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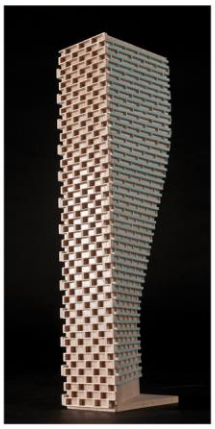
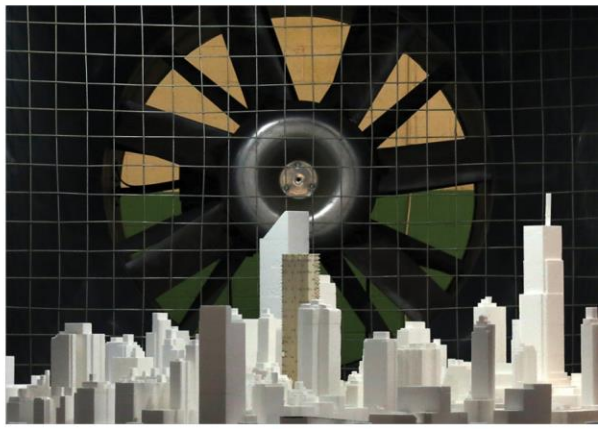
PEDESTRIAN LEVEL WIND STUDY

Pickering Design Centre Master Plan
Pickering, Ontario

Report: 20-305-PLW-2024





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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Zoning By-law Amendment (ZBLA) application requirements for the proposed master plan development situated at 1755 Pickering Parkway in Pickering, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind comfort and safety within and surrounding the subject site, and to identify areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

The study involves simulation of wind speeds for sixteen (16) 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 wind comfort and safety guidelines. Since the City of Pickering does not specify a Terms of Reference for pedestrian level wind studies, the City of Toronto wind criteria were used, as they represent the standards applied in a nearby city and are consistent with industry standards. A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-9, and is summarized as follows:

1) 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 surrounding sidewalks, transit stops, the public areas of the Citywalk townhome development to the northeast, neighbouring existing surface parking lots, public roads, private driveways, drop-off areas, walkways, and in the vicinity of building access points, are considered acceptable. The areas of interest that are predicted to experience windier conditions are described as follows:

    a. **Northwest Corner of Block 1 and Private Driveways Between Blocks 1 and 2 and 4 and 5:** 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. The prevailing winds are predicted to downwash over the podium and tower façades towards grade-level, accelerating around exposed building corners.

Between Blocks 1 and 2 and 4 and 5, these winds are predicted to accelerate around the exposed building corners and be channeled in the gap between the blocks.

- An isolated area at the northwest corner of Block 1 is predicted to experience uncomfortable wind conditions, exceeding the walking threshold for approximately 3% and 6% of the time during the spring and winter seasons, respectively. The noted conditions are predicted to impact a section of the east sidewalk along Brock Road and the nearby proposed multi-use pathway.

- Windier conditions are predicted between Blocks 1 and 2, where isolated conditions that may be considered uncomfortable for walking are predicted throughout the year. The windiest conditions are predicted to be mostly located on the roadway, where pedestrian access and use is expected to be limited.

- Windier conditions are predicted between Blocks 4 and 5, where isolated conditions that may be considered uncomfortable for walking are predicted during the spring season, exceeding the walking threshold for approximately 2% of the time. As the walking percentage exceedance is considered marginal and limited in extent, the noted conditions may be considered satisfactory.

- Mitigation strategies that may be considered by the design team may include terracing of the podiums, if feasible, particularly along northern, western, and eastern elevations, and massing articulations and canopies that extend from select podium façades, as well as wind screens at grade. It is recommended that a mitigation strategy be developed in collaboration with the building and landscape architects as the design of the proposed development progresses. This work is expected to support the future Site Plan Control application submission.

b. **Public Park.** During the typical use period, conditions within the central public park are predicted to be suitable for standing. If the park includes programmed seating areas, comfort levels may be improved by implementing landscaping elements around sensitive areas such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

   The extent of the mitigation measures is dependent on programming. If required, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the proposed development progresses. This work is expected to support the future Site Plan Control application submission.

c. **Possible Building Access Points.** Windy conditions are predicted to occur in the vicinity of the possible building access points along the west elevation of Block 2, along the central underpass of Block 3, along the west elevation of Block 4, along the south elevation of the north wing of Block 5, and along the west elevation of the south wing of Block 5. If feasible, it is recommended that primary building entrances be located away from the noted areas. Alternatively, it is recommended that primary entrances along the noted elevations be recessed into their respective building façades by at least 1.5 m.

2) Regarding the common amenity terrace serving Block 6 at Level 2, wind conditions are predicted to be suitable for sitting throughout the year, which is considered acceptable.

3) Regarding the common amenity terraces serving Block 1 at Level 7 and Block 3 at Level 8, wind comfort conditions during the typical use period and recommendations regarding mitigation are described as follows:

   a. **Block 1, Level 7 Amenity Terrace**: Wind conditions are predicted to be suitable for standing within the majority of the terrace, with sitting conditions predicted to occur to the east and west of the terrace.

   b. **Block 3, Level 8 Amenity Terrace**: Wind conditions are predicted to be suitable for standing within the majority of the terrace, with conditions suitable for sitting predicted to occur near the tower façade and at the northwest corner of the terrace.

c. To improve comfort levels within the Block 1 and Block 3 amenity terraces, mitigation inboard of the terrace perimeters that is targeted around sensitive areas is recommended, in combination with tall perimeter wind screens installed in place of standard height guards. Inboard mitigation could take the form of wind screens or other common landscape elements. Canopies may also be required above sensitive areas.

d. The extent of the 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. This work is expected to support the future Site Plan Control application submission.

4) The foregoing statements and conclusions apply to common weather systems, during which two pedestrian areas within or surrounding the subject site may experience conditions that could be considered dangerous, as defined in Section 4.4. Specifically, the safety criterion may be exceeded on an annual basis within isolated regions at the above-noted windier areas between Blocks 1 and 2 and 4 and 5, where sections of the walkways serving the proposed development are predicted to occasionally receive conditions uncomfortable for walking. Further investigation, which may include additional wind testing, may be required to develop an appropriate strategy to improve wind comfort and to resolve safety conditions within the noted areas.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Pickering Ridge Lands Inc. to undertake a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment (ZBLA) application requirements for the proposed masterplan development situated at 1755 Pickering Parkway in Pickering, Ontario (hereinafter referred to as "subject site" or "proposed development"). A PLW study was conducted in March 2022[1] for the previous design of Block A 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 wind 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, industry standard wind comfort and safety guidelines, architectural drawings prepared by Turner Fleischer Architects Inc. in January 2024, surrounding street layouts and existing and approved future building massing information obtained from the City of Pickering, recent satellite imagery, and experience with numerous similar developments in Pickering and elsewhere. Since the City of Pickering does not specify a Terms of Reference for pedestrian level wind studies, the City of Toronto wind criteria were used, as they represent the standards applied in a nearby city and are consistent with industry standards.

2. TERMS OF REFERENCE

The subject site is located at 1755 Pickering Parkway in Pickering, situated on a parcel of land bordered by Pickering Parkway to the north, Highway 401 to the south, and Brock Road to the west. The master plan is divided into seven phases/blocks by internal public roads and private driveways: Block 1, Block 2, Block 4, Block 5, and Block 7, are situated from the west to the east, respectively, fronting Highway 401, and Block 3 and Block 6 are located to the north of a central public park, fronting Pickering Parkway. A low-rise commercial building and surface parking is located to the west of Block 3, while a development comprising several blocks of townhouses is located to the east of Block 6.

[1] Gradient Wind Engineering Inc., '*Pickering Design Centre – Block A – Pedestrian Level Wind Study*', [March 25, 2022]

Block 1 comprises Tower 1A and Tower 1B (31 storeys each) located to the west and east, respectively, above a common 7-storey podium with its long axis-oriented to the north. Drop-off areas are provided along a private driveway to the south of Block 1. The building steps back from all elevations at Level 6 to accommodate private terraces. A common amenity terrace is provided to the north at Level 7.

Block 2 comprises Tower 2A (24 storeys), Tower 2B (32 storeys), and Tower 2C (43 storeys) located from the west to the east, respectively, above a common near-rectangular 7-storey podium. Drop-off areas are provided along private driveways to the north of Block 2, which connect to a central east-west orientated public road that divides the lower buildings from the central public park. The western portion of the park comprises the north portion of Block 2.

Block 4 comprises Tower 4A (43 storeys) and Tower 4B (32 storeys) located to the west and east, respectively, above a common, nominally rectangular 7-storey podium. Private driveways from the southern east-west public road are located to the north and east of Block 4.

Block 5 comprises Tower 5 (26 storeys) rising to the south above a nominally 'C'-shaped podium, with a drop-off area provided along the private driveway within the inset of the 'C'-shaped planform to the west. The building steps back from the west elevation of the north wing at Levels 4 and 6, and private terraces are accommodated within setbacks from the north elevation at Levels 9, 15, and 21.

Block 7 comprises Tower 7 (20 storeys) rising to the west above a 5-storey podium with its long axis-oriented to the south. Private driveways are located to the north and west of Block 7. Access to the private driveways is provided via a public road to the north of Blocks 5 and 7 that extends along the north elevation of the central public park and the south elevations of Blocks 3 and 6 to connect to Brock Road. The building steps back from all elevations at Level 6 and terraces are accommodated within setbacks from the east elevations at Levels 10, 13, 15, and 18.

Block 3 comprises Tower 3 (26 storeys) rising to the south above a nominally 'C'-shaped 7-storey podium with its long axis-oriented to the east. A driveway connecting the northern east-west public road to Pickering Parkway is located to the east of Block 3. The building steps back from all elevations at Level 8 to accommodate a common amenity terrace.

Block 6 comprises Tower 6A (23 storeys) and Tower 6B (22 storeys) located at the northwest corner and to the south, respectively, above a nominally 'L'-shaped 7-storey podium, with its long axis-oriented to the north. A driveway to the east connects Pickering Parkway to the northern east-west public road. The building steps back from inner corner podium to the south at Level 2 to accommodate an amenity terrace.

Regarding wind exposures, the near-field surroundings (defined as an area falling within 200-metres (m) of the subject site) are characterized by a mix of low-rise residential and commercial buildings from the west clockwise to the northeast, with a mid-rise building and high-rise residential buildings to the west, green space from the east clockwise to the south-southeast, and low-rise commercial and industrial buildings from the south clockwise to the southwest. Highway 401, the GO Transit – Metrolinx line, and the VIA Rail railway extend from the east to the southwest. Notably, a development comprising rows of 3-storey townhomes is approved at 1842 & 1856 Notion Road, to the immediate northeast of the subject site, and a development comprising five towers (ranging in height from 25 to 32 storeys) is approved at 1899 Brock Road, situated approximately 180 m to the northwest of the subject site.

The far-field surroundings (defined as the area beyond the near field and within a 2-kilometre (km) radius) are characterized by a mix of mostly low-rise massing and green spaces in all directions, with isolated mid- and high-rise buildings to the northeast, south, and west.

Figure 1A illustrates the subject site and surrounding context representing the proposed future massing scenario and Figure 1B illustrates the subject site and surrounding context representing the existing massing scenario. Figures 2A-2H illustrate the computational model 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 subject site; (ii) identify areas where wind conditions may interfere with the intended uses of outdoor spaces; and (iii) recommend suitable mitigation measures.

4. METHODOLOGY

The approach followed to quantify 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 Greater Toronto Area wind climate, and synthesis of computational data with industry-accepted guidelines. Since the City of Pickering does not specify a Terms of Reference for pedestrian level wind studies, the City of Toronto wind criteria[2] were used, as they represent the standards applied in a nearby city and are consistent with industry standards. The following sections describe the analysis procedures, including a discussion of the comfort guidelines.

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 subject 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 Lester B. Pearson International Airport in Mississauga, Ontario. 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 proposed 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 stronger wind speed values.

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the subject site for 16 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 780 m. The process was performed for two context massing scenarios, as noted in Section 2.

