



143 COLUMBIA STREET WEST

WATERLOO, ON

PEDESTRIAN WIND ASSESSMENT

PROJECT #2100367

NOVEMBER 3, 2021

SUBMITTED TO

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1. INTRODUCTION



Rowan Williams Davies & Irwin Inc. (RWDI) was retained to conduct a qualitative assessment of the pedestrian wind conditions expected around a proposed development at 143 Columbia Street West in Waterloo, Ontario. This effort is intended to inform good design and has been conducted in support of the Site Plan Control Application for the project.

The proposed project is located on the south side of Columbia Street West between Phillips Street and Lester Street (Images 1). The site is occupied by low-rise residential buildings and surrounded by tall, existing and future buildings to the west, south and northeast directions and by low and mid-rise buildings in other directions.

The proposed project consists of three 25-storey residential buildings, as shown in Images 2 and 3. They have rectangular floor plans with low podiums. Key pedestrian areas on and around the site include building entrances, amenity areas, parking spaces on the property and public sidewalks.



Image 1: Aerial View of the Existing Site and Surroundings

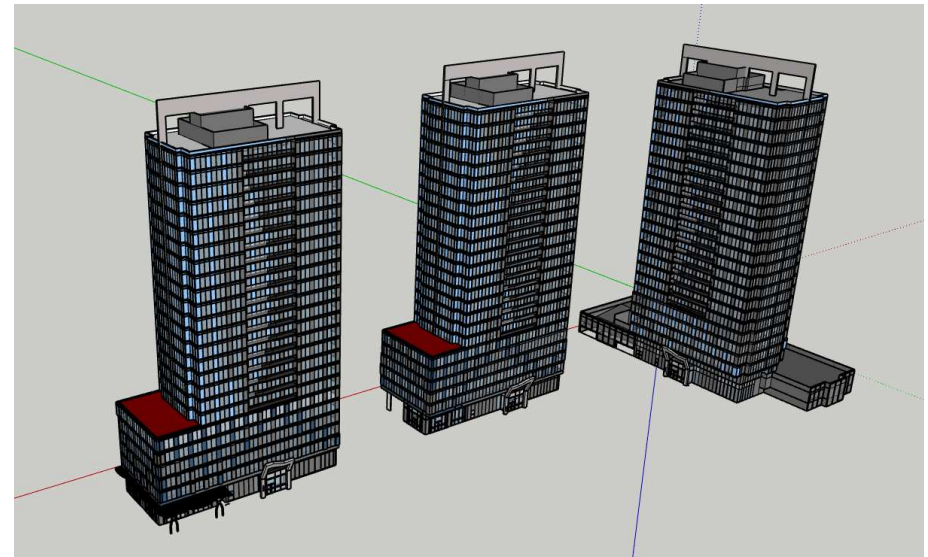


Image 2: Project Rendering – View from Northwest

1. INTRODUCTION

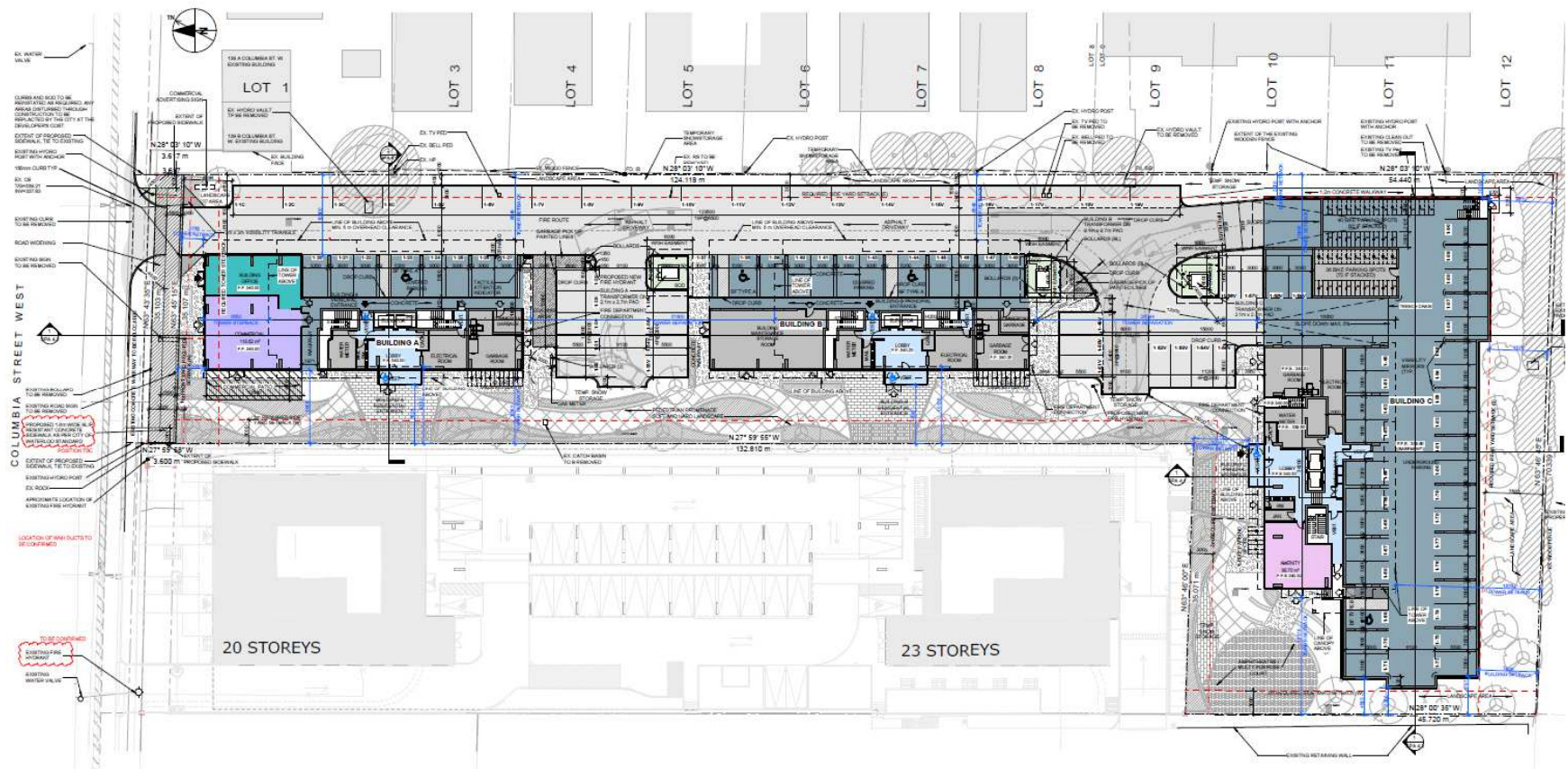


Image 3: Project Site Plan

2. METHODOLOGY



Predicting wind speeds and occurrence frequencies is complex. It involves the combined assessment of building geometry, orientation, position and height of surrounding buildings, upstream terrain and the local wind climate.

