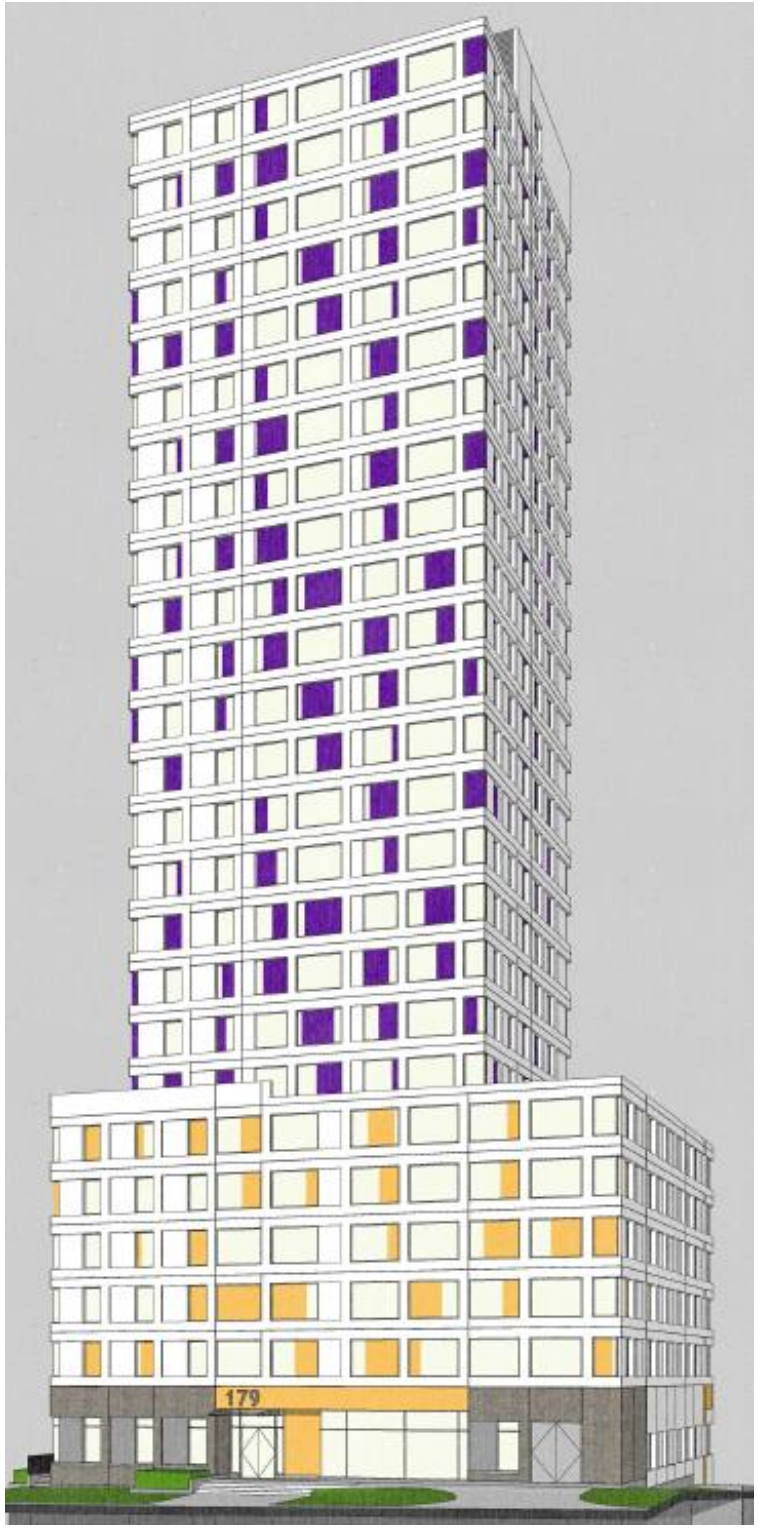
100 Stone Road West, Suite 201
Guelph, Ontario, N1G 5L3
226.706.8080 |
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Date: October 26, 2023

Re: Pedestrian Wind Assessment

177-179 Albert Street
Waterloo, Ontario

SLR Project #241.030998.00001



Credit: WalterFedy

Prepared by
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Revision	Date	Prepared by	Checked by	Approved by
0	July 5, 2023	Stefan Gopaul	Tahrana Lovlin	Tahrana Lovlin
1	July 6, 2023	Stefan Gopaul	--	--
2	October 26, 2023	Stefan Gopaul	Tahrana Lovlin	Tahrana Lovlin

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1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (SLR) was retained by 14688210 Canada Inc. to conduct a pedestrian wind assessment for the proposed development at 177-179 Albert Street in Waterloo, Ontario. This report is provided in support of the joint Official Plan Amendment (OPA) and Zoning Bylaw Amendment (ZBA) application for the development.

1.1 Existing Development

The proposed development is located at the northwest corner of Albert Street and Seagram Drive in Waterloo. The site is currently occupied by two single-family residences.

Figure 1 provides an aerial view of the immediate study area. A site visit was conducted by SLR on June 18, 2023, and a virtual site visit was conducted using Google Earth images dated August 17, 2022. Several images of the site and surroundings are included in **Figures 2a** through **2d**.

The site is immediately surrounded by mid-rise institutional buildings to the north and southeast; landscaped green space to the east; and low-rise residential buildings in all other directions. Beyond the immediate surroundings are a mix of high-rise, mid-rise and low-rise residential, commercial, and institutional buildings in all directions, as well as park space to the south and southwest.

Typically, developments under construction within a 500 m radius are included as existing surroundings on the assumption that construction will be completed prior to the proposed development. For this assessment, the in-construction developments at 240 Hemlock Street was included as part of the existing surroundings.



Figure 1: Aerial view of existing site & surroundings
Credit: Google Earth Pro, dated 8/17/2022.



Figure 2a: Looking south at the site

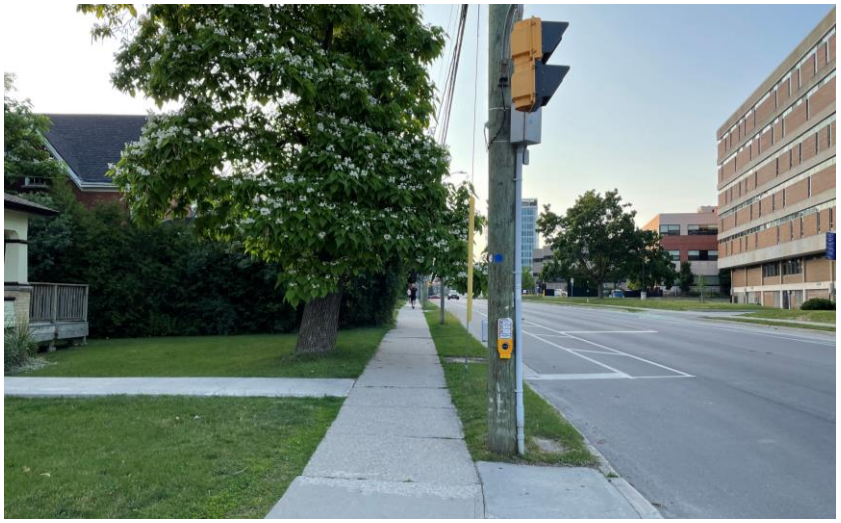


Figure 2b: Looking northwest along Albert Street



Figure 2c: Looking northeast along Seagram Drive



Figure 2d: Looking southwest along Seagram Drive

1.2 Proposed Development

The proposed development is a 25-storey building with six-storey podium (**Figure 3**) with an approximate height of 78 m, located at the northwest corner of Albert Street and Seagram Drive, in Waterloo.

