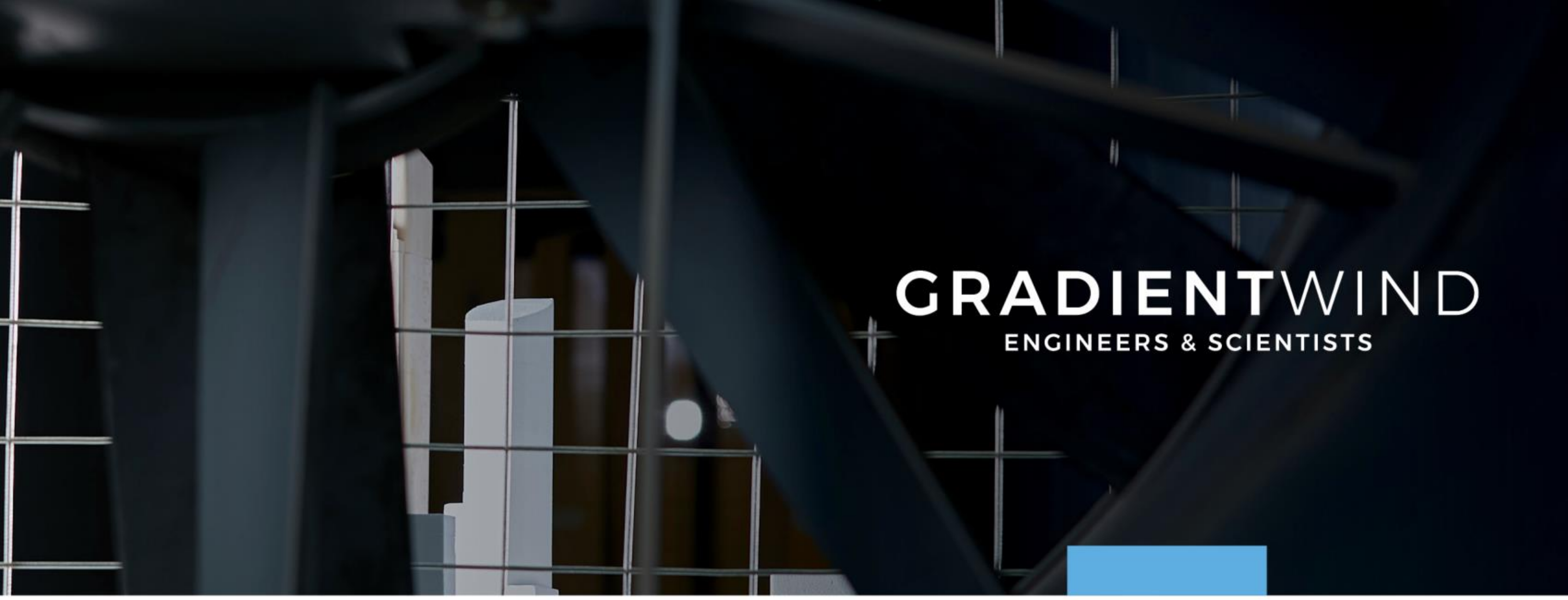
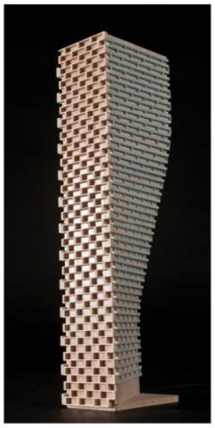
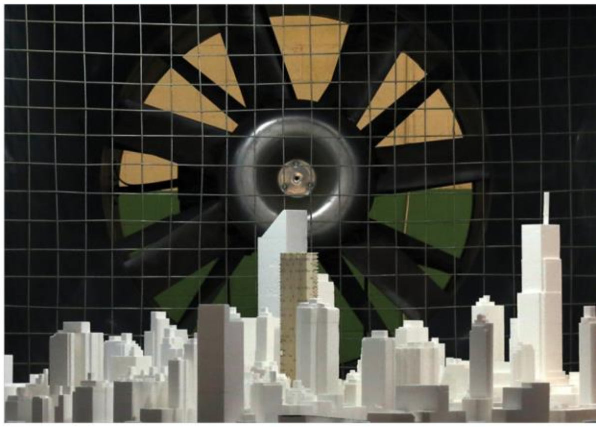


PEDESTRIAN LEVEL WIND STUDY

265 Catherine Street
Ottawa, Ontario

Report: 23-055-PLW-2024





March 18, 2024

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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Site Plan Control application resubmission requirements for the proposed multi-building development located at 265 Catherine Street in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

The study involves simulation of wind speeds for selected wind directions in a three-dimensional (3D) computer model using the computational fluid dynamics (CFD) technique, combined with meteorological data integration, to assess pedestrian wind comfort and safety within and surrounding the subject site according to City of Ottawa wind comfort and safety criteria. The results and recommendations derived from these considerations are detailed in the main body of the report (Section 5), illustrated in Figures 3A-8, and summarized as follows:

1) While the introduction of the proposed development is predicted to produce generally windy conditions at grade, most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for their intended pedestrian uses throughout the year. Specifically, conditions over most surrounding sidewalks and walkways, in the vicinity of the nearby transit stop, neighbouring existing surface parking, and on-street parking, within the publicly accessible open space, and in the vicinity of most building access points, are considered acceptable.

2) The windy conditions at grade to the northeast of Building A, to the southwest of Building B, and between Buildings A and B are primarily attributed to a combination of factors:

    a. The proposed development is exposed to prevailing winds from multiple directions, owing to the mostly suburban environs of the proposed development, and the windy conditions are expected following the introduction of the building development in its surroundings.

Furthermore, salient winds are predicted to downwash over the podium and tower façades of Buildings A and B towards grade-level and to accelerate around the northeast corner of Building A, around the southwest corner of Building B, and between Buildings A and B.

b. An isolated area between Buildings A and B is predicted to experience uncomfortable wind conditions during the winter, while to the northeast of Building A, an isolated area is predicted to experience uncomfortable conditions during the spring and winter.

c. The walking comfort exceedances of 2% and 5% during the spring and winter, respectively, at the northeast corner of Building A, and the exceedance of 2% between Buildings A and B during the winter are expected to be improved to achieve the walking comfort class by introducing canopies to Buildings A and B, extending from their north elevations and wrapping around their respective northeast corners. The canopies would be expected to deflect downwash winds incident on the two buildings, including vortices that are predicted to form at the northeast corners away from the ground floor. Additional details of the canopies are provided in Section 5.1. Furthermore, a 1.8-m-tall wind screen extending 2 m to the north from the northeast corner of Building B is recommended to help diffuse winds accelerating around the exposed building corner.

3) Three other grade-level areas of interest are predicted to experience windier conditions:

a. **Glashan Public School Yard**: Following the introduction of the proposed development, conditions over the neighbouring areas of the Glashan Public School yard to the east of the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, during the autumn, and suitable for walking, or better, during the winter and spring. These conditions are expected following the introduction of a tall building development.

b. **Driveway and Pedestrian Open Space and Parkland Dedication**: Wind conditions during the typical use period (that is, May to October, inclusive) within the above-noted areas and recommendations regarding mitigation, where required, are described as follows:

- Conditions within the central driveway and pedestrian open space are predicted to be suitable for a mix of sitting and standing with an isolated region suitable for strolling. As pedestrian usage through the space is expected to comprise mostly strolling and walking activities, the noted conditions are considered acceptable for the intended pedestrian uses.

- Conditions within the parkland dedication are predicted to be suitable for sitting to the west and standing to the east. Depending on programming, the noted conditions may be considered acceptable. Specifically, if the noted windier areas suitable for standing will not accommodate designated seating areas, the noted conditions would be considered acceptable. If required by programming, comfort levels at designated seating areas to the east within the parkland dedication may be improved by implementing landscaping elements that are targeted around sensitive areas such as tall wind screens and clusters of coniferous trees in dense arrangements, in combination with strategically placed seating with high-back benches or other local wind mitigation.

c. **Building Access Points along West Elevation of Building A**: With the exception of the entrance to the retail space at the southwest corner of Building A, which is served by a sliding door, to ensure safe operability throughout the year, it is recommended that the primary entrances along the west elevation of Building A be recessed into the building façade by at least 2 m.

  - Additionally, given the predicted acceleration of winds over the driveway between Buildings A and B, stress on the hardware supporting the swing doors along the west elevation of Building A is expected to be large. The use of robust hardware is recommended for the noted doors.

4) In accordance with the architectural plans for Level 7, the common amenity terraces serving Buildings A and B atop their respective podia at Level 7 were modelled with perimeter wind screens ranging in height from 1.8 m to 2.4 m from the local walking surface. The MPH Level terrace serving Tower 2 was modelled with a 1.8-m-tall wind screen along its full perimeter. Wind conditions for these terraces during the typical use period and recommendations regarding wind mitigation, where required, are described as follows:

   a. **Building A, Level 7**: Conditions are predicted to be suitable for sitting closer to the Tower 1 elevations and near the northwest corner of the terrace and standing throughout the remainder of the area, with a small, isolated region suitable for strolling to the west. Conditions over the pedestrian bridges connecting Buildings A and B are predicted to be suitable for sitting to the west and suitable for standing to the east.

   b. **Tower 3, North Level 7:** Conditions within the terrace to the north of Tower 3 at Level 7 are predicted to be suitable for sitting, which is considered acceptable.

   c. **Tower 3, Southwest Level 7:** Conditions within the amenity terrace serving Tower 3 to the southwest at Level 7 are predicted to be suitable for standing to the southwest and sitting to the north and southeast. If the southwest corner of the terrace will not include designated seating areas, the noted wind conditions would be considered acceptable.

   d. **Building B, East Level 7**: Conditions are predicted to be suitable for mostly standing, with areas suitable for sitting along the east elevation of Tower 3 and to the north, south, and southwest of Tower 2; conditions within the remaining terrace areas are predicted to be suitable for standing.

   e. **Tower 2, MPH Level Common Amenity Terrace**: Conditions are predicted to be suitable for mostly sitting, with areas suitable for standing along the south elevation of the terrace. Where conditions are suitable for standing, they are also predicted to be suitable for sitting for at least 75% of the time, where the target is 80% to achieve the sitting comfort criterion. If the programming for the south elevation of this terrace will not include designated seating areas, the noted conditions would be considered.

f. The terrace areas between Towers 2 and 3 and at the southwest corner of Tower 1 are expected to provide active use spaces, an urban farm is programmed at the north elevation of Building A, and the bridge linking the two buildings is comprised of a walking pathway. These areas are expected to have minimal seating or lounging spaces and activities, and the predicted conditions following the introduction of the perimeter wind screens are considered acceptable for the intended pedestrian uses of these areas.

g. Regarding the remaining areas of the terrace serving Building A, mitigation inboard of the perimeter is recommended for the seating and lounging areas at the centre of the terrace and to the north and southwest. Specifically, strategically placed east-west and north-south orientated high-back seating may improve comfort levels around seating areas to the west and southwest. Additionally, a combination of 1.8-m-tall wind screens or clusters of coniferous trees located around sensitive areas, and canopies located above designated seating areas may improve comfort levels centrally throughout the terrace.

h. The extent of the mitigation measures is dependent on the programming of the noted spaces. The mitigation strategy will continue to evolve and be refined in collaboration with the building and landscape architects as the design of the proposed development progresses.

5) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

Addendum: The PLW study was completed based on architectural drawings that were prepared by BDP Quadrangle in February 2024. An updated architectural design was distributed to the consultant team in March 2024, in which several recommendations of the current study regarding wind mitigation have been implemented. Specifically, the building entrances along the west elevation of Building A are now either recessed into the building façade by 2 m or served by a sliding door. Furthermore, a wind screen now extends from the northeast corner of Building B, in accordance with the recommendations in the current study. Finally, canopies have been included along the northeast elevations of Buildings A and B. However, owing to constraints from vehicular movement on the driveway between Buildings A and B, the recommended return of the canopy serving Building B at its northeast canopy along the east elevation cannot be accommodated in the architectural design.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 11034936 Canada Inc. to undertake a pedestrian level wind (PLW) study to satisfy Site Plan Control application resubmission requirements for the proposed multi-building development located at 265 Catherine Street in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). A PLW study was conducted in April 2023[1] for the previous design of the proposed development (submitted for concurrent Zoning By-law Amendment and Site Plan Control applications). Our mandate within this study is to investigate wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by BDP Quadrangle in February 2024, surrounding street layouts and existing and approved future building massing information obtained from the City of Ottawa, as well as recent satellite imagery.

2. TERMS OF REFERENCE

The subject site is located at 265 Catherine Street in Ottawa, situated within a city block bounded by Arlington Avenue to the north, Kent Street to the east, Catherine Street to the south, and Lyon Street North to the west.

The proposed development comprises three buildings: Building A to the east, comprised of Tower 1 rising to 32-storeys above an 'L'-shaped six-storey podium; Building B to the west, comprised of Towers 2 and 3 rising to 36- and 34-storeys, respectively, above a shared 'L'-shaped six-storey podium; and Building C to the north which is comprised of three-storey townhouses. Building A comprises Phase 1, and Buildings B and C comprise Phase 2 of the proposed development. The podia serving Buildings A and B have their long axes oriented along Catherine Street and are connected at the podia roof level (Level 7) by a pedestrian bridge. The buildings share below-grade parking levels, and the three towers are topped with mechanical penthouses (MPH). A parkland dedication is provided at the northeast corner of the subject site, a

[1] Gradient Wind Engineering Inc., '*265 Catherine Street – Pedestrian Level Wind Study*', [April 10, 2023]

woonerf-style vehicular driveway and pedestrian open space is situated between Buildings A and B, and a publicly accessible open space is situated between Buildings B and C.

Above the below-grade parking, the ground floor of Building A includes a nearly central residential lobby with main entrances to its north, a loading space to the west, and retail spaces throughout the remainder of the level. An east-west covered pedestrian link is located between the retail spaces at the northwest corner and to the west of Building A, connecting the central driveway and pedestrian open space and the parkland dedication. Access to the underground parking is provided by a ramp near the southwest corner of Building A from Catherine Street. The ground floor of Building B includes a residential main entrance, retail spaces, and a management office to the south, a residential entrance to the west, retail spaces at the northwest corner, indoor amenities to the north and northeast, and a garbage and loading space to the east. Access to the underground parking from Arlington Avenue is provided by a ramp near the centre of the north façade of Building B. Levels 2-6 of Buildings A and B are reserved for residential use and Level 7 is comprised of indoor amenities. At the northwest corner of Building A at Level 2, the podium steps back from all elevations, while Building B steps back from the east elevation of the short axis at Level 2 and from the northwest corner at Level 4, and both buildings step back from the south elevation at Level 5 to accommodate private terraces. The buildings step back from all elevations at Level 7 to accommodate continuous amenity terraces atop the connected podia. Towers 1, 2, and 3 rise above the podia with near rectangular planforms and are comprised of residential units. Tower 2 is also served by an amenity terrace adjoining a skylounge amenity at the MPH Level.

The near-field surroundings, defined as an area within 200-metres (m) of the subject site, include low-rise massing in all compass directions, Glashan Public School to the northeast, and isolated mid-rise buildings to the east, southeast, and west. Notably, a 16-storey mixed-use development is approved at 30-48 Chamberlain Avenue (ZBLA), approximately 190 m to the southeast. The far-field surroundings, defined as an area beyond the near-field but within a 2-kilometre (km) radius of the subject site, are characterized by low-rise massing and isolated mid- and high-rise buildings from the east-northeast clockwise to the west-northwest, low- and mid-rise massing following by the urban massing of the Ottawa downtown core from the west-northwest clockwise to the northeast, and a mix of low-, mid-, and high-rise massing in the remaining compass directions. The Ottawa downtown core is situated approximately 1.1 km to the north, and Dow's Lake is approximately 1.5 km to the south-southwest.

A site plan for the proposed massing scenario is illustrated in Figure 1, while Figures 2A-2D illustrate the computational models used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind conditions at key areas within and surrounding the development site; (ii) identify areas where 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 subject site within a virtual environment, meteorological analysis of the Ottawa area wind climate, and synthesis of computational data with City of Ottawa wind comfort and safety criteria[2]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

4.1 Computer-Based Context Modelling

A computer based PLW 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 mechanical effects of wind, were determined by combining measured wind speed data from CFD simulations with statistical weather data obtained from Ottawa Macdonald-Cartier International Airport. The general concept and approach to CFD modelling is to represent building and topographic details in the immediate vicinity of the subject 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 stronger wind speeds.

[2] City of Ottawa Terms of References: Wind Analysis
https://documents.ottawa.ca/sites/default/files/torwindanalysis_en.pdf

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. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 515 m.

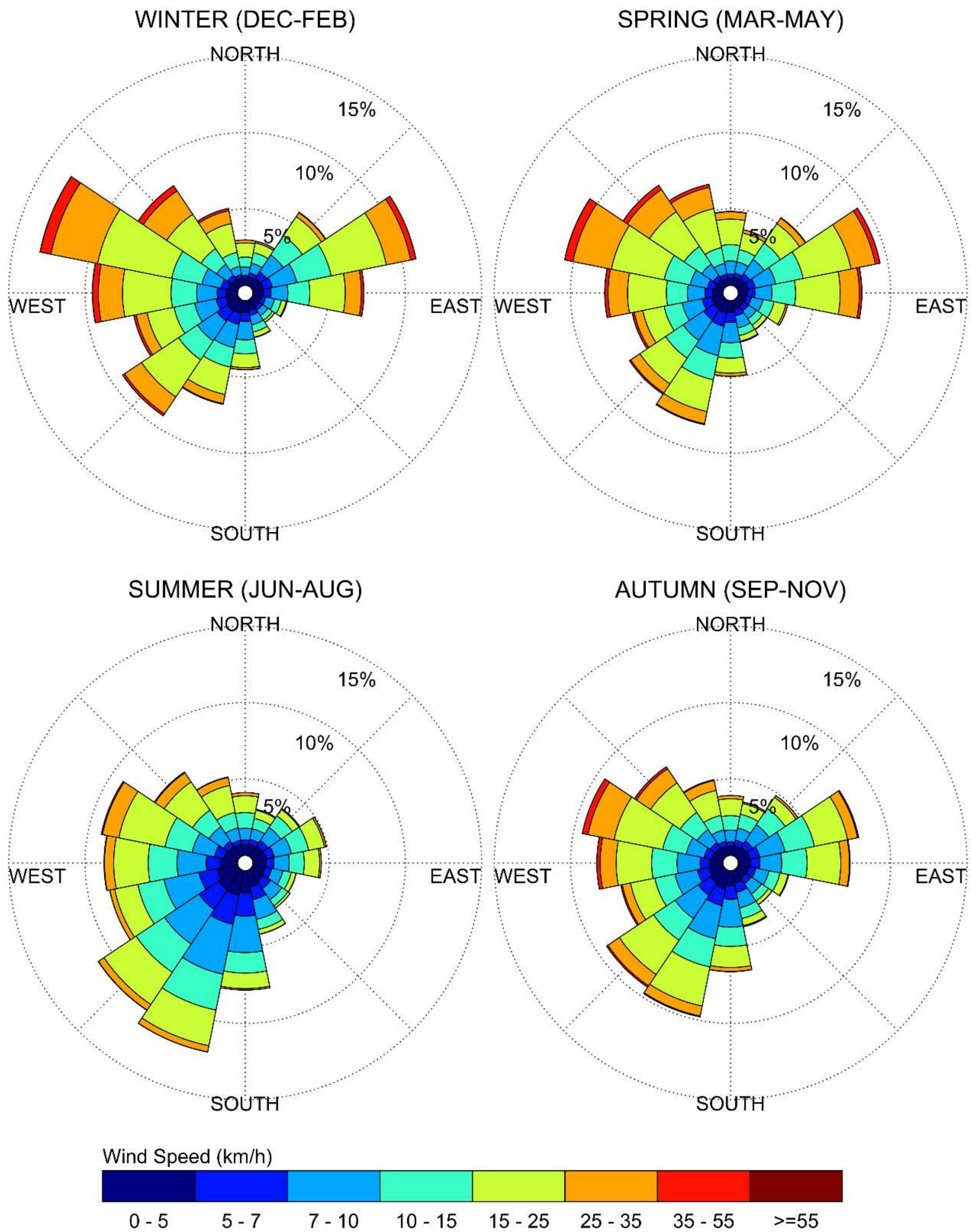
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the numerous elevated common amenity terraces serving the proposed development were referenced to the wind speed at gradient height to generate mean and peak velocity ratios, which were used to calculate full-scale values. 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 wind flow simulation technique are presented in Appendix A.

4.3 Historical Wind Speed and Direction Data

A statistical model for winds in Ottawa was developed from approximately 40 years of hourly meteorological wind data recorded at Ottawa Macdonald-Cartier International Airport and obtained from Environment and Climate Change Canada. Wind speed and direction data were analyzed for each month of the year to determine the statistically prominent wind directions and corresponding speeds, and to characterize similarities between monthly weather patterns.

The statistical model of the Ottawa 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 kilometers per hour (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 prominent wind speeds and directions can be identified by the longer length of the bars. For Ottawa, the most common winds occur for westerly wind directions, followed by those from the east, while the most common wind speeds are below 36 km/h. The directional prominence and relative magnitude of wind speed changes somewhat from season to season.

SEASONAL DISTRIBUTION OF WIND
OTTAWA MACDONALD-CARTIER INTERNATIONAL AIRPORT



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 Wind Comfort and Safety Criteria – City of Ottawa

Pedestrian wind comfort and safety criteria are based on the mechanical effects of wind without consideration of other meteorological conditions (that is, temperature and relative humidity). The comfort criteria assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Five pedestrian comfort classes based on 20% non-exceedance mean wind speed ranges are used to assess pedestrian comfort: (1) Sitting; (2) Standing; (3) Strolling; (4) Walking; and (5) Uncomfortable. The gust speeds, and equivalent mean speeds, are selected based on the Beaufort scale, which describes the effects of forces produced by varying wind speed levels on objects. Wind conditions suitable for sitting are represented by the colour blue, standing by green, strolling by yellow, and walking by orange; uncomfortable conditions are represented by the colour magenta. Specifically, the comfort classes, associated wind speed ranges, and limiting criteria are summarized as follows:

PEDESTRIAN WIND COMFORT CLASS DEFINITIONS

Wind Comfort Class	GEM Speed (km/h)	Description
SITTING	≤ 10	Mean wind speeds no greater than 10 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 16 km/h.
STANDING	≤ 14	Mean wind speeds no greater than 14 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 22 km/h.
STROLLING	≤ 17	Mean wind speeds no greater than 17 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 27 km/h.
WALKING	≤ 20	Mean wind speeds no greater than 20 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 32 km/h.
UNCOMFORTABLE	> 20	Uncomfortable conditions are characterized by predicted values that fall below the 80% target for walking. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

Regarding wind safety, the pedestrian safety wind speed criterion 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 90 km/h is classified as dangerous. From calculations of stability, it can be shown that gust wind speeds of 90 km/h would be the approximate threshold wind speed that would cause an average elderly person in good health to fall. Notably, 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.

