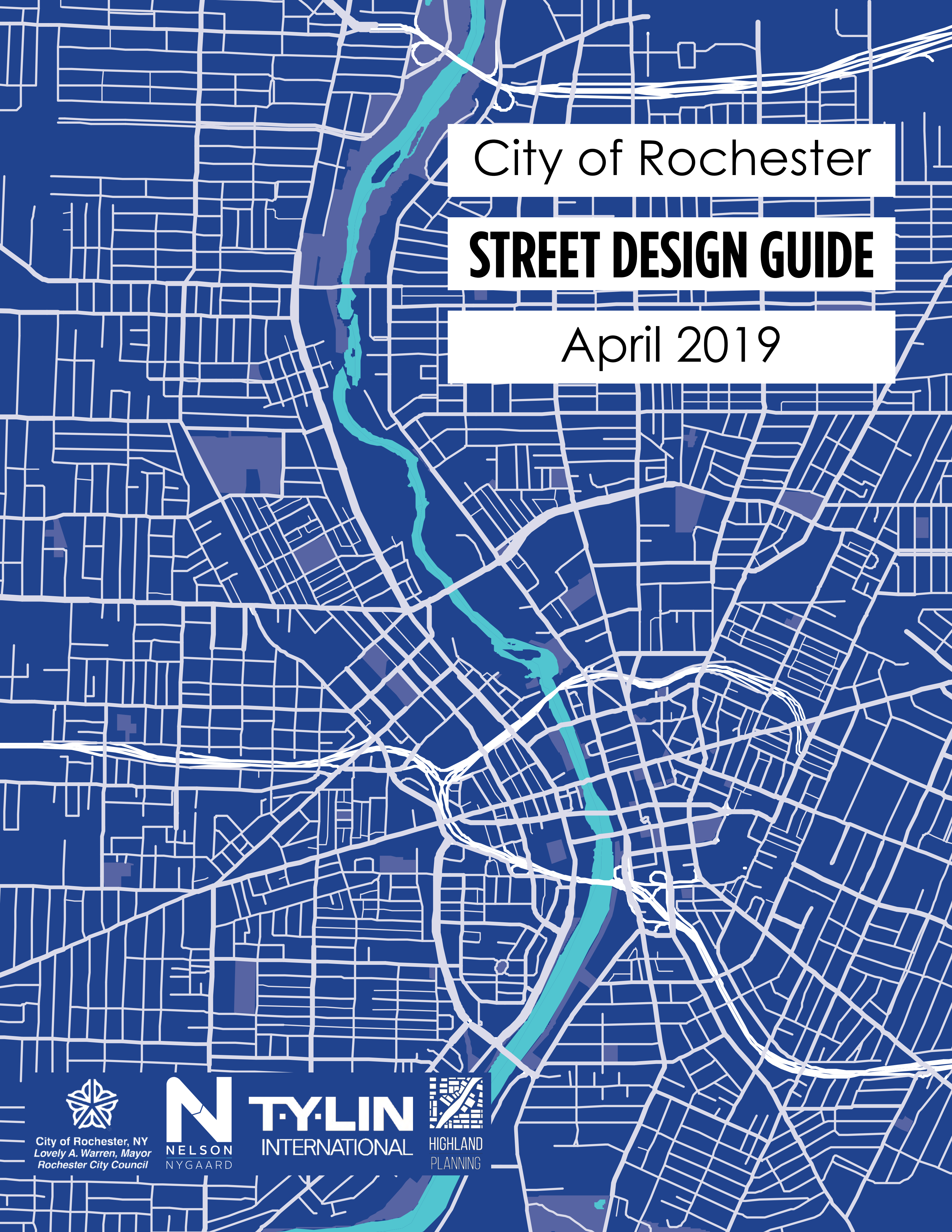

City of Rochester

STREET DESIGN GUIDE

April 2019

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

NELSON NYGAARD

T·Y·LIN INTERNATIONAL

HIGHLAND PLANNING

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OVERVIEW

The Rochester Comprehensive Access and Mobility Plan envisions a transportation system that improves the quality of life of Rochesterians by enabling access and connectivity between destinations and neighborhoods. The system should work for users of all ages and abilities whether they walk, bike, drive, or take public transportation, and should support businesses by enabling the movement of goods and employees.

The City of Rochester Complete Streets policy seeks to create an interconnected network of transportation facilities that accommodate all modes of travel in a manner that is consistent with neighborhood context and supportive of community goals by incorporating active transportation modes into the planning, design, and operation of all future City street projects. The policy defines Complete Streets as streets that are planned, designed, operated, and maintained to enable safe access for all users, and upon which pedestrians, bicyclists, transit users, persons with disabilities, and motorists of all ages and abilities are able to safely move along and across.

The City of Rochester's Bureau of Architecture & Engineering, within the Department of Environmental Services, utilizes a pavement management system to assess the relative condition of city streets and rank them to determine maintenance priorities. This data is used in the Capital Improvement Program (CIP) development process to allocate limited available resources to the streets with the greatest needs as well as to align the street improvement program with other City goals and priorities. Once a street is selected for inclusion in the CIP, it proceeds to the engineering and design phases before going to construction.

The City of Rochester Street Design Guide provides detailed information on street design considerations to assist street designers and engineers, City planning and zoning, and members of the public in ensuring that updates and additions to the City's street network meet Rochester's goals. The Guide covers four primary topics:

STREET TYPOLOGY DEFINITION

Street types are outcome-oriented, driven by an overall vision for the intended future state—both localized and network wide. All types of streets must be complete streets that support a safe transportation environment and network connectivity for users of all modes. However, since each street has a finite amount of space, some streets may emphasize one or more modes over others by design while still recognizing that all modes will occasionally make use of the street.

The City of Rochester Street Design Guide assigns a street typology to all City streets based on a street's aspirational land use characteristics and transportation function. Typology assignment has been based on the synthesis of suggestions received from multiple stakeholder groups during a street design guide workshop.

SELF-ENFORCING DESIGN AND CONTROLS

Self-enforcing design is the overarching objective of the Street Design Guide. Self-enforcing design provides environmental cues to street users to enable them to naturally and intuitively comply with speed and other operating expectations. Design controls reflect the character and context of the street (intended users) as well as the desired and expected behavior of all street users.

OPERATIONAL PERFORMANCE METRICS

The goals of different street users often conflict. Contemporary performance measures should take a multidisciplinary approach, looking at urban streets and traffic at the macro and the micro scale, through the lens of safety, economy, and design, and inclusive of the goals and behaviors of everyone using the street.

DESIGN ELEMENTS

A street's right-of-way is divided into different zones, each with its own design elements, operational goals, and users. The Street Design Guide provides detailed recommendations for the use, design, operations, and maintenance of the component parts of a street.

Source: Keith Ewing (CC BY-NC 2.0)

TYPOLOGY DEFINITION

The Rochester Street Design Guide assigns a street type to all City streets based on a street's aspirational land use characteristics and transportation function. A street may not have the same typology for its entire length. For example, a street may travel through a low-density residential neighborhood to a neighborhood business district (South Avenue)or between industrial and commercial districts (Lyell Avenue).

Street types are outcome-oriented, driven by an overall vision for the intended future state—both localized and network wide. All types of streets must be complete streets that support a safe transportation environment and network connectivity for users of all modes. However, since each street has a finite amount of space, some streets may emphasize one or a set of modes over other modes by design while still recognizing that all modes will occasionally make use of the street. Certain areas along a corridor, such as school zones, may attempt to include elements beyond those required or typically desired for that typology. Designers should also consider how to incorporate green stormwater management best practices on all streets.

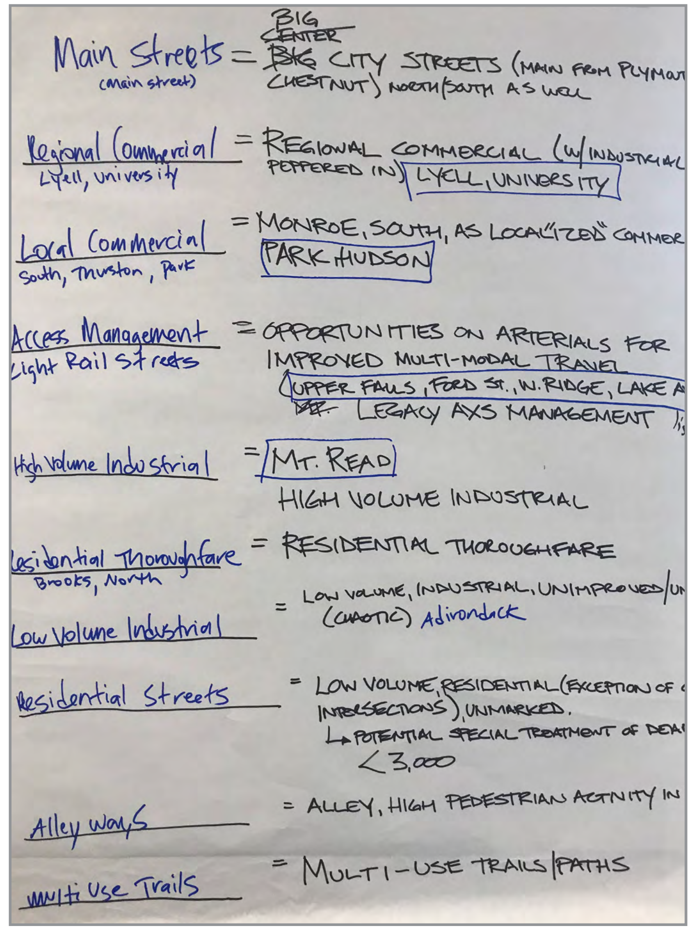
DEFINITION PROCESS

On December 3, 2018, City staff representing Planning, Zoning, Engineering, and Environmental Services as well as representatives of the Rochester-Genesee Regional Transportation Authority, the Monroe County Department of Transporation, and the Genesee Transportational Council participated in a street design workshop intended to develop a set of street typologies.

Comprehensive Access and Mobility Plan project background was presented to attendees, prefacing a longer presentation meant to familiarize workshop participants with street design principles, street design guides in general, the concept of assigning street typologies rather than relying on functional classifications, and best practices in street design guides as embodied by national (NACTO, ITE Manuals) and city-specific (Ann Arbor, Columbus, etc.) examples. An initial set of potential street typologies for Rochester as a starting point for workshop activities.

Workshop participants were split into groups, each responsible to develop a street typology set for Rochester. In many cases, naming of the typologies took a backseat to a focus on present day and aspirational corridor context. Each team designed and presented a suite of up to ten typologies to the larger group. The work of all groups was collectively synthesized into the typologies presented in this street design guide. The harmonized hierarchy of street types features orders of streets (Activity, Link, Local) grouped by context (Regional, Downtown, Neighborhood, Industrial).

Key characteristics, examples, priority users, and design objectives are described on the following pages for each typology. Required, recommended, and optional street design elements for each street type are also listed. Street typology assignments are mapped in aggregate at the end of this section and individually by type in the Appendix of this document.



REGIONAL ACTIVITY

Image Capture: June 2017 © 2019 Google

Regional Activity streets serve a larger purpose in the regional transportation network. Often serving auto-oriented commercial uses as well as institutional and industrial land uses, the street environment tends to lack distinctive character.

In addition to the high volume of motor vehicle traffic, including a significant number of commercial vehicles traveling at higher speeds, these streets act as primary transit routes. Pedestian and bicycle activity is present. Travel speeds should be kept low to encourage better land use practices on current nearby low-density or undeveloped parcels along these corridors.

Regional Activity streets are important beyond the City's transportation network as they often act as a City gateway, an urban-suburban transition that connects points within the City to travel corridors that continue further into the region.

EXAMPLE STREETS

- West Ridge Road
- Upper Falls Boulevard (pictured)
- Lake Avenue
- Elmwood Avenue

PRIORITY USERS

Regional Activity streets should emphasize through vehicle travel while cognizant of providing safe through travel for all modes. Access for workers and customers must be prioritized.

DESIGN OBJECTIVES AND TYPICAL FEATURES

Redesigned Regional Activity streets should improve street character and support current and planned land uses while maintaining critical connectivity for through travel. While challenging, pedestrian mobility is imperative. Due to the high traffic volumes and higher speeds, non-motorized users should be well protected from moving traffic.

- **Sidewalks (5 feet minimum width)** are required on both sides of the street. Streetscape elements, especially trees, are recommended.
- **Travel lanes should be 11 feet wide** to allow for transit and goods movement activity. Transit-only lanes and median protected center turning lanes may be considered.
- It is recommended that bicycle facilities are **physically separated from traffic by a buffer**.
- On-street parking is **optional.**

DOWNTOWN ACTIVITY

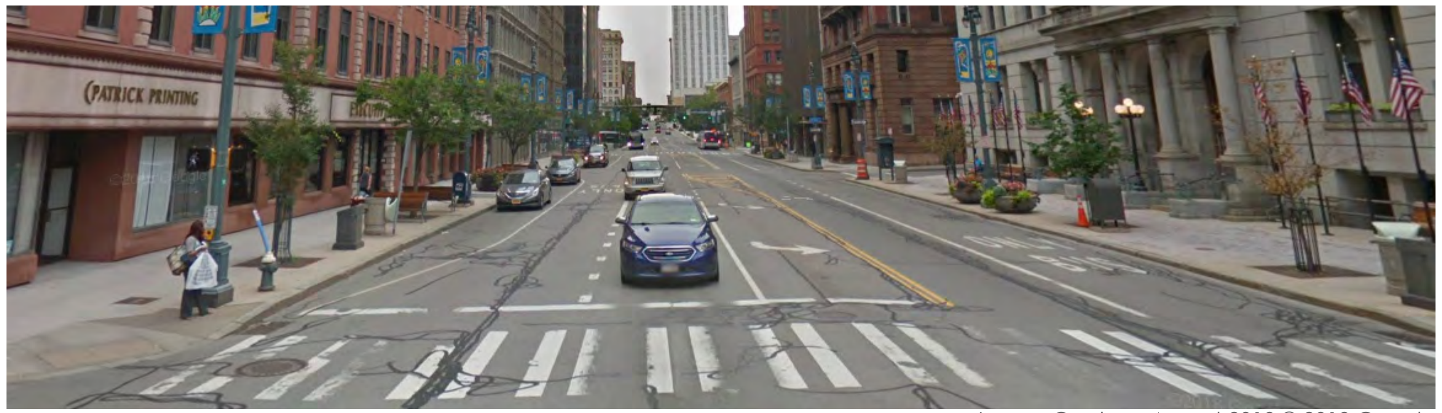


Image Capture: August 2018 © 2019 Google

Downtown Activity streets are Rochester's principal employment and entertainment streets. The streets also support a number of residents, institutions, students, and workers at the highest densities. These streets have specific design requirements to provide a high quality public realm that contributes to the City's sense of place.

Downtown Activity streets are important links in the local and regional transportation network. Travel demands are intense, with high volumes of travelers using personal vehicles, arriving and departing via transit, bicycling, and reaching final destinations on foot.

Parking is important, though is not always provided on street. The supply of off-street parking downtown generally dwarfs the on-street supply. Despite high volumes, vehicular traffic speeds should be kept generally slow to allow for a more comfortable street environment.

EXAMPLE STREETS

- Main Street (pictured)
- Clinton Avenue
- Chestnut Street

PRIORITY USERS

Downtown Activity streets should emphasize the pedestrian mode first and foremost. Pedestrians are present for a variety of reasons and each becomes an active user of the public space.

DESIGN OBJECTIVES AND TYPICAL FEATURES

Downtown Activity streets should create a distinctive sense of place while promoting access to downtown destinations via multiple modes. Movement should be smooth and efficient with minimal circling and congestion.

- **Sidewalks (8 feet minimum width)** on both sides of the street are required.
- **Lane widths of 11 feet** reflect expected transit operations. Transit-only lanes are an option where need and physical space allow. **Medians should be used to shorten crossing distances** and protect center turning lanes.
- Due to high vehicular volume, **protected bicycle facilities are recommended**. Consider frequent vehicle turning movements in design.
- On-street parking, protected by bump outs is **recommended**.

DOWNTOWN LINK

Image Capture: August 2018 © 2019 Google

Downtown Link streets are connections that carry local downtown traffic between Downtown Activity streets. Like Downtown Activity Streets, these streets serve the highest downtown densities and mixed uses.

Unlike Downtown Activity, these streets may have lower traffic volumes and travel speeds should be kept low by design to respect the relatively high pedestrian traffic volume while allowing for reliable vehicular traffic flow.

Downtown Link streets are traveled by all modes, but primarily pedestrians. Where alleys and off-loading facilities do not exist, Downtown Link streets are likely to serve the majority of downtown curbside deliveries. These links may feature transit service as buses depart from and return to the RTS Transit Center. Downtown Link streets are often more attractive options for bicycle routing versus Downtown Activity streets.

EXAMPLE STREETS

- Fitzhugh Street (pictured)
- Pleasant Street
- Scio Street

PRIORITY USERS

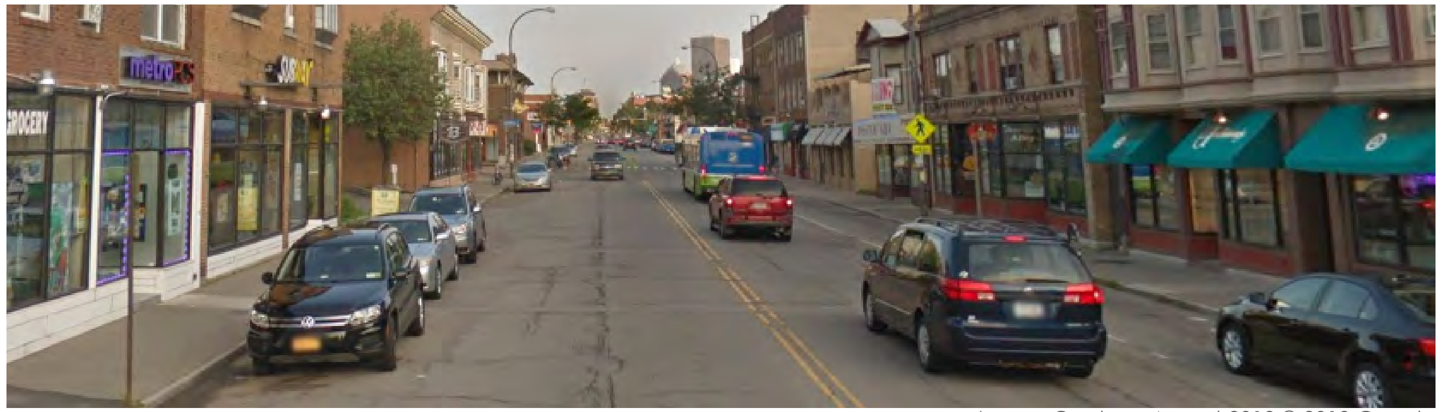
As with Downtown Activity Streets, Downtown Link streets should emphasize pedestrians first. Workers, customers, students, and visitors arriving via any mode all become pedestrians and active users of downtown public space.

DESIGN OBJECTIVES AND TYPICAL FEATURES

Downtown Link streets should continue to create a sense of place on less-traveled downtown streets and accommodate all modes. Transit and goods delivery activity may be less prevalent.

- **Sidewalks (8 feet minimum width)** on both sides of the street and street trees are required.
- Travel lanes should be scaled appropriately to the common users of the street, **most often 10 feet in width**. Where there will be transit operations, lanes should be **11 feet wide**.
- **Dedicated bicycle lanes are recommended**. Protected facilities are only recommended to link together the off-street network where physical constraints and opportunities allow.
- On-street parking protected by bump outs **should be provided on both sides of the street**.

NEIGHBORHOOD ACTIVITY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Neighborhood Activity streets are primarily commercial corridors that also serve a critical roles in the larger transportation network. Neighborhood Activity streets are unique areas within Rochester neighborhoods that serve medium intensity mixed uses, including newer flexible mixed uses and are defined as prime areas to accommodate infill development.

Neighborhood Activity streets are moderate to high volume multimodal streets. While typically oriented along a corridor, they can be arranged as a grouping of streets to create mixed-use neighborhoods within or near development sites.

Neighborhood Activity streets accommodate travel demands to and through the business district and must provide safe access for all modes of travel, although they may be prioritized for one or more modal emphases (High-frequency transit is most likely to operate on this street typology).

EXAMPLE STREETS

- Monroe Avenue (pictured)
- North Clinton Avenue
- University Avenue
- West Main Street

PRIORITY USERS

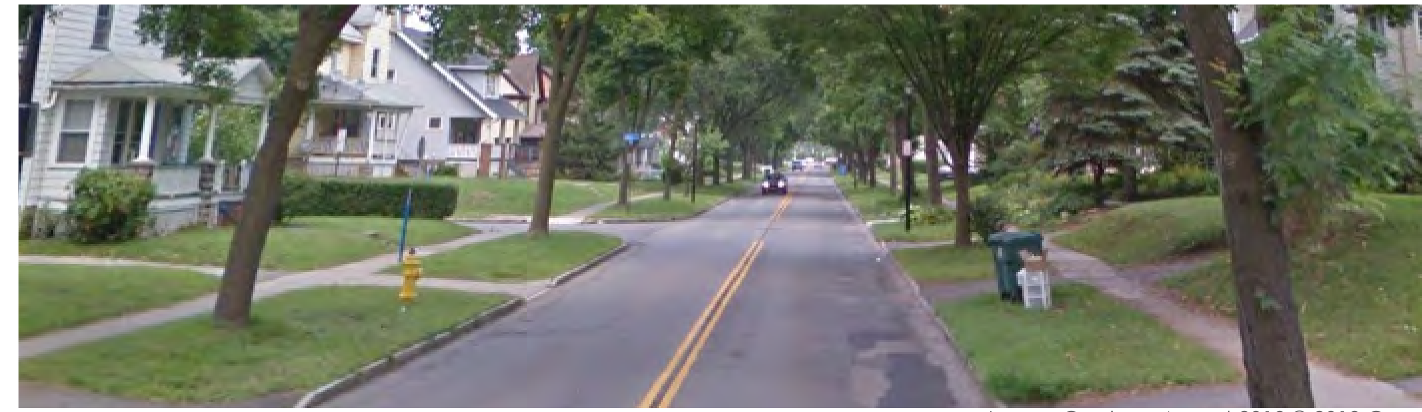
Commercial customers and employees arriving on foot, bike, via transit, and by personal vehicle. Delivery vehicles must also be accommodated.

DESIGN OBJECTIVES AND TYPICAL FEATURES

Neighborhood Activity streets should support economic productivity of the corridor and enhance multimodal access and through travel while enabling unobstructive goods delivery.

- **Sidewalks (8 feet minimum width)** on both sides of the street, large canopy trees, and pedestrian seating are required.
- Travel lane width is variable dependent on modal emphasis. Lanes should be **11 feet wide on transit corridors**, 10 feet wide elsewhere.
- Noting difficulty due to right-of-way constraints, **dedicated bicycle lanes are recommended**. Protected facilities may be considered where daily traffic exceeds 6,000 vehicles per day.
- On-street parking on one or both sides of the street along with sufficient and convenient bicycle parking is **recommended**. Any parking lane **should be protected by bump outs**.

NEIGHBORHOOD LINK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Neighborhood Link streets are predominantly residential corridors that serve a similar role to that of Neighborhood Activity streets in the transportation network. Community facilities such as parks or recreation centers, schools, or places of worship are common on these streets and may be interspersed with some limited commercial use.

These streets may have moderate to higher volumes of traffic—particularly during peak travel hours. Vehicle travel must be maintained at modest speeds to respect the more residential character of this street type and/or likelihood of children crossing the roadway.

Neighborhood Link streets are primary streets for all modes of travel including pedestrians, bicyclists, private vehicles, transit, and delivery trucks. They often have some level of transit service and some may feature frequent transit service. Neighborhood Link streets may also serve as critical backbones of the on-street bicycle network.

EXAMPLE STREETS

- Brooks Avenue (pictured)
- Bay Street
- Jay Street

PRIORITY USERS

Neighborhood Link streets are complete streets and must provide safe accommodation for all users. Some streets may be recognized as key links in a certain modal network and thus slightly prioritize the efficient travel of that mode.

DESIGN OBJECTIVES AND TYPICAL FEATURES

Neighborhood Link streets should protect residential quality of life while accommodating crosstown connectivity via a variety of modes.

- **Sidewalks (5 feet minimum width)** on both sides of the street and street trees are required.
- Travel lane width is variable dependent on modal emphasis. Lanes should be **11 feet wide on transit corridors**, 10 feet wide elsewhere.
- **Dedicated bicycle lanes are recommended**. Protected facilities may be considered where daily traffic exceeds 6,000 vehicles per day.
- On-street parking on one or both sides of the street is **optional**. Where present, on-street parking **should be protected by bump outs**.

NEIGHBORHOOD LOCAL

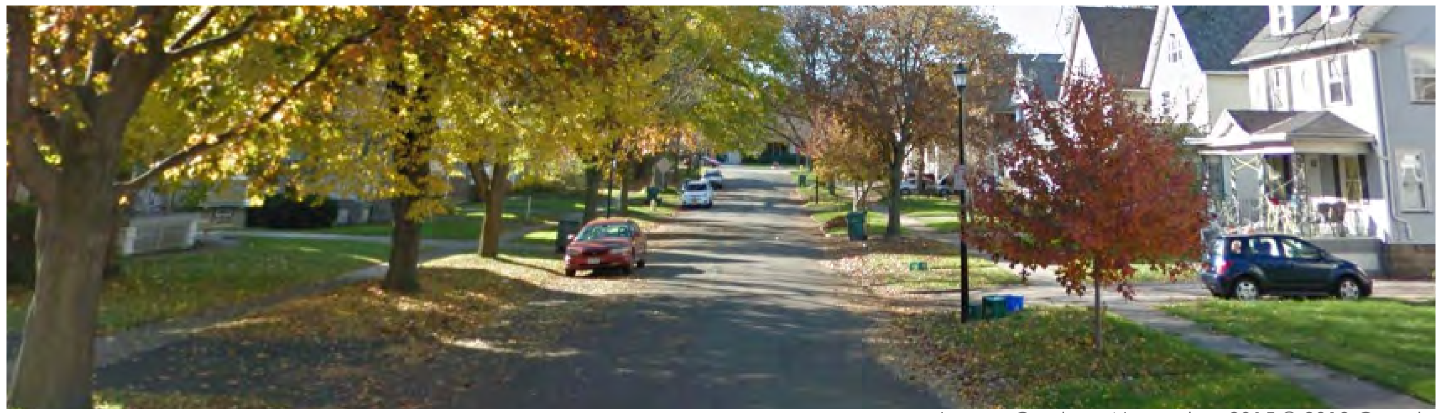


Image Capture: November 2015 © 2019 Google

Neighborhood Local streets provide access to local residents while inviting those residents to use the streets as public linear recreational space. Neighborhood Local streets generally correlate to low and medium density residential areas as defined by the City's Placemaking Plan where building types are primarily single family houses, divided houses, or smaller apartment buildings.

Neighborhood Local streets are not principal streets in the citywide vehicular network, but serve as an important link for pedestrians and cyclists who generally travel at lower speeds. Neighborhood local streets are primary candidates for bicycle boulevard implementation rather than dedicated bicycle lanes and generally do not feature transit service. Additionally, truck traffic may be restricted on these streets.

EXAMPLE STREETS

- Gorsline Street (pictured)
- Linden Street
- Post Avenue
- Grand Avenue
- Evergreen Street

PRIORITY USERS

Residents of Neighborhood Local streets, pedestrians and cyclists of all types and abilities, and especially vulnerable users including young children, seniors, and persons with disabilities.

DESIGN OBJECTIVES AND TYPICAL FEATURES

In an effort to design streets that maintain low vehicle volumes and travel speeds, emphasize green infrastructure and open space, and continue to provide access to residences, the following features are employed:

- **Sidewalks (5 feet minimum width)** on both sides of the street are required. A tree lawn should be provided between the sidewalk and street.
- **Narrower travel lanes (10 feet)** and limited network connectivity generally manage speeds and deter non-local traffic. Traffic calming elements are appropriate as a supplemental implementation.
- Separate bicycle facilities are generally not provided. Safe and low-stress bicycle accommodation is **provided within the street**.
- On-street parking is **generally provided** on one or both sides of the street.

INDUSTRIAL LINK

Image Capture: August 2018 © 2019 Google

Industrial Link streets are regional connections that primarily serve large-scale industry, often isolated manufacturing, warehousing, and distribution uses. Industrial Links are rarely found in close proximity to residential or commercial uses, may be relatively isolated from other streets, may occur in small pockets among other street types, or may comprise an entire distinct district.

Industrial Link streets often experience a more pronounced difference between peak and non-peak hour traffic volumes because they are located near employment centers. Access via a variety of modes including transit, bicycle, and by foot remains important.

These streets serve industrial corridors and are built to accommodate commercial trucks. While there may be fewer pedestrians and bicyclists here, these streets may also serve as through-routes for these users to adjacent land uses.

EXAMPLE STREETS

- Buffalo Road
- Lexington Avenue (pictured)
- Driving Park Avenue
- Portions of Lyell Avenue

PRIORITY USERS

Industrial Link streets should prioritize freight and service vehicles, but are are still complete streets and should retain multimodal access for workers, proprietors, customers, and clients.

