

March 19, 2018

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Inverse Developments Ltd.
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To Whom It May Concern,

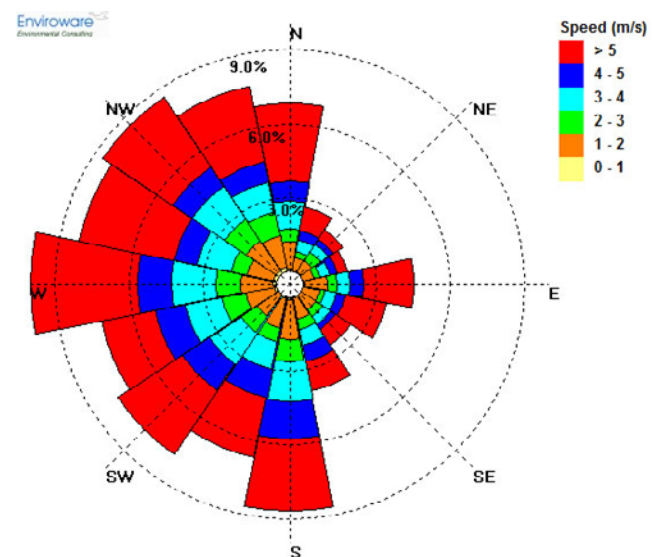
RE: Proposed Wellington Street Wind Impact Qualitative Assessment

The proposed 8 storey (plus penthouse) mixed use development project is located on the west side of Wellington Street in Halifax (mid block). To the north, is the QEII and VG Hospital, and to the south is several towers ranging in height from 13-15 storeys. Other buildings in the neighbourhood range in height from 2-3 storeys. The 8-storey building will replace six 3-storey buildings (See Fig.1).

The following assessment looks to interpret the likely wind impacts on surrounding properties and sidewalks as a result of the construction of the proposed development. Wind data recorded at the local Shearwater Airport between 1953 and 2000 was assembled and analyzed using Windrose Pro 2.3 to understand the intensity, frequency, and direction of winds at the proposed site. The resulting diagram (Fig. 2) shows that the highest and most frequent annual wind speeds from the west and south and Fig 3. Shows this pattern in the context of the site.

Throughout the year, much of the stronger winds which could impact human thermal comfort come from the west (~13% of the time winds are greater than 5m/s), from the north and north-west (~12% of the time) and from the south and south-west (~9% of the time).

Wind changes in direction and intensity throughout the year. Strong winds (>20 mph) are usually associated with uncomfortable conditions for pedestrians. In Figure 4, the strongest winds occur most frequently in the winter (from the west and north west) and spring (mostly from the west but occasionally from the north east). It is these winds that can cause uncomfortable thermal conditions in downtowns as a result of building design, though street trees can significantly reduce the impacts of strong winds around large buildings. Planting fast growing wind tolerant species will go a long way



WindRose PRO

Figure 2. Wind Rose for Shearwater Airport. Annual wind diagram shows winds in the FROM direction.

