4.0 Design Toolbox

4.1 Design for Thermal Comfort: Overall Strategy

4.2 Design Toolbox: Design at the Neighbourhood Scale

4.3 Design Toolbox: Design at the Block scale

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4.1 DESIGN FOR THERMAL COMFORT: OVERALL STRATEGY

Designing with thermal comfort in mind should be a fundamental consideration from the outset of any development project. By implementing the design strategies outlined in this section, we, as a city, can proactively create public spaces that prioritize the physical and mental well-being of those who live, work, learn, play in, and visit the city, particularly as the climate changes. The guidelines emphasize the importance of integrating thermal comfort considerations into the core fabric of a project's planning and design strategy and strongly discourage addressing thermal comfort as a secondary consideration. The following sections outline the key steps in applying the thermal comfort lens to projects.

Within Toronto, two distinct climates emerge due to proximity to Lake Ontario: the 'Waterfront' area, which is cooler and breezier, and the 'Inland' area, which is warmer and less influenced by the lake.

4.1.1 Understand What Impacts Thermal Comfort:

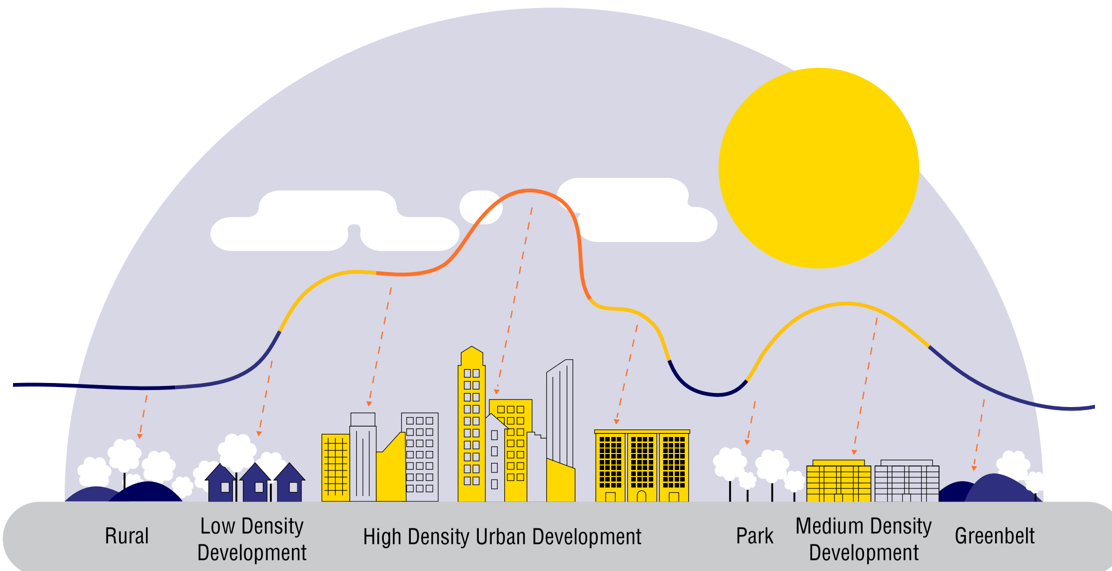
As described in Chapter 3, thermal comfort is mainly influenced by a combination of air temperature, radiant temperature, humidity, and wind speed, though other factors can influence how a person feels. The built environment, in particular, can impact wind speed and radiant temperature. With every design decision, keep in mind how the decision impacts thermal comfort's key influencing factors, and how those design features work with together or conflict to create comfortable environments.

4.1.2 Understand the Climatic Conditions:

Climatic conditions, including prevailing winds, access to sunlight and shade, play pivotal roles in shaping the microclimate of a given location.

A. Toronto Climate Context:

Toronto has a semi-continental climate, with warm, humid summers and cold winters, moderated by Lake Ontario on the southern boundary of the city. Spring and autumn (shoulder seasons) are shorter than summer and winter, featuring varied weather with alternating periods of dry, sunny weather and rain. The majority of days in the spring and autumn are sunny and pleasant, with moderate rather than cold temperatures. Nights are cool, but frosts are rare. Winters in Toronto are cold, and snowfalls are frequent. The high annual and in-season variability of thermal conditions and significant freeze-thaw cycles pose challenges to maintaining and operating the public realm. The shift toward a warmer global climate on average has been accompanied by an increase in warm extremes and a decrease in cold extremes.



Urban Heat Island Effect

B. Urban Heat Island Effect:

The Urban Heat Island (UHI) effect refers to the phenomenon where urban areas experience higher temperatures than their rural surroundings. This effect results primarily from the absorption and retention of heat by buildings, roads, and other structures, which replace natural vegetation and soil that would typically cool the area through shading and evapotranspiration. UHI is intensified by human activities such as transportation, energy usage, and industrial processes, which release additional heat.

In Toronto, the urban heat island (UHI) effect is uniquely influenced by the city's proximity to Lake Ontario, where temperature and humidity can be moderated by the lake and land breeze mesoscale phenomena. This creates distinct "Waterfront" and "Inland" climates within the city, with the main differences being changes in wind profile and humidity levels. Proximity to the shoreline leads to windier and more humid conditions, while inland areas tend to be warmer and drier. Wind plays a significant role in the calculation of external thermal comfort – particularly in cooler climates like Toronto, where it can alleviate heat in warmer seasons but also contributes to wind chill in colder weather.

C. Projected Climatic Conditions

The weather data used to create the baseline climate for thermal comfort assessment in Toronto is based on projections representing the region's climate in 2050. These projections reflect typical future conditions rather than extremes, so they cannot predict extreme weather events like heatwaves. However, they do account for trends showing an increase in average temperature.

For both coastal and inland conditions, the forecast data indicates that the annual average air temperature will be 2.8°C higher than currently experienced in Toronto. This increase varies throughout the year, with the most significant changes occurring during winter and summer.

4.1.3 Analyze the Development Area's Microclimate:

Every site has its unique microclimate, influenced by factors such as proximity to water bodies, topography, built environment, and vegetation. Understanding these microclimatic conditions is vital for designing spaces that are more comfortable. The existing and planned infrastructure and built form around the site can offer clues about potential thermal comfort challenges or opportunities. Consider the unique features of the development context such as:

A. Wind Direction: Wind can significantly affect thermal comfort, especially in colder months. Understanding the prevailing wind directions and velocities throughout the year helps in designing buildings and landscape elements that can serve as windbreaks or, conversely, enhance natural ventilation during warmer months by channeling the prevailing winds of that season.

B. Sunlight Analysis: Understanding the site's exposure to sunlight throughout the year is essential. This involves studying the sun's location and trajectory, considering the surrounding buildings and natural features that might cast shadows, and assessing how these factors change with the seasons. A site with limited sun exposure in colder months could be less comfortable compared to one that receives ample sunlight; it might require different strategies to improve comfort conditions.

C. Land cover: The type of land cover in a specific area can significantly impact the thermal comfort of that site. Different materials, such as asphalt, grass, water, and concrete, have distinct thermal properties that directly influence the temperature of the surroundings. Urban areas with a predominance of asphalt and concrete can contribute to the urban heat island effect, where temperatures are higher than in surrounding rural or built-up areas. This effect is due to the increased heat absorption, storage, and reduced natural cooling provided by vegetation. Conversely, lands covered with grass and vegetation absorb less heat in comparison and can provide a cooler and more comfortable environment during the summer.

