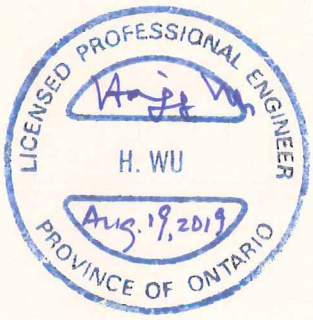
REPORT

2093, 2097 AND 2101 OLD LAKESHORE ROAD, 2096 AND 2100 LAKESHORE ROAD

BURLINGTON, ONTARIO

PEDESTRIAN WIND STUDY
RWDI #1901341
August 22, 2019



SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI was retained to conduct a pedestrian wind assessment for the proposed 2093, 2097 and 2101 Old Lakeshore Road, 2096 and 2100 Lakeshore Road in Burlington, Ontario (**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 **3b**, while the associated wind speeds are listed in **Table 1**. These results can be summarized as follows:

- The existing wind conditions on the site are generally comfortable for standing during the summer months (May to October), and standing and strolling during the winter months (November to April), which are appropriate for the intended use.

- With the addition of the proposed project, wind speeds at the areas on and around the site are expected to slightly increase. Wind conditions are expected to be comfortable for strolling or better during the summer, and walking or strolling during the winter, which are appropriate for the intended pedestrian usages. Uncomfortable wind conditions are expected at some localized areas to the northwest of the site and along Lakeshore Road, during the winter.

- During the summer, wind conditions on Level 2 and Level 7 terraces of proposed development are generally expected to be comfortable for sitting and standing.

- For the existing configurations, wind conditions at all location on and around the site are expected to meet the safety criterion. With the addition of the proposed development, winds are expected to meet the recommended safety criterion at all grade level and terrace areas except three locations at the grade to the north and south of the proposed building.

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Table 1: Pedestrian Wind Comfort and Safety Conditions

1 INTRODUCTION

RWDI was retained to conduct a pedestrian wind assessment for the proposed 2093, 2097 and 2101 Old Lakeshore Road, 2096 and 2100 Lakeshore Road in Burlington, Ontario. This report presents the project objectives, background and approach, and discusses of the results from RWDI's assessment and provides conceptual wind control measures, where necessary.

1.1 Project Description

The project (site shown in **Image 1**) is located on the south side of Martha Street between Lakeshore Road and Old Lakeshore Road. The proposed building is 83.2 m tall, consisting of a 27-storey tower with outdoor amenities at the 7th level.

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 building entrances, public sidewalks and outdoor amenities.



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 1:400 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 (**Image 2B**),

The wind tunnel model included all relevant surrounding buildings and topography within an approximately 480 m 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 44 specially designed wind speed sensors to measure mean and gust speeds at a full-scale height of approximately 1.5 m 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 design team.

