East Village Plot N18/19, London, United Kingdom

Wind Microclimate

For

Stratford Village Property Holdings 1 (SVPH1) and Stratford Village Property Holdings 2 (SVPH2)

8 December 2022

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Executive Summary

A wind microclimate study has been carried out by FD Global Limited (FDG) using a combination of Computational Fluid Dynamics (CFD) numerical modelling based analysis and model-scale boundary layer wind tunnel testing based analysis to provide an assessment of the pedestrian level wind environment for the proposed East Village Plot N18/19 development project. The study has considered the wind regime for existing and proposed site conditions and incorporates the generic wind climate at the site based on long-term wind statistics that have been manipulated using industry standard models of the Atmospheric Boundary Layer (ABL). The potential for the proposed development to impact the ground level wind microclimate in the proposed site conditions has been explored for existing surrounding conditions and also for future site context that comprises the proposed site conditions for Victory Park / Belvedere and Plot N16 within the East Village masterplan as well as other known committed developments.

From this assessment the following key conclusions and observations are drawn for the proposed Plot N18/19 development:

- With the proposed development in place the wind microclimate in the public realm will remain suitable for the planned uses in existing surrounding context with the cleared Plot N16 site and also in future surrounding context including the proposed Plot N16 development and the proposed Victory Park/Belvedere development as well as consented developments that are not part of the East Village Masterplan development.

- The exception to the above is two sensitive receptors in Celebration Avenue (Receptor G91) and Anthems Way (Receptor G8) that require wind mitigation measures for the surrounding condition with the cleared Plot N16 site.

- The present wind assessment has developed wind mitigation measures and validated these for effectiveness in providing suitable mitigation against these impacts. Specifically, the wind mitigation measures comprise of 14m height trees within the proposed soft landscaping measures along the south western perimeter of the site boundary. With wind mitigation measures in place the proposed development has no residual impacts through the public realm for any of the assessment scenarios.

- The wind impacts of the proposed development compare favourably to those of the consented reference scheme.

1. Table of Contents

2. Overview

The present report summarises the key processes and findings of wind microclimate studies that have included Computational Fluid Dynamics (CFD) based modelling and model-scale boundary layer wind tunnel testing based approaches carried out by FD Global Limited (FDG) for the proposed redevelopment of the East Village Plot N18/19 site in central London, United Kingdom.

The studies provide an assessment of potential wind impacts on the public realm, in key areas of sensitive pedestrian uses within the development and the surrounding areas for the proposed site conditions and benchmarks these to the existing site conditions, based on accepted UK industry standard criteria.

In particular, the assessment gives detailed consideration to potential cumulative wind impacts with the proposed redevelopments at the East Village Victory Park / Belvedere and Plot N16 sites. Furthermore, the assessment provides a comparison of potential wind impacts of the proposed N18/19 development with the earlier consented reference scheme.

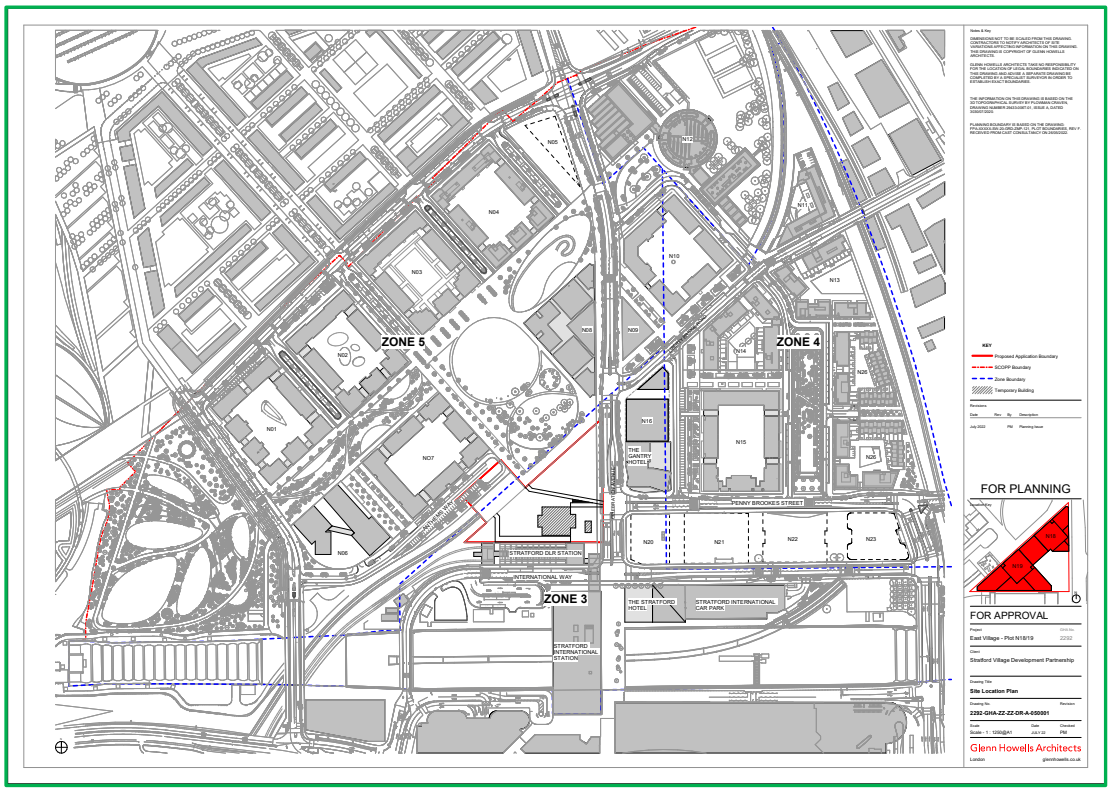
3. The Site

3.1. The Site Location

Plots N18/N19 (the Site) collectively comprise a triangular Site to the immediate north of the Stratford International Docklands Light Railway (DLR) Station.

The Site comprises one of the last remaining vacant development Plots within East Village and is currently occupied by Get Living's management suite.

The Site is bounded by Celebration Avenue to the east, Victory Park and Anthems Way to the northwest and Stratford International DLR Station to the immediate south.



The Site Location

3.2. Site Description

The Site is located within East Village – an established and vibrant residential neighbourhood that forms part of the wider Stratford City development. The Site is currently occupied by Get Living's management suite, a single storey building that has occupied the Site since 2014 (it will be removed to facilitate permanent development). A temporary pedestrian route connecting to Victory Park runs through the Site. The triangular site is defined by three edges: south, east and northwest.

The south of the Site is occupied by the Stratford International DLR station, beyond which lies International Way and Stratford International Station (SIS). The south edge abuts the rail line which is sunken below grade but open to the elements above. A large retaining wall separates the rail line from the edge of the site. The primary station entrance is adjacent to the southeast corner of the site at approximately 6.8 AOD.

The northwest side of the Site faces Victory Park and the existing outdoor gym along Anthems Way. It is relatively flat at 13.0m AOD. Whilst the northwest is bounded by Victory Park and Anthems Way, the Site is located right up to the edge of the High Meads Loop Enclosure (HMLE) which is partially open to above at the south corner, but primarily covered to from existing Neighbourhood Equipped Area of Play (NEAP) and Victory Park. A pedestrian and cycle route runs along the north western boundary of the Site in a north east/south west axis. This comprises cyclists in a shared pedestrian environment.

The east side of the Site is adjacent to Celebration Avenue, a two-way carriageway that runs north/south through East Village, connecting to the wider highway network. The road is adopted highway by the London Borough of Newham (LBN). There is a significant slope along Celebration Avenue from approximately 8.0m AOD at the DLR entrance up to 13.0m AOD at the northernmost edge of the Site. Celebration Avenue is well used by pedestrians coming to and from the DLR or Westfield.

3.3. The Surrounding Terrain

The far field terrain roughness that affects the generic wind regime at the site in terms of wind strength and gustiness for winds approaching the site from the northerly, easterly, southerly, and westerly wind sectors is characterised as built up urban/suburban terrain. This terrain category has been used in the assessment of the site specific wind profiles that define the vertical variation of wind speed and turbulence with height for each wind sector.

Site Location – Far Field View and Terrain

The wind regime at the site is affected by the near-field surrounding terrain that can locally cause effects such as wind shielding and/or wind funnelling and is shown below in top down view.

The Site and Near-Field Surrounding Buildings

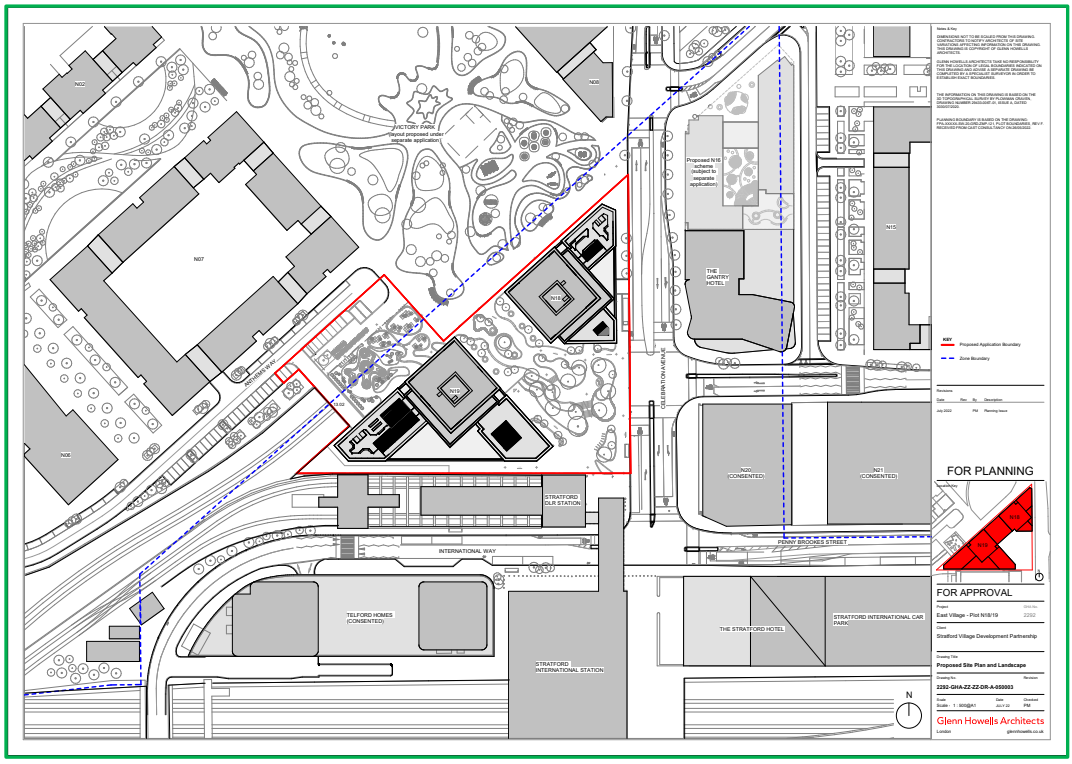
The buildings of the surrounding area that have been considered in the wind microclimate assessment extend up to 650m distance from the nominal centre of the site. For the purpose of the present wind microclimate assessment the site specific wind regime has been analysed based on upwind terrain categorisations for each approach wind sector.

3.4. Existing Site Access

The Site does not currently have vehicular access and is accessed on foot only. The southeast corner connects to the DLR station entrance and allows people to flow through the forecourt of the former Get Living management suite and up into Victory Park. Service access is provided behind a controlled gate along the south edge of the site.

3.5. The Proposed Development

Reserved Matters Application for layout, scale, design, appearance, access and landscaping pursuant to Conditions B1, B8, B9, B10, K6, K6a, Q1 and Q4 of the Stratford City Outline Planning Permission (ref: 10/90641/EXTODA) comprising the construction of two buildings extending to G+39 storeys (+147.6 m AoD) at N18 and G+34 storeys (+132.0 AoD) at N19 to provide up to 848 residential units with complementary retail (Use Class E (a)-(c) and Sui Generis (drinking establishments and hot food takeaways); associated blue badge parking, motorcycle and cycle parking; new vehicular access from Anthems Way and Celebration Avenue; alterations to the existing open space within Victory Park and the redesign of the existing Neighbourhood Equipped Area of Play (NEAP) to allow the creation of a new vehicular access; and associated works, together with approval in writing pursuant to condition O9 to erect residential dwellings that will experience levels of ground borne noise from railway tracks in excess of the maximum level cited in condition O8 of the outline planning permission.



Site Plan and Landscaping

3.6. Proposed Site Access

Vehicular access to the Site is proposed from Anthems Way to Plot N19 and from Celebration Avenue to Plot N18. The Anthems Way access will result in the relocation of the existing NEAP (to be secured as part of a separate planning application submitted concurrently with this RMA). This provides the main access into the Plot including car parking (blue badge only to serve N19 – no standard car parking spaces are proposed) and refuse/service access.

The Celebration Avenue access provides access to the 7 blue badge car parking spaces for Plot N18. A lay-by along Celebration Avenue will be relocated to allow for refuse/service and visitor drop-off.

There will be three resident access points the building: the primary residential entrance from Station Square and two secondary entrances from Victory Park.

The primary entrance is designed to accommodate all residents, including those on foot, in wheelchairs/scooters and on bikes. The entrance will have two sets of automatic sliding doors to create a draught lobby and allow for hands free entrance to optimise inclusive design. Cyclists have direct access to the cycle store just inside the lobby. Fob security points will provide security.

At park level, Plots N18 and N19 each have a lobby on the corner facing the Gateway and Victory Park. These lobbies provide direct access to resident cores and connect to the main lobby below at Station Level through the lifts and feature stairs.

A central route diagonally (known as “the Gateway”) and centrally through the Site provides a direct link from Westfield/Stratford international DLR/Stratford International Station up to Victory Park, and the Velodrome beyond.

There is no cycle route through the public realm. The design is intended for pedestrians and wheelchairs only. The circa 5m level change through the site is accommodated with a 1:21 or less compliant slope which meanders between the buildings, offering lift free access that connects the DLR station to Victory Park. The route is surrounded by greenery and active ground floor uses. The top of the route will legibly and intuitively lead to the Velodrome from Victory Park.

3.7. Building Massing

The proposed Plot N18/19 development is shown in the following figures in elevation view.

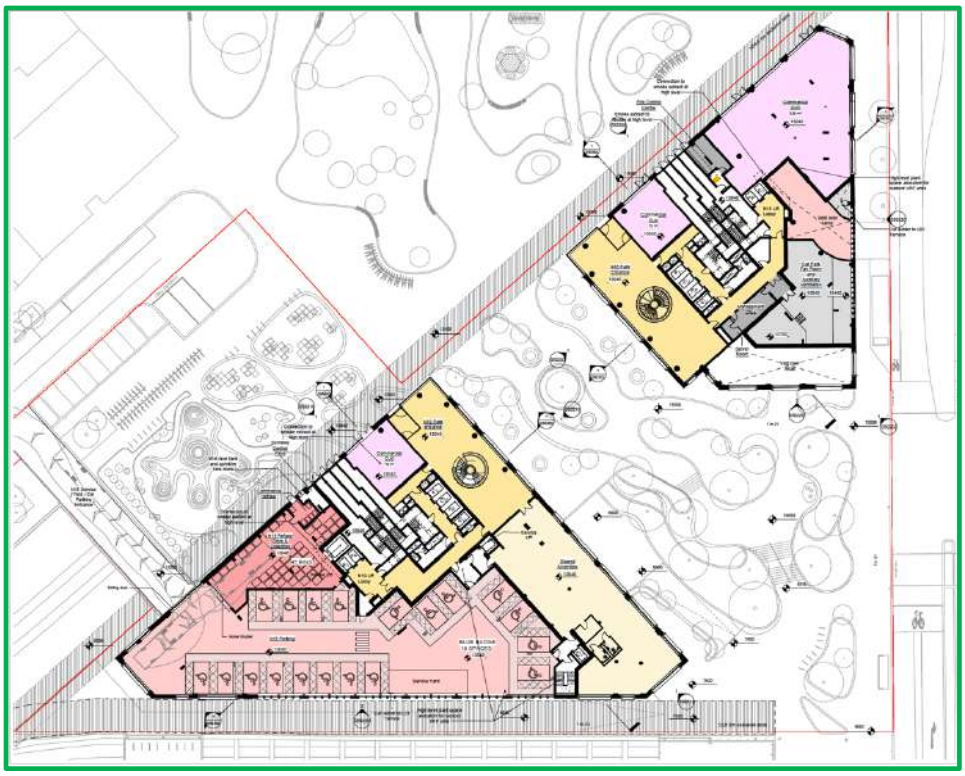
Proposed Site – N/18 and N/19 North West Elevation

Proposed Site – N/18 and N/19 North East Elevation

Proposed Site – N/18 and N/19 South East Elevation

Proposed Site – N/18 and N/19 South West Elevation

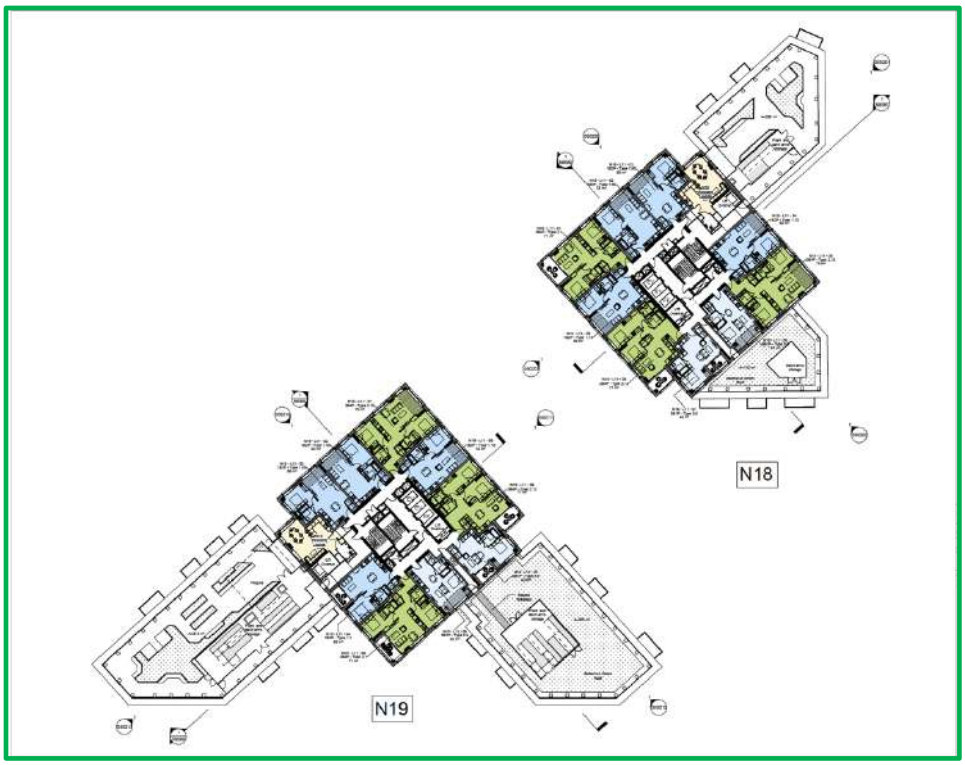
The site slopes from north west to south east at ground level. The public realm at ground level in the areas surrounding the proposed development is shown below by way of ground floor plans at park level and at station level.



Proposed Site – Ground Floor Plan at Park Level

Proposed Site – Ground Floor Plan at Station Level

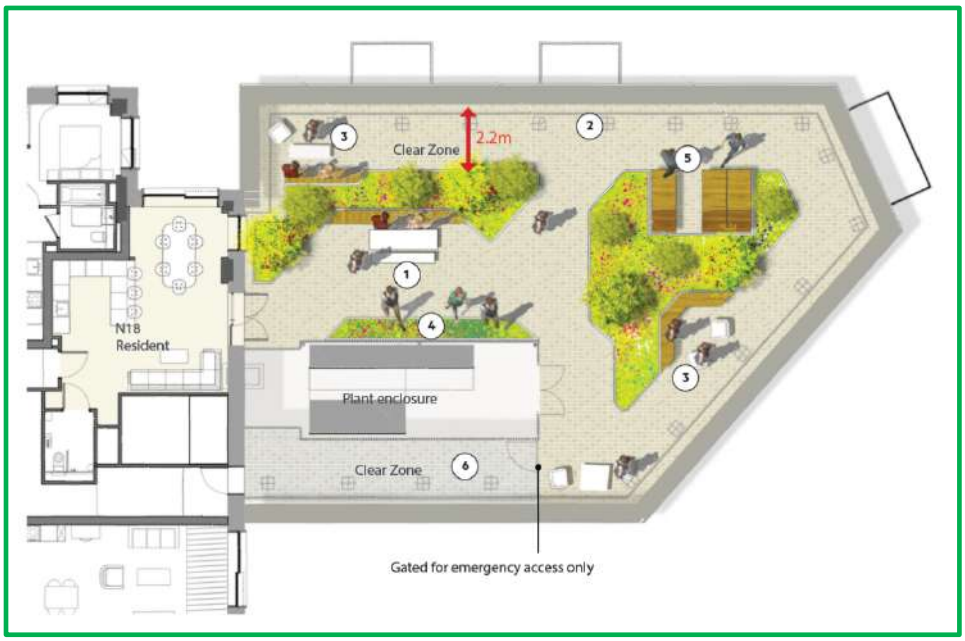
At elevated level the public realm comprises roof terraces at level 11 which are shown in plan below.



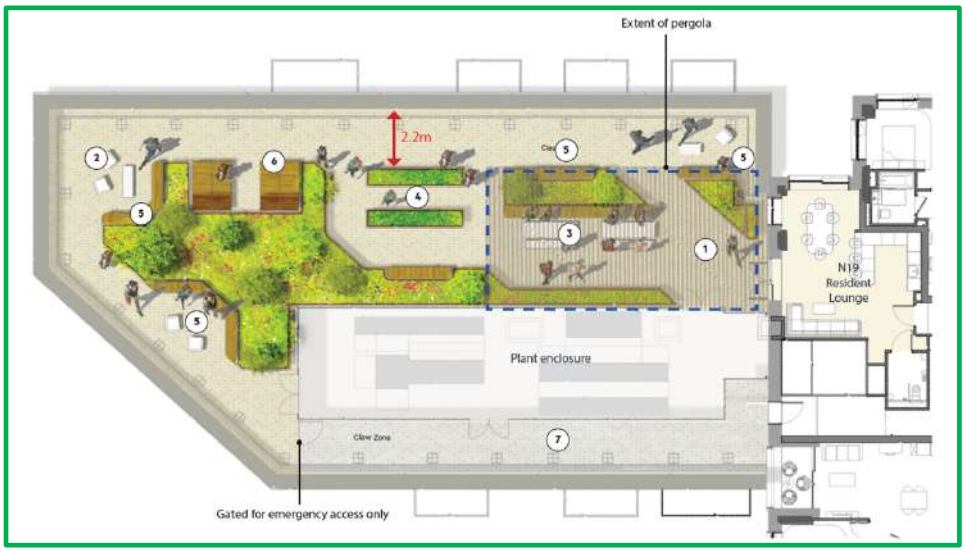
Proposed Site – Amenity Terraces at Level 11

The public realm within the site incorporates significant hard and soft landscaping measures. These are shown in illustrative form for ground level and level plan views.

Proposed Site – Ground Level Soft Landscaping Plans



Proposed Site – Soft Landscaping Plans N/18 Level 11



Proposed Site – Ground Level Soft Landscaping Plans N/19 Level 11

3.8. Future Committed Developments / Emerging Context

The wind microclimate assessments have given due consideration of the emerging context and known future developments that are either under construction or at an advanced stage in the planning process beyond the proposed developments within the East Village Masterplan. The present assessment incorporates these developments as separate modelling scenarios based on the emerging context information that has been derived from the respective planning portals. These modelling scenarios consider specific developments that are deemed to affect the wind regime at the site that have been provided to FDG for the purpose of the present wind microclimate assessment.

The committed developments that have been considered in the assessment specifically include :

1. East Village Plot 5
2. East Village Plot N16
3. East Village Plot N18/19
4. East Village Plot N20
5. East Village Plot N21
6. East Village Plot N23
7. East Village Plot N25
8. IQL South S2 & S3
9. IQL South S4
10. IQL South S10
11. IQL South S1/S11
12. Stratford Waterfront
13. Madison Square Gardens
14. Chobham Farm Zone 1 Full
15. Legacy Communities Scheme (LCS)
16. LCS PDZ6 Phase 3
17. LCS PDZ6 Phase 4
18. LCS PDZ5
19. LCS PDZ4
20. UCL East
21. Stratford Centre
22. Stratford International Bus Layover Site
23. Stratford City Zone 1
24. Westfield
25. Westfield M7
26. Westfield Cherry Lane
27. Westfield Angel Lane
28. 304-308 High Street
29. 302-312 High Street Stratford
30. Jubilee House
31. Queens Yard
32. James Riley Point
33. Land Adjacent to Meridian Steps

The present assessment has included the above numbered committed development sites 1, 14, 16, 17 and 24 as part of the existing surrounding context on the basis that their construction is deemed to be at a sufficiently progressed stage so that their impact on the wind regime of the Plot N16 site is not considered to be materially different from what it would be expected to be at full completion.

Furthermore, the above numbered committed development sites 12, 13, 21, 25, 27 and 33 have not been included explicitly in the 'Committed Development' modelling scenarios because they are not deemed to affect the wind regime at the Plot N18/19 site.

4. Wind Comfort Assessment Methodology

4.1. Overview

The local site wind regime around buildings is governed by the background windiness, the aerodynamics of the development itself and aerodynamic proximity effects from the surrounding buildings, which can cause wind funnelling, downdraft and/or wind shielding effects. All of these factors vary respectively with approach wind direction and need to be accounted for wind sector by wind sector.

The predictive assessment of pedestrian wind comfort in the built environment requires consideration of the generic wind regime at the site in terms of the wind strength and the wind turbulence which determines the gustiness. In addition, local ground level wind flow patterns that are likely to occur in the proposed site conditions between the target development being assessed and the surrounding buildings, need to be assessed for prevailing and non-prevailing wind directions. Lastly, the frequency of occurrence of key wind events predicted for the proposed site conditions needs to be assessed based on long term wind statistics for the site.

Combining the three components of the wind assessment allows exceedance of wind speed bands that relate to accepted UK industry standard comfort and safety criteria to be predicted and, therefore, the suitability of the pedestrian wind environment for its' planned uses in key areas to be assessed.

The present assessment is based on CFD modelling of the wind flow patterns around the development for 36 wind directions. The technical details are given in Appendix B of the report. The methodology of the present assessment is consistent with the assessment methodology of the reference scheme implemented in the 2014 ARUP/BMT wind reports and has been agreed with ARUP / LDDC in regards of:

- Wind climate statistics
- Wind tunnel modelling approaches
- Definition of sensitive receptors
- CFD and wind tunnel testing matrices
- Assessment criteria

As a result, the methodology applied in the present assessment is self-consistent with that of the reference scheme and allows like for like comparison of the key outcomes.

4.2. Wind Comfort and Safety Assessment Criteria

The present assessment is based on the UK industry standard accepted formulation of the so-called Lawson criteria (the LDDC version), originally developed by Professor Tom Lawson of Bristol University, UK. The comfort criteria are based on a 5% time exceedance of the threshold wind speeds, that relate to tolerable wind conditions for categorised types of pedestrian activity. These are tabulated below. It is conventional to apply these criteria on a seasonal basis considering summer and worst case seasonal comfort ratings. The LDDC criteria also requires an assessment of pedestrian safety with respect to wind force. The safety criteria are based on a 0.022% (once per annum) seasonal exceedance of the threshold wind speeds 15 m/s and 20 m/s. The criteria are shown below.

Threshold Mean- hourly Wind Speed Exceeded < 5% of the Time	Comfort Rating / Activity	Qualifying Comments
0 - 4m/s	C4 - Long-term standing / sitting	Reading a newspaper and eating and drinking
4 - 6m/s	C3 - Short-term standing / sitting	Appropriate for bus stops, window shopping and building entrances
6 - 8m/s	C2 - Leisure thoroughfare / strolling	General areas of walking and sightseeing
8 - 10m/s	C1 - Pedestrian transit / thoroughfare (A-B)	Local areas around tall buildings where people are not likely to linger
> 10m/s	C0 - Uncomfortable for all uses	Uncomfortable for all pedestrian activities

LDDC Comfort Criteria

Mean and GEM wind speed (0.22% exceedance)	Category	Description
> 15 m/s	S2 - Unsuitable for general public	Less able and cyclists find conditions physically difficult
> 20 m/s	S1 - Unsuitable for able-bodied	Able-bodied persons find conditions difficult. Physically impossible to remain standing during gusts.

LDDC Safety Criteria

4.3. Impact Significance Criteria

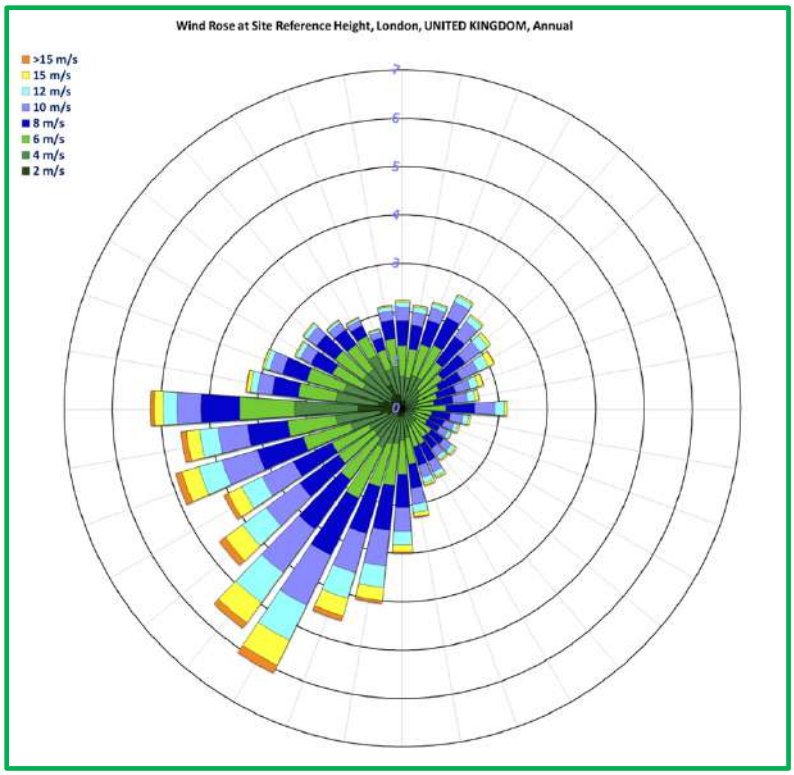
The significance of the potential impacts of the proposed development have been assessed on the basis of impact significance criteria of the 2019 City of London Tall Building Guidelines, for on-site and off-site sensitive receptors. They are shown below.

On-site Receptors		
Significance	**Trigger**	**Mitigation required?**
Major Adverse	Conditions are 'unsafe'.	**Yes**
Moderate Adverse	Conditions are 'unsuitable' (in terms of comfort) for the intended pedestrian use.	**Yes**
Negligible	Conditions are 'suitable' for the intended pedestrian use.	**No**
Moderate Beneficial	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	**No**

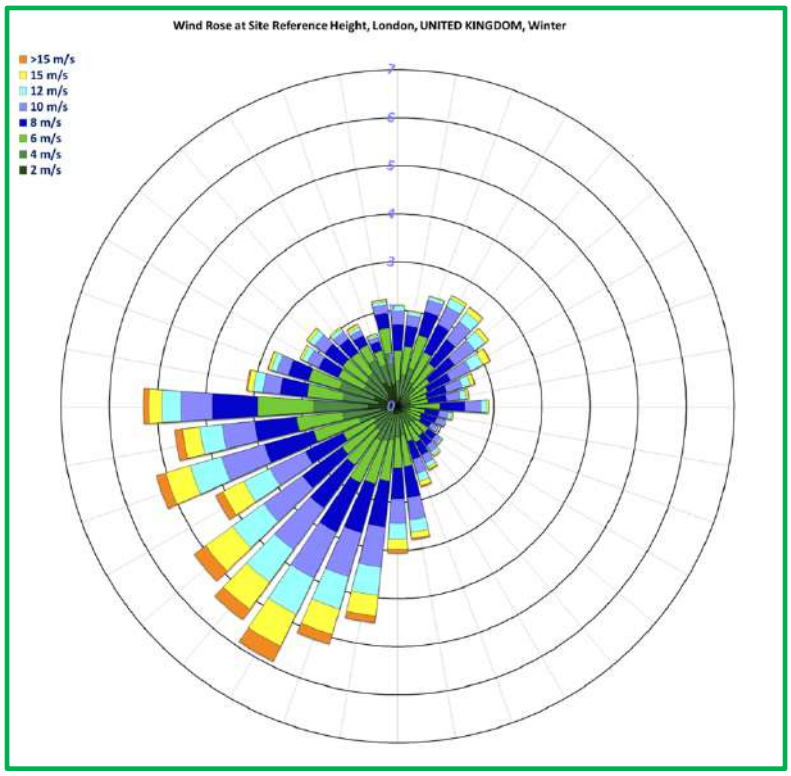
Off-site Receptors		
Significance	**Trigger**	**Mitigation required?**
Major Adverse	Conditions that were 'safe' in the baseline scenario become 'unsafe' as a result of the Proposed Development. OR Conditions that were 'suitable' in terms of comfort inthe baseline scenario become 'unsuitable' as a result of the Proposed Development.OR Conditions that were 'unsafe' in the baseline scenario are made worse as a result of the Proposed Development.	**Yes**
Moderate Adverse	Conditions that were 'suitable' in terms of comfort in the baseline scenario are made windier (by at least one comfort category) as a result of the Proposed Development but remain 'suitable' for the intended pedestrian activity.	**No**
Negligible	Conditions remain the same as in the baseline scenario.	**No**
Major Beneficial	Conditions that were 'unsafe' in the baseline scenario become 'safe' as a result of the Proposed Development.	**No**
Moderate Beneficial	Conditions that were 'unsuitable' in terms of comfort in the baseline scenario become 'suitable'as a result of the Proposed Development. OR Conditions that were 'unsafe' in the baseline scenario are made better as a result of the Proposed Development (but not so as to make them 'safe').	**No**

4.4. Site Specific Wind Climate/Statistics

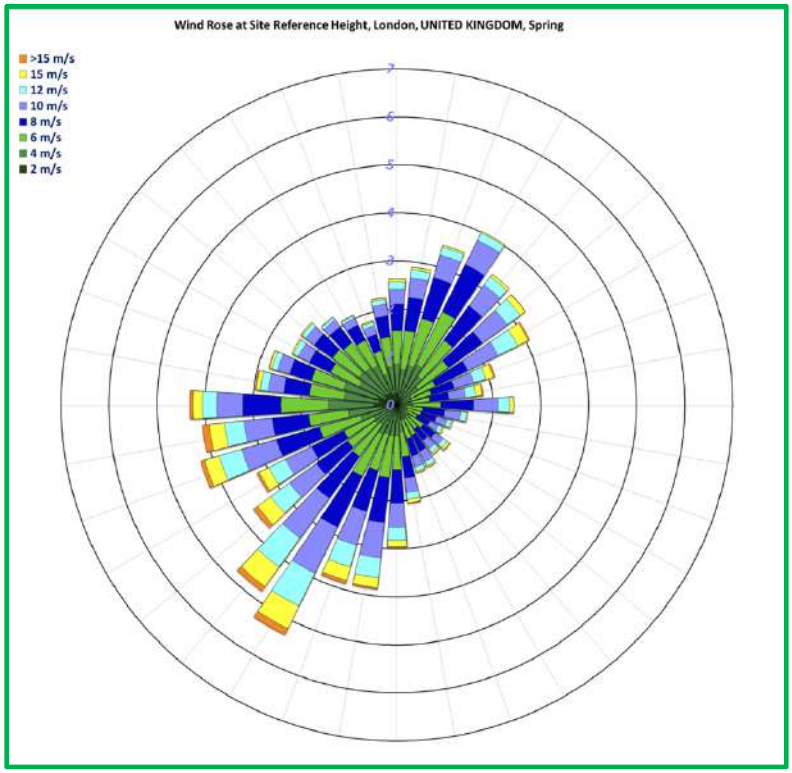
The wind climate statistics that have been applied in the present assessment are based on the wind climate properties given in the ARUP / BMT 2014 wind reports for the reference scheme which have been adjusted for the building reference height at the site in accordance with site specific wind transposition factors. The resulting site specific wind roses are shown below in form of annual and seasonal statistics.



