REPORT

CAMBRIDGE CROSSING PARCEL Q2

CAMBRIDGE, MA

PEDESTRIAN WIND STUDY
RWDI # 2103076
June 16, 2021

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI was retained to conduct a pedestrian wind assessment for the proposed Cambridge Crossing Parcel Q2 in Cambridge, MA (Image 1). Based on our wind-tunnel testing for the proposed development under the Existing and Proposed configurations (Images 2A and 2B), and the local wind records (Image 3), the potential wind comfort and safety conditions are predicted as shown on site plans in Figures 1A through 2B, while the associated wind speeds are listed in Table 1. These results can be summarized as follows:

- Wind speeds are not expected to exceed the wind criterion for pedestrian safety for either configuration.
- Wind speeds on and around the existing site are comfortable for the intended pedestrian use throughout the year and are typical for this area of Cambridge.
- With the addition of the proposed development, wind conditions at all areas assessed, including the main entrance, are expected to be comfortable for the intended pedestrian usage during the summer and winter months.

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1 INTRODUCTION

RWDI was retained to conduct a pedestrian wind assessment for the proposed Cambridge Crossing Parcel Q2 in Cambridge, MA. This report presents the project objectives, approach and the main results from RWDI's assessment.

1.1 Project Description

The project (site shown in Image 1) is located at the southeast corner of Water Street and North Point Boulevard. It consists of a 5-story laboratory building with a mechanical penthouse for a total height of 115.8 ft.

1.2 Objectives

The objective of the study was to assess the effect of the proposed development on local conditions in pedestrian areas on and around the study site and provide recommendations for minimizing adverse effects, if needed. This quantitative assessment was based on wind speed measurements on a scale model of the project and its surroundings in one of RWDI's boundary-layer wind tunnels. These measurements were combined with the local wind records and compared to appropriate criteria for gauging wind comfort and safety in pedestrian areas. The assessment focused on critical pedestrian areas, including main building entrance and public sidewalks.

Image 1: Aerial View of Site and Surroundings (Photo Courtesy of Google™ Earth)

2 BACKGROUND AND APPROACH

2.1 Wind Tunnel Study Model

To assess the wind environment around the proposed project, a 1:300 scale model of the project site and surroundings was constructed for the wind tunnel tests of the following configurations:

A - Existing: Existing site with existing surroundings (Image 2A), and

B - Proposed: Proposed project with existing surroundings and future masterplan buildings (Image 2B).

The wind tunnel model included all relevant surrounding buildings and topography within an approximately 1200 ft radius of the study site. The wind and turbulence profiles in the atmospheric boundary layer beyond the modelled area were also simulated in RWDI's wind tunnel. The wind tunnel model was instrumented with 37 specially designed wind speed sensors to measure mean and gust speeds at a full-scale height of approximately 5 ft above local grade in pedestrian areas throughout the study site. Wind speeds were measured for 36 directions in a 10-degree increments. The measurements at each sensor location were recorded in the form of ratios of local mean and gust speeds to the mean wind speed at a reference height above the model. The placement of wind measurement locations was based on our experience and understanding of the pedestrian usage for this site and reviewed by ZGF Architects LLP.

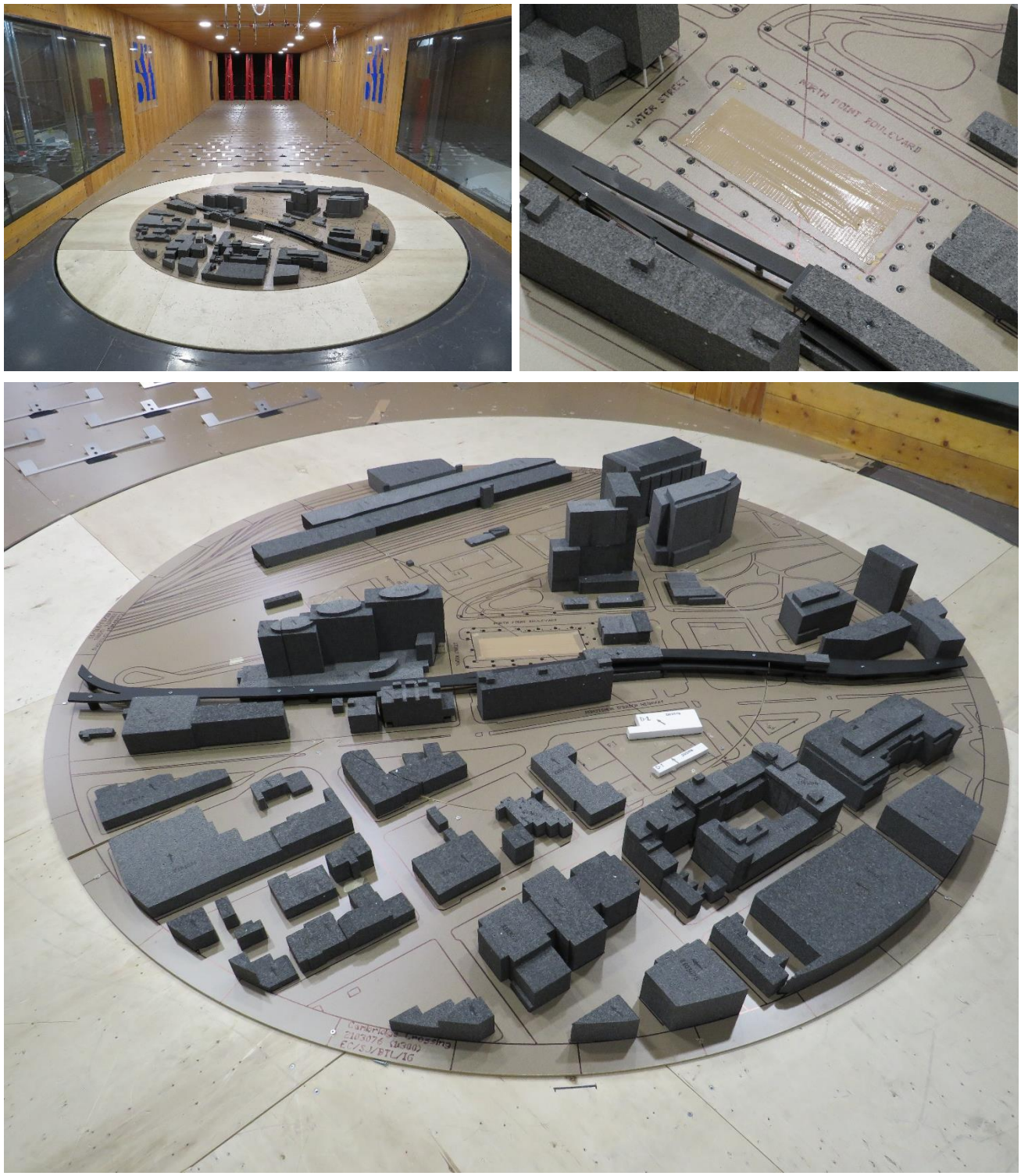
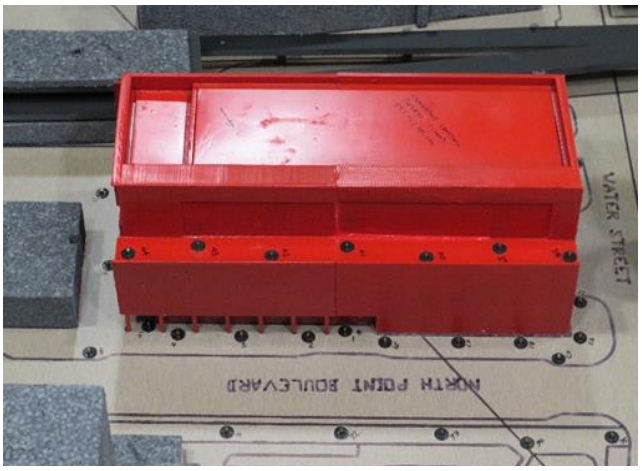


