506-510, 516 HESPELER ROAD AND 1000 LANGS DRIVE

CAMBRIDGE, ON

PEDESTRIAN WIND ASSESSMENT

PROJECT #2202703
MAY 25, 2022

SUBMITTED TO

Legion Heights Hespeler Inc.

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the potential wind conditions at pedestrian levels on and around the proposed project at 506-510, 516 Hespeler Road and 1000 Langs Drive in Cambridge, Ontario. The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development in support of the Official Plan Amendment (OPA) and Zoning By-law Amendment (ZBA) applications.

The project site is located west of Hespeler Road and south of Langs Drive, in low-rise industrial and commercial area as shown in Image 1.

The proposed project is a mixed-use development consisting of five 20-storey residential buildings (A through E), each with an outdoor amenity terrace at Floor 7. The buildings will have a tower-on-podium type of massing (Image 2), which is favourable for reducing wind impacts at ground level. Pedestrian areas of interest include the buildings entrances, sidewalks/walkways and the amenity terraces at Floor 7 (Image 3).

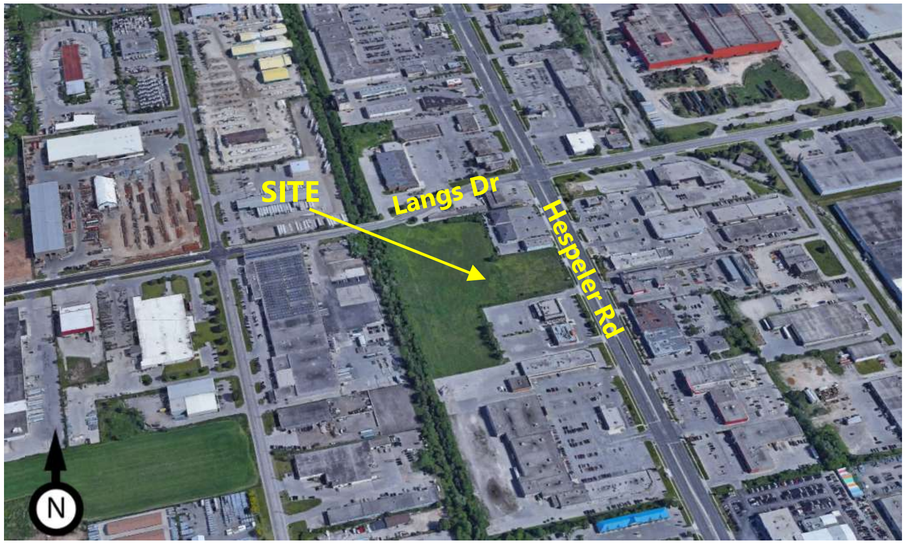


Image 1: Aerial View of the Existing Site and Surroundings
(Credit: Google Maps)

