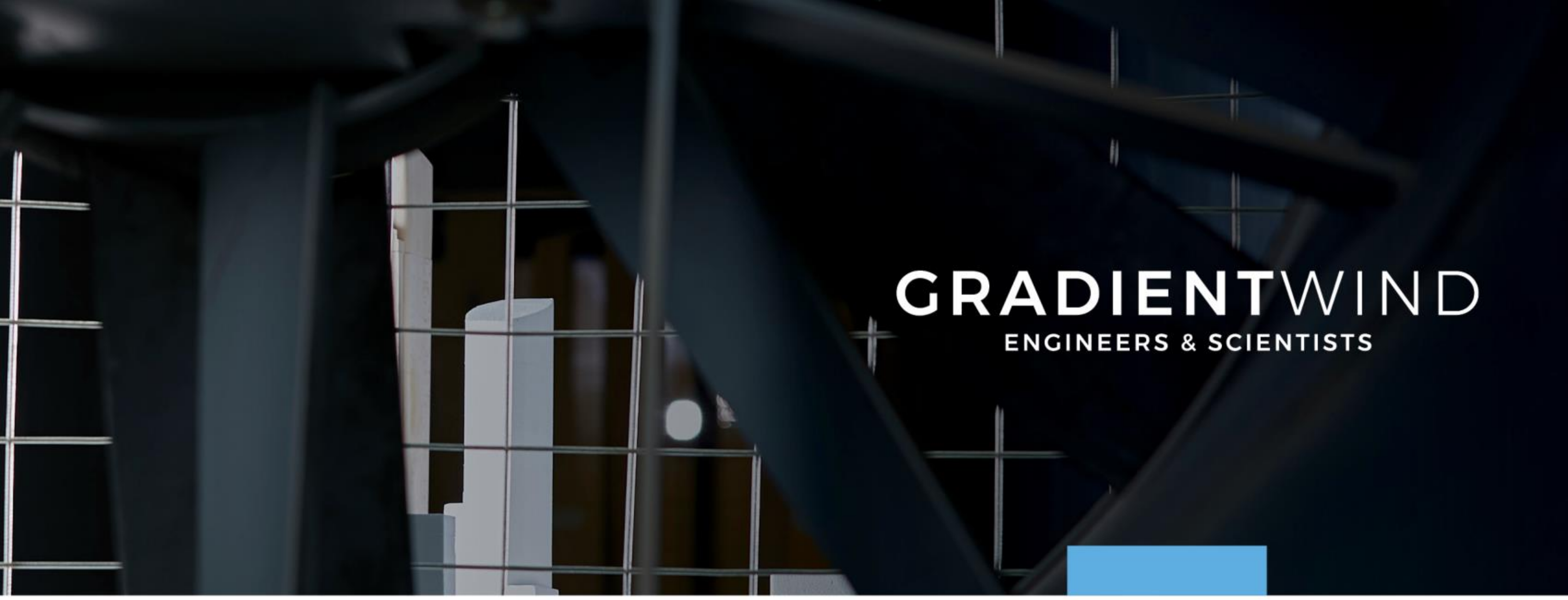
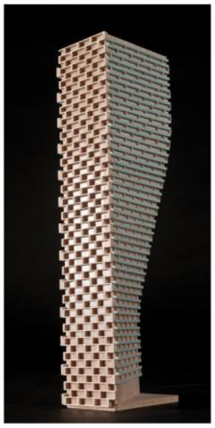
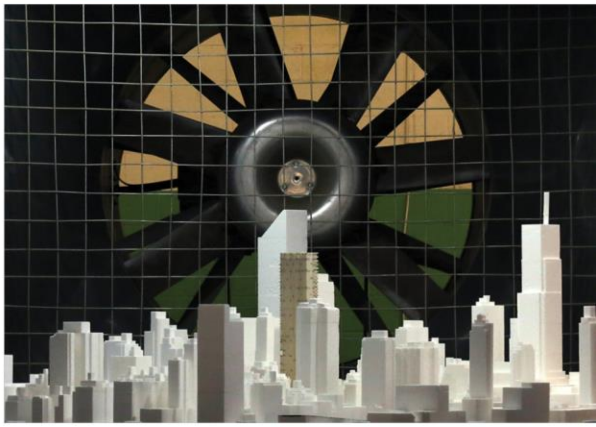


PEDESTRIAN LEVEL WIND STUDY

1694 Upper James Street,
Hamilton, Ontario

REPORT: GW25-099-WTPLW





August 15, 2025

PREPARED FOR
Royal Living Development Group Inc.
1059 Upper James Street, Suite 207
Kitchener, Ontario
L9C 3A6

PREPARED BY
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EXECUTIVE SUMMARY

This report describes a wind tunnel pedestrian level wind study undertaken to assess wind conditions for a proposed mixed-use development located at 1694 Upper James Street, in Hamilton, 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, walkways, laneways, parking areas, nearby private yards, transit stops, landscaped spaces, and building access points. Wind comfort is also evaluated over the Level 3 outdoor amenity terrace. 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 Hamilton wind criteria, architectural drawings provided by KNYMH Architecture + Solutions in July 2025, surrounding street layouts, as well as existing and approved future building massing information obtained from the City of Hamilton, and recent site imagery.

A complete summary of the predicted wind conditions is provided in Section 5 of this report and is also illustrated in Figures 2A through 4B, as well as Tables A1-A2 and B1-B3 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Hamilton, we conclude that the future wind conditions over most grade-level pedestrian wind-sensitive areas within and surrounding the study site will be acceptable for the intended uses on a seasonal basis. Exceptions include a portion of sidewalk along Upper James Street and residential lobby entrance near the southeast corner of the building, and a portion of sidewalk along Malton Drive to the north, for which mitigation is recommended as described in Section 5.2.

Additionally, the majority of the Level 3 outdoor amenity terrace will be comfortable for sitting or more sedentary activities during the summer. However, mitigation is recommended for an isolated windy area, as outlined in Section 5.2.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site, aside from a noted section of the Level 3 outdoor amenity terrace, were found to experience conditions that could be considered unsafe.

TABLE OF CONTENTS

1. INTRODUCTION

This report describes a wind tunnel pedestrian level wind (PLW) study undertaken to assess wind conditions for a proposed mixed-use development located at 1694 Upper James Street, in Hamilton, Ontario. Two configurations were studied: (i) *existing scenario*, including all approved, surrounding developments and without the proposed development, and (ii) *proposed scenario* with the proposed development in place. The study was performed in accordance with industry standard wind tunnel testing techniques, City of Hamilton wind criteria, architectural drawings provided by KNYMH Architecture + Solutions in July 2025, 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 wind tunnel pedestrian wind study is the proposed mixed-use development located at 1694 Upper James Street, Hamilton, Ontario. The study site is situated on the east edge of a parcel of land bounded by Upper James Street to the east, Malton Drive to the north, Christie Street to the west, and Alderson Drive to the south.

The study building comprises two approximately “L”-shaped 12-storey towers with a 2-storey connection, longitudinally aligned with Upper James Street. One level of below-grade parking is accessed from the centre of the covered surface level parking, open to a laneway on the west side of the study building. At grade, the building contains lobby and indoor amenity space along the north and south elevations, with commercial space along Upper James Street, as well as surface level parking contained within the centre of the approximate “C” shape of the building. At Level 2, the north, east, and south elevations contain residential units, while the centre and west side of the building contains above grade parking. At Level 3, the west and east elevations set back through the centre to accommodate an outdoor amenity terrace, with the building splitting into the two towers on the north and south elevations of the building, which continue containing residential units. From Level 3 to Level 7, the towers rise with uniform floor plate and protruding balcony configurations, before the west elevations set back at Levels 8 and 10. Above Level 10, the towers rise with uniform floorplates to Level 12, where mechanical penthouses complete the development.

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 primarily by low-rise buildings in all directions with Corpus Christi Catholic Elementary School is located to the south. The far-field surroundings (defined as the area beyond the near field and within a two-kilometer radius) are generally characterized by a mixture of low-rise suburban and open exposure in all directions, with William Connell Park located approximately 930 metres distant to the northwest quadrant, the Olmstead Park located approximately 630 metres distant to the northeast quadrant, the Mount Hamilton Cemetery located approximately 920 metres distant to the east quadrant, and Turner Park located approximately 1.2 kilometres distant in the southeast quadrant.

Grade-level areas investigated include sidewalks, walkways, laneways, parking areas, nearby private yards, transit stops, landscaped spaces, and building access points. Wind comfort is also evaluated over the Level 3 outdoor amenity terrace. Figures 1A and 1B illustrates the *existing* and *proposed* study sites and surrounding context, 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 Hamilton area wind climate and synthesis of wind tunnel data with industry-accepted guidelines. 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 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 75 sensor locations on the scale model in Gradient Wind's wind tunnel at grade. Wind speed measurements were performed for each of the 75 sensors for 36 wind directions at 10° intervals. Figures 1A and 1B illustrates the *existing* and *proposed* study sites and surrounding context, respectively, while sensor locations used to investigate wind conditions are illustrated in Figures 2A through 4B.

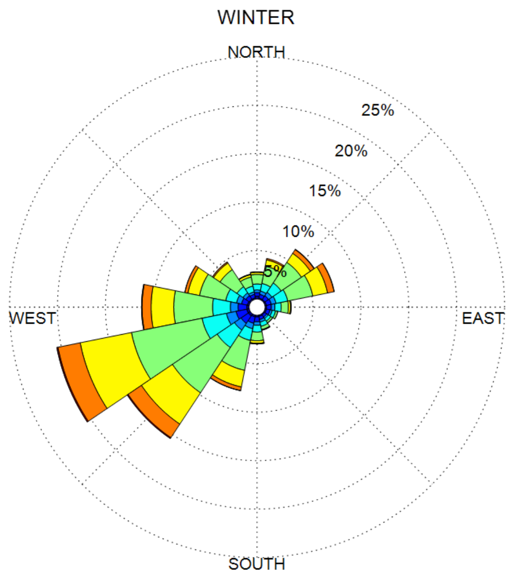
Mean and peak wind speed values for each location and wind direction were calculated from real-time pressure measurements, recorded at a sample rate of 500 samples per second, and taken over a 60-second time period. This period at model-scale corresponds approximately to one hour in full-scale, which 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.

