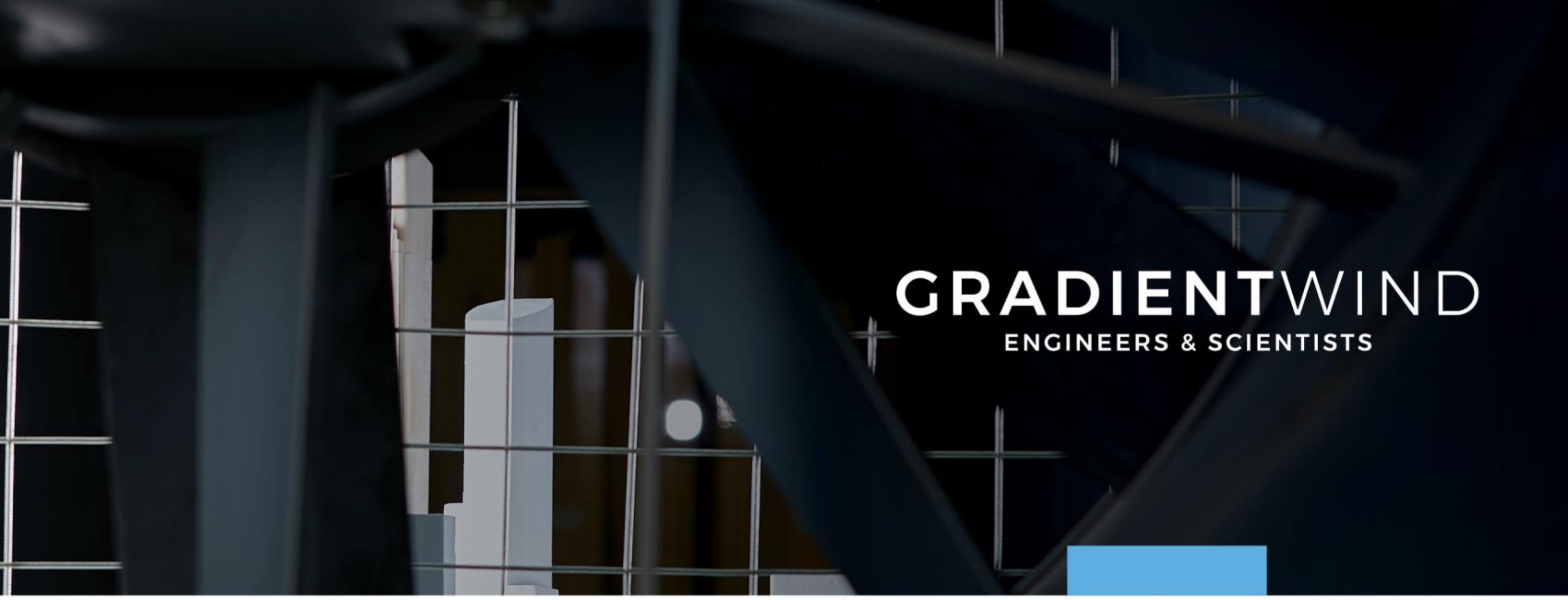
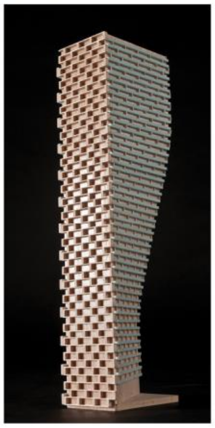
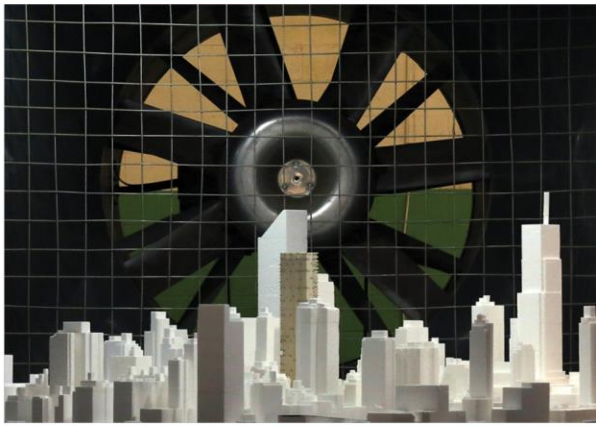


PEDESTRIAN LEVEL WIND STUDY

175 Wynford Drive
Toronto, Ontario

Gradient Wind Report: 20-088-PLW





September 1, 2020

PREPARED FOR
DVP Hotel Development LP
c/o Freed Developments
552 Wellington Street West
Penthouse Suite 1500
Toronto, ON M5V 2V5

PREPARED BY
Edward Urbanski, M.Eng., Junior Wind Scientist
Andrew Sliasas M.A.Sc., P.Eng., Principal

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
GRADIENTWIND.COM

EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study for the proposed mixed-use development located at 175 Wynford Drive in Toronto, Ontario. Our mandate within this study is to investigate pedestrian wind comfort within and surrounding the subject site, and to identify any areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where necessary.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, preliminary drawings prepared by Quadrangle in May 2020 and updated in August, surrounding street layouts and existing and approved future building massing information obtained from the City of Toronto, as well as recent site imagery.

A complete summary of the predicted wind conditions is provided in Section 5 of this report and illustrated in Figures 3A-4D following the main text. Based on CFD test results, meteorological data analysis, and experience with similar developments in the Greater Toronto Area, we conclude that many grade-level areas within and surrounding the development site, including sidewalks, walkways, laneways, parking lots, and building access points will be acceptable for the intended pedestrian uses on a seasonal basis. Exceptions include:

- Uncomfortable wind conditions near the northwest corners of both the Delmanor Wynford and Accolade (181 Wynford Drive) buildings, as well as over sidewalk areas along the south driveway
- Uncomfortable conditions near the southwest corner of Tower 1, the northwest corner of Tower 2, and the at the northeast corner of Tower 3
- Various potential entrance locations
- The central courtyard area.

Mitigation may include tall perimeter wind barriers (wind screens, dense coniferous plantings, or a combination thereof) positioned to block salient westerly winds, more localized wind screening to shield seating or other sedentary use areas, and canopies and recessed doorways for building entrance locations.

Wind conditions within the elevated amenity terraces will also require mitigation to provide sitting conditions and reduce the potential for dangerous wind speeds. A detailed mitigation strategy will be developed in coordination with the design team as the site design evolves.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, an isolated area near the southeast corner of Tower 1 will experience unsafe wind conditions based on annual wind statistics.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Freed Developments on behalf of DVP Hotel Development LP to undertake a pedestrian level wind (PLW) study for the proposed mixed-use development located at 175 Wynford Drive in Toronto, Ontario (hereinafter referred to as the "subject site"). Our mandate within this study is to investigate pedestrian wind comfort within and surrounding the subject site, and to identify any areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where necessary.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, preliminary drawings prepared by Quadrangle in May 2020 and updated in August 2020, surrounding street layouts and existing and approved future building massing information obtained from the City of Toronto, as well as recent site imagery.

2. TERMS OF REFERENCE

The planned, multi-building mixed-use development is located on an irregular parcel of land northwest of the intersection of Wynford Drive and Eglinton Avenue East in Toronto, Ontario. The subject site comprises two buildings each with two towers atop an 8-storey podium on the east and west sides of the site. The west portion, located nearest to the Don Valley Parkway, includes Tower 1 at the south side of the podium and Tower 2 at the north side. The two towers taper as a function of increasing height. The east portion, overlooking Wynford Drive, includes Tower 3 at the north side of the podium and Tower 4 at the south side. Both podia include outdoor amenity areas on Level 9.

It is noted that, since the pedestrian wind testing occurred, the building heights and configurations have been modified somewhat. Specifically, Tower 2 has reduced from 49-storeys to 45-storeys, and Tower 4 has increased from 45-storeys to 49-storeys. As well, a two-storey east-west opening has been included for the west building, Tower 1 is now L-shaped and the orientation has been rotated approximately 45 degrees clockwise as compared to the tested configuration, and the step-backs at higher levels of the tower have been slightly modified. The expected influence of the noted changes on pedestrian wind comfort are discussed in Section 5.

