5566 ROBINSON STREET & 6158 ALLENDALE AVENUE

NIAGARA FALLS, ON

WIND DRIVEN MIST ASSESSMENT

PROJECT #2201139

APRIL 1, 2022

SUBMITTED TO

La Pue International Inc
(c/o Pawel Fugiel)

SUBMITTED BY

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the potential wind impact that may be caused by the proposed 5566 Robinson Street & 6158 Allendale Avenue (also known as Niagara-77) development on the misting conditions of Horseshoe Falls in the City of Niagara Falls, Ontario.

The project site is located about 1.2 km to the northwest of the Horseshoe Falls. It is situated at the southeast corner of the intersection between Robinson Street and Allendale Avenue (Image 1).

The project, at 77 storeys, is a high-rise tower, currently planned for 680 residential and 312 hotel units. In addition, the project includes 6-storey above grade and 6-storey underground parking (Image 2).

The area that is often wetted by mist from Horseshoe Falls is around Table Rock Centre along Niagara Boulevard on the Canadian side of the Falls (Image 1).

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

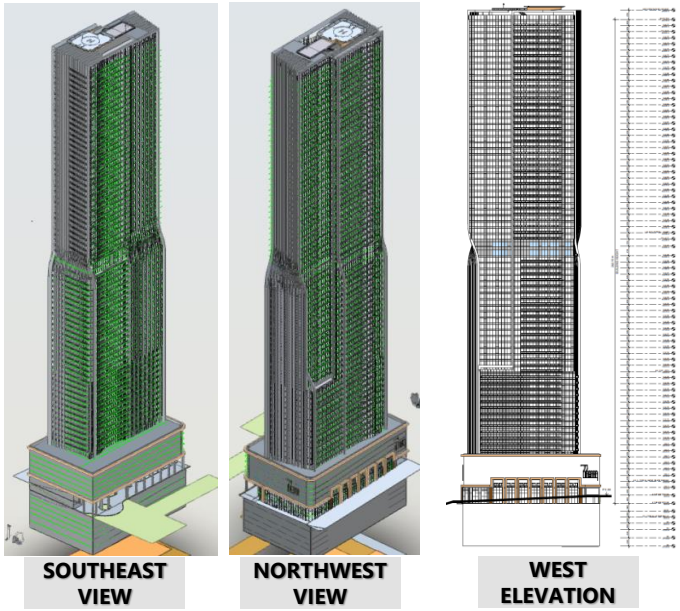

Image 2: Conceptual Massing

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2. METHODOLOGY

2.1 Objective

The objective of this assessment is to provide a qualitative evaluation of the potential wind impact of the proposed development on misting around the Falls. Our assessment is based on the following:

- A review of the regional meteorological data from St. Catharines Niagara District Airport;
- Drawings of the proposed project received by RWDI on March 8, 2022;
- The use of Orbital Stack, an in-house computational fluid dynamics (CFD) tool, to aid in the assessment of wind flows around buildings;
- RWDI's previous wind and misting studies in Niagara Falls; and,
- Our engineering judgment, experience and expert knowledge of wind flows around buildings.

2.2 CFD for Wind Simulation

CFD is a numerical modelling technique for simulating wind flows 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.

To simulate the turbulence nature of wind flows around the existing and proposed buildings, the escarpment and the Falls, an advanced CFD technique, Large Eddy Simulation (LES), was used for the current project.

2.3 Simulation Model

Wind flows were simulated using Orbital Stack for the existing and proposed site buildings with the existing surroundings. The computer models are shown in Image 3. For the purposes of this computational study, the 3D models were simplified to include only the necessary building and terrain details that would affect the local wind flows in the area around the site. Landscaping and other smaller architectural and accessory features were not included in the computer model as is the norm for this level of assessment. In addition, misting and water were not included in the simulation.

The simulation was conducted for only one wind direction: the northwest or 315°. The approaching winds are modelled with typical suburban mean speed and turbulence profiles. Results of wind speeds and directions are presented side by side for the existing and proposed configurations to illustrate the potential changes in wind speeds and directions that may be caused by the proposed development.

