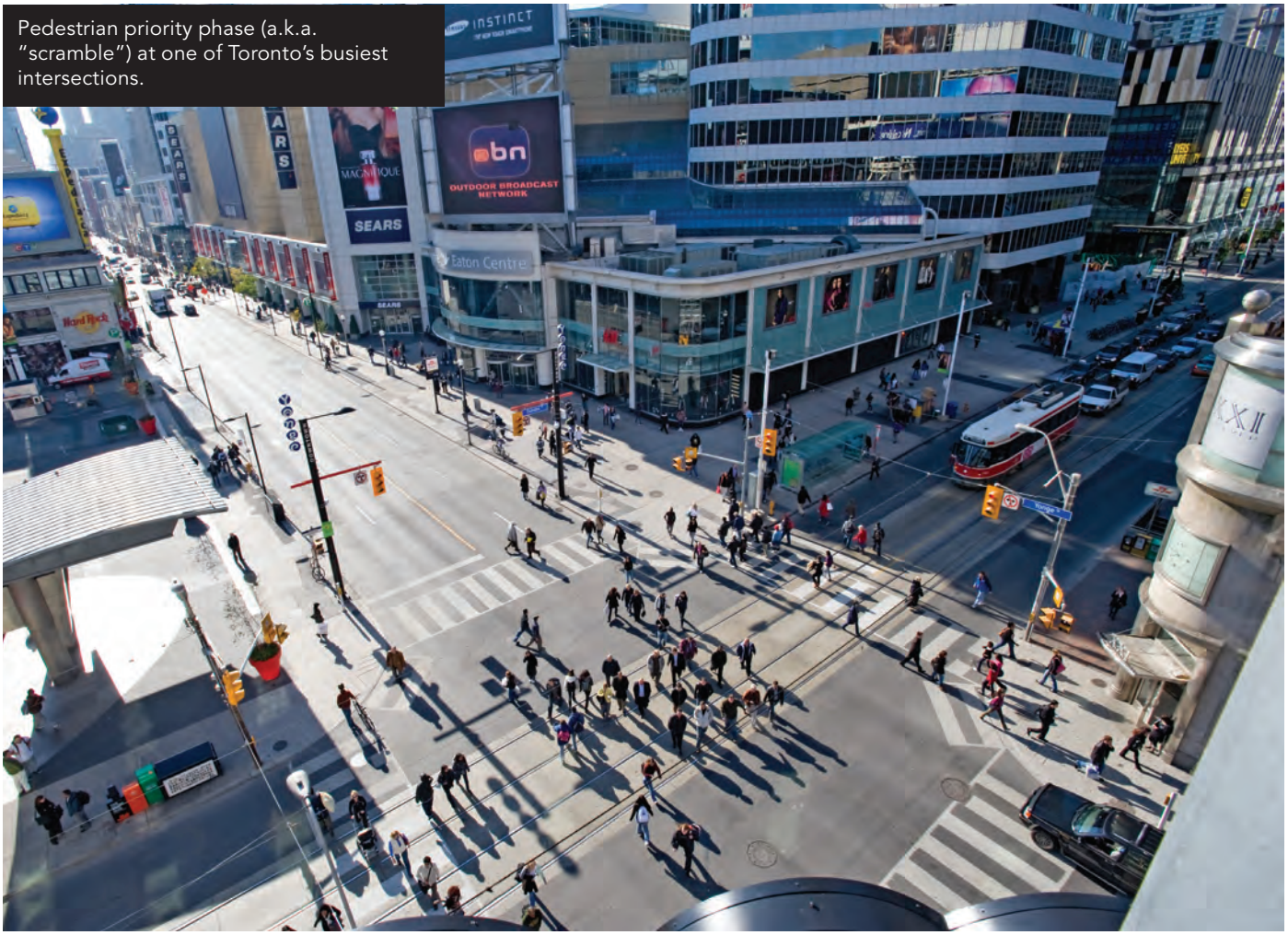
9.4

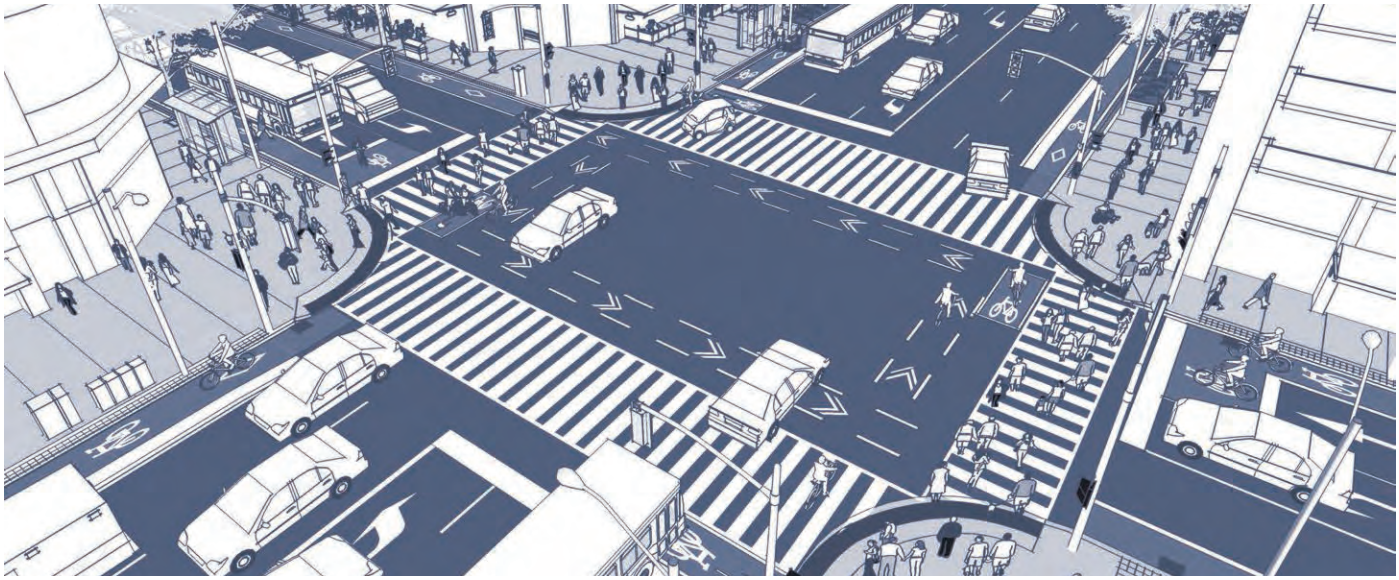
CONTEXT-SENSITIVE INTERSECTION DESIGN

Intersection design will depend on street context including nearby land uses, users of the street, and role in the network. The variety of Toronto's intersections is vast, and local conditions play a key role in the design and selection of elements. The street design process will ensure full consideration of the needs of various users and help to weigh the benefits and drawbacks of different intersection features.

