PIER 8 BLOCK 16

HAMILTON, ON

PEDESTRIAN WIND ASSESSMENT

PROJECT #2103408
NOVEMBER 03, 2021

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the potential wind conditions at pedestrian levels on and around the proposed Block 16 of the Pier 8 development in Hamilton, Ontario, in support of its Official Plan Amendment (OPA) application. The objective of this preliminary assessment is to assist the evaluation of the potential wind impact of the proposed development prior to the detailed CFD simulations or Wind Tunnel testing.

The project site is located at the waterfront park in north Hamilton, surrounded by Lake Ontario to the north and by a mixture of low-rise and mid-rise buildings to the south (Image 1).

The project will consist primarily of a 45-storey tower with a setback at Level 31 (Image 2). It has a curved façade, reducing the potential interaction with local winds. In addition to sidewalks and properties near the project site, key areas of interest for this assessment include the main entrances to the buildings and outdoor amenity areas at both grade level and Level 31 (Image 3).

Image 1: Aerial view of the existing site and surroundings
Credit: Google Maps

Image 2: Conceptual massing

1. INTRODUCTION

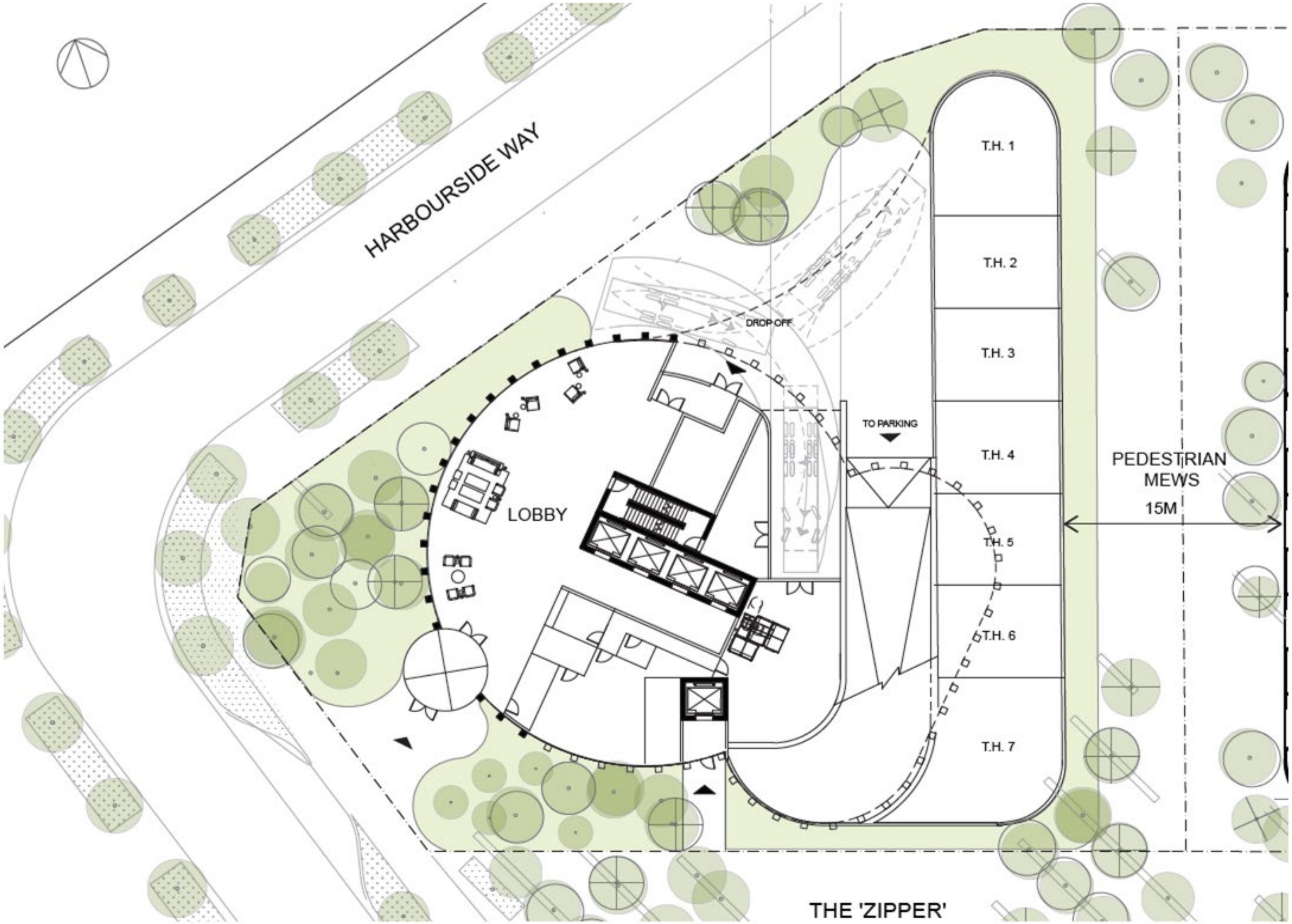


Image 3: Ground floor plan

2. METHODOLOGY

2.1 Objective

The objective of this preliminary assessment is to provide an evaluation of the potential wind impact of the proposed development on pedestrian areas around it. The assessment is based on the following:

