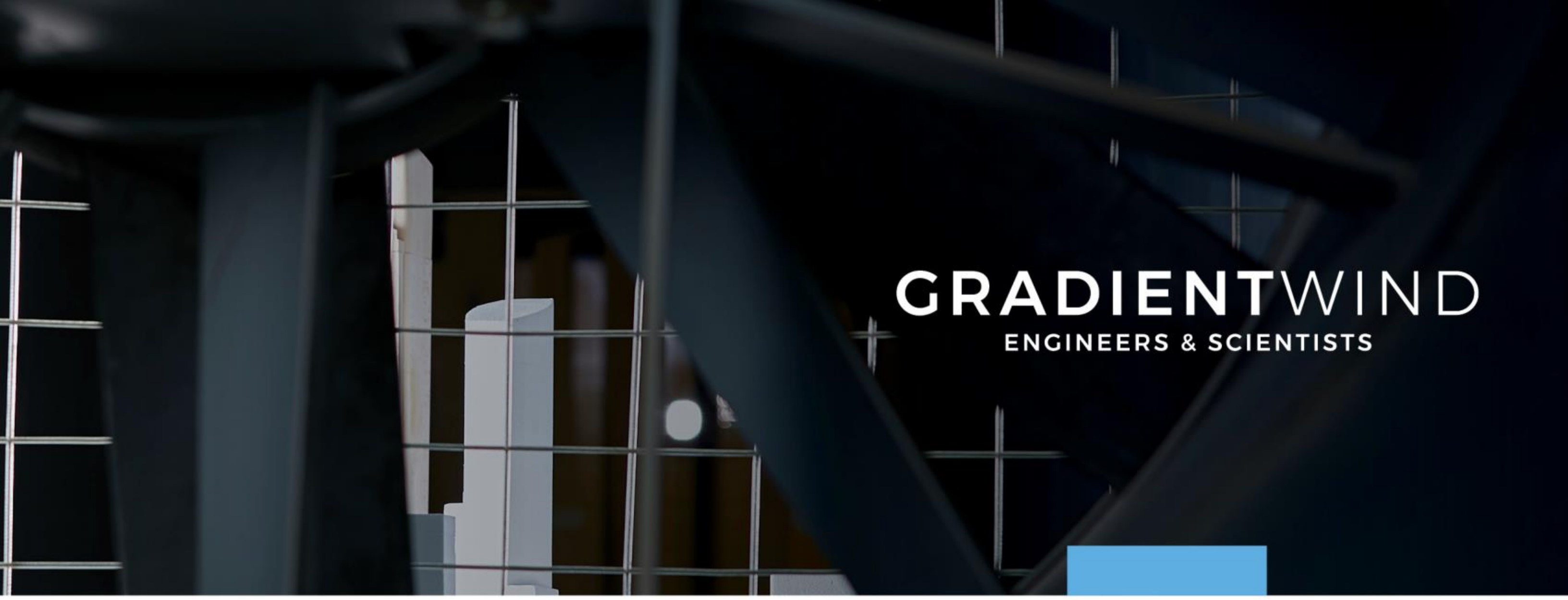
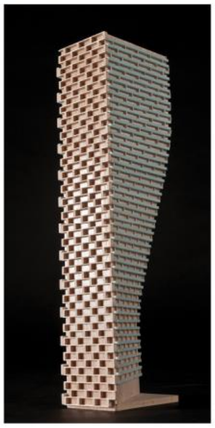
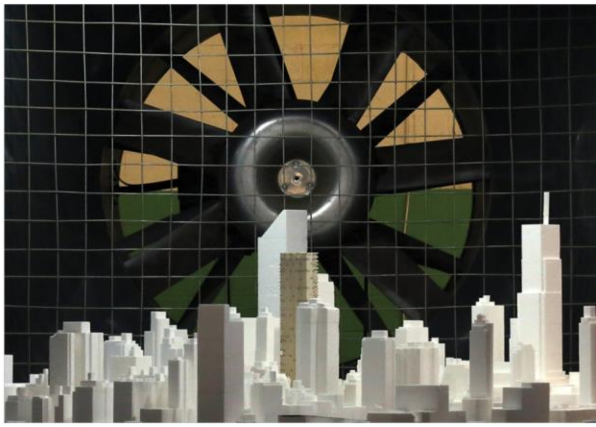


PEDESTRIAN LEVEL WIND STUDY

13 Mountain Street & 19 Elm Street
Grimsby, Ontario

Report: 21-077-PLW





May 14, 2021

PREPARED FOR
Valentine Coleman 1 Inc. & Valentine Coleman 2 Inc.
180 Bloor Street West, Suite 701
Toronto, ON M5S 1T6

PREPARED BY
Sacha Ruzzante, MASc, Wind Scientist
Justin Ferraro, P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a comparative pedestrian level wind (PLW) study to satisfy concurrent Official Plan Amendment (OPA) and Zoning By-law Amendment application requirements for the proposed development located at 13 Mountain Street and 19 Elm Street in Grimsby (hereinafter referred to as the "subject site" or "proposed development"). Per the approved Terms of Reference document for PLW studies, provided in Appendix B, our mandate within this study is to investigate 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 necessary.

A complete summary of the predicted wind conditions is provided in Section 5 of this report and illustrated in Figures 3A-7B. Based on computer simulations using the CFD technique, meteorological data analysis, and experience with numerous similar developments, the study concludes the following:

1) Following the introduction of the proposed development, most grade-level areas within and surrounding the subject site are predicted to continue to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. While the introduction of the proposed development is predicted to increase wind speeds in some areas, conditions over the surrounding sidewalks and properties, and in the vicinity of most building access points, are predicted to be acceptable for the intended uses throughout the year.

    a. Following the introduction of the proposed development, conditions during the autumn and winter seasons in the vicinity of the entrance serving the existing adjacent building at 21 Elm Street are predicted to be suitable for walking or better at least 80% of the time, while conditions are predicted to be suitable for standing during the spring and summer seasons. Based on industry standards, it is recommended that conditions in the vicinity of primary building entrances be comfortable for standing at least 80% of the time throughout the year; equivalently, the 80th percentile gust wind speed should be no greater than 22 km/h. Near this entrance, the 80th percentile gust wind speed during the winter season is predicted to be approximately 25 km/h, which exceeds the standing guideline by 3 km/h. This area is also predicted to be suitable for standing at least 70% of the time during the winter season.

b. Conditions in the vicinity of the lobby entrance at the south end of the proposed development are predicted to be suitable for sitting during the summer season, standing during the spring and autumn seasons, becoming suitable for walking during the winter season. Since this entrance may be considered a secondary entrance, the noted conditions may be considered acceptable. However, if the entrance is expected to receive frequent use, we suggest that the entranceway be reviewed at the detailed design stage to ensure conditions in the area are suitable for standing, or better, throughout the year.

2) Conditions within the outdoor amenity area on the east side of the proposed development, and the plaza on the west side, are predicted to be suitable for sitting at least 85% of the time during the typical use period of May to October, inclusive. These conditions are considered acceptable.

3) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions are expected anywhere over the subject site. During extreme weather events, (e.g., 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.

GRADIENTWIND
ENGINEERS & SCIENTISTS

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Valentine Coleman 1 Inc. & Valentine Coleman 2 Inc. to undertake a comparative pedestrian level wind (PLW) study to satisfy concurrent Official Plan Amendment (OPA) and Zoning By-law Amendment application requirements for the proposed development located at 13 Mountain Street and 19 Elm Street in Grimsby (hereinafter referred to as the "subject site" or "proposed development"). Per the approved Terms of Reference (ToR) document for PLW studies[1], provided in Appendix B, our mandate within this study is to investigate 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.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, architectural drawings provided by SvN Architects + Planners in April 2021, surrounding street layouts and existing and approved future building massing information obtained from the City of Grimsby, and recent site imagery.

2. TERMS OF REFERENCE

The subject site is situated at the northeast corner of Mountain Street and Elm Street. The proposed development is a 7-storey mixed-use building integrated with the existing Woolverton House and Woolverton Hall.

At grade, the building includes a lobby at the north, indoor amenity space along the centre of the west side of the floorplan, townhouse units, storage, and building services space. Woolverton House will be expanded and will continue to serve commercial functions at grade and residential uses at Level 2, while Woolverton Hall will serve as a community hall. The main residential entrance is located at the northern extent of the west elevation. An outdoor plaza is located between Woolverton Hall and Woolverton House, adjacent to the indoor amenity space, which may comprise outdoor amenity space, a commercial patio, and a 'flex square'. On the east side, an outdoor amenity is provided, adjacent to the townhouse units. Underground parking is accessible from a driveway at the north of the subject site.

[1] Gradient Wind Engineering Inc., '*Pedestrian Level Wind Study Terms of Reference*' [Mar 29, 2021]

The building steps back from the northeast corner and from the south at Level 5, and from all elevations at Level 7. These roof areas comprise private terraces. The building is served by a mechanical penthouse.

Regarding wind exposures, the near-field surroundings of the development (defined as an area falling within a 200-metre (m) radius of the site) comprise low-rise buildings in all directions. The far-field surroundings (defined as the area beyond the near field and within a 2-kilometre (km) radius) include primarily low-rise buildings from the west clockwise to the southeast; Lake Ontario lies at approximately 1.5 km to the north. Beamer Memorial Conservation Area lies approximately 300 m to the south, where the Niagara Escarpment begins to rise sharply to a height of approximately 100 m above the subject site. Site plans for the proposed and existing massing scenarios are illustrated in Figures 1A and 1B, respectively, while Figures 2A-2F illustrate the computational models used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to: (i) determine comparative pedestrian level wind comfort and safety conditions at key outdoor areas at grade level, inclusive of the abutting properties, as well as the entire road allowances for Elm Street and Mountain Street, per the ToR in Appendix B; (ii) identify areas where future 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 Grimsby area wind climate, and synthesis of computational data with industry-accepted guidelines. The following sections describe the analysis procedures, including a discussion of the comfort guidelines.

4.1 Computer-Based Context Modelling

A computer-based PLW wind study was performed to determine the influence of the wind environment on pedestrian comfort and safety at key outdoor areas within and surrounding the subject site at grade level, inclusive of the abutting properties, as well as the entire road allowances for Elm Street and Mountain Street, per the ToR in Appendix B. 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 John C. Munro International Airport in Hamilton.

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 more conservative (i.e., windier) wind speed values.

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 14 wind directions and two massing scenarios, as noted in Section 2. The CFD simulation models were centered on the subject site, complete with surrounding massing within a diameter of approximately 840 m.

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 on a continuous measurement plane 1.5 m above local grade were referenced to the wind speed at gradient height to generate mean and peak velocity ratios, which were used to calculate full-scale values. The 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 CFD wind flow simulation technique are presented in Appendix A.

