BATHURST STREET & RICHMOND STREET

TORONTO, ONTARIO

PEDESTRIAN WIND ASSESSMENT

PROJECT #2102877
APRIL 20, 2021

SUBMITTED TO

Toronto (Bathurst & Richmond) LP
2 St. Clair Ave East
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SUBMITTED BY

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EXECUTIVE SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed development at 152-164 Bathurst Street and 623-627 Richmond Street in Toronto, Ontario. Our assessment was based on the local wind climate, the design of the proposed development as provided to us in April 2021, the existing surrounding buildings, and computational modeling and simulation of wind conditions.

Our findings are summarized as follows:

- Grade level wind speeds during the summer season are expected to be within acceptable levels.
- During the winter season, the northwest corner of the building and the primary residential entrance are expected to experience wind speeds that are higher than desired. Wind control concepts are described.
- No unsafe winds are expected at grade level around this project.
- The outdoor amenity spaces at Levels 10 and 17 will have inappropriate wind conditions for the intended use. Wind control concepts are provided.

RWDI can help guide the placement of wind control features, including landscaping, to help achieve appropriate levels of wind comfort based on the programming of the outdoor amenity spaces.

The predicted wind conditions should be quantified and confirmed using wind tunnel scale model tests at an appropriate design stage.

1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the potential pedestrian wind conditions around the development proposed at 152-164 Bathurst Street and 623-627 Richmond Street in Toronto, Ontario. The objective of this assessment is to provide a preliminary and qualitative evaluation of the potential wind impact of the proposed development in support of the OPA/ZBA Application.

The project site is located at the corner of Richmond and Bathurst Streets and will surround an existing 2.5 storey heritage building located directly on the southwest corner of the intersection (shown in red in **Image 1**).

The site is surrounded by low-rise buildings to the south, west and north. Taller buildings exist to the southeast through northeast.

The project includes two levels of underground parking, ground floor retail and residential within a 17-storey tower. Total GFA of the project is approximately 16,300 m^2.

In addition to public sidewalks, the key areas of interest for this assessment include the main residential entrance off Richmond Street, retail entrances, two outdoor amenity spaces on Level 10 (west and south) and one amenity space on Level 17 (see **Image 2**).

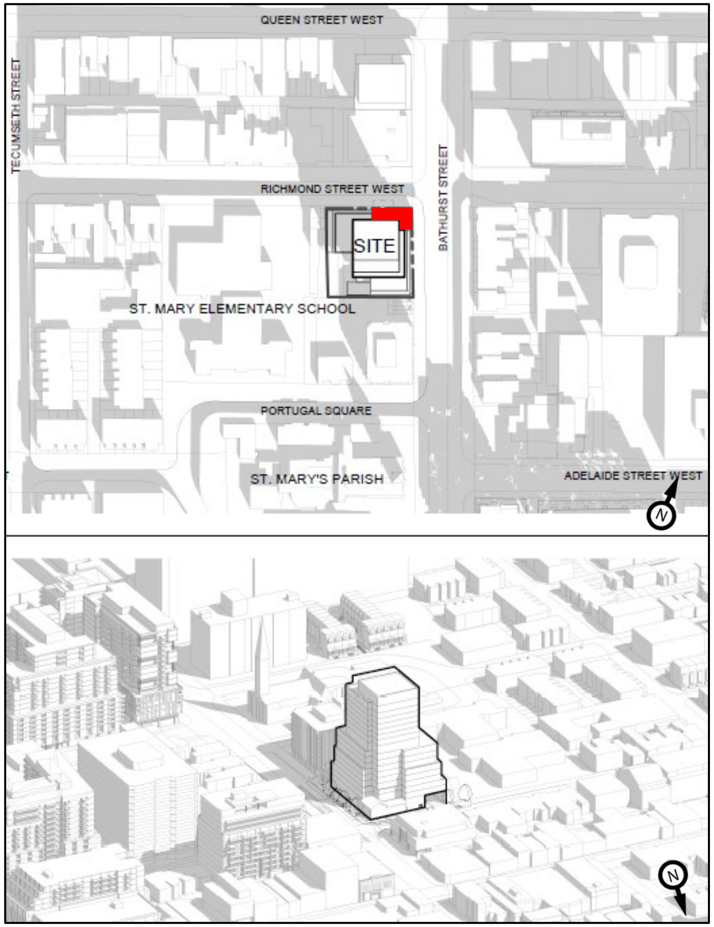


Image 1: Context Map and 3D view of project site and surroundings
Credit: Kirkor Architects and Planners

