REPORT

601 SCOTTSDALE DRIVE

GUELPH, ON

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT #2302908
September 22, 2023

SUBMITTED TO

Sydney Zhang
Coordinator, Real Estate Development
sydneyz@forumam.com

Forum 601 Scottsdale LP
181 Bay Street
East Podium, 2nd Floor
Toronto, ON M5J 2T3

SUBMITTED BY

Tim Aiello, M.Sc.
Technical Coordinator
Tim.Aiello@rwdi.com

Hanqing Wu, Ph.D., P.Eng.
Senior Technical Director / Principal
Hanqing.Wu@rwdi.com

Maja Bokara, PGCert, EP.
Project Manager
Maja.Bokara@rwdi.com

RWDI AIR Inc.
600 Southgate Drive
Guelph, ON N1G 4P6
T: 519.823.1311 x2440

LICENSED PROFESSIONAL ENGINEER
H. WU
Sept 21 23
PROVINCE OF ONTARIO

rwdi.com

1. INTRODUCTION

RWDI AIR Inc. (RWDI) was retained to conduct a pedestrian wind assessment for the proposed development at 601 Scottsdale Drive in Guelph, Ontario. The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development in support of Zoning By-Law Amendment (ZBA) and Official Plan Amendment (OPA) applications.

The project site is located at the northwest corner of Stone Road and Scottsdale Drive, with Highway 6 bordering the west side of the proposed development. The site is primarily surrounded by low-rise suburban neighbourhoods and commercial zones (Image 1).

The project is the second phase of a student residential suite development, consisting of 490 units spread across two 7-storey towers (Phase 2A and Phase 2B, Image 2) connected by a 1-storey indoor amenity. In addition to sidewalks and properties near the project site, key areas of interest for this assessment include the primary and secondary entrances and grade-level outdoor amenities indicated in Image 3.

On September 19, 2023, after the computer simulation, revised architectural drawings were received by RWDI with changes to the 1-storey amenity space and more detailed landscaping design among other updates. These changes are minor with respect to general pedestrian wind conditions and the conclusions and recommendations provided in this report are still applicable.

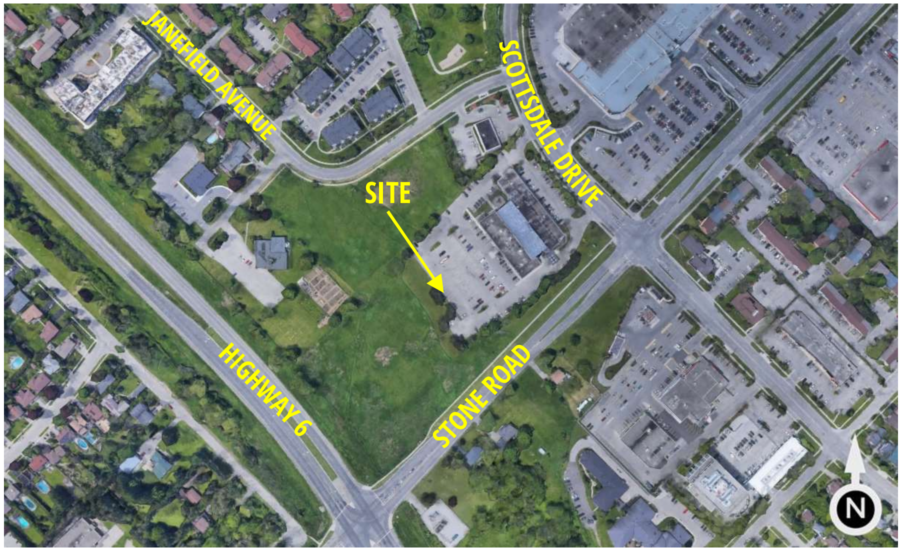


Image 1: Aerial View of the Existing Site and Surroundings
Source: Google Maps

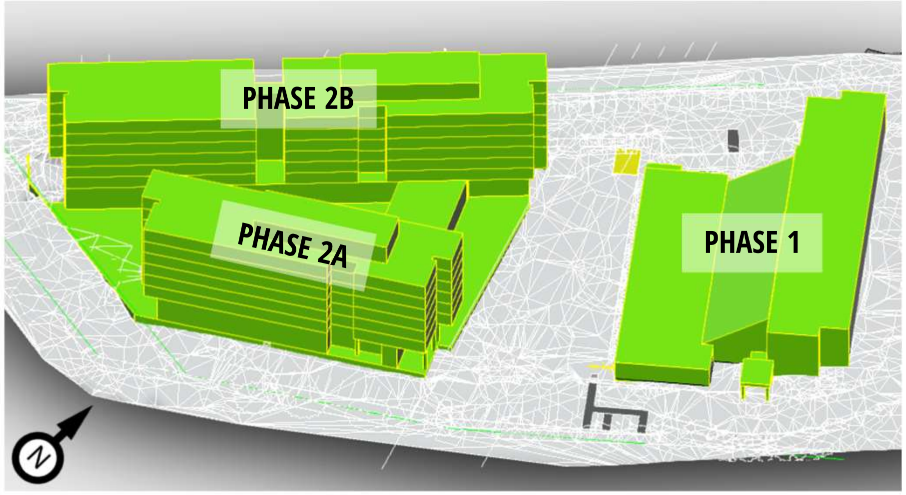


Image 2: Conceptual Massing of the Existing (Right) and Proposed (Left) Development

