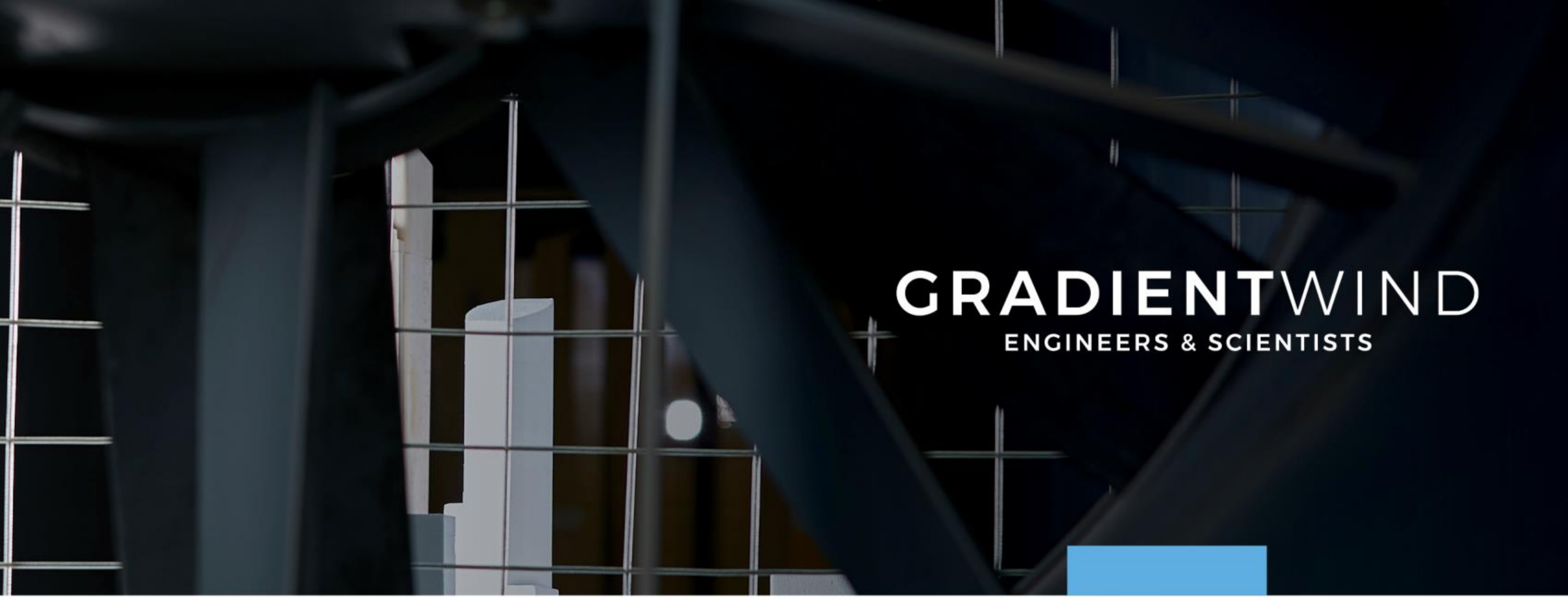
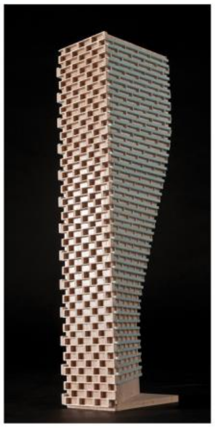
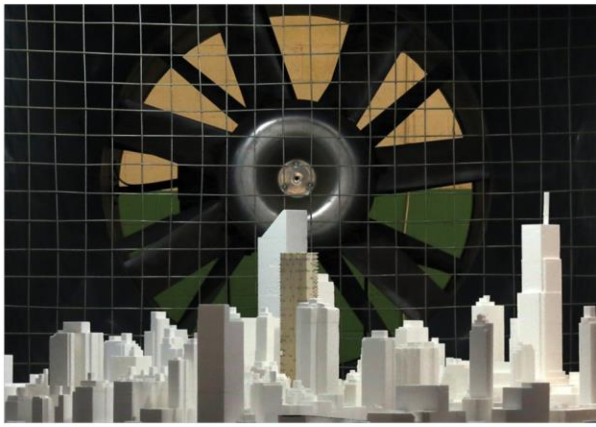


PEDESTRIAN LEVEL WIND STUDY

400 Coventry Road
Ottawa, Ontario

Report: 22-272-PLW-2023





July 14, 2023

PREPARED FOR
400 Coventry Investments Inc.
110-85 Rue Bellehumeur
Gatineau, QC J8T 8B7

PREPARED BY
Sunny Kang, B.A.S., Project Coordinator
Daniel Davalos, MESc., Wind Scientist
Justin Ferraro, P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Site Plan Control application submission requirements for the proposed multi-building development located at 400 Coventry Road 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-9, and summarized as follows:

1) All grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, transit stops, laneways, walkways, surface parking, drop-off areas, existing parking lots, and in the vicinity of building access points, are considered acceptable. Exceptions are as follows:

    a. Wind comfort conditions in the vicinity of the nearby transit stop north of Coventry Road are predicted to be suitable for standing during the spring, summer, and autumn, becoming suitable for a mix of standing and strolling during the winter. We recommend implementing a typical shelter for the noted transit stop which provides pedestrians with a means to protect themselves from the elements, including during periods of strong wind activity.

    b. Because of the windy conditions predicted to occur between Towers C and D and between Towers D and E1, it is recommended that the entrances along the south elevation of Towers D and E1 be recessed within the façade or flanked by tall wind screens to provide calmer wind conditions.

c. Wind comfort conditions over the parkland are predicted to be suitable for sitting over most of the area, with standing conditions to the north and south during the typical use period. Depending on the programming of the parkland, the noted conditions may be considered acceptable. Specifically, if the noted windier areas will not accommodate seating or more sedentary activities, the noted conditions would be considered acceptable.

2) Wind comfort conditions within the amenity terraces (modelled with 1.8-m-tall wind screens around their full perimeters) serving the proposed development during the typical use period and recommendations regarding mitigation are described as follows:

a. **Tower A, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing near the southwest and northwest corners of the terrace.

b. **Towers A & B, Podium Roof Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing to the east.

c. **Tower B, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the east of the tower and at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace.

d. **Towers B & C1, Podium Roof Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting near the southeast corner and to the north and west of the terrace, and suitable for standing elsewhere throughout the terrace.

e. **Tower C1, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing to the east, south, and west of the terrace.

f. **Towers C1 & C2, Podium Roof Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the north, south, and west of the terrace, and suitable for standing elsewhere throughout the terrace.

g. **Tower C2, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the east, south, and west of the tower and at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace.

h. **Towers D, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the east and at the southwest and northwest corners of the terrace, and suitable for standing elsewhere throughout the terrace.

i. **Tower E1, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the east and at the southwest and northwest corners of the terrace, and suitable for standing elsewhere throughout the terrace.

j. **Towers E1 & E2, Podium Roof Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting at the southeast corner and to the north and west of the terrace, and suitable for standing elsewhere throughout the terrace.

k. **Tower E2, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting close to the tower façade and at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace.

l. To improve comfort levels within the terraces, mitigation inboard of the terrace perimeters targeted around sensitive areas is recommended, in combination with taller wind screens along the full perimeter of the terraces. This inboard mitigation could take the form of inboard wind barriers or clusters of coniferous plantings in dense arrangements, and canopies located around sensitive areas.

m. The extent of mitigation measures is dependent on the programming of the terraces. An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the proposed development progresses.

3) 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.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 400 Coventry Investments Inc. to undertake a pedestrian level wind (PLW) study to satisfy Site Plan Control application submission requirements for the proposed multi-building development located at 400 Coventry Road in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). A PLW study was conducted in October 2022[1] for the previous design of the 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.

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 NEUF architect(e)s in June 2023, 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 400 Coventry Road in Ottawa, situated at the southwest intersection of Coventry Road and Belfast Road and bordered by Highway 417 to the south and existing low-rise commercial buildings and parking lots to the west. A central east-west laneway is proposed to extend from Belfast Road to the existing parking lots. Drop-off zones are provided along the north elevation of the noted laneway.

The proposed development comprises seven nominally rectangular towers; beginning from the west and rotating counterclockwise around the site, the towers are referred to as Towers A, B, C1, C2, D, E1, and E2. Towers A, B, C1 and C2 are situated to the south of the central laneway and share three below-grade parking levels. Towers D, E1, and E2 are situated to the north of the central laneway and share three below-grade parking levels. All towers are topped with a mechanical penthouse (MPH) and all podia roofs and tower MPH Levels are served by an amenity terrace. A parkland is situated to the west of the subject

[1] Gradient Wind Engineering Inc., '*400 Coventry Road – Pedestrian Level Wind Study*', [Oct 20, 2022]

site, bordered by Tower E2 to the north, Tower D to the east, the central laneway to the south, and the existing parking lot to the west.

Towers A (18 storeys), B (30 storeys), C1 (28 storeys), and C2 (27 storeys) share a common six-storey podium comprising a nominally ‘U’-shaped planform with its long axis-oriented along Highway 417. Above below-grade parking, the ground floor of the shared podium includes residential lobbies at the northwest and northeast corners and along the inner south elevation of the ‘U’-shaped planform, townhouse units to the south, a common space to the east, and residential units throughout the remainder of the level. Seating areas are situated in between Towers A and B and a waste management area is located near the inner southeast corner of the ‘U’-shaped planform. Access to underground parking (shared by Towers A, B, C1 and C2) is provided by a ramp at the northwest corner via the central laneway from Belfast Road. The noted laneway also provides access to the surface parking and drop-off zones situated within the inset of the ‘U’-shaped planform. Levels 2-18, 2-30, 2-28, and 2-27 of Towers A, B, C1, and C2, respectively, are reserved for residential use. The podium steps back from the west elevation of Tower C2 at Level 3 and from all elevations at Level 7.

Tower D (20 storeys) rises above a six-storey podium. Above below-grade parking, the ground floor includes a residential lobby to the west, residential units along the north elevation, common spaces along the east elevation, and a moving space to the south. Levels 2-20 are reserved for residential use. The building steps back from the west and north elevations at Level 4 and from all elevations at Level 7.

Tower E1 (25 storeys) and Tower E2 (23 storeys) share a common six-storey podium. Above below-grade parking, the ground floor of the shared podium includes residential lobbies at the northwest corner and to the east, retail space to the north, and townhouse units to the south. Access to underground parking (shared by Towers D, E1, and E2) is provided by a ramp at the northwest corner from Coventry Road. Levels 2-25 and 2-23 of Towers E1 and E2, respectively, are reserved for residential use. The podium steps back from the north elevation at Level 2, from the south and west elevations at Level 4, and from all elevations of each tower at Level 7.

The near-field surroundings, defined as an area within 200-metres (m) of the subject site, include low-rise commercial buildings from the west clockwise to the east, with parking lots to the west, Presland Park approximately 150 m to the north, and Highway 417 extending from the southeast to the southwest. Of note, a six-storey residential building has been approved for Site Plan Control at 300 Tremblay Road, approximately 200 m to the south-southeast of the subject site since the original PLW study that was conducted in October 2022, therefore, this development was only included in the proposed massing scenario and not in the existing massing scenario.

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 a mix of low-rise residential and commercial buildings with isolated mid- and high-rise residential buildings in all compass directions. Notably, St. Laurent Shopping Centre is situated approximately 510 m to the east and the Ottawa River flows from the west-southwest to the northwest, approximately 1.3 km to the west of the subject site.

