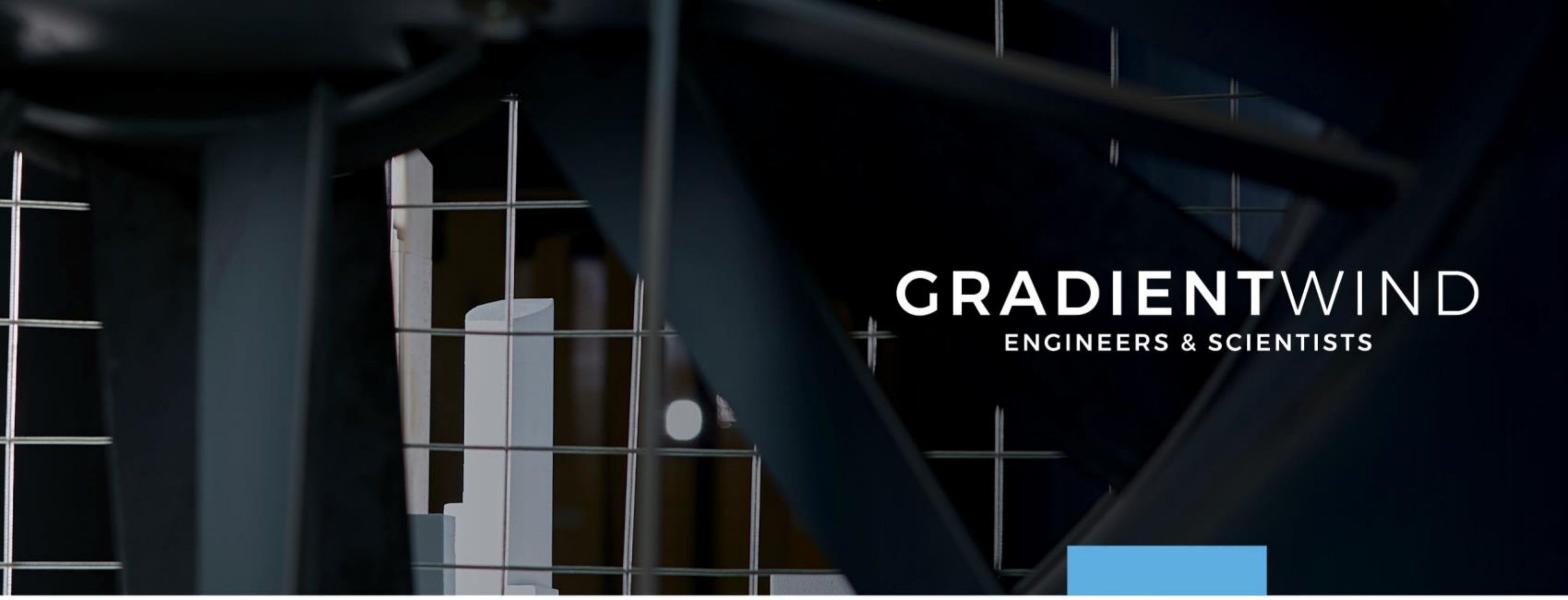
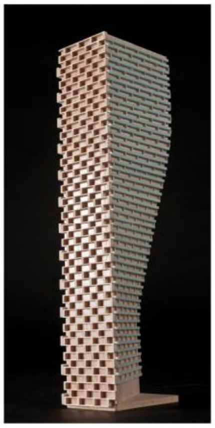


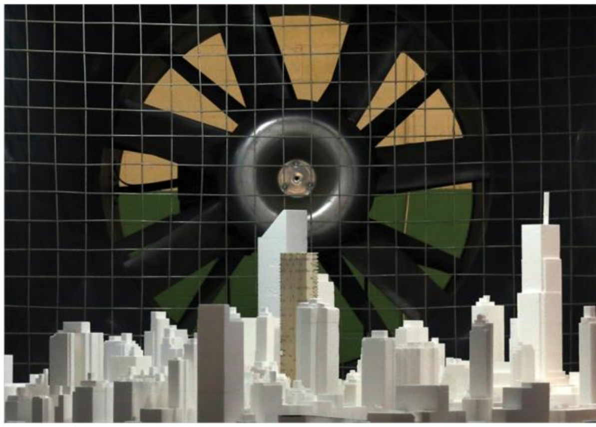
GRADIENTWIND
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

Oakes Hotel
Niagara Falls, Ontario

Report: 22-366-PLW





May 2, 2023

PREPARED FOR
Hennepin's View Inc.
6361 Fallsview Blvd,
Niagara Falls, ON L2G 3V9

PREPARED BY
Sunny Kang, B.A.S., Project Coordinator
David Huitema, M.Eng., Junior Wind Scientist
Justin Ferraro, P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment (ZBLA) application requirements for the proposed hotel redevelopment, referred to as "Oakes Hotel", located at 6546 Fallsview Boulevard and 6503-6519 Stanley Avenue in Niagara Falls, Ontario (hereinafter referred to as the "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.

The study involves simulation of wind speeds for sixteen (16) 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. A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-8B, and is summarized as follows:

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

    a. **North Sidewalk, Portage Road.** Windy conditions are predicted throughout the year at the southeast corner of the proposed development over the sidewalk along Portage Road. Specifically, following the introduction of the proposed development, a limited area of uncomfortable conditions during the winter are predicted at the southeast corner the hotel redevelopment, exceeding the walking threshold for 3% of the time during the winter season. Notably, windy conditions along Portage Road are also predicted with the existing massing.

b. **Existing Surface Parking to the East:** Conditions during the winter are predicted to be uncomfortable at the southwest corner of the existing surface parking to the immediate east of the proposed development. The noted area exceeds the walking comfort criterion for 3% of the time during the winter season.

2) Regarding the Level 8 terrace event space situated to the east of the south tower, conditions are predicted to be suitable for sitting during the summer, which is considered acceptable.

3) Wind comfort conditions within the terrace event space at Level 8 serving the north tower are predicted to be suitable for a mix of sitting and standing during the summer season.

   a. Comfort conditions within the terrace may be improved with tall perimeter guards, in combination with inboard wind barriers and canopies around sensitive areas.

   b. The extent of wind mitigation measures is dependent on the programming of the space. An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects. This work is expected to support the future Site Plan Control application.

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 over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Hennepin's View Inc. to undertake a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment (ZBLA) application requirements for the proposed hotel redevelopment, referred to as "Oakes Hotel", located at 6546 Fallsview Boulevard and 6503-6519 Stanley Avenue in Niagara Falls, Ontario (hereinafter referred to as the "subject site" or "proposed development"). Our mandate within this study is to investigate wind conditions within and surrounding the subject site, and to identify areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered.

The study is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, Niagara Region wind comfort and safety criteria, architectural drawings provided by architects-Alliance in January 2022, surrounding street layouts and existing and approved future building massing information obtained from the City of Niagara Falls, and recent site imagery.

2. TERMS OF REFERENCE

The subject site is located at two civic addresses: 6546 Fallsview Boulevard and 6503-6519 Stanley Avenue, in Niagara Falls, Ontario. The 6546 Fallsview Boulevard subject site (hereinafter referred to as the "Fallsview subject site") is situated at the northeast intersection of Fallsview Boulevard and Portage Road. A hotel building comprising two 58-storey towers, inclusive of a common seven-storey podium, is proposed at this subject site. The noted subject site comprises a downwards slope towards the northeast, with the upper ground floor at the level of Fallsview Boulevard and the lower ground floor along the east elevation accessed via a laneway from Portage Road at the southeast corner of the subject site. The 6503-6519 Stanley Avenue subject site (hereinafter referred to as the "Stanley subject site") is situated at the southwest intersection of Stanley Avenue and Dixon Street and comprises a seven-storey parking facility.

Above a basement level which includes building support spaces and administrative offices, the lower ground floor of the hotel building includes a main lobby, lounge areas, and parking valet and parking services to the east, storage and laundry areas to the west, employee support areas and administrative offices to the north, and shared building support spaces throughout the remainder of the level. Access to the drop-off and valet parking areas along the east elevation is provided by the laneway from Portage

Road. The upper ground floor includes a main lobby to the west, multi-purpose facilities to the north and south, a retail space to the east, and shared building support spaces throughout the remainder of the level. Levels 2-7 comprise a central open atrium which divides the shared podium into north and south sections which are occupied by various hotel function and recreation facilities and indoor amenities. Level 8 comprises restaurants in both towers, with adjoining terrace event spaces and rooftop gardens to the west and east of the north and south towers, respectively. Both towers rise with nominally rectangular planforms above the shared podium and are reserved for hotel guest suites.

The ground floor of the parking facility comprises a nominally 'L'-shaped planform, with its short axis-oriented along Stanley Avenue, and includes a luggage storage/holding area and shuttle pick-up/drop-off areas to the north, a lounge to the south, a valet drop-off area to the west of the noted spaces, and a potential two-storey retail space to the east. The remainder of the level comprises surface parking. A bus loop extends from Dixon Street to the shuttle pick-up/drop-off area. Levels 2-7 comprise a nominally rectangular planform. The existing 4-storey Days Inn and associated surface parking to the south of the site are retained.

Regarding wind exposures, the near-field surroundings of the Fallsview subject site (defined as an area falling within a 200-metre (m) radius of the subject site) are characterized by high-rise buildings to the northwest, the Fallsview Casino Resort and several taller hotel buildings to the north and northeast, further high-rise hotel buildings to the south, and a mix of low-rise commercial buildings and surface parking with an isolated mid-rise building from the south-southwest clockwise to the northwest. To the east is a significant topographic drop towards the Niagara River Parkway and the proposed parking facility is situated approximately 200 m to the west.

The near-field surroundings of the proposed parking facility comprise a mix of low-rise commercial buildings and parking lots in all compass directions with a high-rise hotel building to the northeast, and a mid-rise hotel building to the southeast. A development comprising a 72-storey mixed-use building and a separate 4-storey parkade is approved for Official Plan Amendment and ZBLA at 6605 Stanley Avenue, approximately 150 m to the west-southwest and 40 m to the south of the Fallsview and Stanley Avenue subject sites, respectively. The parking structure is situated to the southwest of the intersection of Dixon Street and Cleveland Avenue, approximately 400 m and 100 m to the west of the Fallsview and Stanley Avenue subject sites, respectively.

The far-field surroundings (defined as the area beyond the near field and within a two-kilometre (km) radius) primarily comprise a mix of low-rise massing and green spaces with isolated mid-rise buildings in all compass directions and high-rise buildings to the north and south along the Niagara River, which flows south-north approximately 350 m to the east of the Fallsview subject site. Niagara's Horseshoe Falls are located approximately 400 m to the southeast. Additionally, a mixed-use development comprising three 26-storey towers above a shared 4-storey podium is approved for ZBLA at 6663, 6671, and 6683 Stanley Avenue and 5640 and 5582 Dunn Street, approximately 200 m to the southwest and 150 m to the south of the Fallsview and Stanley Avenue subject sites, respectively.

Figure 1A illustrates the subject site and surrounding context, representing the proposed future massing scenario, while Figure 1B illustrates the subject site and surrounding context, representing the existing massing scenario. Figures 2A-3H illustrate the computational models used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind conditions at key areas within and surrounding the subject 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 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 Niagara Falls area wind climate, and synthesis of computational data with Niagara Region wind criteria[1]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

[1] Niagara Region, *Pedestrian Level Wind Study Terms of Reference Guide*, 2022

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 the Niagara Falls International Airport in Niagara County, New York. 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 proposed 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 stronger 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 subject site for 16 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 617 m. The process was performed for two context massing scenarios, as noted in Section 2.