Image 2A: Wind Tunnel Study Model – Existing Configuration



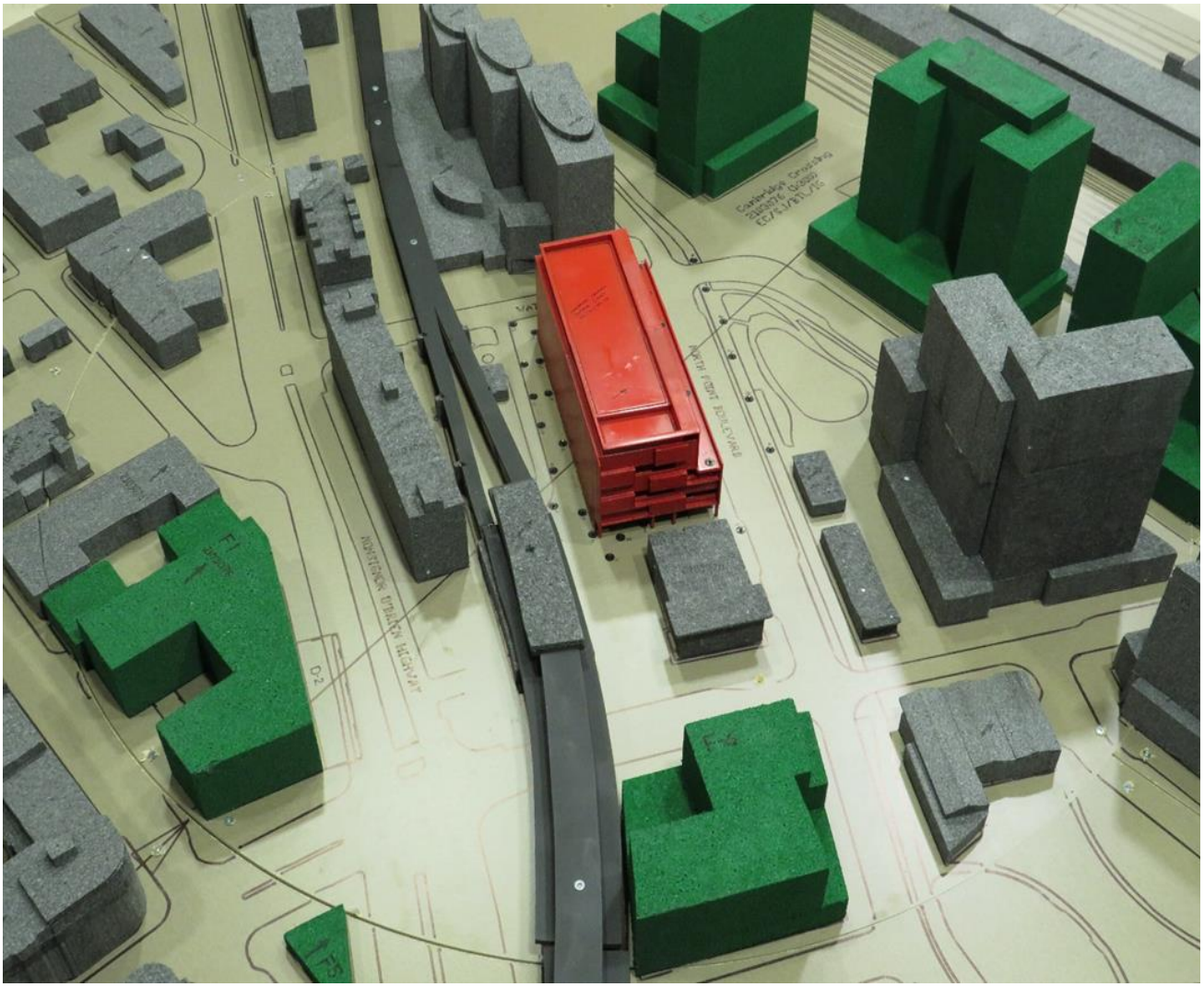
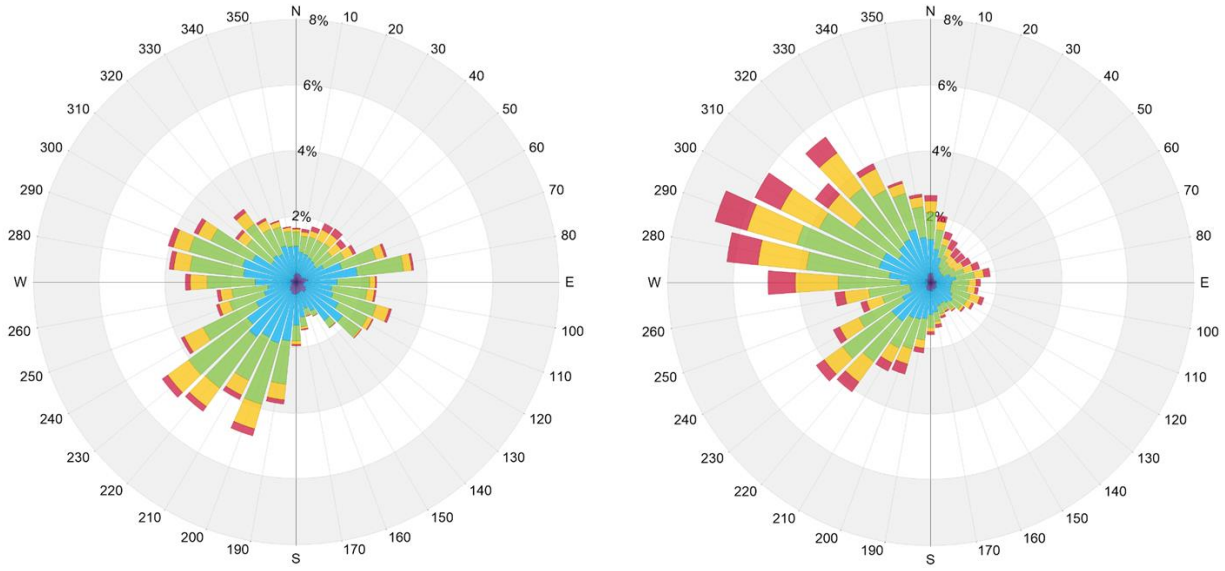