Over the years, RWDI has conducted thousands of wind-tunnel model studies on pedestrian wind conditions around buildings, yielding a broad knowledge base. In some situations, this knowledge and experience, together with literature, allow for a reliable, consistent and efficient desktop estimation of pedestrian wind conditions without wind-tunnel testing. This approach provides a screening-level estimation of potential wind conditions and offers conceptual wind control measures for improved wind comfort, where necessary.

In order to quantify and confirm the predicted conditions or refine any of the suggested conceptual wind control measures, physical scale model tests in a boundary-layer wind tunnel would be required.

RWDI's assessment is based on the following:

- Architectural and landscaping drawings received by RWDI on October 15 and 28, and November 2, 2021;
- A review of the regional long-term meteorological data recorded at Waterloo-Wellington International Airport;
- Use of RWDI's proprietary software (*WindEstimator*¹) for providing a screening-level numerical estimation of potential wind conditions around generalized building forms;
- Wind-tunnel studies and desktop assessments undertaken by RWDI for projects in the Waterloo area;
- RWDI's engineering judgement and knowledge of wind flows around buildings^{2,3}; and,
- RWDI Criteria for pedestrian wind comfort and safety.

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

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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.

3. METEOROLOGICAL DATA



Meteorological data from Waterloo-Wellington International Airport recorded from 1991 to 2020 were used as reference for wind conditions. This is the nearest station to the project site with long-term reliable wind data.

