25 HILLCREST AVENUE AND 3154 HURONTARIO

MISSISSAUGA, ONTARIO

PEDESTRIAN WIND ASSESSMENT

PROJECT #2200433
MAY 27, 2022

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the potential wind conditions at pedestrian levels on and around the proposed 25 Hillcrest Avenue and 3154 Hurontario project site in Mississauga, Ontario. The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development in support of the Zoning Bylaw Application (ZBA).

The development site is located west of Hurontario Street between Hillcrest Avenue and John Street to the South and North side, respectively. The project site is surrounded by low-rise suburban neighbourhoods in the surrounding proximity; parking lots located adjacent to the site on the northwest and southwest side, and midrise building located across the parking lot on the southwest side. The far extents also include scattered tall buildings to the northwest and southeast directions (**Image 1**).

The proposed development consists of five (5) towers ranging from 35 to 50 storeys (**image 2**). In addition to sidewalks and properties near the project site, key areas of interest for this assessment include the main entrances to the buildings, drop-off areas, patio areas at grade, and above grade amenity terraces (**Image 3**).

Image 1: Aerial view of the existing site and surroundings
Credit: Google Maps

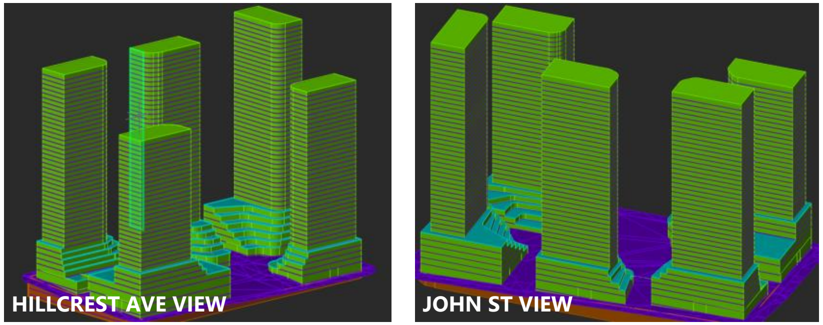


Image 2: Conceptual Massing

1. INTRODUCTION

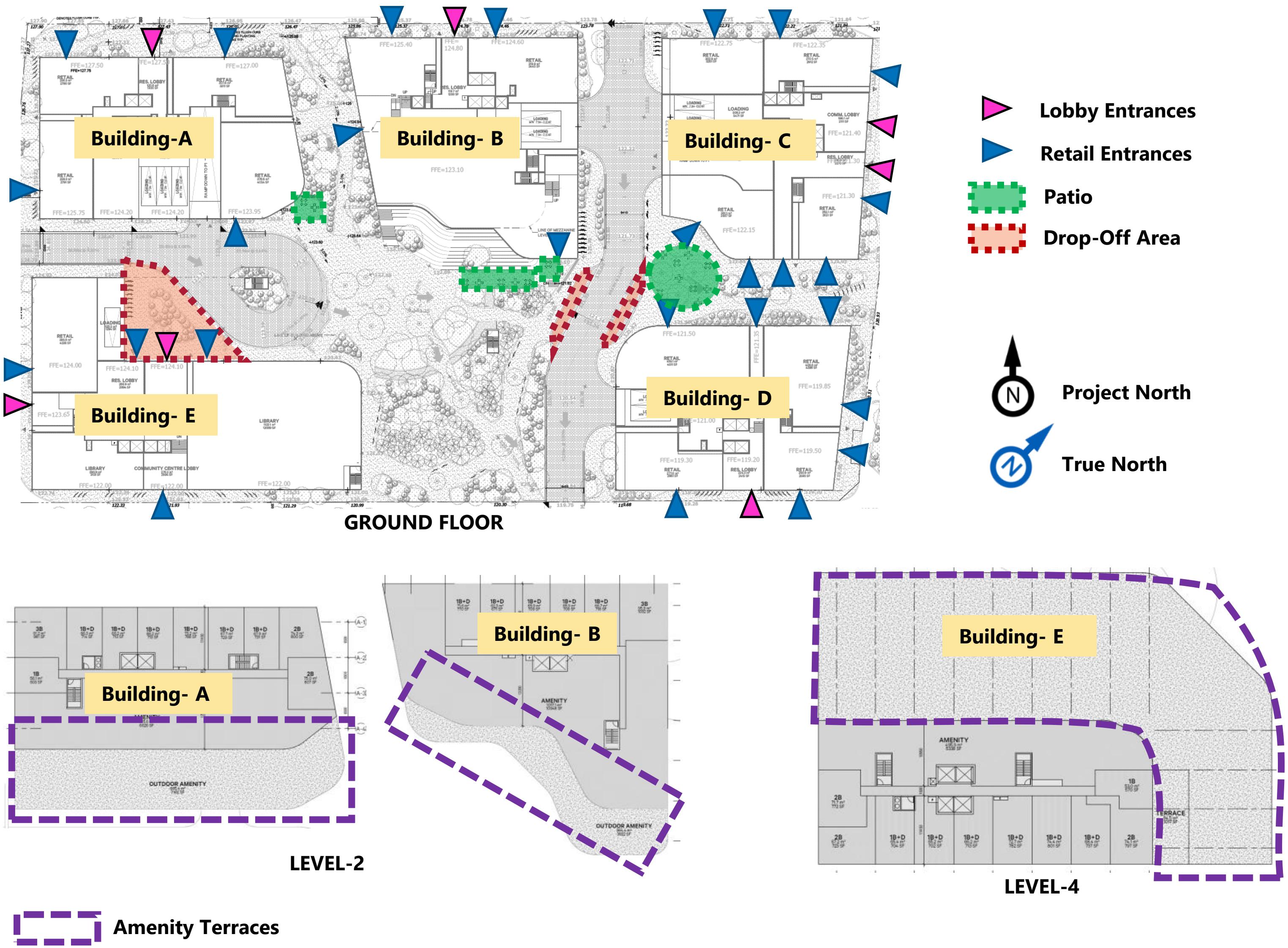


Image 3: Floor plans

2. METHODOLOGY

2.1 Objective

The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development on pedestrian areas around it. The assessment is based on the following:

- A review of the regional long-term meteorological data from the Toronto Pearson International Airport;
- 3D e-model of the proposed project received on March 14, 2022, and updated 3D e-model and landscape plans received on April 08, 2022;
- The use of *Orbital Stack*, an in-house computational fluid dynamics (CFD) tool, to aid in the assessment of wind comfort levels;
- The use of RWDI's proprietary tool WindEstimator[1] for estimating the potential wind conditions around generalized building forms;
- The City of Mississauga wind comfort and safety criteria;
- Wind tunnel studies completed by RWDI for similar projects in Mississauga; and,
- Our engineering judgment, experience, and expert knowledge of wind flows around buildings[1-3].

