REPORT

ROSE STREET HOUSING DEVELOPMENT

BARRIE, ONTARIO

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT #2401448
January 17, 2024

SUBMITTED TO

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1. INTRODUCTION

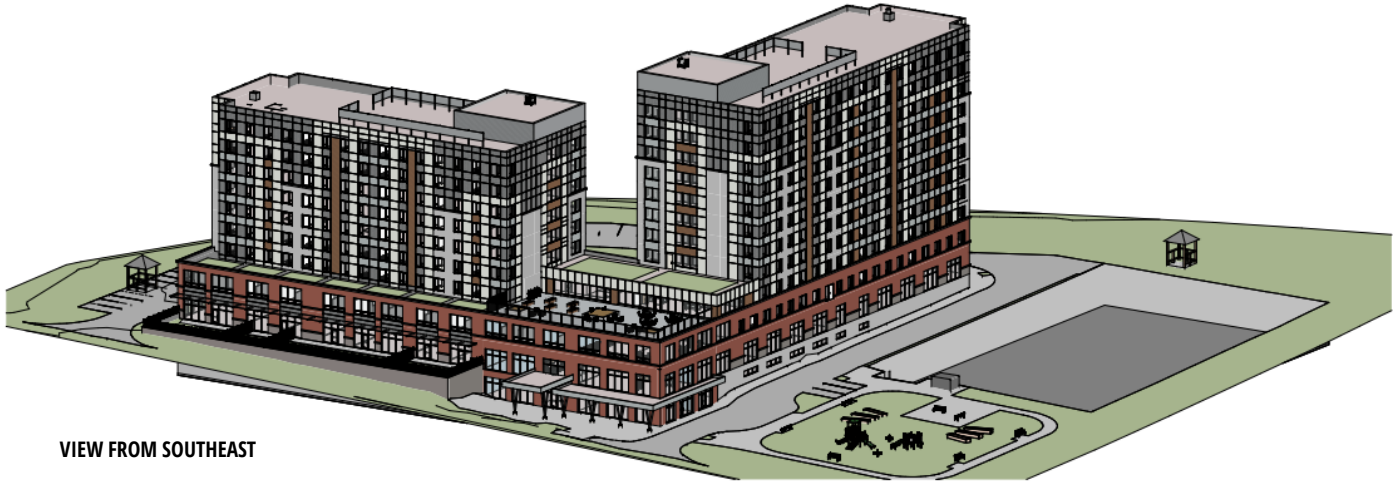
Rowan Williams Davies & Irwin Inc. (RWDI) was retained to conduct a pedestrian wind assessment for the proposed Rose Street Housing Development project in Barrie, Ontario. The objective of this assessment is to provide an evaluation of the potential impact of the proposed development on wind conditions as it relates to pedestrian comfort and safety.

The project site is located on Rose Street, south of King's Highway 400 and west of Peel Street (**Image 1**). The proposed project is an 11-storey community services housing development. The design features an L-shaped structure with an 11-storey wing and a 9-storey wing connected by a 3-storey podium, and a separate 2-storey building with parking and commercial spaces (**Image 2**). Outdoor amenity use is planned at ground level to the south of the Parking/commercial structure, on Level 1 of the 9-storey wing on the south side, and on Level 3 of the podium between the two wings. The current design features designated outdoor amenity space at ground level and on the main structure.

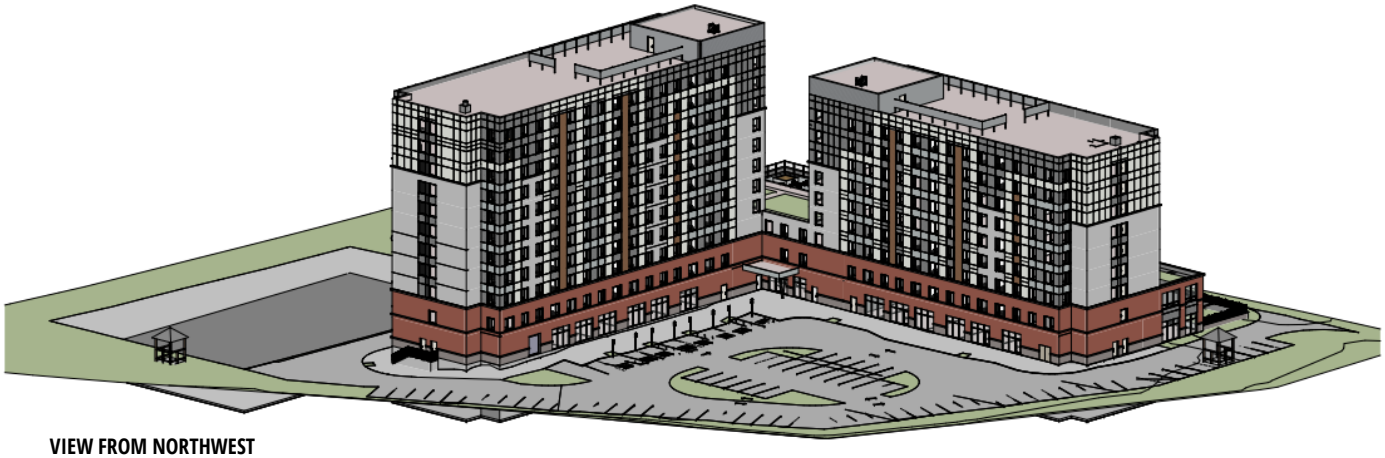
Key areas of interest for this assessment include the main entrances to the building, proposed outdoor amenity areas, the sidewalks on Rose Street and properties in the immediate vicinity of the site. **Image 3** shows a site plan identifying the key areas of interest.