Regarding wind exposures, the near-field surroundings of the development (defined as an area falling within a 500-metre (m) radius of the site) are characterized by a moderate concentration of high-rise residential buildings northwest clockwise to northeast and directly south of the subject site across Eglinton Avenue East. Most notably Accolade (181 Wynford Drive) and Delmanor Wynford are adjacent to the northwest and southeast of the subject site, respectively. Other surrounding areas comprise a mix of tree covered space or open space including Flemingdon Park Golf Club located south of the subject site. The Don Valley Parkway is located immediately west of the subject site orientated north to south. The far-field surroundings (defined as the area beyond the near field and within a 5 km radius) are characterized by primarily suburban and low-rise industrial exposures with pockets of open spaces in all directions and particularly along the Don Valley. A site plan is illustrated in Figure 1, while Figures 2A and 2B illustrate the computational model used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to: (i) determine comparative pedestrian level wind comfort and safety conditions at key outdoor areas; (ii) identify areas where future wind conditions may interfere with the intended uses of outdoor spaces; and (iii) recommend suitable mitigation measures, where required.

4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the site is based on CFD simulations of wind speeds across the study site within a virtual environment, meteorological analysis of the Greater Toronto Area (GTA) wind climate, and synthesis of computational data with industry-accepted guidelines[1]. The following sections describe the analysis procedures, including a discussion of the pedestrian comfort guidelines.

4.1 Computer-Based Context Modelling

A computer-based PLW wind study was performed to determine the influence of the wind environment on pedestrian comfort over the proposed development site. Pedestrian comfort predictions, based on the

[1] City of Toronto, Application Support Material: Terms of Reference

mechanical effects of wind, were determined by combining measured wind speed data from CFD simulations with statistical weather data obtained from Lester B. Pearson International Airport.

The general concept and approach to CFD modelling is to represent building and topographic details in the immediate vicinity of the study site on the surrounding model, and to create suitable atmospheric wind profiles at the model boundary. The wind profiles are designed to have similar mean and turbulent wind properties consistent with actual site exposures.

An industry standard practice is to omit trees, vegetation, and other existing and planned landscape elements from the model due to the difficulty of providing accurate seasonal representation of vegetation. The omission of trees and other landscaping elements produces slightly more conservative (i.e., windier) wind speed values.

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 12 wind directions and two massing scenarios, as noted in Section 2. The CFD simulation model was centered on the study building, complete with surrounding massing within a diameter of approximately 840 m.

Mean and peak wind speed data obtained over the study site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade, and 1.5 m above the amenity terraces at Levels 2 and 5, were referenced to the wind speed at gradient height to generate mean and peak velocity ratios, which were used to calculate full-scale values. The gradient height represents the theoretical depth of the boundary layer of the earth's atmosphere, above which the mean wind speed remains constant. Further details of the CFD wind flow simulation technique are presented in Appendix A.

4.3 Meteorological Data Analysis

A statistical model for winds in Toronto was developed from approximately 40-years of hourly meteorological wind data recorded at Lester B. Pearson International Airport and obtained from Environment and Climate Change Canada. Wind speed and direction data were analyzed for each month of the year in order to determine the statistically prominent wind directions and corresponding speeds, and to characterize similarities between monthly weather patterns. Based on this portion of analysis, the four seasons are represented by grouping data from consecutive months based on similarity of weather patterns, and not according to the traditional calendar method; spring is defined as April-May, summer as June-September, autumn as October-November, and winter as December-March.

The statistical model of the Toronto area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate seasonal distribution of measured wind speeds and directions in km/h. Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction represents the percentage of time for various wind speed ranges per wind direction during the measurement period. The preferred wind speeds and directions can be identified by the longer length of the bars. For Toronto, representative of the GTA, the most common winds concerning pedestrian comfort occur from the southwest clockwise to the north, as well as those from the east. The directional preference and relative magnitude of the wind speed varies somewhat from season to season, with the summer months displaying the calmest winds relative to the remaining seasonal periods.

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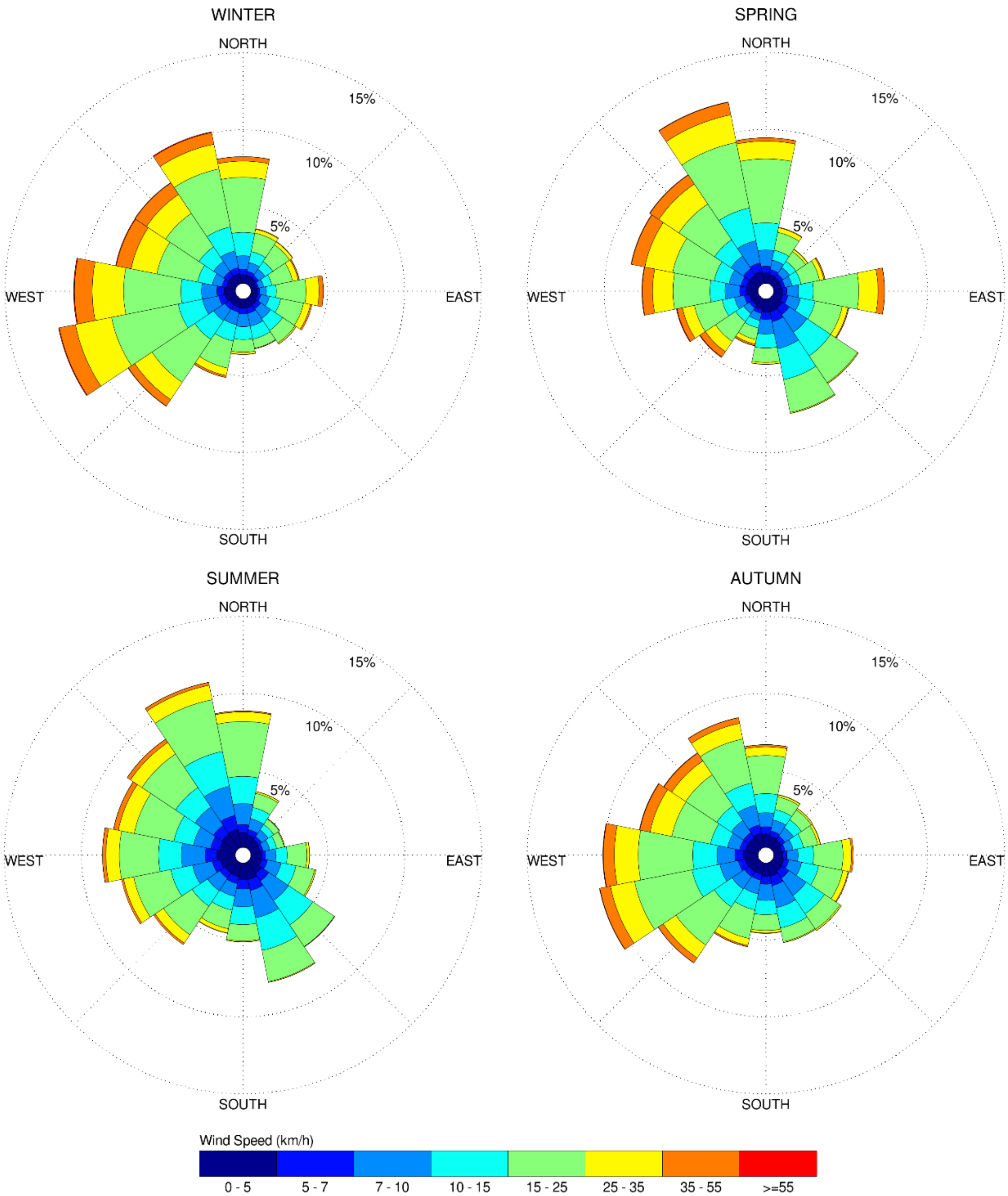
SEASONAL DISTRIBUTION OF WIND
LESTER B. PEARSON INTERNATIONAL AIRPORT, MISSISSAUGA, ONTARIO



Notes:

1. Radial distances indicate percentage of time of wind events.
2. Wind speeds are mean hourly in km/h, measured at 10 m above the ground.

