There are benefits to sun access on streets, not only for comfort, growth and health, but also as a magnet for economic development. Sunlight is a valuable amenity that is, second to location, a top priority for real estate, as light draws in pedestrians, potential customers and residents[14]. Building shadows that project onto sidewalks can deteriorate the vibrancy and use of streets. As an important resource, sunlight should be prioritized on Downtown's streets.

TRENDS & TRAJECTORY OF CHANGE

"The natural phenomenon of sunlight is frequently taken for granted"[15]. In light of rapid and intense growth, many of Downtown's streets are subject to considerable shadowing. Tall buildings will continue to be a form of growth Downtown, but should be located and designed in such a way that they do not detract from the public realm through excessive shadowing. With the increasing height of tall buildings and the intensity of development on small sites, shadowing impacts are reaching farther from their immediate site and surroundings. It is important that consideration of the impact of tall buildings on sidewalks be given to not only the sidewalks immediately surrounding these tall buildings areas, but also to the far reaching impacts of tall buildings across multiple city blocks. Separation between tall buildings, coupled with other massing strategies, can help to ensure that shadowing on streets and sidewalks is intermittent and does not impact the public realm and more sensitive land uses.

TORONTO PLANNING & REGULATORY CONTEXT

The Sun, Wind, and Pedestrian Comfort: A Study of Toronto's Central Area (1991) study of micro-climatic conditions particular to Toronto selected representative streets and open spaces, developed a modelling methodology to test different scenarios, and concluded with recommendations and implementation tools. It includes a few relevant recommendations:

> A street classification standard for all streets of the Central Area, with 3, 5 and 7-hour categories on September 21st:
>
> - "Three-hour Time Window: Business Streets".
> - "Five-hour Time Window: Promenades, Historic Streets, Medium-density residential streets and mixed-use streets".
> - "Seven-hour Time Window: Low-density residential streets".
>
> "Restrict the allowable height of future development to guarantee three or more hours of sunlight during a period encompassing midday along sidewalks of streets in the Central Area".

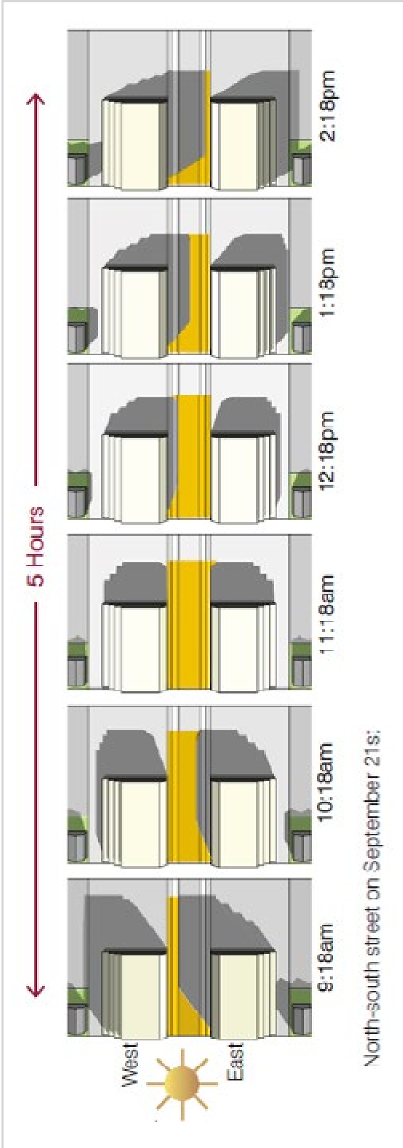


Figure 77. Extract from Avenues & Mid-rise Buildings study, showing 5 hour sunlight protection on sidewalks

14 Kilgannon, Corey. *Darkness at Noon.* The New York Times, 2001.

15 *Sun, Wind, and Pedestrian Comfort: A study or Toronto's Central Area.* City of Toronto Planning and Development Department, 1991.

Based on the findings and recommendations of the Bosselman Study, City Plan '91 included policies and mapping to identify "Streets and Parks in the Central Core Subject to Sunlight Standards." These parameters for sunlight protection for streets were subsequently translated into the zoning by-law. More recently, the City's guidelines for both tall and mid-rise building typologies include direction for the siting, massing and design of buildings, and base buildings in particular, to allow for sunlight access onto streets. Similar direction can also be found in a number of SASPs Downtown. **Refer to Appendix I for full Toronto planning and regulatory context excerpts.**

PRECEDENTS OF GUIDELINES & REGULATIONS IN OTHER CITIES

Most of the cities studied use transition policies and angular planes to control sunlight on streets, as their prevailing built form is mid and low-rise. Some cities with tall building areas use indirect policies, such as separation distances and floorplate sizes, to control the density of shadows, or protect sunlight on streets through a case-by-case evaluation. **Refer to Appendix I for full excerpts and additional graphics from the precedent city research.**

Mississauga, Ontario - Standards for Shadow Studies (2014)

The City of Mississauga includes a hierarchy of streets (opposite boulevard including full width of sidewalk) with different protection time frames, and checkpoints, as well as angular planes depending on street type and right of way dimensions.

London, Ontario - The London Plan

The London Plan advocates for podiums for taller buildings to allow "sunlight to penetrate into the right-of-way" (Policy 292). Furthermore, this is reiterated in a new urban design policy:

> "Access to Sunlight: ix) The design and positioning of new buildings should have regard for the impact of the proposed development on year-round sunlight conditions on adjacent properties and streets. In reviewing proposed developments, access to sunlight for adjacent properties should be maximized to enhance the potential for energy conservation and the amenity of residential areas and open space areas, such as parkettes and outdoor plazas" (amended by OPA No. 88 – OMB Order No. 2314 – approved 99/12/23).

Victoria, Australia - Guidelines for Higher Density Residential Development

As higher density buildings result in an increase in the overall volume of building envelopes, these guidelines were created to ensure that these increases are accommodated to protect character, privacy, usability, pedestrian scale and sunlight. It specifies that shopping streets should be preserved for its access to sunlight.

> "2.3: To protect sunlight access to public spaces. Shadows cast by a new development should not be considered in isolation, but as part of the cumulative shadowing effect of surrounding buildings, structures and trees. Each new building will add to this overshadowing and should be considered as an additional impact to the existing situation".

> "A key decision about overshadowing is the appropriate time of the year to measure when additional overshadowing might occur – there are two choices: equinox (22 September) or winter solstice (22 June). The appropriate measure for private open space is typically accepted as equinox, but local policy can identify public spaces that should be protected at the winter solstice. These spaces will typically include local open spaces and plazas. Where a shopping street currently enjoys sun at mid winter there will usually be a reasonable presumption that the sun access will be preserved".

TESTING

Since existing City of Toronto policies currently treat parks, open spaces and streets differently, the process of testing sunlight onto streets was fundamentally different than that for testing sunlight onto open spaces. In order to design a coherent testing process, the Methodology, Geography and Morphology had to be defined.

Methodology

Unlike parks and open spaces, existing policies for the protection of sunlight onto streets in Toronto frame the evaluation based on the number of hours of sun per day received onto the street during the equinoxes. While the no net-new shadow approach was binary in nature (build zone/no-build zone), the key challenge of the hourly approach is that there may be more than one possible result which renders the production of final no-build zones unviable.

Generally, the moment of the day when the light of sun reaches the street with less impact in development is when the sun is at its highest altitude in the sky, at

Demonstration of the no-build zone (in yellow) for a no net-new shadow target of 3 hours symmetrical around noon (10:30 am- 1:30 PM), December 21st along Queen St: even if formulated as no net new-shadow, which implies that any area with less than 3 hours would be lost, the resulting limitations are generally equivalent to a 45 degree angle policy.

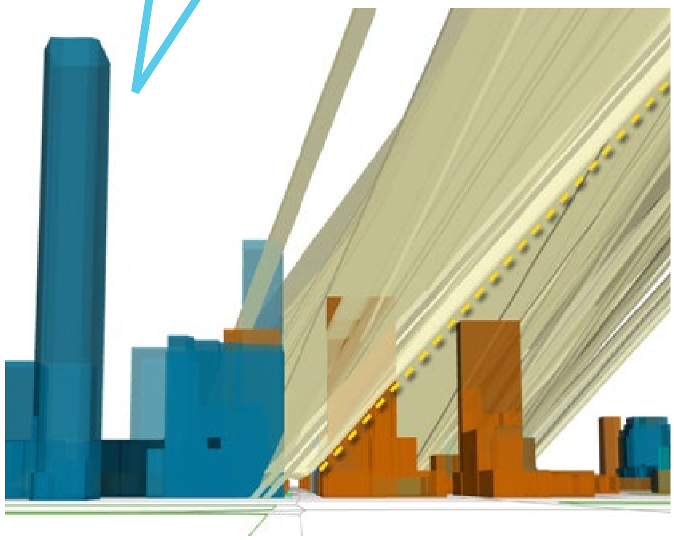


Figure 78. Sun/shadow testing by Perkins+Will)