Image 1: Aerial view of the existing site and surroundings
Source: Google Earth

1. INTRODUCTION



VIEW FROM SOUTHEAST



VIEW FROM NORTHWEST

Image 2: 3D Views of the proposed project model (Parking Structure not shown)

1. INTRODUCTION

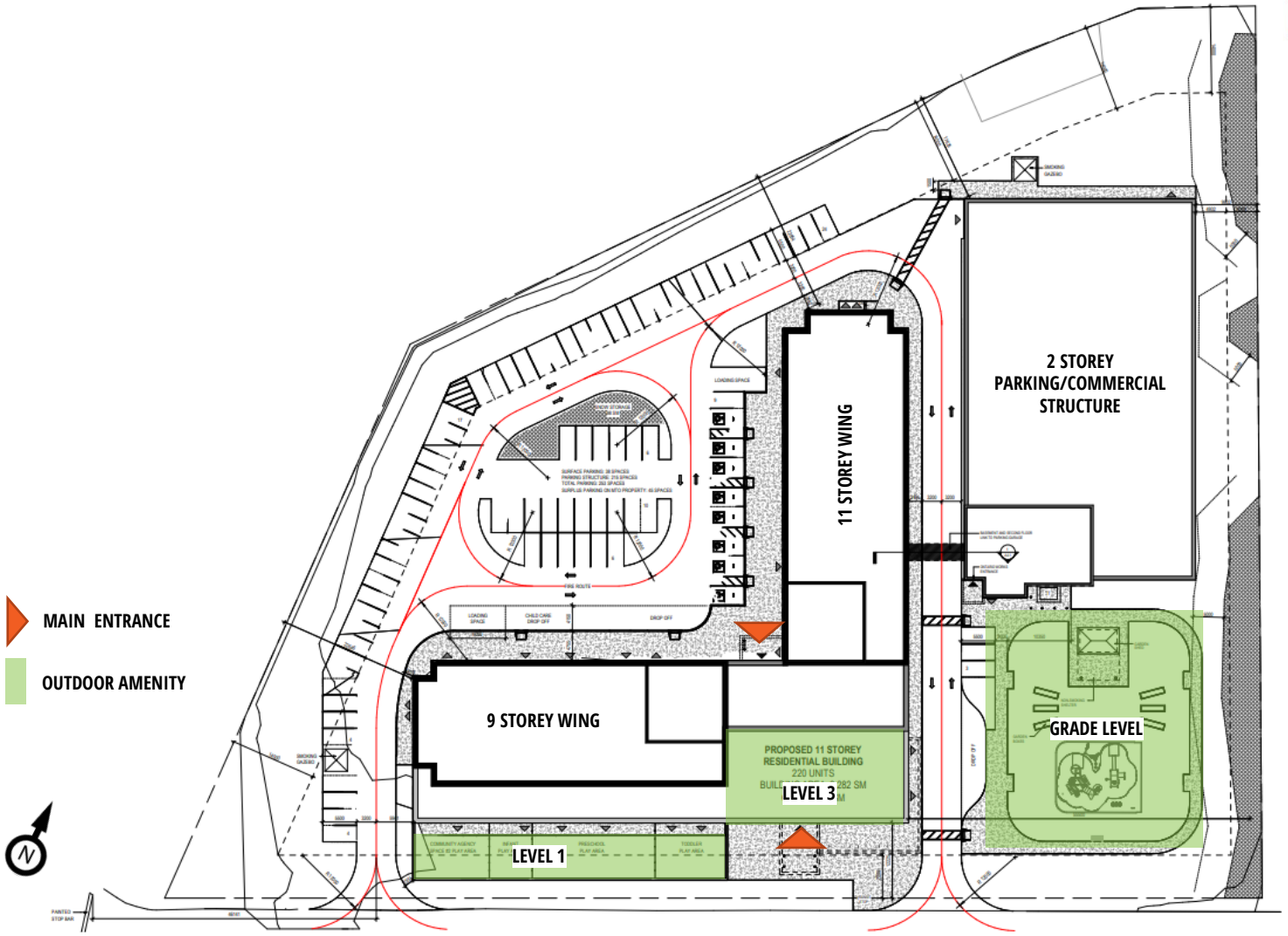


Image 3: Site plan identifying key outdoor areas of interest

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) modelling. The assessment is based on the following:

- A review of the regional long-term meteorological data from Egbert Climate Station;
- Architectural information received on December 14, 2023;
- 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 wind and 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:

- Existing: Existing site and surroundings.
- Proposed: Proposed development with the existing surroundings.

The computer model of the proposed building is shown in **Image 4**, and the Existing and Proposed configurations with the proximity model are shown in **Images 5** and **6**, 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 in order to provide more conservative wind conditions (as is the norm for this level 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 1.5m above concerned levels, to the mean wind speed at a reference height. The data was then combined with meteorological records obtained from Egbert Climate Station to determine the wind speeds and frequencies in the simulated areas.