4.4 Pedestrian Comfort and Safety Guidelines

Pedestrian comfort and safety guidelines are based on the mechanical effects of wind without consideration of other meteorological conditions (i.e., temperature, relative humidity). The comfort guidelines assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Four pedestrian comfort classes are based on 80% non-exceedance gust wind speed ranges, which include (i) Sitting; (ii) Standing; (iii) Walking; and (iv) Uncomfortable. More specifically, the comfort classes and associated gust wind speed ranges are summarized as follows:

(i) **Sitting** – A wind speed no greater than 16 km/h is considered acceptable for sedentary activities, including sitting.

(ii) **Standing** – A wind speed greater than 16 km/h but no greater than 22 km/h is considered acceptable for activities such as standing or leisurely strolling.

(iii) **Walking** – A wind speed greater than 22 km/h but no greater than 30 km/h is considered acceptable for walking or more vigorous activities.

(iv) **Uncomfortable** – A wind speed greater than 30 km/h is classified as uncomfortable from a pedestrian comfort standpoint. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this comfort class.

The pedestrian safety wind speed guideline is based on the approximate threshold that would cause a vulnerable member of the population to fall. A 0.1% exceedance gust wind speed of greater than 90 km/h is classified as dangerous. The wind speeds associated with the above categories are gust wind speeds. The gust speeds, and equivalent mean speeds, are selected based on 'The Beaufort Scale', presented on the following page, which describes the effects of forces produced by varying wind speed levels on objects. Gust speeds are included because pedestrians tend to be more sensitive to wind gusts than to steady winds for lower wind speed ranges. For strong winds approaching dangerous levels, this effect is less important because the mean wind can also create problems for pedestrians. The mean gust speed ranges are selected based on 'The Beaufort Scale', which describes the effect of forces produced by varying wind speeds on levels on objects.

THE BEAUFORT SCALE

Number	Description	Wind Speed (km/h)	Description
2	Light Breeze	6-11	Wind felt on faces
3	Gentle Breeze	12-19	Leaves and small twigs in constant motion; Wind extends light flags
4	Moderate Breeze	20-28	Wind raises dust and loose paper; Small branches are moved
5	Fresh Breeze	29-38	Small trees in leaf begin to sway
6	Strong Breeze	39-49	Large branches in motion; Whistling heard in electrical wires; Umbrellas used with difficulty
7	Moderate Gale	50-61	Whole trees in motion; Inconvenient walking against wind
8	Gale	62-74	Breaks twigs off trees; Generally impedes progress

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 80% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if wind speeds of 16 km/h were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting or more sedentary activities. Similarly, if 30 km/h at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As most of these criteria are based on subjective reactions of a population to wind forces, their application is partly based on experience and judgment.

Once the pedestrian wind speed predictions have been established at tested locations, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for their associated spaces. This step involves comparing the predicted comfort class to the desired comfort class, which is dictated by the location type represented by the sensor (i.e., a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their desired comfort classes are summarized on the following page.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Standing / Walking
Public Sidewalks / Pedestrian Walkways	Walking
Outdoor Amenity Spaces	Sitting / Standing
Cafés / Patios / Benches / Gardens	Sitting / Standing
Plazas	Sitting / Standing / Walking
Transit Stops	Sitting / Standing
Public Parks	Sitting / Standing / Walking
Garage / Service Entrances	Walking
Vehicular Drop-Off Zones	Standing / Walking
Laneways / Loading Zones	Walking

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-3D, which illustrate seasonal wind conditions at grade level, and Figures 4A-4D, which illustrate seasonal wind conditions on the Level 9 elevated amenity terraces. The colour contours indicate predicted regions of the various comfort classes noted in Section 4.4. Wind conditions suitable for sitting are represented by the colour green, standing by yellow, walking by blue, while conditions considered uncomfortable for walking are represented by the colour magenta.

5.1 Wind Comfort and Safety Conditions – Grade Level

Following development of the subject site, wind conditions over surrounding areas are predicted to be moderately windy during the summer season, becoming windy throughout the remaining three colder seasons. Wind conditions are summarized below for various areas of interest.

Sidewalks, Walkways, and Laneways: The majority of sidewalks, walkways, and laneways within and surrounding the subject site will be comfortable for walking, or better, throughout the year. Exceptions occur where conditions are predicted to be uncomfortable for walking or more vigorous activities and are as follows;

- Near the northwest corner the Delmanor Wynford during the winter
- Sidewalks along the south laneway during the spring and winter seasons.
- At the northwest corner of Accolade (181 Wynford Drive) during the winter season.

These conditions are largely the result of by salient westerly winds and somewhat less common but still prominent easterly winds.

Primary Building Entrances: The majority of potential building entrance locations are expected to be suitable for standing or better year-round, which is acceptable. Entrances planned along the east elevation of the west podium or near windier building corners (indicated by the colour blue on Figures 3A-3D), mitigation will need to be considered. Appropriate mitigation may include wind barriers flanking the entrances, recessing entrances into the building façade, and/or installing canopies to deflect downwash flows.

Central Area: Conditions within the central area will be suitable for a mix of sitting and standing during the summer season, becoming suitable for walking or better during the remaining three colder seasons. During the summer season, sitting conditions will occur near the west façade of the east podium. If seating areas will be provided over windier areas between the buildings, a comprehensive mitigation plan comprising vertical wind barriers and/or canopies will need to be implemented. Such mitigation will be coordinated as the design evolves.

Other Areas: Uncomfortable wind conditions are also predicted near the southwest corner of Tower 1, the northwest corner of Tower 2, and the northeast corner of Tower 3. Furthermore, unsafe conditions are predicted for the southwest corner of Tower 1. If pedestrian activity will occur at these areas, wind comfort may be improved through the use of canopies or increased building setbacks above the ground floor, as well as vertical wind barriers.

The revised building heights and tower configurations, as compared to the tested design, are expected to impact to the pedestrian wind comfort predictions over select areas. Specifically, the two-storey height east-west walkway through the west podium is expected to be moderately windy on account of prominent westerly and easterly winds flowing through the space. If building entrances are desired near or along this opening, it will likely be necessary to recess the doorways within the building façade to provide local relief from winds. The revised orientation of Tower 1 is also expected to produce somewhat different wind patterns over the grade-level locations at the southwest portion of the site. While it is still likely that uncomfortable and potentially unsafe conditions will occur in proximity to Tower 1, the location of these conditions may vary somewhat from what is described in this report.

5.2 Wind Comfort and Safety Conditions – Elevated Amenity Terraces

Wind conditions over the amenity terraces at Level 9 are predicted to be windy during the typical use period, defined as the late spring through the early Autumn. Wind conditions are summarized for each terrace below.

West Podium Terrace: The terrace is mostly predicted to be suitable for walking during the typical use period with an area at the east side uncomfortable for walking. As well, a large portion of the roof space will exceed the annual wind safety criterion. The noted windy conditions are due to acceleration and channeling of westerly winds between the towers to the north and south. The installation of tall vertical wind barriers along the west perimeter of the space, coupled with canopies/pergolas near the inward-facing tower elevations and additional targeted wind barriers internal to the space will be necessary to achieve suitable calm wind conditions during the typical use period. Such mitigation will be developed with the design team as the terrace plan progresses.

East Podium Terrace: The terrace is mostly predicted to be suitable for standing during the warmer months, while an area at the south side will not achieve the wind safety criterion. The installation of tall vertical wind barriers along the west perimeter of the space, coupled with canopies/pergolas near the inward-facing tower elevations and additional targeted wind barriers internal to the space will be necessary to achieve suitable calm wind conditions during the typical use period. Such mitigation will be developed with the design team as the terrace place progresses.