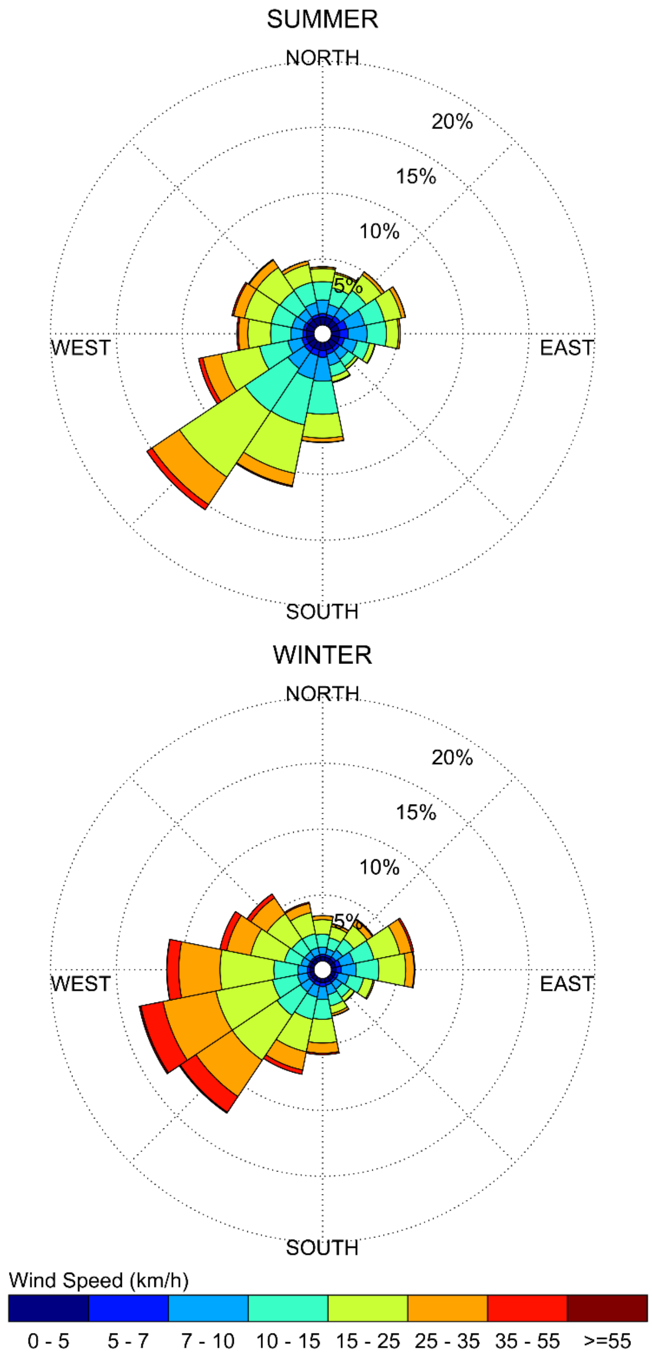
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the Level 8 common amenity terraces serving the proposed hotel redevelopment 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 Niagara Falls was developed from approximately 40 years of hourly meteorological wind data recorded at Niagara Falls 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 two distinct seasons, as stipulated in the wind criteria. Specifically, the summer season is defined as May though October, and the winter season is defined as November through April, inclusive.

The statistical model of the Niagara Falls 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 Niagara Falls, 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
NIAGARA FALLS INTERNATIONAL AIRPORT, NIAGARA COUNTY, NEW YORK



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 – Niagara Region

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. Since both mean and gust wind speeds affect pedestrian comfort, their combined effect is defined in the Niagara Region Pedestrian Level Wind Study Terms of Reference Guide. Specifically, the criteria are defined as a Gust Equivalent Mean (GEM) wind speed, which is the greater of the mean wind speed or the gust wind speed divided by 1.85.

The wind speed ranges 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. Four pedestrian comfort classes and corresponding gust wind speed ranges are used to assess pedestrian comfort: (1) Sitting; (2) Standing; (3) Walking; and (4) Uncomfortable. Specifically, the comfort classes, associated wind speed ranges, and limiting criteria are summarized as follows:

1) **Sitting:** GEM wind speeds no greater than 10 km/h occurring at least 80% of the time would be considered acceptable for sedentary activities, including sitting.

2) **Standing:** GEM wind speeds no greater than 15 km/h occurring at least 80% of the time are acceptable for activities such as standing, strolling or more vigorous activities.

3) **Walking:** GEM wind speeds no greater than 20 km/h occurring at least 80% of the time are acceptable for walking or more vigorous activities.

4) **Uncomfortable:** 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, gust wind speeds greater than 90 km/h, occurring more than 0.1% of the time on an annual basis (based on wind events recorded for 24 hours a day), are 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.

THE BEAUFORT SCALE

Number	Description	Gust Wind Speed (km/h)	Description
2	Light Breeze	9-17	Wind felt on faces
3	Gentle Breeze	18-29	Leaves and small twigs in constant motion; wind extends light flags
4	Moderate Breeze	30-42	Wind raises dust and loose paper; small branches are moved
5	Fresh Breeze	43-57	Small trees in leaf begin to sway
6	Strong Breeze	58-74	Large branches in motion; Whistling heard in electrical wires; umbrellas used with difficulty
7	Moderate Gale	75-92	Whole trees in motion; inconvenient walking against wind
8	Gale	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 GEM wind speeds of 10 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 GEM wind speeds of 20 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 desired comfort classes, which are dictated by the location type for each region (for example, a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their typical windiest desired comfort classes are summarized on the following table. Depending on the programming of a space, the desired comfort class may differ from this table.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired 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 4A-5B and 6A-7B which illustrate wind conditions at grade level for the proposed and existing massing scenarios of the Fallsview and Stanley Avenue subject sites, respectively. Conditions are presented as continuous contours of wind comfort and correspond to the various comfort classes noted in Section 4.4. Wind conditions suitable for sitting are represented by the colour blue, standing by green, and walking by yellow; uncomfortable conditions are represented by the colour orange.

Figures 8A-8B illustrate wind conditions over the Level 8 common amenity terraces serving the proposed hotel redevelopment at Level 8. The details of these conditions are summarized in the following pages for each area of interest.

5.1 Wind Comfort Conditions – Grade Level

Wind comfort conditions within and surrounding the Fallsview subject site are described as follows:

Sidewalks, Transit Stop, and Walkways Along Fallsview Boulevard: Following the introduction of the proposed hotel redevelopment, wind comfort conditions over the public sidewalks along Fallsview Boulevard are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of standing and walking during the winter. Conditions in the vicinity of the nearby transit stop along Fallsview Boulevard are predicted to be suitable for sitting during the summer, becoming suitable for standing during the winter. Conditions over the walkways along the west elevation of the subject site are predicted to be suitable for a mix of sitting and standing throughout the year, with isolated regions suitable for walking during the winter at the southwest corner of the podium. The noted conditions are considered acceptable.

Conditions over the sidewalks along Fallsview Boulevard with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for walking, or better, during the winter. Conditions in the vicinity of the nearby transit stop along Fallsview Boulevard are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the winter. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Existing Parking Lot West of Subject Site: Following the introduction of the proposed hotel redevelopment, conditions over the existing parking lot serving the low-rise building to the west are predicted to be suitable for mix of sitting and standing during the summer, becoming suitable for walking, or better, during the winter. The noted conditions are considered acceptable.

Conditions over the noted parking lot with the existing massing are predicted to be suitable mostly for sitting during the summer, becoming suitable for standing during the winter. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Laneway and Walkway North of Subject Site: Conditions over the laneway to the north of the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for walking, or better, during the winter. Conditions over the walkway along the north elevation are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of sitting, standing, and walking during the winter. The noted conditions are considered acceptable.

Laneway, Drop-off Areas, and Walkways East of Subject Site: Conditions in the vicinity of the drop-off areas and walkways along the laneway situated along the east elevation of the subject site are predicted to be suitable for sitting throughout the year. Conditions over the walkway along the east elevation of the proposed development at the upper ground level are predicted to be mostly suitable for sitting throughout the year. The noted conditions are considered acceptable.

Existing Laneway, Surface Parking, and Walkway East of Subject Site: Following the introduction of the proposed hotel redevelopment, the existing laneway, walkways, surface parking, and drop-off areas serving the Fallsview Casino Resort to the east of the Fallsview subject site are predicted to be suitable for mix of sitting and standing during the summer, becoming suitable for walking, or better, during the winter. The noted conditions are considered acceptable.

Conditions over the noted areas serving the Fallsview Casino Resort with the existing massing are predicted to be suitable mostly for sitting during the summer with an isolated region suitable for standing, and suitable for a mix of sitting and standing with isolated regions suitable for walking during the winter. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions with the proposed development are nevertheless considered acceptable.

Existing Surface Parking East of Subject Site: Conditions over the existing surface parking to the immediate east of the Fallsview subject site with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the winter. Following the introduction of the proposed development, conditions within the existing surface parking to the immediate east of the Fallsview subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of mostly standing and walking during the winter, with a limited region of uncomfortable conditions predicted at the southwest corner of the parking lot during the winter season, exceeding the walking threshold for 3% of the time during the winter.

Walkway Along South Elevation: Wind comfort conditions along the walkway along the south elevation of the upper ground level of the proposed hotel redevelopment are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of mostly standing and walking during the winter. The noted conditions are considered acceptable.

Sidewalks Along Portage Road: Following the introduction of the proposed hotel redevelopment, the public sidewalks along Portage Road are predicted to be suitable for standing during the summer, becoming suitable for a mix of mostly standing and walking during the winter. The windiest conditions are situated at the intersection of Portage Road and the proposed laneway east of the subject site, which is predicted to be uncomfortable during the winter, exceeding the walking threshold for 3% of the time during the winter season. While the noted conditions are predicted to occur mostly over the road surface, conditions are predicted to impact a small section of the sidewalk along Portage Road.

Conditions over the sidewalks along Portage Road with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of standing and walking during the winter. The introduction of the proposed hotel redevelopment produces windier conditions along Portage Road in comparison to existing conditions, particularly at the southeast corner of the subject site where wind speeds are predicted to exceed the walking threshold for 3% of the time during the winter season.

Building Access Points serving the Fallsview Subject Site: Conditions in the vicinity of all building access points serving the hotel redevelopment are predicted to be suitable for standing, or better, throughout the year. The noted conditions are considered acceptable.

Wind comfort conditions within and surrounding the Stanley subject site are described as follows:

Sidewalks, Transit Stops, and Building Access Along Stanley Avenue and Dunn Street: Following the introduction of the proposed parking facility, conditions over the public sidewalks in the vicinity of the subject site along Stanley Avenue and Dunn Street, including the bus loop and valet drop-off along Dunn Street and the nearby transit stops along Stanley Avenue, are predicted to be suitable for their intended uses throughout the year. Specifically, conditions are predicted to be suitable for sitting during the summer, with isolated regions suitable for standing over Stanley Avenue, becoming suitable for standing, or better, during the winter, with an isolated region suitable for walking over Stanley Avenue. Conditions over the bus loop and valet drop-off are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable.

Conditions over the sidewalks along Stanley Avenue and Dunn Street and in the vicinity of the nearby transit stops along Stanley Avenue with the existing massing are predicted to be suitable for standing, or better, during the summer, becoming suitable mostly for standing during the winter. Notably, the introduction of the proposed parking structure development is predicted to improve comfort levels along Stanley Avenue and Dunn Street, in comparison to existing conditions.

Nearby Existing Surface Parking: Following the introduction of the proposed parking facility, wind comfort conditions over the nearby existing surface parking serving the Days Inn hotel to the south, the surface parking to the north across Dixon Street, and the surface parking to the west are predicted to be suitable for sitting during the summer, and suitable for standing, or better, during the winter.

Conditions over the noted surface parking with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, and mostly standing during the winter. Notably, the introduction of the proposed parking facility is predicted to improve comfort levels in the noted areas, in comparison to existing conditions.

5.2 Wind Comfort Conditions – Common Amenity Terraces

East Level 8 Terrace Event Space: During the summer, wind comfort conditions over the terrace event space serving the proposed hotel redevelopment along the east elevation of the south tower at Level 8 are predicted to be suitable for sitting, as illustrated in Figure 8A. The noted conditions are considered acceptable.

West Level 8 Terrace Event Space: During the summer, wind comfort conditions over the terrace event space serving the proposed hotel redevelopment at Level 8 along the west elevation of the north tower are predicted to be suitable for sitting to the east and west, and suitable for standing throughout the remainder of the terrace, as illustrated in Figure 8A. During the same period, the areas that are predicted to be suitable for standing are also predicted to be suitable for sitting for at least 65% of the time, where the target is 80% to achieve the sitting comfort criterion.

The windy conditions are mainly attributed to the exposure of the terrace to prominent westerly winds, in combination with downwash of winds from the west elevation of the north tower. The sitting percentages in the noted windier areas of the terrace may be improved by implementing a combination of tall perimeter guards, typically glazed and preferably solid, and in-board wind barriers and canopies installed around sensitive areas. The extent of wind mitigation measures is dependent on the programming of the space.

An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects. This work is expected to support the future Site Plan Control application.

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.

