REPORT

STILLWATER STATION MASTERPLAN

OTTAWA, ON

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT #2302695
FEBRUARY 1, 2023

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to conduct a pedestrian wind assessment for the proposed Stillwater Station Masterplan project located at 1987 Robertson Road in Ottawa, Ontario. The objective of this assessment is to provide an evaluation of the potential impact of the proposed development on pedestrian-level wind conditions in support of the OPA/ZBL and Secondary Plan.

The project site is located on the northeast side of the intersection of Moodie Drive and Robertson Road, in the Bells Corners neighbourhood. The site is surrounded by low-rise suburban neighbourhoods to the south, low-rise commercial buildings to the east and west, and is open to the north

The north side of the development will consist of towers ranging from 18 and 32-storeys, some having a shared 6-storey podium, while the south side is planned to have 4 to 6-storey buildings (Image 2). In addition to sidewalks and properties near the project site, important areas of interest for this assessment include public parks (Image 3), podium rooftops, and the roofs of the shorter 4 to 6-storey buildings.

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

Image 2: Conceptual Massing of the Proposed Project

1. INTRODUCTION

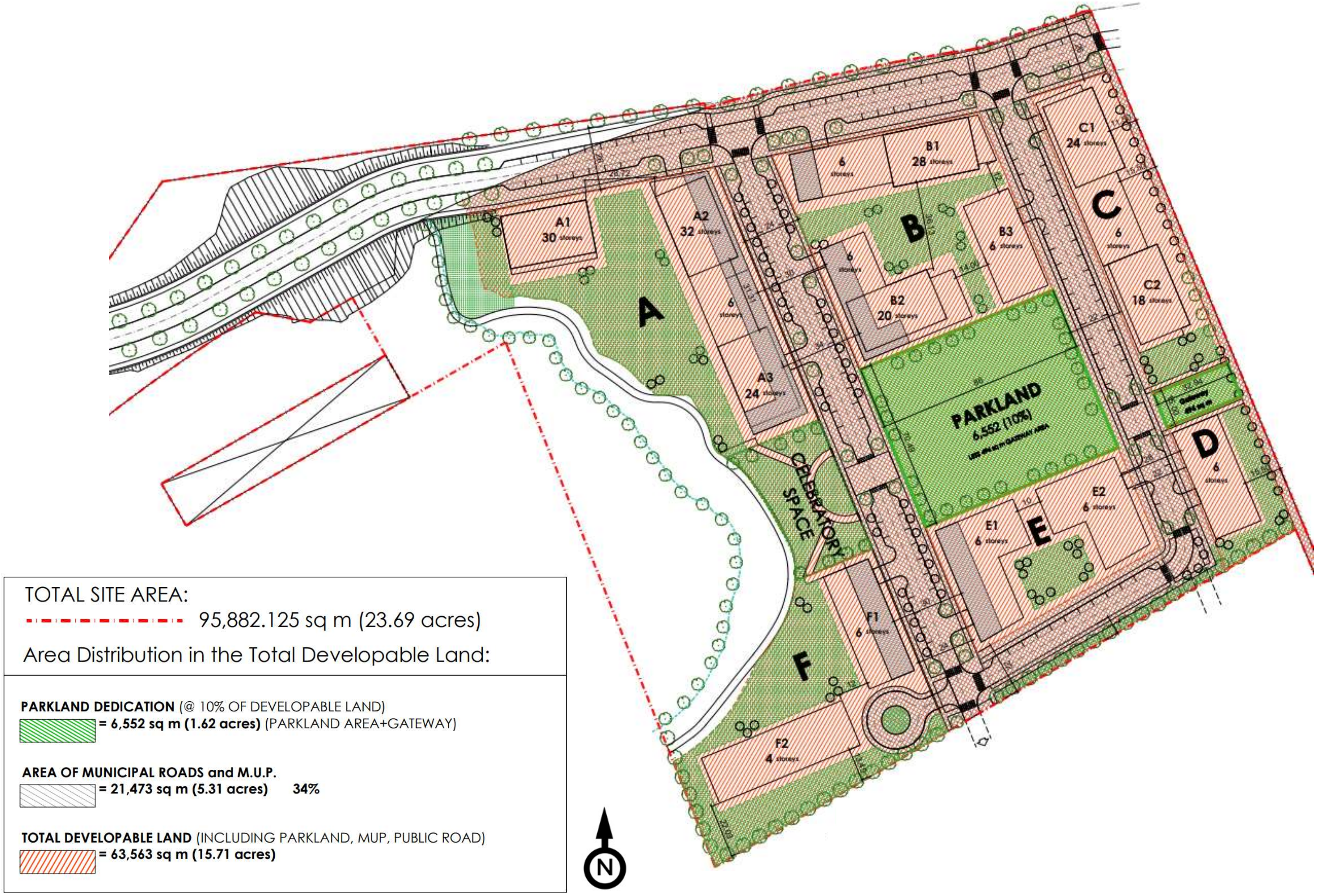

Image 3: Site Master Plan

2. METHODOLOGY

2.1 Objective

The objective of this assessment is to provide an evaluation of the potential impact of the proposed development on wind conditions in pedestrian areas on and around it based on Computational Fluid Dynamics (CFD) modelling. The assessment is based on the following:

- A review of the regional long-term meteorological data from Ottawa Macdonald-Cartier International Airport;
- 3D e-model of the proposed project and site plan received on January 5th, 2023;
- The use of *Orbital Stack*, an in-house CFD tool;
- RWDI's engineering judgment, experience, and expert knowledge of wind flows around buildings[1-3]; and,
- The RWDI wind comfort and safety criteria.

Note that other microclimate issues such as those relating to cladding and structural wind loads, door operability, 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 that can be used 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 behaviour of wind and refine any conceptual mitigation measures, more detailed assessment would be required using either boundary-layer wind tunnel or transient computational modelling.

2.3 Simulation Model

CFD simulations were completed for two scenarios:

- **Existing**: Existing site and surroundings.
- **Proposed**: Proposed development with the existing surroundings.