Note that other microclimate issues such as those relating to cladding and structural wind loads, door operability, building air quality, snow impact, noise, vibration, etc. are not part of the scope of this assessment

2.2 CFD for Wind Simulation

CFD is a numerical technique for simulating wind flow in complex environments. For modelling winds around buildings, CFD techniques are used to generate a virtual wind tunnel where flows around the site, surroundings and the study building are simulated at full scale. The computational domain that covers the site and surroundings are divided into millions of small cells where calculations are performed, which allows for the "mapping" of wind conditions across the entire study domain. CFD excels as a tool for wind modelling and presentation for providing early design advice, comparing different design and site scenarios, resolving complex flow physics, and helping diagnose problematic wind conditions.

Gust conditions are infrequent but deserve special attention due to their potential impact on pedestrian safety. The computational modelling method used in the current assessment does not quantify the transient behaviour of the wind, including wind gusts. The effect of gust, i.e., wind safety, is predicted qualitatively in this assessment using analytical methods and wind-tunnel-based empirical models[1]. The assessment has been conducted by experienced microclimate specialists in order to provide an accurate prediction of wind conditions.

In order to quantify the transient behavior of wind and refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel or more detailed transient computational modelling would be required.

2. METHODOLOGY

2.3 Simulation Model

Wind flows were simulated using Orbital Stack, an in-house computational fluid dynamics (CFD) tool, for the Existing and Proposed site configurations with the existing surroundings.

The computer model of the project building and the existing site with the proximity model are shown in **Images 4 and 5**, respectively. For the purposes of this computational study, the 3D models were simplified to include only the necessary building and terrain details that would affect the local wind flows in the area and around the site. Landscaping and other smaller architectural and accessory features were not included in the computer model in order to provide more conservative wind conditions (which is standard for this level of assessment). Landscaping can assist with decreasing the severity of the wind conditions however any quantitative effects would require additional study.

The wind speed profiles in the atmospheric boundary, approaching the modelled area were simulated for 16 directions (starting at 0°, at 22.5° increments around the compass). Wind data in the form of ratios of wind speeds at approximately 1.5m above concerned levels, to the mean wind speed at a reference height were obtained. The data was then combined with meteorological records obtained from Toronto Pearson International Airport to determine the wind speeds and frequencies in the simulated areas.

