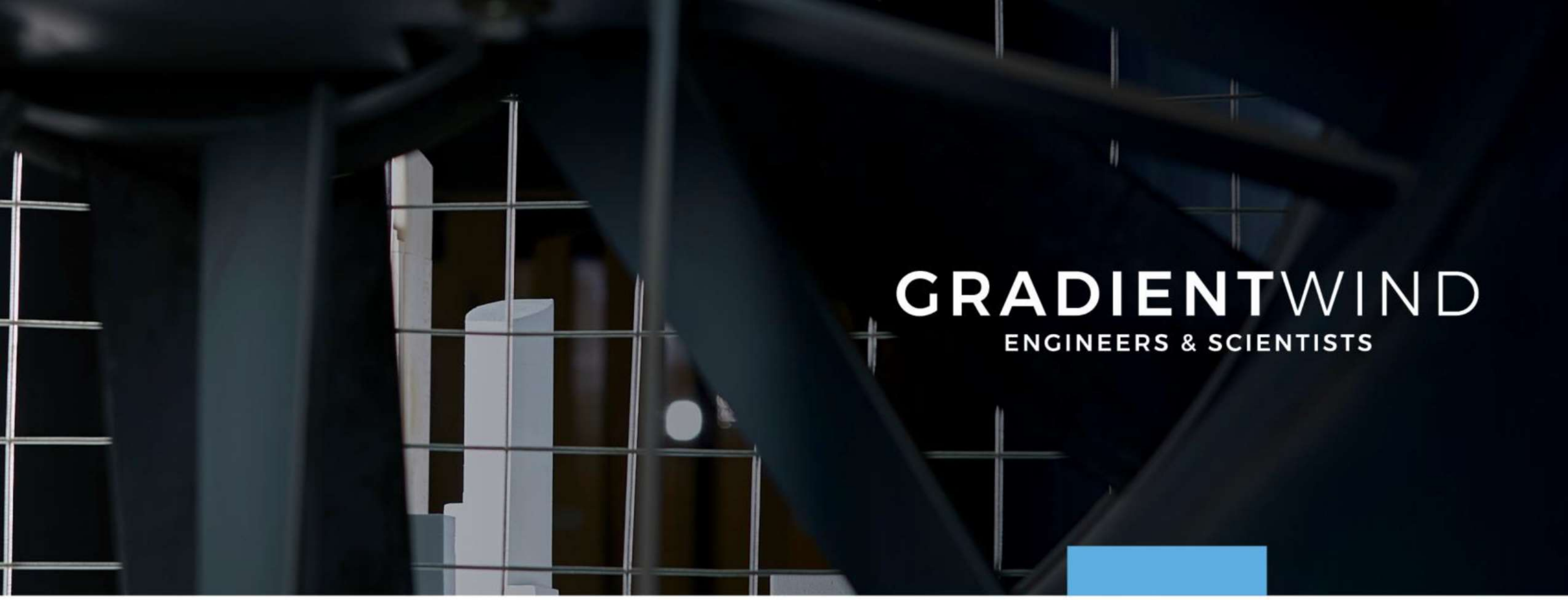

GRADIENTWIND
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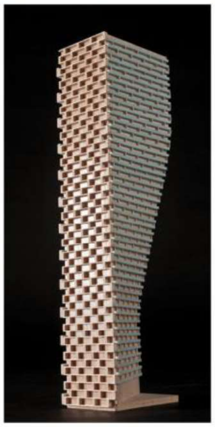
PEDESTRIAN LEVEL WIND STUDY

1296-1300 Carling Avenue
Ottawa, Ontario

Report: 25-123-PLW



December 8, 2025

PREPARED FOR
Ambassador Realty
185 Somerset Street West
Ottawa, ON K2P 0J2

PREPARED BY
Justin Denne, M.A.Sc., Junior Wind Scientist
David Huitema, M.Eng., P.Eng., CFD Lead Engineer

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 at 1296-1300 Carling 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 wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

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

1) Most areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Conditions over surrounding sidewalks, transit stops, neighbouring surface parking lots, proposed walkways, the proposed drive aisle, surface parking, and drop-off area, as well as in the vicinity of the loading bays and building access points, are considered acceptable.

2) During the spring and winter seasons, an isolated area of conditions that may be considered occasionally uncomfortable for walking is predicted in the vicinity of the north corner of the proposed development.

    a. The exceedance of the walking threshold over the noted area may be considered marginal and limited in extent and impact; as such, the conditions over the area may be considered satisfactory. Furthermore, wind conditions over the area will be improved following the introduction of the high-density massing comprising the proposed redevelopment of the Westgate Shopping Centre at 1309 Carling Avenue.

3) During the typical use period (that is, May to October, inclusive,) wind comfort conditions within the Level 3 common amenity terraces are predicted to be suitable for mostly sitting, with standing conditions predicted around the west and north corners of the north tower. The noted conditions may be considered acceptable if the windier areas will not include programmed seating activities.

    a. If required by programming, mitigation may take the form of 1.8-m-tall wind screens around the northern perimeter of the terrace in combination with inboard mitigation, such as wind screens, free-standing canopies/trellises, dense arrangements of plantings in tall planters, and other common landscape elements.

    b. The extent of mitigation measures is dependent on the programming of the terrace. If required by programming, the mitigation strategy may be confirmed as the design of the proposed development progresses towards the Site Plan Control application stage.

4) 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.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Ambassador Realty 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 at 1296-1300 Carling Avenue in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within the current study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by Architects DCA Inc. in August 2025, 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 1296-1300 Carling Avenue in Ottawa, situated approximately 120 metres (m) to the southwest from the intersection of Carling Avenue and Merivale Road on a parcel of land bordered by Carling Avenue to the northwest, a low-rise hotel with a surface parking lot to the east, low-rise residential dwellings to the southeast, and an existing high-rise residential building with a surface parking lot to the southwest. The proposed development comprises a north and south tower rising to 28 storeys and 8 storeys, respectively, above a common 2-storey podium. Each tower is topped with a mechanical penthouse (MPH).

Above five levels of underground parking, the ground floor comprises a 'C'-shaped planform with its long axis-oriented to the northeast. The ground floor includes residential lobbies central to each tower connected via a corridor and an indoor amenity, retail space fronting Carling Avenue to the northwest, bike storage at the east corner, and building support spaces throughout the remainder of the floor. A drive aisle extends from Carling Avenue along the southwest elevation of the subject site, providing access to a drop-off area and surface parking within the 'C'-shaped planform, an underground parking ramp beneath the south tower, and loading spaces beneath each tower.

Level 2 is open to below to the northwest with amenity space programmed along the northeast elevation and at the south corner and bike storage at the east corner. Atop the 2-storey podium at Level 3, the north and south towers comprise nominally rectangular planforms where the south corner of the north tower overhangs the drop-off area below. At this level, the north tower is reserved for indoor amenities while the south tower includes an indoor amenity at the north corner and residential units throughout the remainder of the level. Common amenity terraces are located atop the 2-storey podium, accessible via the indoor amenities. At Level 4, the north tower overhangs Level 3 from all elevations while the south tower overhangs Level 3 from the west elevation and steps back from the north and south corner, accommodating private terraces. The remaining levels of each tower rise with a nominally rectangular planform and are programmed for residential units.

The near-field surroundings (defined as an area within 200 m of the subject site) include a low-rise hotel with a surface parking lot to the east, low-rise commercial buildings with surface parking and low-rise residential dwellings from the east clockwise to the south, a surface parking lot followed by low-rise residential dwellings to the southwest, a mix of low- and high-rise buildings and surface parking to the west-southwest, Carling Avenue followed by the Westgate Shopping Centre and surface parking to the northwest, and a high-rise building to the north. Notably, a development comprising five towers (ranging in height from 24 to 36 storeys) is proposed within the lands currently occupied by the Westgate Shopping Centre at 1309 Carling Avenue. 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 suburban massing in all directions with the open fields of the Central Experimental Farm from the east clockwise to the south, approximately 750 m to the east-northeast, and isolated mid- and high-rise buildings in all directions. Notably, Highway 417 is oriented southwest-northeast approximately 200 m to the northwest followed by Hampton Park.