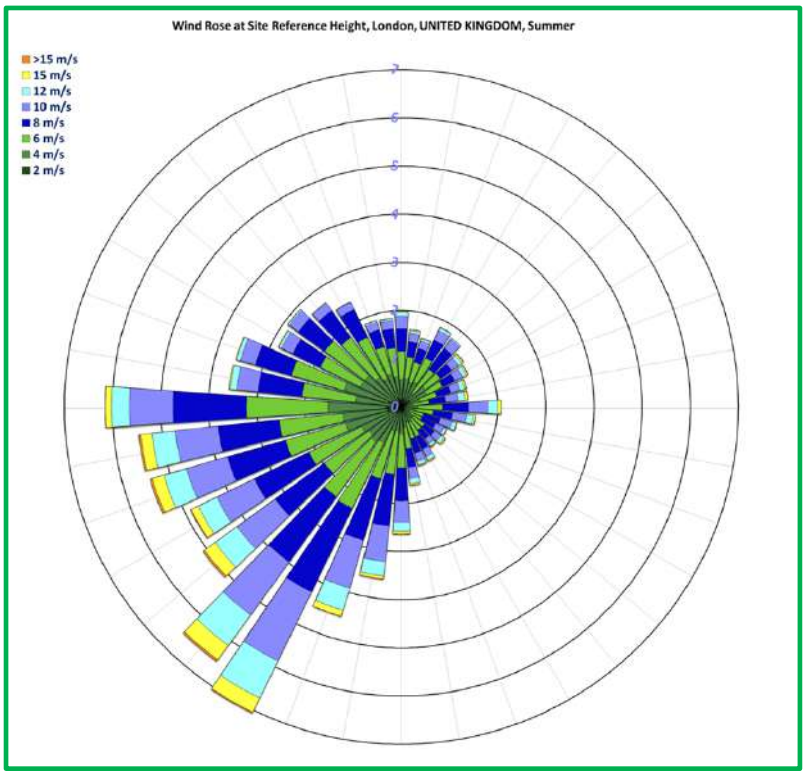
Wind Frequency Distribution by Wind Sector – Annual (At Reference Height)



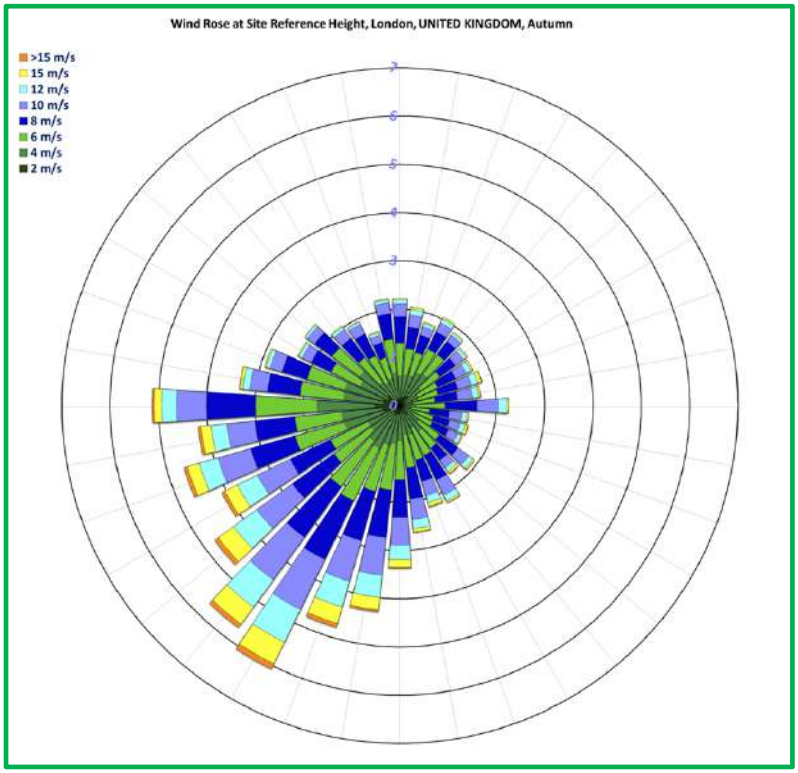
Wind Frequency Distribution by Wind Sector – Winter (At Reference Height)



Wind Frequency Distribution by Wind Sector – Spring (At Reference Height)



Wind Frequency Distribution by Wind Sector – Summer (At Reference Height)



Wind Frequency Distribution by Wind Sector – Autumn (At Reference Height)

It can be seen that the prevailing wind sectors at the site across all seasons are South West (SW), West South West (WSW) and West (W). In Spring and Winter the north easterly (NE) wind sector emerges as

a second dominant wind sector (30° EoN to 60° EoN), though winds originating from this wind sector are weaker than the prevailing south westerly winds.

5. Wind Comfort / Safety Assessment

5.1. Assessment Scenarios

The assessment scenarios for the present wind microclimate assessment are shown in 3D isometric view in Appendix A and are tabulated below in summary format. The scenarios comprise baseline scenarios for the existing conditions in Victory Park / Belvedere and cleared sites for development plots N18/19 and N16. The proposed site conditions have been assessed for a number of sequential scenarios with and without the proposed developments for Victory Park / Belvedere and Plot N16 and also the consented reference scheme. The sequence of scenario numbers is part of a greater assessment matrix that encapsulates primary planning scenarios for N16 and Victory Park / Belvedere.

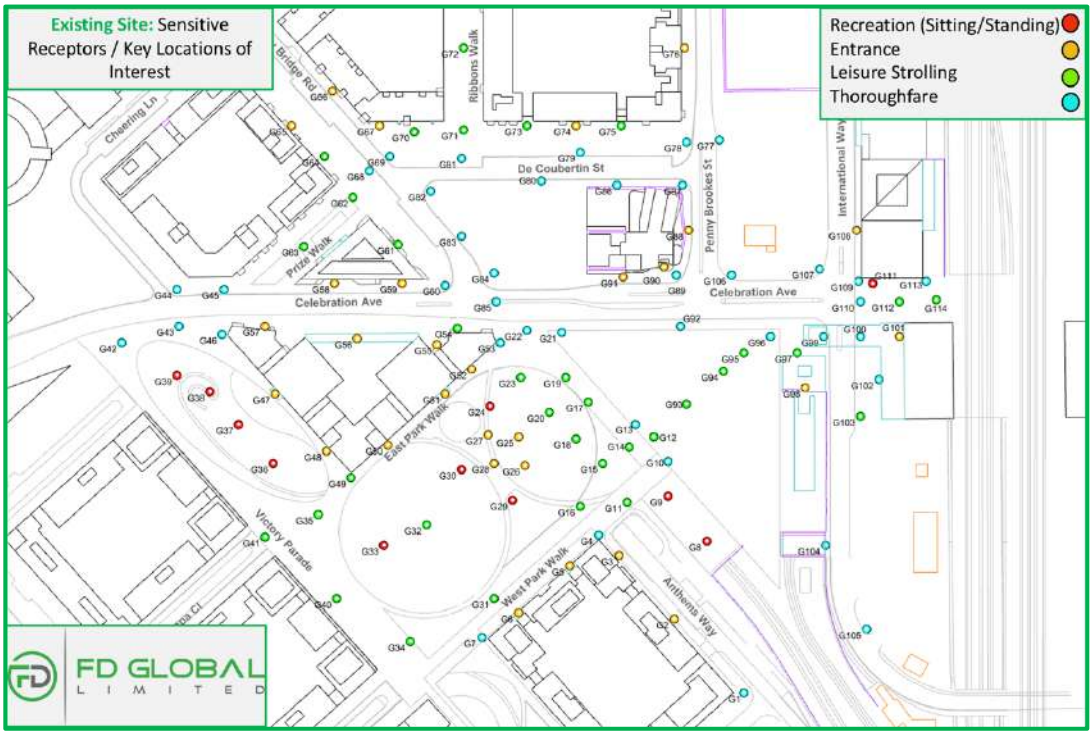
In particular, the assessment scenarios refer to the four scenarios of the ARUP scoping report (ASR) 'East Village_N18 19_ Scoping note to LLDC_draft 17.01.2022' dated 17th January 2022. The table below itemises the scenarios including cross-references to the ASR scenario numbers for ease of reference against the ARUP Scoping report.

Assessment Scenario No.	Description
1 (ASR Scenario 1)	**Existing** site conditions for Victory Park/Belvedere, **Empty** site Plot N18/19, **Empty** site Plot N16, **Existing** surrounding buildings
3 (ASR Scenario 2)	**Existing** site conditions for Victory Park/Belvedere, **Proposed** Plot N18/19, **Empty** site Plot N16, **Existing** surrounding buildings
5 (ASR Scenario 3)	**Proposed** site conditions for Victory Park/Belvedere, **Proposed** Plot N18/19, **Empt**y site Plot N16, **Existing** surrounding Buildings
6 (ASR Scenario 4)	**Proposed** site conditions for Victory Park/Belvedere, **Proposed** Plot N18/19, **Proposed** site Plot N16, **Existing** surrounding Buildings
7	**Existing** site conditions for Victory Park/Belvedere, **Consented** Plot N18/19, **Empty** site Plot N16, **Existing** surrounding buildings
8	**Proposed** site conditions for Victory Park/Belvedere, **Proposed** Plot N18/19, **Proposed** site Plot N16, **Existing** surrounding Buildings + **Committed Developments**

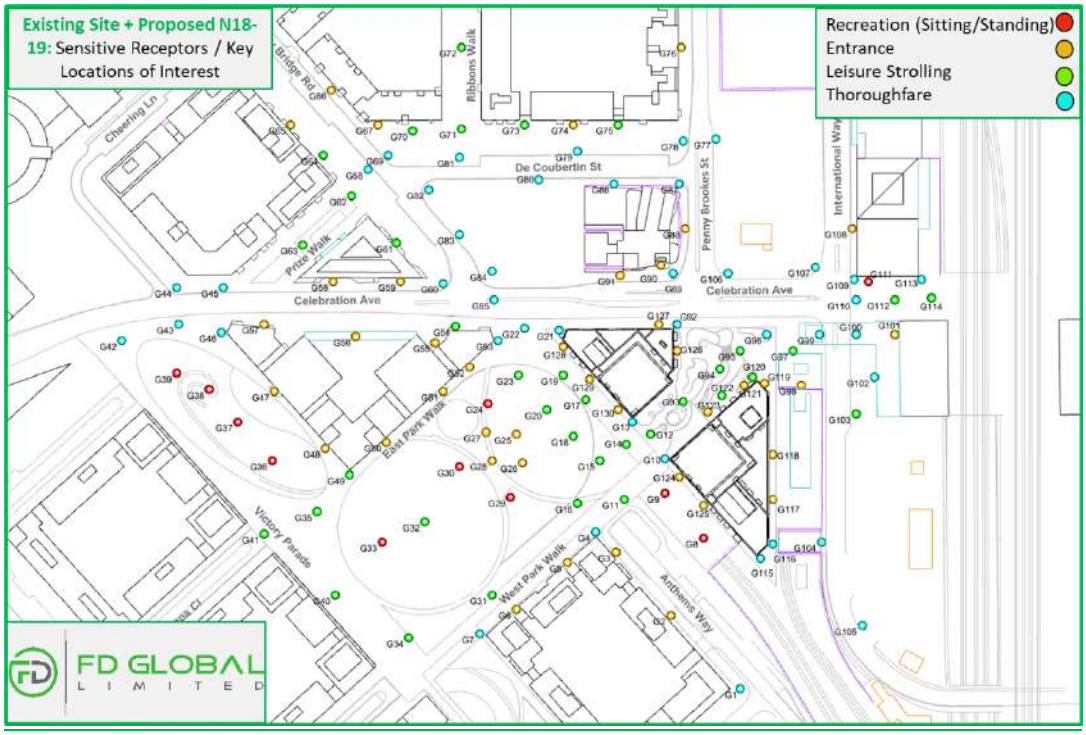
All assessment scenarios have been evaluated using CFD simulations. The wind tunnel tests have been carried out for assessment scenarios 1, 3, 5 and 6 and also associated mitigation testing.

5.2. Sensitive Receptors in the Public Realm

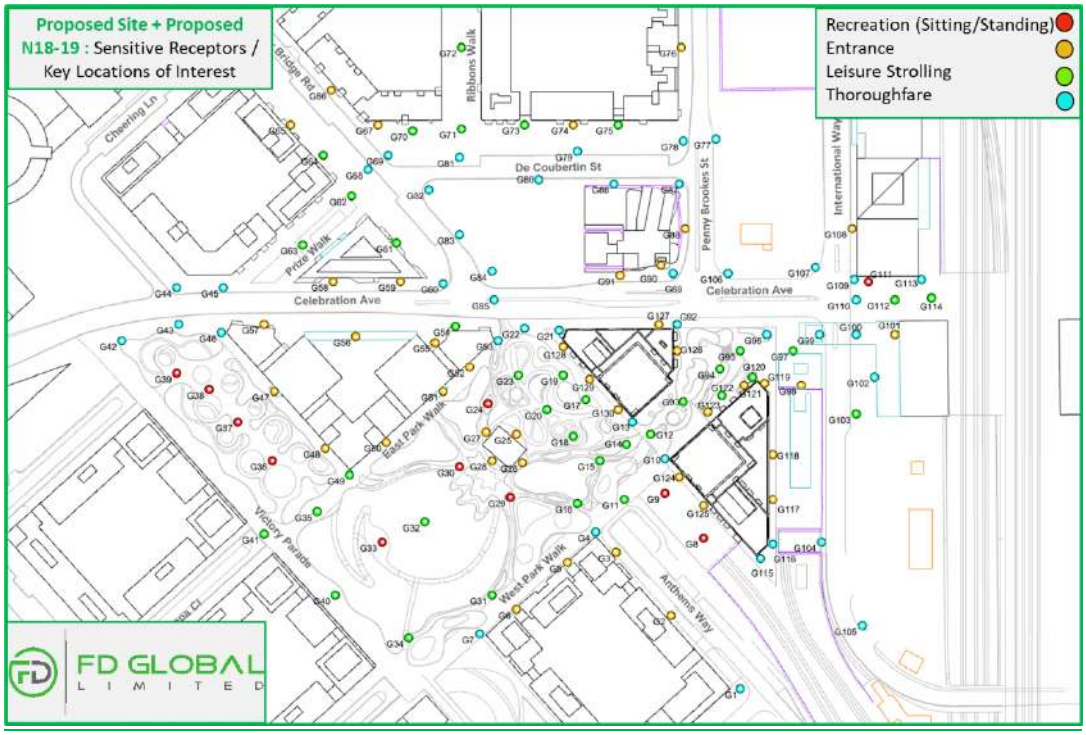
Based on FDG's understanding of the planned pedestrian uses in the proposed site conditions, minimum target comfort ratings have been defined for the various sensitive receptors in the public realm. These are based on the above set of criteria that ensures the pedestrian wind environment is suitable for the planned pedestrian activities. The target safety rating at all locations is 'safe for all users'.



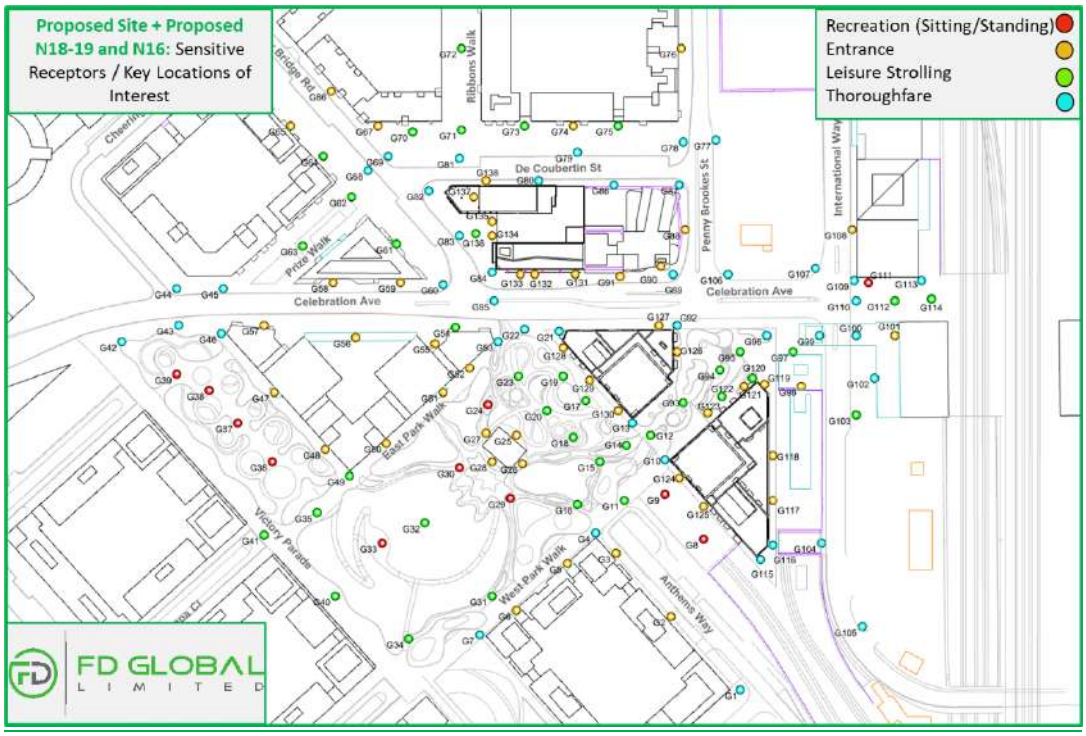
Sensitive Receptors and Target Comfort Levels – Assessment Scenario 1 (ASR Scenario 1)



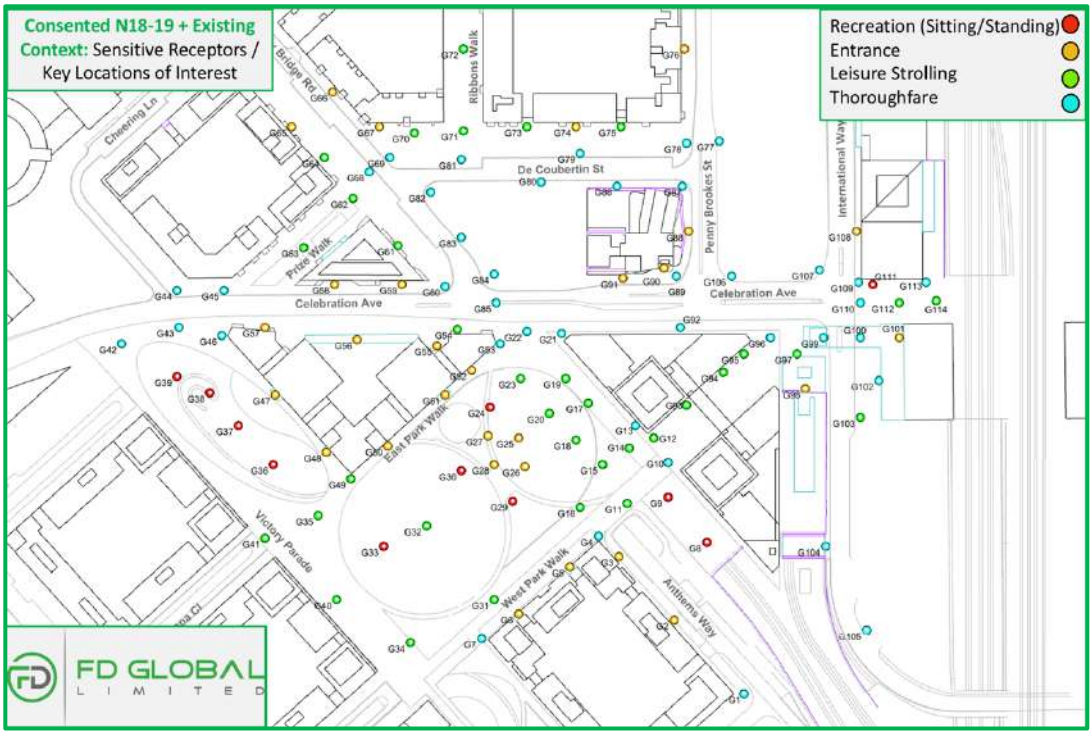
Sensitive Receptors and Target Comfort Levels – Assessment Scenario 3 (ASR Scenario 2)



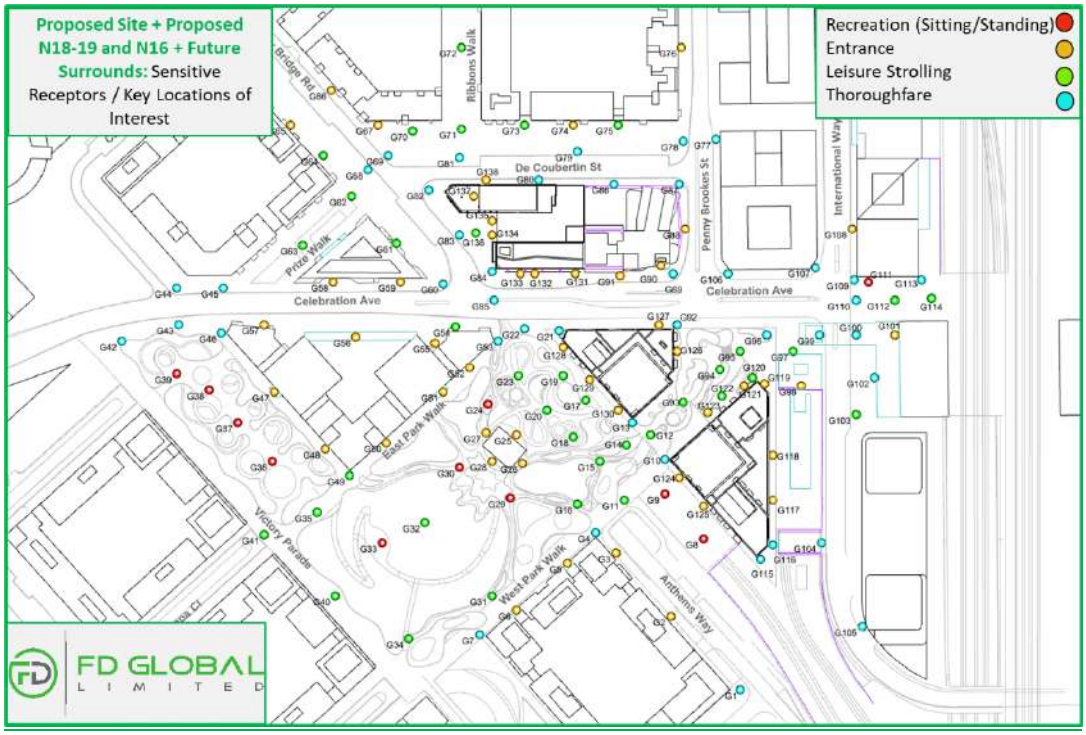
Sensitive Receptors and Target Comfort Levels – Assessment Scenario 5 (ASR Scenario 3)



Sensitive Receptors and Target Comfort Levels – Assessment Scenario 6 (ASR Scenario 4)



Sensitive Receptors and Target Comfort Levels – Assessment Scenario 7



Sensitive Receptors and Target Comfort Levels – Assessment Scenario 8

5.3. Wind Comfort and Safety Ratings

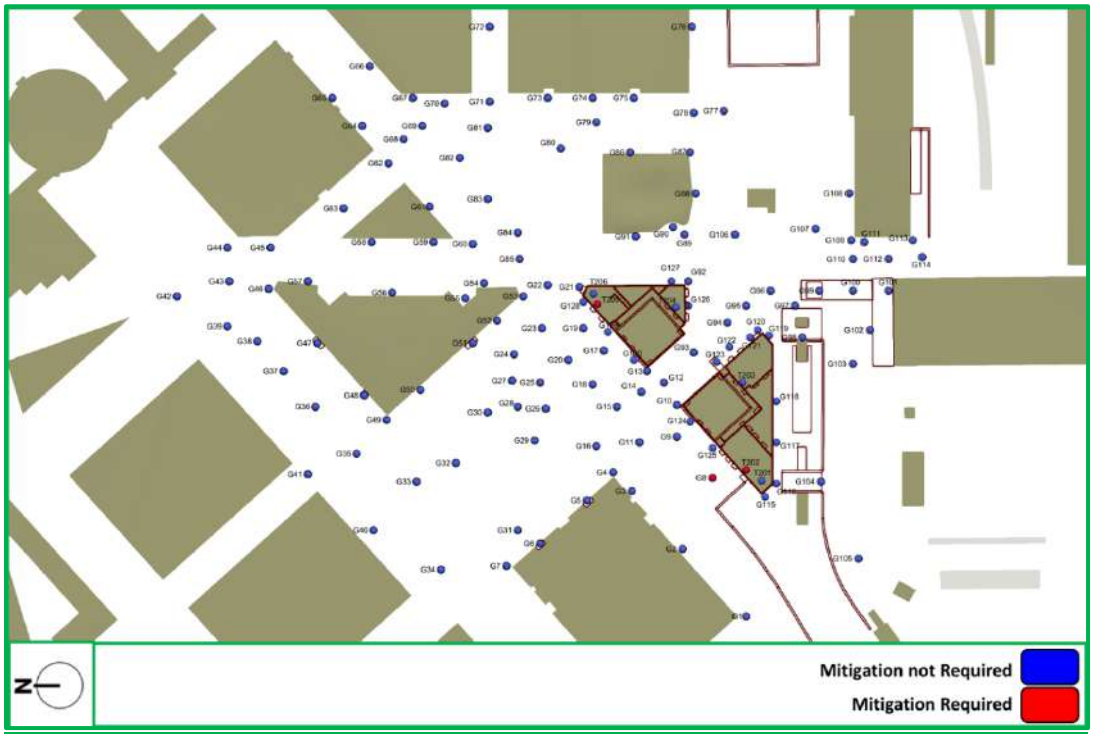
The results for the wind comfort and safety ratings analysis are given in Appendix C and D for the ground level public realm and for the balconies and roof terraces respectively. The assessment has been performed for each season of the year and the results are summarised in terms of worst season and summer, which is the established UK industry standard for wind microclimate assessments.

6. Impact Significance and Suitability of Wind Comfort and Safety in the Proposed Site Conditions

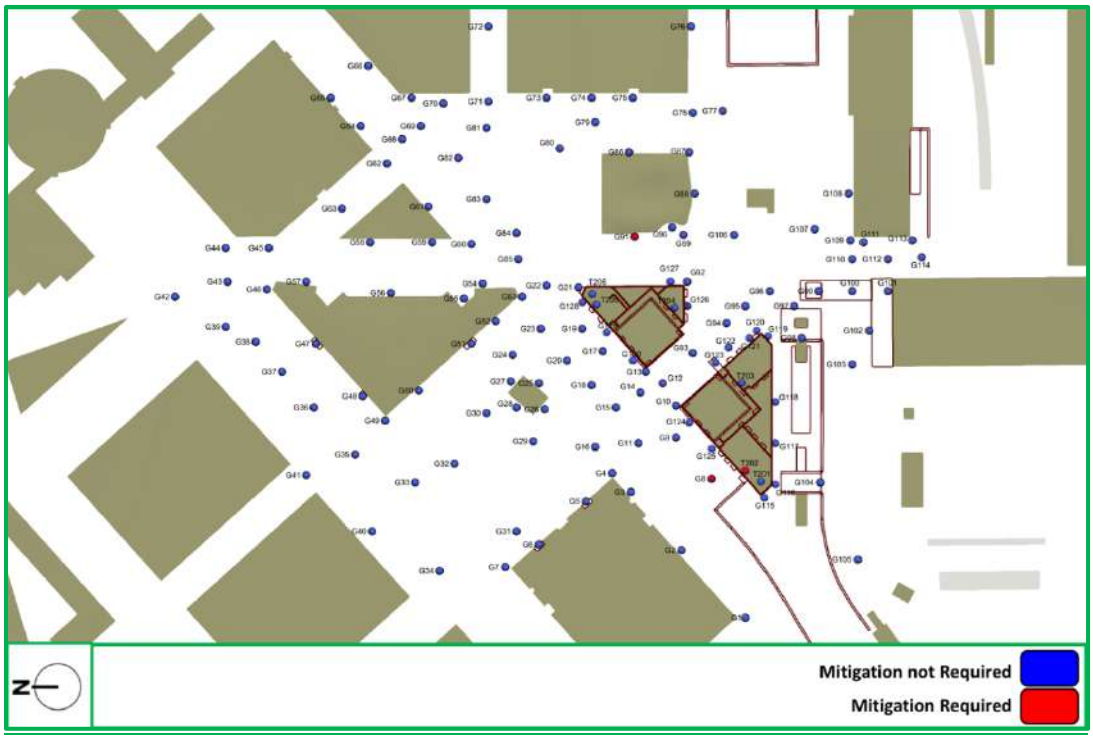
6.1. Public Realm at Ground Level – Without Mitigation Measures

The suitability of wind comfort and safety in the proposed site conditions and the possible consequent need for local mitigation has been identified by comparing estimated worst-case wind comfort ratings between the CFD and wind tunnel test assessments against the minimum target comfort ratings using the UK industry standard criteria that form the basis of the present assessment. The final need for mitigation for each of the assessment scenarios in turn has been established by application of the impact significance criteria where an impact is rated as 'Major Adverse'.

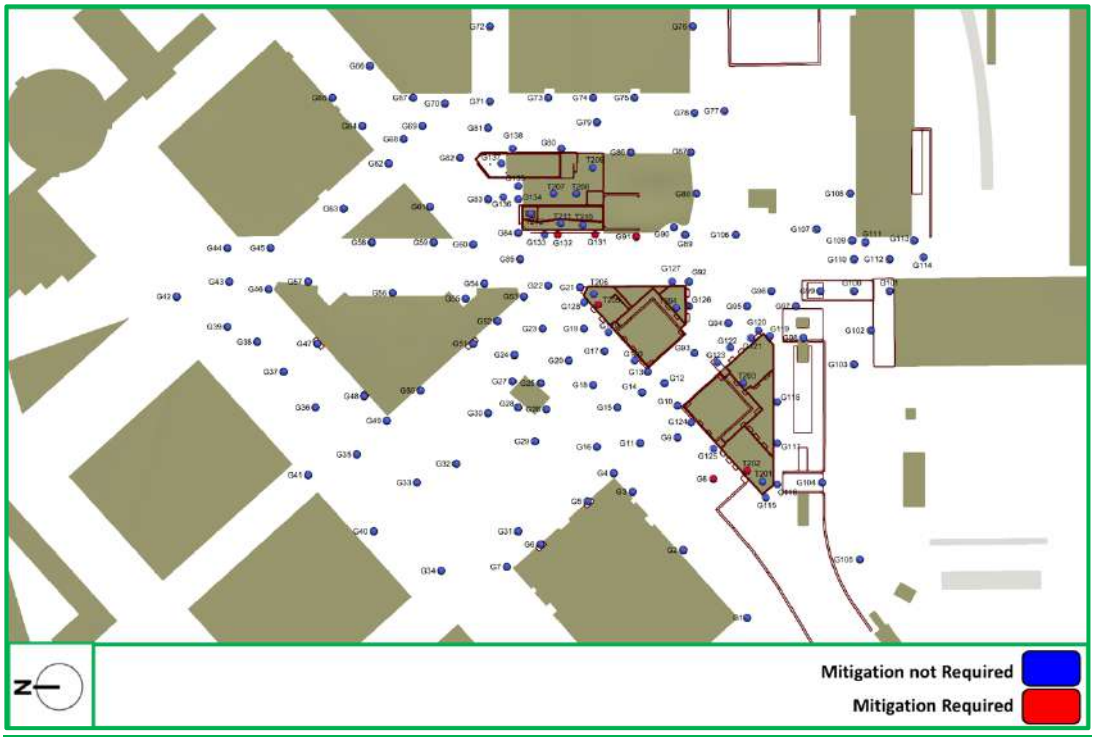
The key outcomes are summarised in form of the impact significance criteria ratings shown in graphical format below for the sensitive receptor locations that have been identified as key focus areas.



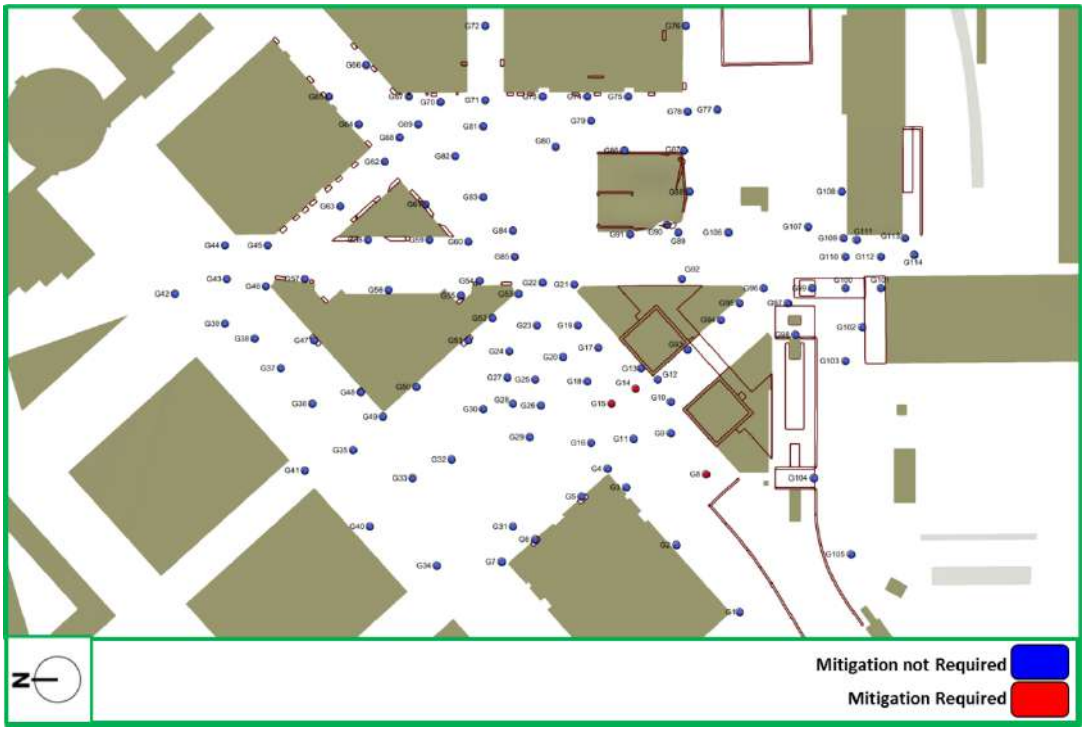
Assessment Scenario 3 – Without Mitigation - Impact Significance (ASR Scenario 2)



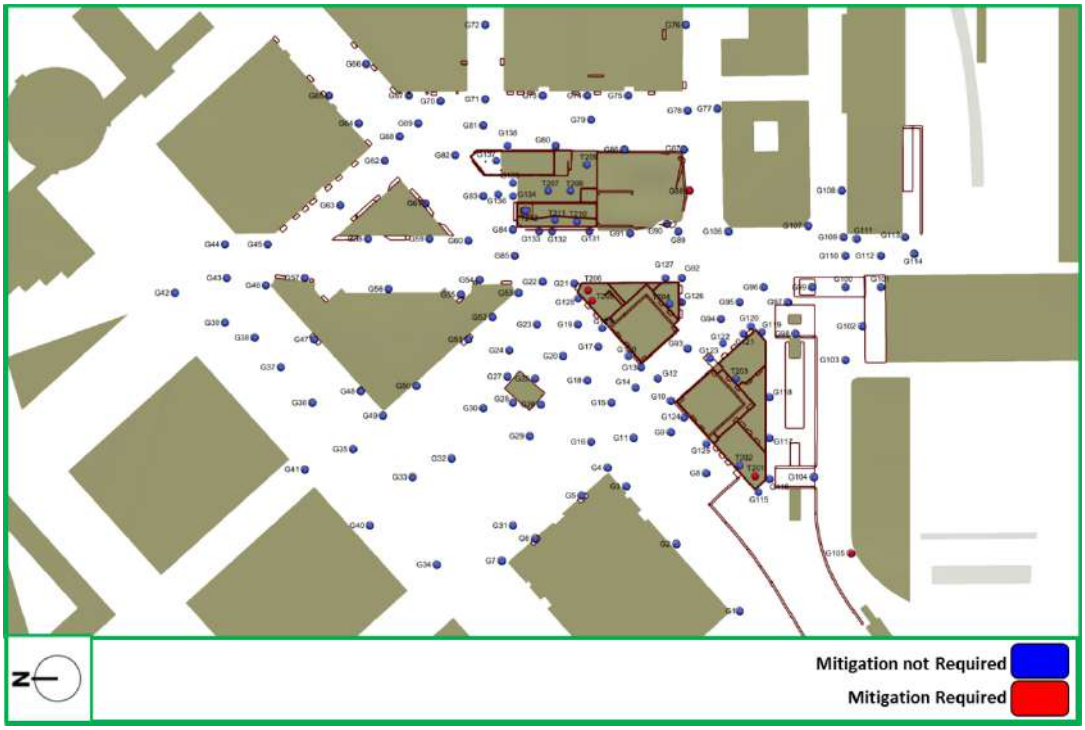
Assessment Scenario 5 – Without Mitigation - Impact Significance (ASR Scenario 3)



Assessment Scenario 6 – Without Mitigation - Impact Significance (ASR Scenario 4)



Assessment Scenario 7 – Without Mitigation - Impact Significance



Assessment Scenario 8 – Without Mitigation – Impact Significance

It can be seen that with the proposed Plot N18/19 development in existing surrounding conditions and the cleared Plot N16 site, the wind conditions in the public realm and in future surrounding conditions comprising the proposed Victory Park / Belvedere and proposed N16 developments remain suitable for planned pedestrian activity (Assessment Scenario 3 // ASR Scenario 2 and Assessment Scenario 5 // ASR Scenario 3 respectively). The exception to this is very localised impacts in Celebration Avenue

(Receptor G91) and Anthems Way (Receptor G8) that would warrant introduction of wind mitigation measures for this development stage.

With the committed developments in place (Assessment Scenario 8) the wind mitigation measures at these locations will no longer be required. It is noted, however, that the committed developments introduce impacts that require mitigation along Penny Way (Receptor G88) and at the western stretch of International Way (Receptor G105). The assessment has also shown that these residual impacts are predominantly associated with the impacts of these proposed committed developments themselves rather that with the proposed Plot N18/19 development. It is further noted that the present assessment does not include any wind mitigation measures that may have been developed for the committed developments that are causing the impacts.

Comparison of the wind impacts of the proposed Plot N18/19 development with those of the consented Plot N18/19 reference design in existing surrounding context with the cleared Plot N16 site (Assessment Scenario 5 and Assessment Scenario 7 respectively) shows that overall, the impacts of the proposed development are no worse than those of the consented reference scheme that shows stronger impacts in Anthems Way.

6.2. Wind Comfort and Safety for Balconies and Roof Terraces - Without Mitigation Measures

The wind microclimate on all of the balconies is safe for all assessment scenarios. In the absence of the proposed Plot N16 development and any soft landscaping the Level 11 roof terrace of Plot N18 experiences a local safety impact on the corner of the plant room. With the 1.5 m high perimeter parapets this impact can be suitably mitigated. It is noted that the choice of construction material for the parapets is not material in their effectiveness in providing the required wind shelter. The wind tunnel test has explored the potential impacts of the 1.5 perimeter parapets extensions and also a nominal soft landscaping scheme at these levels.

All balconies are safe for all users. In terms of wind comfort all balconies experience wind conditions in the worst season and in summer that are in the standing sitting category and are thus suitable for recreational uses.

The exception to this is the lowest 4 levels of the most western balconies of the low rise block of Plot N19, where wind conditions exceed the standing/sitting (C3/C4) category for more than 5% of the time in the worst case seasons (Autumn and Winter). This means that the percentage of time for which the wind comfort conditions on these particular balconies will be suitable for outdoor recreation involving long periods of sitting will be reduced, particularly in the worst case seasons. It is noted that in the worst case season (winter) these balconies are likely to be used less frequently for recreational activities due to non-wind related environmental conditions such as temperature and precipitation.

The balconies have been modelled at a balustrade height of 1.35 m and an overall solidity of 15%, which offers little wind resistance and, therefore, wind shielding. If it deemed desirable to increase the percentage of time for which the particular balconies in question are to be suitable for outdoor recreational use, then consideration should be given in the post-application design development stages of the project to installing means by which the balustrade solidity can be increased to a minimum of 50% in the worst case seasons.

