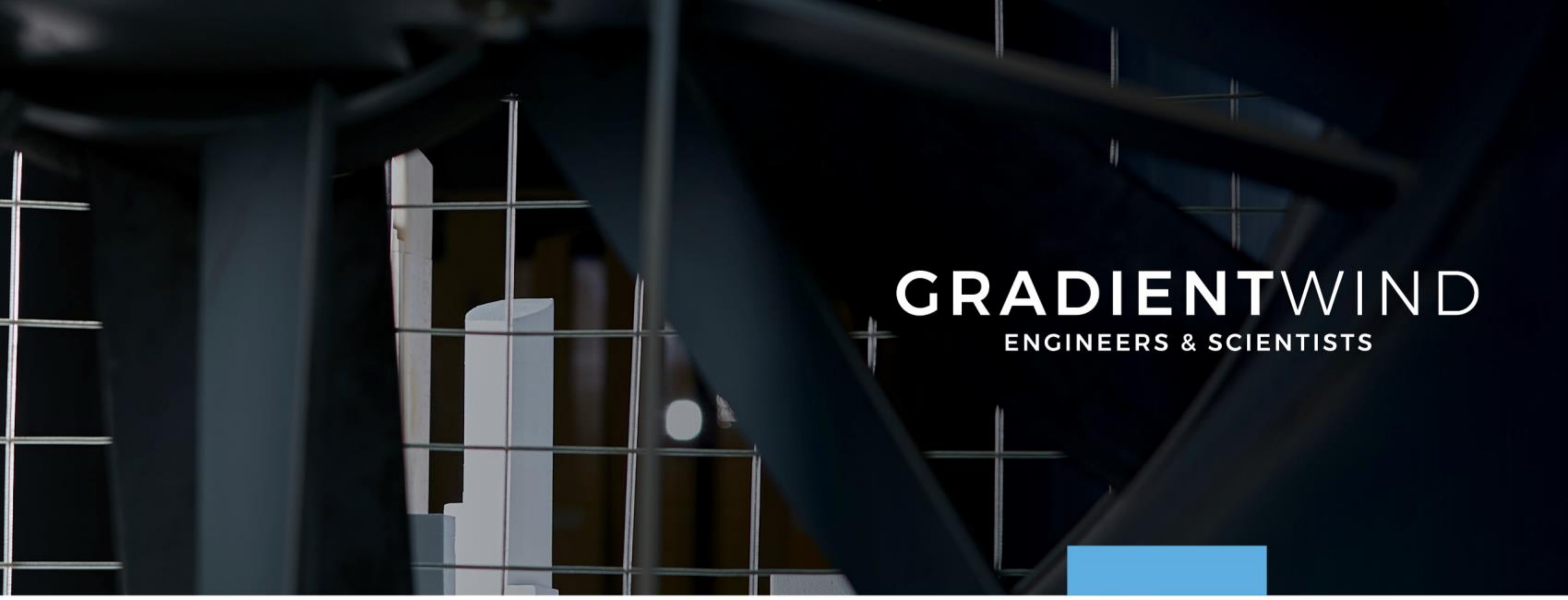
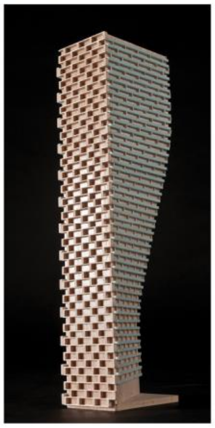
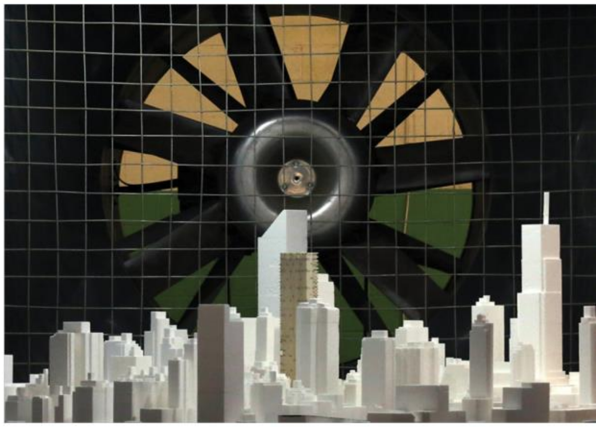


PEDESTRIAN LEVEL WIND STUDY

1900-2000 City Park Drive
Ottawa, Ontario

Report: 23-075-PLW





November 23, 2023

PREPARED FOR
Colonnade BridgePort ITF City Park LP
16 Concourse Gate, Suite 200
Ottawa, ON K2E 7S8

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 Zoning By-law Amendment application requirements for the proposed multi-phase development located at 1900-2000 City Park Drive 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) Most 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, City Centre Park, existing residential development to the north, existing neighbouring surface parking lots and laneways, proposed laneways and 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. **Park 1.** During the typical use period, conditions within Park 1, which is situated between Towers A and E, are predicted to be suitable mostly for sitting with small regions of conditions suitable for standing predicted at the southeast and southwest corners of the park. It is recommended that the noted regions predicted to be suitable for standing are programmed as walkways or soft landscaping areas, such as coniferous plantings.

b. **Park 2 and Proposed Plazas.** During the typical use period, conditions within Park 2, which is situated to the west of Tower F, and within the Phase 1 plazas are predicted to be suitable for a mix of sitting and standing, while conditions within the Phase 2 plaza are predicted to be mostly suitable for standing. If required by programming, comfort levels at seating and lounging areas within Park 2 and the noted plazas within the subject site 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.

c. The extent of mitigation measures is dependent on the programming of the spaces. 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.

2) The podia roofs and penthouse (PH) levels were considered as potential common amenity terraces in the present study. Notably, the noted potential PH level common amenity terraces were modelled with 1.8-m-tall wind screens along their full perimeters. Wind comfort conditions during the typical use period and recommendations regarding mitigation, where applicable, are described as follows:

a. Wind comfort conditions within the potential common amenity terraces serving Towers D, E, F, and H at the PH level, and Buildings E, F, and G at the podium roof level are predicted to be suitable for mostly sitting. The noted conditions are considered acceptable.

b. Wind conditions within the potential common amenity terraces serving Towers A, B, and C at their respective podium roof and PH levels, Buildings D and H at the podium roof level, and Building G at the PH level are predicted to be suitable for mostly a mix of sitting and standing.

- If the programming of these spaces includes seating or lounging activities, comfort levels at the windier areas within these potential common amenity terraces may be improved with the implementation of mitigation inboard of the terrace perimeters and targeted around sensitive areas, in combination with taller perimeter wind screens. Inboard mitigation could take the form of wind screens or other common landscape elements. Canopies may also be required above sensitive areas.

- 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.

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 Colonnade BridgePort ITF City Park LP to undertake a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment application requirements for the proposed multi-phase development located at 1900-2000 City Park Drive in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by NEUF architect(e)s in October 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 1900-2000 City Park Drive in Ottawa, situated to the south of City Park Drive on a parcel of land bordered by City Park Drive to the northwest, two high-rise buildings to the northeast, the confederation line light rail transit to the southeast, and the City Centre Park to the southwest. Throughout this report, City Park Drive is referred to as project north.

The proposed development comprises two phases: Phase 1 (2000 City Park Drive) to the east and Phase 2 (1900 City Park Drive) to the west of the subject site. Phase 1 includes Tower A (20 storeys), Tower B (30 storeys), Tower C (28 storeys), Tower D (21 storeys), and Tower E (20 storeys), situated from the northeast corner clockwise to the northwest, respectively. Phase 2 includes Tower F (20 storeys), Tower G (26 storeys), and Tower H (30 storeys), situated to the north, southeast, and southwest, respectively. Towers B-H are topped with a penthouse (PH) level and all towers share below-grade parking which is accessed by ramps at the northwest corner of Tower B and at the southwest corner of Tower D via laneways from City Park Drive. Parks are located between Towers A and E (Park 1) and to the west of Tower F (Park 2), and plazas are located between Towers A and B, and to the northwest of Towers C and G. The podia roofs and PH levels of all towers were considered as potential common amenity terraces.

The ground floor of Tower A comprises a nearly central inset within the building footprint and includes a lobby to the west, common areas to the south, and residential units throughout the remainder of the level. Levels 2-20 are reserved for residential occupancy. The building steps back from the west elevation at Level 3 and from all elevations at Level 4.

The ground floor of Tower B includes a lobby at the northwest corner, common areas to the north, and residential units to the south. Levels 2-30 are reserved for residential occupancy. The building steps back from the north and west elevations at Level 3, from the north and east elevations at Level 7, and from the west elevation at the PH Level.

The ground floor of Tower C includes a lobby to the west, common areas to the north, and residential units to the south. Levels 2-28 are reserved for residential occupancy. The building steps back from the north and west elevations at Level 2, from the north and east elevations at Level 7, and from the west elevation at the PH Level.

The ground floor of Tower D includes a lobby to the east, common areas to the north, and residential units to the south. Levels 2-21 are reserved for residential occupancy. The building steps back from the north and east elevations at Level 3, from the north and west elevations at Level 7, and from the east elevation at the PH Level.

The ground floors of Towers E and F include lobbies at the southeast corner, common areas to the south, and residential units along the north elevation. Levels 2-20 are reserved for residential occupancy in both towers. Tower E steps back from the north elevation at Level 3, from the south and west elevations at Level 4, and from the west elevation at the PH Level, while Tower F steps back from the north elevation at Level 3, from the north, east, and south elevations at Level 4, and from the east elevation at the PH Level.

The ground floors of Towers G and H include a shared lobby and common areas to the north and residential units to the south. Levels 2-26 of Tower G and Levels 2-30 of Tower H are reserved for residential occupancy. Tower G steps back from the north and west elevations at Level 3, from the north and east elevations at Level 7, and from the south and west elevations at the PH Level, while Tower H steps back from the north and east elevations at Level 3, from the north and west elevations at Level 7, and from the east elevation at the PH Level.

The near-field surroundings, defined as an area within 200 m of the subject site, include City Centre Park to the west, low-rise residential dwellings from the west-northwest clockwise to the north, a movie theatre to the north-northeast, a high-rise development to the east-northeast, and low-rise residential dwellings to the south. Notably, the LRT Line 1 railway extends from the east to the southwest of the subject site. 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 low-rise suburban massing in all compass directions with isolated mid- and high-rise buildings, and by green space from the east-northeast clockwise to the south. The Pine View Golf Course is located approximately 1 km to the east.

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[1]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

[1] 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 580 m. The process was performed for two context massing scenarios, as noted in Section 2.