Image 2B: Wind Tunnel Study Model – Proposed Configuration

2.2 Meteorological Data

Wind statistics recorded at Boston Logan International Airport between 1995 and 2020, inclusive, were analyzed for the Summer (May through October) and Winter (November through April) seasons. Image 3 graphically depicts the directional distributions of wind frequencies and speeds for these two seasons. Winds from the southwest and northwest quadrants are predominant throughout the year, as indicated by the wind roses. Strong winds of a mean speed greater than 15 mph measured at the airport (at an anemometer height of 30 ft) occur for 14.8% and 27.7% of the time during the summer and winter seasons, respectively.

Wind statistics were combined with the wind tunnel data to predict the frequency of occurrence of full-scale wind speeds. The full-scale wind predictions were then compared with the wind criteria for pedestrian comfort and safety.



Wind Speed (mph)	Probability (%) Summer	Winter
Calm	3.2	2.7
1-5	9.1	6.7
6-10	36.7	28.3
11-15	36.1	34.5
16-20	11.3	17.6
>20	3.5	10.1

Image 3: Directional Distribution of Winds Approaching Boston Logan International Airport between 1995 and 2020

2.2 RWDI Pedestrian Wind Criteria

The RWDI pedestrian wind criteria, which have been developed by RWDI through research and consulting practice since 1974, are used in the current study. These criteria have been widely accepted by municipal authorities as well as by the building design and city planning community. Regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can affect a person's perception of the wind climate. Therefore, comparisons of wind speeds for the existing and proposed building configurations are the most objective way in assessing local pedestrian wind conditions. In general, the combined effect of mean and gust speeds on pedestrian comfort can be quantified by a Gust Equivalent Mean (GEM).

Comfort Category	GEM Speed (mph)	Description
Sitting	≤ 6	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away
Standing	≤ 8	Gentle breezes suitable for main building entrances, bus stops, and other places where pedestrians may linger
Strolling	≤ 10	Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park
Walking	≤ 12	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
Uncomfortable	> 12	Strong winds of this magnitude are considered a nuisance for all pedestrian activities, and wind mitigation is typically recommended

Notes:
(1) *GEM Speed = max (Mean Speed, Gust Speed/1.85)* and *Gust Speed = Mean Speed + 3*RMS Speed*;
(2) Wind conditions are considered to be comfortable if the predicted GEM speeds are within the respective thresholds for at least 80% of the time between 6:00 and 23:00. Nightly hours between 0:00 and 5:00 are excluded from the wind analysis for comfort since limited usage of outdoor spaces is anticipated; and,
(3) Instead of standard four seasons, two periods of summer (May to October) and winter (November to April) are adopted in the wind analysis, because in a cold climate such as that found in **Cambridge**, there are distinct differences in pedestrian outdoor behaviours between these two-time periods.