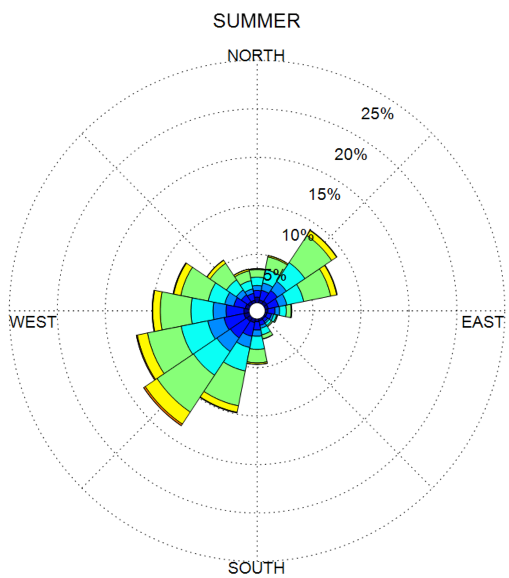
4.3 Meteorological Data Analysis

A statistical model for winds in Hamilton was developed from approximately 40-years of hourly meteorological wind data recorded at John C. Munro Hamilton 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. Following the Terms of Reference: Pedestrian Level Wind Study for Downtown Hamilton, the year is represented by a two-season model, and not according to the traditional calendar method.

The statistical model of the Hamilton area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate 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 Hamilton, the most common winds concerning pedestrian comfort occur from the southwest, followed by those from the-northeast. 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 winter.

SEASONAL DISTRIBUTION OF WINDS FOR VARIOUS PROBABILITIES
JOHN C. MUNRO HAMILTON INTERNATIONAL AIRPORT, HAMILTON, ONTARIO





Notes:

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

4.4 Pedestrian Comfort and Safety Guidelines

Pedestrian comfort and safety guidelines are based on the mechanical effects of wind without consideration of other meteorological conditions (i.e. temperature, relative humidity). The comfort guidelines assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Four pedestrian comfort classes are based on 80% non-exceedance Guest Equivalent Mean (GEM) wind speed ranges, which include (i) Sitting; (ii) Standing; (iii) Strolling, (iv) Walking; and (v) Uncomfortable. More specifically, the comfort classes and associated GEM wind speed ranges are summarized as follows:

(i) **Sitting** – A wind speed below 10 km/h (i.e. 0 – 10 km/h) would be considered acceptable for sedentary activities, including sitting.

(ii) **Standing** – A wind speed below 14 km/h (i.e. 10 km/h – 14 km/h) is acceptable for activities such as standing.

(iii) **Strolling** – A wind speed below 17 km/h (i.e. 14 km/h – 17 km/h) is acceptable for activities such as strolling.

(iv) **Walking** – A wind speed below 20 km/h (i.e. 17 km/h – 20 km/h) is acceptable for walking or more vigorous activities.

(v) **Uncomfortable** – A wind speed over 20 km/h is classified as uncomfortable from a pedestrian comfort standpoint. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

The pedestrian safety wind speed guideline is based on the approximate threshold that would cause a vulnerable member of the population to fall. A 0.1% exceedance gust wind speed of greater than 90 km/h is classified as dangerous.

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if wind speeds of 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 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 at tested locations, 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 represented by the sensor (i.e. a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their desired comfort classes are summarized below.

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 / Strolling
Outdoor Amenity Spaces	Sitting / Standing
Cafés / Patios / Benches / Gardens	Sitting / Standing / Strolling
Plazas	Strolling
Transit Stops	Standing
Public Parks	Sitting / Walking
Garage / Service Entrances	Walking
Vehicular Drop-Off Zones	Walking
Laneways / Loading Zones	Walking

5. RESULTS AND DISCUSSION

Tables A1 through A2 in Appendix A provide a summary of seasonal comfort predictions for each sensor location under the *existing* massing scenario. Similarly, Tables B1 through B3 in Appendix B provide the seasonal comfort predictions for under the *proposed* massing scenario. The tables indicate the 80% non-exceedance GEM wind speeds and corresponding comfort classifications as defined in Section 4.4. In other words, a wind speed threshold of 19.1 for the summer season indicates that 80% of the measured data falls at or below 19.1 km/h during the summer months and conditions are therefore suitable for walking, as the 80% threshold value falls within the exceedance range of 17-20 km/h for walking. 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, strolling, walking, etc.).

The most significant findings of the PLW study are summarized in Sections 5.1 and 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 4B. Conditions suitable for sitting are represented by the colour blue, while standing is represented by green, strolling by yellow, and walking by orange. Conditions considered uncomfortable for walking are represented by the colour magenta. For locations where the wind safety criterion is exceeded, the sensor is highlighted in red.

5.1 Pedestrian Comfort Suitability – *Existing Scenario*

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables A1-A2 in Appendix A and illustrated in Figures 2A through 2B, this section summarizes the significant findings of the PLW study with respect to the *existing scenario*, as follows:

1. All public sidewalks, walkways, laneways, parking areas, nearby private yards, and landscaped spaces within and surrounding the proposed development currently experience wind conditions suitable for walking or better during each seasonal period.
2. Nearby private yards will experience wind conditions suitable for walking or better throughout the year.

3. Nearby transit stops on the northeast (Sensor 1) and southwest (Sensor 41) corner of Malton Drive and Upper James Street currently experience conditions comfortable for standing in the summer and strolling in the winter.

4. The tested area of the Corpus Christ Catholic Elementary School yard (Sensor 15) is currently comfortable for standing during the summer and strolling during the winter.

5. 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.

5.2 Pedestrian Comfort Suitability – *Proposed Scenario*

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables B1-B3 in Appendix B and illustrated in Figures 3A through 4B, this section summarizes the significant findings of the PLW study with respect to the *proposed scenario*, as follows:

1. Most public sidewalks, parking areas, walkways, laneways, and landscaped spaces within and surrounding the proposed development will experience wind conditions suitable for walking or better during each seasonal period, which is acceptable for the intended uses of the spaces. Exceptions include a portion of sidewalk along Upper James Street to the southeast (Sensors 9-14, 49 & 50), and along Malton Drive to the north (Sensor 30) that experience conditions uncomfortable for walking during the winter. It is notable that all areas achieve the annual safety criterion, and many exceedances of the walking threshold are marginal (<1km/h exceedance, see Appendix B).

   For the remaining areas (Sensors 30 and 14), it is recommended to incorporate staggered vertical wind barriers at the northwest and southeast corners of the proposed development. Barriers may take the form of dense coniferous/marcescent plantings, high-solidity windscreens, or a combination thereof, and should rise at least 2.0 metres at the time of installation. The exact composition and configuration of such mitigation can be coordinated with the team as the design progresses.

2. All nearby private yards will experience wind conditions suitable for strolling or better during each seasonal period, which is acceptable for the intended uses of the spaces, and represents a marginal improvement when compared to the *existing* scenario.

3. Nearby transit stops on the northeast (Sensor 1) and southwest (Sensor 41) corner of Malton Drive and Upper James Street will experience conditions comfortable for standing or better in the summer and strolling or better in the winter. It is notable that these conditions are marginally improved from the *existing* scenario, and are considered acceptable.

4. Of the primary building access points throughout the development, the retail entrances (Sensors 41, 42, 46 & 47), along with the residential lobby access point along the northeast elevation (Sensor 39) will experience standing or better conditions throughout the year, which is acceptable.

   The south residential lobby entrance (Sensor 50) will experience standing conditions during the summer, and uncomfortable conditions during the winter. This entrance will benefit from the mitigation recommended for the nearby sidewalk in Item 1 above, but to ensure the noted entrance will be comfortable for standing during each seasonal period, it is recommended to recess the entrance into the building façade or flank the doorway with vertical wind barriers. Barriers may take the form of dense coniferous plantings, high-solidity windscreens, or a combination thereof, and should rise at least 2.0 metres at the time of installation. The exact composition and configuration of such mitigation can be coordinated with the team as the design progresses.

5. All secondary building access points (Sensors 44, 48, 51-53 & 64) throughout the development will be comfortable for strolling or better throughout the year, which is acceptable.

6. Most of the Level 3 outdoor amenity terrace (Sensors 66-75) will experience conditions comfortable for sitting during the summer. Exceptions include standing conditions isolated to the centre of the terrace (Sensor 75), and uncomfortable, dangerous conditions isolated to the terrace space between the two towers (Sensor 71). It is notable that the standing condition exceedance of the sitting threshold is marginal (<2km/h exceedance, see Appendix B), therefore these conditions (Sensor 75) are considered acceptable.

Due to uncomfortable and dangerous conditions at Sensor 71 from the prominent westerly winds channeling between the towers, it is recommended to avoid pedestrian access over this area, if possible. If pedestrian usage is desired, it is recommended to raise the east perimeter guard to 2.4 metres above the walking surface. It is also recommended to provide overhead protection, such as canopies or pergolas along the adjacent tower façades to protect from downwash flows, and staggered vertical wind barriers throughout the space, to deter westerly winds from channeling between the towers.

7. Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site, apart from the noted section of the Level 3 outdoor amenity terrace, were found to experience wind conditions that are considered unsafe.

6. CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the methodology, results, and recommendations related to a pedestrian level wind study for the proposed mixed-use development located at 1694 Upper James Street, in Hamilton, 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 of this report and is also illustrated in Figures 2A through 4B, as well as Tables A1-A2 and B1-B3 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Hamilton, we conclude that the future wind conditions over most grade-level pedestrian wind-sensitive areas within and surrounding the study site will be acceptable for the intended uses on a seasonal basis. Exceptions include a portion of sidewalk along Upper James Street and residential lobby entrance near the southeast corner of the building, and a portion of sidewalk along Malton Drive to the north, for which mitigation is recommended as described in Section 5.2.