The distributions of wind frequency and directionality for the summer (May through October) and winter (November through April) seasons are shown by the wind roses in Image 3.

When all winds are considered (regardless of speeds), winds from the south-southwest through northwest and the east directions are predominant during both summer and winter.

Strong winds of a mean speed greater than 30 km/h (red and yellow bands in Image 3) measured at the airport at an anemometer height of 10 m occur more often in the winter than in the summer. They are from the southwest through west-northwest and east directions.

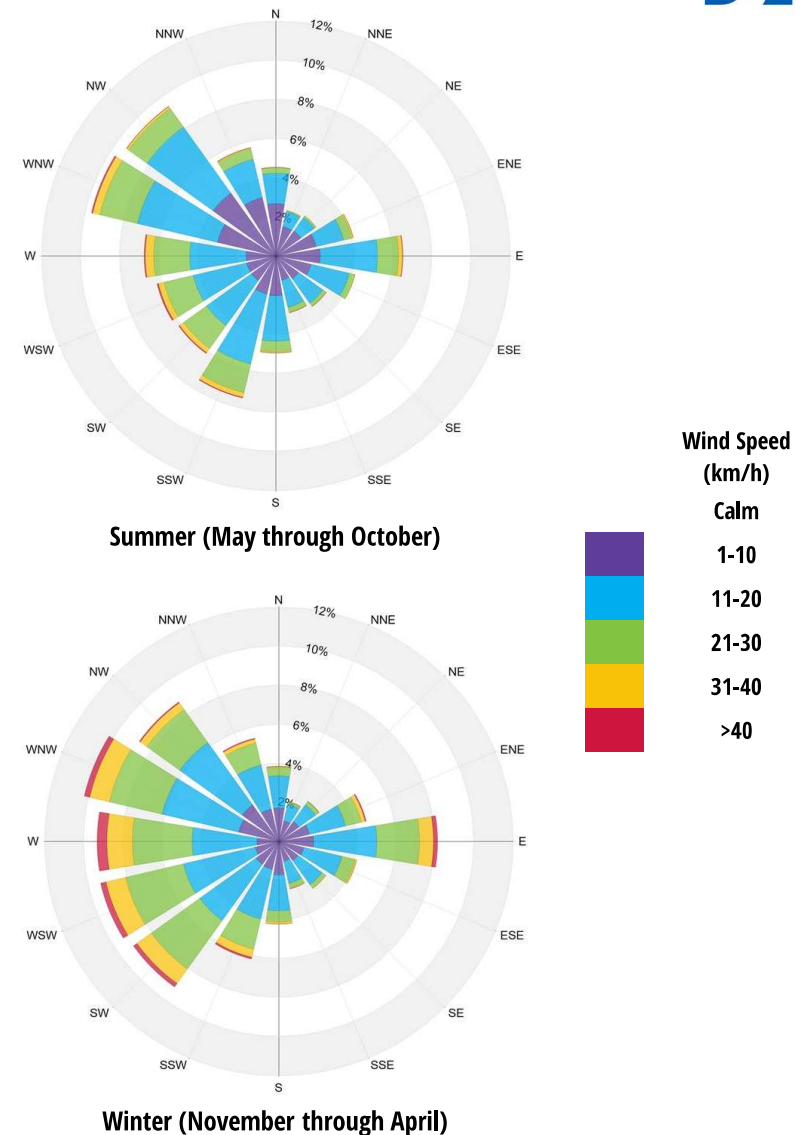


Image 3: Directional Distribution of Winds Approaching Waterloo-Wellington International Airport (1991 – 2020)

4. WIND CRITERIA



The RWDI pedestrian wind criteria are used in the current study. These criteria have been developed by RWDI through research and consulting practice since 1974. They have also been widely accepted by municipal authorities, building designers and the city planning community including the City of Waterloo. The criteria are as follows:

4.1 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.

4.2 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 (≤ 14 km/h): Gentle breezes suitable for main building entrances and bus stops.

Strolling (≤ 17 km/h): Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park.

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

Uncomfortable: The comfort category for walking is not met.