Safety Criterion	Gust Speed (mph)	Description
Exceeded	> 56	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is typically required.

Notes:
(1) Based on an annual exceedance of 9 hours or 0.1% of the time for 24 hours a day; and,
(2) Only gust speeds need to be considered in the wind safety criterion. These are usually rare events, but deserve special attention in city planning and building design due to their potential safety impact on pedestrians.

3 RESULTS AND DISCUSSION

The predicted wind conditions are shown on site plans in Figures 1A through 2B located in the "Figures" section of this report. These conditions and the associated wind speeds are also represented in Table 1, located in the "Tables" section of this report.

Wind conditions that meet the safety criterion are predicted at all locations for all configurations assessed (see Table 1). The following is a detailed discussion of the suitability of the predicted wind conditions for the anticipated pedestrian use of each area of interest.

Wind conditions comfortable for walking or strolling are appropriate for sidewalks and walkways as pedestrians will be active and less likely to remain in one area for prolonged periods of time. Lower wind speeds conducive to standing are preferred at main entrances where pedestrians are apt to linger.

3.1 Existing Configuration

Existing wind speeds are comfortable for standing during the summer (see Figure 1A), and comfortable for standing or strolling during the winter season (see Figure 2A) at most locations at and around the project site.

3.2 Proposed Configuration

Compared to the existing wind conditions, throughout the year lower wind speeds comfortable for sitting and standing are expected for the proposed configuration near the north and east facades of the building due to sheltering provided by the proposed building and future masterplan buildings (see Figure 1B & 2B).

Wind activity comfortable for sitting during the summer season and standing during the winter season is anticipated at the main entrance of the proposed building (Location 1 in Figures 1B and 2B), hence appropriate for the intended pedestrian usage of the main building entrance.

Suitable wind conditions are also predicted on all sidewalks on and around the project, except Location 35 where uncomfortable wind conditions are detected in the winter (Figure 2B). This is a marginal case, and likely caused by wind flow accelerations between the proposed and future buildings. Existing and proposed landscaping, which was not included in the wind tunnel testing, would reduce the wind speeds at this location to an acceptable level.

4 APPLICABILITY OF RESULTS

The wind conditions presented in this report pertain to the model of the Cambridge Crossing Parcel Q2 constructed using the drawings and information listed below. Should there be any design changes that deviate from this list of drawings, the wind condition predictions presented may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on wind conditions.

File Name	File Type	Date Received (dd/mm/yyyy)
210407 Cambridge Crossing Kick Off Call Slides	Microsoft Word	07/04/2021
208402B069A	DWG	13/04/2021
2021 CX Context_model	SktechUp	20/04/2021
25320.CCQ2_ARCH_20210514	Revit	14/05/2021

5 REFERENCES

1. ASCE Task Committee on Outdoor Human Comfort (2004). *Outdoor Human Comfort and Its Assessment*, 68 pages, American Society of Civil Engineers, Reston, Virginia, USA.

2. Williams, C.J., Hunter, M.A. and Waechter, W.F. (1990). "Criteria for Assessing the Pedestrian Wind Environment," *Journal of Wind Engineering and Industrial Aerodynamics*, Vol.36, pp.811-815.

3. Williams, C.J., Soligo M.J. and Cote, J. (1992). "A Discussion of the Components for a Comprehensive Pedestrian Level Comfort Criteria," *Journal of Wind Engineering and Industrial Aerodynamics*, Vol.41-44, pp.2389-2390.

4. Soligo, M.J., Irwin, P.A., and Williams, C.J. (1993). "Pedestrian Comfort Including Wind and Thermal Effects," *Third Asia-Pacific Symposium on Wind Engineering*, Hong Kong.

5. Soligo, M.J., Irwin, P.A., Williams, C.J. and Schuyler, G.D. (1998). "A Comprehensive Assessment of Pedestrian Comfort Including Thermal Effects," *Journal of Wind Engineering and Industrial Aerodynamics*, Vol.77&78, pp.753-766.

6. Williams, C.J., Wu, H., Waechter, W.F. and Baker, H.A. (1999). "Experiences with Remedial Solutions to Control Pedestrian Wind Problems," *Tenth International Conference on Wind Engineering*, Copenhagen, Denmark.