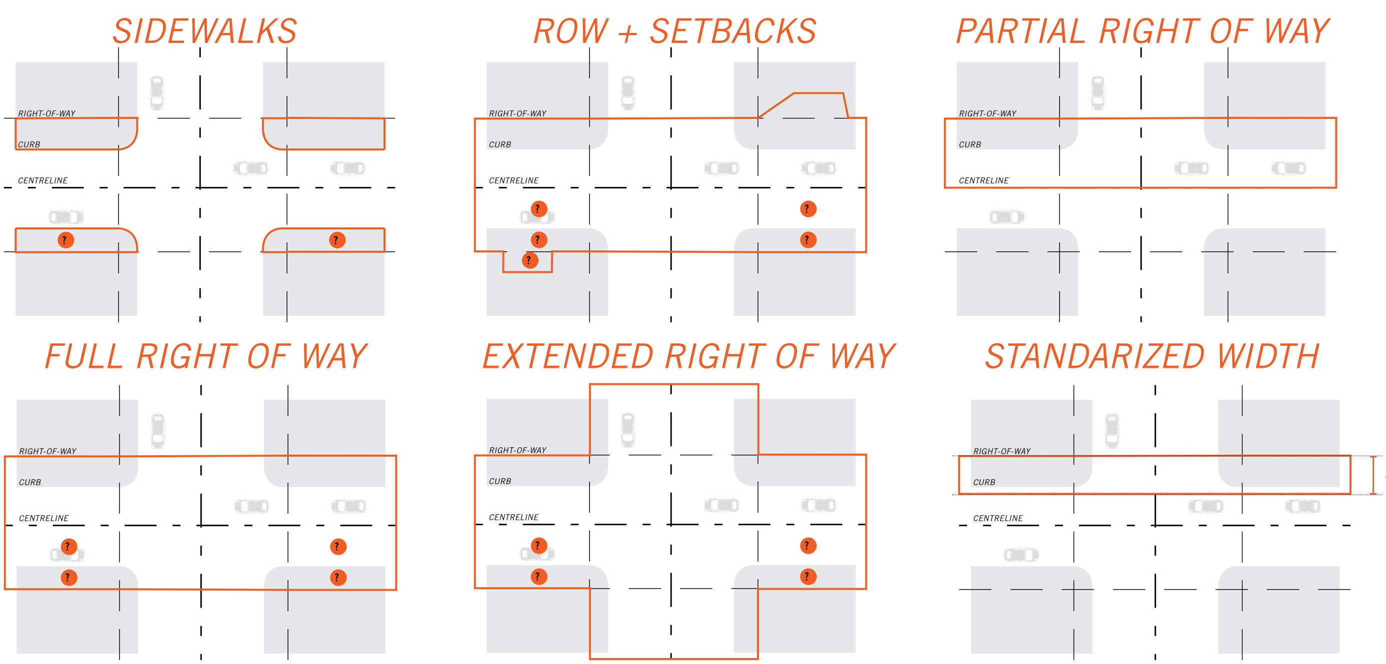
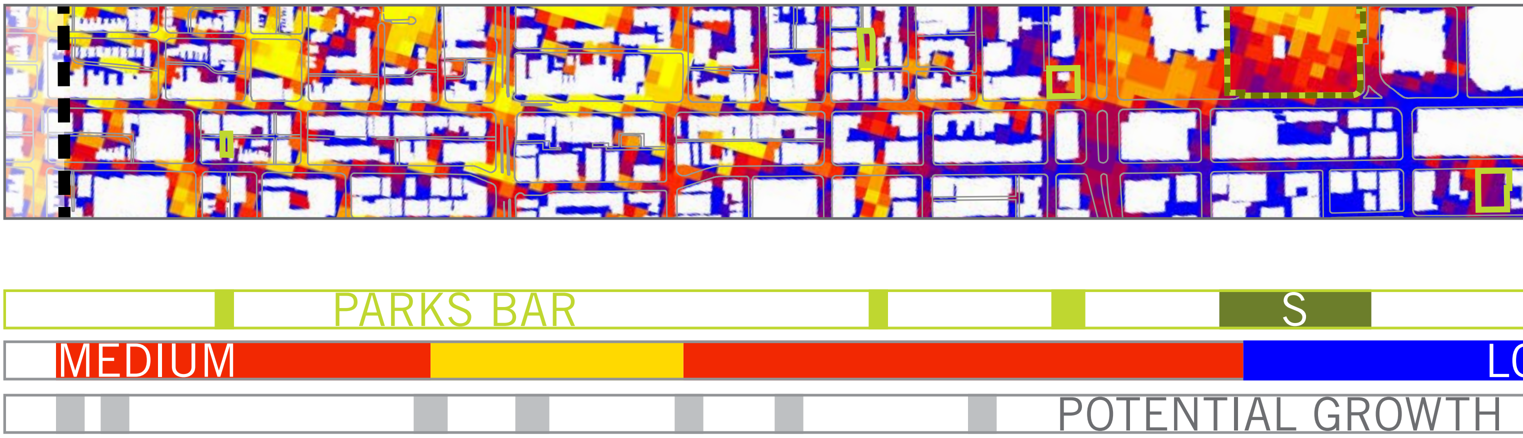


Figure 79. Various interpretations of the "area of a sidewalk" (illustration by Perkins+Will)

Queen Street



Yonge Street

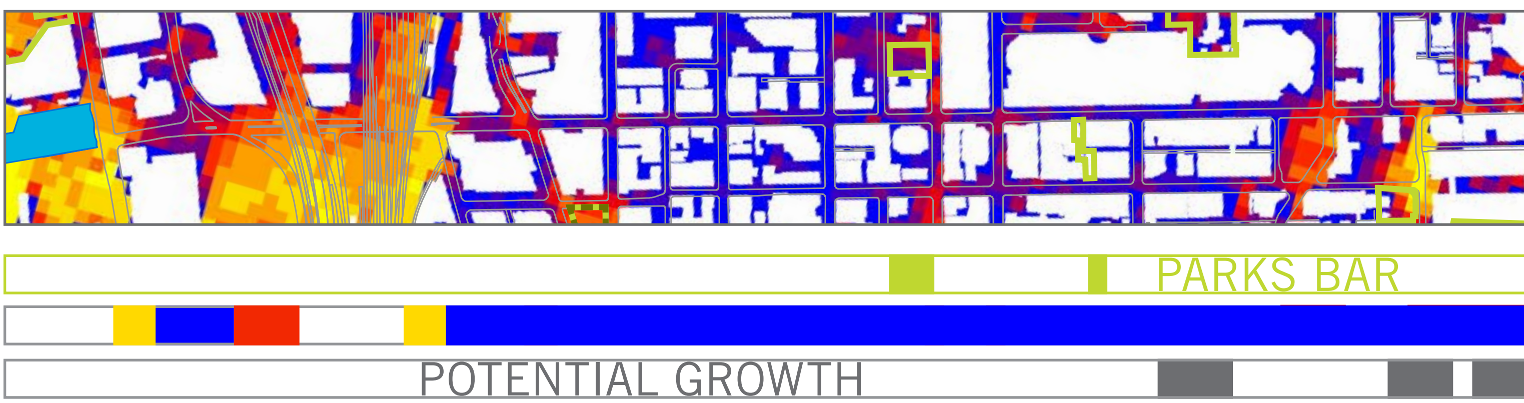
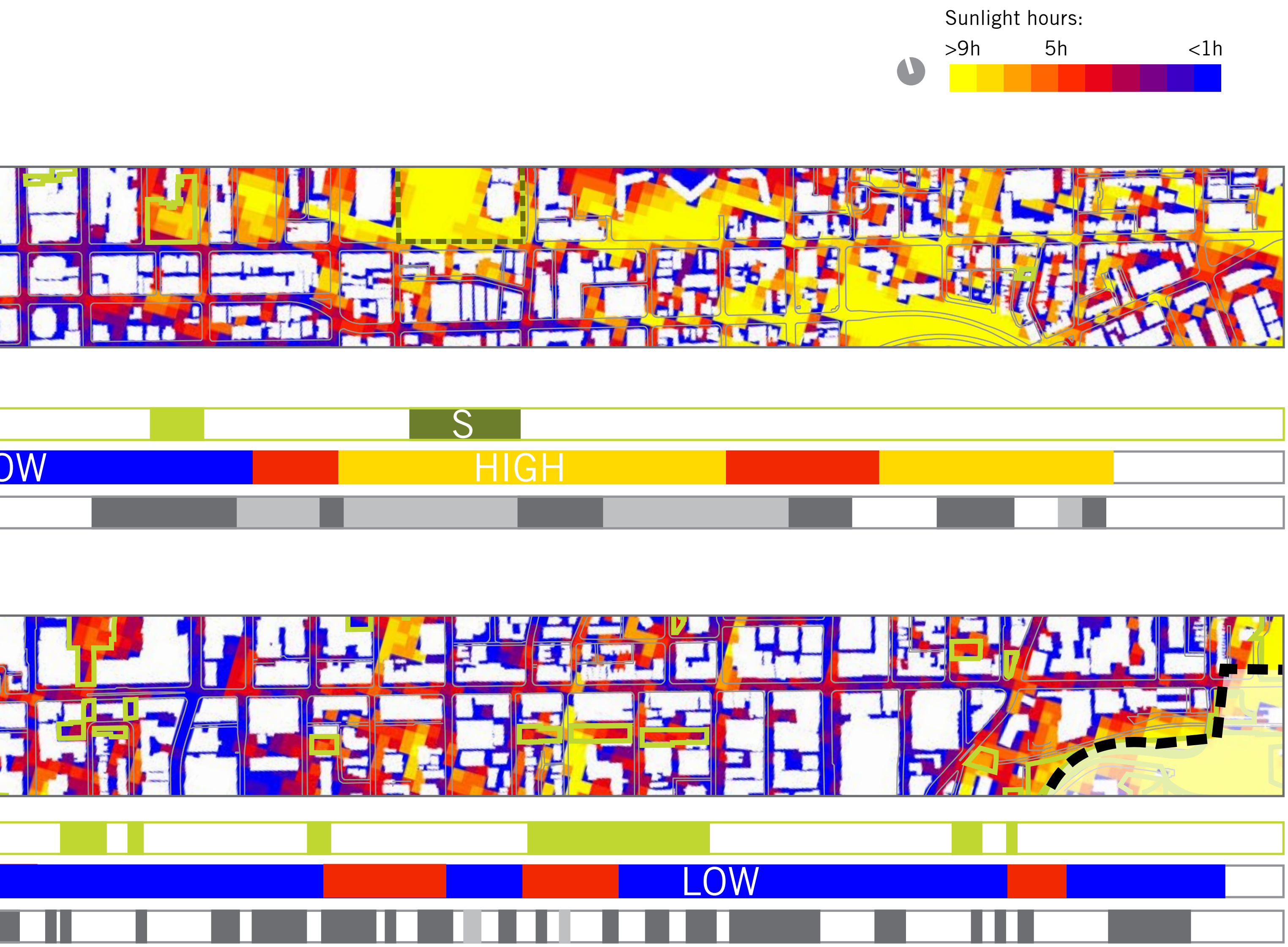


Figure 80. Sun analysis for Great Streets under existing conditions (testing by Perkins+Will)


Sunlight hours:
>9h
5h
<1h
S
OW
HIGH
LOW

solar noon. Therefore, the test was designed to calculate a no net-new shadow solar cone for the targeted hours symmetrical around noon.

Geography

The Downtown Plan, as well as other components of the TOcore work, in particular the Downtown Parks and Public Realm Plan and Mobility Strategy, provide a framework to rationalize the importance of certain streets Downtown. The network of Priority Retail Streets capture the patterns of pedestrian activity and the Great Streets, as identified in the Downtown Parks and Public Realm Plan, speaks to the cultural and historical significance of certain corridors. The testing process focused on both priority retail streets[16] and Great Streets. However, the analysis revealed that both priority retail streets and Great Streets extend across areas of different planned contexts, and thus varying height and densities. It was concluded that any additional requirement to protect for sunlight onto streets should be aligned with the planned context as expressed by the land uses designations, in particular for the four new *Mixed Use Areas* resulting from the Downtown Plan.

