REPORT

157 & 165 CROSS AVENUE

OAKVILLE, ONTARIO

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT # 2306764
February 13, 2024

SUBMITTED TO

Cross Realty LP

CC: Clarence Zichen Qian
Distrikt
90 Wingold Ave., Unit 1
Toronto, Ontario M6B 1P5
czqian@distrikt.com

SUBMITTED BY

Henrique D.L. Gambassi, B.Sc., EIT
Technical Coordinator
henrique.delimagambassi@rwdi.com

Hanqing Wu, Ph.D., P.Eng.
Senior Technical Director | Principal
hanqing.wu@rwdi.com

Scott Bell, GSC
Project Manager
scott.bell@rwdi.com

RWDI
600 Southgate Drive
Guelph, Ontario N1G 4P6
T: 519.823.1311 x2245

rwdi.com

1. INTRODUCTION

Rowan Williams Davies and Irwin Inc. (RWDI) was retained to conduct a pedestrian wind assessment for the proposed project at 157 & 165 Cross Avenue in Oakville, Ontario. The objective of this assessment is to provide an evaluation of the potential impact of the proposed development on pedestrian-level wind conditions and provide wind control recommendations, where necessary.

The project site is located south of Queen Elizabeth Way, on Cross Avenue. The site is surrounded by low-rise buildings and parking lots in all directions (Image 1). The proposed project will consist of two high-rise towers connected by a stepped 3-storey podium (approximate heights shown in Image 2).

In addition to sidewalks and adjacent properties, areas of interest for this assessment include residential and commercial entrances at grade (Image 3), Privately-Owned Publicly Accessible Spaces (POPS), and shared outdoor amenities on Levels 2 and 3. Private terraces were not considered in this assessment.

Image 1: Aerial view of the existing site and surroundings (source: Google Maps)

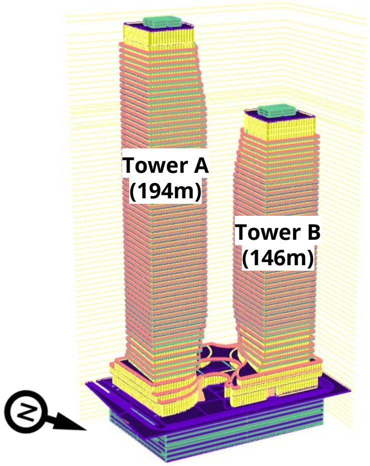
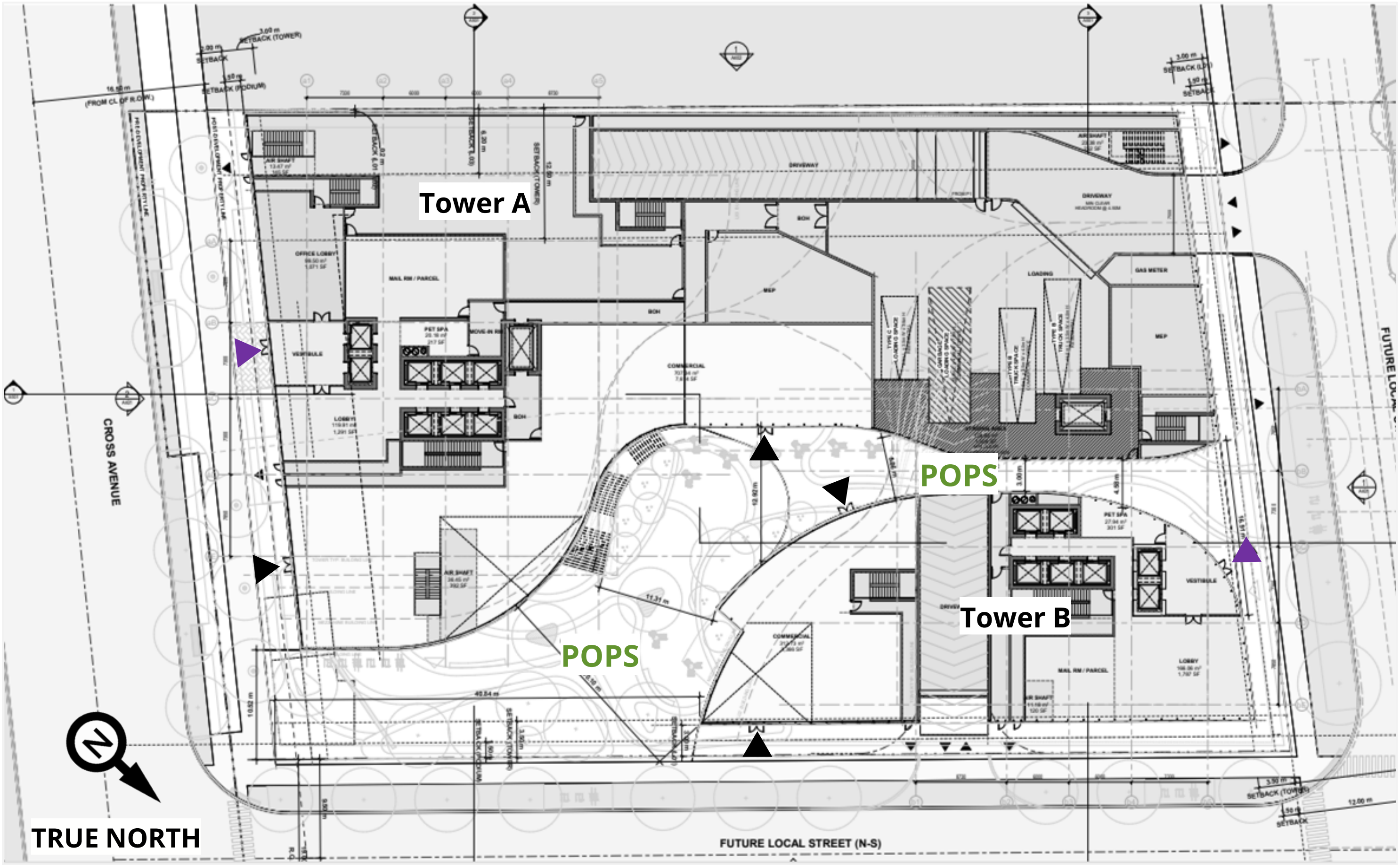


Image 2: Conceptual massing

2. METHODOLOGY



RESIDENTIAL ENTRANCE COMMERCIAL ENTRANCE

Image 3: Site plan with main building entrances and Privately-Owned Publicly Accessible Spaces (POPS) highlighted

2. METHODOLOGY

2.1 Objective

The objective of this assessment is to provide an evaluation of the potential impact of the proposed development on wind conditions in pedestrian areas on and around it based on Computational Fluid Dynamics (CFD). The assessment is based on the following:

- A review of the regional long-term meteorological data from Billy Bishop Toronto City Airport;
- 3D model of the proposed project and architectural drawings received in January 2024 (see Section 6);
- The use of *Orbital Stack*, an in-house CFD tool;
- RWDI's engineering judgment, experience, and expert knowledge of wind flows around buildings[1-3]; and,
- The RWDI wind comfort and safety criteria.