1. INTRODUCTION

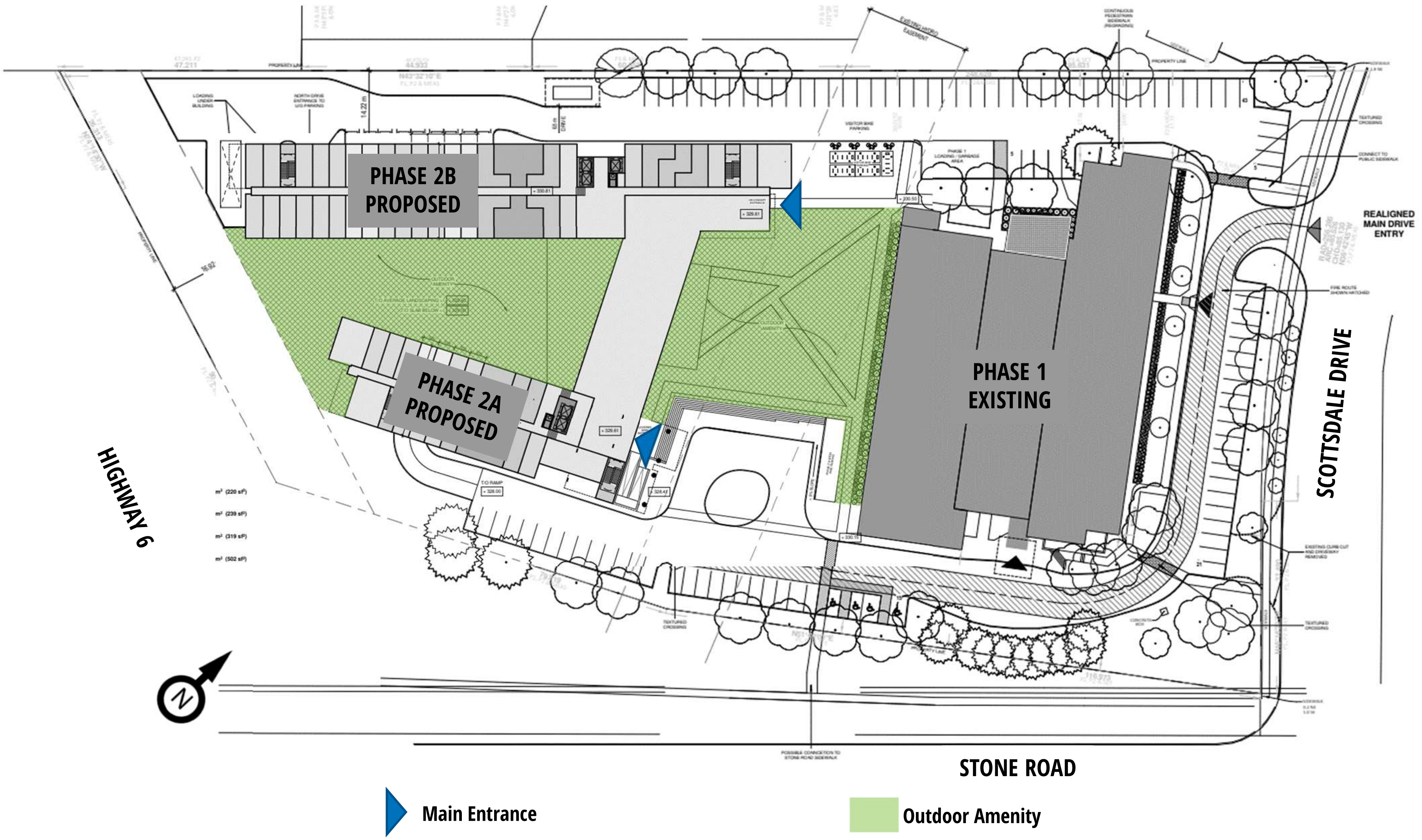


Image 3: Ground Floor Plan Identifying Key Outdoor Areas of Interest

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 the Region of Waterloo International Airport;
- 3D model and architectural plans of the proposed development received on July 4, 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 criteria specified in the *Pedestrian Level Wind Studies Terms of Reference* (May 2019) prepared by the city of Guelph.

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 flows in complex environments. For this analysis, CFD techniques were used to generate a virtual wind tunnel where flows around the site and its surroundings were simulated in full scale. The computational domain that covered the site and its surroundings was divided into millions of small cells where calculations were performed, yielding a prediction of wind conditions across the entire study domain. CFD excels as a tool for wind modelling, presenting early design advice, comparing different design and site scenarios, resolving complex flow physics, and helping diagnose problematic wind conditions.

While the computational modelling method used in the current assessment does not explicitly simulate the transient behaviour of turbulent wind, its effects were estimated based on other calculated quantities. RWDI has found this approach to be appropriate for the assessment of typical wind comfort conditions. Wind safety issues, which relate to transient, higher-speed gusts, are discussed qualitatively, based on the CFD predictions and our extensive wind-tunnel experience for similar projects.

In order to quantify the transient behaviour of wind and refine any conceptual mitigation measures, a more detailed assessment would be required using either boundary-layer wind tunnel or more detailed transient computational modelling.

2.3 Simulation Model

CFD simulations were completed for two scenarios:

- Existing: Existing Phase 1 development and surroundings.
- Proposed: Proposed Phase 2 development with the existing Phase 1 and other 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 5 and 6, 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 small 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 approximately 1.5 m above concerned levels, to the mean wind speed at a reference height. The data was then combined with meteorological records obtained from the Region of Waterloo International Airport to determine the wind speeds and frequencies in the simulated areas.