Additionally, the majority of the Level 3 outdoor amenity terrace will be comfortable for sitting or more sedentary activities during the summer. However, mitigation is recommended for an isolated windy area, as outlined in Section 5.2.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site, aside from a noted section of the Level 3 outdoor amenity terrace, 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,

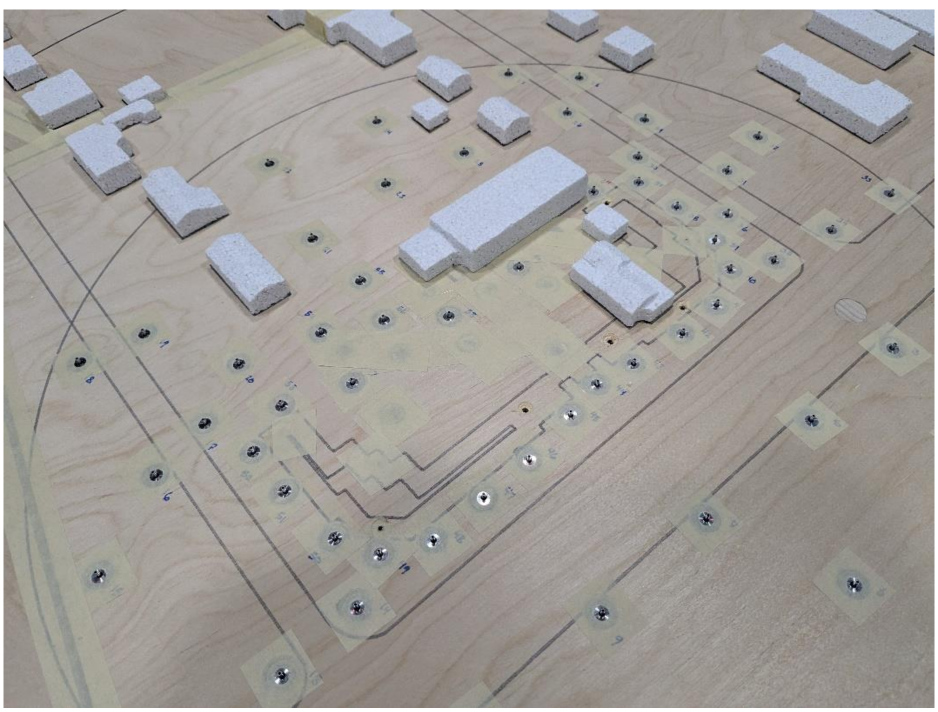
Gradient Wind Engineering Inc.