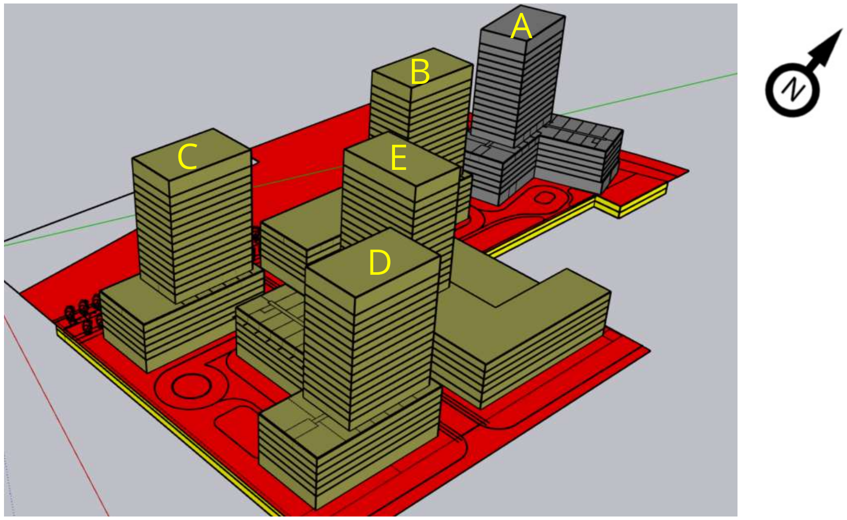


Image 2: Conceptual Massing

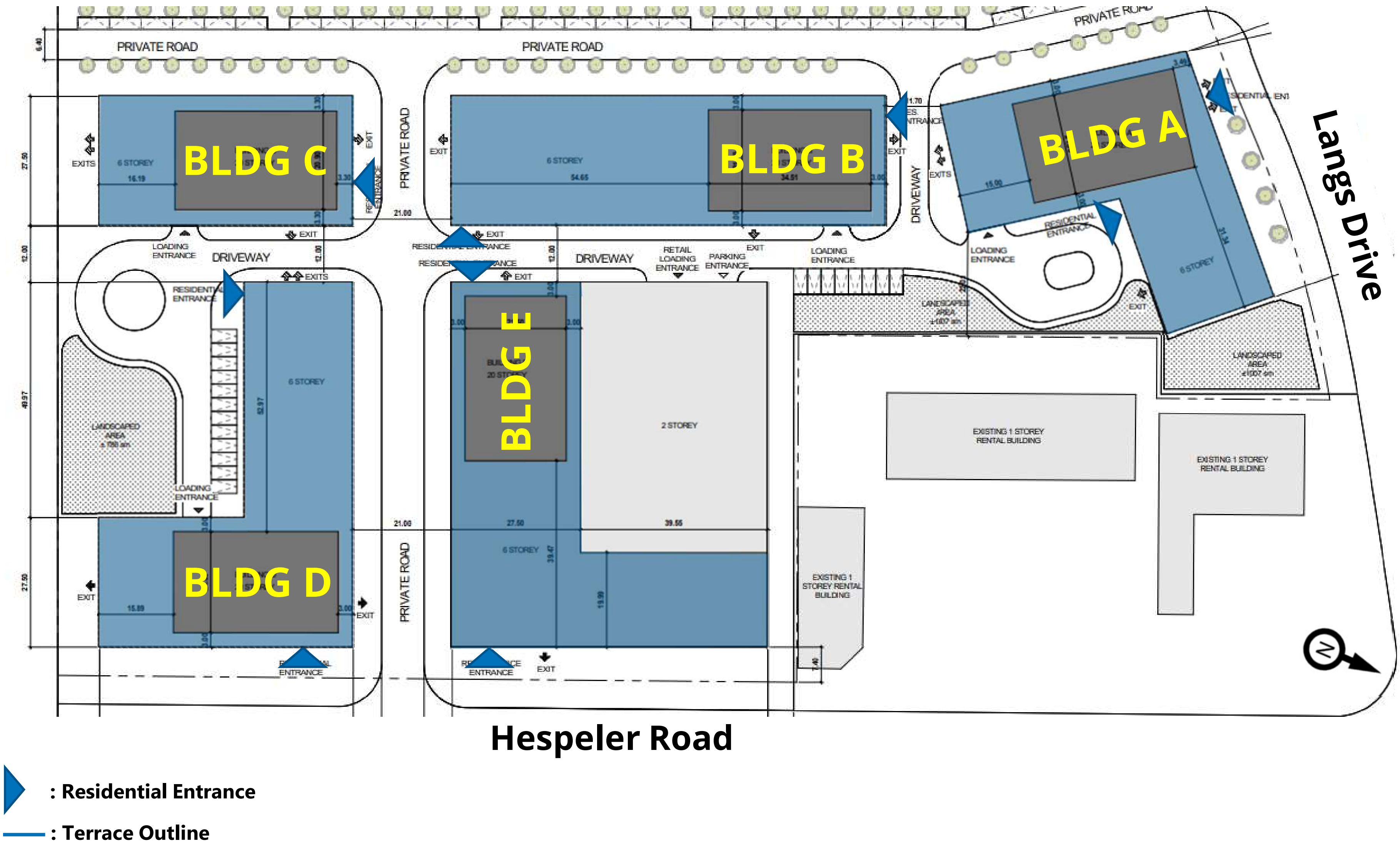


Image 3: Site Plan of the Proposed Buildings (Courtesy of BDP Quadrangle)

2. METHODOLOGY

2.1 Objective

The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development on pedestrian areas around it. The assessment is based on the following:

- A review of the regional long-term meteorological data from Region of Waterloo International Airport;
- 3D e-model of the proposed project and architectural drawings received from BDP Quadrangle on April 28, 2022;
- The use of *Orbital Stack*, an in-house computational fluid dynamics (CFD) tool, to aid in the assessment of wind comfort levels;
- The use of RWDI's proprietary tool WindEstimator[1] for estimating the potential wind conditions around generalized building forms;
- The RWDI wind comfort and safety criteria; and,
- Our engineering judgment, experience, and expert knowledge of wind flows around buildings[1-3].

Note that other wind-induced issues such as those relating to cladding and structural wind loads, door operability, snow impact, etc. are not part of the scope of this assessment

2.2 CFD for Wind Simulation

CFD is a numerical modelling technique for simulating wind flow in complex environments. For urban wind modelling, 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 are 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 urban wind modelling for providing early design advice, resolving complex flow physics, and helping diagnose problematic wind conditions. It is useful for the assessment of complex buildings and contexts and provides a good representation of general wind conditions which makes it easy to judge or compare designs and site scenarios.

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 behavior of wind and refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel or more detailed transient computational modelling would be required.

2. METHODOLOGY

2.3 Simulation Model

Wind flows were simulated using Orbital Stack, an in-house computational fluid dynamics (CFD) tool, for the Existing and Proposed site configurations with the existing surroundings.

The computer model of the proposed buildings is shown in Image 4, and the Existing and Proposed Configurations with the proximity model are shown in Images 5 and 6, respectively. For the purposes of this computational study, 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 wind speed profiles in the atmospheric boundary, approaching the modelled area were simulated for 16 directions (starting at 0°, at 22.5° increments around the compass). Wind data 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 were obtained. The data was then combined with meteorological records obtained from Region of Waterloo International Airport to determine the wind speeds and frequencies in the simulated areas.