Toronto's future weather projection

According to the Pacific Climate Impacts Consortium (PCIC), Toronto's air temperatures in 2050 are projected to increase as follows:

Seasonal Temperature Changes:

- Winter: +3.1°C
- Summer: +2.8°C
- Shoulder Seasons (Spring and Fall): +2.6°C

Current vs. Forecast Average Temperatures

To put this in context, it is helpful to compare the average temperatures from a typical current year with the forecast datasets:

Inland:

- Current average: 9.3°C
- 2050s average: 11.5°C

Waterfront:

- Current average: 8.8°C
- 2050s average: 12.1°C

An update to climate projections for Toronto will be made in 2024 in collaboration between the City of Toronto and the Toronto and Region Conservation Authority (TRCA).

Thermal Comfort in Employment Areas

In Toronto's Employment Areas, characterized by industrial buildings, dominance of asphalt and concrete, and limited greenery, several challenges to thermal comfort arise. Impermeable structures and large expanses of parking lots in industrial areas significantly contribute to heat absorption, exacerbating the urban heat island effect.

Trees, as part of Toronto's urban forest, are essential for keeping the city cool and comfortable. They provide shade and release moisture, creating a natural cooling effect.

D. Proximity to Temperature Moderating Features:

The design of urban spaces adjacent to water bodies or green features influences the creation of microclimates, impacting the thermal experience of these areas.

- Bodies of water: Water has a unique ability to moderate temperatures. Bodies of water, due to their high heat capacity, absorb and release heat more slowly than land surfaces. Areas adjacent to water bodies, such as lakes or ponds, exhibit a moderating effect on temperatures, contributing to a more stable and pleasant thermal environment.
- Trees: Trees represent one of the most effective ways to keep Toronto healthier and more thermally comfortable. Urban forests and ravines contribute to thermal comfort through shading. Trees provide shade—deciduous trees, for instance, offer dynamic shade (providing shade in the summer while allowing sunlight in the winter)—reducing the direct impact of sunlight on surfaces during the summer. Trees also release moisture through a process called evapotranspiration, which can have a cooling effect on the surrounding air.

Urban development shapes microclimates by affecting wind patterns, sunlight, and temperature.

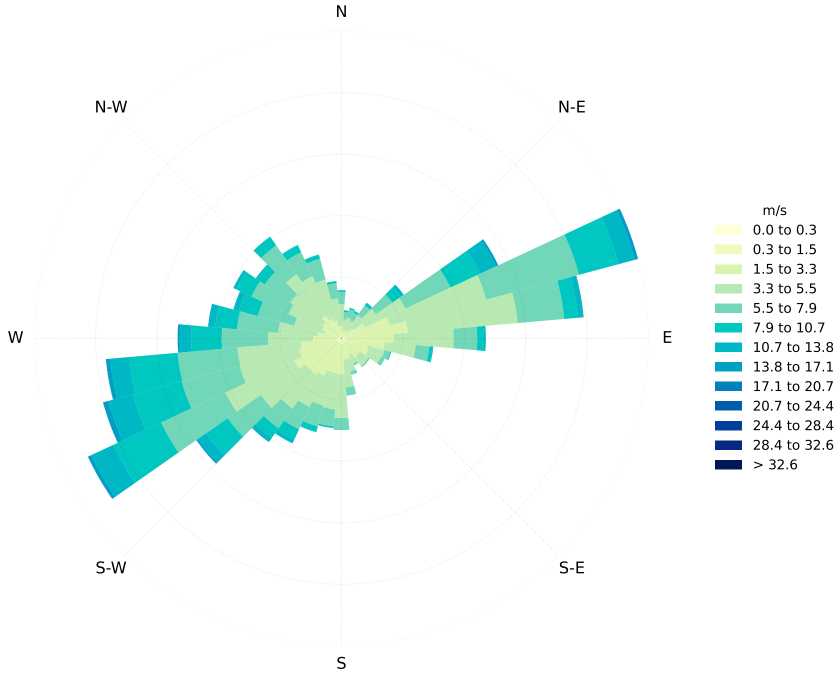
E. Urban Development

Urban development plays a crucial role in shaping an area's microclimate by influencing wind patterns, access to sunlight, and temperature regulation. High-density developments with tall buildings can create wind tunnels that accelerate wind speeds, while the strategic placement of buildings and landscape features can act as windbreaks, improving thermal comfort. The height and arrangement of buildings also affect sunlight penetration, with tall structures casting long shadows that reduce sunlight exposure. Thoughtful urban planning that ensures adequate spacing and optimizes building orientation can maximize sunlight, enhancing natural light and warmth.

However, urban development often leads to the removal of vegetation, including trees, and eliminates permeable spaces necessary for planting new trees, which are vital for natural cooling. Additionally, extensive use of concrete and asphalt can exacerbate the urban heat island effect, but incorporating green space, trees, green roofs, green walls, and permeable surfaces can help mitigate this, promoting natural cooling and ventilation. Understanding these impacts is essential for creating sustainable and comfortable urban environments.

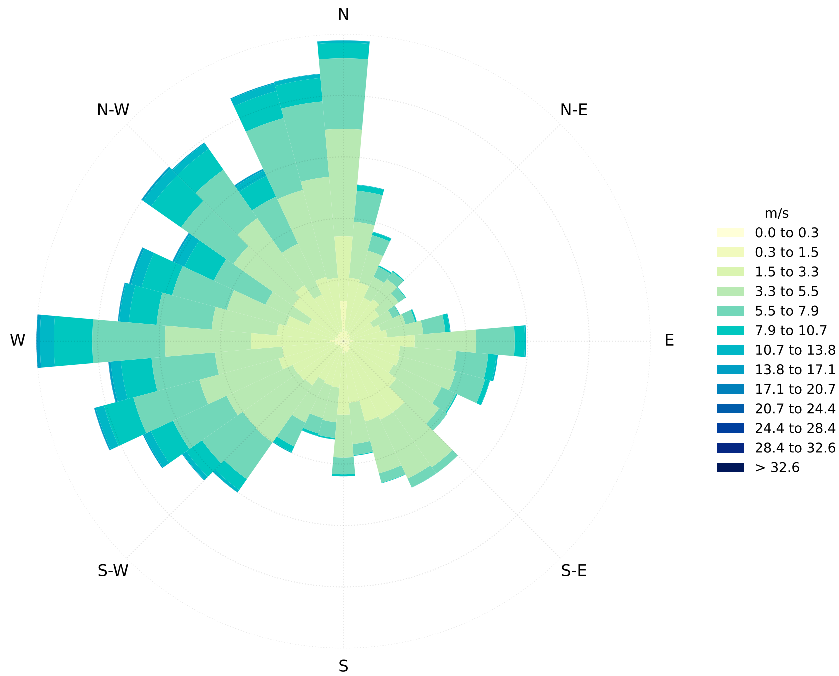
Waterfront Windrose

1998-01-01 to 2017-12-31



Inland Windrose

1998-01-01 to 2017-12-31

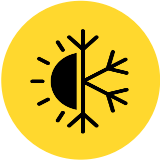


Typical wind direction in Toronto shown through windrose diagrams for Waterfront and Inland climatic conditions.

4.1.4 Understand Human Activity Patterns:

Understanding how people use or are likely to use the space can also guide design decisions and the prioritization of interventions. Areas with high pedestrian traffic might require different considerations compared to less frequented spaces.