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

2.2 CFD for Wind Simulation

CFD is a numerical technique that can be used for simulating wind flows in complex environments. For this analysis, CFD techniques were used to generate a virtual wind tunnel where flows around the site and its surroundings were simulated in full scale. The computational domain that covered the site and its surroundings was divided into millions of small cells where calculations were performed, yielding a prediction of wind conditions across the entire study domain. CFD excels as a tool for wind modelling, presenting early design advice, comparing different design and site scenarios, resolving complex flow physics, and helping diagnose problematic wind conditions.

While the computational modelling method used in the current assessment does not explicitly simulate the transient behaviour of turbulent wind, its effects were estimated based on other calculated quantities. RWDI has found this approach to be appropriate for the assessment of typical wind comfort conditions. Wind safety issues, which relate to transient, higher-speed gusts, are discussed qualitatively, based on the CFD predictions and our extensive wind-tunnel experience for similar projects.

In order to quantify the transient behaviour of wind and refine any conceptual mitigation measures, a more detailed assessment would be required using either boundary-layer wind tunnel or transient computational modelling.

2. METHODOLOGY

2.3 Simulation Model

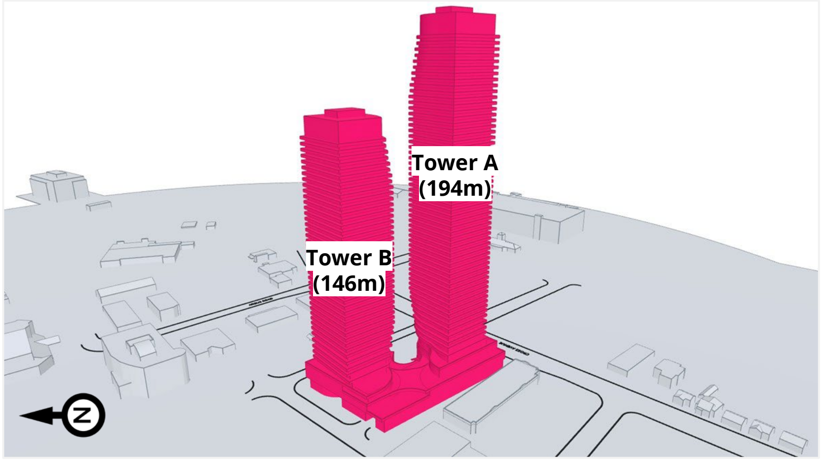
CFD simulations were completed for two scenarios:

a) Existing: existing site and surroundings.

b) Proposed: proposed project with existing surroundings.

The computer model of the proposed buildings is shown in Image 4, and the Existing and Proposed configurations with the proximity model are shown in Images 5a and 5b, respectively. The 3D models were 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 to assess the impact of the building mass alone (which is typical of this type of assessment).