1. INTRODUCTION

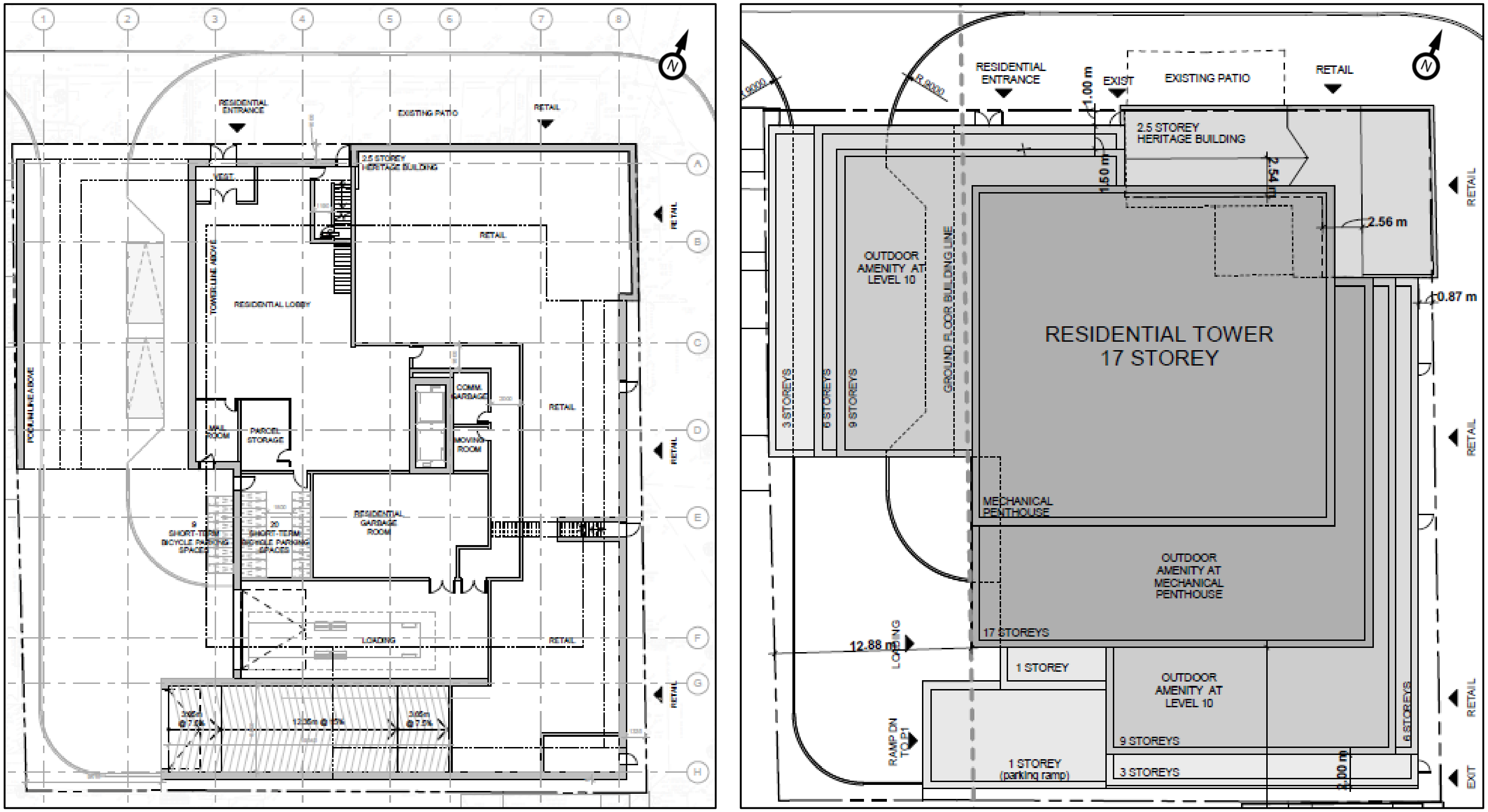


Image 2: Ground floor plan (left) and roof plan (right)

2. METHODOLOGY

The objective of this assessment is to provide a preliminary and qualitative evaluation of the potential wind impact of the proposed development. The assessment is based on the following:

- A review of the regional long-term meteorological data from Billy Bishop Toronto City Airport;
- 3D e-model of the proposed project and 2D architectural floor plans received by RWDI on April 6 and March 30, 2021:
- The use of *Orbital Stack*, an in-house computational fluid dynamics (CFD) tool, to aid in visualization of general wind-flow patterns for a qualitative wind assessment;
- The use of RWDI's proprietary tool *WindEstimator*[2] for estimating the potential wind conditions around generalized building forms;
- Pedestrian wind comfort studies completed by RWDI for similar projects; and,
- Our engineering judgment, experience and expert knowledge of wind flows around buildings[1-3];

This qualitative approach provides a preliminary computational assessment of expected pedestrian wind conditions and identifies areas of accelerated or lower wind speeds. In order to confirm and quantify potential wind conditions and refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel may be performed at a later design stage.

1. H. Wu and F. Kriksic (2012). "Designing for Pedestrian Comfort in Response to Local Climate", *Journal of Wind Engineering and Industrial Aerodynamics*, vol.104-106, pp.397-407.
2. H. Wu, C.J. Williams, H.A. Baker and W.F. Waechter (2004), "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions", *ASCE Structure Congress 2004,* Nashville, Tennessee.
3. C.J. Williams, H. Wu, W.F. Waechter and H.A. Baker (1999), "Experience with Remedial Solutions to Control Pedestrian Wind Problems", *10th International Conference on Wind Engineering*, Copenhagen, Denmark.

2. METHODOLOGY

2.1 Simulation Model

Wind flows around the proposed development and existing surroundings were simulated using *Orbital Stack*, an in-house computational fluid dynamics (CFD) tool.

The computer model of the site and surroundings used for the simulations is shown in **Images 3 and 4**. For the purposes of this computational study, the 3D model was simplified to include only the necessary building massing and terrain details that would affect the local wind flows in the area and around the site. Landscaping and other smaller architectural features were not included in the computer model in order to provide more conservative wind conditions (as is the norm for this level of assessment).

The mean wind speed profile in the atmospheric boundary, approaching the modelled area were simulated for 16 directions (starting at 0°, at 22.5° increments around the compass). Wind data in the form of ratios of mean speeds at approximately 1.5 m above ground and other concerned areas, to mean wind speed at a reference height were obtained. The data was then combined with meteorological records obtained from Billy Bishop Toronto City Airport.

As the project progresses, a wind tunnel study is suggested to quantify the effect of winds accounting for greater design detail (e.g., landscaping).