Morphology

The matter of defining the geography of the street to be protected was not simple. Existing City policies refer to the street in different terms. In addition to the discrepancy in methodology between the different policies, there is the matter of the lack of definition of the sidewalk boundary itself. Firstly, it is unclear whether a sidewalk includes extensions into private areas by means of setbacks. Secondly, the use of the curb as the limit of a sidewalk may be unreliable because it may be relocated through road redesign, as illustrated by examples of road re-alignment within Downtown, such as along Queens Quay, or where the right-of-way includes areas for active transportation (i.e. bike lanes) that would benefit from access to sunlight. An additional issue is the impact of the asymmetry of streets in terms of access to sunlight. Any testing should acknowledge the difficulties of ensuring any level of sunlight on the south side of the street. Similarly, if specific periods of time were dictated, the west side of the street generally benefits from morning sun, while the east side depends on the afternoon hours. The preferred definition of a sidewalk for the purpose of sunlight protection is captured in the Recommendations. **Full descriptions of Methodology, Geography and Morphology employed during the testing can be found in Appendix J.**

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16 TOcore Proposals Report

FINDINGS

- From the analysis of existing sunlight access conditions, there are many streets which have high sunlight access, and others, mainly in the Financial District, that have low sunlight access. Many of the areas outside of the core have good access to sunlight, with 4 or more hours of sunlight onto the street.
- Most of the precedent cities studied use transition policies and angular planes to control sunlight on streets, as the prevailing built form is mid and low-rise.
- Some precedent cities with tall building areas use indirect policies, such as separation distances and floorplate sizes, to control the density of shadows, or protect sunlight on streets through a case-by-case evaluation.
- As the overall height of tall buildings increases, the span of their shadows lengthen, and the shadow cast

(CONTINUED)

FINDINGS (CONTINUED)

from a tall building several blocks away may start to impact low and mid-rise areas that would otherwise have good sunlight access based on their adjacent built form. These far-reaching impacts make it difficult to regulate sunlight on streets by simply regulating the built form fronting onto adjacent streets.

- Shadows from groupings of tall buildings, when close to each other, may amalgamate and cover streets as one larger shadow for a longer period of time.
- The modelling exercise demonstrated that sunlight protection onto a street may hinder the potential for taller buildings located generally south of low and mid-rise areas.
- To-date, the City-Wide Tall Building Guidelines' direction has generally informed the height and shape of base buildings only to provide for sunlight onto streets, and indirectly reinforced by tall building separation distances.

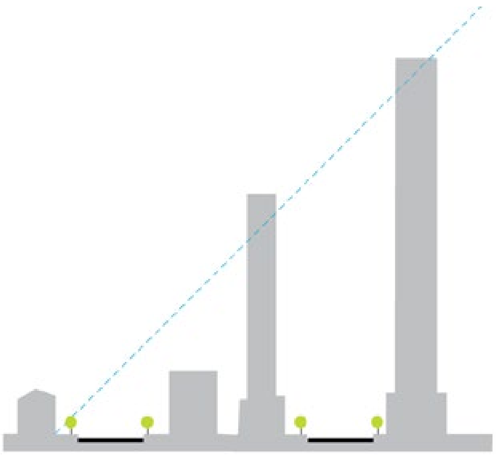

Figure 81. Demonstration of the potential issue of taller buildings casting shadows onto neighbourhood or mainstreet character streets

RECOMMENDATIONS

1. **Continue to shape and scale the base or podium of tall buildings to allow for sunlight access to streets.**
2. **Balance access to sunlight on streets with the recognition that sunlight access policies will impact the overall height of buildings beyond the street on which they are located.**
3. **Continue to shape and scale mid-rise buildings to allow for sunlight on streets as per the direction in Performance Standard #4A from the Avenues & Mid-Rise Buildings Study, through the application of the angular planes and step-backs.**
4. **Ensure that development applications provide sufficient detail and geographic context to enable City Planning to review the impacts of sunlight on streets beyond the immediate site for all areas within Downtown, given the complexity of understanding, predicting and regulating sunlight on streets.**
5. **Amend the Development Guide's Sun/Shadow Study Terms of Reference to include consideration for sunlight protection on streets for mid-rise and tall buildings, by requiring a broader geography for review.**
6. **Define the area of the street to be protected from shadow, consistently across all documents in a measurable fashion. The recommended areas for consideration are the areas between the right of way and the offset of such line to the maximum width of the boulevard within the block, in order to protect for the potential future expansion of the sidewalk if the street were to be reconfigured.**
7. **Protect the area between the right of way and the offset of such line to the maximum width of the boulevard within the block, in order to protect for the potential future expansion of the sidewalk if the street were to be reconfigured.**

COMFORT

SAFETY

01C. PEDESTRIAN-LEVEL WINDS

OBJECTIVE

Locate, design and mass buildings to reduce and mitigate uncomfortable wind conditions on the public realm and other outdoor spaces.

RATIONALE

The provision of thermal comfort can be challenging as there is an extensive range of environmental conditions to mitigate, particularly in built up urban areas. Wind is an important contributing factor affecting thermal comfort for pedestrians – it can contribute or detract from the safety, comfort and utility of the public realm. Similar to the cumulative impacts of shadows from buildings, wind impacts from multiple developments can significantly influence how wind impacts the pedestrian realm. The physical environment, its air movement, temperature distribution, and solar access all affect the perception of users as to the level of comfort related to particular places[17]. Lower urban wind speed is one of the main urban climatic features affecting thermal comfort in high density cities, such as Toronto, that are located in cold regions. It affects not only the disposition of individuals to engage in outdoor activities or willingness to choose walking over other modes of transportation, but also reduces the ability for certain plant materials to thrive. Under severe weather conditions, urban winds may even represent a safety hazard, causing objects to topple, and flying debris, creating unsafe walking conditions. The impacts of pedestrian level winds also vary by user, as children or seniors have a lower thermal comfort threshold.

Accelerated winds from tall buildings are caused by the "downdraught effect": when the wind hits the façade of a tall building, it can be pushed up, around the sides, or down towards the sidewalk where it swirls around and creates wind tunnels at the pedestrian level. Additionally, if several tall buildings are sited near each other, a form of the Venturi effect[18] occurs. This should be avoided wherever possible. Typically, comfort levels are measured against the Lawson Comfort Criteria, which quantifies the speed of wind and relates it to the activity an individual can comfortably do.

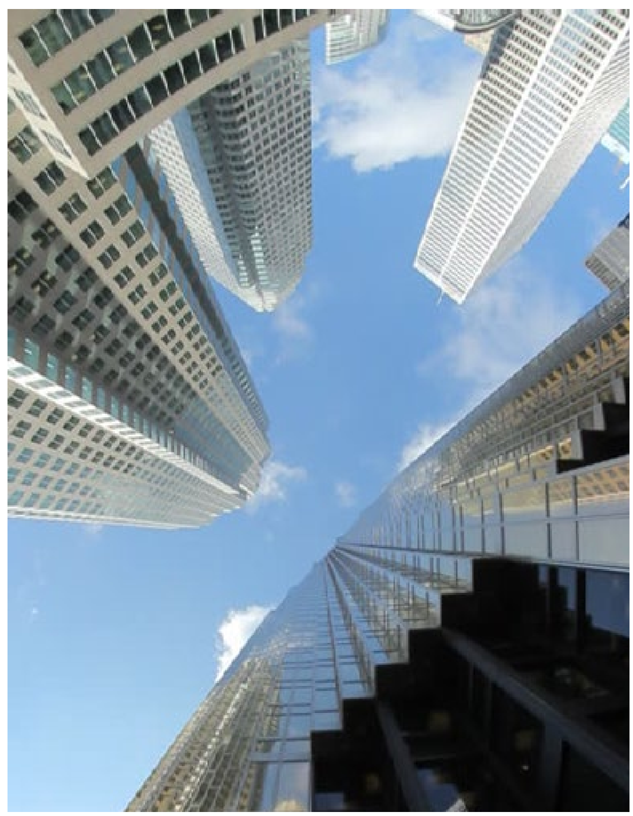

Figure 82. The canyon effect created by some tall buildings can create uncomfortable pedestrian realm experiences (image credit: Shutterstock)

17 Szucs, Ágota. *Wind comfort in a public urban space—Case study within Dublin Docklands.* Dublin: Frontiers of Architectural Research, 2013.

18 The Venturi effect is a "channelling" effect where wind is squeezed through a narrow space, accelerating before reaching the ground.

TRENDS & TRAJECTORY OF CHANGE

The overall height and number of tall buildings Downtown has increased since the beginning of the 2000s. In addition, a large share of Downtown's projected population growth for the next 25 years is likely to occur in the form of tall buildings. Tall buildings have the greatest impact on wind gusts at the pedestrian level. As buildings go higher, the speed of air hitting them rises, increasing ground winds below. In order to provide pedestrian comfort, mitigating design measures are required to break the gusting before it reaches the ground. Failure to do so increases the potential for comfort levels on open spaces and streets and can fluctuate or may worsen with each new tall building.

TORONTO PLANNING & REGULATORY CONTEXT

The Official Plan contains few details about the creation of a comfortable microclimate; there is a need to update and expand these requirements. The City-Wide Tall Building Guidelines directs that tall buildings provide "greater tower separation, setbacks, and stepbacks proportionate to increases in tower floor plate size or height to mitigate resultant wind"(3.2.1b). It also recognizes the direct impact of building design on the pedestrian level wind effect:

> "Locate, orient, and design tall buildings to promote air circulation and natural ventilation, yet minimize adverse wind conditions on adjacent streets, parks and open space, at building entrances, and in public and private outdoor amenity" (4.3 Pedestrian Level Wind Effects).

According to the Toronto Development Guide: Site Plan Control Applications (2011), for large sites, waterfront sites and/or sites where a substantial increase in height is requested, a Preliminary Wind Study may be required in addition to the Final Wind Study. This additional study may require quantitative wind testing by a certified wind tunnel specialist, and evaluates pedestrian comfort based on wind force, thermal comfort and wind chill to evaluate the comfortable use of sidewalks and open spaces for appropriate uses including sitting, standing and walking. Also, mitigation solutions must be provided for areas found to be uncomfortable or severe. **Refer to Appendix K for full Toronto planning and regulatory context excerpts.**

PRECEDENTS OF GUIDELINES & REGULATIONS IN OTHER CITIES

Almost every city studied for pedestrian-level wind terms of reference varies in its approach to quantifying levels of comfort. Most cities do not have specific planning requirements for measuring and evaluating wind impacts, but do require comprehensive Wind Impact Assessments as part of the planning application review process for projects of a certain scale and significance. **Refer to Appendix K for full excerpts and additional graphics from the precedent city research.**

Chicago, USA - Development Manual (2012)

Neither the Chicago Zoning and Land Use Ordinance, nor community plans include any mention of wind speed control. The Development Manual, which provides guidance for Planned Development (PD) applications, Lake Michigan and Chicago Lakefront Protection applications, proposed zoning map amendments within designated industrial corridors, and interagency referral items, includes a brief description of how to analyze wind impact. A quantitative wind impact analysis of pedestrian levels showing the impact of the project on surrounding areas with particular attention to nearby public spaces may be requested of buildings in excess of 600 feet (182.88 metres) in height and/or adjacent to existing or proposed publicly accessible parks, plazas, playgrounds, beaches, or inland waterways. Metric used is miles per hour. Velocity should be measured at a scale equivalent to 4.5 to 5 feet (1.37 to 1.52 metres) above ground level.

