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Date: October 21, 2024

Re: Pedestrian Wind Assessment
177-179 Albert Street
Waterloo, Ontario
SLR Project #241.030998.00001

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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 the intersection 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.

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.



Figure 1: Aerial view of existing site & surroundings
Credit: Esri, Maxar, Earthstar Geographics, and the GIS User Community (Image Date May 1, 2020)

1.2 Proposed Development

The proposed development is a 30-storey residential building with a five-storey podium (Figure 2). The building has an approximate height of 98 m and is 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 on the east facade along Albert Street. A commercial entrance is located on the south facade along Seagram Drive. There are a few secondary entrances and exits around the development, as shown in Figure 3a. There are outdoor amenity spaces at grade, as well as on Level 6, as shown in Figures 3a and 3b.

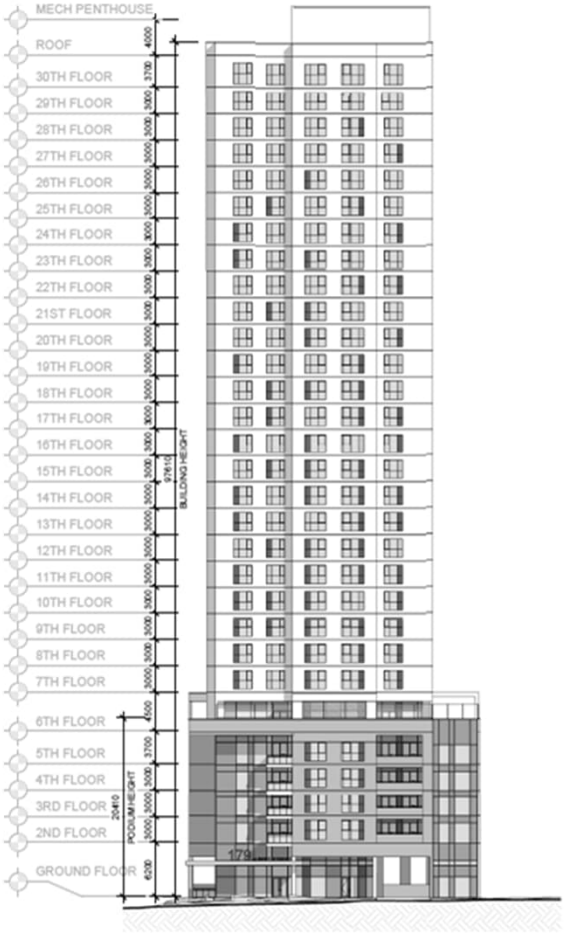
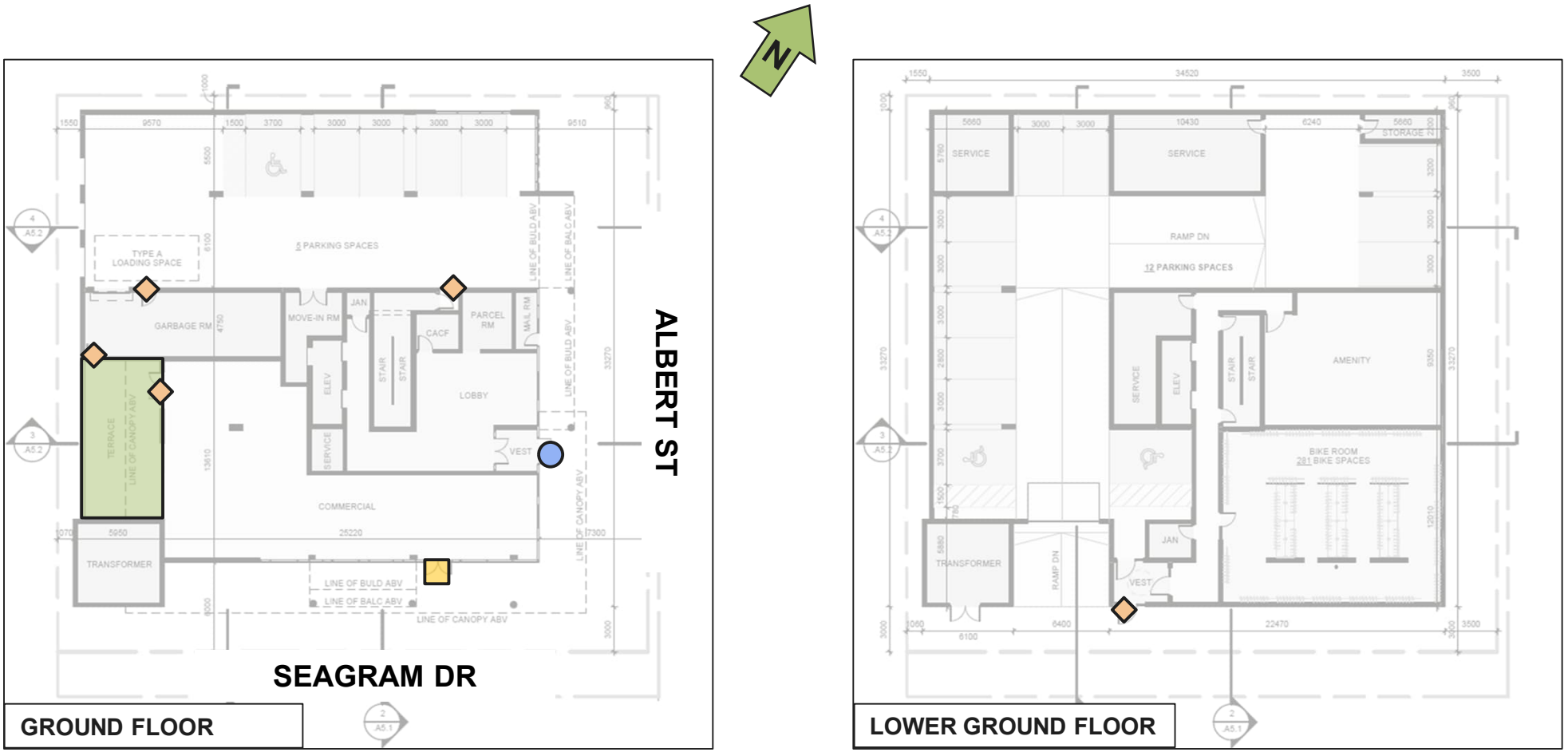


