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IBI Group Architects (Canada)

Date: May 31, 2018

To: Starlight Investments
1400 - 3280 Bloor Street West, Centre Tower
Toronto, Ontario M8X 2X3

Re: **Pedestrian Wind Assessment**
1485 Williamsport Drive & 3480 Havenwood Drive
Mississauga, Ontario
Novus Project #17-0260

Novus Team:

Sr. Engineer:	Jenny Vesely, P.Eng.
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TABLE OF CONTENTS

1.0 INTRODUCTION

Novus Environmental Inc. (Novus) was retained by the Starlight Investments to conduct a pedestrian wind assessment for the proposed development at 1485 Williamsport Drive and 3480 Havenwood Drive in Mississauga, Ontario. This report is in support the Official Plan Amendment (OPA) and Zoning By-law Amendment (ZBA) applications for the development.

1.1 Existing Development

The proposed development is located at 1485 Williamsport Drive and 3480 Havenwood Drive, just northeast of the Dixie Road and Bloor Street intersection. The site is currently occupied by parking lots and a low-rise maintenance building. **Figure 1** provides an aerial view of the immediate study area. A virtual site visit was conducted by Novus using Google Earth Pro™ images dated April 2015; these images are included in **Figures 2a** through **2d**.

Immediately surrounding the site are mid-rise residential buildings to the north, northeast, southeast, south, northwest and west. These existing buildings (A and B) are similar in height to the proposed development. To the north there is Gulleden Park, while to the east is a parking lot. Beyond the immediate surroundings there low-rise residential and commercial in all directions, and some high-rise residential to the southwest.

Approved developments and developments under construction in the surrounding area were also included as existing surroundings for the analysis. For this assessment no approved developments or developments under construction were found in a 500m radius.

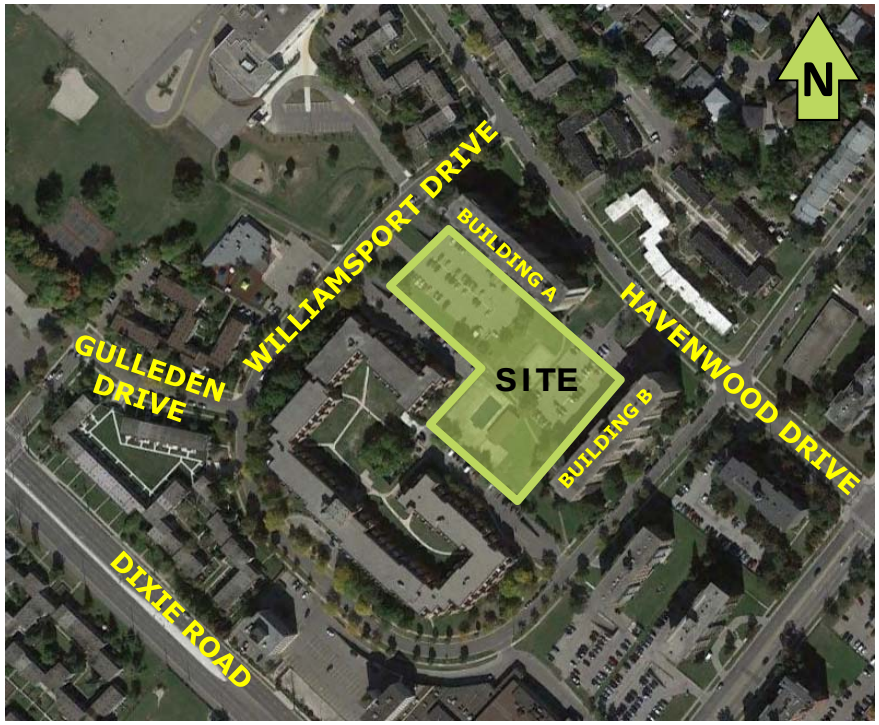

Figure 1: Aerial view of existing site and surroundings
Credit: Google Earth Pro™, dated October 9, 2016

Figure 2a: Looking southeast at site

Figure 2b: Looking southwest at site

Figure 2c: Looking northeast along Williamsport Drive

Figure 2d: Looking northwest along Havenwood Drive

1.2 Proposed Development

The proposed development includes two eight-storey residential buildings (Buildings C and D) connected by a two-storey residential lobby. On the west side of Building D there is an outdoor terrace, in addition to a terrace atop the residential lobby between the buildings. There is also an outdoor amenity space on the south half of the site.

An early rendering of the development is shown in **Figure 3**.

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. These features, as well as the outdoor amenity spaces and terraces, are shown in **Figure 4**. Also, to the north of Williamsport Drive there is a YMCA Child Care Centre.

Figure 3: Preliminary rendering of proposed development
Credit: IBI Group Architects (Canada), dated March 20, 2018

