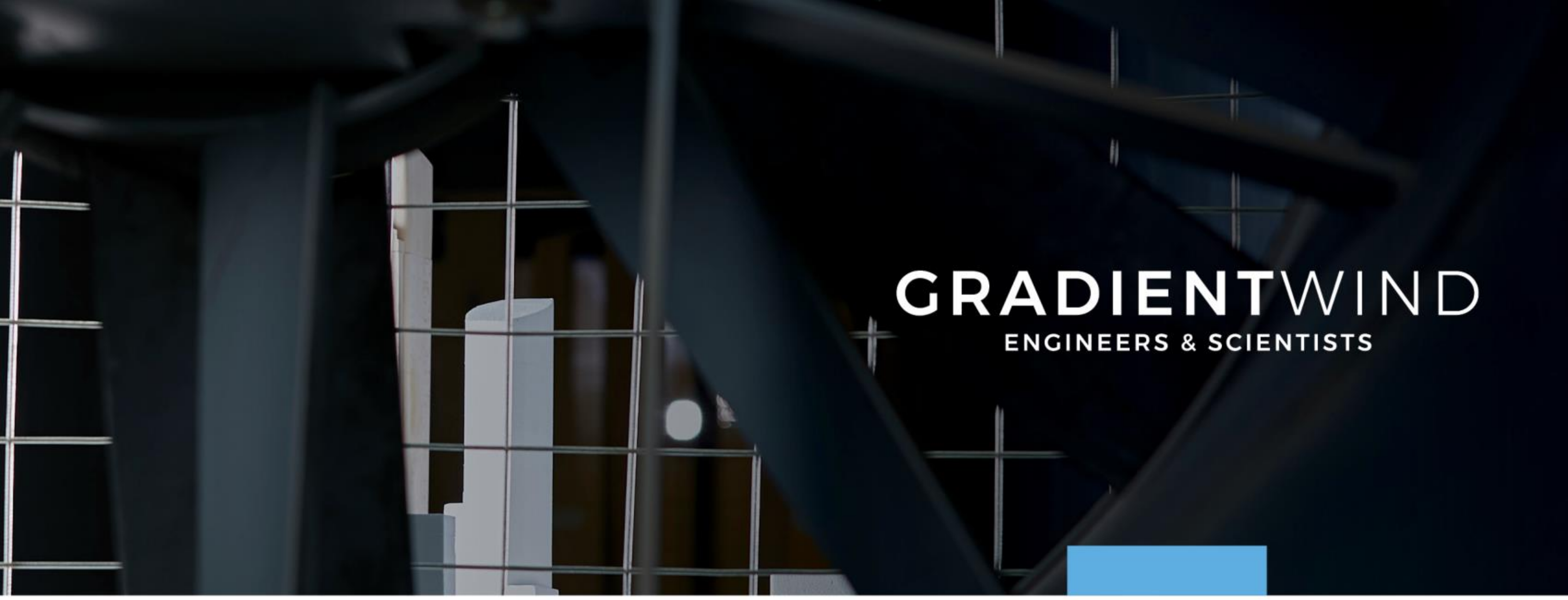
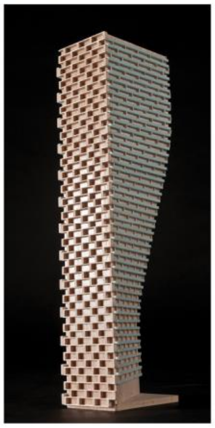
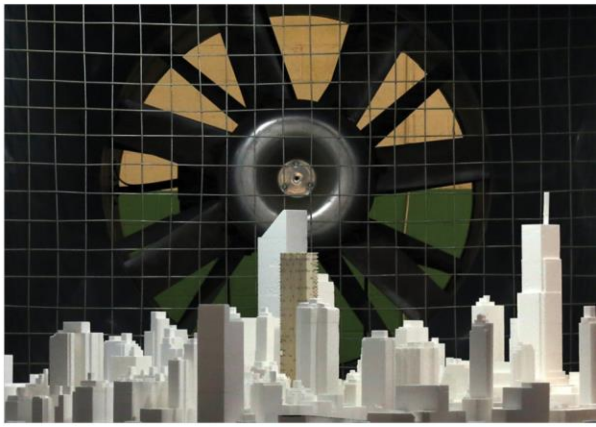


PEDESTRIAN LEVEL WIND STUDY

3085 Hurontario Street
Mississauga, Ontario

REPORT: GWE21-021-WTPLW





July 6, 2021

PREPARED FOR
Equity Three Holdings Inc.
53 Village Centre Place
Mississauga, Ontario
L4Z 1V9

PREPARED BY
Patrick Shorey, B.A.Sc., EIT, Junior Wind Scientist
Andrew Sliasas, M.A.Sc., P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a pedestrian level wind study undertaken to assess wind conditions for a proposed mixed-use, three-building development located at 3085 Hurontario Street in Mississauga, Ontario. The study involves wind tunnel measurements of pedestrian wind speeds using a physical scale model, combined with meteorological data integration, to assess pedestrian comfort at key areas within and surrounding the study site. Grade-level areas investigated include sidewalks, driveways, parking areas, transit stops, landscaped spaces, outdoor amenity areas, and building access points. Wind comfort is also evaluated over the rooftop amenity areas. To evaluate the influence of the proposed development on the existing wind conditions surrounding the site, two massing configurations were studied: (i) existing conditions without the proposed development, and (ii) conditions with the proposed development in place. The results and recommendations derived from these considerations are summarized in the following paragraphs and detailed in the subsequent report.

Our work is based on industry standard wind tunnel testing and data analysis procedures, City of Mississauga wind criteria, architectural drawings provided by Diamond Schmitt Architects in May 2021, surrounding street layouts, as well as existing and approved future building massing information and recent site imagery.

A complete summary of the predicted wind conditions is provided in Section 5.2 of this report, and is also illustrated in Figures 2A-3B, as well as Tables A1-A4 and B1-B5 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Mississauga, we conclude that conditions over most pedestrian-sensitive areas within and surrounding the development site will be acceptable for the intended pedestrian uses on an annual and seasonal basis. Exceptions are over portions of the amenity courtyard between Buildings 1 and 2 and the associated amenity entrances of Building 1, for which mitigation is recommended, as described in Section 5.2. The Building 1 podium rooftop amenity and central portion of the Building 2 podium rooftop amenity will be comfortable for standing during the summer months, and mitigation is recommended, as described in Section 5.2. The southeast portion of the Building 2 podium rooftop amenity, as well as the Building 3 rooftop amenity, will be comfortable for sitting or more sedentary activities throughout the summer months, without mitigation.

A comparison of the existing versus future wind comfort surrounding the study site indicates that the proposed development will generally reduce wind comfort over neighbouring grade-level areas from the northeast clockwise to the south, and generally improve conditions to the west. Where wind speeds increase, conditions nevertheless remain acceptable for the intended uses.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site were found to experience wind conditions that could be considered unsafe.

TABLE OF CONTENTS

1. INTRODUCTION

This report describes a pedestrian level wind study undertaken to assess wind conditions for a proposed mixed-use, three-building development located at 3085 Hurontario Street in Mississauga, Ontario. The study was performed in accordance with industry standard wind tunnel testing techniques, City of Mississauga wind criteria, architectural drawings provided by Diamond Schmitt Architects Inc. in May 2021, surrounding street layouts and existing and approved future building massing information, as well as recent site imagery.

2. TERMS OF REFERENCE

The focus of this pedestrian wind study is the proposed mixed-use, multi-building development located at 3085 Hurontario Street in Mississauga, Ontario. The study site occupies an L-shaped parcel of land at the east corner of Hurontario Street and Kirwin Avenue, and is bounded on all remaining sides by low-rise massing and surface parking areas.

The proposed development comprises three buildings of varying heights, known as Building 1, 2, and 3. Building 2, at the east corner of the site, comprises 33- and 35-storey towers arranged northwest-southeast over opposing ends of a nine-storey podium. Building 3, nine storeys, is to the northwest of Building 2, having a rectangular planform, longitudinally aligned northwest-southeast. Building 1 is southwest of Building 2, separated by an exterior amenity courtyard, and comprises a 30-storey tower rising from the northwest end of a seven-storey podium. A private road along the northwest perimeter of the site provides access to the interior of the site from Kirwin Avenue and Hurontario Street. At ground level, Building 1 contains mixed-use space and a residential lobby entrance fronting Hurontario Street, with an amenity space and additional lobby entrance facing the amenity courtyard. Building 2 contains townhouse units along the northeast elevation, with amenity and residential entrances facing the shared courtyard to the southwest. Building 3 contains townhouse units at the northwest end of the building, with lobby and amenity entrances fronting the private road along the southwest elevation. Above grade, outdoor amenity areas are located over the Buildings 1 and 2 podia rooftops, and over the Building 3 rooftop.

Regarding wind exposures, the near-field surroundings of the development (defined as an area falling within a 200-metre radius of the site) are characterized by low- and mid-rise buildings in all directions. The far-field surroundings (defined as the area beyond the near field and within a two-kilometer radius) comprise low-rise suburban exposure in all directions, with a concentration of high-rise buildings to the northwest along Hurontario Street beyond 1,100 metres.

Grade-level areas investigated include sidewalks, driveways, parking areas, transit stops, landscaped spaces, outdoor amenity areas, and building access points. Wind comfort is also evaluated over the rooftop amenity areas. Figures 1A and 1B illustrate the study site and surrounding context for the future and existing test scenario, respectively, and Photographs 1 through 6 depict the wind tunnel model used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind comfort and safety conditions at key areas within and surrounding the development site; (ii) identify areas where wind conditions may interfere with the intended uses of outdoor spaces; (iii) recommend suitable mitigation measures, where required; and (iv) evaluate the influence of the proposed development on the existing wind conditions surrounding the site.

4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the site is based on wind tunnel measurements of wind speeds at selected locations on a reduced-scale physical model, meteorological analysis of the Mississauga area wind climate and synthesis of wind tunnel data with industry-accepted guidelines[1]. The following sections describe the analysis procedures, including a discussion of the pedestrian comfort and safety guidelines.

4.1 Wind Tunnel Context Modelling

A detailed PLW study is performed to determine the influence of local winds at the pedestrian level for a proposed development. The physical model of the proposed development and relevant surroundings,

[1] City of Mississauga Urban Design Terms of Reference, Wind Comfort and Safety Studies, June 2014

illustrated in Photographs 1 through 6 following the main text, was constructed at a scale of 1:400. The wind tunnel model includes all existing buildings and approved future developments within a full-scale diameter of approximately 840 metres. The general concept and approach to wind tunnel modelling is to provide building and topographic detail in the immediate vicinity of the study site on the surrounding model, and to rely on a length of wind tunnel upwind of the model to develop wind properties consistent with known turbulent intensity profiles that represent the surrounding terrain.

An industry standard practice is to omit trees, vegetation, and other existing and planned landscape elements from the wind tunnel model due to the difficulty of providing accurate seasonal representation of vegetation. The omission of trees and other landscaping elements produces slightly more conservative wind speed values.

4.2 Wind Speed Measurements

The PLW study was performed by testing a total of 126 sensor locations on the scale model in Gradient Wind's wind tunnel. Of these 126 sensors, 108 were located at grade and the remaining 18 sensors were located over the rooftop amenities. Wind speed measurements were performed for each of the 126 sensors for 36 wind directions at 10° intervals. Figures 1A and 1B illustrate a plan of the site and relevant surrounding context for the future and existing test scenario, respectively, while sensor locations used to investigate wind conditions are illustrated in Figures 2A through 3B.