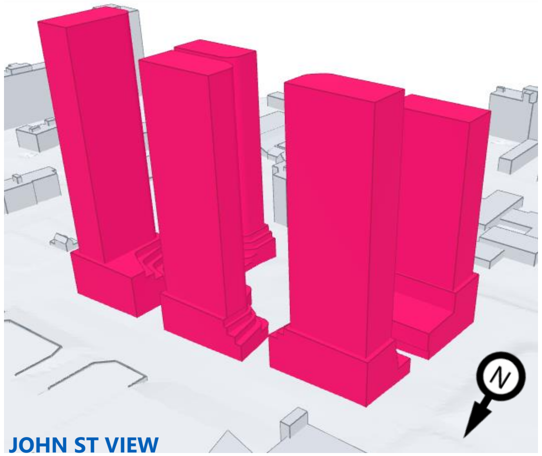


Image 4: Computer model of the proposed project

2. METHODOLOGY

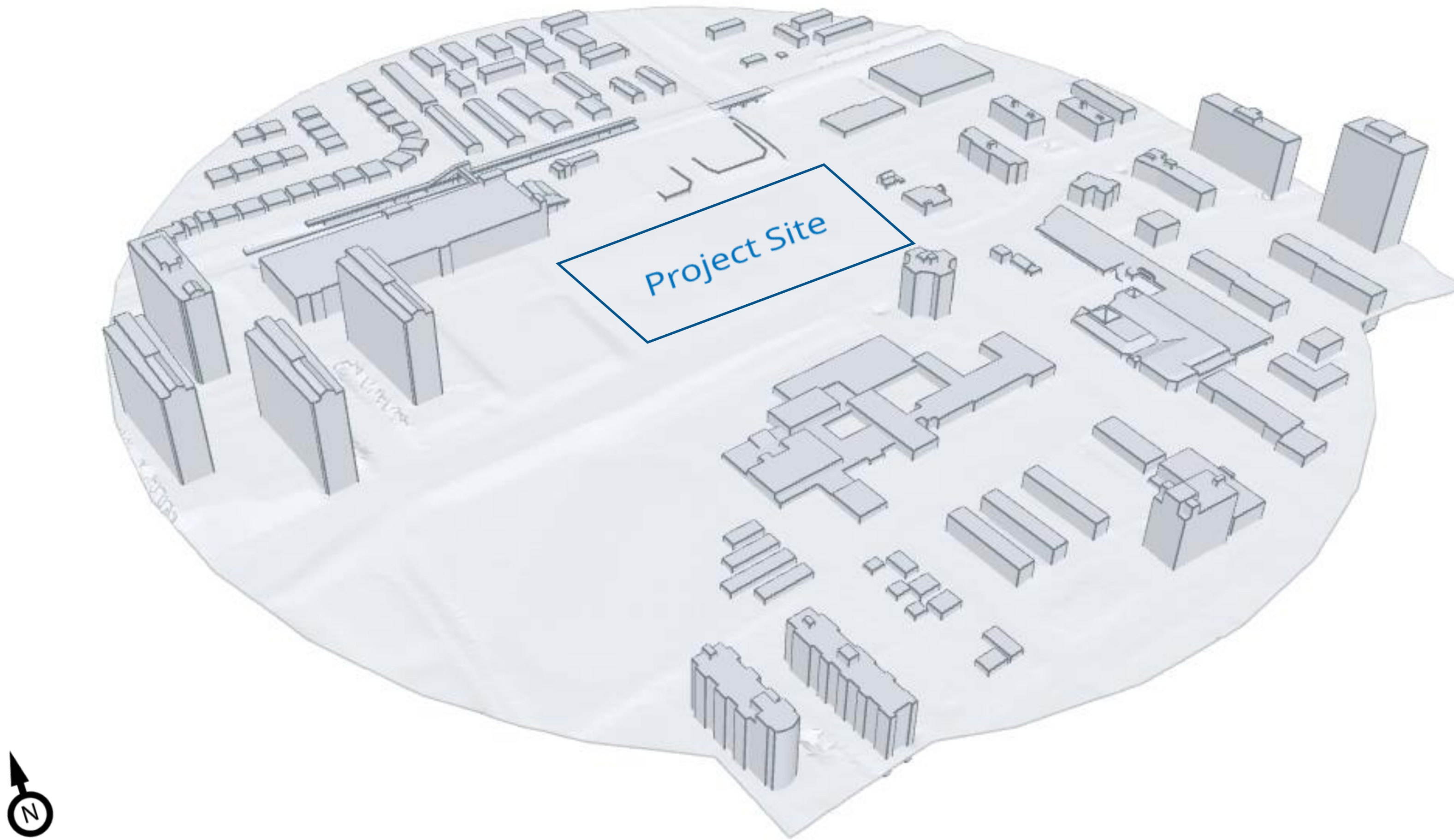


Image 5: Computer model of the existing site and extended surroundings

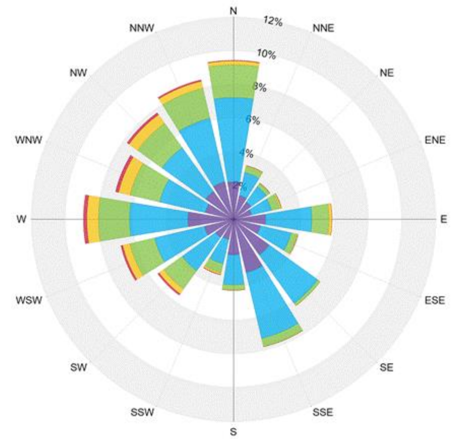
2.4 Meteorological Data

Long-term wind data recorded at Toronto Pearson International Airport between 1990 and 2020, inclusive, were analyzed for the summer (May to October) and winter (November to April) months. **Image 6** graphically depicts the directional distributions of wind frequencies and speeds for these periods.

In the summer and winter, winds from southwest through north directions are predominant, with secondary frequent wind component from the southwest quadrant in the summer and from the east direction in the winter.

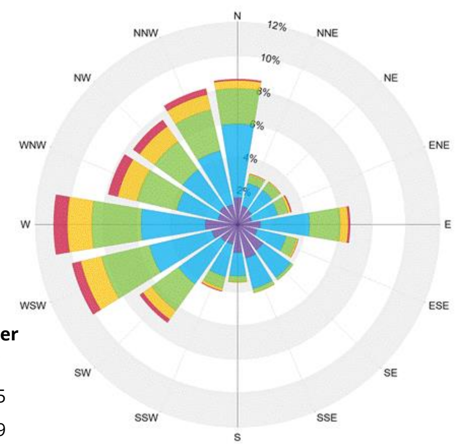
Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10m) are more frequent in the winter (red and yellow bands in **Image 6**). These winds potentially could be the source of uncomfortable or severe wind conditions, depending on the site exposure and development design.

Wind statistics were combined with the simulated data to predict the wind conditions at the project site and assessed against the wind criteria for pedestrian comfort.



Summer (May through October)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	5.3	3.7
1-10	30.7	22.5
11-20	42.9	39.9
21-30	16.2	22.6
31-40	3.9	8.1
>40	0.9	3.3



Winter (November through April)

Image 6: Directional distribution of wind approaching Toronto Pearson International Airport (1990 to 2020)

3. WIND CRITERIA

The Mississauga pedestrian wind criteria, developed in June 2014, are specified in the Urban Design Terms of Reference, “Pedestrian Wind Comfort and Safety Studies”. The criteria are as follows:

3.1 Pedestrian Safety Criterion

Pedestrian safety is associated with excessive gust that can adversely affect a pedestrian’s balance and footing. If strong winds that can affect a person’s balance (**90 km/h**) occur more than **0.1%** of the time or 9 hours per year, the wind conditions are considered severe.

3.2 Pedestrian Comfort Criteria

Wind comfort can be categorized by typical pedestrian activities:

Sitting (≤ 10 km/h): Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away.

Standing (≤ 15 km/h): Gentle breezes suitable for main building entrances and bus stops.

Walking (≤ 20 km/h): Relatively high speeds that can be tolerated if one’s objective is to walk, run or cycle without lingering.

Uncomfortable: None of the above criteria are met.

Wind conditions are considered suitable for sitting, standing or walking if the associated mean wind speeds are expected for at least four out of five days (**80% of the time**). Wind control measures are typically required at locations where winds are rated as uncomfortable or they exceed the wind safety criterion.

Note that these wind speeds are assessed at the pedestrian height (i.e., 1.5m above grade or the concerned floor level), typically lower than those recorded in the airport (10m height and open terrain).

These criteria for wind forces represent average wind tolerance. They are sometimes subjective and regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can also affect people's perception of the wind climate.

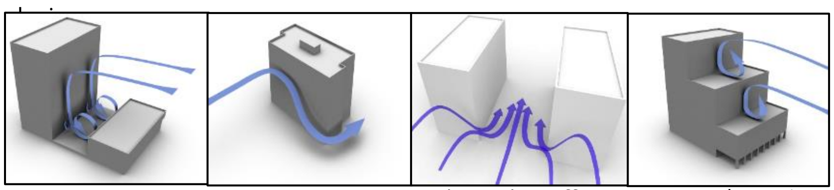
For the current development, wind speeds comfortable for walking are appropriate for sidewalks and walkways; and lower wind speeds comfortable for standing are required at the main building entrance and drop-off areas. For amenity spaces, calm wind conditions comfortable for sitting or standing are desired in the summer when these areas are typically in use.

4. RESULTS AND DISCUSSION

4.1 Wind Flow Around the Project

Wind generally tends to flow over buildings of uniform height, without disruption. Buildings that are taller than their surroundings tend to intercept and redirect winds around them. The mechanism in which winds are directed down the height of a building is called *Downwashing*. These flows subsequently move around exposed building corners, causing a localized increase in wind activity due to *Corner Acceleration*. When two buildings are situated side by side, wind flow tends to accelerate through the space between the buildings due to *Channeling Effect* caused by the narrow gap. Moreover, Stepped massing, low roofs and canopies diffuse downwash and reduce the potential wind impact on the ground level. These flow patterns are illustrated in **Image 7**.