6.3. Mitigation Measures

Based on the application of the impact significance criteria, the need for wind mitigation measures has been identified in a number of sensitive receptors in the public realm at ground level and within the amenity spaces on the level 11 terraces. Accordingly, the present assessment has included repeat scenario testing with wind mitigation measures in place. The wind mitigation measures have been validated for effectiveness in the key impact scenarios through repeat wind tunnel testing with wind mitigation measures in place for assessment scenario 5 and scenario 6. It is noted that since performing the wind tunnel tests, the soft and hard landscaping plans at the level 11 roof terraces have been subject to design development as per the details given in the earlier report sections. These are deemed to be such that they are equivalent or better that the presently recommended measures.

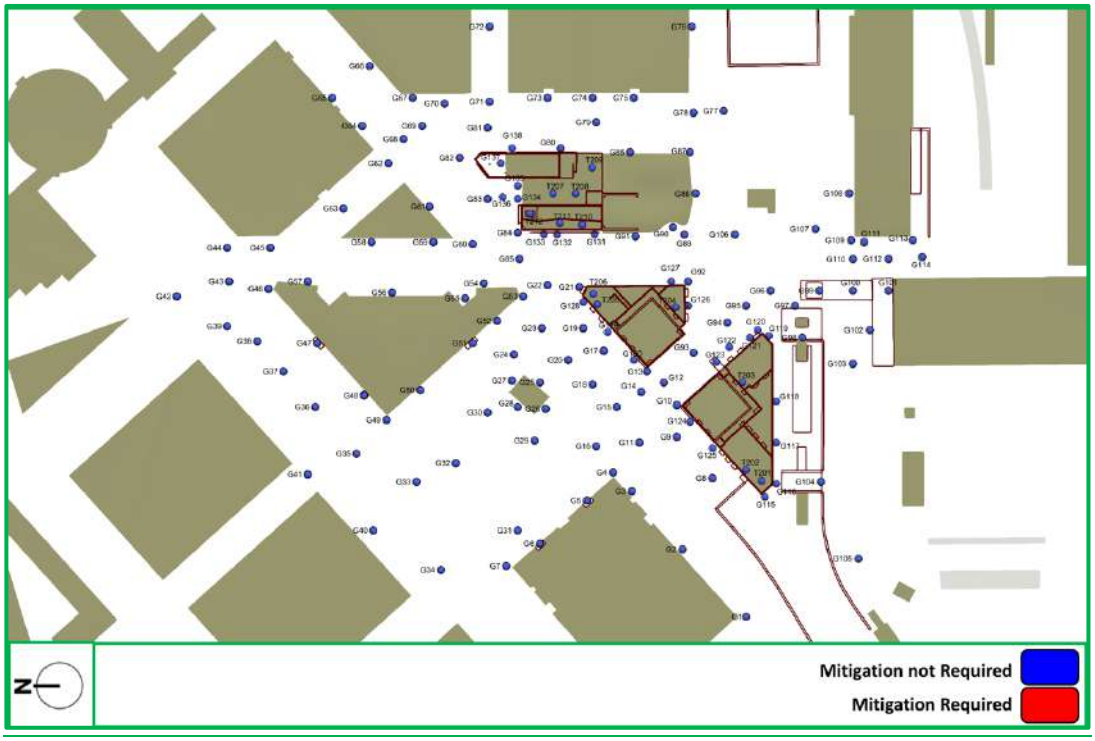
The wind mitigation measures are summarised in schematic form below. Their physical implementation on the wind tunnel model is shown in Appendix E. Specifically, the wind mitigation measures at ground level consist of additional trees in the space between N18 and N19 and also additional shrubs and greenery in the vicinity of the playground of Anthems Way. On the level 11 terraces, the wind mitigation measures consist of the 1.5 m perimeter parapet extensions and soft landscaping.

Wind Mitigation Measures

6.4. Public Realm at Ground Level and Elevated Amenity Spaces – With Mitigation Measures

The outcomes of the repeat assessment with wind mitigation measures in place in terms of the impact significance criteria and the associated requirement for further mitigation measures are shown below for assessment scenarios 5 and 6.

Assessment Scenario 5 – With Mitigation - Impact Significance (ASR Scenario 3)



Assessment Scenario 6 – With Mitigation - Impact Significance (ASR Scenario 4)

7. Key Conclusions and Observations

A comprehensive quantitative wind microclimate assessment has been carried out based on CFD modelling and on boundary layer wind tunnel testing approaches. From this assessment the following conclusions and recommendations are drawn for the proposed Plot N18/19 development:

- With the proposed development in place the wind microclimate in the public realm will remain suitable for the planned uses in existing surrounding context with the cleared Plot N16 site and also in future surrounding context including the proposed Plot N16 development and the proposed Victory Park/Belvedere development as well as consented developments that are not part of the East Village Masterplan development.

- The exception to the above is two sensitive receptors in Celebration Avenue (Receptor G91) and Anthems Way (Receptor G8) that require wind mitigation measures for the surrounding condition with the cleared Plot N16 site.

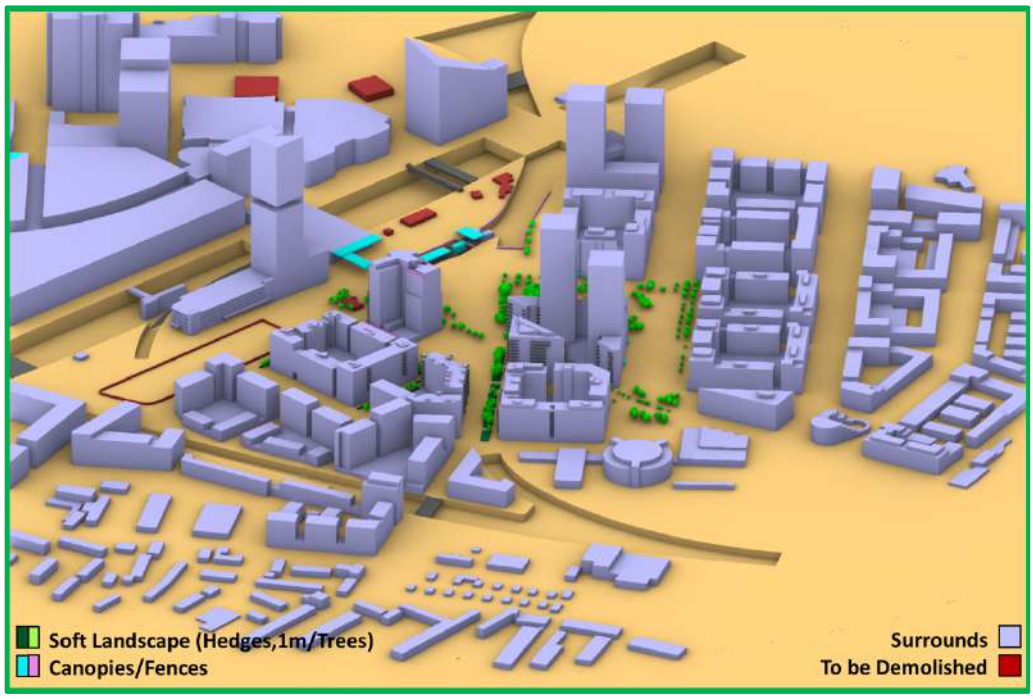
- The present wind assessment has developed wind mitigation measures and validated these for effectiveness in providing suitable mitigation against these impacts. Specifically, the wind mitigation measures comprise of 14m height trees within the proposed soft landscaping measures along the south western perimeter of the site boundary. With wind mitigation measures in place the proposed development has no residual impacts through the public realm for any of the assessment scenarios.

- The wind impacts of the proposed development compare favourably to those of the consented reference scheme.

APPENDIX A. CAD MODELS OF ASSESSMENT CONFIGURATIONS

A.1. Assessment Scenario 1 - Existing site conditions for Victory Park/Belvedere, Empty site Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 1)

Viewed From Above

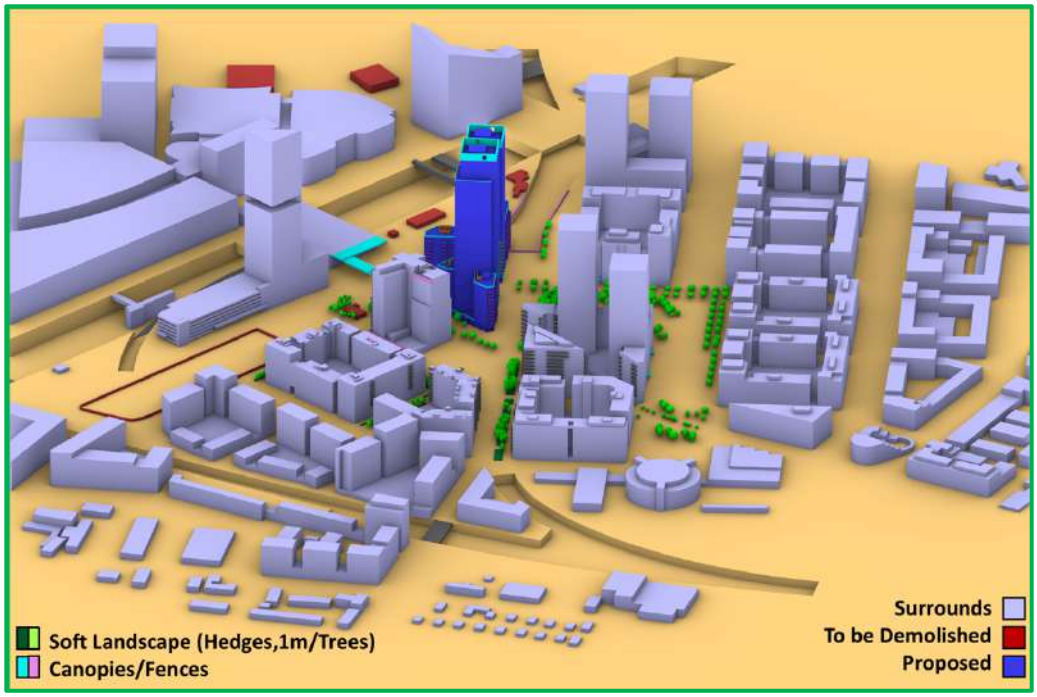


Viewed From North East

Viewed From South West

A.2. Assessment Scenario 3 - Existing site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 2)

Viewed From Above

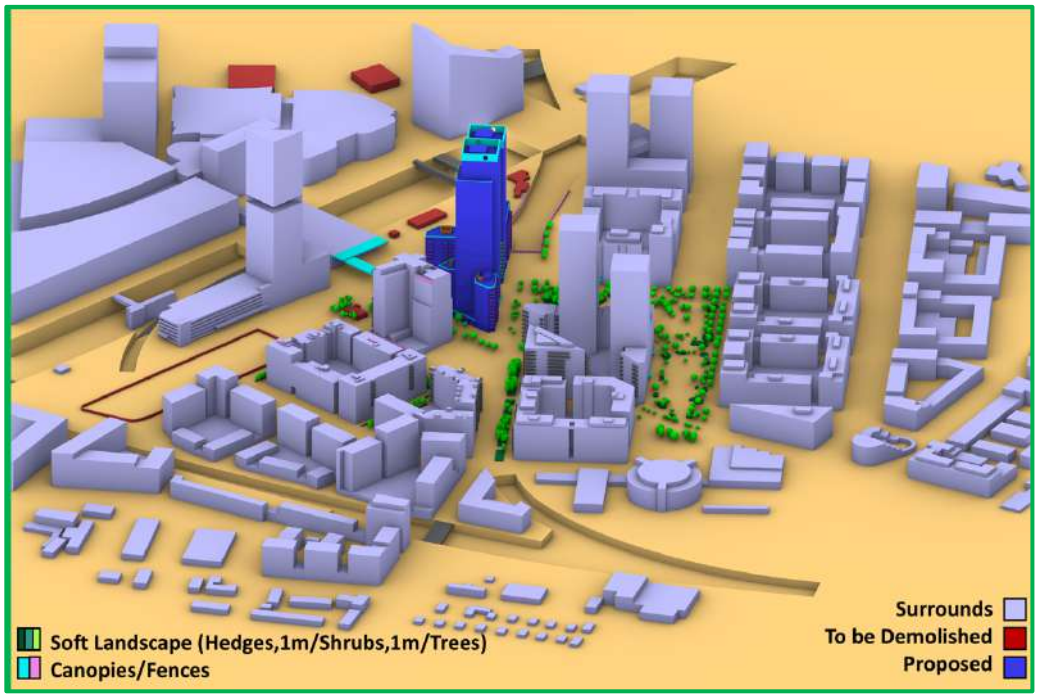


Viewed From North East

Viewed From South West

A.3. Assessment Scenario 5 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding Buildings (ASR Scenario 3)

Viewed From Above

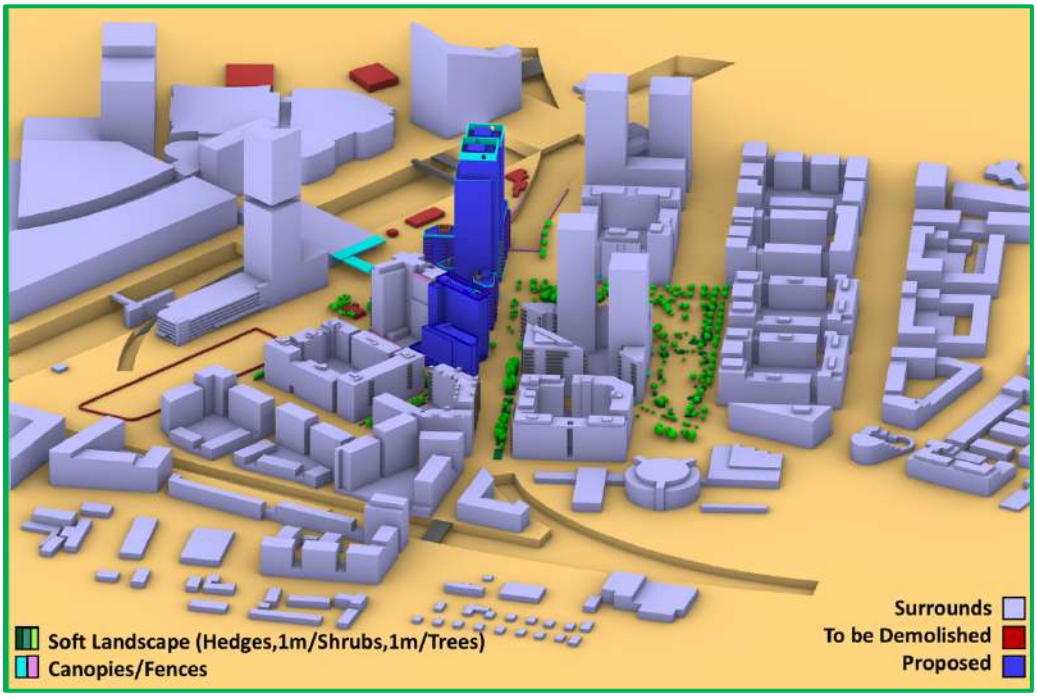


Viewed From North East

Viewed From South West

A.4. Assessment Scenario 6 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed site Plot N16, Existing surrounding Buildings (ASR Scenario 4)

Viewed From Above

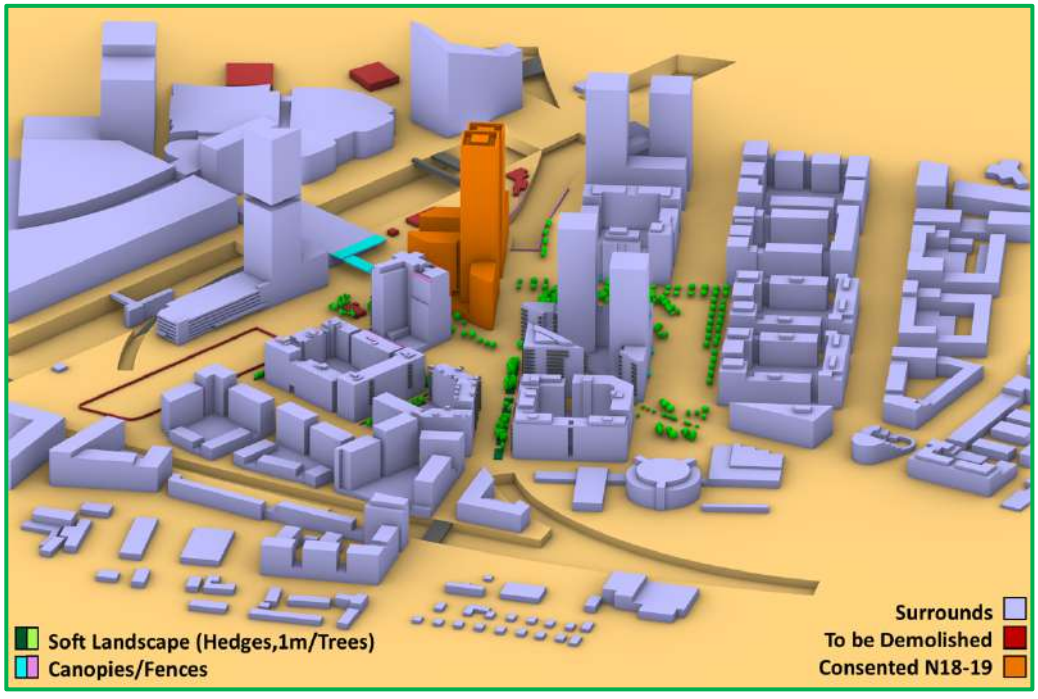


Viewed From North East

Viewed From South West

A.5. Assessment Scenario 7 - Existing site conditions for Victory Park/Belvedere, Consented Plot N18/19, Empty site Plot N16, Existing surrounding buildings

Viewed From Above

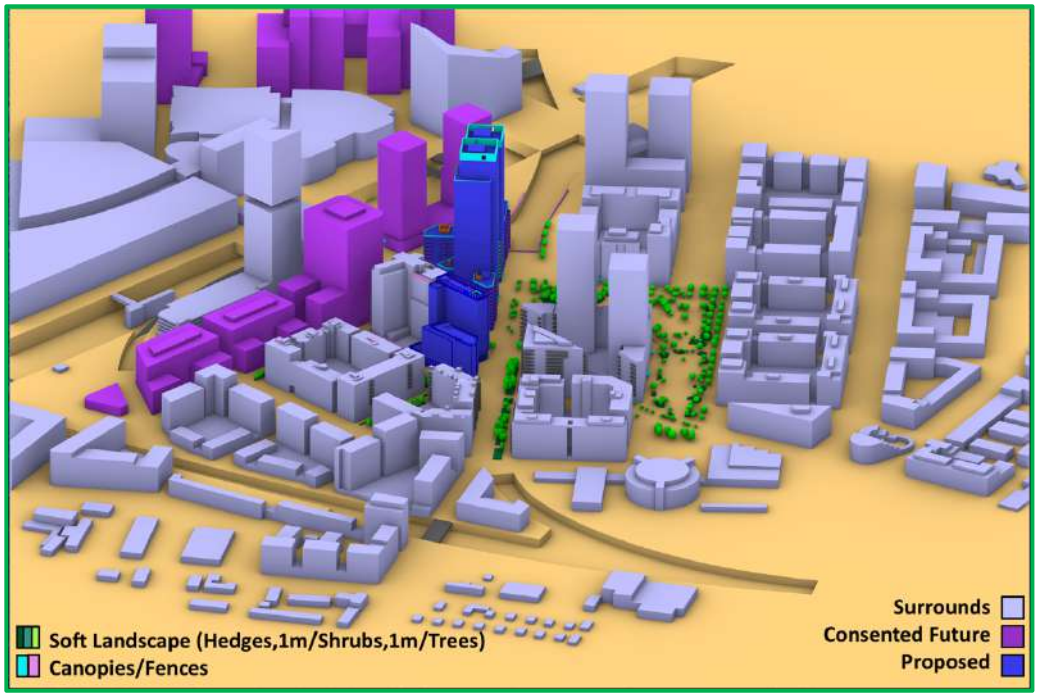


Viewed From North East

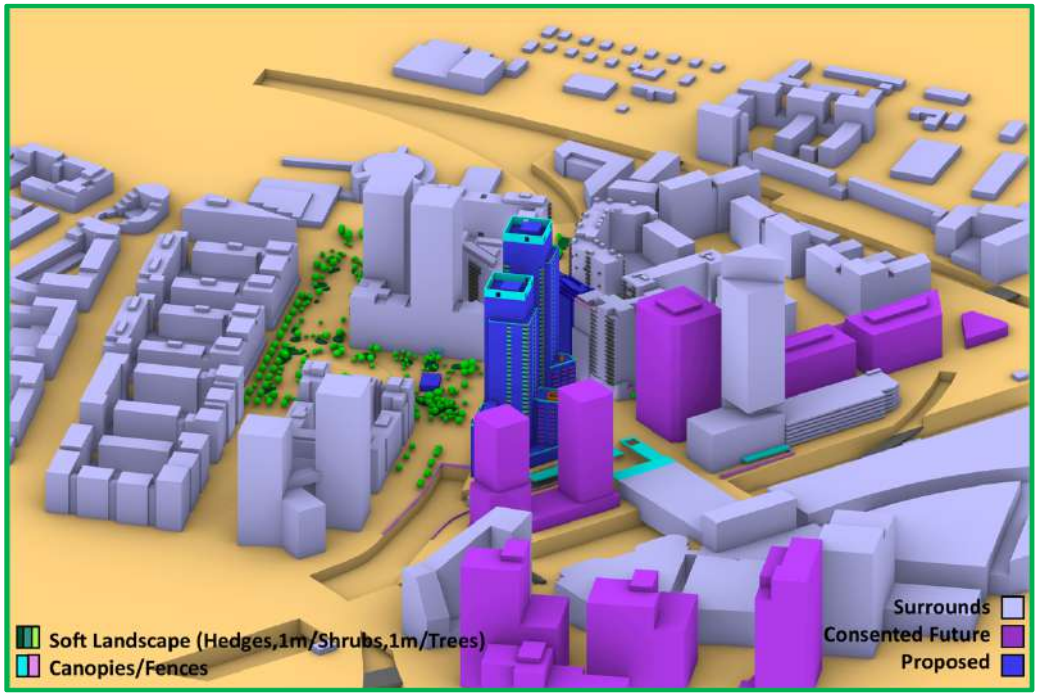
Viewed From South West

A.6. Assessment Scenario 8 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed site Plot N16, Existing surrounding buildings + Committed Developments

Viewed From Above



Viewed From North East



Viewed From South West

APPENDIX B. CFD SIMULATIONS - TECHNICAL DETAIL

B.1. General

The multi-purpose CFD software Helyx (https://engys.com/products/helyx, version 3.2) was used for the wind environment simulations. A total of 36 steady state atmospheric boundary layer simulations were completed per configuration, covering full 360° of the approaching winds, with a wind sector increment of 10.0°.

B.2. Spatial Discretization

The spatial discretization of the 3D model was completed with helyxHexMesh utility, part of the CFD code Helyx. Various computational meshes, consisting of 10 to 20 million hexahedral and polyhedral elements, were constructed for 22 site configurations.

Details of the generated numerical grids are provided in Figure B.1 and Figure B.2. The computational domain for the purpose of the atmospheric boundary layer simulations includes the proposed development site with 500m in radius explicit representation of the surrounds, 1000 m in radius ground surface and the outer boundaries (wind and sky at 1000 m height from the ground).

The base cell size in the numerical grid was defined to 32.0 m. The refinement level increased to 0.05 m in the zone closest to the proposed site, in order to capture the detailed geometrical features. Also, additional 5 prism surface layers were introduced to all pedestrian ground level surfaces, with first layer height of approximately 0.15 m.

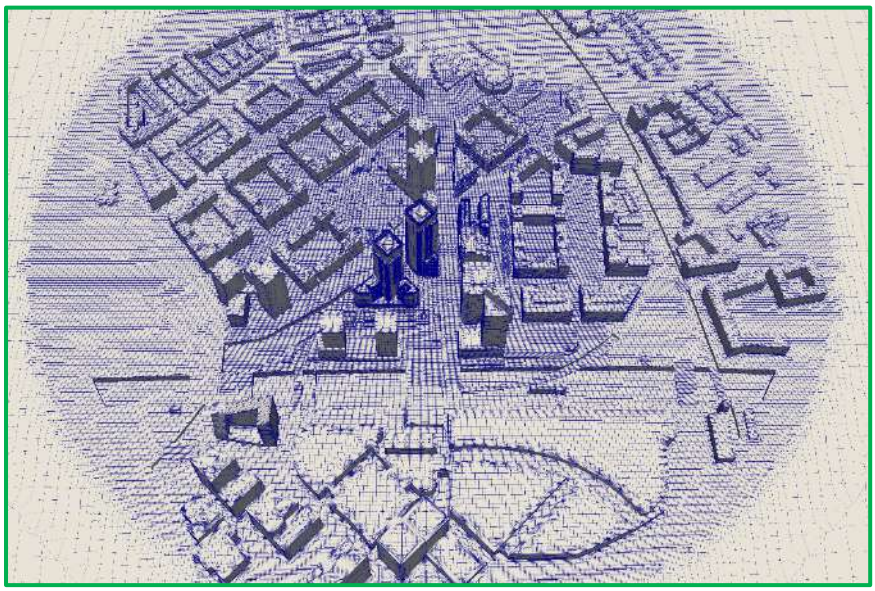


Figure B.1 – View of the spatial discretization

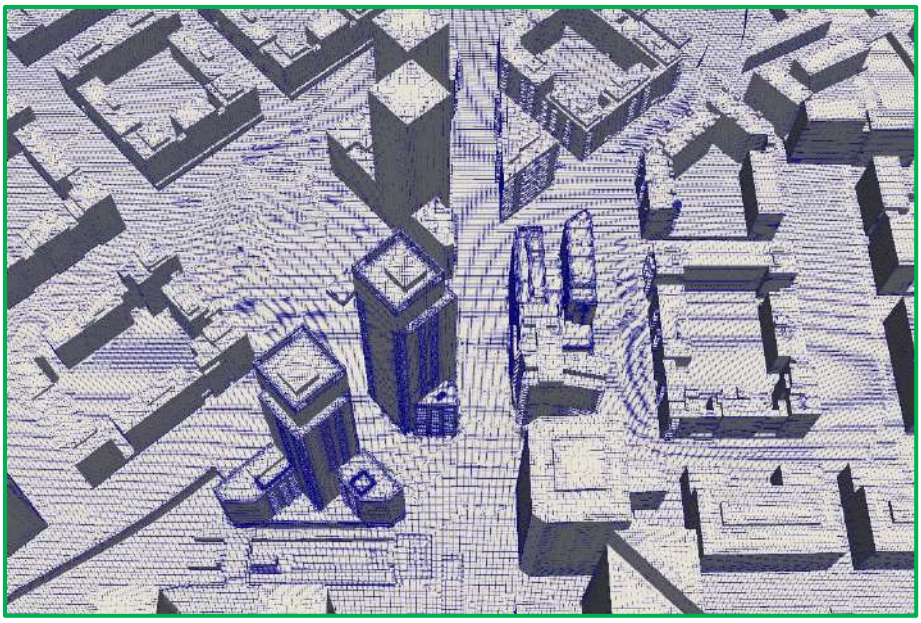


Figure B.2 - Close-up view of the spatial discretization

B.3. Solution Methods

The RANS (Reynolds-averaged Navier–Stokes) CFD simulations were performed, based on the simpleFoam solver. The modelling of an incompressible fluid flow was completed with combinations of semi-implicit method for pressure-linked equations (SIMPLE) algorithms. The resulted flow turbulent features were modelled with introduction of the Shear Stress Transport (SST) k-ω turbulence model. This model was suggested by Menter [1] and is based on a two-equation eddy-viscosity approach, where the SST model formulation combines the use of a k-ω in the inner parts of the boundary layer, but also switches to a k-ε behaviour in the free-stream regions of the solutions. Further details for the selected turbulence model are provided in the work of Menter [2].

B.4. Initial and Boundary Conditions

The atmospheric boundary layer flow was simulated by implementing a logarithmic velocity profile model presented by Richards and Hoxey [3], with the following main assumptions:

- The vertical velocity component at the domain boundary is negligible.
- The pressure gradient and shear stress are constant.

The model implies the following equation for the mean inlet velocity at the CFD domain:

$$U(z) = \frac{U^*}{\kappa} ln\left(\frac{z + z_0}{z_0}\right)$$

Where:

- κ - is the von Karman's constant;
- z - is the distance from the ground surface in vertical direction;

- z_o - is the ground surface roughness length in meters.

The friction velocity U* is calculated by the following equations:

$$U^* = \kappa \frac{U_{ref}}{ln\left(\frac{z_{ref} + z_0}{z_0}\right)}$$

Where:

- z_{ref} – is the reference height in meters;
- U_{ref} - is the reference velocity in m/s measured at z_{ref}.

The turbulent velocity fluctuations at the domain inlet are induced by the constant shear stress with height, maintained by the turbulent kinetic energy k equation below:

$$k(z) = \frac{U^{*2}}{\sqrt{C_\mu}}$$

Where:

- Cμ = 0.09 - is the usual k-ε turbulence model constant.

All surface boundary conditions were modelled as smooth walls with a no-slip condition. Only, a no-slip wall boundary condition with a varying roughness length height based on the terrain analysis for the site was applied on the ground surface outside the explicit surrounds area of the domain.

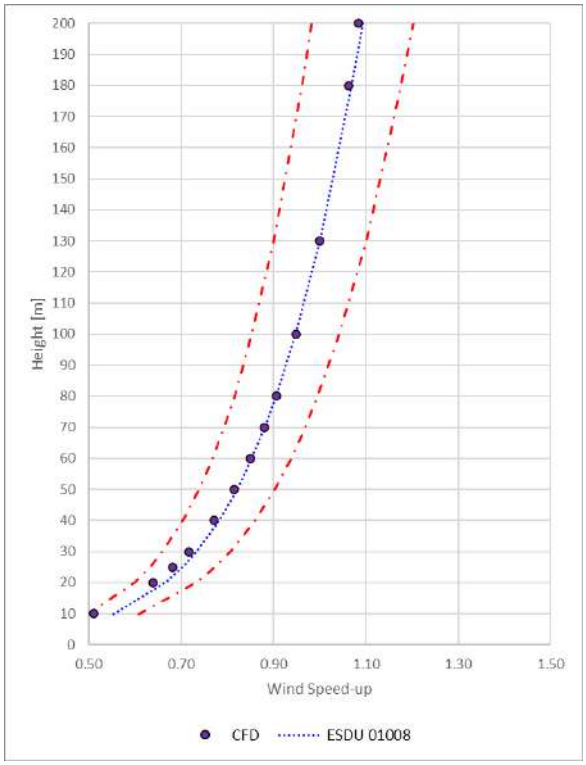


Figure B.3 – Wind Velocity Profile

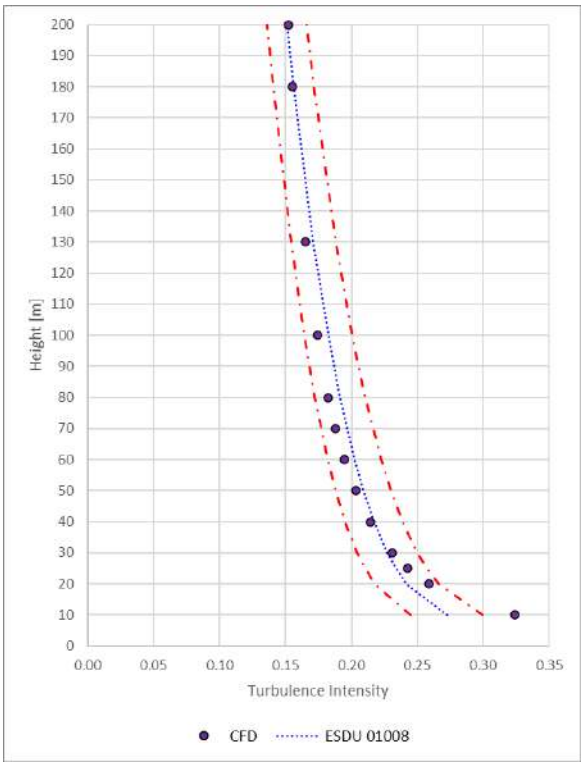


Figure B.4 – Turbulence Intensity Profile

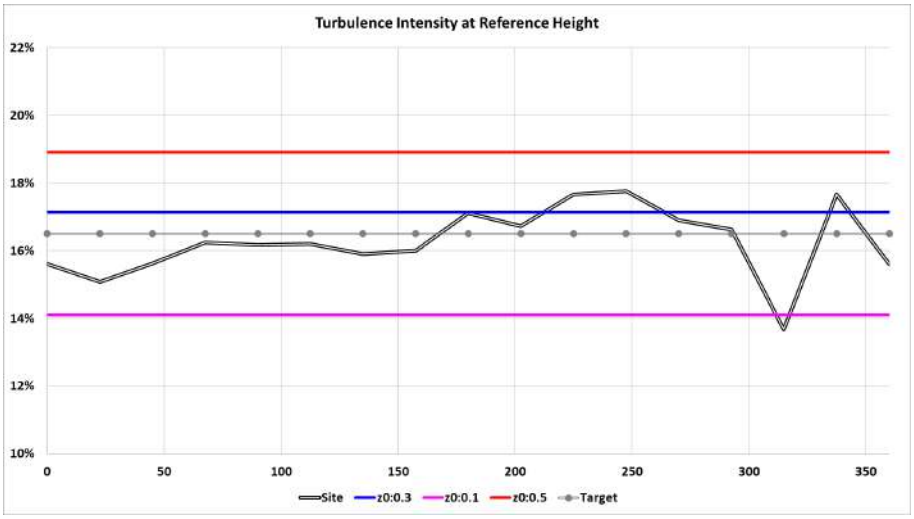


Figure B.5 – Turbulence Intensity at 80m Reference Height

B.5. Gust Equivalent Mean Calculation

The LDDC wind comfort and safety criteria requires wind gusts to be accounted for over and above the mean wind force. Industry standard defines the impact of gusty winds on pedestrian comfort in terms of the so-called gust equivalent mean (GEM) factor which allow relative strength of gust to be measured up against the mean wind force so that the relative importance can be accounted for in the wind comfort assessment. In accordance with industry standard the gust wind speed is accounted by a calculation of the equivalent mean wind speed, considering the standard deviation of the mean wind speed, in particular the turbulent kinetic energy, k:

$$\sigma_U = \sqrt{k * {}^{2}/_{3}}$$

Based on the work of Melbourne [4], the peak gust wind speed is derived following this equation:

$$\widehat{U} = U_{MEAN} + 3.5\sigma_U$$

And the Gust Equivalent Mean (GEM) is derived based on following relation:

$$U_{GEM} = \widehat{U}/1.85$$

B.6. References

[1] Menter F., (1993), Zonal Two Equation k-ω Turbulence Models for Aerodynamic Flows, AIAA Paper 93-2906;

[2] Menter F., (2011), Turbulence Modelling for Engineering Flows, ANSYS Inc.;

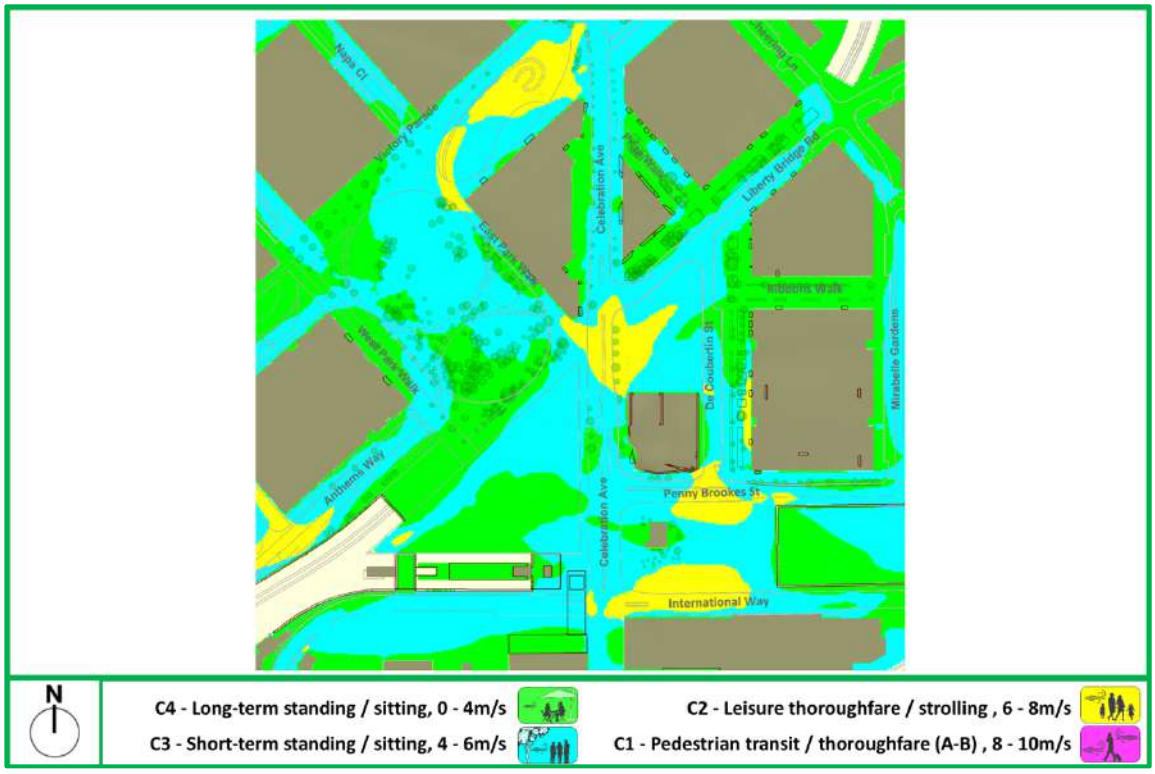
[3] Richards, P.J. and Hoxey, R.P., Appropriate boundary conditions for computational wind engineering models using the k-ε turbulence model, Journal of Wind Engineering and Industrial Aerodynamics, vol. 46 & 47, pp. 145-153, 1993.

[4] Melbourne, W.H., Criteria For Environmental Wind Conditions, Journal of Industrial Aerodynamics, 3, 241-249, 1978.