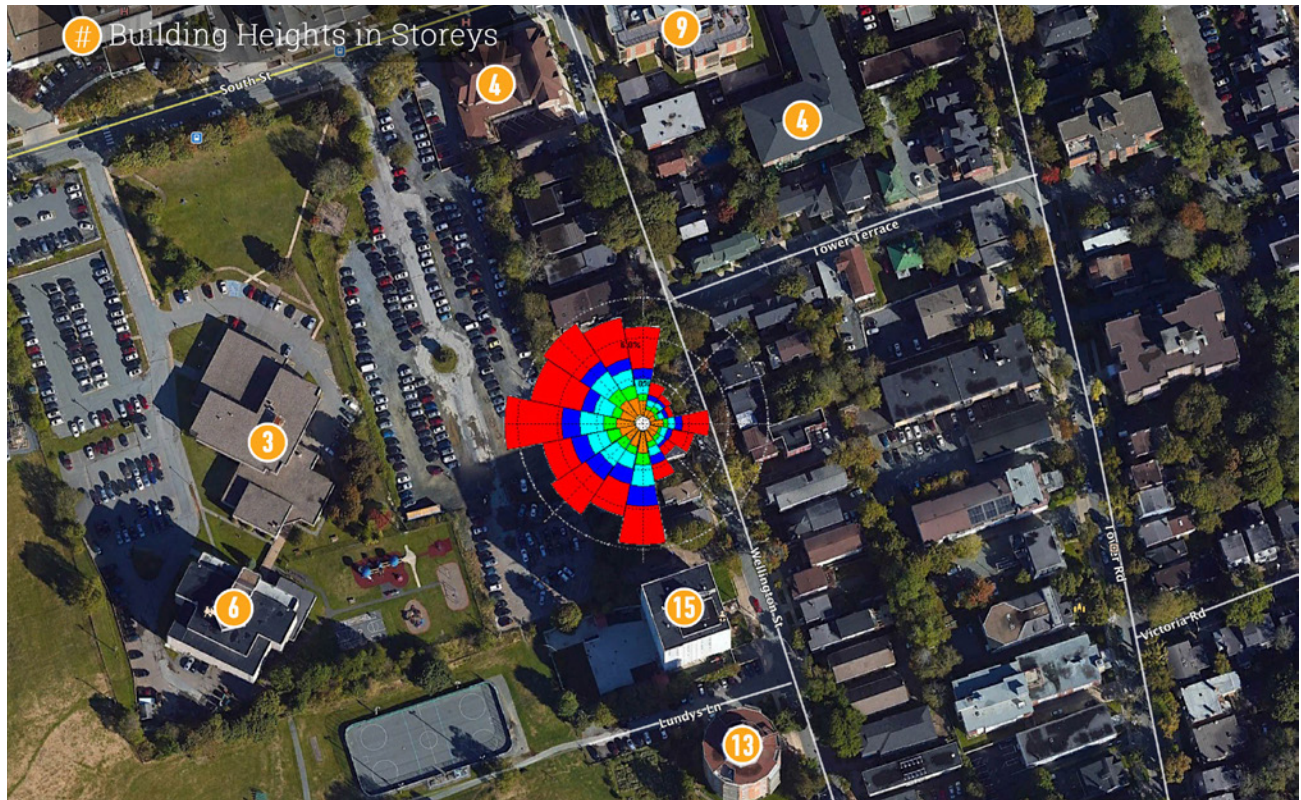
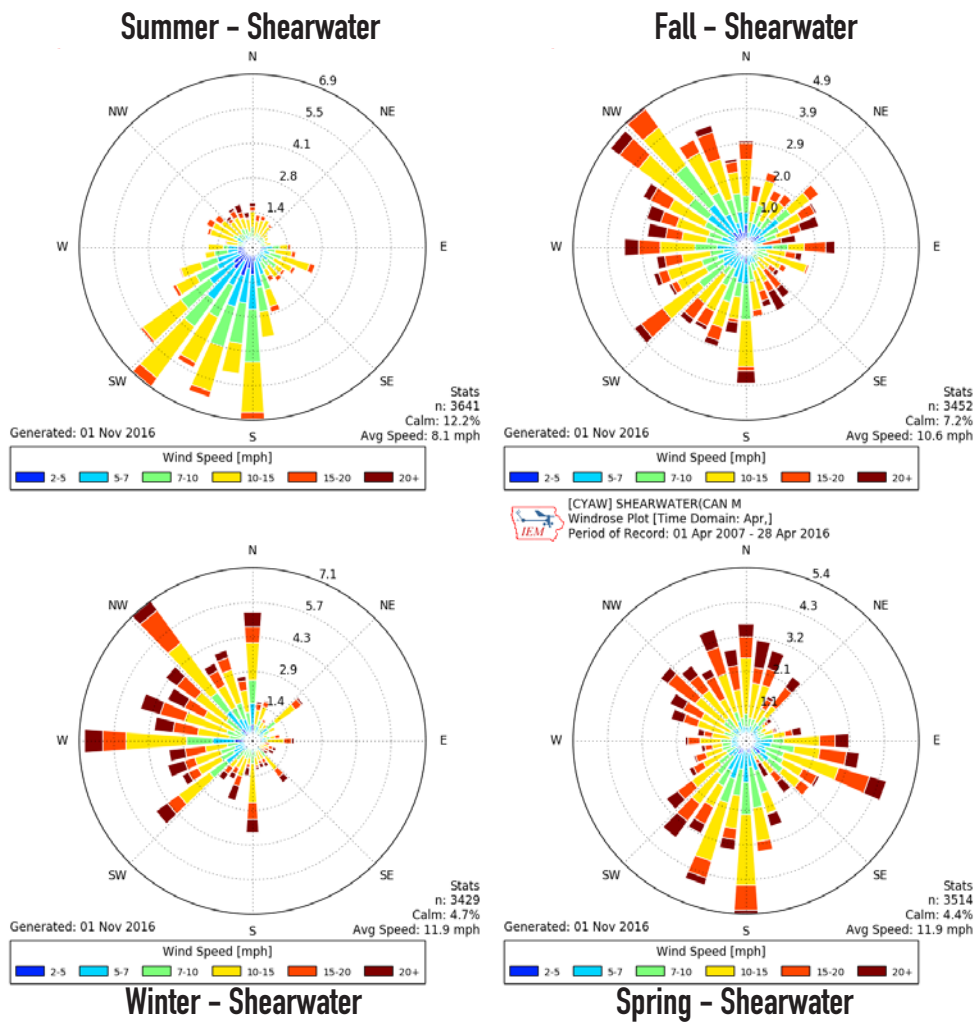