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if a mean wind speed of 10 km/h (equivalent gust wind speed of approximately 16 km/h) were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting. Similarly, if mean wind speed of 20 km/h (equivalent gust wind speed of approximately 32 km/h) at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As 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 throughout the subject site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for discrete regions within and surrounding the subject site. This step involves comparing the predicted comfort classes to the target comfort classes, which are dictated by the location type for each region (that is, a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their typical windiest target comfort classes are summarized on the following page. Depending on the programming of a space, the desired comfort class may differ from this table.

TARGET PEDESTRIAN WIND COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Target Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Walking
Public Sidewalk / Bicycle Path	Walking
Outdoor Amenity Space	Sitting / Standing
Café / Patio / Bench / Garden	Sitting / Standing
Transit Stop (Without Shelter)	Standing
Transit Stop (With Shelter)	Walking
Public Park / Plaza	Sitting / Standing
Garage / Service Entrance	Walking
Parking Lot	Walking
Vehicular Drop-Off Zone	Walking

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-3D, illustrating wind conditions at grade level for the proposed massing scenario, by Figures 5A-5D, illustrating wind conditions over the common amenity terraces serving Buildings A and B atop the podia at Level 7, and by Figures 7A-7D, illustrating wind conditions over the common amenity terrace serving Tower 2 of Building B at the MPH Level. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes presented in Section 4.4.

Wind comfort conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figures 4, 6, and 8 illustrate comfort conditions at grade level, over the noted Level 7 amenity terraces, and over the noted MPH Level amenity terrace, respectively, consistent with the comfort classes in Section 4.4. The details of these conditions are summarized in the following pages for each area of interest.

5.1 Wind Comfort Conditions

Neighbouring Existing Surface Parking Lots: Following the introduction of the proposed development, conditions over the neighbouring existing surface parking lots situated to the south of the subject site are predicted to be suitable for mostly sitting during the summer, becoming suitable for a mix of mostly sitting and standing throughout the remainder of the year. Conditions over the neighbouring existing surface parking lots situated to the west of the subject site are predicted to be suitable for standing, or better, during the summer, becoming suitable for a mix of mostly standing and strolling throughout the remainder of the year. Conditions over the neighbouring existing surface parking lot to the northeast of the subject site are predicted to be suitable for a mix of sitting and standing throughout the year. The noted conditions are considered acceptable.

While the introduction of the proposed development produces windier conditions over the surface parking lots to the south, west, and northeast of the subject site in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Sidewalks and Transit Stop along Catherine Street: Following the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along Catherine Street are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, throughout the remainder of the year, with an isolated region suitable for walking at the intersection of Catherine Street and Lyon Street North during the winter and spring and an isolated region suitable for walking at the intersection of Catherine Street and Kent Street during the winter. Conditions in the vicinity of the nearby transit stop along Catherine Street are predicted to be suitable for sitting during the summer and autumn, becoming suitable for a mix of sitting and standing during the winter and spring. The noted conditions are considered acceptable.

While the introduction of the proposed development produces windier conditions over Catherine Street in comparison to existing conditions (refer to Section 5 of the noted previous PLW report for a detailed description of the predicted wind comfort conditions under the existing massing scenario), wind comfort conditions with the proposed development are nevertheless considered acceptable.

Sidewalks along Lyon Street North: Following the introduction of the proposed development, wind conditions over the nearby public sidewalks along Lyon Street North are predicted to be suitable for standing, or better, during the summer, becoming suitable for strolling, or better, throughout the remainder of the year, with an isolated region suitable for walking at the intersection of Catherine Street and Lyon Street North during the winter and spring. The noted conditions are considered acceptable.

While the introduction of the proposed development produces windier conditions over Lyon Street North in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Sidewalks and Existing On-Street Parking along Arlington Avenue: Following the introduction of the proposed development, wind conditions over the nearby public sidewalks and on-street parking along Arlington Avenue are predicted to be suitable for sitting during the summer, with standing conditions to the west, becoming suitable for standing, or better, throughout the remainder of the year, with an isolated region suitable for strolling at the intersection of Lyon Street North and Arlington Avenue during the spring, autumn, and winter. The noted conditions are considered acceptable.

While the introduction of the proposed development produces windier conditions over Arlington Avenue in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Sidewalks along Kent Street: Following the introduction of the proposed development, wind conditions over the nearby public sidewalks along Kent Street are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for walking, or better, throughout the remainder of the year, with an isolated region of conditions that may be considered uncomfortable for walking located at the northeast corner of Building A during the spring and winter seasons.

Specifically, the windiest conditions are situated to the northeast of Building A, where conditions over the noted region are predicted to be suitable for walking for approximately 75% of the time during the winter season, representing a 5% exceedance of the walking threshold, and for approximately 78% of the time during the spring season, representing a 2% exceedance of the walking threshold. The noted conditions are predicted to impact a section of the west sidewalk along Kent Street and the walkway to the north of Building A.

These conditions are primarily attributed to the downwash of prevailing winds on the north façade of Building A towards grade-level, and the acceleration of prevailing winds around the exposed northwest corner of Building A.

To mitigate the windier conditions at the northeast corner of Building A, a canopy that extends 3 m in depth from the north façade of Building A is recommended, inclusive of a return along the east elevation that extends outwards by at least 1.3 m. The underside of the canopy should have a clear height no greater than 4 m as measured from established grade. The length of the canopy along the north elevation should extend at least 10 m, as measured from the northeast corner of Building A, while the return along the east elevation should extend at least one quarter of its total floorplate width (approximately 5.7 m).

Glashan Public School Yard: Following the introduction of the proposed development, wind comfort conditions over the neighbouring areas of the Glashan Public School Yard are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, during the autumn, and suitable for walking, or better, during the winter and spring. These conditions are expected following the introduction of a tall building development.

Walkways within the Subject Site: Wind comfort conditions over the walkway and driveway between Buildings A and B are predicted to be suitable for strolling, or better, during the summer, becoming suitable for walking, or better, throughout the remainder of the year, with a region of conditions during the winter that may be considered uncomfortable for walking located over the driveway between Buildings A and B. Specifically, conditions over the noted region are predicted to be suitable for walking for approximately 78% of the time during the winter season, representing a 2% exceedance of the walking threshold. To mitigate the noted windier conditions, a canopy that extends 3 m in depth from the north façade of Building B is recommended, inclusive of a return along the east elevation that extends outwards by at least 2 m. The underside of the canopy should have a clear height no greater than 4 m as measured from established grade. The length of the canopy along the north elevation should extend at least 10 m, as measured from the northeast corner of Building A, while the return along the east elevation should extend at least 5 m from the northeast corner. Furthermore, a 1.8-m-tall wind screen extending 2 m to the north from the northeast corner of Building B is recommended to help diffuse winds accelerating around the exposed building corner.

With the exception of the above-noted northeast corner of Building A, conditions over the remaining walkways throughout the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, throughout the remainder of the year, with isolated regions suitable for walking to the southwest of Building B. The noted conditions are considered acceptable.

Driveway and Pedestrian Open Space, Publicly Accessible Open Space, and Parkland Dedication: The proposed development is served by several outdoor areas. Wind comfort conditions during the typical use period, as illustrated in Figure 4, and recommendations regarding mitigation, where required, are described as follows:

- **Driveway and Pedestrian Open Space**: Conditions over the central pedestrian open space are predicted to be suitable for a mix of sitting and standing with an isolated region suitable for strolling between Buildings A and B. As pedestrian usage through the space is expected to comprise mostly strolling and walking with limited seating activities, the noted conditions are considered acceptable for the intended pedestrian uses during the typical use period.

- **Publicly Accessible Open Space**: Wind conditions within the publicly accessible open space situated between Buildings B and C are predicted to be suitable for mostly sitting and are considered acceptable.

- **Parkland Dedication**: Conditions within the parkland dedication situated at the northeast corner of the subject site are predicted to be suitable for sitting to the west and suitable for standing to the east. Depending on the programming of the parkland dedication, the noted conditions may be considered acceptable. Specifically, if the noted windier areas to the east that are suitable for standing will not accommodate designated seating or lounging activities, the noted conditions would be considered acceptable.

  If required by programming, comfort levels at designated seating areas to the east within the parkland dedication may be improved by implementing landscaping elements that are targeted around sensitive areas such as tall wind screens and clusters of coniferous trees in dense arrangements, in combination with strategically placed seating with high-back benches or other local wind mitigation.

Building Access Points: Conditions in the vicinity of the building access points along the west elevation of Building A are predicted to be suitable for a mix of standing and strolling during the summer, becoming suitable for a mix of strolling and walking throughout the remainder of the year. With the exception of the entrance to the retail space at the southwest corner of Building A, which is served by a sliding door, it is recommended that the primary entrances along the west elevation of Building A be recessed into the building façade by at least 2 m to ensure safe operability throughout the year. Additionally, given the predicted acceleration of winds through the driveway between Buildings A and B, stress on the hardware supporting the swing doors along the west elevation of Building A is expected to be large. The use of robust hardware is recommended for the noted doors.

Conditions in the vicinity of the remaining building access points serving the proposed development are predicted to be suitable for standing, or better, throughout the year. The noted conditions are considered acceptable.

5.2 Wind Comfort Conditions – Common Amenity Terraces

Buildings A and B are served by common amenity terraces atop the podia at Level 7 and Tower 2 of Building B is served by a common amenity terrace at the MPH Level. The common amenity terraces serving Buildings A and B atop the podia at Level 7 include perimeter wind screens ranging in height from 1.8 m to 2.4 m above the local walking surface, as illustrated on the floor plan for Level 7. The MPH Level terrace serving Tower 2 was modelled with a 1.8-m-tall wind screen along its perimeter. Wind comfort conditions during the typical use period within the noted amenity terraces, as illustrated in Figure 6, and recommendations regarding mitigation are described as follows:

Building A, Level 7 Common Amenity Terrace: Conditions within the common amenity terrace serving Building A at Level 7 are predicted to be suitable for mostly standing with conditions suitable for sitting closer to the Tower 1 elevations and at the northwest corner of the terrace. Conditions over the pedestrian bridges connecting Buildings A and B are predicted to be suitable for sitting to the west and suitable for standing to the east.

Tower 3, North Level 7 Common Amenity Terrace: With the perimeter wind screen mitigation as described in the introductory paragraph, conditions within the common amenity terrace serving Tower 3 to the north at Level 7 are predicted to be suitable for sitting, which is considered acceptable.

Tower 3, Southwest Level 7 Common Amenity Terrace: With the perimeter wind screen mitigation as described in the introductory paragraph, wind conditions within the common amenity terrace serving Tower 3 to the southwest at Level 7 are predicted to be suitable for standing to the southwest and sitting to the east and north. If seating areas are programmed along the south elevation of Tower 3, where conditions are predicted to be suitable for sitting, the noted conditions may be considered acceptable.

Building B, East Common Amenity Terrace: Conditions within the common amenity terrace serving Building B at Level 7 to the east of Tower 3 are predicted to be suitable for sitting along the east elevation of Tower 3 and to the north, south, and southwest of Tower 2; conditions within the remaining terrace areas are predicted to be suitable for standing.