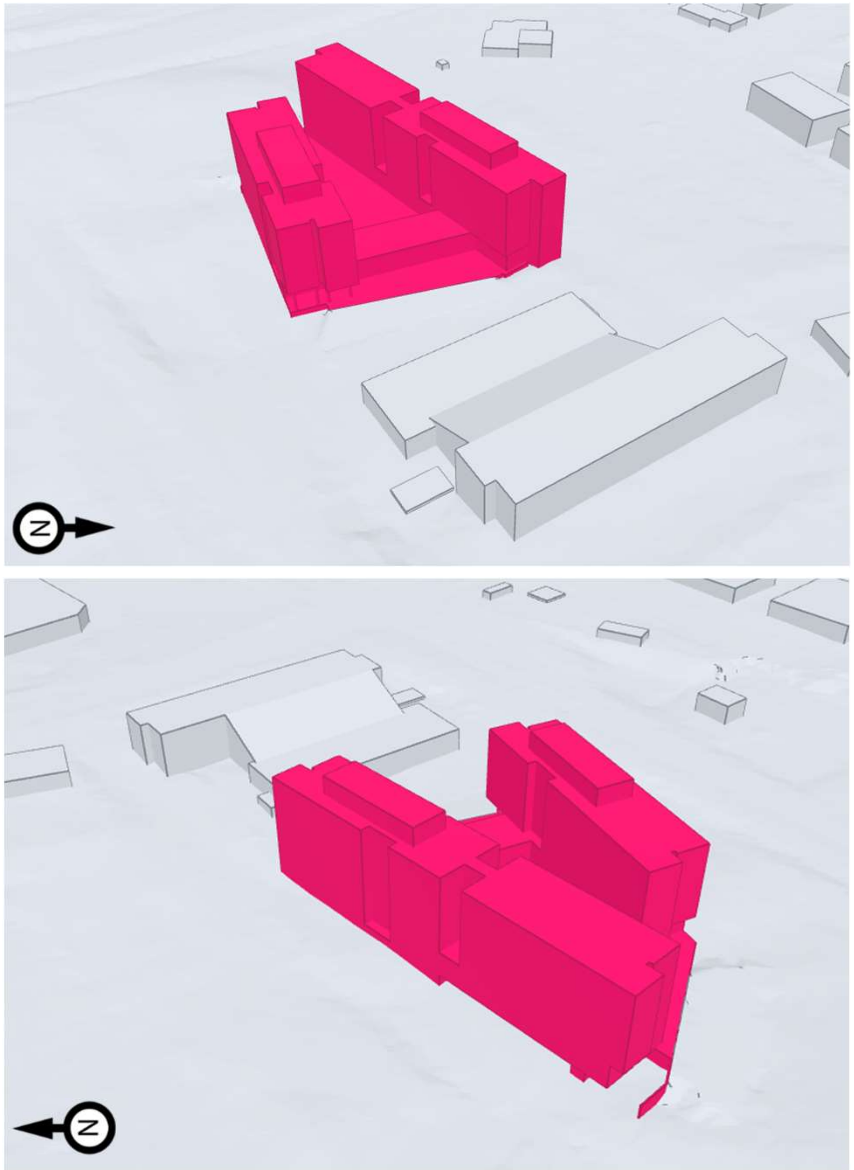


Image 4: Computer Model of the Proposed Development

2. METHODOLOGY

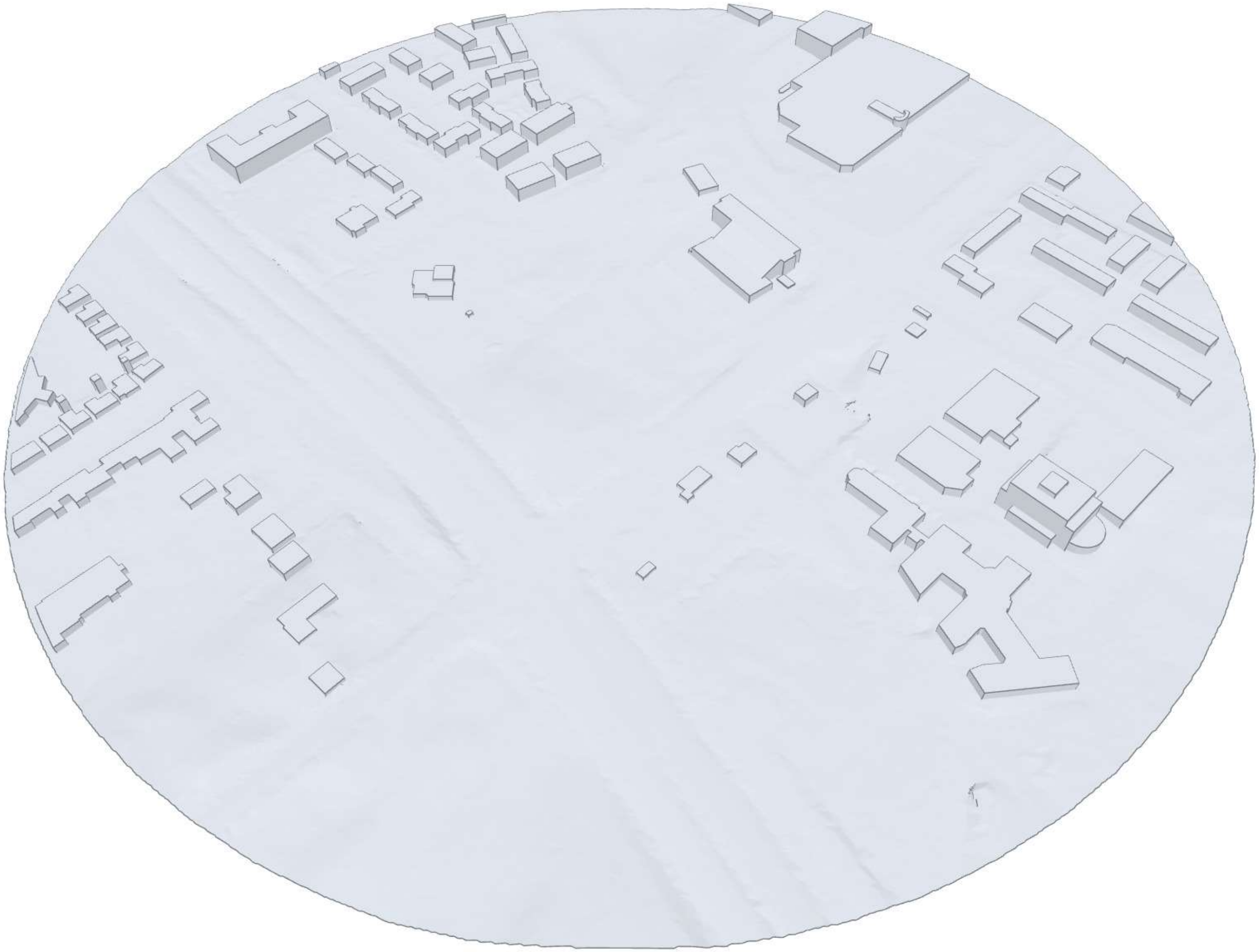


Image 5: Computer Model of the Existing Site and Extended Surroundings

2. METHODOLOGY

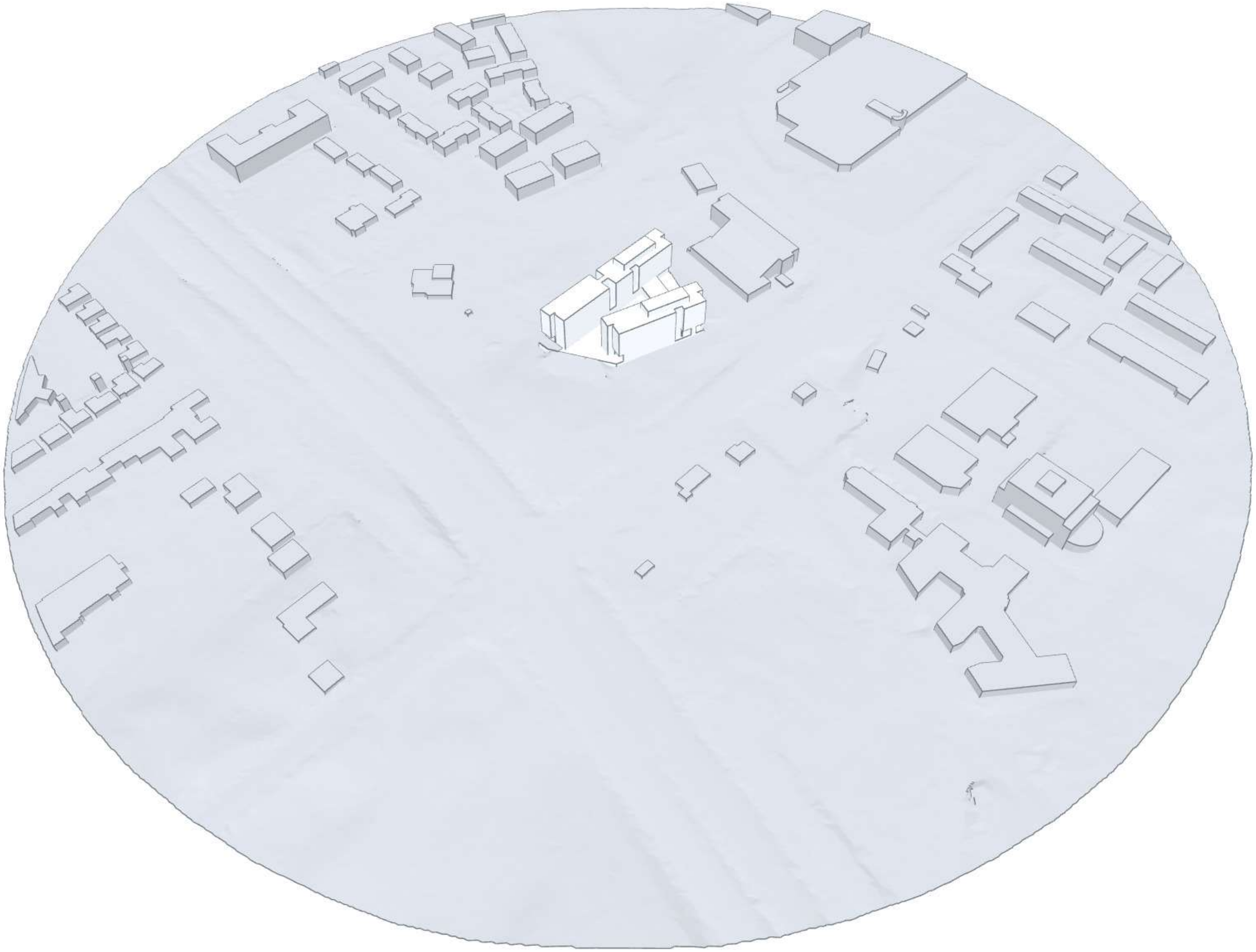


Image 6: Computer Model of the Proposed Site and Extended Surroundings

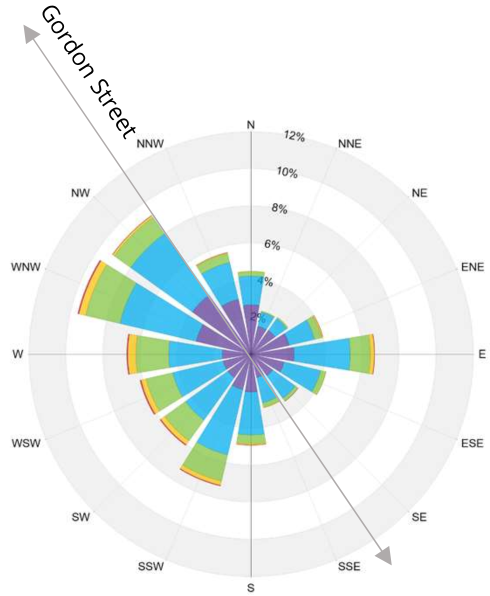
2. METHODOLOGY

Long-term wind data recorded at the Region of Waterloo International Airport between 1991 and 2021, 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.

Winds from the southwest and northwest quadrants, as well as the east are predominant in both seasons.