Figure 3. Wind Rose overlay on top of the proposed development site. Orange numbers denote building storeys.



Beaufort Scale

2-5 mph	calm
5-7 mph	light breeze
7-10 mph	gentle breeze
10-15 mph	moderate breeze
15-20 mph	fresh breeze
+20 mph	strong breeze

Figure 4. Seasonal Wind Direction for Shearwater Airport

towards mitigating wind problems on the street in the future.

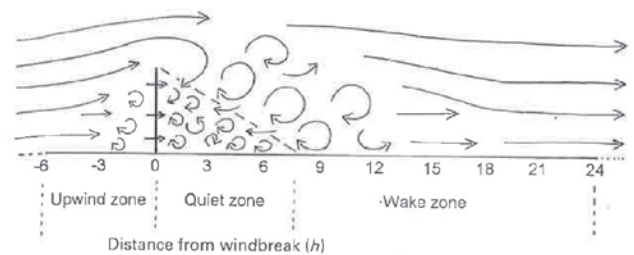
During fall and winter months wind primarily strong winds blow from the north-west and west (See Fig 4). Throughout the spring strong winds can blow in many directions but predominantly from the north east (nor-easters), east and north directions. In the summer, winds predominantly originate from the south and south west, however, very little wind exceeds 20 mph.

The proposed development replaces a six 3-storey buildings on Wellington Street on the east side of the Street. To the south are two large 13 and 15 storey towers which could have a significant influence on wind patterns in the local neighbourhood.

Urban Windbreak Impacts

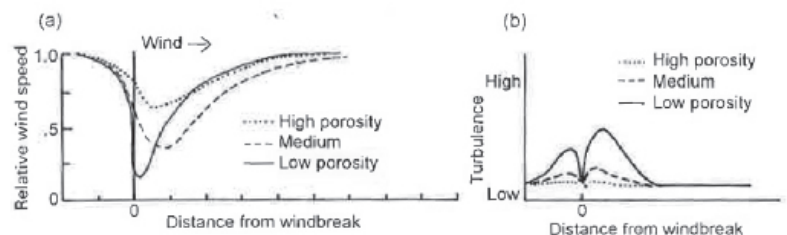
As shown in Fig. 5 the new building will impact sidewalk conditions differently at different times of the year. In the winter and fall, when it's coldest, Wellington Street is somewhat aligned with the prevailing wind direction (north westerly), and in the summer, prevailing wind from the south are accelerated by the existing towers to the south.