- A review of the regional long-term meteorological data from Hamilton International Airport;
- 3D e-model and plans of the proposed project received on October 7 and October 27, 2021.
- The use of *Orbital Stack*, an in-house computational fluid dynamics (CFD) tool, to aid in the visualization of wind flows;
- The use of RWDI's proprietary tool WindEstimator[1] for estimating the potential wind conditions around generalized building forms;
- Wind tunnel studies completed by RWDI for similar projects in the nearby region; and,
- Our engineering judgment, experience, and expert knowledge of wind flows around buildings[1-3].

Note that other microclimate issues such as those relating to cladding and structural wind loads, door operability, building air quality, snow impact, noise, vibration, etc. are not part of the scope of this assessment.

2.2 CFD in Urban Wind Modelling

CFD is a numerical modelling technique for simulating wind flow in complex environments. For urban wind modelling, CFD techniques are used to generate a virtual wind tunnel where flows around the site, surroundings and the study building are simulated at full scale. The computational domain that covers the site and surroundings are divided into millions of small cells where calculations are performed, which allows for the "mapping" of wind conditions across the entire study domain. CFD excels as a tool for urban wind modelling for providing early design advice, resolving complex flow physics, and helping diagnose problematic wind conditions. It is useful for the assessment of complex buildings and contexts and provides a good representation of general wind conditions which makes it easy to judge or compare designs and site scenarios.

Gust conditions are infrequent but deserve special attention due to their potential impact on pedestrian safety. The computational modeling method used in the current assessment does not quantify the transient behaviour of the wind, including wind gusts. In the current study, the level of windiness is predicted qualitatively using CFD and the information is associated with pedestrian usability through analytical methods and wind-tunnel-based empirical models1. The assessment has been conducted by experienced microclimate specialists in order to provide an accurate prediction of wind conditions.

In order to quantify the transient behavior of wind and refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel or more detailed transient computational modeling would be required.

2. METHODOLOGY

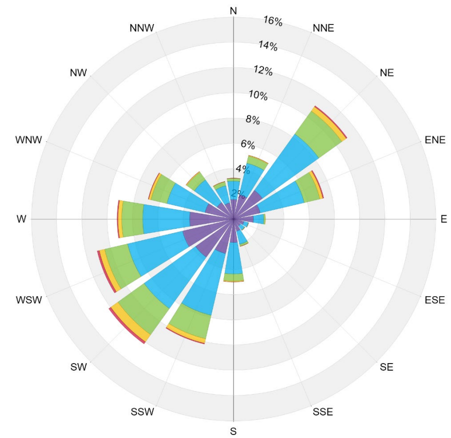
2.4 Meteorological Data

Long-term wind data recorded at Hamilton International Airport between 1991 and 2021, inclusive, were analyzed for the summer (May to October) and winter (November to April) months. Image 4 graphically depicts the directional distributions of wind frequencies and speeds for these periods.

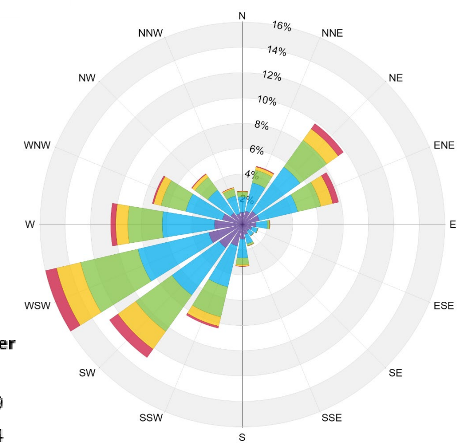
Winds from the southwest quadrant, as well as from the northeastern directions are predominant in both seasons.

Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10m) are more frequent in the winter than in the summer (red and yellow bands in Image 4). These winds potentially could be the source of uncomfortable wind conditions, depending on the site exposure and development design.

Wind statistics were combined with the simulated data to predict the wind conditions at the project site and assessed against the wind criteria for pedestrian comfort.