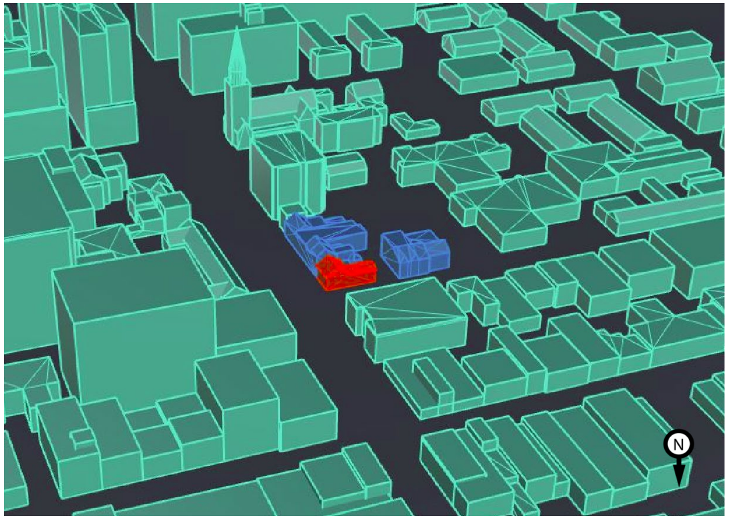


Image 3: Computer model of the existing site and surroundings

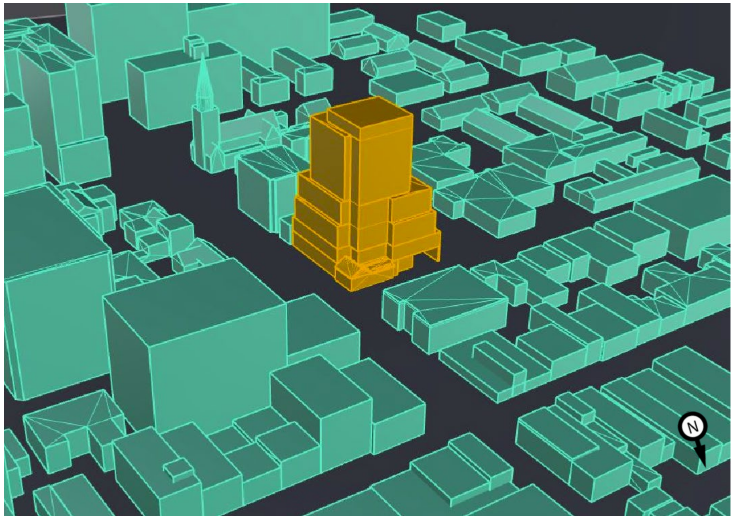
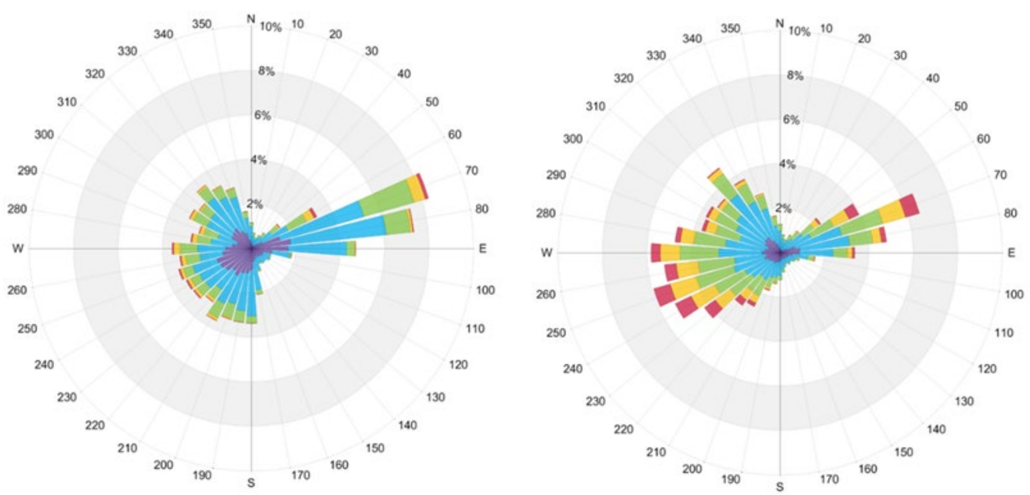


Image 4: Computer model of the proposed site and surroundings

2.2 Meteorological Data

Wind statistics recorded at Billy Bishop Toronto City Airport between 1988 and 2018, 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 northeast directions are predominant in the summer and winter seasons 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 4.3% and 17.3% of the time during the summer and winter seasons, respectively, and they are primarily from the west-southwest and east-northeast directions.

Wind statistics were combined with the *Orbital Stack (*CFD) 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 through October)

Winter (November through April)

Wind Speed (km/h)	Probability (%) Summer	Probability (%) Winter
Calm	5.7	2.7
1-10	30.6	17.2
11-20	43.4	38.0
21-30	16.0	25.0
31-40	3.4	11.4
>40	0.9	5.9

Image 5: Directional distribution of winds approaching Billy Bishop Toronto City Airport from 1988 to 2018

3. CRITERIA

The RWDI pedestrian wind criteria are used in the current study. These criteria have been developed by RWDI through research and consulting practice since 1974. They have also been widely accepted by municipal authorities, building designers and the city planning community. The criteria are as follows:

3.1 Safety Criterion

Wind safety is associated with excessive gust that can adversely affect a pedestrian's balance and footing. If strong winds that can affect a person's balance (**90 km/h**) occur more than **0.1%** of the time or 9 hours per year, the wind conditions are considered severe.

3.2 Pedestrian Comfort Criteria

Wind comfort can be categorized by typical pedestrian activities:

Sitting (≤ 10 km/h): Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away.

Standing (≤ 14 km/h): Gentle breezes suitable for main building entrances and bus stops.

Strolling (≤ 17 km/h): Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park.

Walking (≤ 20 km/h): Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.

Uncomfortable: The comfort category for walking is not met.

Wind conditions are considered suitable for sitting, standing, strolling or walking if the associated mean wind speeds are expected for at least four out of five days (**80% of the time**). Wind control measures are typically required at locations where winds are rated as *uncomfortable* or they exceed the wind safety criterion.

Note that these wind speeds are assessed at the pedestrian height (i.e., 1.5 m above grade or the concerned floor level), typically lower than those recorded in the airport (10 m height and open terrain).

These criteria for wind forces represent average wind tolerance. They are sometimes subjective and regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can also affect people's perception of the wind climate.