Lauren Thomas, B.ASc.
Junior Wind Scientist

Angelina Gomes, P.Eng.,
Wind Engineer

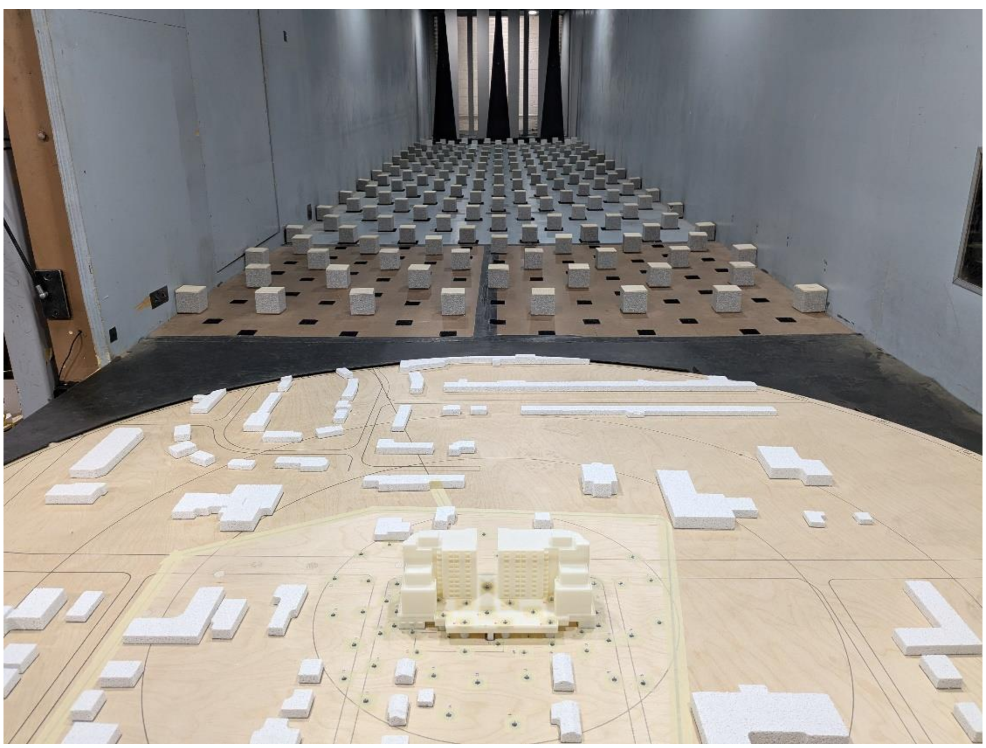
GW25-099-WTPLW

PHOTOGRAPH 1: CLOSE-UP VIEW OF <u>EXISTING</u> CONTEXT MODEL LOOKING SOUTHEAST

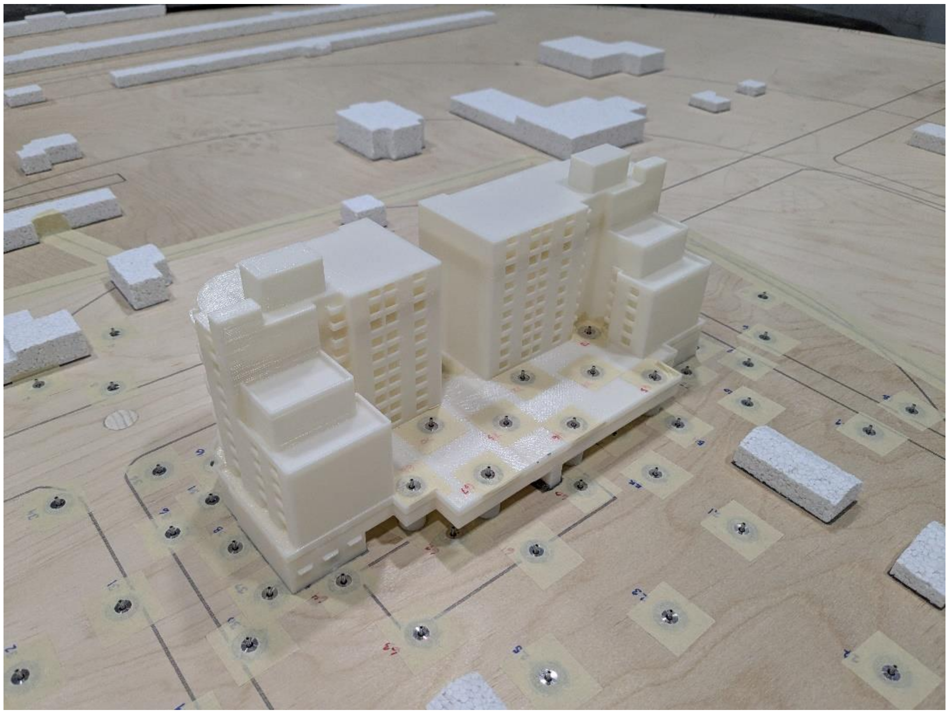


PHOTOGRAPH 2: CLOSE-UP VIEW OF <u>EXISTING</u> CONTEXT MODEL LOOKING NORTHWEST

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

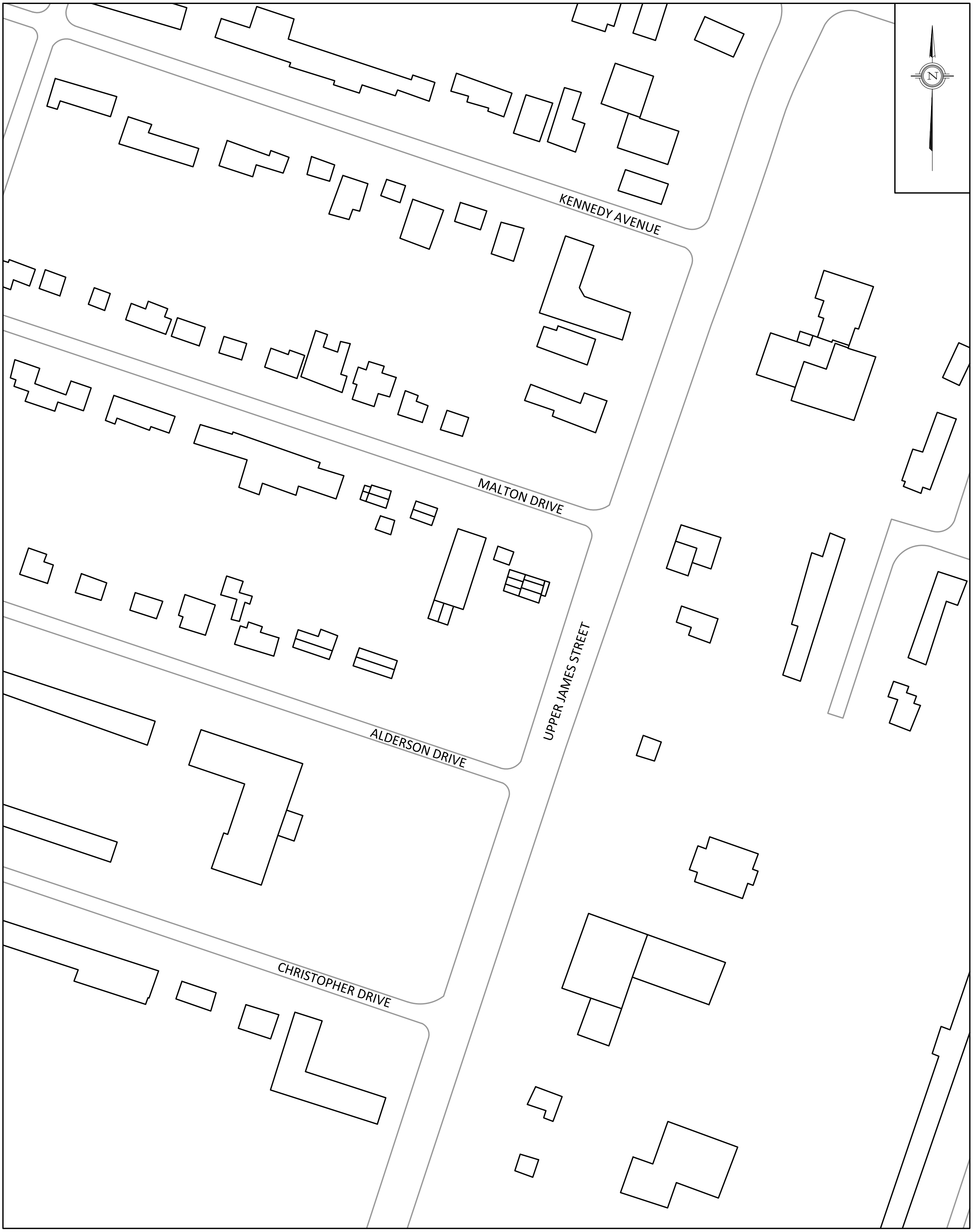


PHOTOGRAPH 4: PROPOSED STUDY MODEL INSIDE THE GWE WIND TUNNEL LOOKING UPWIND



PHOTOGRAPH 5: CLOSE-UP VIEW OF <u>PROPOSED</u> STUDY MODEL LOOKING SOUTHEAST

PHOTOGRAPH 6: CLOSE-UP VIEW OF <u>PROPOSED</u> STUDY MODEL LOOKING NORTHWEST



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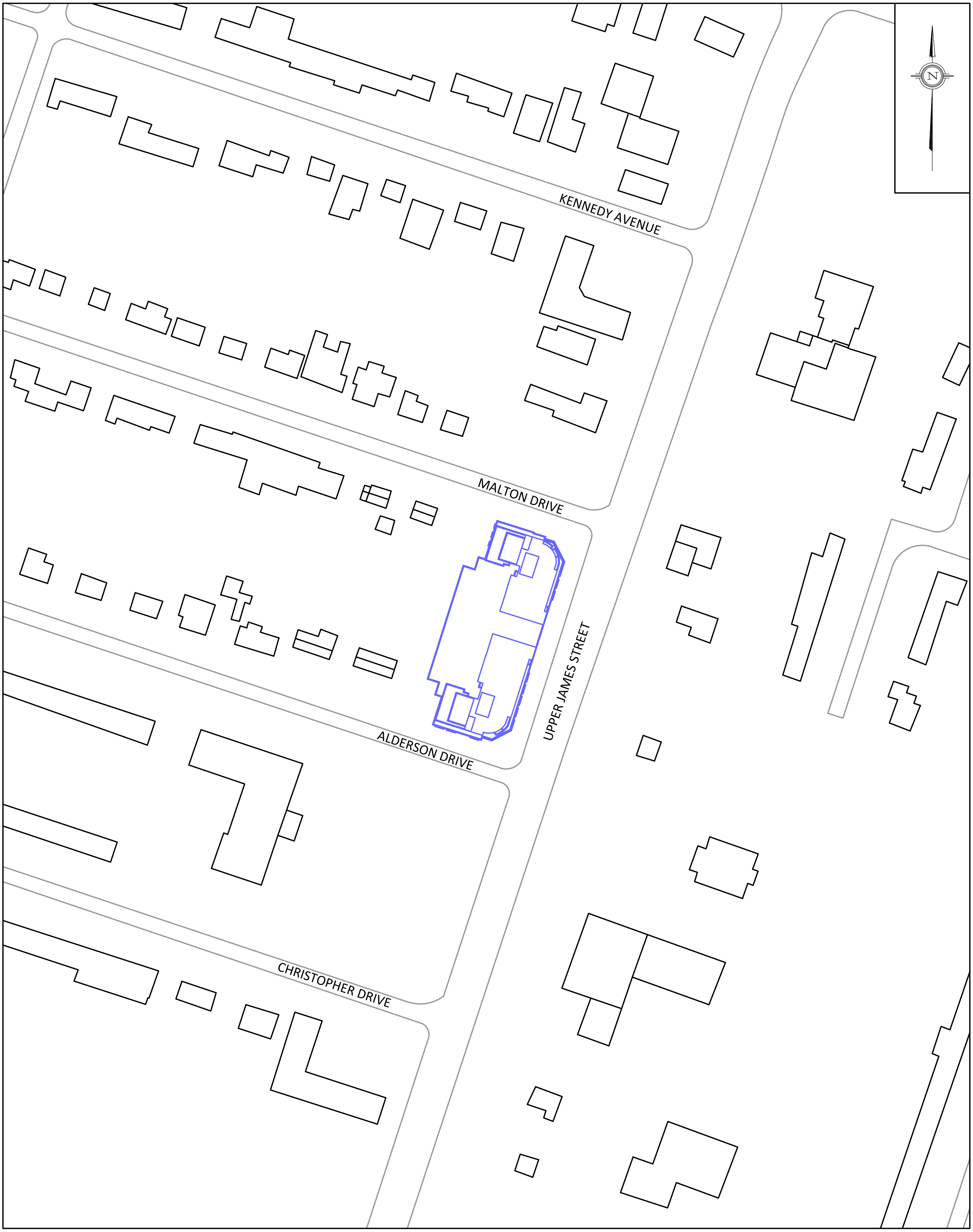
PROJECT	1694 UPPER JAMES STREET, HAMILTON PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500 (APPROX.)	DRAWING NO.	GW25-099-PLW-1A
DATE	AUGUST 15, 2025	DRAWN BY	K.A.

DESCRIPTION

FIGURE 1A:
EXISTING SCENARIO
AND SURROUNDING CONTEXT



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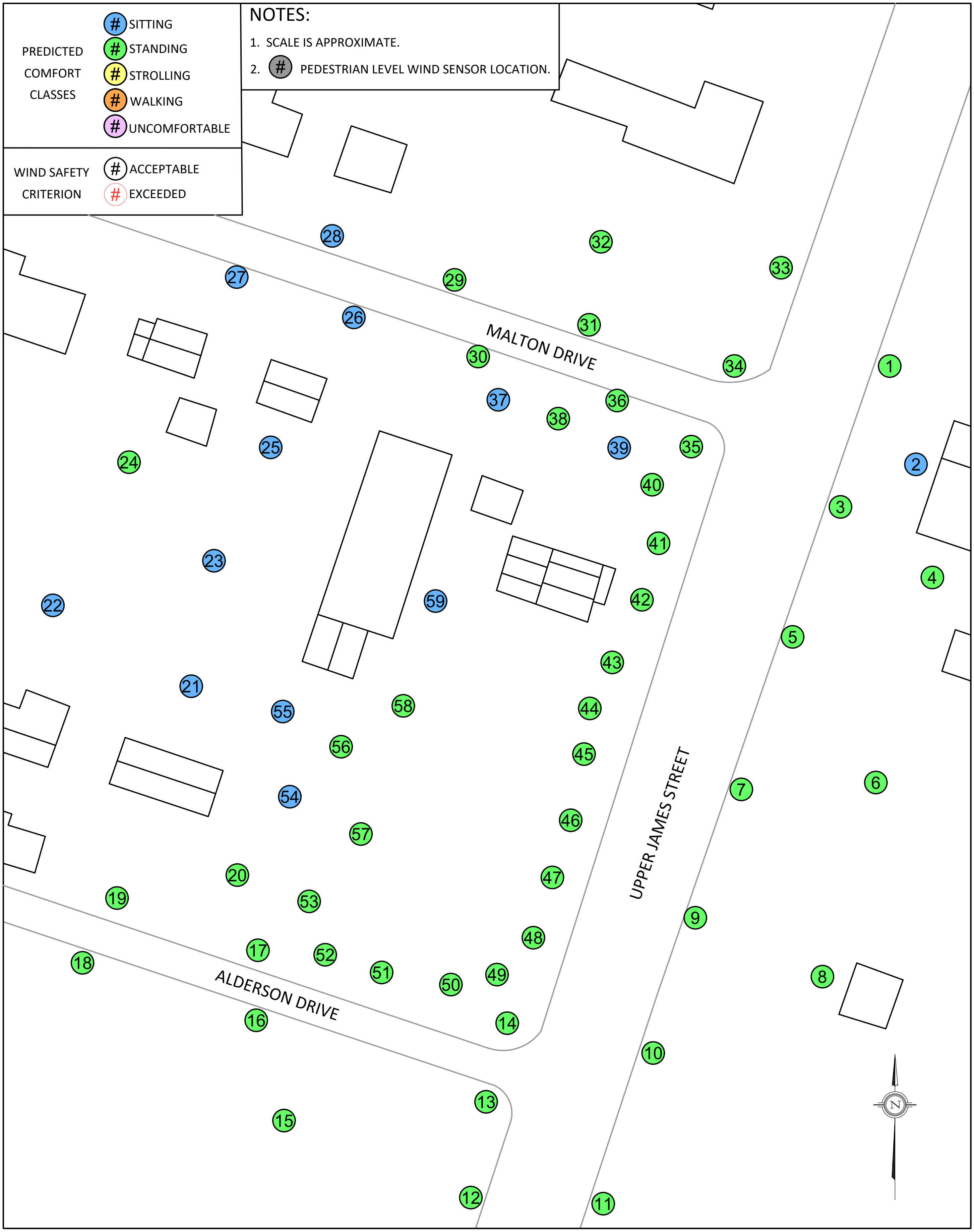
PROJECT	1694 UPPER JAMES STREET, HAMILTON PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500 (APPROX.)	DRAWING NO.	GW25-099-PLW-1B
DATE	AUGUST 15, 2025	DRAWN BY	K.A.

DESCRIPTION

FIGURE 1B:
FUTURE SCENARIO
AND SURROUNDING CONTEXT



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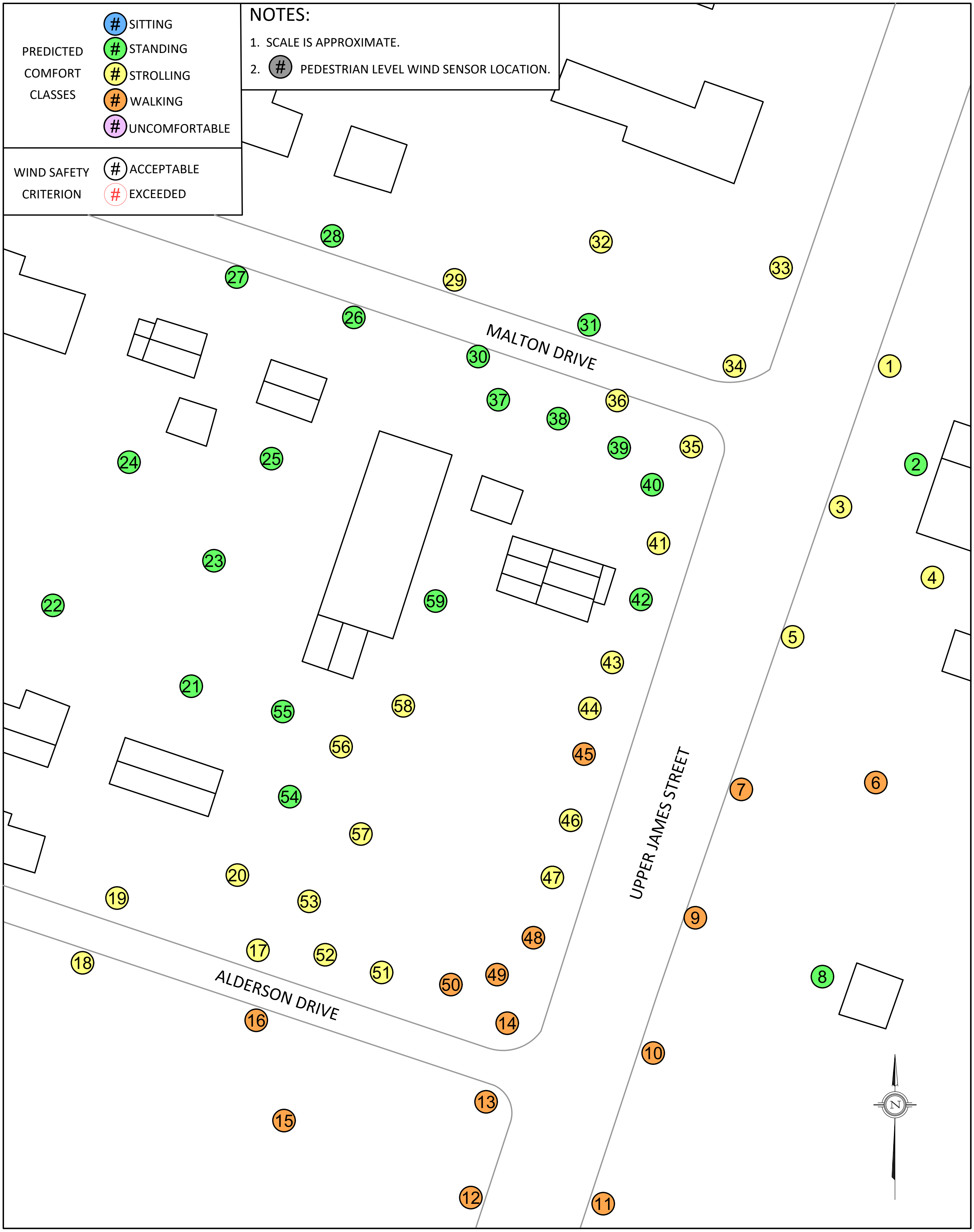
PROJECT	1694 UPPER JAMES STREET, HAMILTON PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION FIGURE 2A: SUMMER EXISTING GRADE LEVEL PLW SENSOR LAYOUT PEDESTRIAN COMFORT PREDICTIONS
SCALE	1:970 (APPROX.)	DRAWING NO. GW25-099-PLW-2B	
DATE	AUGUST 15, 2025	DRAWN BY K.A.	



