



CITY OF GRAND RAPIDS

**VITAL STREETS**

**DESIGN GUIDELINES**

**SEPTEMBER 2017**



**OVERVIEW ..... IV**

**DESIGN CONTROLS .....1-1**

- INTRODUCTION ..... 1-2
- DESIGN AND CONTROL VEHICLES ..... 1-17
- OPERATIONAL PERFORMANCE METRICS ..... 1-19
- PEAK PERIOD AND FORECAST YEAR ..... 1-26
- TRANSPORTATION DEMAND MANAGEMENT ..... 1-27

**DESIGN ELEMENTS .....2-1**

- ZONES OF THE STREET ..... 2-1
- STREET DIMENSIONS ..... 2-2
- FACILITY SELECTION ..... 2-2

**PEDESTRIAN ZONE ..... 2-5**

- SIDEWALK ..... 2-9
- SHARED USE PATH ..... 2-13
- STREET TREES & PLANTERS ..... 2-15
- STREET LIGHTING ..... 2-19
- SIDEWALK RAMPS ..... 2-21
- CROSSWALKS & MIDBLOCK CROSSINGS ..... 2-23
- PEDESTRIAN SIGNALS ..... 2-27
- PEDESTRIAN REFUGE ISLAND ..... 2-29
- DRIVEWAYS & CURBCUTS ..... 2-31
- SIDEWALK DINING & OUTDOOR MERCHANDISING ..... 2-33
- TRANSIT STOPS ..... 2-35
- WAYFINDING ..... 2-39
- PUBLIC SEATING ..... 2-41
- WASTE & RECYCLING RECEPTACLES ..... 2-43
- BICYCLE PARKING ..... 2-45
- BICYCLE REPAIR STATIONS ..... 2-47
- BICYCLE LOCKERS ..... 2-49
- BICYCLE PARKING STATIONS ..... 2-50
- BIKE SHARE STATIONS ..... 2-51

**STATIC ZONE ..... 2-53**

- ON-STREET PARKING ..... 2-54
- PARKING METERS ..... 2-58
- LOADING ZONES ..... 2-60
- ELECTRIC VEHICLE CHARGING STATIONS ..... 2-62
- BULB-OUTS ..... 2-63
- BUS BULBS ..... 2-66
- PARKLETS ..... 2-68
- BICYCLE PARKING CORRALS ..... 2-70
- PUBLIC ART ..... 2-72
- ALLEYS ..... 2-73
- BOLLARDS & OTHER FIXED OBJECTS ..... 2-75



# CONTENTS

<b>TRAVEL ZONE</b> .....	<b>2-76</b>
LANE WIDTHS .....	2-77
GENERAL TRAVEL LANES .....	2-79
TURN LANES .....	2-81
TIME RESTRICTED PARKING LANES .....	2-83
DEDICATED TRANSIT LANES .....	2-85
SHARED TRANSIT LANES .....	2-87
BUS QUEUE JUMP LANE .....	2-89
MEDIANS .....	2-91
SEPARATED BICYCLE FACILITIES .....	2-94
BUFFERED BICYCLE LANES .....	2-96
CONTRAFLOW BICYCLE LANE .....	2-98
CLIMBING BICYCLE LANES .....	2-100
CONVENTIONAL BICYCLE LANES .....	2-102
ADVISORY BICYCLE LANE .....	2-105
BIKE SHARED LANE MARKINGS .....	2-107
BICYCLE BOULEVARD .....	2-109
<b>TRAFFIC CALMING</b> .....	<b>2-111</b>
HORIZONTAL SPEED CONTROL MEASURES .....	2-113
VERTICAL CONTROL DEVICES .....	2-115
STREET STRIPING MODIFICATION .....	2-118
NEIGHBORHOOD ROUNDABOUT .....	2-120
VOLUME CONTROL DEVICES .....	2-122
<b>INTERSECTIONS</b> .....	<b>2-124</b>
PEDESTRIAN YIELD CONTROLS .....	2-126
STOP CONTROLS AT CROSSWALK .....	2-129
LEADING PEDESTRIAN INTERVAL .....	2-131
ROUNDABOUTS .....	2-133
RAISED INTERSECTION .....	2-136
BICYCLE FACILITIES AT INTERSECTIONS .....	2-138
BIKE BOXES .....	2-140
BICYCLE TRAFFIC SIGNALS .....	2-142
TWO-STAGE TURN QUEUE .....	2-144
<b>GREEN INFRASTRUCTURE</b> .....	<b>2-146</b>
CURB EXTENSION BIORETENTION .....	2-148
LINEAR BIORETENTION + MEDIAN BIOSWALES .....	2-150
STORMWATER PLANTER .....	2-152
LEACHING BASIN .....	2-154
FLEXIBLE POROUS PAVEMENT .....	2-156
<b>IMPLEMENTATION AND OVERSIGHT</b> .....	<b>3-1</b>
WHO: ROLES AND RESPONSIBILITIES .....	3-1
WHAT: VITAL STREETS PERFORMANCE METRICS .....	3-12
HOW: PROJECT INITIATION AND IMPLEMENTATION PROCESS .....	3-12
WHY: PERFORMANCE MONITORING .....	3-14
OPERATIONS AND MAINTENANCE .....	3-17
DEMONSTRATION PROJECTS .....	3-19

# OVERVIEW

Quality streets and effective transportation networks are critical to the health, safety, enjoyment, and economic strength of the Grand Rapids community and the preservation of the Grand River watershed. Grand Rapids defines Vital Streets as “complete streets with green infrastructure.” In 2014, city voters approved Vital Streets funding and made a bold commitment to improving the quality of city streets and providing equitable access and mobility for all people.

The Vital Streets Design Guidelines provide detailed information on street design considerations to assist street designers, members of the public, and city officials with ensuring the city’s streets meet Grand Rapids goals. The Guide includes three sections:

## **DESIGN CONTROLS**

Self-enforcing design is one of the objectives of the Vital Streets Plan. 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 as well as the desired and expected behavior of street users of all ages and abilities.

## **DESIGN ELEMENTS**

Street right-of-way is divided into different zones, each with its own design elements, operational goals, and users. This section provides detailed recommendations for the use, design, operations, and maintenance of the component parts of a street - everything from waste receptacles and street trees to separated bike lanes. Green infrastructure opportunities are highlighted throughout with a green leaf icon.

## IMPLEMENTATION AND OVERSIGHT

The final section of the Design Guidelines focuses on the projects needed to implement Vital Streets. It includes details on implementation and oversight responsibilities, along with project prioritization, development, and performance monitoring. A detailed equity analysis highlights areas with the greatest investment opportunities.



### SHARED USE PATH

Shared use paths—also called multiuse paths or sidepaths—are facilities shared by pedestrians, bicyclists, and other non-motorized users. These facilities are generally wider than typical sidewalks and are most suitable in areas that feature lower levels of concentrated pedestrian and business activity. Shared use paths are separated from vehicle travel lanes, providing a more comfortable experience for a wide range of non-motorized users.

**USE**

- Shared use paths are commonly used as recreational facilities along rivers, streams, and other waterways; adjacent to railroads or along utility corridors; or within parks and open space areas.
- Shared use paths are a viable solution on higher volume streets such as Cross Streets. Driveways, access streets, and intersections of conflict between vehicles and motorized travelers must be carefully designed to avoid conflicts between trail users and intersecting vehicular traffic to ensure safety.
- Shared use paths attract a wide range of users traveling at widely varied speeds—from people moving at a leisurely pace to bicyclists traveling at higher speeds. Care must be taken to minimize conflict between different user types through additional path width, signage, or design cues such as striping or separation.
- Shared use paths are further described in the 2017 Grand Rapids Parks and Recreation Strategic Master Plan. The Plan creates a vision for the long-term development, programming, and sustainability of Grand Rapids' parks, public open spaces, and recreation facilities.

**DESIGN**

- Shared use paths should not be immediately adjacent to vehicle travel lanes or curbside parking. A minimum pathway width of five feet is typically required, although more generous parkways are desired.
- Shared use paths must have a minimum, unobstructed width of 10 feet; 12-16 feet is preferred.
- Shared use paths with a higher intensity of use should consider separation of users—separating pedestrians from bicyclists and/or separating oncoming directional travel.
- Shared use paths should have less than a two percent cross slope to facilitate stormwater runoff and meet ADA requirements. As with sidewalks, grades greater than eight percent should be avoided to the extent possible.
- Drainage and/or stormwater infiltration facilities must be included to avoid ponding. Adjacent land uses cannot discharge stormwater onto trail facilities.
- Shared use paths should extend across driveways and be clearly marked and signed at street crossings.
- Shared use paths are commonly constructed of concrete and/or asphalt.
- Trail-oriented stop signs and/or bicycle or pedestrian signals may be advised in some instances.
- Shared use paths should provide logical connectors to the on-street community and commuter bicycle network and trail network.
- A vertical clear height of at least ten feet should be maintained over a shared use path.
- Motorized vehicles are not permitted on shared use paths except mobility devices for persons with disabilities like motorized wheelchairs and scooters.<sup>10</sup> In some cases, bollards or other barriers may be needed to prevent motorist access. However, shared use path designs should consider dimensions that facilitate snow removal, and provide access for sweeping maintenance and snow clearance vehicles.

**PERVIOUS PAVEMENT** such as porous concrete or asphalt. Flexible pavements are preferred for pervious pavement at street crossings to assist in the infiltration of rainwater into the stormwater network. It is effective at storing, infiltrating, and treating runoff from impervious surfaces. A variety of flexible porous pavements can be used, including concrete pavers, paving grids, pervious concrete, porous asphalt, porous rubberized asphalt, and glass porous paving.

**GREEN INFRASTRUCTURE** adjacent to shared use paths is an ideal opportunity for green infrastructure, such as a bioswale. Low impact design features should be designed to prevent pedestrians or bicyclists from inadvertently tripping or falling into the facility.

**High limbed street trees** contribute positively to the overall comfort and appeal of shared use paths and should be provided wherever possible. However, the distance of the trees from the edge of the trail is an important consideration to ensure adequate clearance.

**SPECIAL CONSIDERATIONS**

- Wayfinding is a strong complement to shared use paths. Wayfinding signs and maps are important elements to make available along

10 Michigan Road Use Act (SR) 195 Section 700B (bicycle or wheelchair) reads: in other motor vehicles or other motor vehicles, including wheelchairs, scooters, and other motor vehicles, shall be prohibited from using any shared use path or bicycle path.

**VITAL STREETS PLAN 2-13**

### SHARED USE PATH

**OPERATIONS AND MAINTENANCE**

- Shared use paths may or may not include striping and associated routine maintenance.
- Sweeping, debris removal including bulk dumping removal
- Pavement crack sealing
- Adjacent property owners, the city, or nearby businesses may be responsible for clearing snow and ice, and removing typical debris.
- Shared use paths should not be used for snow storage.
- Use of flexible porous pavements may require additional maintenance activities to maintain permeability.
- Sweeping to keep free of debris and hazards.

**REFERENCES**

- ASDOTO Guide for Pedestrian Facilities, 2002
- ASDOTO Guide for Bicycle Facilities, 2002
- Chapter 5, Division 1
- Federal Highway Administration
- [http://www.fhwa.dot.gov/transportation/bicycle\\_pedestrian/overview/](http://www.fhwa.dot.gov/transportation/bicycle_pedestrian/overview/)
- <http://www.transportation.gov/transportation>

**1**

**2**

**3**

**4**



2-14

- 1** The 'Use' section provides guidelines for when to include the design element on a street. The 'Design' section includes specific points to consider in the street design.
- 2** The green leaf icon indicates a green infrastructure special consideration.
- 3** References are citations and links for more technical information.
- 4** Most design elements have a diagram showing the location of the feature in red.

This document is a complement to the Vital Streets Plan, which outlines the goals and objectives of Vital Streets and presents a framework for street design that considers both transportation function and urban form. The Vital Streets Plan includes seven street types and modal emphasis corridors, along with performance targets for the city's streets.

Technical appendices to the Design Guidelines provide additional background and details. These are:

- » Glossary of Terms
- » Street Cross Sections
- » Best Practices Technical Memo
- » Gap Analysis Technical Memo
- » Mobile GR Technical Memo
- » Bicycle Master Plan



# DESIGN CONTROLS

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**Two key principles drive the design of Vital Streets in Grand Rapids:**



**ALL STREETS SHOULD BE SAFE  
AND ACCESSIBLE FOR ALL USERS.**



**STREETS SHOULD BE LOGICAL  
AND INTUITIVE TO USE.**

These two principles go hand in hand. The design of a street shapes how people use it, how fast they travel on it, and who else they expect to encounter on it. How motor vehicles operate on the street is a major component of how safe a street is, with slower generally being safer for all road users.

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**Self-enforcing design** is one of the objectives of the Vital Streets Plan. 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 guides travelers to naturally “do the right thing” when using the street. This improves safety for all users and serves the objectives and desired outcomes of Vital Streets.

Street design is determined through 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. Some controlling factors cannot be determined through policy—such as street topography or climatic factors—however, several factors can be determined through policy and controlled through design choices.

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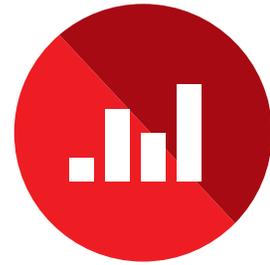
The most significant and relevant design choices and controls to Grand Rapids are:



**VEHICLE DESIGN SPEED**



**DESIGN AND CONTROL  
VEHICLE**



**OPERATIONAL  
PERFORMANCE  
METRICS**



**PEAK PERIOD AND  
FORECAST YEAR**



**ALL TYPES OF USERS  
AND EXPERIENCES**

## SELF-ENFORCING DESIGN

Whether we realize it or not, much of our behavior on a street is influenced by the environmental cues we get from the design of the street itself.

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 awareness of peripheral vision 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.

Stated simply, wide, flat roads make people feel like they should drive faster, while they intuitively sense that slower speeds are appropriate when streets are narrow and enclosed.

Traffic control officers, including the Michigan State Police, point out that 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. This ensures that Vital Streets deliver street designs that allow drivers to intuitively understand the "reasonable and proper" travel speed. It also supports the larger objectives of street operation and community context without over-reliance on posted regulatory signs or other 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 enforcement personnel. Street design communicates to drivers equitably and in a common language, without profiling and without bias against individual drivers.

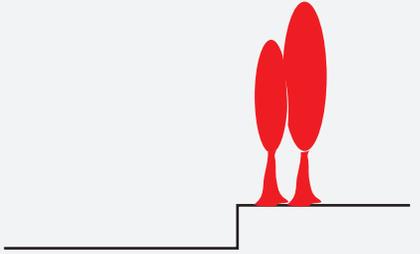
**A number of different techniques are employed in creating self-enforcing or self-regulating streets. Among the most effective are:**



**TRAVEL LANE WIDTHS**



**TURNING RADII**



**STREET EDGE FEATURES**



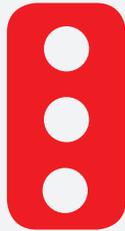
**LINE OF SIGHT**



**SPEED MANAGEMENT, SUCH AS HORIZONTAL OR VERTICAL DEFLECTION FEATURES**



**PRESENCE OF MULTIPLE MODES OF TRANSPORTATION**



**SIGNALS**



**PROGRESSION SPEED**



**INTERSECTION CONTROLS (ROUNDBOUTS)**



**NUMBER OF LANES**

## DESIGN SPEED

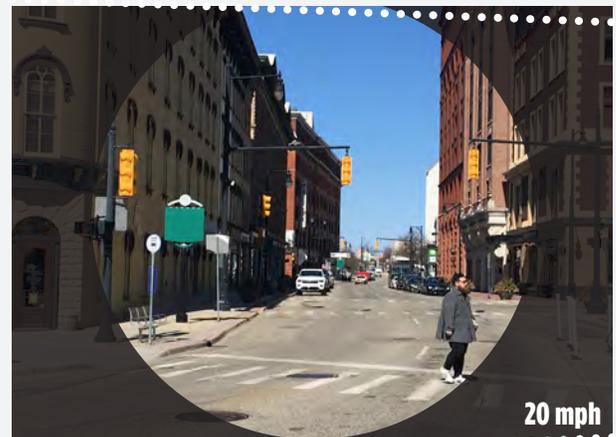
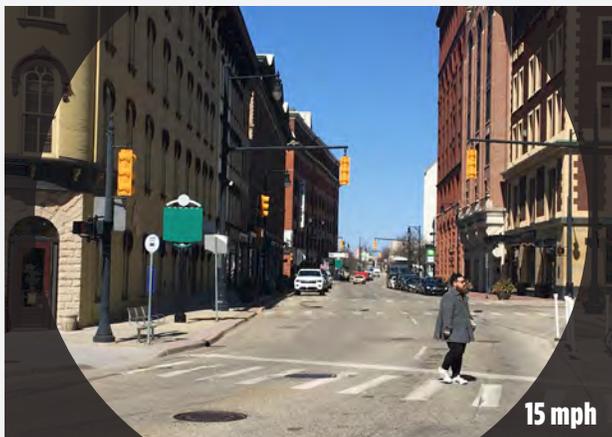
### WHY SPEED MATTERS

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 rates should a crash occur.

## PERIPHERAL AWARENESS

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 afford more attention to activities occurring along the street edge, such as crossing pedestrians and school children or animals playing in front yards. Particularly for older drivers, this allows a higher margin of error. 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. For example, a pedestrian crossing the street or a driver emerging from a vehicle parked on-street.

FIGURE 1 SIGHT DISTANCE AT DIFFERENT SPEEDS



## STOPPING DISTANCE AND CRASH SURVIVAL RATES

Motor vehicles are heavy; transit vehicles and freight delivery trucks are heavier. By their nature, heavy objects traveling at even moderate rates of speed possess tremendous momentum, cause severe damage, and exert exponentially greater force than 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, vehicles cannot due to their size and weight. The faster vehicles are moving, the more time and distance they require to reduce the force of their potential impact.

For example, a typical passenger car traveling at just 20 MPH covers 29 feet per second. Assuming that a driver can perceive a danger and respond in as little as 1.5 seconds, the vehicle will have already travelled 44 feet at speed before the driver brakes. Using a standard deceleration rate of 15 feet per second, it will take another 1 second and 19

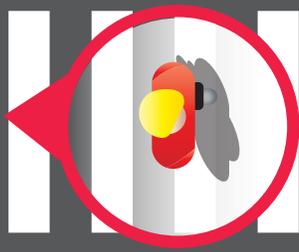
feet for the vehicle to stop, traveling a total of 63 feet in the 2.5 seconds it took to perceive, respond, and stop. At 30 MPH, it will also take 2.5 seconds, but the vehicle will cover 109 feet of ground. At 40 MPH, the vehicle will stop in under 3 seconds, but will have traveled 164 feet.<sup>1</sup>

This means that if an object, such as a pedestrian, suddenly appears 75 feet (or nearly 4 car lengths) 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 before striking—thus drastically increasing the risk of death and severe injury.<sup>2</sup>

1 "Vehicle Stopping Distance and Time." National Association of City Transportation Officials. [http://nacto.org/docs/usdg/vehicle\\_stopping\\_distance\\_and\\_time\\_upenn.pdf](http://nacto.org/docs/usdg/vehicle_stopping_distance_and_time_upenn.pdf) Accessed September 2016.

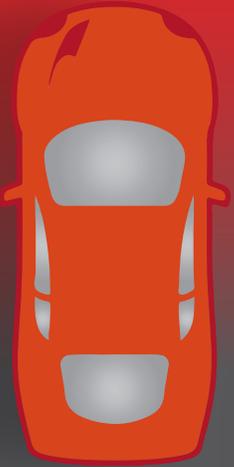
2 Impact Speed and a Pedestrian's Risk of Severe Injury or Death, AAA Foundation for Traffic Safety, September 2011, pg 12" and W.A. Leaf and D.F. Preusser. "Literature Review on Vehicle Travel Speeds and Pedestrian Injuries Among Selected Racial/Ethnic Groups." National Highway Traffic Safety Administration, U.S. Department of Transportation. October 1999. Figure 1. <http://www.nhtsa.gov/people/injury/research/pub/hs809012.html> Accessed September 2016.





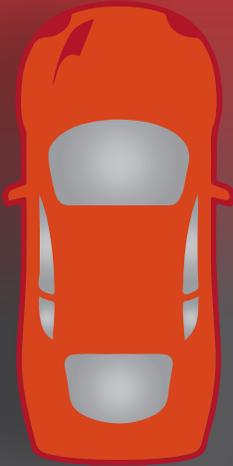
**20**  
MPH

**19'**  
TO STOP



**30**  
MPH

**43'**  
TO STOP



**40**  
MPH

**76'**  
TO STOP

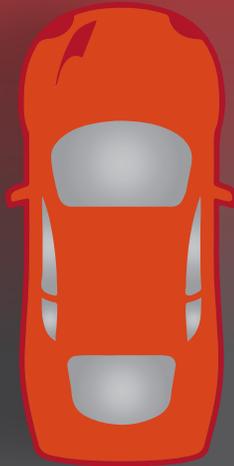
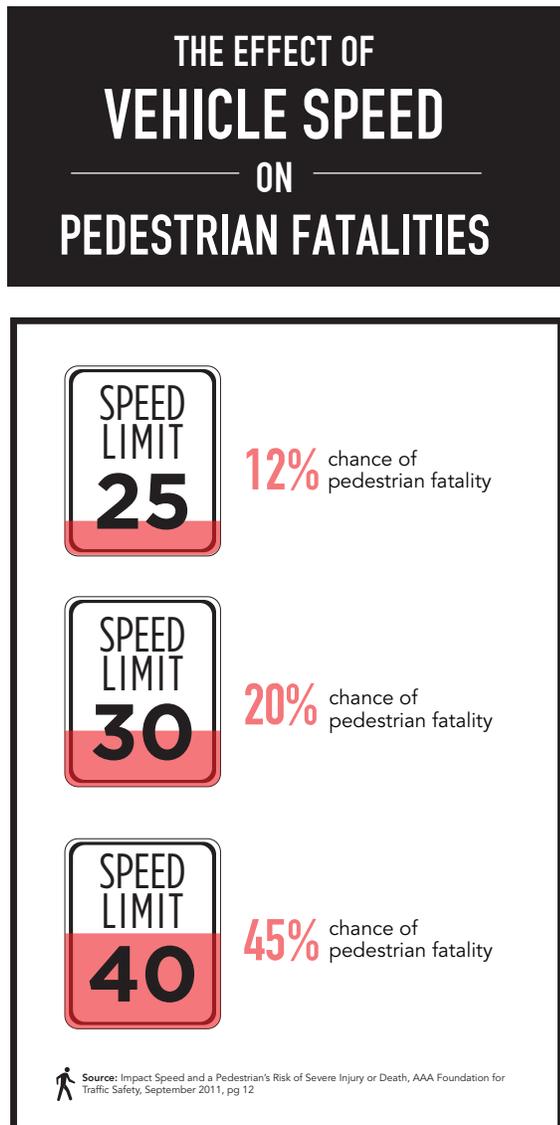


FIGURE 2 STOPPING DISTANCE AT DIFFERENT SPEEDS

FIGURE 3 THE EFFECT OF VEHICLE SPEED ON PEDESTRIAN FATALITIES

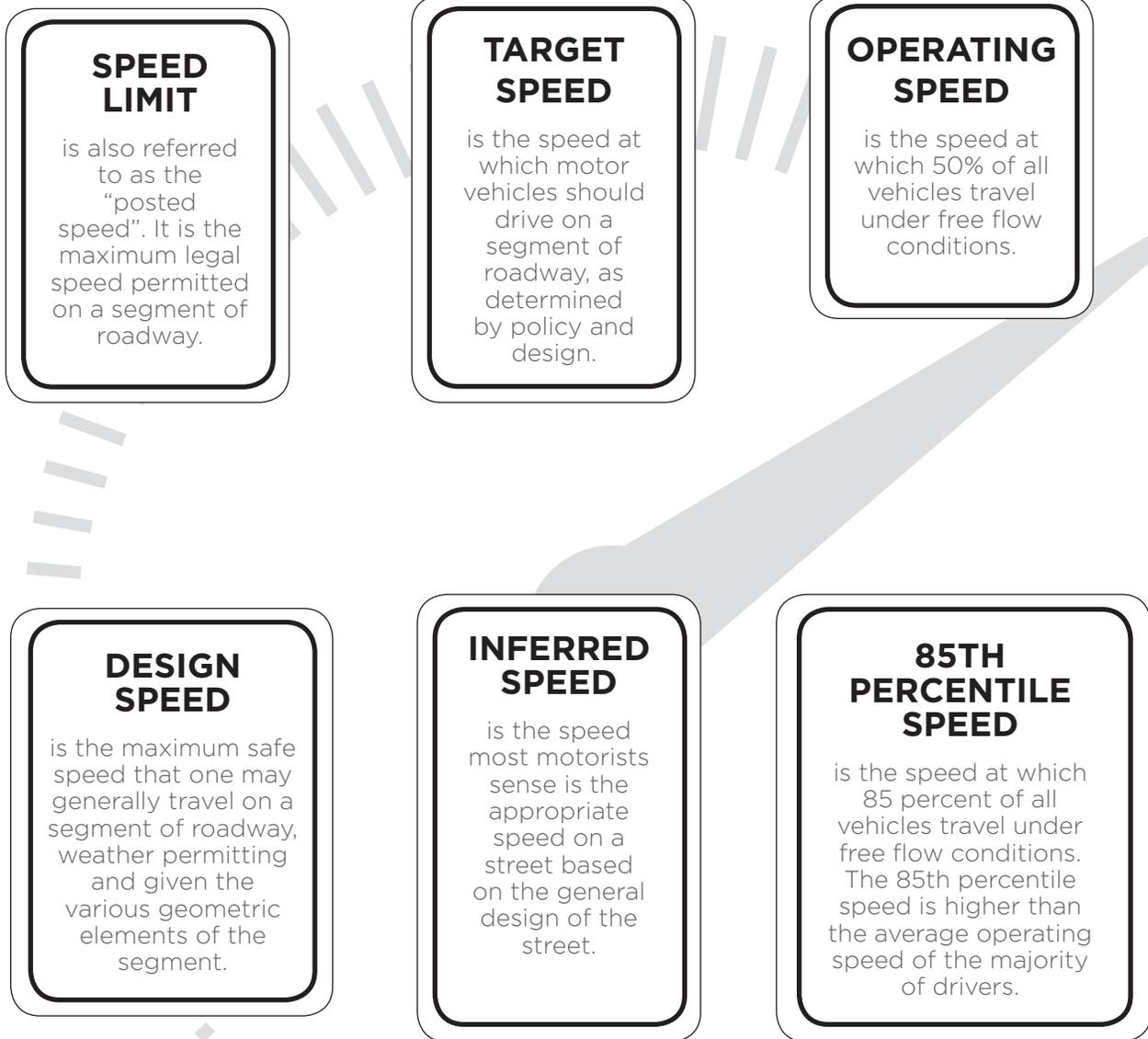


Street designers can anticipate and plan for known occasions that require a vehicle to stop, such as at intersections or crossings. However, they must also be cognizant of the potential consequences of unanticipated events when stopping distance cannot always be adequately provided or accommodated. In these instances, vehicles traveling at higher rates of speed will travel further and/or strike with greater force, too often resulting in death or serious injury.

Street design that intrinsically guides drivers to operate at speeds consistent with desired safety outcomes, and in harmony with expected community uses, can preserve human life. Moreover, encouraging people to travel at lower speeds can prevent not only traffic fatalities, but also serious injuries.

## DEFINING AND DETERMINING SPEED

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



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. It is no wonder then that the operating speed is often well in excess of the legally posted speed limit and 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 very design of the street must instruct drivers as to the appropriate speed.

Rather than focusing on the maximum legal speed permitted, street designers must focus on the target speed and deliver a street that produces an identical operating speed. This requires that the street is designed in such a way that the drivers can infer the proper speed from the sensations and cues of 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 must converge to produce an identical operating speed at or below the legal speed limit which will capture 85 percent of all vehicles traveling under free-flowing traffic conditions.

FIGURE 4 BALANCING SPEEDS IN STREET DESIGN

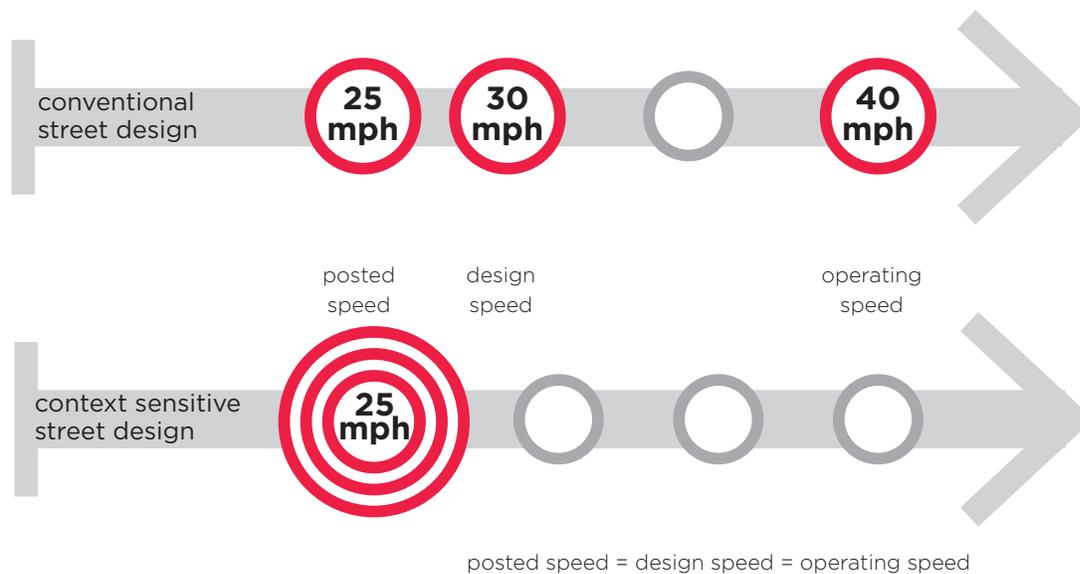
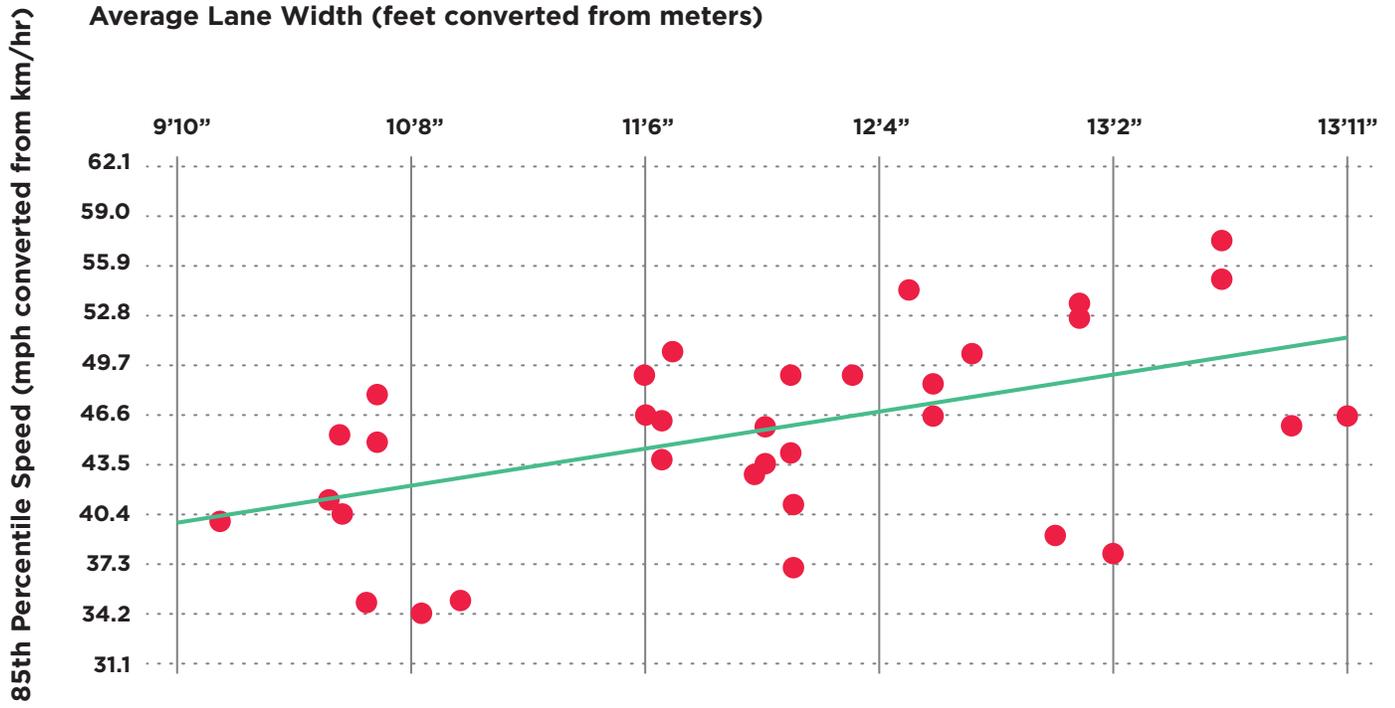


FIGURE 5 WIDE TRAVEL LANES ARE CORRELATED WITH HIGHER VEHICLE SPEEDS



As the width of the lane increased, the speed on the roadway increased...When lane widths are 1 m (3.3 ft) greater, speeds are predicted to be 15 km/h (9.4 mph) faster.

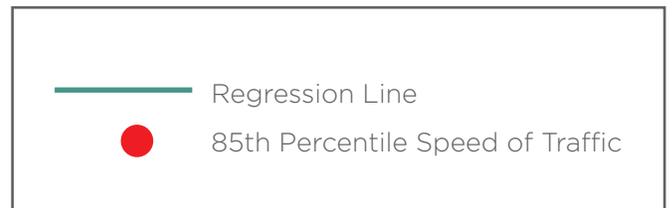


Chart source: Fitzpatrick, Kay, Paul Carlson, Marcus Brewer, and Mark Wooldrige, 2000. "Design Factors That Affect Driver Speed on Suburban Streets." Transportation Research Record 1751:18-25.

## SELF-REGULATING TECHNIQUES TO MANAGE SPEED

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 AND MARKINGS

While many factors influence driver speed, wider lanes correlate with higher travel speeds, while narrower lanes contribute to slower driving speeds.<sup>1</sup> Narrow travel lanes have a positive effect on the overall safety outcomes of the street and reduce vehicle crash rates.

In addition, research in Michigan specifically concludes that narrower, 10- or 11-foot travel lanes are no less safe than wider, 12-foot lanes: "There is no indication that the use of 3.0 or 3.3 m (10- or 11-ft lanes) rather than 3.6 m (12-ft) lanes, for arterial midblock segments leads to increases in accident frequency. There are situations in which use of narrower lanes may provide benefits in traffic operations, pedestrian safety, and/or reduced interference with surrounding development."<sup>2</sup>

There is no consistent, statistically significant relationship between lane width and safety for midblock sections...There is no indication that the use of 3.0 or 3.3 m (10- or 11-ft lanes), rather than 3.6 m (12-ft) lanes, for arterial midblock segments leads to increases in accident frequency. There are situations in which use of narrower lanes may provide benefits in traffic operations, pedestrian safety, and/or reduced interference with surrounding development.<sup>3</sup>

- 1 Kay Fitzpatrick, Paul Carlson, Marcus Brewer, Mark Wooldridge. "Design Factors That Affect Driver Speed on Suburban Arterials." FHWA/TX-00/1769-3. Texas Department of Transportation, Austin, 2001. <http://trjjournalonline.trb.org/doi/abs/10.3141/1751-03?journalCode=trr> Accessed September 2016.
- 2 Ingrid Potts, Douglas Harwood, Karen Richard. "Relationship of Lane Width to Safety for Urban and Suburban Arterials." Midwest Research Institute. Transportation Research Board

- 3 Annual Meeting. 2007. <https://www.smartgrowthamerica.org/app/legacy/documents/cs/resources/lanewidth-safety.pdf> Accessed September 2016.



10-foot wide travel lanes accommodate the majority of vehicles using urban streets while maintaining a narrower street profile that supports speed management objectives. Streets with frequent transit services or significant volumes of truck traffic (8% or more heavy vehicles) may require an 11-foot lane to accommodate these vehicles. On multi-lane streets, this lane should be closest to the curb. All other lanes should maintain the minimum width. In some instances, travel lanes as narrow as 9- to 9.5-feet are acceptable.

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.

Somewhat related to the discussion of lane width is the concept of unmarked facilities and driver uncertainty. Simply put, this is the notion that when users are provided a clearly marked and designated facility—be it a bike lane, a crosswalk, or a vehicle travel lane—they feel entitled to this space. Some places—notably a number of communities in Germany and elsewhere in Europe—have removed lane designations and intersection traffic controls entirely. In such an uncertain and undesignated environment, travelers tend to operate with more caution and greater awareness of other users. While this may not be appropriate for widespread practice throughout Grand Rapids, it is the concept that generally supports the slow speed environments on shared and Link Residential streets.

### **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 lower 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 that deserve consideration:

- » Effective corner radius
- » Actual corner radius

The effective corner radius is the turning radius a vehicle can track without encroaching on or over the curb. Curbside parking or bicycle facilities along the edge of the street increase the effective corner radius of an intersection. Curb extensions decrease it. The smaller the turning radius, the lower the vehicle turning speed and better the pedestrian visibility.

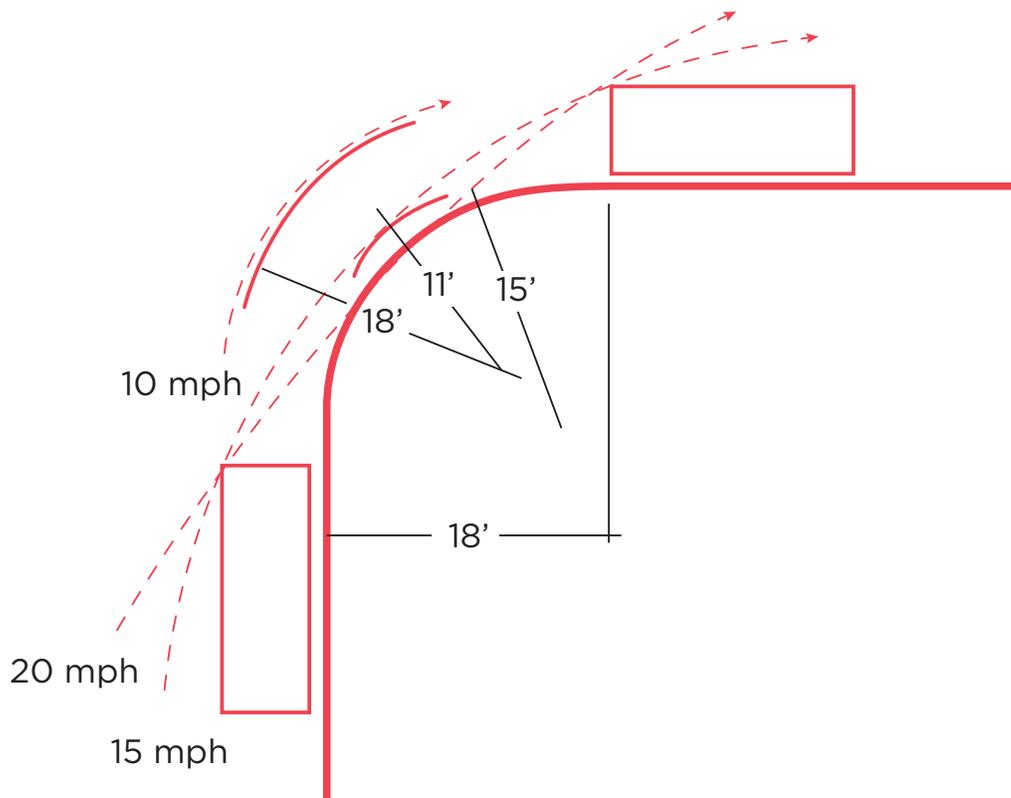
The actual corner radius is the actual built edge of the curb. The smaller the corner radius, the shorter the crossing distances and the better the pedestrian visibility.

In general, the effective corner radii are larger than the actual corner radii.

Street designers should use the smallest practical actual corner radius as possible that preserves an effective curb radius appropriate to the design control vehicle(s) and the overall objectives of the street. Grand Rapids' typical radius is 25 feet. An actual corner radius of 5 to 15 feet and effective radius of 15 to 25 feet is generally preferred for intersections without a substantial volume of larger turning vehicles, such as neighborhood residential streets. At locations with a significant number of turning trucks or buses, an effective corner radius of 25 to 35 feet may be necessary. A 35-foot effective corner radius is generally the maximum required to accommodate most vehicles at a 90-degree intersection.

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 onto the curb area if and when required to slowly navigate a turn, taking into consideration the skew of the intersection, on-street parking, and utility poles and boxes. Sometimes the design vehicle is a pedestrian; smaller radii should be the default when additional queuing space is needed or where there is an expectation that the design control should be people with mobility impairments. Larger curb radii, in combination with diagonal access ramps, can leave people entering a motor vehicle travel lane as the first part of their crossing.

**FIGURE 6 EFFECTIVE CORNER TURNING 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 hugs the corner.

## ACTIVITIES ALONG THE STREET EDGE

While the evidence supporting the relationship between driver speed and edge conditions is still in its infancy, it is hypothesized that the activities of the street edge have a strong effect on the driver. Active uses that generate interest and activity on the street edge draw driver attention and slow driver speed.

A growing body of research has found that vertical elements such as street trees have positive implications for safety performance and outcomes. Planted medians not only narrow the visual appearance of the roadway but also bring street edge elements closer to the driver on both sides. They further support the intent of self-regulating design that produces a driver response in line with target travel speeds. These buffers also increase pedestrian comfort walking across and along roads and improve safety by narrowing the focus of the driver, causing them to slow down.

Conventional street design tries to remove any fixed objects—such as trees or light poles—from alongside the street in order to provide a clear zone in case a driver loses control of their car. In doing so, however, the street environment lacks visual markers to give the driver a sense of their travel speed, which inadvertently encourages them to drive faster. Self-regulating design creates a lively street environment that increases driver experience an awareness of their travel speeds, enabling drivers to intuitively travel at speeds appropriate to the street context.

The common toolkit of traffic calming devices (see Traffic Calming section of Design Elements chapter) are generally considered the principal techniques for speed management. Such devices include bulb-outs, neighborhood traffic circles, diverter islands, speed humps, raised intersections, and the like. However, most traffic calming features are installed retroactively in response to observed speeding or other non-compliant behavior on a street. Streets designed with self-enforcing design generally do not need to have additional traffic calming added as they already manage speeds through context. The aim of traffic calming is to create self-enforcing design, which reduces or eliminates the need for traditional calming devices such as speed humps.



# DESIGN AND CONTROL VEHICLES

## DESIGN VEHICLE: DESIGNING FOR DOMINANT USERS

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 deliver on the commitment of safe and easily navigable streets for all, Vital Streets design in Grand Rapids uses two “Design Vehicles”:

- 1. MOTOR VEHICLES THAT COMPRISE 10% OR MORE OF THE TYPICAL VOLUME OF TRAFFIC DURING THE PEAK HOUR.**
- 2. THE HUMAN AS A “DESIGN VEHICLE”.**

For most local or link streets, the motorized design vehicle will be a passenger car. On more significant corridors (Network Residential, Neighborhood Business, and Urban Center), 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 target speed without impeding the operation of other designated lanes or encroaching into the pedestrian zone at intersections and corners.

Regardless of the motorized design vehicle, streets must also provide for the safe navigation of pedestrians of all ages and abilities. This can be done by selecting a human “design vehicle” to a user representative of a broad segment of other likely street users. This human “design vehicle” is selected as a user representative of a broad segment of other likely street users. For example, using 13-year old unaccompanied pedestrian 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 largely safe and accessible to the majority of other non-motorized users, including the very old and the very young. Older adults, for example, have slower reaction times and the increasing prevalence of smartphones means there are more distracted drivers.

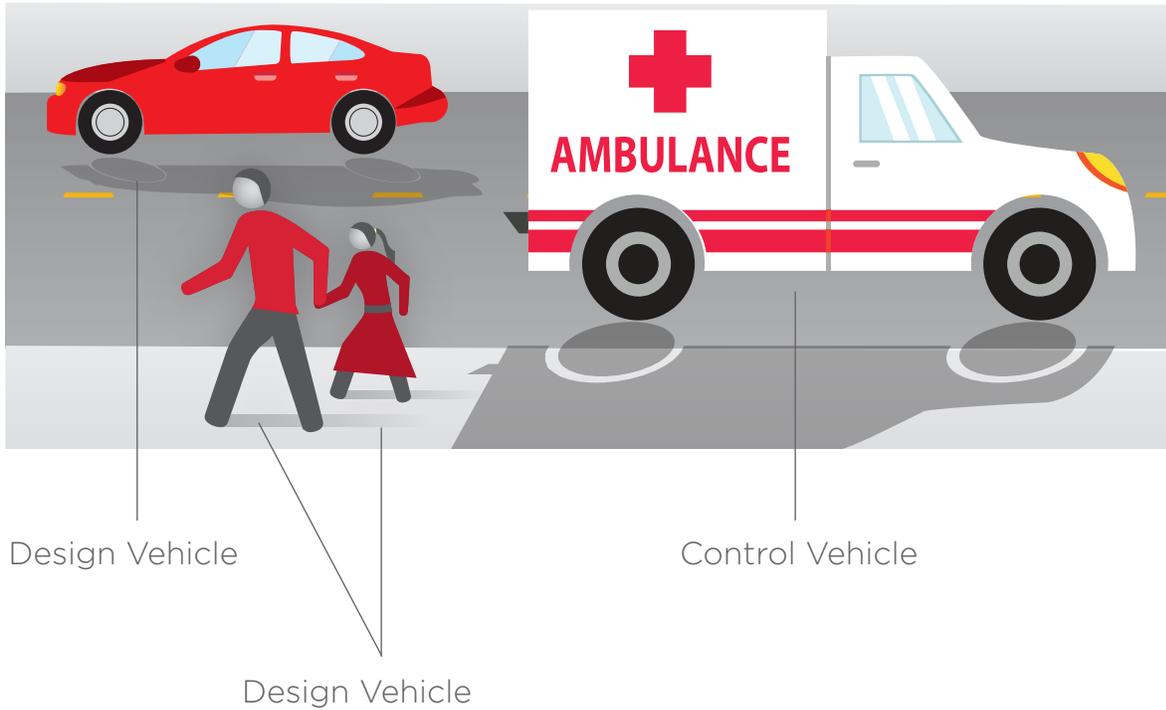
This is a bold and radically different approach to application of the design vehicle control. Considering both motorized and human design vehicles yields street design that enables the safe circulation and operation of motor vehicles, without compromising the safety and accessibility of non-motorized users with whom they share the street.

## CONTROL VEHICLE: ACCOMMODATING OCCASIONAL OR EPISODIC USERS

Control vehicles are vehicles that may use a street facility on occasion. Because these vehicles are not a regular presence on the street, it is acceptable that they may require other street users to make operational adjustments in order to accommodate them.

Common control vehicles may include trash trucks, emergency vehicles, diverted municipal buses, larger trucks, or construction vehicles.

These vehicles must be accommodated in street design; accommodation that requires encroachment into adjacent or opposing travel lanes, static zone, multi-point turns, or minor encroachment into the pedestrian zone at corners is acceptable.



# OPERATIONAL PERFORMANCE METRICS

## 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.

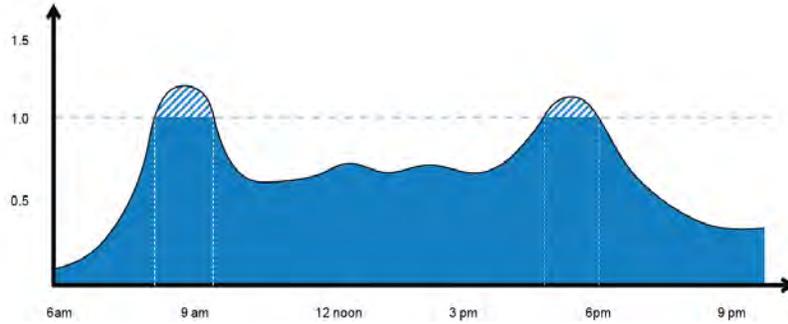
The letter assignments are reminiscent of school grading where most students aspire to get straight As, and Ds and Es are typically undesired or unacceptable. In contrast, vehicle LOS at the higher end of the spectrum (A - C) indicate surplus or unused capacity while Ds and Es indicate full use of operational capacity.

LOS is strictly an evaluation of the free movement of motor vehicles. In complex and dynamic urban areas, stopped transit vehicles or pedestrians in crosswalks can degrade vehicle level of service but are precisely the kinds of activities and users Vital Streets seek to support and encourage. LOS does not reflect the street's performance for pedestrians, bicyclists, or other non-drivers, or drivers who are searching for parking, turning into a driveway, or otherwise not driving through.

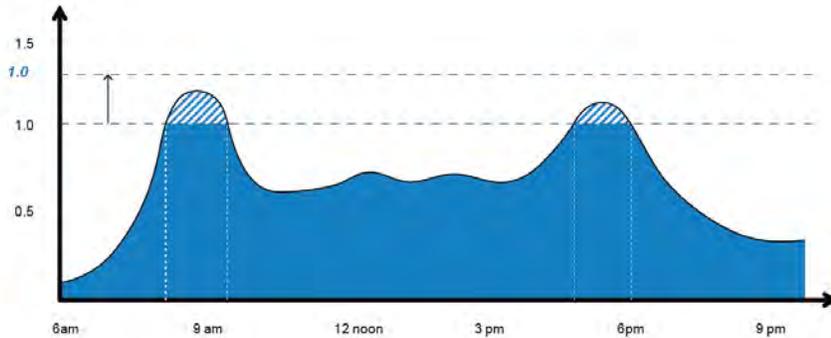
LOS generally describes conditions during the “worst of the worst”—the peak hour or even peak 15 minutes of the busiest day. It presumes that a whole street design must change to solve for any level of congestion above a set amount during a short period of the day. Seeking to achieve a LOS A results in increasing the number of travel lanes, increasing speeds, and wider rights of way—extra capacity that could be used for development, open space, or other productive uses. Instead, the goal should be to seek alternative ways to satisfy this travel need either in a different mode, along an alternative route, or at another period of the day when surplus capacity is available. These actions describe the goals of transportation demand management, described in further detail on the following pages.

The following graphics illustrate how LOS works.

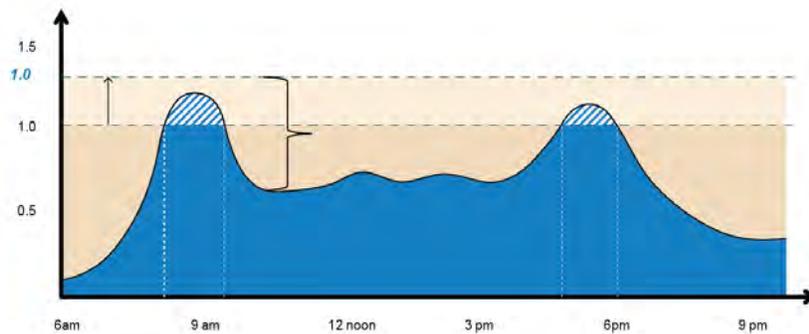
First, travel demand is spread throughout the course of the day, with more people traveling during the morning and evening peak periods. During peaks, roads can be congested above their capacity, represented by the dashed lines.



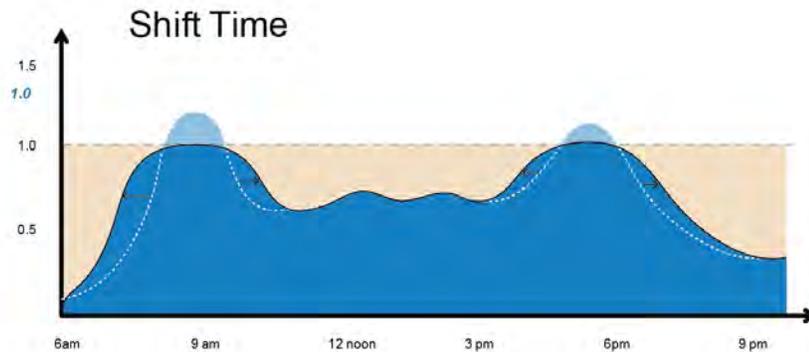
A city can respond to this congestion by expanding the roadway capacity and building more roads to handle the peak period of traffic. This is shown here by increasing the dashed line.



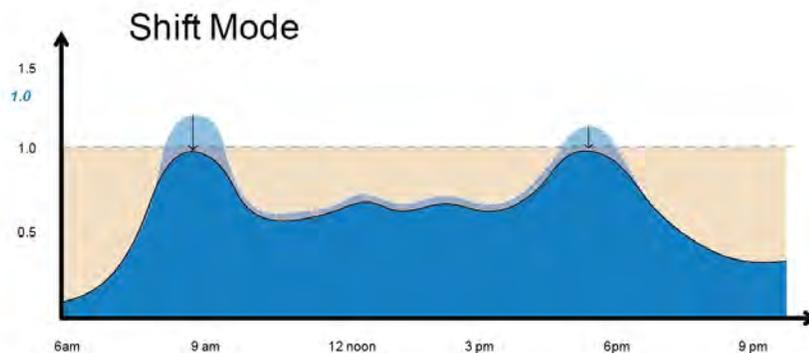
However, while this may reduce the delay for drivers during the peak periods, it also increases the amount of land devoted to roads, land which could have been used for parks, schools, open space, or housing. This is shown as wasted space in yellow below.



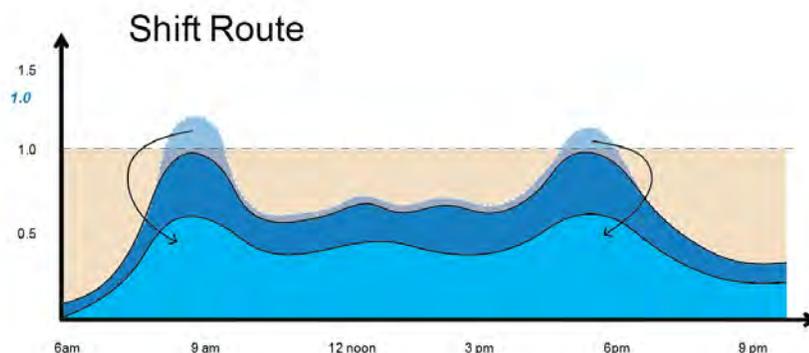
As an alternative, a city can shift some of the travel during the peak periods to reduce the number of cars on the road. This can be done by encouraging drivers to travel at other times; and/or



Encouraging people to travel using other modes of transportation, such as walking, biking, or using transit which reduces the number of cars on the road during the peak times; and/or



Encouraging people to drive on non-congested streets by utilizing the street grid more efficiently.



These techniques are called Transportation Demand Management (TDM).

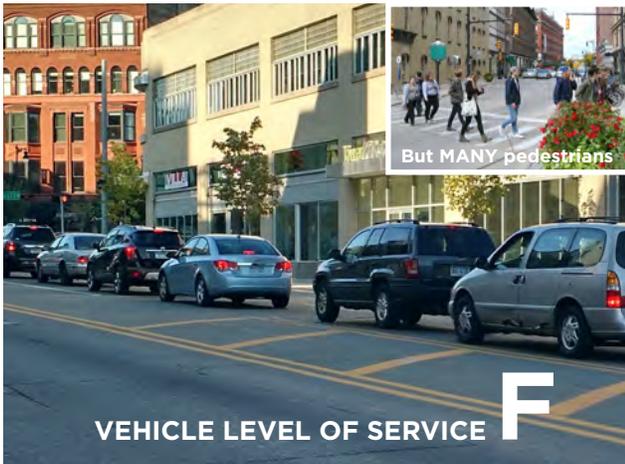
Vehicle LOS often has an inverse relationship to economic vitality, quality of life, and healthy communities. High LOS grades are common in areas that do not attract a number of visitors or host limited activity while vibrant, dynamic areas that attract a number of users have lower vehicle levels of service. In other words, LOS measures places that vehicles move through, not where people linger.

Finally, LOS assigns the same importance to all vehicles regardless of the number of travelers they are transporting. In vehicle LOS, the same weight is given to a single-occupant vehicle as a city bus carrying 30 passengers. In this calculation, the delay experienced by each passenger on the bus is 1/30th as important as the delay experienced by a single driver.

LOS can also present an incomplete picture of the value or impact of a street enhancement. LOS is commonly calculated for each major intersection. While one intersection may increase delay of vehicles

at that intersection, travel time through the whole of the improved segment may remain unchanged. Thus it would be inappropriate to assume that a degradation of level of service at one point translates into an actual degradation in performance for travelers along a corridor.

Lastly, LOS measures are only evaluated when there is a change such as an additional development, reconfiguration of an intersection, or reallocation of street right of way. The implication of the LOS evaluation then is that this last action is singularly responsible for the change in level of service. In reality, LOS is the product and responsibility of all investments and activities in the network, regardless of when they first occurred.



## ALTERNATIVE PERFORMANCE EVALUATION MEASURES

Cities, states, and municipal departments throughout the country 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 Vital Streets. No single measure alone should be used, but when used in concert with one another, these measures provide valuable insight for street design.

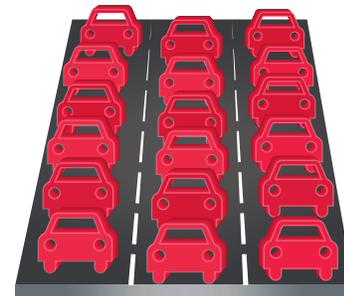
### PERSON THROUGHPUT/PERSON CAPACITY

Person throughput is the number of all travelers, regardless of mode, accommodated through a particular cordon (or count location) on a corridor. Unlike vehicle LOS, person throughput values all people equally and weighs the impacts to each the same.

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 the reality 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 vehicle travel, thereby optimizing available right of way space for the greatest number of travelers.

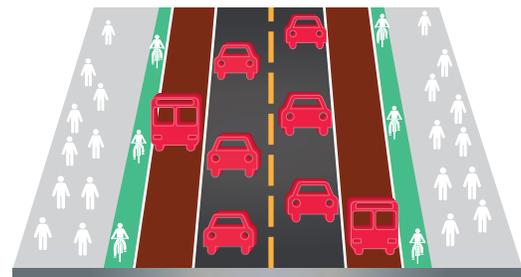
FIGURE 7: MOVING CARS VS. MOVING PEOPLE

### MOVING CARS



**28.4 PEOPLE**  
PER BLOCK

### MOVING PEOPLE



**125 PEOPLE**  
PER BLOCK

A city block is assumed to be 40 feet curb to curb and 300 feet long. The space needs for pedestrians and vehicles are based on 'Evaluating Transportation Land Use Impacts,' by the Victoria Transport Policy Institute (2014). The average number of passengers per automobile is 1.6 based on the National Household Travel Survey (2009). Buses were assumed to carry 45 people.

## 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 to evaluate and prioritize investments in infrastructure. They measure thirty indicators of pedestrian and bicycle environmental quality at both the segment and intersection levels, including safety, traffic, street design, land use, and perceived safety. The department has made the index available for general use and provides technical assistance in its application. While valuable measures, especially when considered alongside vehicle LOS, the index must be adapted and tailored for use in Grand Rapids' environment and context.

### MODE SHARE

Mode share is the percentage distribution of how people commute to work (drive alone, carpool, public transit, bicycle, on foot, work from home, or other). 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.

While mode share can be calculated after a project improvement through travel surveys or direct observational studies, forecasting mode share—or bicycle or pedestrian demands—is an imperfect science at best. Using empirical data from numerous studies nationwide, Grand Rapids can draw logical and defensible conclusions that achieving the bold mode share targets the city has adopted will require that streets provide connected, accessible, and inviting pedestrian facilities; efficient, safe, and logical bicycle infrastructure; and regular, rapid, and reliable transit services with quality stops and amenities.

Vital Streets in Grand Rapids will contribute to the city's commitment to reduce single-occupant vehicle travel to 50% and work toward achieving a 45% drive-alone rate by 2035.



