REPORT

BRANT & GHENT MASTERPLAN

BURLINGTON, ON

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT #2004219
October 31, 2022

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 Brant and Ghent Masterplan in Burlington, Ontario. The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development.

The project site is located at the intersection of Brant Street and Ghent Avenue (**Image 1**). It is currently occupied by low-rise buildings, a parking lot and a vacant land. The surrounding buildings are typically low in all directions, except three relatively tall buildings along Ghent Avenue to the southwest. Tall buildings also exist to the distant southeast and south near Lake Ontario.

The project is a mixed-use development that will consist of three parcels (**Image 2**).

- **Parcel A** consists of 25-storey Tower A and 18-storey Tower B sitting atop a 5-storey stepped podium.
- **Parcel B** consists of a 25-storey tower sitting atop a 7-storey stepped podium.
- **Parcel C** is a 9-storey building with a stepped massing form.

In addition to sidewalks and properties near the project site, key areas of interest for this assessment include the main entrances to the buildings, park areas south of Parcel A and East of Parcel (**Image 3**).



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

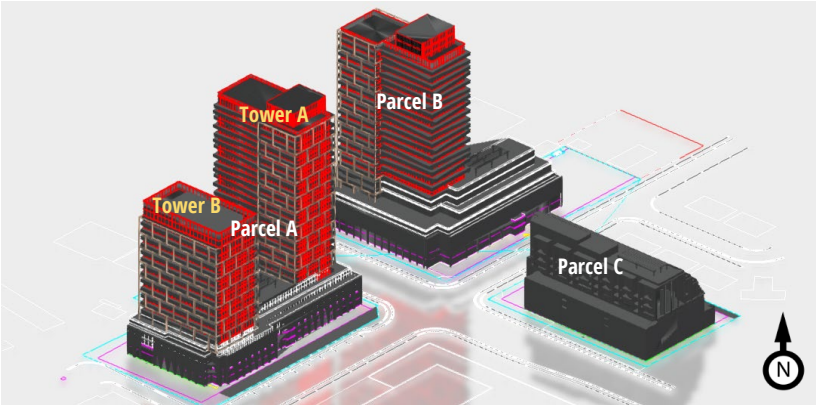
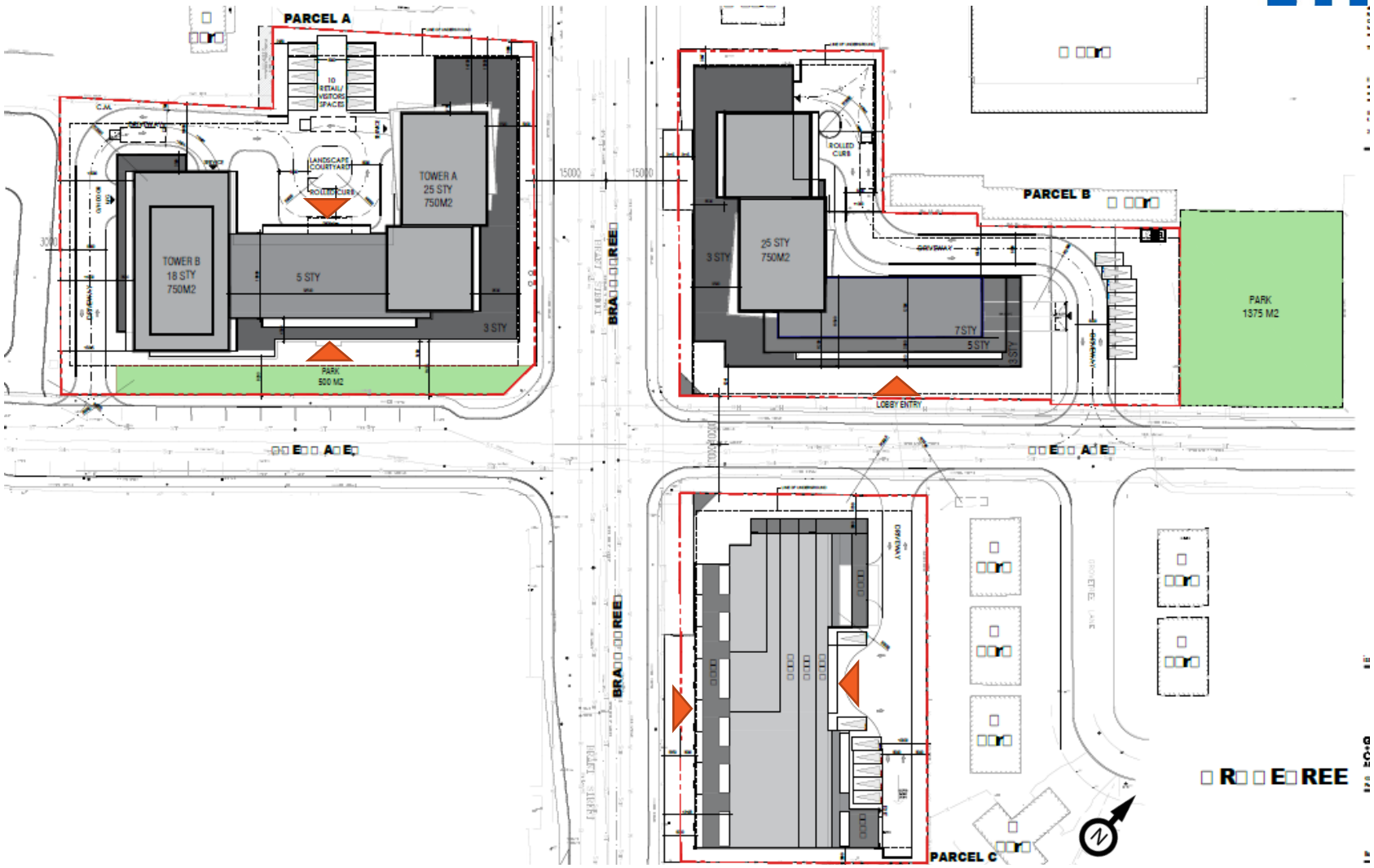