Site plans for the proposed and existing massing scenarios are illustrated in Figures 1A and 1B, while Figures 2A-2H illustrate the computational models used to conduct the study. The existing massing scenario includes the existing massing and any future developments approved by the City of Ottawa.

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.

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

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.

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 610 m. The process was performed for two context massing scenarios, as noted in Section 2.

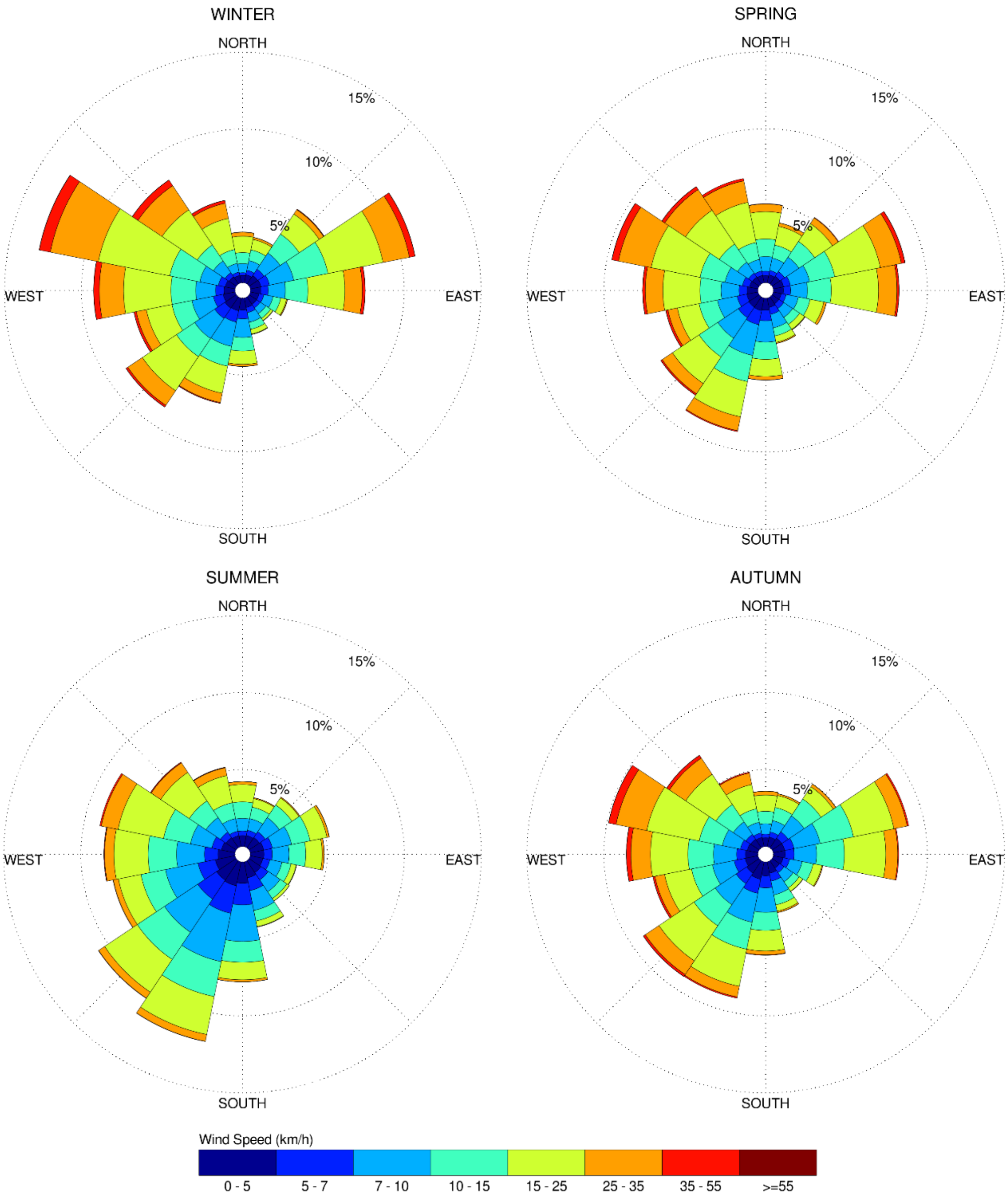
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the common amenity terraces serving the proposed development 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 comfort and safety criteria are based on the mechanical effects of wind without consideration of other meteorological conditions (that is, temperature, relative humidity). The comfort criteria assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Five pedestrian comfort classes are based on 20% non-exceedance mean wind speed ranges, which include (1) Sitting; (2) Standing; (3) Strolling; (4) Walking; and (5) Uncomfortable. More specifically, the comfort classes and associated mean wind speed ranges are summarized as follows:

1) **Sitting:** 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.

2) **Standing:** 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.

3) **Strolling:** 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.

4) **Walking:** 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.

5) **Uncomfortable:** 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.

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. 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 BEAUFORT SCALE

Number	Description	Gust Wind Speed (km/h)	Description
2	Light Breeze	9-17	Wind felt on faces
3	Gentle Breeze	18-29	Leaves and small twigs in constant motion; wind extends light flags
4	Moderate Breeze	30-42	Wind raises dust and loose paper; small branches are moved
5	Fresh Breeze	43-57	Small trees in leaf begin to sway
6	Strong Breeze	58-74	Large branches in motion; Whistling heard in electrical wires; umbrellas used with difficulty
7	Moderate Gale	75-92	Whole trees in motion; inconvenient walking against wind
8	Gale	93-111	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 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 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 desired 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 desired comfort classes are summarized on the following page. Depending on the programming of a space, the desired comfort class may differ from this table.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired 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-6B, illustrating wind conditions at grade level for the proposed and existing massing scenarios, and by Figures 8A-8D, illustrating wind conditions over the common amenity terraces serving each tower at their respective podia roof and MPH Levels. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes presented in Section 4.4. 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.

Wind comfort conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figures 7 and 9 illustrate comfort conditions at the grade level and over the noted amenity terraces serving the proposed development, 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 – Grade Level

Sidewalks along Coventry Road: Following the introduction of the proposed development, wind comfort conditions over the public sidewalks along Coventry Road are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for standing, or better, with a small, isolated region suitable for strolling during the autumn, and suitable for strolling, or better, during the winter and spring. The noted conditions are considered acceptable.

Conditions over the sidewalks along Coventry Road with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions are nevertheless considered acceptable.

Transit Stops along Coventry Road: Prior to the introduction of the proposed development, wind comfort conditions in the vicinity of the nearby transit stop south of Coventry Road are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. The noted conditions remain unchanged following the introduction of the proposed development. As such, wind conditions with the proposed development are considered acceptable.

Following the introduction of the proposed development, wind comfort conditions in the vicinity of the nearby transit stop north of Coventry Road are predicted to be suitable for standing during the spring, summer, and autumn, becoming suitable for a mix of standing and strolling during the winter. We recommend implementing a typical shelter for the noted transit stop which provides pedestrians with a means to protect themselves from the elements, including during periods of strong wind activity.

Conditions in the vicinity of the nearby transit stop north of Coventry Road with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year.

Sidewalks and Transit Stop along Belfast Road: Following the introduction of the proposed development, wind comfort conditions over the public sidewalks along Belfast Road are predicted to be suitable mostly for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year with isolated regions suitable for strolling during the autumn, winter, and spring.

Conditions in the vicinity of the nearby transit stops to the east and west of Belfast Road are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. The noted conditions are considered acceptable.

Conditions over the sidewalks along Belfast Road with the existing massing are predicted to be suitable for sitting during the summer with standing conditions near the bridge of Belfast Road which extends over Highway 417, becoming suitable for a mix of sitting and standing throughout the remainder of the year with isolated regions of strolling during the winter and spring. Conditions over the nearby transit stop to the east of Belfast Road are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year, while conditions in the vicinity of the nearby transit stop to the west of Belfast Road are predicted to be suitable for sitting throughout the year. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions are nevertheless considered acceptable.

Existing Parking Lots West of Subject Site: Prior to the introduction of the proposed development, wind comfort conditions over the existing parking lots serving the adjacent low-rise commercial buildings to the west of the subject site are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the autumn, and suitable for standing, or better, during the winter and spring. The noted conditions remain unchanged following the introduction of the proposed development. As such, wind conditions with the proposed development are considered acceptable.

Parkland West of Subject Site: During the typical use period, conditions over the parkland to the west of the subject site are predicted to be suitable for sitting over most of the area, with standing conditions to the north and south, as illustrated in Figure 7. During the same period, the areas that are predicted to be suitable for standing are also predicted to be suitable for sitting for at least 78%, 77%, and 76% of the time, near the northwest corner, near the northeast corner, and to the south, respectively, where the target is 80% to achieve the sitting comfort class.

Depending on the programming of the parkland, the noted conditions may be considered acceptable. Specifically, if the noted windier areas will not accommodate seating or more sedentary activities, the noted conditions would be considered acceptable. If required by programming, comfort levels within the parkland may be improved with targeted wind barriers installed around sensitive areas. Wind barriers could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options, in combination with other local wind mitigation.

Walkways, Surface Parking, Seating Areas, and Drop-off Zones along Laneways Within Subject Site: Wind comfort conditions over the walkways, surface parking, and drop-off areas along the laneway situated central to the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of standing and strolling throughout the remainder of the year with small, isolated regions suitable for walking during the winter. Conditions over the walkways, surface parking, and drop-off areas along the laneway within the inset of the nominally 'U'-shaped podium serving Towers A, B, C1, and C2 are predicted to be suitable for sitting throughout the year with a small, isolated region suitable for standing during the winter. Owing to channeling of winds between Towers D and E1, conditions over the walkways in between Towers D and E1 are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing and strolling during the spring and autumn with a small, isolated region suitable for walking during the spring, and suitable for a mix of standing, strolling, and walking during the winter. Conditions over the remaining walkways within the subject site are predicted to be suitable for a mix of sitting and standing throughout the year with isolated regions suitable for strolling during the winter and spring. The noted conditions are considered acceptable.

Conditions over the seating areas situated in between Towers A and B are predicted to be suitable for sitting with an isolated region suitable for standing to the west during the summer, becoming suitable for a mix of sitting and standing during the spring and autumn, and suitable mostly for standing during the winter. During the typical use period, conditions are predicted to be suitable for sitting over most of the area, with an isolated region of standing conditions to the west, as illustrated in Figure 7. Depending on the programming of the seating areas, the noted conditions may be considered acceptable. Specifically, if the seating areas are located away from the noted windier area, the noted conditions would be considered acceptable.

Building Access: Owing to channeling of winds between Towers C2 and D, wind comfort conditions in the vicinity of the building access points along the south elevation of Tower D are predicted to be suitable for sitting during the summer, becoming suitable for standing during the autumn, and suitable for a mix of standing and strolling during the winter and spring. Owing to channeling of winds between Towers D and E1, wind comfort conditions in the vicinity of the building access points along the south elevation of Tower

E1 are predicted to be suitable for standing during the summer, becoming suitable for strolling throughout the remainder of the year. Owing to the protection of the building façade, conditions in the vicinity of the building access points along the north elevation of Tower D are predicted to be suitable for sitting throughout the year. Because of the noted windy conditions, it is recommended that the entrances along the south elevation of Towers D and E1 be recessed within the façade or flanked by tall wind screens to provide calmer wind conditions.

Wind comfort 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

The proposed development is served by common amenity terraces at the various podia roof and tower MPH Levels, which were modelled with 1.8-m-tall wind screens along their full perimeters. With the noted mitigation, wind comfort conditions within the amenity terraces during the typical use period and recommendations regarding mitigation are described as follows:

Tower A, MPH Level Common Amenity Terrace: Wind comfort conditions within the amenity terrace serving Tower A at the MPH Level are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing near the southwest and northwest corners of the terrace, as illustrated in Figure 9.