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-8B. Based on computer simulations using the CFD technique, meteorological data analysis of the Niagara Falls wind climate, Niagara Region wind comfort and safety criteria, and experience with numerous similar developments in Niagara Falls and elsewhere, the study concludes the following:

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

    a. **North Sidewalk, Portage Road.** Windy conditions are predicted throughout the year at the southeast corner of the proposed development over the sidewalk along Portage Road. Specifically, following the introduction of the proposed development, a limited area of uncomfortable conditions during the winter are predicted at the southeast corner the hotel redevelopment, exceeding the walking threshold for 3% of the time during the winter season. Notably, windy conditions along Portage Road are also predicted with the existing massing.

    b. **Existing Surface Parking to the East:** Conditions during the winter are predicted to be uncomfortable at the southwest corner of the existing surface parking to the immediate east of the proposed development. The noted area exceeds the walking comfort criterion for 3% of the time during the winter season.

2) Regarding the Level 8 terrace event space situated to the east of the south tower, conditions are predicted to be suitable for sitting during the summer, which is considered acceptable.

3) Wind comfort conditions within the terrace event space at Level 8 serving the north tower are predicted to be suitable for a mix of sitting and standing during the summer season.

    a. Comfort conditions within the terrace may be improved with tall perimeter guards, in combination with inboard wind barriers and canopies around sensitive areas.

b. The extent of wind mitigation measures is dependent on the programming of the space. An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects. This work is expected to support the future Site Plan Control application.

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 over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

Sincerely,

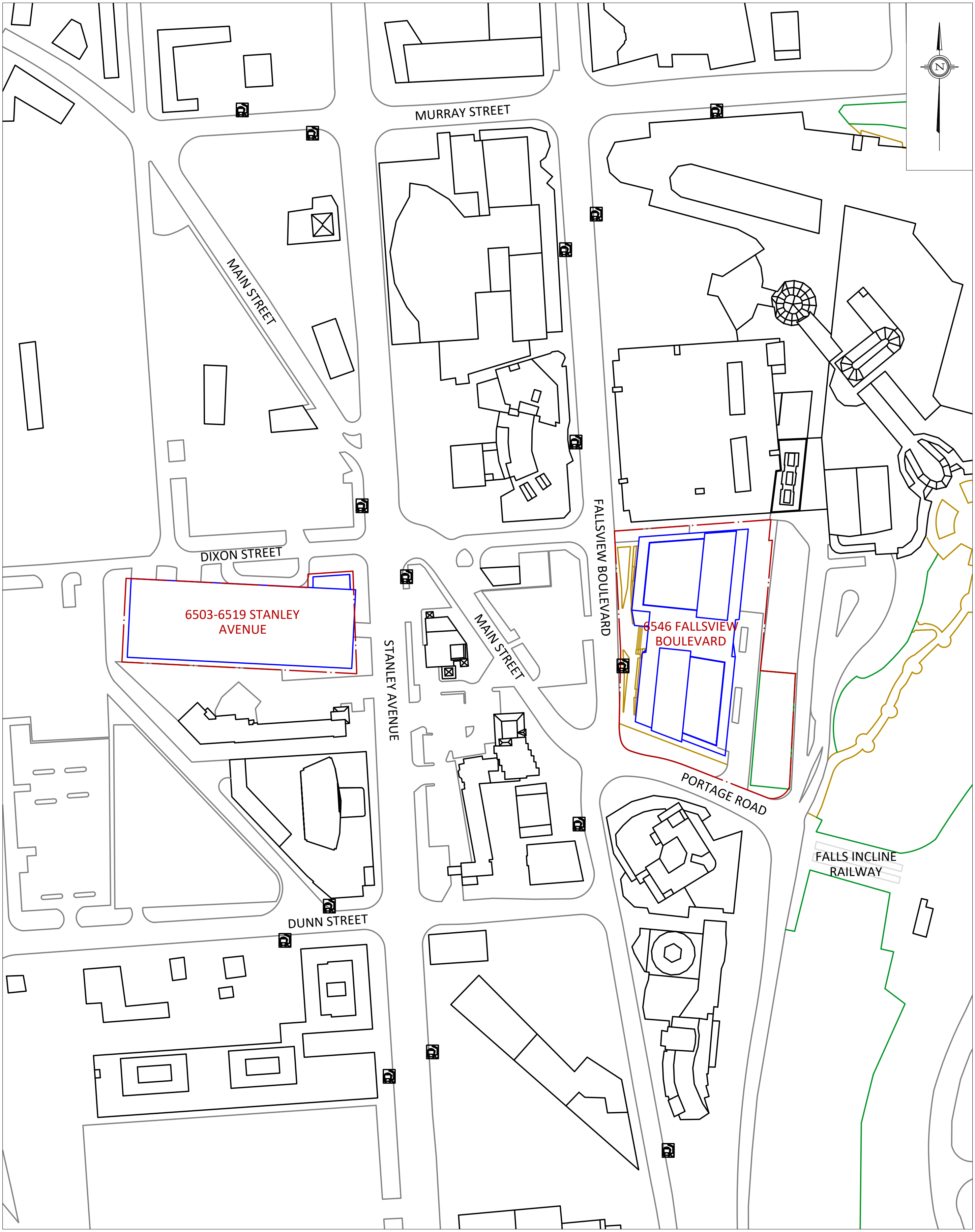
Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. D. FERRARO
100158495
May 2, 2023
PROVINCE OF ONTARIO

David Huitema, M.Eng.
Junior Wind Scientist

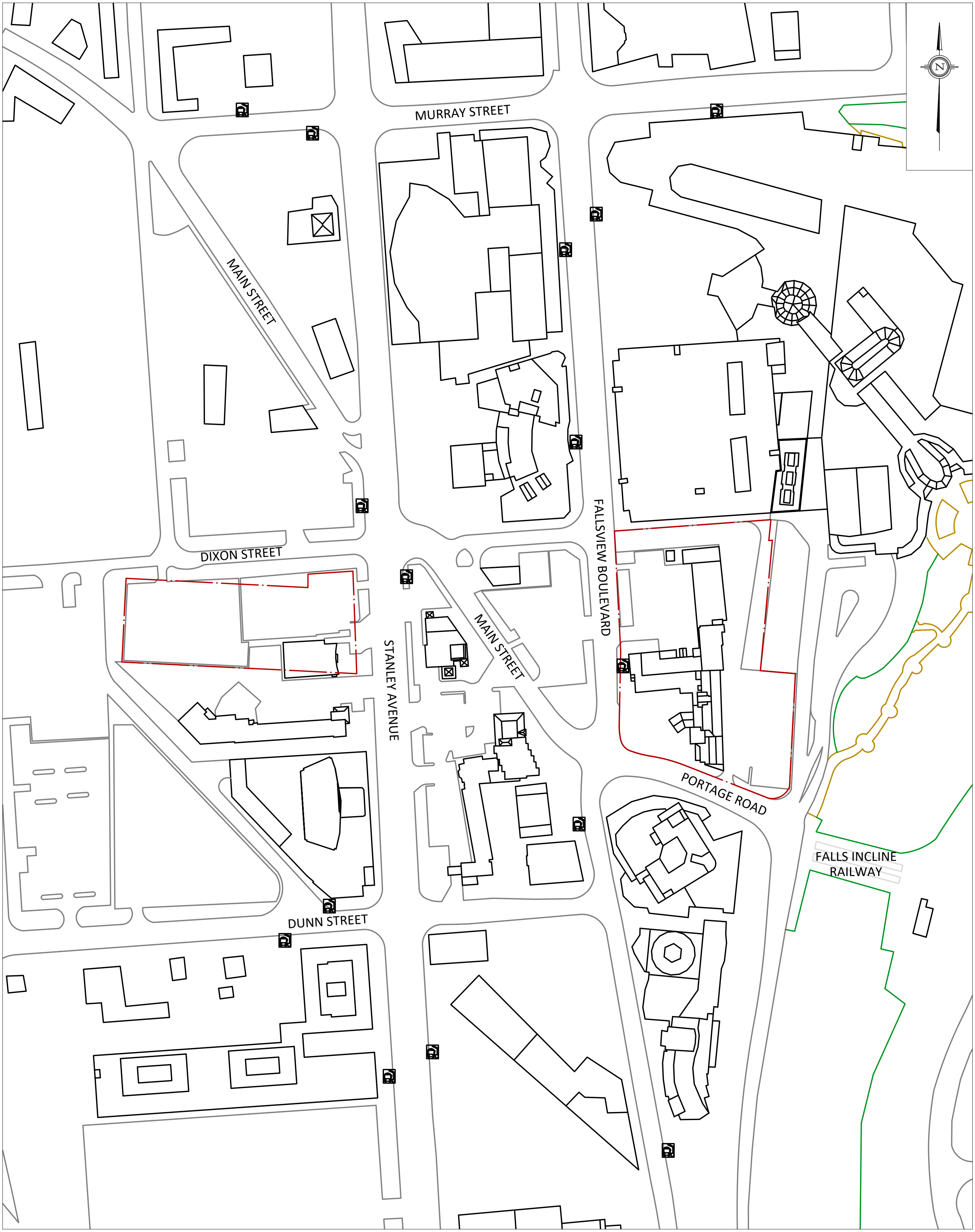
Justin Ferraro, P.Eng.
Principal

Sunny Kang, B.A.S.
Project Coordinator



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

PROJECT		DESCRIPTION
OAKES HOTEL, NIAGARA FALLS PEDESTRIAN LEVEL WIND STUDY		FIGURE 1A: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
SCALE 1:3000	DRAWING NO. 22-366-PLW-1A	
DATE MARCH 6, 2023	DRAWN BY S.K.	



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PROJECT	OAKES HOTEL, NIAGARA FALLS PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:3000	DRAWING NO.	22-366-PLW-1B
DATE	MARCH 6, 2023	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1B:
EXISTING SITE PLAN AND SURROUNDING CONTEXT