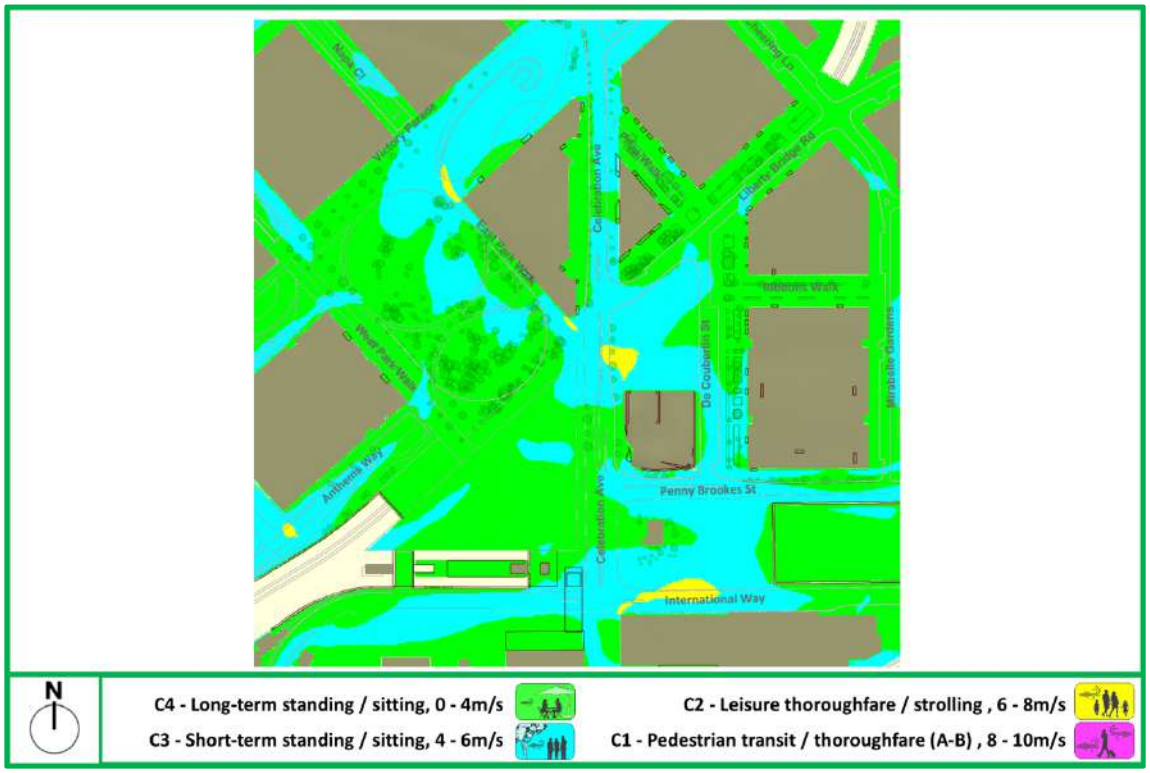
APPENDIX C. WIND COMFORT AND SAFETY RATING ASSESSMENT RESULTS – CFD ANALYSIS – GROUND LEVEL PUBLIC REALM

C.1. Assessment Scenario 1 - Existing site conditions for Victory Park/Belvedere, Empty site Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 1)

Safety Ratings



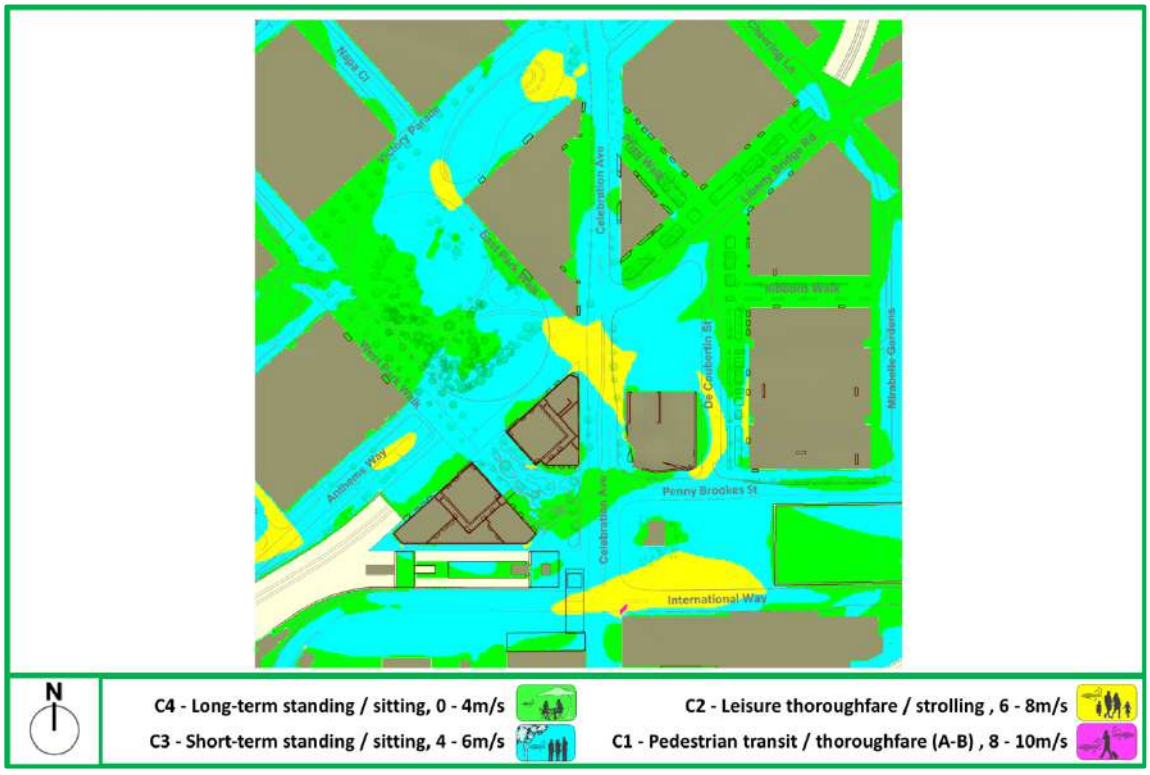
Comfort Ratings – Worst Season



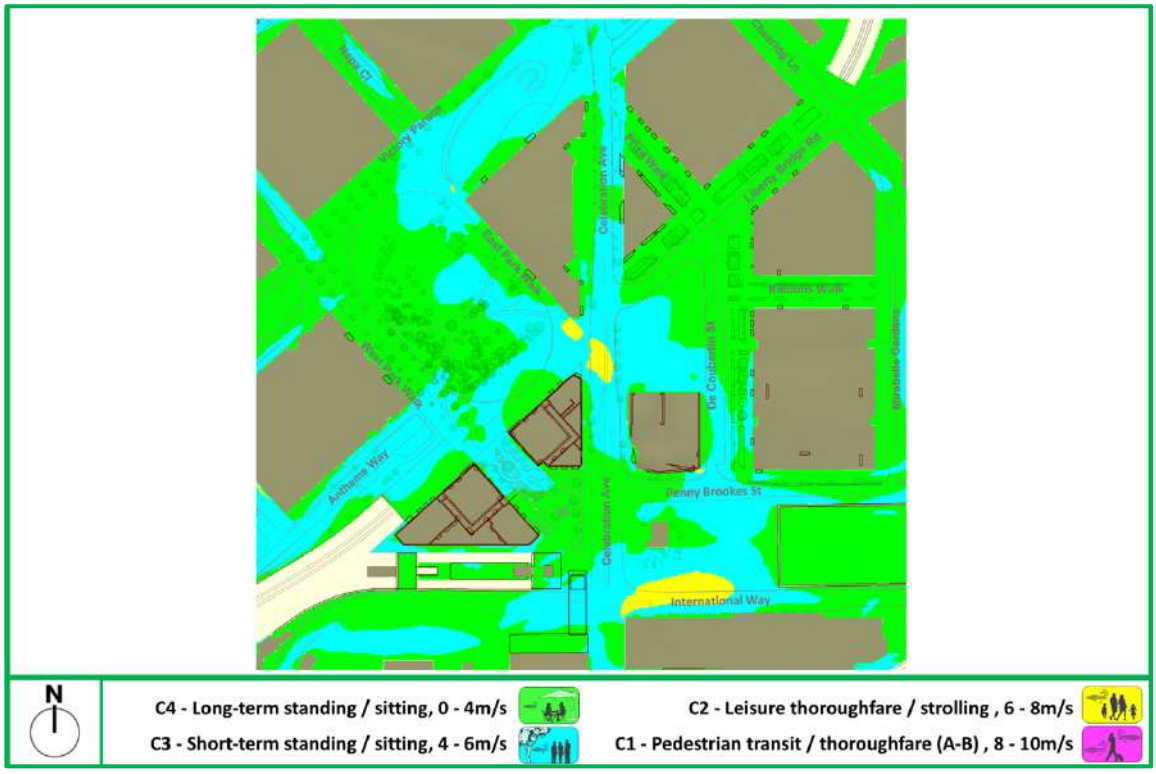
Comfort Ratings – Summer Season

C.2. Assessment Scenario 3 - Existing site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 2)

Safety Ratings Ground Level



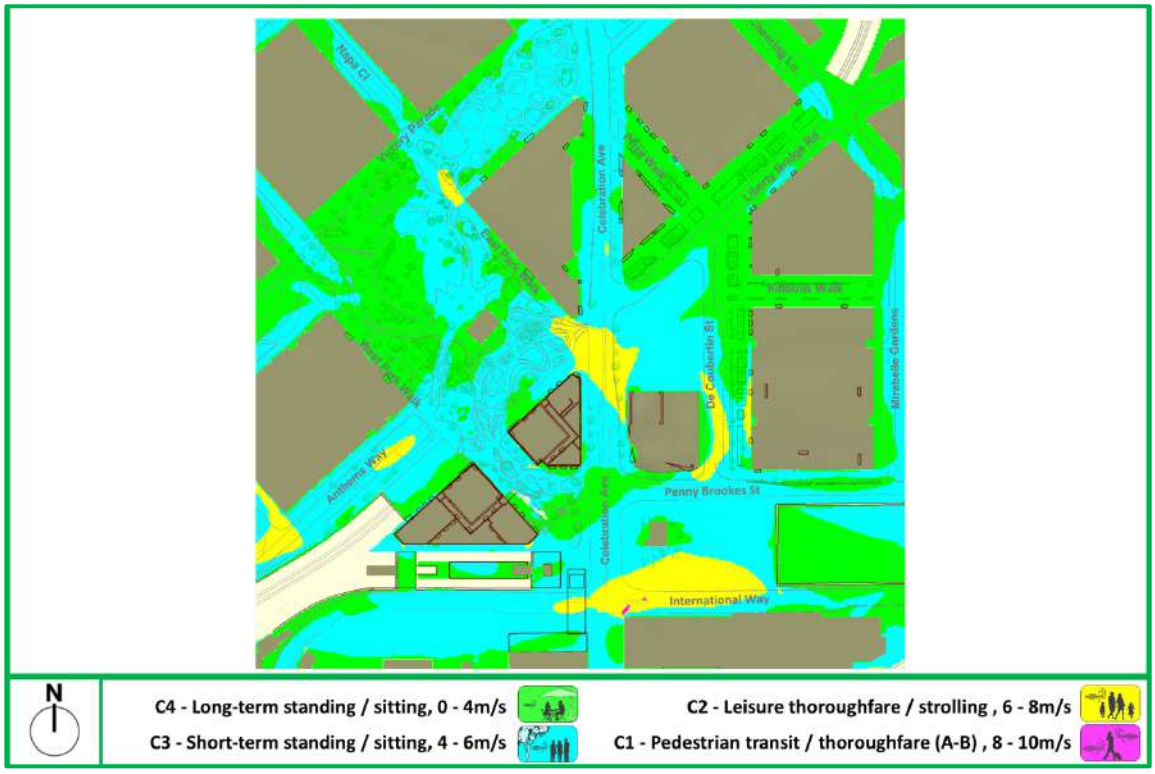
Comfort Ratings – Worst Season



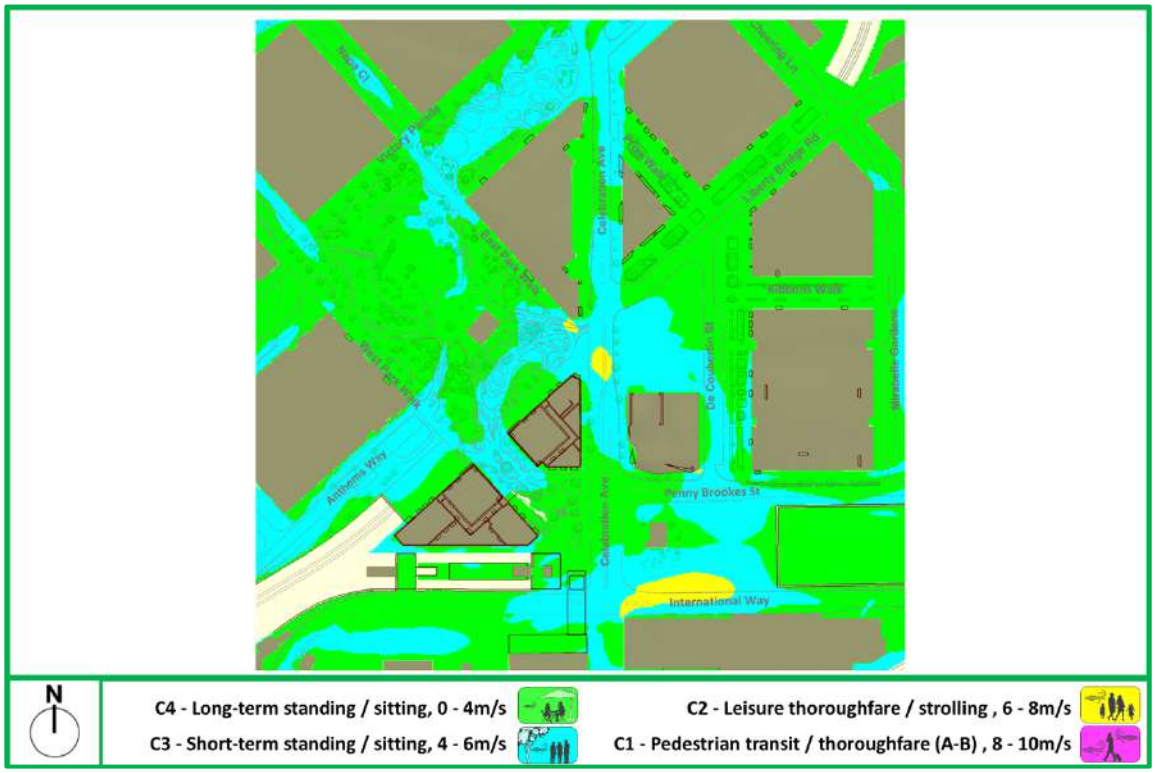
Comfort Ratings – Summer Season

C.3. Assessment Scenario 5 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding Buildings (ASR Scenario 3)

Safety Ratings Ground Level



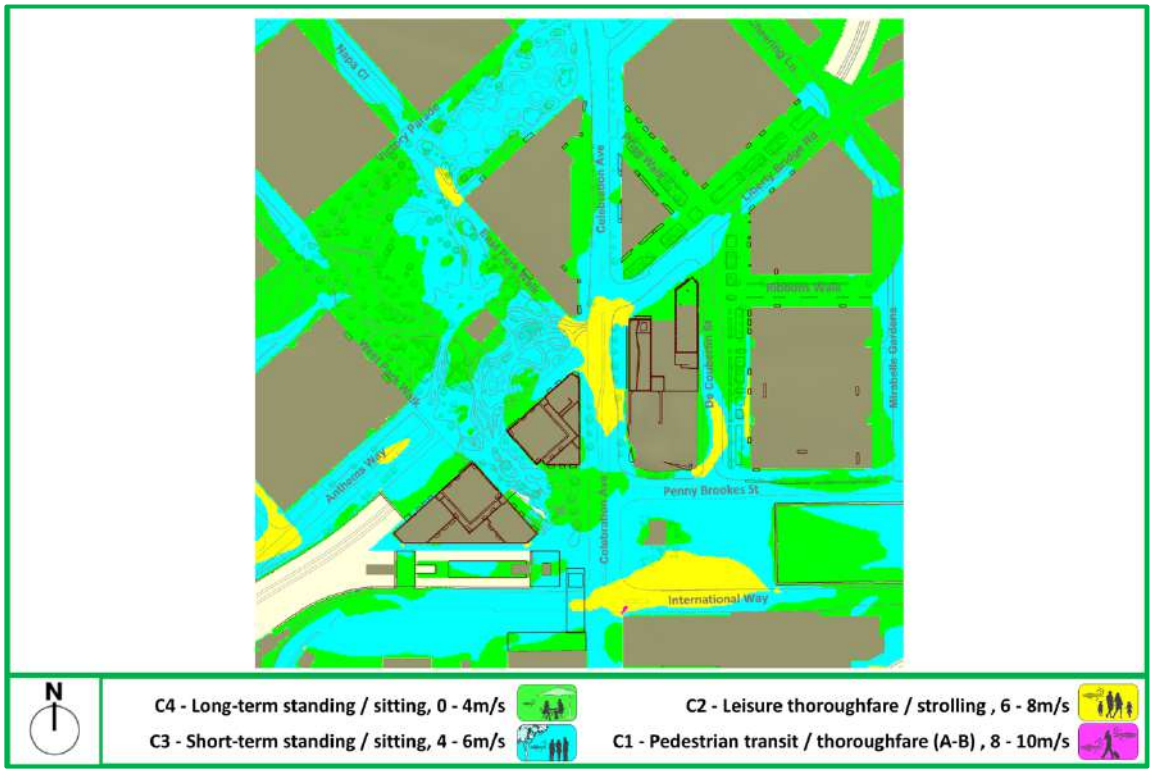
Comfort Ratings – Worst Season



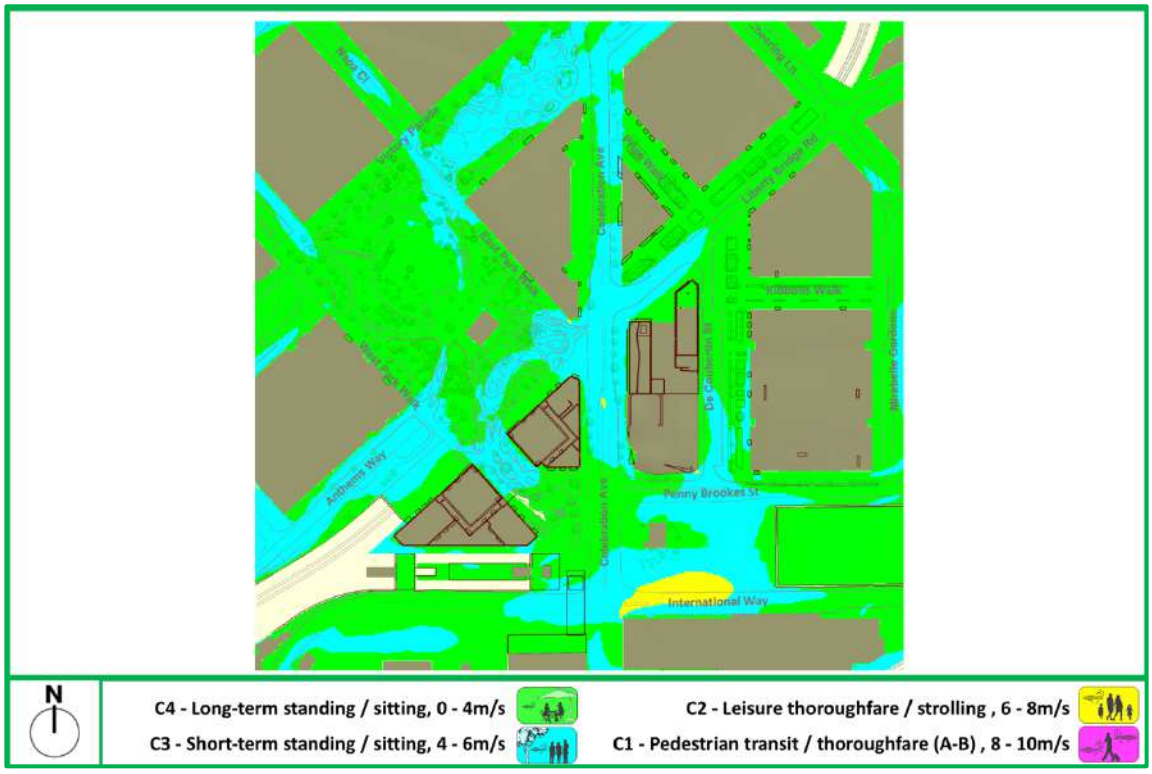
Comfort Ratings – Summer Season

C.4. Assessment Scenario 6 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed Plot N16, Existing surrounding Buildings (ASR Scenario 4)

Ground Level Safety Ratings



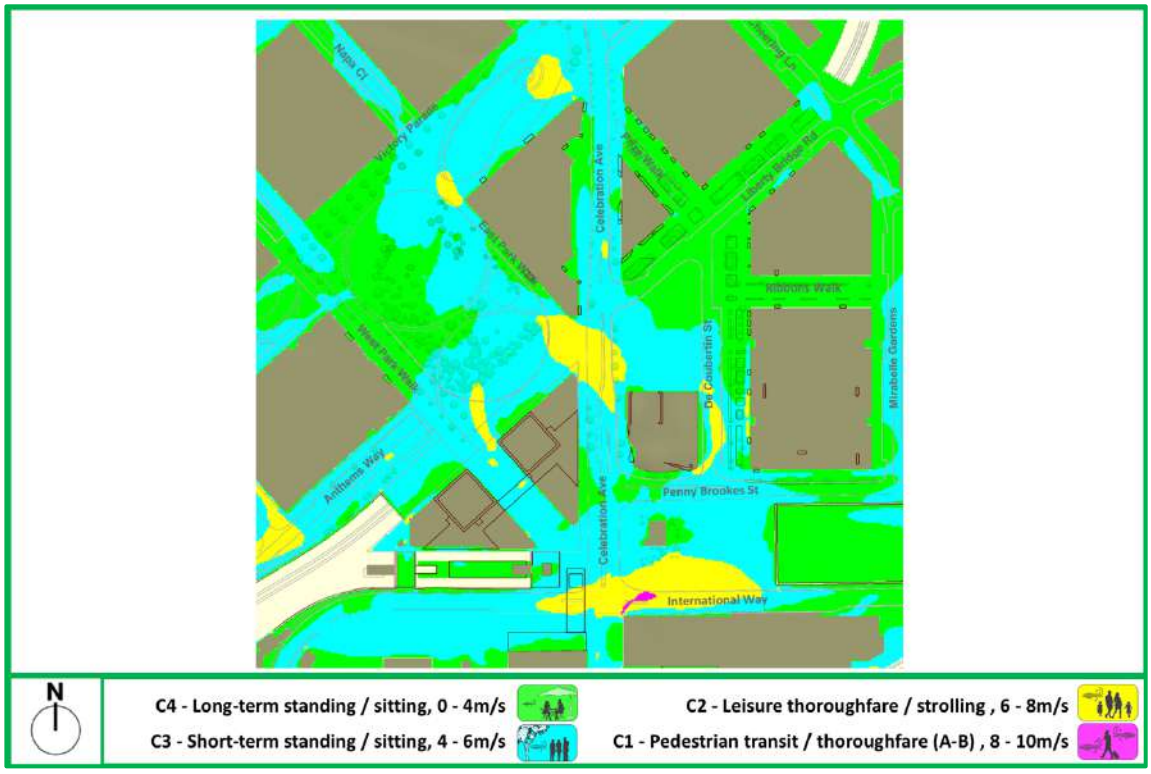
Comfort Ratings – Worst Season



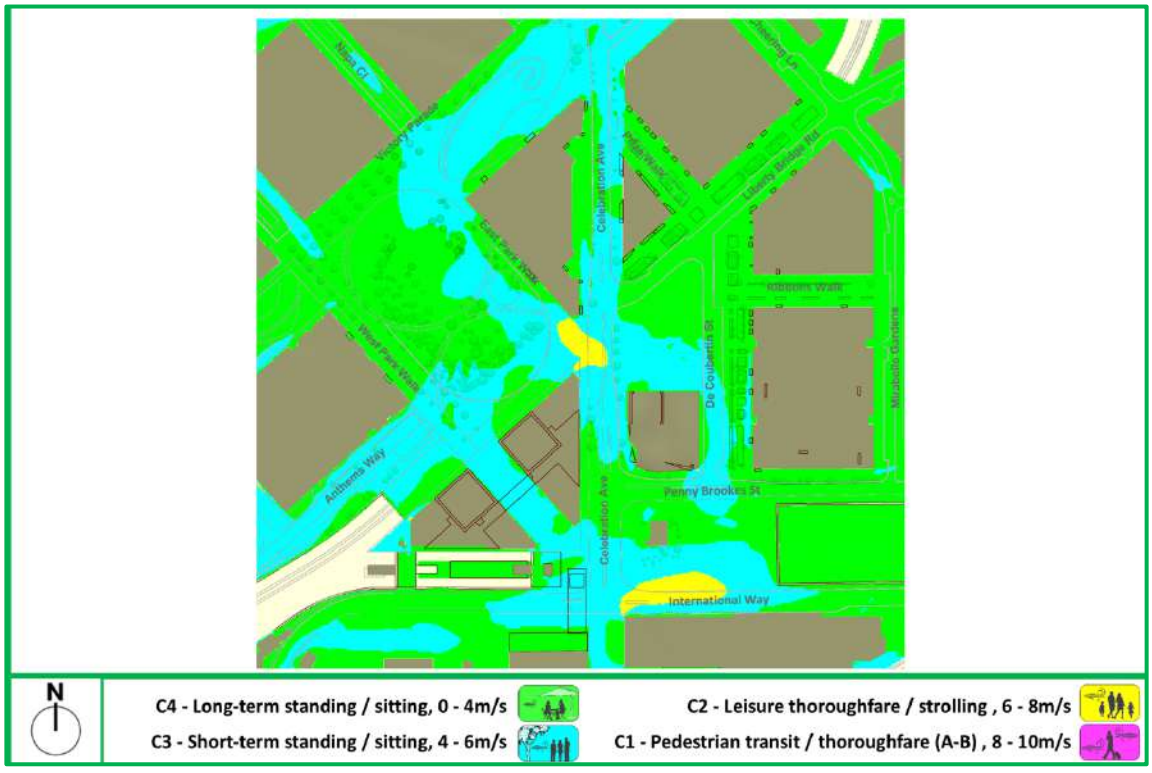
Comfort Ratings – Summer Season

C.5. Assessment Scenario 7 - Existing site conditions for Victory Park/Belvedere, Consented Plot N18/19, Empty site Plot N16, Existing surrounding buildings

Ground Level Safety Ratings



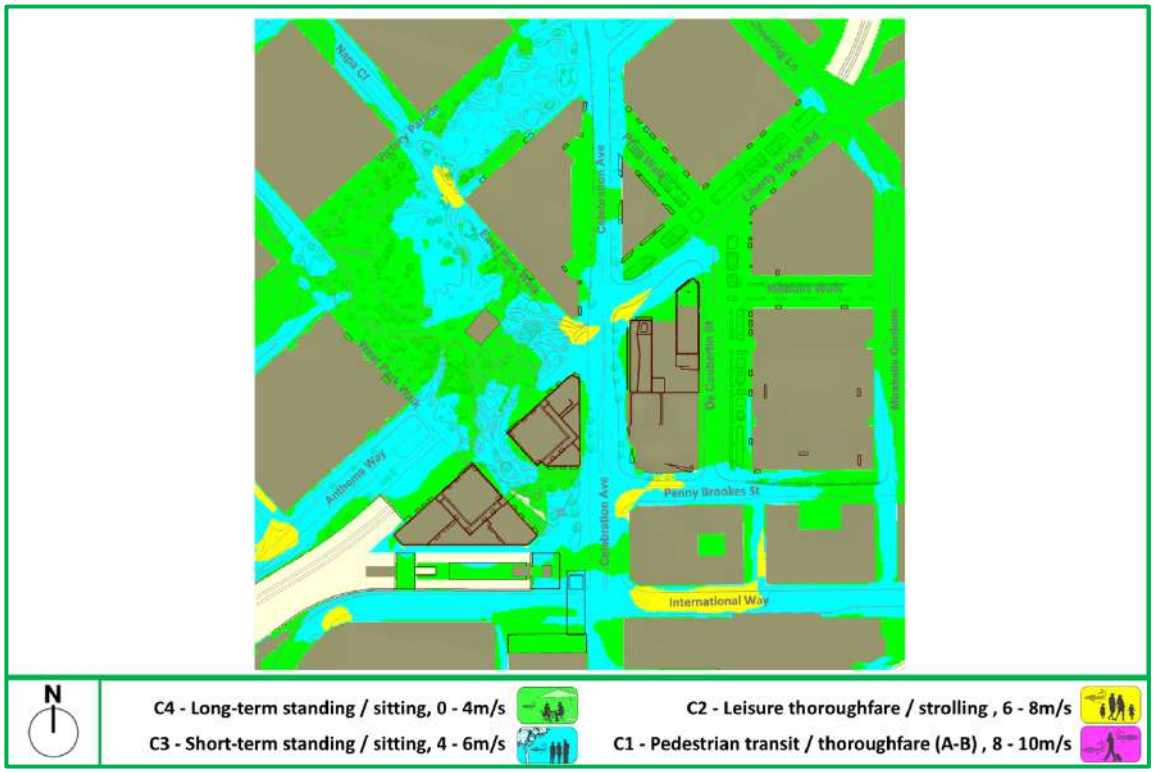
Comfort Ratings – Worst Season



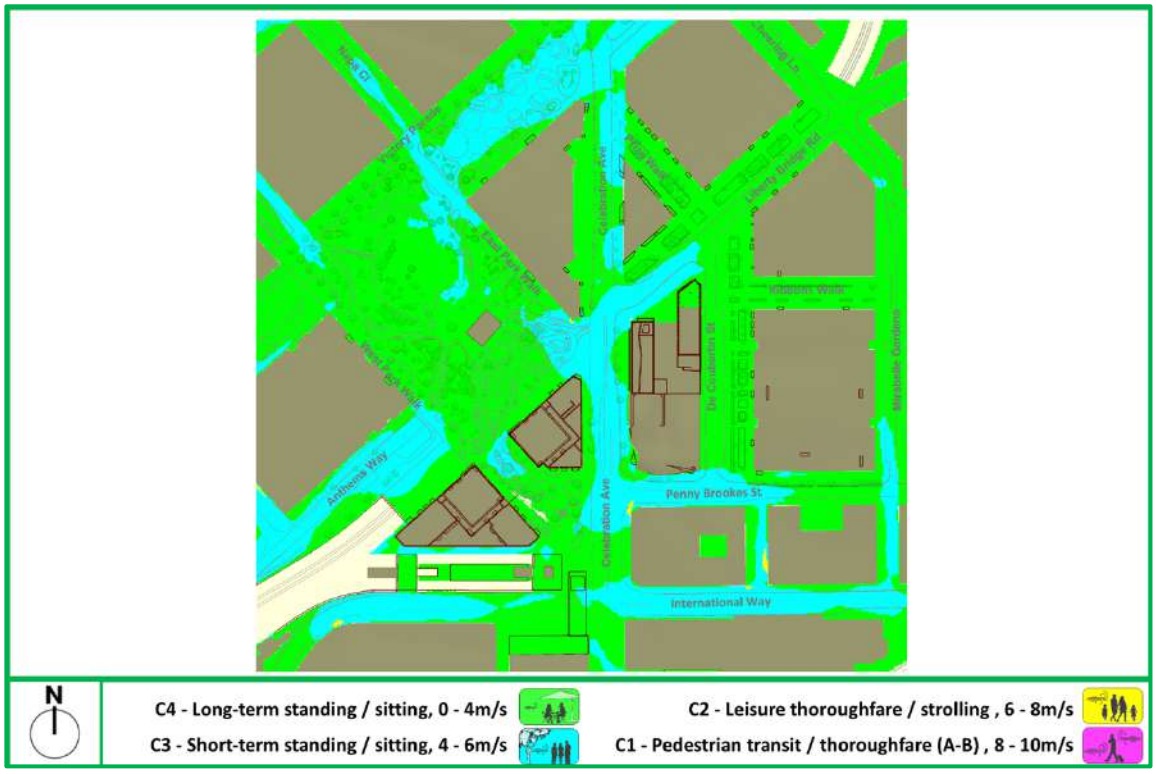
Comfort Ratings – Summer Season

C.6. Assessment Scenario 8 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed site Plot N16, Existing surrounding buildings + Committed Developments

Ground Level Safety Ratings



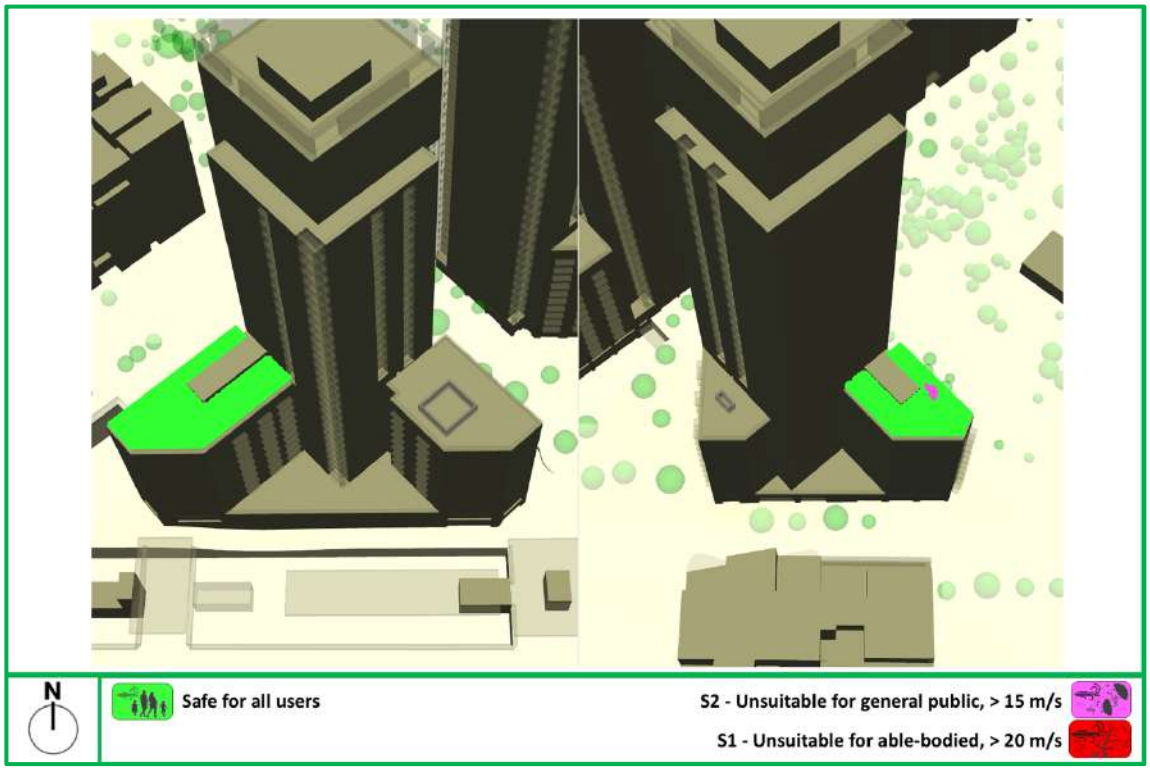
Comfort Ratings – Worst Season



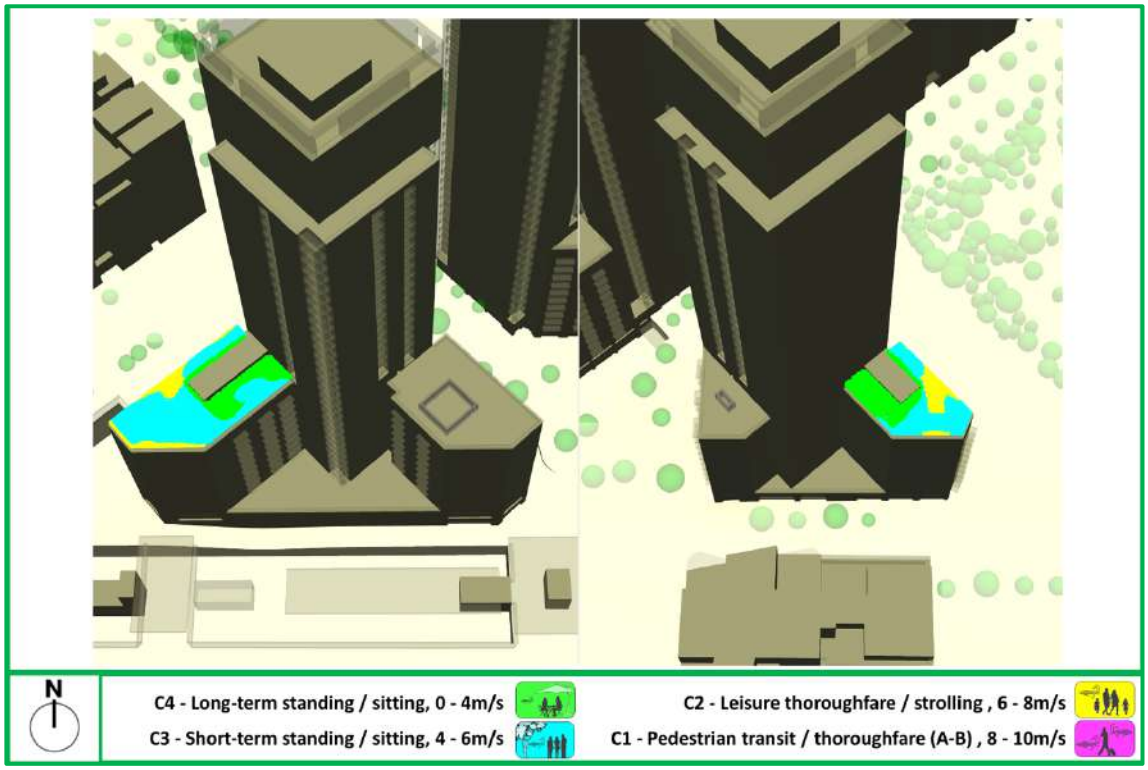
Comfort Ratings – Summer Season

APPENDIX D. WIND COMFORT AND SAFETY RATING ASSESSMENT RESULTS – CFD ANALYSIS FOR ELEVATED LEVELS

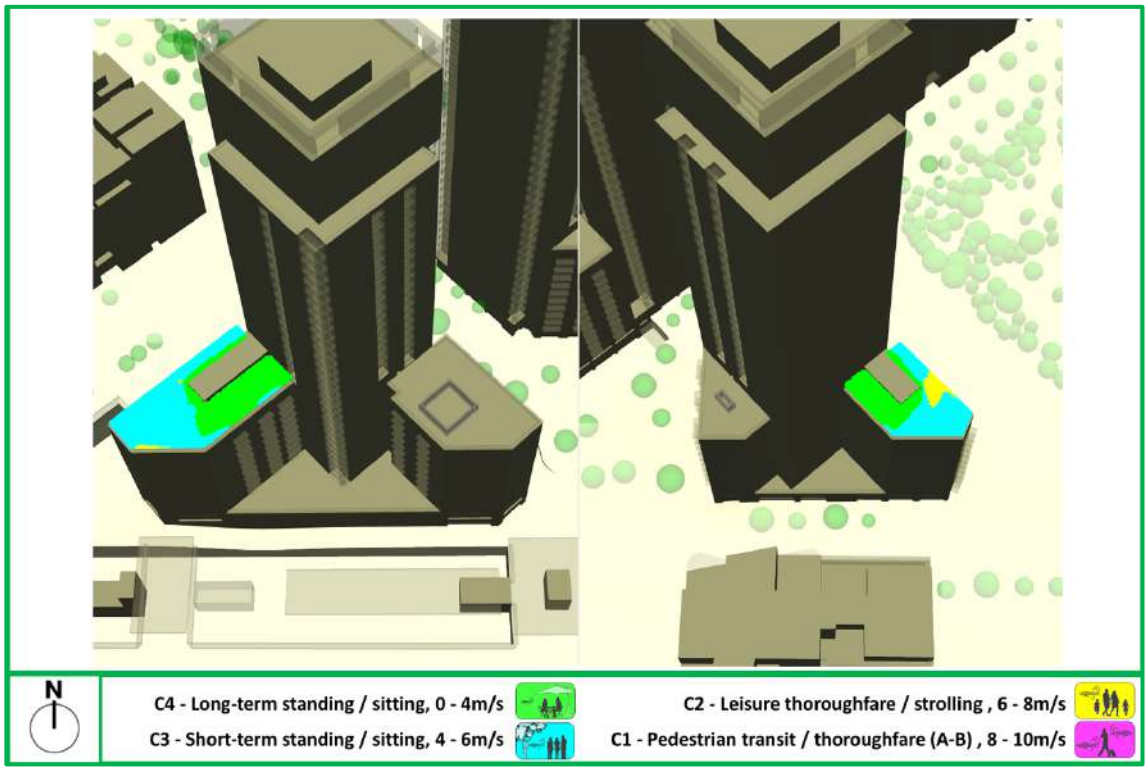
D.1. Assessment Scenario 3 - Existing site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 2)