Wake zones for zero porosity structures (like a building) can extend 8-30 times the height of a structure. A 8-storey building can generate increased wind speeds between 200-650 metres on the downwind side (see Fig. 5). Beyond the wake zone, there is typically more turbulence and eddies as a result of more turbulent air. This can be characterized as being slightly more gusty winds with quiet periods interspersed with gusts of wind. Directly behind the windbreak, the quiet zone can extend from up to 8m on the downwind side. In this quiet zone, wind speeds can actually be reduced and street trees can play a big part in the wind reduction. At the edges of the building, wind speeds can increase as wind flows around the structure and accelerates. This can be even more pronounced when between two tall buildings creating a wind funnel effect.



Zones with altered airflow caused by a windbreak. Vertical dimension is magnified for illustration. Vertical line indicates windbreak; h = height of windbreak. Large eddies = strong turbulence. Uninterrupted airflow in the open is to the left of the upwind zone, and to the right of the wake zone. Widths of zones are approximate. Based on several sources.

Figure 5. Windbreak Diagram



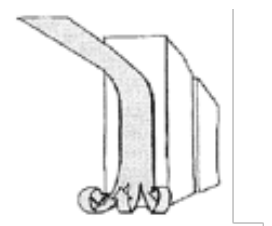
Effect of windbreak porosity on streamline and turbulent airflows. (a) Streamline airflow based on treebelts of different foliage densities; wind measurements at 1.4 m height. From Heisler & DeWalle (1988) with permission of Elsevier Science Publishers. (b) Generalized expected turbulence pattern based on Robinette (1972), Rosenberg et al. (1983), Heisler & DeWalle (1988), McNaughton (1988).

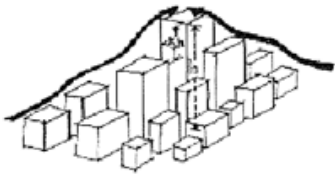
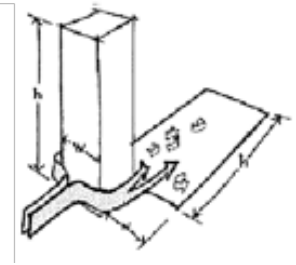
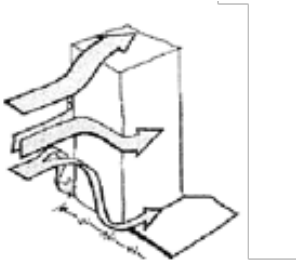
Figure 6. Porosity Diagram

Wind Impacts from tall Buildings

There will be a number of impacts from the new building including:

1. **Downwash:** Wind speed increases with height so when a tower is exposed to wind, the pressure differential between the top and the bottom of tower forces the high pressure at the top down the windward face dramatically increasing pedestrian wind speeds. The taller the exposed face is, the higher the wind speed will be at the base. The stepback at the 3rd storey on the new building will receive the bulk of





this downwash rather than Wellington Street. As a reference, a 30 storey building can cause up to 100% increase in wind speeds at the base unless downwash is mitigated by a podium.

2. **The corner effect:** at the windward corners of buildings there can be unexpected increases in wind speeds as wind forces around the windward corners from high pressure on the windward face to low pressure on the lee side. Some of the ways to decrease this impact is to create pyramidal steps which increases the surface area of the edges. This has been designed into the Wellington Street tower.
3. **The Wake Effect:** Wake is generally caused by both the downwash and corner effect. The greatest impact area occurs within an area of direct proportion to the tower height and width on the downwind side of the wind. Impacts are minimized by creating a stepback base on the building.
4. **Building Groups:** The effects that occur individually around buildings cannot be applied directly to groups of buildings. The cumulative effect of many clustered tall buildings, like in this situation, can create a wide range of different wind scenarios that must be modelled as a group to understand the cumulative impacts.