Image 2: Conceptual massing/rendering of the proposed project

1. INTRODUCTION



RESIDENTIAL ENTRANCE

Image 3: Roof plans identifying building entrances and key outdoor areas of interest

2. METHODOLOGY

2.1 Objective

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

- A review of the regional long-term meteorological data from Hamilton International Airport;
- Floor plans of the proposed project received on September 13, 2022, and the 3D e-model received on October 05, 2022;
- 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 wind-related issues such as 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 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 is 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, a more detailed assessment would be required using either a boundary-layer wind tunnel or transient computational modelling.

2. METHODOLOGY

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 winds 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 approximately 1.5m above concerned levels, to the mean wind speed at a reference height. The data was then combined with meteorological records obtained from Hamilton International Airport to determine the wind speeds and frequencies in the simulated areas.

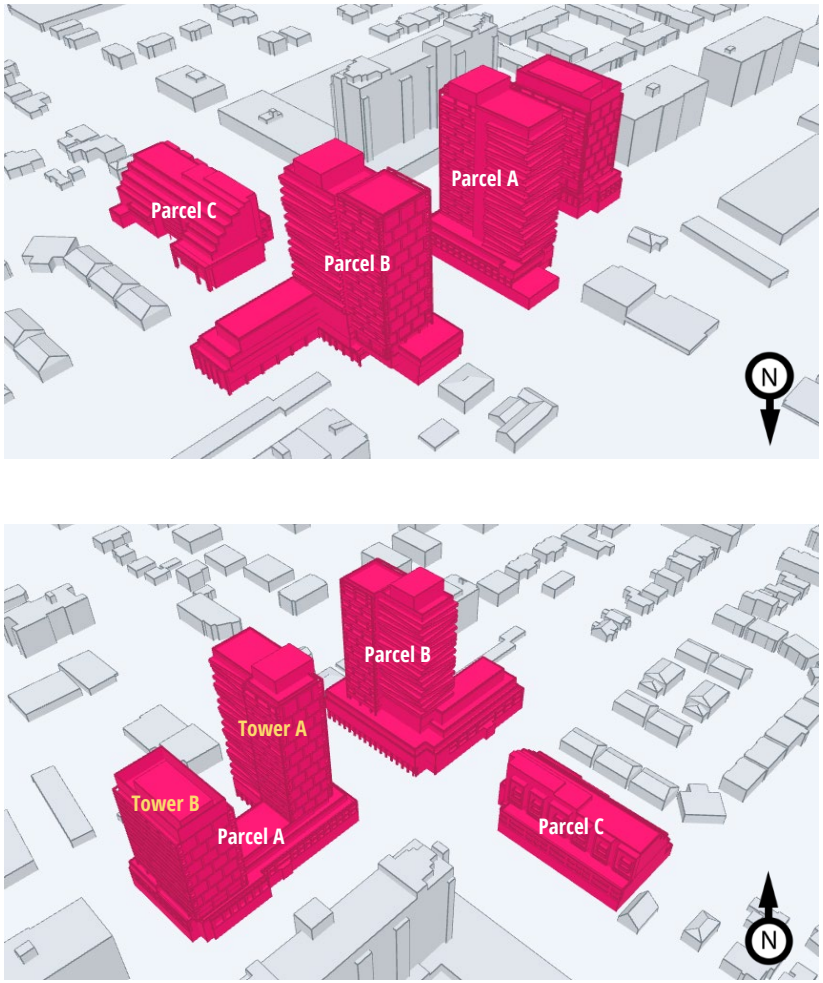


Image 4: Computer model of the proposed project

2. METHODOLOGY

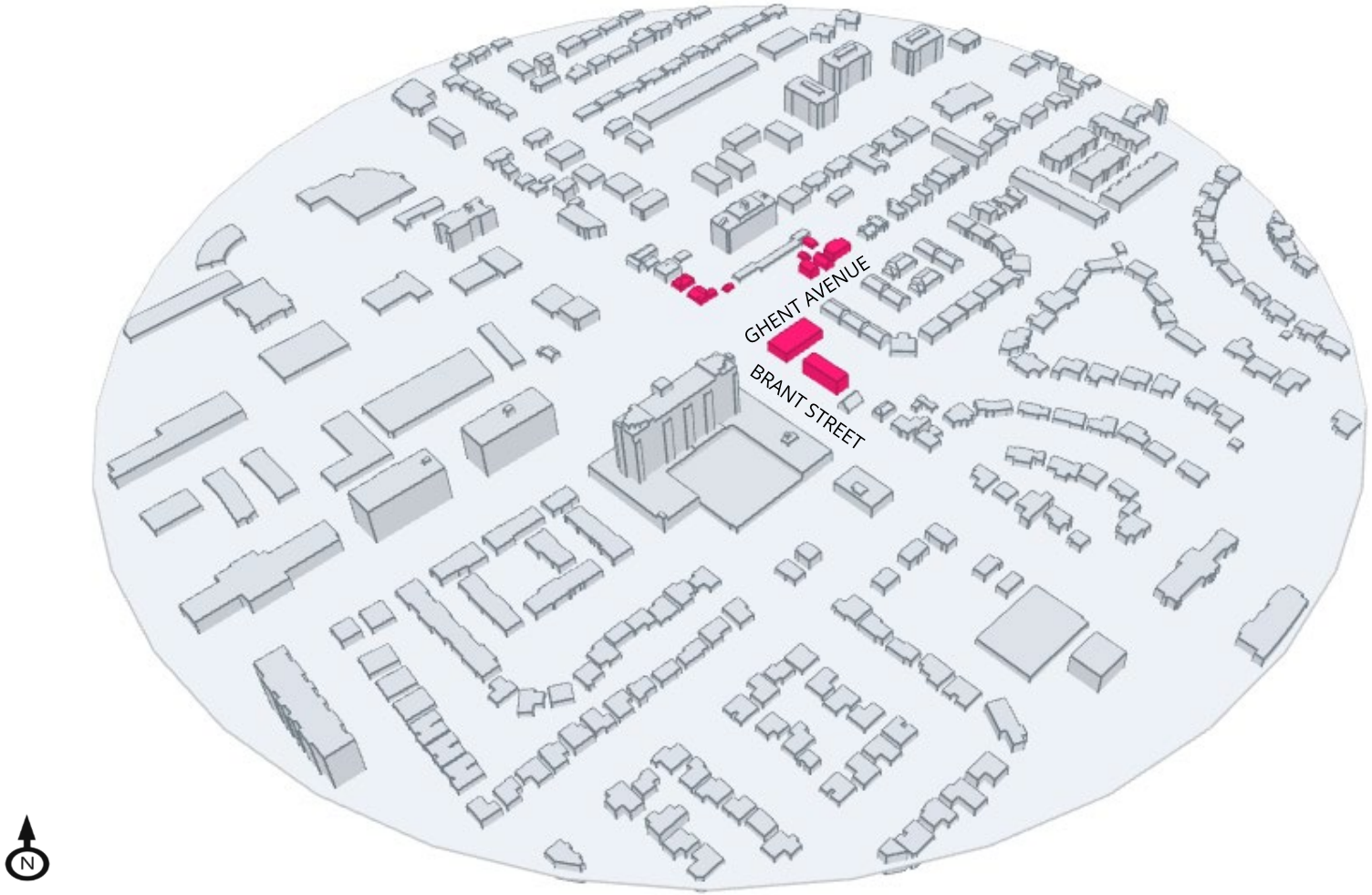


Image 5a: Computer model of the existing site and extended surroundings

2. METHODOLOGY

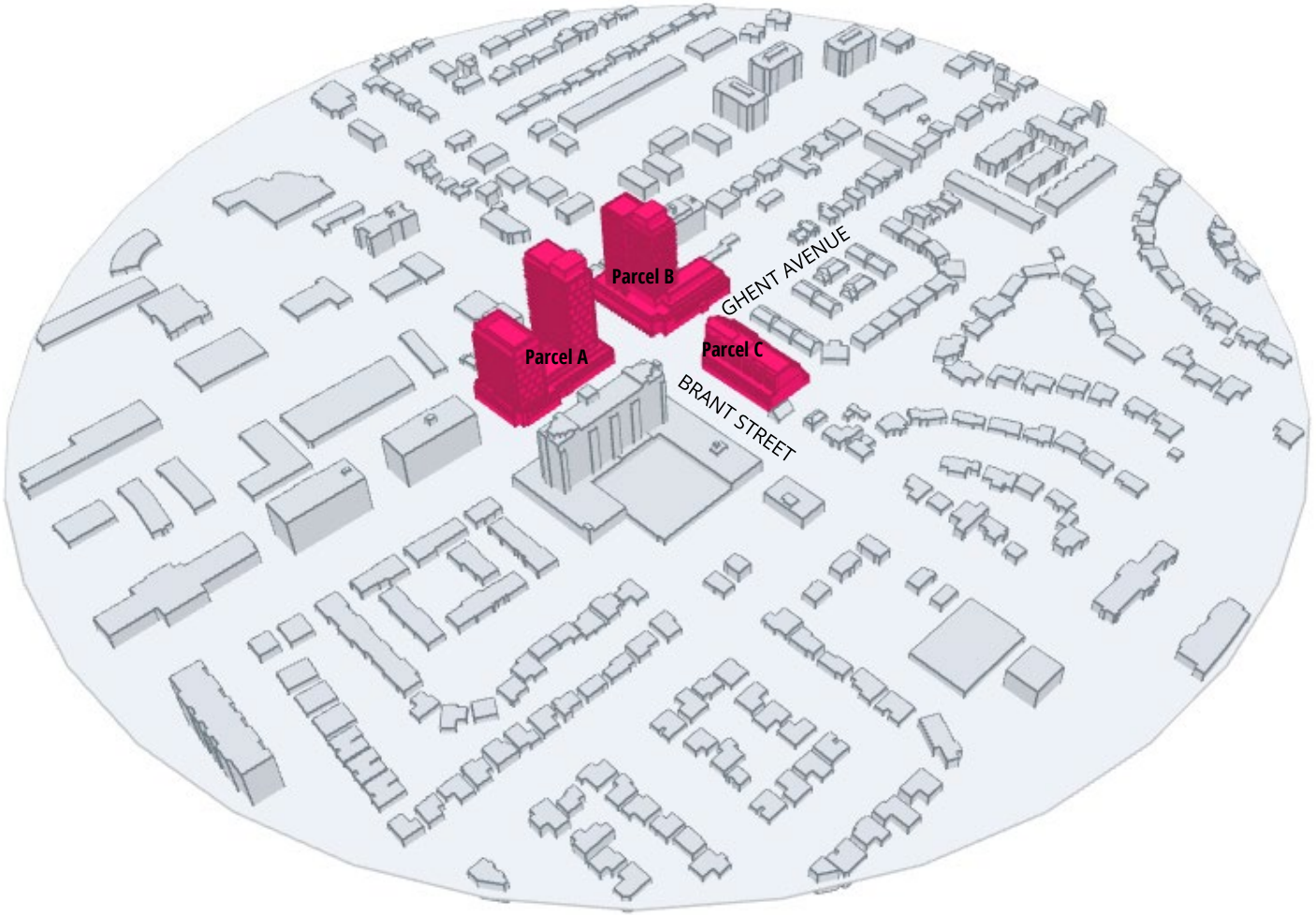


Image 5b: Computer model of the proposed project and extended surroundings

2. METHODOLOGY