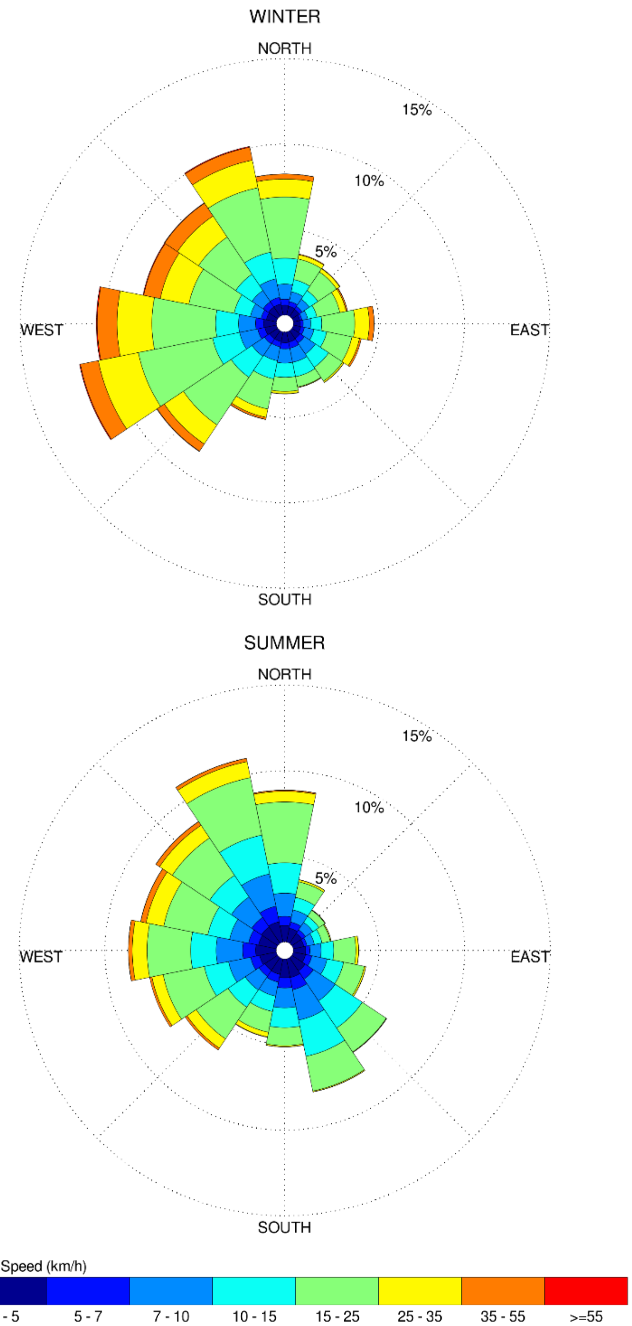
Mean and peak wind speed values for each location and wind direction were calculated from real-time pressure measurements, recorded at a sample rate of 500 samples per second, and taken over a 60-second time period. This period at model-scale corresponds approximately to one hour in full-scale, which matches the time frame of full-scale meteorological observations. Measured mean and gust wind speeds at grade were referenced to the wind speed measured near the ceiling of the wind tunnel to generate mean and peak wind speed ratios. Ceiling height in the wind tunnel represents the depth of the boundary layer of wind flowing over the earth's surface, referred to as the gradient height. Within this boundary layer, mean wind speed increases up to the gradient height and remains constant thereafter. Appendices C and D provide greater detail of the theory behind wind speed measurements. Wind tunnel measurements for this project, conducted in Gradient Wind's wind tunnel facility, meet or exceed guidelines found in the National Building Code of Canada 2015 and of 'Wind Tunnel Studies of Buildings and Structures', ASCE Manual 7 Reports on Engineering Practice No 67.

4.3 Meteorological Data Analysis

A statistical model for winds in Toronto, representative of the Mississauga area, was developed from approximately 40-years of hourly meteorological wind data recorded at Pearson International Airport, and obtained from the local branch of Atmospheric Environment Services of Environment Canada. Wind speed and direction data were analyzed for each month of the year in order to determine the statistically prominent wind directions and corresponding speeds, and to characterize similarities between monthly weather patterns. Based on this portion of the analysis, the four seasons are represented by grouping data from consecutive months based on similarity of weather patterns, and not according to the traditional calendar method.

The statistical model of the Mississauga 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 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 preferred wind speeds and directions can be identified by the longer length of the bars. For Toronto, 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.

SEASONAL DISTRIBUTION OF WINDS FOR VARIOUS PROBABILITIES
PEARSON INTERNATIONAL AIRPORT, TORONTO, 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. Since both mean and gust wind speeds affect pedestrian comfort, their combined effect is defined in the City of Mississauga Urban Design Terms of Reference[1]. More 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 GEM wind speed ranges are used to assess pedestrian comfort, which include: (i) Sitting; (ii) Standing; (iii) Walking; and (iv) Uncomfortable. More specifically, the comfort classes, wind speed ranges, and limiting criteria are summarized as follows:

(i) **Sitting** – GEM wind speeds below 10 km/h occurring more than 80% of the time would be considered acceptable for sedentary activities, including sitting.

(ii) **Standing** – GEM wind speeds below 15 km/h (i.e. 10-15 km/h) occurring more than 80% of the time are acceptable for activities such as standing, strolling or more vigorous activities.

(iii) **Walking** – GEM wind speeds below 20 km/h (i.e. 15-20 km/h) occurring more than 80% of the time are acceptable for walking or more vigorous activities.

(iv) **Uncomfortable** – Uncomfortable conditions are characterized by predicted values that fall below the 80% criterion for walking. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

Gust wind speeds greater than 90 km/h, occurring more than 0.1% of the time on an annual basis, 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 a vulnerable member of the population to fall.

THE BEAUFORT SCALE

NUMBER	DESCRIPTION	WIND SPEED (KM/H)	DESCRIPTION
2	Light Breeze	4-8	Wind felt on faces
3	Gentle Breeze	8-15	Leaves and small twigs in constant motion; Wind extends light flags
4	Moderate Breeze	15-22	Wind raises dust and loose paper; Small branches are moved
5	Fresh Breeze	22-30	Small trees in leaf begin to sway
6	Strong Breeze	30-40	Large branches in motion; Whistling heard in electrical wires; Umbrellas used with difficulty
7	Moderate Gale	40-50	Whole trees in motion; Inconvenient walking against wind
8	Gale	50-60	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 or more sedentary activities. 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 most of 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 across the study site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for their associated spaces. This step involves comparing the predicted comfort class to the desired comfort class, which is dictated by the location type. 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	Walking
Public Sidewalks / Pedestrian Walkways	Walking
Outdoor Amenity Spaces	Sitting / Standing
Cafés / Patios / Benches / Gardens	Sitting / Standing
Plazas	Standing / Walking
Transit Stops	Standing
Public Parks	Sitting / Walking
Garage / Service Entrances	Walking
Vehicular Drop-Off Zones	Walking
Laneways / Loading Zones	Walking

Following the comparison, the location is assigned a descriptor that indicates the suitability of the location for its intended use. The suitability descriptors are summarized as follows:

- **Acceptable**: The predicted wind conditions are suitable for the intended uses of the associated outdoor spaces without the need for mitigation.
- **Acceptable with Mitigation**: The predicted wind conditions are not acceptable for the intended use of a space; however, following the implementation of typical mitigation measures, the wind conditions are expected to satisfy the required comfort guidelines.
- **Mitigation Testing Recommended**: The effectiveness of typical mitigation measures is uncertain, and additional wind tunnel testing is recommended to explore other options and to ensure compliance with the comfort guidelines.
- **Incompatible**: The predicted wind conditions will interfere with the comfortable and/or safe use of a space and cannot be feasibly mitigated to acceptable levels.

5. RESULTS AND DISCUSSION

5.1 Pedestrian Comfort Suitability – Future Conditions

Tables A1 through A4 in Appendix A provide a summary of seasonal comfort predictions for each sensor location under the future massing scenario considering the study building and all approved surrounding developments. The tables indicate the 80% non-exceedance gust wind speeds and corresponding comfort classifications as defined in Section 4.4. In other words, a gust wind speed threshold of 12.1 for the summer season indicates that 80% of the measured data falls at or below 12.1 km/h during the summer months and conditions are therefore suitable for standing, as the 80% threshold value falls within the exceedance range of 10-15 km/h for standing. The tables include the predicted threshold values for each sensor location during each season, accompanied by the corresponding predicted comfort class (i.e. sitting, standing, walking, etc.).

The most significant findings of the PLW are summarized in the Section 5.2. To assist with understanding and interpretation, predicted conditions for the proposed development are also illustrated in colour-coded format in Figures 2A through 3B. Conditions suitable for sitting are represented by the colour green, while standing is represented by yellow, walking by blue, and uncomfortable for walking by magenta. Measured mean and gust velocity ratios, which constitutes the raw data upon which the results are based, will be made available upon request.

5.2 Summary of Findings – Future Conditions

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables A1-A4 in Appendix A, this section summarizes the most significant findings of the PLW study with respect to future conditions, as follows:

1. Most surrounding public sidewalks, surface parking, and landscaped areas within and surrounding the development site will be comfortable for walking or better throughout the year. The exception is over an isolated potion of sidewalk at the north end of the study site (Sensor 78), where conditions become uncomfortable for walking during the winter months. Because wind speeds only marginally exceed the walking criterion, and are considered safe (Refer to Tables A1-A4 under "Pedestrian Safety"), the noted conditions are considered acceptable without the need for mitigation.

2. The shared amenity courtyard between Buildings 1 and 2 (Sensors 89-105) will be comfortable for walking or better during the summer months, with some areas becoming uncomfortable for walking during the winter months (Sensors 100, 102, 104). To ensure the entire courtyard is comfortable for standing or better during the summer months, and walking or better during the winter, it is recommended to install clusters of vertical wind barriers within the centre of the turn-about at the north end of the courtyard, as well as interspersed within the south portion of the courtyard. Barriers may take the form of high-solidity wind barriers, dense coniferous plantings in planters, or a combination thereof, and should rise at least 2.0 metres above grade to effectively buffer prominent northwesterly winds channelling though the courtyard area. Canopy or pergola structures at the base of the towers and adjacent to the inward-facing elevations will also help mitigate downwash effects. Where sitting conditions within the courtyard are desired, it is recommended to install localized wind barriers to the immediate north and west of designated seating areas. The exact placement and configuration of mitigation can be coordinated at a later date as the landscape plans develop.

3. All secondary and service entrances serving the development will be comfortable for walking or better on a seasonal basis. All private townhome and most primary building entrances will be comfortable for standing or better throughout the year. The noted conditions are considered acceptable for the intended uses of the spaces. The Buildings 1 and 2 courtyard-facing lobby entrances (Sensors 102 and 98, respectively), as well as the Building 1 amenity entrances (Sensors 104 & 105) will variably exceed the desired standing and walking criteria. For the lobby entrances it is recommended to retain the existing sliding door configurations, and either recess the doorways within the building façade or flank the entrance with vertical wind barriers. To ensure the amenity entrances are comfortable for standing throughout the year, it is recommended to either recess these entrances within the building façade or flank the doorways with vertical wind barriers. For all entrances that do not achieve the standing criterion, it is also recommended to provide a canopy overhead to deflect downwash flows. It is also worth noting that entrances within the courtyard will further benefit from the mitigation recommended for the courtyard, described in Item 2., above.

4. Nearby transit stops on both sides of Hurontario Street (Sensors 36 & 48) will be comfortable for standing or better throughout the year, which is acceptable.

5. Without mitigation, the Building 1 Level 8 amenity terrace (Sensors 119-126) will generally be comfortable for standing during the summer months. To ensure sitting conditions throughout the terrace during the summer months, it is recommended to install 2.0-metre-high wind barriers along the southwest and northeast perimeters of the space, as well as targeted barriers internal to the space. As well, it is recommended to provide canopy or pergola structures at the base of the tower façade over the amenity area. The exact configuration of such mitigation can be coordinated with the design team as the landscape plans develop.

6. The Building 2 Level 10 amenity terrace over the southeast end of the podium rooftop (Sensor 118) will be comfortable for sitting throughout the year, which is ideal, while the portion of the amenity terrace located centrally between the two towers (Sensors 115-117) will be comfortable for standing. To ensure the central amenity terrace is comfortable for siting throughout the summer months, it is recommended to install 2.0-metre-high wind barrier around the full perimeter of the space. A canopy or pergola is also recommended at the inward-facing base of the southeast tower over the amenity area. The exact configuration of such mitigation can be coordinated with the design team as the landscape plans develop.

7. The Building 3 rooftop terrace (Sensors 109-114) will be comfortable for sitting throughout the summer months, without mitigation.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site were found to experience wind conditions that are considered unsafe.