FIGURE 8 MODE SHARE TARGETS

MODE	2013 MODE SHARE	COMMITTED TARGET (2035)	LONG TERM GOAL
Transit	1 - 2%	5 - 10%	20%
Walk	3 - 5%	10%	12%
Bike	0.2%	2%	5%
Carpool/Rideshare	-	15%	20%
Single-Occupancy Vehicle (SOV)	95%	70%	45%

Source: Vital Streets Plan adopted by the City Commission, December 2016



# PEAK PERIOD AND FORECAST YEAR

A number of other controls are also considered in street design. These too are worthy of conscious reevaluation and critical thought. These include:

## PEAK PERIOD

Street design is often focused on accommodating travel demands at the busiest hour of the busiest day. While this is logical, it can easily result in oversized facilities that are underused most hours of the day. This can have unintended negative consequences for both capital and maintenance costs as well as challenge operations and enforcement. Whenever possible, street designers and public policies should encourage the spreading of the peak to take advantage of existing unused capacity available at other times of the day.

## FORECAST YEAR

Street design often attempts to anticipate and accommodate projections of future traffic generation. In many instances this becomes a self-fulfilling prophecy where street design invites (or “induces”) additional traffic volumes. Reliability of traffic forecasts is generally low, and most great U.S. cities were planned and built long before the introduction of modern traffic forecasting methods and remain great places to this day. Today, we have the added complication of a highly dynamic transportation future where innovations in mobility introduce even greater uncertainty to future traffic demand forecasts. In general, it is recommended that street designers build to the future they desire rather than the future they fear.

# TRANSPORTATION DEMAND MANAGEMENT

Complete street design is closely tied to Transportation Demand Management (TDM). A very basic definition of the TDM concept is a pursuit of more desirable demand and supply conditions, within individual or cumulative transportation networks, through policies and practices that influence the timing, intensity, and mode share of travel demand peaks. The most common and frequent conditions targeted by TDM efforts are the morning and afternoon peaks in commute travel which are the primary source of “gridlock” conditions on local roads and regional highways. TDM can also be a very effective way to reduce constraints in developed areas where right of way is constrained, areas experiencing rapid growth in population or employment, and within downtown parking systems.

Vital Streets implementation can increase the effectiveness of TDM in Grand Rapids by improving the functionality and viability of transit, bicycling, and walking. In return, implementing TDM measures can facilitate Vital Streets project implementation. Combined into an iterative series of improvements, Vital Streets and TDM can continually optimize Grand Rapids’ mobility networks for all users.

With sustained and effective implementation, TDM is key to reduce the amount of right-of-way necessary to accommodate peak parking demand and personal-vehicle traffic volumes. By providing tools to bring more optimal balance to supply and demand conditions, TDM can create capacity for curbside designs and regulations that accommodate non-driving modes and functions.



# DESIGN ELEMENTS

## ZONES OF THE STREET

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 Vital Streets Guidelines identifies three conceptual 'zones' that can make up the right of way of the street.

### TRAVEL ZONE

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

### 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.

### PEDESTRIAN ZONE

Also called the Sidewalk Zone, the Zone is the portion of the street between the curb line and the property line. This area is comprised of three areas. The Frontage Zone transitions to the public realm from buildings and private development space; the Through Zone provides adequate space for pedestrians to travel, and the Amenity Zone both buffers pedestrians from the travel area and provides space for streetscaping and amenities.



## **STREET DIMENSIONS**

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 each zone are shown here. Some of these zones or elements (such as transit lanes) may not be present on all streets; dimensions are to be used as applicable and feasible. Best engineering design and judgment should be used to balance between different zones of the street.

## **FACILITY SELECTION**

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 may need to increase or decrease to improve user comfort and/or when used in conjunction with other elements.

MINIMUM STREET DIMENSION TABLE

	Neighborhood Residential	Link Residential	Network Residential	Neighborhood Business	Maker/Industrial	Crosstown Connector	Urban Center
<b>PEDESTRIAN ZONE</b>	Shy zone			<b>2'</b>	<b>4'</b>		<b>2'</b>
	Sidewalk clear zone	<b>5'</b>	<b>6'</b>	<b>6'</b>	<b>10'</b>	<b>6'</b>	<b>10'</b>
	Landscape strip (trees and/or grass)	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>10'</b>
	Shared Use Path (Sidepath)		<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>
	Parkway	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>8'</b>	<b>10'</b>
	Sidewalk cafes and vending				<b>10'</b>		<b>10'</b>
	Curb extension	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>
<b>STATIC ZONE</b>	Bus shelters		<b>4.5'</b>	<b>4.5'</b>	<b>4.5'</b>	<b>4.5'</b>	<b>4.5'</b>
	Bus Bulbs		<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>
	On-street parking and loading	<b>8'</b>	<b>8'</b>	<b>8'</b>	<b>8'</b>	<b>8'</b>	<b>8'</b>
	Parkettes and Platform Dining				<b>6'</b>		<b>6'</b>
	Bicycle corrals				<b>6'</b>		<b>6'</b>
<b>TRAVELWAY</b>	Shared lanes	<b>11'</b>	<b>11'</b>	<b>11'</b>	<b>11'</b>	<b>11'</b>	<b>11'</b>
	Vehicle lanes	<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>
	Dedicated Transit Lanes			<b>12'</b>	<b>12'</b>	<b>12'</b>	<b>12'</b>
	Shared street	<b>20'</b>					<b>20'</b>
	Bicycle lane		<b>5'</b>	<b>5'</b>	<b>5'</b>	<b>5'</b>	<b>5'</b>
	Contraflow bicycle lane		<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>	<b>6'</b>
	Protected bicycle lane/cycle track		<b>8'</b>	<b>8'</b>	<b>8'</b>	<b>8'</b>	<b>8'</b>
	Two-way cycle track		<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>
	Transit queue jump lane			<b>12'</b>	<b>12'</b>	<b>12'</b>	<b>12'</b>
	Center/Right/Left turn lanes		<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>
	Median		<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>	<b>10'</b>





# SIDEWALK

Strictly speaking, the sidewalk is the paved portion of the overall street right-of-way intended to provide for pedestrian through travel. For that reason, and to avoid confusion, in this guide the term “sidewalk” is used only to refer to the **through zone** of the pedestrian zone. It is important to remember that the entire pedestrian zone (which is sometimes referred to as the “sidewalk”) includes the frontage zone and parkway zone, in addition to the sidewalk through zone.

Access and movement for people of all ages and abilities is critical in sidewalk design. Sidewalks must permit the unimpeded travel of individuals walking and those using mobility assistance devices year round.

Sidewalks contribute to the social environment of the city and should be designed to comfortably accommodate two people walking abreast and still permit the passing of one individual in the oncoming direction.

## USE

- Sidewalks are needed on every street in the city. The one exception is specifically designed and managed shared streets with low volumes of vehicle traffic where pedestrians may safely and comfortably mix with the range of other street users (such as on very low volume Neighborhood Residential streets in modern neighborhoods).
- Sidewalks should be provided on both sides of the street—this is particularly true on commercial streets (Neighborhood Business and Urban Center), streets with higher volumes of auto traffic (Network Residential and Crosstown Connector), and streets with transit service or industrial uses (Maker/Industrial Streets). Explicit justification is needed when sidewalks are provided on only one side of the street.
- The effective width, and the dimension that should be used to calculate sidewalk width, is established by drawing a straight line parallel to the curb along the inner edge of any and all obstacles in the Frontage Zone of the street and any and all obstacles in the Parkway Zone.
- Pedestrians are the priority users of the sidewalk. Bicycling on the sidewalk is prohibited in downtown<sup>3</sup> and should generally be discouraged elsewhere because of the different travel

<sup>3</sup> - Grand Rapids Municipal Code Article 8, Sec. 10.132. - Sidewalks, Bicycle Lanes and Bicycle Trails.

characteristics of people walking versus bicycling. The provision of low stress community bicycle facilities can reduce bicyclist use of sidewalks.

- Some bicyclists, especially children and those uncomfortable with riding in the street, choose to ride on sidewalks. However, since sidewalks are designed for walking speeds, people who choose to ride on sidewalks must maintain a low rate of speed and exercise caution around people walking, provide generous space when passing pedestrians, always yield to pedestrian movements, and be aware of potential safety conflicts with motor vehicles, especially when crossing driveways, alleys, and intersections.
- Motor vehicles, including motorcycles or motor scooters, are prohibited on sidewalks.<sup>4</sup> Drivers crossing the sidewalk at driveways and alleys and at crosswalks at intersections must yield to people walking and/or bicycling.<sup>5</sup>
- Vehicle Parking and loading/unloading shall not occur within or across a sidewalk.

4 [Michigan Legislature: Michigan Vehicle Code \(Public Act 300 of 1949, as amended\)](#)

5 [Michigan Legislature: Michigan Vehicle Code \(Public Act 300 of 1949, as amended\)](#)

## DESIGN

- Sidewalks should be continuous throughout the city and connected across streets with marked or unmarked crosswalks.
- Accessible curb ramps must be provided at every legal crossing, unless there are safety considerations due to the intersection operations or configuration.
- Sidewalks should have a minimum clear, unobstructed width of five feet in residential areas or six feet in all other areas, except in areas with design constraints, where a minimum of four feet would be permissible.
- Sidewalks should be appropriately scaled to anticipated pedestrian volumes. Narrow sidewalks with high pedestrian volumes lead to crowding and discomfort. Wide sidewalks with few pedestrians feel desolate and empty.
- Sidewalks must have adequate cross slope to facilitate stormwater runoff, but not so great as to introduce a noticeable and uncomfortable slope to sidewalk users (typically less than two percent).<sup>6</sup>
- Sidewalks should be designed with the minimal grade practical given street topography. Grades greater than 8 percent should be avoided to the extent possible.<sup>7</sup>

6 United States Access Board. Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way. 36 CFR Part 1190. Cross Slope (R302.6) <https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/proposed-rights-of-way-guidelines/chapter-r3-technical-requirements>

7 United States Access Board. Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way. 36 CFR Part 1190.



- Sidewalks are to continue at grade across driveways, alleys and service drives. Sidewalk materials should continue through these crossings to indicate the priority of the pedestrian zone.
  - Sidewalks should be constructed of concrete. Brick or alternative materials may be used upon approval by city staff and completion of a maintenance agreement. Materials should be consistent, at a minimum, along an entire block face, and consistent materials should be used throughout a distinct district.
  - The sidewalk surface must be firm, stable, smooth, slip-resistant, well-maintained, and free of tripping hazards. The sidewalk zone should have a consistent material along the entire block face. Coursing is discouraged and should be avoided, as it frequently has settlement issues.
  - Objects hanging over the sidewalk, such as signs, banners, planter boxes or baskets, or other features must provide at least seven feet of clear vertical height, or have an encroachment permit. In areas where it is legal to ride on the sidewalk, clearance should accommodate bicyclists operating height of 8.3 feet.
  - Sidewalks and the adjacent parkways are typically separated from vehicular travel with a raised curb. Shared streets, also known as woonerfs or home zone streets, are the exception. Shared streets are very slow speed, low volume streets that do not provide a distinct zone for pedestrians, static activities, or vehicular travel—all uses mix together and share the space equally.
  - Sidewalks should be level with building entrances. Where they are not, curb ramps compliant with the Americans with Disabilities Act (ADA) should be provided either outside the right-of-way or within the frontage zone.
  - Planters may be used in the frontage zone to keep pedestrians away from door and driveway openings.
  - Whenever possible, sidewalks should not be immediately adjacent to travel lanes. Sidewalks are more comfortable when buffered from moving traffic by parked cars and parkway space.
  - Sidewalks should be appropriately lit. Pedestrian oriented lighting is desired in areas with significant pedestrian use. Pedestrian crossings should always be well lit.
-  Sidewalks may utilize flexible porous pavements with maintenance agreements in place. Flexible porous pavement allows stormwater to pass through the pavement to a stone storage layer beneath. The water then either infiltrates into the soil or flows through an underdrain to the storm drain network. It is effective in storing, infiltrating, and treating runoff from impervious surfaces. A variety of flexible porous pavements exist, including concrete pavers, paving grids, pervious concrete, porous asphalt, porous rubberized asphalt, and glass porous paving.



 Parkway are ideal for the infiltration of sidewalk stormwater runoff through green infrastructure. If unimproved, the parkway can infiltrate the runoff from the sidewalk. If improved with bioswales and in the right soils, parkways adjacent to the road can take runoff from the street too, not just the sidewalk.

### SPECIAL CONSIDERATIONS

- Sidewalk materials and patterns may vary in certain districts of the city per locally adopted streetscape plans or with city approval. Sidewalk materials and designs should not vary property by property.
- Continuous safe and accessible pedestrian walkways should be maintained even in areas of construction. Maintenance of traffic plans should address pedestrian connections and minimize repeated pedestrian crossings to navigate construction zones.

### OPERATIONS AND MAINTENANCE

- Sidewalks must be kept clear of snow and ice and should never be used for snow storage.
- Property owners are responsible for the day to day clearing of sidewalks from snow, ice, and other debris to maintain a clear and accessible path of travel.<sup>8</sup>
- The City is responsible for general sidewalk maintenance and construction.
- Continuous, safe and accessible pedestrian walkways should be maintained even in areas of construction.<sup>9</sup>

### REFERENCES

- United States Access Board. Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way. Published in the Federal Register on July 26, 2011. 36 CFR Part 1190. <https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/proposed-rights-of-way-guidelines>



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<sup>8</sup> Grand Rapids Municipal Code. Chapter 58. Article 3. Snow and Ice Removal and Article 7. Cleaning Sidewalks.

<sup>9</sup> Grand Rapids Municipal Code. Chapter 58. Article 4. Obstructing Streets. [https://www.municode.com/library/mn/grand\\_rapids/codes/code\\_of\\_ordinances?nodeld=COOR\\_CH58STSIOTPUPL\\_ARTIINGE\\_S58-4OBST](https://www.municode.com/library/mn/grand_rapids/codes/code_of_ordinances?nodeld=COOR_CH58STSIOTPUPL_ARTIINGE_S58-4OBST)



# SHARED USE PATH

Shared use paths—also called multiuse paths or sidepaths—are facilities shared by pedestrians, bicyclists, and other non-motorized users. These facilities are generally wider than typical sidewalks and are most suitable in areas that feature lower levels of concentrated pedestrian and business activity. Shared use paths are separated from vehicle travel lanes, providing a more comfortable experience for a wide range of non-motorized users.

## USE

- Shared use paths are commonly used as recreational facilities along rivers, streams, and other waterways; adjacent to railways or along utility corridors; or within parks and open space areas.
- Shared use paths may be a viable solution on higher volume or higher speed streets, such as Crosstown Connector. Driveways, access streets, and other points of conflict between vehicles and non-motorized travelers must be severely limited and carefully designed to reduce conflicts between trail users and intersecting vehicular traffic to ensure safety.
- Shared use paths attract a wide range of users traveling at widely varied speeds—from people moving at a leisurely pace to bicyclists traveling at higher speeds. Care must be taken to minimize conflict between different user types through additional path width, signage, or design cues such as striping or separation.
- Shared use paths are further described in the 2017 Grand Rapids Parks and Recreation Strategic Master Plan. The Plan creates a vision for the long-term development, programming, and sustainability of Grand Rapids' parks, public open spaces, and recreation facilities.

## DESIGN

- Shared use paths should not be immediately adjacent to vehicle travel lanes or curbside parking. A minimum parkway width of five feet is typically required, although more generous parkways are desired.
- Shared use paths must have a minimum, unobstructed width of 10 feet; 12-16 feet is preferred.
- Shared use paths with a higher intensity of use should consider separation of users—separating pedestrians from bicyclists and/or separating oncoming directional travel.
- Shared use paths should have less than a two percent cross slope to facilitate stormwater runoff and meet ADA requirements. As with sidewalks, grades greater than eight percent should be avoided to the extent possible.
- Drainage and/or stormwater infiltration facilities must be included to avoid ponding. Adjacent land uses cannot discharge stormwater onto trail facilities.
- Shared use paths should extend across driveways and be clearly marked and signed at street crossings.
- Shared use paths are commonly constructed of concrete and/or asphalt.
- Trail-oriented stop signs and/or bicycle or pedestrian signals may be advised in some instances.
- Shared use paths should provide logical connections to the on-street community and commuter bicycle network and trail networks.
- A vertical clear height of at least ten feet should be maintained over a shared use path.
- Motorized vehicles are not permitted on shared use paths except mobility devices for persons with disabilities like motorized

## SHARED USE PATH

wheelchairs and scooters.<sup>10</sup> In some cases, bollards or other barriers may be needed to prevent motorized access. However, shared use path designs should consider dimensions that facilitate snow removal, and provide access for sweeping maintenance and snow clearance vehicles.

• Pervious materials, such as porous concrete or asphalt, can be considered for trail pavement. Flexible porous pavement allows stormwater to pass through the pavement to a stone storage layer beneath. The water then either infiltrates into the soil or flows through an underdrain to the storm drain network. It is effective in storing, infiltrating, and treating runoff from impervious surfaces. A variety of flexible porous pavements can be used, including concrete pavers, paving grids, pervious concrete, porous asphalt, porous rubberized asphalt, and glass porous paving.

• Given the limited number of crossing points, the parkway adjacent to shared use paths is an ideal opportunity for green infrastructure, such as a bioswale. Low impact design features should be designed to prevent pedestrians or bicyclists from inadvertently tripping or falling into the facility.

• High limbed street trees contribute positively to the overall comfort and appeal of shared use paths and should be provided wherever possible. However, the distance of the trees from the edge of the trail is an important consideration to ensure adequate clearance.

## SPECIAL CONSIDERATIONS

- Wayfinding is a strong complement to shared use paths. Wayfinding signs and maps are important elements to make available along

<sup>10</sup> Michigan Penal Code. Act 328 of 1931. Section 750.419 Operating or riding motorcycle; moped, or other motor vehicle on bicycle path or sidewalk; misdemeanor; exception. [http://www.legislature.mi.gov/\(S\(4tjdb0u5w4pwm10ckjagqauc\)\)/mileg.aspx?page=getObject&objectName=mcl-750-419](http://www.legislature.mi.gov/(S(4tjdb0u5w4pwm10ckjagqauc))/mileg.aspx?page=getObject&objectName=mcl-750-419)

trail facilities, at trailheads, and as resource materials so residents and visitors can more easily utilize the on-and off-street nonmotorized transportation network. A coordinated wayfinding system within the City and throughout the region should be developed and implemented.

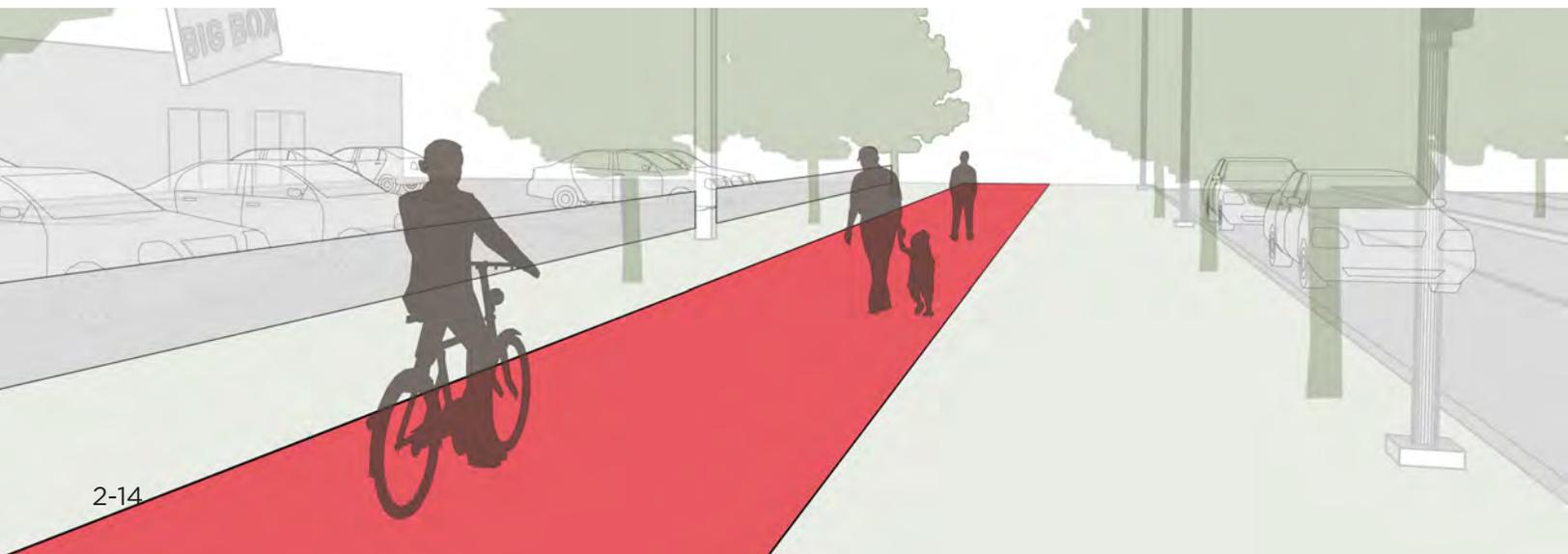
- Designers may consider providing layby areas of seating or bicycle parking. These areas should be offset from the shared use path and should not constrain the clear width of the path.
- In some instances, shared use paths do not need to be paved; however, the surface of the trail should still be firm and stable and well drained.

## OPERATIONS AND MAINTENANCE

- Shared use paths may or may not include striping and associated routine maintenance.
- Sweeping, debris removal including bulk dumping removal
- Pavement crack sealing
- Adjacent property owners, the city, or nearby businesses may be responsible for clearing snow and ice, and removing typical debris.
- Shared use paths should not be used for snow storage.
- Use of flexible porous pavements may require additional maintenance activities to maintain permeability.
- Sweeping to keep free of debris and hazards.

## REFERENCES

- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2012
  - Section 3.2.14: Off-Road and Shared-Use Paths
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Chapter 5: Design of Shared Use Paths
- Federal Highway Administration.
  - [https://www.fhwa.dot.gov/environment/bicycle\\_pedestrian/resources/design\\_nonmotor/shared/index3.cfm#s22](https://www.fhwa.dot.gov/environment/bicycle_pedestrian/resources/design_nonmotor/shared/index3.cfm#s22)





# STREET TREES & PLANTERS

Great cities have great street trees. Street trees contribute to the character of both residential and commercial streets. They provide shade and reduce heat in summer, offer visual interest in winter, and help manage stormwater.

Mature trees provide significant stormwater quantity and rate control benefits through soil storage, interception, and evapotranspiration. A tree with a 25-foot diameter canopy can hold the 1-inch, 24-hour storm event from 2,400 square feet of impervious surface. Interception and evapotranspiration also decrease runoff volume with larger trees providing exponentially more benefit than smaller trees.

Grand Rapids has a goal to achieve 40% tree canopy in the city.

## USE

- Street trees should be included on every street, whenever possible. They are particularly important on residential, Neighborhood Business, Crosstown Connector, and Urban Center streets. Trees are required on all street projects unless an exception is allowed due to technical constraints or other site limitations.
- Trees are most important in the Parkway Zone and help to define the consistent edge of the street.
- Street trees are important in high pedestrian traffic areas and in high

impervious areas in order to provide a cooler micro-climate and more hospitable pedestrian environment. However, trees should be protected from substantial pedestrian traffic that may compact their roots.

- Street trees can be incorporated into the static zone of the street, particularly in vegetated green infrastructure facilities such as Curb Extension Bioretention, Linear Bioretention & Median Swales, or Stormwater Planters, as well as plaza spaces through the use of tree grates or landscape planters.
- Trees should not be placed in the clear vision area outlined in the City Ordinance or be placed in the corner clearance area that adversely impacts drivers and pedestrians visibility and sight distance.

## DESIGN

- Trees should be selected from the city's approved tree species list<sup>11</sup>. Larger street trees are strongly encouraged. Proper selection of tree species includes:
  - Size of growing area, soil, and drainage.
  - Width and height of the tree relative to the distance between trees and the distance between trees and adjacent structures (buildings, bridges).

<sup>11</sup> Grand Rapids Approved Tree Species List. <http://www.urbanforestproject.com/downloads/approvedtrees.pdf>

- Presence of other street elements that would adversely impact trees or be adversely impacted by trees, such as signs, street light and traffic signal poles, or overhead utilities.
  - Deep root structure to minimize impacts on underground utilities and sidewalk pavement.
  - Tree characteristics like seed pods, fruits, sap, and low branching are typically avoided.
  - Depth of the soil is based on the size of the root ball, with the top of the root ball flush with the finished grade of the planter (absent of mulch cover) and accounting for a 6 to 12 inches of compacted planting soil below the root ball. Do not place root ball directly on undisturbed grade. Provide at least 500 cubic feet of soil per tree. Preferred soil volumes are:
    - Small Tree: 600 cubic feet
    - Medium Tree: 1,000 cubic feet
    - Large Tree: 1,500 cubic feet
    - Multiple Trees: Provide a continuous tree trench at least 8-feet-wide by 3-feet-deep
  - For trees up to 3 inches in caliper, a minimum of 12 inches of new planting soil mix must surround the root ball (e.g. 2 foot diameter root ball requires a minimum 4 foot diameter area of planting soil). For trees 3 inches in caliper or larger, 18 inches of planting soil mix must surround the root ball.
  - Street Trees are typically located in one of three types of conditions:
    - Within open lawn or planting areas. Should be a minimum of 3-feet wide provided the proper volumes are provided.
    - Within a landscape planter of vegetated green infrastructure facility. A minimum of 4-feet wide subject to the soil volumes indicated below.
    - Within a tree grate or tree pit/trench. The grate structure and opening for the trunk may be smaller than the total soil volume and growing area, which should be sized to the soil volumes indicated below.
  - Street tree types are generally consistent along a block length or along the entire street, however there are also benefits to featuring a diverse range of street tree types.<sup>12</sup>
-  Street trees are an important component of green infrastructure. As part of the tree design, explore opportunities for using structural soils below existing paved areas when they can be connected to the growing zone of tree roots.
- Tree branches should be trimmed to seven feet above the sidewalk to provide a clear walking space for pedestrians. Trees may need to be trimmed even higher where street signs are present.
  - Trees require adequate water and drainage. Trees must be regularly watered, especially during the first two years after planting. Raised planters may be needed where there are seasonal water flows or snow melt.

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<sup>12</sup> Grand Rapids 2012 Street Tree Planting Plan. <http://grcity.us/parks/Pages/Tree-Planting.aspx>



## OPERATIONS AND MAINTENANCE

- Trees require routine maintenance including tree trimming and health assessments by the City. The City of Grand Rapids Forestry division provides numerous tree services not limited to: emergency response for tree-related emergencies; pruning; removal of diseased, dead, and dying trees; and administering a tree planting and maintenance program.
- Planted street trees should have a two-year warranty period, including a maintenance contract providing tree care for the first two years following installation.
- At least 20-gallons of water should be provided to each tree immediately following planting. Information on watering, weeding, mulching, and uncompacting soil for street tree care is at: <http://grcity.us/parks/Pages/Caring-For-Your-Street-Tree.aspx>.

## SPECIAL CONSIDERATIONS

- Avoid placing street trees near major utilities, utility leads, vaults, access panels, or other utility infrastructure that are within the soil growth zone.
- Preserve trees on slopes and riverbanks to prevent soil erosion.
- Seek advice from a professional on the health of each tree and the effects of planned construction. Determine what procedures should be followed to protect the trees. Identify trees to be protected and preserved during the site planning process (i.e., greater than 4 inches in diameter per City standard).
- Hybrid designs containing part open landscape planters and part covered tree trenches may be utilized with special approval.
- Consider the provision of water connection spigots in close proximity to tree planting areas.
- Do not store any equipment or materials within the drip line of a tree.



## REFERENCES

- NACTO: Urban Street Design Guide, 2013
- Street Design Elements: Sidewalks; Street Trees <http://nacto.org/publication/urban-street-design-guide/street-design-elements/sidewalks/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004, Section 3.2.13: Ambience, Shade, and Other Sidewalk Enhancements
- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011 Section 5.3.11: Landscaping
- City of Grand Rapids Street Classification Policy, 1996 Section 11. Plants
- Grand Rapids 2012 Street Tree Planting Plan. <http://grcity.us/parks/Pages/Tree-Planting.aspx>
- Grand Rapids Zoning Code. [http://grcity.us/design-and-development-services/Planning-Department/Documents/ZONING\\_ORDINANCE\\_LastAmended\\_12-15-15\\_WEB\\_LINKS.pdf](http://grcity.us/design-and-development-services/Planning-Department/Documents/ZONING_ORDINANCE_LastAmended_12-15-15_WEB_LINKS.pdf)
- Grand Rapids Zoning Ordinance. Reference ordinances for new development as follows:
  - Minimum number and size of trees planted in common space.
  - Overlay district tree planting requirements.
  - Landscaping requirements (prohibited trees).
  - Tree protection/replacement requirements.
  - Street tree planting requirements.
- Johnson, G. R. 2013. Protecting Trees from Construction Damage: A Homeowner's Guide. University of Minnesota Extension. Last Accessed: March 24, 2015
  - <http://www.extension.umn.edu/garden/yard-garden/trees-shrubs/protecting-trees-from-construction-damage/>



# STREET LIGHTING

Street lighting generally takes the form of either lighting over the roadway (roadway lighting) or over the sidewalk or trail (pedestrian lighting) – although some lighting serves both purposes. Pedestrian lighting is generally lower (12 to 18 feet above sidewalk level) with closer spacing while roadway lighting is higher (22 feet or more) with greater spacing distance. Lighting improves both safety and the sense of security. Lighting should be carefully designed to avoid light pollution (unnecessary lighting), intrusive light (light cast into private residences and adjacent buildings), and unattractive color rendition (e.g. yellow color of sodium vapor lights).

The operating cost of electricity for street lighting can be a major expense for cities, therefore many cities are seeking adoption of more energy efficient lighting strategies such as LED lighting and/or street lights powered by renewable energy.

## USE

- Street lighting must illuminate the roadway/travel way and Pedestrian Zone, as well as crosswalks and other conflict points.
- Street lighting is desirable on all street types and is a priority in the Urban Center and Neighborhood Business districts as well as other critical travel corridors such as Network Residential and Crosstown Connector. Alleys may or may not have street lighting.

- Pedestrian-oriented street lighting may be difficult in areas with above ground electrical and communication utilities. Undergrounding of utilities should be strongly encouraged and/or mandated – especially with street or Pedestrian Zone reconstruction projects.

## DESIGN

- Street lighting should provide consistent lighting levels and avoid high contrasts of light and dark areas. In some cases, low lighting is preferable over bright lighting to avoid areas of intense shadow.
- Street light spacing should prioritize the provision of even illumination. However, the spacing of street lights can also contribute to a clear sense of the street edge and traffic calming (as vehicle speeds are often influenced by the spacing distance of vertical street elements).
- Light poles are generally set back two feet from the face of curb in a straight line along the street edge. Additionally, lighting may be provided on bump outs.
- Pedestrian level lighting is generally sufficient to illuminate both the Pedestrian Zone and Travel Zone in the typical Grand Rapids street (55 to 65 foot wide right-of-way). Wider streets may require unique fixtures for Pedestrian Zone and Travel Zone lighting.
- Pedestrian Zone lighting is generally spaced 20 to 40 feet apart (measured from the center of the pole). Travel Zone lighting may be spaced 60 to 120 feet apart depending on the lighting element.

- It is typical to alternate street lights in the Pedestrian Zone with street trees (combined spacing of 10 to 20 feet apart).
- Effective, high efficiency lighting such as LED light fixtures are strongly encouraged as a means to reduce energy costs.
- Full cut off or shielded lighting should be used to support “Dark Skies” objectives.

 Street lighting spacing and design should facilitate and accommodate robust growth of street trees and installation of green infrastructure features.

### SPECIAL CONSIDERATIONS

- Higher levels of lighting may be desired at transit stops, bike share stations, or other areas of concentrated pedestrian activity. Pedestrian scaled lighting may be used in areas where pedestrian demand is high or in special districts or areas that are intended to have a special character or sense of place.
- Light poles may be arranged in an “alternate” or “opposite” configuration. Opposite configurations are typically associated with more formal, higher order streetscapes.
- Brackets for banners, hanging baskets, or other ornamentation may be affixed or integrated into the light pole as long as they do not obstruct pedestrian travel and are approved by the city.

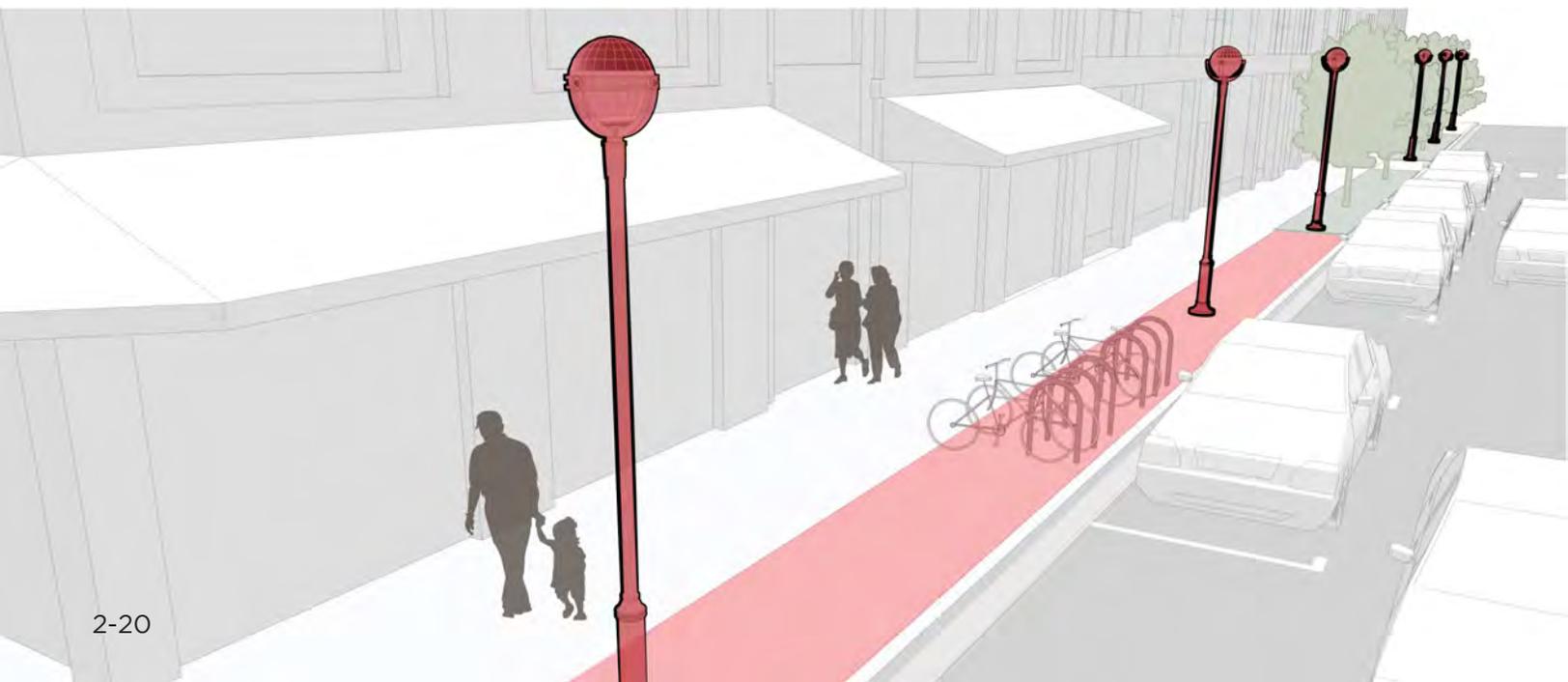
- Street signage, bicycle parking, and/or single space parking meters may be integrated into light poles to reduce sidewalk clutter. Light poles may also accommodate micro-cells.

### OPERATIONS AND MAINTENANCE

- LED lighting elements will reduce electric utility costs for street lighting.
- 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.

### REFERENCES

- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 3.2.11: Pedestrian Facility Lighting
- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
  - Section 5.3.8: Roadway Lighting
- Illuminating Engineering Society. Road Lighting Guide. <http://www.ies.org/store/product/road-lighting-1363.cfm>
- Illuminating Engineering Society. Design Guide for Residential Street Lighting (DG-21-15) <http://www.ies.org/store/product/design-guide-for-residential-street-lighting-dg2115-6373.cfm>





# SIDEWALK RAMPS

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

## USE

- Sidewalk ramps are generally necessary at all marked pedestrian crossings, both at intersections and at midblock locations.
- Sidewalk ramps are required with any sidewalk construction or reconstruction at intersections or other crossing points.
- 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.
- Sidewalk ramps, including temporary ones, should be provided when a pedestrian detour is needed to maintain access during sidewalk closures.

## DESIGN

- Sidewalk ramps shall adhere to standards established by the Michigan Department of Transportation (MDOT) in compliance with Public Rights-of-way Accessibility Guidelines (PROWAG).
- Sidewalk ramps generally consist of four basic components:
  - The approach, which is generally the sidewalk leading to a sidewalk ramp.

- The landing is a clear level area at the top of the ramp and must be at least 48" square.
- The ramp extending between street and sidewalk grades. Sidewalk ramps with slopes less than 5% tend to be more user friendly. Sidewalk ramps between 5% and 8.3% are acceptable, but should provide a landing area. Areas that require slopes greater than 8.3% may need to utilize a "switchback" design to keep slopes within the acceptable range. A 2% landing is always required if there is a turning movement needed.
- Flares are triangular areas flanking the ramp and joining with the approach surface. Flares may have a maximum slope of 10%.
- Sidewalk ramps should be the width of the sidewalk and must be a minimum of four feet wide, although six feet is generally preferred. Areas with high concentrations of pedestrian traffic and/or shared use paths may require even wider sidewalk ramp openings.
- Sidewalk ramps should be oriented perpendicular to the natural curb line and oriented to the desired line of travel, typically indicated by the center of the crosswalk. Separate ramps are typically provided for each directional crossing. Corner sidewalk ramps should not be used. (Perpendicular sidewalk ramps on tangent or directional ramps on radius of corner aid snow removal because plows are traveling straight along the edge of the ramp. Ramps that are located on the radius of the ramp are more susceptible to plows leaving a wedge of snow in front of ramp from traveling past).
- The sidewalk ramp shall lie within the area of the crosswalk. Side flares may extend beyond the width of crosswalk if

necessary. A sidewalk ramp is not needed if a person in a wheelchair would not approach from that side (if the ramp abuts a planter, flower bed, tree pit, driveway approach, etc.).

- Where sidewalk ramps lead to a legal crossing, ramps shall be provided at both ends of the crossing.
- Detectable warning strips with a color that contrasts with the surrounding pavement are required.

### SPECIAL CONSIDERATION

- Sidewalk ramps should be designed to avoid water ponding at the base of the ramp.
- Sidewalk ramps should be constructed of concrete. Pavers or other special materials should not be used without city approval and a maintenance agreement.

### OPERATIONS AND MAINTENANCE

- Adjacent property owners are responsible for snow clearance from sidewalk ramps. All parts of the path used by a person in a wheelchair must be cleared, from the sidewalk to the roadway, particularly after a snowplow as cleared the street.<sup>13</sup>

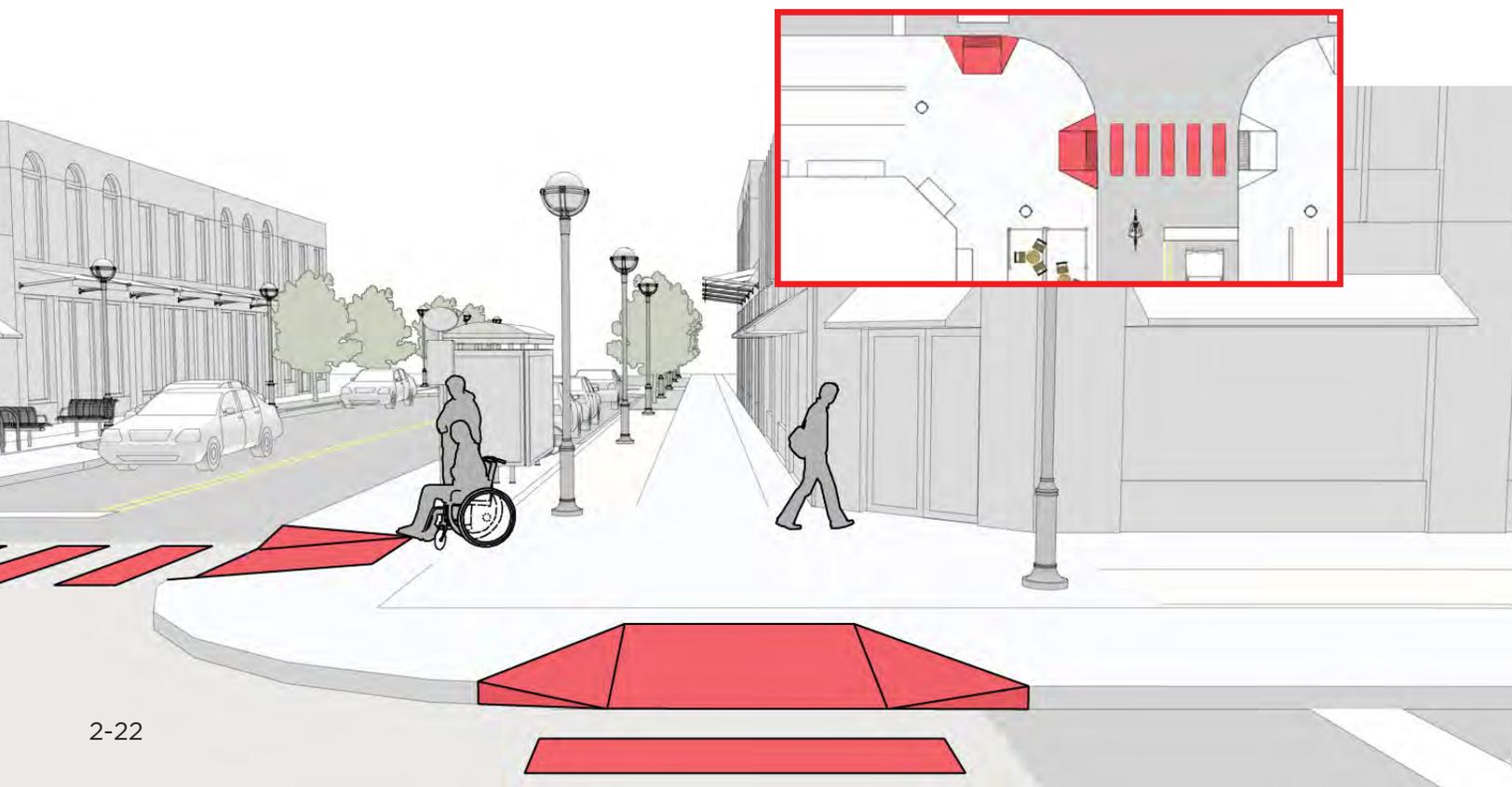
<sup>13</sup> Grand Rapids Municipal Code, Chapter 58, Article 3, Snow and Ice Removal [https://www.municode.com/library/mn/grand\\_rapids/codes/code\\_of\\_ordinances?nodeId=COOR\\_CH58STSIOTPUPL\\_ARTIINGE\\_S58-3SNICRE](https://www.municode.com/library/mn/grand_rapids/codes/code_of_ordinances?nodeId=COOR_CH58STSIOTPUPL_ARTIINGE_S58-3SNICRE)

## REFERENCES

- City of Grand Rapids Street Classification Policy, 1996
- Section 7. Pedestrian Movement, 7.5, 7.9
- Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way
- Chapter R3: Technical Requirements
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
- Section 3.3.5: Sidewalk and Curb Treatments at Pedestrian Crossings
- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
- Section 4.17.3: Curb Ramps

## DETAILS

- City of Grand Rapids Standard Construction Specifications, 1993 Edition
  - Standard Details P-9 Sidewalk Ramp in Paved Parkway
  - Standard Details P-9A Sidewalk Ramp in Unpaved Parkway
  - Standard Details P-9B Location of Sidewalk Ramps at Intersections
  - Standard Details P-9C Sidewalk Ramp in Reinforced Concrete Over Areaways
- MDOT Road Standard Plans
  - Special Detail R-28-J Sidewalk Ramp and Detectable Warning Details <http://mdotcf.state.mi.us/public/design/englishstandardplans/spdetails/index.htm>





# CROSSWALKS & MIDBLOCK CROSSINGS

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

Crosswalks may occur at intersections or at mid-points along a block. Midblock crossings are crossings that occur between intersections. Crosswalks are generally marked facilities; however, pedestrians are legally permitted to cross at unmarked locations wherever two or more streets intersect.

## USE

- Marked crosswalks should be provided at all significant pedestrian crossing locations such as at major intersections; in the downtown, urban center, and neighborhood business corridors; higher density districts; and near schools, parks, community facilities, or other significant pedestrian generators.
- Marked crosswalks may be located at either signalized intersections or unsignalized (e.g. stop controlled, uncontrolled, or roundabout) crossings; at intersections and/or midblock.
- Marked crosswalks should be considered on streets with traffic volumes above 3,000 Average Daily Traffic (ADT), speed limit higher than 25 mph, or corridors with multiple travel lanes. Lower volume crossings generally remain unmarked. Education is necessary to inform drivers that drivers must yield to pedestrians crossing the street, whether marked or unmarked.
- Midblock crossings should not be used when within 400 feet of a crosswalk at an intersection.

	Neighborhood Residential	Link Residential	Network Residential	Neighborhood Business	Maker/ Industrial	Crosstown Connector	Urban Center
Neighborhood Residential	O	O	O	O	O	O	O
Link Residential	O	A	A	A	A	A	A
Network Residential	O	A	R	R	R	R	R
Neighborhood Business	O	A	R	R	R	R	R
Maker/ Industrial	O	A	R	R	R	R	R
Crosstown Connector	O	A	R	R	R	R	R
Urban Center	O	A	R	R	R	R	R

**O = OPTIONAL**  
**A = ADVISED**  
**R = REQUIRED**

## DESIGN

- Crosswalks shall be as wide as, or wider, than the sidewalks they connect. Sidewalks should be at least six feet wide, and 10 feet is preferred for heavily travelled areas.
- Crosswalks should encompass the desired line of travel observed at a particular location. Sidewalk ramps shall be provided to serve all marked crosswalks.
- Crosswalk markings shall be clear and legible. The standard crosswalk type consists of two parallel lines and is acceptable at most locations. High visibility markings - typically of the “Continental” design - are advised at high volume pedestrian locations, areas of heightened safety concern, or areas with concentrations of more vulnerable pedestrians.
- Marked and unmarked crossings should be adequately lighted to provide safety and visibility for both pedestrians and motorists.
- Crossing distance shall be as short as possible to minimize exposure and risk. Street designers should look for the optimal alignment to reduce risk and exposure distance.
- Continuous crossings in excess of 44 feet in length should be avoided. For crossings greater than 44 feet, consider utilization of pedestrian refuge islands.
- Where pedestrian activity is routine or frequent, pedestrian crossing phases should be included in the traffic signal timing sequences with push buttons added as needed to extend crossing phases.
- Crosswalk surface may be asphalt, concrete or non-slip pavers providing a level surface.
- The MMUTCD provides guidance on the minimum required pedestrian clearance interval, which is the most significant component of overall pedestrian crossing time. In areas with an increased concentration of vulnerable pedestrians, such as along Transit Emphasis corridors and in areas with higher volumes of pedestrians, the minimal clearance interval should be increased to expect and accommodate slower moving pedestrians.
- Crosswalks and midblock crossings at uncontrolled locations without a stop sign or signal control may require special design attention, such as a marked crosswalk, pedestrian crossing signs, and/or parking restrictions to ensure

drivers are able to see pedestrians about to enter the crosswalk. Midblock crossings with trail crossings such as at parks and major facility entrances may require further enhancements such as raised crossings, rapid flashing beacons, pedestrian hybrid beacons, curb extensions, or median refuge islands.

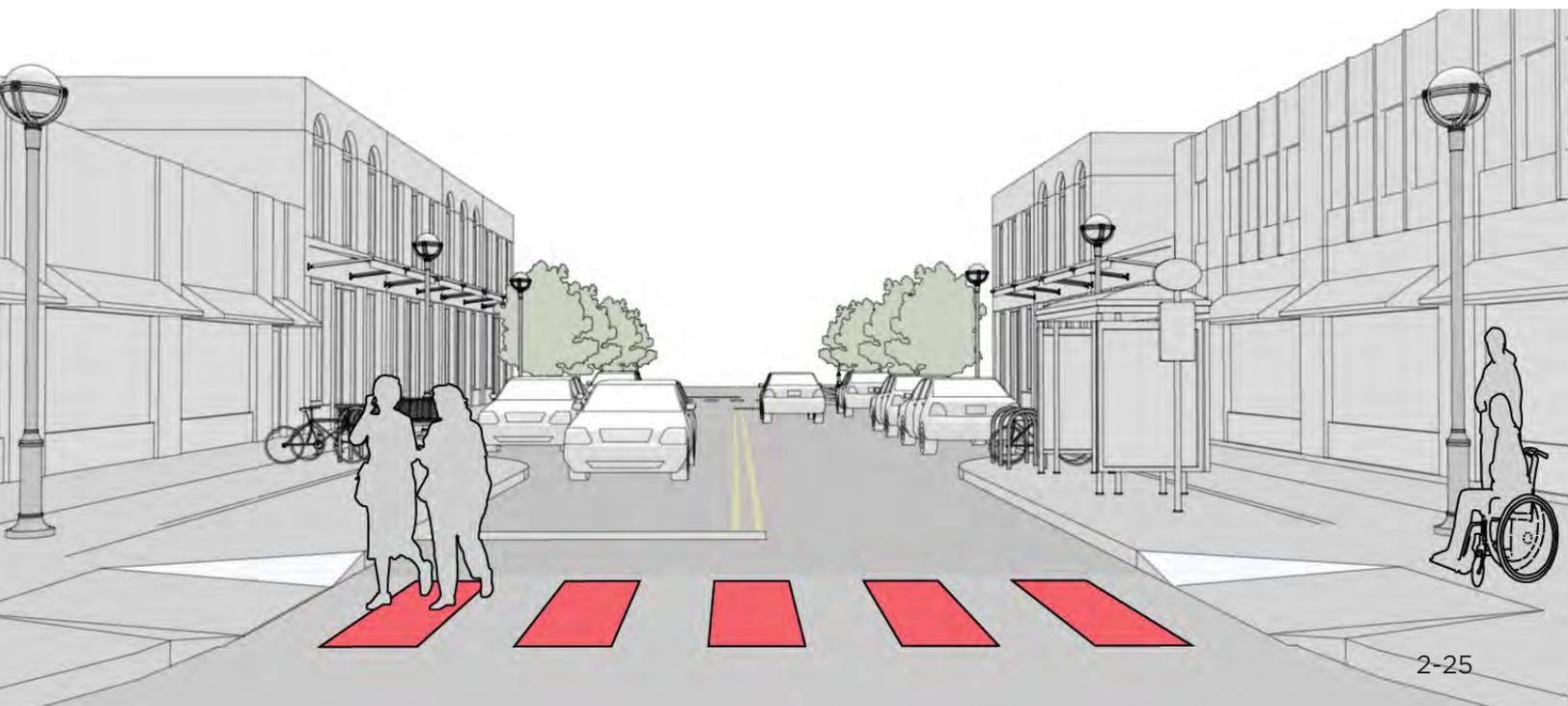
## SPECIAL CONSIDERATIONS

- Raised crosswalks may be used in areas of high pedestrian volumes or locations with demonstrated safety concerns, where vehicle volumes and speeds are generally low. Raised crosswalks elevate the crosswalk slightly above the typical grade of the street, improving visibility.
- Decorative crosswalks may be considered by the city with a maintenance agreement, but are generally discouraged. Decorative crosswalk treatments must be compliant with all current requirements in the MMUTCD or Federal documents. Decorative crosswalks are typically temporary and not for permanent installation.
- Enhanced pedestrian treatments, such as Rapid Flash Rectangular Beacons (RFRBs) or pedestrian-actuated hybrid beacons should be considered only after lesser or more traditional treatments have been used. If warranted, they

may be used at locations with high traffic volumes and travel speeds. Implementation of such devices will need to be based on current standards and research and an engineering study will need to be completed to warrant such treatment.

## OPERATIONS AND MAINTENANCE

- Crosswalk markings may be installed in a slightly staggered pattern to avoid the typical vehicle wheel track, which may help minimize maintenance requirements. Markings may also be inset into the pavement to prevent 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.
- Crosswalks must be cleared of snow and ice and remain visible even in wintery conditions. Crosswalk sidewalk ramps must not be blocked by snow, ice, or pools of water.



## REFERENCES

- City of Grand Rapids – Pedestrian Crossing Pavement Marking Policy
- City of Grand Rapids – Mid-Block Crossing Policy (Draft)
- NACTO: Urban Street Design Guide, 2013
- Intersection Design Elements: Crosswalks and Crossings <http://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 3.3.4: Crosswalks
  - Section 3.4: Midblock Crossings
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
  - Chapter 9. Traveled Way Design Guidelines: Midblock Crossings
  - <http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad>
  - Chapter 10. Intersection Design Guidelines: Pedestrian Treatments at Intersections – Crosswalks
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- MMUTCD, 2011
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  - Section 3B.18: Crosswalk Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)
  - Part 4 Highway Traffic Signals: Chapter 4F. Pedestrian Hybrid Beacons [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart4\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart4_2011.pdf)
- MDOT: Guidance for Installation of Pedestrian Crosswalks on Michigan State Trunkline Highways, 2014 [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_guidance\\_for\\_installation\\_of\\_pedestrian\\_crosswalks\\_on\\_michigan\\_state\\_trunkline\\_highways.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_guidance_for_installation_of_pedestrian_crosswalks_on_michigan_state_trunkline_highways.pdf)
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- Notes Manual 212B Signs with Rectangular Rapid Flashing Beacons [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_note212b.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_note212b.pdf)
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- MDOT Pavement Marking Standards
  - PAVE-900-E Pavement Arrow and Message Details [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-900-e.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-900-e.pdf)
  - PAVE-945-C Intersection, Stop Bar and Crosswalk Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-945-c.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-945-c.pdf)
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  - SHS-E01-REG “R” Regulatory Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)
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# PEDESTRIAN SIGNALS

Pedestrian signals, like vehicle signals, inform pedestrians when it is safe and appropriate to cross the street and when to stop and wait. Pedestrian signals, also called “ped heads”, consist of a white “WALK” symbol and a flashing and/or steady “DON’T WALK” symbol or words.

These basic pedestrian signals may be enhanced with pedestrian countdowns and/or accessible pedestrian signals (APS). “Pedestrian countdowns” provide information on the number of seconds remaining in a pedestrian cycle. Accessible pedestrian signals (APS) are “an integrated device that communicates information about the WALK and DON’T WALK intervals at signalized intersections in non-visual formats (i.e., audible tones and vibrotactile surfaces).”<sup>14</sup> Sometimes called “Audible Pedestrian Signals,” accessible signals aid pedestrians with visual impairments.

MMUTCD permits pedestrian signals to be fixed (also known as “pre-timed”) or actuated. Pre-timed signals provide a pedestrian walk phase for every leg of an intersection during every cycle, regardless of whether pedestrians are present or not. Actuated signals provide a walk phase only when pedestrians are present.

<sup>14</sup> Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG), Advisory R209

## USE

- Pedestrian signals should be installed at all signalized intersections with crosswalks.
- In general, fixed-time signals should be used in urban areas to ensure crossings are visible and predictable for all users and that signals regularly provide adequate time to cross. As a rule of thumb, where pedestrians can reasonably be assumed present at 50% or more of signal cycles, pedestrian crossing phases should be automatic (e.g. pre-timed). At less-trafficked intersections, actuated signals (using push buttons or loop detectors) may be appropriate.

## DESIGN

- Provision of pedestrian countdown information is generally desired at all intersections with pedestrian signal heads. MMUTCD requires that numbers must be immediately adjacent (below or beside) to the “DON’T WALK” symbol. Countdown displays should be dark at all times except during the pedestrian clearance phase. If the pedestrian crossing width exceeds 90 feet, increase the height of the numerical display to ensure visibility and legibility.
- Pedestrian crossing time must, at a minimum, meet the current MMUTCD standard. Required pedestrian crossing time is dependent on the total distance of pedestrian exposure. This is the distance where a pedestrian is off the

curb and in the vehicle zone. Pedestrian crossing distances, and therefore required pedestrian crossing times, may be reduced through the use of bulb-outs.

- Pedestrian actuated signals should be located adjacent to the landing of the desired crossing with a maximum reach of 18" to the signal push button.

### SPECIAL CONSIDERATIONS

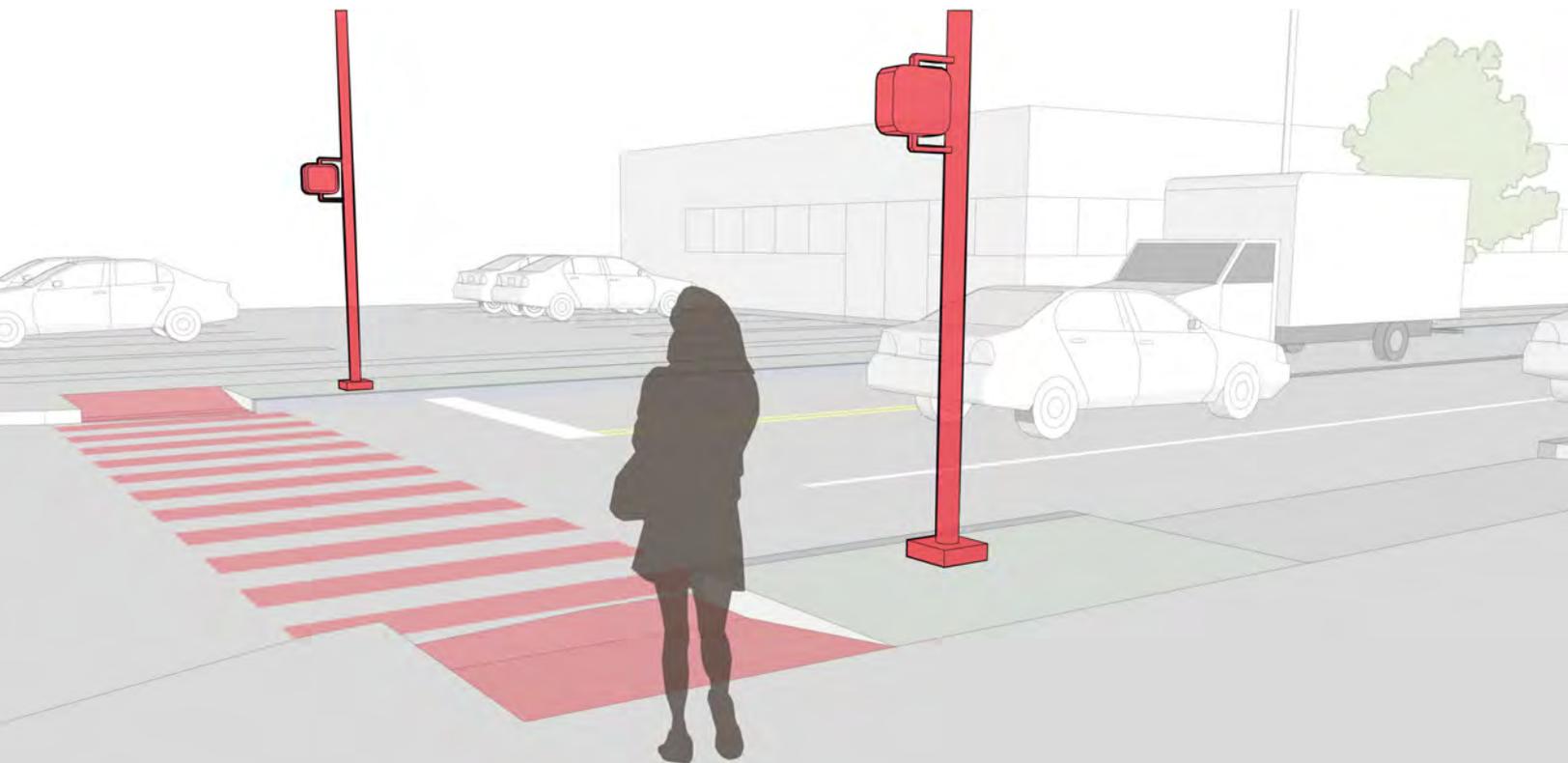
- In high pedestrian locations, such as the downtown, near major pedestrian generators, or near schools or senior centers, additional pedestrian time may be needed or desired because of slower walking speeds.
- Use LED or other low energy signal technologies for more energy efficient countdown displays.