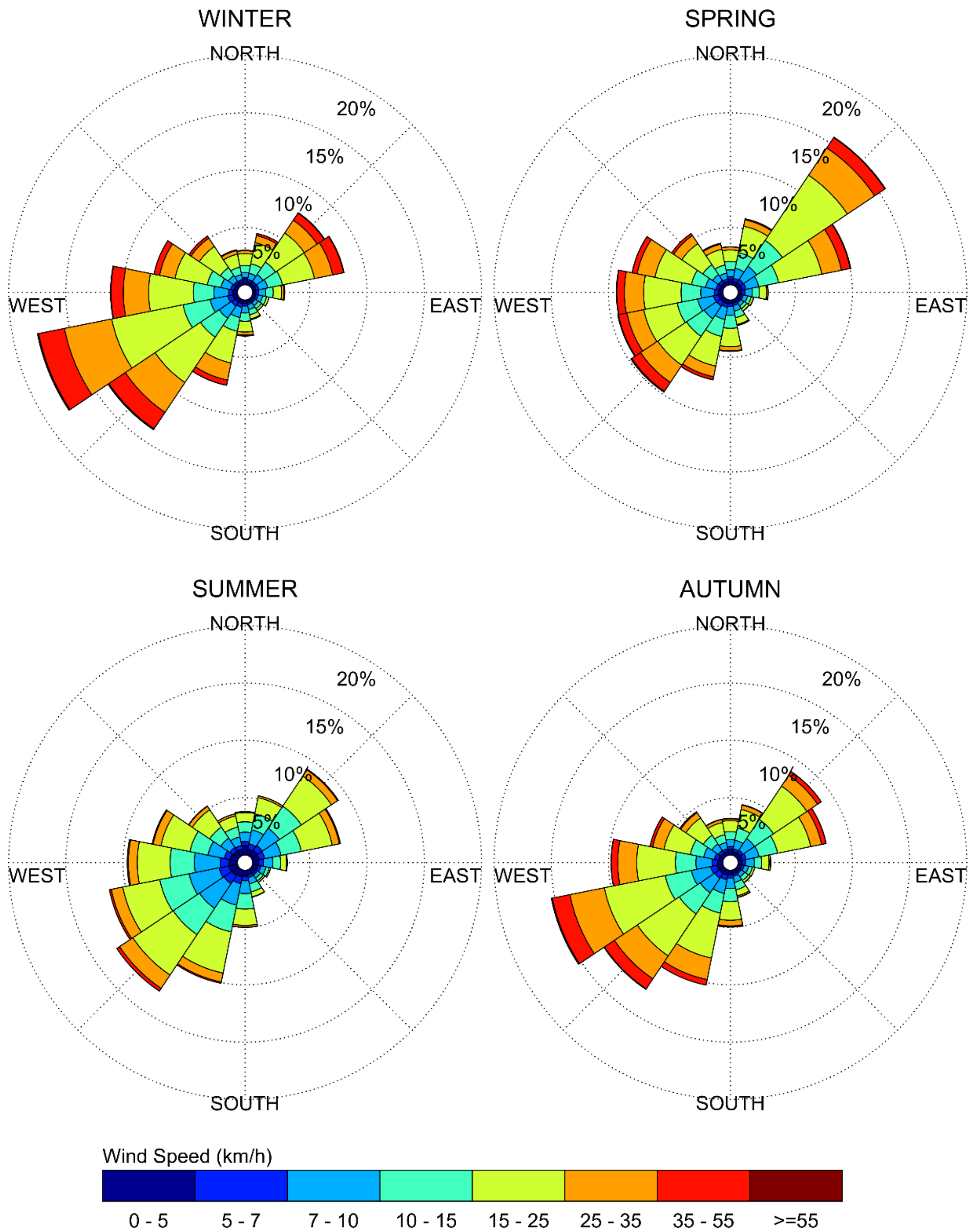
4.3 Meteorological Data Analysis

A statistical model for winds in Hamilton, representative of Grimsby, was developed from approximately 47 years of hourly wind data recorded at John C. Munro International Airport in Hamilton 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 Hamilton area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate the seasonal distribution of measured wind speeds and directions in km/h. Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction shows the frequency distribution of wind speeds for each wind direction during the measurement period. The most common wind speeds and directions can be identified by the longer length of the bars. For Hamilton, the most common winds concerning pedestrian comfort occur from the southwest clockwise to the north, as well as those from the east. The directional preference and relative magnitude of the wind speed varies somewhat from season to season, with the summer months displaying the calmest winds relative to the remaining seasonal periods.

As Grimsby lies approximately halfway between Hamilton and St. Catharines, an analysis of wind speeds at Niagara District Airport in St. Catharines was also undertaken. Wind speeds and directions at the two locations were found to agree well between the two sites, although John C. Munro International Airport tends to experience somewhat stronger winds from the northeast, while Niagara District Airport tends to experience stronger winds from the southeast and north-northwest. On average, considering all wind directions, mean wind speeds recorded at John C. Munro International Airport are approximately 6% higher than those recorded at Niagara District Airport. The use of data from Hamilton is therefore considered somewhat conservative.

SEASONAL DISTRIBUTION OF WIND
JOHN C. MUNRO INTERNATIONAL AIRPORT, HAMILTON, ONTARIO



Notes:

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

4.4 Pedestrian Comfort and Safety Guidelines

Pedestrian comfort and safety guidelines are based on the mechanical effects of wind without consideration of other meteorological conditions (i.e., temperature, relative humidity). The comfort guidelines assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Four pedestrian comfort classes are based on 20% non-exceedance gust wind speed ranges, which include (i) Sitting; (ii) Standing; (iii) Walking; and (iv) Uncomfortable. More specifically, the comfort classes and associated gust wind speed ranges are summarized as follows:

(i) **Sitting** – A mean wind speed no greater than 10 km/h is considered acceptable for sedentary activities, including sitting. The corresponding gust wind speed is 16 km/h.

(ii) **Standing** – A mean wind speed no greater than 14 km/h is considered acceptable for activities such as standing or leisurely strolling. The corresponding gust wind speed is 22 km/h.

(iii) **Walking** – A mean wind speed no greater than 20 km/h is considered acceptable for walking or more vigorous activities. The corresponding gust wind speed is 30 km/h.

(iv) **Uncomfortable** – A mean wind speed greater than 20 km/h (gust wind speed greater than 30 km/h) is classified as uncomfortable from a pedestrian comfort standpoint. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this comfort class.

The pedestrian safety wind speed guideline 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 greater than 90 km/h is classified as dangerous. The wind speeds associated with the above categories are gust wind speeds. The gust speeds, and equivalent mean speeds, are selected based on 'The Beaufort Scale', presented on the following page, which describes the effects of forces produced by varying wind speed levels on objects. Gust speeds are included because 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.

THE BEAUFORT SCALE

Number	Description	Wind Speed (km/h)		Description
		Mean	Gust	
2	Light Breeze	6-11	9-17	Wind felt on faces
3	Gentle Breeze	12-19	18-29	Leaves and small twigs in constant motion; wind extends light flags
4	Moderate Breeze	20-28	30-42	Wind raises dust and loose paper; small branches are moved
5	Fresh Breeze	29-38	43-57	Small trees in leaf begin to sway
6	Strong Breeze	39-49	58-74	Large branches in motion; Whistling heard in electrical wires; umbrellas used with difficulty
7	Moderate Gale	50-61	75-92	Whole trees in motion; inconvenient walking against wind
8	Gale	62-74	93-111	Breaks twigs off trees; generally impedes progress

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 wind speeds of 16 km/h were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting or more sedentary activities. Similarly, if 30 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 guidelines 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 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 desired comfort classes, which are dictated by the location type for each region (i.e., a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their desired comfort classes are summarized on the following page.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Standing / Walking
Public Sidewalks / Pedestrian Walkways	Walking
Outdoor Amenity Spaces	Sitting / Standing
Cafés / Patios / Benches / Gardens	Sitting / Standing
Plazas	Sitting / Standing / Walking
Transit Stops	Sitting / Standing
Public Parks	Sitting / Standing / Walking
Garage / Service Entrances	Walking
Vehicular Drop-Off Zones	Standing / Walking
Laneways / Loading Zones	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 seasonal wind conditions at grade level for the proposed and existing massing scenarios. Conditions are presented as continuous contours of wind comfort within and surrounding the subject site. The colour contours indicate predicted regions of the various comfort classes noted in Section 4.4. Wind conditions suitable for sitting are represented by the colour green, standing by yellow, and walking by blue; uncomfortable conditions are represented by the colour magenta.

In addition, Figure 7A shows the percentage of time that areas at grade are predicted to be suitable for sitting during the typical use period of outdoor amenities (May to October, inclusive). Figure 7B shows the percentage of time that areas will be suitable for standing during the winter season.

5.1 Wind Comfort Conditions – Grade Level

Mountain Street: Following the introduction of the proposed development, the sidewalks along Mountain Street, adjacent to the subject site, are predicted to be suitable for standing immediately to the northwest of the proposed building and suitable for sitting elsewhere. During the spring and autumn, conditions to the northwest of the proposed building are predicted to be suitable for walking, while the remainder of the sidewalk is predicted to be suitable for standing. During the winter, conditions are predicted to be suitable for walking over much of the sidewalk, while conditions to the southwest of the proposed building, near the intersection of Mountain and Elm Streets, are predicted to remain suitable for standing.

Prior to the introduction of the proposed development, conditions are estimated to be suitable for sitting during the summer, and suitable for a mix of sitting and standing during the spring and autumn. During the winter, conditions are estimated to be mostly suitable for standing, although a region near the northwest corner of Woolverton Hall is estimated to be suitable for walking.

Although the introduction of the proposed development is expected to somewhat increase wind speeds in this area, the noted conditions under both massing scenarios are considered acceptable with respect to the wind comfort guidelines provided in Section 4.4.

Elm Street: Following the introduction of the proposed development, the sidewalks along Elm Street are predicted to be suitable for a mix of sitting and standing during the summer, and suitable for walking or better during the remaining colder seasons. The windier conditions are predicted to occur along the southern façade of the proposed building and along Elm Street to the southeast.

Prior to the introduction of the proposed building, conditions are estimated to be suitable for sitting during the summer, mostly suitable for sitting during the spring and autumn, and mostly suitable for standing during the winter. Although the introduction of the proposed development is expected to somewhat increase wind speeds in this area, the noted conditions under both massing scenarios are considered acceptable with respect to the wind comfort guidelines provided in Section 4.4.

Plaza: The plaza between Woolverton House and Woolverton Hall, which may include outdoor amenity space, a commercial patio, and a 'flex square', is predicted to remain mostly suitable for sitting during the spring, summer, and autumn. During the winter, standing conditions are predicted to intrude on the western portion of the plaza, while most of the area will remain suitable for sitting. In addition, Figure 7A shows that the area is predicted to be suitable for sitting at least 85% of the time during the typical use period. The noted conditions are considered acceptable with respect to the wind comfort guidelines provided in Section 4.4.