Wind conditions are considered suitable for sitting, standing, strolling 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., 1.5 m above grade or the concerned floor level), typically lower than those recorded in the airport (10 m 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 or strolling are appropriate for sidewalks; lower wind speeds comfortable for standing are required for main entrances where pedestrians may linger, and calm wind speeds suitable for sitting are desired in areas where passive activities are anticipated, such as outdoor amenity areas, during the summer season when these spaces are typically in use.

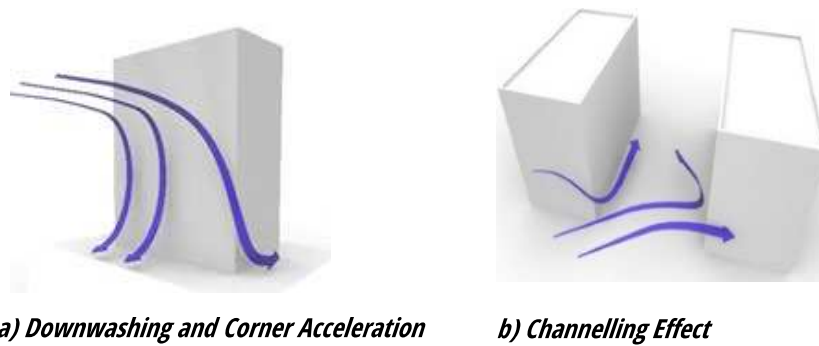
5. RESULTS AND DISCUSSION



5.1 Wind Flow Around Buildings

Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level (Downwashing, Image 5a). These winds subsequently move around exposed building corners (Image 5a) and through the space between two buildings (Image 5b), causing a localized increase in wind activity. If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable conditions.

Design details such as stepped massing, tower setback from a podium edge, chamfered corners, deep canopies close to ground level, wind screens / tall trees etc. (Image 6) can help reduce wind speeds. The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings.