Following are some examples of common types of intersections and their considerations for complete streets design.



Pedestrian priority phase (a.k.a. "scramble") at one of Toronto's busiest intersections.



For illustrative purposes.

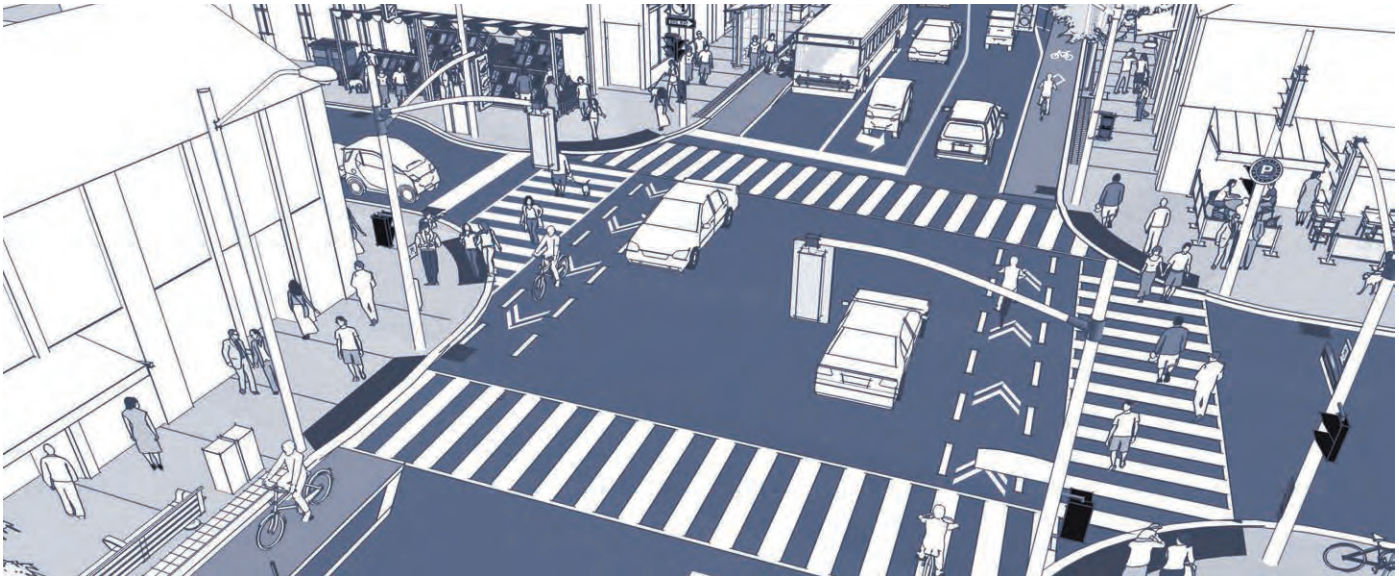
MAIN STREETS OR MIXED-USE CONNECTORS

Main Streets or Mixed-use Connectors often have a combination of high traffic volumes, high approach speeds, transit stops and pedestrian and cycling activity. The challenge becomes balancing the need to reduce risk to all road users, while accommodating traffic capacity and turning movements for larger vehicles. Consider the following design treatments:

- Due to the size of these intersections, clear alignments and pavement markings are needed to guide the paths for all road users and to provide predictable and visible movements.
- To help pedestrians of all ages and abilities to safely cross wide roadways, consider pedestrian crossing islands, zebra crosswalk markings, the City's standard curb radii, leading pedestrian interval (LPI) signals, adequate space for pedestrians waiting on street corners (e.g., declutter corners, rightsize corner, set back buildings, etc.), and other pedestrian safety measures.
- To make cyclists more visible to other road users, mark bicycle facilities through the intersection, including bike boxes or queue boxes, providing designated bicycle signal phases where appropriate, and regulatory and warning signs for motorists where notable conflicts exist.
- Analyze intersection capacity from a multi-modal perspective and focus on moving people, such as by prioritizing transit, in order to reduce traffic congestion as intersections become busier with residential and employment growth. Consider planned land uses, anticipated mode split shifts, and latent demand for pedestrian, cyclists and transit users during the design process.

Crossing at a major intersection in North York.

A main street intersection in Scarborough.



For illustrative purposes.

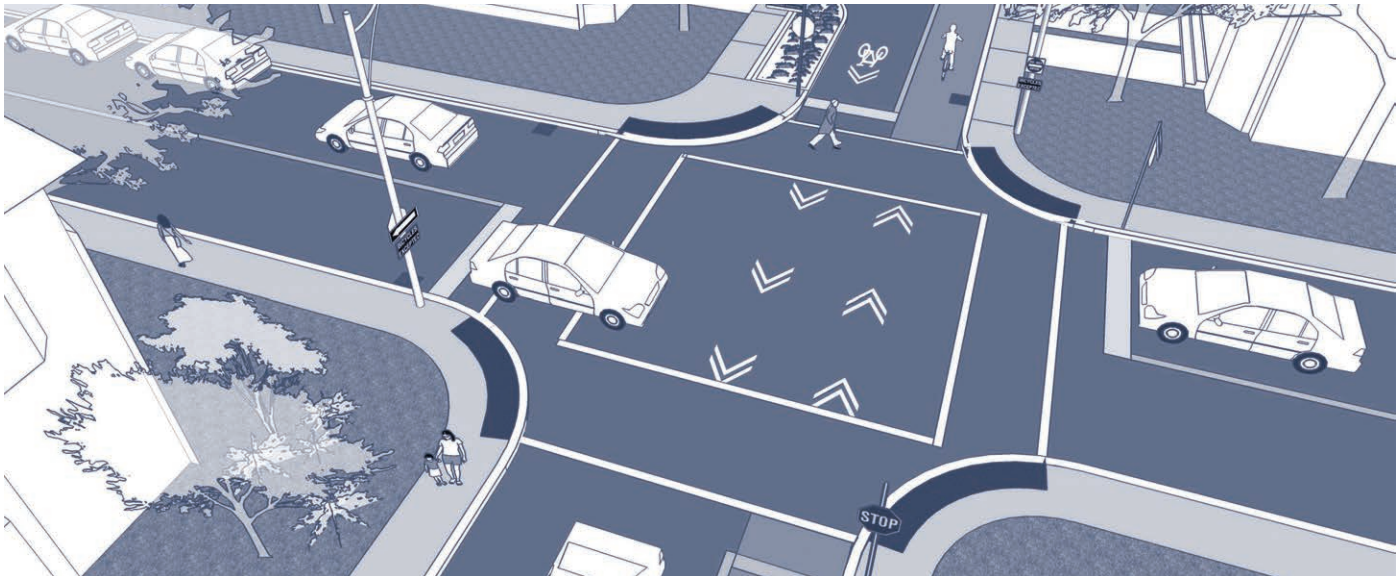
INTERSECTIONS BETWEEN RESIDENTIAL STREETS WITH MAIN, CIVIC AND CONNECTOR STREETS