Summer
(May through October)



Winter
(November through April)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	3.8	2.2
1-10	33.9	21.9
11-20	43.1	39.4
21-30	15.5	24.0
31-40	2.9	8.9
>40	0.7	3.5

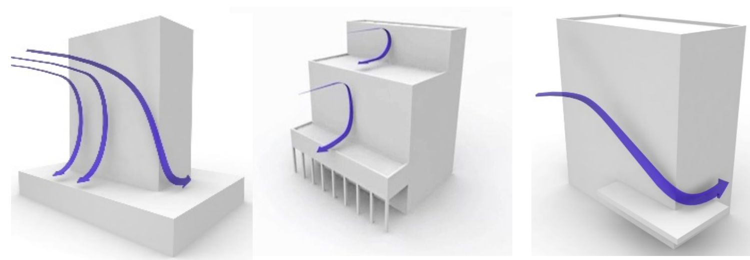
Image 4: Directional distribution of wind approaching Hamilton International Airport (1990 to 2021)

3. RESULTS AND DISCUSSION

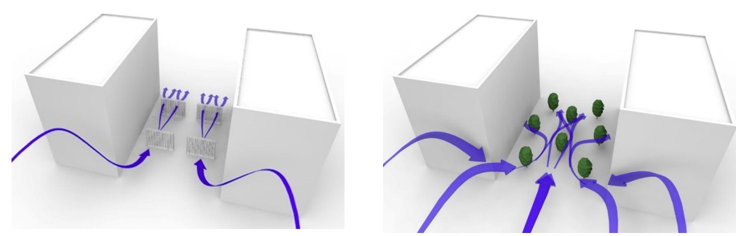
3.1 Wind Flow Around the Project

Buildings that are taller than their surroundings tend to intercept and redirect winds around them. 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, and in relatively narrow gaps between buildings due to Channelling of winds. These flow patterns are illustrated in Image 5.

Stepped massing and low podium are considered as positive features that can reduce the impact of downwashing flows by keeping winds away from the ground. Other design details that can help reduce wind speeds include overhead canopies close to ground level, wind screens / tall trees with dense landscaping, etc. (Image 6). The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings

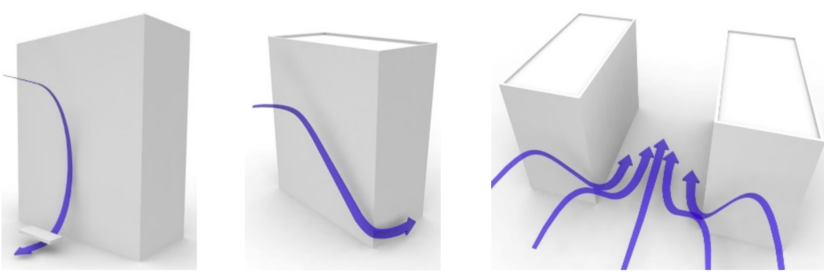


Podium **Stepped Massing** ***Canopy***



Screens ***Landscaping***

Image 6: Examples of common wind control measures



Downwashing ***Corner Acceleration*** ***Channelling***

Image 5: General wind flow patterns

3. RESULTS AND DISCUSSION

3.2 Existing Configuration

The site is on the waterfront and therefore exposed to winds approaching unobstructed over the water. Existing buildings near the site are low-rise and will not redirect winds to create any notable impact. Wind conditions at all areas on and around the site in the existing scenario are considered comfortable for pedestrian uses during the summer. Due to seasonally stronger winds in the winter, wind speeds increase across the site and conditions uncomfortable for pedestrians are anticipated around corners of existing buildings in the surrounding area, which reveals the windy nature of this fully exposed site.

3.3 Proposed Configuration

3.3.1 Positive Design Features

Although the introduction of a tall development in a low-rise context is expected to result in an increase in ground level wind speeds, the impact of this project will be limited to the perimeter of the site. The aerodynamic shape of the massing, as well as other design features such as the low podium and the canopy above the northeast entrance, are expected to reduce the potential effects of downwashing and corner acceleration. The wind impact would be lower than that of a rectilinear massing of a similar height. We understand that the design team is looking into incorporating trees, large shrubs and other landscaping elements on the property, which will help diffuse wind flow around the base of the building and further reduce wind impacts.

3.3.2 Building Perimeter and Neighbouring Properties

The simulated wind flow patterns around the proposed development are presented in Images 7 and 8. Prevailing winds from the northeast and southwest will be intercepted and redirected around the tower and lower townhouse massing, resulting in wind accelerations at ground level.

Accounting for the benefits of the building-form as mentioned previously, resultant wind conditions at most areas across the site are expected to be favorable for pedestrian use in the summer and winter. High wind activity that would potentially be uncomfortable is anticipated to the northwest and southeast of the tower, as winds will downwash and accelerate around the tower and the lower townhouse massing.