The multi-building project will be taller than the buildings that currently exist in the surrounding area. The project is expected to redirect winds around it. The proposed massing design, with multiple steps and protruding balconies are favourable for reducing wind impacts at the grade to some extent and are recommended to be retained in the final



Downwashing | Corner Acceleration | Channeling Effect | Stepped massing

Image 7: General wind flow patterns

4.2 Simulation Results

The predicted wind comfort conditions for the existing and proposed configurations are presented in **Images 8a through 9b** and in **Image 13** for the summer and winter assessments. The results are presented as colour contours of wind speeds calculated based on the wind criteria (Section 3.2). The contours represent wind speeds at a horizontal plane approximately 1.5 m above the concerned level.

The assessment against the safety criterion (Section 3.1) was conducted, based on the predicted wind conditions and our wind tunnel experience with similar development. The areas where the criterion is expected to be exceeded are discussed in following sections within this report.

A detailed discussion of the expected wind conditions with respect to the prescribed criteria and applicability of the results follows in Sections 4.3. and 4.4. The discussion includes recommendations for wind control to reduce the potential for high wind speeds for the design team's consideration.

4. RESULTS AND DISCUSSION

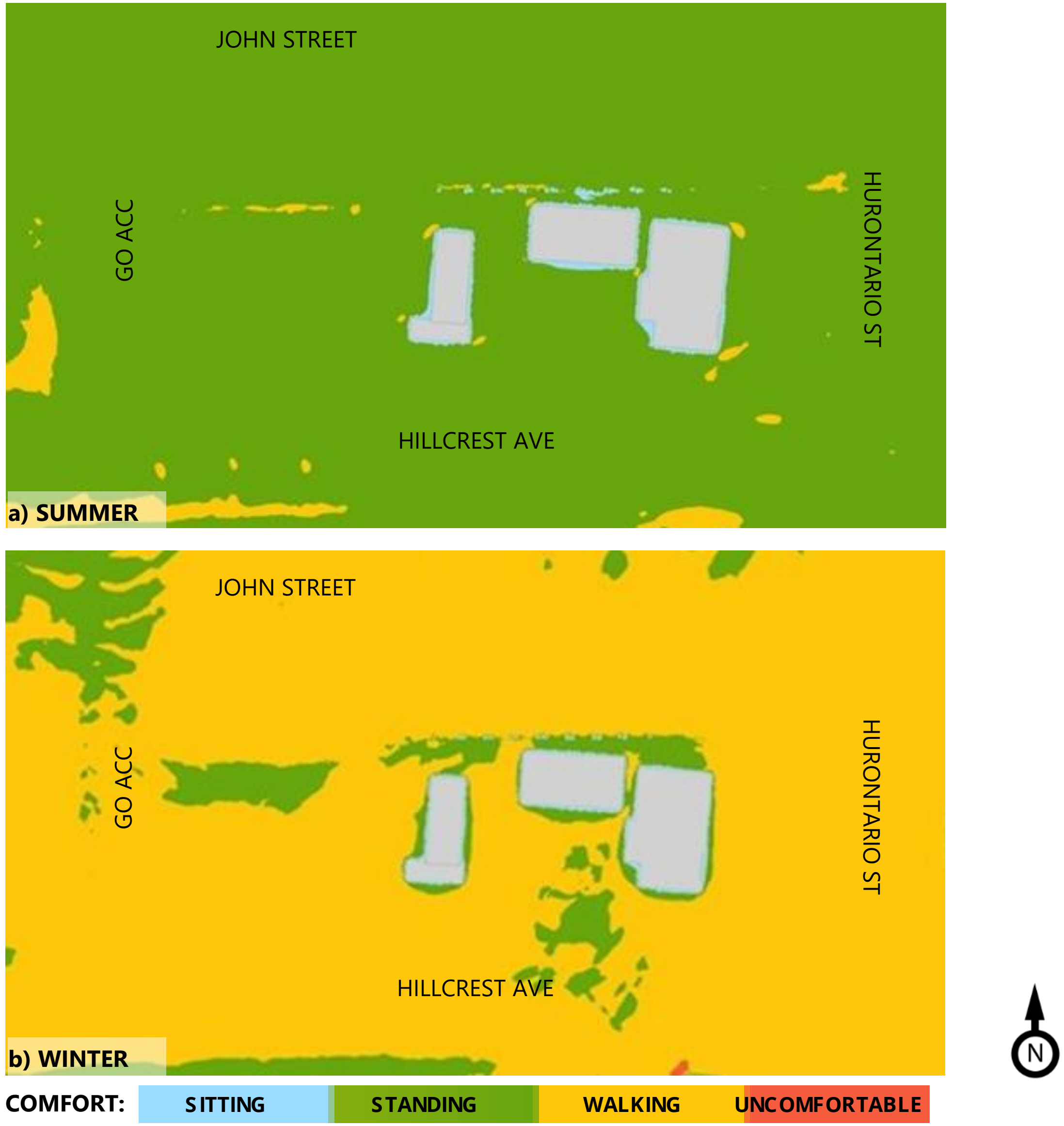


Image 8: Predicted wind conditions – Existing Configuration: GROUND LEVEL

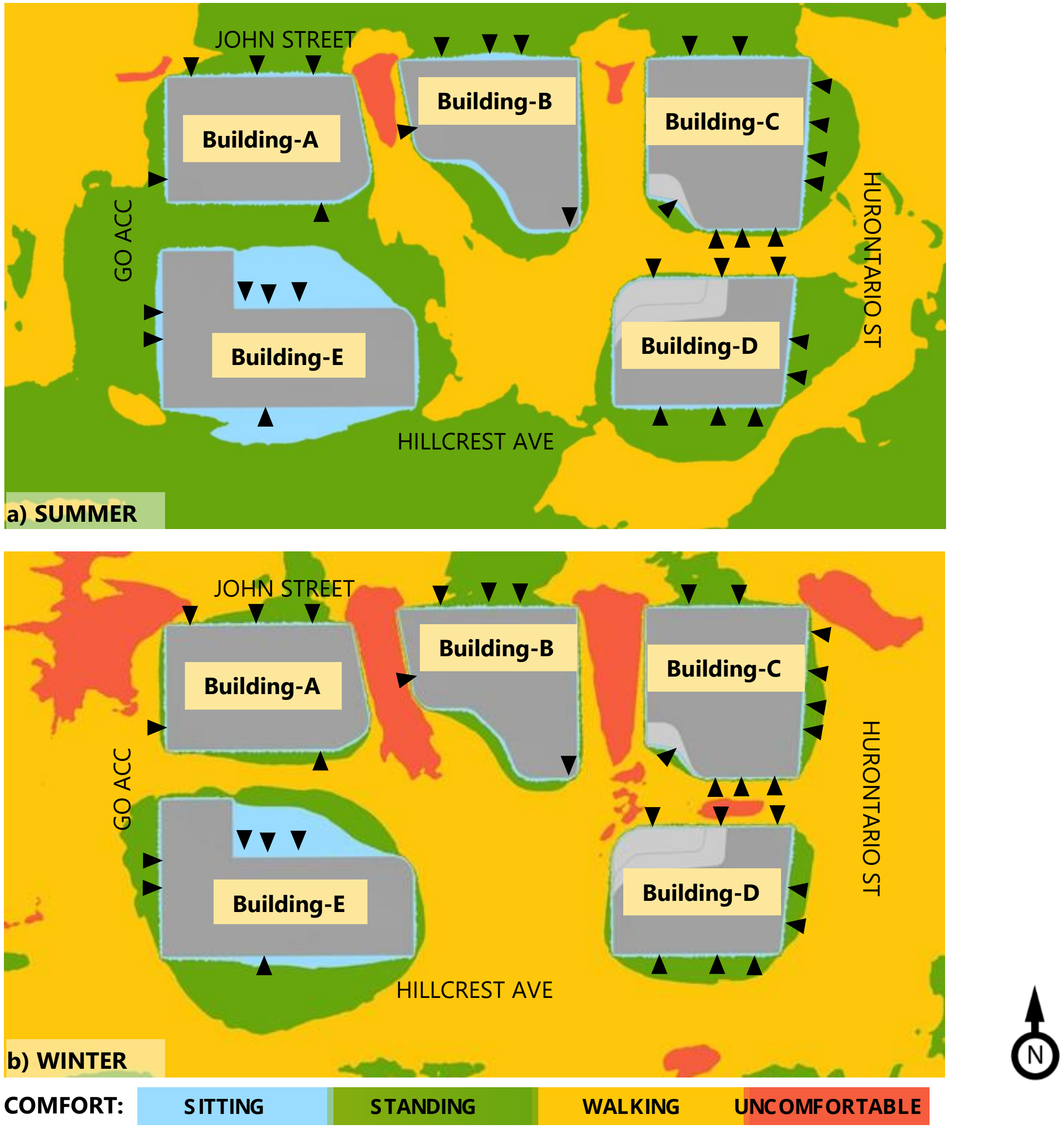


Image 9: Predicted wind conditions – Proposed Configuration: GROUND LEVEL

4.3 Existing Scenario

The existing building on the site is low-rise, like the neighbouring buildings, and therefore will not redirect winds to create any notable impact. Wind conditions at most areas in the existing scenario are considered to be comfortable for standing in the summer (green regions in **Image 8a**). Seasonally stronger wind speeds during the winter months results in walking conditions predicted around the site (yellow regions in **Image 8b**).

Wind conditions at all areas near the project site are expected to meet the safety criterion.

4.4 Proposed Scenario

The predominant winds from the north through the west directions are incident on the northern façades of the Buildings A-C. Grade level areas closer to the northern facades of Buildings A-C and adjacent building corners are susceptible to the prevailing winds as they downwashing over the facades and accelerate around the corners, hence higher wind activity is expected in the areas. Also, the prevailing winds are expected to flow through the gaps between the Buildings A-C and result in increased wind activities. The buildings will have a stepped massing near the ground; steps advancing towards the inner building facades facing the central space at site which is favourable for reducing wind speeds within the central space between the buildings.