Outdoor Amenity: The outdoor amenity on the east side of the proposed building is predicted to be suitable for sitting during the summer and mostly suitable for sitting during the remaining colder seasons. During the spring, autumn, and winter, conditions near the edges of the area are predicted to be suitable for standing. In addition, Figure 7A shows that the area is predicted to be suitable for sitting at least 85% of the time during the typical use period. The noted conditions are considered acceptable with respect to the wind comfort guidelines provided in Section 4.4.

Building Entrances, Proposed Development: Conditions in the vicinity of the primary building entrance serving the proposed development, as well as the entrances serving Woolverton House and Woolverton Hall, are predicted to be suitable for standing, or better, throughout the year. These conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Conditions in the vicinity of the lobby entrance at the south end of the proposed development are predicted to be suitable for sitting during the summer season, standing during the spring and autumn seasons, becoming suitable for walking during the winter season. Since this entrance may be considered a secondary entrance, the noted conditions may be considered acceptable. However, if the entrance is expected to receive frequent use, we suggest that the entranceway be reviewed at the detailed design stage to ensure conditions in the area are suitable for standing, or better, throughout the year.

Building Entrances, Surrounding Area: Most entrances serving the surrounding buildings are predicted to continue to experience conditions suitable for standing, or better, throughout the year. However, following the introduction of the proposed development, conditions during the autumn and winter in the vicinity of the entrance serving the existing adjacent building at 21 Elm Street are predicted to be suitable for walking or better at least 80% of the time, while conditions are predicted to be suitable for standing during the spring and summer seasons. Based on industry standards, it is recommended that conditions in the vicinity of primary building entrances be comfortable for standing at least 80% of the time throughout the year; equivalently, the 80^{th} percentile gust wind speed should be no greater than 22 km/h.

Near this entrance, the 80th percentile gust wind speed during the winter season is predicted to be approximately 25 km/h, which exceeds the standing guideline by 3 km/h. This area is also predicted to be suitable for standing at least 70% of the time during the winter season.

Existing conditions in the immediate vicinity of this entrance are estimated to be suitable for sitting during the spring, summer, and autumn. During the winter, the area is estimated to be suitable for standing at least 85% of the time.

5.2 Wind Safety

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 at grade. During extreme weather events, (e.g., 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.

5.3 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 (i.e., 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 site would alter the wind profile approaching the site; and (ii) development in proximity to the site would cause changes to local flow patterns. In general, development in urban centers creates reduction in the mean wind speeds and localized increases in the gustiness of the wind.

Regarding primary and secondary building access points, wind conditions predicted in this study are only applicable to pedestrian comfort and safety. As such, the results should not be construed to indicate wind loading on doors and associated hardware.

6. SUMMARY AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 of this report and illustrated in Figures 3A-7B. Based on computer simulations using the CFD technique, meteorological data analysis, and experience with numerous similar developments, this study concludes the following:

1) Following the introduction of the proposed development, most grade-level areas within and surrounding the subject site are predicted to continue to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. While the introduction of the proposed development is predicted to increase wind speeds in some areas, conditions over the surrounding sidewalks and properties, and in the vicinity of most building access points, are predicted to be acceptable for the intended uses throughout the year.

    a. Following the introduction of the proposed development, conditions during the autumn and winter seasons in the vicinity of the entrance serving the existing adjacent building at 21 Elm Street are predicted to be suitable for walking or better at least 80% of the time, while conditions are predicted to be suitable for standing during the spring and summer seasons. Based on industry standards, it is recommended that conditions in the vicinity of primary building entrances be comfortable for standing at least 80% of the time throughout the year; equivalently, the 80th percentile gust wind speed should be no greater than 22 km/h. Near this entrance, the 80th percentile gust wind speed during the winter season is predicted to be approximately 25 km/h, which exceeds the standing guideline by 3 km/h. This area is also predicted to be suitable for standing at least 70% of the time during the winter season.

    b. Conditions in the vicinity of the lobby entrance at the south end of the proposed development are predicted to be suitable for sitting during the summer season, standing during the spring and autumn seasons, becoming suitable for walking during the winter season. Since this entrance may be considered a secondary entrance, the noted conditions may be considered acceptable. However, if the entrance is expected to receive frequent use, we suggest that the entranceway be reviewed at the detailed design stage to ensure conditions in the area are suitable for standing, or better, throughout the year.

2) Conditions within the outdoor amenity area on the east side of the proposed development, and the plaza on the west side, are predicted to be suitable for sitting at least 85% of the time during the typical use period of May to October, inclusive. These conditions are considered acceptable.

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, (e.g., 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
May 14, 2021
PROVINCE OF ONTARIO

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Wind Scientist

Justin Ferraro, P.Eng.
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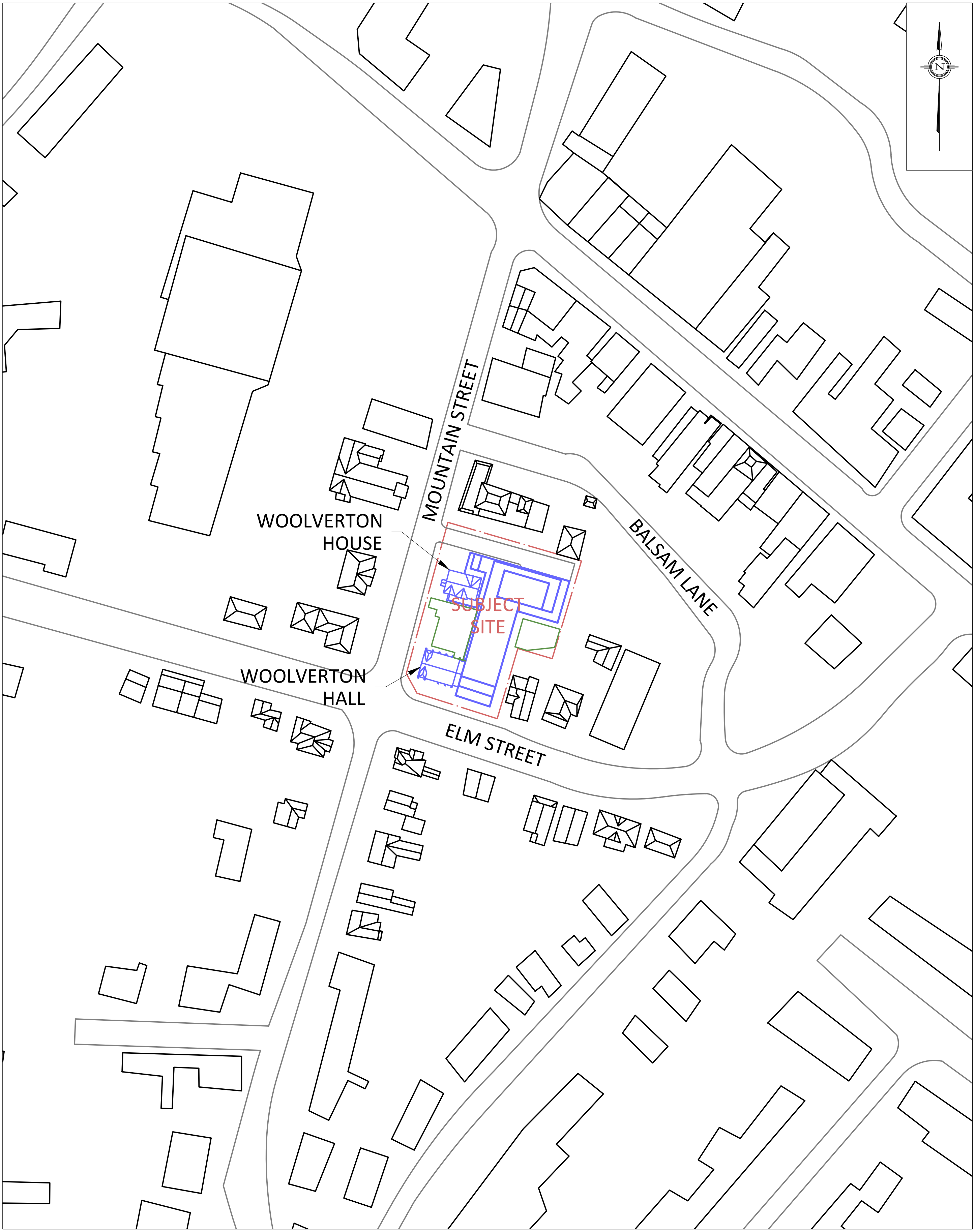

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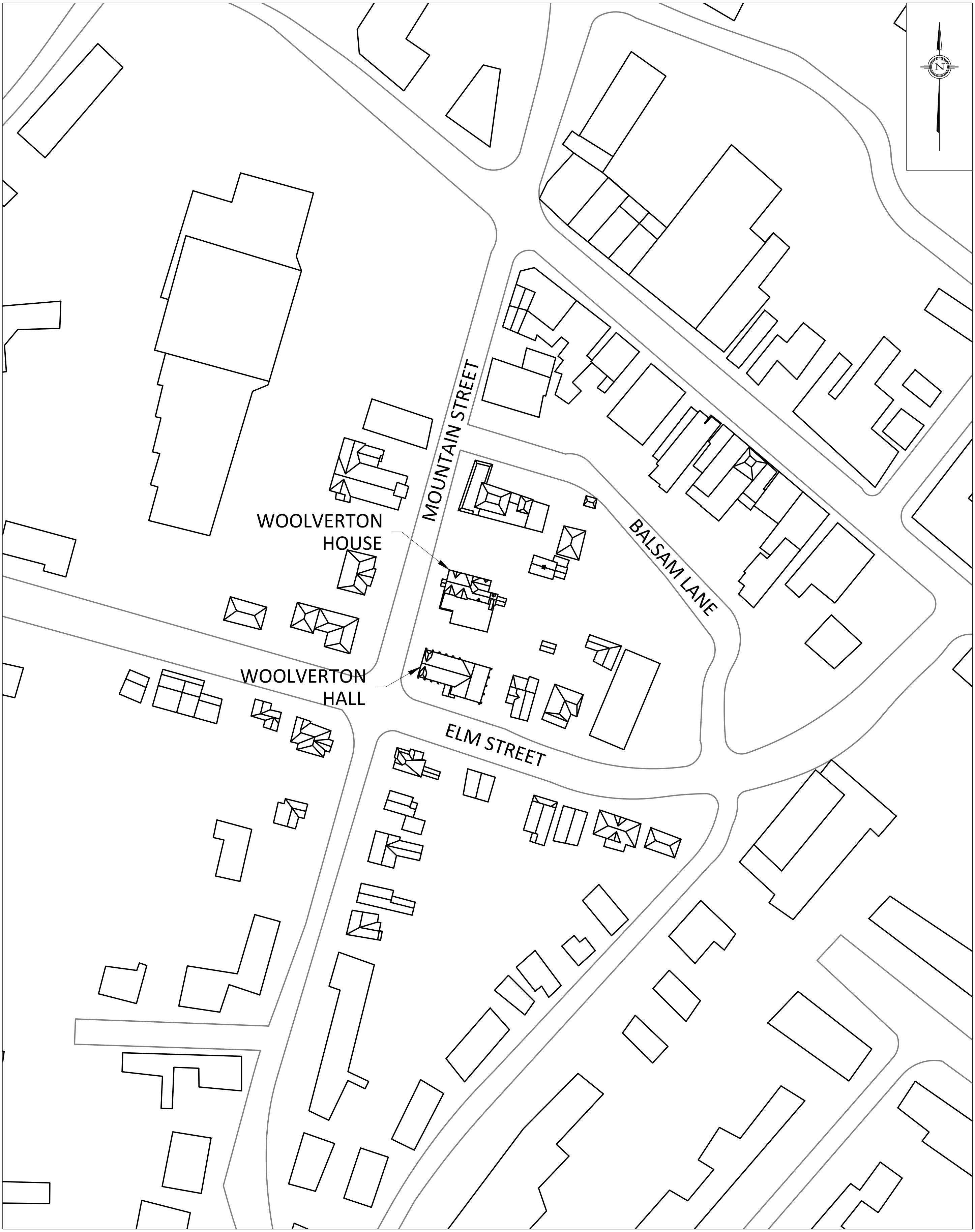
PROJECT	13 MOUNTAIN STREET & 19 ELM STREET, GRIMSBY PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2000	DRAWING NO.	21-077-1A
DATE	MAY 10, 2020	DRAWN BY	O.R.