5.3 Pedestrian Comfort Suitability – Existing Versus Future Conditions

To evaluate the influence of the study building on existing wind conditions at and near the study site, an additional pedestrian level wind test was performed for the existing site massing without the study building present. A comparison of wind comfort results for the existing and future configurations is provided in Tables B1 to B5 in Appendix B, which provide a summary of the comparative wind comfort predictions based on annually-averaged wind statistics. The future and existing massing scenarios are shown in Photographs 1 through 6 following the main text.

Pedestrian wind comfort resulting from the construction of the study building and future surrounding developments may be described as being *unchanged*, *improved*, or *reduced* as compared to the existing conditions. These designations are not strictly determined by the predicted percentage values, rather by the change to the predicted comfort class.

A review of Tables B1 to B5 indicates that wind comfort over surface parking, sidewalks, and landscaped areas from the northeast clockwise to the south will generally be reduced, while to the west, concentrated near the intersection of Kirwin Avenue and Hurontario Street, conditions are generally improved. Where wind speeds increase, conditions nevertheless remain acceptable for the intended uses.

6. CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the methodology, results, and recommendations related to a pedestrian level wind study for the proposed mixed-use, three-building development located at 3085 Hurontario Street in Mississauga, Ontario. The study was performed in accordance with industry standard wind tunnel testing and data analysis procedures.

A complete summary of the predicted wind conditions is provided in Section 5.2 of this report, and is also illustrated in Figures 2A-3B, as well as Tables A1-A4 and B1-B5 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Mississauga, we conclude that conditions over most pedestrian-sensitive areas within and surrounding the development site will be acceptable for the intended pedestrian uses on an annual and seasonal basis. Exceptions are over portions of the amenity courtyard between Buildings 1 and 2 and the associated amenity entrances of Building 1, for which mitigation is recommended, as described in Section 5.2. The Building 1 podium rooftop amenity and central portion of the Building 2 podium rooftop amenity will be comfortable for standing during the summer months, and mitigation is recommended, as described in Section 5.2. The southeast portion of the Building 2 podium rooftop amenity, as well as the Building 3 rooftop amenity, will be comfortable for sitting or more sedentary activities throughout the summer months, without mitigation.

A comparison of the existing versus future wind comfort surrounding the study site indicates that the proposed development will generally reduce wind comfort over neighbouring grade-level areas from the northeast clockwise to the south, and generally improve conditions to the west. Where wind speeds increase, conditions nevertheless remain acceptable for the intended uses.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site were found to experience wind conditions that could be considered unsafe.

This concludes our pedestrian level wind study and report. Please advise the undersigned of any questions or comments.

Sincerely,

Gradient Wind Engineering Inc.

Patrick Shorey, B.A.Sc., EIT
Junior Wind Scientist

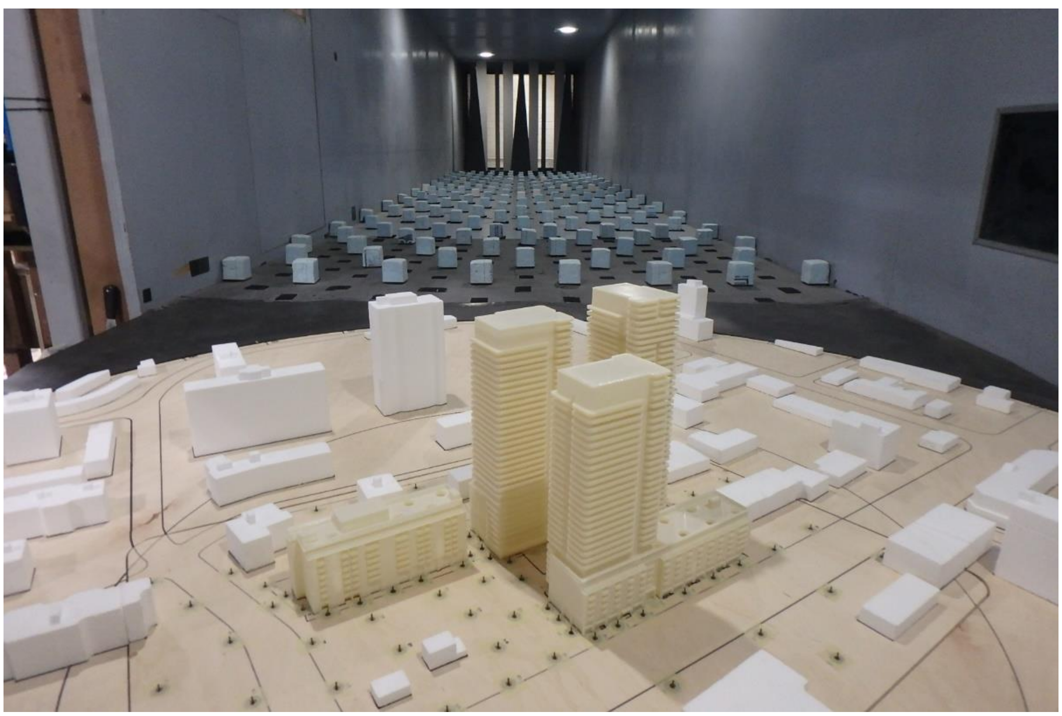
Andrew Sliasas, M.A.Sc., P.Eng.

