Pedestrian Level Wind Study

West Village
70 Mississauga Road South & 181 Lakeshore Road West

Mississauga, Ontario

REPORT: GWE17-112-PLW

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EXECUTIVE SUMMARY

This report describes a comparative pedestrian level wind study undertaken to assess wind comfort for the proposed mixed-use, multi-building development located at 70 Mississauga Road South and 181 Lakeshore Road West in Mississauga, Ontario, also referred to as West Village. The study involves wind tunnel measurements of pedestrian wind speeds using a physical scale model, combined with meteorological data integration, to assess pedestrian comfort and safety at key areas within and surrounding the development site. Two configurations were assessed and compared: the existing conditions, and conditions following construction of the proposed development. The results and recommendations derived from these considerations are summarized in the following paragraphs and detailed in the subsequent report.

The study is based on City of Mississauga guidelines for wind studies, industry standard wind tunnel testing and data analysis procedures, an updated 3D model provided by Giannone Petricone Associates Inc. Architects in October 2018, surrounding street layouts, existing and approved future building massing information, and recent site imagery.

A complete summary of the predicted wind conditions is provided in Sections 5.1 through 5.3 of this report and illustrated in Figures 1A through 2B. Based on the wind tunnel test results, meteorological data analysis and experience with similar developments in Mississauga, we conclude that the large majority of grade-level pedestrian-sensitive locations will be suitable for the intended uses throughout the year. During the summer, possible exceptions include windier corner areas adjacent to buildings C, P, T and U, if building entrances are desired at these locations. During the winter, exceptions include sidewalks and building access points at these same corner locations, which are intended to be suitable for walking or better. Generic mitigation in the form of wind barriers, canopies, recessed doorway locations, or a combination thereof, are described in Section 5.2.

A comparison of existing versus future conditions indicates that wind conditions over the study site will largely be improved or unchanged in a few areas following construction of the proposed development.

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 conditions that could be considered unsafe.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (GWE) was retained by Port Credit West Village Partners to undertake a comparative pedestrian level wind study for the proposed mixed-use development located at 70 Mississauga Road South and 181 Lakeshore Road West in Mississauga, Ontario. Our mandate within this study, as outlined in GWE proposal #17-177P R1, dated July 3, 2018, is to investigate pedestrian wind comfort within and surrounding the development site, and to identify any areas where wind conditions may interfere with pedestrian activities so that mitigation measures may be considered, where necessary.

Our work is based on industry standard wind tunnel testing techniques, an updated 3D model provided by Giannone Petricone Associates Inc. Architects in October 2018, surrounding street layouts, existing and approved future building massing information obtained from the City of Mississauga, and recent site imagery.

2. TERMS OF REFERENCE

The focus of this comparative pedestrian wind study is the proposed mixed-use, multi-building development located at 70 Mississauga Road South and 181 Lakeshore Road West, also referred to as West Village. The study site is located on a nearly square parcel of land bounded by Lakeshore Road West to the northwest, Mississauga Road to the northeast, a row of existing, low-rise residential buildings to the southwest and a waterfront trail followed by Lake Ontario to the southeast.

The development site, organized into Blocks A through U, comprises a variety of buildings ranging from three-storey townhouses to tall buildings rising to 29 storeys above grade. The buildings are anticipated to contain residential units, retail and/or commercial units or a combination of the two, as well as live-work units and campus facilities. The taller buildings are concentrated along the southeast perimeter of the site adjacent to the waterfront, as well as along the centre of the site running east to west. The site also contains four designated parks (similarly located to the southeast and centrally) and various pedestrian walkways.

The near-field surroundings (within 200 metres of the study site) comprise Lake Ontario to the southeast and predominantly low-rise, suburban residential buildings in remaining directions, with several low-rise commercial buildings and one high-rise apartment building along Lakeshore Road West. At greater distances (within 2 kilometres of the study site), the surroundings are dominated by low-rise suburban

buildings and green space from the southwest clockwise to north, a mixture of low, medium and high buildings followed by low-rises to the northeast, and Lake Ontario to the southeast. The Queen Elizabeth Way and Mississauga Golf and Country Club are located approximately 2 kilometres to the west, and Credit River is located approximately 380 metres to the north.

Grade-level pedestrian areas considered in this study include surrounding sidewalks, pedestrian walkways, public parks, parking lots, transit stops and building access points. The results and recommendations derived from these considerations are summarized in the following paragraphs and detailed in the subsequent report. Figure 1 illustrates the study site and surrounding context, while 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; and (iii) recommend suitable mitigation measures, where required; (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, 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

[1] Toronto Development Guide, Pedestrian Level Wind Study Terms of Reference, November 2010

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 180 grade-level sensor locations on the scale model in GWE's wind tunnel. For testing of the existing conditions, a subset of the first 45 sensors was used. Wind speed measurements were performed for each of the sensors for 36 wind directions at 10° intervals. Figure 1 illustrates a plan of the site and relevant surrounding context, while sensor locations used to investigate wind conditions are illustrated in Figures 1A through 2B, and in reference images provided throughout the report.

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 A and B provide greater detail of the theory behind wind speed measurements. Wind tunnel measurements for this project, conducted in GWE'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.

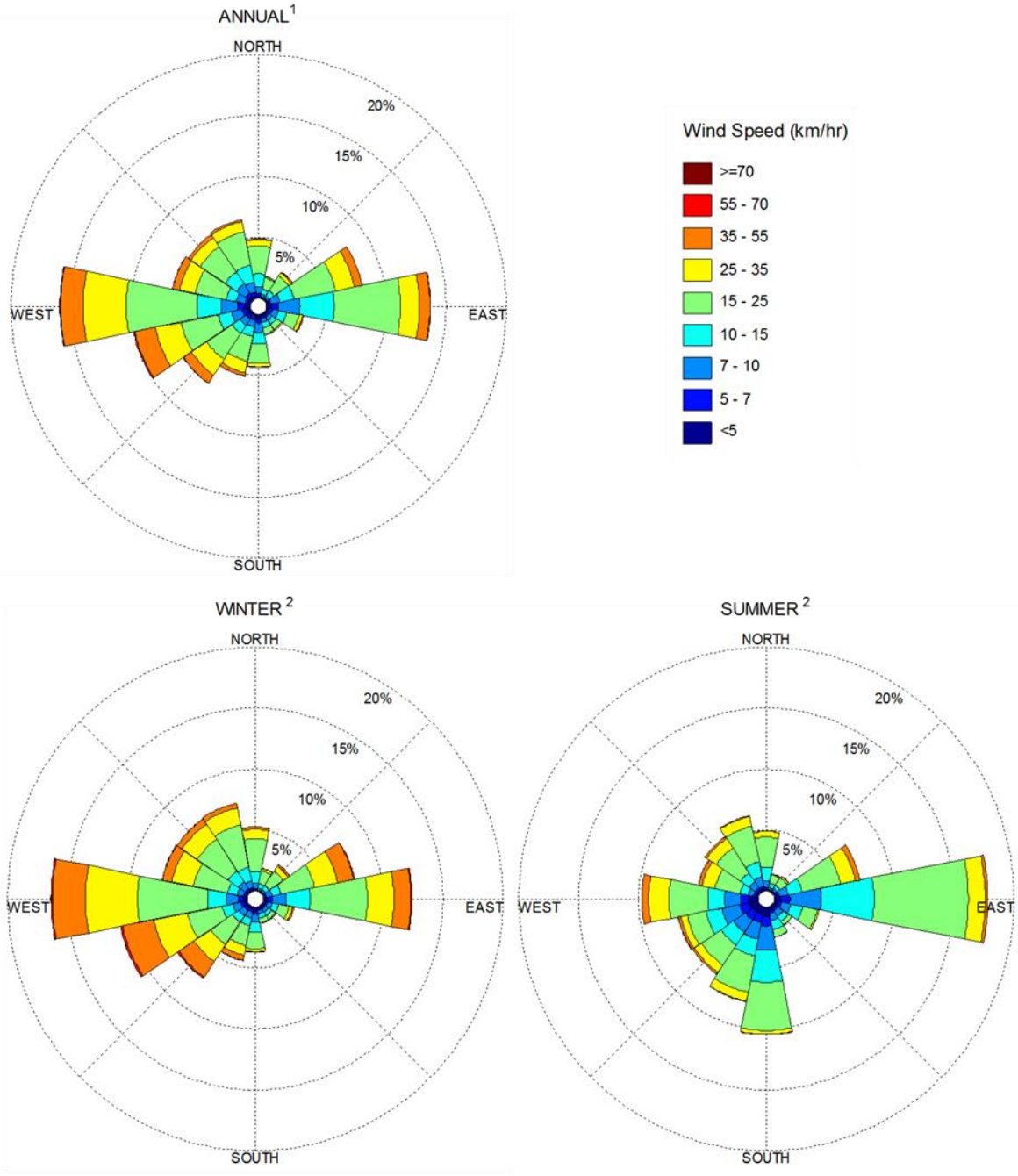
4.3 Meteorological Data Analysis

A statistical model for winds in Mississauga was developed from approximately 35-years of hourly meteorological wind data recorded at Toronto Island Billy Bishop Airport, and obtained from the local branch of Atmospheric Environment Services of Environment Canada. Wind speed and direction data were analyzed during the appropriate hours of pedestrian usage (i.e., between 06:00 and 23:00) and divided into two distinct seasons, as stipulated in the noted City of Mississauga Urban Design Terms of Reference[2]. More specifically, the summer season is defined as May through October, while the winter season is defined as November through April, inclusive.

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 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 preferred wind speeds and directions can be identified by the longer length of the bars. For Mississauga (south of the Queen Elizabeth Way, or QEW), the most common winds concerning pedestrian comfort during the winter season occur for westerly wind directions, followed by those from the east. The most common winds during the summer season occur for easterly wind directions. The directional preference and relative magnitude of the wind speed varies somewhat from season to season. Also, by convection in microclimate studies, wind direction refers to the wind origin (e.g., a north wind blows from north to south).

[2] City of Mississauga, *Urban Design Terms of Reference: Pedestrian Wind Comfort and Safety Studies*. 2014.

SEASONAL DISTRIBUTION OF WINDS FOR VARIOUS PROBABILITIES
TORONTO ISLAND BILLY BISHOP AIRPORT, TORONTO (1971-2006)



Notes:

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

4.4 Pedestrian Comfort Guidelines

Pedestrian comfort criteria are based on mechanical wind effects without consideration of other meteorological conditions (i.e., temperature and relative humidity). The criteria provide an assessment of comfort, assuming 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.

Five pedestrian comfort classes and corresponding gust wind speed ranges are used to assess pedestrian comfort, which include: (i) Sitting; (ii) Standing; (iii) Walking; (iv) Uncomfortable; and (v) Dangerous. More specifically, the comfort classes, associated wind speed ranges, and limiting criteria are summarized as follows:

(i) **Sitting** – GEM wind speeds below 10 km/h (i.e., 0-10 km/h) that occur 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., 0-15 km/h) that occur 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., 0-20 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.

(v) **Dangerous** – 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 an average elderly person in good health 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 80% 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 Access Point	Standing
Secondary Building Access Point	Walking
Public Sidewalks / Pedestrian Walkways	Walking
Transit Stops	Standing
Outdoor Amenity Spaces	Sitting / Standing
Cafés / Patios / Benches / Gardens	Sitting / Standing
Public Parks	Sitting / Walking
Garage / Service Entrances	Walking
Vehicular Drop-Off Areas	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

Tables 1 through 30, beginning on the following page, provide a summary of seasonal comfort predictions for each sensor location under the future massing scenario. The tables indicate the predicted percentages of time that wind speeds will fall into the ranges defined in the guidelines. A higher numerical value equates to a greater percentage of time that wind speeds will be lower, and therefore more comfortable. Pedestrian comfort is determined by the percentage of time that wind speeds will fall within the stated ranges.

The predicted values within each table are accompanied by a suitability assessment that includes the predicted comfort class (i.e. sitting, standing, walking, etc.), the location type, the desired comfort class, and a suitability descriptor. The predicted comfort class is defined by the predicted wind speed range percentages, while the location type and the desired comfort class relate to the sensor placement on the wind tunnel model. The suitability descriptor is assigned based on the relationship between the predicted comfort class (for each seasonal period) and the desired comfort class.

Following Tables 1 through 30, the most significant findings of the PLW are summarized. To assist with understanding and interpretation, predicted conditions for the proposed development are also illustrated in colour-coded format in Figures 2A through 5B. Conditions suitable for sitting are represented by the colour green, standing by yellow, and walking by blue. Measured mean and gust velocity ratios, which constitutes the raw data upon which the results are based, will be made available upon request.

An inset figure of the sensor locations accompanies each table for ease of review. Sensor locations coloured in pink represent Sensors 1-45, which were used for testing of both existing and future conditions. Sensor locations coloured in orange (Sensors 46-180) represent locations tested for the future conditions only.

TABLE 1: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #1	**Summer**	87	97	99	Sitting	Green Space	Walking	Acceptable
	Winter	76	93	98	Standing			
Sensor #2	**Summer**	70	89	96	Standing	Green Space	Walking	Acceptable[1] (See S. 5.2)
	Winter	52	75	87	Walking			
Sensor #3	**Summer**	72	90	97	Standing	Green Space	Walking	Acceptable[1] (See S. 5.2)
	Winter	50	73	87	Walking			
Sensor #4	**Summer**	65	86	95	Standing	Walkway/ Plaza	Walking/ Sitting	Acceptable[1] (See S.5.2)
	Winter	45	69	83	Walking			
Sensor #5	**Summer**	67	85	94	Standing	Walkway/ Plaza	Walking/ Sitting	Acceptable[1] (See S.5.2)
	Winter	44	67	82	Walking			
Sensor #6	**Summer**	58	80	92	Standing	Park	Sitting/ Standing	Acceptable[1] (See S.5.2)
	Winter	38	62	80	Walking			

[1] Acceptable without seating

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

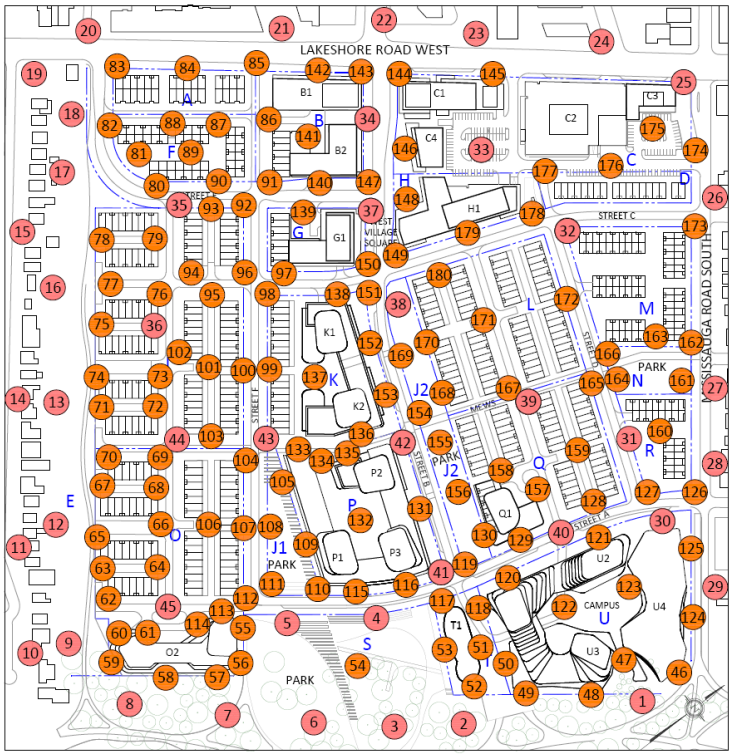


TABLE 2: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #7	**Summer**	76	91	96	Standing	Park	Sitting/ Standing	Acceptable[1] (See S.5.2)
	Winter	54	74	86	Walking			
Sensor #8	**Summer**	76	91	97	Standing	Green Space	Walking	Acceptable[1] (See S. 5.2)
	Winter	54	76	88	Walking			
Sensor #9	**Summer**	71	87	95	Standing	Green Space	Walking	Acceptable
	Winter	52	74	86	Walking			
Sensor #10	**Summer**	74	91	97	Standing	Green Space	Walking	Acceptable
	Winter	53	76	88	Walking			
Sensor #11	**Summer**	68	87	95	Standing	Public Sidewalk	Walking	Acceptable
	Winter	52	76	89	Walking			
Sensor #12	**Summer**	81	95	99	Sitting	Green Space	Walking	Acceptable
	Winter	66	87	96	Standing			