DESCRIPTION

FIGURE 1A:
PROPOSED MASSING SCENARIO
SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	13 MOUNTAIN STREET & 19 ELM STREET, GRIMSBY PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2000	DRAWING NO.	21-077-1B
DATE	MAY 10, 2020	DRAWN BY	O.R.

DESCRIPTION

FIGURE 1B:
APPROVED MASSING SCENARIO
SITE PLAN AND SURROUNDING CONTEXT

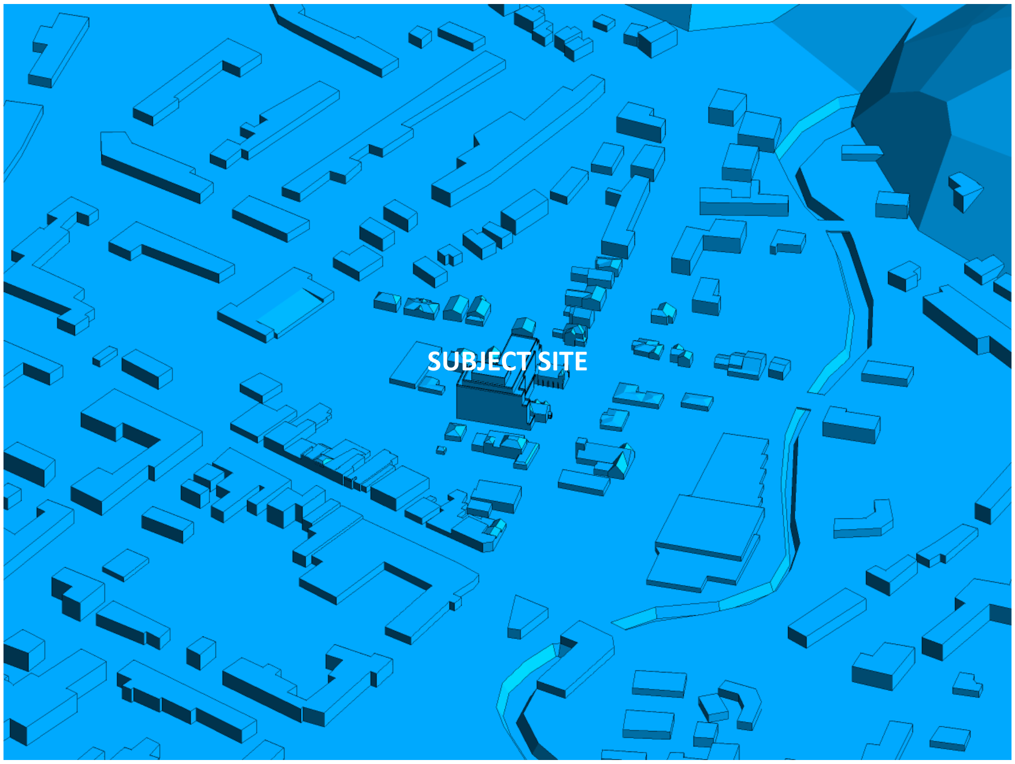


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

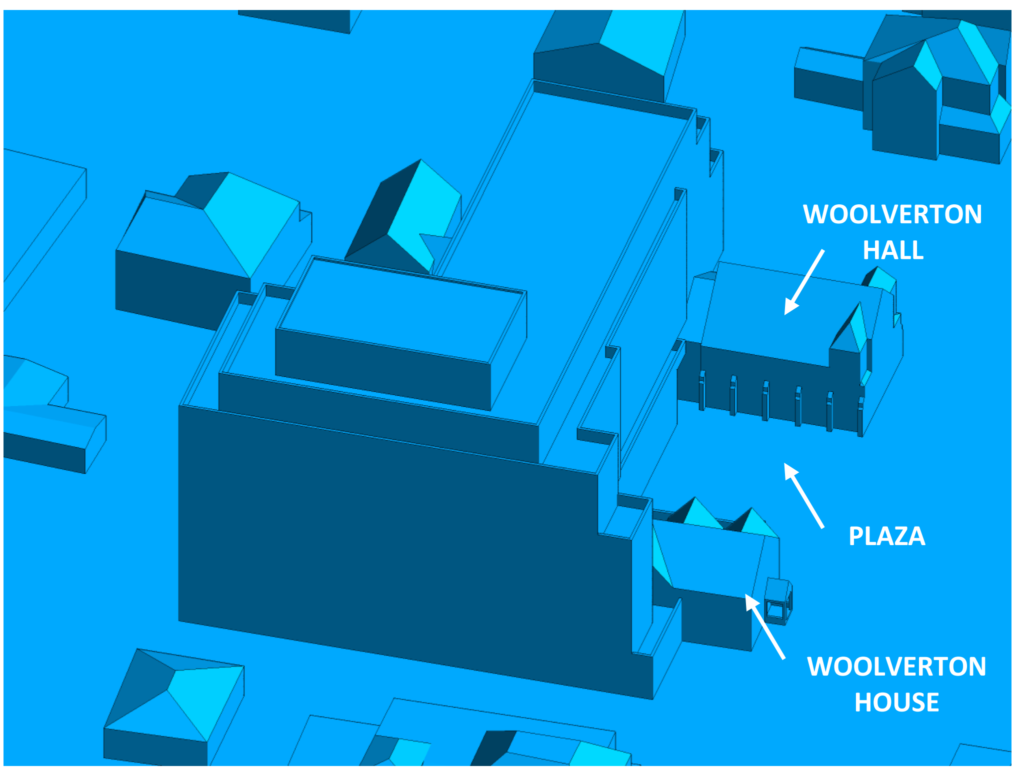


FIGURE 2B: CLOSE-UP VIEW OF FIGURE 2A

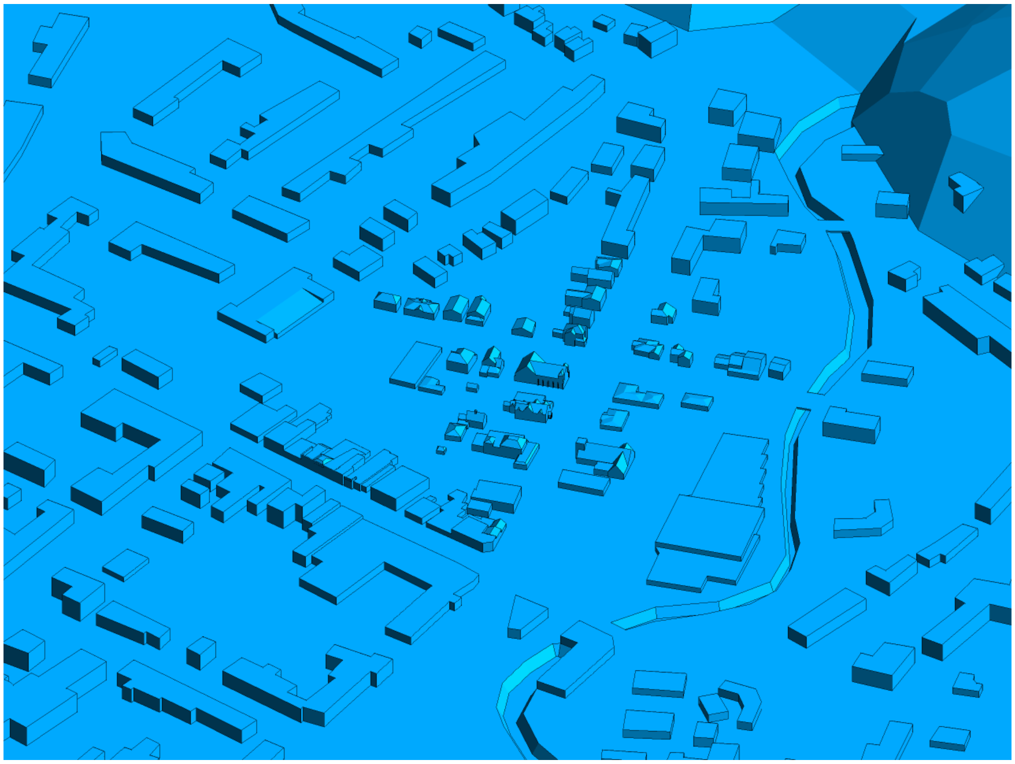


