Shadow and Wind Study
Guidelines and Terms of Reference

Council Presentation – June 9, 2020

City of Burlington in collaboration with Brook McIlroy

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Purpose of the Study

The in-force Official Plan has limited policy for evaluating shadow and wind impacts resulting from new development

This study investigated the best approaches for the City to assess the expected impact of new development on sun and wind

The aim is to maintain a high level of comfort and well-being currently enjoyed by residents and visitors in Burlington

The City has developed new guidelines and submission requirements for Shadow Studies, and Pedestrian Level Wind Studies

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Development Application Context

Background reports & supporting studies required

Zoning By-law Amendment	Official Plan Amendment	Site Plan Control Approval	Plan of Subdivision Approval	Committee of Adjustment

Planning Justification Report
Stormwater Management Report
Functional Servicing Report
Tree Inventory and Vegetation Management Plan
Traffic/Transportation Impact Study
Top-of-Bank Demarcation and Creek Assessment
Noise and Vibration Study
Shadow Analysis
Environmental Site Screening Checklist/ Phase I Environmental Site Assessment
Phase II Environmental Site Assessment/ Record of Site Condition Report
Heritage Impact Statement

Archaeological Report
Wind Impact Study
Sensitive Land Use (Risk Assessment) Report
Agricultural Impact Assessment Report
Hydrogeology Study
Commercial Market Impact Study
Geotechnical Study/Slope Stability Analysis
Environmental Impact Study
Park Concept Plan
Land Assembly Documents
Landfill Impact Study

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Precedent Study

Data gathered from a number of municipalities

Primary Municipalities Considered (among others)

- Mississauga
- Vaughan
- Barrie
- Brampton
- Guelph
- Hamilton
- Oakville
- Ottawa
- Richmond Hill
- Toronto
- Winnipeg

Guidelines & Policy Areas Analyzed

- Requirements / Study Triggers
- Evaluation / Comfort Criteria (sun and wind)
- Test Times and Dates (sun)
- Safety Criteria (wind)
- Test Location Criteria (wind)

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Public Consultation Open Houses

Technical presentations and interactive table discussions

Two Open Houses
- Daytime Open House - 12:00-2:00pm @ Central Recreation Centre
- Evening Open House - 6:00-8:00pm @ Art Gallery of Burlington

Key Areas of Feedback from Table Discussions
- Concern about shadowing around recent and proposed development sites in the downtown, transportation corridors including walking and bike paths, and Brant Street in particular
- Concern about shadowing and wind impacts on residences near proposed Appleby Mall development, as well as Lakeside Plaza in Appleby
- Concerns about wind impacts near Lake Ontario, and accuracy of wind data and studies
- Concerns about sun access in winter months, including ice formation
- Consider maximum hours of shading, and analysis of properties affected by new shadows

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Additional Public Consultations

Worksheets, Emails, and Online Feedback

Key Areas of Feedback from **Individual Worksheets** distributed at Open Houses
- Suggestions for winter and year-round analysis of shadows, and analysis of impact on stable residential areas when adjacent to growth areas

Key Areas of Feedback from **Email Comments**
- Uncomfortable wind conditions should be mitigated and may be necessary in streets near Lake Ontario
- Suggestions for 5 hours minimum sunlight during equinoxes
- Special consideration of shadows on Residences, Parks, Schools, Transportation Corridors, Trees

Key areas of Feedback from **Online Mapping & Survey**
- Identification of specific areas of concern for wind and shadows mainly downtown and near Lake Ontario
- Concerns about proposed mid-rise and tall towers, residential shadowing, wind mitigation, and climate change

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Development Community Outreach

Feedback Received from Design, Development, and Builder Community

Key Areas of Feedback

- Suggest City undertake creation of a continually updated digital 3D model for study purposes
- Suggest study radius should consider building height and potential areas of impact
- Suggest reduction of number of conditions to be studied
- Suggest less complex analysis be required in early stages of development applications
- Consider different conditions and use patterns in specific parks and open spaces
- Concern about onerous analysis required for impacts on residential neighbours
- Suggestions for credentials required to undertake studies
- Concern about winter shadow analysis criteria and restrictions on density and height
- Suggestions for number of wind sensors and directions to be used in studies
- Request for special considerations and case-by-case analysis for projects in specific areas