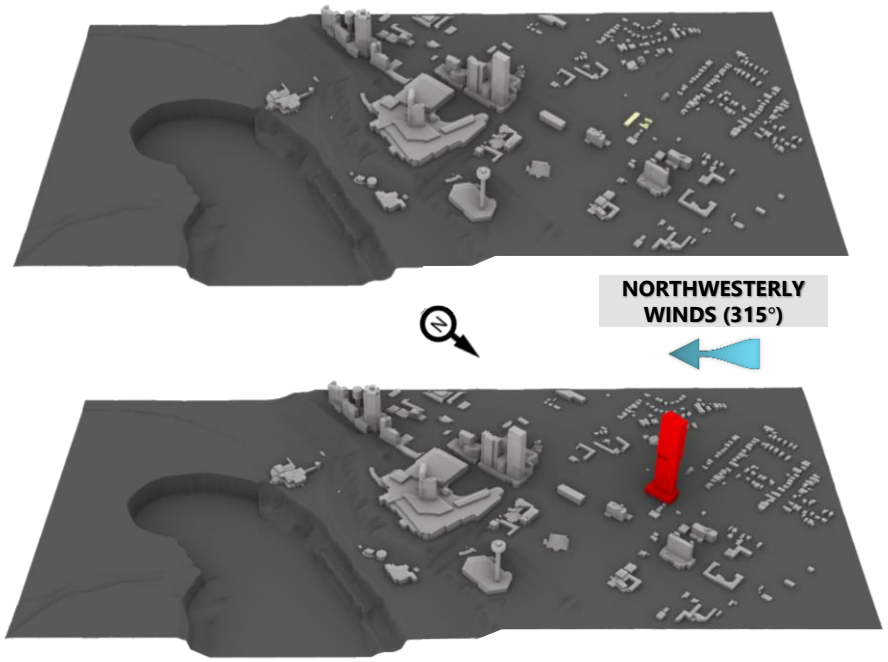
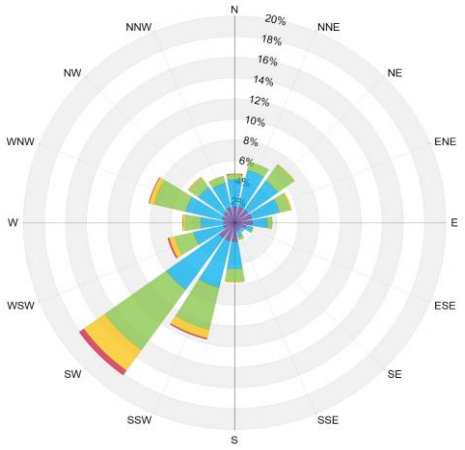


Image 3: Computer models of the existing site (top) and proposed project (bottom) with existing surroundings (northeast view)

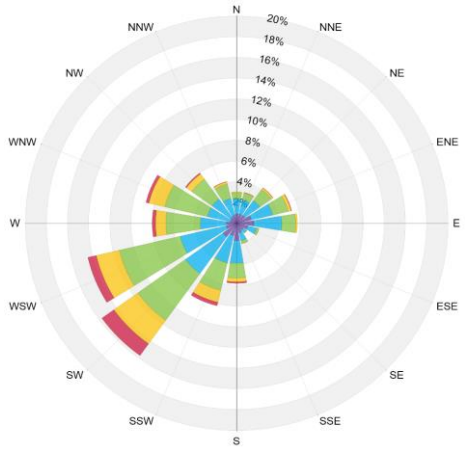
2.4 Meteorological Data

Meteorological data from St. Catharines Niagara District Airport for the period from 2012 to 2020 were used as a reference for wind directionality in the area as this is the nearest station to the site with long-term, hourly wind data. The distribution of wind frequency and directionality is shown in the wind rose in Image 4.

Due to the location of the site relative to the Falls, the project can have direct impact on the misting condition only through the northwesterly winds (Image 3). However, these winds are not common and are expected to happen less than 5% of the time during summer (i.e., May through October) when misting is more likely to happen. Therefore, based on the wind history and the site location, the proposed project is not expected to have a major impact around the Table Rock area. To further investigate the impact of the proposed building, winds from the northwest direction or 315° are selected for the CFD simulations and this is considered to be worst-case scenario for the potential impact on misting.



Summer
(May through October)



Winter
(November through April)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	3.1	2.1
1-10	22.6	17.4
11-20	42.4	33.4
21-30	25.9	32.9
31-40	5.2	10.7
>40	0.9	3.4

Image 4: Directional distribution of winds approaching St. Catharines Niagara District Airport (2012-2020)

3. WIND CRITERIA

3.1 Background

As water cascades over Horseshoe Falls and into the gorge below, an air plume rises, carrying a large amount of mist. The mist would fall back to the river below under no wind conditions. Typically, the mist would be carried in the same direction as the wind. For instance, the east and northeast winds would push the mist westward onto the Canadian side, but this will not be influenced by the proposed project, which is located to the northwest of the Falls. On the other hand, the prevailing southwest winds should push the mist eastward to the US side, but it is believed that tall buildings on the top of the escarpment in the Fallsview area may have created a reversed flow that pulls the mist plume back to the Canadian side (Image 5). The size of the wake behind the proposed project is critical for the direction of mist movement. The current CFD simulation is intended to compare the recirculation flows behind the existing buildings with and without the proposed project in place, for an infrequent northwest wind direction.