Long-term wind data recorded at Hamilton 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.

When all winds are considered (regardless of speeds), winds are frequent from the southwest and northeast quadrants for both seasons, 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 more frequent in the winter than in the summer (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 RWDI wind criteria for pedestrian comfort.

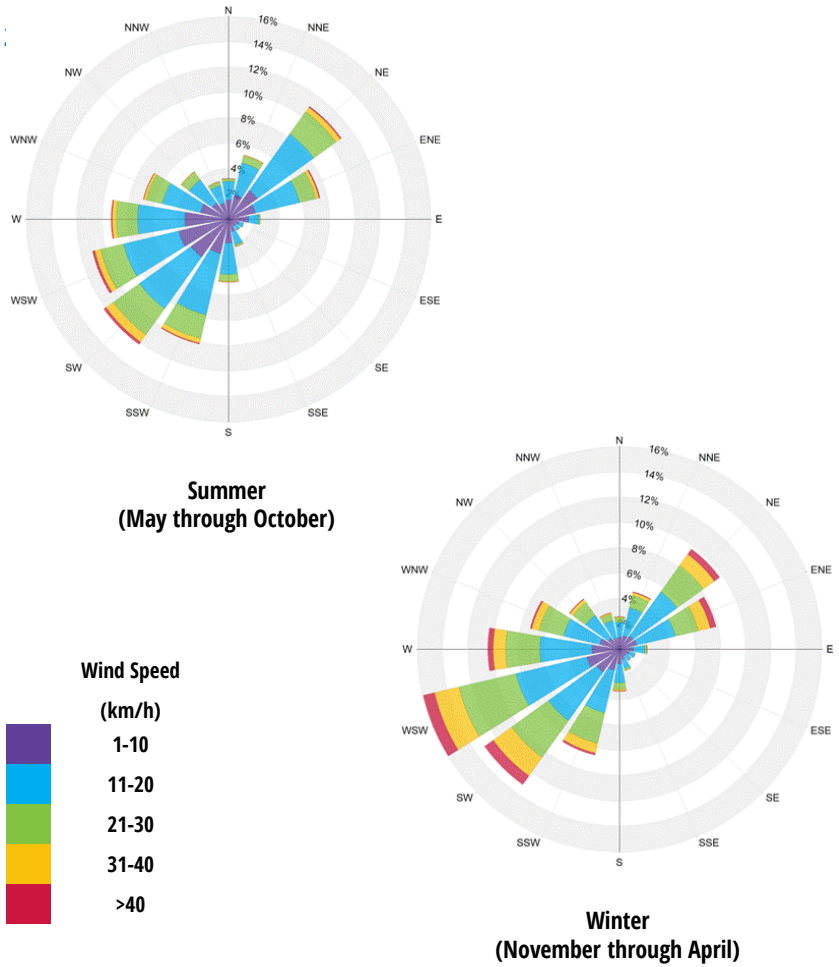


Image 6: Directional distribution of wind approaching Hamilton International Airport (1990 to 2020)