A. Identifying Key Activity Areas: Start by identifying where the most significant human activities are likely to occur within the development and surrounding area. This could include areas with high foot traffic, such as busy sidewalks and areas for socializing, recreation, commerce, or transit. Understanding these activity hubs allows for a more targeted approach.



B. Design for Year-Round Activities: Recognize that activity patterns may change with the seasons. Spaces that are popular in summer, like outdoor plazas, might be less frequented in winter. Designing these spaces to be adaptable, such as converting a summer plaza into a winter skating rink, can keep the area lively year-round.

C. Design for Active and Passive Uses: When designing urban spaces, considering the level of activity, such as sitting, standing, walking, in relation to thermal comfort, is essential for creating environments that are both functional and comfortable throughout the year. Active areas, like sports fields and jogging tracks, require cooling strategies such as opportunities for shade and exposure to wind to counteract the increased body heat generated by physical activities. Conversely, passive areas, such as seating zones and gardens, benefit from strategies that provide a balanced access to both sunlight and shade.

Understanding where people gather helps prioritize areas for enhanced thermal comfort.

Toronto Parkland Strategy

The Parkland Strategy provides the City with a long-term vision and framework for the enhancement of Toronto's parks system through the creation of new parks, the expansion of existing parks, and the provision of improved access to them. The Parkland Strategy is a planning framework that includes the Park Catchment methodology, Parks Planning Priorities, and Acquisition Prioritization framework, and that can be implemented through Development Review and Planning Studies.

Toronto Ravine Strategy

The Toronto Ravine Strategy document outlines a comprehensive approach to managing and enhancing Toronto's extensive network of ravines with a focus on balancing protection and sustainable use. It sets out five guiding principles: Protect, Invest, Connect, Partner, and Celebrate, each with specific actions for implementation.

Toronto Strategic Forest Management Plan

The Strategic Forest Management Plan is a functional document that provides regional context, outlines current practices, and defines future direction for local urban forest management. This Plan provides direction for forest management over the next 10 years through the vision, strategic goals and a series of actions that address the key management challenges identified for Toronto's urban forest.

4.1.5 Apply an Equity Lens:

As emphasized in Chapter 2 – Guiding Principles, the intent of the guidelines is that focused attention should be given to vulnerable populations and areas that are disproportionately affected by extreme climatic conditions (e.g., seniors, youth, individuals experiencing homelessness, and communities in areas disadvantaged in terms of access to high-quality public open spaces). To effectively apply an equity lens in designing for thermal comfort, consider the following steps and guidance:

A. Enhancing Tree Canopy Using Toronto's Tree Equity Score Analyzer (TESA): The Tree Equity Score Analyzer (TESA) tool, developed by the nonprofit organization American Forests, assigns scores ranging from 0 to 100 to indicate the level of tree equity within a community. A lower score signifies a higher priority for addressing the tree canopy gap in that neighbourhood, while a higher score, closer to 100, indicates robust tree equity. The tool integrates tree canopy cover data with demographic and socio-economic information to pinpoint opportunities for expanding canopy cover at the neighbourhood level. Tree equity is defined by the adequacy of tree coverage in a neighbourhood, ensuring that all residents can benefit from the trees. Urban Forestry is adopting this innovative approach to address the inequitable distribution of urban forests across communities, aligning with the City's goal of achieving 40 per cent tree canopy cover. Toronto is the first Canadian municipality to use the Tree Equity Score Analyzer to strategically enhance canopy growth at the neighbourhood scale.

B. The Parkland Strategy: Prioritize areas with low parkland provision, as identified by the Parkland Strategy. Parks need to be located in a way that reduces disparities in access, ensuring all Torontonians can enjoy high-quality parks and natural spaces throughout the city. The Parkland Strategy provides the City with a long-term vision and framework for the enhancement of Toronto's park system and has been developed to address the planning, acquisition and development of parks to ensure that Toronto's parks system will grow to support the needs of people and maintain a livable city.

C. Focus on High-Density Residential Areas: Prioritize areas with a high-density residential development for the development of comfortable public outdoor spaces. In these neighbourhoods, many of the residents rely on public amenities for access to outdoor space. These shared spaces support large populations and are under increasing pressure as the city grows. The City of Toronto has a 20-year plan set in 2019 that already prioritized parkland acquisition, where the development of comfortable public outdoor spaces can be achieved.

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D. Use Neighbourhood Profiles for Data-Driven Planning: The City's 'Neighbourhood Profiles' provide socioeconomic and age data for each neighbourhood. This resource can help identify areas where public outdoor amenities might be lacking and where residents, especially certain age groups, might be more vulnerable to the effects of extreme weather conditions. Understanding the age demographics is crucial for tailoring outdoor spaces to meet the specific needs of different age groups, from playgrounds for young children to accessible walking paths for seniors.

E. Designing Around Child Care Centres, Schools, Playgrounds, and Senior Spaces: Prioritize thermal comfort in and around childcare centres, schools, playgrounds, and areas frequently used by seniors. Both children and seniors are more vulnerable to temperature extremes, making it essential to ensure these spaces provide adequate thermal comfort for their well-being.

F. Improving Walkability for All Abilities: Design sidewalks and public spaces with children, seniors, and differently abled bodies in mind. Ensure that routes are thermally comfortable by maximizing the planting and maintenance of street trees and providing rest areas with comfortable seating. Ensure that all public spaces are accessible and inclusive, especially for those with mobility challenges.

Toronto's diverse range of weather conditions call for flexible design solutions such as movable furniture and structures.

4.1.6: Designing for Seasonal Variability:

Toronto's approach to thermal comfort in public spaces is a unique challenge due to its semi-continental climate. The city experiences a diverse range of weather conditions throughout the year. The impact of climate change is expected to make Toronto's weather warmer and wetter – increasing the frequency of extreme weather incidents throughout the seasons.

Warmer temperatures mean the risk of heat stress increases throughout the year, and while not expected during winter months the effects of these temperatures also impact other conditions like rainfall events becoming more intense as warmer air can hold more moisture. This necessitates a versatile and adaptive design strategy for public spaces to ensure thermal comfort year-round. In Toronto, where the climate varies from hot, humid summers to cold winters, the design of public spaces involves a thoughtful integration of natural elements and built form strategies to ensure comfort throughout the year.

During hot summers, mitigating high temperatures and humidity is essential. Tree canopies help lower temperatures by shading surfaces and through evapotranspiration, which releases moisture into the air, cooling it. Beyond tree canopies, other forms of green infrastructure such as green roofs, planted meadows, and various types of green spaces also contribute to reducing the urban heat island (UHI) effect. Complementing this, water features like fountains provide immediate cooling relief through the same evaporative processes. Additionally, incorporating shade structures like pergolas or awnings enhance shade while using light-reflecting materials and vegetation minimize heat absorption. These combined approaches effectively combat the urban heat island effect, creating comfortable public spaces during summer.

In colder months, different strategies are necessary. Building designs can minimize wind channeling and downwashing, while landscape designs can include natural barriers that protect public outdoor spaces from strong winds. Maximizing sun exposure is crucial for mitigating the cold, ensuring that areas remain well-lit and warm during the shorter days.

During the transitional spring and fall seasons, the presence of deciduous trees is particularly beneficial. These trees provide shade in the summer and, as they lose their leaves in autumn, allow sunlight to filter through, warming spaces in the colder months. This natural adaptability makes them an ideal choice for providing seasonal thermal comfort.

