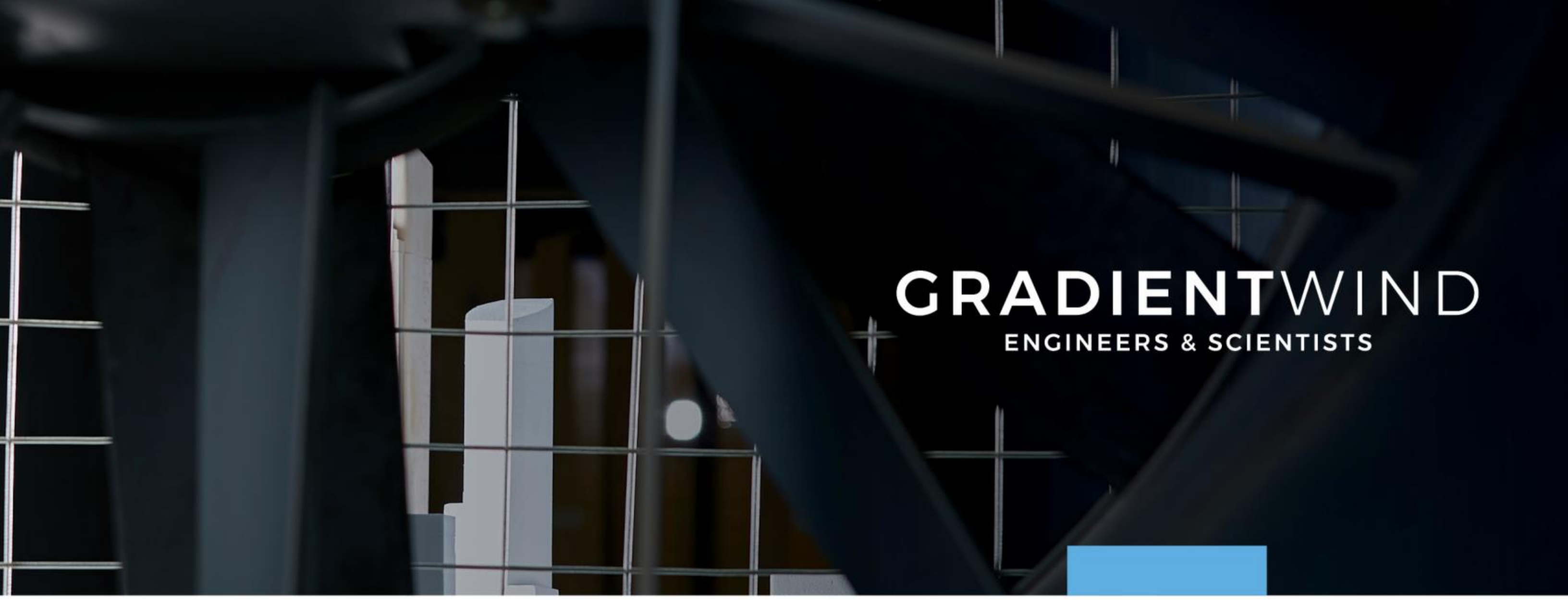
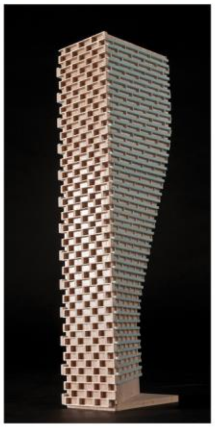


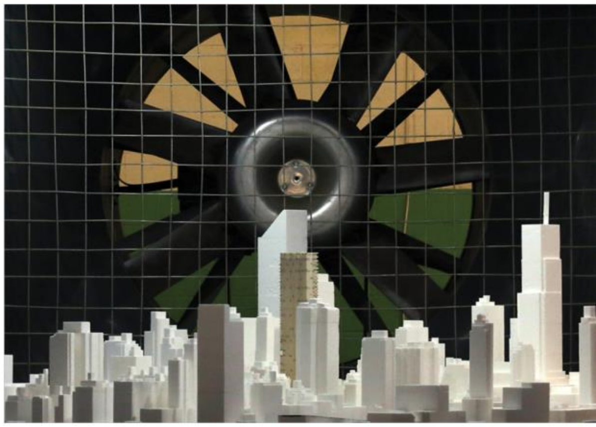
GRADIENTWIND
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

2829 Dumaurier Avenue
Ottawa, Ontario

Report: 20-150-PLW-2024





April 2, 2024

PREPARED FOR
11034936 Canada Inc.
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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy a Site Plan Control application resubmission for the proposed development located at 2829 Dumaurier 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) While the introduction of the proposed development is predicted to produce generally windy conditions at grade, 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, most nearby surface parking and driveways, the proposed drop-off area, in the vicinity of building access points, and over most of the proposed surface parking, drive aisle, and walkways, are considered acceptable.

2) The proposed development is exposed to prevailing winds from multiple directions, owing to the mostly suburban environs of the proposed development and the windier conditions are expected following the introduction of the proposed development in its surroundings.

    a. Prevailing winds from multiple directions are predicted to downwash over the façades of the podium and tower towards grade and accelerate around the principal corners of the building, and between the proposed development and the Boys and Girls Club (BGC) of Ottawa building to the north and the low-rise commercial building to the south.

b. Regions of conditions that may occasionally be considered uncomfortable for walking are situated to the northeast and northwest of the 4-storey podium during the spring and winter months, and to the southwest and south of the tower throughout the year.

c. The noted conditions are predicted to impact isolated sections of the existing surface parking to the northwest and southeast of the subject site, the driveway from Dumaurier Avenue to the BGC, and the proposed drive aisle, surface parking, and walkways at the south and southwest elevations of the subject site.

d. Notably, the windiest conditions beyond the extent of the subject site are located over the driveway to the BGC, where pedestrian access is expected to be limited. As pedestrian usage of the driveway is expected to be limited, and the exceedance of the walking threshold over the surface parking serving the BGC may be considered marginal during the colder months when pedestrians are not expected to linger, wind conditions with the proposed development over the noted driveway, sidewalk, and surface parking serving the BGC may be considered satisfactory.

3) The common amenity terrace at Level 5 serving the proposed development was modelled with 1.8-metre-tall wind screens along its full perimeter. During the typical use period (May to October, inclusive), conditions within the terrace are predicted to be suitable for a mix of mostly standing and strolling, with areas of conditions suitable for sitting along to the tower façade.

a. In addition to tall wind screens around the full perimeter of the terrace, mitigation inboard of the perimeter will be required. The extent of the mitigation measures is dependent on the programming of the terrace. An appropriate mitigation strategy will continue to be developed in collaboration with the building and landscape architects as the design of the proposed development progresses.

4) The foregoing statements and conclusions apply to common weather systems, during which one region within the immediate vicinity of the subject site may experience wind conditions that approach the wind safety threshold, as defined in Section 4.4. Specifically, the safety criterion may be exceeded on an annual basis within an isolated region to the south and southwest of the tower at grade level where comfort levels are also predicted to exceed the walking comfort criterion during all seasons. Further investigation and coordination with the design team may be required to develop an appropriate strategy to improve wind comfort and to resolve potential wind safety exceedances within the noted areas.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 11034936 Canada Inc. to undertake a pedestrian level wind (PLW) study to satisfy Site Plan Control application resubmission requirements for the proposed development located at 2829 Dumaurier Avenue in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). A PLW study was conducted in January 2021[1] for the previous design of the proposed development. Our mandate within the current 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 RLA Inc. in March 2024, 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 2829 Dumaurier Avenue in Ottawa, situated on a parcel of land bounded by Dumaurier Avenue to the east, low-rise buildings to the south, a high-rise residential building with surface parking to the southwest and west, and a low-rise community building with surface parking to the north.

The proposed development comprises a rectangular 40-storey tower which rises from the south leg of a 4-storey podium. The building steps back from all elevations at Level 5, which accommodates outdoor amenity space to the north and east on the roof of the podium. The tower steps back from the north elevation at Level 39 and is topped by a mechanical penthouse (MPH).

[1] Gradient Wind Engineering Inc., '*2829 Dumaurier Avenue – Pedestrian Level Wind Study*', [Jan 22, 2021]

Above the underground parking levels, the ground floor includes an indoor amenity to the north, commercial units to the east, a lobby and main entrance to the southeast, shared building support spaces to the southwest, and bike storage to the west. A drive aisle along the south and west elevations provides access to at-grade parking along the southwest elevation of the subject site and to the underground parking entrance to the northwest. Level 5 includes an indoor amenity to the north and residential units to the south, and the remaining levels of the podium and tower comprise residential occupancy.

The near-field surroundings, defined as an area within 200-metres (m) of the subject site, include a 14-storey residential building to the southwest, Ruth Wildgen Park to the west and northwest, Dumaurier Park to the east, and low-rise buildings and surface parking in the remaining compass directions. Notably, the new Pinecrest Station serving the Confederation Line West Light Rail Transit (LRT) project is currently under construction approximately 215 m to the east-southeast 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, include primarily a mix of green space and low-rise residential buildings in all directions, as well as mid-rise buildings along Richmond Road to the north and near the intersection of Baseline Road and Greenbank Road to the southeast. The Ottawa River lies approximately 1.3 km to the west-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[2]. 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.

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.