4.4.1 Sidewalks and Neighbouring Properties

The wind speeds at most sidewalks and areas on and around the proposed development are expected to continue to be comfortable for standing in the summer, and walking in the winter, similar to the existing scenario (**Images 8c and 8d**). In comparison to the existing scenario, higher wind speeds are anticipated at the western and northern end of the development during the summer season with conditions comfortable for walking. These conditions are appropriate for sidewalk use. Strong prevailing winds from the north through west directions are expected to result in strong corner accelerations induced from downwashing of winds along the northwestern, northern, and eastern facades of Buildings A -C and increase wind speeds near the adjacent building corners along John Street; uncomfortable wind conditions are anticipated in these sidewalk areas throughout the year (see red regions in **Images 9a and 9b**). Also, during the winter season due to seasonally stronger winds, uncomfortable conditions along these sidewalk areas along John Street are more pronounced and prevail at extended areas in the passageways between buildings and along the nearby sidewalks (see red regions in **Images 9b**).

Uncomfortable conditions occurring at the passage space between Building B & C and near the northwest corner of Building A can be considered acceptable since majority of these areas occur on vehicular roadways that will likely not be accessed by pedestrians.

4. RESULTS AND DISCUSSION

Wind speeds potentially exceeding the prescribed safety criterion are expected near the northern façade corners of Buildings A-C on John Street, and the passages between the buildings A-C. Wind tunnel testing is required to quantify gust impacts and confirm these conditions.

In order to reduce wind speeds along the northern corner of Buildings A-C and through the gaps between Buildings A & B and B & C, horizontal wind mitigation measures in the form of over head canopies or trellises along the northern facades of Buildings A, B, and C, and extending the canopies around the building corners are recommended. Alternatively, we recommend increasing the offset of the tower from the edge of the podium on Buildings A to C to help deflect winds away from the ground.

As per the 3-D model received on April 8th 2022, the balcony overhangs along the northwestern facades of Buildings A, B, and C will slightly alleviate the elevated wind speeds at grade along John Street. The proposed landscaping plan includes planters and deciduous trees around these windy sidewalk areas, which might marginally contribute to reducing wind speeds. Note that deciduous trees generally will lower wind speeds around them in the summer. Coniferous trees afford wind control benefits in the winter months as well. Hence, additionally we recommend including vertical wind control features around the windy corners to diffuse winds accelerating in these areas. These could be in the form of coniferous type plantings or wind screens as shown in the examples in **Image 10**.