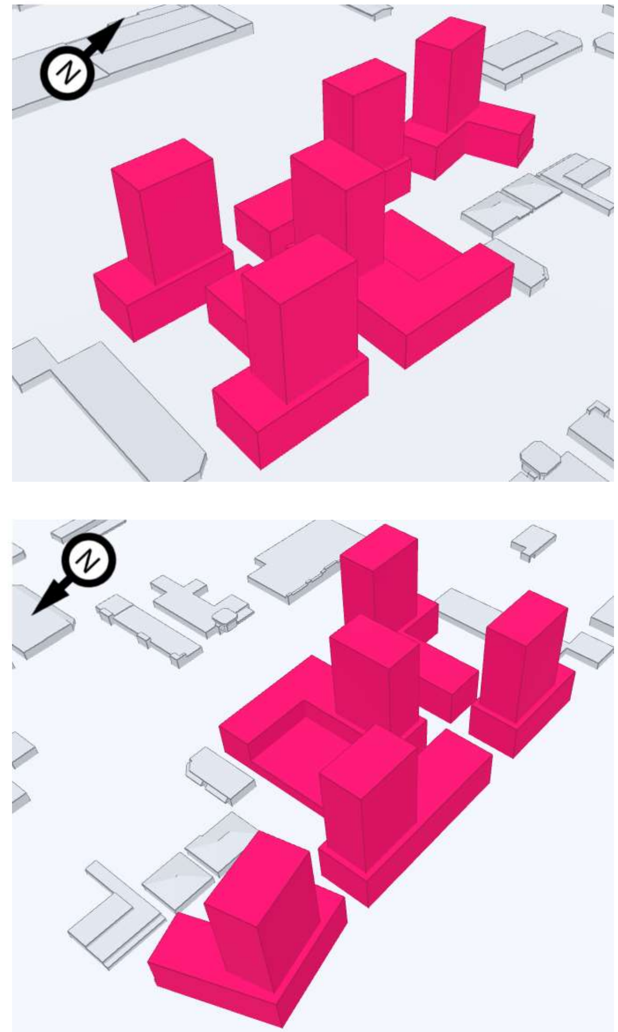


Image 4: Computer Model of Proposed Project

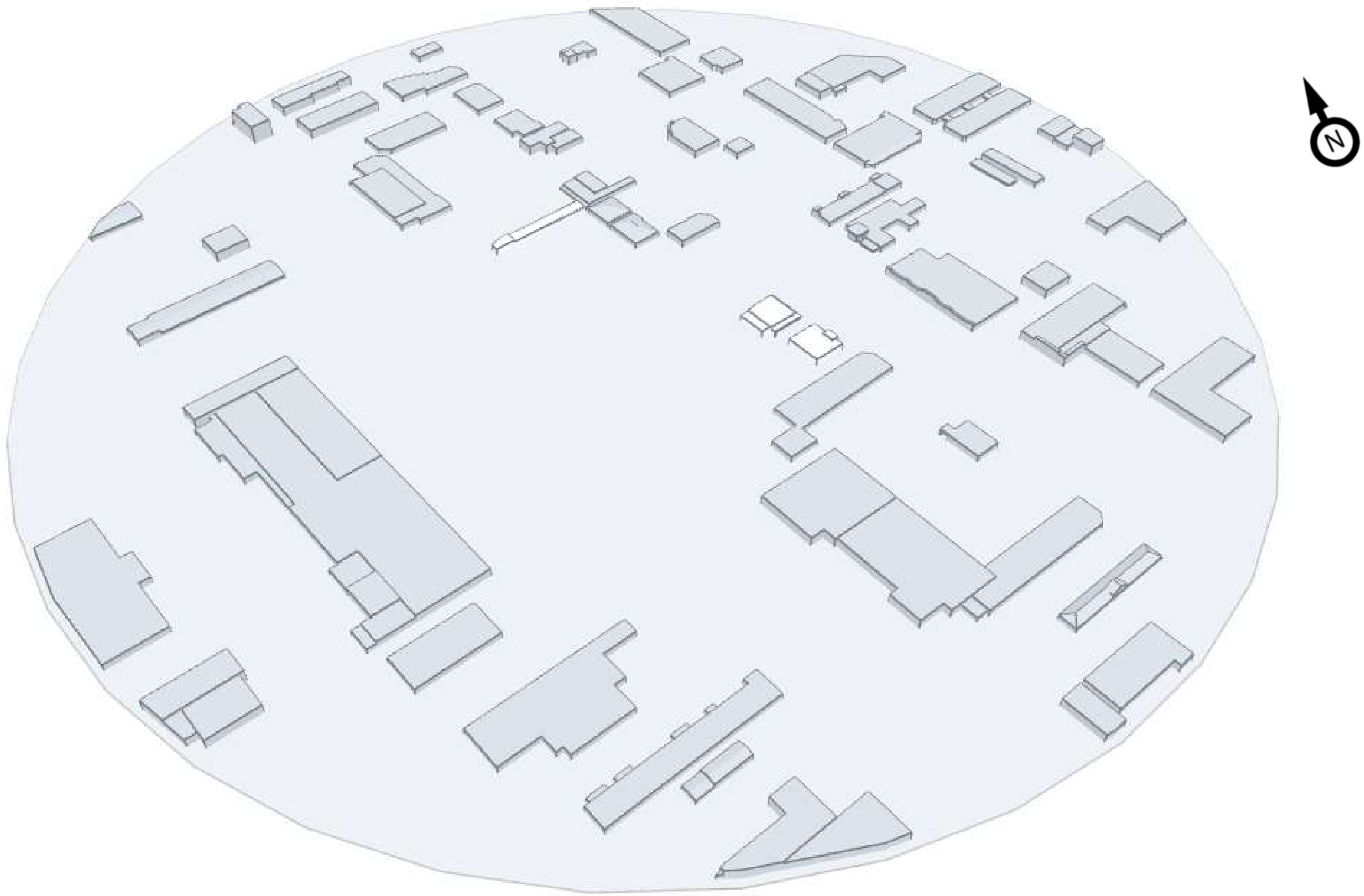


Image 5: Computer Model of the Existing Site and Extended Surroundings

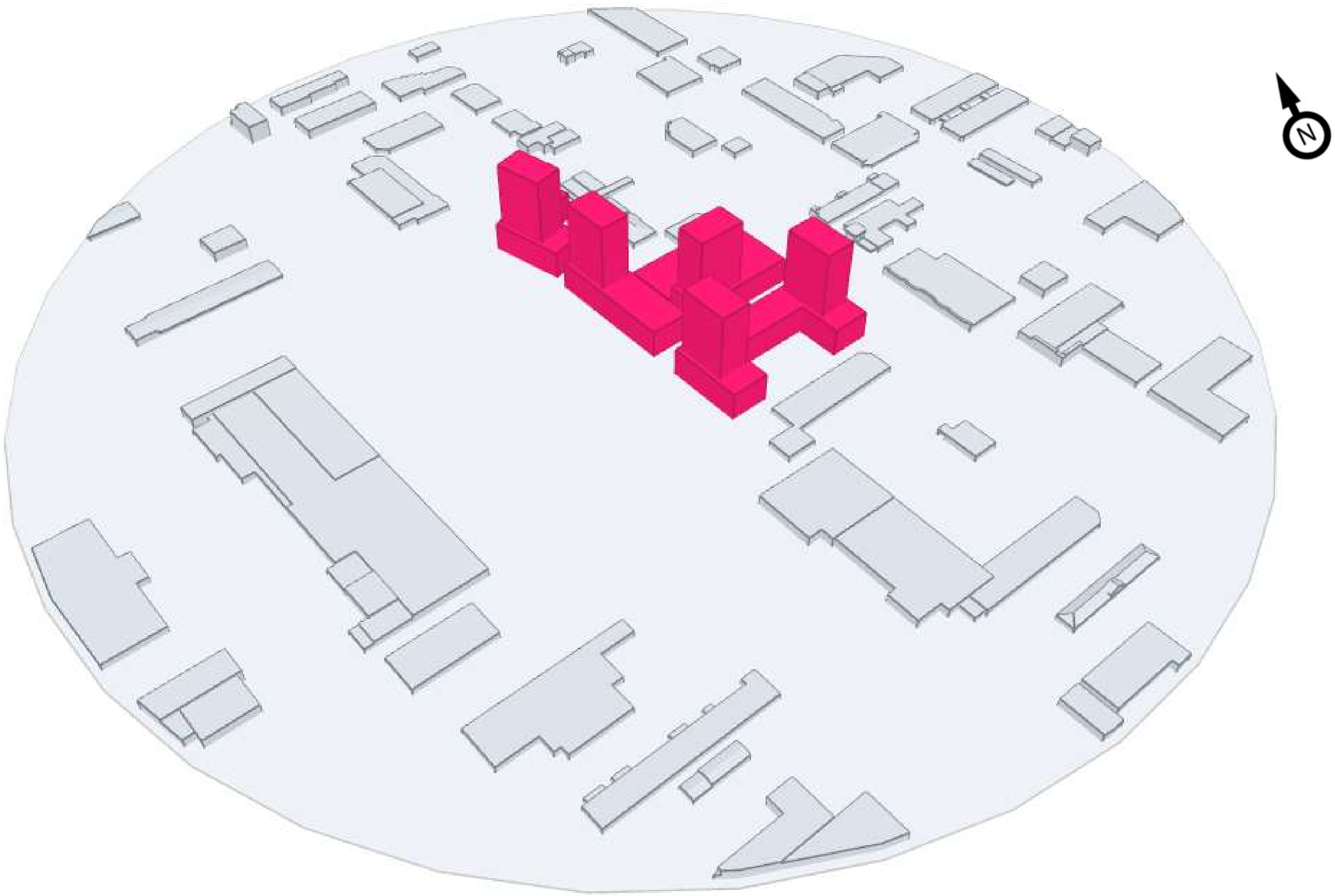


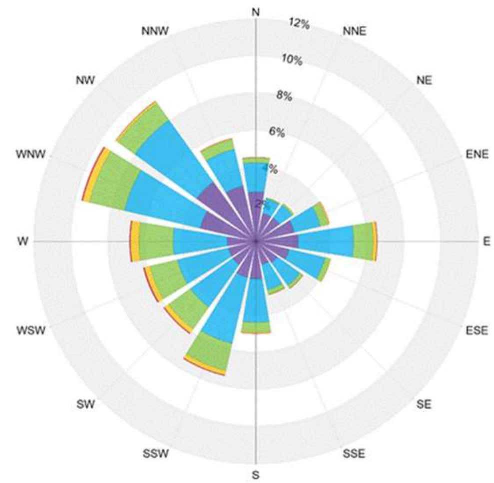
Image 6: Computer Model of the Proposed Development and Existing Surroundings

2.4 Meteorological Data

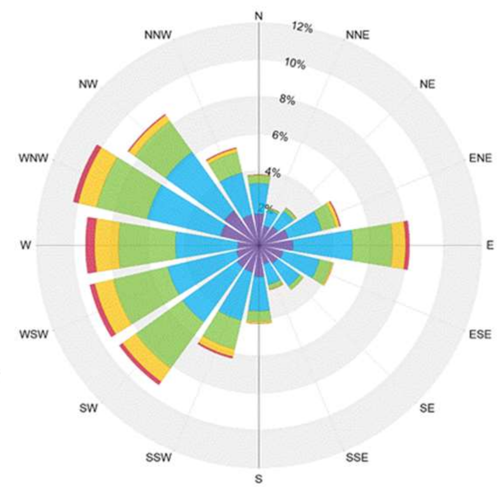
Long-term wind data recorded at Region of Waterloo International Airport between 1990 and 2020, inclusive, were analyzed for the summer (May to October) and winter (November to April) months. Image 7 graphically depicts the directional distributions of wind frequencies and speeds for these periods.

Winds from the east and southwest through northwest directions are predominant in both the summer and winter 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 (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)



Winter (November through April)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	13.2	6.4
1-10	33.6	24.4
11-20	37.4	38.8
21-30	13.2	22.3
31-40	2.2	6.4
>40	0.3	1.7

Image 7: Directional Distribution of Wind Approaching Region of Waterloo International Airport (1990 to 2020)

3. WIND CRITERIA

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

3.1 Pedestrian Safety Criterion

Pedestrian safety is associated with excessive gust that can adversely affect a pedestrian's balance and footing. If strong winds that can affect a person's balance (> **90km/h**) occur more than **0.1%** of the time or 9 hours per year, the wind conditions are considered severe.

3.2 Pedestrian Comfort Criteria

Wind comfort is expressed in terms of typical pedestrian activities that the speeds would be conducive to:

Sitting (≤ 10 km/h): Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away.
Standing (≤ 14 km/h): Gentle breezes suitable for main building entrances and bus stops.
Strolling (≤ 17 km/h): Moderate winds that are appropriate for window shopping and strolling along a downtown street, plaza or park.
Walking (≤ 20 km/h): Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable: The comfort category for walking is not met.

Wind conditions are considered suitable for sitting, standing, strolling or walking if the associated mean wind speeds are expected for at least four out of five days (**80% of the time**). Wind control measures are typically required at locations where winds are rated as uncomfortable or they exceed the wind safety criterion.

Note that these wind speeds are assessed at the pedestrian height (i.e., 1.5m above grade or the concerned floor level), typically lower than those recorded in the airport (10m height and open terrain).

These criteria for wind forces represent average wind tolerance. They are sometimes subjective and regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can also affect people's perception of the wind climate.