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

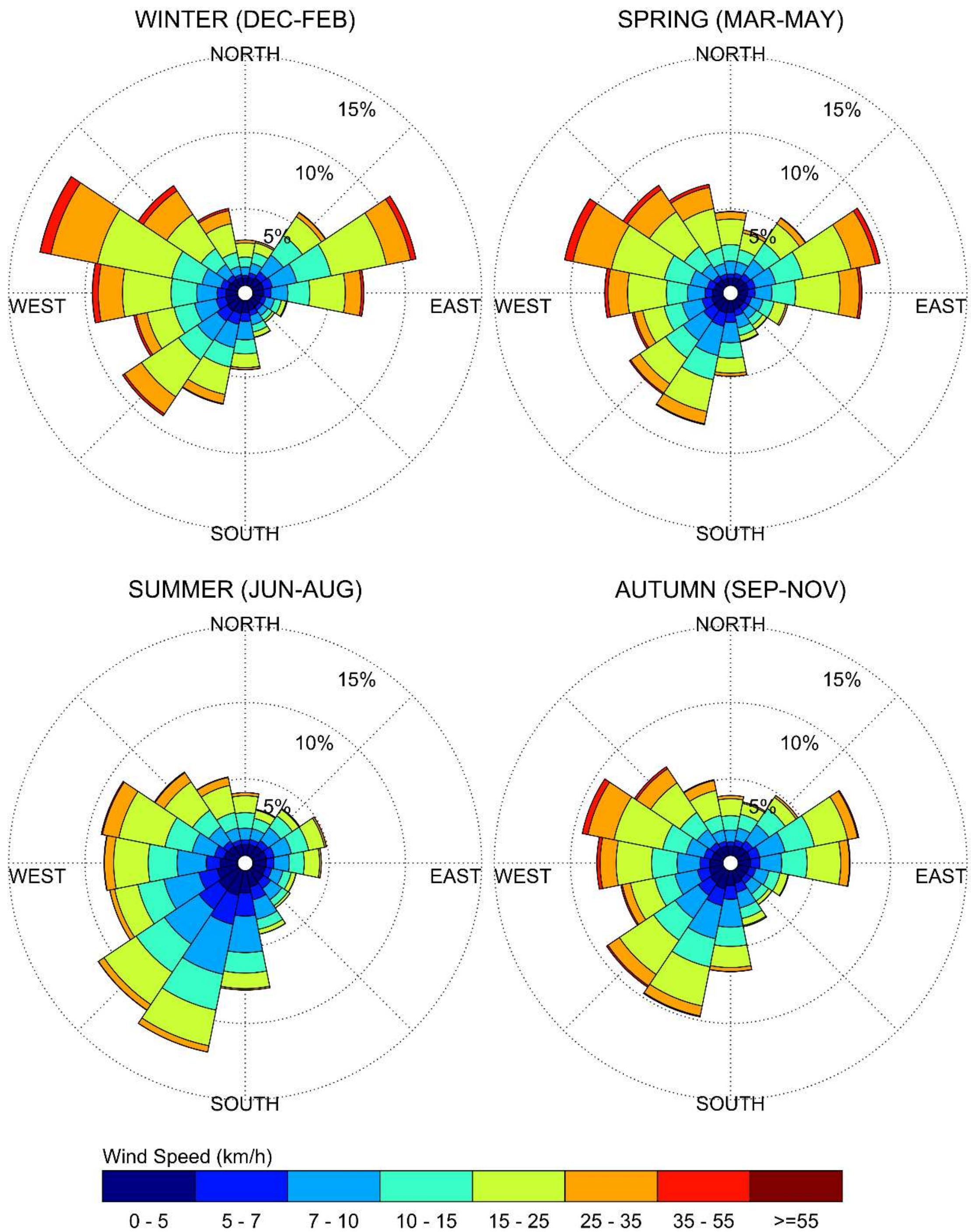
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and over the Level 5 common amenity terrace were referenced 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	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 common amenity terrace serving the proposed development at Level 5. 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 comfort conditions at grade level and over the Level 5 amenity terrace, respectively, consistent with the comfort classes in Section 4.4.

5.1 Wind Comfort Conditions – Grade Level

The mostly suburban environs of the subject site and the limited built-up massing in the vicinity of the proposed development exposes the subject site to prevailing winds. Specifically, salient winds from multiple directions, including those from the east and southwest clockwise to the northwest, are predicted to downwash over the façades of the podium and tower towards grade and to accelerate around the principal corners of the building and between the proposed development and the neighbouring low-rise buildings to the north and south.

Regions of conditions that may occasionally be considered uncomfortable for walking are situated to the northeast and northwest of the proposed development during the spring and winter, and to the southwest and south of the tower throughout the year. The noted conditions are predicted to impact isolated sections of the existing surface parking to the northwest and southeast of the subject site, the driveway from Dumaurier Avenue to the Boys and Girls Club (BGC) of Ottawa building, and the proposed drive aisle, surface parking, and walkways at the south and southwest elevations of the subject site.

The predicted grade-level wind conditions within and surrounding the subject site are summarized below for each area of interest.

Sidewalks along Dumaurier Avenue: Following the introduction of the proposed development, wind conditions over the public sidewalks along Dumaurier Avenue are predicted to be suitable for strolling, or better, during the summer and autumn seasons, becoming suitable for walking, or better, during the spring and winter. The noted conditions are considered acceptable.

Conditions along Dumaurier Avenue 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 three remaining seasons. While the introduction of the proposed development produces windier conditions along Dumaurier Avenue in comparison to existing conditions, conditions with the proposed development along over the sidewalks along Dumaurier Avenue are nevertheless considered acceptable for public sidewalks.

Dumaurier Park: Prior to the introduction of the proposed development, wind comfort conditions during the typical use period (that is, May to October, inclusive) within the neighbouring areas of Dumaurier Park to the east of the subject site are predicted to be suitable for mostly standing, becoming suitable for a mix of standing and strolling following the introduction the proposed development. The noted conditions may be considered acceptable for an active-use park area.

Existing Surface Parking Lot Serving Commercial Building to the South: Following the introduction of the proposed development, conditions over the existing surface parking lot to the south are predicted to be suitable for walking, or better, throughout the year, with an isolated region of conditions that may occasionally be considered uncomfortable for walking during the colder months situated at the north perimeter.

Wind conditions over the noted surface parking lot with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the three colder seasons.

Existing Surface Parking to the Southwest of the Subject Site: Following the introduction of the proposed development, conditions within the existing surface parking located to the southwest of the subject site are predicted to be suitable for strolling, or better, throughout the year. The noted conditions are considered acceptable.

Prior to the introduction of the proposed development, conditions over the noted parking lot are predicted to be suitable for standing, or better, throughout the year. While the introduction of the proposed development produces windier conditions over the noted parking lot, conditions with the proposed development are nevertheless considered acceptable.

Driveway and Existing Parking Lot Serving the Community Building to the Northwest: Following the introduction of the proposed development, conditions over the driveway and adjoining sidewalk to the BGC of Ottawa building located to the northwest are predicted to be suitable for strolling, or better, during the summer, becoming suitable for mostly walking, or better, during the three colder seasons. Conditions that may occasionally be considered uncomfortable for walking during the spring and winter are predicted over the driveway, where pedestrian access is expected to be limited.

Where conditions may be considered uncomfortable over the driveway, they are predicted to be suitable for walking for approximately 75% of the time during the spring and winter seasons, representing a 5% exceedance of the walking threshold. As pedestrian usage of the driveway is expected to be limited, conditions with the proposed development over the noted driveway and sidewalk to the BGC may be considered satisfactory.

Similarly, over the parking lots accessed by the noted driveway, conditions are predicted to be suitable for strolling, or better, during the summer, becoming suitable for mostly walking, or better, throughout the remainder of the year, with a region of conditions that may be considered uncomfortable for walking during the spring and winter located within an isolated portion of the neighbouring parking lot. Where conditions may be considered uncomfortable for walking, they are predicted to be suitable for walking for approximately 79% and 78% of the time during the spring and winter seasons, respectively, representing exceedances of 1% and 2% of the walking comfort criterion. As these conditions are located within a limited region of the noted surface parking lot, where pedestrians are not expected to linger during the colder months, and the noted exceedances may be considered marginal, the noted conditions may be considered satisfactory.

Under the existing massing, conditions along the noted driveway and sidewalk are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the remaining months of the year.

Proposed Drop-Off Area: Wind conditions over the proposed drop-off area at the south elevation of the site are predicted to be suitable for mostly strolling, or better, throughout the year, which is considered acceptable.

Proposed Walkways, Surface Parking, and Drive Aisle: Within the subject site, wind comfort conditions over most walkways, surface parking, and the proposed drive aisle are predicted to be suitable for walking, or better, throughout the year. The windiest conditions, as noted above, are located to the southwest and south of the 40-storey tower, where conditions that may be considered uncomfortable for walking are predicted throughout the year. Further investigation and coordination with the design team may be required to develop an appropriate strategy to improve wind comfort within the noted areas.

Building Access Points: Owing to the protection of the building façade, 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, which is considered acceptable.

5.2 Wind Comfort Conditions – Level 5 Common Amenity Terrace

The common amenity terrace serving the proposed development at Level 5 was modelled with 1.8-m-tall wind screens along its full perimeter. During the typical use period, conditions within the terrace are predicted to be suitable for a mix of mostly standing and strolling, with areas of conditions suitable for sitting along to the tower façade, as illustrated in Figure 9.

In addition to tall wind screens around the full perimeter of the terrace, mitigation inboard of the perimeter will be required. A successful wind mitigation strategy responds to the programming of the terrace. An appropriate mitigation strategy will continue to evolve in collaboration with the building and landscape architects as the design of the proposed development progresses.

5.3 Wind Safety

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, one pedestrian area within the subject site may experience wind conditions that approach the wind safety threshold, as defined in Section 4.4. Specifically, the wind safety criterion may be exceeded on an annual basis within an isolated region to the south and southwest of the tower at grade level where comfort levels are also predicted to exceed the walking comfort criterion during all seasons. Further investigation and coordination with the design team may be required to develop an appropriate strategy to improve wind comfort and to resolve potential wind safety exceedances within the noted areas.

5.4 Applicability of Results

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

6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 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) While the introduction of the proposed development is predicted to produce generally windy conditions at grade, 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, most nearby surface parking and driveways, the proposed drop-off area, in the vicinity of building access points, and over most of the proposed surface parking, drive aisle, and walkways, are considered acceptable.

2) The proposed development is exposed to prevailing winds from multiple directions, owing to the mostly suburban environs of the proposed development and the windier conditions are expected following the introduction of the proposed development in its surroundings.

    a. Prevailing winds from multiple directions are predicted to downwash over the façades of the podium and tower towards grade and accelerate around the principal corners of the building, and between the proposed development and the Boys and Girls Club (BGC) of Ottawa building to the north and the low-rise commercial building to the south.

    b. Regions of conditions that may occasionally be considered uncomfortable for walking are situated to the northeast and northwest of the 4-storey podium during the spring and winter months, and to the southwest and south of the tower throughout the year.

c. The noted conditions are predicted to impact isolated sections of the existing surface parking to the northwest and southeast of the subject site, the driveway from Dumaurier Avenue to the BGC, and the proposed drive aisle, surface parking, and walkways at the south and southwest elevations of the subject site.

d. Notably, the windiest conditions beyond the extent of the subject site are located over the driveway to the BGC, where pedestrian access is expected to be limited. As pedestrian usage of the driveway is expected to be limited, and the exceedance of the walking threshold over the surface parking serving the BGC may be considered marginal during the colder months when pedestrians are not expected to linger, wind conditions with the proposed development over the noted driveway, sidewalk, and surface parking serving the BGC may be considered satisfactory.

3) The common amenity terrace at Level 5 serving the proposed development was modelled with 1.8-metre-tall wind screens along its full perimeter. During the typical use period (May to October, inclusive), conditions within the terrace are predicted to be suitable for a mix of mostly standing and strolling, with areas of conditions suitable for sitting along to the tower façade.

a. In addition to tall wind screens around the full perimeter of the terrace, mitigation inboard of the perimeter will be required. The extent of the mitigation measures is dependent on the programming of the terrace. An appropriate mitigation strategy will continue to be developed in collaboration with the building and landscape architects as the design of the proposed development progresses.

4) The foregoing statements and conclusions apply to common weather systems, during which one region within the immediate vicinity of the subject site may experience wind conditions that approach the wind safety threshold, as defined in Section 4.4. Specifically, the safety criterion may be exceeded on an annual basis within an isolated region to the south and southwest of the tower at grade level where comfort levels are also predicted to exceed the walking comfort criterion during all seasons. Further investigation and coordination with the design team may be required to develop an appropriate strategy to improve wind comfort and to resolve potential wind safety exceedances within the noted areas.