[1] Acceptable without seating

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

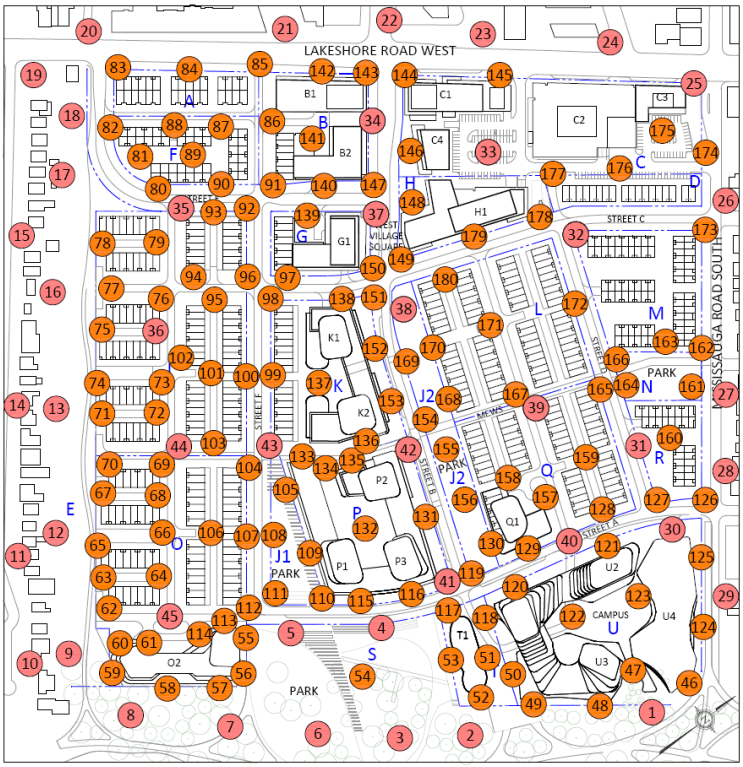


TABLE 3: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #13	**Summer**	74	91	97	Standing	Green Space	Walking	Acceptable
	Winter	59	81	92	Standing			
Sensor #14	**Summer**	88	96	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	74	91	97	Standing			
Sensor #15	**Summer**	88	96	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	70	87	94	Standing			
Sensor #16	**Summer**	69	88	96	Standing	Green Space	Walking	Acceptable
	Winter	55	78	91	Walking			
Sensor #17	**Summer**	76	92	97	Standing	Green Space	Walking	Acceptable
	Winter	64	83	93	Standing			
Sensor #18	**Summer**	89	98	100	Sitting	Green Space	Walking	Acceptable
	Winter	75	93	98	Standing			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

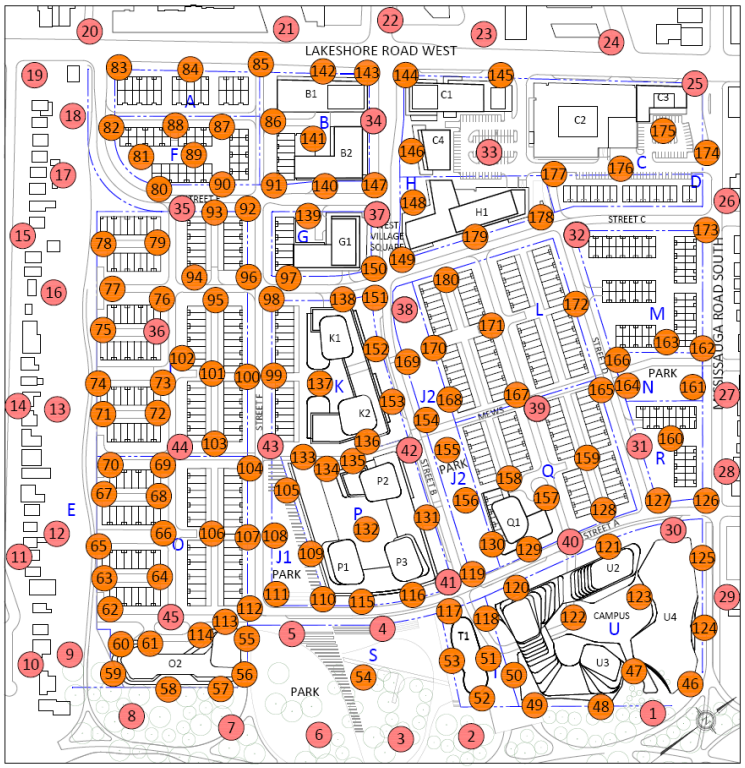


TABLE 4: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #19	**Summer**	73	91	97	Standing	Green Space	Walking	Acceptable
	Winter	54	78	91	Walking			
Sensor #20	**Summer**	78	93	98	Standing	Transit Stop	Standing	Acceptable
	Winter	58	80	92	Standing			
Sensor #21	**Summer**	86	95	98	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	76	90	96	Standing			
Sensor #22	**Summer**	81	94	98	Sitting	Transit Stop	Standing	Acceptable
	Winter	61	84	94	Standing			
Sensor #23	**Summer**	90	98	99	Sitting	Parking Lot	Walking	Acceptable
	Winter	75	93	98	Standing			
Sensor #24	**Summer**	86	96	98	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	68	88	96	Standing			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

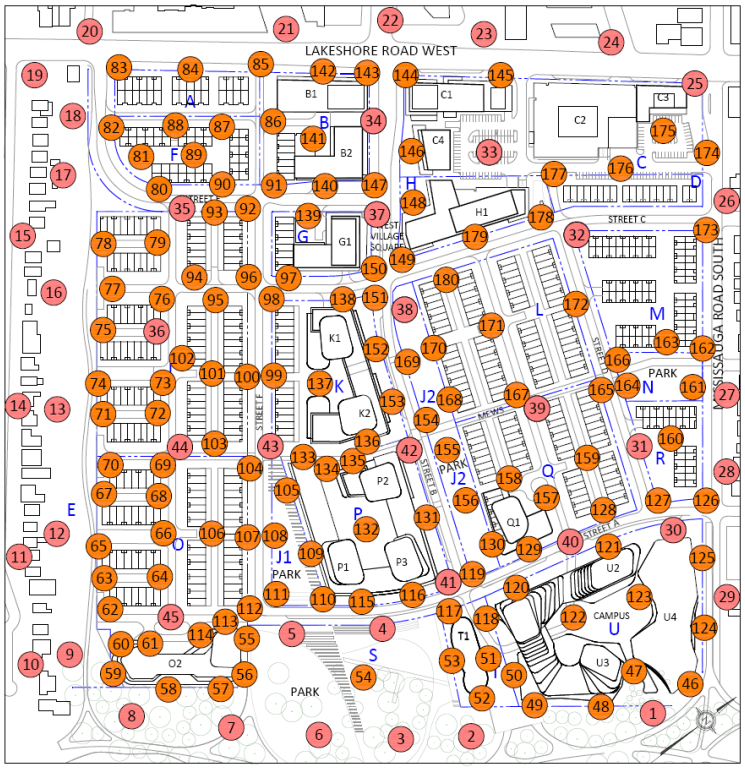


TABLE 5: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		**≤ 10**	**≤ 15**	**≤ 20**				
Guideline (% of Time)		**≥80%**	**≥80%**	**≥80%**				
Sensor #25	**Summer**	59	79	90	Walking	Transit Stop	Standing	Acceptable w/ Mitigation[2]
	Winter	42	62	77	Uncomfortable			
Sensor #26	**Summer**	78	92	97	Standing	Parking Lot	Walking	Acceptable
	Winter	58	77	88	Walking			
Sensor #27	**Summer**	84	96	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	68	88	96	Standing			
Sensor #28	**Summer**	78	92	97	Standing	Public Sidewalk	Walking	Acceptable
	Winter	59	80	91	Standing			
Sensor #29	**Summer**	89	96	99	Sitting	Green Space	Walking	Acceptable
	Winter	78	92	98	Standing			
Sensor #30	**Summer**	87	97	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	70	89	97	Standing			

[2] Acceptable with mitigation as described in Section 5.2.

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

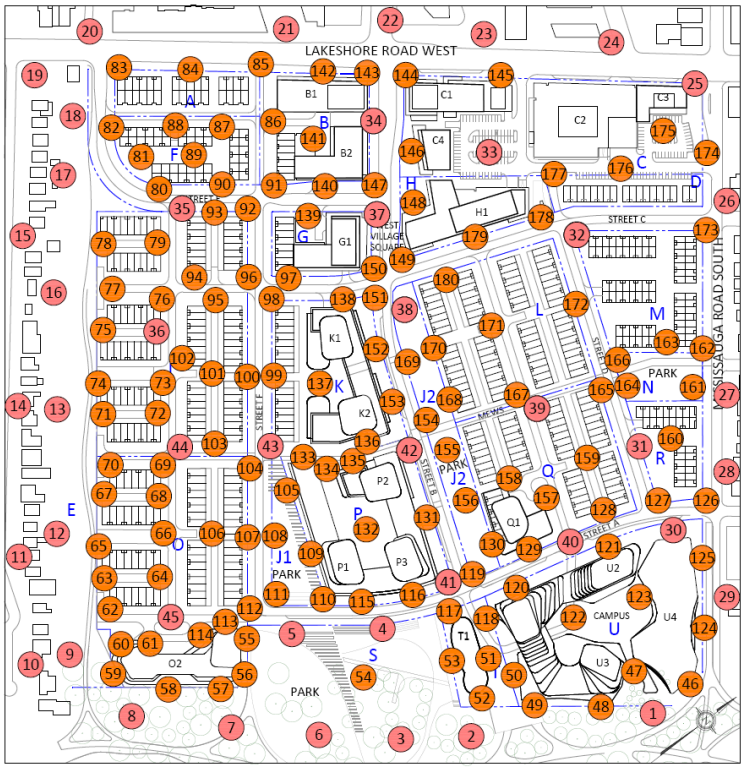


TABLE 6: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #31	**Summer**	85	96	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	67	86	95	Standing			
Sensor #32	**Summer**	88	96	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	70	88	95	Standing			
Sensor #33	**Summer**	85	95	99	Sitting	Parking Lot	Walking	Acceptable
	Winter	67	87	95	Standing			
Sensor #34	**Summer**	82	96	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	69	90	98	Standing			
Sensor #35	**Summer**	87	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	69	88	95	Standing			
Sensor #36	**Summer**	86	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	69	88	96	Standing			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

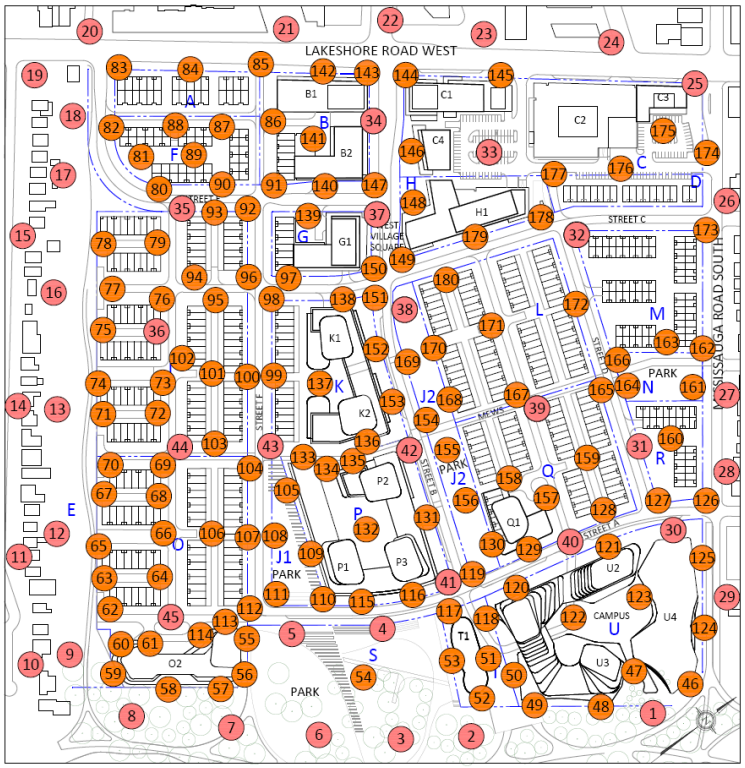


TABLE 7: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #37	**Summer**	73	90	97	Standing	Public Sidewalk	Walking	Acceptable
	Winter	54	77	90	Walking			
Sensor #38	**Summer**	76	91	97	Standing	Park	Sitting/ Walking	Acceptable[1] (See S. 5.2)
	Winter	56	78	89	Walking			
Sensor #39	**Summer**	96	99	100	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	85	96	99	Sitting			
Sensor #40	**Summer**	72	90	97	Standing	Public Sidewalk	Walking	Acceptable
	Winter	55	79	92	Walking			
Sensor #41	**Summer**	51	74	87	Walking	Public Sidewalk	Walking	Acceptable w/ Mitigation[2]
	Winter	35	58	76	Uncomfortable			
Sensor #42	**Summer**	84	96	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	71	91	97	Standing			

[1] Acceptable without seating; [2] Acceptable with mitigation as described in Section 5.2

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

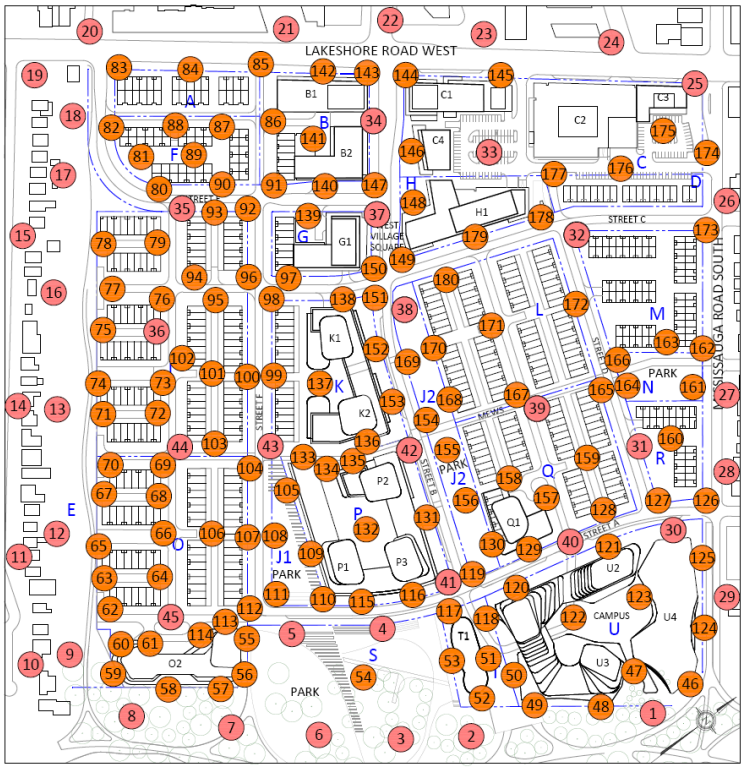


TABLE 8: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #43	**Summer**	74	91	98	Standing	Public Sidewalk	Walking	Acceptable
	Winter	59	82	93	Standing			
Sensor #44	**Summer**	84	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	71	91	98	Standing			
Sensor #45	**Summer**	81	95	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	67	88	96	Standing			
Sensor #46	**Summer**	74	88	95	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	64	83	92	Standing			
Sensor #47	**Summer**	84	96	99	Sitting	Walkway/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	78	93	98	Standing			
Sensor #48	**Summer**	80	94	98	Sitting	Potential Entrance	Walking/ Standing	Acceptable
	Winter	71	90	96	Standing			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