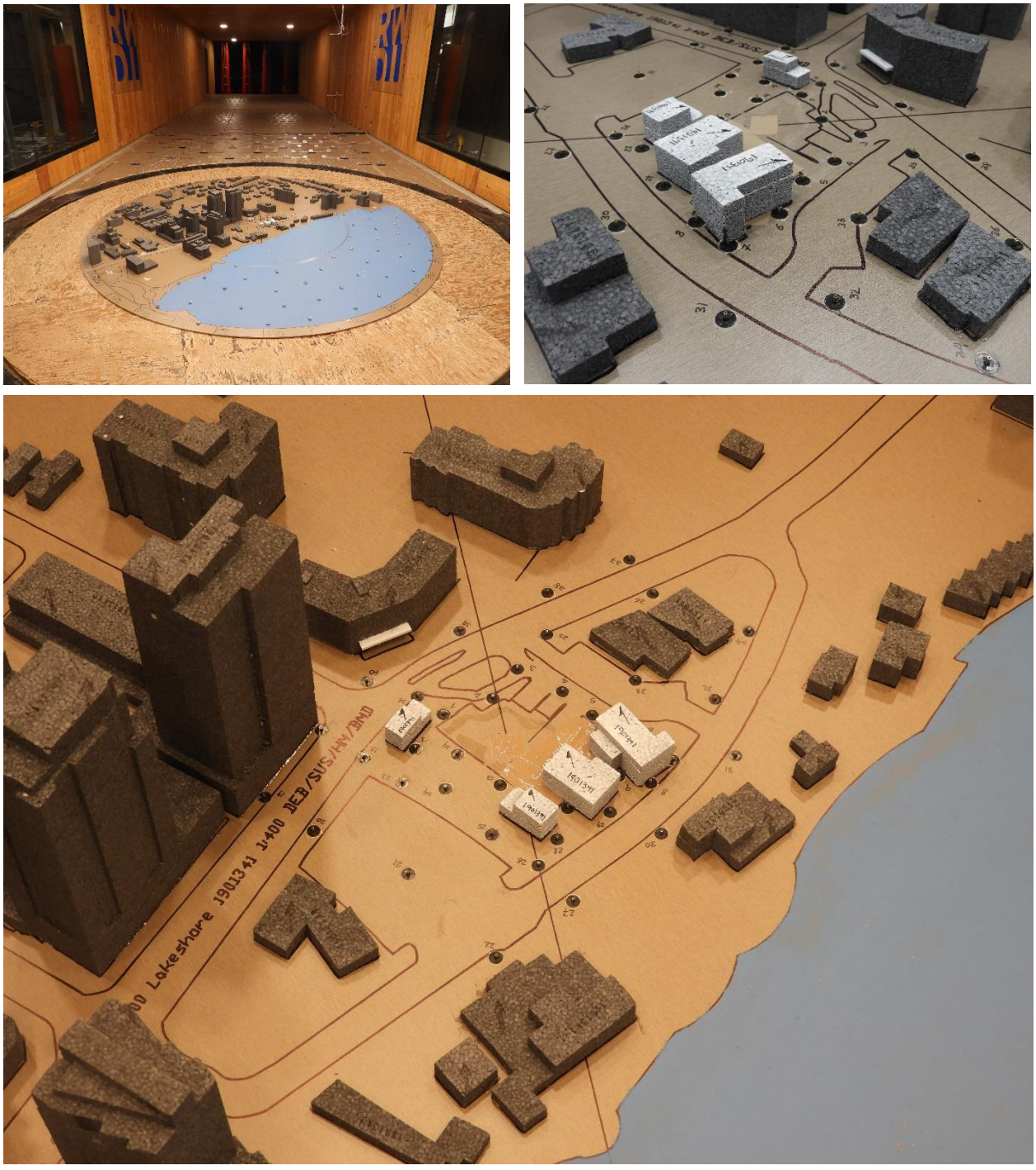


Image 2A: Wind Tunnel Study Model – Existing Configuration

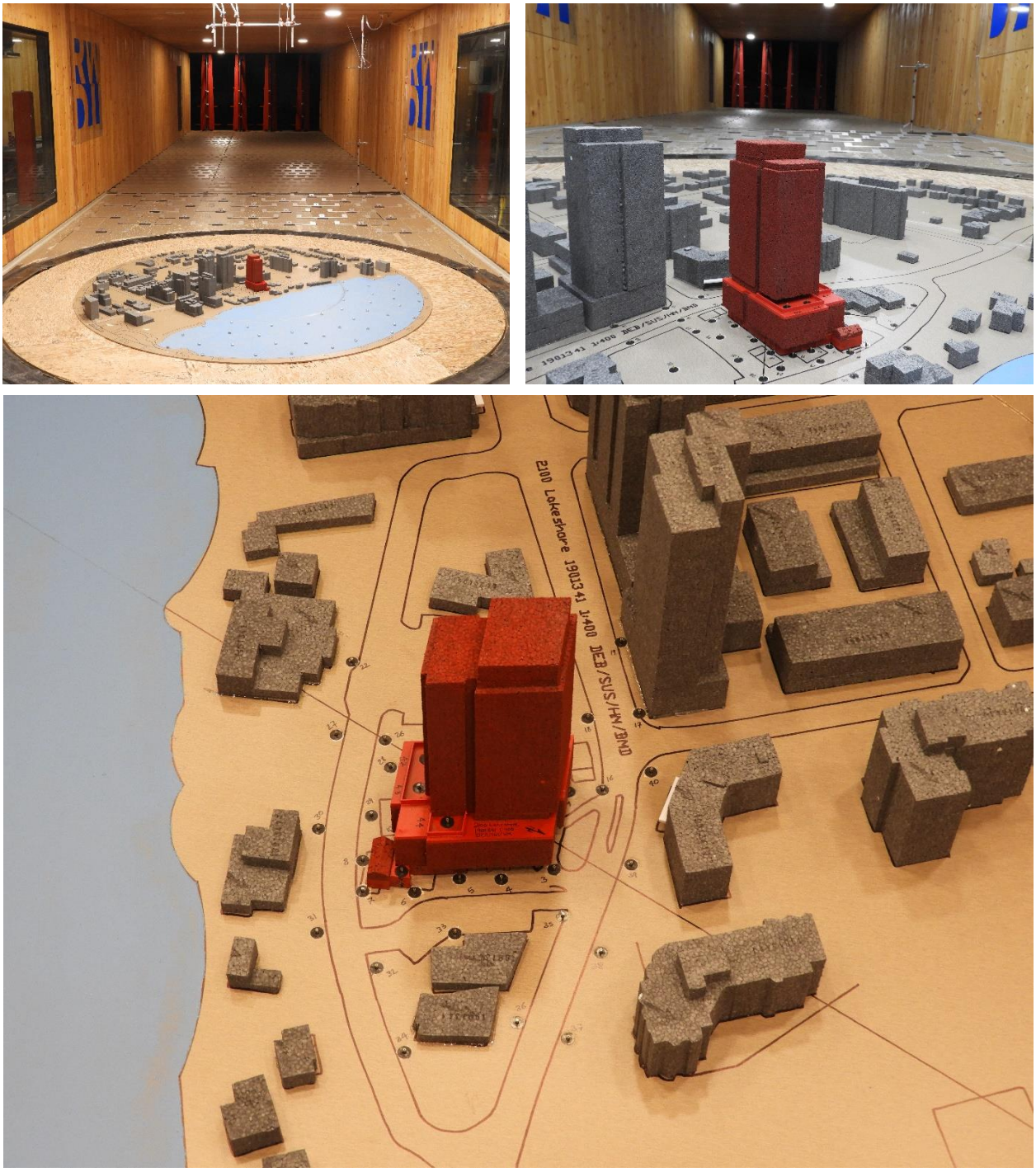
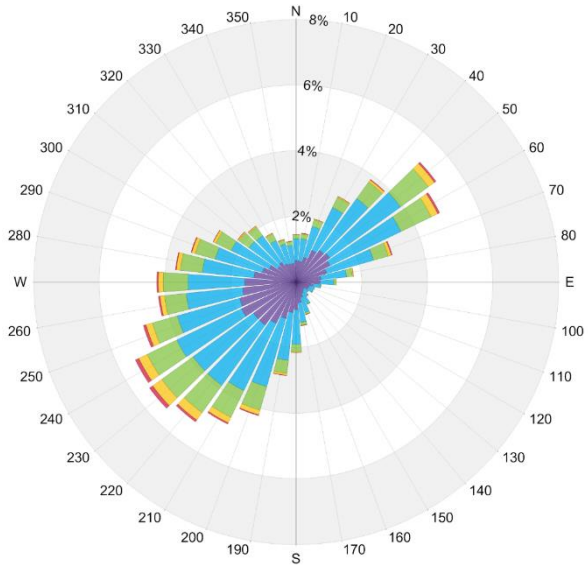