Towers A & B, Podium Roof Common Amenity Terrace: Wind comfort conditions within the amenity terrace in between Towers A and B at the Podium Roof Level are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing to the east, as illustrated in Figure 9.

Tower B, MPH Level Common Amenity Terrace: Wind comfort conditions within the amenity terrace serving Tower B at the MPH Level are predicted to be suitable for sitting at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace, as illustrated in Figure 9.

Towers B & C1, Podium Roof Common Amenity Terrace: Wind comfort conditions within the amenity terrace in between Towers B and C1 at the Podium Roof Level are predicted to be suitable for sitting near the southeast corner and to the north and west of the terrace, and suitable for standing elsewhere throughout the terrace, as illustrated in Figure 9.

Tower C1, MPH Level Common Amenity Terrace: Wind comfort conditions within the amenity terrace serving Tower C1 at the MPH Level are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing to the east, south, and west of the terrace, as illustrated in Figure 9.

Towers C1 & C2, Podium Roof Common Amenity Terrace: Wind comfort conditions within the amenity terrace in between Towers C1 and C2 at the Podium Roof Level are predicted to be suitable for sitting to the north, south, and west of the terrace, and suitable for standing elsewhere throughout the terrace, as illustrated in Figure 9.

Tower C2, MPH Level Common Amenity Terrace: Wind comfort conditions within the amenity terrace serving Tower C2 at the MPH Level are predicted to be suitable for sitting to the east, south, and west of the tower and at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace, as illustrated in Figure 9.

Tower D, MPH Level Common Amenity Terrace: Wind comfort conditions within the amenity terrace serving Tower D at the MPH Level are predicted to be suitable for sitting to the east and at the southwest and northwest corners of the terrace, and suitable for standing elsewhere throughout the terrace, as illustrated in Figure 9.

Tower E1, MPH Level Common Amenity Terrace: Wind comfort conditions within the amenity terrace serving Tower E1 at the MPH Level are predicted to be suitable for sitting to the east and at the southwest and northwest corners of the terrace, and suitable for standing elsewhere throughout the terrace, as illustrated in Figure 9.

Towers E1 & E2, Podium Roof Common Amenity Terrace: Wind comfort conditions within the amenity terrace in between Towers E1 and E2 at the Podium Roof Level are predicted to be suitable for sitting at the southeast corner and to the north and west of the terrace, and suitable for standing elsewhere throughout the terrace, as illustrated in Figure 9.

Tower E2, MPH Level Common Amenity Terrace: Wind comfort conditions within the amenity terrace serving Tower E2 at the MPH Level are predicted to be suitable for sitting close to the tower façade and at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace, as illustrated in Figure 9.

To improve comfort levels within the terraces, mitigation inboard of the terrace perimeters targeted around sensitive areas is recommended, in combination with taller wind screens along the full perimeter of the terraces. This inboard mitigation could take the form of inboard wind barriers or clusters of coniferous plantings in dense arrangements, and canopies located around sensitive areas.

The extent of mitigation measures is dependent on the programming of the terraces. An appropriate mitigation strategy will be developed 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-9. 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) All grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, transit stops, laneways, walkways, surface parking, drop-off areas, existing parking lots, and in the vicinity of building access points, are considered acceptable. Exceptions are as follows:

    a. Wind comfort conditions in the vicinity of the nearby transit stop north of Coventry Road are predicted to be suitable for standing during the spring, summer, and autumn, becoming suitable for a mix of standing and strolling during the winter. We recommend implementing a typical shelter for the noted transit stop which provides pedestrians with a means to protect themselves from the elements, including during periods of strong wind activity.

   b. Because of the windy conditions predicted to occur between Towers C and D and between Towers D and E1, it is recommended that the entrances along the south elevation of Towers D and E1 be recessed within the façade or flanked by tall wind screens to provide calmer wind conditions.

   c. Wind comfort conditions over the parkland are predicted to be suitable for sitting over most of the area, with standing conditions to the north and south during the typical use period. Depending on the programming of the parkland, the noted conditions may be considered acceptable. Specifically, if the noted windier areas will not accommodate seating or more sedentary activities, the noted conditions would be considered acceptable.

2) Wind comfort conditions within the amenity terraces (modelled with 1.8-m-tall wind screens around their full perimeters) serving the proposed development during the typical use period and recommendations regarding mitigation are described as follows:

   a. **Tower A, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing near the southwest and northwest corners of the terrace.

   b. **Towers A & B, Podium Roof Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing to the east.

   c. **Tower B, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the east of the tower and at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace.

   d. **Towers B & C1, Podium Roof Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting near the southeast corner and to the north and west of the terrace, and suitable for standing elsewhere throughout the terrace.

   e. **Tower C1, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting over most of the area, with conditions predicted to be suitable for standing to the east, south, and west of the terrace.

f. **Towers C1 & C2, Podium Roof Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the north, south, and west of the terrace, and suitable for standing elsewhere throughout the terrace.

g. **Tower C2, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the east, south, and west of the tower and at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace.

h. **Towers D, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the east and at the southwest and northwest corners of the terrace, and suitable for standing elsewhere throughout the terrace.

i. **Tower E1, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting to the east and at the southwest and northwest corners of the terrace, and suitable for standing elsewhere throughout the terrace.

j. **Towers E1 & E2, Podium Roof Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting at the southeast corner and to the north and west of the terrace, and suitable for standing elsewhere throughout the terrace.

k. **Tower E2, MPH Level Common Amenity Terrace**: Wind comfort conditions are predicted to be suitable for sitting close to the tower façade and at the four corners of the terrace, and suitable for standing elsewhere throughout the terrace.

l. To improve comfort levels within the terraces, mitigation inboard of the terrace perimeters targeted around sensitive areas is recommended, in combination with taller wind screens along the full perimeter of the terraces. This inboard mitigation could take the form of inboard wind barriers or clusters of coniferous plantings in dense arrangements, and canopies located around sensitive areas.

m. The extent of mitigation measures is dependent on the programming of the terraces. An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the proposed development progresses.

3) 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,

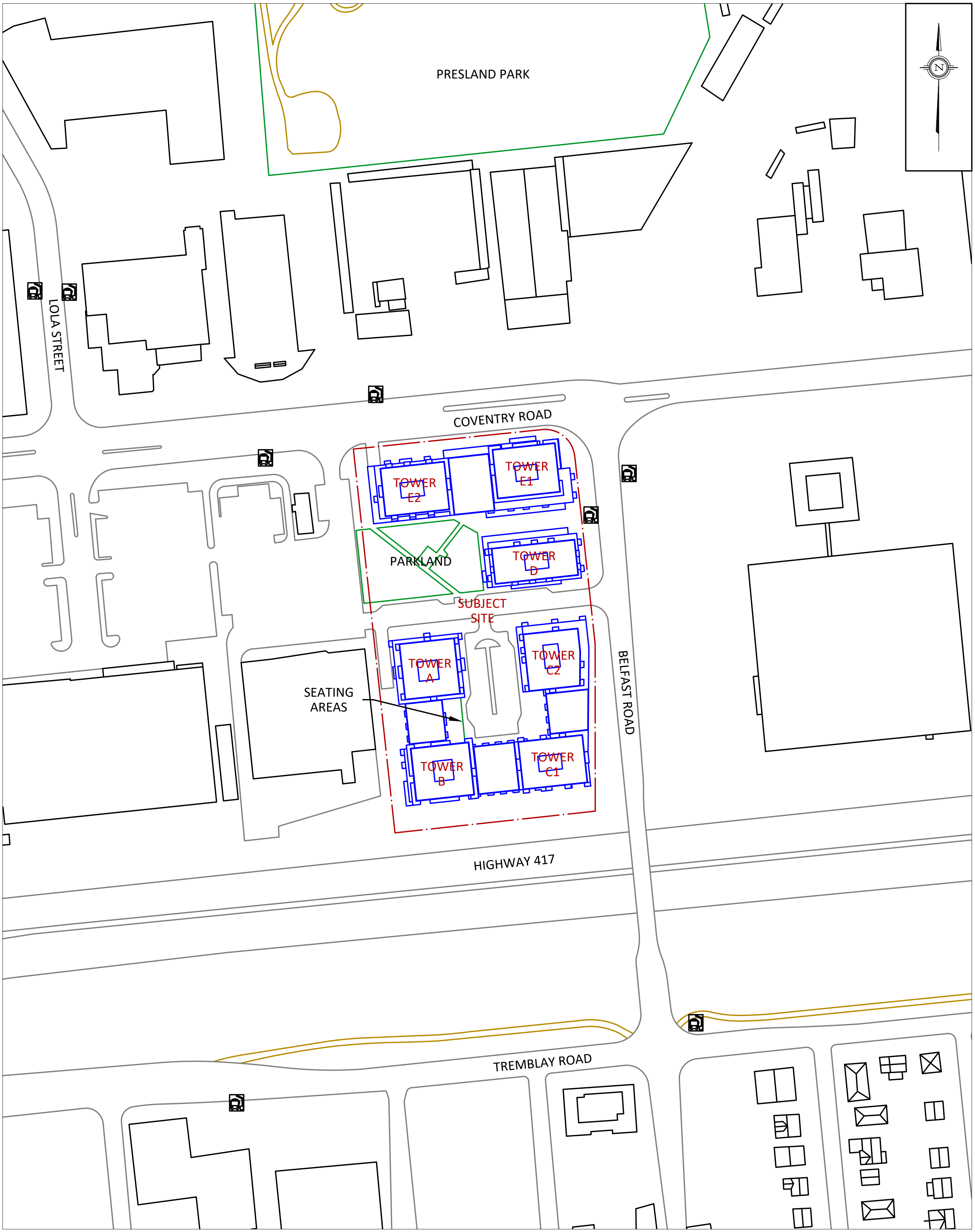
Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. D. FERRARO
100158495
July 14, 2023
PROVINCE OF ONTARIO