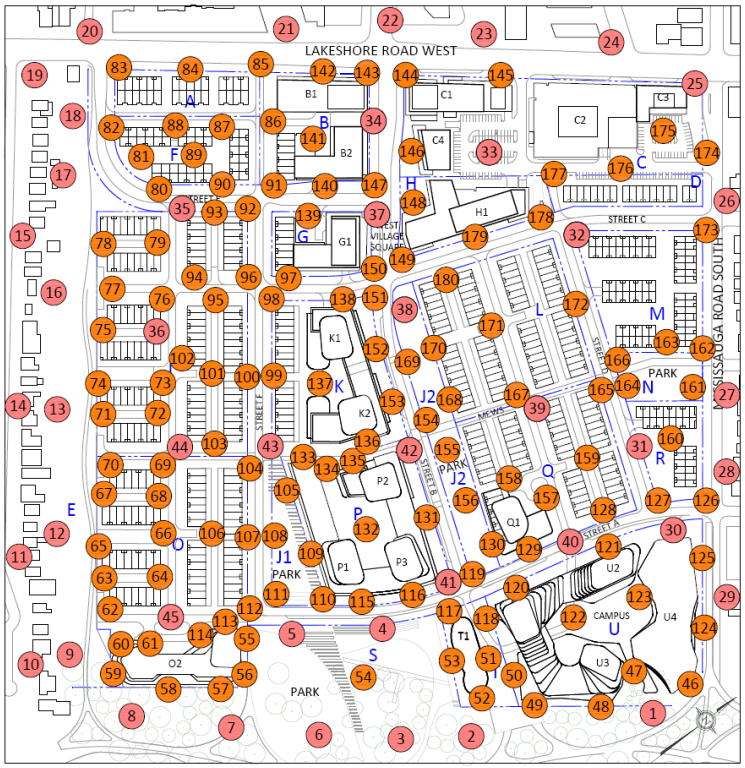


TABLE 9: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #49	**Summer**	80	93	98	Sitting	Potential Entrance	Walking/ Standing	Acceptable
	Winter	72	87	94	Standing			
Sensor #50	**Summer**	76	92	98	Standing	Potential Entrance	Walking/ Standing	Acceptable
	Winter	62	82	92	Standing			
Sensor #51	**Summer**	66	83	92	Standing	Potential Entrance	Walking/ Standing	Acceptable[3]
	Winter	48	70	84	Walking			
Sensor #52	**Summer**	72	89	96	Standing	Potential Entrance	Walking/ Standing	Acceptable[3]
	Winter	58	78	89	Walking			
Sensor #53	**Summer**	82	94	98	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	62	82	92	Standing			
Sensor #54	**Summer**	68	87	95	Standing	Walkway/ Park	Sitting/ Walking	Acceptable[1] (See S. 5.2)
	Winter	48	71	85	Walking			

[1] Acceptable without seating; [3] Acceptable if no adjacent primary entrances are on building façade

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

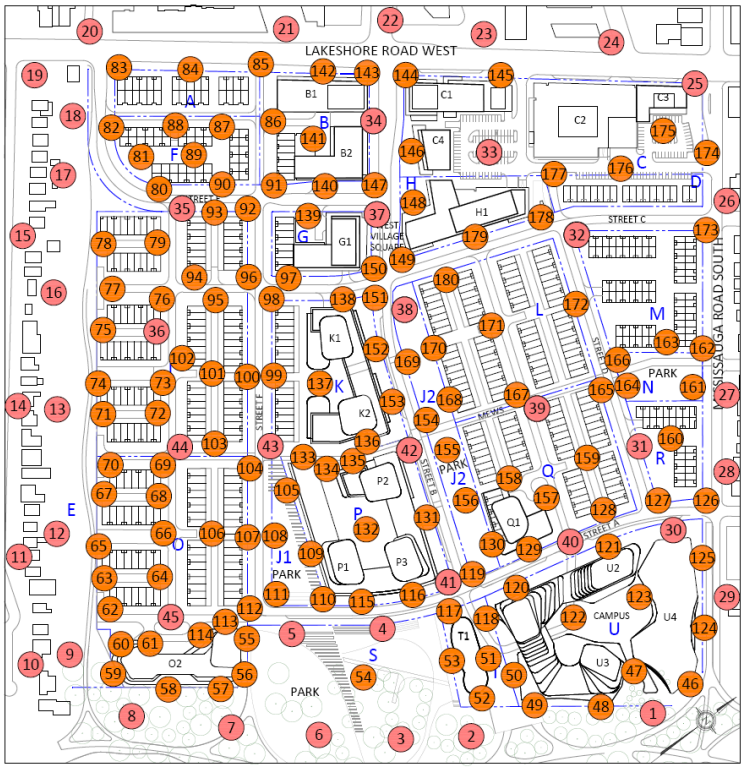


TABLE 10: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #55	**Summer**	67	82	91	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	51	69	82	Walking			
Sensor #56	**Summer**	89	96	99	Sitting	Walkway/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	75	91	97	Standing			
Sensor #57	**Summer**	75	90	96	Standing	Potential Entrance	Walking/ Standing	Acceptable[3]
	Winter	57	76	88	Walking			
Sensor #58	**Summer**	78	91	97	Standing	Potential Entrance	Walking/ Standing	Acceptable
	Winter	61	80	91	Standing			
Sensor #59	**Summer**	72	85	92	Standing	Potential Entrance	Walking/ Standing	Acceptable[3]
	Winter	55	71	81	Walking			
Sensor #60	**Summer**	81	93	97	Sitting	Potential Entrance	Walking/ Standing	Acceptable
	Winter	66	83	93	Standing			

[3] Acceptable if no adjacent primary entrances are on building façade

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

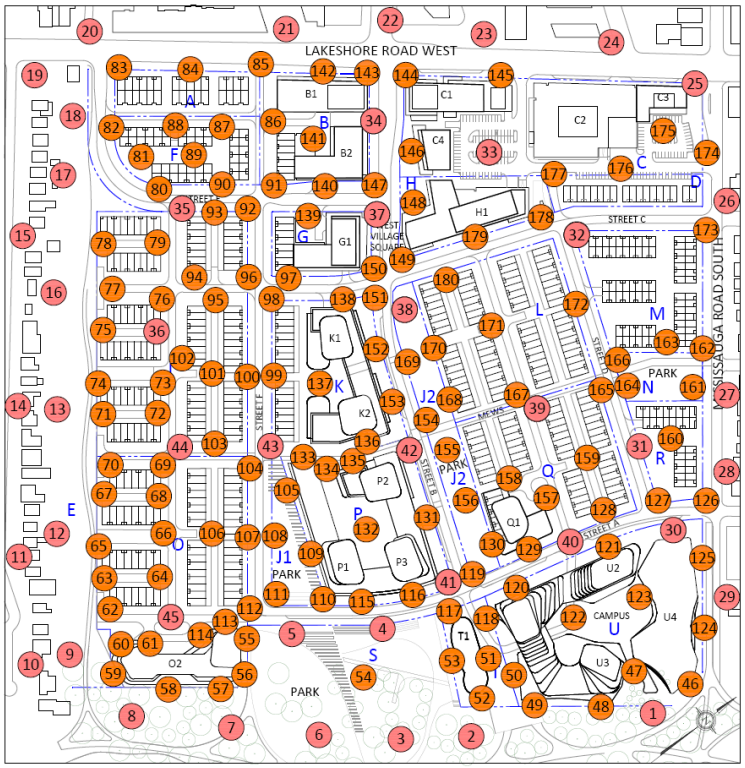


TABLE 11: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #61	**Summer**	95	99	100	Sitting	Potential Entrance	Walking/ Standing	Acceptable
	Winter	86	97	100	Sitting			
Sensor #62	**Summer**	85	97	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	66	86	95	Standing			
Sensor #63	**Summer**	91	99	100	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	81	96	99	Sitting			
Sensor #64	**Summer**	92	99	100	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	79	95	99	Standing			
Sensor #65	**Summer**	90	98	100	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	78	94	99	Standing			
Sensor #66	**Summer**	82	95	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	64	85	95	Standing			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

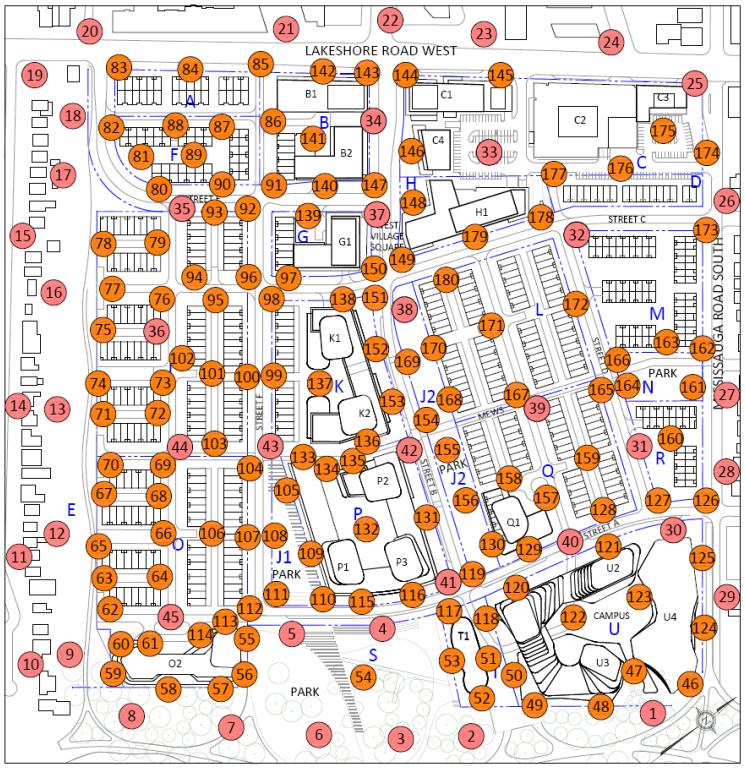


TABLE 12: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #67	**Summer**	89	98	100	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	74	93	98	Standing			
Sensor #68	**Summer**	78	93	98	Standing	Public Sidewalk	Walking	Acceptable
	Winter	60	82	93	Standing			
Sensor #69	**Summer**	87	97	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	68	88	96	Standing			
Sensor #70	**Summer**	81	94	98	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	69	89	96	Standing			
Sensor #71	**Summer**	76	92	97	Standing	Public Sidewalk	Walking	Acceptable
	Winter	56	78	90	Walking			
Sensor #72	**Summer**	93	99	100	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	82	96	99	Sitting			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

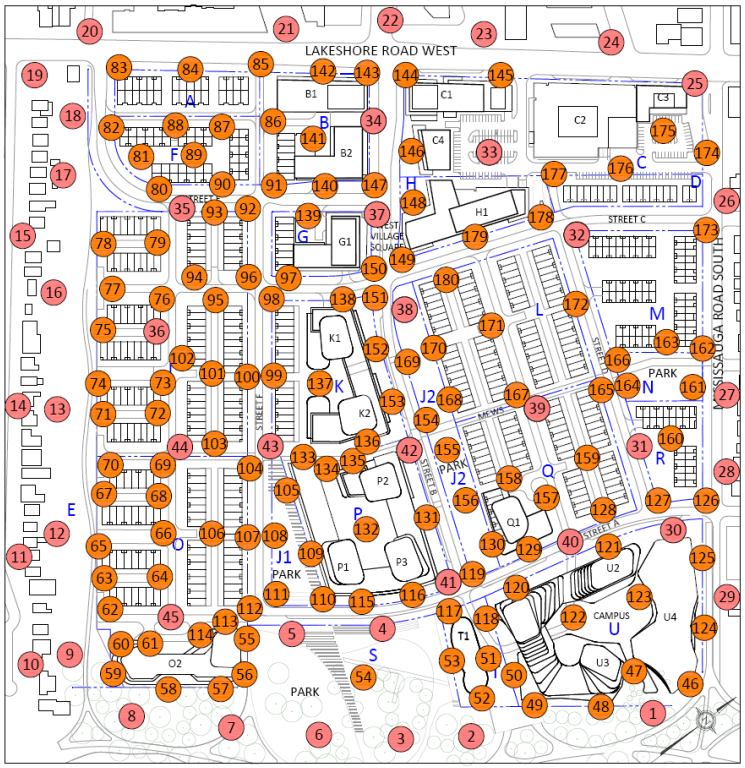


TABLE 13: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #73	**Summer**	82	95	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	64	86	95	Standing			
Sensor #74	**Summer**	74	91	97	Standing	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	58	81	93	Standing			
Sensor #75	**Summer**	87	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	69	89	97	Standing			
Sensor #76	**Summer**	80	94	98	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	60	84	95	Standing			
Sensor #77	**Summer**	65	86	95	Standing	Public Sidewalk	Walking	Acceptable
	Winter	48	72	86	Walking			
Sensor #78	**Summer**	68	87	95	Standing	Public Sidewalk	Walking	Acceptable
	Winter	50	71	85	Walking			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

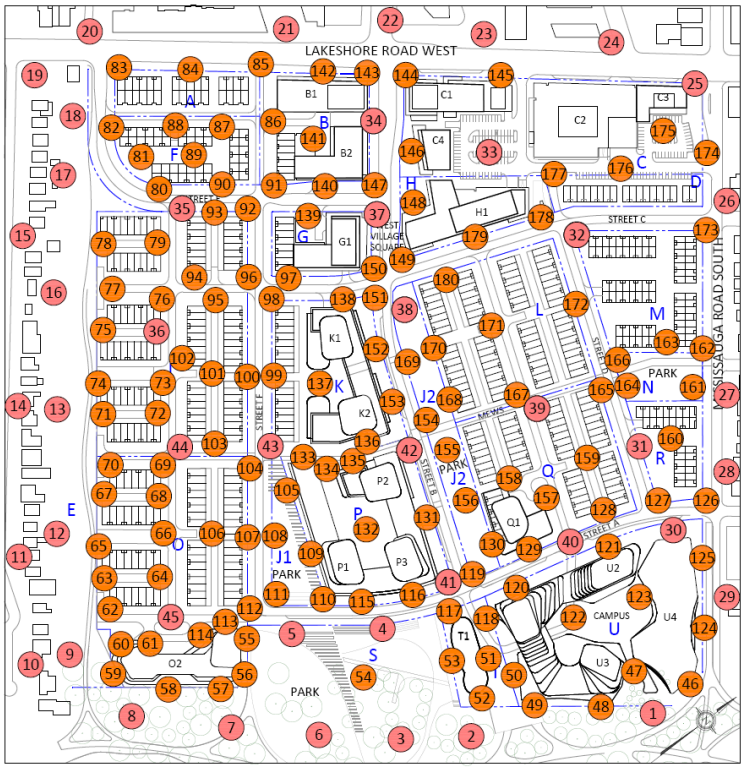


TABLE 14: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #79	**Summer**	82	95	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	65	86	95	Standing			
Sensor #80	**Summer**	91	98	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	75	90	95	Standing			
Sensor #81	**Summer**	81	95	99	Sitting	Parking Lot/ Green Space	Walking	Acceptable
	Winter	65	87	96	Standing			
Sensor #82	**Summer**	77	92	97	Standing	Public Sidewalk	Walking	Acceptable
	Winter	59	81	92	Standing			
Sensor #83	**Summer**	71	89	96	Standing	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable w/ Mitigation [2]
	Winter	53	76	89	Walking			
Sensor #84	**Summer**	87	97	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	68	88	96	Standing			

[2] Acceptable with mitigation as described in Section 5.2

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

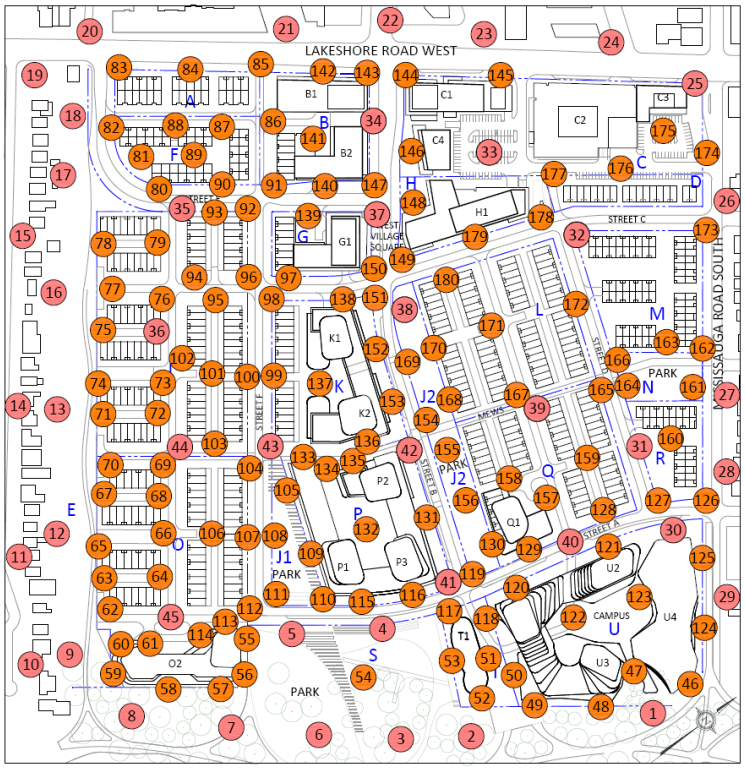


TABLE 15: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #85	**Summer**	71	89	97	Standing	Public Sidewalk	Walking	Acceptable
	Winter	52	77	91	Walking			
Sensor #86	**Summer**	90	98	100	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	78	94	99	Standing			
Sensor #87	**Summer**	86	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	69	90	97	Standing			
Sensor #88	**Summer**	91	98	100	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	78	94	99	Standing			
Sensor #89	**Summer**	91	98	100	Sitting	Parking Lot/ Green Space	Walking	Acceptable
	Winter	80	95	99	Sitting			
Sensor #90	**Summer**	85	96	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	71	90	97	Standing			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