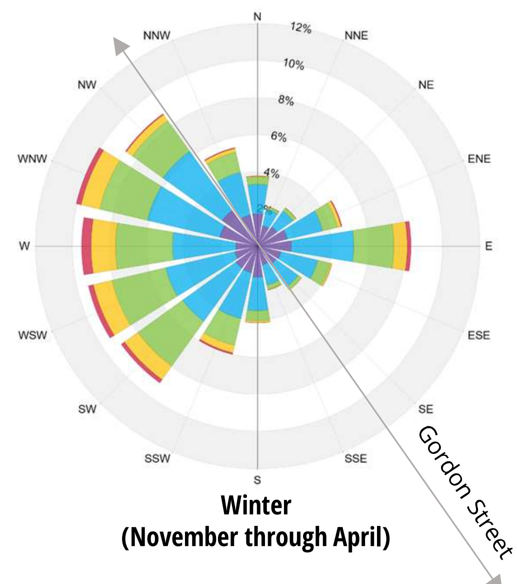
Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) are more frequent in the winter (red and yellow bands in Image 7). These winds potentially could be the source of uncomfortable or severe wind conditions, depending on the site exposure and development design.

Wind statistics were combined with the simulated data to predict the wind conditions at the project site and assessed against the wind criteria for pedestrian comfort.



Summer
(May through October)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	14.1	6.6
1-10	33.5	24.5
11-20	37.2	38.9
21-30	12.7	21.8
31-40	2.1	6.5
>40	0.3	1.7



Winter
(November through April)

Image 7: Directional Distribution of Wind Approaching the Region of Waterloo International Airport (1991 to 2021)

3. WIND CRITERIA

The criteria specified in the *Pedestrian Level Wind Studies Terms of Reference* (May 2019) prepared by the city of Guelph are used in the current study and presented below.

Comfort Category	GEM Speed (km/h)	Description
Sitting	≤ 10	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away
Standing	≤ 15	Gentle breezes suitable for main building entrances, bus stops, plazas, and other places where pedestrians may linger
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 of this magnitude are considered a nuisance for all pedestrian activities, and wind mitigation is typically recommended

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

Notes:

1) GEM speeds are equal to the gust speed divided by 1.85, or the mean speed (whichever is larger); and,
2) GEM speeds listed above are based on a seasonal exceedance of 20% of the time between 06:00 and 23:00.
3) The safety criterion is based on an annual exceedance of 9 hours or 0.1% of the time for 24 hours a day.

Wind conditions are considered suitable for sitting, standing, 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 unsafe, uncomfortable or are not compatible with the intended pedestrian use.

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.

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.

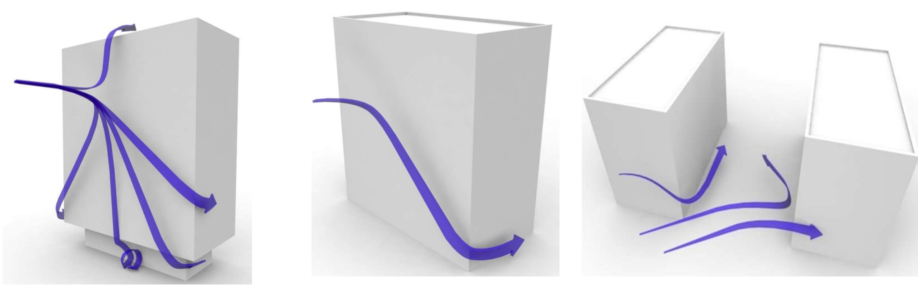
The criteria specified in the *Pedestrian Level Wind Studies Terms of Reference* (May 2019) prepared by the city of Guelph are used in the current study and is presented below.

4. RESULTS AND DISCUSSION

4.1 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*. When winds travel through spaces between buildings, under bridges, or in passages, flow tends to be accelerated, resulting in *Channelling*. These flow patterns are illustrated in Image 8.

The project, at seven storeys, will be taller than the buildings that exist in the surrounding area. The project is expected to redirect winds around it; however, potential wind impacts would be moderated by the orientation of the building massing, providing shelter to areas of interest from prevailing easterly and westerly winds.



Downwashing Corner Acceleration Channelling

Image 8: General Wind Flow Patterns

4.2 Presentation of Results

The results of the assessment are presented and 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, approximately 1.5 m above the concerned level in Images 9 through 11. The assessment against the safety criterion was conducted qualitatively based on the predicted wind conditions and our extensive experience with wind tunnel assessments. The discussion includes recommendations for wind control to reduce the potential for high wind speeds for the consideration of the design team.

<u>Target Conditions</u>

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 use of passive spaces are anticipated, such as outdoor amenities, especially during the summer when these areas are typically in use.

4.3 Existing Scenario

The existing site includes an empty lot, and the parking lot for the Phase 1 building. Wind conditions at most areas in the existing scenario are comfortable for standing in the summer (Image 9a) and for walking in the winter (Image 9b). Away from the existing site, elevated wind speeds are expected in winter at the intersection of Hanlon Parkway and Stone Road West, and in the southwest and northeast parking lots surrounding the Phase 1 building (Image 9b).

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

4.4 Proposed Scenario

4.4.1 Sidewalks and Neighbouring Properties

Although the introduction of a relatively tall building in a low-rise context will result in an increase in wind speeds, the orientation of the project massing is expected to provide shelter from prevailing westerly winds to areas immediately around the proposed buildings, and to areas east of the site. The project is not expected to worsen wind conditions on neighbouring properties.

The resulting wind speeds at most sidewalks and areas outside the property are expected to continue to be comfortable for standing in the summer, and walking in the winter, similar to the existing scenario (Images 9c and 9d). These conditions are appropriate for sidewalk and parking uses.

During the winter months, higher wind speeds that are potentially uncomfortable for pedestrian use are expected occasionally at the southwest corner of Phase 2A, and at the northeast and southwest corners of Phase 2B as a result of corner-accelerated and channelling wind flows (Image 9d). These conditions occur within parking lots and ramps that will likely not be accessed by pedestrians, and therefore the high wind conditions may be acceptable.