5.3 Applicability of Results

Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the study site. Future changes (i.e., construction or demolition) of these surroundings may cause changes to the wind effects in two ways, namely: (i) changes beyond the immediate vicinity of the site would alter the wind profile approaching the site; and (ii) development in proximity to the site would cause changes to local flow patterns. In general, development in urban centers creates reduction in the mean wind speeds and localized increases in the gustiness of the wind.

Regarding primary and secondary building access points, wind conditions predicted in this study are only applicable to pedestrian comfort and safety. As such, the results should not be construed to indicate wind loading on doors and associated hardware.

6. SUMMARY AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 of this report and illustrated in Figures 3A-4D following the main text. Based on CFD test results, meteorological data analysis, and experience with similar developments in the Greater Toronto Area, we conclude that many grade-level areas within and surrounding the development site, including sidewalks, walkways, laneways, parking lots, and building access points will be acceptable for the intended pedestrian uses on a seasonal basis. Exceptions include:

- Uncomfortable wind conditions near the northwest corners of both the Delmanor Wynford and Accolade (181 Wynford Drive) buildings, as well as over sidewalk areas along the south driveway
- Uncomfortable conditions near the southwest corner of Tower 1, the northwest corner of Tower 2, and the at the northeast corner of Tower 3
- Various potential entrance locations
- The central courtyard area.

Mitigation may include tall perimeter wind barriers (wind screens, dense coniferous plantings, or a combination thereof) positioned to block salient westerly winds, more localized wind screening to shield seating or other sedentary use areas, and canopies and recessed doorways for building entrance locations.

Wind conditions within the elevated amenity terraces on will also require mitigation to provide sitting conditions and reduce the potential for dangerous wind speeds. A detailed mitigation strategy will be developed in coordination with the design team as the site design evolves.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, an isolated area near the southeast corner of Tower 1 will experience unsafe wind conditions based on annual wind statistics.

This concludes our pedestrian level wind study and report. Please advise the undersigned of any questions or comments.

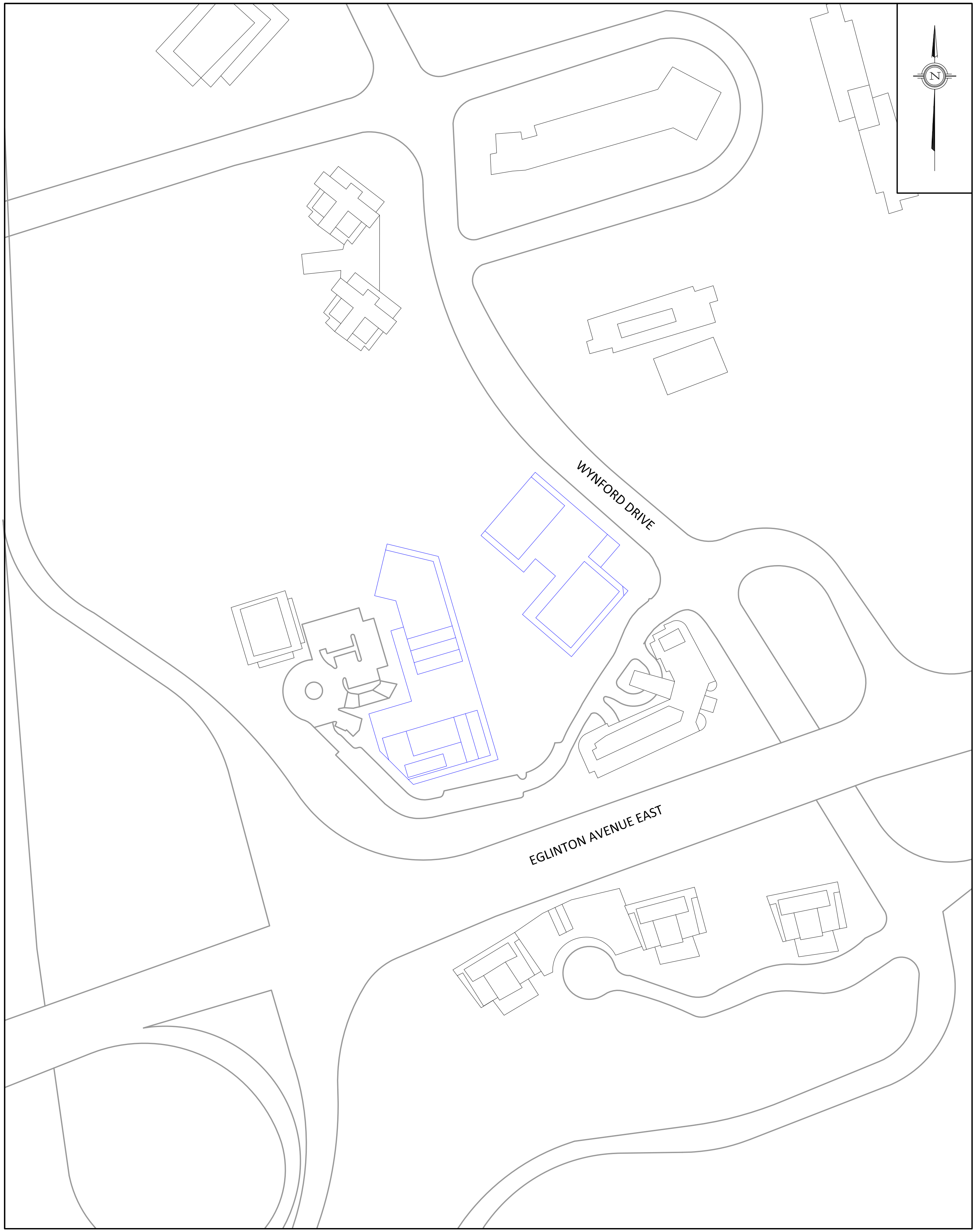
Sincerely,

Gradient Wind Engineering Inc.

Edward Urbanski, M.Eng.,
Junior Wind Scientist

Andrew Sliasas M.A.Sc., P.Eng.,.
Principal

Gradient Wind File #20-088



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PROJECT: DON VALLEY HOTEL, TORONTO PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 1: SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:2500	DRAWING NO.: GW20-088-PLW-1	
DATE: JUNE 15, 2020	DRAWN BY: C.E.	

