5034, 5054 AND 5080 NINTH LINE

MISSISSAUGA, ONTARIO

PEDESTRIAN WIND ASSESSMENT

PROJECT #2003946
JULY 30, 2021

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the potential pedestrian wind conditions around the proposed project at 5034, 5054 and 5080 Ninth Line in Mississauga, 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 Rezoning Application to be submitted to the City of Mississauga.

The project site is located on the west side of Eglinton Avenue West between Ninth Line and Highway 407 (**Image 1**). It is a largely unoccupied land with a few trees and low buildings. Surroundings include low residential buildings across Ninth Line, and open land and roadways in other directions, as shown in **Image 1**.

Image 2 is a rendered view of the project consisting of multiple residential buildings. The buildings are labelled in **Image 3** on the next page with their heights (number of storeys) in parentheses. Buildings A, B and C are the tallest at 12 storeys, followed by Buildings D (10), E (6) and F (8). There are also two stacked 3-storey townhouses to the west.

Pedestrian areas of concern include public sidewalks along Ninth Line, walkways around the proposed buildings, building entrances and drop-off areas, and outdoor amenity spaces, POP and public park see **Image 3** for details.

Image 1: Aerial view of the site and surroundings (Credit: Google Earth)

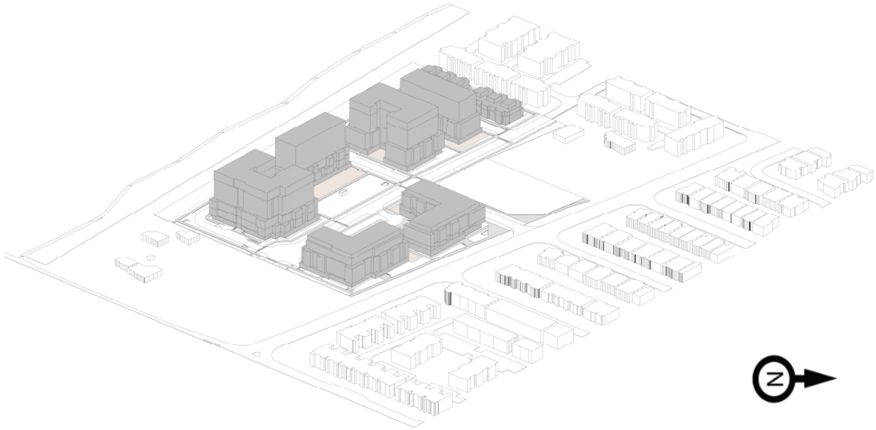


Image 2: Rendered view of the project and existing surroundings

1. INTRODUCTION

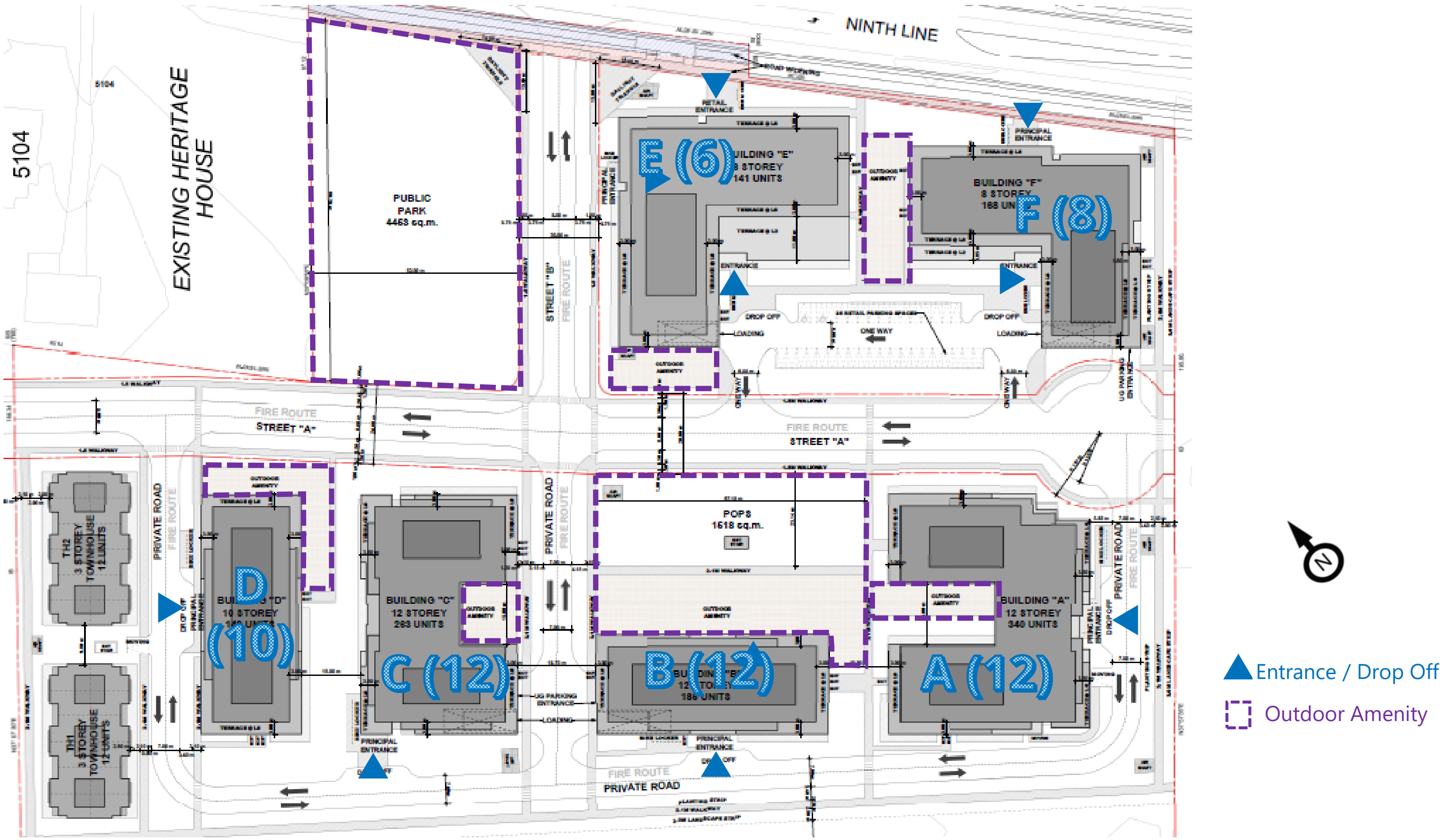


Image 3: Master site plan with building labels, storeys (in parentheses) and key pedestrian areas

2. METHODOLOGY

2.1 Objective

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 Toronto Pearson International Airport;
- Drawings and 3D model of the proposed project received by RWDI on June 22 and July 8 and 15, 2021;
- The use of *Orbital Stack*, an in-house computational fluid dynamics (CFD) tool, to aid in the assessment of wind comfort levels for the existing and proposed conditions;
- Pedestrian wind comfort studies completed by RWDI for projects in Mississauga and around the world; 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 are typically required at a later design stage.

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

2.2 CFD for Wind Modelling

CFD is a numerical modelling technique for simulating wind flow in complex environments. For 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 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. The effect of gust, i.e., wind safety, is predicted qualitatively in this assessment using analytical methods and wind-tunnel-based empirical models. 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

2.3 Simulation Model

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

The computer model is shown in **Image 4**. For the purpose of this computational study, the 3D model was simplified to include only the necessary building and terrain details that would affect the local wind flows in the area and around the site. Landscaping and other smaller architectural and accessory 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 wind speed profiles 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 wind speeds at approximately 1.5m above ground, to the mean wind speed at a reference height were obtained. These ratios were then combined with meteorological records obtained from Toronto Pearson International Airport to determine the wind speeds and frequencies in the simulated areas.

As the project design advances, a wind tunnel study should be conducted to quantify the wind impact in greater detail.