The computer model of the proposed building is shown in Image 4, and the Existing and Proposed configurations with the proximity model are shown in Images 5a, and 5b, respectively. 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 (as is the norm for this level of assessment).

The wind approaching the modelled area were simulated for 16 directions (starting at 0°, at 22.5° increments around the compass), accounting for the effects of the atmospheric boundary layer and terrain impacts. Wind data were obtained in the form of ratios of wind speeds at 1.5 m above levels of interest, to the mean wind speed at a reference height. The data was then combined with meteorological records obtained from Ottawa Macdonald-Cartier International Airport to determine the wind speeds and frequencies in the simulated areas.

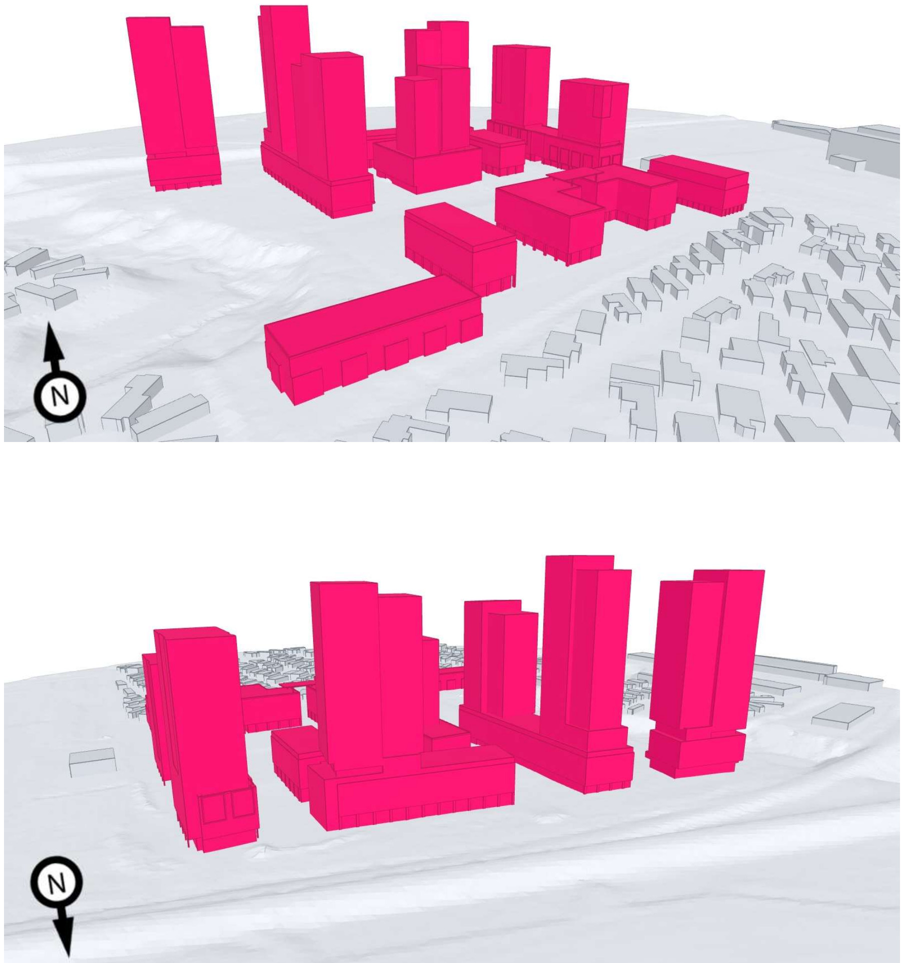

Image 4: Computer model of the proposed project

2. METHODOLOGY

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

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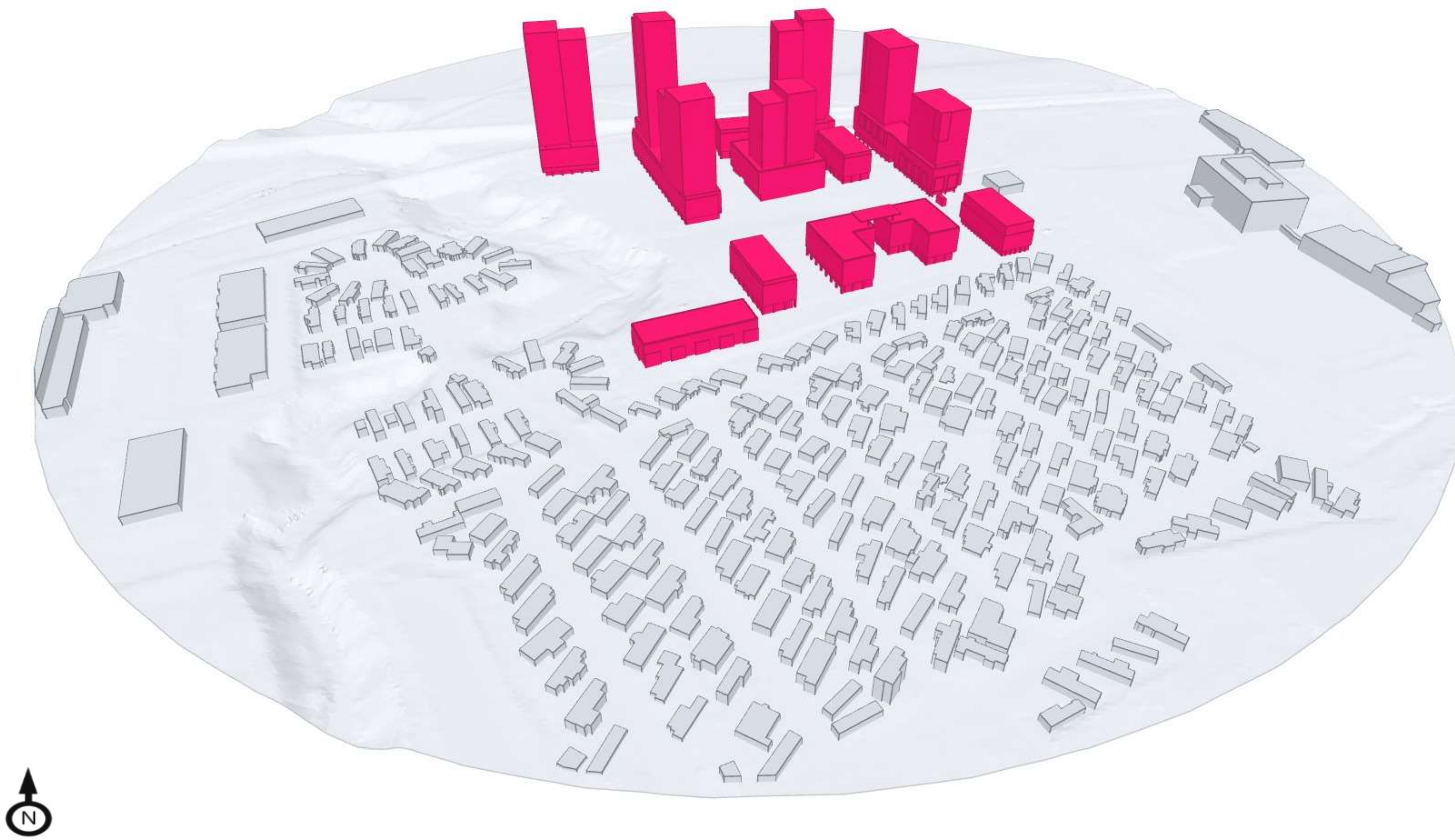