### MAINTENANCE AND OPERATIONS

- Snow clearance at curb ramps and sidewalks must provide clear access to APS push buttons.
- Adequacy of pedestrian crossing time should be routinely monitored and adjusted, especially when there is a change in land use near the intersection.

### REFERENCES

- City of Grand Rapids Street Classification Policy, 1996
  - Section 7. Pedestrian Movement, 7.9
- MMUTCD, 2011
  - Part 4 Highway Traffic Signals: Chapter 4E. Pedestrian Control Features
  - Section 4E.07: Countdown Pedestrian Signals [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart4\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart4_2011.pdf)
  - Section 4E.08: Pedestrian Detectors [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart4\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart4_2011.pdf)
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
- Section 4.1.4: Pedestrian-Actuated Signals





# PEDESTRIAN REFUGE ISLAND

Pedestrian refuge islands are raised or curbed sections within the roadway that provide a safe landing zone for pedestrians to use while crossing a street with multiple travel lanes. Refuge islands, also known as pedestrian crossing islands, decrease pedestrian risk by reducing the crossing distance and breaking up longer crossings into two or more stages. Because the pedestrian is crossing fewer lanes of traffic, pedestrians more easily find gaps to cross at unsignalized crossings. Pedestrian refuge islands also function as a traffic calming device and may present an opportunity for green infrastructure.

## USE

- Pedestrian refuge islands are most often used on multilane roadways where a pedestrian must cross 44 feet or more of continuous roadway or where they are necessary to provide a safe crossing.
- Pedestrian refuge islands may also be used as a traffic calming or traffic channelization device, often in concert with mini roundabouts or acute angle right turns.

## DESIGN

- Pedestrian refuge islands shall have marked crosswalks connecting to sidewalks. The pedestrian walk should continue at street grade through a pedestrian island with a width of the pedestrian clear zone and a minimum of four feet. Detectable warnings such as raised bumps, should be used where crosswalks cross islands.

- Pedestrian refuge islands shall be raised above the level of the roadway and protected with a vertical curb.
- Pedestrian refuge islands should be at least eight feet wide and preferably 10 feet wide in order to comfortably accommodate single pedestrians, pedestrians with strollers or using mobility assistance devices, or pedestrians with bicycles. Wider medians may be necessary at multi-use trail crossings to accommodate persons on bicycles, including bicycles towing trailers or tag-alongs behind them.
- Landscaping on pedestrian refuge islands must comply with MMUTCD standards so as not to impede sightlines and visibility.
- Lighting should be provided to ensure safety and visibility for pedestrians and drivers.

🌿 Pedestrian refuge islands provide opportunities to introduce stormwater management systems such as infiltration pits, rain gardens, or pervious areas in the roadway.

🌿 Landscaped medians can be designed for stormwater bio-retention.

🌿 Larger medians can include street trees and native plantings.

## OPERATIONS AND MAINTENANCE

- Pedestrian refuge islands will introduce some additional costs to routine maintenance such as street repaving. Landscaped pedestrian refuge islands will need regular landscape maintenance and may need irrigation.
- Pedestrian refuge islands should accommodate the turn radii of snow clearance equipment and emergency response vehicles. Pedestrian refuge islands that are lane diverters or channelization features must provide adequate width from curb-to-curb to enable snow plows to proceed through the gap.
- Pedestrian refuge islands should not generally be used for snow storage; however, portions of the island not used for walking surface may accommodate some temporary snow storage if it does not impede sight lines. They should be regularly cleared of snow and gravel.
- Walking surfaces should be designed for adequate drainage to avoid the pooling of water and propensity to ice over. Walking surfaces should be wide enough to accommodate snow removal equipment.

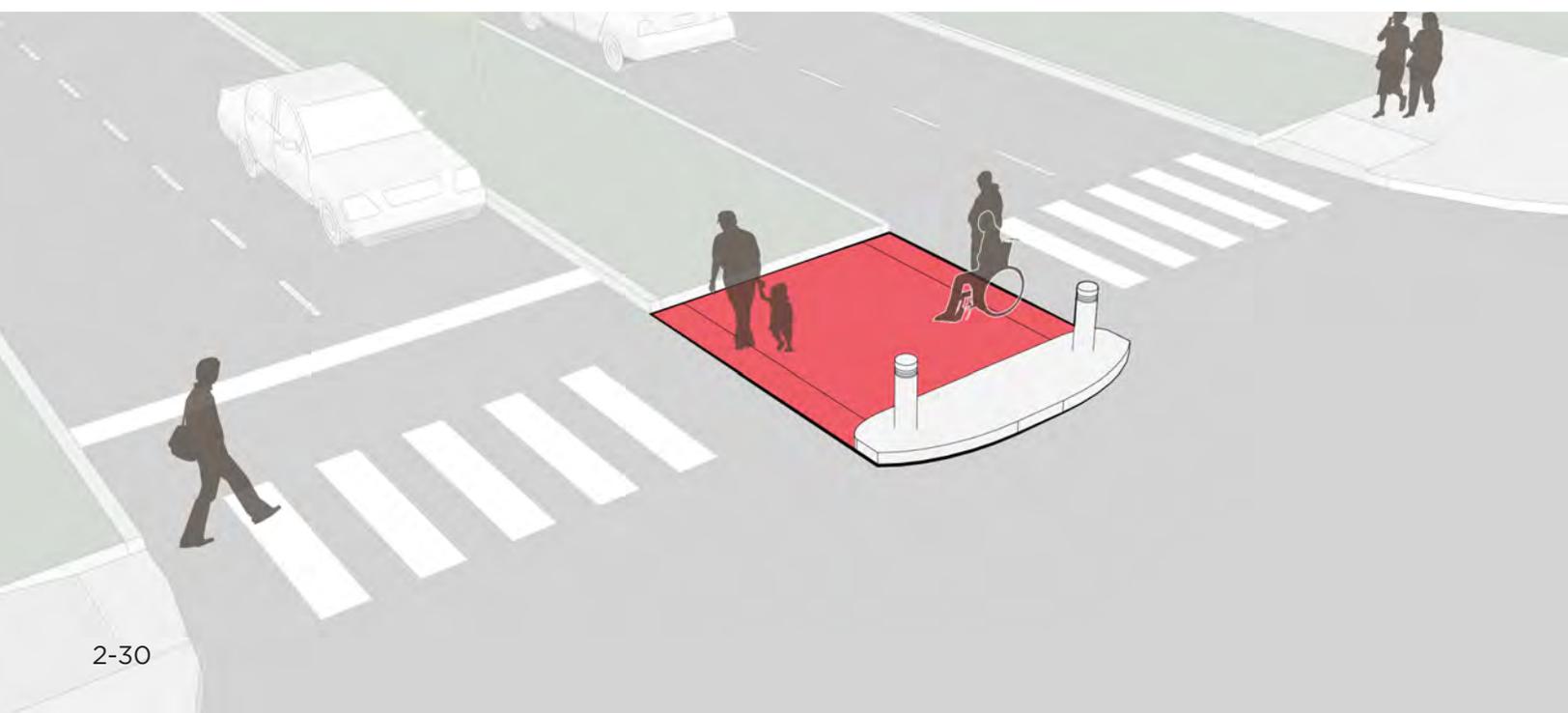
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  - Intersection Design Elements: Crosswalks and Crossings: Pedestrian Safety Islands <http://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/pedestrian-safety-islands/>

- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 3.3.2: Crossing Distance Considerations
  - Section 3.3.3: Turning Movements
  - Section 3.4: Midblock Crossings
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
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  - Section 3I.06: Pedestrian Islands and Medians [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)

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  - SHS-E01-REG “R” Regulatory Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)
  - SHS-E02-WARN “W” Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e02\\_warning.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e02_warning.pdf)





# DRIVEWAYS & CURBCUTS

Driveways and curb cuts provide access from the public right-of-way through the pedestrian zone to private property. While driveways and curb cuts provide essential access to private property, they introduce conflict with pedestrian and bicycle travel, and reduce the efficiency of vehicular travel corridors. Cities around the country are working to encourage shared access points and restore or reintroduce alley networks to reduce the impact of and need for driveways and 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 and two per property whenever practical.
- Driveways should be discouraged, minimized, or prohibited on critical vehicle network streets (such as Crosstown Connector) and on streets with a high concentration of pedestrian activity (such as Urban Center and Neighborhood Business Streets).
- Existing driveways and curb cut access points should be consolidated whenever possible for shared access and to reduce conflict points along roadways.
- Alleys serving multiple properties or users should be considered in infill developments and redevelopments to minimize the number of necessary curb cuts. These alleys can be regarded as small streets and provide key connections in the street network.

## DESIGN

- Sidewalks have priority over driveways and curb cuts. Sidewalks should proceed straight and at grade across driveways and curb cuts as to abide with the ADA. Sidewalk materials should also extend across the driveway providing clear visual reference that pedestrians have the right-of-way and that vehicles must yield.
- Driveway width should be minimized to the extent possible. Driveway openings of 10 feet are adequate for one-way access or to service a single residential property. Driveways that are designated Fire Apparatus Access Roads (Fire Lanes) must be a minimum of 20' wide and have appropriate turning radii for fire apparatus.
- Driveway apron turn radii should be as tight as practical to slow vehicles entering into and across the Pedestrian Zone.
- Driveways should be designed to provide clear sight lines of the sidewalk without the vehicle entering the pedestrian Through Zone. Driveways may utilize stop signs and markings and/or speed humps to slow and stop egressing vehicles before they enter the pedestrian zone. Drivers must not block the pedestrian zone as they enter into or egress from private property.
- Drivers utilizing driveways or curb cuts must always yield to pedestrians.
- Conflict markings, which indicate where bicyclists should travel through an intersection, should be used on bicycle lanes that cross high volume driveways to increase awareness of potential conflict points.

 Driveways and other access ramps can be made from flexible porous pavement. Flexible porous pavement allows stormwater to pass through the pavement to a stone storage layer beneath. The water then either infiltrates into the soil or flows through an underdrain to the storm drain network. It is effective in storing, infiltrating, and treating runoff from impervious surfaces. A variety of flexible porous pavements are available, including concrete pavers, paving grids, pervious concrete, porous asphalt, porous rubberized asphalt, and glass porous paving.

## SPECIAL CONSIDERATIONS

- Where the Pedestrian Zone, and in particular the Parkway Zone, are constrained such that the driveway apron cannot rise to sidewalk height, the sidewalk may be lowered to an intermediary height between street and sidewalk level through the use of sidewalk ramps and well executed design.

## OPERATIONS AND MAINTENANCE

- Maintenance of driveways is the responsibility of the private property owner.
- No parking or loading/unloading shall occur within the sidewalk through the driveway.

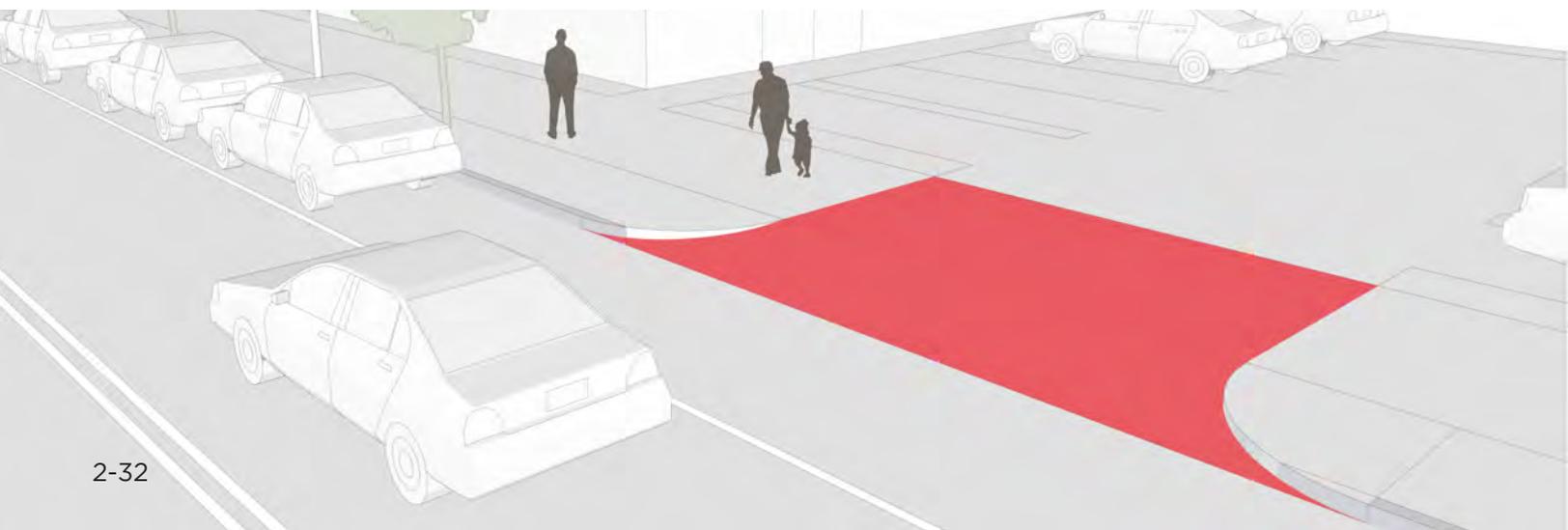
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- NACTO: Urban Street Design Guide, 2013

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- Streets: Commercial Alley <http://nacto.org/publication/urban-street-design-guide/streets/commercial-alley/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 2.4.4: Driveways and Access
  - Section 3.2.6: Driveway Access Management
- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
  - Section 4.15.2: Driveways
  - Section 5.3.2: Cross-Sectional Elements
- MDOT Traffic and Safety Notes
  - Notes Manual 608A Spacing for Commercial Drives and Streets [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_note608a.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_note608a.pdf)

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- City of Grand Rapids Standard Construction Specifications, 1993 Edition
  - Standard Details P-2 Radius Driveway Return and Approach Details and Sidewalk Details
  - Standard Details P-2A Radius Alley Return and Approach Details and Sidewalk Details
  - Standard Details P-3 Combined Driveway Approach and Sidewalk
  - Standard Details P-3A Dub-Down Driveway Approach Details
  - Standard Details P-4 Combined Dub-Down Alley Approach and Sidewalk Details
  - Standard Details P-4A Standard Dub-Down Alley Approach Details
  - Standard Details P-17 Alley Pavement
- MDOT Road Standard Plans
  - Standard Plan R-29-I Driveway Openings & Approaches, and Concrete Sidewalks <http://mdotcf.state.mi.us/public/design/files/englishstandardplans/files/R029I.pdf>
- MDOT Geometric Design Guides
  - GEO-680-B Commercial Driveways [http://mdotcf.state.mi.us/public/tands/Details\\_Web/geo680b.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/geo680b.pdf)





# SIDEWALK DINING & OUTDOOR MERCHANDISING

Sidewalks and adjacent areas are important spaces within the street environment for commercial activity.

Sidewalks outside of many storefronts are vital to the success of many types of businesses. Where sidewalks are sufficiently wide, businesses may request to use sidewalk space in front of their establishments for café dining and outdoor retail.

Sidewalk dining, also called café dining, enables restaurants, coffee shops, bars, and other establishments to provide outdoor seating space for patrons. Café dining is distinct from a parklet. Café dining is reserved for the exclusive use of particular dining patrons, whereas parklets are available to the general public. Outdoor merchandising enables the display and sale of retail goods within the public right-of-way. Both have demonstrated positive effects on patronage, commercial sales, and productivity.

Sidewalk dining and outdoor merchandising help to animate a street, adding life, vitality, and safety to the public environment.

## USE

- Space for café dining and outdoor merchandising is encouraged in commercial areas. Businesses must request and receive permission in the form of an encroachment permit before utilizing the sidewalk space for private activity.
- Café dining and outdoor merchandising is most common in the Urban Center and Neighborhood Business streets but may also be considered for Maker/Industrial Streets, Crosstown Connector streets, and mixed use areas along Network Residential streets. In residential areas, however, loud activities and hours of permitted use should be limited.

## DESIGN

- Sidewalk cafes and outdoor merchandising may be located in either the amenity zone or frontage zone of the street. The location for sidewalk dining or retailing should be consistent for all properties along that block face to ensure a straight path of travel for the pedestrian clear zone.
- A consistent pedestrian clear zone width must be maintained that does not intrude in the through space. Sidewalk dining or merchandising must maintain at least the minimum six feet of effective sidewalk width for pedestrian traffic.
- Café seating in the parkway zone must extend at least two feet from the edge of

curb to permit use of curbside parking spaces or other uses.

- Sidewalk cafes and outdoor merchandise displays may only occupy space directly in front of the storefront with which they are associated and may not encroach on other frontages.
- A-frame or sandwich board signs should be placed to avoid obstructing the pedestrian through zone to allow pedestrians to pass.
- Sidewalk café furniture may vary and is subject to approval. Furniture must be durable and appropriate for outdoor use. Café tables may be no larger than three feet wide (or in diameter).
- Outside merchandise may be displayed only while the associated storefront is open and must be removed daily.
- By City Ordinance, outdoor merchandise is limited to fresh flowers, food, original artwork, or temporary displays by local businesses.

### OPERATIONS AND MAINTENANCE

- Most sidewalk occupancy uses are not well-suited for the winter, unless heaters are provided. All furnishings and fixtures of sidewalk cafes should be removed from the sidewalk zone and stored when not in use.

- Occupied areas must make note of where utility access panels, vault covers, and other utility connection points are located and provide ready access to utilities if needed for maintenance or other utility operations.
- Sidewalk occupants are required to ensure that their occupancy conforms to the layout stipulated in their permit at all times. Sidewalk occupants should ensure that a clear path of travel is maintained and sandwich boards do not impede pedestrian travel.
- Sidewalk occupants are required to keep areas free from trash, debris, food scraps, or other refuse on a daily basis.
- Street trees shall not be trimmed by the business owner or adversely affected in any way.

### REFERENCES

- Downtown Alliance – Downtown Streetscape Design Guidelines
  - Section 5. Streetscape Design Guidelines: Private Effort; Sidewalk Cafes
- Downtown Grand Rapids Inc. Parklet Manual
  - [http://s3.amazonaws.com/downtowngr.org/general/DGRI\\_Parklet\\_Manual\\_April\\_2014.pdf?mtime=20150407190535](http://s3.amazonaws.com/downtowngr.org/general/DGRI_Parklet_Manual_April_2014.pdf?mtime=20150407190535)





# TRANSIT STOPS

Transit stops are designated places where riders can board or alight transit vehicles. Grand Rapids has three types of fixed-route public transit – downtown circulator service, local bus service, and Bus Rapid Transit (BRT).

At a minimum, bus stops may be as simple as 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 the availability of transit service, explains how it works, and makes transit an appealing travel option.

BRT stops have more robust amenities for passenger comfort and enhanced operations. BRT stops will include shelters and seating, ticket machines for off-board fare collection, distinctive branding, and may be raised above typical curb level to provide level boarding.

## USE

- Transit stops are located along corridors with transit services. A transit stop is required for fixed-route transit service.
- The level of amenity at a transit stop varies depending on the volume of passengers using that stop, the level of transit emphasis on that corridor, or the trip generators served by the stop. For example, stops in front of a senior center need seating and shelters.
- The provision of shelters and other amenities is also determined by the width of the Pedestrian Zone.
- On Transit Emphasis streets and in locations with high ridership, stops should provide an enhanced waiting environment, such as covered waiting shelter, formal seating, informal seating, rider information, and real-time information.
- Transit stops may be located at the near-side or far-side of intersections as well as at midblock locations:
- Where buses operate in mixed traffic and stop in the travel lane and/or at signalized intersections, far-side stops are generally preferable.
- Near-side stops are generally preferred at stop-controlled locations
- The location of the bus stop will be the result of multiple factors including operations, routing and transfers, and local land use and right-of-way context.
- Transit stops are most successful when they provide comfortable places for passengers to wait and sufficient information to understand the services provided.

### DESIGN

- Transit stops on urban streets are generally either pull-out stops located at the natural curb line or in-lane stops located on a bus bulb.
- At minimum, every transit stop must:
  - Be indicated with an appropriately located transit sign or “flag.” The transit sign indicates to drivers where to halt to align doors with passenger landing areas.
  - Have a paved landing area at each door connected to a continuous sidewalk network leading to and from the stop location with appropriate and accessible pedestrian crossings.
  - Meet the accessibility requirements of the Americans with Disabilities Act of 1990.
  - Be illuminated by street lights for early morning and evening passengers.
  - Have signposts indicating the transit services provided at the stop (routes and providers). Signposts should be located at the front of the transit stop, two feet behind the curb.
- Transit stops must be proximate to crosswalks. Where stops are not at an intersection, pedestrian crossings should be accommodated behind the departing transit vehicle.
- Near side transit stops should be set back 10 feet from crosswalks; however, a minimum five feet of setback is required.
- Transit stops should be designed to accommodate the full length of at least one transit vehicle. The length of the stop depends on both vehicle type, stop location, and service frequency. Pull-out stops require greater length than in-lane stops. Pull-out stops for 30 or 40 foot buses should be at least:
  - 80 feet long for far-side stops.
  - 110-120 feet long for near-side and midblock stops.
- Stops on routes utilizing articulated buses require an additional 20 feet of length.
- Corridors with a high frequency of bus service (such that more than one bus may service the stop at the same time) may require longer stops.
- Regulatory signs are required indicating the limits of the transit stop zone. Parking and loading should be prohibited within the stop area. Driveways should be restricted within the stop areas.
- Transit stops should accommodate passenger access or egress from every door of the vehicle.
  - Boarding/landing zones should be provided at all transit vehicle doors. They shall be five feet long (parallel to the curb) and eight feet deep.



- The front boarding zone may be measured from the transit signpost. For a typical 40 foot bus, the distance between the front and rear doors and their respective landing zones is 10 feet, while the doors of articulated buses are 18 feet apart.
- Boarding/landing zones should be clear of all obstructions, including street trees, signal or light poles, and signposts. Street trees should be set 10 feet back from landing zones.
- Boarding zones generally occur at the typical sidewalk grade—typically five to seven inches above street level. Level, or near-level, boarding may be achieved by raising the passenger landing zone 10 to 14 inches above street level (for low-floor vehicles).
  - Where boarding zones are raised, ramped travel paths a minimum of four feet wide must be provided to the landing zone. Any grade difference between the landing zone and surrounding sidewalk should be indicated with warning paint or protected with a railing.
  - Detectable warning strips 24 inches deep should be applied along the curb of raised boarding/landing zones.
- Transit stop amenities should be appropriate to the passenger volume and activity at that stop. The Rapid has guidelines to inform the selection of appropriate amenities. Additional amenities typically include:
  - Waste and/or recycling facilities
  - Seating or leaning bars
  - Wayfinding or informational signage or boards
  - Transit shelters
  - Public art
  - Special or additional lighting
- A minimum 4-foot clear zone around all amenities is required to accommodate circulation and movement for all users.

## TRANSIT SHELTERS

- Shelters in Grand Rapids are typically 9 feet wide and 4.5 feet deep.
- Shelters may be located along the curb or behind the pedestrian clear zone in the frontage zone.
  - When located along the curb, shelters may open toward the street or toward the sidewalk clear zone.
    - When located along the curb and opening toward the street, shelters must be located at least four feet behind the curb.
    - When located along the curb, opening toward the sidewalk, shelters must be located at least two feet behind the curb.
  - When located in the frontage zone, shelters should open toward the sidewalk. They should be set at least one foot from a blank building face or integrated into the building wall, such as an alcove or awning.
- Shelters should be fully or partially enclosed on one, but preferably two sides, to provide protection from wind, snow, and rain.
- Shelters should be mostly transparent for security and to reduce sight obstructions.
- Transit shelters should not be utilized where they would result in less than six feet of pedestrian through zone for the adjacent sidewalk. In these locations, consider the use of bus bulbs to provide additional space for a shelter and passenger waiting area while maintaining the minimum pedestrian through zone.
-  Consider the opportunity for green roofs or solar lighting on transit shelters if there is not adequate street lighting nearby.

## SPECIAL CONSIDERATIONS

- Transit shelters provide the opportunity for additional information such as real-time bus arrival displays, advertising panels, and larger maps of the stop area and/or transit system.

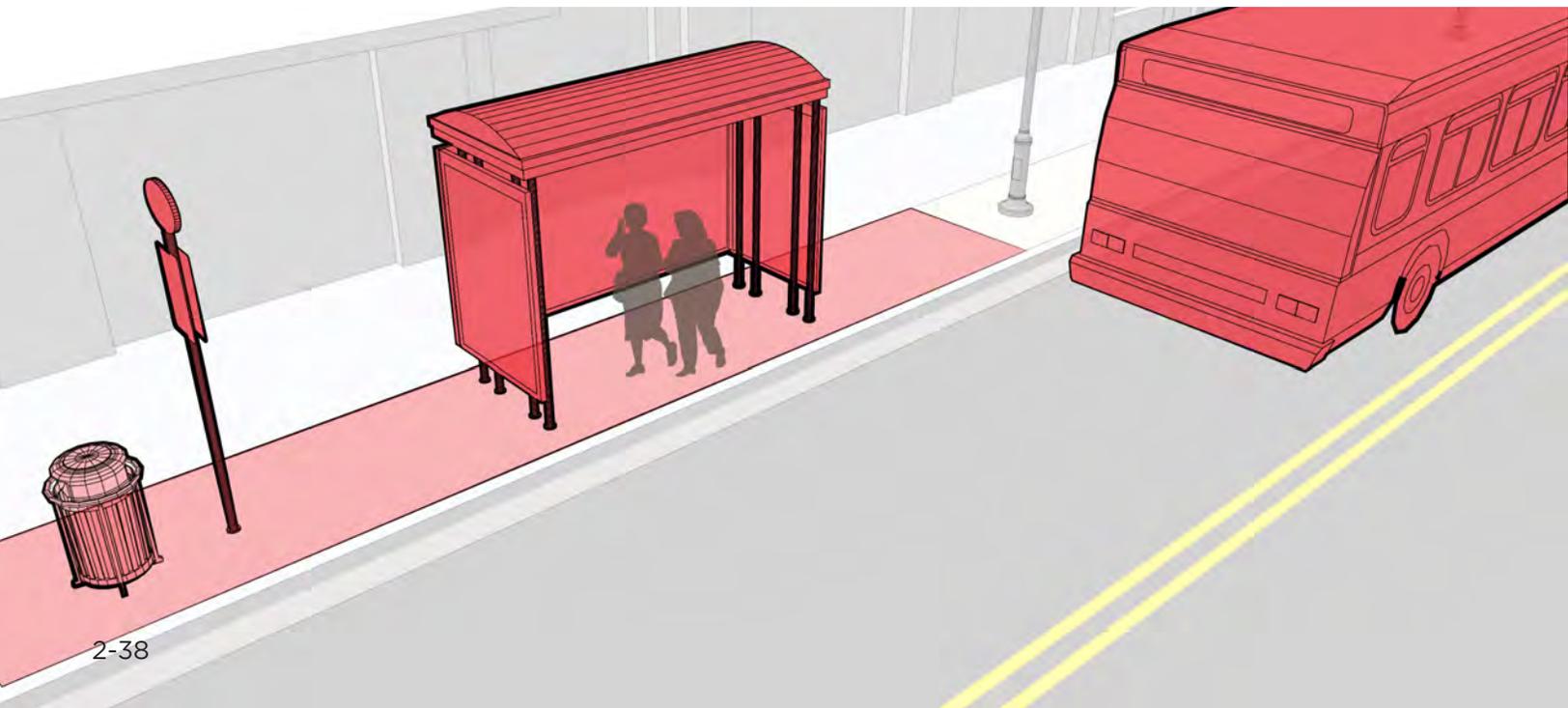
- Increasingly, major transit stops are designed to be “mobility hubs” integrated with other mobility systems including bike share and car share services, taxis and ride sharing providers, and to provide wayfinding to local civic destinations or businesses.
- Coordinate bus shelters, tree pits, and any amenities anchored in the pavement of the sidewalk with underground utilities. Locate bus shelters at least one foot from manholes and other utility access points and 10 feet from fire hydrants. Transit shelters should not be located above utility vaults.

### OPERATIONS AND MAINTENANCE

- The Rapid is responsible for shelter maintenance and repair along the Rapid’s fixed route transit corridors, and the City’s Mobile GR/Parking department is responsible for maintenance and repair along the DASH circulator routes. Other parties can contribute to the operations and maintenance of bus shelters, such as CIDs, BIDs, DGRI, Neighborhood Associations, etc.
  - Bus shelters require quick repair if panels are broken or damaged. The shelter must also be regularly washed and any litter accumulating in and around the shelter removed.
  - Transit stops must be cleared of snow and ice both in their landing zones and clear pathways must be provided to cleared sidewalk paths.
- A pathway from the landing zone to the cleared roadway space must be maintained at a width sufficient to enable deployment of wheelchair lifts. This can be particularly challenging as roadway plowing tends to pile snow up at the curb line. This berm of snow must be cut through to enable a clear path for passenger boarding and alighting.

### REFERENCES

- United States Access Board. Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way. Published in the Federal Register on July 26, 2011. 36 CFR Part 1190
- Downtown Alliance – Downtown Streetscape Design Guidelines
- Streetscape Design Guidelines: Public Realm





# WAYFINDING

Wayfinding clearly defines pedestrian, bicycle, and vehicle networks to guide travelers to destinations of interest or connecting networks. Wayfinding is typically provided via signage and may be directional (orienting a user to where they are or connecting networks), informational (informing travelers of areas of interest or local offerings), or conformational (reassuring a user that they are still on the same route). Wayfinding is typically static (e.g. typical signage) but may also be dynamic, changing in response to real time information. Wayfinding signage can be supplemented with maps and web-based applications to help users plan and carry out their trip.

## USE

- Wayfinding is used to guide pedestrians, bicyclists, and motorists to assist them in navigating transportation networks.
- Wayfinding may provide a variety of information including directional indicators and other information such as estimated travel time or distance to destinations of interest (e.g. 5-minute walk to Van Andel Arena; five blocks to Silver Line).
- Wayfinding is typically located on higher order streets (e.g. Network Residential, Business Commercial, Crosstown Connector, and Urban Center) but may be on lower order streets for community routes such as neighborhood greenways or bicycle boulevards.
- Wayfinding may be on streets or on off-street facilities (e.g., multi-use trails).

## DESIGN

- Wayfinding should follow a consistent design palette to aid in identification and legibility. Grand Rapids has an adopted wayfinding system for the downtown.
- Wayfinding should be oriented to the appropriate user. For example, pedestrian wayfinding should be located adjacent to the sidewalk and at eye level; bicycle signage should be oriented toward bicyclists; 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 (e.g. pedestrians) should generally be inconspicuous to other users (e.g. drivers) to avoid confusion.
- Wayfinding should be simple, straightforward, concise, and uncluttered.
- Signage should be compliant with the MMUTCD if intended for drivers and should not conflict with traffic signs. Signage should use reflective materials in low light conditions to improve legibility.
- Wayfinding signage should be located in the furnishing zone and must not impede pedestrian, bicycle or vehicle movement. Wayfinding signage must maintain both horizontal clearances as well as vertical clearances.
- Grand Rapids' current wayfinding system includes four sign types – the District Welcome Signs, District Directional Signs, Locational Directional Signs, and Pedestrian Kiosks. In addition, private

wayfinding signage is also utilized on Medical Mile (Michigan St.) to guide patients and visitors.

## SPECIAL CONSIDERATIONS

- Logos, other than public or quasi-public agencies or entities, are generally discouraged on wayfinding signs in an urban environment. Clear, direct language is encouraged.

## OPERATIONS AND MAINTENANCE

- Keeping wayfinding updated in a dynamic city can be a challenge. Responsibility for updating wayfinding should be established prior to installation.
- Wayfinding, like other signs, is 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.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Bikeway Signing & Marking: Bike Route Wayfinding Signage and Markings System <http://nacto.org/publication/urban-bikeway-design-guide/bikeway-signing-marking/bike-route-wayfinding-signage-and-markings-system/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 4.2: Pedestrian-Related Signing
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.11: Bicycle Guide Signs/Wayfinding
- MMUTCD, 2011
  - Part 2 Signs: Chapter 2D. Guide Signs – Conventional Roads [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2d\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2d_2011.pdf)
  - Part 9 Traffic Control for Bicycle Facilities: Chapter 9B. Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)

## DETAILS

- City of Grand Rapids Frequently Used Detail
  - City Standard Wayfinding Sign Foundation Detail
- MDOT Standard Highway Signs
  - SHS-E08\_D\_GUIDE “D” Guide Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e08\\_d\\_guide.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e08_d_guide.pdf)





# PUBLIC SEATING

Public seating creates more accessible and inviting streetscapes for all users, especially those with mobility challenges, by providing places to rest and enjoy the street environment. They may include benches, chairs, seat-walls, and other fixed structures that provide seating for pedestrians to relax.

## USE

- Public seating, aside from that associated with transit stops, is generally limited to areas with higher concentrations of pedestrian activity, public parks, plazas, or other open spaces, 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 security.

## DESIGN

- Public seating is generally located in the parkway zone of the street but may be located in the frontage zone parallel to the building line, facing the sidewalk.

- Seating may take any number of forms, including the traditional bench-type seating, chair or stool type seating, or unique artistic seating.
- Seating may be aligned parallel or perpendicular to the curb. Seating parallel to and along the curb should be oriented toward the sidewalk and away from traffic (except in the case of seating provided at transit stops which may orient toward the street and transit service).
- Seating must not impede or encroach upon the pedestrian clear zone. It should be placed in such a way that use does not block major pedestrian movements, building entries, loading zones, or other street functions.
- When public seating is provided perpendicular to the curb, it is recommended that at least two seats be provided facing one another. For seating other than bench-type seating, it is recommended that at least two seats be provided. Cluster groups of seating to face each other to allow for small groups to converse.
- 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 along the curb line should maintain two feet of clearance from the curb.
- Seating should not be located within five feet of fire hydrants and should generally maintain four feet of clearance from other street fixtures.

- Benches and seats shall have a seating depth of at least 18 inches.
- Design benches, rows, or individual seats with breaks, arm rests, or other elements that provide an interrupted seating edge to discourage furnishings from being used as a feature for purposes other than sitting (e.g. skateboarding, sleeping).
- Provide a mixture of seating types, where multiple street furnishings are used in close proximity, to accommodate different users' needs. Include both backed and backless bench seating and seating both with and without armrests.
- Street furnishings shall be cast-in place or otherwise fixed into the street to prevent unauthorized removal.
- Standard manufactured designs that are readily replaceable should generally be used unless there is an explicit maintenance agreement in place for unique fixtures.

Seating and street furniture can be integrated as protection for street trees, bio-retention planters, and native plantings.

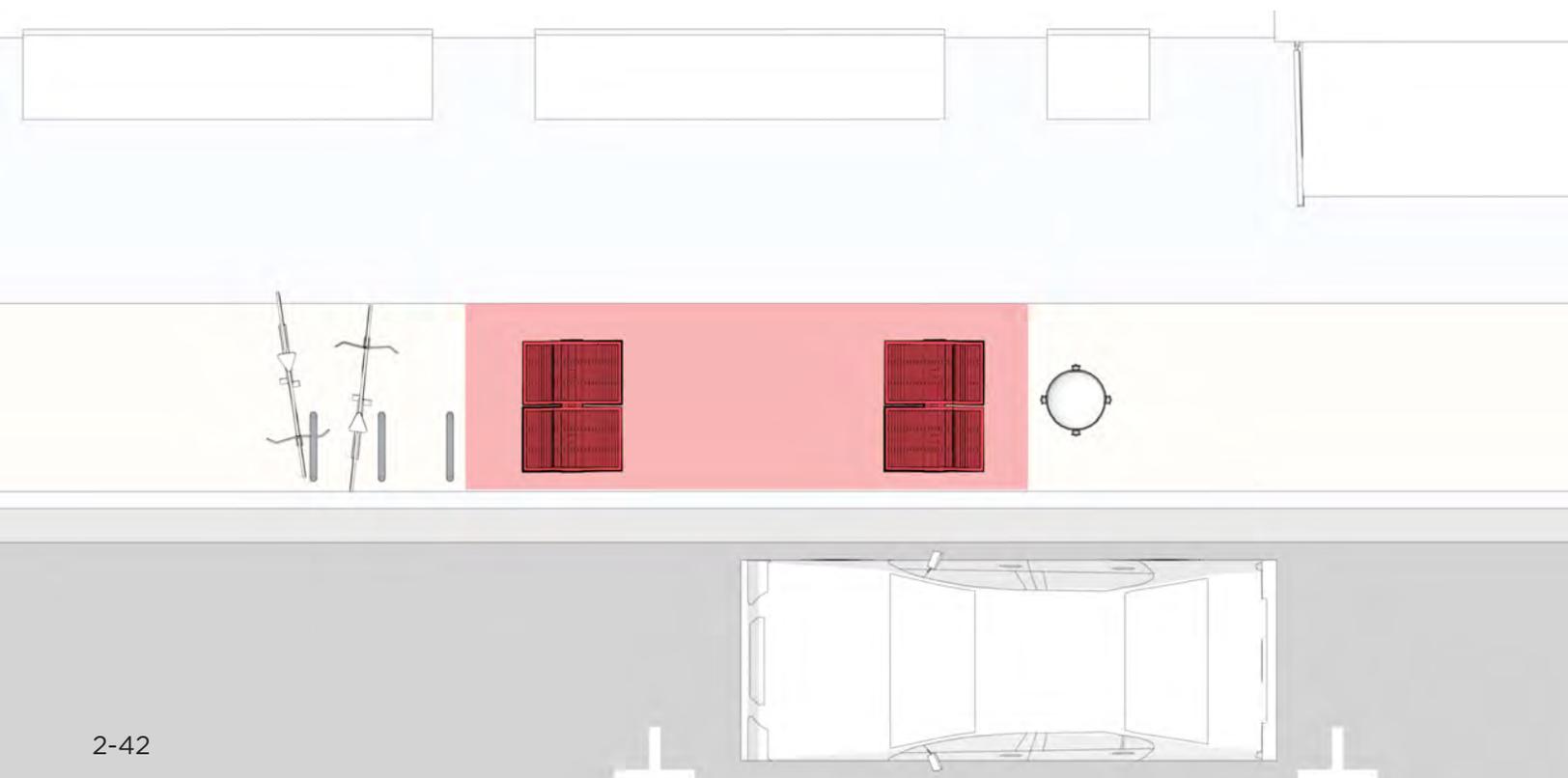
Trees should be used to shade seating areas.

## SPECIAL CONSIDERATIONS

- Consider opportunities to integrate seating into building walls or other street elements in areas where sidewalk dimensions are constrained.
- Concrete seat-walls can integrate metal banding or obstructions to discourage use for recreational activities (e.g. skateboarding) while still allowing use as seating.
- Do not place seating on top of utility covers, vaults, or infrastructure elements that require access.

## OPERATIONS AND MAINTENANCE

- Street furnishings and public seating should be of a standard type that is consistent throughout the city or neighborhood and easily and reliably procured. Non-standard seating should only be used when there is a clear and established maintenance agreement in place.
- 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 and comfortable for all users.
- Seating may be removed during winter months if the parkway zone is commonly required for snow storage.





# WASTE & RECYCLING RECEPTACLES

Waste and recycling receptacles help keep the city clean and beautiful, and minimize the opportunity for loose trash and refuse.

Waste and recycling receptacles should be provided regularly throughout the city so that pedestrians encounter them frequently when walking. Receptacles should be durable, visible, and placed conveniently. Receptacles should be of a standard type and easy for maintenance workers to access and empty.

## USE

- Waste and recycling receptacles are welcome in all types of areas, but are generally concentrated in areas with a significant quantity of pedestrians such as transit stops, commercial areas, and near institutions such as schools or recreation centers.
- Waste and recycling receptacles must be placed so they do not block major pedestrian movements (sidewalk clear zones), building entries, loading zones, or other street functions.
- Place receptacles in locations accessible to curbside pickup and maintenance crews.

## DESIGN

- Waste and recycling receptacles shall be constructed out of durable materials (such as metal or durable rubber) and finishes with a minimum standard warranty of 3-years.
- Receptacles shall be closed on the top or otherwise covered such that rain, snow, and other precipitation does not enter the receptacles and mix with refuse.
- Receptacles shall be secured to the ground and be designed with an inner container or other mechanism that can be removed to facilitate collection of refuse.
- Standardized waste and recycling receptacles should be used.
- Receptacles should be standard manufactured designs that are readily replaceable and common throughout a district or area. Custom designs and other special order receptacles are generally discouraged; however, standard designs may be modified to display branding or identification of the local area or business organization.

## SPECIAL CONSIDERATIONS

- Do not place receptacles directly on top of utility covers, vaults, or infrastructure elements that require access.
- Coordinate location and design of waste receptacles with solid waste management agency to ensure it meets all their needs for easy emptying and maintenance.

- Do not locate waste receptacles in areas that may block transit passengers from boarding or alighting at transit stops.

### OPERATIONS AND MAINTENANCE

- Downtown Grand Rapids, Inc. is responsible for waste or recycling receptacles and their waste removal downtown. The City of Grand Rapids, business improvement districts, and adjacent businesses are responsible for those located outside of downtown.
- 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, both to prevent damage as well as to keep receptacles accessible and usable throughout the year.





# 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 in the amenity zone, which may damage these elements, compromise their appropriate use, or impede pedestrian, bicycle, or vehicle travel.

## USE

- Bicycle parking is used by workers, residents, visitors, and patrons.
- Bicycle parking is appropriate on all but the lowest order street types and should be encouraged to facilitate and enable bicycle use. Bicycle parking is generally unnecessary on Neighborhood Residential streets and may be less common on Link Residential streets (except near or at community destinations such as parks, centers, and schools).
- Bicycle parking should be placed at regular intervals along a corridor. Bicycle parking should be provided in sufficient quantities and with sufficient frequency to meet bicycle parking demands and provide convenient access to destinations.
- Locating bicycle parking near corners or street intersections increases both visibility and convenience of bicycle parking. Parking in front of store fronts is also encouraged for convenience.

However, bicycle parking must meet corner clearance and not impede pedestrian crossings at intersections.

- Bicycle parking racks are generally used for short and medium term bicycle parking. Bicycle racks should not be used for long term storage of bicycles unless installed in a covered and/or secured location like a bicycle parking cage or room inside a building.
- Bicycles abandoned at short-term bicycle racks should be removed and recovered.

## DESIGN

- Bicycle parking racks should:
  - Support the bicycle frame at two locations.
  - Enable the user to lock both frame and at least one wheel.
  - Support bicycles of all frame types (step through, diamond, etc.).
  - Allow front-in and back-in parking.
  - Be affixed firmly into the sidewalk or street surface.
  - Be of a material type and shape to resist cutting.
- The inverted U rack or bicycle loop are common and meet City code for rack type functionality. “Wave” racks, comb types, or schoolyard style racks are **not** allowed.
- Bicycle racks should generally be placed in the parkway/furnishing zone when in the sidewalk space. In areas with significant bicycle parking demand, bicycle corrals (bicycle parking in the static zone of the street) should be considered. For more information about

bicycle corrals, see that section of the Design Guidelines.

- 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 are designed for short term parking. They are most convenient to users when placed within 50 feet of building entrances.
- Bicycle racks are generally aligned parallel to the curb. However where sidewalk areas are wide enough, they may be aligned at an angle or perpendicular to the curb.
- Bicycle racks should be placed in such a manner that a parked bicycle is at least two feet from the curb and does not impede pedestrian traffic.
- Bicycle racks should be placed at least five feet from fire hydrants, crosswalks, or midblock crossings and their sidewalk ramps. Racks should be three to four feet from loading zones, street furniture, driveways, or bus stops or shelters. Racks should not interfere with parked car doors.
- Bicycle racks may be a single fixture or multiple racks grouped in one location. Bicycle racks should accommodate at least two bicycles. Bicycle racks aligned parallel to each other should be 30" on center apart. Bicycle racks in a line (end to end) should be 72" apart to provide a 48" aisle between them when bicycles are parked.
- Groups of bicycle racks may be covered to provide additional benefit to bicycle users and protect bicycles from sun and rain. Bicycle parking covers generally consist of an elevated roof, but bicycle parking shelters can be considered. As

with other fixtures in the sidewalk zone, covered bicycle parking must not impede the pedestrian clear zone.

## SPECIAL CONSIDERATIONS

- Distinctive or special bicycle rack designs (artistic bicycle racks) can be used for placemaking in certain areas, such as downtown or commercial districts. However, these racks must still meet the performance criteria described above. A maintenance plan should also be required for any non-standard racks.

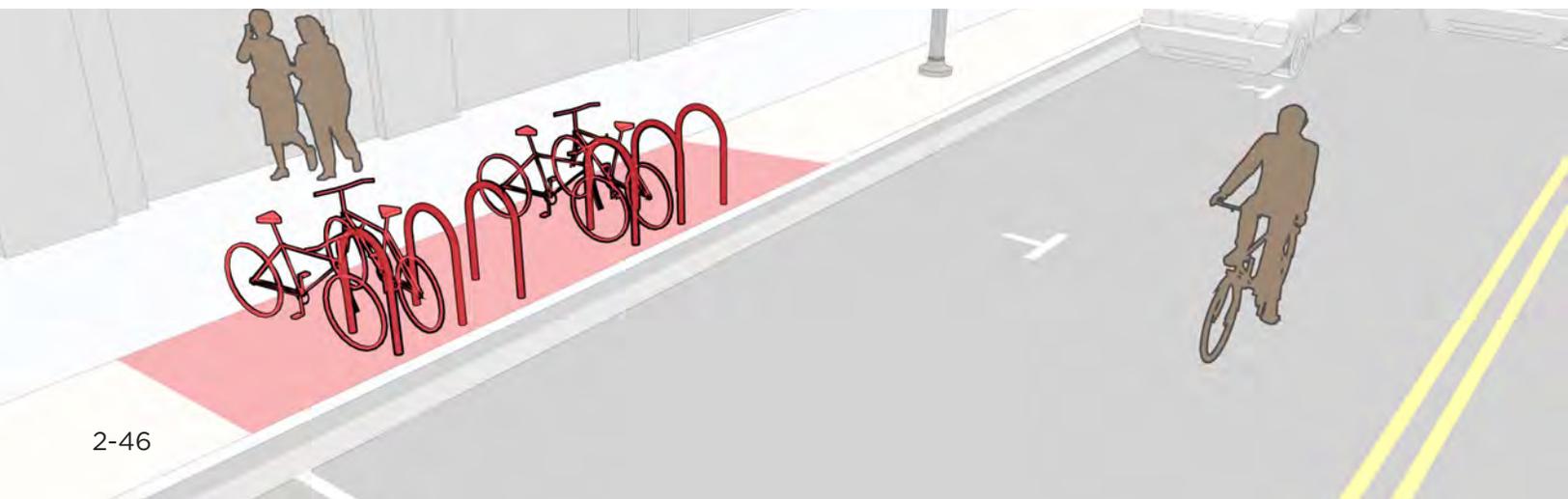
## OPERATIONS AND MAINTENANCE

- Bicycles left at bicycle racks for an extended period of time should be removed. A policy on abandoned bike removal may be needed.<sup>15</sup>
- 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.

## REFERENCES

- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 6.3: Short-Term Bicycle Parking Facilities
- APBP Bicycle Parking Guidelines, 2nd Edition, 2010
  - Chapter 2. Facilities
- APBP Essentials of Bike Parking: Selecting and Installing Parking that Works, 2015
  - Section 05: Bicycle Rack Selection [http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle\\_Parking/EssentialsofBikeParking\\_FINA.pdf](http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle_Parking/EssentialsofBikeParking_FINA.pdf)

<sup>15</sup> Grand Rapids Municipal Code. Article V. Section 66.151 Unclaimed Bicycles. [https://www.municode.com/library/mn/grand\\_rapids/codes/code\\_of\\_ordinances?nodeId=COOR\\_CH66TRVE\\_ARTVBI\\_S66-151UNBI](https://www.municode.com/library/mn/grand_rapids/codes/code_of_ordinances?nodeId=COOR_CH66TRVE_ARTVBI_S66-151UNBI)





# BICYCLE REPAIR STATIONS

Image Source: <http://www.rapidgrowthmedia.com/devnews/043015DGRIBicyclistepairStations.aspx>

Bicycle repair stations are commonly located in the public space along bicycle emphasis corridors. 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.

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 such as an air pump, screwdrivers, crescent wrenches, Allen wrenches, tire levers, and torque wrenches.

## USE

- Bicycle repair stations are located along higher density corridors or areas of high bicycle demand.
- They are generally co-located with significant bicycle parking.

- Bicycle repair stations make bicycling more convenient and reliable by enabling people who bicycle the ability to make common repairs easily.
- Bicycle repair stations are generally privately sponsored and maintained.

## DESIGN

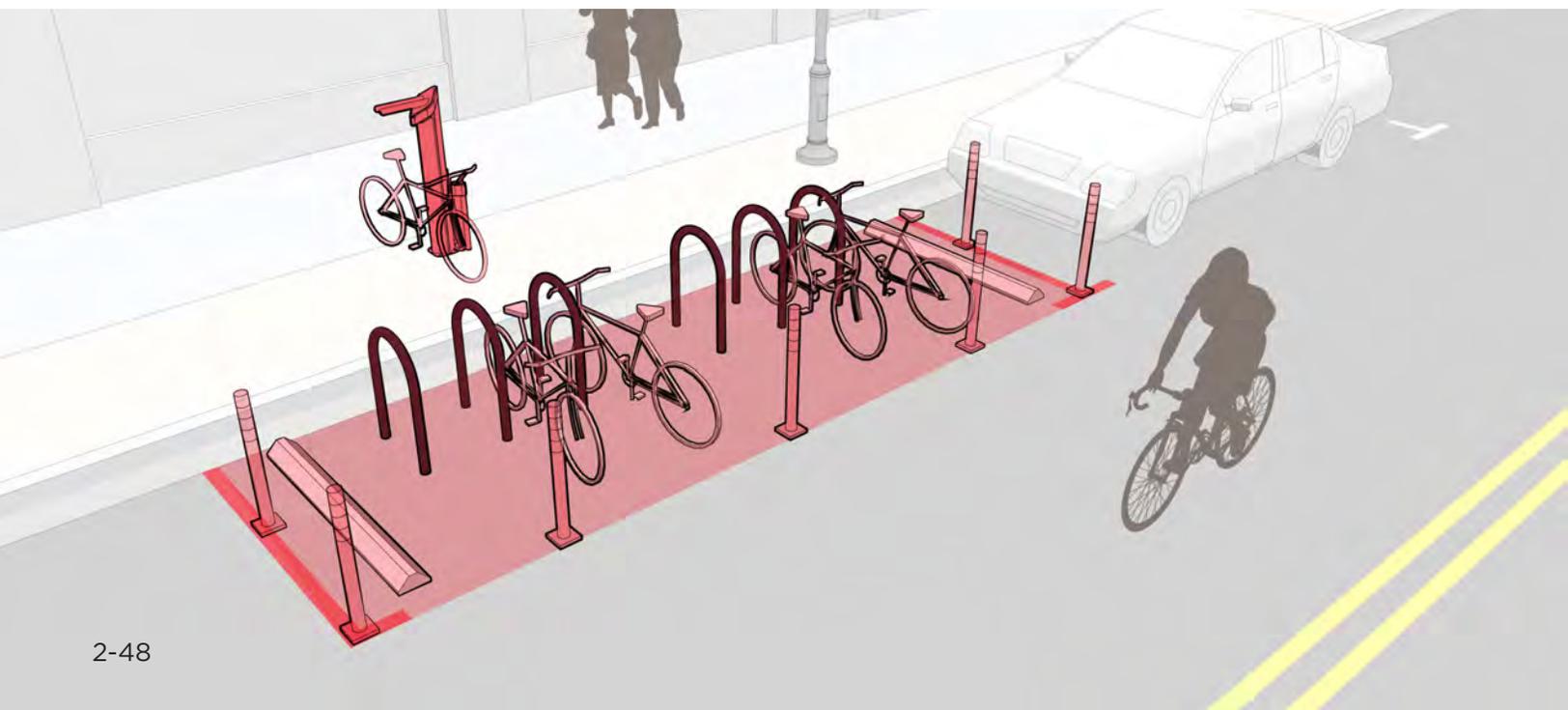
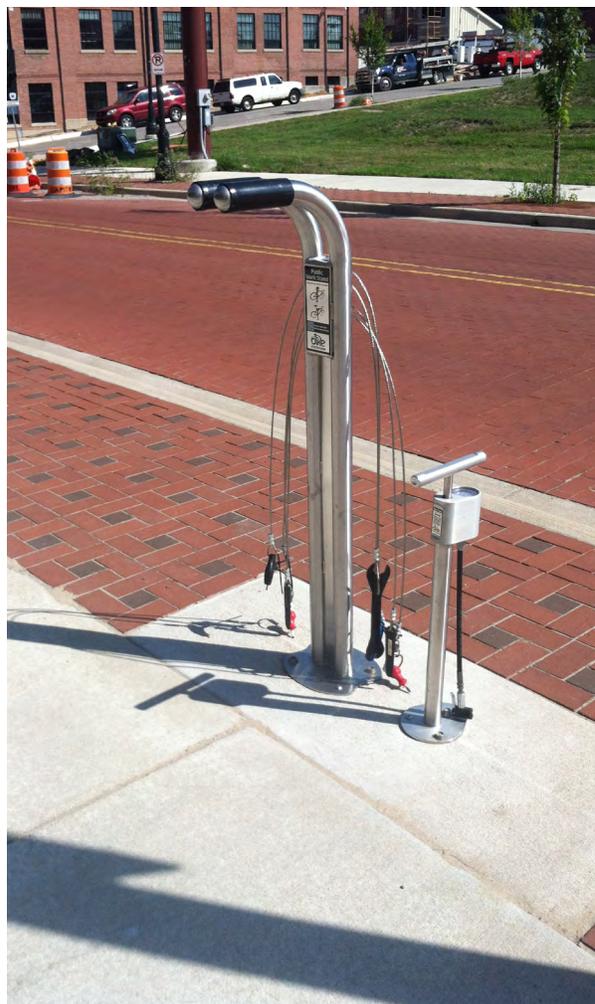
- A variety of bicycle repair stations are commercially available and can be simply affixed to the street or sidewalk area.
- Bicycle repair stations should be located near to bicycle parking, but should not impede the easy use of bicycle racks for bicycle parking.
- Bicycle repair stations are commonly located along major bicycle facilities such as heavily used cycle tracks or trails.
- 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 parkway/furnishing zone of the street but may be located in the frontage zone or in the static zone alongside bicycle corrals.

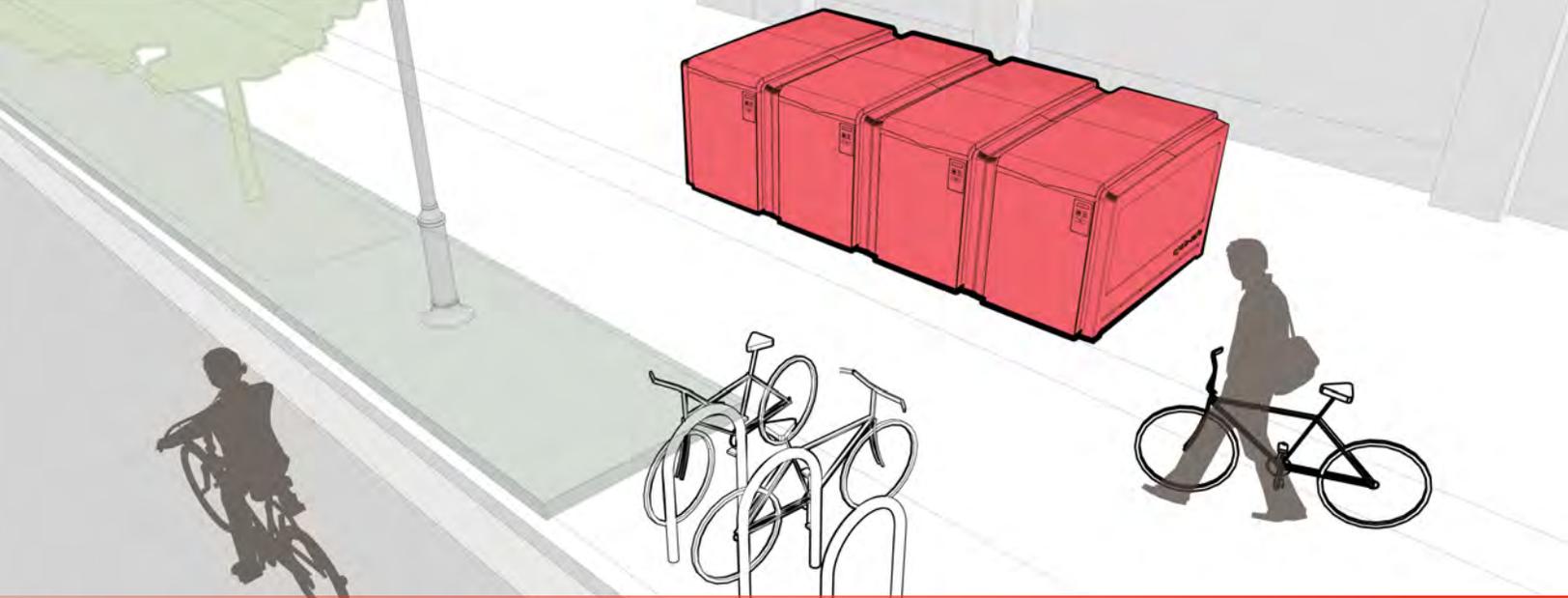
## SPECIAL CONSIDERATIONS

- Use cables to affix tools to the bicycle stand to prevent theft.
- Bicycle repair stations may be sponsored by local bicycle friendly businesses.
- Bicycle repair stations are especially useful when situated in close proximity to pressurized air pumps for tire inflation.
- All publicly available bike repair stations should also be included on bike-oriented wayfinding.

## OPERATIONS AND MAINTENANCE

- Bicycle repair stations must be checked periodically and routinely to ensure all tools are present and in working order, and to make repairs/replacements as needed. Replacement parts should be kept on hand.
- Sponsors of bicycle repair stations should have a maintenance agreement in place.





# BICYCLE LOCKERS

Bicycle lockers provide longer term bicycle parking than is typically provided by bicycle racks. Bike lockers securely protect a bicycle and its components as well as other related gear, including a helmet, bags, shoes, lights, and clothing from weather and theft.

## USE

- The use of bicycle lockers in the public realm is generally limited to major transit stops and around transit stations. Bicycle lockers, or secure bicycle rooms or cages with bicycle racks, are common within parking garages and buildings or located within park-and-ride lots where highly secure and flexible long-term bicycle parking is needed for those who use a bicycle for first- or last-mile connections.

## DESIGN

- The size, shape, and layout of lockers depend on the existing space and specific site needs but typically one locker fits one bicycle. Two common types of bicycle lockers exist: traditional, keyed individual lockers that are rentable by a single user, and electronic lockers (e-lockers) that are available on-demand on a daily or hourly basis.
- Bicycle lockers are large and often placed in groups. They typically range in size from 22 square feet for an individual locker to 41 square feet for a quad of lockers (four) thus requiring substantial space for their placement. As with all other features in the sidewalk zone, bicycle lockers must not impede pedestrian travel.

- Location of the lockers should ensure adequate clearance for access and egress of a bicycle. Lockers should be spaced for 90+ degree door opening and if stacked, provide assistance with lifting bicycles.
- Lockers should be clearly labeled as bicycle parking and signs should be posted with directions for use. The area should have information on membership or where to direct questions.

## SPECIAL CONSIDERATIONS

- Bicycle stations are an attractive, high quality alternative to bike lockers.

## OPERATIONS AND MAINTENANCE

- Bicycle lockers may need to be replaced when they show signs of wear that may damage bicycles.
- Bicycle lockers should be inspected regularly to assure they are used as intended.
- Public lockers require a leasing process, currently available through the City's MobileGR department.