[2] Toronto, *Pedestrian Level Wind Study Terms of Reference Guide*, 2022
https://www.toronto.ca/wp-content/uploads/2022/03/8f9c-CityPlanning-ToR-Wind-Guide.pdf

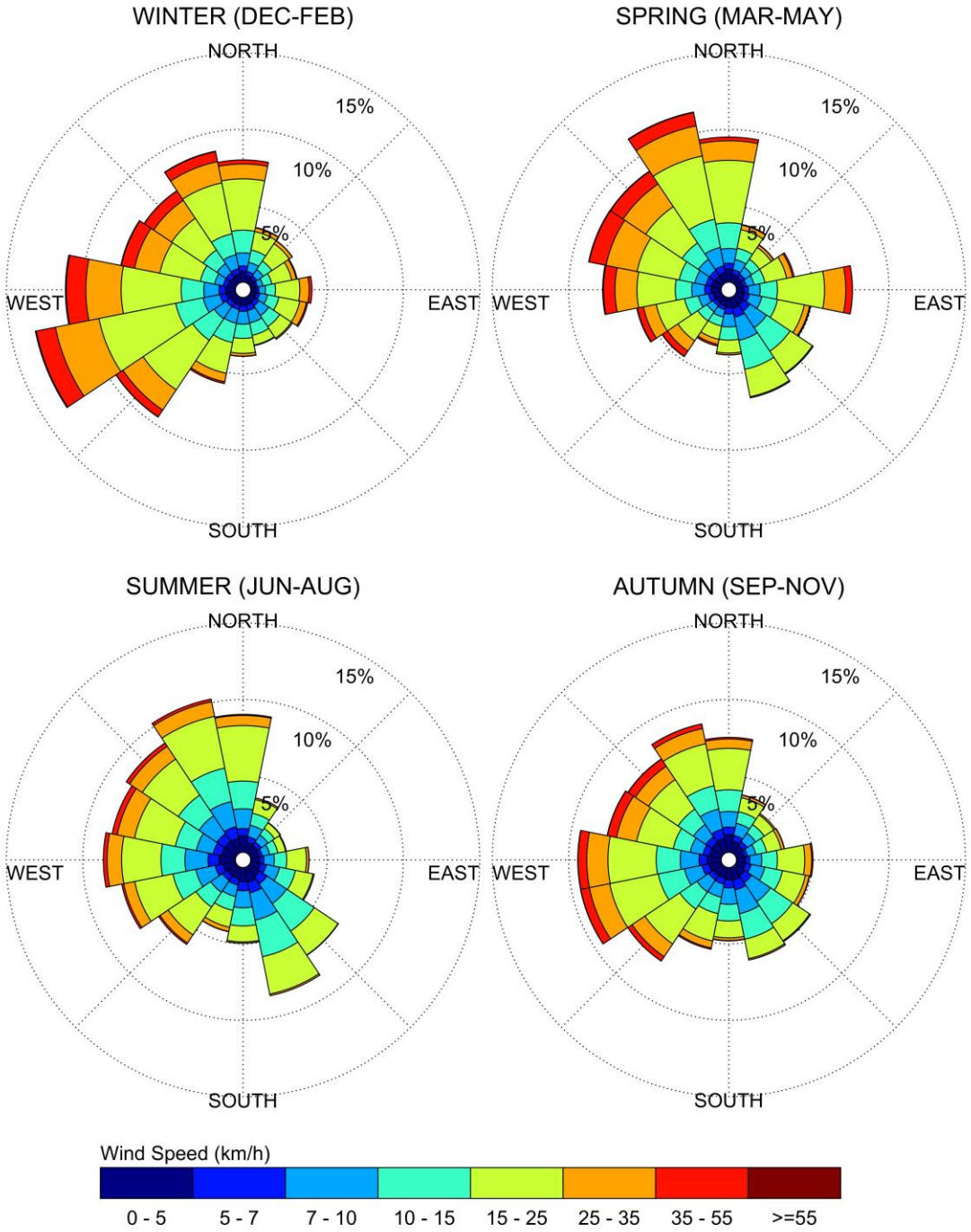
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the common amenity terraces serving the proposed development 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 Pickering was developed from approximately 40 years of hourly meteorological wind data recorded at Lester B. Pearson International Airport and obtained from Environment and Climate Change Canada. Wind speed and direction data were analyzed during the appropriate hours of pedestrian usage (that is, between 06:00 and 23:00) and divided into four distinct seasons. Specifically, spring is defined as March through May, summer is defined as June through August, autumn is defined as September through November, and winter is defined as December through February, inclusive.

The statistical model of the Greater Toronto Area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate seasonal distribution of measured wind speeds and directions in 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 preferred wind speeds and directions can be identified by the longer length of the bars. For the Greater Toronto Area, representative of Pickering, the most common winds occur for westerly and northwesterly wind directions, followed by those from the east, while the most common wind speeds are below 36 km/h. The directional preference and relative magnitude of wind speed changes somewhat from season to season.

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



Notes:

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

4.4 Pedestrian Comfort and Safety Guidelines

Pedestrian wind comfort and safety guidelines are based on the mechanical effects of wind without consideration of other meteorological conditions (that is, temperature and relative humidity). The comfort guidelines assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Since both mean and gust wind speeds affect pedestrian comfort, their combined effect is defined in the City of Toronto Pedestrian Level Wind Study Terms of Reference Guide. Specifically, the guidelines are defined as a Gust Equivalent Mean (GEM) wind speed, which is the greater of the mean wind speed or the gust wind speed divided by 1.85.

The wind speed ranges are based on the Beaufort scale, which describes the effects of forces produced by varying wind speed levels on objects. Four pedestrian comfort classes and corresponding gust wind speed ranges are used to assess pedestrian comfort: (1) Sitting; (2) Standing; (3) Walking; and (4) Uncomfortable. Wind conditions suitable for sitting are represented by the colour blue, standing by green, and walking by yellow; uncomfortable conditions are represented by the colour orange. 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	GEM wind speeds no greater than 10 km/h occurring at least 80% of the time are considered acceptable for sedentary activities, including sitting.
STANDING	≤ 15	GEM wind speeds no greater than 15 km/h occurring at least 80% of the time are considered acceptable for activities such as standing, strolling, or more vigorous activities.
WALKING	≤ 20	GEM wind speeds no greater than 20 km/h occurring at least 80% of the time are considered acceptable for walking or more vigorous activities.
UNCOMFORTABLE	> 20	Uncomfortable conditions are characterized by predicted values that fall below the 80% target for walking. Brisk walking and exercise, such as jogging, are considered acceptable for moderate excesses of this criterion.

Regarding wind safety, gust wind speeds greater than 90 km/h, occurring more than 0.1% of the time on an annual basis (based on wind events recorded for 24 hours a day), are 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.

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 GEM wind speeds of 10 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 GEM wind speeds of 20 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 below. 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
Café / Patio / Bench / Garden	Sitting / Standing
Transit/Bus Stop (Without Shelter)	Standing
Transit/Bus Stop (With Shelter)	Walking
Public Park / Plaza / Amenity Space	Sitting / Standing
Garage / Service Entrance / Parking Lot	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 illustrate wind conditions over the common amenity terraces serving Block 1 at Level 7, Block 3 at Level 8, and Block 6 at Level 2. Conditions are presented as continuous contours of wind comfort within and surrounding the subject site and correspond to the various comfort classes noted in Section 4.4.

Wind comfort conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figures 7 and 9 illustrate wind comfort conditions at grade level and within the noted common 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 Brock Road: Following the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along Brock Road are predicted to be suitable for standing, or better, during the summer and autumn with isolated regions suitable for walking, becoming suitable for a mix of mostly standing and walking during the winter and spring. The windiest conditions are situated to the northwest of Block 1, where a region of uncomfortable conditions is predicted during the winter and spring. Specifically, conditions during the winter season are predicted to be suitable for walking for approximately 74% of the time, representing a 6% exceedance of the walking threshold, while conditions during the spring season are predicted to be suitable for walking for at least 77% of the time, representing a 3% exceedance of the walking threshold. The noted conditions are predicted to impact small, isolated sections of the east sidewalk along Brock Road and the multi-use pathway to the north of Block 1.

The proposed development is exposed to prevailing winds from multiple directions, owing to the mostly suburban environs of the proposed development, and the noted wind conditions are expected following the introduction of the building development in its surroundings. The windy conditions to the northwest of Block 1 are attributed to the acceleration of salient winds around the exposed northwest corner of Block 1.

The proposed development includes positive design features such as tower setbacks from the podium façades, which help deflect prominent winds that downwash and accelerate over the façades. If feasible, it is recommended that the setbacks of Tower 1A from the west and north podium elevations be increased to improve the deflection of prevailing winds from these directions. Additional mitigation strategies, such as podium and tower massing articulations and canopies that extend from select podium façades, may also be considered by the design team.

Conditions over the sidewalks along Brock Road with the existing massing are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for a mix of standing and walking during the winter and spring. The introduction of the proposed development produces windier conditions in comparison to existing conditions.

Sidewalks and Transit Stops along Pickering Parkway: Prior to the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along Pickering Parkway are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for walking, or better, during the winter and spring. The noted conditions remain similar following the introduction of the proposed development. The noted wind conditions are considered acceptable for public sidewalks.

Following the introduction of the proposed development, conditions in the vicinity of the nearby westbound transit stop to the north of Pickering Parkway are predicted to be suitable for standing, or better, during the summer, becoming suitable for standing throughout the remainder of the year, while conditions in the vicinity of the nearby eastbound transit stop to the south of Pickering Parkway are predicted to be suitable for standing throughout the year. The noted conditions are considered acceptable.

Conditions in the vicinity of the noted transit stops with the existing massing are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing during the winter and spring. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions are nevertheless considered acceptable.

Neighbouring Existing Surface Parking Lots: Prior to the introduction of the proposed development, wind comfort conditions over the neighbouring existing surface parking lots to the west and north of the subject site are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for walking, or better, during the winter and spring. The noted conditions remain mostly unchanged following the introduction of the proposed development and the wind conditions with the proposed development are considered acceptable.

Citywalk Townhomes: Wind comfort conditions throughout the year over the public pedestrian areas of the Citywalk townhome development to the northeast are predicted to be suitable for standing, or better, prior to and following the introduction of the proposed development, which is considered acceptable.

Public Roads, Private Driveways, Drop-off Areas, and Walkways within Subject Site: Conditions over the drop-off areas serving Blocks 1, 2, 4, and 7 are predicted to be suitable for standing, or better, throughout the year, while conditions over the drop-off area serving Block 5 are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for a mix of standing and walking during the winter. The noted conditions are considered acceptable.

Conditions over the multi-use pathway through the proposed development are predicted to be suitable for walking, or better, throughout the year, with the above-noted isolated region of uncomfortable wind conditions during the winter season at the northwest corner of Block 1 predicted to impact a small section of the pathway as it connects to Brock Road.

Conditions over most of the sidewalks along the public roads and private driveways and the walkways within the subject site are predicted to be suitable for walking, or better, throughout the year. The windiest conditions are situated between Blocks 1 and 2, where a region of uncomfortable conditions is predicted throughout the year and between Blocks 4 and 5 where a region of uncomfortable conditions is predicted during the spring. Conditions that may be considered uncomfortable for walking during the spring season are located between Blocks 5 and 7 and to the northeast of Block 7; however, these conditions are located over roadways or greenspace where pedestrian access is limited.

Specifically, the windiest conditions between Blocks 1 and 2 are predicted to mostly impact sections of the roadway over the private driveway, where pedestrian access and use is expected to be limited.

During the spring season, conditions between Blocks 4 and 5 are predicted to be suitable for walking for approximately 78% of the time, representing a 2% exceedance of the walking threshold. As the walking percentage exceedance is considered marginal and isolated in extent, the noted conditions may be considered satisfactory.

As noted above, the suburban environment surrounding the proposed development exposes the subject site to prevailing winds from multiple directions, which are predicted to downwash over the podium and tower façades towards grade-level. Between Blocks 1 and 2 and 4 and 5, these winds are predicted to accelerate around the exposed building corners and be channeled in the gap between the blocks.

Mitigation strategies that may be considered by the design team may include terracing of the podiums, if feasible, particularly along northern, western, and eastern elevations, and podium and tower massing articulations and canopies that extend from select podium façades, as well as wind screens at grade that diffuse accelerating winds around building corners and through the gaps between the blocks.

It is recommended that a mitigation strategy be developed in collaboration with the building and landscape architects as the design of the proposed development progresses. This work is expected to support the future Site Plan Control application submission.

Public Park: During the typical use period, wind comfort conditions within the public park situated central to the subject site are predicted to be suitable for standing. If seating areas are programmed within the park, comfort levels may be improved by implementing landscaping elements around sensitive areas such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

The extent of the mitigation measures is dependent on the programming of the public park. If required by programming, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the proposed development progresses. This work is expected to support the future Site Plan Control application submission.