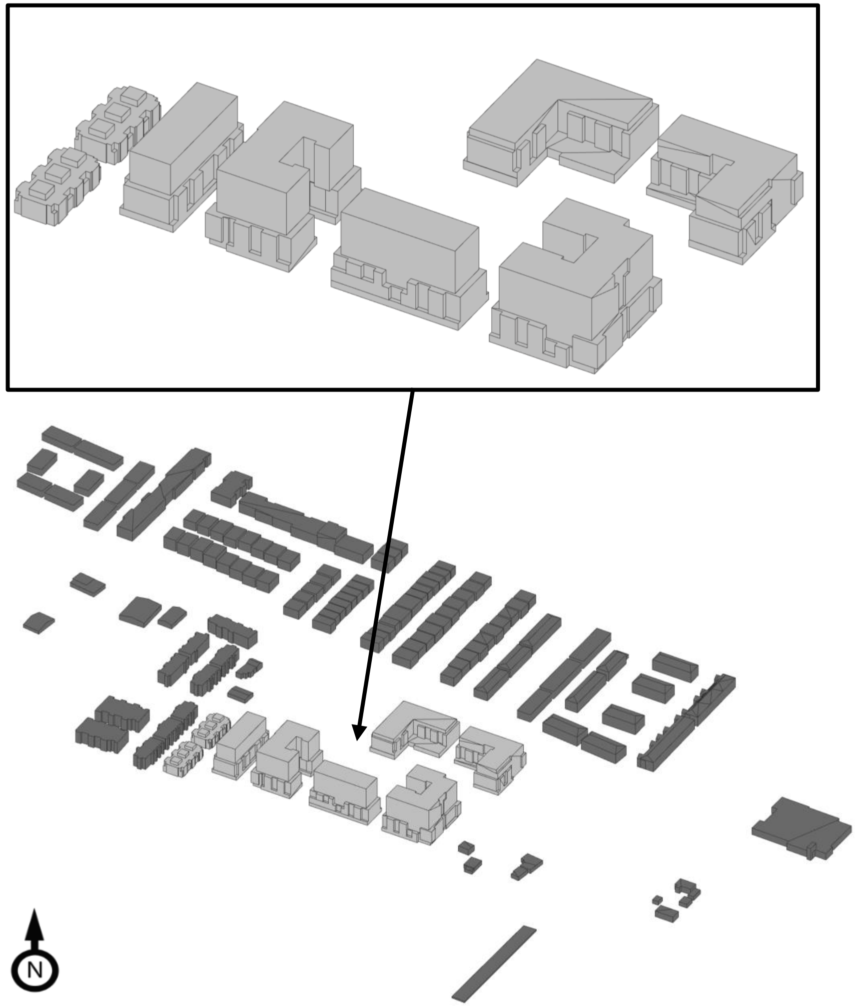


Image 4: Computer model of the proposed development with existing surroundings

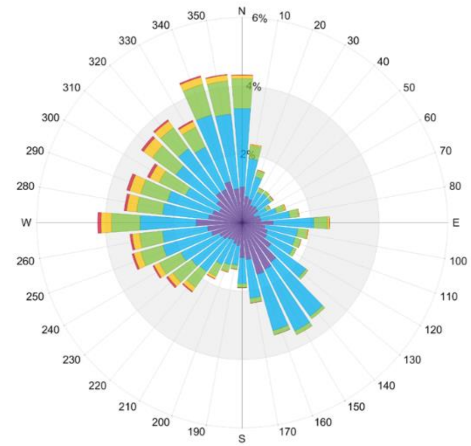
2. METHODOLOGY

2.4 Meteorological Data

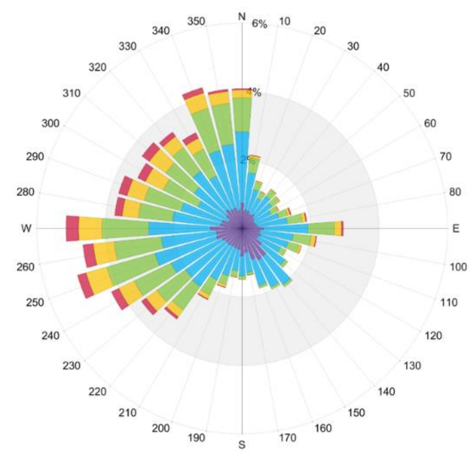
Meteorological data from Toronto Pearson International Airport for the period from 1989 to 2019 were used as a reference for wind conditions in the area as this is the nearest station to the site with long-term, hourly wind data. The distributions of wind frequency and directionality for the summer (May through October) and winter (November through April) seasons are shown in the wind roses in **Image 5**.