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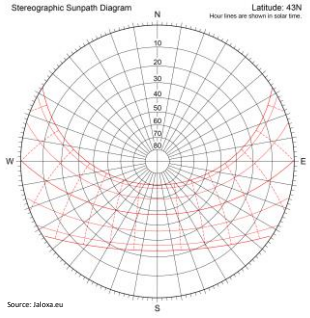
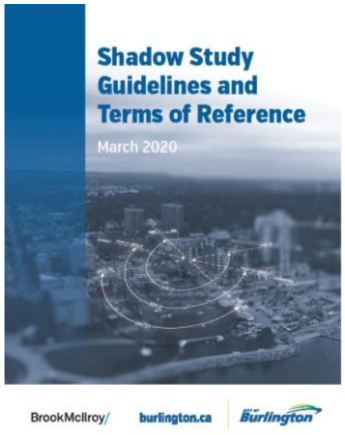
Shadow Study

Guidelines and Terms of Reference





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Shadow Studies

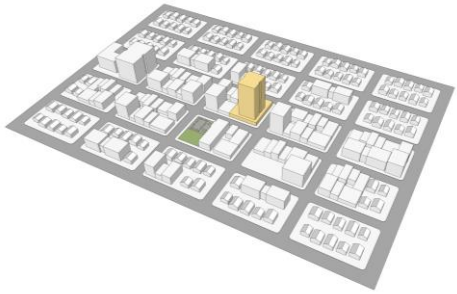
Evaluation Methods

Triggers for Studies

- Building Height (5 storeys)
- Proximity to shadow-sensitive uses
  - Key Civic and Cultural Spaces
  - Private Outdoor Amenity Spaces
  - Parks and Open Space
  - Places where Children Play
  - Public Realm and Sidewalks

Shadow Impact Criteria

- Net New Shadows
- Sun Access Factor (SAF) Calculations



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Shadow Studies

Submission Format

Specific submission format requirements ensure consistency and legibility across applications.

- Drawings: March 21st, June 21st, September 21st, and December 21st with consistent view, scale, and colours
- Base Mapping: Study area relative to building size and impact area, identification of shadow-sensitive areas
- Written Analysis discussing quantification of impacts, satisfaction of Shadow Impact Criteria, Cumulative Shadow Impacts, and Mitigation proposed
- Submission Checklist Completed

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Shadow Studies

Example Shadow Drawing

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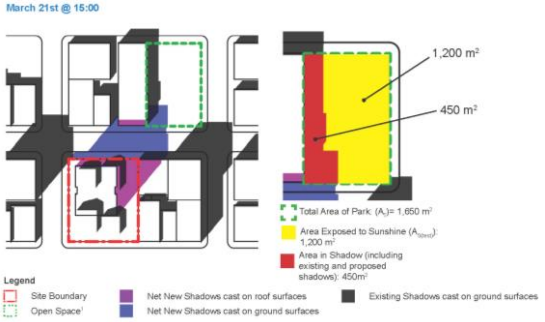
Shadow Studies

Example Shadow Impact Criteria Calculation



Example 3 – Parks and Open Space

1. Total area of adjacent park (A_t) = 1,650 m²
2. Areas exposed to sunshine at each hourly test time ($A_{1\,hour}$):

09:00 ($A_{1\,hour\,09:00}$) = 1,380 m²	14:00 ($A_{1\,hour\,14:00}$) = 1,458 m²
10:00 ($A_{1\,hour\,10:00}$) = 1,650 m²	15:00 ($A_{1\,hour\,15:00}$) = 1,200 m²
11:00 ($A_{1\,hour\,11:00}$) = 1,620 m²	16:00 ($A_{1\,hour\,16:00}$) = 730 m²
12:00 ($A_{1\,hour\,12:00}$) = 1,600 m²	17:00 ($A_{1\,hour\,17:00}$) = 582 m²
13:00 ($A_{1\,hour\,13:00}$) = 1,590 m²	18:00 ($A_{1\,hour\,18:00}$) = 85 m²