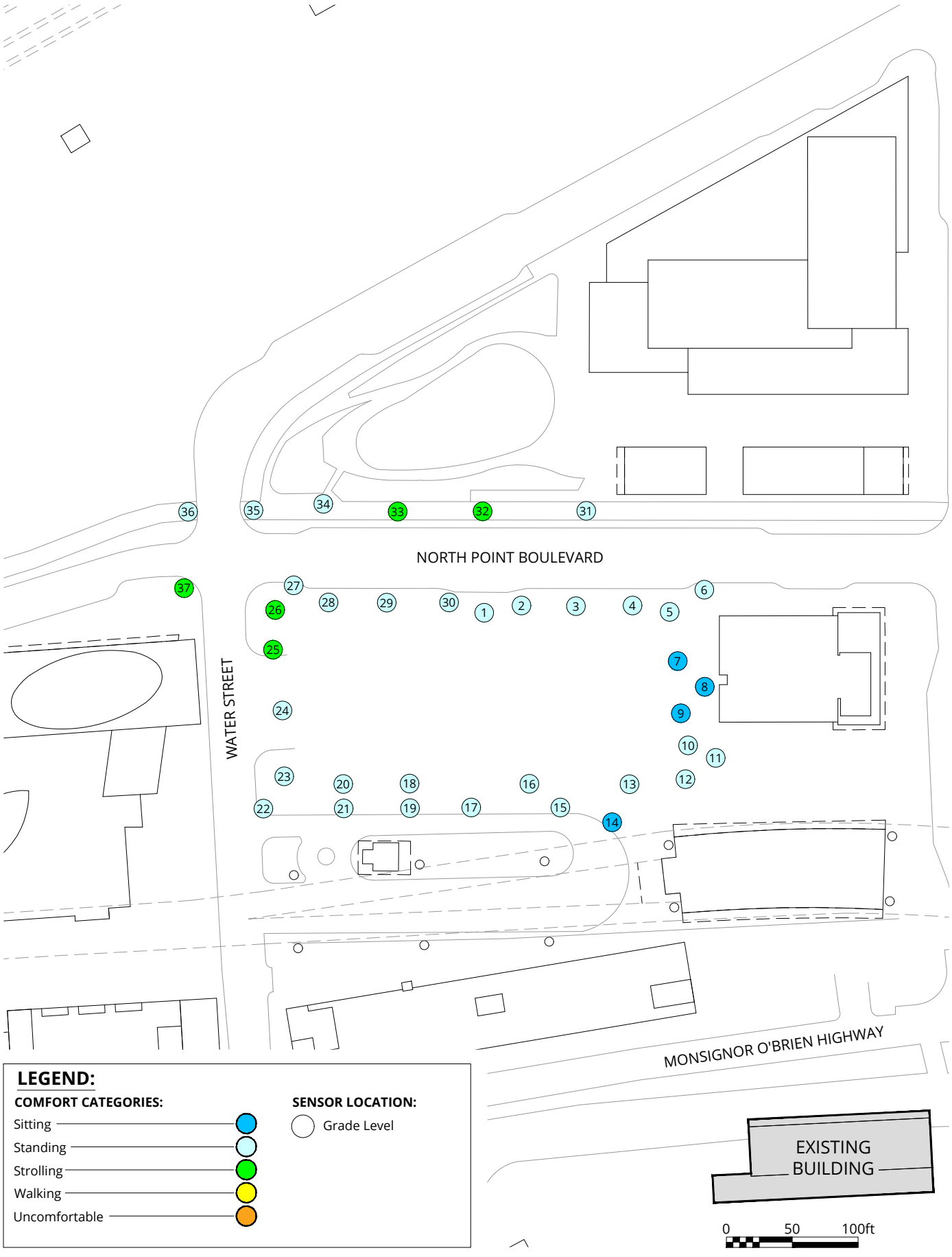
7. Lawson, T.V. (1973). "Wind Environment of Buildings: A Logical Approach to the Establishment of Criteria", *Report No. TVL 7321*, Department of Aeronautic Engineering, University of Bristol, Bristol, England.

8. Durgin, F. H. (1997). "Pedestrian Level Wind Criteria Using the Equivalent average", *Journal of Wind Engineering and Industrial Aerodynamics*, Vol. 66, pp.215-226.

9. Wu, H. and Kriksic, F. (2012). "Designing for Pedestrian Comfort in Response to Local Climate", *Journal of Wind Engineering and Industrial Aerodynamics*, Vol.104-106, pp.397-407.

10. Wu, H., Williams, C.J., Baker, H.A. and Waechter, W.F. (2004), "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions", *ASCE Structure Congress 2004,* Nashville, Tennessee.

FIGURES



LEGEND:

COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Grade Level

EXISTING BUILDING

0 50 100ft

Pedestrian Wind Comfort Conditions

Existing Configuration

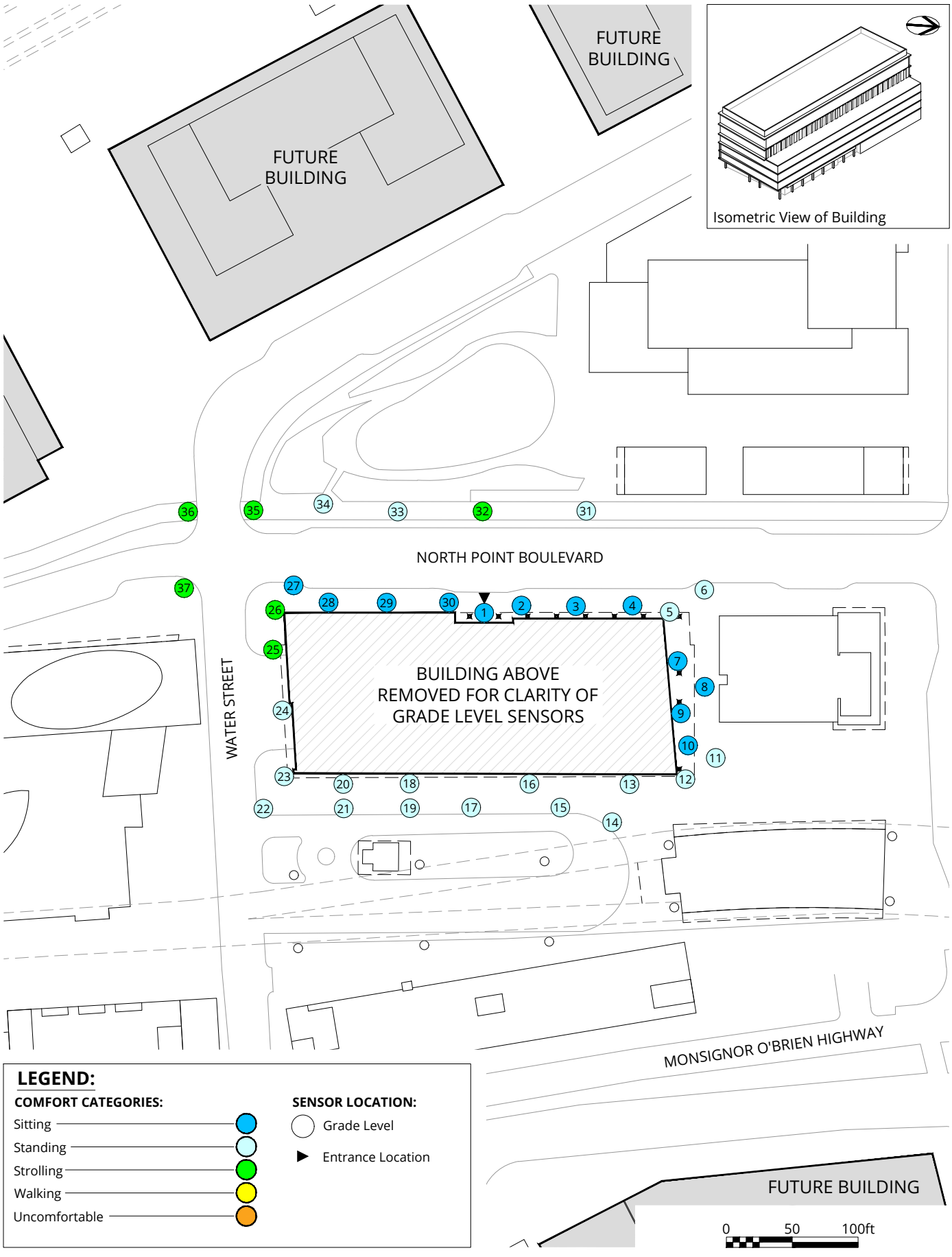
Summer (May to October, 6:00 to 23:00)

Cambridge Crossing Parcel Q2 - Boston, MA

Project #2103076

True North

Drawn by:	GRE	Figure:	1A
Approx. Scale:	1"=100'		
Date Revised:	Jun. 10, 2021		



LEGEND:

COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Grade Level
- Entrance Location

Pedestrian Wind Comfort Conditions

Proposed Configuration

Summer (May to October, 6:00 to 23:00)

Cambridge Crossing Parcel Q2 - Boston, MA

Project #2103076

True North

Drawn by:	GRE	Figure:	1B
Approx. Scale:	1"=100'		
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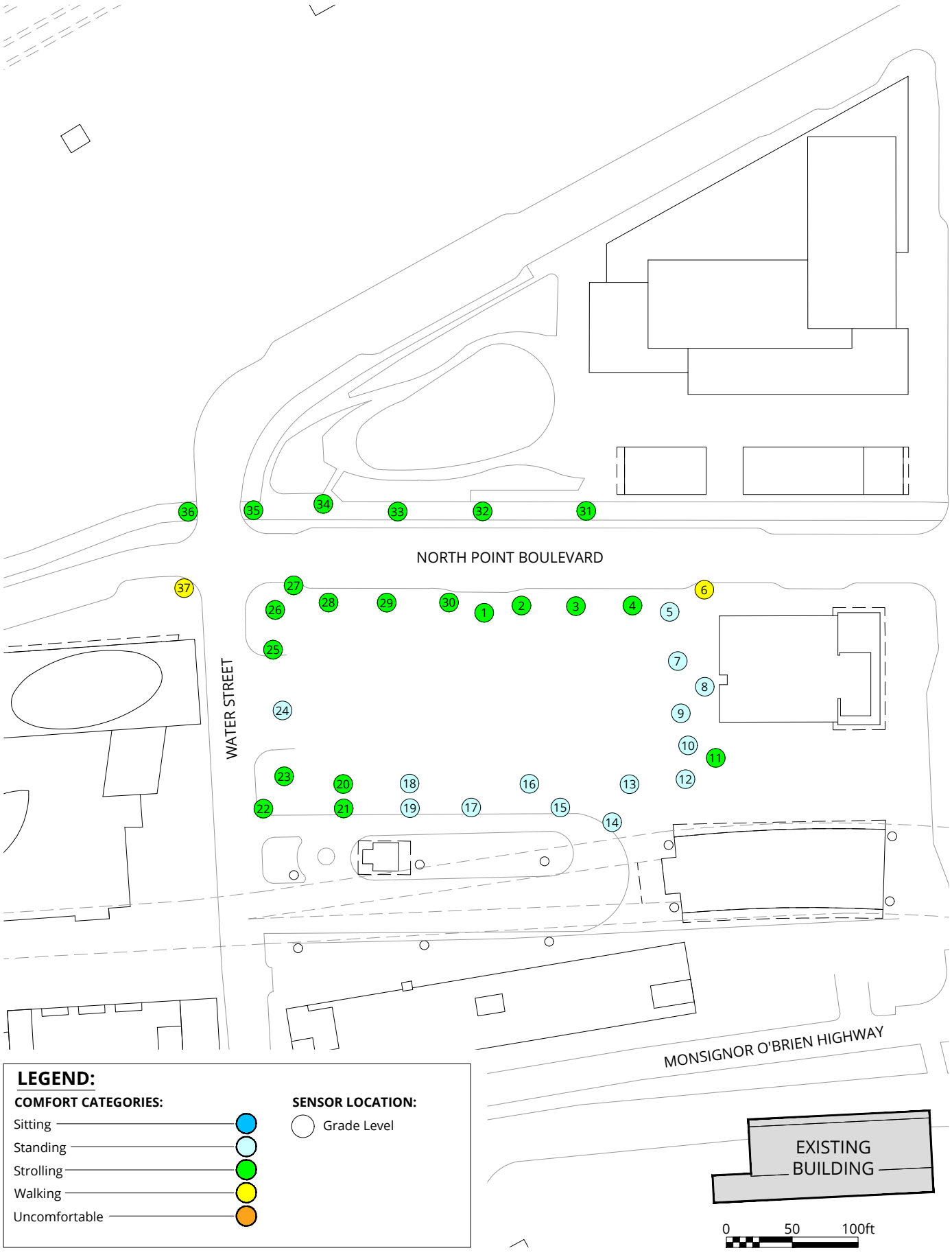