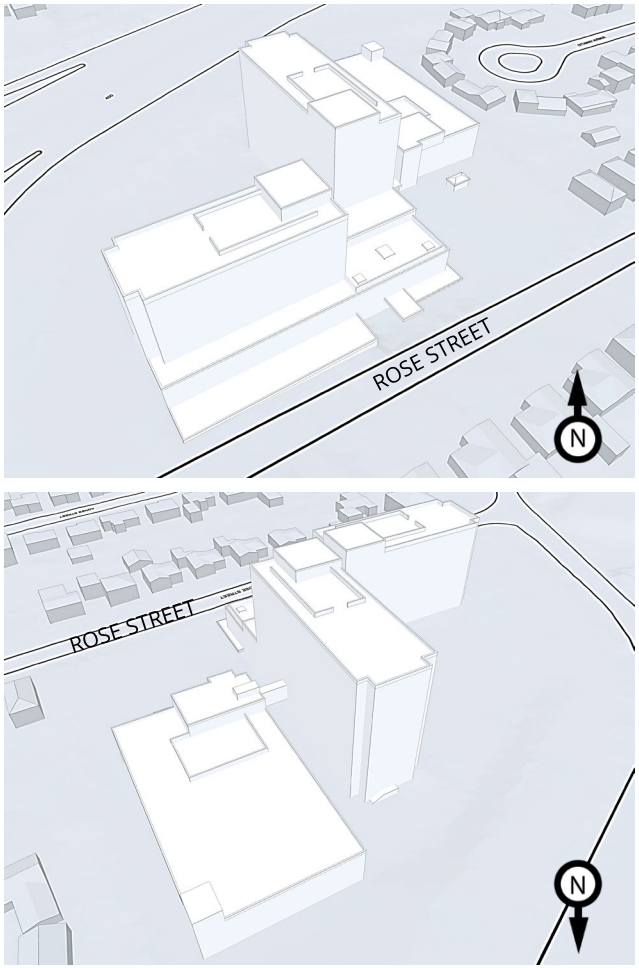


Image 4: Computer model of the proposed project

2. METHODOLOGY

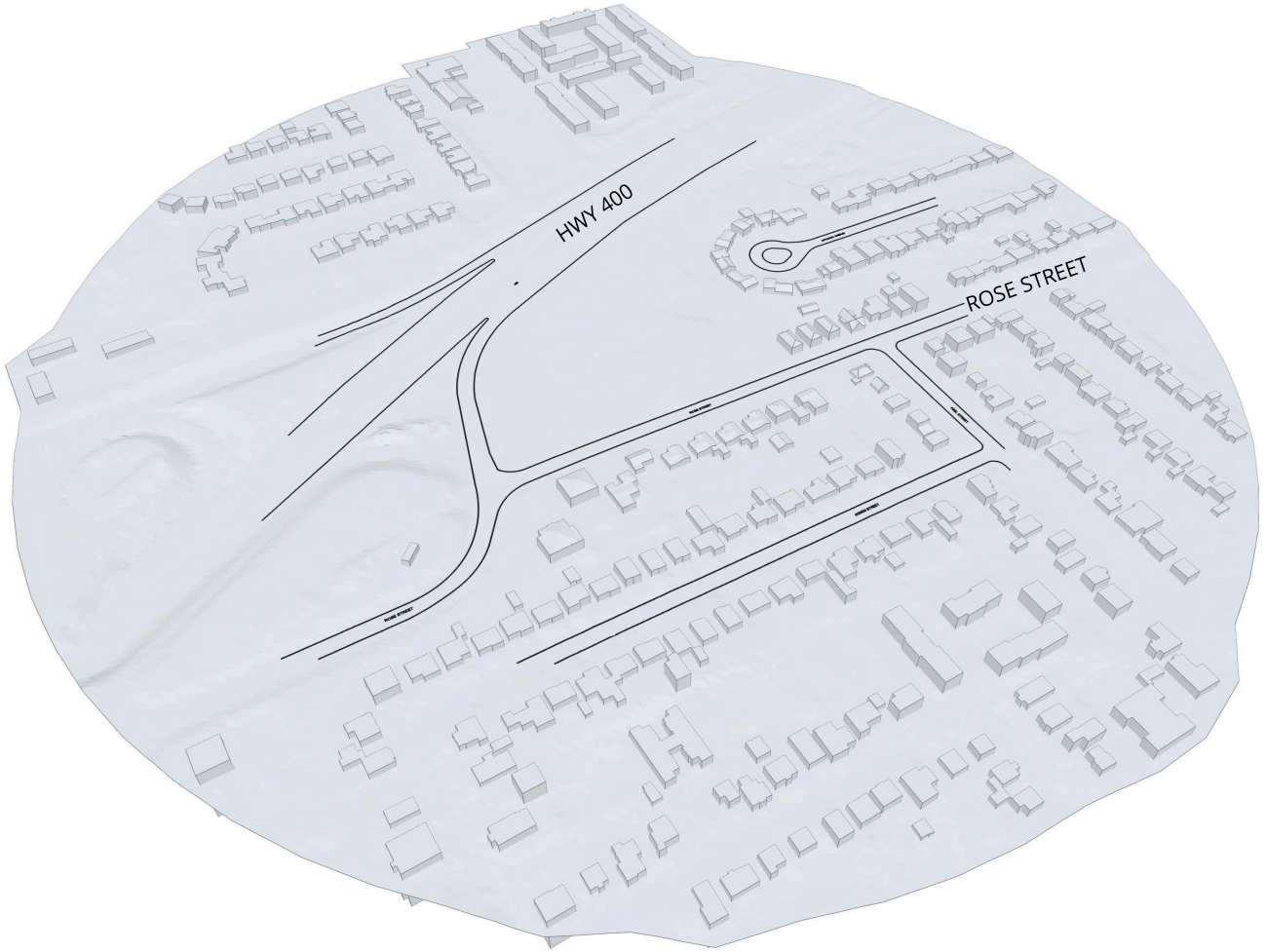


Image 5: Computer model of the existing site and surroundings

2. METHODOLOGY

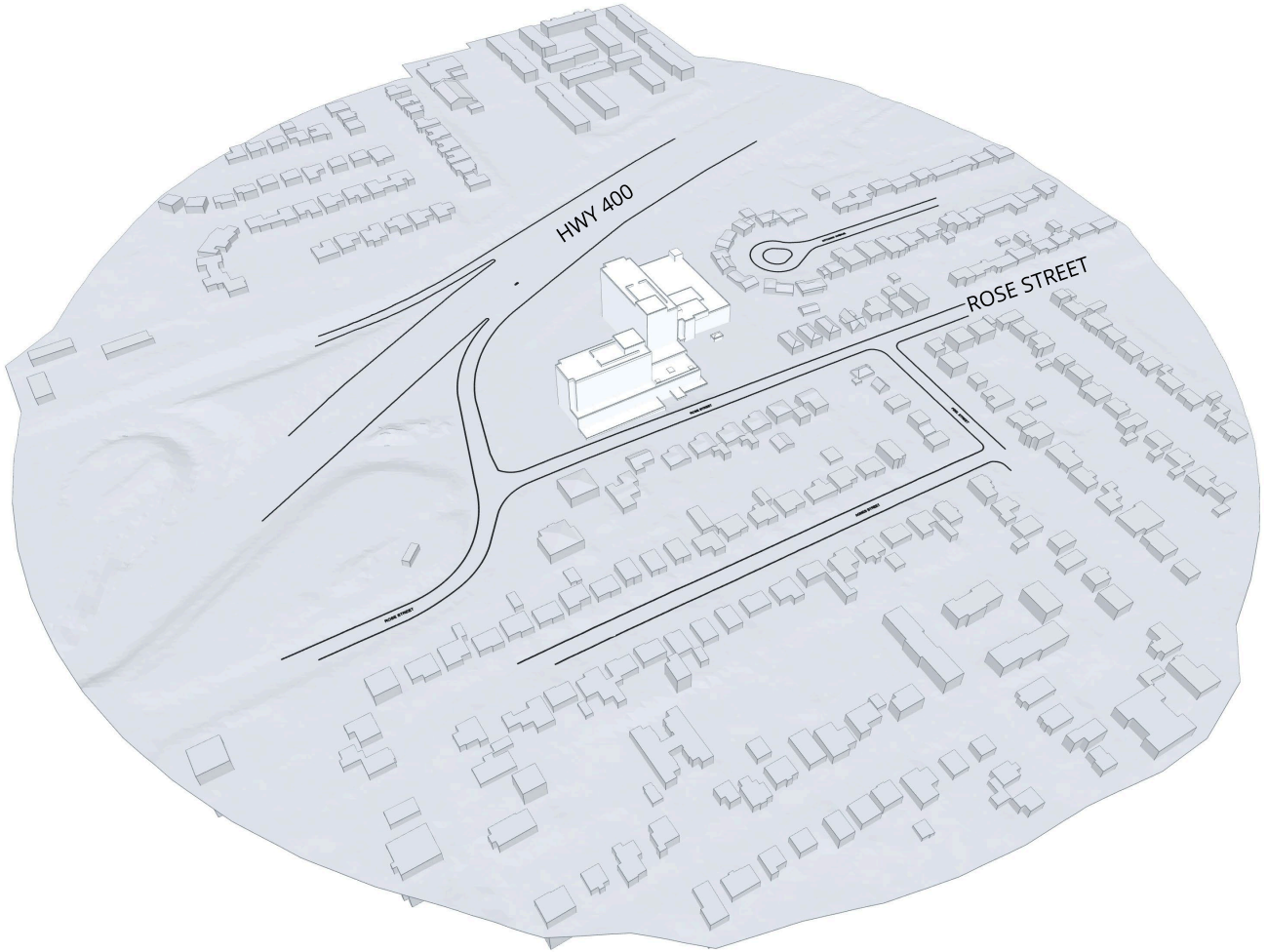


Image 6: Computer model of the proposed project and existing surroundings

2. METHODOLOGY

Long-term wind data recorded at Egbert Climate Station between 2005 and 2021, inclusive, were analyzed for the summer (May to October) and winter (November to April) months. **Image 7** graphically depicts the directional distributions of wind frequencies and speeds for these periods.

In the summer and winter seasons, winds from the north-northwest and southerly directions are predominant. Strong winds of a mean speed greater than 20 km/h measured at the met station (at an anemometer height of 10m) are more frequent in the winter (green and yellow bands in **Image 7**). These winds potentially could be the source of elevated wind speeds 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.