Number of test times = 10

3. The averages for the nine one-hour intervals ($A_{1\,interval}$):

09:00-10:00 ($A_{1\,interval\,09:00-10:00}$) = (1,380 m² + 1,650 m²) ÷ 2 = 1,515 m²
10:00-11:00 ($A_{1\,interval\,10:00-11:00}$) = (1,650 m² + 1,620 m²) ÷ 2 = 1,635 m²
11:00-12:00 ($A_{1\,interval\,11:00-12:00}$) = (1,620 m² + 1,600 m²) ÷ 2 = 1,610 m²
12:00-13:00 ($A_{1\,interval\,12:00-13:00}$) = (1,600 m² + 1,590 m²) ÷ 2 = 1,595 m²
13:00-14:00 ($A_{1\,interval\,13:00-14:00}$) = (1, 590 m² + 1,458 m²) ÷ 2 = 1,524 m²
14:00-15:00 ($A_{1\,interval\,14:00-15:00}$) = (1, 458 m² + 1,200 m²) ÷ 2 = 1,329 m²
15:00-16:00 ($A_{1\,interval\,15:00-16:00}$) = (1,200 m² + 730 m²) ÷ 2 = 965 m²
16:00-17:00 ($A_{1\,interval\,16:00-17:00}$) = (730 m² + 582 m²) ÷ 2 = 656 m²
17:00-18:00 ($A_{1\,interval\,17:00-18:00}$) = (582 m² + 85 m²) ÷ 2 = 334 m²

Number of test intervals = 9
Sum of ($A_{1\,interval}$) = 11,163 m²

4. The overall average area in sunshine ($A_{1\,average}$) = [sum of ($A_{1\,interval}$)] ÷ [# of intervals]
= 11,163 m² ÷ 9
= 1,240 m²
5. SAF = ($A_{1\,average}$) ÷ A_t
= 1,240 m² ÷ 1,650 m²
= 0.75

0.75 is greater than 0.50. Therefore, the SAF meets the criteria.

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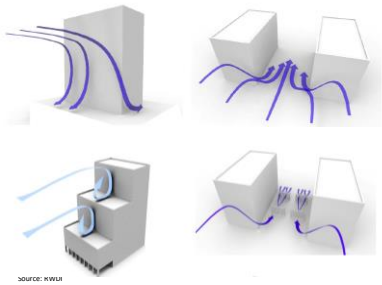
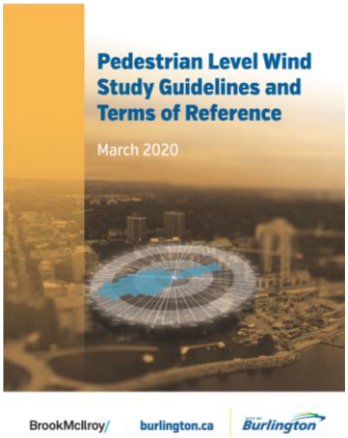
Pedestrian Level Wind Study

Guidelines and Terms of Reference





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Pedestrian Level Wind Study

Guidelines and Terms of Reference

Triggers for Studies

- Building Height (At the discretion of Staff)
  - 5 Storeys → Qualitative Study (desktop analysis and/or computer analysis)
  - 12 Storeys → Quantitative Study (physical wind tunnel test)
- Number of Buildings
  - Two or more 5 storeys in height → Quantitative Study
- Site Location
  - Between QEW and Lake Ontario → Quantitative Study
  - Near low-rise residential neighbourhood area → Quantitative Study
- Site Area (size)
  - 3 hectares or more in area

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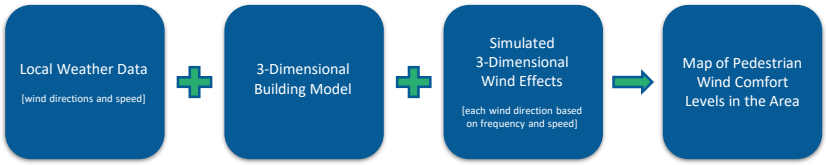
Pedestrian Level Wind Study

Methods: Inputs and Outputs



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Pedestrian Level Wind Study

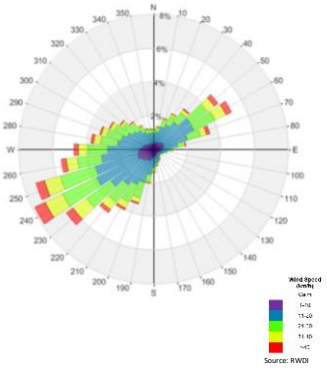
Study Methodology

Wind Data Collection

- John C. Munro Airport provides 30 years of hourly wind data
- Other nearby stations may be used to supplement and confirm directionality and speeds

Type of Study

- Qualitative
  - Desktop Assessment
  - Computational Fluid Dynamics Simulation
- Quantitative
  - Wind Tunnel Test