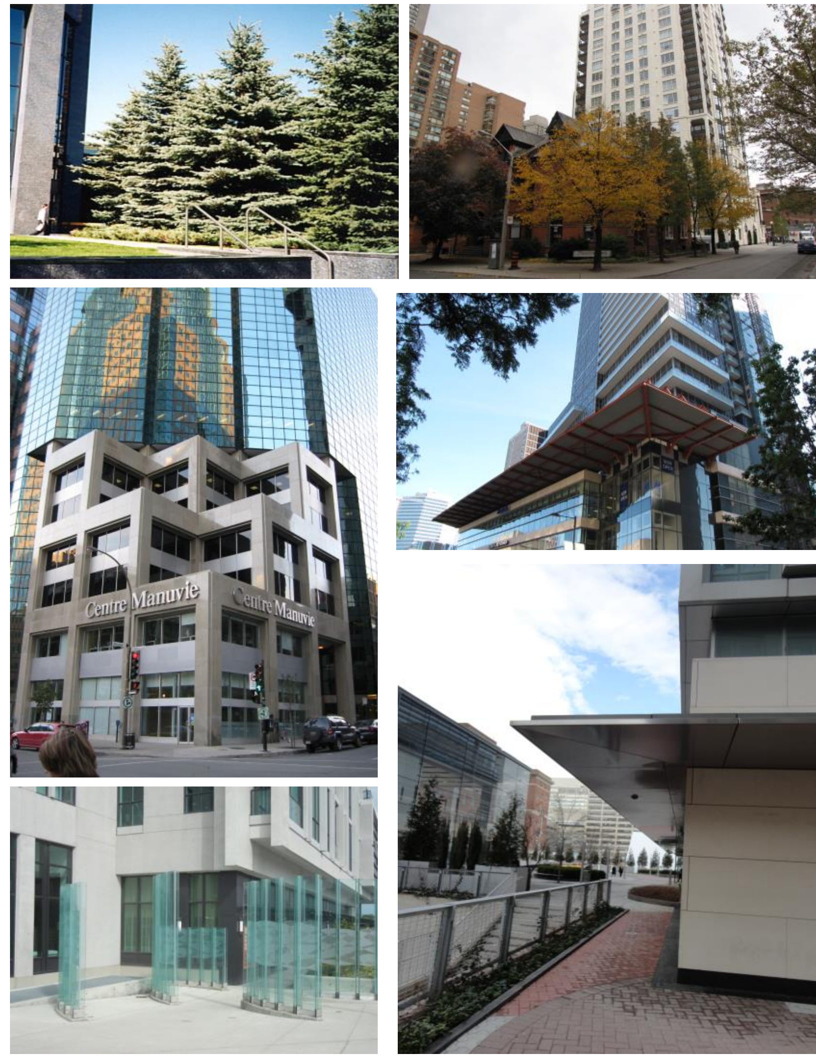


Image 10: Design strategies for wind control on sidewalks

4.4.2 Building Entrances

The main entrances to the proposed development are identified in Images 9a and 9b. Wind conditions at most entrances are predicted to be comfortable for sitting or standing throughout the year which is ideal. Higher than desired wind speeds with walking conditions are predicted at the retail entrance near the northwestern corner of Building-A, which is due to prevailing winds downwashing off the tall façade and accelerating around the corner; overhead canopy wrapping around the northwestern corner of Building A as mentioned in the previous section will likely help in alleviating wind conditions at this building entrance (**Image 11**).

Also, the wind conditions at the building entrances along the southern façade of Building-C and northern façade of Building-D are shown to be comfortable for walking over the year which is mainly due to winds accelerating between Buildings C and D. Vertical screens/tall planters at least 2 m high placed on either sides of the entrance area may reduce wind speeds locally within the entrance area (**Image 11**). Additionally, recessing these entrances into the building façades can also offer protection and mitigate elevated wind speeds.

4.4.3 Drop off areas

The drop-off area located to the north of Building-E is planned under the building overhang and is sheltered from the prevailing winds, hence sitting conditions are predicted to occur over the year which is ideal for the intended usage. The drop-off areas at the shared space between Buildings B, C, & D are predicted to be comfortable for walking over the year. However, during the winter slightly uncomfortable conditions could potentially occur at the drop-off space near the northwestern corner of Building-E. Any coniferous landscaping alleviate the sidewalk conditions between Buildings B & C may alleviate these marginal uncomfortable conditions.

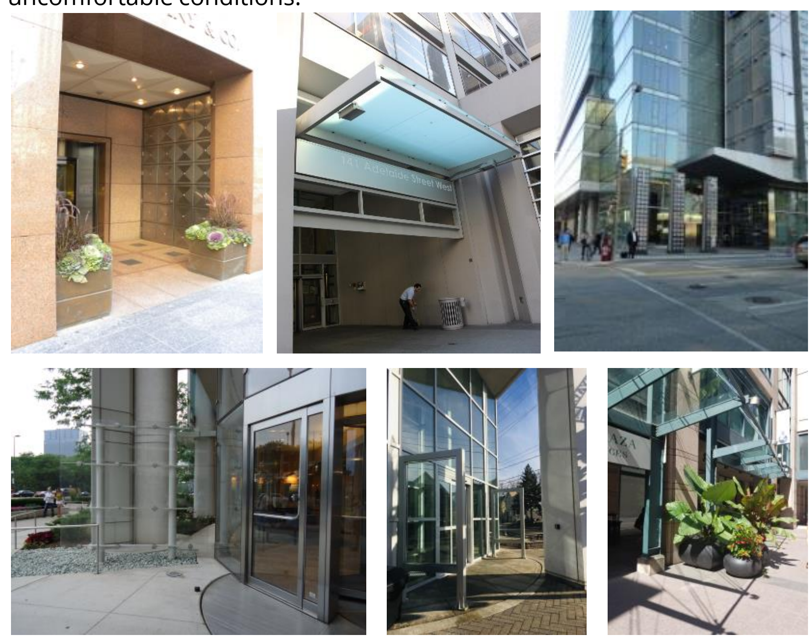


Image 11: Design strategies for wind control of Entrances

4.4.4 Grade Level Patio Areas

The outdoor patio spaces are predicted to be comfortable for walking or better during the summer season when these areas will be open to pedestrian usage. Conditions comfortable for walking are windier than desired for prolonged use for passive activities (dining, sitting, etc.). The proposed landscaping plan depicts implementation of deciduous trees near these patio areas which will likely lower wind speeds and enhance wind comfort conditions locally in those areas. Furthermore, targeted wind control features in the form of planters or wind screens as shown in **Image 12** should be considered around designated seating areas to create a localized low wind patron zone.

