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| DATE: | July 6, 2021 | RWDI REFERENCE #: 1902973 |
| TO: | Toga Development & Construction | |
| FROM: | Kevin Peddie | Email: kevin.peddie@rwdi.com |
| | Michael Pieterse | michael.pieterse@rwdi.com |
| RE: | Toga Central – Pedestrian Wind Comfort Assessment Western Gateway Sub-Precinct Block C – Response to Submissions | |

It is understood that the Project Review Panel convened on 5 May 2021 to review the Block C draft Response to Submissions (RtS). Recommendations and advice was provided by the PRP to assist with updating the final RtS and for DPIE consideration during the assessment. The following commentary was noted with regards to the local wind environment. This assessment also responds to key comments made by the City of Sydney within their submission on the publicly exhibited planning proposal.

1 Project Review Panel

1.1 Wind Environment Comments

The panel noted its previous advice regarding the need for the Western Gateway design guide to be finalised and submitted with the RTS. The panel also noted the proposal results in significant wind issues with the comfort criteria of two locations are reduced from ‘walking’ to ‘uncomfortable’.

Recommendation

- *Recommend the design guide be finalised and submitted with the RTS and that the wind comfort criteria be consistent with the PRP’s previous advice noting the need for walking, standing and sitting criteria at key locations (refer to the wind comfort criteria noted in the schedule attached to the PRP’s July 2020 advice).*
- *Recommend the proponent carefully consider its RTS approach to wind, noting that the wind issues are significant. It is recognised that the wind issues located between Blocks A and B will require a coordinated proponent response, however other wind issues to the north and south of the proposed envelope should be addressed by the Block C proponent.*



1.2 RWDI Clarifications

Updated Draft Wind Comfort Criteria

The draft Wind Comfort Criteria Map developed for the Western Gateway precinct has been prepared by TfNSW for inclusion within the Western Gateway Design Guide (WGDG) and is noted in the following image. This has been updated since the original Planning Proposal wind environment study report for the Toga Central development. The updated wind criteria notes the following key aspects:

- Wind impacts from any development must not exceed the Wind Safety Standard which is an annual maximum peak 0.5 second gust wind speed in 1 hour of 24 m/s.
- Wind impacts from any development on public domain should not exceed the Wind Comfort Standard criteria for sitting, standing and walking taking into consideration the intended use of the space. The wind comfort standard is an hourly mean wind speed or gust equivalent mean wind speed, whichever is greater, for each wind direction of no more than 5% of all hours in the year. These standards are:
 - walking through the OSD connection and footpaths - 8 m/s
 - standing at building entrances, bus stops - 6 m/s
 - sitting in future public spaces - 4 m/s
- New development within the Western Gateway Sub Precinct should achieve the proposed wind comfort criteria on land outside the sub-precinct (i.e. the area outside the redline boundary on the Wind Criteria Map), unless it can be demonstrated that existing wind conditions in that area do not currently achieve the identified wind comfort criteria.
- Development subject to a quantitative wind effects report must not cause a wind speed that exceeds the Wind Safety Standard, the Wind Comfort Standard for Walking and the Wind Comfort Standard for Sitting in Parks except unless it can be demonstrated that the existing wind speeds in those locations exceed the standard.
- A minimum of 200sqm of contiguous space that is open to the sky within the defined Railway Square area is to achieve the Wind Comfort Standard criterion for sitting, and may be achieved with the assistance of well-considered and well-designed localised wind mitigation measures.



Image 1: Draft Wind Comfort Criteria Map for the Western Gateway Sub-Precinct
(NB: This is yet to be endorsed)

RWDI are now providing the wind engineering studies for all three blocks of the Western Gateway Sub-Precinct. This will enable a more collaborative understanding and response for the wind environment conditions throughout the precinct instead of a disjointed approach.