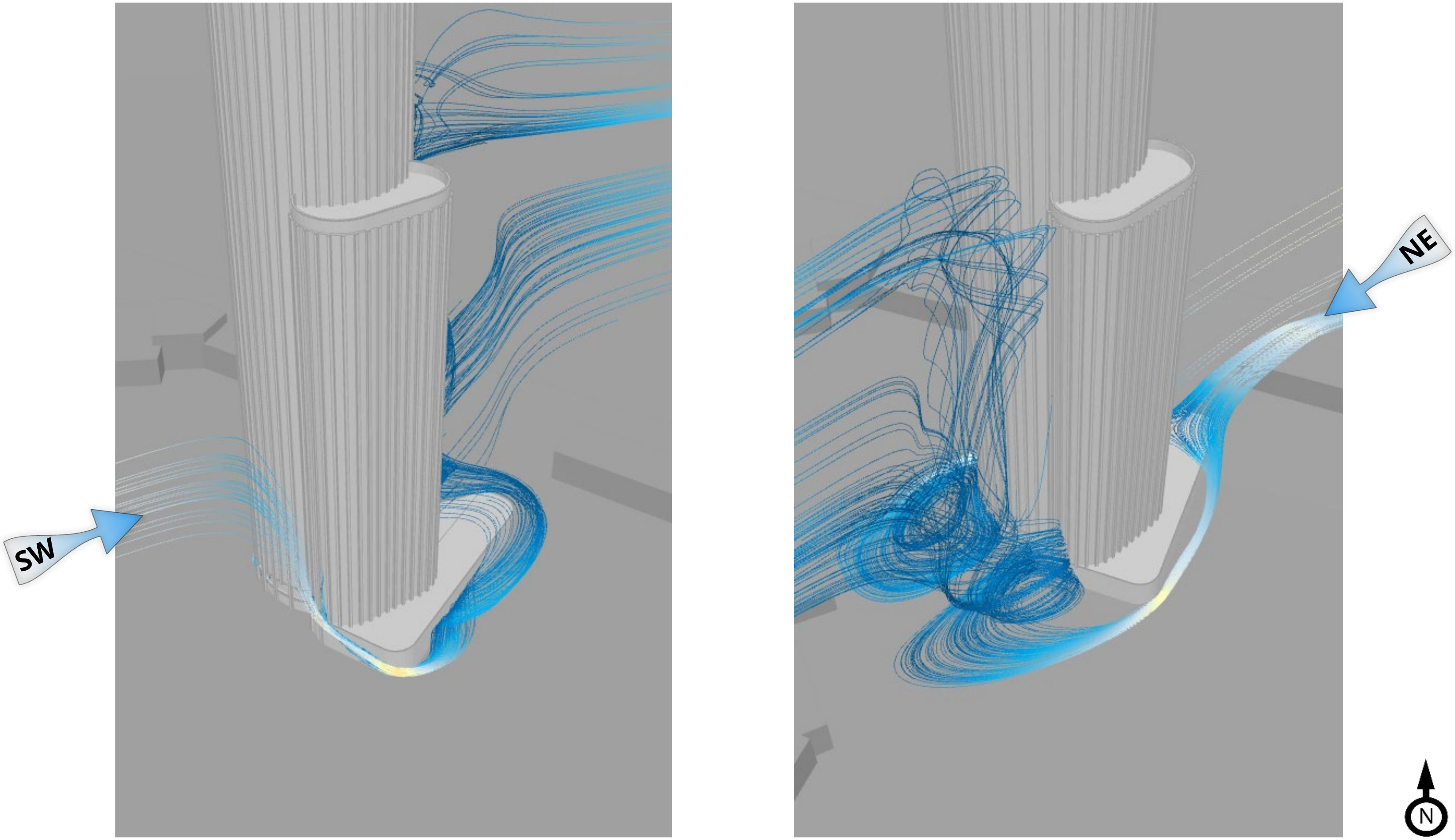
3.3.3 Main Entrances

Wind conditions at the northeast entrance are predicted to be satisfactory for the intended passive use due to sheltering provided by the canopy above. Higher wind speeds than desirable for an entrance use are anticipated near the southwest entrance, as this area is exposed to the prevailing southwesterly winds in both seasons.

3.3.4 Pedestrian Mews

While predicted wind conditions through the mews are considered suitable for the intended use during the summer, uncomfortable conditions are expected during the winter, particularly at the south end due to the aforementioned building-induced wind accelerations.