## REFERENCES

- APBP Bicycle Parking Guidelines, 2nd Edition, 2010; Chapter 2. Facilities
- APBP Essentials of Bike Parking: Selecting and Installing Parking that Works, 2015
  - Section 03: Long-Term Parking [http://cymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle\\_Parking/EssentialsofBikeParking\\_FINA.pdf](http://cymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle_Parking/EssentialsofBikeParking_FINA.pdf)



# BICYCLE PARKING STATIONS

A bicycle parking station is a self-standing cage, room, or integrated storefront in a highly visible location that provides a secure long-term bicycle parking. Bicycle stations differ from other bike parking facilities in that they can offer additional amenities to people who bike, such as an attendant, showers or personal lockers, sales of bicycle parts and supplies, or bicycle repairs and rentals.

## USE

- Bicycle parking stations provide commuters who use a bicycle a low-cost place to store their bicycle.
- Bicycle parking stations are generally located near regional transit stations and/or central to the downtown core.
- Bicycle parking stations are generally not located in the public space of the street, but are incorporated into property sites, due to their size and space occupied.

## DESIGN

- Bicycle parking stations can be self-serve or have a valet to park bicycles.
- Bicycle parking stations are access controlled by an attendant, card key, or key pad.
- Bicycle stations provide bicycle parking in a shared room or space and unlike bicycle lockers, typically have limited

space for the storage of helmets, clothes, or other belongings.

- Hanging racks with vertical offset or stacking double-decker racks are commonly used. If stacking racks are used in self-serve stations, assistance should be provided.

 Bicycle parking stations often include green roofs or solar lighting.

## SPECIAL CONSIDERATIONS

- Bicycle parking stations should feature clear signage that facilitates wayfinding. Signage should ideally be located near bicycle facilities such as bicycle lanes, cycle tracks, or trails and also near popular destinations or large trip generators.

## OPERATIONS AND MAINTENANCE

- Bicycle parking stations require a unique maintenance plan and are often operated as a concession or contract service.

## REFERENCES

- APBP Bicycle Parking Guidelines, 2nd Edition, 2010
  - Chapter 2. Facilities
- APBP Essentials of Bike Parking: Selecting and Installing Parking that Works, 2015
  - Section 03: Long-Term Parking [http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle\\_Parking/EssentialsofBikeParking\\_FINA.pdf](http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle_Parking/EssentialsofBikeParking_FINA.pdf)



# BIKE SHARE STATIONS

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.
- Bike share stations should be located throughout the bike share system service area in sufficient density to make them easily accessible to all major destinations. They should be provided for redundancy when parking spaces in the preferred location are full.
- For “smart bike” systems, bike share stations (or “hubs”) should accommodate some amount of spill-over parking.

## 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 such as park-and-ride lots; locating bike share stations near these intermodal facilities encourages trips by multiple modes.
- Bike share stations are commonly located in the parkway zone of the street, but may also be located in the static zone along the curb or in public parks or plazas. Stations may also be placed on private property with appropriate approvals and ensured full public 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.
- If bike share stations utilize solar panels, they must be placed in locations that receive sufficient sunlight.
- Bike share stations must avoid obstructing utilities, fire hydrants, or other street furniture.

## OPERATIONS AND MAINTENANCE

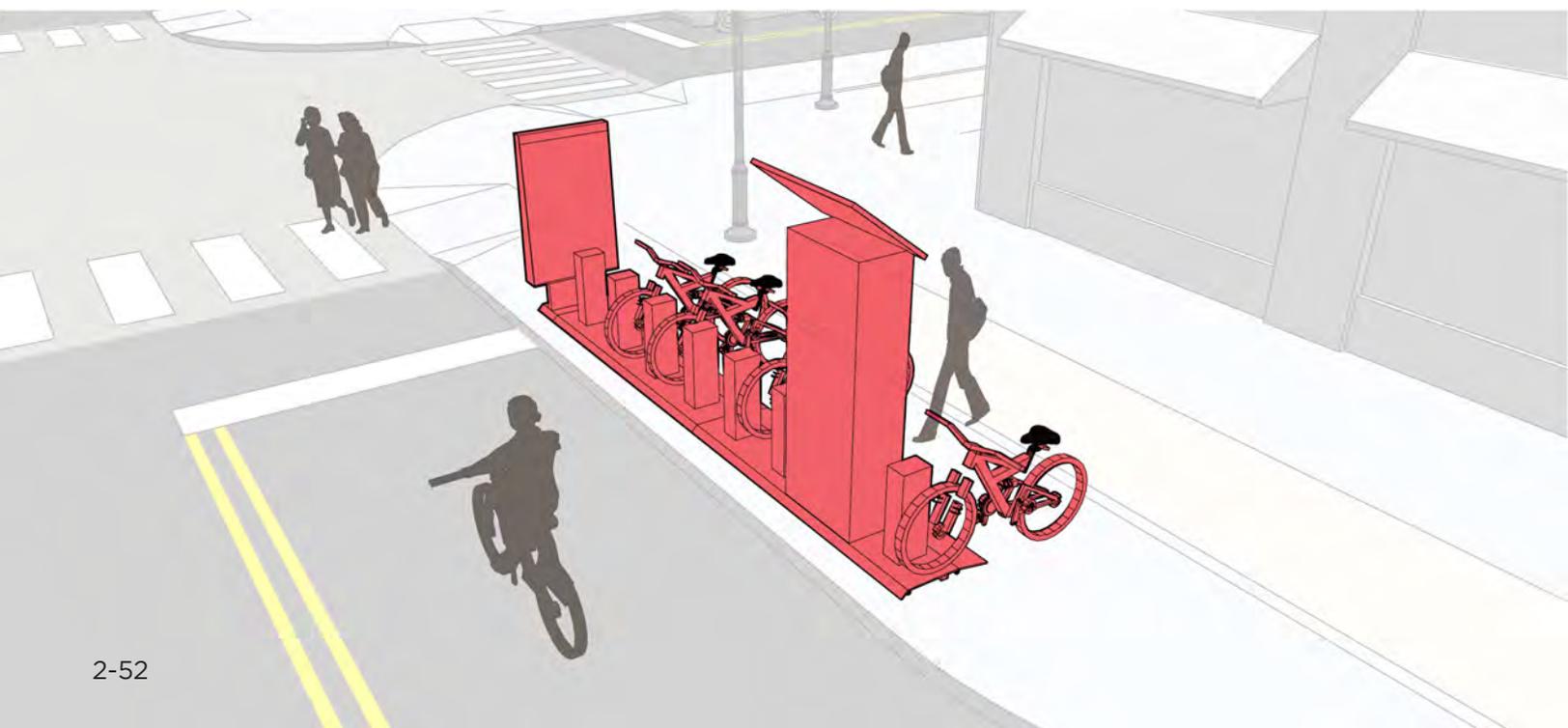
- Bike share stations and bicycles need routine maintenance, including snow removal around stations.
- Newer modular or dockless bike share stations may be easier to move and accommodate construction, changing user demand, or other needs. The number of bicycles per station may be increased or decreased according to demand and season.

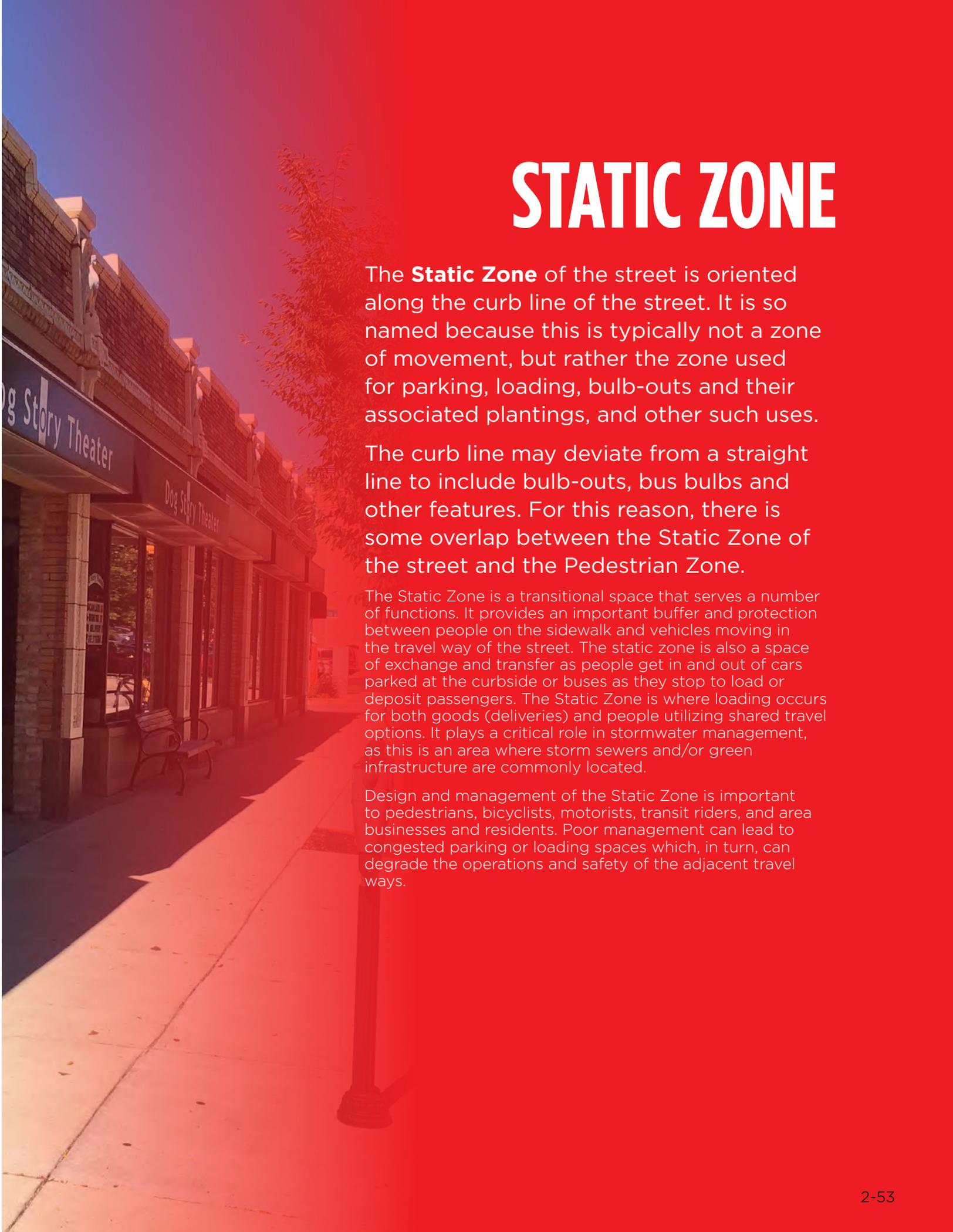
## SPECIAL CONSIDERATIONS

- Access to and from a bike share station must be considered, especially when located outside of the roadway. The placement should maximize convenience for bike share users, yet minimize conflicts with pedestrians and discourage the need for bicyclists to access the station by riding on the sidewalk.
- Access for station maintenance and bicycle resets should also be considered.

## REFERENCES

- APBP Bicycle Parking Guidelines, 2nd Edition, 2010
  - Chapter 2. Facilities
- APBP Essentials of Bike Parking: Selecting and Installing Parking that Works, 2015
  - Section 03: Long-Term Parking [http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle\\_Parking/EssentialsofBikeParking\\_FINA.pdf](http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle_Parking/EssentialsofBikeParking_FINA.pdf)





# STATIC ZONE

The **Static Zone** of the street is oriented along the curb line of the street. It is so named because this is typically not a zone of movement, but rather the zone used for parking, loading, bulb-outs and their associated plantings, and other such uses.

The curb line may deviate from a straight line to include bulb-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 way 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 to load or deposit passengers. The Static Zone is where loading occurs for both goods (deliveries) and people utilizing shared travel options. It 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 ways.



# 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 provides traffic calming benefits. On-street parking buffers pedestrians from adjacent traffic, which can be critical to providing a comfortable walking and bicycling environment on fast-moving, heavily-trafficked streets where a cycle track or sidewalk may be located adjacent to the curb. In residential areas, on-street parking provides residents and visitors with short-term and overnight parking spaces. On-street parking may be aligned along the roadway, parallel to the curb, at an angle to the curb, or perpendicular to the curb, depending on the width and operation of the street.

## USE

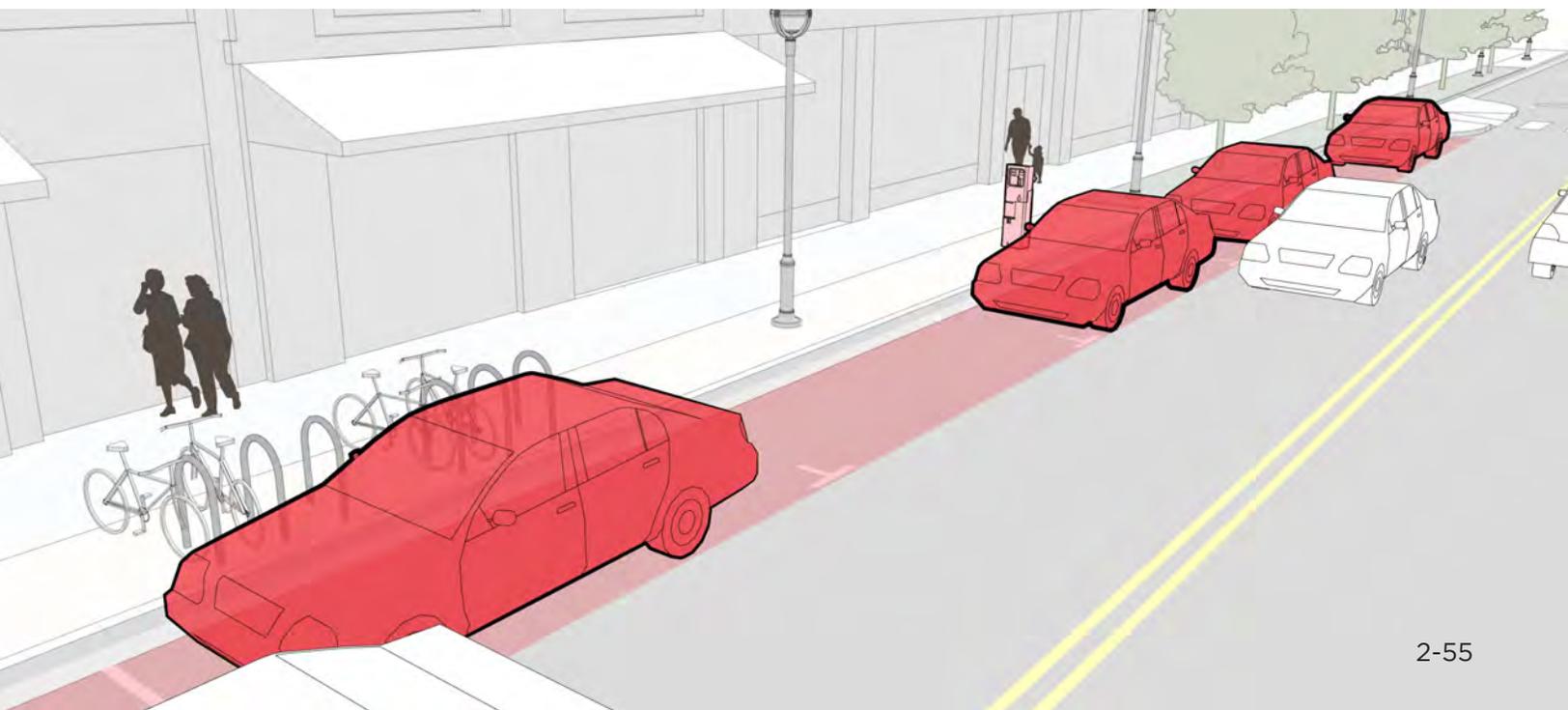
- On-street parking is generally appropriate on all street types, although it may be less common on limited access Crosstown Connector streets.
- While valuable, on-street parking is a benefit, not a need on most streets. Vital Streets must first safely accommodate the mobility needs of all travelers, before using right-of-way space for parking.
- Where rights-of-way are narrow, on-street parking may be removed to meet recommended sidewalk widths or other travelway needs.
- On-street parking must be effectively managed such that one or two parking spaces are generally available on every block to prevent motorists from circling the block looking for parking and unnecessarily adding to traffic volumes. Pricing is often the most effective means of managing curbside parking.
- On-street parking may be located on one or both sides of the street.
- Parallel parking spaces may also be used for loading and drop off.
- Angled parking uses less linear curb length per parking space than traditional parallel parking so more spaces can be provided on the same block, but only in locations with sufficient right of way widths. Angled parking is generally limited to lower speed, lower volume streets and is generally not suitable for commercial loading purposes.

- If angled parking is desired, back-in angled parking should be utilized as it improves sight lines and can be used in combination with bicycle lanes. Front-in angled parking can create safety issues given the poor visibility while backing out of spaces. It cannot be used in combination with standard bicycle lanes.

## DESIGN

- Typically, on-street parking is oriented curbside, parking parallel to the curb. While perpendicular or angled parking are also acceptable configurations, they are only appropriate on wider streets and generally those without bicycle facilities. If a street is intended to serve both bicycle facilities and angled parking, then back-in angled parking should be used.)
- Parking spaces may be marked or unmarked depending on how they are managed. In commercial areas, individual 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 of parked vehicles into adjoining travel ways. At minimum, white pavement markings should indicate the limit of allowed parking in the vicinity of intersections. In residential areas, parking spaces are generally unmarked.
- Parallel curbside parking spaces require a minimum of seven feet of width and 18 feet of length, 8 feet wide by 22 feet long is preferred, inclusive of the gutter pan. When using MDOT funds in commercial areas and along bus and truck routes, eight feet is required. A wider parking lane may be considered in loading zones with frequent large vehicles (e.g., large trucks, school buses) taking into consideration the street type and turnover expected.
- Parking shall be prohibited within 15 feet of either side of fire hydrants per current City Code.
- Parking should be prohibited at least 20 feet from nearside of midblock crosswalks, but presently there is no code requirement to prohibit parking a minimum distance from midblock crosswalks.
- Parking should be prohibited at bus stops.
- Parking should be restricted within 30 feet of traffic controls to maintain clear line of sight and all other areas prohibited by city ordinance (Chapter 181, Article 4, Section 10.45).<sup>16</sup>
- Parking may be immediately adjacent to the curb or, if used in conjunction with protected bicycle lanes or other similar treatments, aligned some distance from the curb.

<sup>16</sup> [https://www.municode.com/library/mi/grand\\_rapids/codes/code\\_of\\_ordinances?nodeId=TITX--TRAFFIC\\_CH181GETRRE\\_ART4PARE\\_S10.45PRPA](https://www.municode.com/library/mi/grand_rapids/codes/code_of_ordinances?nodeId=TITX--TRAFFIC_CH181GETRRE_ART4PARE_S10.45PRPA)



-  Permeable paving such as pervious concrete or pavers should be considered for stormwater management.
-  On streets with narrow sidewalks, where tree planting is limited by conflicts with utilities or driveways, or where there is a desire to visually narrow the roadway, landscaped planters or subsurface tree cells may be placed between parking spaces at regular intervals. The planters should not exceed the width of the parking lane.

### SPECIAL CONSIDERATIONS

- The U.S. Access Board Draft Public Rights-of-Way Accessibility Guidelines (PROWAG) provides guidance on accessible parking spaces.<sup>17</sup> If parking meters are present, they 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 installed with payment slot roughly 40" high (from the surface of the sidewalk) and viewer at roughly 42".
- Designated handicapped parking zones should be provided, particularly adjacent to locations where there is known to be high demand for such spaces.
- The State of Michigan has two types of handicapped parking placards—one with a special seal, which means free parking, and one without the special seal, which gives the vehicle the ability to park at the blue designated meters but they need to pay the meters. The handicapped license plate is the latter (pay).
- Curbside parking may introduce conflict with bicyclists within the first two to three feet of a parked car. This is known as the “dooring zone”—the area where auto drivers or passengers may inadvertently open their door into a passing bicyclist. Parking lanes and adjacent facilities should be designed with adequate space to minimize such risks. Moving on-street parking away from the curb to act as a buffer between a bicycle facility and vehicle travel lanes reduces this risk.
- On-street parking may be combined with bulb-outs, parklets, platform dining, bike parking corrals, or other curb zone uses

to enhance the pedestrian experience, safety and multimodal access, particularly in commercial areas.

- In residential areas, residential permit parking may be used as a management strategy for preserving resident access to curbside parking at times when demand from nearby uses might otherwise constrain availability. When applied, parking is restricted to two hours for any vehicle lacking a resident-parking permit. Application of this program is based on request from individual neighborhoods, and documentation of impacts from non-neighborhood uses.

### MANAGEMENT AND OPERATIONS

- Where it is not precluded by heavy vehicles, the parking lane can be paved in concrete or special paving materials to match the pavement used on the adjacent sidewalk.
- Particularly on active commercial streets or areas with high pedestrian volumes or numerous cafes and restaurants, the parking lane may be used for flexible active uses such as café seating on a temporary or semi-permanent basis.
- On-street vehicle parking spaces may be converted to bicycle parking or bicycle parking may also be provided in the parking lane where there is not enough room to park a car, such as between driveways. One 20-foot parking space can accommodate up to 12 bicycles on six U-racks in a bike coral without cluttering limited sidewalk space.
- Head-in angled parking is discouraged because of the lack of visibility between bicyclists and drivers backing out of spaces.
- Back-in angle parking provides motorists with better vision of bicyclists, pedestrians, cars, and trucks as they exit a parking space and enter moving traffic. Back-in angle parking also eliminates the risk of opening a door into traffic that is present in parallel parking situations.
- Snow removal from on street parking spaces is generally completed by the city, however this is a lower priority than clearing travel ways. When necessary, on-street parking spaces may be used for snow storage.

<sup>17</sup> <http://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/background/access-advisory-committee-final-report/x02-6-vehicular-ways-and-facilities>

## REFERENCES

- City of Grand Rapids Street Classification Policy, 1996; Section 6. On-Street Parking, 6.1
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.6.5: Bicycle Lanes and On-Street Parking
- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
  - Section 4.20: On-Street Parking
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
  - Chapter 9. Traveled Way Design Guidelines: On-Street Parking Configuration and Width <http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad>
- MMUTCD, 2011
  - Part 2 Signs: Chapter 2B. Regulatory Signs, Barricades, and Gates [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2b\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2b_2011.pdf)
  - Part 3 Markings: Chapter 3B. Pavement and Curb Markings; Section 3B.19: Parking Space Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)
- MDOT Traffic and Safety Notes
  - Notes Manual 705A Angled Parking [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_note705a.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_note705a.pdf)

## DETAILS

- MDOT Pavement Marking Standards
  - PAVE-956-B Parking Area Pavement Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-956-b.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-956-b.pdf)
  - PAVE-957-A Back-In Angle Parking [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-957-a.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-957-a.pdf)





# PARKING METERS

Parking meters are generally provided within the parkway/furnishing zone of the street, but are discussed here in conjunction with curbside parking.

Meters are one means to manage parking utilization and ensure there is adequate availability of parking at any given point in time. Parking meters permit payment for the use of curbside space. Parking meters may control only one space or multiple spaces. Modern parking meters accept a range of payment methods, including coins, paper bills, and credit. Parking may also be paid for without the use of a meter by way of online or cellphone payment options. More advanced meters can communicate payment and occupancy status to a central control center enabling real time information-sharing and management.

Multi-space meters use a single payment kiosk to manage payment for a number of spaces on that block or in the area. They may use a unique identifier, such as a space number or the license plate of the vehicle, or may issue a ticket for display in the car window.

## USE

- Metered parking is generally implemented in commercial or mixed-

use districts where there is significant competition for curbside space. Parking meters are generally unnecessary and potentially inappropriate in areas where parking demand is low.

- Metering should only be in effect during hours of demand where curbside occupancy routinely exceeds 85%.

## DESIGN

- Multi-space meters typically govern 10 parking spaces per kiosk and may utilize “pay by space”, “pay and display,” or “pay by license plate” technologies. Multi-space meters should be conveniently located to access all the spots adjacent to the area.
- Smart single-space meters govern only a single space and are mounted with no more than two meters per 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 installed with payment slot roughly 40” high (from the surface of the sidewalk) and viewer at roughly 42”.
- Smart meters should be configured to allow payment through credit cards or mobile devices. They should transmit information wirelessly to Parking Services

and facilitate real-time monitoring and maintenance.

- Meters should be located a minimum of 18" from the curb. A clear path should provide access to and from parked cars to the pedestrian clear zone.

## SPECIAL CONSIDERATIONS

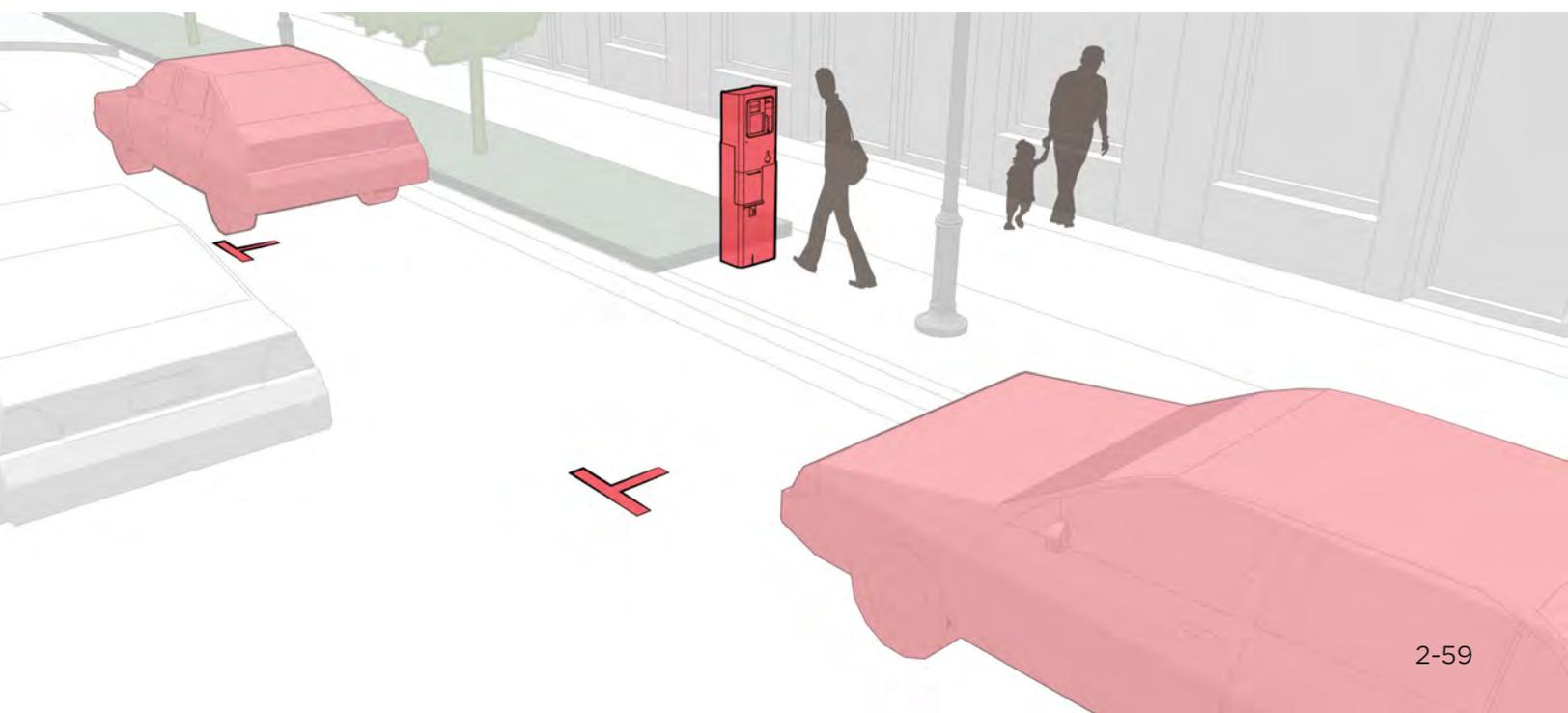
- If possible, meter rates should be adjusted appropriate to both time of day and location to respond to varying levels of demand.
- Signage should indicate the location of multi-space meters, days and hours of parking meter operation, and any limitations on parking duration.
- Smart meters allow drivers to pay using a variety of different payment methods, while maintaining parking revenues due to the more efficient utilization of parking spaces by customers. Smart meters should be solar-powered and should be located to receive adequate sunlight to ensure reliable operation.

## OPERATIONS AND MAINTENANCE

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

## REFERENCES

- MDOT Pavement Marking Standards
  - PAVE-956-B Parking Area Pavement Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-956-b.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-956-b.pdf)
  - PAVE-957-A Back-In Angle Parking [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-957-a.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-957-a.pdf)
- MDOT Pavement Marking Standards; PAVE-955-B On-Street Parking Zone Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-955-b.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-955-b.pdf)
- MDOT Standard Highway Signs; SHS-E01-REG "R" Regulatory Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)
- MDOT Traffic and Safety Notes
  - Notes Manual 705A Angled Parking [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_note705a.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_note705a.pdf)





# LOADING ZONES

A loading zone is a dedicated space at the curbside intended for short-term use to directly service nearby businesses or properties. There are typically two types of users of loading zones – freight trucks for the receipt or delivery of goods and passengers for pick up or drop off.

Loading zones help promote a strong economy and a vibrant retail environment. A sufficient number of loading zones, appropriately located and designed, can dramatically improve the safety, operation, and vitality of a street. Locating loading zones adjacent to commercial uses may reduce the incidence of trucks double-parking and the cost of goods delivery borne by local businesses and their consumers. However, loading zones also take up space that could otherwise be used for parking, pedestrian, or transit space, and therefore should be well managed to optimize use.

## USE

- Loading zones are intended for short duration parking of 20 minutes or less. Loading zones are typically reserved for only a portion of the day and used for general parking or travel at other times. Increasingly in downtown areas, off-peak loading hours are encouraged—particularly midday or late evening.
- Loading zones are generally used by a number of businesses or properties on a block and are a shared resource. There is typically one 40-foot loading zone per block.
- Alleys should be used for loading whenever possible. Off-street loading facilities are generally required for new developments and should be designed and managed to facilitate their use.

- Loading zones in high demand areas must be effectively managed to mitigate against trucks double-parking in travel lanes. Pricing is often the most effective means of managing access and balancing demand with supply, especially when pricing aligns with time-of-day strategies to shift loading activity away from periods of peak short-term parking demand.

## DESIGN

- Loading zones intended for material deliveries shall be designed to accommodate, at minimum, a single-unit 30-foot delivery vehicle.
- Loading zones shall be eight feet wide and are typically 40 feet long.
- Loading zones shall be well-marked to indicate to other drivers they cannot park there while loading hours are in effect.
- Loading zones should be placed near intersections, and preferably on the far side of intersections, to facilitate access to and from the rear of trucks and to have close access to sidewalk ramps for moving materials into buildings. Transit stops shall not to be used for private loading.
- Loading zones shall not be located or sized such that they impede the use of adjacent crosswalks.

 As with other parking lanes, permeable paving should be considered for stormwater management in the loading zone.

## SPECIAL CONSIDERATIONS

- Sidewalk space adjacent to loading zones should be reasonably clear of furnishings, landscaping, and other obstacles.

Hydrants maybe allowed in loading zones in special circumstances, though they are strongly discouraged.

- Loading zones may be used for passenger drop-off provided trucks are not actively seeking access.
- Loading zones that are contiguous with transit stops should be monitored to ensure loading activities do not encroach into the transit zone.
- Do not plant street trees adjacent to loading zones due to potential conflicts with delivery vehicles, unless adequate space is provided for the tree canopy to grow without contacting delivery trucks.
- Taxi stands and valet service areas may be permanent or temporary, operating at specific times of day or days per year. Valet services are licensed by the City Clerk’s office in order to operate.
- Loading zones should not be placed near properties with sufficient off-street parking that could be utilized for loading and unloading.

## OPERATIONS AND MAINTENANCE

- Enforcement can be a significant concern and challenge for loading zones. Clear signage is necessary, but reliable enforcement is also required to ensure loading zones are not used for auto parking or longer duration parking by commercial vehicles.
- Delivery dwell time may be restricted in the loading zone to 20 minutes (maximum) to ensure turnover and prevent double-parking from other

delivery vehicles. Consider metering loading zones to encourage turn over.

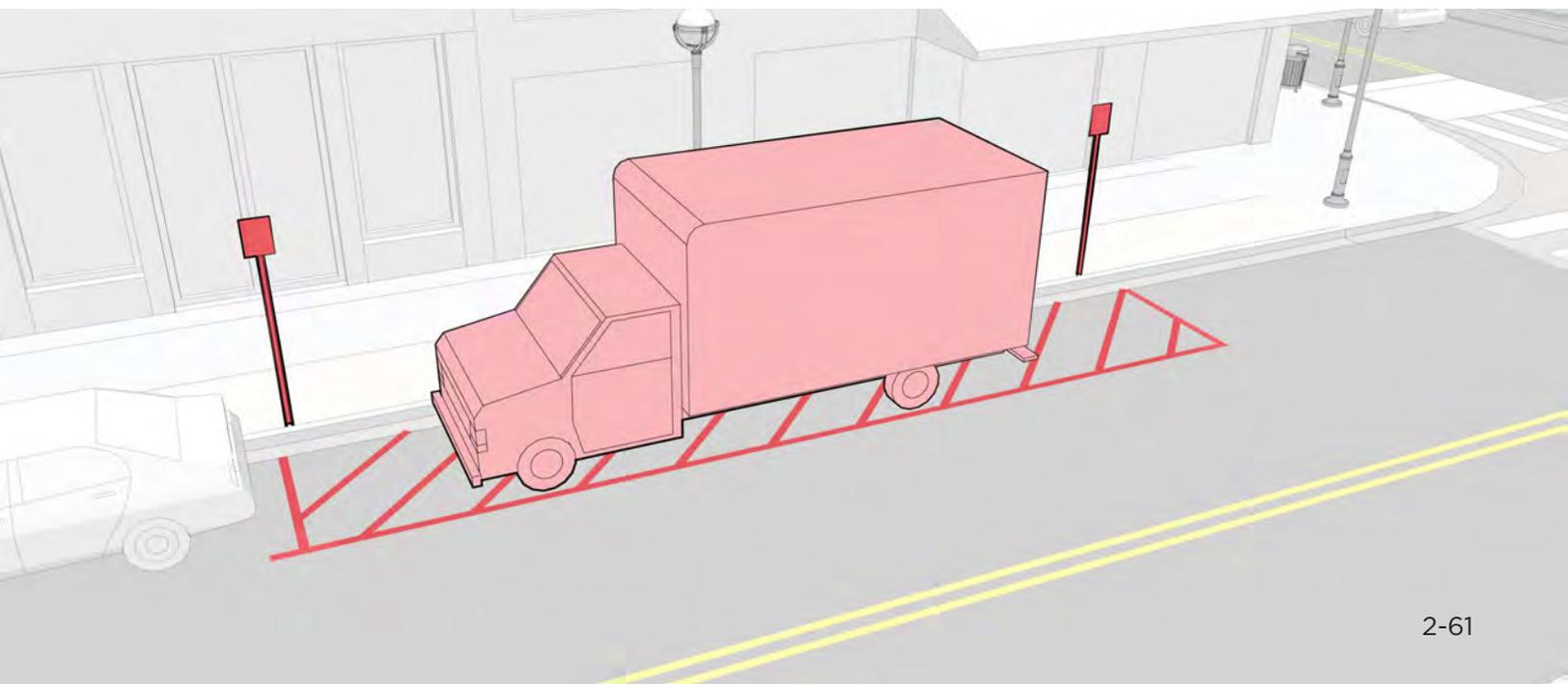
- Collaboration should be encouraged among businesses to coordinate and/or stagger delivery times to discourage double-parking if multiple businesses are sharing the loading zone.
- Loading during off-peak hours (typically early morning or late evening) should be encouraged. Consider reserving zones for loading only during these preferred times.
- Use of loading zones for other uses during non-delivery hours may be permitted. Typical uses include curbside parking (after normal metered hours), taxi stands, or valet parking operations.

## REFERENCES

- MMUTCD, 2011
  - Part 2 Signs: Chapter 2B. Regulatory Signs, Barricades, and Gates [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2b\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2b_2011.pdf)
  - Part 3 Markings: Chapter 3B. Pavement and Curb Markings
  - Section 3B.19: Parking Space Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)

## DETAILS

- MDOT Standard Highway Signs
  - SHS-E01-REG “R” Regulatory Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)





# ELECTRIC VEHICLE CHARGING STATIONS

Electric vehicle charging stations supply energy for the recharging of electric vehicles (EV), such as plug-in electric vehicles, including electric cars, neighborhood electric vehicles, and plug-in hybrids. Typically, higher speed charging facilities are desired at curbside locations to avoid long term parking at curbside locations.

## DESIGN

- All curbside electric vehicle charging stations should meet the Society of Automotive Engineers (SAE) Standard J1772, with alternating current (AC) Level 1 or Level 2 charging stations.
- Charging stations should provide a SAE J1772-2009 connector as the standard method for fueling connection.
- Charging stations should be placed near utility feeder lines, clear from traffic, and away from flood zones.
- Charging stations should be installed directly on the sidewalk a minimum of 18" from the curb. Charging stations, unlike parking meters, are best located at the center of each parking space to maximize access for different positioning of EV charging ports.
- The charging station should be protected by bollards or other measures to prevent damage or abuse.
- Signs should designate EV-only parking, instructions for use, and time limits for charging.

- On-street EV charging stations should have a cord management system to ensure functionality in inclement weather and prevent any tripping or cord tangling issues.



Increasing the number and location of electric vehicle charging stations makes it easier for people to use these types of vehicles and reduce gasoline use.

## SPECIAL CONSIDERATIONS

- EV hardware and software should be periodically tested and repaired or replaced. Stations should be connected to an online network in order to allow for software maintenance and user inquiries to be conducted remotely by an operator.
- Charging stations that provide ports for multiple vehicles may require additional or enhanced electrical service in coordination with the utility company.

## OPERATIONS AND MAINTENANCE

- An operations and maintenance agreement can be put in place with private vendors to provide service to the charging station.
- Special maintenance planning is generally required and should be part of any EV curbside charging program.



# BULB-OUTS

Bulb-outs, also known as curb extensions or 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 locations, reduced crossing distances enables shorter walk phases and greater flexibility in signal timing. At intersections, the narrower street profile, coupled with the tighter turn radii, can encourage slower driving, calm traffic, and increase safety for everyone.

- **Corner Extensions:** The most common type of bulb-out, these are located at intersections and typically wrap around the corner, extending the curb into both intersecting streets.
- **Midblock Extensions:** Also known as pinch points or chokers, midblock extensions are installed along a block face. Midblock extensions can be used to narrow a street for traffic calming, additional sidewalk space, or in conjunction with a midblock pedestrian crossing. Midblock extensions also provide space for street trees.
- **Transit Extensions:** Also known as bus bulbs, these extend the sidewalk to enable buses to board and alight passengers. Transit extensions provide critical space to install transit stop amenities and helps modestly decrease transit travel time. They can occur at far, near, or midblock locations. When used on high priority bicycle lanes, the bicycle lanes should wrap behind the transit shelter.

## USE

- Bulb-outs are appropriate on all streets, but especially encouraged on higher volume streets such as Urban Center, Network Residential, Neighborhood Commercial, and Crosstown Connector.
- Bulb-outs on streets that accommodate transit vehicles will need to carefully consider the turning radii of those vehicles. Regardless of street type, bulb-outs shall only be used where a curb lane is present and used for parking or loading, not travel.
- Bulb-outs are particularly beneficial in commercial frontage contexts where pedestrian volumes are high and activity concentrated, where traffic calming is desired, on very wide streets, and/or where sidewalks are narrow.

## DESIGN

- Bus-bulbs may be used at near-side, far-side or midblock locations, though far-side and midblock locations are preferred.
- Bulb-outs shall not narrow any bicycle or general traffic lanes to an unsafe width. The width of extensions shall preserve one to two feet of shy distance between the curb face and the first travel lane or bicycle lane. When applied to streets with on-street parking, bulb-outs are typically six to seven feet wide; alternatively, bulb-outs can shadow the length of the parking stall if parking is on the diagonal.

- Corner or midblock extensions with crosswalks shall be at least as wide as the crosswalk, and ideally extend to the stop bar. The curve of the extension must fit outside of any crosswalks.
- Bulb-outs are intended to narrow pedestrian crossing distance and slow traffic speeds. To accomplish this, maintain tight turning radii no greater than 20 feet. The effective turning radius may be wider.
- At corners with turn restrictions, use the turning radius of the extension to make the turn more difficult, ensuring that transit vehicles or through-traffic are not delayed by motorists turning. Where vehicles may be expected to mount the curb during turning, a thicker concrete section should be used to ensure durability.
- Bulb-outs shall have a 45-degree return to the street.
- Fire hydrants should be located in bulb-outs, if present.

 Combine bulb-outs with stormwater management features, such as rain gardens, trees, landscaping, or bioswales, to absorb and collect rainwater and reduce impervious surface area. However, green infrastructure in curb extensions should not create safety hazards for pedestrians.

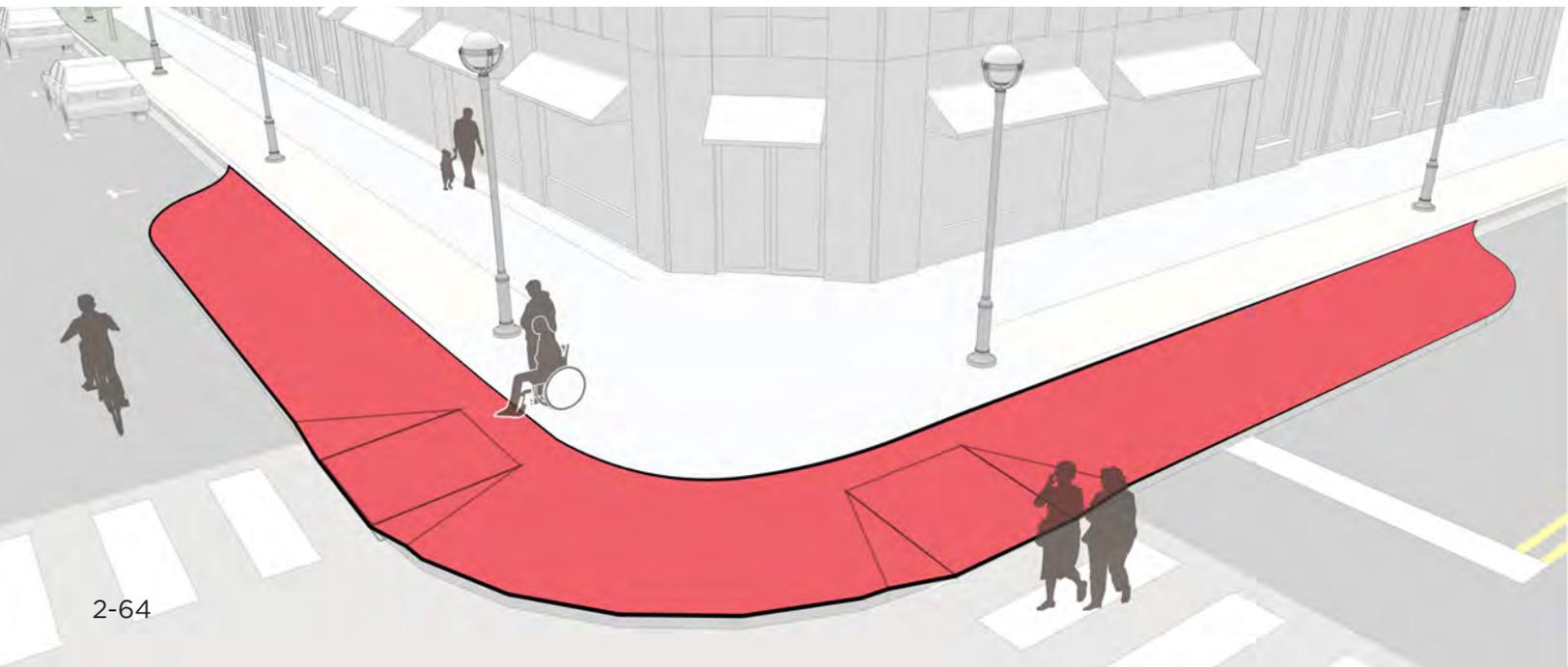
 Bulb-outs with green infrastructure should not be located on streets with more than 5% slope.

## OPERATIONS AND MAINTENANCE

- Bulb-outs can be a temporary installation, using low-cost materials such as paint, bollards, and planters. This may be useful for a location where a more expensive installation may not be warranted, or as a trial for a permanent solution. Temporary extensions, defined by rubber curbing, flexible posts, or similar, should be removed in winter months to facilitate snow removal.
- All green infrastructure applications in bulb-outs should have well developed and committed maintenance plans prior to installation.
- Bulb-outs may make snow removal and/or street sweeping more complicated, though special equipment should not be necessary if they are designed with return radii adequate to accommodate snow removal and sweeping vehicles.

## SPECIAL CONSIDERATIONS

- Any street furniture or landscaping in a bulb-out shall maintain clear pedestrian accessible routes and access to ramps. Any objects located in the extension such as furnishings or landscaping, must not interfere with corner sight triangles.
- Bulb-outs are an effective way to restrict parking near intersections and maintain or increase visibility at corners. Consider making the extension at least 20 feet long, to prevent motorists from parking within 20 feet of an intersection. However, if trees are planted in a bulb-out, ensure that sight distances are not impacted at intersections.



- Bulb-outs may be ideal locations for bicycle parking. Ensure parked bicycles do not obstruct pedestrian paths nor block the sight triangle at corners.
- Bulb-outs may have an impact on business loading, delivery access, garbage removal, and street sweeping. If well-managed and designed, they can serve as a location to consolidate business waste for removal where alleys do not exist.
- Bulb-outs may limit the ability to change the street design in the future, such as the location of bus zones, lane layout, and crosswalks. They may also make the street less flexible for construction routing.
- The design of bulb-outs must be cognizant of stormwater drainage and avoid ponding of water at the curb. Where bulb-outs conflict with stormwater facilities, the stormwater facilities must be relocated, additional inlets provided to enable proper drainage, or replaced with green infrastructure where soil conditions allow.
- Bulb-outs may require relocating utilities. They may also require moving a fire hydrant closer to the extended curb to ensure emergency vehicle access, which may increase cost. Alternatively, bulb-outs help enforce parking restrictions, making hydrants more readily available.
- Curb painting is not necessary, but subject markers or proper signage should be installed.

## REFERENCES

- City of Grand Rapids Standard Construction Specifications, 1993 Edition
  - Standard Details P-5 Curb and Separate Gutter, Roll Curb and Gutter and Combined Curb and Gutter Details
- City of Grand Rapids Street Classification Policy, 1996
  - Section 9. Bus Movement
  - Section 10. Streetscape
- City of Grand Rapids Downtown Alliance Streetscape Design Guidelines
  - Corner Bump-out with Transit Stop Option
- NACTO: Urban Street Design Guide, 2013
  - Street Design Elements: Bulb-outs <http://nacto.org/publication/urban-street-design-guide/street-design-elements/curb-extensions/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 2.6.2: Traffic-Calming Methods
  - Section 3.3.1: Curb Radii
  - Section 3.3.2: Crossing Distance Considerations
  - Section 3.3.3: Turning Movements
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.6: Bicycles and Traffic Calming
- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
  - Chapter 10. Intersection Design Guidelines: Bulb-outs <http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad>

## DETAILS

- City of Grand Rapids Standard Construction Specifications, 1993 Edition
  - Standard Details P-5 Curb and Separate Gutter, Roll Curb and Gutter and Combined Curb and Gutter Details



# BUS BULBS

Bus bulbs are a transit bulb-out that facilitates in-lane transit stops on streets with on-street parking. They are also commonly called transit bulbs as well as boarding bulbs or side transit islands depending on the street assemblage. Bus bulbs improve transit operations, speed, and reliability by eliminating the need for buses to merge in and out of traffic at stops. Bus bulbs also can provide additional space for enhanced passenger amenities and highlight the presence (and option) of transit. Bus bulbs shorten the pedestrian crossing distance, benefiting people walking. Bulbs should be prioritized 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 at stops.

## 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 are time-restricted (e.g. sometimes travel lanes, sometimes parking).
- Bus bulbs may be used on streets with bicycle facilities (lanes, protected or buffered) with accommodating design at stops (see special design considerations below). In this instance, bus bulbs are commonly called side boarding islands.
- Bus bulbs are most appropriate in commercial or retail areas where they can facilitate pedestrian street crossings. They are also appropriate at transit stops with moderate to high passenger volumes where sidewalk space is insufficient to adequately accommodate both transit passengers and pedestrian needs. Locations where vulnerable users of the street, such as older adults, children, or persons with disabilities frequently cross the street, should also be priorities.

- They may be used for near-side, far-side or midblock stops, though far-side and midblock stops are preferred.

## DESIGN

- Bus bulbs can shorten the distance required for transit stops. The length must, however, remain long enough so that all doors of buses may open onto the bus bulb-out “platform”.
- Stops with multiple routes and/or high frequency transit service may require longer bus bulbs to accommodate two or more buses.
- Bus bulbs extend from the curb edge out to within two feet of the outside of the travel lane (the lane in which the bus is traveling) or a bicycle lane.
- Bus bulbs should have a return angle of 45 degrees and five 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.
- Transit amenities (e.g. transit sign poles, shelters, waste receptacles, seating, etc.) should generally be located on bus bulbs, provided adequate clearance requirements are met for landing zones, adjacent clear pedestrian zone and clearance between fixtures, fixtures and curb, and fixtures and bicycle facility (if present).
- Bus bulbs may be located adjacent to driveways, alleys, and other curb cuts provided that adequate space and return angle is provided for their access and egress. Adequate sight-distance should be provided.

 Bus bulbs provide an opportunity to incorporate pervious pavement and landscaping. Landscaping may include stormwater retention and/or filtration provided it does not conflict with the transit loading space.

## SPECIAL CONSIDERATIONS

- On streets with bicycle facilities, provide cut-through for curbside bicycle lanes and cycle tracks behind bus bulbs.
- Near-side bus bulbs with a right turn restriction should be designed with the curb to self-enforce the turn restriction.
- Bus bulbs allow buses to stop in the travel lane and thus may cause occasional traffic delay behind transit vehicles.
- Bus bulb retrofits may require drainage modification.
- When transit vehicles turn right after stopping at a bulb, pulling back the stop bar on the intersecting street ensures that the vehicle can make the right turn.
- Bus bulbs must not impede storm water drainage from the street. Utility vaults should not be located in bus bulbs. Bulbs may be added without reconstruction of the curb, provided that stormwater drainage is adequately handled and sidewalk cross slopes are ADA compliant.

## OPERATIONS AND MAINTENANCE

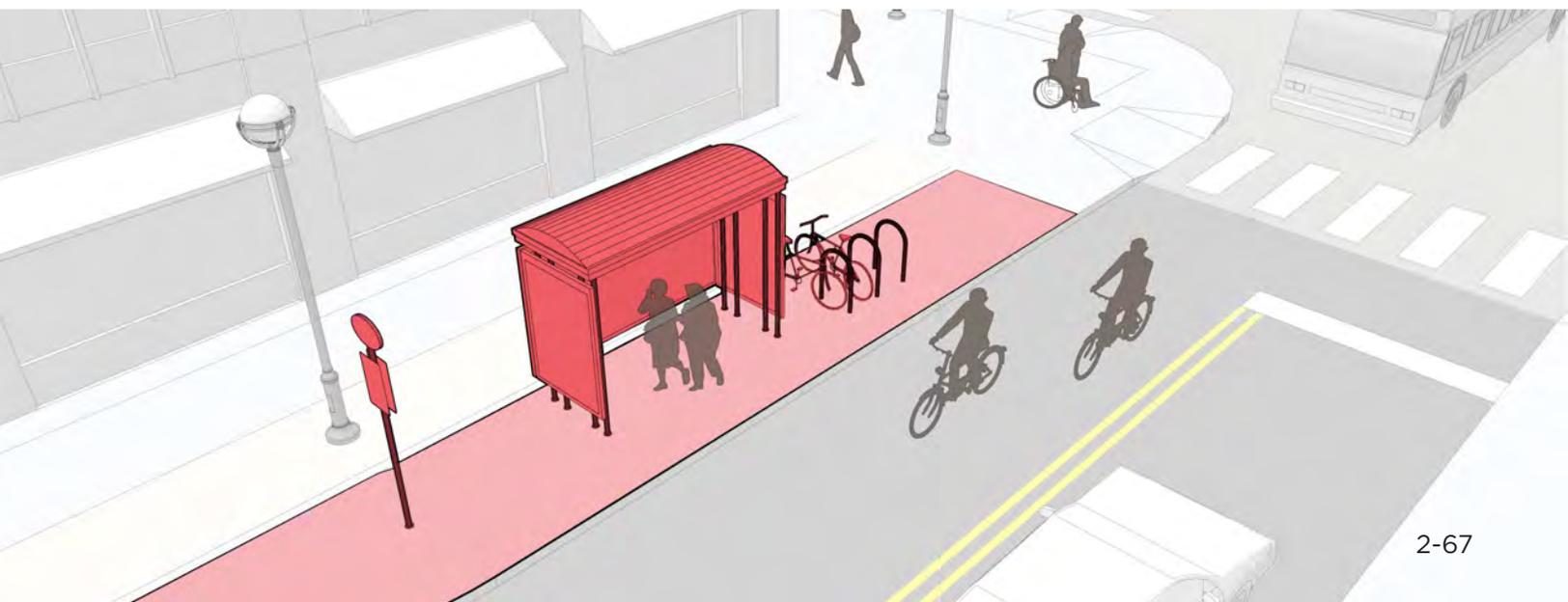
- Bus bulb-outs should not be used for snow storage and should have a maintenance plan for snow clearance.

## REFERENCES

- City of Grand Rapids Standard Construction Specifications, 1993 Edition
  - Standard Details P-5 Curb and Separate Gutter, Roll Curb and Gutter and Combined Curb and Gutter Details
- City of Grand Rapids Street Classification Policy, 1996
  - Section 9. Bus Movement
  - Section 10. Streetscape
- City of Grand Rapids Downtown Alliance Streetscape Design Guidelines
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- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.6: Bicycles and Traffic Calming
- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
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## DETAILS

- City of Grand Rapids Standard Construction Specifications, 1993 Edition
  - Standard Details P-5 Curb and Separate Gutter, Roll Curb and Gutter and Combined Curb and Gutter Details





# PARKLETS

Streets can provide ample opportunity to turn underutilized spaces in urban areas into attractive amenities for public interaction, art, dining, or other activated uses. Parklets are temporary or seasonal mini plazas located in the parking lane. Often the product of a partnership between the city and local businesses, residents, 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 convert curbside parking spaces into a public seating platforms, with plantings, landscaping, and/or bicycle racks.
- 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 their outdoor dining seating capacity and public space on a given street.
- While parklets are foremost intended as assets for the community, their presence has also been shown to increase revenues for adjacent businesses.
- Parklets generally entail the conversion of one or more parallel parking spaces, but may vary according to the site, context, and desired character of the installation. Where a parklet stretches the length of an entire curb, accessibility, turning radii, and sightlines must be taken into account.

## DESIGN

- To ensure increased protection from moving traffic and parking cars, parklets must be buffered using a reflectorized wheel stop at a desired distance of three to four feet from the parklet and include vertical elements that make them visible to traffic, such as reflective flexible posts or bollards.

- Parklets have a desired maximum width of six feet (or one foot less than the width of the parking lane).
- Parklets should have a flush transition at the sidewalk and curb to permit easy access and avoid tripping hazards.
- Parklets should avoid corners and are best placed at least one parking space away from the intersection corner. Where installation of a parklet is under consideration for a site near an intersection, volumes of turning traffic, sightlines, visibility, and daylighting should be taken into account.
- Site selection should consider the level of utilization and nearby pedestrian volumes both during the day and at night.
- Incorporate seating into the parklet. Seating may be integrated into the design itself or made possible with moveable tables and chairs. If seating is built in, at least one space needs to be open for accessible seating for a person with a wheelchair/scooter.
- Designs for the substructure of a parklet vary and depend on the slope of the street and overall design for the structure. The substructure must accommodate the crown of the road and provide a level surface for the parklet.
- Parklets should use a slip-resistant surface to minimize hazards and should be accessible to wheelchair users.
- Parklet floor load-bearing weight standards vary. At a minimum, design for 100 pounds per square foot.
- Parklets must not block or impede drainage or stormwater inlets. Small channels between the base and the platform can be used to facilitate drainage along the curb and gutter.
- Parklet siting shall avoid obstructing underground utility access and electrical transformer vaults.
- All parklets shall comply with the Building Code if constructed on a platform.
- Parklets should not use any flammable materials or be constructed in a manner which would violate the Finish Materials chapter of the City's Building Code.
- Bicycle parking may be incorporated into or adjacent to the parklet.

## SPECIAL CONSIDERATIONS

- Parklet locations should consider the speed of adjacent traffic, the presence of nearby bicycle facilities, bus stop locations, and parking demand and turnover.

## 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 trash and debris. Where no local partners are present, a parklet may be installed and managed by the city as a traditional park or public space.
- Parklets should be removed during the winter to prevent conflicts with plows and street cleaning vehicles.

## REFERENCES

- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 3.2.13: Ambience, Shade, and Other Sidewalk Enhancements



# BICYCLE PARKING CORRALS

Bicycle parking corrals are bicycle racks installed in the curb lane of the street where automobiles typically park. 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. Typically, one vehicle parking space can 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 and parkway zone dimensions are narrow and where bicycle racks located on the sidewalk would impede pedestrian flow.
- Proposed bicycle parking corrals need to be reviewed by the City for traffic safety and operations issues as well as for concurrence with required City codes.

## DESIGN

- Bicycle parking corrals should provide enough 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 bike corral should be demarcated using paint, bollards, rubber curb, or planters. A curb stop or other hard deflector should be four feet from the corral.
- The rack must support the bicycle frame in at least two places, allowing both the frame and the wheel to be locked. Bicycle racks should prevent the bicycle from tipping over, and allow both front-in or back-in parking.
- 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 or commercial areas.
- All proposed corral designs must go through the City's Art Advisory Committee, which can be found here: [grcity.us/city-manager/Documents/2777\\_1100-06.pdf](http://grcity.us/city-manager/Documents/2777_1100-06.pdf).

## SPECIAL CONSIDERATIONS

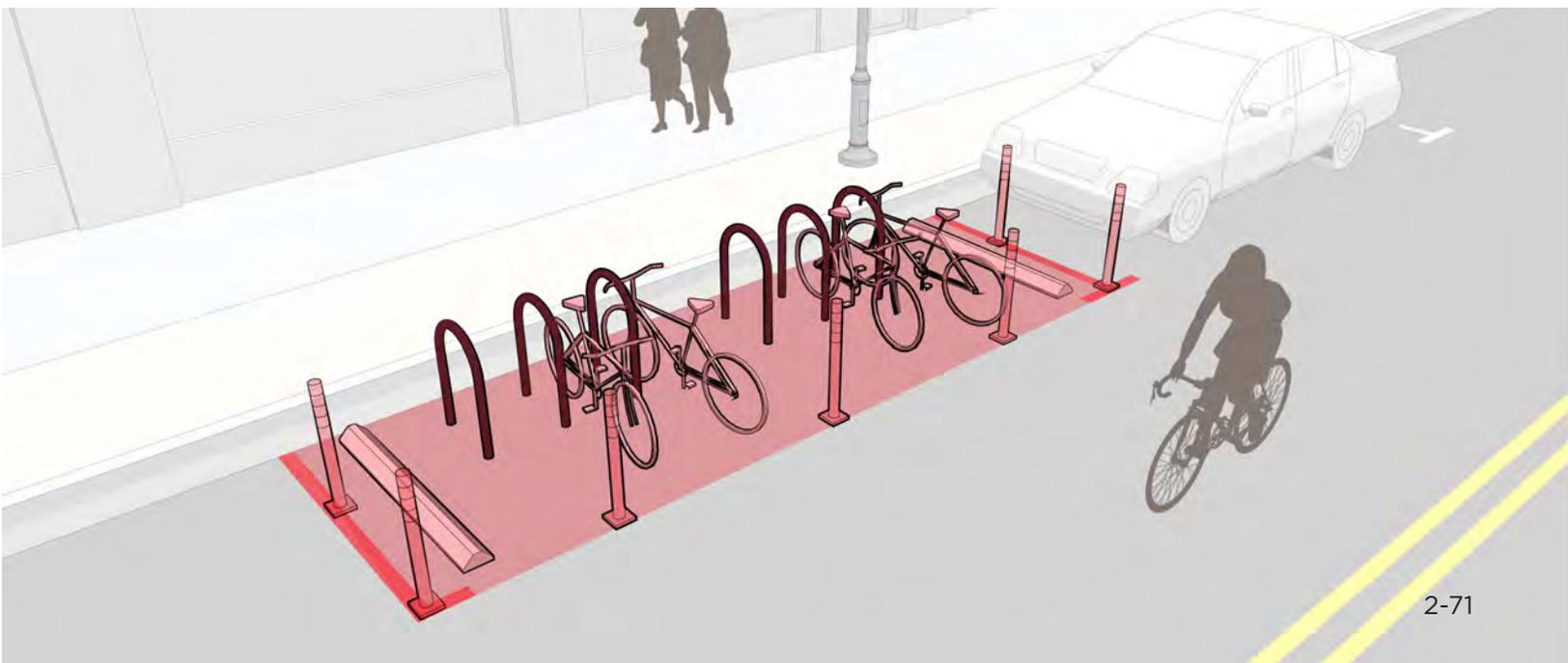
- Bike corral locations should consider the speed of adjacent traffic, the presence of nearby bicycle facilities, bus stop locations, and parking demand and turnover.
- Distinctive or special bicycle rack designs can be used for place-making in certain areas, such as downtown or commercial districts. However, a maintenance plan should also be developed so any non-standard racks are adequately maintained and can be reasonably replaced if damaged.
- Bike corrals located at street corners can also improve visibility at intersections by eliminating the opportunity for larger vehicles to park at street corners. By creating de facto bulb-outs to shorten pedestrian crossings, bike corrals improve visibility for cars turning into traffic from side streets, though turning radii should be confirmed so the corral does not impact sight lines.