For the current development, wind speeds comfortable for *walking* or *strolling* are appropriate for sidewalks where pedestrians are likely to be active and moving intentionally, *standing* for entrances and calmer wind speeds suitable for *sitting* are desired in areas where prolonged periods of passive activities are anticipated, such as the outdoor amenity areas.

4. RESULTS AND DISCUSSION

4.1 Wind Flow Around Buildings

Taller buildings can have the tendency to redirect winds downwards significantly which can cause adverse wind conditions at pedestrian levels. Particularly, in relatively open surroundings, buildings tend to intercept and redirect winds around them in this way. The mechanism in which winds are directed down the height of a building is called Downwashing. These flows subsequently move around exposed building corners, causing a localized increase in wind activity due to Corner Acceleration. Large groups of built structures of similar or greater height compared to the project, and dense cluster of tall trees help diffuse wind flow and shelter the site to a great extent. These generalized flow patterns are illustrated in **Image 6**.

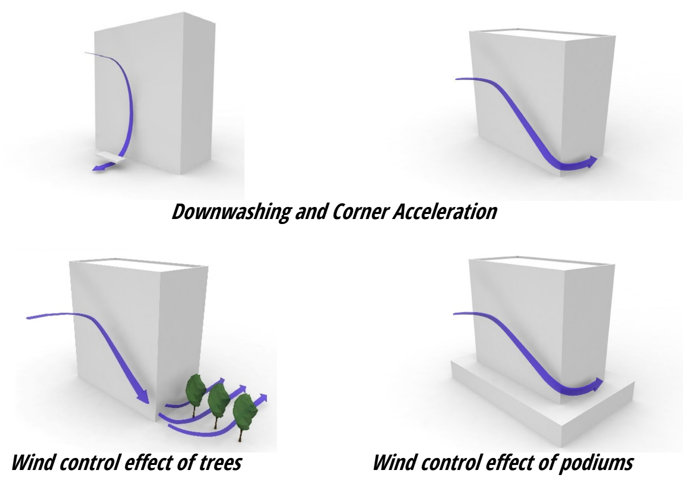


Image 6: Generalized wind flows

4.2 Simulation Results

The results of the simulations done without trees and landscaping, for the summer and winter season, are presented in **Image 7 through 9**, as still images of color contours of predicted wind speed ranges. The results correspond to a horizontal plane approximately 1.5 metres above the concerned level. These results are for the average wind condition; actual wind speeds vary with time. The conditions presented are approximate and intended for reference. The following color scale is used for representation of wind conditions against the pedestrian wind comfort criteria:

Blue regions represent low wind speed areas comfortable for *sitting* or *standing*; green indicates medium wind speeds comfortable for *strolling*, and yellow regions are associated with higher winds speeds comfortable for *walking*. The orange and red regions are associated with the highest wind speed regions that may not be suitable for pedestrian usage (i.e., *uncomfortable* and potentially *unsafe*).

4.3 Wind Comfort and Safety Conditions

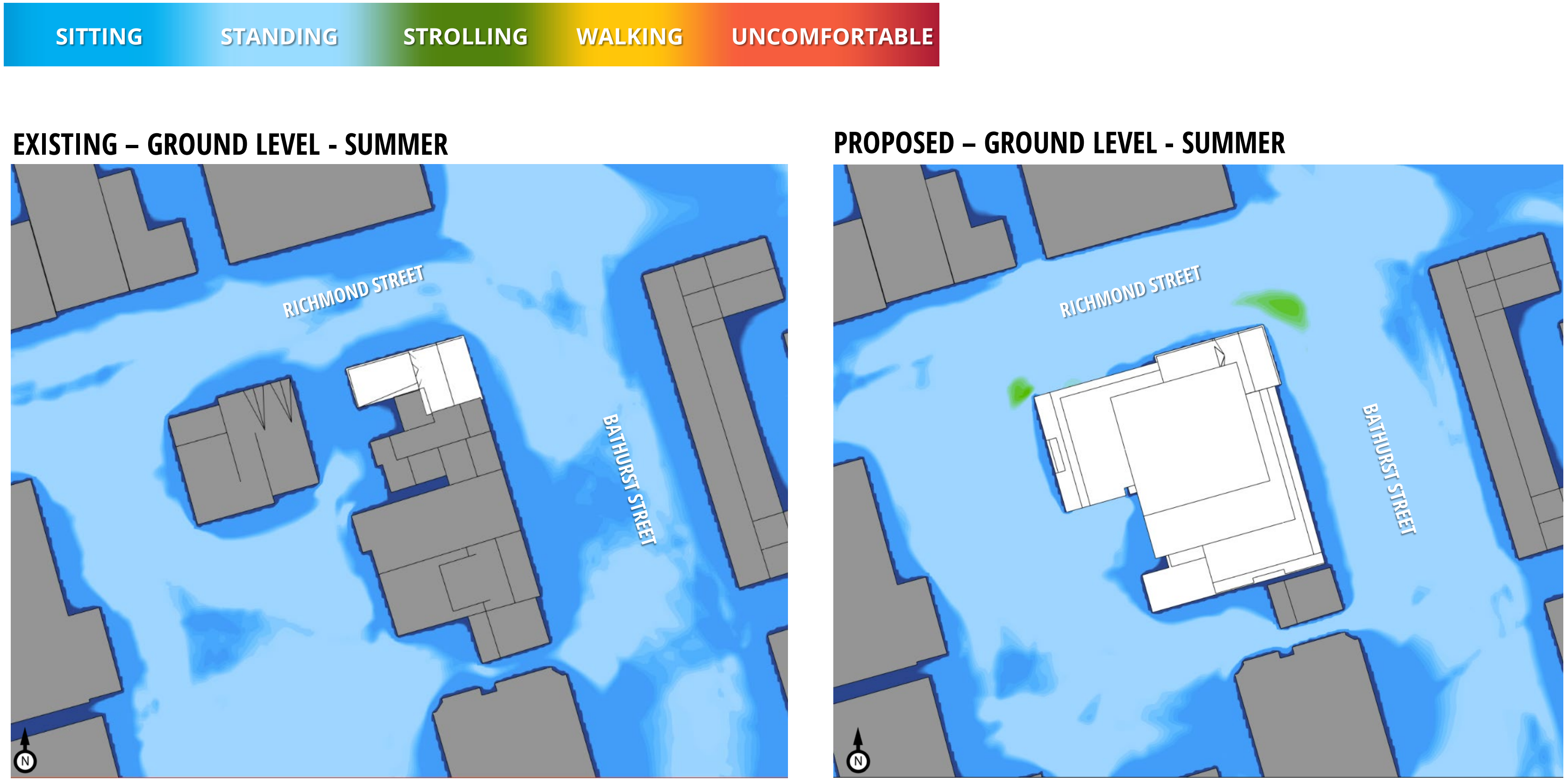
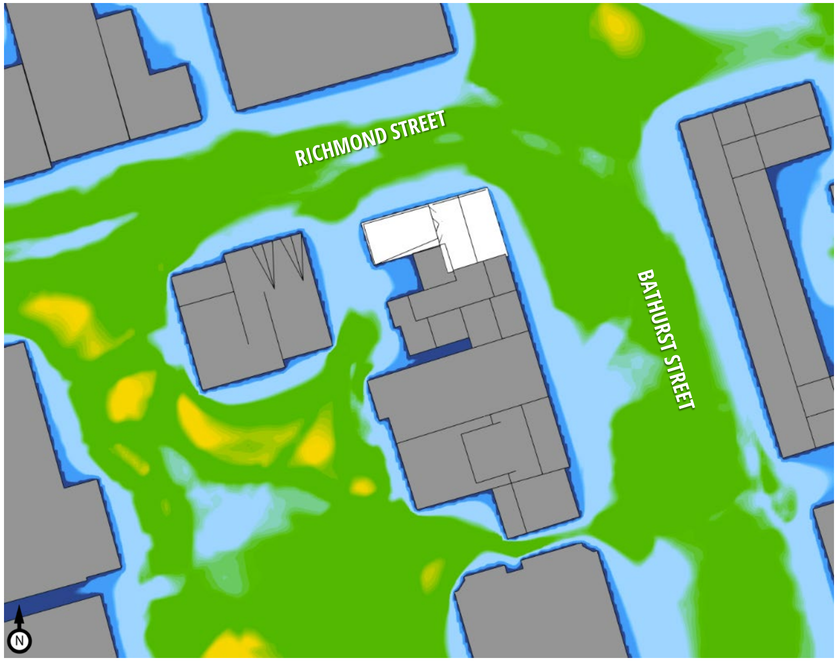