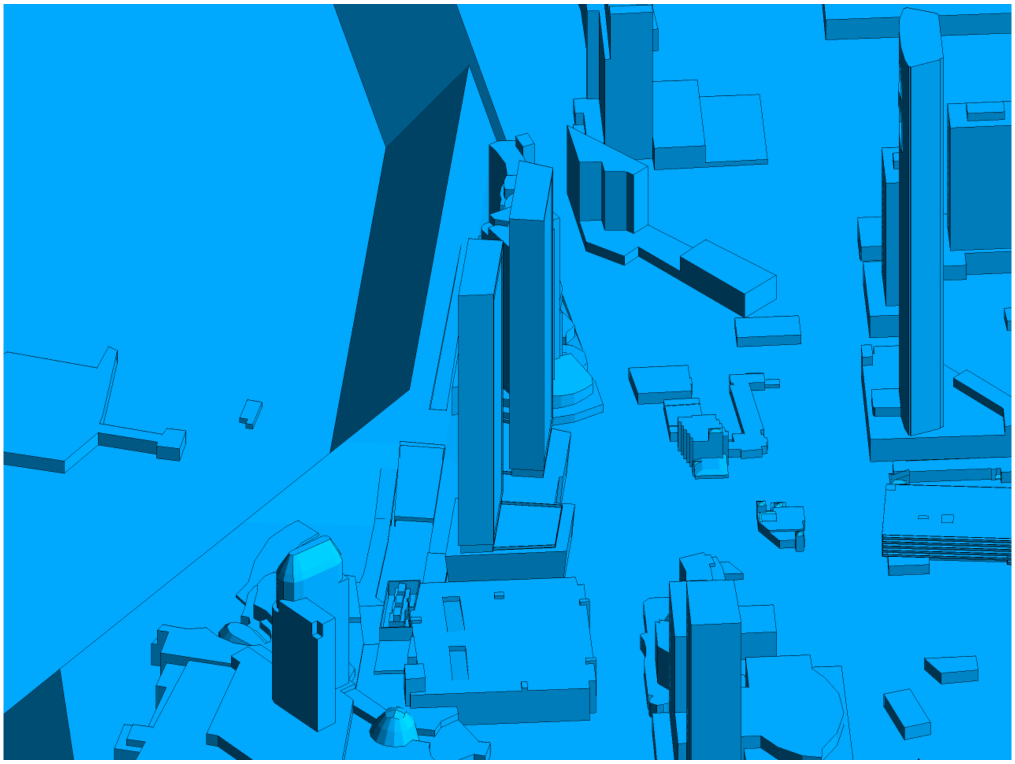


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

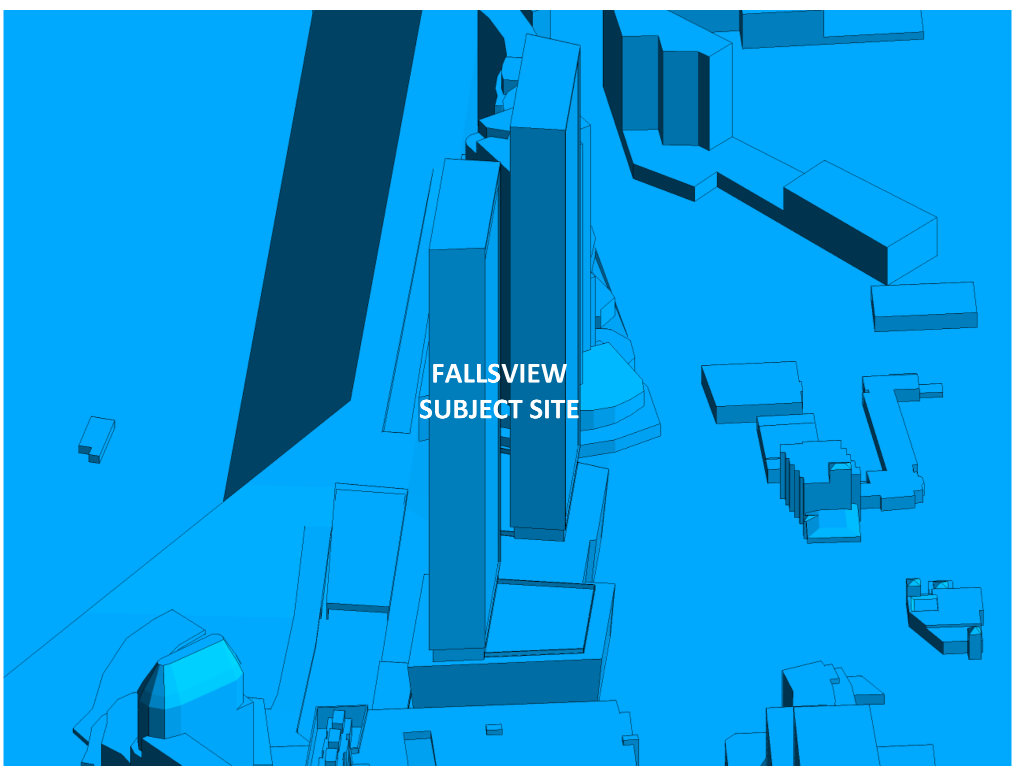


FIGURE 2B: CLOSE-UP VIEW OF FIGURE 2A

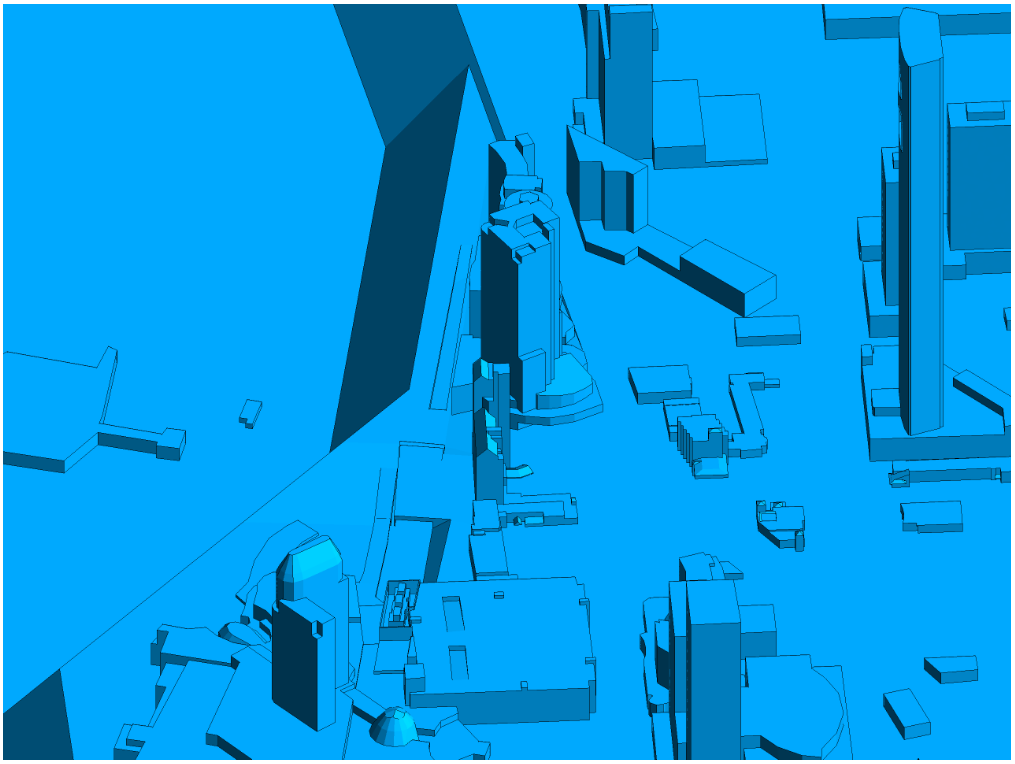


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

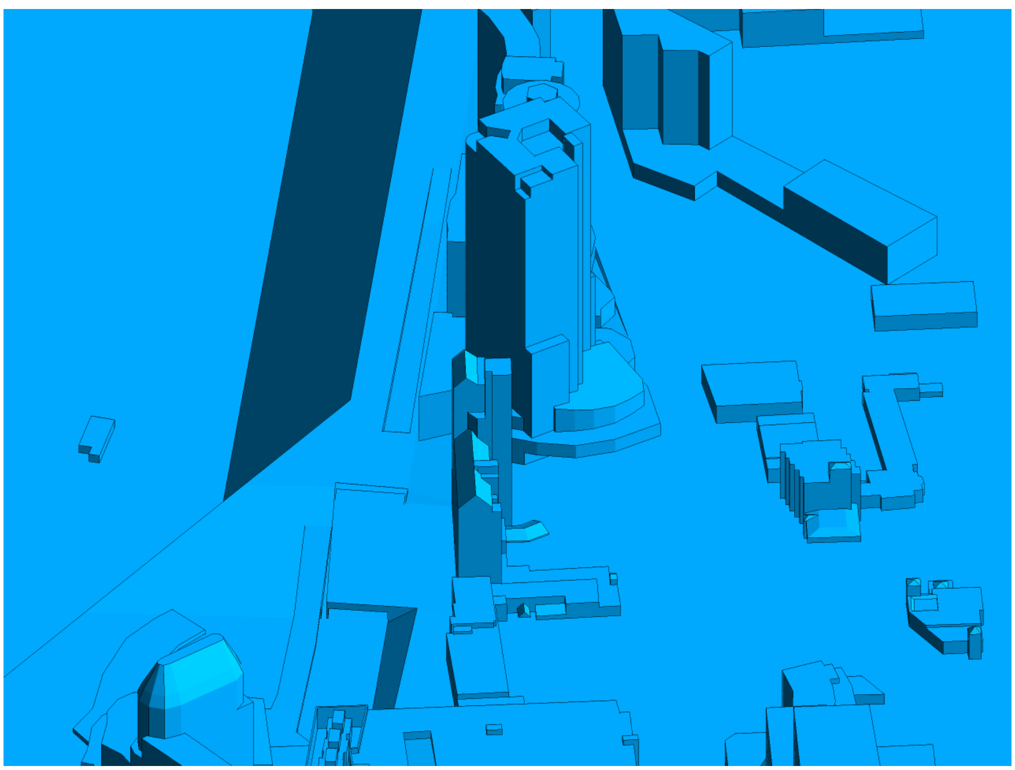


FIGURE 2D: CLOSE-UP VIEW OF FIGURE 2C

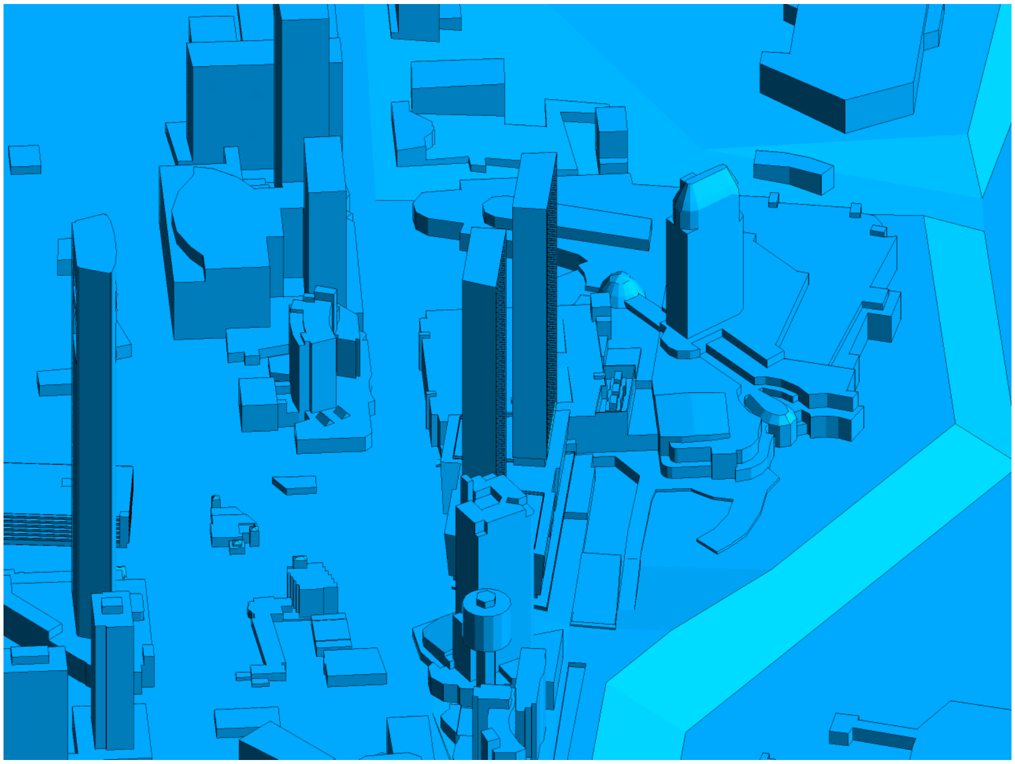


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

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

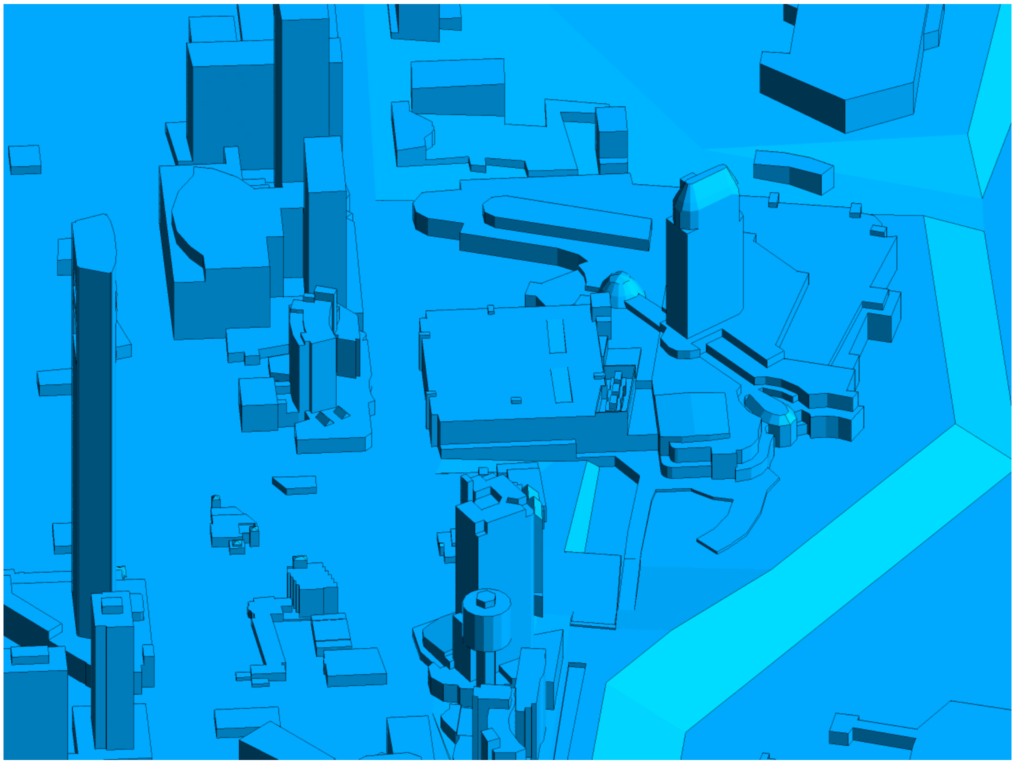


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

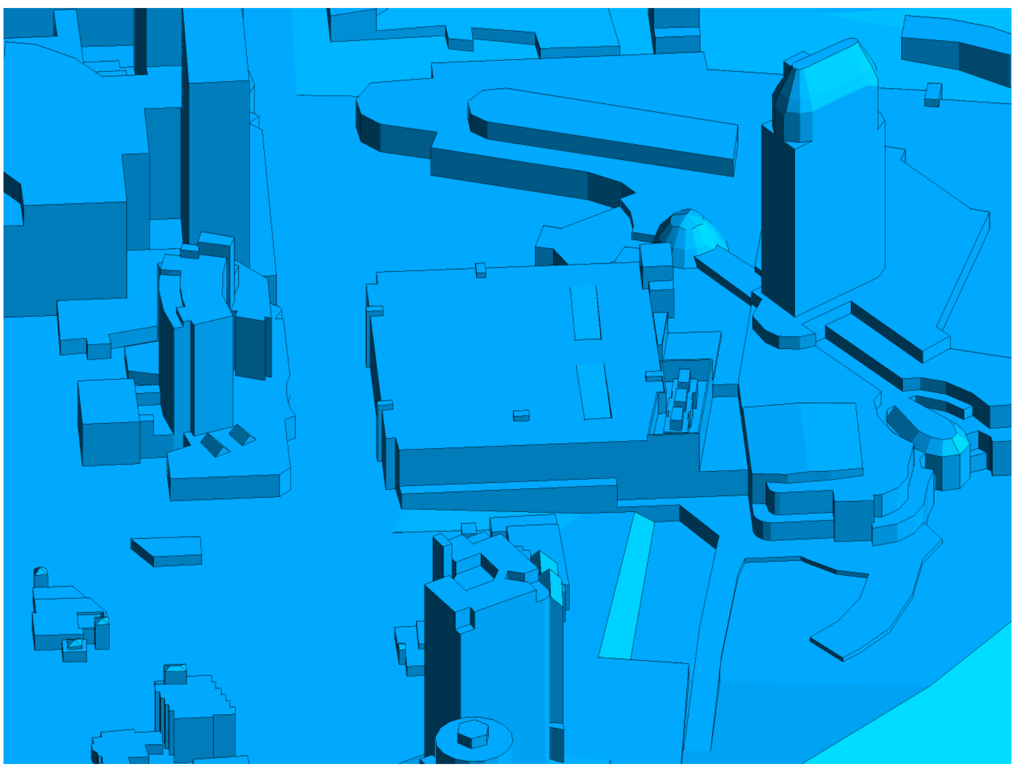


FIGURE 2H: CLOSE-UP VIEW OF FIGURE 2G

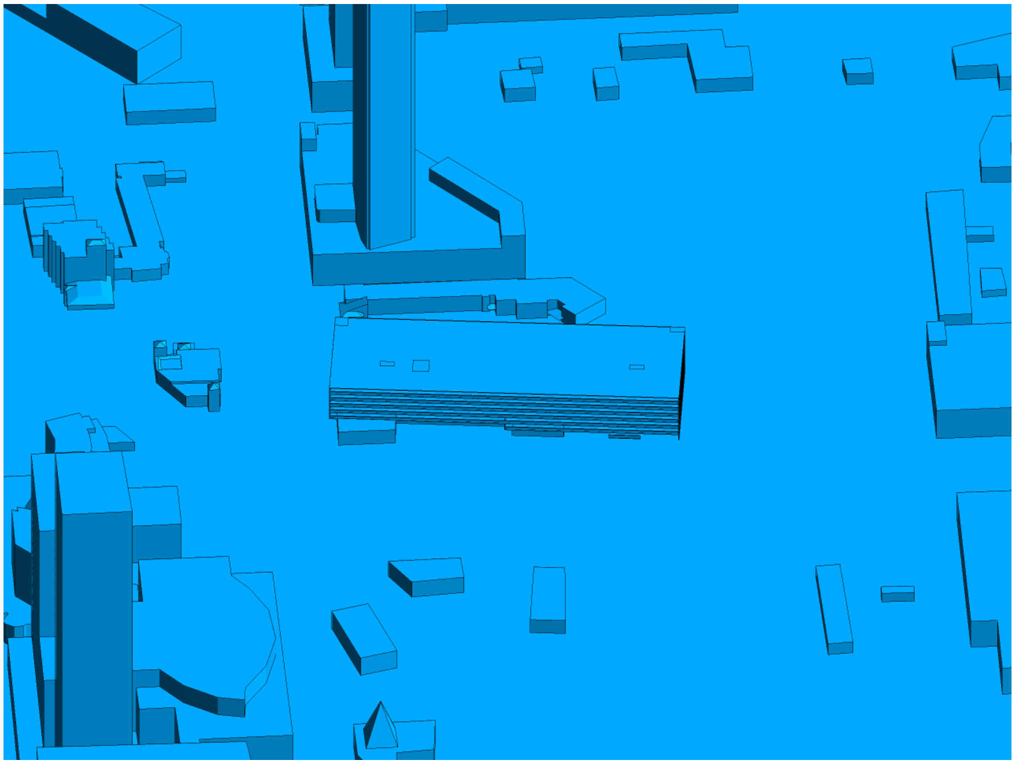