DESIGN OBJECTIVES AND TYPICAL FEATURES

The primary function of Industrial Link streets is to support and strengthen economic activity by enabling efficient commercial activities. Safety is emphasized through reducing conflict opportunity.

- **Sidewalks (5 feet minimum width)** remain required. Streetscape elements are optional.
- **Travel lanes should be 11 feet wide** to allow for unimpeded goods movement and supporting transit activity. Median protected center turning lanes may be considered.
- Because of the blind spots often present in large vehicles, which may comprise more than 10% of total vehicle volumes, **physically separated bicycle facilities are recommended**.
- **On-street parking is an option**, though curbside space may be best used for transit and short-term delivery loading activity.

INDUSTRIAL LOCAL

Image Capture: August 2016 © 2019 Google

A secondary industrial street type is the **Industrial Local** street, which typically serves smaller pockets of industry across the City. Industrial Local streets are generally smaller streets that connect to larger network link streets, but may also serve as access points to larger industrial properties.

Volumes are lower in general on Industrial Local streets, though they may experience a surge of employee traffic at peak hour.

While these streets serve industrial uses and must accomodate commercial truck traffic, required travel lane width and travel speeds are lower, allowing for unprotected pedestrian and bicycle facilities where a need is identified. For example, an industrial office park street or street with obvious function in the transportation network should include complete street treatment.

EXAMPLE STREETS

- Adirondack Street (pictured)
- Nassau Street
- Cairn Street
- Science Parkway
- Mt. Read Boulevard Frontage Roads

PRIORITY USERS

As with Industrial Link streets, Industrial Local streets should prioritize freight and service vehicles. Depending on context, multimodal access for employees may be enhanced.

DESIGN OBJECTIVES AND TYPICAL FEATURES

As the primary objective of Industrial Local streets is to provide local access to industrial sites, most design elements are optional dependent on surrounding land uses and desired network connectivity.

- The sole requirement for Industrial Local streets is **11 feet wide travel lanes**. **Sidewalks are optional** and context dependent.
- Also optional are on-street curbside parking, streetscape elements, and bicycle facilities.
- Depending on network connectivity, Industrial Local streets may be candidates for shared lane markings and integration into the bicycle boulevard network, though vertical traffic calming elements should not be employed.

ALLEY

Image Capture: October 2015 © 2019 Google

Alleys can be designed to play an important role in the street networks of commercial districts as well as residential areas. Both types of alleys serve a utilitarian purpose, allowing for off-street loading and unloading, garage access, and refuse removal. Alleys provide direct property access and eliminate the need for driveways, which improves the walking and biking environment on primary streets.

Alleys generally have very low traffic volume. Potholes and puddling are common. Alleys represent an opportunity to install porous pavements for more effective drainage while not degrading the alley's operation or function.

Alleys operate largely as shared streets, with no regulating striping or curb separation. Dependent on context and need, the City may choose to include alleys as links in pedestrian and bicycle networks. Commercial alleys can be restricted to non-motorized traffic during non-delivery hours.

EXAMPLE STREETS

- Pindle Alley
- Ruff Alley
- Daus Alley (pictured)

PRIORITY USERS

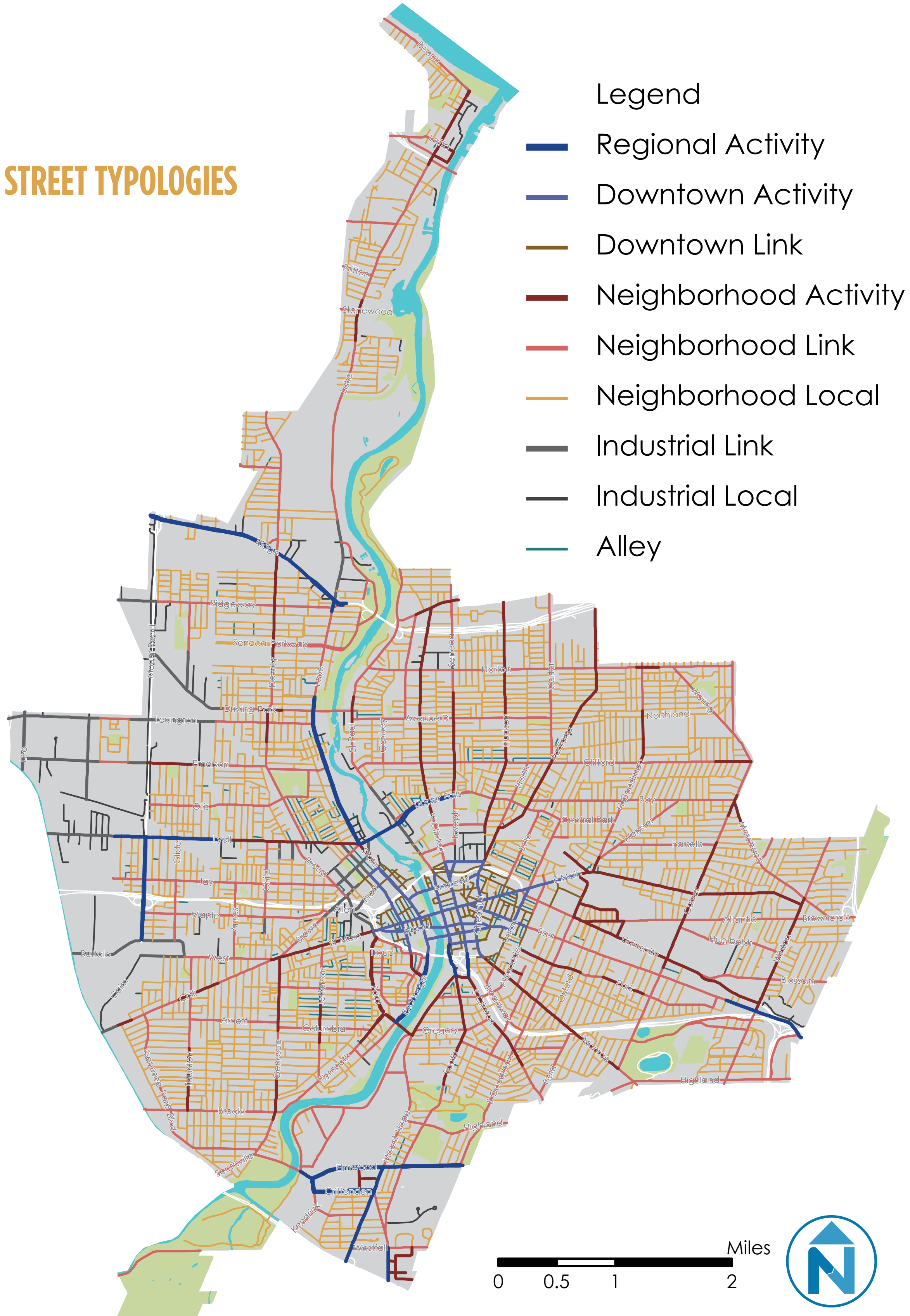
Access is reserved for property owners as well as delivery and utility vehicles. Pedestrians and cyclist should feel comfortable using alleys as shortcuts between streets.

DESIGN OBJECTIVES AND TYPICAL FEATURES

The primary function of alleys is to reduce loading and utility activity on the local street. Alleys have the added benefit of reducing curb cuts, which in turn increases the on-street parking supply and the quality of the tree canopy while reducing the number of conflict points on the parallel street.

- **Pavement or another hardscape treatment are required** in alley design. Depending on the volume of activity, consider porous pavements with high sunlight reflectivity to improve drainage and reduce heat island effects. Where garbage trucks operate, pavements must meet AASHTO H-20 Loading ratings.
- **Lighting is required** in alleys for safety reasons.
- A single lane width limits vehicle traffic while a lack of painted markings or curbing reinforces that space is shared between all modes.

ASSIGNED STREET TYPOLOGIES



RIGHT-OF-WAY ZONES

The elements that make up city streets, from sidewalks to travel lanes to transit stops, all vie for space within a limited right of way. To make clear the tradeoffs between different design choices and optimize the benefits the community receives from its streets, the Rochester Street Design Guide identifies three conceptual 'zones' that can make up the right of way of the street.

PEDESTRIAN ZONE

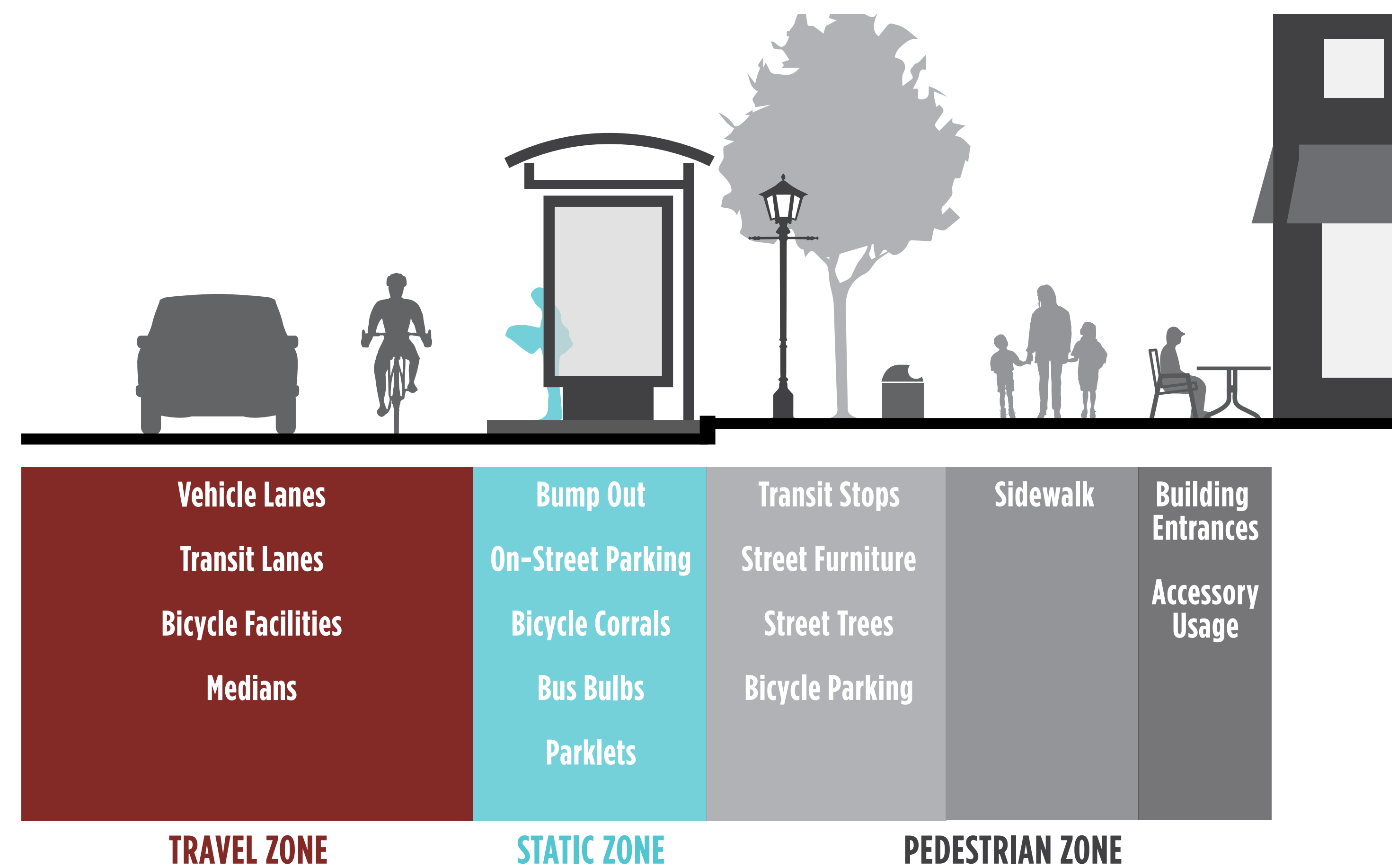
Defined as the portion of the street between the curb line and the property line, the Pedestrian Zone transitions from buildings to the public realm while providing adequate space for pedestrians to travel. The portion of this zone nearest the roadway buffers pedestrians from vehicular travel and provides space for streetscaping and amenities. The portion of this zone closest to the building entrance may accomodate temporary seasonal programming such as private sidewalk café seating on higher order street types. In certain situations, protected bicycle facilities may be located at curb level in the pedestrian zone.

STATIC ZONE

The Static Zone includes elements directly adjacent to the curb on the street side, such as parking spaces and parklets. This zone serves stationary uses and makes up part of the buffer area.

TRAVEL ZONE

The Travel Zone provides facilities for movement of people, including space for motor vehicles, bicycles, and transit vehicles.



ZONE DIMENSION AND FACILITY SELECTION

The target dimensions for each zone of the street are based on the street typology, the mode emphasis (if any), and the available right-of-way. Common street dimensions for various elements are shown here. Some of the design elements may not be present or appropriate for all street typologies.

Within the zones of the street, designers have the ability to select and combine different street elements to achieve the goals and design objectives for the street type. Facility selection is the process of weighing tradeoffs and prioritizing users and uses in the available right of way. Designers should use best engineering judgment to carefully balance modes, while ensuring that all users are safely accommodated. Typical dimensions are to be used as applicable and feasible, but may need to increase or decrease to improve user comfort and/or when used in conjunction with other elements. Note that certain dimensions provided may exceed state minimum requirements and represent an ideal implementation of that element.

Zone	Element	Regional Activity	Downtown Activity	Downtown Link	Neighborhood Activity	Neighborhood Link	Neighborhood Local	Industrial Link	Industrial Local	Alley
PED. ZONE	Walkway (Sidewalk)	5’	8’	8’	8’	5’	5’	5’	5’	
	Landscape strip (trees and/or grass)	6’	6’	6’	6’	6’	6’			
	Temporary programming area		10’	10’	10’					
	Bus shelter	4.5’	4.5’	4.5’	4.5’	4.5’		4.5’		
STATIC ZONE	On-street parking and loading	8’	8’	8’	8’	8’	8’	8’		
	Parklets		6’	6’	6’					
	Bicycle corral		6’	6’	6’					
	Bump out		6’	6’	6’	6’		6’		
TRAVEL ZONE	Vehicle lanes	11’	11’	11’	11’	11’	10’	11’	11’	
	Turning lanes	10’	10’	10’	10’	10’		10’		
	One-way dedicated bicycle lane		5’	5’	5’	5’		5’		
	One-way protected bicycle lane	8’	8’	8’	8’	8’		8’		
	Two-way cycle track	13’	13’	13’	13’	13’		13’		
	Dedicated transit lane	12’	12’							
	Median	10’	10’					10’		

ELEMENT INCLUSION GUIDANCE

The typology definition process groups streets while also defining required, recommended, and optional street treatments. The table below summarizes that guidance per street type for quick reference. Streetscape refers to any combination of street trees, lighting, seating, waste containers, and/or bicycle furnishings. Note that all requirements are subject to site limitations and constraints. The City should strive to satisfy requirements whenever possible.

	Minimum Sidewalk Width	Travel Lane Width	Bicycle Facility	Transit Lanes	On-Street Parking	Protected Center Turning Lanes	Streetscape
REGIONAL ACTIVITY	5'	11'	Recommended Protected	Optional	Optional Protected	Optional	Recommended
DOWNTOWN ACTIVITY	8'	11'	Recommended Protected	Optional	Recommended Protected	Optional	Required
DOWNTOWN LINK	8'	11' (Transit) 10' (Non-Transit)	Recommended Dedicated		Recommended Protected		Required
NEIGHBORHOOD ACTIVITY	8'	11' (Transit) 10' (Non-Transit)	Recommended Dedicated Optional Protected (AADT > 6,000)		Recommended Protected		Required
NEIGHBORHOOD LINK	5'	11' (Transit) 10' (Non-Transit)	Recommended Dedicated Optional Protected (AADT > 6,000)		Optional Unprotected		Required
NEIGHBORHOOD LOCAL	5'	10'	Optional Shared Lane Markings		Recommended Unprotected		Required Optional Discrete Traffic Calming
INDUSTRIAL LINK	5'	11'	Recommended Protected		Optional Unprotected	Optional	Optional
INDUSTRIAL LOCAL	Optional 5'	11'	Optional Shared Lane Markings		Optional Unprotected		Optional

SELF-ENFORCING DESIGN

Self-enforcing design is a key objective of the Rochester Street Design Guide. Self-enforcing design provides environmental cues to street users to enable them to naturally and intuitively comply with speed and other operating expectations. Self-enforcing design is substantially more effective than simply providing signage or relying on enforcement by police because the design uses environmental cues to guide travelers to drive, bicycle, and walk carefully when using the street. This improves safety for all users and helps to achieve the objectives and desired outcomes of the Rochester Comprehensive Access and Mobility Plan.

Street design outcomes are governed by a number of design controls. These controls reflect the character and context of the street as well as the desired and expected behavior of street users. On a very wide road with few buildings, trees, or activities along the street edge, a driver can easily underestimate the speed they are traveling and inadvertently exceed the speed limit. On such streets, the driver's attention focuses on points further ahead and their peripheral awareness diminishes. On a narrow street with buildings and trees providing a sense of enclosure and many active uses along the street edge, drivers have a better sense of the speed they are traveling relative to other users on the street. The slower speed, in turn, increases their perception of activities on the periphery.

The majority of drivers are cautious, prudent, and drive at speeds that are reasonable and proper, regardless of the posted speed limit. It is therefore incumbent upon the street designer to consider every aspect of street design and its components. The Rochester Street Design Guide delivers street designs that allow drivers to intuitively understand the reasonable and proper travel speed. It also supports the larger objectives of street operation without over-reliance on active enforcement measures.

One of the benefits of self-regulating design is that it minimizes the need for active police enforcement. This delivers street safety while at the same time minimizing the need for interaction between travelers and law enforcement personnel. Self-regulating street design equitably communicates safe operational behavior to all drivers at all times.

The most effective techniques employed in creating self-enforcing streets are:

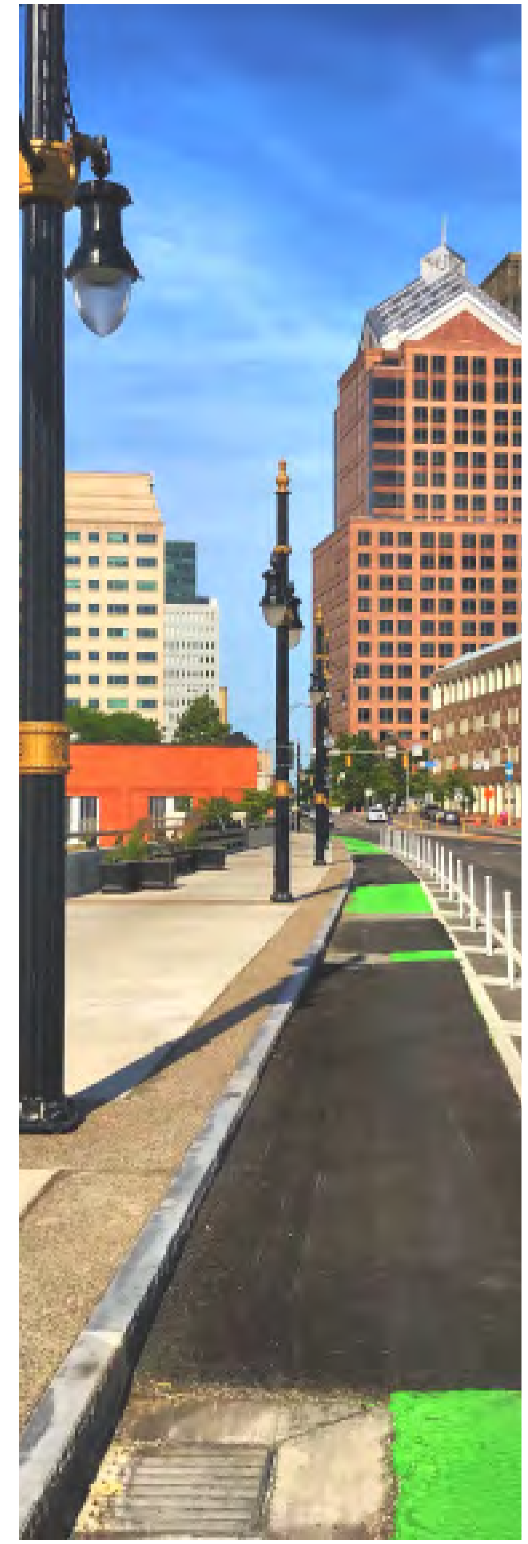
- TRAVEL LANE WIDTHS
- TURNING RADII
- STREET EDGE FEATURES
- LINE OF SIGHT
- SPEED MANAGEMENT, SUCH AS HORIZONTAL OR VERTICAL DEFLECTION FEATURES
- PRESENCE OF MULTIPLE MODES OF TRANSPORTATION
- SIGNALS
- NUMBER OF LANES

DESIGN SPEED

Vehicle speed has a profound effect on the use and enjoyment of urban streets and is perhaps the single most important factor in safety outcomes. Vehicle speed affects a driver's peripheral awareness, the stopping distance required to avoid a crash, and survival and injury rates should a crash occur.

At slow rates of speed, drivers can stop more quickly and have more time to react to objects or incidents further down the road. Drivers can focus on a wider perspective of the street and pay more attention to activities occuring along the street edge, such as crossing pedestrians or school children playing in front yards. This allows a higher margin of error for drivers of all ages and abilities. At even moderately higher rates of speed on major roads, drivers must focus more attention on activities in the street further ahead of them that pose the most obvious potential threat. This narrowing of focus means drivers are less aware of and less able to respond to unanticipated incidents that may spring from the street edge, such as a pedestrian crossing the street or a driver emerging from a vehicle parked at the curb.

DRAFT
SELF-ENFORCING DESIGN



Source: Arian Horbovetz

DEFINTION

Speed in street design can be referred to in a number of ways:

- The **Speed Limit** is also referred to as the posted speed. It is the maximum legal speed permitted on a segment of roadway. The standard speed limit on non-limited access expressways in the City of Rochester is 30 miles per hour except as indicated in Schedule A on file with the City's Traffic Control Board.
- The **Target Speed** is the desired speed at which motor vehicles travel on a street, determined by policy and design.
- The **Operating Speed** is the speed at which 50% of all vehicles travel under free flow conditions.
- The **Design Speed** is the maximum safe speed that one may generally travel on a segment of roadway, weather permitting and depending on geometric characteristics of the segment.
- The **Inferred Speed** is the speed most motorists sense is the appropriate speed on a street based on the general design of the street.
- The **85th Percentile Speed** is the speed at which 85 percent of all vehicles travel under free flow conditions. The 85th percentile speed is higher than the average operating speed of the majority of drivers.

In conventional street design, the design speed used for the street may be 5 to 10 MPH above the legal speed limit. This conservative approach to design results in an environment that conveys an even greater inferred speed to the driver. Drivers feel they are penalized for traveling at a speed that feels natural and intended.

Effectively managing speed cannot rely solely on the posting of regulatory signs. The design of the street should naturally compel drivers to drive at the desired and appropriate speed.

Rather than focusing on the maximum legal speed permitted, street designers should instead focus on the target speed and **deliver a street that produces an identical operating speed**. This requires a street to be designed in such a way that drivers can infer the proper speed from the cues they receive from the street environment.

A measure of success in street design is when operating speed matches target speed. To accomplish this, design speed and inferred speed should converge to produce an identical operating speed at the minimum legal speed limit which will capture 85 percent of all vehicles traveling under free-flowing traffic conditions.

STOPPING DISTANCE

Motor vehicles, transit buses, and delivery trucks traveling at even moderate rates of speed possess tremendous momentum and can exert exponentially greater force compared to smaller, slower objects, such as bicycles, operating in the same space.

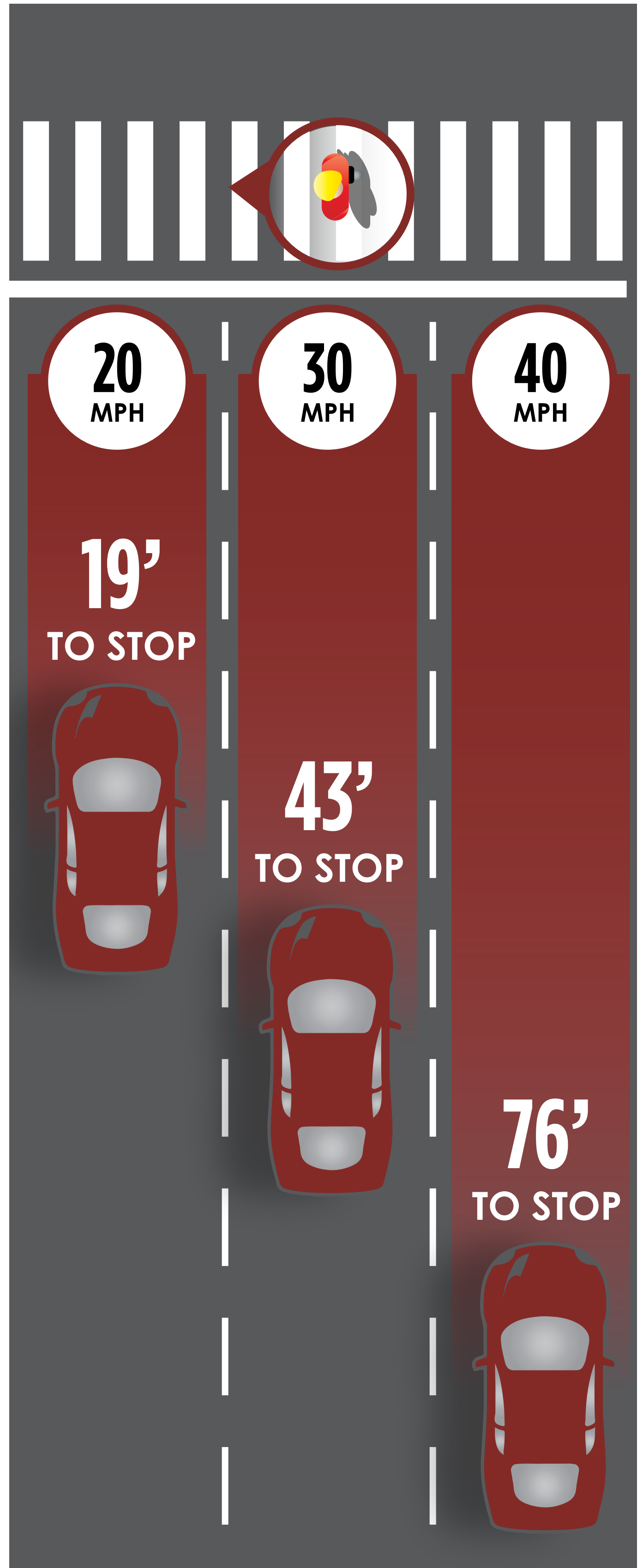
In addition, while pedestrians and even bicyclists can react and stop or adjust very quickly to unanticipated conflicts in the street, automobiles cannot due to their size and weight. The faster an automobile is traveling, the more time and distance is required to avoid a potential collision.

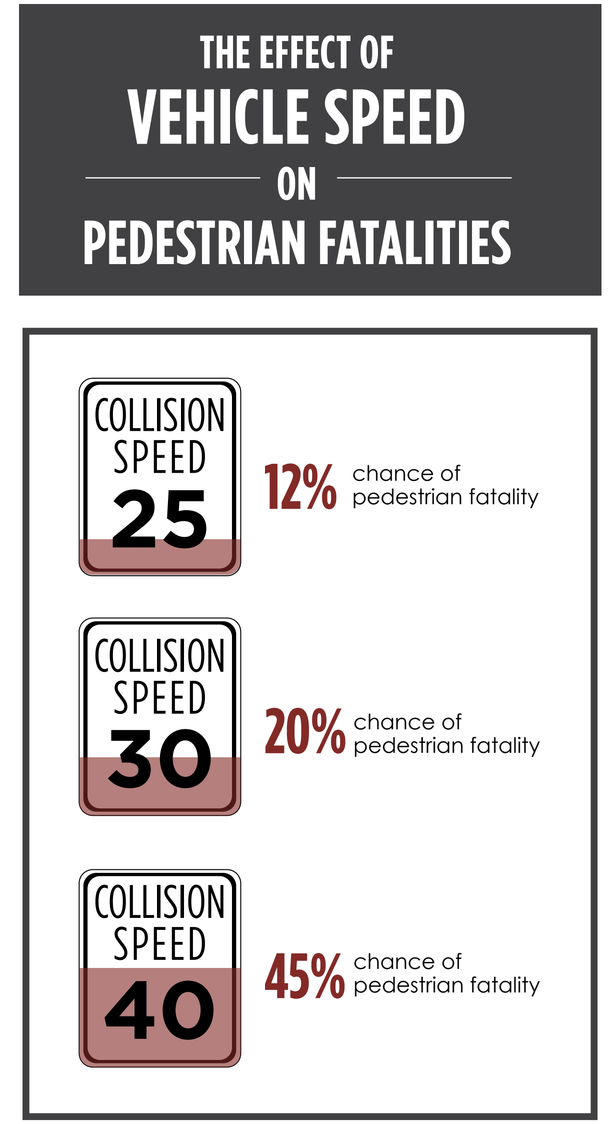
In addition to the required stopping distance in the figure at right, a driver's recognition and response to perceived danger takes time, during which the vehicle continues to travel at the original speed. Even if the driver reacts in 1.5 seconds, the vehicle travelling 20 mph requires 44 additional feet to stop. At 30 miles per hour, the driver requires 109 feet in total to assess, react, and stop the vehicle. At 40 miles per hour, that number is 164 feet.