Tower 2, MPH Level Common Amenity Terrace: Wind comfort conditions within the common amenity terrace serving Tower 2 at the MPH Level are predicted to be suitable for mostly sitting, with areas suitable for standing along the south elevation of the terrace. Where conditions are suitable for standing, they are also predicted to be suitable for sitting for at least 75% of the time, where the target is 80% to achieve the sitting comfort criterion. If the programming for the south elevation of this terrace will not include designated seating areas, the noted conditions would be considered acceptable without further mitigation.

The terrace areas between Towers 2 and 3 and at the southwest corner of Tower 1 are expected to provide active use spaces. Additionally, an urban farm is programmed at the north elevation of Building A, and the bridge linking the two buildings is comprised of a walking pathway. These areas are considered to have minimal seating or lounging spaces and activities, and the predicted wind conditions in these areas following the introduction of the perimeter wind screens as described in the introductory paragraph are considered acceptable for the intended pedestrian uses of these areas.

Regarding the remaining areas of the terrace serving Building A, mitigation inboard of the perimeter is recommended for the seating and lounging areas at the centre of the terrace and to the north and southwest. Specifically, strategically placed east-west and north-south orientated high-back seating may improve comfort levels around seating areas to the west and southwest. Additionally, a combination of 1.8-m-tall wind screens or clusters of coniferous trees located around sensitive areas, and canopies located above designated seating areas may improve comfort levels centrally throughout the terrace.

The extent of the mitigation measures is dependent on the programming of the noted spaces. The mitigation strategy will continue to evolve and be refined in collaboration with the building and landscape architects as the design of the proposed development progresses.

5.3 Wind Safety

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within or surrounding the subject site are expected to experience conditions that could be considered dangerous, as defined in Section 4.4.

5.4 Applicability of Results

Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the subject site. Future changes (that is, 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 subject site would alter the wind profile approaching the subject site; and (ii) development in proximity to the subject site would cause changes to local flow patterns.

6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-8. Based on computer simulations using the CFD technique, meteorological data analysis of the Ottawa wind climate, City of Ottawa wind comfort and safety criteria, and experience with numerous similar developments, the study concludes the following:

1) While the introduction of the proposed development is predicted to produce generally windy conditions at grade, most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for their intended pedestrian uses throughout the year. Specifically, conditions over most surrounding sidewalks and walkways, in the vicinity of the nearby transit stop, neighbouring existing surface parking, and on-street parking, within the publicly accessible open space, and in the vicinity of most building access points, are considered acceptable.

2) The windy conditions at grade to the northeast of Building A, to the southwest of Building B, and between Buildings A and B are primarily attributed to a combination of factors:

    a. The proposed development is exposed to prevailing winds from multiple directions, owing to the mostly suburban environs of the proposed development, and the windy conditions are expected following the introduction of the building development in its surroundings. Furthermore, salient winds are predicted to downwash over the podium and tower façades of Buildings A and B towards grade-level and to accelerate around the northeast corner of Building A, around the southwest corner of Building B, and between Buildings A and B.

    b. An isolated area between Buildings A and B is predicted to experience uncomfortable wind conditions during the winter, while to the northeast of Building A, an isolated area is predicted to experience uncomfortable conditions during the spring and winter.

    c. The walking comfort exceedances of 2% and 5% during the spring and winter, respectively, at the northeast corner of Building A, and the exceedance of 2% between Buildings A and B during the winter are expected to be improved to achieve the walking comfort class by introducing canopies to Buildings A and B, extending from their north elevations and wrapping around their respective northeast corners. The canopies would be expected to deflect downwash winds incident on the two buildings, including vortices that are predicted to form at the northeast corners away from the ground floor. Additional details of the canopies are provided in Section 5.1. Furthermore, a 1.8-m-tall wind screen extending 2 m to the north from the northeast corner of Building B is recommended to help diffuse winds accelerating around the exposed building corner.

3) Three other grade-level areas of interest are predicted to experience windier conditions:

   a. **Glashan Public School Yard**: Following the introduction of the proposed development, conditions over the neighbouring areas of the Glashan Public School yard to the east of the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, during the autumn, and suitable for walking, or better, during the winter and spring. These conditions are expected following the introduction of a tall building development.

   b. **Driveway and Pedestrian Open Space and Parkland Dedication**: Wind conditions during the typical use period (that is, May to October, inclusive) within the above-noted areas and recommendations regarding mitigation, where required, are described as follows:

      - Conditions within the central driveway and pedestrian open space are predicted to be suitable for a mix of sitting and standing with an isolated region suitable for strolling. As pedestrian usage through the space is expected to comprise mostly strolling and walking activities, the noted conditions are considered acceptable for the intended pedestrian uses.

      - Conditions within the parkland dedication are predicted to be suitable for sitting to the west and standing to the east. Depending on programming, the noted conditions may be considered acceptable. Specifically, if the noted windier areas suitable for standing will not accommodate designated seating areas, the noted conditions would be considered acceptable. If required by programming, comfort levels at designated seating areas to the east within the parkland dedication may be improved by implementing landscaping elements that are targeted around sensitive areas such as tall wind screens and clusters of coniferous trees in dense arrangements, in combination with strategically placed seating with high-back benches or other local wind mitigation.

c. **Building Access Points along West Elevation of Building A**: With the exception of the entrance to the retail space at the southwest corner of Building A, which is served by a sliding door, to ensure safe operability throughout the year, it is recommended that the primary entrances along the west elevation of Building A be recessed into the building façade by at least 2 m.

- Additionally, given the predicted acceleration of winds over the driveway between Buildings A and B, stress on the hardware supporting the swing doors along the west elevation of Building A is expected to be large. The use of robust hardware is recommended for the noted doors.

4) In accordance with the architectural plans for Level 7, the common amenity terraces serving Buildings A and B atop their respective podia at Level 7 were modelled with perimeter wind screens ranging in height from 1.8 m to 2.4 m from the local walking surface. The MPH Level terrace serving Tower 2 was modelled with a 1.8-m-tall wind screen along its full perimeter. Wind conditions for these terraces during the typical use period and recommendations regarding wind mitigation, where required, are described as follows:

a. **Building A, Level 7**: Conditions are predicted to be suitable for sitting closer to the Tower 1 elevations and near the northwest corner of the terrace and standing throughout the remainder of the area, with a small, isolated region suitable for strolling to the west. Conditions over the pedestrian bridges connecting Buildings A and B are predicted to be suitable for sitting to the west and suitable for standing to the east.

b. **Tower 3, North Level 7:** Conditions within the terrace to the north of Tower 3 at Level 7 are predicted to be suitable for sitting, which is considered acceptable.

c. **Tower 3, Southwest Level 7:** Conditions within the amenity terrace serving Tower 3 to the southwest at Level 7 are predicted to be suitable for standing to the southwest and sitting to the north and southeast. If the southwest corner of the terrace will not include designated seating areas, the noted wind conditions would be considered acceptable.

d. **Building B, East Level 7**: Conditions are predicted to be suitable for mostly standing, with areas suitable for sitting along the east elevation of Tower 3 and to the north, south, and southwest of Tower 2; conditions within the remaining terrace areas are predicted to be suitable for standing.

e. **Tower 2, MPH Level Common Amenity Terrace**: Conditions are predicted to be suitable for mostly sitting, with areas suitable for standing along the south elevation of the terrace. Where conditions are suitable for standing, they are also predicted to be suitable for sitting for at least 75% of the time, where the target is 80% to achieve the sitting comfort criterion. If the programming for the south elevation of this terrace will not include designated seating areas, the noted conditions would be considered.

f. The terrace areas between Towers 2 and 3 and at the southwest corner of Tower 1 are expected to provide active use spaces, an urban farm is programmed at the north elevation of Building A, and the bridge linking the two buildings is comprised of a walking pathway. These areas are expected to have minimal seating or lounging spaces and activities, and the predicted conditions following the introduction of the perimeter wind screens are considered acceptable for the intended pedestrian uses of these areas.

g. Regarding the remaining areas of the terrace serving Building A, mitigation inboard of the perimeter is recommended for the seating and lounging areas at the centre of the terrace and to the north and southwest. Specifically, strategically placed east-west and north-south orientated high-back seating may improve comfort levels around seating areas to the west and southwest. Additionally, a combination of 1.8-m-tall wind screens or clusters of coniferous trees located around sensitive areas, and canopies located above designated seating areas may improve comfort levels centrally throughout the terrace.

h. The extent of the mitigation measures is dependent on the programming of the noted spaces. The mitigation strategy will continue to evolve and be refined in collaboration with the building and landscape architects as the design of the proposed development progresses.

5) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

Sincerely,

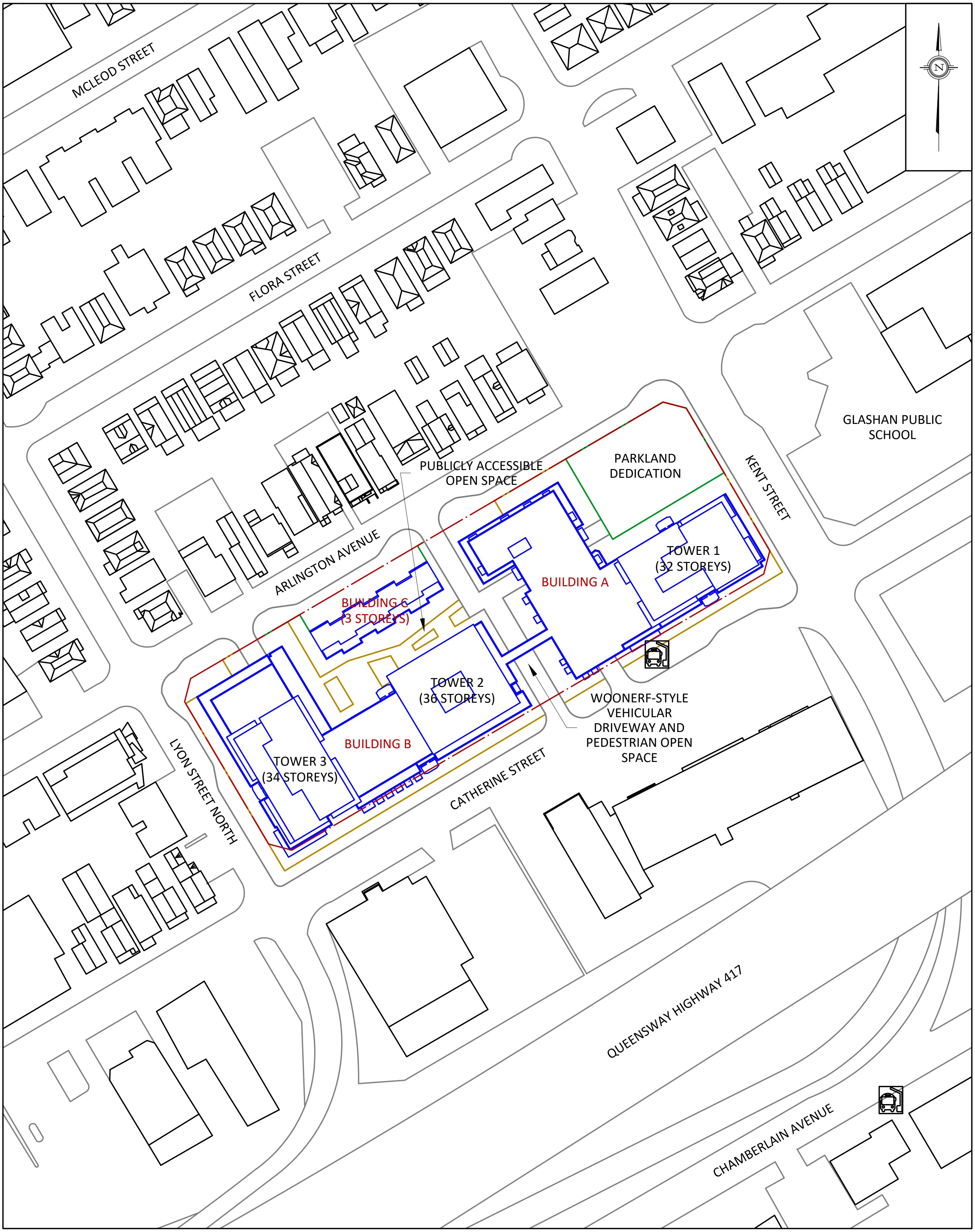
Gradient Wind Engineering Inc.