a) Downwashing and Corner Acceleration

b) Channelling Effect

Image 5: Generalized Wind Flows

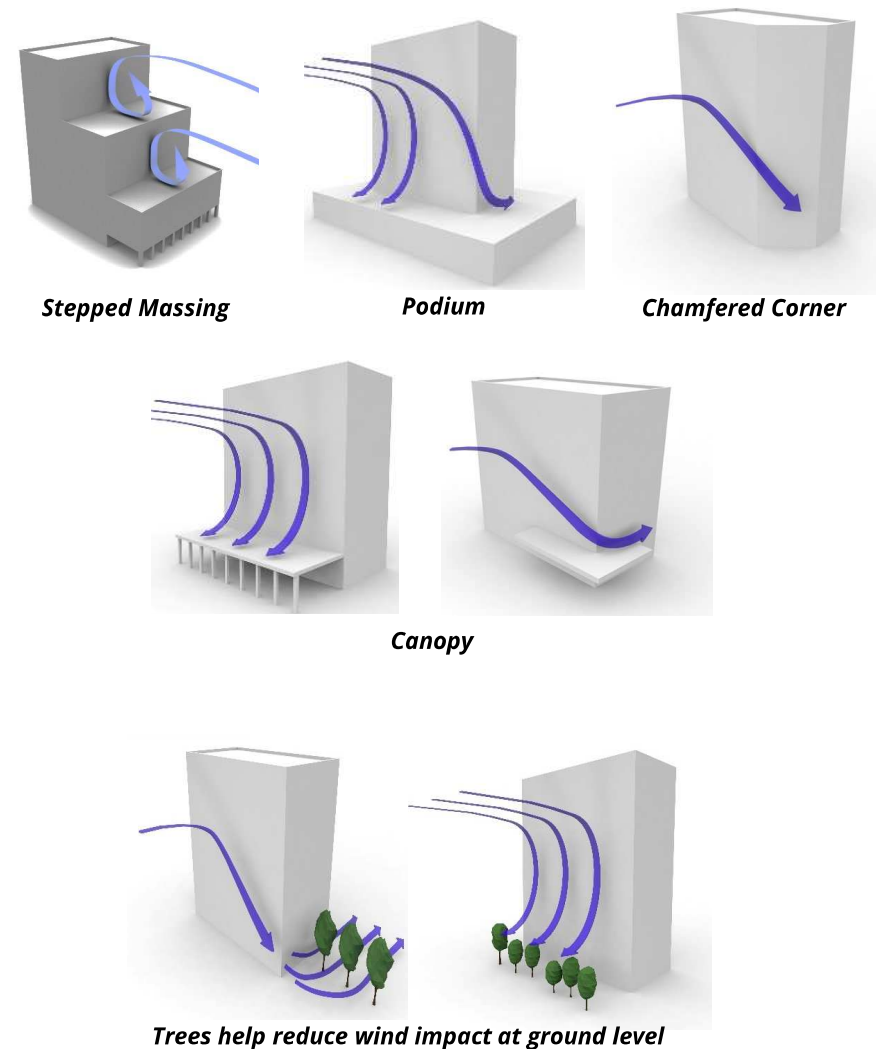


Image 6: Examples of Common Wind Control Measures

5. RESULTS AND DISCUSSION



5.2 Existing Scenario

The prevailing westerly wind approaching the project site is preconditioned by the surroundings. To the immediate west of the site, there are two tall buildings under construction, and they will be 15 and 20 storeys, as indicated in Image 3. There are also two existing towers along Phillips Street (Image 1). These tall buildings, together with other institutional and commercial buildings to the west, provide sheltering for the current development site from the westerly winds.

The existing buildings on the site are low-rise. As such, there are no significant structures that would deflect ambient winds to ground to cause adverse wind impacts on the site. Currently, wind conditions on sidewalks along adjacent streets around the site are comfortable for sitting or standing in the summer and for strolling or walking in the winter.

Wind conditions exceeding the safety criterion are not expected.

5.3 Proposed Scenario: Safety

The wind safety criterion is predicted to be met in ground-level areas on and around the development. This is due to the sheltering offered by the tall existing and under-construction buildings to the west, as discussed above. In addition, the proposed Buildings A and B have large setbacks at the 7th floor and Building C has a large, 3-storey podium (Image 2), which will reduce the direct impact of downwashing flows off the towers.

5.4 Proposed Scenario: Comfort

The following sections provide a discussion of the potential wind comfort conditions around the project. The expected wind conditions are shown in Images 7a and 7b for the summer and winter seasons, respectively.

5.4.1 Main Entrances

The main entrances to the proposed buildings are identified as A1, A2 and A3 in Image 7. The proposed vestibule at each entrance is beneficial from a wind perspective, as it serves as a sheltered waiting area for the patrons on particularly windy or cold days. Wind conditions at the entrances are expected to be comfortable for sitting or standing in the summer (Image 7a). During the winter season, due to seasonally stronger winds, wind conditions around these entrances are expected to be comfortable for strolling or walking. These conditions are not ideal for entrance areas where pedestrians are expected to be lingering for a period of time. Wind mitigation measures can help to improve these conditions if desired. Specific wind mitigation options can be discussed with the design team.