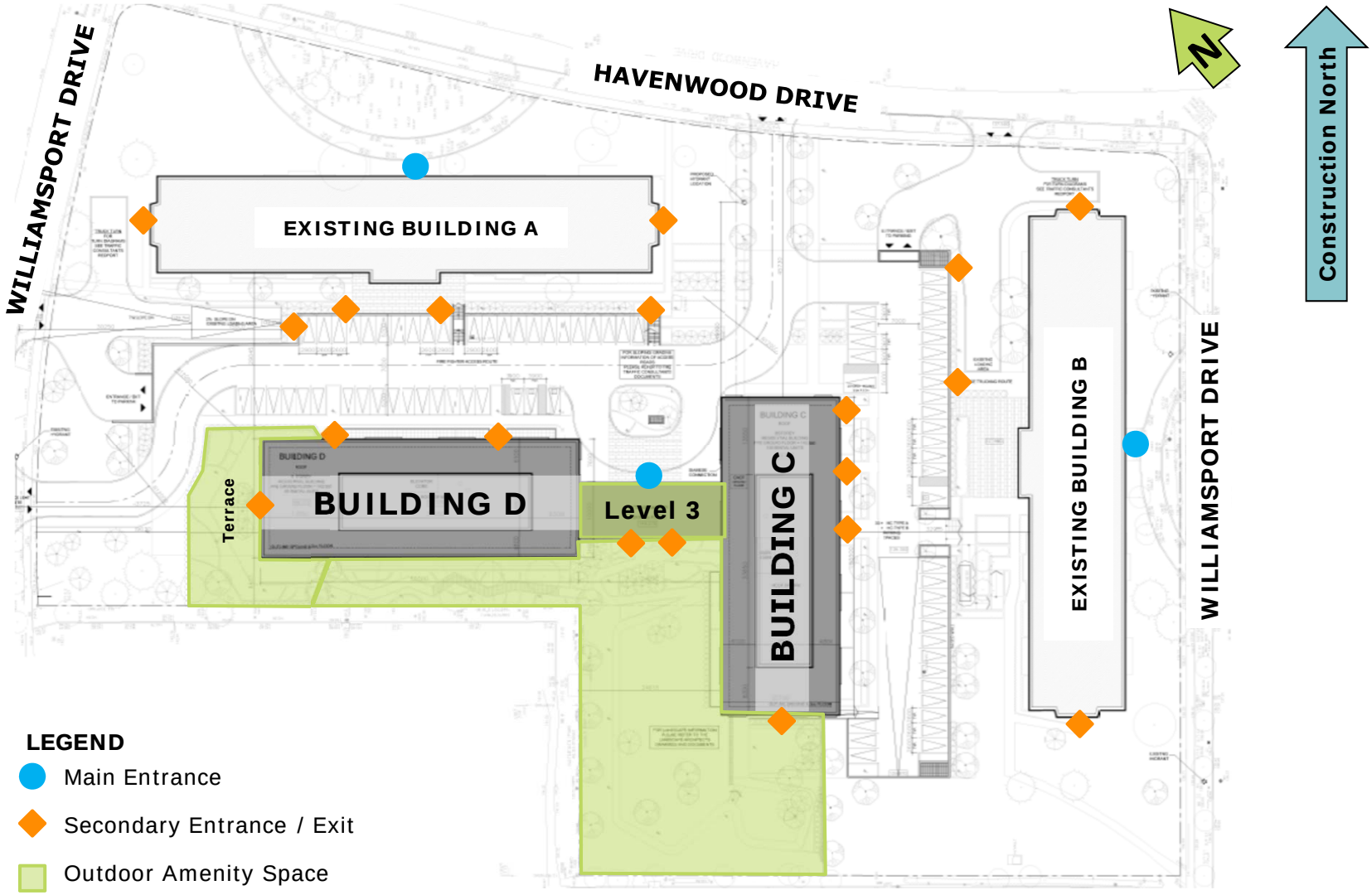

Figure 4: Areas of interest

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, especially when assessing mean wind speeds. This CFD-based mean wind speed assessment employs a comparable analysis methodology to that used in wind tunnel testing.

2.1 Methodology

Wind comfort conditions for areas of interest were predicted on and around the development site to identify potentially problematic windy areas. A 3D model of the proposed development as well as floor plans and elevations were provided by IBI Ground Architects (Canada) on April 12th and 16th, 2018. A view of the 3D model used in the computer wind comfort analysis is shown in **Figure 5**. This model included surrounding buildings within approximately 450 m from the study site. The simulations were performed using CFD software by Meteodyn Inc. Updated architectural information was provided May 16th, 2018; this information was taken into account with the text of the report.

The entire 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 various upwind conditions and wind characteristics encountered around the actual site. Wind flows for a total of 16 compass directions were simulated. Although wind speeds are calculated throughout the entire modeled area, wind comfort conditions were only plotted for a smaller area immediately surrounding the proposed development.

Wind flows were predicted for both the existing site, as well as with the proposed development for comparison purposes. The CFD-predicted wind speeds for all test directions and grid points were then 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; these results are shown in the various wind flow images. The analysis of wind conditions is undertaken for two seasons: Winter (November to April) and Summer (May to October).

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, etc.) are not considered in the comfort rating.

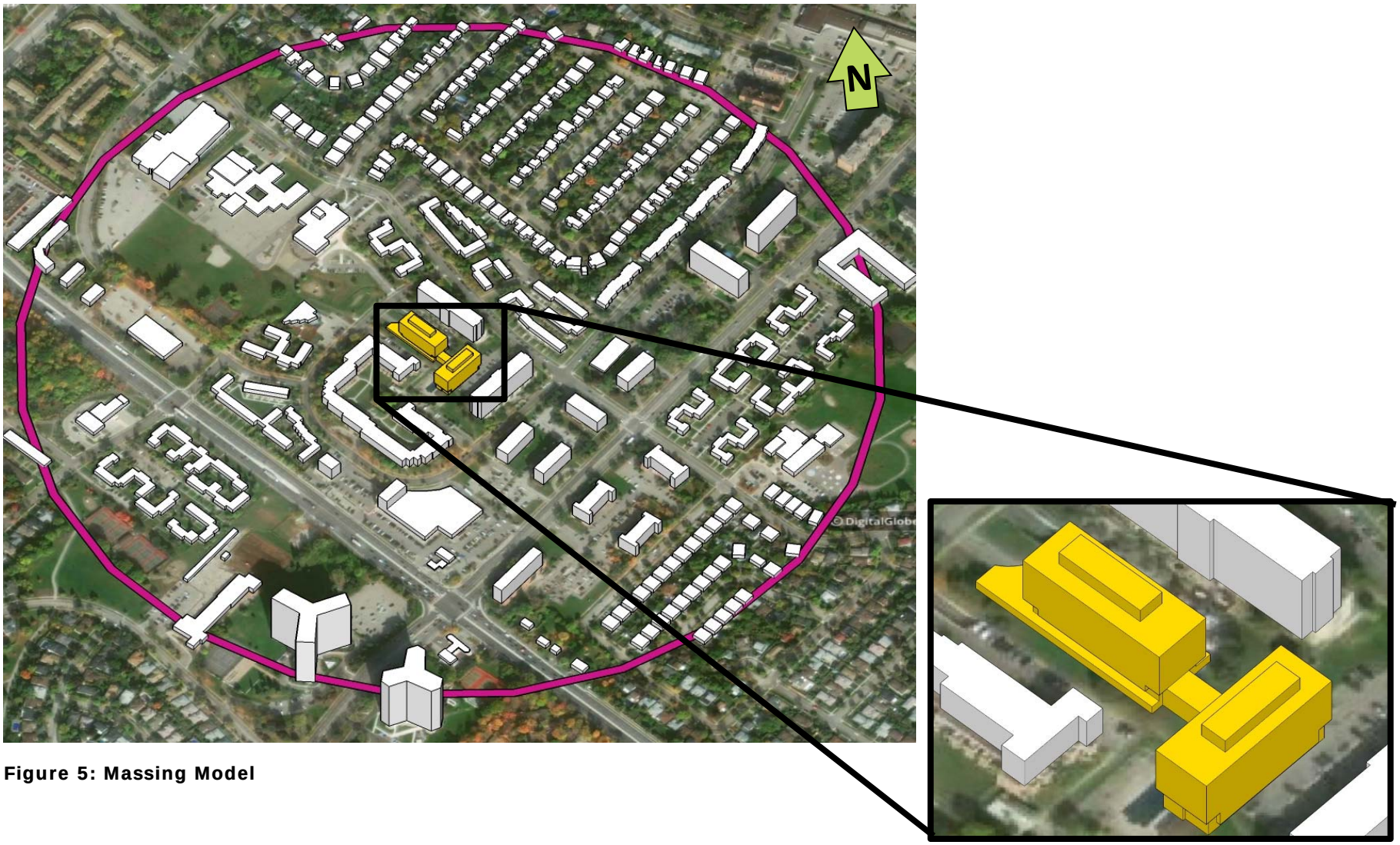

Figure 5: Massing Model

2.2 Wind Climate

Wind data recorded at Pearson International Airport in Toronto for the period of 1986-2015 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 northerly through westerly directions are most prevalent. The seasonal wind roses readily show how the prevalent winds shift throughout the year. The seasonal wind roses show daytime winds, from 6:00 – 23:00, while the annual wind rose shows all hours.