1.3 Areas of Interest

Areas of interest for pedestrian wind conditions include those areas which pedestrians are expected to use on a frequent basis. Typically, these include sidewalks, main entrances, transit stops, plazas and parks.

The main entrance is situated along the east facade, with secondary entrances and/or exits located along the west, south, and east facades, as shown in **Figure 4**.

A commercial outdoor patio is located along the south facade at grade. Above grade, there is a rooftop patio at Level 7, on the podium roof.



Figure 3: Conceptual rendering of proposed development
Credit: WalterFedy

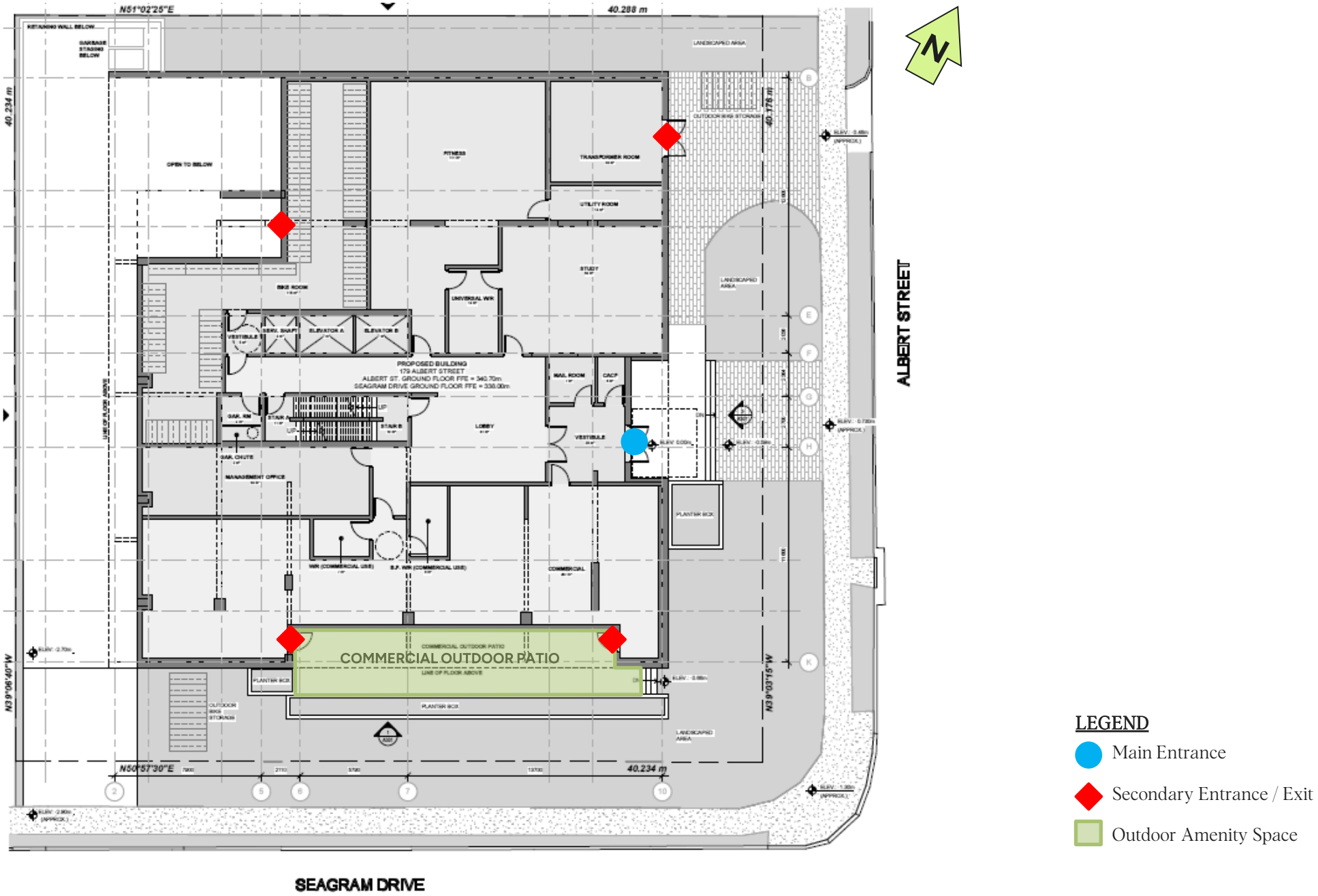


Figure 4: Areas of Interest (Grade)

2.0 APPROACH

A screening-level assessment was conducted using computational fluid dynamics (CFD). As with any simulation, there are some limitations with this modeling technique, specifically in the ability to simulate the turbulence, or gustiness, of the wind. Nonetheless, CFD analysis remains a useful tool to identify potential wind issues. This CFD-based wind speed assessment employs a comparable analysis methodology to that used in wind tunnel testing. The results of CFD modeling are also an excellent means of readily identifying relative changes in wind conditions associated with different site configurations or with alternative built forms.

2.1 Methodology

Wind comfort conditions were predicted on and around the development site to identify potentially problematic windy areas. Architectural site plan, floor plans, elevations, and a 3D model of the proposed development were provided by MHBC on May 31, 2023. Views of the 3D models used in the computer wind comfort analysis is shown in **Figure 5**. This model included surrounding buildings within 500 m from the study site centre. The simulations were performed using CFD software by Meteodyn Inc.

The 3D space throughout the modeled area is filled with a three-dimensional grid. The CFD virtual wind tunnel calculates wind speed at each one of the 3D grid points. The upstream "roughness" for each test direction is adjusted to reflect the upwind conditions encountered around the site. Wind flows for 16 compass directions were simulated. Although wind speeds are calculated throughout the modeled area, wind comfort conditions were only plotted for a smaller area immediately surrounding the proposed development.

SLR assessed two configurations, for comparison, as follows:

- **Existing Configuration:** Existing site with existing and in-construction surroundings.
- **Proposed Configuration:** Proposed development with existing and in-construction surroundings.

A view of the two configurations are shown in **Figures 5a** and **5b**.

The CFD-predicted wind speeds for all test directions and grid points were combined with historical wind climate data for the region to predict the occurrence of wind speeds in the pedestrian realm, and to compare against wind criteria for comfort and safety. The analysis of wind conditions is undertaken for two seasons: summer (May to October) and winter (November to April).

Results are presented through discussion of the wind conditions along major streets and the areas of interest. The comfort criteria are based on predictions of localized wind forces combined with frequency of occurrence. Climate issues that influence a person's overall "thermal" comfort, (e.g., temperature, humidity, wind chill, exposure to sun or shade) are not considered in the comfort rating.



Figure 5a: Massing Model – Existing Configuration



Figure 5b: Massing Model – Proposed Configuration

2.2 Wind Climate

Wind data recorded at Waterloo Region International Airport in Breslau, Ontario, for the period of 1993 to 2020 were obtained and analysed to create a wind climate model for the region. Annual and seasonal wind distribution diagrams ("wind roses") are shown in **Figure 6**. These diagrams illustrate the percentage of time wind blows from the 16 main compass directions. Of main interest are the longest peaks that identify the most frequently occurring wind directions. The annual wind rose indicates that wind approaching from the southwest through northwest and east directions are most prevalent. The seasonal wind roses readily show how the prevalent winds shift throughout the year.