Daniel Davalos, MESc.
Wind Scientist

Justin Ferraro, P.Eng.
Principal

Sunny Kang, B.A.S.
Project Coordinator



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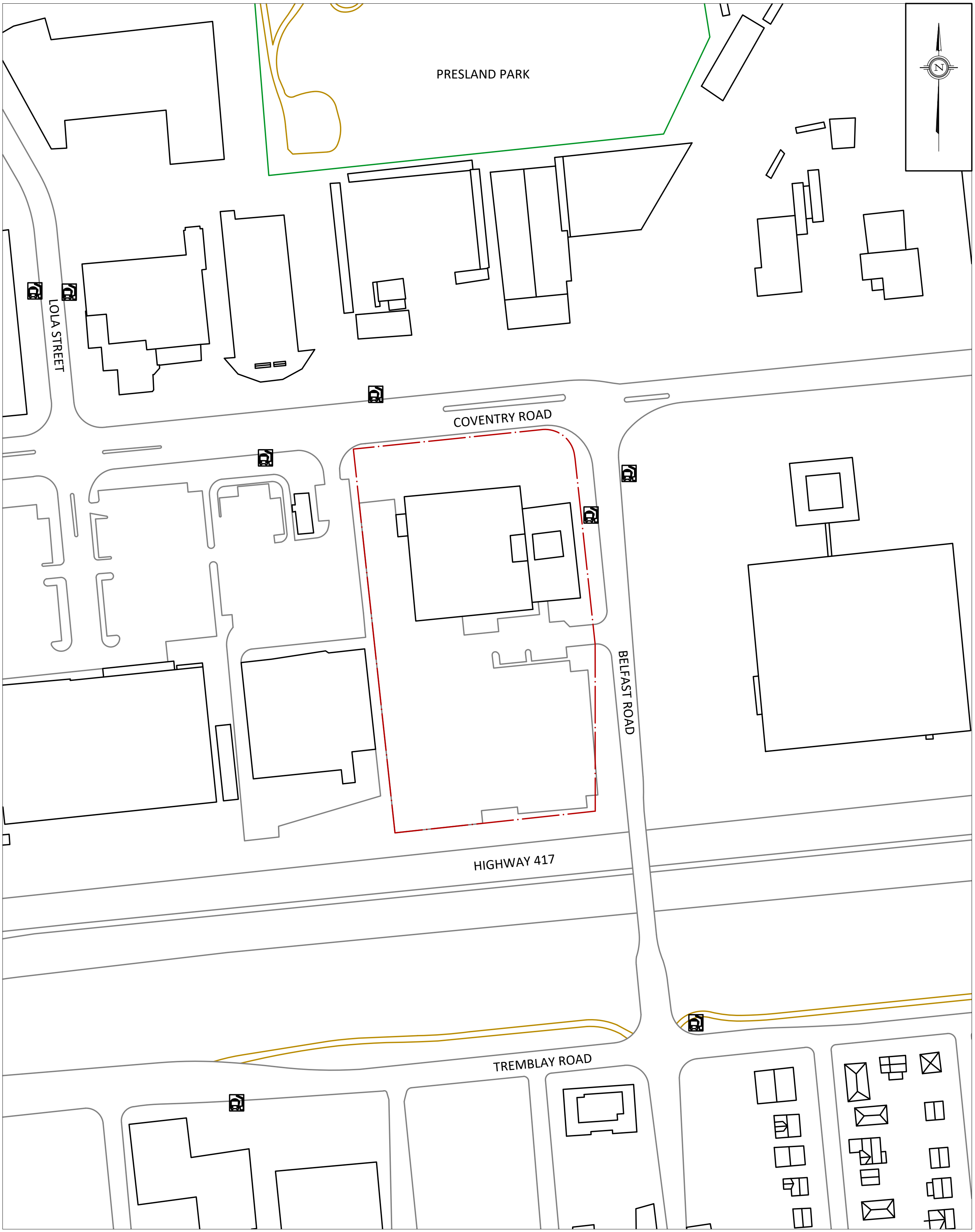
PROJECT	400 COVENTRY ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500	DRAWING NO.	22-272-PLW-2023-1A
DATE	JULY 14, 2023	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	400 COVENTRY ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT
SCALE 1:2500	DRAWING NO. 22-272-PLW-2023-1B		
DATE JULY 14, 2023	DRAWN BY S.K.		