Image 2B: Wind Tunnel Study Model – Proposed Configuration

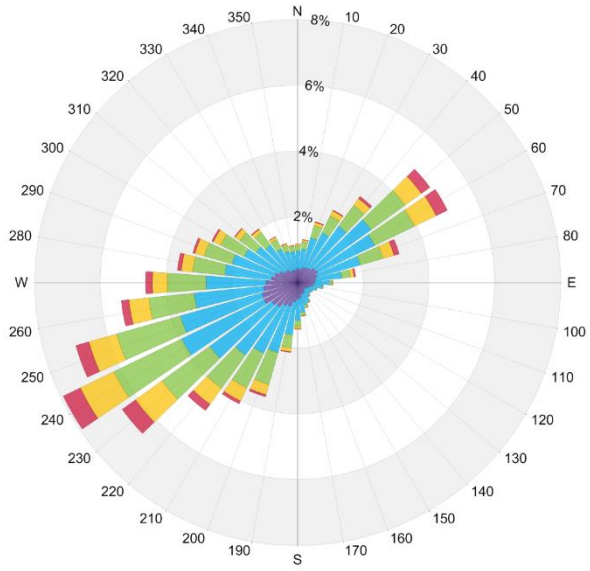
2.2 Meteorological Data

Wind statistics recorded at Hamilton International Airport between 1987 and 2017, 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 northeast and southwest directions are predominant in both the summer and winter as indicated by the wind roses. Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) occur for 3.8% and 13.0% 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.



Summer (May – October)



Winter (November – April)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	4.1	2.5
1-10	33.6	21.4
11-20	43.3	39.7
21-30	15.1	23.3
31-40	3.0	9.3
>40	0.8	3.7

Image 3: Directional Distribution of Winds Approaching Hamilton International Airport from 1987 to 2017

2.3 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 (km/h)	Description
Sitting	≤ 10	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away
Standing	≤ 14	Gentle breezes suitable for main building entrances, bus stops, and other places where pedestrians may linger
Strolling	≤ 17	Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park
Walking	≤ 20	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
Uncomfortable	> 20	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);
(2) GEM speeds listed above are based on a seasonal exceedance of 20% 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 **Burlington**, there are distinct differences in pedestrian outdoor behaviours between these two-time periods.

Safety Criterion	Gust Speed (km/h)	Description
Exceeded	> 90	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 **3b** 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. The following is a detailed discussion of the suitability of the predicted wind conditions for the anticipated pedestrian use of each area of interest.

3.1 Grade Level (Locations 1 through 40)

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.

3.1.1 Existing Configuration

Wind conditions on and around the site are comfortable for standing or sitting during the summer months (May to October), and strolling or better during the winter months (November to April). These conditions are considered appropriate for the intended pedestrian use.

Wind conditions at all locations on and around the site are expected to meet the safety criterion.

3.1.2 Proposed Configuration

With the addition of the proposed development, wind speeds at the areas on and around the project site are expected to increase. Wind conditions are predicted to be comfortable for strolling or better during the summer and walking or better in the winter at most areas. However, uncomfortable wind conditions are expected at some localized areas to the northwest of the site along Lakeshore Road, during the winter.

It is worth mentioning that neither existing or proposed landscaping was included in the current wind tunnel test; if required, the landscaping plan can be tested in the Site Plan Approval stage. As shown in the proposed landscaping plan in **Image 4**, the deciduous shrubs in domes at the north of project site along Lakeshore Road are a positive that can help improve the wind conditions around that area during the summer months. If lower wind speeds are desired year - round, landscaping with coniferous or marcescent trees would improve wind conditions around these areas. Examples of these landscaping are shown in **Image 5**.

Main entrances of the proposed building are situated near Locations 1, 2, 8, 10, 11, 12, 13, and 14 in **Figures 1b**, **2b** and **3b**. Lower wind speeds conducive to standing are preferred at main entrances where pedestrians are apt to linger. Wind conditions are expected to be comfortable for standing or sitting at all entrances during the summer (**Figure 1b**), which is considered suitable for these areas. In the winter, seasonally higher wind speeds are expected to result in conditions comfortable for strolling at entrance Locations 1, 2, 8, 11 and 14 (**Figure 2b**), which might be slightly higher than desired for entrances. If lower wind speeds are desired for these entrances, typical wind control measures would include recessing entrances and installing planters/screens on both sides of the entrances. Examples of wind control strategies for entrances are shown in **Image 6**.

Wind conditions are expected to meet the recommended safety criterion at all grade level areas except three locations at the north and south of the proposed building (see Locations 3, 16 and 26 in **Figure 3b**).