## OPERATIONS AND MAINTENANCE

- Bicycle racks may need to be replaced when they show signs of wear that may damage bicycles. Likewise, racks and any barriers surrounding the corral need to be replaced or removed in a timely manner if they have been damaged.
- Some designs for bike parking corrals include large planter pots, which can be maintained by local businesses, community groups, or individual volunteers.

## REFERENCES

- APBP Bicycle Parking Guidelines, 2nd Edition, 2010
  - Chapter 2. Facilities: In-street Bicycle Parking Facilities (Bicycle Corrals)
- APBP Essentials of Bike Parking: Selecting and Installing Parking that Works, 2015
  - Section 02: Short-Term Parking [http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle\\_Parking/EssentialsofBikeParking\\_FINA.pdf](http://c.ymcdn.com/sites/www.apbp.org/resource/resmgr/Bicycle_Parking/EssentialsofBikeParking_FINA.pdf)





# PUBLIC ART

Streets are public spaces and important opportunities for civic display of art, design, and place-making. Public art adds interest to the street, celebrates identity of a place or a local community, and can function as a wayfinding tool by orienting users of the street to where they are within the city. Public art has the ability to unify a district or serve as a transition between neighborhoods. Public art increases cultural awareness, stimulates imagination, and provokes creative dialog.

Ideally, public art is integrated into the overall street environment and is an organic part of the public space rather than a foreign presence dropped incoherently into the place.

## USE

- Public art adds interest to the street and can create more walkable places and unique experiences in the city.
- Public art should not introduce distraction or hazards and should not present an obstacle to mobility.

## DESIGN

- Public art in the street will be experienced by people moving at different speeds and designs should consider how the installation will be experienced by people using different modes of transportation, in different locations in the right-of-way, and at different times of the day.
- Public art can take multiple different forms. It can be two dimensional on flat surfaces such as murals, mosaics, or printing on walls, streets, or sidewalks. It may be three dimensional such as sculptures. It may be integrated into street furnishings such as seating, bicycle hoops, or light poles. It can be visual, tactile, or audible.

- The placement and design of public art should not block any portion of the roadway or pedestrian through zone, should not impede mobility, and should not distract drivers focused on the road.
- The location, installation, and design of public art should be considered early in the project development process and support the goals and objectives of the street.

## SPECIAL CONSIDERATIONS

- Community involvement is an integral piece of the public art process. Residents, business owners, and patrons should be given the opportunity to provide input on the installation of public art projects.

## OPERATIONS AND MAINTENANCE

- Public art pieces that are owned by the City of Grand Rapids will be maintained by the City, and a maintenance plan must be developed prior to installation of the art in the public space. Any specific maintenance requirements, such as preservation, landscaping, or repairs should be discussed with the artist in advance.
- For art that is not publicly owned, the sponsoring organization must have an agreed-upon maintenance plan that details maintenance responsibilities. This is typically determined during the permit process. The City reserves the right to remove any public art installation that is poorly maintained or introduces any hazard to the public.



# ALLEYS

Alleys feature low volume and low speed vehicular traffic, operating in narrow access ways typically located behind and between buildings. Alleys typically provide access to adjacent residential or commercial properties for parking or services. Alleys are shared access points that typically service a number of individual properties, thus reducing the need for numerous separate access points on the street.

## USE

- Alleys provide rear access to buildings and can provide access to parking spaces located behind the building. Alleys commonly provide service access to adjacent businesses and residences.
- Because they provide access to private properties, alleys are an important tool to limit the number of curb cuts on busier streets where people may be walking and bicycling.

## DESIGN

- Alleys should be appropriately designed for their use and operation. Alleys typically must support service vehicles such as trash trucks and delivery vehicles, and therefore must be scaled to accommodate access by these vehicles. The standard alley width in a residential area is 16 feet. In commercial areas, alleys should be 18 feet to allow trucks to utilize the alley for deliveries. Narrow widths are the most effective way to maintain slow travel speeds in the alley network.
- Alleys may have a number of turns within a block. Short sight lines deter the use of alleys by cut-through vehicles. Alleys must be designed to ensure large vehicles can negotiate turns slowly but safely.
- Lighting in alleys is important to ensure a safe environment.
- Access to parking should be from an alley, where one exists or can be provided.
-  Alleys can be an ideal location for green infrastructure that may not be possible on higher volume or wider streets. Green alleys can be constructed with low-impact pavement materials, such as pervious pavements with high reflectivity to reduce heat-island effects.
-  To avoid puddling, stormwater run-off should be infiltrated in-place using rain gardens at the edge of the alley or near entrances.

## SPECIAL CONSIDERATIONS

- Alleys are not eligible for Act 51 funding and were not planned for investment in the Vital Streets plan. While alleys are desired and encouraged, they must be privately funded.
- Parking within the alley right of way should be discouraged or prohibited.
- Alleys should not be closed wherever possible and the right-of-way preserved.

## OPERATIONS AND MAINTENANCE

- Maintenance agreements must be agreed upon with the establishment of new alleys. The City generally does not have resources for the maintenance of new alleys.
- Parking and the storage of dumpsters and other obstacles should not be permitted within the right-of-way of the alley, as this impedes vehicular access, circulation, and service in the alley.
- Maintenance and snow clearance on alleys are a low priority for the City. Abutting property owners should be encouraged and enabled to take over maintenance responsibilities.
- Snow clearing equipment should be able to pass through alleys in the winter. Alleys should not be used for snow storage.
- Due to their less visible nature parallel to the street network, alleys should have a regular repair and resurfacing cycle in order to avoid deep potholes and costly pavement repairs.

## REFERENCES

- City of Grand Rapids Street Classification Policy, 1996
  - Section 3. Driveways
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 2.4.4: Driveways and Access
  - Section 3.2.6: Driveway Access Management
- City of Grand Rapids Standard Construction Specifications, 1993 Edition
  - Standard Details P-2A Radius Alley Return and Approach Details and Sidewalk Details
  - Standard Details P-4 Combined Dub-Down Alley Approach and Sidewalk Details
  - Standard Details P-4A Standard Dub-Down Alley Approach Details
  - Standard Details P-17 Alley Pavement



# BOLLARDS & OTHER FIXED OBJECTS

Many engineering guides and older street design practices call for the pedestrian zone and the static zone to be clear of 'fixed objects' such as street trees, signs, benches, or street lighting in order to reduce the probability of a vehicle experiencing a traumatic crash if it were to leave the roadway. While maintaining a parkway or furnishing zone clear of all fixed objects may protect the occupant of an errant vehicle, it does not protect people within the street's pedestrian zone.

This policy was generally intended for higher speed roadways lacking vertical curbs where pedestrians are rarely present. Maintaining a clear zone free of fixed objects is not a controlling criteria in the National Highway System (NHS) design standards and is generally unnecessary and potentially undesirable in an urban environment.

Roads in urban contexts benefit from a lively street edge. Street furnishings provide important amenities for pedestrians by adding functionality and vitality to the street. Such furnishings include public seating, bicycle racks, trees and planters, parking meters, public art, signage, bollards, trash receptacles, and other elements. Site furnishings not only increase the functionality of the street for pedestrians and other users, but also can help separate vulnerable pedestrians from moving vehicles.

## USE

- Fixed objects in the parkway/amenity zone of the street are generally permitted

if they serve an identified functional purpose. This purpose may be to provide additional protection for pedestrians from the risk of errant vehicles.

## DESIGN

- Fixed objects must not impede or encroach upon the pedestrian clear zone of the street.
- Fixed objects must not impede access to crosswalks or any designated curbside loading areas such as bus stops or commercial zones.
- Fixed objects should maintain four feet of distance from any other fixed objects.
- Fixed objects should be set back from the curb face a minimum of 18 inches.

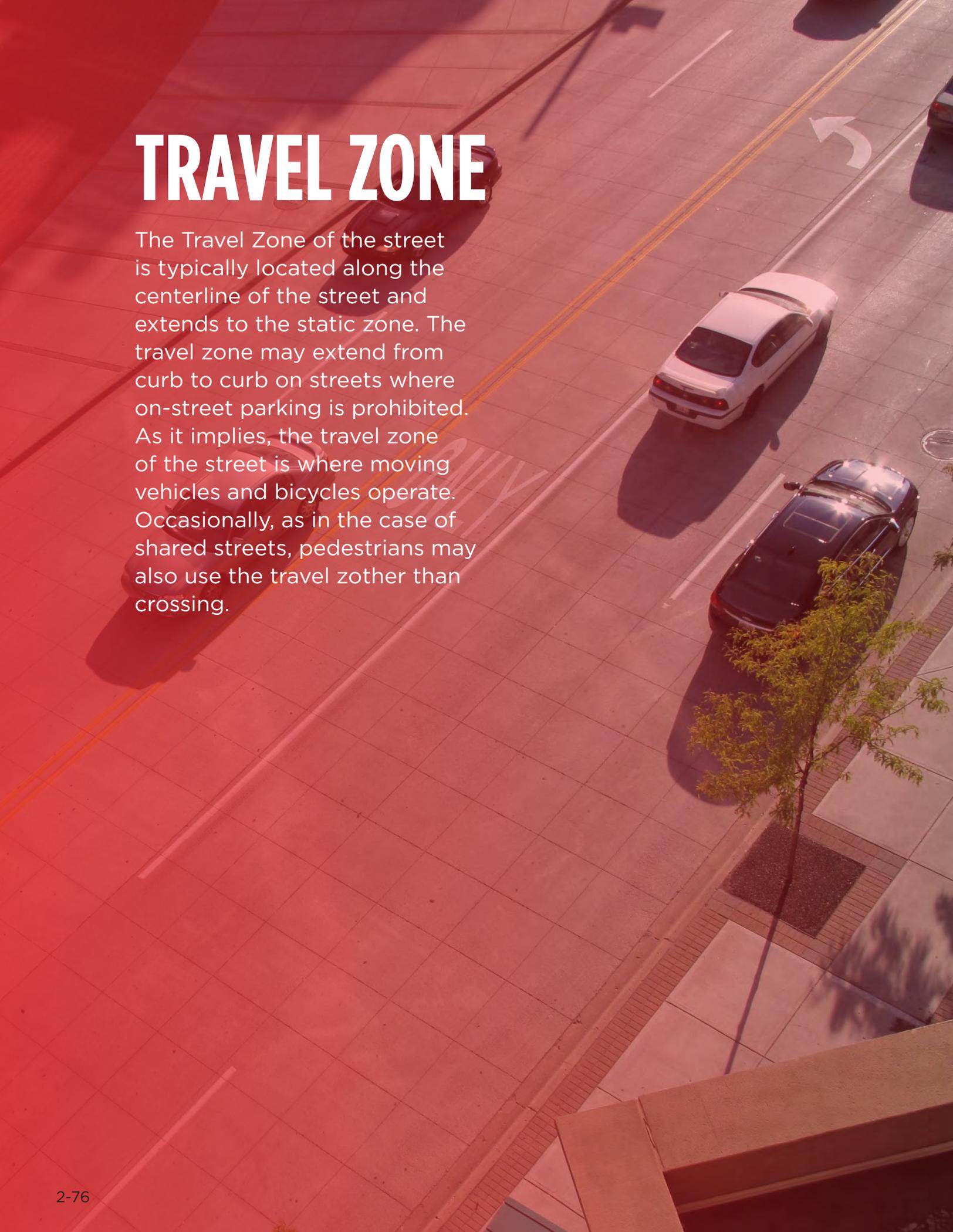
## SPECIAL CONSIDERATIONS

- Parkway and amenity zones may be used for snow storage. Snow storage should be considered when contemplating the installation of bollards or other fixed objects along the street edge.

## OPERATIONS AND MAINTENANCE

- Street designers should consider the impact of fixed objects on the cost of or ability to maintain streets.
- Depending on the nature of the fixed object, maintenance agreements may be required.

# TRAVEL ZONE

An aerial photograph of a city street, viewed from a high angle. The street is paved with light-colored concrete or asphalt, featuring double yellow lines down the center and white lane markings. A white sedan is driving in the right lane, and a dark sedan is in the left lane. A small tree with green leaves is planted on the sidewalk to the right. The entire image has a semi-transparent red overlay on the left side, where the text is located.

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 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 25 mph. Shared streets should be designed to encourage speeds no greater than 15 mph. The speed limit is the maximum permitted speed, and the street must be safe to travel at this maximum speed (the speed limit). However in some street types—such as Neighborhood Residential and Urban Center—and in some areas, school zones, the desired speed may actually be lower than the maximum permitted speed.

The dimensions and assemblage 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 can reduce the distance needed to cross a street as well as impacts on the community. Minimizing travel lane widths can also provide space for facilities for the safe movement of other users in the street right of way, such as transit bulbs, wider sidewalks, street trees, or bicycle facilities.

The widespread application of 12-foot travel lanes is due to the belief that they improved safety by reducing the probability of side swipe crashes and increased vehicle throughput. However, research has indicated that in most cases, travel lane widths between 10 feet and 11 feet on urban arterials do not negatively impact overall motor vehicle safety or operations, and also have no measurable effect on capacity.<sup>18</sup>

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 many streets in Grand Rapids have 12-foot travel lanes, 10-foot travel lanes are more appropriate where posted vehicle speeds are 45 mph or less.<sup>19</sup>

<sup>18</sup> Potts, Ingrid B, Harwood, Douglas W and Richard, Karen R. *Relationship of Lane width to Safety for Urban and Suburban Arterials*. Washington, D.C. : Transportation Research Board, 2007.

<sup>19</sup> The American Association of State Highway Transportation Officials' (AASHTO) Policy on Geometric Design of Highways and Streets (commonly referred to as the "Green Book")

Engineering judgment must be used to determine if lane widths should be expanded or narrowed from the recommended widths below.

### RECOMMENDED LANE OR TRAVELWAY WIDTHS IN THE CITY OF GRAND RAPIDS.

TRAVEL LANE / TRAVELWAY USE	RECOMMENDED WIDTH
Yield street (exclusive of on street parking generally required on at least one side)	16'
Travel lane directly adjacent to the curb	11'
Typical general purpose travel lane	10'
Turn lane	10'
Bicycle Facility	6'
Frequent transit bus lane or lane with high volume of heavy vehicles (>8%)	11'

On streets with high volumes of heavy vehicles (greater than eight percent), one 11-foot wide travel lane, inclusive of the gutter, should be provided in each direction (generally the curb-side lane).

Lane widths should consider the design of elements, their users, and the overall assemblage of the street and examine interactions between adjacent elements.

- For example, gutter pans are typically one to two feet wide with a minor seam between the gutter and the paved roadway surface. This seam is not a concern for the wide tires of a motor vehicle, but it can be problematic for the thin tires of many types of bicycles. For this reason, gutter pans may be included in the total dimension of vehicle travel lanes but should not be included as a component of bicycle lane width, particularly on bicycle emphasis streets.

It is sometimes inadvisable to choose the narrowest dimension for all elements within the static zone and travelway of the street, as this leaves little room for error.

- For example, the minimum dimension for a parking lane is seven feet. The bare minimum width for a bicycle lane is five feet when next to a curb and four feet without a curb. Travel lanes are preferred to be at least 10 feet. When these minimum dimensions are used together next to a median or centerline, there is little room for doors to open and bicycles

to maneuver around them. Increasing the bicycle lane dimension to six feet keeps parking close to the curb and maintains the perception of a narrow travel lane which reduces travel speeds.

- 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 lanes or streets, such as yield streets, do not have separately defined “lanes” but rather a generally shared space that provides the necessary lane width; they may also require vehicles to “yield” to one another as they pass. Yield streets are generally two-way low volume (fewer than 1,500 vehicles per day) low speed (less than 25 mph) streets. Rather than individual lane widths these streets have an overall clear travelway width.



# GENERAL TRAVEL LANES

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 the occasional transit vehicle or heavy truck.

Bicycles are generally permitted in the general purpose lane, especially when designated bicycle facilities are not provided on the street. When bicycles use a general purpose travel lane, it is recommended they “take the lane”—meaning people on bicycles should ride in the center of the travel lane making themselves clearly visible to vehicles approaching from the rear. As permitted users of travel lanes, it is appropriate for bicycles to assert use over the full lane just as other vehicles would. Vehicles wishing to overtake bicycles must do as they would for other vehicles—waiting to pass until the opposing lane is clear in order to cross out of the lane and safely pass the other vehicle or bicycle. Grand Rapids has a five foot passing law that is intended to improve bicycle safety as motorists make safe and legal passes around people on bicycles.

The number of travel lanes required 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 the required green infrastructure elements. When determining the number of travel lanes needed, designers should consider how the street is used throughout the day and not just during the peak hour or peak 15 minutes. Excess travel lanes during hours of the day when there are lower vehicle volumes can lead to excessive speeding and work against the objectives of self-enforcing street design. Designers must consider what will deliver the safest functional street.

## USE

- Travel lanes are typical features in all street types, although the number and width of the travel lanes varies by street type. Lower order streets (Neighborhood Residential, Link Residential, Neighborhood Business, and Maker/Industrial streets) typically features two travel lane—one operating in each direction. Because desired operating speed is low, lane widths are generally narrow. Higher order streets (Network Residential, Crosstown Connector, and Urban Center) *may* have a greater number of travel lanes; however, travel lanes may still be narrow to promote self-regulating design.
- Corridors with certain modal priority emphasis overlays—such as transit emphasis or vehicle/truck emphasis—may have wider travel lanes to facilitate their designated use.

## DESIGN

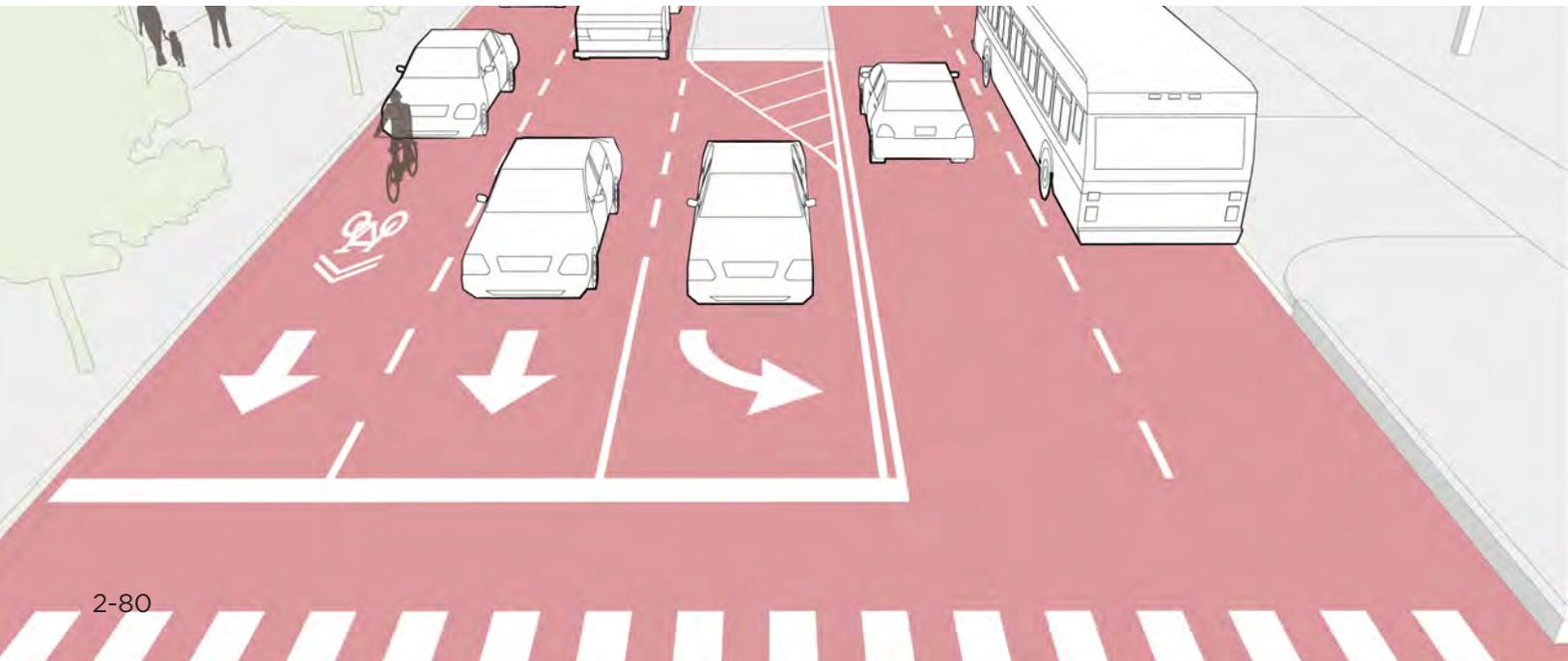
- Travel lanes must be assembled together with other roadway elements including additional lanes in the same or opposing directions, turning lanes, parking lanes, bicycle facilities, transit lanes and/or stops, and sidewalk zone facilities; engineering judgement should be applied to determine the appropriate width of travel lanes.
- General purpose travel lanes are typically demarcated with either yellow center line markings for vehicles traveling in opposite directions and/or white adjacent lane markings for vehicles traveling in the same direction.
- Markings are typically required only at the outer edge of the lane.
- Travel lanes should have a generally smooth pavement surface. Typically, this requires that streets be routinely maintained and potholes and other disruptions repaired in a timely manner.
- Utility access such as vaults and manholes, should be kept out of general purpose travel lanes to the extent possible in order to minimize risk to utility workers and minimize disruption to normal street operations when utility maintenance is required.

## OPERATIONS AND MAINTENANCE

- Travel lanes must generally be kept clear of snow and ice. They should be designed to facilitate rapid drainage.
- Travel lanes must be routinely maintained; they often suffer degradation during the cold winter months or following heavy rainfall events.

## REFERENCES

- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
- MMUTCD, 2011





# TURN LANES

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 and/or oncoming vehicle traffic in order to complete a turn. Turn lanes, particularly center turn lanes, can significantly improve vehicle throughput. Often, four-lane bi-directional streets can be reduced to one lane in each direction (with a center turn lane) and still maintain roadway vehicle capacity while creating space for other uses, such as bicycle facilities, wider sidewalks, or a parking lane. This is known as a road diet.

The assemblage of travel lanes together with turn lanes can have a substantial effect on the street experience, especially for pedestrians. Although a “typical section” taken at a midblock location may result in a relatively narrow cross section, inclusion of right- and/or left-turn lanes at intersections can dramatically increase the total roadway width and pedestrian crossing distance.

## USE

- Turn lanes can dramatically improve the throughput of vehicular corridors. However, without adding protected traffic signal phases, they do introduce additional conflict and uncertainty in their interaction with other modes. Turn lanes should only be used where necessary and after evaluation of their impact on the safety and operation of other modes on the corridor.
- Turn lanes are generally only required on higher order streets such as Crosstown Connector, Urban Center, Neighborhood Business, and Network Residential. Maker/Industrial streets may also benefit from turn lanes given the higher proportion of heavy vehicles expected on these streets.

## DESIGN

- Turn lanes are generally 10 feet wide. Center turn lanes may require slightly more generous 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 or may not be managed through separate signal phases depending on the volume and other intersection operations.

## SPECIAL CONSIDERATIONS

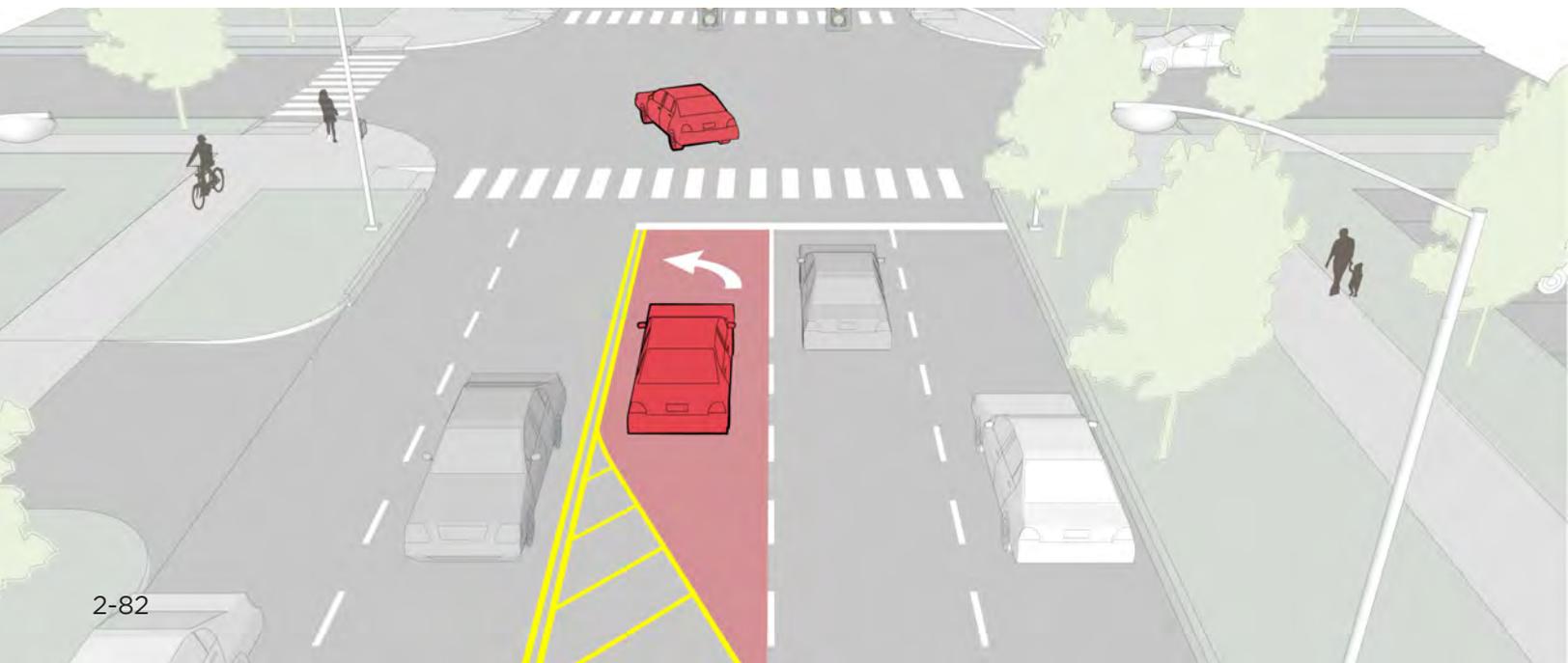
- For streets where the addition of turn lanes requires pedestrians to cross more than four lanes of traffic, look for ways to install pedestrian crossing islands to provide a safe haven for pedestrians crossing the corridor.

## REFERENCES

- MMUTCD, 2011
  - Part 2 Signs: Chapter 2B. Regulatory Signs, Barricades, and Gates [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2b\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2b_2011.pdf)
  - Part 3 Markings: Chapter 3B. Pavement and Curb Markings
  - Section 3B.01: Yellow Center Line Pavement Markings and Warrants
  - Section 3B.03: Other Yellow Longitudinal Pavement Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)

## DETAILS

- MDOT Standard Highway Signs
  - SHS-E01-REG “R” Regulatory Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)





# TIME RESTRICTED PARKING LANES

Time restricted parking lanes, also referred to as peak time restricted parking lanes, are 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 converted to other purposes, including transit lanes and bicycle lanes.

Peak time restricted parking lanes can increase the capacity of the roadway for general purpose traffic. Depending on conditions, an additional travel lane can improve capacity by 600 to 1,000 vehicles per hour. However, the capacity advantages of peak time restricted parking lanes for moving general purpose traffic assume universal compliance with the parking restriction; enforcement is required to deter illegally parked vehicles during peak hours.

## USE

- Peak time restricted parking lanes may be considered on roadways where additional capacity is needed during peak hours.
- Restricting parking, stopping, and standing at the curbside during peak hours can improve traffic capacity and flow. However the decision to restrict parking should be carefully weighed against the other vital demands on curbside use, such as loading and deliveries, parking or access for persons with disabilities, and the need to create a buffer for sidewalk users. Planners and designers should carefully evaluate the effects of temporary parking restrictions on local businesses, community character, and other roadway users.
- In some situations, there may be benefits to removing peak time restricted parking lanes where they currently exist.

## DESIGN

- Peak hour restricted parking lanes should be a minimum of 10' wide to serve as a travel lane. However, if designed at 12' wide, these lanes can accommodate both parked cars and bicycles in off-peak times.
- Bulb-outs or curb extensions should not be used on streets with time restricted parking.

## SPECIAL CONSIDERATIONS

- Converting parking lanes to general purpose travel lanes at peak times can make it difficult to install bicycle lanes due to safety concerns associated with having moving traffic on both sides of the bicycle lane. Potential solutions include separated bicycle lanes or shared travel lanes.
- Right hand turn lanes should be evaluated for conversion to time restricted parking lanes during reconstruction projects to reduce pedestrian crossing distances. Right turn lanes should be used only used in areas of heavy turning movement with significant need.

## OPERATIONS AND MAINTENANCE

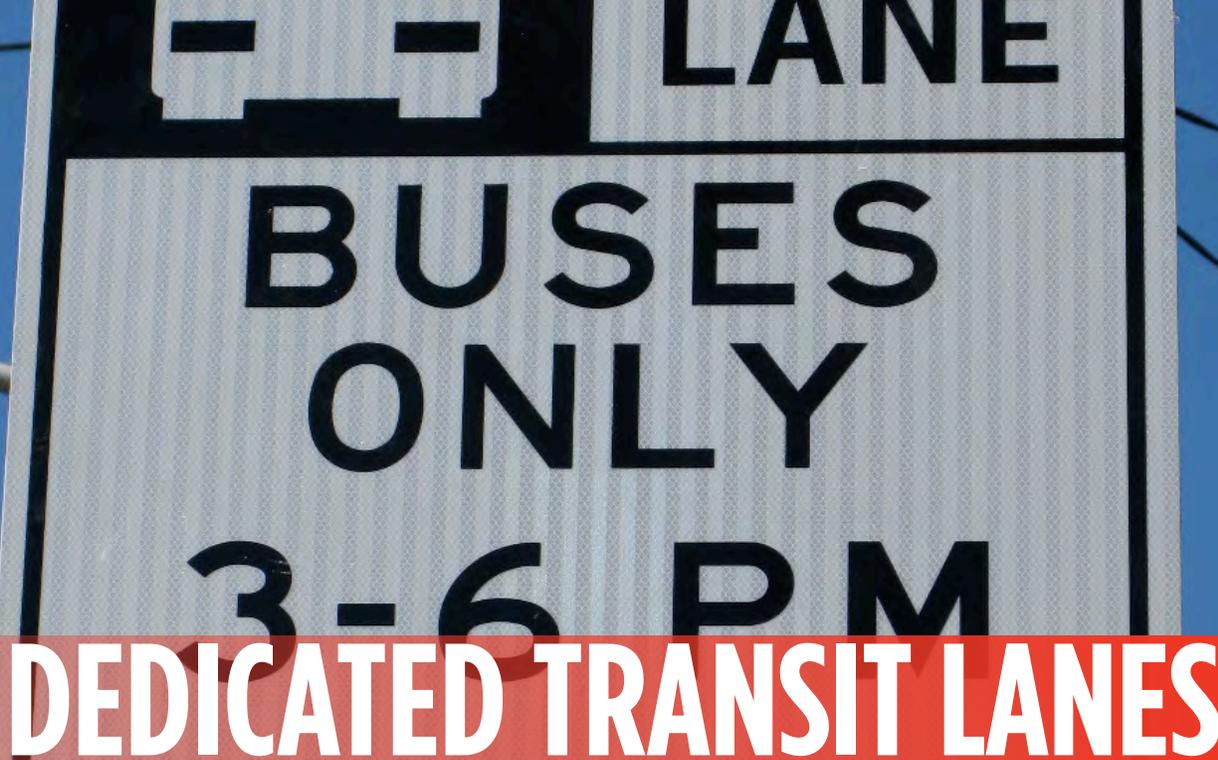
- Temporal use of the curbside space generally requires rigorous enforcement to gain the benefits desired through the restriction.

## REFERENCES

- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
  - Section 4.20: On-Street Parking
- MMUTCD, 2011
  - Part 2 Signs: Chapter 2B. Regulatory Signs, Barricades, and Gates [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2b\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2b_2011.pdf)
  - Part 3 Markings: Chapter 3B. Pavement and Curb Markings
  - Section 3B.19: Parking Space Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)

## DETAILS

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  - SHS-E01-REG “R” Regulatory Signs
  - [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)



Dedicated transit lanes are used to speed up transit services, such as bus, light-rail, bus-rapid transit on busy streets, especially those corridors with frequent service. Owing to the high passenger capacity of transit, a dedicated transit lane can drastically increase the amount of people that can move along a street. Since dedicated transit lanes reduce traffic delays and increase the reliability of high-quality transit service, they are an important part of encouraging transit use, making the service faster, more reliable, and more enjoyable.

- **Curbside lanes** are immediately adjacent to the curb on the right-hand side of the street. Curbside lanes work best on streets with few driveways and limited right turning traffic.
- **Offset lanes** operate outside of a parking lane. Bus stops are located in bus bulbs in the parking lane. Offset lanes are compromised by transit vehicles entering, exiting, and waiting for curbside parking.
- **Median lanes** occupy the center of the street. Transit may operate within a median, typically then separated from general traffic by median islands, or adjacent to a median with doors on both sides of the transit vehicle to permit left and right side boarding.
- **Contraflow bus lanes** are generally implemented on one-way streets where the transit lane operates in the opposite direction of general traffic and is located adjacent to the curb.

- **Transit streets or plazas** are street segments that prohibit private vehicle traffic and reserve the entire travel way for transit vehicles. Bicycles and pedestrians are also generally permitted. Transit plazas are typically used where transit services are extremely frequent, transit use is concentrated, and right-of-ways are severely constrained.

## USE

- Transit lanes are used only on corridors where transit service is very frequent (every 10 minutes or less), ridership is high, and traffic congestion significantly and routinely impedes transit operations.
- Transit lanes may be permanent or time restricted - reserved for transit vehicles only at peak hours of the day and permitted for other uses (such as parking or general traffic) at other times. They may be reserved exclusively for the use of transit vehicles or may have shared use.

## DESIGN

- The minimum acceptable width for a dedicated transit lane is 10 feet for an offset lane or 11 feet for a curbside lane; 12 feet is preferred. 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. If the transit lane is shared for high occupancy vehicle (HOV) use, include appropriate pavement markings.

 Transit lanes may offer an opportunity for porous concrete or asphalt treatments. Where space allows, use rain gardens, bioswales and raised planters in the buffer.

### SPECIAL CONSIDERATIONS

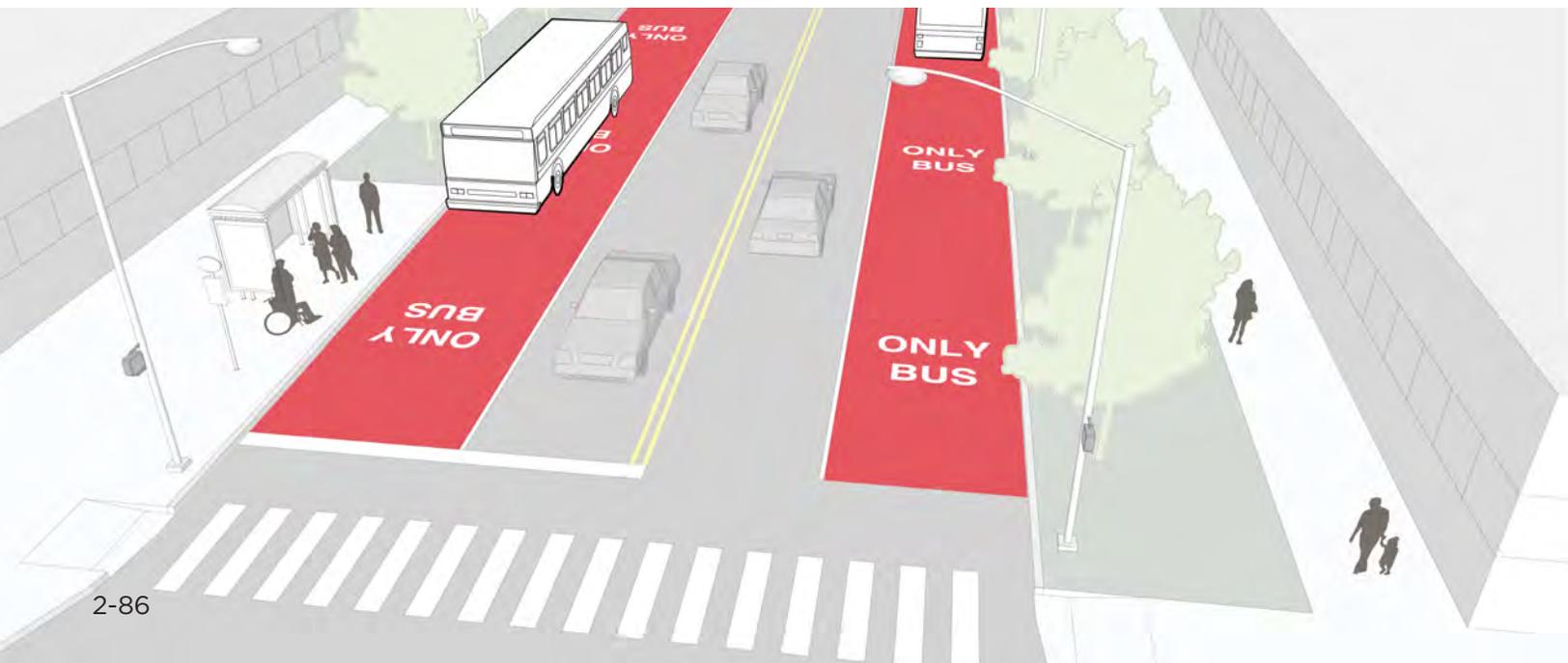
- Transit lanes may be separated from general traffic by soft barriers, such as rumble strips, or physical barriers like concrete curbs or rubber bumpers.
- Making transit lanes visually distinctive may discourage encroachment by other road users.
- Bicycle volumes, transit frequency, available right-of-way, total cross section, frequency of transits stops, and time restricted changes in street operation should be considered in determining the appropriateness of a transit lane.
- Private vehicles using dedicated transit lanes for through travel can be an issue. This not only degrades performance, but introducing serious safety concerns. Education and enforcement is always a necessary component when transit lanes

### OPERATIONS AND MAINTENANCE

- At intersections, bus lanes may become right-turn only lanes. Use a dotted line to denote where private vehicles may enter the bus lane. If the dedicated lane is only in effect for certain hours, consider restricting right turns to keep the lane clear.
- Dedicated transit lanes may require additional enforcement.
- When utility work requires occupying part or all of a dedicated transit lane, have a plan in place to prevent a significant disruption of transit service. Consider repurposing a general traffic lane temporarily, signal changes, or other efforts to reduce delays.
- Transit lanes should not be used for snow storage. In winter, keep access to transit lanes and transit stops clear for both the vehicles and riders. Physically separated transit lanes may require special equipment for snow removal.

### DESIGN REFERENCES

- NACTO: Urban Street Design Guide, 2013 Street Design Elements: Transit Streets <http://nacto.org/publication/urban-street-design-guide/street-design-elements/transit-streets/>



ONLY  
BUS

# SHARED TRANSIT LANES

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

## USE

- Shared transit lanes are appropriate on streets where space constraints preclude the opportunity to provide separate facilities and where bus headways and speeds are moderate (greater than five minute headways). Shared transit lanes typically require less total right-of-way space than separate facilities for each user.
- Shared transit lanes should not be considered on high frequency transit corridors or on corridors where bicycle

volumes are high enough to adversely affect transit operations. In such instances, prioritization of one mode or separate facilities may be necessary.

- Shared bicycle/transit lanes typically are not physically separated from adjacent travel lanes.
- Shared facilities will also generally be comfortable to more experienced bicyclists, so shared transit lanes are typically not an appropriate treatment for community bicycle emphasis corridors.

## DESIGN

- Shared transit lanes should be located in the outermost lane, ideally adjacent to the curb. They may be located adjacent to curbside parking; however, this introduces substantial conflict and degrades operations and safety in the priority lane.
- Shared bicycle/transit lanes should have sufficient width for dual bicycle/transit use. Eleven feet is the minimum adequate dimension.
- Appropriate markings and signage must be provided to ensure all users of the street are aware of the modes that should be using the shared lane.
- Transit/bicycle lanes ideally should be for the exclusive use of these two modes, except at intersections where vehicles may use them as turning lanes.

## SPECIAL CONSIDERATIONS

- Bicycle volumes, transit frequency, available right-of-way, total cross section, frequency of transits stops, and time restricted changes in street operation should be considered in determining the appropriateness of a shared bicycle/transit lane.
- Shared transit lanes are not appropriate on rush hour restricted streets (streets where the curb parking lane converts to a travel lane during peak hours).
- Transit operators should be trained in how to interact with bicyclists in shared bicycle/transit lane facilities. Outreach and education to community members and bicyclists will also help with understanding how to use shared bicycle/transit lanes.
- Typically, shared bicycle/transit lanes should not be used on any street with a posted speed limit above 30 mph.
- Vehicles using shared bicycle/transit lanes for through travel can be a major issue. This not only degrades performance, but introduces serious safety concerns. Education and enforcement is always a necessary component when using shared bicycle/transit lanes.

- Shared bicycle/transit lanes may be less inviting or comfortable for less experienced bicyclists.
- The larger width of shared transit lanes increases the overall width of the street and associated pedestrian crossings, so pedestrian crossing islands may be necessary. It may also work against the objectives of self-enforcing streets as wider travel ways tend to encourage higher vehicle travel speeds.

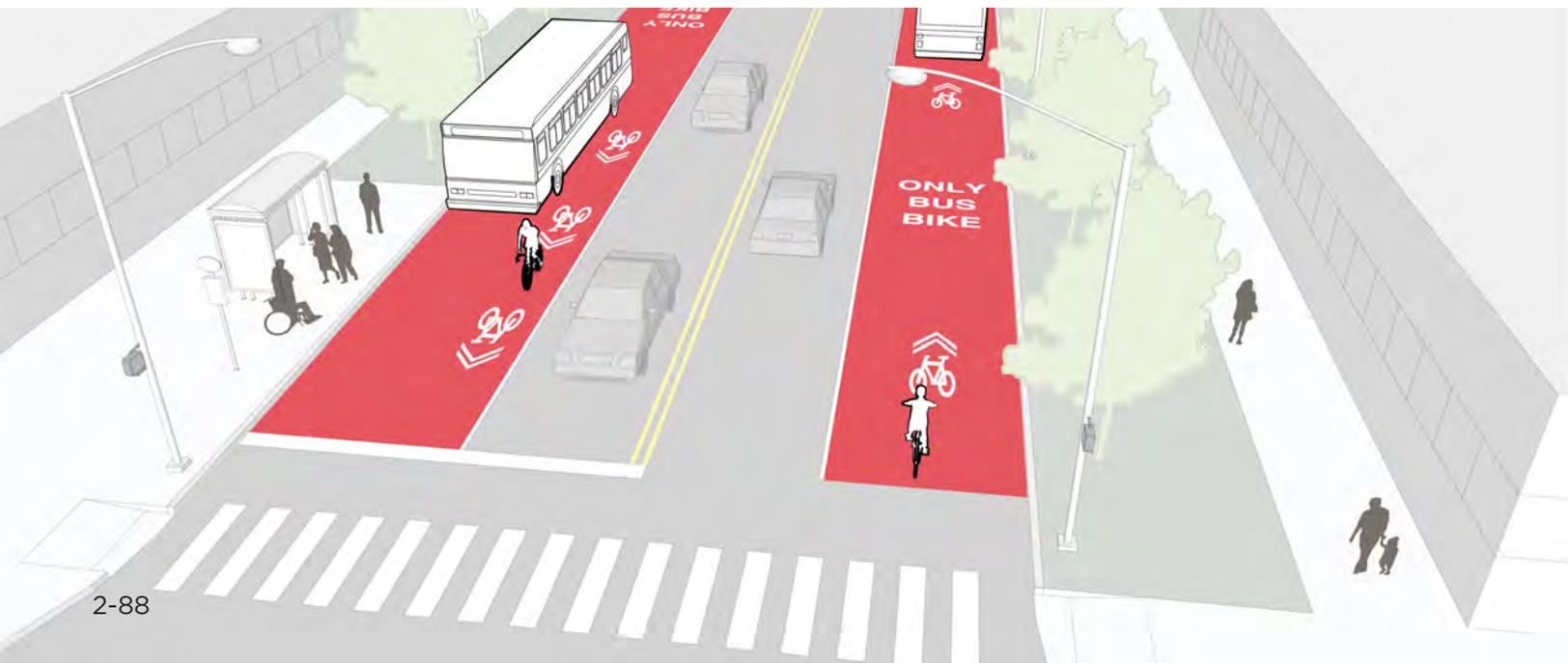
 Transit lanes may offer an opportunity for porous concrete or asphalt treatments. Where space allows, use rain gardens, bioswales and raised planters in the buffer.

## OPERATIONS AND MAINTENANCE

- Shared bicycle/transit lanes generally require a higher level of observation and enforcement than general purpose travel lanes.
- Shared bicycle/transit should be kept clear of snow and debris.
- Shared bicycle/transit lane striping and the associated symbols and signs are additional markings and signs that will require maintenance and replacement.

## REFERENCES

- NACTO: Urban Street Design Guide, 2013
  - Street Design Elements: Transit Streets <http://nacto.org/publication/urban-street-design-guide/street-design-elements/transit-streets/>





# BUS QUEUE JUMP LANE

A bus queue jump lane, also known as a bus bypass lane, is a short 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:

- **Transit Exemption for Right-Turn Lanes:** The bus queue jump lane shares space with the right-turn lane, but transit vehicles are allowed to proceed straight through the intersection.
- **Advanced Stop Bar:** In this configuration, the main stop bar is pushed back several car lengths and a transit-only or “right and transit” lane is placed along the curb ahead of the stop line, so that transit vehicle can pull ahead of other traffic.
- **Shared Right-Turn/Bus Lane:** The entire curbside lane is reserved for transit vehicles, but drivers are allowed to use it for right turns at intersections. This gives buses even more priority, but requires the removal of parking or travel lanes.

## USE

- Best used on primary transit routes at congested intersections where transit vehicles are likely to experience significant delays.
- Place bus stops at the far-side of the intersection to allow buses to take advantage of the bus queue jump lane on the near-side of the intersection. If the bus stop is on the near-side, place it behind the bus queue jump lane.

## DESIGN

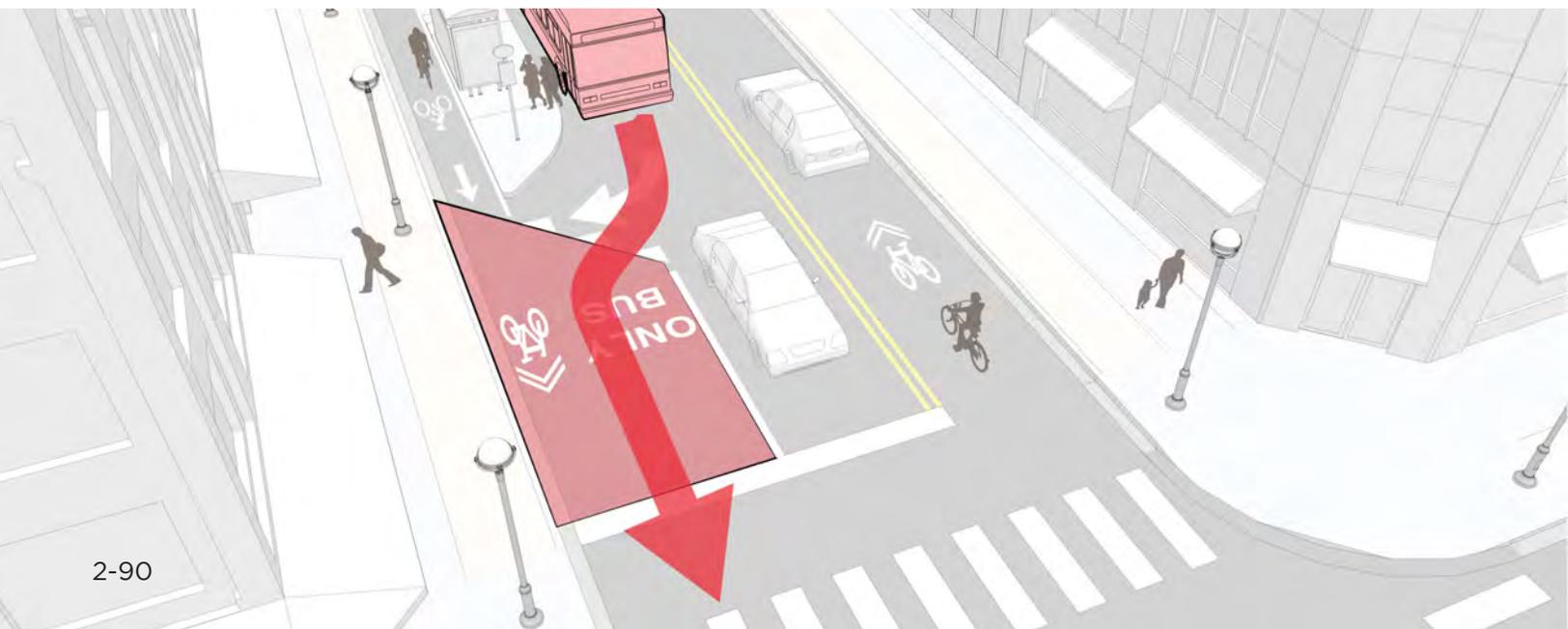
- Design bus queue jump lanes long enough so that buses can move ahead of vehicles stopped at an intersection. Special pavement markings and/or signage may be needed to indicate the space is exclusively for transit vehicles.
- Place an advanced stop bar at least two car lengths ahead of the main traffic stop bar in the bus queue jump lane to give buses a head start.
- 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. This may require an additional right-turn signal phase. Shorter traffic phases may also help to reduce backups at the intersection, making transit signal priority more efficient.

## SPECIAL CONSIDERATIONS

- To be fully effective, use transit signal priority alongside a bus queue jump lane to speed buses through the intersection.
- Where right-of-way is available, consider upgrading bus queue jump lanes to full transit lanes, which increase the speed and reliability of transit and reduce the risk of drivers encroaching on the lane.
- Bus queue jump lanes can give priority to both transit vehicles and bicyclists. However, if the bus queue jump lane is physically separated from the rest of the street, bicyclists should not be allowed to share the lane due to the higher speeds transit vehicles will be able to achieve.
- Exercise caution when placing bicycle lanes next to shared bus queue jump lane/right-turn lanes due to conflicts with drivers merging in and out of the lane. Use green colored pavement markings to identify the conflict zone.
- Parking or other uses of the curbside lane should be set back a far distance from the stop line, depending on the typical length of the traffic queue, to ensure that transit vehicles are able to enter the lane.
- Ensure that the construction of a bus pad does not interfere with underground utilities. Bus queue jump lanes may require a bus pad or other strengthening of the road surface to support standing or waiting transit vehicles.

## OPERATIONS AND MAINTENANCE

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





# MEDIANS

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 be located on the side, separating local access or special purpose lanes such as dedicated travel-ways. Medians increase safety and enhance roadway operations by reducing vehicular movement conflicts, limiting turning movements, and providing a refuge for pedestrians crossing the street.

## USE

- City environments may limit opportunities to incorporate medians into the street. Medians are generally applied to arterial streets as a means to reduce turning movement conflicts and facilitate flow while providing an attractive streetscape environment.
- Medians may be used as an access management tool, a means to limit vehicle conflicts on a corridor to facilitate traffic flow and safety. Medians may

also be used for traffic calming and beautification.

- Used in isolation, roadway medians do not have a significant impact in reducing vehicle speeds. For the purpose of slowing traffic, medians are generally used in conjunction with other traffic calming measures, such as bulb-outs or roadway lane narrowing.
- Center turn lanes provide an opportunity as redevelopment adjusts driveway entryways and alleyways; medians can be installed in places between intersections.

## DESIGN

- Medians may be flush with the pavement and consist of painted markings, a space protected with bollards, or a raised curb. Striped or painted medians may precede more permanent improvements, providing localities an opportunity to test travel behaviors 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 to provide adequate width for pedestrians crossing with strollers, bicycles or wheelchairs.
- Medians must be at least 10 feet wide if they are to provide turn pockets at intersections.

- Where a six foot median width cannot be provided, a narrower raised median (a minimum 4 feet) can still improve crossing safety. In these instances, signals should be timed so that pedestrians can cross in one signal phase.
- Wider medians may also be needed if the crossing accommodates frequent bicycle traffic like at a multi-use trail crossing.
- The median opening or passage for pedestrians (and bicyclists) sometimes can be skewed to the right to provide deeper storage space as well as point the person crossing to look at oncoming traffic.
- Crosswalks should cross medians at street level. The resulting cut-through should equal the width of the crosswalk and be wide enough to accommodate snow removal.
- Provide a median nub at crosswalks to buffer and protect pedestrians from turning traffic in the intersection. This also allows pedestrians to cross a street in either one- or two-stages.
- Design plantings to avoid blocking sight lines for pedestrian, bicyclists, and motorists near intersections and crossings.

 Landscaping medians reduces the impervious surface area in the roadway, allowing stormwater infiltration or retention in the exposed soil. Curbed medians more than 4.5 feet wide should be landscaped and used for stormwater management where possible. To support street trees, medians should be at least six feet in width and a minimum of 15 feet in length per tree, and should conform with soil volume requirements. However, planters adjacent to pedestrian crossings and travel lanes shall keep horizontal and vertical clearances to as to not obscure visibility.

 Providing vegetation helps motorists identify medians. Varying the types of plantings or trees can give motorists a clue to the type of environment they are passing through, leading them to adjust their behavior and speed accordingly. Street trees located within the intersection should avoid blocking sight lines to ensure safety.

## SPECIAL CONSIDERATIONS

- Medians provide an important refuge for pedestrian crossings, particularly for families and older adults who might not make it across the entire street in one light cycle phase. However, medians can also add to the overall width of the roadway unless lanes are reconfigured and the median utilizes existing space. While providing a median can shorten each leg of a crossing, a wide median increases the total street crossing distance, which adds time to the signal sequence and causes traffic delay.
- Do not remove or narrow sidewalks or bicycle facilities to provide medians or pedestrian refuges. Medians should not compromise the ability to accommodate other street uses. It may not be possible to add medians to streets with narrow driveways.
- Do not locate utilities below planted medians, as plantings may affect utility lines and repair or replacement is challenging. Utilities under striped, painted, or paved medians are easier to access with minimum disruption to roadway operations.
- Provide a taper on the leading edge of the median to extend the life of the infrastructure.
- Medians may also provide additional opportunities for placemaking and public art.

## OPERATIONS AND MAINTENANCE

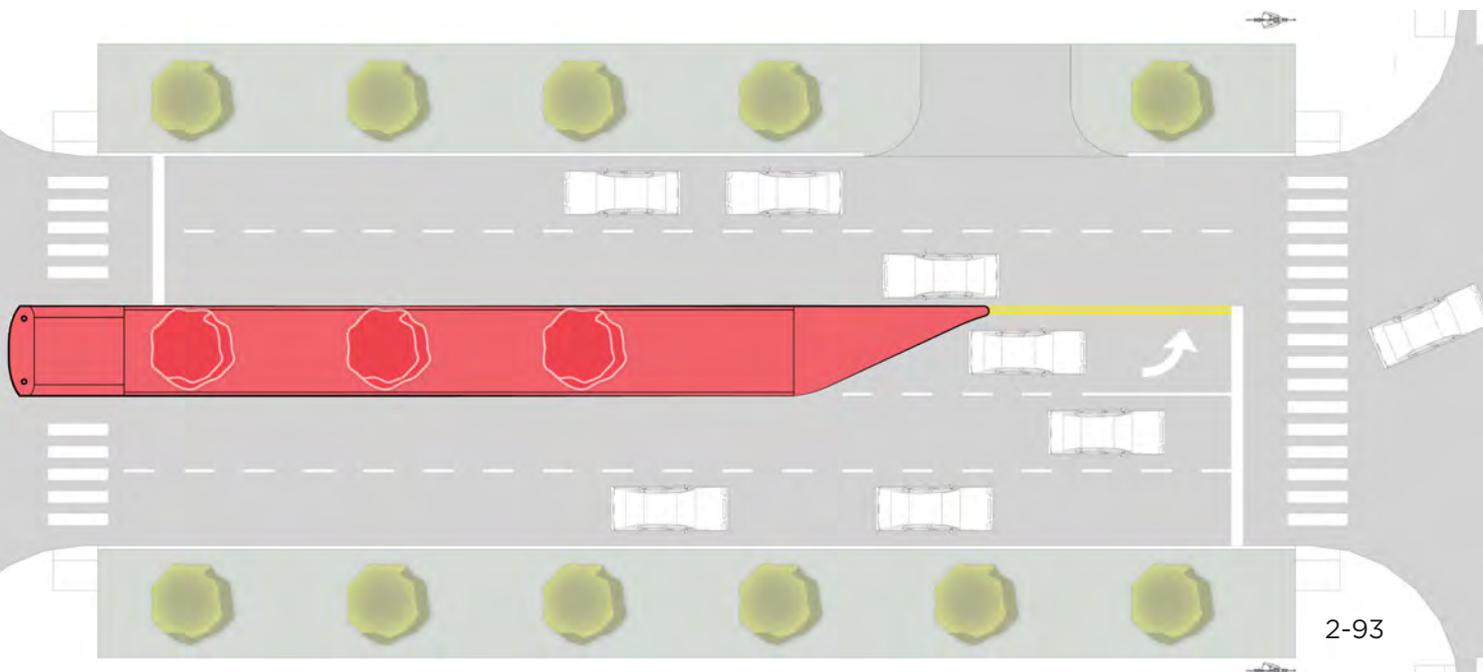
- Medians should be designed with snow removal in mind. Medians can be used for snow storage when necessary, although this may negatively impact planted materials, can block sight lines along the roadway if snow is piled too high, and can trap pedestrians trying to cross at unmarked locations.
- Medians should allow adequate width in the adjacent travel lane to accommodate snow removal vehicles, as well as turn radii that facilitates snow clearing and removal.
- Medians should also be designed for maintenance of the plantings and vegetation. Water trucks or installed water infrastructure may be required.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Intersection Treatments: Median Refuge Island <http://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/median-refuge-island/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
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  - Section 3.3.3: Turning Movements
- AASHTO: A Policy on Geometric Design of Highways and Streets (Green Book), 2011
  - Section 7.3.3: Cross-Sectional Elements
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
  - Chapter 9. Traveled Way Design Guidelines: Medians <http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad>
- ITE/FHWA: Traffic Calming: State of the Practice, 1999
  - Chapter 3: Toolbox of Traffic Calming Measures
  - Vertical Control Measures <http://library.ite.org/pub/48b037de-a555-47f5-2651-bb412d17bab5>
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  - Part 2 Signs: Chapter 2C. Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2c\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2c_2011.pdf)
  - Part 3 Markings: Chapter 3I. Islands [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)

## DETAILS

- MDOT Standard Highway Signs
  - SHS-E01-REG “R” Regulatory Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)
  - SHS-E02-WARN “W” Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e02\\_warning.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e02_warning.pdf)





# SEPARATED BICYCLE FACILITIES

Separated bicycle lanes are on-street bicycle facilities with physical separation between the bicycle facility and the roadway, often through a curb, parked vehicles, planted median raised above street grade, or flexible post. Sometimes referred to as “cycle tracks,” separated bicycle lanes can increase the sense of safety and comfort for bicyclists. Separated bicycle lanes correlate positively with increased bicycling activity, as they improve comfort for all types of bicyclists, especially those that are less experienced riders. Separated facilities can dramatically reduce the risk of bicycle/vehicle conflict.