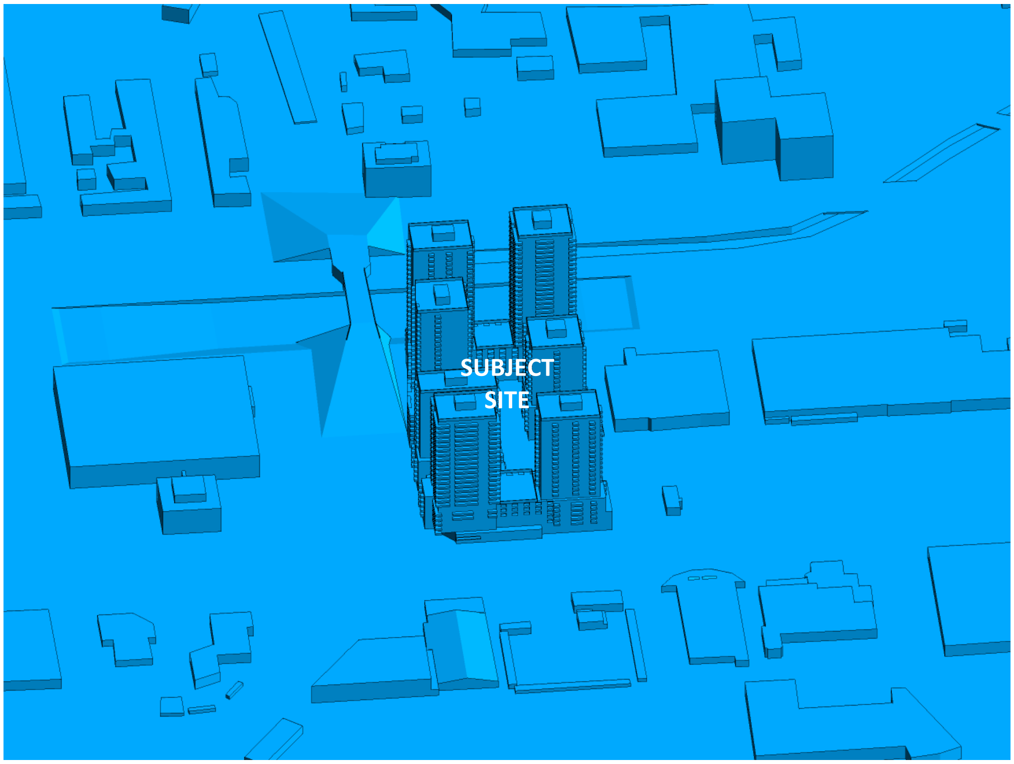


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

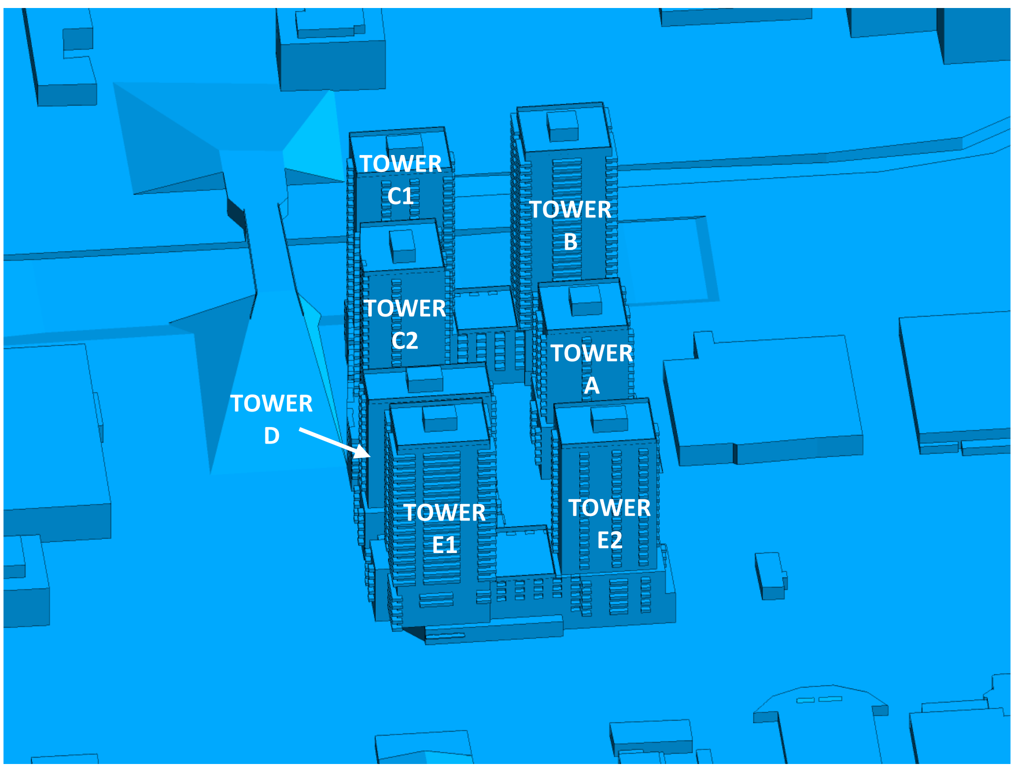


FIGURE 2B: CLOSE UP OF FIGURE 2A

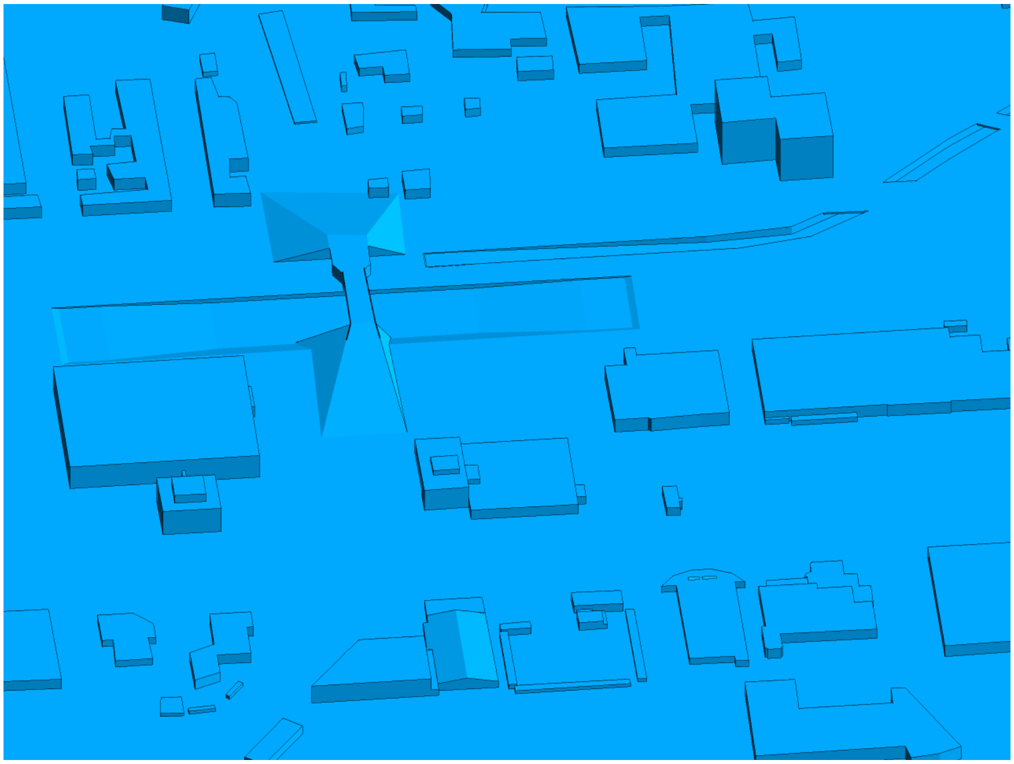


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

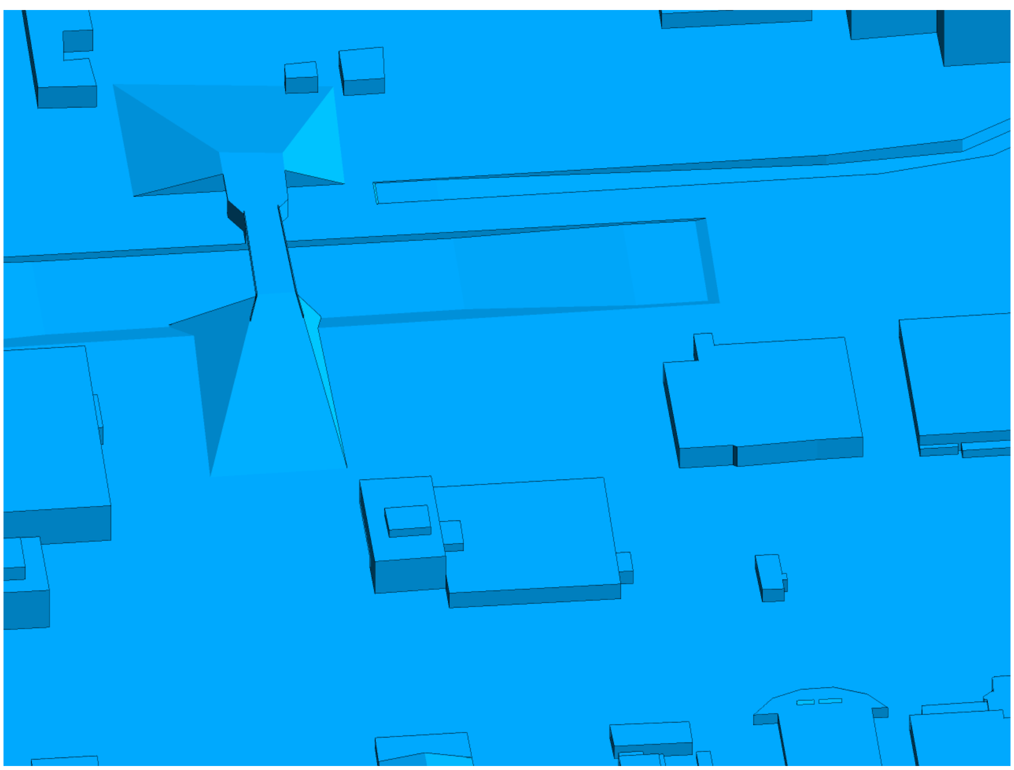


FIGURE 2D: CLOSE UP OF FIGURE 2C

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

FIGURE 2F: CLOSE UP OF FIGURE 2E

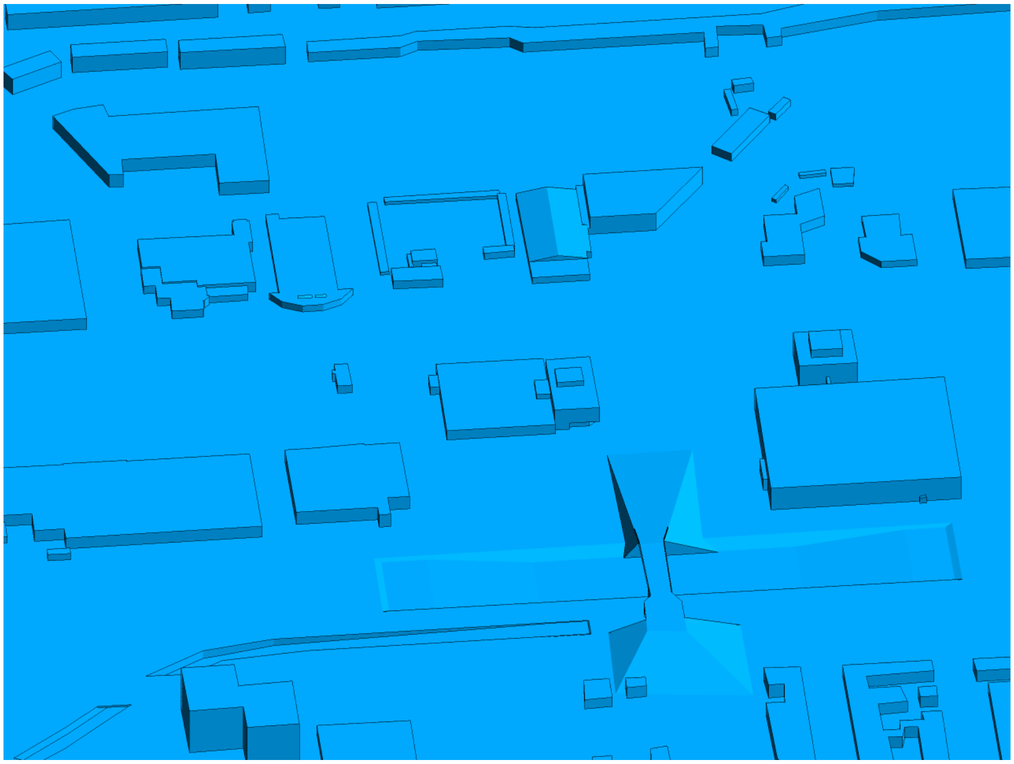


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

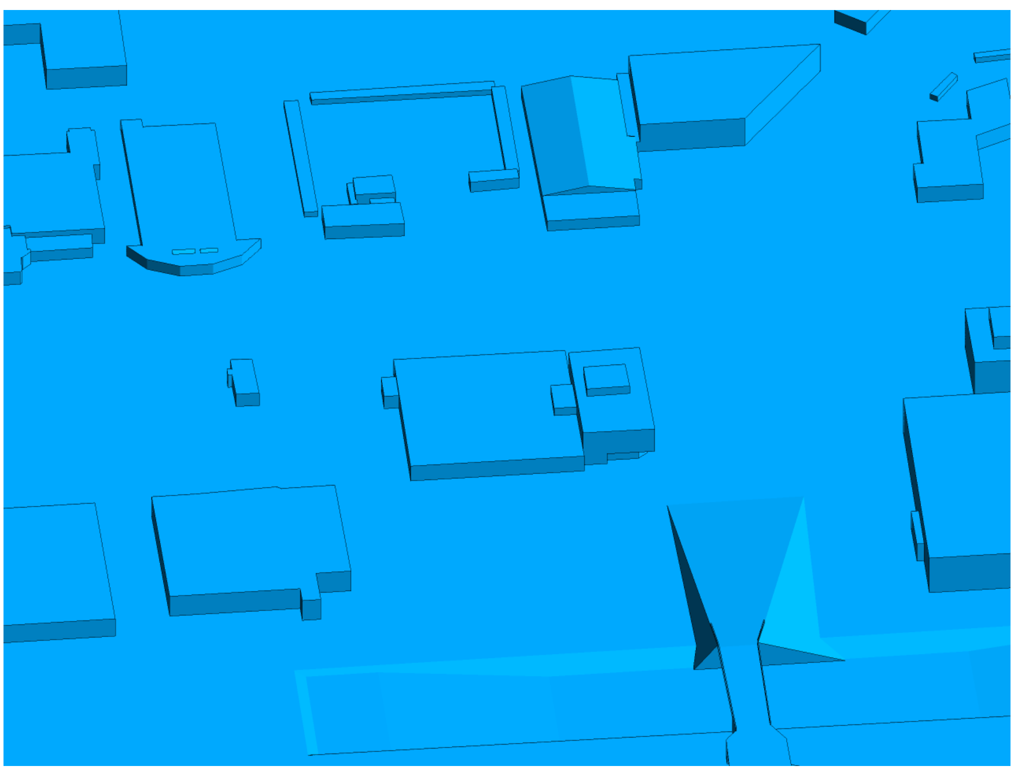


FIGURE 2H: CLOSE UP OF FIGURE 2G

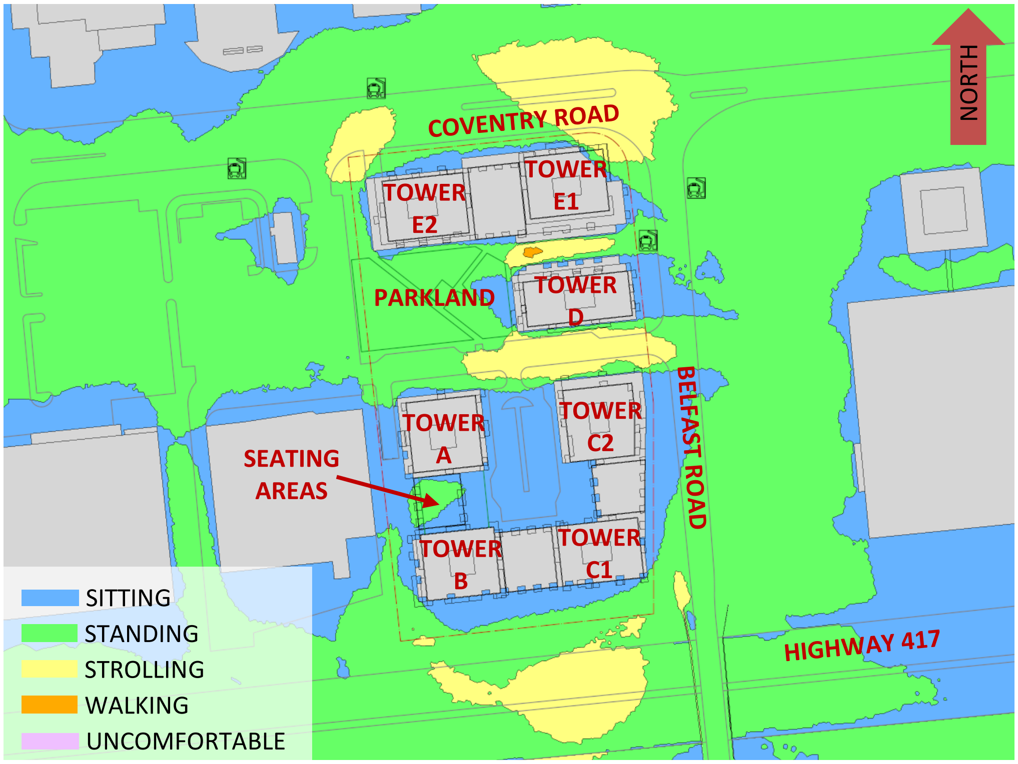


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