Since the original wind environment study for the Toga Central planning proposal (Block C) was prepared, further testing has been undertaken for the Atlassian Central development (Block A), which also noted the proposed Development Application scheme



for the Central Place development (Block B). The following further discussion and figures is based on the wind tunnel testing undertaken by Block A as part of the Response to Submissions, and considered the latest designs available for Block A and B and the reference scheme from Block C. This wind report is currently on public exhibition.

While all schemes are still being finalised, this study provides further insight as to how each development, working collectively, will contribute to the end wind outcome. Modelling with the proposed reference scheme for Block C with the revised design schemes for both the Atlassian Central (Block A) and Central Place Sydney (Block B) developments indicate that the two areas of concern raised by the Project Review Panel to be uncomfortable, will satisfy the walking criterion, in line with the wind comfort criteria map for the area. For Block A this included their current detailed DA design including landscaping and wind mitigation measures, specifically deciduous trees (at time of planting), low level shrubs and porous screening. It is noted that these landscaping and mitigation measures are wholly located within the Block A site only and are not controlled by the proponent for Block C. The Block C massing modelled does not include specific landscaping or mitigation measures, it is expected that such details, if required, will be incorporated as part of a detailed design and wind tunnel testing for a future Block C DA submission.

It is noted that the inclusion of the reference scheme for Block C has the following influence on the wind conditions for the areas of concern to the north and south of the site:

Northern Precinct

Wind conditions in the area to the north of the Western Gateway Precinct were noted to generally improve with the inclusion of the reference massing envelope of Block C. This was due to the additional shielding of the southerly winds coming up Lee Street. It was also noted that the Block C tower provided additional shielding of the westerly winds to the Block A site which reduced some of the redirection of the westerly winds to the area north of the precinct. The influence of the Block C tower form on the wind conditions can be noted for the areas represented by sensors 42, 44, 46, 47 and 49, with the wind speeds in these areas reducing, including sensor 46 satisfying the sitting criteria and sensor 44 now satisfying the safety criteria.

The area just to the north of the site, adjacent to Lee Street/Pitt Street, represented by sensors 38 to 40 were found to experience negligible difference in wind conditions with the inclusion of the Block C tower. This is due to the form of the tower being setback from this corner.

Locations further to the north along Pitt Street and George Street are noted to not be influenced by the inclusion of the Block C tower reference scheme, with no difference in the measured wind conditions for these two areas.



Southern Precinct

Wind conditions to the south of the site on Lee Street (locations 2, 5, 6 and 19) and within Railway Square (locations 53 to 63) are noted to generally be unchanged with the inclusion of the Block C reference scheme tower.

The wind conditions throughout Railway Square and along Lee Street are governed by the southerly wind direction which are directed up Lee Street due to the street alignment and built form. As such, the inclusion of the Block C reference scheme is noted to have no influence on the wind conditions in this area.

The wind conditions for the majority of Henry Deane Plaza (locations 3 to 8, 10, 11, 19, 31, 32 and 34) are noted to be generally unchanged with the inclusion of the Block C reference scheme design, noting little influence of the tower on these flow patterns. Four locations however, at the south-eastern corner of the Block C site are noted to become slightly windier with the inclusion of the Block C tower however are noted to still satisfy the walking comfort criteria which is in line with the Draft Wind Comfort Map for the precinct. Two locations in this area, represented by sensors 9 and 12, are noted to marginally exceed the safety limit criteria.

The increase in wind conditions at the south-eastern corner of the Block C site is due to the southerly winds which pass through the gap between Block A and B, directed over the Block C site. As such the inclusion of a built form creates a localised downwash of this redirected southerly wind, to the ground plane. While the design of the Block C tower form will have an influence on the conditions in this area, the design of the elements in the gap between Block A and B is noted to also have an influence as discussed in the following section. The design of the Block C tower can be responsive to this wind flow, with multiple design responses that can provide the required outcome at this location, if required. The appropriate stage at which to specify what these would be is as part of a detailed design for a future DA submission. Such submission will be informed by any further development in the Block A and Block B designs in order to ensure that there is a combined response for the precinct. Although the specifics of the design will be determined at a future stage, it is noted that horizontal articulation could be in the form of recesses or protrusions in the building form itself with a variation in the floor plate extent or as elements attached to the primary façade as in the case of fins. It may also comprise a combination of devices, subject to the architectural response. The criteria for such design devices would be to provide the necessary disruption to any downwash wind patterns and would be informed and verified by wind tunnel testing.