The directions from which stronger winds (e.g., > 30 km/h) approach are also of interest as they have the highest potential of creating problematic wind conditions, depending upon site exposure and the building configurations. The wind roses in **Figure 6** also identify the directional frequency of these stronger winds, as indicated in the figure's legend colour key. On an annual basis, strong winds occur from the northwesterly and westerly sectors, as well as from the east. All wind speeds and directions were included in the wind climate model.

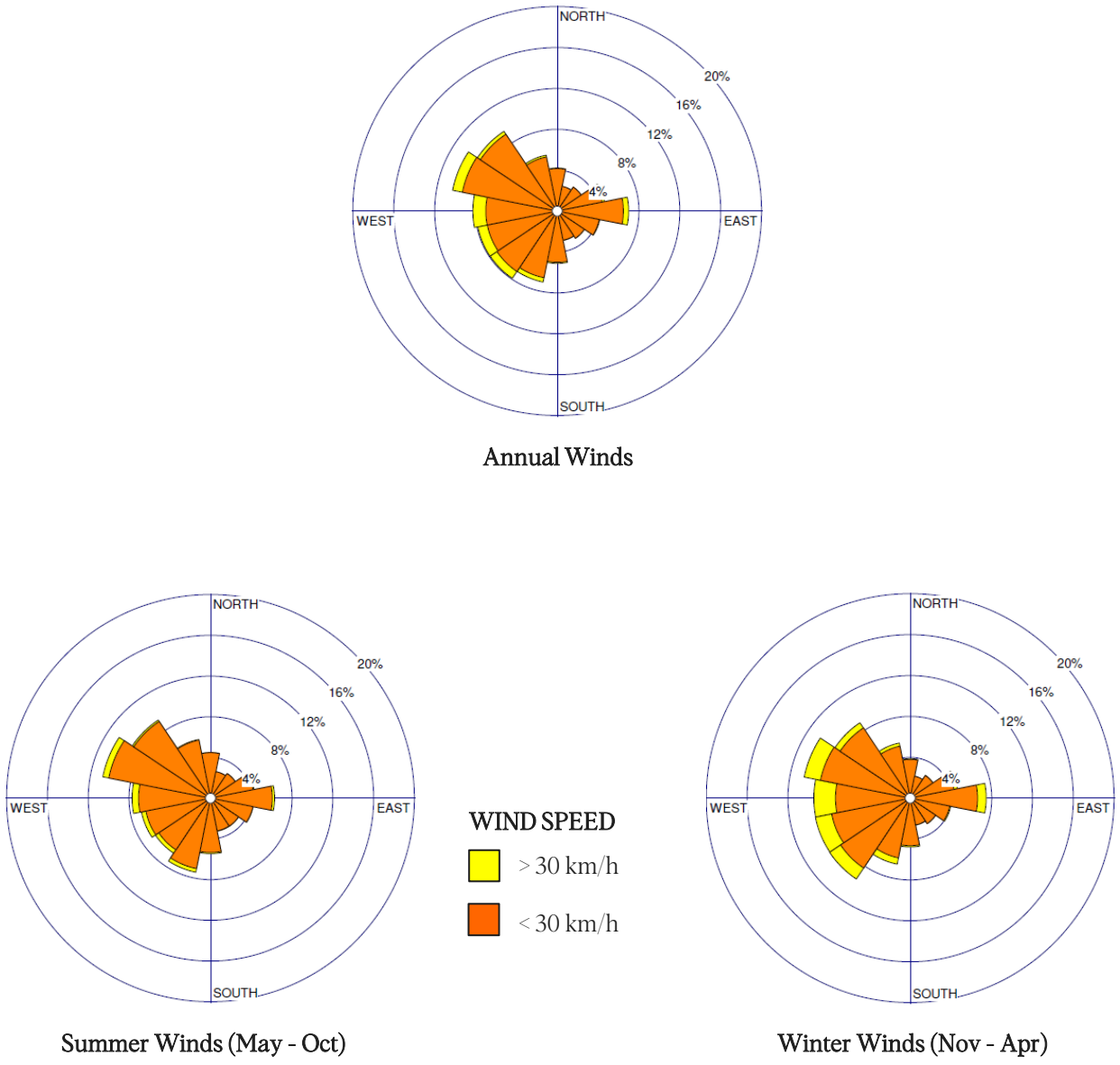


Figure 6: Wind Roses for Waterloo Region International Airport (1993 – 2020)

3.0 PEDESTRIAN WIND CRITERIA

Wind comfort conditions are discussed in terms of being acceptable for certain pedestrian activities and are based on predicted wind force and the expected frequency of occurrence. Wind chill, clothing, humidity and exposure to direct sun, for example, all affect a person's thermal comfort; however, these influences are not considered in the wind comfort criteria.

The criteria utilized for this analysis is provided by the City of Waterloo, in the Terms of Reference for pedestrian wind studies. The comfort criteria, which is based on certain predicted hourly gust-equivalent mean (GEM) wind speeds being exceeded 20% of the time, are summarized in **Table 1**. By allowing for a 20% exceedance, it assumes wind speeds will be comfortable for the corresponding activity at least four out of five days. The comfort criteria consider only daytime hours, between 6:00am and 11:00pm. GEM is defined as the maximum mean wind speed or the gust wind speed divided by 1.85.

The criterion for wind safety in the table is based on hourly gust wind speeds that are exceeded nine hours per year (approximately 0.1% of the time). When more than one event is predicted annually, wind mitigation measures are then advised. The wind safety criterion is shown in **Table 2**.

Table 1: Wind Comfort Criteria

Activity	Comfort Ranges for GEM Wind Speed Exceeded 20% of the Time		Description of Wind Comfort
Sitting	< 10 km/h	< 2.8 m/s	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away.
Standing	< 15 km/h	< 4.2 m/s	Gentle breezes suitable for main building entrances, bus stops, plazas, and other places where pedestrians may linger.
Walking	< 20 km/h	< 5.6 m/s	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable	≥ 20 km/h	≥ 5.6 m/s	Strong winds of this magnitude are considered a nuisance for all pedestrian activities, and wind mitigation is typically recommended.

Table 2: Wind Safety Criterion

Activity	Safety Criterion Gust Wind Speed Exceeded Once Per Year (0.1%)		Description of Wind Effects
Any	> 90 km/h	> 25 m/s	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is required.

4.0 RESULTS

Figures 7a through **10b** present graphical images of the wind comfort conditions for the summer and winter months around the proposed development. These typically represent the seasonal extremes of best and worst case. The "comfort zones" shown are based on an integration of wind speed and frequency for all 16 wind directions tested with the seasonal wind climate model. The presence of mature trees can lead to wind comfort levels that are marginally more comfortable than shown, during seasons when foliage is present. **Appendix A** presents the wind safety conditions on an annual basis.