Image 5b: Computer model of proposed project and extended surroundings

3. METEOROLOGICAL DATA

Wind statistics recorded at Ottawa Macdonald-Cartier International Airport between 1989 and 2019, inclusive, were analyzed for the spring (March through May), summer (June through August), fall (September through November) and winter (December through February) seasons. Image 6 graphically depicts the directional distributions of wind frequencies and speeds for these four seasons.

Winds from the southwest through northwest are predominant throughout the year, with secondary contribution from the east and northeast as indicated by the wind roses. Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) are most frequent in the winter, followed by spring and fall, and least frequent in the summer.

Wind statistics were combined with the simulated wind data to predict the full-scale wind conditions, which were then compared with the wind criteria.

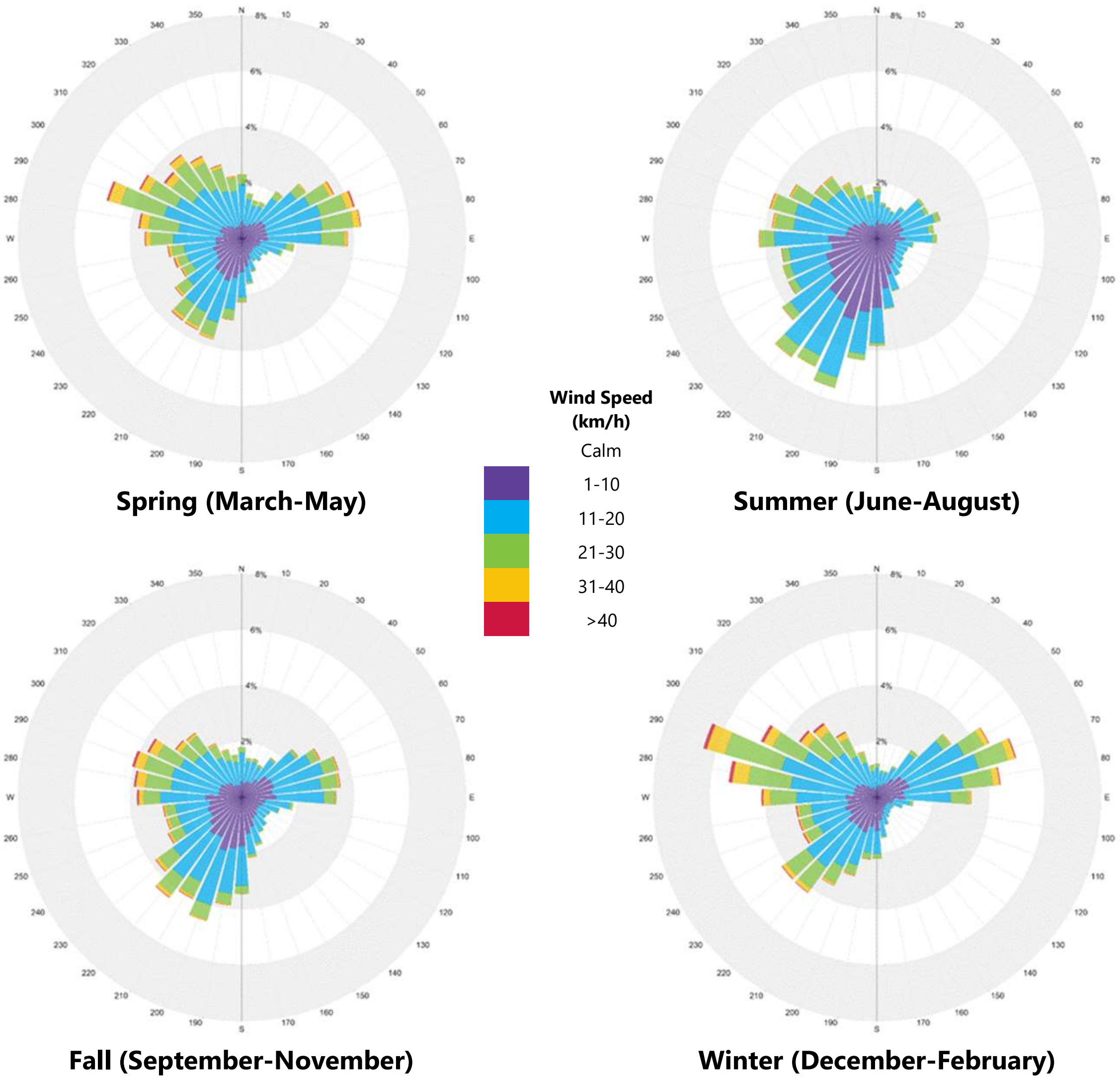


Image 6: Directional Distribution of Winds Approaching Ottawa Macdonald-Cartier International Airport from 1990 to 2020

3. WIND CRITERIA

The present study uses the criteria specified in the Terms of Reference of The City of Ottawa for assessing pedestrian-level wind conditions. The criteria consider pedestrian comfort (pertaining to common wind speeds conducive to different levels of human activity) and safety (pertaining to infrequent but strong gusts that could affect a person's footing).