Furthermore to this, it is noted that this gap between Block A and B will be part of a future access to the Central Station OSD development, with built forms of varying heights noted in this future precinct. The expected built form in this area is expected to breakup these redirected southerly winds between Block A and B, preventing this wind effect reaching this location.



388 George Street, Sydney

(Note: Image courtesy of Skyscrapercity)



825 Ann Street, Fortitude Valley

(Note: Image courtesy of HDR)

Image 2: Project examples of horizontal articulation

Pavilion Design Development

Modelling undertaken in co-ordination between Block A and Block B indicated the collaborative approach at the nexus of the three sites to improve the overall conditions. Pavilion design modelled consists of the angled pavilion roof as well as a screen option as per that noted in the Block A RtS submission wind report. The Pavilion design is located within Block B and is not controlled by the Block C proponent, however it is understood that Block B is continuing to refine the design of the Pavilion and such refinements may improve the wind conditions in the south east corner of Block C. Block C will respond to this design and specifically will consider any changes to the design as part of a future DA submission.



Angled Roof Pavilion



Solid Balustrade on Pavilion Roof

Image 3: Pavilion Roof Options (extract from the submitted Block A RtS Wind Environment Report)



As can be noted in Image 5, potential variations to the pavilion structure between Block A and B provided notable improvement to the wind conditions in Henry Deane Plaza, with only one localised area at the south-eastern corner of the Toga Central (Block C) is noted to exceed the safety criteria (24.9m/s against a criteria of 24m/s). This modelling was based on the reference scheme for Block C, as such with refinements expected during the Design Competition (such as built form articulation, and finalised design of the Pavilion Structure of Block B) the redirected southerly winds to this nexus between the three sites are expected to be able to be suitably addressed. The results of this study highlight the importance of considering all three sites collectively.

With the inclusion of a detailed design scheme for Block C and expected further refinement of Block A and B and including the expected landscaping for the area, the wind conditions are expected to satisfy the wind criteria outlined for the Western Gateway Precinct.

Wind Comfort Criteria vs Safety Criteria

A query is noted to have been raised by DPIE as to have location 12 can meet the walking criteria but at the same time, marginally exceed the wind safety criteria. This has been discussed in further detail below.

Wind velocity values can be described in terms of a mean velocity, a gust velocity or a combination of the two often referred to as a Gust Equivalent Mean velocity (which consists of the mean velocity and a multiple of the root mean square of the velocity). The variance between the gust component and mean component of wind depends on the turbulence levels for a given area with the mean to gust ratio varying between more open areas (lower turbulence) and urban environments (higher level of turbulence).

Gust wind speeds typically have the greatest wind force impact on pedestrians, with the sudden burst of wind that can make a person lose their footing. It is this gust wind speed that the safety criteria is based on, with an annual probability of exceedance in terms of risk. The Australasian Wind Engineering Society recommends this as a maximum 0.1% probability 3 second moving average gust wind speed of 23m/s at pedestrian height.

For pedestrian comfort however, consideration for both the gust component (which may rustle papers or leaves) as well as a mean component (a constant breeze can annoy patrons in a location over an extended period). The wind velocity associated with wind comfort is categorised and associated with the length of period and frequency of occurrence that a wind speed will be exceeded. There are different criteria globally that are used with an aim to relate frequency of when someone would feel uncomfortable and a wind speed.

In simple terms, safety criteria is aimed at making sure pedestrians are safe from being blown over, with a risk probability of this wind event not more than once or twice a year. Wind comfort however relates to how people use a space, hence consideration of the time periods of general usage is introduced and acceptance that it may feel too windy once every 5 days or a week. Hence why an acceptable wind comfort level can vary with season, what a person is doing or wearing as well as their perception of what comfort is.