FIGURE 3A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

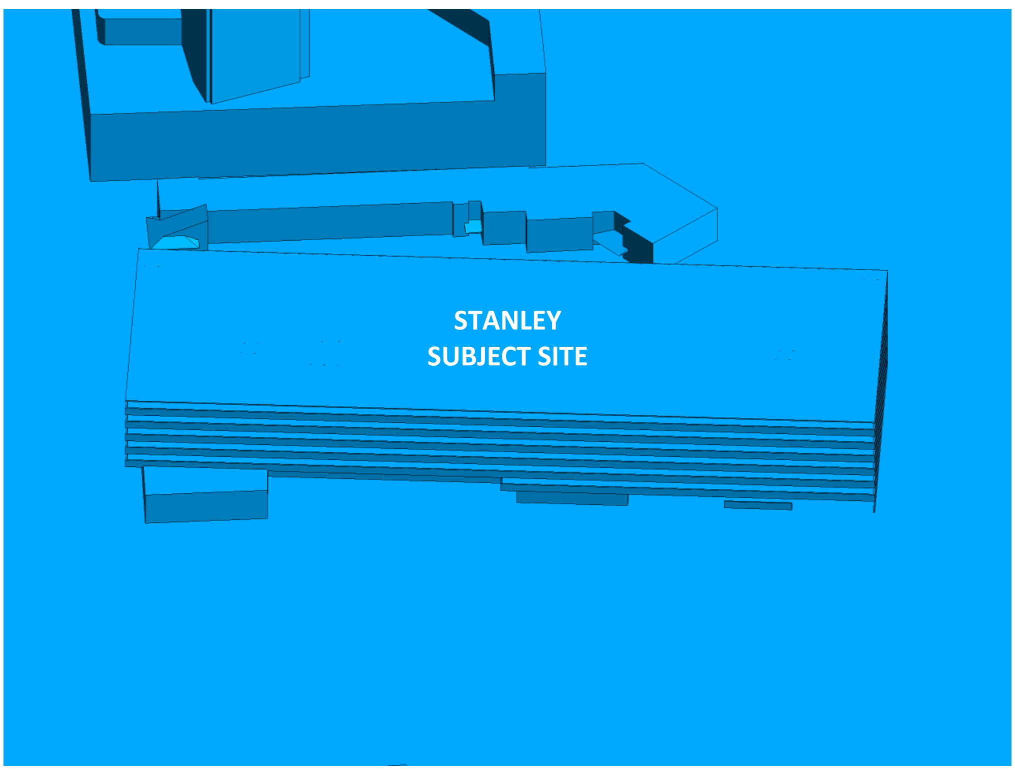


FIGURE 3B: CLOSE-UP VIEW OF FIGURE 3A

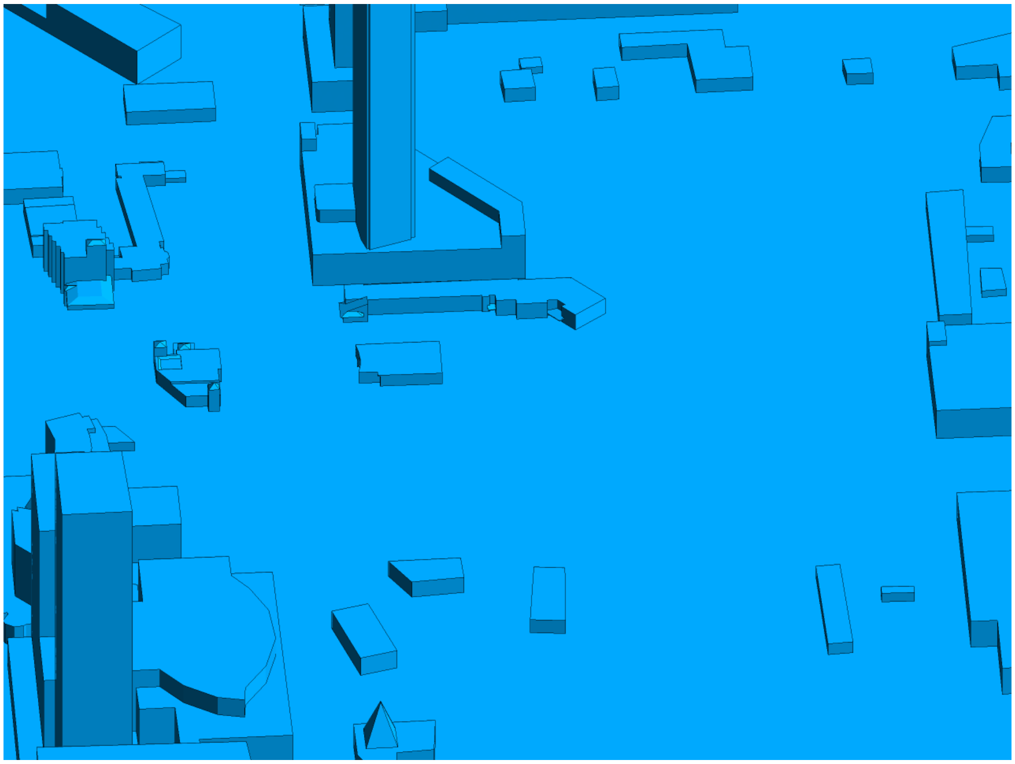


FIGURE 3C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

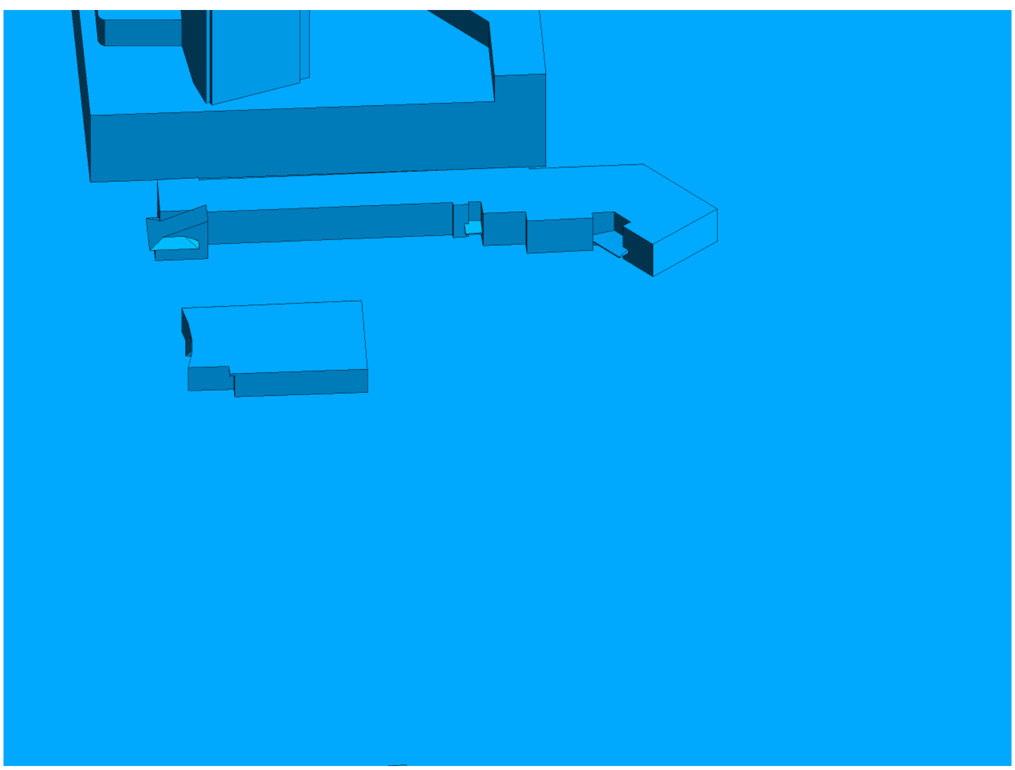


FIGURE 2D: CLOSE-UP VIEW OF FIGURE 3C

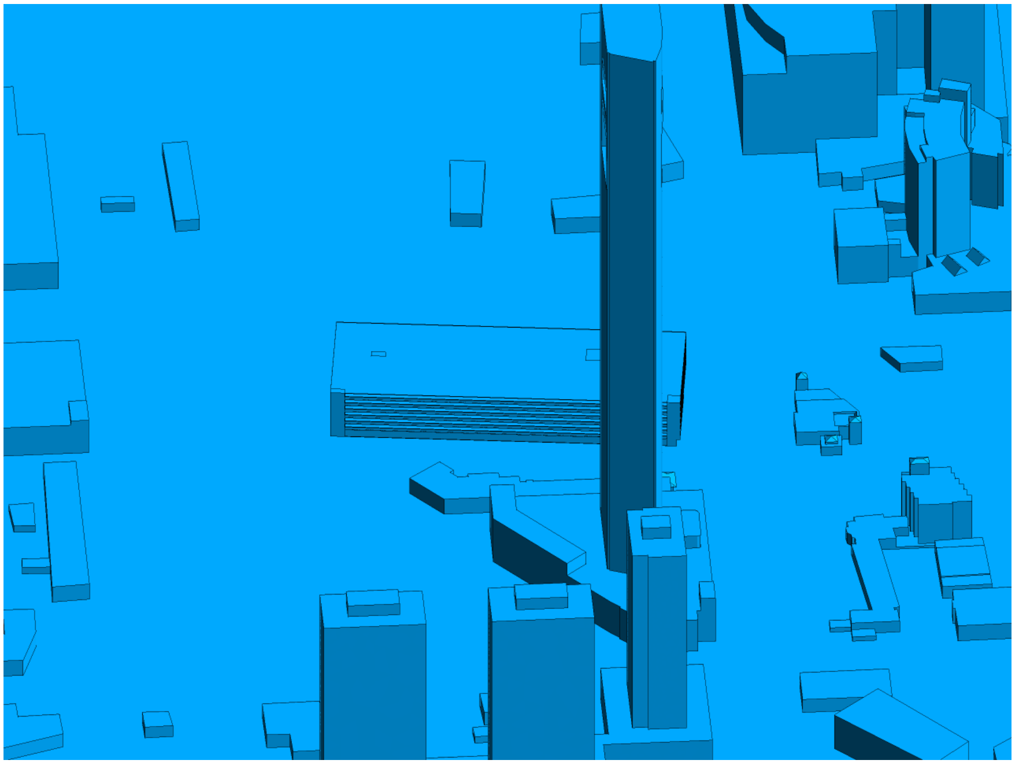


FIGURE 3E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

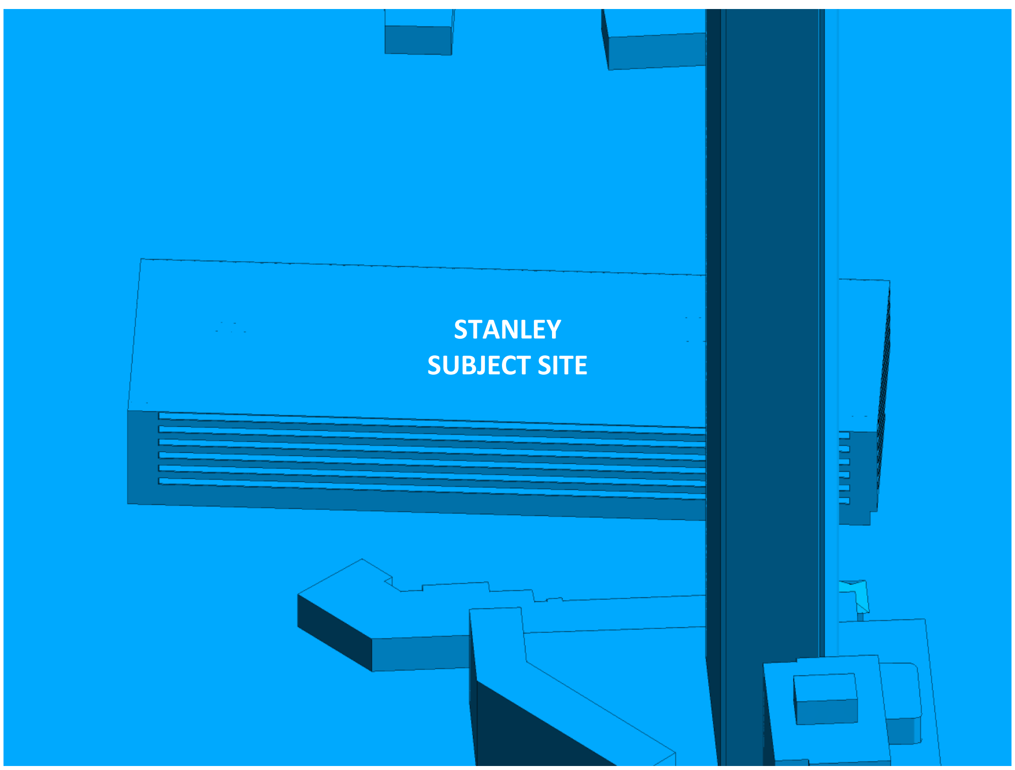


FIGURE 3F: CLOSE-UP VIEW OF FIGURE 3E

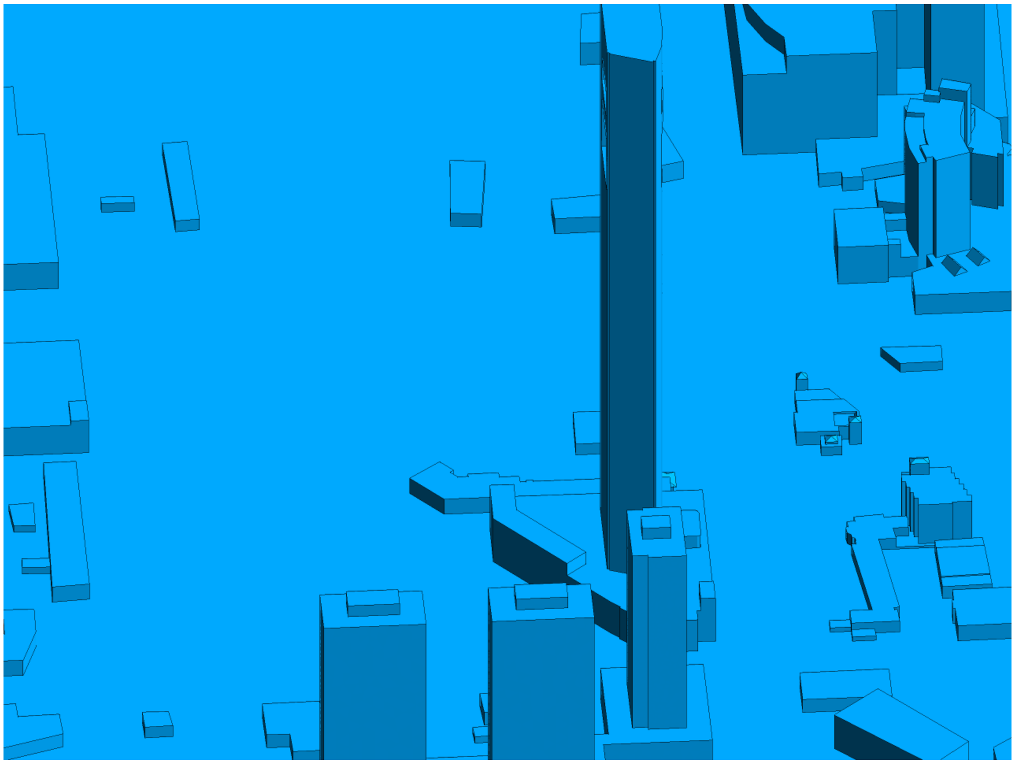


FIGURE 3G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

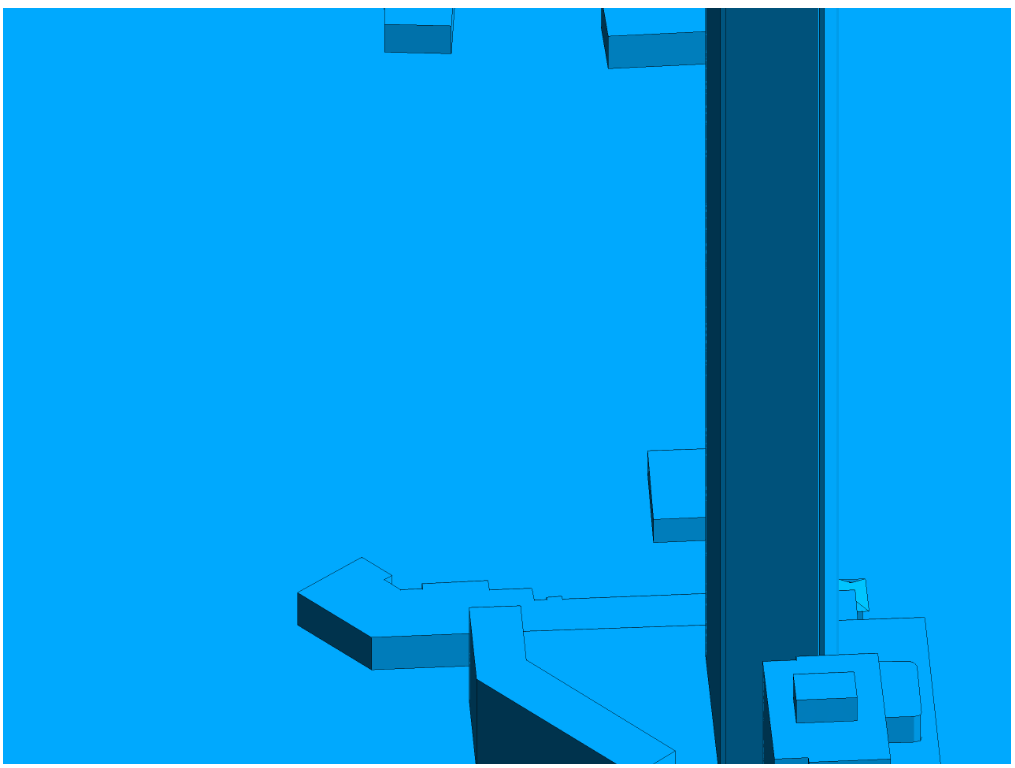


FIGURE 3H: CLOSE-UP VIEW OF FIGURE 3G