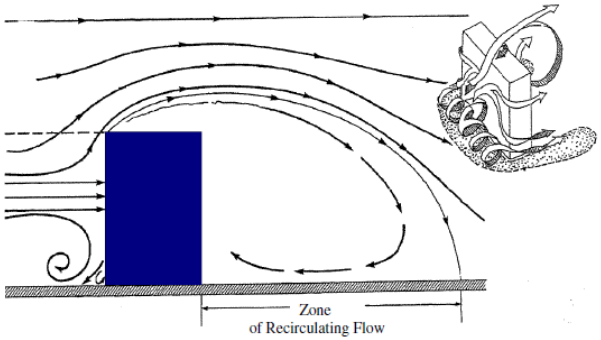


Image 5: Recirculation of wind flow behind buildings

3.2 Simulation Results

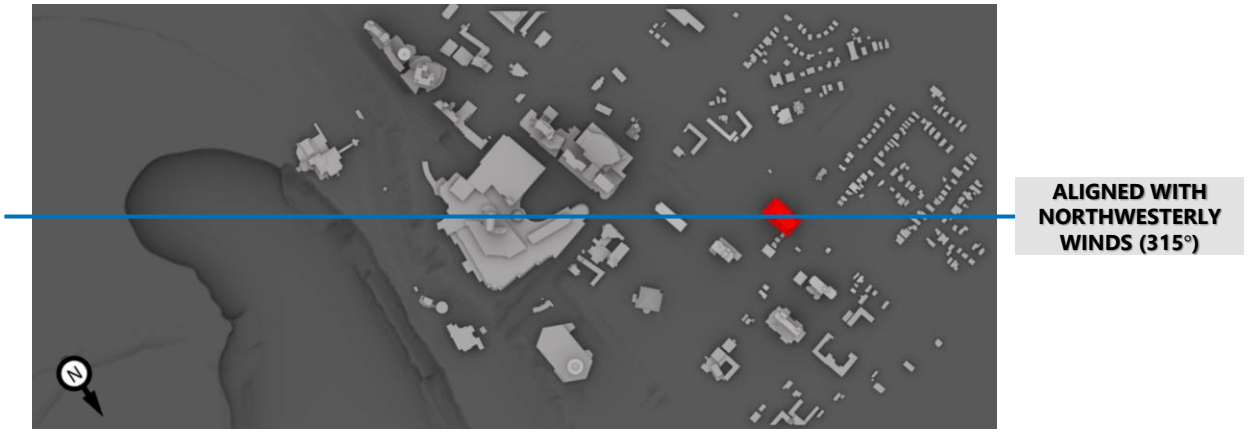
Wind flows around buildings are 3D in nature. To illustrate the 3D wind patterns, wind speeds and directions are presented on one vertical and five horizontal presentation planes, as shown in Image 6. The vertical plane is aligned with the northwesterly direction that cuts through the proposed tower and the center of the Horseshoe Falls (Image 7), while the five horizontal planes are 5, 10, 20, 50 and 100 m above Table Rock (Images 8a through 8e). Qualitative variation of wind speeds at each presentation plane are presented using a low-medium-high scale as shown below, while black arrows in the images are indications of local wind directions.

Low **Medium** **High**

For comparison purposes, Images 7 and 8 show the wind results for the existing and proposed configurations side by side. Brief comments are provided beside the images in Section 3.3 for the wind flow patterns and their potential impact on misting. This is followed by further discussions in Section 3.4. Our conclusions are provided in Section 4 based on the findings of the current assessment.

Wind flow animations from LES simulations on the vertical presentation plane are attached to the appendix of this report.