Other factors impact a persons total holistic comfort level including temperature, humidity, solar radiance, noise and air quality.

Conclusion – Project Review Panel

The wind comfort conditions for the Western Gateway Sub-Precinct will be influenced by all three blocks and as such the design of each block must consider the influence on the surrounding areas. Consideration has been made for the evolving design of Block A and B, on the conditions associated with and influenced by the Block C design scheme. The design development of Block A and B have noted to improve conditions as the designs have evolved from planning proposal to detailed design schemes due to design form and articulation compared to the building envelope. As such the areas and wind conditions able to be influenced are expected to satisfy the wind comfort and safety criteria as the design develops and responds to the noted wind patterns.

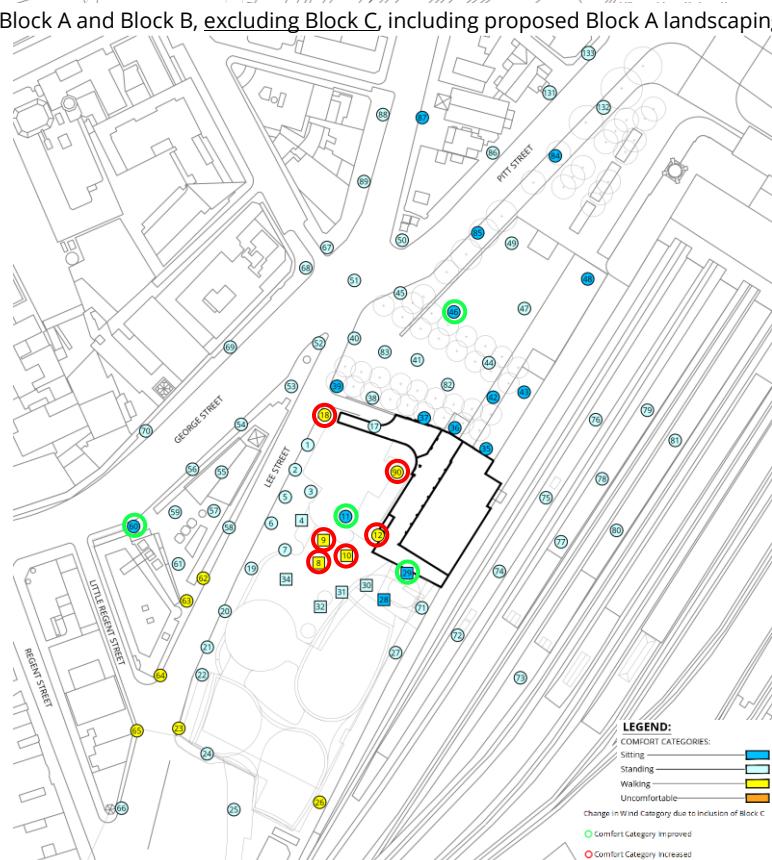
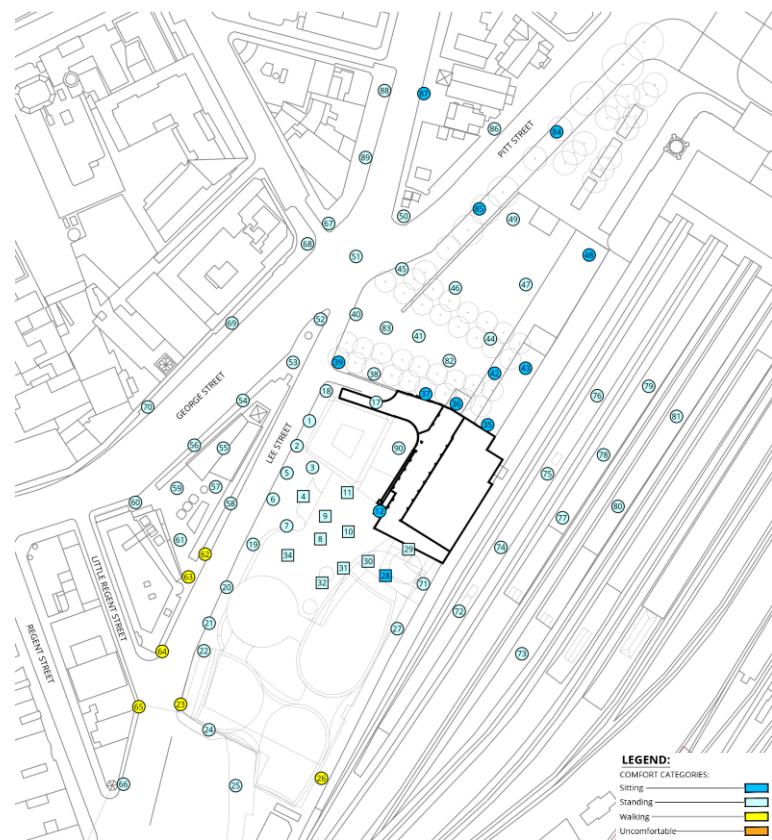
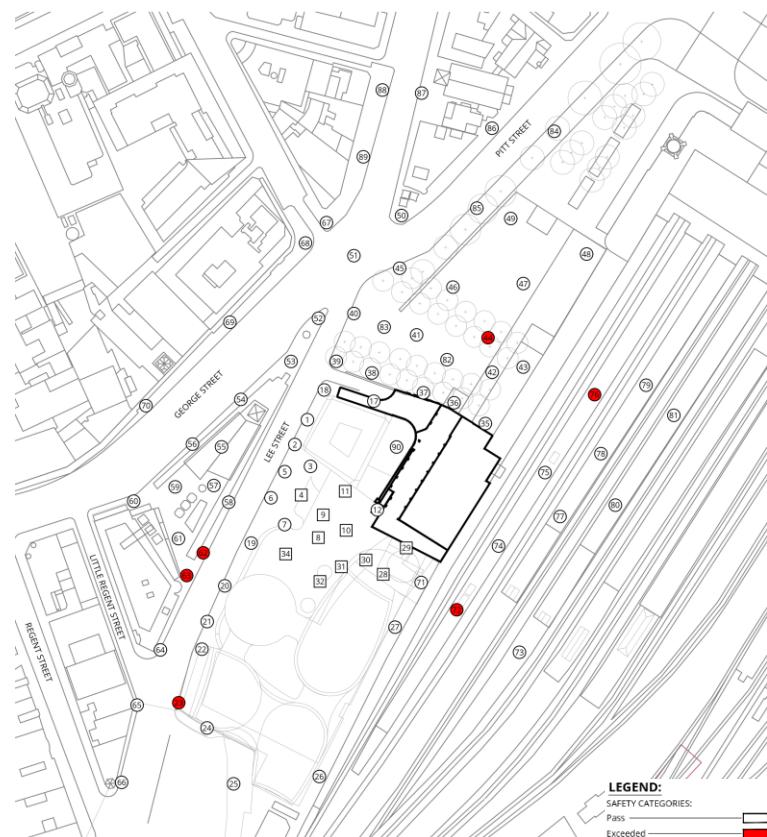
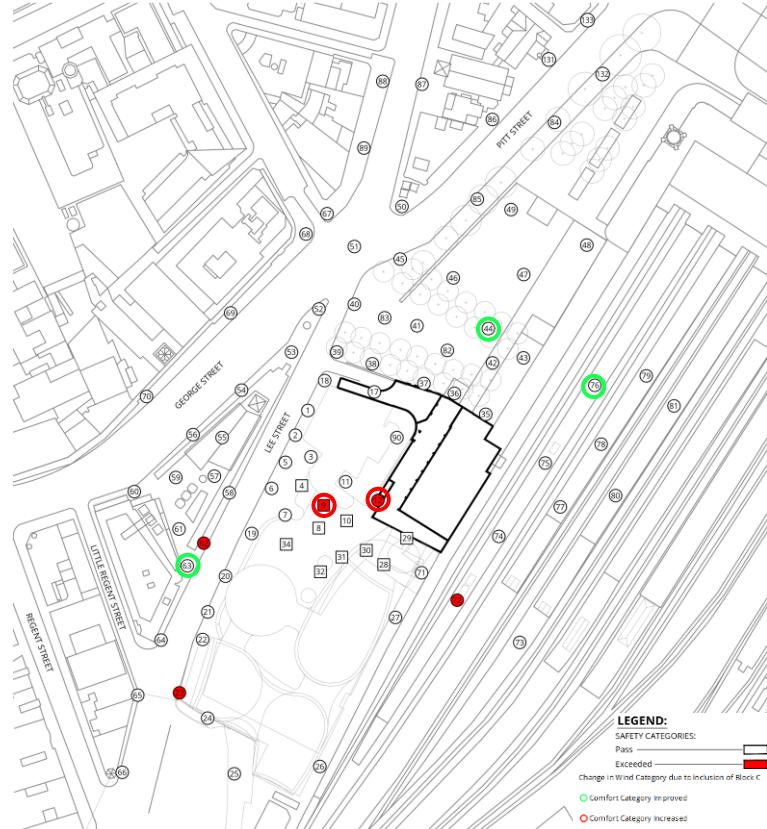