GW21-021-WTPLW

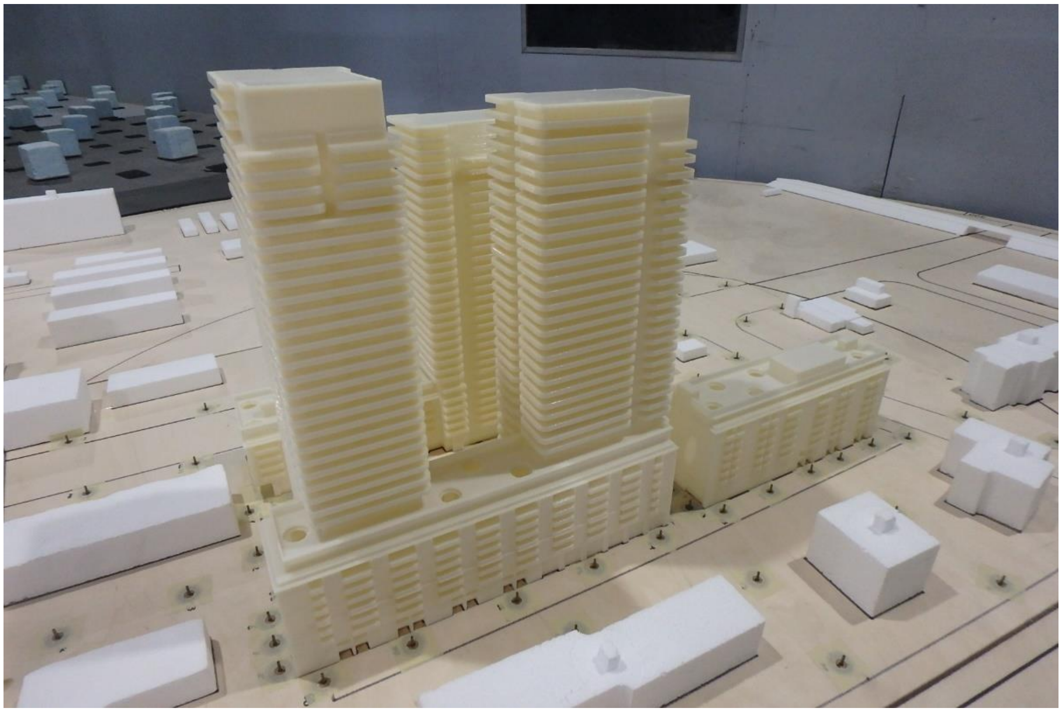
PHOTOGRAPH 1: CLOSE-UP VIEW OF EXISTING CONTEXT MODEL LOOKING NORTH

PHOTOGRAPH 2: CLOSE-UP VIEW OF EXISTING CONTEXT MODEL LOOKING SOUTH

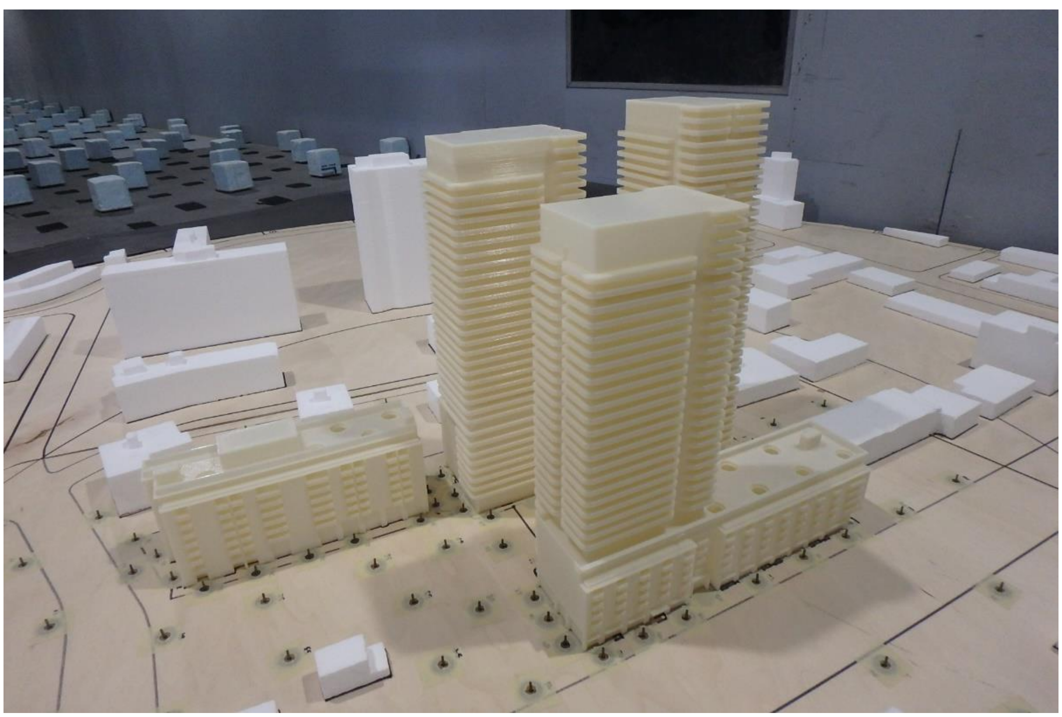
PHOTOGRAPH 3: STUDY MODEL INSIDE THE GWE WIND TUNNEL LOOKING DOWNWIND



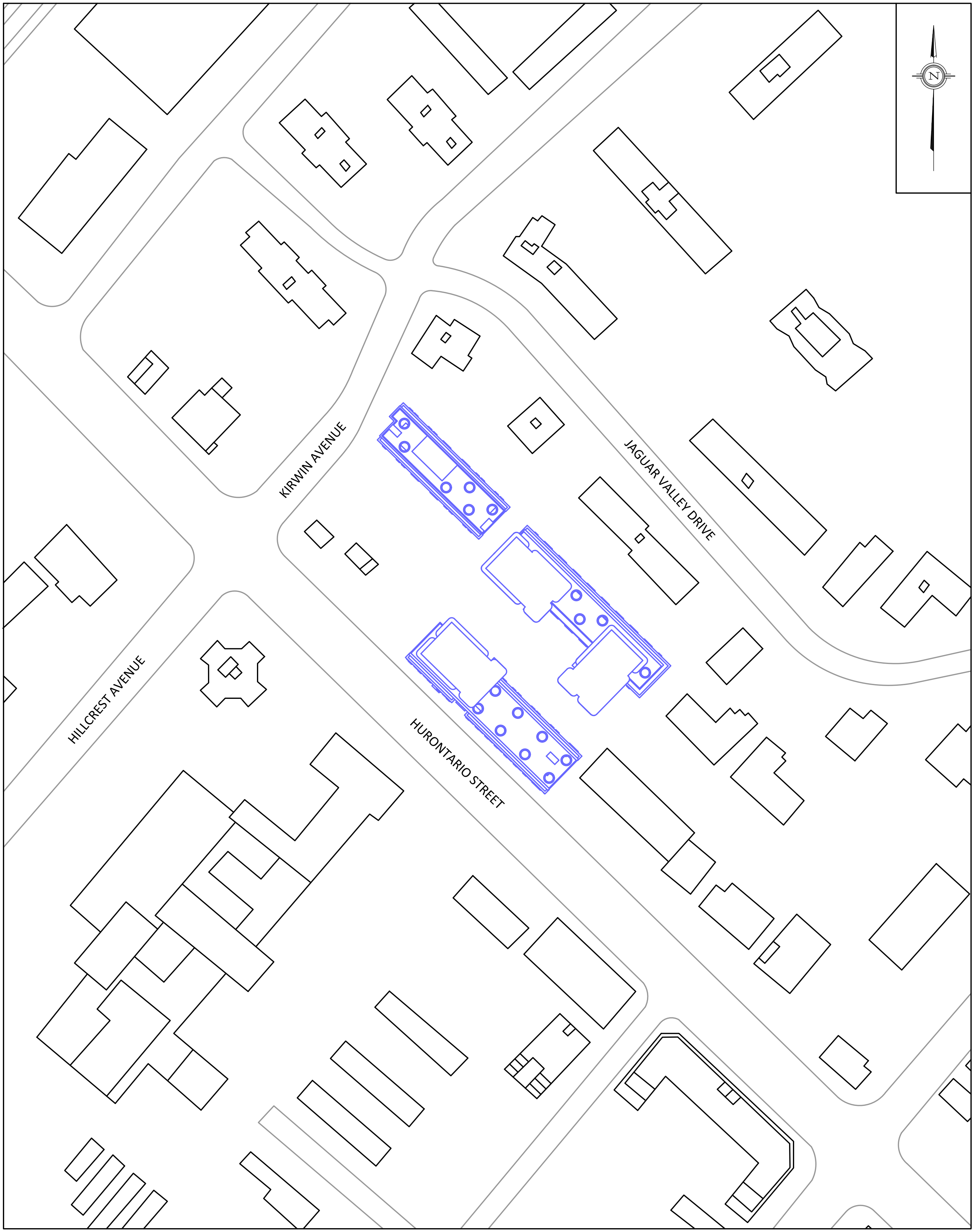
PHOTOGRAPH 4: STUDY MODEL INSIDE THE GWE WIND TUNNEL LOOKING UPWIND



PHOTOGRAPH 5: CLOSE-UP VIEW OF STUDY MODEL LOOKING WEST



PHOTOGRAPH 6: CLOSE-UP VIEW OF STUDY MODEL LOOKING EAST



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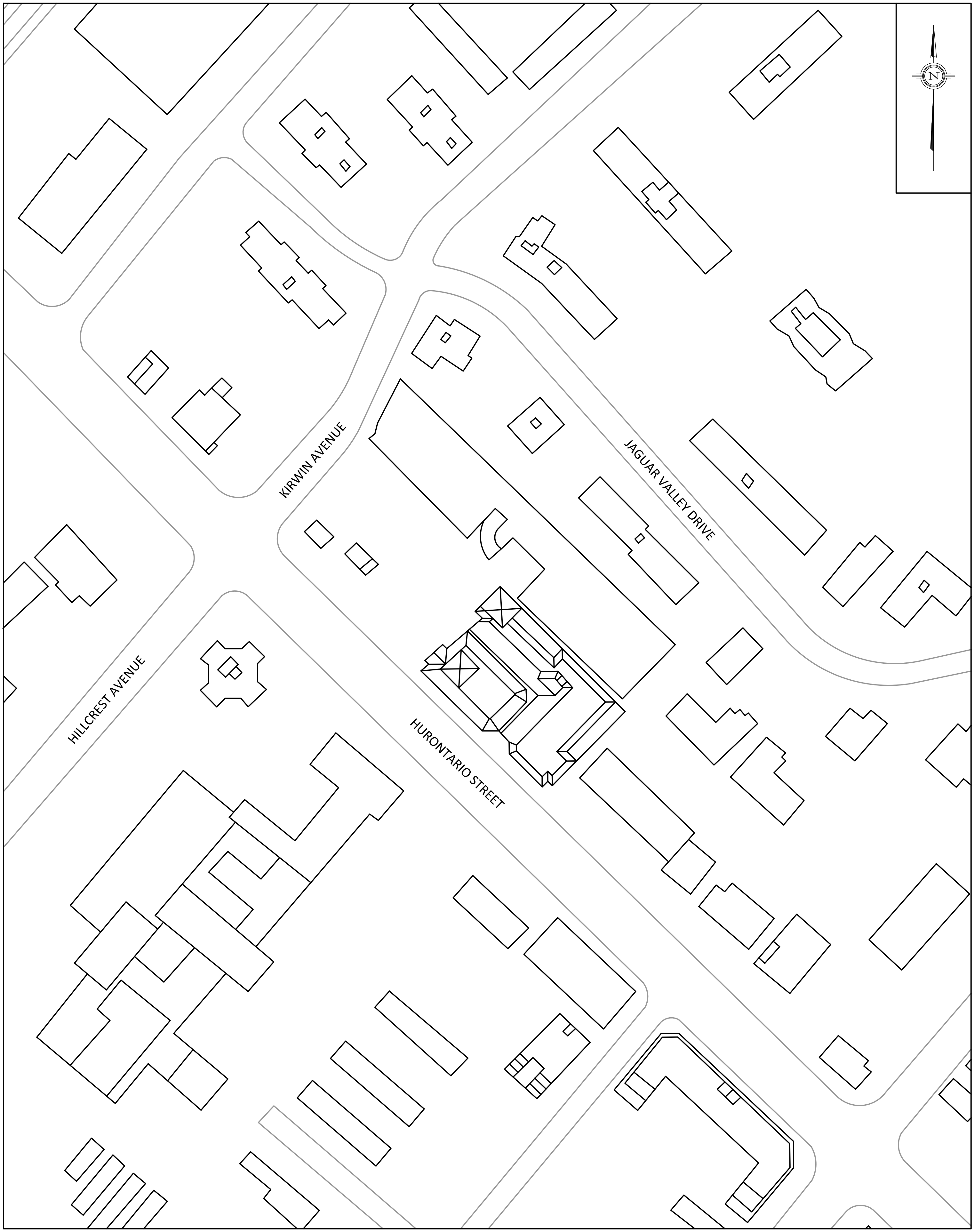
PROJECT	3085 HURONTARIO STREET, MISSISSUAGA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION FIGURE 1A: SITE PLAN AND SURROUNDING CONTEXT FUTURE TEST SCENARIO
SCALE	1:2500 (APPROX.)	DRAWING NO. GWE21-021-PLW-1A	
DATE	JULY 6, 2021	DRAWN BY K.A.	



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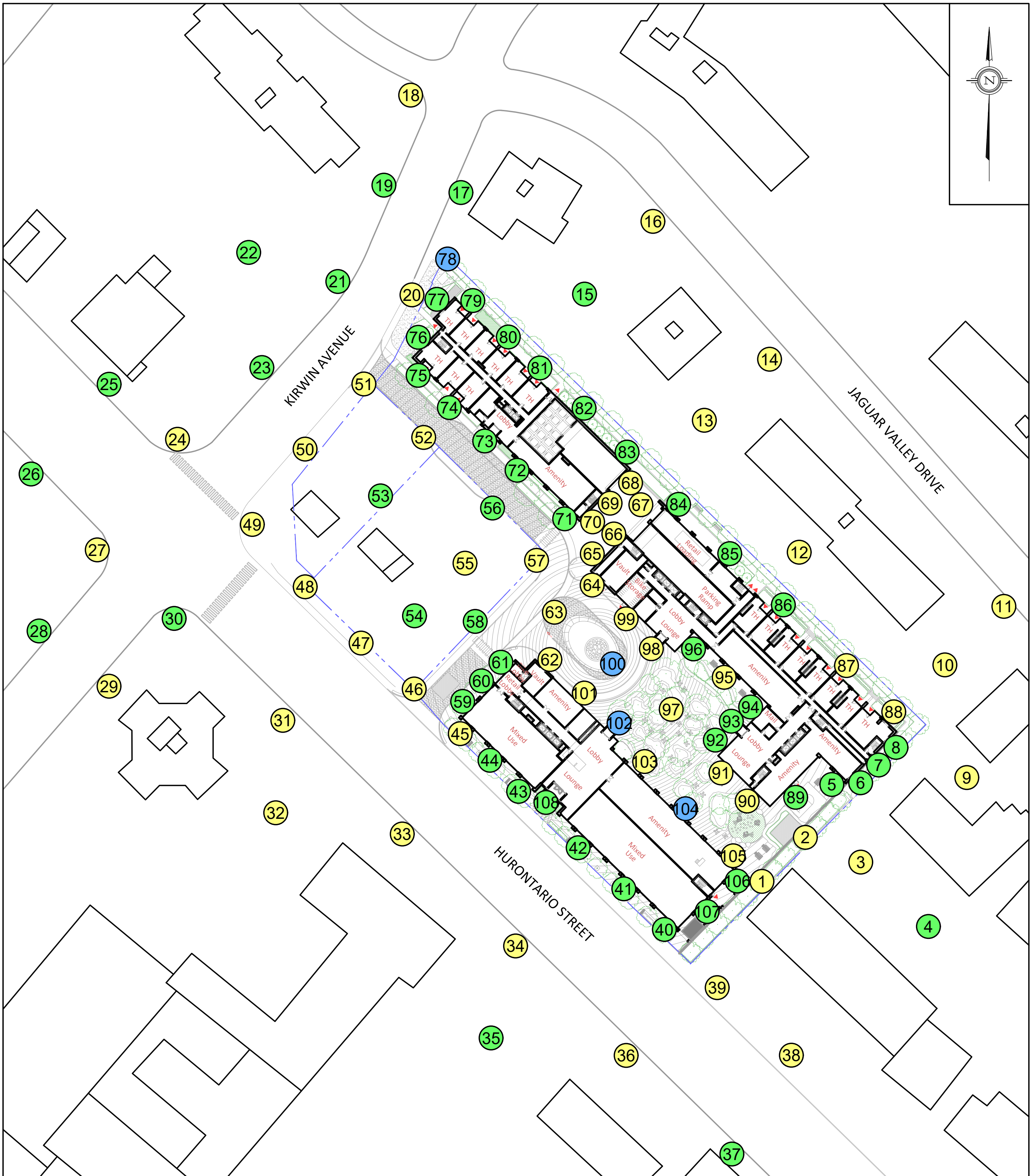
PROJECT	3085 HURONTARIO STREET, MISSISSUAGA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500 (APPROX.)	DRAWING NO.	GWE21-021-PLW-1B
DATE	JULY 6, 2021	DRAWN BY	K.A.

