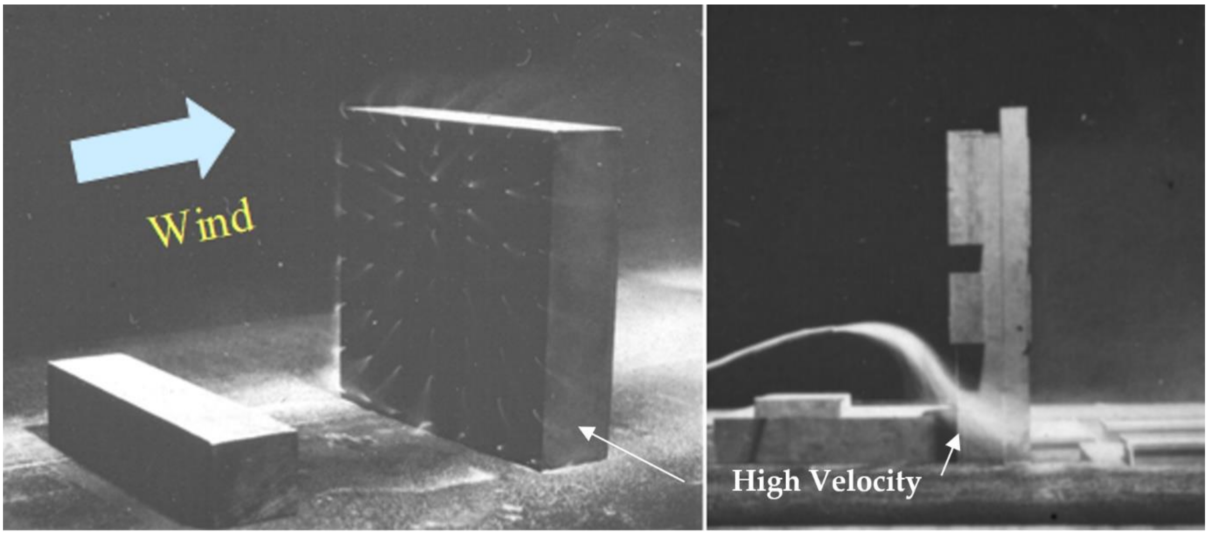


Figure 7: Flow visualisation around a tall building.

Figure 8: Visualisation through corner balconies (L) and channelling between buildings (R).

Appendix 2: Design Wind Pressures

Ultimate Limit State (1000 year) pressures shown. See table below for reduction factors.	
	Multiply Indicated Pressures by
Serviceability Loads (25 year Return Period)	0.65
Water Penetration Resistance	0.195
Balustrade Design	0.6