Image 4a: Wind Comfort Conditions with and without the Block C Reference Design



Proposed Block A and Block B, excluding Block C, including proposed Block A landscaping/mitigation



Proposed Block A and Block B, including Block C, including proposed Block A landscaping/mitigation

Image 4b: Wind Safety Conditions with and without the Block C Reference Design

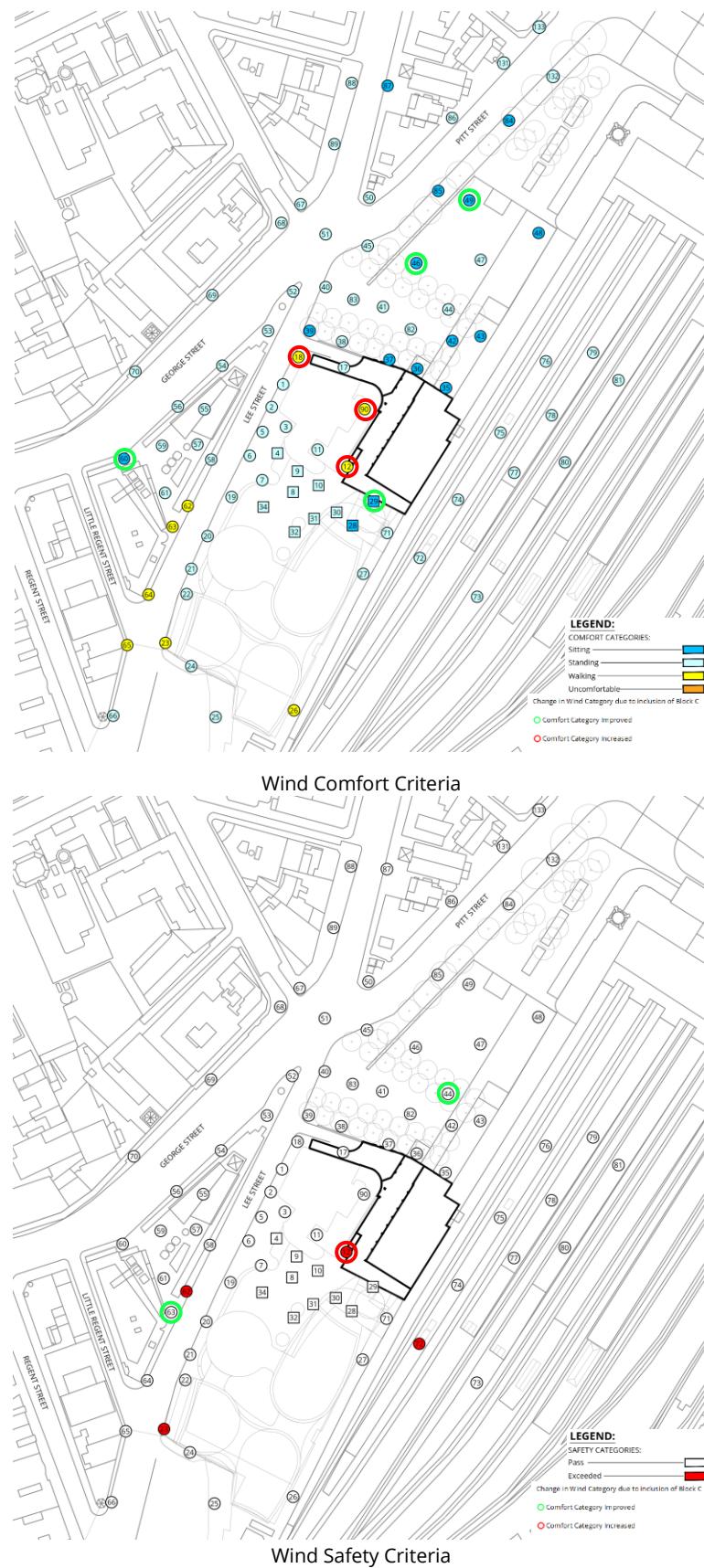


Image 5: Wind Conditions with Alternative Pavilion Structure Design

2 City of Sydney

It is understood that after public exhibition of the planning proposal documents for the Toga Central Development Block C, commentary has been provided on the key submissions received with regards to the wind environment conditions for the ground plane. The comments received are noted below, with commentary in response discussed in this report.

2.1 Wind Environment Comments

The wind modelling should be assessed against the comfort criteria stipulated in the Design Guideline criteria and the recently approved Central Sydney Development Control Plan clause which states that if the existing condition is uncomfortable or unsafe then it must not be made worse. Locations where the modelling shows worse conditions with the addition of the TOGA tower include:

- Locations 9 and 10 (North eastern corner HDP)
- Locations 13 and 14 (Between Blocks A and C)
- Locations 29 and 30 (Devonshire St bridge and stair to OSD)

2.2 RWDI Clarifications

As part of the initial site planning phase, computational modelling and wind tunnel testing was undertaken for Block C to refine the proposed building envelope as well as the most appropriate positioning of the tower on Block C. The wind tunnel testing is able to inform guidelines for the future Design Competition phase, advising Architects how the tower form on Block C can respond to the wind conditions, and mitigate adverse wind impacts to an acceptable level, while enabling flexibility in the ultimate design response within the proposed building envelope.