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



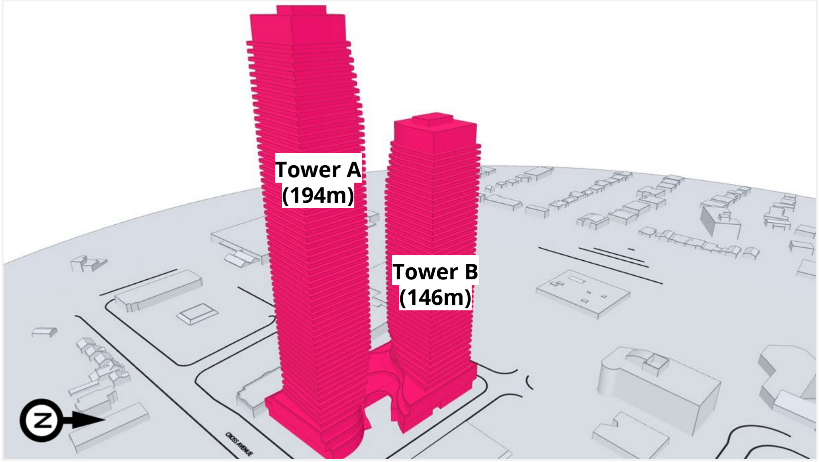


Image 4: Computer model of the proposed project

2. METHODOLOGY

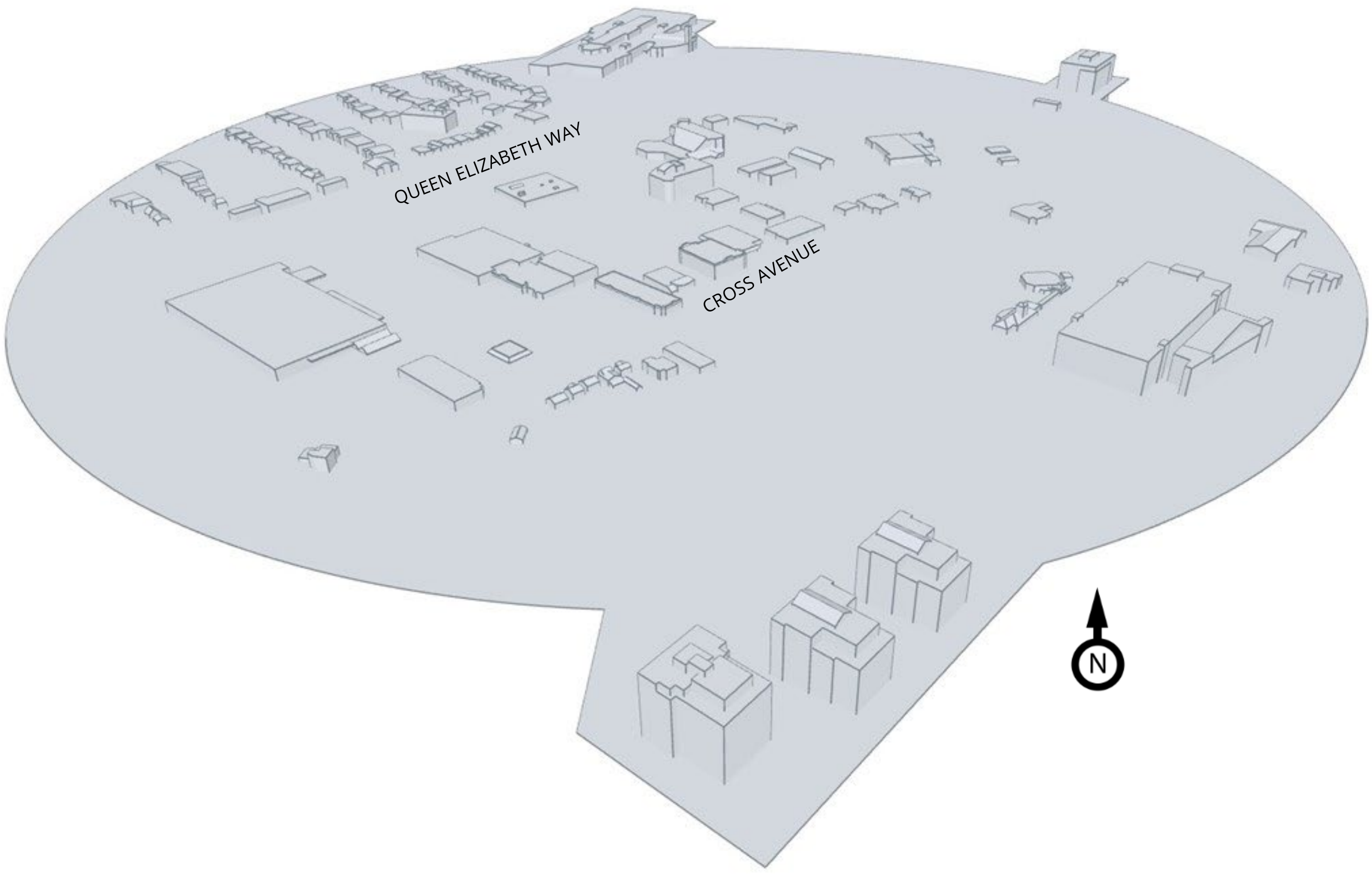


Image 5a: Computer model of the existing site and extended surroundings

2. METHODOLOGY

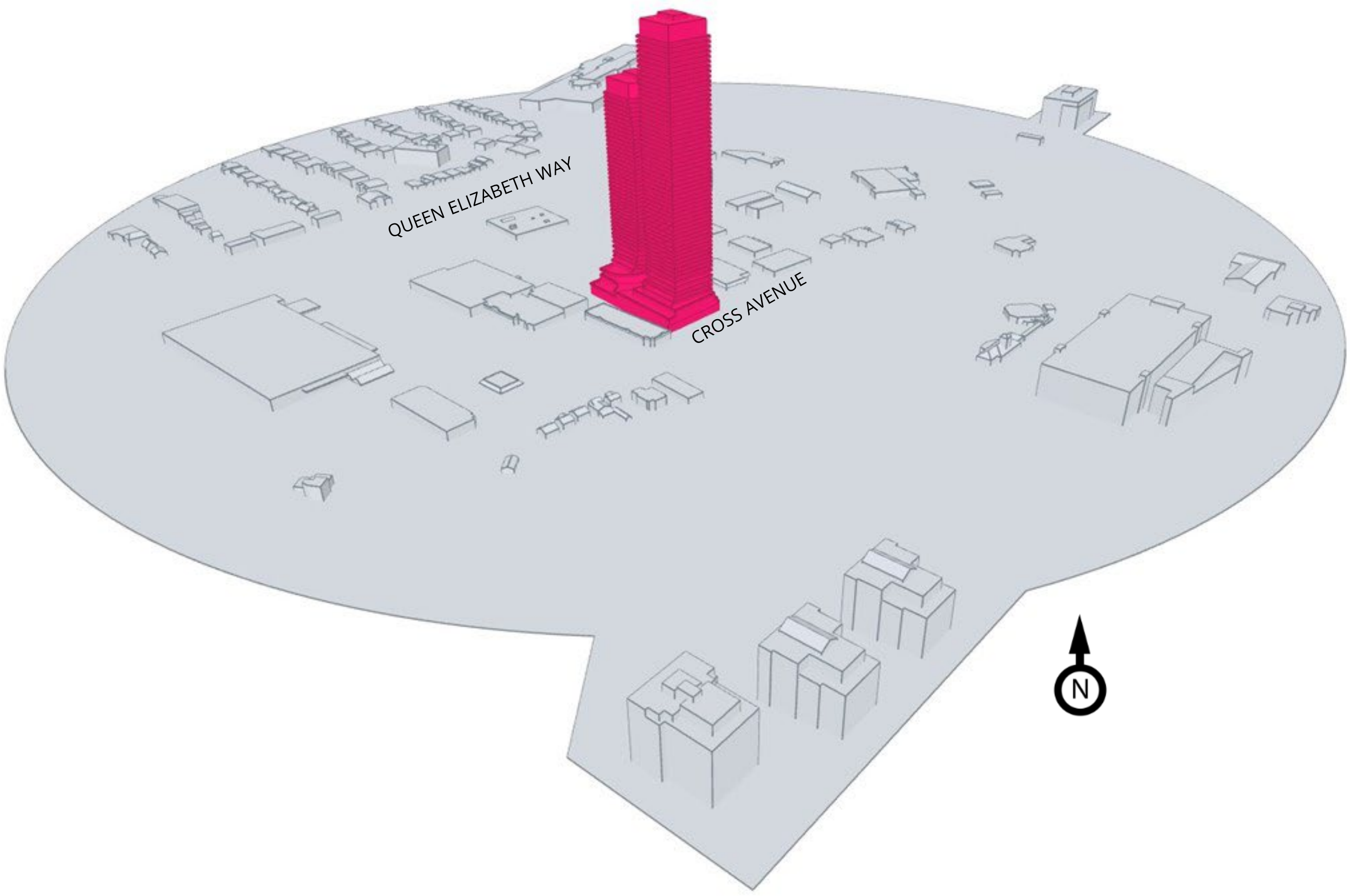


Image 5b: Computer model of the proposed project and existing surroundings

2. METHODOLOGY

2.4 Meteorological Data

Long-term wind data recorded at Billy Bishop Toronto City Airport between 1990 and 2020, inclusive, were analyzed for the summer (May to October) and winter (November to April) months. Image 6 graphically depicts the directional distributions of wind frequencies and speeds for these periods.

In the summer, winds from the easterly directions are predominant, with frequent winds from the southwest and northwest quadrants. In the winter, winds from the west, southwest and northwest are significantly more frequent in addition to winds from the easterly directions.

Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) are more frequent in the winter (red and yellow bands in Image 6). These winds potentially could be the source of uncomfortable or severe 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.

Image 6: Directional distribution of wind approaching Billy Bishop Toronto City Airport (1990 to 2020)

3. WIND CRITERIA

The RWDI pedestrian wind criteria are used in the current study; the criteria presented in the table below, addresses pedestrian safety and comfort. 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.

3.1 Pedestrian Comfort

Pedestrian comfort is associated with common wind speeds conducive to different levels of human activity. Wind conditions are considered suitable for sitting, standing, strolling, or walking if the associated mean wind speeds (see table) are expected for at least four out of five days (80% of the time). The assessment considers winds occurring between 6 AM and midnight. Limited usage of outdoor spaces is anticipated in the excluded period. Speeds that exceed the criterion for Walking are categorized Uncomfortable. 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.