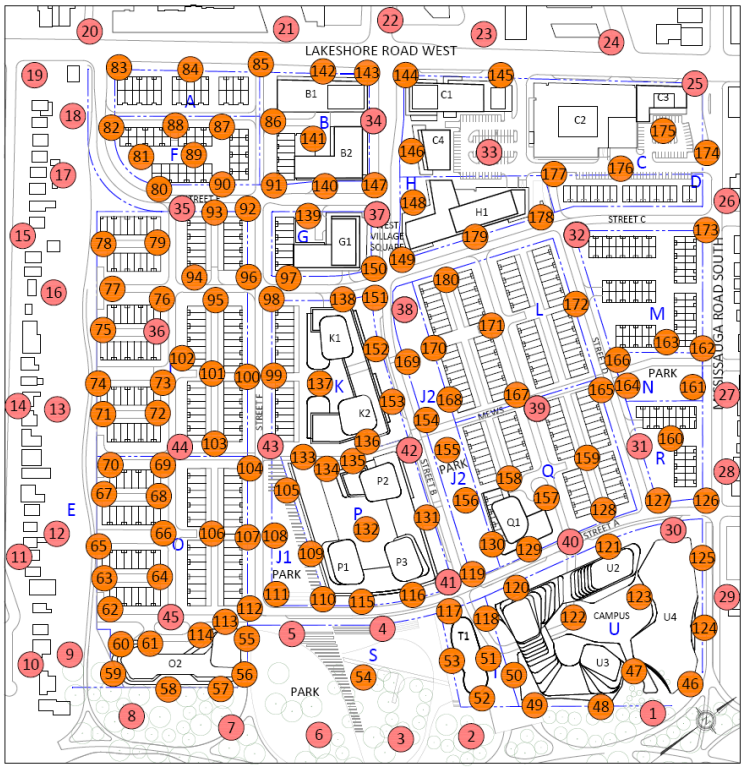


TABLE 16: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #91	**Summer**	92	99	100	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	81	95	99	Sitting			
Sensor #92	**Summer**	89	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	72	91	97	Standing			
Sensor #93	**Summer**	90	98	100	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	75	92	98	Standing			
Sensor #94	**Summer**	77	93	98	Standing	Public Sidewalk	Walking	Acceptable
	Winter	60	81	92	Standing			
Sensor #95	**Summer**	89	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	70	89	96	Standing			
Sensor #96	**Summer**	71	90	97	Standing	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable w/ Mitigation[2]
	Winter	51	76	90	Walking			

[2] Acceptable with mitigation as described in Section 5.2

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

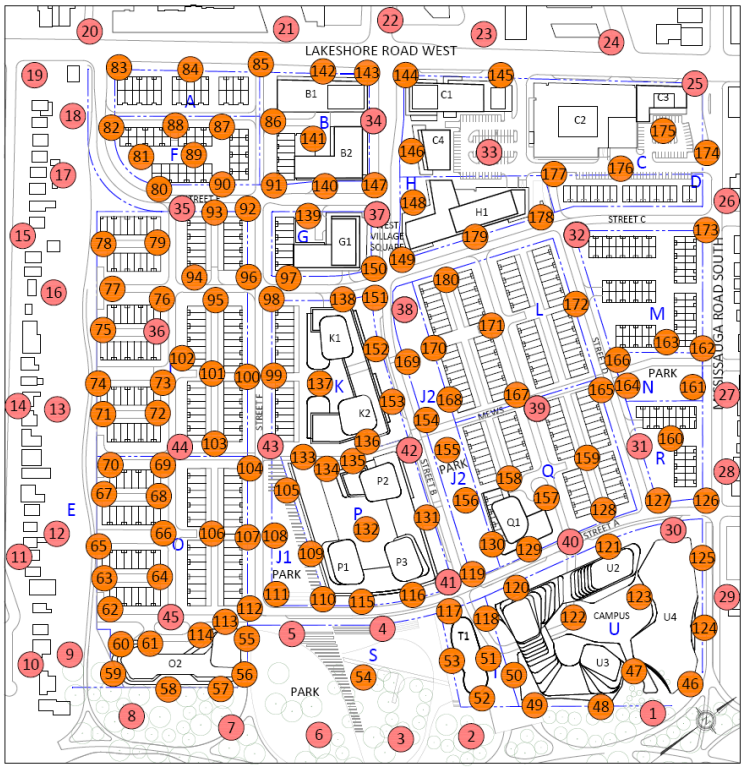


TABLE 17: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #97	**Summer**	75	90	96	Standing	Public Sidewalk	Walking	Acceptable
	Winter	59	80	91	Standing			
Sensor #98	**Summer**	86	95	98	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	71	90	96	Standing			
Sensor #99	**Summer**	89	98	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	72	91	98	Standing			
Sensor #100	**Summer**	87	97	100	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	78	94	98	Standing			
Sensor #101	**Summer**	79	94	98	Standing	Public Sidewalk	Walking	Acceptable
	Winter	60	82	93	Standing			
Sensor #102	**Summer**	90	98	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	76	93	98	Standing			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

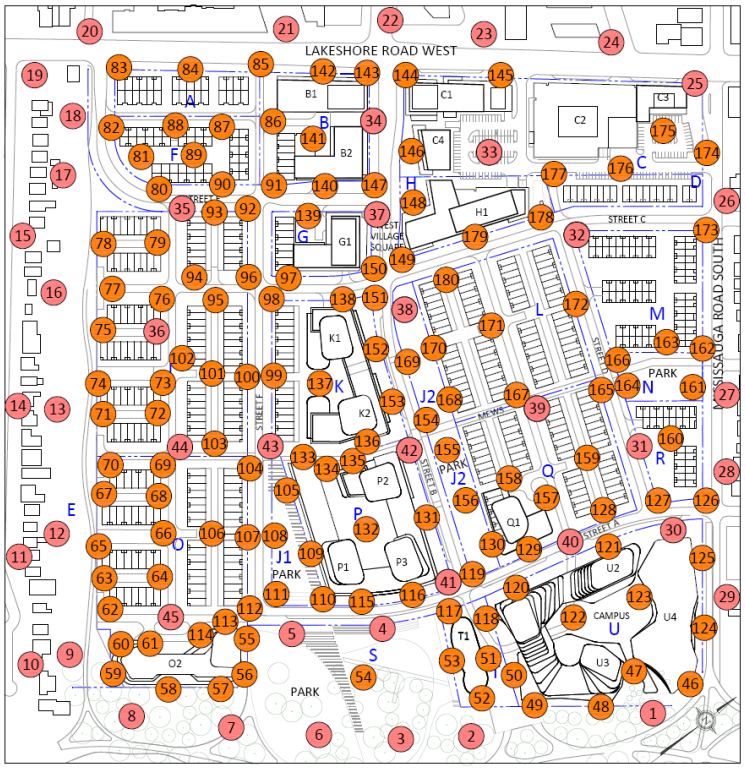


TABLE 18: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #103	**Summer**	76	93	98	Standing	Public Sidewalk	Walking	Acceptable
	Winter	57	81	93	Standing			
Sensor #104	**Summer**	80	94	98	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	67	87	95	Standing			
Sensor #105	**Summer**	75	92	98	Standing	Park/Plaza	Sitting/ Walking	Acceptable[1]
	Winter	65	86	95	Standing			
Sensor #106	**Summer**	70	89	96	Standing	Public Sidewalk	Standing/ Walking	Acceptable[3]
	Winter	50	73	86	Walking			
Sensor #107	**Summer**	68	87	95	Standing	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	49	72	87	Walking			
Sensor #108	**Summer**	71	89	96	Standing	Park/Plaza	Sitting/ Walking	Acceptable[1]
	Winter	58	81	92	Standing			

[1] Acceptable without seating; [3] Acceptable if no adjacent primary entrances are on building façade

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

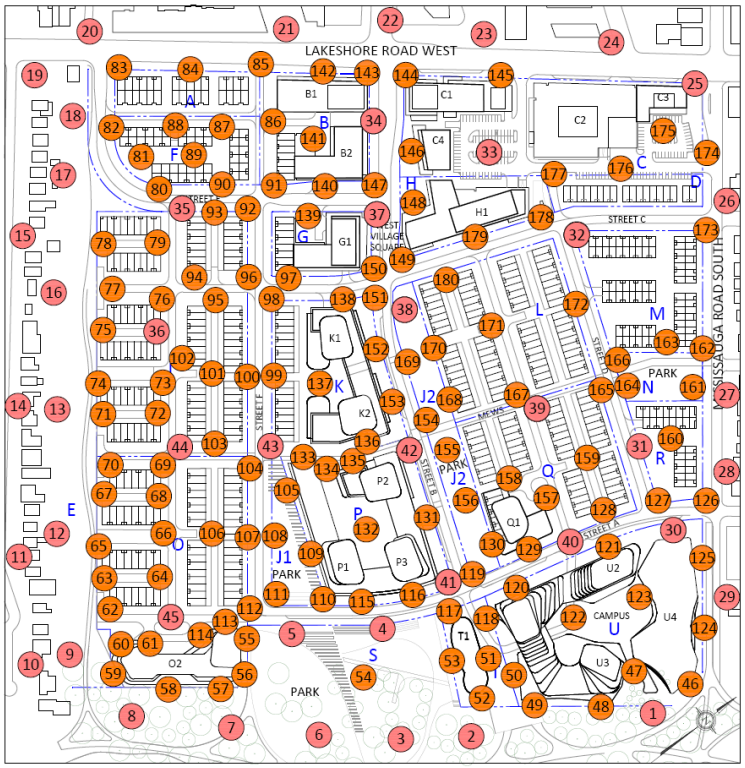


TABLE 19: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #109	**Summer**	67	83	92	Standing	Plaza/ ~ Entrance	Sitting/ Standing	Acceptable[2] w/ Mitigation
	Winter	49	71	84	Walking			
Sensor #110	**Summer**	52	72	85	Walking	Plaza/ ~ Entrance	Sitting/ Standing	Acceptable[2] w/ Mitigation
	Winter	33	53	68	Uncomfortable			
Sensor #111	**Summer**	67	86	95	Standing	Park/Plaza	Sitting/ Walking	Acceptable[1]
	Winter	49	73	87	Walking			
Sensor #112	**Summer**	71	88	96	Standing	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable[2] w/ Mitigation
	Winter	54	77	90	Walking			
Sensor #113	**Summer**	81	95	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	61	83	93	Standing			
Sensor #114	**Summer**	89	97	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	73	91	98	Standing			

[1] Acceptable without seating; [2] Acceptable with mitigation as described in Section 5.2

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

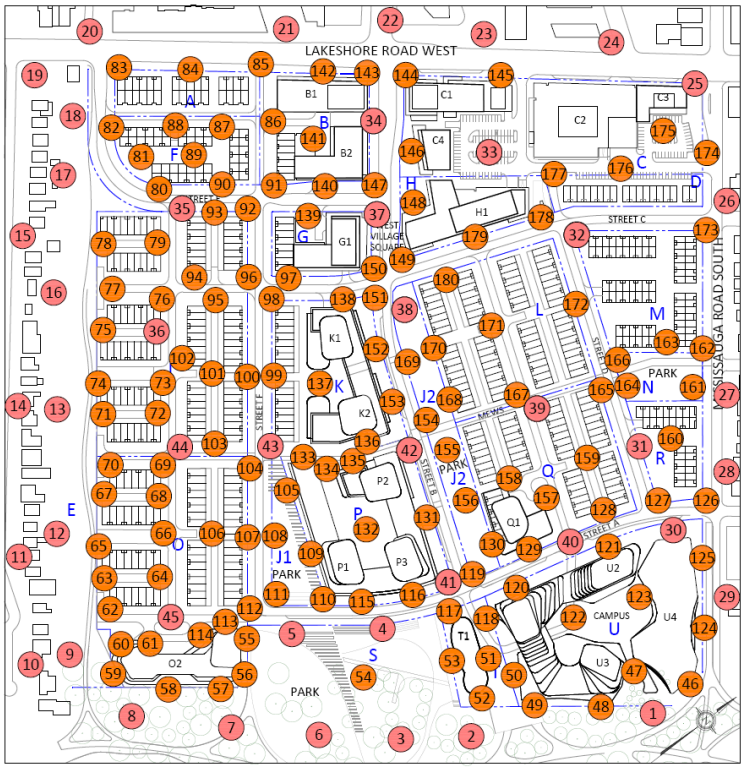


TABLE 20: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #115	Summer	69	86	94	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	50	68	81	Walking			
Sensor #116	Summer	78	91	97	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	61	80	90	Standing			
Sensor #117	Summer	51	72	85	Walking	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable w/ Mitigation
	Winter	33	53	69	Uncomfortable			
Sensor #118	Summer	58	78	90	Walking	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable w/ Mitigation
	Winter	37	60	77	Uncomfortable			
Sensor #119	Summer	60	82	93	Standing	Park/ Sidewalk	Sitting/ Walking	Acceptable[1]
	Winter	47	72	86	Walking			
Sensor #120	Summer	85	94	98	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	69	87	95	Standing			

[1] Acceptable without seating; [3] Acceptable if no adjacent primary entrances are on building façade

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

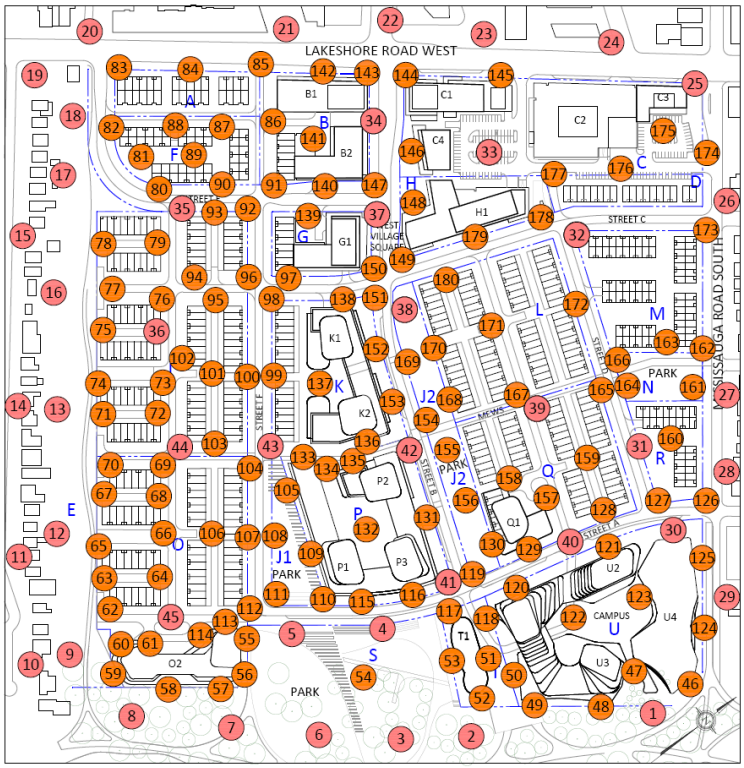


TABLE 21: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #121	**Summer**	86	96	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	69	89	96	Standing			
Sensor #122	**Summer**	78	90	95	Standing	Walkway/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	59	78	89	Walking			
Sensor #123	**Summer**	90	98	100	Sitting	Walkway/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	76	94	99	Standing			
Sensor #124	**Summer**	81	93	98	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	66	86	95	Standing			
Sensor #125	**Summer**	78	92	98	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	68	87	95	Standing			
Sensor #126	**Summer**	75	91	97	Standing	Public Sidewalk	Walking	Acceptable
	Winter	54	77	90	Walking			

[3] Acceptable if no adjacent primary entrances are on building façade

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

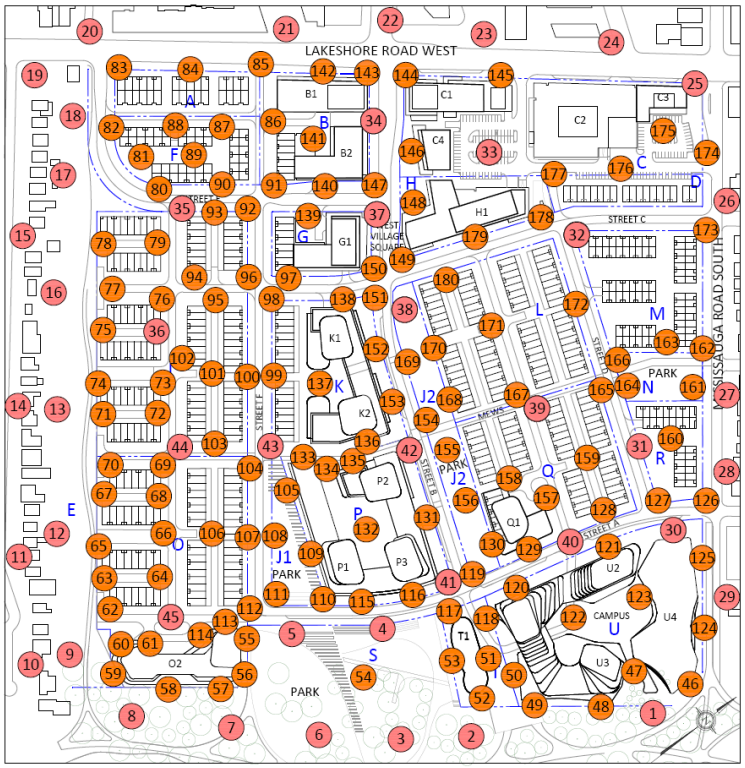


TABLE 22: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #127	**Summer**	82	95	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	62	83	94	Standing			
Sensor #128	**Summer**	82	95	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	67	87	96	Standing			
Sensor #129	**Summer**	77	93	98	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	65	85	94	Standing			
Sensor #130	**Summer**	83	96	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	67	87	95	Standing			
Sensor #131	**Summer**	78	94	98	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	60	84	95	Standing			
Sensor #132	**Summer**	85	97	99	Sitting	Parking Lot/Courtyard	Walking/ Sitting	Acceptable[1]
	Winter	70	90	97	Standing			