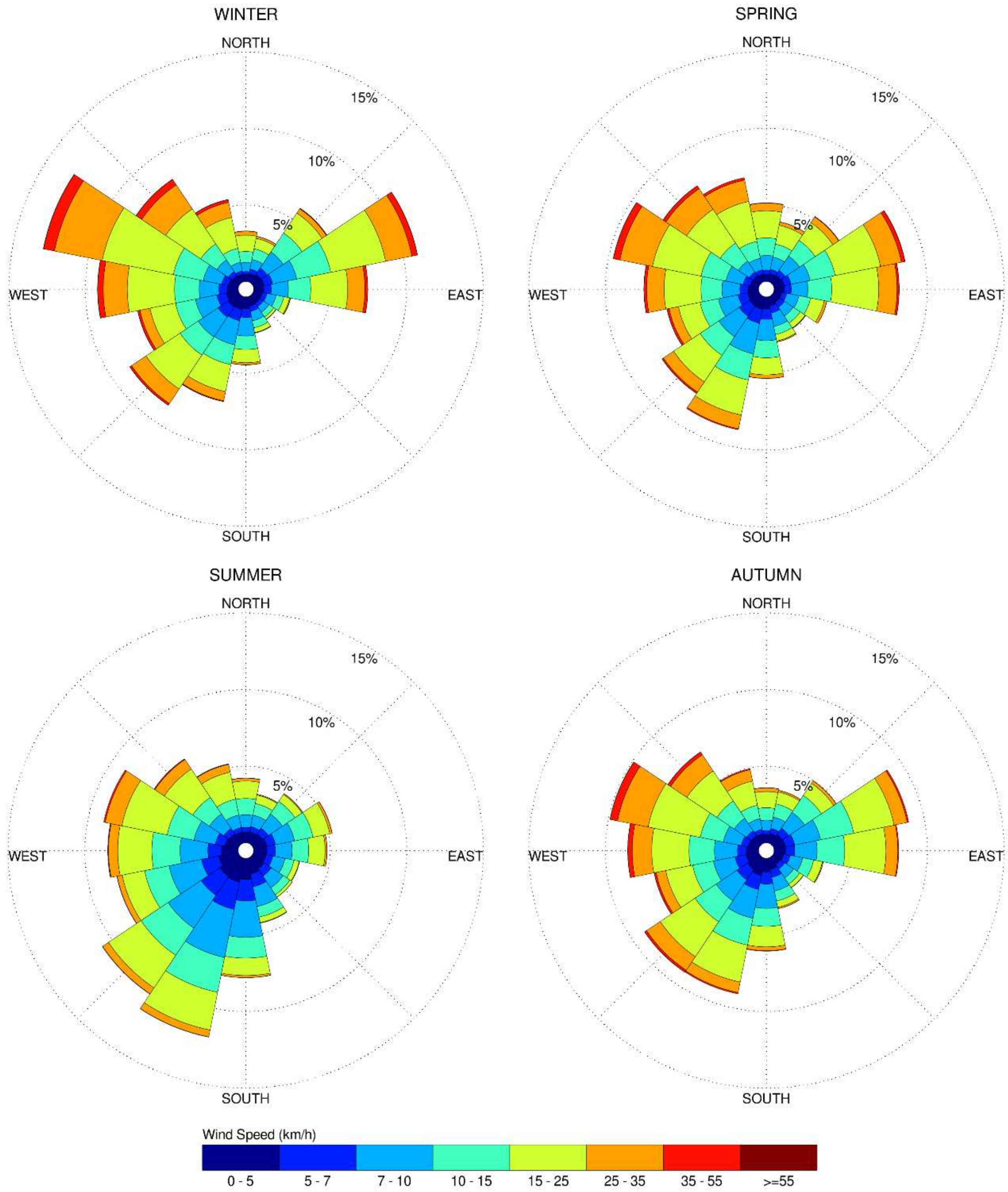
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and over the potential common amenities serving the proposed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

4.3 Historical Wind Speed and Direction Data

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

The statistical model of the Ottawa area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate seasonal distribution of measured wind speeds and directions in kilometers per hour (km/h). Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction represents the percentage of time for various wind speed ranges per wind direction during the measurement period. The prominent wind speeds and directions can be identified by the longer length of the bars. For Ottawa, the most common winds occur for westerly wind directions, followed by those from the east, while the most common wind speeds are below 36 km/h. The directional prominence and relative magnitude of wind speed changes somewhat from season to season.

SEASONAL DISTRIBUTION OF WIND
OTTAWA MACDONALD-CARTIER INTERNATIONAL AIRPORT



Notes:

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

4.4 Pedestrian Wind Comfort and Safety Criteria – City of Ottawa

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

PEDESTRIAN WIND COMFORT CLASS DEFINITIONS

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

Regarding wind safety, the pedestrian safety wind speed criterion is based on the approximate threshold that would cause a vulnerable member of the population to fall. A 0.1% exceedance gust wind speed of 90 km/h is classified as dangerous. From calculations of stability, it can be shown that gust wind speeds of 90 km/h would be the approximate threshold wind speed that would cause an average elderly person in good health to fall. Notably, pedestrians tend to be more sensitive to wind gusts than to steady winds for lower wind speed ranges. For strong winds approaching dangerous levels, this effect is less important because the mean wind can also create problems for pedestrians.

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if a mean wind speed of 10 km/h (equivalent gust wind speed of approximately 16 km/h) were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting. Similarly, if mean wind speed of 20 km/h (equivalent gust wind speed of approximately 32 km/h) at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As these criteria are based on subjective reactions of a population to wind forces, their application is partly based on experience and judgment.

Once the pedestrian wind speed predictions have been established throughout the subject site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for discrete regions within and surrounding the subject site. This step involves comparing the predicted comfort classes to the target comfort classes, which are dictated by the location type for each region (that is, a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their typical windiest target comfort classes are summarized on the following page. Depending on the programming of a space, the desired comfort class may differ from this table.

TARGET PEDESTRIAN WIND COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	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, which illustrate conditions over the potential common amenity terraces serving Towers A-H at the podia roof and PH 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.

Wind comfort conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figures 7A-7B and 9 illustrate comfort conditions at grade level and over the noted potential common amenity terraces serving Towers A-H, 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 and Transit Stops along City Park Drive: Following the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along City Park Drive are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for standing, or better, throughout the remainder of the year. Conditions over the nearby transit stop to the north of City Park Drive are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year, while conditions over the nearby transit stop to the south of City Park Drive are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing during the winter and spring. The noted conditions are considered acceptable.

Wind conditions over the sidewalks along City Park Drive with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year. Conditions in the vicinity of the nearby transit stops along City Park Drive 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 slightly windier conditions over City Park Drive, conditions over the nearby transit stop to the south of City Park Drive are predicted to improve in comparison to existing conditions, and wind comfort conditions with the proposed development are considered acceptable.

Neighbouring Existing Surface Parking Lot and Laneways: Prior to the introduction of the proposed development, conditions over the existing parking lot to the east of the subject site are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year. The noted conditions remain unchanged following the introduction of the proposed development, and conditions with the proposed development are considered acceptable.

With the proposed development, conditions over the existing laneways and adjoining surface parking to the east of the subject site are predicted to be suitable for standing, or better, during the summer, becoming suitable for strolling, or better, throughout the remainder of the year with an isolated region suitable for walking during the winter. Conditions over the existing laneway to the west of the subject site are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for strolling, or better, during the winter and spring. The noted conditions are considered acceptable.

Wind conditions over the laneways and adjoining surface parking to the east 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 strolling during the winter and spring. Conditions over the existing laneway to the west are predicted to be suitable for standing, or better, during the summer, becoming suitable for strolling, or better, throughout the remainder of the year. While the introduction of the proposed development produces windier conditions over the noted existing laneways, wind conditions with the proposed development are nevertheless considered acceptable.

Residential Development North of Subject Site: Prior to the introduction of the proposed development, wind comfort conditions within and surrounding the residential development to the north of the subject site are predicted to be suitable for mostly sitting throughout the year, with isolated regions predicted to be suitable for standing during the spring, autumn, and winter. The noted conditions are predicted to remain practically unchanged following the introduction of the proposed development, and the wind comfort conditions with the proposed development are considered acceptable.

Path Along Line 1 Railway South of Subject Site: Following the introduction of the proposed development, wind comfort conditions over the path along the Line 1 Railway to the south of 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 an isolated region predicted to be suitable for walking during the winter. The noted conditions are considered acceptable.

Conditions over the path along the Line 1 Railway with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for standing during the autumn, and suitable for a mix of standing and strolling during the spring and winter. While the introduction of the proposed development produces slightly windier conditions along the Line 1 Railway, wind comfort conditions with the proposed development are considered acceptable.

City Centre Park: Prior to the introduction of the proposed development, conditions over City Centre Park situated to the west of the subject site are predicted to be suitable for standing, or better, during the typical use period. The noted conditions are predicted to remain mostly unchanged following the introduction of the proposed development. As such, wind conditions with the proposed development are considered acceptable.

Parks and Plazas within Subject Site: Wind comfort conditions during the typical use period and recommendations regarding mitigation over the parks situated between Towers A and E and to the west of Tower F, and the plazas situated between Towers A and B and to the northwest of Towers C and G are described as follows:

- Conditions within Park 1, which is situated between Towers A and E, are predicted to be suitable mostly for sitting with small regions suitable for standing at the southeast and southwest corners. The noted regions predicted to be suitable for standing are recommended to be programmed for transition zones, such as walkways, or for landscaping areas, such as coniferous plantings.

- Conditions within Park 2, which is situated to the west of Tower F, are predicted to be suitable for a mix of sitting and standing with regions suitable for sitting to the east and west of the park.

- Conditions within the plaza situated between Towers A and B are predicted to be suitable for sitting within the majority of the plaza with regions suitable for standing to the south and west.

- Conditions within the plaza situated to the northwest of Tower C are predicted to be suitable for sitting within the majority of the plaza with regions suitable for standing to the west and central to the plaza.

- Conditions within the plaza situated to the northwest of Tower G are predicted to be suitable mostly for standing with a region of conditions suitable for sitting to the north.

- Comfort levels at seating and lounging areas within Park 2 and the noted plazas within the subject site 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 mitigation measures is dependent on the programming of the spaces. 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.

Proposed Laneways and Walkways within Subject Site: Wind conditions over the laneway serving Phase 1 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. Conditions over the laneway serving Phase 2 are predicted to be suitable for standing, or better, during the summer, becoming suitable for strolling, or better, throughout the remainder of the year. Conditions over the walkways within the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, throughout the remainder of the year, with isolated regions suitable for walking at the southwest corners of Buildings B and D during the winter season. The noted conditions are considered acceptable.

Building Access Points: Wind comfort conditions in the vicinity of the primary building entrances 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 during the typical use period within the potential common amenity terraces serving Towers A-H at their respective podium roof levels and PH levels and recommendations regarding mitigation, where applicable, are provided as follows. Notably, all potential PH level common amenity terraces were modelled with 1.8-m-tall wind screens along their full perimeters.

Tower D, PH; Tower E; Tower F; Tower G, Podium; Tower H, PH: Conditions over the potential common amenity terraces serving Tower D at the PH level, Towers E and F at their respective PH and podium roof levels, Tower G at the podium roof level, and Tower H at the PH level are predicted to be suitable for mostly sitting with small, isolated regions suitable for standing, as illustrated in Figure 9. The noted conditions are considered acceptable.

Tower A; Tower B; Tower C; Tower D, Podium; Tower G, PH; Tower H, Podium: Conditions within the potential common amenity terraces serving Towers A, B, and C at their respective PH and podium roof levels, Towers and H at their respective podium roof levels, and Tower G at the podium roof level are predicted to be suitable for a mix of mostly sitting and standing, as illustrated in Figure 9.

If the programming of these spaces includes seating or lounging activities, comfort levels at the windier areas within these potential common amenity terraces may be improved with the implementation of mitigation inboard of the terrace perimeters and targeted around sensitive areas, in combination with taller perimeter wind screens. 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 mitigation measures is dependent on the programming of the spaces. 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.

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) Most 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, City Centre Park, existing residential development to the north, existing neighbouring surface parking lots and laneways, proposed laneways and 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. **Park 1.** During the typical use period, conditions within Park 1, which is situated between Towers A and E, are predicted to be suitable mostly for sitting with small regions of conditions suitable for standing predicted at the southeast and southwest corners of the park. It is recommended that the noted regions predicted to be suitable for standing are programmed as walkways or soft landscaping areas, such as coniferous plantings.

    b. **Park 2 and Proposed Plazas.** During the typical use period, conditions within Park 2, which is situated to the west of Tower F, and within the Phase 1 plazas are predicted to be suitable for a mix of sitting and standing, while conditions within the Phase 2 plaza are predicted to be mostly suitable for standing. If required by programming, comfort levels at seating and lounging areas within Park 2 and the noted plazas within the subject site 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.

   c. The extent of mitigation measures is dependent on the programming of the spaces. 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.

2) The podia roofs and penthouse (PH) levels were considered as potential common amenity terraces in the present study. Notably, the noted potential PH level common amenity terraces were modelled with 1.8-m-tall wind screens along their full perimeters. Wind comfort conditions during the typical use period and recommendations regarding mitigation, where applicable, are described as follows:

   a. Wind comfort conditions within the potential common amenity terraces serving Towers D, E, F, and H at the PH level, and Buildings E, F, and G at the podium roof level are predicted to be suitable for mostly sitting. The noted conditions are considered acceptable.

   b. Wind conditions within the potential common amenity terraces serving Towers A, B, and C at their respective podium roof and PH levels, Buildings D and H at the podium roof level, and Building G at the PH level are predicted to be suitable for mostly a mix of sitting and standing.

