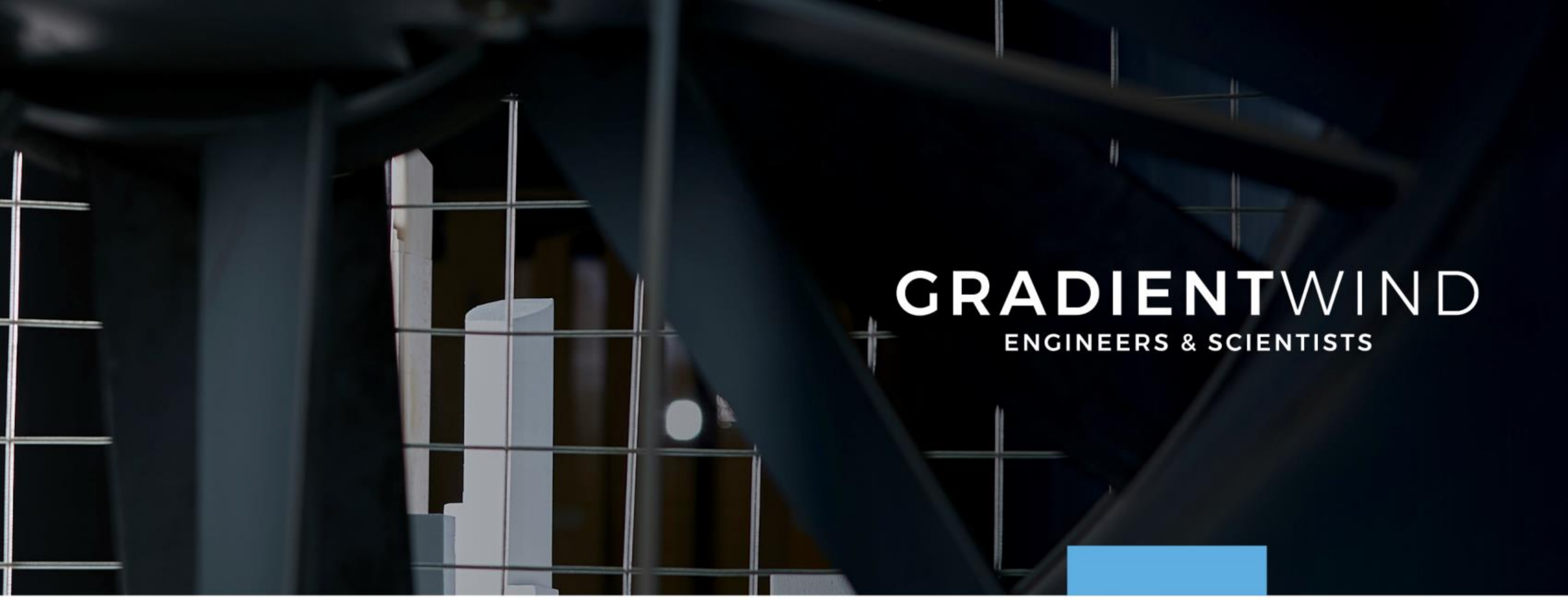
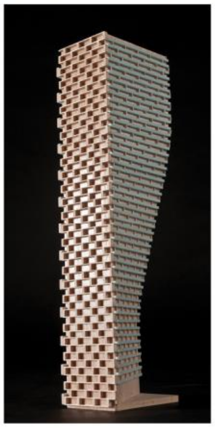
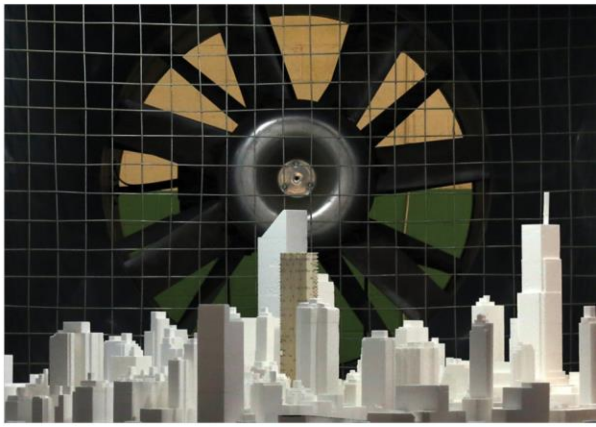


PEDESTRIAN LEVEL WIND STUDY

1657-1673 Carling Avenue
& 386 Tillbury Avenue,
Ottawa, Ontario

Report: 23-139-PLW





June 17, 2024

PREPARED FOR
Inside Edge Properties
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PREPARED BY
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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Zoning By-law Amendment application submission requirements for the proposed mixed-use residential development located 1657-1673 Carling Avenue and 386 Tillbury Avenue in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

The study involves simulation of wind speeds for selected wind directions in a three-dimensional (3D) computer model using the computational fluid dynamics (CFD) technique, combined with meteorological data integration, to assess pedestrian wind comfort and safety within and surrounding the subject site according to City of Ottawa wind comfort and safety criteria. The results and recommendations derived from these considerations are detailed in the main body of the report (Section 5), illustrated in Figures 3A-9, and summarized as follows:

1) All grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, transit stops, surface parking, the proposed drive aisle, walkways, and in the vicinity of building access points, are considered acceptable. One exception is as follows:

    a. Wind comfort conditions over the outdoor amenity located to the north and east of the proposed development are predicted to be suitable for sitting over the majority of the area during the typical use period, with conditions suitable for standing to the northeast.

    b. Depending on the programming of the space, the noted conditions may be considered acceptable. If the windier area to the northeast will not accommodate seating or lounging activities, the noted conditions would be considered acceptable.

    c. If required by programming, sitting conditions may be extended with targeted wind barriers located around seating areas, which could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options.

2) Regarding the common amenity terraces serving the proposed development at Levels 9 and 10, which were modelled with 1.8-m-tall wind screens along their full perimeters, wind conditions during the typical use period and recommendations regarding wind mitigation are described as follows:

   a. **Common Amenity Terrace, Level 9.** Wind comfort conditions are predicted to be suitable for sitting over the majority of the terrace, with conditions suitable for standing predicted to the south.

   b. **Common Amenity Terrace, Level 10.** Conditions are predicted to be suitable for mostly standing, with conditions suitable for sitting along the north elevation and southeast corner of the terrace, and conditions suitable for strolling at the northwest corner of the tower.

   c. Depending on programming, the noted conditions within the Level 9 terrace may be considered acceptable. Specifically, if the windier area to the south will not accommodate seating or lounging activities the noted conditions would be considered acceptable.

   d. To improve conditions within the Level 10 terrace, and within the Level 9 terrace, if required by programming, tall wind screens along the perimeter of the terrace(s) are recommended, in combination with wind barriers inboard of the perimeters that are targeted around sensitive areas and canopies located above designated seating areas. Additionally, a canopy extending from select tower elevations above the Level 10 terrace may be beneficial to deflect downwash incident on the tower façades.

   e. 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. 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.

Addendum: The PLW study was completed based on architectural drawings that were prepared by Project1 Studio in August 2023. Updated drawings were distributed to the consultant team in May 2024 with some changes to the proposed development. Most notably, the proposed development has decreased in height from 30 to 28 storeys. Additionally, a setback has been added to the podium along its west elevation. These changes are considered minor from a wind engineering perspective, and the results and recommendations provided in this study are expected to be representative of the current architectural design. Additional simulations to confirm the wind conditions are not required.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Inside Edge Properties to undertake a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment application submission requirements for the proposed mixed-use residential development located 1657-1673 Carling Avenue and 386 Tillbury Avenue 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.

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 Project1 Studio in August 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 1657-1673 Carling Avenue and 386 Tillbury Avenue in Ottawa, situated central within a parcel of land bounded by Tillbury Avenue to the north, Churchill Avenue to the east, Carling Avenue to the south, and Cole Avenue South to the west, with existing low-rise buildings to the immediate west and east of the proposed development. The proposed development comprises a nominally ‘L’-shaped 30-storey mixed-use residential building, topped with a mechanical penthouse (MPH).

Above two below-grade parking levels, the ground floor includes retail spaces along the south elevation, an indoor amenity at the southwest corner, residential units along the west and north elevations, a residential lobby at the inner corner of the ‘L’-shaped planform, and shared building support spaces throughout the remainder of the level. An outdoor amenity is provided along the east and north elevations of the proposed development. A drive aisle extending from Tillbury Avenue to Carling Avenue, along the east elevation of the subject site, provides access to surface parking and a parking ramp located at the northeast corner of the subject site. Levels 2-8 are reserved for residential use, and the building steps back from the north elevation at Level 4 and from the north, south, and east elevations at Level 7 to accommodate private terraces. Levels 9 and 10 include indoor amenities at the southwest and northwest corners, respectively, and residential units throughout the remainder of the levels. An amenity terrace is located at the southwest corner at Level 9 and at the northwest corner at Level 10. Levels 11-30 rise above the podium with a rectangular planform and are comprised of residential units.

The near-field surroundings, defined as an area within 200-metres (m) of the subject site, are characterized by low-rise massing in all compass directions and a residential development comprising two towers (16 and 18 storeys) under construction at 1619 and 1655 Carling Avenue, to the immediate east 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 low-rise massing with isolated mid- and high-rise buildings in all compass directions. The Rideau River flows from the west to the northwest, approximately 1.6 km to the northwest.

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.

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.

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

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 12 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 480 m. The process was performed for two context massing scenarios, as noted in Section 2.