Comfort Category	GEM Speed (km/h)	Description (Based on seasonal compliance of 80%)
Sitting	≤ 10	Calm or light breezes desired for outdoor 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 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 considered a nuisance for all pedestrian activities. Wind mitigation is typically recommended

3.2 Pedestrian Safety

Pedestrian safety is associated with excessive Gust Speeds that can adversely affect a person's balance and footing. These are usually infrequent events but deserve special attention due to the potential impact on pedestrian safety.

Safety Criterion	Gust Speed (km/h)	Description (Based on annual exceedance of 9 hrs or 0.1% of time)
Exceeded	> 90	Excessive gusts that can adversely affect one's balance and footing. Wind mitigation is typically required

4. RESULTS AND DISCUSSION

4.1 General Wind Flow Mechanisms

Wind tends to flow over buildings of uniform height, without disruption. 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 accelerate around building corners (*Corner Acceleration*) and through gaps formed with adjacent buildings (*Channelling Effect)*. Podiums, canopies, and wind screens can help reduce the impact of tall buildings on wind conditions at ground level. These flow patterns are illustrated in Image 7.

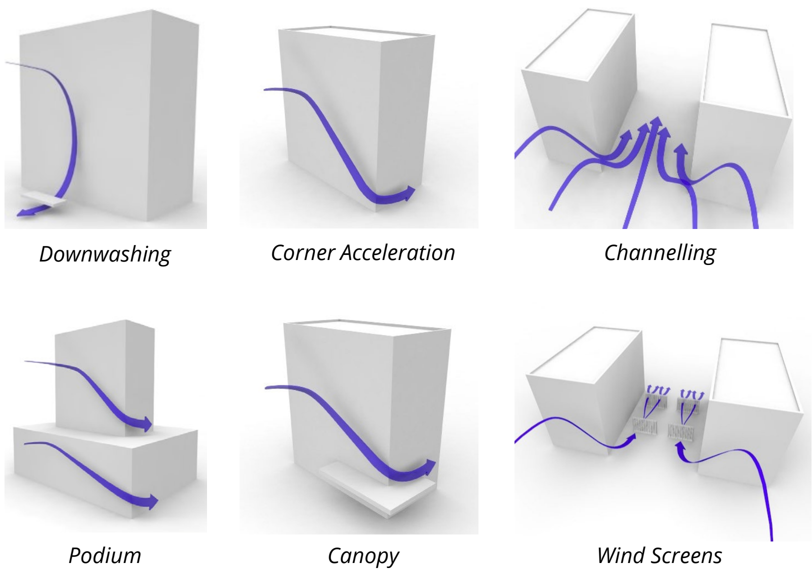


Image 7: General wind flow patterns

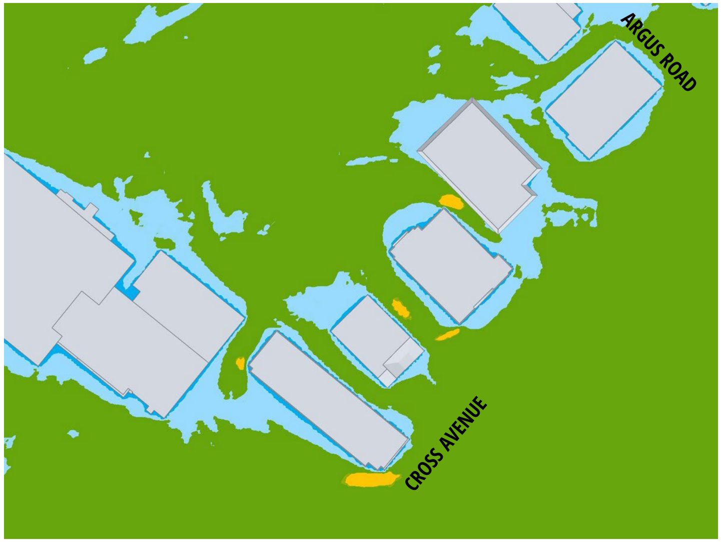
4.2 Simulation Results

The predicted seasonal wind comfort conditions at grade level are presented in Images 8 and 9 for both simulation scenarios, while images 10 and 11 show the predicted comfort conditions on the podium-level terraces.

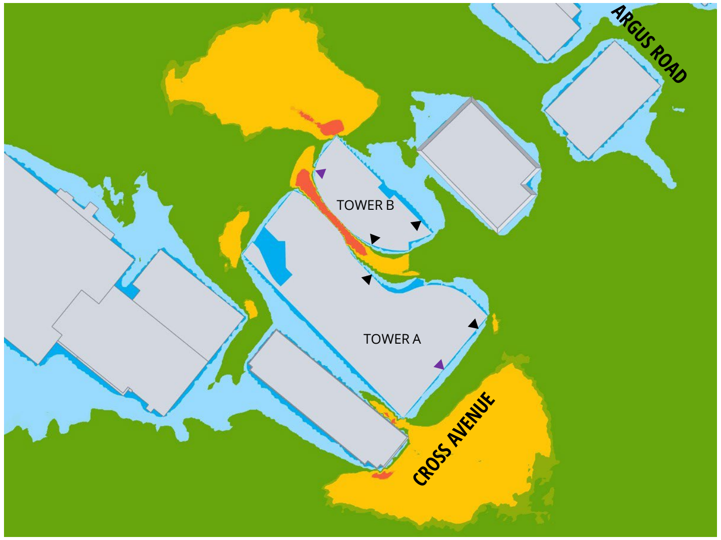
Wind comfort results are presented as colour contours of wind speeds calculated based on the wind criteria outlined in Section 3.1. The contours represent wind speeds at a horizontal plane 1.5 m above the levels of interest. The assessment against the Safety Criterion was conducted qualitatively based on the predicted wind conditions and our extensive experience with wind tunnel assessments in Oakville and the GTA.

The results of the assessment are discussed in detail in Sections 4.3 and 4.4. Section 4.5 presents wind control recommendations for the design team's consideration.

4. RESULTS AND DISCUSSION



(a) EXISTING



(b) PROPOSED

TRUE NORTH

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

▶ RESIDENTIAL ENTRANCE ▶ COMMERCIAL ENTRANCE

Image 8: Predicted wind conditions at grade level – Summer (May through October).