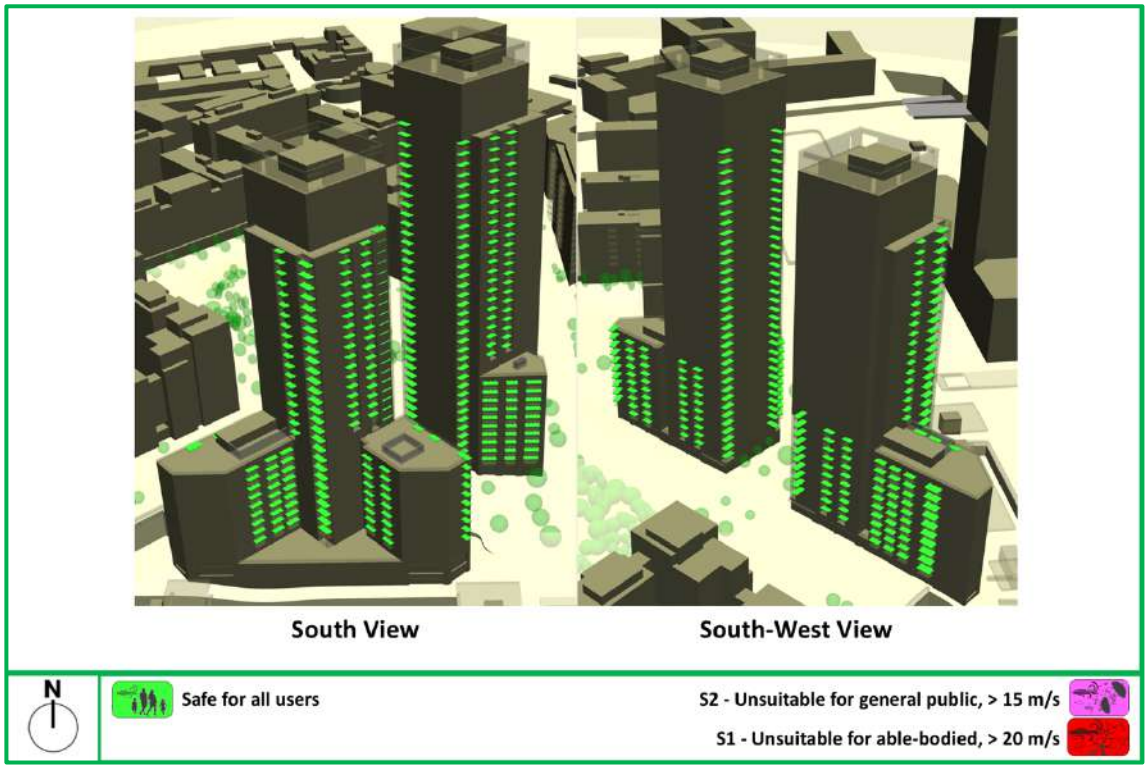
Safety Ratings – LVL 11 Roof Terrace



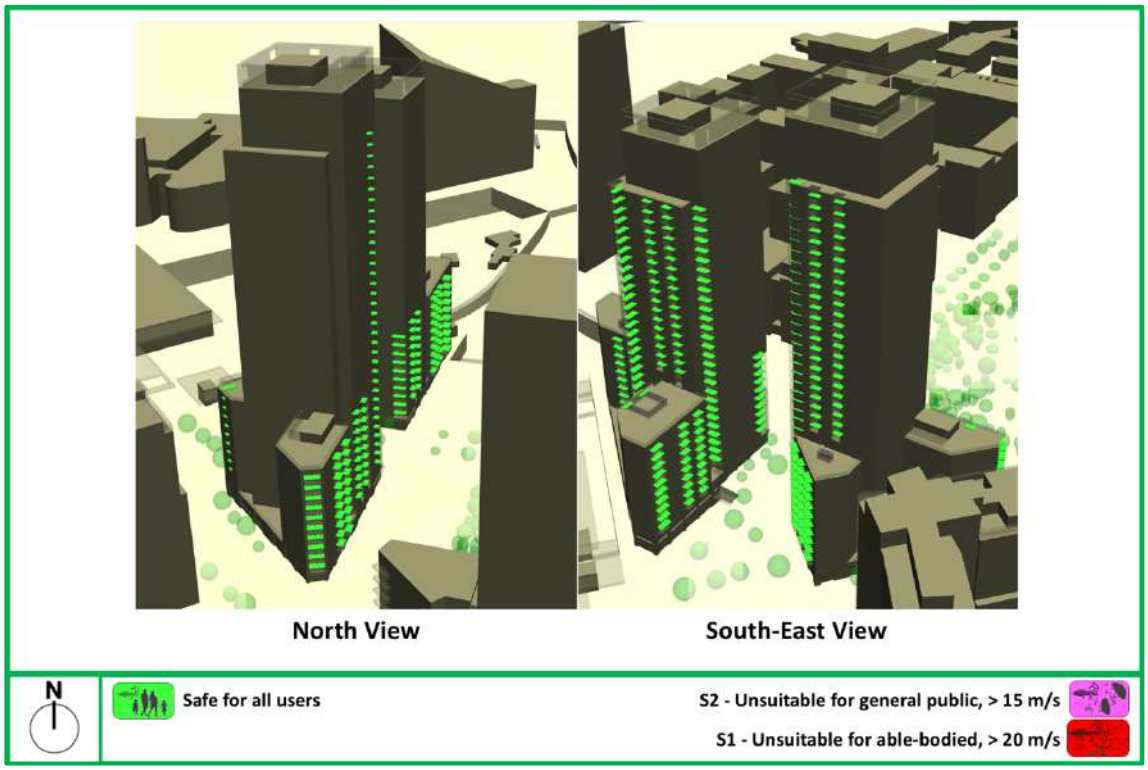
Comfort Ratings – LVL 11 Roof Terrace – Worst Season



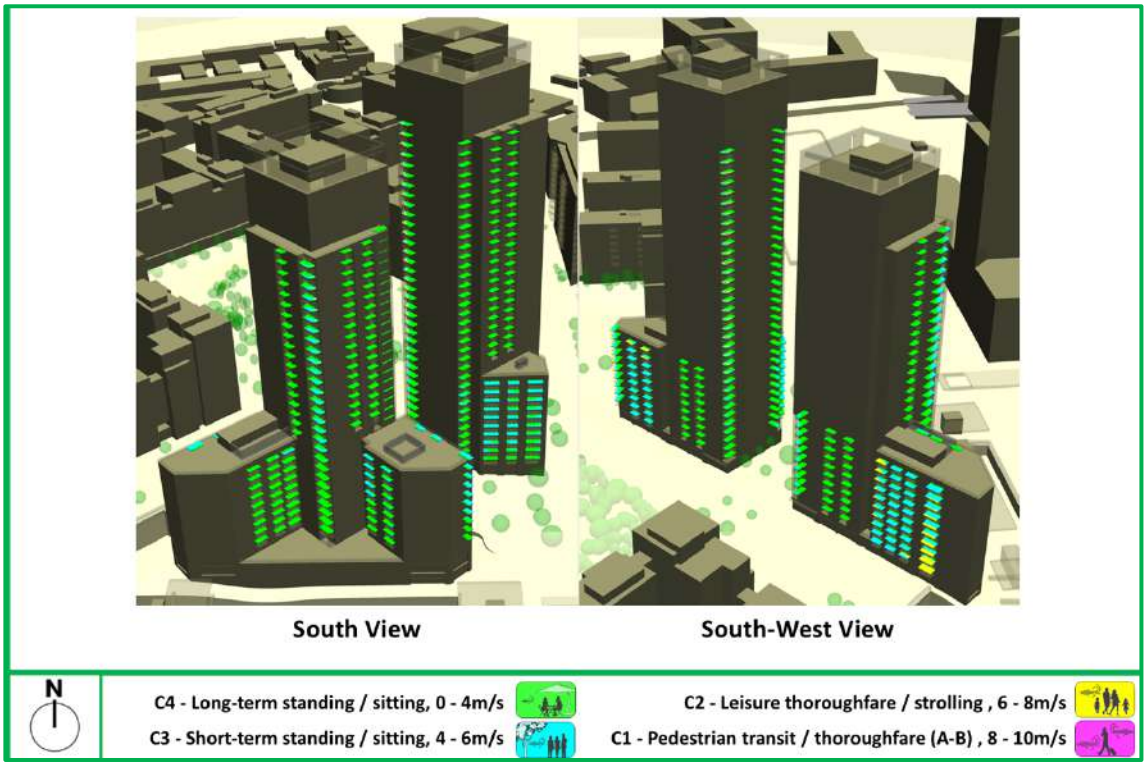
Comfort Ratings – LVL 11 Roof Terrace – Summer



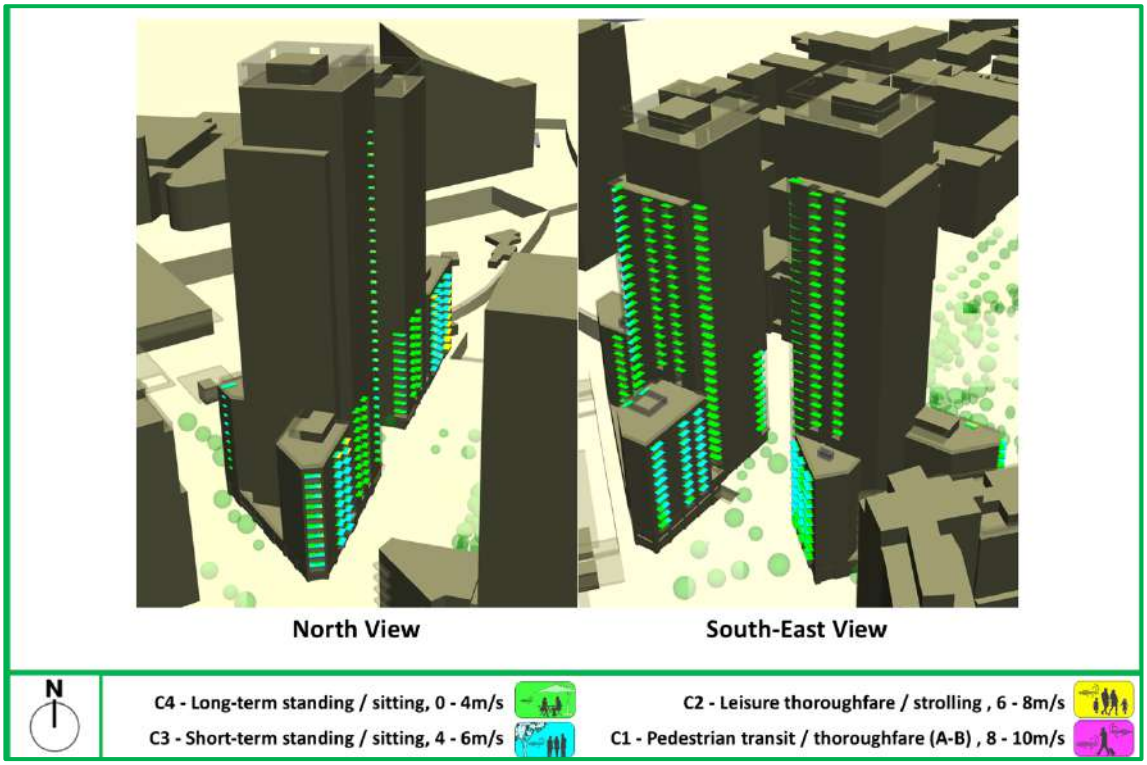
Safety Ratings – Balconies View 1



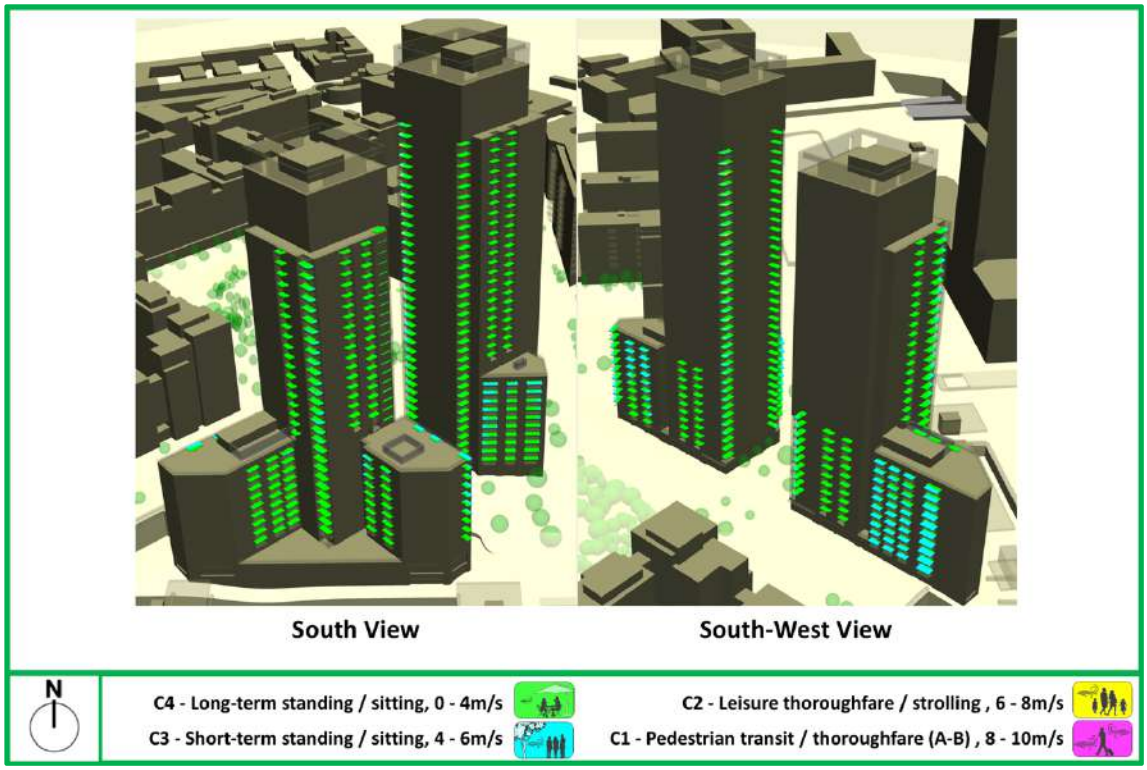
Safety Ratings – Balconies View 2



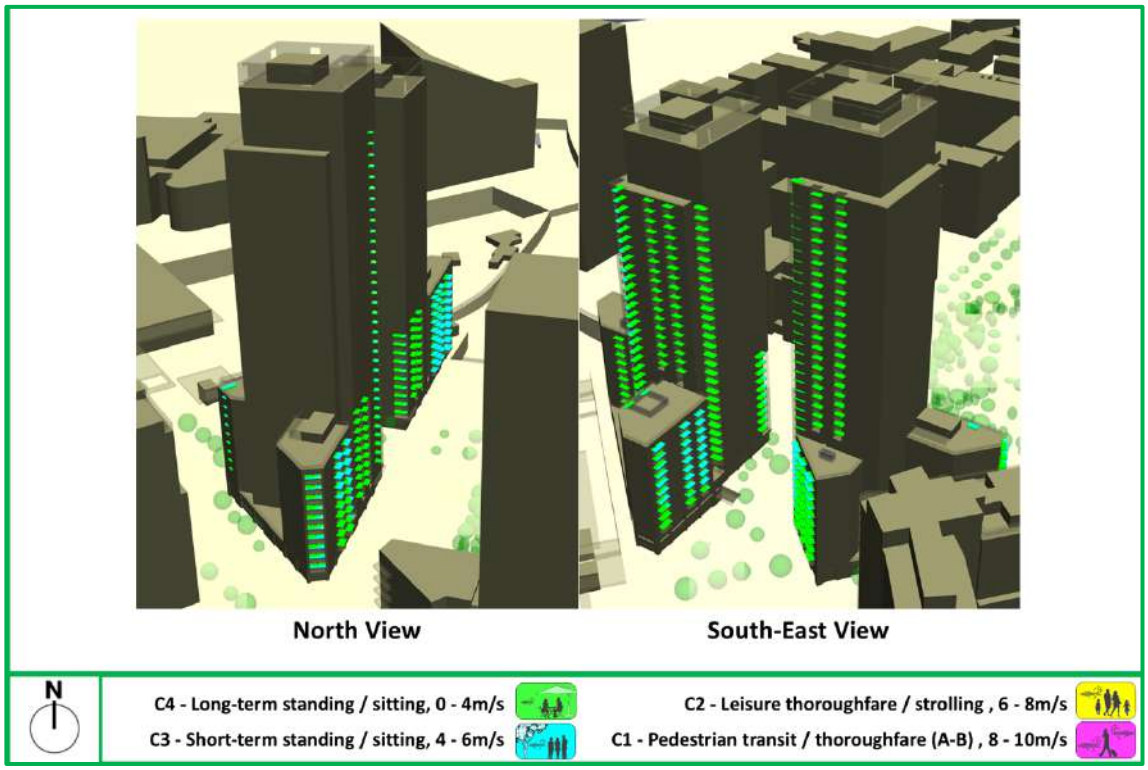
Comfort Ratings – Balconies – Worst Season View 1



Comfort Ratings – Balconies – Worst Season View 2

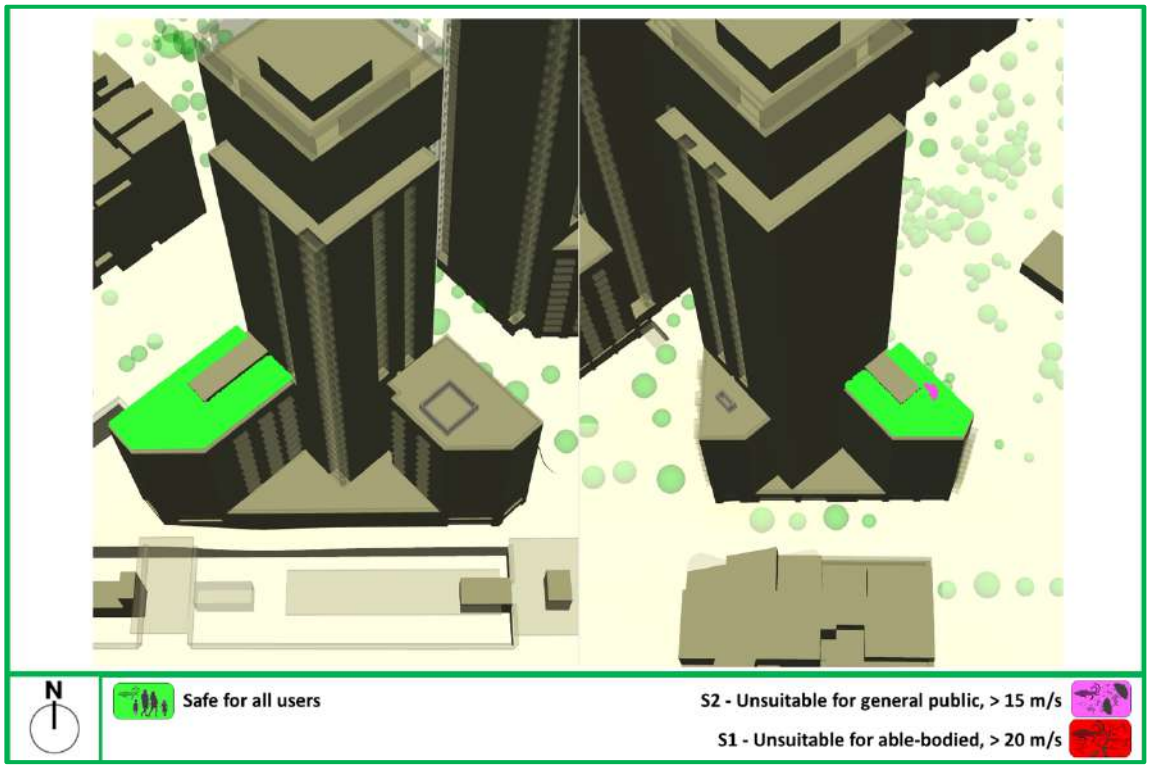


Comfort Ratings – Balconies – Summer View 1

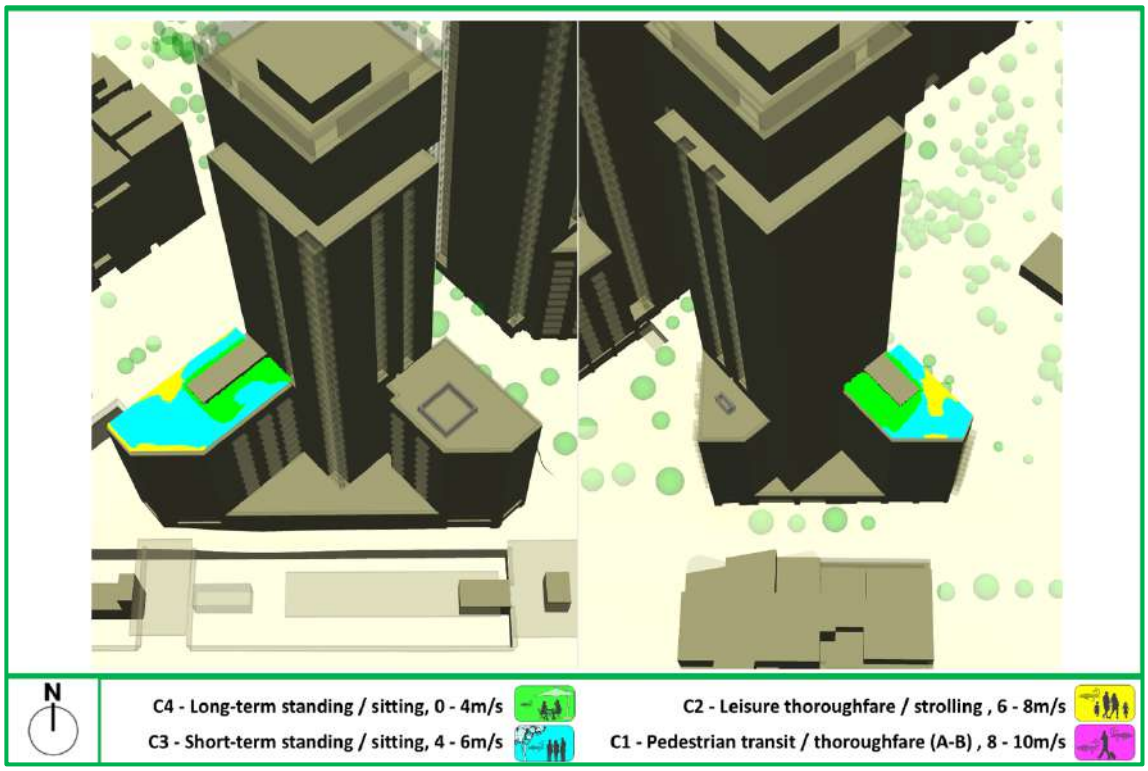


Comfort Ratings – Balconies – Summer View 2

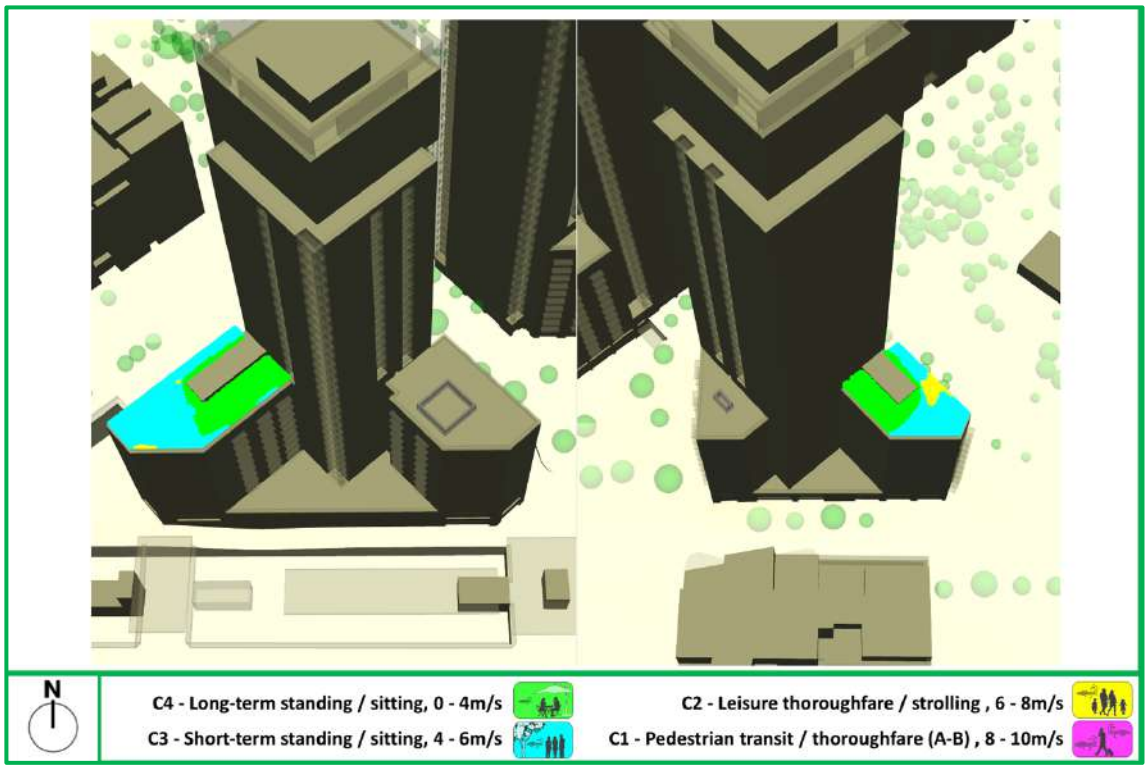
D.2. Assessment Scenario 5 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding Buildings(ASR Scenario 1)



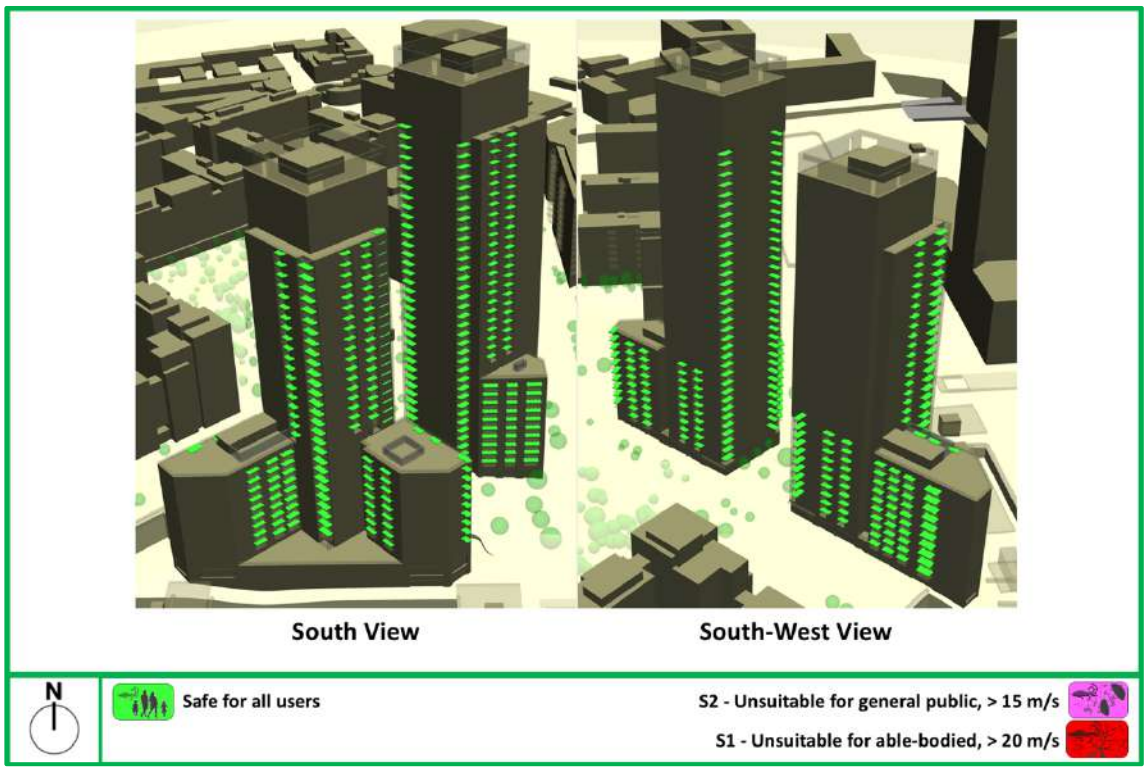
Safety Ratings – LVL 11 Roof Terrace



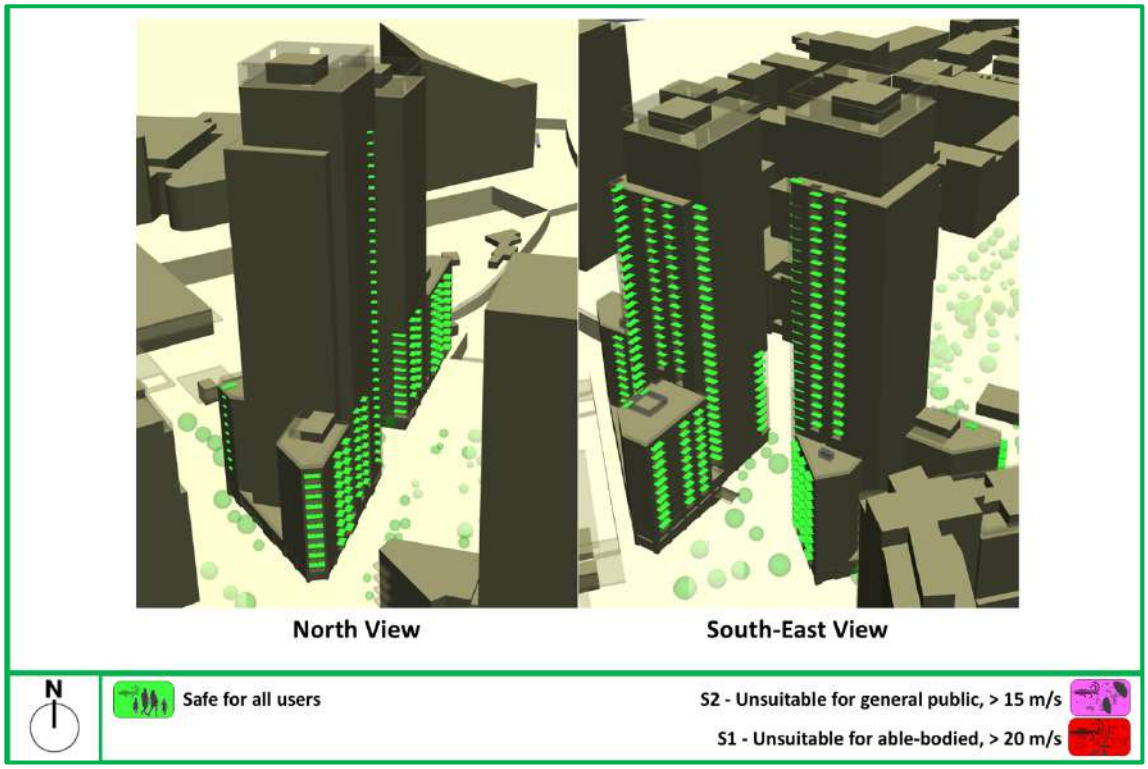
Comfort Ratings – LVL 11 Roof Terrace – Worst Season



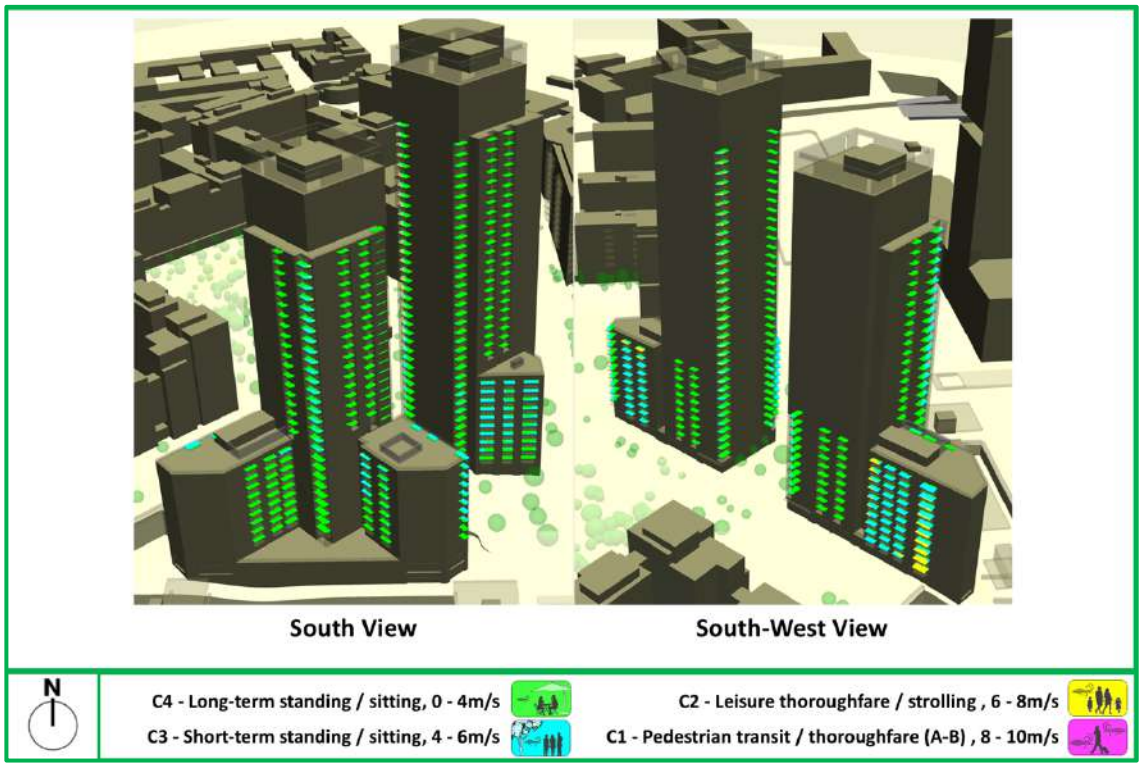
Comfort Ratings – LVL 11 Roof Terrace – Summer