When all winds are considered, winds from the southwest through north directions are predominant throughout the year, with secondary winds from south-southeast in the summer, and from east in the winter.

Strong winds of a speed greater than 30 km/h measured at the airport (red and yellow bands) occur more often in the winter than in the summer season. Winds from the west-southwest through north-northwest and east directions potentially could be the source of uncomfortable or severe wind conditions, depending upon the site exposure and development design.



Summer (May through October)



Winter (November through April)

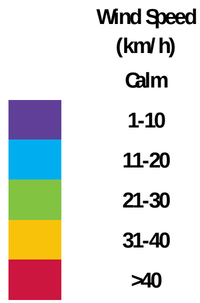


Image 5: Directional Distribution of Winds Approaching Toronto Pearson International Airport (1989 to 2019)

3. WIND CRITERIA

The Mississauga pedestrian wind criteria, developed in June 2014, are specified in the Urban Design Terms of Reference, "Pedestrian Wind Comfort and Safety Studies". The criteria are as follows:

3.1 Safety Criterion

Pedestrian 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 (≤ 15 km/h): Gentle breezes suitable for main building entrances and bus stops.

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

Uncomfortable: None of the above criteria are met.

Wind conditions are considered suitable for sitting, standing 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., 1.5m above grade or the concerned floor level), typically lower than those recorded in the airport (10m 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 are appropriate for sidewalks and walkways; and lower wind speeds comfortable for standing are required at the main building entrance and drop-off areas. For amenity spaces, calm wind conditions comfortable for sitting are desired in the summer when these areas are typically in use.

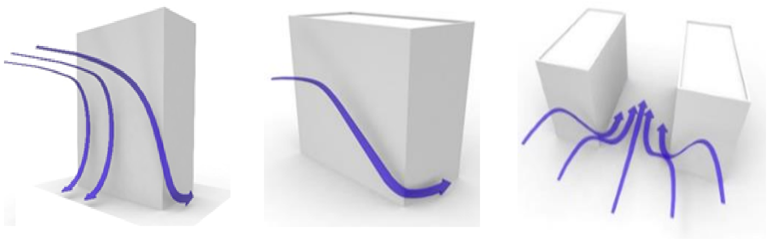
4. RESULTS AND DISCUSSION

4.1 Wind Flows around Buildings

Buildings that are taller than surrounding structures tend to intercept and redirect wind around them. The mechanism in which wind flows are directed down the height of a building is called Downwashing. These flows subsequently move around exposed building corners and along the gaps between buildings, causing localized increase in wind activity in those areas. These flow patterns are illustrated in **Image 6**.

The project comprises six mid-rise buildings and two stacked townhouses, with the potential to create downwashing winds. However, the effect is expected to be moderated by several positive design features. For instance,

- The four tallest buildings (A, B, C and D) are located at the south end of the site, away from the public sidewalks and sheltered by the lower buildings to the west and north (see **Image 3**);
- Buildings E and F are located along Ninth Line and of moderate heights, limiting the potential wind effect on public sidewalks.
- Most entrances and drop-off areas are located in sheltered areas with potential low wind speeds (see I**mage 3**); and
- The existing and future landscaping, not included in the current simulation, would further reduce the wind activity on and around the development.



Downwashing Flow Corner Acceleration Channelling Effect

Image 6: General wind flow mechanisms

4.2 Simulation Results

The wind assessment was conducted for the summer and winter seasons as prescribed in the Terms of Reference. The predicted comfort categories are presented in **Image 7** at approximately 1.5 m above the local grade. The following colour scale is used for representation of wind conditions against the pedestrian wind comfort criteria:

based on the current simulation together with our wind tunnel experience for similar projects in Mississauga. Areas where the criterion is expected to be exceeded potentially are also marked in **Image 7**.

The following sections provide discussions about the applicability of the results and strategies for wind control to reduce the potential for high wind speeds for the design team's consideration.