Wind conditions around the proposed project are predicted to meet the safety criterion.

Note that trees on and around the site, not modelled in this CFD simulation, will lower wind speeds around them. Coniferous trees afford wind control benefits in the winter months as their foliage is retained throughout the year.

4. RESULTS AND DISCUSSION

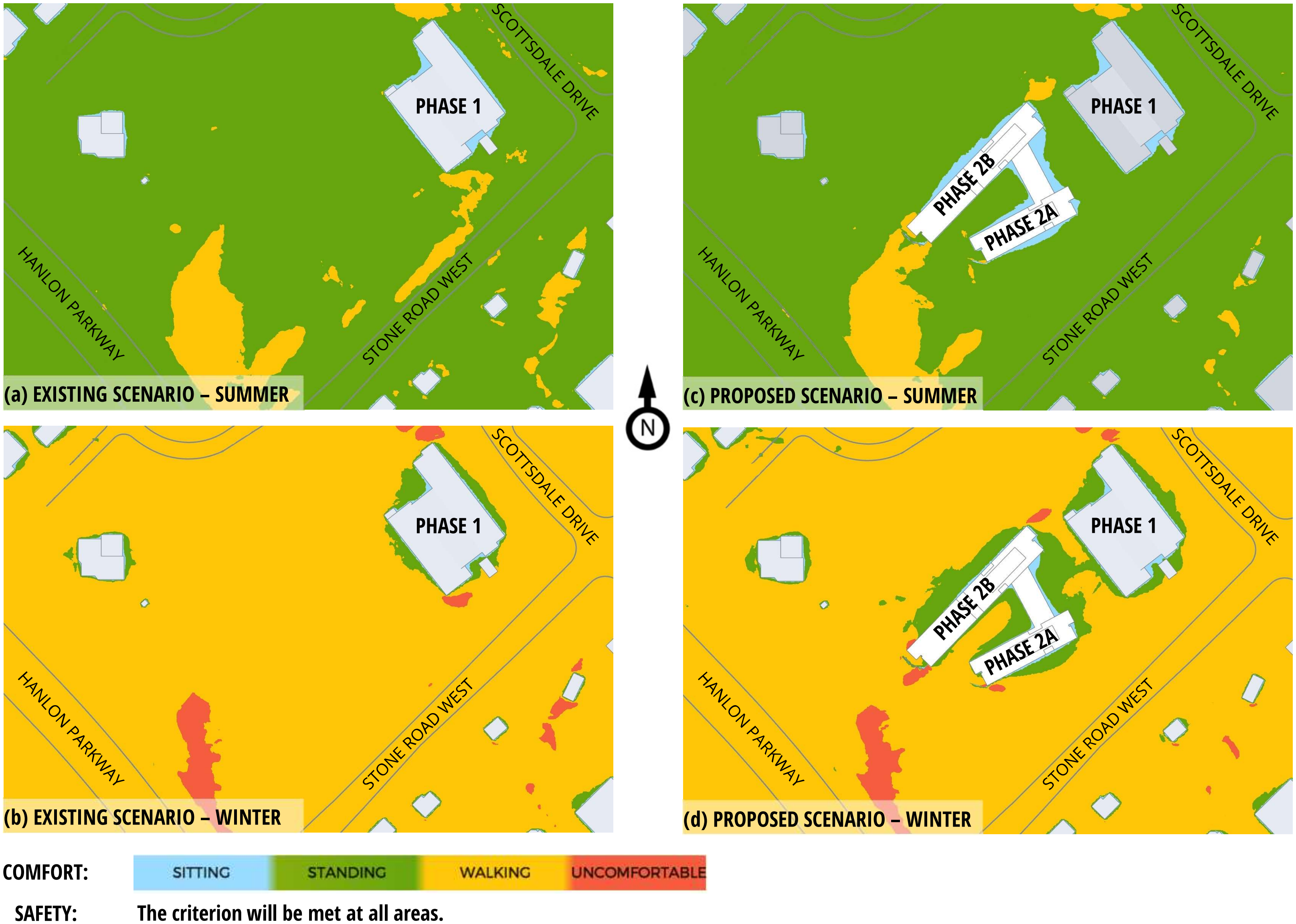


Image 9: Predicted Wind Conditions – GROUND LEVEL

4. RESULTS AND DISCUSSION

4.4.2 Main Entrances

The main entrances are under building overhangs along the east façade of the Phase 2 buildings. As a result, wind conditions near the entrance areas are expected to be comfortable for sitting in the summer and winter (Image 10). These conditions are appropriate for the intended pedestrian operation.