Mississauga, Ontario - Urban Design Terms of Reference: Wind Comfort and Safety Studies (2014)

This Terms of Reference includes methodology to be used by microclimate specialists providing wind comfort studies. The metric used is Gust Equivalent Mean (GEM) wind speed[19]. While the evaluation framework is similar to the standard Lawson Comfort Criteria, the target values are more restrictive:

Comfort Category	Lawson Comfort Criteria (GEM)	Mississauga's Terms of Reference (GEM)
Sitting	<4 m/s (14.4 km/s)	≤ 10 km/h (2.78 m/s)
Pedestrian Standing	4-6 m/s (14.4-21.6 km/s)	≤ 15 km/h (4.17 m/s)
Pedestrian Walking	6-8 m/s (21.6-28.8 km/s)	≤ 20 km/h (5.56 m/s)
Business Walking	8-10 m/s (28.8-36 km/s)	
Uncomfortable	>10 m/s (36 km/s)	≥ 20 km/h (5.56 m/s)

Ottawa, Ontario - Terms of Reference: Wind Analysis

For the City of Ottawa, it is required for all planning submissions to include a wind analysis, which provides a visual model and written evaluation to demonstrate how a proposed development will impact the wind conditions at the pedestrian level. This is particularly important for proposed developments are adjacent to existing or planned low rise development, open spaces, water bodies, and large public amenity areas. There are two types of wind studies:

> "Type 1: Applications seeking an increase in height and/or massing which is either: a tall building(s), 10 storeys or more or a proposed building that is more than twice the height of adjacent existing buildings and is equal to or greater than 20 meters in height".
>
> "Type 2: Tall building applications which have not sought an increase in height or massing".

Ottawa uses Gust Equivalent Mean (GEM) speed to measure the comfort and safety of the wind on pedestrian level uses as well as for amenity areas: "GEM is defined as the maximum mean speed (km/hour) or the guest speed divided by 1.85". The City uses four measuring points to evaluate the comfort of the wind speed.

Category	GEM Speed	Where Applicable
Sitting	≤ 10	Outdoor public and private amenity spaces (e.g. restaurant patios and seating areas)
Standing	≤ 14	Major building entrances and bus stops
Strolling	≤ 17	Sidewalks association with a mainstreet, plazas, and parks
Walking	≤ 20	Sidewalks other than those associated with a mainstreet, bicycle paths and parking lots
Uncomfortable	≥ 20	Winds of this magnitude are considered a nuisance for most activities and wind mitigation measures are recommended.

19 Gust Equivalent Mean (GEM) speed considers both mean and gust wind speeds; The GEM is defined as the maximum mean wind speed or the gust wind speed divided by 1.85.

A Wind Safety Criteria is also used to measure what mitigation strategies are required to eliminate the safety issue:

Category	GEM Speed	Where Applicable
Exceeded	$\geq$ 90	At any test location, wind speeds of this magnitude are considered a safety hazard and wind mitigation is required.

Auckland, New Zealand - Unitary Plan (2013)

The wind policies within the Unitary Plan are applied to buildings exceeding 25m, using Mean wind speed as their metric. The public realm is organized in 5 performance categories with prescribed maximum gust speeds. These categories are analogous to Lawson's categories:

Category A	Areas of pedestrian use or adjacent dwellings containing significant formal elements and features intended to encourage longer term recreational or relaxation use i.e. public open space and adjacent outdoor living space
Category B	Areas of pedestrian use or adjacent dwellings containing minor elements and features intended to encourage short term recreation or relaxation, including adjacent private residential properties.
Category C	Areas of formed footpath or open space pedestrian linkages, used primarily for pedestrian transit and devoid of significant or repeated recreational or relaxational features such as footpaths not covered in Categories A or B above
Category D	Areas of road, carriage way, or vehicular routes, used primarily for vehicular transit and open storage, such as roads generally where devoid of any features or form which would include the spaces in Categories A-C above
Category E	Category E represents conditions which are dangerous to the elderly and infants and of considerable cumulative discomfort to others, including residents in adjacent sites. Category E conditions are unacceptable and are not allocated to any physically defined areas of the city

FINDINGS

- As buildings get taller, and as tall buildings are clustered in close proximity to one another, the built environment will continually impact and change how winds are experienced at the pedestrian level. The dynamic nature of wind speaks to the need to understand the cumulative impact from multiple developments in a given area.
- The Terms of Reference for Pedestrian Level Wind Studies in the City's Development Guide does not provide sufficient detail to ensure consistent information is provided through all application submissions, and does not include targets for evaluation.
- The submission of the detailed Wind Impact Assessment at the Site Plan Application stage does not allow for more substantial changes to be made to the building orientation and massing.

RECOMMENDATIONS

1. **Amend the Terms of Reference in the City's Development Guide for Pedestrian Level Wind Studies to:**
   - **Develop comfort categories that respond to specific geographies (parks, priority retail streets) or activities (sitting, standing);**
   - **Require Wind Impact Assessments, rather than opinion letters, to be submitted at the early stages of the planning application review process i.e. at Zoning By-law Amendment stage, so that the evaluation of pedestrian-level winds can assist to shape the development in order to reduce negative impacts;**
   - **Require all development applications to provide a Wind Impact Assessment that: measures Gust Equivalent Mean; applies evaluation criteria that assesses wind impacts on the pedestrian level; and uses standardized graphics and displays; and**
   - **Require Wind Impact Assessments to include a broad geography and existing and planned development context to evaluate the cumulative existing and future wind conditions in an accurate manner.**
2. **Require architectural responses such as: altering the footprint of tall building elements; increasing step-backs and separation distances; and re-orienting building footprints when the Wind Impact Assessment demonstrates negative impacts on the pedestrian environment.**
3. **Consider mitigation measures such as fencing, wind screens and landscaping, once other architectural responses have been exhausted.**

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COMFORT

VIBRANCY

02. DAYLIGHTING FOR INDOOR SPACES

OBJECTIVE

Locate, mass and design buildings to improve sunlight and daylight into buildings.

RATIONALE

The Romans used sunlight as a material to define and enhance space, anchoring sense of space, while inviting others to engage[20]. Windows in buildings are a source of daylight, provide views to the outdoors, and help inhabitants identify the time of day. Daylighting of buildings influences the environmental factors affecting human health. Adequate daylight illumination and direct daylight (in multi-storey buildings) are fundamental physiological needs. Studies conducted in both non-residential and residential settings have found that a view to the outdoors improves well being through physiological calming, alertness, improved mood and satisfaction[21]. Furthermore, light can enhance productivity in workspaces or schools and create a more comfortable, inviting, interior environment[22]. Access to daylight grounds a building's inhabitants to nature and its benefits.

From a sustainability perspective, the ability to use natural light as a heat and light source is a proactive way to reduce the need for energy-reliant alternatives. Daylighting relies on more than just use of glass and designing façades with the maximum number of windows as possible on a building face; it requires careful consideration of adjacent uses, programming, orientation and siting of a building – all of which is incredibly complex in the infill context of Downtown.

TRENDS & TRAJECTORY OF CHANGE

Building and street orientation are the main factors that determine the amount of light the interiors of buildings can receive. Additional factors include built form obstructions from neighbouring buildings, or in a tall building context, where impacts are from long and quickly-passing shadows that block the sun's path. Downtown, where development is occurring in a primarily infill context, and with units in taller, more closely spaced buildings, daylighting of interior spaces is challenging.

Areas that were once primarily low- and mid-rise, with parks, green setbacks and generous open spaces, allowed for daylight into interior spaces. With the increase of tall buildings, some office and residential units in towers receive direct or passive sunlight, while the spaces closer to the ground are neglected.

Podiums provide opportunities for larger format spaces, including those required for complete communities (e.g. schools, daycares, recreation centres, etc.) and should allow for daylighting. In an infill context, architectural elements such as windows, glazing, breathing spaces and mid-block connections should permeate the larger mass and tight spacing of buildings, all of which will contribute to increased daylighting.

TORONTO PLANNING & REGULATORY CONTEXT

City Planning has limited authority with respect to regulating interior design and layout of interior spaces. Through Section 41 of the Planning Act (Site Plan Control) and the City of Toronto Act, City Planning can provide direction

20 Weber, Cheryl. *Design with Daylight: Natural Lighting.* Mother Earth Living, 2010.

21 City of Toronto. *Staff report for action – Regulations, Policies and Guidelines Respecting Interior Bedrooms.* Toronto, 2016.

22 Autodesk. *Daylighting.* Sustainability Workshop

on exterior materials and matters related to sustainable design. However, outside of the Ontario Building Code (OBC), which identifies minimum glazing requirements for rooms of residential occupancy, there are no policies that specify daylighting of interiors. **Refer to Appendix L for full Toronto planning and regulatory context excerpts.**

PRECEDENTS OF GUIDELINES & REGULATIONS IN OTHER CITIES

Daylight is sustained by two distinct sources of light: *skylight*, the diffuse light from the whole sky, and *sunlight*, the direct solar beam[23]. These have different criteria for quality and different methods of calculation, and must be considered separately. Given the complexity of evaluating the compliance with such criteria, some cities opt for simpler regulatory tools. **Refer to Appendix L for full excerpts and additional graphics from the precedent city research.**

United Kingdom - British Standards and Daylighting guidelines

As a code of practice, BS 8206-2 takes the form of guidance and recommendations. 'Lighting for buildings: Part 2: Code of practice for daylighting' is primarily concerned with the psychological well-being of people, not with the level of illumination. Daylight factor (DF)[24] has been used in the standard as the parameter. For rooms daylighting, the criteria are:

- 5% average DF for rooms without supplementary electric lighting;
- 2% for rooms with supplementary electric lighting.

For rooms in dwellings. the criteria are:

- 1% average DF in bedrooms;
- 1.5% average DF in living rooms; and
- 2% average DF in kitchens[25].

Southwark, UK - Residential Design Standards (2011)

Southwark employs different daylight tests, which should be used where the proposed development faces the affected window of the neighbouring property:

1. Draw a line at 25 degrees upwards from the centre of the affected window;
2. If the proposed development is higher than this 25 degree line, there may be an unacceptable loss of daylight to the affected window.

Alternatively, this test should be used where the proposed development is at a right-angle to the affected window of the neighbouring property:

1. Draw a line at 45 degrees upwards from the centre of the affected window;
2. Draw a line at 45 degrees sideways from the centre of the affected window.