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 developments which have been 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/documents/files/wind_analysis_tor_en.pdf

4.2 Wind Speed Measurements

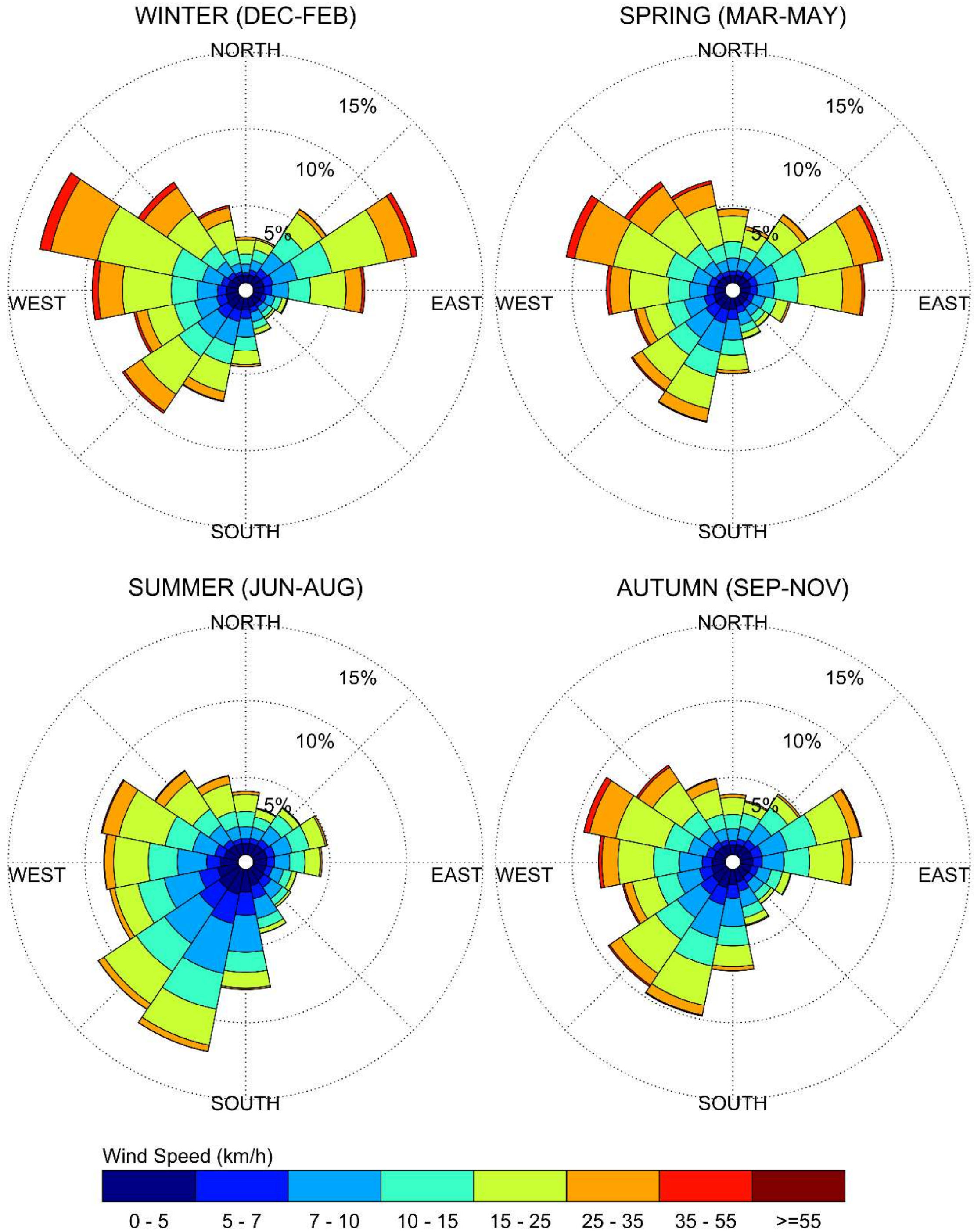
The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 16 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 480 m. The process was performed for two context 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 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 during the appropriate hours of pedestrian usage (that is, between 06:00 and 23:00) and divided into four distinct seasons, as stipulated in the wind criteria. Specifically, the spring season is defined as March through May, the summer season is defined as June through August, the autumn season is defined as September through November, and the winter season is defined as December through February, inclusive.

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 WIND COMFORT CLASSES FOR VARIOUS LOCATION TYPES

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

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-6B, which illustrate wind conditions at grade level for the proposed and existing massing scenarios and by Figures 7A-D, which illustrate wind conditions over the common amenity terrace serving the proposed development at Level 3. 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. Figure 8 illustrates wind comfort conditions within the Level 3 common amenity terrace serving the proposed development during this period, 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

The mostly low-rise environs surrounding the subject site modestly expose the proposed development to prevailing winds, particularly those from the northwest directions and the east-northeast during the spring and winter seasons, which are predicted to downwash over the northwest and northeast facades of the north tower and accelerate around the north corner at grade.

During the spring and winter seasons, an isolated region of conditions that may be considered occasionally uncomfortable for walking is predicted around the north corner of the proposed development during the spring and winter seasons, affecting a limited area of the nearby proposed walkways and the neighbouring surface parking lot. The noted region of windier conditions is predicted to be suitable for walking at least 77% and 79% of the time during the spring and winter seasons, representing exceedances of 3% and 1% of the walking criterion threshold, respectively.

Given the marginal exceedance of the walking threshold, the limited impact on the public realm, and noting that these conditions are located over a region that is currently occupied by existing deciduous plantings located outside of the boundaries of the subject site, the noted conditions may be considered as satisfactory. Furthermore, these isolated uncomfortable conditions will be ameliorated following the introduction of the future high-density massing that is proposed in place of the Westgate Shopping Centre at 1309 Carling Avenue.

Sidewalks along Carling Avenue: Under the existing massing scenario, wind comfort conditions over the nearby public sidewalks along Carling Avenue are predicted to be suitable for strolling, or better, during the spring, autumn, and winter seasons, and suitable for standing, or better, during the summer.

Following the introduction of the proposed development, wind conditions over the noted sidewalks during the spring, autumn, and winter seasons are predicted to be suitable for mostly strolling, or better, with walking conditions predicted around the north corner of the proposed development during the spring and winter seasons. During the summer, wind conditions over the nearby sidewalks are predicted to remain suitable for standing, or better. The noted conditions are considered acceptable for public sidewalks.

Transit Stops along Carling Avenue: Prior to and following the introduction of the proposed development, wind conditions in the vicinity of the nearby westbound transit stop along Carling Avenue are predicted to be suitable for standing, or better, throughout the year, while conditions in the vicinity of the eastbound stop are predicted to be suitable for strolling, or better, throughout the year prior to the introduction of the proposed development, becoming suitable for standing, or better, throughout the year following the introduction of the proposed development. The noted conditions are considered acceptable under the proposed massing scenario.

Sidewalks and Transit Stops along Merivale Road: Prior to and following the introduction of the proposed development, conditions over the nearby public sidewalks along Merivale Road and Thames Street, as well as conditions in the vicinity of the nearby transit stops along Merivale Road, are predicted to be suitable for standing, or better, throughout the year. The noted conditions are considered acceptable for public sidewalks and transit stops.

Neighbouring Surface Parking Lots: Under the existing massing scenario, the nearby neighbouring surface parking lots are predicted to be suitable for mostly strolling, or better, throughout the year, becoming suitable for walking, or better, throughout the year following the introduction of the proposed development. While the introduction of the proposed development introduces modestly windier conditions, the noted conditions are nevertheless considered acceptable for surface parking lots.

Proposed Walkways within the Subject Site: Wind comfort conditions over the proposed walkways within the subject site are predicted to be suitable for mostly walking, or better, during the spring and winter. During the summer and autumn, wind conditions are predicted to be suitable for strolling, or better. The noted conditions may be considered acceptable.

Proposed Drive Aisle, Surface Parking, Drop-Off Area, and Loading Areas within the Subject Site: Wind conditions over the proposed drive aisle, surface parking, drop-off area, and in the vicinity of the loading areas are predicted to be suitable for strolling, or better, during the summer and autumn and walking, or better, during the spring and winter seasons. The noted conditions are considered acceptable.

Building Access Points: Owing to the protection of the building façade, conditions in the vicinity of the primary and secondary building access points serving the proposed development are predicted to be suitable for standing, or better, and walking, or better, throughout year, respectively. Of note, conditions in the vicinity of the primary residential lobby entrances are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable.

5.2 Wind Comfort Conditions – Level 3 Common Amenity Terraces

During the typical use period (that is, May to October, inclusive), wind comfort conditions within the Level 3 common amenity terraces are predicted to be suitable for mostly sitting, with standing conditions predicted around the west and north corners of the north tower. The noted conditions may be considered acceptable if these isolated windier areas will not accommodate sedentary activities.

If required by programming, wind conditions may be improved by implementing wind screens at least 1.8 m in height from the local walking surface around the northern perimeter of the terrace in combination with inboard mitigation, such as wind screens, free-standing canopies/trellises, dense arrangements of plantings in tall planters, and other common landscape elements. The extent of mitigation measures is dependent on the programming of the terrace.

5.3 Wind Safety

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

5.4 Applicability of Results

Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the subject site. Future changes (that is, construction or demolition) of these surroundings may cause changes to the wind effects in two ways, namely: (i) changes beyond the immediate vicinity of the subject site would alter the wind profile approaching the subject site; and (ii) development in proximity to the subject site would cause changes to local flow patterns.