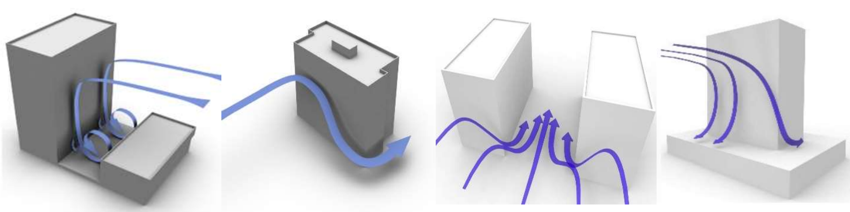
For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks and walkways where pedestrians are likely to be active and moving intentionally. Lower wind speeds comfortable for standing are required at the main entrances of the buildings, where users are likely to linger. Calm wind speeds suitable for sitting are desired in areas where prolonged periods of passive activities are anticipated, such as the proposed outdoor amenity areas, especially during the summer when these areas are typically in use.

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 two buildings are situated side by side, wind flow tends to accelerate through the space between the buildings due to *channelling effect* caused by the narrow gap. *Podium* massing, low roofs and canopies diffuse downwash and reduce the potential wind impact on the ground level. These flow patterns are illustrated in Image 8.

The project, at 20 storeys, will be substantially taller than the buildings that exist in the surrounding area. The project is expected to redirect winds around and between the buildings; however, potential wind impacts at grade level would be moderated by the podium massing.



DOWNWASHING CORNER ACCELERATION CHANNELLING EFFECT PODIUM

Image 8: General Wind Flow Patterns

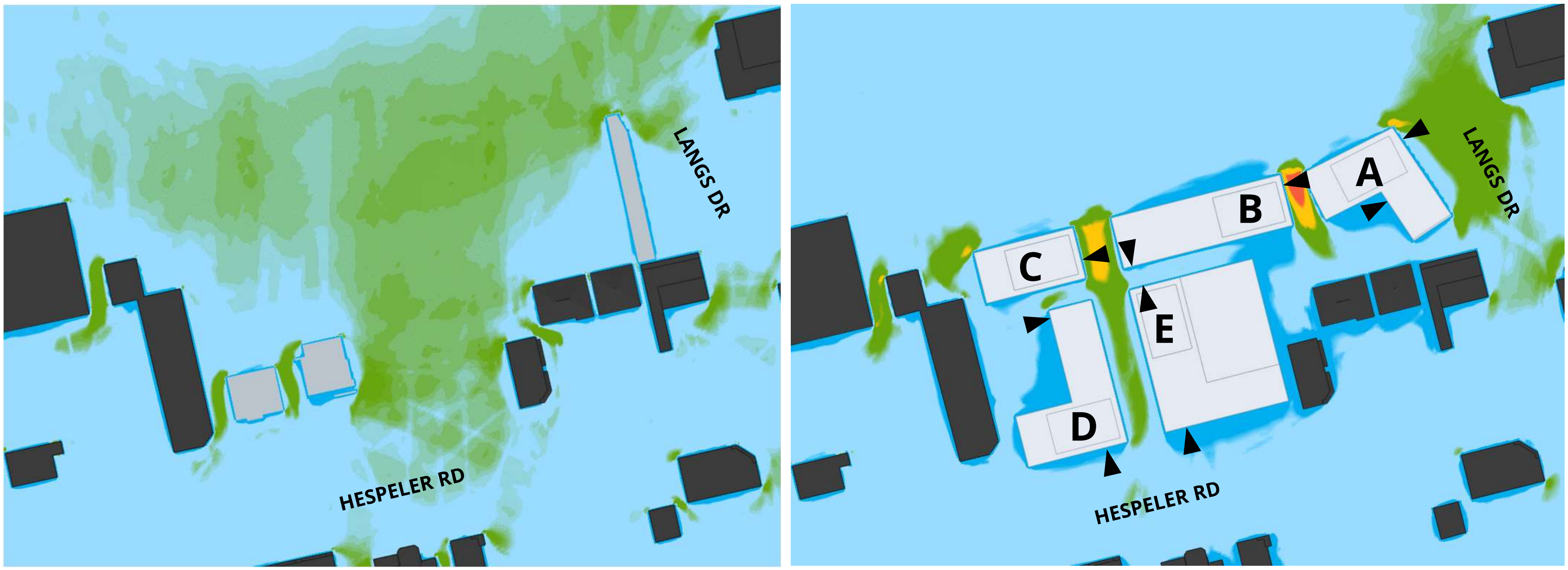
4.2 Simulation Results

The predicted wind comfort conditions for the existing and proposed configurations are presented in Images 9 (summer) and 10 (winter) for the grade level results, and in Image 11 for the amenity terraces. The results are presented as colour contours of wind speeds calculated based on the wind criteria (Section 3.2). The contours represent wind speeds at a horizontal plane approximately 1.5 m above the concerned level.

The assessment against the safety criterion (Section 3.1) was conducted qualitatively based on the predicted wind conditions and our wind tunnel experience with similar developments.

A detailed discussion of the expected wind conditions with respect to the prescribed criteria and applicability of the results follows in Sections 4.3. and 4.4. The discussion includes recommendations for wind control to reduce the potential of high wind speeds for the design team's consideration.