      - If the programming of these spaces includes seating or lounging activities, comfort levels at the windier areas within these potential common amenity terraces may be improved with the implementation of mitigation inboard of the terrace perimeters and targeted around sensitive areas, in combination with taller perimeter wind screens. Inboard mitigation could take the form of wind screens or other common landscape elements. Canopies may also be required above sensitive areas.

      - 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.

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,

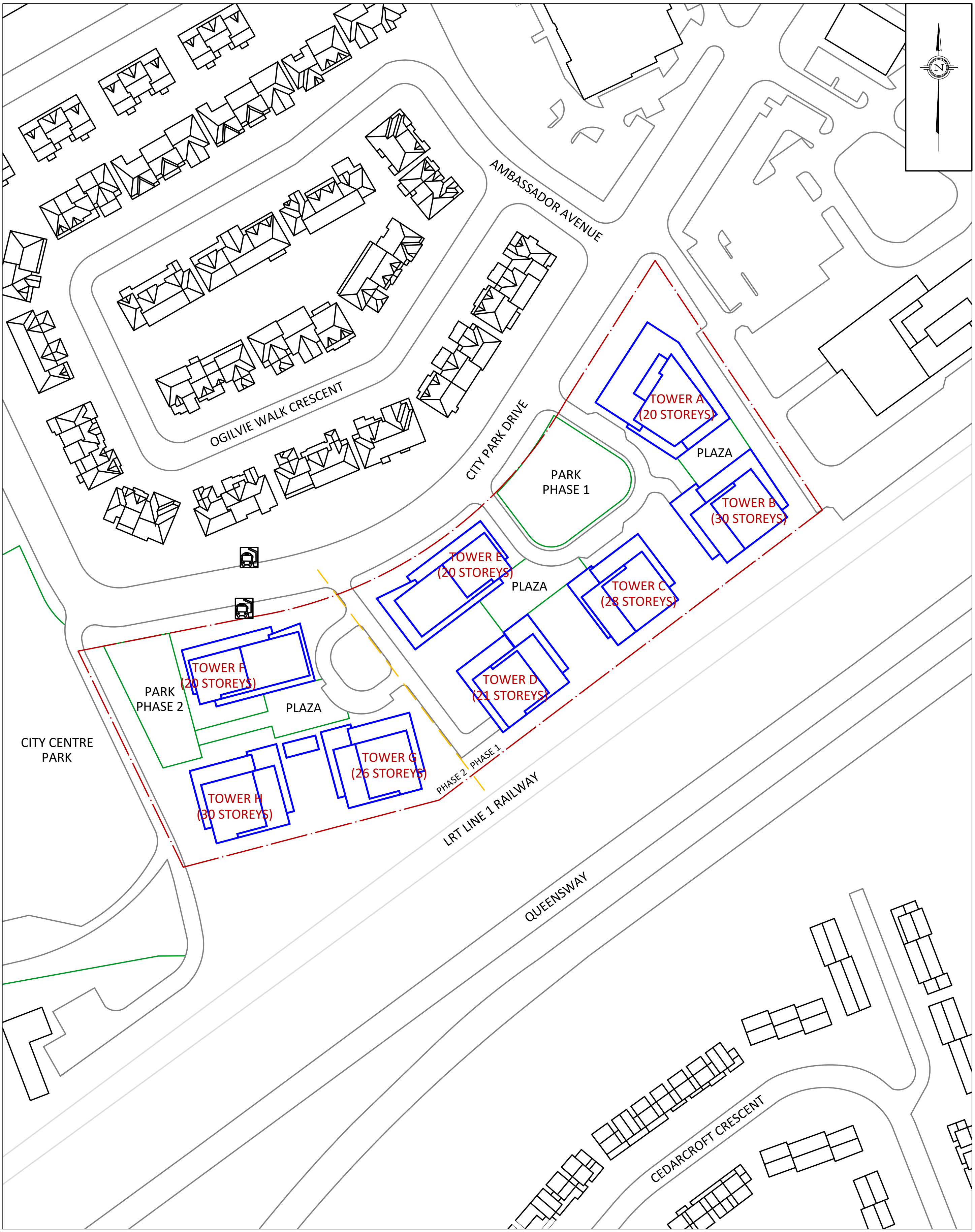
Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. D. FERRARO
100158495
Nov 23, 2023
PROVINCE OF ONTARIO

Daniel Davalos, MESc.
Wind Scientist

Justin Ferraro, P.Eng.
Principal

Sunny Kang, B.A.S.
Project Coordinator

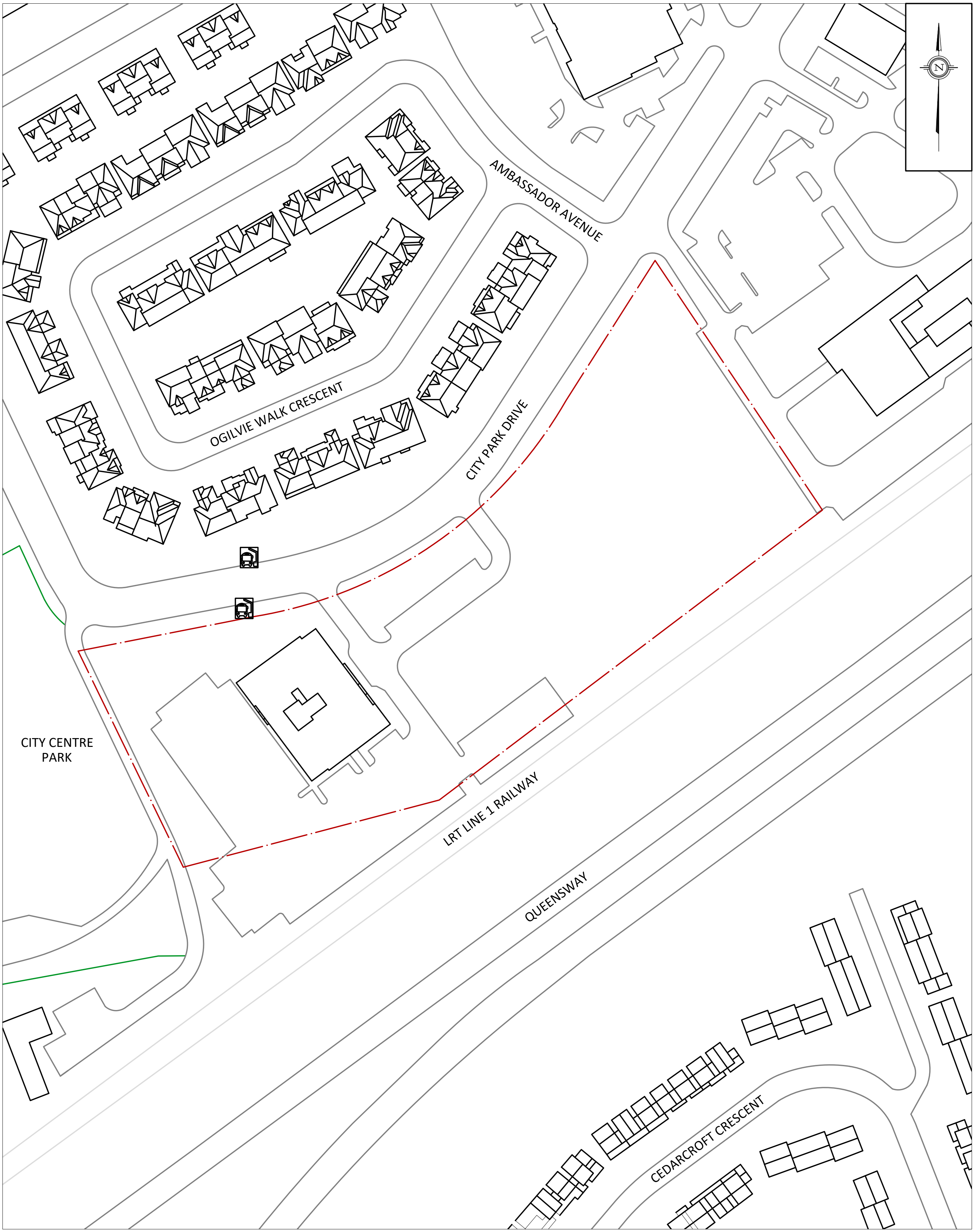


GRADIENTWIND
ENGINEERS & SCIENTISTS
127 WALGREEN ROAD, OTTAWA, ON
613 836 0934 • GRADIENTWIND.COM

PROJECT	1900-2000 CITY PARK DRIVE, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2000	DRAWING NO.	23-075-PLW-1A
DATE	NOVEMBER 10, 2023	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



GRADIENTWIND
ENGINEERS & SCIENTISTS
127 WALGREEN ROAD, OTTAWA, ON
613 836 0934 • GRADIENTWIND.COM

PROJECT	1900-2000 CITY PARK DRIVE, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2000	DRAWING NO.	23-075-PLW-1B
DATE	NOVEMBER 10, 2023	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1B:
EXISTING SITE PLAN AND SURROUNDING CONTEXT