4. RESULTS AND DISCUSSION

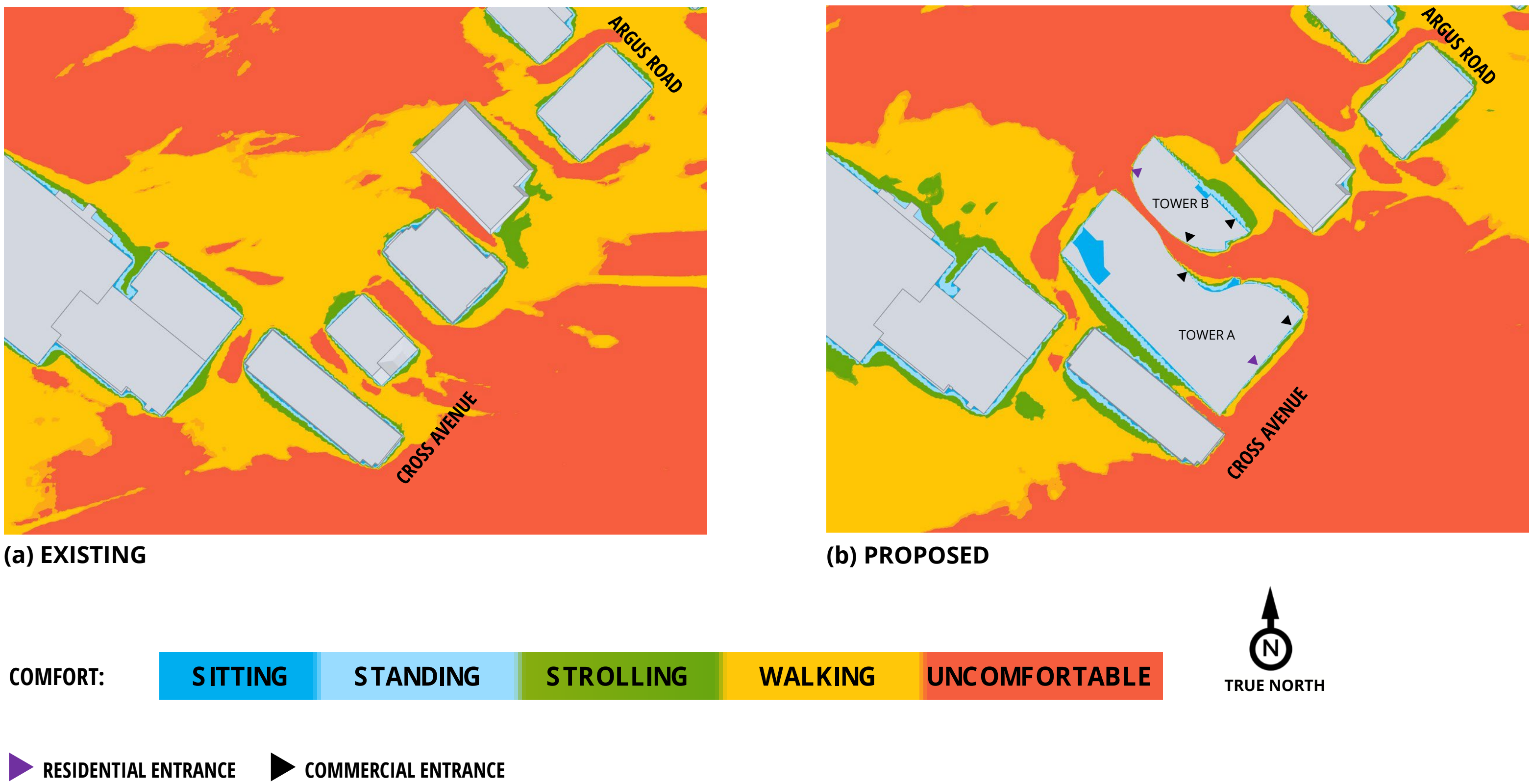
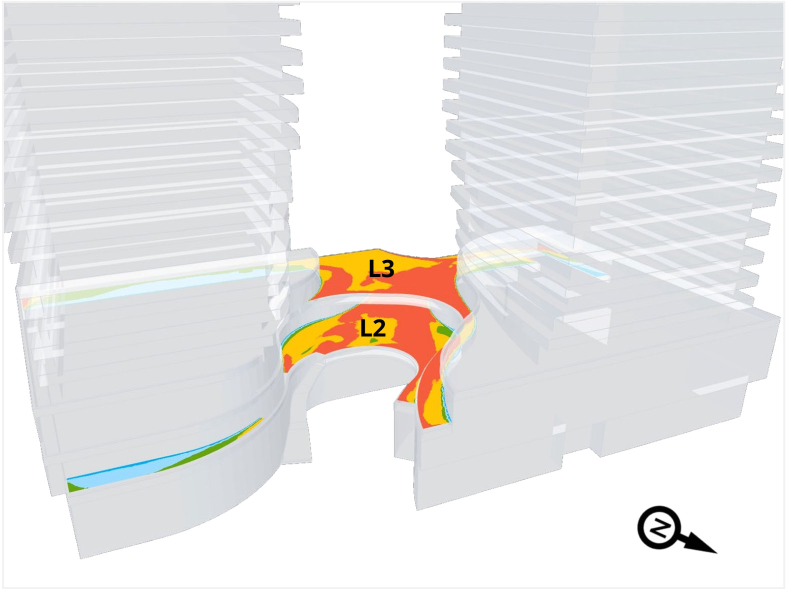
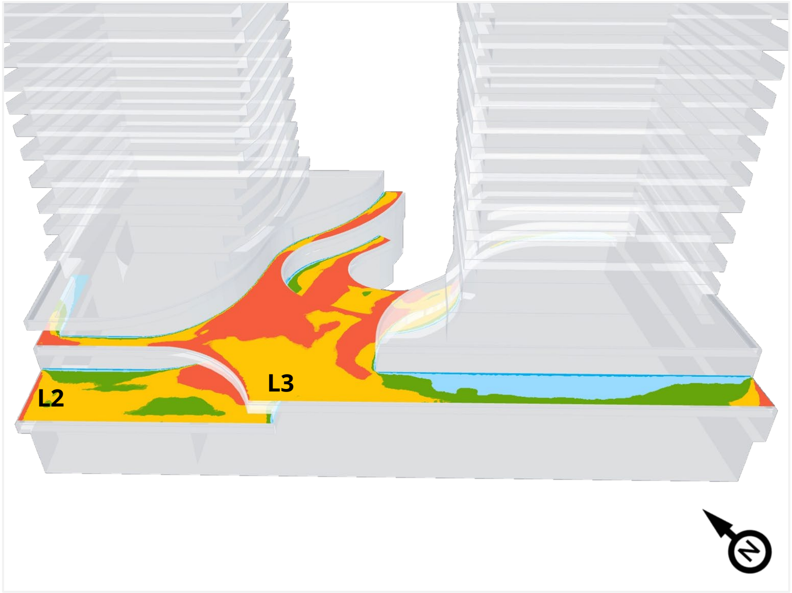


Image 9: Predicted wind conditions at grade level – Winter (November through April).