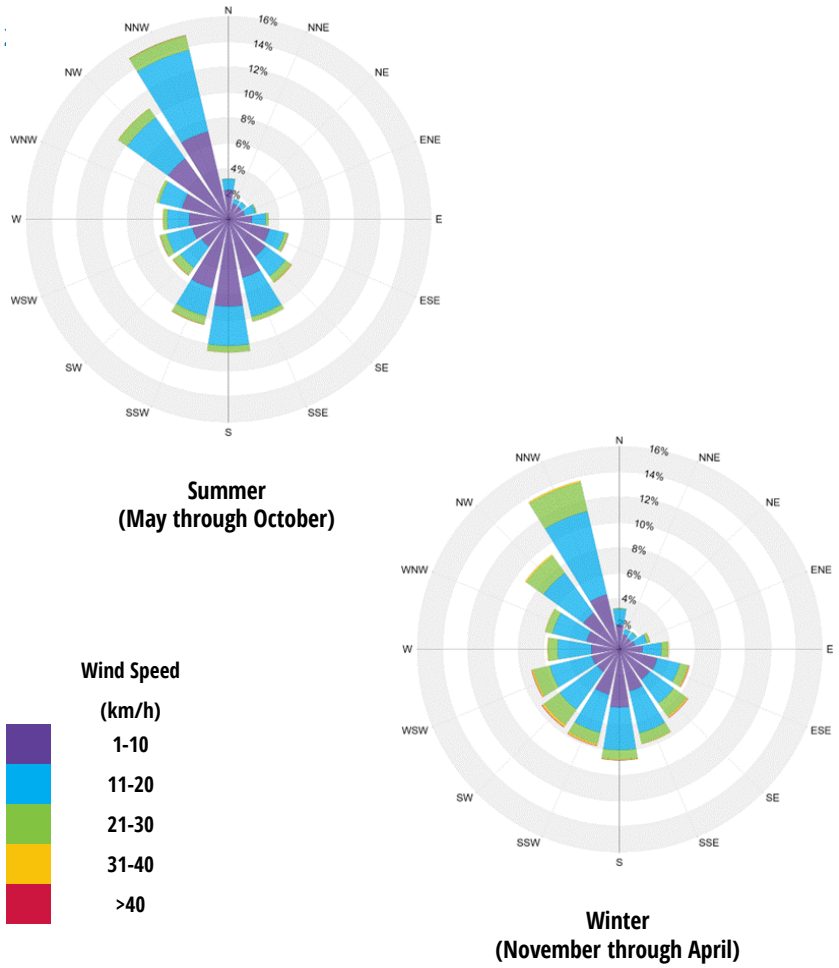


Image 7: Directional distribution of wind approaching Egbert Climate Station (2005 to 2021)

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 Wind Flow Around Buildings

Wind generally tends to flow over buildings of uniform height, without disruption. Buildings that are taller than their surroundings will 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*. These flow patterns are illustrated in **Image 8**. Massing features like low horizontal steps and re-entrant corners help reduce wind accelerations around buildings.

The project, at 11 and 9 storeys, will be taller than the buildings that exist in the surrounding area, and would increase wind speeds around the site. However, potential wind impacts at the grade level would be limited due to the low podium and re-entrant corners of the building, as well as the moderate wind speed characteristics of the area.