Image 7: Predicted summer wind conditions – ground level – existing (left) and proposed (right)

4.3 Wind Comfort and Safety Conditions

EXISTING – GROUND LEVEL - WINTER



PROPOSED – GROUND LEVEL - WINTER

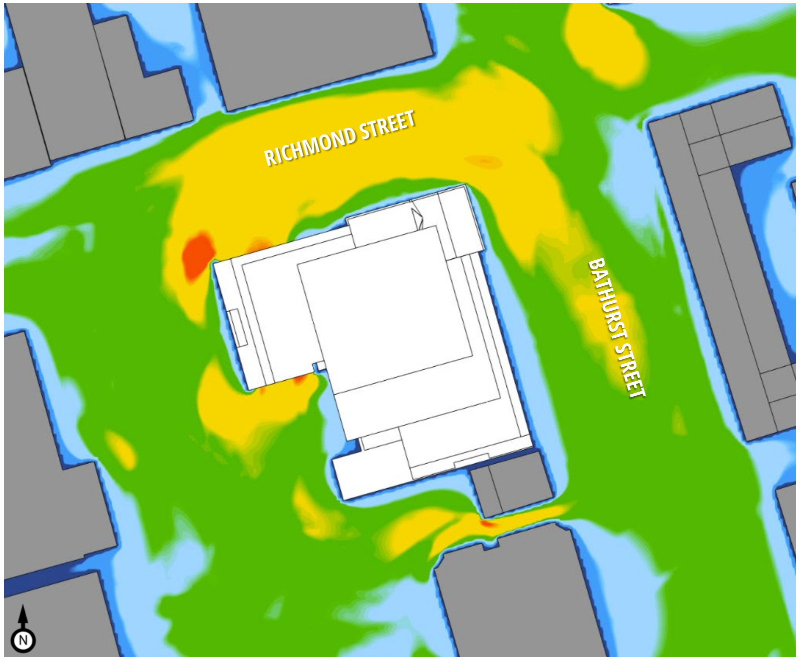
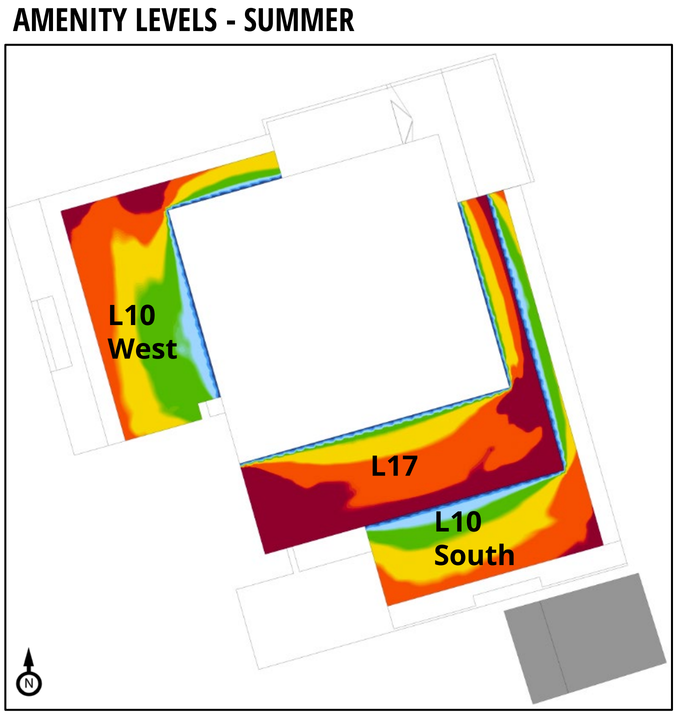