(a) VIEW 1

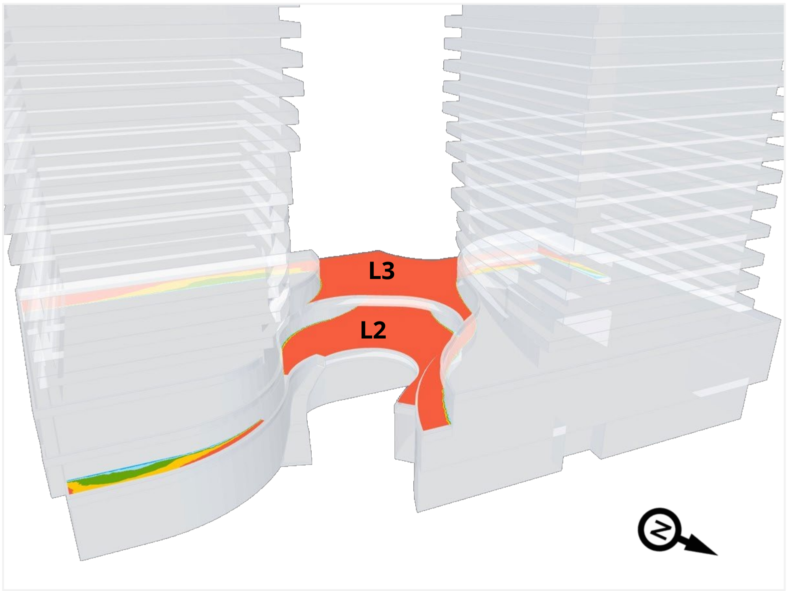


(b) VIEW 2

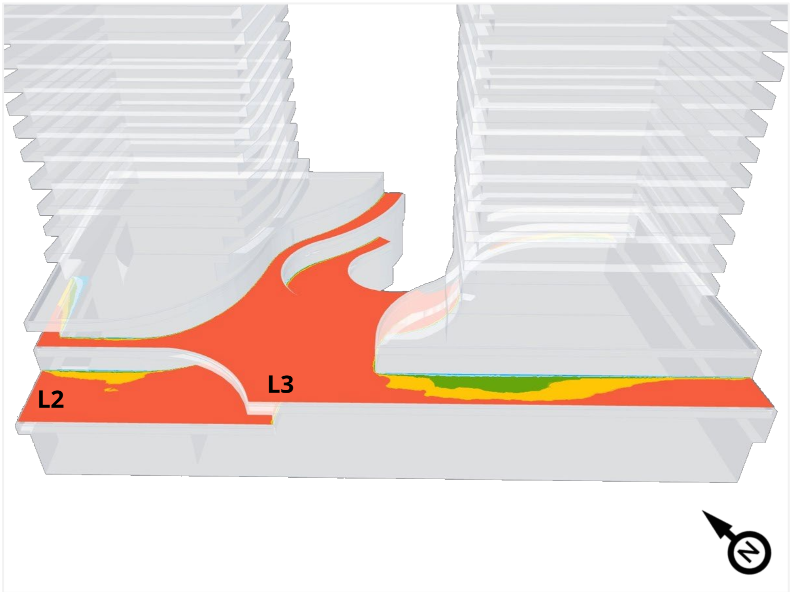
COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

Image 10: Predicted wind conditions on the podium-level terraces – Summer

4. RESULTS AND DISCUSSION



(a) VIEW 1



(b) VIEW 2

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

Image 11: Predicted wind conditions on the podium-level terraces – Winter

4. RESULTS AND DISCUSSION

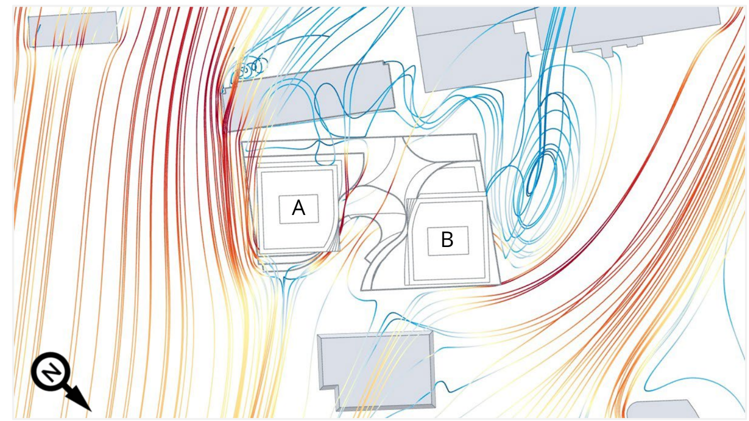
4.3 Existing Scenario

The existing buildings on site are low rise and do not redirect winds to create any notable impact. Wind conditions on and around the site are comfortable for standing or strolling in the summer (Image 8a) and comfortable for walking over a significant part of the assessed area in the winter (Image 9a). Uncomfortable wind conditions occur in some parts of the site in the winter due to the seasonal wind climate in Oakville and the exposure of the site to the prevailing winds. Wind speeds at all areas near the project site likely meet the wind Safety Criterion, due to the lack of tall buildings in the area.

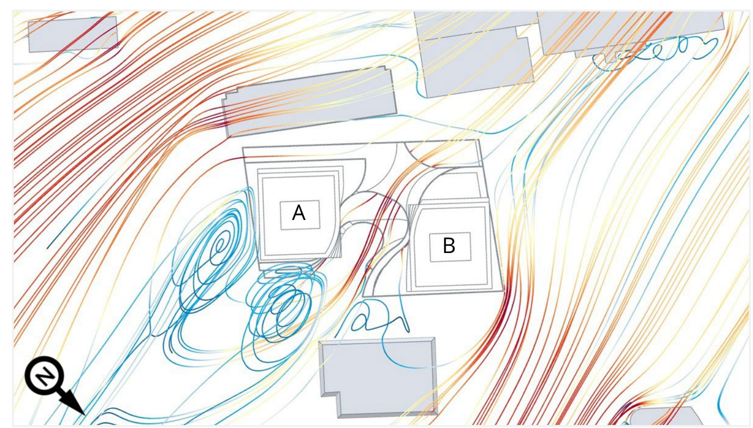
4.4 Proposed Scenario

The proposed buildings are taller than the immediate surroundings in all wind directions. As a result, winds intercepted by the towers at high elevations are expected to downwash to the podium and ground level, accelerating around building corners and through the gap between the towers (Image 12). The resultant on-site wind speeds at grade are expected to be generally higher than in the Existing Scenario.

The impact of these effects at grade is moderated by the podium of the towers, which act as a horizontal break for downwashing winds (see Image 7).



a) East-northeast winds



b) West winds

LOW MEDIUM HIGH

Relative wind intensity:

Image 12: Streamlines of the wind flow around the project

4.4 Proposed Scenario (cont'd)

4.4.1 Sidewalks, Walkways, and POPS

Wind speeds on most sidewalks around the site are expected to be comfortable for strolling or walking in the summer (Image 8b). Uncomfortable wind conditions are anticipated around the north corner of Tower B, between Towers A and B (POPS), and around the south corner of Tower A.

In the winter, wind speeds are predicted to be higher. Speeds comfortable for walking or lower are still predicted in some areas close to the towers; however, uncomfortable wind speeds are anticipated over large areas of the site (Image 9b). Conditions further away from the building are anticipated to remain similar to the existing scenario.