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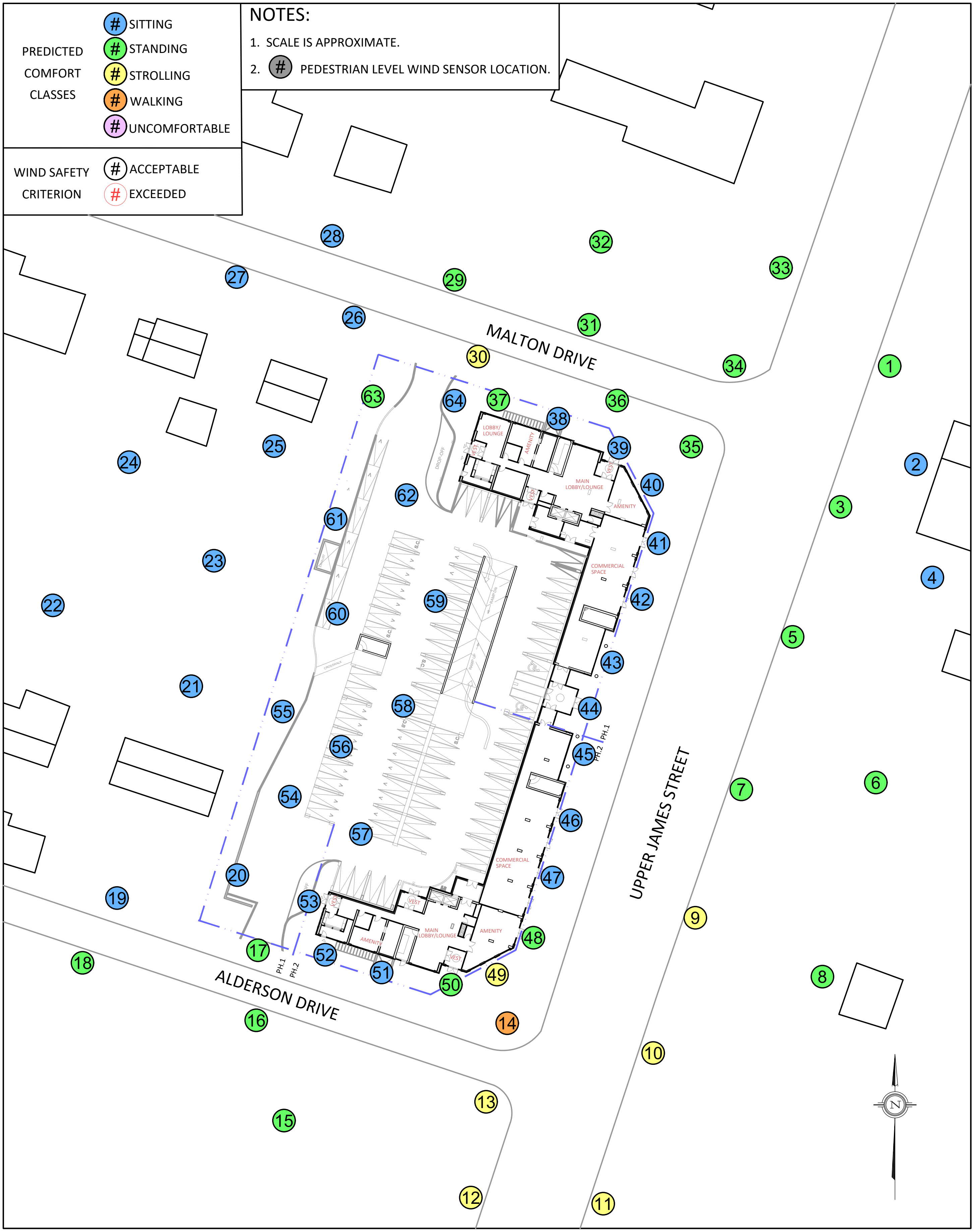
PROJECT: 1694 UPPER JAMES STREET, HAMILTON PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 2B: WINTER EXISTING GRADE LEVEL PLW SENSOR LAYOUT PEDESTRIAN COMFORT PREDICTIONS	
SCALE: 1:970 (APPROX.)	DRAWING NO.: GW25-099-PLW-2D		
DATE: AUGUST 15, 2025	DRAWN BY: K.A.		

PREDICTED COMFORT CLASSES	#	SITTING
	#	STANDING
	#	STROLLING
	#	WALKING
	#	UNCOMFORTABLE
WIND SAFETY CRITERION	#	ACCEPTABLE
	#	EXCEEDED

NOTES:

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



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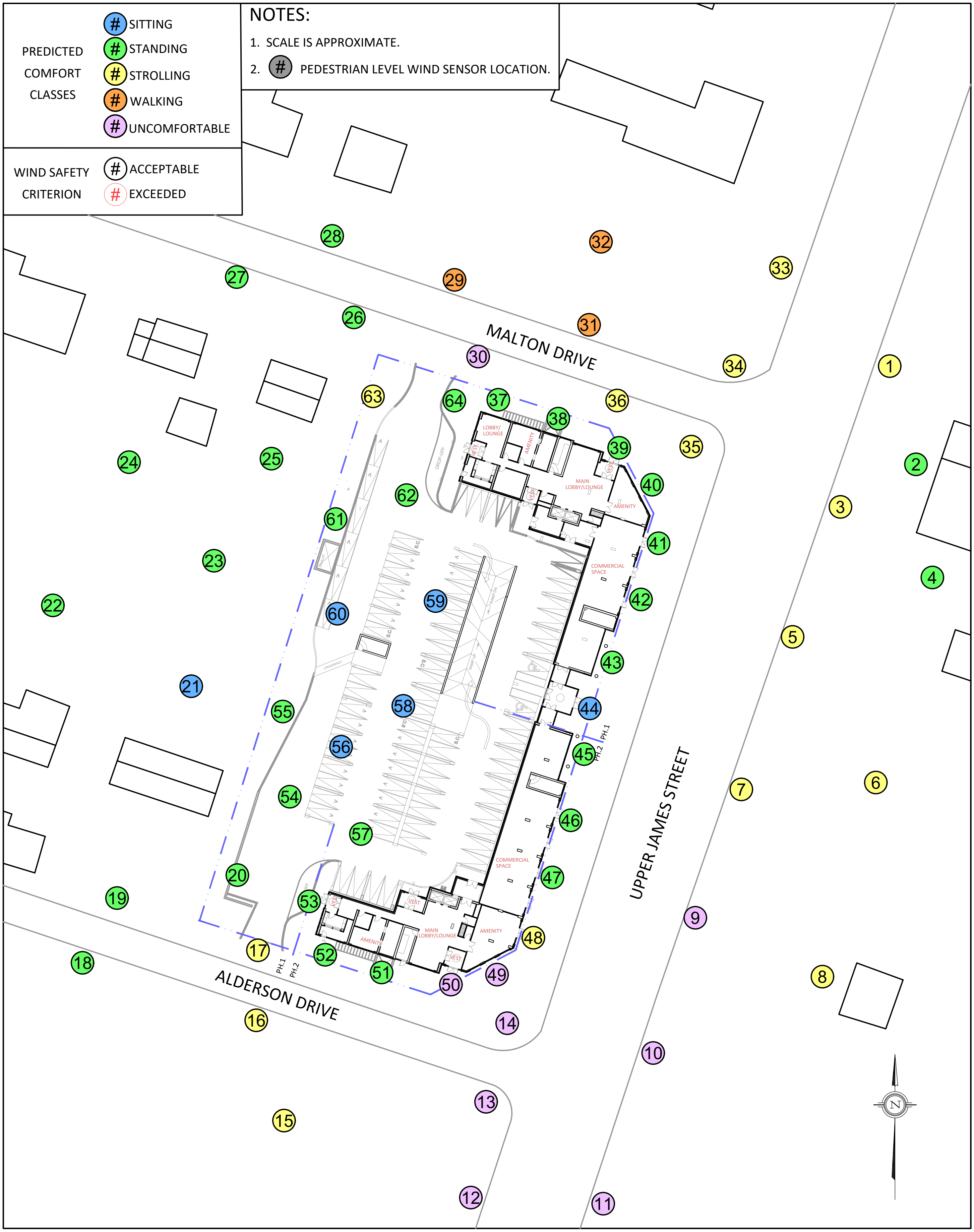
PROJECT	1694 UPPER JAMES STREET, HAMILTON PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:970 (APPROX.)	DRAWING NO.	GW25-099-PLW-3B
DATE	AUGUST 15, 2025	DRAWN BY	K.A.