6. CONCLUSIONS AND RECOMMENDATIONS

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

1) Most areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Conditions over surrounding sidewalks, transit stops, neighbouring surface parking lots, proposed walkways, the proposed drive aisle, surface parking, and drop-off area, as well as in the vicinity of the loading bays and building access points, are considered acceptable.

2) During the spring and winter seasons, an isolated area of conditions that may be considered occasionally uncomfortable for walking is predicted in the vicinity of the north corner of the proposed development.

    a. The exceedance of the walking threshold over the noted area may be considered marginal and limited in extent and impact; as such, the conditions over the area may be considered satisfactory. Furthermore, wind conditions over the area will be improved following the introduction of the high-density massing comprising the proposed redevelopment of the Westgate Shopping Centre at 1309 Carling Avenue.

3) During the typical use period (that is, May to October, inclusive,) wind comfort conditions within the Level 3 common amenity terraces are predicted to be suitable for mostly sitting, with standing conditions predicted around the west and north corners of the north tower. The noted conditions may be considered acceptable if the windier areas will not include programmed seating activities.

    a. If required by programming, mitigation may take the form of 1.8-m-tall wind screens around the northern perimeter of the terrace in combination with inboard mitigation, such as wind screens, free-standing canopies/trellises, dense arrangements of plantings in tall planters, and other common landscape elements.

b. The extent of mitigation measures is dependent on the programming of the terrace. If required by programming, the mitigation strategy may be confirmed as the design of the proposed development progresses towards the Site Plan Control application stage.

4) 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
D. T. HUITEMA
100561777
December 08, 2025
PROVINCE OF ONTARIO

Justin Denne, M.A.Sc.
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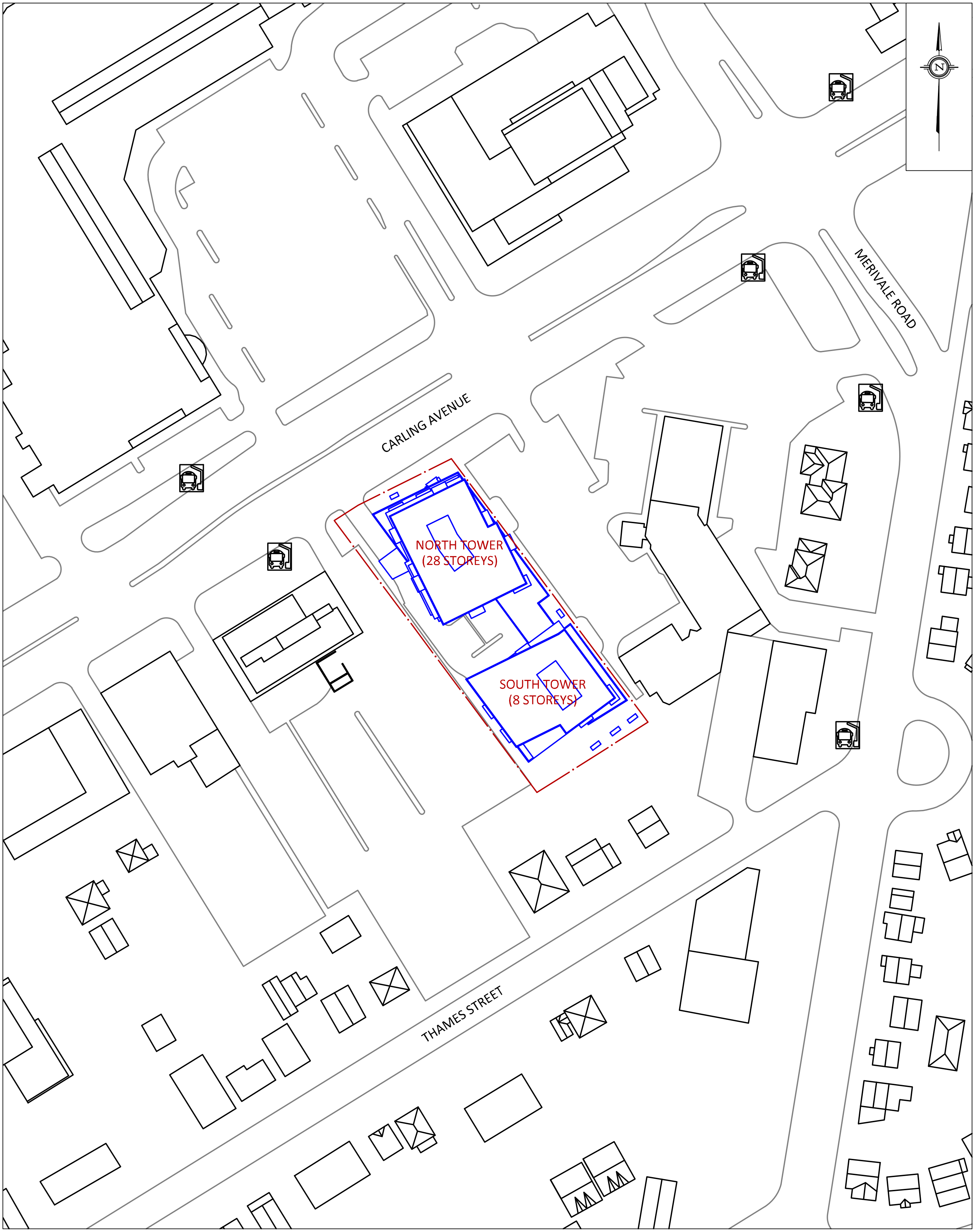

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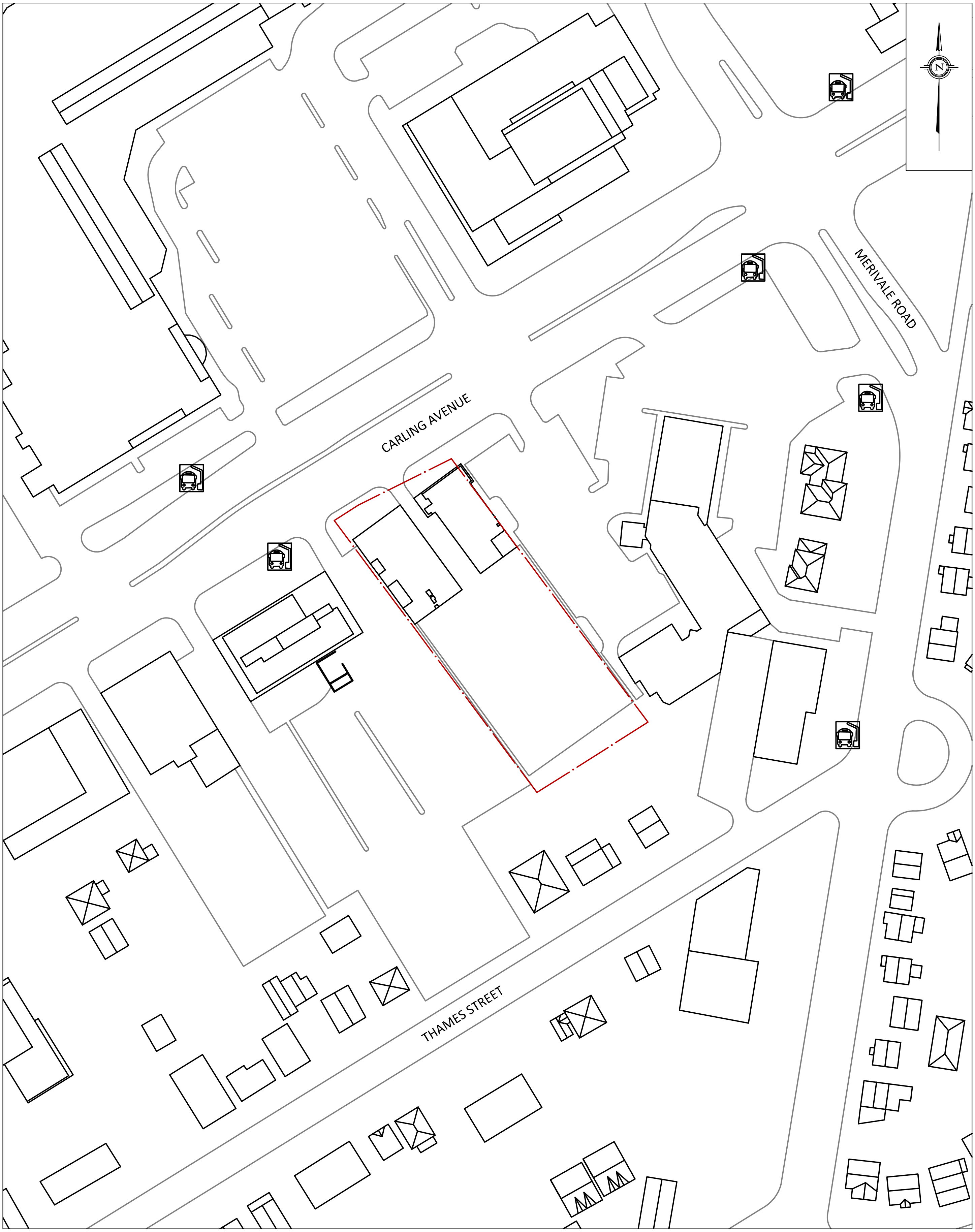
PROJECT	1296-1300 CARLING AVENUE, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1500	DRAWING NO.	25-123-PLW-1A
DATE	SEPTEMBER 11, 2025	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT: 1296-1300 CARLING AVENUE, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:1500	DRAWING NO.: 25-123-PLW-1B	
DATE: SEPTEMBER 11, 2025	DRAWN BY: S.K.	