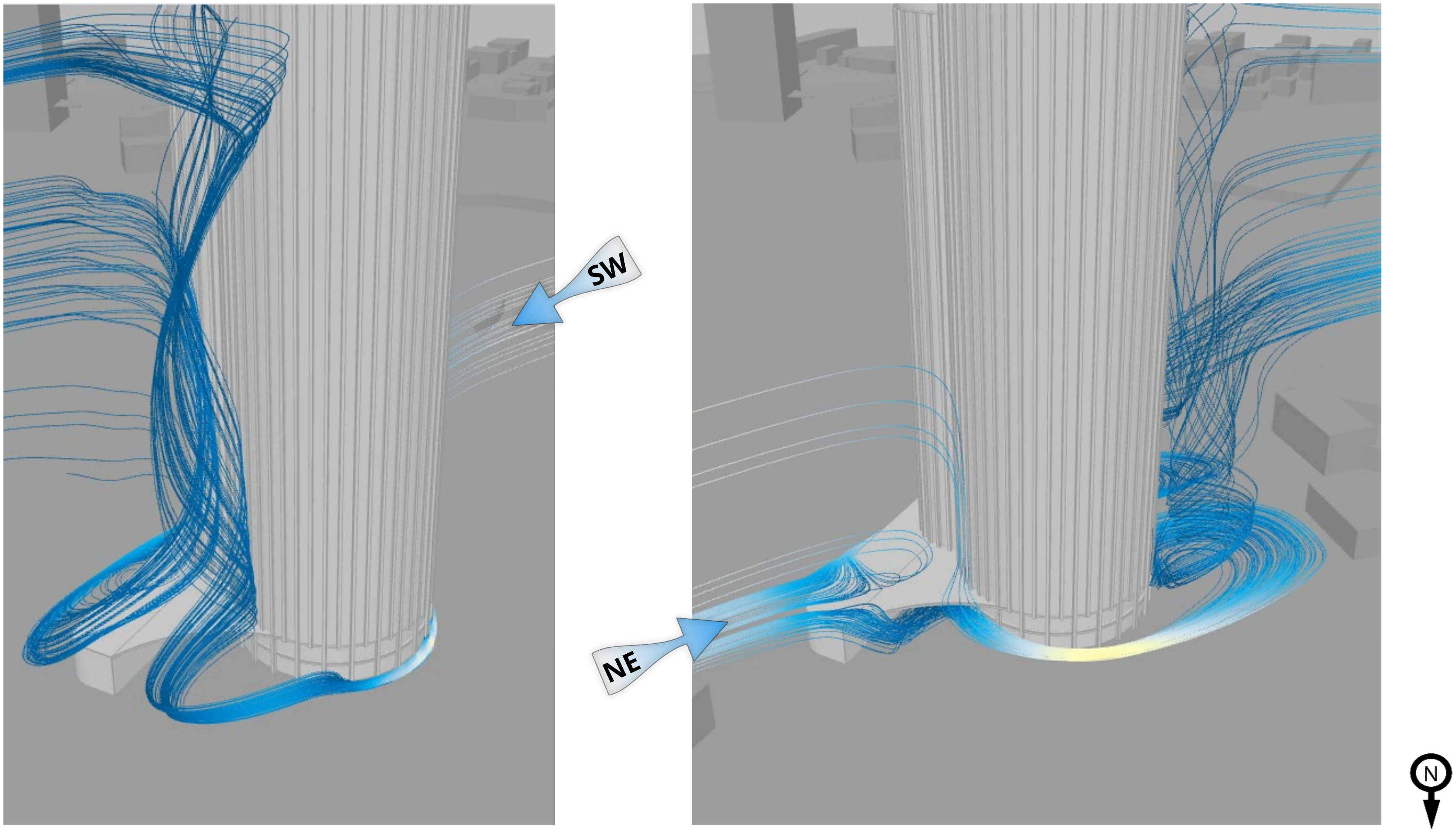
3. RESULTS AND DISCUSSION



Southwestern Winds **Northeastern Winds**

Image 7: Wind flow patterns – South view

3. RESULTS AND DISCUSSION



Southwestern Winds **Northeastern Winds**

Image 8: Wind flow patterns – North view

4. RECOMMENDATIONS

To improve the potential high wind activity expected around the base of the building, the design team is pursuing additional detailed wind assessments and working towards incorporating wind control features as the design develops.

RWDI recommends the consideration of the following strategic wind mitigation options. A combination of these features that best suits the architectural design and operational feasibility is to be determined through further assessment as the design develops. An illustration of the suggested placement of these features are in the plans presented in images 9 and 10 for the design team's consideration. Examples of wind control features are shown in Images 11 through 14.

- Overhead horizontal wind control features at the northwest and southwest portions of the building (canopies, trellises, arbors etc, that are at most 30% open)
- Vertical features around the southwest and western entrances to reduce wind exposure (wind screens or landscaping features, at least 2m tall and at most 30% open)
- Landscape design incorporating dense trees and understorey planting to diffuse winds that downwash at the tower and move away from the building, as well as winds that approach the building at pedestrian height.
    - The areas selected for incorporating landscaping align with where these features would be most impactful – this is a positive design decision (green areas in Images 9 and 10).
    - Note that species selected should be wind tolerant and preferably marcescent or coniferous to extend wind control benefits into the winter months.