DESCRIPTION

FIGURE 3A: SUMMER
FUTURE GRADE LEVEL PLW SENSOR LAYOUT
PEDESTRIAN COMFORT PREDICTIONS



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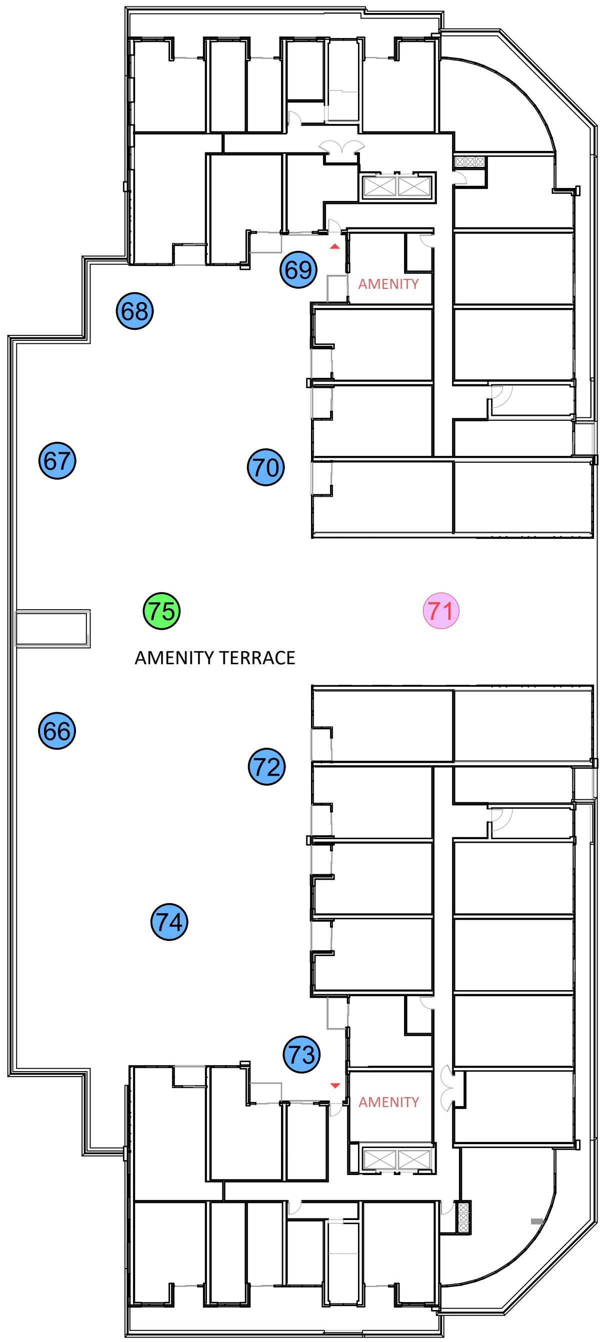
PROJECT	1694 UPPER JAMES STREET, HAMILTON PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 3B: WINTER FUTURE GRADE LEVEL PLW SENSOR LAYOUT PEDESTRIAN COMFORT PREDICTIONS
SCALE	1:970 (APPROX.)	DRAWING NO. GW25-099-PLW-3D	
DATE	AUGUST 15, 2025	DRAWN BY K.A.	

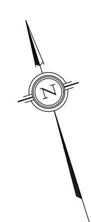
PREDICTED COMFORT CLASSES	
#	SITTING
#	STANDING
#	STROLLING
#	WALKING
#	UNCOMFORTABLE

WIND SAFETY CRITERION	
#	ACCEPTABLE
#	EXCEEDED

NOTES:

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





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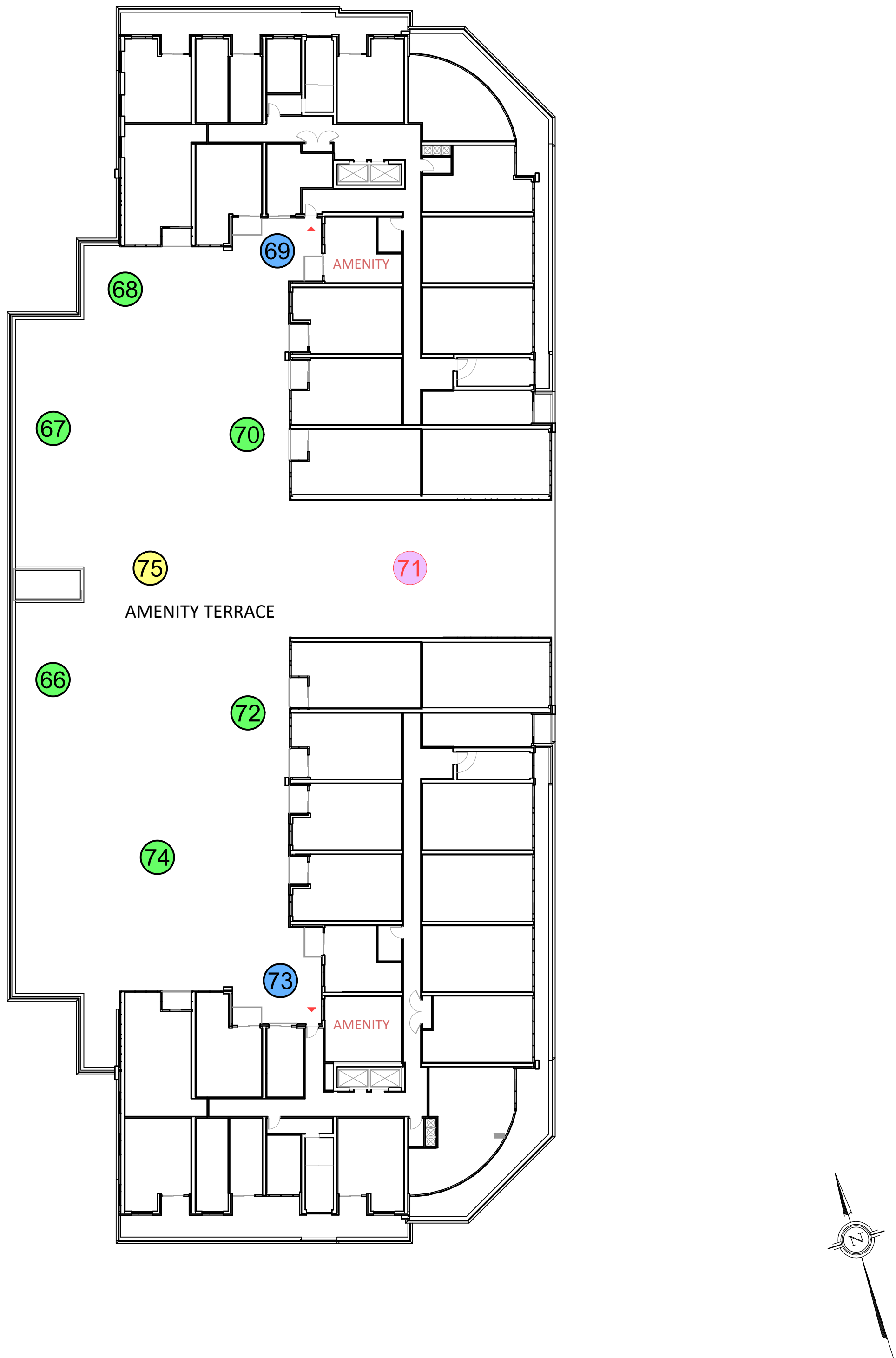
PROJECT	1694 UPPER JAMES STREET, HAMILTON PEDESTRIAN LEVEL WIND STUDY
SCALE	1:600 (APPROX.)
DRAWING NO.	GW25-099-PLW-4B
DATE	AUGUST 15, 2025
DRAWN BY	K.A.
DESCRIPTION	FIGURE 4A: SUMMER FUTURE TERRACE PLW SENSOR LAYOUT PEDESTRIAN COMFORT PREDICTIONS

PREDICTED COMFORT CLASSES	
#	SITTING
#	STANDING
#	STROLLING
#	WALKING
#	UNCOMFORTABLE

WIND SAFETY CRITERION	
#	ACCEPTABLE
#	EXCEEDED

NOTES:

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



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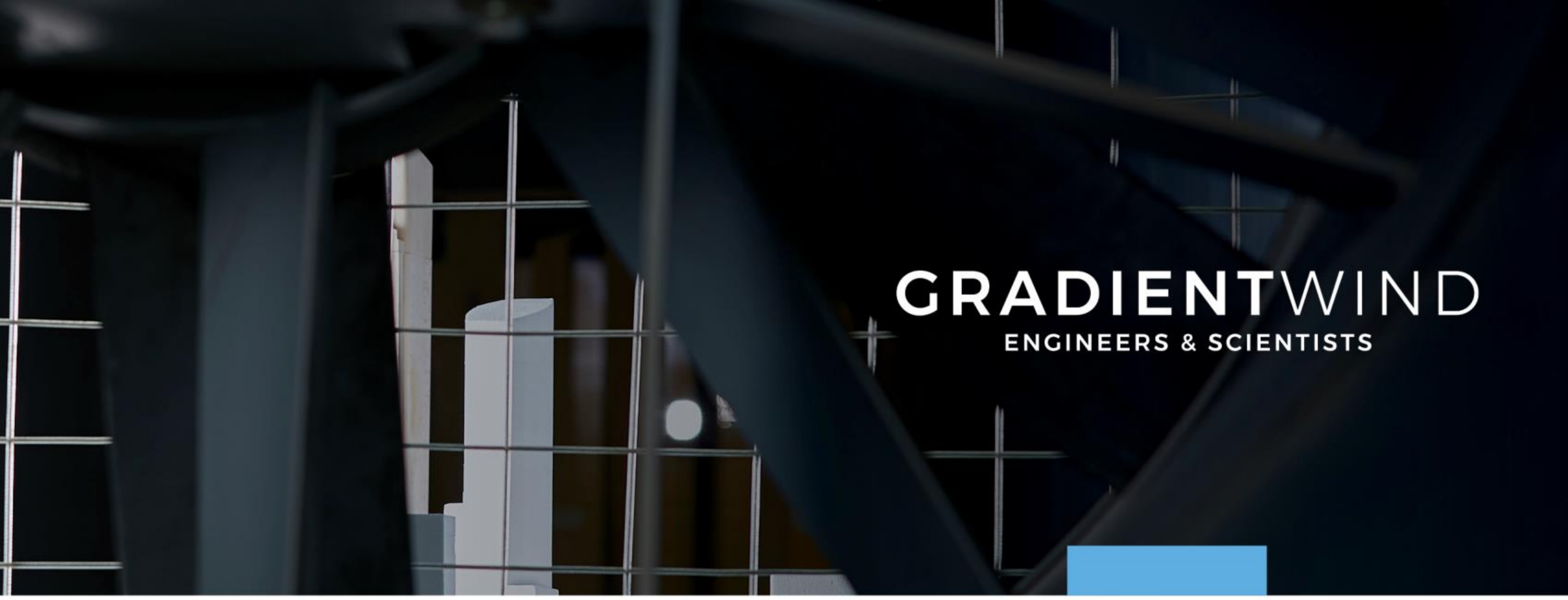
PROJECT	1694 UPPER JAMES STREET, HAMILTON PEDESTRIAN LEVEL WIND STUDY
SCALE	1:600 (APPROX.)
DRAWING NO.	GW25-099-PLW-4D
DATE	AUGUST 15, 2025
DRAWN BY	K.A.
DESCRIPTION	FIGURE 4B: WINTER FUTURE TERRACE PLW SENSOR LAYOUT PEDESTRIAN COMFORT PREDICTIONS