4. RESULTS AND DISCUSSION



(a) EXISTING SCENARIO – SUMMER

(b) PROPOSED SCENARIO – SUMMER

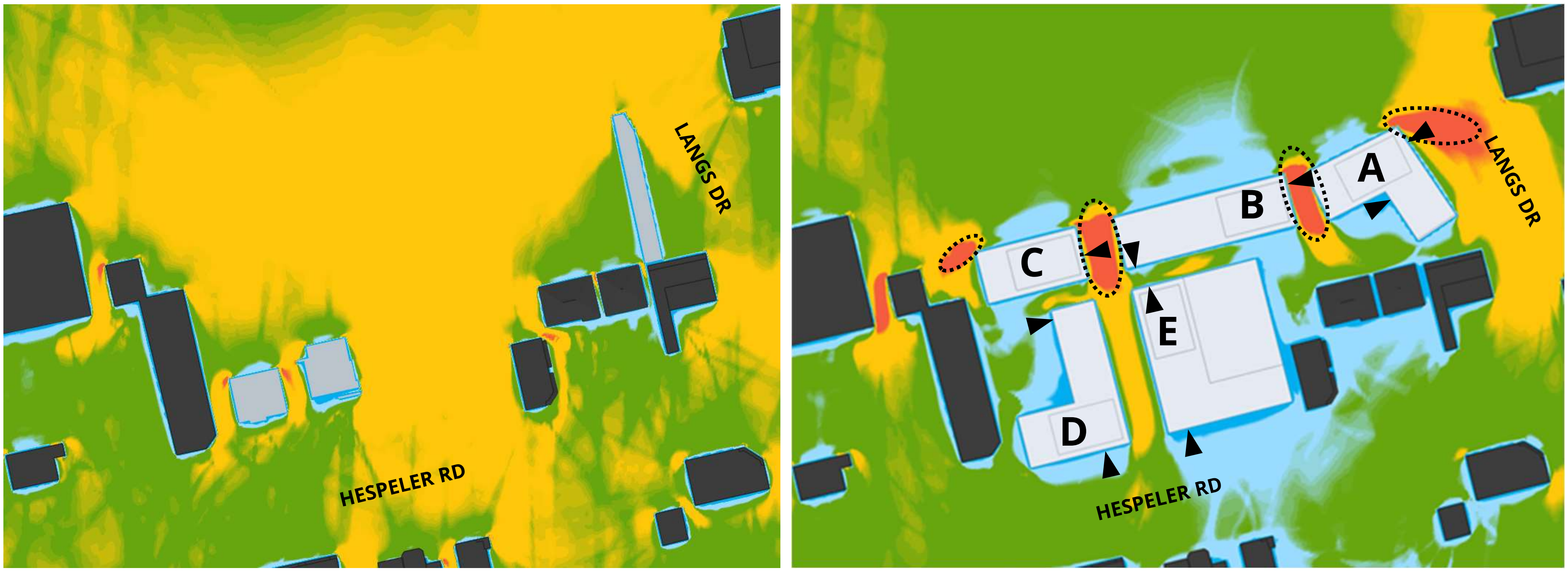
COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: **The criterion will be met at all areas.**

►: **Principal Entrance**

Image 9: Predicted Wind Conditions – GRADE LEVEL – Summer

4. RESULTS AND DISCUSSION



(a) EXISTING SCENARIO – WINTER

(b) PROPOSED SCENARIO – WINTER

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

Areas where possible safety exceedances might occur:

►: Principal Entrance

Image 10: Predicted Wind Conditions – GRADE LEVEL – Winter

4. RESULTS AND DISCUSSION

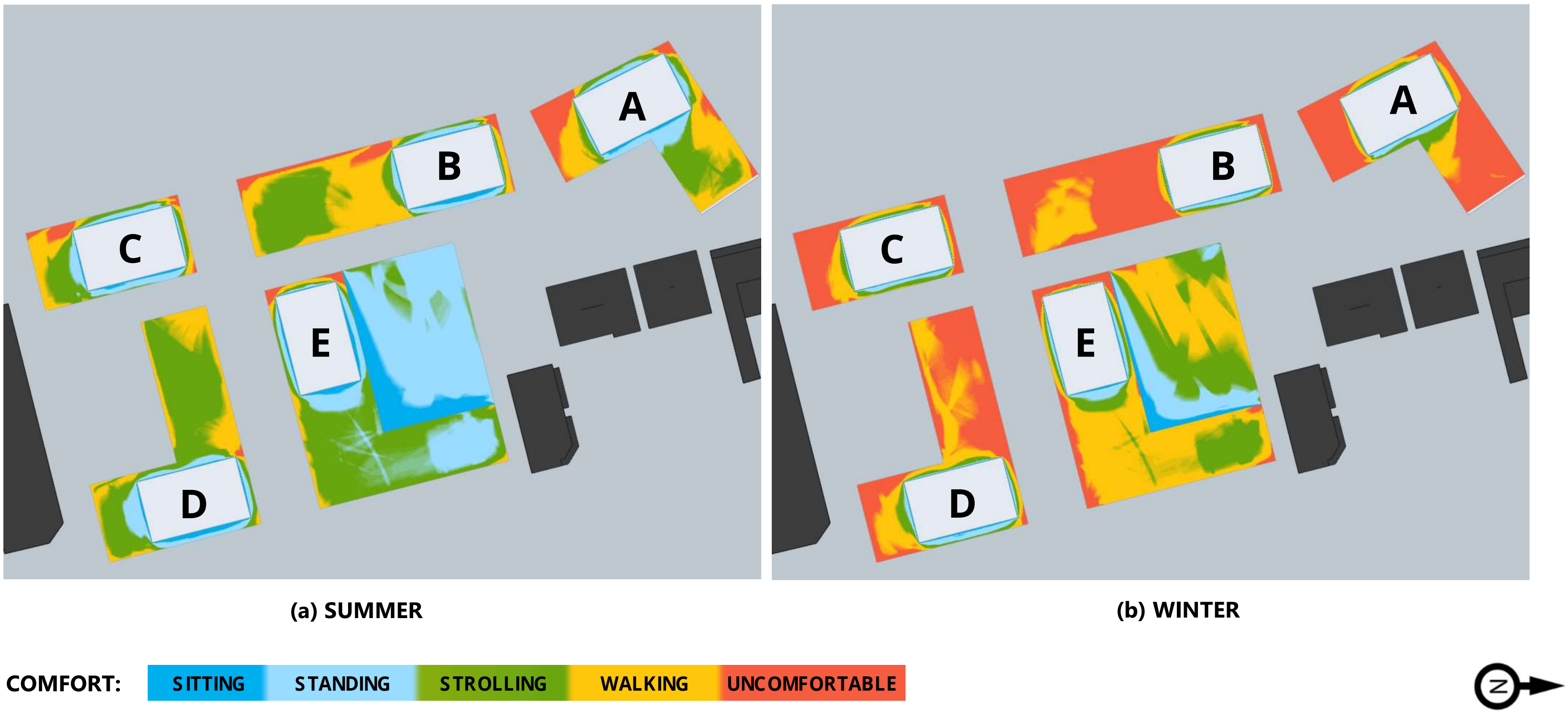


Image 11: Predicted Wind Conditions – Above-Grade Levels – Summer and Winter

4.3 Existing Scenario

The existing buildings on the site are low-rise, like the overall neighbouring buildings, and therefore will not redirect winds to create any notable impact. Wind conditions at most areas around the existing project site are considered comfortable for standing or strolling in the summer (Image 9a) and strolling or walking in the winter (Image 10a). Closer to the perimeters of the buildings, conditions are considered comfortable for sitting or standing year-round (blue regions in Images 9a and 10a). Potential uncomfortable wind conditions may occur in localized areas around exposed building corners in the winter (red regions in Image 10a).

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 Neighboring Properties

Although the introduction of tall buildings in a low-rise context will result in an increase in wind speeds, the impact of the project will be limited to the site and the project is not expected to worsen wind conditions on neighbouring properties. Positively, the proposed development is expected to provide sheltering for the neighbouring areas to the east and west, since the proposed buildings will block most of the prevailing easterly, northwesterly and southwesterly winds.

The resulting wind speeds at most sidewalks and areas outside the property are expected to be comfortable for walking or better throughout the year (Images 9b and 10b). These conditions are appropriate for sidewalk use.

Reduced wind speeds, comfortable for standing in the summer and strolling in the winter, are also expected at the areas to the immediate east and west of the project site, due to the sheltering provided by the proposed buildings (Images 9b and 10b).

However, uncomfortable wind conditions are anticipated between Buildings A and B in the summer (red region in Image 9b). Due to the stronger winds in the winter months, more areas with uncomfortable wind conditions are predicted on the west side of the buildings, more specifically, between Buildings A and B, B and C, as well as near the northwest corner of Building A and the southwest corner of Building C. Wind conditions at these areas may also exceed the annual safety criterion, as identified in Image 10b. Uncomfortable wind conditions are still anticipated at the southwest corner of the neighbouring building to the south of the project site in the winter (red region in Image 10b).

It is our understanding that these high wind speeds occur mainly on roadways. Wind tunnel testing could be conducted at a later design stage to confirm these wind predictions and to develop wind control solutions, if necessary.

4. RESULTS AND DISCUSSION

4.4.2 Entrances

Wind conditions at most residential entrances are expected to be comfortable for sitting or standing in the summer (Images 9b), which is suitable for the intended use. Higher wind speeds, comfortable for walking or strolling, are predicted at the residential entrance of Building C. Wind speeds comfortable for walking and potentially uncomfortable wind conditions are also anticipated near the north entrance of Building B.

In the winter, higher wind speeds are excepted near most of the residential entrances, except for the entrances of Building D and the east entrance of Building E. Additionally, the north entrances of Buildings A, B, and C are located at the areas of potential safety exceedances as shown in Figure 10b.

The simulation results did not include landscaping details. We understand that areas around the proposed building may be landscaped with trees and/or large shrubs. Tall and large plantings will have a localized impact and reduce wind speeds around them. It should be noted that deciduous trees are not effective for reducing wind speeds during the winter months when they are bare, and thus, coniferous vegetation that retain foliage during the colder months should be considered (Image 12).

If feasible, it is recommended to re-locate or recess the north residential entrances of Buildings A, B and C (Image 12).

Based on discussion with the design team, it understood that the design team are considering the use of 2 m high screens, in conjunction with canopies above the entrances. Such wind control measures are expected to lower wind speeds and improve the predicted wind conditions near the entrances. We recommended the use of wide canopies along the exposed west and north façades of the podiums and wrapped around the corners to help deflect downwashing winds and moderate the wind impact of the tall building (Image 12). To quantify the effectiveness of these mitigation features on wind, we would recommend wind tunnel testing be conducted at a later design stage.

Image 12: Design Strategies of Wind Control for Grade Level

4.4.3 Amenity Terraces

Wind speed increases with elevation; the outdoor amenities on the terraces of Buildings A through E at Floor 7 would be exposed to the prevailing winds due to their elevation above the low-rise surroundings. The terraces are also exposed to the downwashing and corner acceleration effects of the prevailing easterly, northwesterly and southwesterly winds (Image 8). As such, conditions on the terraces are expected to be too windy for passive use throughout the year (green, yellow and orange regions in Images 11a and 11b), with conditions potentially exceeding the annual safety criterion. The windy conditions during the winter months may not be of concern due to reduced usage of these outdoor spaces in the colder days.

The conditions at Floor 3 of Building E were assessed in the simulation. The results are predicted to be comfortable for sitting or standing at most areas during the summer (Image 11a). Therefore, the design team may consider moving the outdoor amenity of Building E to the 3rd Floor.

Note that the simulation model did not include guardrails/parapets along the perimeters of the terraces. The design team may consider adding landscaping elements, such as tall guardrails, trees, planers and trellises around these windy areas – see photos in Image 14 for examples.

Guardrails should be at least 2 m tall for wind control benefits. In addition, landscaping/hardscaping elements, in the form of screens, partitions, and trellises, and overhead features like arbors, canopies etc. should not be more than 50% porous. Wind tunnel testing would be the recommended method to assess the impact and effectiveness of any mitigation solutions.