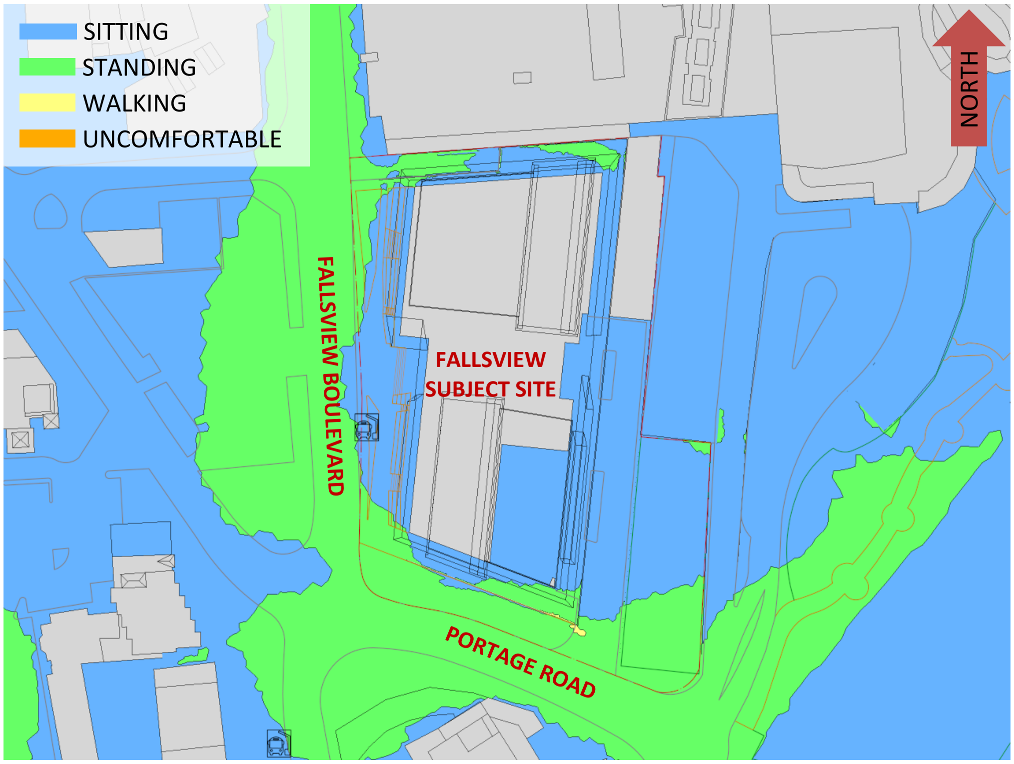


FIGURE 4A: SUMMER – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

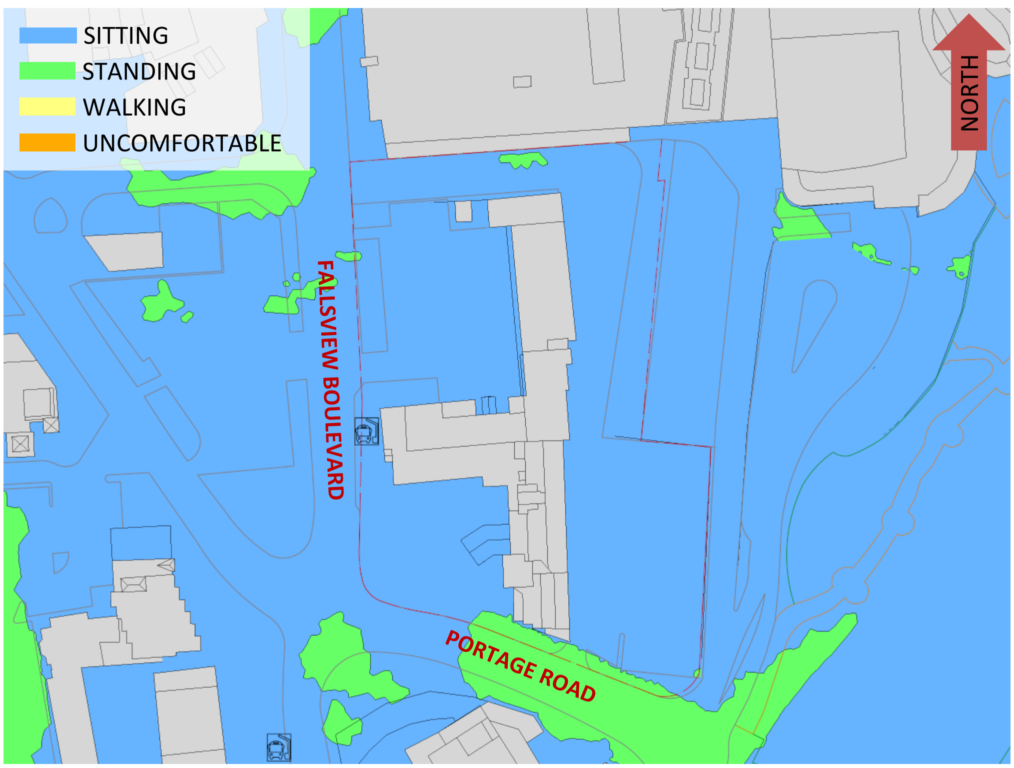


FIGURE 4B: SUMMER – EXISTING MASSING – WIND COMFORT, GRADE LEVEL

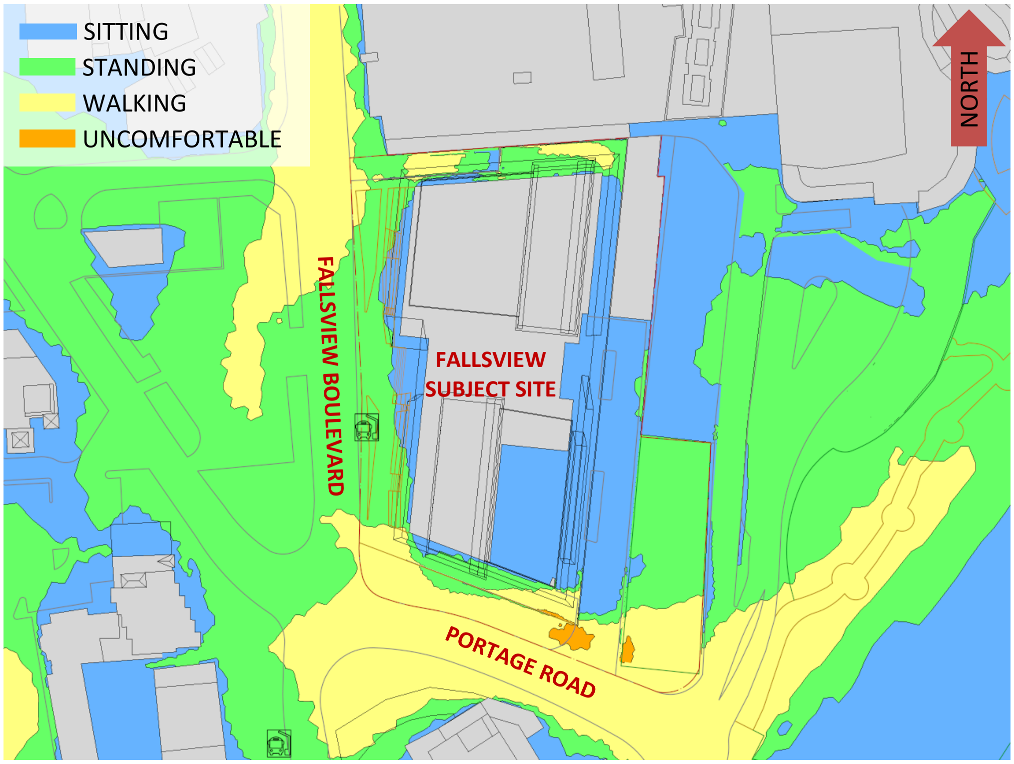


FIGURE 5A: WINTER – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

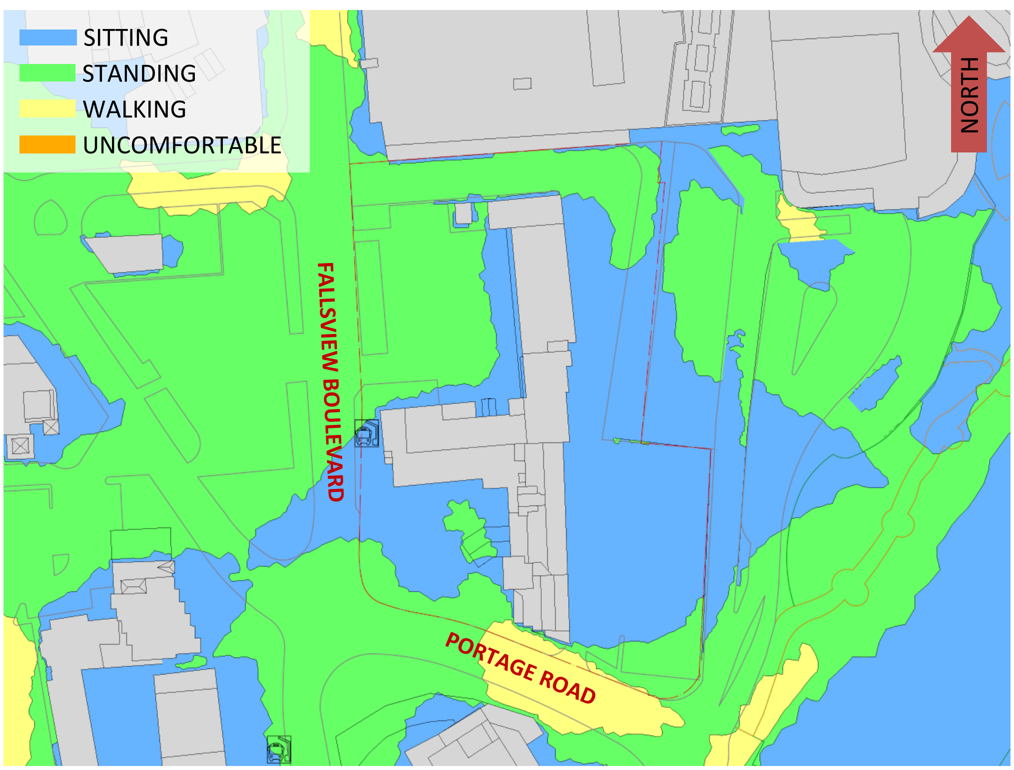


FIGURE 5B: WINTER – EXISTING MASSING – WIND COMFORT, GRADE LEVEL

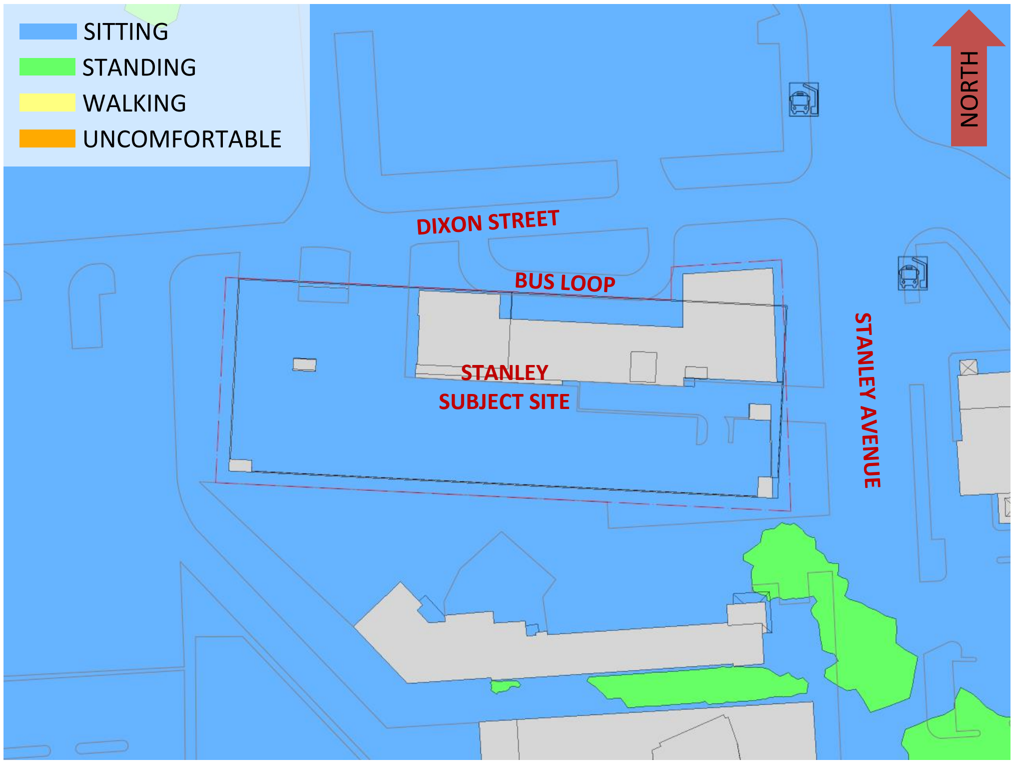


FIGURE 6A: SUMMER – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

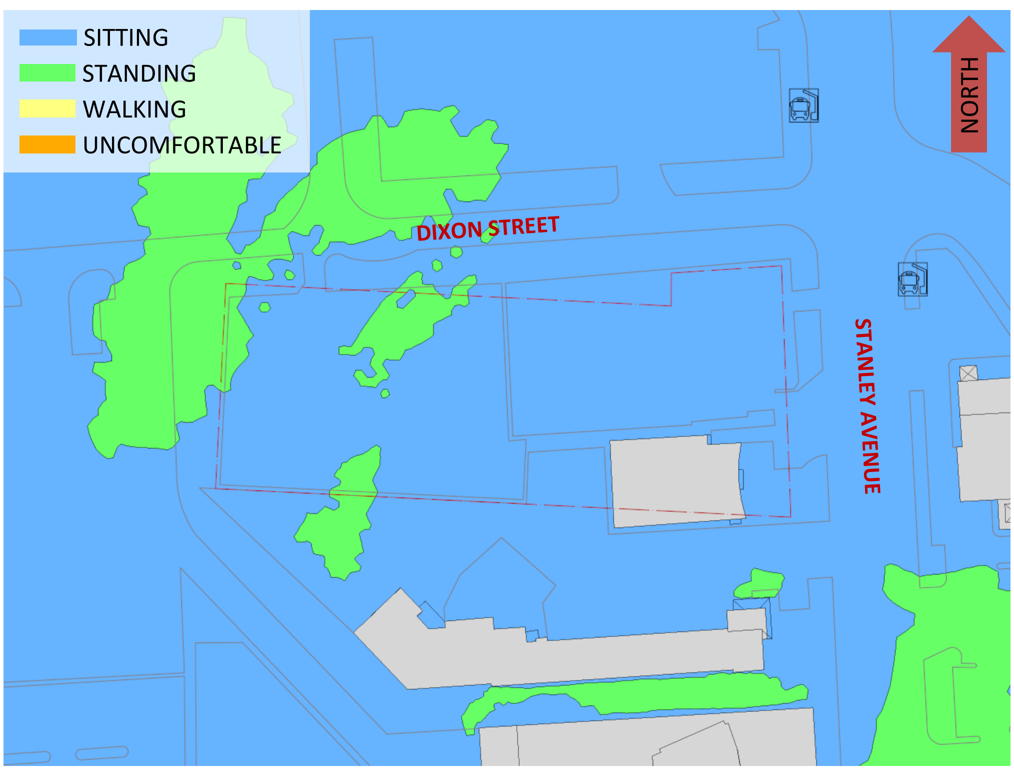


FIGURE 6B: SUMMER – EXISTING MASSING – WIND COMFORT, GRADE LEVEL

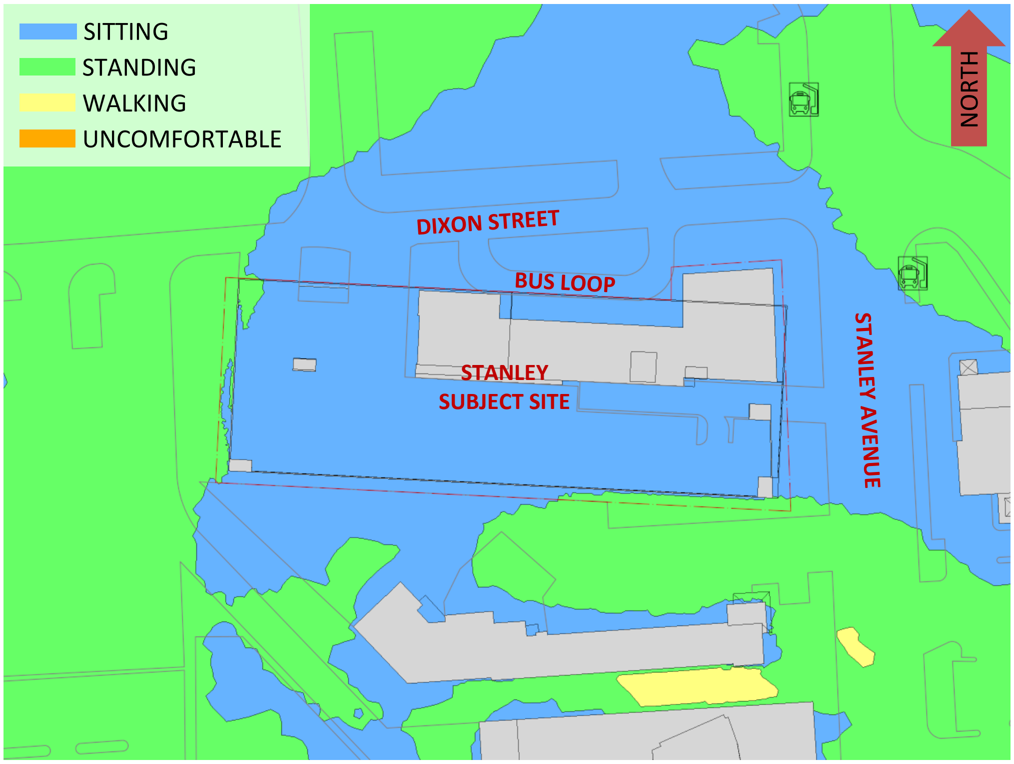