There are generally accepted wind comfort levels that are desired for various pedestrian uses. However, in some climates these may be difficult to achieve in the winter due to the overall climate. For sidewalks, walkways and pathways, wind comfort suitable for walking are desirable year-round but may not be feasible in the winter. The presence of benches on a sidewalk, which are an optional use, does not change the overall wind comfort requirement for sidewalk. Wind conditions of walking are satisfactory for loading areas, laneways, and a limited portion of a sidewalk, considering exposure is brief for pedestrians. For main entrances, transit stops, and public amenity spaces such as parks and playgrounds, wind conditions conducive to standing are preferred throughout the year. For on-site amenity areas, wind conditions suitable for sitting or standing are desirable during the summer, with stronger wind flows, conducive to walking, tolerated in the winter. The most stringent category of sitting is desirable during the summer for dedicated seating areas, such as patios, where calmer wind is expected for the comfort of patrons.

4.1 Building Entrances & Walkways

For the Existing Configuration, on-site wind conditions are expected to be comfortable for sitting or standing year-round (**Figures 7a** and **8a**).

In the Proposed Configuration (**Figures 7b** and **8b**), on-site wind conditions are expected to remain similar to the existing wind conditions. Wind conditions at the main entrances and exits are predicted to be comfortable for sitting throughout the year (**Figures 9a** and **9b**), which is considered appropriate.

Note that the main entrance is situated on the leeward (i.e., east) side of the building, is recessed into the building facade, and is situated beneath the entrance canopy. As such, the entrance is well-sheltered from the prevailing winds; these are positive design features, and all should be retained in the final design.

4.2 Outdoor Amenity

In the Proposed Configuration, wind conditions on the grade-level commercial outdoor patio are expected to be comfortable for sitting in the summer (**Figure 9a**) and sitting or standing in the winter (**Figure 9b**), which is considered appropriate for an outdoor terrace intended for passive use.

Similar to the main entrance, the commercial outdoor patio is also situated on a leeward side of the building (i.e., south), is recessed into the building facade, and is situated beneath a proposed canopy. This area is therefore well-sheltered from the prevailing winds and these positive design features should be retained in the final design.