DESCRIPTION

FIGURE 1B:
SITE PLAN AND SURROUNDING CONTEXT
EXISTING TEST SCENARIO



PREDICTED COMFORT CLASSES

- (#) SITTING
- (#) STANDING
- (#) WALKING
- (#) UNCOMFORTABLE

NOTES:

1. SCALE IS APPROXIMATE.
2. (#) PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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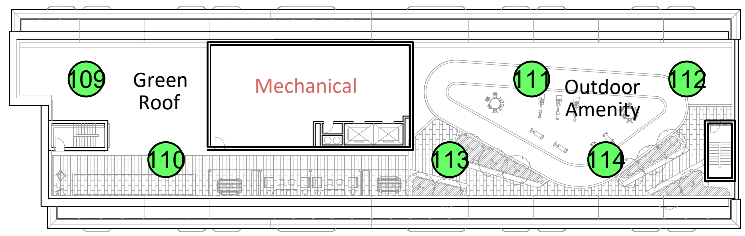
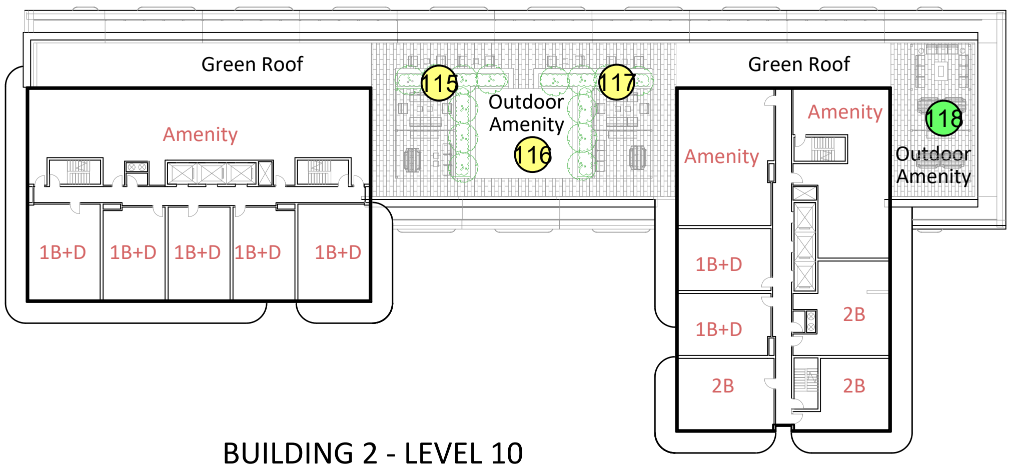
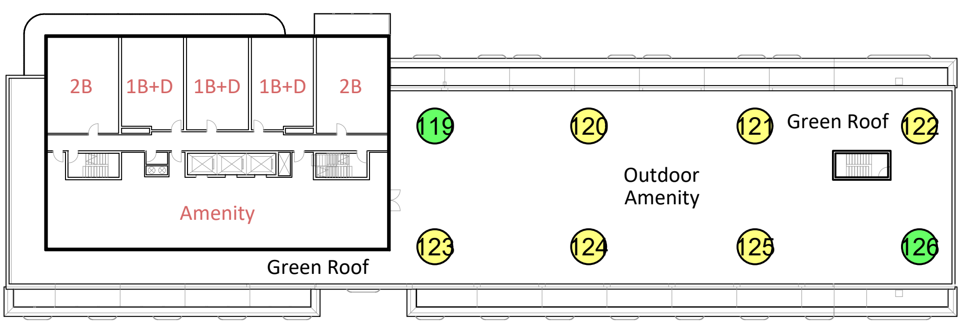
PROJECT		DESCRIPTION
3085 HURONTARIO STREET, MISSISSUAGA PEDESTRIAN LEVEL WIND STUDY		FIGURE 2A: SUMMER GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS
SCALE: 1:1600 (APPROX.)	DRAWING NO.: GWE21-021-PLW-2A	
DATE: JULY 6, 2021	DRAWN BY: K.A.	



BUILDING 3 - ROOFTOP



BUILDING 2 - LEVEL 10



BUILDING 1 - LEVEL 8

PREDICTED COMFORT CLASSES

- (#) SITTING
- (#) STANDING
- (#) WALKING
- (#) UNCOMFORTABLE

NOTES:

1. SCALE IS APPROXIMATE.
2. (#) PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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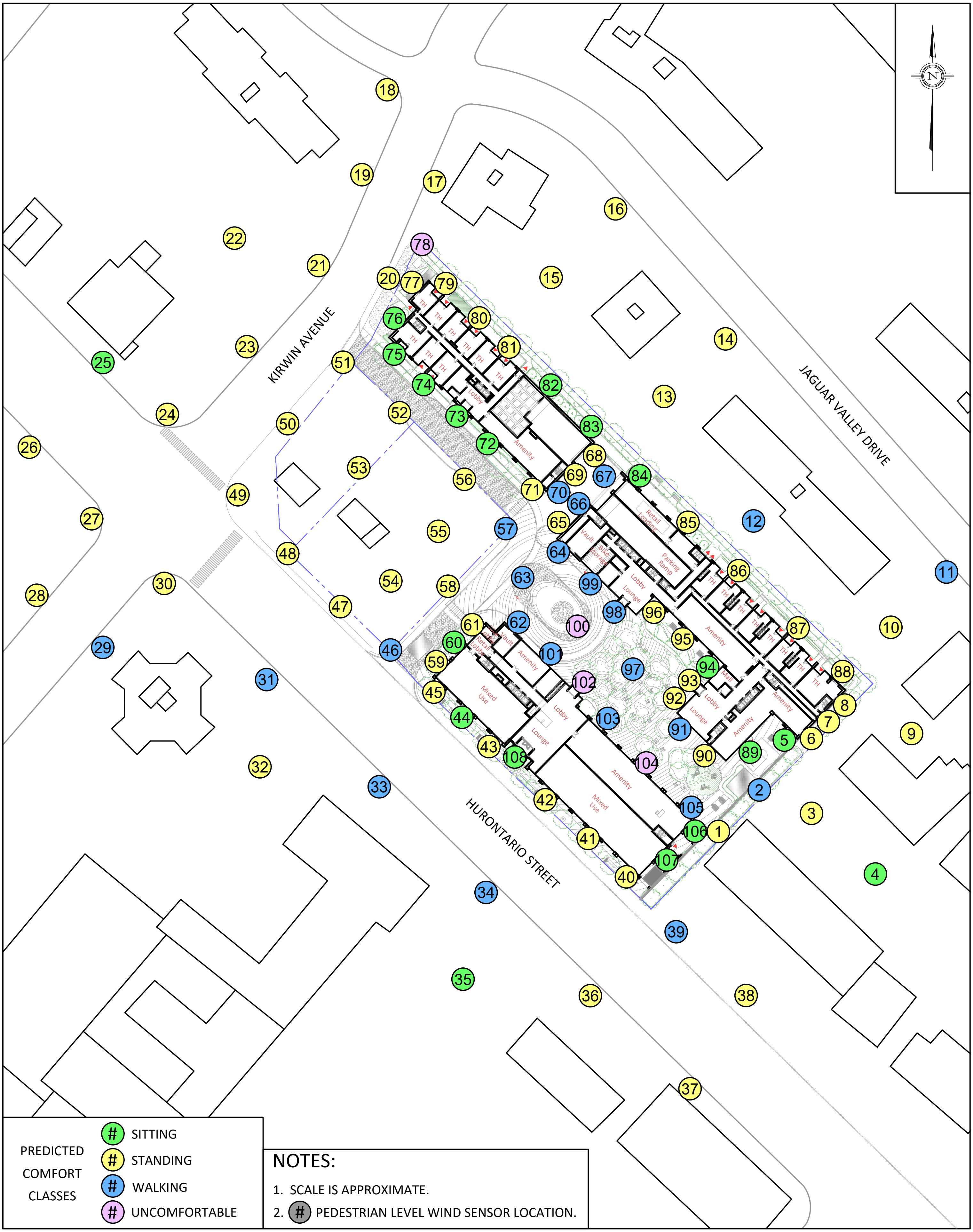
PROJECT	3085 HURONTARIO STREET, MISSISSUAGA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:800 (APPROX.)	DRAWING NO.	GWE21-021-PLW-2B
DATE	JULY 6, 2021	DRAWN BY	K.A.

DESCRIPTION

FIGURE 2B: SUMMER
OUTDOOR AMENITY AREAS
PEDESTRIAN COMFORT PREDICTIONS



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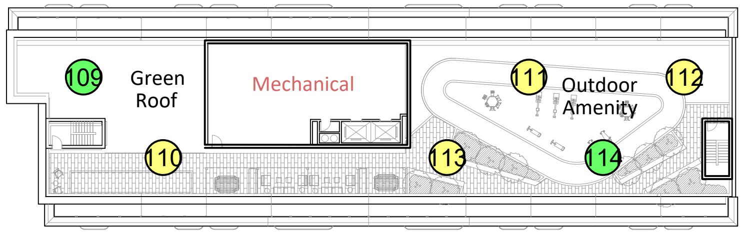
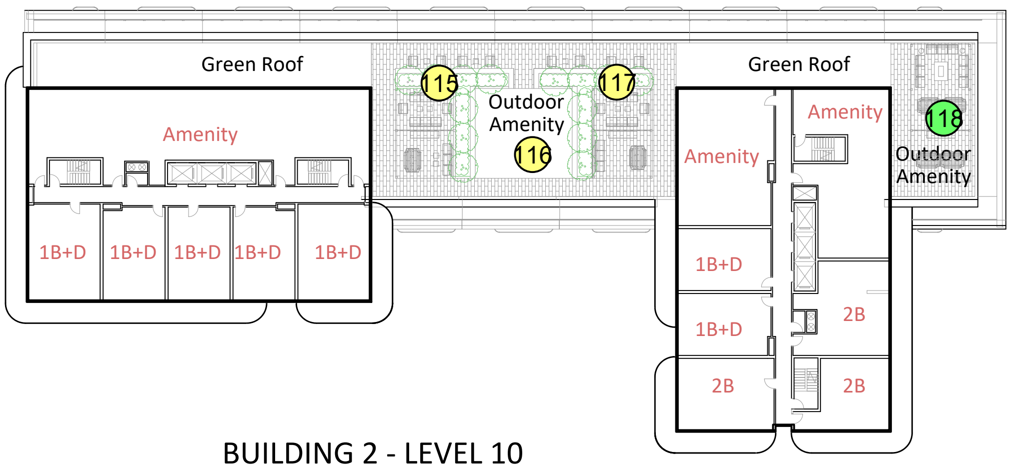
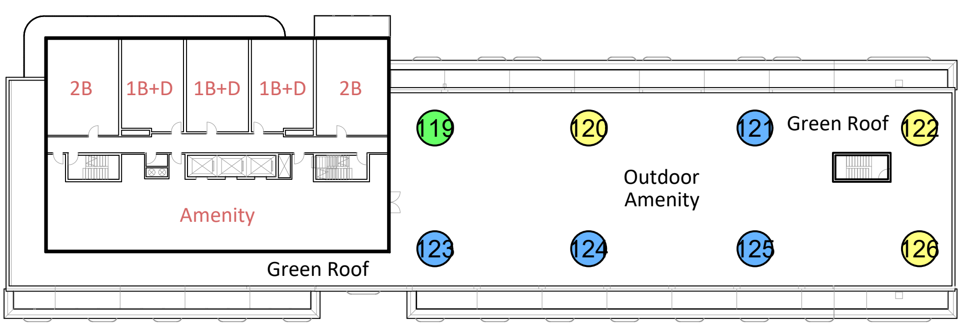
PROJECT		DESCRIPTION
3085 HURONTARIO STREET, MISSISSUAGA PEDESTRIAN LEVEL WIND STUDY		FIGURE 3A: WINTER GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS
SCALE: 1:1600 (APPROX.)	DRAWING NO.: GWE21-021-PLW-3A	
DATE: JULY 6, 2021	DRAWN BY: K.A.	



