



# Urban, Rural and Suburban Complete Streets Design Manual

FOR THE CITY OF NORTHAMPTON AND COMMUNITIES IN  
HAMPSHIRE COUNTY

November 2016



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Disclaimer:

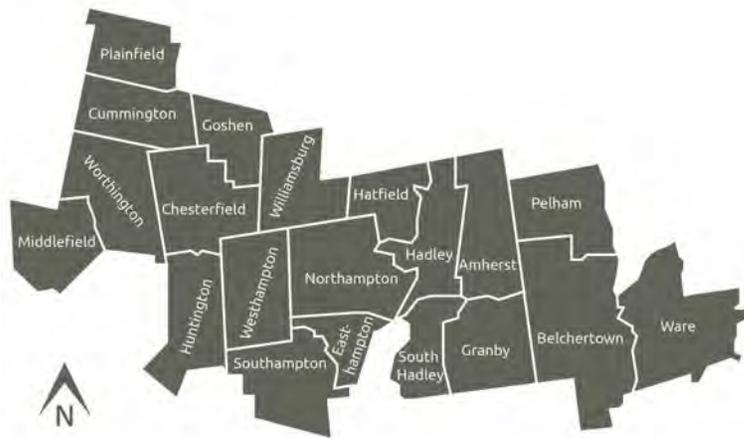
The guidelines here are designed to spark community discussion, but stronger measures to encourage complete streets are encouraged. The City of Northampton has, in many cases, adopted clear complete streets requirements that meet or exceed the standards in this manual. For example, the Northampton subdivision regulations require wider tree belts, concrete sidewalks on both sides of new roads, and narrower street entrances. The City's stricter standards are highly desirable and we endorse that approach.

# INTRODUCTION

This Complete Streets Design Manual is intended for use by the City of Northampton and all communities throughout Hampshire County.

## Goal

The overall goal of the document is to provide a design guide and manual for local planners, engineers and advocates to improve the walkability and bikability of roadways within their communities and create more safer streets for users of all ages and abilities. Another goal is to help bring County-wide consistency to the design of some bicycle and pedestrian facilities that are likely to be incorporated into redesigned streets in cities, towns and villages. The document is the product of a collaborative effort between the City of Northampton, Healthy Hampshire, the Pioneer Valley Planning Commission, consultants Alta Planning + Design, and local planning and public works staff from various Hampshire County communities.



Hampshire County, Massachusetts

## Recommendations

The design recommendations provided here are not intended to impose hard-and-fast “standards,” but instead, to offer consistent guidance for what can sometimes be challenging design and engineering options.

The following are **guiding principles** for the design recommendations found in this manual

- Whether in an urban, suburban or rural context, the walking and bicycling environment should be safe, with minimal conflicts between users.
- The pedestrian and bicycle network will be made accessible with sidewalks, shared-use paths, bike routes and crosswalks enhancing the mobility of residents of all ages and abilities.
- Compared with roadway investments, pedestrian and bicycle network improvements are economically efficient for both initial capital cost and maintenance.
- In aggregate, the facilities in this manual will help to calm traffic and lead to greater safety for all users due to lower traffic speeds, especially on local residential streets.\*
- Design guidelines are flexible and should be applied using professional engineering judgment; this document should complement other resources considered during a design process, and in all cases sound engineering judgment must be used.
- Land-use patterns that encourage pedestrian and bicycle activity on the street is as important to developing complete streets as the infrastructure guidelines provided throughout this manual. Land use patterns, uses, and development styles are key to getting the critical mass of walkers and cyclists to create thriving and sustainable communities.

\*The legislature’s municipal modernization act of 2016 permits communities to lower speed limits on local roads from 30 to 25 MPH, and 20 MPH in special “safety zones”. Communities in Hampshire County should consider this option as an additional tool to create safer streets.

## GUIDANCE FRAMEWORK

The sections that follow serve as an inventory of key pedestrian and bicycle roadway design treatments and provide guidelines for their development. These treatments are important because they represent the tools for creating a pedestrian and bicycle-friendly, safe, accessible community. The guidelines are not, however, a substitute for a more thorough evaluation by a landscape architect or engineer upon implementation of facility improvements. They are very general in nature and further analysis and professional engineering judgement will be required

to accommodate local conditions, including community concerns, topography, cost issues, R.O.W. availability, permitting challenges, and funding opportunities. The following standards and guidelines are referred to in this manual.

