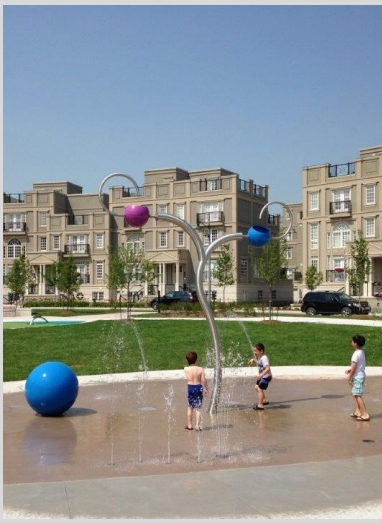
PEDESTRIAN LEVEL WIND STUDY

TERMS OF REFERENCE

SEPTEMBER 2022



INTRODUCTION

PURPOSE

A Pedestrian Level Wind Study (PLW; also referred to as a wind analysis) is a study that may be required at the Zoning By-law (ZBA or rezoning) or Site Plan Application (SPA) stages of planning. The analysis describes how a proposed development will impact wind comfort over pedestrian-sensitive areas within and surrounding the development site on a seasonal basis, as well as evaluates wind safety on an annual basis. The analysis also provides recommendations for mitigation, where necessary, to reduce wind speeds to levels appropriate for the intended pedestrian uses of an area.

WHEN IS THIS REQUIRED?

Zoning By-law (ZBA)

A pedestrian wind analysis at the rezoning stage is useful to identify any design or massing features that could create pedestrian comfort concerns to inform design at the early stages of planning.

At this stage, a wind analysis is required for applications that pursue an increased building height in addition to meeting the following criteria:

- A proposed development greater than 10 storeys, regardless of the height of surrounding buildings
- A proposed development in the range of 6 and 9 storeys that is more than twice the height of existing surrounding buildings

All zoning applications meeting the above criteria require a Computational Fluid Dynamics study

Site Plan Application (SPA)

A wind analysis is required at the SPA stage for one of two situations:

Situation 1

An application that has completed a wind analysis at the rezoning stage will require a subsequent analysis for SPA. The purpose is to identify any changes to the building form made following the preliminary report that would influence pedestrian comfort, and to reassess for these changes as required based on the refined design plan.

Situation 2

An application that has not pursued an increase in height will require a wind analysis if the development is either (i) located on the outskirts of a high-rise area, (ii) is taller than the existing development, or (iii) is located immediately adjacent to a park, plaza, or other large public amenity area. The purpose is to assess pedestrian comfort for applications within characteristically windier areas that did not require assessment at the rezoning stage.

The type of study required for SPA is specified below:

Wind Tunnel Testing for developments that are (i) greater than 20 storeys, (ii) comprise multiple buildings, (iii) feature a complex or atypical massing, or (iv) are located immediately adjacent to a park, plaza, or other large public amenity area

Computational Fluid Dynamics for single tower developments, with or without a podium, of less than or equal to 20 storeys.

WHO PREPARES THIS?

A Pedestrian Level Wind Study must be prepared, signed and stamped by a Professional Engineer who specializes in microclimate studies. If the study is prepared by a company with insufficient experience performing pedestrian level wind analysis (determined at the discretion of the City of Markham), a peer review of the study may be requested at the expense of the applicant.

WHY DO WE NEED THE WIND IMPACT STUDY ?

A Wind Study is needed to ensure that the development application conforms to applicable by-laws and policies from the City of Markham 2014 Official Plan, including, but not limited to:

6.1.4.2 To design streetscapes that support the functional requirements of streets and blocks and create a suitable interface and compatibility with the use, height and density of abutting development by promoting:
b) pedestrian comfort and safety

6.1.8.4 To design and place buildings on a site to be compatible with adjacent or abutting development, a cultural heritage resource itself and adjacent lands, streetscape and parks and open spaces by addressing, where appropriate:
a) transitions in height and massing, including the relationship to the width of the public right-of-way, and adequate setbacks between buildings, the public realm and adjacent or abutting development;
e) comfortable microclimatic conditions including sunlight access and wind conditions, public safety, and adequate privacy conditions for residential buildings and their outdoor amenity areas;
h) building design that:
i) incorporates architectural detailing and features to increase comfort, add interest and achieve a good relationship with neighbouring development

6.3 Designing Sustainable New Communities
The design of these new communities should address, among other things, compatibility with the Greenway System, and the provision of an appropriate transition to established neighbourhoods and employment areas to minimize the potential adverse impact of one on the other.