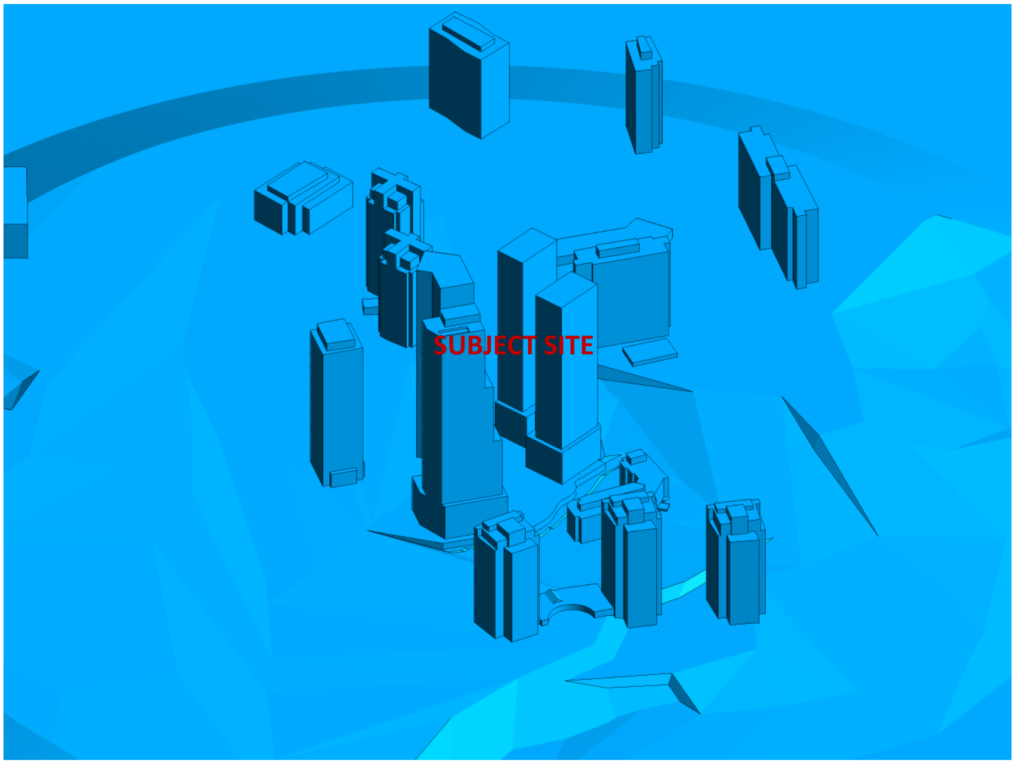


FIGURE 2A: COMPUTATIONAL MODEL, SOUTH PERSPECTIVE

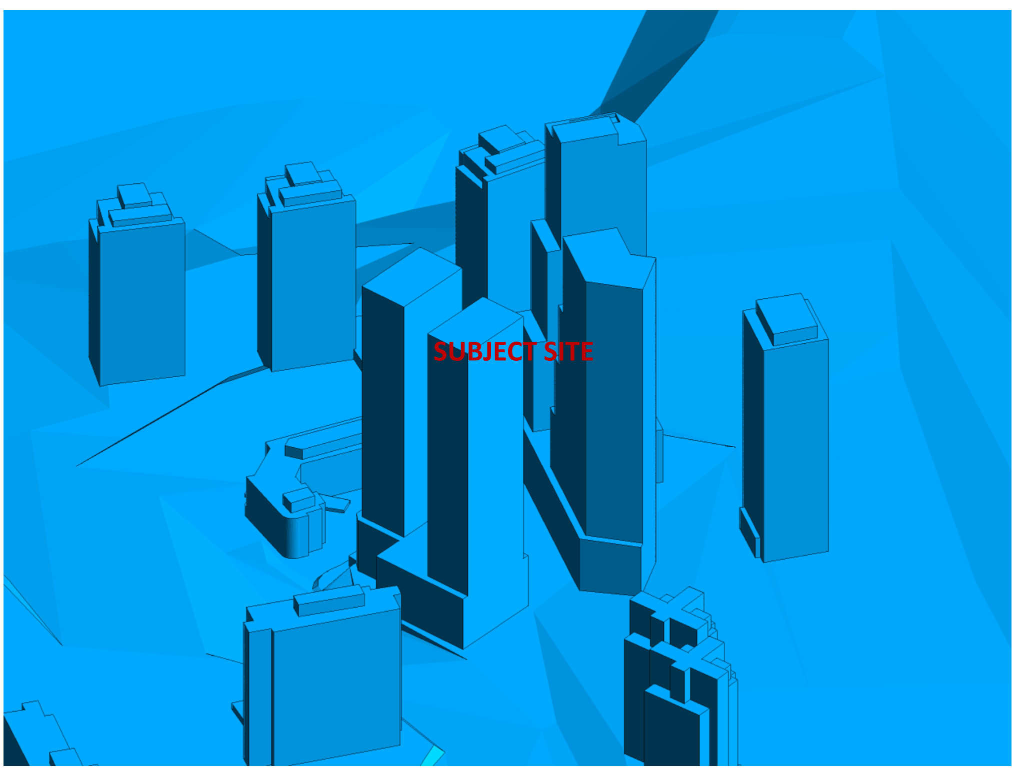


FIGURE 2B: COMPUTATIONAL MODEL, NORTH PERSPECTIVE (CLOSE-UP VIEW)