FIGURE 7A: WINTER – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

FIGURE 7B: WINTER – EXISTING MASSING – WIND COMFORT, GRADE LEVEL

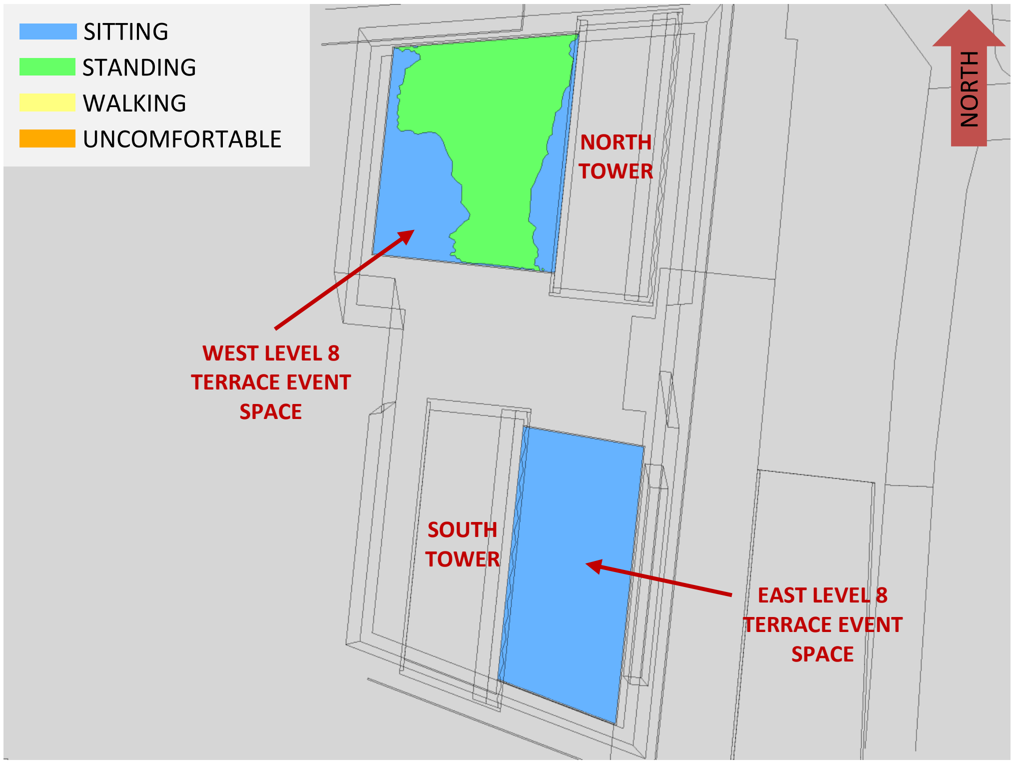


FIGURE 8A: SUMMER – WIND COMFORT, LEVEL 8 COMMON AMENITY TERRACES

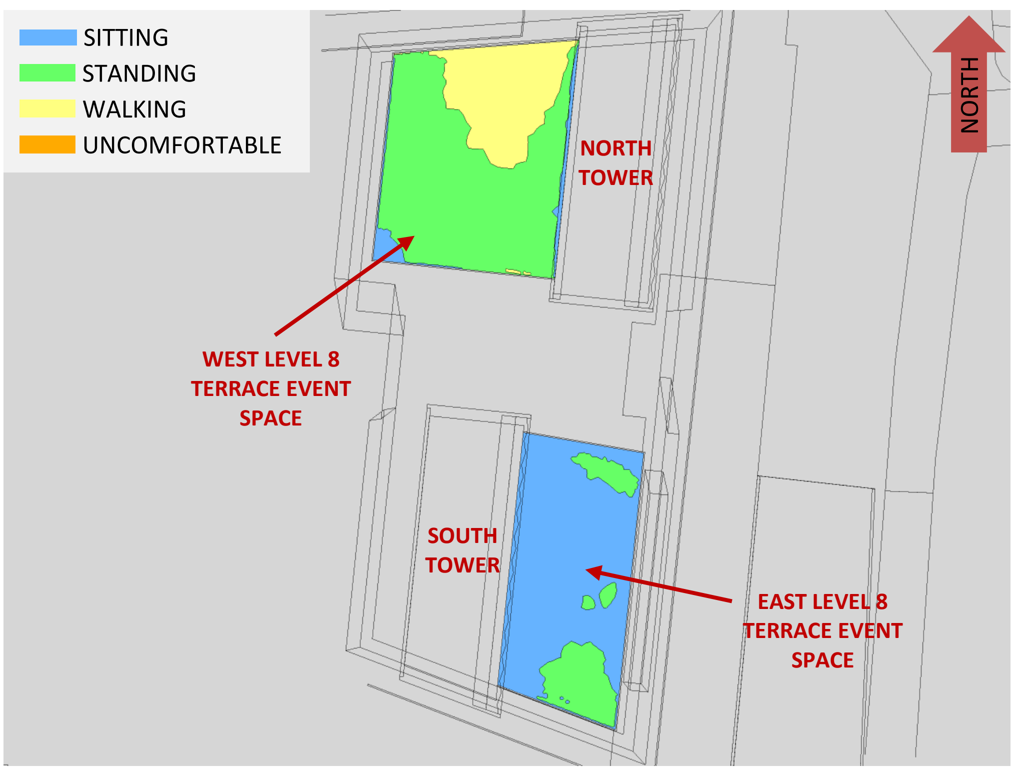
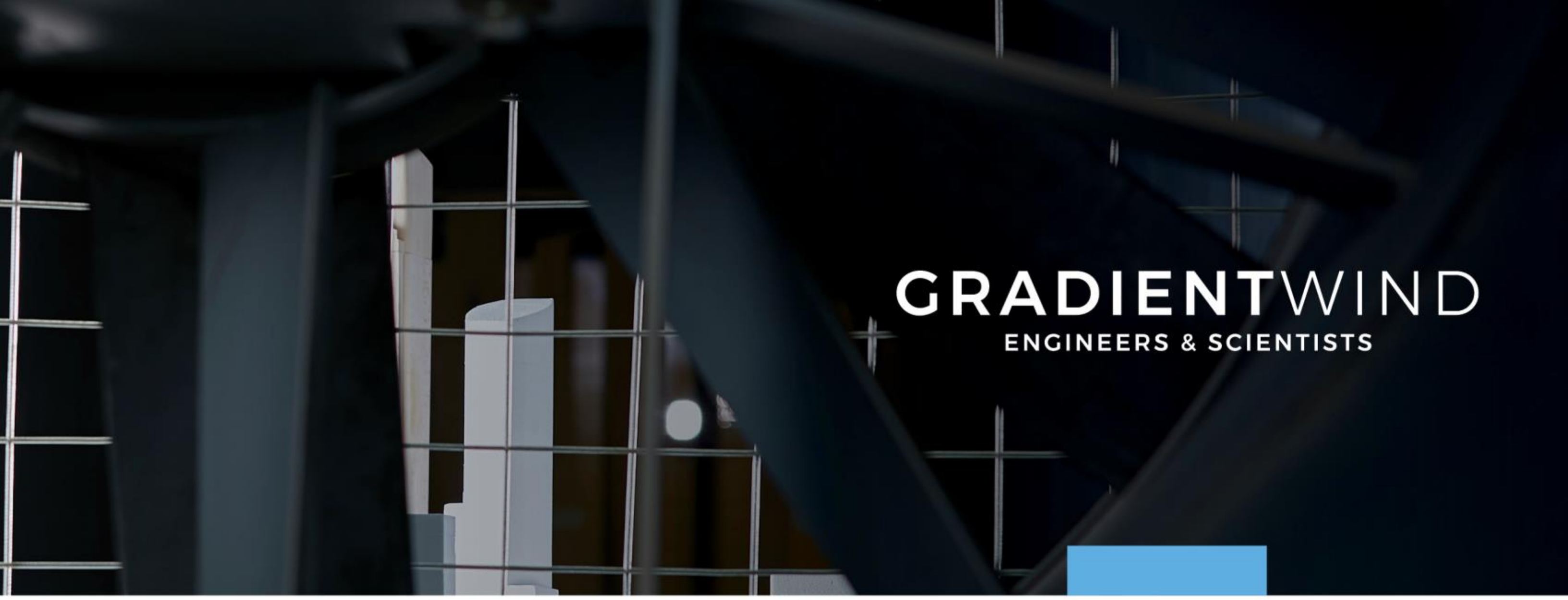


FIGURE 8B: WINTER – WIND COMFORT, LEVEL 8 COMMON AMENITY TERRACES



APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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

$$U = U_g \left(\frac{Z}{Z_g} \right)^{\alpha}$$ 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 35% mean wind speed for Niagara Falls 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 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	0.24
38	0.22
70	0.20
123	0.16
190	0.19
210	0.22
224	0.23
236	0.23
250	0.24
270	0.24
294	0.24
322	0.24

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

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

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

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

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

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

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

REFERENCES

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

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

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