Several Toronto parks offer a form of community and civic amenities as well as ecological elements. Each park receives different levels of solar access due to its surroundings, and local environmental conditions also vary, making each park unique. The design and size of parks should support a variety of year-round programming, maximize sunlight exposure, offer ample shade for visitors, and ensure safety and accessibility for people of all ages and abilities.

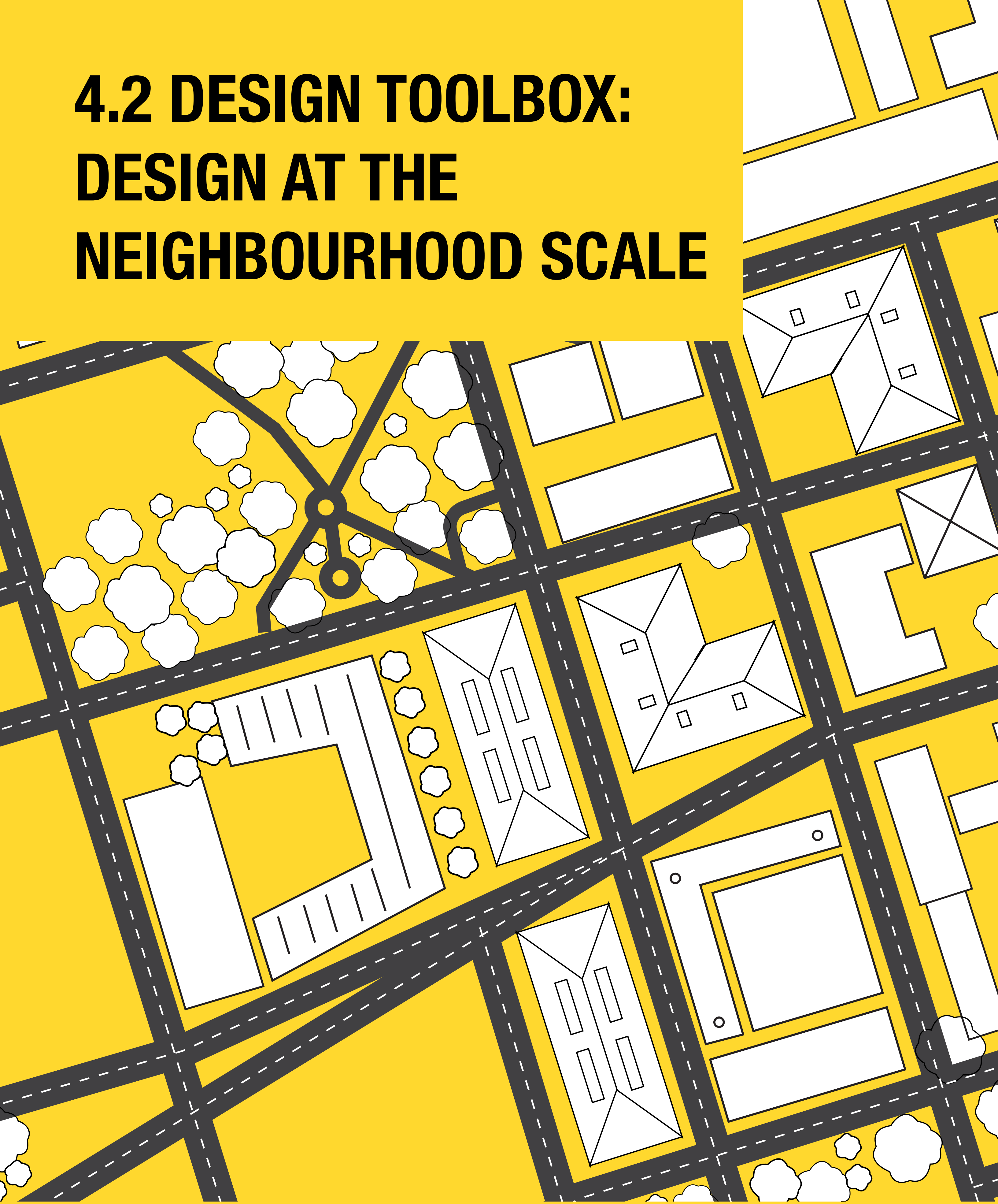
Moreover, these seasons call for flexible design, with modular elements in furniture and features that can be adjusted or moved as the weather changes. Mixed-use spaces are advantageous, serving varied purposes across seasons, such as transforming open spaces into ice rinks in winter or event spaces in summer.

The table below provides an outline of how different environmental elements like vegetation, shade, shelter, wind, and moisture can have varying impacts on thermal comfort depending on the season.

	Positive Impact in Cold Season	Negative Impact in Cold Season	Positive Impact in Warm Season	Negative Impact in Warm Season	Summary
Vegetation	Acts as natural windbreaks, reducing wind exposure.	Conifers can lead to reduced solar gain due to shading, lowering temperatures.	Provides shade and natural cooling, effectively lowering ambient temperatures.	Partially obstruct airflow, potentially increasing perceived temperatures in summer.	Urban greening is often the most effective way to increase thermal comfort and reduce urban heat island effect.
Shade/shelter From Sun	Offers protection from cold winds, minimizing wind chill effects.	Moisture retention can lead to a damp, colder microclimate.	Reduces direct solar exposure, contributing to cooler ambient conditions.	May result in reduced natural lighting.	Urban spaces benefit from well-placed shelters that balance protection and openness. Shelter from the sun is crucial during warmer months but must also be balanced with access to sun during cooler months.
Shelter From Night Sky	Creates a sense of enclosure, offering psychological comfort in outdoor areas, and protection from the colder sky.	Blocks solar gains, which are crucial for warming spaces in colder months.	Shields from direct solar radiation during daytime, reducing heat stress and discomfort.	Increases radiant temperature overnight, leading to warmer conditions in morning.	A balance between shelter when needed and openness when not is required, and considerate design of shelters can aid in making shelter from the sky effective during both cold and warm months.
Wind	Calmer conditions reduce wind chill, making outdoor spaces more bearable.	Wind chill is a significant factor in winter discomfort, amplifying cold.	Increases evaporative cooling rate, providing relief from heat.	Can create a chill effect, making warm days feel unexpectedly cooler.	Wind provides natural ventilation and cooling, but excessive or uncontrolled wind can impact comfort. Designing spaces that harness wind's benefits while minimizing drawbacks is essential for a pleasant urban experience.
Moisture	Moderate humidity can offset the perceived dryness of winter air, enhancing comfort.	Higher humidity can increase heat loss from the body, intensifying cold.	Evaporative cooling from moisture aids in reducing heat stress.	Excessive moisture can lead to issues like mold growth, especially in shade and without airflow.	Blue spaces (including lakes, rivers, and fountains) can enhance the thermal environment during warmer periods but can also cause some drawbacks during cooler periods. man-made blue spaces require appropriate maintenance and safety measures.

Urban spaces benefit from well-placed shelters that balance protection and openness.

4.2 DESIGN TOOLBOX: DESIGN AT THE NEIGHBOURHOOD SCALE



4.2 DESIGN TOOLBOX: DESIGN AT THE NEIGHBOURHOOD SCALE

4.2.1 Pattern of Streets

Strategy

Orient the streets and blocks to optimize solar access and impede prevailing winds where possible. Strategically place outdoor open space and amenities based on the impact of the street pattern on thermal comfort.