Sincerely,

Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. D. FERRARO
100158495
Apr 2, 2024
PROVINCE OF ONTARIO

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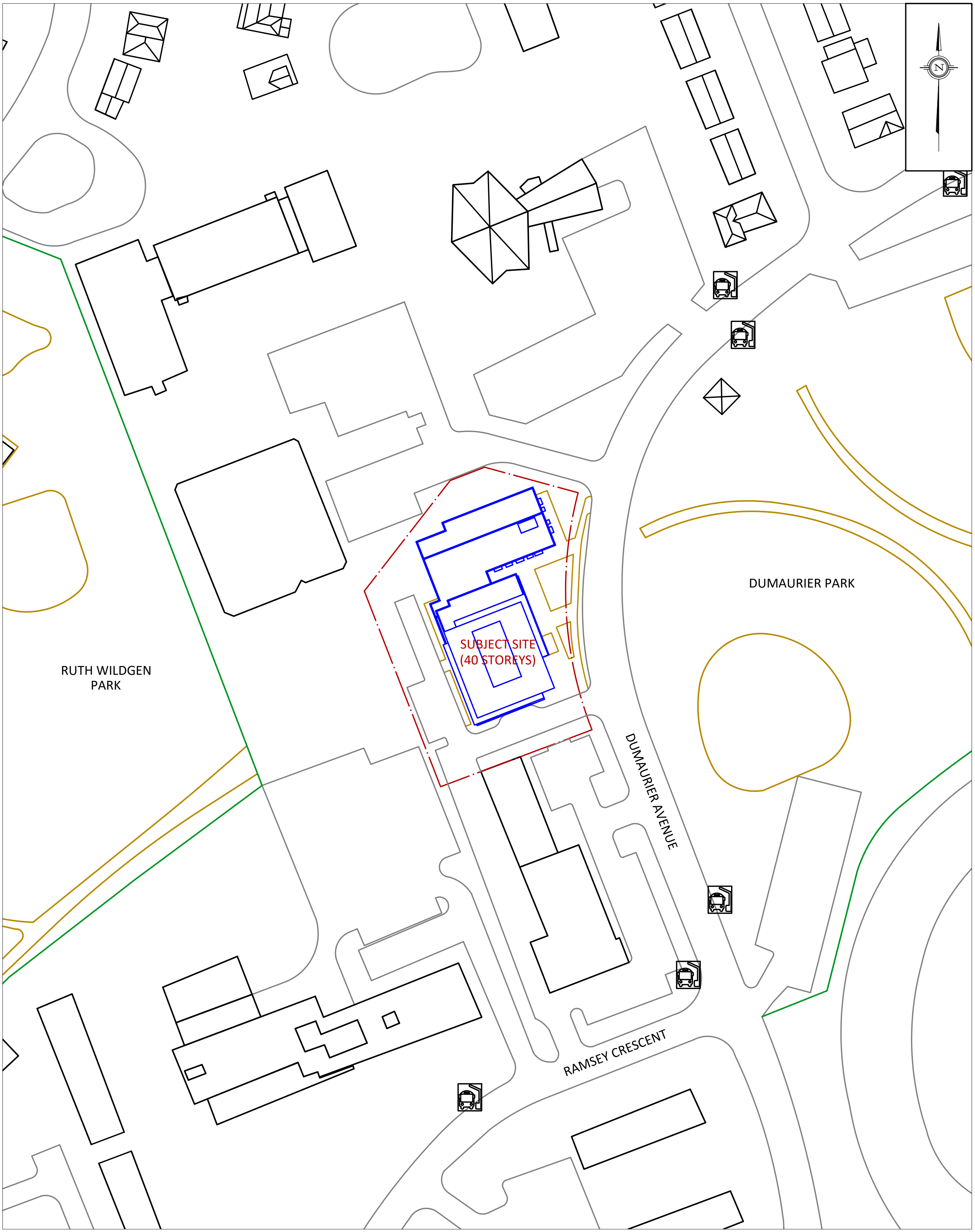

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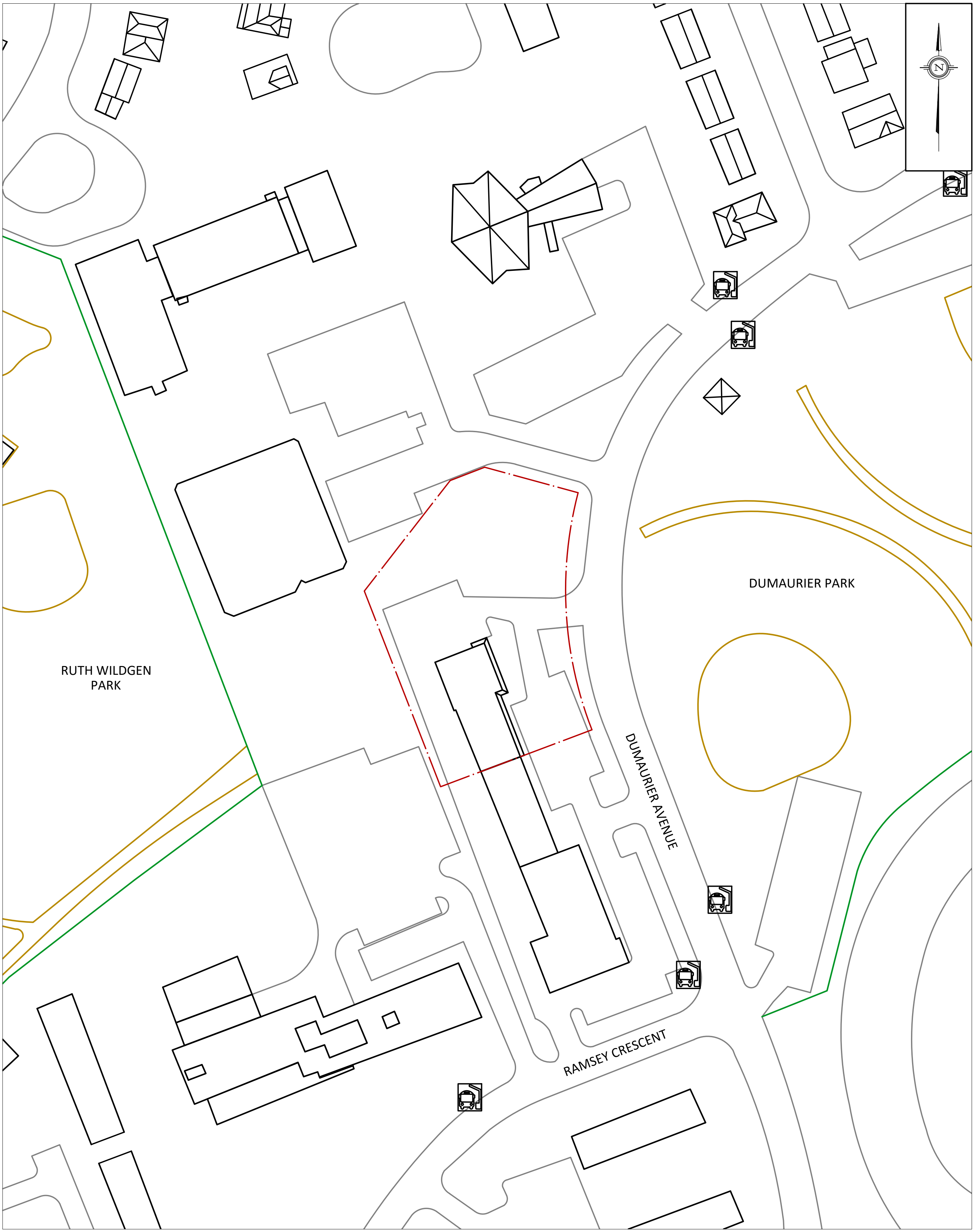
613 836 0934 • GRADIENTWIND.COM

PROJECT	2829 DUMAURIER AVENUE, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1500	DRAWING NO.	20-150-PLW-2024-1A
DATE	APRIL 2, 2024	DRAWN BY	T.K.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	2829 DUMAURIER AVENUE, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT
SCALE 1:1500	DRAWING NO. 20-150-PLW-2024-1B		
DATE APRIL 2, 2024	DRAWN BY T.K.		