APPENDIX A

PEDESTRIAN COMFORT SUITABILITY, TABLES A1-A2 (EXISTING SCENARIO)

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-14 km/h = Standing, 14-17 km/h = Strolling, 17-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

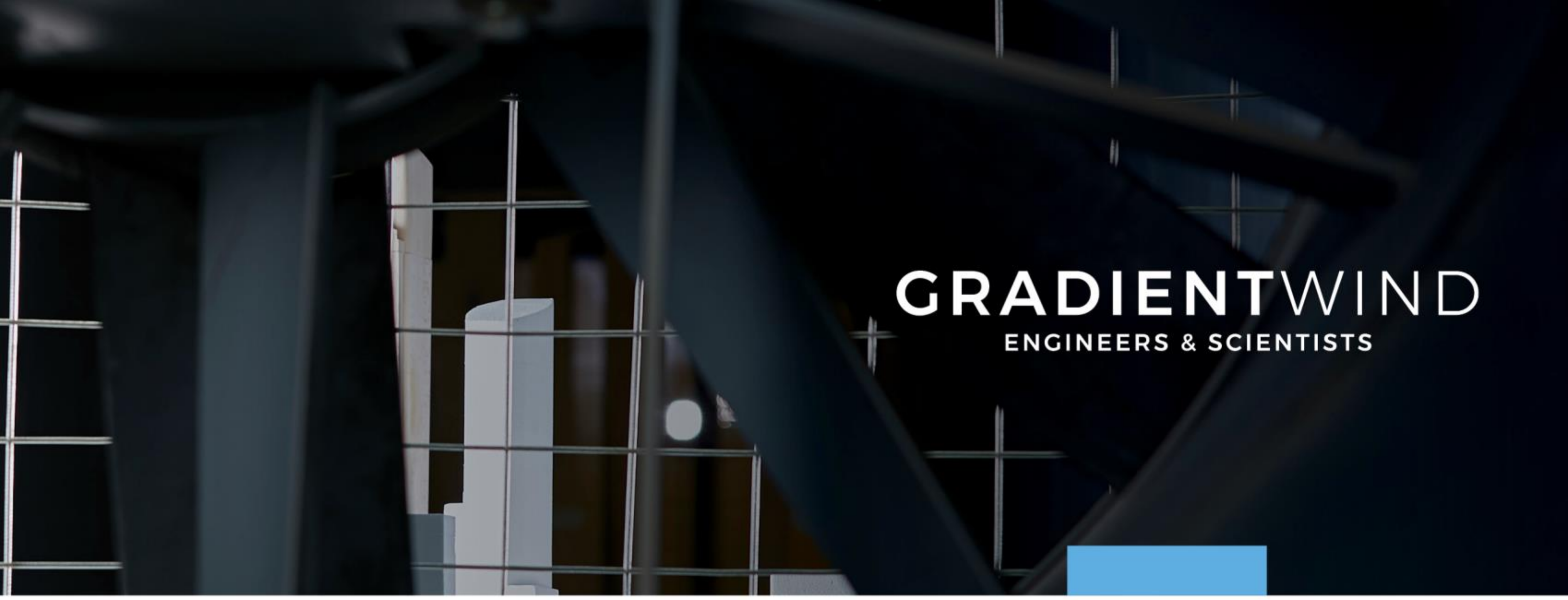
TABLE A1: SUMMARY OF PEDESTRIAN COMFORT (EXISTING SCENARIO)

Sensor	Pedestrian Safety				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	12.5	Standing	16.6	Strolling	56.6	Safe
2	9.6	Sitting	12.8	Standing	46.7	Safe
3	11.6	Standing	15.1	Strolling	51.7	Safe
4	11.6	Standing	15.8	Strolling	50.6	Safe
5	12.5	Standing	16.3	Strolling	51.6	Safe
6	12.7	Standing	17.3	Walking	54.6	Safe
7	14.1	Standing	18.7	Walking	56.5	Safe
8	10.3	Standing	13.3	Standing	52.1	Safe
9	14.3	Standing	18.9	Walking	57.2	Safe
10	13.6	Standing	18.1	Walking	54.5	Safe
11	14.1	Standing	18.5	Walking	57.1	Safe
12	14.4	Standing	18.9	Walking	57.0	Safe
13	13.3	Standing	17.2	Walking	53.4	Safe
14	13.5	Standing	17.8	Walking	55.8	Safe
15	13.6	Standing	17.7	Walking	55.4	Safe
16	13.5	Standing	17.8	Walking	54.4	Safe
17	12.0	Standing	15.6	Strolling	52.0	Safe
18	11.8	Standing	15.9	Strolling	52.6	Safe
19	11.2	Standing	15.5	Strolling	53.5	Safe
20	11.8	Standing	15.9	Strolling	52.3	Safe
21	9.8	Sitting	13.4	Standing	45.6	Safe
22	10.0	Sitting	13.5	Standing	46.3	Safe
23	9.3	Sitting	12.5	Standing	44.5	Safe
24	10.1	Standing	13.9	Standing	47.9	Safe
25	8.7	Sitting	11.9	Standing	43.3	Safe
26	9.5	Sitting	12.3	Standing	44.6	Safe
27	9.7	Sitting	13.0	Standing	44.4	Safe
28	9.5	Sitting	13.4	Standing	46.7	Safe
29	10.5	Standing	14.3	Strolling	49.0	Safe
30	10.3	Standing	13.9	Standing	45.6	Safe
31	10.2	Standing	13.2	Standing	46.5	Safe
32	10.4	Standing	14.1	Strolling	45.5	Safe
33	12.5	Standing	16.3	Strolling	51.6	Safe
34	11.9	Standing	15.1	Strolling	49.1	Safe
35	11.2	Standing	14.6	Strolling	48.0	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-14 km/h = Standing, 14-17 km/h = Strolling, 17-20 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 (EXISTING SCENARIO)

Sensor	Pedestrian Safety				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	11.3	Standing	14.5	Strolling	45.9	Safe
37	9.2	Sitting	11.8	Standing	42.8	Safe
38	10.1	Standing	12.9	Standing	43.5	Safe
39	9.3	Sitting	11.9	Standing	40.5	Safe
40	10.7	Standing	13.5	Standing	45.6	Safe
41	11.2	Standing	14.3	Strolling	46.6	Safe
42	10.4	Standing	12.8	Standing	46.7	Safe
43	12.1	Standing	16.6	Strolling	54.3	Safe
44	12.4	Standing	16.7	Strolling	52.6	Safe
45	13.0	Standing	17.5	Walking	53.5	Safe
46	12.4	Standing	16.7	Strolling	52.4	Safe
47	12.8	Standing	16.8	Strolling	53.8	Safe
48	13.4	Standing	17.7	Walking	53.9	Safe
49	13.9	Standing	18.6	Walking	56.0	Safe
50	14.1	Standing	18.7	Walking	55.8	Safe
51	12.9	Standing	16.7	Strolling	53.1	Safe
52	12.5	Standing	16.4	Strolling	52.9	Safe
53	12.0	Standing	15.8	Strolling	51.8	Safe
54	10.0	Sitting	12.9	Standing	43.8	Safe
55	9.7	Sitting	13.1	Standing	46.0	Safe
56	10.7	Standing	14.5	Strolling	48.0	Safe
57	11.8	Standing	15.6	Strolling	48.6	Safe
58	11.7	Standing	16.3	Strolling	54.2	Safe
59	9.6	Sitting	13.0	Standing	49.9	Safe



APPENDIX B

PEDESTRIAN COMFORT SUITABILITY, TABLES B1-B3
(PROPOSED SCENARIO)

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Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-14 km/h = Standing, 14-17 km/h = Strolling, 17-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B1: SUMMARY OF PEDESTRIAN COMFORT (PROPOSED SCENARIO)

Sensor	Pedestrian Safety				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	10.9	Standing	14.1	Strolling	54.4	Safe
2	9.1	Sitting	11.6	Standing	43.8	Safe
3	11.6	Standing	15.0	Strolling	52.3	Safe
4	9.2	Sitting	12.1	Standing	43.3	Safe
5	12.8	Standing	16.5	Strolling	56.3	Safe
6	12.0	Standing	16.1	Strolling	57.8	Safe
7	12.4	Standing	15.9	Strolling	56.7	Safe
8	12.9	Standing	16.8	Strolling	55.5	Safe
9	15.1	Strolling	20.8	Uncomfortable	72.9	Safe
10	15.1	Strolling	20.7	Uncomfortable	65.5	Safe
11	14.9	Strolling	20.2	Uncomfortable	60.3	Safe
12	15.1	Strolling	20.6	Uncomfortable	62.1	Safe
13	14.9	Strolling	20.7	Uncomfortable	66.8	Safe
14	17.3	Walking	24.3	Uncomfortable	76.5	Safe
15	12.5	Standing	16.9	Strolling	58.0	Safe
16	12.2	Standing	16.7	Strolling	56.9	Safe
17	11.5	Standing	14.7	Strolling	53.6	Safe
18	10.1	Standing	13.3	Standing	45.6	Safe
19	9.1	Sitting	11.9	Standing	41.4	Safe
20	9.7	Sitting	11.7	Standing	45.3	Safe
21	7.1	Sitting	9.0	Sitting	32.1	Safe
22	8.0	Sitting	10.5	Standing	39.1	Safe
23	8.9	Sitting	11.4	Standing	48.9	Safe
24	8.6	Sitting	11.6	Standing	42.5	Safe
25	9.4	Sitting	12.4	Standing	50.5	Safe
26	9.4	Sitting	11.9	Standing	54.7	Safe
27	9.0	Sitting	11.5	Standing	46.1	Safe
28	9.6	Sitting	13.1	Standing	49.3	Safe
29	13.0	Standing	17.7	Walking	56.9	Safe
30	17.0	Strolling	23.5	Uncomfortable	71.8	Safe
31	12.1	Standing	17.2	Walking	61.5	Safe
32	12.3	Standing	17.7	Walking	59.9	Safe
33	11.8	Standing	16.5	Strolling	60.3	Safe
34	11.3	Standing	14.9	Strolling	57.5	Safe
35	11.3	Standing	14.5	Strolling	54.2	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-14 km/h = Standing, 14-17 km/h = Strolling, 17-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B2: SUMMARY OF PEDESTRIAN COMFORT (PROPOSED SCENARIO)