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

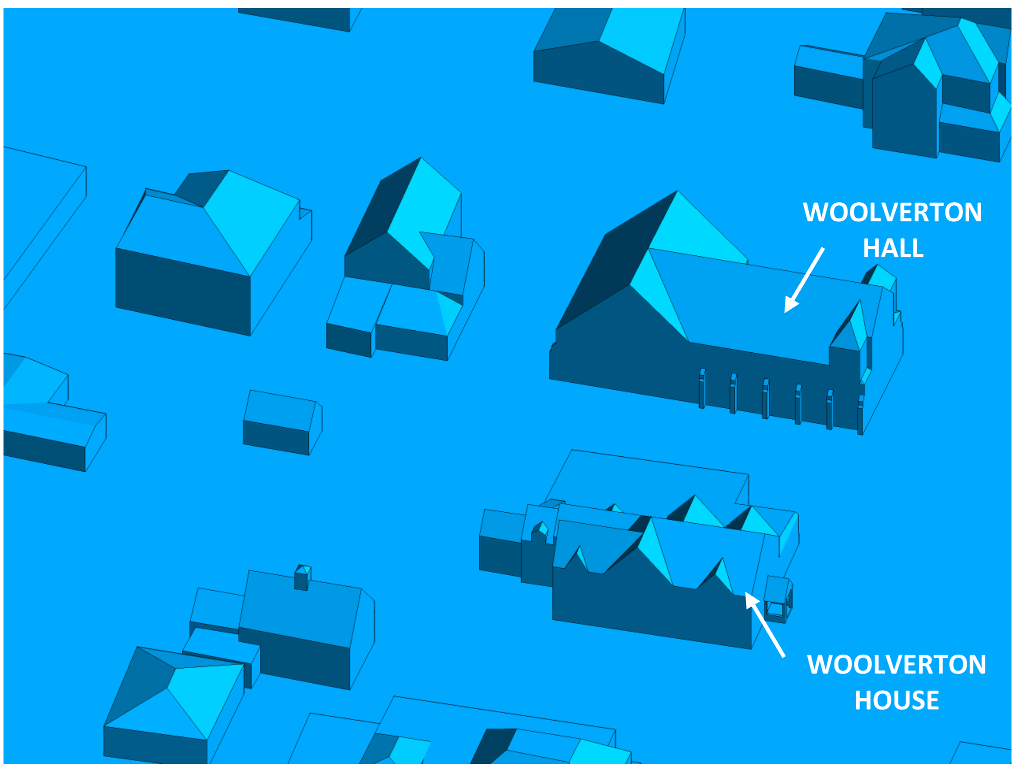


FIGURE 2D: CLOSE-UP VIEW OF FIGURE 2C

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

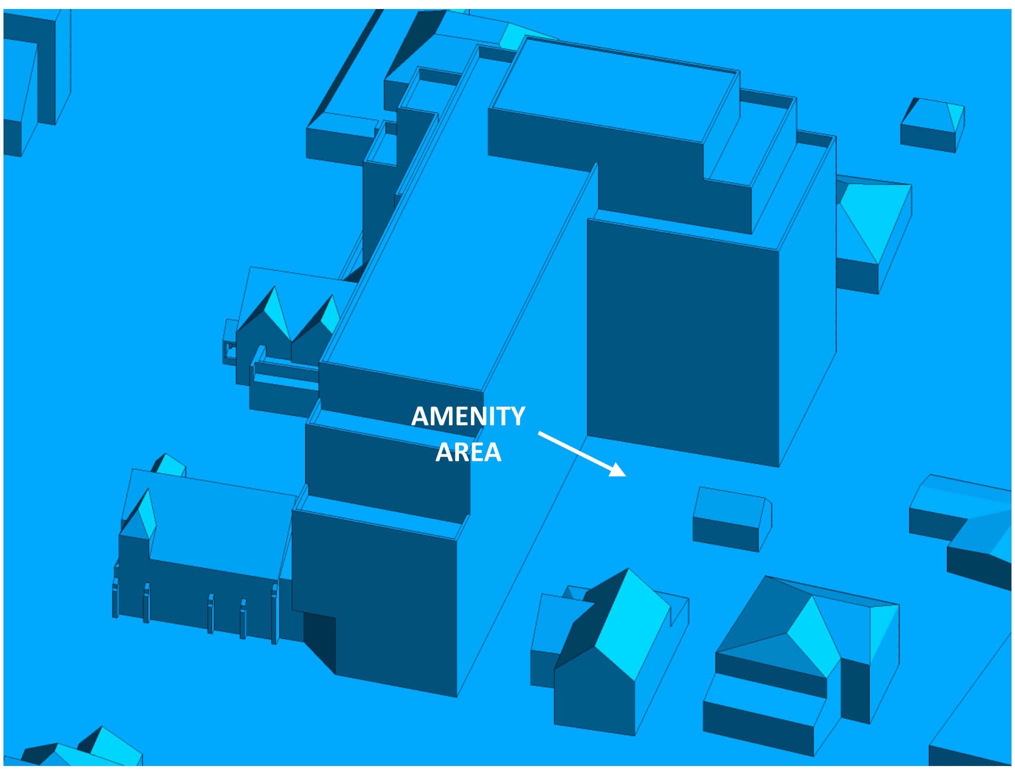


FIGURE 2F: CLOSE-UP VIEW OF FIGURE 2E

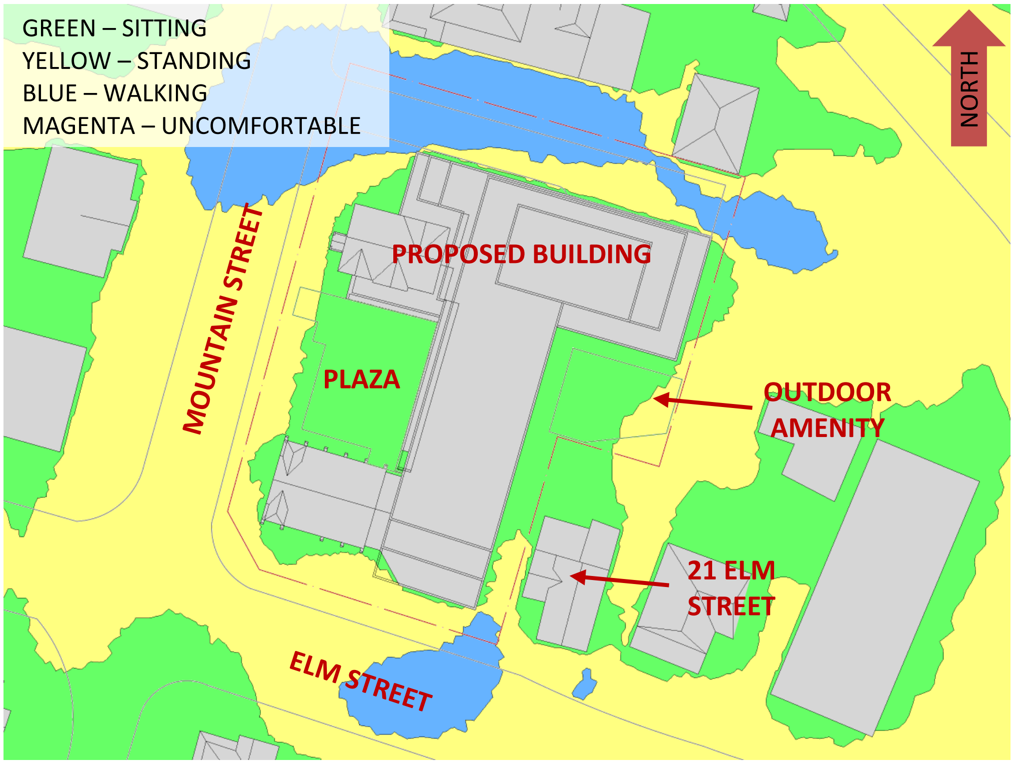


FIGURE 3A: SPRING – PROPOSED MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

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

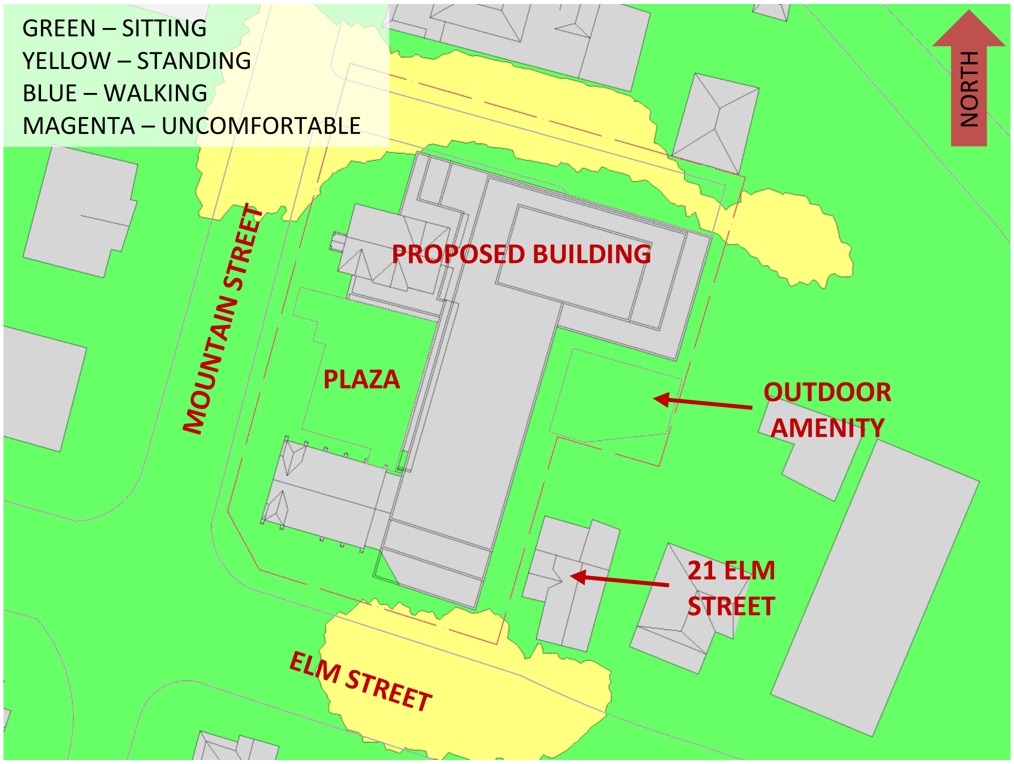


FIGURE 4A: SUMMER – PROPOSED MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