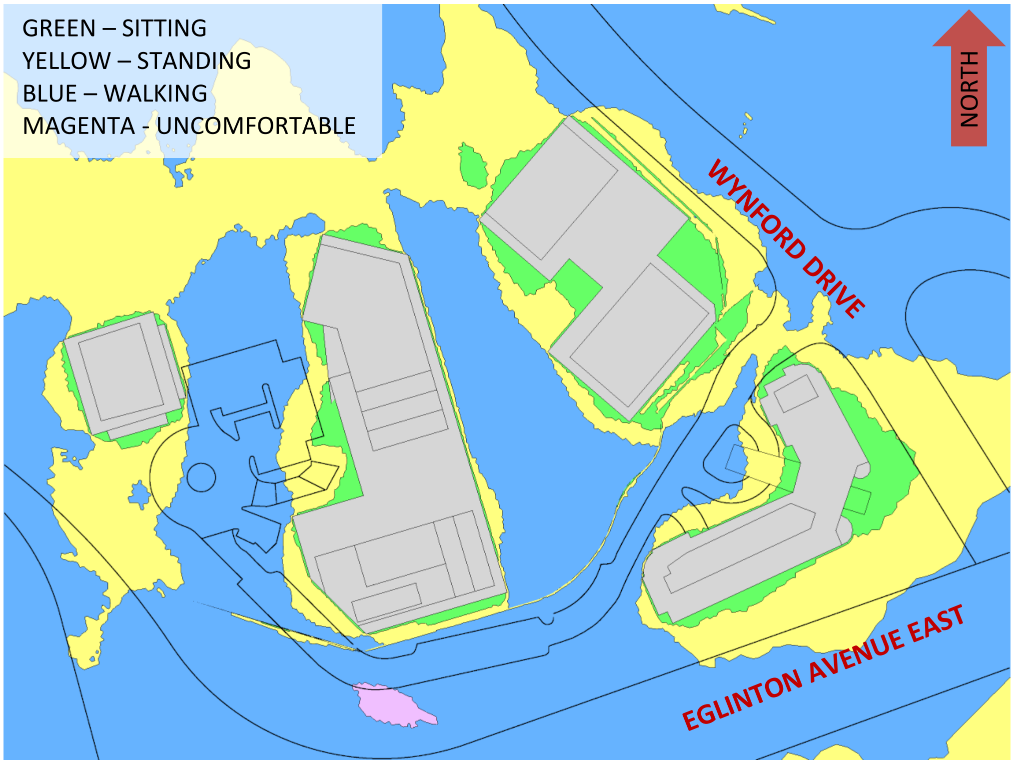


FIGURE 3A: SPRING – PEDESTRIAN WIND COMFORT CONDITIONS, GRADE LEVEL

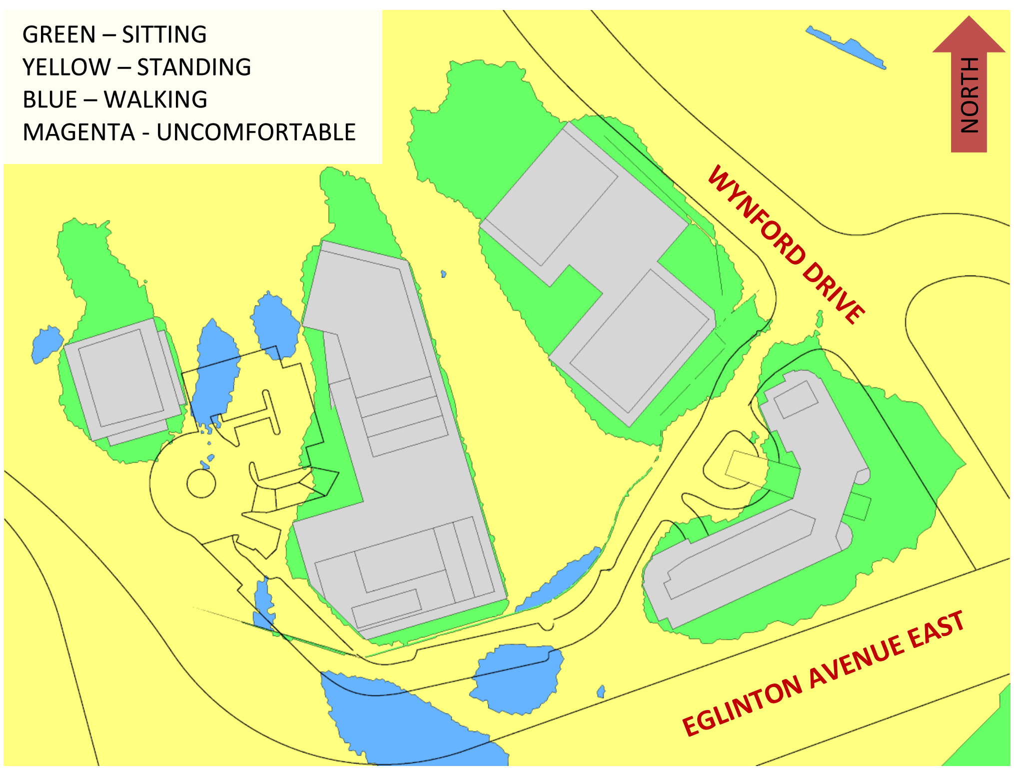


FIGURE 3B: SUMMER – PEDESTRIAN WIND COMFORT CONDITIONS, GRADE LEVEL

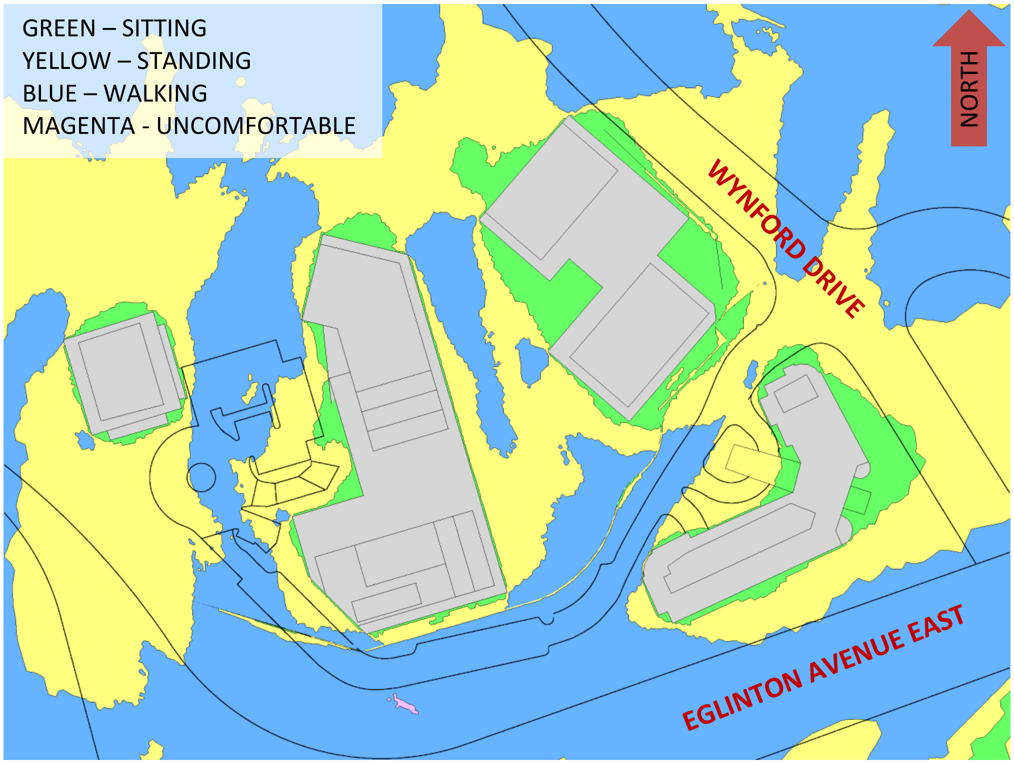


FIGURE 3C: AUTUMN – PEDESTRIAN WIND COMFORT CONDITIONS, GRADE LEVEL

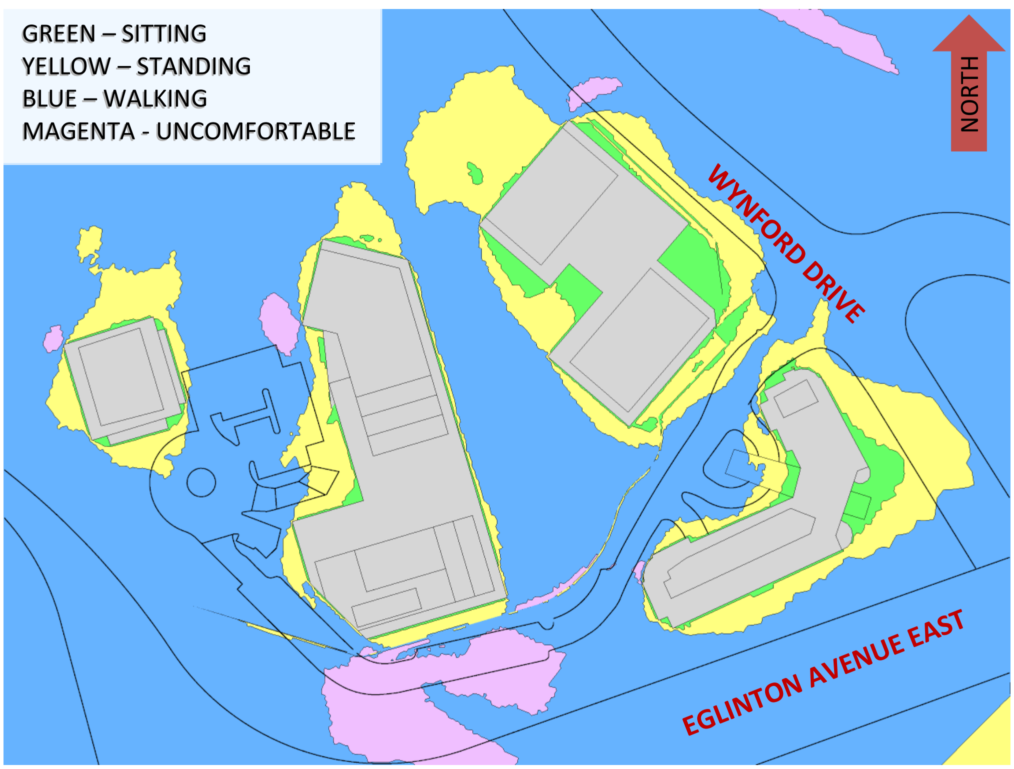


FIGURE 3D: WNTER – PEDESTRIAN WIND COMFORT CONDITIONS, GRADE LEVEL

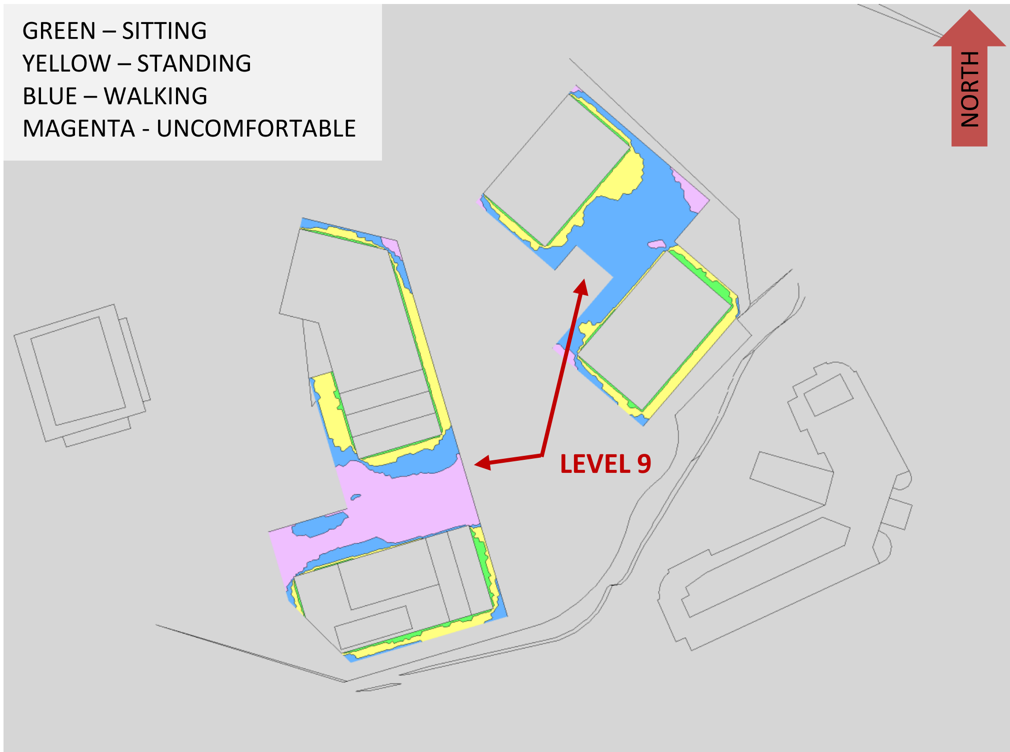


FIGURE 4A: SPRING – PEDESTRIAN WIND COMFORT, TERRACES

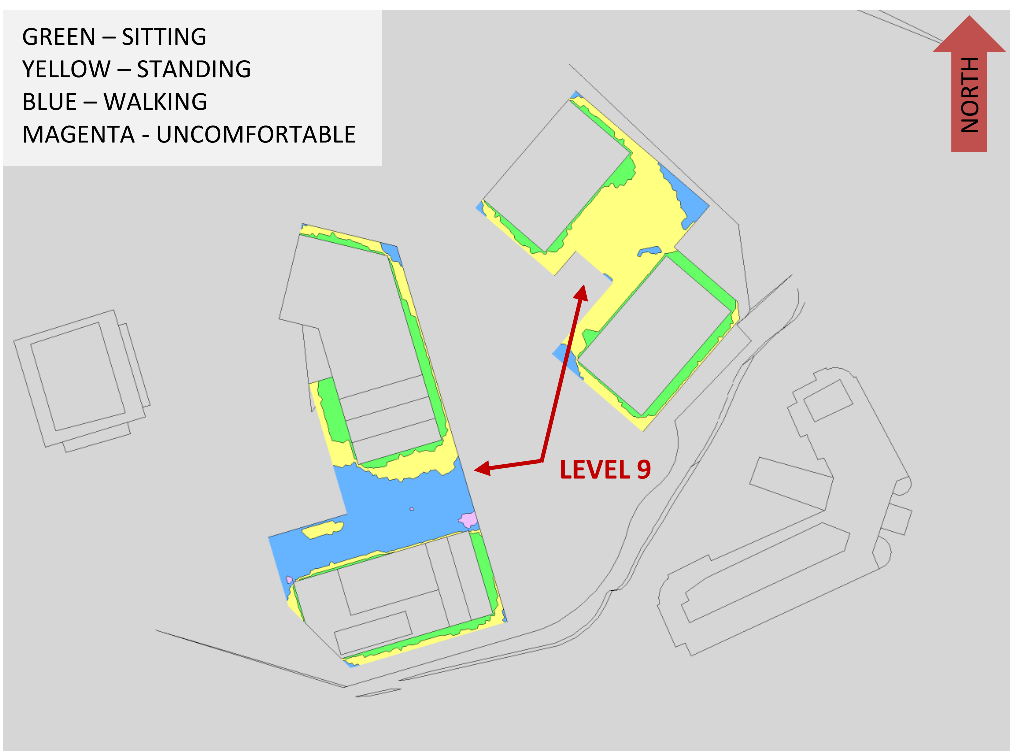


FIGURE 4B: SUMMER – PEDESTRIAN WIND COMFORT, TERRACES

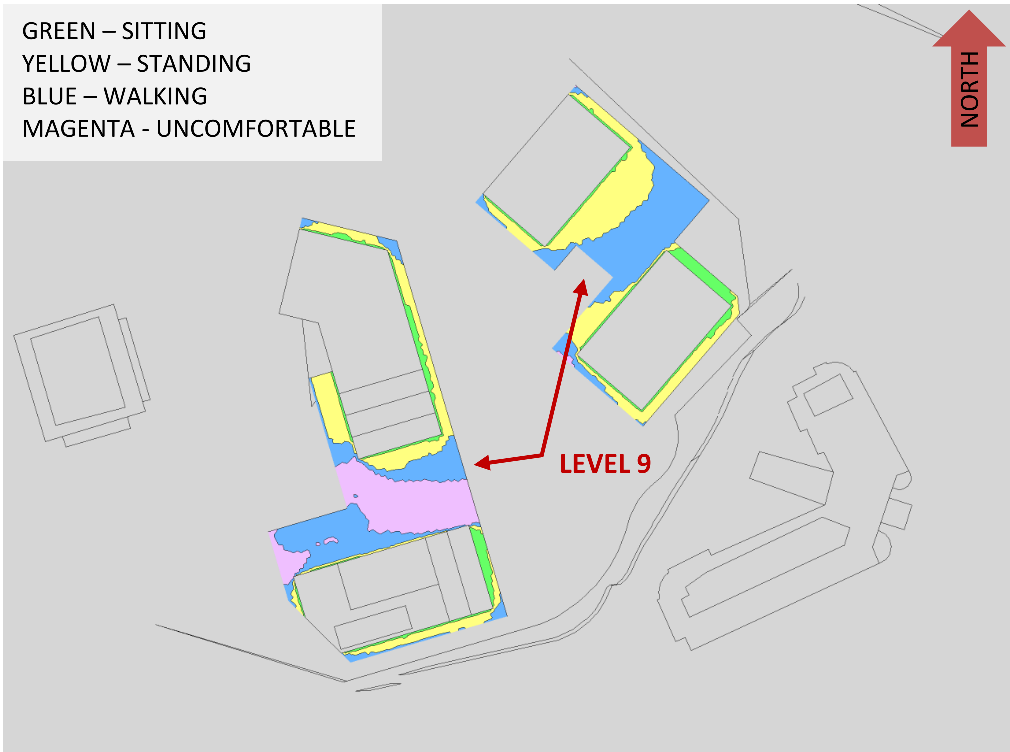


FIGURE 4C: AUTUMN – PEDESTRIAN WIND COMFORT, TERRACES

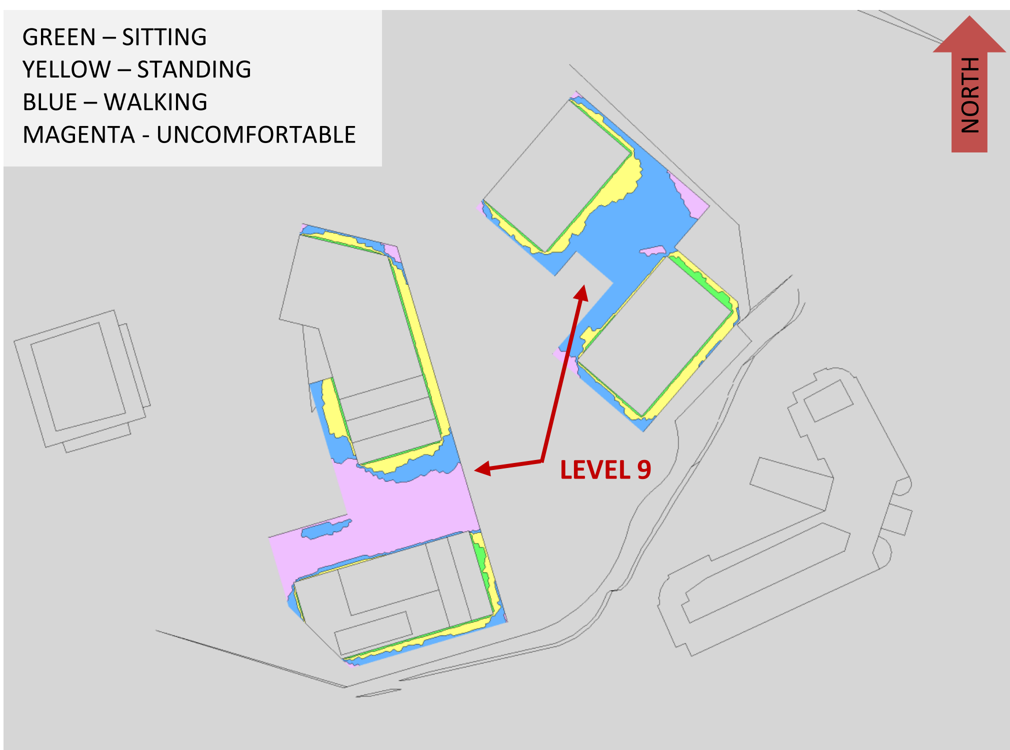
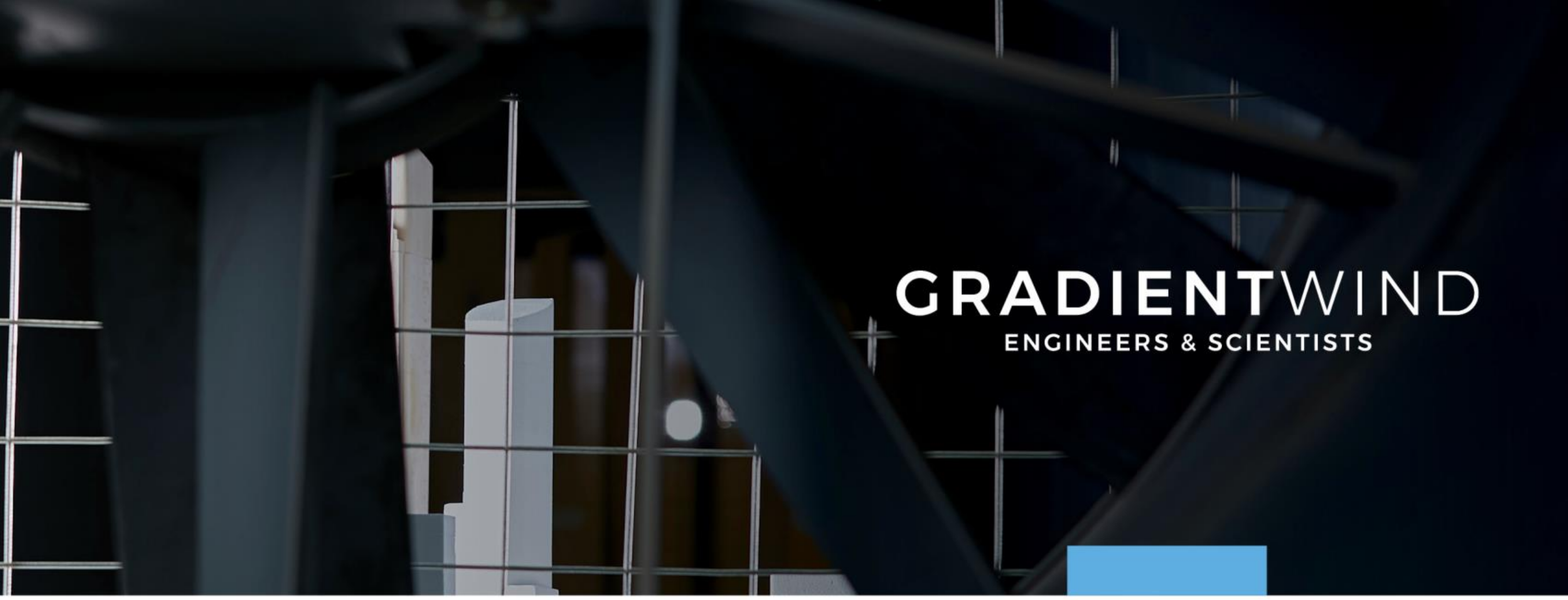
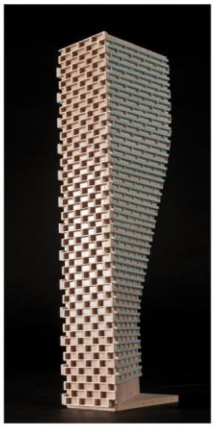
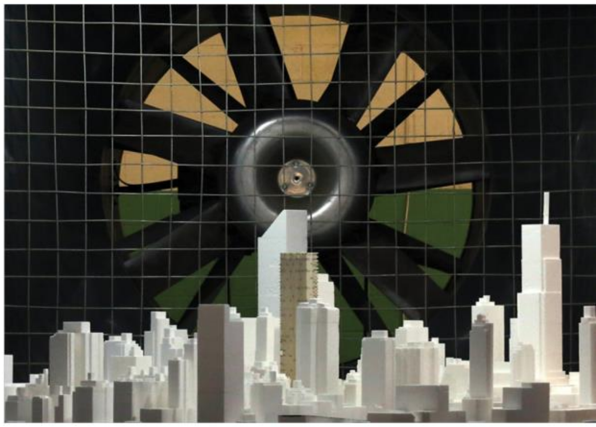


FIGURE 4D: WINTER – PEDESTRIAN WIND COMFORT, TERRACES







APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

The atmospheric boundary layer (ABL) is defined by the velocity and turbulence profiles according to industry standard practices. The mean wind profile can be represented, to a good approximation, by a power law relation, Equation (1), giving height above ground versus wind speed [1], [2].

$$U = U_g \left(\frac{Z}{Z_g}\right)^{\alpha} \qquad \text{Equation (1)}$$