If the proposed development is both higher and wider than these 45 degree lines, there may be an unacceptable loss of daylight to the affected window".

23 Ng, Edward. *Designing High-Density Cities: For Social and Environmental Sustainability.* London: Earthscan, 2010.

24 Daylight factor is the ratio of the light level inside a structure to the light level outside the structure. It is defined as: DF = (Ei / Eo) x 100%, where, Ei = illuminance due to daylight at a point on the indoors working plane, Eo = simultaneous outdoor illuminance on a horizontal plane from an unobstructed hemisphere of overcast sky.

25 Department of the Environment Transport Regions (DETR). *Desktop guide to daylighting - for architects.* Good Practice Guide 245, 1998.

“Designing High-Density Cities: For Social and Environmental Sustainability” (2009)

Part of this comparative study by Edward Ng includes an analysis of vertical obstruction angle restrictions in different cities[26], including angular planes as another common way of controlling the sky component (Figure 84). Based on the City-Wide Tall Building Guidelines and the 2016 ZBLA and OPA for Updating Tall Building Setbacks in the Downtown, that identify 25 metres as the minimum separation distance between tall buildings, the vertical restriction angle would be approximately 83-degrees (Figure 85).

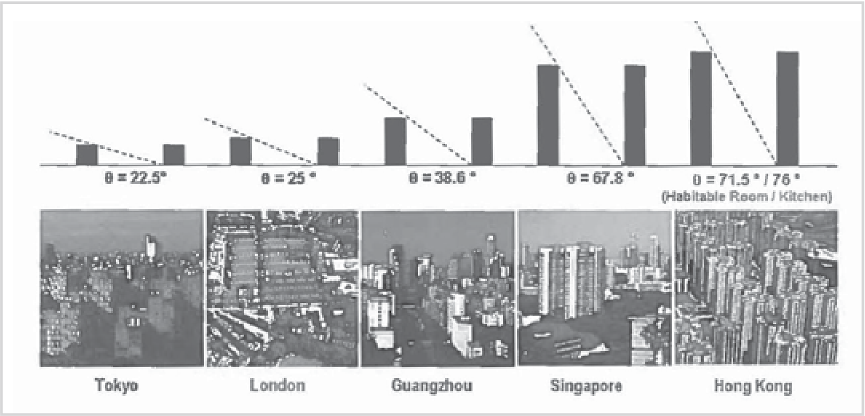

Figure 83. Vertical obstruction angle restrictions in different cities, extract from “Designing High-Density Cities” study

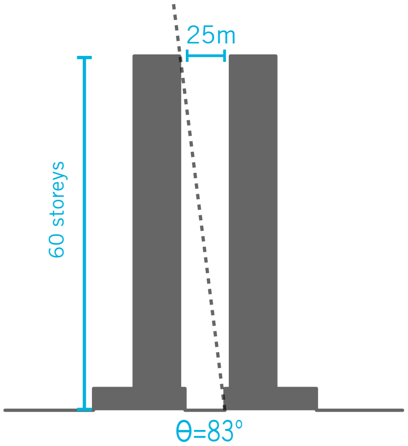

Figure 84. Vertical restriction angle in Toronto (illustration by Perkins+Will)

London, UK - Housing Design Guide (2010)

London’s Housing Design Guide acknowledges that for ground floor dwellings, higher ceilings “can provide better light levels, a better urban scale to the base of larger buildings, the potential for homes to be used more flexibly, and can make ground floor dwellings more suitable for conversion to non-residential uses” (Chapter 5.4).

> “The quality and quantity of natural light in an interior depends on both the surrounding environment and the design of a building - the size and position of windows, the depth and shape of rooms, and the colours of internal surfaces”.

Hong Kong - Lighting and Ventilation Requirements (2015)

In Hong Kong, “the provision of natural light has been controlled by the Building (Planning) Regulations B(P) Reg. 30, 31, and 32 [...which] controls the minimum window glazing area and the distance between buildings”[27]. Some of the tools to ensure daylighting used in Hong Kong include 10 per cent window area to floor area ratio; maximum room depth of 9 metres; minimum window height of 2 metres; and an unobstructed open space known as the rectangular horizontal plane (RHP) outside of the window. The RHP directly outside that has a plan size not less than 203 metres multiplied by one third of the height of the building above the window. This controls the sustaining vertical unobstructed angle of the window.

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26 Ng, Edward. *Designing High-Density Cities: For Social and Environmental Sustainability.* Earthscan, 2009.

27 Hamzah, Baharuddin and Lau, Stephen S.Y. *The development of visible sky area as an alternative daylight assessment method for high-rise buildings in high-density urban environments.* Informa UK Limited, 2014.

City University of Hong Kong - "BST2522 Building Environmental Science 2: Daylighting"

This lecture outlines the importance of daylighting, and its relationship with a number of environmental factors (e.g. solar gain), and building design[28].

> "9.1 Environmental factors: Daylight design is closely related to a number of environmental factors because the use of glass windows to let in light also allows the penetration of solar heat and noise and increases the rate of heat gain or loss of the building fabric".

New York City, USA - Active Design: Shaping the Sidewalk Experience (2013)

New York City requires future guidelines that impact the sidewalk experience to include minimum transparency percentage requirements as well as for incorporating other architectural features to achieve a variety of glazing.

New York City, USA - "Laying the Groundwork" Retail Design Guidelines (2015)

Daylight is not only necessary for residential uses, but also for retail, as these guidelines note, as it will both welcome more customers as well as reduce energy consumption. This can be done through controlling the amount of glazing and transparency.

> "1.1.1 Provide continuous ground-to-ceiling glazing, with internal doors. Where ground-to-ceiling glazing is not possible, meet a target ot 70% transparency between 2 feet and 10 feet above the sidewalk".

Auckland, New Zealand - "Unitary Plan 101" (2017) and Design Manual (2017)

Auckland understands the difficulty in allowing for sunlight in low-rise indoor spaces, especially for terraced, semi-detached, or continuous building masses, where only one building edge has windows or directly engages 'principal living spaces'. Design practices in Auckland plan to optimize solar access in private units while addressing the street. By establishing dimensions of outlook spaces, it provides an area of protection for the indoor uses, ensuring they receive adequate sunlight while maintaining privacy. It uses these privacy controls and building separation to allow for daylighting. Street views, front yard setbacks, and daylight for indoor spaces all go hand in hand.

> "All private open spaces should receive at least five hours of sunlight across at least half of the garden, courtyard, balcony or roof terrace, as measured on the equinox (22 March / September)".

Other Daylighting Metrics

Beyond angle restrictions, a series of more complex daylighting metrics are used to quantify daylighting in high-density contexts, which generally require intensive calculations or computational tools. These include:

- Rectangular Horizontal Plane (RHP), as used in Hong Kong
- Vertical Day Factor (VDF), calculated by the Unobstructed Vision Area (UVA) method
- Visible Sky Area (VSA) is defined as the ratio of projected area of sky (PAS)
- Vertical Sky Component (VSC)

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28 Chan, Apple L.S. *BST2522 Building Environmental Science 2: Daylighting - 9. Design Consideration.* City University of Hong Kong.

FINDINGS

- The Ontario Building Code (OBC) contains provisions that require every room used for sleeping in any building be provided with windows, but makes no reference to hours of sun or shadows received on windows.
- Most regulations reviewed focus on daylighting of private spaces (units) rather than shared spaces (amenity spaces).
- Most regulations reviewed focus on providing daylighting for new spaces (units), rather than preventing interruption of daylighting for existing spaces.
- Most regulations studied were designed to best control the provision of daylight on low to mid-rise neighbourhoods.
- For areas of high density, sophisticated computational tools have been designed to predict the daylight availability of building interiors. However, to date, simpler design and regulatory tools that can be applied have not been developed.
- Testing indicates that the higher a window is located in a wall, the deeper the sunlight penetration is into the interior space.
- Implementation of alternative metrics is difficult to achieve comprehensively Downtown, particularly given the limitations of City Planning to regulate interior layouts for units and buildings.

RECOMMENDATIONS

While the OBC requirements for minimum glass area in units do not protect for daylighting, reasonable opportunities for daylighting in residential units may be achieved by applying separation distances and setbacks between tall buildings. From a technical perspective, a wide range of alternative metrics exist to ensure daylighting within units.

1. **Encourage new developments, particularly on small sites, to incorporate additional setbacks and step-backs to maintain existing levels of daylighting in existing buildings.**
2. **Encourage new development to strategically locate outdoor amenity spaces (e.g. courtyards, large forecourts) and POPS to optimize daylighting into adjacent interior amenity spaces.**
3. **Consider measures that encourage daylighting of interiors of buildings through the application review process, including the following:**
    - **Encourage taller floor to ceiling heights in the base of buildings to: permit more daylight to enter the interior; allow for flexibility or future conversion of uses; and optimize sunlight for non-residential uses through a minimum 4 metre floor to ceiling height;**
    - **Measure the percentage of sunlight received between set time frames to optimize daylighting;**
    - **Evaluate glazing or glass area requirements to optimize daylighting dependent on the use (e.g. higher transparency for retail uses, lower for residential); and**
    - **Orient buildings to maximize daylighting, where there is more than one building is proposed on site.**
4. **Reflect the targets outlined in the OBC, with respect to the provision of minimum glass areas, for new amenity areas and non-residential spaces.**

COMFORT

SAFETY

03. PRIVACY

OBJECTIVE

Siting and orientation of buildings should provide access to natural light, minimize overlook and ensure privacy.

RATIONALE

Buildings help define the boundaries between the public and private realm. There should be an expectation of, and opportunity for, privacy between buildings and between buildings and the public realm. Individuals act differently in private than in public – whether at home, at work, or when participating in recreational activities, individuals need spaces to collect themselves and allowed to be without the unwanted gazes of others. Downtown is dense and compact, and finding the space to create the boundaries between the public and private realm can be difficult. Separation between buildings, the orientation of buildings to one another, and the design of façades can all contribute to ensuring privacy is obtainable for a building's inhabitants.

TRENDS & TRAJECTORY OF CHANGE

Only 30 years ago the predominant built form in the Downtown was fairly low-scale, with most tall buildings isolated on a single block. Since that time, many of Downtown's vacant and underutilized sites and low-rise buildings have been re-developed with mid-rise and tall buildings, with many blocks accommodating multiple tall buildings. This has resulted in tall buildings that are more closely spaced. With fewer large, contiguous sites remaining, proposals to develop tall buildings on smaller lots are increasing. Tall buildings on smaller sites will result in loss of "openness" and access to sky-view, in addition to the loss of privacy.