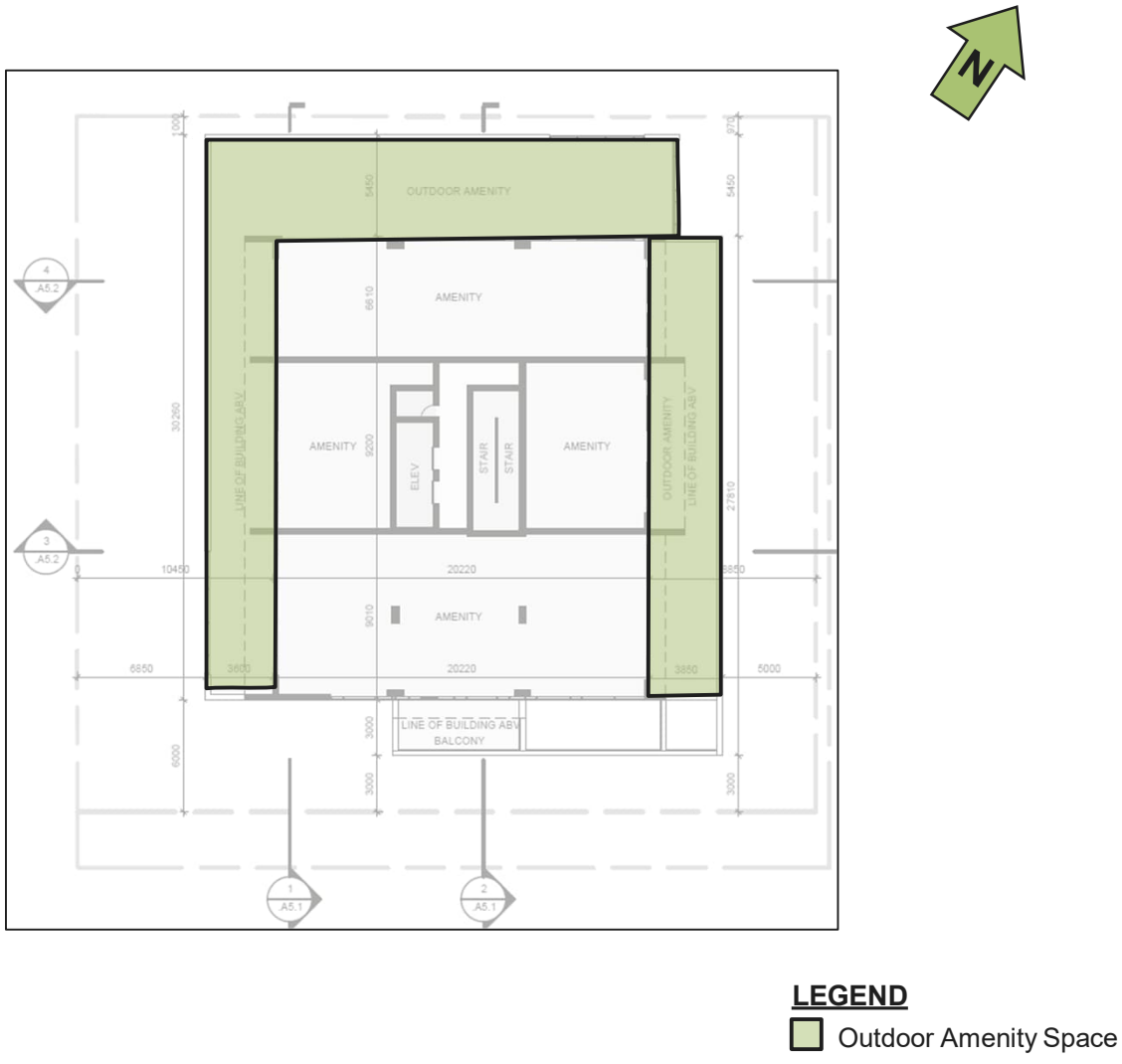
Figure 2: East elevation of the proposed development
Credit: Masri O Inc. Architects



LEGEND

- Main Entrance
- Secondary Entrance / Exit
- Commercial Entrance
- Outdoor Amenity Space

Figure 3a: Areas of interest – Grade
Credit: Masri O Inc. Architects



LEGEND

Outdoor Amenity Space

Figure 3b: Areas of interest – Level 6
Credit: Masri O Inc. Architects

2.0 Approach

A qualitative assessment was conducted using computational fluid dynamics (CFD). As with any approach, there are some limitations with this analysis technique, specifically in the ability to simulate the turbulence of the wind. Nonetheless, a qualitative CFD analysis is a useful tool to identify potential wind issues, as it employs a comparable analysis methodology to that used in quantitative wind tunnel testing.

2.1 Methodology

Wind comfort conditions were predicted on and around the development site to identify potentially problematic windy areas. An architectural set and a 3D model of the proposed development were provided by Masri O Inc. Architects, between August 6 and August 12, 2024. 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 surroundings.
- **Proposed Configuration:** Proposed development with existing surroundings.

A view of the 3D model used in the wind comfort analysis for each configuration is shown in Figures 4a and 4b.

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. This analysis was conducted for the Existing Configuration and Proposed Configuration. 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.

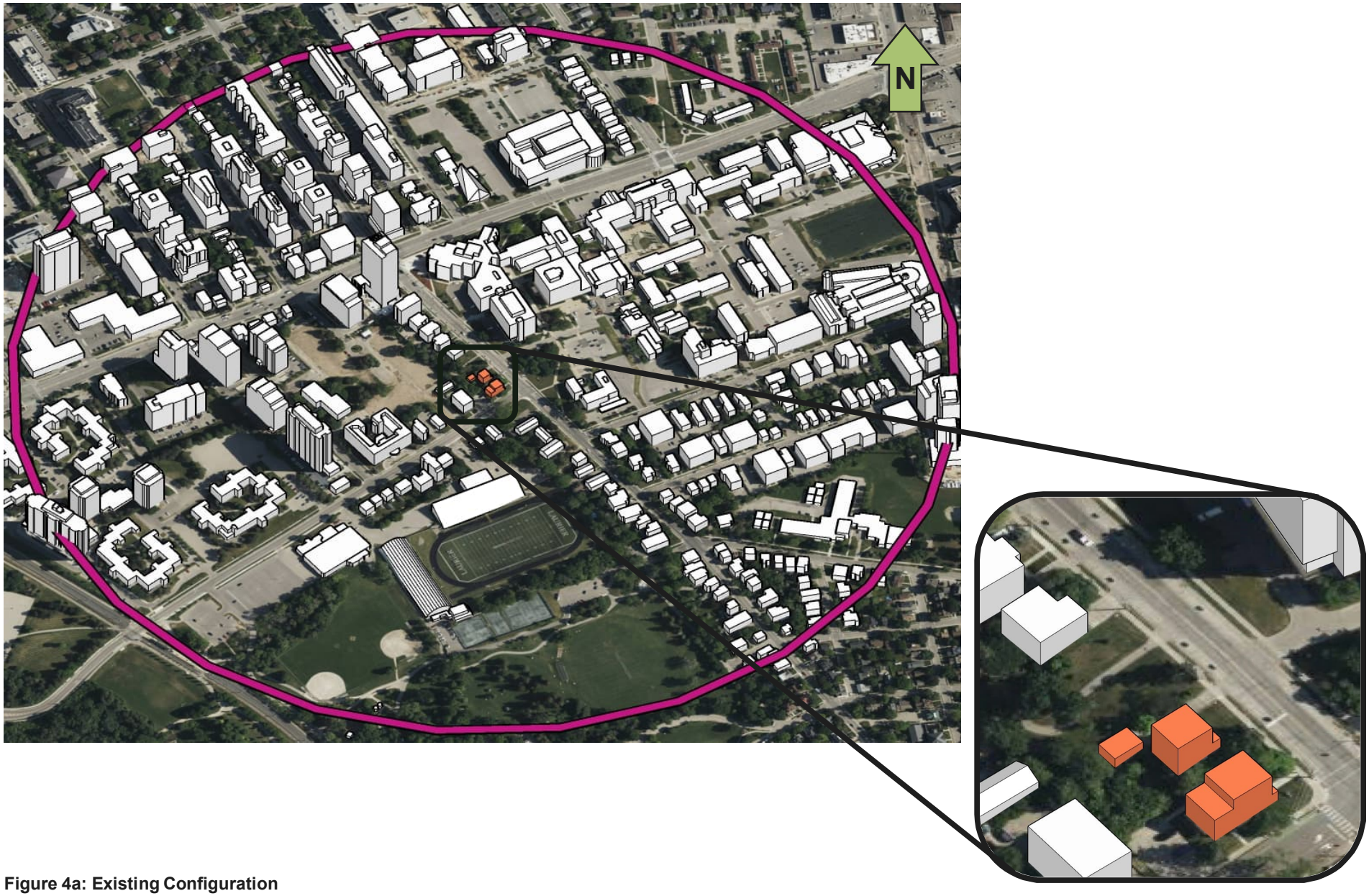


Figure 4a: Existing Configuration



Figure 4b: 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 5. 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 5 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.