Design becomes complex for situations where lower volume streets intersect with higher volume streets, because traffic flow and capacity will focus on the busier street, yet side streets and their users also need to be accommodated. These intersections may be signalized or have two-way stop control such as stop signs. Consider the following design treatments:

- Clearly mark controlled pedestrian and cyclist crossings (i.e. with stop control, PXOs with flashing lights, or signals) wherever they exist.
- Analyze and design intersections taking into account the transportation network. It may not be possible or practical to accommodate all movements at all times (e.g. through or left-turn movements from the side street) at a two-way stop-controlled intersection.
- If there is heavy traffic on the Main, Civic or Connector Street, with insufficient gaps in traffic for safe turns, consider access management strategies such as consolidating and limiting driveways, laybys or other conflict points, and potential turn prohibitions from side streets.

Pavement markings indicate actuated signals for cyclists.

Streetcar at Kingston Road and Scarborough Road.



For illustrative purposes.

INTERSECTIONS AT RESIDENTIAL STREETS

Residential street intersections are characterized by low traffic volumes and slower speeds. In addition, people of all ages and abilities may be on foot in the neighbourhood for various activities such as getting to school, transit or nearby destinations. Consider the following design treatments:

- Enhance pedestrian safety with crosswalks, all-way stop control, curb extensions, raised intersections, and rightsizing corner radii as well as complementary mid-block measures (e.g., chicanes, mid-block curb extensions, etc.).
- In general, delay and capacity are not key factors for residential intersections as they have low volumes and speeds. Design of these intersections focuses on pedestrian accessibility and connectivity to homes, parks, community centres, and the pedestrian network to transit and other streets. Cyclists are often accommodated in a similar manner to motor vehicles or are supported by bicycle-friendly street designs noted in the Cycling chapter of this document (e.g., adequately wide curb lanes, bicycle detection at actuated signals, etc.).
- While larger vehicles such as fire, waste collection and snow plow trucks are important to consider, the turning movements for these vehicles will typically use the width of the roadway to negotiate turns.

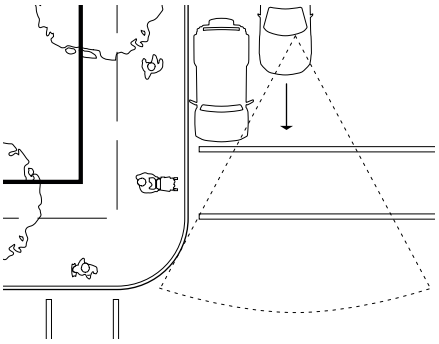
Multi-modal intersection of residential streets.

Residential street intersections may include curb extensions.

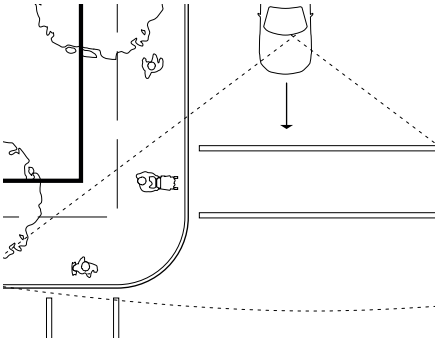
9.5

INTERSECTION ELEMENTS AND GEOMETRIC DESIGN

Various street elements and design features contribute to complete streets strategies for intersections. The selection of features will depend on street context such as land uses, networks, type of intersection, alignment, number and type of lanes, speed, right-of-way widths, and existing and projected volumes of different modal users. The following illustrates some key examples of these features, but is not meant to be an exhaustive list.



Sight line obscured by a parked car.



Improved sight line due to parking prohibition near the corner.

FOR ALL ROAD USERS

PAVEMENT MARKINGS & VISIBLE CROSSINGS

Visible pavement markings such as stop bars, and pedestrian crosswalks (a.k.a. zebra pavement markings or parallel line markings) to indicate where vehicles are to stop and where pedestrians and cyclists cross a roadway at controlled crossings.

SIGHT LINES

A clear view of people, activities and objects. (a.k.a. "daylight triangles" near intersections and driveways). Ensuring good sight lines reduces the risk of conflicts between all street users and promotes safety for all. Regulations that prohibit parking at the corner can also improve blocked sight lines.

CURB RADII

The curved section of a curb that connects two intersecting streets. Its size affects the turning speed of vehicles, pedestrian crossing distances, visibility, and space available for pedestrians waiting to cross the street.

Simple placemaking can be combined with curb extensions, like this example in Etobicoke-York.

PEDESTRIAN-RELATED FEATURES

CURB EXTENSIONS

Curb extensions (a.k.a. bump-outs or bulb-outs) are enlarged sidewalk or boulevard areas at corners. A common complete streets measure that reduces pedestrian crossing distances and signal cycle lengths, and improves visibility and pedestrian waiting areas on corners.