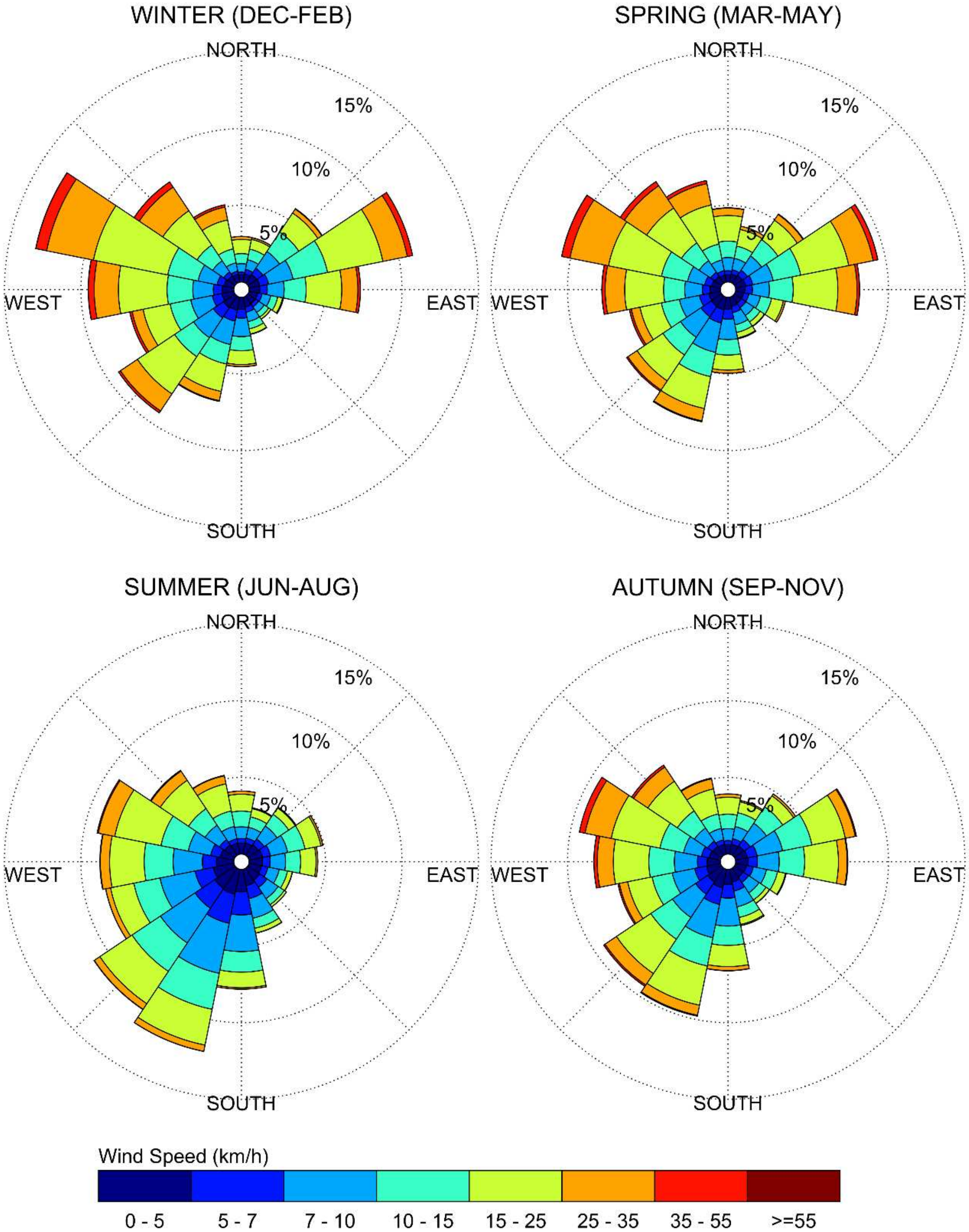
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the common amenity terraces serving the proposed development at Levels 9 and 10 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	Mean 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 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 wind conditions over the common amenity terraces serving the proposed development at Levels 9 and 10. 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 7 and 9 illustrate wind comfort conditions over the grade-level outdoor amenity and over the noted amenity terraces serving the proposed development, respectively, consistent with the comfort classes in Section 4.4. The details of these conditions are summarized in the following pages.

5.1 Wind Comfort Conditions – Grade Level

Sidewalks and Transit Stop along Carling Avenue: Following the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along Carling Avenue are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of sitting, standing, and strolling during the remainder of the year. Wind conditions over the nearby transit stop along Carling Avenue are predicted to be suitable for standing, or better, throughout the year. The noted conditions are considered acceptable.

Wind conditions over the sidewalks along Carling Avenue with the existing massing are predicted to be suitable for mostly sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year, while conditions over the nearby transit stop are predicted to be suitable for sitting throughout the year. While the introduction of the proposed development produces windier conditions over the noted areas in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Surface Parking to the West: Following the introduction of the proposed development, wind conditions over the existing surface parking lot to the west are predicted to be suitable for mostly sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year. The noted conditions are considered acceptable.

Wind conditions over the noted parking lot with the existing massing are predicted to be suitable for mostly sitting throughout the year. While the introduction of the proposed development produces windier conditions over the noted parking lot in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Sidewalks along Tillbury Avenue and Melbourne Avenue: Following the introduction of the proposed development, wind conditions over the nearby public sidewalks along Tillbury Avenue and Melbourne Avenue are predicted to be suitable for standing, or better, throughout the year. The noted conditions are considered acceptable.

Wind conditions over the noted public sidewalks with the existing massing are predicted to be suitable for sitting throughout the year. While the introduction of the proposed development produces windier conditions over the noted public sidewalks in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Outdoor Amenity: During the typical use period, wind comfort conditions over the outdoor amenity area along the north and east elevations of the proposed development are predicted to be suitable for sitting over the majority of the area, with conditions predicted to be suitable for standing to the northeast. Where conditions are suitable for standing, they are also predicted to be suitable for sitting at least 76% of the time during the same period, where the target is 80% to achieve the sitting comfort criterion.

Depending on the programming of the grade-level outdoor amenity, the noted conditions may be considered acceptable. Specifically, if the windier area to the northeast will not accommodate seating or more sedentary activities, then the noted conditions would be considered acceptable. If required by programming, sitting conditions may be extended to the northeast with the implementation of targeted wind barriers around seating areas, which could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options.

Proposed Drive Aisle and Surface Parking: Wind conditions over the proposed drive aisle along the east elevation 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 sitting, standing, and strolling during the autumn, and walking, or better, during the winter. Conditions over the adjoining surface parking spots are predicted to be suitable for a mix of sitting and standing throughout the year. The noted conditions are considered acceptable.

Walkways Within Subject Site: Wind comfort conditions over the walkways throughout the subject site are predicted to be suitable for standing, or better, throughout the year, with conditions suitable for strolling at the northeast and southeast corners of the building along the drive aisle from Carling Avenue during the spring, autumn, and winter. The noted conditions are considered acceptable.

Building Access: Owing to the protection of the building façade, wind conditions in the vicinity of the building access points serving the proposed development are predicted to be suitable for standing, or better, throughout the year, with conditions in the vicinity of the building access points along the drive aisle at the southeast corner of the subject site suitable for strolling, or better, during the spring, autumn, and winter. The noted conditions are considered acceptable.

5.2 Wind Comfort Conditions – Common Amenity Terraces

The proposed development is served by common amenity terraces at Levels 9 and 10, which were modelled with 1.8-m-tall wind screens along their full perimeters.

Common Amenity Terrace, Level 9: With the perimeter wind screen mitigation, as described above, wind comfort conditions during the typical use period over the common amenity terrace serving the proposed development at Level 9 are predicted to be suitable for sitting over the majority of the amenity terrace, with conditions suitable for standing predicted to the south.

Depending on programming, the noted conditions may be considered acceptable. Specifically, if the windier area of the terrace to the south will not accommodate seating or lounging activities, the noted conditions would be considered acceptable. If required by programming, sitting conditions may be extended over the full terrace by implementing tall perimeter wind screens along the perimeter of the terrace, in combination with wind barriers inboard of the terrace perimeter targeted around seating areas to the south and canopies located above designated seating areas.

Common Amenity Terrace, Level 10: With the perimeter wind screen mitigation described above, wind conditions during the typical use period within the common amenity terrace serving the proposed development at Level 10 are predicted to be suitable for mostly standing, with conditions suitable for strolling at the northwest corner of the tower, and conditions suitable for sitting at the southeast corner of the terrace and along the north elevation.

To improve wind conditions within the Level 10 terrace, wind mitigation in the form of tall wind screens along the full terrace perimeter is recommended, in combination with wind barriers inboard of the perimeter targeted around sensitive areas and canopies located above designated seating areas. Additionally, a canopy extending from select tower elevations above the Level 10 terrace may be beneficial to deflect downwash incident on the tower façades.

The extent of the mitigation measures is dependent on the programming of the terrace. 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) All grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, transit stops, surface parking, the proposed drive aisle, walkways, and in the vicinity of building access points, are considered acceptable. One exception is as follows:

    a. Wind comfort conditions over the outdoor amenity located to the north and east of the proposed development are predicted to be suitable for sitting over the majority of the area during the typical use period, with conditions suitable for standing to the northeast.

    b. Depending on the programming of the space, the noted conditions may be considered acceptable. If the windier area to the northeast will not accommodate seating or lounging activities, the noted conditions would be considered acceptable.

c. If required by programming, sitting conditions may be extended with targeted wind barriers located around seating areas, which could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options.

2) Regarding the common amenity terraces serving the proposed development at Levels 9 and 10, which were modelled with 1.8-m-tall wind screens along their full perimeters, wind conditions during the typical use period and recommendations regarding wind mitigation are described as follows:

a. **Common Amenity Terrace, Level 9.** Wind comfort conditions are predicted to be suitable for sitting over the majority of the terrace, with conditions suitable for standing predicted to the south.

b. **Common Amenity Terrace, Level 10.** Conditions are predicted to be suitable for mostly standing, with conditions suitable for sitting along the north elevation and southeast corner of the terrace, and conditions suitable for strolling at the northwest corner of the tower.

c. Depending on programming, the noted conditions within the Level 9 terrace may be considered acceptable. Specifically, if the windier area to the south will not accommodate seating or lounging activities the noted conditions would be considered acceptable.

d. To improve conditions within the Level 10 terrace, and within the Level 9 terrace, if required by programming, tall wind screens along the perimeter of the terrace(s) are recommended, in combination with wind barriers inboard of the perimeters that are targeted around sensitive areas and canopies located above designated seating areas. Additionally, a canopy extending from select tower elevations above the Level 10 terrace may be beneficial to deflect downwash incident on the tower façades.

e. 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. 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
June 17, 2024
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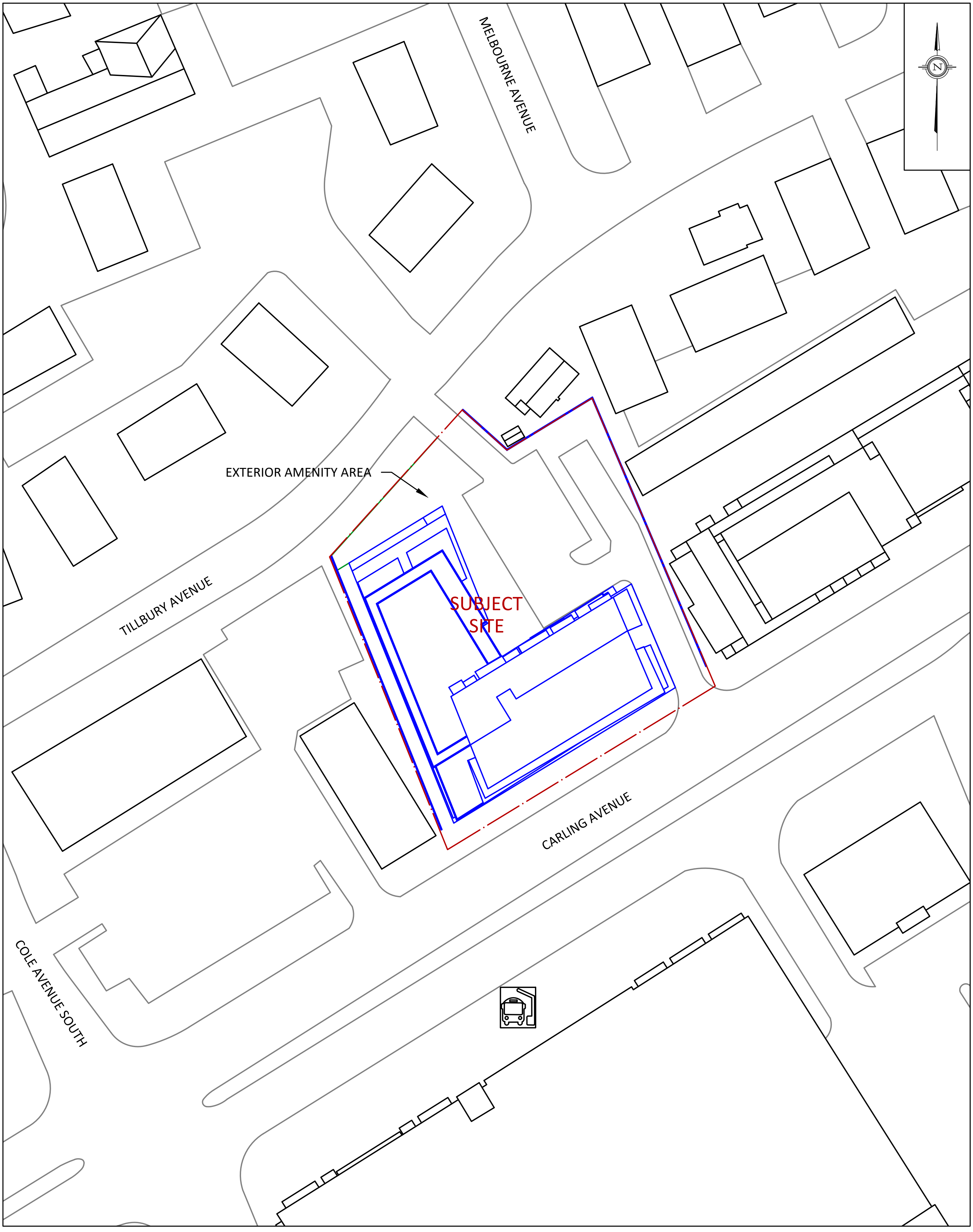