Mar 18, 2024

Daniel Davalos, MESc.
Wind Scientist

Justin Ferraro, P.Eng.
Principal

Sunny Kang, B.A.S.
Project Coordinator



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PROJECT	265 CATHERINE STREET, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION FIGURE 1: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
SCALE	1:1500	DRAWING NO. 23-055-PLW-2024-1	
DATE	MARCH 18, 2024	DRAWN BY S.K.	

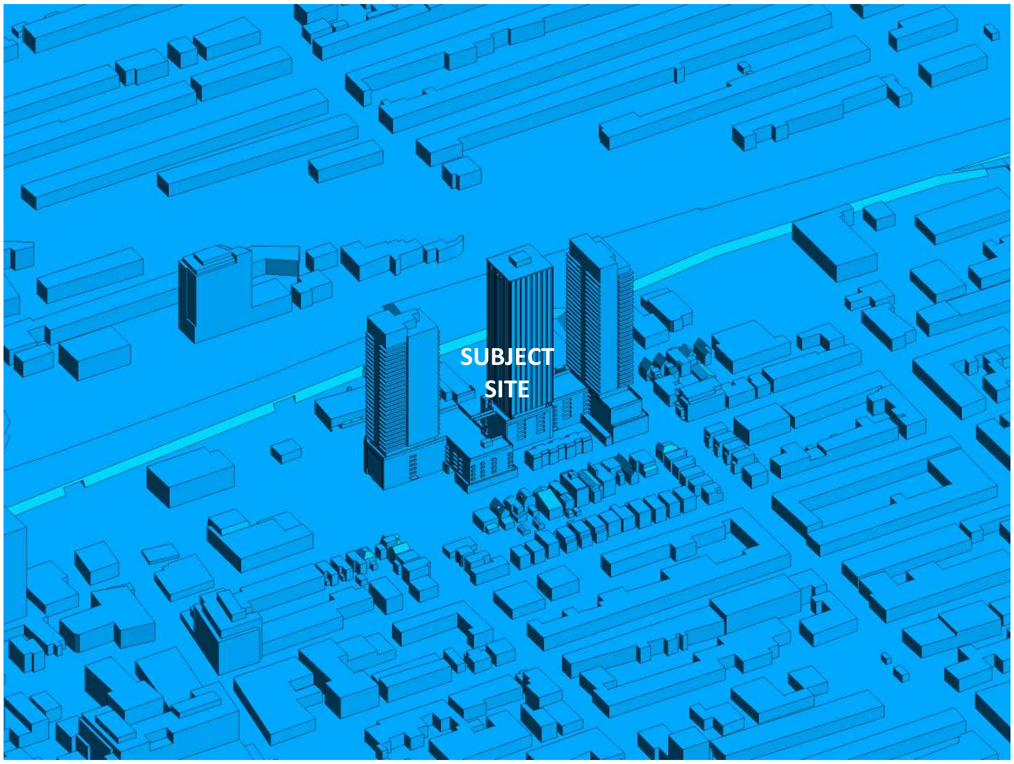


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

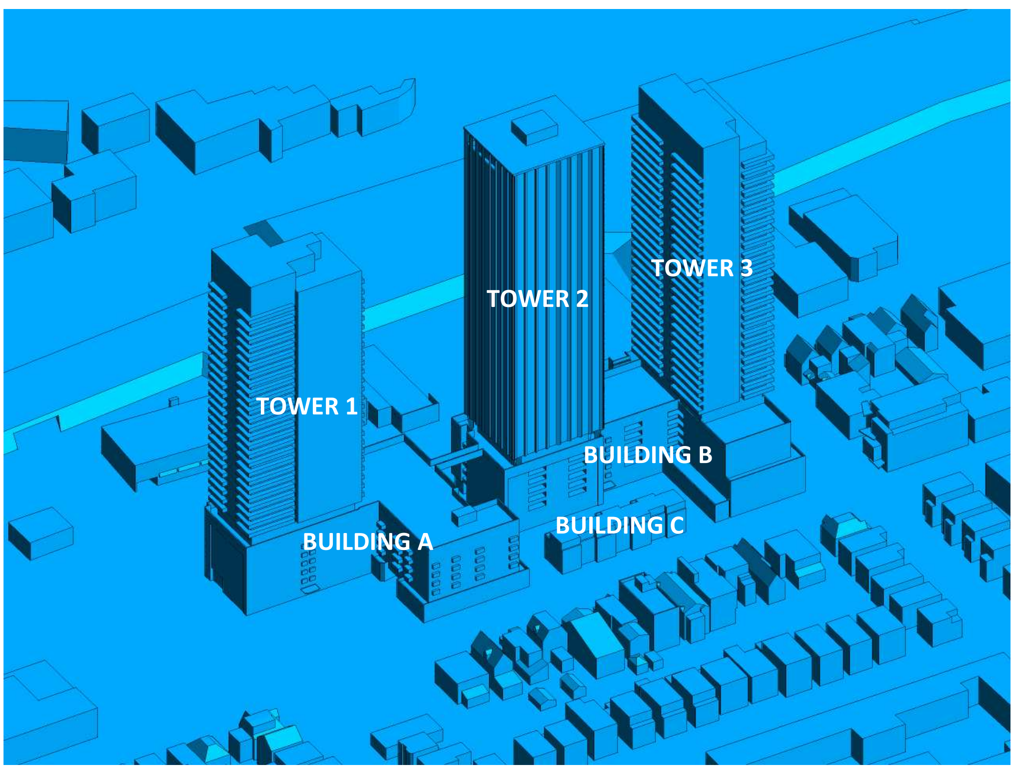


FIGURE 2B: CLOSE UP OF FIGURE 2A

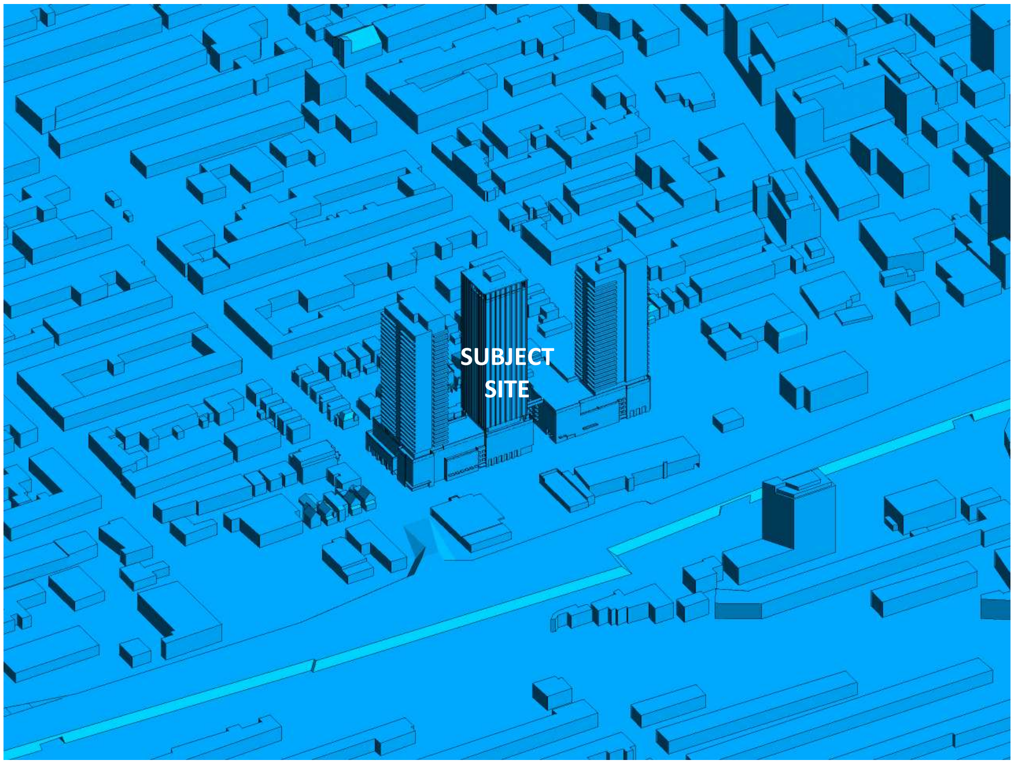


FIGURE 2C: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

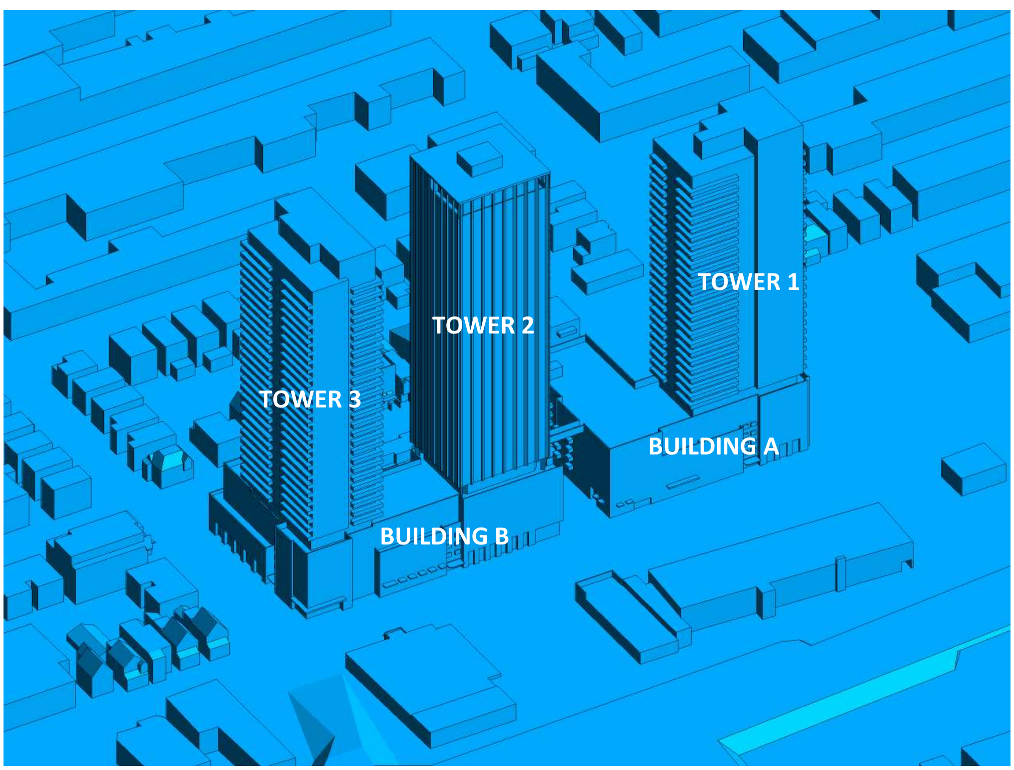


FIGURE 2D: CLOSE UP OF FIGURE 2C

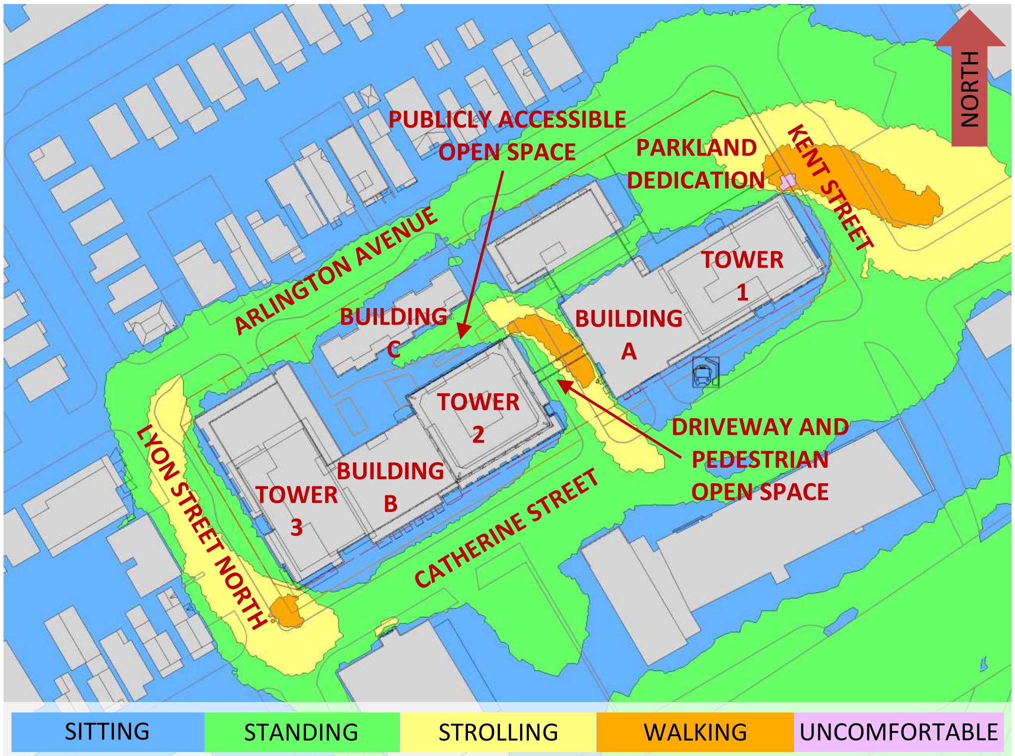