Detailed studies using CFD or Wind tunnel testing should be conducted at a later design stage to quantify the wind impact of the development and to determine the effectiveness of the wind control solutions selected.

4. RECOMMENDATIONS

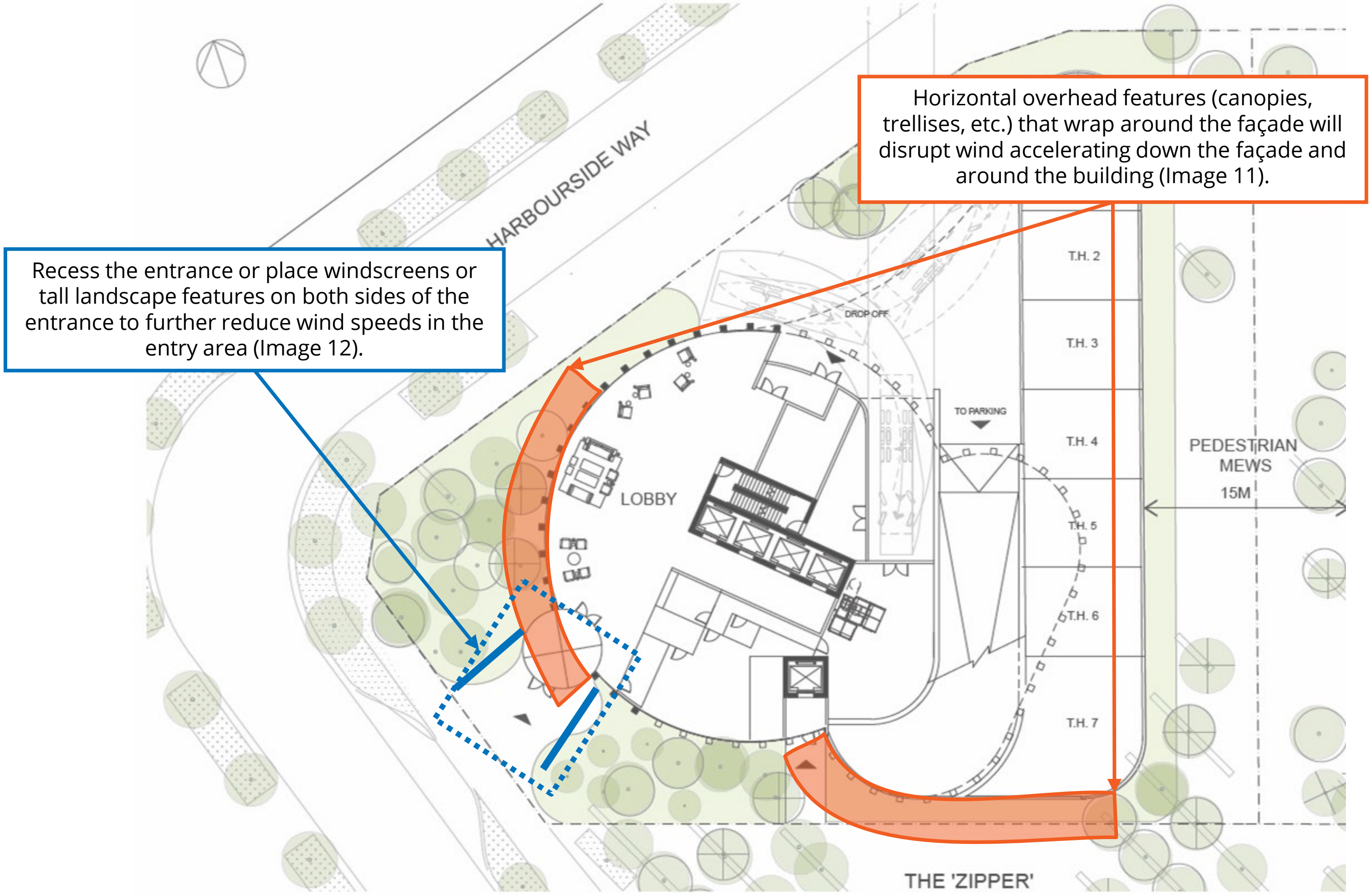


Image 9: Conceptual wind control recommendations

4. RECOMMENDATIONS

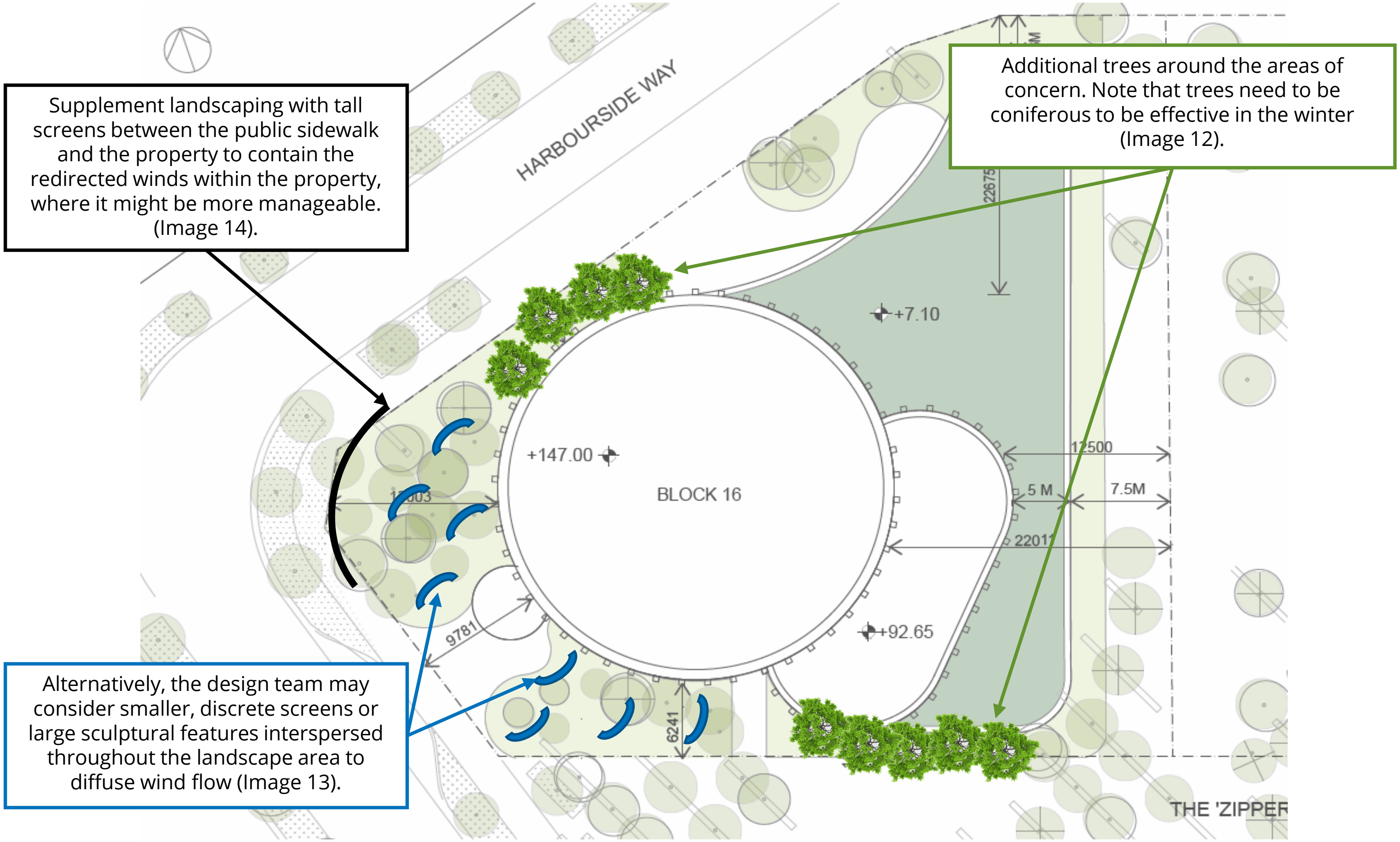


Image 10: Conceptual wind control recommendations

WIND CONTROL EXAMPLE PHOTOS

Overhead Features

Image 11: Canopies and overhead trellises

WIND CONTROL EXAMPLE PHOTOS

Wind Control Features at Entrance

Landscaping Features

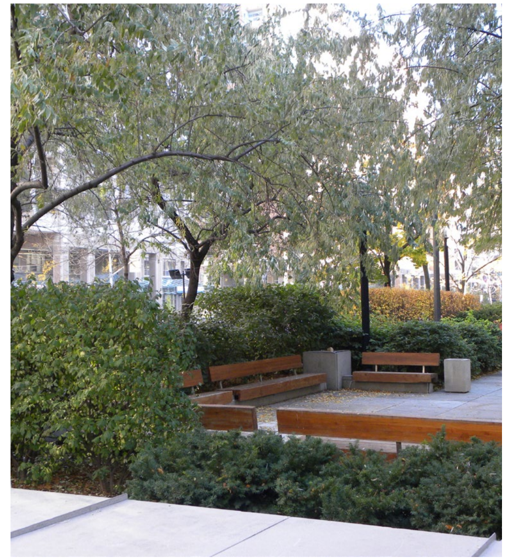


Image 12: Entrance recessing, windscreens, and landscaping

WIND CONTROL EXAMPLE PHOTOS

Large sculptural features

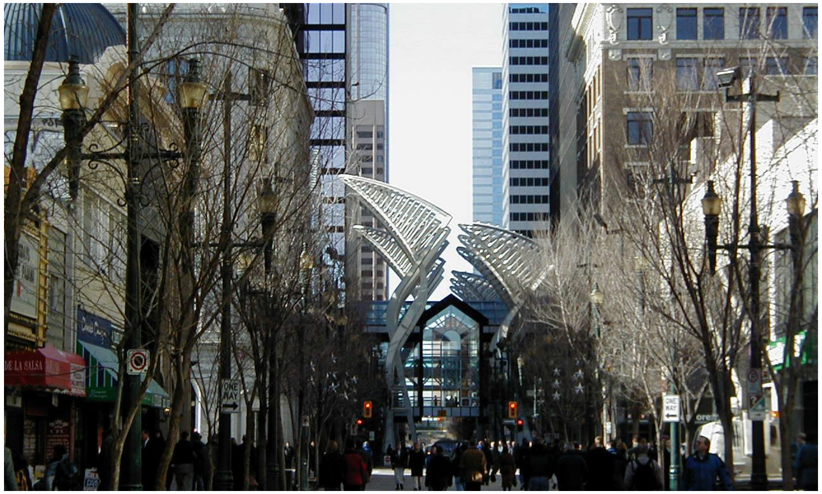


Image 13: Alternatives to trees in the landscape area

WIND CONTROL EXAMPLE PHOTOS

Windscreens

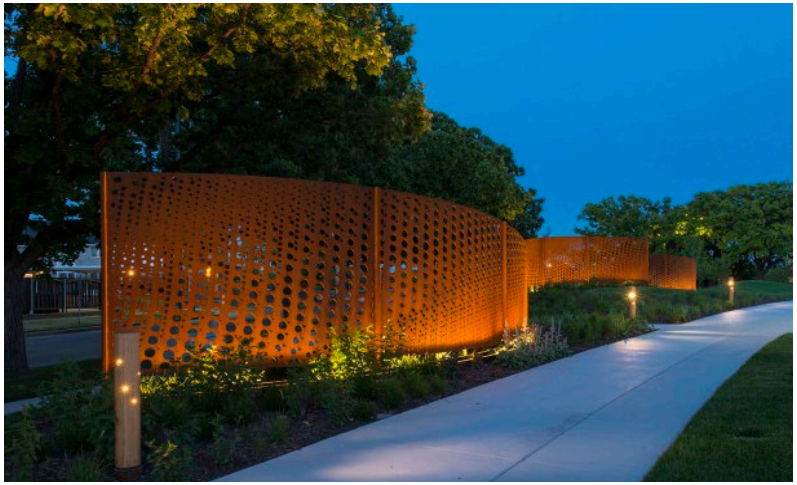


Image 14: Windscreens

5. SUMMARY