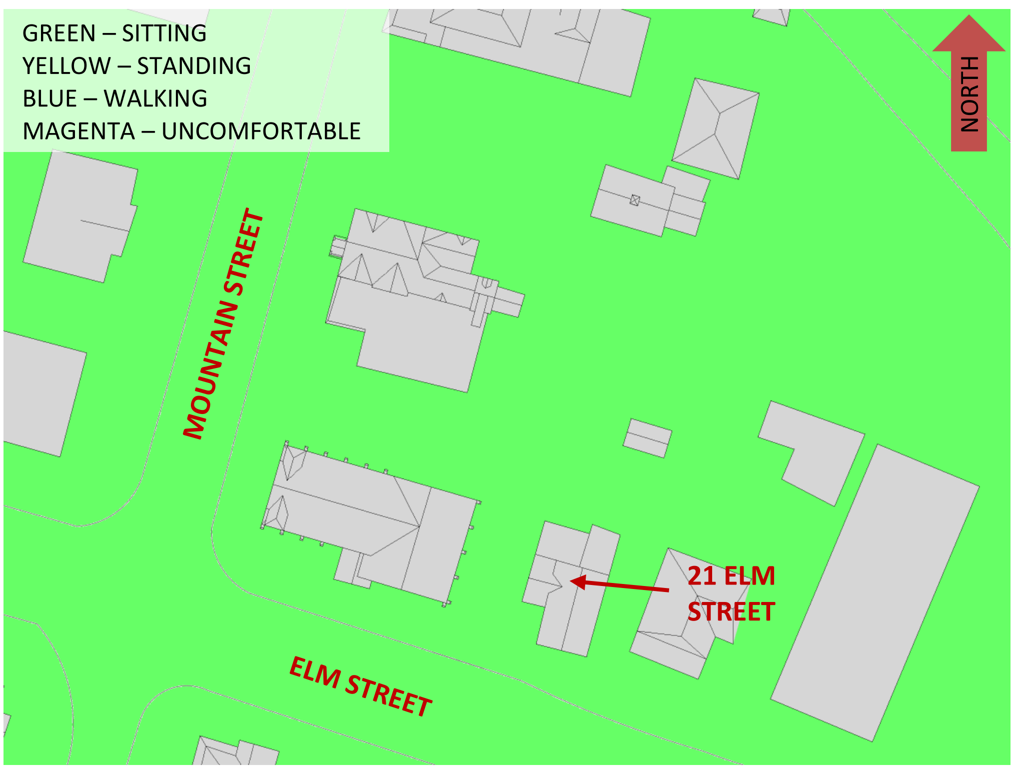


FIGURE 4B: SUMMER – EXISTING MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

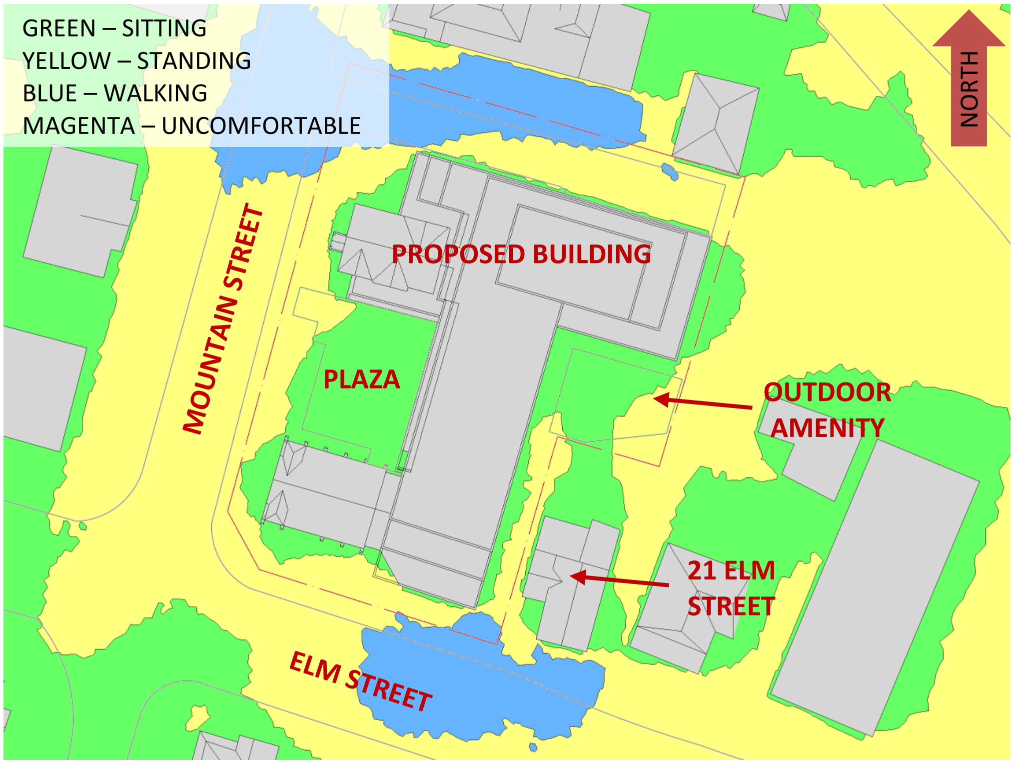


FIGURE 5A: AUTUMN – PROPOSED MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

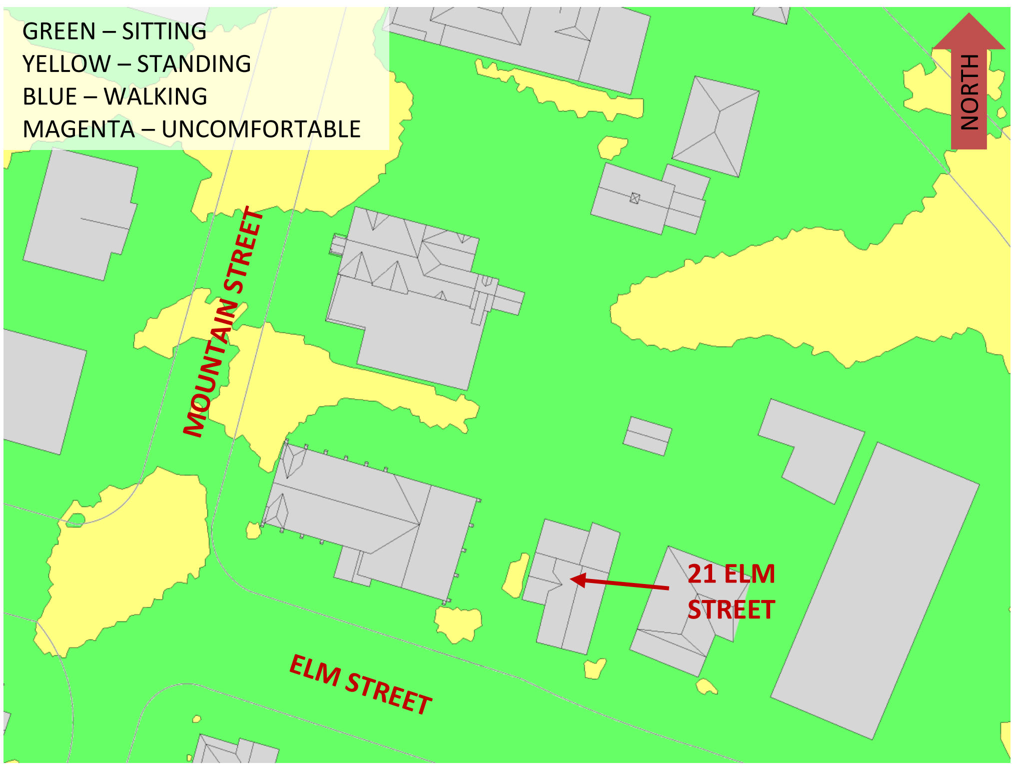


FIGURE 5B: AUTUMN – EXISTING MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

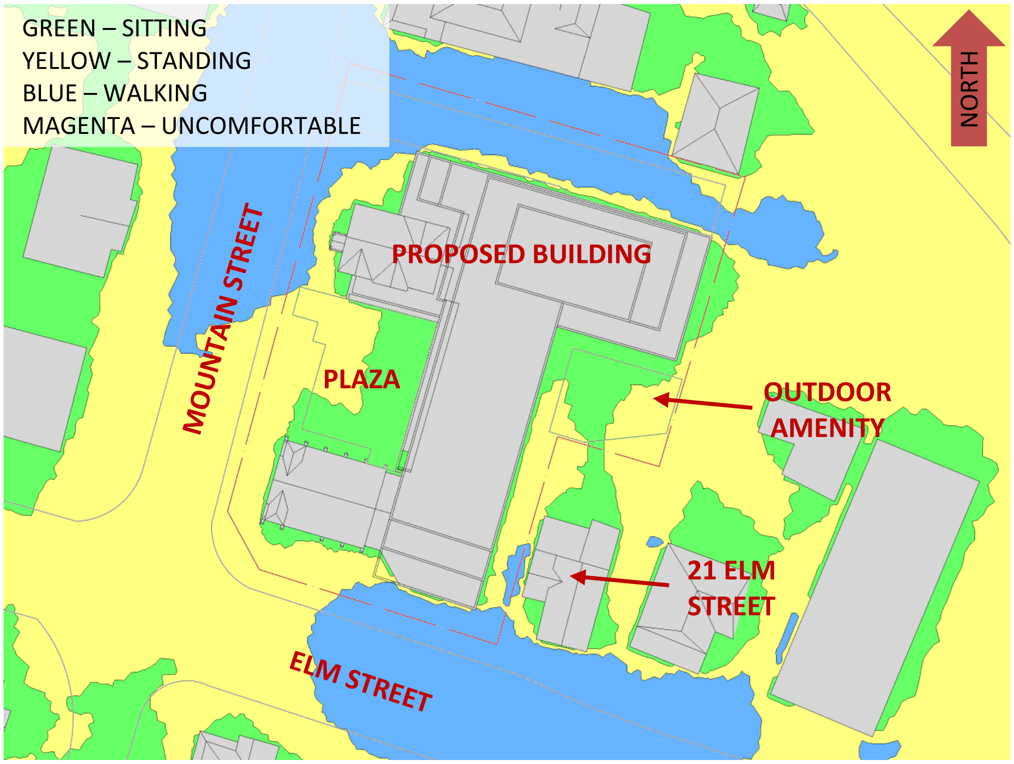


FIGURE 6A: WINTER – PROPOSED MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