Separation between tall buildings was addressed as one of the "quick starts" of the TOcore study through Official Plan and Zoning By-law amendments to update the separation and setback requirements for tall buildings Downtown (adopted by Council in October 2016). This was identified as one of the most important built form parameters to address within the Downtown context.

Figure 85. Left and right: First Canadian Place and area around King Street and Bay Street, 1976 (image credit: City of Toronto Archives and Google Maps)

Separation distances and setbacks for tall buildings are not new built form parameters for the City. Several City documents outline the need for tall building separation, including the Design Criteria for Review of Tall Building Proposals (2006) and later with the City-Wide Tall Building Guidelines (2013) and Downtown Tall Buildings: Vision and Supplementary Guidelines (2012). The proposed Zoning By-law amendments establish minimum required front, side and rear lot line setbacks and the policies provide the planning policy framework for those setbacks, and establish a minimum 25-metre separation distance between tall buildings. The setbacks will apply to the tower portion of a tall building on sites that can support tall buildings. These setbacks protect important planning principles such as providing access to sky-views, light, and privacy, enhancing a development site's ability to provide high-quality public realm improvements, and protecting the development potential of adjacent sites.

TORONTO PLANNING & REGULATORY CONTEXT

The Official Plan sets general guidance for all new developments to be conscious of privacy as an essential element to protect when fitting into planned context, but also in order to limit its impact on existing context:

> "3.1.2.3. New development will be massed and its exterior façade will be designed to fit harmoniously into its existing and/or planned context, and will limit its impact on neighbouring streets, parks, open spaces and properties by: d) providing for adequate light and privacy".

The City-initiated Official Plan Amendment 352 and Zoning By-law 1105-2016 (currently under appeal), look to update the separation requirements for Tall Buildings for the Downtown. Updating the Tall Building setbacks, in part helps to improve privacy for inhabitants of tall buildings by requiring an increase in distance between tall building elements. This update ensures that new

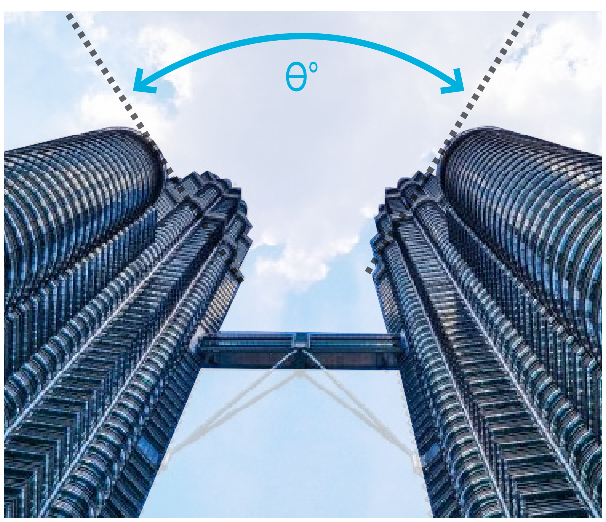

Figure 86. High-rise buildings angled to improve privacy to between facing units in towers - Petronas Towers, Malaysia (image credit: Getty Images)

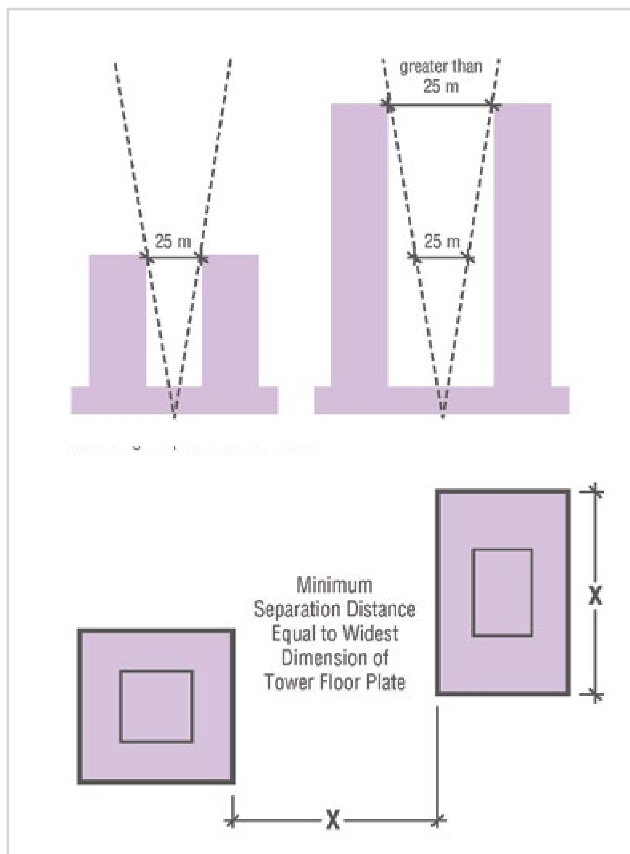

Figure 87. Excerpts from the City-Wide Tall Building Guidelines (2013) include recommendations on adequate tower separation distances

developments provide access to natural light and a reasonable level of privacy. Also, the Mid-Rise Performance Standards and the City-Wide Tall Building Guidelines provide guidance as to achieving transition and separation in an effort to allow for privacy through setbacks and angular planes from adjacent low-rise neighbourhoods. **Refer to Appendix M for full Toronto planning and regulatory context excerpts.**

PRECEDENTS OF GUIDELINES & REGULATIONS IN OTHER CITIES

All cities studied have referred to privacy as an essential element to protect in dense, urban contexts. Strategies for doing so include significant changes to massing or building orientation, as well as small-scale design interventions such as planting or buffering. **Refer to Appendix M for full excerpts and additional graphics from the precedent city research.**

London, Ontario - The London Plan (2016)

The London Plan has a provision in their policy that state that buildings should not cause any harm to existing land, buildings, and amenity, in relation to privacy (Policy B.d).

London, UK - Housing Design Guide (2010)

Developed through a deep understanding of architectural constraints in its contexts, this planning guidance supports protecting the privacy of London residents and promoting the delivery of high-quality, and a range of dwellings. Elements such as balconies, windows, and height regulations come with design recommendations to provide comfortable places of retreat.

Privacy is an important subject within London's Housing Design Guide, which emphasizes that they value all opportunities for residents to look out on and enjoy surrounding public and shared open spaces, and to "relax outdoors without being seen by neighbours or passersby" (Chapter 5.1). To ensure this, built form and design guidance exists in the form of encouraging the use of balconies, terraces, plantings, setbacks, and building orientation. The Guide also requires design proposals to outline how they have protected for privacy:

> "5.1.1 Design proposals should demonstrate how habitable rooms within each dwelling are provided with an adequate level of privacy in relation to neighbouring property and the street and other public spaces".

London Borough of Camden, UK - Planning Guidance (2015)

Building off the direction within the Housing Design Guide, the Planning Guidance of Camden indicates how privacy, further than just between adjacent or facing units, should also be considered with 'overlooking'. This means that vertical angles of view are also an important design element, especially in a context with taller buildings.

> "7.4 Development should be designed to protect the privacy of both new and existing dwellings to a reasonable degree. Spaces that are overlooked lack privacy. Therefore, new buildings, extensions, roof

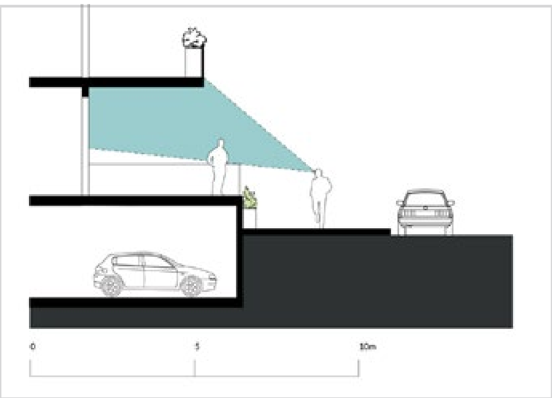

Figure 88. Diagram depicting the range of sight from the street level, and the use of different levels, planting, and screening to provide privacy to the residential units (image credit: Auckland Design Manual)

> terraces, balconies, and the location of new windows should be carefully designed to avoid overlooking. The degree of overlooking depends on the distance and the horizontal and vertical angles of view".

Los Angeles, USA - Downtown Design Guide (2009)

Los Angeles' Downtown Design Guide prescribes minimum "line-of-sight" distances as well as advocating for towers to be offset, curved, or angled to "provide privacy, natural light and air, as well as contribute to an attractive skyline" (Chapter C).

"Residential Unit Spacing: Provide privacy and natural light and air for all residential units. The shortest horizontal distance between the specified window of one residential unit and the specified window or wall or another residential unit in the same project shall have, at a minimum, the "line-of-sight" distances from the middle of the windows specified in Table 6-2".

Auckland, New Zealand - Design Manual (2017)

This online manual provides a specific section of "Guidance for Apartments" including a design checklist for how habitable rooms can be designed and how building massing can be oriented to protect for privacy. This includes using screening devices, planting, and change in levels to ensure residential privacy.

> "To strike a balance between privacy and passive surveillance, a level change between the ground floor and the footpath can be helpful. This will limit visibility into the dwelling while still letting residents look out. Make sure that the entrance to the building remains accessible."

Under the chapter on residential safety guidelines, there are requirements for most landscape plans associated with new developments to show the plant species, their locations, their sizes at the time of planting, and the maximum sizes/heights of plants or trees at their maturity. This shows an acknowledgement that the use of trees or plants is an impactful approach for ensuring residential safety and privacy at the ground level.

Figure 89. How design elements can help ensure privacy for residential uses - Beaumont Quarter, Auckland by Melview Developments / Studio Pacific S333 (image credit: Auckland Design Manual)

FINDINGS

- The need for privacy exists at two scales:
  - Overlook between tall or mid-rise buildings and the areas around them (e.g. respond through building orientation, separation and design); and
  - Between the public and private realm at grade (e.g. respond through at-grade setbacks and design).
- The City-initiated Official Plan Amendment and Zoning By-law for Updating Tall Building Setbacks Downtown (2016) in part helps to improve privacy for inhabitants of tall buildings by providing minimum separation distances between tall buildings.
- Façade design and buffering can also assist in providing privacy. Options such as inset balconies and use of more solid materials help achieve this. Other measures such as fencing, plantings, and screening may also be helpful at the lower levels.
- Limiting the height at which residential uses can face onto a major street or active uses can help protect for privacy.