3. RESULTS AND DISCUSSION



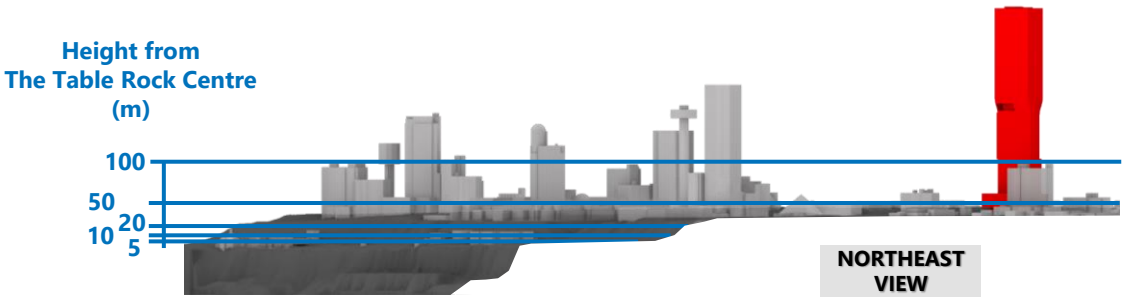
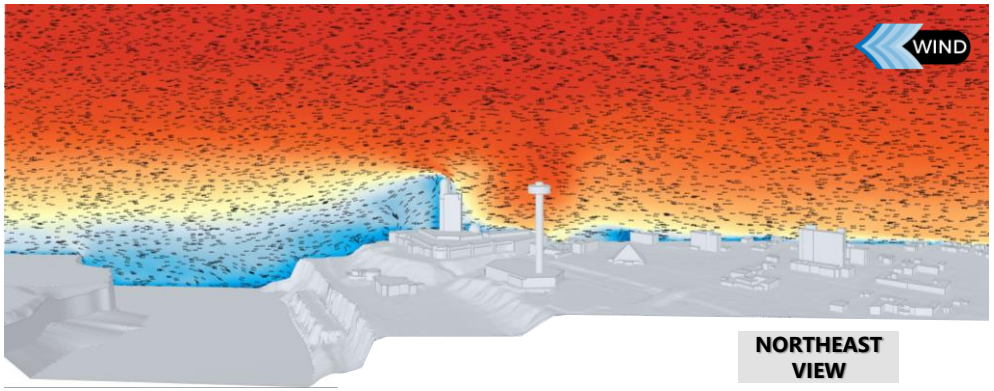


Image 6: One vertical and five horizontal presentation planes

3. RESULTS AND DISCUSSION

Existing Scenario



Proposed Scenario

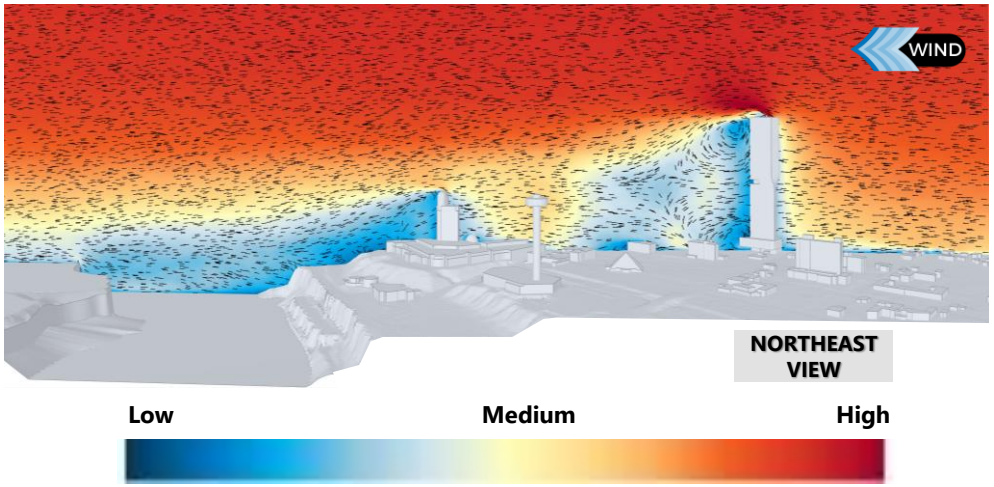


Image 7: Wind flow pattern on vertical presentation plane – through the proposed tower and centre of the Horseshoe Fall

Notes on Proposed Scenario in Image 7

- The reduced wind speeds and reversed wind flows are evident immediately behind the proposed tower.
- The flow pattern near the Table Rock Centre remains similar between the two simulations.