4. RESULTS AND DISCUSSION

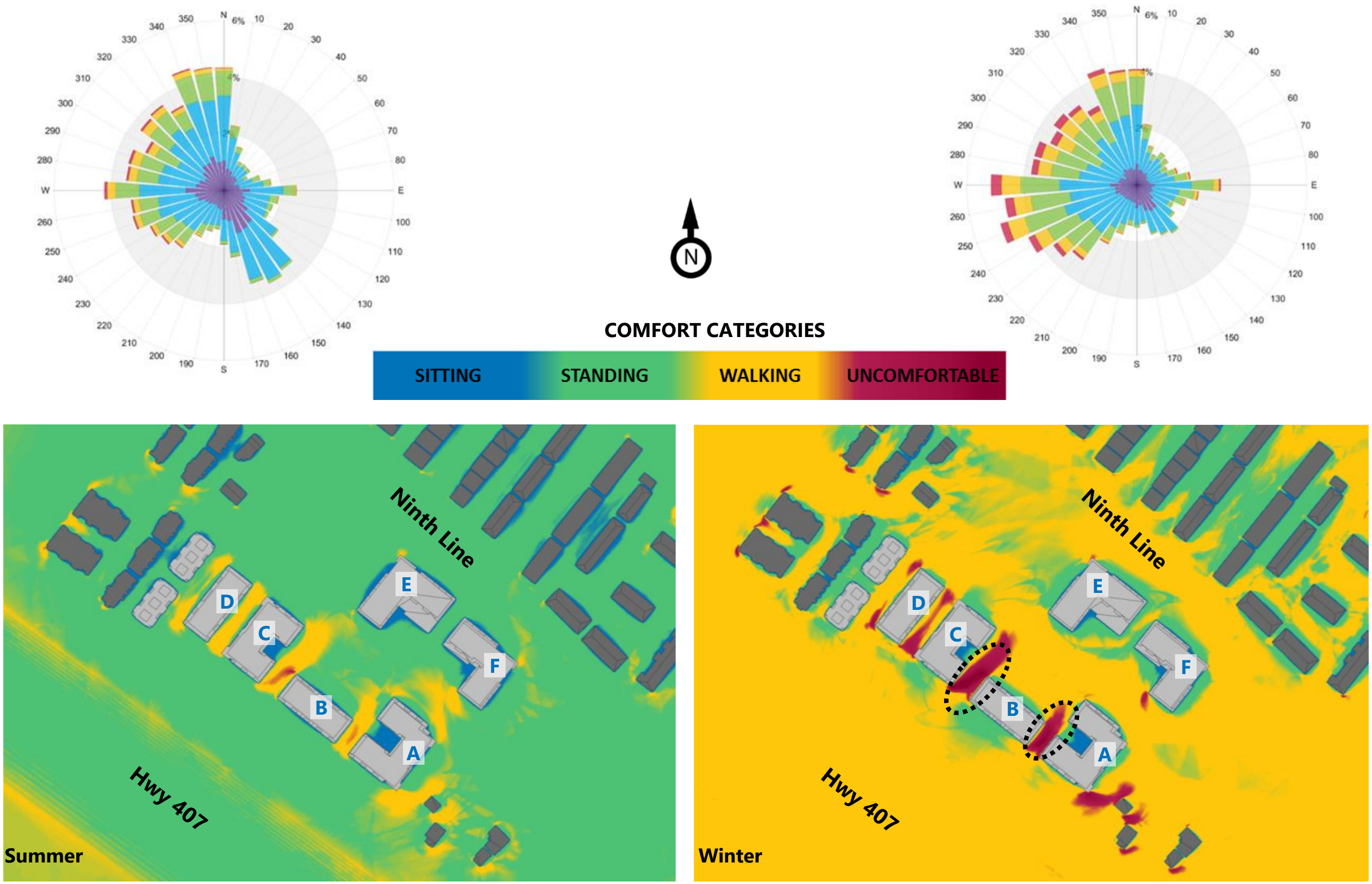


Image 7: Predicted wind comfort conditions

Potential wind safety exceedance

4. RESULTS AND DISCUSSION

4.3 Existing Scenario

As shown in **Image 1**, the existing site is an open land with low-rise built surroundings to the west and north. As a result, the wind conditions shown in **Image 7** for the open areas away from the proposed development are an accurate indication of the existing wind conditions on the site. Present wind conditions are expected to be comfortable for standing in the summer and for walking in the winter (green and yellow colours, respectively, in **Image 7**). Wind conditions exceeding the safety criterion are not expected on or around the existing site.