COMFORT CATEGORIES

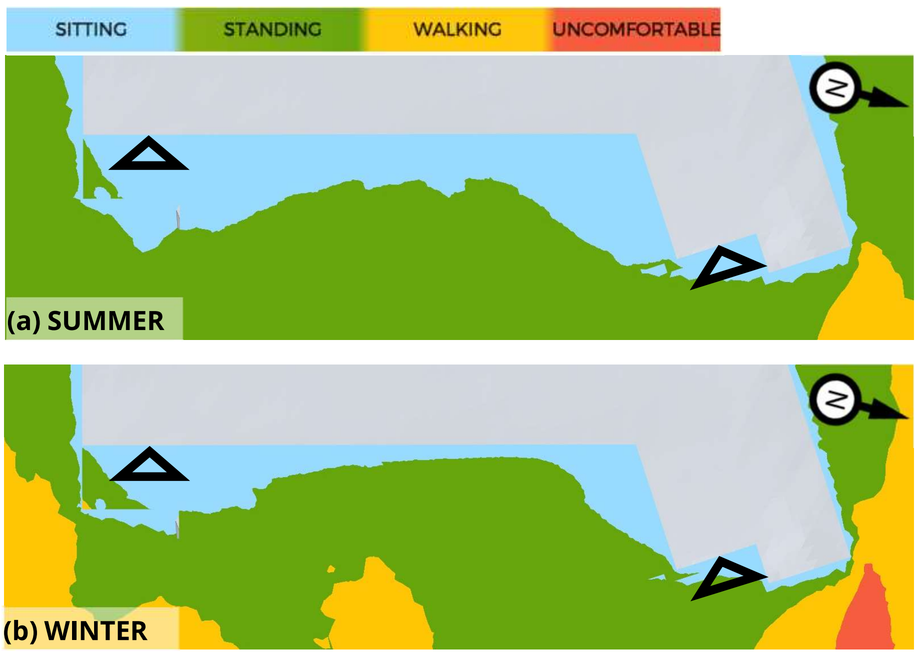


Image 10: Predicted Wind Conditions – MAIN ENTRANCES

4.4.3 Outdoor Amenities

Outdoor amenities are proposed to the east between the Phase 1 and 2 buildings, and to the west in the Phase 2 courtyard (Images 3 and 11). In the summer, wind speeds are expected to be suitable for sitting or standing (Image 11a). Conditions comfortable for sitting are desirable for passive activities, and conditions comfortable for standing would be appropriate for areas where one may linger or actively use the space.

During the winter, most areas within the outdoor amenities are predicted to be too windy for passive use as a result of winds that channel between the Phase 1 and 2 buildings, and between the Phase 2A and 2B towers (Image 11b). Elevated wind conditions may be acceptable, as these areas are not expected to be occupied as frequently during the colder months.

If lower wind speeds are desired during the summer (i.e., comfortable for sitting), the design team may consider implementing wind mitigation elements such as landscaped planters, trellises, and/or wind screens to diffuse prevailing and channelling wind flows. Mitigation elements can be strategically placed around areas intended for gathering or prolonged sitting in order to create respite from undesirable winds. We recommend any screen material to be at a maximum of 30% open porosity and at a height of 2 m. For landscape plantings, any leafy species is beneficial; however, coniferous and/or marcescent species would be required if the mitigation of winds during winter is desired, as they retain adequate foliage throughout the year to diffuse winds. Examples of these elements are shown in Image 12.