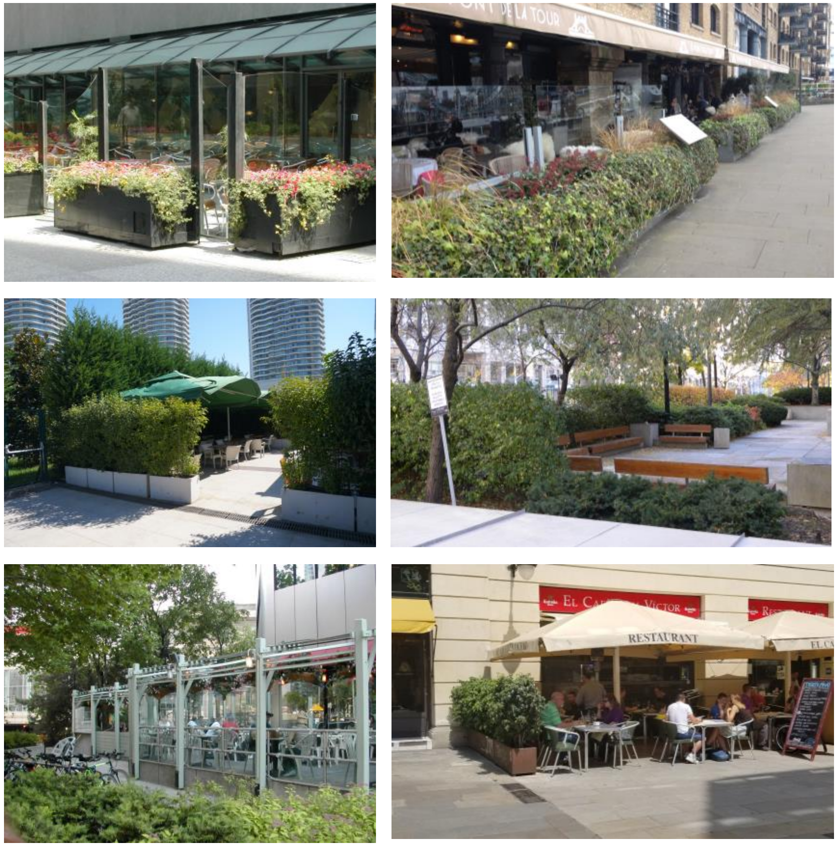


Image 12: Design strategies for wind control at Patio Areas

4.5.4 Above Grade Amenity Terraces

The wind comfort conditions predicted on the Level 2 terraces on Buildings A & B, and Level-4 terrace on Building E are presented in **Image 13**. Wind speeds comfortable for sitting are ideal for relaxed amenity uses like sitting, dining, lounging, etc. Conditions comfortable for standing may be acceptable for short periods of passive activities. Higher wind speeds, categorized for walking, are too high for the typical activities expected on terraces. If the terraces will not be used in the winter, the seasonally higher wind speeds can be deemed acceptable during the colder winter months.

During the summer, wind conditions at the Level-2 terraces of Buildings A and B are predicted to be comfortable for standing in the areas closer to the building façade, and for walking at the outer edges of the terrace space. The Level-4 terrace areas on the Building-E are anticipated to be comfortable for walking in the summer season, with uncomfortable conditions along the terrace periphery. Also, uncomfortable wind conditions during the winter and potential wind safety exceedance are predicted to occur on the level 4 terrace area of Building E. We encourage the design team to consider mitigation features such as minimum 2m tall parapets, wind screens and landscaping around the perimeter of the terraces. These features, will help reduce the exposure of the terrace to the prevailing winds. Also, overhead canopies and trellises can be placed in areas closer to the building façade to locally reduce the impact of downwashing. In addition, the features may be interspersed throughout the terrace or used to surround designated gathering or seating areas. Some examples of wind control features are shown in **Image 14**.