PEDESTRIAN CROSSING ISLANDS

An area protected by curbs where pedestrians can wait or rest while crossing streets. They must have accessible features (e.g. curb ramps, APS and TWSIs) and may be considered for high volume intersections with six or more lanes of traffic. The decision to include islands or medians should be weighed against using that space instead for adequately wide sidewalks, cycling facilities, and planting and furnishing zones.

RAISED CROSSWALKS OR INTERSECTIONS (A.K.A. TABLE TOPS)

These are raised areas of the roadway at intersections. They improve the visibility of pedestrians crossing and increase the awareness of drivers travelling at inappropriate speeds.

PLACEMAKING AT INTERSECTIONS

Depending on street context, there may be features that enhance the sense of place while balancing the need for safety and clear sightlines. Features used at intersections include but are not limited to: wayfinding signs, maps or information pillars; landmarks; gateway features; meeting locations with seating; pedestrian lighting; pedestrian crossing islands with landscaping; decorative pavers; and carefully selected street furniture and/or street art.

Raised crosswalk in Toronto.

Placemaking at intersections may include cafés or other seating.

Left-turn queue boxes indicate a designated area for cyclists to make a left turn.

Arrows indicate the path of cyclists through an intersection.

Skip lines indicate cycling infrastructure through an intersection.

CYCLIST-RELATED FEATURES

BICYCLE LANE MARKINGS

Pavement markings indicating the paths of cyclists, e.g., a bicycle lane through the intersection or between vehicle through-lanes and right-turn lanes at intersections, to increase awareness at conflict points.

CROSS RIDES

Cross rides indicate where cyclists may ride to cross a roadway at controlled crossings, alongside pedestrians. Adequate width and attention to design are required for the crosswalk and cross ride to prevent conflicts among cyclists and more vulnerable pedestrians of all ages and abilities.

LEFT-TURN QUEUE BOX

Pavement markings indicating a safe and designated area for cyclist making a left-turn maneuver. May be accompanied by a right turn on red restriction if the queue box is in the path of vehicular right turns.

BICYCLE QUEUE BOXES

A marked area where most cyclists are anticipated to make two-stage crossings to make a left turn. For pedestrian safety and clear sightlines, avoid pushing crosswalks far back from the intersection.

Cyclists yield to pedestrians boarding a streetcar on Roncesvalles Ave. in Toronto.

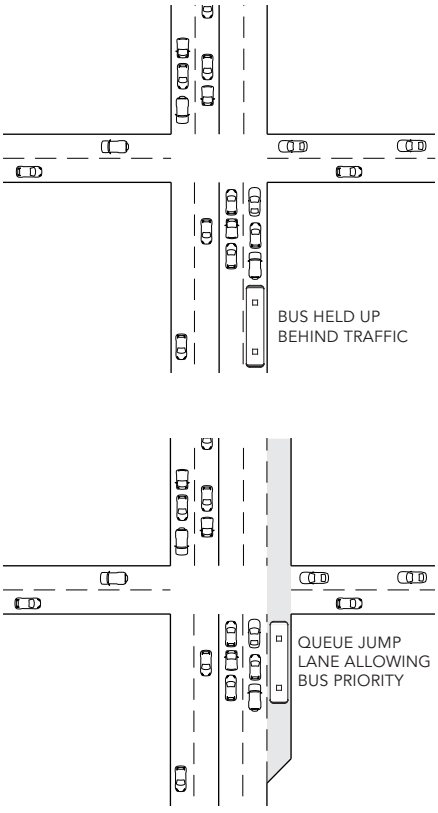
TRANSIT-RELATED FEATURES

TRANSIT LANES
Dedicated lanes for public transit, such as HOV or bus lanes and designated transitways for buses, streetcars or light rail vehicles. These enable greater frequency and reliability of transit service.

TRANSIT STOPS (STOPS, PLATFORMS, AND CROSSINGS)
Locations where transit riders wait for, board, and leave transit vehicles. Transit stops may be curbside or on platforms in the middle of the roadway. They may also include transit branding/signs, transit shelters/benches, wayfinding, schedule or real-time information and transit payment systems.

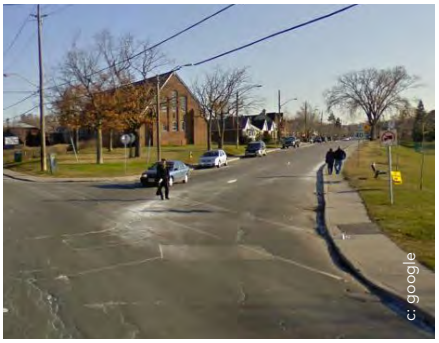
TRANSIT QUEUE JUMP LANES
Queue jump lanes are typically extended right turn lanes that provide opportunities for buses to move to the front of the queue. Considered where heavy volumes of mixed traffic negatively impact transit service, depending on space and impacts to other road users.

TRAFFIC REGULATIONS
Stopping, parking or turn restrictions, as this can improve performance of through movements for transit and other vehicles.



Before and after Queue Jump Lanes are added.


Pavement markings show the path vehicles should take through a skewed intersection.



Before.

After an intersection in Scarborough is normalized.

OTHER INTERSECTION DESIGN STRATEGIES

NORMALIZE OR RE-ALIGN INTERSECTIONS

Reconfigure an irregular intersection (e.g., skewed, offset or complex) that is confusing to road users.

LANE ALIGNMENTS

The path of vehicles as indicated by pavement markings and the physical design and curvature of the road. The desired path for vehicles should be clear and easy to follow, especially where there are transitions in the number of lanes or where there are turn lanes.