[3] Acceptable without seating

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

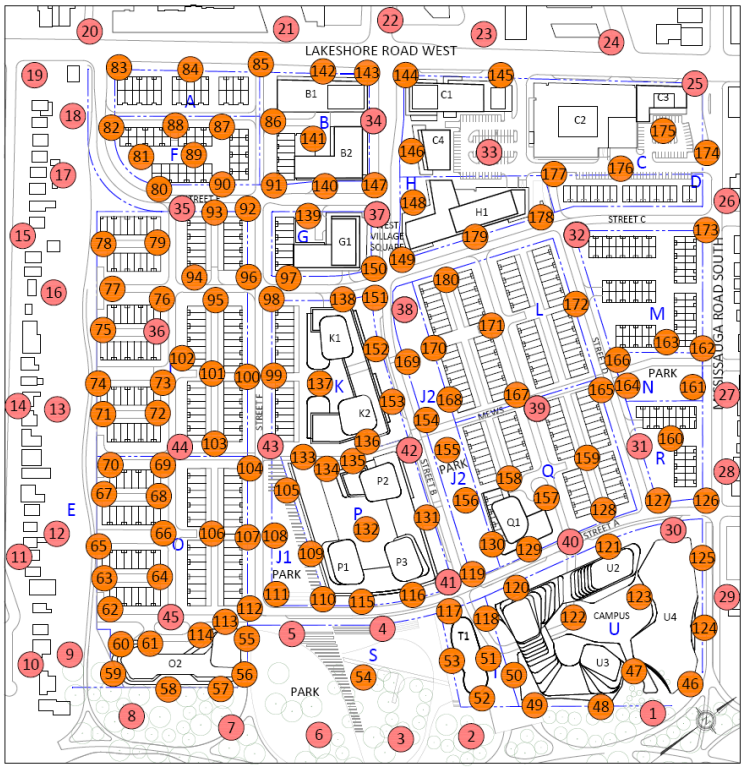


TABLE 23: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #133	Summer	81	92	97	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	60	81	92	Standing			
Sensor #134	Summer	74	91	97	Standing	Walkway/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	54	78	90	Walking			
Sensor #135	Summer	76	90	96	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	56	78	90	Walking			
Sensor #136	Summer	73	89	96	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	55	78	90	Walking			
Sensor #137	Summer	93	99	100	Sitting	Parking Lot/Courtyard	Walking/ Sitting	Acceptable
	Winter	82	96	99	Sitting			
Sensor #138	Summer	63	82	92	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	42	62	78	Uncomfortable			

[3] Acceptable if no adjacent primary entrances are on building façade

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

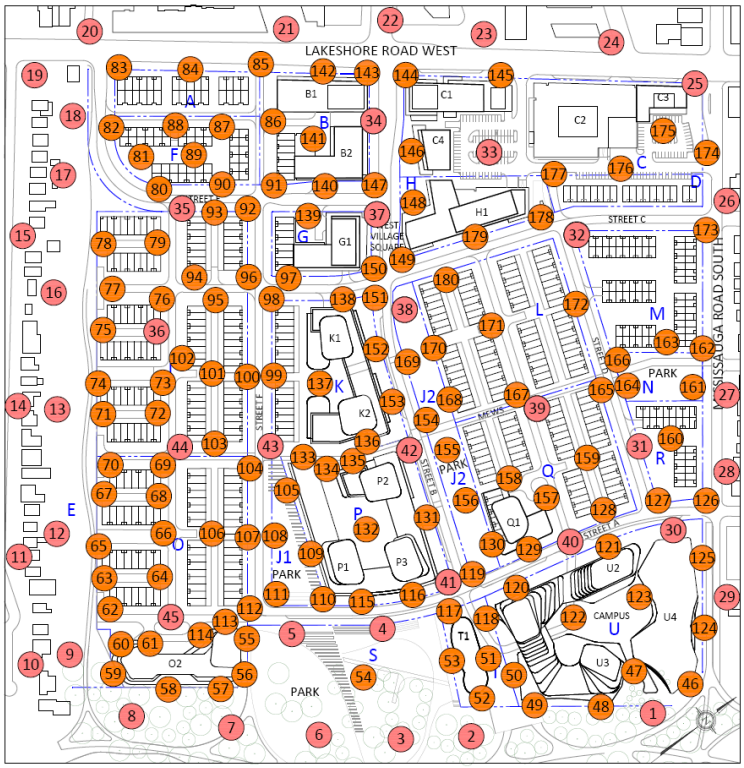


TABLE 24: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #139	**Summer**	80	93	98	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	62	84	95	Standing			
Sensor #140	**Summer**	74	90	97	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	57	80	91	Standing			
Sensor #141	**Summer**	89	97	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	81	95	98	Sitting			
Sensor #142	**Summer**	92	99	100	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	82	96	99	Sitting			
Sensor #143	**Summer**	78	93	98	Standing	Transit Stop	Standing	Acceptable
	Winter	58	81	93	Standing			
Sensor #144	**Summer**	83	94	98	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	64	84	94	Standing			

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

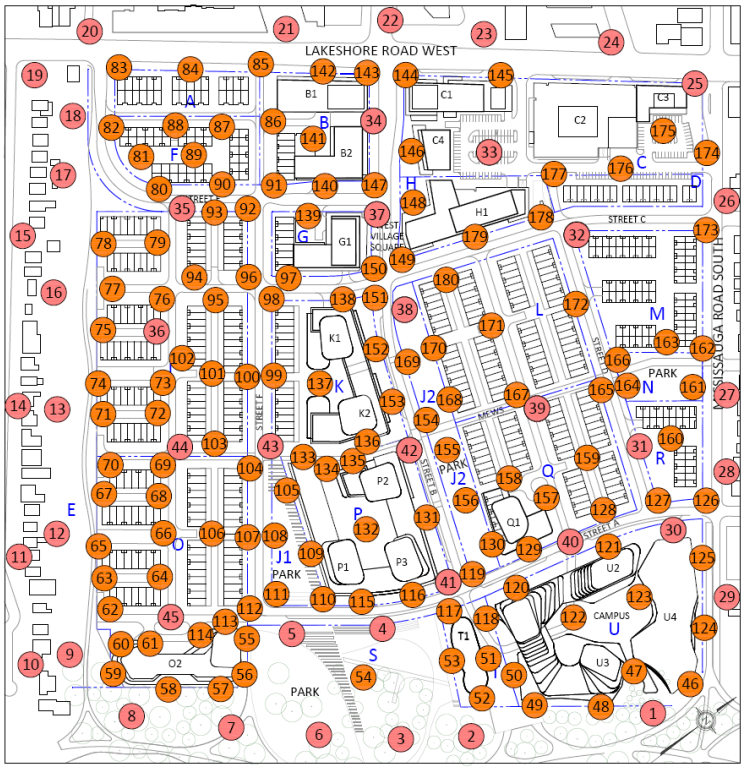


TABLE 25: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #145	Summer	84	96	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	64	85	94	Standing			
Sensor #146	Summer	96	99	100	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	89	98	100	Sitting			
Sensor #147	Summer	69	89	97	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	51	76	91	Walking			
Sensor #148	Summer	93	99	100	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	82	97	100	Sitting			
Sensor #149	Summer	70	88	95	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	49	72	86	Walking			
Sensor #150	Summer	72	90	97	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	51	76	89	Walking			

[3] Acceptable if no adjacent primary entrances are on building façade

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

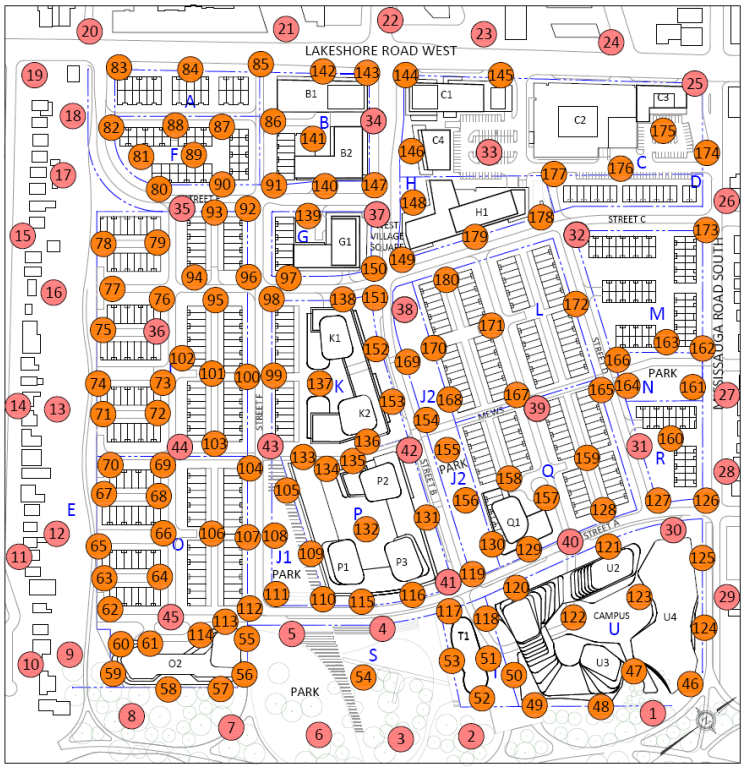


TABLE 26: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #151	**Summer**	66	86	94	Standing	Public Sidewalk	Walking	Acceptable
	Winter	46	69	83	Walking			
Sensor #152	**Summer**	79	93	98	Standing	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	62	84	94	Standing			
Sensor #153	**Summer**	83	96	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable
	Winter	69	90	97	Standing			
Sensor #154	**Summer**	85	97	99	Sitting	Sidewalk/ Park	Walking/ Sitting	Acceptable
	Winter	71	91	97	Standing			
Sensor #155	**Summer**	86	96	99	Sitting	Park	Sitting/ Walking	Acceptable
	Winter	76	92	97	Standing			
Sensor #156	**Summer**	67	86	95	Standing	Park	Sitting/ Walking	Acceptable[1]
	Winter	49	72	87	Walking			

[1] Acceptable if no seating

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

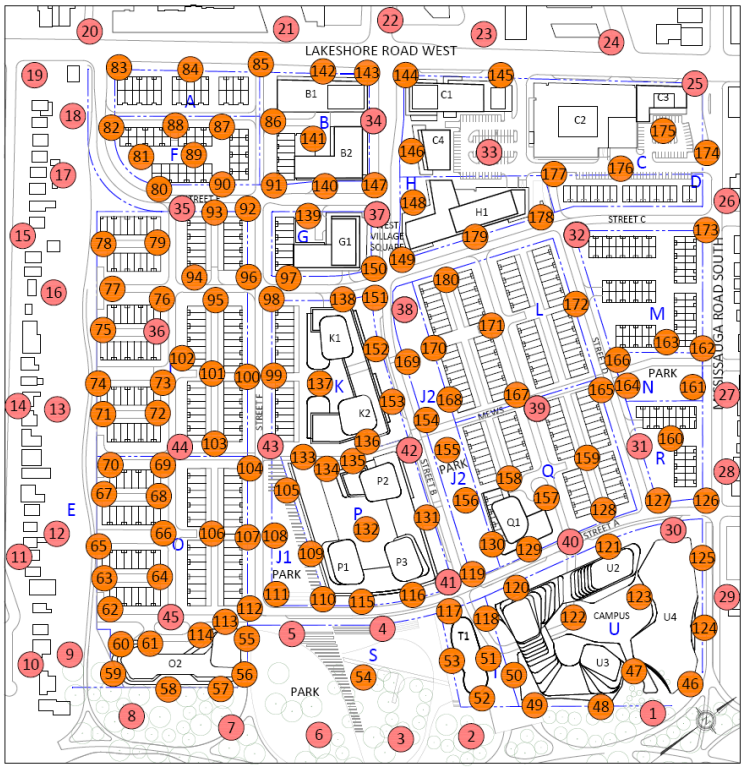


TABLE 27: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #157	**Summer**	88	96	99	Sitting	Pedestrian Walkway	Walking	Acceptable
	Winter	76	92	97	Standing			
Sensor #158	**Summer**	75	89	96	Standing	Pedestrian Walkway	Walking	Acceptable
	Winter	52	73	87	Walking			
Sensor #159	**Summer**	90	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	77	92	97	Standing			
Sensor #160	**Summer**	77	92	98	Standing	Parking Lot/ Green Space	Walking	Acceptable
	Winter	59	81	92	Standing			
Sensor #161	**Summer**	70	87	95	Standing	Park	Sitting/ Walking	Acceptable[1]
	Winter	48	70	84	Walking			
Sensor #162	**Summer**	87	97	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	77	93	98	Standing			

[1] Acceptable if no seating

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

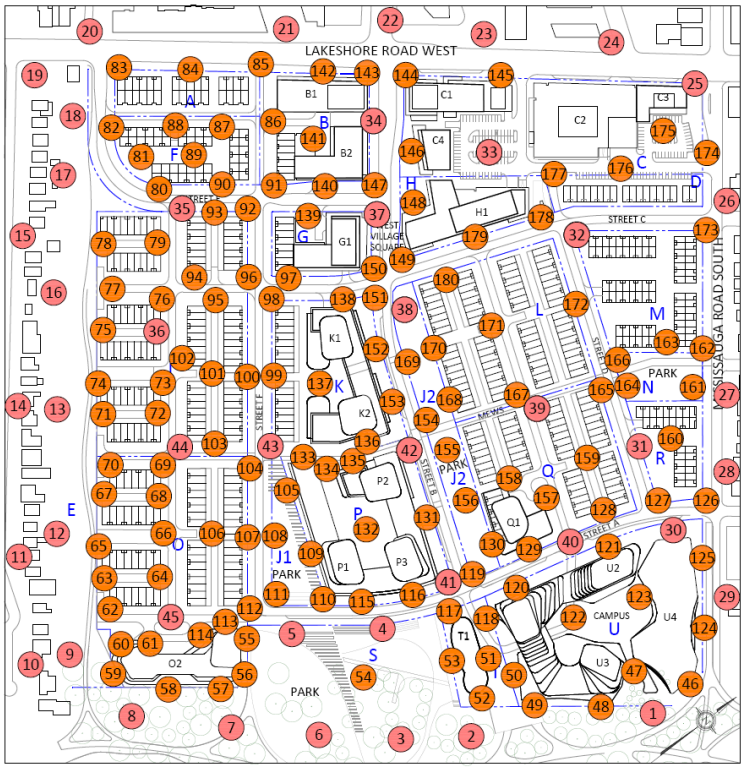


TABLE 28: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #163	**Summer**	81	95	99	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	65	86	95	Standing			
Sensor #164	**Summer**	83	94	98	Sitting	Park	Sitting/ Walking	Acceptable[1]
	Winter	63	82	92	Standing			
Sensor #165	**Summer**	93	99	100	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	79	95	99	Standing			
Sensor #166	**Summer**	70	88	95	Standing	Public Sidewalk	Walking	Acceptable
	Winter	48	72	86	Walking			
Sensor #167	**Summer**	84	94	98	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	64	82	92	Standing			
Sensor #168	**Summer**	83	94	97	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	63	83	92	Standing			