3. WIND CRITERIA

The Burlington pedestrian wind criteria, developed in March 2020, are specified in the Guidelines and Terms of Reference, "Pedestrian Level Wind Study". The table to the right defines the criteria for both wind comfort and safety.

These criteria for wind forces represent average wind tolerance. They are sometimes subjective as 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.

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).

For the current development, wind speeds comfortable for fast walking or leisurely walking are appropriate for sidewalks and walkways; 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 the above-grade terraces, especially during the summer when these areas are typically in use.

Comfort Category	GEM Speed (km/h)	Description
Sitting	≤ 10	Calm or light breezes • Appropriate for dedicated seating areas such as cafes, patios, and outdoor amenity areas
Standing	≤ 14	Gentle breezes • Appropriate for main building entrances, bus stops, and other places where pedestrians may linger
Leisurely Walking	≤ 17	Moderate winds • Appropriate for shopping and strolling along retail streets and parks
Fast Walking	≤ 20	Relative higher speed winds • Appropriate for areas where pedestrians are walking, running, or cycling without lingering
Uncomfortable	> 20	Strong winds • Inappropriate due to nuisance for all pedestrian activities • Wind mitigation measures required

Notes:

(1) GEM is defined as the maximum mean wind speed or gust speed divided by 1.85 (whichever is larger). Gust speed can be directly measured in a wind tunnel or represented by mean wind speed + 3*RMS (Root Mean Square) wind speed.

(2) GEM speeds listed above are based on a seasonal exceedance of 20% of the time between 06:00 and 23:00. The criterion has been met if the wind speeds occur at least four out of five days.

Safety Criterion	Gust Speed (km/h)	Description
Exceeded	> 90	• Excessive gust speeds • Adverse effect on pedestrian's balance and footing • Wind mitigation is required

Notes:

(1) Based on an annual exceedance of 9 hours or 0.1% of the time for 24 hours a day.

(2) Gust speed can be directly measured in a wind tunnel or represented by mean wind speed + 3*RMS wind speed.

4. RESULTS AND DISCUSSION

4.1 Presentation of Results

The results of the assessment are presented and discussed in detail in Sections 4.3 through 4.5. The graphical presentation is in the form of colour contours of wind speeds calculated based on the wind comfort criteria (Section 3), approximately 1.5 m above the concerned level. The assessment against the safety criterion (Section 3) 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 **Image 8d**. A detailed discussion of the expected wind conditions with respect to the prescribed criteria and applicability of the results follows in Sections 4.3 through 4.5. The discussion includes recommendations for wind control to reduce the potential for high wind speeds for the design team's consideration.

Target Conditions

For the current development, wind speeds comfortable for leisurely walking or fast walking 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 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*. Winds can also accelerate through the narrow gap between buildings, due to the *Channelling* Effect. 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 project will be taller than most of the buildings that exist in the immediate surrounding area. Thus, it is expected to redirect winds to the ground. However, the potential wind impacts would be moderated by the stepped podium structures of Parcel A and Parcel B and the stepped massing of Parcel C.

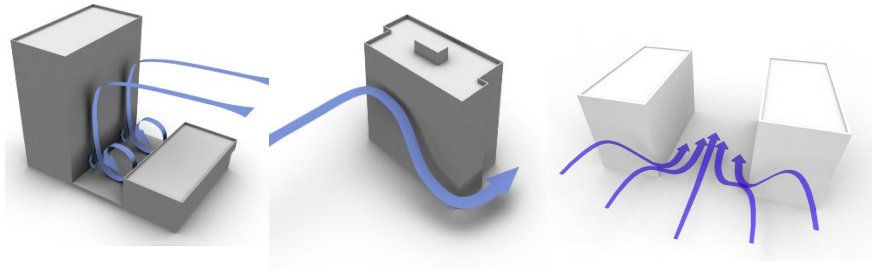


Image 7: General wind flow patterns

4.3 Existing Scenario

The existing site is currently occupied by low-rise buildings and surrounded by similar or taller buildings in all directions. As such, wind conditions on the sidewalks around the site are considered comfortable for standing in the summer (blue regions in **Image 8a**) and for leisurely walking in the winter (green regions in **Image 8b**).