3.1 Pedestrian Comfort

Pedestrian comfort is associated with common wind speeds conducive to different levels of human activity. Wind conditions are considered suitable for sitting, standing, strolling or walking if the associated mean wind speeds (see table) are expected for at least four out of five days (80% of the time). The assessment considers winds occurring between 6 AM and midnight. Limited usage of outdoor spaces is anticipated in the excluded period. Speeds that exceed the criterion for Walking are categorized Uncomfortable. These criteria represent average wind tolerance, and they are sometimes subjective. 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.

Comfort Category	GEM Speed (km/h)	Description (Based on seasonal compliance of 80%)
Sitting	**≤ 10**	Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away
Standing	**≤ 14**	Gentle breezes suitable for main building entrances, bus stops, and other places where pedestrians may linger
Strolling	**≤ 17**	Moderate winds appropriate for window shopping and strolling along a downtown street, plaza or park
Walking	**≤ 20**	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
Uncomfortable	**> 20**	Strong winds considered a nuisance for all pedestrian activities. Wind mitigation is typically recommended

3.2 Pedestrian Safety

Pedestrian safety is associated with excessive Gust Speeds that can adversely affect a person's balance and footing. These are usually infrequent events but deserve special attention due to the potential impact on pedestrian safety.

Safety Criterion	Gust Speed (km/h)	Description (Based on annual exceedance of 9 hrs or 0.1% of time)
Exceeded	**> 90**	Excessive gusts that can adversely affect one's balance and footing. Wind mitigation is typically required.

4. RESULTS AND DISCUSSION

4.1 Presentation of Results

The results of the assessment are presented in Images 8 through 11 (grade) and Image 13 (terraces) – these results are discussed in detail in Sections 4.3 and 4.4. The graphical presentation is in the form of colour contours of wind speeds calculated based on the wind comfort criteria (Section 3.1), 1.5 m above levels of interest. The assessment against the safety criterion (Section 3.2) was conducted qualitatively based on the predicted wind conditions and our extensive experience with wind tunnel assessments. The areas where the criterion may be exceeded are indicated in Images 10b and 11b.

Target Conditions

For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks and walkways where pedestrians are likely to be active and moving intentionally. Lower wind speeds comfortable for standing are required for entrances and areas where people are expected to be engaged in passive activities. Calm wind speeds suitable for sitting are desired in areas where prolonged periods of passive activities are anticipated, such as outdoor amenity areas, seating areas etc., especially during the summer when these areas are typically in use.

4.2 General Wind Flow Mechanisms

Wind 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 and in the gaps between buildings (Corner Acceleration and *Channelling Effect*).

Podiums, canopies, and large trees can help reduce the impact of these effects at ground level. These flow patterns are illustrated in Image 7.