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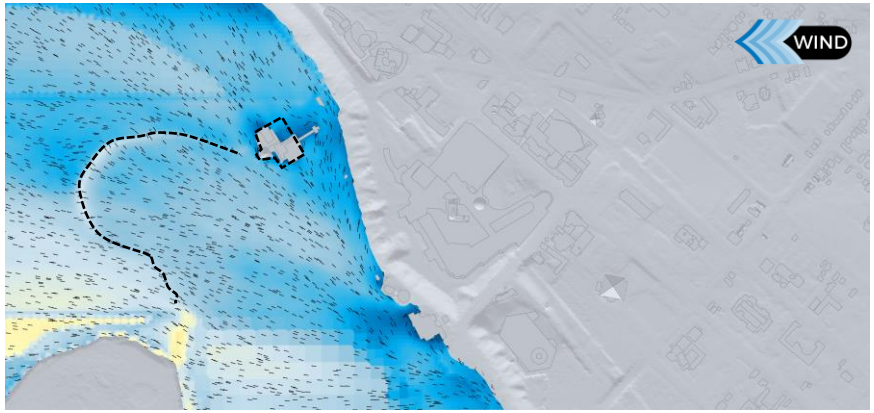
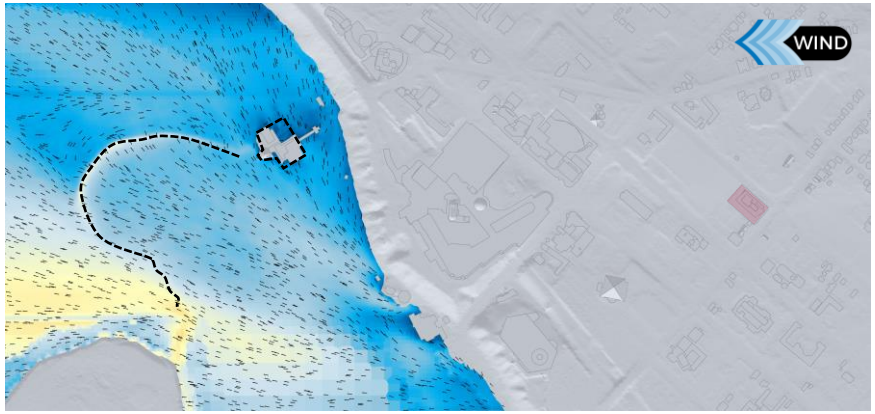
3. RESULTS AND DISCUSSION

Existing Scenario



Proposed Scenario



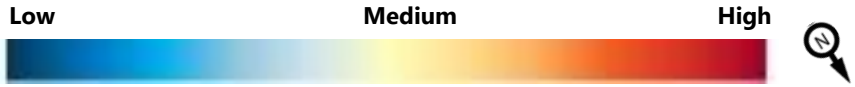


Image 8a: Wind flow pattern on horizontal presentation plane – 5 m above the Table Rock

Notes on Proposed Scenario in Images 8a through 8e

- Wind patterns near the Table Rock and Falls area would remain similar between the exiting and proposed scenarios at all heights.
- In both configurations, the NW winds over the Falls typically blow towards the SE, away from the Table Rock area.

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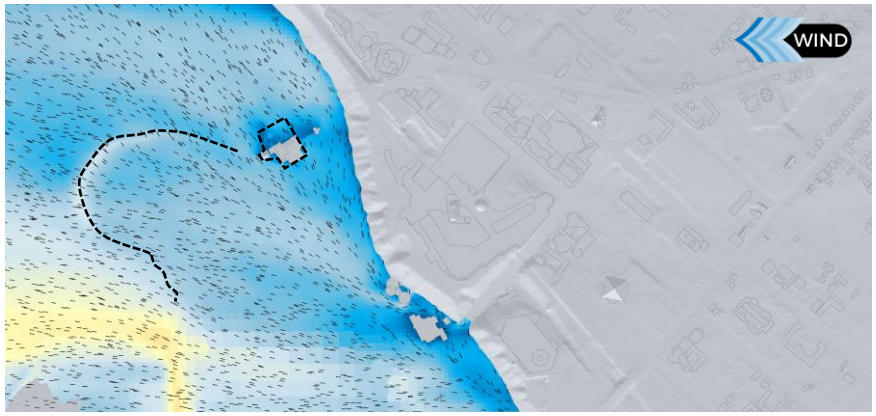
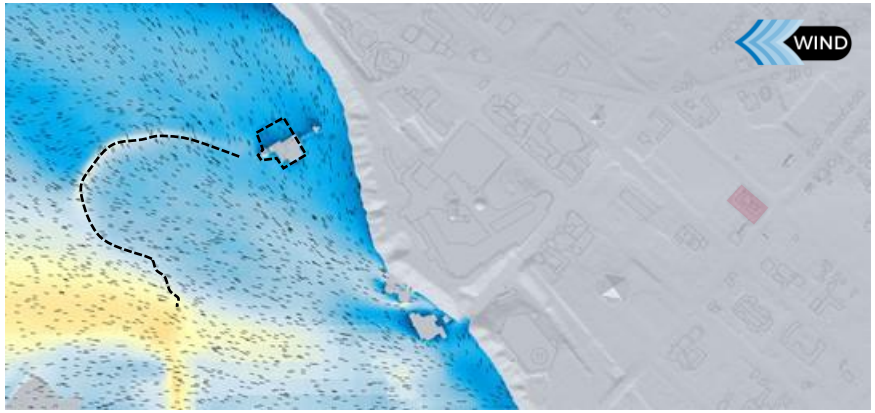
Existing Scenario