Intent

The orientation of building blocks and streets mainly influences the wind speed and direction, and the period of solar access. The objectives are to orient the blocks and streets to minimize exposure to prevailing winds and to design with an understanding of sun path and how access to sunlight varies in different street orientations.

Guidelines

A. Design the street pattern considering the sun path on the public realm. The current street grid in Toronto results in the following:

- Summer:
  - East-West Streets: Receive sunlight throughout the day.
  - North-South Streets: Receive sunlight around midday.
- Spring and Fall Equinox:
  - East-West Streets: Generally allow for morning and afternoon sunlight.
  - North-South Streets: Receive sunlight around midday.
- Winter:
  - East-West Streets: Receive limited access to sunlight throughout the day.
  - North-South Streets: Receive sunlight around midday.

B. Design the street network and pedestrian routes to support small blocks and/or mid-block pathways and crossings, offering multiple route choices which can provide shade and shelter from wind when required.

C. Design the street network to reduce exposure to prevailing winds, when possible. East-west streets are more exposed to prevailing winds while north-south orientation may provide some natural wind protection, especially if buildings are designed to act as windbreaks for the more vulnerable east and west sides.

D. Increase mid-block crossings on long blocks that are oriented east-west to reduce long distances pedestrians must travel to reach their destinations and provide them with an option to minimize exposure to prevailing winds. North-south gaps between buildings can also increase sunlight access to east-west streets.

E. Adapt to the existing street grid by being intentional about the types of uses and programs proposed for each street orientation to improve thermal comfort. While we cannot always design a new street grid, we can strategically utilize the current layout to optimize thermal comfort and functional use based on the unique characteristics of each street's orientation.

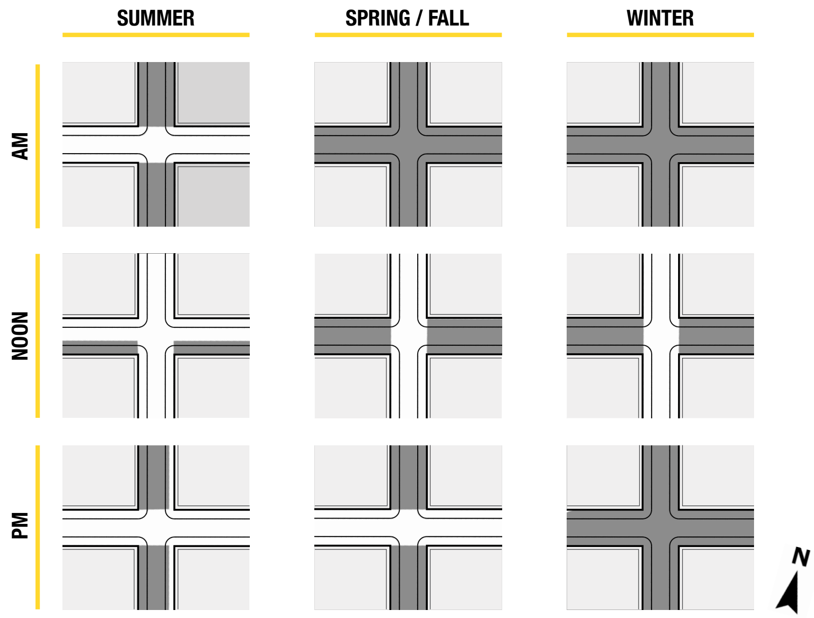
F. Determine through thermal analysis the most influential factor in the thermal comfort of that specific area. This assessment will guide the street orientation and design decisions. Ultimately, the goal is to create an urban environment that is comfortable year-round, taking into account both the sun path and wind patterns. Consequently, there might be no single 'best' orientation but rather a context-sensitive approach that considers the unique characteristics of each site and its surroundings, focusing on the predominant environmental factors impacting thermal comfort.

Toronto's Concession Street Grid

Toronto's downtown street grid consists of north-south and east-west concession lines meeting perfectly perpendicularly and corresponds to a rotation of -16 degrees from geographic North, which means that the downtown street grid aligns with sunrise and sunset in February and October.

When Toronto was founded in the 1793, the city was first surveyed to follow the shore of Lake Ontario, which results in a corresponding grid on a rotation of 16 degrees east of geographic north.

As the city expanded in the 1800s, surveyors modified the concession road alignment, particularly Yonge street which was made to better align with Lake Simcoe further north. Hence Yonge street rotates east from its established grid, north of St. Clair Avenue at Heath Street, which results in the city's major north-south streets adjusting to this shift north of Eglinton.The street grid outside downtown also often reflects constraints due to large ravine corridors which are not strictly oriented north-south.



Shadows cast during the Summer Solstice, Spring/Fall Equinox, and Winter Solstice in Toronto, demonstrated with 20-meter tall buildings spaced 20 meters apart. The illustration is based on Toronto's downtown street grid, with streets rotated -16 degrees from geographic North.

	Sunlight Access	Wind Exposure
East-West Oriented Blocks	Offer the least access to sunlight at street level but the buildings receive optimal solar gain as south-facing sides receive maximum sunlight. To address the street level sunlight access, the City Planning department has a series of sunlight related recommendations in the mid-rise and tall building design guidelines.	More exposed to westerly winds at pedestrian level, potentially increasing wind speeds in streets and open spaces, especially on west-facing sides. Soft and hard landscape (tree canopy, etc.) can help mitigate this effect.
North-South Oriented Blocks	Less optimal for winter solar gain for the buildings due to limited direct sunlight on the longer sides of the buildings but it receives sunshine around mid-day at street level when not shaded from the south.	Offers natural wind protection from westerly winds, potentially creating more sheltered east sides, with potential to increase wind on the west side from downwash from vertical facades to street-level, and wind corner acceleration.

Block orientation in relation to sunlight access and wind exposure in Toronto

Note
The guidelines provide some general guidance however, analysis may be required in some cases to determine the best combination for a given site. This becomes more important in the vicinity of tall buildings.

4.2.2 Streetscape Design

Strategy

Design the streetscape to allow for sunlight access and protection from prevailing winds, wherever possible.

Intent

The design of the streetscape should consider the impact of sunlight and wind on the thermal comfort of users as one of the key considerations. During warmer months, the objectives are to provide both areas that are sunlit and shaded spaces for repose. Also, a light breeze can be a welcome reprieve from extreme heat. Conversely, during colder months, the priority is to provide ample access to sunlight and to mitigate the effects of wind.

Guidelines

A. Street cross-sections may be asymmetrical when providing a preferential response to thermal comfort, such as a wider sidewalk on the north side of a commercial street offering sidewalk patios and/or enhanced tree planting.

B. Street cross-sections are to incorporate deciduous trees. The trees provide shade and wind dissipation in the summer and allow sunlight penetration throughout the winter, optimizing thermal comfort year-round. It is essential to ensure that the sidewalk width meets current standards and trees have access to sufficient soil volume. This is necessary for the trees to grow to a size where their canopy can effectively provide these benefits.

C. Multi-use trails are to be located on the north side of the street, if feasible, to maximize access to sunlight. This orientation increases natural snow melt during winter months, promoting safer and more comfortable walking and cycling conditions.

D. Street benches are to be strategically located to balance exposure to sunlight and protection from prevailing winds. Consider the following specific strategies:

- Placement: Locate benches in areas that receive adequate sunlight during colder months and strategically position them be positioned to benefit from shade provided by tree canopies or shade structures

- Wind Protection: Incorporate landscape features, such as hedges or low walls, near benches to act as windbreaks, reducing the cooling effects of wind during colder months. For windier sites, consider the placement of benches in the lee of buildings or solid street furniture that can block prevailing winds.