In the areas around the north corner of Tower B, between Towers A and B, and around the south corner of Tower A, wind safety criterion may also be exceeded. Wind tunnel testing should be conducted at a later design stage to quantify these wind conditions and to develop wind control solutions.

4.4.2 Building Entrances

Wind conditions at most residential and commercial entrances are anticipated to be comfortable for sitting or standing in the summer, which is appropriate (arrows within blue regions in Image 8b). Higher-than-ideal wind speeds are predicted at the residential entrance on the north side of Tower B and at the commercial entrance on the southwest side of Tower B.

In the winter, wind conditions at the commercial entrance on the east side of Tower B are still predicted to be adequate; however, high wind speeds are predicted at most other entrances (arrows within green, yellow, and orange regions in Image 9b).

4.4.3 Podium-Level Terraces

Wind speeds on most of the podium-level terraces are anticipated to be comfortable for walking in the summer, with uncomfortable conditions occurring over large areas between the two towers (Images 10a and 10b). Positively, a low wind speeds zone is expected on the south side of Tower A. Elevated wind speeds are predicted on the terraces in the winter (Images 11a and 11b).

The Safety Criterion may be exceeded on Levels 2 and 3 between the towers.

4.5 Wind Control Strategies

4.5.1 Grade Level

Potential options for improving wind conditions at grade level are listed below, and conceptual examples are shown in Image 13.

- Making the podia larger relative to the size of the base of the towers.
- Adding architectural steps to the northeast and southwest sides of the towers and/or Installing deep canopies close to the ground along these sides of the buildings, preferably wrapping around corners.
- Chamfering/articulating sharp corners. Arcades/colonnades may also be considered.
- Recessing entrances located in areas of high wind activity or installing wind screens on both sides of the entrances to create sheltered doorways.
- Installing tall wind screens along sidewalks, walkways and in the space between the towers. We recommend that screens be at least 2 m tall and have a small fraction of open area (up to 30%) to slow winds down as they pass through them.
- Selecting tall coniferous or marcescent trees for the sidewalks, especially in areas where wind conditions are predicted to be uncomfortable. Large trees that have dense foliage and are able to retain their leaves in the winter can help to improve wind conditions locally around them.

4.5.2 Podium-Level Terraces

Possible measures for reducing wind speeds on the terraces at podium levels may include:

- Adding large overhead structures (canopies/trellises) around the base of the towers;
- Increasing the height of perimeter guardrails to at least 2 m; and
- Adding local wind screens, partitions, or tall landscaping elements around designated seating areas to created sheltered zones for occupants.

Examples wind control features for terraces are shown in Image 14.