Proposed Scenario



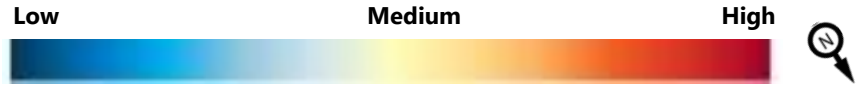


Image 8b: Wind flow pattern on horizontal presentation plane – 10 m above the Table Rock

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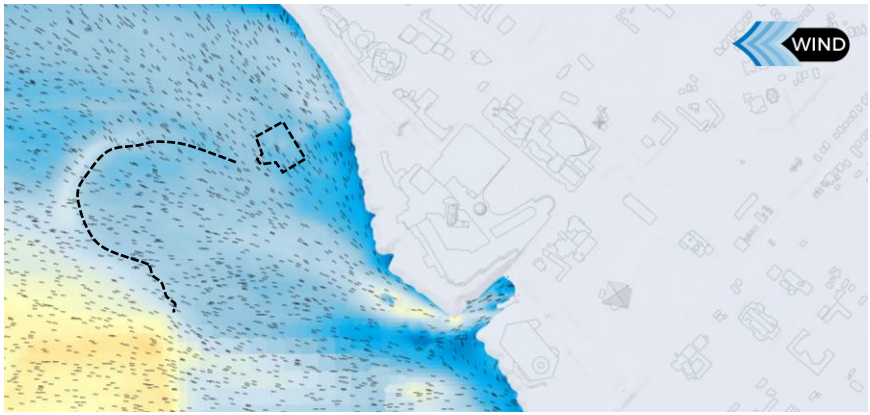
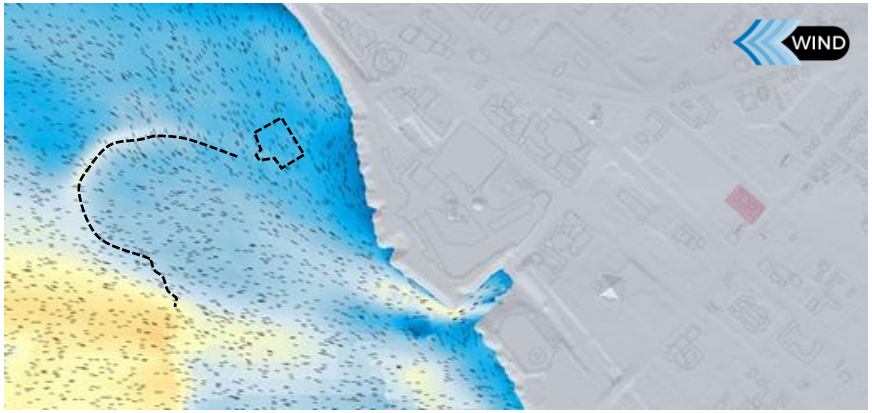
Existing Scenario



Proposed Scenario



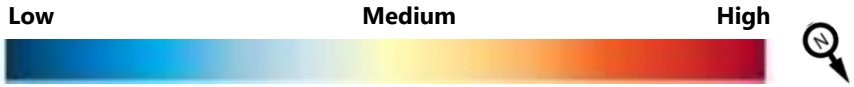


Image 8c: Wind flow pattern on horizontal presentation plane – 20 m above the Table Rock

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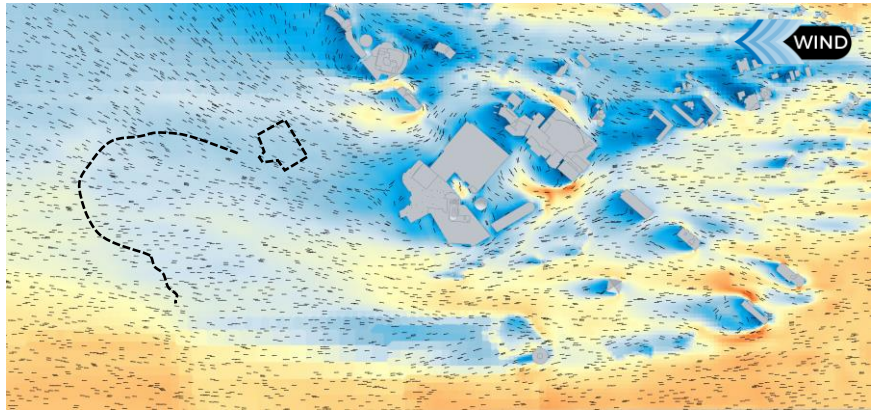
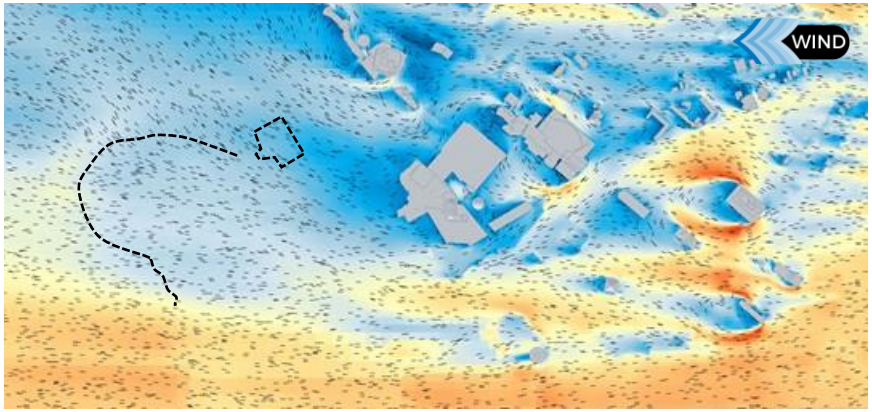
3. RESULTS AND DISCUSSION