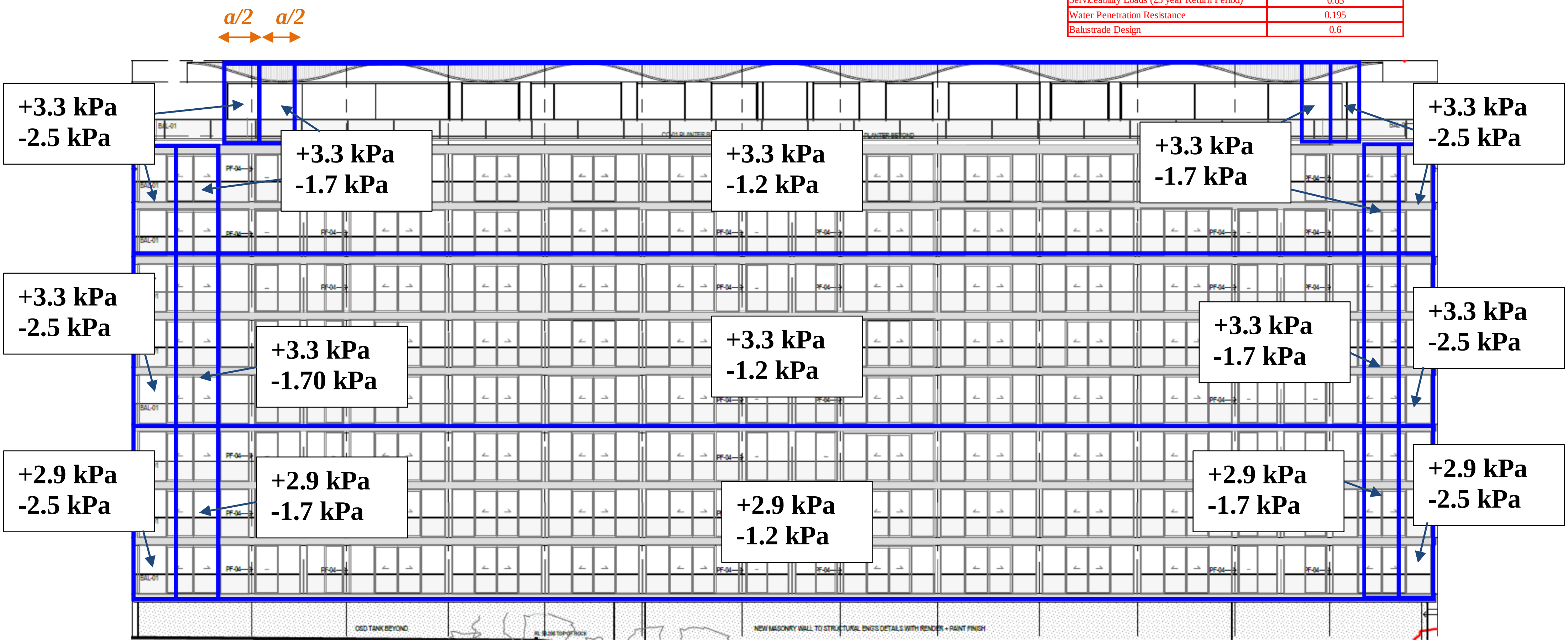
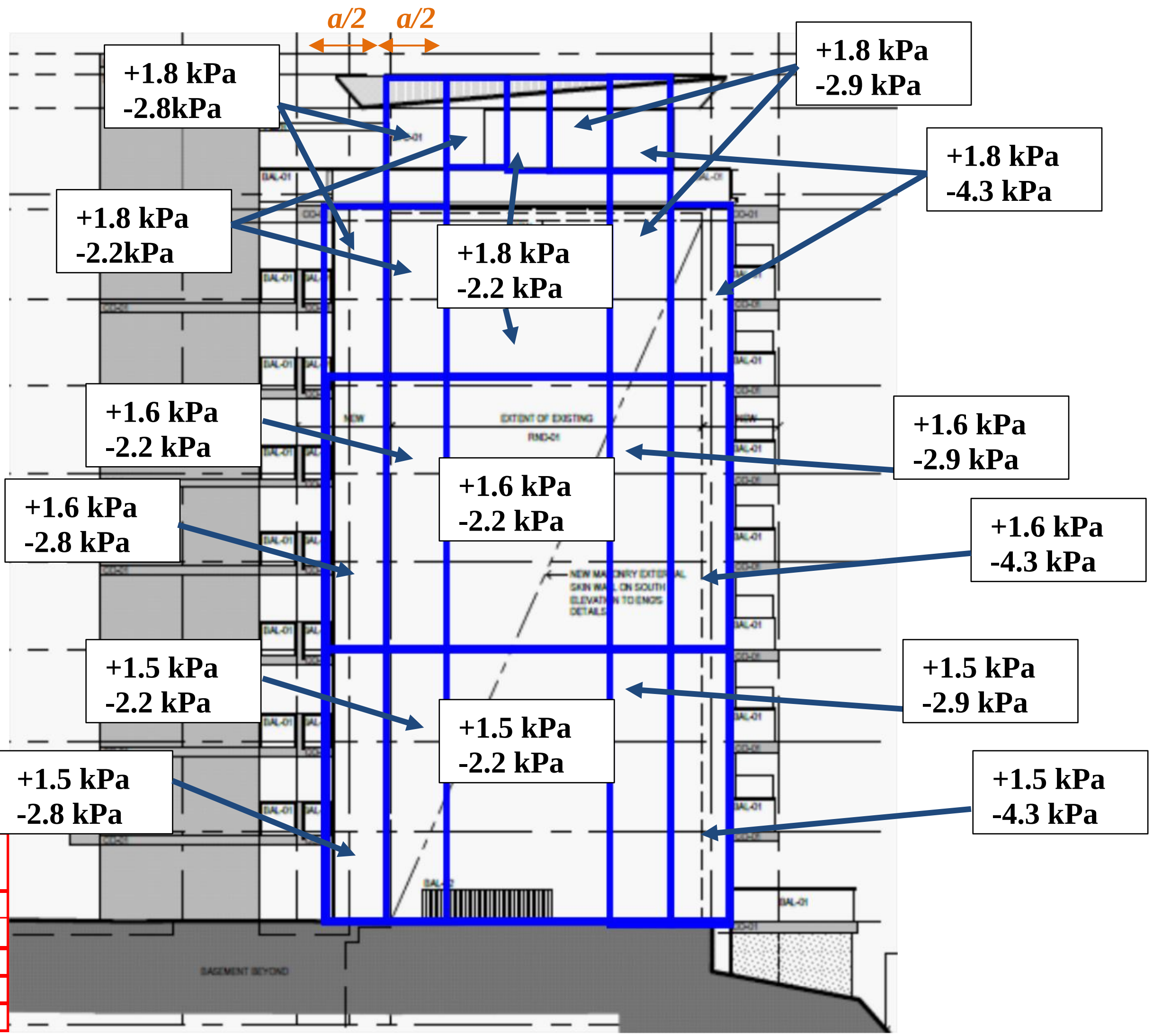