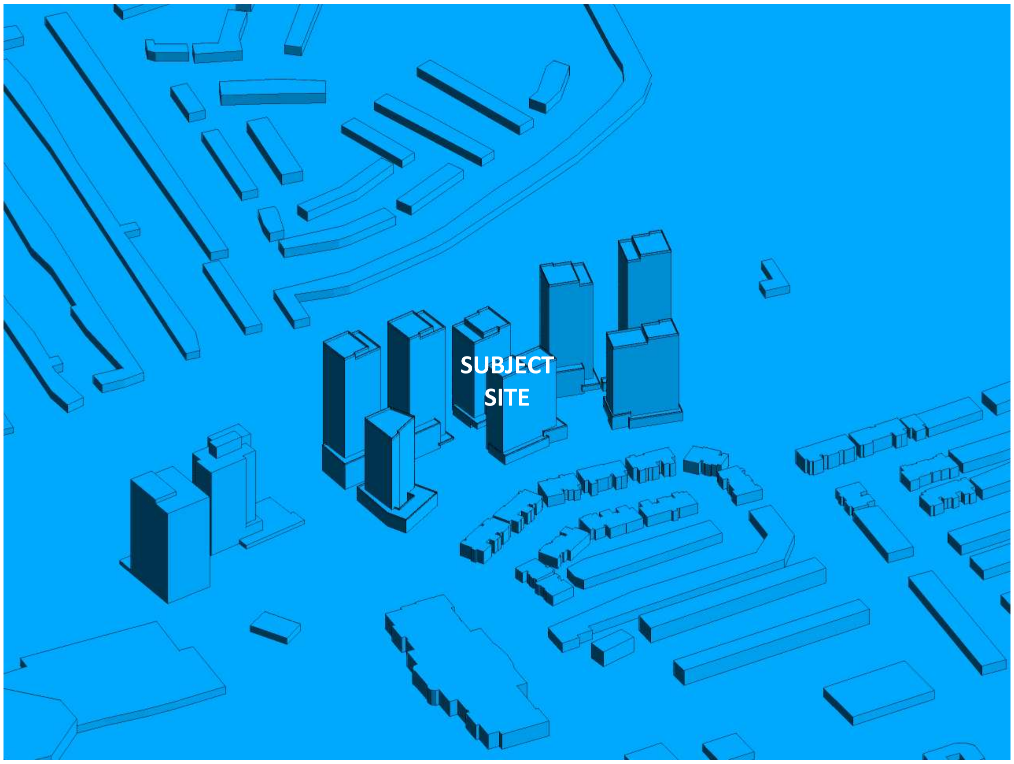


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

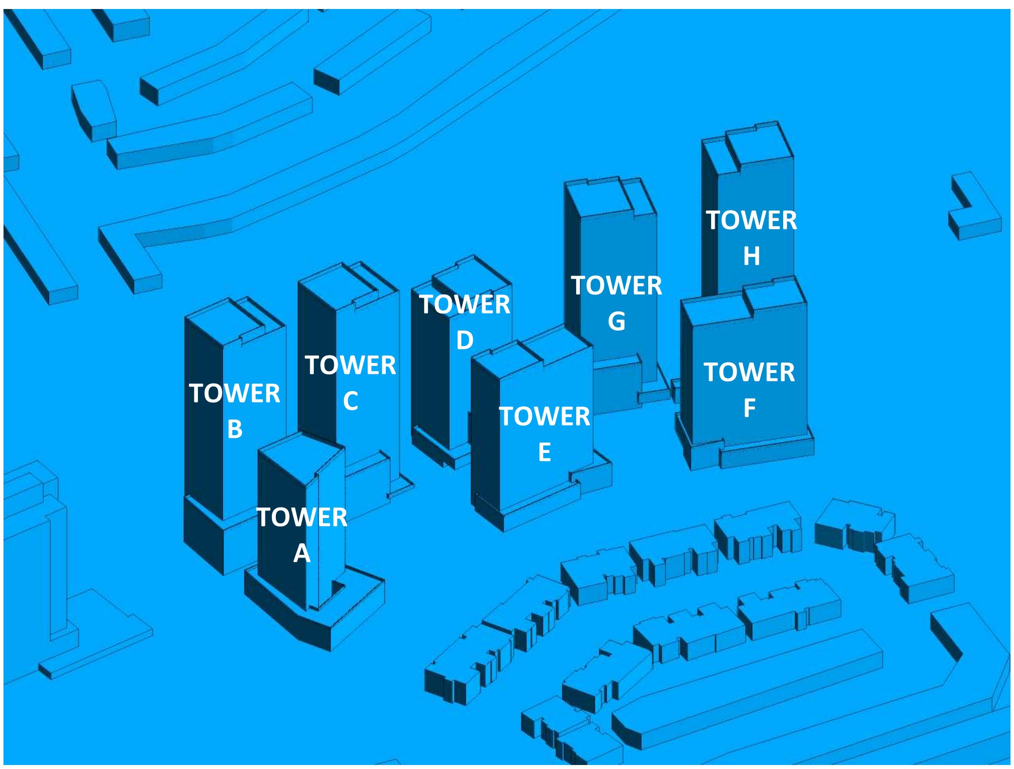


FIGURE 2B: CLOSE UP OF FIGURE 2A

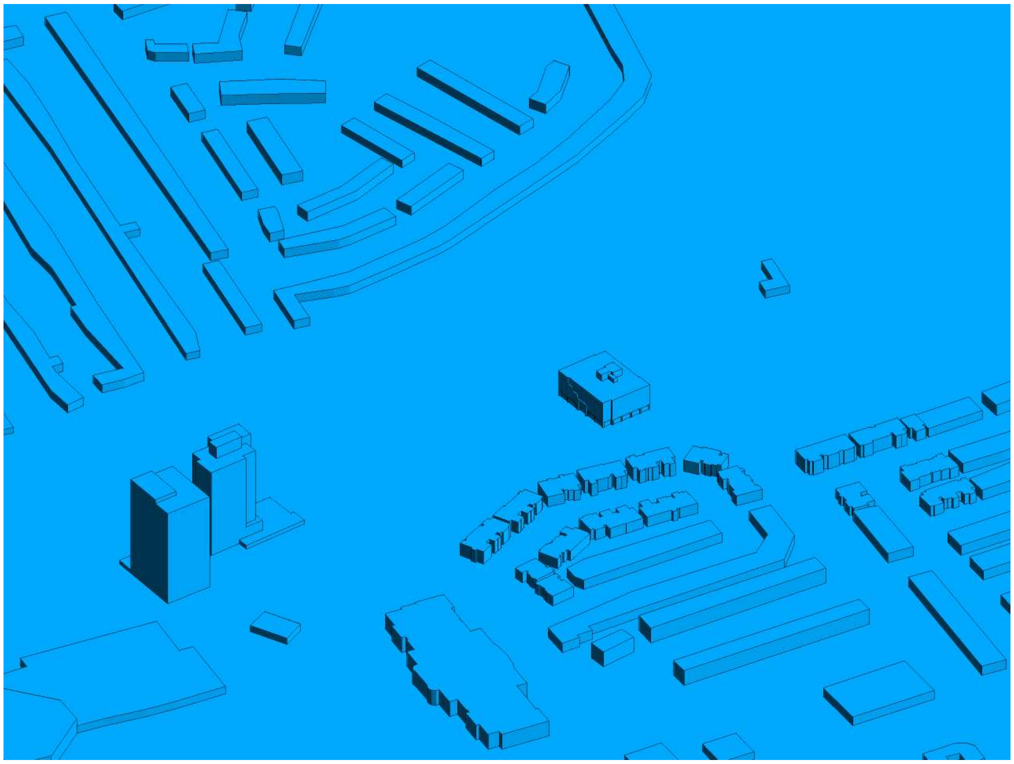


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

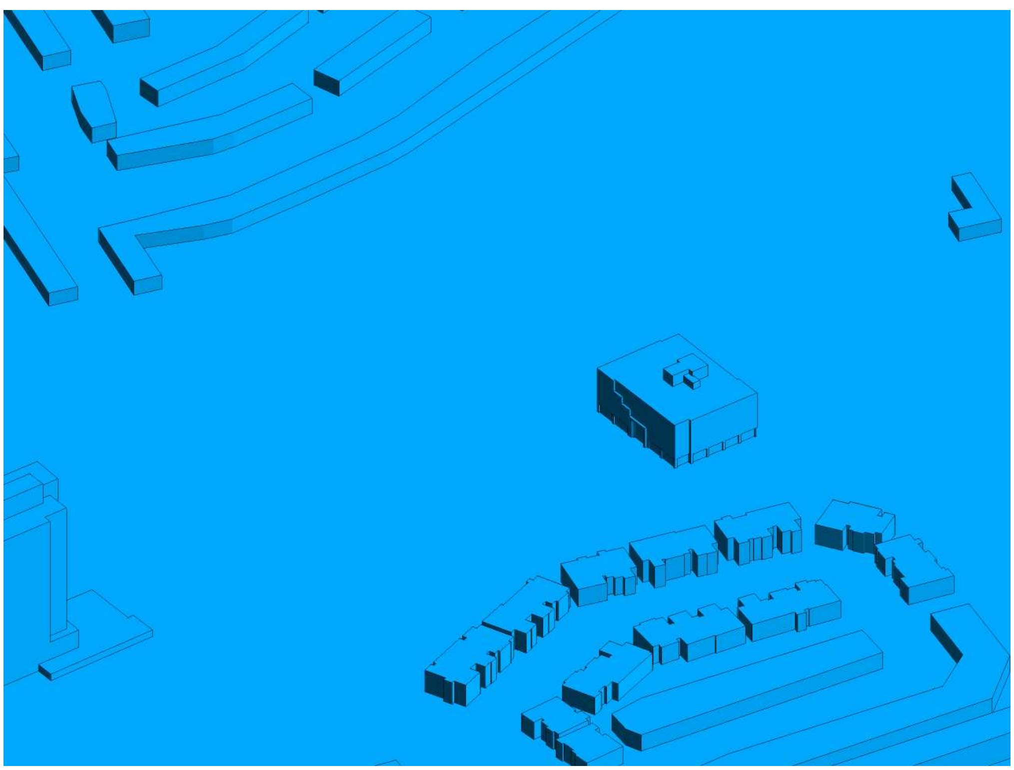


FIGURE 2D: CLOSE UP OF FIGURE 2C

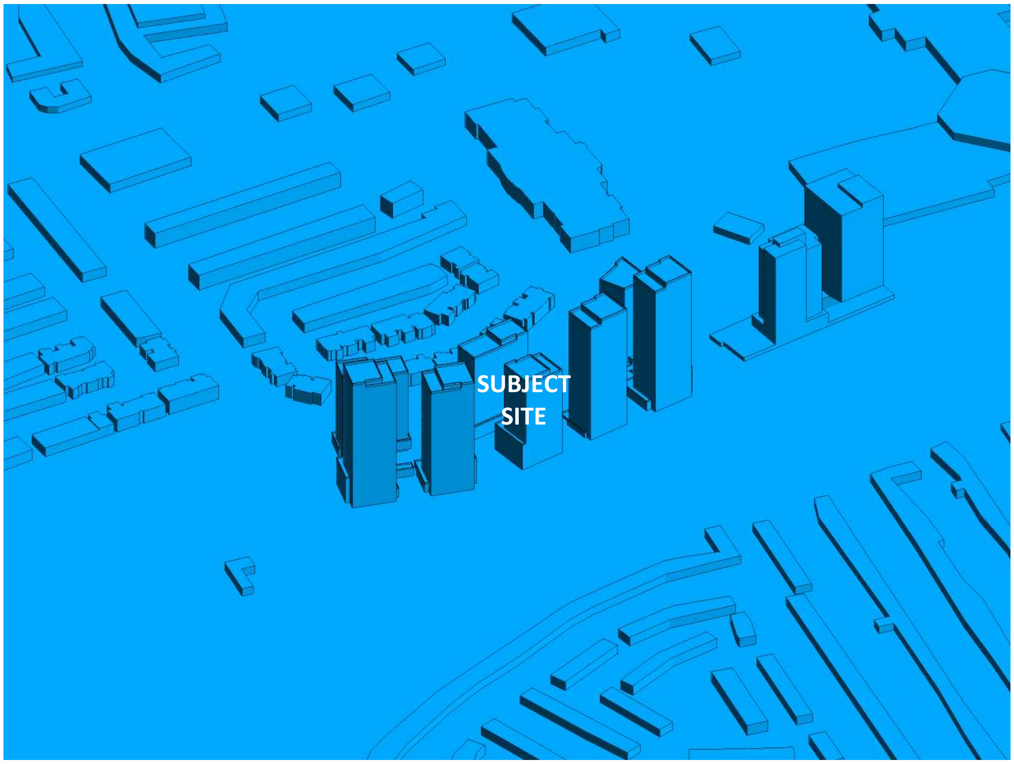


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

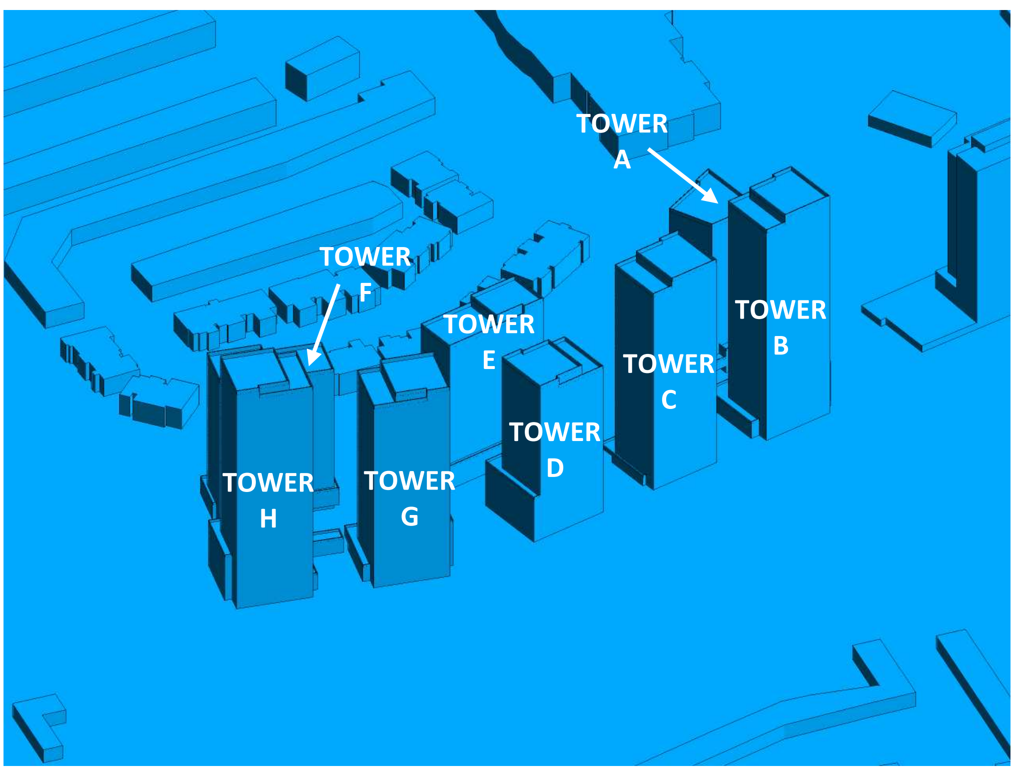


FIGURE 2F: CLOSE UP OF FIGURE 2E

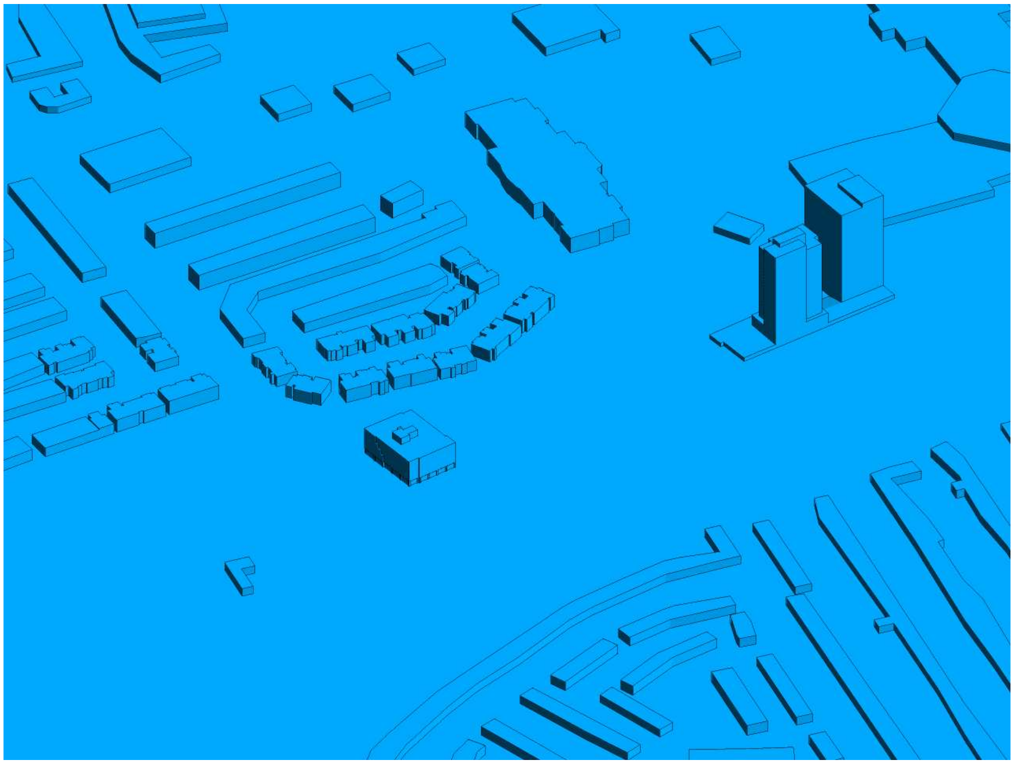