RIGHT-TURN CHANNELS (A.K.A. 'PORK CHOPS' BECAUSE THEY LOOK TRIANGULAR)

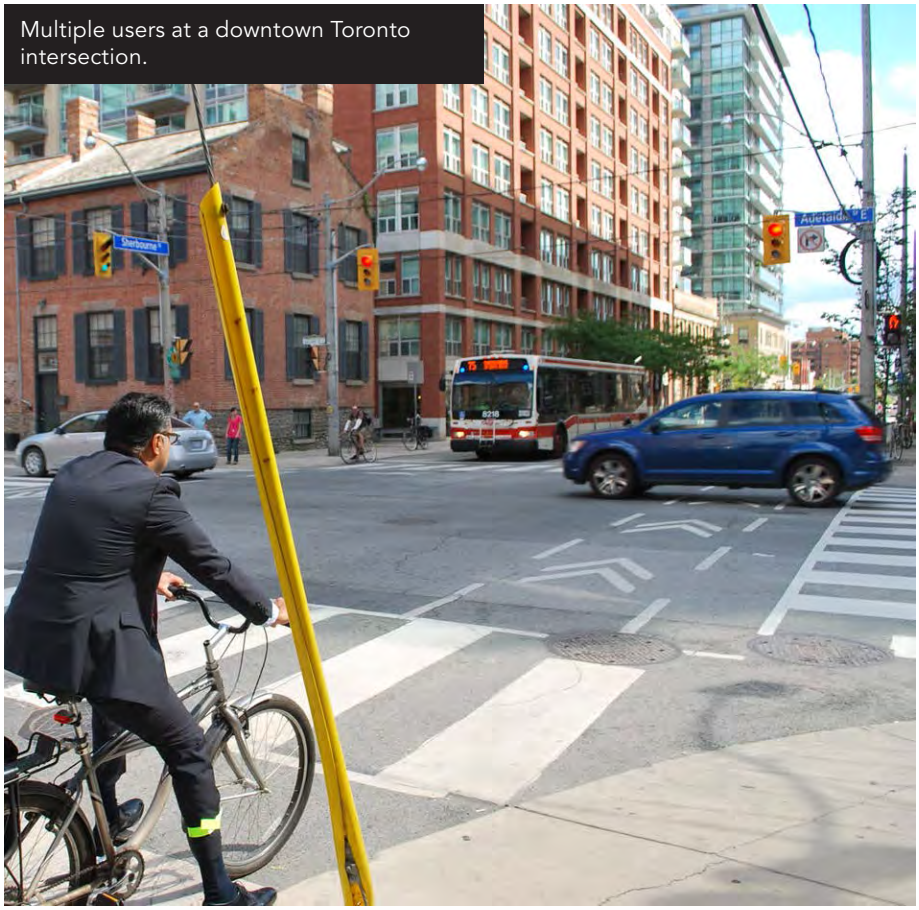
A triangular island used to channel turning traffic. These dedicated turn channels present safety concerns for all road users as they result in poor sightlines, and significant barriers to persons with disabilities. The City of Toronto's policy is to remove right turn channels if possible and not to build new ones. Decisions to maintain existing channels require careful consideration and engineering judgment.

HIGHWAY INTERCHANGES

Interchanges intersect city streets in urban areas and must be designed to accommodate vulnerable road users, including pedestrians of all abilities and cyclists, to ensure safety, accessibility and connectivity with adjacent communities. Review best practices for context-sensitive design options for interchanges intersecting urban areas to support Complete Streets goals.

GRADE SEPARATED FACILITIES

Roads that run overhead or underground are called grade separated. Such facilities create significant barriers between neighbourhoods and for vulnerable road users. Review best practices for context-sensitive design options for addressing safety, multi-modal and placemaking needs so that grade separated facilities support Complete Streets goals.



Multiple users at a downtown Toronto intersection.

Greening of an intersection in Scarborough.

Zebra markings at an intersection in Etobicoke.

9.6 INTERSECTION SIGNALS AND OTHER TRAFFIC CONTROLS

The City of Toronto uses various intersection signals and other traffic control devices to facilitate safe movement of all road users, guided by the recent Traffic Signal Operation Policies and Strategies (2015). These policies align with the complete streets approach and are based on industry standards, guidelines, and best practices, including the Ontario Traffic Manual (OTM) Book 12, the Ontario Highway Traffic Act (HTA), the Manual for Uniform Traffic Control Devices (MUTCD) for Canada, and the Transportation Association of Canada (TAC) Guidelines.

The choice of signal or device is often determined by technical warrants that get updated from time to time by the City to account for best practices. Technical warrants often use numeric inputs and data, such as volumes, collision history, conflict data/near misses, speed, delay and environmental/site audits. What follows is a list of examples of intersection signals and traffic control devices used in the City of Toronto.

INTERSECTION SIGNALS

PEDESTRIAN COUNTDOWN SIGNALS

Device shows the number of seconds left for crossing a street. Pedestrians should begin crossing with the WALK signal and finish crossing by zero.

LEADING PEDESTRIAN INTERVAL

WALK signal is about 5 seconds ahead of the green traffic signal to give pedestrians time to become visible in the crosswalk to drivers.

PEDESTRIAN PRIORITY PHASE ("SCRAMBLE")

Vehicular traffic is stopped on all approaches and pedestrians can cross in any direction, including diagonally. Typically used where there is a large volume of pedestrians, lack of space for pedestrians, and issues with wait times, crowding and safety.

BICYCLE DETECTION AT SIGNALS

Detection technology that allows cyclists to trigger a 'green light' at an intersection and not wait for a larger or heavier vehicle in order to navigate an intersection.

BICYCLE SIGNALS (E.G., TRAIL CROSSINGS)

Electronic signals for cyclists to guide and coordinate their movements with other traffic (e.g., cars, transit and pedestrians) and may indicate bicycle signal phases or other bicycle-specific timing strategies.

LEADING CYCLING INTERVAL

An advanced green for cyclists to give priority to bicycle movements at an intersection.

TRAFFIC SIGNAL PROGRESSION

Modification of signal timing to have coordinated 'green lights' for better traffic flow.