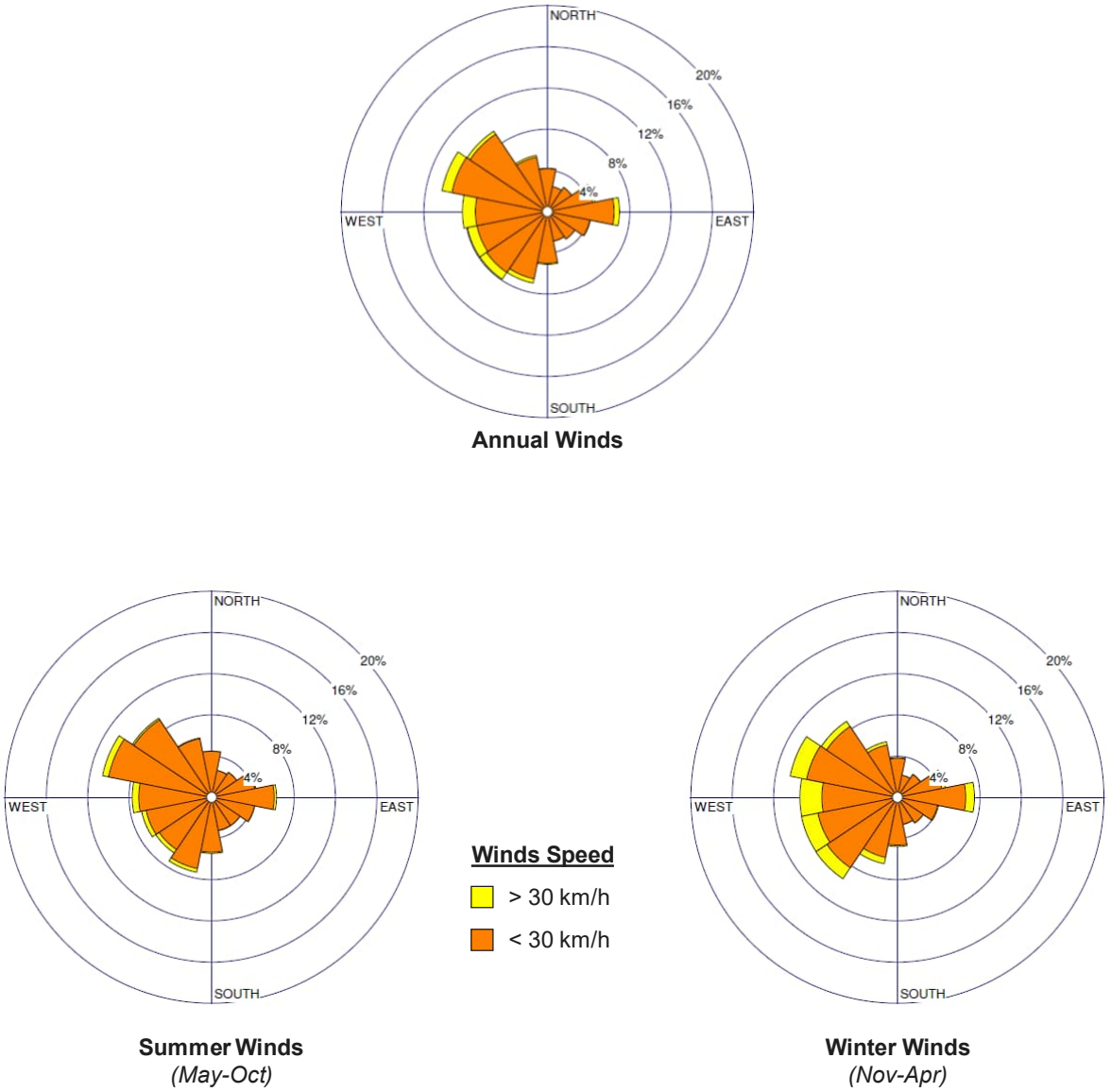


Figure 5: Wind roses for Waterloo Region International Airport (1993-2020)

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

Comfort Category	GEM Wind Speed Exceeded 20% of the time	Description of Wind Comfort
Sitting	≤ 10 km/h	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	Gentle breezes suitable for main building entrances and bus stops.
Walking	≤ 20 km/h	Moderate breezes that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable	> 20 km/h	Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended.

Table 2: Wind Safety Criterion

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

4.0 Results

Figures 6a through 9b 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

In the Existing Configuration, on-site wind conditions are expected to be comfortable for sitting or standing year-round (Figures 6a and 7a).

In the Proposed Configuration, on-site wind conditions are expected to be comfortable for sitting or standing in the summer (Figure 6b), while in the winter wind conditions are anticipated to be conducive to walking or better (Figure 7b).

Wind conditions at all the entrances are anticipated to be comfortable for standing throughout the year (Figures 8a and 8b), which is considered appropriate.

Wind conditions on the commercial terrace on the ground floor are expected to be suitable for sitting in the summer and for standing in the winter, which is suitable for the intended use.

4.2 Outdoor Amenity Terrace

Wind conditions on the Level 6 outdoor amenity terraces are expected to be suitable for sitting and/or standing in the summer (Figure 9a), which is suitable for the intended use.

During the winter, wind conditions are expected to be suitable for walking or better (Figure 9b). Since the amenity terraces are expected to be utilized infrequently during the winter, these wind conditions are considered acceptable.