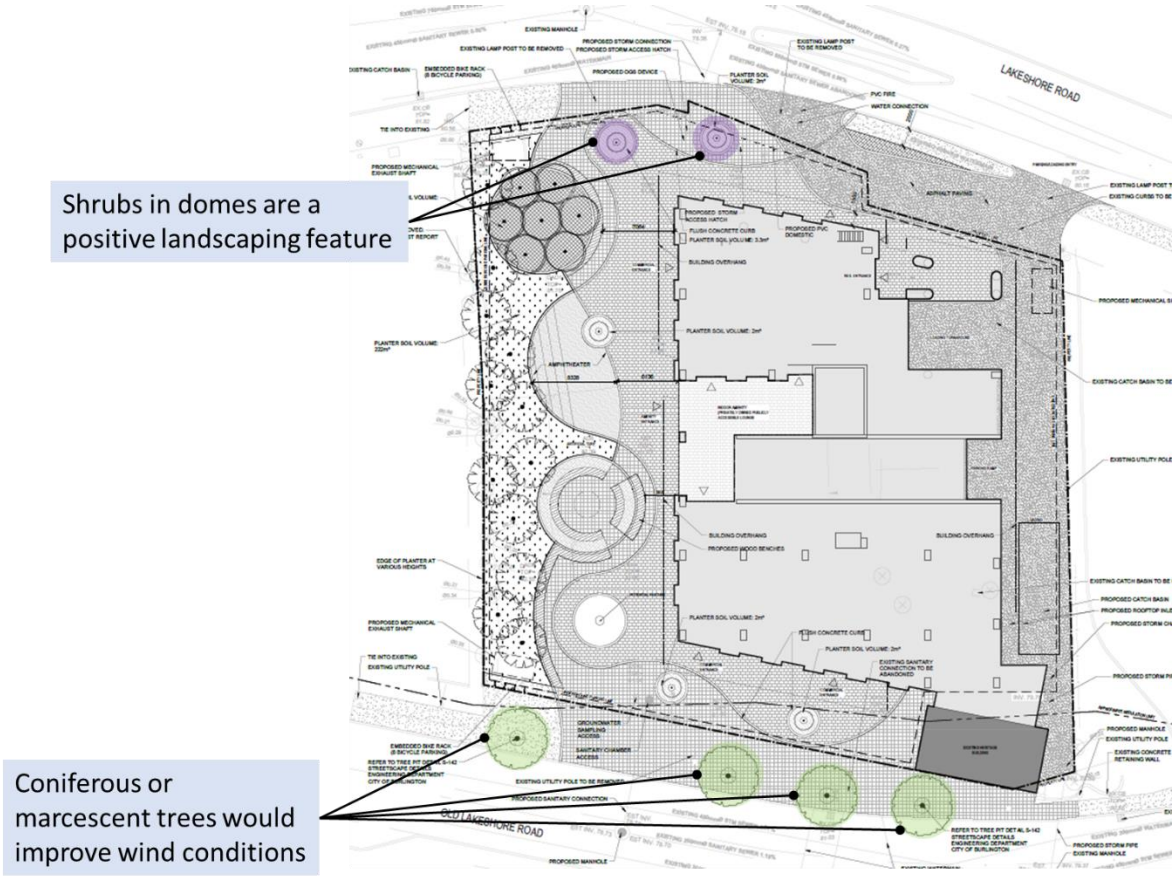


Image 4: Landscaping Plan and Recommended Wind Mitigation Measures



Image 5: Examples of Coniferous and Marcescent Landscaping



Image 6: Wind Control Strategies for Entrances

3.2 Above-Grade Levels (Locations 41 through 44)

It is generally desirable for wind conditions on terraces intended for passive activities to be comfortable for sitting more than 80% of the time in the summer. During the winter, the area would not be used frequently, and increased wind activity would be considered appropriate.

During the summer, wind conditions on the Level 2 and Level 7 outdoor amenities are expected to be comfortable for standing and sitting, which are considered suitable for the intended pedestrian use.

Based on the drawings dated August 22, 2019, Location 44 (**Figures 1B**, **2B** and **3B**) is no longer designated as an outdoor amenity are on the Level 7 terrace.

4 APPLICABILITY OF RESULTS

The drawings and information listed below were received from Studio JCI and were used to construct the scale model of the proposed 2093, 2097 and 2101 Old Lakeshore Road, 2096 and 2100 Lakeshore Road. The wind conditions presented in this report pertain to the proposed as detailed in the architectural design drawings listed in the table 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)
Burlington_20190206.skp	SketchUp Model	07/02/2019

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.