BUILDING 3 - ROOFTOP



BUILDING 2 - LEVEL 10



BUILDING 1 - LEVEL 8

PREDICTED COMFORT CLASSES

- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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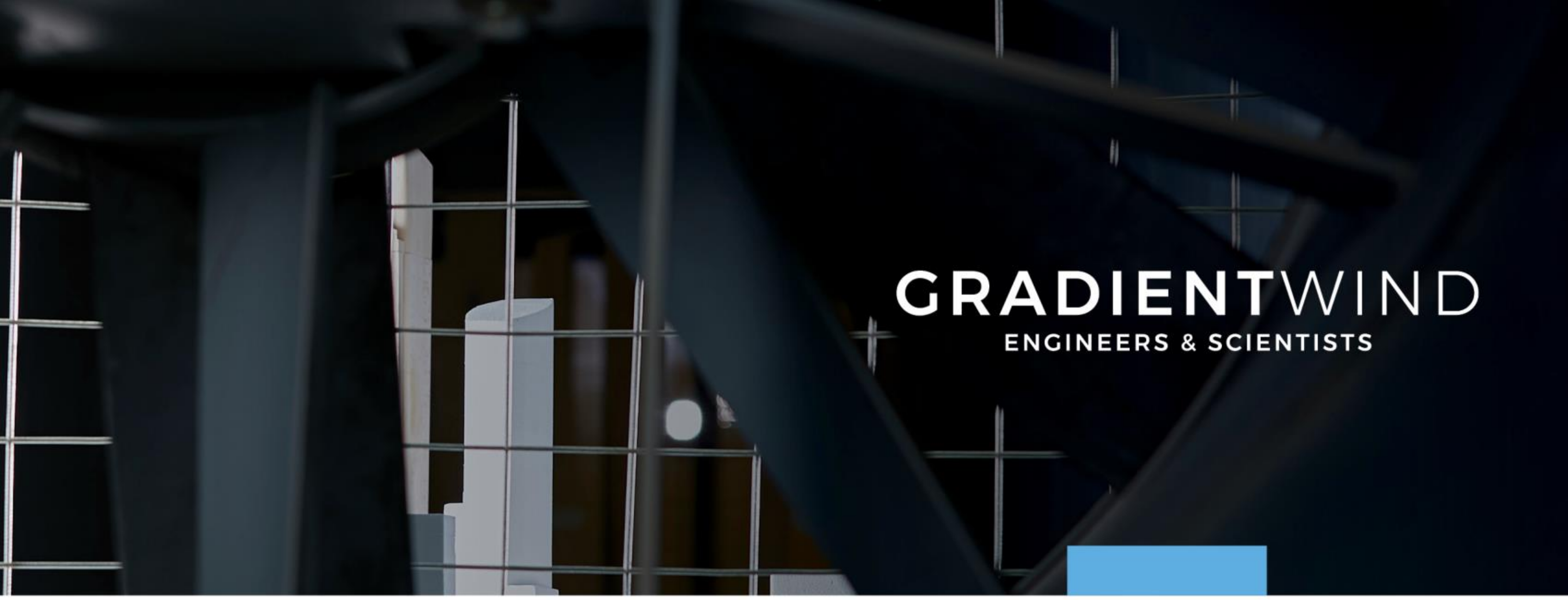
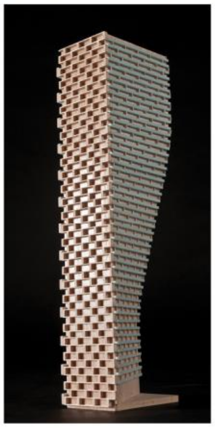
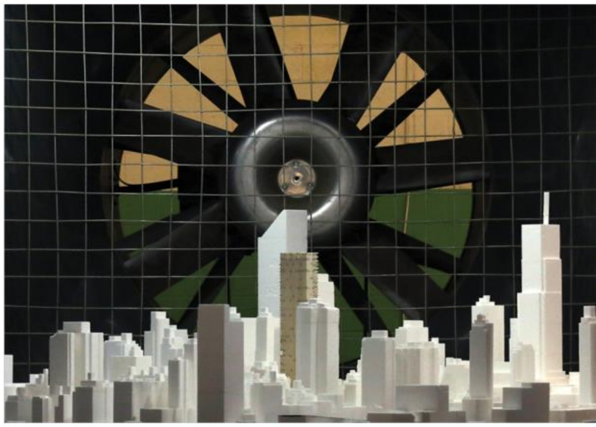
PROJECT	3085 HURONTARIO STREET, MISSISSUAGA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:800 (APPROX.)
DRAWING NO.	GWE21-021-PLW-3B
DATE	JULY 6, 2021
DRAWN BY	K.A.
DESCRIPTION	FIGURE 3B: WINTER OUTDOOR AMENITY AREAS PEDESTRIAN COMFORT PREDICTIONS







APPENDIX A

PEDESTRIAN COMFORT SUITABILITY, TABLES A1-A4
(FUTURE CONDITIONS)

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE A1: SUMMARY OF PEDESTRIAN COMFORT (FUTURE CONDITIONS)

Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	11.5	Standing	14.9	Standing	58.7	Safe
2	14.0	Standing	17.8	Walking	63.9	Safe
3	11.4	Standing	14.2	Standing	63.0	Safe
4	7.8	Sitting	9.8	Sitting	38.7	Safe
5	7.4	Sitting	9.5	Sitting	43.7	Safe
6	9.0	Sitting	11.6	Standing	54.1	Safe
7	7.8	Sitting	10.0	Standing	50.8	Safe
8	8.2	Sitting	10.1	Standing	50.5	Safe
9	10.5	Standing	13.1	Standing	53.1	Safe
10	10.2	Standing	11.8	Standing	48.4	Safe
11	12.0	Standing	15.6	Walking	61.1	Safe
12	13.2	Standing	15.9	Walking	58.0	Safe
13	10.3	Standing	13.5	Standing	50.3	Safe
14	10.4	Standing	12.7	Standing	49.3	Safe
15	9.0	Sitting	12.7	Standing	55.5	Safe
16	10.3	Standing	12.7	Standing	50.9	Safe
17	8.9	Sitting	12.0	Standing	50.2	Safe
18	10.5	Standing	13.9	Standing	55.7	Safe
19	10.0	Sitting	13.0	Standing	50.5	Safe
20	10.2	Standing	14.0	Standing	60.5	Safe
21	9.5	Sitting	11.7	Standing	49.5	Safe
22	9.4	Sitting	11.1	Standing	42.9	Safe
23	9.9	Sitting	12.0	Standing	46.0	Safe
24	11.7	Standing	14.4	Standing	49.3	Safe
25	6.8	Sitting	8.7	Sitting	37.7	Safe
26	9.7	Sitting	11.8	Standing	45.5	Safe
27	10.5	Standing	13.4	Standing	48.1	Safe
28	10.0	Sitting	12.0	Standing	47.8	Safe
29	11.7	Standing	15.2	Walking	59.2	Safe
30	9.5	Sitting	12.6	Standing	51.1	Safe
31	13.4	Standing	16.6	Walking	65.5	Safe
32	11.5	Standing	14.5	Standing	61.2	Safe
33	12.9	Standing	16.2	Walking	60.5	Safe
34	14.5	Standing	18.7	Walking	71.6	Safe
35	7.5	Sitting	9.5	Sitting	37.4	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE A2: SUMMARY OF PEDESTRIAN COMFORT (FUTURE CONDITONS)

Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	11.0	Standing	14.7	Standing	53.4	Safe
37	8.3	Sitting	10.9	Standing	46.1	Safe
38	10.1	Standing	14.7	Standing	62.6	Safe
39	12.6	Standing	18.5	Walking	73.5	Safe
40	9.0	Sitting	13.2	Standing	58.7	Safe
41	9.5	Sitting	13.2	Standing	52.2	Safe
42	8.2	Sitting	11.5	Standing	50.3	Safe
43	8.7	Sitting	11.0	Standing	43.8	Safe
44	7.8	Sitting	9.3	Sitting	40.2	Safe
45	11.9	Standing	14.1	Standing	52.7	Safe
46	14.6	Standing	17.3	Walking	62.8	Safe
47	11.5	Standing	13.8	Standing	48.3	Safe
48	11.1	Standing	13.5	Standing	46.4	Safe
49	11.3	Standing	13.7	Standing	48.6	Safe
50	10.8	Standing	13.7	Standing	47.5	Safe
51	10.6	Standing	12.5	Standing	50.3	Safe
52	10.1	Standing	12.1	Standing	47.8	Safe
53	8.8	Sitting	10.4	Standing	41.5	Safe
54	8.7	Sitting	10.6	Standing	48.6	Safe
55	10.1	Standing	12.2	Standing	49.2	Safe
56	8.9	Sitting	10.5	Standing	41.4	Safe
57	12.9	Standing	15.3	Walking	56.7	Safe
58	9.9	Sitting	12.7	Standing	55.0	Safe
59	8.4	Sitting	10.7	Standing	45.7	Safe
60	7.8	Sitting	9.7	Sitting	42.5	Safe
61	8.9	Sitting	11.3	Standing	52.8	Safe
62	14.7	Standing	19.3	Walking	75.1	Safe
63	13.7	Standing	15.7	Walking	55.0	Safe
64	13.2	Standing	15.3	Walking	58.8	Safe
65	10.5	Standing	13.6	Standing	52.2	Safe
66	12.1	Standing	17.0	Walking	62.7	Safe
67	13.2	Standing	19.3	Walking	77.9	Safe
68	11.1	Standing	14.3	Standing	52.9	Safe
69	11.8	Standing	14.8	Standing	67.6	Safe
70	13.6	Standing	18.5	Walking	69.5	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

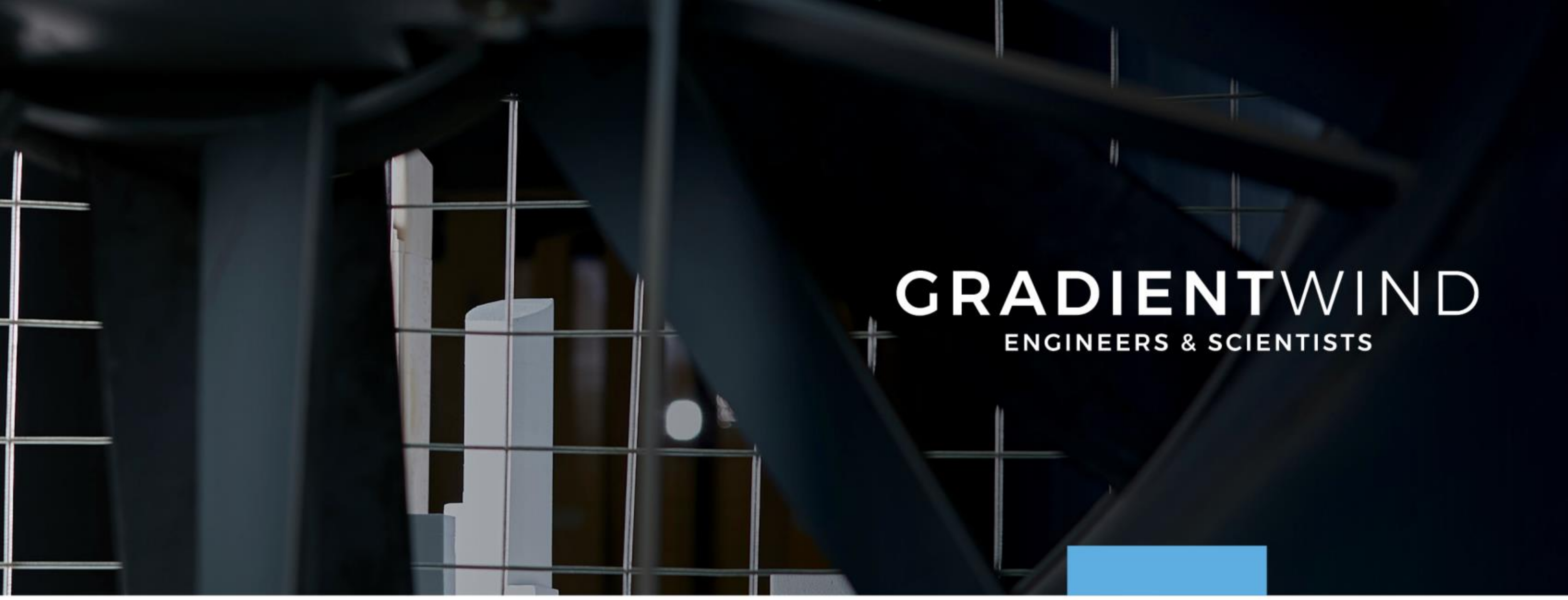
TABLE A3: SUMMARY OF PEDESTRIAN COMFORT (FUTURE CONDITONS)

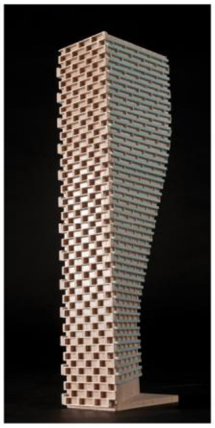
Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
71	9.2	Sitting	12.8	Standing	53.7	Safe
72	6.0	Sitting	7.7	Sitting	32.4	Safe
73	7.7	Sitting	9.4	Sitting	36.4	Safe
74	7.0	Sitting	8.5	Sitting	36.5	Safe
75	8.0	Sitting	9.6	Sitting	47.8	Safe
76	6.5	Sitting	8.4	Sitting	39.7	Safe
77	9.9	Sitting	13.6	Standing	61.2	Safe
78	15.1	Walking	20.2	Uncomfortable	61.5	Safe
79	9.2	Sitting	12.0	Standing	52.0	Safe
80	8.9	Sitting	11.9	Standing	48.9	Safe
81	8.1	Sitting	10.6	Standing	49.1	Safe
82	7.9	Sitting	9.8	Sitting	50.0	Safe
83	7.7	Sitting	9.8	Sitting	43.3	Safe
84	8.0	Sitting	9.8	Sitting	48.9	Safe
85	8.5	Sitting	10.2	Standing	41.9	Safe
86	9.9	Sitting	11.7	Standing	43.1	Safe
87	10.2	Standing	12.7	Standing	51.6	Safe
88	12.1	Standing	14.5	Standing	61.5	Safe
89	7.5	Sitting	9.4	Sitting	39.0	Safe
90	12.0	Standing	14.8	Standing	60.0	Safe
91	13.4	Standing	16.9	Walking	69.8	Safe
92	8.8	Sitting	11.0	Standing	47.2	Safe
93	9.0	Sitting	10.8	Standing	44.1	Safe
94	7.0	Sitting	8.6	Sitting	34.3	Safe
95	11.3	Standing	13.9	Standing	59.9	Safe
96	8.0	Sitting	10.4	Standing	61.3	Safe
97	14.2	Standing	17.4	Walking	61.0	Safe
98	11.7	Standing	15.5	Walking	63.6	Safe
99	12.3	Standing	15.1	Walking	58.4	Safe
100	17.3	Walking	21.5	Uncomfortable	67.6	Safe
101	13.8	Standing	17.1	Walking	63.2	Safe
102	17.6	Walking	21.4	Uncomfortable	66.8	Safe
103	13.2	Standing	16.4	Walking	56.5	Safe
104	15.7	Walking	20.9	Uncomfortable	66.0	Safe
105	12.0	Standing	15.3	Walking	57.0	Safe