Building Access Points Serving the Proposed Development: Windier conditions are predicted in the vicinity of the possible building access points along the west elevation of Block 2, along the underpass situated central to Block 3, along the west elevation of Block 4, along the south elevation of the north wing of Block 5, and along the west elevation of the south wing of Block. If feasible, it is recommended that primary building entrances be located away from the noted windier areas. Alternatively, it is recommended that the noted primary entrances be recessed into their respective building façades by at least 1.5 m.

Conditions in the vicinity of the remaining potential 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

Wind comfort conditions within the common amenity terraces serving Block 1 at Level 7, Block 3 at Level 8, and Block 6 at Level 2 and recommendations regarding mitigation, where required, are described as follows:

Block 1, Level 7 Amenity Terrace: During the typical use period, wind comfort conditions within the common amenity terrace serving Block 1 at Level 7 are predicted to be suitable for standing within the majority of the terrace, with sitting conditions predicted to the east and west of the terrace, as illustrated in Figure 9. Where conditions are suitable for standing, they are also suitable for sitting for at least 73% of the time during the same period, where the target is 80% to achieve the sitting comfort class.

Block 3, Level 8 Amenity Terrace: During the typical use period, wind conditions within the common amenity terrace serving Block 3 at Level 8 are predicted to be suitable for standing within the majority of the terrace, with sitting conditions predicted to occur near the tower façade and at the northwest corner of the terrace.

To improve comfort levels within the Level 7 amenity terrace serving Block 1 and the Level 8 amenity terrace serving Block 3, mitigation inboard of the terrace perimeters that is targeted around sensitive areas is recommended, in combination with tall perimeter wind screens in place of standard height guards. Inboard mitigation could take the form of wind screens or other common landscape elements. Canopies may also be required above sensitive areas.

The extent of the mitigation measures is dependent on the programming of the noted amenity terraces. An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the proposed development progresses. This work is expected to support the future Site Plan Control application submission.

Block 6, Level 2 Amenity Terrace: Wind comfort conditions within the common amenity terrace serving Block 6 at Level 2 are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable.

5.3 Wind Safety

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, two pedestrian areas within or surrounding the subject site may experience conditions that could be considered dangerous, as defined in Section 4.4. Specifically, the safety criterion may be exceeded on an annual basis within isolated regions at the above-noted windier areas between Blocks 1 and 2 and 4 and 5, where sections of the walkways serving the proposed development are predicted to occasionally receive conditions uncomfortable for walking. Further investigation, which may include additional wind testing, may be required to develop an appropriate strategy to improve wind comfort and to resolve safety conditions within the noted areas.

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 of this report and illustrated in Figures 3A-9. Since the City of Pickering does not specify a Terms of Reference for pedestrian level wind studies, the City of Toronto wind criteria were used, as they represent the standards applied in a nearby city and are consistent with industry standards. Based on computer simulations using the CFD technique, meteorological data analysis of the Greater Toronto Area wind climate, industry standard wind comfort and safety guidelines, and experience with numerous similar developments in Pickering and elsewhere, the study concludes the following:

1) 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 surrounding sidewalks, transit stops, the public areas of the Citywalk townhome development to the northeast, neighbouring existing surface parking lots, public roads, private driveways, drop-off areas, walkways, and in the vicinity of building access points, are considered acceptable. The areas of interest that are predicted to experience windier conditions are described as follows:

    a. **Northwest Corner of Block 1 and Private Driveways Between Blocks 1 and 2 and 4 and 5:** 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. The prevailing winds are predicted to downwash over the podium and tower façades towards grade-level, accelerating around exposed building corners. Between Blocks 1 and 2 and 4 and 5, these winds are predicted to accelerate around the exposed building corners and be channeled in the gap between the blocks.

        - An isolated area at the northwest corner of Block 1 is predicted to experience uncomfortable wind conditions, exceeding the walking threshold for approximately 3% and 6% of the time during the spring and winter seasons, respectively. The noted conditions are predicted to impact a section of the east sidewalk along Brock Road and the nearby proposed multi-use pathway.

- Windier conditions are predicted between Blocks 1 and 2, where isolated conditions that may be considered uncomfortable for walking are predicted throughout the year. The windiest conditions are predicted to be mostly located on the roadway, where pedestrian access and use is expected to be limited.

- Windier conditions are predicted between Blocks 4 and 5, where isolated conditions that may be considered uncomfortable for walking are predicted during the spring season, exceeding the walking threshold for approximately 2% of the time. As the walking percentage exceedance is considered marginal and limited in extent, the noted conditions may be considered satisfactory.

- Mitigation strategies that may be considered by the design team may include terracing of the podiums, if feasible, particularly along northern, western, and eastern elevations, and massing articulations and canopies that extend from select podium façades, as well as wind screens at grade. It is recommended that a mitigation strategy be developed in collaboration with the building and landscape architects as the design of the proposed development progresses. This work is expected to support the future Site Plan Control application submission.

b. **Public Park.** During the typical use period, conditions within the central public park are predicted to be suitable for standing. If the park includes programmed seating areas, comfort levels may be improved by implementing landscaping elements around sensitive areas such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

   The extent of the mitigation measures is dependent on programming. If required, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the proposed development progresses. This work is expected to support the future Site Plan Control application submission.

c. **Possible Building Access Points.** Windy conditions are predicted to occur in the vicinity of the possible building access points along the west elevation of Block 2, along the central underpass of Block 3, along the west elevation of Block 4, along the south elevation of the north wing of Block 5, and along the west elevation of the south wing of Block 5. If feasible, it is recommended that primary building entrances be located away from the noted areas. Alternatively, it is recommended that primary entrances along the noted elevations be recessed into their respective building façades by at least 1.5 m.

2) Regarding the common amenity terrace serving Block 6 at Level 2, wind conditions are predicted to be suitable for sitting throughout the year, which is considered acceptable.

3) Regarding the common amenity terraces serving Block 1 at Level 7 and Block 3 at Level 8, wind comfort conditions during the typical use period and recommendations regarding mitigation are described as follows:

a. **Block 1, Level 7 Amenity Terrace**: Wind conditions are predicted to be suitable for standing within the majority of the terrace, with sitting conditions predicted to occur to the east and west of the terrace.

b. **Block 3, Level 8 Amenity Terrace**: Wind conditions are predicted to be suitable for standing within the majority of the terrace, with conditions suitable for sitting predicted to occur near the tower façade and at the northwest corner of the terrace.

c. To improve comfort levels within the Block 1 and Block 3 amenity terraces, mitigation inboard of the terrace perimeters that is targeted around sensitive areas is recommended, in combination with tall perimeter wind screens installed in place of standard height guards. Inboard mitigation could take the form of wind screens or other common landscape elements. Canopies may also be required above sensitive areas.

d. The extent of the 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. This work is expected to support the future Site Plan Control application submission.

4) The foregoing statements and conclusions apply to common weather systems, during which two pedestrian areas within or surrounding the subject site may experience conditions that could be considered dangerous, as defined in Section 4.4. Specifically, the safety criterion may be exceeded on an annual basis within isolated regions at the above-noted windier areas between Blocks 1 and 2 and 4 and 5, where sections of the walkways serving the proposed development are predicted to occasionally receive conditions uncomfortable for walking. Further investigation, which may include additional wind testing, may be required to develop an appropriate strategy to improve wind comfort and to resolve safety conditions within the noted areas.

Sincerely,

Gradient Wind Engineering Inc.

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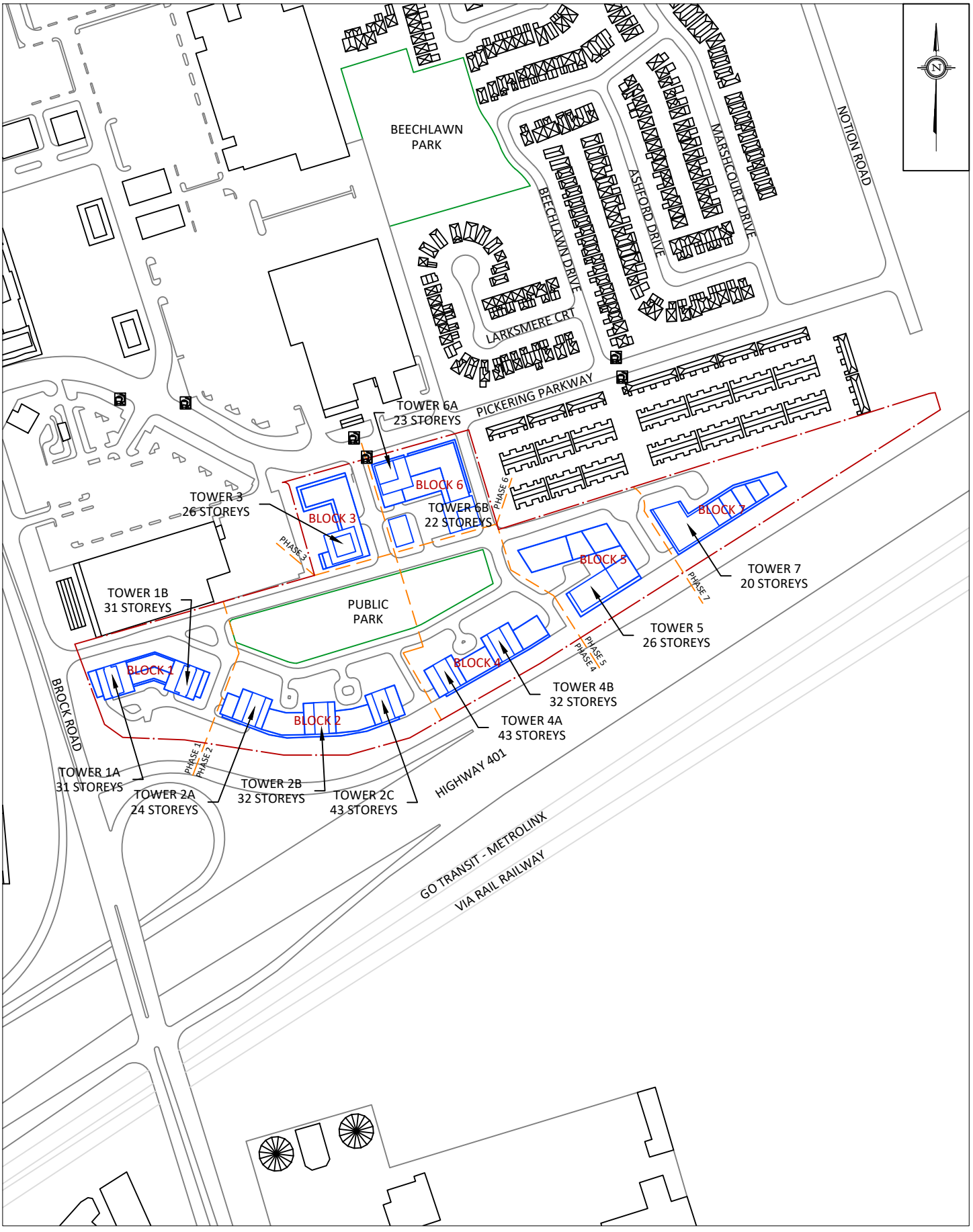