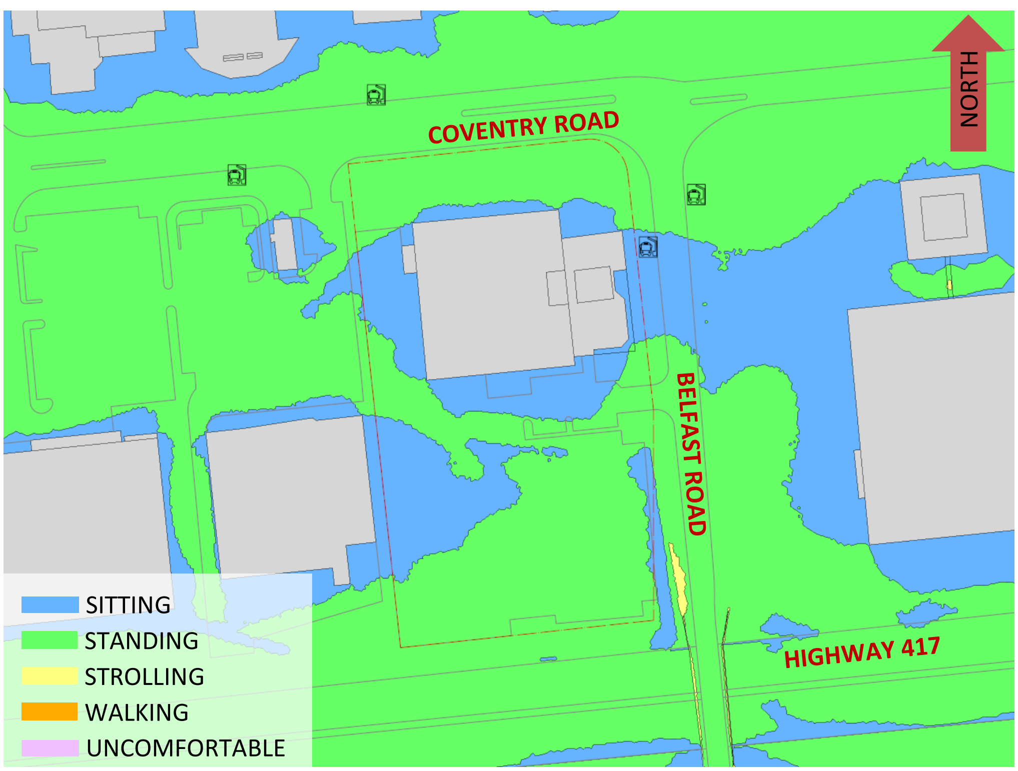


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

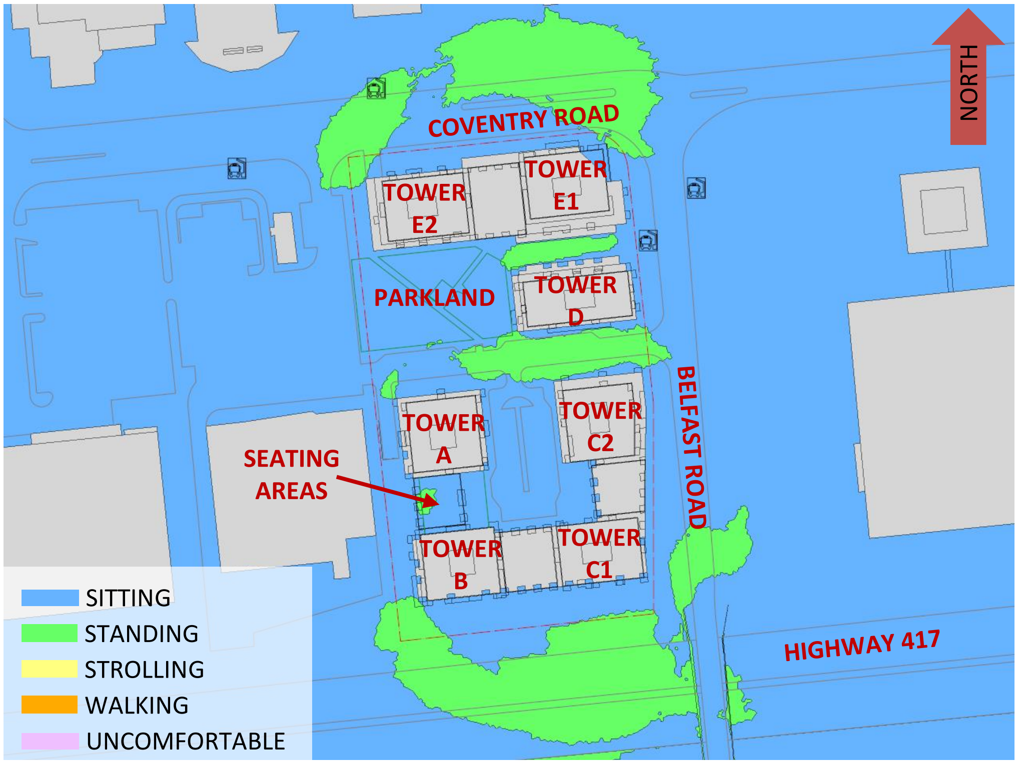


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

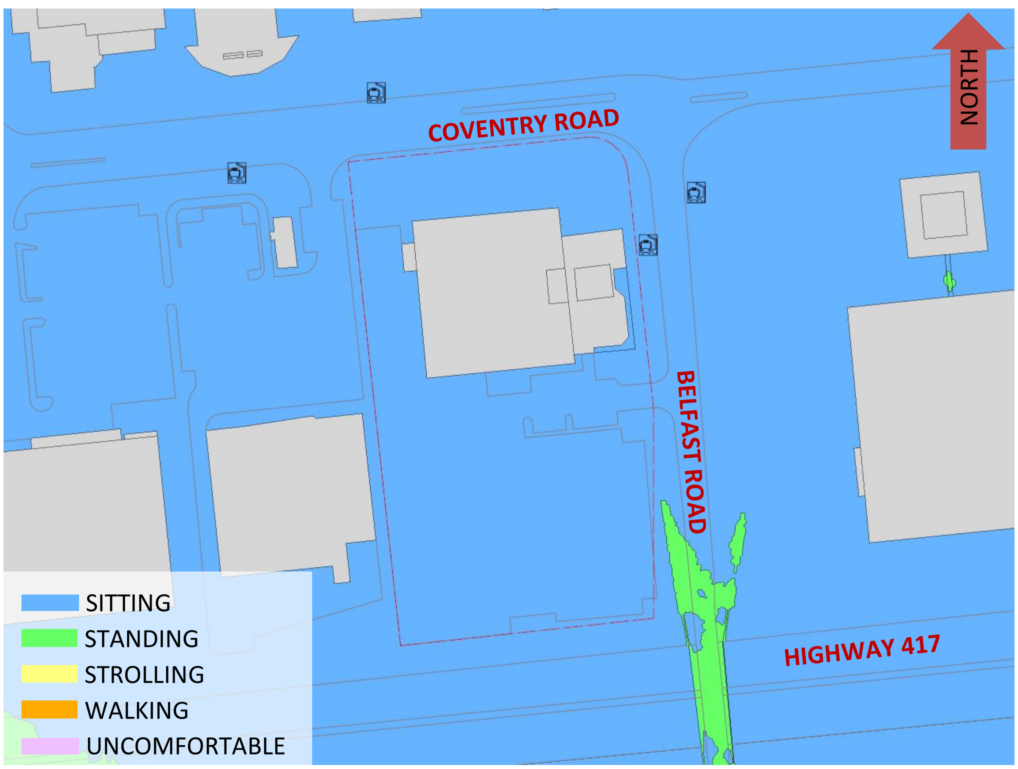


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

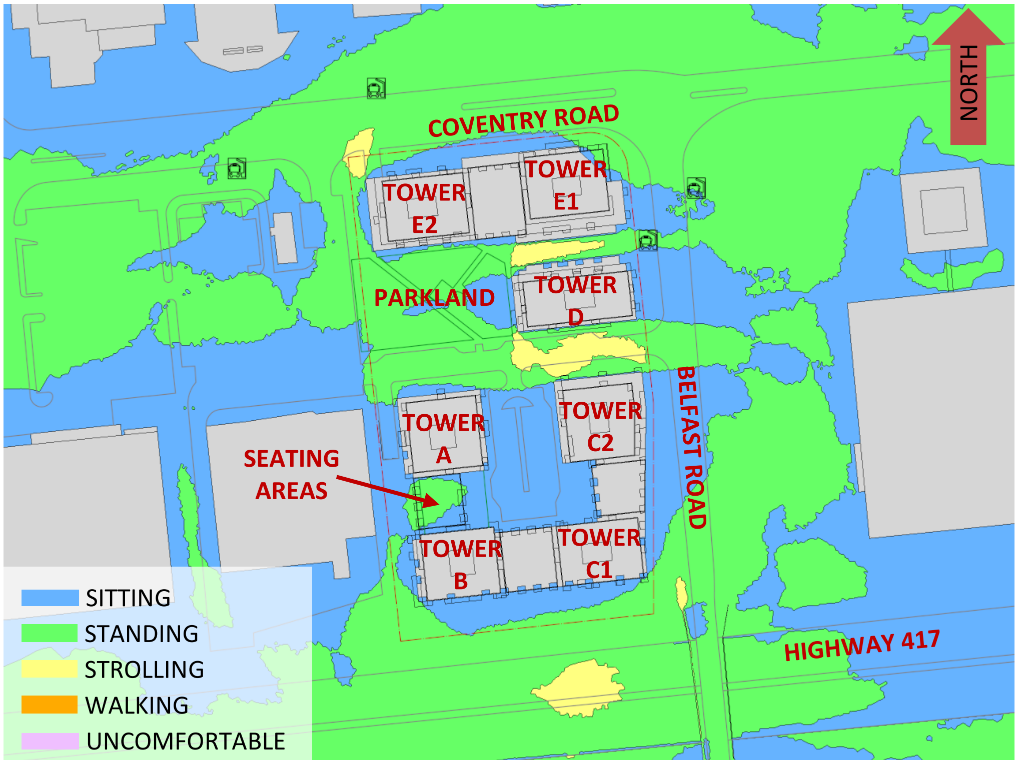


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

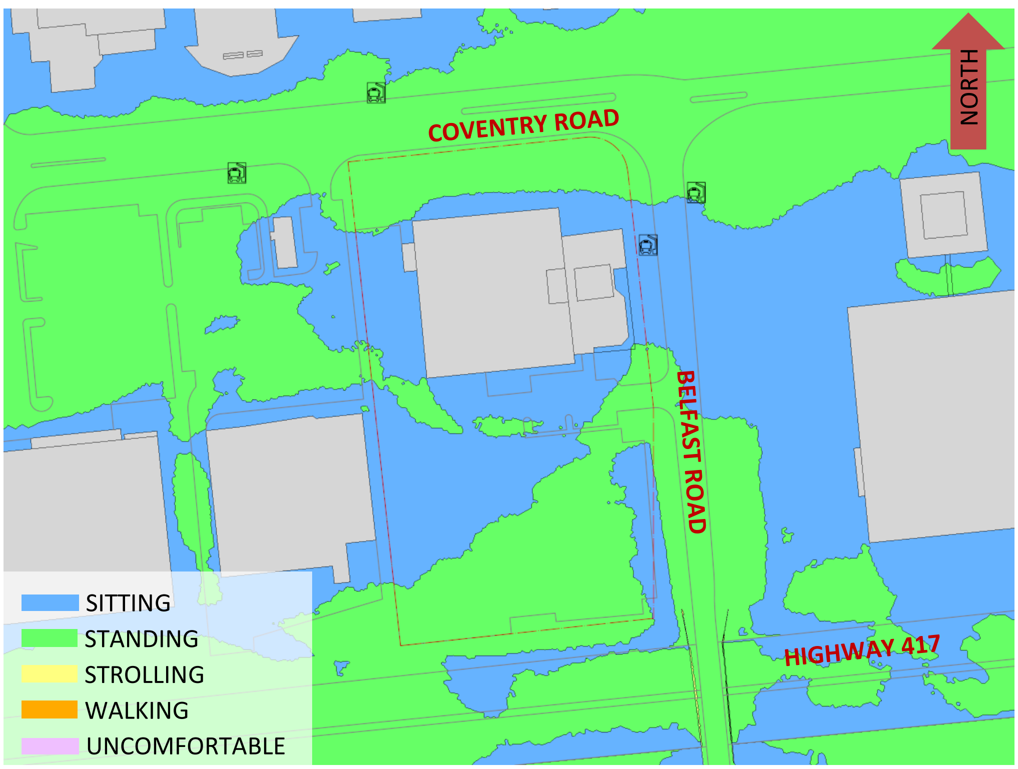


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

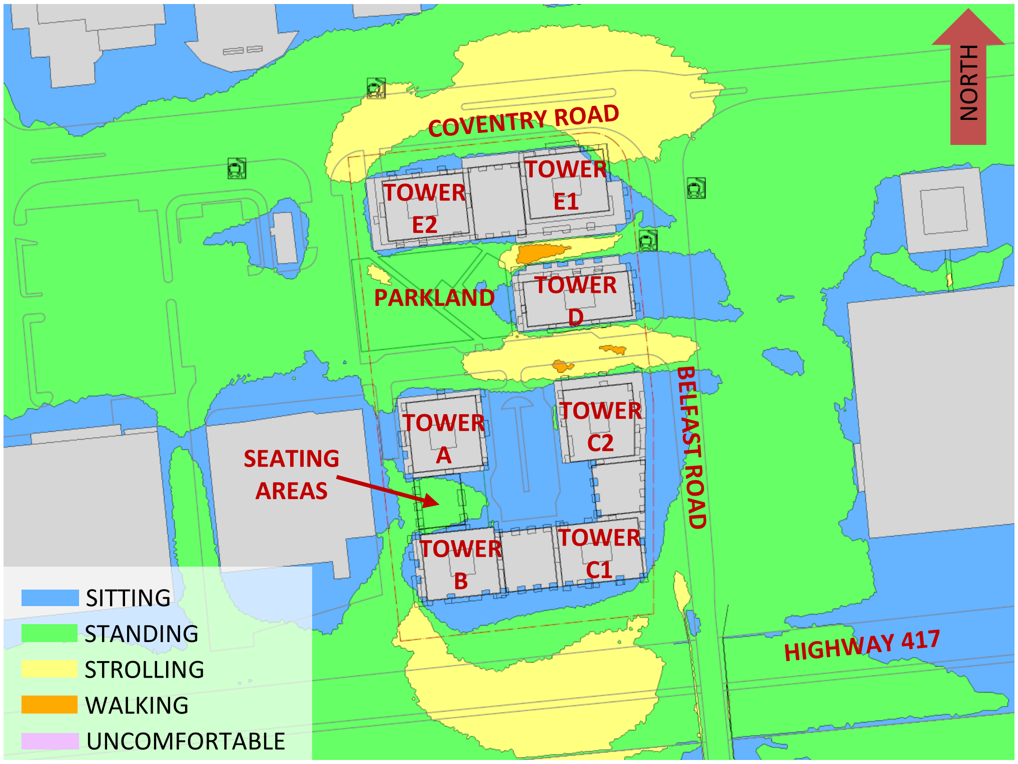


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

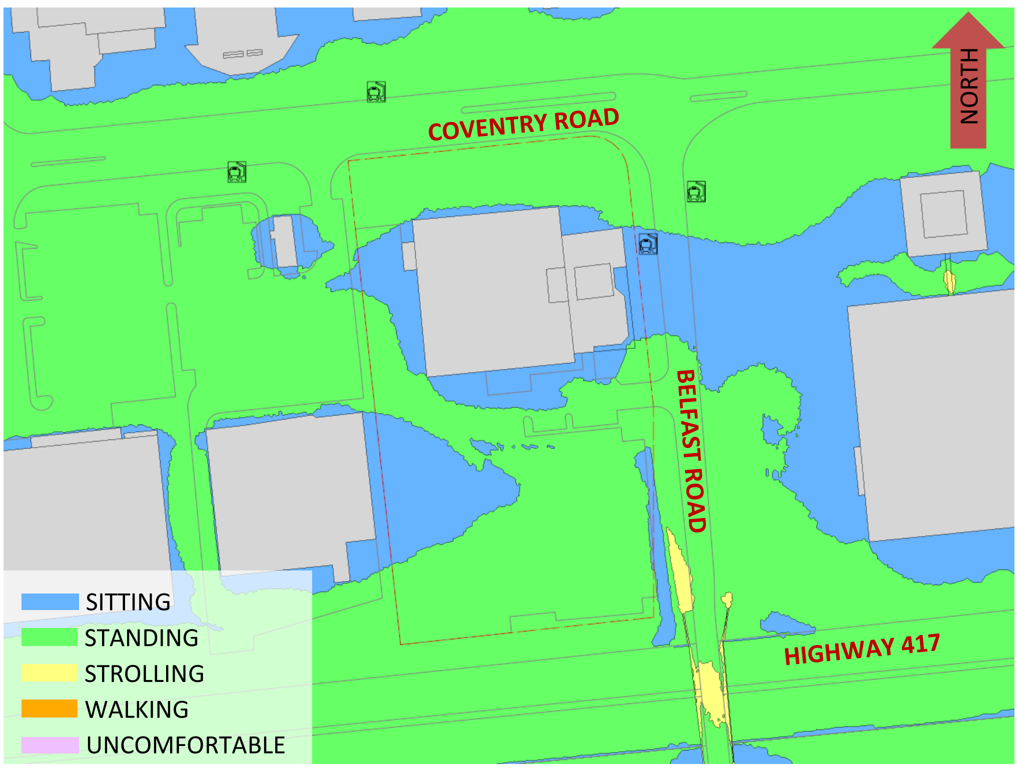


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

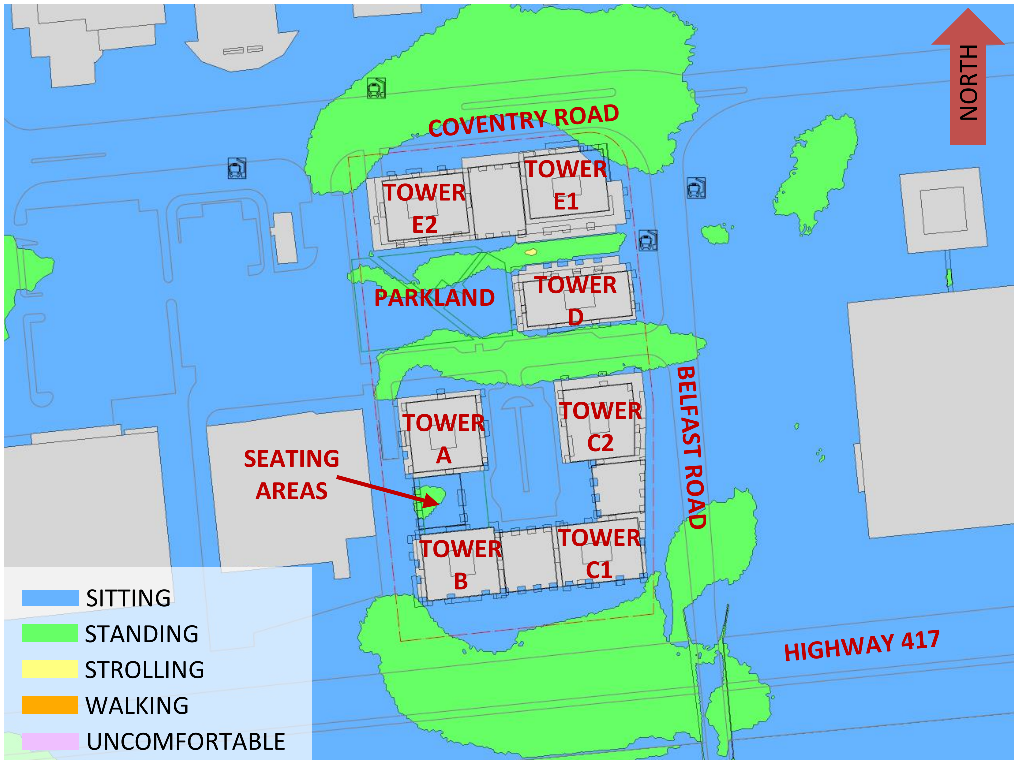


FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

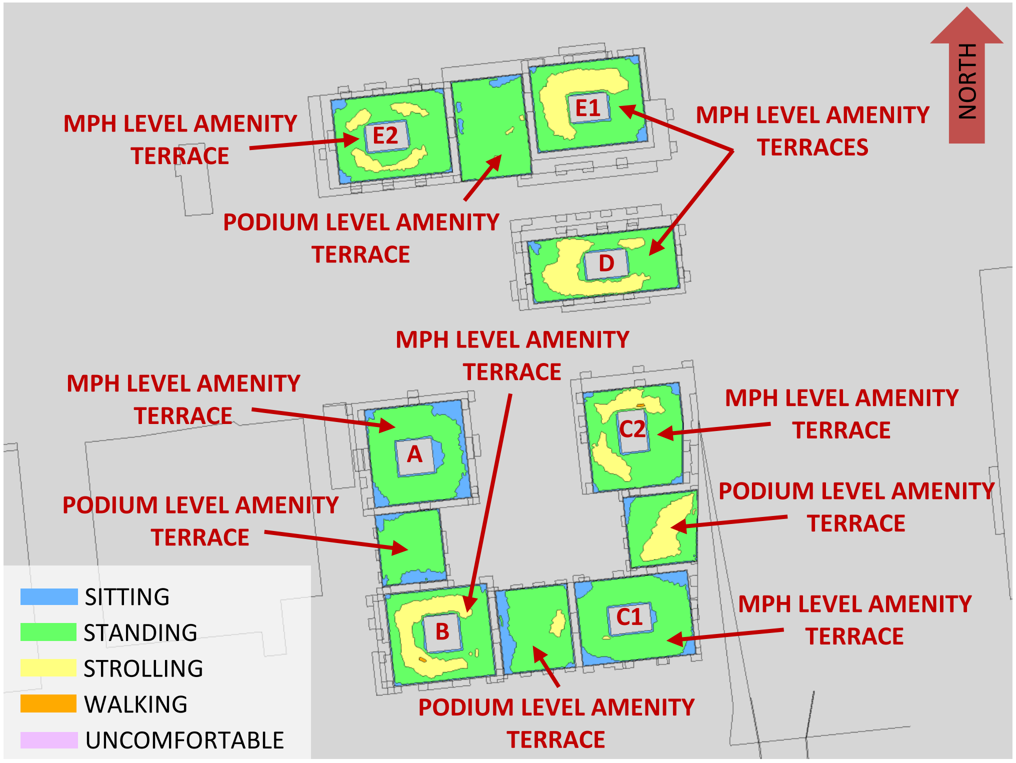


FIGURE 8A: SPRING – WIND COMFORT, COMMON AMENITY TERRACES

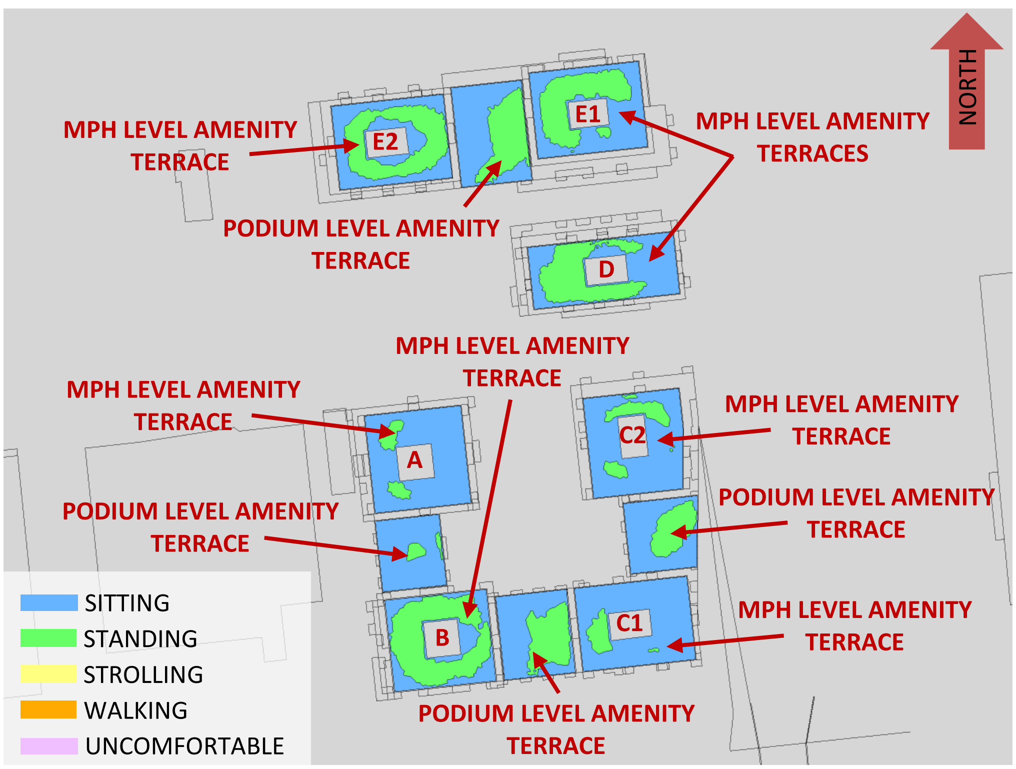


FIGURE 8B: SUMMER – WIND COMFORT, COMMON AMENITY TERRACES

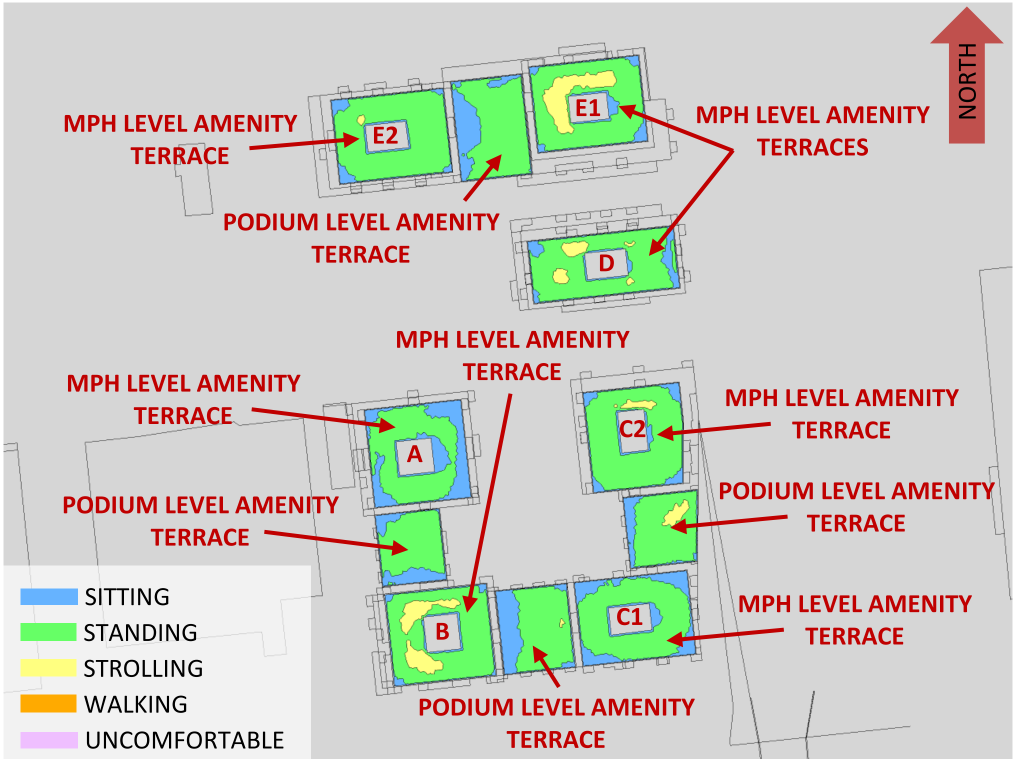


FIGURE 8C: AUTUMN – WIND COMFORT, COMMON AMENITY TERRACES

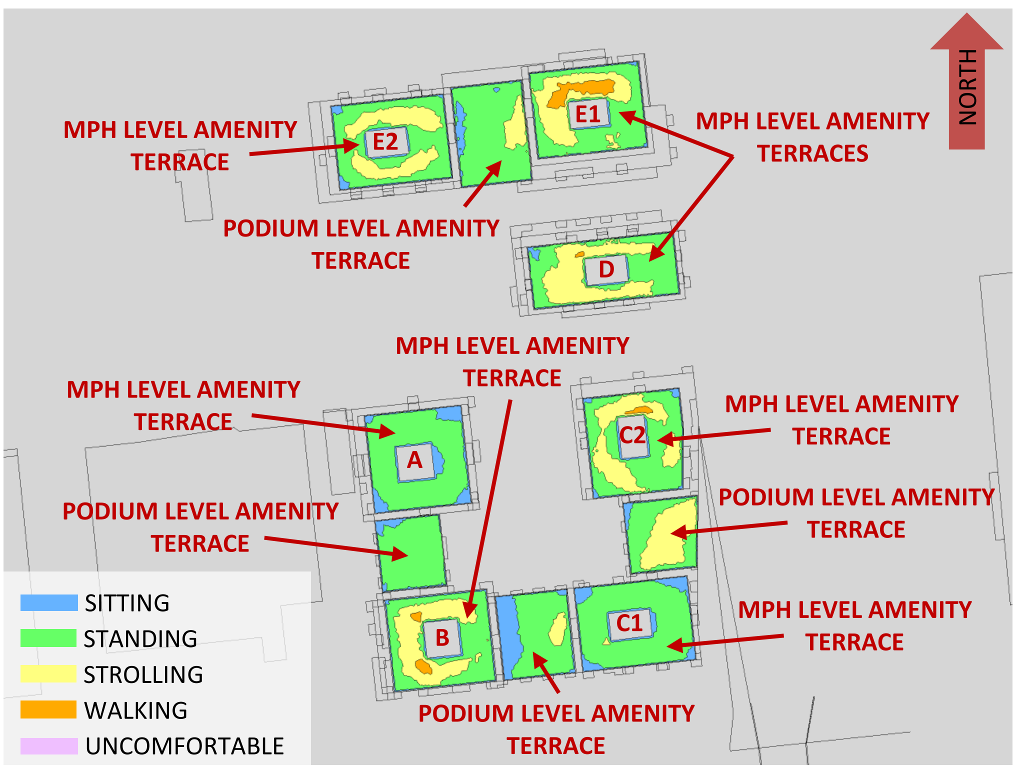


FIGURE 8D: WINTER – WIND COMFORT, COMMON AMENITY TERRACES

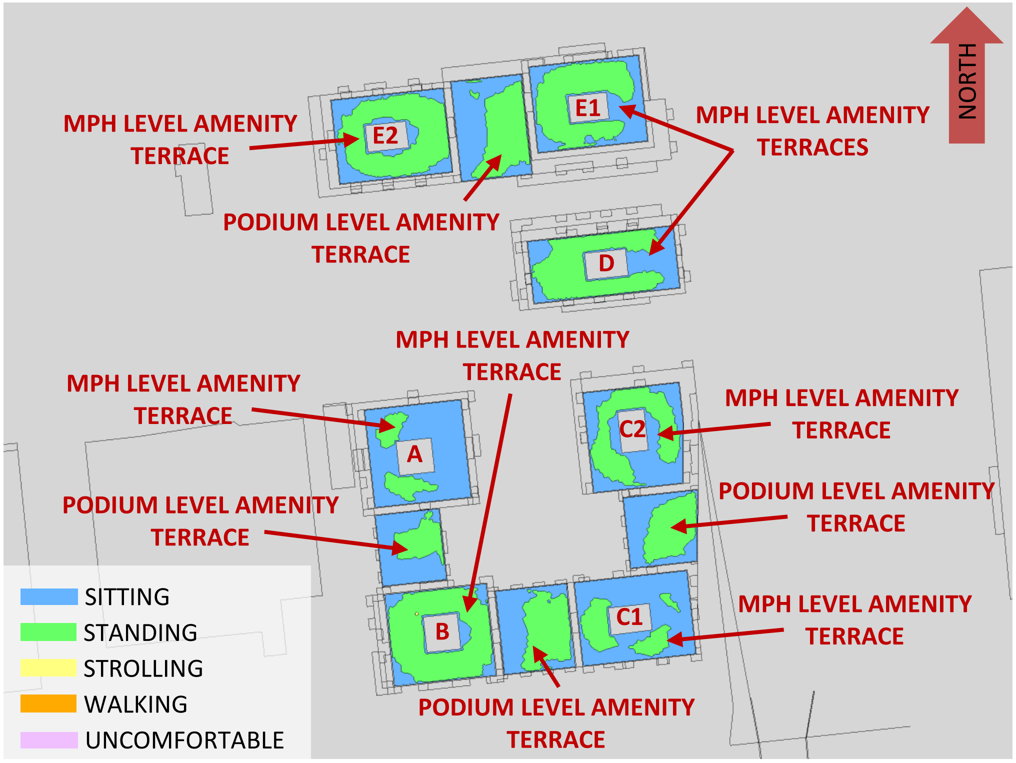
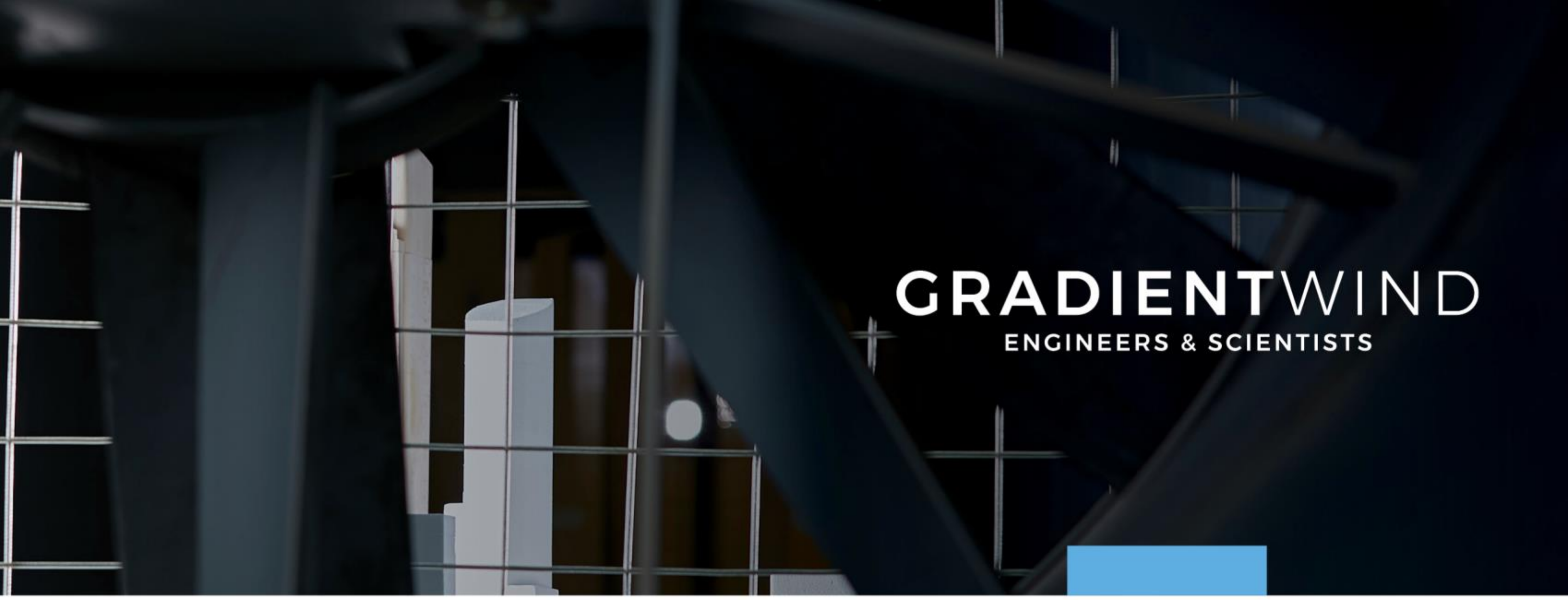


FIGURE 9: TYPICAL USE PERIOD – WIND COMFORT, COMMON AMENITY TERRACES



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, 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	0.25
49	0.25
74	0.24
103	0.24
167	0.24
197	0.24
217	0.25
237	0.23
262	0.26
282	0.25
301	0.25
324	0.25

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).

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

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

where, ***I*** = turbulence intensity, 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.

REFERENCES

[1] P. Arya, "Chapter 10: Near-neutral Boundary Layers," in *Introduction to Micrometeorology*, San Diego, California, Academic Press, 2001.

[2] S. A. Hsu, E. A. Meindl and D. B. Gilhousen, "Determining the Power-Law Wind Profile Exponent under Near-neutral Stability Conditions at Sea," vol. 33, no. 6, 1994.

[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.