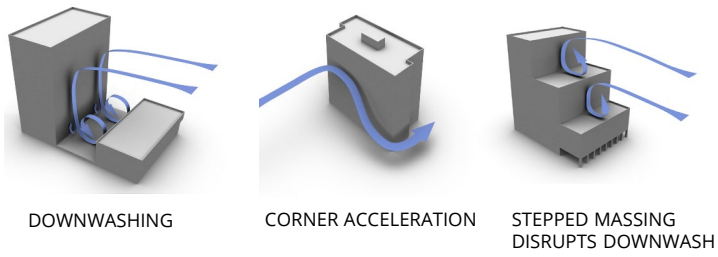


Image 8: General wind flow mechanisms

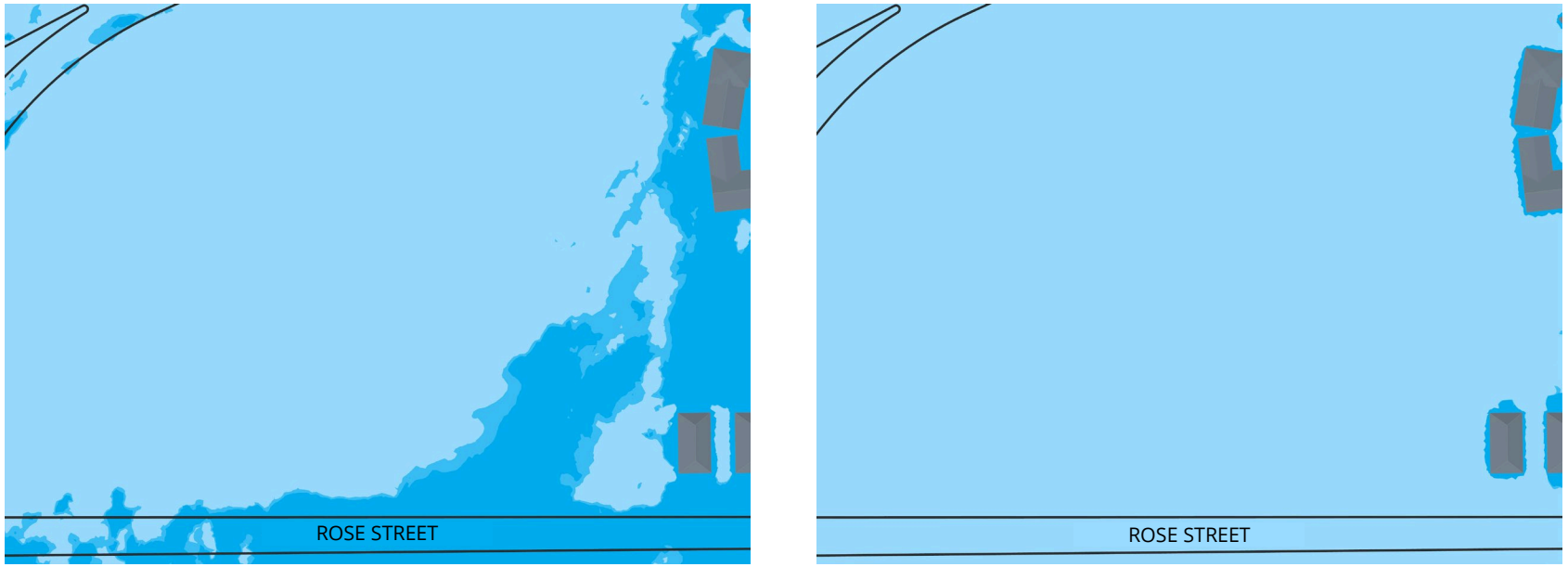
4.2 Simulation Results

The predicted ground-level wind comfort conditions for the existing and proposed configurations are presented in **Images 9** and **10**, respectively, and results for the amenity areas on Levels 1 and 3 are shown in **Image 11**. The results are presented as colour contours of wind speeds calculated based on the wind comfort criteria (Section 3). The contours represent wind speeds at approximately 1.5 m above the local grade. The assessment against the safety criterion (Section 3) was conducted qualitatively based on the predicted wind conditions and our wind-tunnel experience with similar developments.

A detailed discussion of the expected wind conditions with respect to the prescribed criteria and applicability of the results follows in Section 4.3 and 4.4.

Target Conditions