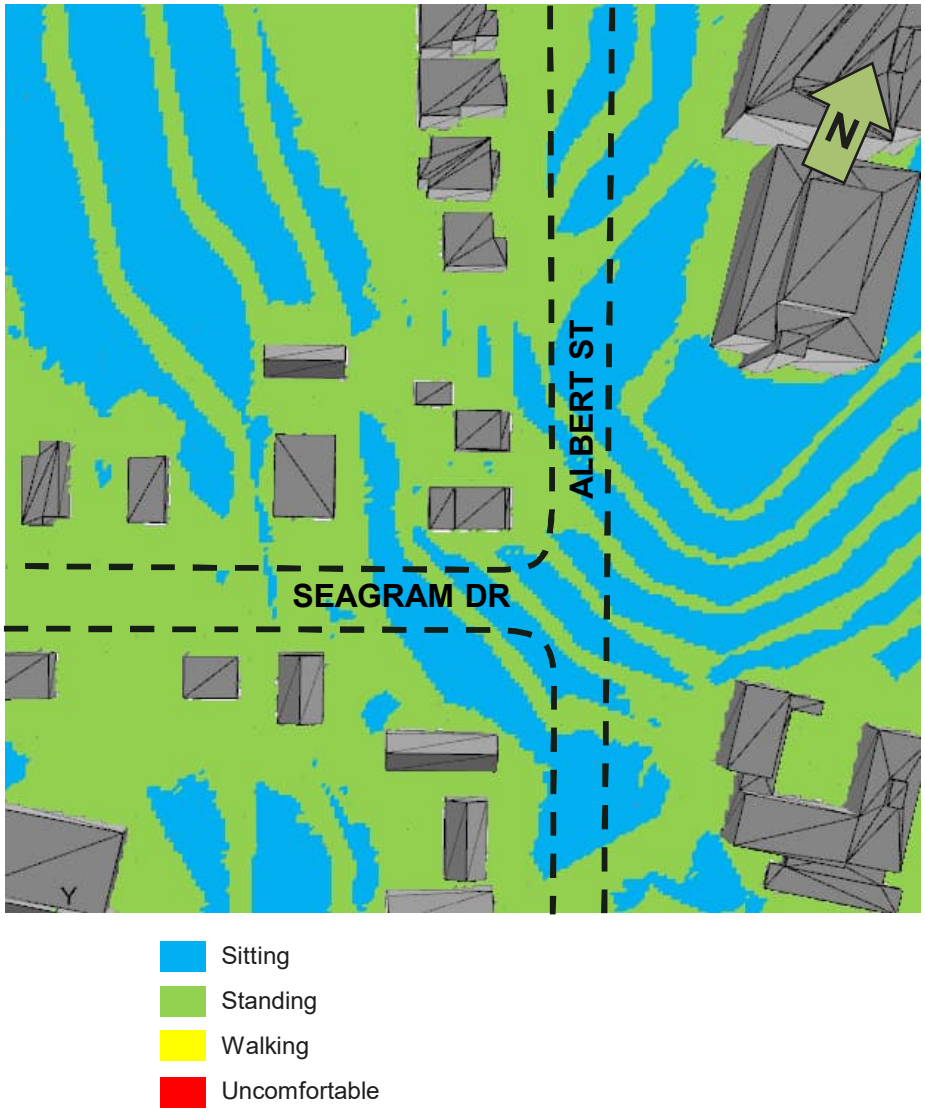


Figure 6a: Existing Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

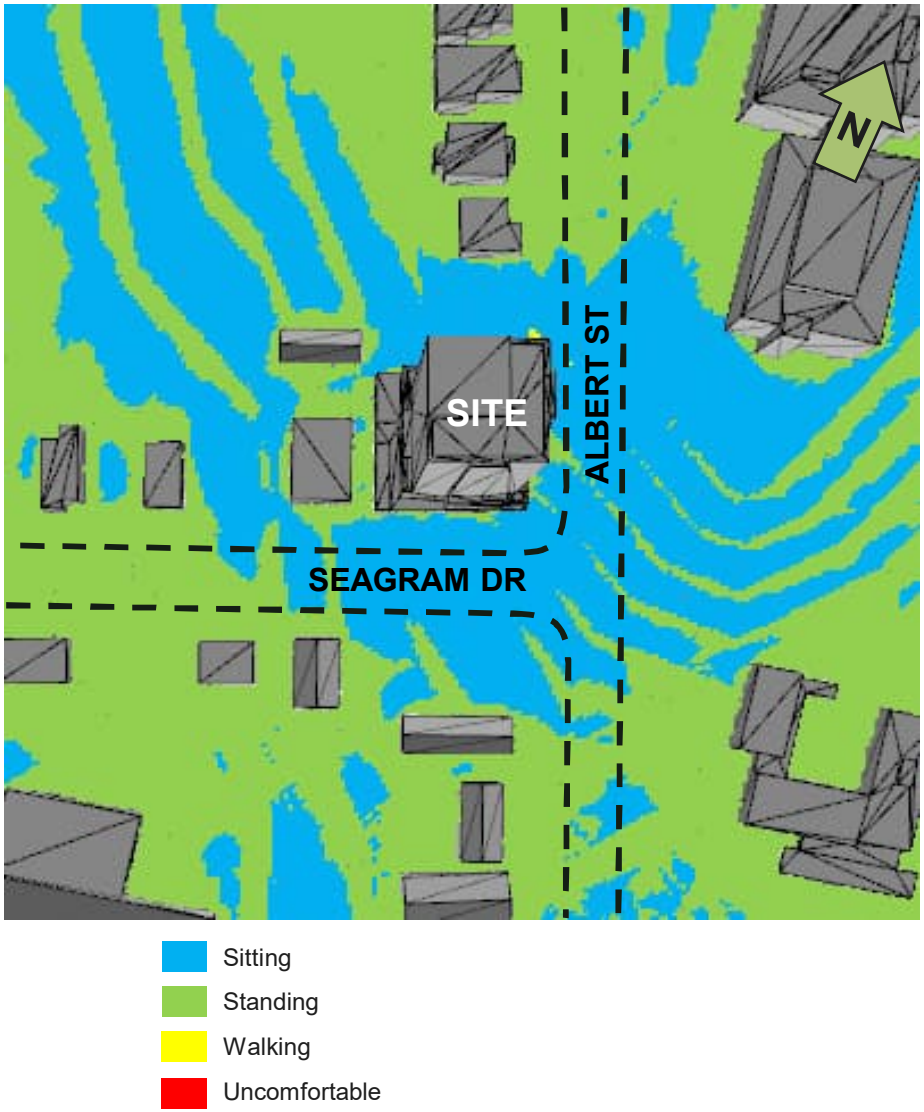


Figure 6b: Proposed Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

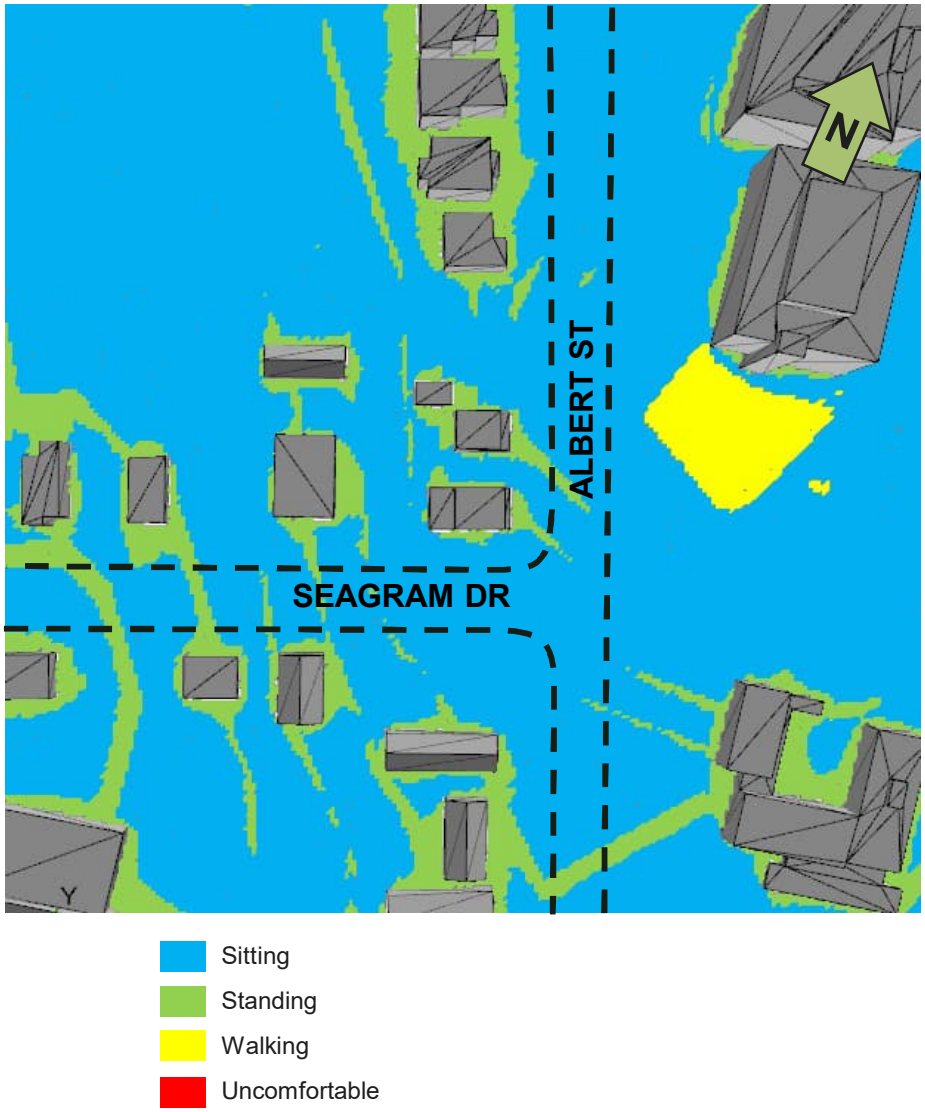


Figure 7a: Existing Configuration – Pedestrian Wind Comfort Winter – On-site & Surrounding Areas