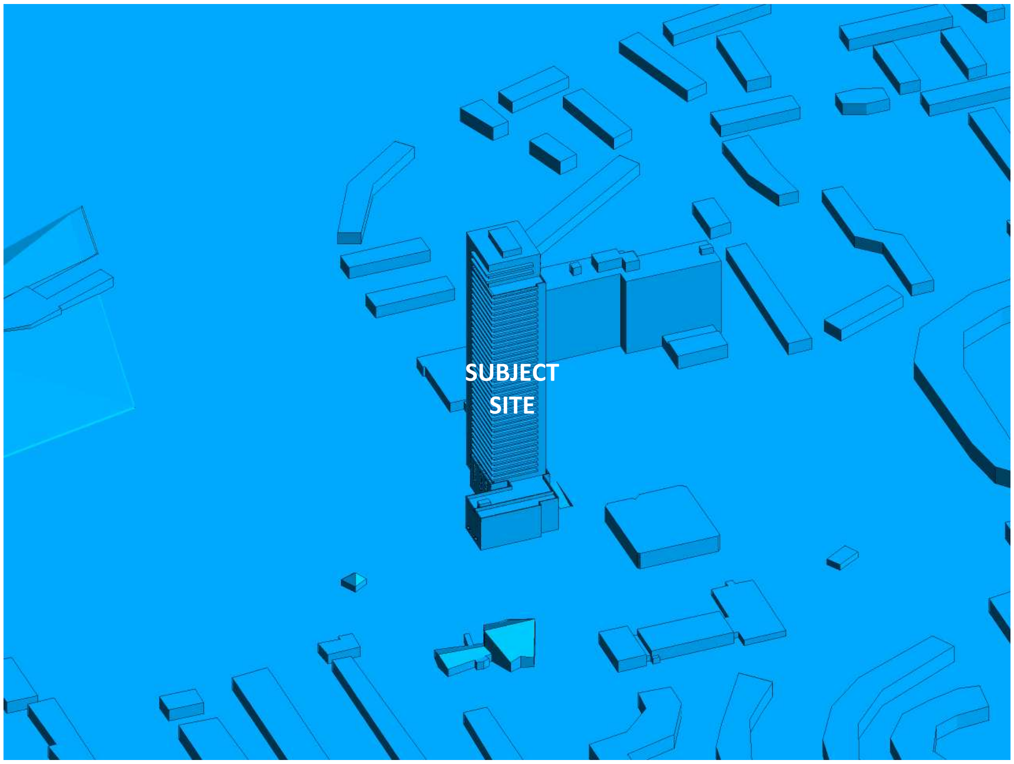


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

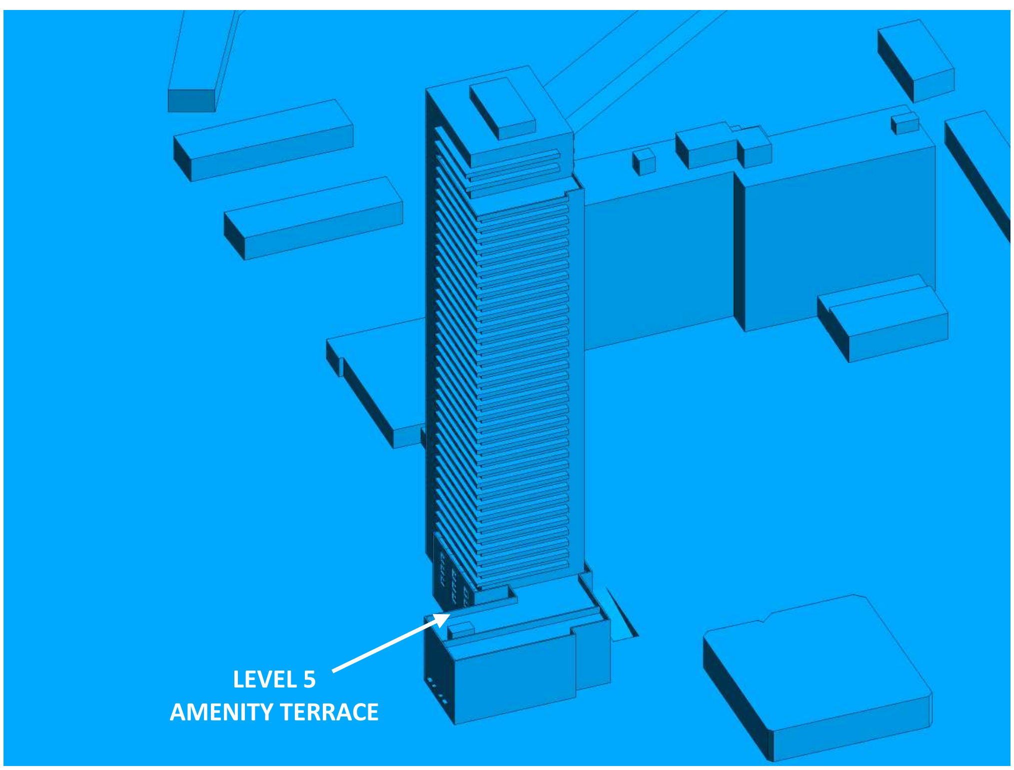


FIGURE 2B: CLOSE UP OF FIGURE 2A

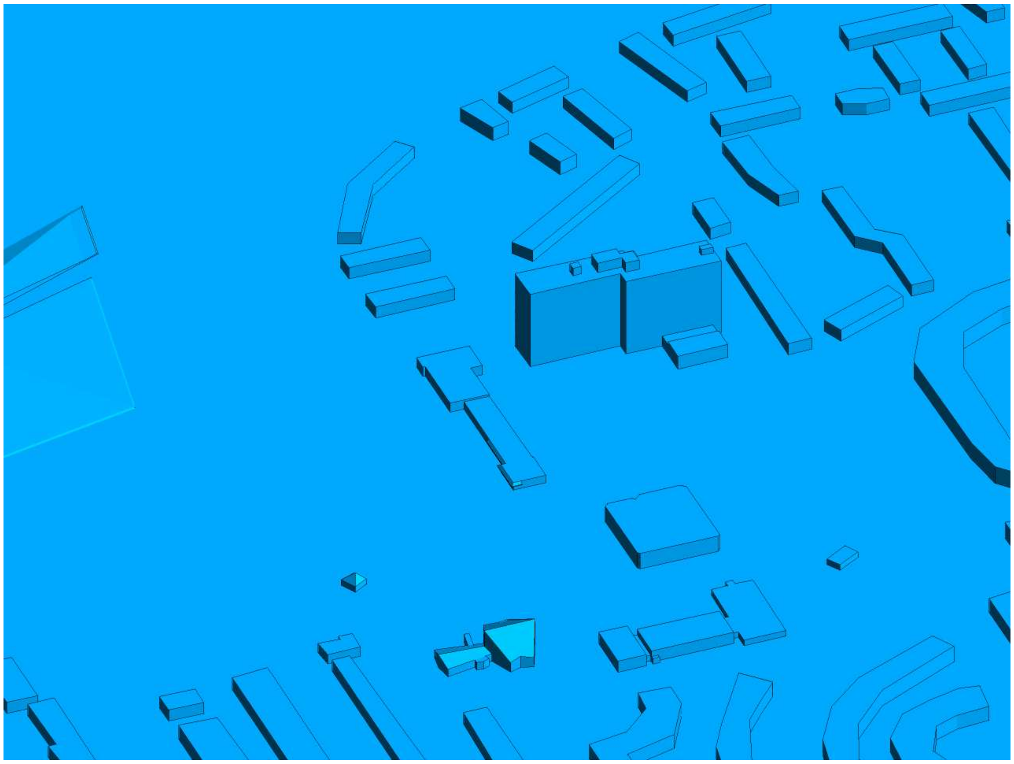


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

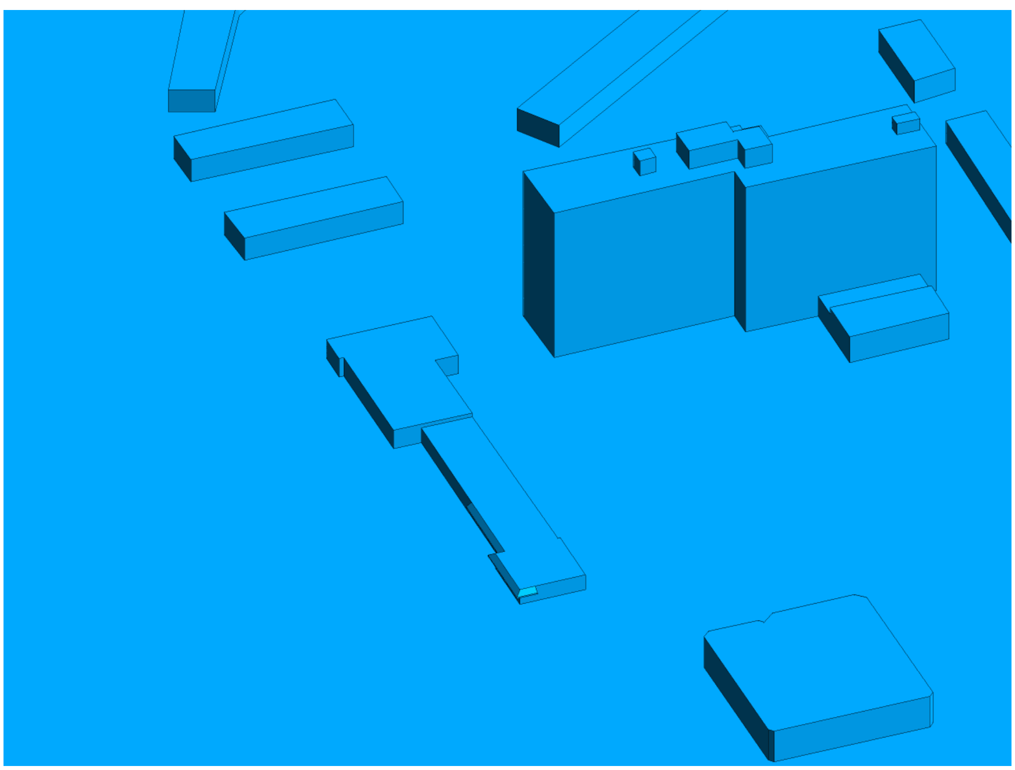


FIGURE 2D: CLOSE UP OF FIGURE 2C

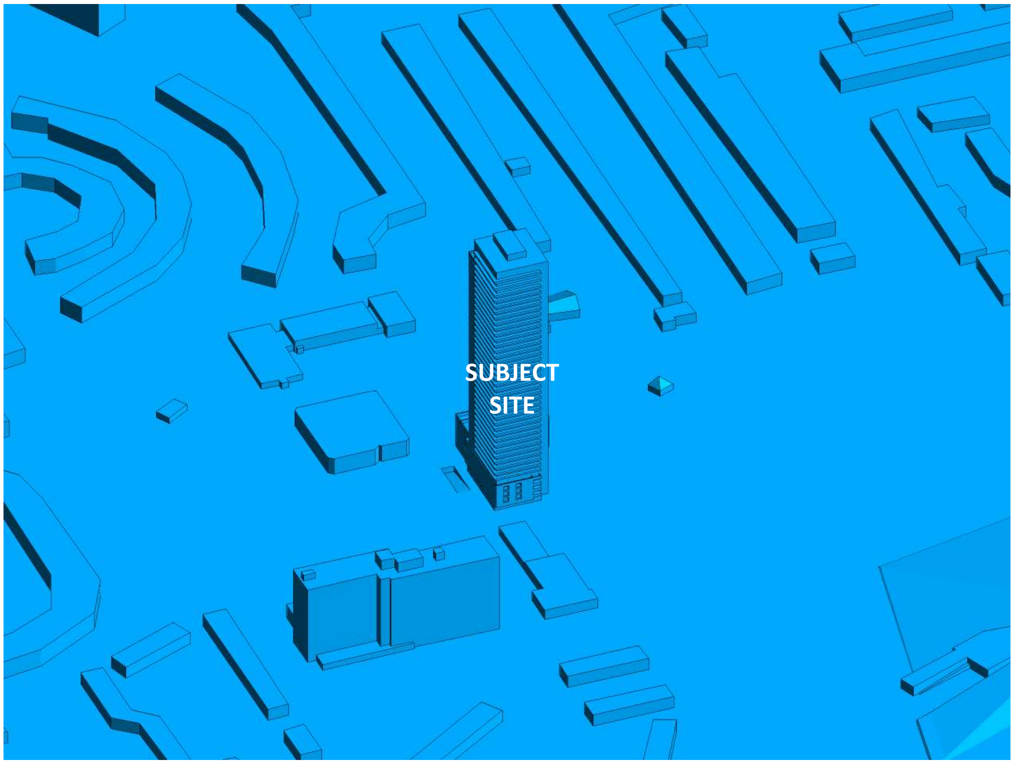


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

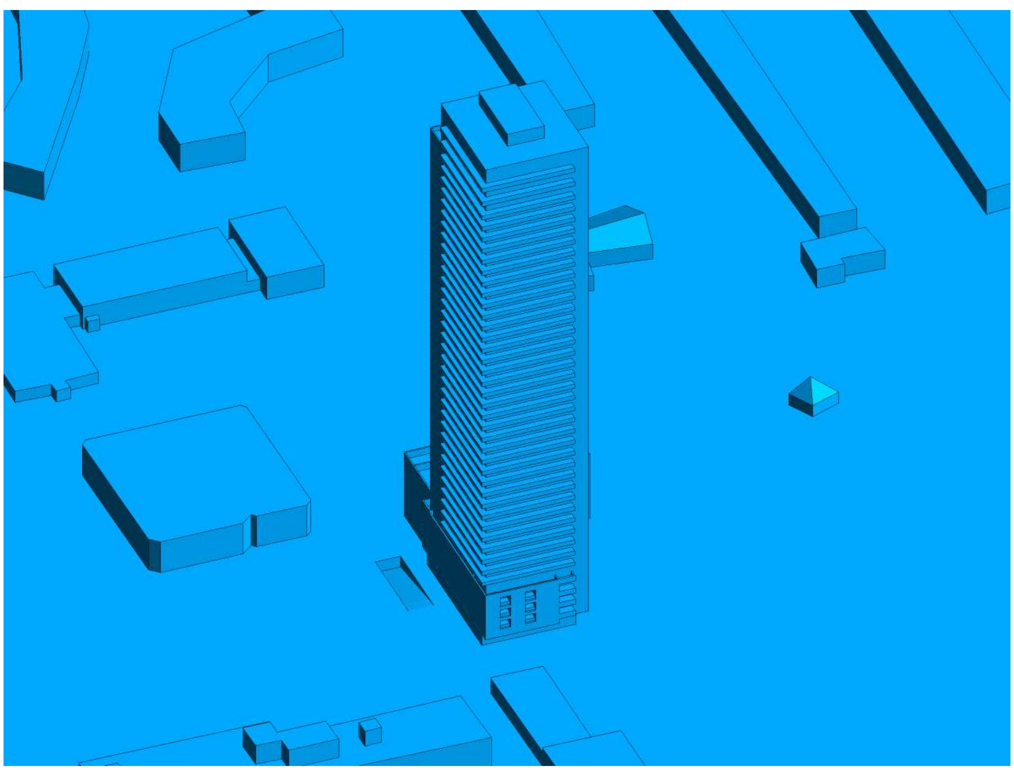


FIGURE 2F: CLOSE UP OF FIGURE 2E

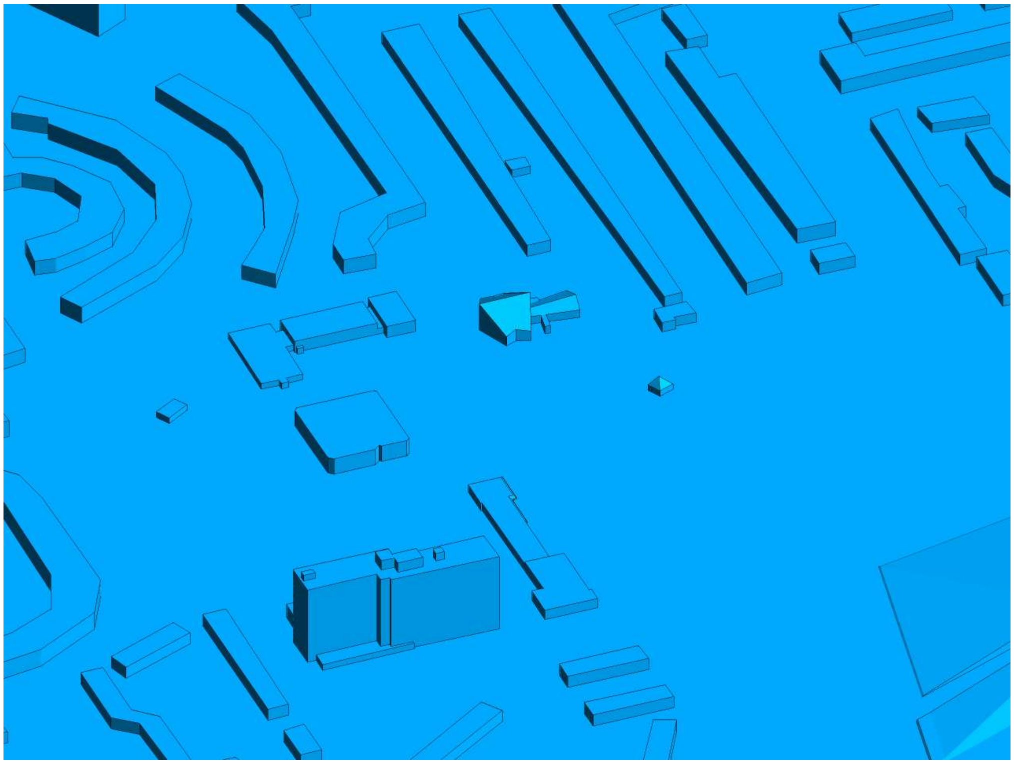


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