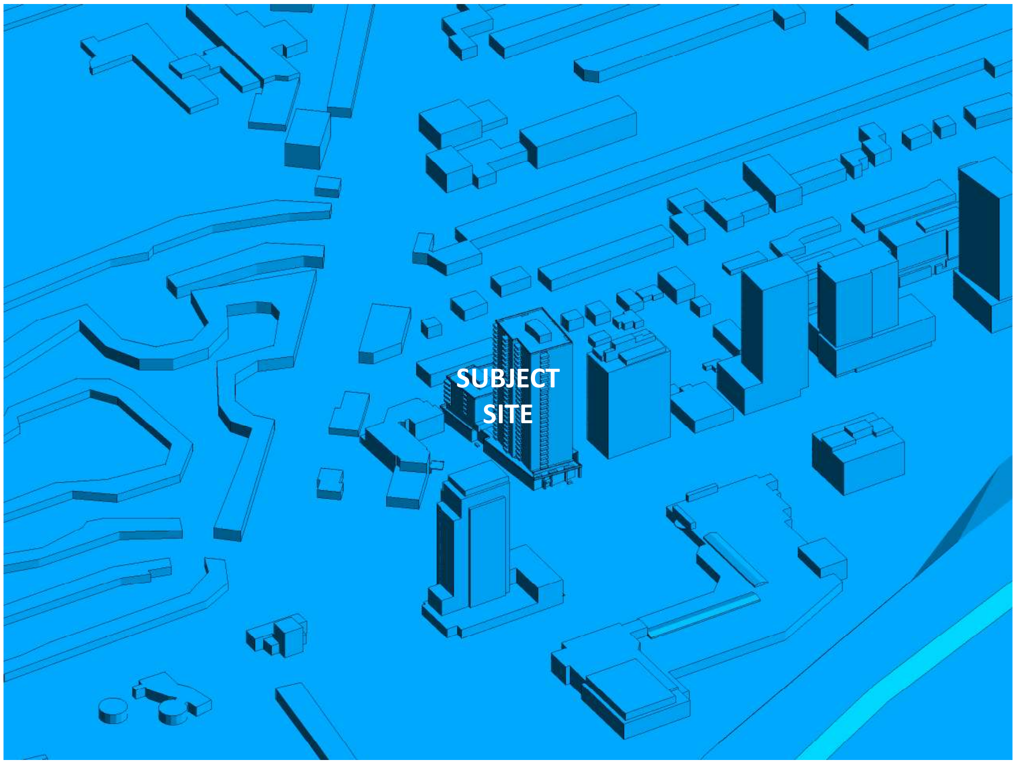


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

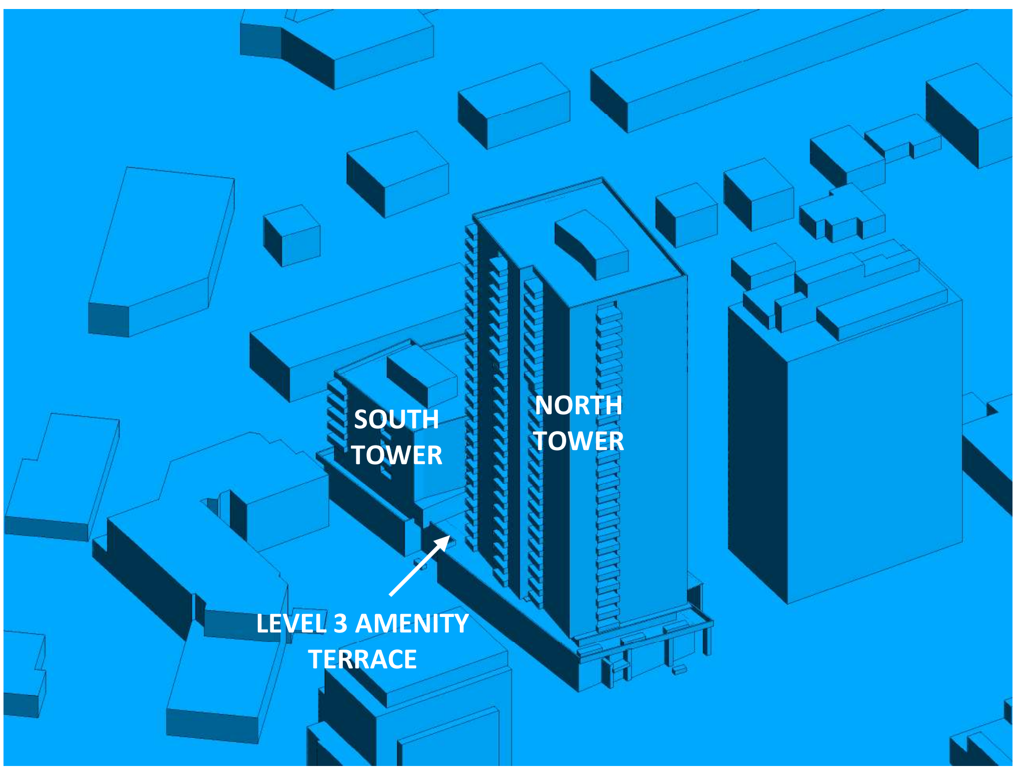


FIGURE 2B: CLOSE UP OF FIGURE 2A

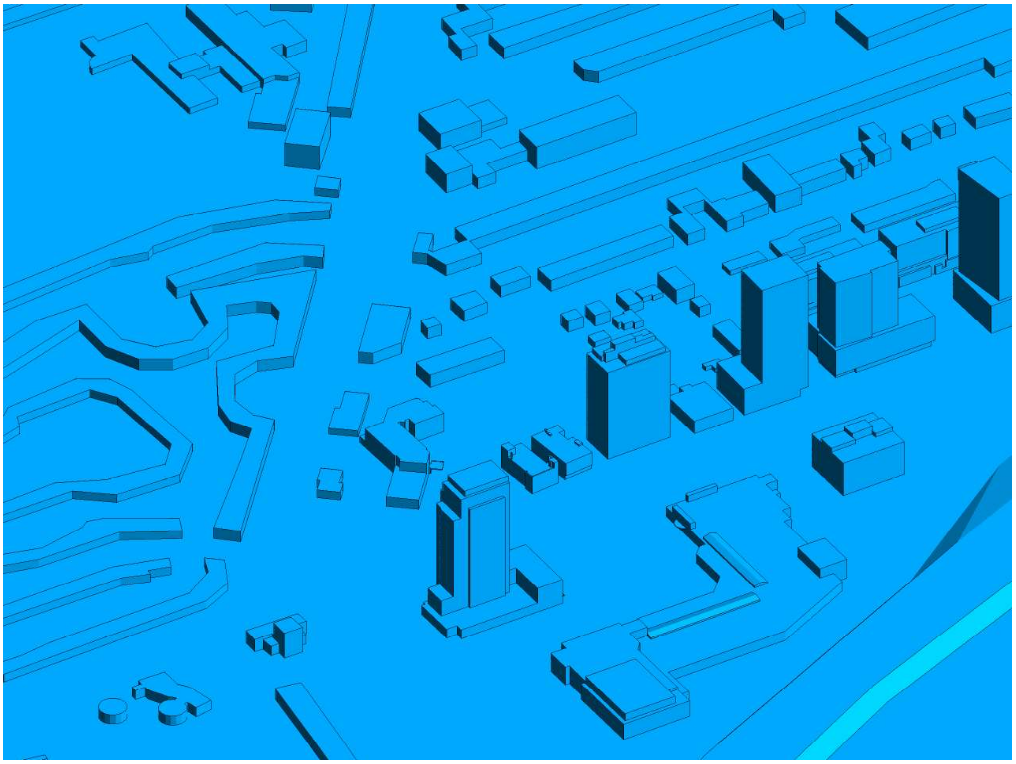


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

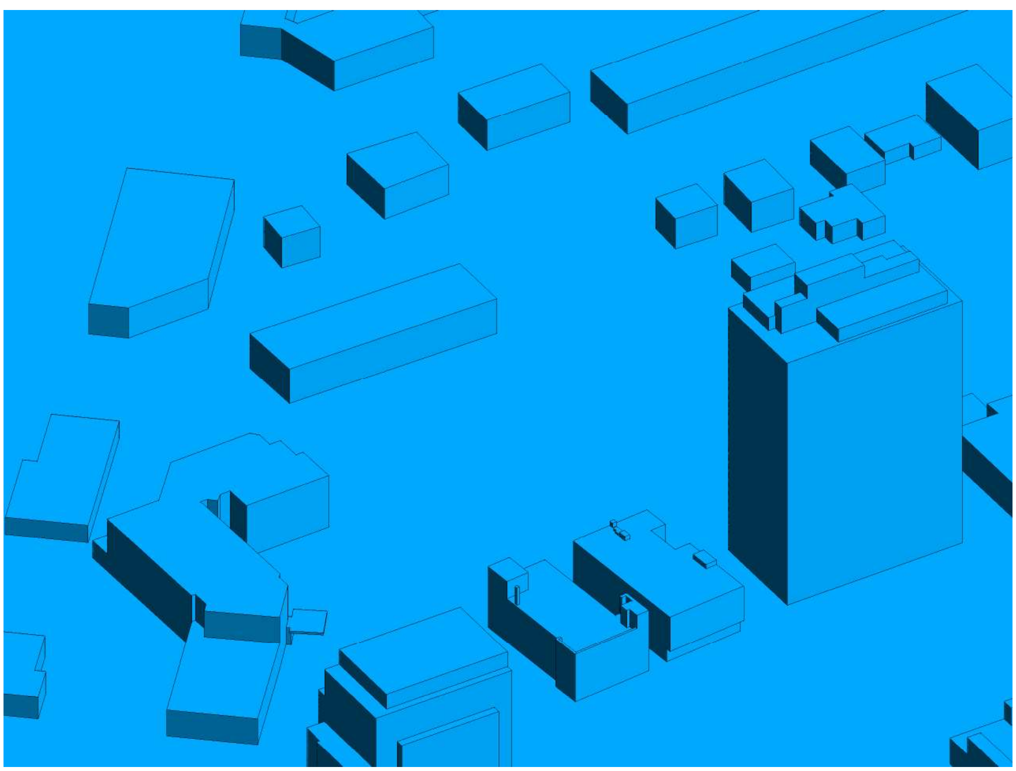


FIGURE 2D: CLOSE UP OF FIGURE 2C

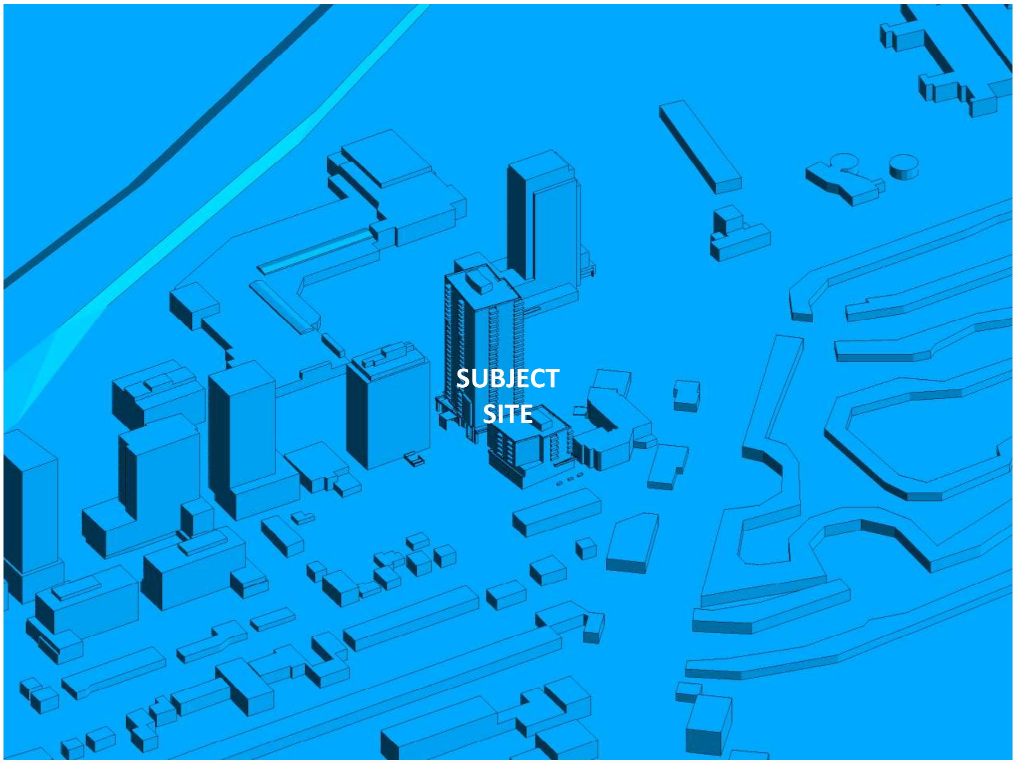


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

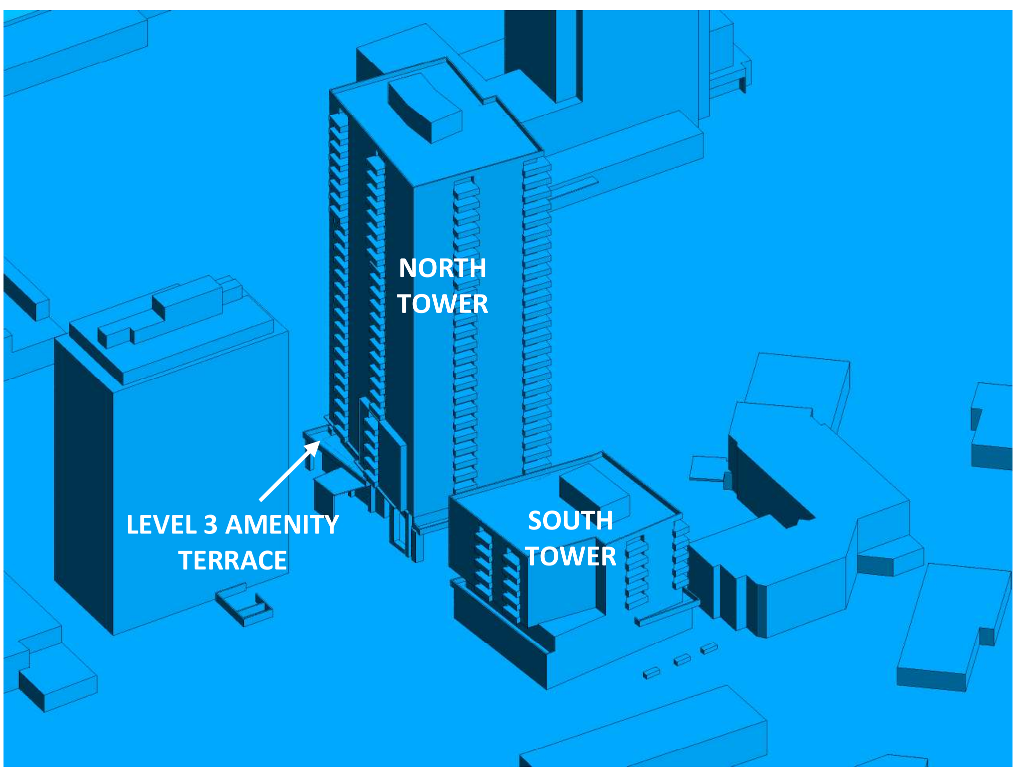


FIGURE 2F: CLOSE UP OF FIGURE 2E

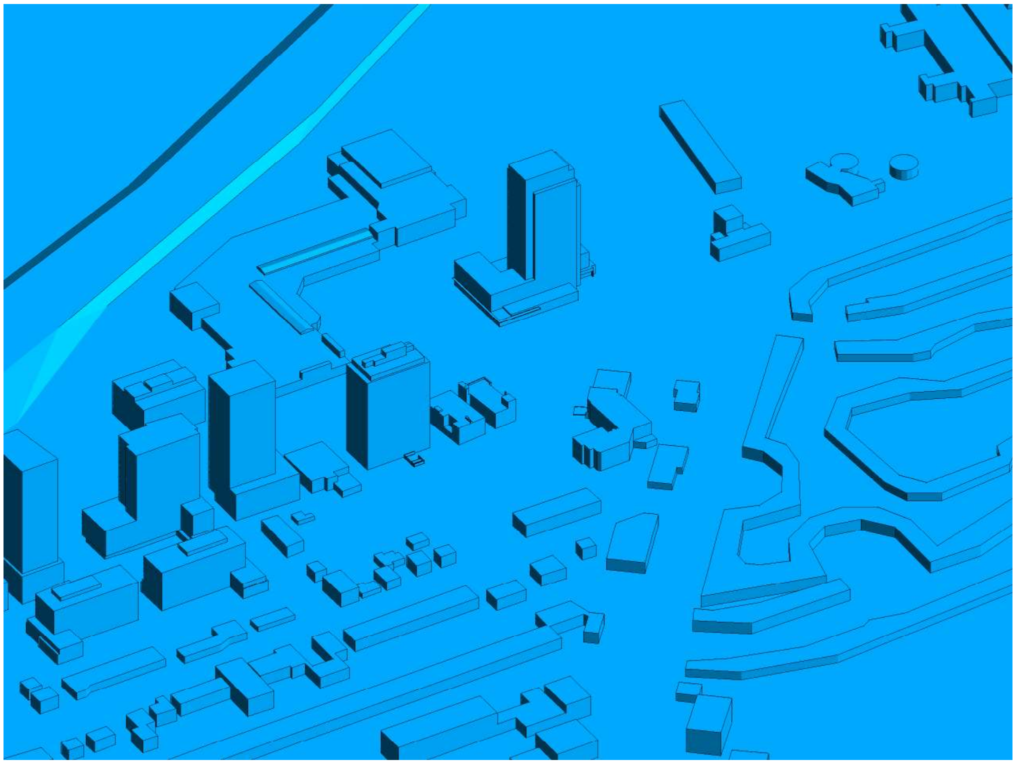


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

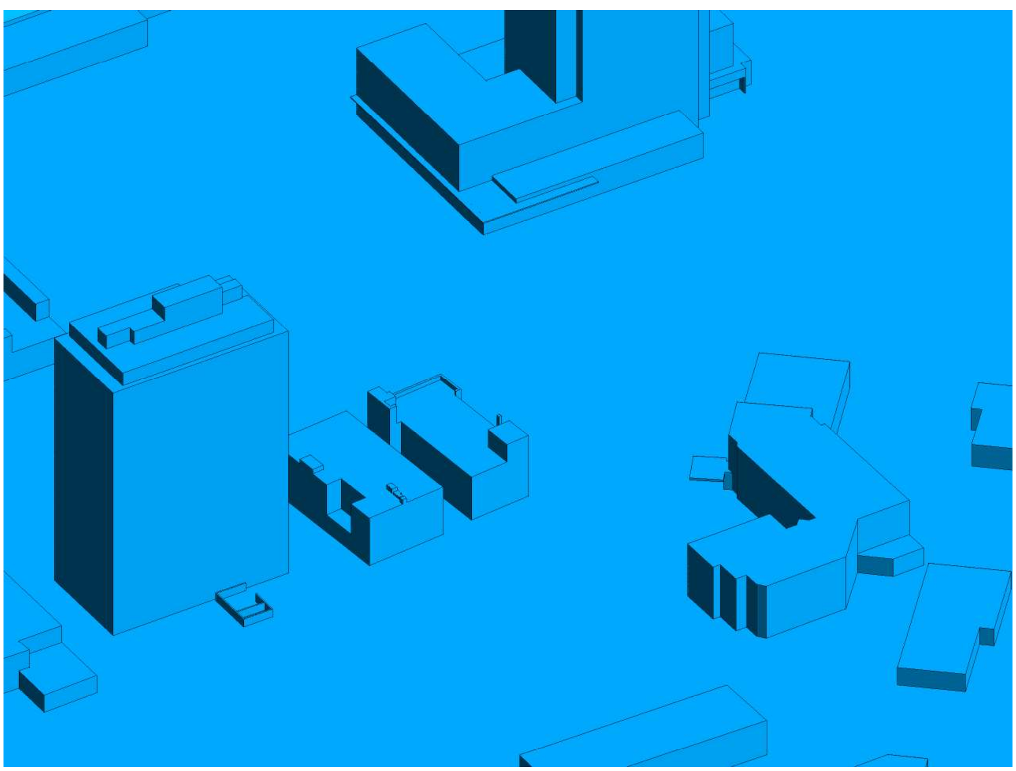