Image 8: Predicted winter wind conditions – ground level – existing (left) and proposed (right)

4. RESULTS AND DISCUSSION

4.3 Wind Comfort and Safety Conditions



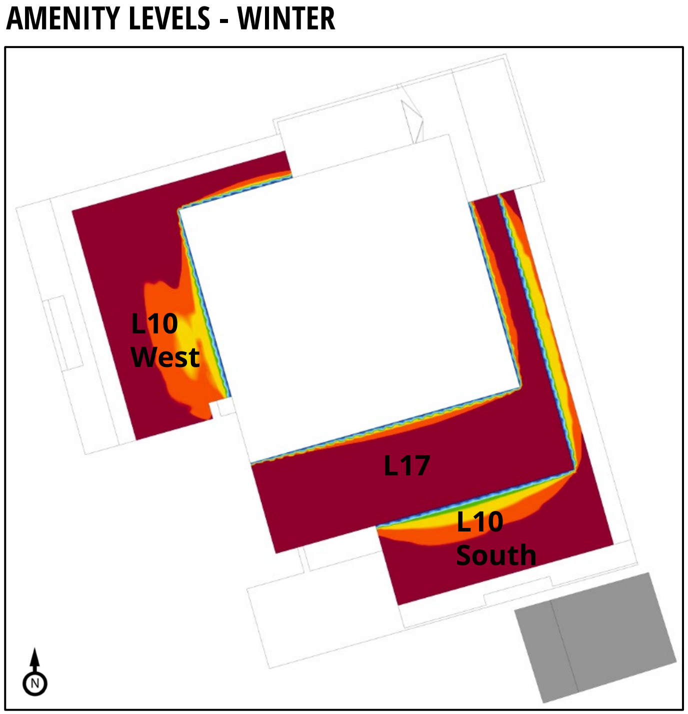


Image 9: Predicted wind conditions – amenity levels – summer (left) and winter (right)

4.4 Existing Scenario

The existing wind conditions on the site and at adjacent sidewalks along Richmond Street and Bathurst Street are comfortable for *sitting* in summer and *standing* in winter (**Images 7 and 8**). These wind conditions are considered appropriate for the existing use.

4.5 Proposed Scenario

With the addition of the proposed building (see **Images 7 and 8**), conditions are expected to become slightly windier than those that currently exist. Summer conditions at ground level will be generally comfortable for *standing* or *strolling*, while seasonally stronger winds in the winter will create conditions that will be mostly comfortable for *standing*, *strolling* or *walking*.

Wind speeds that exceed the wind safety criterion are not expected at grade level anywhere on the site or its immediate surroundings. There is a potential for *unsafe* winds on some of the outdoor amenity spaces at Levels 10 and 17.

4.5.1 Sidewalks

A small increase in local wind speeds is predicted to result in adjacent sidewalk conditions that are comfortable for *standing* or *strolling* in summer (**Image 7**) and *standing*, *strolling* or *walking* in winter (**Image 8**). These are considered acceptable. One exception may occur on the sidewalk near the northwest corner of the proposed building where marginally *uncomfortable* winter winds are likely. These would be caused primarily by north winds downwashing off the north façade of the building and then accelerating around the northwest corner (see directional flows in **Image 10**). West and southwest winds also accelerate around this corner. To improve these conditions on the sidewalk would require the addition of a corner canopy to intercept downwashing north winds and/or the planting of trees that can provide wind protection during the winter (i.e., either coniferous or marcescent trees). Also, the west wall of the enclosed driveway could be made more porous (30% to 50% porous) to help filter southwest and west winds rather than force them around the northwest corner. See **Image 13**. These concepts would need to be verified during a wind tunnel test.

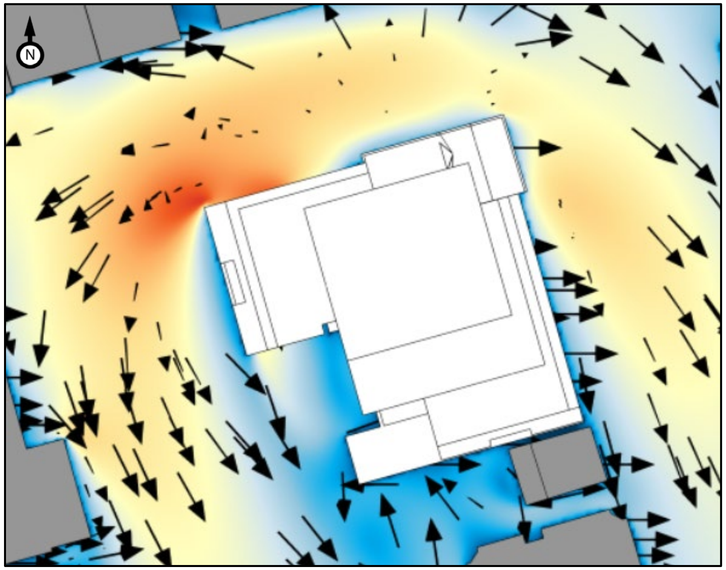


Image 10: Corner acceleration of the north wind

4.5.2 Residential Entrance

As seen in **Image 2** the primary residential entrance is located on the north façade approximately 12 m east of the northwest building corner. The conditions here are expected to be comfortable for *sitting* in summer and *standing* during the winter (see **Images 7 and 8**). These conditions are acceptable, and the result of the entry façade being slightly recessed and protected from overhead winds.

4.5.3 Retail Entrances

All of the retail entrances (as indicated in **Image 2**) are expected to experience winds that will be comfortable for *sitting* in the summer and *standing* in the winter. These conditions should be appropriate, and no additional wind control is recommended.