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

4.4 Proposed Scenario: Grade Level

4.4.1 Sidewalks and Neighbouring Properties

With the proposed project in place, wind speeds along the immediate and nearby sidewalks/walkways are expected to be comfortable for standing or leisurely walking in the summer (**Images 8c**). These conditions are appropriate for sidewalk use. During the winter, wind speeds comfortable for leisurely/fast walking are anticipated at most areas along the sidewalks and walkways which is suitable (**Image 8d**). Localized areas with uncomfortable wind conditions are expected at the southwest corner of Parcel A and the northeast and southwest corners of Parcel B, which are caused by the winds channelling between the buildings and accelerating around the corners (**Image 8d**). The pedestrian wind safety criterion may also be exceeded at these corner areas, primarily due to the winter winds (**Image 8d**).

4.4.2 Main Entrances

Wind conditions at all main entrances are shown to be comfortable for sitting or standing in the summer (**Image 8c**). Due to seasonally stronger winds, higher wind speeds are anticipated in the winter, with conditions remaining suitable for sitting or standing near the north entrance of Parcel A and the entrances to Parcel C. Wind speeds comfortable for leisurely/fast walking, are expected at the south entrance of Parcel A and the entrance of Parcel B (**Image 8d**).

4.4.3 Park Areas at Ground Level

Wind conditions in the proposed park areas near Parcels A and B (see **image 3**) are anticipated to be comfortable for sitting or standing in the summer, which is considered appropriate (**Image 8c**). Wind conditions comfortable for standing or leisurely walking are anticipated in the park areas in the winter (**Image 8d**).

4.5 Recommendations

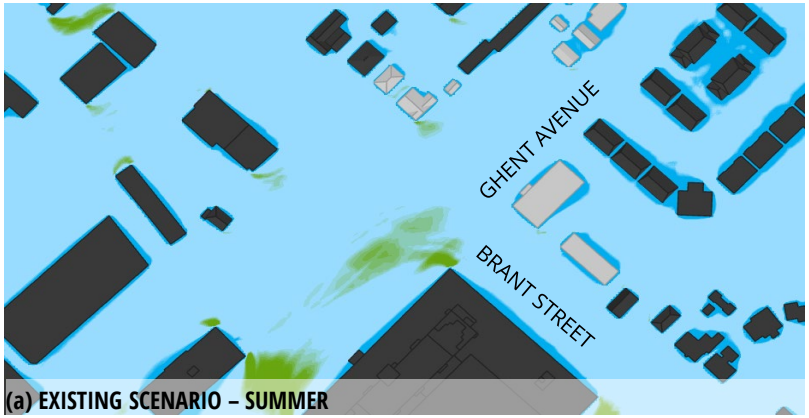
4.5.1 Grade Level

We encourage the design team to consider vertical wind control features in the form of landscaping, screens and porous art features near the corners where uncomfortable wind conditions are anticipated in the winter. Note that landscaping features are only effective when they are in full foliage. Thus, to extend the wind benefits of landscaping to the winter, coniferous/marcescent species should be considered in certain areas.