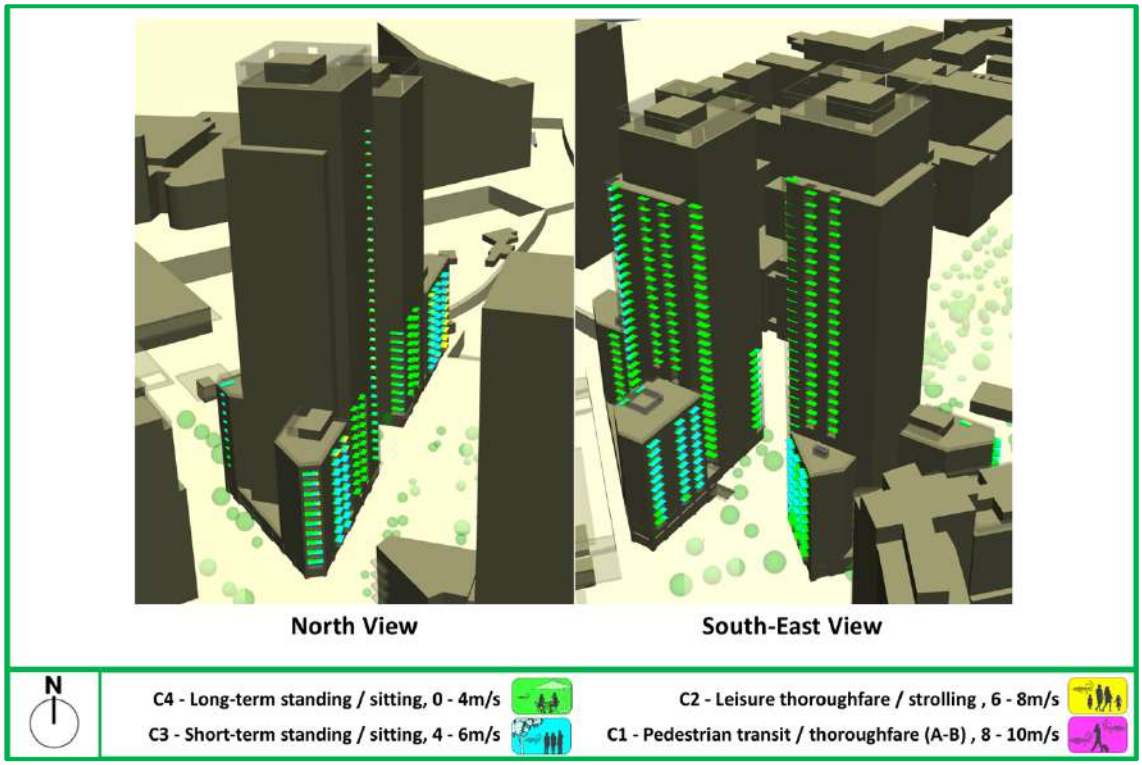
Safety Ratings – Balconies View 1



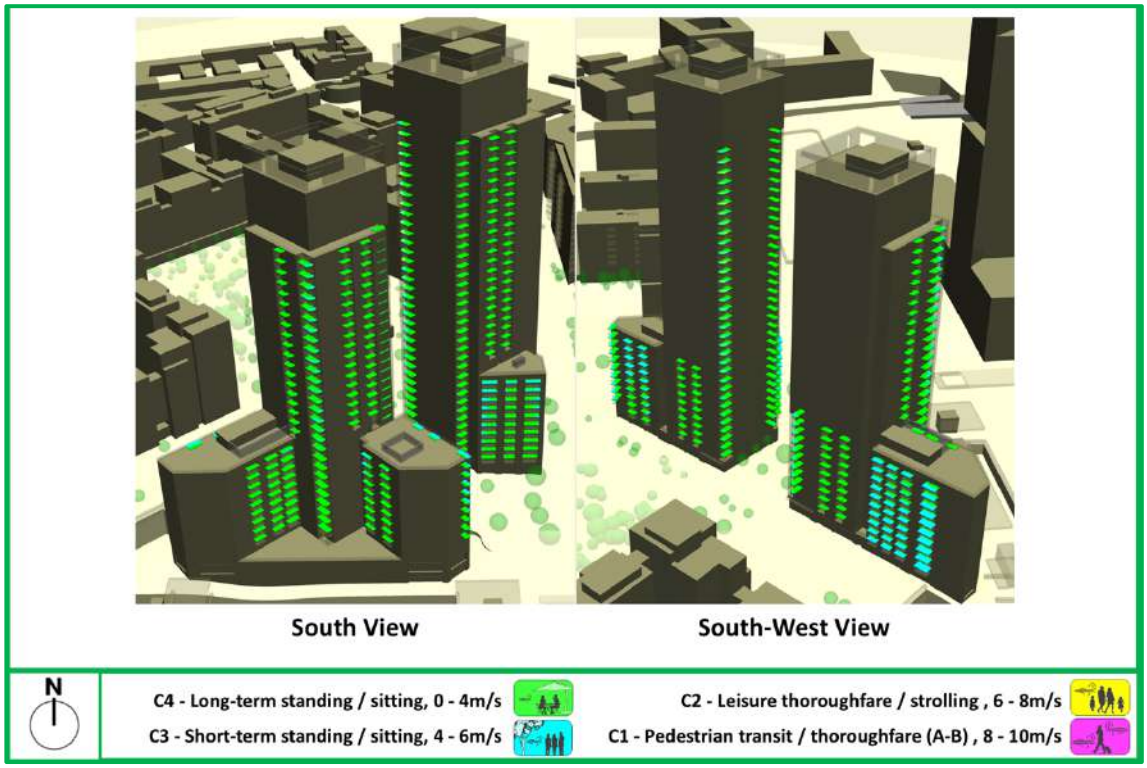
Safety Ratings – Balconies View 2



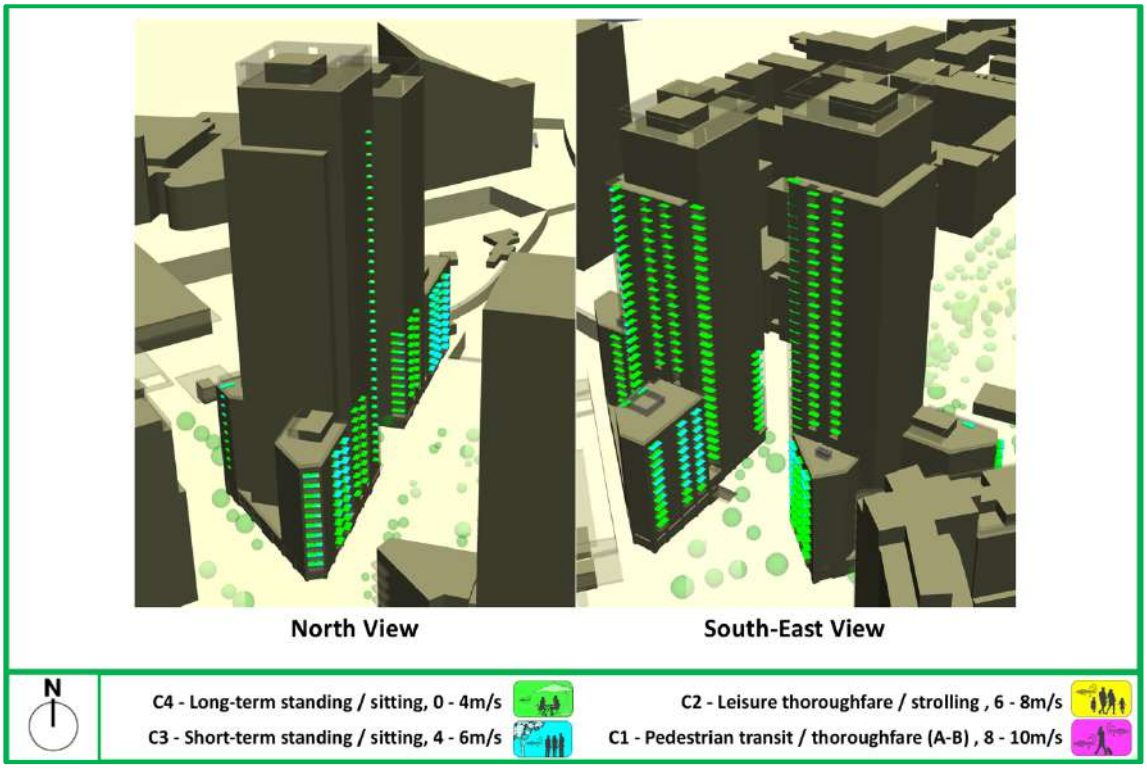
Comfort Ratings – Balconies – Worst Season View 1



Comfort Ratings – Balconies – Worst Season View 2

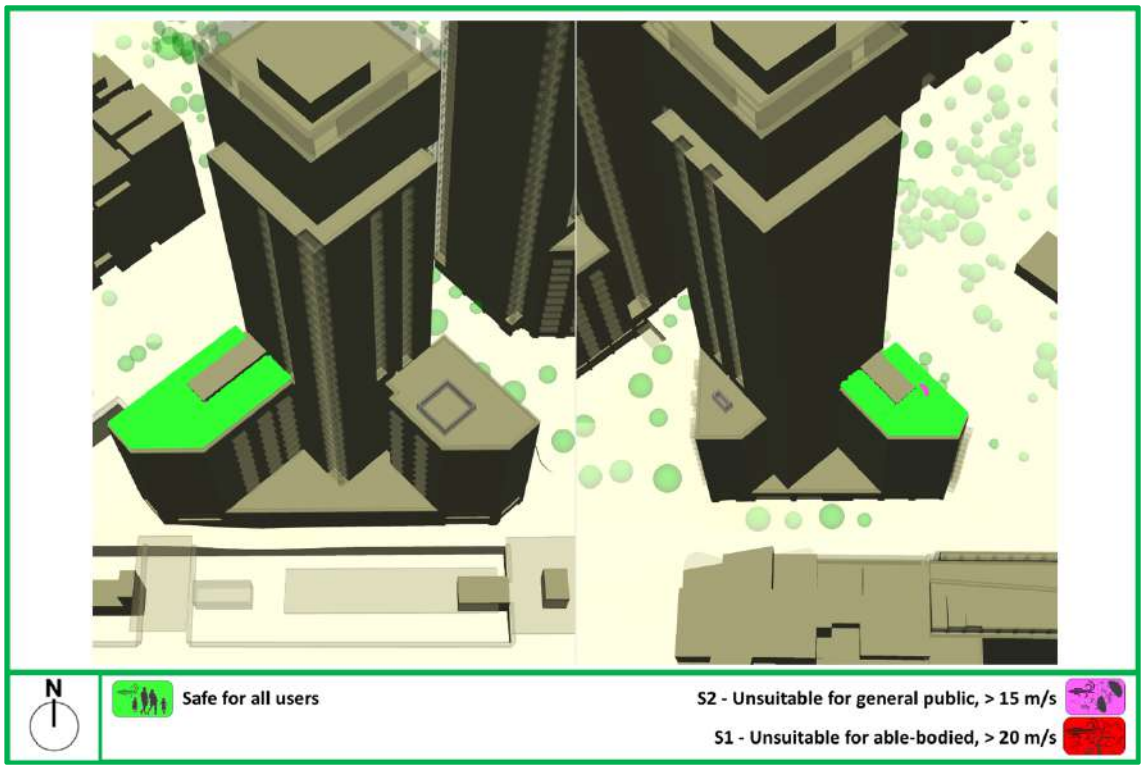


Comfort Ratings – Balconies – Summer View 1

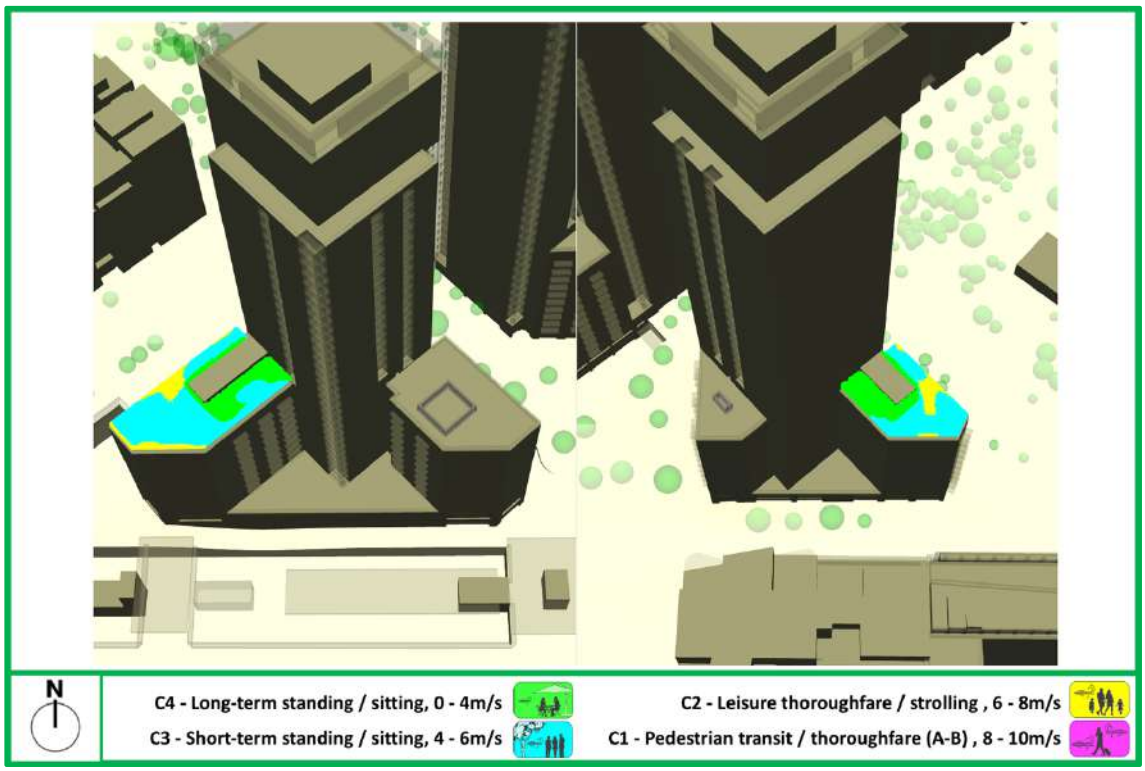


Comfort Ratings – Balconies – Summer View 2

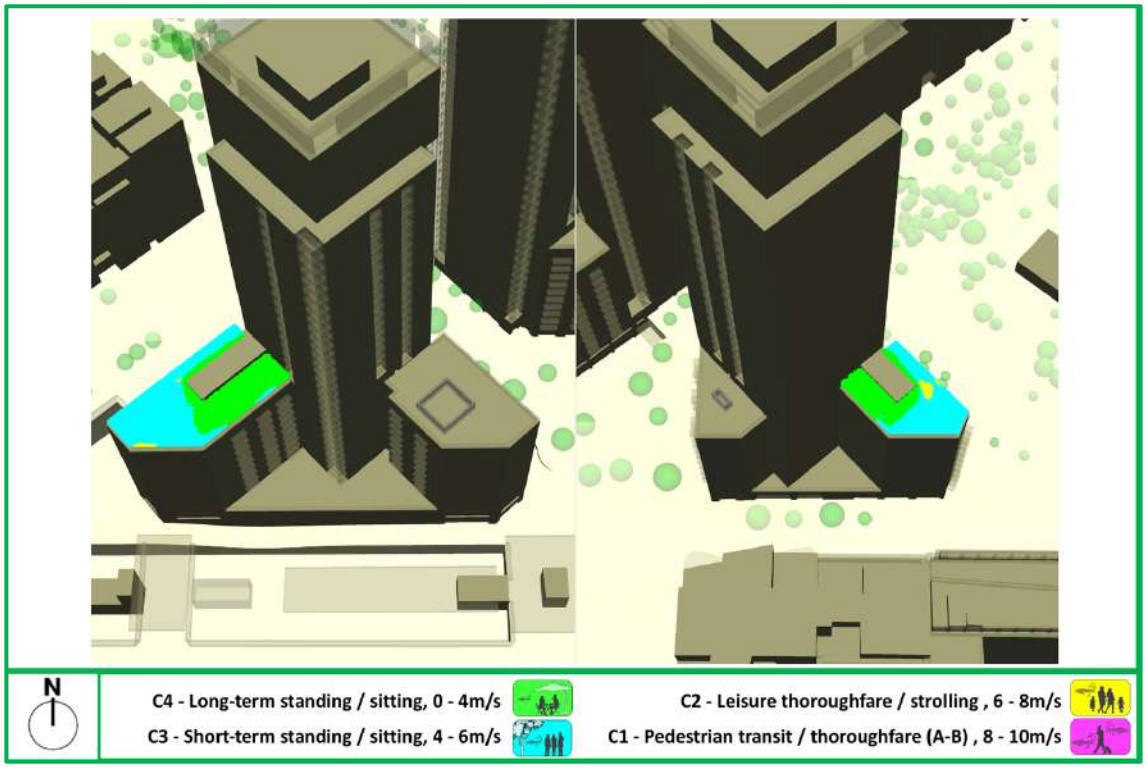
D.3. Assessment Scenario 6 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed Plot N16, Existing surrounding Buildings (ASR Scenario 1)



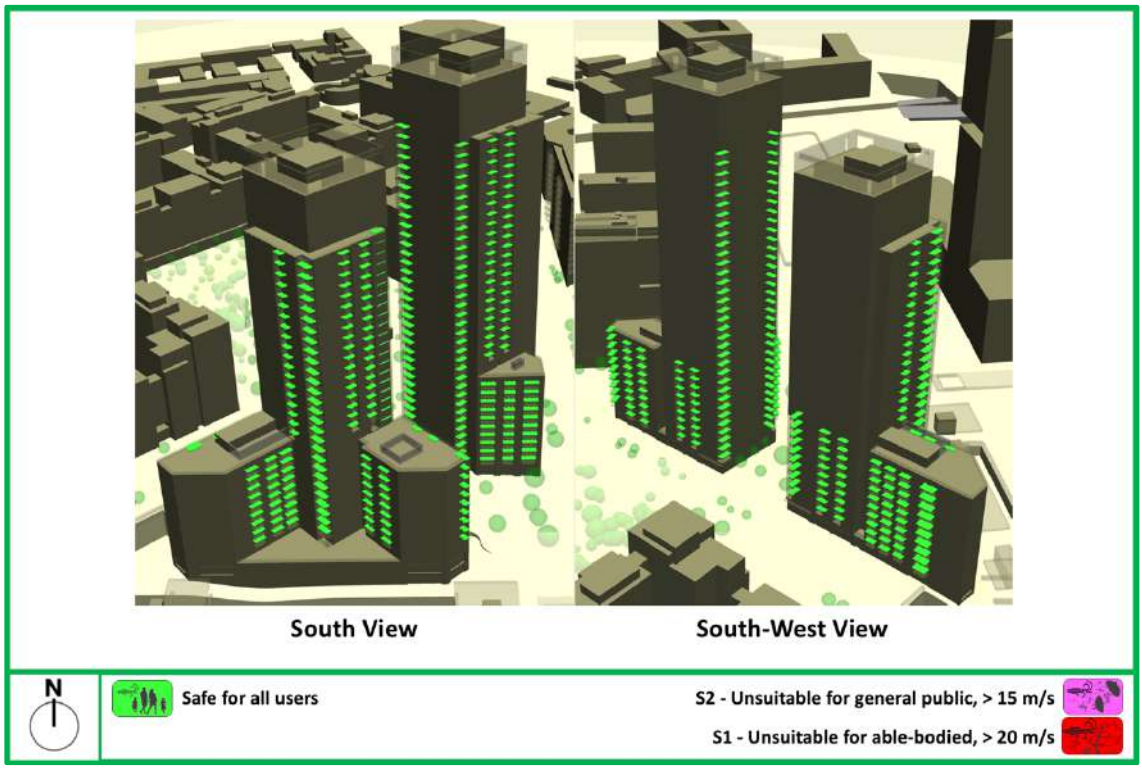
Safety Ratings – LVL 11 Roof Terrace



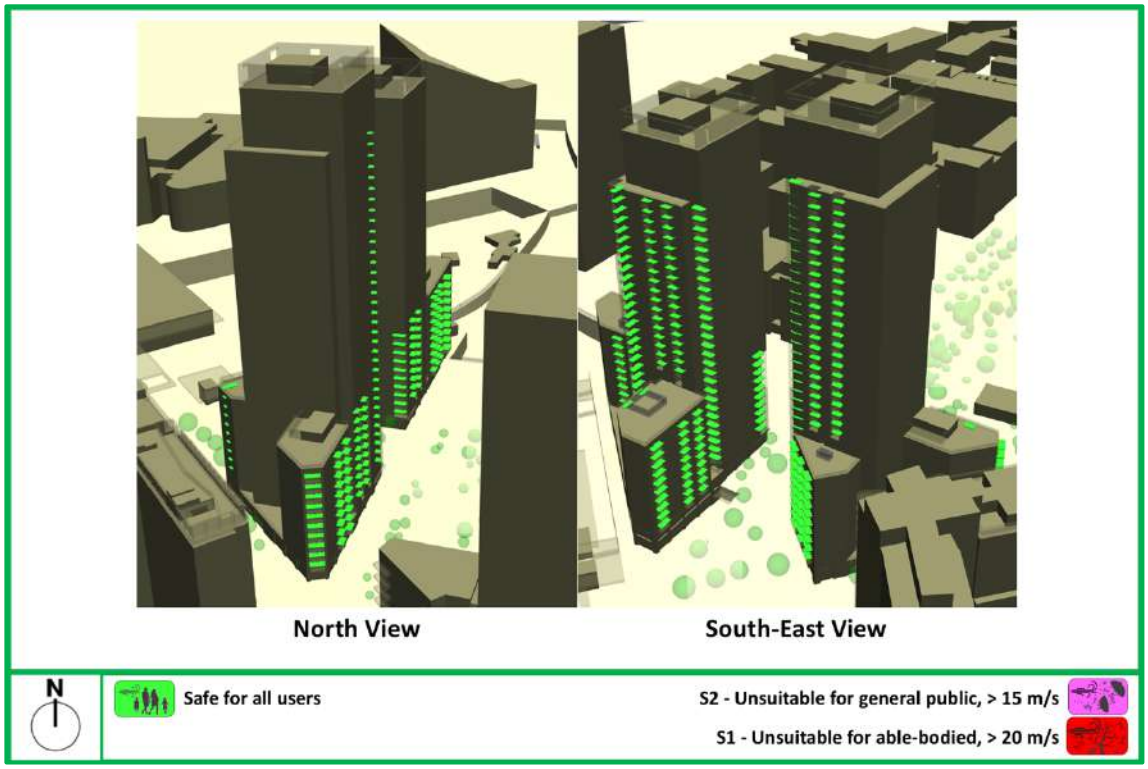
Comfort Ratings – LVL 11 Roof Terrace – Worst Season



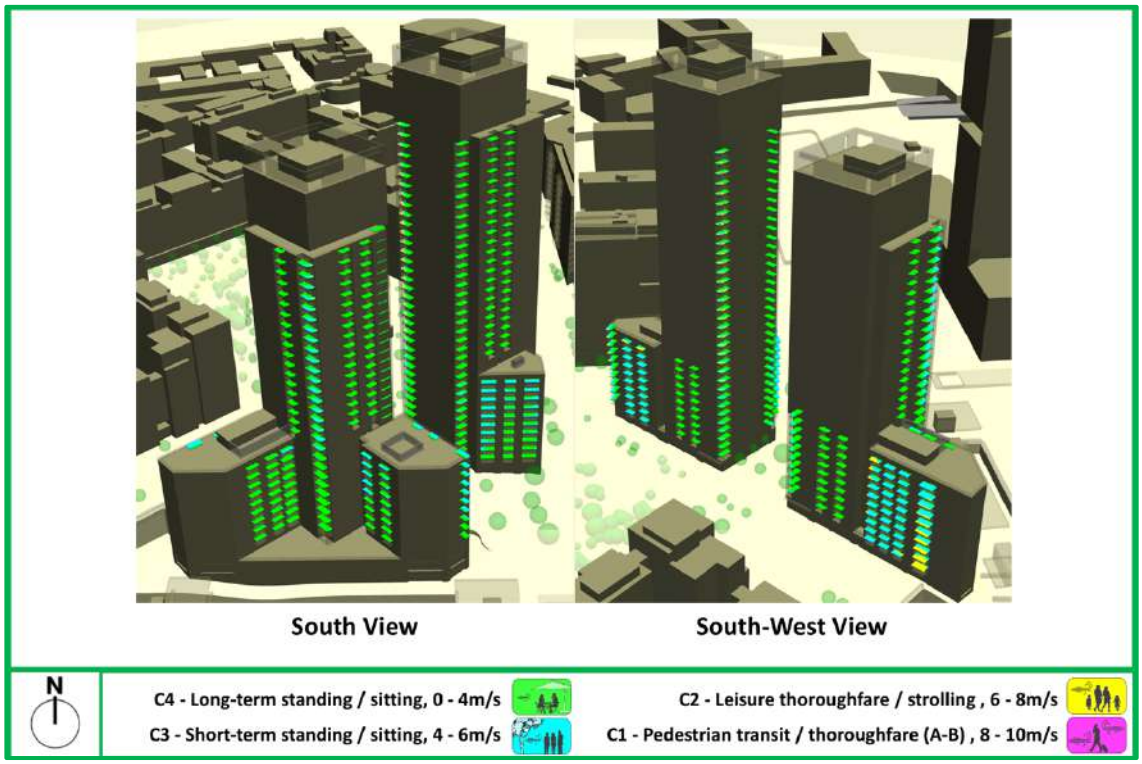
Comfort Ratings – LVL 11 Roof Terrace – Summer



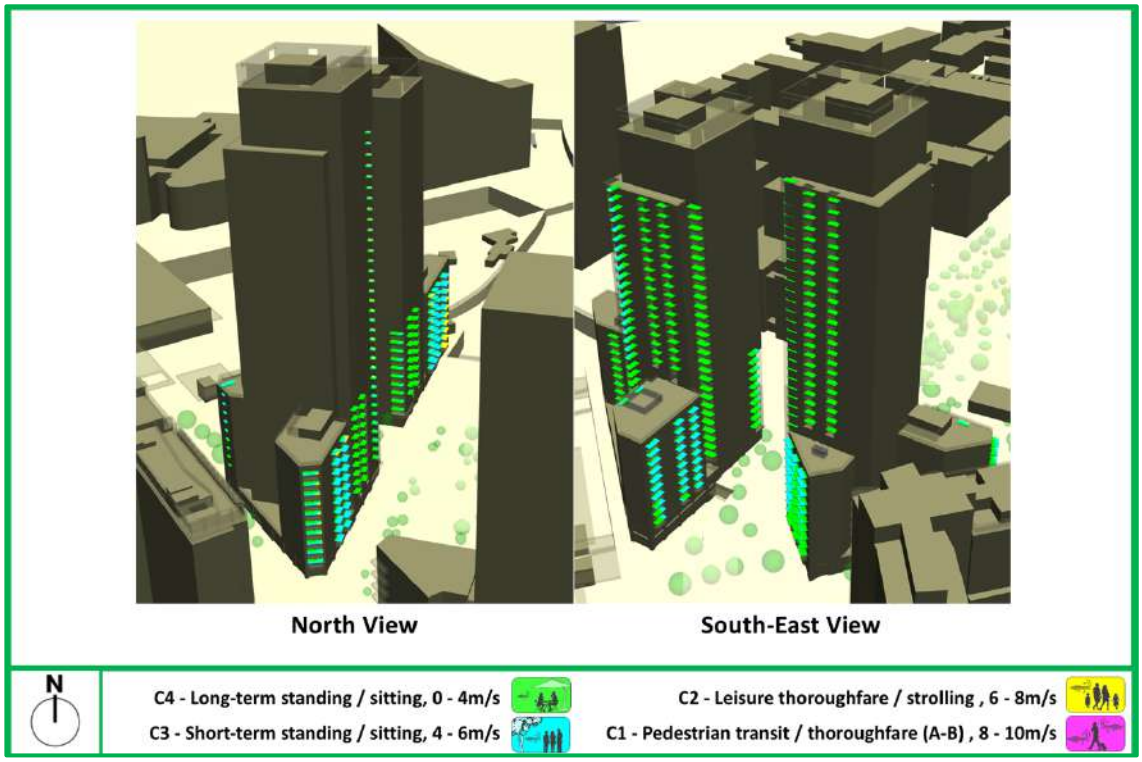
Safety Ratings – Balconies View 1



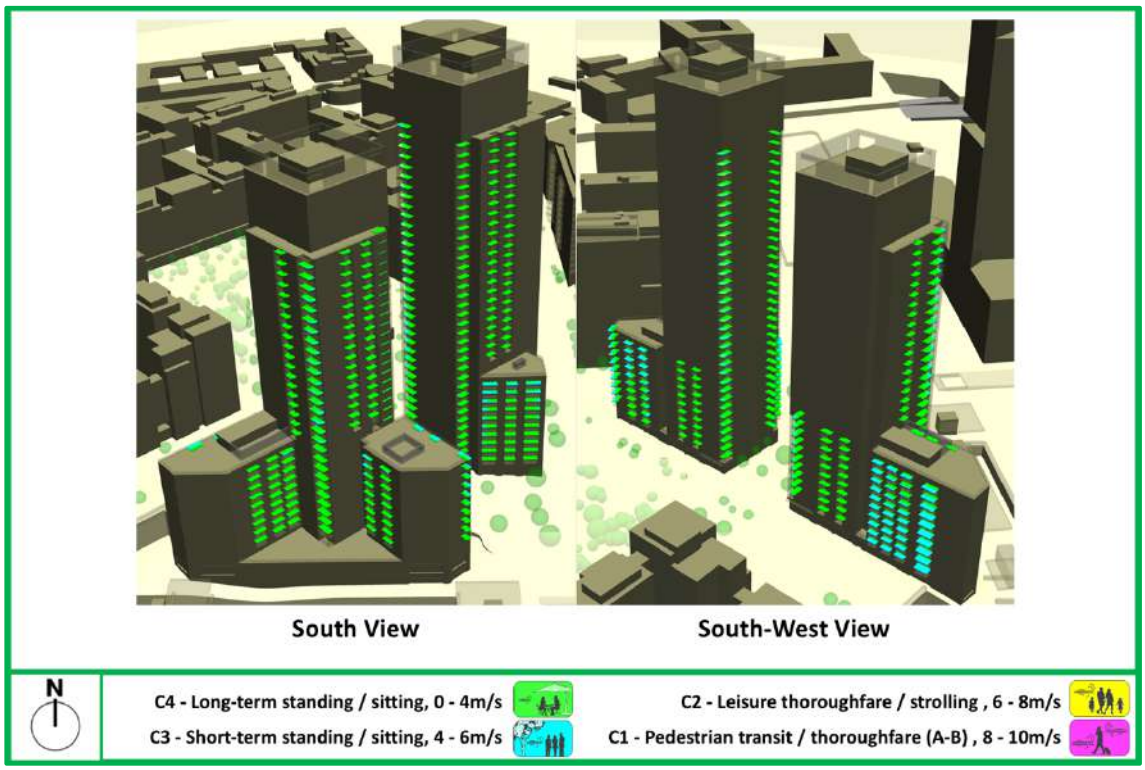
Safety Ratings – Balconies View 2



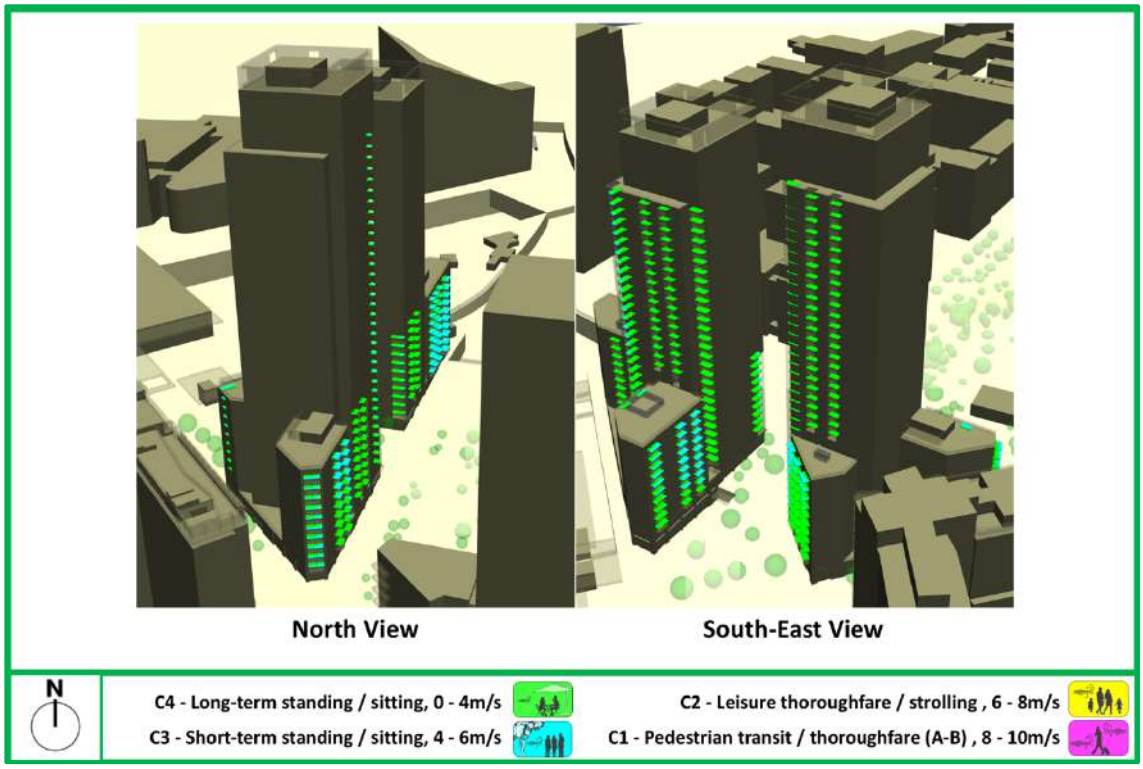
Comfort Ratings – Balconies – Worst Season View 1



Comfort Ratings – Balconies – Worst Season View 2

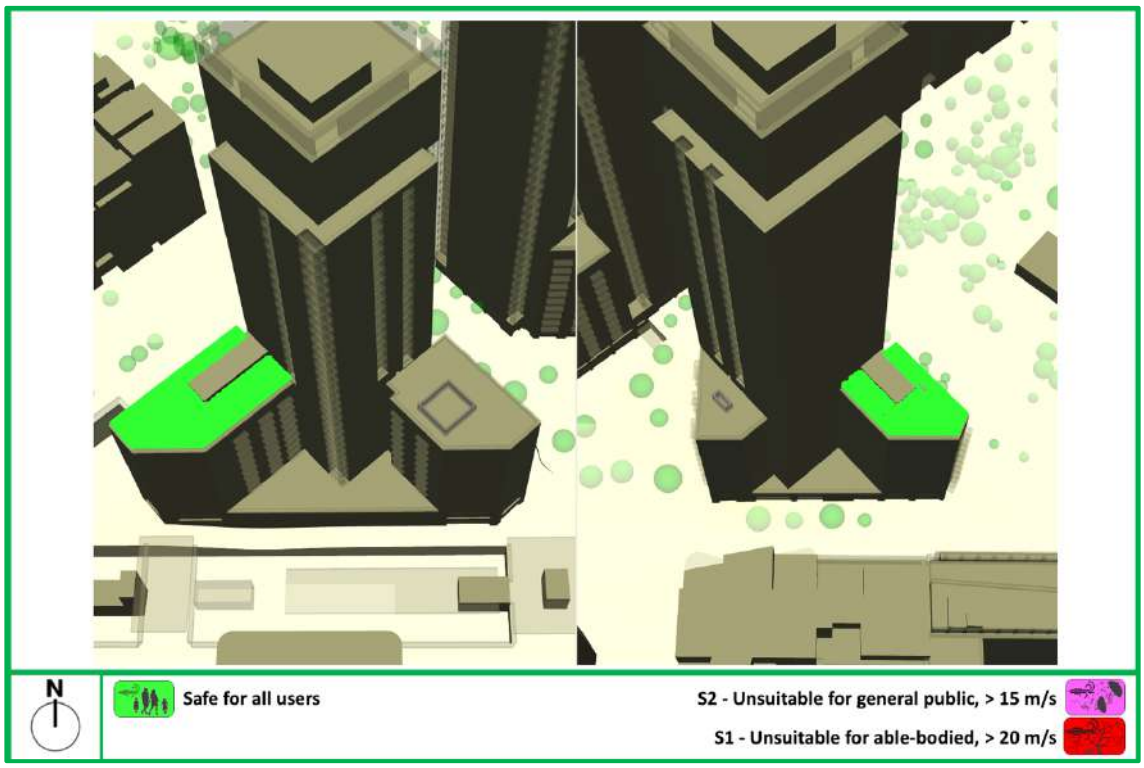


Comfort Ratings – Balconies – Summer View 1

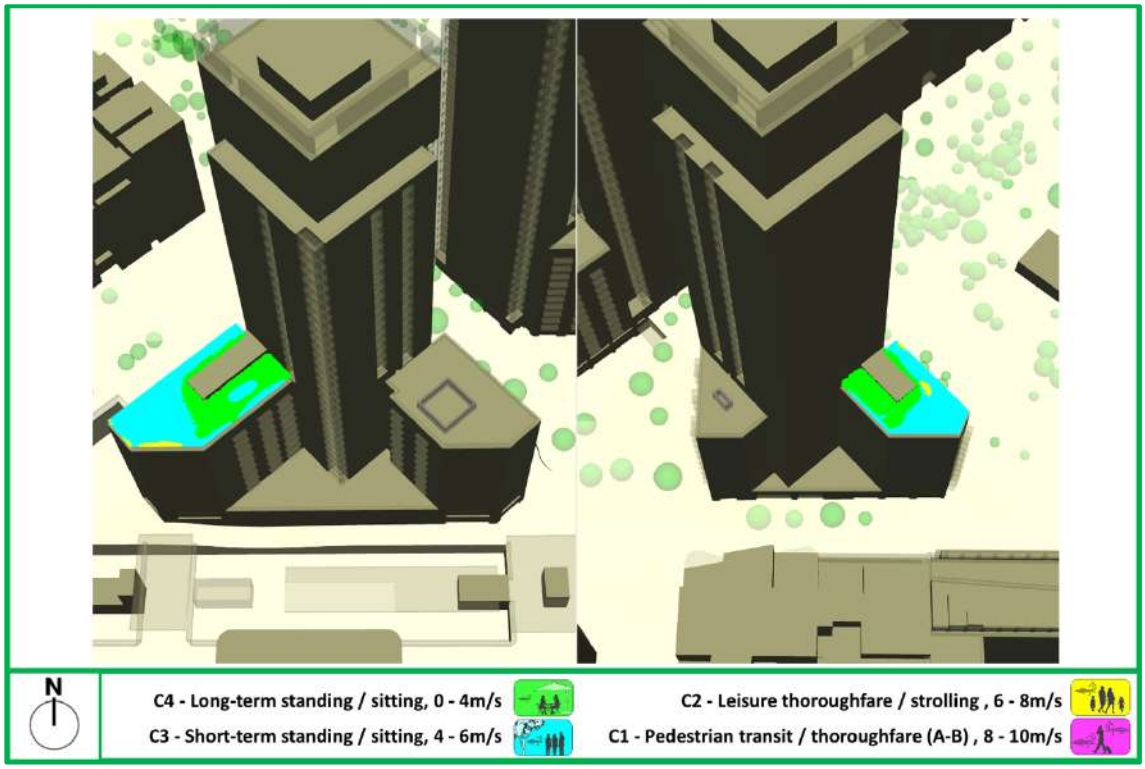


Comfort Ratings – Balconies – Summer View 2

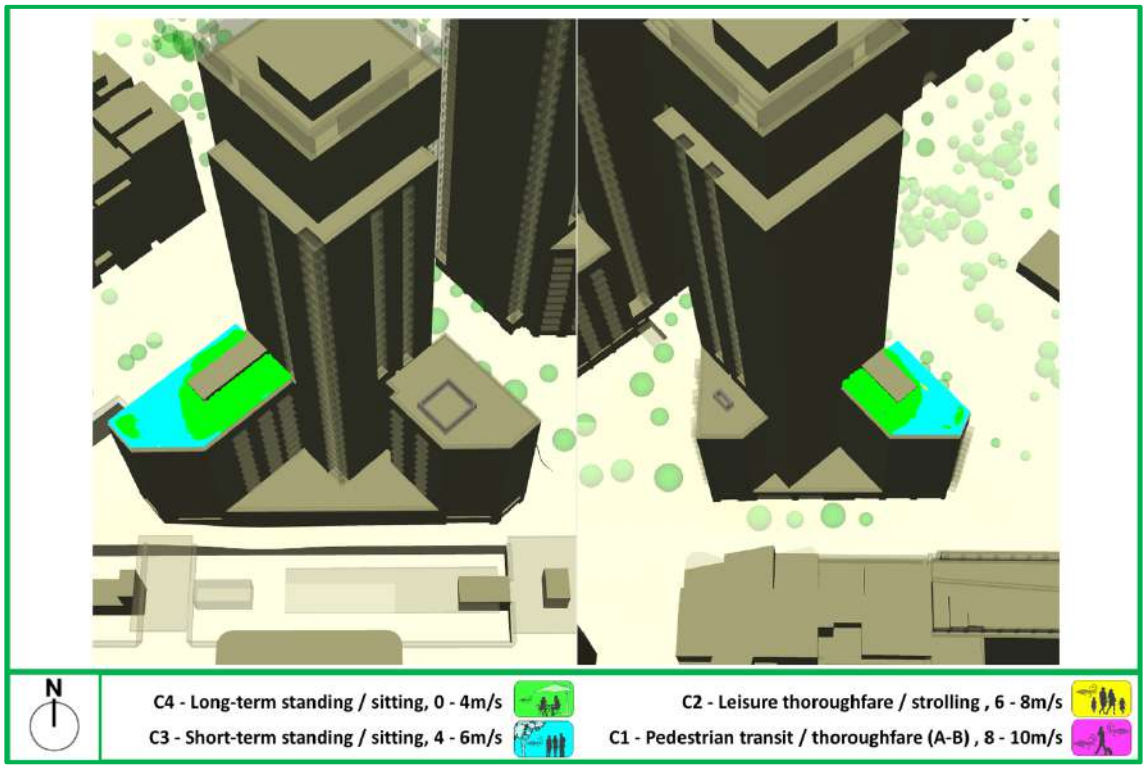
D.4. Assessment Scenario 8 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed Plot N16, Existing surrounding Buildings with Future Developments