4.5.4 Level 10 Outdoor Amenity Spaces

As the outdoor amenity spaces are not likely to be used in the winter, this discussion will focus on summer results only. Wind speeds naturally increase with elevation making elevated amenity spaces more exposed to stronger winds and as such, conditions there will typically be windier than at grade level. The Level 10 terraces (both west and south) can be seen in **Image 9** (left side) where predicted summer conditions will be comfortable for *standing* adjacent to the building façade and then diminish to *uncomfortable* as one goes further outward. These conditions will require supplementary wind control.

It is recommended that wind tunnel tests of a scale model be carried out at an appropriate time to confirm and quantify these conditions and develop appropriate wind control measures where required. In the interim, the team should consider the addition of tall perimeter wind screens as per the guidelines in **Image 11**. Note that in some cases perimeter wind screening alone will not be sufficient to protect the entire outdoor amenity space and intermediate vertical screens / planters will be required to protect the more sensitive passive use areas. In addition, overhead canopies / trellises may should be included close to the tower façade to protect from winds downwashing from above and onto these two amenity spaces. See **Images 12, 13 and 14**.

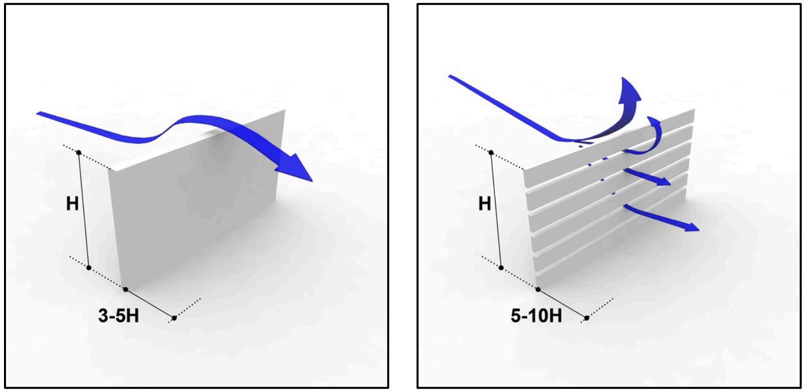


Image 11: Design guidelines for wind screens (solid and porous)

4.5.5 Level 17 Outdoor Amenity Space

As seen in **Image 9** this amenity space will also have inappropriate wind conditions that will require supplementary wind control. At this location most of the winds will flow horizontally from the easterly and westerly directions requiring vertical perimeter wind screens (designed as per **Image 11**) as well as intermediate wind screens / planters to provide areas of improved wind protection for passive use (i.e., seating). See **Images 12, 13 and 14**.

4.5.6 Partially Enclosed Driveway

As can be seen in **Image 2** there is a partially enclosed driveway for vehicles to access from Richmond Street, drive through a portion of the building, back out into the elements and then enter either a loading dock or a ramp to underground parking. Understanding that the wind can flow through this partially enclosed space the conditions here are predicted to be comfortable for *strolling* in summer and *walking* with marginally *uncomfortable* pockets during the winter. As it does not appear that pedestrian access will be encouraged in this area these conditions may be considered acceptable. In the event that doors are contemplated within this partially enclosed driveway they should be appropriately protected (i.e., recessed into the façade and/or provided with vertical wind screens on both sides of the doors). See **Image 12**.

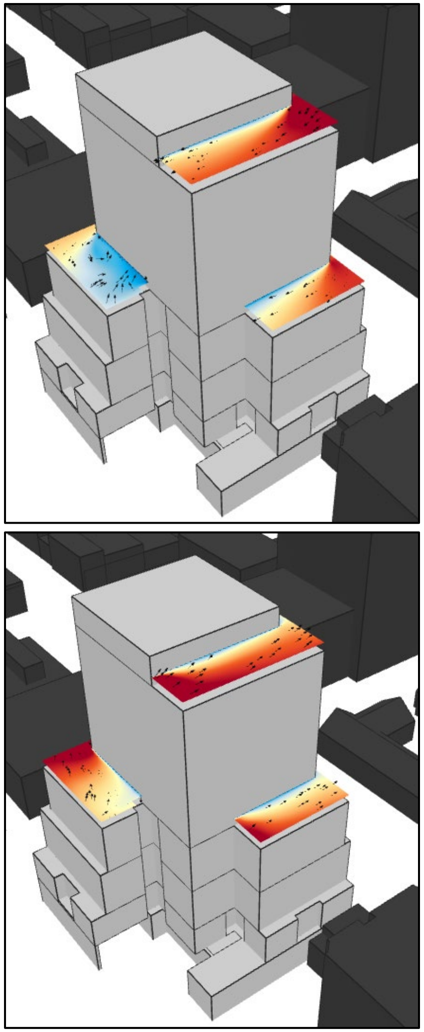


Image 12: Predicted wind flows on amenity levels ENE wind (upper) and SW wind (lower)