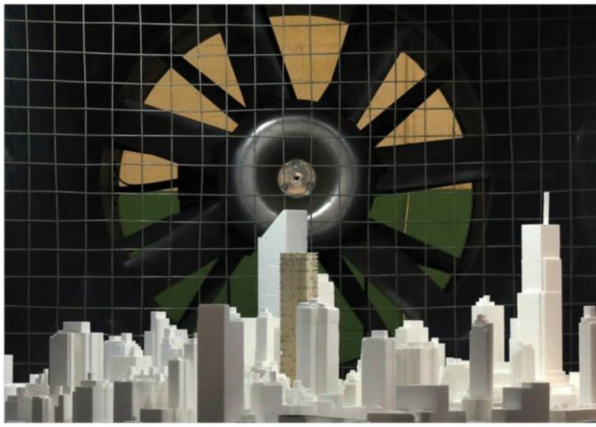
Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE A4: SUMMARY OF PEDESTRIAN COMFORT (FUTURE CONDITIONS)

Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
106	6.9	Sitting	8.3	Sitting	46.7	Safe
107	7.7	Sitting	9.8	Sitting	41.7	Safe
108	6.8	Sitting	8.8	Sitting	34.8	Safe
109	7.5	Sitting	9.6	Sitting	36.6	Safe
110	9.5	Sitting	12.6	Standing	47.2	Safe
111	7.6	Sitting	10.1	Standing	47.1	Safe
112	8.6	Sitting	11.2	Standing	45.7	Safe
113	8.2	Sitting	10.8	Standing	59.8	Safe
114	7.7	Sitting	9.8	Sitting	47.4	Safe
115	11.2	Standing	13.6	Standing	76.4	Safe
116	11.2	Standing	14.5	Standing	56.5	Safe
117	10.4	Standing	14.3	Standing	71.1	Safe
118	8.3	Sitting	9.5	Sitting	54.7	Safe
119	6.8	Sitting	8.4	Sitting	36.2	Safe
120	10.6	Standing	14.1	Standing	59.2	Safe
121	11.6	Standing	15.8	Walking	64.2	Safe
122	10.7	Standing	14.7	Standing	59.6	Safe
123	12.3	Standing	18.0	Walking	81.7	Safe
124	13.5	Standing	18.8	Walking	81.8	Safe
125	12.7	Standing	17.5	Walking	67.6	Safe
126	9.9	Sitting	13.6	Standing	52.7	Safe







APPENDIX B

PEDESTRIAN COMFORT SUITABILITY, TABLES B1-B5
(EXISTING VS FUTURE CONDITIONS)

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Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B1: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
1	Existing	9.5	Sitting	-	12.3	Standing	-
	Future	11.5	Standing	Reduced	14.9	Standing	Unchanged
2	Existing	5.8	Sitting	-	7.4	Sitting	-
	Future	14.0	Standing	Reduced	17.8	Walking	Reduced
3	Existing	6.6	Sitting	-	8.3	Sitting	-
	Future	11.4	Standing	Reduced	14.2	Standing	Reduced
4	Existing	9.3	Sitting	-	11.9	Standing	-
	Future	7.8	Sitting	Unchanged	9.8	Sitting	Improved
5	Existing	7.2	Sitting	-	8.6	Sitting	
	Future	7.4	Sitting	Unchanged	9.5	Sitting	
6	Existing	5.7	Sitting	-	7.1	Sitting	-
	Future	9.0	Sitting	Unchanged	11.6	Standing	Reduced
7	Existing	5.5	Sitting	-	7.0	Sitting	-
	Future	7.8	Sitting	Unchanged	10.0	Standing	Reduced
8	Existing	5.3	Sitting	-	6.9	Sitting	-
	Future	8.2	Sitting	Unchanged	10.1	Standing	Reduced
9	Existing	9.4	Sitting	-	12.1	Standing	
	Future	10.5	Standing	Reduced	13.1	Standing	
10	Existing	7.1	Sitting	-	9.3	Sitting	-
	Future	10.2	Standing	Reduced	11.8	Standing	Reduced
11	Existing	9.0	Sitting	-	11.3	Standing	-
	Future	12.0	Standing	Reduced	15.6	Walking	Reduced
12	Existing	9.9	Sitting	-	12.6	Standing	-
	Future	13.2	Standing	Reduced	15.9	Walking	Reduced
13	Existing	8.7	Sitting	-	11.5	Standing	-
	Future	10.3	Standing	Reduced	13.5	Standing	Unchanged
14	Existing	9.1	Sitting	-	11.5	Standing	-
	Future	10.4	Standing	Reduced	12.7	Standing	Unchanged
15	Existing	6.7	Sitting	-	8.2	Sitting	-
	Future	9.0	Sitting	Unchanged	12.7	Standing	Reduced

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B2: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
16	Existing	9.4	Sitting	-	12.0	Standing	-
	Future	10.3	Standing	Reduced	12.7	Standing	Unchanged
17	Existing	9.7	Sitting	-	12.1	Standing	-
	Future	8.9	Sitting	Unchanged	12.0	Standing	Unchanged
18	Existing	11.6	Standing	-	14.6	Standing	-
	Future	10.5	Standing	Unchanged	13.9	Standing	Unchanged
19	Existing	9.8	Sitting	-	12.2	Standing	-
	Future	10.0	Sitting	Unchanged	13.0	Standing	Unchanged
20	Existing	8.7	Sitting	-	11.3	Standing	-
	Future	10.2	Standing	Reduced	14.0	Standing	Unchanged
21	Existing	10.9	Standing	-	13.9	Standing	-
	Future	9.5	Sitting	Improved	11.7	Standing	Unchanged
22	Existing	9.7	Sitting	-	12.0	Standing	-
	Future	9.4	Sitting	Unchanged	11.1	Standing	Unchanged
23	Existing	10.4	Standing	-	12.9	Standing	-
	Future	9.9	Sitting	Improved	12.0	Standing	Unchanged
24	Existing	11.7	Standing	-	15.0	Standing	-
	Future	11.7	Standing	Unchanged	14.4	Standing	Unchanged
25	Existing	7.7	Sitting	-	10.2	Standing	-
	Future	6.8	Sitting	Unchanged	8.7	Sitting	Improved
26	Existing	9.9	Sitting	-	12.3	Standing	-
	Future	9.7	Sitting	Unchanged	11.8	Standing	Unchanged
27	Existing	11.6	Standing	-	15.1	Walking	-
	Future	10.5	Standing	Unchanged	13.4	Standing	Improved
28	Existing	10.0	Sitting	-	12.4	Standing	-
	Future	10.0	Sitting	Unchanged	12.0	Standing	Unchanged
29	Existing	12.6	Standing	-	16.5	Walking	-
	Future	11.7	Standing	Unchanged	15.2	Walking	Unchanged
30	Existing	11.2	Standing	-	16.0	Walking	-
	Future	9.5	Sitting	Improved	12.6	Standing	Improved

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B3: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
31	Existing	12.5	Standing	-	14.9	Standing	-
	Future	13.4	Standing	Unchanged	16.6	Walking	Reduced
32	Existing	12.3	Standing	-	15.8	Walking	-
	Future	11.5	Standing	Unchanged	14.5	Standing	Improved
33	Existing	8.6	Sitting	-	10.9	Standing	-
	Future	12.9	Standing	Reduced	16.2	Walking	Reduced
34	Existing	10.1	Standing	-	12.7	Standing	-
	Future	14.5	Standing	Unchanged	18.7	Walking	Reduced
35	Existing	8.9	Sitting	-	11.5	Standing	-
	Future	7.5	Sitting	Unchanged	9.5	Sitting	Improved
36	Existing	8.3	Sitting	-	11.2	Standing	-
	Future	11.0	Standing	Reduced	14.7	Standing	Unchanged
37	Existing	7.8	Sitting	-	10.2	Standing	-
	Future	8.3	Sitting	Unchanged	10.9	Standing	Unchanged
38	Existing	8.7	Sitting	-	11.3	Standing	-
	Future	10.1	Standing	Reduced	14.7	Standing	Unchanged
39	Existing	9.3	Sitting	-	12.3	Standing	-
	Future	12.6	Standing	Reduced	18.5	Walking	Reduced
40	Existing	8.6	Sitting	-	11.0	Standing	-
	Future	9.0	Sitting	Unchanged	13.2	Standing	Unchanged
41	Existing	9.7	Sitting	-	12.2	Standing	-
	Future	9.5	Sitting	Unchanged	13.2	Standing	Unchanged
42	Existing	7.1	Sitting	-	9.2	Sitting	-
	Future	8.2	Sitting	Unchanged	11.5	Standing	Reduced
43	Existing	7.6	Sitting	-	9.7	Sitting	-
	Future	8.7	Sitting	Unchanged	11.0	Standing	Reduced
44	Existing	8.4	Sitting	-	10.3	Standing	-
	Future	7.8	Sitting	Unchanged	9.3	Sitting	Improved
45	Existing	12.2	Standing	-	14.5	Standing	-
	Future	11.9	Standing	Unchanged	14.1	Standing	Unchanged

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B4: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
46	Existing	10.8	Standing	-	13.0	Standing	-
	Future	14.6	Standing	Unchanged	17.3	Walking	Reduced
47	Existing	11.2	Standing	-	14.2	Standing	-
	Future	11.5	Standing	Unchanged	13.8	Standing	Unchanged
48	Existing	12.2	Standing	-	16.0	Walking	-
	Future	11.1	Standing	Unchanged	13.5	Standing	Improved
49	Existing	12.1	Standing	-	15.4	Walking	-
	Future	11.3	Standing	Unchanged	13.7	Standing	Improved
50	Existing	12.1	Standing	-	15.9	Walking	-
	Future	10.8	Standing	Unchanged	13.7	Standing	Improved
51	Existing	10.3	Standing	-	12.7	Standing	-
	Future	10.6	Standing	Unchanged	12.5	Standing	Unchanged
52	Existing	11.1	Standing	-	14.6	Standing	-
	Future	10.1	Standing	Unchanged	12.1	Standing	Unchanged
53	Existing	10.3	Standing	-	13.8	Standing	-
	Future	8.8	Sitting	Improved	10.4	Standing	Unchanged
54	Existing	8.9	Sitting	-	11.6	Standing	-
	Future	8.7	Sitting	Unchanged	10.6	Standing	Unchanged
55	Existing	10.7	Standing	-	13.6	Standing	-
	Future	10.1	Standing	Unchanged	12.2	Standing	Unchanged
56	Existing	9.2	Sitting	-	12.3	Standing	-
	Future	8.9	Sitting	Unchanged	10.5	Standing	Unchanged
57	Existing	10.2	Standing	-	13.3	Standing	-
	Future	12.9	Standing	Unchanged	15.3	Walking	Reduced
58	Existing	9.3	Sitting	-	11.8	Standing	-
	Future	9.9	Sitting	Unchanged	12.7	Standing	Unchanged
59	Existing	9.8	Sitting	-	12.3	Standing	-
	Future	8.4	Sitting	Unchanged	10.7	Standing	Unchanged
60	Existing	8.4	Sitting	-	10.6	Standing	-
	Future	7.8	Sitting	Unchanged	9.7	Sitting	Improved