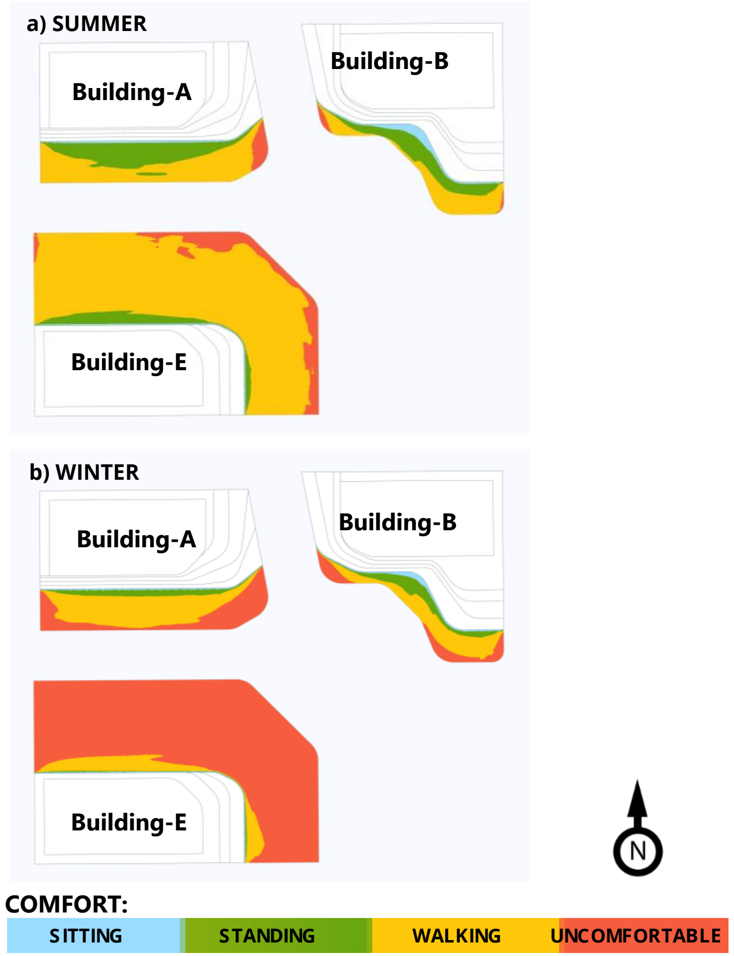


Image 13: Predicted wind conditions – Above Grade Terraces

4. RESULTS AND DISCUSSION

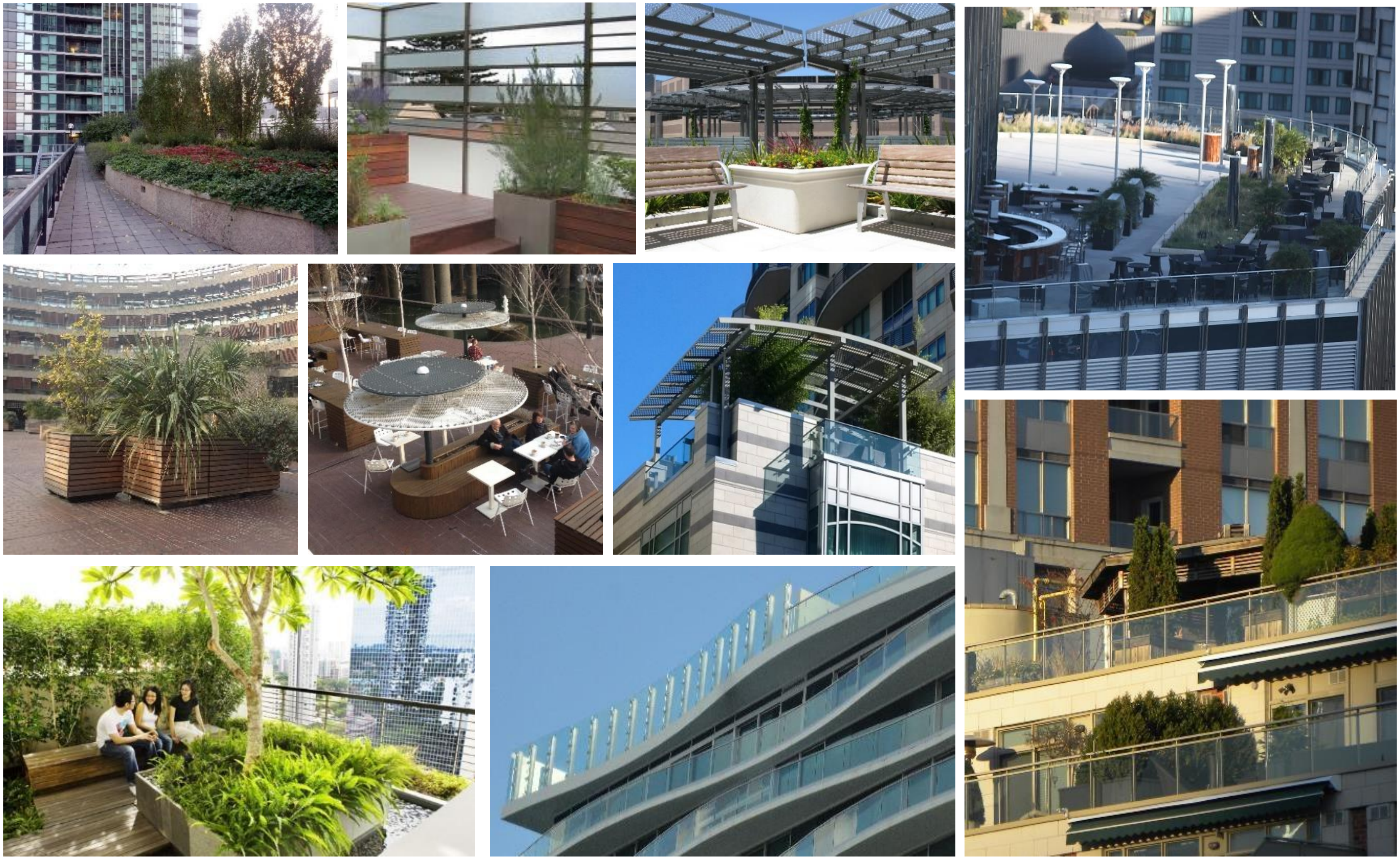


Image 14: Design strategies for wind control on terraces

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed project at 25 Hillcrest Avenue and 3154 Hurontario project site in Mississauga, Ontario. Our assessment was based on the local wind climate, the current design of the proposed development, the existing surrounding buildings, and computational modelling and simulation of wind conditions. Our findings are summarized as follows:

- The proposed buildings are taller than its immediate surroundings, and therefore will redirect wind to ground level. However, several positive features are included within the design such as the stepped massing at few facades which will help moderate wind impacts to some extent.
- Wind conditions at ground level and most building entrances are expected to be appropriate for the intended usage. Sidewalk areas along John street adjacent to the building corners, and areas between the buildings are predicted with uncomfortable wind conditions over the year. Areas associated with high wind activity between the Buildings B and C, and away from the sidewalk areas can considered appropriate since these areas are intended for vehicular roadway usage. Few building entrances, and the patio areas display higher than desired wind speeds; hence appropriate mitigation measures are suggested.
- Wind speeds on the Level-2 and Level-4 above grade podium terraces on Buildings A, B, and E are predicted to be windy for passive use in in the summer when these areas will potentially be used frequently. Wind control strategies have been provided.
- RWDI can help guide the placement of wind control features, including coniferous landscaping, to achieve appropriate levels of wind comfort based on the programming of the various outdoor spaces. Additional assessments using a physical scale model and Wind Tunnel testing is recommended to evaluate the benefits of any suggested wind control measures.

6. APPLICABILITY OF RESULTS

The assessment presented in this report is for the proposed project at 33 Hillcrest Avenue development, based on the information provided by design team on March 14 and April 8, 2022. In the event of any significant changes to the design, construction or operation of the building or addition of surroundings in the future, RWDI could provide an assessment of their impact on the pedestrian wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.

File Name	File Type	Date Received (mm/dd/yyyy)
220314_33 Hillcrest - 3D Model	DWG	03/14/2022
42040_L01 Landscape Plan	PDF	04/08/2022
2022-04-11 33 Hillcrest - 3DView	DWG	04/11/2022

7. REFERENCES

1. H. Wu, C.J. Williams, H.A. Baker and W.F. Waechter (2004), "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions", *ASCE Structure Congress 2004,* Nashville, Tennessee.

2. H. Wu and F. Kriksic (2012). "Designing for Pedestrian Comfort in Response to Local Climate", *Journal of Wind Engineering and Industrial Aerodynamics*, vol.104-106, pp.397-407.

3. C.J. Williams, H. Wu, W.F. Waechter and H.A. Baker (1999), "Experience with Remedial Solutions to Control Pedestrian Wind Problems", *10th International Conference on Wind Engineering*, Copenhagen, Denmark.