## USE

- While separated bicycle lanes offer more protection and attraction than

standard on-street bicycle lanes, they also require a greater amount of street space. Separated bicycle lanes often require the conversion of curbside parking or a travel lane for implementation, which may be a significant concern in denser areas.

- Separated bicycle lanes are the preferred bicycle facility on any bicycle emphasis corridor with traffic volumes in excess of 10,000 vehicles per day. Separated bicycle lanes are also ideal for corridors with vehicle speeds higher than 35 mph, those with high collision rates, or areas with high numbers of bicyclists.

## DESIGN

- Separated bicycle lanes shall have a minimum of five feet exclusive of the buffer for a one-directional facility (seven feet is preferred) and eight feet minimum for a two-way facility (10 feet is preferred), inclusive of the gutter.
- Five feet is the preferred width of the separation barrier between separated bicycle lanes and roadway travel lanes; the minimum width is three feet.
- Parked cars in the parking lane may be used as a barrier between the separated bicycle lane and travel lanes. In this case, temporary or permanent curbing and/or flexible posts may be used to ensure that parked vehicles do not encroach upon the bicycle facility.
- Separated bicycle lanes may be flush with the street level, raised to the sidewalk level, or at an intermediary level between street and sidewalk. For sidewalk-level bicycle lanes, use different colors,

materials or pavement markings to differentiate from pedestrian space.

- Separated bicycle lanes require careful design at intersections to minimize conflicts with turning vehicles and to improve legibility, visibility, and predictability for all travelers. Special bicycle traffic signals may be necessary at signalized intersections, especially for two-way cycle tracks on one-way streets.
- Use colors, yield teeth, and “Yield to Bikes” signage to make it clear that the protected bicycle lane has priority over crossing traffic. Points of conflict should be clearly marked for both the bicyclist and motorist. Bicycle through movements and motor vehicle turning movements should generally be in separate phases at intersections.
- Maintain visibility and sight triangles at driveways, alleys, or intersections.

 Bicycle facilities may offer an opportunity for porous concrete or asphalt treatments. Where space allows, use rain gardens, bioswales and raised planters in the buffer.

## SPECIAL CONSIDERATIONS

- Connectivity among separated bicycle lanes and other low stress bikeways, like bicycle boulevards, is essential to attract a variety of user types.
- Separated bicycle lanes shall be routed behind transit bus bulbs to eliminate conflicts between boarding or alighting passengers and through bicyclists. Bicycle signals may be necessary for two-way separated bicycles lanes.
- Flexible posts may be necessary at entry points to the separated bicycle lane to prohibit vehicles from entering, though these are not desirable and should be used when no other options are possible. Flexible posts or delineators may be helpful for education and awareness for new facility installations as temporary measures.
- Make gutter seams, drainage inlets, and utility covers flush with the ground to prevent conflicts with bicycle tires. Ensure openings in grates are perpendicular to the bicycle direction of travel to avoid trapping bicycle tires.
- If trenching is done in the separated bicycle lane, repair the entire width of the bicycle lane so there is not an uneven surface as this can be particularly

dangerous for bicyclists. Any pavement markings that are removed or damaged with construction shall be replaced.

## OPERATIONS AND MAINTENANCE

- Bicycle facilities should be kept free of debris, which has a tendency to collect at the edge of the lanes, representing a hazard to bicyclists.
- Bicycle lanes should always be plowed during snow events. They should never be used for snow storage.
- If trenching is done in the bicycle lane, repair the entire width of the bicycle lane so there is not an uneven surface as this can be particularly dangerous for bicyclists.
- Avoid locating manholes in bicycle lanes. Ensure any utility or vault covers are flush with the road surface and properly set and maintained.
- Bicycle lane striping and the associated symbols and signs are additional markings and signs that will require maintenance and replacement.
- If colored pavement is used, routine maintenance plans should be in place to keep the pavement markings clear.
- Bicycle facilities may require additional enforcement to ensure they remain free of obstacles, parked vehicles, and delivery trucks.
- When utility work requires occupying part or all of a bicycle lane, have a plan in place to prevent a significant disruption of the bicycle network. Consider adding temporary wayfinding signage around the detour.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Bicycle lanes: Buffered Bicycle lanes <http://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/buffered-bike-lanes/>
  - Cycle Tracks <http://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/>
  - Cycle Tracks: Two-Way Cycle Tracks <http://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/two-way-cycle-tracks/>
- MMUTCD, 2011
  - Part 9 Traffic Control for Bicycle Facilities [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)
- FHWA Separated Bicycle lane Planning and Design Guide.
  - [https://www.fhwa.dot.gov/environment/bicycle\\_pedestrian/publications/separated\\_bikelane\\_pdg/](https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/)



# BUFFERED BICYCLE LANES

Buffered bicycle lanes are on-street bicycle facilities that feature a separation between the bicycle facility and the vehicle travelway created by pavement markings. Buffered lanes increase the distance between vehicles and bicyclists by marking a buffer between the bicycle lane and parked and/or moving traffic. The additional buffer may reduce the risk of bicyclists getting hit by the doors of parked cars and also may allow bicyclists to pass one another without entering the general traffic lane. Buffered bicycle lanes increase comfort over conventional bicycle lanes by providing greater separation from motor vehicle traffic and/or parked cars depending on the location of the marked buffers. Buffered bicycle lanes may not offer the highest level of comfort, but may be installed at a low cost, offer minimal maintenance challenges, and require a more modest cross-section compared to separated or fully protected bicycle lanes.

## USE

- Buffered bicycle lanes may be used on one- or two-way streets with or without on-street parking. Buffered bicycle lanes require more space than conventional bicycle lanes. Implementing them may require reduction of other street elements such as narrowing or converting travel and/or parking lanes.
- Buffered lanes are more effective and appealing on streets with longer blocks and few interruptions, such as driveways or transit stops. Buffered facilities should ideally extend for several contiguous blocks along a corridor.

## DESIGN

- The bicycle lane shall be at least five feet wide including the gutter pan. The added buffer shall be a minimum of 18 inches wide measured from the outside of the bicycle lane stripe, though three feet is preferred. The buffer may extend up to six feet wide in the event of a converted travel lane.
- The buffered area of a buffered bicycle lane is defined by two solid painted lines. Buffers up to three feet wide shall have interior diagonal cross hatching; buffers three feet or wider shall have chevron markings.
- Buffered bicycle lanes shall be placed on the right-hand side of the street, between the travel lane and the parking lane, or between the travel lane and the curb. Buffered bicycle lanes may transition to conventional bicycle lanes at intersections. Avoid placing conventional bicycle lanes to the right of a right-turn lane or the left of a left-turn lane unless a separate bicycle signal is provided.
- Treatments for buffered bicycle lanes at intersections may include conversion to a conventional curbside bicycle lane, a cross-over through lane, or shared space. Buffered bicycle lanes require careful design at intersections to minimize conflicts with turning vehicles and to improve legibility, visibility, and predictability for all travelers.
- Maintain visibility and sight triangles at driveways, alleys, or intersections.

- Bicycle facilities may offer an opportunity for porous concrete or asphalt treatments.

## SPECIAL CONSIDERATIONS

- Connectivity among buffered bicycle lanes and other low stress bikeways, like bicycle boulevards, is essential to attract a wider variety of user types.
- Buffered bicycle lanes shall be routed behind transit bus bulbs to eliminate conflicts between boarding or alighting passengers and through bicyclists.
- Flexible posts may be necessary at entry points to the buffered bicycle lane to prohibit vehicles from entering.
- Make gutter seams, drainage inlets, and utility covers flush with the ground to prevent conflicts with bike tires. Ensure openings in grates are perpendicular to the bicycle direction of travel to avoid trapping bicycle tires.
- Avoid locating manholes and other utility vaults in bicycle lanes. Ensure any utility or vault covers are properly set and maintained to be flush with the road surface.

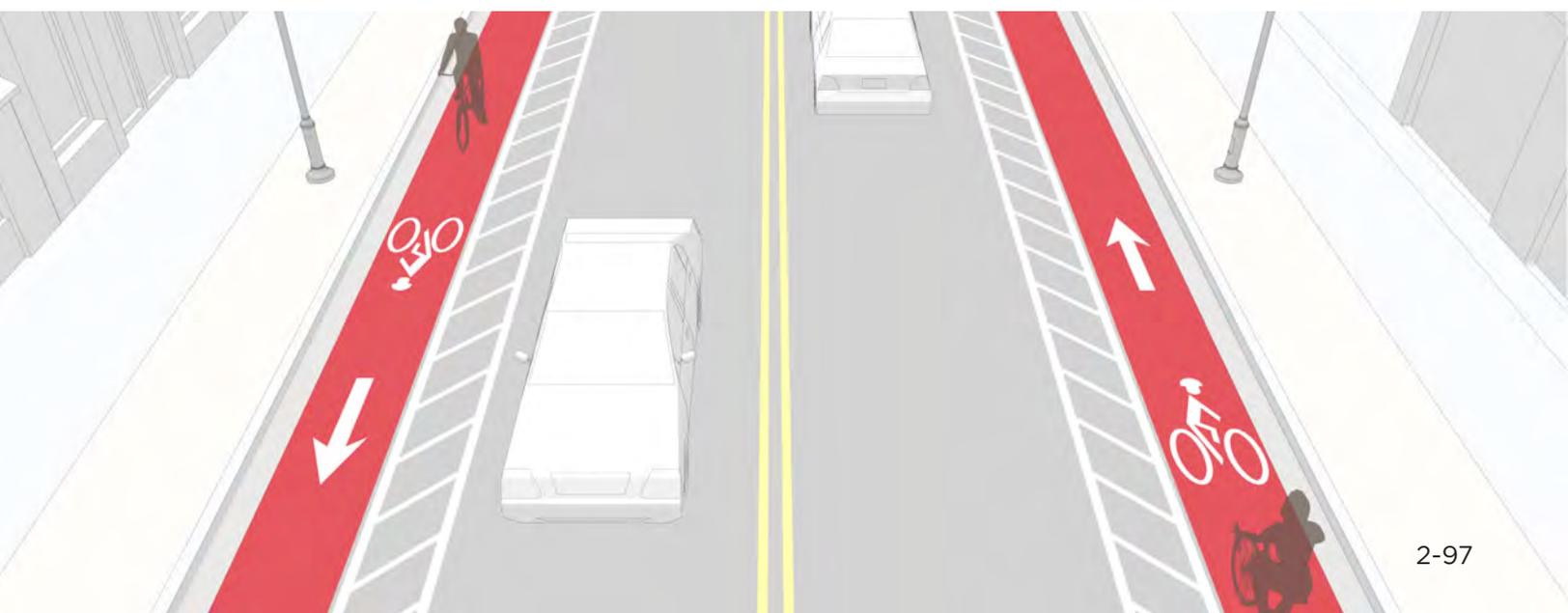
## OPERATIONS AND MAINTENANCE

- Bicycle facilities should be kept free of debris, which has a tendency to collect at the edge of the lanes, creating potential hazards to bicyclists.
- Bicycle lanes should always be plowed during snow events. They shall never be used for snow storage.

- If trenching is done in a buffered bicycle lane, repair the entire width of the bicycle lane to avoid an uneven surface, which can be dangerous for bicyclists. Any pavement markings that are removed or damaged with construction shall be replaced.
- Bicycle lane striping and the associated symbols and signs are additional markings and signs that will require maintenance and replacement.
- If colored pavement or markings are used, routine maintenance plans should be in place to keep the pavement markings clear.
- Bicycle facilities may require additional enforcement to ensure they remain free parked and stopped vehicles, delivery trucks, and other obstacles.
- When utility or other construction work requires occupying part or all of a bicycle lane, establish a plan to prevent a significant disruption of the bicycle network. Consider adding temporary wayfinding signage around the detour.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Bicycle lanes: Buffered Bicycle lanes <http://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/buffered-bike-lanes/>
  - Cycle Tracks <http://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/>
  - Cycle Tracks: Two-Way Cycle Tracks <http://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/two-way-cycle-tracks/>
- MMUTCD, 2011
  - Part 9 Traffic Control for Bicycle Facilities [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)





# CONTRAFLOW BICYCLE LANE

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

## USE

- Contraflow bicycle lanes typically address unique and limited conditions in a downtown where one-way vehicular operations result in inefficient bicycle connections. They improve the ease, attraction, and efficiency of this travel mode and reduce bicycle riding on sidewalks.
- Contraflow bicycle lanes are tools to bridge short interruptions in desired bicycle travel paths.
- Contraflow bicycle lanes are often established on single blocks or short segments in the areas of highest demand.
- Contraflow bicycle lanes should only be used where there is a clear observed need for the connection.

## DESIGN

- Marked contraflow bicycle lanes are located on the left side of travel lanes.
- The contraflow lane is separated from on-coming traffic by a double yellow stripe, which indicates to motorists and bicyclists that they are traveling in opposite directions and not allowed to cross. Alternatively or additionally, the contraflow lane may be separated by a buffer, median, or other barrier.
- Contraflow bicycle lanes shall be a minimum of five feet wide between the yellow striping and face of curb.
- Orient stop signs and traffic signals along the street to face both motorists going one-way and bicyclists in the contraflow lane.
- Extend contraflow lane markings across the intersection to signal the presence of two-way traffic to motorists on cross streets and to direct bicyclists.
- Colored pavement or pavement markings may be used to identify the contraflow lane.
- Bicycle travel in the same direction as vehicle traffic should be accommodated via shared lane markings, bicycle lanes, or other bicycle facilities on the right-hand side of the road.
- Contraflow bicycle lanes require careful design at intersections to minimize conflicts with turning vehicles and to improve legibility, visibility, and predictability for all travelers.

 Bicycle facilities may offer an opportunity for porous concrete or asphalt treatments.

## SPECIAL CONSIDERATIONS

- Contraflow bicycle lanes may be paired with left side bicycle lanes to create side by side bi-directional bicycle facilities.
- If space exists, parking may be located between the contraflow bicycle lane and travel lanes, where it can act as a buffer, or be permitted between the contraflow bicycle lane and the curb to its right.

## OPERATIONS AND MAINTENANCE

- Bicycle facilities should be kept free of debris, which has a tendency to collect at the edge of the lanes, representing a hazard to bicyclists.
- If trenching is done in the bicycle lane, repair the entire width of the bicycle lane and install pavement markings so there is not an uneven surface as this can be particularly dangerous for bicyclists.
- Avoid locating manholes in bicycle lanes. Ensure any utility or vault covers are flush with the road surface and properly set and maintained.
- Bicycle lanes and associated signs and symbols are additional markings that will require maintenance and replacement.
- If colored pavement is used, routine maintenance plans should be in place to keep the pavement markings clear.
- Bicycle facilities may require additional enforcement to ensure they remain free of parked and stopped vehicles, delivery trucks and other obstacles.
- Recess marking to minimize maintenance requirements and maintain reflectivity.
- Contraflow bicycle lanes may be designed to permit snow clearance using existing equipment. Snow should be cleared from the bicycle lanes the same as any other roadway facility. Bicycle lanes of any type should not be used for snow storage.
- When utility or other construction work requires occupying part or all of a bicycle lane, include provisions in the temporary traffic control plans to prevent a significant disruption of the bicycle network. Consider adding temporary wayfinding signage around detours.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014 <http://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/conventional-bike-lanes/>
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.5: Paved Shoulders
  - Section 4.6: Bicycle Lanes
  - Section 4.7: Bicycle Lane Markings and Signs
  - Section 4.8: Bicycle Lanes at Intersections
  - Section 4.9: Retrofitting Bicycle Facilities on Existing Streets and Highways
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
  - Chapter 9. Traveled Way Design Guidelines: Bicycle Lanes <http://library.ite.org/pub/e1c1ff43c-2354-d714-51d9-d82b39d4d4bad>
  - Part 9 Traffic Control for Bicycle Facilities [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)



# CLIMBING BICYCLE LANES

Climbing bicycle lanes are a bicycle lane provided on only the uphill side of a street. Bicyclists traveling uphill typically travel at much slower speeds while bicyclists traveling downhill may approach the speed of vehicles and can therefore share the lane.

## USE

- Climbing bicycle lanes are only used on streets with steep or sustained grades on which there is insufficient space for bicycle lanes on both sides of the street or where traffic volumes are too high to install advisory bicycle lanes.
- Climbing bicycle lanes are appropriate on most street types; however, they are generally more appropriate on streets with moderate traffic volumes (3,000 to 8,000 ADT) and posted speeds of 25 mph or less.

## DESIGN

- Climbing bicycle lanes should be used in the uphill direction on roadways with steep grades to provide a dedicated space for bicyclists.
- Shared lane markings (sharrows) and/or “Bikes May Use Full Lane” signage are installed in the downhill direction.
- Climbing bicycle lanes have the same minimum width (five feet) and design as standard bicycle lanes. Extra width is recommended to accommodate the side-to-side movement of people on bicycles as they pedal up steep hills.

 Bicycle facilities may offer an opportunity for porous concrete or asphalt treatments.

## SPECIAL CONSIDERATIONS

- If on-street parking is provided in the downhill direction, it is particularly important to ensure that bicyclists are directed to ride in a location outside of the door zone.
- Additional signage may be required to advise motorists to expect bicyclists in both directions. Downhill lanes may need signage stating that bicyclists may use the full lane.

## OPERATIONS AND MAINTENANCE

- Bicycle facilities should be kept free of debris, which has a tendency to collect at the edge of the lanes, representing a hazard to bicyclists.
- If trenching is done in the bicycle lane, repair the entire width of the bicycle lane and install pavement markings so there is not an uneven surface as this can be particularly dangerous for bicyclists.
- Avoid locating manholes in bicycle lanes. Ensure any utility or vault covers are flush with the road surface and properly set and maintained.
- Bicycle lanes and associated signs and symbols are additional markings that will require maintenance and replacement.
- If colored pavement is used, routine maintenance plans should be in place to keep the pavement markings clear.
- Bicycle facilities may require additional enforcement to ensure they remain free of parked and stopped vehicles, delivery trucks and other obstacles.
- Recess marking to minimize maintenance requirements and maintain reflectivity.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - <http://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/conventional-bike-lanes/>
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.5: Paved Shoulders
  - Section 4.6: Bicycle Lanes
  - Section 4.7: Bicycle Lane Markings and Signs
  - Section 4.8: Bicycle Lanes at Intersections
  - Section 4.9: Retrofitting Bicycle Facilities on Existing Streets and Highways
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
  - Chapter 9. Traveled Way Design Guidelines: Bicycle Lanes
  - <http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad>
  - Part 9 Traffic Control for Bicycle Facilities [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)



# CONVENTIONAL BICYCLE LANES

Conventional bicycle lanes are dedicated on-street bicycle facilities delineated by striping, signage, and bicycle symbol and arrow pavement markings. Typically, conventional bicycle lanes are located on the right-hand side of the street immediately adjacent to a motor vehicle travel lane running in the same direction as motor vehicle traffic, but alternative configurations are possible.

Conventional bicycle lanes alert motorists to the presence of a bike route, allow bicyclists to use the street with less interference from traffic, and increase comfort for bicyclists and predictability for all roadway users. The provision of bicycle lanes may reduce the incidence of bicyclists riding on sidewalks.

## USE

- Conventional bicycle lanes require the least amount of space of any dedicated on-street bicycle facility, but their installation may require a rebalancing of

space and may include modifications to parking or turn lanes, travel lanes, and/or bulb-outs, etc.

- Conventional bicycle lanes may be used on any street type but are typically not utilized on Neighborhood Residential streets.

## DESIGN

- Conventional bicycle lanes adjacent to the curb should be at least six feet wide inclusive of the gutter pan and a minimum of five feet, unless there is no curb (in which case the minimum would lower to four feet). Two feet should be added to the lane width for bicycle lanes adjacent to guardrails, walls, or other vertical barriers or to create a buffer.
- When the bicycle lane is between the travel lane and parking lane, the combined standard width of the bicycle lane and adjacent parking lane is at least 12 feet wide, though this design places people on bicycles at risk of being hit by an open driver side door from a parked car. A combined width of 13 feet wide is recommended (eight foot parking lane plus a five foot bicycle lane), and the desirable combined width is 14 feet wide (eight foot parking lane plus six foot bicycle lane) to minimize “dooring” conflicts.
- A solid white line must be used to differentiate the conventional bicycle lane from the general traffic lane.

- At intersections, bicycle lane markings should be placed outside of the vehicle path to prevent car tires from wearing them down. Avoid placing conventional bicycle lanes to the right of a right-turn lane or the left of a left-turn lane unless a separate bicycle signal is provided. Bicycle lanes require careful design at intersections to minimize conflicts with turning vehicles and to improve legibility, visibility, and predictability for all travelers.
- Use dotted/dashed lines and colored pavement, preferably green, to indicate areas of conventional bicycle lane/vehicle lane conflict, such as bicycle lane markings continuing through intersections, where right turning lanes cross bicycle lanes, and where transit stops are located
- Maintain visibility and sight triangles at driveways, alleys, or intersections.
- Transition bicycle lanes to the outside of turn lanes at intersections.

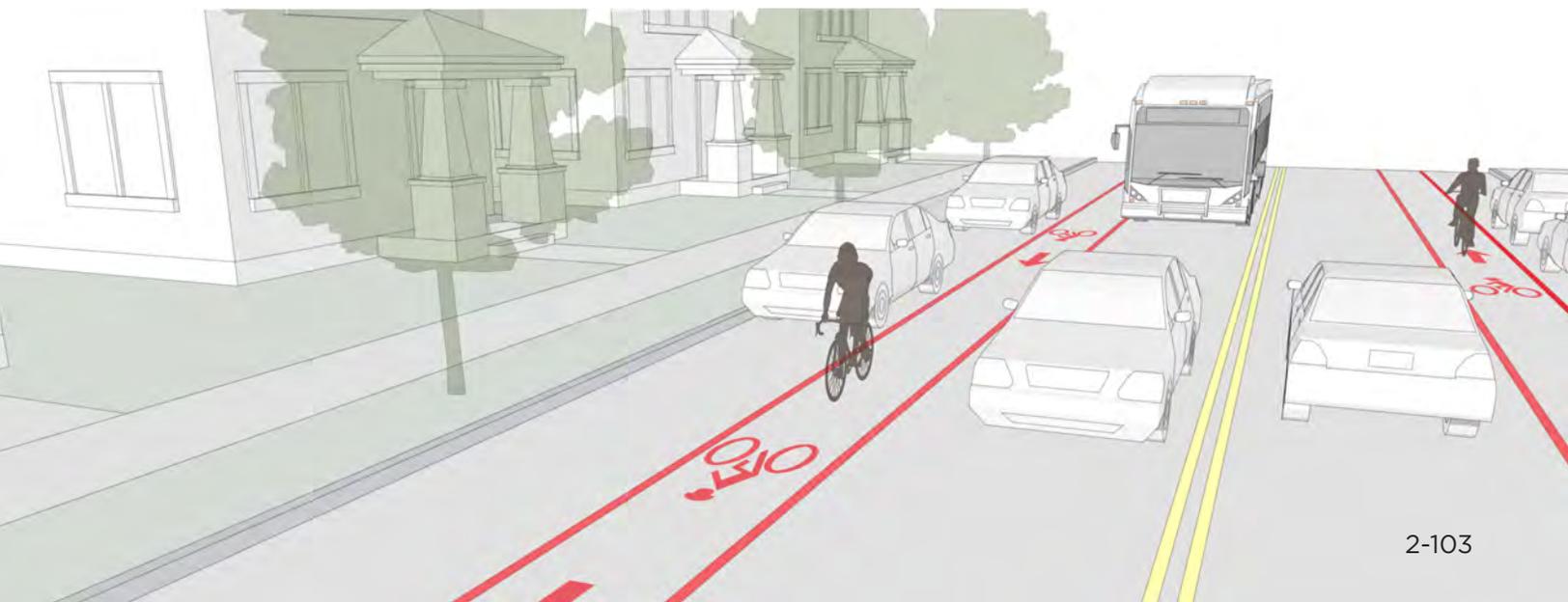
 Bicycle facilities may offer an opportunity for porous concrete or asphalt treatments.

## SPECIAL CONSIDERATIONS

- Use a continuous solid line or place “T” marks between the conventional bicycle lane and the parking lane to mark the inside of the bicycle lane and discourage motorists from encroachment.
- Make gutter seams, drainage inlets, and utility covers flush with the ground to prevent conflicts with bike tires. Ensure the proper use of bicycle-safe drainage grates to avoid trapping bicycle tires.
- Green colored pavement or markings can be used to further distinguish bicycle lanes in areas where there is a particular need. Use alternating sections of green colored pavement or markings to highlight areas of bicycle/vehicle conflicts and solid green to emphasize bike-only lanes.
- Avoid locating manholes in bicycle lanes. Ensure any utility or vault covers are flush with the road surface and properly set and maintained.

## OPERATIONS AND MAINTENANCE

- Bicycle facilities should be kept free of debris, which has a tendency to collect at the edge of the lanes, representing a hazard to bicyclists.
- If trenching is done in the bicycle lane, repair the entire width of the bicycle lane and install pavement markings so there is not an uneven surface as this can be particularly dangerous for bicyclists.
- Avoid locating manholes in bicycle lanes. Ensure any utility or vault covers are flush with the road surface and properly set and maintained.



- Bicycle lanes and associated signs and symbols are additional markings that will require maintenance and replacement. Advisory bicycle lane markings may require frequent repainting because of the increased motor vehicle travel on the dashed white pavement markings.
- If colored pavement is used, routine maintenance plans should be in place to keep the pavement markings clear.
- Bicycle facilities may require additional enforcement to ensure they remain free of parked and stopped vehicles, delivery trucks and other obstacles.
- Recess marking to minimize maintenance requirements and maintain reflectivity.
- Snow should be cleared from the bicycle lanes the same as any other roadway facility. Bicycle lanes of any type should not be used for snow storage.
- When utility or other construction work requires occupying part or all of a bicycle lane, include provisions in the temporary traffic control plans to prevent a significant disruption of the bicycle network. Consider adding temporary wayfinding signage around detours.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - <http://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/conventional-bike-lanes/>
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.5: Paved Shoulders
  - Section 4.6: Bicycle Lanes
  - Section 4.7: Bicycle Lane Markings and Signs
  - Section 4.8: Bicycle Lanes at Intersections
  - Section 4.9: Retrofitting Bicycle Facilities on Existing Streets and Highways
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
  - Chapter 9. Traveled Way Design Guidelines: Bicycle Lanes
  - <http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad>
  - Part 9 Traffic Control for Bicycle Facilities [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)



# ADVISORY BICYCLE LANE

Advisory bicycle lanes are bicycle lanes that drivers can enter into and are marked with a dashed instead of solid line. They make safe bicycle and vehicle travel possible on narrow roads, by dedicating a space for people on bicycles that require motorists to use the street as a yield street. Advisory bicycle lanes can be used where the width of a two-way street is too narrow for the installation of a standard or separated bicycle lane, and are often accompanied by a centerline removal.

## USE

- Advisory bicycle lanes are only appropriate on lower volume streets with daily vehicle volumes below 1,500, although they may be used on streets with volumes of up to 3,000 ADT.
- Advisory bicycle lanes may only be used on low speed streets at or below 25 mph.
- Advisory bicycle lanes are intended for use on two-way streets.
- Advisory bicycle lanes may be appropriate treatments in the community bicycle network given the low volumes and low speeds of the streets on which they are applied. They are also desirable as facilities in the commuter bicycle network.

### DESIGN

- Streets with advisory bicycle lanes are similar to yield streets. They consist of one travel way in the center without a center lane marking. The bicycle lanes are marked outside the travel way with a solid white line on the right and a dotted line to the left. Motorists are expected to use the center of the travel way, away from the bicycle space. If a motorist encounters an oncoming vehicle they must yield to passing bicyclists and then use a portion of the shared bicycle lanes to pass.
- The minimum lateral width of travel lane is 16' between advisory bicycle lanes.
- Advisory bicycle lanes require careful design at intersections to minimize conflicts with turning vehicles and to improve legibility, visibility, and predictability for all travelers.

### SPECIAL CONSIDERATIONS

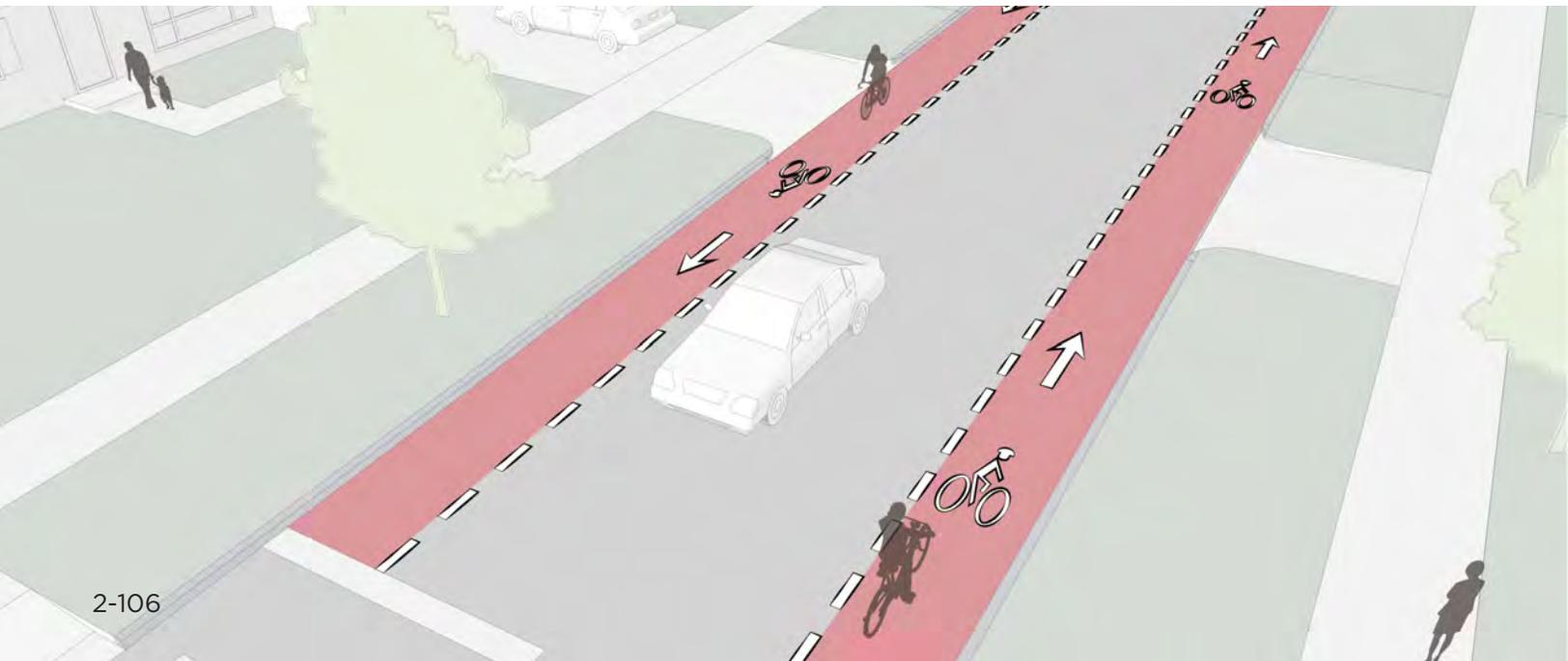
- Motorists are allowed to merge into the advisory bicycle lane. However, motorists must first yield to bicyclists in the bicycle lane.
- Bicyclists must be prepared for a motorist in a vehicle to enter the bicycle lane more often than on streets with conventional bicycle facilities.

### OPERATIONS AND MAINTENANCE

- Advisory bicycle lane markings may require frequent repainting because of the increased motor vehicle travel on the dashed white pavement markings.

### REFERENCES

- FHWA. Bicycle Facilities and the Manual on Uniform Traffic Control Devices. Dashed Bicycle Lanes [https://www.fhwa.dot.gov/environment/bicycle\\_pedestrian/guidance/mutcd/dashed\\_bike\\_lanes.cfm](https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/mutcd/dashed_bike_lanes.cfm)





# BIKE 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 outside the door zone. Shared lane markings also remind bicyclists to ride with traffic, not against it. Shared lane markings do not create a dedicated bicycle facility, so some bicyclists will not be comfortable riding in travel lanes and relying on these markings to alert motorists.

Shared lane markings are generally considered a minimalist bicycle accommodation and should be limited in their use. Shared lane markings are not dedicated facilities and do not provide any added separation from motor vehicle traffic to bicyclists.

## 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 not appropriate solutions for any bicycle emphasis corridor, except when used as wayfinding on bicycle boulevards.
- 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 generally not appropriate on streets

with high traffic volumes and vehicle speeds above 35 mph. On streets with high traffic volumes and higher speeds, dedicated bike facilities should be used or bike traffic routed onto other streets.

- Shared lane markings are not typically used on roadways with very low vehicle volumes and speeds, such as neighborhood residential streets unless used as wayfinding for bicycle boulevards.

## DESIGN

- Shared lane markings are two chevron symbols positioned above a bicycle symbol. The chevrons should guide bicyclists out of the door zone and be positioned to point bicyclists in the direction of travel.
- If the travel lane is adjacent to the curb, shared lane markings are positioned at least four feet from the curb face. If the travel lane is adjacent to a parking lane, shared lane markings are placed at least 12 feet from the face of curb.
- Shared lane markings should be placed in both directions of travel if other bicycle facilities, such as climbing lanes, are not provided.

## SPECIAL CONSIDERATIONS

- Experimental treatments include the use of dotted lines and/or painted zones used in conjunction with shared lane markings to designate the bicycle line of travel. These are referred to as “priority shared lanes.” Although more visible, priority shared lanes are not an adequate substitute for dedicated bicycle facilities on streets with high traffic volumes and higher speeds.
- Additional street signage, such as a “Bikes May Use Full Lane” signs, may be used in conjunction with shared lane markings to further reinforce the shared use of the road for motorists.

## OPERATIONS AND MAINTENANCE

- As shared lane markings are additional pavement markings in the roadway, they require maintenance to ensure they remain highly visible. Use of dotted lines and/or colored markings in conjunction with shared lane markings adds further maintenance requirements.
- Placing shared lane markings toward the center of the travel lane may reduce wear and fading because the shared lane markings are located between the primary wheel track of vehicles.
- The travel lane and parking lane should be cleared of snow for the full width to reduce vehicle encroachment onto the line of travel established by shared lane markings.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Bikeway Signing & Marking: Shared Lane Markings <http://nacto.org/publication/urban-bikeway-design-guide/bikeway-signing-marking/shared-lane-markings/>
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.4: Marked Shared Lanes
  - MMUTCD, 2011
  - Part 9 Traffic Control for Bicycle Facilities: Chapter 9C. Markings
  - Section 9C.07: Shared Lane Marking [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)
- MDOT Traffic and Safety Notes
  - Notes Manual 306A Procedure for Installing Shared Lane Marking [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_note306a.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_note306a.pdf)

## DETAILS

- MDOT Pavement Marking Standards
  - PAVE-961-B Shared Lane (Sharrow) Marking [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-961-b.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-961-b.pdf)





# BICYCLE BOULEVARD

Bicycle boulevards, also known as neighborhood greenways, neighborways, and neighborhood slow streets, utilize lower volume local and collector streets to create a network of lower speed and lower traffic volume streets for people walking and bicycling while still maintaining local vehicular access.

Bicycle boulevards are the backbone of the community bicycle network and typically feature shared lane markings and bike route signage. These streets can also feature traffic calming design elements such as bulb-outs, chicanes, roundabouts, and diverters to manage vehicle volumes, slow traffic, and limit cut-through vehicles.

## USE

- Bicycle boulevards are typically only used on lower order streets such as neighborhood residential or link residential, although they may be applied on other street types as well where vehicle volumes are moderate to low and can be effectively managed.

- Bicycle boulevards typically have traffic volumes of 1,500 vehicles per day or lower, preferably. Travel speeds should not be higher than 25 mph.
- Bicycle boulevards are best accomplished in neighborhoods with a grid street network (where vehicle through-traffic can be directed to parallel routes), but can also be accomplished by combining a series of road segments or road and trail segments to form one continuous route.
- Bicycle boulevards should be long enough to provide an attractive stretch of travel. They should connect to other bicycle boulevards (community bicycle facilities) and/or commuter bicycle facilities to form a complete network.

## DESIGN

- Bicycle boulevards typically employ a range of speed and traffic calming treatments such as neckdowns, chicanes, bulb-outs, diverters, and other such devices.
- Wayfinding is particularly important for bicycle boulevards. Bicycle boulevard corridors may follow slightly circuitous routes, so clear signage is required and directional pavement markings oriented toward the bicyclist are encouraged.

 Bicycle boulevards are sometimes referred to as neighborhood greenways as they may provide additional

opportunities for green infrastructure facilities in the street and public right of way.

- Bicycle boulevards provide a good opportunity to provide street trees, rain gardens, and other plantings, as these elements can be integrated with traffic speed and volume management treatments.

### SPECIAL CONSIDERATIONS

- Street crossings are a major consideration for the location and design of bicycle boulevards. Street crossings must be carefully designed to provide logical, safe, and intuitive crossings for even the most vulnerable users. Additional treatments beyond marked crosswalks are often necessary, such as signage, median refuge islands, bulb-outs, rapid flashing beacons, and/or bicycle signal heads.
- Traffic signals may be considered where low volume streets suitable for bicycle boulevards cross high volume streets that may not be comfortable for less experienced, community bicyclists.

### OPERATIONS AND MAINTENANCE

- Traffic conditions, including motor vehicle speeds and volumes and bicyclist delay, should be monitored before implementation and on a regular basis after implementation. If conditions exceed the target thresholds, additional speed and/or volume management treatments should be implemented.
- Additional enforcement may be needed, especially for newly established bicycle boulevards.
- Most local streets that would serve as bicycle boulevards do not receive priority street maintenance services, especially snow and ice removal. Local streets that are improved to serve as bicycle boulevards should receive higher priority street maintenance services so they are usable year round.

### REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Bicycle Boulevards <http://nacto.org/publication/urban-bikeway-design-guide/bicycle-boulevards/>
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.10: Bicycle Boulevards
- MMUTCD, 2011
  - Part 9 Traffic Control for Bicycle Facilities [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)





# 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 Vital Streets 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 Vital Street project could provide more permanent and integrated design solutions.

Speed control elements may be accompanied by operational strategies to reduce vehicles speeds such as targeted enforcement efforts or speed display signs.

Traffic calming should be evaluated and possibly implemented on a neighborhood or district scale as volume or speed changes on one segment may adversely impact the surrounding streets. Traffic calming installations should not divert traffic to other Neighborhood Residential streets, but may divert vehicles to higher order streets (Network Residential, Crosstown Connector, and Urban Center). The potential impacts of traffic diversion should be evaluated for all traffic calming installations.

With all traffic calming devices, accommodation of emergency response vehicles, snow plows, or 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 expressway, truck, or transit routes.



# HORIZONTAL SPEED CONTROL MEASURES

Horizontal speed controls reduce traffic speeds and reinforce safe, pedestrian-friendly streets by breaking up the linear path of vehicles through horizontal shifts. By forcing drivers around horizontal curves and blocking long views of the road ahead, vehicle speeds can be reduced on neighborhood streets. Horizontal deflections include chicanes, neck-downs/chokers, and center islands. Mini-traffic circles are also a form of horizontal speed control.

## USE

- Horizontal speed control elements should be applied on streets with speed limits below 30 mph, and where there is higher than desired operating speeds. They should be used on lower order streets (Neighborhood Residential, Link Residential, Neighborhood Business, and Maker/Industrial streets).
- They may also be used on streets where traffic volumes are higher than desired and frequently used by cut-through traffic on a regular basis.

- Horizontal speed control elements may be accompanied by operational strategies to reduce vehicles speeds, such as targeted enforcement efforts or speed display signs.

## DESIGN

### CHICANE

Chicanes are bulb-outs that alternate from one side of the street to the other, forming S-shaped curves. Vehicles slow their speeds to pass through the series of curves. A chicane-like effect can be achieved sometimes at less cost, by alternating on-street parking from one side of the street to the other. Chicanes can be landscaped to provide visual amenity and neighborhood identity, as well as to provide mid-point refuge for pedestrian crossings at crosswalks.

- Chicanes are located midblock and may be used in conjunction with other traffic calming measures.
- The shifts in alignment should be at least one lane width, with deflection angles of at least 45 degrees, and center islands to prevent drivers from following a straight “racing line” path through the feature.
- The number of chicanes will depend on the length of the street, but generally a series of at least three bulb-outs are needed to create the S-shaped curves needed to slow vehicle speeds.

- Chicanes might not be appropriate on steep streets where there is a grade that exceeds five percent.

### BULB-OUTS AND NECK-DOWNS

Bulb-outs are vertical treatments that narrow the street by expanding the sidewalk or adding a planting strip, often at midblock pedestrian crossings. Neck-downs are bulb-outs at intersections that tighten the curb radii at the corner, reducing the pedestrian crossing distance, increasing pedestrian visibility and lowering the speeds of turning vehicles. Both treatments are particularly useful on streets with longer block lengths where motorists tend to pick up speed.

- Neck-downs are located at intersections while chokers are midblock.
- Neck-downs and chokers are commonly coupled with on-street parking bays and crosswalks.
- Neck-downs should not be used on streets with separated bicycle lanes or other separated facilities where they would result in moving bicyclists into the traffic flow.

Sometimes called midblock medians, median slow points, or median chokers, 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 in order to travel around it. Travel speeds are reduced due to the narrow path of travel at that location and the need to shift horizontally around the curve. Center islands also act as effective pedestrian refuge locations.

- Center islands may be located at the approach to an intersection or midblock.

 Horizontal control measures often provide opportunities for plantings, street trees, and low impact development in the bulb-out.

### SPECIAL CONSIDERATIONS

- Roadway narrowing can be enhanced by vertical design elements that draw attention to the constriction and provide visual cues to the driver to slow down. Street trees, street furniture, signage, and public art are all opportunities to create special places along the calmed streets.

- Well-designed lateral shifts—often using protected parking bays—in otherwise straight streets are one of the few measures that can be used on higher order streets, such as Network Residential, where higher traffic volumes and higher posted speeds preclude other traffic calming measures.

### OPERATIONS AND MAINTENANCE

- The impact of traffic calming treatments at the network or neighborhood level should be monitored prior to and after installation to ensure there are no adverse impacts.
- Vertical control measures can be installed on a pilot basis to assess potential impacts before permanent treatments are deployed.
- 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. The bulb-outs can offer space to store snow in winter; however, visual cues, particularly vertical elements, should alert snow plow operators of the change in the roadway.

### REFERENCES

- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 2.6.2: Traffic-Calming Methods
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.6: Bicycles and Traffic Calming
- ITE/FHWA: Traffic Calming: State of the Practice, 1999
  - Chapter 3: Toolbox of Traffic Calming Measures
  - Horizontal Measures <http://library.ite.org/pub/48b037de-a555-47f5-2651-bb412d17bab5>



# VERTICAL CONTROL DEVICES

Vertical controls reduce traffic speeds, may assist in managing volume, and reinforce safe, pedestrian-friendly streets by using forces of vertical acceleration to discourage speeding.

Speed humps, speed tables, raised crossings, speed cushions, and textured pavements are common vertical speed control measures. 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 travel volumes and reduce cut-through traffic. Vital Streets projects should generally not require these measures, as they will be designed to promote self-regulating design.

## USE

- Vertical speed control elements are most appropriate on streets with speed limits less than 30 mph, and where there is higher than desired operating speeds. They will be most common on lower order streets (Neighborhood Residential, Link Residential, and Neighborhood Business) as well as alleys.
- They may also be used on streets where traffic volumes are higher than desired and frequently used by cut-through traffic.

- Vertical speed control elements may be accompanied by operational strategies to reduce vehicular speeds such as targeted enforcement efforts or speed display signs. They also may be installed in tandem with horizontal speed control measures such as bulb-outs or chicanes, or applied individually on streets with a constrained right-of-way.

## DESIGN

### SPEED HUMPS AND TABLES

Speed humps are parabolic vertical traffic calming devices intended to slow traffic speeds on low-volume, low-speed roads. 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 humps are often referred to as “bumps” on signage and by the public.

- Vertical speed control elements shall be accompanied by the appropriate signage and pavement markings warning drivers of the upcoming device.
- Speed humps should not be placed in front of driveways or other significant access areas. They should be located where there is sufficient visibility and available lighting.
- Speed humps should be designed to the following criteria:

- Slopes should not exceed 1:10 or be less steep than 1:25.
- Side slopes on tapers should be no greater than 1:6.
- The vertical lip should be no more than a quarter-inch high.
- They are not constructed into the gutter pan to not impede drainage.
- Spacing for vertical speed controls should be determined based on the target speed of the roadway. Typically, speed humps are placed 200–250 feet apart; humps should be spaced no more than 500 feet apart. To achieve greater speed reductions, space speed humps closer together.
- Speed humps may be applied on one-way or two-way roads, a minimum 50 feet from the nearest intersection.

### SPEED TABLE

Speed tables are midblock traffic calming devices that raise the entire wheelbase of a vehicle to reduce its traffic speed. Speed tables are longer than speed humps and flat-topped, with a height of 3-3.5 inches and a length of 22 feet. Vehicle operating speeds for streets with speed tables range from 25-45 mph, depending on the spacing. Where applied, speed tables may be designed as raised midblock crossings, often in conjunction with bulb-outs.

- Speed tables shall be accompanied by the appropriate signage and pavement markings to warn drivers.
- Speed tables should be designed to the following criteria:
  - Slopes should not exceed 1:10 or be less steep than 1:25.
  - Side slopes on tapers should be no greater than 1:6.
  - The vertical lip should be no more than a quarter-inch high.
- Where a speed table coincides with a crossing or crosswalk, it should be designed as a raised crosswalk with appropriate signage and pavement markings
- Locate vertical speed control elements where there is sufficient visibility and available lighting, a minimum 50' distance from intersections

### TEXTURED PAVEMENTS

Roadway materials can have significant impacts on traffic safety and vehicle speeds, user comfort, vehicle maintenance costs, stormwater management, and street noise. Paving treatments and textured pavements can help reduce speeds and are more commonly used on streets with high volumes of pedestrians and lower volumes of motor vehicle traffic.

- Historic cobblestone streets and alleys are an example of the effects of textured pavements on vehicle speeds. Modern textured pavements, such as brick pavers, are smoother than cobblestones, which helps accommodate bicyclists.
- The use of paving treatments in parking lanes can visually reduce the width of the roadway.
- Regardless of the material used on the roadway, an accessible, smooth travel path must be provided at crosswalks in order to accommodate people with disabilities.
- Pedestrian crossings must meet accessibility requirements by providing a smooth, stable, and slip-resistant accessible path, and should include the necessary reflective markings as required in the MUTCD.
- Pavers should not be used in crosswalks.
- Surfaces such as smooth granite or tile should not be used as they create slippery conditions for bicyclists and pedestrians in wet weather. Consider the reflective characteristics of the pavement, or porous asphalt that provides a unique texture and color.
- Pavements that resist heaving and rutting should be used for locations where heavy vehicles stand or park, or locations that are less durable, such as high-volume intersections or steep grades.

### RAISED INTERSECTION

Raised intersections are created by raising the level of the roadway at an intersection to the same level as the sidewalk. Raised intersections are a similar concept to speed tables but are applied to the entire intersection. Raised intersections make it physically more difficult for drivers to go through intersections at higher speeds, improve drivers' awareness of pedestrian crossings, and help define locations where pedestrians are expected. Use of these

approaches should be only in appropriate locations based on engineering judgement, keeping in mind maintenance, operations, and effectiveness.

- 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 and crossings can be used as gateway treatments to signal to drivers when there are transitions to a slower speed environment that is more pedestrian-oriented.
- Raised crossings and intersections require detectable warnings at the curb line for persons with visual impairments.
- Signage to indicate the raised intersection must be provided.
- Design speeds, transit routes, and emergency vehicle routes must be considered when designing approach ramps.

## SPECIAL CONSIDERATIONS

- Vertical speed control elements are most effectively implemented at a neighborhood level, rather than by request on a single street. While they may deter cut-through traffic on one street, traffic conditions on surrounding streets may worsen as a result.

## OPERATIONS AND MAINTENANCE

- 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 ramps.
- Vertical traffic calming must be designed to permit snow removal and accommodate street sweeping vehicles that do not damage the vertical speed control elements. Snow plow operators should be adequately warned and trained.
- The impact of traffic calming treatments at the network or neighborhood level should be monitored prior to and after installation to ensure there are no adverse impacts. Vertical control measures can be installed on a pilot

basis to assess potential impacts before permanent treatments are deployed.

- Vertical traffic calming must maintain signage and markings.

## REFERENCES

- NACTO: Urban Street Design Guide, 2013
  - Street Design Elements: Vertical Speed Control Elements
  - <http://nacto.org/publication/urban-street-design-guide/street-design-elements/vertical-speed-control-elements/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 2.6.2: Traffic-Calming Methods
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.6: Bicycles and Traffic Calming
- ITE/FHWA: Traffic Calming: State of the Practice, 1999
  - Chapter 3: Toolbox of Traffic Calming Measures
  - Vertical Measures <http://library.ite.org/pub/48b037de-a555-47f5-2651-bb412d17bab5>
  - Chapter 4: Engineering and Aesthetic Issues
  - Geometric Design Dimensions: Speed Humps and Tables <http://library.ite.org/pub/e27821e7-2354-d714-51e1-e3d3096ec30b>
  - U.S. Traffic Calming Manual, 2009. <https://www.planning.org/publications/book/9026718/>
- MMUTCD, 2011
  - Part 2 Signs: Chapter 2C. Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2c\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2c_2011.pdf)
  - Part 3 Markings: Chapter 3B. Pavement and Curb Markings
  - Section 3B.25 Speed Hump Markings
  - Section 3B.26 Advance Speed Hump Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)

## DETAILS

- City of Grand Rapids Frequently Used Detail
  - City Standard Speed Table
- MDOT Standard Highway Signs
  - SHS-E02-WARN “W” Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e02\\_warning.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e02_warning.pdf)

# STREET STRIPING MODIFICATION

A street striping modification—sometimes called a road diet—is a change in roadway striping, typically accomplished by removing 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 for other uses in order to discourage speeding and weaving; reduce the potential for rear end and side swipe collisions; improve sight distances for left-turning vehicles; reallocate space for sidewalks, standard bicycle lanes, bicycle lanes, bus bulbs, or curbside parking, which in turn creates a buffer between motor vehicle traffic and pedestrians; and improve

access for emergency vehicles by allowing them to use the center turn lane to bypass traffic if a continuous two-way left turn lane is provided.

## USE

- The most common configuration involves converting a four-lane road to three lanes, with two travel lanes with a turn lane in the center of the roadway.
- Four lane streets with traffic volumes less than 15,000 vehicles per day are generally good candidates for four to three lane conversions.
- Four lane streets with volumes between 15,000 to 20,000 vehicles per day may be good candidates for four to three lane conversions. A traffic analysis examining speed, volume and types of traffic is needed to determine feasibility.

## DESIGN

- The minimum width of the center turn lane is 10 feet.
- Four to three lane conversions typically have minimal effects on the vehicular capacity of the roadway because left-turning vehicles are moved into a common two-way left turn lane. If the remaining space is utilized for designated bicycle lanes, slower moving bicycle traffic is moved into its own lanes, which minimizes delays between vehicles and bicycles.

- If considered during reconstruction, raised center islands may be incorporated in between intersections to provide improved pedestrian crossings, incorporate landscape elements, and reduce travel speeds. Bulb-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 center islands, with opportunities for green infrastructure such as bioswales.

## SPECIAL CONSIDERATIONS

- The design of street reconfigurations should consider signal placement and alignment, signal timing, intersection capacity, and turn movements with traffic shifts at major intersections

## OPERATIONS AND MAINTENANCE

- Intersection design and operation should be monitored to determine the results of the project.

## REFERENCES

- City of Grand Rapids Street Classification Policy, 1996
  - Section 12. Traffic Calming, 12.9
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.9.2: Retrofitting Bicycle Facilities Without Roadway Widening
- FHWA: Road Diet Information Guide
  - [http://safety.fhwa.dot.gov/road\\_diets/info\\_guide/rdig.pdf](http://safety.fhwa.dot.gov/road_diets/info_guide/rdig.pdf)



# NEIGHBORHOOD ROUNDABOUT

Neighborhood roundabouts are circular or elliptical islands located at the intersection of low speed and low volume neighborhood residential streets. Roundabouts provide advantages for all road users as they reduce the need for a full stop and enable vehicles to continuously move through an intersection when conflicting traffic is not present. They can be installed using simple markings or raised islands, but they also provide great opportunities to include stormwater management facilities, landscaping, or pieces of art.

## USE

- An ideal treatment for uncontrolled intersections, roundabouts can reduce vehicle speeds and crashes in low-volume areas.
- Roundabouts are a good alternative to stop-controlled intersections and are usually preferred to four-way stops. They are more efficient and slow traffic to a neighborhood speed.
- Enhance roundabout visibility with signage and pavement markings, if needed.

## DESIGN

- Provide approximately 15 feet of clearance from the curb face to the outer edge of the circle.
- A mountable curb/curb apron should be provided at roundabouts where large trucks or emergency vehicles require access in constrained spaces.

- Crosswalks may be marked to clarify where pedestrians should cross and grant them priority. ADA-compliant ramps are required.
- Regulatory and/or warning signage should be provided to remind traffic to proceed counterclockwise around the circle.
- Roundabouts are ideal locations for art or neighborhood gateway treatments where likelihood of encroachment by larger vehicles is minimal; however, elements must not obstruct visibility.

Landscaping in the center island can reduce the impervious surface area in the roadway and allow stormwater infiltration or retention.

Street trees located should avoid blocking sight lines to ensure safety.

A neighborhood or community partner should be identified for maintenance of any plantings.

## OPERATIONS AND MAINTENANCE

- Roundabouts should be designed with snow removal in mind. They can be used for snow storage when necessary, although this may negatively impact planted materials and can block sight lines along the roadway.
- Roundabouts should allow adequate width in the adjacent travel lane to accommodate snow removal vehicles as well as turn radii that facilitate snow clearing and removal.

## SPECIAL CONSIDERATIONS

- Careful attention should be paid to the available lane width and turning radius.
- Incorporate intersection crossing markings to guide bicyclists through the intersection if being used as a community bicycle facility.
- If plantings are incorporated, they should require minimal maintenance and access paths for maintenance crews should be incorporated into the overall design.
- Designs should consider the speed of the roadway.
- Access to underground utilities should be considered.
- Plantings should be hardy and drought and salt resistant.

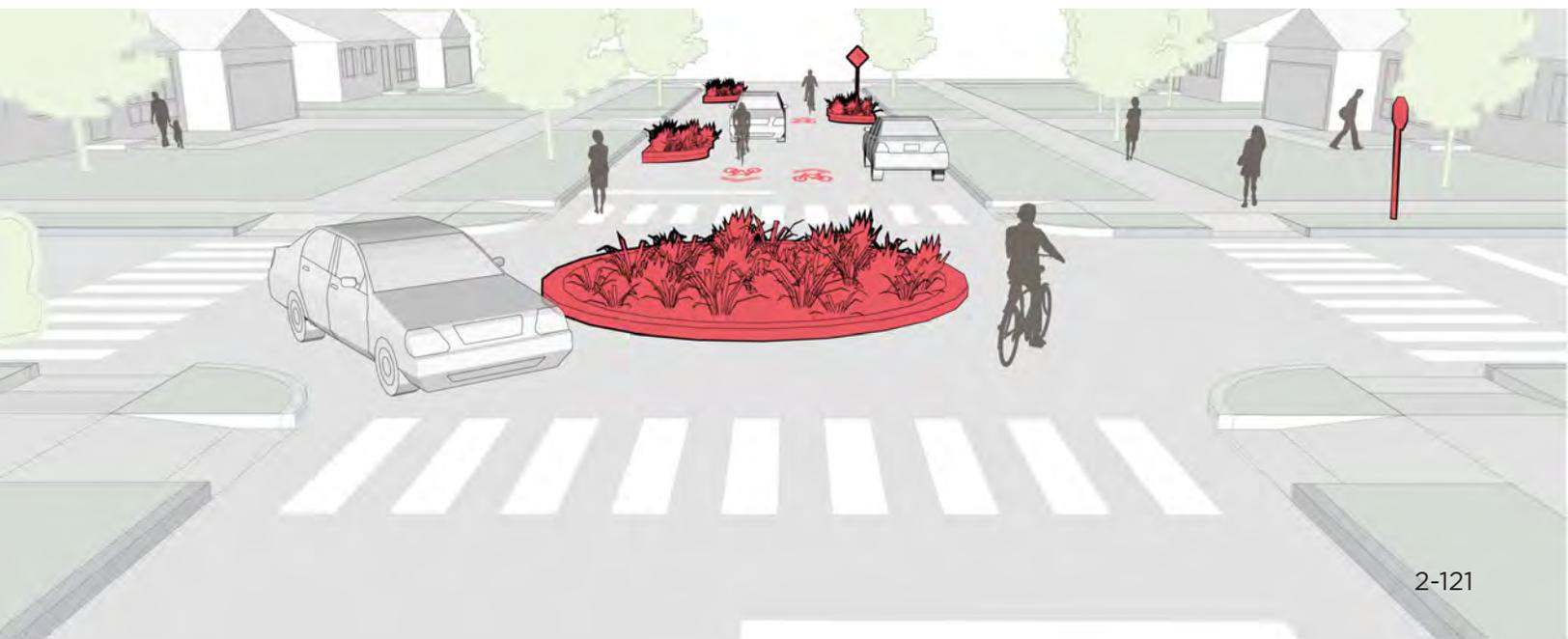
## REFERENCES

- City of Grand Rapids Street Classification Policy, 1996
  - Section 12. Traffic Calming, 12.3
- NACTO: Urban Street Design Guide, 2013
  - Intersections: Minor Intersections
  - Mini-Roundabout <http://nacto.org/publication/urban-street-design-guide/intersections/minor-intersections/mini-roundabout/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 3.3.2: Crossing Distance Considerations
  - Section 3.3.3: Turning Movements
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.11: Bicycle Travel at Roundabouts
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010

- Chapter 10. Intersection Design Guidelines: Modern Roundabouts <http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad>
- ITE/FHWA: Traffic Calming: State of the Practice, 1999
  - Chapter 3: Toolbox of Traffic Calming Measures
  - Horizontal Measures <http://library.ite.org/pub/48b037de-a555-47f5-2651-bb412d17bab5>
- Chapter 4: Engineering and Aesthetic Issues
  - Geometric Design Dimensions: Traffic Circles and Roundabouts <http://library.ite.org/pub/e27821e7-2354-d714-51e1-e3d3096ec30b>
- MMUTCD, 2011
  - Part 2 Signs: Chapter 2B. Regulatory Signs, Barricades, and Gates [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2b\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2b_2011.pdf)
  - Part 2 Signs: Chapter 2C. Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2c\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2c_2011.pdf)
  - Part 2 Signs: Chapter 2D. Guide Signs – Conventional Roads [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2d\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2d_2011.pdf)
  - Part 3 Markings: Chapter 3C. Roundabout Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)

## DETAILS

- MDOT Pavement Marking Standards
  - PAVE-951-A Roundabout Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-951-a.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-951-a.pdf)
- MDOT Standard Highway Signs
  - SHS-E01-REG “R” Regulatory Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)
  - SHS-E02-WARN “W” Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e02\\_warning.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e02_warning.pdf)
  - SHS-E08\_D\_GUIDE “D” Guide Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e08\\_d\\_guide.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e08_d_guide.pdf)





# VOLUME CONTROL DEVICES

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, often referred to as cut-through traffic. 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 with speeds limits less than 30 mph that feature higher than desired traffic volumes. They should be applied to lower order streets (Neighborhood Residential, Link Residential, Neighborhood Business, and Maker/Industrial streets).
- Semi-diverters and diverters should be carefully considered as they limit connectivity and the functionality of the street grid. They are inappropriate for use on emergency response routes, bus routes, or streets classified as collector or higher.