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B5: COMPARATIVE SUMMARY OF PEDESTRIAN COMFORT

Sensor	Massing Scenario	Summer Pedestrian Comfort			Winter Pedestrian Comfort		
		Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing	Wind Speed (km/h) 80% data ≤	Predicted Comfort Class	Future Comfort Class Compared to Existing
61	Existing	8.4	Sitting	-	10.7	Standing	-
	Future	8.9	Sitting	Unchanged	11.3	Standing	Unchanged
62	Existing	6.3	Sitting	-	8.0	Sitting	-
	Future	14.7	Standing	Reduced	19.3	Walking	Reduced
63	Existing	6.8	Sitting	-	8.6	Sitting	-
	Future	13.7	Standing	Reduced	15.7	Walking	Reduced
64	Existing	9.8	Sitting	-	13.3	Standing	-
	Future	13.2	Standing	Reduced	15.3	Walking	Reduced

APPENDIX C

WIND TUNNEL SIMULATION OF THE NATURAL WIND

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WIND TUNNEL SIMULATION OF THE NATURAL WIND

Wind flowing over the surface of the earth develops a boundary layer due to the drag produced by surface features such as vegetation and man-made structures. Within this boundary layer, the mean wind speed varies from zero at the surface to the gradient wind speed at the top of the layer. The height of the top of the boundary layer is referred to as the gradient height, above which the velocity remains more-or-less constant for a given synoptic weather system. The mean wind speed is taken to be the average value over one hour. Superimposed on the mean wind speed are fluctuating (or turbulent) components in the longitudinal (i.e. along wind), vertical and lateral directions. Although turbulence varies according to the roughness of the surface, the turbulence level generally increases from nearly zero (smooth flow) at gradient height to maximum values near the ground. While for a calm ocean the maximum could be 20%, the maximum for a very rough surface such as the center of a city could be 100%, or equal to the local mean wind speed. The height of the boundary layer varies in time and over different terrain roughness within the range of 400 metres (m) to 600 m.

Simulating real wind behaviour in a wind tunnel requires simulating the variation of mean wind speed with height, simulating the turbulence intensity, and matching the typical length scales of turbulence. It is the ratio between wind tunnel turbulence length scales and turbulence scales in the atmosphere that determines the geometric scales that models can assume in a wind tunnel. Hence, when a 1:200 scale model is quoted, this implies that the turbulence scales in the wind tunnel and the atmosphere have the same ratios. Some flexibility in this requirement has been shown to produce reasonable wind tunnel predictions compared to full scale. In model scale the mean and turbulence characteristics of the wind are obtained with the use of spires at one end of the tunnel and roughness elements along the floor of the tunnel. The fan is located at the model end and wind is pulled over the spires, roughness elements and model. It has been found that, to a good approximation, the mean wind profile can be represented by a power law relation, shown below, giving height above ground versus wind speed.

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

Where; U = mean wind speed, U_g = gradient wind speed, Z = height above ground, Z_g = depth of the boundary layer (gradient height) and α is the power law exponent.

Figure B1 on the following page plots three velocity profiles for open country, and suburban and urban exposures.

The exponent α varies according to the type of upwind terrain; α ranges from 0.14 for open country to 0.33 for an urban exposure. Figure C2 illustrates the theoretical variation of turbulence for open country, suburban and urban exposures.

The integral length scale of turbulence can be thought of as an average size of gust in the atmosphere. Although it varies with height and ground roughness, it has been found to generally be in the range of 100 m to 200 m in the upper half of the boundary layer. Thus, for a 1:300 scale, the model value should be between 1/3 and 2/3 of a metre. Integral length scales are derived from power spectra, which describe the energy content of wind as a function of frequency. There are several ways of determining integral length scales of turbulence. One way is by comparison of a measured power spectrum in model scale to a non-dimensional theoretical spectrum such as the Davenport spectrum of longitudinal turbulence. Using the Davenport spectrum, which agrees well with full-scale spectra, one can estimate the integral scale by plotting the theoretical spectrum with varying L until it matches as closely as possible the measured spectrum:

$$f \times S(f) = \frac{\dfrac{4(Lf)^2}{U_{10}^{\ 2}}}{\left[1 + \dfrac{4(Lf)^2}{U_{10}^{\ 2}}\right]^{\frac{4}{3}}}$$

Where, f is frequency, S(f) is the spectrum value at frequency f, U10 is the wind speed 10 m above ground level, and L is the characteristic length of turbulence.

Once the wind simulation is correct, the model, constructed to a suitable scale, is installed at the center of the working section of the wind tunnel. Different wind directions are represented by rotating the model to align with the wind tunnel center-line axis.

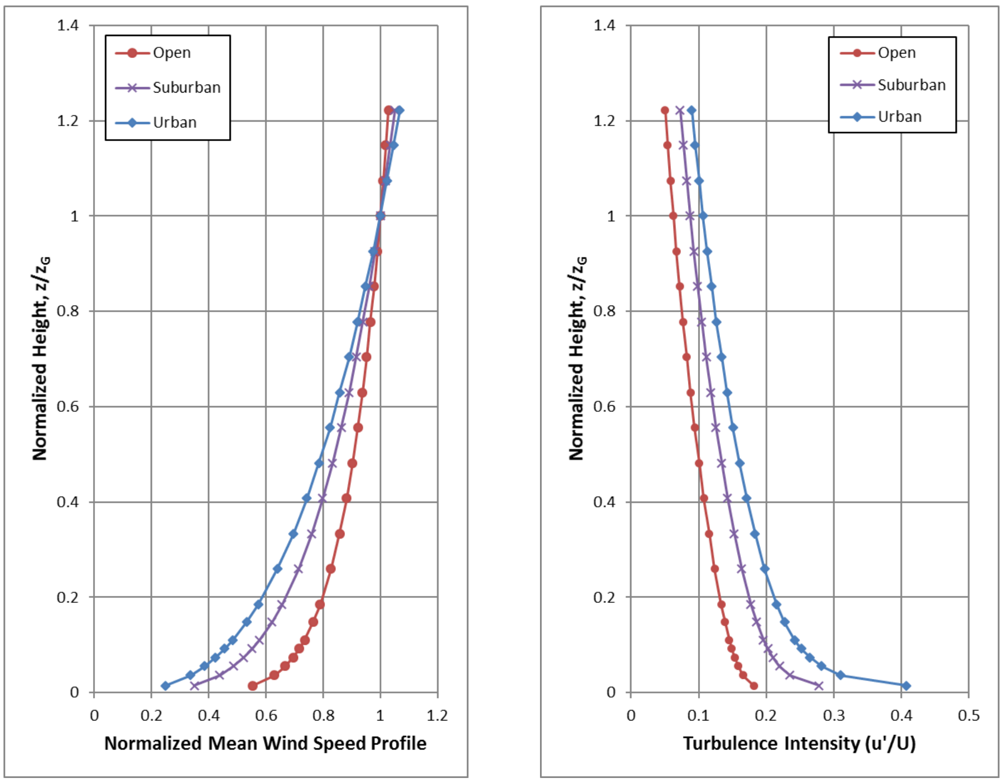

FIGURE C1 (LEFT): MEAN WIND SPEED PROFILES;
FIGURE C2 (RIGHT): TURBULENCE INTENSITY PROFILES

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APPENDIX D

PEDESTRIAN LEVEL WIND MEASUREMENT METHODOLOGY

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PEDESTRIAN LEVEL WIND MEASUREMENT METHODOLOGY

Pedestrian level wind studies are performed in a wind tunnel on a physical model of the study buildings at a suitable scale. Instantaneous wind speed measurements are recorded at a model height corresponding to 1.5 m full scale using either a hot wire anemometer or a pressure-based transducer. Measurements are performed at any number of locations on the model and usually for 36 wind directions. For each wind direction, the roughness of the upwind terrain is matched in the wind tunnel to generate the correct mean and turbulent wind profiles approaching the model.

The hot wire anemometer is an instrument consisting of a thin metallic wire conducting an electric current. It is an omni-directional device equally sensitive to wind approaching from any direction in the horizontal plane. By compensating for the cooling effect of wind flowing over the wire, the associated electronics produce an analog voltage signal that can be calibrated against velocity of the air stream. For all measurements, the wire is oriented vertically so as to be sensitive to wind approaching from all directions in a horizontal plane.

The pressure sensor is a small cylindrical device that measures instantaneous pressure differences over a small area. The sensor is connected via tubing to a transducer that translates the pressure to a voltage signal that is recorded by computer. With appropriately designed tubing, the sensor is sensitive to a suitable range of fluctuating velocities.

For a given wind direction and location on the model, a time history of the wind speed is recorded for a period of time equal to one hour in full-scale. The analog signal produced by the hot wire or pressure sensor is digitized at a rate of 400 samples per second. A sample recording for several seconds is illustrated in Figure D1. This data is analyzed to extract the mean, root-mean-square (rms) and the peak of the signal. The peak value, or gust wind speed, is formed by averaging a number of peaks obtained from sub-intervals of the sampling period. The mean and gust speeds are then normalized by the wind tunnel gradient wind speed, which is the speed at the top of the model boundary layer, to obtain mean and gust ratios. At each location, the measurements are repeated for 36 wind directions to produce normalized polar plots, which will be provided upon request.

In order to determine the duration of various wind speeds at full scale for a given measurement location the gust ratios are combined with a statistical (mathematical) model of the wind climate for the project site. This mathematical model is based on hourly wind data obtained from one or more meteorological stations (usually airports) close to the project location. The probability model used to represent the data is the Weibull distribution expressed as:

$$P\left(>U_g\right) = A_\theta \bullet \exp\left[\left(-\frac{U_g}{C\theta}\right)^{K\theta}\right]$$

Where,

P (> $\boldsymbol{U_g}$***)*** is the probability, fraction of time, that the gradient wind speed $\boldsymbol{U_g}$ is exceeded; $\boldsymbol{\theta}$ is the wind direction measured clockwise from true north, ***A***, ***C***, ***K*** are the Weibull coefficients, (Units: A - dimensionless, C - wind speed units [km/h] for instance, K - dimensionless). $\boldsymbol{A_\theta}$ is the fraction of time wind blows from a 10° sector centered on $\boldsymbol{\theta}$.

Analysis of the hourly wind data recorded for a length of time, on the order of 10 to 30 years, yields the $\boldsymbol{A_\theta}$, $\boldsymbol{C_\theta}$ and $\boldsymbol{K_\theta}$ values. The probability of exceeding a chosen wind speed level, say 20 km/h, at sensor *N* is given by the following expression:

$$P_N(>20) = \Sigma_\theta P\left[\frac{(>20)}{\left(\frac{U_N}{U_g}\right)}\right]$$

$$\boldsymbol{P_N\,(>20) \;=\; \Sigma_\theta P\,\{>20/(U_N/Ug)\}}$$

Where, $\boldsymbol{U_N/U_g}$ is the gust velocity ratios, where the summation is taken over all 36 wind directions at 10° intervals.

If there are significant seasonal variations in the weather data, as determined by inspection of the C_θ and K_θ values, then the analysis is performed separately for two or more times corresponding to the groupings of seasonal wind data. Wind speed levels of interest for predicting pedestrian comfort are based on the comfort guidelines chosen to represent various pedestrian activity levels as discussed in the main text.

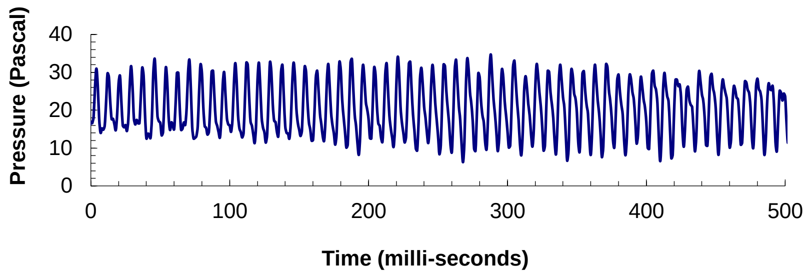

FIGURE D1: TIME VERSUS VELOCITY TRACE FOR A TYPICAL WIND SENSOR

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