TRANSIT SIGNAL PRIORITY

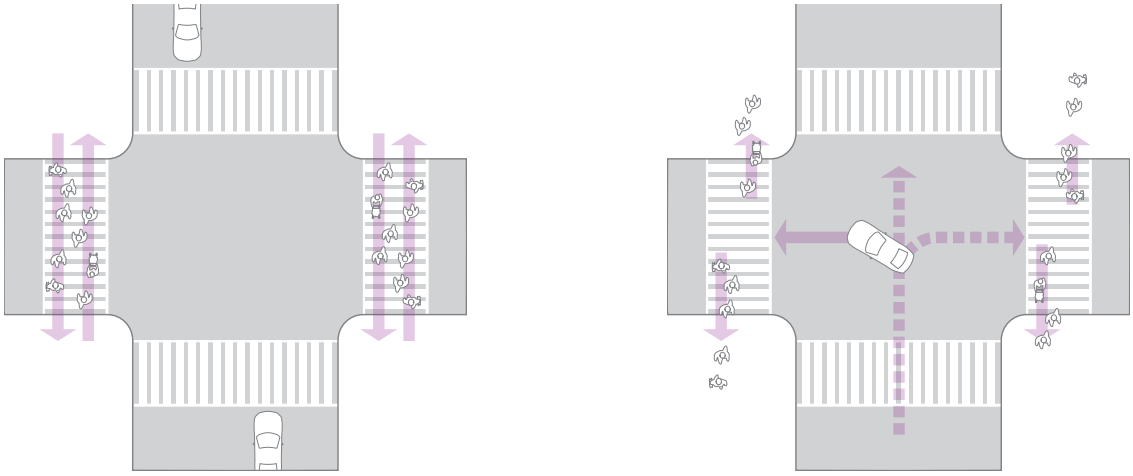
Modification of signal timing for transit vehicles such as extending 'green light'.

BLANK-OUT NO LEFT TURN SIGN

Electronic sign (a.k.a. LED Blank-Out Sign) that is well-illuminated to indicate time-of-day restrictions for left turns at intersections. Its purpose is to help drivers recognize turn restrictions to improve compliance and traffic flow.

DEDICATED OR SEPARATED LEFT TURN SIGNALS

Also called a fully-protected left-turn phase, vehicles may turn left only while facing a left turn green arrow, and have the right-of-way with no conflicting movements with other road users permitted.



A Leading Pedestrian Interval gives pedestrians a five second head start, making them more visible to turning motorists.

OTHER TRAFFIC CONTROLS

STOP SIGNS (OR STOP CONTROLS)

A sign that indicates to vehicles to come to a complete stop (at the stop line or crosswalk) and wait until the way is clear before entering the intersection.

PEDESTRIAN CROSSOVERS (PXOS)

Designated areas for pedestrians to cross where there are no traffic signals. Drivers and cyclists are to watch for pedestrians at these crossings and must yield the right-of-way to pedestrians in the crosswalk. Pedestrian crossovers are indicated by signs, markings, and yellow lights. It is against the law to pass any vehicle within 30m of the pedestrian crossover.

SCHOOL CROSSWALKS

Designated areas for pedestrians to cross where there are no traffic signals, and located on the route to or in the vicinity of schools. School crosswalks are indicated by signs and markings, and/or where a school crossing guard is present.

YIELD TO PEDESTRIANS

A sign that indicates to vehicles to let pedestrians go first, and to stop and wait for any pedestrians to fully cross the road at the crosswalk.

YIELD SIGN

A sign that indicates to vehicles to let traffic in the intersection or approaching the intersection to go first, and to stop if necessary and proceed only when the way is clear.

RIGHT TURN ON RED RESTRICTION

A sign that indicates to vehicles that they are not allowed to turn right when facing a red traffic light. No Right Turns On Red are implemented for various safety reasons, including to reduce collisions of right-turning vehicles with vehicles proceeding on their green light, and also between right-turning vehicles and pedestrians crossing with their WALK signal.

Signals and traffic control devices are often combined with physical, built environment features, such as rightsized traffic lanes, curb radii/ extensions, and cycling facilities to create safer streets.

Seniors crossing at a major intersection in Scarborough.

GENERAL GUIDANCE ON INTERSECTION SIGNALS AND TRAFFIC CONTROL DEVICES

When reviewing or making decisions about signals or traffic control devices, there are some key considerations to keep in mind for the safety and comfort of all road users regardless of age and ability:

- **Key principles of complete streets:** Provide equitable consideration of all road users, and consideration of a street's context in the design of the street and the selection of traffic control devices.
- **Safety first:** Consider the use of a combination of physical design (e.g., rightsized traffic lanes and corner radii) and traffic control features to achieve the desired 'target speed' for the street's context.
- **Use future, not past data:** Use projected future volumes and not past or existing data for all modes in the analysis and review of future infrastructure, new developments and environmental assessment studies.
- **Connectivity in Networks & Desire Lines:** Understand existing and aspirational pedestrian and cyclist desire lines and active transportation networks to identify opportunities to introduce safe crossings, such as PXOs or Traffic Control Signals.
- **Spacing between controlled crossings:** Consider land uses, density, pedestrian volumes and demographics when looking at spacing of controlled crossings. All pedestrians, especially persons with disabilities benefit from having more closely spaced crossing opportunities. The desire for widely spaced intersections for faster motor vehicle movements needs to be weighed against the impacts on safety, connectivity and accessibility of pedestrians and cyclists.
- **Adequate crossing times and walk speeds accounting for all ages and abilities:** Consider how to best accommodate slow walkers through the provision of the shortest possible crossing distance and adequate signal time. Long crossing distances not only increase pedestrian exposure to risk of collision in the street, they also require longer signal cycles to give enough time to safely cross the street.
- **Reduce need to push buttons (use fixed-time mode)**: Fixed time or automated walk signals are appropriate in locations with moderate and higher pedestrian volumes, such as downtown and main street shopping areas, and in the proximity of pedestrian trip generators.
- **TTC or Fire pre-emption:** Identify if there is currently or potentially the need to operate with TTC or Fire pre-emption and weigh the needs and benefits given the street context and network.

Street and intersection design must consider the roles of streets at different times of the day and night.

- **Coordinated signal timing:** The purpose of coordinated signal timing is to help manage traffic flow along a corridor. In addition, balancing the traffic volumes between intersections helps to prevent or reduce queued up traffic. In real life conditions, however, there are numerous disruptions that may make it difficult to perfectly meter traffic.

- **Short signal cycles:** In general, short signal cycles (60-90 seconds) are preferred as they provide predictable and regular crossings, and generally minimize overall delay for all users. While short cycles tend to encourage people to obey the signals compared with locations with longer delays, the short cycle length needs to be weighed against the safety benefits of separated signal phases, such having dedicated left-turn signals.

- **Different times of day and night:** Consider the changing nature and role of a street throughout the course of the day, as demand may change by mode and by direction during different times. Traffic signal timing should be adjusted to meet various modal and directional demands to optimize people-moving capacity and convenience.