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 4** 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. All wind speeds and directions were included in the wind climate model.

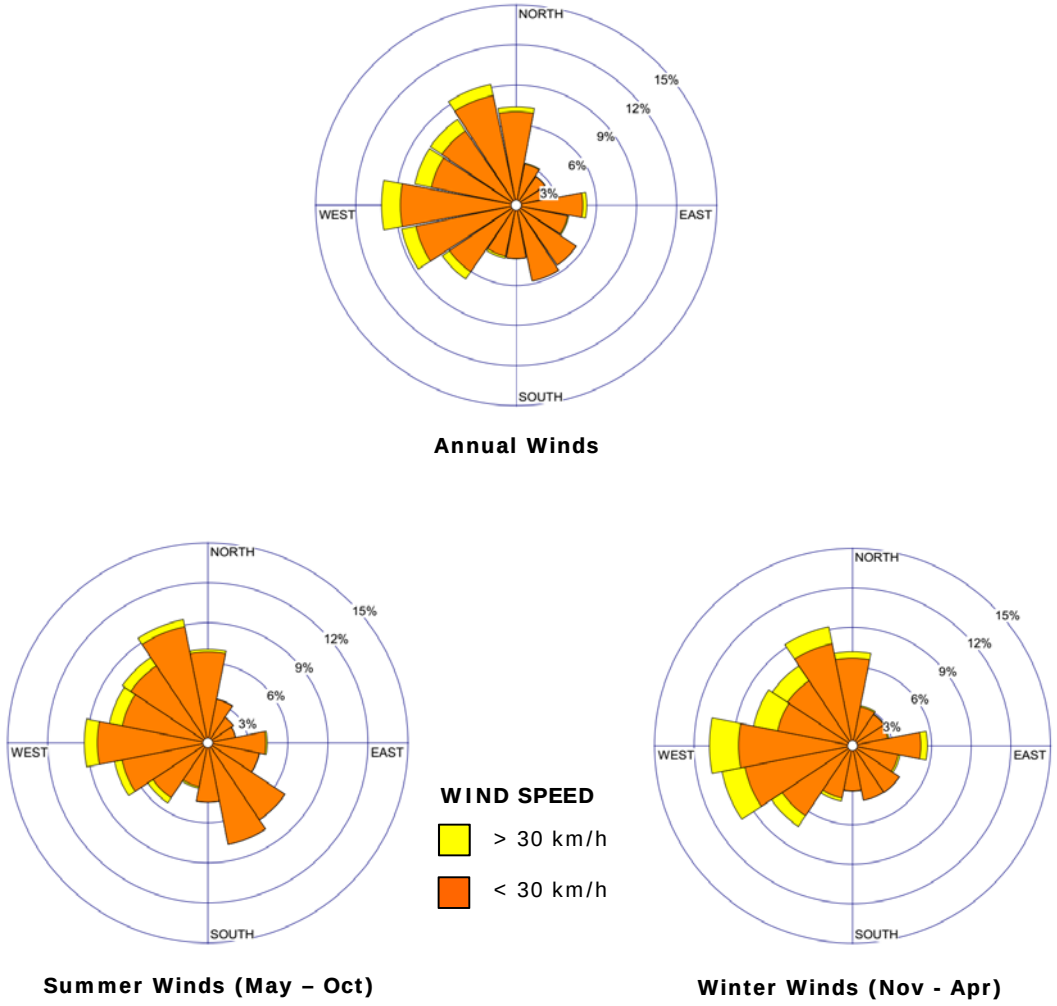

Figure 6: Wind Roses for Pearson (1986-2015, 6am–11pm)

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 Mississauga, in the document *Urban Design Terms of Reference – Pedestrian Wind Comfort and Safety Studies* (June 2014). 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) assuming a 24 hour day. 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 Effects
Sitting	0 to 10 km/h	0 to 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	0 to 15 km/h	0 to 4.2 m/s	Gentle breezes suitable for main building entrances and bus stops.
Walking	0 to 20 km/h	0 to 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 most 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 typically 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 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 assessment does not account for the presence of mature trees, thus wind comfort conditions for months when foliage is present could be better than those predicted. **Appendix A** has graphical images of the wind safety conditions on an annual basis. **Appendix B** includes wind flow vectors for two vertical sections of the site.

There are generally accepted wind comfort levels that are desired for various pedestrian uses. For example, for public sidewalks, wind comfort suitable for **walking** would be desirable year-round. For main entrances and transit stops, wind conditions conducive to **standing** would be preferred throughout the year, but can be difficult to achieve in regions where winter winds are inherently harsh. For amenity spaces, wind conditions suitable for **sitting** and/or **standing** are generally desirable during the summer months. The most stringent category of **sitting** is considered appropriate for cafes and dedicated seating areas, while for public parks **sitting** and/or **standing** would be appropriate in the summer.

4.1 Existing Wind Conditions

In the summer wind conditions on the existing site are generally comfortable for standing (**Figure 7a**). There are a few localized areas where wind conditions are conducive to walking. Along the nearby sidewalks, wind conditions are suitable for walking or better. In the outdoor playground of the nearby YMCA child care centre, wind conditions are comfortable for standing in the summer. In Gulleden Park, just west of Williamsport Drive, wind conditions are suitable for walking in the summer.

In the winter, wind conditions on the existing site are suitable for walking or better. On the surrounding sidewalks of Havenwood Drive and Williamsport Drive wind conditions are also generally comfortable for walking or better (**Figure 8a**), including Gulleden Park. The exception is along the west facade of the existing Building A, along Williamsport Drive, where wind conditions are uncomfortable. Uncomfortable wind conditions also occur at the westerly corners of the existing Building B. In the outdoor playground of the YMCA, wind conditions are comfortable for walking in the winter.

At the main entrances to the existing Buildings A and B, wind conditions are comfortable for sitting or standing throughout the year (**Figures 7a** and **8a**).