Thus, if a pedestrian, suddenly appears 75 feet in front of a driver, at 20 MPH the driver will be able to react and stop before striking them. In contrast, vehicles operating at even moderately higher speeds may not be able to stop in time, drastically increasing the risk of death and severe injury.

SAFETY IMPACT

Street designers can anticipate and plan for known occasions that require a vehicle to stop, such as at intersections or crossings. However, they must also be cognizant of the potential consequences of unanticipated events when adequate stopping distance cannot always be provided. In these instances, vehicles traveling at higher rates of speed will strike with greater force, possibly resulting in death or serious injury. As seen in the graphic on the following page, risk of pedestrian fatality is





Source: *Impact Speed and a Pedestrian's Risk of Severe Injury or Death*, AAA Foundation for Traffic Safety, September 2011

correlated to speed of the colliding motor vehicle. At low speeds, risks are low: at impact speeds below 15 mph, 91% percent of pedestrian who are struck do not sustain serious injuries and very few die. As speeds increase, small changes in speed significantly increase pedestrian fatality risk. Risks are even higher for older pedestrians. The average risk of death for a 70-year-old pedestrian is equal to the average risk for a 30-year-old pedestrian struck by a vehicle traveling 10 mph faster. Street design that intrinsically guides drivers to operate at speeds consistent with desired safety outcomes can reduce not only traffic fatalities, but also the number and severity of serious injuries among pedestrians.

SELF-REGULATED SPEED MANAGEMENT TECHNIQUES

Three features of street design significantly contribute to the driver's perception of speed: lane widths, turning radii, and activities along the street edge.

LANE WIDTHS

A 2000 study published in the Transportation Research Record entitled, *Design Factors That Affect Driver Speed on Suburban Streets* found that while many factors influence driver speed, wider lanes correlate with higher travel speeds, while narrower lanes contribute to slower driving speeds. Narrow travel lanes have a positive effect on the safety of the street by reducing vehicle crash rates.

In addition, research presented by the Midwest Research Institute at the 2007 Transportation Research Board Annual Meeting concluded that narrower, 10- or 11-foot travel lanes led to no increases in collision frequency compared to 12-foot lanes. Findings further stated that the use of narrower lanes may provide benefits in traffic operations, pedestrian safety, and/or reduced interference with surrounding development.

10-foot wide travel lanes accommodate the majority of vehicles using City streets while maintaining a street profile that supports speed management objectives. Streets with frequent transit services or significant volumes of truck traffic require an 11-foot lane to accommodate those vehicles. On streets with multiple lanes of travel in one direction, this lane should be closest to the curb. All other lanes should measure the minimum width.

It is important that the determination of travel lane width be made within the overall assemblage of the street. While 10-foot travel lanes are generally preferred, utilizing the narrowest acceptable dimension for all street features such as bike facilities and parking lanes may result in friction between users and decreased safety. Facilities adjacent to a travel lane should be increased to at least the preferred dimension while maintaining the narrowest acceptable marked space for the travel lane.

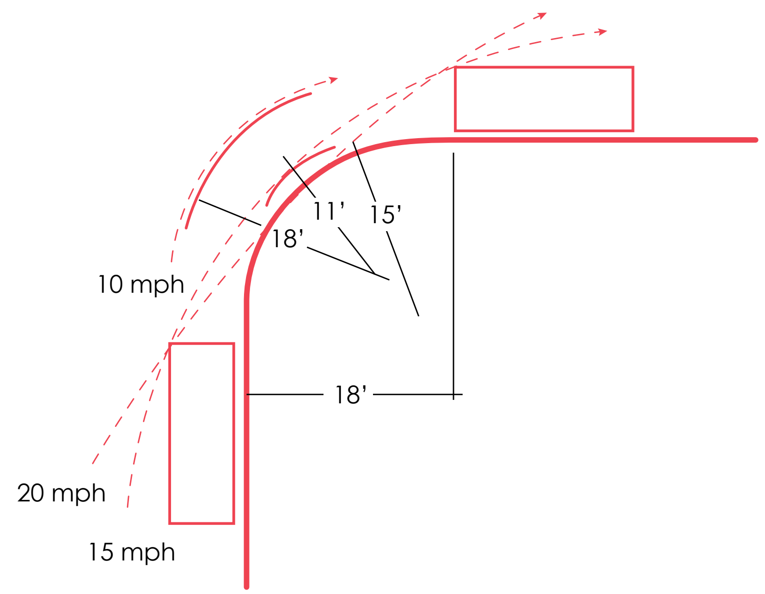
TURNING AND CORNER RADII

Turning and corner radii affect the speed of turning vehicles, the alignment and length of crosswalks, and, consequently, the risk and exposure of crossing pedestrians. A smaller turning radius lowers the speed of vehicles in the intersection, improving safety for pedestrians.

The turning radius is often thought of as one measure, but in fact there are two measures to consider:

- Effective corner radius
- Actual corner radius

The effective corner radius is the turning radius a vehicle can track without encroaching on the curb. Curbside parking or bicycle facilities along the edge of the street increase the effective corner radius of an intersection. Bump outs decrease the effective corner radius. A smaller turning radius results in a lower vehicle turning speed and better pedestrian visibility. In general, effective corner radii are larger than actual corner radii.



NOTES:

- A 15-foot corner radius yields a 20 mph passenger vehicle turning speed if parked vehicles are no closer than 18 feet from the intersection.
- An 11-ft corner radius yields a 15 mph turning speed.
- A 6-ft wide curb extension with an 18-foot radius yields a 10 mph turning speed if the vehicle travels as close as possible to the corner.

Source: American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets.* Washington D.C.: 2011; Formula 3-8.

Street designers should use the smallest practical actual corner radius that preserves an effective curb radius appropriate to the design vehicle and the overall objectives of the street. Effective corner radii are configured to the needs of design vehicles and the mode emphasis of the street. Control vehicles that rarely use the street, such as fire trucks, may encroach into oncoming lanes if and when required to slowly navigate a turn. Smaller radii should be the default where there is an expectation of high levels of use by persons with disabilities.

DESIGN ELEMENTS ALONG THE STREET EDGE

Vertical elements such as street trees have positive implications for safety performance. Planted medians and curbside objects not only narrow the visual appearance of the roadway, but also bring street edge elements closer to the driver on both sides, providing the driver with a more intuitive sense of their travel speed and causing them to slow to target travel speeds. These buffers also increase pedestrian comfort walking across and adjacent to the roadway. Note that Federal Highway Administration requirements maintain an 18 inch minimum horizontal clearance to vertical obstructions unless a design exception is approved to provide adequate clearance for heavy duty vehicle mirrors and for opening curbside doors.

Unlike an arrangement that alters the street context to provide a clear zone to compensate for driver error, and inadvertently encourages more dangerous driving habits, self-regulating design creates a lively street environment that supports drivers in intuitively traveling at speeds appropriate to the street context.

DESIGN VEHICLE

In conventional street design, the design vehicle is the largest motor vehicle that uses a street with considerable frequency. However, motor vehicles are not the only frequent users of an urban street. Geometric and operational design decisions made to accommodate motor vehicles significantly affect the ability of non-vehicular users to navigate the street safely and intuitively. Not all streets should be designed to accommodate all types of vehicles.

In order to provide safe and navigable streets for all users, Rochester street designers should **design for vehicles that comprise 10% or more of the typical volume of peak hour traffic.** An equally important consideration should be designing for the pedestrian.

For Neighborhood Local streets, the motorized design vehicle will be a passenger car. On higher order streets, the motorized design vehicle may be a school bus, municipal bus, or single unit delivery truck. Some streets with routinely high proportions of heavy vehicles may require the use of even larger motorized design vehicles, such as tractor trailers. Streets should be designed so that the motorized design vehicle may operate in the designated travel way at the desired design speed without impeding operation in other lanes or encroaching into the pedestrian zone at intersections and corners.

Regardless of the motorized design vehicle, streets must also allow pedestrians of all ages and abilities to navigate the City safely. This can be done by considering the pedestrian as a second priority user, representative of other likely street users. Using a child or senior on foot as the design vehicle is one way to evaluate if street design and operation is sufficiently logical and safe to navigate. Streets reasonably navigable by this less experienced and more vulnerable user will be safe and accessible to the majority of other non-motorized users.

The selection of a design vehicle impacts the characteristics of that street. Before selecting a design vehicle, consider the overall context of the roadway and how a larger control vehicle, such as a fire truck or tractor-trailer, might operate within the proposed design.

- Curb radii designed to accommodate the larger vehicles operating at higher speeds degrade the pedestrian environment and result in longer crossing distances.
- Emergency vehicles are permitted full use of the right-of-way in both directions, especially where tight curb radii may necessitate use of the opposite lane during a turn.
- Transit vehicles, such as articulated buses, benefit from the use of a larger effective turning radius.
- Oversized trucks and other large vehicles may be restricted from certain corridors based on existing context, vulnerable street users, or impractical operational impacts.
- Where operation is allowed, large vehicles may experience infrequent operating challenges.

HIGH-PRIORITY CONSIDERATIONS

The design vehicle is a frequent user of a given street and dictates the minimum required turning radius and lane width. A control vehicle is a larger more infrequent user that can complete turns using additional space within the intersection. Adopt both a design vehicle and a control vehicle standard based on context-specific street types.

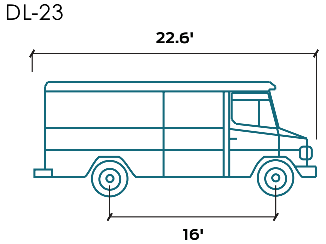
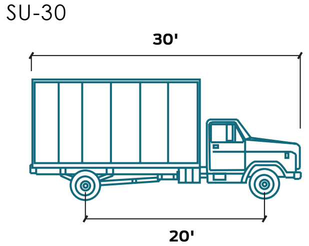
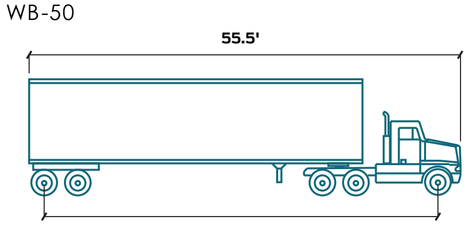
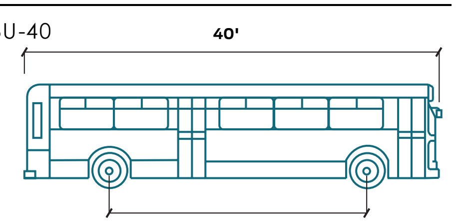
A transit bus may be a design vehicle on street where transit is emphasized and where buses turn. Buses must be able to turn without reversing. Consider removing parking near the intersection or recessing the stop line on the receiving street.

Consider slower design speeds when determining local street geometries. Vehicles traveling at slower speeds can make difficult turns that may be challenging or unsafe at higher speeds.

RECOMMENDED CONSIDERATIONS

Adopt a default design vehicle that is a frequent user of urban streets—the delivery truck (DL-23). Package delivery trucks commonly travel on city streets, and have an inside turning radius of 22.5 feet.

Designation of freight routes should be considered in coordination with primary bicycle, transit, and pedestrian corridors, as well as through analysis of key access routes, bridge hazards, and land uses.

STREET TYPE	DESIGN VEHICLE
Activity, Link, and Local Streets	DL-23 
Certain Activity Streets	SU-30 
Freight Emphasis Streets Note: Trucks are permitted to use the full intersection when making turns onto a receiving street.	WB-50 
Transit Emphasis Streets Note: Buses are permitted to use the full intersection when making turns onto a receiving street, but this is not preferable.	BU-40 

OPERATIONAL PERFORMANCE METRICS

Measuring the performance of a given street or network is an imperfect process. A street that works extremely well for one set of users may be difficult to use for another, just as a corridor with no delay at one point may experience significant delay at an intersection or elsewhere along the corridor. Performance measures must take a multidisciplinary approach, looking at urban streets and traffic at the macro and the micro scale, through the lens of safety, economy, and design, and inclusive of the goals and behaviors of everyone using the street.

The goals of different street users often conflict. For pedestrians, public safety, adequate sidewalk width, protection from rain, and shade from the sun together make a successful street. Bicyclists desire connectivity and minimal detour or delay in addition to feeling safe and protected from moving traffic. Transit service may be measured by its speed, convenience, reliability, and frequency of service. Motorists want to arrive at their destination as quickly and safely as possible with limited delay. Drivers feel safest when buffered from other moving vehicles, bicyclists, and crossing pedestrians. Freight operators want to move goods from their origin to their destination as easily and quickly as possible. Emergency responders are responsible for attending to events as quickly as possible and benefit from predictability along their routes. Urban street design must strive to balance these goals, making strategic tradeoffs in search of an optimal scenario.

The development of holistic performance measures requires a clarification of the problems that a designer is trying to solve. While a multi-modal performance metric such as person delay may improve upon auto-based level of service (LOS), delay alone fails to capture the success of a street outside of its ability to move people through it. A street with low person delay is not necessarily a great street, especially if it has no economic activity or shade trees to improve the public realm.

VEHICLE LEVEL OF SERVICE (LOS)

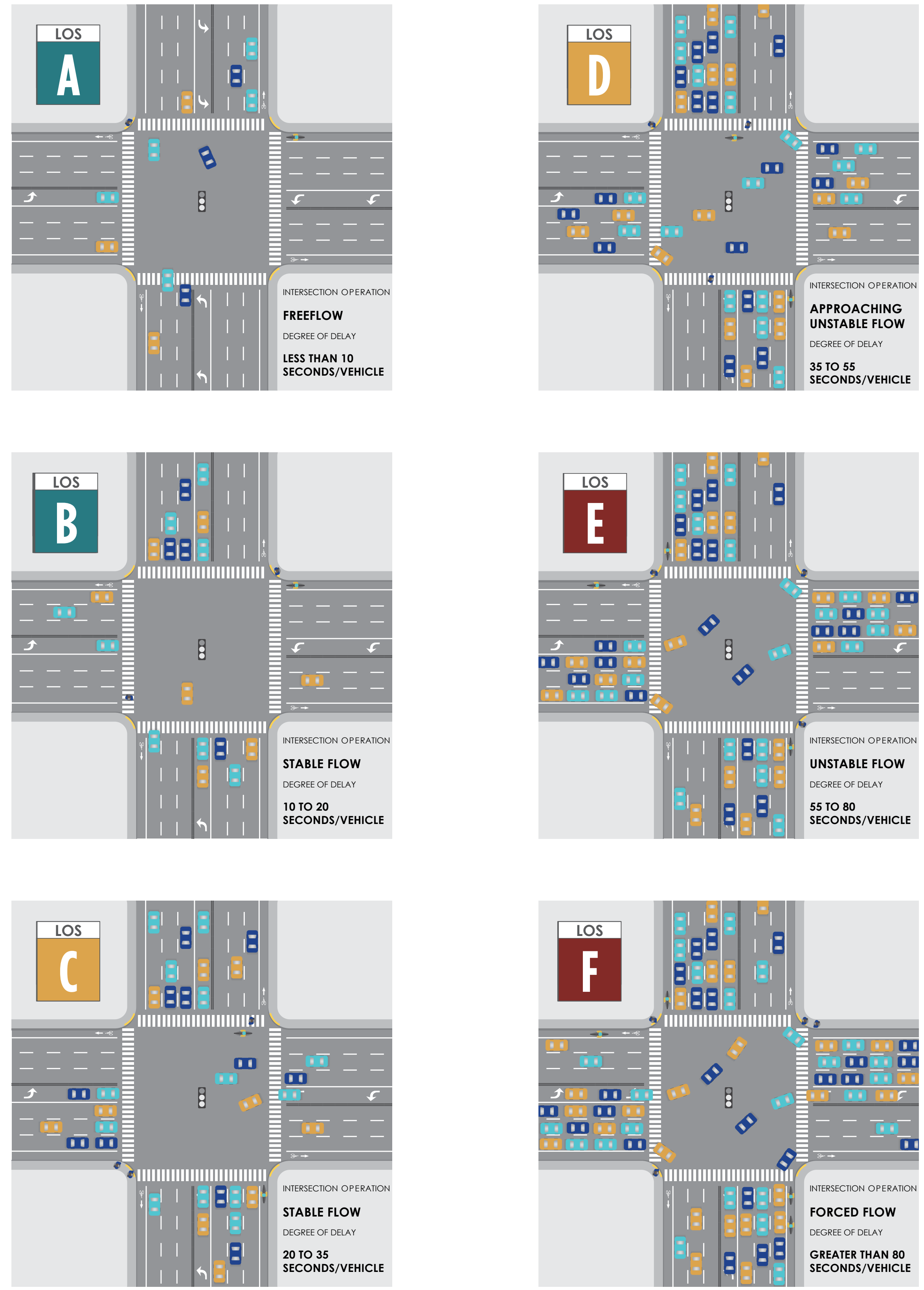
Vehicle Level of Service is among the most commonly used metrics of street and intersection operational performance. LOS is a measure of vehicle congestion at intersections reflected by letter grades that range from A to F. LOS as a measure of street performance has a number of limitations.

While congested roadways affect the efficiency of transit operations and the safety of pedestrian crossings, LOS is primarily an evaluation of the free movement of motor vehicles. Conversely, stopped transit vehicles or pedestrians in crosswalks can degrade vehicle level of service but are precisely the kinds of activities and users the Comprehensive Access and Mobility Plan seeks to support and encourage. LOS does not accurately reflect the street's performance for non-drivers.

In vehicle LOS, the same importance is assigned to a single-occupant vehicle as a full transit bus. LOS can also incompletely capture the impact of a street enhancement. LOS is commonly calculated for each intersection. While intersection improvements may decrease the vehicle delay at that intersection, travel time through a series of street segments may remain unchanged.

LOS generally describes conditions during the height of daily congestion—the peak hour or even peak 15 minutes of the busiest day. Seeking to achieve a higher LOS grade based on a level of congestion during a short period of the day results in increasing the number of travel lanes, increasing speeds, and wider rights of way—extra capacity that could be used for development, public space, or other productive uses. Instead, the goal should be to seek alternative ways to satisfy this travel need either via a different mode, along an alternative route, or at another period of the day.

Vehicle LOS often has an inverse relationship to economic vitality, quality of life, community health. High LOS grades are common in areas that attract few visitors and host limited activity while vibrant, dynamic areas that attract high numbers of visitors have lower vehicle levels of service. These considerations, along with mobility goals for Rochester transportation corridors, encourage the evaluation of replacement transportation system performance metrics. Cities and states across the continent have adopted alternative measures to supplement or replace vehicle LOS. These measures can be used to evaluate design alternatives and measure project and program performance for future street design efforts. No single measure is intended to be used alone, but when applied together they provide valuable insight for street design.



VEHICLE MILES TRAVELED (VMT)

VMT measures the amount and distance people drive, without taking the number of passengers within a vehicle into account. Typically, development at a greater distance from other land uses and in areas without transit generates more driving than development near other land uses with more robust transportation options. Currently, VMT information is used to help measure air quality impacts, especially in California where the state has replaced vehicular LOS with VMT in transportation analysis related to their Environmental Quality Act (CEQA).

VMT metrics define impact significance thresholds that require project impact and cumulative impact analyses. When a significant impact is identified, mitigation measures are considered to reduce that impact. Mitigation encourages infill development and can also deliver improved transit, bicycle, and pedestrian facilities. VMT is also useful in general plan or program-level analysis, helping to identify long-range transportation impacts.

The change from LOS to VMT analysis, already adopted by the cities of Pasadena, San Francisco, Oakland, and now San José, to measure and mitigate for the amount of induced vehicle travel, better aligns the desired effect of environmental policy with actual environmental impacts from traffic. Focusing on delays to vehicles ends up encouraging more driving, which leads to higher pollution and greenhouse gas emission levels. In contrast, measuring the amount of traffic a development produces gives a clearer picture of its potential environmental impacts.

PERSON THROUGHPUT

Person throughput is the number of all travelers, regardless of mode, accommodated through a particular point on a corridor. Unlike vehicle LOS, person throughput values all users equally and equally weighs the impacts to each.

Person throughput can be an evaluation measure when estimating the theoretical person capacity of a transportation alternative or a performance measure recording the actual throughput of users. Person-capacity reflects that non-drive-alone alternatives such as mass transit, bicycling, and walking can move many more people in the same area of roadway space as single occupant vehicles, optimizing the available right-of-way for the greatest number of travelers.

PEDESTRIAN/BICYCLE ENVIRONMENTAL QUALITY INDEX (PEQI/BEQI)

The Pedestrian Environmental Quality Index and associated Bicycle Environmental Quality Index were developed by the San Francisco Department of Public Health in 2008 to evaluate and prioritize investments in infrastructure. The index measures thirty indicators of pedestrian and bicycle environmental quality at both the segment and intersection levels, including vehicular conflict, street design, land use, and perceived personal safety. The department has made the index available for use and provides technical assistance in its application. While valuable measures, the indices are best suited to smaller geographic areas rather than city-wide application due to the time consuming nature of data collection.

For example, in the Boyle Heights neighborhood of Los Angeles, community members chose a smaller geographic area of about nine square blocks and 26 intersections for evaluation. Following training and surveys, street and intersection scores were calculated based on contributions to pedestrian safety and walkability. Scores helped community members focus initial improvements. An implementation of PEQI or BEQI in Rochester would first require identification of a focus area through analysis of another metric that is more conducive to a citywide application such as MMLOS.

MODE SHARE

Mode share is the percentage distribution of the modes people use to commute to and from work. It is a benchmark that can be used to evaluate the number of travelers relative to the capacity of the street, assess the City's right-of-way allocation and use, and measure progress towards sustainability goals such as a citywide policy to reduce single occupancy vehicle (SOV) trips.

Peer cities, for example Grand Rapids, Michigan, have adopted mode share targets for 2035 and longer term goals to reduce the mode share of SOV commute trips from 95% in 2013 to 70% in 2035 and ultimately to 45%. This is accomplished through sizable increases in commuting by foot, by transit, and by bicycle, which require that streets provide connected, accessible, and inviting pedestrian facilities; efficient, safe, and logical bicycle infrastructure; and regular, rapid, and reliable transit services.

While mode share can be calculated after an improvement project through travel surveys or direct observations, forecasting mode share—or bicycle or pedestrian demands—is difficult.

Source: UCLA Center for Occupational and Environmental Health

MULTIMODAL LEVEL OF SERVICE MEASURES (MMLOS)

In late 2013, the City of Ottawa completed a full update to their Transportation Master Plan (TMP). The TMP includes recommendations and actions that support the development of Complete Streets to provide safe and efficient roads. One of the tools identified to support the process was the development of an MMLOS framework, which is intended for use in the assessment of road design and the allocation of street right-of-way.

Draft guidelines were released in 2015 to build upon the high level direction of the TMP and to provide a detailed overview of how the service indicators are to be used and interpreted for each mode–pedestrians, cycling, transit, freight trucks, and motor vehicles–as part of the transportation impact assessment process.

The MMLOS tools should be applied to a variety of projects whenever detailed analysis of transportation impacts is required. The MMLOS criteria allows for comparison of modes in order to evaluate trade-offs by assessing the relative attractiveness and comfort of any particular mode along a corridor. An overview of these varying factors are described in the table below.

The Pedestrian Level of Service (PLOS) tool is intended to evaluate pedestrian comfort, safety and convenience. The segment analysis component is based on pedestrian facility quality and adjacent traffic impact while the intersection analysis component considers two factors–pedestrian delay, and pedestrian exposure to traffic at signalized intersections.

The bicycle level of service tool evaluates both roadway segments and signalized intersections for the level of traffic stress (LTS) experienced by cyclists using the corridor. Results are mapped to level of service A-F in order to allow comparison with other modes.

MODE	ELEMENT	LEVEL OF SERVICE	
Pedestrians (PLOS)	Segments	High level of comfort	Low level of comfort
	Intersections	Short delay, high level of comfort, low risk	Long delay, low level of comfort, high risk
Bicycles (Mapped BLTS)	Segments	High level of comfort	Low level of comfort
	Intersections	Low level of risk/stress	High level of risk/stress
Trucks (TkLOS)	Segments	Unimpeded movement	Impeded movement
	Intersections	Unimpeded movement/short delay	Impeded movement/long delay
Transit (TLOS)	Segments	High level of reliability	Low level of reliability
	Intersections	Short delay	Long delay
Vehicles (LOS)	Intersections	Low lane utilization	High lane utilization

Source: *City of Ottawa Multi-Modal Level of Service Guidelines*
Note vehicular level of service is evaluated only at intersections per City transportation impact assessment guidelines

Transit level of service evaluates the relative attractiveness of transit based on transit travel time, transit priority provided to transit vehicles on varying facilities, and cross-conflicts such as driveways.

While traditional LOS accounts for heavy vehicles by considering the percentage of trucks and buses in the traffic volume, some elements of roadway segments and intersections clearly affect the operational ability of freight vehicles. Truck level of service (TkLOS) attempts to complement LOS by considering the physical space available for trucks to negotiate corners and operate safely within travel lanes. The objective of evaluating TkLOS is to facilitate goods movement. The evaluation of TkLOS is not necessary for all streets and should be limited to key delivery access routes.

The ultimate objective of developing a MMLOS program is to enable designers and the public to evaluate transportation choices. All MMLOS tools should be used and presented in relation to each other. Different streets with different associated land-use contexts will experience varying levels of service for each mode.

Any city implementing a MMLOS program should develop modal level of service targets. In order to introduce local context, these targets should be based on the City's Placemaking Plan Character Area designations and street typologies. The character area designations provide a sense of the surrounding land use, density, and desired level of commercial activity while street typologies represent approximate vehicular volume capacity and speed. The target-setting process provides an understanding of how trade-offs can be made to support the goals and policies laid out in the Placemaking Plan. There are two important potential outcomes to consider:

- Targets are not intended to create wide corridors that achieve high LOS grades for all modes along new or relatively unconstrained rights-of-way. The implementation of MMLOS should also be considered in relation to other factors influencing street design, including urban design and built form characteristics.
- In constrained environments, an MMLOS framework is intended to facilitate modal prioritization decisions. The framework guides and supports decisions to provide high quality facilities for certain modes, even at the expense of others.

Source: Keith Ewing (CC BY-NC 2.0)

DESIGN ELEMENTS

Design elements are the buildng blocks of street design. Grouped according to right-of-way zone definitions and common applications, elements are catalogued along with clear definitions and detailed guidance on the use, design, operations, and maintenance of these building blocks.

- **Pedestrian Zone Elements**
- **Static Zone Elements**
- **Travel Zone Elements**
- **Intersection Design Elements**
- **Traffic Calming Elements**
- **Green Infrastructure Elements**

PEDESTRIAN ZONE

The Pedestrian Zone of the street is one of the most dynamic and economically vital portions of the overall street right-of-way. The pedestrian zone is generally defined as the portion of the street between the curb line and the property line, although this zone may also extend into the street in the form of bump outs or crosswalks.

The Pedestrian Zone consists of many of the fixed features of the street including street trees, street lighting, bus shelters, bicycle racks, and public seating. The pedestrian zone must provide space for people to walk through as well as places for people to gather and wait. The Pedestrian Zone is an intermodal space as people shift from transit, a personal vehicle, or bicycle to pedestrian travel.

The Pedestrian Zone consists of three distinct subareas:

Frontage Area: Running parallel to and abutting the property line, the frontage area is the transitional area between the private realm and the public realm. The frontage area is generally not a zone of through travel and is excluded from sidewalk width calculations.

Clear Area: The clear area is the portion of the street that allows pedestrian travel. The Federal Highway Administration (FHWA) refers to this as the effective sidewalk width and it is generally the only area that is included in sidewalk width calculations.

Landscape and Amenity Area: This area is located between the pedestrian clear area and the curb. In low intensity areas, this zone is mostly grass and/or trees. In higher intensity areas, such as downtown and other commercial districts, this zone is generally paved hardscape with trees in pits or planters. Most street features are located in this zone, including street lighting, traffic signal poles, seating, and others.

SIDEWALK

The sidewalk is the paved portion of the right-of-way intended for pedestrian travel. It is important to note that the entire pedestrian zone, which is sometimes referred to as the sidewalk, includes area that accomodates street furniture and fixtures in addition to the pedestrian walkway. Access and movement for people of all ages and abilities is critical in sidewalk design. Sidewalks contribute to the social environment of the city.

USE

- Sidewalks are needed on most streets in the City. Exceptions include Industrial Local streets, alleys, and specifically designed and managed shared streets with low volumes of vehicle traffic where pedestrians may safely and comfortably mix with all other street users.
- Sidewalks are appropriate for, and should be provided on both sides of the street.