- Adaptive Design: Use movable benches where possible, allowing users to adjust their position seasonally or as daily weather conditions change. This flexibility helps users find the most comfortable spot in terms of both sunlight and wind exposure.

Street benches can be located strategically to benefit from seasonal shade cast by trees.

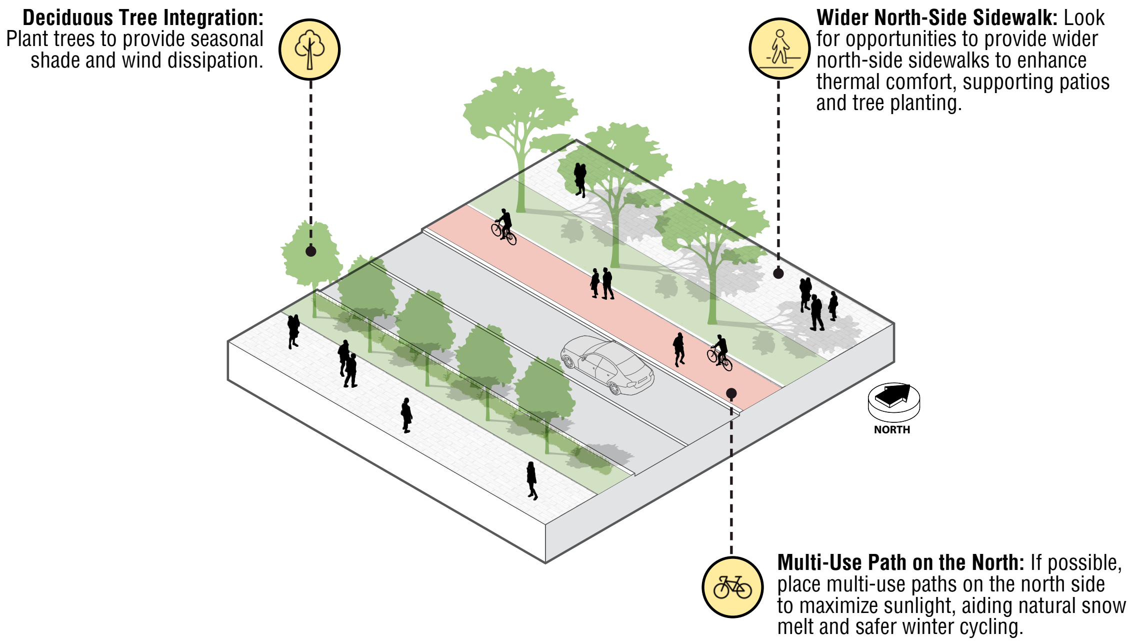


Diagram illustrating an asymmetrical street cross-section designed for optimal sunlight access and wind protection. For illustrative purposes only.

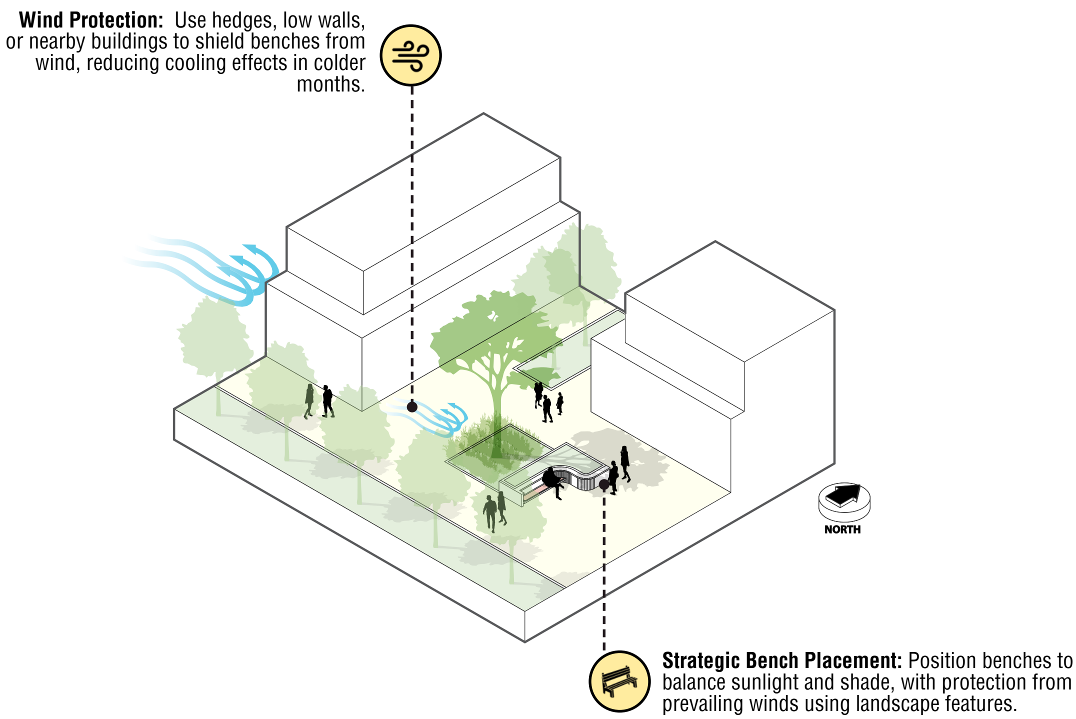


Diagram illustrating strategically placed benches to balance sunlight, shade, and wind protection. For illustrative purposes only.

4.2.3 Placement and Orientation of Publicly Accessible Open Space

Strategy

Locate, orient, and design publicly accessible open spaces including parks, plazas, and Privately Owned Publicly Accessible Spaces (POPS) to allow for sunlight access and protection from prevailing winds, wherever possible.

Intent

The location and orientation of publicly accessible open spaces should consider the impact of sunlight and wind on the thermal comfort of users as one of the key considerations when determining the placement and orientation of those spaces. Policy 3.1.3.2 of the Official Plan speaks to "prioritizing" the provision of accessible open space on blocks that have access to direct sunlight and daylight.

Guidelines

A. Locate and orient Publicly accessible open spaces to maximize sunlight penetration, if possible, such as along the south side of a block where buildings occupy the north side.

B. Provide access to sun-shelters during summer months in areas where people congregate to increase usability during periods of high air temperature.

C. Identify opportunities to expand and connect parks and green spaces. Larger parks have a more significant impact on cooling.

D. Place publicly accessible open spaces where they are shielded from prevailing winds by buildings or structures. This is of particular importance in locations where taller buildings may result in exacerbated wind conditions.

The Impact of the Size and Shape of Parks on Cooling Effect at the Neighbourhood Level

The size and shape of parks and natural features can have a significant impact on local microclimatic conditions. The cooling effects of small parks have been demonstrated to be between 1.2-2.4°C, with larger parks having a greater effect and distance around these parks where that effect can be felt up to 400 metres. These effects are further increased with vegetative landcover and water. Additionally, the shape of natural features also plays a role in affecting air temperature, with green spaces concentrated in a single region, without a complex boundary, being more effective at providing urban cooling than more complex and linear parks.[1]

[1]Feng, Xiaojing, et al. 'Quantifying and Comparing the Cooling Effects of Three Different Morphologies of Urban Parks in Chengdu'. Land, vol. 12, no. 2, Feb. 2023, p. 451. DOI.org (Crossref), https://doi.org/10.3390/land12020451.