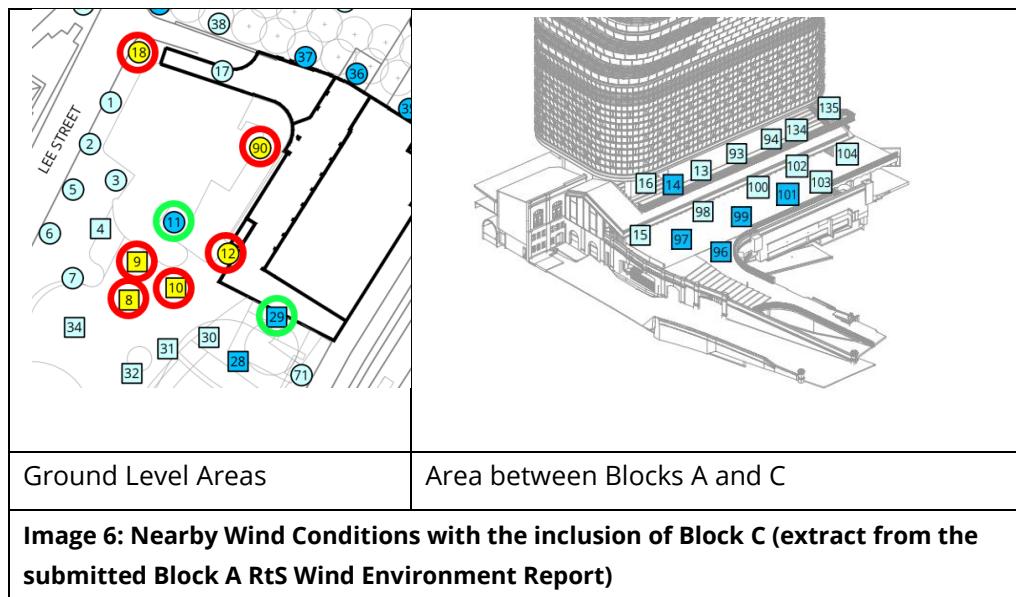
Modelling during this process was based on the available massing models at the time for Block A and Block B developments. This ensured that modelling and conclusions were comparing like-for-like with wind reports prepared for the broader Western Gateway Sub-Precinct. Wind modelling based on the building envelopes will provide a more conservative assessment of the final expected wind conditions for the precinct. The likely inclusion of articulation of the built form and façade will further assist in breaking up and slowing the wind flow in the precinct, resulting in calmer conditions. As such modelling of the updated design schemes for Block A and B will be included in future Development Applications for Block C.

Wind tunnel testing for the existing conditions as noted in the Pedestrian Wind Study report prepared for the Block C planning proposal indicated that the massing forms of Block A and B will impact the ground level wind conditions which will need to be considered as the design for Block A and Block B progress. The site location of the tower form of Block C has been responsive to these existing wind conditions with the following key aspects noted for the surrounding areas:

- The impact of wind on the proposed Third City Square has been documented in the wind assessment submitted with the rezoning application. This report

demonstrates that with the inclusion of the Block C reference design in the wind tunnel, that the wind comfort categories to the Third City Square are maintained or improved. Notably, four locations within the Third City Square are improved from a standing category to a sitting category (refer to Image 4a).

- The report also notes standing criteria is achieved on both sides of George Street and Pitt Street following the inclusion of the Block C reference design, demonstrating appropriate pedestrian amenity around the Third City Square.
- The City's submission highlights six locations, in three general areas, where the inclusion of the Block C reference design has resulted in wind conditions increasing within the sub-precinct. The City's submission notes two locations in the north eastern corner of Henry Deane Plaza and between Block A and Block C as resulting in worse conditions. With the updated design of Block B the following effects on the wind conditions are noted:
 - Location 9 and 10 both satisfy the walking criterion. While Location 9 was found to exceed the safety criteria with Block C included (Image 4b), it was found to be resolved with the alternative pavilion structure modelled.
 - The wind tunnel study for Block A RtS submission included additional study points (96 to 104) in place of where locations 13 and 14 were noted. This area is noted to satisfy the sitting and standing criteria with the wind mitigation on the Block A area as discussed in Section 1.2.
 - Locations 29 and 30 will satisfy the sitting and standing criteria respectively.



- The locations noted by the City of Sydney to require wind mitigation in association with Block C, are generally in the nexus of the three blocks of the sub-precinct. It is noted that the continuing development of Block A as well as Block B (including the pavilion design) has continued to improve the conditions in this nexus area. It is therefore acknowledged that conditions in this area will



need to be considered during the detailed design process and collaboration of the three blocks.

The results of the wind tunnel study note that the majority of the adverse wind impacts associated with the sub-precinct are not within the control of Block C, which is largely due to the significant work undertaken during the initial site planning phase to optimise the tower positioning and form to minimise wind impacts. However the design team for Block C will continue to work collaboratively with the stakeholders of the Western Gateway Sub-Precinct as the design for each block progresses. This will help to ensure that suitable wind conditions can be achieved for the overall precinct in a holistic approach in terms of design and mitigation strategies.