For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks and walkways where pedestrians are likely to be active and moving intentionally. Lower wind speeds comfortable for standing are required for entrances and areas where people are expected to be engaged in passive activities. Calm wind speeds suitable for sitting are desired in areas where prolonged periods of passive activities are anticipated, such as outdoor amenity areas, seating areas etc., especially during the summer when these areas would be typically in use.



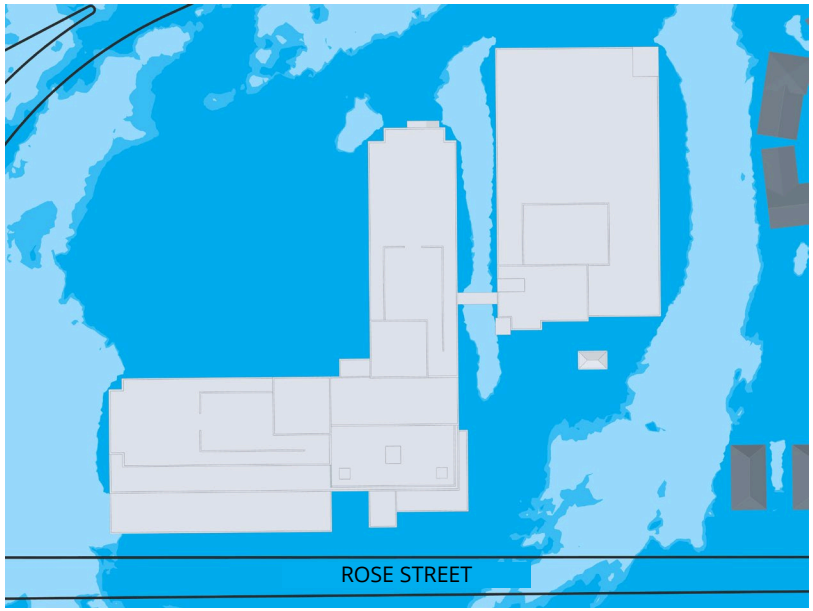
(a) SUMMER **(b) WINTER**

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: The criterion will be met at all areas assessed

Image 9: Predicted wind conditions – GROUND LEVEL – EXISTING SCENARIO

4. RESULTS AND DISCUSSION



(a) SUMMER

(b) WINTER

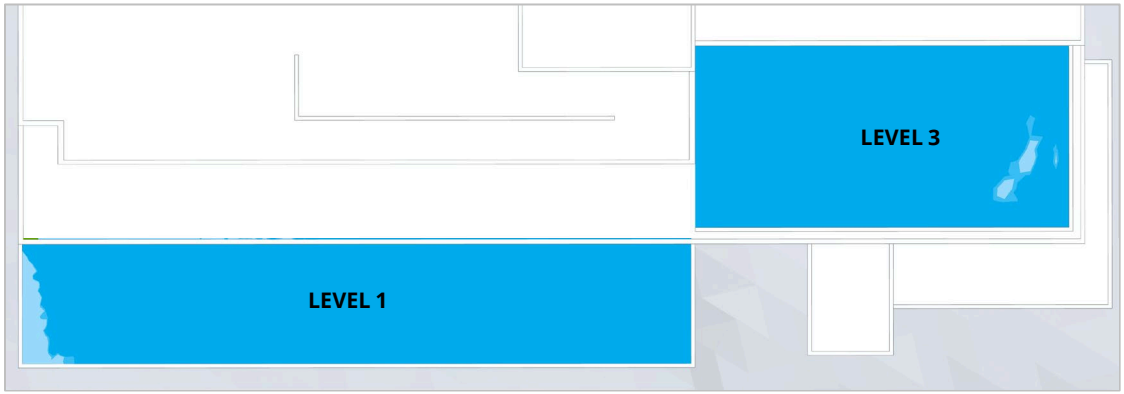
COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: The criterion will be met at all areas assessed