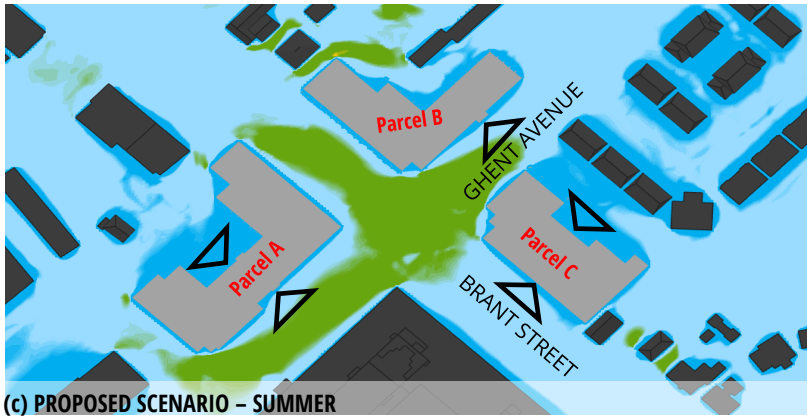
To resolve the elevated wind speeds near the south entrance of Parcel A and the main entrance of Parcel B, recessing entrances behind their respective facades or installing screens on both sides of the doors is recommended.

Examples of the use of wind control measures applicable to the ground level are shown in **Image 9**.

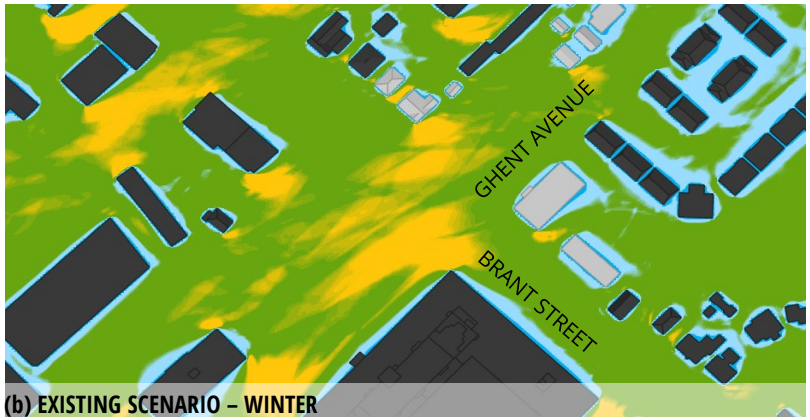
4. RESULTS AND DISCUSSION



(a) EXISTING SCENARIO – SUMMER



(c) PROPOSED SCENARIO – SUMMER



(b) EXISTING SCENARIO – WINTER



(d) PROPOSED SCENARIO – WINTER

COMFORT: SITTING | STANDING | LEISURELY WALKING | FAST WALKING | UNCOMFORTABLE

SAFETY: Areas where the safety criterion may be exceeded.

RESIDENTIAL ENTRANCE

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Image 8: Predicted wind conditions – GROUND LEVEL
RWDI Project #2004219
October 31, 2022

4. RESULTS AND DISCUSSION



Image 9: Design strategies for wind control at grade level

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed Brant & Ghent Masterplan in Burlington, 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 and around the existing site are suitable for the intended pedestrian use throughout the year and meet the pedestrian safety criterion.
- The proposed development will be taller than most of the buildings that exist in the immediate surrounding area, causing the redirecting of winds to the ground level. The stepped podium structures of Parcel A and B and the stepped massing of Parcel C are positive design aspects and will help moderate the wind impact of the project.
- Wind conditions near the main entrances and the ground-level parks are expected to be appropriate for the intended usage throughout the year. Exceptions are the south entrance of Parcel A and the main entrance of Parcel B during the winter
- Wind speeds along the immediate and nearby sidewalks/walkways are expected to be comfortable for the intended use throughout the year. Exceptions are localized areas where uncomfortable wind conditions are anticipated at the southwest corner of Parcel A and the northeast and southwest corners of Parcel B in the winter. The pedestrian wind safety criterion may also be exceeded at these corner areas during winter months.
- As the design develops, further wind studies in the form of wind tunnel testing will be conducted to further quantify the wind environment and possible mitigation around the proposed project.

6. DESIGN ASSUMPTIONS

The findings/recommendations in this report are based on the building geometry and architectural drawings communicated to RWDI in September and October 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)
1398.16x.Brant + Ghent-Current Plans	PDF	09/13/2022
1398_oct_04_001	3D Studio Max	10/05/2022

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 Molinaro Group ("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.

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.