STRUCTURE AND FORMAT

WHAT SHOULD BE INCLUDED?
Submission Requirements

The Pedestrian Level Wind Study Should Include:

- Descriptions of the types of wind studies available: detailed studies (computational fluid dynamics or wind tunnel testing)
- Criteria to determine which type of study is appropriate for a building development application, based on application phase and characteristics of the proposed development
- Guidelines for conducting each study, including appropriate testing and analysis parameters, wind comfort criteria, and mitigation measures, as well as guidelines for content and reporting

Assumptions:

A pedestrian level wind analysis requires the following:

- The model must include all existing buildings
- The model must include all planned developments, including applications that are active or have been approved
- All buildings within a 350 m radius of the subject site to be included

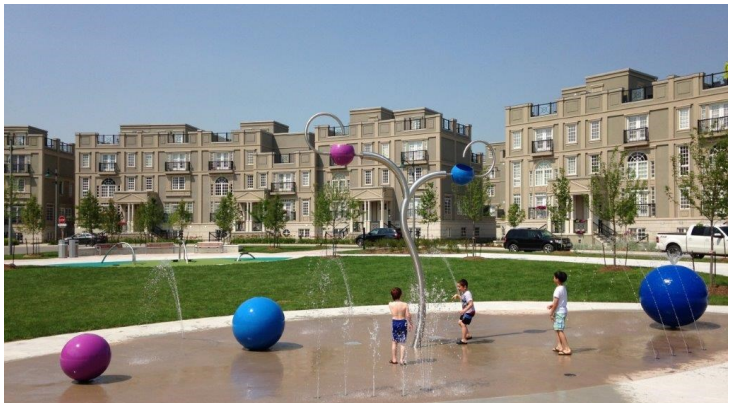
Types of Wind Study

Computational Fluid Dynamics (CFD)

A quantitative computer-based study performed using wind speed simulations on a 3D model of the study site and surroundings. This study should illustrate pedestrian comfort over the site using comfort contours. Sensor locations are to be approved by City staff prior to commencement of the study.

Wind Tunnel Testing

Wind tunnel testing of a physical scale model of the study site and surroundings. This detailed quantitative study determines pedestrian comfort at discrete sensor locations. The number, placement and extent of the sensors should be sufficient to capture the influence of the new development on surrounding buildings. Typically, sensors placed up to the distance equal to the height of the study building, in all directions surrounding the subject site, is sufficient to achieve this goal. The impact area may be increased depending on context (e.g. parks, schools, other adjacent public open spaces, etc.)