Pedestrian Wind Comfort Conditions

Existing Configuration

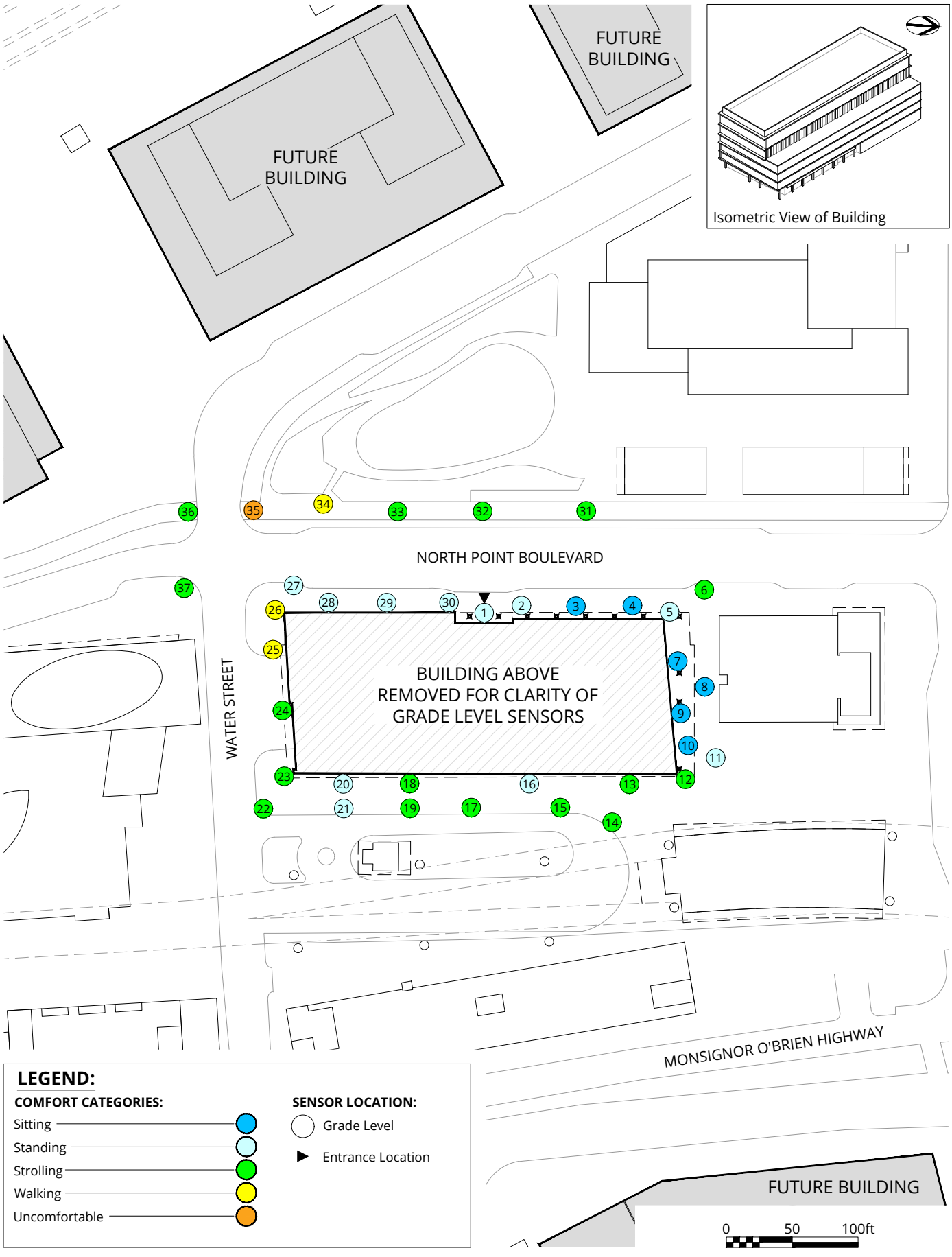
Winter (November to April, 6:00 to 23:00)

Cambridge Crossing Parcel Q2 - Boston, MA

Project #2103076

True North

Drawn by:	GRE	Figure:	2A
Approx. Scale:	1"=100'		
Date Revised:	Jun. 10, 2021		



LEGEND:

COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Grade Level
- Entrance Location

Pedestrian Wind Comfort Conditions

Proposed Configuration

Winter (November to April, 6:00 to 23:00)