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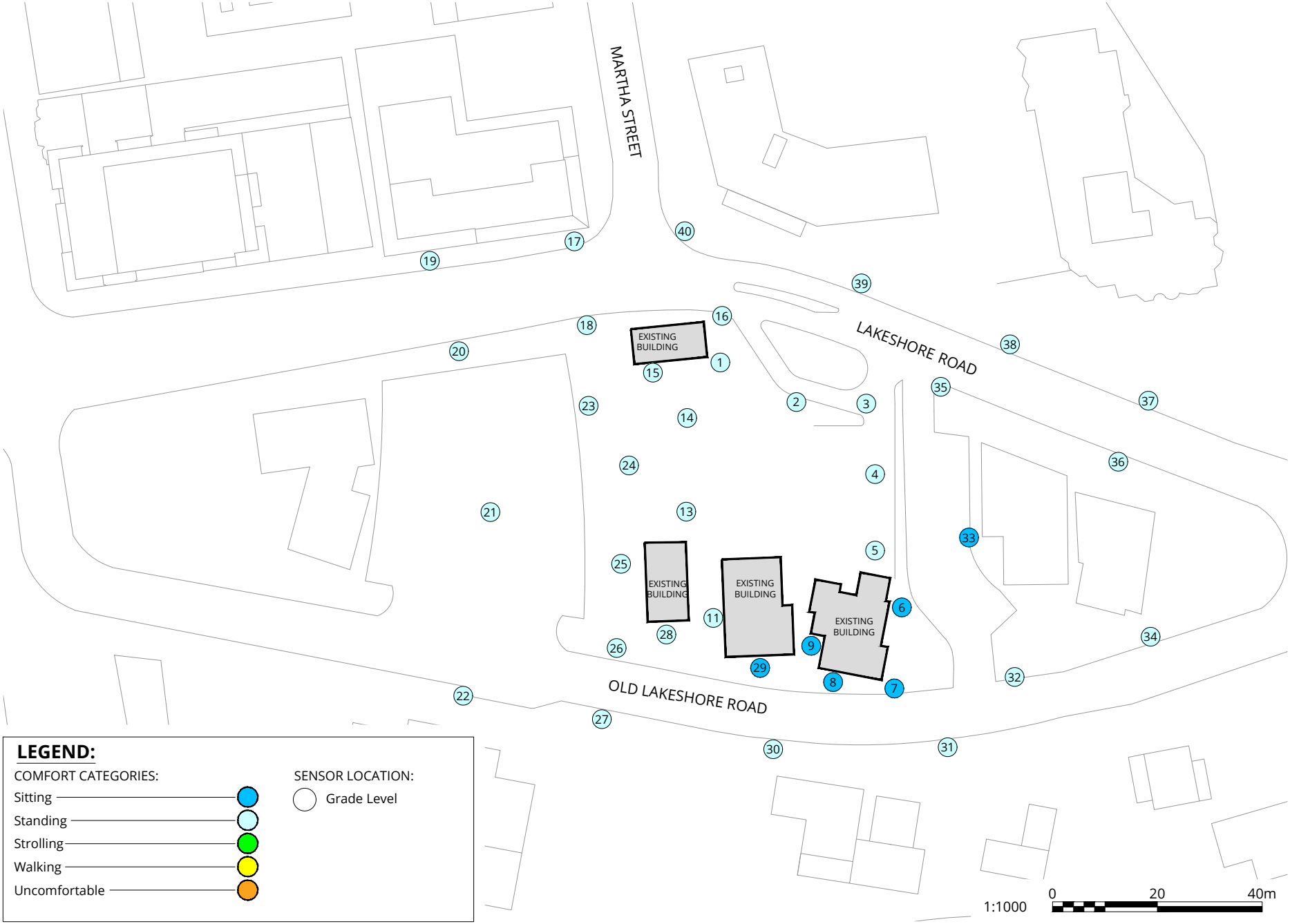
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10. Wu, H., Williams, C.J., Baker, H.A. and Waechter, W.F. (2004), "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions", *ASCE Structure Congress 2004,* Nashville, Tennessee.

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FIGURES



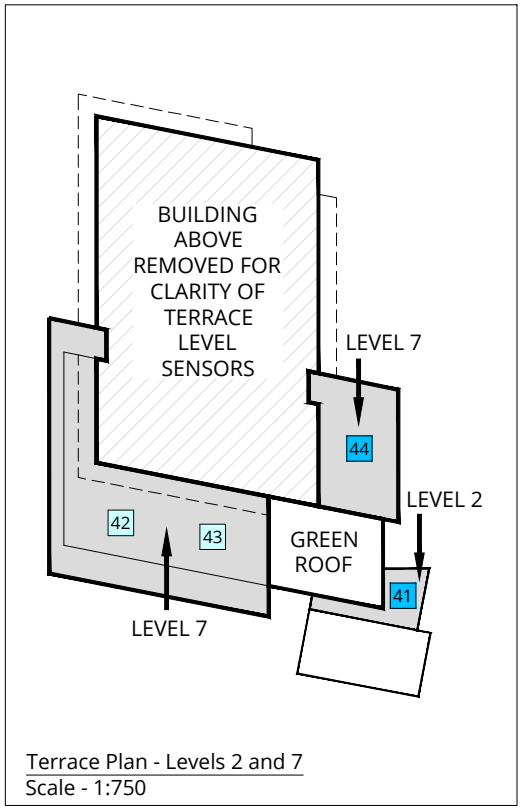
Pedestrian Wind Comfort Conditions
Existing Configuration
Summer (May to October, 6:00 to 23:00)

2093 and 2097 Old Lakeshore Road, 2096, 2100 and 2101 Lakeshore Road – Burlington, ON

Project #1901341

True North

Drawn by: GRE	Figure: 1a
Approx. Scale:	1:1000
Date Revised:	Feb. 28, 2019



Terrace Plan - Levels 2 and 7
Scale - 1:750

LEGEND:

COMFORT CATEGORIES:
- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:
- Grade Level
- Terrace Level
- Entrance Location