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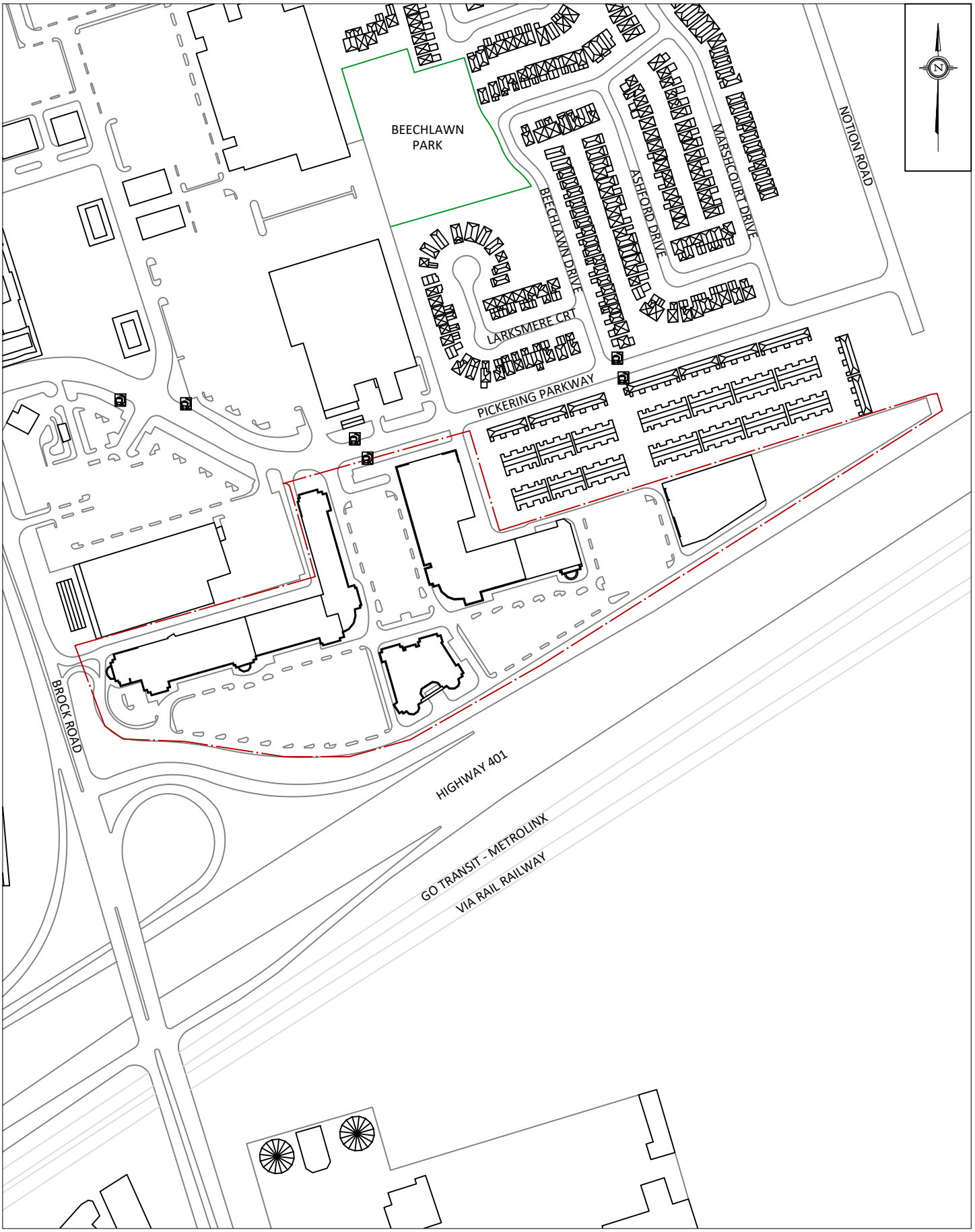
PROJECT	PICKERING DESIGN CENTRE MASTER PLAN, PICKERING PEDESTRIAN LEVEL WIND STUDY
SCALE	1:4000
DRAWING NO.	20-305-PLW-2024-1A
DATE	FEBRUARY 1, 2024
DRAWN BY	S.K.
DESCRIPTION	FIGURE 1A: PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	PICKERING DESIGN CENTRE MASTER PLAN, PICKERING PEDESTRIAN LEVEL WIND STUDY
SCALE	1:4000
DRAWING NO.	20-305-PLW-2024-1B
DATE	FEBRUARY 1, 2024
DRAWN BY	S.K.