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

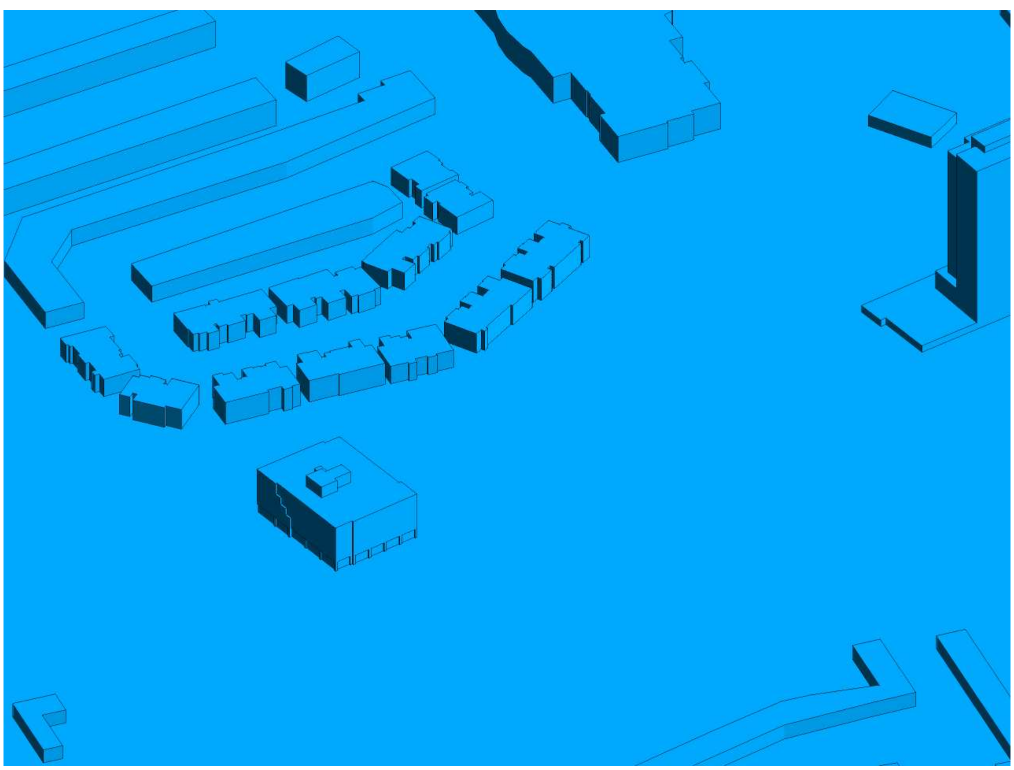


FIGURE 2H: CLOSE UP OF FIGURE 2G

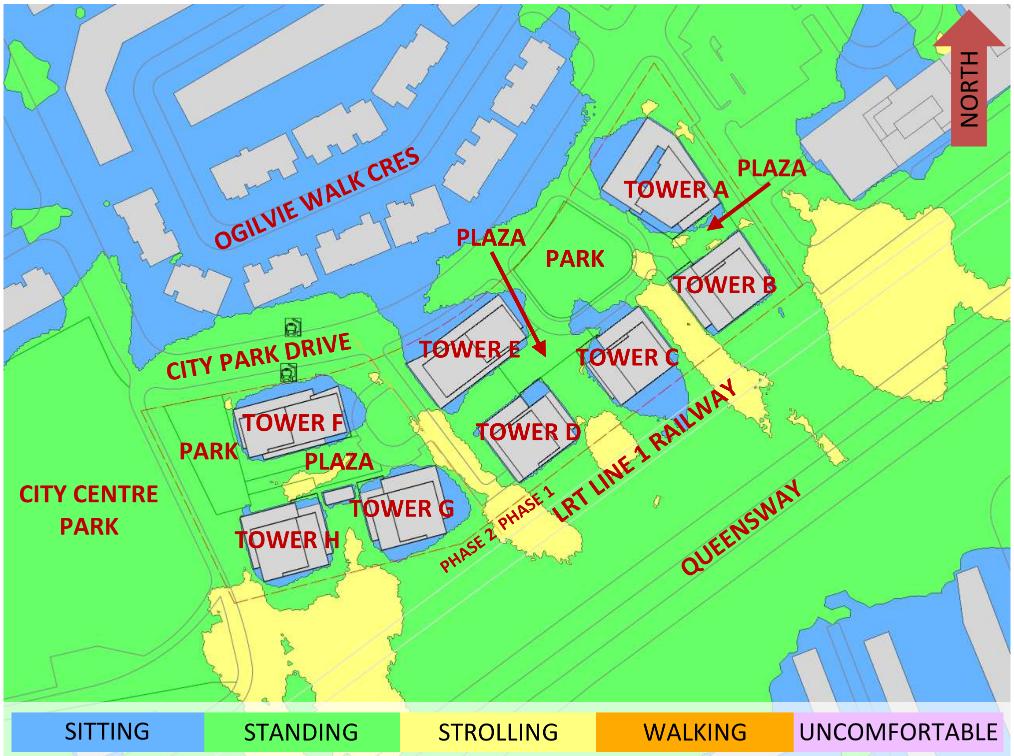


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

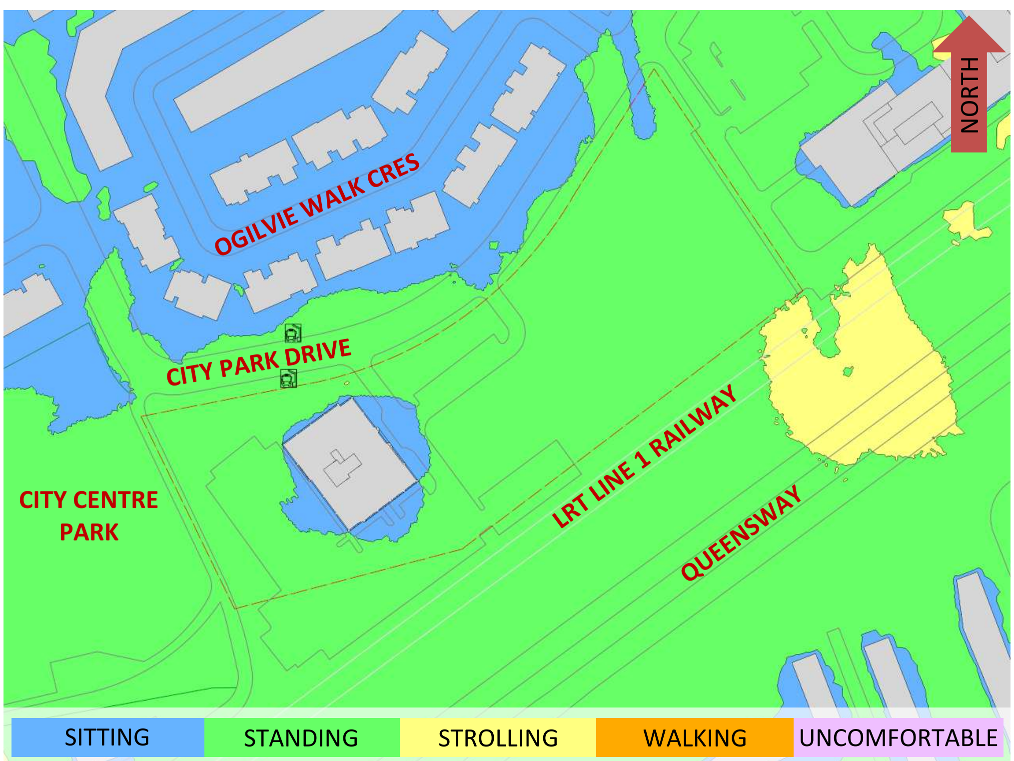


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

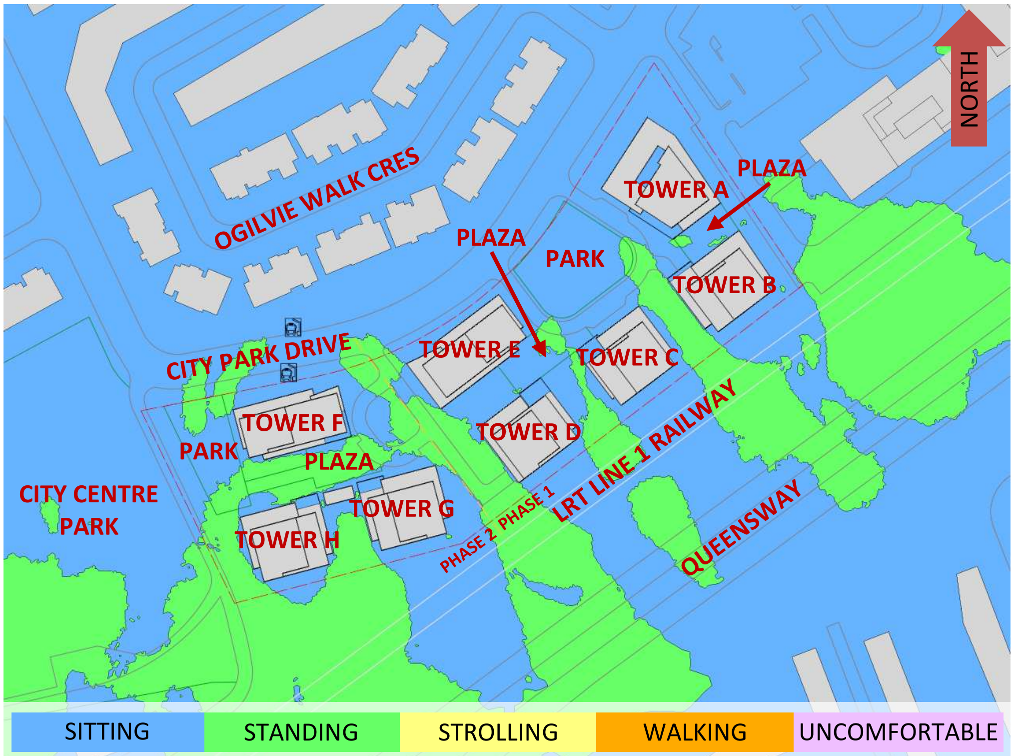


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

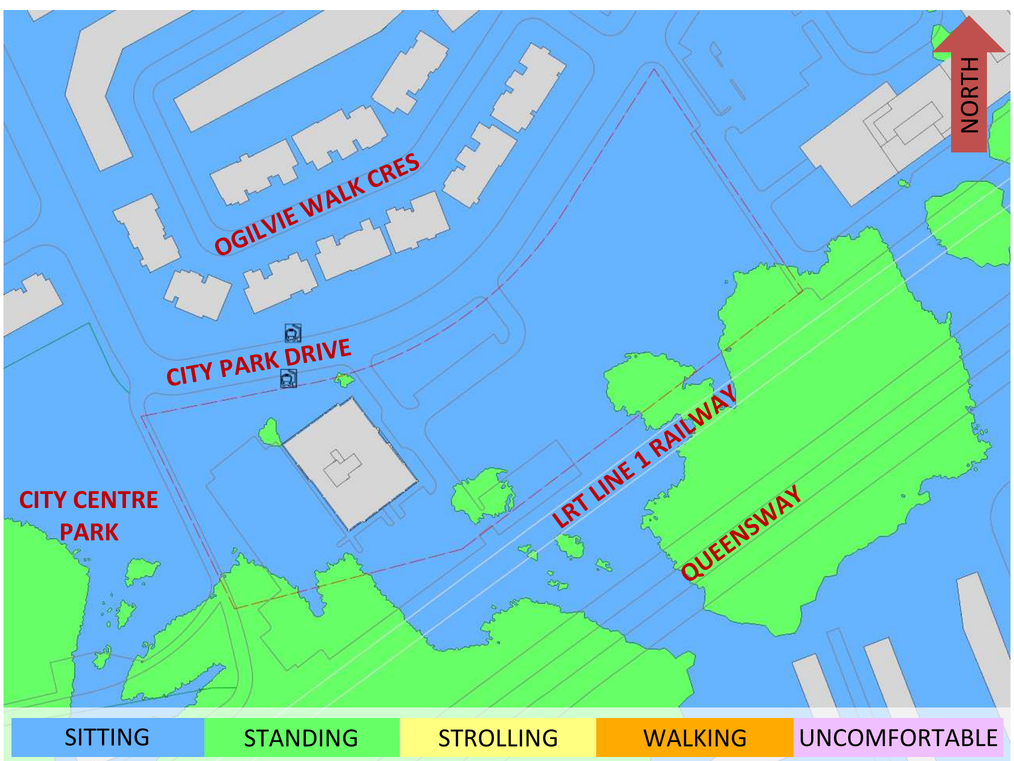


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

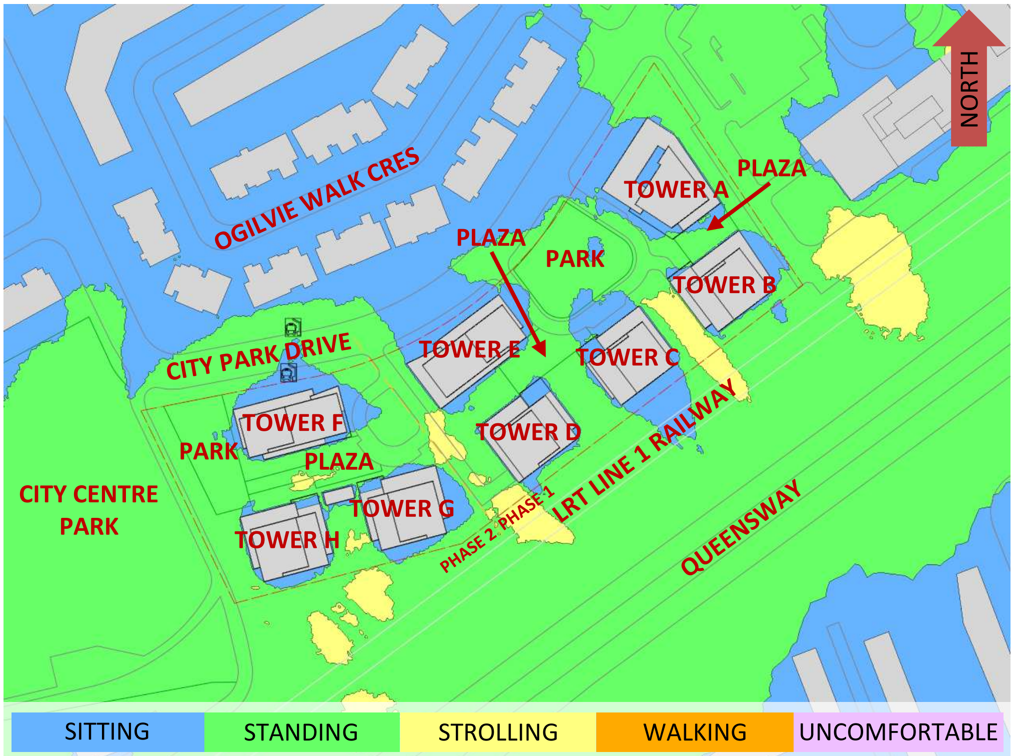