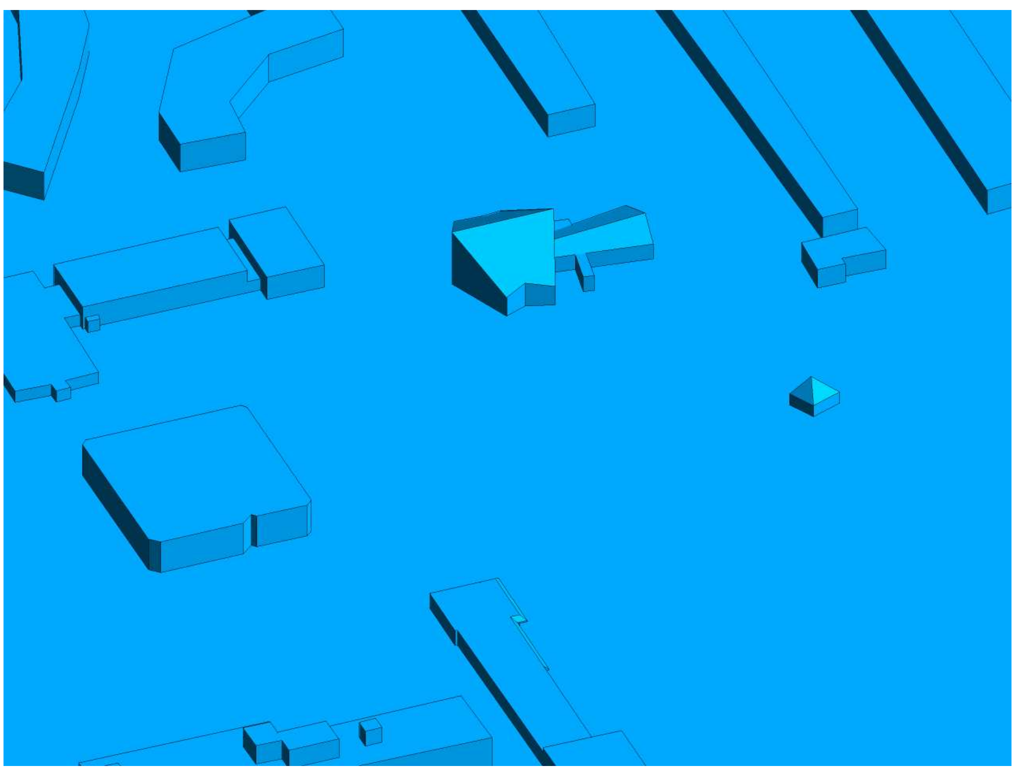


FIGURE 2H: CLOSE UP OF FIGURE 2G

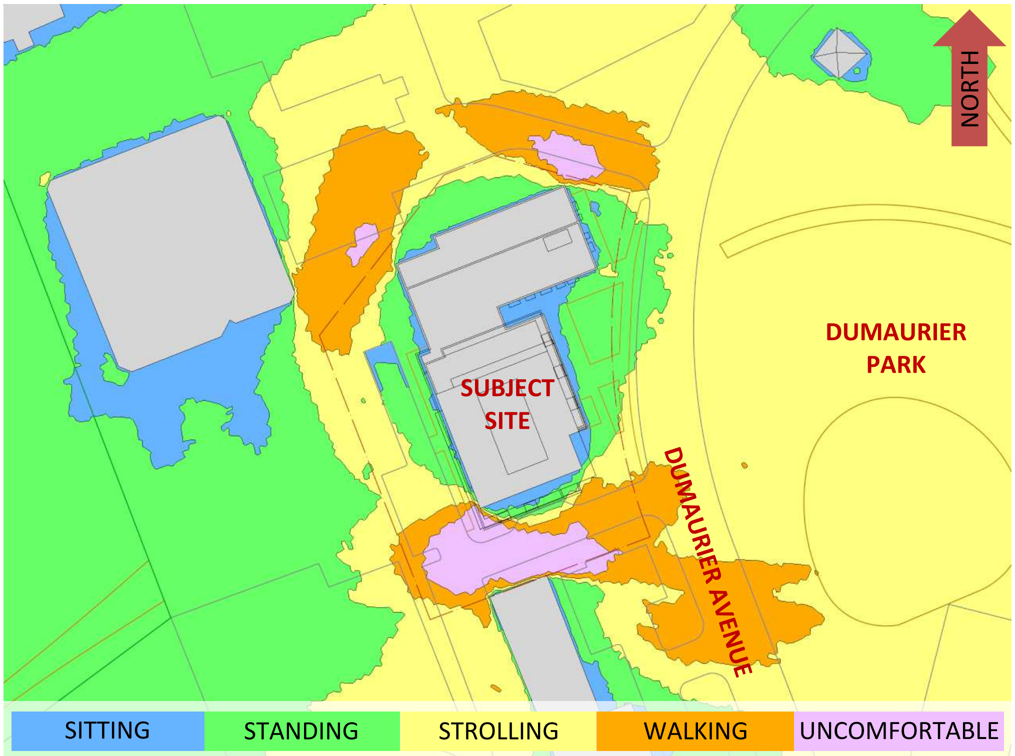


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

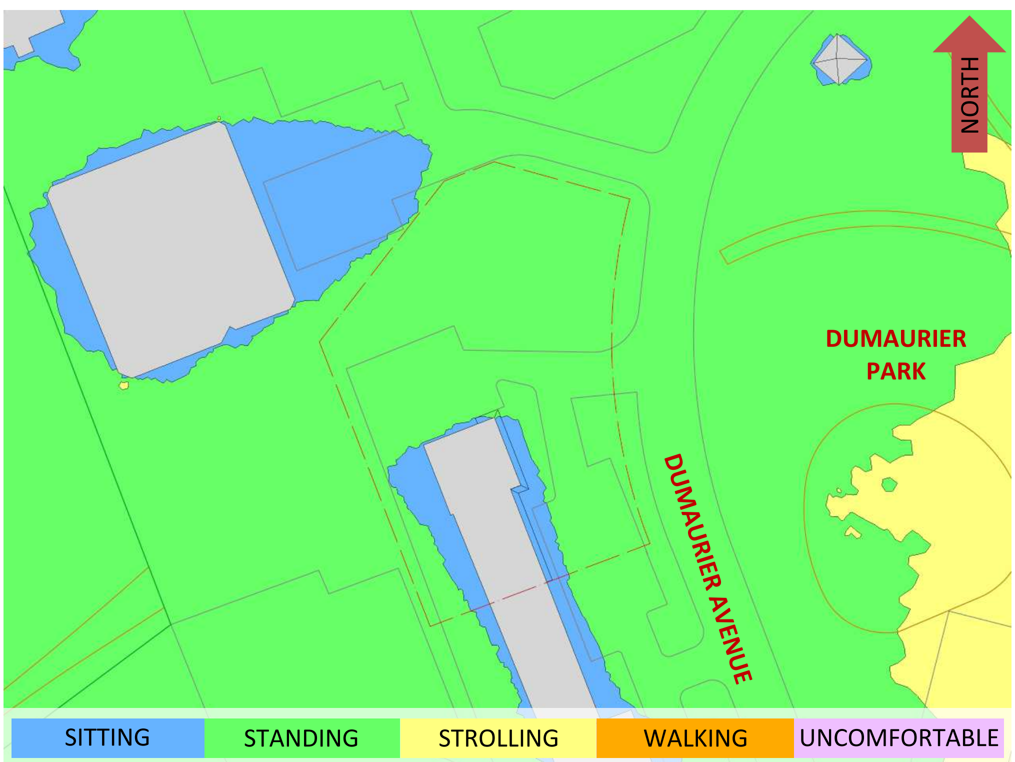


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

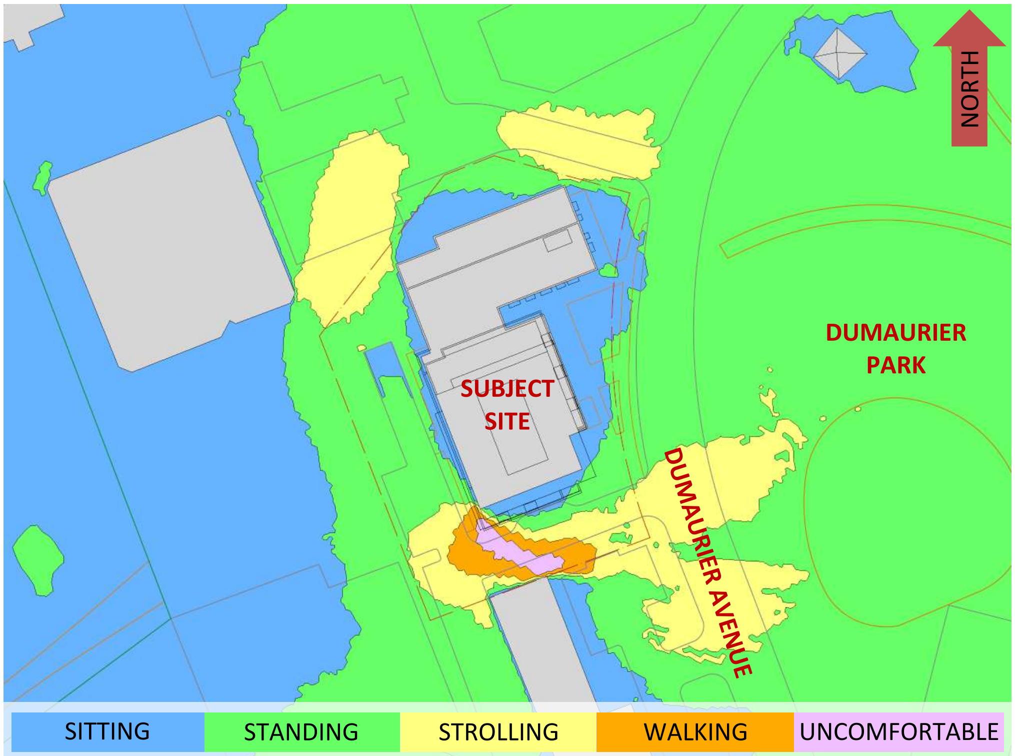


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

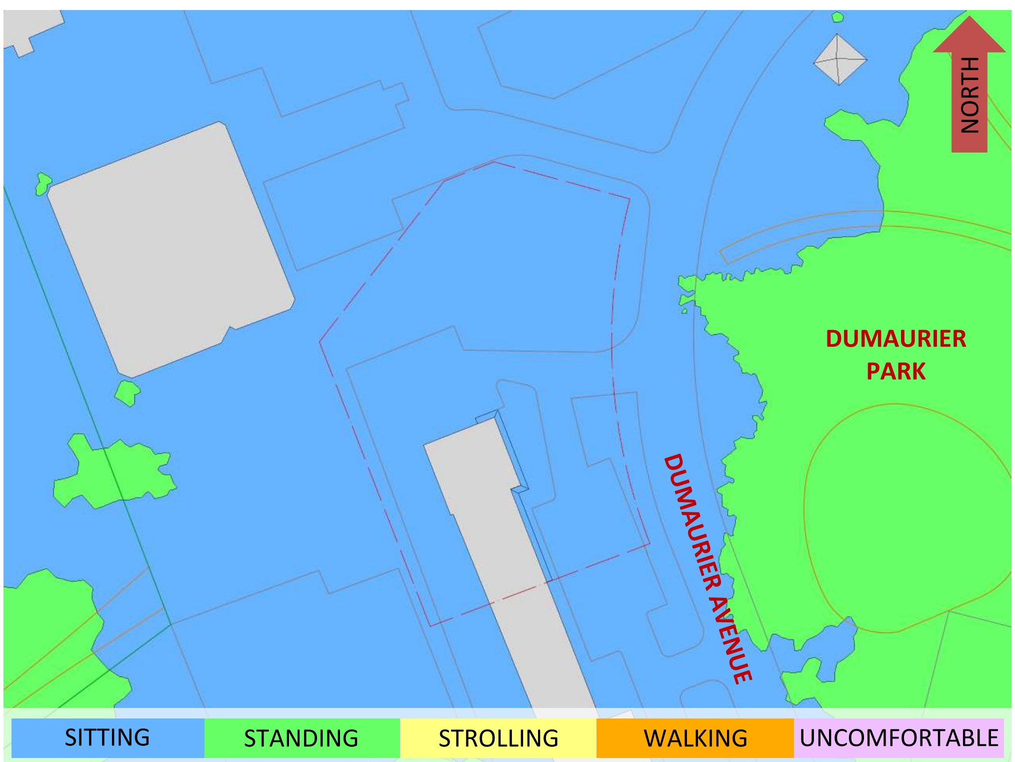


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

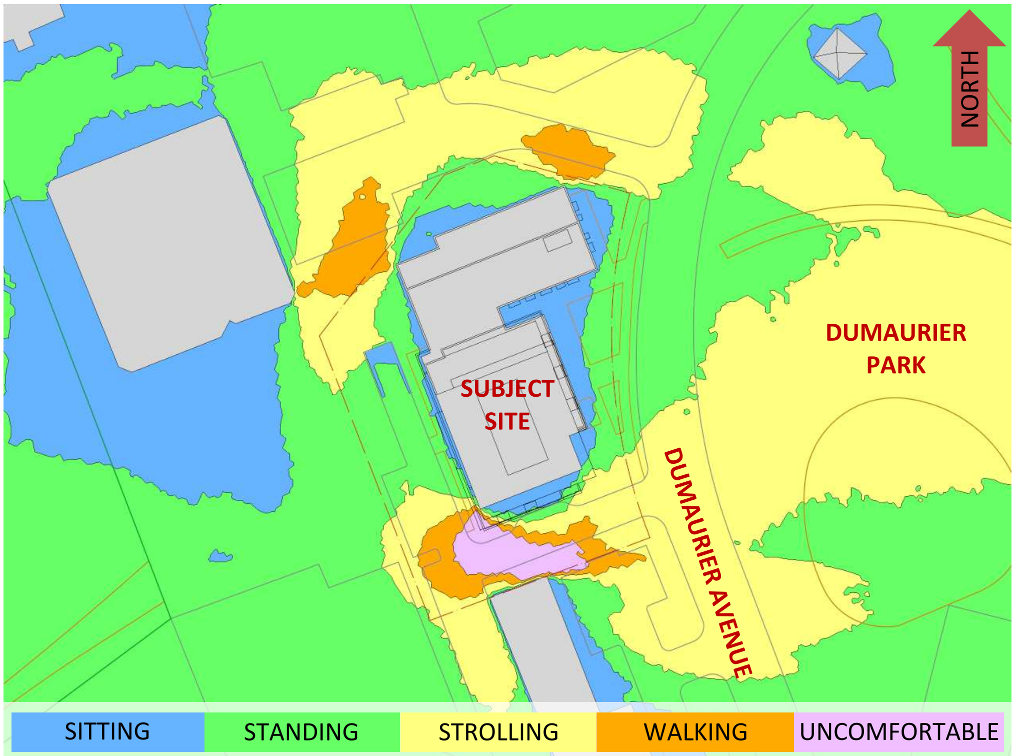


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

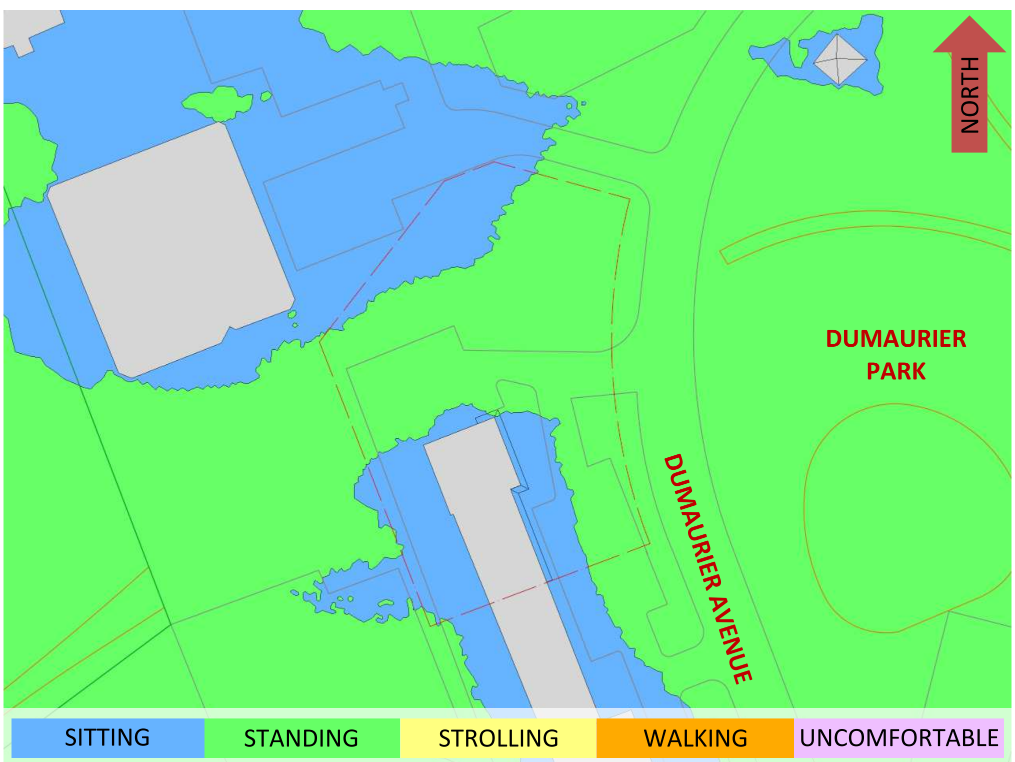