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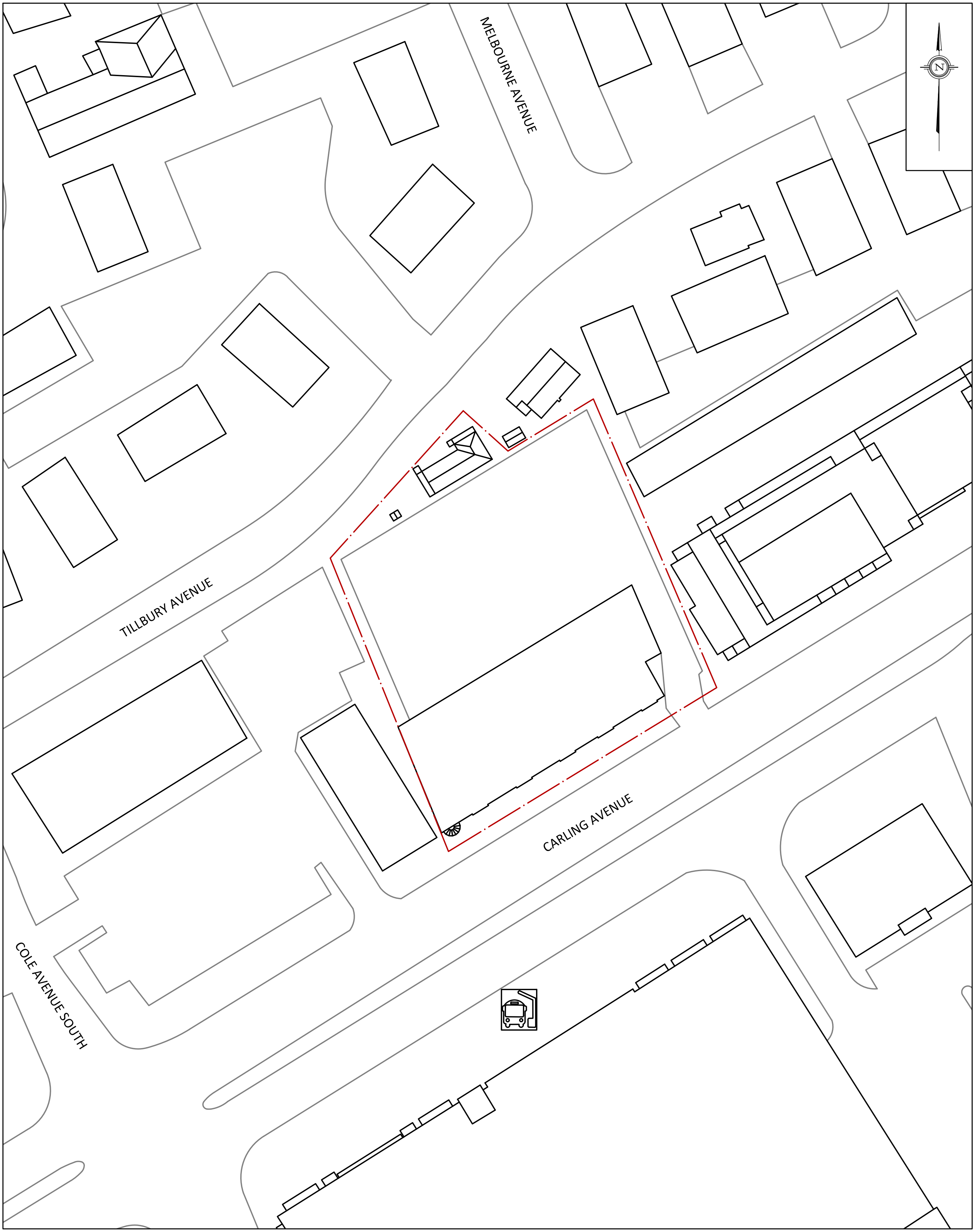
PROJECT: 1657-1673 CARLING AVE & 386 TILLBURY AVE, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 1A: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:1000	DRAWING NO.: 23-139-PLW-1A	
DATE: JUNE 17, 2024	DRAWN BY: T.K.	



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PROJECT: 1657-1673 CARLING AVE & 386 TILLBURY AVE, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:1000	DRAWING NO.: 23-139-PLW-1B	
DATE: JUNE 17, 2024	DRAWN BY: T.K.	