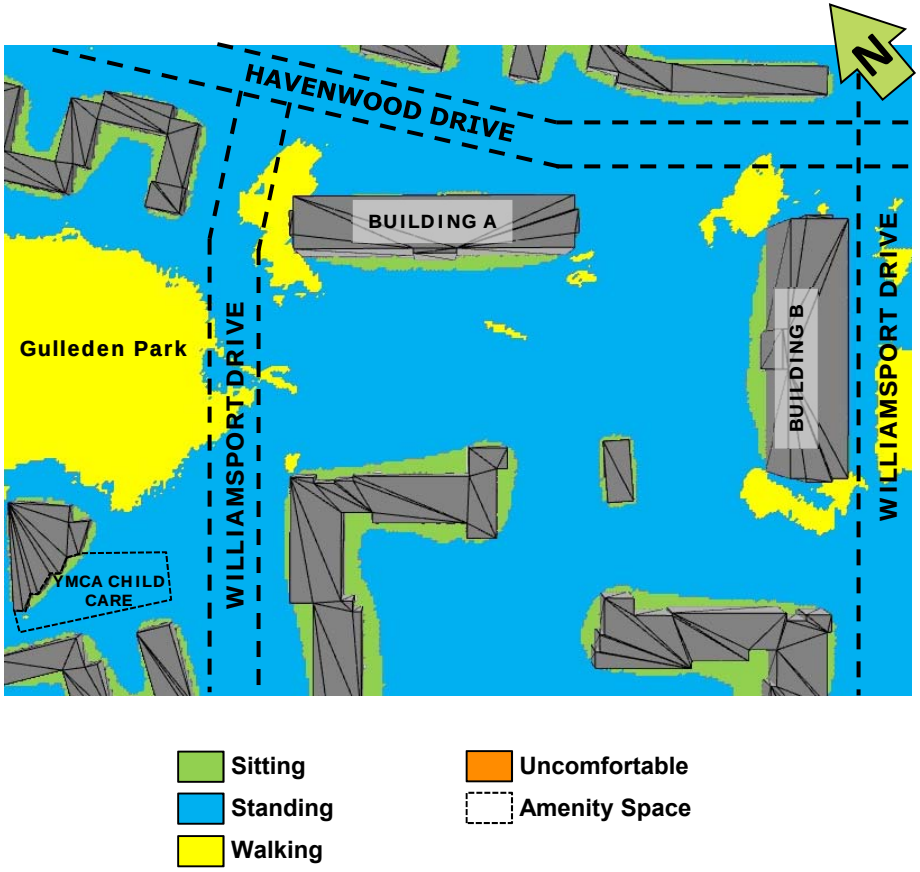

Figure 7a: Existing Conditions – Grade Level – Summer

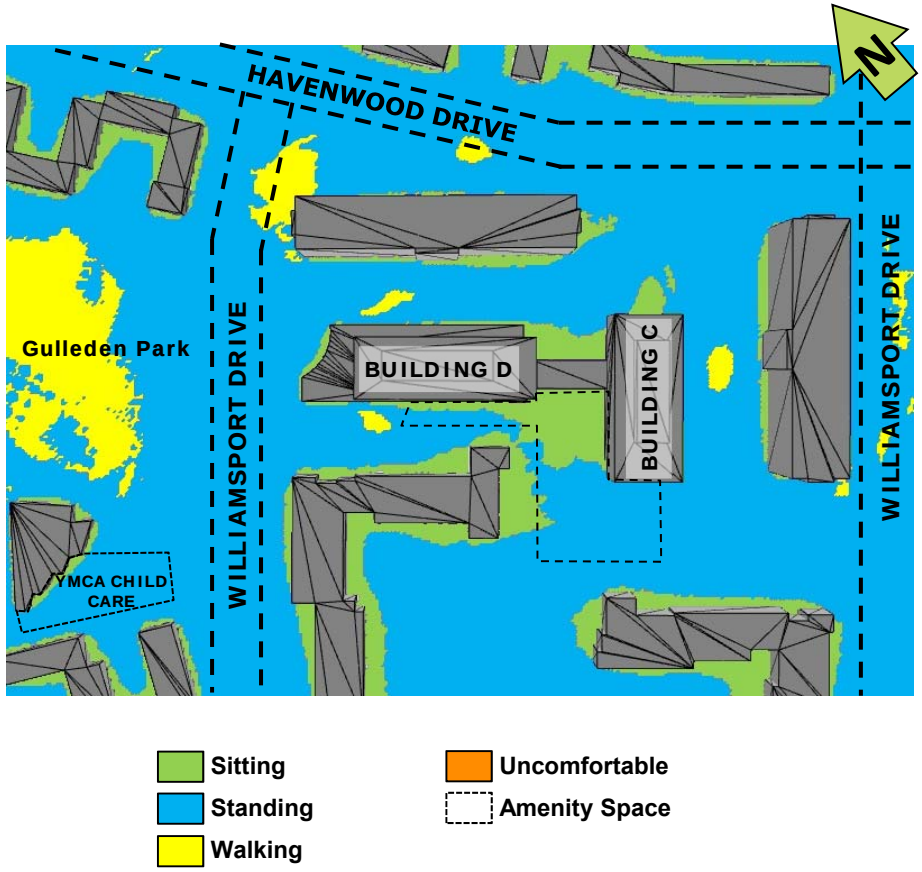

Figure 7b: Proposed Conditions – Grade Level – Summer

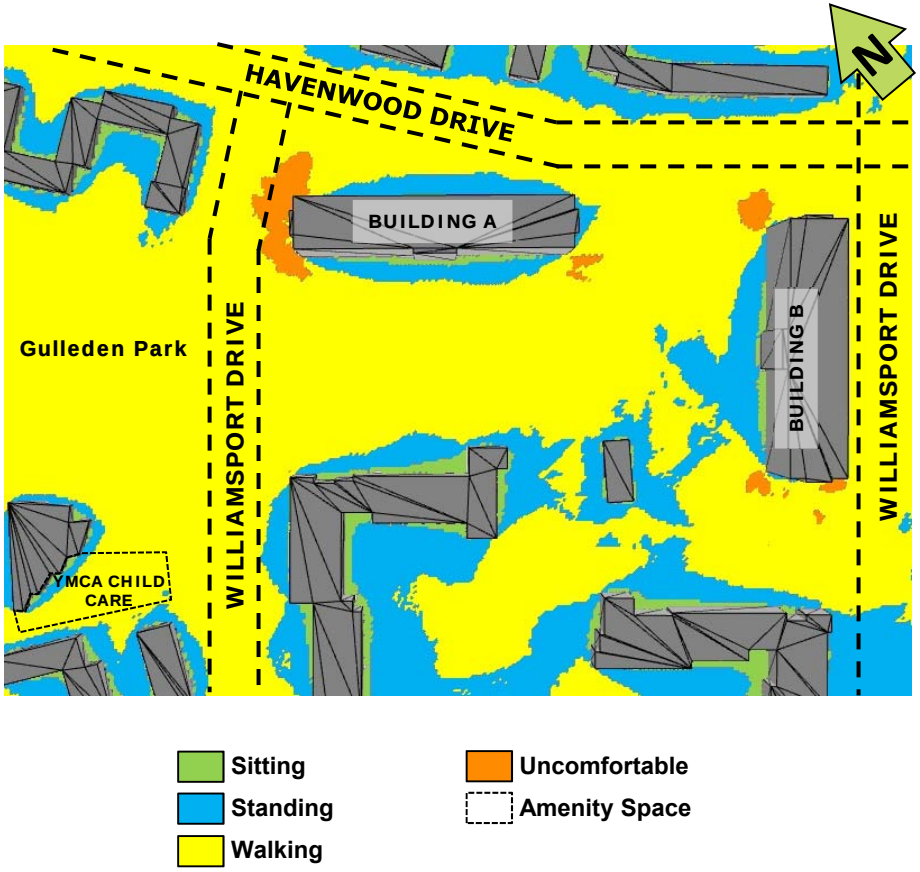

Figure 8a: Existing Conditions – Grade Level – Winter

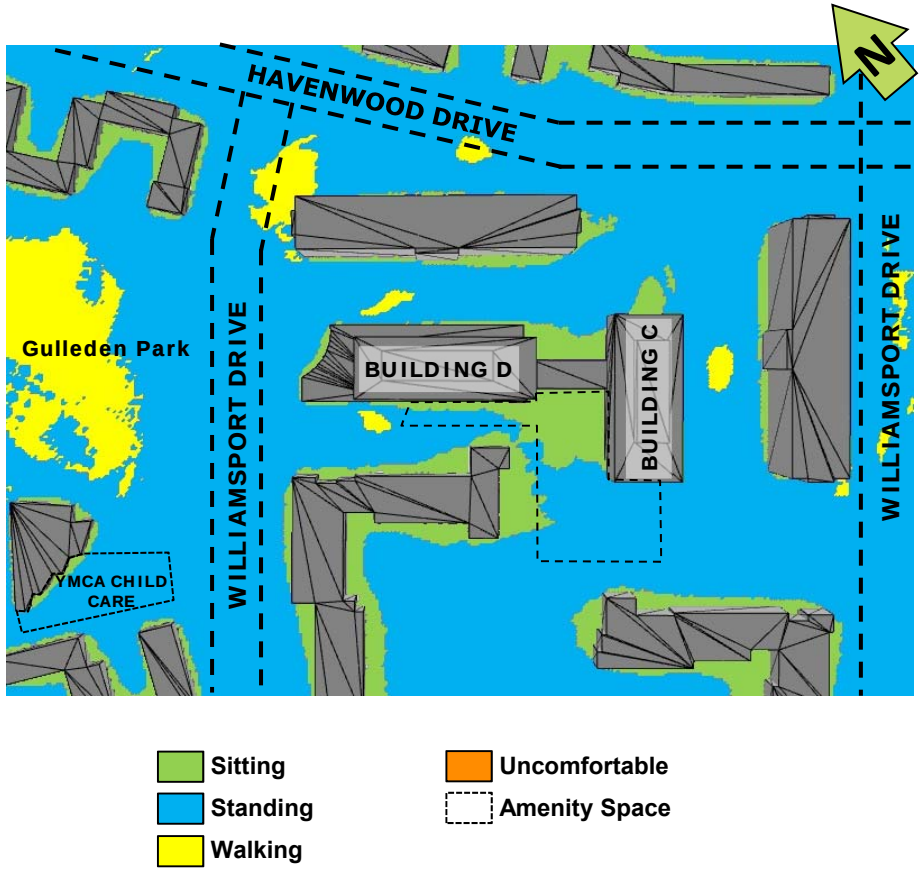

Figure 8b: Proposed Conditions – Grade Level – Winter

4.2 Building Entrances & Walkways

The main entrance to the new development is located on the north facade of the low-rise building connecting Buildings C and D. Wind conditions at this entrance are comfortable for sitting in the summer (**Figures 7b** and **9a**). At the numerous secondary entrances and exits around the development (**Figure 4**) wind conditions are comfortable for standing in the summer. On the walkways surrounding the new development, wind conditions are suitable for walking or better in the summer.

In the winter, wind conditions at the main entrance remain comfortable for sitting (**Figures 8b** and **9b**). Wind conditions at the numerous secondary entrances and exits are comfortable for standing when directly on a facade of the one of the towers. Those exits connected to the parking structure are slightly more exposed and hence will be comfortable for walking in the winter (**Figure 9b**). On the walkways surrounding the new development, wind conditions are conducive to walking or better in the winter.

These wind conditions are considered appropriate for the intended usage.

4.3 Outdoor Amenity Spaces