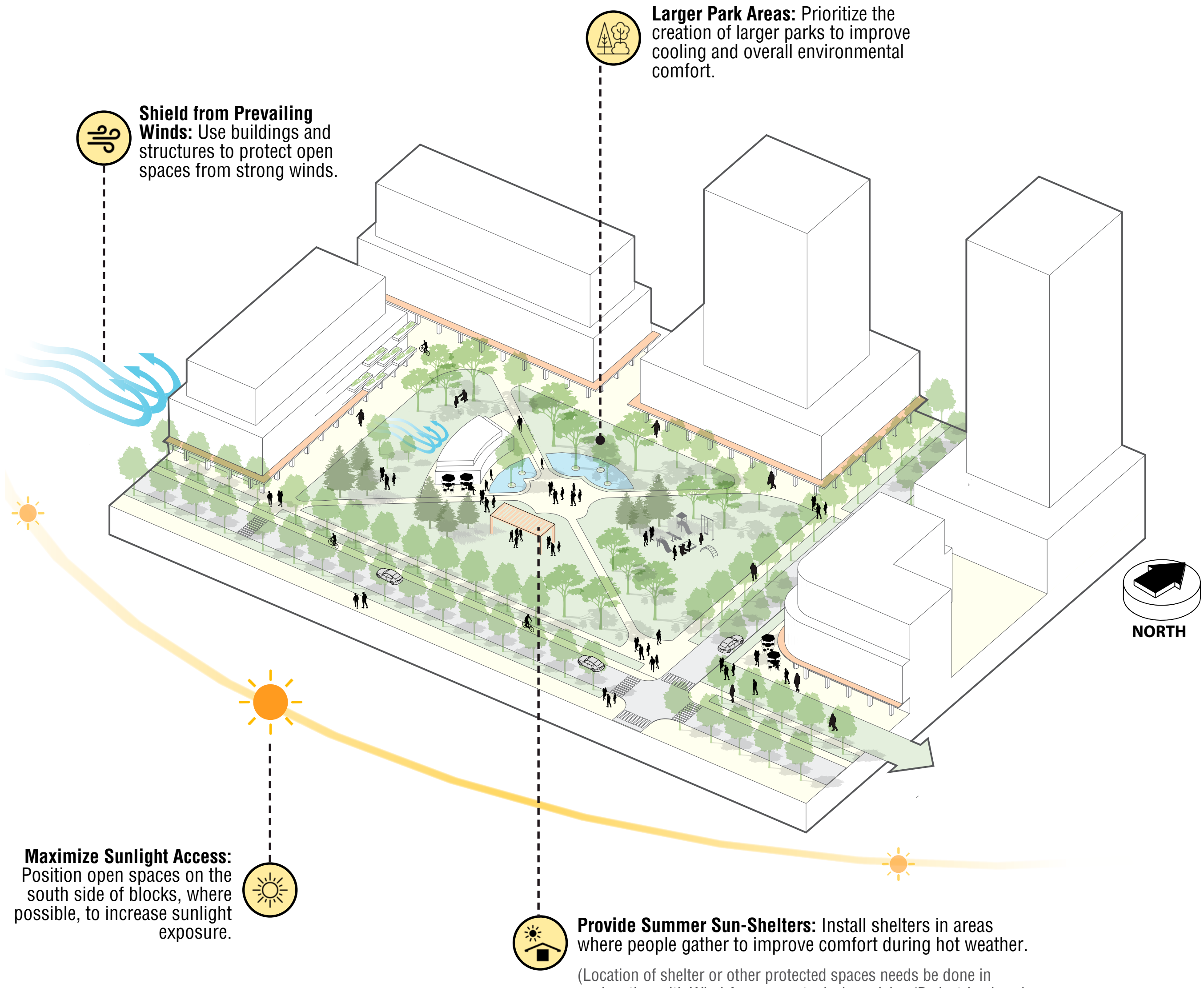


Diagram showcasing the design, strategic placement, and orientation of open spaces to maximize sunlight access and wind protection. For illustrative purposes only.

4.2.4 Proximity to Natural Features

Strategy

Leverage nearby natural features as natural cooling elements.

Intent

Cooling sources such as ravines and urban forests have significant impacts on local climates. Toronto's ravine systems contribute significantly to the city's urban forest, as they represent 38 per cent of the city's tree cover. The objective is to enhance access to the cooling effects of the natural feature, for areas adjacent to those features, to mitigate the Urban Heat Island effect on the urban built-up areas.

Guidelines

A. Preserve and expand ecological sources including forests, wetlands, ravines, natural parks, and natural reservoirs.

B. Design buildings to gradually increase in height as they move away from natural cooling sources, if possible. This stepped approach helps in extending the cooling effects further into the urban area. There are several factors affecting the benefits of cooling sources, and these need to be reviewed on an individual basis to help reap the benefits.

C. Incorporate pedestrian connections that connect neighbourhoods with these features to facilitate easier access to areas with cooler microclimates, enhancing overall urban thermal comfort.

D. Educate residents and create awareness about the City’s ravine network and promote access to it through effective signage, wayfinding, and education campaigns. This will foster appreciation and use of these natural spaces.

Toronto's ravine systems contribute significantly to the city's urban forest

Facilitate access to natural features such as ravines to improve access to areas with colder microclimate.

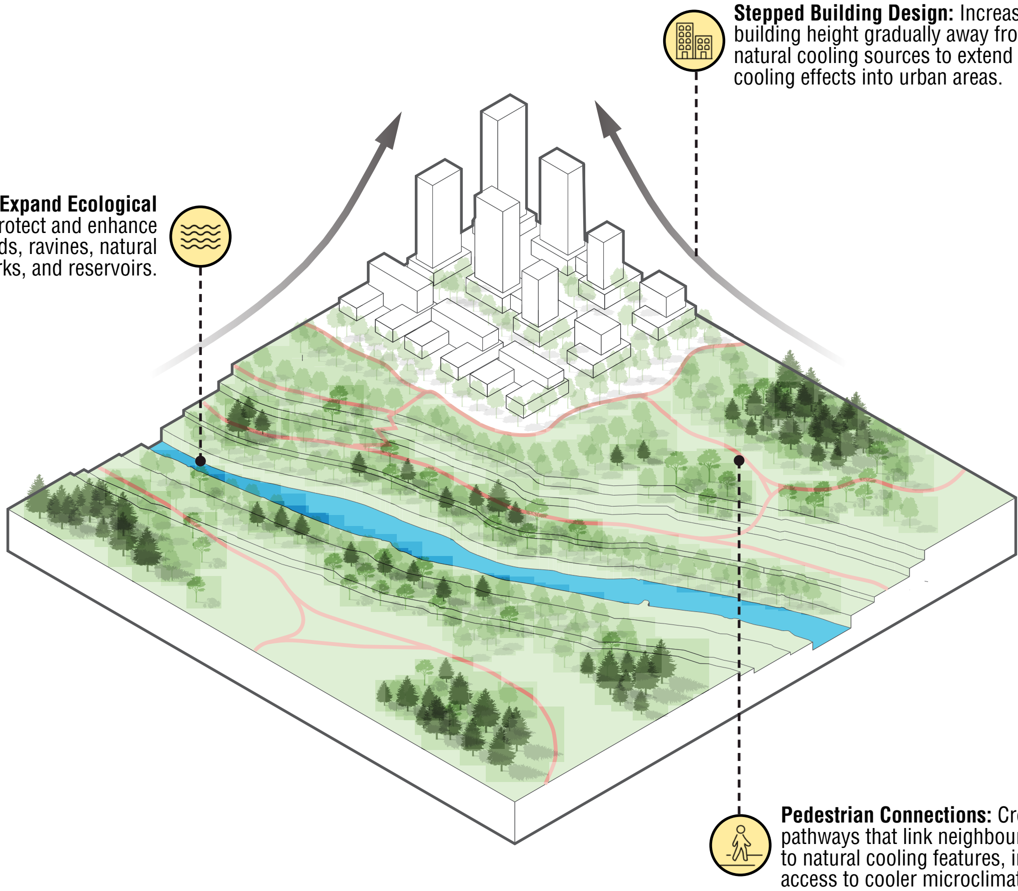


Diagram showcasing how to leverage nearby natural features as cooling elements in urban design. For illustrative purposes only.