5. WIND CONTROL CONCEPTS

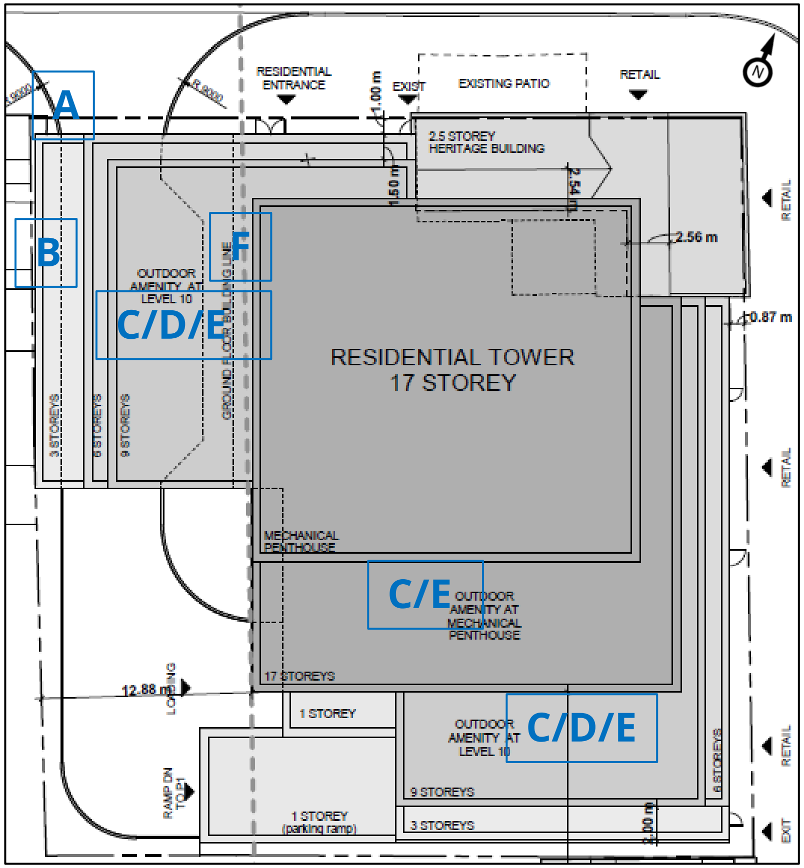


Image 13: Wind Control Concepts

LEGEND:

A	**Corner canopy and/or winter trees**
B	**Driveway sidewall to be 30% to 50% porous**
C	**Tall perimeter wind screens**
D	**Overhead trellis >70% solid**
E	**Intermediate screens / planters**
F	**Protect grade level entry doors**

5. WIND CONTROL CONCEPTS

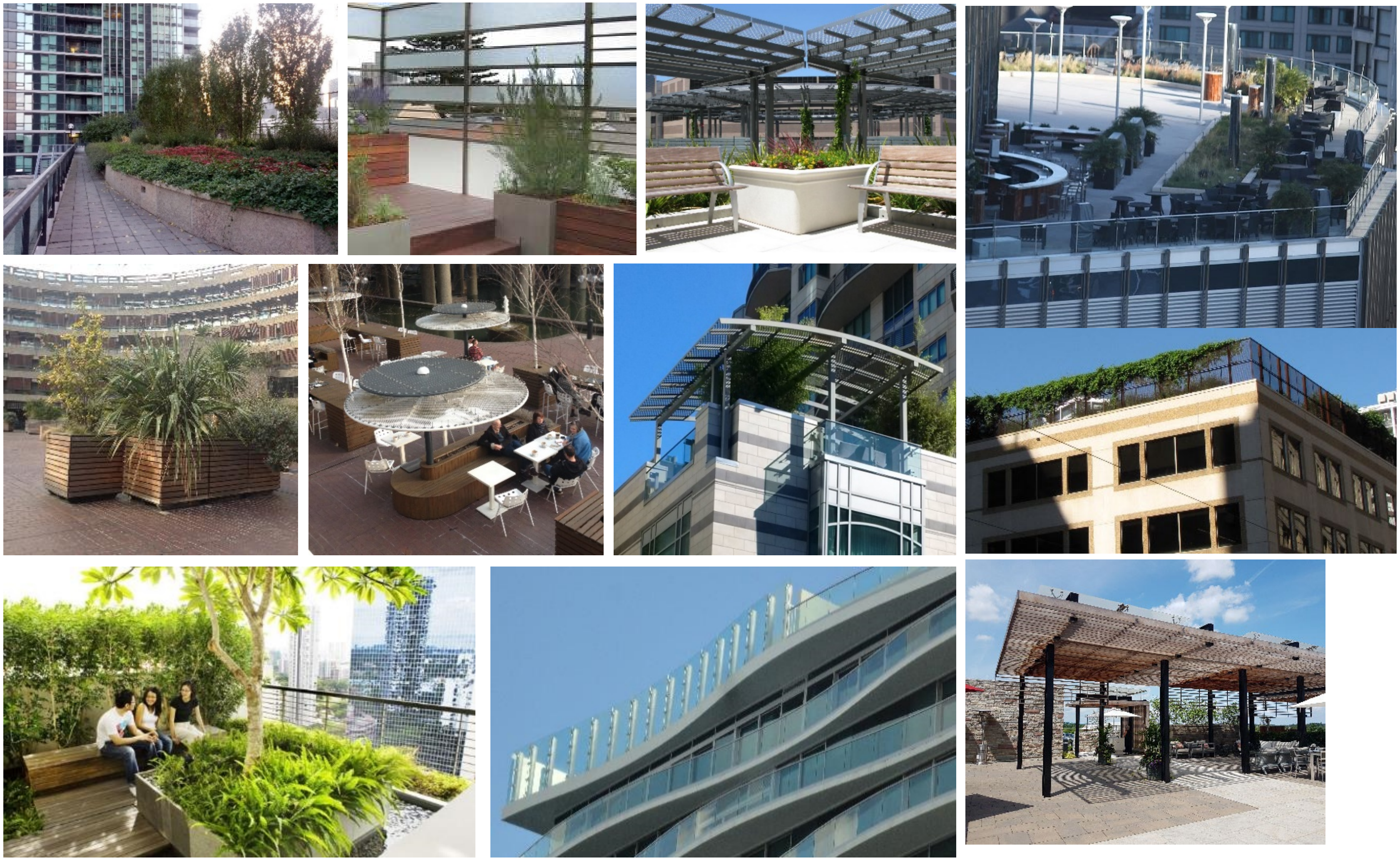


Image 14: Examples of wind control on amenity terraces

6. APPLICABILITY OF RESULTS

The assessment presented in this report is for the proposed 152-164 Bathurst Street and 623-627 Richmond Street project in Toronto and was based on the design information provided to RWDI on March 30 through April 8, 2021.

In the event of any significant changes to the design, construction or operation of the building or addition of surroundings in the future, RWDI could provide an assessment of their impact on the pedestrian wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.