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

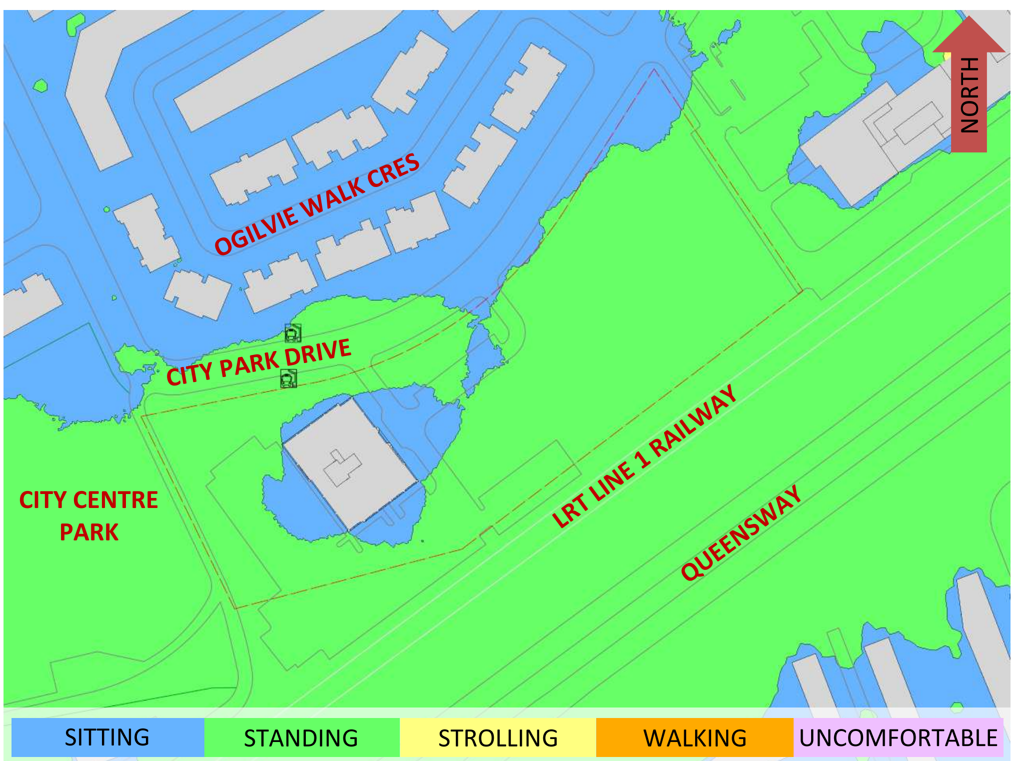


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

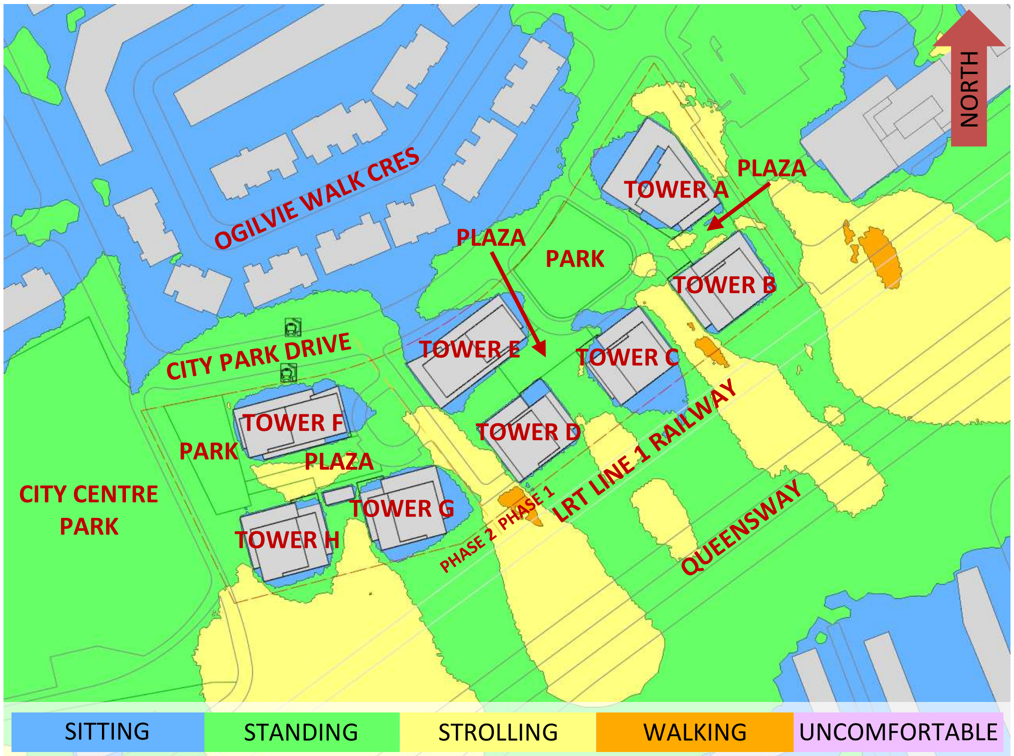


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

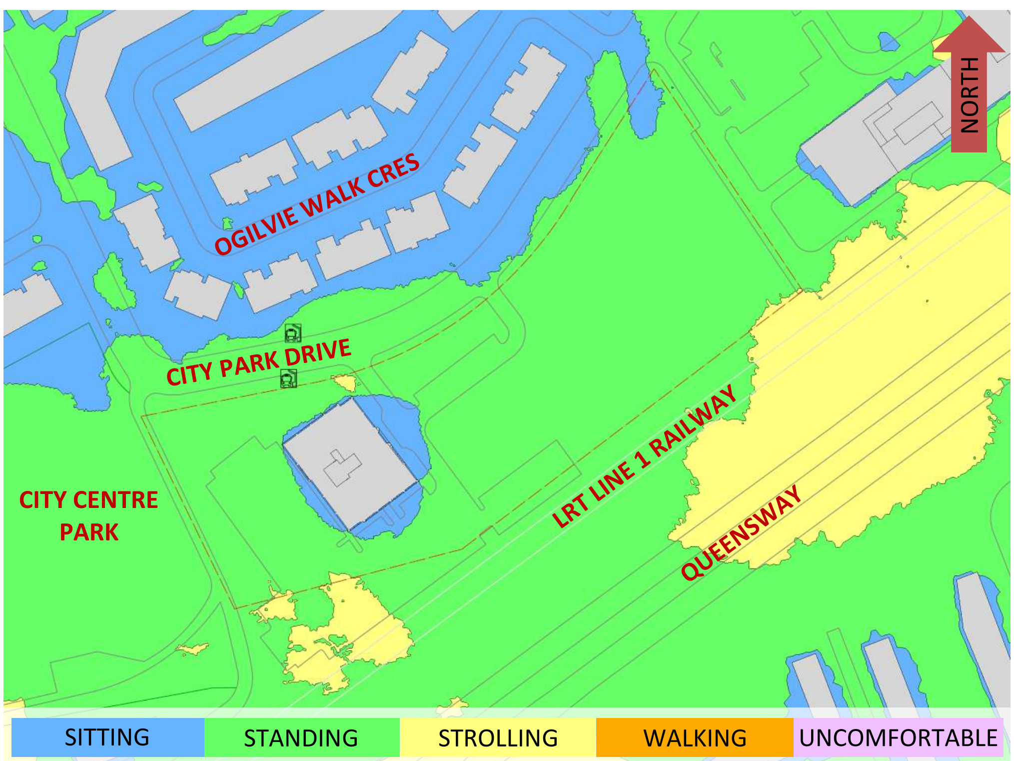


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

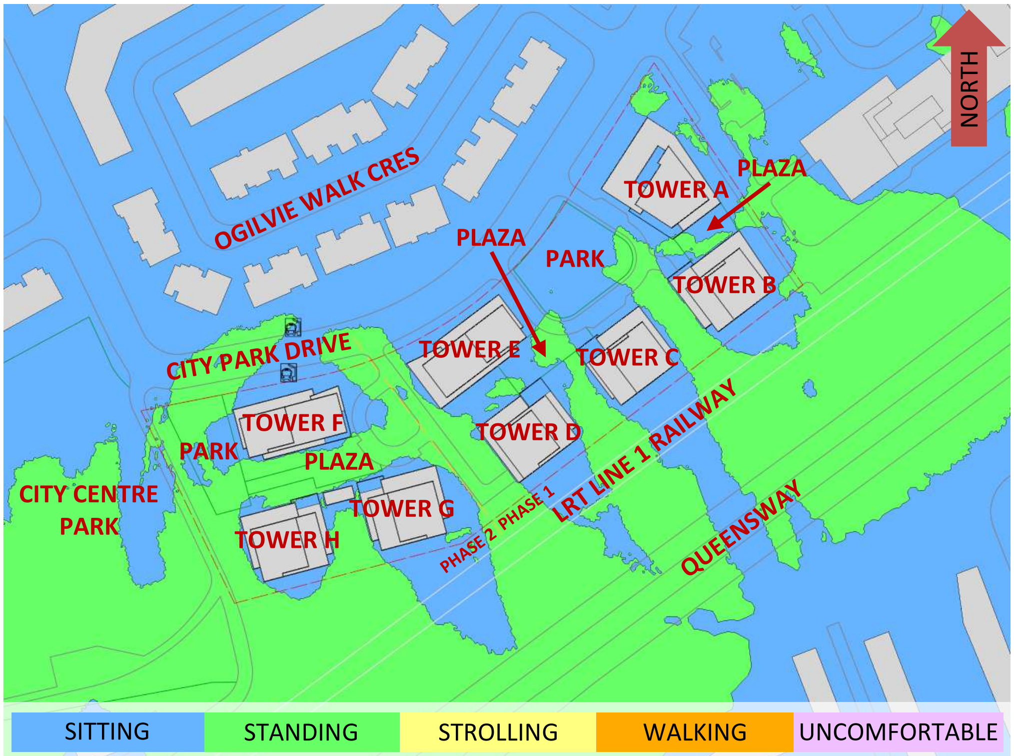


FIGURE 7A: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

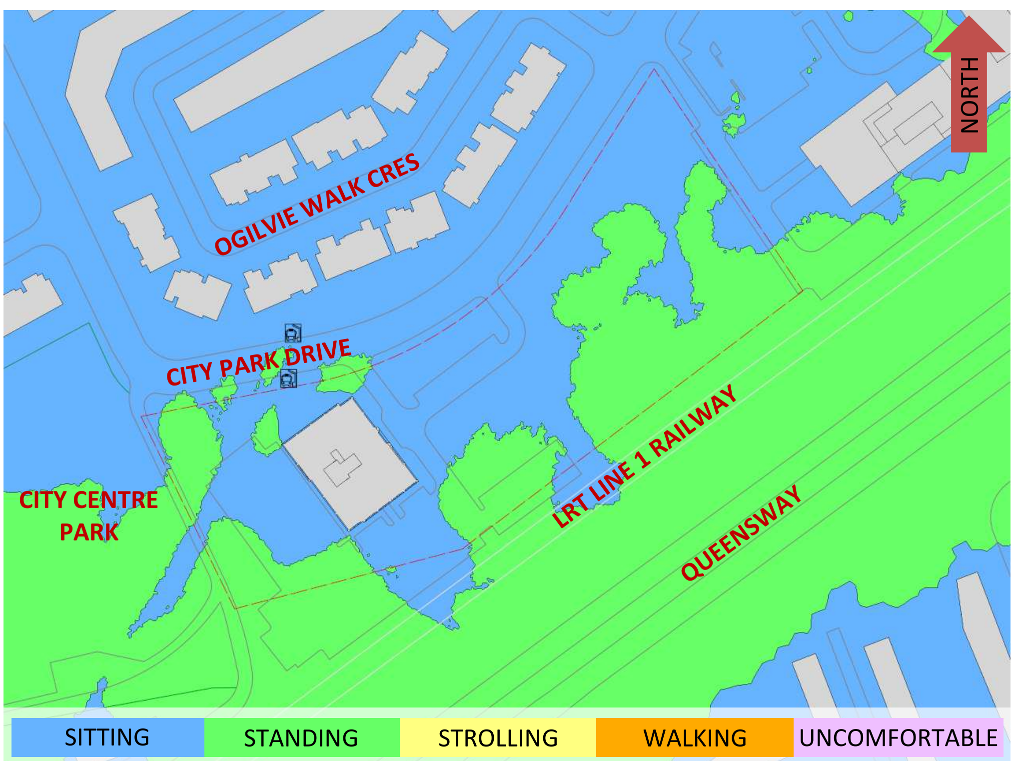


FIGURE 7B: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