FIGURE 2H: CLOSE UP OF FIGURE 2G

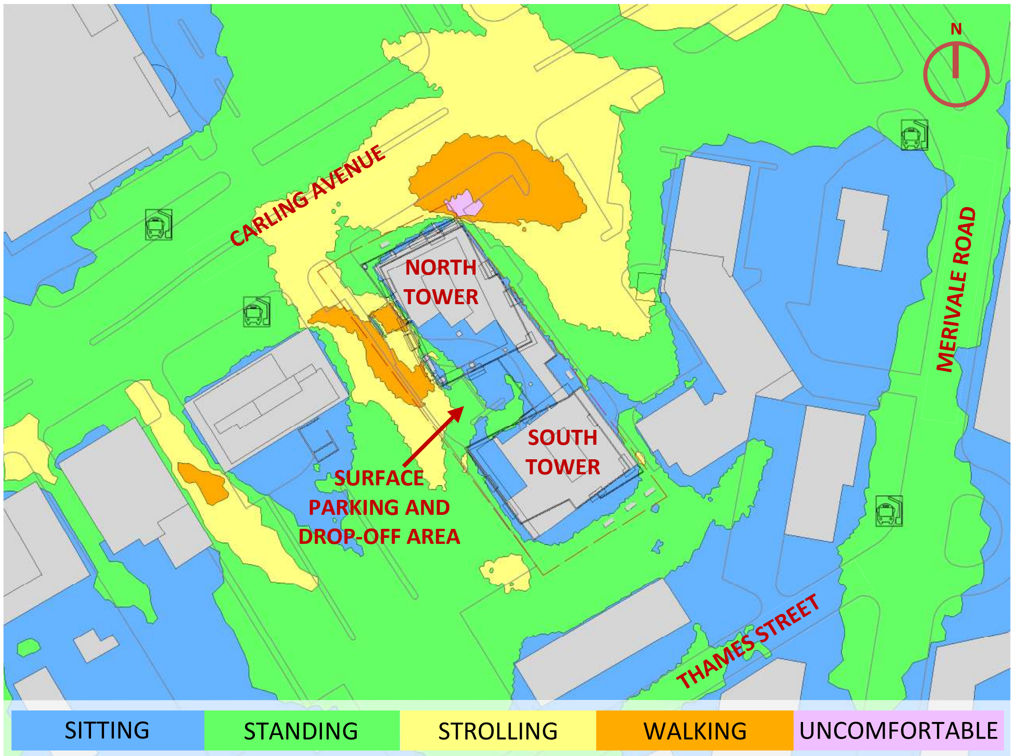


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

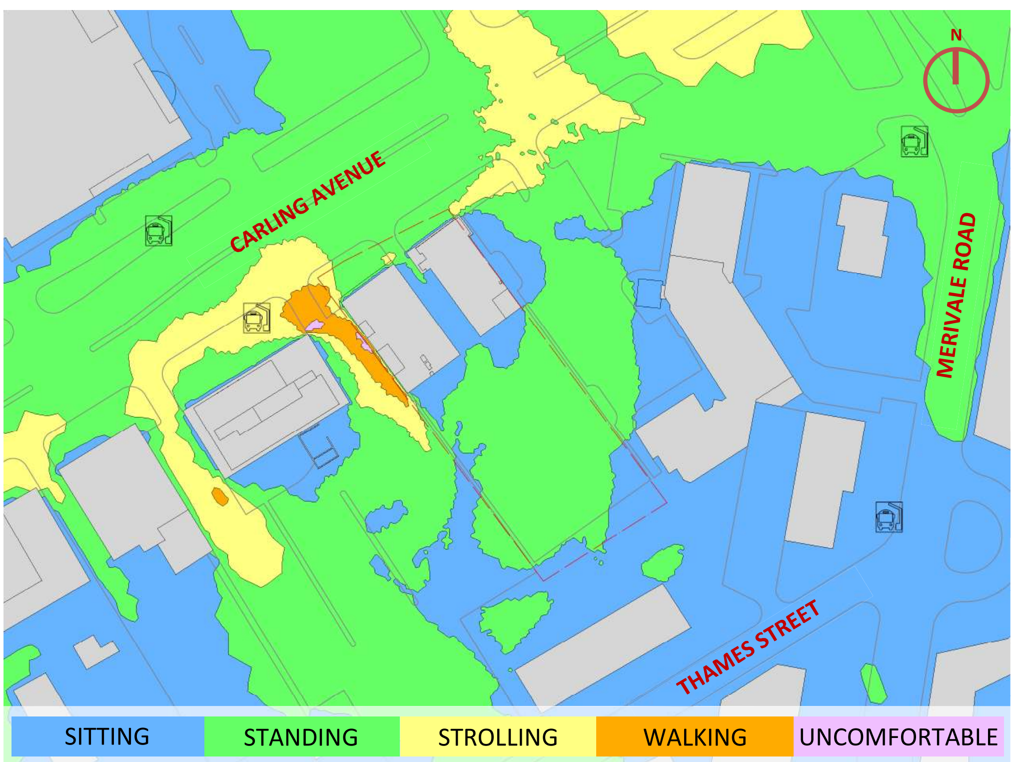


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

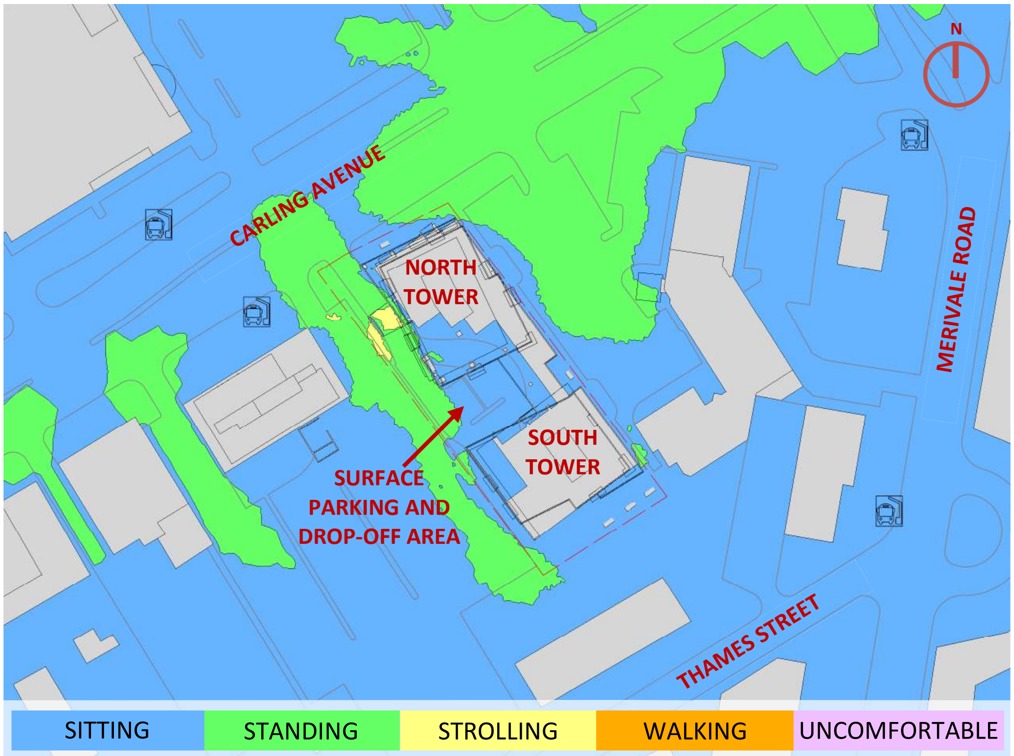


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

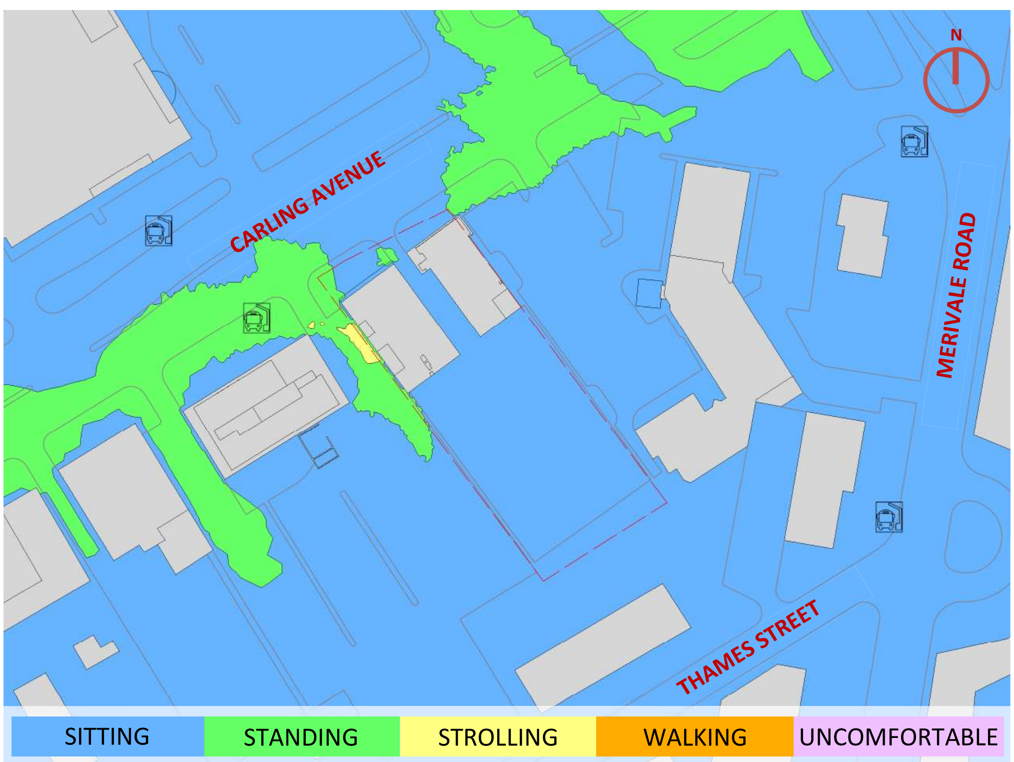


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

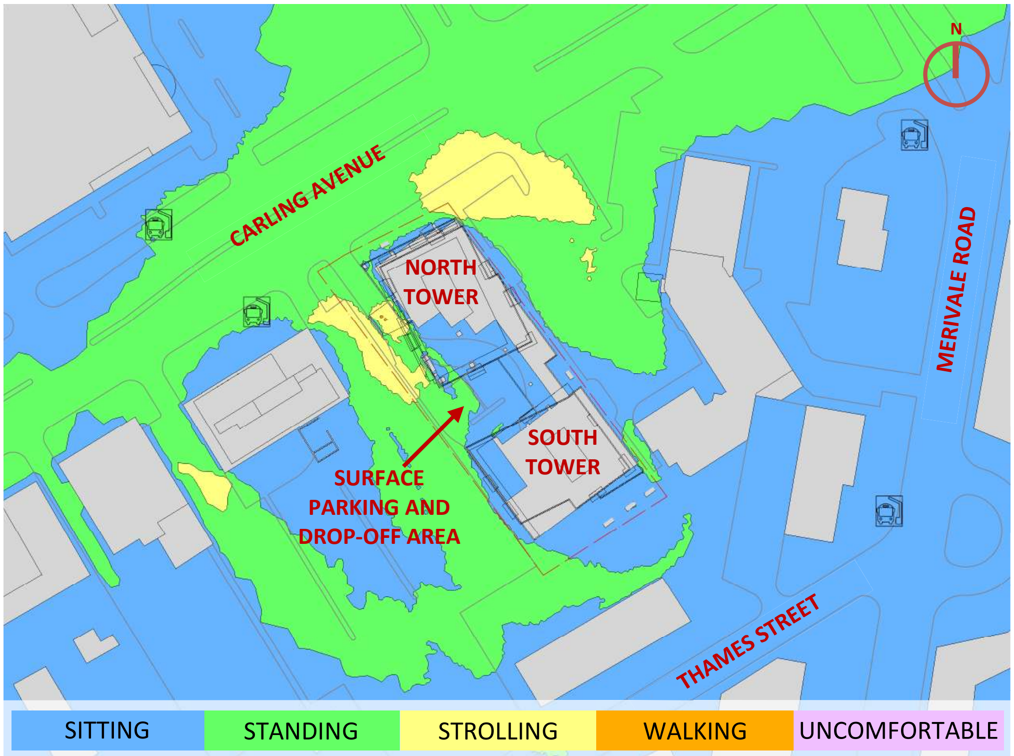


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

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

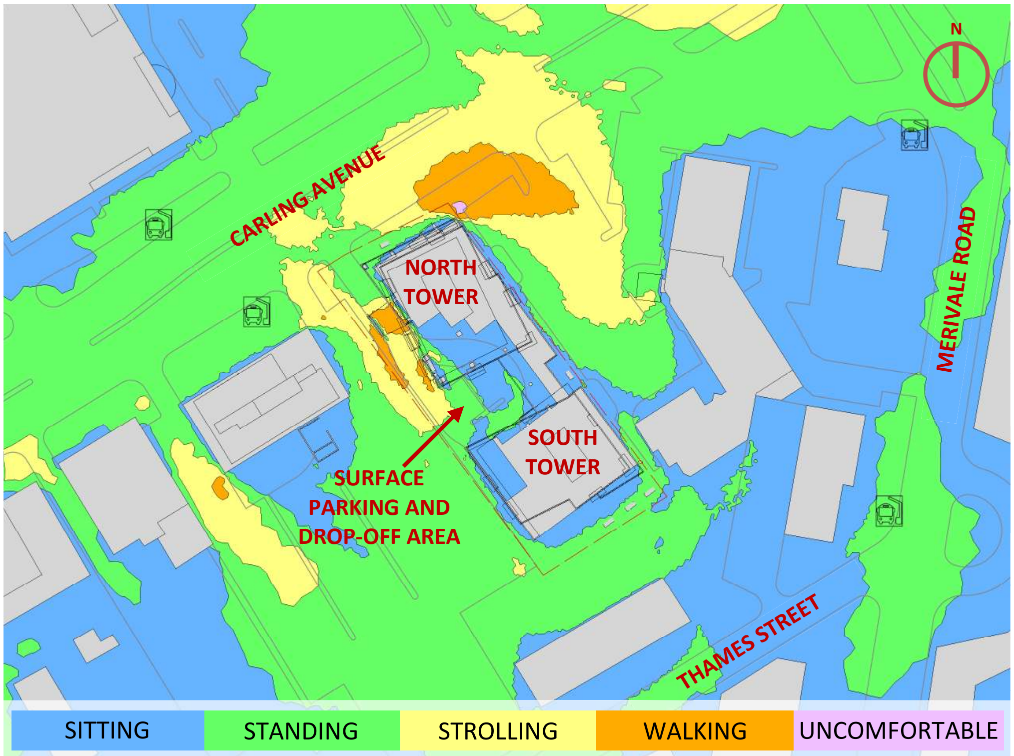


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