On the west side of Building D there is an amenity terrace (**Figure 4**). In the summer, wind conditions in this space are generally comfortable for sitting or standing. Along the north and south edges of the space wind conditions are suitable for walking in the summer (**Figure 10a**). On the amenity terrace between the buildings, on Level 3, wind conditions are generally conducive to sitting or standing in the summer. The exception is along the south edge, where wind conditions are suitable for walking. In the amenity space on the south half of the site, wind conditions are generally comfortable for sitting or standing in the summer.

In the winter, wind conditions on the Building D terrace are generally comfortable for walking or better (**Figure 10b**). However, uncomfortable wind conditions occur along the north and south edges of the space. Between the proposed buildings, wind conditions on the amenity space are generally suitable for walking or better in the winter. The exception is along the south edge, where wind conditions are uncomfortable. In the amenity space on the south portion of the site, wind conditions remain comfortable for sitting or standing in the winter.

To improve wind conditions on the Building D terrace, we suggest the design team consider installing wrap-around trellises (50% to 70% solid, 3m width) at the northwest and southwest corners of the building. These features will disrupt the downwashing flows of the westerly and northwesterly winds. Alternatively, strong umbrellas could be used where necessary, to disrupt the vertical wind flows at the building corners.

To improve wind conditions on the amenity terrace between the buildings, we suggest including dense, tall landscaping along the south edge of the space, to disrupt the wind flows. Strong umbrellas should also be considered for the area.