DESCRIPTION

FIGURE 1B:
EXISTING SITE PLAN AND SURROUNDING CONTEXT

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

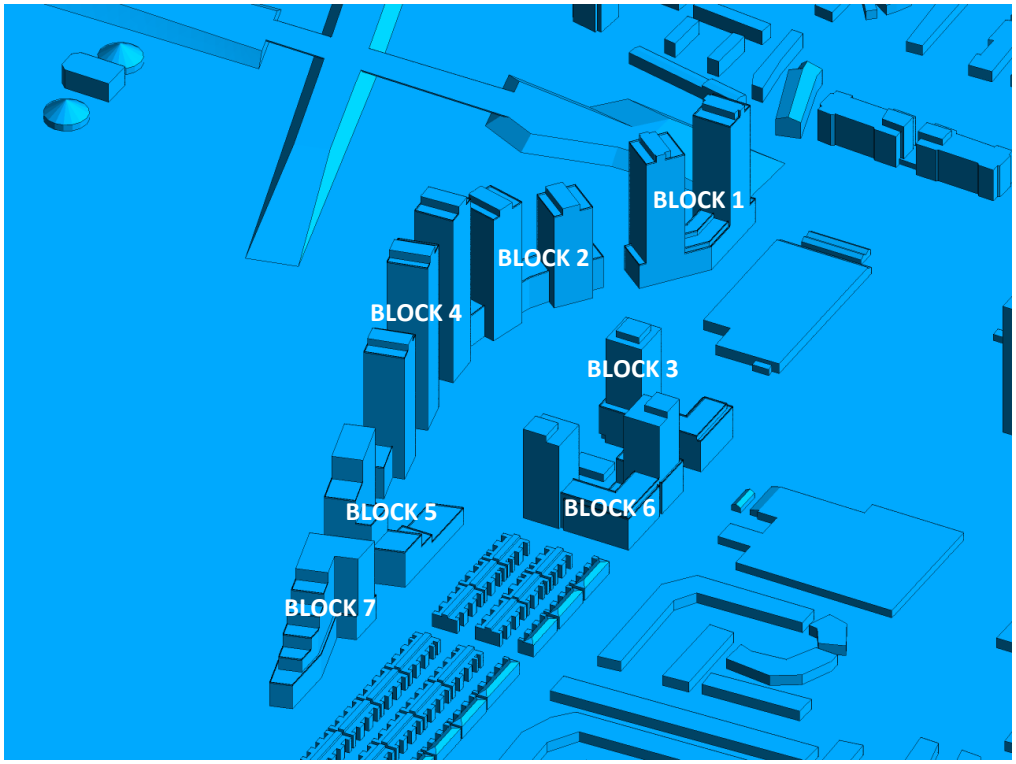


FIGURE 2B: CLOSE-UP VIEW OF FIGURE 2A

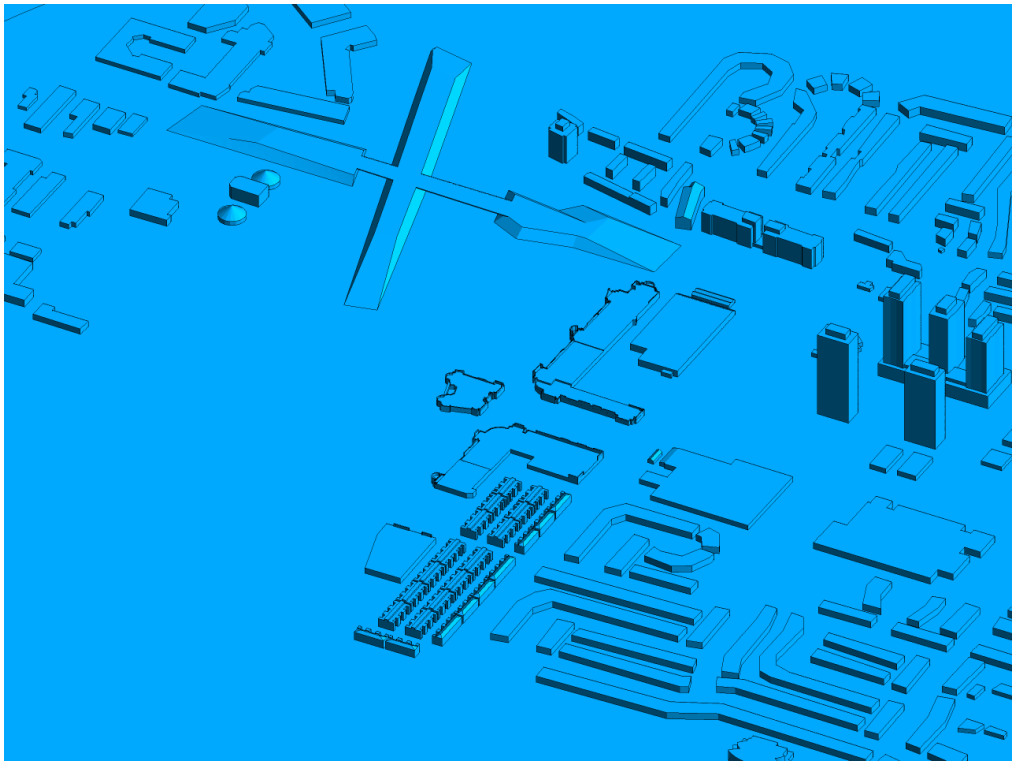


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTHEAST PERSPECTIVE

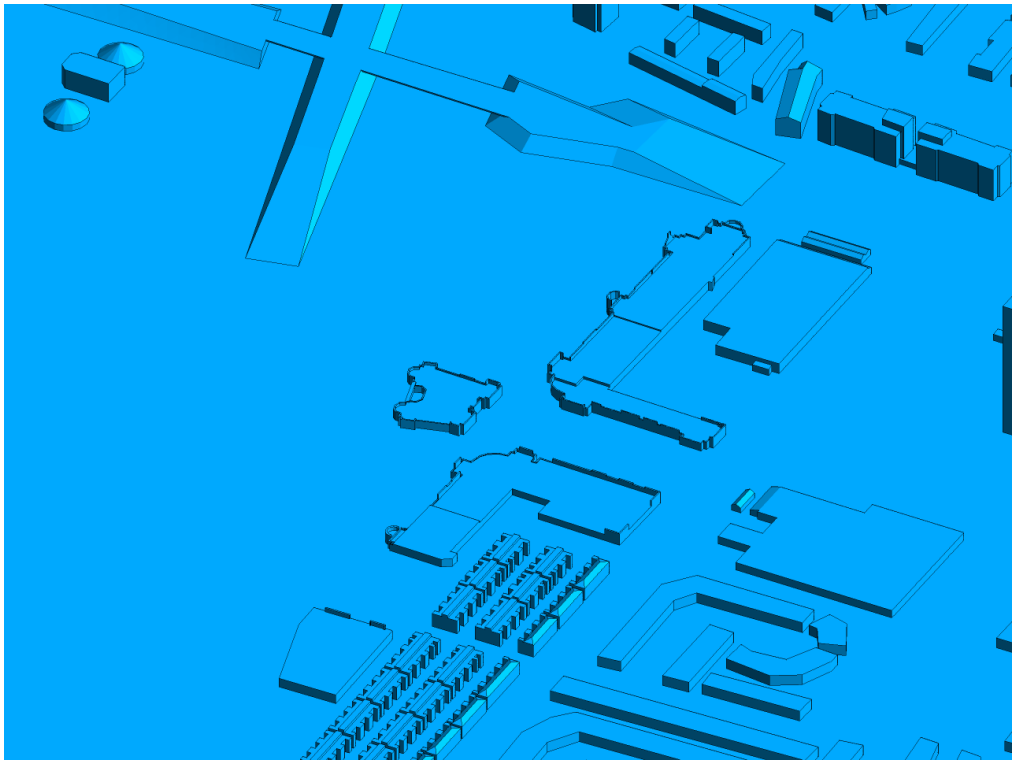


FIGURE 2D: CLOSE-UP VIEW OF FIGURE 2C

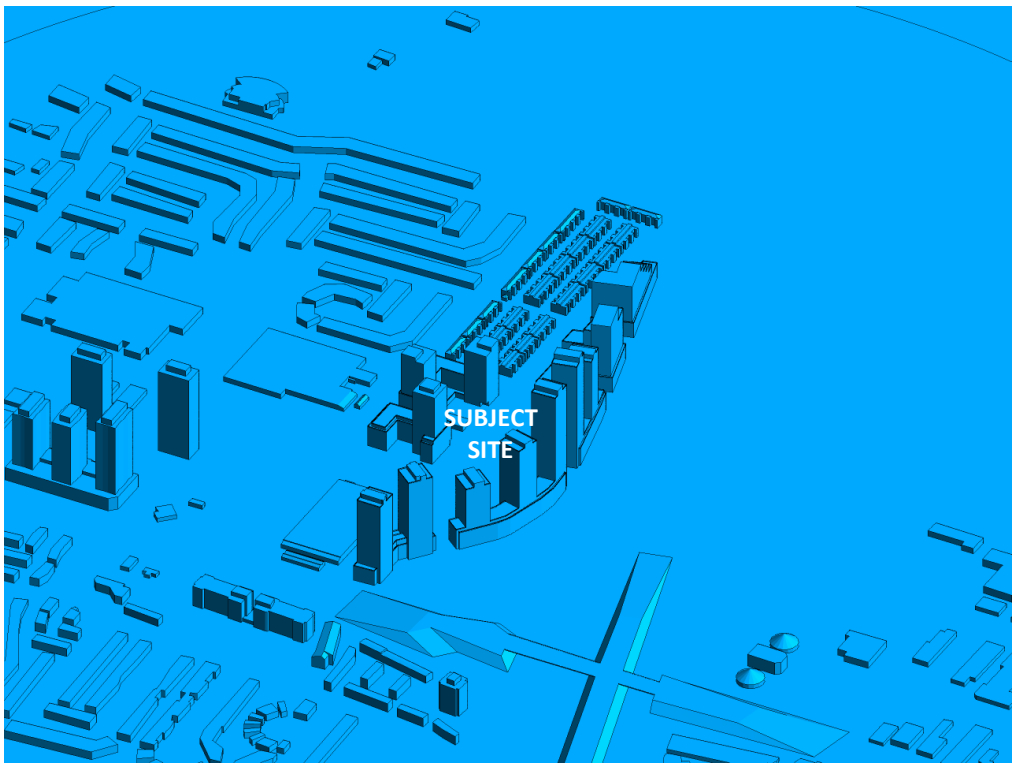


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTHWEST PERSPECTIVE

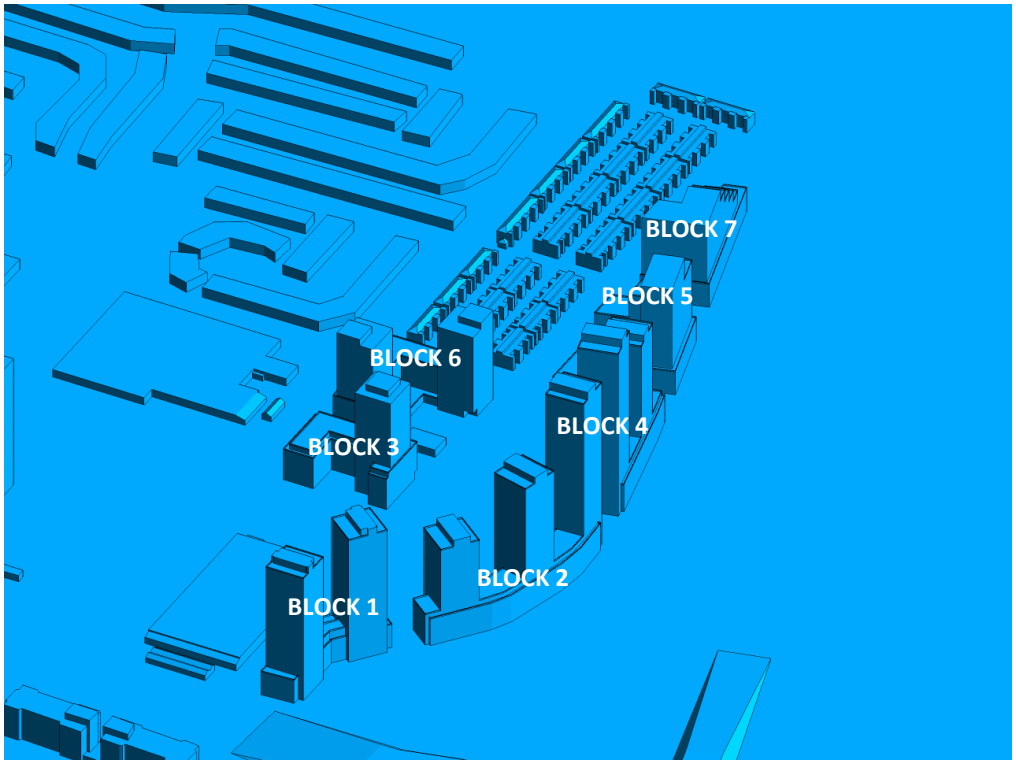


FIGURE 2F: CLOSE-UP VIEW OF FIGURE 2E

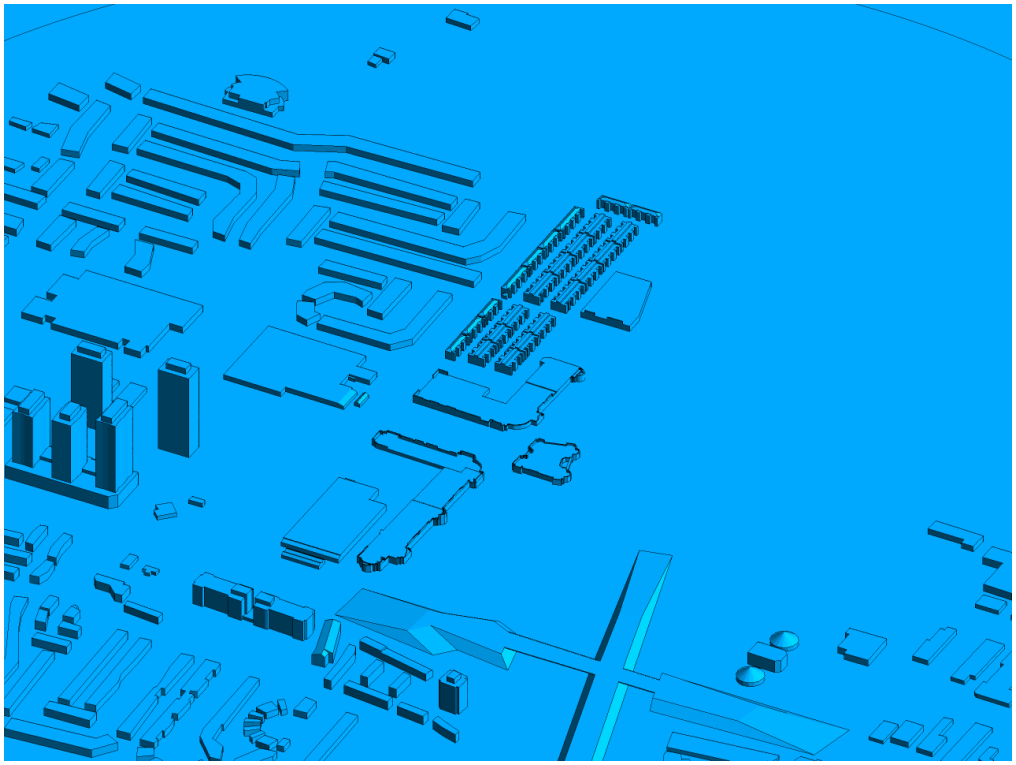


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTHWEST PERSPECTIVE

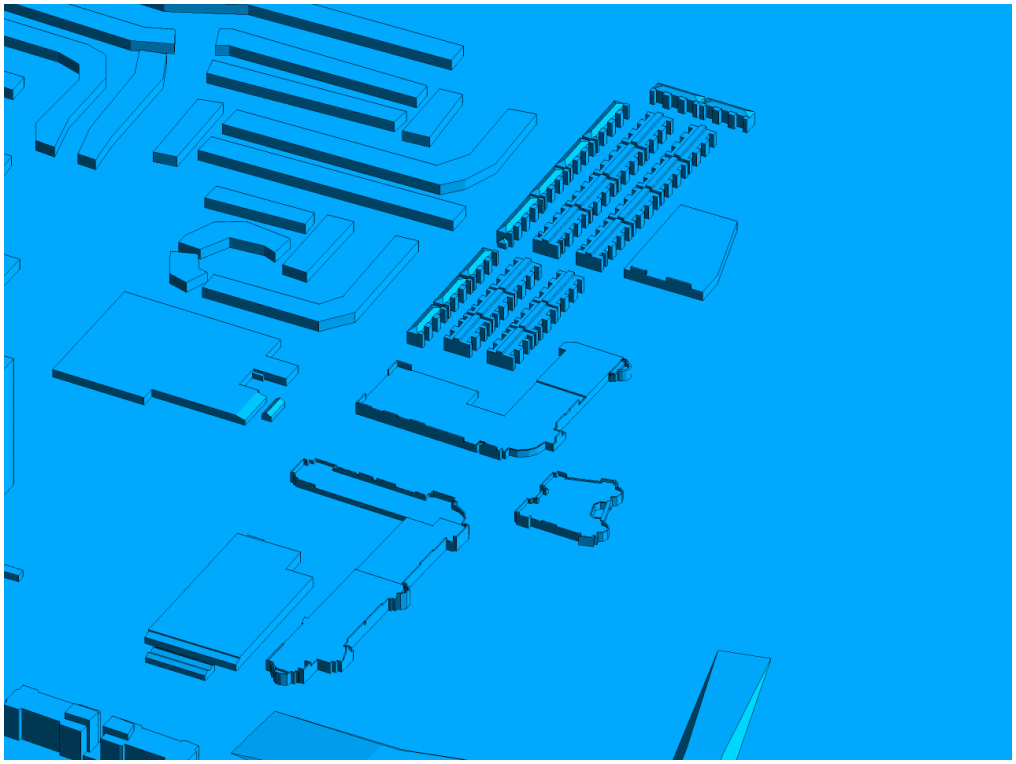