Pedestrian Wind Comfort Conditions

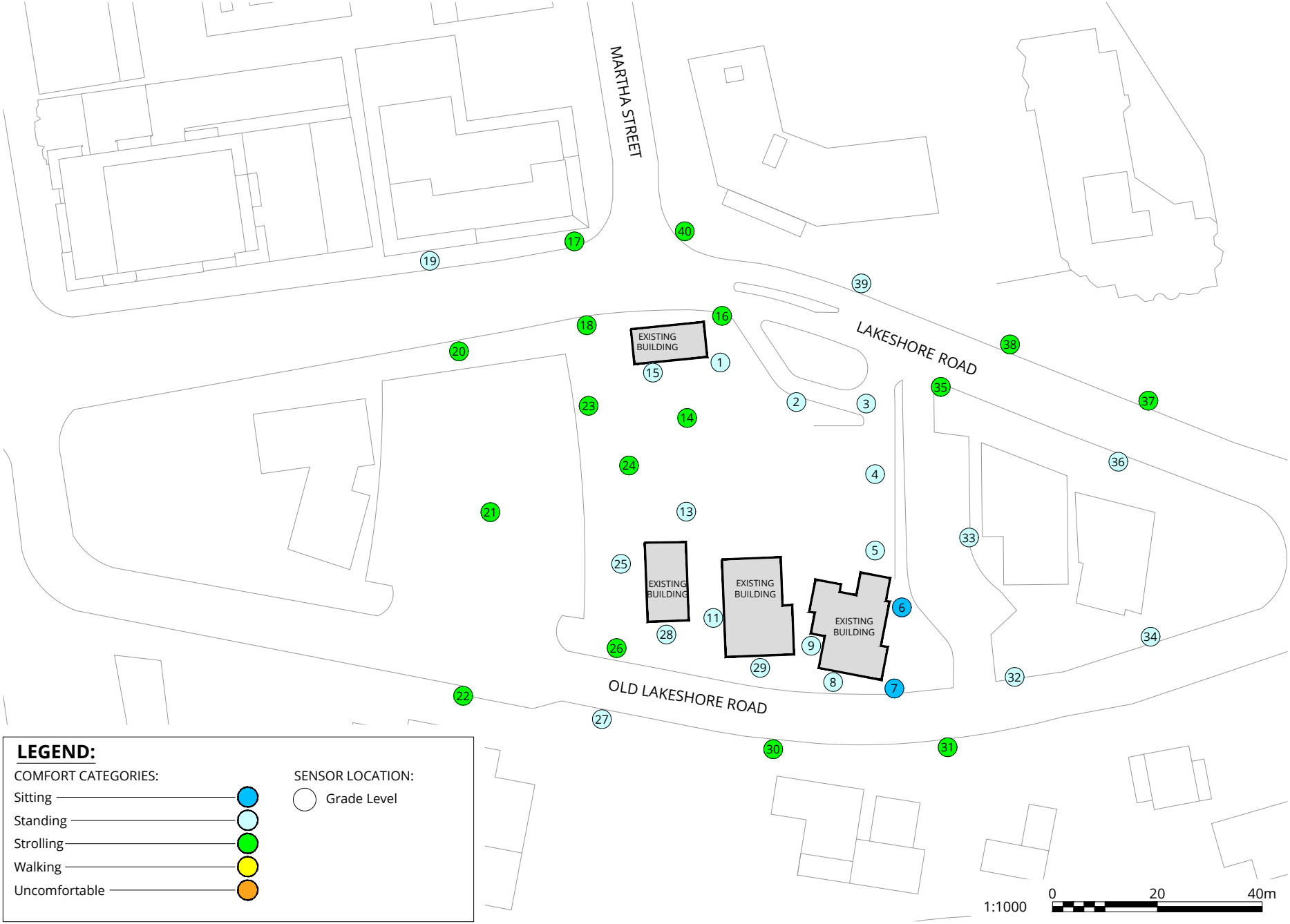
Proposed Configuration
Summer (May to October, 6:00 to 23:00)

2093 and 2097 Old Lakeshore Road, 2096, 2100 and 2101 Lakeshore Road – Burlington, ON

Project #1901341

True North

Drawn by: GRE	Figure: 1b
Approx. Scale:	1:1000
Date Revised:	Feb. 28, 2019



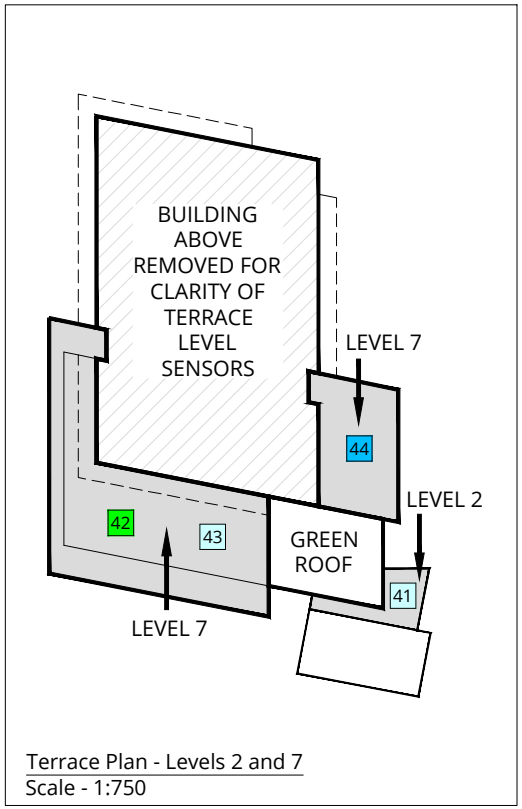
Pedestrian Wind Comfort Conditions
Existing Configuration
Winter (November to April, 6:00 to 23:00)

2093 and 2097 Old Lakeshore Road, 2096, 2100 and 2101 Lakeshore Road – Burlington, ON

Project #1901341

True North

Drawn by: GRE	Figure: 2a
Approx. Scale:	1:1000
Date Revised:	Feb. 28, 2019



Terrace Plan - Levels 2 and 7
Scale - 1:750

LEGEND:

COMFORT CATEGORIES:
- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:
- Grade Level
- Terrace Level
- Entrance Location