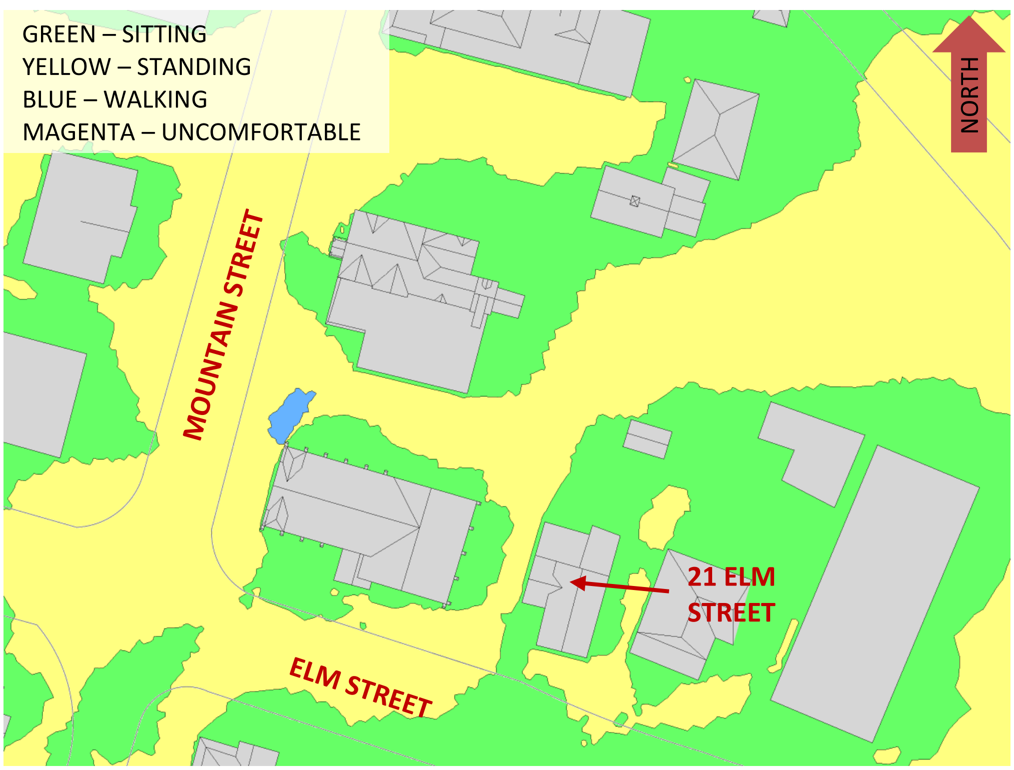


FIGURE 6B: WINTER – EXISTING MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

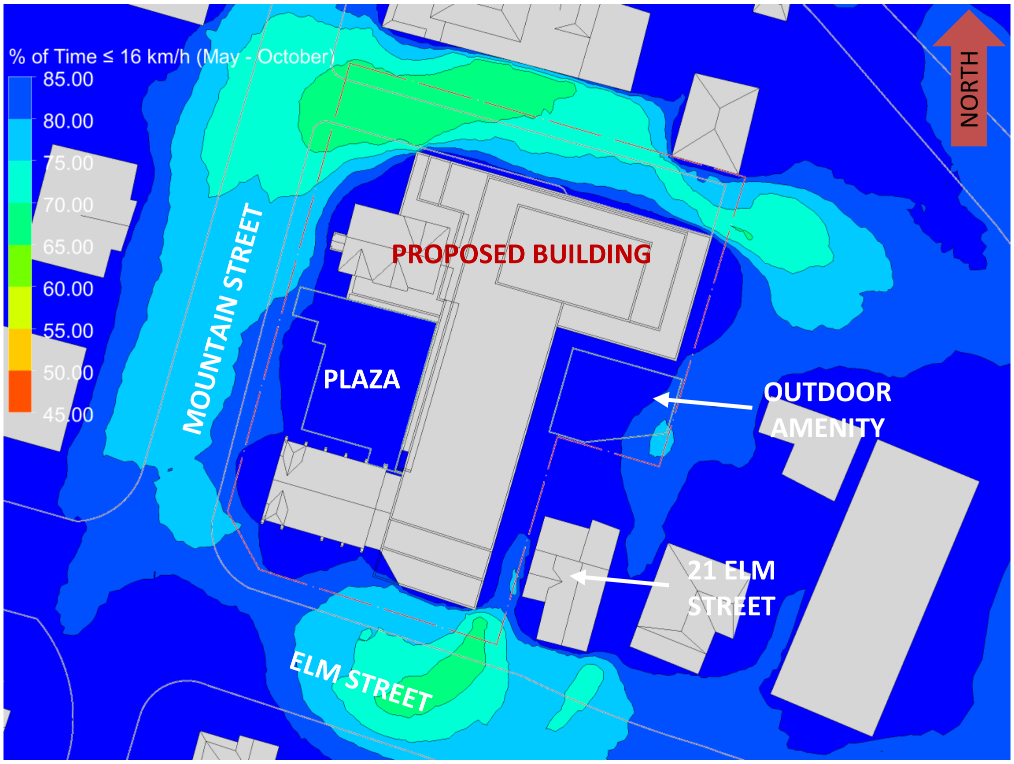


FIGURE 7A: TYPICAL USE PERIOD – % OF TIME SUITABLE FOR SITTING, GRADE LEVEL

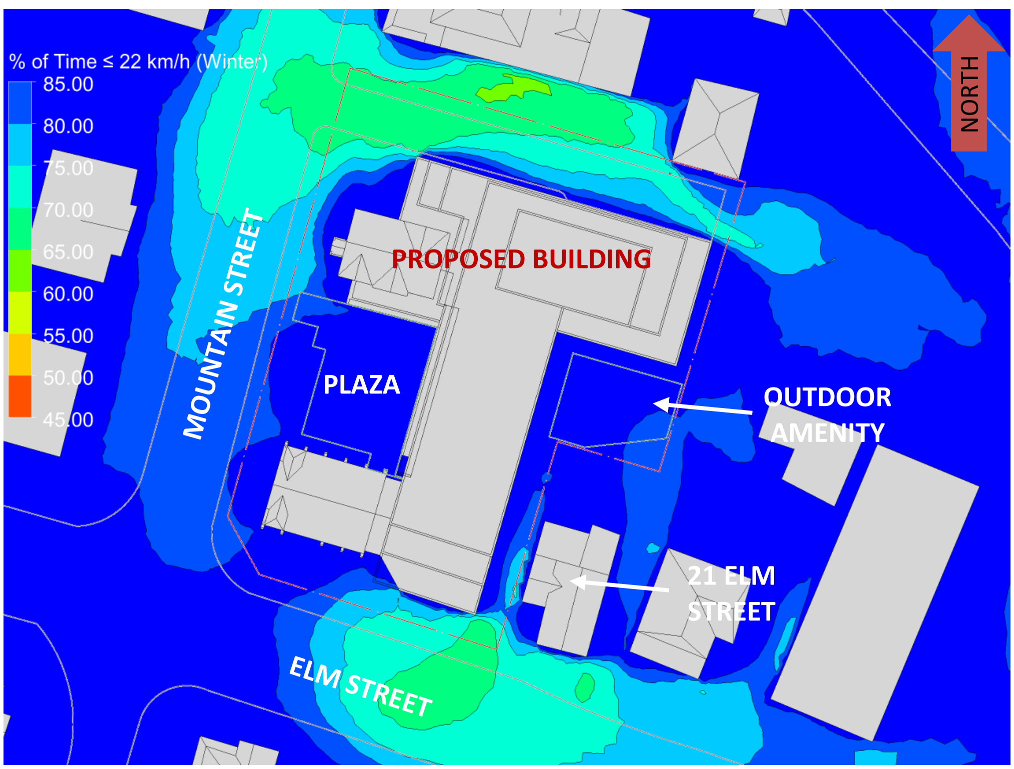
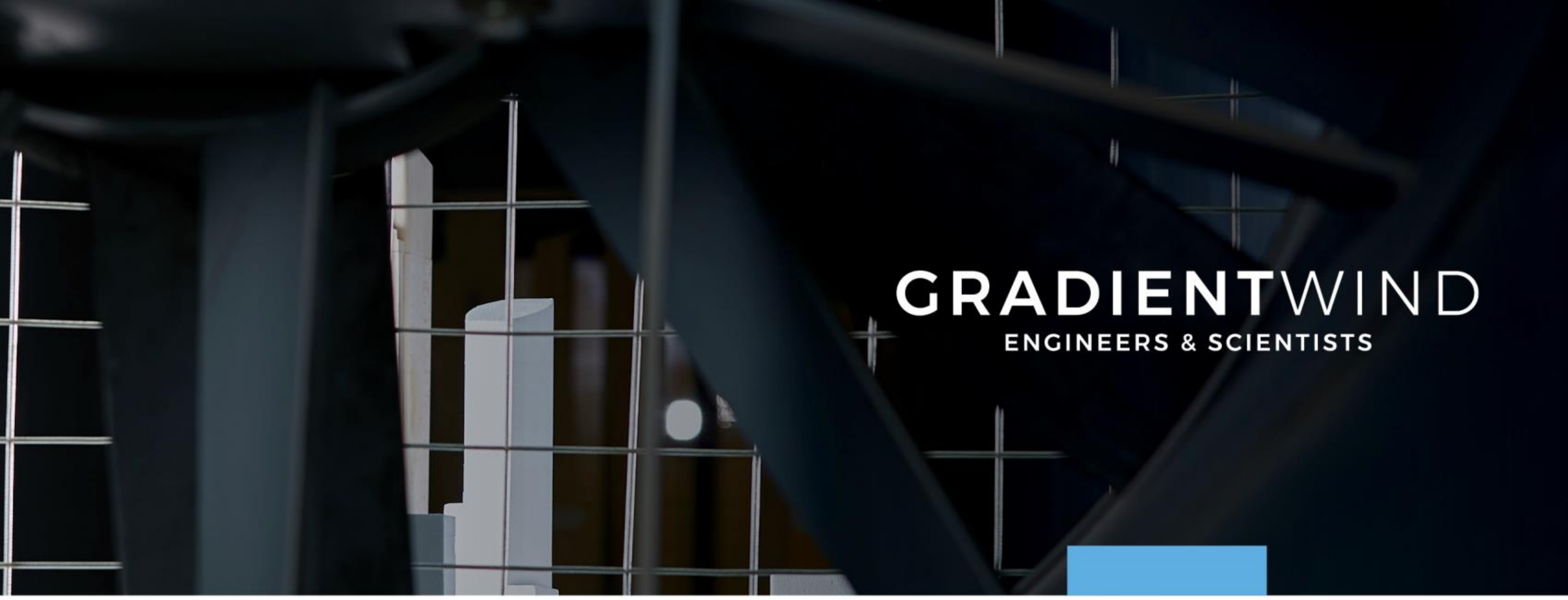
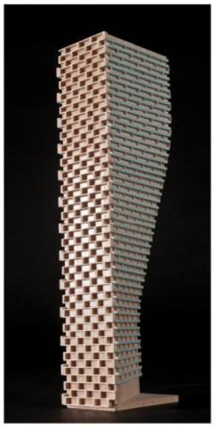
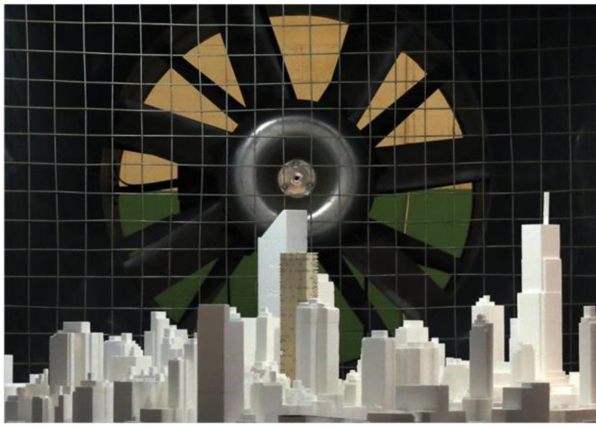


FIGURE 7B: WINTER – % OF TIME SUITABLE FOR STANDING, GRADE LEVEL







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 50% mean wind speed for Toronto based on historical climate data and statistical analyses. When the results are normalized by this velocity, they are relatively insensitive to the selection of gradient wind speed.