Residential entrance

Image 10: Predicted wind conditions – GROUND LEVEL – PROPOSED SCENARIO

4. RESULTS AND DISCUSSION



(a) SUMMER

(b) WINTER

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: The criterion will be met at all areas assessed

Image 11: Predicted wind conditions – ELEVATED OUTDOOR AMENITY AREAS – PROPOSED SCENARIO

4.3 Existing Scenario

The existing site is currently unoccupied and surrounded by low-rise buildings. As such, there are no structures that would redirect wind to create unfavourable conditions. Wind conditions at all areas on and around the existing site are considered comfortable for sitting or standing in the summer and winter (**Image 9**). The pedestrian wind safety criterion is met at all areas assessed in the existing configuration.

4.4 Proposed Scenario

The proposed development would be taller than the buildings that exist in the immediate surrounding area. Therefore, the proposed building would be exposed to wind at high elevations and redirect wind around it, resulting in an increase in wind speeds in the immediate vicinity of the site. However, the potential wind impact would be moderated by several factors:

- Wind climate in the region is characterized by low to moderate wind speeds through most of the year.
- The proposed design includes low podiums and massing steps which will act as horizontal breaks for downwashing wind flows.
- The L-shaped form will create several vertical breaks for wind flowing through the site.
- Both towers are designed with reentrant corners facing into the prevailing wind which will help break corner acceleration flows.

Wind conditions at all areas off-site and most areas at grade on-site are expected to continue to be comfortable for sitting or standing in the summer and winter, similar to the existing scenario (**Image 10**). These speeds are appropriate for all pedestrian activities and conducive to the expected activities at drop off and entrance areas. Higher wind speeds comfortable for strolling are expected around the east side of the eastern 9-storey wing and at the north end of the passage between the 11-storey wing and the parking garage, which is conducive to the active and transient pedestrian use expected in those areas.

Outdoor amenity areas are proposed at ground level to the south of the parking/commercial structure, on the south side of the 9-storey wing at Level 1 and at the southeast corner on the podium deck on Level 3 (see **Image 3**), and wind comfort results for these areas are presented in **Image 11**. Wind conditions in these areas are expected to be comfortable for sitting in the summer, which is appropriate for passive uses such as sitting, reading, dining, children's activities, etc. In the winter months, wind speeds may continue to be appropriate for passive uses but higher wind speeds comfortable for standing are likely to occur frequently – this may be acceptable considering the limited outdoor use expected in the cold months.

The pedestrian safety criterion is expected to be met at all areas assessed at grade level and in the amenity areas considering the low to moderate ambient wind speeds and wind-responsive massing design.

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian wind impact of the proposed Rose Street Housing Development project in Barrie, 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:

- Wind conditions on and around the existing site are suitable for the pedestrian use throughout the year. The pedestrian wind safety criterion is met at all areas assessed.
- The addition of the proposed development is expected to increase wind speeds around the site and reduce wind speeds on-site. Overall, wind conditions are expected to continue to be appropriate for the various user activities expected at the entrances, sidewalks, parking areas.
- Wind speeds on the proposed amenity areas are expected to be appropriate for the anticipated seasonal use.
- The wind conditions resulting from the addition of the proposed project are expected to meet the wind safety criterion.

6. DESIGN ASSUMPTIONS

The findings/recommendations in this report are based on the building geometry and architectural information communicated to RWDI in December 2023, 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)
Simcoe County Affordable Housing - Rose St Barrie - December 07, 2023 - P.GAR - Consultant Copy.rvt	Revit	12/14/2023
Simcoe County Affordable Housing - Rose St Barrie - December 11, 2023 - Option 2-R3 - For Wind Study.rvt	Revit	12/14/2023

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 & Irwin Inc. (RWDI) for County of Simcoe, Social Housing Department ("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.