Pedestrian Wind Comfort Conditions

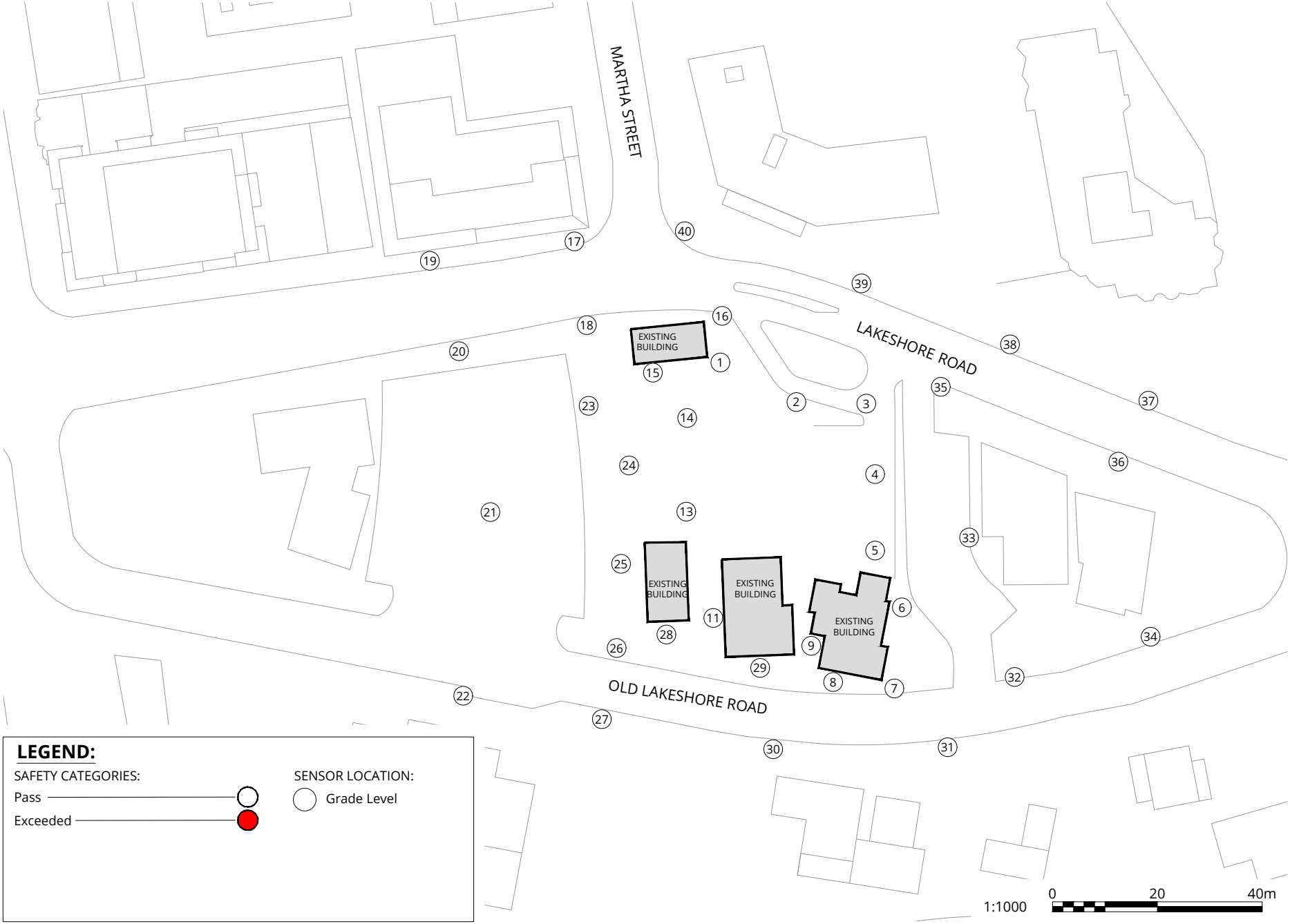
Proposed Configuration
Winter (November to April, 6:00 to 23:00)

2093 and 2097 Old Lakeshore Road, 2096, 2100 and 2101 Lakeshore Road – Burlington, ON

Project #1901341

True North

Drawn by: GRE	Figure: 2b
Approx. Scale:	1:1000
Date Revised:	Feb. 28, 2019



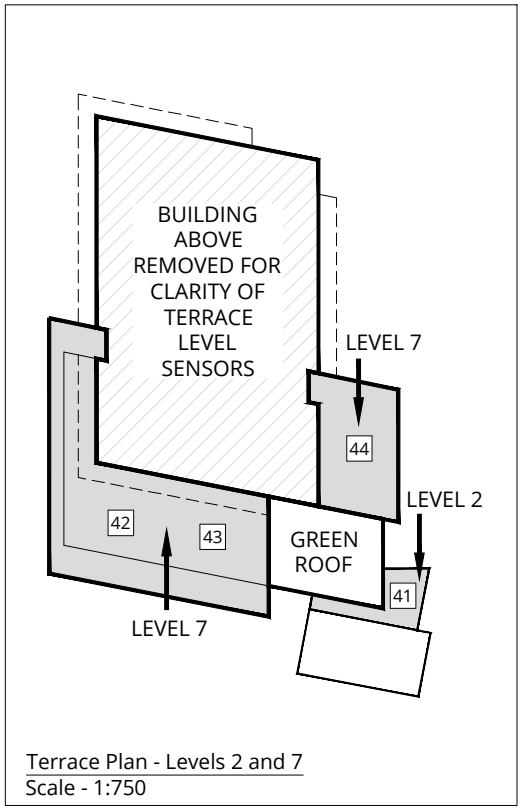
Pedestrian Wind Safety Conditions
Existing Configuration
Annual (January to December, 0:00 to 23:00)

2093 and 2097 Old Lakeshore Road, 2096, 2100 and 2101 Lakeshore Road – Burlington, ON

Project #1901341

True North

Drawn by: GRE	Figure: 3a
Approx. Scale:	1:1000
Date Revised:	Feb. 28, 2019



Terrace Plan - Levels 2 and 7
Scale - 1:750

LEGEND:

SAFETY CATEGORIES:
- Pass
- Exceeded

SENSOR LOCATION:
- Grade Level
- Terrace Level
- Entrance Location

Pedestrian Wind Safety Conditions

Proposed Configuration
Annual (January to December, 0:00 to 23:00)

2093 and 2097 Old Lakeshore Road, 2096, 2100 and 2101 Lakeshore Road – Burlington, ON