Figure 9: 1000-year return period design pressures – East elevation. *a* = 4.4 m.



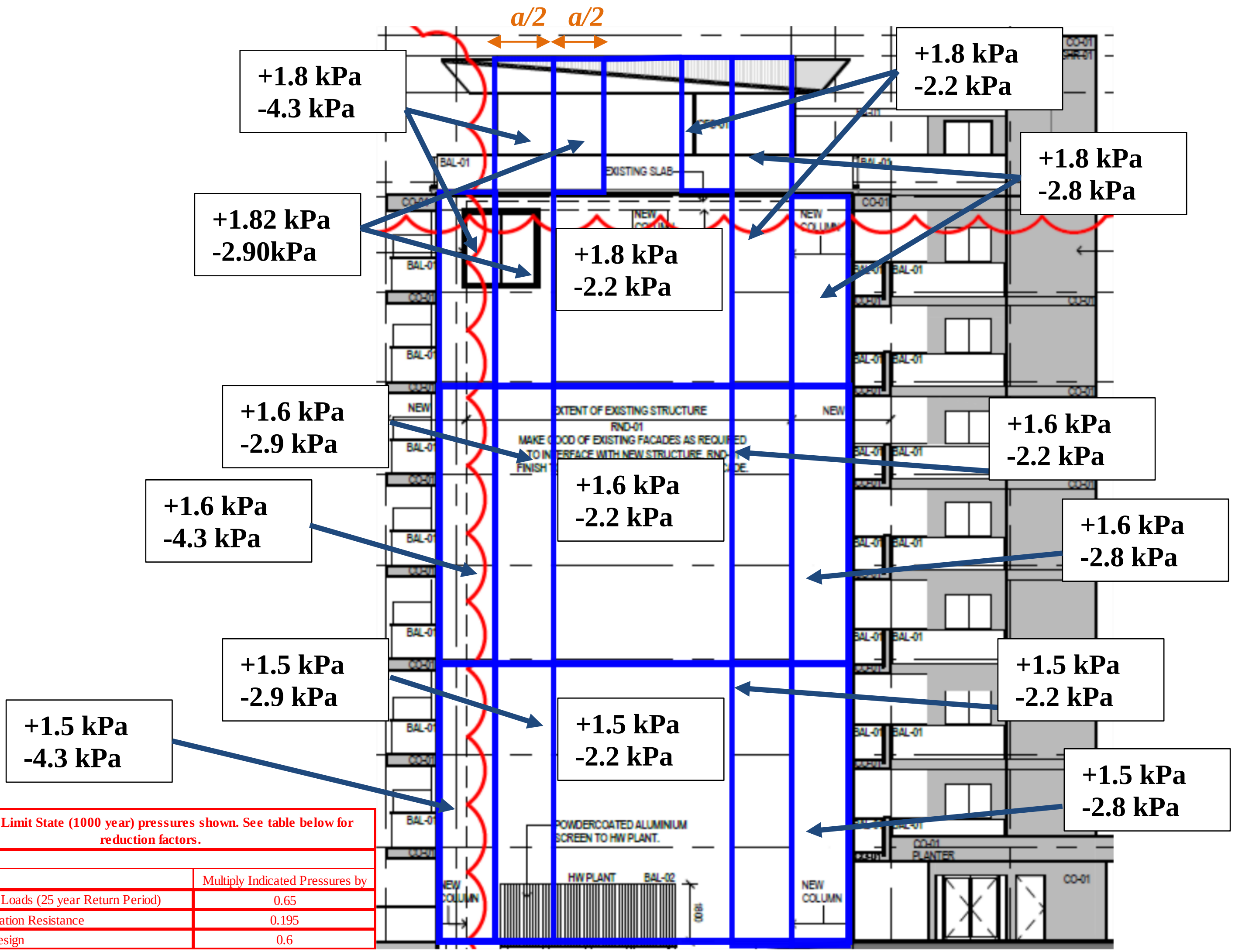
Ultimate Limit State (1000 year) pressures shown. See table below for reduction factors.