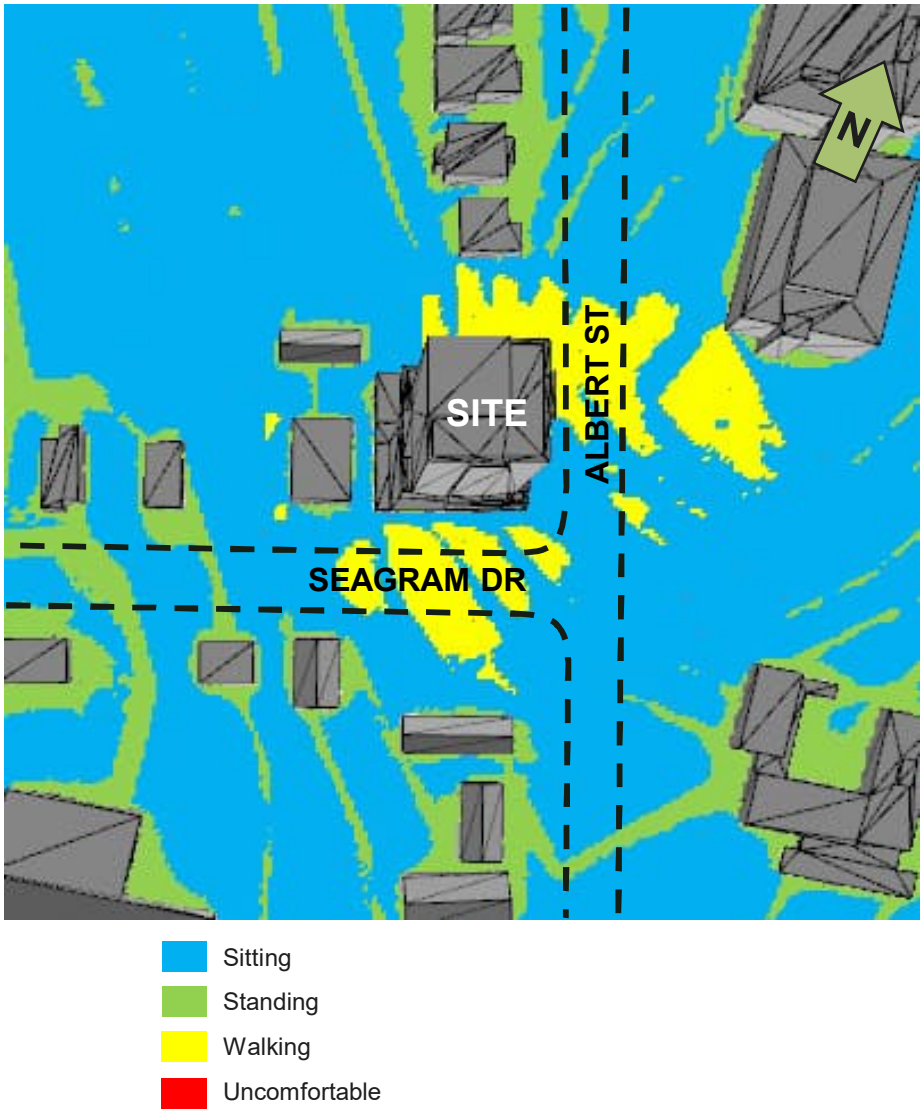


Figure 7b: Proposed Configuration – Pedestrian Wind Comfort Winter – On-site & Surrounding Areas

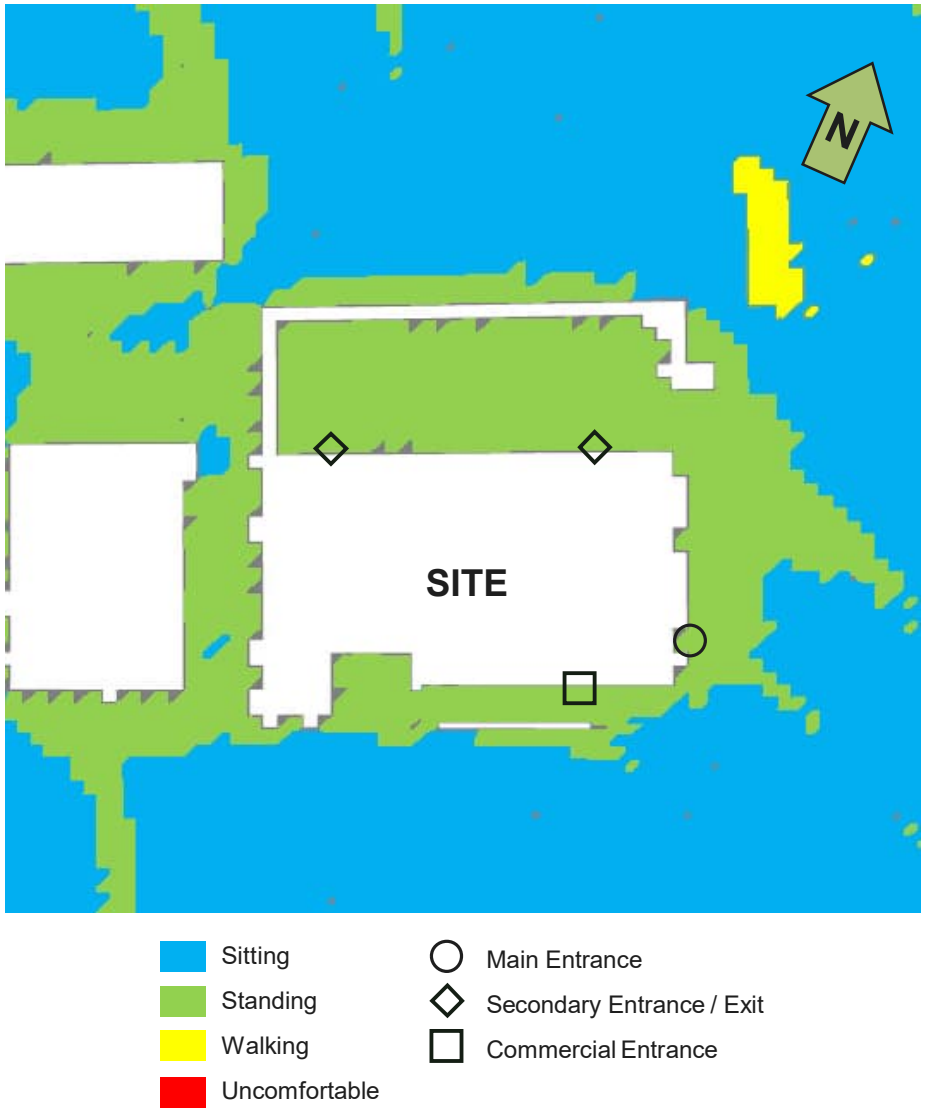


Figure 8a: Proposed Configuration – Pedestrian Wind Comfort Summer – Building Entrances & Walkways