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

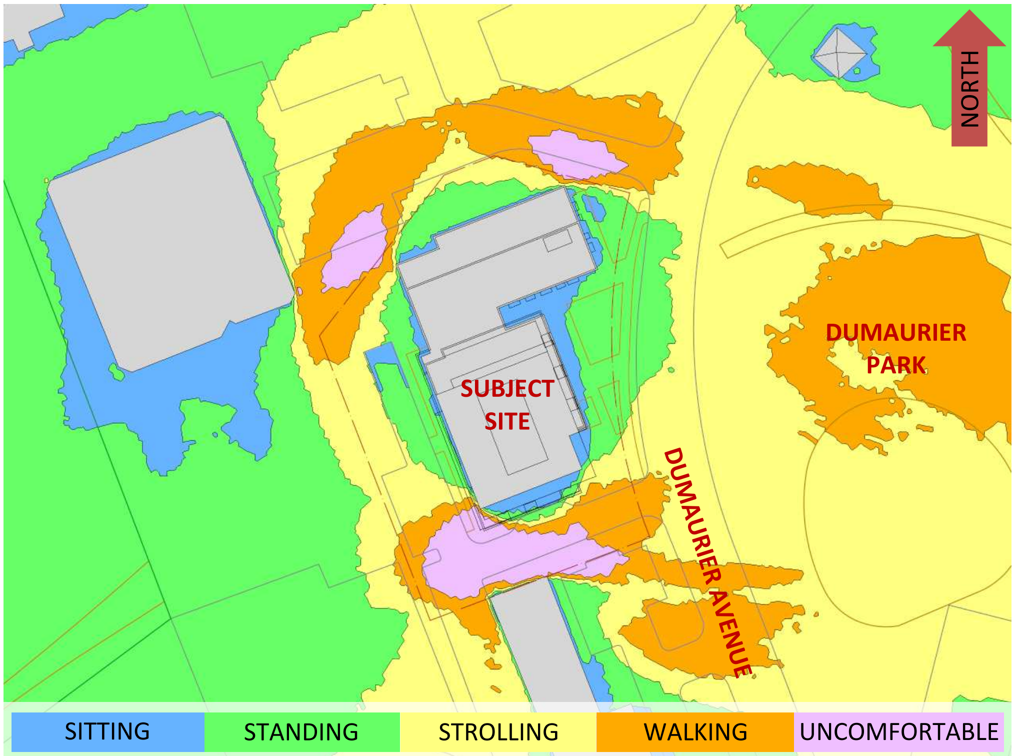


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

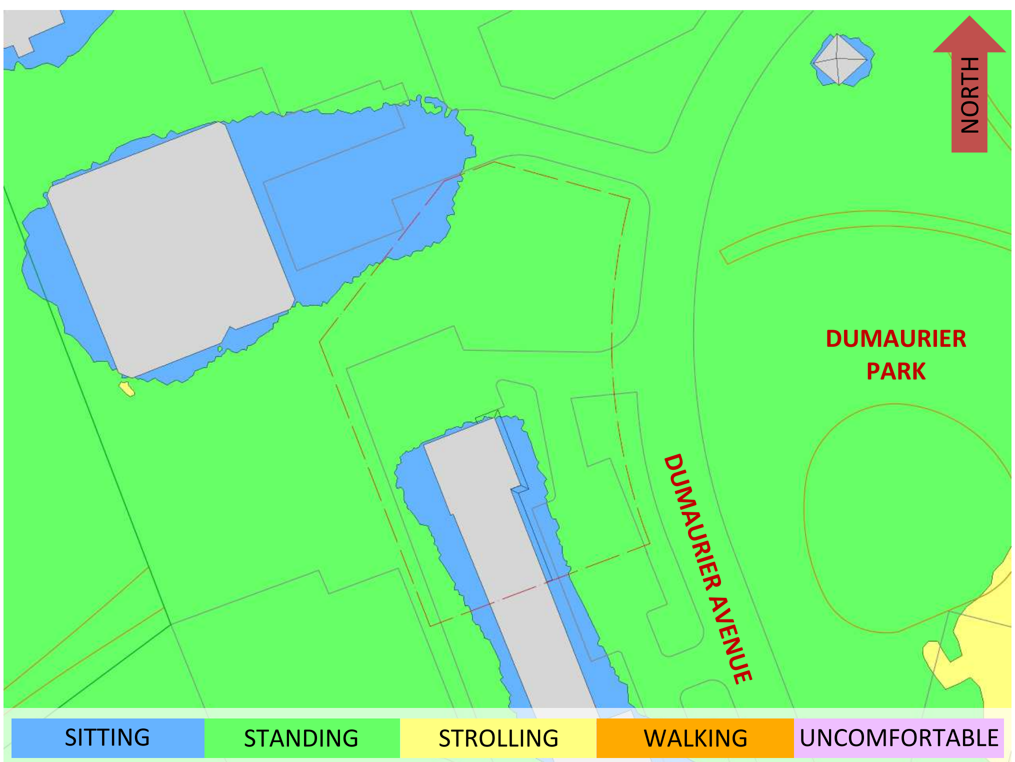


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

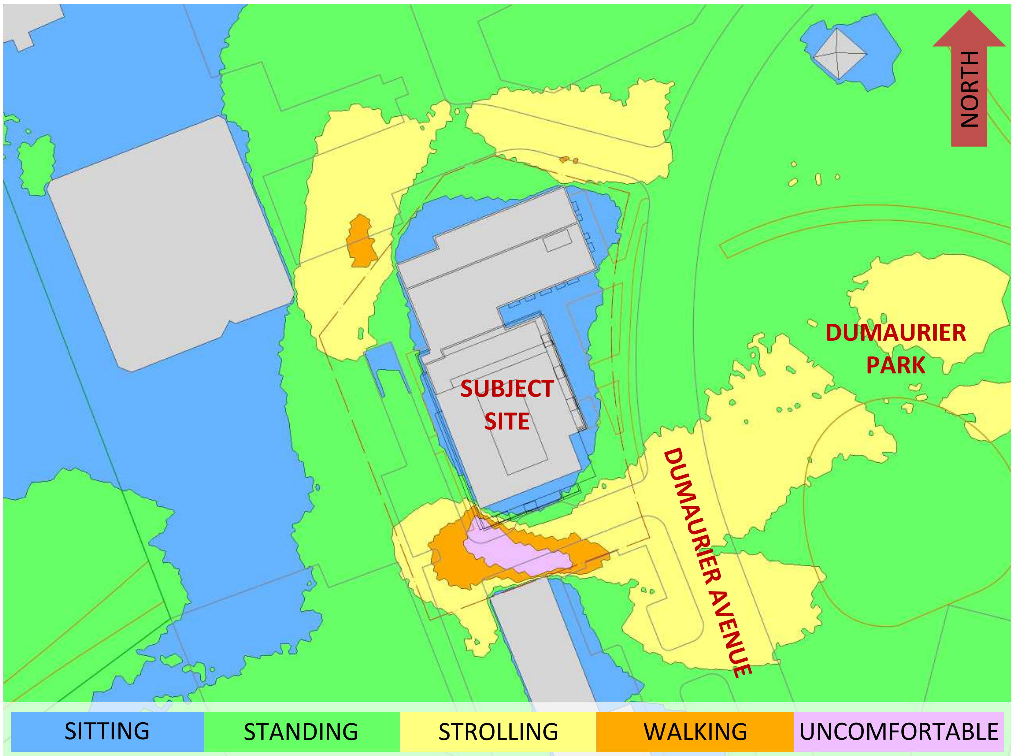


FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

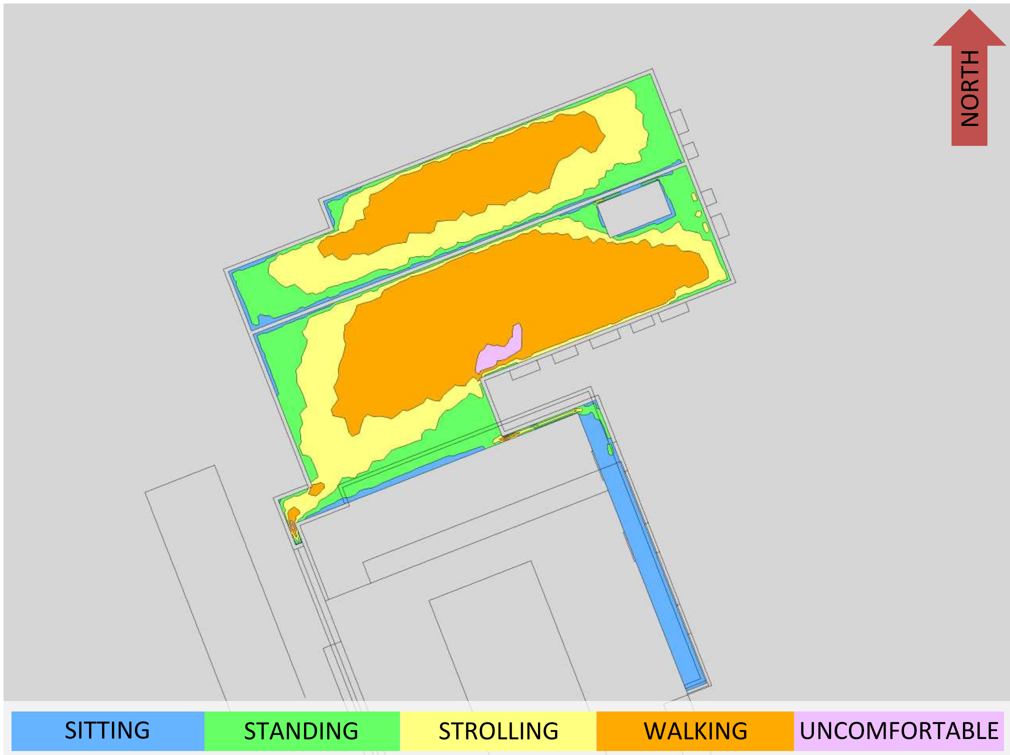


FIGURE 8A: SPRING – WIND COMFORT, LEVEL 5 AMENITY TERRACE

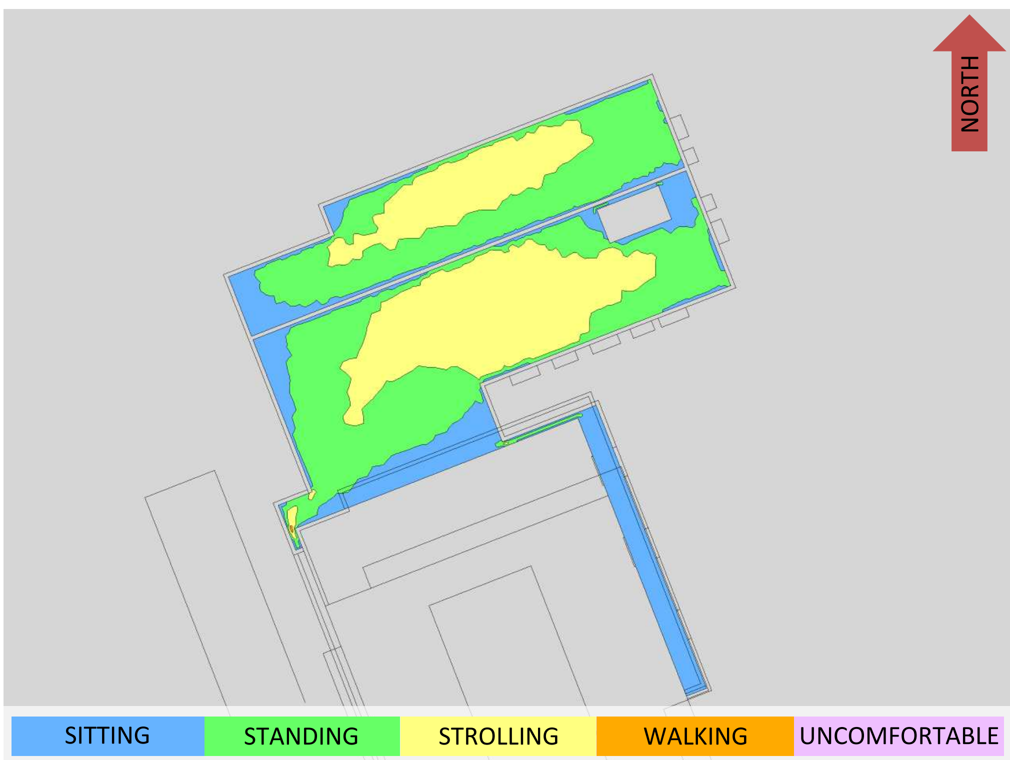


FIGURE 8B: SUMMER – WIND COMFORT, LEVEL 5 AMENITY TERRACE

FIGURE 8C: AUTUMN – WIND COMFORT, LEVEL 5 AMENITY TERRACE