[1] Acceptable if no seating

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

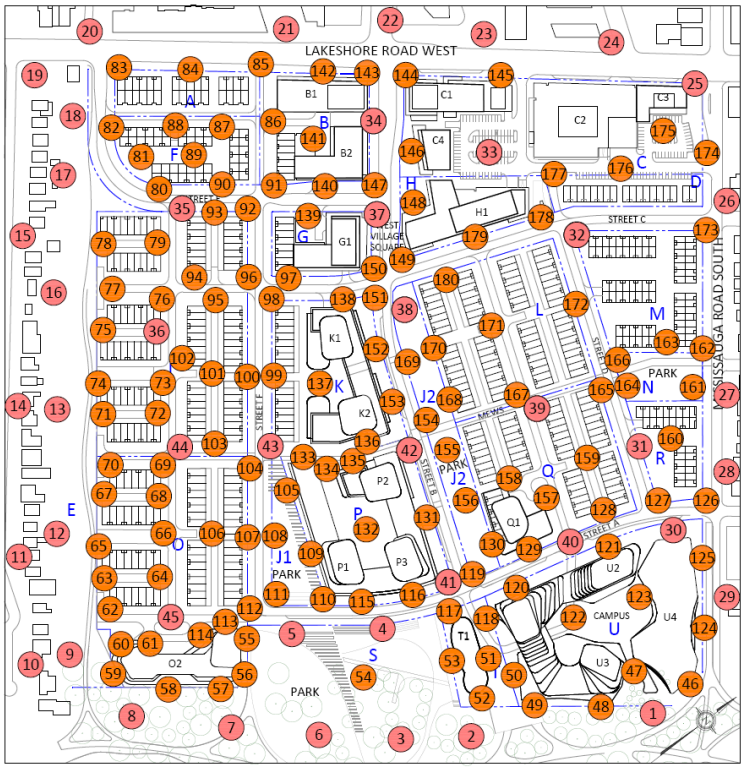


TABLE 29: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #169	**Summer**	75	91	97	Standing	Park	Sitting/ Walking	Acceptable[1]
	Winter	54	76	89	Walking			
Sensor #170	**Summer**	90	98	100	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	77	93	98	Standing			
Sensor #171	**Summer**	83	94	98	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	63	82	92	Standing			
Sensor #172	**Summer**	80	93	98	Sitting	TH Entrance/ Sidewalk	Standing/ Walking	Acceptable
	Winter	59	80	92	Standing			
Sensor #173	**Summer**	76	91	97	Standing	Public Sidewalk	Walking	Acceptable
	Winter	56	77	89	Walking			
Sensor #174	**Summer**	85	97	99	Sitting	Public Sidewalk	Walking	Acceptable
	Winter	68	90	97	Standing			

[1] Acceptable if no seating

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS

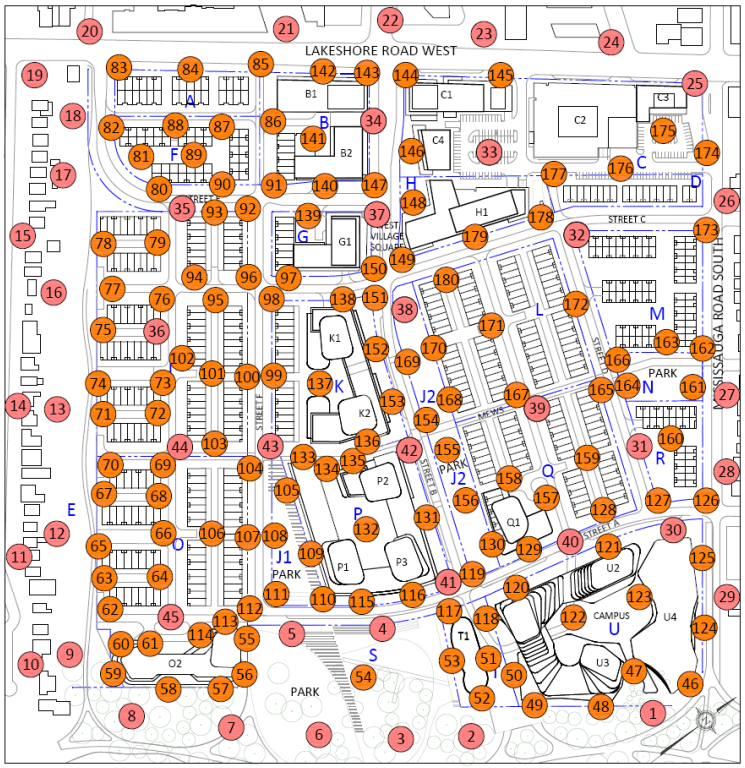
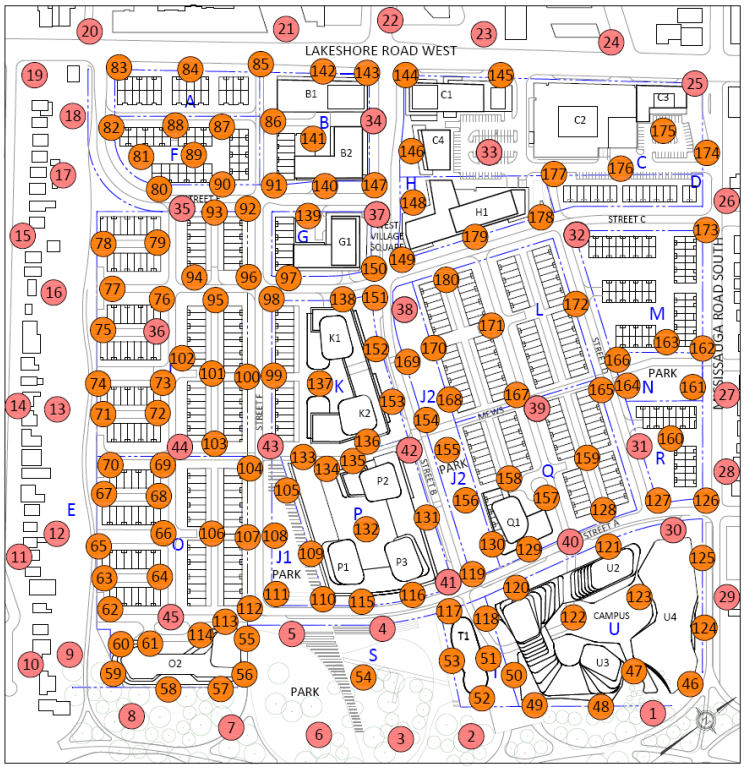


TABLE 30: SUMMARY OF PEDESTRIAN COMFORT

Activity Type		Sitting	Standing	Walking	Predicted Comfort Class	Location Type	Desired Comfort Class	Suitability
Wind Speed Range (km/h)		≤ 10	≤ 15	≤ 20				
Guideline (% of Time)		≥80%	≥80%	≥80%				
Sensor #175	**Summer**	86	95	99	Sitting	Parking Lot	Walking	Acceptable
	Winter	67	85	94	Standing			
Sensor #176	**Summer**	83	95	99	Sitting	Parking Lot	Walking	Acceptable
	Winter	63	86	95	Standing			
Sensor #177	**Summer**	75	90	95	Standing	Public Walkway	Walking	Acceptable
	Winter	51	72	84	Walking			
Sensor #178	**Summer**	83	95	98	Sitting	Public Walkway	Walking	Acceptable
	Winter	67	88	96	Standing			
Sensor #179	**Summer**	85	96	99	Sitting	Sidewalk/ ~ Entrance	Walking/ Standing	Acceptable[3]
	Winter	66	85	94	Standing			
Sensor #180	**Summer**	82	93	97	Sitting	Public Walkway	Walking	Acceptable
	Winter	62	79	89	Walking			

[3] Acceptable if no adjacent primary entrances are on building façade

70 MISSISSAUGA ROAD SOUTH AND 181 LAKESHORE ROAD WEST: PLW SENSOR LOCATIONS



5.2 Summary of Findings

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables 1 through 30 in Section 5.1, this section summarizes the most significant findings of the PLW study, as follows:

Summer

The large majority of grade-level areas within and surrounding the study site will be suitable for the intended uses throughout the year without mitigation. Possible exceptions include windier corner areas adjacent to buildings C, P, T and U (façades where entrances are blue sensors in Figure 1B), if building entrances are desired for these areas. If entrances are desired, mitigation is recommended in the form of recessed doorway locations, and/or canopies extending from the building façades over the entrance path.

Public plazas, parks or adjacent green space do not experience unusually strong wind conditions over the development site. Some mitigation may be required nonetheless, depending on the intended uses of the areas, which is however outside the scope of this study's recommendations.

The transit stop at the intersection of Lakeshore Road West and Mississauga Road South (Sensor 25) will not achieve the desired classification of standing during the winter season. However, this site is equipped with a three-walled transit vestibule, which will allow pedestrians to take cover during limited windy period. Therefore, wind conditions at this transit stop location are acceptable.

Winter

1. Most public sidewalks and walkways within and surrounding the study site will be suitable for walking or better. Exceptions include sidewalks adjacent to the building corners of buildings C, P, T, K and U (magenta sensors in Figure 2B), which will experience conditions uncomfortable for walking. To reduce wind speeds in these areas to comfortable levels, it will be necessary to install vertical wind barriers extending from building corners towards the sidewalks, and/or horizontal canopies extending from the façades of buildings. With both strategies, the intent is to limit corner acceleration of westerly and easterly winds approaching the site. Barriers may take the form of high-solidity wind screens, dense coniferous plantings, or a combination thereof. The exact placement and configuration of barriers can be determined at a later date as the landscape plan develops.

2. Public plazas, parks or adjacent green space do not experience unusually strong wind conditions over the development site. Some mitigation may be required nonetheless, depending on the intended uses of the areas, which is however outside the scope of this study's recommendations.

3. Most transit stops will be suitable for standing or better throughout the year, which is acceptable. The exception is the transit stop at the intersection of Mississauga Road South and Lakeshore Road West (Sensor 25), which may experience limited periods of windier conditions uncomfortable for walking. This area is equipped with a three-walled transit vestibule, which will allow pedestrians to take cover during windier conditions. Further, wind speeds at this area will be reduced following the mitigation recommended above for Building C at no additional effort. For these reasons, these conditions are considered acceptable.

4. Most townhouse entrances will be suitable for standing or better throughout the year. Exceptions include the townhouse entrances at Sensors 78, 83, 96, 107, 112, 170, 156 and 166, which will experience conditions unsuitable for standing. For these windier areas, mitigation is recommended in the form of recessed doorway locations, and/or canopies extending from the building façade over the entrance path to provide suitable conditions for users.

5. If primary entrances are to be located in windier locations of the remaining building façades (entrances denoted by blue or magenta sensors in Figure 2B), mitigation is recommended in the form of recessed doorway locations, and/or canopies extending from the building façades over the entrance path. Mitigation recommended in Item 1 above will serve to reduce winds at several of these locations at no additional effort. The exact configuration of mitigation will be confirmed as the site design progresses.

6. 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 Existing versus Future Pedestrian Comfort

An additional test was performed for the existing site massing to evaluate the influence of the study building and other future surrounding developments on the existing wind conditions near the study site. Photographs 1 and 2, following the main text, illustrate the context model of existing buildings, whereas Photographs 3 through 6 show the future configuration incorporating a model of the study building and other future developments. The wind comfort results from the future development configuration are compared to the existing conditions in Tables 31 to 34 beginning on the following page.

Pedestrian wind comfort resulting from construction of the study building is 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 a change of the predicted comfort class.

Tables 31 to 34 indicate that overall, wind conditions over the study side will largely be improved or unchanged in a few areas following construction of the proposed development.

TABLE 31: SUMMARY OF PEDESTRIAN COMFORT – EXISTING VS FUTURE CONDITIONS

Sensor	Season	Wind Speed Range (km/h)			Predicted Comfort Class (Existing Conditions)	Future Comfort Class Compared to Existing
		≤ 10 (Sitting)	≤ 15 (Standing)	≤ 20 (Walking)		
1	Summer	61	83	94	Standing	Improved
	Winter	39	63	81	Walking	Improved
2	Summer	57	80	92	Standing	Unchanged
	Winter	36	60	78	Uncomfortable	Improved
3	Summer	58	80	92	Standing	Unchanged
	Winter	37	61	79	Uncomfortable	Improved
4	Summer	46	70	85	Walking	Improved
	Winter	27	48	66	Uncomfortable	Improved
5	Summer	57	79	91	Walking	Improved
	Winter	35	59	77	Uncomfortable	Improved
6	Summer	48	72	86	Walking	Improved
	Winter	28	50	68	Uncomfortable	Improved
7	Summer	59	80	91	Standing	Unchanged
	Winter	39	63	80	Walking	Unchanged
8	Summer	66	84	93	Standing	Unchanged
	Winter	52	73	85	Walking	Unchanged
9	Summer	66	85	95	Standing	Unchanged
	Winter	50	73	87	Walking	Unchanged
10	Summer	80	95	99	Sitting	Reduced
	Winter	61	84	95	Standing	Reduced
11	Summer	64	85	94	Standing	Unchanged
	Winter	46	69	84	Walking	Unchanged
12	Summer	75	90	97	Standing	Improved
	Winter	58	80	91	Standing	Unchanged
13	Summer	66	85	94	Standing	Unchanged
	Winter	45	69	84	Walking	Improved
14	Summer	82	94	98	Sitting	Unchanged
	Winter	68	88	96	Standing	Unchanged

TABLE 32: SUMMARY OF PEDESTRIAN COMFORT – EXISTING VS FUTURE CONDITIONS

Sensor	Season	Wind Speed Range (km/h)			Predicted Comfort Class (Existing Conditions)	Future Comfort Class Compared to Existing
		≤ 10 (Sitting)	≤ 15 (Standing)	≤ 20 (Walking)		
15	**Summer**	79	93	98	Standing	Improved
	Winter	61	82	92	Standing	Unchanged
16	**Summer**	64	85	94	Standing	Unchanged
	Winter	43	66	82	Walking	Unchanged
17	**Summer**	68	87	95	Standing	Unchanged
	Winter	48	72	86	Walking	Improved
18	**Summer**	79	92	98	Standing	Improved
	Winter	68	87	94	Standing	Unchanged
19	**Summer**	67	87	95	Standing	Unchanged
	Winter	46	70	85	Walking	Unchanged
20	**Summer**	66	83	92	Standing	Unchanged
	Winter	49	70	83	Walking	Improved
21	**Summer**	71	88	95	Standing	Improved
	Winter	62	82	92	Standing	Unchanged
22	**Summer**	65	85	94	Standing	Improved
	Winter	47	71	86	Walking	Improved
23	**Summer**	75	91	97	Standing	Improved
	Winter	63	85	94	Standing	Unchanged
24	**Summer**	77	92	97	Standing	Improved
	Winter	60	83	93	Standing	Unchanged
25	**Summer**	78	91	95	Standing	Reduced
	Winter	56	75	85	Walking	Reduced
26	**Summer**	70	87	94	Standing	Unchanged
	Winter	50	69	82	Walking	Unchanged
27	**Summer**	78	91	96	Standing	Improved
	Winter	59	77	87	Walking	Improved
28	**Summer**	65	85	94	Standing	Unchanged
	Winter	43	67	82	Walking	Improved

TABLE 33: SUMMARY OF PEDESTRIAN COMFORT – EXISTING VS FUTURE CONDITIONS

Sensor	Season	Wind Speed Range (km/h)			Predicted Comfort Class (Existing Conditions)	Future Comfort Class Compared to Existing
		≤ 10 (Sitting)	≤ 15 (Standing)	≤ 20 (Walking)		
29	**Summer**	72	89	96	Standing	Improved
	Winter	53	75	87	Walking	Improved
30	**Summer**	58	82	93	Standing	Improved
	Winter	39	63	81	Walking	Improved
31	**Summer**	56	79	92	Walking	Improved
	Winter	35	59	77	Uncomfortable	Improved
32	**Summer**	60	83	94	Standing	Improved
	Winter	41	67	84	Walking	Improved
33	**Summer**	60	82	94	Standing	Improved
	Winter	44	69	85	Walking	Improved
34	**Summer**	58	81	93	Standing	Improved
	Winter	40	65	83	Walking	Improved
35	**Summer**	62	84	94	Standing	Improved
	Winter	43	68	84	Walking	Improved
36	**Summer**	58	81	92	Standing	Improved
	Winter	38	63	80	Walking	Improved
37	**Summer**	55	78	91	Walking	Improved
	Winter	36	60	78	Uncomfortable	Improved
38	**Summer**	53	77	91	Walking	Improved
	Winter	34	57	76	Uncomfortable	Improved
39	**Summer**	55	79	91	Walking	Improved
	Winter	35	58	76	Uncomfortable	Improved
40	**Summer**	53	77	90	Walking	Improved
	Winter	33	55	74	Uncomfortable	Improved
41	**Summer**	54	78	90	Walking	Unchanged
	Winter	33	56	74	Uncomfortable	Unchanged
42	**Summer**	54	77	91	Walking	Improved
	Winter	34	58	77	Uncomfortable	Improved

TABLE 34: SUMMARY OF PEDESTRIAN COMFORT – EXISTING VS FUTURE CONDITIONS

Sensor	Season	Wind Speed Range (km/h)			Predicted Comfort Class (Existing Conditions)	Future Comfort Class Compared to Existing
		≤ 10 (Sitting)	≤ 15 (Standing)	≤ 20 (Walking)		
43	**Summer**	55	78	91	Walking	Improved
	Winter	34	57	75	Uncomfortable	Improved
44	**Summer**	58	80	91	Standing	Improved
	Winter	37	61	79	Uncomfortable	Improved
45	**Summer**	58	79	91	Walking	Improved
	Winter	36	59	77	Uncomfortable	Improved

6. CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the methodology, results, and recommendations related to a comparative pedestrian level wind study for the proposed mixed-use development located at 70 Mississauga Road South and 181 Lakeshore Road West in Mississauga, Ontario. The study was performed in accordance with the scope of work described in GWE proposal #17-177P R1, dated July 3, 2018. The work is based on industry standard wind tunnel testing and data analysis procedures, an updated 3D model provided by Giannone Petricone Associates Inc. Architects in October 2018, surrounding street layouts, existing and approved future building massing information obtained from the City of Mississauga, and recent site imagery.