DESIGN

- Sidewalks must permit the unimpeded travel of individuals walking and those using mobility assistance devices year round.
- Sidewalks should have a minimum clear width of five (5) feet exclusive of the curb. Along Downtown and Neighborhood Activity corridors, eight (8) feet is preferred to accommodate two people walking abreast while still permitting the passing of one pedestrian or wheelchair user in the opposite direction.
- Sidewalks should be continuous and connected across streets with crosswalks. ADA-compliant accessible curb ramps must be provided at every designated crossing.
- Sidewalks must have adequate cross slope to facilitate stormwater runoff. The surface must be stable, slip-resistant, and free of tripping hazards.

OPERATIONS AND MAINTENANCE

- The pedestrian clear area of the sidewalk must be kept clear of snow and ice and should never be used for snow storage.
- While the City is responsible for general sidewalk maintenance and construction, ground floor occupants and building owners are respsonible to keep the adjoining sidewalk free and clear from obstructions including snow and ice.
- Safe, and accessible pedestrian walkways should be maintained in construction areas.

DRAFT
PEDESTRIAN ZONE

STREET TREES

Street trees contribute to the character of both residential and commercial streets. They provide shade and reduce heat in summer, mitigate air pollution, dampen street noise, and help manage stormwater.

Mature trees provide significant stormwater management benefits through soil storage, interception, and evapotranspiration. Larger trees decrease runoff exponentially more than smaller trees.

USE

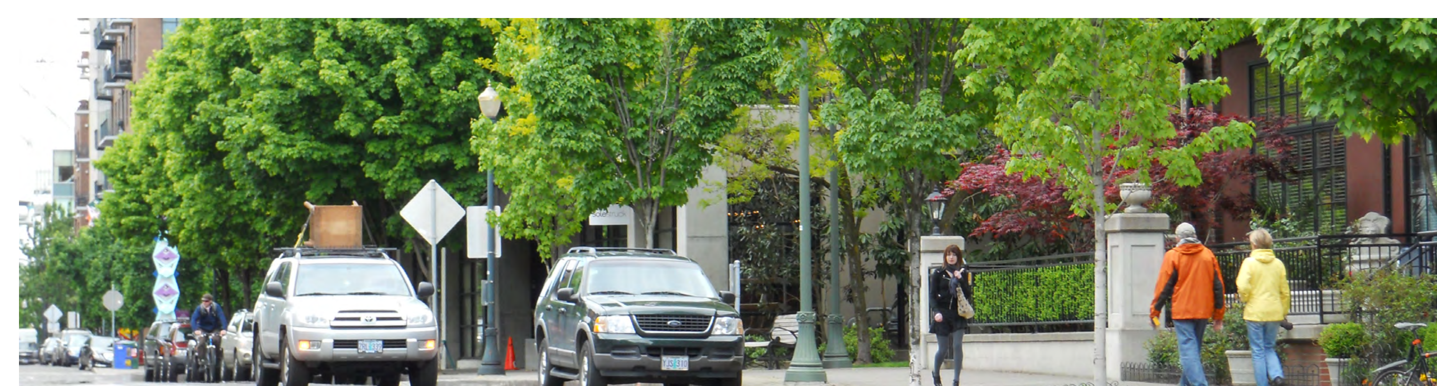
- Street trees should be included on every street, where possible, but are particularly important on Downtown and Neighborhood street types.
- Trees are required on all street projects unless not permitted by technical constraints such as inadequate planting strip width or soil volume.
- Trees are important in helping to define a consistent edge of the street.
- Street trees are important in high pedestrian traffic areas and in areas with large amounts of impervious surfaces.
- Street trees can be incorporated into the Static Zone of the street in green infrastructure facilities such as bioretention areas and planters.

DESIGN

- Trees should be selected from the City's Urban Forest Master Plan. Proper selection considers:
  - Size of growing area, soil, and drainage.
  - Width of the tree relative to the distance between trees and adjacent structures.
  - Presence of elements that would adversely impact or be adversely impacted by trees.
  - Deep root structure to minimize impacts on underground utilities and paved areas.
- Trees should be protected from substantial pedestrian traffic that may compact their roots.
- Trees should not compromise the visibility of traffic signs or signals or the sight distance of pedestrians, cyclists, and drivers at intersections.

OPERATIONS AND MAINTENANCE

- Trees require routine maintenance including tree trimming and health assessments.
- Planted street trees should have a maintenance contract providing tree care for the first two years following installation.
- New plantings require immediate and consistent watering.



STREET LIGHTING

Street lighting generally takes the form of either lighting over the roadway or sidewalk – although some lighting serves both purposes. Pedestrian lighting fixtures are generally installed lower with closer spacing while roadway lighting is placed higher with larger spacing. Lighting improves both safety and the sense of security.

USE

- Street lighting is desirable on all street types and is a priority along Downtown and Neighborhood street types. Alleys may not have street lighting.
- Pedestrian-oriented street lighting may be difficult in areas with above ground utilities.

DESIGN

- Street light spacing should prioritize even illumination and clear sense of the street edge.
- Street lighting should illuminate the roadway and pedestrian zone as well as crosswalks. Wider streets may require unique fixtures to light both the pedestrian and travel zones.
- Street lighting should provide consistent lighting levels and avoid contrasts of light and dark areas. In some cases, low lighting is preferable.
- Light poles should be set back two feet from the face of curb in a straight line along the street edge. Lighting may be provided on bump outs.
- Pedestrian zone lighting is generally spaced 20 to 40 feet apart. Travel Zone lighting may be spaced 60 to 120 feet apart depending on the lighting element.
- Street lights in the pedestrian zone may alternate with street trees spaced 10 to 20 feet apart.
- Full cut off or shielded lighting should be used to avoid light pollution and light cast into private residences and adjacent buildings.
- Street lighting should take advantage of timers, daylight sensors, and motion detection to reduce energy use and increase efficiency.

OPERATIONS AND MAINTENANCE

- The City should pursue more energy efficient lighting strategies such as LED lighting and/or street lights powered by renewable energy.
- Lighting fixtures should generally be limited to a small number of approved standards. This contributes to a cohesive public realm and more cost-effective maintenance. Unique street light fixtures may be approved with a confirmed maintenance agreement.

CURB CUTS

Curb cuts provide vehicular access from the public right-of-way through the pedestrian zone to private property. While driveways and curb cuts provide essential access, they introduce conflict with pedestrian, bicycle, and through vehicle travel, and reduce the efficiency of vehicular travel corridors. Cities are working to encourage shared access points and restore or reintroduce alley networks to reduce the need for curb cuts.

USE

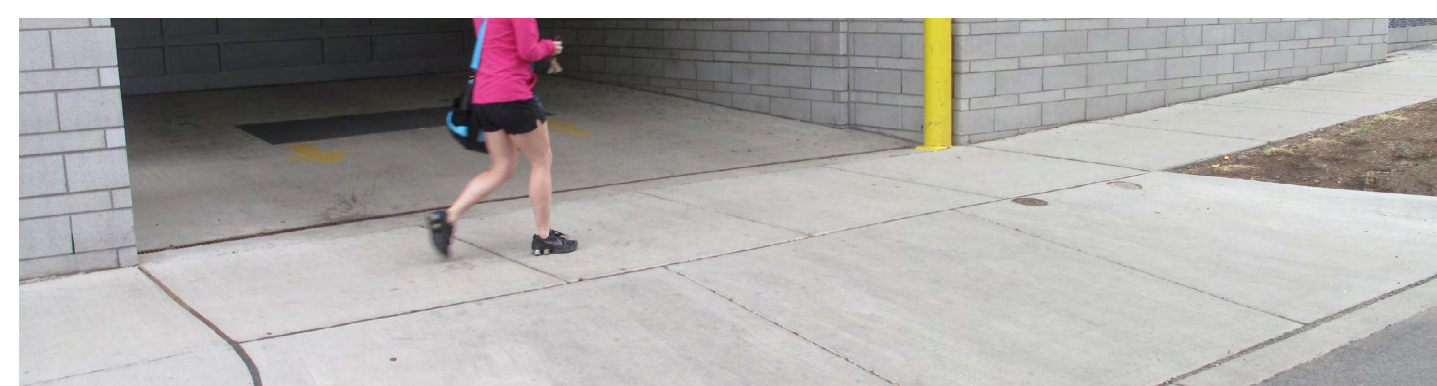
- Driveways and curb cuts should be used only when access from alleys or shared access facilities is not available.
- Driveways and curb cuts should be located on the lowest order street abutting a property.
- Limit properties to one vehicular curb cut on each street frontage whenever practical.
- Driveways should be discouraged, minimized, or prohibited on streets with a high concentration of pedestrian activity such as Downtown and Neighborhood Activity streets.
- Existing curb cuts should be consolidated or eliminated whenever possible reduce conflict.

DESIGN

- The maximum width for residential, one-way commercial, and two-way commercial driveways are 15', 16', and 24', respectively. (Construction Details Section S608)
- Curb cuts that serve designated fire lanes must be a minimum of 20' wide and have appropriate turning radii for fire apparatus.
- Sidewalks should proceed straight and at grade across driveways and curb cuts as required by the ADA. Sidewalk materials should also extend across the driveway providing clear visual reference that pedestrians have priority.
- Driveway width and turn radii should be minimized to the extent practical to slow vehicles crossing the pedestrian clear zone.
- Driveways need to be spaced far enough from intersections to ensure that traffic entering or exiting a driveway does not conflict with traffic queueing at the intersection.

OPERATIONS AND MAINTENANCE

- Parking and loading activities must not be permitted where the driveway crosses the sidewalk or at the curb cut.



TRANSIT STOPS

Transit stops are designated places where riders board and disembark from transit vehicles. Stops may be a sidewalk with a paved connection to the curb adjacent to a transit stop signpost, or may include a range of amenities such as a shelter, seating, waste receptacles, dynamic information displays, and/or public art. A well-designed stop calls attention to transit service, explains how it works, and makes transit an appealing travel option.

USE

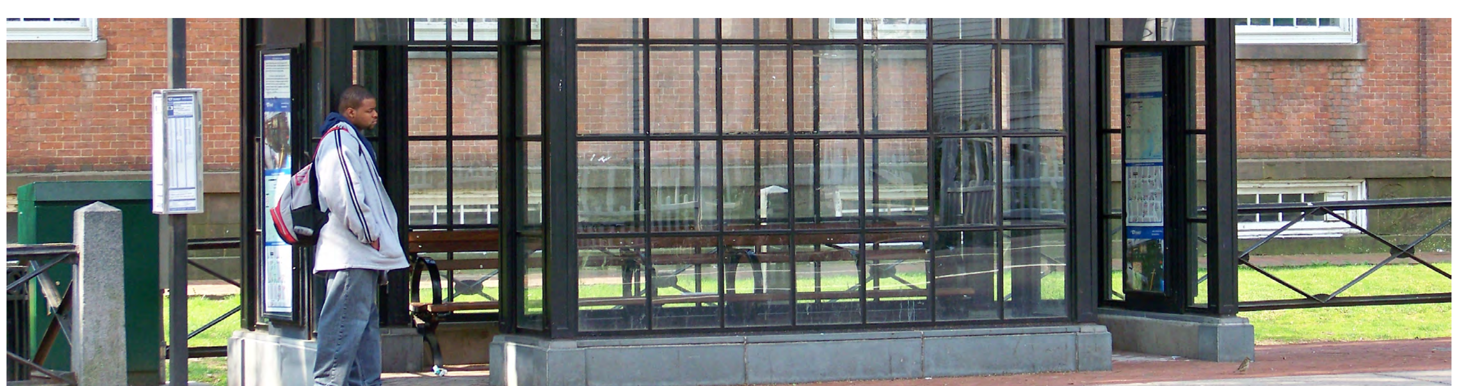
- Transit stops are located along corridors with transit services. A transit stop is required for fixed-route transit service.

DESIGN

- Every transit stop should be identified with a transit sign, located at the front of the bus stop, two feet behind the curb, that indicates the transit services provided at that stop and assists drivers in aligning doors with loading areas.
- Far-side in-lane stops located on a bus bulb confer the highest priority to transit at most signalized intersections while reducing conflict.
- Pull-out stops for 40-foot buses are typically 90 feet long when located near-side, and 100 feet when located far-side (NACTO). Stops for articulated buses require an additional 20 feet.
- Near side transit stops should be set back at least 15 feet from crosswalks (NACTO).
- Each stop should be illuminated by streetlights and feature a paved landing area at each bus door connected to a continuous sidewalk that meets the accessibility requirements of the ADA.

OPERATIONS AND MAINTENANCE

- Regulatory signs are required indicating the limits of the transit stop zone. Parking and loading should be prohibited within the stop area.
- Currently, RGRTA is responsible for shelter maintenance and repair along RTS fixed route transit corridors. The City or other entities can contribute to the construction, operations, and maintenance of future bus shelters.
- Bus shelters require quick repair if panels are broken or damaged. The shelter must also be regularly washed and cleaned of debris/litter.
- Landing zones and pathways must be cleared of snow and ice, at a width sufficient to enable deployment of wheelchair lifts.



DRAFT
PEDESTRIAN ZONE

PARKING METERS

Meters are one means to manage parking utilization and ensure there is adequate availability of on-street parking at any time. Parking meters permit payment for the use of curbside space. Parking meters may control only one space or multiple spaces. More advanced meters can communicate payment and occupancy status to a central control center enabling real time information-sharing and management.

USE

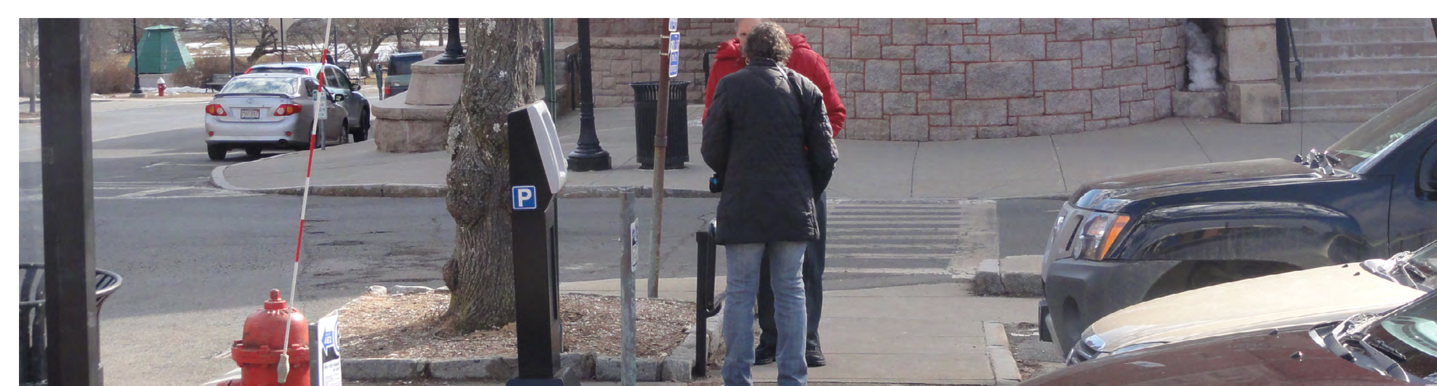
- Metered parking is generally implemented in commercial or mixed-use districts where there is significant competition for curbside space.
- Parking meters are unnecessary in areas where parking demand is low.
- Metering should be in effect during hours that curbside occupancy routinely exceeds 85%.

DESIGN

- Multi-space meters typically govern 10 parking spaces per kiosk. Multi-space meters should be conveniently located not more than 150 feet from any space that they serve.
- Smart single-space meters govern only a single space. No more than two meters are mounted on each post. Single space meters are placed immediately to the front or rear of the spot they are to serve.
- All parking meters must be accessible to persons with disabilities providing a smooth level pathway of at least 36" in width to access the meter.
- Meters should be located a minimum of 18" from the curb. A clear path should provide access to and from parked cars to the main sidewalk.
- Signage should indicate the location of multi-space meters, days and hours of parking meter operation, and any parking duration limitations.

OPERATIONS AND MAINTENANCE

- Parking meters and pathways leading to them should be kept clear of snow to facilitate use.
- Parking meters require regular collection of cash payments and regular maintenance of parts and operations.



WAYFINDING

Wayfinding clearly defines pedestrian, bicycle, and vehicle networks to guide travelers to destinations of interest or connecting facilities. Wayfinding is typically provided via signage and may orient a user, inform travelers of areas of interest or local offerings, or reassure a user that they are still on the same route.

The 2012 Center City Pedestrian Circulation and Wayfinding Study has created an excellent foundation for enhancing the Downtown pedestrian environment. The system should be expanded to areas beyond Downtown, adding long distance non-motorized wayfinding principles.

USE

- Wayfinding is typically located on higher order streets (e.g. Downtown Activity, Downtown Link, Neighborhood Activity) but may be placed on lower order streets for programmed routes such as bicycle boulevards.

DESIGN

- Wayfinding should follow a consistent design palette to aid in identification and legibility.
- Wayfinding may provide estimated travel time or distance information to destinations of interest (e.g. 5-minute walk to Arena).
- Signage should be located in the pedestrian zone, but must not impede movement.
- Pedestrian and bicycle wayfinding should be located at eye level. Vehicle signage should be at a location and scale consistent with driver's line of sight and speed of travel.
- Wayfinding oriented to one user should be inconspicuous to other users to avoid confusion.
- Signage should be compliant with the MUTCD and should not conflict with traffic signs.
- Signage should use reflective materials in low light conditions to improve legibility.

OPERATIONS AND MAINTENANCE

- Keeping wayfinding updated can be a challenge. Responsibility for updating signs should be established prior to installation.
- Wayfinding signs are often subject to abuse and theft. Similarly, wayfinding signs are often removed and stored during construction. Responsibility for storage, reinstallation, replacement, and maintenance must be clarified prior to installation.

DRAFT
PEDESTRIAN ZONE

PUBLIC SEATING

Public seating creates more accessible and inviting streetscapes for all users, especially those with mobility challenges, by providing places to rest. Structures may include benches, chairs, and seat-walls.

USE

- Public seating, aside from that associated with transit stops, is generally limited to areas with higher concentrations of pedestrian activity and/or where there is other demonstrated need.
- Seating locations should be carefully evaluated to ensure that they will be visible and regularly used to enhance the user's sense of security.

DESIGN

- Public seating is generally located on the street side of the pedestrian zone, but may be located closer to the building line, facing the sidewalk.
- Seating may take any number of forms, including bench-type seating, chair or stool type seating, or unique artistic seating.
- Seating parallel to and along the curb should maintain two feet of clearance from the curb and be oriented away from traffic, with the exception of seating provided at transit stops.
- When public seating is provided perpendicular to the curb, it is recommended that at least two seats be provided facing one another.
- Seating must not impede or encroach upon the pedestrian walkway. It should be placed in such a way that does not block building entries, loading zones, or other street functions.
- A 3-foot minimum clear zone shall be provided to the sides and front of the seat to provide ADA accessibility and clearance for wheelchairs
- Seating should not be located within five (5) feet of fire hydrants, should maintain four (4) feet of clearance from other fixtures, and should not block signage visibility or driver sight distance.

OPERATIONS AND MAINTENANCE

- Street furnishings and public seating should be of a standard type that is easily and reliably procured. Non-standard seating should only be used under a maintenance agreement.
- Street furnishings should be constructed from long lasting and durable materials and finishes.
- Seating should be regularly inspected for damage to ensure it is safe for use.
- Snow should be cleared from seating as part of routine pedestrian zone winter maintenance.

WASTE AND RECYCLING

Waste and recycling receptacles help keep the city clean and beautiful, reducing the likelihood of loose trash and refuse.

USE

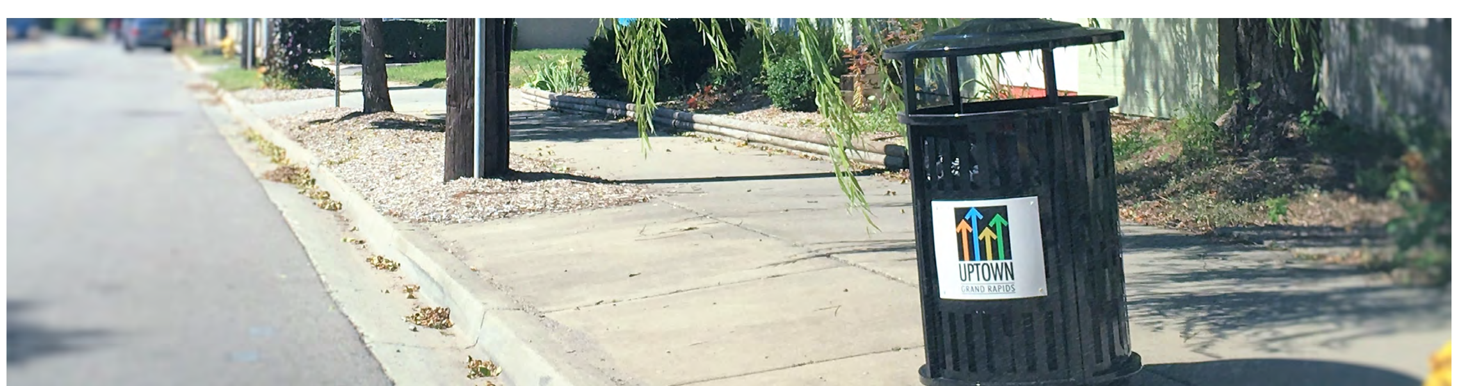
- Waste and recycling receptacles are welcome in all areas, but are generally concentrated in areas with a high quantity of pedestrians such as transit stops, commercial areas, and/or near institutions such as schools or recreation centers.

DESIGN

- Waste and recycling receptacles must be placed so they do not block major pedestrian movements, building entries, loading zones, or other street functions.
- Do not locate waste receptacles where transit passengers board or disembark.
- Receptacles should be covered such that rain, snow, and other precipitation does not enter the receptacles and mix with refuse.
- Receptacles should be secured to the ground and be designed with an inner container that can be removed to facilitate collection of refuse.
- Receptacles should be standard manufactured designs, constructed out of durable materials, that are common throughout a district. Custom designs and other special order receptacles are generally discouraged.
- Do not place receptacles directly on top of utility covers or vaults.
- Place receptacles in locations accessible to curbside pickup and maintenance crews.
- Coordinate location and design of waste receptacles with the Solid Waste Management Division to ensure it meets their needs for easy emptying and maintenance.

OPERATIONS AND MAINTENANCE

- The City is responsible for waste or recycling receptacles and their waste removal.
- Private development projects of substantial scale should provide public waste and recycling receptacles. These may be conveyed to the City provided they are the standard design.
- Snow should be cleared from around receptacles to facilitate waste removal. Snow should not be piled or stored on top of receptacles to prevent damage as well as to keep receptacles accessible year-round.



BICYCLE PARKING

Bicycle parking is vital in an urban environment. Bicycle parking, like vehicle parking, provides easy access to City destinations. It is essential in making bicycling a convenient mode of travel. Insufficient provision of bicycle racks can lead people traveling by bicycle to lock bicycles to other street fixtures, which may damage these elements, compromise their intended use, or impede pedestrian travel.

USE

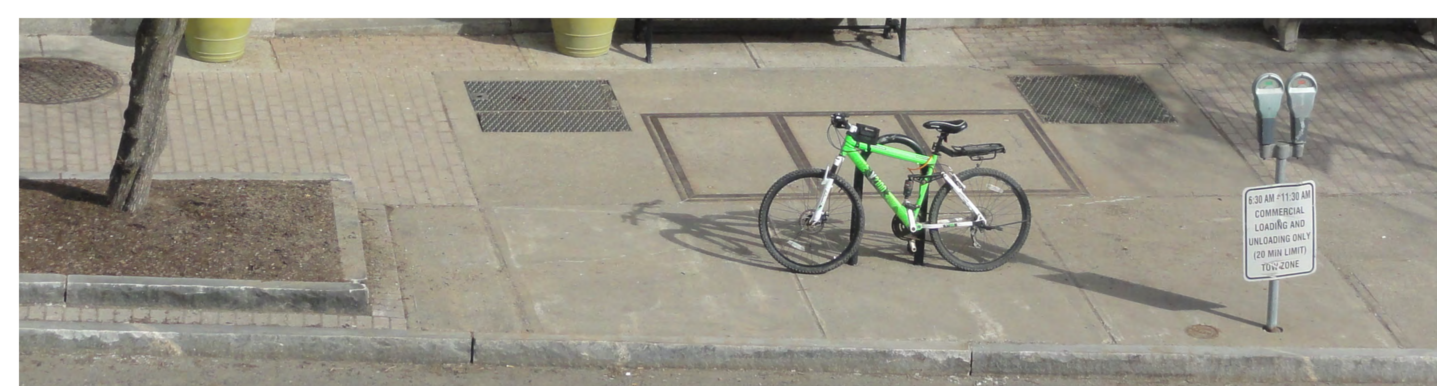
- Bicycle parking is appropriate on all but the lowest order street types and should be encouraged to facilitate bicycle use
- Bicycle parking is generally unnecessary on Neighborhood Local streets and may be less common on Neightborhood Link streets except near or at community destinations.

DESIGN

- Bicycle parking racks should allow the user to lock both the frame and at least one wheel.
- Bicycle racks should be affixed firmly into the sidewalk or street surface and made of a material type and shape to resist cutting/rusting.
- The common inverted U rack or bicycle loop are recommended rack design types. Wave and schoolyard style racks are not recommended.
- Bicycle racks should be placed in the sidewalk space aligned parallel and at least two feet from the curb.
- Bicycle racks should be placed in locations with high visibility to make them easy to find and use, and to provide passive security.
- Bicycle racks should be placed at least five (5) feet from fire hydrants, crosswalks, or midblock crossing ramps. Racks should be three to four (3-4) feet from loading zones, street furniture, or bus stops/shelters. Racks should not interfere with parked car doors and must not impede pedestrian traffic.

OPERATIONS AND MAINTENANCE

- Bicycles left at bicycle racks for an extended period of time should be removed.
- Bicycle racks may need to be replaced when they show signs of wear that may damage bicycles. Loose anchors may need to be repaired to ensure the rack remains secure.
- Monitoring bicycle rack occupancy can help determine when additional racks are needed.



BICYCLE REPAIR

Bicycle repair stations provide a place for bicyclists to make minor repairs on their bicycles such as repairing a flat tire, fixing a chain, or tightening loose parts. Repair stations make bicycling more convenient and reliable by enabling cyclists to make common repairs while away from home. Bicycle repair stations typically consist of an upright fixture to allow the bicycle to be lifted and hung while it is being worked on. A number of basic tools are affixed to the stand.

USE

- Bicycle repair stations are commonly located along major bicycle facilities such as heavily used cycle tracks or trails.
- They are generally co-located with significant bicycle parking.

DESIGN

- A variety of bicycle repair stations are commercially available and can be simply affixed to the street or sidewalk area.
- Repair stations should include an air pump, screwdrivers, crescent wrenches, allen wrenches, tire levers, and may include torque wrenches. Use cables to attach tools to the bicycle stand to prevent theft.
- Bicycle repair stations should be located near to bicycle parking, but should not impede the easy use of bicycle racks for bicycle parking.
- Bicycle repair stations should be located at least four feet from the curb and all other objects to enable easy use and to prevent the bicycle rack from impeding any other use or travel flow.
- Bicycle repair stations are typically located in the Pedestrian Zone of the street but may be located in the Static Zone near bicycle corrals.
- All publicly available bike repair stations should also be included on bike-oriented wayfinding.

OPERATIONS AND MAINTENANCE

- Bicycle repair stations must be checked routinely to ensure all tools are present and in working order, and to make repairs/replacements. Replacements should be kept on hand.
- Repair stations may be sponsored by local bicycle friendly businesses. Sponsors should have a maintenance agreement in place.

BIKE SHARE STATION

Bike share stations are locations where people can rent and return bicycles for typically short trips from the shared system. Bike share stations may be as simple as groups of bicycle racks that provide a space to lock "smart" bike share bicycles using integrated locks, or smart docking stations for shared bicycles.

USE

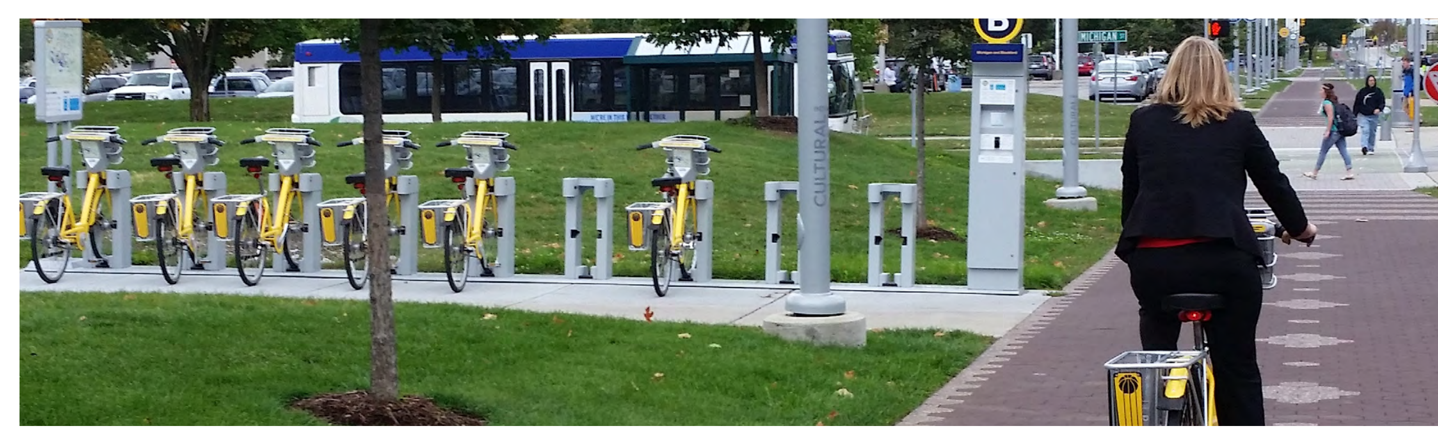
- Bike share stations should be located to encourage bicycle trips for commuting, shopping, running errands, social outings, exercise, and sightseeing.
- Bike share stations may be a wide range of sizes depending on the intensity of bicycle demand. However, they typically range from 10 to 30 bicycle docking or parking spaces.