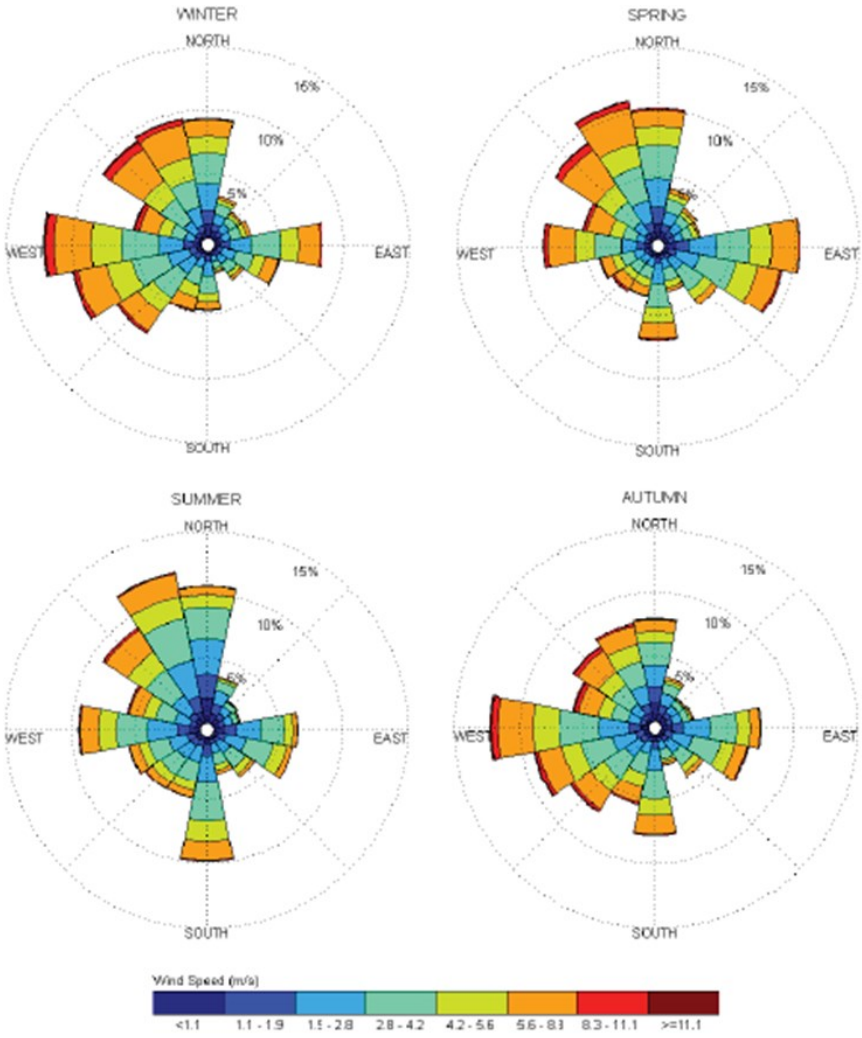
Analysis

Meteorological Analysis
Meteorological analysis must be performed using a minimum of 30 years of hourly wind data, obtained from Buttonville Municipal Airport.

Data representing each of the four seasons must be grouped as follows:

- Winter - December to March
- Spring - April and May
- Summer - June to September
- Fall - October and November

Example Figure (i): Seasonal Distribution of Winds for Various Probabilities: Buttonville Municipal Airport, Markham, Ontario



Notes:
1. Radial distance indicate percentage of time of wind events.
2. Wind speeds represent mean hourly wind speeds measured at 10 m above the ground

Evaluation Criteria

Wind Comfort

The following categories of pedestrian comfort will be used to evaluate wind speeds within and surrounding the study site on a seasonal basis.

The Gust Equivalent Mean (GEM) wind speed should be used, which is the greater of the mean wind speed or the gust wind speed divided by 1.85. GEM wind speeds are categorized based on an 80% non-exceedance factor gust (ie. wind speeds ≤ 10 km/hr occurring more than 80% of time are suitable for sitting).

Wind Safety

Gust wind speeds will be used to assess wind safety. Wind speeds exceeding 90 km/h occurring more than 0.1% on annual basis are considered dangerous and will require mitigation.

Mitigation

Where a proposed development does not achieve the desired pedestrian comfort criteria, the evaluation will consider the desired comfort category, building massing, orientation and design features to recommend suitable options for mitigation.

Possible mitigations may include, but are not limited to, the following:

- Modifications to the Building Massing (such as the introduction of building setbacks, podiums, overhangs, and/or smoothed or transitioning building corners)
- Wind Barriers (such as wind screens, dense coniferous plantings, raised parapets, or earth berms)
- Canopies
- Entrance Modifications (such as recessed entrances, relocation of entrances away from building corners, or replacing swing doors with vestibules or sliding doors)

Recommended mitigation measures may require additional confirmation testing following the study submission as the landscape plan or site plan progresses.

Category	Speed (km/hr)	Where applicable
Sitting	≤10	Outdoor amenity areas (ie. parks, elevated amenity terraces, restaurant patios, grade-level seating areas)
Standing	≤15	Primary building entrances and transit stops
Walking	≤20	Sidewalks, parking lots, bicycle paths, secondary building access points
Uncomfortable	≥20	Moderate excesses falling within this category would be acceptable for brisk walking and exercise such as jogging

Contents of a Wind Analysis:

Pedestrian-Sensitive Locations

The wind analysis should evaluate pedestrian comfort at all grade-level and elevated pedestrian-sensitive areas within and surrounding the study site.

Examples of Pedestrian-Sensitive Areas/Sensor Locations:

- Building Access Points
- Sidewalks, Transit Stops and Parking Lots
- Elevated Outdoor Amenity Areas or Amenity Terraces
- Grade-level Outdoor Amenity Areas (including parks, plazas, courtyards, restaurant patios, privately owned public spaces, etc).