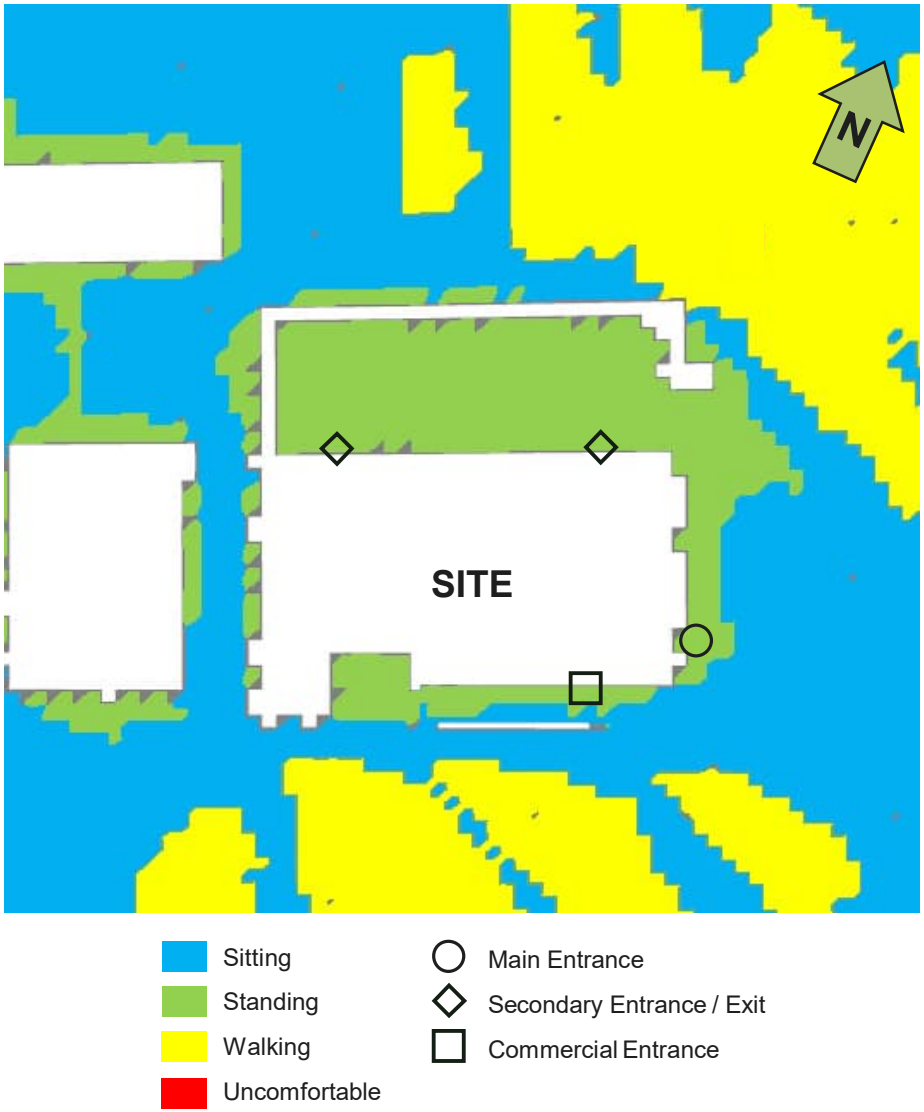


Figure 8b: Proposed Configuration – Pedestrian Wind Comfort Winter – Building Entrances & Walkways

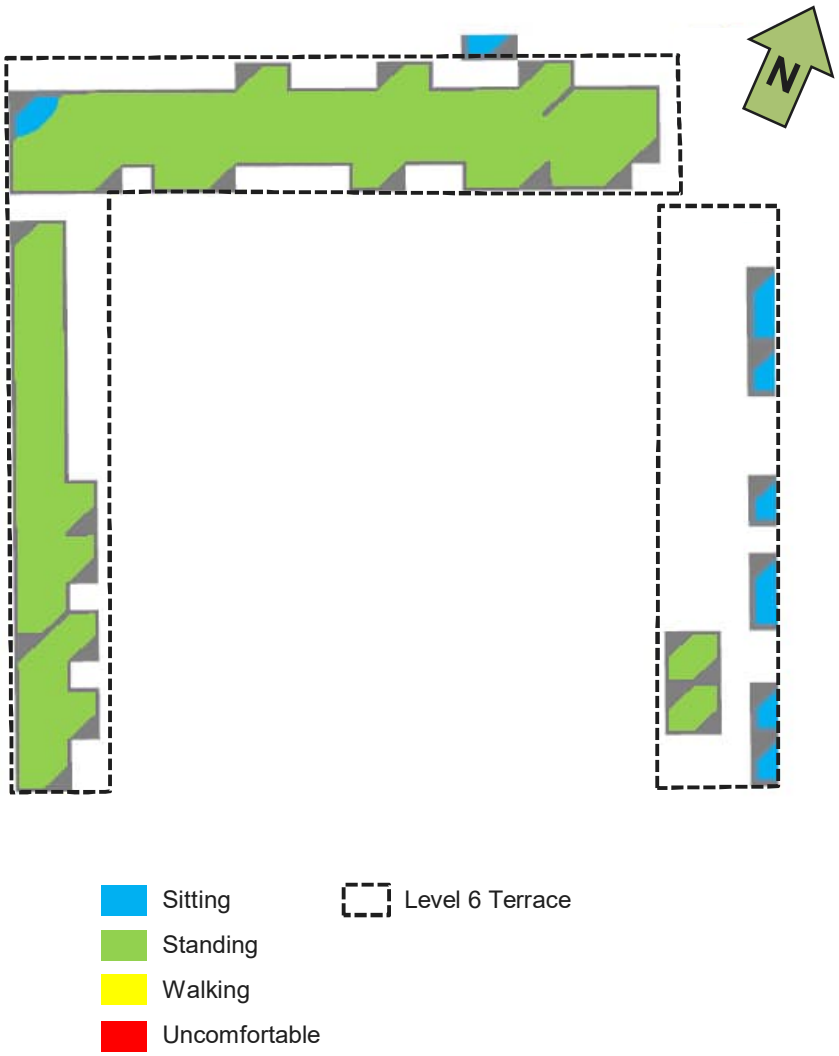


Figure 9a: Proposed Configuration – Pedestrian Wind Comfort Summer – Amenity Terraces