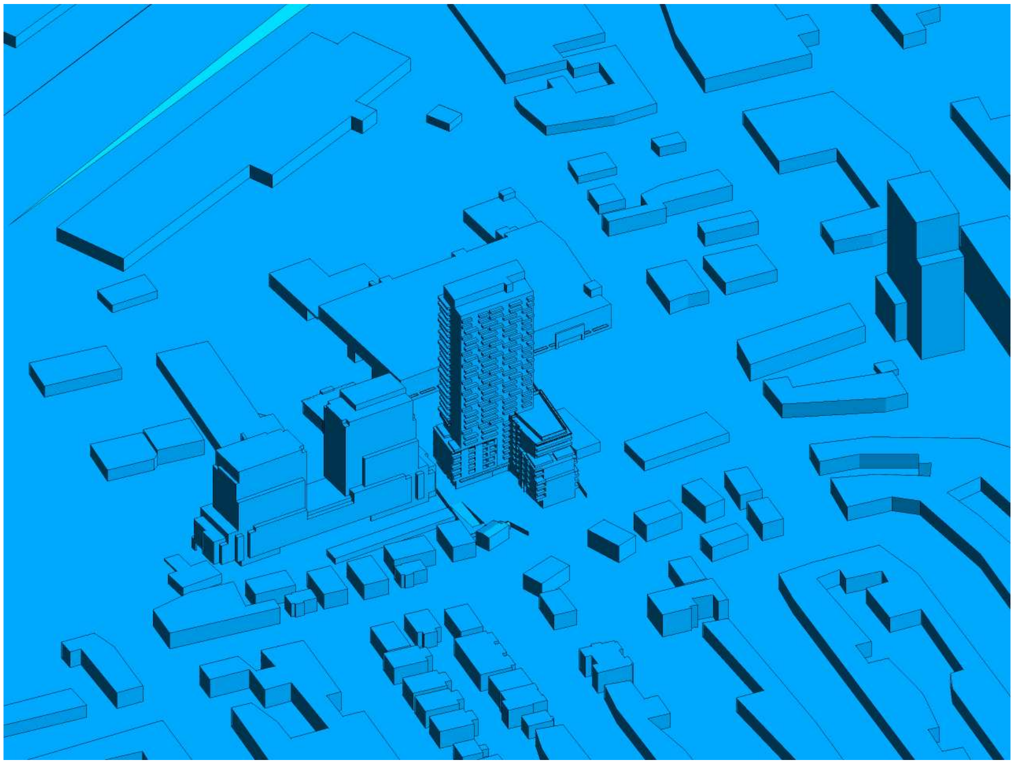


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

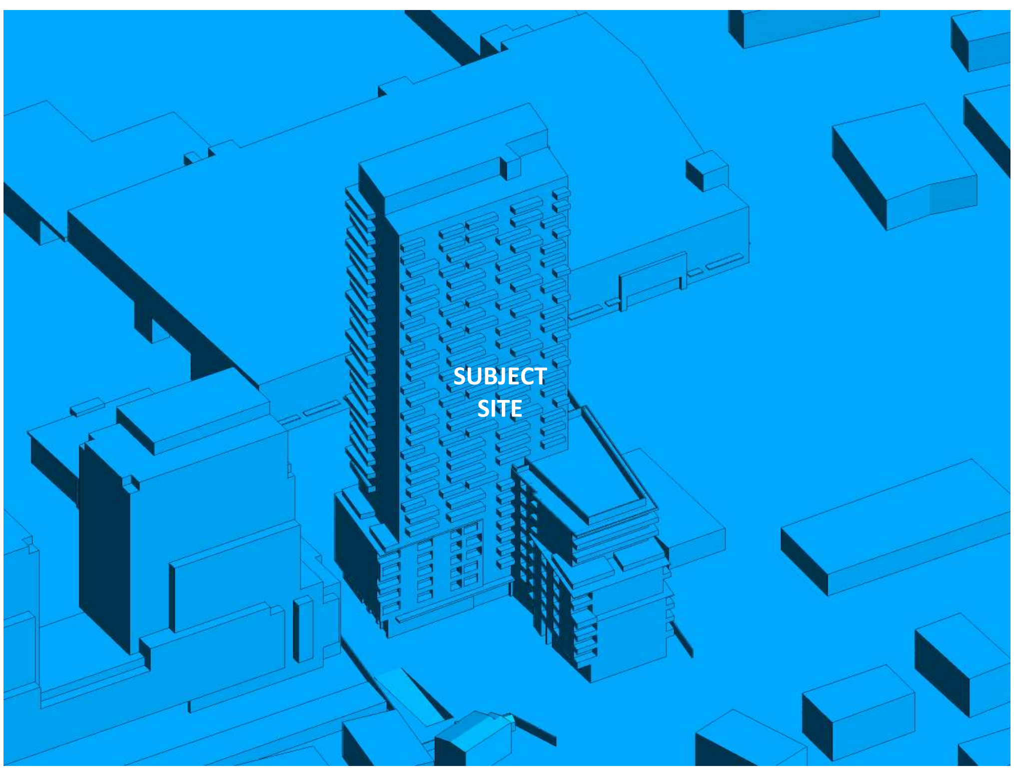


FIGURE 2B: CLOSE UP OF FIGURE 2A

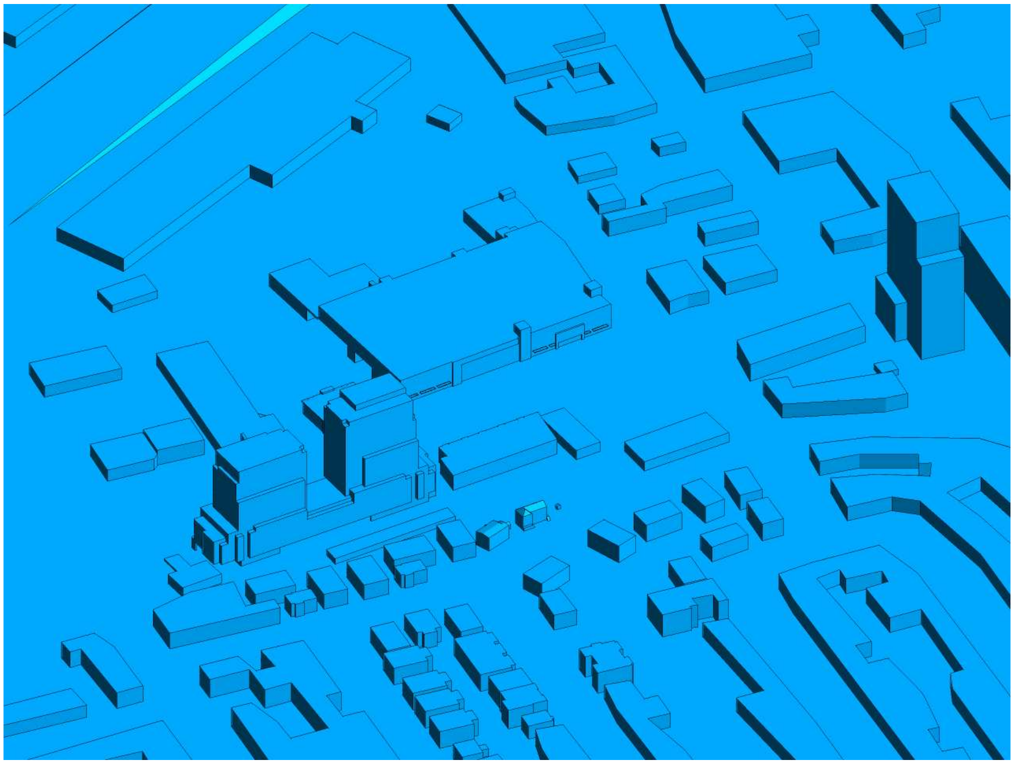


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

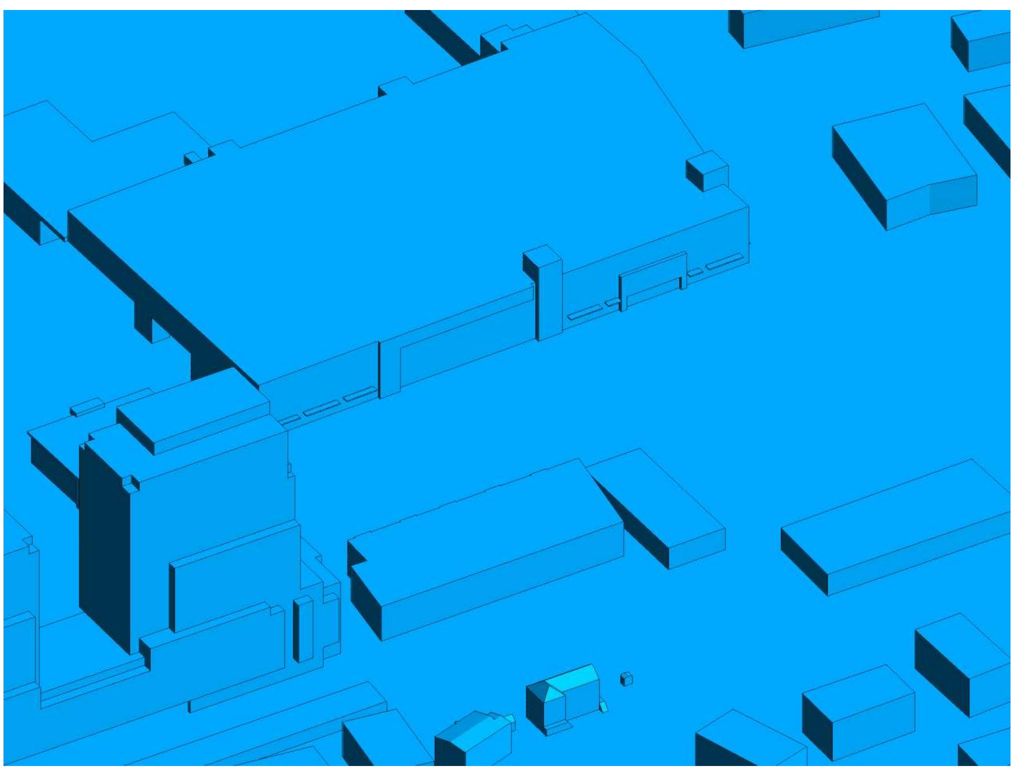


FIGURE 2D: CLOSE UP OF FIGURE 2C

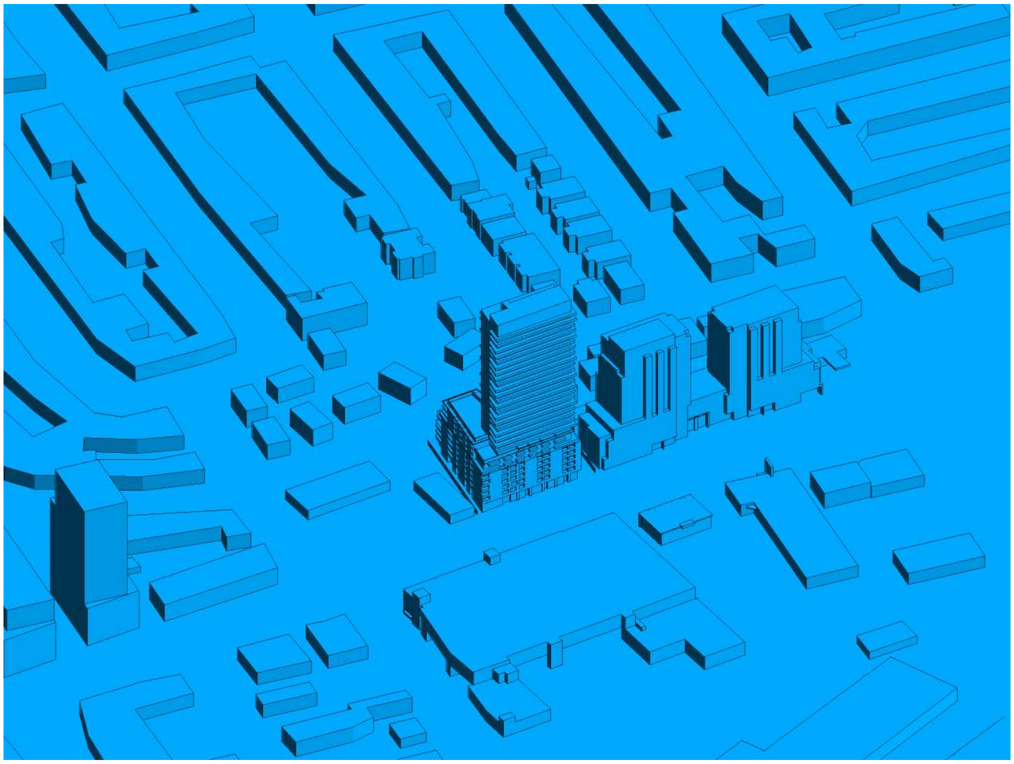


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

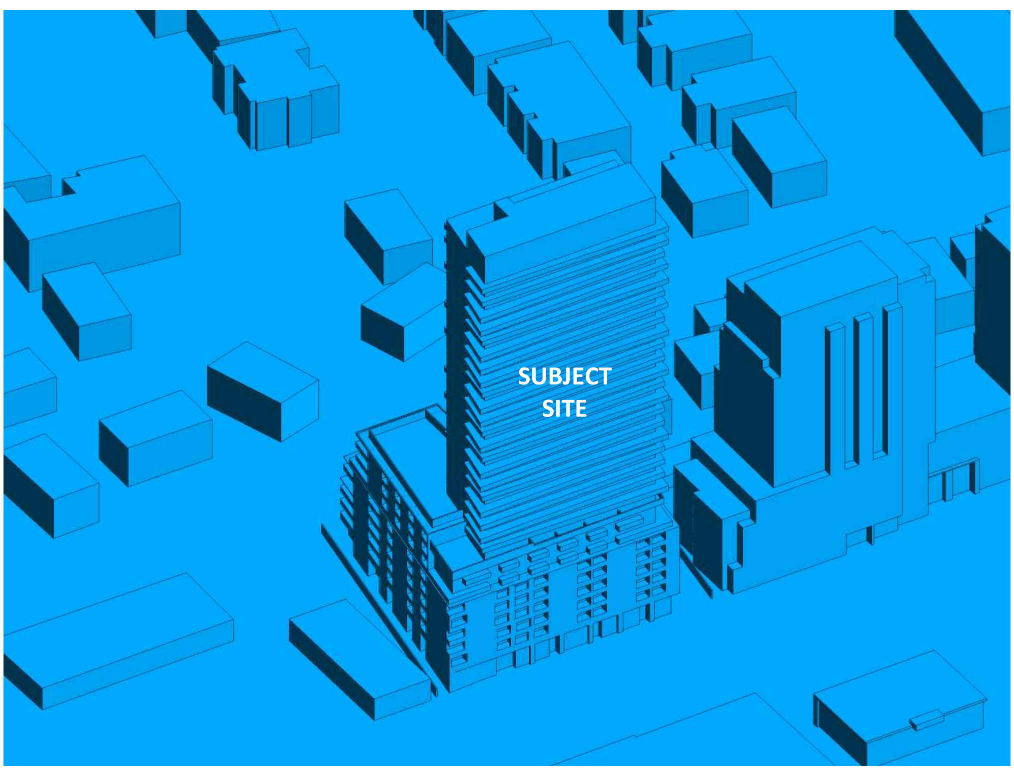


FIGURE 2F: CLOSE UP OF FIGURE 2E

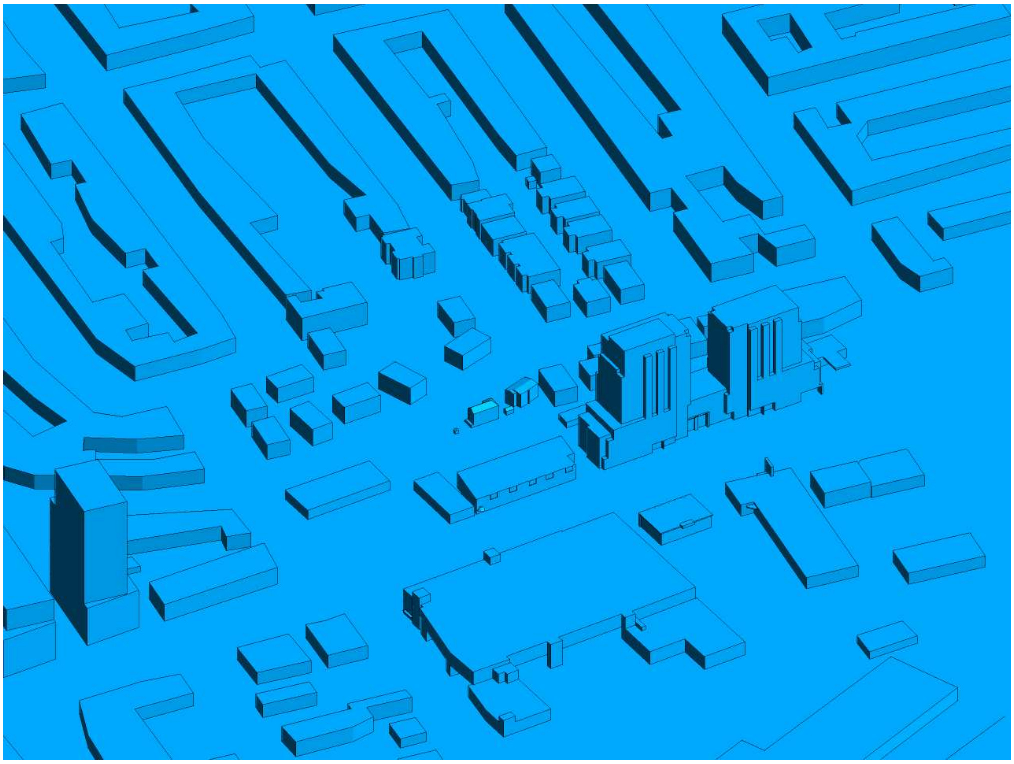


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

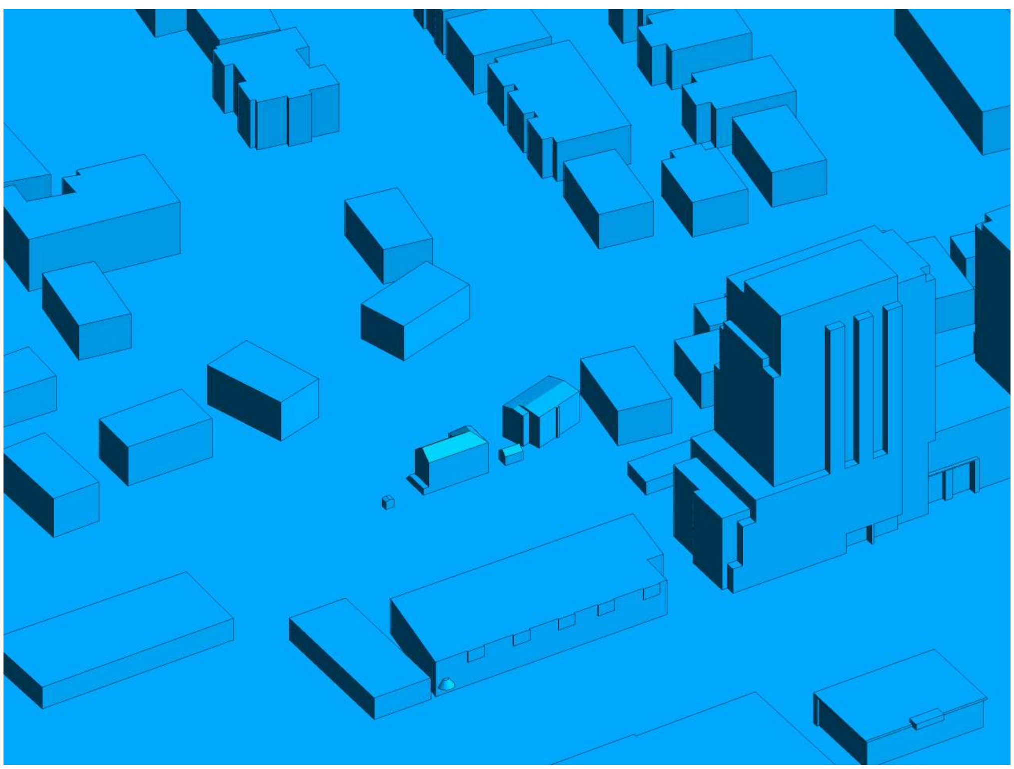