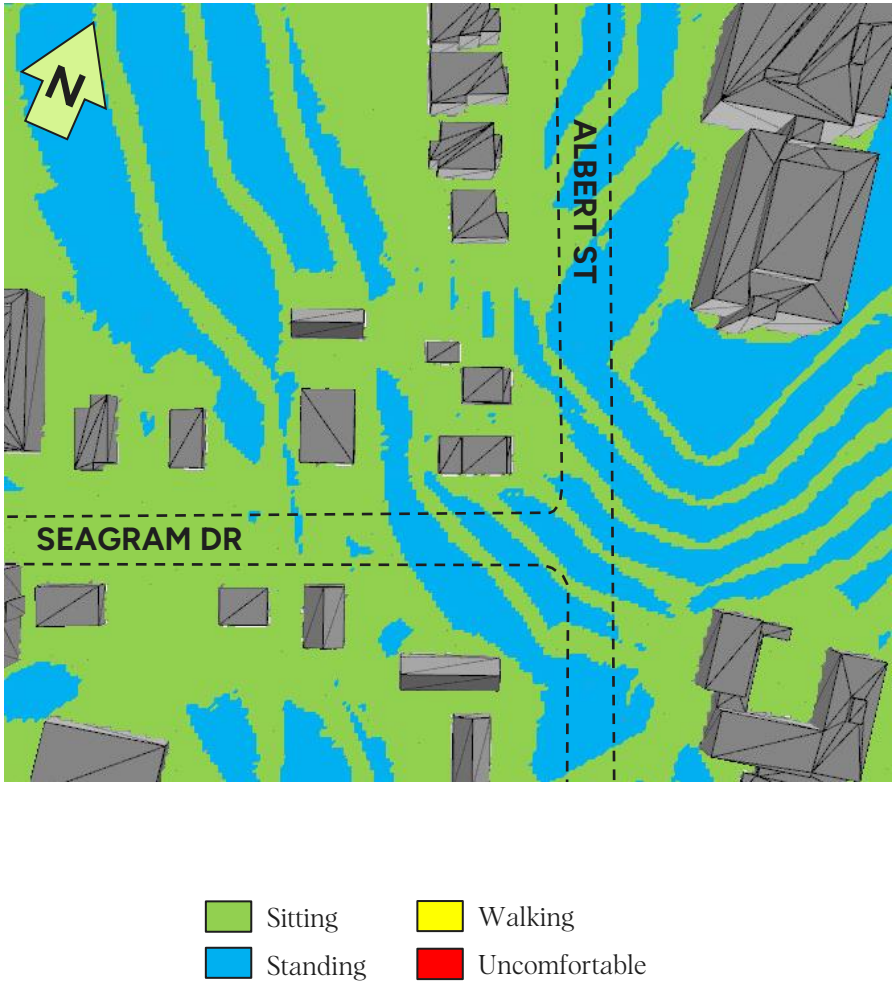


Figure 7a: Existing Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

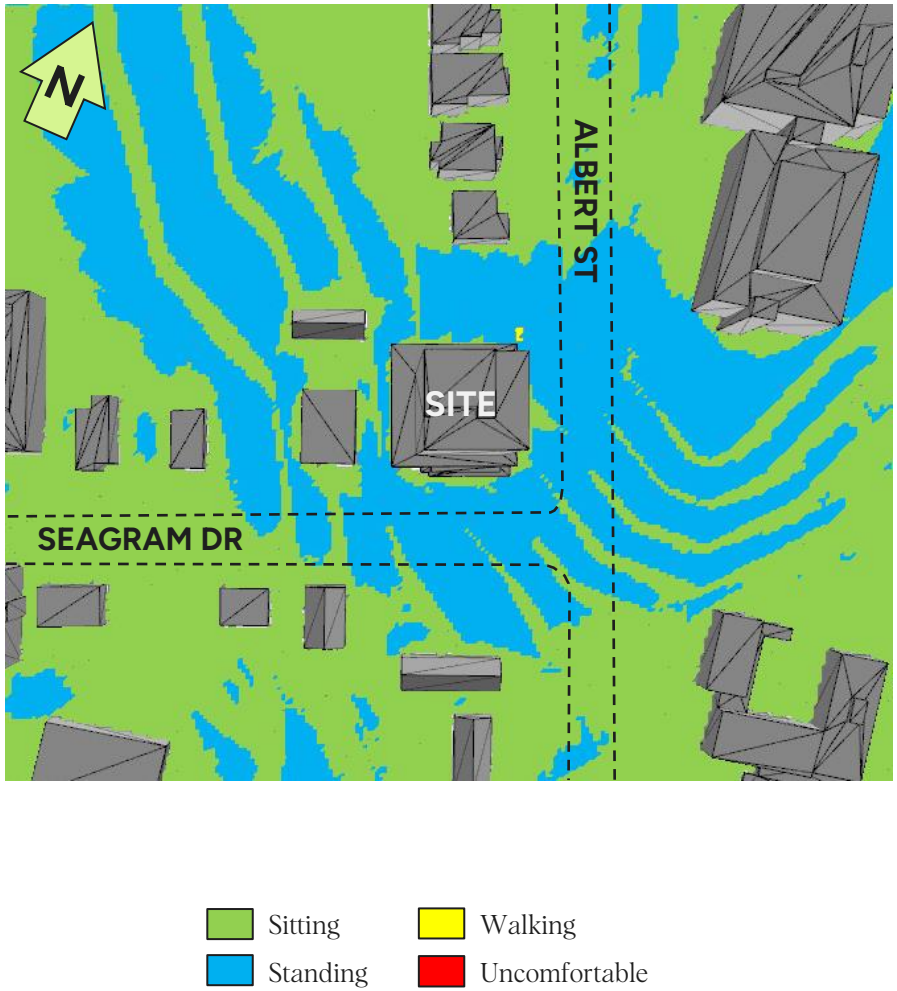


Figure 7b: Proposed Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

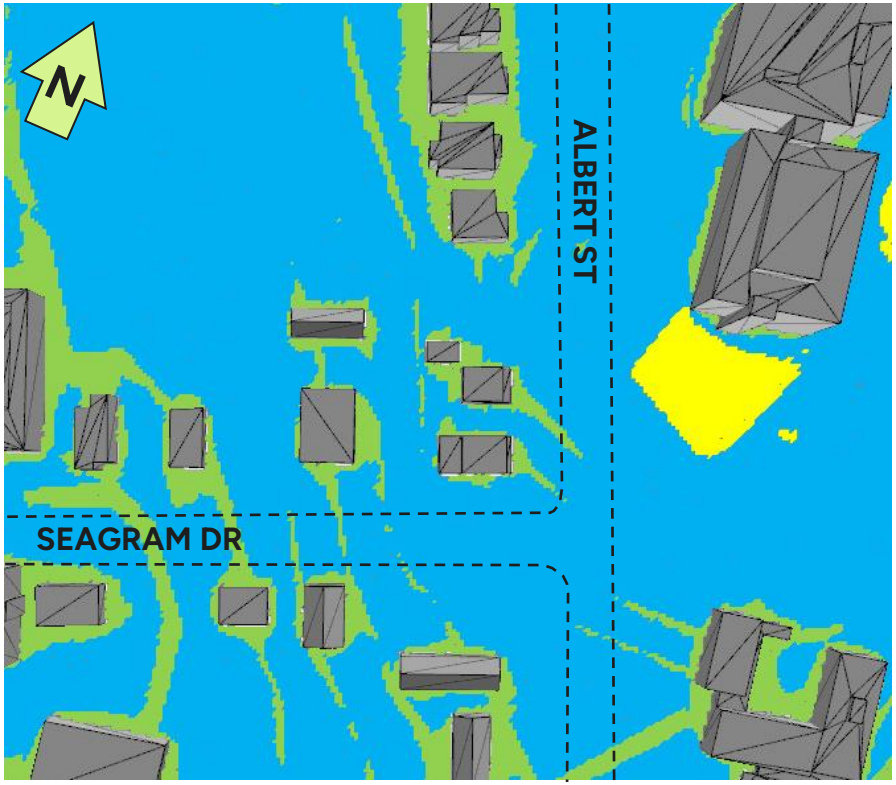


Figure 8a: Existing Configuration – Pedestrian Wind Comfort Winter – On-site & Surrounding Areas

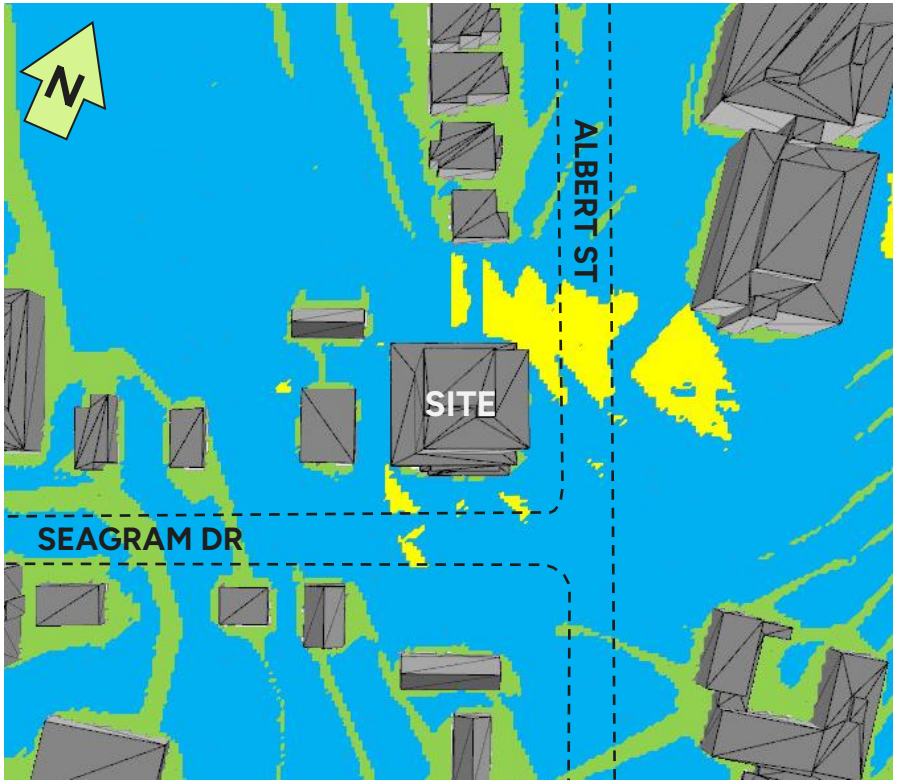


Figure 8b: Proposed Configuration – Pedestrian Wind Comfort Winter – On-site & Surrounding Areas

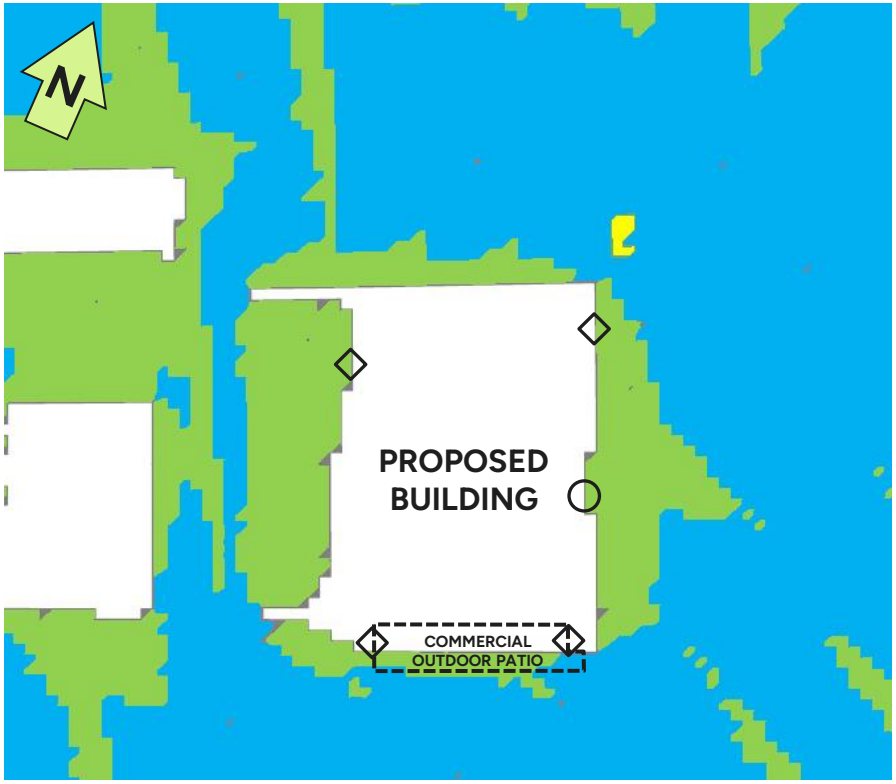


Figure 9a: Proposed Configuration – Pedestrian Wind Comfort Summer – Building Entrances & Walkways