FIGURE 2H: CLOSE-UP VIEW OF FIGURE 2G

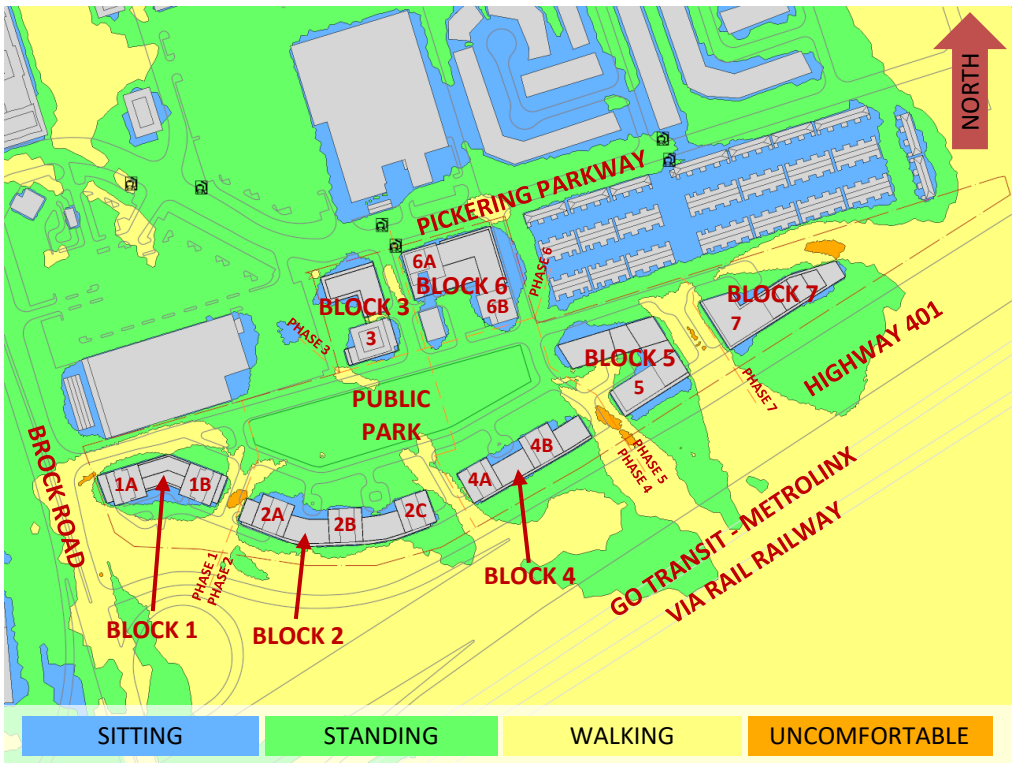


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

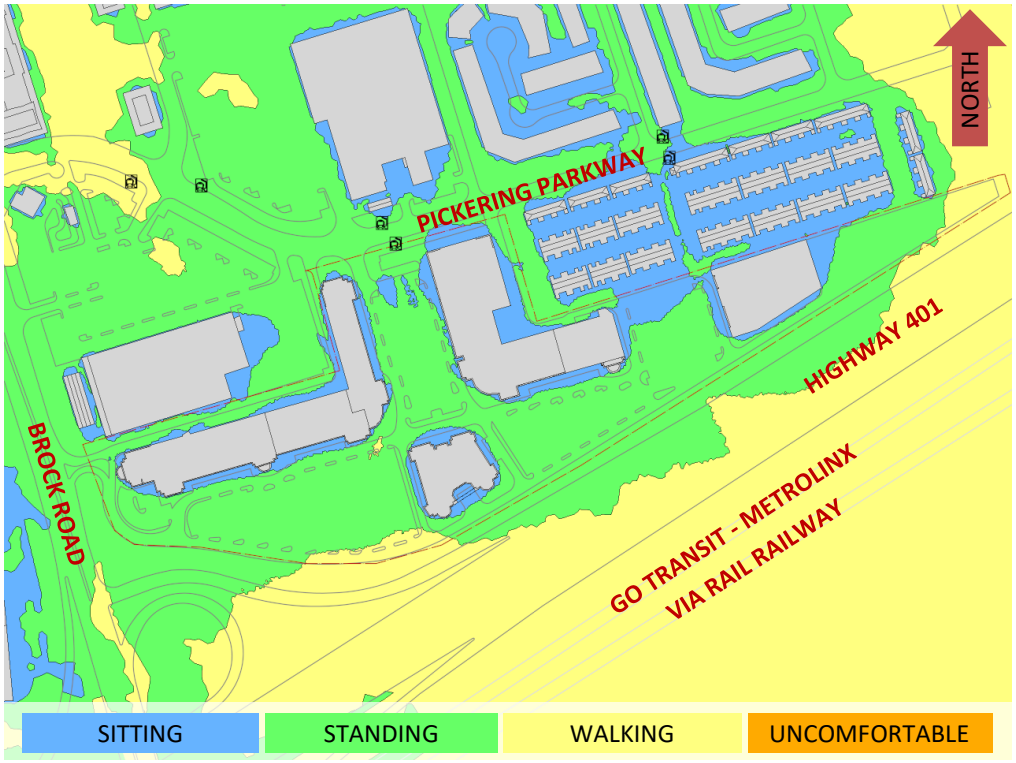


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

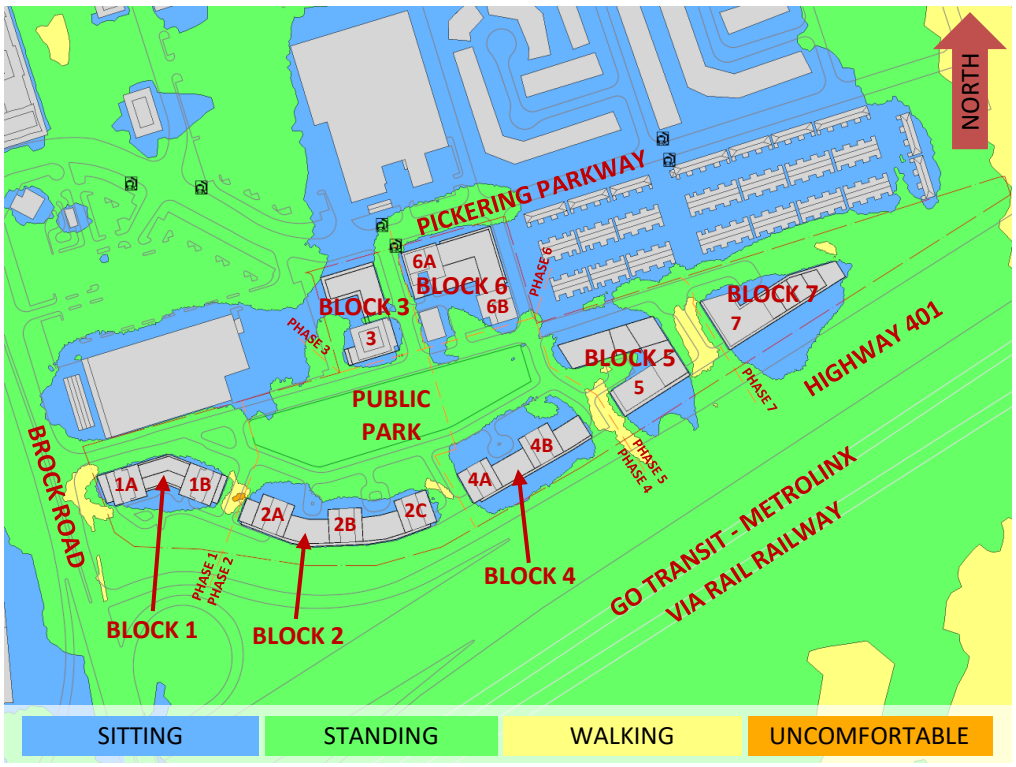


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

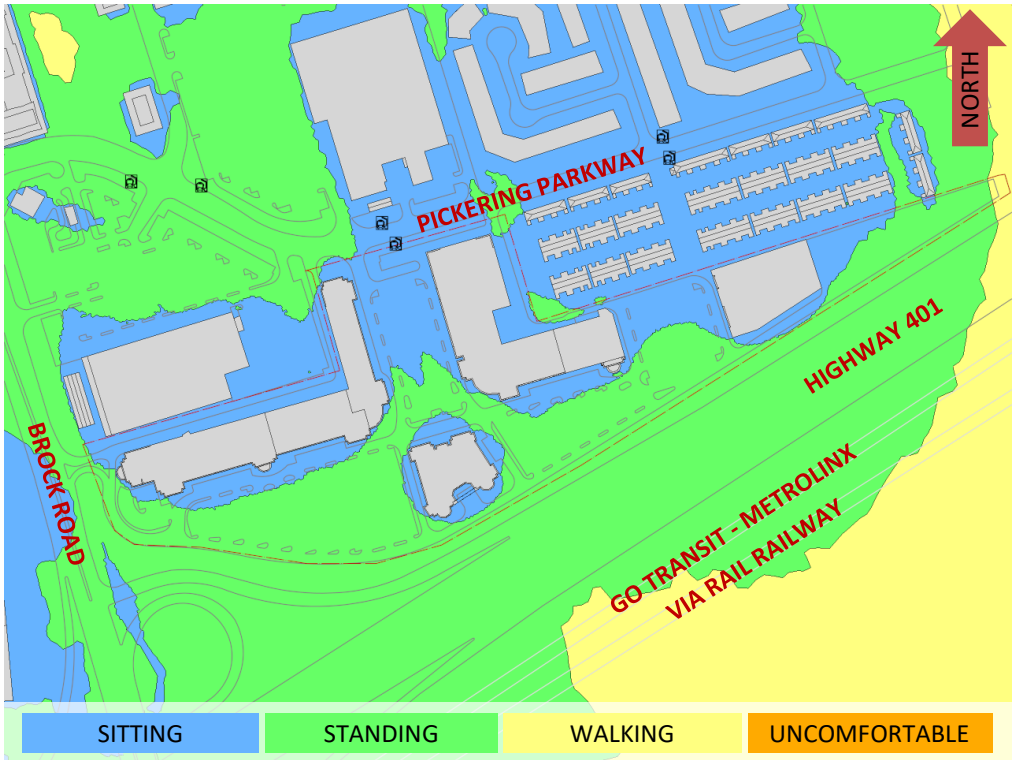


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

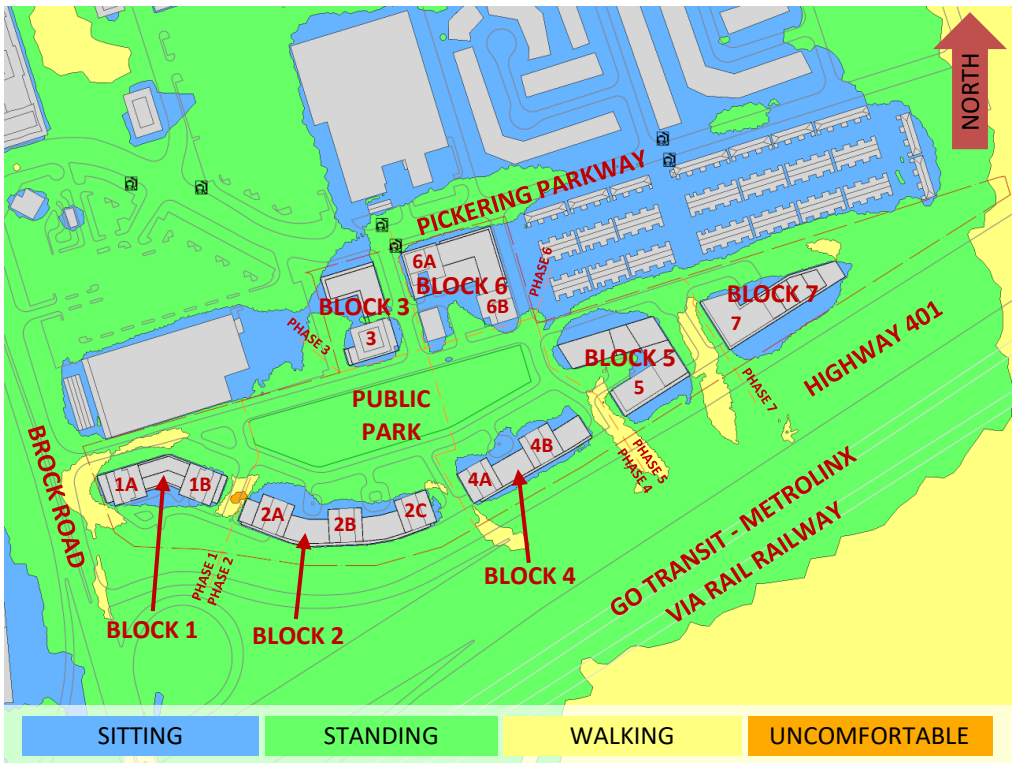


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

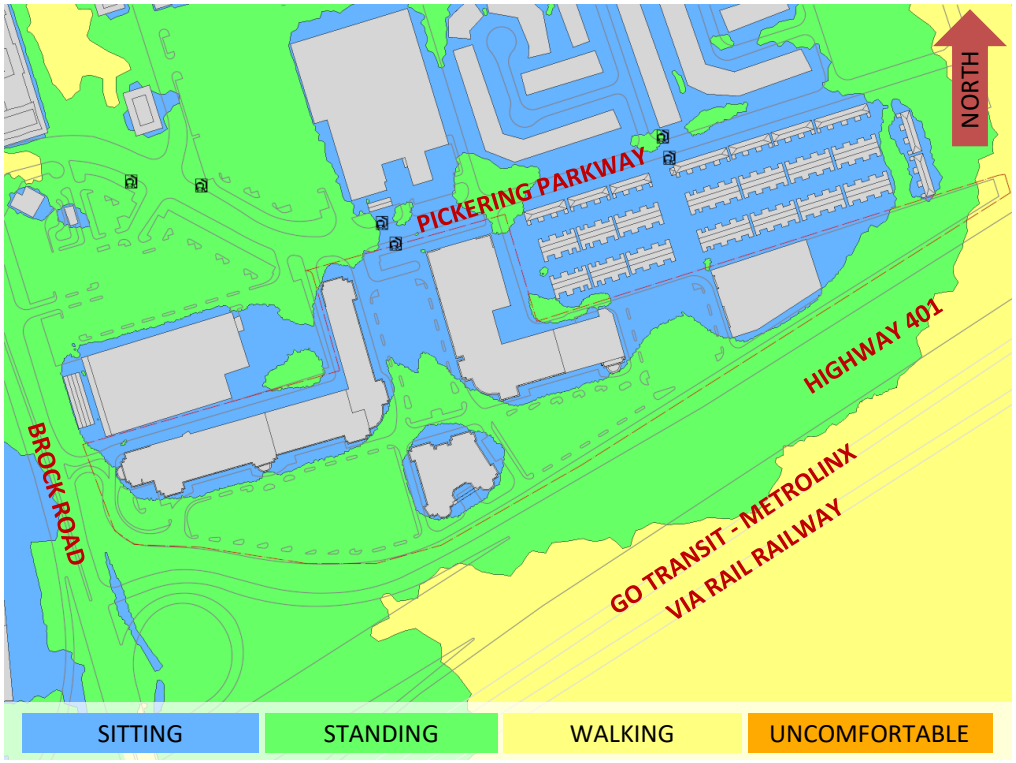


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

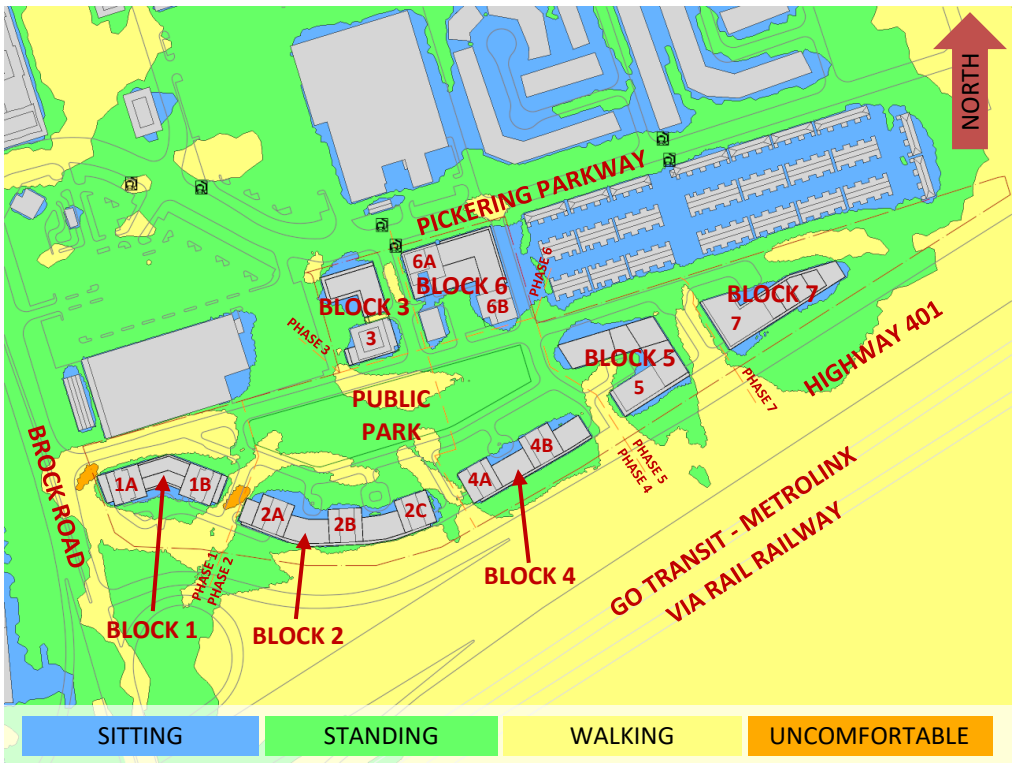


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

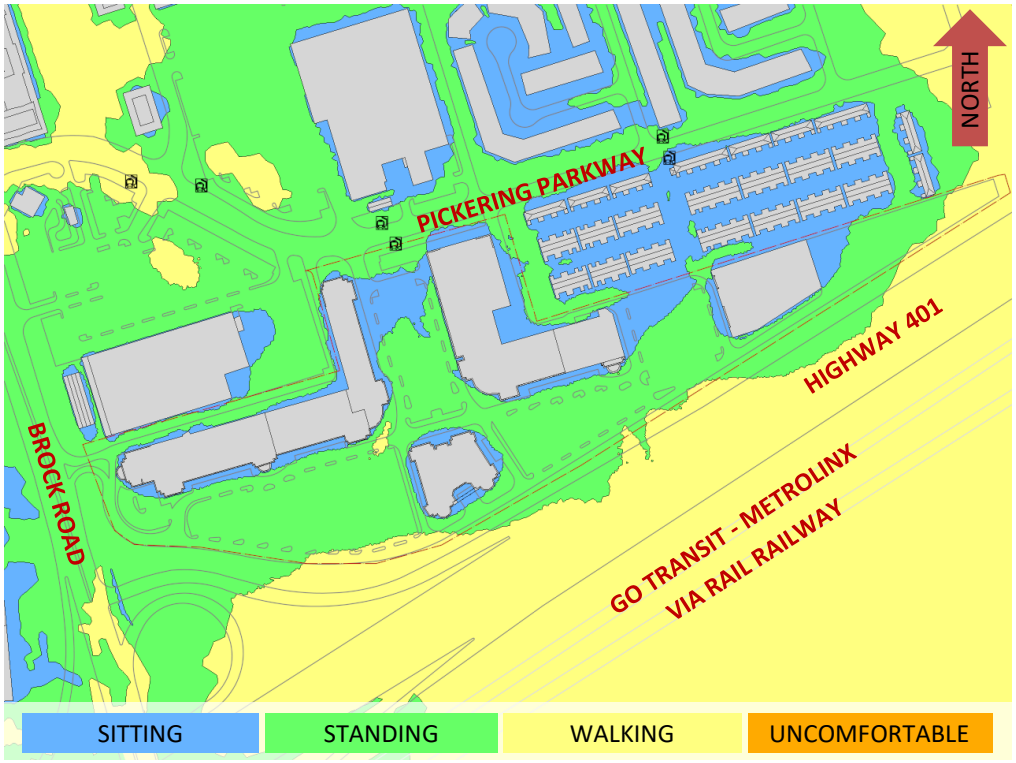