Existing Scenario



Proposed Scenario



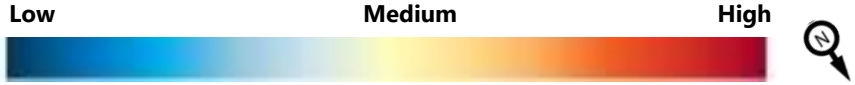


Image 8d: Wind flow pattern on horizontal presentation plane – 50 m above the Table Rock

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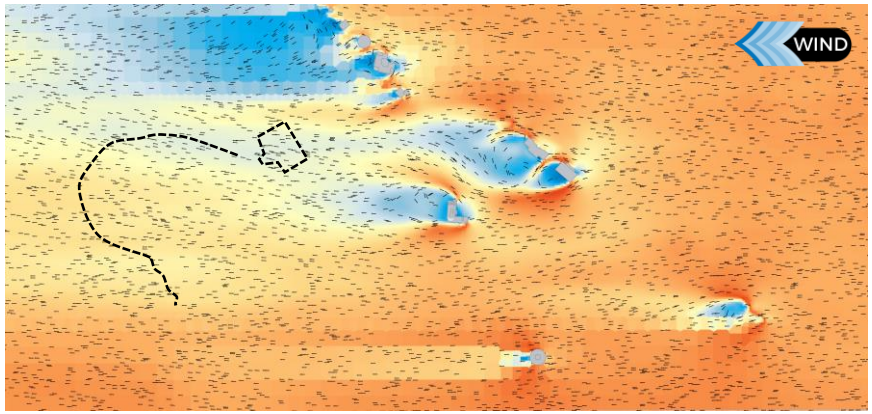
Notes on Proposed Scenario in Images 8d and 8e

- Reduced wind speeds and reversed flows are evident immediately behind the proposed tower;
- The primary wake of the tower extends about 400 m down wind;
- Slightly reduced speeds above the Table Rock Centre, but no change in the wind patterns.

Existing Scenario



Proposed Scenario

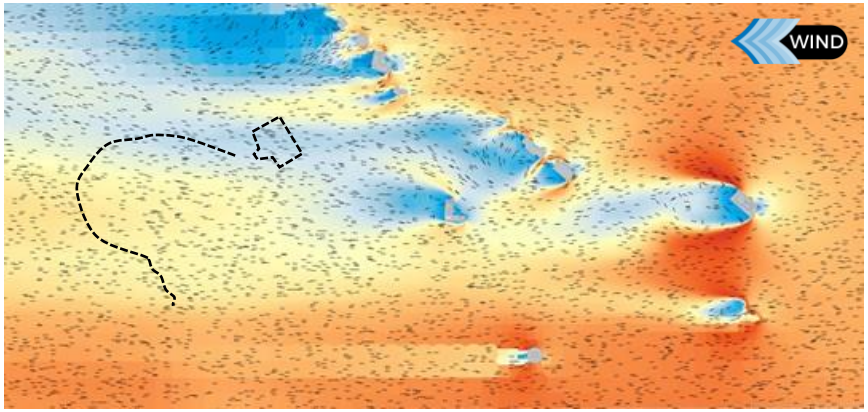


Image 8e: Wind flow pattern on horizontal presentation plane – 100 m above the Table Rock

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3.3 Summary of Flow Patterns

The reversed wind flows are evident behind the proposed tower, as shown by the black arrows in Images 7, 8d and 8e. Fortunately, due to the large distance between the project and the Falls (approximately 1200 m), the wake area with the reversed wind flows is not expected to reach the Table Rock Centre at any height, i.e., no additional mist from the Falls will be pulled back to the Canadian side when the winds are from the northwest.