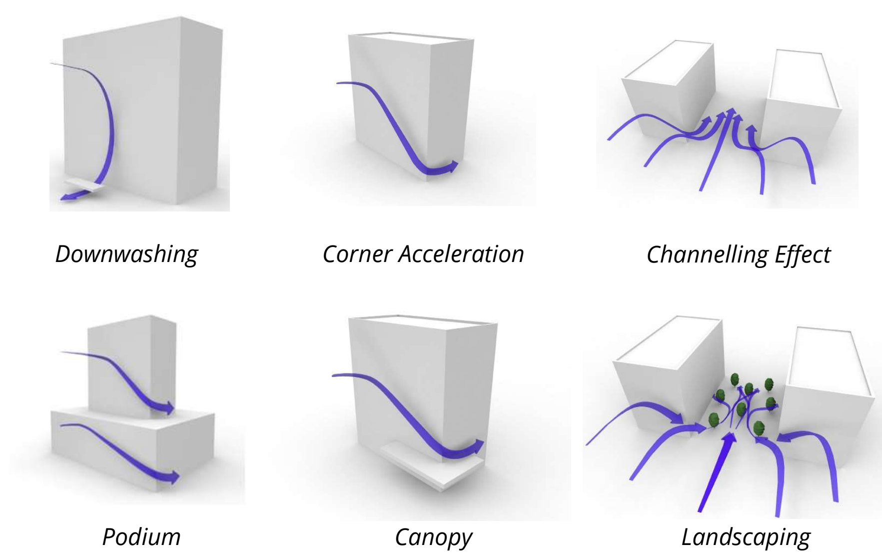
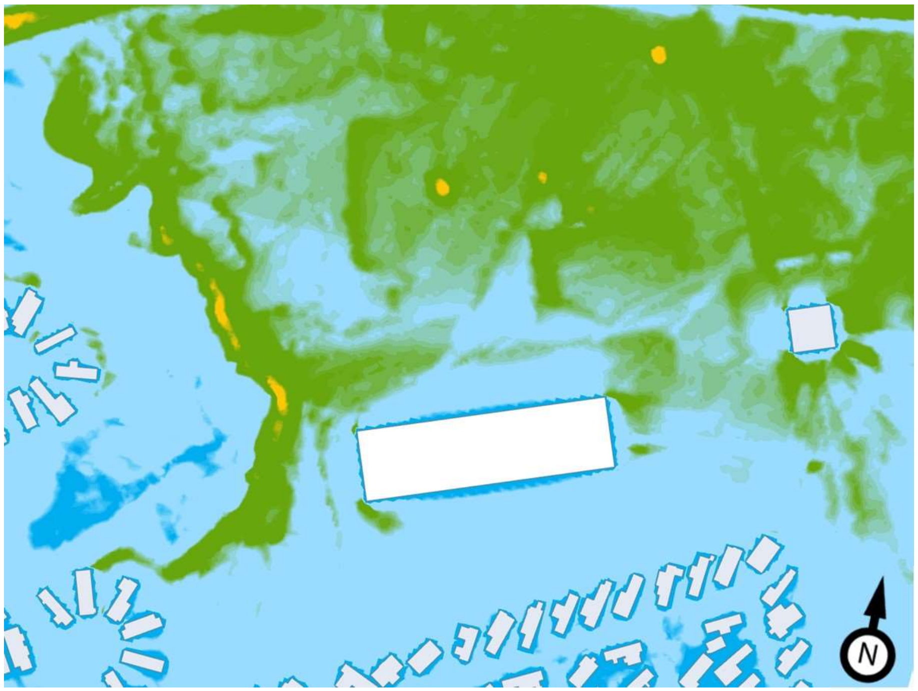
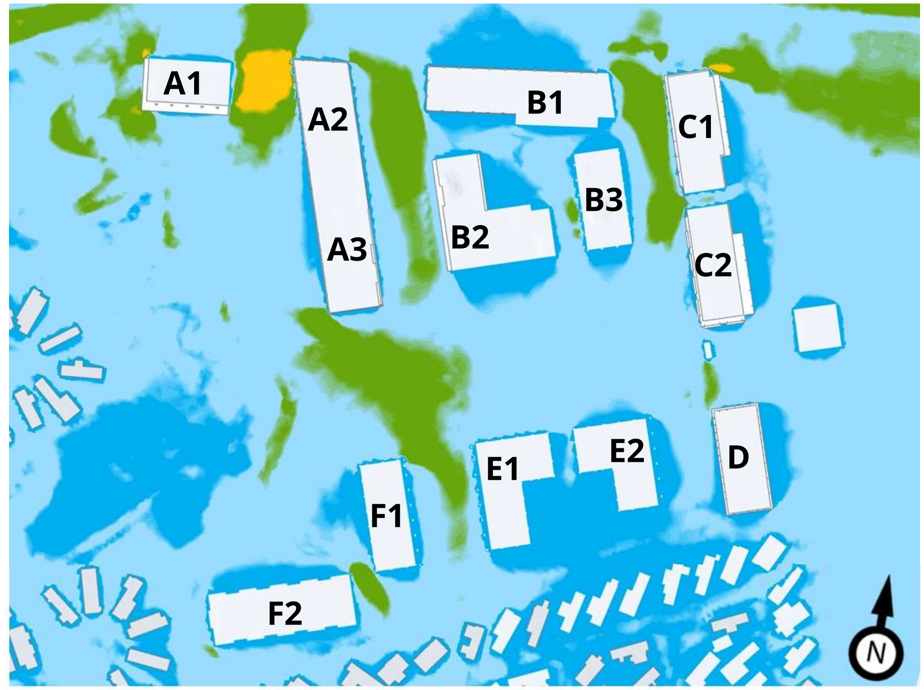


Image 7: General wind flow patterns

4. RESULTS AND DISCUSSION



(a) EXISTING



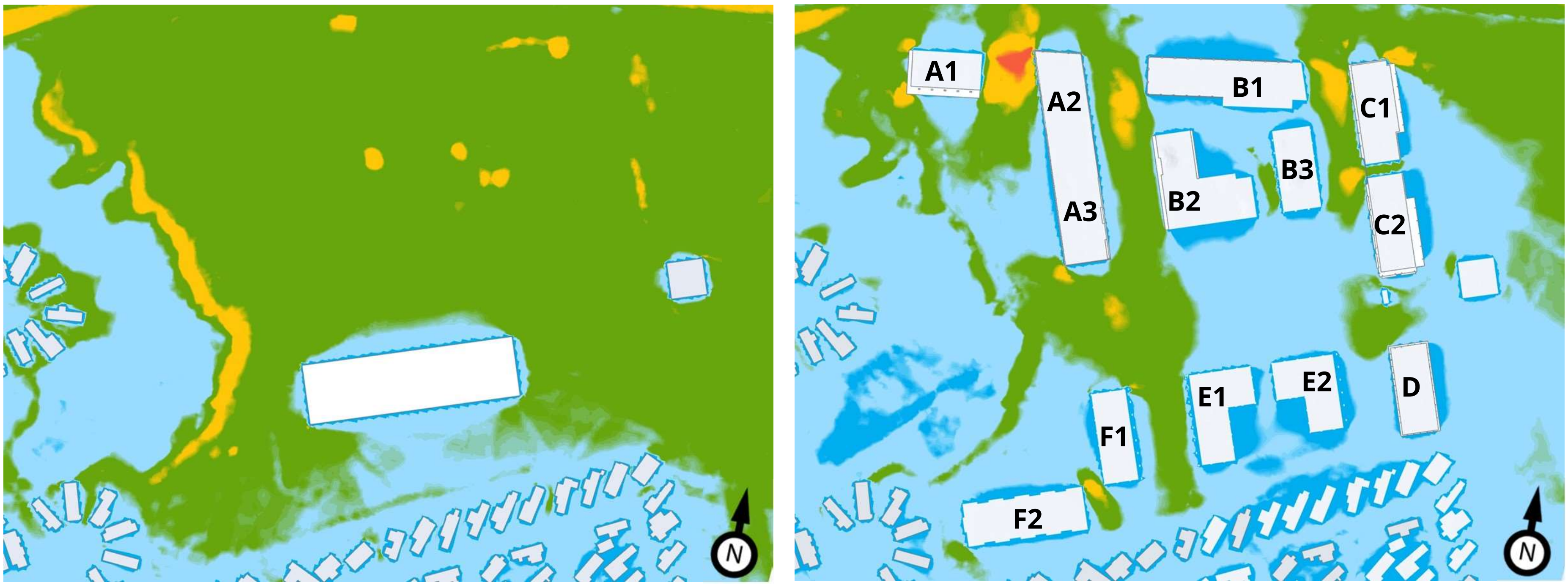
(b) PROPOSED

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: Areas where there is a potential for the wind safety criterion to be exceeded