4. RESULTS AND DISCUSSION

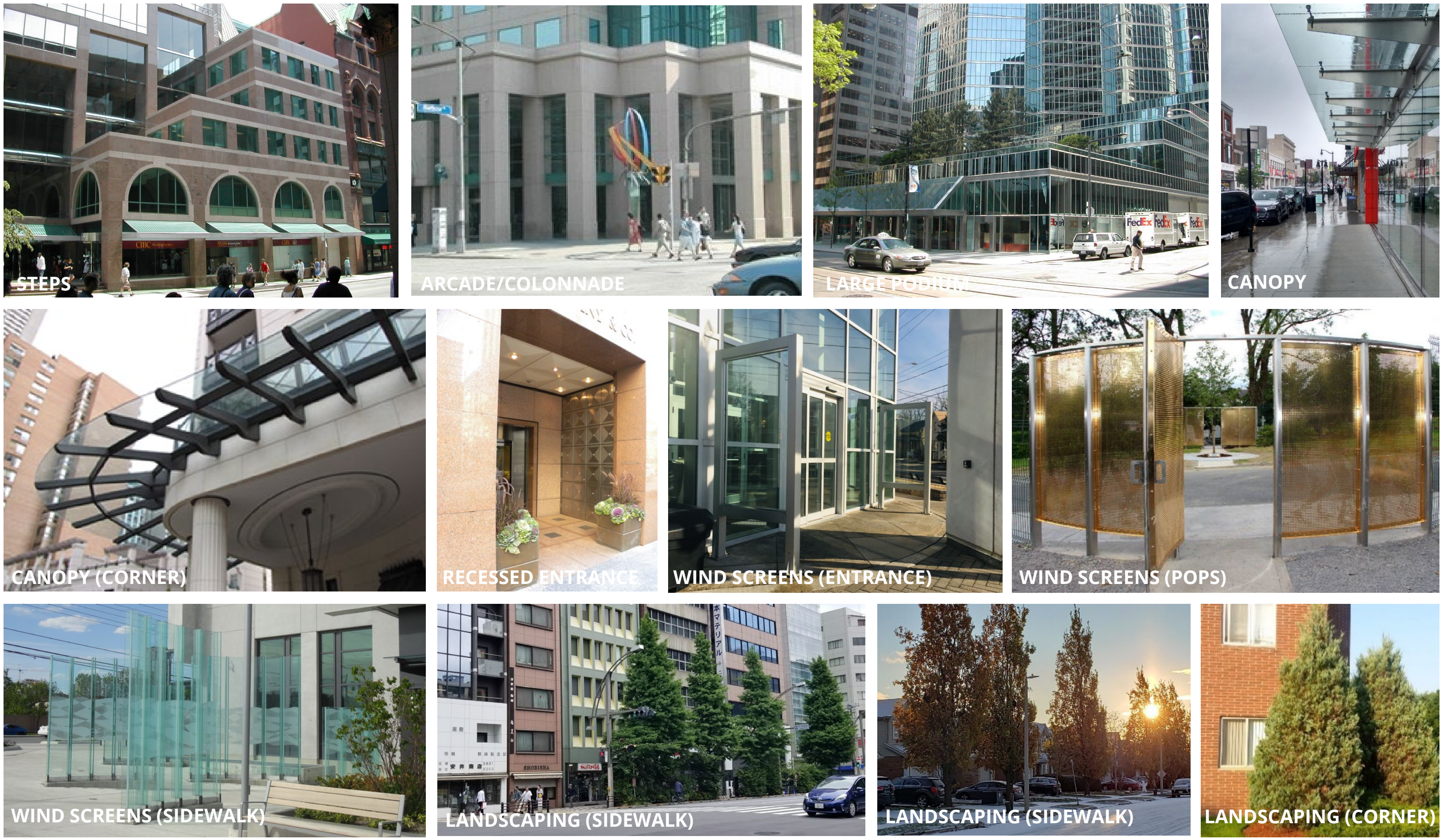


Image 13: Wind control features applicable to the site

4. RESULTS AND DISCUSSION

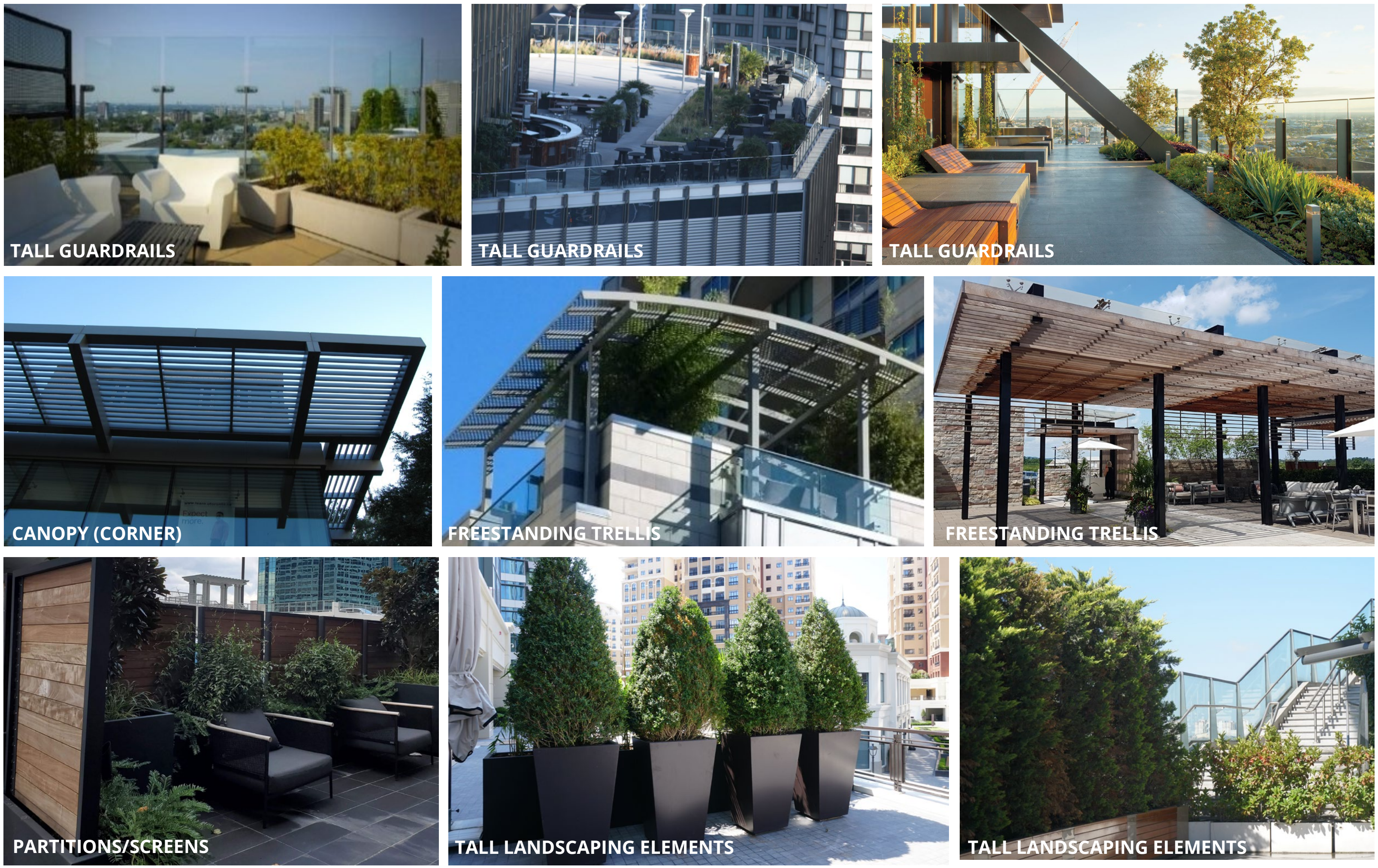


Image 14: Wind control features applicable to terraces

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed project at 157 & 165 Cross Avenue in Oakville, Ontario. Our assessment was based on computational modelling, simulation and analysis of wind conditions for the proposed development design, in conjunction with the local wind climate data and the RWDI wind criteria for pedestrian comfort and safety. Our findings are summarized as follows:

- In the existing scenario, wind speeds on and around the site are appropriate for pedestrian use in the summer. Higher wind speeds occur during the winter, with conditions being uncomfortable in some areas due to the site exposure.
- The proposed towers are significantly taller than their surroundings and, as a result, their interaction with the prevailing winds is expected to induce higher wind speeds at grade level when compared to the Existing scenario. Current design features such as the podium of the towers help to moderate the wind impact at grade.
- With the addition of the proposed buildings, wind conditions in most areas on the sidewalks around the site are expected to remain suitable for pedestrian use during the summer. Uncomfortable wind speeds are predicted around the north corner of Tower B, between Towers A and B (POPS), and around the south corner of Tower A. In the winter, however, elevated wind speeds are predicted on most of the site.
- Appropriate wind speeds are anticipated at most building entrances in the summer. Wind speeds at the entrances on the north and southwest sides of Tower B are predicted to be higher than ideal. In the winter, wind speeds at the northeast entrance of Tower B are still expected to be adequate. However, speeds at most other entrances are predicted to be higher than recommended.
- In the summer, wind speeds on the shared podium-level terraces (Levels 2 and 3) are expected to be generally higher than recommended for outdoor amenities in the summer. Adequate wind speeds are anticipated on the south side of Tower A.
- The Safety Criterion may be exceeded at grade around the north corner of Tower B, between Towers A and B, and around the south corner of Tower A. Exceedances may also occur between the two towers on the terraces on Levels 2 and 3.
- Conceptual wind control measures are discussed in the report. RWDI can help guide the placement of wind control features to achieve appropriate levels of wind comfort based on the programming of the various outdoor spaces.
- Wind tunnel testing should be conducted at later design stages to quantify the predicted wind conditions and refine the recommended wind control measures.

6. DESIGN ASSUMPTIONS

The findings/recommendations in this report are based on the building geometry communicated to RWDI (listed below). Should the details of the proposed design and/or geometry of the building change significantly, results may vary.

File Name	File Type	Date Received (mm/dd/yyyy)
23-107 2024-01-26 3D CAD	.DWG	01/29/2024
23-107 2024-01-26 Architectural Progress Set	.PDF	01/29/2024
240201 - L100_Landscape Layout	.PDF	02/05/2024

Changes to the Design or Environment

It should be noted that wind comfort is subjective and can be sensitive to changes in building design and operation that are possible during the life of a building. These could be, for example: outdoor programming, operation of doors, elevators, and shafts pressurizing the tower, changes in furniture layout, etc. In the event of changes to the design, construction, or operation of the building in the future, RWDI could provide an assessment of their impact on the discussions included in this report. It is the responsibility of Others to contact RWDI to initiate this process.

7. STATEMENT OF LIMITATIONS

This report was prepared by Rowan Williams Davies and Irwin Inc. for Cross Realty LP ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein and authorized scope. The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

8. 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.