FIGURE 2H: CLOSE UP OF FIGURE 2G

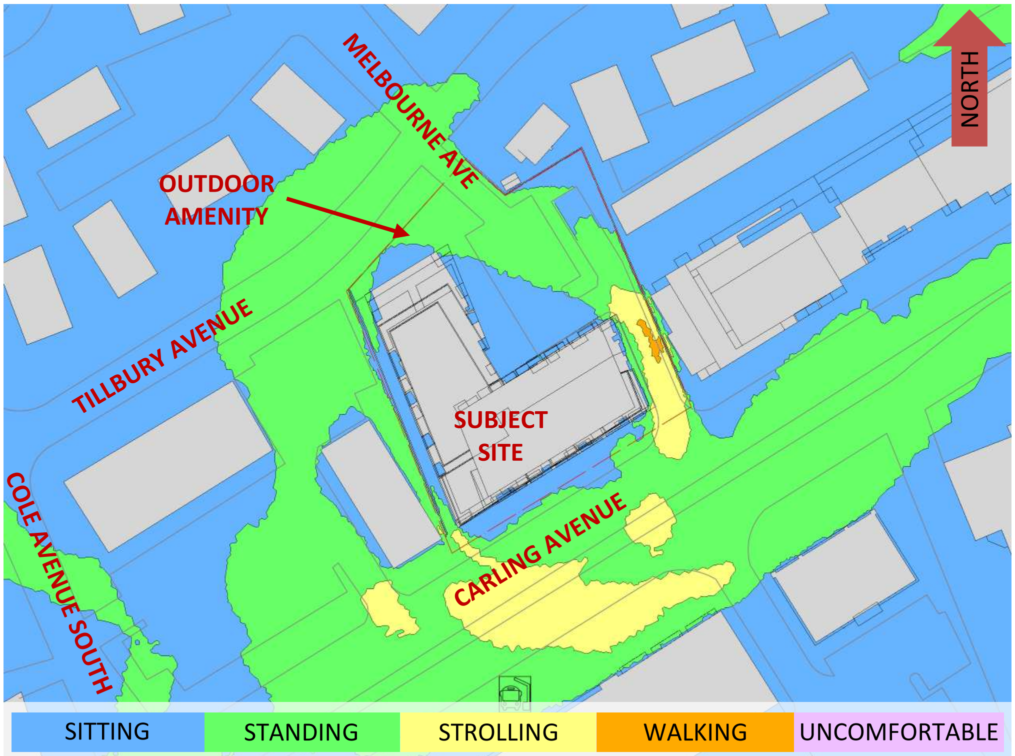


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

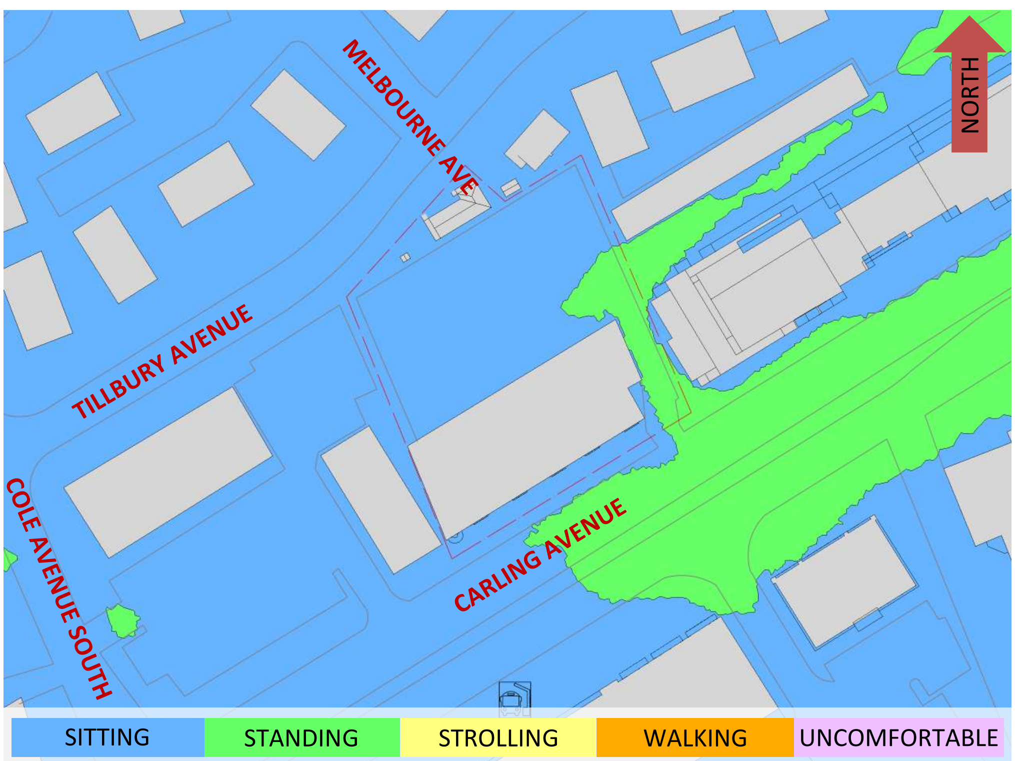


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

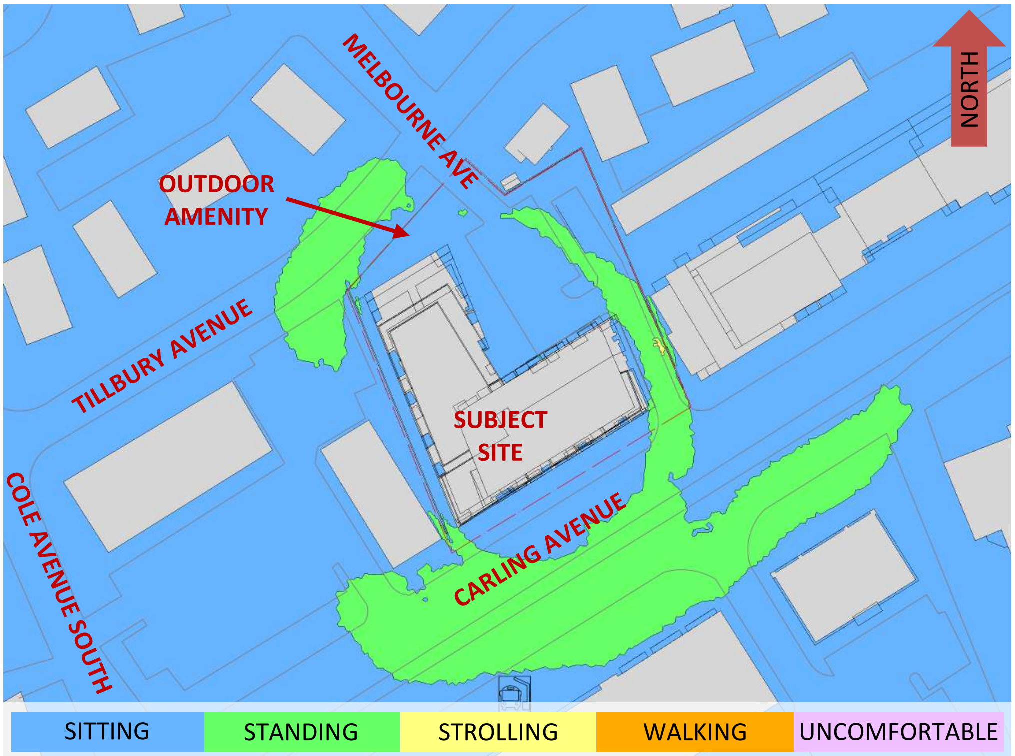


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

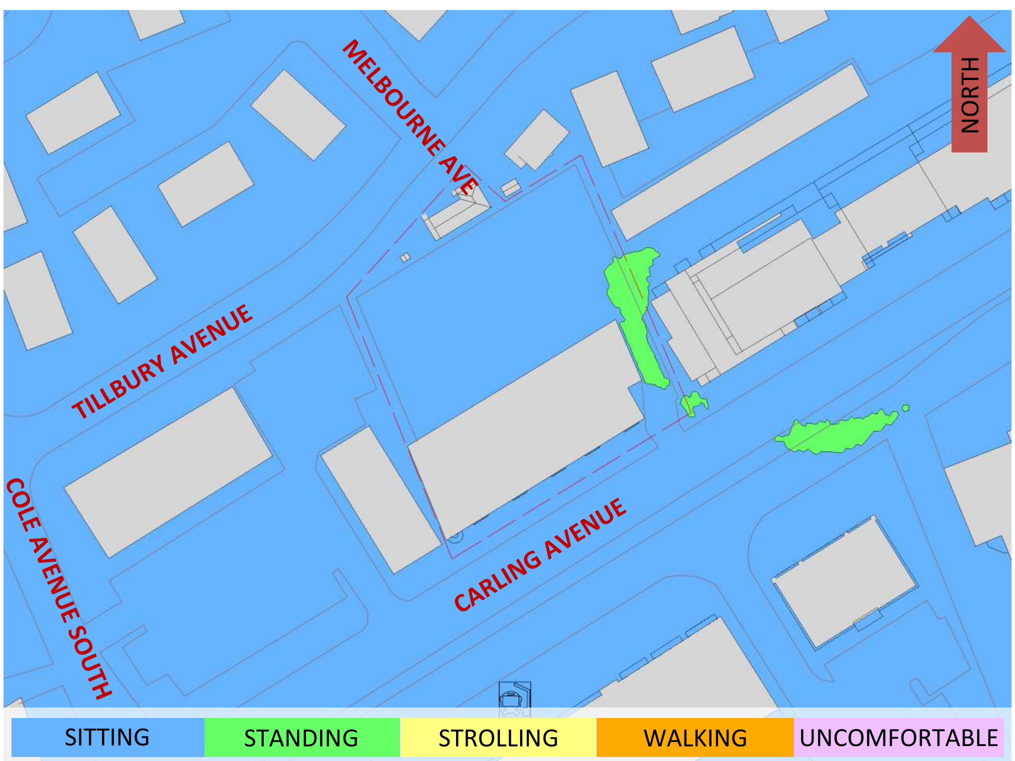


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

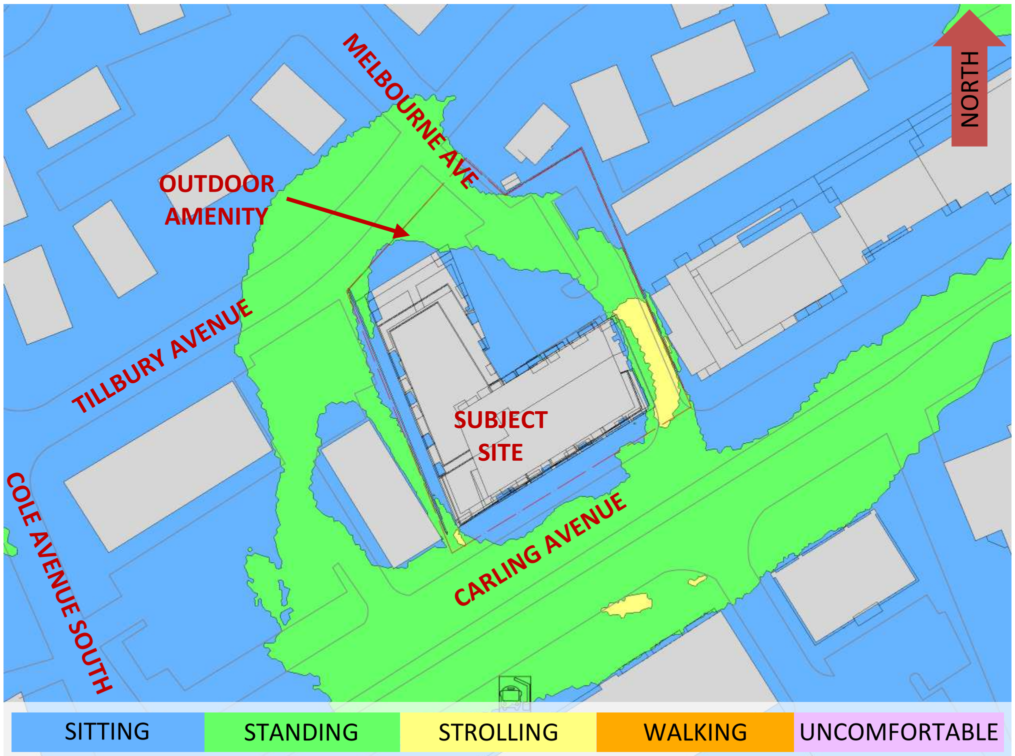


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

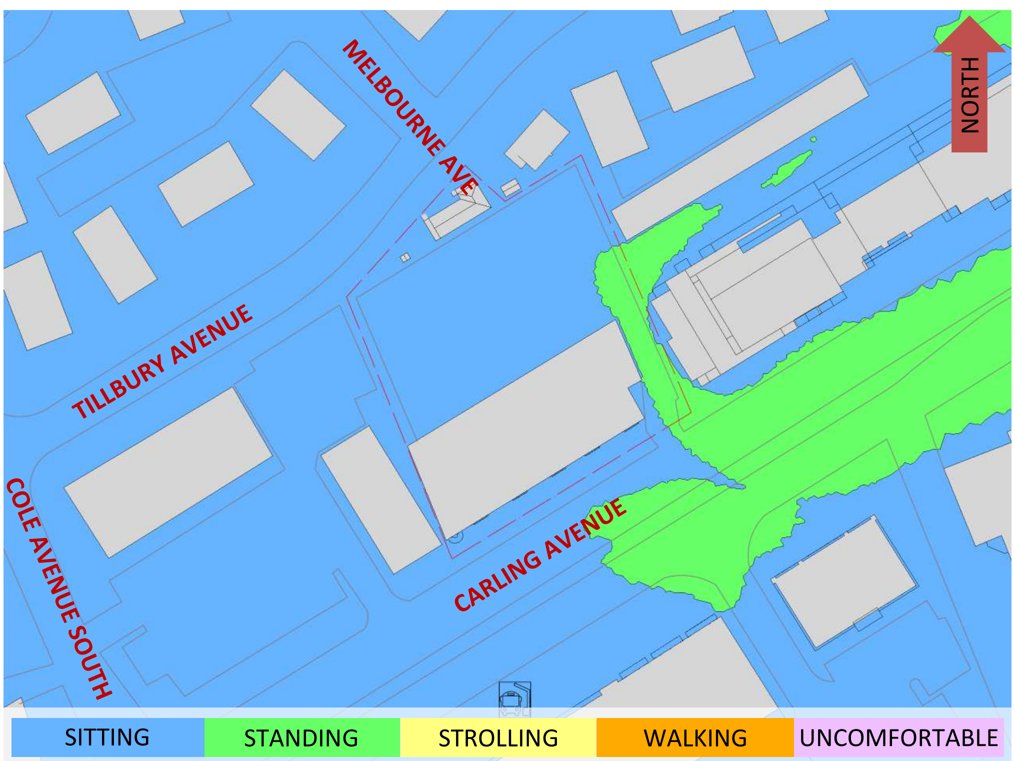


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

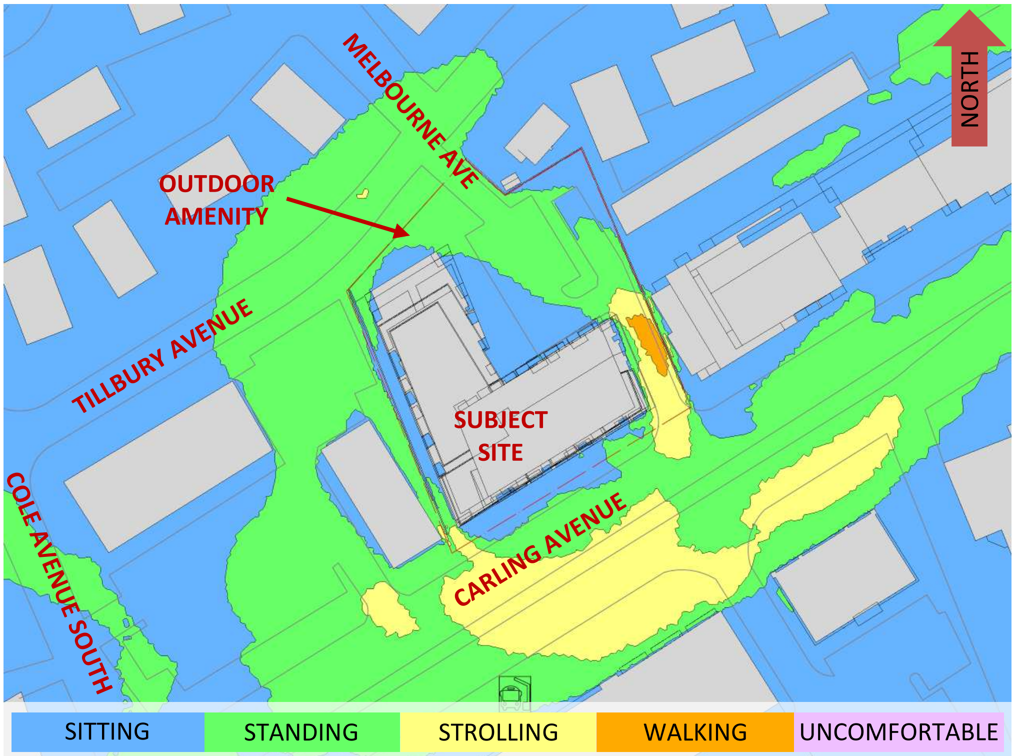