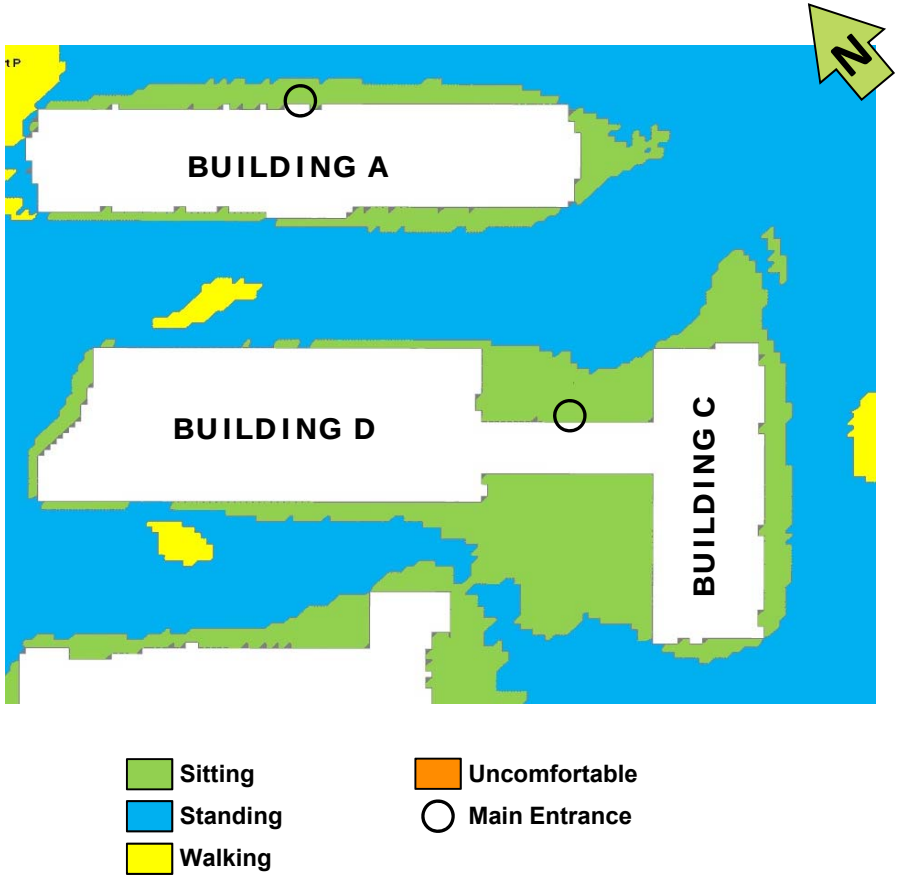

Figure 9a: Proposed Configuration – Grade – Summer

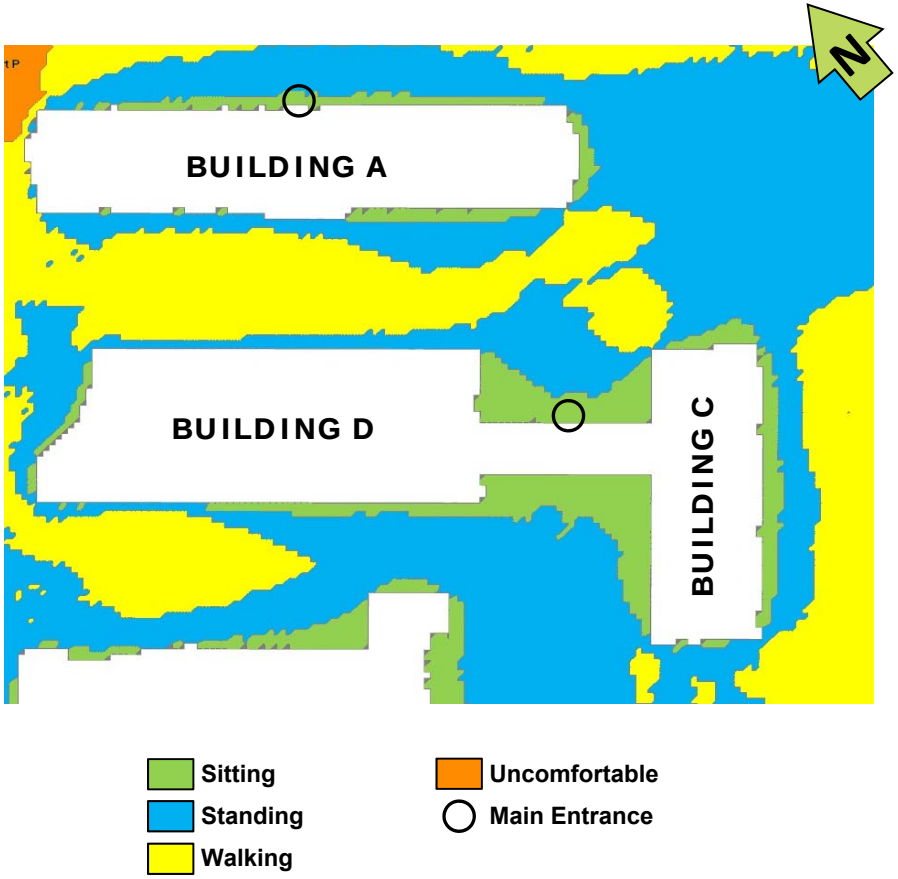

Figure 9b: Proposed Configuration – Grade – Winter

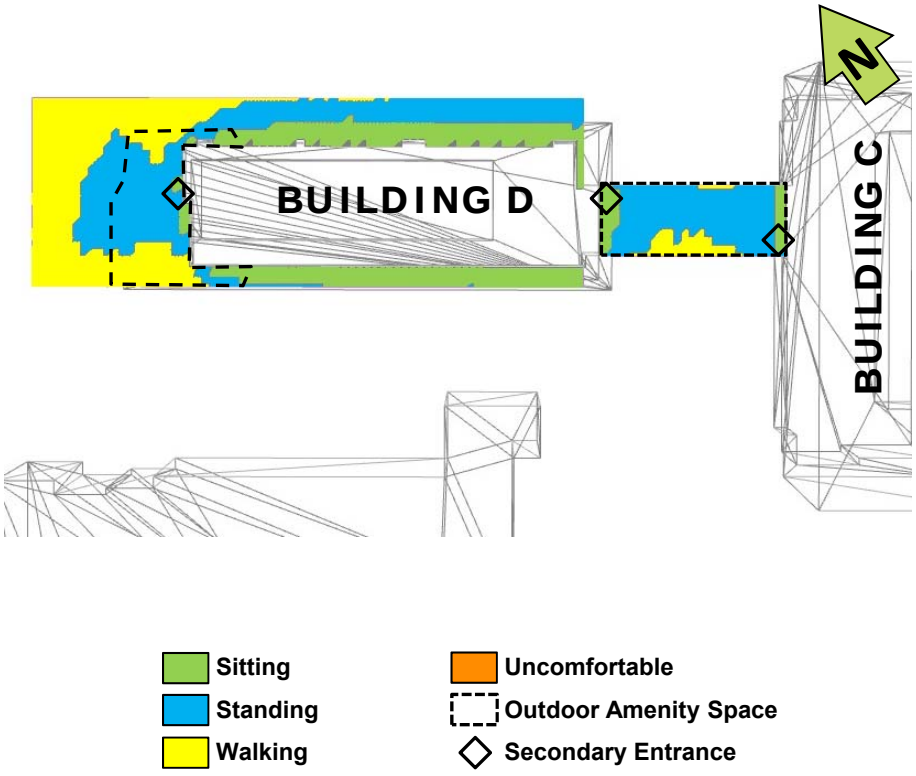

Figure 10a: Proposed Configuration – Amenity – Summer

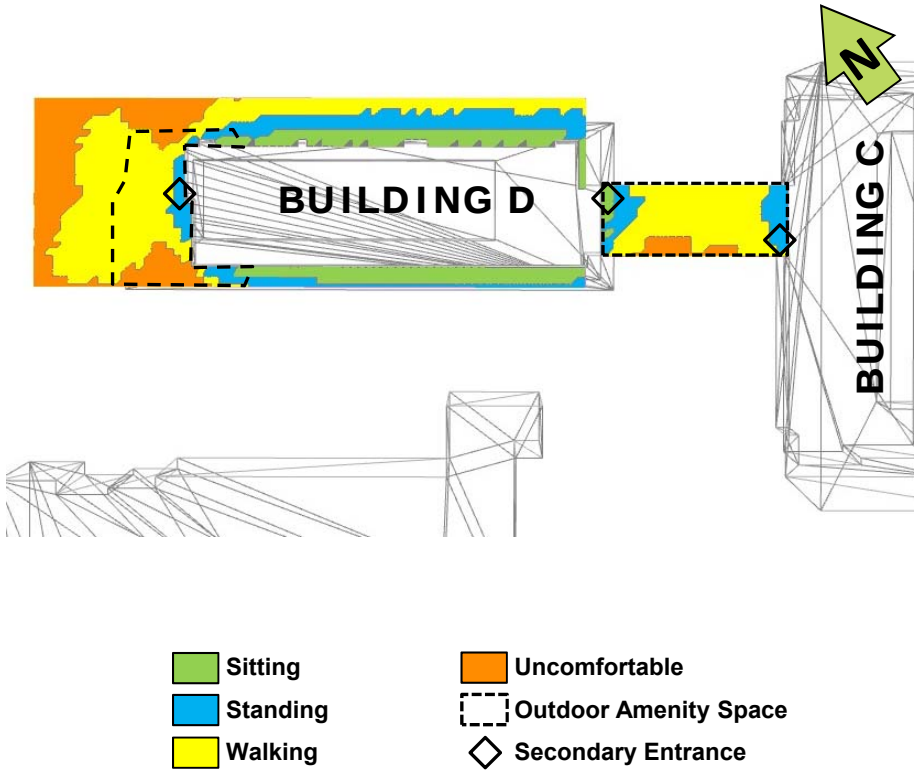

Figure 10b: Proposed Configuration – Amenity – Winter

4.4 Surrounding Sidewalks

In the Proposed Configuration, wind conditions on the surrounding sidewalks are comfortable for walking or better in the summer season (**Figure 7b**). In the outdoor playground of the nearby YMCA child care centre, wind conditions are comfortable for standing in the summer.

In the winter, wind conditions on the surrounding sidewalks are generally comfortable for walking or better (**Figure 8b**). The exception is on the west side of the existing Building A and on Williamsport Drive in the winter, where wind conditions are uncomfortable (**Figure 8b**). Note this is an existing wind condition (**Figure 7b**). Wind conditions in the outdoor playground of the YMCA child care centre remain comfortable for walking in the winter.

As these wind conditions are similar to existing conditions, they are considered appropriate.

4.5 Wind Safety

In the Existing Configuration, the wind safety criterion is met in all areas on and around the site, with the exception of the southwest corner of the existing Building B.

In the Proposed Configuration, the wind safety criterion is met in all areas on and surrounding the site, including the amenity spaces. This is an improvement from the existing wind conditions.

Images can be found in **Appendix A**.

5.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the proposed development at 1485 Williamsport Drive and 3480 Havenwood Drive in Mississauga have been assessed through numerical modeling techniques. Based on the results of our assessment, the following conclusions have been reached:

- The wind safety criterion is met in all areas on and surrounding the development in the Proposed Configuration. The wind safety criterion was not met at the southwest corner of existing Building B in the Existing Configuration.
- Wind conditions at the numerous entrances and exits are comfortable for the intended usage throughout the year.
- Wind conditions on the sidewalks surrounding the development are generally comfortable for walking or better throughout the year. These are similar to existing wind conditions.
- Wind conditions on the outdoor amenity spaces are generally suitable for the intended usage. Recommendations are provided where applicable.
- No additional analysis is required.

6.0 ASSESSMENT APPLICABILITY

This assessment is based on computer modeling techniques and provides a qualitative overview of the pedestrian wind comfort conditions on and surrounding the proposed development site. Any subsequent alterations to the design may influence these findings, possibly requiring further review by Novus.

Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Sincerely,
Novus Environmental Inc.