Sensor	Pedestrian Safety				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	11.1	Standing	14.4	Strolling	57.0	Safe
37	10.5	Standing	13.3	Standing	60.7	Safe
38	9.1	Sitting	11.7	Standing	53.4	Safe
39	9.0	Sitting	11.7	Standing	55.0	Safe
40	9.2	Sitting	12.0	Standing	51.3	Safe
41	8.7	Sitting	10.6	Standing	47.5	Safe
42	8.4	Sitting	10.3	Standing	40.0	Safe
43	8.5	Sitting	10.3	Standing	44.1	Safe
44	7.6	Sitting	9.5	Sitting	41.1	Safe
45	8.4	Sitting	10.4	Standing	45.3	Safe
46	8.6	Sitting	10.6	Standing	48.4	Safe
47	8.8	Sitting	10.8	Standing	48.9	Safe
48	13.1	Standing	15.6	Strolling	65.4	Safe
49	14.9	Strolling	21.3	Uncomfortable	76.2	Safe
50	13.0	Standing	20.2	Uncomfortable	79.4	Safe
51	7.5	Sitting	10.7	Standing	46.2	Safe
52	8.7	Sitting	12.4	Standing	61.8	Safe
53	8.7	Sitting	11.2	Standing	44.7	Safe
54	9.7	Sitting	11.9	Standing	53.6	Safe
55	8.4	Sitting	10.6	Standing	46.1	Safe
56	6.1	Sitting	8.2	Sitting	30.2	Safe
57	7.9	Sitting	11.4	Standing	50.7	Safe
58	5.6	Sitting	7.5	Sitting	26.1	Safe
59	5.8	Sitting	7.7	Sitting	26.5	Safe
60	6.8	Sitting	9.0	Sitting	34.7	Safe
61	8.1	Sitting	10.7	Standing	41.5	Safe
62	7.7	Sitting	10.3	Standing	38.7	Safe
63	12.4	Standing	16.5	Strolling	60.5	Safe
64	8.6	Sitting	12.0	Standing	49.1	Safe
66	9.2	Sitting	12.5	Standing	49.9	Safe
67	8.8	Sitting	11.3	Standing	44.8	Safe
68	9.1	Sitting	12.4	Standing	48.9	Safe
69	5.5	Sitting	7.4	Sitting	24.9	Safe
70	8.4	Sitting	11.4	Standing	42.9	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-14 km/h = Standing, 14-17 km/h = Strolling, 17-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B3: SUMMARY OF PEDESTRIAN COMFORT (PROPOSED SCENARIO)

Sensor	Pedestrian Safety				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
71	21.4	Uncomfortable	30.3	Uncomfortable	93.0	Dangerous
72	7.8	Sitting	10.9	Standing	44.2	Safe
73	5.9	Sitting	7.8	Sitting	26.4	Safe
74	8.4	Sitting	11.7	Standing	48.6	Safe
75	11.6	Standing	15.0	Strolling	72.9	Safe

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 C1 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.

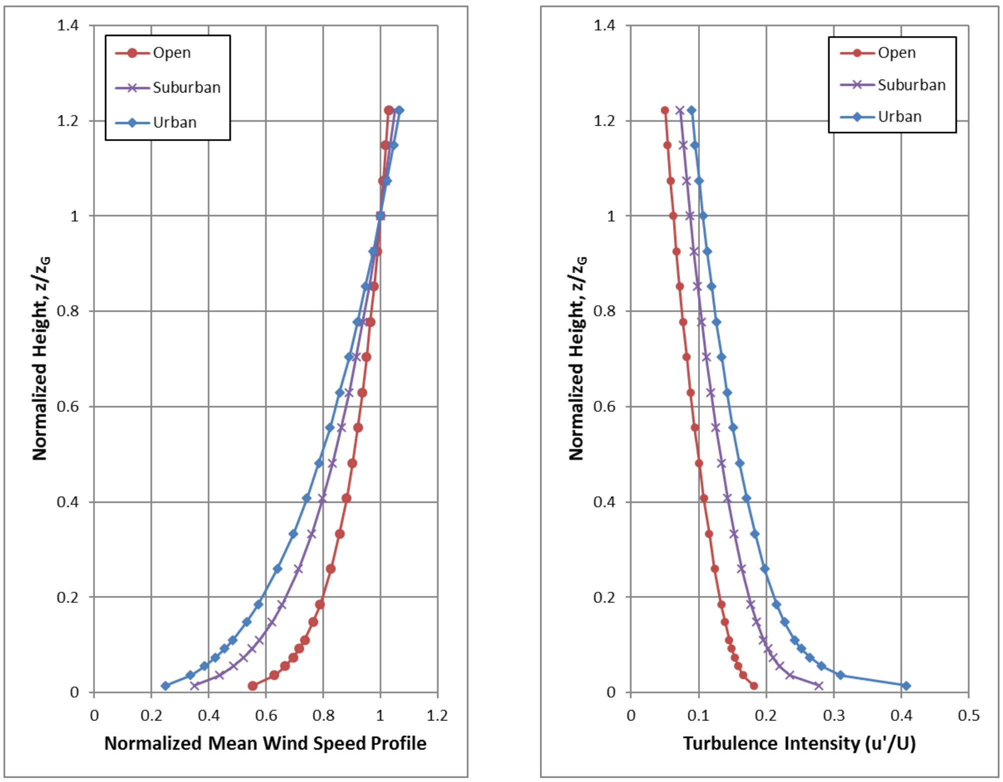

FIGURE C1 (LEFT): MEAN WIND SPEED PROFILES;
FIGURE C2 (RIGHT): TURBULENCE INTENSITY PROFILES

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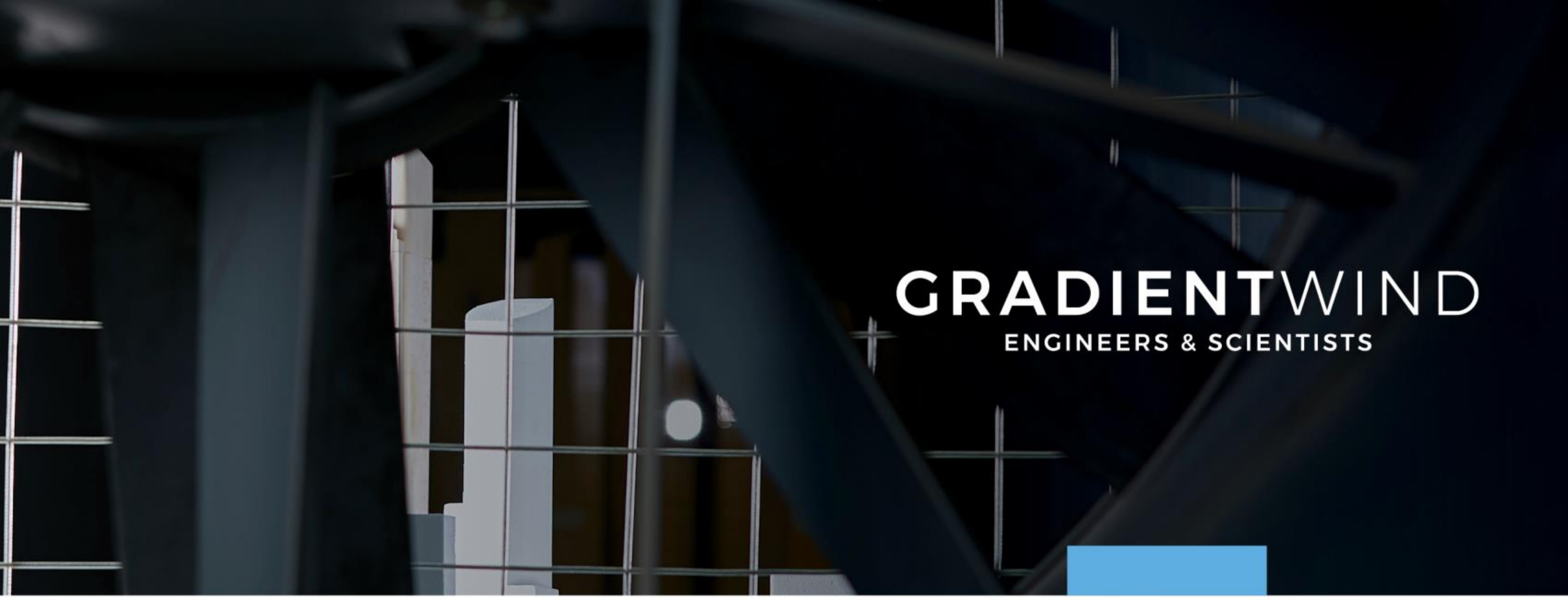
1. Teunissen, H.W., 'Characteristics of The Mean Wind And Turbulence In The Planetary Boundary Layer', Institute For Aerospace Studies, University Of Toronto, UTIAS # 32, Oct. 1970

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

4. Bradley, E.F., Coppin, P.A., Katen, P.C., '*Turbulent Wind Structure Above Very Rugged Terrain*', 9th Australian Fluid Mechanics Conference, Auckland, Dec. 1966



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 (> 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 $\boldsymbol{C_\theta}$ and $\boldsymbol{K_\theta}$ 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.

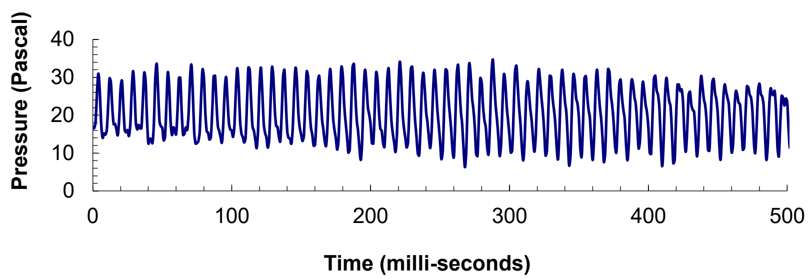

FIGURE D1: TIME VERSUS VELOCITY TRACE FOR A TYPICAL WIND SENSOR

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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.