DESIGN

- Stations should be located in areas with popular destinations and in high density areas.
- Bike share stations are highly desirable near transit stops and intermodal facilities. Locating bike share stations near these facilities encourages trips by multiple modes.
- Bike share stations are commonly located in the pedestrian zone of the street, but may also be located in the static zone or in public spaces. Stations may also be placed on private property with appropriate approvals and ensured access.
- Parked bicycles, and the space required to get bicycles in and out, must not impede use of the pedestrian zone or adjacent travel lanes.
- Bike share stations must avoid obstructing utilities, fire hydrants, other street furniture, or the sight distance of pedestrians, cyclists, and drivers at intersections.

OPERATIONS AND MAINTENANCE

- Newer modular or dockless bike share stations may be easier to move and accommodate construction or changing user demand.
- The placement of a bike share station should maximize convenience for bike share users, yet minimize conflicts with pedestrians and discourage bicycle riding on the sidewalk.
- Van access for station maintenance and bicycle rebalancing should also be considered.



STATIC ZONE

The Static Zone of the street is located adjacent to the curb line of the street. It is so named because this is typically not a zone of through movement, but rather the zone used for parking, loading, and other uses.

The curb line may deviate from a straight line to include bump outs, bus bulbs and other features. For this reason, there is some overlap between the Static Zone of the street and the Pedestrian Zone.

The Static Zone is a transitional space that serves a number of functions. It provides an important buffer and protection between people on the sidewalk and vehicles moving in the Travel Zone of the street. The static zone is also a space of exchange and transfer as people get in and out of cars parked at the curbside or buses as they stop for boarding and disembarking passengers. The Static Zone is where freight loading often occurs. It also plays a critical role in stormwater management, as this is an area where storm sewers and/or green infrastructure are commonly located.

Design and management of the Static Zone is important to pedestrians, bicyclists, motorists, transit riders, and area businesses and residents. Poor management can lead to congested parking or loading spaces which, in turn, can degrade the operations and safety of the adjacent Travel Zone.

ON-STREET PARKING

On-street parking provides support to local commercial businesses, offices, and residents by providing a convenient location for short-term parking. On-street parking in commercial areas not only provides access to adjacent businesses, but also buffers pedestrians from adjacent traffic, which can be critical to providing a comfortable walking environment on fast-moving, heavily-trafficked streets. In residential areas, on-street parking provides residents and visitors with short-term and overnight parking spaces.

USE

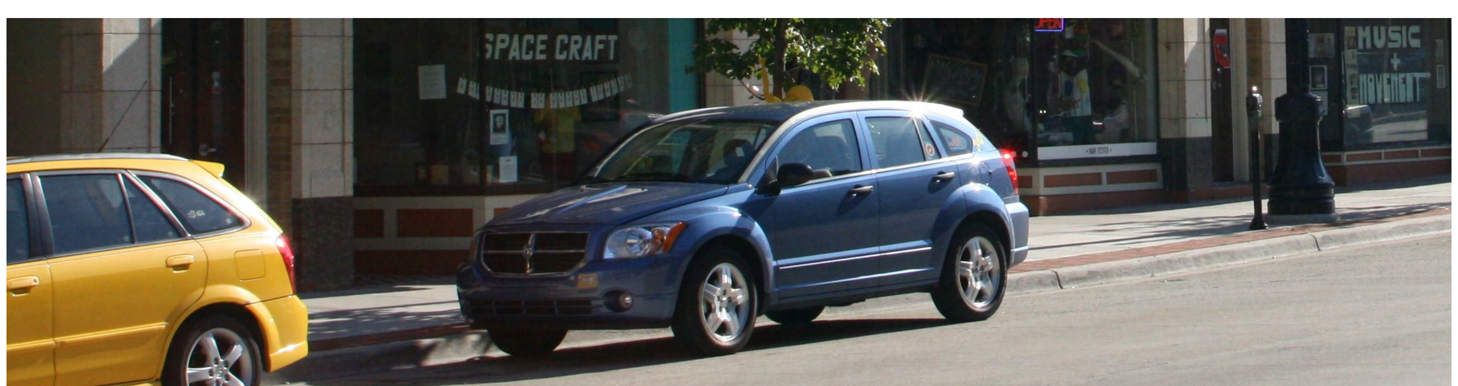
- On-street parking is appropriate on most street types; less common on Industrial street types.
- While valuable, right-of-way space should only be used for on-street parking after the mobility needs of all travelers are met.
- On-street parking may be removed to meet minimum recommended sidewalk widths.

DESIGN

- Typically, on-street parking is curbside parking parallel to the curb. While perpendicular or angled parking are also acceptable configurations, they are only appropriate on wider streets without bicycle facilities.
- Parking spaces may be marked with T and L pavement markings at their outside edge or defined with a solid white line to discourage encroachment into adjoining travel lanes.
- Parallel curbside parking spaces should be 8 feet wide by 21 feet long. A minimum of 7 feet of width and 18 feet of length is required.

OPERATIONS

- On-street parking must be effectively managed such that spaces are typically available on each blockface to prevent added traffic volumes while motorists search for parking.
- Particularly on active commercial streets, the parking lane may be used for flexible uses such as café seating on a semi-permanent basis.
- Bicycle parking may also be provided in the parking lane where there is not enough room to park a car, such as between driveways.
- Snow removal from on street parking spaces is completed by the city using time restrictions. When necessary, on-street parking spaces may be used for temporary snow storage.



LOADING ZONES

A loading zone is a dedicated space at the curbside intended for short-term use to directly service nearby properties. There are typically two users of loading zones – freight trucks for the receipt or delivery of goods and automobiles for passenger pick up/drop off. Appropriately located loading zones can improve the operation of a street. Locating loading zones adjacent to commercial uses may reduce the incidence of double-parked delivery trucks. Loading zones also take up space that could otherwise be used for parking, pedestrian, or transit space and should be well managed.

USE

- Loading zones are generally shared by a number of businesses or properties on a block. There is typically one loading zone per block.
- Loading zones are intended for short duration parking of 20 minutes or less. In business activity areas, off-peak loading hours are encouraged.
- Loading zones may be designated for private vehicle passenger pick-up/drop off and/or for use by taxis and other ride-hailing services.
- Alleys should be used for loading when possible.

DESIGN

- Loading zones for deliveries should be designed to house a single-unit 30-foot delivery vehicle.
- Loading zones should be located near the far side of intersections to facilitate access to and from the rear of trucks via sidewalk ramps.
- Freight loading zones should be 40 feet long and 8 feet wide. Per ADA, passenger loading zones must be 20 feet long and 8 feet wide.
- Zones should be well-marked to indicate no parking allowed during loading hours.
- Loading zones must not impede the use of adjacent crosswalks.

OPERATIONS AND MAINTENANCE

- Regular enforcement is required to ensure that loading zones are not used for parking.
- Delivery dwell time should be restricted in the loading zone to ensure turnover.
- If multiple businesses are sharing the loading zone, they should be encouraged to coordinate delivery times to discourage double-parking.
- Loading zones may be used for other purposes during non-delivery hours. Typical uses include curbside parking or valet parking operations.

BUMP OUTS

Bump outs visually and physically narrow the street by extending the sidewalk, reducing pedestrian crossing distance, and increasing pedestrian visibility and line of sight. At signalized intersections, reduced crossing distances enable shorter walk phases. The narrower street profile encourages slower driving, increasing safety for all roadway users.

USE

- Bump outs are appropriate on all streets, but especially encouraged on higher volume streets such as Downtown and Neighborhood Activity.
- Bump outs should only be used where a curb lane is present that is not used for travel.
- Bump outs are particularly beneficial in commercial frontage contexts where pedestrian volumes are concentrated and streets are wide.
- The most common type of bump outs are located at intersection corners.
- Midblock bump outs can be used to narrow a street for traffic calming or be used in conjunction with a midblock crossing.

DESIGN

- Bump outs should not narrow any bicycle or general traffic lanes to an unsafe width. One (1) to two (2) feet should remain between the curb and the first travel or bicycle lane.
- Corner or midblock bump outs with crosswalks should be as wide as the crosswalk, and ideally extend to the stop bar.
- At corners with turn restrictions, use a bump out to make the turn more difficult, while ensuring that transit vehicles are not delayed.
- The decision to place bump outs on streets that accommodate transit vehicles should carefully consider bus turning radii requirements.

OPERATIONS AND MAINTENANCE

- Bump outs can be a temporary trial installation, using bollards and planters. Temporary extensions should be removed in winter months to facilitate snow removal.
- Green infrastructure applications should have maintenance plans prior to installation.
- Special snow removal equipment should not be necessary if bump outs are designed with turn radii adequate for the current fleet.

BUS BULBS

Bus bulbs are a bump out that facilitates in-lane transit stops on streets with on-street parking. Bus bulbs improve transit operations, speed, and reliability by eliminating the need for buses to merge in and out of traffic at stops. Like bump outs, bus bulbs benefit pedestrians by shortening the crossing distance. Bus bulbs also can provide additional space for enhanced transit passenger amenities.

USE

- Bus bulbs can be used in any location where on-street parking is present. Bus bulbs may not be used on streets where curbside uses vary throughout the day.
- Bus bulbs may be used on streets with bicycle facilities with an accommodating design at stops. In this instance, bus bulbs are commonly called side boarding islands.
- Bus bulbs are most appropriate on streets with moderate to high transit ridership volumes and/or streets where transit vehicles may be delayed by merging in and out of traffic.
- They may be used at near-side, far side, or mid-block bus stops, though far side and mid-block stops are preferred.

DESIGN

- The length parallel to the roadway must allow all bus doors to open directly onto the bus bulb.
- Bus bulbs extend from the curb edge to within two feet of the outside of the travel lane.
- Bus bulbs should have a return angle of 45 degrees and 15 foot radii to facilitate vehicle turns, snow clearance and/or street sweeping.
- Bus bulbs will generally be designed at a curb height consistent with the rest of the street and join level with the adjacent sidewalk.
- On streets with bicycle facilities, provide cut-through for bicycle lanes behind bus bulbs.
- Transit amenities, such as shelters and seating, should be located on bus bulbs, provided adequate clearance requirements are met for landing zones and maintaining clearance with pedestrian walkways or bicycle facilities.
- Near side bus bulbs with a right turn restriction should be designed with the curb to self-enforce the restriction.

OPERATIONS AND MAINTENANCE

- Bus bulbs should not be used for snow storage and should have a plan for snow clearance.

Source: NACTO (CC BY-NC 2.0)

PARKLETS

Parklets are seasonal mini plazas located in the parking lane. Parklets convert curbside parking spaces into a public seating platform, including landscaping. Often the product of a partnership between a city and local businesses or neighborhood associations, these amenities have a distinctive design and accommodate unmet demand for public space, particularly on thriving neighborhood retail streets or commercial areas.

USE

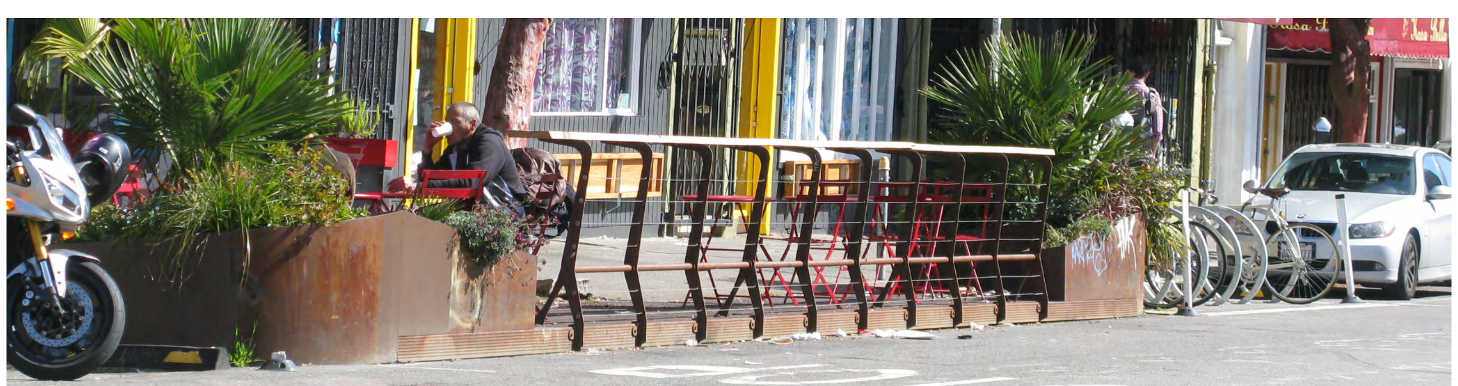
- Parklets are typically applied where narrow or congested sidewalks prevent the installation of traditional sidewalk cafés or where local property owners or residents see a need to expand the public space along their street.
- While parklets are principally intended as community assets, their presence can increase revenues for adjacent businesses.

DESIGN

- To ensure increased protection from moving traffic and parking cars, parklets must be buffered using a reflective wheel stop at a distance of three to four feet from the parklet and include vertical elements such as reflective flexible posts or bollards.
- The maximum width of parklets should be one foot less than the width of the parking lane.
- Parklets should have a flush transition at the curb to permit easy access.
- Parklets are best placed at least one parking space away from the intersection corner. Where a parklet is considered for a site near an intersection, volumes of turning traffic, sightlines, and visibility should be taken into account.
- The parklet substructure must accommodate the crown of the road and provide a level surface for the parklet.

OPERATIONS AND MAINTENANCE

- Parklets are typically administered through partnerships with adjacent businesses and/or surrounding residents. Design and installation costs are typically borne by nearby residents or businesses and these partners maintain and program the parklet, keeping it free of debris.
- Parklets should be removed during the winter to prevent conflicts with snow removal equipment and street cleaning vehicles.



DRAFT
STATIC ZONE

BICYCLE CORRALS

Bicycle parking corrals are bicycle racks installed in the curb lane of the street where automobiles typically park. One vehicle parking space can usually accommodate 10 bicycle parking spaces.

USE

- Bicycle parking corrals are most often used in areas of high bicycle parking demand and/or in areas where sidewalks are narrow and bicycle racks would impede pedestrian flow.

DESIGN

- Bicycle corrals typically consist of groups of six, nine, or 12 inverted U or hoop style bicycle racks or a single rack unit with parking for eight to 12 bicycles installed in the parking strip.
- Bicycle parking corrals should provide adequate clearance for bicycles from the adjacent travel lane. Racks should be placed perpendicular to the curb in wider streets where at least 96 inches is available and angled on narrower streets where a minimum 80 inches is available. Racks should be spaced at least 36 inches apart; 48 inches is recommended.
- The corral should be demarcated using paint, bollards, rubber curb, or planters. Any hard deflector should be four feet from the corral.
- Bicycle parking racks should allow the user to lock both the frame and at least one wheel. Rack design should prevent the bicycle from tipping over.
- Bicycle racks must be durable and securely anchored to prevent theft.
- Corrals should be located as close as possible to the main entrances to buildings.

OPERATIONS AND MAINTENANCE

- Racks and any barriers surrounding the corral need to be replaced or removed in a timely manner if they have been damaged.
- Bicycle racks should be replaced when they show signs of wear that may damage bicycles.
- Proposed bicycle corrals need to be reviewed by the City for traffic safety and operations issues as well as for adherance to City code.
- Some designs for bike parking corrals include large planter pots, which can be maintained by local businesses, community groups, or individual volunteers.

TRAVEL ZONE

The Travel Zone of the street is typically located along the centerline of the street and extends to the Static Zone. The Travel Zone may extend from curb to curb on streets where on-street parking is prohibited. As it implies, the Travel Zone of the street is where moving vehicles and bicycles operate. Occasionally, as in the case of shared streets, pedestrians may also use the Travel Zone other than at a marked crossing.

While we typically think of cars, buses, and trucks as the principal operators in the Travel Zone of the street, this is also typically the zone of bicycle travel. Even where off-street trail facilities are provided, bicycles are still legal users of the Travel Zone. The Travel Zone must be designed to provide safe facilities and safe operation to protect all users.

Speed is a critical factor in safety. Most city streets should be designed to produce an operating speed that does not exceed the posted speed, generally 30 miles per hour. Shared streets should be designed to encourage speeds no greater than 15 mph. The posted speed limit is the maximum permitted speed, and the street must be safe to travel on at this speed. However in some street types—such as Neighborhood Local and Downtown Link—and in areas such as school zones, the desired speed may actually be lower than the maximum permitted speed.

The dimensions, type, and location of facilities in the Travel Zone should create "self-regulating streets" in which the design of the street encourages users to travel at an appropriate speed for that street type. In general, self-regulating streets should have a posted speed limit that is the same as the design speed and the target operating speed.

LANE WIDTHS

Travel lane width is a significant factor in how drivers interpret the appropriate speed of travel on a street and is a key element to self-regulating street design. Travel lanes also tend to be the largest street element in the total cross section. As such, reducing travel lane widths directly reduces the street crossing distance. Minimizing travel lane widths can also provide space for facilities for the safe movement of other users, such as bus bulbs, wider sidewalks, street trees, or bicycle facilities.

The application of 12-foot travel lanes is due to a belief that they improve safety by reducing the probability of side swipe crashes and increased vehicle throughput. However, the Transportation Research Board's publication *Relationship of Lane width to Safety for Urban and Suburban Arterials* indicates that in most cases, travel lane widths between 10 feet and 11 feet on urban arterials do not negatively impact overall motor vehicle safety, operations, or capacity.

AASHTO's *Policy on Geometric Design of Highways and Streets* states that the use of the narrowest appropriate lane width results in lower speeds, increased safety, less severe crashes, and more space for other critical uses of the right of way. While some streets in Rochester have 12-foot travel lanes, 10-foot travel lanes are more appropriate on lower speed roads such as those posted 30 miles per hour within the City of Rochester.

On streets that often host higher volumes of heavy vehicles, such as transit buses, large trucks, and emergency response vehicles, one 11-foot wide travel lane should be provided in each direction.

Lane widths should examine interactions between the design of adjacent elements, their users, and the overall assemblage of the street. It is sometimes inadvisable to choose the narrowest dimension for all elements within the Static and Travel Zones of the street. Examples include:

- The inclusion of gutter pan width in the total dimension of vehicle travel lanes, but not as a component of bicycle lane width.
- Using the minimum dimension for a parking lane, bicycle lane, and travel lane simultaneously, leaving little room for vehicle doors to open and for cyclists to maneuver around them.

Where streets have a designated modal emphasis, the preferred dimension for the selected modal facility should be used.

Lane widths may be marked or unmarked, depending on the street type. Unmarked streets, such as yield streets, do not have separately defined lanes, but rather a shared space that provides the necessary lane width while requiring that vehicles yield to one another as they pass. Yield streets are generally two-way low volume streets with on-street parking.

TRAVEL LANE TYPE	RECOMMENDED WIDTH
Typical general purpose travel lane	10'
Travel lane - transit, freight, or emergency emphasis	11'
Turning lane	10'
Dedicated bicycle lane	5'
One-way protected bicycle lane	8'
Dedicated transit lane	12'
Shared or yield street	16'
Raised median	10'

VEHICLE TRAVEL LANE

Travel lanes are the typical lanes of a vehicular street. Travel lanes are typically designed for general purpose use—meaning they are appropriate for passenger vehicles, delivery vehicles, and transit vehicles or heavy truck. Bicycles are generally permitted in the general purpose lane, especially when designated bicycle facilities are not provided on the street.

The appropriate number of travel lanes on a street depends on the desired volume of vehicle travel on the street, the desired operating environment on the street, and the remaining right-of-way space available after accommodating all users, as well as green infrastructure elements.

USE

- Travel lanes are present features in all street types, although the number and width varies by type. Lower order streets typically features two travel lanes—one operating in each direction. Because desired operating speed is low, lane widths are generally narrow. Higher order streets (Regional Activity, Downtown Activity) may have a greater number of travel lanes; albeit narrow to promote self-regulation.

DESIGN

- When determining the number and width of travel lanes, designers should consider how the street is used throughout the entire day and not just simply during peak periods. Excess travel lanes coupled with lower vehicle volumes can lead to excessive speeding and work against the objectives of self-enforcing street design.
- Travel lanes should be assembled together with other roadway elements including turning lanes, parking lanes, bicycle facilities, bump outs, and other horizontal calming elements.
- Corridors with certain modal priority emphasis—such as transit emphasis or vehicle/truck emphasis—may require wider travel lanes.
- General purpose travel lanes are typically demarcated with yellow center lane markings for vehicles traveling in opposite directions and white dashed lane markings for vehicles traveling in the same direction.

OPERATIONS AND MAINTENANCE

- Travel lanes must be kept clear of snow and ice. They should be designed to facilitate rapid drainage following heavy rainfall.

VEHICLE TURN LANE

Turn lanes provide a space for vehicles to move out of the general flow of traffic into a dedicated space to wait for a gap in pedestrian or vehicle traffic in order to complete a turn. The assemblage of travel lanes together with turn lanes can have a substantial effect on the experience of pedestrians. Turn lanes, particularly center turn lanes, can dramatically improve the throughput of vehicular corridors. However, turn lanes can introduce additional conflict and uncertainty in their interaction with other modes. Additionally, the inclusion of right- and/or left-turn lanes at intersections can dramatically increase the total roadway width and pedestrian crossing distance.

USE

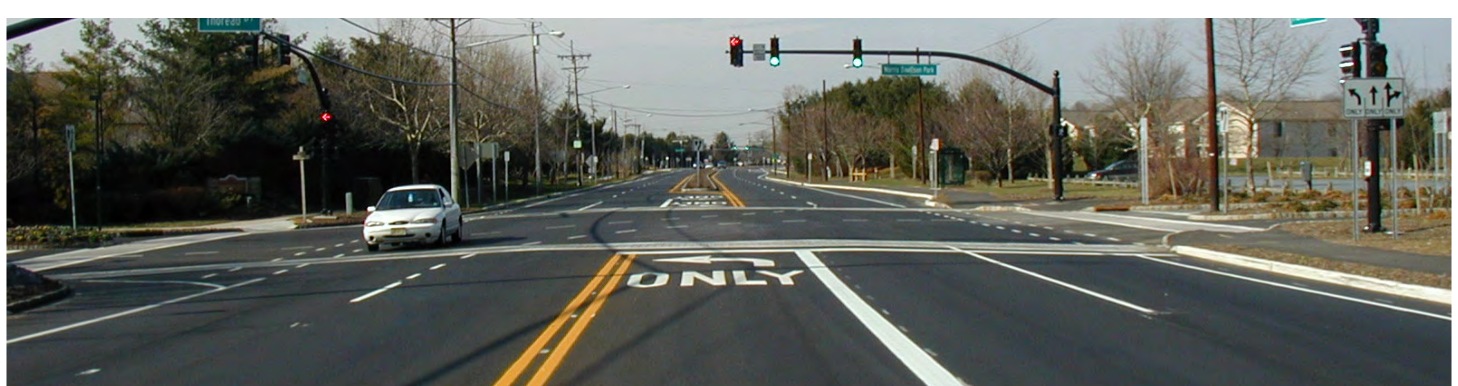
- Turn lanes should only be used where necessary and after evaluation of their safety and operational impact on other modes.
- Turn lanes are generally only required on higher order streets such as Regional Activity, Downtown Activity, and Neighborhood Activity. Downtown, Neighborhood, and Industrial Link streets may also benefit from turn lanes given the proportion of heavy vehicles expected on these streets.

DESIGN

- Turn lanes are generally 10 feet wide. Center turn lanes may require slightly more width.
- Turn lanes should be designed with appropriate length to accommodate reasonably expected queuing demand. Turn queue bays should not be longer than is required.
- Turn lanes may be managed via separate signal phases depending on the volume and other intersection operations.
- For streets where the addition of turn lanes requires pedestrians to cross four or more lanes of traffic, look for ways to install pedestrian crossing islands to provide a safe haven for pedestrians crossing the corridor.

OPERATIONS AND MAINTENANCE

- Like through travel lanes, turn lanes must drain properly following heavy rain and be kept clear of snow and ice.



PEAK HOUR TRAVEL LANE

Peak hour travel lanes are curbside parking lanes that are converted to other uses during peak or rush hour times. Traditionally, this is done to convert parking lanes to general purpose travel lanes. However, time restricted parking lanes can also be temporarily converted to other purposes, including transit and bicycle lanes.

Peak hour travel lanes can increase the capacity of the roadway for general traffic. Depending on conditions, an additional travel lane can improve capacity by 600 to 1,000 vehicles per hour.

USE

- Time restricted lanes may be considered on roadways where additional capacity is needed during peak hours.
- Restricting parking, stopping, and standing at curbside during peak hours can improve traffic capacity and flow. However, the decision to restrict parking should be carefully weighed against the other demands on curbside use, such as loading and deliveries, access for persons with disabilities, and the need to create a buffer for sidewalk users.

DESIGN

- Peak hour travel lanes should be a minimum of 10 feet wide to serve as a travel lane. If designed wider, these lanes can accommodate both parked cars and bicycles in off-peak times.
- Peak hour travel lanes are not compatible with bump outs.
- Converting parking lanes to general purpose travel lanes at peak times can make it difficult to install dedicated bicycle lanes due to safety concerns associated with having moving traffic on both sides of the bicycle lane.
- Right hand turn lanes should be evaluated for conversion to time restricted parking lanes during roadway reconstruction projects to reduce pedestrian crossing distances during off-peak hours.

OPERATIONS AND MAINTENANCE

- Temporary use of the curbside space for vehicular travel requires rigorous enforcement to realize the envisioned circulation benefits.

TRANSIT LANE

Dedicated transit lanes are used to reduce delay for transit services on busy streets, especially those corridors with frequent service. Owing to the high passenger capacity of transit, a dedicated transit lane can help to dramatically increase the amount of people that can move along a high-ridership transit corridor. Dedicated transit lanes reduce traffic delays and increase the reliability of transit service.

USE

- Transit lanes are used only on corridors where transit service is very frequent and traffic congestion routinely impedes transit operations.
- Transit lanes may be time restricted and permitted for other uses at other times.
- Curbside lanes are immediately adjacent to the curb and work best on streets with few driveways and limited right turning traffic.
- Offset lanes operate outside of a parking lane. Offset lanes may be compromised by vehicles entering and exiting curbside parking.
- Median lanes occupy the center of the street. Transit may operate within a wide median or adjacent to a median boarding platform.

DESIGN

- The preferred width for a dedicated transit lane is 12 feet. Gutters may be included in the calculated dimension of a curbside transit lane.
- The street should be clear for a vertical distance of 12 feet above the street surface. Banners or trees overhanging a curbside used for bus travel shall be maintained above this height.
- Fixtures or plantings should maintain a 2 foot clear zone from the curb where buses or other vehicles travel in the curb lane.
- If the lane is permanently reserved for bus only use, apply BUS ONLY pavement markings.
- At intersections, bus lanes may become right-turn only lanes. Use a dotted line to denote where other vehicles may enter the bus lane.

OPERATIONS AND MAINTENANCE

- Dedicated transit lanes may require additional enforcement.
- Create a plan to prevent significant disruption of transit service when utility work requires occupying part or all of a transit lane.
- In winter, keep access to transit lanes and transit stops clear for both the vehicles and riders.

DRAFT
TRAVEL ZONE

SHARED TRANSIT LANE

Under certain circumstances, a shared lane reserved for transit vehicles and bicyclists can provide improved accommodation for both groups. Shared transit lanes are specifically designed to provide room for the two users to maneuver together as buses start and stop along a corridor.

USE

- Shared transit lanes are appropriate on streets where space constraints preclude the ability to provide separate facilities and where bus headways and speeds are moderate. Shared transit lanes typically require less total right-of-way space than separate facilities for each user.
- This lane type should not be considered on high frequency transit corridors or on corridors where bicycle volumes are high enough to adversely affect transit operations.
- Shared transit lanes are not an appropriate treatment on desired low-stress bicycle corridors.
- Shared transit lanes are not appropriate on time restricted streets where the parking lane converts to a travel lane during peak hours.

DESIGN

- Shared transit lanes should be located in the outermost lane, ideally adjacent to the curb.
- Shared transit lanes typically are not physically separated from adjacent travel lanes and thus, should have sufficient width for dual bicycle/transit use. The minimum adequate width is twelve (12) feet.
- Appropriate markings and signage must be provided to ensure that all users of the street are aware of the lane configuration and permitted lane users.
- Shared transit lanes should be for the exclusive use of buses and cyclists, except at intersections, where other vehicles may use them as right turning lanes.