Based on the CFD simulation for the northwesterly winds, the local history of the wind patterns and our understanding of mist dispersion, it is our opinion that the proposed project will not have any significant impact on the existing misting conditions in the Table Rock Centre area.

3.4 Further Discussions

Records from the Niagara Parks Commission indicated there was a considerable increase in misting events after the construction of high-rise hotel towers in the Fallsview area. It is believed that, during the west and southwest winds, the reversed air flows behind these buildings pull the mist plume from the Falls back onto the Canadian side. This can be explained by (1) the tall hotel towers constructed in the recent years form a "solid wall" along the escarpment, creating a large wake area with reversed air flows; and (2) these buildings are in a short distance from the Falls (300 m), as demonstrated by Image 9 below. In contrast, the currently proposed project is located away from this "wall" and further away to the northwest of the Falls. Therefore, it will not have a significant impact on the existing misting conditions.

Image 9: A wall of tall buildings on the top of the escarpment (Source: Google Earth)

5. SUMMARY

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the potential wind impact that may be caused by the proposed 5566 Robinson Street & 6158 Allendale Avenue (also known as Niagara-77) development on the misting conditions of Horseshoe Falls in the City of Niagara Falls, Ontario. Our 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 flows around buildings using the LES technique.

Our findings are summarized as follows:

- The project is located to the distant northwest of the Falls and winds from the northwest direction are infrequent in the area.
- For the northwest winds, the reversed wind flows in the wake are evident behind the proposed towers, but they are not expected to reach the Table Rock Centre area.
- The increase in misting events in recent year is likely caused by the wall of the tall hotel towers along the escarpment, and their short distance from the Falls.
- Given the large distances from the Falls and from the existing wall of tall buildings in the Fallsview area, and the local history of the wind directionality, the proposed project will not have any significant impact on the existing misting conditions in the Table Rock Centre area.

Note that the CFD simulations were conducted for the air flows around the relevant buildings and topography, and no mist or water was modelled in the process of this qualitative impact assessment.

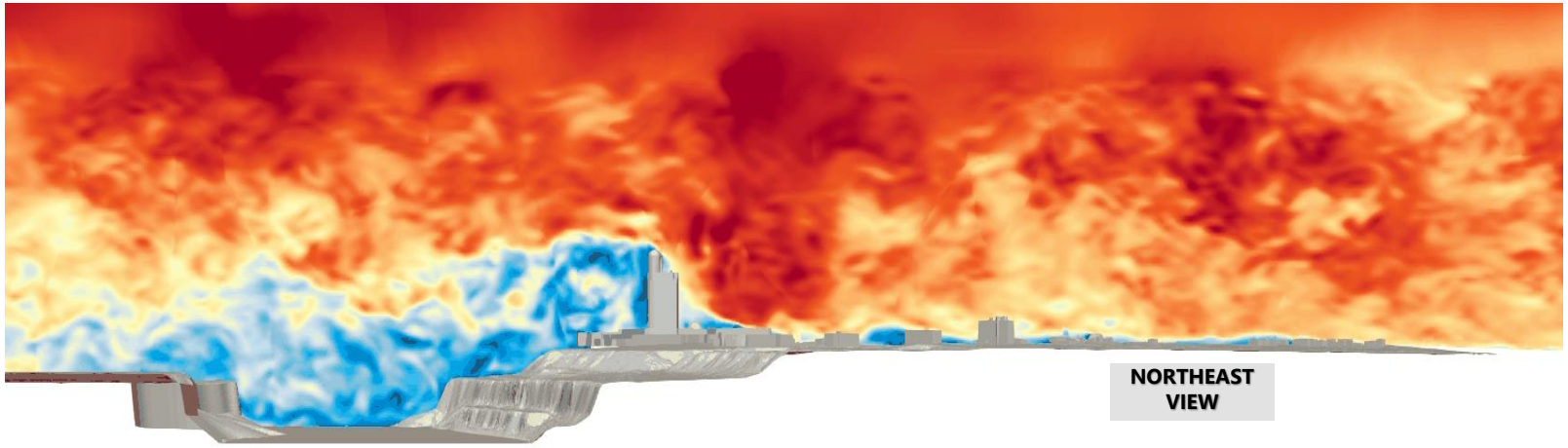
6. APPLICABILITY OF RESULTS

The assessment presented in this report is for the proposed project, 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)
121034 - Niagara77 - Site - revised - 2022.02.22.rvt	3D model	03/07/2022

7. APPENDIX

Existing Scenario-northwesterly winds (Image has the animation link attached to it)



Proposed Scenario-northwesterly winds (Image has the animation link attached to it)