Pedestrian Comfort:

Pedestrian comfort and safety is an important factor to consider in the design of a building and an area's built form, especially in a windier coastal city such as Halifax. The design of a building will impact how wind interacts at the ground level, impacting the pedestrian experience. The Beaufort scale is an empirical measure that relates wind speed to observed conditions on land and sea. The attached Beaufort scale is a general summary of how wind affects people and different activities, and distinguishes at what points wind speeds can become uncomfortable or dangerous.

A building can impact both the wind speed and the wind turbulence at the pedestrian level. Wind turbulence not only creates uncomfortable environments through the rising of dust and other particles, it also decreases the temperature on the site. A properly designed building can mitigate some of the negative impacts of wind on the street level.

Seasonal Wind Impacts

Looking at the seasonal wind impacts (Fig. 4), in the winter and fall, the prevailing direction for strong winds (in excess of 20 mph) come from the northwest, west and north wind directions are. Approximately 48% of all winds come from the northwest. Winter winds are also stronger than those in the summer, with around fifteen percent of all winds reaching speeds above 20 mph. Strong winds only occur about 5% of the time in the north to west quadrant winter and about 3.5% of the time from the south to west quadrant. In the fall it's generally the same but with less frequency than the winter. During the winter and fall the north west corner of the building and the sidewalk on the north of the building will experience higher wind speeds. When the wind comes from the west or southwest, there will be a funnel effect between the new building and the 15 storey building to the south. The existing building is likely having a strong impact now, and the new 8-storey addition will exacerbate the wind between the two buildings when the wind comes from the west (about 1-2% of the time). This impact could be lessened by planting fast growing wind tolerant trees on on street between the existing and proposed building (the existing

maples planted here are showing signs of wind dessication). Any new street trees should be selected for wind resistance and will require a carefully designed tree pit.

During the summer the majority of winds come from the southwest quadrant, approximately 85% of the time. There are very little winds that exceed 20 mph in the summer so the new building will have very little impact during the summer months.

In the spring, strong winds come from many directions with some of the most frequent coming from the north, northeast and even the easterly directions. During the spring this wind direction will have little to no impact on the streetscape or surrounding properties even though the strong winds are most frequent in the spring. The funnel effect between the new building and the 15 storey tower could accelerate winds in the parking lot to the west of the new development. Spring winds from a northerly direction (about 2% of the time) will experience increased wind speeds on the street in the spring.

COMFA Model (Brown and Gillespie, 1995)

Dr. Robert Brown of the University of Guelph developed the COMFA model to model human thermal comfort as a result of a number of variables including wind speed. Human thermal comfort is more pronounced during low-activity situations like sitting than during high-activity situations like running. The model is explained in the paper by Brown and LeBlanc (2003). Mr. LeBlanc was also the co-author with Dr. Brown in the 2008 ed. "Landscape Architectural Graphic Standards", Microclimate chapter. This model is the basis for the theoretical assessment of human thermal comfort changes as a result of the building explained below.

Wind Comfort Assessment

Changes in wind speed as a result of buildings vary depending on wind direction and building morphology. On street sides of the proposed building, 'streamlines' can occur where the wind is accelerated through the openings between buildings. However, with Wellington Street's north west orientation, the street will see only slightly increased streamline wind levels when winds come directly from the north and northwest. The new building could result in increased uncomfortable conditions 3-4% of the time in the winter, 2-3% of the time in the spring and almost no impact in the summer. In this case, the 2 existing buildings which are almost double the height of the new proposed building is likely already causing increased pedestrian discomfort that will only be marginally increased by this new development.

Summary

This new proposed building will have a marginal impact on increased pedestrian discomfort in the Wellington Street area. This new development should add fast growing wind tolerant street trees where there are gaps in street trees now. The design of the building with a 3 storey podium will significantly improve the impacts of the building on human thermal comfort on the street and surrounding neighbourhood. The presence of the 15 storey building to the south will create wind funnels when the wind comes from the west and southwesterly direction.

If you have any questions, please contact me at your convenience.

Sincerely,



Robert LeBlanc, President
Ekistics Plan + Design