OPERATIONS AND MAINTENANCE

- Shared transit lanes generally require a higher level of observation and enforcement.
- Transit operators should be trained in interaction with cyclists in shared bicycle/transit lanes.
- Lanes should be kept clear of snow and debris.
- Pavement markings will require maintenance and replacement.

DRAFT
TRAVEL ZONE

BUS QUEUE JUMP LANE

A bus queue jump lane, also known as a bus bypass lane, is a truncated bus lane located at the approach to a traffic signal. Buses use the lane to bypass waiting traffic, significantly improving transit travel time. Bus queue jumps may take many forms.

USE

- Transit exempt right turn lanes allow buses to proceed straight through the intersection from a right turn lane.
- The main stop bar may be pushed back and a transit-only lane placed along the curb ahead of the stop line so that the transit vehicle can pull ahead to an advanced stop bar.
- A shared right turn/bus lane reserves the curbside lane for transit vehicles with the exception of right turns by general traffic. This gives buses priority for a longer distance, but requires the removal of parking or travel lanes.
- Queue jump lanes are best used on overlapping transit routes at intersections where buses are likely to experience more significant delays.
- Place bus stops at the far-side of the intersection to allow buses to take advantage of the bus queue jump lane located on the near-side.

DESIGN

- Design bus queue jump lanes long enough so that buses can bypass stopped vehicles.
- Special pavement markings and/or signage may be needed to indicate the space is exclusively for transit vehicles.
- Place an advanced stop bar at least two car lengths ahead of the main traffic stop bar .
- Provide space on the other side of the intersection for the bus to reenter traffic.
- Modify traffic signal timing to allow right-turning drivers to clear the bus queue jump lane in order for transit vehicles to use it. Shorter traffic phases may help to reduce backups.
- To be fully effective, use transit signal priority alongside a bus queue jump lane.
- Exercise caution when placing bicycle lanes next to bus queue jump lanes due to conflicts with buses and right turning drivers. Identify the conflict zone with colored pavement markings.

OPERATIONS AND MAINTENANCE

- Bus queue jump lanes can be cleared of snow using regular snow removal equipment and should never be used for snow storage.

MEDIAN

A median divides lanes of traffic. Medians are generally in the center of the right-of-way, dividing opposing directions of traffic. They may also separate local access or special purpose lanes. Medians increase safety and enhance roadway operations by reducing vehicular movement conflicts, limiting turning movements, and potentially (but not necessarily) providing a refuge for pedestrians crossing the street. Medians can improve environmental quality and incorporate stormwater source control when planted.

USE

- Medians are generally applied to high volume streets to reduce turning movement conflicts while providing an attractive streetscape.
- Medians may be used as an access management tool, a means to limit vehicle conflicts, and/or traffic calming on a corridor.
- For the purpose of slowing traffic, medians are generally used in conjunction with other traffic calming measures, such as lane narrowing.

DESIGN

- Striped or painted medians may precede more permanent improvements, providing an opportunity to test travel behavior before making a significant capital investment.
- Raised medians within the travel zone provide opportunities for landscaping, street trees, and two-stage pedestrian crossings.
- Medians should be a minimum of six feet wide. Those protecting turning lanes or accommodating pedestrian refuge areas should be at least 10 feet wide.

OPERATIONS AND MAINTENANCE

- Medians should be designed with snow removal in mind. Medians can be used for snow storage when necessary, although this may negatively impact planted materials and can block sight lines along the roadway.
- Medians should allow adequate width in the adjacent travel lane as well as turn radii that accommodate snow removal vehicles.
- Medians should also be designed for maintenance of the plantings and vegetation. Installed water infrastructure may be required.

DEDICATED BICYCLE LANE

Dedicated bicycle lanes are on-street bicycle facilities delineated by lane markings as well as bicycle symbol and arrow pavement markings. Bicycle lanes are typically located on the right side of the street immediately adjacent to a vehicle travel lane travelling in the same direction as vehicle traffic. Conventional bicycle lanes alert motorists to the presence of a bike route, allow cyclists to use the street with less interference, and increase comfort and predictability for all roadway users. The provision of bicycle lanes may reduce the incidence of cyclists riding on sidewalks.

USE

- The installation of bicycle lanes may require a reallocation of roadway width and may include modifications to travel, parking and turn lanes.
- Bicycle lanes are typically not used on Neighborhood Local streets.

DESIGN

- Conventional bicycle lanes should be at least five feet wide. Those lanes adjacent to the curb should be six feet wide including the gutter pan.
- When the bicycle lane is between the travel lane and parking lane, a minimum combined width of 13 feet is recommended eight (8) foot parking lane plus a five (5) foot bicycle lane).
- Preferred bicycle and parking lane combined width is 14 feet to minimize vehicle door conflict.
- A solid white line must be used to differentiate the bicycle lane from the general travel lane.

OPERATIONS AND MAINTENANCE

- Bicycle lanes should be kept free of debris, which represents a hazard to bicyclists.
- Avoid locating manholes and drainage grates in bicycle lanes. Ensure that utility covers are flush with the roadway.
- Bicycle lane striping and associated signs and symbols are additional markings that will require maintenance and replacement.
- If colored pavement is used, maintenance plans should keep the markings clear and legible.
- Additional enforcement may be required to ensure that bicycle lanes remain free of parked and stopped vehicles, including delivery trucks.
- Snow should be cleared from bicycle lanes as with any other roadway facility. Bicycle lanes should not be used for snow storage.

CONTRAFLOW BICYCLE LANE

Contraflow bicycle lanes are a dedicated bicycle lane on one-way streets that permit bicyclists to lawfully travel in the opposite direction of motorized traffic. They effectively make the street two-way for cyclists while maintaining one-way operations for vehicles.

USE

- Contraflow bicycle lanes typically address unique conditions where one-way vehicular operations result in inefficient bicycle connections. They may reduce the incidence of wrong-way cycling and cycling on sidewalks.
- Contraflow bicycle lanes are tools to bridge short interruptions in desired bicycle travel paths.
- Contraflow lanes are often employed on single blocks in the areas of highest demand.
- Contraflow lanes should only be used where there is an observed need for the connection.

DESIGN

- Marked contraflow bicycle lanes are located on the left side of travel lanes, based on the direction of vehicular travel.
- Contraflow lanes are separated from traffic by a double yellow line, indicating to motorists that cyclists are traveling in the opposite direction.
- The contraflow lane may be separated by a buffer, median, or other barrier.
- Contraflow bicycle lanes should be a minimum of five feet wide between the striping and curb.
- Orient stop signs and traffic signals along the street to face cyclists in the contraflow lane.
- Extend contraflow lane markings across the intersection to signal the presence of two-way traffic to motorists on cross streets.
- Colored pavement or pavement markings may be used to identify the contraflow lane.
- Bicycle travel in the same direction as vehicular traffic should be accommodated via facilities on the right side of vehicular travel lanes.

OPERATIONS AND MAINTENANCE

- Contraflow lanes should be kept free of debris.
- Pavement markings will require periodic maintenance and replacement.
- Contraflow lanes should be designed to permit snow clearance using existing equipment.
- Lanes should not be used for snow storage.

PROTECTED BICYCLE LANE

Protected bicycle lanes facilities with physical separation from vehicular travel lanes. Protected bicycle lanes can increase the sense of safety and comfort for bicyclists, especially those that are less experienced riders. Protected bicycle lanes correlate positively with increased bicycling activity as they improve comfort for cyclists while reducing the risk of bicycle/vehicle conflict.

USE

- There are two types of protected bicycle lanes
  - A one-way on-street bicycle lanes protected by a physical buffer
  - A two-way cycle track either located in the Travel Zone and protected by a physical barrier or located at curb level and set back from the roadway in the Pedestrian Zone.
- Protected bicycle lanes are the preferred bicycle facility on any corridor emphasizing bicycle use that experiences vehicle volumes in excess of 10,000 per day.
- Protected bicycle lanes are ideal for corridors with vehicle speeds higher than 35 mph, high collision rates, or high numbers of cyclists.

DESIGN

- Protected bicycle lanes shall have a minimum width of five (5) feet exclusive of the buffer for a one-directional facility and eight (8) feet minimum for a two-way facility.
- The minimum desired width of the buffer space is three (3) feet. This space can accomodate planters, raised medians, or flexible posts.
- Parked cars may be used as a barrier between the bicycle lane and travel lanes, but requires an additional three (3) foot buffer to allow for passenger loading and prevent door collisions.

OPERATIONS AND MAINTENANCE

- Bicycle facilities should be kept free of debris.
- Facilities should always be cleared following snow events, may require special equipment, and should never be used to store snow.
- Avoid locating manholes in lanes. Ensure that utility covers are flush with the lane surface.
- If colored pavement is used, maintenance plans should keep the markings clear and legible.
- Maintenance plans should prevent a significant disruption of the bicycle network when utility work requires occupying a bicycle lane.

SHARED LANE MARKINGS

Shared lane markings for bicycles, often referred to as “sharrows”, are pavement markings that indicate a lane explicitly intended to be shared by motor vehicles and bicyclists. Shared lane markings alert motorists to expect bicyclists, remind motorists of the legitimacy of bicyclists to use the roadway, and orient bicyclists to the preferred line of travel. Shared lane markings should not be considered a dedicated bicycle facility and should be used sparingly.

USE

- Shared lane markings may be used on all street types. However their use should be limited to locations where no other solution is possible.
- Shared lane markings are often used as wayfinding for bicycle boulevards, but otherwise not used on low volume local streets.
- The City limits their use of shared lane markings to situations where the street segment is a bicycle boulevard or designated trail connection; to fill gaps between bike lane sections; or to guide bicyclists through an intersection where bike lanes cannot be accommodated.
- Because bicyclists remain in mixed traffic, shared lane markings generally do little to enhance comfort for the most vulnerable or risk-intolerant bicyclists and are not appropriate on streets with high vehicle volumes and speeds.

DESIGN

- Shared lane markings are two chevron symbols positioned above a bicycle symbol. The chevrons should guide cyclists away from parked vehicles and point cyclists in the direction of travel.
- If the travel lane is adjacent to the curb, shared lane markings must be positioned in the center of the lane per State policy. If the travel lane is adjacent to a parking lane, markings are placed at least 14 feet from the curb face.
- Shared lane markings on non-local streets should be supplemented by signage.

OPERATIONS AND MAINTENANCE

- Shared lane markings require maintenance to ensure they remain highly visible.
- Placing shared lane markings toward the center of the travel lane, between the primary wheel tracks of vehicles, may reduce wear and fading.

BICYCLE BOULEVARD

Bicycle boulevards utilize local streets with less vehicle traffic to create a lower stress network for people walking and bicycling while still maintaining local vehicular access. Bicycle boulevards typically feature shared lane markings and bike route signage. These streets can also feature traffic calming design elements to slow traffic and limit cut-through traffic.

The City of Rochester completed a Bicycle Boulevard Plan in 2015 to identify parallel bicycle-friendly streets along key arterial corridors characterized by high automobile traffic volumes, high parking demand, and/or constrained rights of way.

USE

- Bicycle boulevards are typically only used on lower order streets such as Neighborhood Local or Industrial Local, although they may be applied on other streets where vehicle volumes are low and can be effectively managed.
- Bicycle boulevards typically experience traffic volumes of 1,500 vehicles per day or lower. Travel speeds should not be higher than 25 mph.
- Bicycle boulevards should be long enough to provide an attractive stretch of travel and should connect to a complete bicycle network.

DESIGN

- Bicycle boulevards typically employ a range of speed and traffic calming treatments such as chicanes, bulb-outs, diverters, and others.
- Clear signage and directional pavement markings are encouraged as bicycle boulevard corridors may follow somewhat indirect routes.
- Bicycle boulevards are sometimes referred to as neighborhood greenways as they represent opportunities to integrate green infrastructure into traffic speed and volume management.
- Traffic signals may be considered where bicycle boulevards cross high vehicular volume streets.

OPERATIONS AND MAINTENANCE

- Traffic conditions should be monitored before and after implementation. If conditions do not meet desired targets, additional management treatments should be implemented.
- Local streets that are designated bicycle boulevards should receive higher priority street maintenance services throughout the year.

SHARED STREET

Depending on a street's volume and role in the traffic network, it has the potential to be redesigned and enhanced as a shared street. Shared streets can meet the desires of adjacent land uses while functioning as public space. Low speed vehicle access is maintained while permitting loading activity at designated hours. Shared streets are designed to slow traffic speeds using pedestrian volumes, design elements, and other implicit cues to slow or divert traffic.

USE

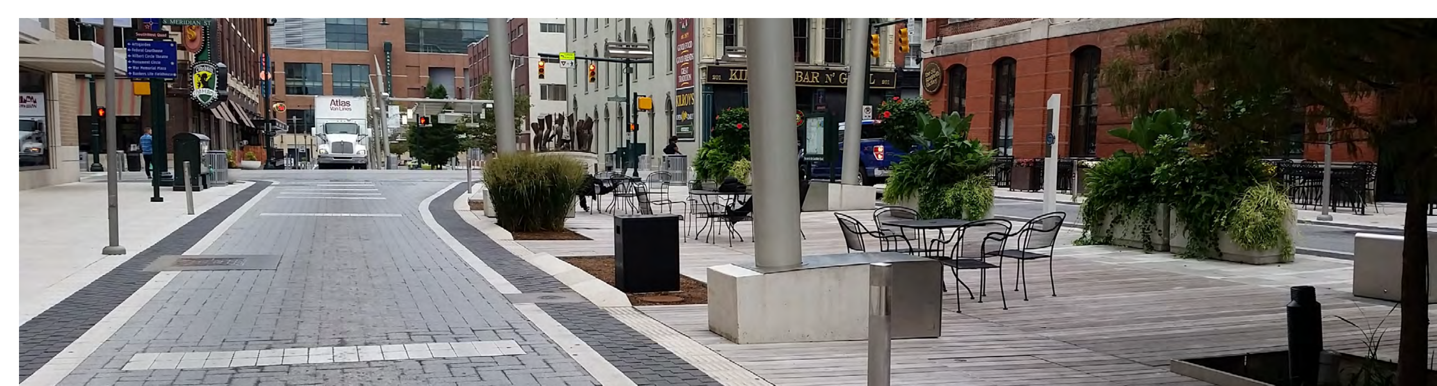
- Shared streets may be appropriate for business streets where sidewalk congestion forces pedestrians to walk in the street.
- They may also be appropriate where delivery vehicles obstruct non-motorized traffic, forcing pedestrians and cyclists to mix with motorists.
- Shared streets are generally not appropriate for streets that emphasize transit activity.

DESIGN

- Textured pavements that are flush with the curb reinforce the shared operation of the street and delineate a non-linear or narrow path of travel.
- Depending on the overall street width, designers may consider providing a clear path protected from traffic. Street furniture may be placed to provide definition for a pedestrian-only area.
- Commercial shared streets should be accessible by single-unit delivery trucks where necessary. Where alleys do not exist, shared streets may be designed to accommodate large trucks. Loading zones may be defined through pavement patterns, striping, and/or signage.
- Shared street space should be designed to facilitate snow removal as well as drainage. Drainage channels should be provided either at the center of the street or along the flush curb and are often used to differentiate the shared area from the clear path.

OPERATIONS AND MAINTENANCE

- Special pavements may be subject to additional maintenance costs and should be selected based on long-term durability. Materials should be compatible with snow removal equipment.
- Prior to the permanent application of a shared street, car-free hours or temporary materials may be used to test a conversion and evaluate the potential impact on traffic operations.



INTERSECTION DESIGN

Intersections are where different users and uses of the street combine and intersect. Intersections can be the most challenging street element to design as they are the location of a majority of conflicts and crashes. Therefore, a focus on quality design is important to ensure the safety of all users. Just as street segments can be designed to be self-regulating, designers should strive to make complex movements at intersections safe, self-evident, and predictable to all users.

Intersections should be designed as a component of a corridor and the larger street network. Trade-offs can often be made between design decisions at one intersection and the impact on the network in terms of traffic volume and capacity. For example, a traffic signalization project can increase vehicle throughput and reduce delay at an intersection, but benefits will be greater if signals are coordinated along a corridor.

Intersections can range from simple crossings that are relatively straightforward to complex junctions that require careful planning and design. Regardless of the level of complexity, intersections should be designed to be as compact as possible, minimizing crossing distances, complexity, and delay for all modes. Wherever possible, dedicated turn lanes should be limited in order to improve pedestrian and bicycle safety.

Intersection design configurations should reflect the surrounding land uses and built environment. Designs should convert skewed intersections to right angles and reallocate unnecessary lanes to public space. Designers should align lanes so that the number of approach and departure lanes are equal at intersections and limit opportunities for people traveling through intersections to make unexpected or sudden movements.

CROSSWALK

Crosswalks are critical components of the street that facilitate a connected and continuous pedestrian network. Crosswalks are marked facilities that carry pedestrians across vehicular and bicycle travel ways.

USE

- Marked crosswalks should be provided at all signalized intersections and near schools, parks, community facilities, or other pedestrian generators.
- Marked crosswalks may be located at unsignalized crossings (e.g. stop controlled, uncontrolled, or roundabout) at intersections or mid-block.

DESIGN

- Crosswalks should be as wide as the sidewalks they connect; at least five (5) feet wide while eght (8) feet or wider is preferred in areas of higher foot traffic.
- Crosswalks should encompass the desired line of travel observed at a particular location. Sidewalk ramps should be provided to serve all marked crosswalks.
- Crosswalk markings shall be clear and legible.
- High visibility markings, such as the City's Ladder Bar Type L design, are advised in areas of high pedestrian volume or where more vulnerable users are concentrated.
- Crossings should be optimally aligned and as short as possible to minimize exposure time/risk.
- Designers should avoid the use of crosswalk segments longer than the width of four (4) travel lanes. For longer crossings, consider the use of pedestrian refuge islands.
- Crosswalk surface may be asphalt, concrete or non-slip pavers providing a level surface, but should also minimize vibrations for persons using wheeled moblity aids.

OPERATIONS AND MAINTENANCE

- Crosswalk markings should be installed in a slightly staggered pattern to avoid the typical vehicle wheel track and minimize maintenance requirements. Markings may also be inset into the pavement to prevent snow plow damage.
- Visibility of crosswalks is essential. Crosswalk markings should be refreshed at regular intervals.
- Crosswalks must be cleared of snow and ice and remain visible even in wintery conditions. Crosswalks must not be blocked by snow, ice, or pools of water, especially near sidewalk ramps.

SIDEWALK RAMP

Sidewalk ramps are short ramps cutting through a curb or built up to it that provide the transition from the sidewalk to the street, most often located at intersections. Sidewalk ramps are essential in providing mobility to persons with disabilities. They also contribute to overall utility and livability for a wide range of users, including people pushing or pulling strollers, delivery carts, luggage, or utility carts as well as people walking with a cane, crutches, or a bicycle.

USE

- Per ADA Title II, newly constructed or altered street level pedestrian walkways must contain curb ramps or other sloped areas to street level at any intersection having curbs or other barriers.
- Sidewalk ramps are used with both sidewalks and shared use paths.
- Sidewalk ramps may be used to provide access to accessible curbside parking spaces or passenger loading areas.
- Temporary sidewalk ramps should be provided when a pedestrian detour is needed to maintain access during sidewalk closures.

DESIGN

- Ramp dimensions should comply with PROWAG R304.2 and R304.5, a minimum of four (4) feet wide, though six (6) feet is preferred. Areas with high concentrations of pedestrian traffic may require wider sidewalk ramp openings.
- Sidewalk ramps should be oriented perpendicular to the natural curb line and oriented to the desired line of travel. Separate ramps should be provided for each crossing wherever feasible.
- Detectable warning strips that contrast with the surrounding pavement are required.

OPERATIONS AND MAINTENANCE

- As part of the sidewalk, adjacent property owners are responsible for snow clearance from sidewalk ramps. All parts of the path must be cleared, particularly after a snowplow has cleared the street.
- Detectable warning strips are particularly vulnerable to damage from snow removal operations. FHWA guidance recommends complete replacement of damaged curb ramp elements as a long term repair solution.

PEDESTRIAN SIGNAL

Pedestrian signals, like vehicle signals, inform pedestrians when it is appropriate to cross the street and when to stop and wait. Pedestrian signals consist of a white WALK symbol, a flashing and/or steady DON'T WALK symbol, and a countdown timer.

Basic pedestrian signals may be enhanced with audible signals. Pedestrian countdowns provide visual information on the time remaining in a pedestrian cycle. Accessible pedestrian signals are an integrated device that communicate cycle information to pedestrians with visual impairments.

MUTCD permits pedestrian signals to operate on fixed timing or actuation. Pre-timed signals provide a pedestrian walk phase for each leg of an intersection during every cycle, regardless of whether pedestrians are present. Actuated signals provide a walk phase only when pedestrians make a request.

USE

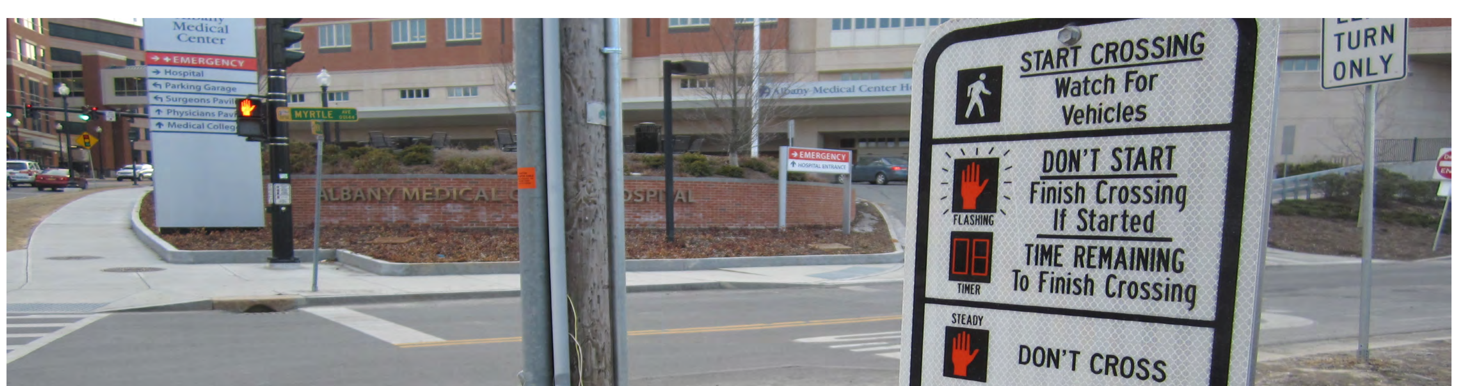
- Pedestrian signals should be installed at all signalized intersections with crosswalks.
- Fixed-time signals should be used where high pedestrian activity is expected on all crosswalks to ensure adequate crossing time. At intersections that experience less foot traffic, actuated signals are more appropriate.

DESIGN

- Provision of pedestrian countdown information is desired at all intersections with pedestrian signals. If the pedestrian crossing width exceeds 90 feet, increase the height of the numerical display to ensure visibility and legibility.
- Pedestrian crossing time that meets the MUTCD standard is dependent on the crossing distance. Crossing distances, and therefore required crossing times, may be reduced through the use of bump outs.
- Signal actuators should be located adjacent to the landing of the desired crossing with a maximum reach of 18" to the signal push button.

OPERATIONS AND MAINTENANCE

- Snow clearance at curb ramps and sidewalks must provide clear access to push buttons.
- Adequacy of pedestrian crossing time should be routinely monitored and adjusted.



PEDESTRIAN REFUGE

Pedestrian refuge islands are raised or curbed sections within the roadway that provide a landing zone for pedestrians to use while crossing a street with multiple travel lanes. Refuge islands decrease pedestrian risk by breaking up longer crossings into two or more stages. Because the pedestrian is crossing fewer lanes of traffic per stage, pedestrians are more easily able to find time to cross at unsignalized crossings. Refuge islands can also function as traffic calming devices and opportunities to apply green infrastructure.

USE

- Pedestrian refuge islands are most often used on multilane roadways where a pedestrian must cross four (4) or more consecutive travel lanes.
- Pedestrian refuge islands may also be used as a traffic calming or traffic channelization device in concert with roundabouts or shallow right turns.

DESIGN

- Refuge islands should connect to sidewalks via marked crosswalks. The crosswalk should continue at street grade through the island, employing detectable warnings, such as raised bumps, while within the island.
- Refuge islands should be 10 feet wide in order to accommodate pedestrians with strollers, mobility assistance devices, or bicycles.
- Landscaped medians can be designed for stormwater bio-retention. Larger medians can include street trees and native plantings.
- Landscaping on pedestrian refuge islands must comply with MUTCD standards so as not to impede sightlines and visibility.

OPERATIONS AND MAINTENANCE

- Refuge islands may introduce additional costs to street repaving. Landscaped pedestrian refuge islands will require regular landscape maintenance and may need irrigation.
- Pedestrian refuge islands should accommodate the width and turn radii of snow clearance equipment and emergency response vehicles.
- Pedestrian refuge islands should not generally be used for snow storage. They should be regularly cleared of snow and debris.
- Walking surfaces should be designed to avoid the pooling and icing of water while wide enough to allow for snow removal equipment.

ROUNDABOUT

Roundabouts are a circular intersection control where the turning movements are physically separated by a central island, and traffic moves circularly around the island. Vehicles leave the intersection by turning right at the appropriate leg.

According to the AASHTO Highway Safety Manual, roundabouts have been proven safer than stop-controlled and signalized intersections. They enable continuous movement through the intersection when conflicting traffic is not present, but implementation is a challenge in urban environments due to space requirements.

USE

- New York State requires the evaluation of a roundabout before considering a traffic signal.
- Roundabouts can be designed to handle a range of vehicle volumes and can be applied to single-lane (preferred) or double-lane roadways.

DESIGN

- A mountable curb apron should be provided at roundabouts where large trucks or emergency vehicles require access in constrained spaces.
- Crosswalks should be marked and set back at least 20 feet from the entry of the roundabout.
- Sight distance for drivers entering the roundabout should be maintained to the left so that drivers are aware of vehicles and bicycles in the circle as well as to the right when exiting the roundabout through pedestrian crossings.
- Splitter islands are medians or pedestrian refuge islands that allow pedestrians to cross one direction of traffic at a time, and also guide traffic into and out of the roundabout.
- If a bicycle facility is present on an approach, the roundabout can have bicycle take-off and re-entry ramps to allow cyclists to either merge with traffic or move onto the sidewalk.

OPERATIONS AND MAINTENANCE

- Roundabouts should allow adequate width in the travel lane as well as a turn radius that accommodates snow removal vehicles.
- Roundabouts can be used for snow storage when necessary, although this may negatively impact planted materials and can block sight lines along the roadway.
- Pedestrian refuge islands at roundabouts require sweeping and snow removal.

BIKE BOX

A bike box is a dedicated area for cyclists at the front of a traffic lane at signalized intersections. Bike boxes make cyclists more visible to motorists by positioning them at the head of a queue during a stop cycle. They provide a space for cyclists to queue that does not conflict with crosswalks. Bike boxes also enable cyclists to safely position for a left turn during a stop cycle at an intersection. On corridors of high bicycle activity, bike boxes enable cyclists to progress forward at the onset of the green signal cycle, reducing conflicts with right turning vehicles.

USE

- Bike boxes are used only at signalized intersections.
- Bike boxes are most beneficial on streets with high bicycle traffic volumes, locations with significant left turn bicycle activity, and/or intersections where conflicts between bicycle and right turning vehicles are common.
- Bike boxes may also be desirable in high pedestrian use areas to protect crosswalks from encroachment by bicycles or vehicles.

DESIGN

- The bike box is formed by two parallel pavement marking lines at least six inches wide forming a box at least 10 feet or more in depth and extending from the outside of the bicycle lane across all travel lanes in the direction of travel.
- Bike boxes are located between the crosswalk and the vehicle stop bar.
- The vehicle stop bar shall be moved behind the bike box at least 2 feet to prevent motor vehicle encroachment into the bike box.
- Bike boxes shall be separate and distinct from the crosswalk and may be moved further back from the crosswalk to prevent bicyclists from blocking the crosswalk.
- Right turn on red restrictions must be employed to avoid conflicts with queued cyclists.

OPERATIONS AND MAINTENANCE

- Education and enforcement may be needed to ensure all users are aware of and comfortable using bike boxes.
- Bike boxes are additional pavement markings that will require maintenance.

TWO-STAGE TURN QUEUE

A two-stage turn queue provides a less stressful left-turn option for cyclists via a queue box or protected area where cyclists may move out of the through traffic lane on the right hand side of a street and wait for the green cycle of the intersecting road before completing the turn. The two separate stages for a bicyclist to complete a left turn increases travel time for bicyclists, although the benefit of comfort may outweigh the time penalty.

USE

- Two-stage turn queue boxes are generally used in conjunction with other bicycle facilities, such as bicycle lanes or protected bicycle lanes, but may be used on any corridor where safe and comfortable accommodation of left-turning bicycles is needed.
- Two-stage turn queue boxes are especially appropriate where there are significant volumes of turning cyclists along preferred travel routes and/or where accommodating less confident cyclists is necessary.
- Two-stage turn queue boxes are particularly beneficial on streets with more than one travel lane in any one direction including turn lanes.