Project #1901341

True North

Drawn by: GRE	Figure: 3b
Approx. Scale:	1:1000
Date Revised:	Feb. 28, 2019

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	12	Standing	14	Standing	57	Pass
	Proposed	13	Standing	15	Strolling	73	Pass
2	Existing	12	Standing	14	Standing	56	Pass
	Proposed	13	Standing	15	Strolling	78	Pass
3	Existing	11	Standing	14	Standing	58	Pass
	Proposed	14	Standing	17	Strolling	93	Exceeded
4	Existing	11	Standing	14	Standing	54	Pass
	Proposed	11	Standing	13	Standing	58	Pass
5	Existing	11	Standing	13	Standing	59	Pass
	Proposed	10	Sitting	12	Standing	54	Pass
6	Existing	8	Sitting	10	Sitting	45	Pass
	Proposed	12	Standing	15	Strolling	68	Pass
7	Existing	8	Sitting	10	Sitting	47	Pass
	Proposed	14	Standing	17	Strolling	79	Pass
8	Existing	10	Sitting	12	Standing	55	Pass
	Proposed	14	Standing	17	Strolling	75	Pass
9	Existing	9	Sitting	11	Standing	50	Pass
	Proposed	10	Sitting	13	Standing	66	Pass
10	Existing	-	-	-	-	-	-
	Proposed	10	Sitting	13	Standing	56	Pass
11	Existing	11	Standing	14	Standing	55	Pass
	Proposed	12	Standing	15	Strolling	67	Pass
12	Existing	-	-	-	-	-	-
	Proposed	10	Sitting	13	Standing	56	Pass
13	Existing	11	Standing	14	Standing	56	Pass
	Proposed	11	Standing	14	Standing	64	Pass
14	Existing	12	Standing	15	Strolling	58	Pass
	Proposed	13	Standing	15	Strolling	66	Pass
15	Existing	11	Standing	14	Standing	54	Pass
	Proposed	17	Strolling	21	Uncomfortable	86	Pass
16	Existing	13	Standing	16	Strolling	72	Pass
	Proposed	19	Walking	22	Uncomfortable	91	Exceeded
17	Existing	12	Standing	15	Strolling	78	Pass
	Proposed	14	Standing	16	Strolling	90	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
18	Existing	14	Standing	17	Strolling	67	Pass
	Proposed	17	Strolling	20	Walking	88	Pass
19	Existing	11	Standing	14	Standing	69	Pass
	Proposed	11	Standing	14	Standing	77	Pass
20	Existing	13	Standing	16	Strolling	71	Pass
	Proposed	13	Standing	16	Strolling	84	Pass
21	Existing	12	Standing	15	Strolling	61	Pass
	Proposed	14	Standing	17	Strolling	77	Pass
22	Existing	12	Standing	15	Strolling	56	Pass
	Proposed	12	Standing	15	Strolling	76	Pass
23	Existing	12	Standing	15	Strolling	60	Pass
	Proposed	17	Strolling	21	Uncomfortable	88	Pass
24	Existing	13	Standing	15	Strolling	61	Pass
	Proposed	15	Strolling	19	Walking	80	Pass
25	Existing	11	Standing	14	Standing	59	Pass
	Proposed	15	Strolling	19	Walking	86	Pass
26	Existing	12	Standing	15	Strolling	58	Pass
	Proposed	15	Strolling	19	Walking	94	Exceeded
27	Existing	11	Standing	14	Standing	56	Pass
	Proposed	14	Standing	17	Strolling	87	Pass
28	Existing	11	Standing	14	Standing	58	Pass
	Proposed	15	Strolling	19	Walking	89	Pass
29	Existing	10	Sitting	12	Standing	52	Pass
	Proposed	15	Strolling	18	Walking	88	Pass
30	Existing	13	Standing	16	Strolling	68	Pass
	Proposed	16	Strolling	19	Walking	79	Pass
31	Existing	12	Standing	15	Strolling	58	Pass
	Proposed	14	Standing	17	Strolling	72	Pass
32	Existing	11	Standing	13	Standing	53	Pass
	Proposed	13	Standing	16	Strolling	65	Pass
33	Existing	10	Sitting	13	Standing	49	Pass
	Proposed	15	Strolling	18	Walking	74	Pass
34	Existing	11	Standing	13	Standing	56	Pass
	Proposed	12	Standing	14	Standing	62	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
35	Existing	12	Standing	15	Strolling	60	Pass
	Proposed	15	Strolling	18	Walking	79	Pass
36	Existing	11	Standing	13	Standing	56	Pass
	Proposed	11	Standing	14	Standing	56	Pass
37	Existing	13	Standing	15	Strolling	64	Pass
	Proposed	12	Standing	15	Strolling	60	Pass
38	Existing	13	Standing	16	Strolling	72	Pass
	Proposed	14	Standing	17	Strolling	67	Pass
39	Existing	11	Standing	13	Standing	59	Pass
	Proposed	15	Strolling	18	Walking	77	Pass
40	Existing	14	Standing	16	Strolling	67	Pass
	Proposed	16	Strolling	19	Walking	77	Pass
41	Existing	-	-	-	-	-	-
	Proposed	9	Sitting	12	Standing	65	Pass
42	Existing	-	-	-	-	-	-
	Proposed	13	Standing	17	Strolling	84	Pass
43	Existing	-	-	-	-	-	-
	Proposed	12	Standing	14	Standing	64	Pass
44	Existing	-	-	-	-	-	-
	Proposed	8	Sitting	10	Sitting	54	Pass

Seasons		Hours
Summer	May - October	6:00 - 23:00 for comfort
Winter	November - April	0:00 - 23:00 for safety
Configurations		
Existing	Without the proposed development	
Proposed	With the proposed development	

Comfort Speed (km/h)	
(20% Seasonal Exceedance)	
≤ 10	Sitting
11 - 14	Standing
15 - 17	Strolling
18 - 20	Walking
> 20	Uncomfortable

Safety Speed (km/h)	
(> 0.1% Annual Exceedance)	
≤ 90	Pass
> 90	Exceeded