	Multiply Indicated Pressures by
Serviceability Loads (25 year Return Period)	0.65
Water Penetration Resistance	0.195
Balustrade Design	0.6

Figure 10: 1000-year return period design pressures – South elevation. a = 4.4 m.

Ultimate Limit State (1000 year) pressures shown. See table below for reduction factors.	
	Multiply Indicated Pressures by
Serviceability Loads (25 year Return Period)	0.65
Water Penetration Resistance	0.195
Balustrade Design	0.6

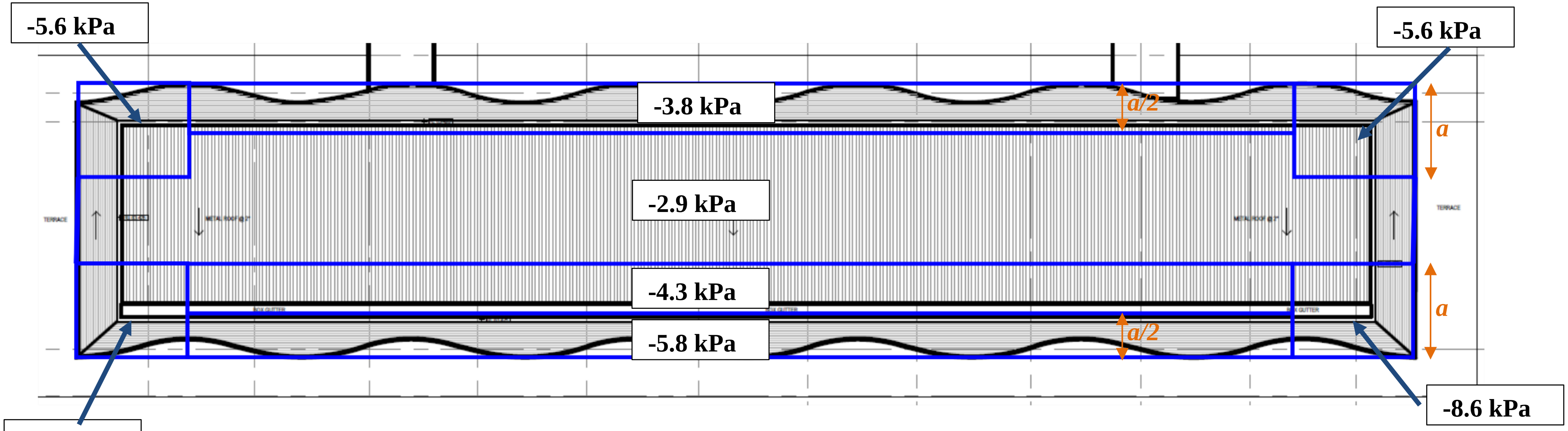
Figure 11: 1000-year return period design pressures – West elevation. *a* = 4.4 m.



Ultimate Limit State (1000 year) pressures shown. See table below for reduction factors.

	Multiply Indicated Pressures by
Serviceability Loads (25 year Return Period)	0.65
Water Penetration Resistance	0.195
Balustrade Design	0.6

Figure 12: 1000-year return period design pressures – North elevation. a = 4.4 m.



Ultimate Limit State (1000 year) pressures shown. See table below for reduction factors.	
	Multiply Indicated Pressures by
Serviceability Loads (25 year Return Period)	0.65
Water Penetration Resistance	0.195
Balustrade Design	0.6

Figure 13: 1000-year return period design pressures – Roof. a = 4.4 m.