5. RESULTS AND DISCUSSION

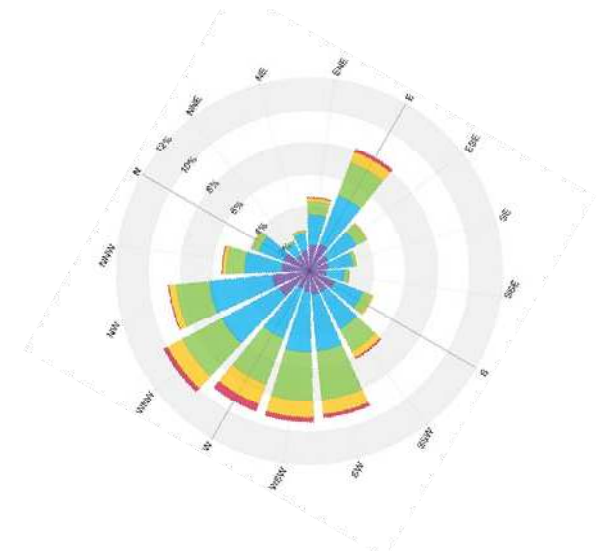
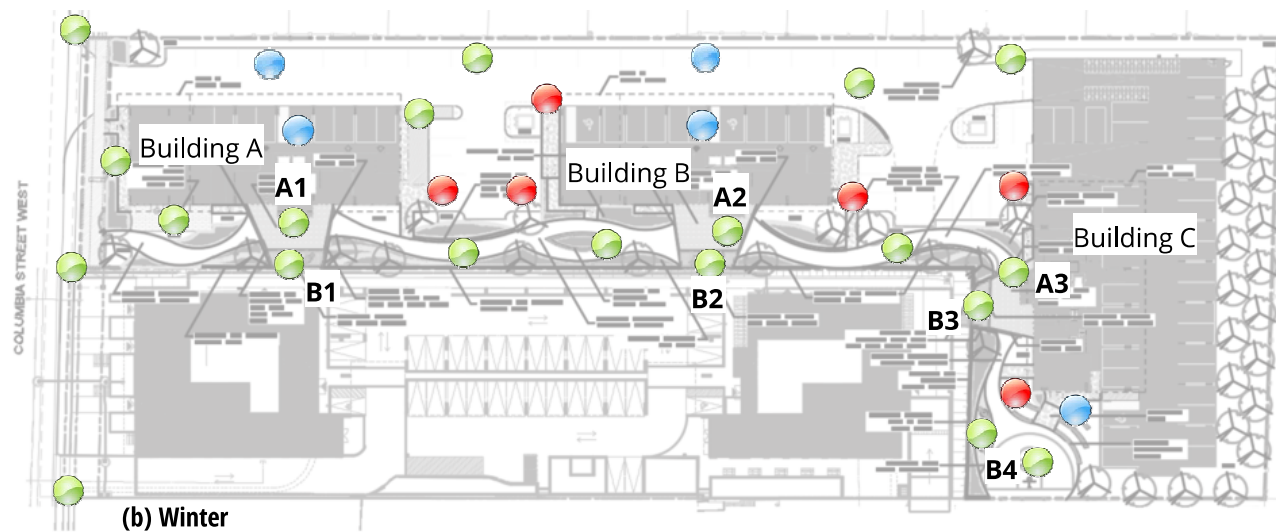
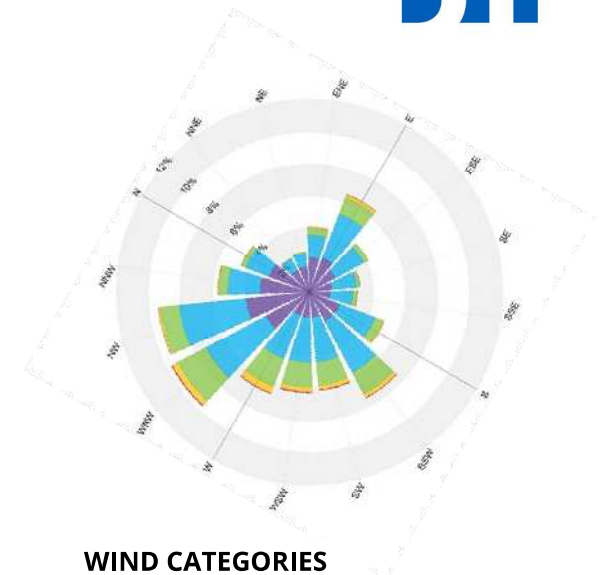
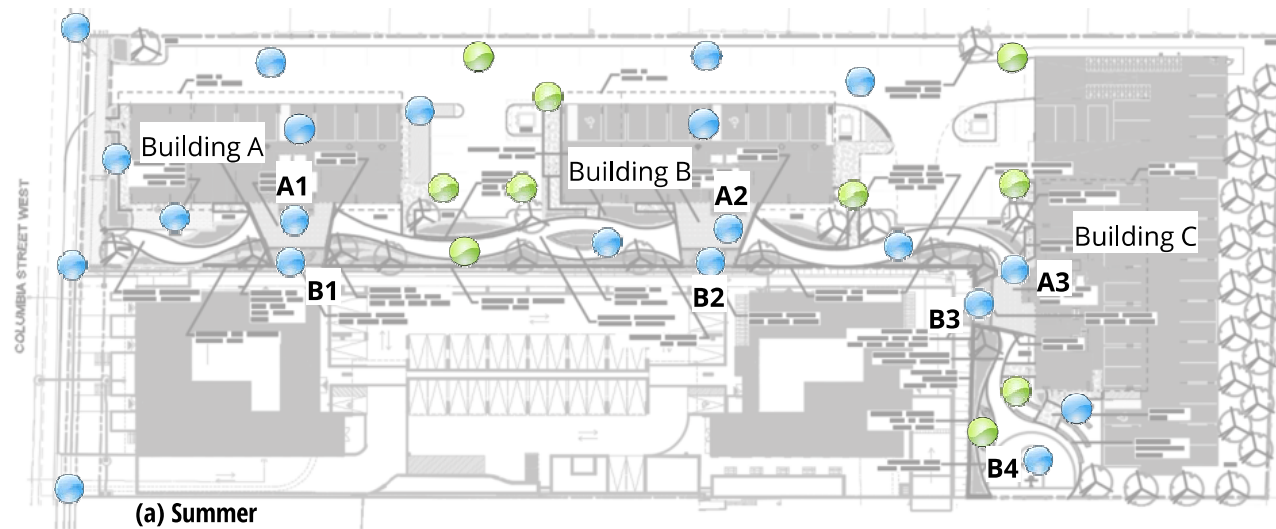