Jenny Vesely, P. Eng.
Sr. Engineer – Microclimate

Tahrana Lovlin, MAES, P.Eng.
Specialist - Microclimate

7.0 REFERENCES

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Appendix A

Pedestrian Wind Safety Results
Annual

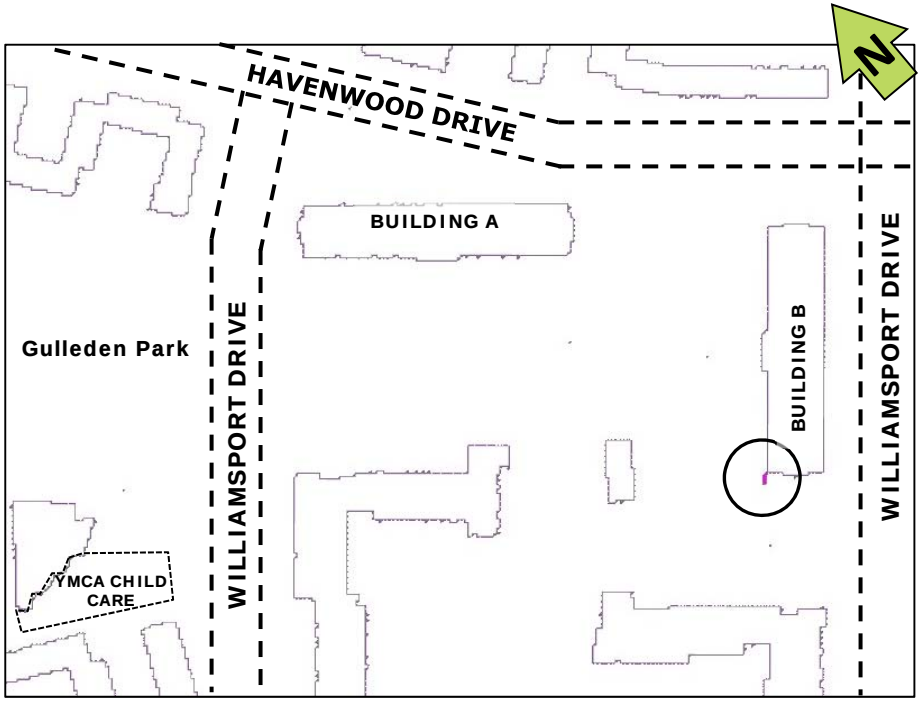

Figure A1a: Wind Safety – Existing Configuration – Grade Annual

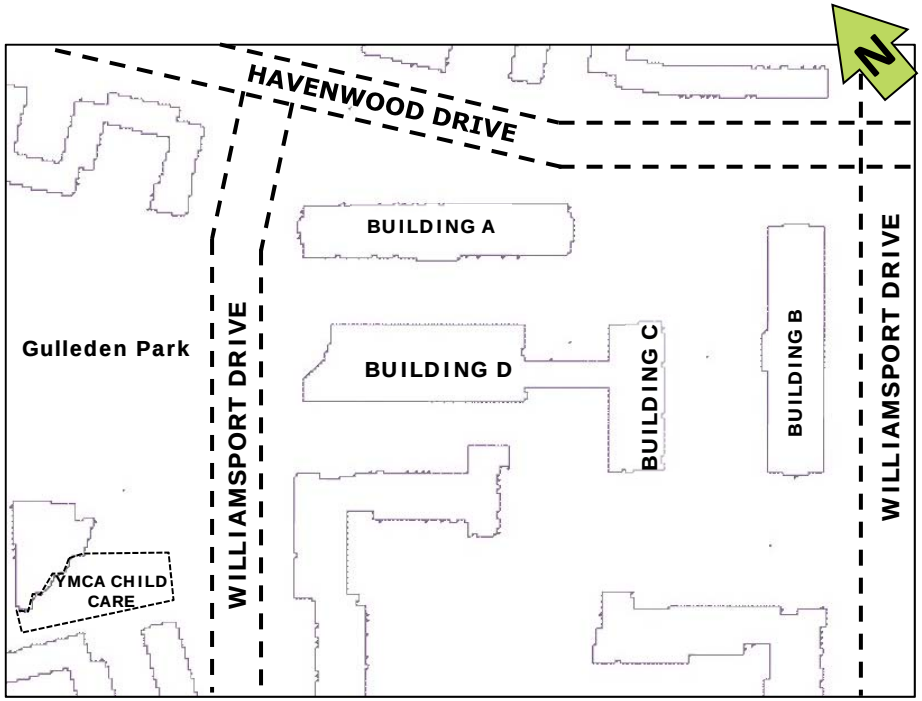

Figure A1b: Wind Safety – Proposed Configuration – Grade Annual

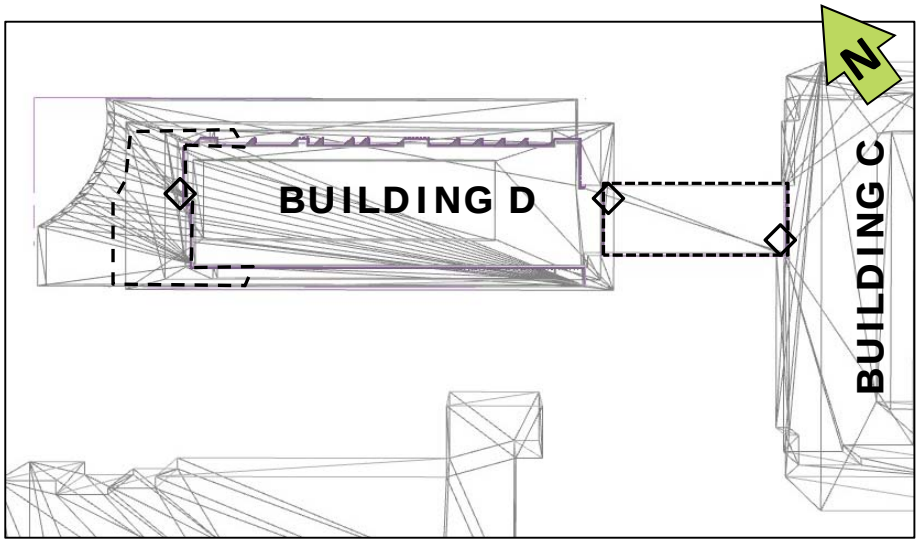

Figure A2: Wind Safety – Existing Configuration – Amenity Annual

Appendix B

Wind Flow Vectors – Proposed Configuration
Vertical Slices

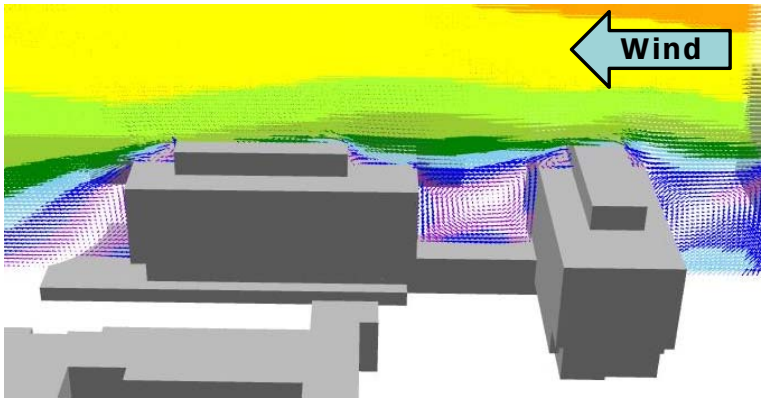

Figure B1: Wind Flow Vectors – Vertical Slice (NW/SE)
Wind from southeast

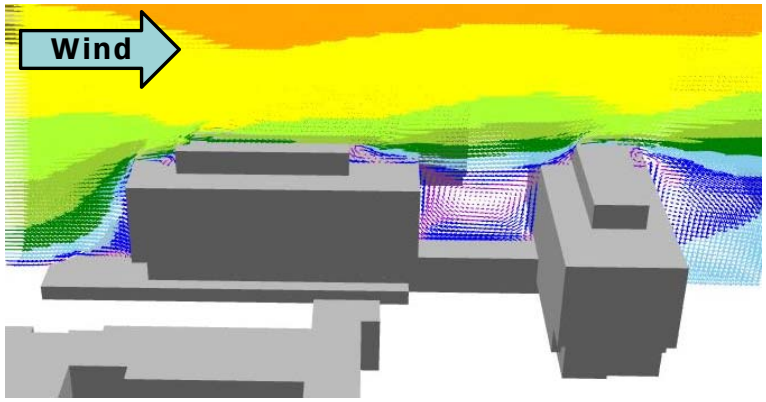

Figure B2: Wind Flow Vectors – Vertical Slice (NW/SE)
Wind from northwest

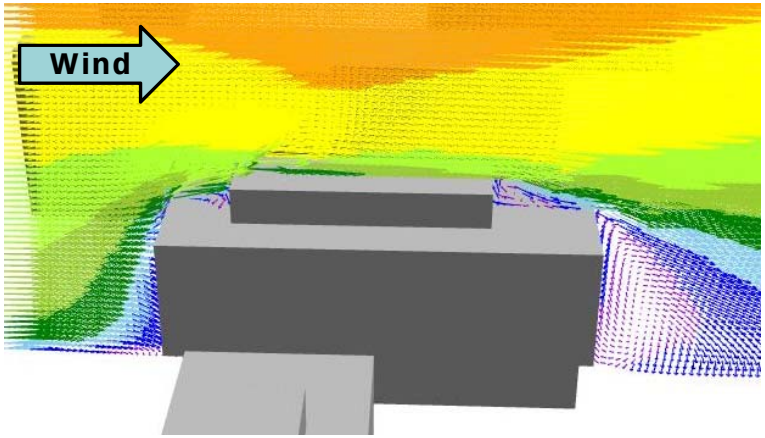

Figure B3: Wind Flow Vectors – Vertical Slice (NE/SW)
Wind from northeast

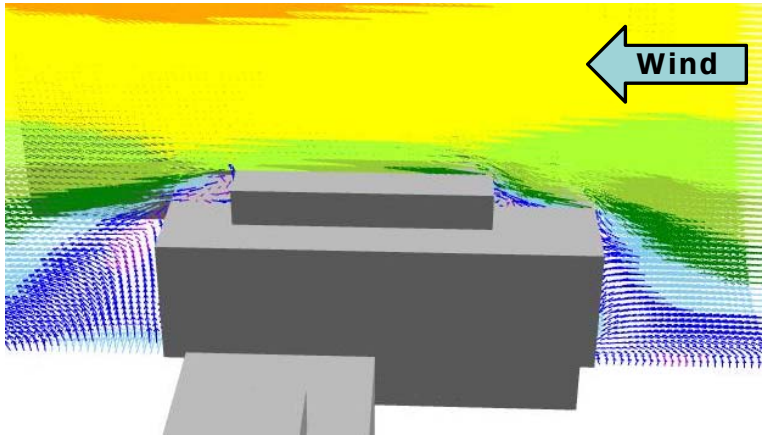

Figure B4: Wind Flow Vectors – Vertical Slice (NE/SW)
Wind from southwest