RECOMMENDATIONS

1. **Ensure transition in built form through separation distances, step-backs or angular planes between tall and mid-rise buildings and other low-scaled areas to minimize overlook and enhance privacy.**
2. **Increase the minimum separation distance of 25 metres between towers to ensure privacy, particularly where:**
   - **Privacy and overlook issues cannot be resolved; and/or**
   - **The existing context indicates more than 25 metres is appropriate.**
3. **Orient buildings to offset overlook and maximize privacy. This requires careful consideration of the site and its potential, and a commitment to achieving the best possible living conditions. Buildings should be oriented on sites in such a manner as to maximize privacy and minimize overlook, while balancing other site opportunities and constraints.**
4. **Increase privacy and reduce overlook through various methods, including:**
   - **Use of inset fenestration and screening of balconies;**
   - **Angling facing building walls, avoiding parallel faces, or reducing the amount of parallel overlaps; and**
   - **Where overlook is unavoidable, encouraging fencing and planting on the ground level of tall and mid-rise buildings can assist to reduce overlook and enhance privacy from neighbouring areas and streets.**
5. **Enhance privacy for at-grade conditions (e.g. where residential units front onto a main street) through increased setbacks, changes in grade, and other buffering methods, such as landscaping.**
6. **Increase privacy for residential units that face onto main streets by providing vertical separation from the street level, by limiting residential units in the base or lower floors of buildings.**

COMFORT

SAFETY

DIVERSITY

04. CONNECTIVITY

OBJECTIVE

Pedestrian comfort and safety should be prioritized on all streets Downtown, with buildings that support and enhance mobility and the pedestrian network.

RATIONALE

The built environment helps to frame the pedestrian experience – or the 'last mile'[29] of all journeys – and contributes to Downtown's connectivity. The convenience of a last mile trip is defined by three factors: the distance to transit; how easy it is to pair a transit trip with active transportation such as walking or cycling; and, how pleasant the experience of walking or cycling is. The issue is simplified when the last mile is the only mile – when neighbourhoods provide walkable access to the complete range of uses and amenities that support urban life, such as jobs, housing, retail, parks and open spaces and community facilities. Through an urban lense, it is adequate form and function that dictate a pedestrian's ease, willingness, and ability to move within and around the city. If the three key factors conditioning pedestrian mobility are the length of distances, ease of movement and quality of the experience, built form can greatly contribute to connectivity by providing permeability within the block, expanding and improving the pedestrian realm, and providing an engaging design at grade levels.

> "As cities get more and more compact, they become more walkable. In denser residential areas they are better designed and more attractive destinations. We are less dependent on our cars and use public transport more."
>
> Chinmoy Sarkar

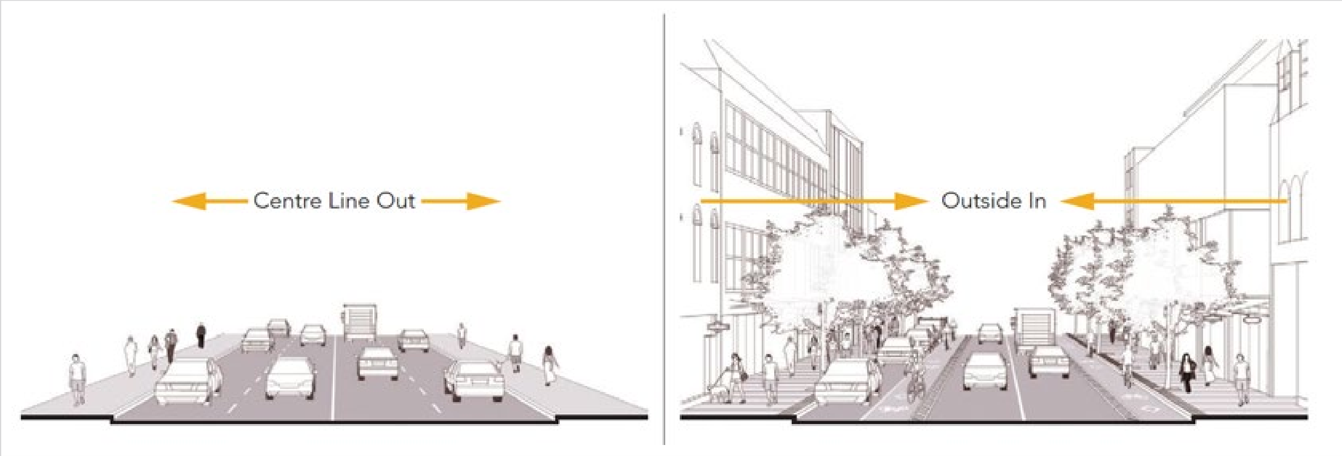

Figure 90. A shift from prioritizing auto-mobility to multi-modal mobility and access and liveability (image credit: Complete Street Guidelines)

29 Last mile is a term used in supply chain management and transportation planning to describe the movement of people and goods from a transportation hub to a final destination in the home. It is often used in transportation planning to describe the difficulty in getting people from a transportation hub to their final destination.

TRENDS & TRAJECTORY OF CHANGE

In much of Downtown, sidewalks are narrow and overcrowded. Near Union Station, sidewalks are spilling over with pedestrians as surges of commuters rush to make their GO Train connections[30], with current pedestrian volumes of over 30,000 individuals in the morning peak hour. While some streets are going through changes in their roadway functionality in order to accommodate a larger share of active transportation (e.g. Richmond/Adelaide cycle lanes, King Street Pilot Study, REimagining Yonge Street), most street configurations will not be changed substantially in the coming years, as costs of redesigning and rebuilding is a major impediment.

Therefore, the greatest opportunity to expand the public realm is through development, by setting buildings back at-grade to expand the boulevard and allow for pedestrian improvements. In the Downtown context, where much of the development is infill development, improvements will often be implemented on a site-by-site basis but based on an overall goal of achieving an expanded pedestrian realm. These pedestrian improvements are already encouraged through existing policies and urban design guidelines and implemented through development applications, and as Downtown continues to grow, it is essential that this happens in a consistent manner.

Large development sites may either present opportunities to improve connectivity by providing connections between or inside buildings; by providing cycling infrastructure or transit connections, they may decrease connectivity by turning its back on the human scale. Advocating for the creation of redundant systems in our pedestrian or active transportation networks allows Downtown to be resilient and flexible for all users. This requires changes that include: providing for connectivity within the built form to support these active transportation modes; buildings that respond to the street and providing a higher level of permeability within buildings.

TORONTO PLANNING & REGULATORY CONTEXT

Connectivity is recognized in the Official Plan as one of the main principles of the City's vision of a vibrant and modern city. It acknowledges that Toronto aspires to continue to be a "City of Connections", as all aspects of our daily lives are "linked and we have to understand relationships and interdependencies to ensure future success" (Chapter 2).

Figure 91. Interior connections create efficiency, convenience, and willingness for moving around the city - Brookfield Place, Toronto (image credit: Urban Toronto)

30 City of Toronto. *TOcore Proposals Report*. Toronto, 2016.

The City-Wide Tall Building Guidelines, Avenues and Mid-Rise Buildings Study and other Downtown SASPs provide guidance on creating wider sidewalks. Specifically, the minimum curb to building face width ranges from 6.0 metres (Tall Buildings Guidelines) and 4.8 metres (Mid-Rise Buildings). Acknowledgement of the necessary design interventions and elements to support pedestrian, cycling, and transit activity is outlined in supportive tools such as the Complete Street Guidelines and the online Streetscape Manual.

Overall, the City's built form regulations generally do not identify permitted building frontage length beyond the setback controls, which impacts the frequency of mid-block connections. The Mid-Rise Performance Standards identifies a maximum block length and the City-Wide Tall Building Guidelines identifies a minimum frontage transparency for retail spaces. **Refer to Appendix N for full Toronto planning and regulatory context excerpts.**

PRECEDENTS OF GUIDELINES & REGULATIONS IN OTHER CITIES

Connectivity is a core principle for all cities studied, but each one varies in its approach in classifying, quantifying, or qualifying connectivity. **Refer to Appendix N for full excerpts and additional graphics from the precedent city research.**

London, Ontario - The London Plan (2016)

Within their Official Plan, London demonstrates an understanding of the harmonious relationship that is required between transportation and development. Further, it emphasizes accessibility and that all parts of the transport network must be "used safely, easily, and with dignity by all Londoners" (Chapter 6.1) as a priority of city building that is reflective of connectivity goals.

New York City, USA - Active Design: Shaping the Sidewalk Experience (2013)

These guidelines are able to capture the sidewalk experience by quantifying the physical range of sight along the vertical or horizontal dimensions. It understands that the 'human scale' can be measured and used to design streets, with the ground floors having the most direct and intimate impact on the pedestrian.

> "The human eye typically perceives the space within the angles of 50-55° above and 70-80° below a horizontal line [...] the vertical height most intensely experienced by the pedestrian is the lower one-two floors of a building. This lower portion of the wall plane is most successful when it contains a sufficient level of detail and articulation [...] more closely readable to the human eye, and renders the sidewalk experience interesting and engaging for the walker".
>
> "I. The scale of the Street: 100 metres is the farthest distance that the human eye can see people/objects in motion".

Figure 92. Figure from New York City Active Design Study, showing scales of pedestrian experience and time of travel

"II. The scale of the Building: roughly 25 metres is the distance at which the human eye can begin to read facial expression. It is the mid-scale of the rhythm often demonstrated when there are a series of different buildings, and therefore vertical distinctions between them, on the same block".

"III. The scale of the Establishment/Unit: 0 to 7 metres is the scale at which the senses are most engaged with the complexities of façade articulation, active entries, transparency, textures, awnings, signage, architectural details".

New York City, USA - Active Design Guidelines (2010)

New York City has a collection of active design guidelines that analyzes the critical elements of the street and sidewalk network that best create an accessible and pedestrian or cyclist-friendly environment for all. This includes adequate buffers between pedestrians and vehicles, minimizing mid-block vehicular curb cuts, and making direct links between bicycling and transit (Chapters 2.7, 2.9 & 2.11). Furthermore, the guidelines defines the relationship between transportation and development with five variables:

"Researchers have identified five 'D' variables that are key to analyzing the relationship between urban design and travel patterns: Density, diversity, design [...] destination accessibility and distance to transit [...] developing and maintaining these five qualities is therefore essential to promoting active living through urban design and planning".

New York City, USA - Zoning Regulation

New York City requires development to include pedestrian circulation spaces. Specifically, it is included in Chapter 37-52 of the City's Zoning Regulation, which lists a variety of spaces (e.g. arcade, sidewalk widening, public plaza, etc.) and the type of lots (corner, through, or interior) that can and are required to provide such spaces.