MORE INFORMATION:

- City of Toronto. Accessibility Design Guidelines. 2004.
- City of Toronto. Complete Interchanges: Urbanization of Grade Separated Facilities. Anticipated 2017.
- City of Toronto. Criteria for Evaluating Request for Queue-Jump Lanes. Updates underway (in use internally).
- City of Toronto. Curb Radii Guidelines. 2015.
- City of Toronto. Traffic Signal Operations Policies and Strategies. 2015.
- "Highway Safety Manual." American Association of State Highway and Transportation Officials. 2016.
- Institute of Transportation Engineers and Congress for the New Urbanism. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach. 2010.
- Ministry of Transportation of Ontario. Ontario Traffic Manual Book 11: Pavement, Hazard and Delineation Markings. 2000.
- Ministry of Transportation of Ontario. Ontario Traffic Manual Book 12: Traffic Signals. 2012.
- Ministry of Transportation of Ontario. Ontario Traffic Manual Book 15: Pedestrian Crossing Facilities. 2016.
- Ministry of Transportation of Ontario. Ontario Traffic Manual Book 18: Cycling Facilities. 2013.
- National Association of City Transportation Officials. Urban Street Design Guide. 2013.
- New York City Department of Transportation. Making Safer Streets. 2013.
- Transportation Association of Canada. Pedestrian Crossing Control Guide. 2012.
- Welle, Ben. "Cities Safer by Design: Guidance and Examples to Promote Traffic Safety through Urban and Street Design". World Resources Institute. 2015.

c. DTAH

This section provides a summary of the overarching process for delivering street projects in Toronto.

The conclusion outlines the intended outcomes and benefits of providing complete streets design guidance.

CONCLUSION

C.1

PROJECT DELIVERY PROCESS

Figure C-1 shows the overarching process for project delivery. The process varies for different project types. However, each project generally follows a similar framework from initiation to completion. The Toronto Complete Streets Guidelines inform and guide staff and others involved in each of the stages of delivering street projects.

PROJECT INITIATION

Street projects are initiated for various reasons, such as for state of good repair, new developments, safety, or Business Improvement Areas. At the outset, staff will outline the needs, goals and budgets, take into account complete streets vision and goals, and consult the City's plans, like the 10-year Capital Plan and area-specific plans.

CONTEXT ANALYSIS

A key step noted in Chapter 3 is gathering and reviewing all the background data to inform the street's context and the project's objectives. This work will likely involve reviewing area plans, site assessments, additional data collection and analysis, and consultation.

PRELIMINARY DESIGN AND DECISION MAKING

Once the project's objectives are established, a complete streets decision-making framework can be developed to weigh the pros and cons of street design options. (See Chapter 3 for more guidance.) Design options are developed based on the understanding of the street's context, a risk assessment of impacts on vulnerable road users, and complete streets guidance. An evaluation and documentation of the options is done and usually involves consultation on the evaluaton criteria and the options. Challenges will include dealing with trade-offs and coming up with creative solutions. Project costing and design adjustments are made as the street design and approvals are agreed upon by many parties and finalized.

CONSTRUCTION DESIGN

The agreed-upon street design is passed on to the engineering and construction teams for detailed construction engineering work. Engineers should consult client divisions and staff (e.g., Beautiful Streets, Cycling Infrastructure, Pedestrian Projects, Toronto Water, Urban Design, etc.) on the construction specifications and standards for complete street elements. It is costly to change designs at this stage, but minor changes may be necessary for review and refinement. Sometimes projects are deferred if the scope increases and more major changes require more time and resources.

CONSTRUCTION ADMINISTRATION

The detailed designs are completed and the project is usually contracted out for construction. Construction notifications and communications with the public are best practices.

Both staff and contractors working in the City of Toronto must observe Ontario Traffic Manual Book 7: Temporary Conditions and the City's work zone policies. Attention is required to safely and clearly accommodate pedestrians and cyclists in construction work zones.

OPERATIONS AND MAINTENANCE

Operation and maintenance needs should be considered throughout the planning and design process. Project outcomes should be monitored and lessons learned should be documented and shared. Where possible, measuring the performance of streets should be integrated before, during and after street projects are built.

MORE INFORMATION

- "Construction Standards – Engineering & Construction Services – Services." City of Toronto. Accessed October 27, 2016.
- City of Toronto. Guidelines for Covered Walkways. 2014.
- City of Toronto. Guidelines for Work on Streets in the Area of Schools. 2014.
- City of Toronto. Standards for Cycling Safety in Work Zones. Anticipated 2017.
- Ministry of Transportation of Ontario. Ontario Traffic Manual Book 7: Temporary Conditions. 2014.