4. RESULTS AND DISCUSSION

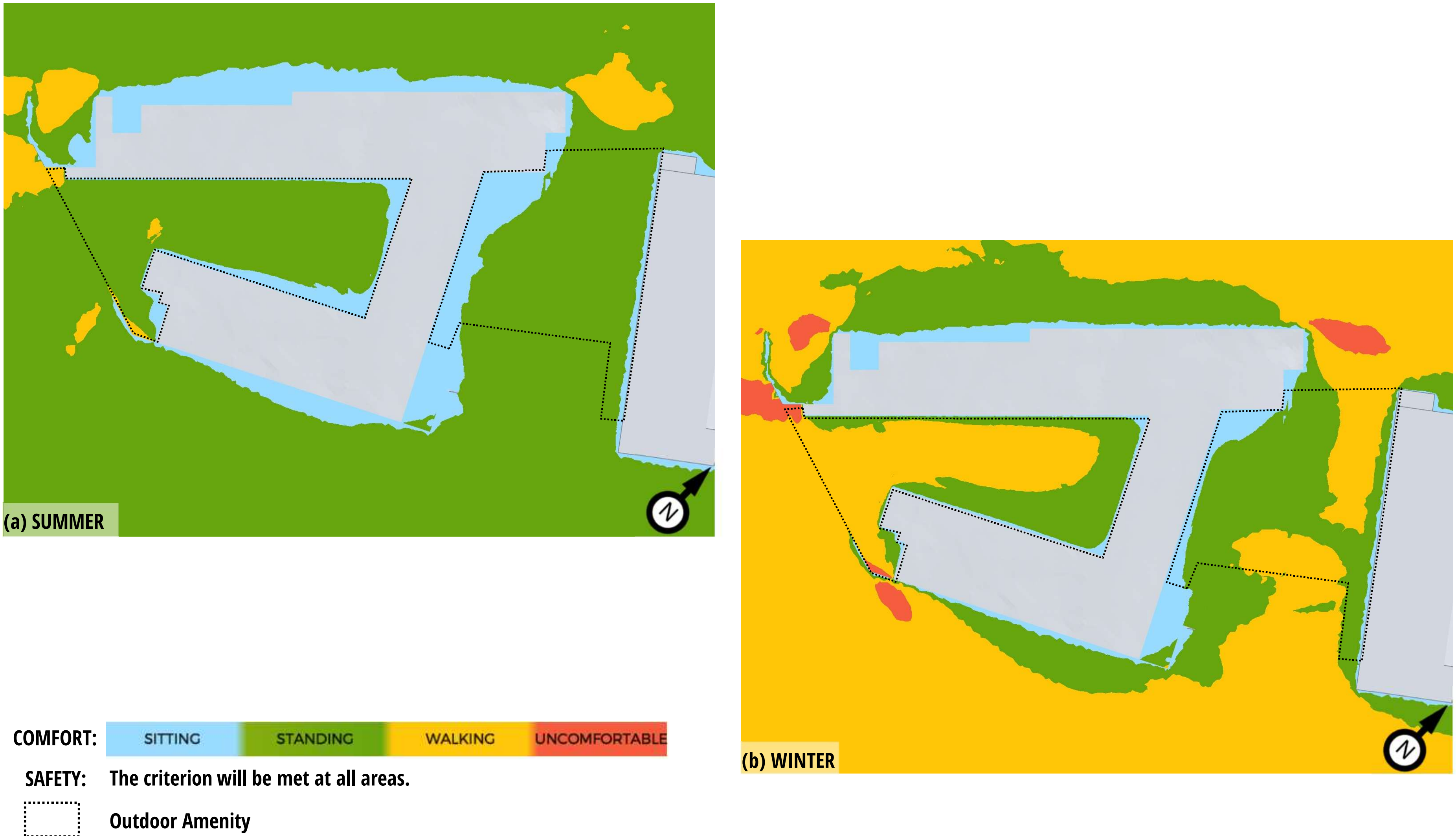


Image 11: Predicted Wind Conditions – OUTDOOR AMENITIES

4. RESULTS AND DISCUSSION

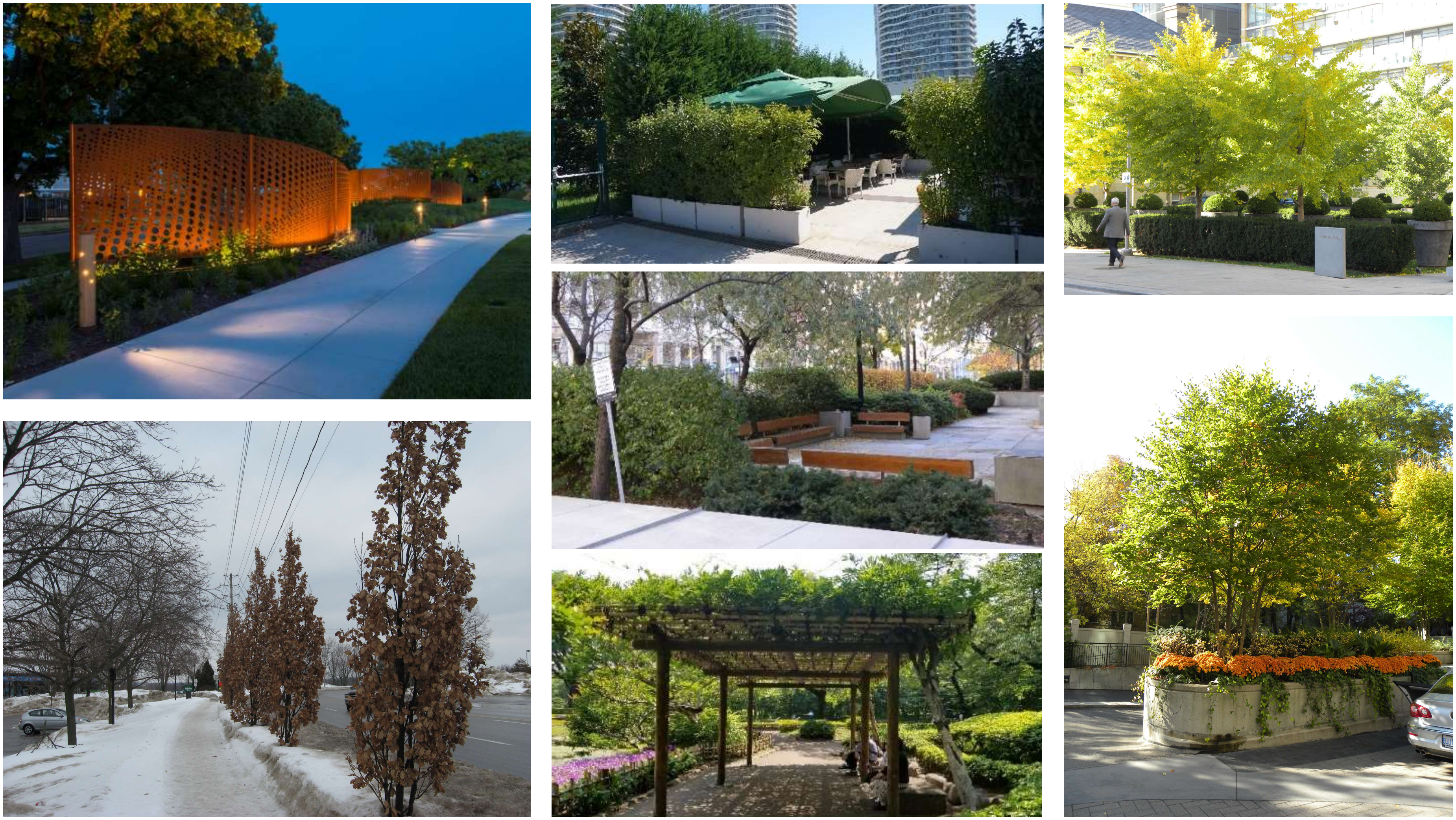


Image 12: Design Strategies for the Outdoor Amenities

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian-level wind impact of the proposed development at 601 Scottsdale Drive in Guelph, 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:

- Existing wind conditions are primarily considered suitable for the intended use throughout the year, where wind speeds meet the pedestrian safety criterion.
- Wind conditions at ground level, including the main entrances and surrounding sidewalks, are expected to be appropriate for the intended use. The project is not expected to have a notable influence on wind conditions on other properties, and the pedestrian wind safety criterion is anticipated to be met.
- Wind speeds in the outdoor amenities are predicted to be appropriate for passive use in some areas in the summer and may be higher than desired for passive use in the winter. Wind control strategies have been provided.
- Potentially uncomfortable wind speeds are expected to the southwest of the site in the winter and in the surrounding parking lots in the Existing and Proposed scenarios. However, these conditions may be acceptable as they are predicted to occur in non-pedestrian areas. 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.
- On September 19, 2023, after the computer simulation, revised architectural drawings were received by RWDI with changes to the 1-storey amenity space and more detailed landscaping design among other updates. These changes are minor with respect to general pedestrian wind conditions and the conclusions and recommendations provided in this report are still applicable.

6. DESIGN ASSUMPTIONS

The findings/recommendations in this report are based on the building geometry and architectural drawings communicated to RWDI in July 2023, 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)
Arch ZBA Coord Dwgs 23-07-04 r1	PDF	07/04/2023
3DView ALMA Guelph 23-07-04	CAD	07/04/2023

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 RWDI AIR Inc. for Forum 601 Scottsdale LP ("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.