4.4 Proposed Scenario

While wind conditions in most areas around the proposed development are expected to be similar to those that currently exist on the site, increased wind speeds are predicted in several areas, including the gaps between the proposed buildings and the exposed building corners. These wind conditions are mostly comfortable for walking in the summer and uncomfortable in the winter as indicated by the yellow and red colours, respectively, in **Image 7**.

Main Entrances and Drop-Offs

As shown in **Image 3**, the main entrances and drop-off areas are located on the east side of Building A, south side of Buildings B and C. For Building E and F, residential entrances are located in the recessed building corners and retail entrances front Ninth Line to the north. These entrances and drop-off areas are protected by the proposed buildings from one or more prevailing winds and wind conditions comfortable for standing are predicted throughout the year (green areas in **Image 7**).

However, wind speeds around the main entrance to Building D are predicted to be comfortable for walking (**Images 3 and 7**) and these wind speeds are considered higher than desired for a main entrance. We recommend the doors be recessed from the main façade. Alternatively, a large canopy can be considered above the entrance and/or wind screens/planters on both sides of the doorway for wind protection – see **Image 8** for examples.

Sidewalks and Walkways

There are public sidewalks along Ninth Line, where wind conditions are predicted to be comfortable for walking or better for both seasons, suitable for the intended use.

Similar wind conditions are expected on the future sidewalks and walkways on and around the proposed development. Exceptions are the areas around the southeast corner of Building A and western corners of Building D as well as gaps between Building A, B, C and D, where wind speeds may become uncomfortable in the winter (red areas in the right diagram of **Image 7**). Potentially, the gust wind speeds between Buildings A, B and C may exceed the wind safety criterion, primarily during the winter.

Wind tunnel testing is recommended at a later design stage to quantify these wind conditions and, if necessary, to develop wind control solutions.