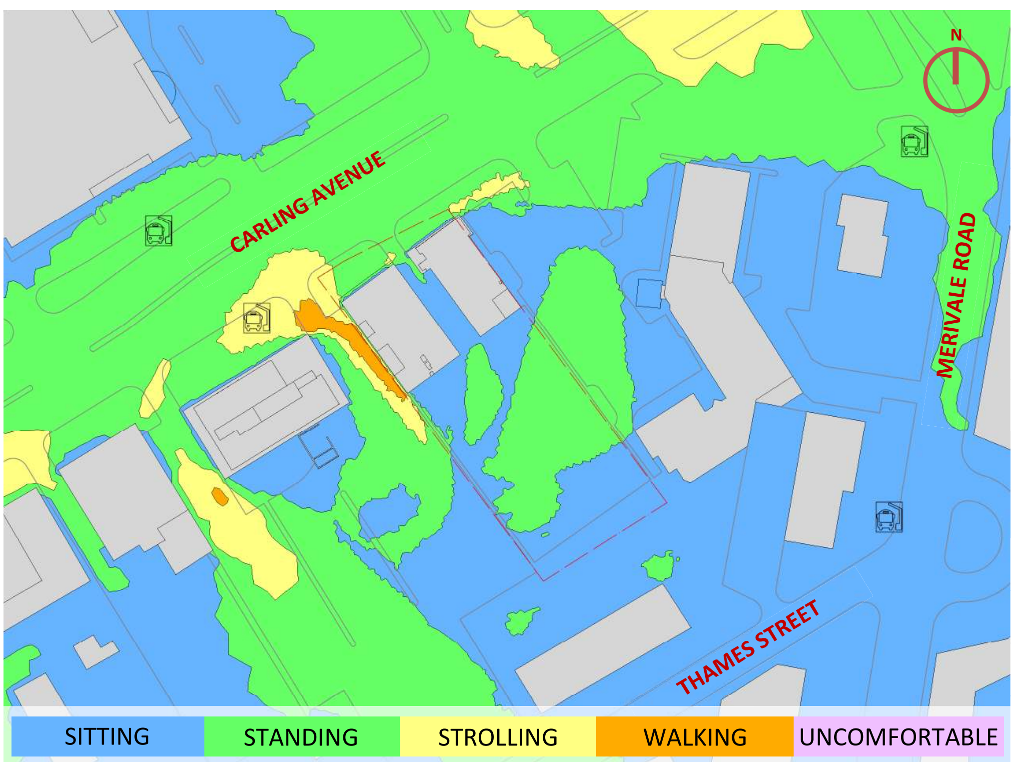


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

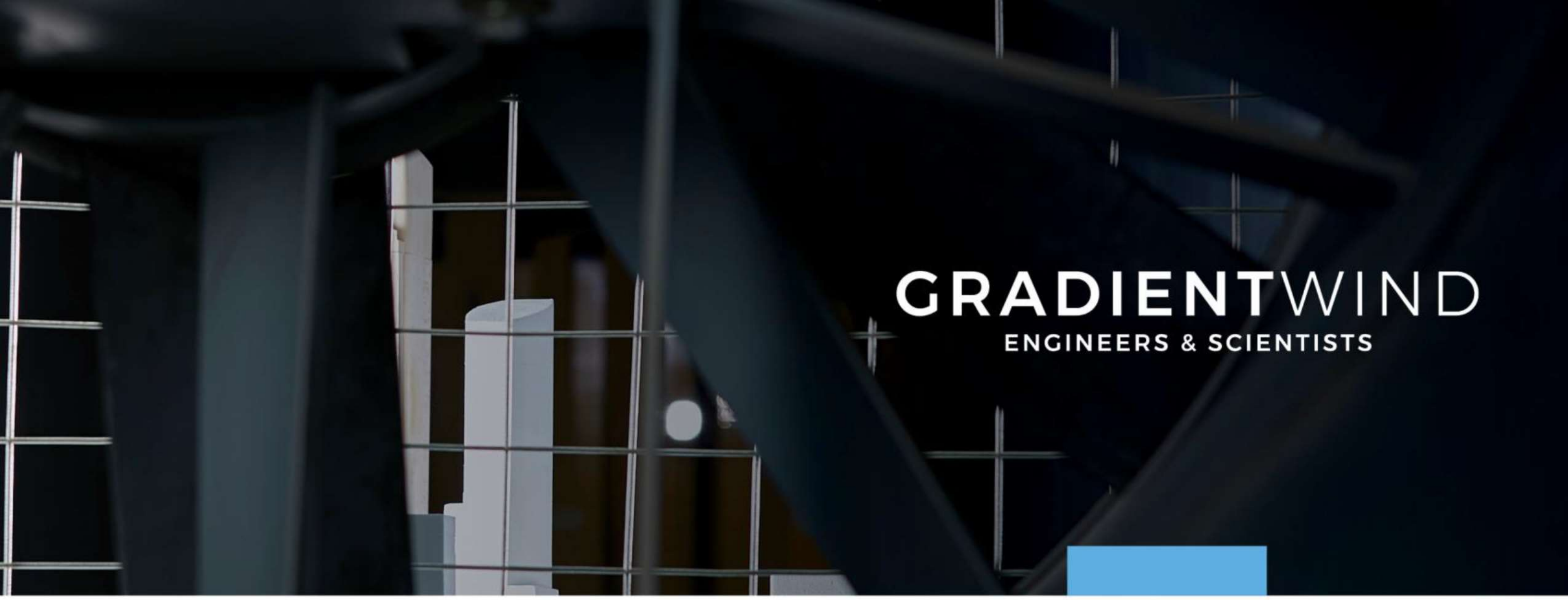
FIGURE 7A: SPRING – WIND COMFORT, LEVEL 3 AMENITY TERRACE

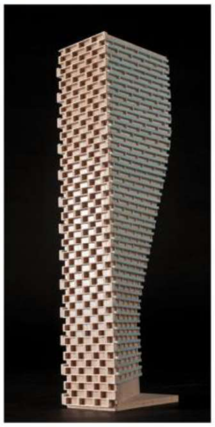
FIGURE 7B: SUMMER – WIND COMFORT, LEVEL 3 AMENITY TERRACE

FIGURE 7C: AUTUMN – WIND COMFORT, LEVEL 3 AMENITY TERRACE

FIGURE 7D: WINTER – WIND COMFORT, LEVEL 3 AMENITY TERRACE

FIGURE 8: TYPICAL USE PERIOD – WIND COMFORT, LEVEL 3 AMENITY TERRACE





APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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

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

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

For the model, U_g is set to 6.5 metres per second (m/s), 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 is 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
22.5	0.25
45	0.24
67.5	0.22
90	0.21
112.5	0.21
135	0.24
157.5	0.24
180	0.24
202.5	0.25
225	0.25
247.5	0.25
270	0.24
292.5	0.24
315	0.24
337.5	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).

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

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

where $\boldsymbol{I}$ = turbulence intensity, $\boldsymbol{L_t}$ = turbulence length scale, $\boldsymbol{Z}$ = height above ground, and α is the power law exponent used for the velocity profile in Equation (1).

Boundary conditions on all other domain boundaries are defined as follows: the ground is a no-slip surface; the side walls of the domain have a symmetry boundary condition; the top of the domain has a specified shear, which maintains a constant wind speed at gradient height; and the outlet has a static pressure boundary condition.

REFERENCES

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[3] Y. Tamura, H. Kawai, Y. Uematsu, K. Kondo, and T. Okhuma, "Revision of AIJ Recommendations for Wind Loads on Buildings," in *The International Wind Engineering Symposium, IWES 2003*, Taiwan, 2003.