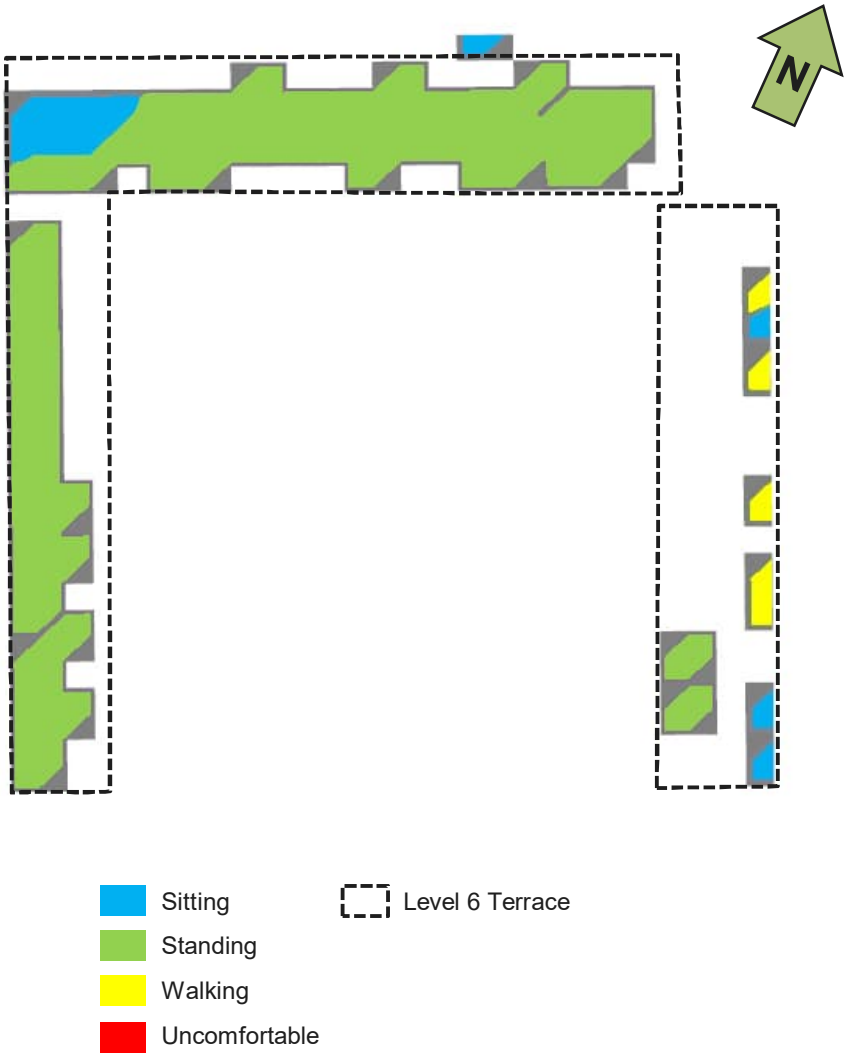


Figure 9b: Proposed Configuration – Pedestrian Wind Comfort Winter – Amenity Terraces

4.3 Surrounding Sidewalks

For both the Existing Configuration and the Proposed Configuration, wind conditions on the sidewalks surrounding the site are predicted to be comfortable for walking or better throughout the year (Figures 6a through 7b). These wind conditions are considered appropriate.

4.4 Wind Safety

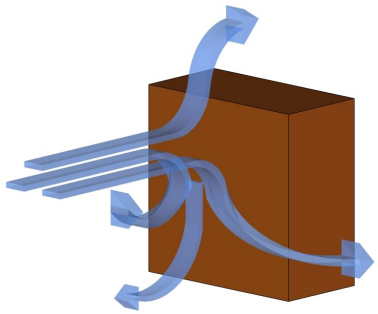
In both the Existing Configuration and Proposed Configuration, the wind safety criterion is predicted to be exceeded off-site, along the south facade of the adjacent Wilfrid Laurier University campus building (Figure A1a). Thus, these strong wind flows are due to the existing building, not the proposed development.

In the Proposed Configuration, the wind safety criterion is expected to be exceeded off-site, along the south facade of the adjacent Wilfrid Laurier University campus building (Figure A1b), but the area of influence is noticeably smaller. In addition, the wind safety criterion is expected to be exceeded along the entire north side of the proposed development, as well as on near the southeast corner (Figure A1b). This can be attributed to the strong prevailing wind flows being intercepted at higher elevations and redirected to grade, in a mechanism known as downwashing. These flows subsequently accelerate around building corners. An illustration is shown on the right.

In addition, the wind safety criterion is predicted to be exceeded at the northeast corner of the outdoor amenity terrace on Level 6.

To improve wind conditions at grade, we recommend the design team consider including vertical wind mitigation measures along the south side of the building, to disrupt the downwashing wind flows.

SLR will work with the owner and design team as the design progresses to the Site Plan Approval (SPA) submission, in order to incorporate practical and effective wind control measures.



Downwashing wind flows

5.0 Updated Architectural Information

Updated architectural information was received from Masri O Inc. Architects on October 3, 2024, after the analysis was completed.

SLR noted the following differences in the revised design:

- The podium height on the north side of the tower was reduced in height by two storeys. Previously the podium was five storeys in height, it is now three storeys tall.
- The north facade of the podium was previously 1 m from the north property line. It is currently 2 m from the north property line.
- The outdoor amenity space has been removed from atop the podium. There is now only outdoor amenity space to the east and west of the tower on the 6th floor.

These changes will have a negligible influence on pedestrian wind comfort on the site and surroundings. Therefore, with the revised design, wind conditions are expected to remain similar to those presented in Section 4.0.

6.0 Conclusion & Recommendations

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

- The safety criterion is expected to be exceeded along the south facade of the nearby Wilfrid Laurier University campus building in both the Existing Configuration and the Proposed Configuration.
- In the Proposed Configuration, the safety criterion is predicted to be exceeded immediately to the north and south of the proposed development. The safety criterion is also expected to be exceeded at the northeast corner of the outdoor amenity spaces at Level 6. Recommendations are provided.
- On-site wind conditions, including at the main and commercial entrances, are predicted to be suitable for the intended use year-round in the Proposed Configuration.
- Wind conditions on the outdoor amenity terraces are expected to be suitable for the intended pedestrian use in the summer.
- In the Existing Configuration and the Proposed Configuration, on the sidewalks surrounding the proposed development, wind conditions are anticipated to be suitable for the intended use throughout the year.
- We recommend confirming these wind conditions through a quantitative wind tunnel study as the project progresses SPA. SLR will work with the owner and the design team to help develop appropriate wind control measures where necessary.

7.0 Statement of Limitations

This report has been prepared by SLR Consulting (Canada) Ltd. (SLR) for 14688210 Canada Inc. (Client) in accordance with the scope of work and all other terms and conditions of the agreement between such parties. SLR acknowledges and agrees that the Client may provide this report to government agencies, interest holders, and/or Indigenous communities as part of project planning or regulatory approval processes. Copying or distribution of this report, in whole or in part, for any other purpose other than as aforementioned is not permitted without the prior written consent of SLR.

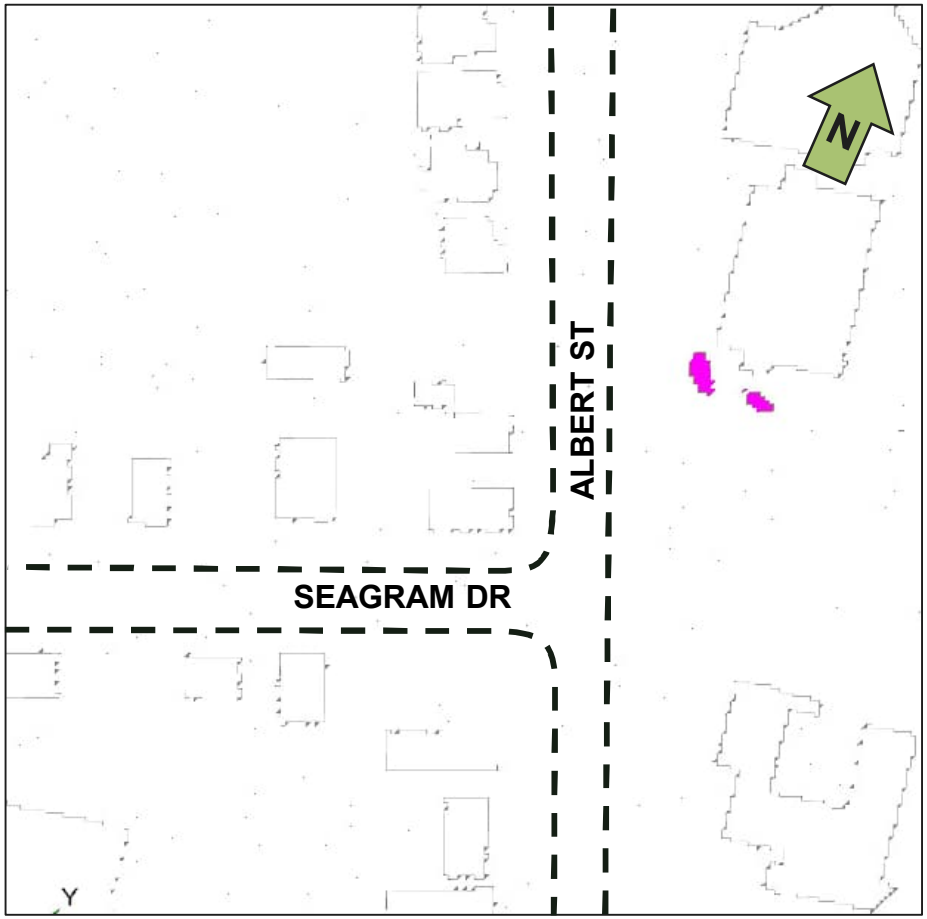
Any findings, conclusions, recommendations, or designs provided in this report are based on conditions and criteria that existed at the time work was completed and the assumptions and qualifications set forth herein.