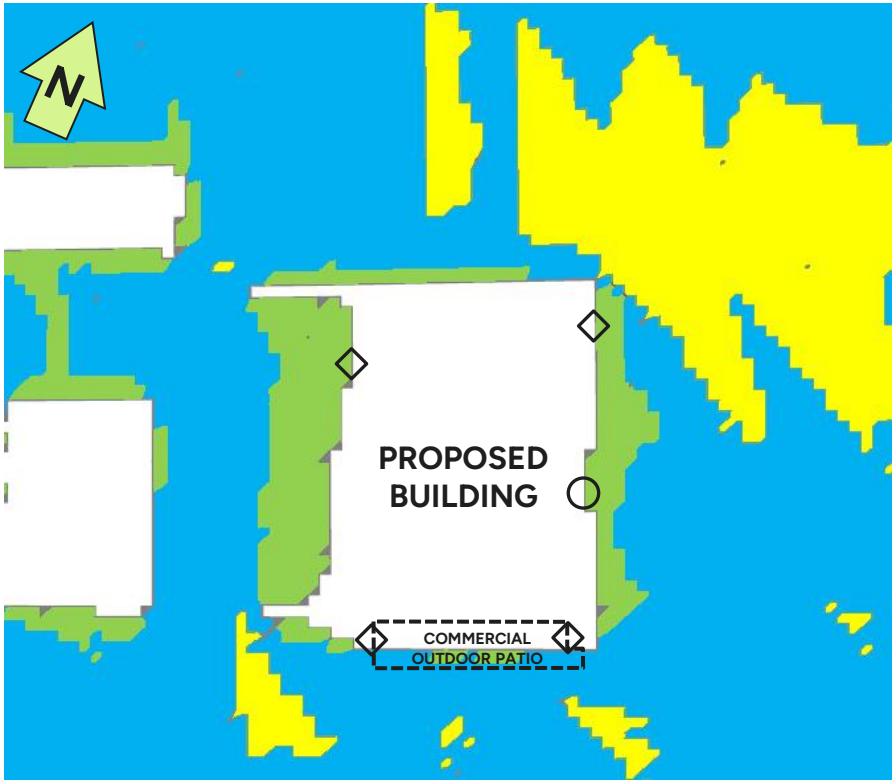


Figure 9b: Proposed Configuration – Pedestrian Wind Comfort Winter – Building Entrances & Walkways

Wind conditions on the Level 7 rooftop patio are characterized by strong winds throughout the year given its exposure to the prevailing winds and its location at the base of the tower.

As such, wind conditions on the Level 7 rooftop patio are predicted to be mainly comfortable for walking or better in the summer (**Figure 10a**). At the southwest corner of the space, wind conditions are uncomfortable in the summer. In the winter (**Figure 10b**), uncomfortable wind conditions are generally expected throughout the rooftop patio, with calmer wind conditions predicted closer to the west and south sides of the tower. Although stronger winds may not be of concern in the winter, as the terrace will be used infrequently, these wind conditions are considered unsuitable for passive use in the summer.

It is recommended that tall screens be implemented along the north, west, and south edges of the rooftop patio, in conjunction with overhead protection such as trellises or canopies, to improve wind conditions on the terrace. These wind control features will disrupt the strong horizontal wind flows as well as the deflected wind flows that are downwashing around the tower and accelerating around the southwest corner of the rooftop patio.

4.3 Surrounding Sidewalks

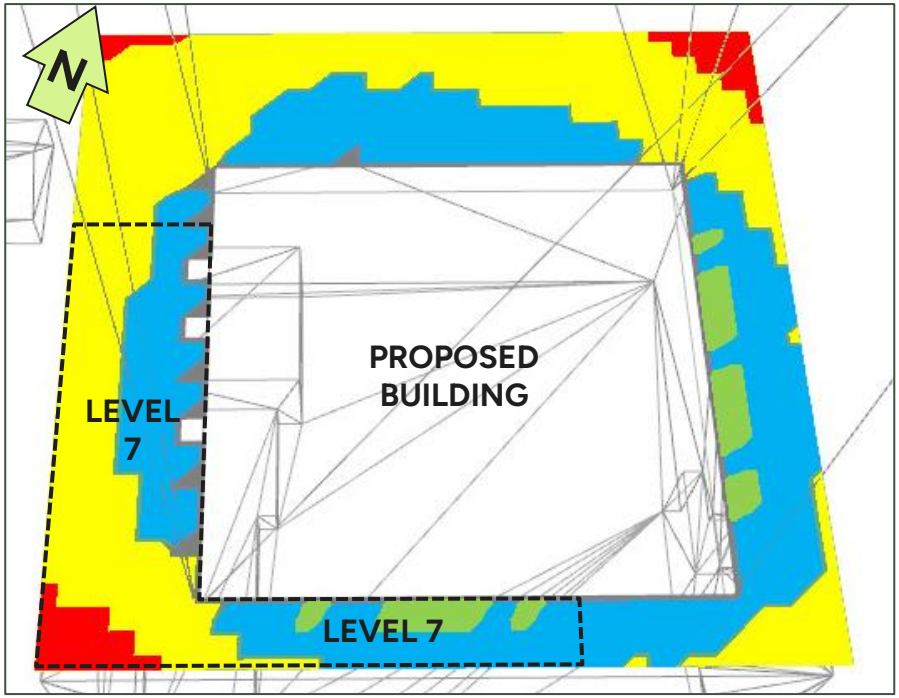
For both the Existing and Proposed Configurations, wind conditions on the sidewalks surrounding the site are predicted to be comfortable for walking or better throughout the year (**Figures 7a** through **8b**). These wind conditions are considered appropriate.

4.4 Wind Safety

For both the Existing and Proposed Configurations, the wind safety criterion (**Appendix A**) is expected to be met on an annual basis in most grade-level areas, including at all entrances and exits, on all surrounding sidewalks, and at the grade-level commercial outdoor patio.