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

FIGURE 3B: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

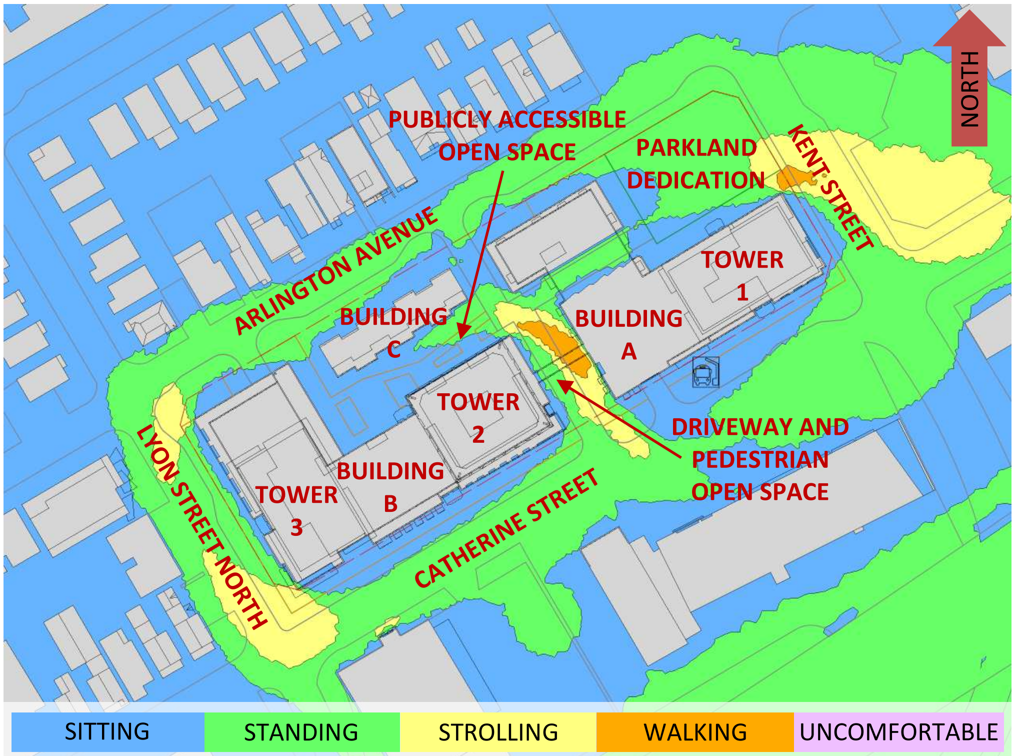


FIGURE 3C: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

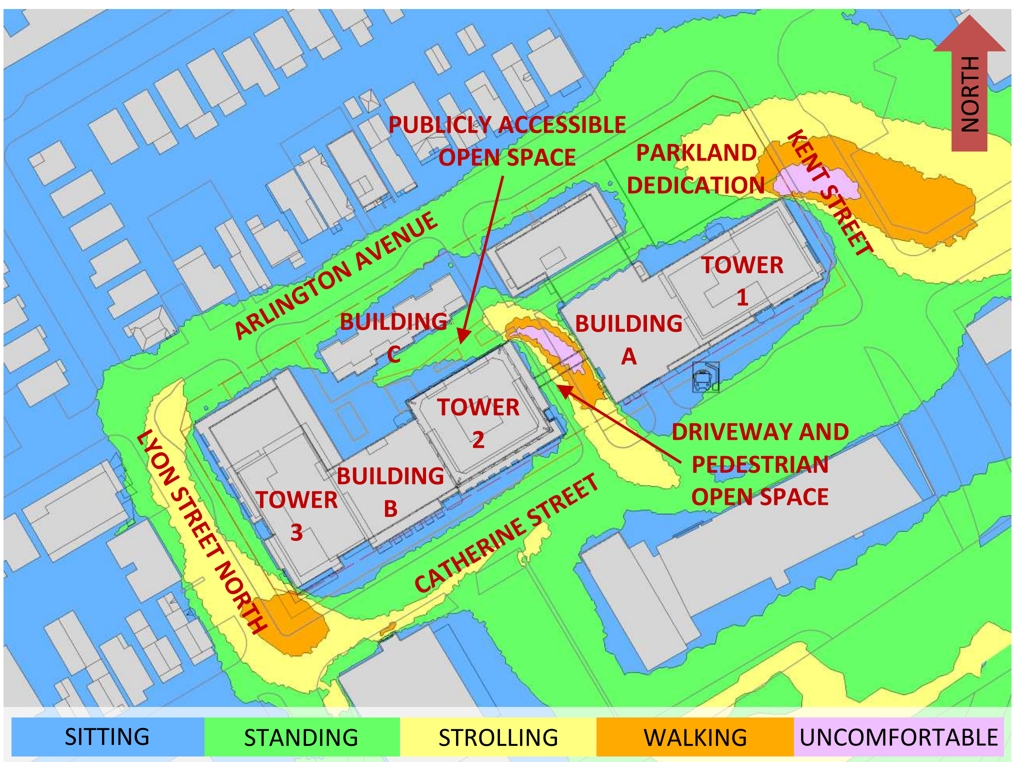


FIGURE 3D: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

FIGURE 4: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

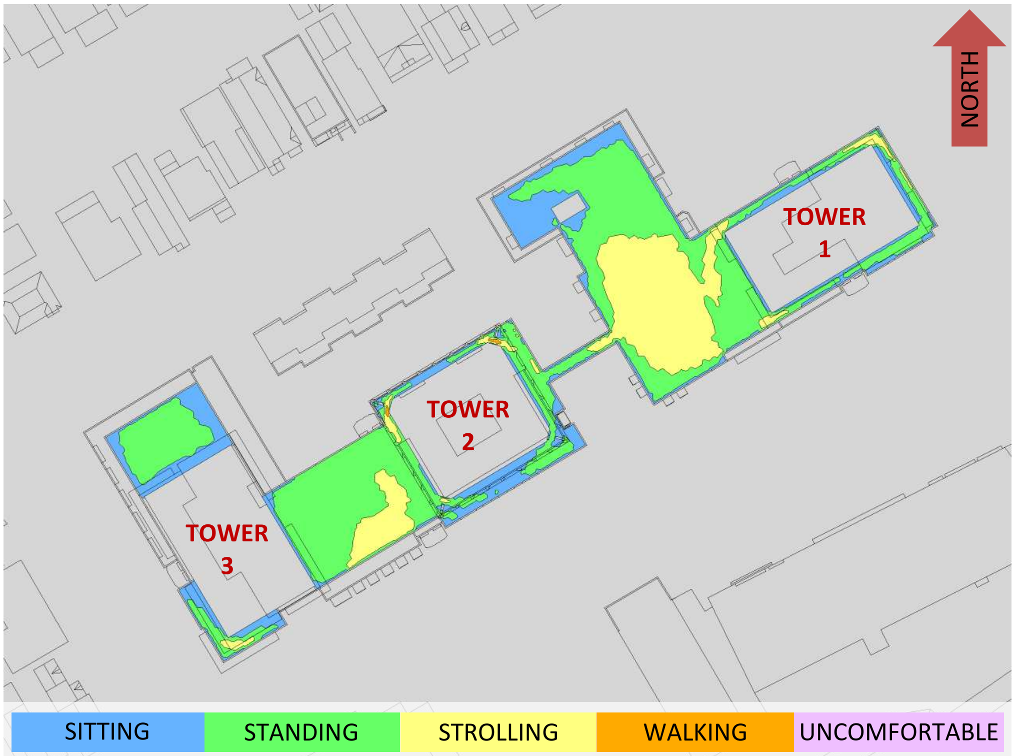


FIGURE 5A: SPRING – WIND COMFORT, LEVEL 7 COMMON AMENITY TERRACES

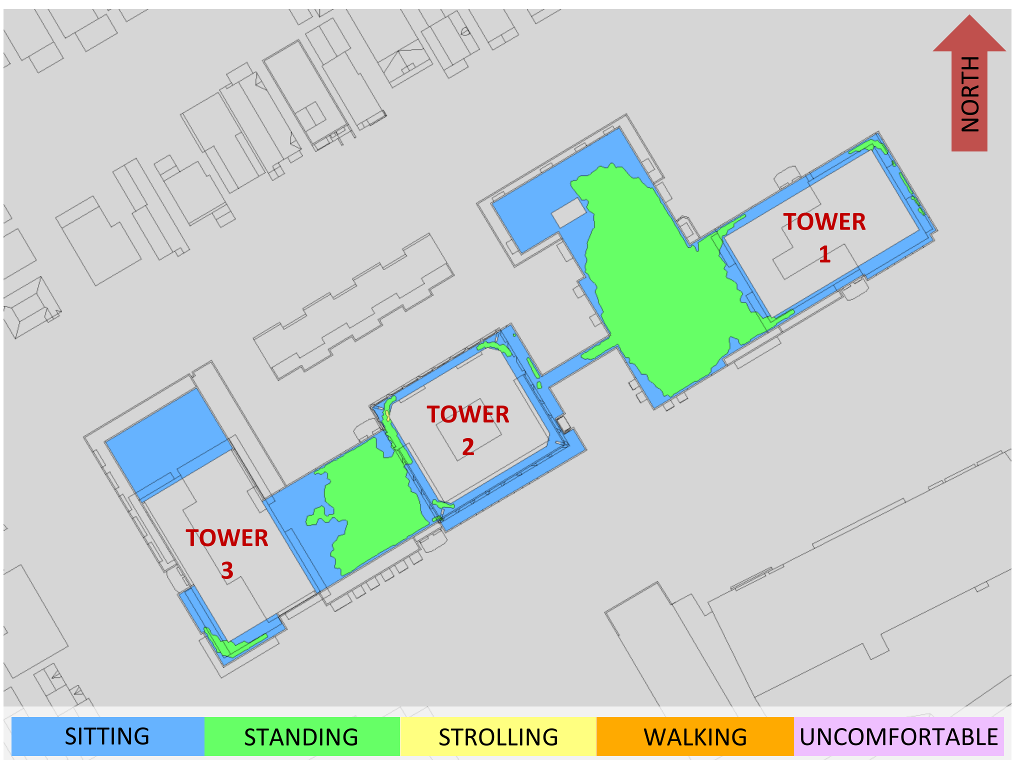


FIGURE 5B: SUMMER – WIND COMFORT, LEVEL 7 COMMON AMENITY TERRACES

FIGURE 5C: AUTUMN – WIND COMFORT, LEVEL 7 COMMON AMENITY TERRACES

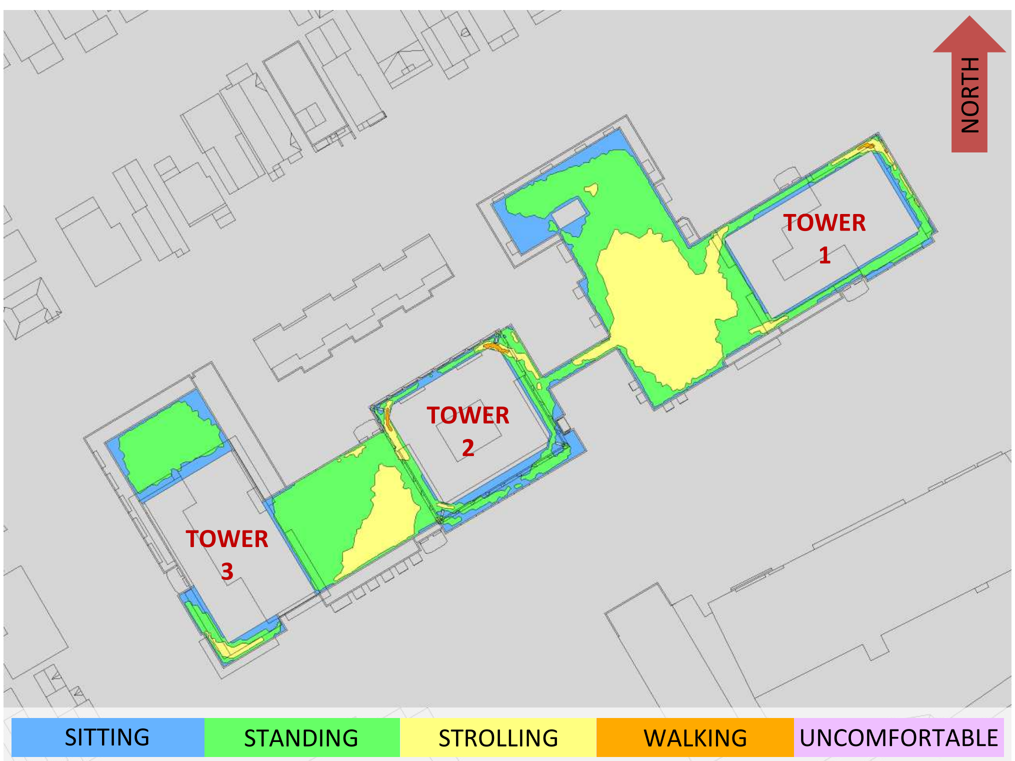


FIGURE 5D: WINTER – WIND COMFORT, LEVEL 7 COMMON AMENITY TERRACES

FIGURE 6: TYPICAL USE PERIOD, LEVEL 7 COMMON AMENITY TERRACES