Image 8: Predicted wind conditions – GROUND LEVEL – SUMMER

4. RESULTS AND DISCUSSION



(a) EXISTING

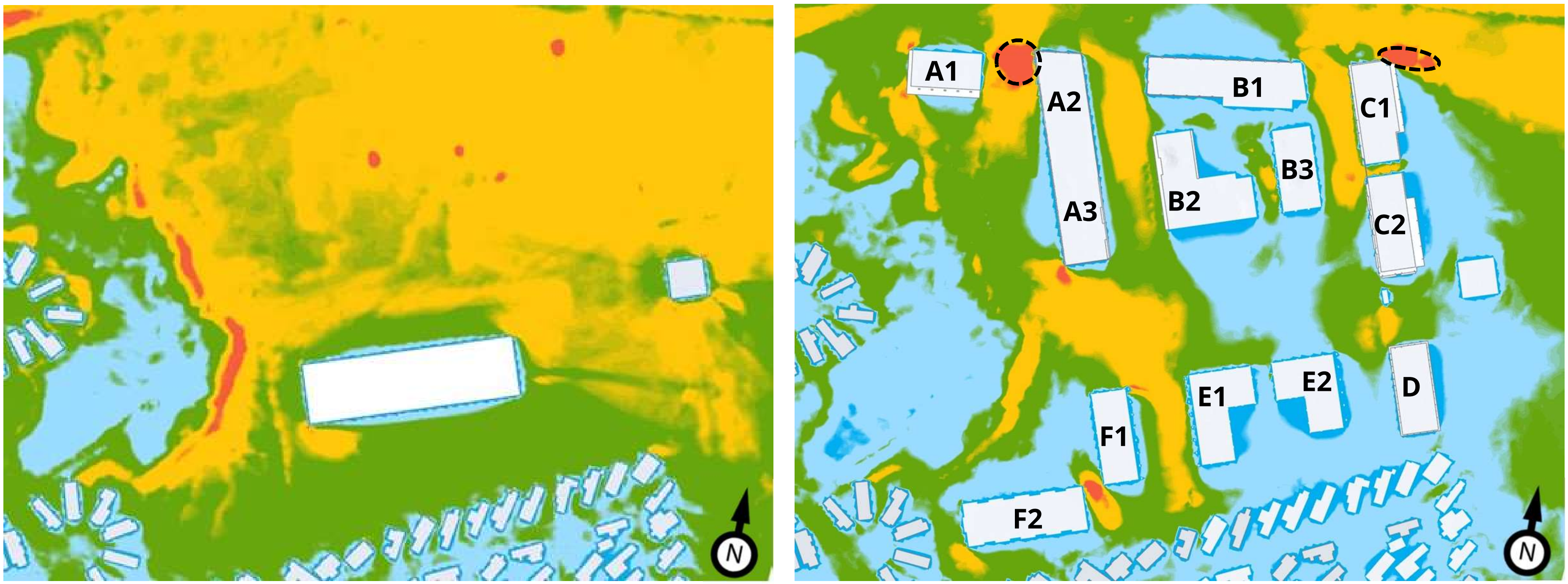
(b) PROPOSED

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: Areas where there is a potential for the wind safety criterion to be exceeded

Image 9: Predicted wind conditions – GROUND LEVEL – FALL

4. RESULTS AND DISCUSSION

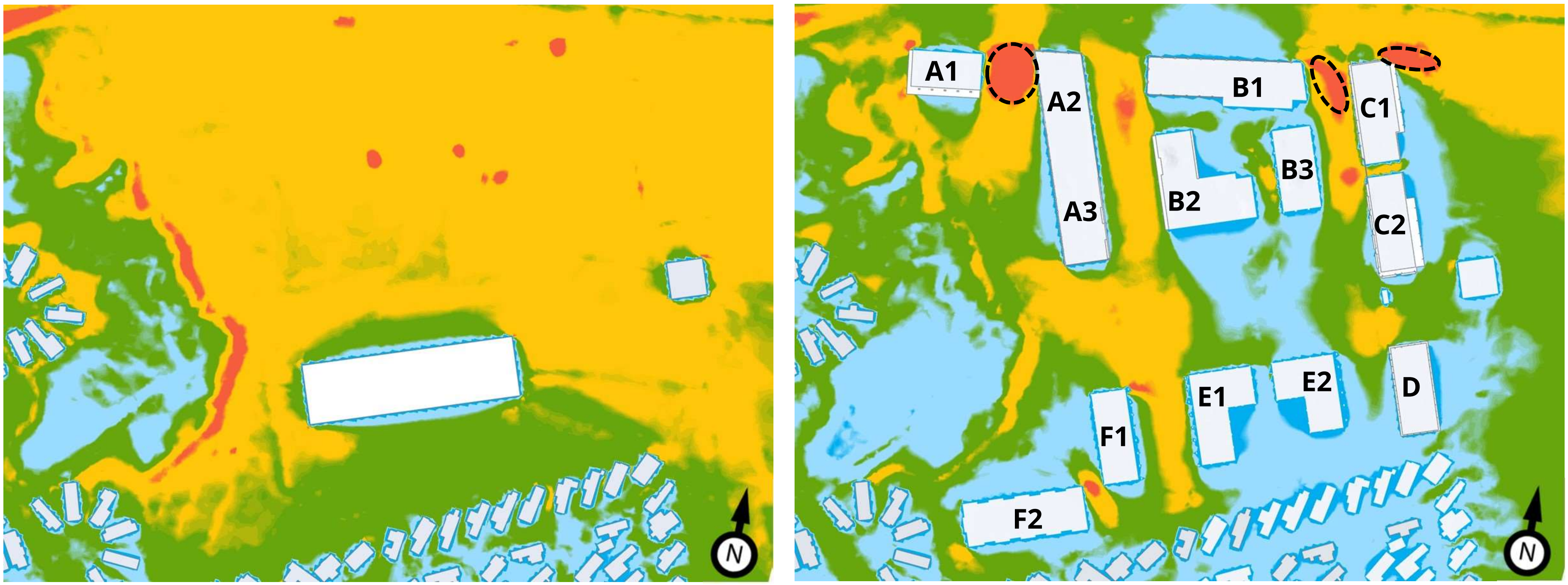


(a) EXISTING **(b) PROPOSED**

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: Areas where there is a potential for the wind safety criterion to be exceeded