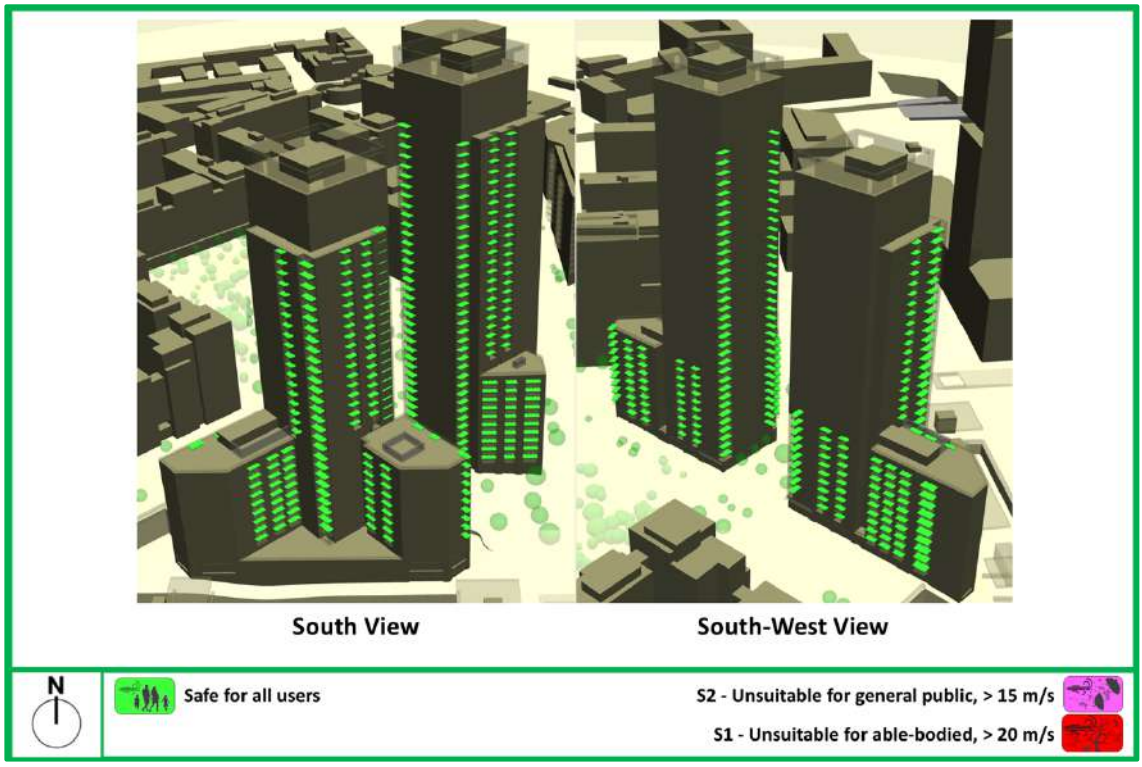
Safety Ratings – LVL 11 Roof Terrace



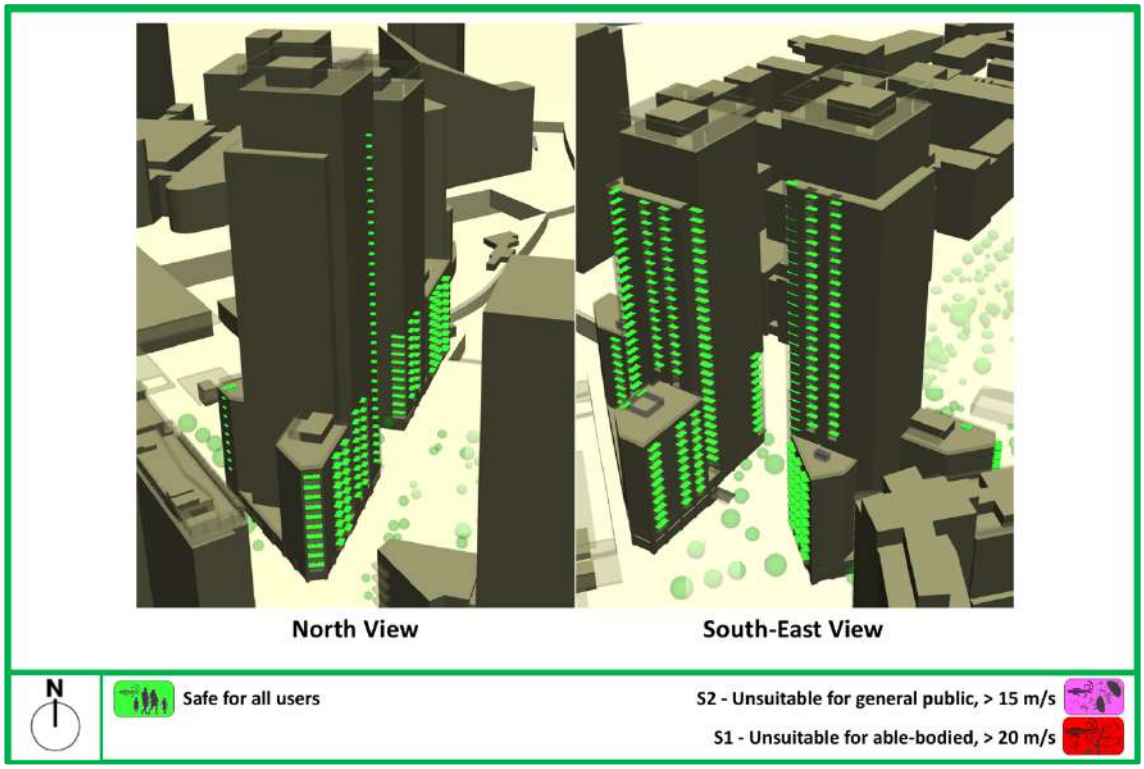
Comfort Ratings – LVL 11 Roof Terrace – Worst Season



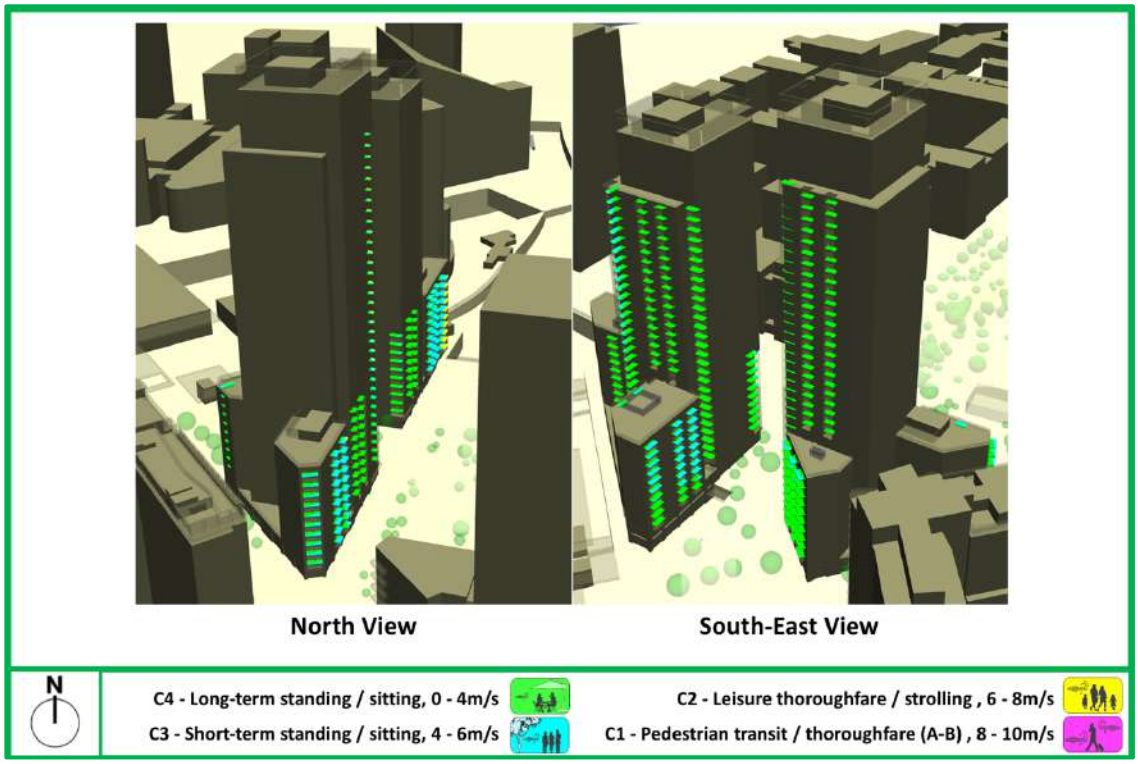
Comfort Ratings – LVL 11 Roof Terrace – Summer



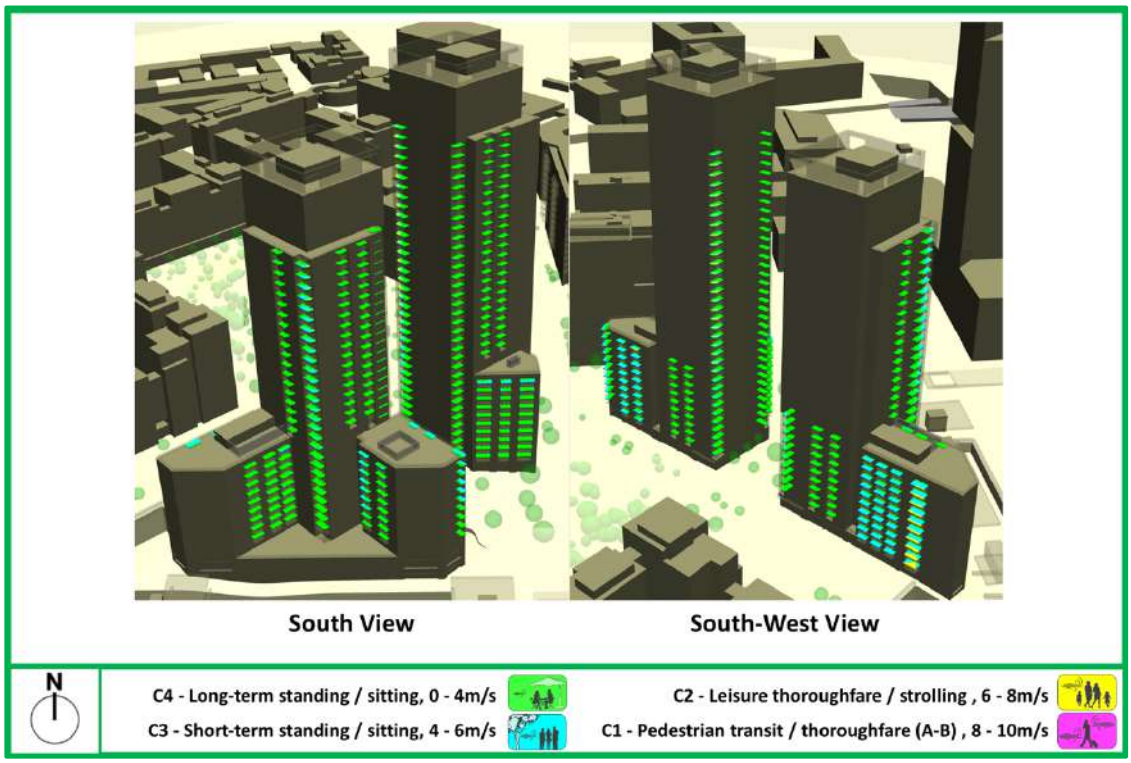
Safety Ratings – Balconies View 1



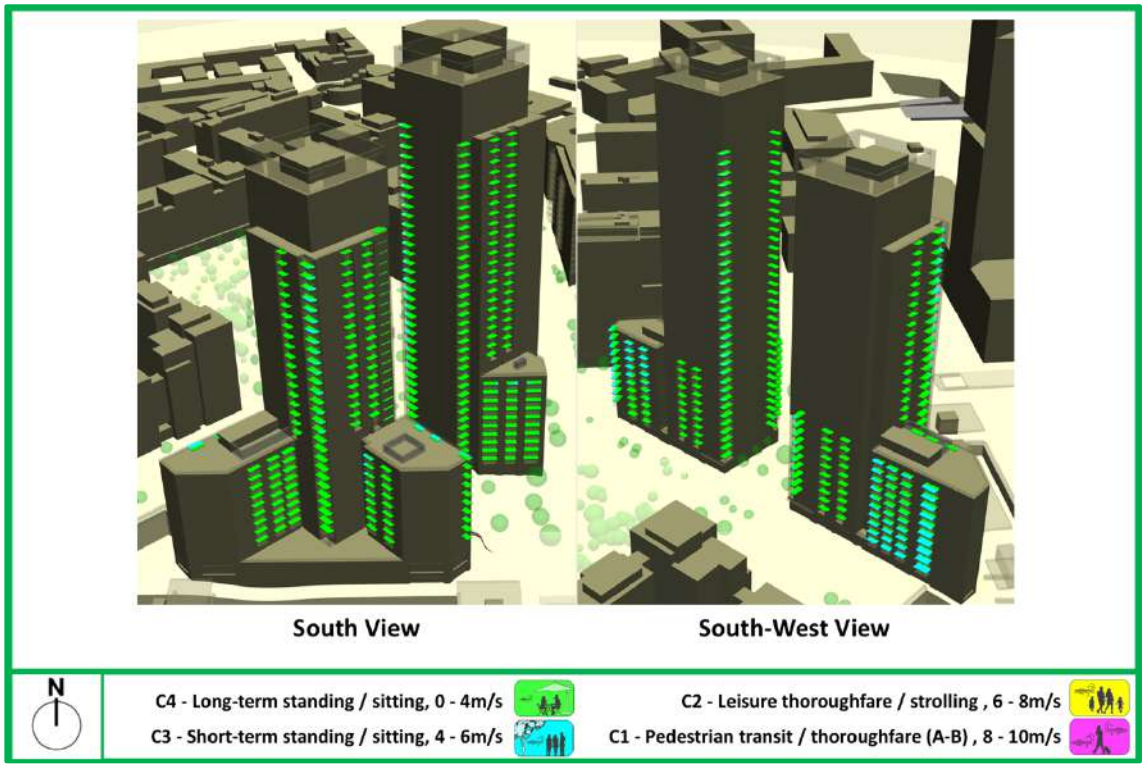
Safety Ratings – Balconies View 2



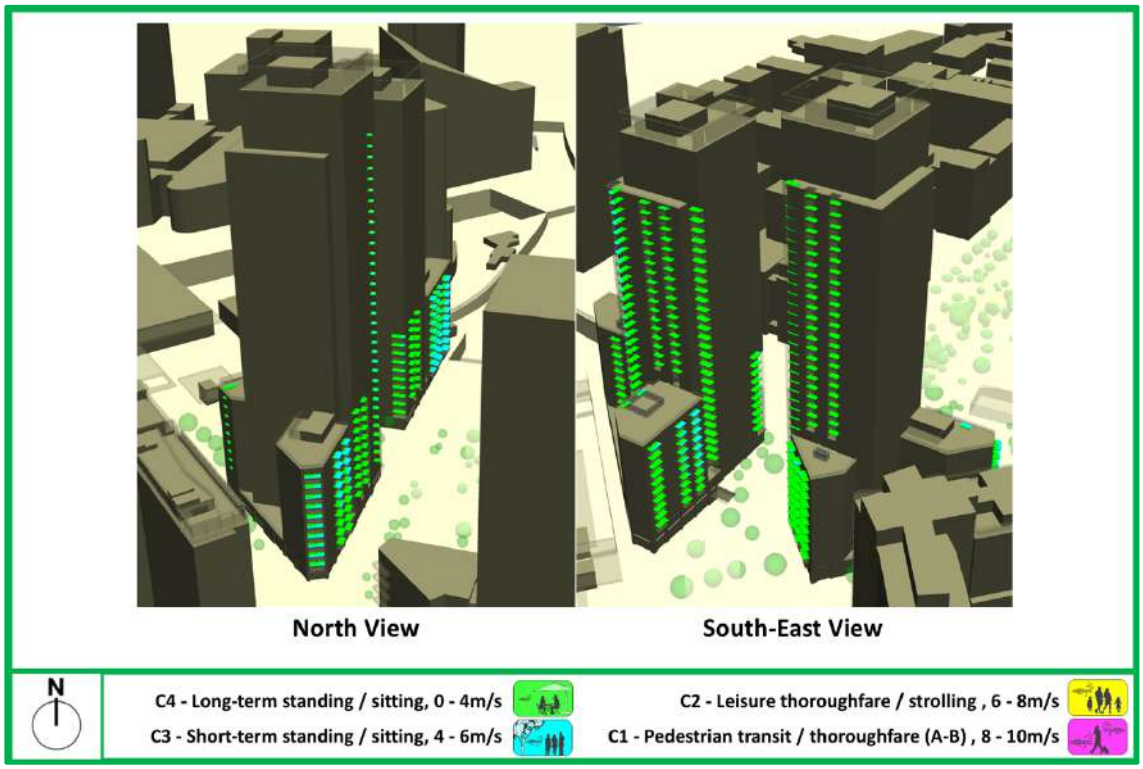
Comfort Ratings – Balconies – Worst Season View 1



Comfort Ratings – Balconies – Worst Season View 2



Comfort Ratings – Balconies – Summer View 1



Comfort Ratings – Balconies – Summer View 2

APPENDIX E. WIND TUNNEL MODEL PICTURES

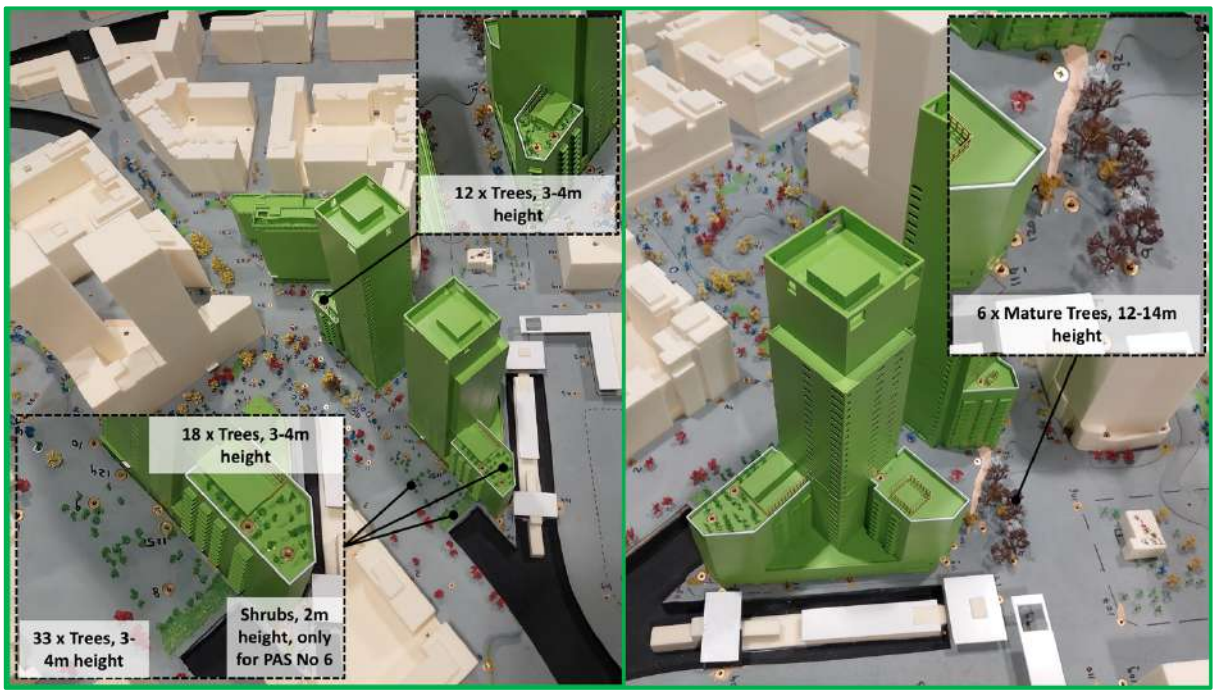
E.1. Assessment Scenario 1 - Existing site conditions for Victory Park/Belvedere, Empty site Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 1)

E.2. Assessment Scenario 3 - Existing site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 2)

E.3. Assessment Scenario 5 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding Buildings (ASR Scenario 3)

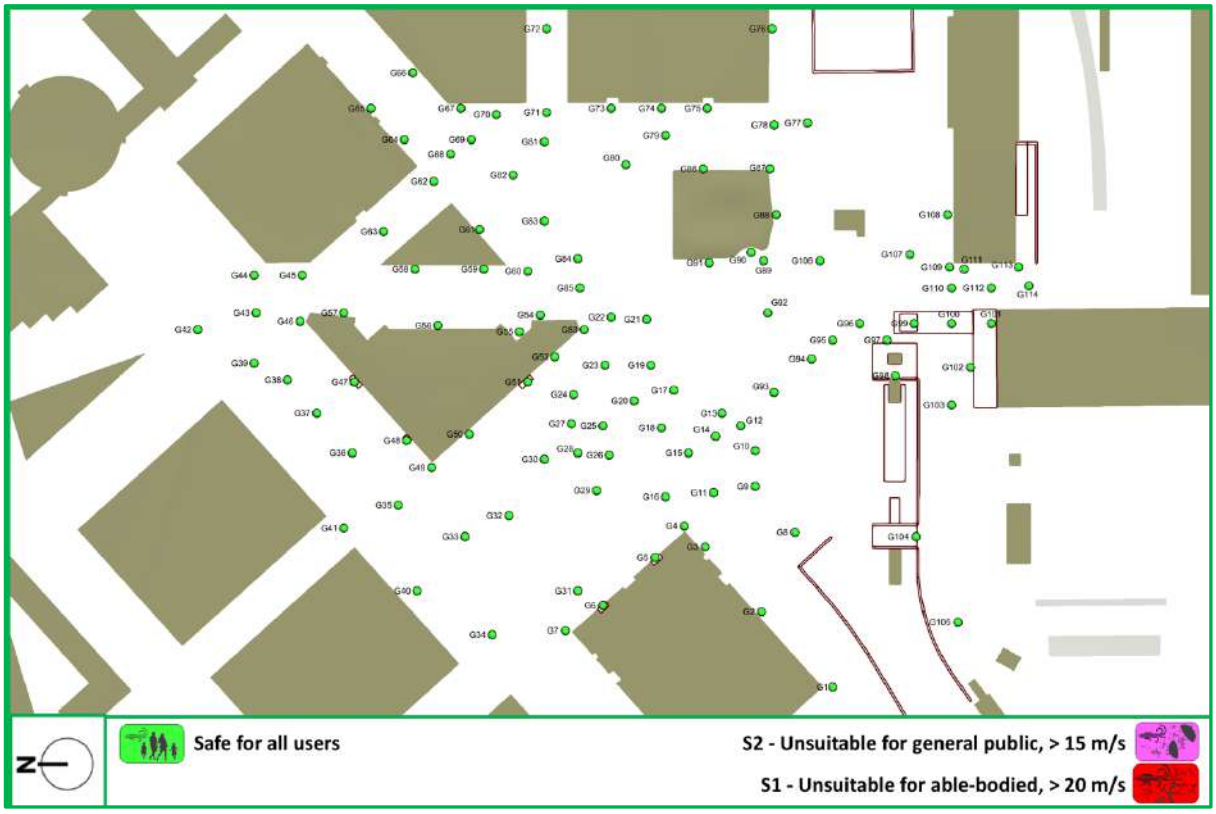
E.4. Assessment Scenario 6 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed Plot N16, Existing surrounding Buildings (ASR Scenario 4)

E.5. Mitigation Measures

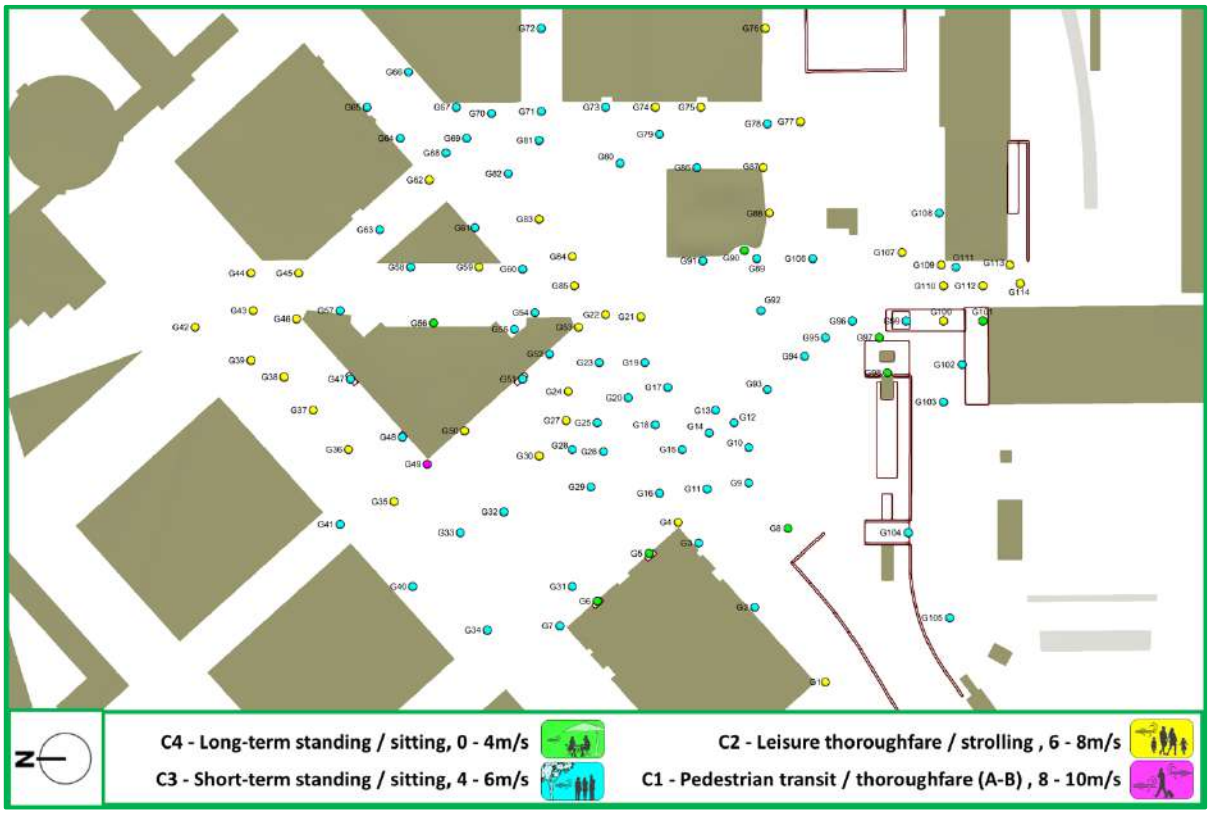


APPENDIX G. WIND COMFORT AND SAFETY RATING ASSESSMENT RESULTS – WIND TUNNEL ANALYSIS – WITHOUT MITIGATION

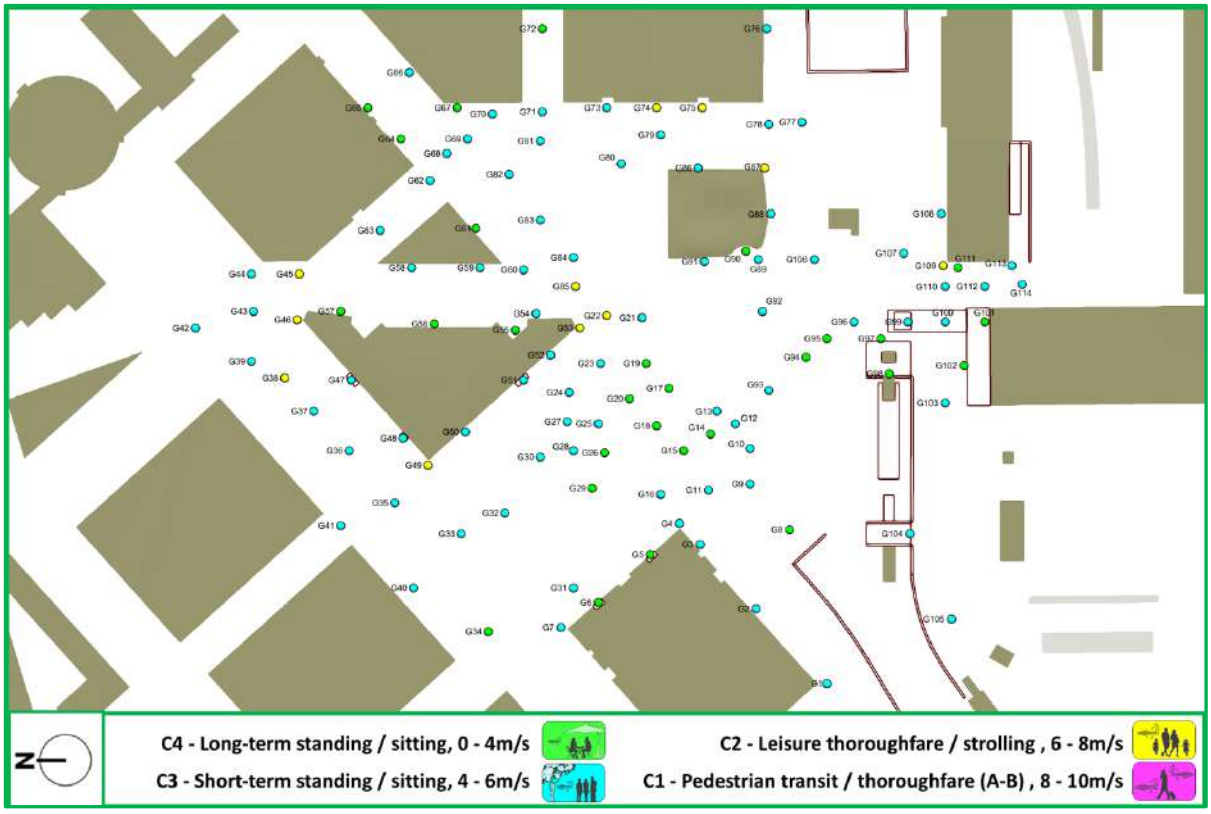
G.1. Assessment Scenario 1 - Existing site conditions for Victory Park/Belvedere, Empty site Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 1)



Safety Ratings

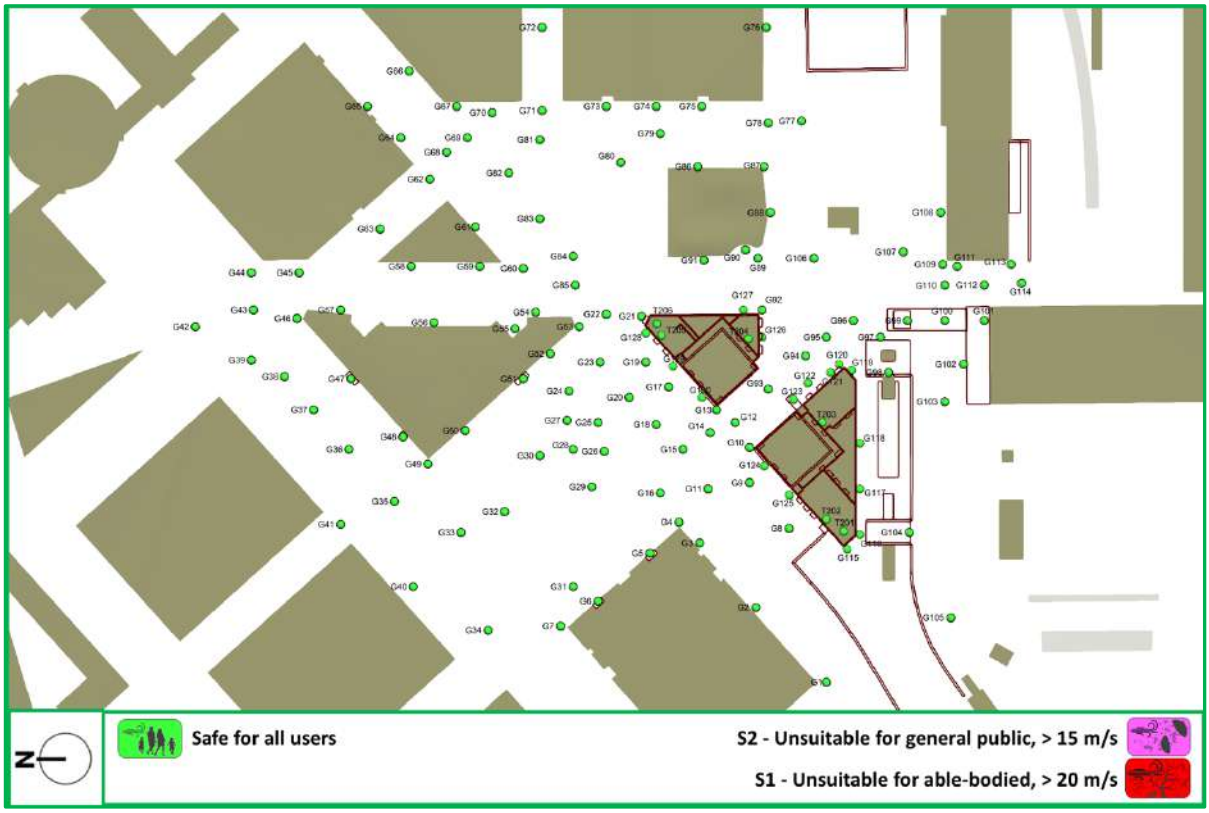


Comfort Ratings – Worst Season

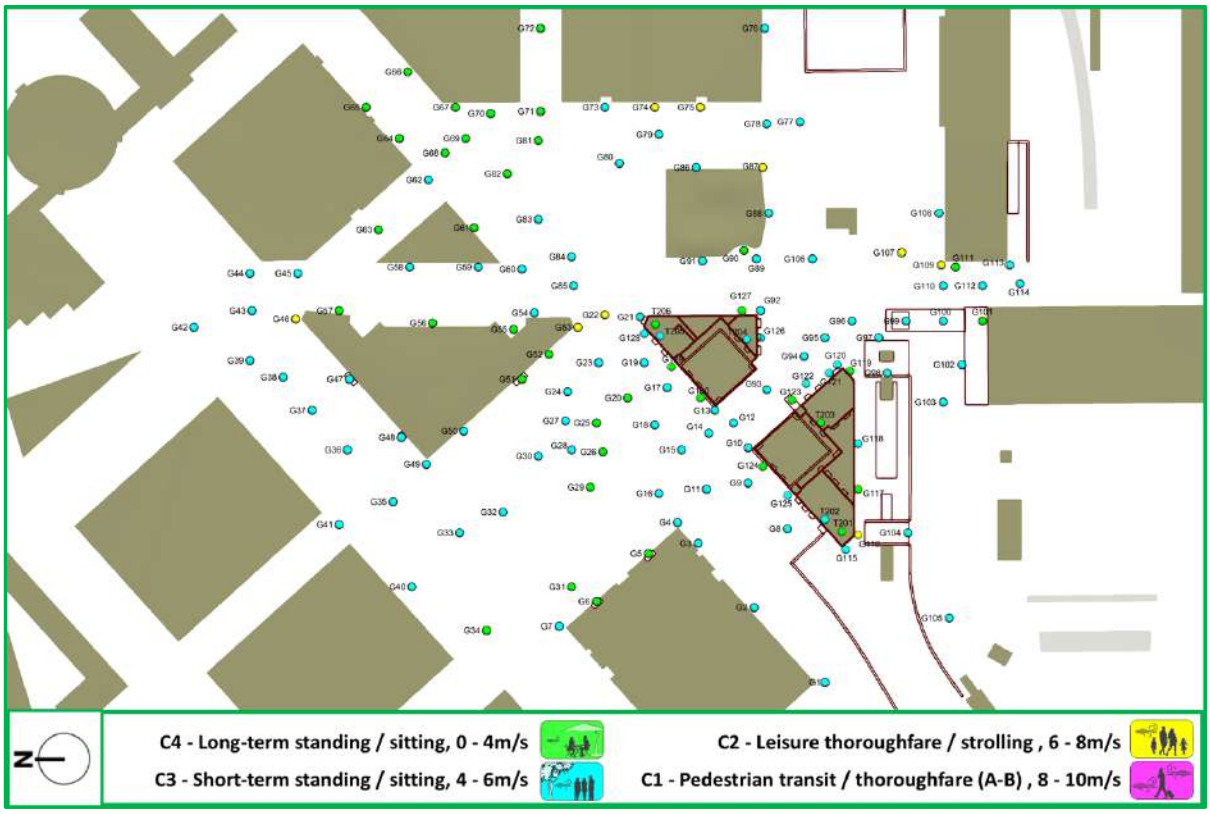


Comfort Ratings – Summer

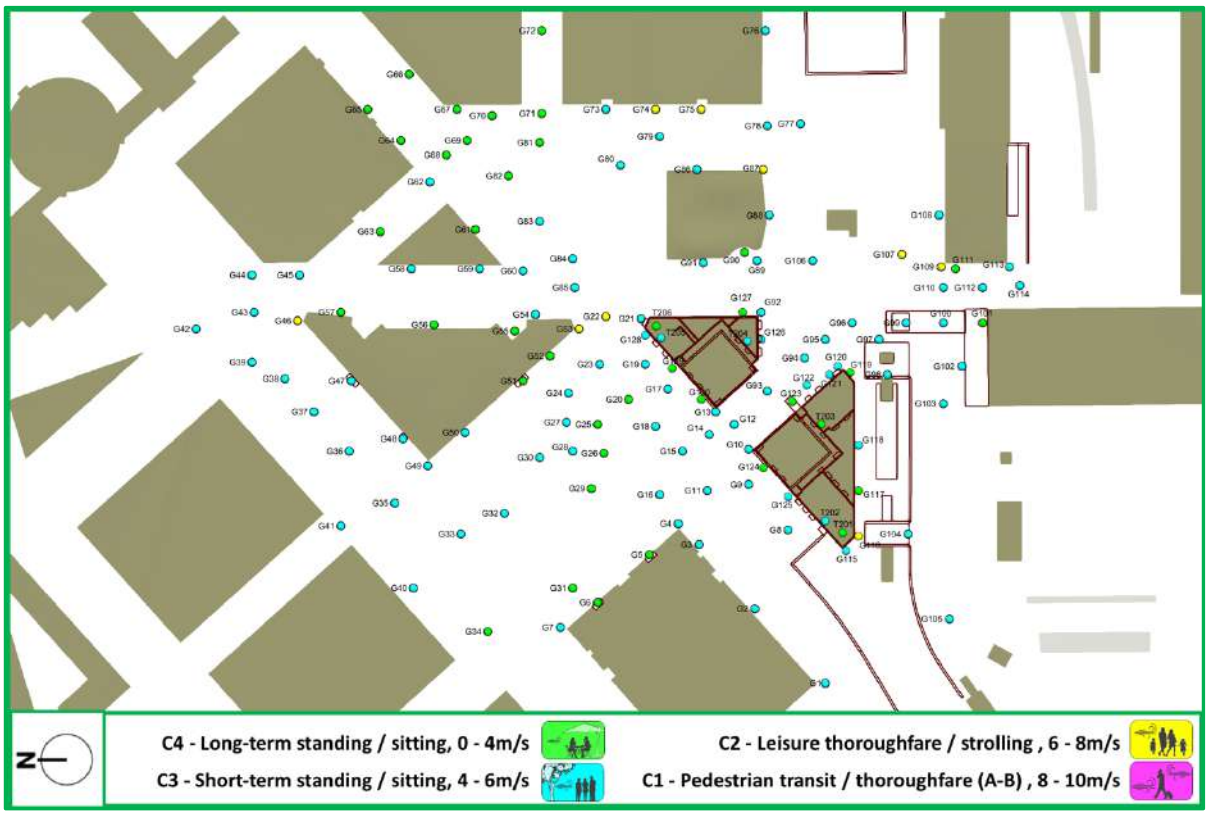
G.2. Assessment Scenario 3 - Existing site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding buildings (ASR Scenario 2)