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

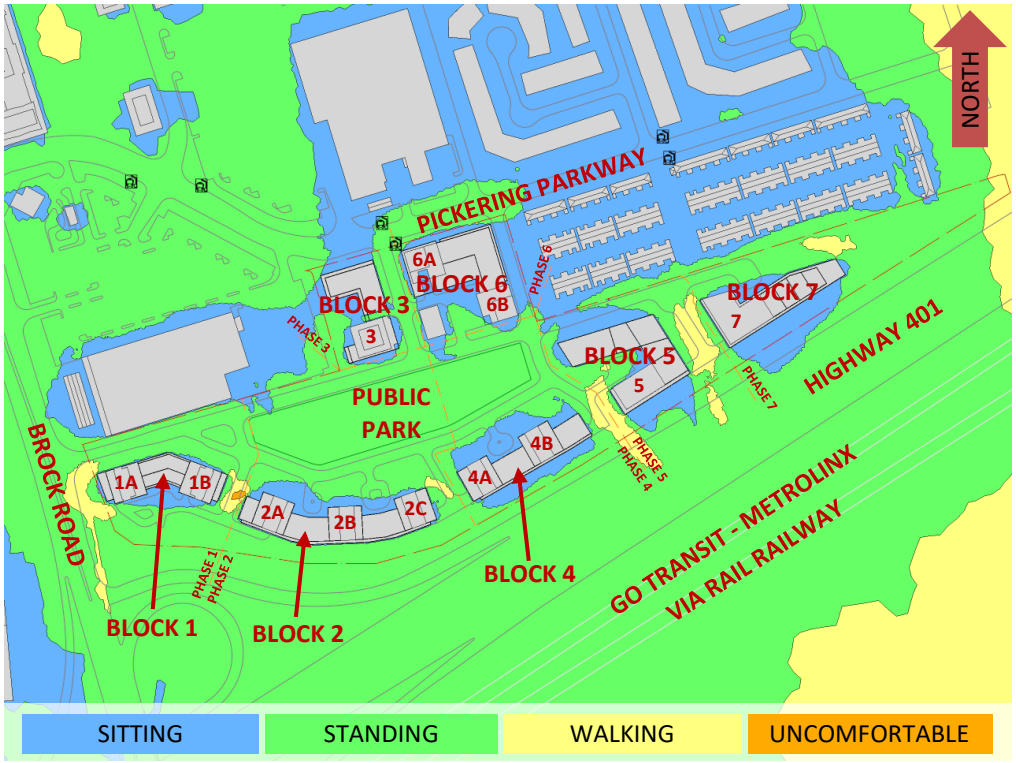


FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

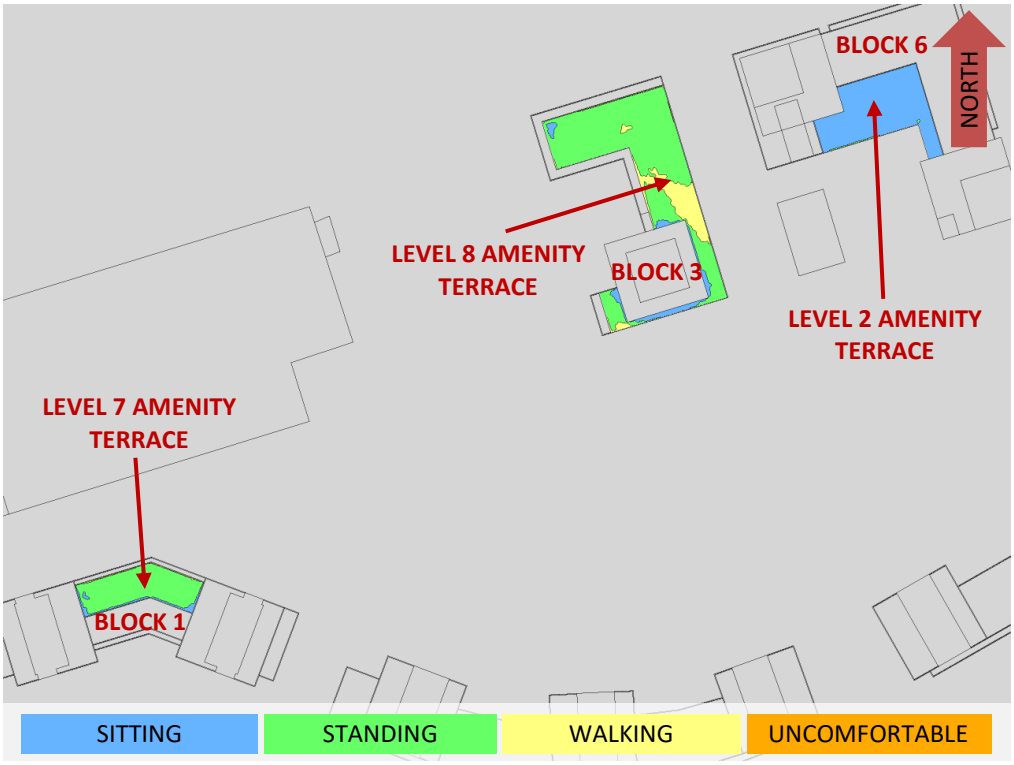


FIGURE 8A: SPRING – WIND COMFORT, COMMON AMENITY TERRACES

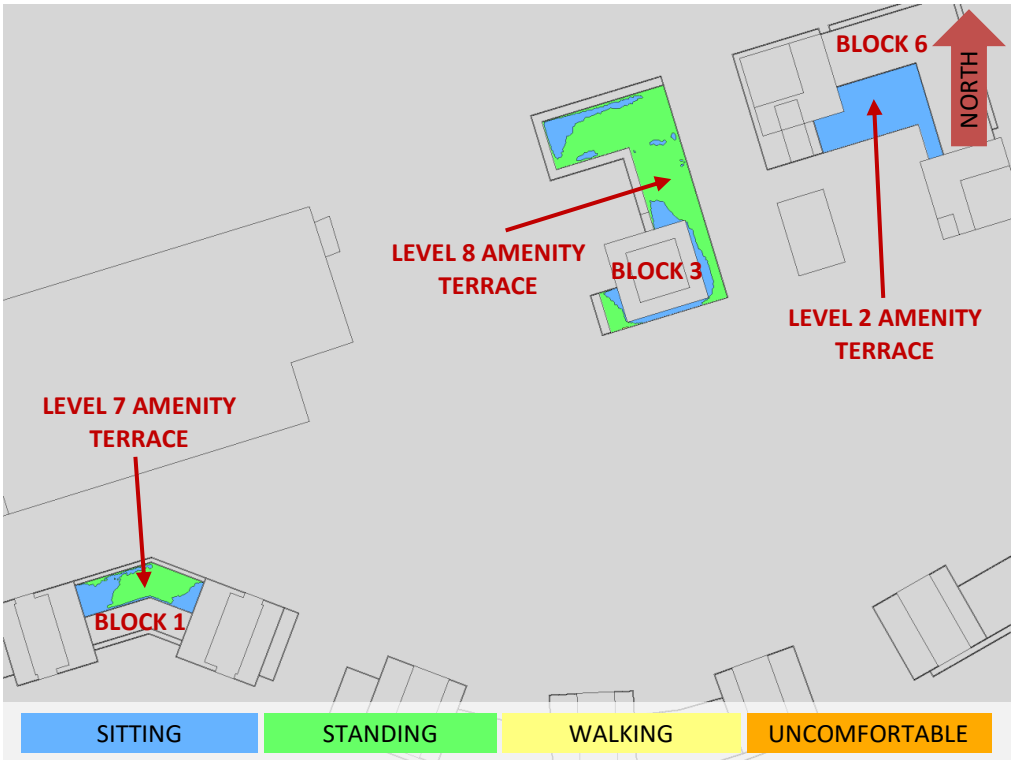


FIGURE 8B: SUMMER – WIND COMFORT, COMMON AMENITY TERRACES

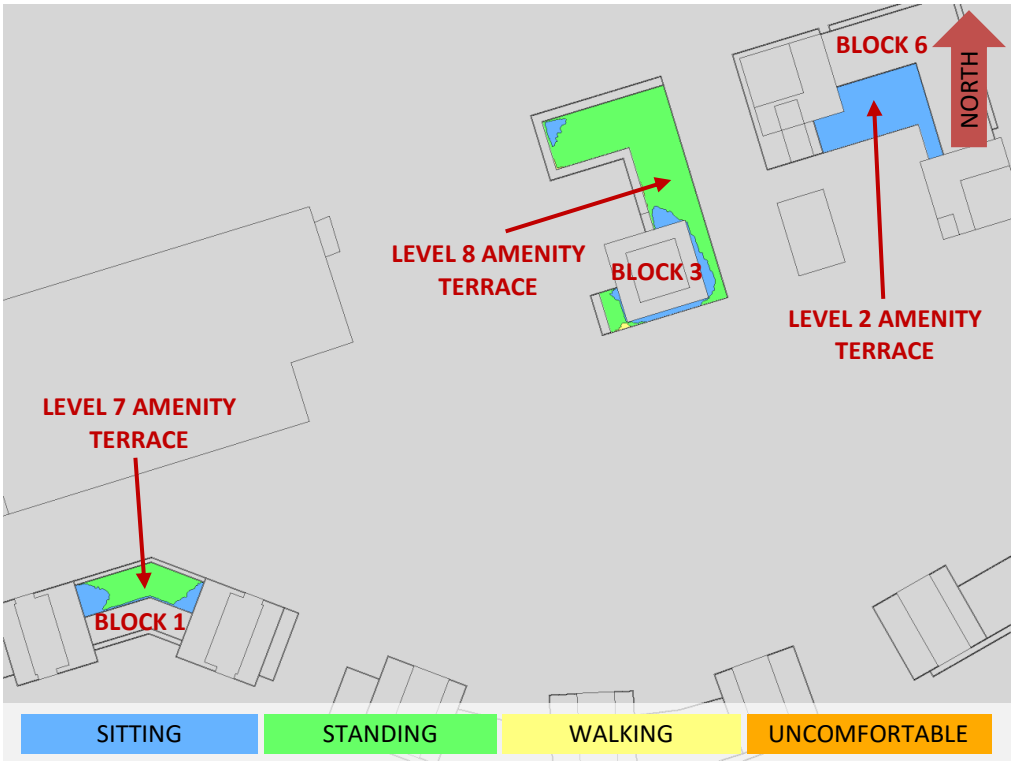


FIGURE 8C: AUTUMN – WIND COMFORT, COMMON AMENITY TERRACES

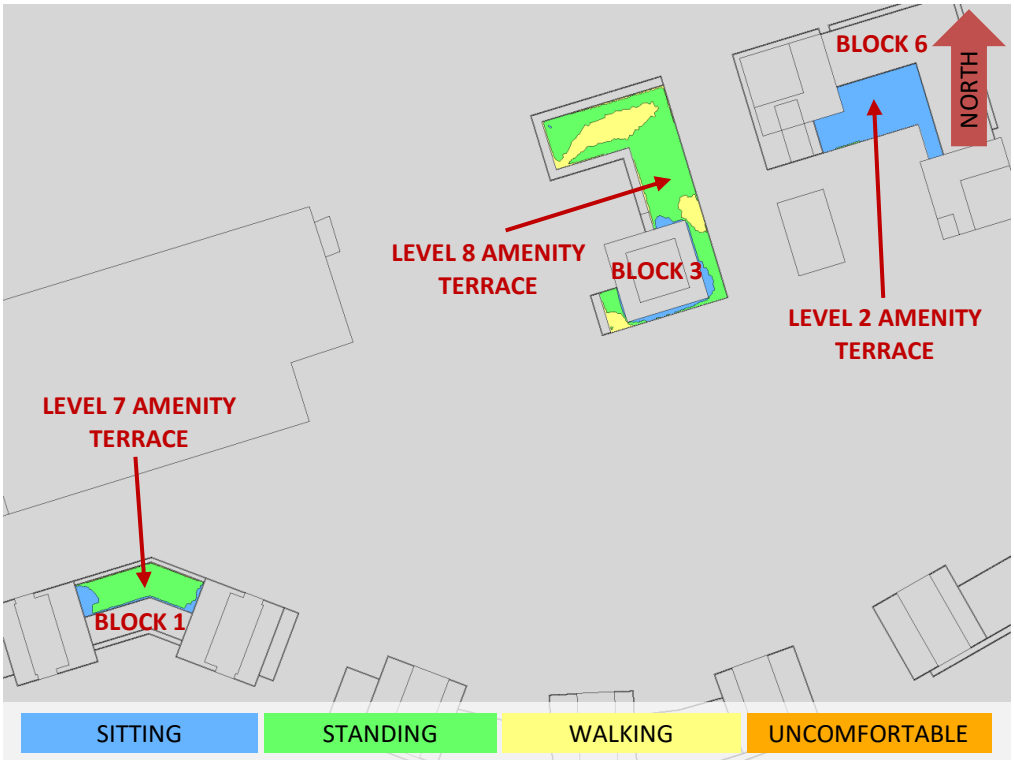


FIGURE 8D: WINTER – WIND COMFORT, COMMON AMENITY TERRACES

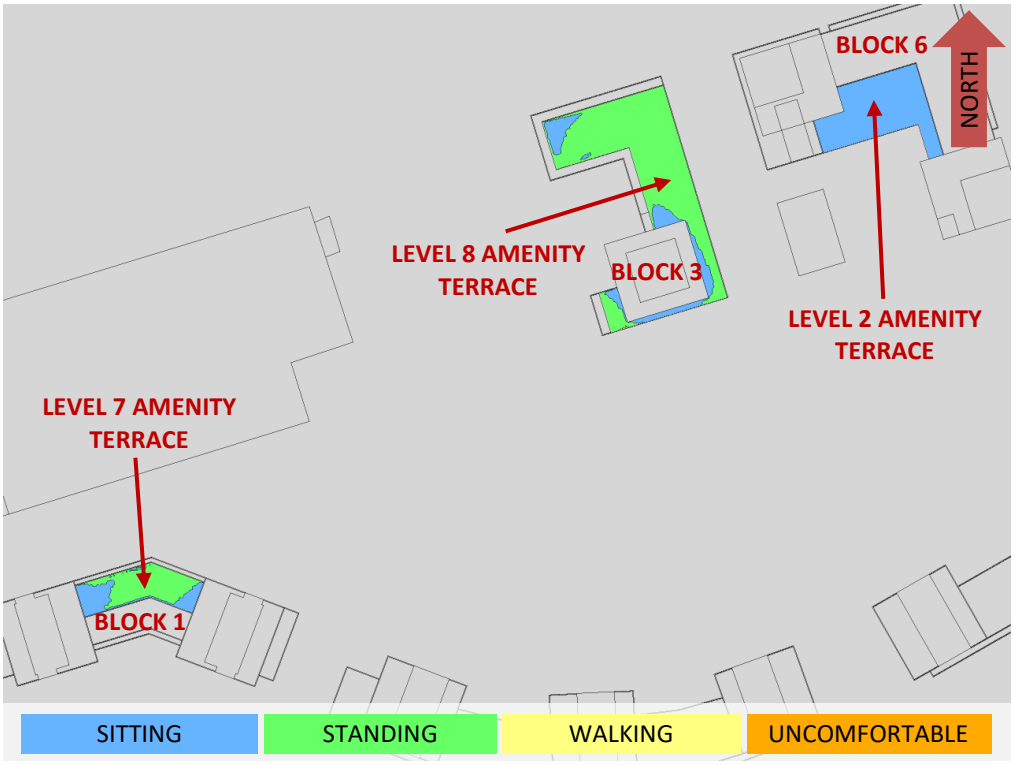
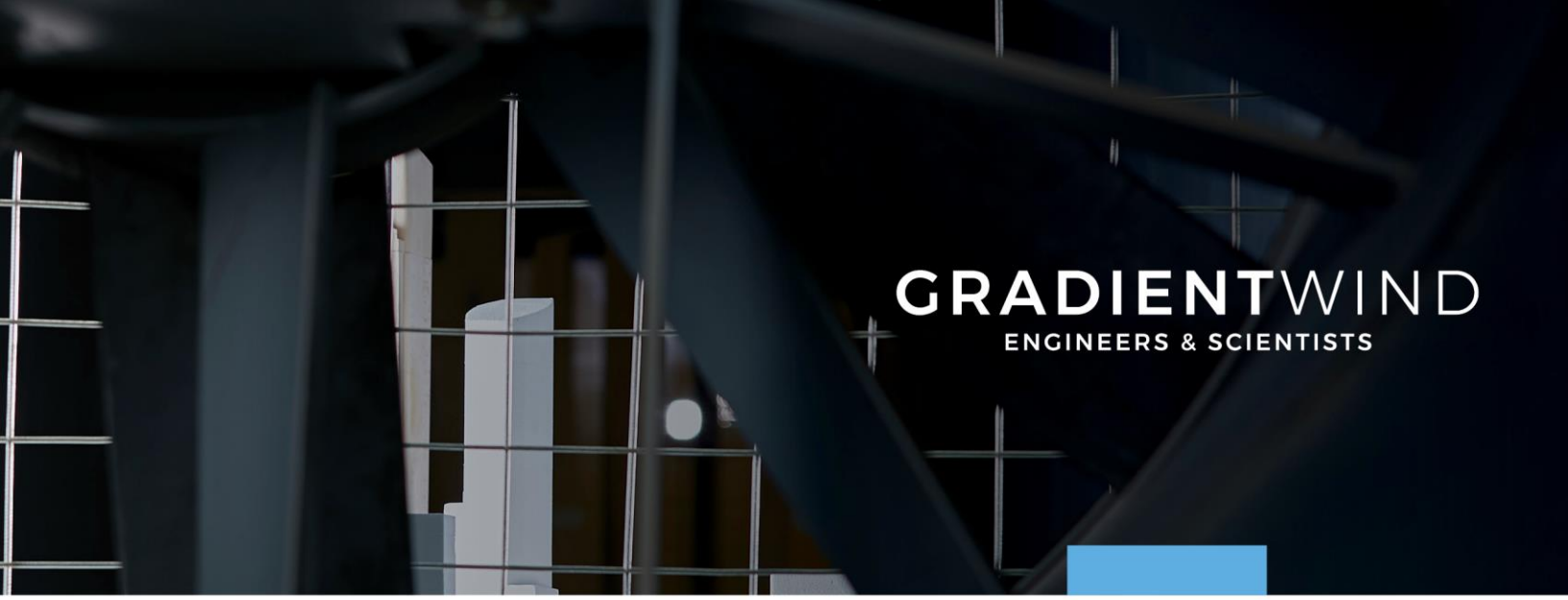
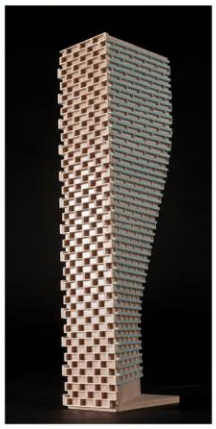
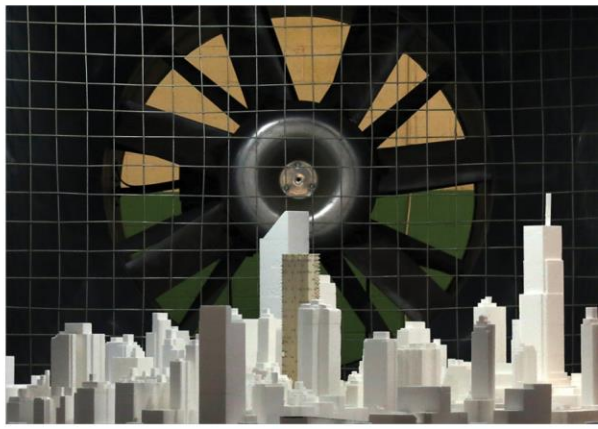


FIGURE 9: TYPICAL USE PERIOD – WIND COMFORT, COMMON AMENITY TERRACES







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

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

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

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

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

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

Wind Direction (Degrees True)	Alpha Value (α)
0	0.22
22.5	0.23
45	0.23
67.5	0.23
90	0.22
112.5	0.22
135	0.20
157.5	0.21
180	0.21
202.5	0.21
225	0.22
247.5	0.24
270	0.24
292.5	0.22
315	0.22
337.5	0.22

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, 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.

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[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.