DESIGN

- A two-stage turn queue shall consist of a first stage bicycle facility, usually a bicycle lane, and a second stage green painted queue box that accommodates the cyclist waiting for the signal prior to completing the turn. Appropriate signage per the MUTCD should also be posted.
- The two-stage turn queue box shall be at least 10 feet wide by 4 feet deep but may be made larger based on expected cyclist volume.
- The turn queue box for the second stage shall be in a location aligned with the rightmost travel lane or bicycle facility of the receiving street.
- Two-stage turn queue boxes should not be placed adjacent to transit stops to avoid conflict between transit passengers and cyclists.

OPERATIONS AND MAINTENANCE

- Two-stage turn queues require additional pavement markings and may add additional maintenance complexity (e.g. green markings).
- Placing markings between vehicle tire tracks may reduce wear and tear.
- Two-stage turn queues should be cleared of snow concurrent with other street snow removal.

TRAFFIC CALMING

Traffic calming refers to geometric strategies to reduce the volume or speed of vehicles traveling on a street. Traffic calming design elements can be implemented as part of street re-design projects as a component of a self-regulating design, or alongside other design features that also reduce speeds, such as street trees, pedestrian lighting, and landscaping.

Traffic calming measures may be used to retrofit existing streets experiencing volumes or speeds that are not in line with the form and function of the street network. In this way, they may function as pilot projects that demonstrate a proof of concept and educate drivers and the public on how the street could function with reduced vehicle speeds or traffic volumes. If the results are favorable, a future project could provide more permanent and integrated design solutions.

Traffic calming should be evaluated and possibly implemented on a neighborhood or scale as volume or speed changes on one street segment may adversely impact the surrounding streets. Traffic calming installations should not divert traffic to other Neighborhood Local streets, but may divert vehicles to higher order streets (Regional Activity, Downtown Activity, Neighborhood Activity, Neighborhood Link, and Industrial Link). The potential impacts of diverted traffic should be evaluated for all traffic calming projects.

With all traffic calming devices, accommodation of emergency response vehicles, snow plows, and garbage trucks should be a consideration. Delays to emergency response vehicles should be minimized by the appropriate placement and design of traffic calming devices. In some cases, certain traffic calming devices may not be appropriate. For example, vertical traffic calming devices should not be used on primary emergency response routes or on corridors where freight or transit are emphasized.

HORIZONTAL CONTROL

Horizontal speed controls reduce traffic speeds and reinforce safe, pedestrian-friendly neighborhood streets by forcing drivers around horizontal curves and blocking long views of the road ahead through horizontal shifts. Horizontal deflections include chicanes, bulb-outs, and center islands.

USE

- Bulb-outs narrow the street mid-block by expanding the sidewalk or planting strip.
- Bump outs are bulb-outs at intersections that reduce pedestrian crossing distance, increase visibility, and lower turning speeds.
- Chicanes are bulb-outs that alternate from one side of the street to the other. Vehicles slow their speeds to pass through the series of curves.
- Center islands are a small median or island located at the centerline of a street that causes traffic to shift its path to the right.
- Horizontal speed control elements should be applied on lower order streets, primarily Neighborhood Local streets, where traffic volumes are higher than desired and are frequently used as cut-through routes.

DESIGN

- Horizontal elements should not be used where cyclists would be forced into the traffic flow.
- Shifts in chicane alignment should be at least one lane in width with deflection angles of at least 45 degrees, and include center islands to prevent drivers from following a straight path.
- Center islands may be located at the approach to an intersection or midblock.
- Lateral shifts are one of the few calming measures that can be used on higher order streets, such as Neighborhood Link, where higher volumes preclude other calming measures.

OPERATIONS AND MAINTENANCE

- Monitor the impact of traffic calming treatments at the network or neighborhood level prior to and after installation.
- Horizontal control measures that result in added bulb-outs will require additional maintenance of trees, street furniture, or landscaping.
- Designs should consider snow removal operations. Visual cues should alert snow plow operators of the change in the roadway.
- Bulb-outs may offer snow storage space.

ROAD DIET

A street striping modification—sometimes called a road diet—is a change in roadway striping that typically reduces the number of motor vehicle travel lanes. This strategy can be applied broadly to a wide variety of street types where one or more travel lanes are repurposed in order to discourage speeding, improve sight distances for left-turning vehicles, and/or allocate space for other facilities (e.g. bicycle lanes, bus bulbs, curbside parking).

USE

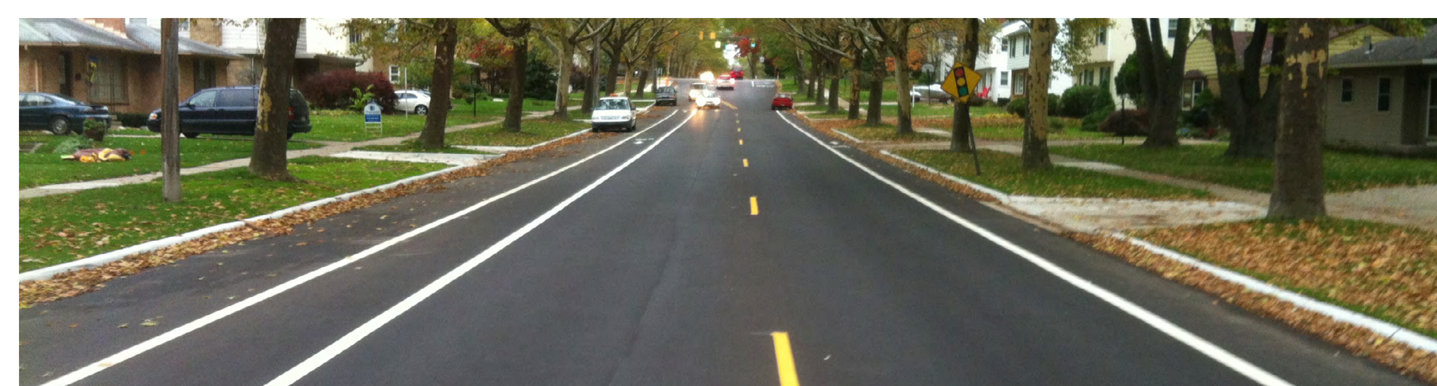
- The most common configuration involves converting a four-lane road to two travel lanes and a center turning lane.
- Four lane streets with traffic volumes less than 15,000 vehicles per day are generally good candidates for four to three lane conversions. Directional volumes are also a consideration.
- A four lane street with volumes between 15,000 and 20,000 vehicles per day may also be a good conversion candidate. A traffic analysis examining speed, volume, and types of traffic is needed to determine feasibility.
- As left-turning vehicles are moved into a common lane, and delays between vehicles and bicycles are minimized, four to three lane conversions typically have minimal effects on the vehicular capacity of the roadway.

DESIGN

- Center turn lane minimum width is 10 feet.
- If considered during reconstruction, raised medians may be incorporated in between intersections to provide improved pedestrian crossings, incorporate landscape elements, and reduce travel speeds. Bump outs may also be added if reconstruction work is involved.
- The space gained for a center turn lane is often supplemented with painted, textured, or raised medians, with opportunities for green infrastructure such as bioswales.

OPERATIONS AND MAINTENANCE

- The design of street reconfigurations should consider signal placement and alignment, signal timing, intersection capacity, and turn movements with traffic shifts at major intersections
- Intersection design and operation should be monitored to determine project results.



VERTICAL CONTROL

Vertical controls reduce traffic speeds, may assist in managing volume, and reinforce pedestrian-friendly streets by using raised roadway features. Speed humps, speed tables, and rasied crosswalks are common vertical speed control measures.

USE

- Vertical control measures may be a temporary or short-term method for reducing speeds. Over the longer term, self-regulating designs are more desirable to manage traffic. Vertical measures are not required for any street typology.
- Speed humps are parabolic vertical traffic calming devices intended to slow traffic speeds.
- Speed tables are midblock traffic calming devices that raise the entire wheelbase of a vehicle to reduce its traffic speed.
- Raised crosswalks elevate the crosswalk above street level, improving pedestrian visibility.
- Vertical speed control elements are most appropriate on lower order streets where vehicle volumes are higher than desired and that are frequently used by cut-through traffic.
- Vertical control measures can be installed on a pilot basis to assess potential impacts.

DESIGN

- All vertical controls should be accompanied by signage and pavement markings warning drivers of the upcoming control device.
- Speed humps are three to four inches high and 12–14 feet wide, with a ramp length of three to six feet, depending on target speed.
- Speed tables are flat-topped, with a height of 3-3.5 inches and a length of 22 feet.
- Vertical elements should not be placed in front of driveways or other significant access areas.
- Designs should ensure proper drainage and should permit snow removal and accommodate street sweeping vehicles while not damaging the vertical speed control elements.

OPERATIONS AND MAINTENANCE

- Vertical speed control elements shall be accompanied by signage and pavement markings warning approaching drivers.
- Monitor the impact of traffic calming treatments at the network and neighborhood level prior to and after installation.
- Snow plow operators should be adequately warned and trained.

DRAFT
TRAFFIC CALMING

RAISED INTERSECTION

Raised intersections create a slow speed crossing at low volume intersections. They are created by raising the level of the roadway to the same level as the sidewalk. Raised intersections are a similar concept to speed tables but are applied to the entire intersection.

USE

- Raised intersections are appropriate in areas of high pedestrian demand, in school zones, and locations where pedestrian visibility and motorist yielding have been identified as concerns
- Raised intersections can be used as a gateway treatment that signals to drivers a transition to a slower speed environment.
- Raised intersections are generally not used in areas with high traffic volumes, along major transit or emergency services routes, and multilane streets.

DESIGN

- Care should be taken to maintain direct routes across intersections aligning pedestrian desire lines on either side of the sidewalk.
- Signage to indicate the raised intersection to drivers must be provided.
- Raised crossings and intersections also require detectable warnings at the curb line for persons with visual disabilities.
- Design speeds, transit routes, and emergency vehicle routes must be considered when designing approach ramps.
- High-visibility or textured paving materials can be used to enhance the contrast between the raised crossing or intersection and the surrounding roadway.
- Designs should ensure proper drainage. Raised intersections can simplify drainage inlet placement by directing water away from the intersection. If the intersecting streets are sloped, catch basins should be placed on the high side of the intersection at the base of the ramp.

OPERATIONS AND MAINTENANCE

- Installation of raised crossings and intersections may affect snow removal operations. Snow plow operators should be adequately warned and trained.

VOLUME CONTROL

While most traffic calming approaches have some effect on both volume and speed, some measures are primarily targeted at discouraging or eliminating opportunities for vehicles to pass through certain streets. Volume control devices can include full and half street closures, diverters, median barriers, and forced turn islands. They are generally more permanent traffic calming solutions and must be implemented as part of a network solution as the diverted traffic will likely be relocated to nearby streets.

USE

- Volume control elements are best suited to long, straight streets that experience higher than desired traffic volumes.
- Semi-diverters prevent vehicles from crossing an intersection in one direction while permitting traffic in the opposite direction to pass through.
- A somewhat less common volume control measure, diagonal diverters are barriers installed across an intersection blocking through movement. Like half closures, diagonal diverters are usually staggered to create circuitous routes through neighborhoods.
- Volume control elements limit connectivity and the functionality of the street grid.
- Volume control elements should only be applied to lower order streets and are inappropriate for use on emergency response routes, bus routes, or higher order typologies.

DESIGN

- Semi-diverters should be located at the end of a block to prevent vehicles from entering but allow exits.
- Volume control elements may divert traffic to other low-volume streets.
- Provisions should be made for the continuation of pedestrian and bicycle routing through or around volume control diversions.

OPERATIONS AND MAINTENANCE

- Operation of the street network should be monitored to ensure that traffic is diverted to higher level streets as intended.
- Designs may require modification to increase compliance. Drivers may be less likely to drive around diverters or barriers if they are extended or angled for right turns out of the neighborhood.

MINI ROUNDABOUT

Mini roundabouts are circular islands located at the center of intersections. They can be installed using simple raised islands, but also provide great opportunities to include stormwater management facilities, art and/or landscaping. Mini roundabouts can be used at existing intersections to replace two-way stop control, all-way stop control, or a traffic signal. Mini roundabouts can improve the operation of an intersection by reducing the dominance of the traffic flow from one direction over others, facilitating access and reducing delay to minor street movements, and improving overall intersection capacity.

USE

- Mini roundabouts should only be considered in space constrained intersections with low desired approach speeds.
- Mini roundabouts offer a low-speed, low-noise intersection option for residential environments.
- A mini roundabout can be an ideal application to reduce delay at stop-controlled intersections that do not meet signal warrants.

DESIGN

- The location of the central island should allow for all movements to be accommodated at the intersection with counterclockwise circulation.
- Designing the central island size and location to provide deflection through the roundabout will encourage proper circulation and reduced speeds through the intersection.
- Shared-lane markings or intersection crossing markings should guide bicyclists through the intersection.
- Where a bicycle boulevard turns at a minor intersection, use bicycle wayfinding route markings and reinforce route direction using shared-lane markings.

OPERATIONS AND MAINTENANCE

- Shrubs or trees in the roundabout further the traffic calming effect and beautify the street, but need to be properly maintained so they do not hinder visibility.

MID-BLOCK CROSSING

Midblock crossings are crossings that occur between intersections, facilitating crossings to desired pedestrian destinations that are not well served by the existing network.

USE

- Install where there is a significant pedestrian desire line. Frequent applications include midblock bus stops, transit stations, parks, building entrances, and midblock passageways.
- Midblock crossings should not be used when within 400 feet of a crosswalk at an intersection.

DESIGN

- High visibility crosswalk markings are advised at high volume pedestrian locations, areas of heightened safety concern, or areas with concentrations of more vulnerable pedestrians.
- Advance yield markings at midblock crossings should be set back 20–50 feet to ensure that a person crossing the street is visible to a second driver when the first driver is yielding.
- Continuous crossings in excess of four (4) consecutive travel lanes should be avoided. For longer crossings, consider the use of pedestrian refuge islands.
- Midblock crossings at uncontrolled locations may require special design attention, such as pedestrian crossing signs, and/or parking restrictions to ensure visibility of pedestrians about to enter the crosswalk.
- Raised crosswalks may be used where vehicle volumes and speeds are generally low. Raised crosswalks elevate the crosswalk above the typical grade of the street, improving visibility.
- Midblock crossings where trails cross the roadway, such as within parks, may require further enhancements such as raised crosswalks, rapid flashing beacons, or bump outs.
- Enhanced pedestrian treatments, such as actuated beacons, should be considered only after more traditional treatments are used.

OPERATIONS AND MAINTENANCE

- Crosswalk markings may be installed in a slightly staggered pattern, or inset into the pavement, to avoid the typical wheel track and/or damage from snow plows.
- Visibility of crosswalks is essential. Crosswalk markings should be refreshed at regular intervals. After street repaving, crosswalks should be remarked as soon as possible.

PEDESTRIAN YIELD CONTROL

Stop and yield control devices can make it easier for pedestrians and motorists to see one another, discouraging encroachment on the crosswalk, and preventing multiple-threat collisions. Multiple-threat collisions occur when there are multiple lanes of travel in the same direction and the vehicle in the near lane yields while the vehicle in the far lane does not yield because the pedestrian is blocked from view.

USE

- Advanced Yield Markings are coordinated signage used at uncontrolled mid-block locations and intersections to encourage drivers to stop further back from crosswalks.
- In-street YIELD TO PEDESTRIAN signs are placed in the roadway at uncontrolled crosswalk locations to remind drivers of the pedestrian right-of-way.
- Rectangular Rapid-Flash Beacons (RRFB) are pedestrian crossing signs combined with an intensely flashing beacon that is only activated by a pedestrian call button.
- Pedestrian Hybrid Beacons (PRB) are often used at midblock crossings to increase driver awareness of pedestrians. A red PRB beacon is illuminated when activated by a pedestrian.

DESIGN

- Advance yield markings and signs shall be placed 20 feet to 50 feet in advance of crosswalks on uncontrolled approaches, and parking should be prohibited in the area between the yield markings and the crosswalk.
- In-street signs should be placed in the roadway close to the crosswalk location on the center line, on a lane line, or on a median island. They should not obstruct the crosswalk.
- In-street signs should be designed to bend over and bounce back when struck.
- RRFBs should be installed on both sides of the roadway at the edge of the crosswalk; placed curbside below the pedestrian crossing sign and above the arrow indication.

OPERATIONS AND MAINTENANCE

- In-street yield signs may be permanent or temporary. They should be removed during winter to facilitate snow removal operations.
- In-street signs require regular monitoring and should be replaced when damaged.

GREEN INFRASTRUCTURE

Per the City of Rochester & Monroe County Green Infrastructure Retrofit Manual, Green infrastructure is a design strategy that applies a natural systems approach to managing stormwater and creating healthier, more sustainable environments. Rochester's green infrastructure includes green spaces and the links between them, such as community gardens, streetscapes, sidewalks, and trail areas.

Street designers must balance the needs of competing road users when designing within limited street right-of-way. They must carefully consider how best to incorporate green infrastructure elements. In many cases, green infrastructure elements can be incorporated into other street elements, such as medians or bulb-outs.

The objectives of green infrastructure in design are to:

- Reduce stormwater run-off that would normally flow directly into the sewer system.
- Improve water quality by filtering pollutants.
- Slow stormwater run-off velocity.
- Reduce local flooding and ponding.
- Provide a "traffic calming" element and pedestrian safety.

Text for these design elements was adapted from the Green Infrastructure Guidance Manual, prepared originally for the City of Grand Rapids by TetraTech and modified for the Grand Rapids Vital Streets Plan. For more complete information on green infrastructure designs and considerations, including typical plans, profiles, and sections for various elements, refer to the City of Rochester & Monroe County Green Infrastructure Retrofit Manual.

BIORETENTION

Bump outs can be designed as a space to manage stormwater through bioretention. When designed with an opening in the curb they can catch stormwater as it flows down the curb and/or collect water from adjacent sidewalks. Collected water is then trapped in a low planting area and is dispersed either through plant uptake or ground infiltration. The soil and other features help to filter pollutants from the water.

USE

- Use at intersections where bump outs are possible, including mid-block crossing locations.
- Use in locations where stormwater flows along the curb line, especially where there is a slight slope for direction into the bioretention area.
- Use in locations where stormwater overflows can be directed or connected to an appropriate outlet structure prevent localized flooding.

DESIGN

- Do not locate in places that impede necessary pedestrian movement, such as crosswalks, sidewalks, or access to street furnishings.
- Coordinate placement with bicycle lanes or routes to ensure the safe passage of bicycles.
- Avoid use in areas with less than 2 feet to the water table or bedrock and in areas of known soil/groundwater contamination.
- Bump out bioretention facilities should be designed to work with other green infrastructure practices to manage stormwater volumes.
- A stone reservoir area should be installed below the planting soil.
- The surface area should generally be between four and seven percent of the tributary area.
- In general, bump out bioretention areas narrower than 3-feet should be avoided.
- Infiltration planters should be curbed when adjacent to sidewalks or street furnishings.

OPERATIONS AND MAINTENANCE

- Clean inlets, outlets, and overflows.
- Remove weeds during the establishment period. Add mulch when needed.
- Use low-profile native plants for reduced maintenance and unimpeded line-of-sight.
- On slopes, check dams as needed to provide stepped, flat bottoms in the bioretention area.

DRAFT
GREEN INFRASTRUCTURE

MEDIAN BIOSWALE

Linear bioretention facilities are located between the curb/gutter or shoulder of the road and sidewalk. They can be designed with curb-cut opening that allows stormwater to enter the linear bioretention facility from the gutters or with a grass filter strip with roads without curbs. The stormwater runoff is then captured in a depressed planting area and then either infiltrates into the soil or flows through an underdrain to the storm drain network.

USE

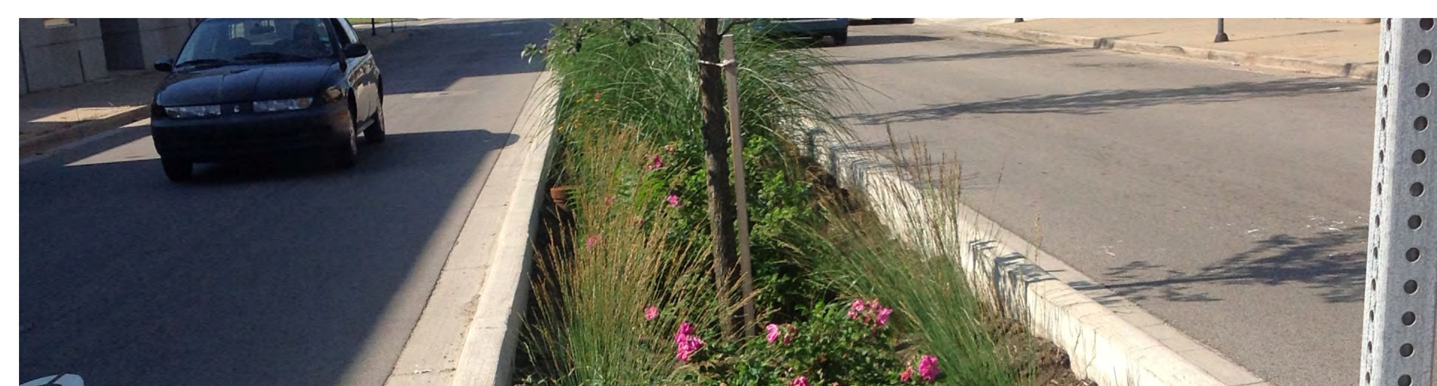
- Median bioswales are designed and function in much the same way as those found at bump outs, but are located in the center portion of the roadway between the travel lanes.
- Use in locations where stormwater flows along curb line or where runoff flows from adjacent paved areas.
- Use in locations where overflow water can be directed or connected to an outlet point.
- Use in locations where the green space between the curb and sidewalk is at least 6 feet wide and not dominated by other public uses.

DESIGN

- Do not locate in places that impede pedestrian movement, such as crosswalks, sidewalks, or access to parking meters or street furnishings.
- Coordinate placement with bicycle lanes or routes to ensure the safe passage of bicycles adjacent to the curb line.
- The total surface area of the linear bioretention should be one percent of the drainage area.
- A stone reservoir area should be installed below the planting soil.
- Avoid conflicts with fire hydrants and other above ground utilities or underground utilities.
- Meet requirements for emergency vehicle access along the roadway.

OPERATIONS AND MAINTENANCE

- Clean inlets, outlets, and overflows.
- Remove weeds during the establishment period. Add mulch when needed.
- Use low-profile native plants for reduced maintenance and unimpeded line-of-sight.
- On slopes, check dams as needed to provide stepped, flat bottoms in the bioretention area.



STORMWATER PLANTER

A stormwater planter is a vegetated green infrastructure practice relying on specified soils and vegetation to treat and absorb stormwater. It is different from other vegetated best management practices as it typically has concrete vertical side walls allowing it to be incorporated into congested street corridors or attached to the perimeter of a building.

USE

- Most appropriate in locations where stormwater flows along a curb line and can be directed into the Stormwater Planter and/or where stormwater overflows can be directed or connected to an appropriate outlet structure.
- Can also be used adjacent to or in close proximity to a building to collect downspout discharge water.

DESIGN

- The surface area should be about 5 to 7 percent of the drainage area.
- Provide a stone reservoir area below the planting soil and separated by a geotextile fabric to provide maximal storage volume.
- Design the storage layer to drain within 24 to 48 hours by an underdrain or infiltration.
- Do not locate a stormwater planter downstream of sediment sources.
- Avoid installation where the water table is less than 2 feet below the storage layer.
- Where water is directed to the Stormwater Planter from adjacent sidewalk or pedestrian areas, provide breaks in the wall and/or metal inlet structures to allow water to pass through.
- Provide a perforated underdrain pipe that takes excess water to the storm sewer system. Keep the elevation of the top of the overflow lower than the adjacent sidewalk or road.
- Use deep-rooted native plants for reduced future maintenance.
- Ensure that ADA access is maintained if taking up sidewalk space.

OPERATIONS AND MAINTENANCE

- Clear debris from inlets and overflow grates.
- Remove accumulated sediment.
- Remove weeds during plant establishment and annually thereafter.
- Remove trash and debris weekly.

DRAFT
GREEN INFRASTRUCTURE

LEACHING BASIN

Leaching or iniltration basins collect roadway runoff and provide the opportunity for stormwater to infiltrate in lieu of an outlet to a storm sewer pipe. There are several types of leaching or infiltration basins, including basins that contain a porous bottom consisting of loose aggregate. This type of basin allows water to infiltrate into the ground underneath the basin. Another type of basin contains both a leaching bottom and orifice holes punched along the vertical walls of the catch basin to provide additional infiltration capacity.

USE

- Unless there is a technical or environmental concern, leaching basins should be used in place of standard catch basins where soils are well drained.
- Leaching catch basins are preferred in locations at the upstream points along a stormwater drainage system where volumes are smaller.
- Best suited at locations with no inlet pipes, i.e., offline with only an inlet grate.
- Not recommended where sediment loading is likely to result in clogging of infiltration surface.
- Leaching basins can be integrated with linear infiltration trenches and/or porous pavements.

DESIGN

- Soil infiltration and depth to ground water must be investigated to determine the feasibility of a leaching basin in a particular location.
- Use a pre-cast concrete basin structure with a deep sump, typically up to 10-feet deep and 3-feet in diameter, with 1" diameter perforations.
- The basin structure should be surrounded by 2-foot thick layer of coarse aggregate to function as a stone reservoir.
- Provide a minimum 3-foot separation between bottom of basin and the high groundwater level.
- Use an inlet grate structure that is bike-friendly.

OPERATIONS AND MAINTENANCE

- Inspect at least once every four years.
- Avoid compaction of soils in leaching basin infiltration area.
- Clean leaching basin grates where water enters the structure as needed.
- Remove accumulated debris in the sump to ensure drainage through structure.

POROUS PAVEMENT

Flexible porous pavement allows stormwater to pass through the pavement to a stone storage layer. The water then either infiltrates into the soil or flows through an underdrain to the storm drain network. There are a variety of flexible porous pavements including concrete pavers, paving grids, pervious concrete, porous asphalt, porous rubberized asphalt, and glass porous paving.

USE

- Roadway parking lanes.
- Low-volume roads, alleys and protected bicycle facilities.
- Plazas, paths, sidewalks, and tree pits.
- In areas where impervious space is highly utilized and paved space cannot be spared for vegetated green infrastructure practices.

DESIGN

- Design the system so that the storage layer drains within 24 to 48 hours.
- Ensure that the drainage area has no significant sediment sources that will clog pavement.
- Coordinate review by an arborist or forester for impacts to nearby trees.
- To reduce the amount of sediment that collects on the flexible porous pavement, the area that drains to the flexible porous pavement should be largely impervious.
- Cost of flexible porous pavement tends to be higher than traditional pavement. Costs vary with location and contractor familiarity of the installation.

OPERATIONS AND MAINTENANCE

- Allow porous concrete to cure for a minimum of three months before applying salt.
- Remove sediment and particulates from porous pavement void spaces with a high efficiency vacuum sweeper at least twice per year.
- Pressure washing porous pavement is not recommended; particulate can further embed.
- Stone between pavers will need to be replaced after vacuuming as needed.
- Use of sand and fine aggregate for winter road conditions should not be used.
- Use of porous pavements can provide cost savings by reducing the amount of other storm treatment systems required.