A complete summary of the predicted wind conditions is provided in Sections 5.1 through 5.3 of this report, and illustrated in Figures 1A through 2B. Based on the wind tunnel test results, meteorological data analysis, and experience with similar developments in Mississauga, we conclude that the large majority of grade-level pedestrian-sensitive locations will be suitable for the intended uses throughout the year. During the summer, possible exceptions include windier corner areas adjacent to buildings C, P, T and U if building entrances are desired at these locations. During the winter, exceptions include sidewalks and building access points at these same corner locations, which are intended to be suitable for walking or better. Generic mitigation in the form of wind barriers, canopies, recessed doorway locations, or a combination thereof, are described in Section 5.2.

A comparison of existing versus future conditions indicates that wind conditions over the study site will largely be improved or unchanged in a few areas following construction of the proposed development.

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 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,

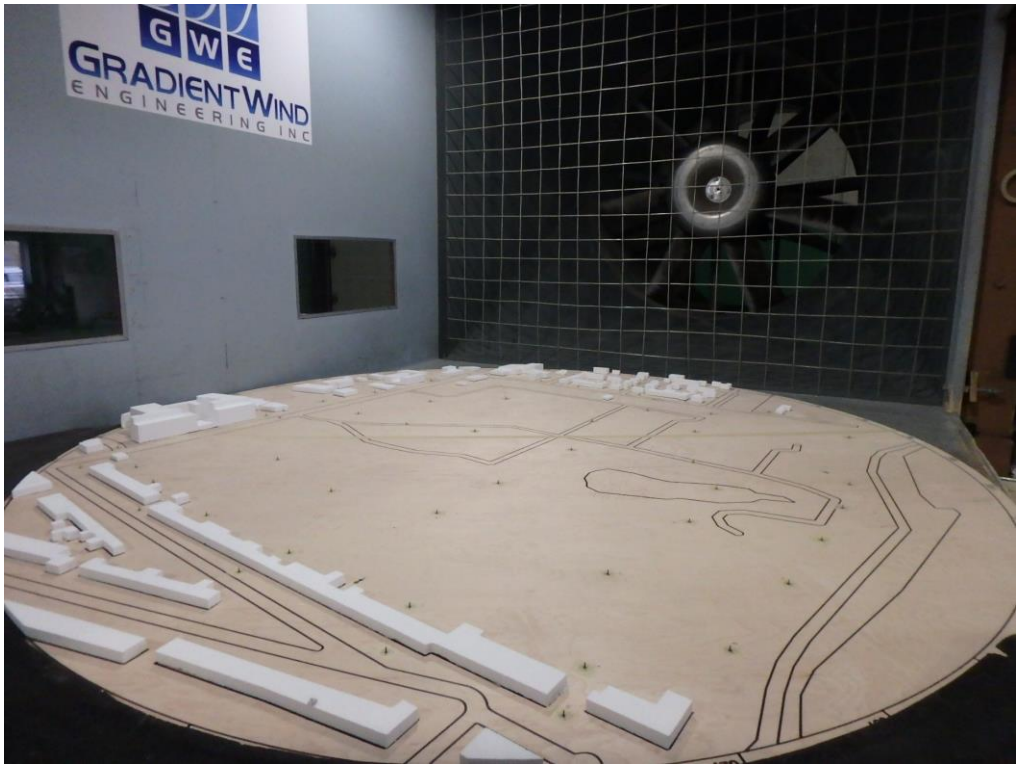
Gradient Wind Engineering Inc.

Justin Ferraro,
Project Manager

Vincent Ferraro, M.Eng., P.Eng.
Managing Principal

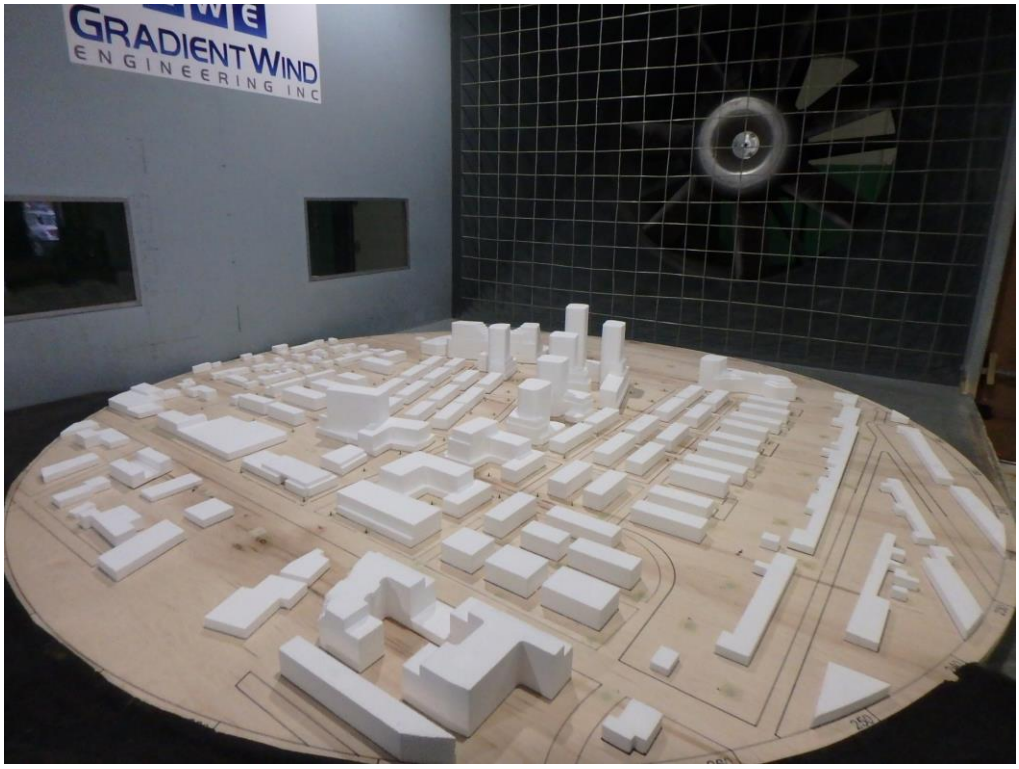
Megan Prescott, MESc.,
Assistant Project Manager

GWE17-112-PLW



PHOTOGRAPH 1: VIEW OF EXISTING CONDITIONS LOOKING DOWNWIND

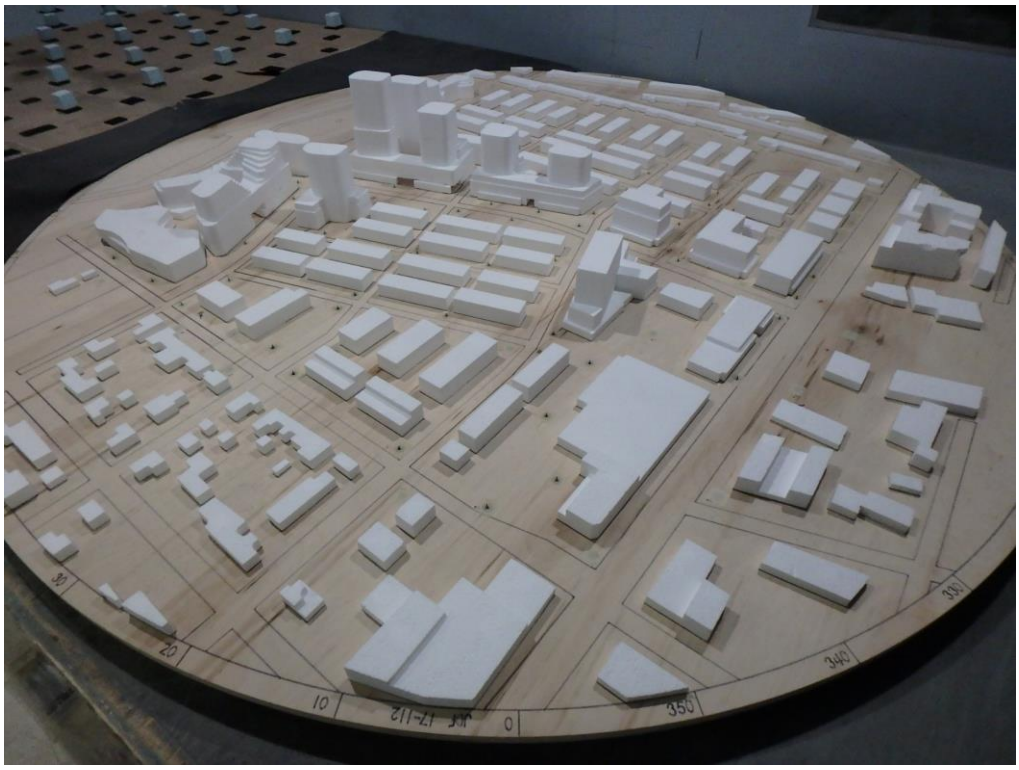
PHOTOGRAPH 2: VIEW OF EXISTING CONDITIONS LOOKING UPWIND



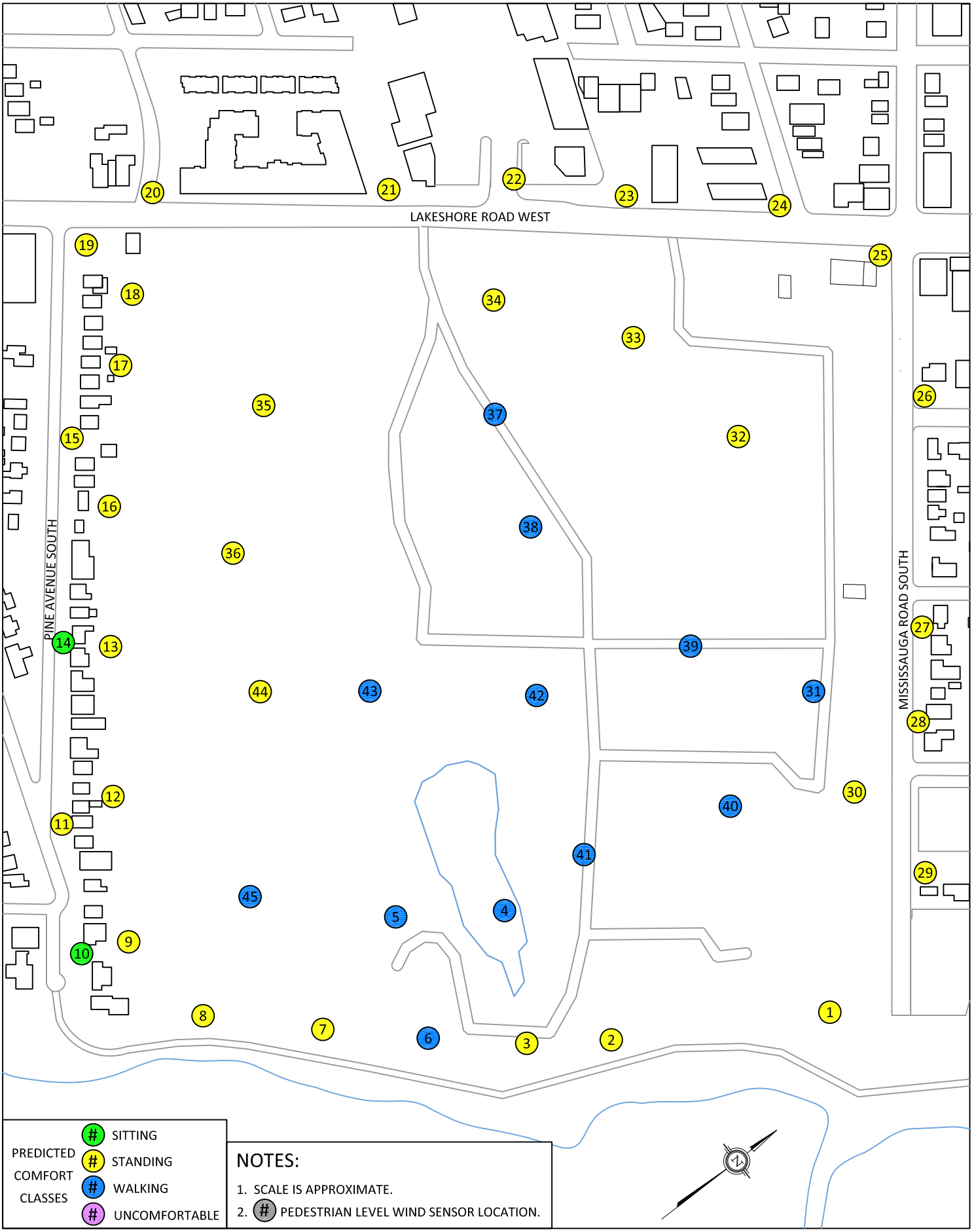
PHOTOGRAPH 3: VIEW OF STUDY MODEL LOOKING DOWNWIND

PHOTOGRAPH 4: CLOSE-UP VIEW OF STUDY MODEL LOOKING UPWIND

PHOTOGRAPH 5: STUDY MODEL LOOKING WEST



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



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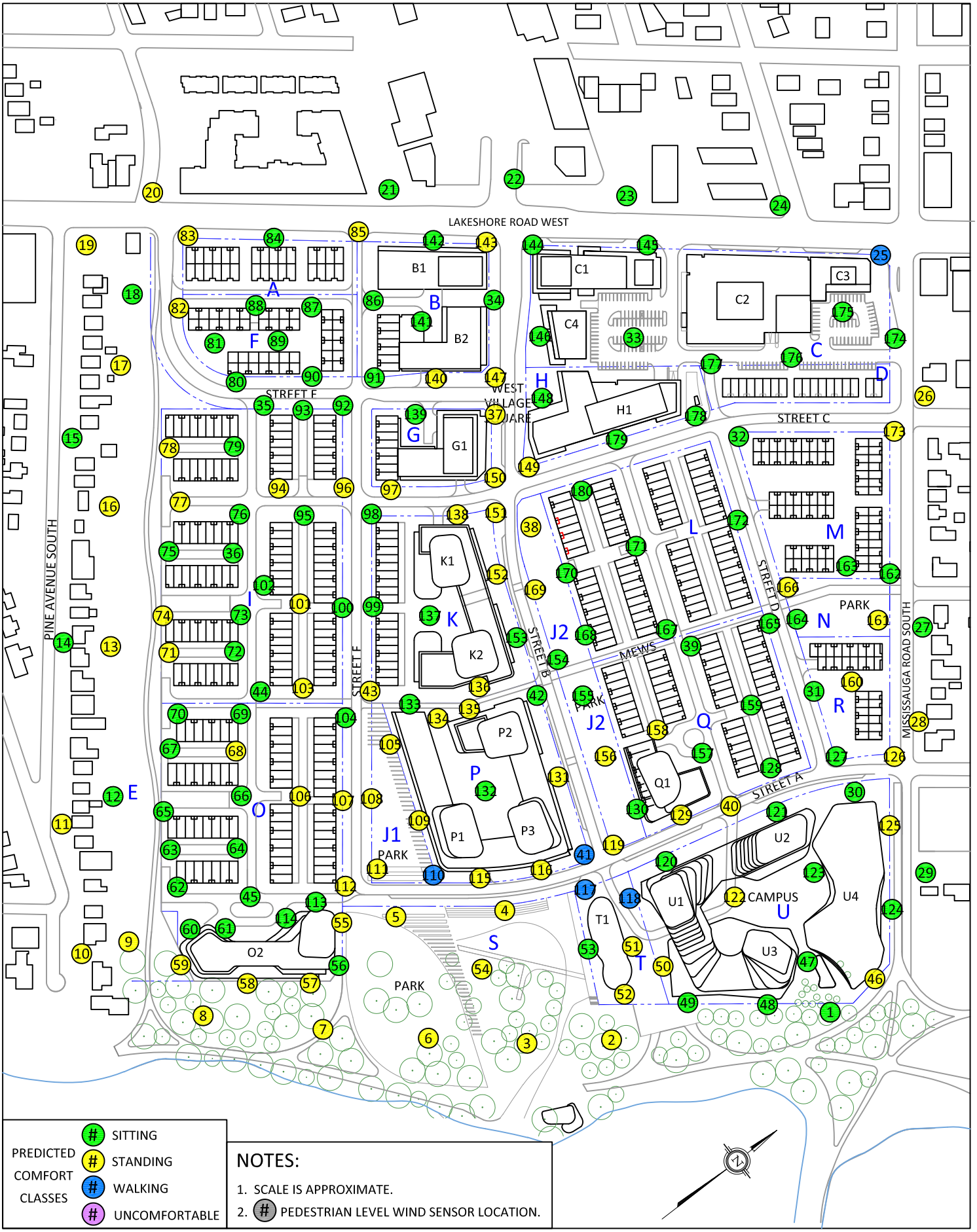
PROJECT	70 MISSISSAUGA ROAD SOUTH, MISSISSAUGA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:3500 (APPROX.)
DRAWING NO.	GWE17-112-PLW-2018-1A
DATE	NOVEMBER 1, 2018
DRAWN BY	K.A.
DESCRIPTION	FIGURE 1A: SUMMER EXISTING SITE PLAN PEDESTRIAN COMFORT PREDICTIONS