This report may contain data or information provided by third party sources on which SLR is entitled to rely without verification and SLR does not warranty the accuracy of any such data or information.

Nothing in this report constitutes a legal opinion nor does SLR make any representation as to compliance with any laws, rules, regulations, or policies established by federal, provincial territorial, or local government bodies, other than as specifically set forth in this report. Revisions to legislative or regulatory standards referred to in this report may be expected over time and, as a result, modifications to the findings, conclusions, or recommendations may be necessary.

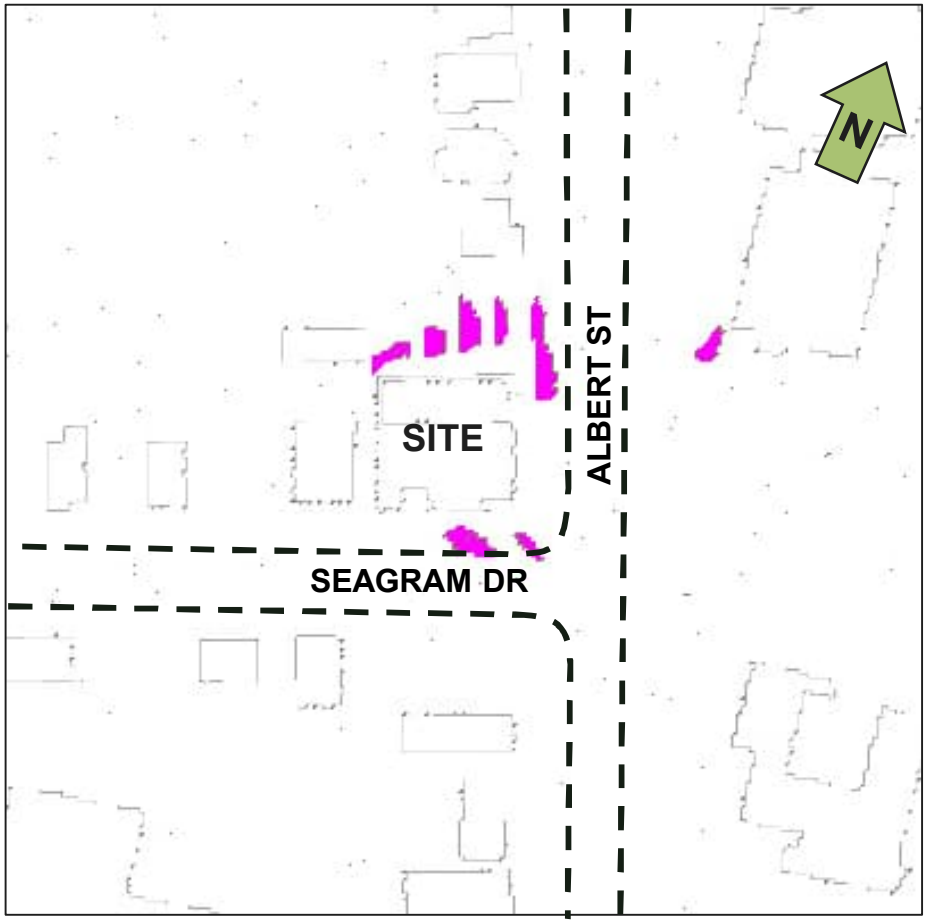
Appendix A

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

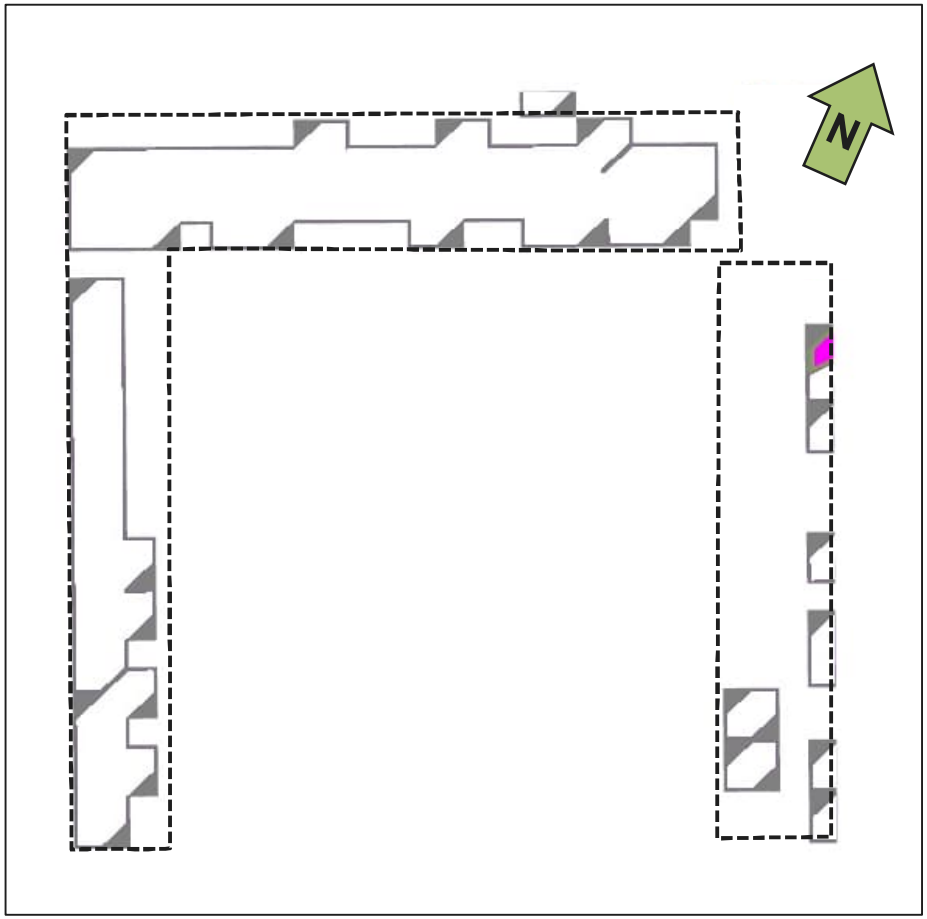


Figure A2: Proposed Configuration – Wind Safety Annual – Amenity Terraces