where, $\boldsymbol{U}$ = mean wind speed, $\boldsymbol{U_g}$ = gradient wind speed, $\boldsymbol{Z}$ = height above ground, $\boldsymbol{Z_g}$ = depth of the boundary layer (gradient height), and α is the power law exponent.

For the model, U_g is set to 6.5 metres per second (m/s), which approximately corresponds to the 50% mean wind speed for Toronto based on historical climate data and statistical analyses. When the results are normalized by this velocity, they are relatively insensitive to the selection of gradient wind speed.

Z_g is set to 540 m. The selection of gradient height is relatively unimportant, so long as it exceeds the building heights surrounding the subject site. The value has been selected to correspond to our physical wind tunnel reference value.

α is determined based on the upstream exposure of the far-field surroundings (i.e., the area that it not captured within the simulation model).

Table 1 presents the values of α used in this study, while Table 2 presents several reference values of α. When the upstream exposure of the far-field surroundings is a mixture of multiple types of terrain, the α values are a weighted average with terrain that is closer to the subject site given greater weight.

TABLE 1: UPSTREAM EXPOSURE (ALPHA VALUE) VS TRUE WIND DIRECTION

Wind Direction (° True)	Alpha (α) Value
0	0.26
40	0.24
97	0.24
136	0.23
170	0.25
210	0.27
237	0.23
258	0.22
278	0.23
300	0.24
322	0.24
341	0.23

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

Upstream Exposure Type	α