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

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

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

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

Wind Direction (Degrees True)	Alpha Value (α)
0	0.17
40	0.17
60	0.17
80	0.21
125	0.24
175	0.22
205	0.20
220	0.20
235	0.20
250	0.21
265	0.24
285	0.23
310	0.22
335	0.17

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

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

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

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

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

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

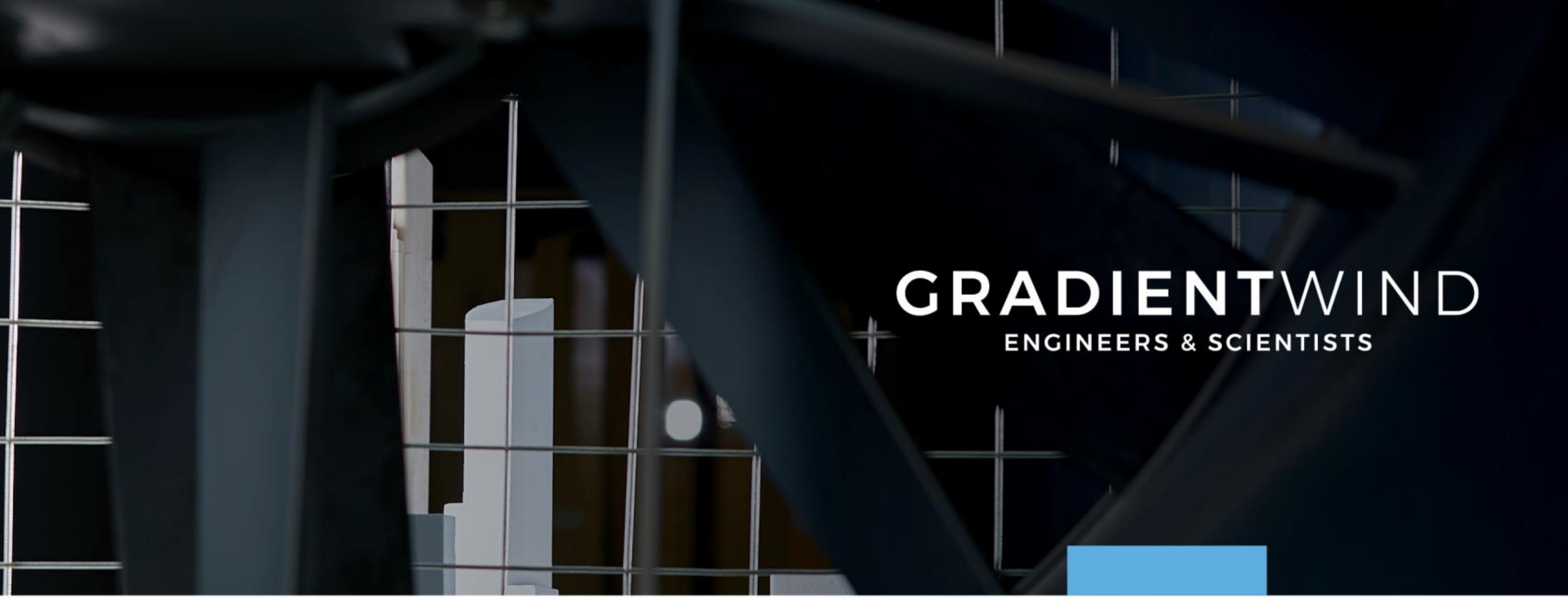
Boundary conditions on all other domain boundaries are defined as follows: the ground is a no-slip surface; the side walls of the domain have a symmetry boundary condition; the top of the domain has a specified shear, which maintains a constant wind speed at gradient height; and the outlet has a static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

REFERENCES

[1] P. Arya, "Chapter 10: Near-neutral Boundary Layers," in *Introduction to Micrometeorology*, San Diego, California, Academic Press, 2001.

[2] S. A. Hsu, E. A. Meindl and D. B. Gilhousen, "Determining the Power-Law WInd Profile Exponent under Near-neutral Stability Conditions at Sea," vol. 33, no. 6, 1994.

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



APPENDIX B

PEDESTRIAN LEVEL WIND STUDY TERMS OF REFERENCE

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March 29, 2021

Valentine Coleman 1 Inc. & Valentine Coleman 2 Inc.
180 Bloor Street West, Suite 701
Toronto, ON M5S 1T6

Re: Pedestrian Level Wind Study Terms of Reference
13 Mountain Street and 19 Elm Street, Grimsby
Gradient Wind File 21-077

1. INTRODUCTION

In support of concurrent Official Plan Amendment (OPA) and Zoning By-law Amendment (ZBA) applications for the proposed building massing located at 13 Mountain Street and 19 Elm Street in Grimsby, Ontario, this document describes a detailed pedestrian level wind (PLW) study based on computational fluid dynamics (CFD) technique. The PLW study is used to assess expected pedestrian wind comfort and safety at grade and over common elevated amenity terraces of the proposed massing. The study will be comparative, providing wind conditions with and without the proposed building present. The study will also include wind conditions at grade level for the abutting properties, as well as the entire road allowances for Elm Street and Mountain Street.

If significant changes to the proposed building occur after the PLW study is completed, an updated wind study would be required for the ZBA application.

If wind conditions at grade with the proposed building present are predicted to be significantly uncomfortable or if wind safety exceedances are identified through the CFD PLW study, a quantitative study based on wind tunnel testing of a physical scale model of the proposed building within its surroundings may be required to be submitted for review and approval.

2. METHODOLOGY

2.1 Meteorological & Topographical Data Analysis

Analysis of hourly meteorological data is required to perform wind studies. For this purpose, a statistical model of the climate affecting Grimsby is developed from hourly wind data recorded at Hamilton's International Airport. The statistical wind model is formulated on the standard Weibull probability distribution and is used to predict future wind events based on historical data. The probability wind model is a weighting function, which gives higher importance to wind directions and wind speeds which occur more frequently. Separate probability models are available for the annual and seasonal periods, including winter and summer. The statistical climate models are combined with raw wind data to correctly interpret the impact of winds on the proposed building.

2.2 Evaluation Criteria

2.2.1 Wind Comfort

The following categories of pedestrian wind comfort will be used to evaluate wind speeds within and surrounding the subject site on a seasonal basis. The Gust Equivalent Mean (GEM) wind speed should be used, which is defined as the greater of the mean wind speed or the gust wind speed divided by 1.85. GEM wind speeds are categorized based on a 20% non-exceedance of the speeds noted in the table below. This is a simple analysis when analyzing test data derived from physical wind tunnel testing, which accounts for time-varying measurements by combining the mean wind speed with its standard deviation to produce a gust wind speed. However, when performing the analysis based on data derived from computer simulations (CFD), which are steady state, the Turbulence Kinetic Energy (TKE) is required to estimate the magnitude of wind gusts. TKE is the kinetic energy associated with turbulent eddies.

Category	Speed (km/h)	Where Applicable
Sitting	≤ 10	Outdoor amenity areas (i.e., elevated amenity terraces, restaurant patios, grade-level seating areas)
Standing	≤ 14	Primary building entrances and transit stops
Walking	≤ 20	Sidewalks, parking lots, bicycle paths, secondary building access points
Uncomfortable	> 20	Moderate excesses falling within this category would be acceptable for brisk walking and exercise such as jogging

For example, wind speeds no greater than 10 km/h occurring at least 80% of time are suitable for sitting.

2.2.2 Wind Safety

Gust wind speeds will be used to assess wind safety. Wind speeds greater than 90 km/h occurring more than 0.1% on annual basis (9 hours) are considered dangerous. Wind mitigation would be required to provide safe conditions for pedestrians.

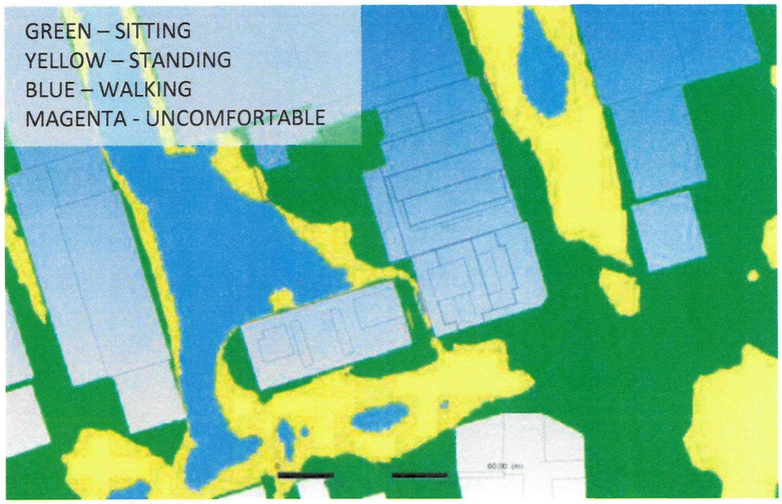
2.3 CFD Simulations

In the CFD method, the three-dimensional space around a building or other structure is divided into many tiny elements, of which there may be millions. Each element possesses the physical attributes which describes the flow field. When the equations for each element are combined, and solved, a continuous picture emerges of the desired flow quantity including pressure, velocity, temperature, or any other specified quantity of interest.

The PLW study will be undertaken using computer-based simulations on a 3D model of the subject site placed among surrounding buildings and will assess both existing and future massing conditions with and without the proposed development present. The study involves the following procedure:

- Create a digital full-scale 3D model of the subject site and surroundings within a radius of 410 m.
- For existing conditions without the proposed development present, perform wind speed simulations for 12 wind directions representing the full compass azimuth around the site.
- Introduce the proposed development and repeat the 12 wind simulations.
- Combine wind speed results with wind statistics for Grimsby.
- Generate comfort contours for each of 4 seasons.
- Compare results for existing and future conditions.
- Provide recommendations for mitigation, if necessary.

Data from the foregoing analyses, including wind speed information and direction data, would be synthesized to generate comfort contours on a seasonal basis. Comfort contours provide a classification for pedestrian comfort over the subject site according to the definitions provided in Section 2.2.1, and infer suitable pedestrian uses over the area. The figure on the following page provides an example of comfort contours generated for the winter season; the results do not represent wind conditions for the subject site at 13 Mountain Street and 19 Elm Street, Grimsby.



Example: Predicted pedestrian wind comfort for the winter season
(similar contour plots are prepared for each of four seasons)

Please advise the undersigned of any questions or concerns.

Sincerely,

Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
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MAR 29, 2021
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