All sensor locations must be reviewed and approved by the City prior to conducting wind analysis. The study must also contain the following elements:

A. **Meteorological Data**: A section identifying the meteorological data used in the evaluation (ie. data source); An image visualizing the directional character of local winds on a seasonal basis (ie. wind rose)
B. **Summary of Findings**: A written summary must identify the predicted comfort class for each pedestrian-sensitive location.
C. **Figures**: All studies require a figure(s) showing grade-level and elevated pedestrian-sensitive locations within and immediately adjacent to the proposed development. Quantitative studies have the following additional requirements:

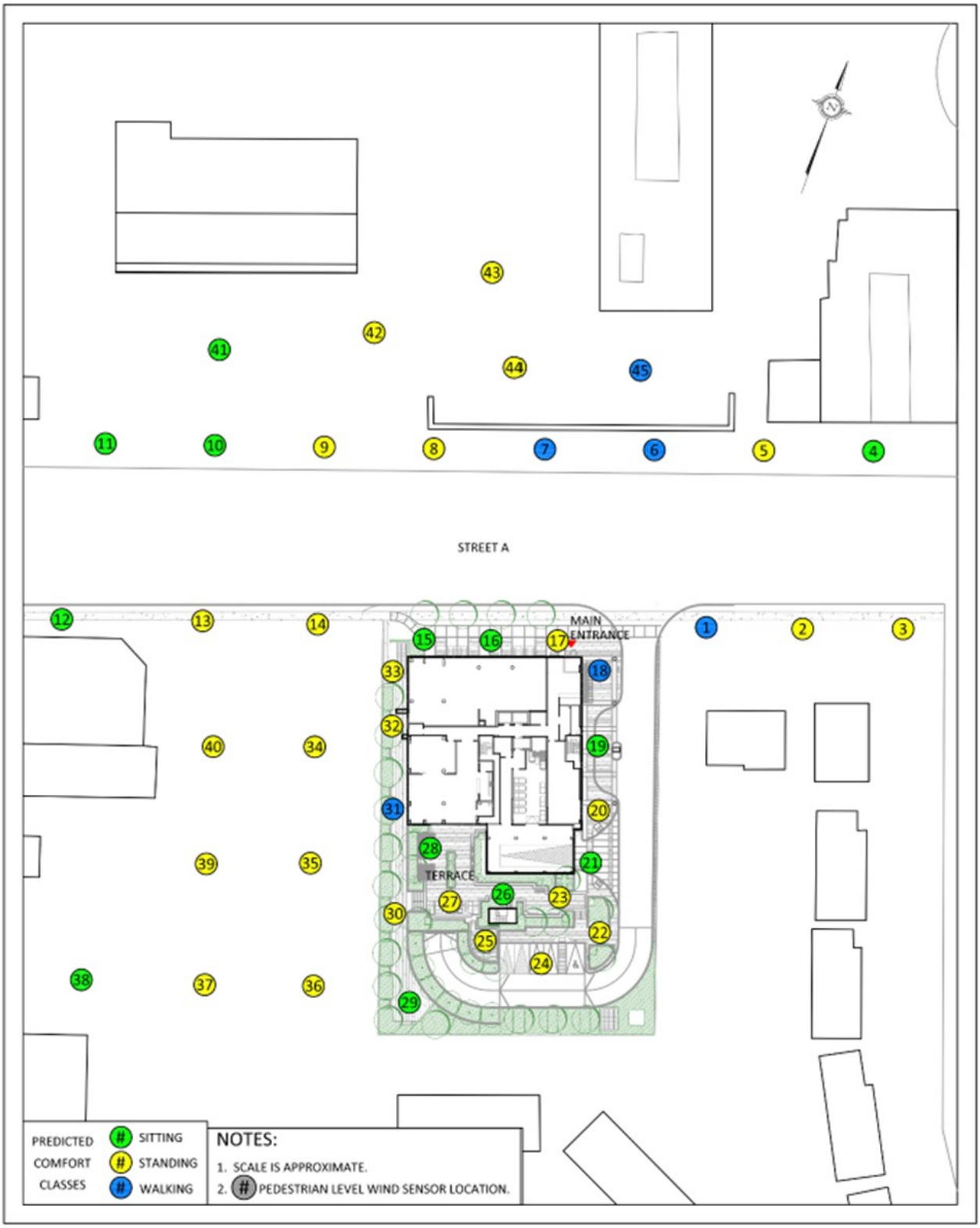
   Wind Tunnel Studies

   (ii) a figure showing sensor locations, and (iii) tables containing numerical pedestrian comfort results for each sensor location, by season.

   CFD Studies

   Pedestrian comfort contours generated for the study.

Example Figure (ii): Wind Tunnel-Based Study



Example Figure (iii): CFD Pedestrian Comfort Contours