RWDI was retained to provide an evaluation of the potential pedestrian level wind impact of the proposed Block 16 of the Pier 8 development in Hamilton, ON. This preliminary assessment was based on the local wind climate, the current design of the proposed development, the existing surrounding buildings, and computational modelling and simulation of wind conditions. Our findings are summarized as follows:

- The building design incorporates several wind-responsive features that will moderate its wind impact, relative to a rectilinear design subject to strong ambient winds on the waterfront.
- Wind conditions are satisfactory for intended active pedestrian use across the Existing site, however the site is considered windy in the winter due to seasonally stronger winds and the open exposure.
- With the introduction of Proposed development, overall conditions at the ground level are expected to be suitable for the intended use in the summer.
- During the winter, winds speeds to the northwest and southeast of the tower are predicted to be unfavourable for pedestrian comfort.
- The design team is pursuing detailed studies and wind control measures to reduce the potential wind impact of the development.
- Detailed studies using CFD or Wind tunnel testing should be conducted at a later design stage to quantify these wind conditions and to determine the effectiveness of wind control solutions selected.

6. APPLICABILITY

The preliminary assessment presented in this report is for the proposed Block 16 of the Pier 8 development based on the information provided by design team listed in the table below. 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.

File Name	File Type	Date Received (mm/dd/yyyy)
212710_BLOCK16_ArchitecturalReportUpdate	PDF	10/27/2021
210710_3D MODEL FOR ACOUSTIC AND WIND CONSULTANTS	Rhino	10/07/2021

7. REFERENCES

1. 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.

2. 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.

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.