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

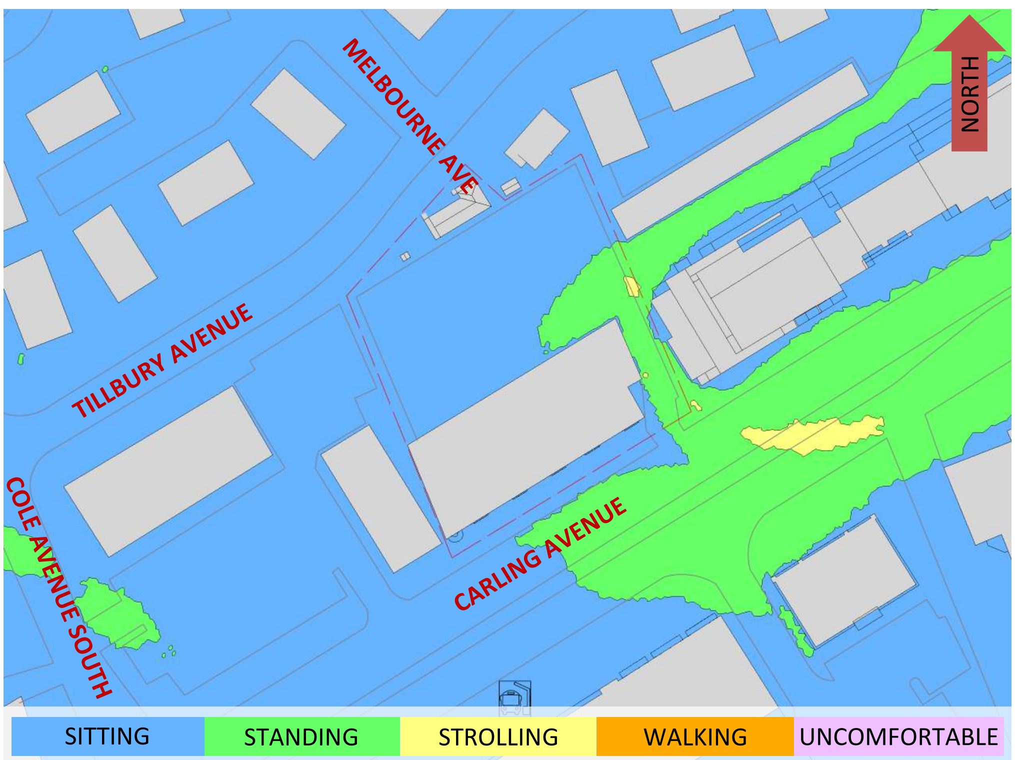


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

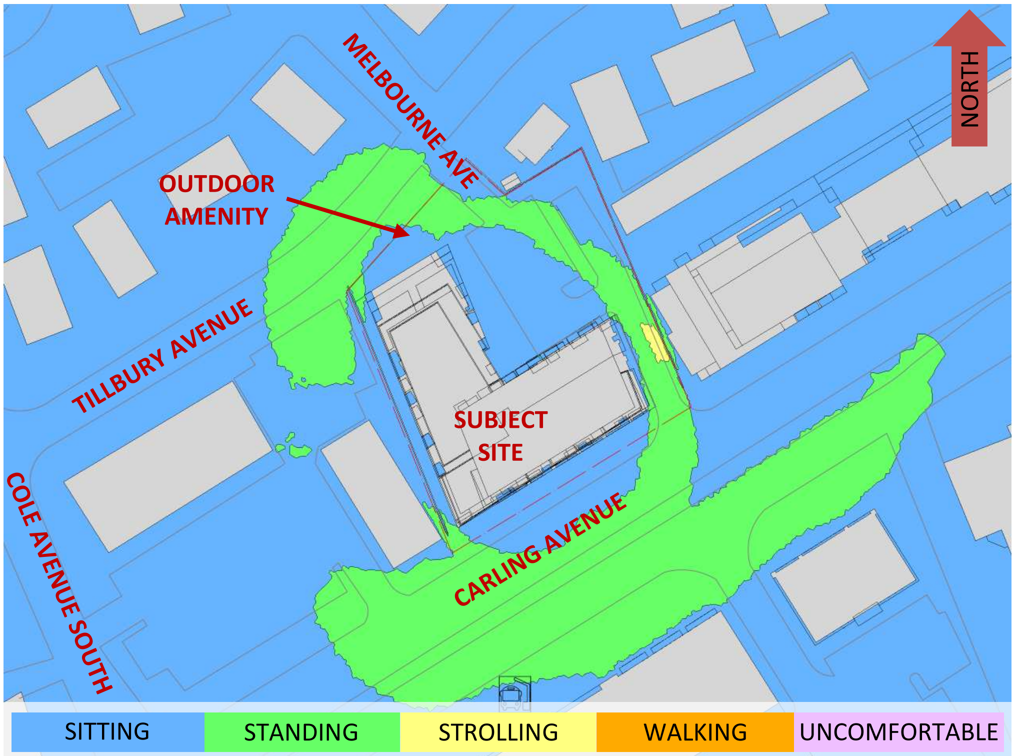


FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

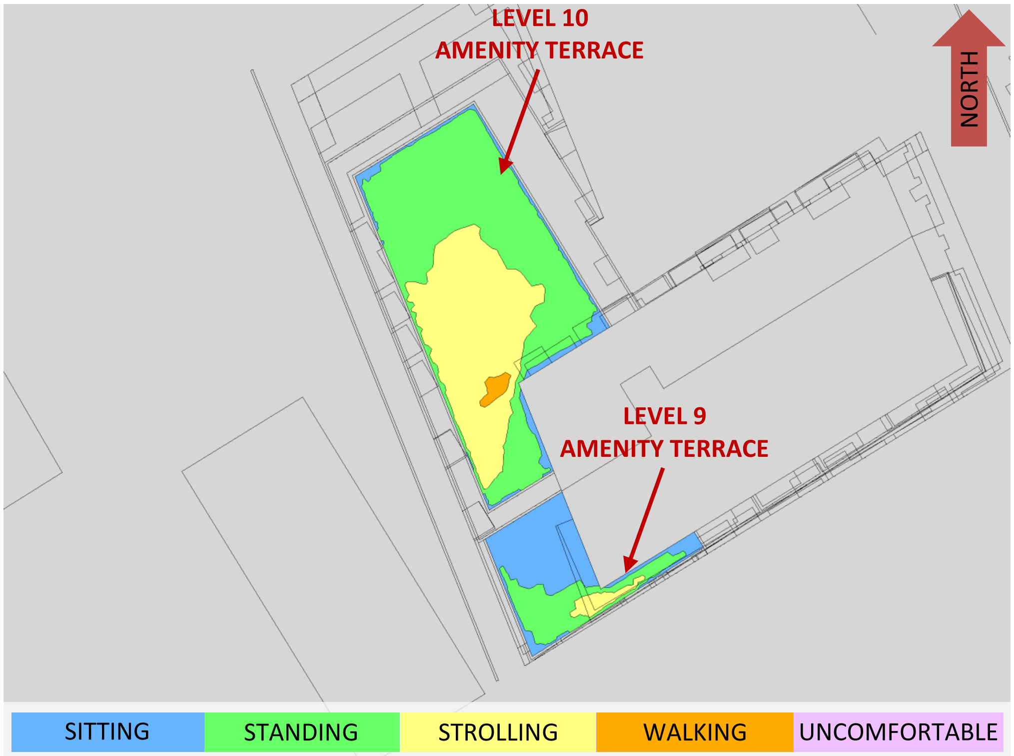


FIGURE 8A: SPRING – WIND COMFORT, COMMON AMENITY TERRACES

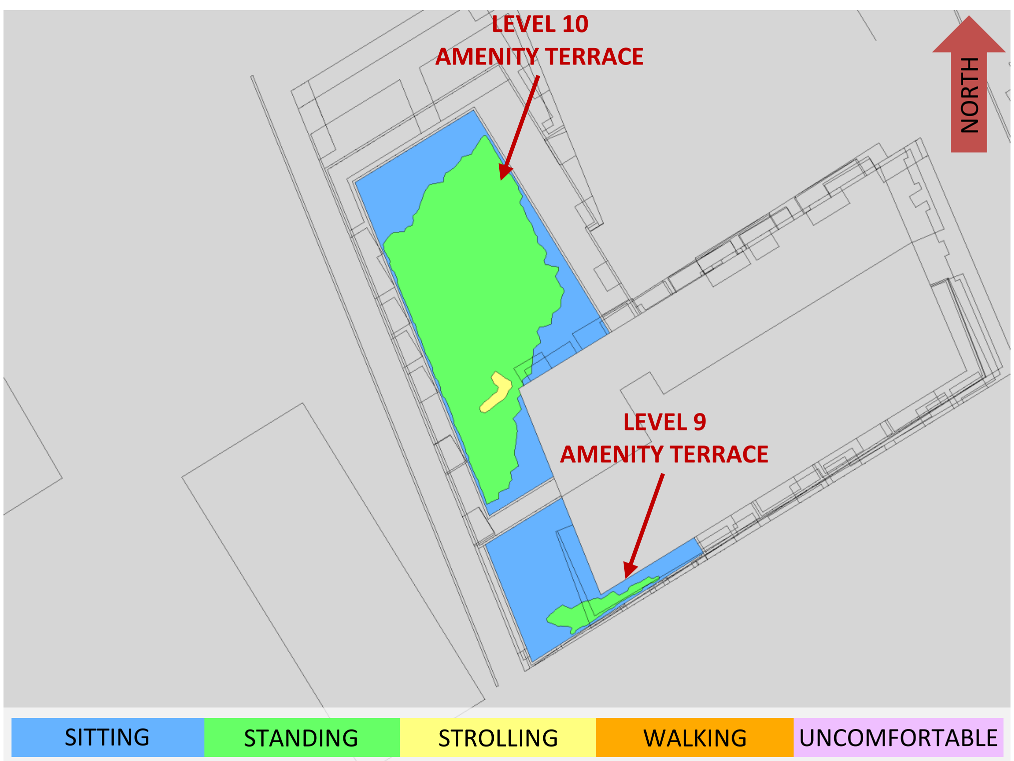


FIGURE 8B: SUMMER – WIND COMFORT, COMMON AMENITY TERRACES

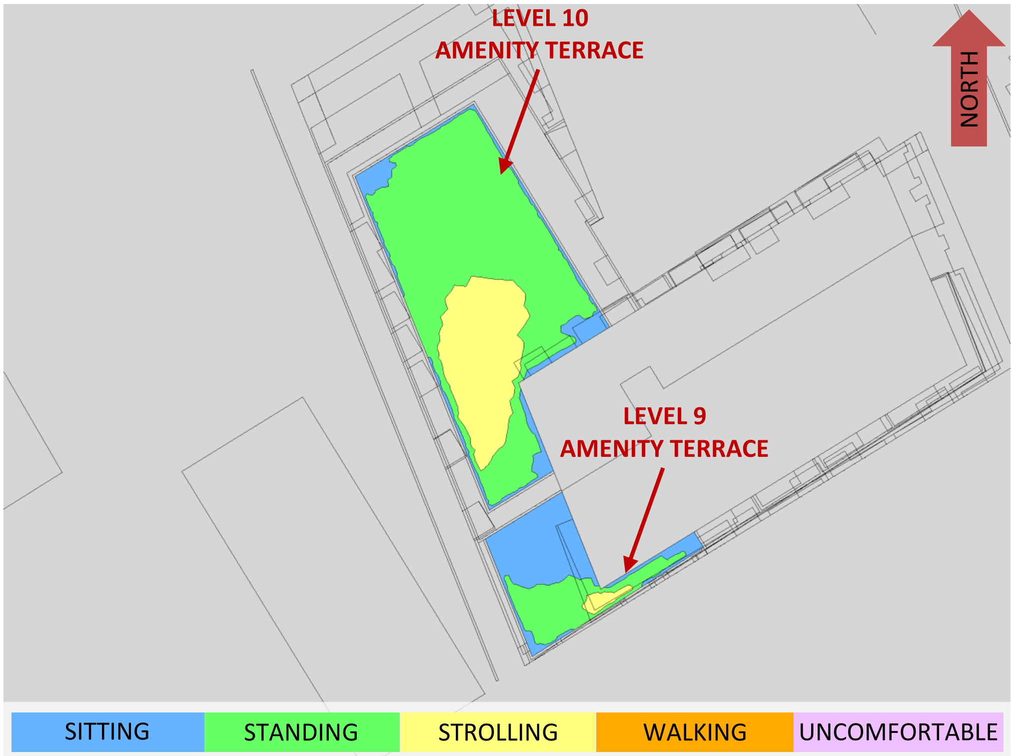


FIGURE 8C: AUTUMN – WIND COMFORT, COMMON AMENITY TERRACES

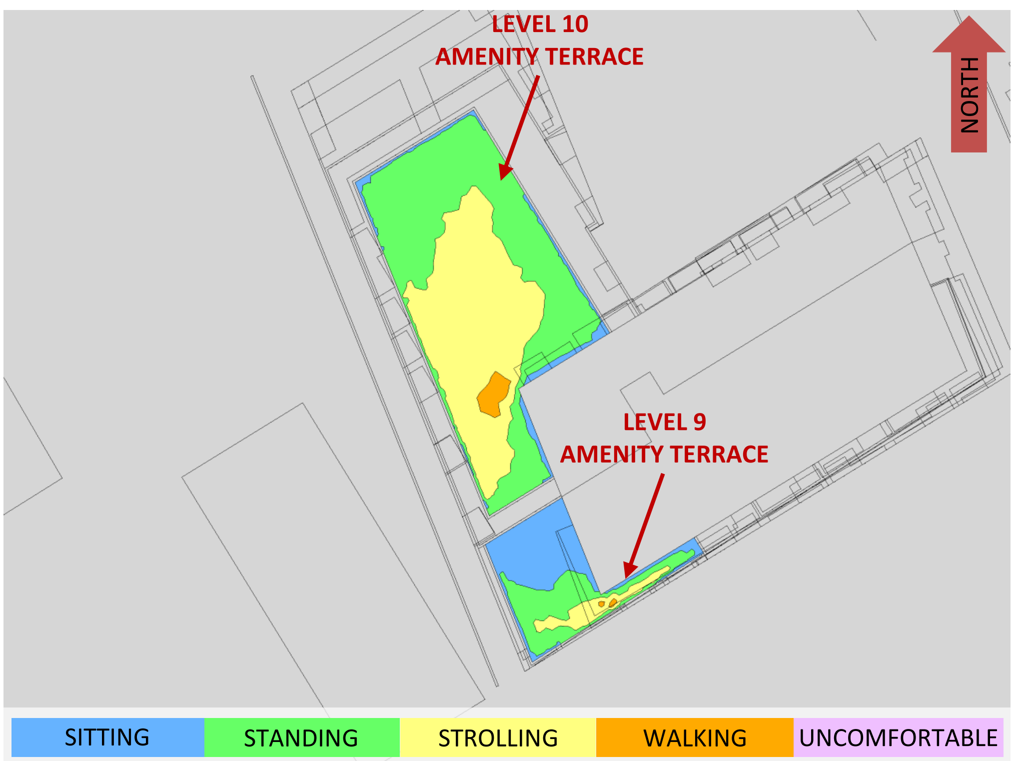


FIGURE 8D: WINTER – WIND COMFORT, COMMON AMENITY TERRACES