4. RESULTS AND DISCUSSION

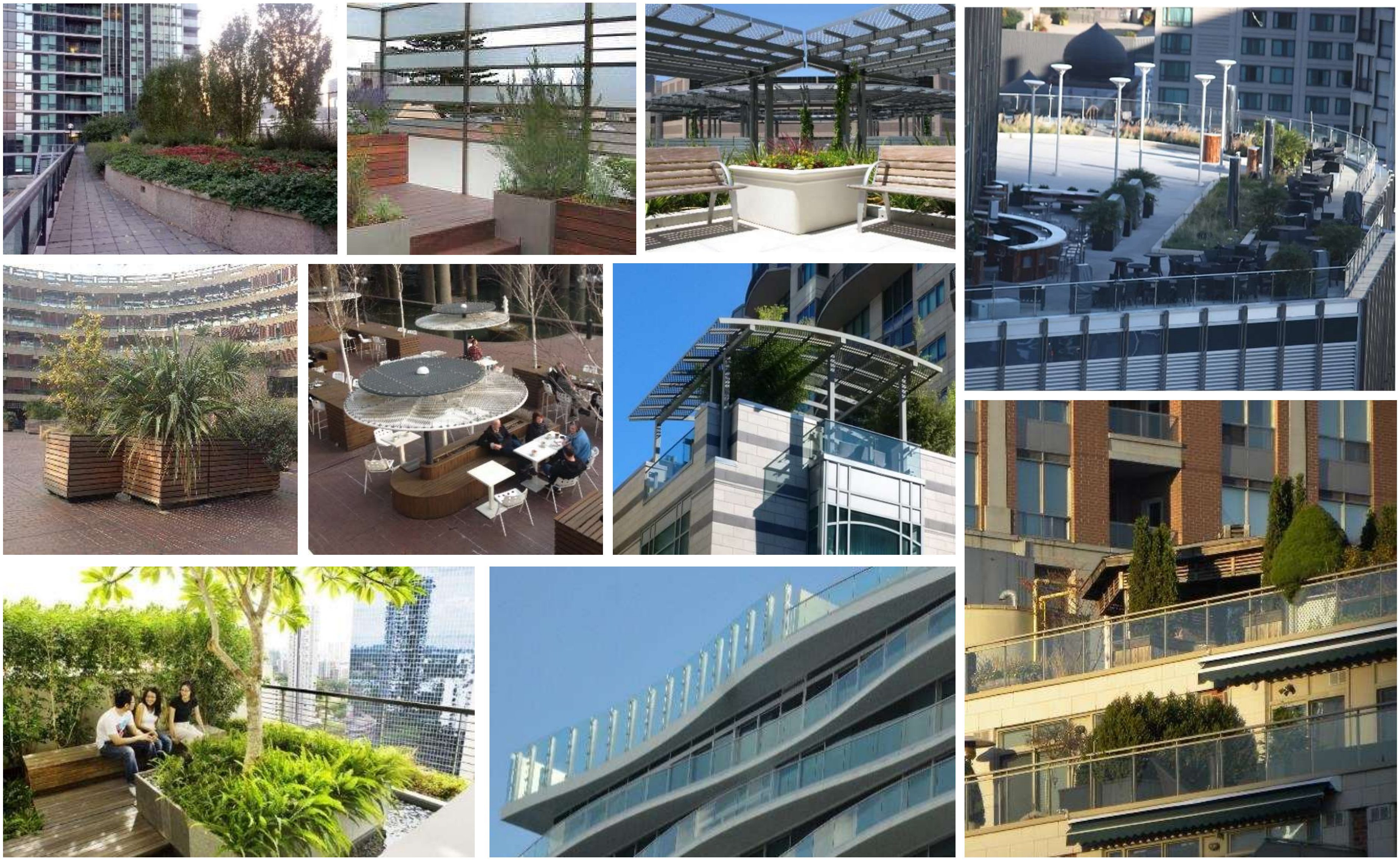


Image 12: Design Strategies for Wind Control at Floor 7 Amenity Terraces.

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed project at 506-510, 516 Hespeler Road and 1000 Langs Drive in Cambridge, Ontario. Our assessment was based on the local wind climate, the current design of the proposed development, the existing surrounding buildings, and computational modelling and simulation of wind conditions. Our findings are summarized as follows:

- The proposed buildings are taller than their surroundings, and therefore will redirect wind to ground level. However, the podium massing will help moderate wind impacts to a large extent.
- Existing wind conditions at most areas are considered appropriate for the intended pedestrian use.
- The project is not expected to have a notable influence on wind conditions on other properties. Positively, the proposed buildings will provide sheltering for the neighbouring areas to the east and west, from the prevailing easterly, northwesterly and southwesterly winds.
- Wind conditions at ground level, including the sidewalks and most entrances, are expected to be appropriate for the intended usage during the summer. Elevated wind speeds are predicted near the residential entrance of Building C, and uncomfortable wind conditions are expected Between Buildings A and B, where the residential entrance of Building B is located. Higher wind speeds that potentially exceed the safety criterion are predicted between the buildings and at multiple entrances during the winter.
- The design team is considering the use of 2 m high screens, in conjunction with canopies above the entrances. Such wind control measures are expected to lower wind speeds and improve the predicted wind conditions near the entrances. We recommended the use of wide canopies along the exposed west and north façades of the podiums and wrapped around the corners to help deflect downwashing winds and moderate the wind impact of the tall building.
- Wind speeds at Floor 7 terraces are predicted to be too windy and uncomfortable for passive use throughout the year, potentially exceeding the safety criterion. Wind conditions at the 3rd Floor of Building E are suitable for passive use in the summer, and thus, the design team may consider moving the outdoor amenity area of Building E from Floor 7 to Floor 3.
- Wind tunnel testing is suggested to quantify and assess the wind comfort and safety conditions on and around the project site and to confirm the effectiveness of any mitigation.

Wind control strategies are discussed in the report. 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.

6. APPLICABILITY OF RESULTS

The assessment presented in this report is for the proposed project at 506-510, 516 Hespeler Road and 1000 Langs Drive, based on the information provided by design team. In the event of any significant changes to the design, construction or operation of the building or addition of surroundings in the future, RWDI could provide an assessment of their impact on the pedestrian wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.

File Name	File Type	Date Received (mm/dd/yyyy)
2022-04-11 - Hespeler Road - Massing Model	Sketchup	04/11/2022
2022-04-28 - Hespeler Road - Preliminary Plans and Stats	PDF	04/28/2022
21-248-506-510 & 516 Hespeler Road_Landscape (2022-05-04)	PDF	05/04/2022

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.