Open Water	0.14-0.15
Open Field	0.16-0.19
Light Suburban	0.21-0.24
Heavy Suburban	0.24-0.27
Light Urban	0.28-0.30
Heavy Urban	0.31-0.33

The turbulence model in the computational fluid dynamics (CFD) simulations is a two-equation shear-stress transport (SST) model, and thus the ABL turbulence profile requires that two parameters be defined at the inlet of the domain. The turbulence profile is defined following the recommendations of the Architectural Institute of Japan for flat terrain [3].

$$I(Z) = \begin{cases} 0.1\left(\frac{Z}{Z_g}\right)^{-\alpha-0.05}, & Z > 10\ \text{m} \\ 0.1\left(\frac{10}{Z_g}\right)^{-\alpha-0.05}, & Z \leq 10\ \text{m} \end{cases} \qquad \text{Equation (2)}$$

$$L_t(Z) = \begin{cases} 100\ \text{m}\sqrt{\frac{Z}{30}}, & Z > 30\ \text{m} \\ 100\ \text{m}, & Z \leq 30\ \text{m} \end{cases} \qquad \text{Equation (3)}$$

where, ***I*** = turbulence intensity, $\boldsymbol{L_t}$ = turbulence length scale, ***Z*** = height above ground, and **α** is the power law exponent used for the velocity profile in Equation (1).

Boundary conditions on all other domain boundaries are defined as follows: the ground is a no-slip surface; the side walls of the domain have a symmetry boundary condition; the top of the domain has a specified shear, which maintains a constant wind speed at gradient height; and the outlet has a static pressure boundary condition.

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