## DESIGN

Sometimes called a half street closure, semi-diverters prevent vehicles from crossing an intersection in one direction of a street while permitting traffic in the opposite direction to pass through. It is an alternative to one-way street operation for a block and it allows residents on the block limited two-way travel opportunity. A semi-diverter should be located at the end of a block to prevent vehicles from entering but allowing exits.

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.



Diverters and median barriers can create opportunities for landscaping, street trees, and low impact development.

## SPECIAL CONSIDERATIONS

- Volume control elements may divert traffic to other low-volume streets, which may increase trip lengths.
- Wherever traffic diversion techniques are employed, provisions should be made for the continuation of pedestrian and bicycle routing through or around the diversion.
- Care must be taken in design of diversion installations to allow for emergency vehicles and not lengthen emergency response times.

## OPERATIONS AND MAINTENANCE

- Operation of the street network should be monitored to ensure that traffic is diverted to higher level streets as intended, and that low volumes on one segment is not diverted onto a parallel low volume street. Devices should minimize disturbances to other low volume streets.
- If compliance is an issue, designs should be modified to increase compliance. Drivers may be less likely to go around the diverters or barriers if they are extended down the street, or angled for right turns out of the neighborhood, making turns into the neighborhood less desirable.
- A combination of measures can also be used to increase compliance, such as half closures with opposing center islands to make through movements more awkward.

## REFERENCES

- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 2.6.2: Traffic-Calming Methods
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.6: Bicycles and Traffic Calming
- ITE/FHWA: Traffic Calming: State of the Practice, 1999
- Chapter 3: Toolbox of Traffic Calming Measures

# INTERSECTIONS

Intersections are where different users and uses of the street combine and intersect. Intersections can be the most challenging element to street design, because they are where the majority of conflicts and crashes occur. Therefore, a focus on quality design is very important to ensure the safety of all street users. Just as street segments can be designed to be 'self-regulating', designers should strive to make intersections similarly self-evident to all users. . Intersection design should facilitate visibility and predictability for all users, creating an environment in which complex movements are evident, simple, and obvious.

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 of those design objectives 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 the benefits will be greatest if signals can be timed throughout a corridor.

There are several different types of intersection designs, traffic signals, and timing. Use of these devices should be only in appropriate locations based on engineering judgement, keeping in mind maintenance, operations, and effectiveness. Given that safe design should be self-evident, locations should be carefully selected.

## INTERSECTION CONFIGURATIONS

Intersections can range from simple crossings that are relatively straightforward to complex, multiway 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 unnecessary turn 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. Aligning intersections at right angles also facilitates transportation system management, such as signal timing, transit signal priority, and leading pedestrian intervals.

Finally, by focusing on simplifying and reducing the size of intersections, there may be opportunities to reclaim public space. The location of reclaimed space can be in the middle of an intersection or extended from corners or legs of an intersection. The

additional space can be closed for motor vehicle use and then used for multiple other purposes, such as widening sidewalks, adding bicycle and/or transit facilities, providing space for traffic control devices, utilities, plantings, green infrastructure, street furniture, or public art. Reclaiming space can entail short-term or temporary solutions, such as seasonal parklets or bicycle share stations, or longer-term, permanent changes, such as the removal of a travel lane or closure of slip lanes.

## REFERENCES

- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 3.3.3: Turning Movements
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.10: Bicycle Travel Through Interchange Areas
- MMUTCD, 2011
  - Part 2 Signs: Chapter 2D. Guide Signs – Conventional Roads
  - Section 2D.45: Signing on Conventional Roads on Approaches to Interchanges [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2d\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2d_2011.pdf)
  - Part 3 Markings: Chapter 3B. Pavement and Curb Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)
- NACTO: Urban Street Design Manual. Intersections.

## DETAILS

- MDOT Standard Highway Signs
  - SHS-E08\_D\_GUIDE “D” Guide Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e08\\_d\\_guide.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e08_d_guide.pdf)



# PEDESTRIAN YIELD CONTROLS

Stop and yield control devices can make it easier for pedestrians and motorists to see one another, discouraging motor vehicles from encroaching on the crosswalk, and thereby 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 to the pedestrian while the motor vehicle in the far lane does not yield because the pedestrian is blocked from their view. There are several different types of controls, as outlined below. Use of these devices should be only in appropriate locations based on engineering judgement, keeping in mind maintenance, operations, and effectiveness. Given that safe design should be self-evident, locations should be carefully selected.

- **Advanced Yield Markings:** Coordinated signage used at uncontrolled and yield-controlled midblock locations and intersections to encourage drivers to stop further back from crosswalks.
- **In-street “YIELD TO PEDESTRIAN” Signs:** Signs placed in the roadway at crosswalk locations to remind roadway users of the laws regarding the right-of-way at unsignalized midblock locations and intersections.

- **Rectangular Rapid-Flash Beacons (RRFB):** Pedestrian crossing signs combined with an intensely flashing beacon that is only activated when a pedestrian is present. The flash is a fast flickering pattern activated by a pedestrian call button.

## USE

- Advance yield markings should not be used at locations where drivers are required to stop in compliance with a “STOP” sign or a signal.
- Advance yield markings and signs can be used on two-lane, three-lane, and four-lane roadways; however, they are less effective on four-lane roadways unless vehicle operating speeds are 25 mph or less.
- In-street signs can be used in conjunction with advanced warning signs and pedestrian crossing signs at crosswalks.
- RFBs can be used when a traffic signal is not warranted at an unsignalized crossing. They are not appropriate at intersections with signals or “STOP” signs.

## DESIGN

- In-street “YIELD TO PEDESTRIAN” signs should only be used at uncontrolled intersections. They are prohibited from use at signalized, stop-controlled, or yield-controlled intersections.
- Yield lines at unsignalized crossings should be accompanied by “YIELD HERE TO PEDESTRIAN” signs.
- Advance yield lines and signs shall be placed 20’ to 50’ in advance of crosswalks on uncontrolled approaches, and parking shall be prohibited in the area between the yield line 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 also be placed to avoid turning vehicles from knocking over the sign, and should be designed to bend over and bounce back when struck.
- RFBs should be placed curbside below the pedestrian crossing sign and above the arrow indication pointing at the crossing.
- RFBs should be used in conjunction with advance yield lines and pedestrian crossing signs.
- RFBs are installed on both sides of the roadway at the edge of the crosswalk. If there is a pedestrian refuge or other type of median, an additional beacon should be installed in the median.
- Another indicator should be installed facing the pedestrian to indicate that the RFB has been activated. The push button and other components of the crosswalk must meet all other accessibility requirements.

## 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. Damaged signs send the message to pedestrians that a crossing is not safe.
- Trees and other vegetation should be regularly trimmed to maintain visibility.
- Regular maintenance is required. In-street yield pedestrian signs are frequently hit by vehicles, particularly during the winter season. These signs should be removed to coincide with odd/even winter parking restrictions.

## SPECIAL CONSIDERATIONS

- The effectiveness of marked advance yield/stop lines depends on motorist compliance. If placed too far in advance of the crosswalk, motorists might ignore the line.
- Pavement markings can be used to reinforce NO PARKING signage specific to pedestrian yield zones.
- When determining where to place advance yield lines and signs within the 20’ to 50’ range, consideration should be given to the number of lanes pedestrians must cross, motor vehicle speeds, sight lines, on-street parking, and turning movements.
- Advance yield lines may be staggered, so that yield lines in one lane are closer to the crosswalk than the yield lines in an adjacent lane. Staggered yield lines can improve drivers’ view of pedestrians, provide better sight distance for turning vehicles, and increase the turning radius for left-turning vehicles.
- In-street YIELD TO PEDESTRIAN signs work best on lower speed, two lane roads. They are not recommended for roads with higher speeds or traffic volumes where drivers are less likely to see them.
- In-street signs may be used in combination with pedestrian warning signs, which should be placed on the right side of the road on the sidewalk or mounted on a mast arm above the crosswalk.

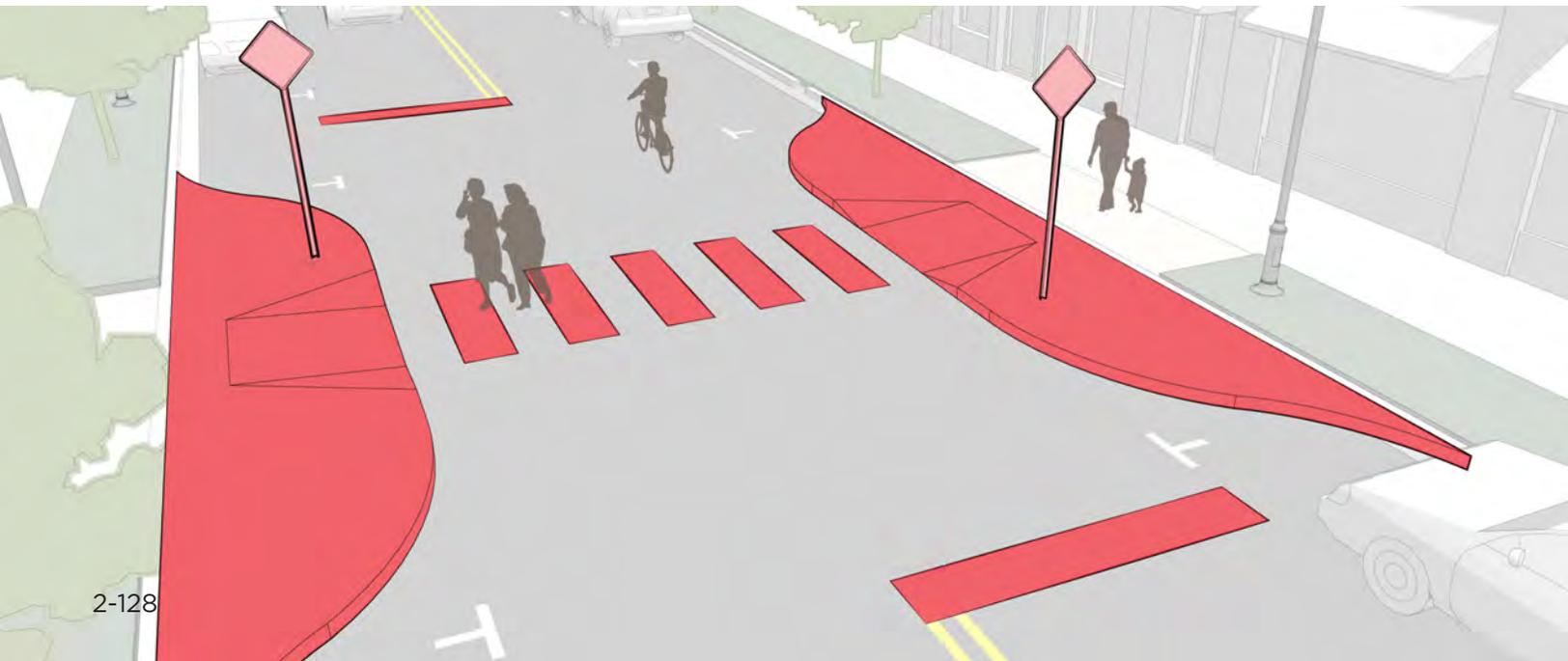
- RFBs should be limited to locations with critical safety concerns and should not be installed in locations with sight distance constraints that limit a driver's ability to view pedestrians on the approach to the crosswalk.
- RFBs are usually implemented at higher volume pedestrian crossings, but may also be considered for priority bicycle route crossings or locations where bicycle facilities cross roads at midblock locations. If RFBs are used for these bicycle crossings, the beacons need to be automatically triggered or bicycle-accessible push buttons to actuate the beacon should be installed.
- Audible Pedestrian Signals shall be considered where known vulnerable populations exist (reside or visiting) near key intersections, such as hospitals and schools.

## REFERENCES

- NACTO: Urban Street Design Guide, 2013
  - Intersection Design Elements: Traffic Signals <http://nacto.org/publication/urban-street-design-guide/intersection-design-elements/traffic-signals/>
- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Bicycle Signals <http://nacto.org/publication/urban-bikeway-design-guide/bicycle-signals/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 4.1: Pedestrian Signals
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.4: Traffic Signals
  - Section 4.12.5: Detection for Bicycles at Traffic Signals
- MMUTCD, 2011
  - Part 4 Highway Traffic Signals [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart4\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart4_2011.pdf)
- MDOT Traffic and Safety Notes
  - Notes Manual 207C Guidelines for Pedestrian Push Button Use & Location [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_note207c.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_note207c.pdf)

## DETAILS

- MDOT Pavement Marking Standards
  - PAVE-945-C Intersection, Stop Bar and Crosswalk Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-945-c.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-945-c.pdf)





# STOP CONTROLS AT CROSSWALK

The goal of controlling intersections is to provide the safest, most efficient means to move people across an intersection, whether walking, riding a bicycle, taking transit, or driving. Specific attention should be given to more vulnerable roadway users, such as pedestrians and bicyclists.

There are several different types of controls, as outlined below. Use of these approaches should be only in appropriate locations based on engineering judgement, keeping in mind maintenance, operations, and effectiveness.

- **Stop signs** indicate that all road users on their approach to the intersection are required to come to a complete stop before entering the intersection and then may proceed if there are no other users close to or within the intersection.
- **Pedestrian signals** should be provided at all signalized intersections in all directions. Pedestrian signal indications are Walk, flashing Don't Walk, Don't Walk, or walking person and raised hand symbols.

- **High-Intensity Activated Crosswalk (HAWK) signals** are often used at midblock crossings and crosswalks at major streets to increase driver awareness of pedestrians. A red HAWK beacon is not illuminated until it is activated by a pedestrian, triggering the warning flashing beacon phase while the pedestrian is crossing.

## USE

- Marked crosswalks should be installed at each leg of all signalized intersections, unless otherwise determined by an engineering study.
- Marked crosswalks should be installed at each leg of all stop-controlled intersections near pedestrian generators.
- Marked crosswalks should be installed at each leg of a roundabout intersection.

## DESIGN

- Stop lines should be striped at signalized intersections no less than four feet and no more than 30 feet from the crosswalk to discourage motorists from encroaching in the crosswalk.
- Stop lines should be striped at stop-controlled intersections no less than four feet and no more than 30 feet from the approach of crosswalks, unless determined otherwise by an engineering study.

## SPECIAL CONSIDERATIONS

- Engineering judgment should be used to establish the most appropriate controls on a site-specific basis. The following factors should be considered when determining intersection controls:
  - Vehicular, bicycle, and pedestrian traffic volumes on all approaches
  - Number and angle of approaches
  - Approach speeds
  - Sight distance available on each approach
  - Reported crash experience
  - Land uses in the area,
  - Location of transit stops
- Depending on the type of intersection and the selected control devices, it may not always be appropriate to mark crosswalks at all legs of an intersection. Alternate treatments may be necessary to optimize safety and visibility.
- Staggered stop bars may be appropriate where occlusion is present.
- Mid-block crossings should be considered in appropriate areas that would enhance pedestrian safety

## REFERENCES

- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.7: Bicycles and Traffic Management
- MMUTCD, 2011
  - Part 2 Signs: Chapter 2B. Regulatory Signs, Barricades, and Gates [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2b\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2b_2011.pdf)
  - Part 2 Signs: Chapter 2C. Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2c\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2c_2011.pdf)
  - Part 3 Markings: Chapter 3B. Pavement and Curb Markings
  - Section 3B.16: Stop and Yield Lines [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)
  - Part 4 Highway Traffic Signals: Traffic Control Signals – General
  - Section 4B.04: Alternatives to Traffic Control Signals [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart4\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart4_2011.pdf)

## DETAILS

- MDOT Pavement Marking Standards
  - PAVE-945-C Intersection, Stop Bar and Crosswalk Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-945-c.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-945-c.pdf)





# LEADING PEDESTRIAN INTERVAL

A leading pedestrian interval (LPI) is a brief period at the beginning of a signal phase that permits pedestrians to enter the crosswalk before any other traffic is permitted to advance. LPIs improve the visibility of pedestrians by raising their visibility with right and left turning vehicles. Studies show that LPIs reduce pedestrian vehicle collisions by up to 60%

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## USE

- LPIs are appropriate for use on any street type; however, they are typically used at intersections with significant pedestrian volumes and high volumes of conflicting turning vehicles, such as commercial areas and areas of high student concentrations.
- LPIs may also be used on streets approaching a higher volume streets to improve the visibility of pedestrians crossing parallel to high volume, higher-speed streets.

20 A.C. Fayish and Frank Gross, "Safety effectiveness of leading pedestrian intervals evaluated by a before-after study with comparison groups," Transportation Research Record No. 2198 (2010): 15-22

## DESIGN

- Requires the concurrent use of pedestrian signals.
- Shall not be used with leading left turns.
- Must be a minimum of three seconds in duration, but more commonly provide five or more seconds to permit pedestrians to cross at least one lane of vehicle traffic.
- Should be accompanied by audible pedestrian signals for visually impaired pedestrians.

## SPECIAL CONSIDERATIONS

- Restrict "Right on Red" turns at locations where LPIs are used. Right on red turns are generally undesirable at intersections with high and regular pedestrian volumes.
- At locations with extremely high pedestrian volumes, combine the LPI with signal timing that displays the "DON'T WALK" signal for pedestrians even while the green phase is still shown for parallel traveling vehicles. This brief period at the end of the cycle provides an opportunity for vehicles to complete turns after the majority of pedestrians have completed their crossing.
- Combine LPIs with bulb-outs to further increase pedestrian visibility and safety.

- Bicyclists may also benefit from LPIs by clearing an intersection to permit vehicle turns.
- A lagging pedestrian interval option operates similarly to a leading pedestrian interval, except that the pedestrian walk interval starts several seconds after the adjacent through movement phase. This option allows a waiting right-turn queue to clear before the pedestrian walk indication is presented and reduces conflicts with right-turning vehicles. It is applicable to intersections where there is a high right-turn volume and either an exclusive right-turn lane (or lanes) or the two intersecting roads have one-way traffic.
- A pedestrian scramble or Barnes Dance is an exclusive pedestrian phase that allows pedestrians to cross the intersection in any direction and in a diagonal path. It is applicable to intersections where there are extremely high numbers of pedestrians.

## REFERENCES

- MMUTCD, 2011
  - Part 2 Signs: Chapter 2B. Regulatory Signs, Barricades, and Gates [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2b\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2b_2011.pdf)
  - Part 2 Signs: Chapter 2C. Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2c\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2c_2011.pdf)
  - Part 3 Markings: Chapter 3B. Pavement and Curb Markings
  - Section 3B.16: Stop and Yield Lines [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)
  - Part 4 Highway Traffic Signals: Traffic Control Signals – General
  - Section 4B.04: Alternatives to Traffic Control Signals [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart4\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart4_2011.pdf)

## DETAILS

- MDOT Pavement Marking Standards
  - PAVE-945-C Intersection, Stop Bar and Crosswalk Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-945-c.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-945-c.pdf)



# ROUNDBABOUTS

Roundabouts are a circular intersection control where the turning movements are physically separated by a central island, and traffic moves along the travel lanes surrounding the central island. Vehicles leave the intersection by executing a right-turn maneuver at the appropriate leg.

Roundabouts have been proven safer and more efficient than stop-controlled and signalized intersections.<sup>21</sup> They provide advantages for all road users as they reduce the need for a full stop and enable continuous movement through the intersection when conflicting traffic is not present. Roundabouts are the preferred intersection design in Grand Rapids, though implementation in a constrained urban environment is a challenge due to the amount of right-of-way required.

## USE

- Roundabouts are a yield-control method instead of the use of signalized intersections and can be designed to accommodate a range of vehicle volumes.
- Roundabouts can be single-lane or double-lane, but generally feature slower vehicle speeds (15-25 MPH), throughout the roundabout. Single-lane roundabouts are preferred.
- Limited right-of-way is a constraint.

<sup>21</sup> Roundabouts reduce the types of crashes where people are seriously hurt or killed by 78-82% when compared to conventional stop-controlled and signalized intersections, per the AASHTO Highway Safety Manual.

## DESIGN

- Roundabouts should have the appropriate number of lanes and lane assignment to achieve adequate capacity, lane volume balance, and continuity of lanes through the roundabout.
- A mountable curb/curb apron should be provided at roundabouts where large trucks or emergency vehicles require access in constrained spaces.
- Crosswalks should be marked to clarify where pedestrians should cross and that they have priority. Marked crosswalks are required to be 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 for pedestrian crossings.
- ADA-compliant ramps and detectable warnings are required to ensure safe pedestrian crossings.
- Splitter islands are medians or pedestrian refuge islands that increase pedestrian safety. These allow pedestrians to cross one direction of traffic at a time and guide traffic into the roundabout, physically separating entering and exiting vehicles. Additionally, splitter islands can be used as a place for mounting signs.
- Regulatory and/or warning signage should be provided to remind traffic to proceed counterclockwise around the circle.

- Designs should incorporate intersection crossing markings to guide bicyclists through the intersection.
- If a bicycle facility is present on an approach roadway, the roundabout can have bicycle take-off and re-entry ramps to allow bicyclists to either merge with traffic or move onto the sidewalk or shared use path.
- Roundabout designs should maintain visibility with paint and reflectors and sight distances.
- Roundabout designs should achieve smooth channelization that is intuitive to drivers and results in vehicles naturally using the intended lanes.
- Landscaping in roundabouts reduces the impervious surface area in the roadway, allowing stormwater infiltration or retention in the exposed soil.
- Any street trees or other vegetation included in roundabout intersections should avoid blocking sight lines of all users to ensure safety. Street trees are not recommended in the center island.
- Roundabouts are ideal locations for art or neighborhood gateway treatments; however, these elements must not obstruct visibility.

## SPECIAL CONSIDERATIONS

- Education and awareness may be needed in areas where people are unfamiliar with roundabouts.
- Careful attention should be paid to the available lane width and turning radius used with roundabouts.
- In emergency routes, roundabouts should be designed for large trucks, including a special purpose apparatus such as a ladder fire truck. This is accomplished by using features such as:
  - Wider entry and exit lanes for efficient movement of traffic through the roundabout.
  - Mountable aprons and curbs intended for use by vehicles with a wide and/or long wheelbase.
  - Curvature and radii that allow for easy turning movements, including U-turns.
- If plantings are incorporated, they should require minimal maintenance and access paths for maintenance crews should be incorporated into the overall design.



- Designs should consider the speed of the intersecting roadways. Multi-lane roundabouts require additional considerations and can be more challenging to implement due to right-of-way constraints, traffic control in relation to other intersections, and potential driver abilities. A feasibility analysis should be required to model the intersection during planning.
- Access to underground utilities should be considered.

## OPERATIONS AND MAINTENANCE

- Roundabouts should be designed with snow removal in mind. They can be used for snow storage when necessary, although this may negatively impact planted materials and can block sight lines along the roadway.
- Roundabouts should allow adequate width in the adjacent travel lane to accommodate snow removal vehicles, as well as turn radii that facilitates snow clearing and removal.
- Sweeping/snow cleaning in pedestrian refuge islands.

## REFERENCES

- City of Grand Rapids Street Classification Policy, 1996
  - Section 12. Traffic Calming, 12.3
- NACTO: Urban Street Design Guide, 2013
  - Intersections: Minor Intersections
  - Mini-Roundabout <http://nacto.org/publication/urban-street-design-guide/intersections/minor-intersections/mini-roundabout/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 3.3.2: Crossing Distance Considerations
  - Section 3.3.3: Turning Movements
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.11: Bicycle Travel at Roundabouts
- ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
  - Chapter 10. Intersection Design Guidelines: Modern Roundabouts <http://library.ite.org/pub/e1c1ff43c-2354-d714-51d9-d82b39d4dbad>
- ITE/FHWA: Traffic Calming: State of the Practice, 1999
  - Chapter 3: Toolbox of Traffic Calming Measures
  - Horizontal Measures <http://library.ite.org/pub/48b037de-a555-47f5-2651-bb412d17bab5>
- Chapter 4: Engineering and Aesthetic Issues
  - Geometric Design Dimensions: Traffic Circles and Roundabouts <http://library.ite.org/pub/e27821e7-2354-d714-51e1-e3d3096ec30b>
- MMUTCD, 2011
  - Part 2 Signs: Chapter 2B. Regulatory Signs, Barricades, and Gates [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2b\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2b_2011.pdf)
  - Part 2 Signs: Chapter 2C. Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2c\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2c_2011.pdf)
  - Part 2 Signs: Chapter 2D. Guide Signs – Conventional Roads [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart2d\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart2d_2011.pdf)
  - Part 3 Markings: Chapter 3C. Roundabout Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart3\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart3_2011.pdf)

## DETAILS

- MDOT Pavement Marking Standards
  - PAVE-951-A Roundabout Markings [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_pave-951-a.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_pave-951-a.pdf)
- MDOT Standard Highway Signs
  - SHS-E01-REG “R” Regulatory Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e01\\_regulatory.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e01_regulatory.pdf)
  - SHS-E02-WARN “W” Warning Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e02\\_warning.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e02_warning.pdf)
  - SHS-E08\_D\_GUIDE “D” Guide Signs [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mdot\\_signs\\_e08\\_d\\_guide.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signs_e08_d_guide.pdf)



# RAISED INTERSECTION

Raised intersections create a safe, 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.

Raised intersections physically change an intersection to make it difficult for drivers to operate at unsafe speeds. They also improve drivers' awareness of pedestrian crossings and define locations where pedestrians are expected. Raised intersections increase visibility between drivers and pedestrians by raising pedestrians in the motorists' field of view and giving pedestrians an elevated vantage point from which to look for oncoming traffic. They can create pedestrian crossings that are more comfortable, convenient, and accessible since transitioning between the sidewalk and roadway does not require negotiating a curb ramp.

## USE

- Raised intersections are appropriate in areas of high pedestrian demand.
- Raised intersections and crossings can be used as gateway treatments to signal to drivers when there are transitions to a slower speed environment that is more pedestrian-oriented.
- Care should be taken to maintain direct routes across intersections aligning pedestrian desire lines on either side of the sidewalk.
- Raised intersections are generally not used in areas with high traffic volumes, along major transit or EMS routes, and multilane streets.

## DESIGN

- Raised crossings and intersections require detectable warnings at the curb line for persons with visual disabilities.
- 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.

## SPECIAL CONSIDERATIONS

- Raised intersections should be considered in school zones and locations where pedestrian visibility and motorist yielding have been identified as concerns.
- Design speeds 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.
- Installation of raised crossings and intersections may affect snow removal operations. Snow plow operators should be adequately warned and trained.

## REFERENCES

- NACTO: Urban Street Design Guide, 2013
  - Intersections: Minor Intersections
  - Raised Intersections <http://nacto.org/publication/urban-street-design-guide/intersections/minor-intersections/raised-intersections/>
- AASHTO: Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
  - Section 2.6.2: Traffic-Calming Methods
  - ITE/FHWA: Traffic Calming: State of the Practice, 1999
  - Chapter 3: Toolbox of Traffic Calming Measures
  - Vertical Measures <http://library.ite.org/pub/48b037de-a555-47f5-2651-bb412d17bab5>



# BICYCLE FACILITIES AT INTERSECTIONS

The majority of motor vehicle crashes involving bicycles in urban areas occur at intersections. Bicycles are not considered vehicles in State of Michigan Vehicle Code, but they are required to follow the same rules of the road as motorists. Good intersection design makes bicycling more comfortable and attractive, reduces conflicts with motor vehicles and pedestrians, and contributes to reduced crashes and injuries. Bicycles have different operating characteristics than motor vehicles, so special considerations are necessary in designing traffic signals that accommodate both motorists and bicyclists.

## USE

- When designing intersections for bicyclists, approaches should be evaluated and designs should maintain continuity of bicycle facilities to the maximum extent feasible.
- Streets with dedicated bicycle lanes should consider striping through more complex signalized and complicated intersections to provide additional guidance and safety measures for bicyclists. This design principle is especially important at intersections where there are conflicting vehicular movements, unsignalized crossings, and/or crossings of more than four travel lanes.
- Bicyclists generally may have slower acceleration rates than motorists, and traffic signal phasing design considerations should include adjustment of minimum green intervals, clearance time, and extension time where appropriate.

- Special bicycle signals should be considered for bicycle tracks, two-way bicycle tracks, and contraflow bicycle facilities.
- Signal progression should be designed so that the needs of all users are considered, with appropriate design speeds and traffic signal coordination settings.

## DESIGN

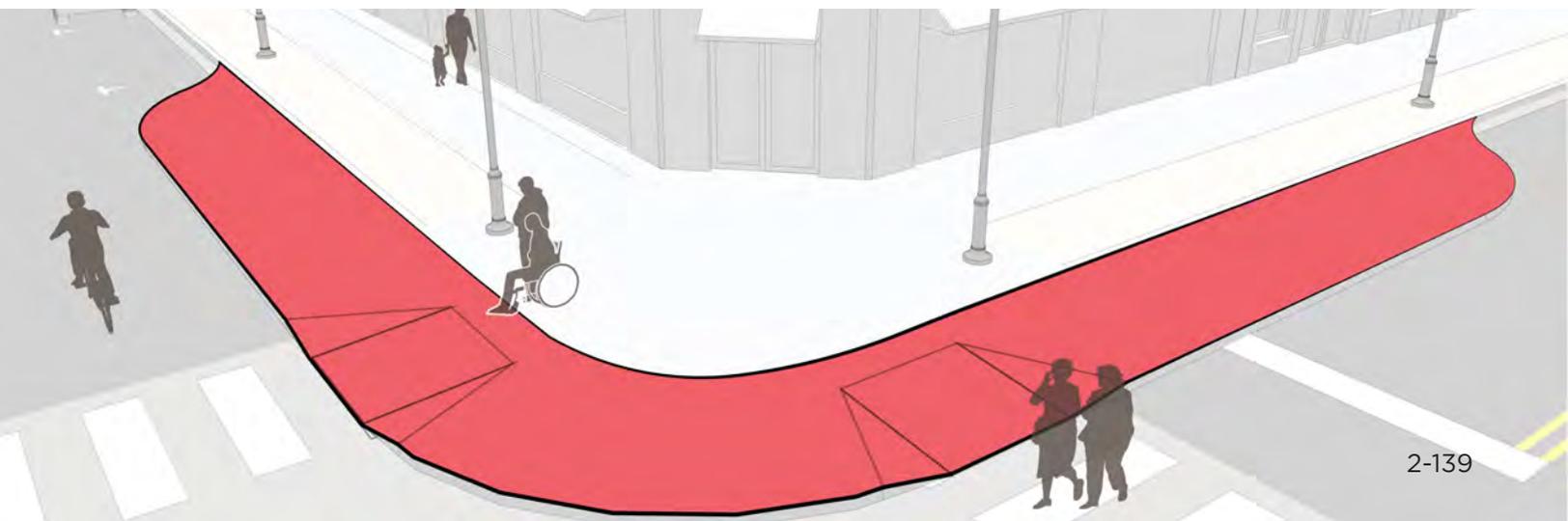
- Standard details for bicycle lane markings at intersections are provided in the MUTCD, the AASHTO Bike Guide, and the NACTO Urban Bikeway Design Guide.
- Dedicated bicycle lanes should be provided on intersection approaches and either carry through the intersection or be picked up on the other side.
- At intersections with a dedicated right turn lane, bicycle lanes should be provided to the left of the right turn only lane unless bicycle signals and dedicated phasing is provided.
- In order for bicyclists to prompt the green phase at signalized intersections, bicycle detection devices should be installed.
- Traffic signal detection devices should be located within bicycle lanes, bicycle boxes or where appropriate. They should be marked with a bicycle detector pavement marking symbol and supplemental signage as needed.
- When it is not feasible for the detection device to be located within the bicycle lane or bicycle box, detection devices should be located prior to the stop bar and span an appropriate distance to provide for left, through, and right turning bicyclists.

## SPECIAL CONSIDERATIONS

- The AASHTO Guide for the Development of Bicycle Facilities provides a specific formula to estimate minimum green time in traffic signal phasing for bicycles from a standing position. It is based on average adult bicyclists who can typically operate at 10 mph. A slower speed or extended time may be appropriate at locations utilized by young children, such as near schools or where trails intersect streets
- Bicycle lane markings, including green-colored pavement, shared lane markings, dashed bicycle lane lines, and signage should be provided through intersections per engineering judgment.
- Selective removal of parking spaces may be needed to provide adequate visibility and to establish sufficient bicycle lane width at approaches to intersections.
- Shared lane markings may be used where space is not available for bicycle lanes at intersections; however, this should only be done if no other design is possible.
- Opportunities to remove existing vehicular right-hand turn-lanes to create space for on-street bicycle facilities should be evaluated.
- Bicycle lanes at the entrance and exit of a roundabout should allow direct access to a shared use bicycle/pedestrian path around the perimeter of the intersection via bicycle-specific sidewalk ramps; ramps should be provided for bicyclists to mount the sidewalk prior to the intersection and re-enter the roadway after traveling around the intersection. Circular intersection designs should also enable bicyclists to mix with traffic and proceed through the intersection.
- Typical detection of bicycles at signalized intersections is performed by loop detectors at actuated or semi-actuated intersections. Detection devices can also include:
  - Video detection,
  - Infra-red detection,
  - Microwave detection, or
  - Magnetometers.
- Bicycle signal heads provide dedicated signal indications to bicyclists and should be positioned for maximum visibility to bicycle traffic. They should be coordinated with pedestrian and non-conflicting vehicular movements to increase safety and minimize overall intersection delay.
- A combined bicycle lane/turn lane places a suggested bicycle lane within the inside portion of a dedicated motor vehicle turn lane. Shared lane markings or conventional bicycle stencils with a dashed line can delineate the space for bicyclists and motorists within the shared lane or indicate the intended path for through bicyclists.
- Green pavement or pavement markings may be used at high conflict points such as heavy merge areas with right turn lanes, slip lanes, and at interchanges. -

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014; Intersection Treatments <http://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/>
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.8: Bicycle Lanes at Intersections
  - Section 4.12.10: Bicycle Travel Through Interchange Areas
  - Section 4.12.11: Bicycle Travel at Roundabouts





# BIKE BOXES

A bike box is a dedicated area for bicyclists at the front of a traffic lane at a signalized intersection. Bike boxes make bicyclists more visible to motorists by positioning them at the head of a queue during a stop cycle. They provide a space for bicyclists to queue outside of crosswalk areas. Bike boxes enable bicyclists to safely position for a left turn during a stop cycle at an intersection. On corridors of high bicycle activity, bike boxes cluster multiple bicyclists and enable them 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 thick 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 but not more than seven 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 create more separation and prevent bicyclists from blocking the crosswalk.

- Bicycle symbol pavement markings are located within the bike box in all lanes over which it extends.
- Right turns on red must be reviewed where bike boxes are used. Right turn on red restrictions or prohibition of turns shall be considered to avoid conflicts with queued and waiting bicyclists. If employed, appropriate signage shall be installed.

## 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.

## SPECIAL CONSIDERATIONS

- Pavement marking or signs may be used to indicate to vehicles where to stop to avoid encroachment on the bike box.
- Green pavement or pavement markings are commonly used in bike boxes to enhance visibility and compliance but are not required.
- Bike boxes are commonly used in conjunction with dedicated bicycle facilities. Where bicycle lanes are not present, a bicycle ingress lane may be used to provide bicycles access to the bike box as they approach the intersection. Green pavement or pavement markings may be used in the bicycle approach area.
- Bicycle egress lanes may continue into the intersection to indicate the area of potential conflict between motorists and bicyclists. Green pavement or pavement markings may be used.
- While bike boxes facilitate the positioning of bicyclists to make left-hand turns, lateral movement by a bicyclist after the initiation of the green phase could introduce conflicts with motorists. Two-stage turn queues are an alternative to accommodate left turning bicyclists.
- Education and outreach to motorists, bicyclists and pedestrians may be necessary to ensure their safe and appropriate use.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Intersection Treatments: Bike Boxes <http://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/bike-boxes/>
- FHWA: Bicycle and Pedestrian Program Guidance
  - Bicycle Facilities and the Manual on Uniform Traffic Control Devices [http://www.fhwa.dot.gov/environment/bicycle\\_pedestrian/guidance/mutcd/bicycle\\_box.cfm](http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/mutcd/bicycle_box.cfm)
- MMUTCD, 2011
  - Part 9 Traffic Control for Bicycle Facilities [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)



# BICYCLE TRAFFIC SIGNALS

Bicycles have different operating characteristics than motor vehicles and may require a bicycle specific traffic signal. Bike signals have the same color signal heads as vehicle signals (green, yellow, and red) with the image of a bicycle stenciled on the lens. Bike signals can be used to provide leading bicycle intervals at intersections to separate bicyclists from conflicts with drivers, pedestrians, or transit vehicles. They are also typically used to accommodate more complex intersection operations with the use of bidirectional protected bicycle lanes.

## USE

- Bike signals are generally required to support the operation of bicycle facilities that separate bicyclists from motor vehicle traffic with potential turning conflicts. Protected bicycle lanes, contraflow bicycle lanes, and two-way cycle tracks are examples of facilities where bike signals are often needed.
- Bike signals may be considered at intersections with conventional bicycle lanes or other types of facilities to improve intersection operations or to decrease vehicle or pedestrian conflicts at major crossings.
- Bike signals may be appropriate where shared use side paths cross a street and bicyclists and pedestrians require different clearance times.
- They may also be necessary at complex intersections that may otherwise be difficult to navigate, such as intersections with high numbers of crashes between bicycles and motor vehicles.

## DESIGN

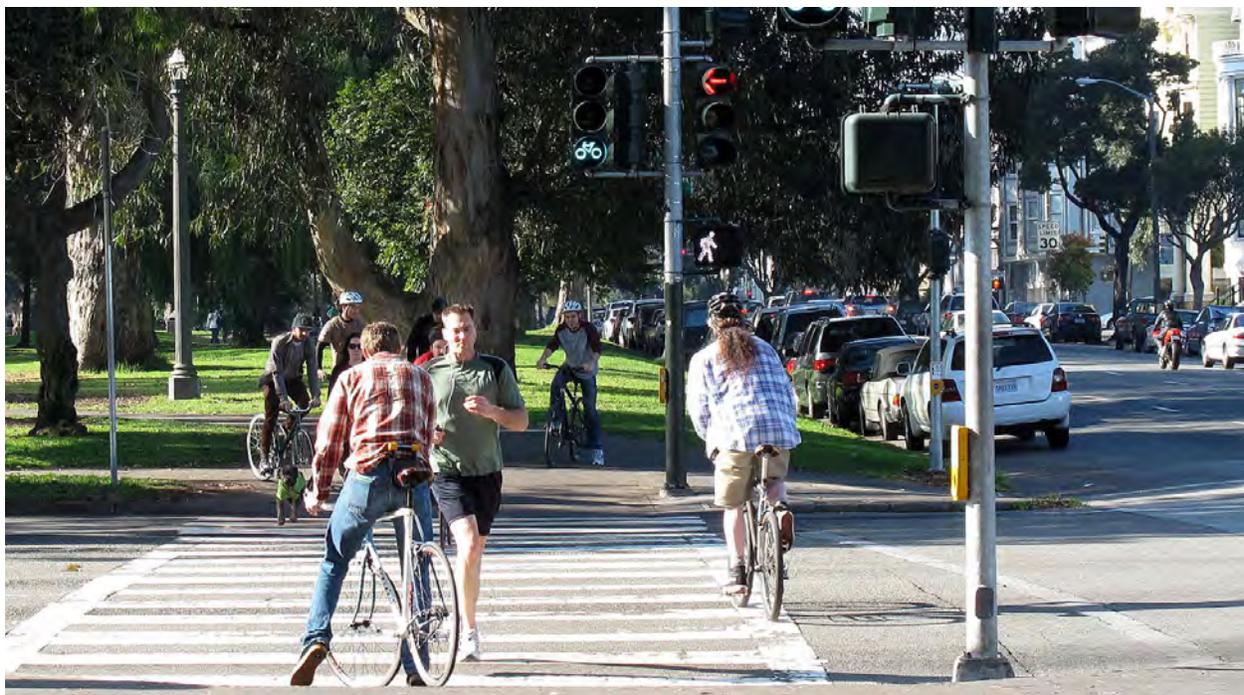
- Bike signals may be achieved through minor modification of existing signal equipment or with installation of a new traffic signal.
- The bicycle signal head shall be placed in a location clearly visible to oncoming bicycles.
- If not a regular part of the signal phasing, detection and/or actuation is required.

## SPECIAL CONSIDERATIONS

- Engineering judgment should be used to establish the most appropriate controls on a site-specific basis. The following factors should be considered when determining intersection controls:
  - Vehicular, bicycle, and pedestrian traffic volumes on all approaches
  - Bicycle facilities and turning movements
  - Vehicle speeds
  - Sight distance available on each approach
  - Reported crash experience
- Bike signals may be needed to meet the needs of vulnerable users, such as at intersections near schools.

## REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Bicycle Signals <http://nacto.org/publication/urban-bikeway-design-guide/bicycle-signals/>
- AASHTO: Guide for the Development of Bicycle Facilities, 2012
  - Section 4.12.4: Traffic Signals
  - Section 4.12.5: Detection for Bicycles at Traffic Signals
- MMUTCD, 2011
  - Part 4 Highway Traffic Signals [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart4\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart4_2011.pdf)
  - Part 9 Traffic Control for Bicycle Facilities: Chapter 9D. Signals [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)





# TWO-STAGE TURN QUEUE

A two-stage turn queue (TSTQ) box provides a protected area for bicyclists to 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 proceeding across to complete the turn. Two-stage turn queues reduce bicycle/vehicle conflicts and provide a less stressful left-turn option. 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. Even where two-stage turn queues are provided, their use is optional. Bicyclists may still lawfully complete a left turn from the left-most travel lane where vehicular left turns are also permitted.

## USE

- Two-stage turn queue boxes may be used on any street type, but are especially appropriate where there are significant volumes of turning bicyclists, along preferred travel routes where increased bicycling is encouraged, and/or where accommodation of less confident bicyclists is needed.
- Two-stage turn queue boxes are particularly beneficial on streets with more than one travel lane in any one direction including turn lanes.

- Two-stage turn queue boxes can be used at 4-legged intersections as well as “T” or 3-legged intersections.
- Two-stage turn queue boxes are commonly used to provide left turns where bicyclists typically travel on the right hand side of the street but may similarly be used to accommodate right turns from a left-side bicycle facility.
- 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.

## DESIGN

- A two-stage turn shall consist of a “first stage” bicycle travel facility, a bicycle lane, and a “second stage” queue box that accommodates the bicyclist waiting for the signal prior to completing the turn.
- The two-stage turn queue box shall be at least 10 feet wide by 4 feet deep but may be increased in size based on the expected volume of queued bicyclists.
- The turn queue box for a second stage of the maneuver shall be in a protected location between the crosswalk and the closest through bicycle or travel lane. Two-stage turn queue should align with the right side travel lane or bicycle facility of the receiving street.

- Pavement markings in the two-stage turn queue shall signify a bicyclist and indicate proper direction and positioning.
- Right turns on red must be reviewed where turn boxes are used. Right turn on red restrictions or prohibition of turns shall be considered to avoid conflicts with queued and waiting bicyclists. If employed, appropriate signage shall be installed.
- Two-stage turn queue boxes should not be placed adjacent to transit stops as there may be a conflict between passengers boarding and bicyclists waiting in the queue.

### OPERATIONS AND MAINTENANCE

- Two-stage turn queues result in additional pavement marking that will require maintenance. The use of green markings may add additional maintenance complexity. Placing markings between vehicle tire tracks may reduce wear and tear.
- Two-stage turn queues should be cleared of snow concurrent with all other street snow removal activities.

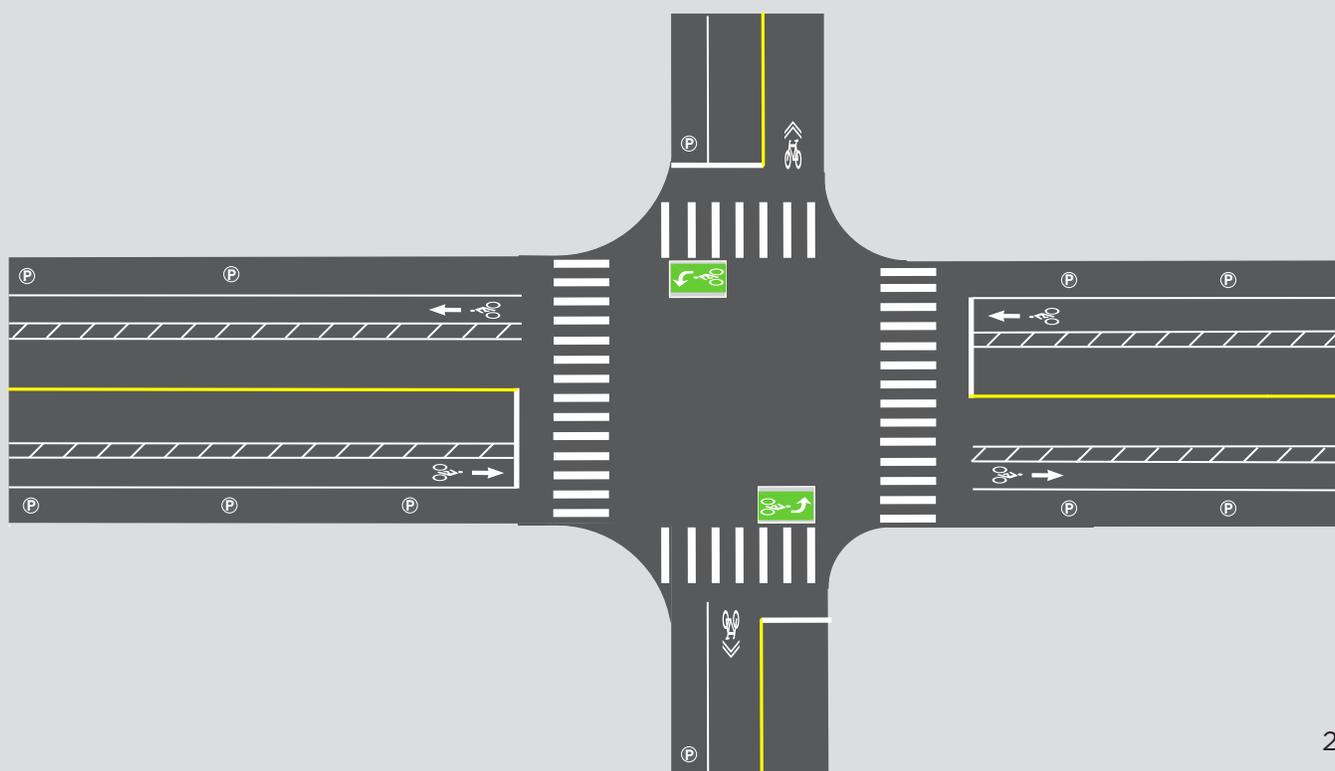
### SPECIAL CONSIDERATIONS

- Use green pavement or pavement markings to increase visibility and legibility of the two-stage turn queue box.

- If bicycle lanes are present, use dashed lines to indicate bicycle lane through the intersection and ensure queued bicyclists stay clear of this travel facility.
- If detectable/actuated signals are used, ensure bicycles will be detected in the two-stage turn queue. Bicycles should not be required to use pedestrian actuation to gain crossing.
- Under constrained circumstances, crosswalks may be adapted to enable space for bicycle queuing. Alternatively, a standard bike box may be used. This, however, requires bicyclists to cross the pedestrian line of travel and should only be used where pedestrian volumes are low.
- Bulb-outs may be constructed on the far side of the intersection to enhance the protection of people waiting in the queue box, especially if drivers frequently pass slowed or stopped vehicles on the right side.

### REFERENCES

- NACTO: Urban Bikeway Design Guide, Second Edition, 2014
  - Intersection Treatments: Two-Stage Turn Queue Boxes <http://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/two-stage-turn-queue-boxes/>
- MMUTCD, 2011
  - Part 9 Traffic Control for Bicycle Facilities [http://mdotcf.state.mi.us/public/tands/Details\\_Web/mmutcdpart9\\_2011.pdf](http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart9_2011.pdf)



# GREEN INFRASTRUCTURE

Green infrastructure is the network of open spaces, parks and other natural areas that supports native species, maintains ecological processes to sustain clean air and water and contributes to health and quality of life. Grand Rapids' green infrastructure includes environmental assets, green spaces and the links between them, such as wetlands, community gardens, streetscapes, sidewalks, and trails.

The Green Grand Rapids Master Plan Update provides the vision for the future of Grand Rapids and the use of Green Infrastructure across six areas: Natural Systems, Greening, Connections, the Grand River, Parks & Recreation, and Local Food. The ‘Connections’ theme explores how complete streets improvements, off-street trails, and transit can provide expanded areas for street trees, landscaping, and stormwater management best practices.

## GREEN INFRASTRUCTURE AND VITAL STREETS

Vital streets are complete streets with green infrastructure. Per the Vital Streets Guide, low impact design will be the default design approach for street, sidewalk and right-of-way repair, improvement, and reconstruction projects. Low impact design shall be used unless clear engineering difficulties prevent its use in order to enable the City to achieve a minimum of Stormwater Management Level C investment by FY 2022 as depicted in the 2013 Stormwater Asset Management and Capital Improvement Plan.

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. In other situations, green infrastructure can be incorporated on its own. Balancing the needs of street users with the proper application of green infrastructure should be sought.

The objective of Grand Rapids’ green infrastructure is to:

- Reduce stormwater run-off that would normally flow directly into the City’s already overburdened storm 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.
- Increase habitat for birds and butterflies.
- Increase native plantings and plant species diversity.

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 Vital Streets. For more complete information on green infrastructure designs and considerations and use, refer to the Stormwater Management Oversight Commission.

Low impact design will be the default design approach for street, sidewalk, and right-of-way repair, improvement and reconstruction. It shall be used unless clear engineering difficulties prevent its use in order to enable the City to achieve a minimum of Stormwater Management Level C investment by FY2022 as depicted in the 2013 Stormwater Asset Management and Capital Improvement Plan.



# CURB EXTENSION BIORETENTION

Curb Extensions can be designed as a space to capture and 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 sidewalk areas. Collected water is then trapped in a low planting area and is disbursed either through plant evapotranspiration or infiltration. The water that infiltrates runs through soil that helps clean pollutants from the water.

## USE

- At intersections, curb lines, pedestrian crosswalk locations, and/or where curb extensions are present or possible, including mid-block crossing locations.
- In locations where stormwater flows along the curb line, especially where there is a slight slope and water can be directed into the bioretention area.

- In locations where stormwater overflows in the bioretention facility can be directed or connected to an appropriate outlet structure (e.g. existing stormwater drain line) in order to prevent localized flooding during high rain events.
- Do not locate in places that impede necessary pedestrian movement, such as crosswalks, clear pedestrian walking zones, and access to parking meters, benches, or street furnishings.
- Coordinate placement with bicycle lanes or routes to ensure the safe passage of bicycles adjacent to the extended curb line.
- Avoid use in areas with less than 2 feet to water table or bedrock and in areas of known soil/groundwater contamination.

## DESIGN

- Curb Extension Bioretention facilities should be designed to work in concert with other green infrastructure practices to manage the target stormwater volumes, such as integration with adjacent paved areas that utilize porous pavement or transitions into linear bioretention areas beyond the extent of the curb extension.
- Provide a stone reservoir area below the planting soil and separated by a geotextile fabric to provide maximal storage volume and prevent planting medium from migrating downward into the stone.
- The surface area is generally between four and seven percent of the tributary

area. Excessive sources of sediment (e.g., dirt roads, gravel shoulders, gravel driveways) should be excluded from the drainage area.

- The width of the curb extension must consider minimum lane requirements for required travel lanes and accommodate the required clear sidewalk / walking zone width. In general, curb extension bioretention areas narrower than 3-feet should be avoided.
- Infiltration planters should be curbed with a minimum of 6 inches wide and 4 inches high curb when adjacent to Sidewalk and Amenity Zone areas. When adjacent to the road curb, this additional curbing is not required along that side of the infiltration planter.
- Prioritize the use of native plants in the landscaped portion of the bioretention facility. Provide a 2" thick mulch layer. The facility should be designed such that the top of the mulch layer is at least 4" below but not more than 18" below the adjacent sidewalk grade. The growing medium should contain a blend of sand, compost, and soil to allow drainage and support plant growth. Selected plant materials should be tolerant of both drought and wet conditions, as well as being salt tolerant.
- When water runoff is captured from the street, it should be brought into the infiltration planter through a covered flow inlet structure that does not break the top surface of the curb or walkable pavement surfaces.
- Provide stone settling area at inlet points, slowing water and allowing sediment to settle out of the water flows.
- Connect to existing storm drainage structures through standpipes and/or underdrains to accommodate overflow.
- Avoid conflicts with fire hydrants and other above ground utilities or underground utilities.
- If overhead utility lines are present, use smaller trees or shrubs in the planting the bioretention area to minimize crown conflicts.
- Meet requirements for emergency vehicle access along the roadway.

## OPERATIONS AND MAINTENANCE

- Clean inlets, outlets, and overflows.
- Remove accumulated debris.
- Remove weeds regularly.
- During the one- to two-season establishment period, weed and water plants on a weekly basis during the growing season.
- Add additional mulch when needed, typically every other year.

## SPECIAL CONSIDERATIONS

- On steep slopes, provide check dams as needed to provide stepped, flat bottoms in the bioretention area to promote water collection and infiltration.
- Provide signage as needed to alert motorists and pedestrians.

## REFERENCES

- SEMCOG Low Impact Development Manual for Michigan (2008). Refer to Planter Boxes, Native Landscaping, and Bioretention sections for additional design guidance.
- Grand Rapids Green Infrastructure Guidance Manual (2015)
- Grand Rapids Green Infrastructure Technical Reference Manual (2013)





# LINEAR BIORETENTION + MEDIAN BIOSWALES

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.

Median bioswales are designed and function in much the same way, but are located in the center portion of the roadway between the travel lanes. Median bioswales are typically curbed with inlet structures points for water to enter the bioswale.

## USE

- In locations where stormwater flows along curb line or where runoff can sheet flow from adjacent pavement areas, such as road surfaces or sidewalk areas.

- In locations where overflow water can be directed or connected to an appropriate outlet point (such as existing stormwater drains).
- In locations where the green space between the curb and sidewalk is at least 6-feet wide and not dominated by utilities or other public uses.
- Do not locate in places that impede necessary pedestrian movement, such as crosswalks, clear pedestrian walking zones, and access to parking meters, benches, or street furnishings.
- Coordinate placement with bicycle lanes or routes to ensure the safe passage of bicycles adjacent to the extended curb line.
- Avoid installation of linear bioretention in areas where the water table is less than 2 feet below the bottom of the surface and in areas of known soil/groundwater contamination.

## DESIGN

- The total surface area of the linear bioretention should be around one percent of the external drainage area up to a maximum of 10 acres of tributary area. Excessive sources of sediment should be excluded from the drainage area. In-line linear bioretention should be sized to convey at least a 10-year, 24-hour storm event safely.
- A stone reservoir area should be installed below the planting soil. It should be separated by a geotextile fabric to

provide maximal storage volume and prevent planting medium from migrating downward into the stone.

- Side slopes should be no steeper than 3 horizontal to 1 vertical.
- The preferred minimum width for Linear Bioretention and Median Bioswales is 6-feet. Linear Bioswales are typically set behind the curb at the edge of the road. When used in residential contexts, curbs adjacent to the sidewalk and pedestrian walking areas is not generally used, allowing water to sheet flow into the facility instead.
- Include pretreatment sumps / stone fore bays at the inlet points with easy access for maintenance. Provide a stone channel or other mechanism at the inlet to slow velocities if needed.
- Ensure the overflow elevation is lower than the downstream bank yet above the bottom of the linear bioretention to promote infiltration. Provide a perforated underdrain pipe that takes excess water to the storm sewer system.
- Include an impermeable liner when within 10 feet of a basement.
- Prioritize the use of native plants in the landscaped portion of the bioretention facility. Provide a 2" thick mulch layer. The facility should be designed such that the top of the mulch layer is at least 4" below but not more than 18" below the adjacent sidewalk grade. The growing medium should contain a blend of sand, compost, and soil to allow drainage and support plant growth. Selected plant materials should be tolerant of both drought and wet conditions, as well as being salt tolerant.
- Avoid conflicts with fire hydrants and other above ground utilities or underground utilities.
- If overhead utility lines are present, use smaller trees or shrubs in the planting the bioretention area to minimize crown conflicts.
- Meet requirements for emergency vehicle access along the roadway.

## OPERATIONS AND MAINTENANCE

- Clean inlets, outlets, and overflows.
- Remove accumulated debris.
- Remove weeds regularly.

- Use deep-rooted native plants for reduced maintenance.
- Add mulch when needed, typically every other year.
- During the one-to-two season establishment period, weed and water plants on a weekly basis.

## SPECIAL CONSIDERATIONS

- On steep slopes, provide check dams as needed to provide stepped, flat bottoms in the bioretention area to promote water collection and infiltration.
- Provide signage as needed to alert motorists and pedestrians.

## REFERENCES

- SEMCOG Low Impact Development Manual for Michigan (2008). Refer to Planter Boxes, Native Landscaping, and Bioretention sections for additional design guidance.
- Grand Rapids Green Infrastructure Guidance Manual (2015)
- Grand Rapids Green Infrastructure Technical Reference Manual (2013)





# 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.

Planter boxes are often categorized either as flow-through planter boxes or infiltrating planter boxes. Infiltrating planter boxes have an open bottom to allow infiltration into the underlying soils. Flow-through planter boxes are completely lined and have an underdrain system to convey flow that is not taken up by plants to drainage areas.

## USE

- Most appropriate in locations where stormwater flows along a curb line and can be directed into the Stormwater Planter and 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 where downspout discharge water can be directed into the Stormwater Planter.
- Do not locate a stormwater planter downstream of sediment sources (e.g., gravel shoulders, gravel driveways, dirt roads).
- Avoid installation where the water table is less than 2 feet below the bottom of the storage layer.

## DESIGN

- The sizing of the stormwater planter varies depending upon the goals for infiltrating stormwater, but generally the surface area should be about 5 to 7 percent of the drainage area. If the goal is to treat the stormwater rather than infiltrate it, there are patented high flow rate engineered media available that can decrease the required stormwater planter footprint.
- Provide a stone reservoir area below the planting soil and separated by a geotextile fabric to provide maximal storage volume and prevent planting medium from migrating downward into the stone. Design the storage layer to drain within 24 to 48 hours by an underdrain or infiltration.
- Use retaining walls, geotextile separators, or impermeable liners to avoid undermining adjacent structures.

- When water runoff is captured from the street, it should be brought into the infiltration planter through a covered flow inlet structure that does not break the top surface of the curb or walkable pavement surfaces.
- 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 pretreatment sump at the inlets with easy access for maintenance.
- 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.
- Prioritize the use of native plants in the Stormwater planter. Provide a 2" thick mulch layer. The facility should be designed such that the top of the mulch layer is at least 4" below but not more than 18" below the adjacent sidewalk grade. The growing medium should contain a blend of sand, compost, and soil to allow drainage and support plant growth. Selected plant materials should be tolerant of both drought and wet conditions, as well as being salt tolerant.
- If the stormwater planter walls are taller than curb height, place outside of the reach of open car doors where on-street parking is present and adjacent to the Stormwater Planter.
- Provide periodic pedestrian walkways or "bridges" from roadside parking to the sidewalk area.
- Avoid conflict with existing underground and above ground utilities.
- 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.
- Water plants during plant establishment.
- Use deep-rooted native plants for reduced maintenance.
- Remove trash and debris weekly.