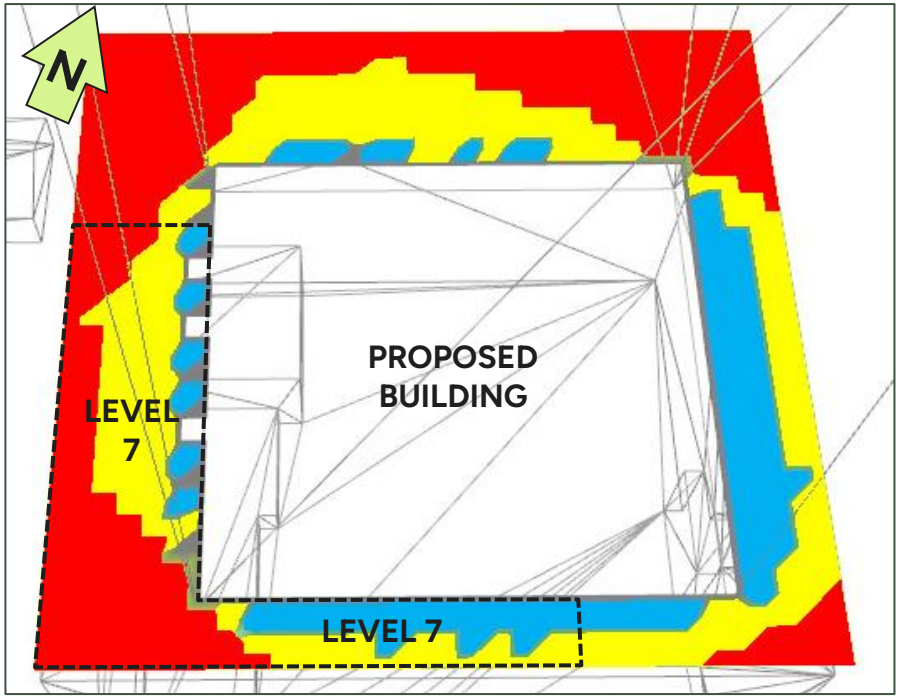
However, in the Existing Configuration, the criterion is predicted to be exceeded off-site, near the southwest corner of the adjacent Wilfrid Laurier University campus building (**Figure A1a**). In the Proposed Configuration, the criterion is expected to be exceeded on-site at the northwest and northeast corners of the proposed building (**Figure A1b**). It should be noted that elevated wind activity at the off-site location is an existing condition, is not the result of the presence of the proposed development and is predicted to be slightly improved by the presence of the proposed development itself.

Moreover, the wind safety criterion is predicted to be exceeded in most areas of the Level 7 rooftop patio on an annual basis. Recommendations for wind control in this area are provided in **Section 4.2** and are applicable to both wind comfort and wind safety.



Sitting
Standing
Walking
Uncomfortable
Amenity Space

Figure 10a: Proposed Configuration – Pedestrian Wind Comfort Summer – Amenity Terrace



Sitting
Standing
Walking
Uncomfortable
Amenity Space

Figure 10b: Proposed Configuration – Pedestrian Wind Comfort Winter – Amenity Terrace

5.0 UPDATED ARCHITECTURAL INFORMATION

Updated architectural information was received from WalterFedy on October 23, 2023, after the CFD simulations for this assessment were conducted.

The revised design would reduce the overall tower height from approximately 78 m to 75 m. The redesign would otherwise remain similar to that which was analyzed and discussed in **Section 4.0**.

The proposed height reduction will have a negligible influence on pedestrian wind comfort on the site. As such, with the revised design, wind conditions are expected to remain similar to those presented **Section 4.0**.

6.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the proposed development at 177-179 Albert Street in Waterloo have been assessed through computational fluid dynamics modeling techniques. Based on the results of our assessment, the following conclusions have been reached:

- The wind safety criterion is generally expected to be met at most grade-level areas in both the Existing and Proposed Configurations. However, exceedances occur near the southwest corner of the Wilfrid Laurier University campus building, as well as at the northwest and northeast corners of the proposed development, and over most of the Level 7 rooftop patio. Note that elevated wind activity at the Wilfrid Laurier University campus building is an existing condition, is not the result of the presence of the proposed development and is predicted to be slightly improved by the presence of the proposed development.
- On-site wind conditions, including all entrances and exits and the grade-level commercial outdoor patio, are predicted to be suitable for the intended use year-round in the Proposed Configuration
- Wind conditions on the Level 7 rooftop patio are characterized by strong winds year-round given its location at the southwest corner of the podium roof and the tower's general exposure to prevailing winds. Wind control recommendations are provided.
- On the sidewalks surrounding the proposed development, wind conditions are anticipated to be suitable for the intended use throughout the year.
- Updated architectural information, received on October 23, 2023, show an overall building height reduction of roughly 3 m, which will have a negligible influence on pedestrian wind comfort on the site. As such, wind conditions are expected to remain similar to those presented in this report.

7.0 LIMITATIONS OF LIABILITY

This report has been prepared and the work referred to in this report has been undertaken by SLR Consulting (Canada) Ltd. (SLR) for 14688210 Canada Inc., hereafter referred to as the "Client". It is intended for the sole and exclusive use of the Client. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. Other than by the Client and by the City of Waterloo their role as land use planning approval authorities, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted unless payment for the work has been made in full and express written permission has been obtained from SLR.

This report has been prepared in a manner generally accepted by professional consulting principles and practices for the same locality and under similar conditions. No other representations or warranties, expressed or implied, are made.

Opinions and recommendations contained in this report are based on conditions that existed at the time the services were performed and are intended only for the client, purposes, locations, time frames and project parameters as outlined in the Scope or Work and agreement between SLR and the Client. The data reported, findings, observations and conclusions expressed are limited by the Scope of Work. SLR is not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. SLR does not warranty the accuracy of information provided by third party sources.

8.0 REFERENCES

Blocken, B., and J. Carmeliet (2004) "Pedestrian Wind Environment around Buildings: Literature Review and Practical Examples" *Journal of Thermal Environment and Building Science*, 28(2).

Cochran, L. (2004) "Design Features to Change and/or Ameliorate Pedestrian Wind Conditions" ASCE Structures Conference 2004.

Davenport, A.G. (1972) "An Approach to Human Comfort Criteria for Environmental Wind Conditions", *Colloquium on Building Climatology*, Stockholm, September 1972.

Durgin, F.H. (1997) "Pedestrian level wind criteria using the equivalent average" *Journal of Wind Engineering and Industrial Aerodynamics* 66.

Isyumov, N. and Davenport, A.G., (1977) "The Ground Level Wind Environment in Built-up Areas", Proc. of 4th Int. Conf. on Wind Effects on Buildings and Structures, London, England, Sept. 1975, Cambridge University Press, 1977.

Isyumov, N., (1978) "Studies of the Pedestrian Level Wind Environment at the Boundary Layer Wind Tunnel Laboratory of the University of Western Ontario", *Jrnl. Industrial Aerodynamics*, Vol. 3, 187-200, 1978.

Irwin, P.A. (2004) "Overview of ASCE Report on Outdoor Comfort Around Buildings: Assessment and Methods of Control" ASCE Structures Conference 2004.

Kapoor, V., Page, C., Stefanowicz, P., Livesey, F., Isyumov, N., (1990) "Pedestrian Level Wind Studies to Aid in the Planning of a Major Development", *Structures Congress Abstracts*, American Society of Civil Engineers, 1990.

Koss, H.H. (2006) "On differences and similarities of applied wind criteria" *Journal of Wind Engineering and Industrial Aerodynamics* 94.

Soligo, M.J., P.A., Irwin, C.J. Williams, G.D. Schuyler (1998) "A Comprehensive Assessment of Pedestrian Comfort Including Thermal Effects" *Journal of Wind Engineering and Industrial Aerodynamics* 77/78.

Stathopoulos, T., H. Wu and C. Bedard (1992) "Wind Environment Around Buildings: A Knowledge-Based Approach" *Journal of Wind Engineering and Industrial Aerodynamics* 41/44.