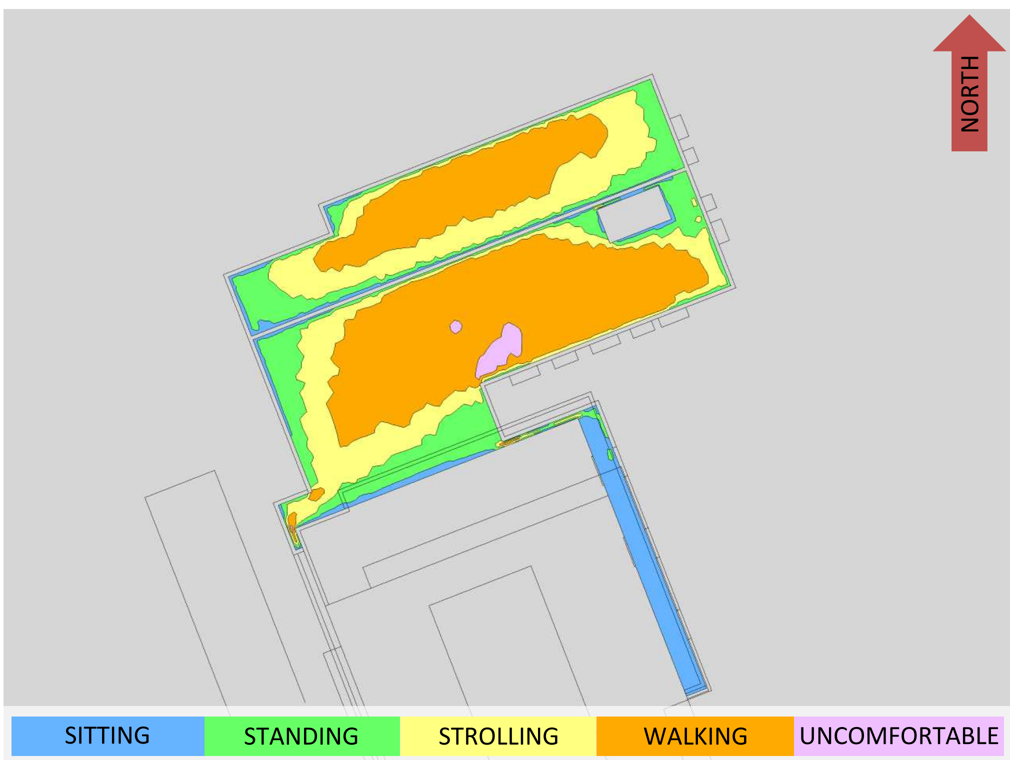


FIGURE 8D: WINTER – WIND COMFORT, LEVEL 5 AMENITY TERRACE

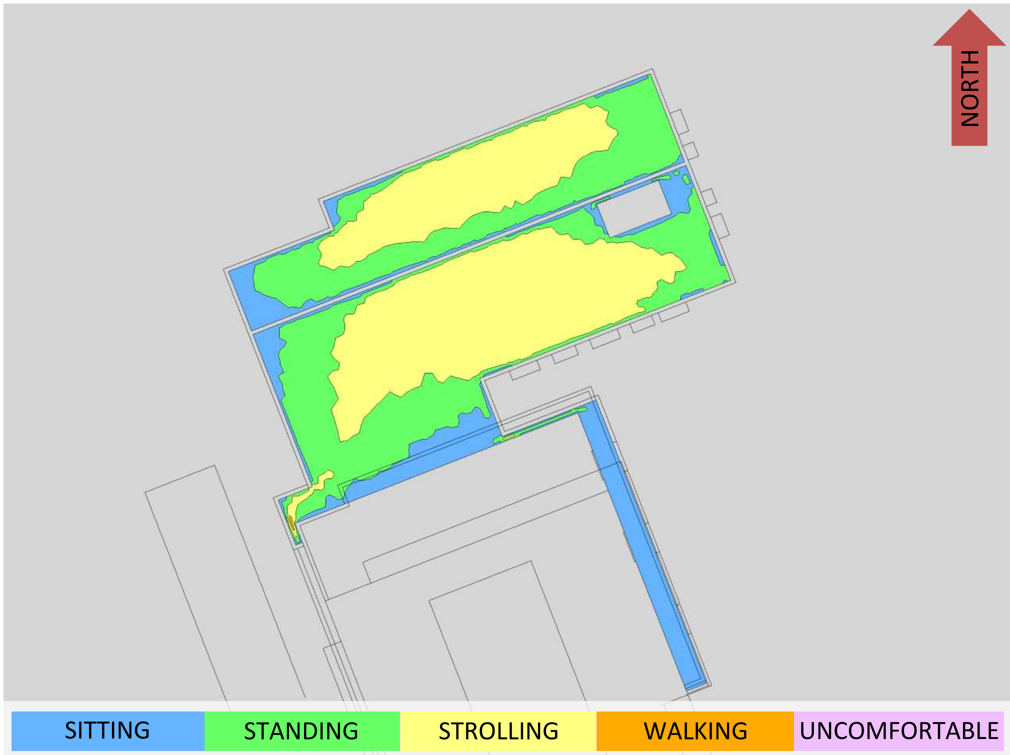
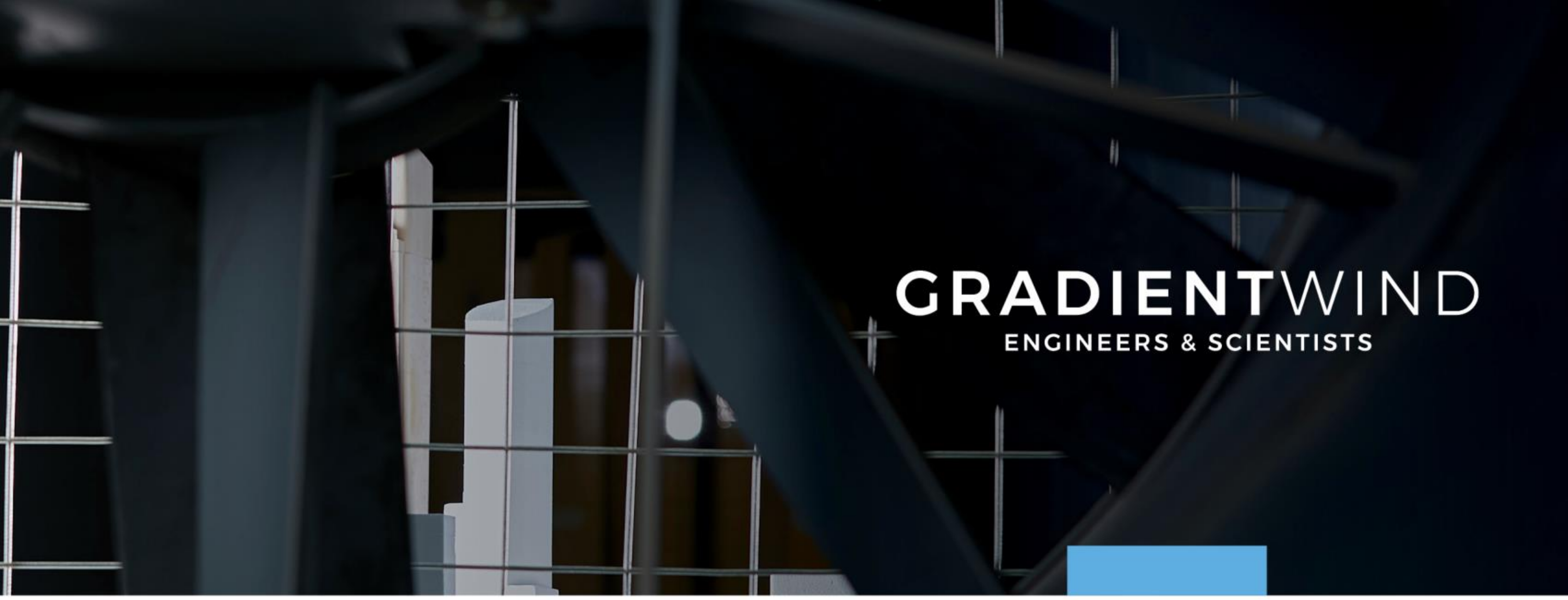
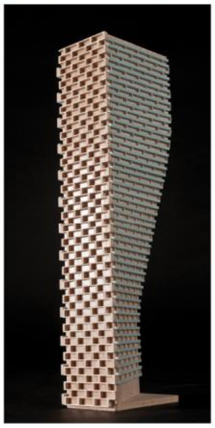
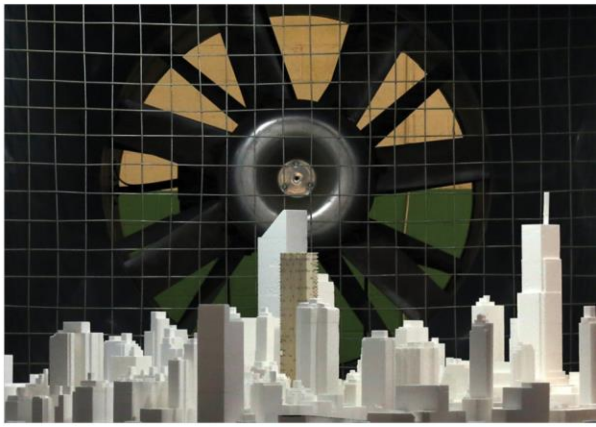


FIGURE 9: TYPICAL USE PERIOD – WIND COMFORT, LEVEL 5 AMENITY TERRACE







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, 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	0.24
74	0.23
103	0.24
167	0.24
197	0.23
217	0.23
237	0.22
262	0.24
282	0.22
301	0.21
324	0.22

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

Upstream Exposure Type	Alpha Value (α)
Open Water	0.14-0.15
Open Field	0.16-0.19
Light Suburban	0.21-0.24
Heavy Suburban	0.24-0.27
Light Urban	0.28-0.30
Heavy Urban	0.31-0.33

The turbulence model in the computational fluid dynamics (CFD) simulations is a two-equation shear-stress transport (SST) model, and thus the ABL turbulence profile requires that two parameters be defined at the inlet of the domain. The turbulence profile is defined following the recommendations of the Architectural Institute of Japan for flat terrain (3).

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

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.