Image 10: Predicted wind conditions – GROUND LEVEL – WINTER



(a) EXISTING (b) PROPOSED

COMFORT: SITTING STANDING STROLLING WALKING UNCOMFORTABLE

SAFETY: Areas where there is a potential for the wind safety criterion to be exceeded

Image 11: Predicted wind conditions – GROUND LEVEL – SPRING

4.3 Existing Scenario

The existing site is mostly empty, having only one low-rise building, which does not redirect winds to create any notable impact. Wind conditions at most areas are comfortable for standing or strolling in the summer and fall (light blue and green regions in Images 8a and 9a) and comfortable for walking in the winter and spring (yellow regions in Images 10a and 11a). Wind speeds close to the facade of the existing building on site are comfortable for standing in the summer and fall, and comfortable for strolling in the winter and spring.

Wind speeds on adjacent properties to the south are generally comfortable sitting or standing during the summer and fall, with speeds on the area to the west of the site being slightly higher. In the winter and spring, wind speeds comfortable for strolling occur between the properties to the south, while locations to the west are again slightly windier.

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

4.4 Proposed Scenario

4.4.1 Grade Level

With the addition of the proposed buildings, wind conditions on most areas of the site are expected to continue to be comfortable for standing or strolling in the summer and fall (Images 8b and 9b). These conditions are adequate for sidewalks and walkways but are not ideal for outdoor dining/seating areas – the design team is encouraged to use Images 8b through 11b to assist with programming the use of outdoor spaces as the design evolves. Higher wind speeds are anticipated between the towers on the north side of the development – these speeds remain adequate for pedestrian use during the summer, however, speeds between towers A1 and A2 are predicted to exceed the walking comfort threshold in the fall season.

In the winter and spring, wind speeds across the site are generally higher due to the seasonal wind climate in Ottawa. Wind speeds on most of the site remain suitable for strolling or walking, and positively, large areas with lower wind speeds comfortable for standing are still predicted in the central part of the development in zones sheltered from the prevailing wind directions (Images 10b and 11b). High wind activity is anticipated at the north-south corridors between the north towers, in the space between buildings F1 and F2 (south side), and near some exposed building corners. Wind speeds in these areas are predicted to be uncomfortable on a seasonal basis, as indicated by the orange regions in Images 10b and 11b.

The wind safety criterion (annual) may potentially be exceeded between towers A1 and A2, between Towers B1 and C1, and near the northeast corner of tower C1 (see circled regions in Images 10b and 11b).

4.4 Proposed Scenario (cont'd)

4.5.1 Grade Level (cont'd)

Possible ways of improving local wind conditions at grade include both architectural and landscaping measures. If feasible, the following measures below should be considered:

- Adding tower setbacks, corner articulations, and/or corner canopies to towers A1, A2, B1, and C1. These same features may also be considered to improve wind conditions near building corners with elevated wind speeds.

- Avoid placing main building entrances at locations with wind speeds above the comfort threshold for standing. As this may not always be feasible, recessing entrances from the building façades and/or adding wind screens locally around the entrances may also be considered.

- Planting trees large trees with dense foliage along sidewalks and park areas – the trees act as dissipative elements for the wind and can help lower wind speeds near them. Coniferous (or marcescent) trees are recommended, as they are able to retain their leaves during the winter, which makes them more effective for wind control.

Examples shown in Image 12.

Image 12: Examples of wind control strategies applicable to the site

4.4 Proposed Scenario (cont'd)

4.5.2 Terraces

Most building terraces are anticipated to be too windy for passive activities during the summer, when these spaces are used the most; wind speeds on most podium rooftops are anticipated to be comfortable for strolling, with lower wind speeds conducive to standing occurring near the base of the towers, and uncomfortable wind speeds close to the west edges of the podia (Image 13). Wind conditions on most rooftops of the 4 and 6-storey buildings are expected to be comfortable for strolling or walking, with lower windspeeds suitable for standing occurring on the roof of building E2, and uncomfortable wind speeds near the edges of buildings F1, F2, E1, and B3. Elevated wind speeds are predicted in the remaining seasons, especially near the edges of the terraces and between the towers, where the wind safety criterion may be exceeded. If the use of these spaces is to be extended into the colder months of the year, it is strongly recommended that the design team considers wind control strategies.

Wind conditions on the roof of the 4 to 6-storey buildings can be improved by increasing the height of the guardrails to at least 2 m to address the direct exposure of these areas to the prevailing winds. Conditions may also be improved by strategically positioning landscaping elements and/or wind screens near designated seating areas. For the podium rooftops, in addition to the recommendations above, the design team may also consider including horizontal features such as trellises near the base of the towers. Perforated horizontal features can be used to slow down downwashing winds from the towers, reducing pedestrian-level wind speeds. Examples are shown in Image 14.

Image 13: Predicted wind conditions – ABOVE-GROUND TERRACES (SUMMER)