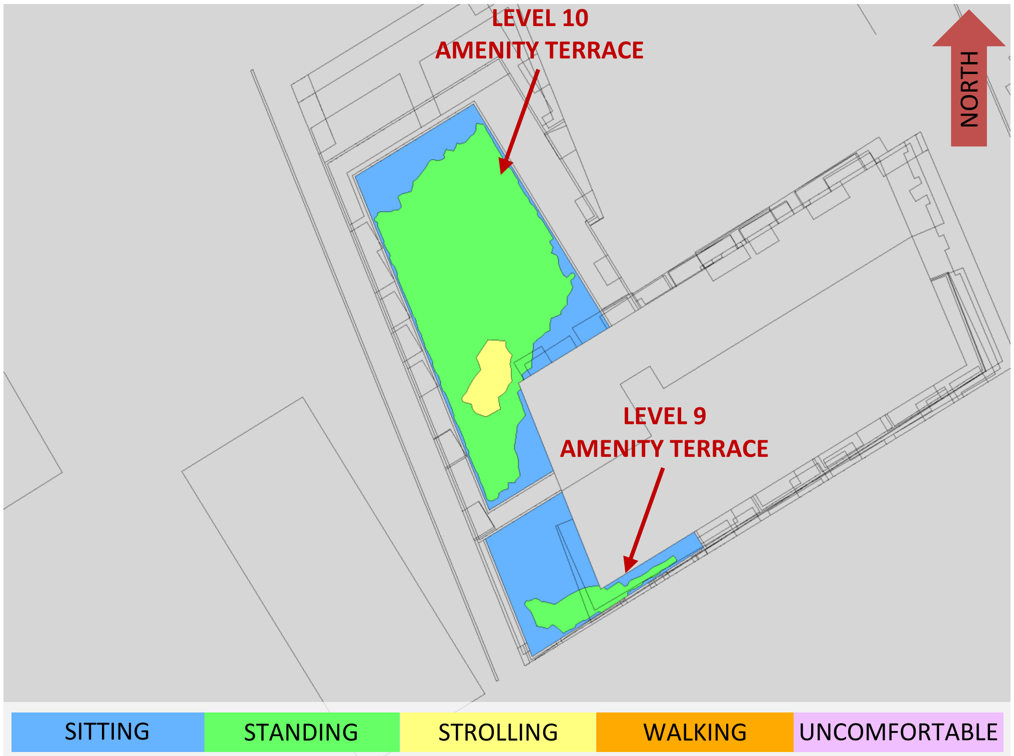
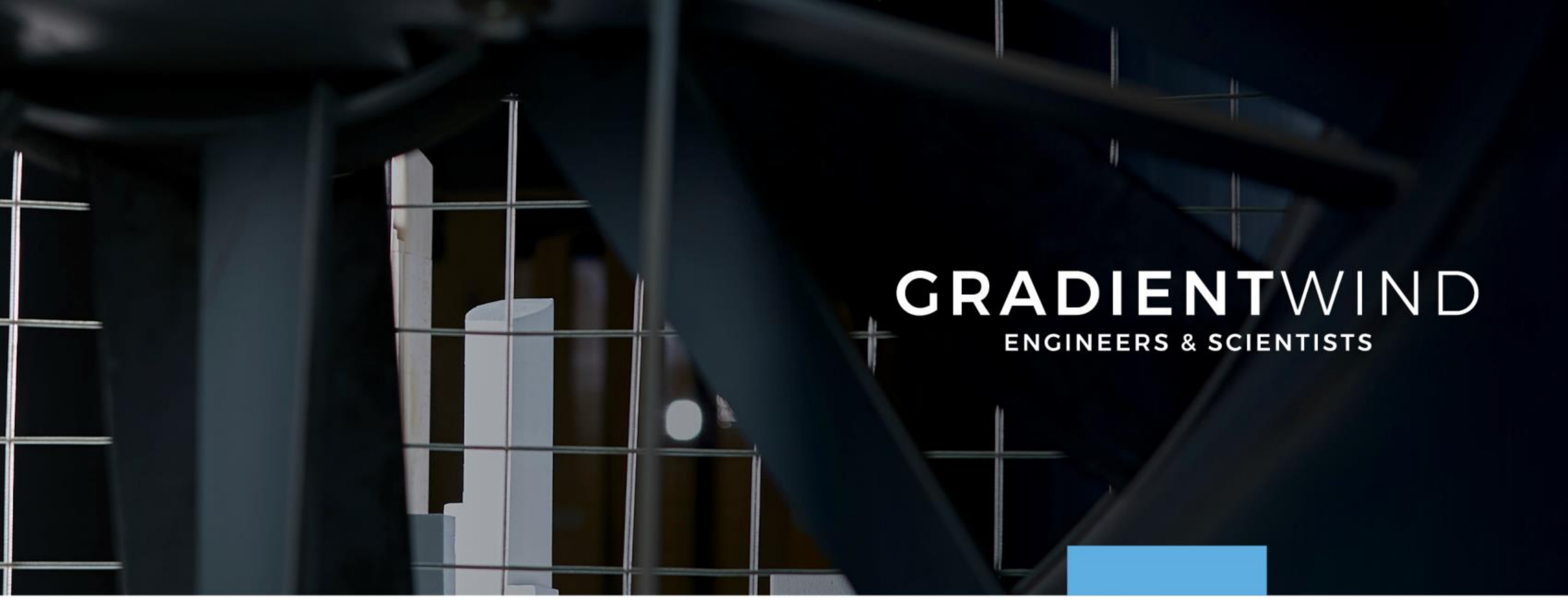
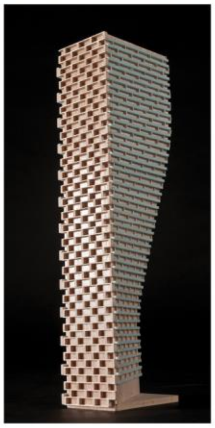
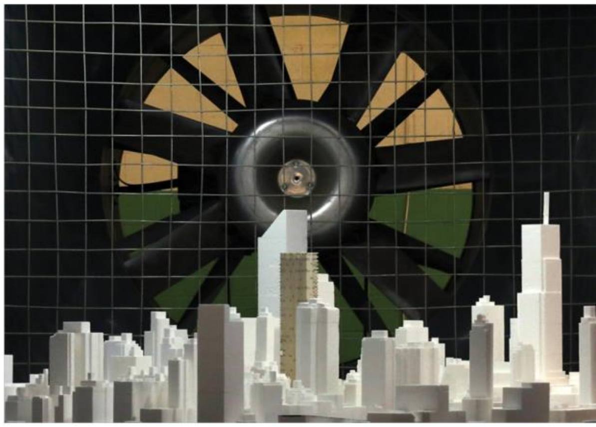


FIGURE 9: TYPICAL USE PERIOD – WIND COMFORT, COMMON AMENITY TERRACES







APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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

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

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

For the model, U_g is set to 6.5 metres per second, which approximately corresponds to the 60% mean wind speed for Ottawa based on historical climate data and statistical analyses. When the results are normalized by this velocity, they are relatively insensitive to the selection of gradient wind speed.

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

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

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

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

Wind Direction (Degrees True)	Alpha Value (α)
0	0.25
49	0.24
74	0.23
103	0.23
167	0.23
197	0.23
217	0.24
237	0.24
262	0.23
282	0.23
301	0.23
324	0.23

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.

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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.