## SPECIAL CONSIDERATIONS

- The walls of the Stormwater Planter can be increased in height and width to provide seatwalls and places for pedestrians to rest.

## REFERENCES

- SEMCOG Low Impact Development Manual for Michigan (2008). Refer to Planter Boxes, Native Landscaping, and Bioretention sections for additional design guidance.
- Grand Rapids Green Infrastructure Guidance Manual (2015)
- Grand Rapids Green Infrastructure Technical Reference Manual (2013)



# LEACHING BASIN

Leaching or infiltration 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. Leaching or infiltration basins can replace standard catch basins and are best suited in locations where the native soil is sandy or silty loam (Hydrologic Soil Group A and B soils).

## USE

- Unless there is a technical 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 (beginning of system) along a stormwater drainage system where volumes are relatively 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.

## DESIGN

- Perform an infiltration test at the location of each leaching basin.
- The tributary area to each leaching basin should be based on typical spacing of basins along a roadway. Soil infiltration and depth to ground water must be investigated to determine the feasibility of a leaching basin in a particular area.
- Use a pre-cast concrete basin structure with a deep sump. Typically, this sump is up to 10-feet deep and 3-feet in diameter, with 1" diameter perforations to allow stormwater water to infiltrate out of the sump.
- The basin structure should be surrounded by 2-foot thick layer of coarse aggregate (MDOT 6A or equivalent) to function as a stone reservoir.
- Work with City requirements to provide adequate freeboard to the roadway surface above the maximum water elevation for the design storm event
- Avoid compaction of soils in leaching basin infiltration area.
- Provide a minimum 3-foot separation between bottom of leaching basin and seasonal high groundwater.
- Use an inlet grate structure that is bike-friendly.

## OPERATIONS AND MAINTENANCE

- Inspect structure once every four years (or more frequently as indicated by structure performance).
- Clean leaching basin grates where water enters the structure as needed.
- Remove accumulated debris in the sump to ensure drainage through structure.
- Leaching basins are slightly more expensive compared to a standard catch basin.
- Installing leaching basins could reduce the amount of storm sewer infrastructure required.

## SPECIAL CONSIDERATIONS

- Leaching basins can be used in conjunction with porous pavements in the roadway area.
- Leaching basins can be integrated with linear infiltration trenches that provide a larger area for infiltration to occur.

## REFERENCES

- SEMCOG Low Impact Development Manual for Michigan (2008). Refer to Planter Boxes, Native Landscaping, and Bioretention sections for additional design guidance.
- Grand Rapids Green Infrastructure Guidance Manual (2015)
- Grand Rapids Green Infrastructure Technical Reference Manual (2013)





# FLEXIBLE 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. It is effective in storing, infiltrating, and treating runoff from impervious surfaces. There are a variety of flexible porous pavements including concrete pavers, paving grids, pervious concrete, porous asphalt, porous rubberized asphalt, and glass porous paving. Flexible porous pavement can be used in parking lots, parking lanes, low-volume roads, alleys, sidewalks, and plazas.

## USE

- Roadway parking lanes
- Low-volume roads, alleys and bicycle facilities
- Plazas, paths, and sidewalks
- In areas where impervious space is highly utilized and cannot be spared for vegetated green infrastructure practices. In general, vegetated practices should be used as a first choice where space permits.
- Ensure that the drainage area has no significant sediment sources (e.g., gravel shoulders, gravel driveways, dirt roads) that will clog pavement.
- Select flexible porous pavement conducive to bike traffic in the area.
- Coordinate review by an arborist or forester for impacts to nearby trees.

## DESIGN

- Design the system so that the storage layer drains within 24 to 48 hours by infiltration or an underdrain.
- 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. The impermeable surface can be two to five times the surface area of the flexible porous pavement depending on the extent of sediment in the runoff.

- Specify a geotextile separator between the storage layer and adjacent soils to prohibit migration of fine soils into the storage layer.
- Size the stone drainage layer to meet local design standards.
  - Consider the potential for shifting pavement (especially modular systems) on slopes greater than five percent.
  - Allow porous concrete to cure for a minimum of three months before applying salt.
  - For concrete paver systems, incorporate a concrete header between the paver area and adjacent asphalt to decrease paver shifting.

## OPERATIONS AND MAINTENANCE

- Remove accumulated sediment and particulates from the flexible porous pavement void spaces with a high efficiency vacuum sweeper at least twice per year.
- Pressure washing pavement is not recommended as particulates could further embed.
- Stone between pavers will need to be replaced after vacuuming as needed.
- Use of sand and fine aggregate for winter road conditions will quickly clog flexible porous pavement and should not be used.

- Cost of flexible porous pavement tends to be higher than traditional pavement. Costs vary with location and contractor familiarity of the installation.
- Concrete pavers and articulating concrete blocks tend to be more expensive than porous asphalt or pervious concrete.
- Use of flexible porous pavements can provide cost savings by reducing the amount of other storm treatment systems required.

## SPECIAL CONSIDERATIONS

- For roads and parking lots, flexible porous pavement can be incorporated within parking lanes and stalls to intercept flow from driving lanes. This can be more cost effective than using flexible porous pavement across the entire paved area.

## REFERENCES

- SEMCOG Low Impact Development Manual for Michigan (2008). Refer to Planter Boxes, Native Landscaping, and Bioretention sections for additional design guidance.
- Grand Rapids Green Infrastructure Guidance Manual (2015)
- Grand Rapids Green Infrastructure Technical Reference Manual (2013)



# IMPLEMENTATION AND OVERSIGHT

This section of the Design Guidelines focuses on the process the city will take to implement Vital Streets. It includes details on who is responsible for decision-making, what factors are considered in project development, where projects are prioritized, and how projects will meet Vital Streets goals and outcomes.

## WHO: ROLES AND RESPONSIBILITIES

The Vital Streets Plan and Design Guidelines were developed in 2015 and 2016 with oversight from the Vital Streets Oversight Commission (VSOC) and subject matter experts, with input from City of Grand Rapids staff.

They are intended to be “living documents” and will evolve as the community changes. It is expected that the Vital Streets Plan and Design Guidelines will be updated as street conditions, travel patterns, and land uses change over time. The Design Guidelines will also likely need to be supplemented with more detailed guidance on emerging topics as needed. The VSOC should regularly revisit the Vital Streets Plan and consult with city staff on any issues that arise from implementation and oversight. National and State guidance on design is also very likely to be modified as the field of transportation is going through a period of rapid transformation.

Vital Streets implementation and oversight requires commitment from across the City, from the VSOC members and the public, to city staff and the City Commission. Each has a role to play in ensuring Grand Rapids achieves its stated goals and objectives for the city’s streets. The following table lists the roles and responsibilities for implementation of Vital Streets.

## DESIGN TEAM

The underlying philosophy of the work of the City of Grand Rapids’ Design Team is based on collaborative decision-making. The group

does not “vote” and the process is not top-down. Rather, decisions are made through an iterative process whereby experts in their field of discipline contribute to an exchange and, ultimately, a decision that will best serve the public interest. This dialogue recognizes the numerous considerations and trade-offs that must be made when designing for a constrained urban context. Design Team takes a holistic view of the built environment; using data-driven, professional judgement to arrive at consensus decisions.

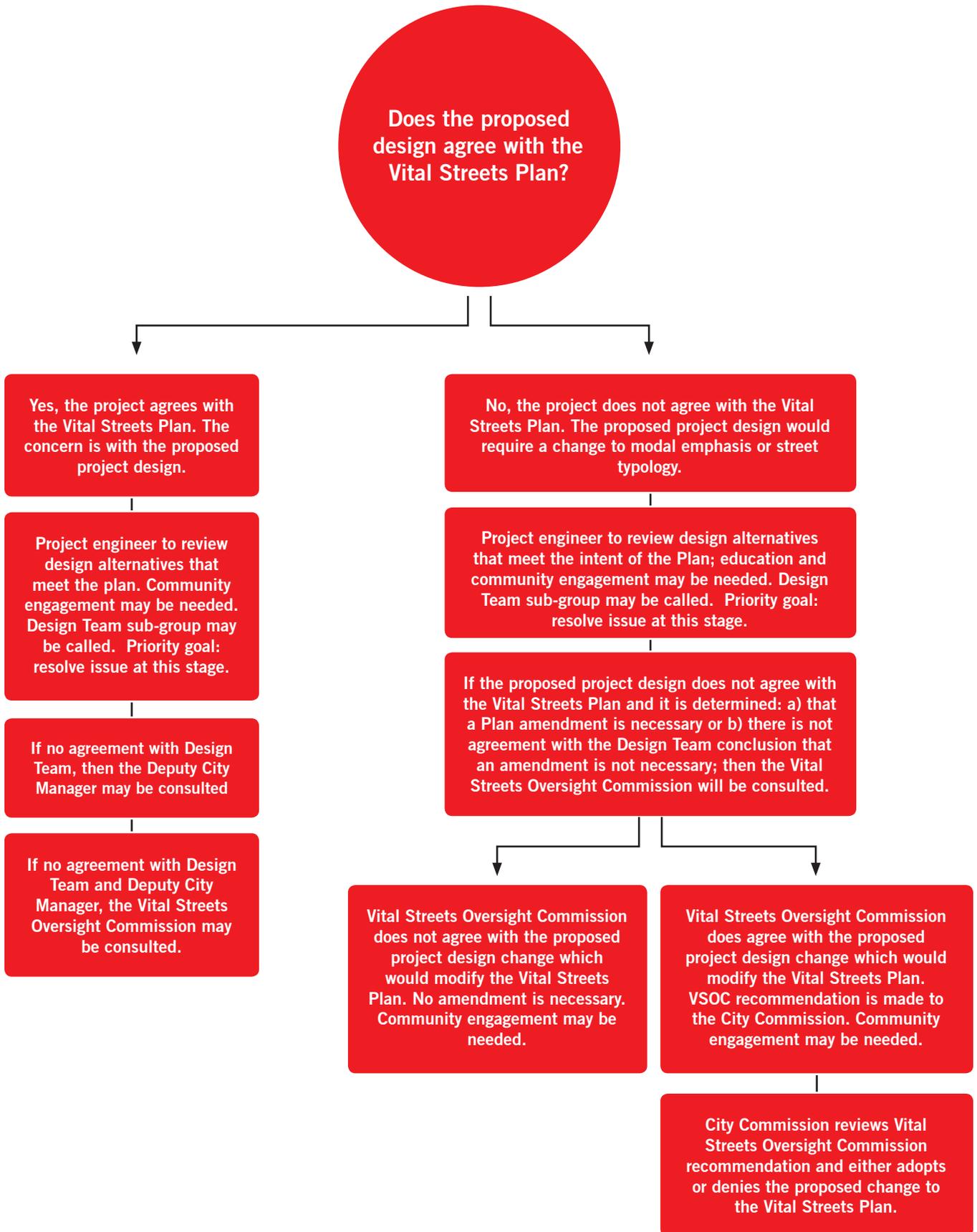
Design Team meets regularly to review development proposals, easements, and encroachments, discuss public improvement projects, and collaborate on initiatives. The Design Team, under the direction of the Deputy City Manager, is comprised of staff with decision-making authority from various City Departments including MobileGR/ Parking Services, Economic Development, Parks and Recreation (including Forestry), Fire, Environmental Services, DGRI, Water, Traffic Safety, Engineering, Public Services, and Community Engagement.

The coordinated, multi-disciplinary format of the meetings allows members to quickly and efficiently arrive at innovative and workable solutions that meet the City’s goals. The face-to-face dialogue benefits the City organization as each Design Team member ultimately stretches their expertise into other fields and an environment of creative “one upmanship” is created. These various perspectives are also interjected into the daily work of staff during Site Plan Review and other perfunctory functions, which allows staff to provide better customer service to the development community and citizens. Quality design becomes everyone’s work - not just one individual’s responsibility.

FIGURE 1 VITAL STREETS ROLES AND RESPONSIBILITIES

Action	Primary Responsibility	Process	Final/Follow up Action
<b>DEVELOPMENT, MODIFICATION AND UPDATE OF THE VITAL STREET PLAN</b>			
Development or modification/ amendment of Vital Streets <b>PLAN</b>	VSOC	VSOC with public and stakeholder consultation	Finalization and/or routine update of Vital Streets <b>PLAN</b>
Adoption of Vital Streets <b>PLAN</b>	City Commission	<b>Update Process (Proactive Revision):</b> Design Team identifies, and VSOC recommends modification (minor) or update (major) to <b>PLAN</b> – ideally annual update; modifications may be as necessary	VSOC, as a body, approves (or doesn't). Approved changes transmitted to City Commission for adoption (or not)
Significant/major changes to street type or modal emphasis overlay potentially requiring <b>PLAN</b> amendment	1. Design Team 2. VSOC	<b>Modification/Amendment Process (Reactive Revision):</b> <ul style="list-style-type: none"> <li>Design Team seeks design solution that complies with intent of <b>PLAN</b></li> <li>If no design solution, Design Team may recommend plan amendment to VSOC</li> </ul>	<i>If no design solution</i> , VSOC, as a body, approves change (or doesn't) and transmits modification to <b>PLAN</b> to City Commission for approval (or not)
<b>DEVELOPMENT, MODIFICATION AND UPDATE OF Design Guidelines</b>			
Development of <b>Design Guidelines</b>	Design Team	Updates/additions/protests to Design Team for consideration	Administrative change (if necessary); notice to VSOC
Update or revise <b>Design Guidelines</b>	Design Team and City Staff	Consultation with local design professionals; MDOT, etc.	Administrative change; notice to VSOC
<b>PROJECT DESIGN AND DEVELOPMENT</b>			
Project identification and definition of limits and intent/objective	Design Team and City Asset Managers	Submission of proposed Vital Streets Capital Plan for adoption or modification by VSOC	VSOC approves Vital Streets Capital Plan
Street and facility design selection	City Staff, reviewed/ approved by Design Team	Design Team will craft a workable solution within the guidelines of the adopted plan. Stakeholders can request a change to the project design	Modified design, within guideline allowances
<b>PERFORMANCE METRICS</b>			
<b>PROJECT</b> performance evaluation	City Staff + Design Team	N/A	Performance data information item to VSOC
<b>PROGRAMATIC</b> Review of performance	VSOC adopts performance metrics and reviews outcomes Design Team collects and reports data	May modify performance metrics as required to appropriately track and measure outcomes.	Baseline and data collection of metrics

FIGURE 2 VITAL STREETS DECISION MATRIX



## COMMUNITY ENGAGEMENT

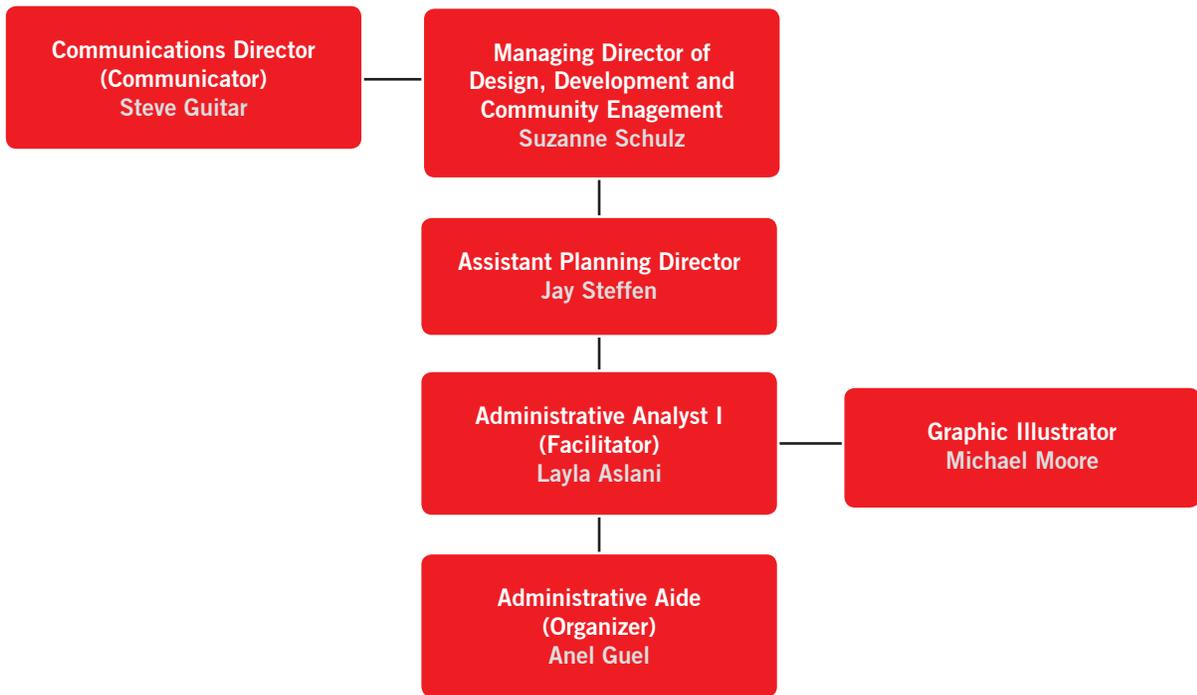
Implementation of Vital Streets requires active involvement from community members, residents, and businesses. City staff are committed to creating opportunities for constructive dialogue with the community so that they understand trade-offs in decision-making, Vital Streets Plan goals, the logic behind a design, and how changes on one street are connected to the overall transportation network. This section details a Community Engagement Plan for Engineering and Streets.

The Community Engagement Division (CE) serves as the go-to professionals within the City for assistance with public engagement. The mission is to assist City Departments with public involvement to yield outcomes built on understanding community desires and City plan recommendations. The City of Grand Rapids Community Engagement Division formed in fall 2014 in response to the desire of Grand Rapids citizens, City Commissioners, and foundations to increase communication between the City and public about projects and initiatives.

The CE Division's work will:

- » Increase awareness and transparency of City projects and initiatives.
- » Build community ownership and a shared vision.
- » Communicate in a manner that is proactive rather than reactive.
- » Celebrate successes.
- » Build and maintain relationships with community advocates, organizations, and citizens.
- » Build neighborhoods and business districts that attract people.

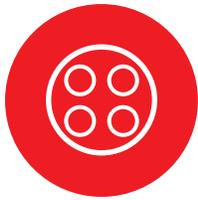
FIGURE 3 COMMUNITY ENGAGEMENT ORGANIZATIONAL CHART



## COMMUNITY ENGAGEMENT DIVISION APPROACH

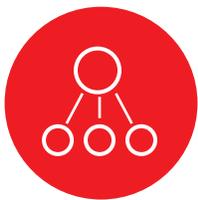
The City of Grand Rapids uses a three-pronged staffing approach to best serve the needs of the City. The Communicator is stationed in the Executive Office, while the Facilitator and Organizer are in the Design, Development and Community Engagement Department.

### Communicator



The Communicator role is stationed in the Executive Office with one full time position. The position will support community engagement by advising the Mayor and Manager on policy strategy, community relations, and issue management; coordinating City messages and media; managing consultant services; developing external and internal relations; and establishing an organizational core competency to inform the public in an effective and transparent manner.

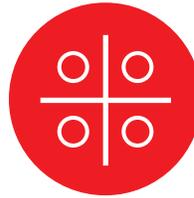
### Facilitator



The Facilitator is stationed in the Design, Development and Community Engagement Department with one full time position. This position will support community engagement by executing responsibilities associated with project management and coordination for “client” departments such as Engineering, Parks, and Planning where extensive community engagement is required for streets projects, parks plans, and large-scale planning efforts. This role will lead development of public engagement plans (agenda, meeting structure, facilitation techniques, and reporting) and establishing

effective working relationships with diverse constituencies and City departments. Additionally, they should have, knowledge of public infrastructure construction and operation, public speaking experience, and conflict resolution skills.

### Organizer



The Organizer is stationed in the Design, Development and Community Engagement Department with one half of a full time position. This position will support community engagement

by assisting with interdepartmental and community coordination, public meeting notices, postcard mailings, scheduling and advertising, meeting setup, meeting minutes, website management, social media responses/monitoring, and research. Responsibilities will be associated with “client” departments such as Engineering, Parks, and Planning and include data collection and analysis, mapping and multiple modes of communication, and effective working relationships with diverse constituencies and City departments.

## LEVELS OF ENGAGEMENT

The City of Grand Rapids defines infrastructure projects into light, medium, and heavy categories for engagement depending on the project type.

**FIGURE 4 LEVELS OF COMMUNITY ENGAGEMENT**

LEVEL OF ENGAGEMENT	TYPE OF PROJECT	RESPONSIBLE DEPARTMENT	METHODS
<b>Light – informative approach</b>	<ul style="list-style-type: none"> <li>• Road maintenance like cape and crack sealings and temporary pavings</li> <li>• Rotomill and resurfacings and reconstructions that return road to previous state</li> </ul>	Public Services - Streets for cape sealing, wedging, and crack sealing projects. Engineering for rotomill and resurfacing projects.	<ul style="list-style-type: none"> <li>• Postcard or full mailer</li> <li>• Website</li> <li>• Email alert</li> <li>• News stories and press releases</li> <li>• 311</li> <li>• Construction preparation meeting (for reconstruction only)</li> </ul>
<b>Medium – design input needed</b>	<ul style="list-style-type: none"> <li>• Rotomill and resurfacings or reconstructions that add green infrastructure</li> </ul>	Engineering	<ul style="list-style-type: none"> <li>• Full mailer</li> <li>• Website</li> <li>• Email alert</li> <li>• Online survey</li> <li>• Street signs</li> <li>• Concept design meeting</li> <li>• Business association meeting</li> <li>• Preferred design meeting, if needed</li> <li>• Construction preparation meeting</li> <li>• 311</li> </ul>
<b>Heavy – design input needed</b>	<ul style="list-style-type: none"> <li>• Rotomill and resurfacings or reconstructions that move curbs, are in a business district, or that change road geometry</li> </ul>	Engineering	<ul style="list-style-type: none"> <li>• Same as for Medium engagement, except the preferred design meeting is not optional</li> </ul>

## DIGITAL ENGAGEMENT

Websites offer the community a source for digital education. The City of Grand Rapids Construction Updates webpage has an Interactive Road Closure and Detour Map that shows full, partial, parking, and sidewalk closures. The site features project specific pages for each project organized by both street name and project name to provide more information to the public. Project pages include design options, existing conditions, identified issues, and detour maps. Individuals interested in receiving email notifications can add themselves to a distribution list. People on this list received digital versions of the mailed notifications for all projects.

Social media is a tool for interaction and provides an opportunity to engage, educate, and encourage citizens. Information about Vital Streets projects may be distributed through the City of Grand Rapids and the Grand Rapids Police Department Facebook pages on occasion.

## MAILINGS

Highly graphic, easy to understand documents are used for mailings. For terms that cannot be replaced with simpler words, the mailers offer a definition and/or illustration. The mailers also refer citizens who want detailed information to the Construction Update website. Mailers also provide details about the proposed designs to better prepare residents for the meetings and entice them to attend.

Property notification mailings are sent to two groups. The **Adjacent Impact Area** are properties directly connected with the project site. For heavy and medium projects, the initial data gathering mailing is sent using this list to elicit responses for community sourced information. The **Transit Impact Area** are properties within 350 feet of the project site and were assumed to be directly impacted by construction-based route changes. These are used in heavy, medium, and light projects.

When a rotomill and resurfacing, rehabilitation, or reconstruction project impacts a business district, the City of Grand Rapids will make contact with the business association to provide information and offer to attend a meeting. The Community Engagement Division created a business construction guide available online and included in mailers to business districts. Modeled after guides in other cities, the guide explains the engagement process and tips on maintaining business during construction.



The Construction Business Guide created by CE.

## MEETINGS

Community meetings include City staff members from the Engineering Department, Community Engagement Division, and Lighting, Signals, and Signs. The meetings are facilitated by the Community Engagement Division. There are three meetings associated with Vital Streets projects.

- » Meeting 1: Concept Design Meeting
- » Meeting 2: Preferred Design Meeting
- » Meeting 3: Construction Preparation Meeting

Community meetings typically include a short presentation followed by a facilitated discussion. The meetings are interactive and ask attendees questions during the presentation. Additionally, depending on the proposed design(s), the meetings feature games or activities to facilitate conversation and help citizens brainstorm or understand ideas.

## STREET SIGNS

The Community Engagement Division uses MDOT-mandated signs for all construction projects regardless of if they involve MDOT. This sign informs people of the project who may not live near the proposed project limits, but use the affected road regularly. A second sign is placed near construction projects to indicate the project is funded by the income tax extension.



The Wealthy Street public meeting sign.



An example of the street sign mandated for MDOT-related projects.

## WHERE: PROJECT PRIORITIZATION

The Vital Streets Plan establishes the framework, goals, and objectives for the preservation and reconstruction of streets throughout Grand Rapids. To achieve these goals, each year city staff will submit a Vital Streets five-year capital work program and annual project list to the VSOC for approval; which will then be sent to the City Commission as part of the budget process. City staff will use a data-driven approach to evaluate and prioritize projects, considering metrics tied to the goals of Vital Streets. The Vital Streets Guide and Sidewalks Investment Guidelines require that the City consider asset management, balance and distribution across the city, outcomes from engagement, maintaining access, completion of safe walking and bicycle routes and coordination with other projects when making annual investments.

- » **FUNDING.** City staff will look to leverage other funding opportunities, such as grant opportunities, private partnerships, development projects, and where asset investments overlap (e.g. water, sewer, DDA, others).
- » **ASSET MANAGEMENT.** A PASER rating (Pavement Surface Evaluation and Rating) measures pavement conditions. The Grand Valley Metropolitan Council (<http://gvmc.org>) collects this common

metric each year on behalf of the City of Grand Rapids and the metric will be used to identify streets most in need of immediate repair. The 15-year plan prepared by the Sustainable Streets Task Force and adopted by the City relies heavily on asset management through preventative maintenance, rehabilitation and then reconstruction. The right type of maintenance must be done at the right time in the life of a facility to preserve the investment and avoid shortening facility life, otherwise more extensive and often more expensive investments may be required sooner in the life of the facility.

» **SAFETY.** The Vital Streets Plan recognizes Vision Zero in making design and investment decisions. Information on crash locations and severity will be used to identify critical safety hotspots that can be addressed through Vital Streets projects. Other considerations may include areas where there are excessive

vehicle speeds with high levels of pedestrian or bicyclists or incompatible speeds and routes for emergency services.

» **CONNECTIVITY AND CONTINUITY.** To build out the multimodal transportation system in Grand Rapids, projects may be needed to complete key gaps. Projects may be prioritized to provide access to community destinations like parks, schools and employment centers. This will be measured by buffering around key public destinations and existing bicycle and pedestrian facilities to determine where opportunities might lie. The existing walkway improvement prioritization process is a component of this element.

» **GEOGRAPHIC BALANCE.** All parts of the city have needs. Projects should be distributed across the community; however, there may be economy of scale in grouping small projects together. Maintenance of all modes of traffic

## WALKWAY IMPROVEMENT PRIORITIZATION CRITERIA

The Walkway Improvement Prioritization Process ranks potential walkway projects based on the Comprehensive Plan walkway priorities and other appropriate measures. The criteria include: safety, connection to services and facilities, completion of links in the system, connection to transit, existing infrastructure, distance from a school, and location in relation to arterials.

- Does the route demonstrate a need, such as signs of pedestrian use (Goat Path) or have public interest for the installation of a walk?
- Is the route on a street that is a transit route or provide access to transit?
- Does this route connect to community facilities (parks, medical facilities, adult foster care, rehab) or commercial centers (shopping, retail, university)?
- Is this a safe route for schoolchildren to and from school?
- Does the location provide access to a variety of amenities (Dining, groceries, shopping, parks, schools and entertainment)?
- Does this route complete gaps in the City's walkway system?
- Does the project have grants or private development funds secured to offset the overall cost of this project?
- Is this route along a major, minor or local roadway?
- Is there existing infrastructure along this route that will significantly reduce project costs?
- Has there been public support or concern regarding the development for this route?

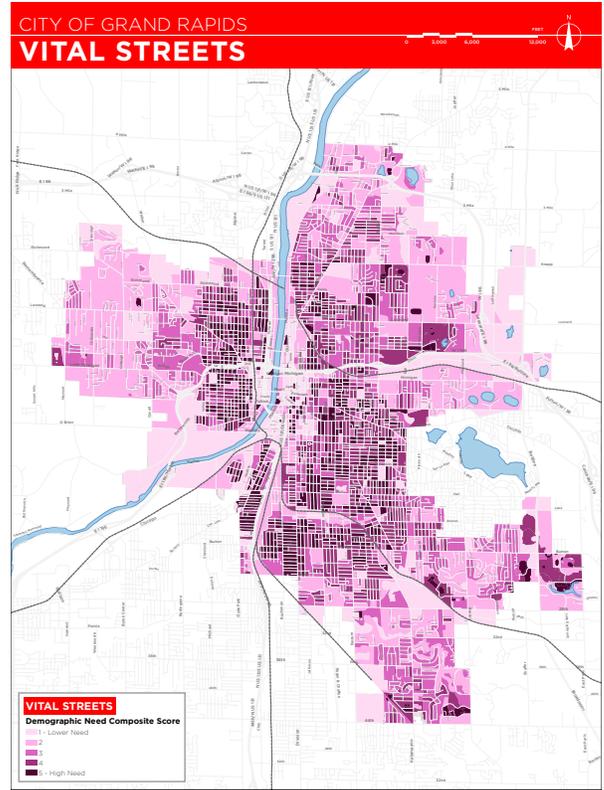
should also be considered in project selection to ensure the continued safe flow of travel around the city even during construction season. Grand Rapids has limited resources to design and contract projects each year, so balance should also be sought between less complex projects that can be done relatively quickly and those that may require more complex engineering, public engagement, or more extensive timeframes.

- » **HYPER-LOCAL AND REGIONAL IMPACT.** Projects of regional significance, as well as projects cited in neighborhood Area-Specific Plans (ASPs), are important considerations. The planning work of other agencies and organizations that intersect with city streets inform where community “energy” exists. The implementation of plans that are reasonable and feasible can strengthen community engagement.
- » **EQUITY.** Vital Streets projects can also leverage other benefits to the community, such as network efficiency, economic development opportunities, community development, and operational efficiencies. These other factors include an analysis of equity and access to opportunity.

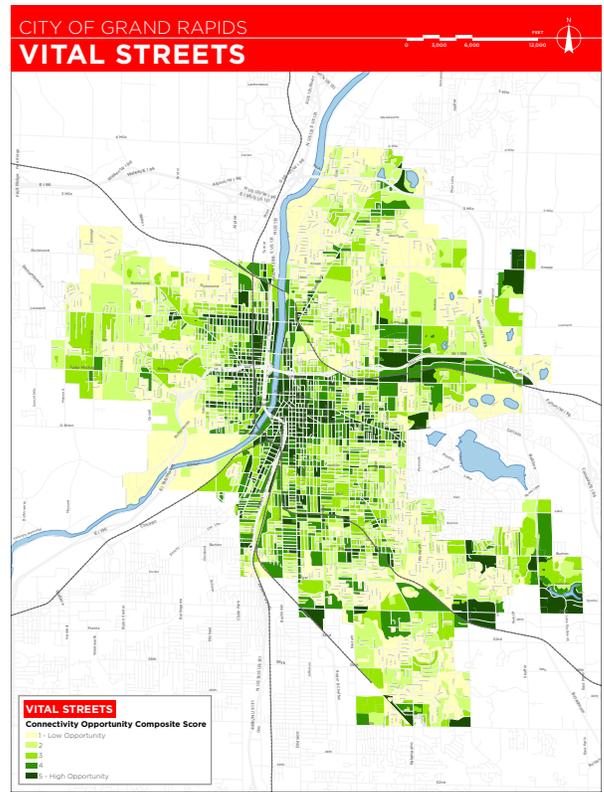
Equity refers to the ability of all residents to access areas of opportunity. The equity analysis includes estimation of the areas of the city with the greatest mobility needs in consideration with places with the greatest opportunities.

Areas of “Need” includes identification of areas with significant populations that typically have a greater reliance on non-automobile travel such as lower income populations, youth too young to drive and persons who may seek to drive less, persons with disabilities, and communities of color. Areas of safety concern, as indicated by substantial crash events, also constitute a need.

“Opportunity” identifies locations where Vital Streets investments may increase access such as completing gaps in the existing pedestrian or bicycle system, investments near known pedestrian generators such as schools or recreation centers, and facilities within or leading to significant job centers.

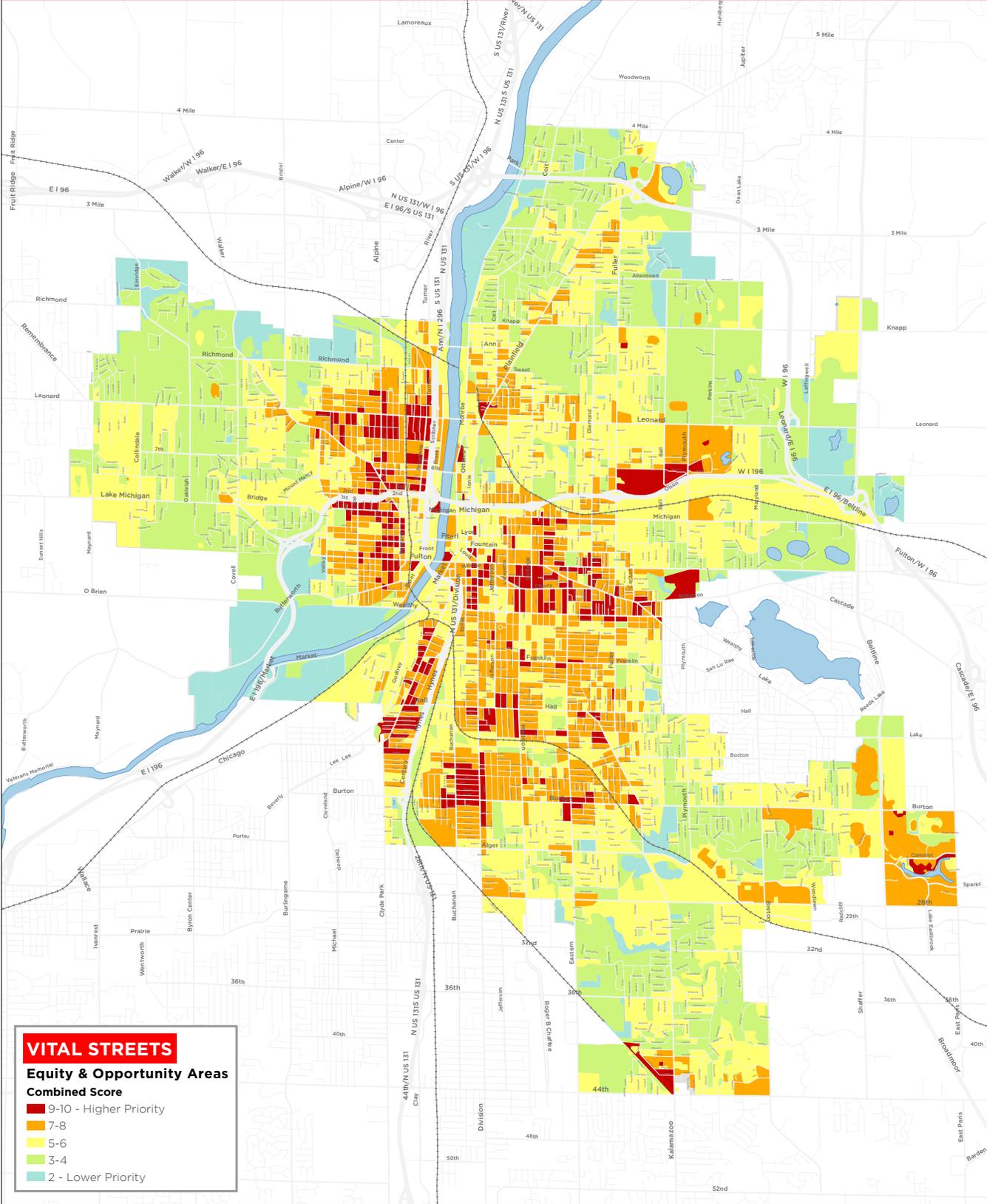


Areas of Need



Areas of Opportunity.

# CITY OF GRAND RAPIDS VITAL STREETS



Grand Rapids Equity Analysis Map.

## WHAT: VITAL STREETS PERFORMANCE METRICS

Vital Streets will be designed, constructed, and maintained to meet the goals and objectives identified by the residents of Grand Rapids. By focusing on the goals community members would like to see for their streets in conjunction with the application of professional judgement on matters regarding safety, cost, maintenance, and vulnerable road user accommodations, designers can make choices and weight difficult tradeoffs in design decisions with the confidence that they know what to solve for.

The VSOC established the following objectives for Vital Streets:

- » Reduced conflict, greater predictability, and more transparency in street design
- » Increased coordination
- » Consistent baseline guidelines
- » Institutionalized “life-cycle” thinking and design
- » Clear methods for prioritization and selection
- » Metrics and methods for performance evaluation
- » Increased accessibility throughout the city
- » Progress toward achieving a vision of zero traffic-related fatalities

Vital Streets will be evaluated by how well they meet the goals and ideals of Grand Rapids citizens, which considers all modes of travel. The most common metric used in traditional transportation studies is Level of Service (LOS), which is a measure of delay and density of traffic. However, this conventional approach overlooks road users who are not driving. Overbuilding for a single transportation mode, rather than considering the effects of decisions on all modes and users is inconsistent with Vital Streets.

The goals for Vital Streets are to ensure:

- » Street fatalities and injuries decrease for all age groups.
- » The number of trips by walking, bicycling, and transit increases.
- » Vehicle travel is reduced.
- » Prevailing speeds of vehicles on local streets decrease.

- » Stormwater runoff is reduced.
- » Water quality in the Grand River improves.
- » Retail sales and tourism increase.
- » Positive resident experience.

## HOW: PROJECT INITIATION AND IMPLEMENTATION PROCESS

Once identified for funding, the planning, development, and design of Vital Streets projects is a process that occurs over multiple steps. Professional judgement will be used to group, consolidate, or phase streets segments into logical projects. Vital Streets projects may be several block lengths, one or two blocks, or even portions of a block. Project identification and packaging will consider other qualitative factors, such as modifying the project area or scope to address gaps in the multimodal network or to lessen impacts on residents or businesses.

**FIGURE 5 GRAND RAPIDS VITAL STREETS DEVELOPMENT PROCESS**

<b>1</b>	<b>Identify Project Scope</b>	<ul style="list-style-type: none"> <li>Review project requirements</li> <li>Conduct soil borings</li> <li>Assign project manager</li> <li>Gather data and information</li> <li>Develop preliminary project scope</li> <li>Identify Project Objectives</li> <li>Alternatives Analysis</li> <li>Review Adopted Community Plans</li> <li>Finalize scope</li> </ul>
<b>2A</b>	<b>Design – Preliminary Concept Development</b>	<ul style="list-style-type: none"> <li>Develop preliminary alignment survey</li> <li>Develop concepts</li> <li>Review final survey</li> <li>Public meeting on preliminary design</li> <li>Select concept</li> <li>Obtain right of way (if needed)</li> <li>Obtain existing performance metrics</li> </ul>
<b>2B</b>	<b>Design – Final/Preferred</b>	<ul style="list-style-type: none"> <li>Develop drawings</li> <li>Prepare specifications</li> <li>Present to design team</li> <li>Public Preferred Design Meeting</li> <li>Design Team Approval</li> <li>Permits</li> <li>Maintenance agreements (if needed)</li> <li>City Engineer’s Approval</li> </ul>
<b>3</b>	<b>Bidding and Award</b>	<ul style="list-style-type: none"> <li>Bid proposal package and drawings</li> <li>Solicit and advertise bids</li> <li>Pre-bid meeting (if needed)</li> <li>City Engineer’s review and approval</li> </ul>
<b>4</b>	<b>Construction</b>	<ul style="list-style-type: none"> <li>City Commission award</li> <li>Public Information Meeting (where applicable)</li> <li>Notice to proceed/Preconstruction meeting</li> <li>Substantial completion certification</li> </ul>
<b>5</b>	<b>Post-Construction</b>	<ul style="list-style-type: none"> <li>Maintenance plan</li> <li>Ongoing maintenance funding</li> </ul>
<b>6</b>	<b>Evaluation* and Reporting</b>	<ul style="list-style-type: none"> <li>Obtain post-construction performance metrics</li> <li>Benchmarking</li> <li>Project financials close out</li> </ul>

\* As needed, project evaluation (data collection, analysis, and reporting) of selected projects as determined by the Design Team and/or the VSOC where the project illustrates a unique condition, which will add to the understanding of design modifications, pilot projects, or fulfilling community needs.

**1. Identify and Scope Project**

Projects identified for Vital Street funding by the City of Grand Rapids Engineer’s Office should be coordinated with other agencies impacted by project. These other agencies could include; other City Departments, private utilities, neighborhood associations, business associations, historic preservation, and/or property owners. A design charrette or public meetings can be used to discuss the goals, objectives, and timing of the project.

The phase deliverables will include: stated design intent for project, project budget, preliminary project scope, project schedule, priority selection, and resource identification.

**2A. Design – Preliminary Concept Development**

By developing concept options, the project team can brainstorm possible ways to meet the objectives of the street type and mode emphasis. Once a concept is selected, the project team will develop the concept further to share the ideas with the public and the Design Team. Soil borings would be ordered and performed during the preliminary design phase in order to provide information into the selection of green infrastructure components.

The phase deliverables will include: baseline data, concept alternatives, updated schedule, updated priorities, updated resources, updated budget including funding breakdowns, and a community engagement meeting.

**2B. Design- Final/Preferred**

Once a concept is approved by the Design Team, the City of Grand Rapids Engineer’s Office will finalize the design details for the project using the Vital Streets Design Guidelines. Design details could include; electrical, sewer, water, private utilities, curb, grades, green infrastructure, traffic signal, green infrastructure, and landscaping.

The project team will then develop drawings, specifications, cost estimates, a schedule, and public information materials. After check print comments and questions have been finalized, the City Engineer's office will secure permits and construction bids.

The phase deliverables will include: preferred design, community engagement meeting, approved specifications, approved drawings, engineer's estimate, permits, and easements.

### **3. Bidding and Award**

The City Engineer's office oversees the process of selecting a contractor. After bids are received, the City reviews each submission and the City Commission awards the project to the lowest responsive bidder.

### **4. Construction**

The City Engineer's office and the contractor conduct a preconstruction meeting to confirm the proposed work and construction schedule. Throughout construction of the project, progress meetings occur to resolve project issues in a timely manner and to inform the Engineer's Office and public about construction progress.

### **5. Post-Construction**

Maintenance is very important to ensure a successful project. Public Services, Street Maintenance, Environmental Services, Sidewalks, and/or Downtown Grand Rapids Inc., may be responsible for maintaining the site for the projected lifespan of the project. A maintenance plan should be developed for new design elements that will not be maintained by the City or by agreement with a separate organization, such as a community group, business district, or neighborhood association.

### **6. Evaluation and Reporting**

Once a project is complete, Design Team will monitor the street to see if the project achieved the intended goals and objectives. For some projects, especially those on major corridors or using more innovative design solutions, the Design Team may gather and evaluate data from before and after the project is completed. Projects should be assessed for level of maintenance, durability, compliance and degree of impact for Vital Streets Plan goals, and lessons to be learned for applicability to future designs.

Benchmarking is a process to occasionally compare progress to other areas or across similar streets. The goal is to assess how

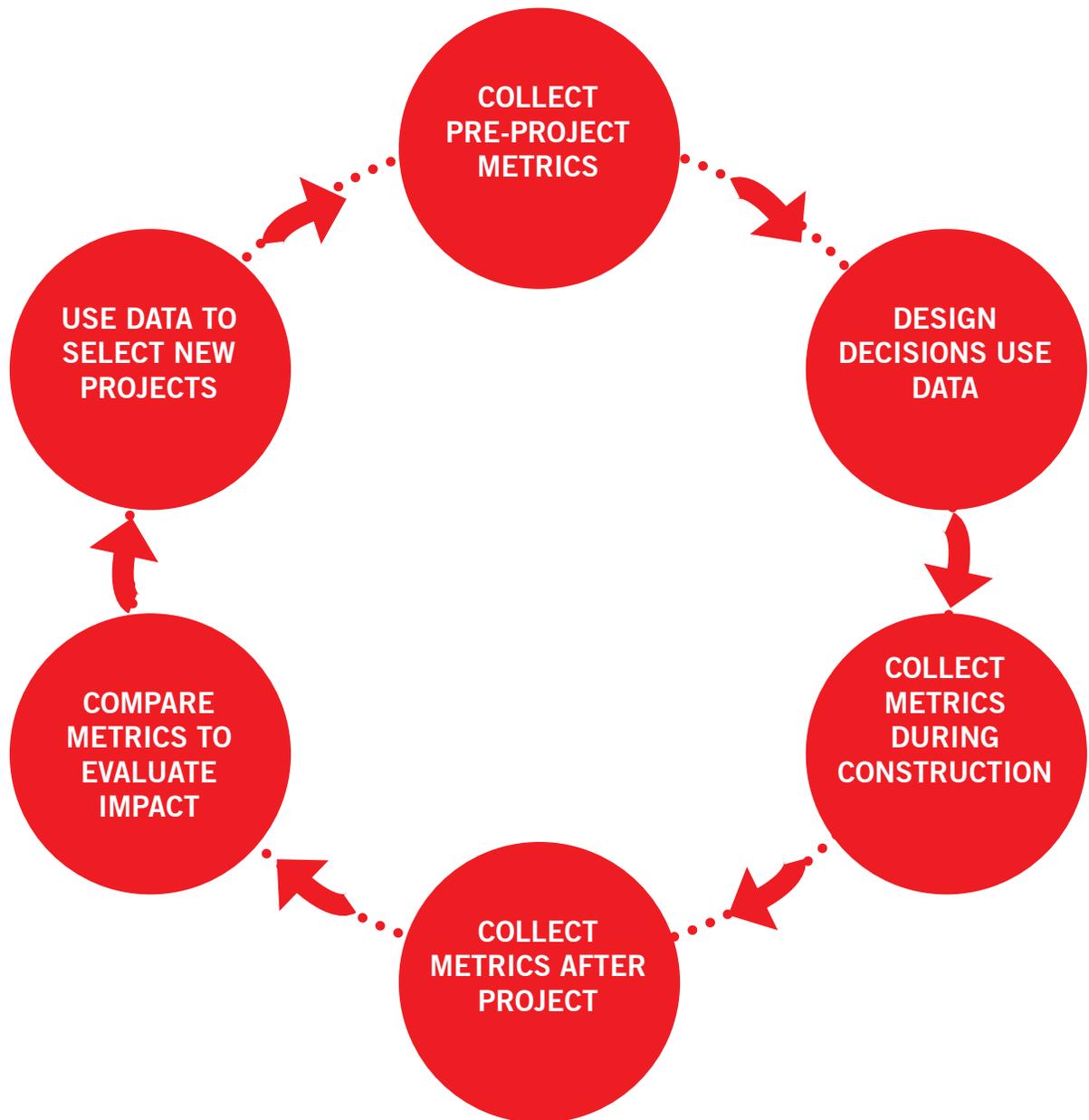
Grand Rapids is doing compared to other peer communities. This progress should be undertaken every few years to test how Vital Streets compare to other street designs. Benchmarking can also provide valuable information about larger national trends, which might impact Grand Rapids metrics. For example, if national demographic trends change driving rates, this might explain in part, changes to driving rates locally.

Benchmarking can also be used to make comparisons between key streets within Grand Rapids over time. The city can select a sample of key streets that are all one type and track changes to performance metrics on them over time. This data will increase understanding of how a particular type of street functions and allow designers to make comparisons between treatments and design features. For example, if a transit signal priority is working well on one street but not on another; perhaps there are other design elements that could be implemented to achieve the same goals.

## **WHY: PERFORMANCE MONITORING**

Design Team will use a performance monitoring process to provide a continuous feedback loop to Vital Streets projects, design decisions, operations, and maintenance. The process of Plan/Do/Check/Act is an integral part of Asset Management and the culture of City so that staff is continuously learning and improving throughout the various project phases.

In a project's design phase, baseline data on the street can be used to understand how the road is functioning and what improvements would best achieve the objectives of the street. During the preliminary concept design phase, Design Team will identify any additional data requirements that should be collected pre-construction to analyze post-construction outcomes. Metrics during the construction phase can track how a project impacts residents and businesses located nearby. Construction metrics can also be used in procurement and contracting to assess contractor performance. These metrics are helpful to draw comparisons across different projects and locations to understand potential impacts and mitigate them in the future.



Once a project is completed, the city may return to the same locations as where baseline data was collected to take measurements after the project is complete. The timing of the after data collection will depend on the type and the scale of the project. The timing should allow enough time to pass for users to adjust to the new facility but not too much time that other conditions or factors nearby could have an impact on travel patterns. For example, a new development opening nearby or another construction project creating a detour to the facility.

Comparing the before, during, and after data will provide the city with a tool to communicate the impacts of Vital Streets projects to community members and stakeholders. Data can tell an important part of the story in grant funding applications and also be used to inform decision-making about where and when future projects may be needed. For example, if a particular crosswalk design is especially effective in one location, other similar locations might be prioritized for the same type of project.

The performance measurement process will generate new types of data and additional data, which must be maintained. Additional resources will be needed to create and maintain a database of performance data that is organized and accessible to the Design Team.

## PERFORMANCE METRICS

Vital Streets projects may include elements of road diets, intersection improvements that enhance pedestrian safety, bicycle facility projects, lane narrowing projects, new sidewalk construction, and/or resurfacing. The metrics may be used to evaluate the benefits and impacts of these different types of projects may be different, but city staff should strive to gather as much data as possible:

Project Information	
Project limits:	
Posted speed limit (initial and changed if applicable)	
Initial Project Purpose:	
Dates of Construction:	
Total project cost:	

	Data	Year	Data	Year
% Good and Fair Condition (PASER)				
Presence of Bike Facilities (N/Y + type)				
Number of on-street parking spaces (both sides); usage				
Annual average daily traffic (AADT)				
Number of Total Crashes (3 year average)				
Number of Fatalities				
Number involving bicycles or peds				
85 <sup>th</sup> percentile Vehicle Travel Speeds				
Vehicle/Capacity (V/C) ratio				
Vehicle LOS (avg. for corridor or intersection)				
Stormwater flow				
Peak hour traffic volume				
Avg. parking utilization 10am-8pm (on street)				
Pedestrian count (avg for corridor or total for intersection)				
Presence of ADA compliant ramps				
Bicycle count (avg for corridor or total for intersection)				
Transit ridership (avg. boarding and alighting for stops)				
Heavy truck count				

Items Required by SOC Bylaws/Vital Streets Guidelines and/or MDEQ Permit For Each Project									
Project Name	Infiltration Practice	Volume Infiltrated per Year	Infiltration Practice Cost	Water Quality Practice	Acreage of Treatment (First Inch)	Water Quality Practice Cost	Total Vital Streets Cost	Total Project Cost	Disturbed Area

## OPERATIONS AND MAINTENANCE

Voter-supported Vital Streets funding is intended to ensure that Grand Rapids roadways are brought into a state of fair to good repair and are operated and maintained to remain in good repair into the future, in addition to the overall design objectives stated previously. With adequate funding for regular maintenance and routine upkeep, unnecessary street reconstruction can be avoided and road repair funding can be maximized over time. In addition, gradually the use of self-enforcing designs may reduce the need for excessive street markings, signage, and signals, which will change some maintenance costs. For example, street designs that rely on visual cues are much more durable and reliable than pavement markings that require annual maintenance cycles.

It is important to note that “hidden” infrastructure assets that assist in creating Vital Streets, whether it is in the form of green infrastructure (e.g. trees and bioswales) or traffic control devices such as roundabouts as opposed to traffic signals, have their own maintenance requirements. In some cases, new or innovative facilities may require more signs or markings and specialized maintenance protocols. These facilities, however, may deliver higher value outcomes than standard designs. Early evaluation and discussion about a project’s desired goals, design alternatives, and a maintenance assessment will allow those trade-offs to be understood.

Maintenance and operations refers to multimodal transportation strategies to maximize the efficiency, safety, and utility of existing and planned transportation infrastructure. Examples include maintaining local traffic signals and crosswalks to operating regional transit services and managing parking. By incorporating lifecycle costs and designing streets for a flexible uses in the future, Grand Rapids will be well positioned for long-term fiscal sustainability.

Plans to clear snow and ice from all travel facilities in the right of way, including bike lanes, sidewalks, transit stops, and vehicle lanes should be developed and regularly adopted. For protected bike facilities, new equipment at the appropriate width may be needed to clear the lanes. Bike lanes and sidewalks should never be used for snow storage, and clear paths to and from bus stops to the curb should be provided for transit passengers to safely access buses.

The Vital Streets street typology provides essential considerations in determining how to operate the system. Just as the network function, vehicle throughput, and surrounding land uses determine the facilities and design, these same elements determine how the street should function. Roadway operations need to be considered from multiple perspectives: the function a street provides within the overall transportation system, safely accommodating the users traveling on it, and the communities through which it passes.

This section provides operational strategies, maintenance policies and tools, and a project prioritization process for the City of Grand Rapids to ensure vital streets projects continue to provide mobility and access to the community throughout their useful life.

## DEMAND MANAGEMENT

Transportation Demand Management (TDM) programs, sometimes called travel options programs, provide information and incentives to reduce single-occupant vehicle travel during peak periods. Cities now look at demand management as a way to increase capacity of an existing transportation system by focusing on many approaches, not just on one mode. The key is to provide a full range of highly attractive transportation options, a strong mix of land uses, and incentives to change travel behaviors.

TDM seeks to do two things: 1) promote more efficient modes of travel to move more people in the same amount of roadway space, and 2) spread travel demand across more hours of the day to take advantage of space and capacity when it is available. TDM seeks to reduce auto trips and, hopefully, vehicle miles traveled, by increasing travel options.

In addition to reducing congestion and delays during the morning and afternoon peaks in commute travel, TDM can also be a very effective means to increase travel options and reduce constraints within parking systems. With sustained and effective implementation, TDM can directly facilitate Vital Streets efforts by reducing the amount of right-of-way necessary to accommodate peak parking demand.

Leading practices from across the country contain common elements:

- » Integrated TDM programs across multiple employers and institutions closely coordinated with the municipality and transit authorities.
- » Strong regional leadership and coordination of TDM strategies, often including mode split targets with regular measurement and reporting of performance and progress.
- » Pricing and incentives to influence mode choice and travel demand.
- » Expanded transportation options, which can include improvements to bicycling and walking options as well as transit and ridership strategies.
- » Incentives to use alternative modes, which includes commuter benefits for transit use and flexible scheduling.
- » Parking management, which includes a host of parking incentives and disincentives.
- » Adoption of public policies that imbed TDM into the land development process.
- » Broad and effective education, outreach, and promotion programs that not only improve the public's awareness of alternative modes, but actively assist them in their day to day travel planning and choices.

Vital Streets Design Guidelines implementation can increase the effectiveness of TDM in Grand Rapids, by improving the functionality of transit, bicycling, and walking, and in doing so, creating more viable options for Grand Rapids travelers. In return, TDM can facilitate Vital Streets implementation, by clarifying and expanding the potential gains of streets designed to work for "all users". Combined into an iterative series of improvements, Vital Streets and TDM can achieve a series of improvements that are able to continually optimize Grand Rapids' mobility networks.

Grand Rapids can continue working with employers, employees, and residents to increase the use of public transit, ridesharing (carpooling, vanpooling) teleworking, walking, and bicycling through a variety of methods. Companies should be encouraged to promote ridesharing and provide transit benefits, while wayfinding signage and highly visible bike facilities and route information can assist residents with information on travel options available in their community.

As a regional destination, Grand Rapids hosts large scale events throughout the year that impact travel patterns. Delays or changes to travel patterns from sports events, concerts, festivals, or conventions should proactively be managed through travel demand management information, such as bicycle parking, walking and bicycling information, variable message signs, and roadway operations.

### **MAINTENANCE AGREEMENTS**

Grand Rapids has policies on private parties maintaining city assets, but these policies should be regularly updated to include street features such as bio swales, medians, or crosswalks. Working with the business community for snow removal and/or branding and marketing design elements will increase their ownership and utilization over time. The use of performance standards, including enforcement and penalties for non-compliance should be considered to insure that facilities are properly cared for over time. Maintenance agreements need to have clear performance standards, enforcement procedures (and staffing resources) and penalties if not met, OR the option to pay the City to maintain above and beyond a certain standard.

### **TRAFFIC SIGNAL COORDINATION**

Traffic signal timing and pedestrian countdown signals can improve safety for people walking or bicycling, reduce congestion for motorists, and improve safety along a corridor. On transit emphasis streets, transit signal priority (TSP) can be used to give buses a head start pulling out of an intersection. Finally, traffic signal phasing can be used to ensure pedestrians have adequate time to cross an intersection or to provide a separate bicycle signal phase for key parts of the bike network.

### **MATERIALS SELECTION AND MAINTENANCE**

Developing typical procurement procedures and construction specifications can standardize design elements and reduce maintenance costs over time. In addition, considering lifecycle maintenance and operations costs during project design and facility selection can inform decision-making and trade-offs about the benefits and costs of specialized or singular designs.

## PARKING MANAGEMENT

A key component of managing transportation demand is understanding the supply and demand of on- and off-street parking. The price, availability, and ease of parking provides support to local commercial businesses, offices and residents and should be actively priced and managed.

Progressive parking policies are policies that better manage a city's existing supply of parking. A key component of any progressive parking policy is a concept known as demand-responsive pricing (also known as variable-rate pricing, performance-based pricing, or dynamic pricing). Demand-responsive pricing charges the lowest possible rate that achieves availability targets, better aligning price and demand to ensure there is always an open parking space. Researchers have determined the ideal parking occupancy rate to be around 85%, which leaves roughly one to two spaces available per block so that cars no longer have to circle the block to find parking. To achieve this occupancy rate, cities increase the cost of parking or reduce time limits in areas with occupancy rates higher than 85%, and decrease the cost of parking or increase time limits in areas with occupancy rates lower than 85%.

In Grand Rapids, the newly expanded department, Mobile GR, is responsible for helping achieve the City's economic development and quality of life goals by increasing the number of people who take transit, walk, bike, or commute or travel in a way other than driving alone. Opportunities to expand or improve multimodal mobility as a means to reduce dependence on driving and parking include the following strategies for all on- and off-street City maintained parking lots:

- » Transition to demand-based parking rates with availability as the primary performance measure for short-term parking
- » Reward ride sharing with premium parking locations
- » Parking cash out
- » Reduce the need for drivers to re-park their cars, through promotion of public parking, optimal walking conditions, and circulator bus service.
- » Supply high quality, functional and convenient bicycle parking

Various cities throughout the United States have successfully implemented parking policies to better manage the parking supply in their most popular neighborhoods, with some investing meter revenue in local improvements like expanded bicycling and transit amenities, streetscape improvements, and sidewalk improvements. This can reinforce the message that the primary purpose of parking rates is to manage demand and keep spaces available, not to fill budget holes.

## TRANSIT SYSTEM COORDINATION

Vital Streets implementation will improve the functionality of transit, driving, bicycling, and walking, and in doing so, creating more viable options for Grand Rapids travelers. Highly effective transit services require both infrastructure and operations to thrive. The Vital Streets Guide provides details on much of the infrastructure, such as comfortable bus shelters, clear and legible signs, and transit priority lanes to facilitate transit. However, Grand Rapids will need to closely collaborate and coordinate the infrastructure with transit services, such as direct bus routes, efficient stop locations, and the frequency of buses. This will be a key component of managing and operating vital streets in a way that balance the needs of all users.

## DEMONSTRATION PROJECTS

The construction of Vital Streets offers the opportunity for rapid implementation and short-term applications of the Design Guidelines through pilot projects. Pilot projects can be installed for a short time to measure the impacts of a new design approach, demonstrate new or innovative applications in areas where capital construction may not be immediately possible, or to provide the opportunity for members of the public to test a new design and provide feedback.

These temporary installations – also called “living previews” or “dress rehearsals” – will be most successful in locations where the pilot project temporary design closely resembles what a permanent design would look and feel like. For each potential location, city staff will determine and communicate the intended purpose of the demonstration project, the expected length of the installation, and evaluation metrics to determine the project's impacts and benefits.