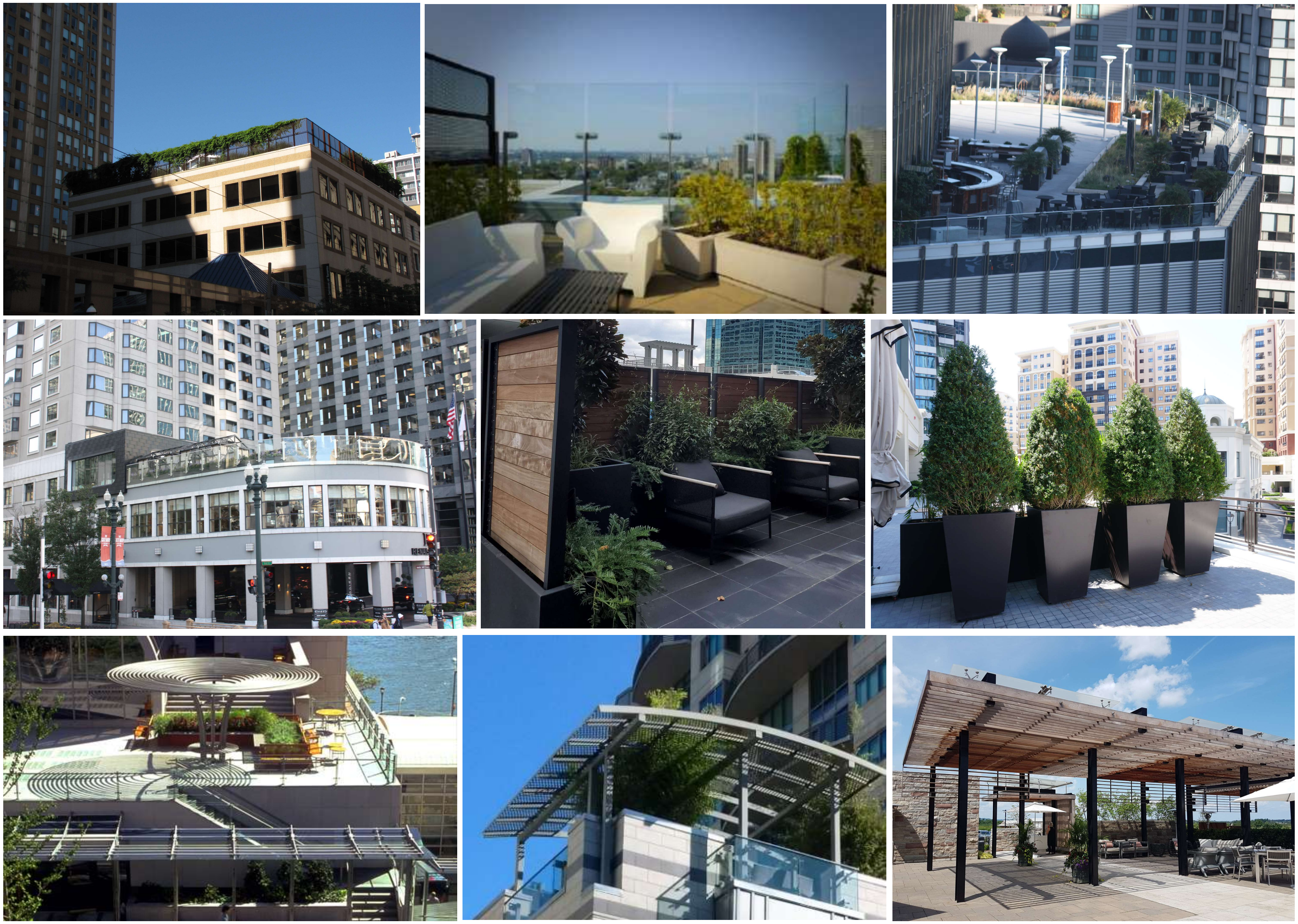


Image 14: Examples of wind control strategies applicable to terraces

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed Stillwater Station Masterplan project at 1987 Robertson Road in Ottawa, Ontario. Our assessment was based on computational modelling, simulation and analysis of wind conditions for the proposed development design, in conjunction with the local wind climate data and the RWDI wind criteria for pedestrian comfort and safety. Our findings are summarized as follows:

- Wind conditions on most of the existing site and adjacent properties are adequate for pedestrian use. Localized areas with higher wind speeds exist to the west of the site due the influence of the local topography.
- With the addition of the proposed buildings, wind conditions on most locations on the site are expected to be suitable for sidewalks and walkways. No locations with uncomfortable wind conditions are anticipated at grade level in the summer, while only one area between towers A1 and A2 is predicted to exceed the comfort threshold during the fall season.
- In the winter and spring, wind speeds across the site are generally higher due to the seasonal wind climate. Areas with uncomfortable wind conditions are predicted during the winter between towers A1 and A2, near the northeast corner of Tower C1, between buildings F1 and F2, and at localized zones near some exposed building corners. In the spring, additional locations with uncomfortable wind conditions are predicted between Tower A2 and the podium of Tower B1, and between Towers B1 and C1.
- The wind safety criterion (annual) may potentially be exceeded between Towers A1 and A2, between Towers B1 and C1, and near the northeast corner of Tower C1.
- Most areas on the podium rooftops and on the roofs of the 4 to 6-storey buildings on the south side of the site are expected to be too windy for passive use during the summer, especially near the edges of the terraces.
- Conceptual wind control measures are presented for both grade level and the building terraces in order to improve the wind conditions to appropriate levels. If desired, wind tunnel testing can be conducted to further quantify these wind conditions and to refine any wind control solutions.

RWDI can help guide the placement of wind control features, including landscaping, to achieve appropriate levels of wind comfort based on the programming of the various outdoor spaces.

6. DESIGN ASSUMPTIONS

The findings/recommendations in this report are based on the building geometry and architectural drawings communicated to RWDI on January 5 of 2022, listed below. Should the details of the proposed design and/or geometry of the building change significantly, results may vary.

File Name	File Type	Date Received (mm/dd/yyyy)
1811 - Stillwater Master Plan & views 22.01.03	.PDF	01/05/2023
1811-site-20230102	.SKP	01/05/2023

Changes to the Design or Environment

It should be noted that wind comfort is subjective and can be sensitive to changes in building design and operation that are possible during the life of a building. These could be, for example: outdoor programming, operation of doors, elevators, and shafts pressurizing the tower, changes in furniture layout, etc.. In the event of changes to the design, construction, or operation of the building in the future, RWDI could provide an assessment of their impact on the discussions included in this report. It is the responsibility of Others to contact RWDI to initiate this process.

7. STATEMENT OF LIMITATIONS

This report was prepared by Rowan Williams Davies & Irwin Inc. for The Properties Group Management Ltd. ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein and authorized scope. The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

8. 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.