Melbourne - Places for People (2015)

The "Places for People" is a long-term, city-wide study that has recently adopted a new analysis called the Local Liveability Study that aims to challenge the thinking around

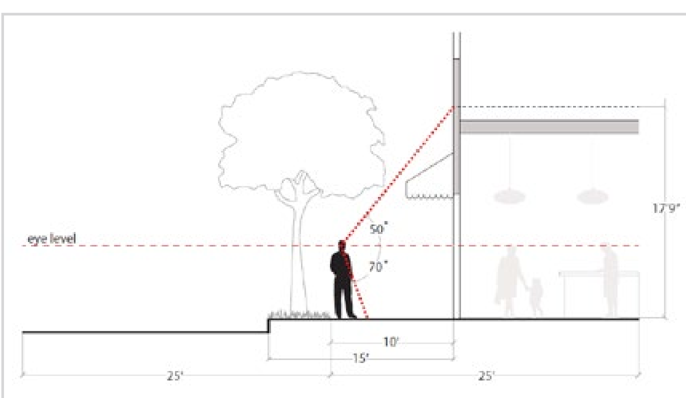

Figure 93. Figure from New York City Active Design Study, showing the relation of the human scale to the sidewalk room

Figure 94. Illustration from San Francisco Urban Design Guidelines, showing how the facade can be used to define the streetwall at the unit scale

planning and design. In this document, The City of Melbourne considers laneways as a type of critical public space that both permeates the street grid to allow for higher connectivity, but also as an animated place for public activities. The availability of these places both in the day and the night is an important feature that "changes the nature of the immediate area".

> "As individual places, laneways offer a welcome juxtaposition to the central city's uniform street grid. Their smaller scale intensifies sensory interaction, with the physical space positioning aesthetic details, sights and smells at a range more easily discernible to humans: this is known as the 'human scale'".

Melbourne - Planning Scheme (updated 2017)

The direction expressed in the Places for People study has been adopted into its Planning Scheme: "Lanes provide some of the most important and unique public spaces within the Central City. They provide a setting for people, buildings and activities, and more importantly the exchange between these elements". (Clause 22.20 Lane Policy)

San Francisco - Urban Design Guidelines (2017)

These guidelines believe in promoting a harmonious relationship between open spaces, streets, and buildings. By providing breaks in the streetwall, scaling blocks to influence the street, or ensuring that all open spaces are connected to create a greater network, these guidelines are prescriptive in its approach to facilitate a more pedestrian-friendly envrionment.

Florida, USA - Envisioning Florida's Future: Transportation and Land Use in an Automated Vehicle World Final Report (2016)

Recent research cautions of the potential scale of the Automated Vehicle (AV) market and its capacity to deeply alter the established commuter modal split in cities. Several municipalities have been developing studies to assess how AV technology might impact the built environment in the coming decades, with special attention to road design and public realm. This report summarizes the work of a research team from Florida State University's Department of Urban & Regional Planning to envision the impact of AV technology on Florida's communities. Key findings include: narrower traffic lanes, removal of medians, higher drop-off activity and therefore a new approach to access management within developments, less cluttered urban spaces due to removal of signage requirements, slows down pedestrian/cycling movements, but also encourages redevelopment opportunities. Generally, the competing demand for curb space will possibly require longer, wider and/or more regulated sidewalk zones. The incorporation of AV technology in our built form thinking is important for future-proofing the Downtown.

"How Do Different Modes Compare?" - PlanItMetro Blog (2014)

This article analyzes the pros and cons of different transit modes and the various purposes they serve[31]. The study compares different jurisdictions to see what external factors and trade-offs also influence mode selection in different municipalities. The main driver of mode choice is typically driven by existing transit and land use measures; a chart (Figure 96) was developed to compare commuter rail, commuter bus, heavy rail, light rail, streetcar, bus rapid transit, and enhanced bus modes to land use intensity (household density and employment density), vehicle capacity, stop spacing, trip length, and overall capital/operating costs.

This study demonstrates how different densities, and therefore different building types, can be more appropriate

31 Allison. *How do different modes compare?* PlanItMetro: Metro's Planning Blog, 2014.

than others, depending on the transit service provided. While higher densities are appropriate for transit hubs, midrise buildings are most suitable along linear transit systems where they provide a continuous framing and animation of the adjacent public realm.

Mode	Right-of-Way	Corridor/Station Area Land Use Intensity [1]						Capacity [2]		Distance		Cost [3]	
		Households per Acre			Employees per Acre								
Local Examples		Local Min-Max Examples	Suburbs	Central Jurisdictions/ Core	Local Min-Max Examples	Suburbs	Central Jurisdictions/ Core	Passengers per Vehicle	Corridor (passengers per hour per direction)	Station/Stop Spacing (average)	Passenger Trip Length (average)	Capital Cost	Operating Cost (per passenger mile)
Commuter Rail VRE MARC	Dedicated	<1 - Stafford County; 13 - Silver Spring	2-4	>4	<1 - Stafford County; 140 - L'Enfant Plaza	N/A (Typically residential or Park-and-Ride)	N/A (Varies by corridor and terminal stations)	90-190 seated	2,500 - 40,000	2 - 10 miles	24 miles	$ - $$$ • $5 - $100 million per mile • $33 million per 8-car train with locomotive	¢ $0.30 - $0.50
Heavy Rail Metrorail	Dedicated	1 - Branch Ave Metro; 27 - Columbia Heights Metro	12-18	>18	1 - Addison Rd Metro; 350 - Farragut West Metro	25-35	>35	65-75 seated 100-120 total (Metrorail)	25,000 (Metrorail)	0.5 - 1 mile	5 miles	$$ - $$$ • $100 - $600 million per mile • $80 - $300 million per station • $22 million per 8-car train	¢ $0.30 - $0.50
Light Rail Purple Line (Planned)	Dedicated / Shared	6 - Purple Line Corridor	3-7	>7	12 - Purple Line Corridor	8-18	>18	40-80 seated 180 total	3,600	0.75 - 1.5 miles	5 miles	$$ - $$$ • $50 - $150 million per mile (includes vehicles)	¢ $0.40 - $0.80
Modern Streetcar Columbia Pike Streetcar (planned) DC Streetcar (under construction)	Dedicated / Shared	13 - Columbia Pike; 19 - H St NE	3-6	>6	30 - Columbia Pike; 50 - H St NE	5-15	>15	30-50 seated 120 total	1,200	0.5 mile	4 miles	$$ • $30 - $80 million per mile (includes vehicles)	¢ $0.50 - $0.85
Commuter Bus MTA Commuter Bus PRTC OmniRide Loudoun County Transit Private Operators	Dedicated / Shared	N/A (Long distance point-to-point service)						45 - 65 seated	100 - 1,000	Varied; Stops Clustered at Route Start and End	20 - 60 miles	$ • $500K - $600K per vehicle	¢ Dependent on operator
Bus Rapid Transit Corridor Cities Transitway (planned) CCPY Transitway (under construction)	Dedicated	2 - Corridor Cities Transitway; 11 - CCPY Transitway	3-6	>6	8 - Corridor Cities Transitway; 44 - CCPY Transitway	8-18	>18	60 seated 95-105 total	1,900-2,100	0.5 mile	5 miles	$$ • $5 - $30 million per mile • $500K - $800K per vehicle	¢ $0.40 - $0.60
Enhanced Bus Metrobus MetroExtra Priority Corridor Network (planned)	Shared	3 - various suburban PCN lines; 26 - 16th St NW line	3-6	>6	3 - various suburban PCN lines; 108 - 16th St NW line	8-18	>18	40 - 45 seated 60-70 total	1,200-1,400	0.25 - 0.5 mile	4 miles	$ • $250K - $2 million per mile • $400K - $750K per vehicle	¢ $0.40 - $0.65

[1] Land Use Intensity as measured within 1/2 mile of Metrorail stations or transit corridors
N/A = Not Applicable

[2] Vehicle and Corridor Capacity based on recent WMATA and other industry experience, APTA National Transit Database, and VDRPT Transit Service Design Guidelines
[3] Capital and Operating Costs based on recent WMATA and other industry experience, APTA National Transit Database, and VDRPT Transit Service Design Guidelines

Figure 95. Comparison of various transit modes (based on Washington Region local examples) and their relationship to land use intensity (residential and employment), capacity, distance, and cost (image credit: planitmetro blog)

FINDINGS

- Pedestrian connectivity is increasingly important in the Downtown context, given the finite space in the rights-of-ways, and the increased demand for walking, cycling and surface transit. Given the increased number of pedestrians, there is a need to enhance and expand the sidewalk network.
- Downtown's small blocks and narrow rights of ways enhance connectivity. Connectivity is further enhanced through mid-block connections and breaking up of blocks by the introduction of open spaces.
- The PATH and other climate-controlled pedestrian networks provide a strong network of connections and reduce the intensity of pedestrians on Downtown sidewalks, particularly during business hours and in inclement weather.
- Decreasing personal car ownership, increasing use of ride-sharing programs and the potential use of

(CONTINUED)

FINDINGS (CONTINUED)

autonomous vehicles will increase the need for drop-off locations for both people and goods. This could challenge the continuity of the pedestrian realm and bicycle infrastructure.

- In most cities, 'connectivity' is rarely thought of as a complete multi-modal system, but rather as separate networks of cycling, walking, transit, and vehicular traffic. This can result in gaps for transfers between modes.
- When Toronto's planning framework is compared to those of other cities, the current requirements for the provision of pedestrian circulation spaces associated with new developments requires a higher and more detailed level of classification space, as seen in New York City's Zoning Regulation (e.g. arcade, plaza, entrance area, etc.).
- Laneways serve an important transportation capacity function. The increased use of laneways for pedestrians and cyclists can contribute to connectivity, provided it does not negatively impact the utility, safety, and function of the space.

RECOMMENDATIONS

1. **Increase the pedestrian space at-grade by requiring a minimum 6-metre sidewalk or boulevard between the building face and curb throughout Downtown.**
2. **Require more than 6 metres where increased pedestrian intensity and activity is anticipated.**
3. **Limit building frontages to a maximum of 100 metres to maximize pedestrian connectivity and break up long building frontages with midblock connections, open spaces, atriums or breezeways.**
4. **Design and mass buildings to contribute positively to legibility of the pedestrian circulation system, through wayfinding and building design.**
5. **Promote connections and expansions of the PATH and other climate-controlled pedestrian networks.**
6. **Promote the use of publicly-accessible interior communal spaces, such as atriums and wintergardens.**
7. **Encourage the use of underutilized laneways to provide public, intimate pedestrian spaces that permeate the urban fabric and provide higher connectivity, safety and accessibility.**
8. **Develop a classification of pedestrian circulation spaces (e.g. arcade, plaza, entrance areas, etc.) to encourage new developments to provide connectivity in various forms, such as differentiating plaza spaces from pathways.**
9. **Require new developments to contribute to pedestrian connectivity through provision of on-site connections and responding to the block and broader context.**
10. **Allocate drop-off spaces within buildings to reduce the need for at-grade turnarounds or lay-bys, thereby improving the public realm.**
11. **Design residential and visitor cycling amenities to ensure that they are convenient, visible and accessible, including providing signalization and the opportunity to be operated remotely.**

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