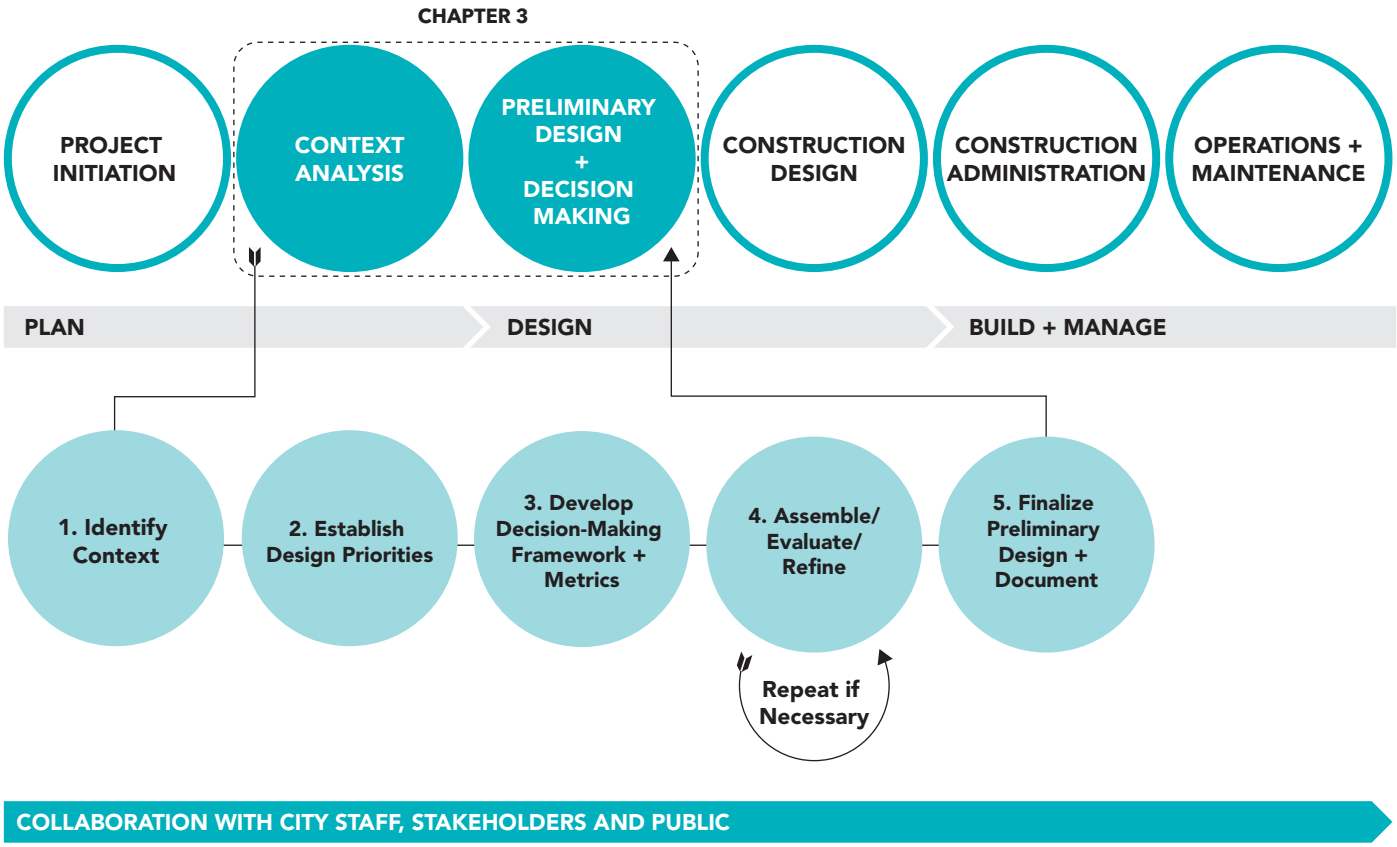


Figure C-1: Toronto Complete Streets Project Delivery Process

C.2 CONCLUSION

The goal of the Complete Streets Guidelines is to provide a primer on the important considerations in designing our streets to fully consider all uses and users of our streets. The guidance is meant to aid City staff and others to think of the important considerations in each of the steps in street design. By providing complete streets design guidance and setting out a multi-disciplinary approach to designing our streets, the potential outcomes and benefits are that:

- Stakeholders will be more informed about street design considerations;
- Street design processes will be more inclusive of the many stakeholders and citizens who are affected by street projects;
- More consistency, clarity and transparency will be encouraged through documenting the evaluation of street design options and the rationale behind decisions made.

The Guidelines contain a vision, goals and design guidance that align with the City's current policies, and as such, will be updated every five years similar to Toronto's Official Plan.

Street design is an evolving practice. In the coming years, design strategies used elsewhere, and technologies that do not yet readily exist in Toronto, will affect how we plan, design, build and operate our streets. Street designers should stay up-to-date on the latest best practices to learn from research and designs from other jurisdictions to continue the improvements to our city's street network.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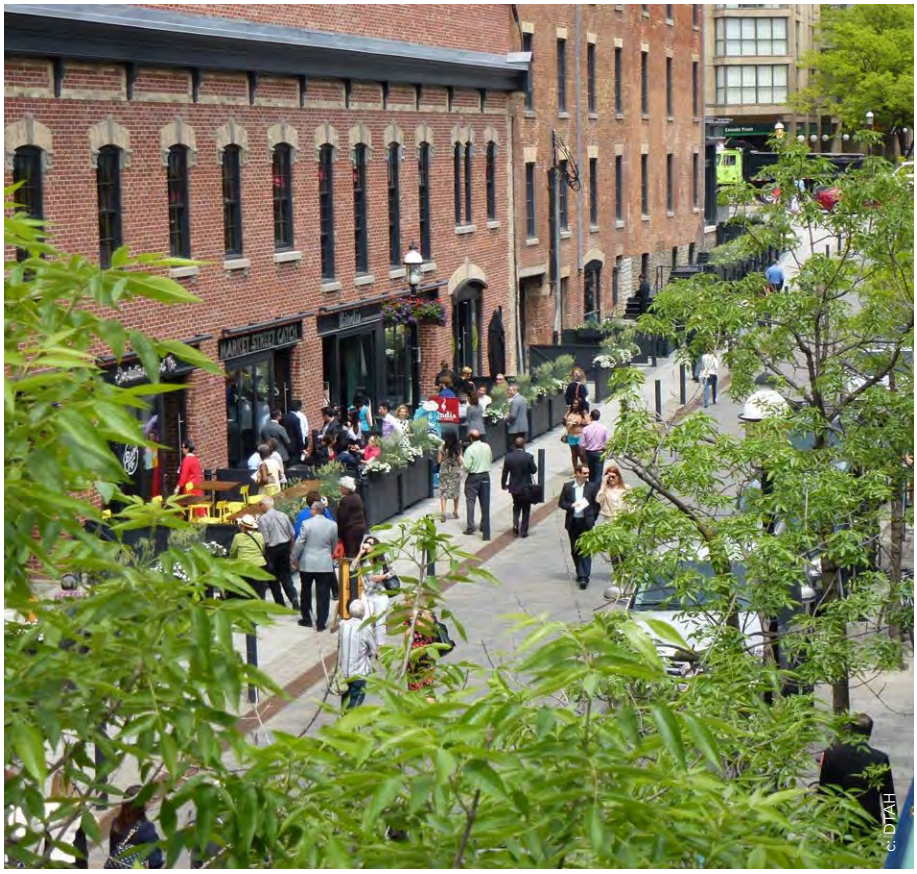
PLANET


MARKET STREET ZONE
c. DTAH

OUR STREETS
ARE THE COMMON SPACE WHERE OUR CITY COMES TOGETHER.

OUR STREETS
THROUGH THEIR LOOK, FEEL, AND FUNCTION SHOULD DEMONSTRATE HOW WE WANT TORONTO TO BE AND TO CHANGE.


9402




STOP
STOP



MAXIMUM
60