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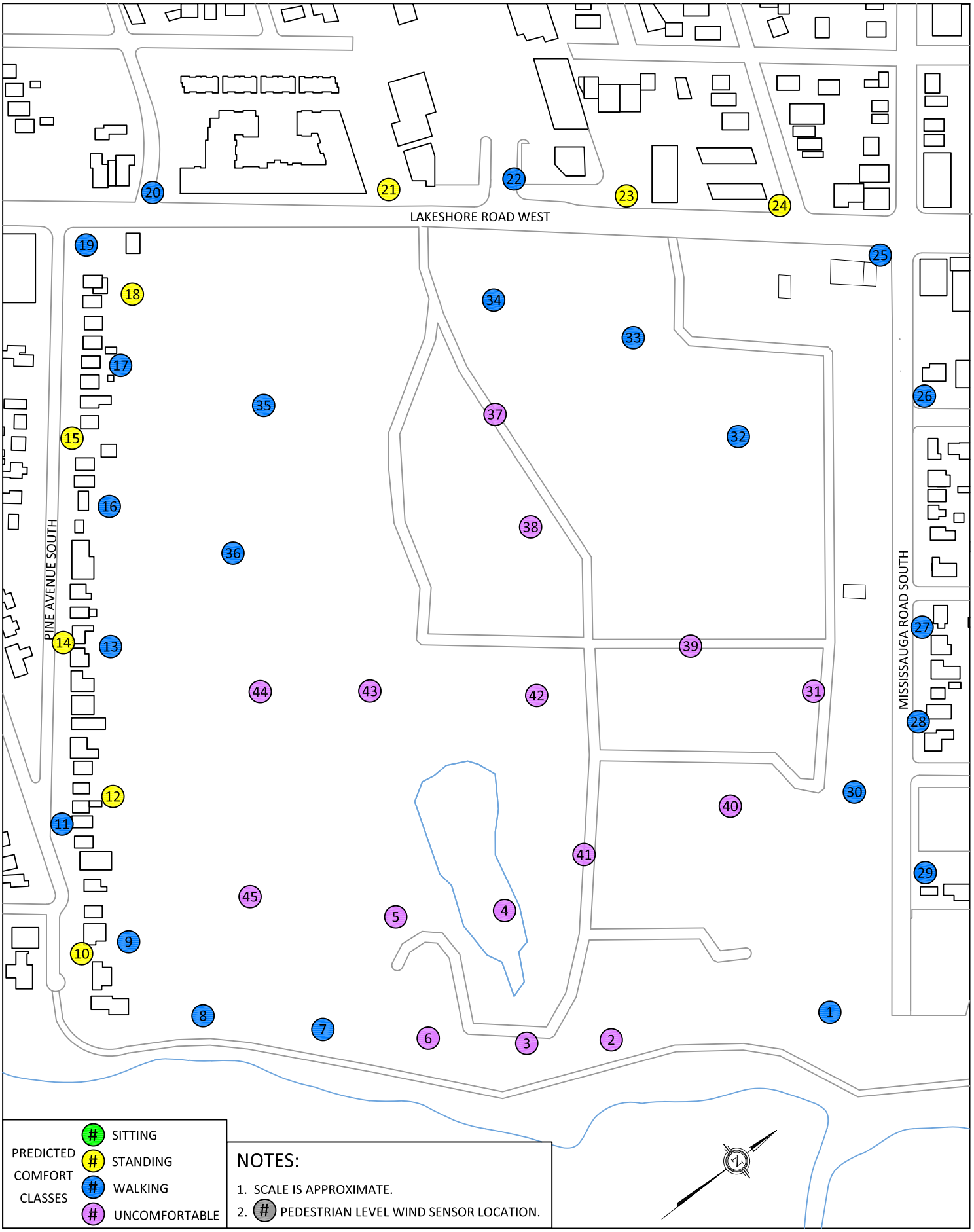
SCALE	1:3500 (APPROX.)
DRAWING NO.	GWE17-112-PLW-2018-1B
DATE	NOVEMBER 1, 2018
DRAWN BY	K.A.
DESCRIPTION	FIGURE 1B: SUMMER FUTURE SITE PLAN PEDESTRIAN COMFORT PREDICTIONS



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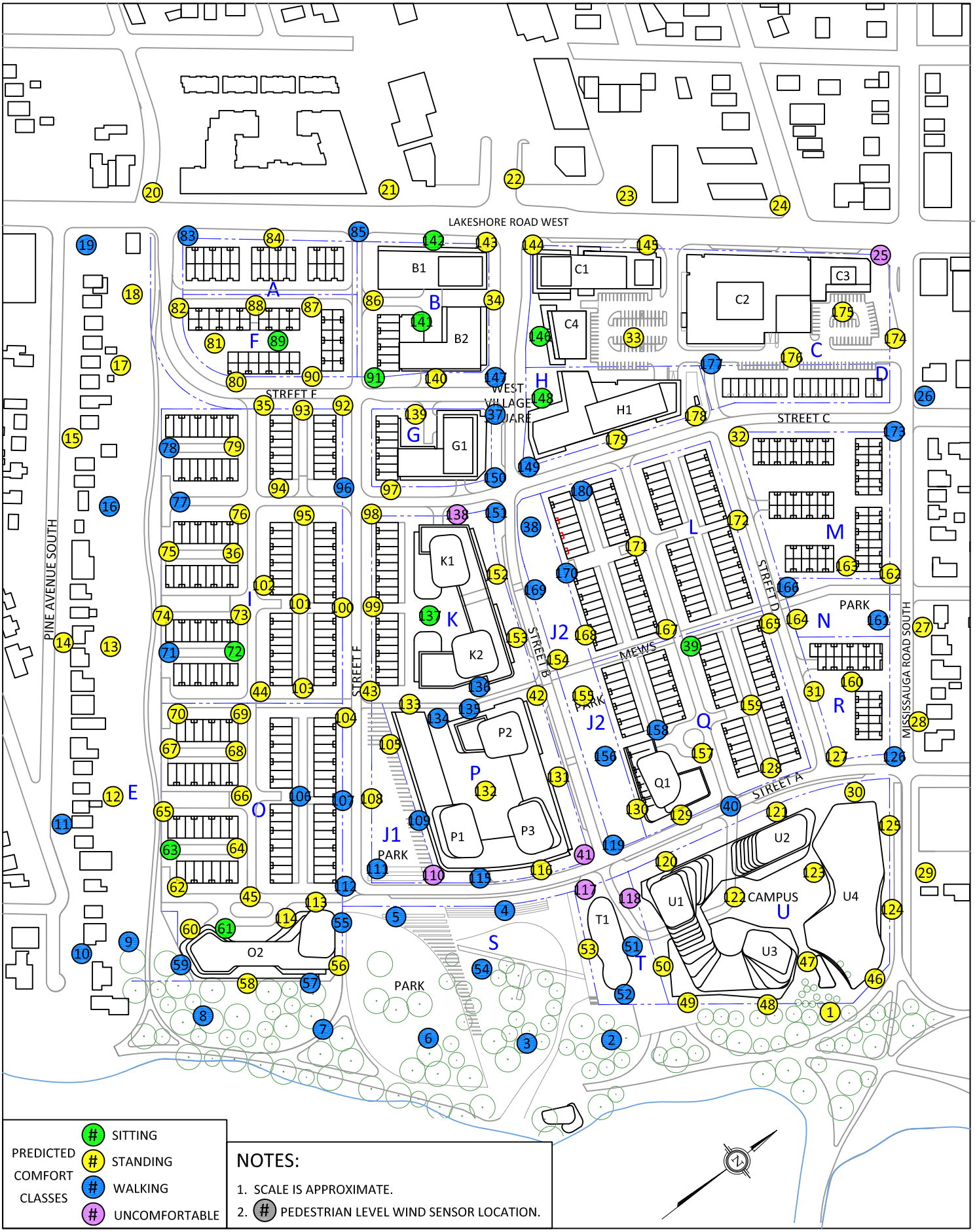
SCALE	1:3500 (APPROX.)
DRAWING NO.	GWE17-112-PLW-2018-2A
DATE	NOVEMBER 1, 2018
DRAWN BY	K.A.

DESCRIPTION

FIGURE 2A: WINTER
EXISTING SITE PLAN
PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES

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

NOTES:

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

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PROJECT	70 MISSISSAUGA ROAD SOUTH, MISSISSAUGA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:3500 (APPROX.)
DRAWING NO.	GWE17-112-PLW-2018-2B
DATE	NOVEMBER 1, 2018
DRAWN BY	K.A.
DESCRIPTION	FIGURE 2B: WINTER FUTURE SITE PLAN PEDESTRIAN COMFORT PREDICTIONS

APPENDIX A

WIND TUNNEL SIMULATION OF THE NATURAL WIND

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 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; $\boldsymbol{U}$ = 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.

Figure A1 plots three such profiles for the open country, suburban and urban exposures.

The exponent α varies according to the type of terrain; α = 0.14, 0.25 and 0.33 for open country, suburban and urban exposures respectively. Figure A2 illustrates the theoretical variation of turbulence in full scale and some wind tunnel measurement for comparison.

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:

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

Where, ***f*** is frequency, ***S(f)*** is the spectrum value at frequency ***f***, U_{10} 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.

References

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2. Flay, R.G., Stevenson, D.C., '*Integral Length Scales In An Atmospheric Boundary Layer Near The Ground*', 9th Australian Fluid Mechanics Conference, Auckland, Dec. 1966

3. ESDU, '*Characteristics of Atmospheric Turbulence Near the Ground*', 74030

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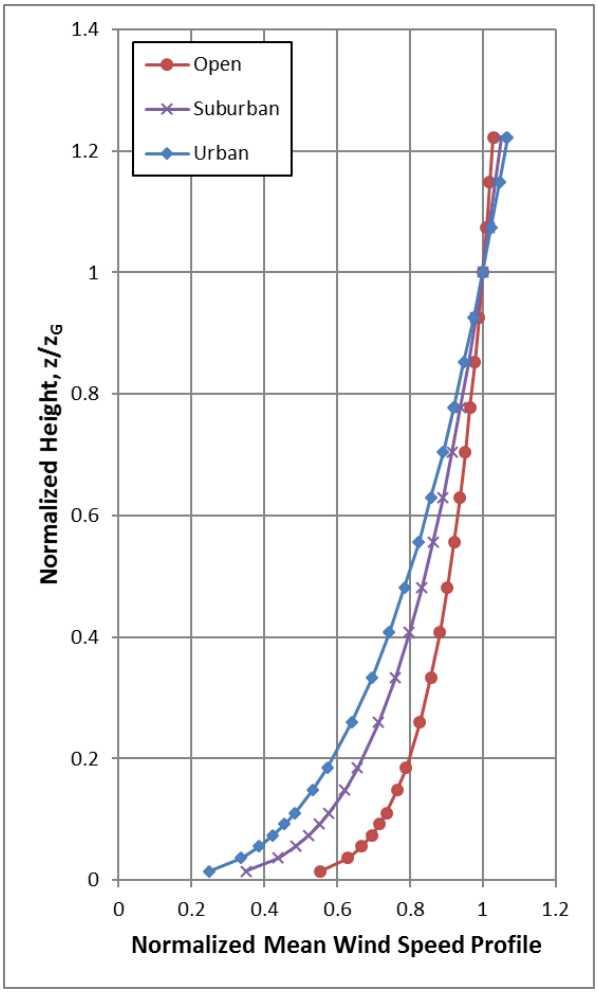


Figure A1: Mean Wind Speed Profiles

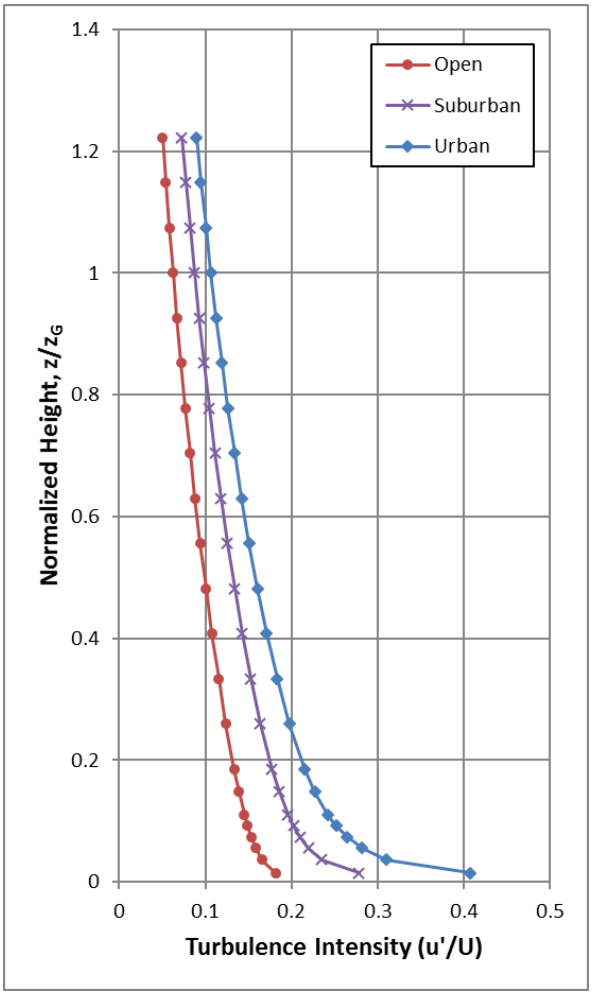


Figure A2: Turbulence Intensity Profiles

APPENDIX B

PEDESTRIAN LEVEL WIND MEASUREMENT METHODOLOGY

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 B1. 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 (> U_g) is the probability, fraction of time, that the gradient wind speed ***U_g*** is exceeded; ***θ*** 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). ***A_θ*** is the fraction of time wind blows from a 10° sector centered on ***θ***.

Analysis of the hourly wind data recorded for a length of time, on the order of 10 to 30 years, yields the ***A_θ***, ***C_θ*** and ***K_θ*** values. The probability of exceeding a chosen wind speed level, say 20 km/h, at sensor *N* is given by the following expression:

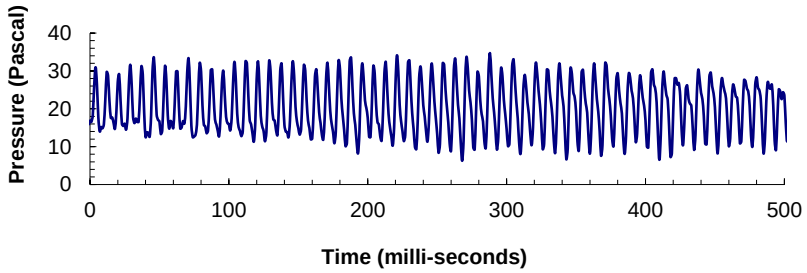
$$P_N(>20) = \Sigma_\theta P\left[\frac{(>20)}{\left(\frac{U_N}{U_g}\right)}\right]$$

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

Where, ***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 B1: TIME VERSUS VELOCITY TRACE FOR A TYPICAL WIND SENSOR



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2. Wu, S., Bose, N., 'An *extended power law model for the calibration of hot-wire/hot-film constant temperature probes*', Int. J. of Heat Mass Transfer, Vol.17, No.3, pp.437-442, Pergamon Press.