4.2.5 Increase Cooling Features at Neighbourhood Scale

Strategy

Mitigate the Urban Heat Island (UHI) effects at the neighbourhood scale

Intent

In urban neighbourhoods that lack natural cooling features such as water bodies, forests, or parks, surface temperatures are often higher, leading to a pronounced urban heat island (UHI) effect. This is especially true in densely built areas where materials like concrete and asphalt absorb and re-radiate heat. To mitigate these effects, a neighbourhood-scale strategy is essential, focusing on increasing greenery, reducing heat absorption, and integrating water features. The aim is to create artificial microclimates that replicate the cooling effects of natural environments.

Guidelines

A. Increase green spaces through the following considerations:

- Parks and Gardens: Increase the number of parks and strategically locate them within neighbourhoods at a walkable distance, as outlined in the City-wide Parkland Strategy.
- Green Corridors: Create green corridors linking different parts of the neighbourhood, facilitating airflow and providing shaded walkways. Green corridors refer to linear stretches of vegetation that connect larger areas of natural habitat, like parks or natural reserves, but within an urban context. In cities, green corridors can include features like Green Streets, green hydro corridors, and rail trails (green pathways created along railway lines).
- Vertical Greenery: Encourage the use of living walls and green facades on buildings, which can reduce the reflectivity of those facades and improve air quality.
- Green Roofs: Promote the installation of green roofs on buildings, where not otherwise required. Green roofs contribute to overall neighbourhood cooling by replacing heat-absorbing surfaces with vegetation.
- Re-Greened Spaces: Reclaim green space by reducing excess and/or redundant paved or hardscaped areas in existing parks and public spaces through conversion to green space and softscape.

B. Incorporate water features such as public fountains, splash pads, and ponds in public spaces to provide evaporative cooling and aesthetic value.

C. Plant trees in a strategic and equitable manner through the following considerations:

- Plant deciduous trees for summer shade and winter sunlight penetration. Use coniferous trees to provide additional wind protection during colder months taking into account potential visibility issues and where space permits.
- Plant multibranch trees strategically to allow for added protection during winter months as multibranch trees reduce ground-level wind speed and reduce wind chill.
- Increase tree canopy at strategic locations. Utilize the Tree Equity Score Analyzer tool to identify areas of low tree equity and explore opportunities to increase tree canopy in the neighbourhoods that need it the most.
- Choose tree and plant species that are resilient to urban conditions and effective in providing shade and cooling.
- Refer to Section 4.4.1 for more guidelines on tree planting.

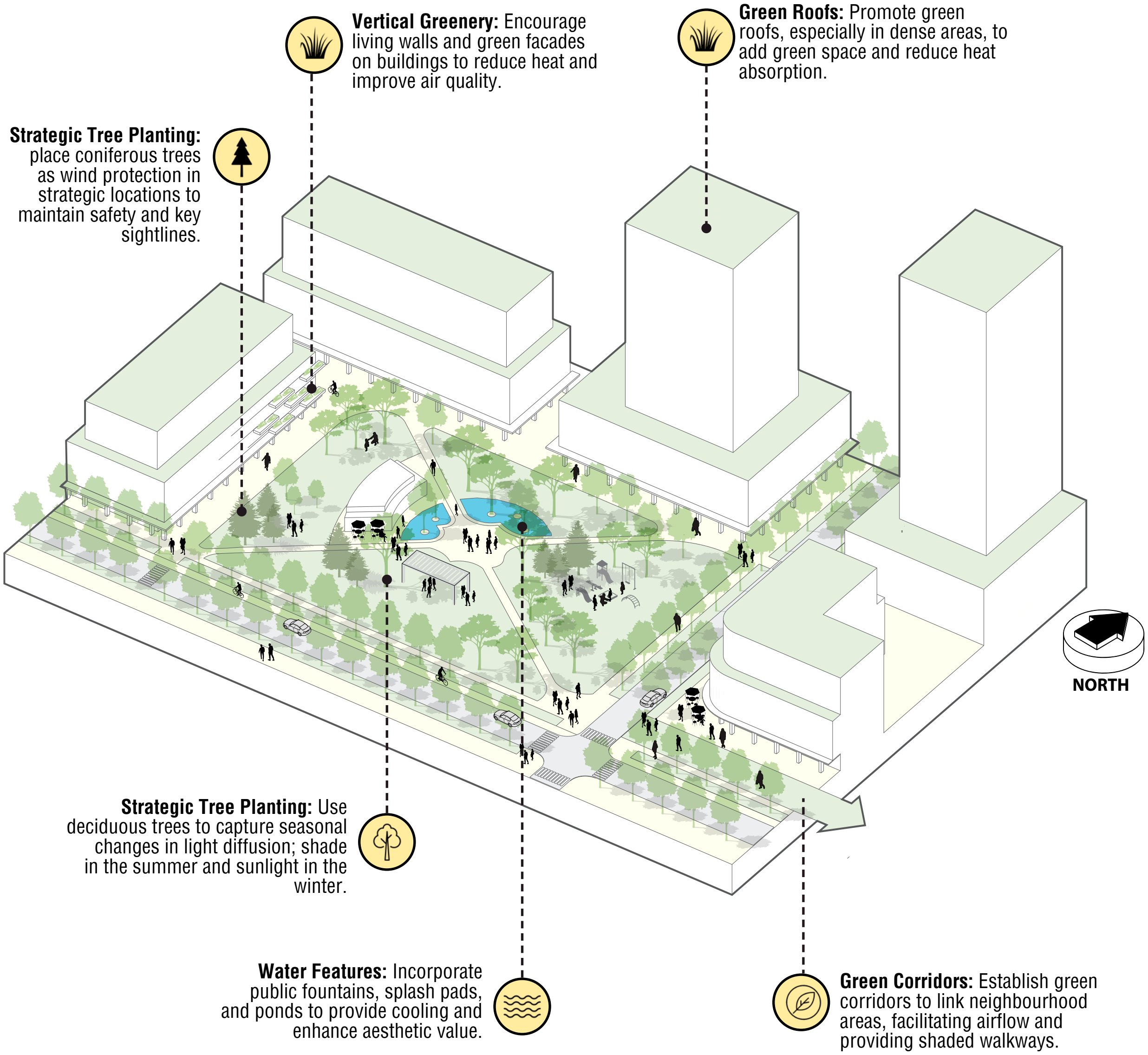


Diagram showcasing the design, strategic placement, and orientation of open spaces to maximize sunlight access and wind protection. For illustrative purposes only.