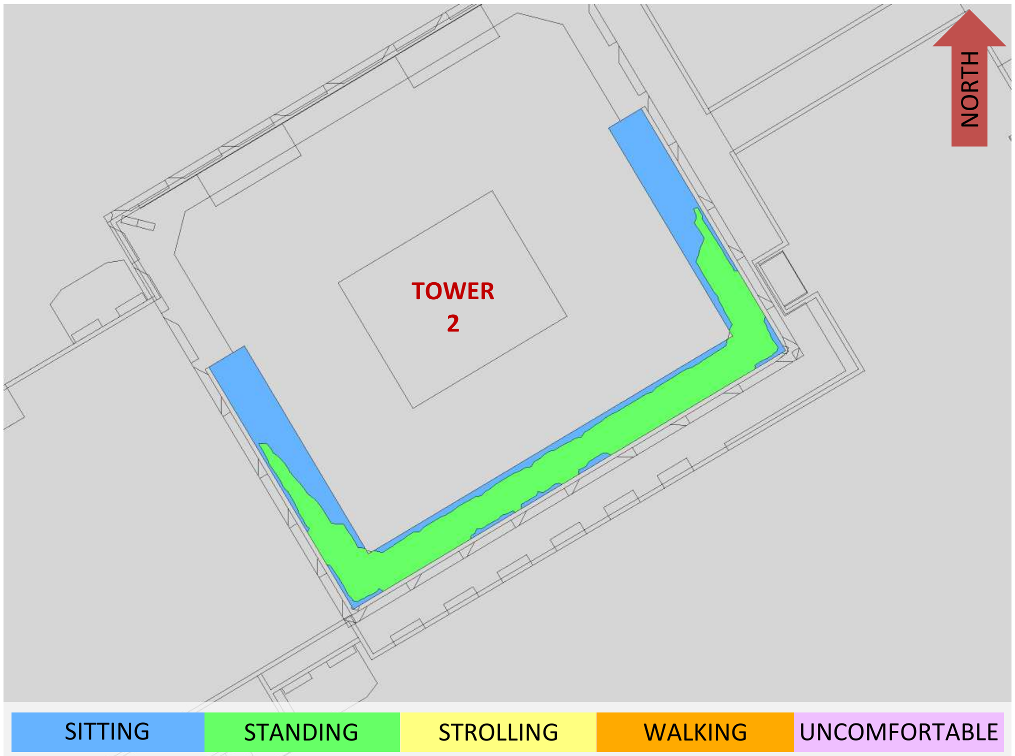


FIGURE 7A: SPRING – WIND COMFORT, TOWER 2 MPH LEVEL AMENITY TERRACE

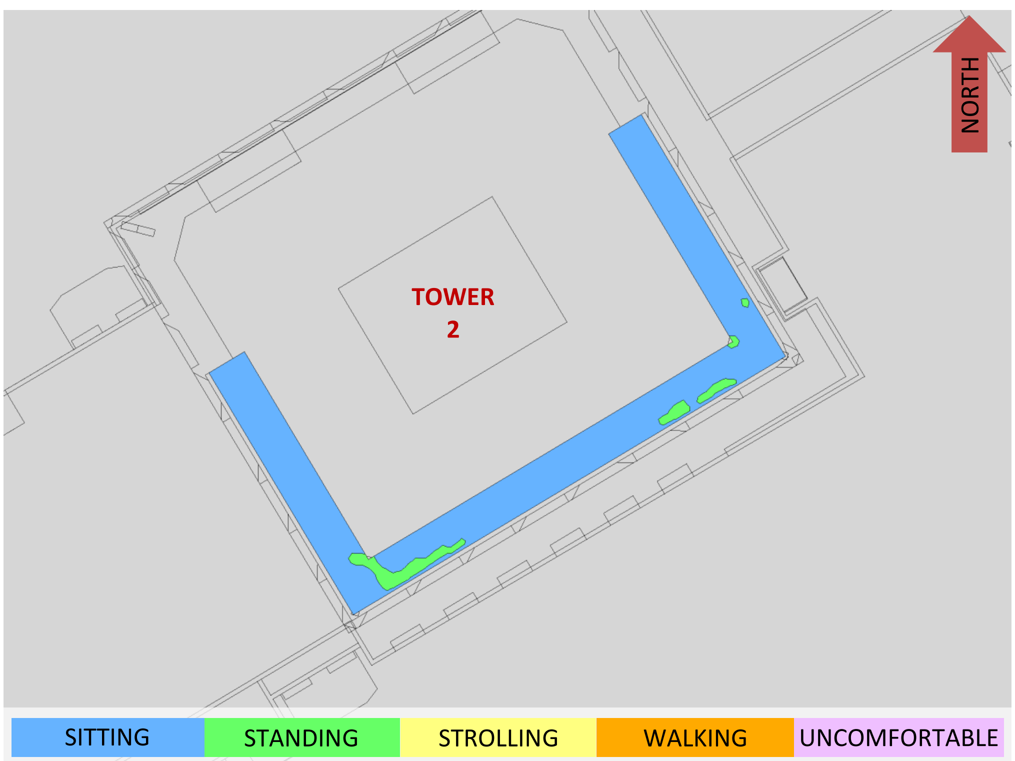


FIGURE 7B: SUMMER – WIND COMFORT, TOWER 2 MPH LEVEL AMENITY TERRACE

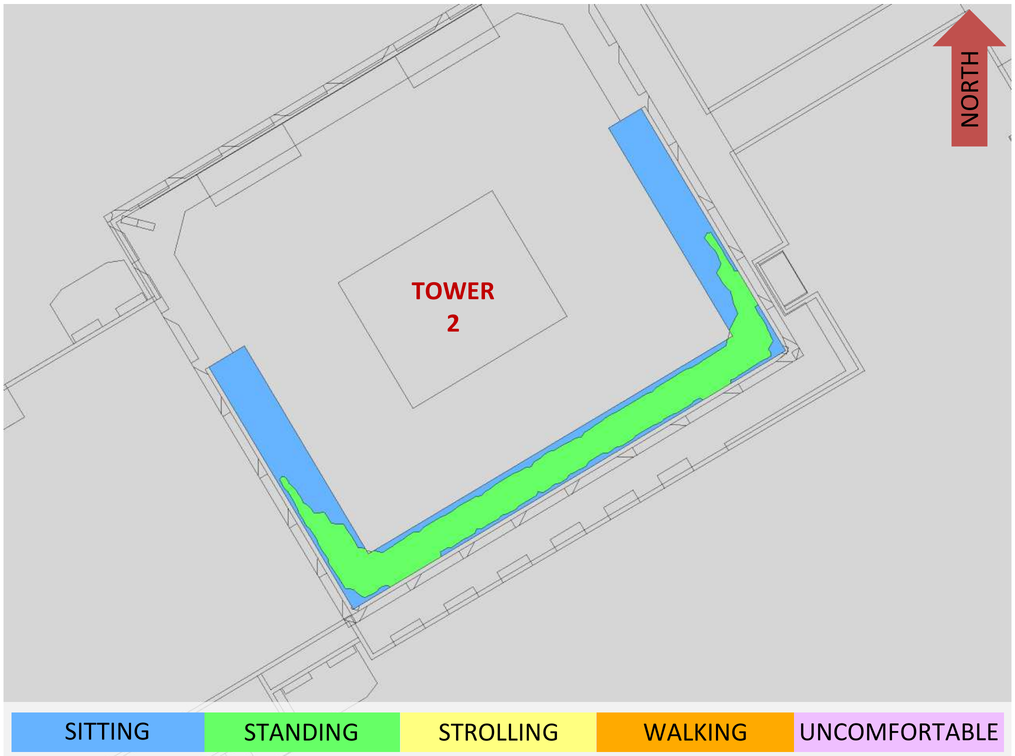


FIGURE 7C: AUTUMN – WIND COMFORT, TOWER 2 MPH LEVEL AMENITY TERRACE

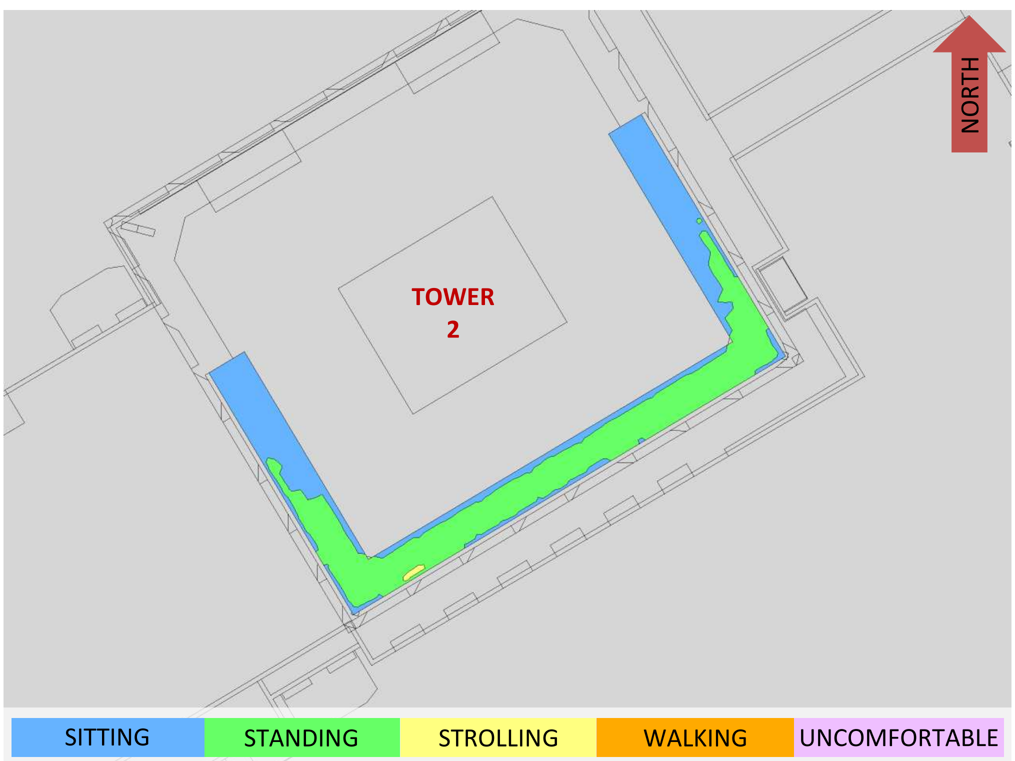


FIGURE 7D: WINTER – WIND COMFORT, TOWER 2 MPH LEVEL AMENITY TERRACE

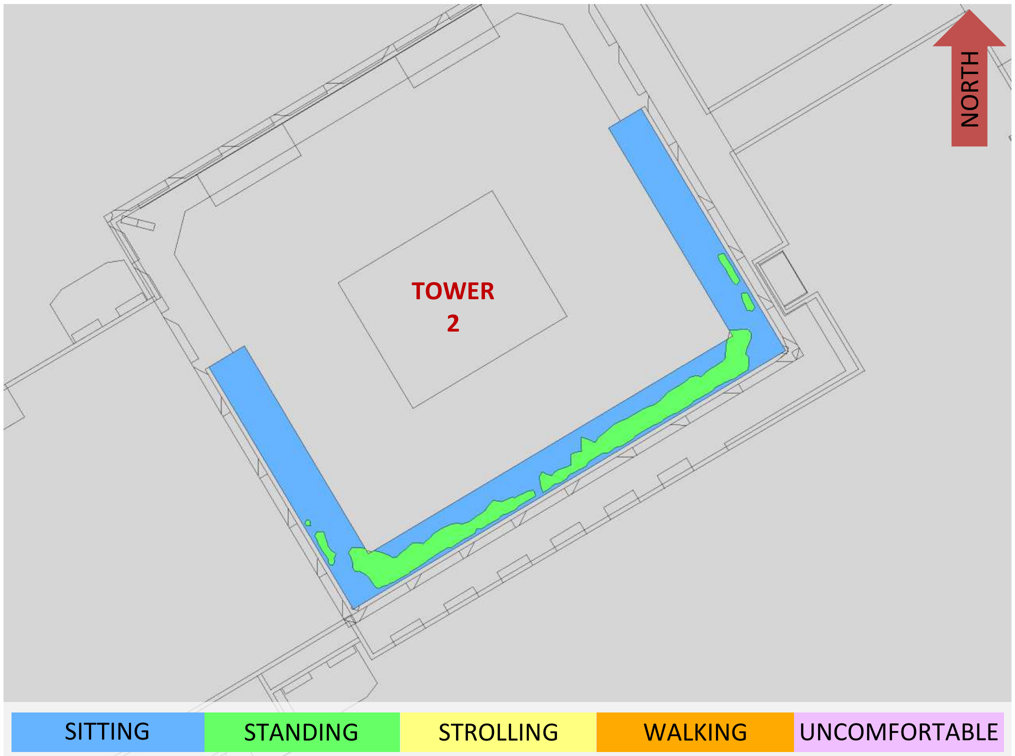
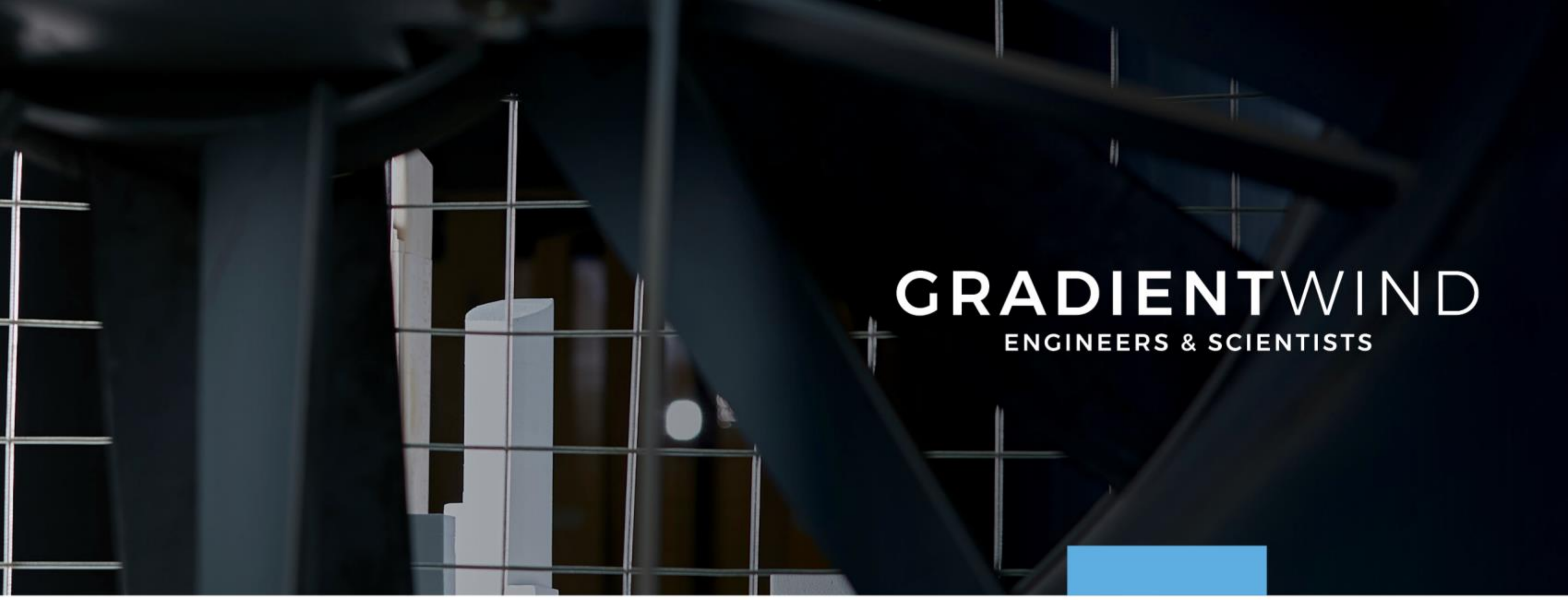
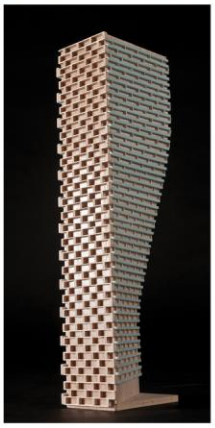
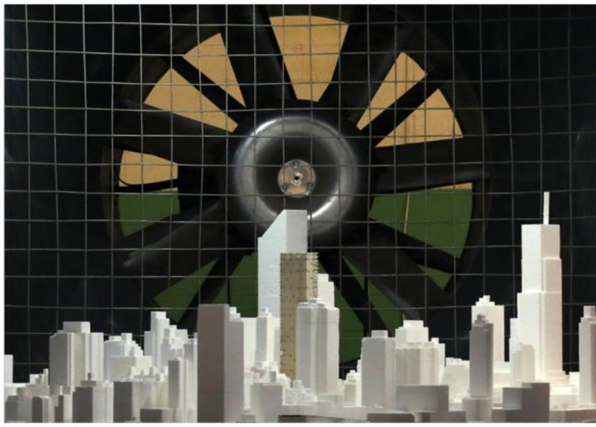


FIGURE 8: TYPICAL USE PERIOD, TOWER 2 MPH LEVEL AMENITY TERRACE







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, which approximately corresponds to the 60% mean wind speed for Ottawa 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 (that is, 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 (Degrees True)	Alpha Value (α)
0	0.30
49	0.28
74	0.26
103	0.26
167	0.25
197	0.24
217	0.25
237	0.25
262	0.26
282	0.26
301	0.27
324	0.30

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

Upstream Exposure Type	Alpha Value (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, $\boldsymbol{I}$ = turbulence intensity, $\boldsymbol{L_t}$ = turbulence length scale, $\boldsymbol{Z}$ = 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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[3] Y. Tamura, H. Kawai, Y. Uematsu, K. Kondo and T. Okhuma, "Revision of AIJ Recommendations for Wind Loads on Buildings," in *The International Wind Engineering Symposium, IWES 2003*, Taiwan, 2003.