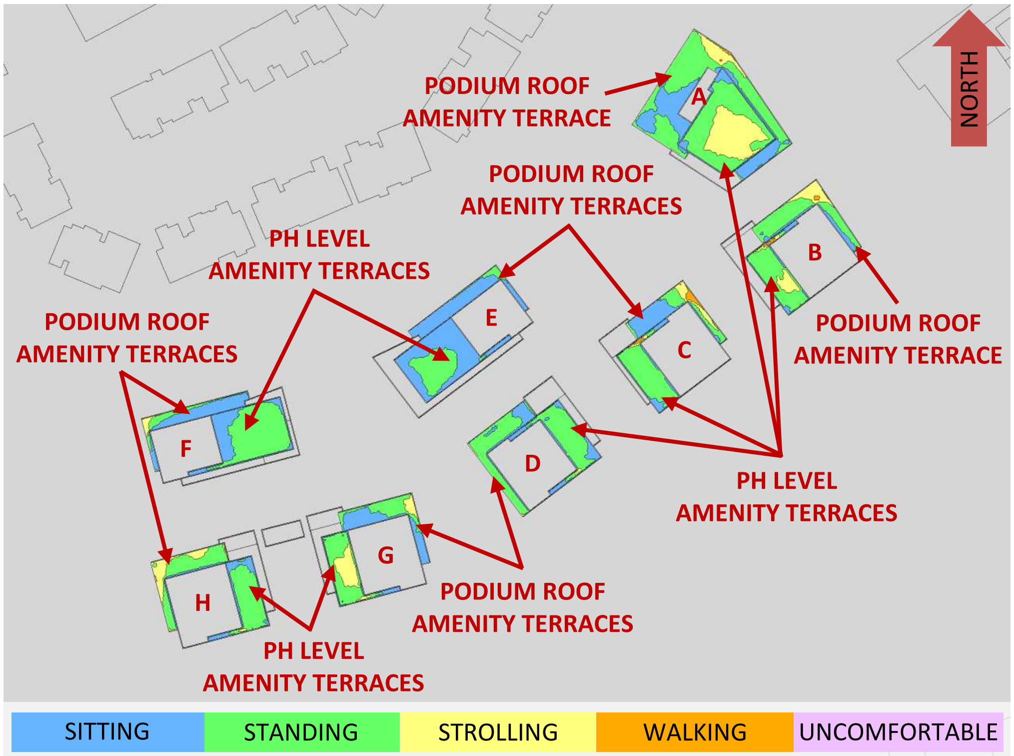


FIGURE 8A: SPRING – WIND COMFORT, POTENTIAL AMENITY TERRACES

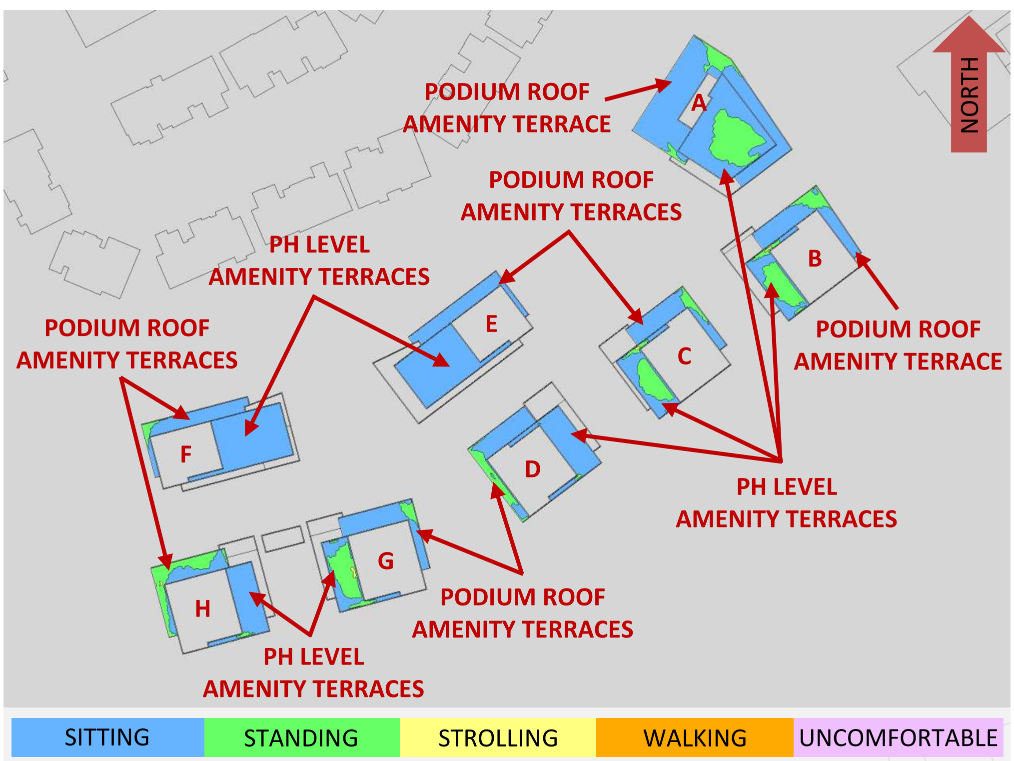


FIGURE 8B: SUMMER – WIND COMFORT, POTENTIAL AMENITY TERRACES

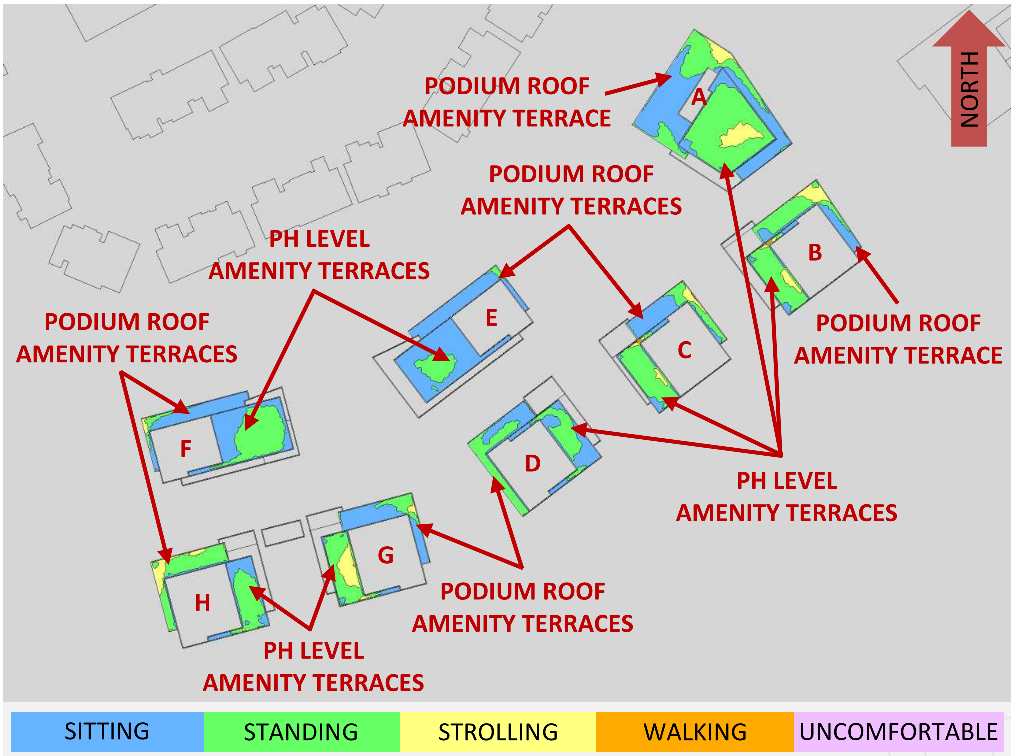


FIGURE 8C: AUTUMN – WIND COMFORT, POTENTIAL AMENITY TERRACES

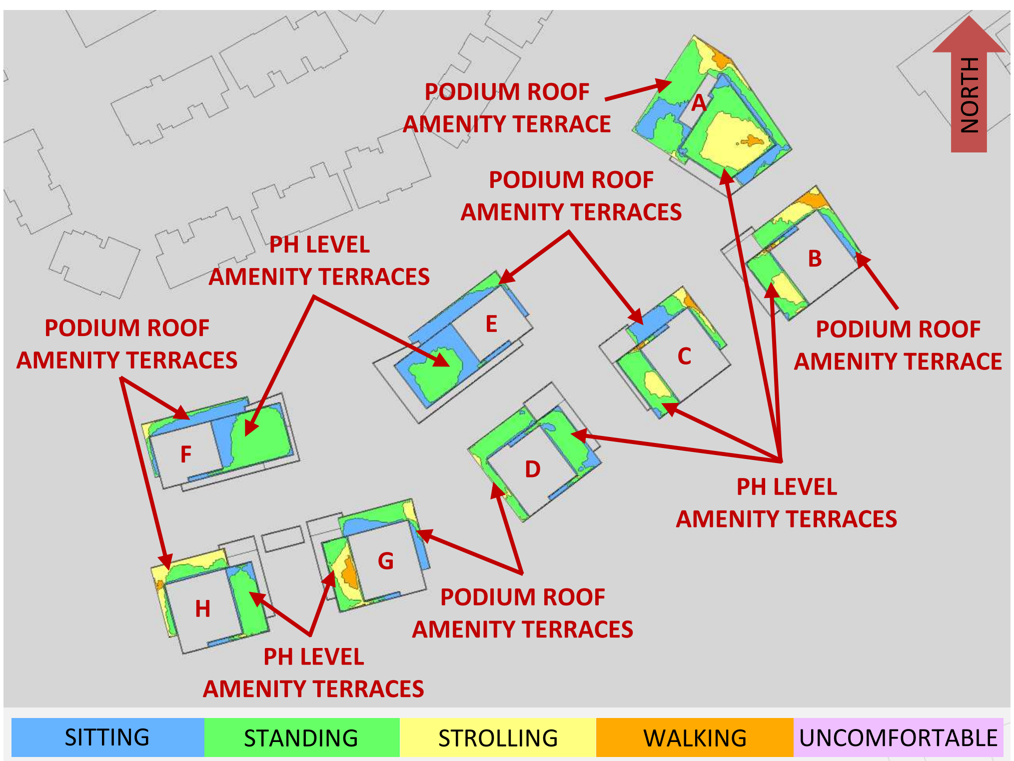


FIGURE 8D: WINTER – WIND COMFORT, POTENTIAL AMENITY TERRACES

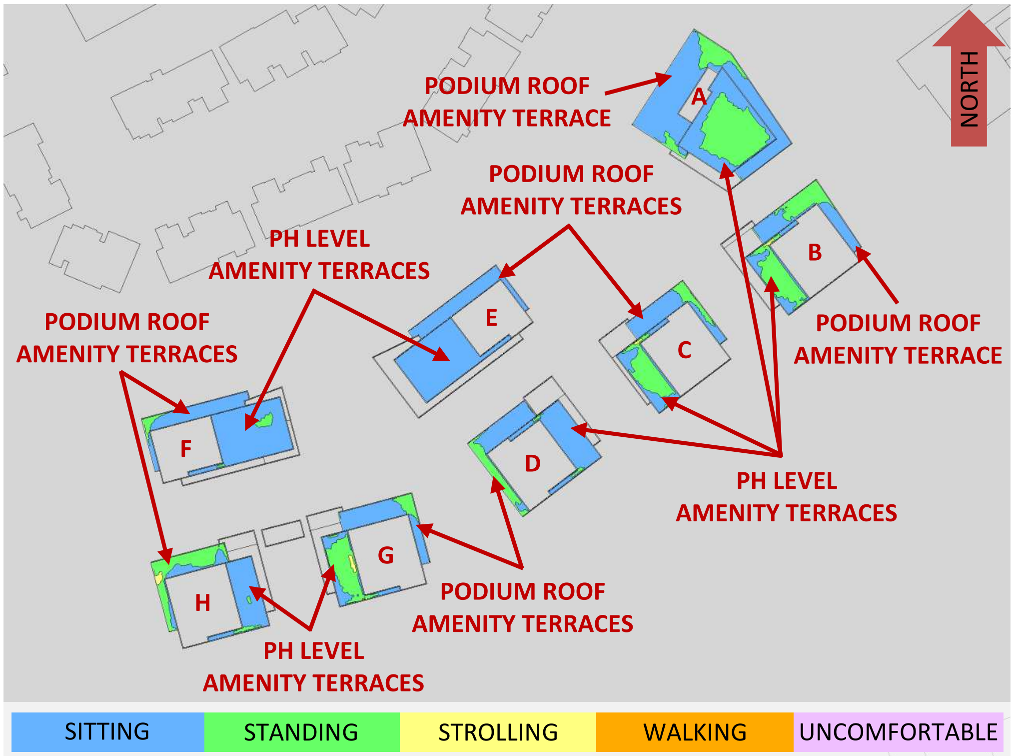
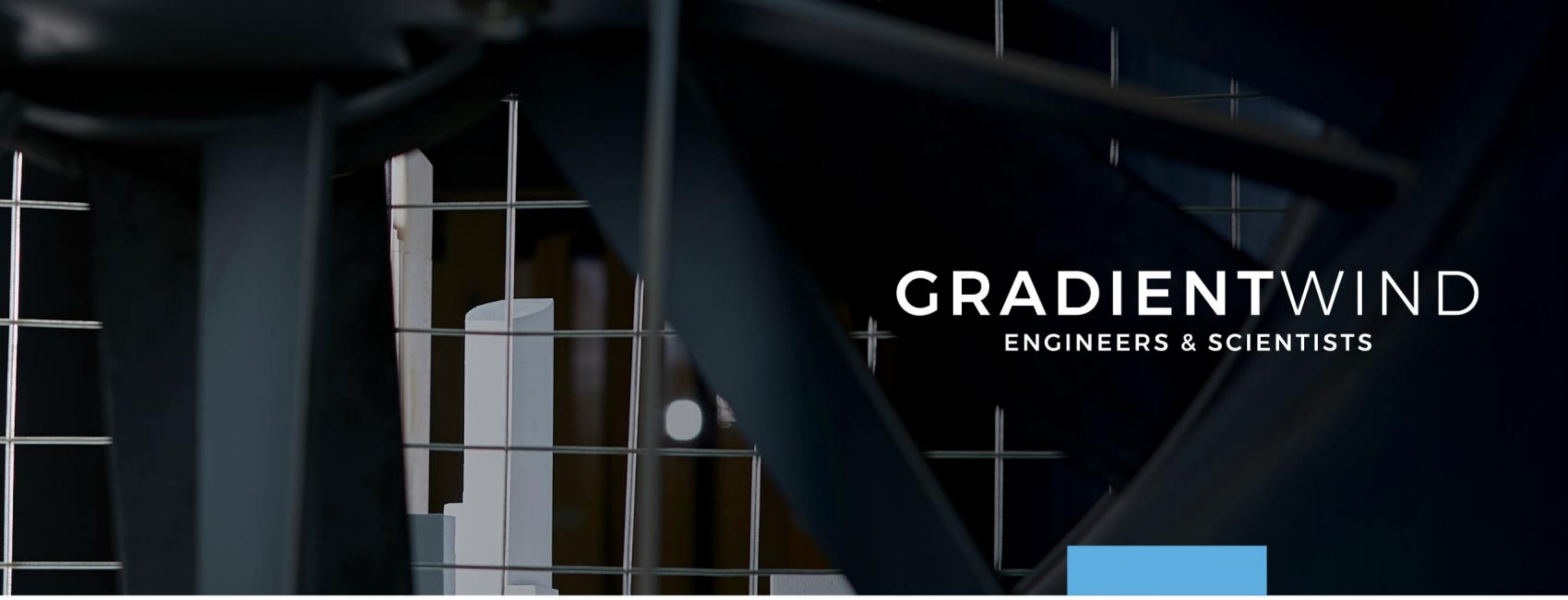
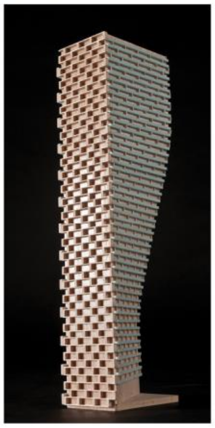
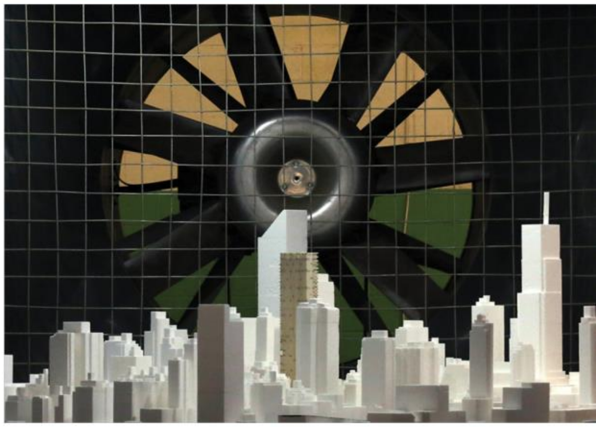


FIGURE 9: TYPICAL USE PERIOD – WIND COMFORT, POTENTIAL AMENITY TERRACES







APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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

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, U_g = gradient wind speed, Z = height above ground, 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	0.23
49	0.22
74	0.20
103	0.21
167	0.23
197	0.22
217	0.22
237	0.22
262	0.23
282	0.24
301	0.24
324	0.24

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.