Safety Ratings

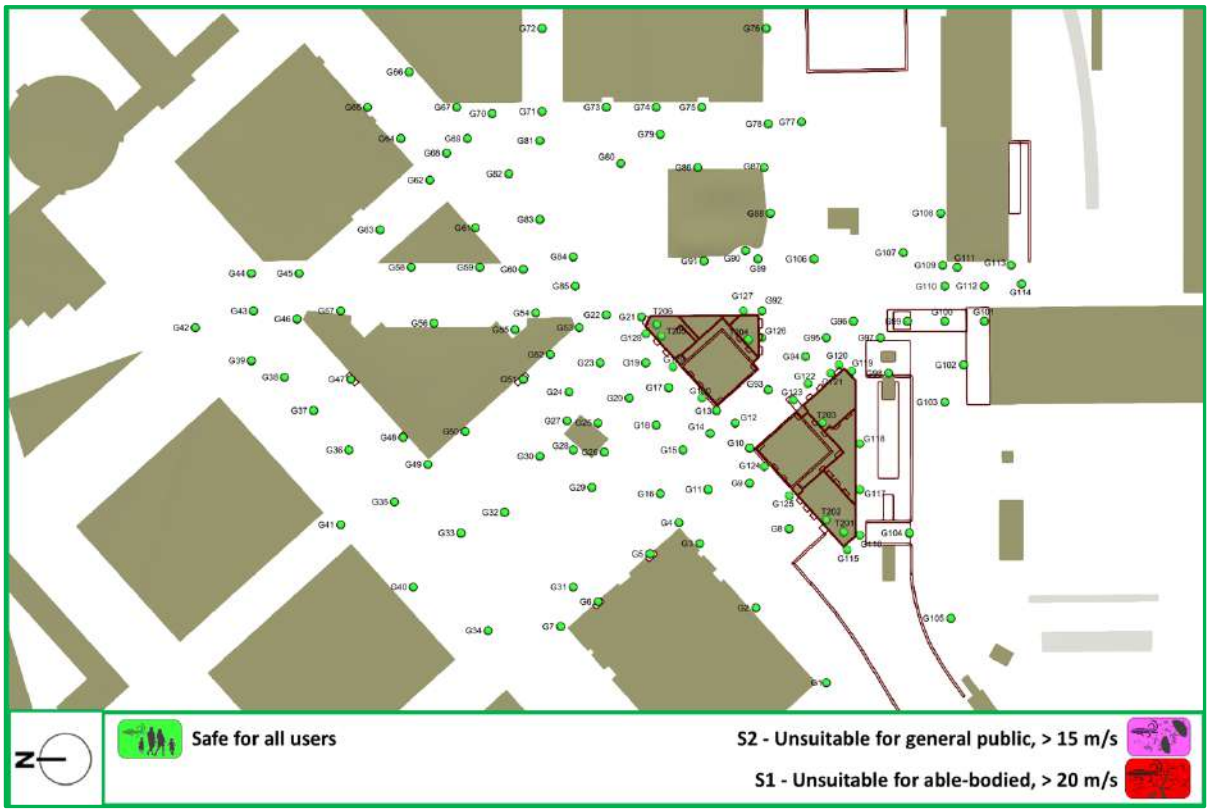


Comfort Ratings – Worst Season

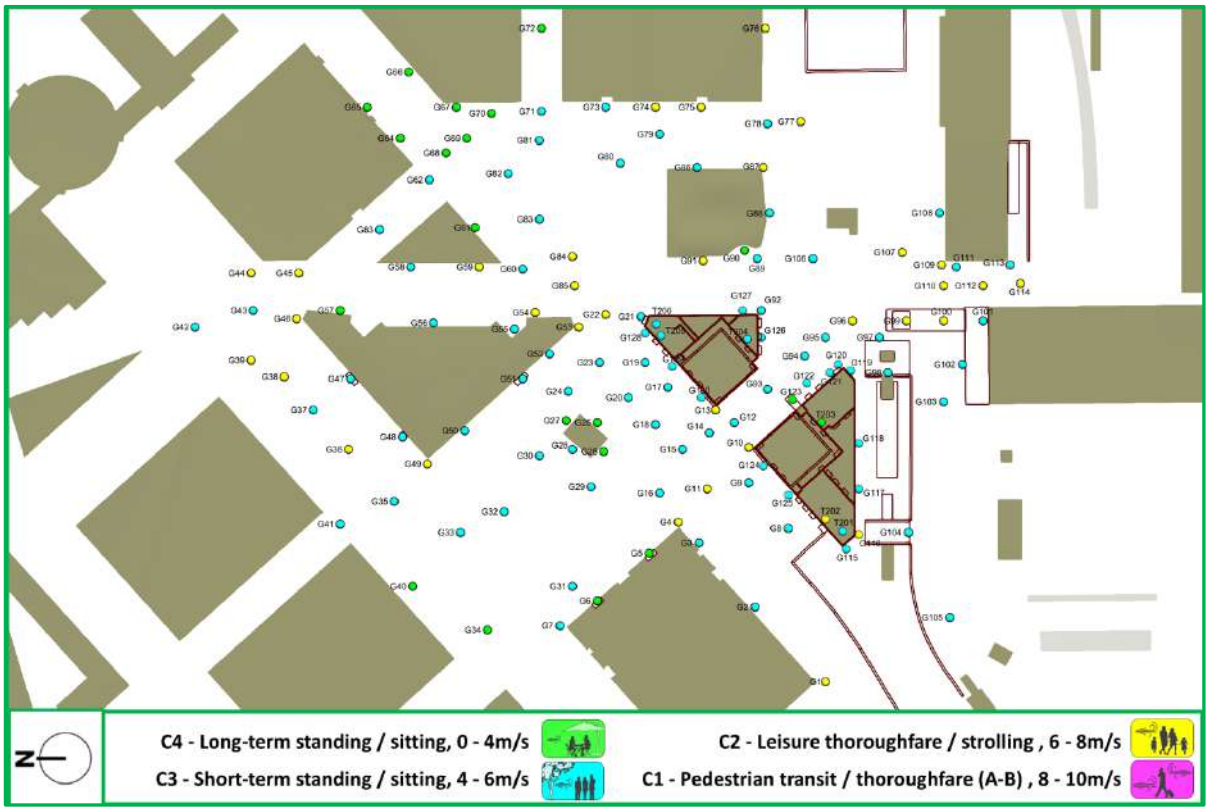


Comfort Ratings – Summer

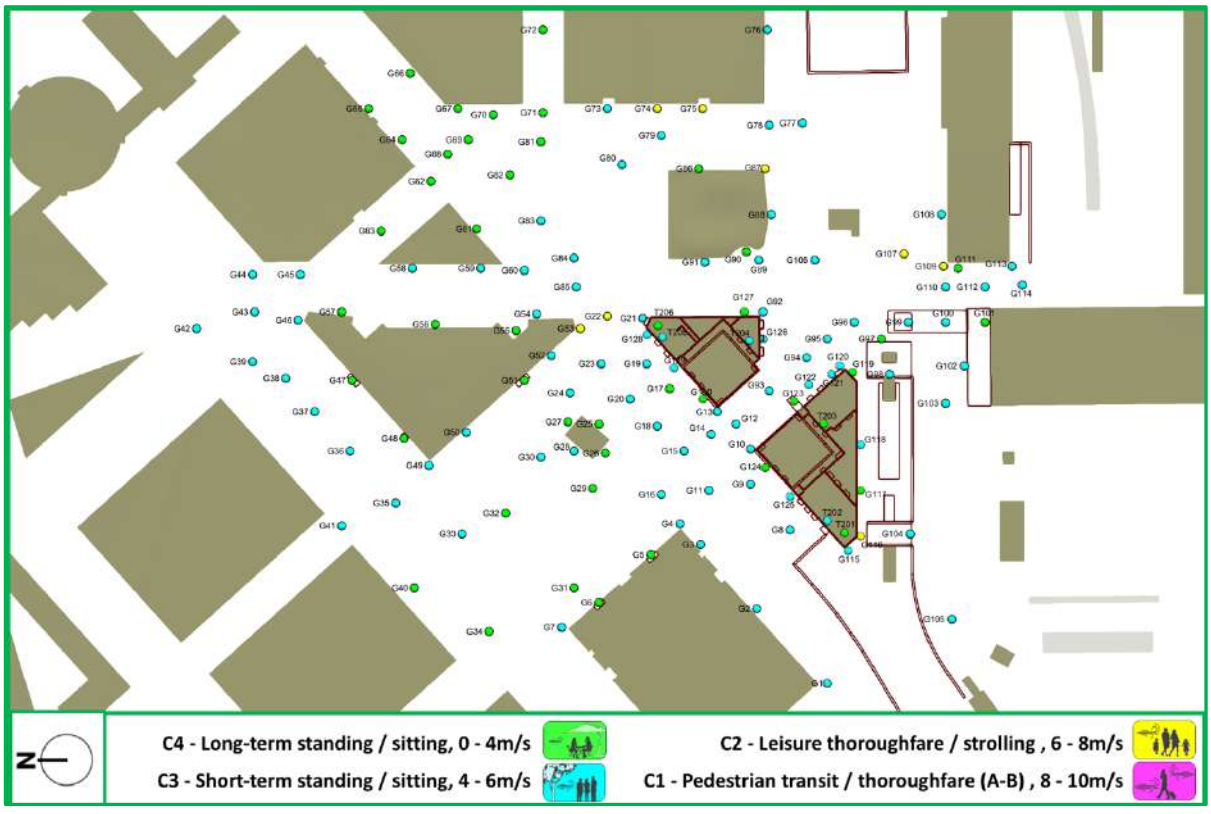
G.3. Assessment Scenario 5 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding Buildings (ASR Scenario 3)



Safety Ratings

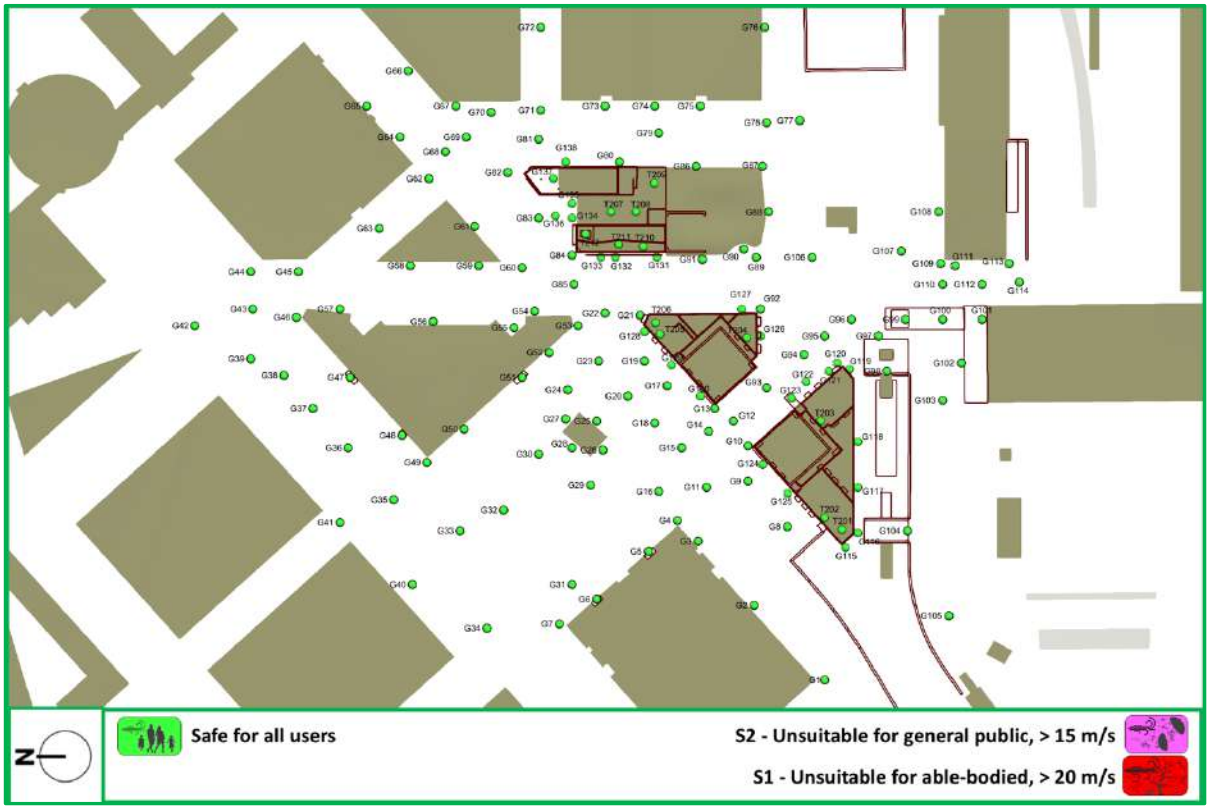


Comfort Ratings – Worst Season

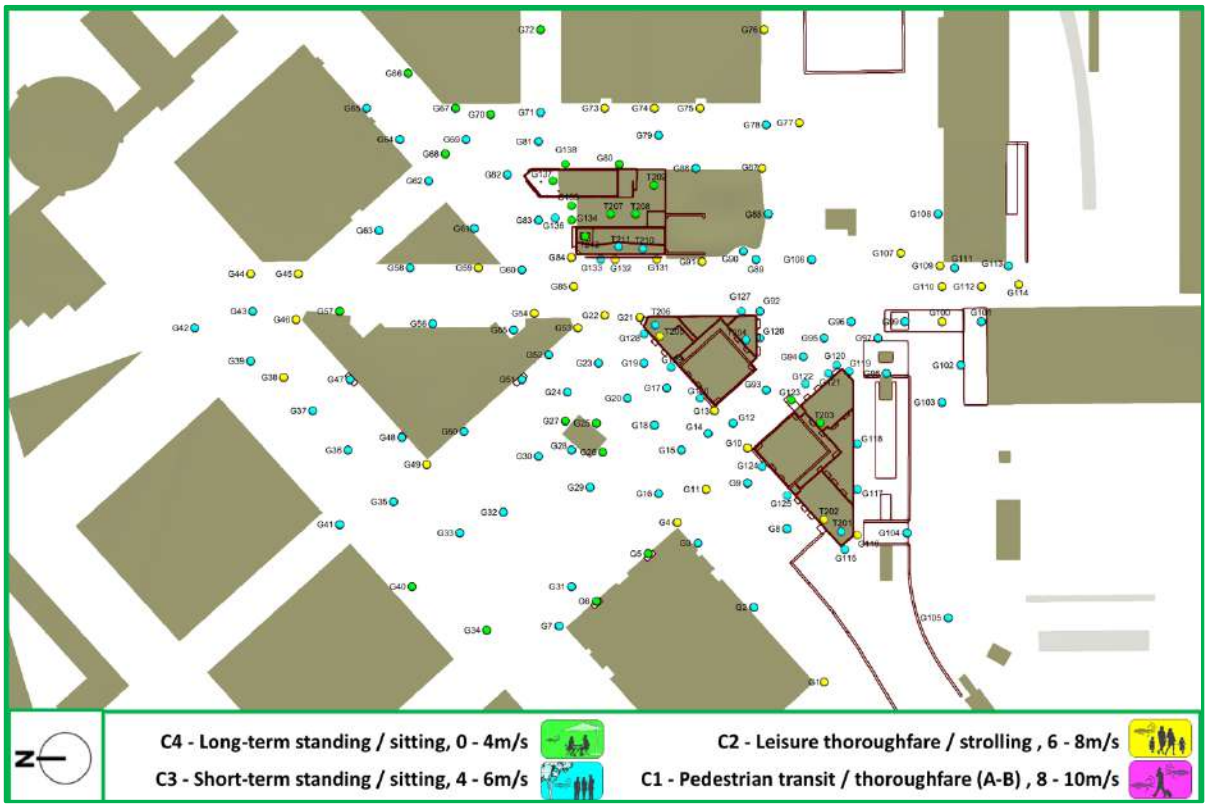


Comfort Ratings – Summer

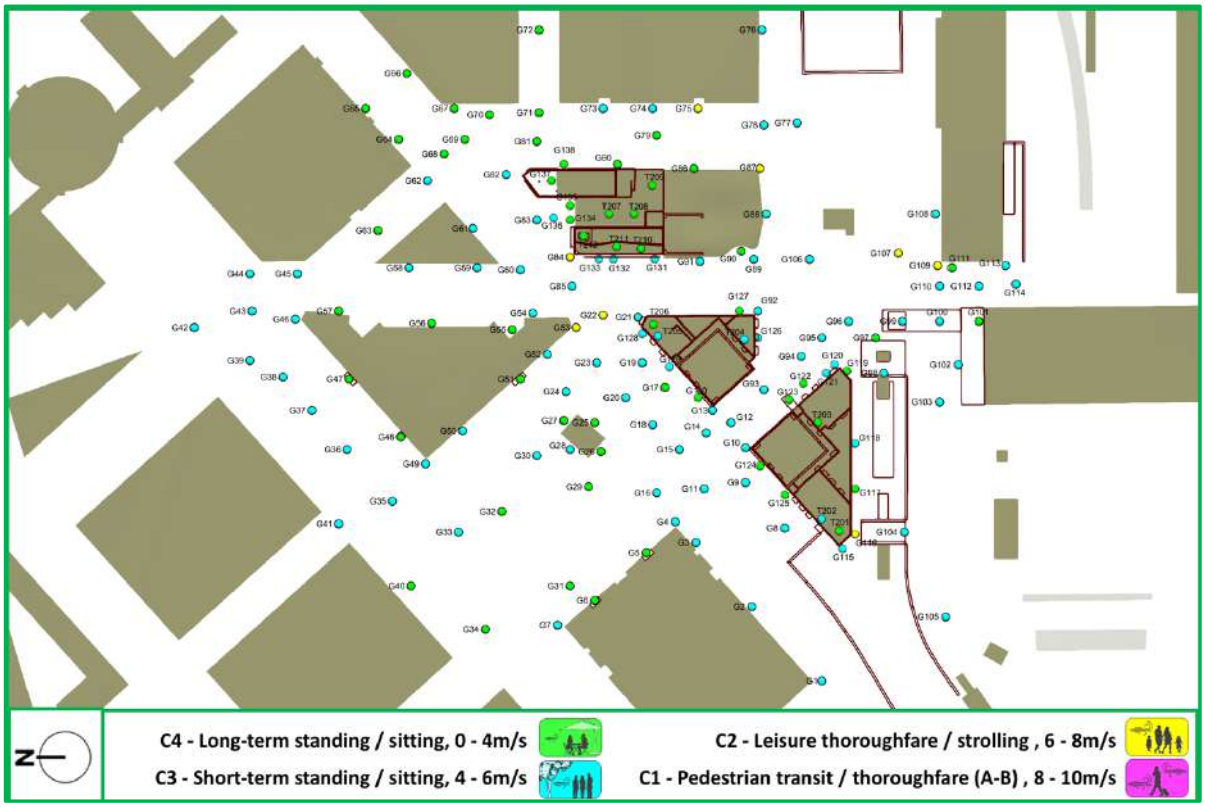
G.4. Assessment Scenario 6 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed Plot N16, Existing surrounding Buildings (ASR Scenario 4)



Safety Ratings



Comfort Ratings – Worst Season

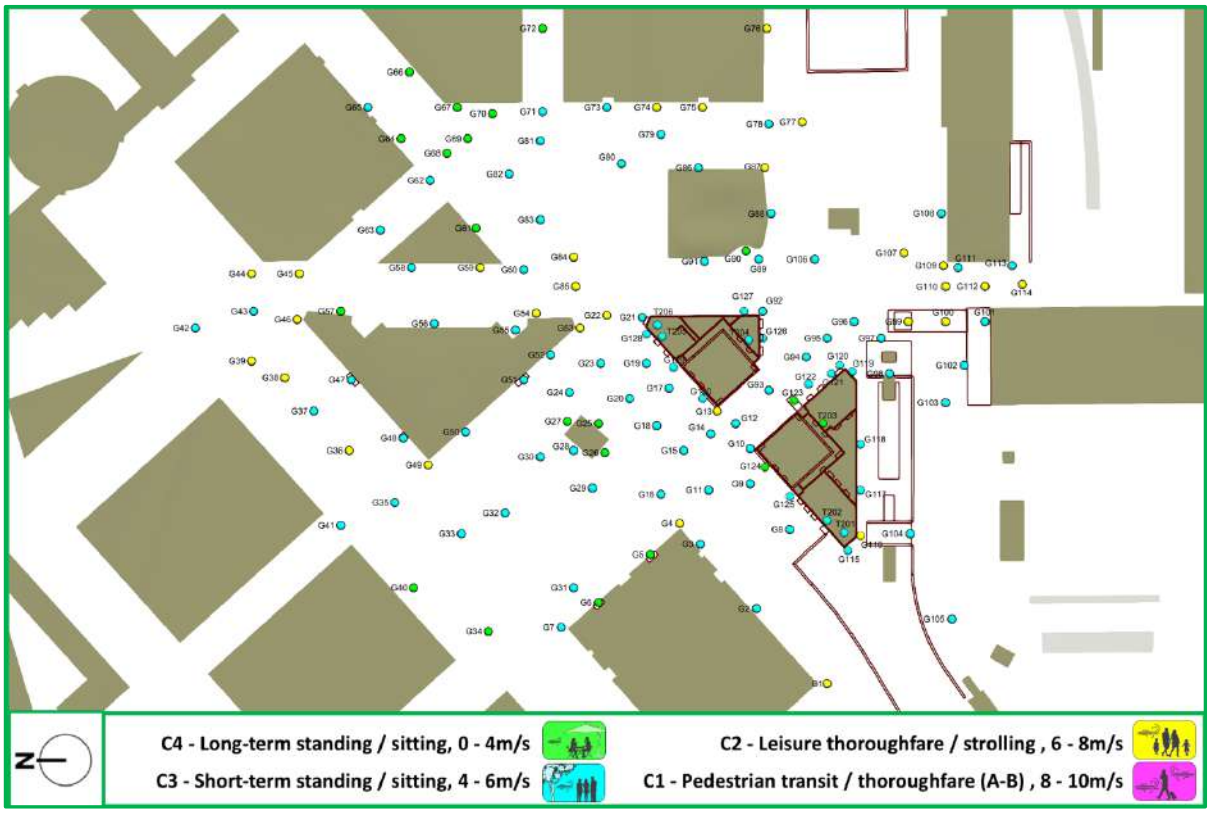


Comfort Ratings – Summer

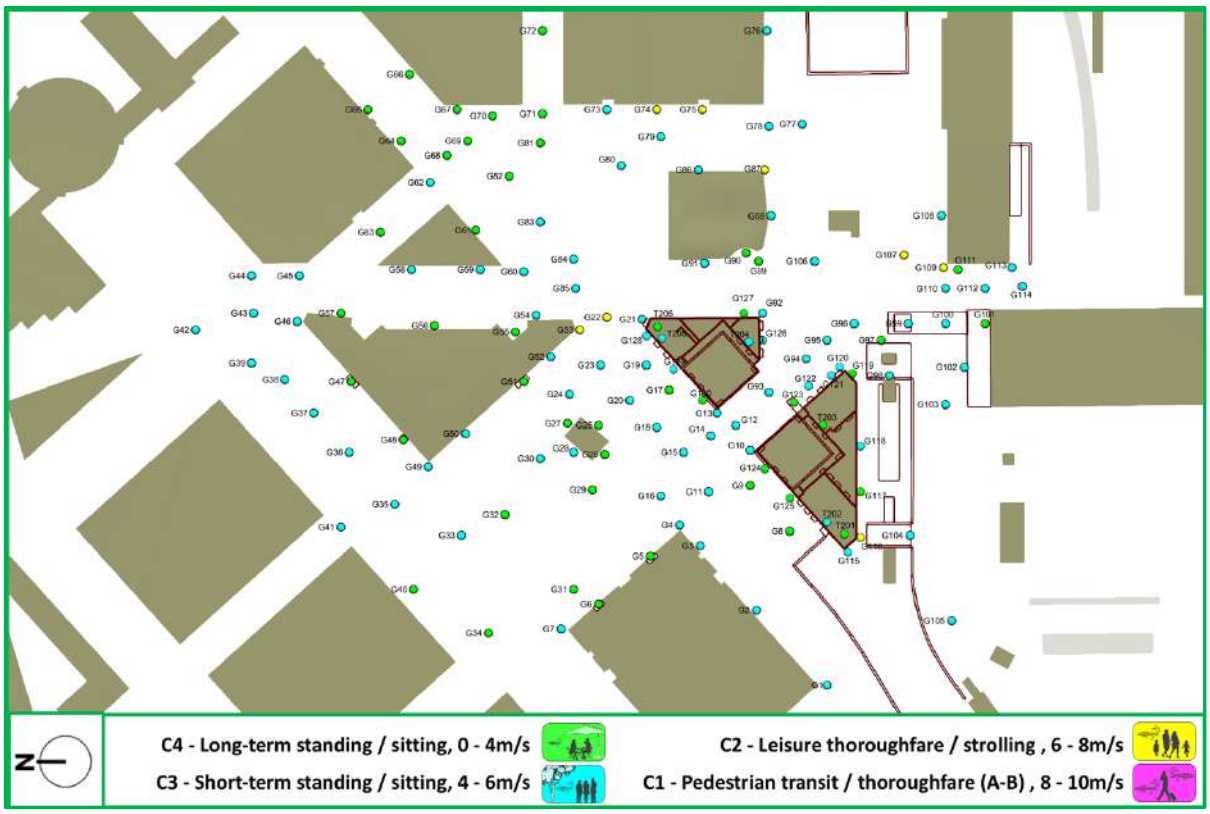
APPENDIX H. WIND COMFORT AND SAFETY RATING ASSESSMENT RESULTS – WIND TUNNEL ANALYSIS – WITH MITIGATION

H.1. Assessment Scenario 5 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Empty site Plot N16, Existing surrounding Buildings (ASR Scenario 3)

Safety Ratings

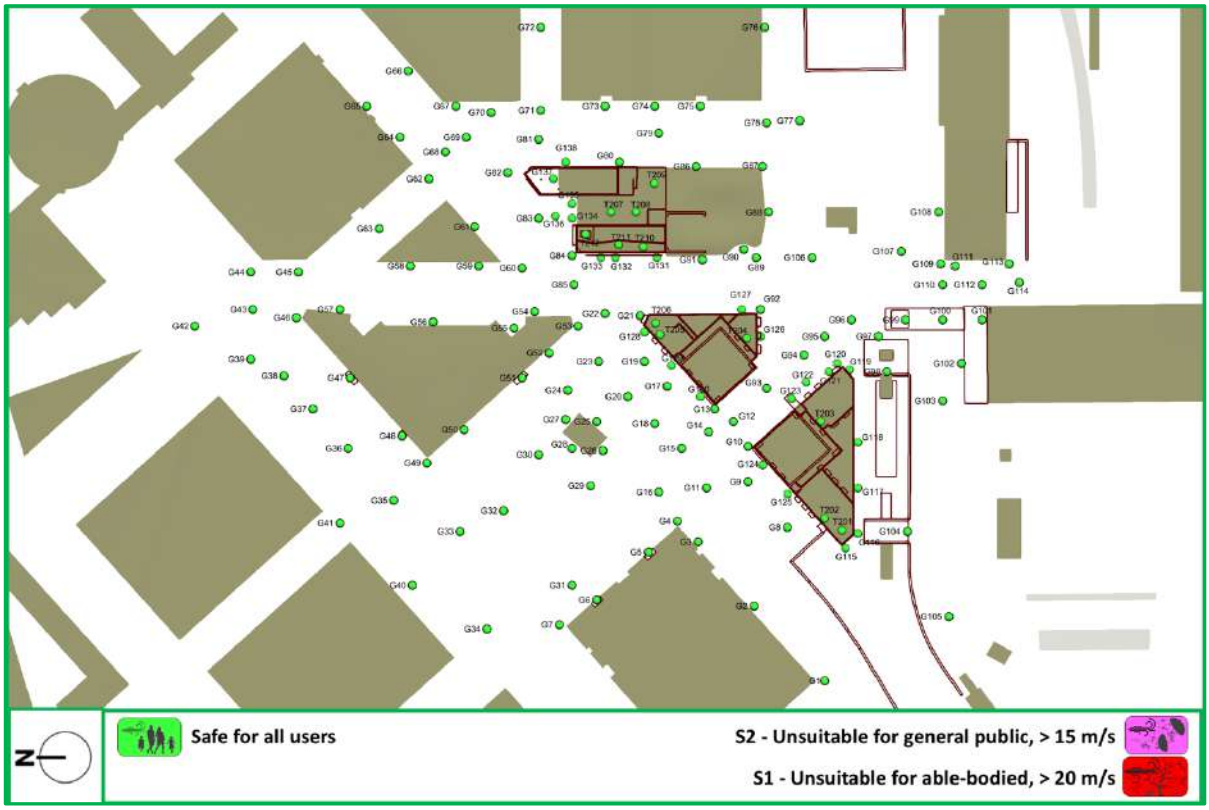


Comfort Ratings – Worst Season

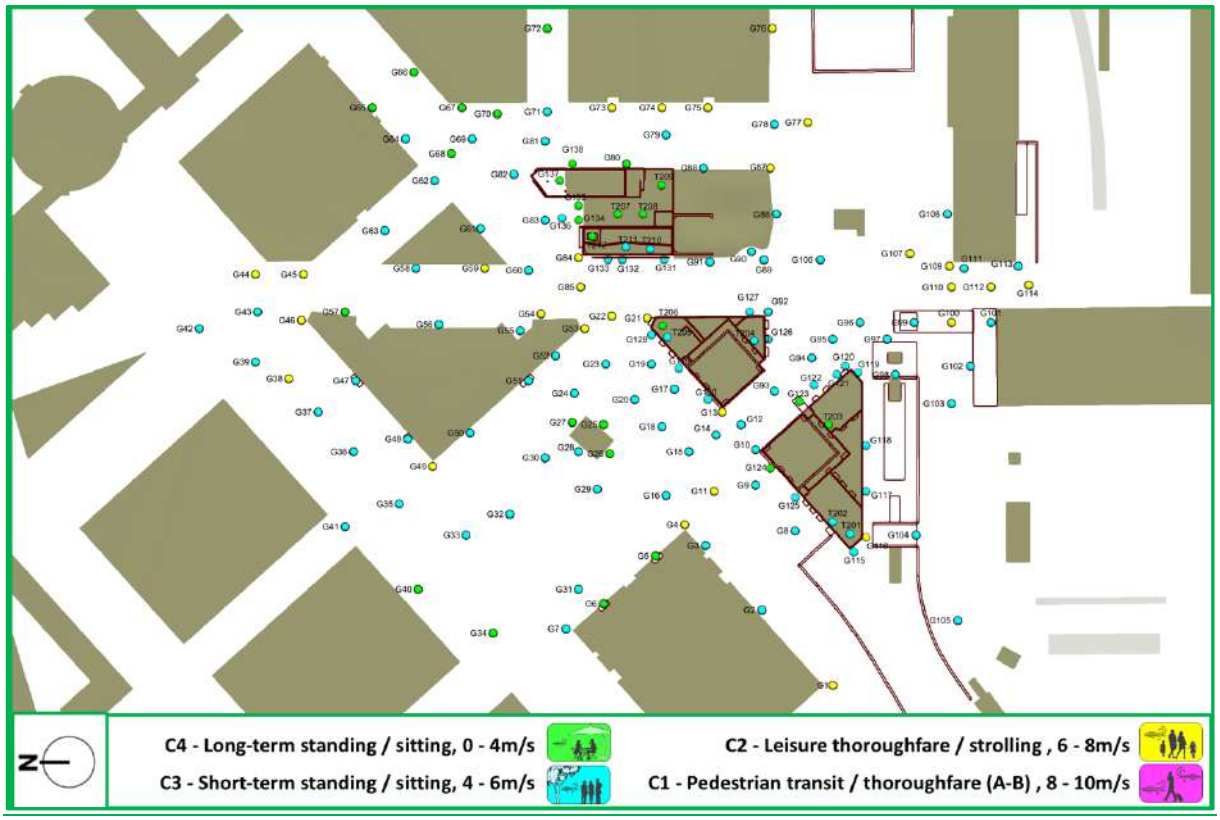


Comfort Ratings – Summer

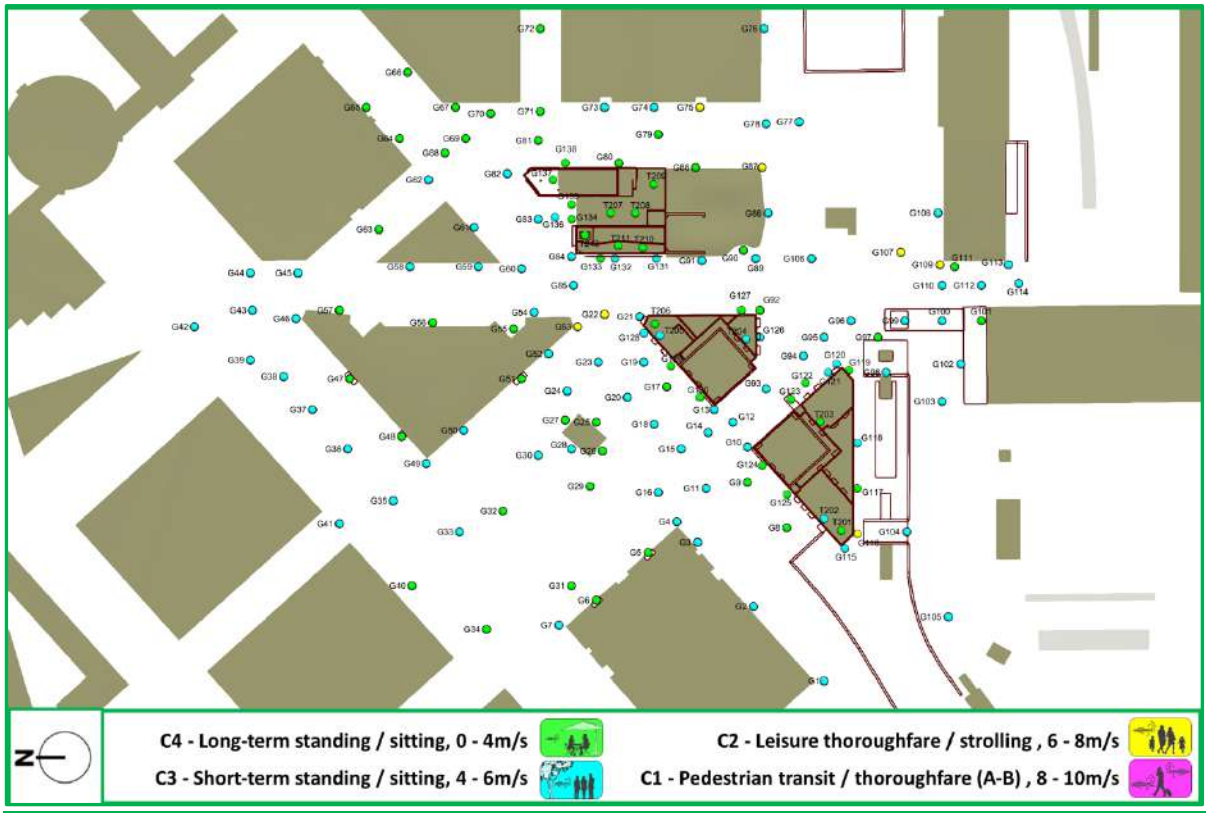
H.2. Assessment Scenario 6 - Proposed site conditions for Victory Park/Belvedere, Proposed Plot N18/19, Proposed Plot N16, Existing surrounding Buildings (ASR Scenario 4)



Safety Ratings



Comfort Ratings – Worst Season



Comfort Ratings – Summer