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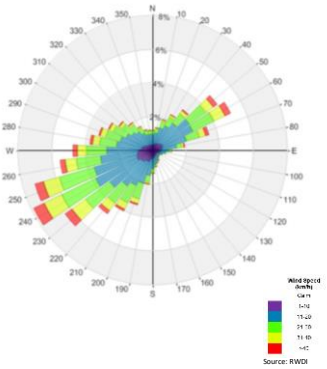
Pedestrian Level Wind Study

Criteria & Mitigation



Impact Criteria

- Gust Equivalent Mean (GEM) Wind Speed Thresholds for:
  - Sitting
  - Standing
  - Leisurely Walking
  - Fast Walking
  - Uncomfortable Conditions
  - Pedestrian Safety

Mitigation Methods when Criteria is not met

- Change shape / mass of building
- Increase separation, setbacks, step-backs
- Screening, Canopies, Colonnades, Recesses
- Landscaping on its own is NOT an acceptable mitigation method

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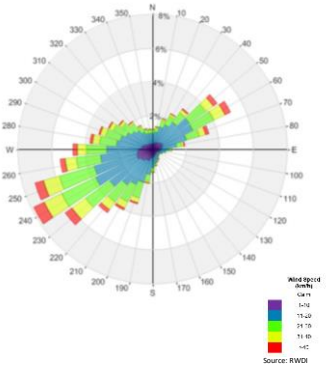
Pedestrian Level Wind Study

Submission Format



Physical Context

- Building and site information
- Surrounding context information
- Study approach
  - Type of study
  - Configurations of existing and proposed buildings
  - Test results
  - Mitigation strategies proposed and tested
  - Wind sensor locations (wind tunnel test only)

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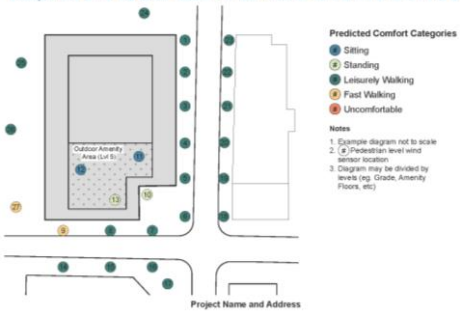
Pedestrian Level Wind Study

Example Wind Tunnel Sensor Location Plan

Example Wind Tunnel Test Sensor Location Plan and Predicted Pedestrian Wind Comfort Criteria



Example Wind Tunnel Test Sensor Location Description

1	Sidewalk	11	Outdoor amenity area (Lvl 5)	21	Sidewalk
2	Sidewalk	12	Outdoor amenity area (Lvl 5)	22	Sidewalk
3	Sidewalk	13	Outdoor amenity area (Lvl 5)	23	Sidewalk
4	Sidewalk	14	Sidewalk	24	Surface parking
5	Sidewalk	15	Sidewalk	25	Surface parking
6	Sidewalk	16	Transit Stop	26	Surface parking
7	Transit Stop	17	Entrance (adjacent building)	27	Surface parking
8	Sidewalk	18	Sidewalk		
9	Sidewalk	19	Sidewalk		
10	Major building entrance	20	Sidewalk		

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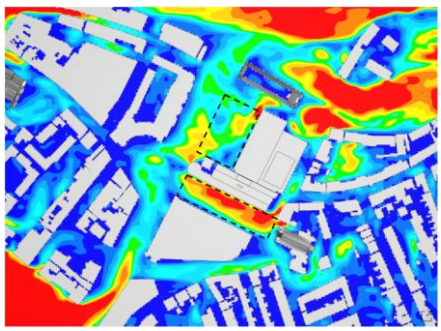
Pedestrian Level Wind Study

Example CFD Analysis Output



	Comfort category	Gust Equivalent Mean Speed m/s (kmh)
	Sitting	≤ 2.7 (10)
	Standing	≤ 3.8 (14)
	Strolling	≤ 4.7 (17)
	Walking	≤ 5.5 (20)
	Uncomfortable	> 5.5 (20)
	Exceeded	> 25 (90)

Source: Simscale

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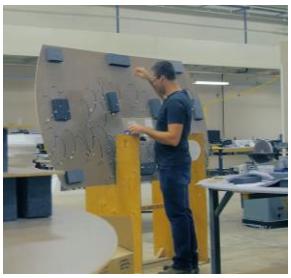
Pedestrian Level Wind Study

Example Wind Tunnel Test Model with Sensors



Source: RWDI

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