4. RESULTS AND DISCUSSION

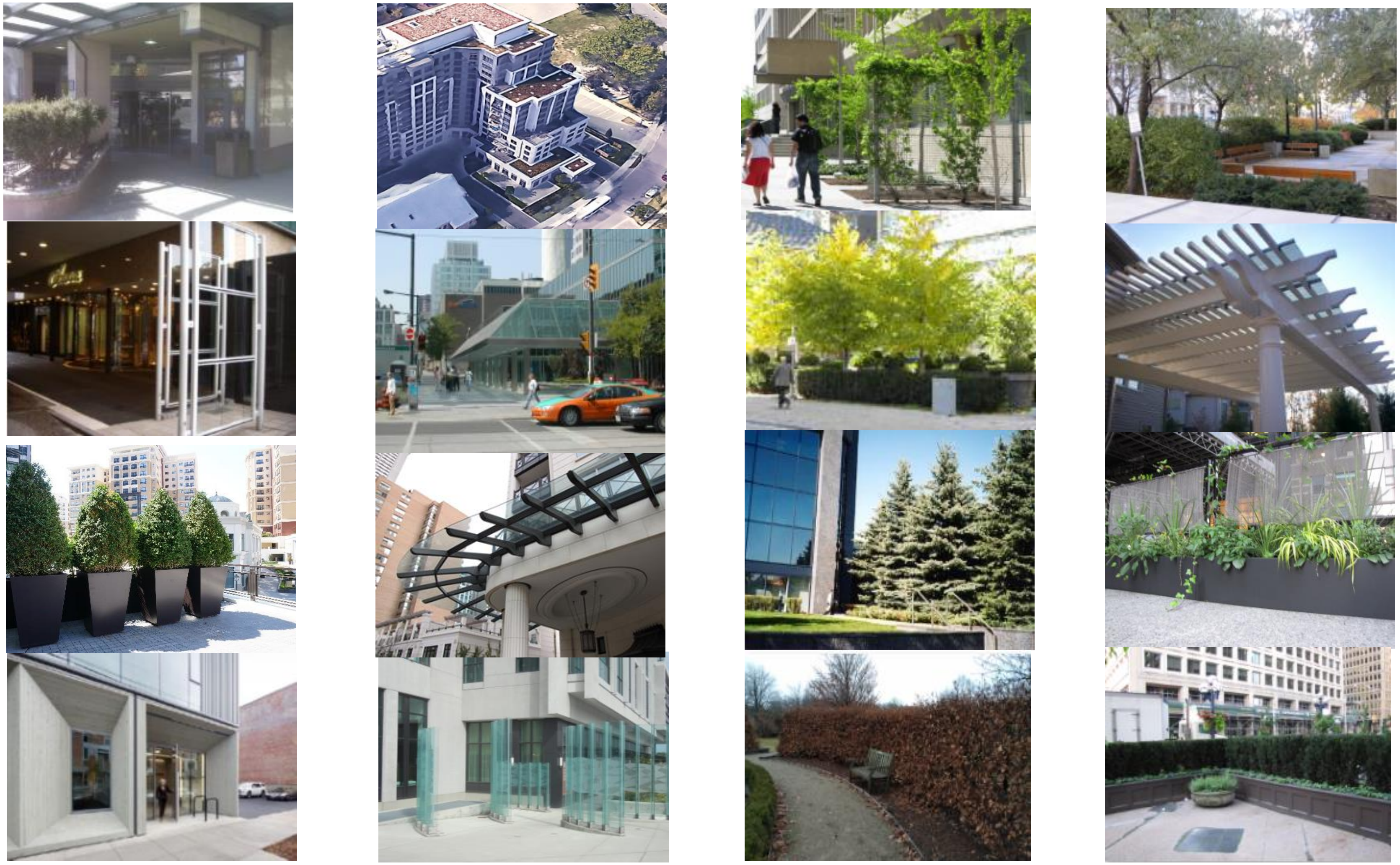


Image 8: Wind control features: Examples for entrance/drop off, sidewalk and outdoor amenity

4.4 Proposed Scenario (continued)

Lower wind speeds in these gaps and around building corners can be achieved by introducing additional tower setbacks and articulations, if feasible. Localized wind control measures such as canopies, screens and coniferous landscaping, as shown in the photo examples in **Image 8**.

Outdoor Amenities at Grade

As shown in **Image 3**, there are several amenity spaces around the proposed buildings, plus a large POPS north of Building B and a public park west of Building E. Without modelling any landscaping for these areas, wind conditions are predicted to be generally comfortable for standing in the summer and for walking in the winter. In the space between Building C and D, higher wind speeds comfortable for walking I the summer and uncomfortable in the winter are expected (**Image 7**). In contrast, low wind speeds comfortable for sitting are predicted for the courtyards of Buildings A and C throughout the year.

If lower wind speeds are desired, typical wind control measures may include tall screens and trees along the perimeter of these areas. Localized wind control measures, such as planters, screens and trellises, may also be considered around any planned seating areas (see **Image 8** for examples).

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed project at 5034, 5054 and 5080 Ninth Line in Mississauga, Ontario, Our assessment was based on the local wind climate, the current design of the proposed development, and computational modeling and simulation of wind conditions. Our findings are summarized as follows:

- The proposed project consists of mid-rise buildings that will be exposed to the predominant winds due to the low-rise and open surroundings. However, several positive design features such as building arrangement, entrance locations, etc., are expected to moderate the wind impact caused by the project.
- The addition of the project is not expected to alter the existing wind conditions along Ninth Line and other surrounding areas. Suitable wind conditions are predicted for most walkways, building entrances and drop-off areas.
- However, increased wind speeds are expected around exposed building corners and along the gaps between the proposed buildings. These wind speeds may be uncomfortable in the winter and potentially exceed the wind safety criterion. Higher-than-desired wind speeds are also predicted at the main entrance to Building D, and on several amenity spaces ~~at and above grade~~, especially during the winter season.
- Wind control strategies and examples have been provided for these areas. The potential wind impact should be quantified by wind tunnel tests at a later design stage when the need and extent of wind control measures can be determined and refined.

6. APPLICABILITY OF RESULTS

The assessment presented in this report are for the proposed project at 5034, 5054 and 5080 Ninth Line in Mississauga, Ontario, based on the information 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)
Ninth Line_Site Plan Master_18 June 2021	PDF	6/22/2021
17179 - 3d mass - July 08, 2021	DWG	07/08/2021
3D view	PDF	7/15/2021
Site Plan_Updated	PDF	7/15/2021

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.