Cambridge Crossing Parcel Q2 - Boston, MA

Project #2103076

True North

Drawn by: GRE	Figure: 2B
Approx. Scale:	1"=100'
Date Revised:	Jun. 10, 2021

TABLES

Table 1: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort				Wind Safety	
		Summer		Winter		Annual	
		Speed (km/h)	Rating	Speed (km/h)	Rating	Speed (km/h)	Rating
1	Existing	8	Standing	9	Strolling	38	Pass
	Proposed	6	Sitting	7	Standing	27	Pass
2	Existing	8	Standing	10	Strolling	38	Pass
	Proposed	5	Sitting	7	Standing	28	Pass
3	Existing	8	Standing	9	Strolling	36	Pass
	Proposed	5	Sitting	6	Sitting	24	Pass
4	Existing	8	Standing	10	Strolling	36	Pass
	Proposed	5	Sitting	6	Sitting	25	Pass
5	Existing	7	Standing	8	Standing	34	Pass
	Proposed	7	Standing	8	Standing	35	Pass
6	Existing	8	Standing	11	Walking	38	Pass
	Proposed	8	Standing	9	Strolling	39	Pass
7	Existing	6	Sitting	7	Standing	29	Pass
	Proposed	6	Sitting	5	Sitting	29	Pass
8	Existing	6	Sitting	7	Standing	28	Pass
	Proposed	6	Sitting	6	Sitting	26	Pass
9	Existing	6	Sitting	7	Standing	29	Pass
	Proposed	6	Sitting	6	Sitting	28	Pass
10	Existing	7	Standing	8	Standing	32	Pass
	Proposed	4	Sitting	4	Sitting	22	Pass
11	Existing	7	Standing	10	Strolling	34	Pass
	Proposed	7	Standing	8	Standing	32	Pass
12	Existing	7	Standing	8	Standing	32	Pass
	Proposed	8	Standing	10	Strolling	37	Pass
13	Existing	7	Standing	8	Standing	31	Pass
	Proposed	7	Standing	9	Strolling	36	Pass
14	Existing	6	Sitting	8	Standing	32	Pass
	Proposed	8	Standing	10	Strolling	38	Pass
15	Existing	7	Standing	8	Standing	32	Pass
	Proposed	8	Standing	10	Strolling	37	Pass
16	Existing	7	Standing	8	Standing	34	Pass
	Proposed	7	Standing	8	Standing	33	Pass

Table 1: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort				Wind Safety	
		Summer		Winter		Annual	
		Speed (km/h)	Rating	Speed (km/h)	Rating	Speed (km/h)	Rating
17	Existing	7	Standing	8	Standing	34	Pass
	Proposed	8	Standing	10	Strolling	36	Pass
18	Existing	7	Standing	8	Standing	38	Pass
	Proposed	7	Standing	9	Strolling	36	Pass
19	Existing	7	Standing	8	Standing	35	Pass
	Proposed	8	Standing	10	Strolling	37	Pass
20	Existing	8	Standing	9	Strolling	38	Pass
	Proposed	7	Standing	8	Standing	34	Pass
21	Existing	8	Standing	9	Strolling	37	Pass
	Proposed	7	Standing	8	Standing	34	Pass
22	Existing	8	Standing	9	Strolling	41	Pass
	Proposed	8	Standing	9	Strolling	41	Pass
23	Existing	8	Standing	9	Strolling	42	Pass
	Proposed	8	Standing	9	Strolling	39	Pass
24	Existing	8	Standing	8	Standing	48	Pass
	Proposed	7	Standing	9	Strolling	42	Pass
25	Existing	10	Strolling	10	Strolling	47	Pass
	Proposed	9	Strolling	12	Walking	43	Pass
26	Existing	9	Strolling	10	Strolling	43	Pass
	Proposed	9	Strolling	12	Walking	43	Pass
27	Existing	8	Standing	10	Strolling	42	Pass
	Proposed	6	Sitting	7	Standing	32	Pass
28	Existing	8	Standing	10	Strolling	41	Pass
	Proposed	6	Sitting	7	Standing	30	Pass
29	Existing	8	Standing	9	Strolling	39	Pass
	Proposed	6	Sitting	7	Standing	31	Pass
30	Existing	8	Standing	10	Strolling	37	Pass
	Proposed	6	Sitting	8	Standing	40	Pass
31	Existing	8	Standing	10	Strolling	41	Pass
	Proposed	8	Standing	10	Strolling	39	Pass
32	Existing	9	Strolling	10	Strolling	41	Pass
	Proposed	9	Strolling	10	Strolling	42	Pass

Table 1: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort				Wind Safety	
		Summer		Winter		Annual	
		Speed (km/h)	Rating	Speed (km/h)	Rating	Speed (km/h)	Rating
33	Existing	9	Strolling	10	Strolling	39	Pass
	Proposed	8	Standing	10	Strolling	41	Pass
34	Existing	8	Standing	10	Strolling	39	Pass
	Proposed	8	Standing	11	Walking	43	Pass
35	Existing	8	Standing	10	Strolling	39	Pass
	Proposed	10	Strolling	13	Uncomfortable	49	Pass
36	Existing	8	Standing	10	Strolling	38	Pass
	Proposed	9	Strolling	10	Strolling	43	Pass
37	Existing	9	Strolling	11	Walking	45	Pass
	Proposed	9	Strolling	10	Strolling	42	Pass

Season	Months	Hours	Comfort Speed (mph)		Safety Speed (mph)	
Summer	May - October	6:00 - 23:00 for comfort	(20% Seasonal Exceedance)		(0.1% Annual Exceedance)	
Winter	November - April	6:00 - 23:00 for comfort	≤ 6	Sitting	≤ 56	Pass
Annual	January - December	0:00 - 23:00 for safety	7 - 8	Standing	> 56	Exceeded
Configurations			9 - 10	Strolling		
Existing	Existing site and surroundings		11 - 12	Walking		
Proposed	Project with existing surroundings & future masterplan b		> 12	Uncomfortable		