Image 7: Predicted Wind Comfort Conditions in (a) Summer (upper) and (b) Winter (lower)

5. RESULTS AND DISCUSSION



5.4 Proposed Scenario: Comfort

5.4.2 Amenity Areas

The landscaping plan received on October 15, 2021 shows benches and a half basketball court (Locations B1 through B4 in Image 7). With the proposed landscaping in place, suitable wind conditions comfortable for sitting or standing are generally expected for these areas during the summer (Image 7a). Higher wind speeds in the winter (Image 7b) are not an issue for these areas due to reduced outdoor usage in cold months.

5.4.3 Sidewalks

The wind effect of the project on surrounding areas is expected to be moderate as discussed in Sections 5.2 and 5.3. Wind conditions on the surrounding sidewalks along Phillips Street and Lester Street will not be negatively affected by the proposed development due to their separations from the new buildings. Slightly increased wind speeds may occur immediately north of Building A on the sidewalks along Columbia Street West, but the resultant wind conditions are anticipated to still be comfortable for sitting or standing in the summer and for strolling or walking in the winter, appropriate for sidewalks.

The project is not expected to influence wind conditions in the extended surroundings.

5.4.4 Parking Spaces and Walkways

Users of parking spaces and walkways are typically active, not staying in one area for prolonged periods of time. Therefore, high wind speeds comfortable for strolling or walking are acceptable. This criterion is expected to be met at most areas around the project.

The parking spaces underneath Buildings A and B are well protected from the prevailing westerly winds and, hence, low wind speeds are expected. However, outdoor parking spaces between the proposed towers will be affected by the prevailing winds being channelled through these areas, resulting in uncomfortable wind conditions in the winter, especially around exposed building corners (Image 7b). Wind mitigation measures can help to improve these conditions if desired. Specific wind mitigation options can be discussed with the design team.

6. SUMMARY



RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed project at 143 Columbia Street West, Waterloo, Ontario. Our assessment was based on the local wind climate, the current design of the proposed development, the existing surrounding buildings, our experience with wind tunnel testing of similar buildings, and screening-level modelling of wind flows around buildings.

Our findings are summarized as follows:

- Due to the presence of tall buildings in the surroundings, especially to the west of development site, wind approaching the site is preconditioned.
- Although the proposed buildings are relatively tall, the existing tall surrounding and the inclusion of podiums and stepped massing will reduce the potential wind impacts on pedestrian areas at grade. The project is not expected to affect wind conditions in the extended surroundings.
- Wind conditions at grade on and around the proposed project are not expected to exceed the recommended criteria for pedestrian safety.
- In general, wind conditions on sidewalks and other public/common areas on and around the project are expected to be comfortable for the intended use.

- Suitable wind conditions are also expected around the main entrances and ground level amenity areas during the summer.
- Higher wind speeds are expected in the winter, including the potential uncomfortable wind conditions in the parking area around exposed tower corners and between the proposed towers.
- Conceptual wind control can be reviewed with the design team if reduced wind speeds are desired at any areas.

7. APPLICABILITY OF RESULTS



The assessment presented in this report are for the proposed project based on the information listed below. 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)
2021-61 143 Columbia - L1 (For Coordination)	dwg	10/15/2021
143 Columbia_Design Model FINAL	skp	11/02/2021
143 Columbia_Site Plan	pdf	10/28/2021