Source: Philadelphia Water Department (CC BY 2.0)

APPENDIX

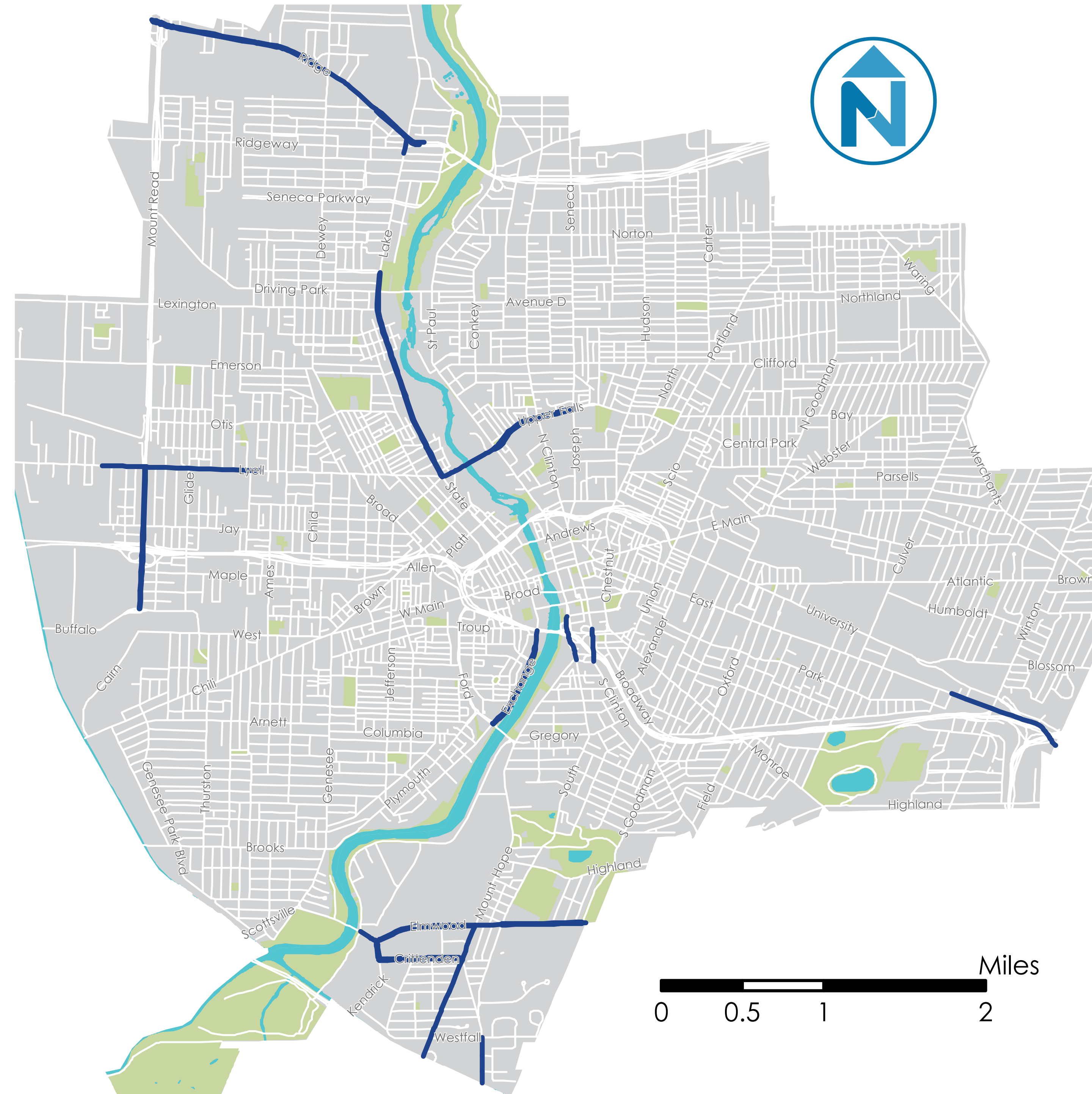
Street Typology Assignment Maps

- Center City Zoom
- Regional Activity
- Downtown Activity
- Downtown Link
- Neighborhood Activity
- Neighborhood Link
- Neighborhood Local
- Industrial Link
- Industrial Local
- Alley

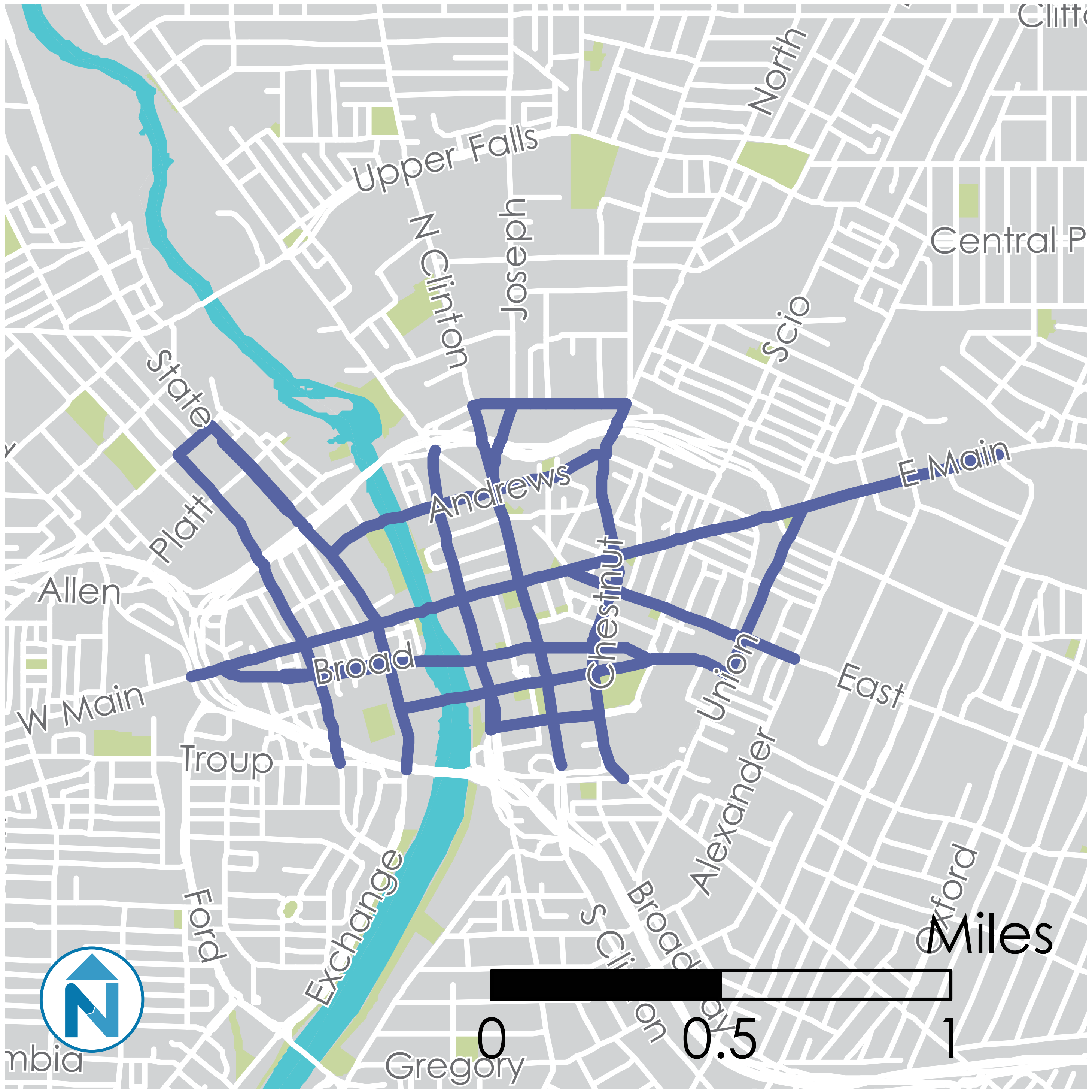
STREET TYPOLOGY ASSIGNMENT
CENTER CITY ZOOM

DRAFT
APPENDIX

STREET TYPOLOGY ASSIGNMENT
REGIONAL ACTIVITY



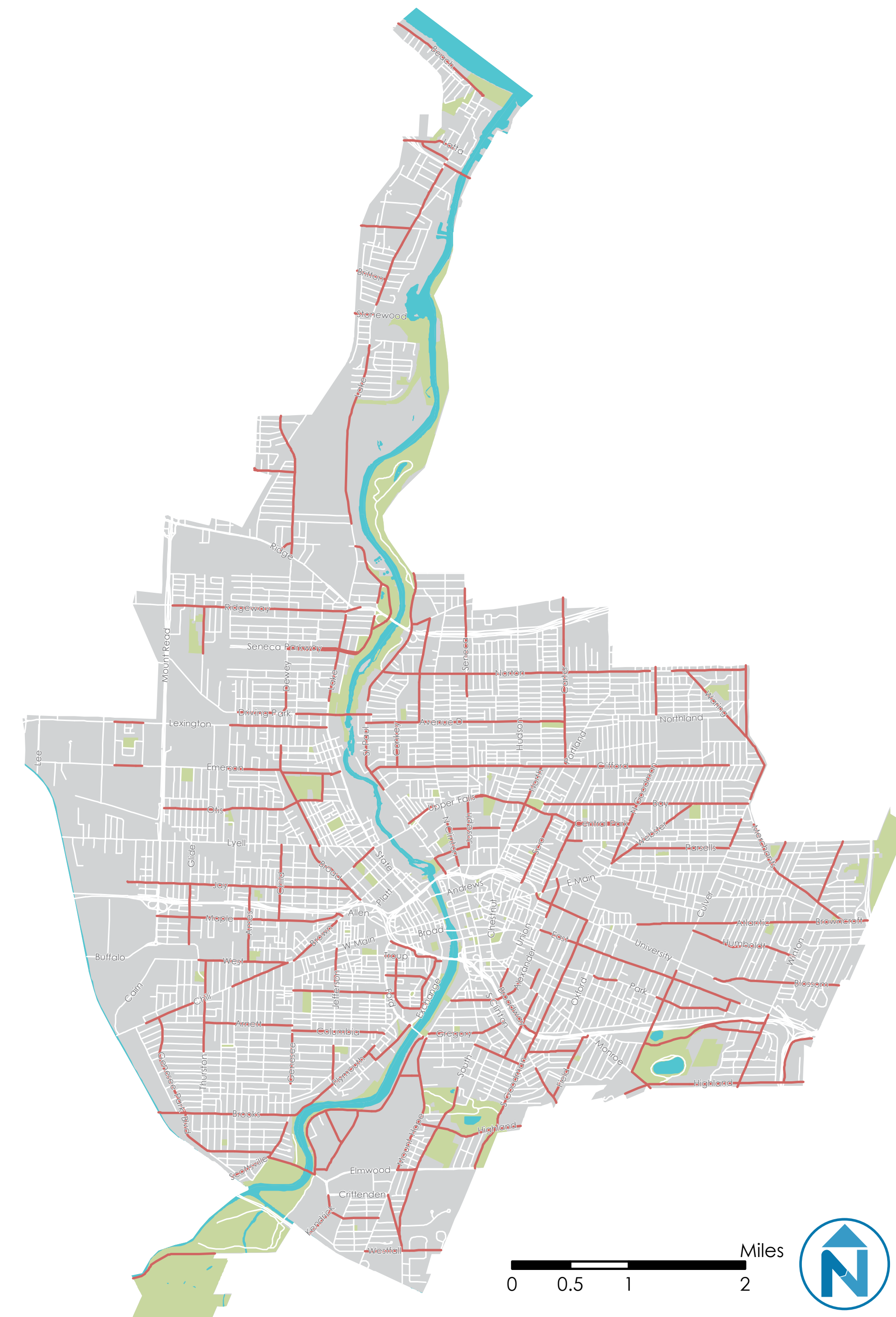
STREET TYPOLOGY ASSIGNMENT
DOWNTOWN ACTIVITY



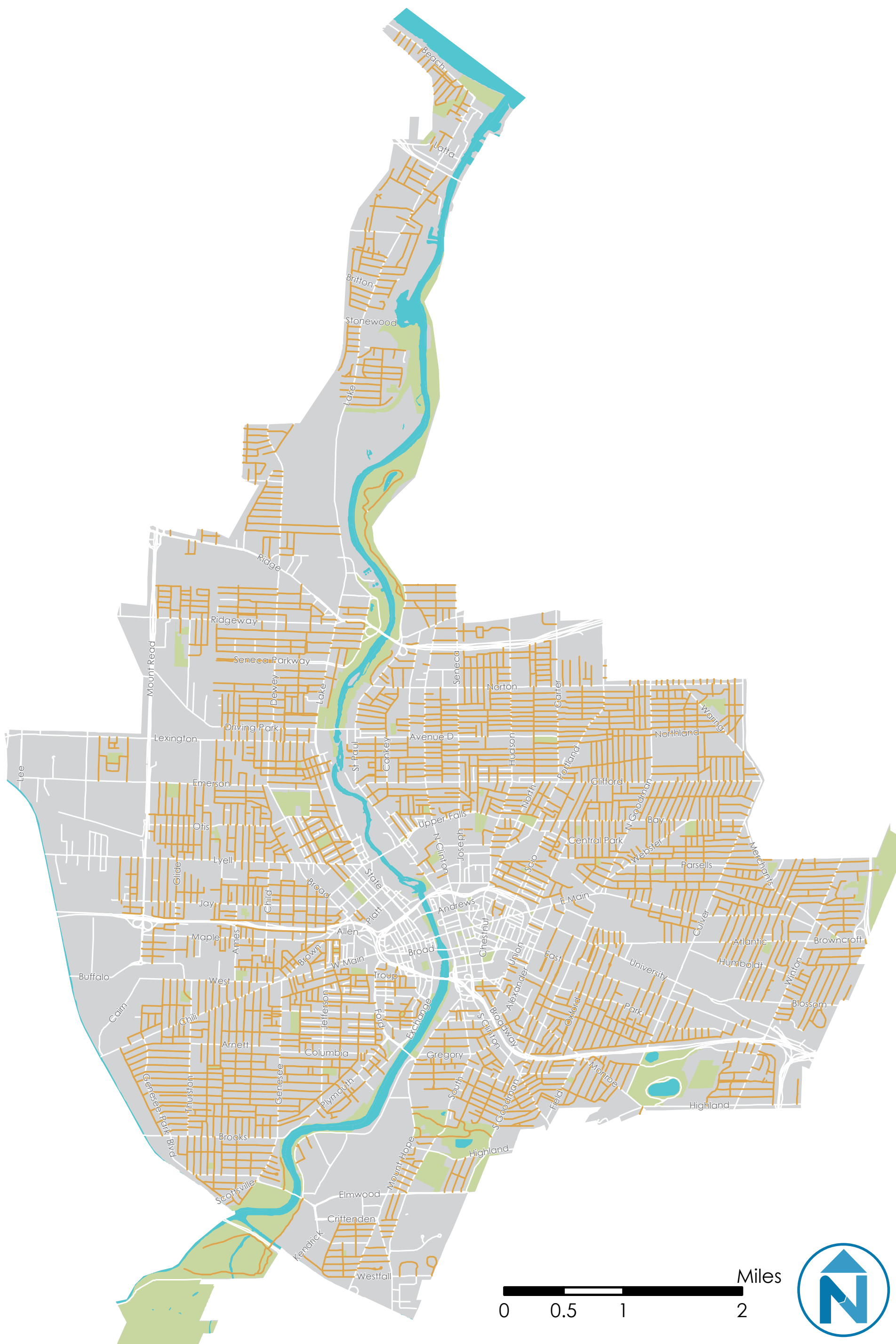
STREET TYPOLOGY ASSIGNMENT
DOWNTOWN LINK

STREET TYPOLOGY ASSIGNMENT
NEIGHBORHOOD ACTIVITY

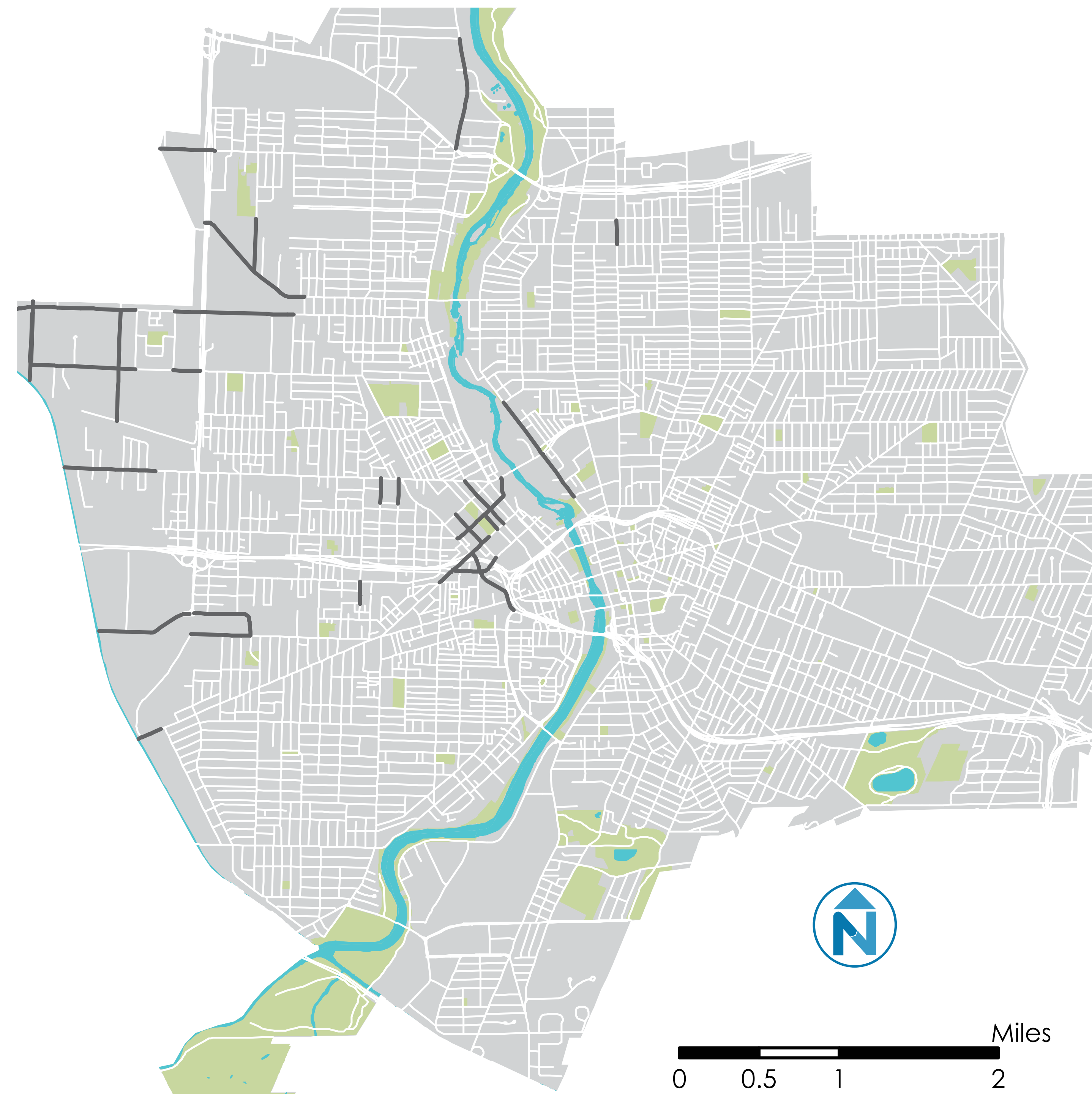
STREET TYPOLOGY ASSIGNMENT
NEIGHBORHOOD LINK



STREET TYPOLOGY ASSIGNMENT
NEIGHBORHOOD LOCAL



STREET TYPOLOGY ASSIGNMENT
INDUSTRIAL LINK



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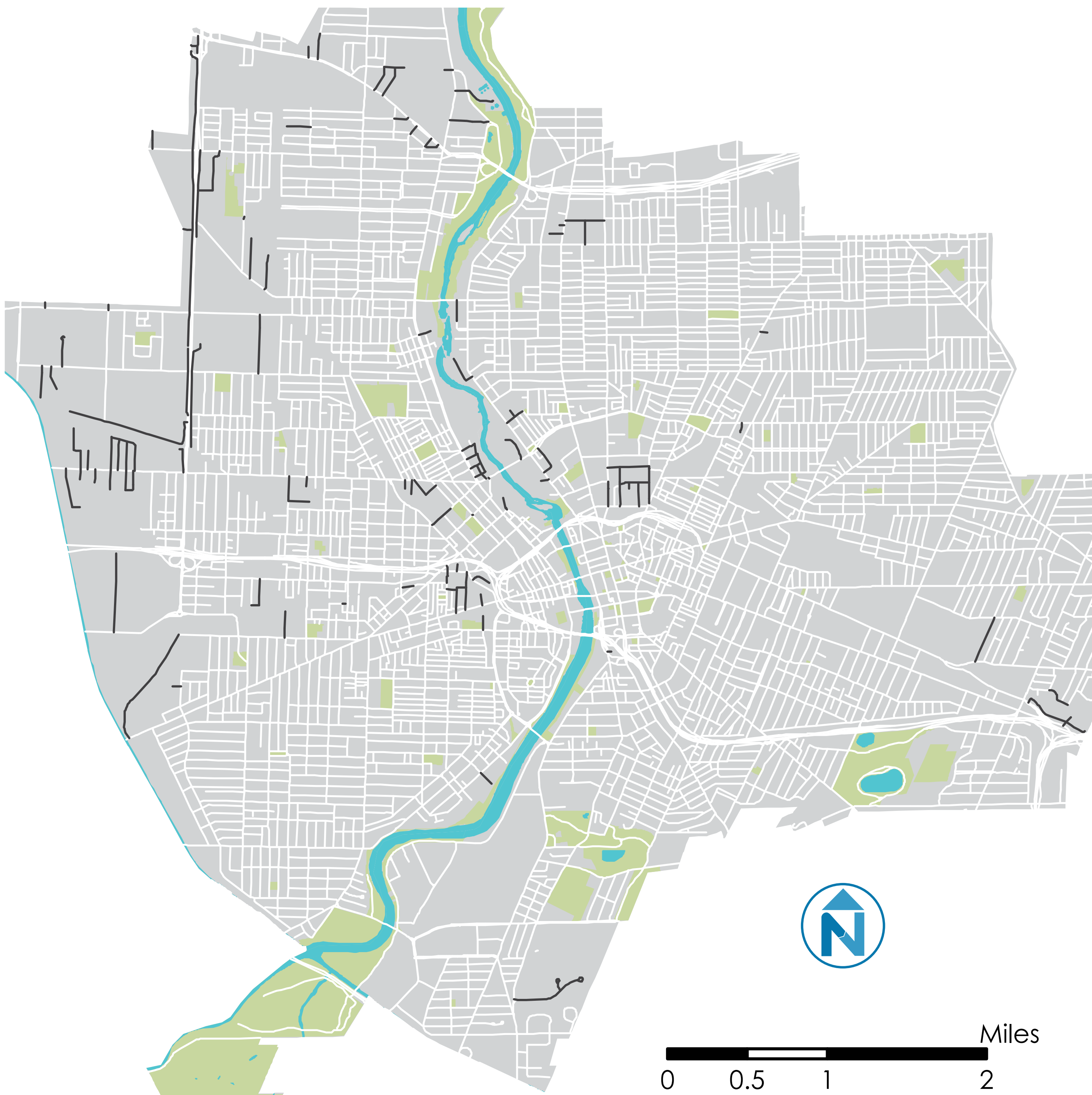
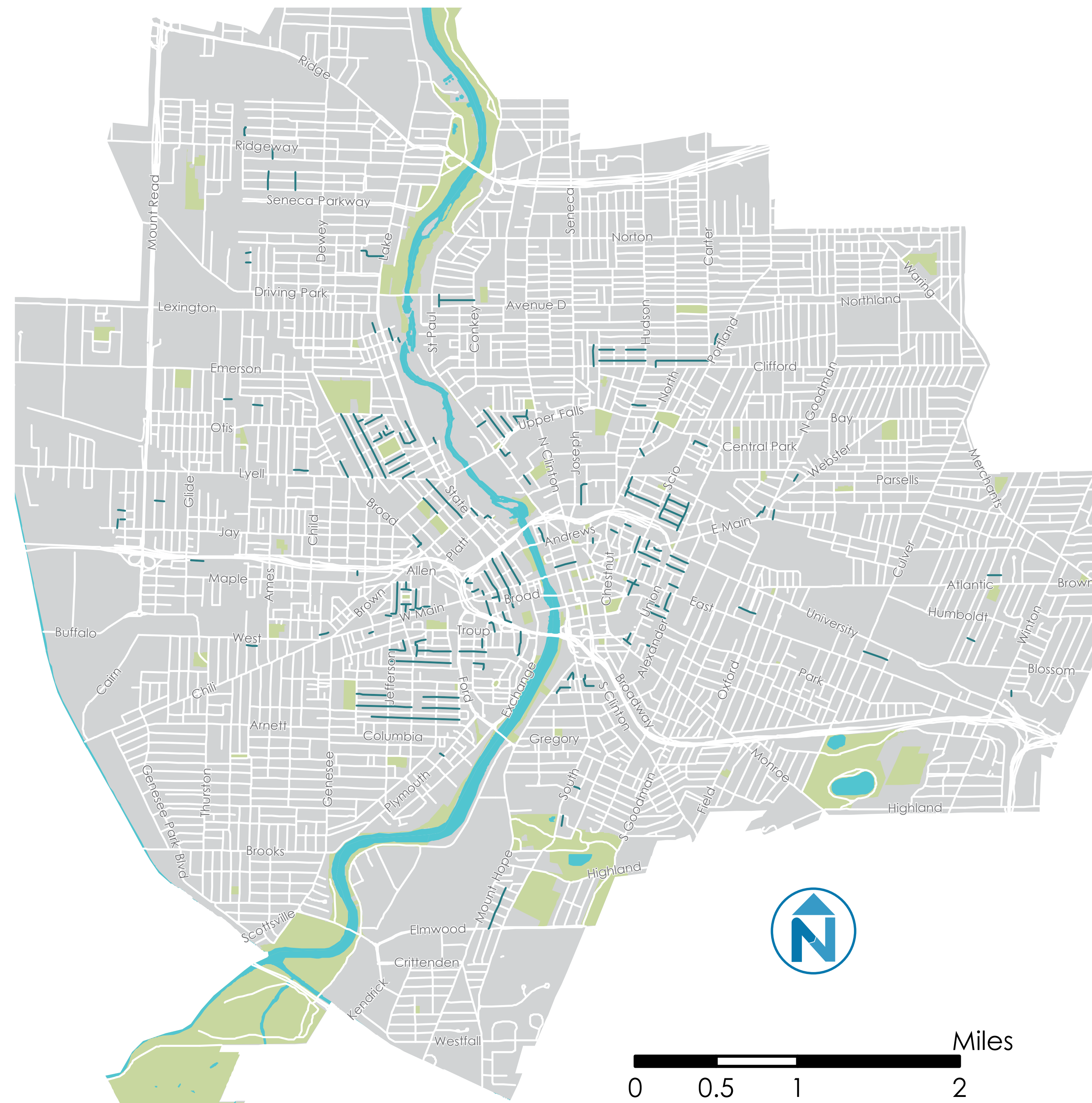
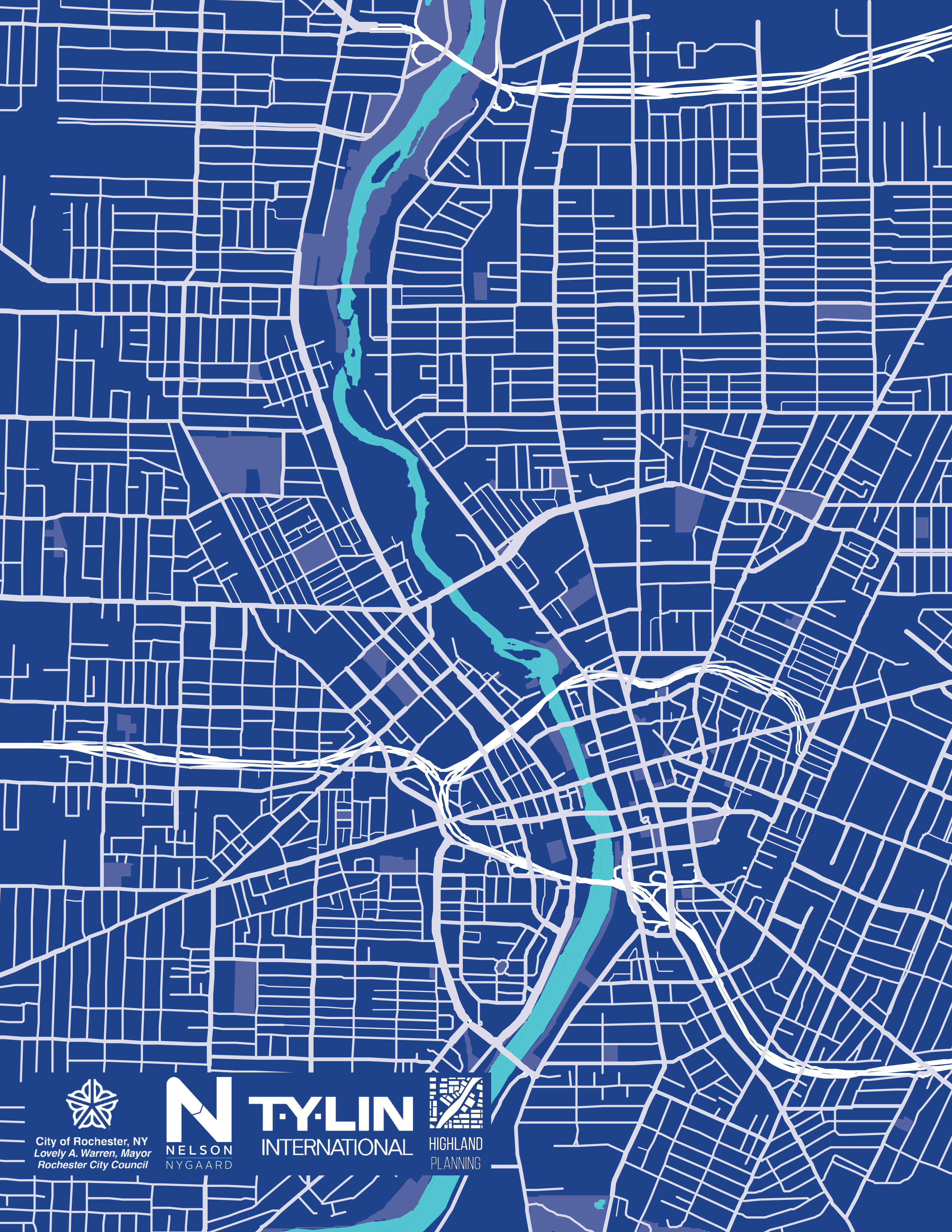
INDUSTRIAL LOCAL



STREET TYPOLOGY ASSIGNMENT
ALLEY





City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

NELSON
NYGAARD

T·Y·LIN
INTERNATIONAL

HIGHLAND
PLANNING