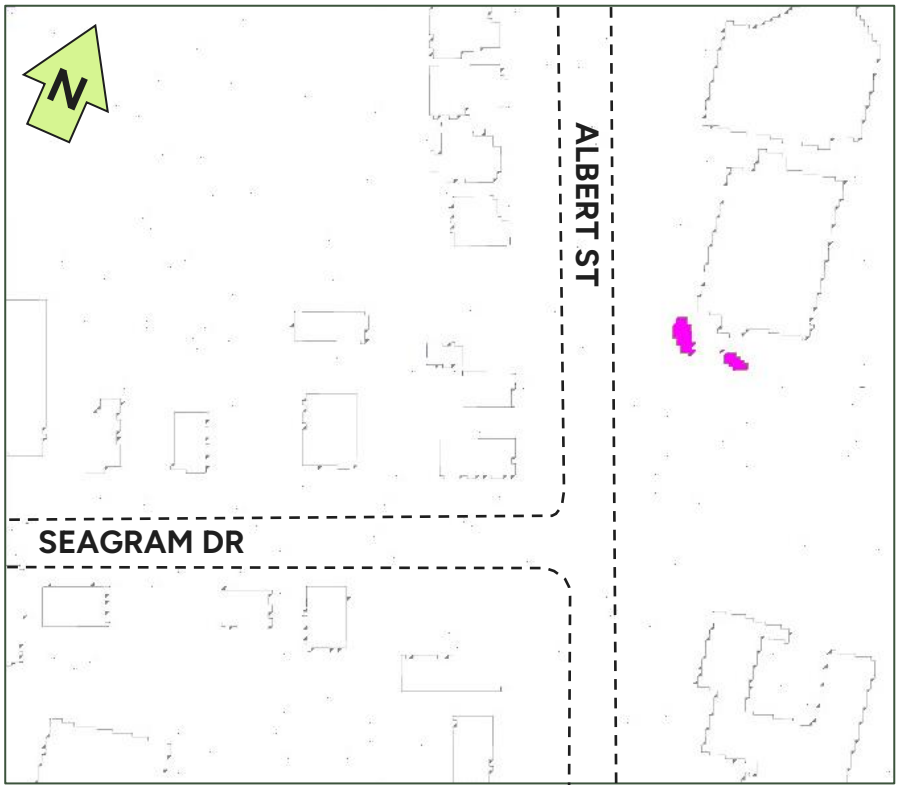
Stathopoulos, T., and H. Wu (1995) "Generic models for pedestrian-level winds in built-up regions" *Journal of Wind Engineering and Industrial Aerodynamics* 54/55.

Wu, H., C.J. Williams, H.A. Baker and W.F. Waechter (2004) "Knowledge-based Desk-top Analysis of Pedestrian Wind Conditions", ASCE Structures Conference 2004.

Appendix A

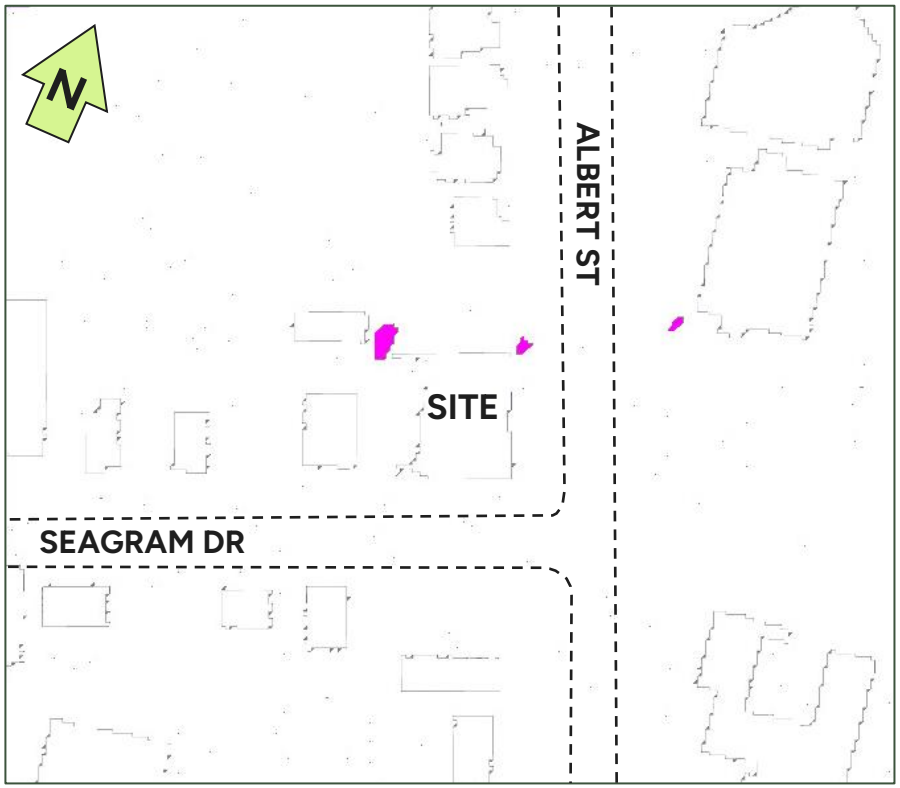
Pedestrian Wind Safety Analysis

Annual



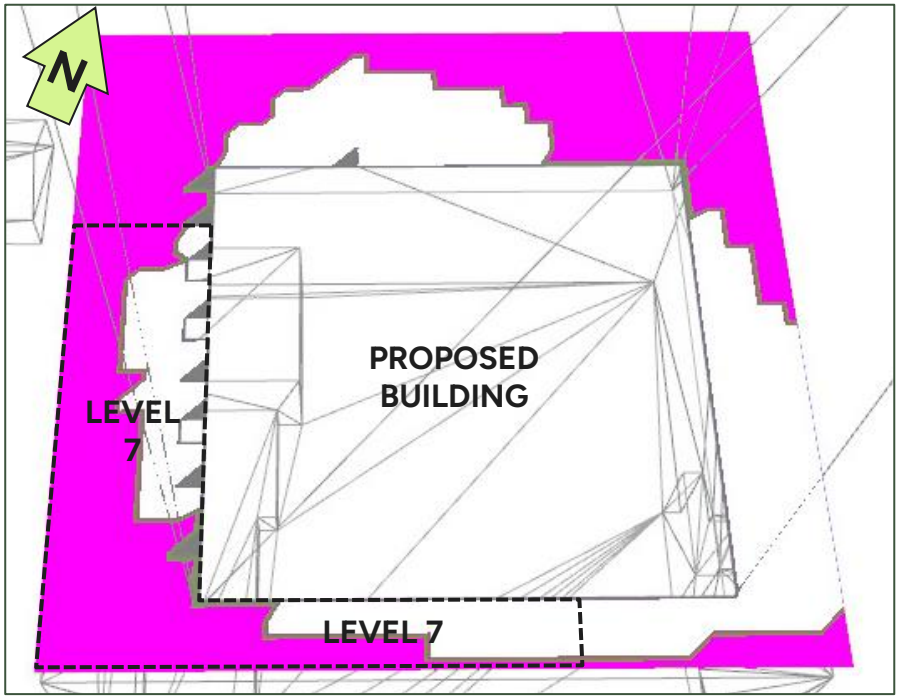
Exceeded Safety Criterion

Figure A1a: Existing Configuration – Wind Safety Annual – On-site & Surrounding Areas



Exceeded Safety Criterion

Figure A1b: Proposed Configuration – Wind Safety Annual – On-site & Surrounding Areas



Exceeded Safety Criterion

Amenity Space

Figure A1c: Proposed Configuration – Wind Safety Annual – Amenity Terrace