### Guidance

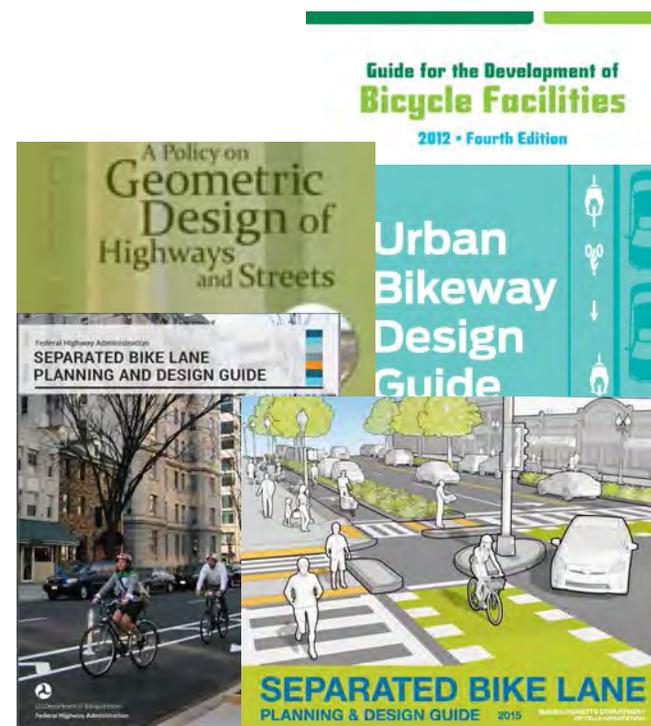
American Association of State Highway and Transportation Officials (AASHTO) **Guide for the Development of Bicycle Facilities** (2012), provides guidance on dimensions, use, and layout of specific bicycle facilities. The AASHTO **Guide for the Planning, Design, and Operation of Pedestrian Facilities** (2004) offers the same guidance for designing for pedestrians.

The National Association of City Transportation Officials' (NACTO) **Urban Bikeway Design Guide** (2012) and **Urban Street Design Guide** (2013) **Urban Transit Street Design Guide** (2015) offers guidance on the current state of the practice designs.

The AASHTO **A Policy on Geometric Design of Highways and Streets** (2011) commonly referred to as the “Green Book,” contains the current design research and practices for highway and street geometric design.

The FHWA **Separated Bike Lane Planning and Design Guide** (2015) provides federal endorsement of physically separated bike lanes and preferred design standards.

Locally in Massachusetts, the MassDOT **Project Development and Design Guide** (2006) and the **Separated Bike Lane Planning and Design Guide** (2015) offers considerations and strategies for the development of traffic calming elements, pedestrian facilities and separated bike lanes.



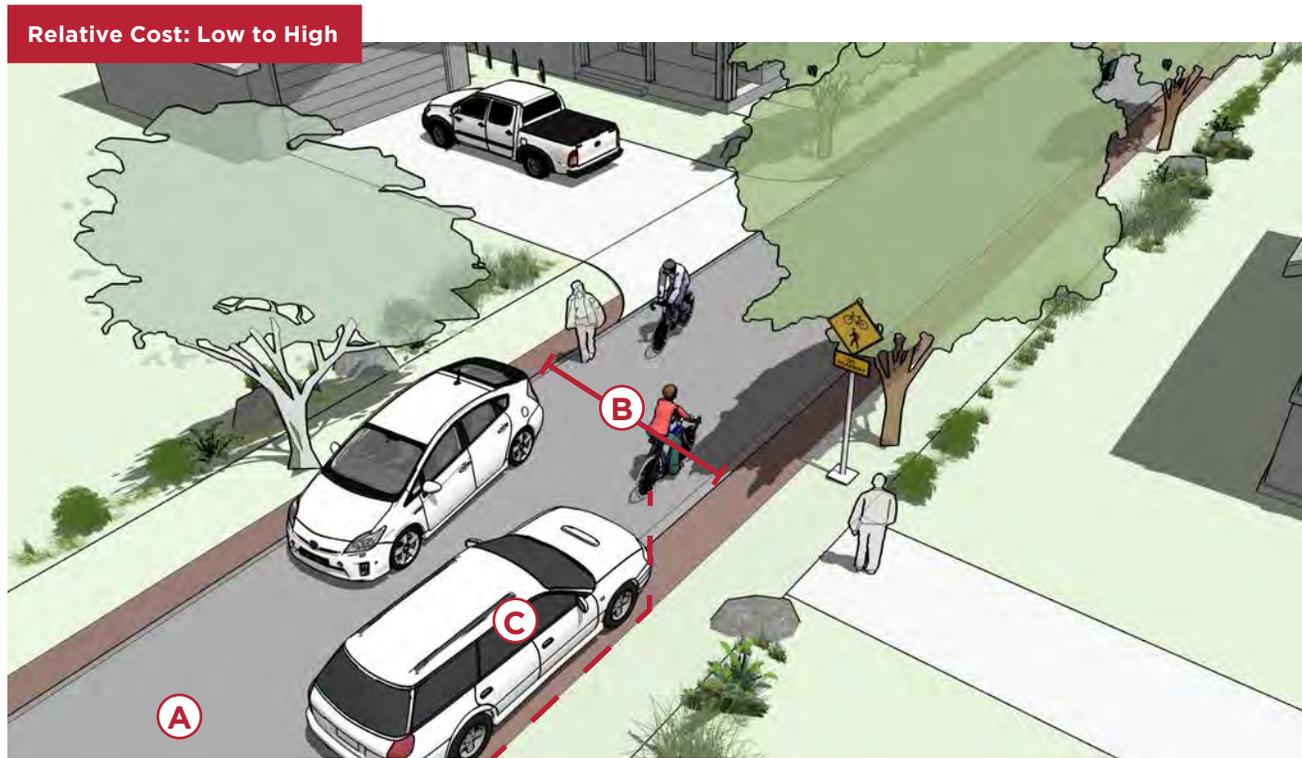
# PEDESTRIAN FACILITIES



## PEDESTRIAN FACILITIES

## LOCAL SHARED ROADWAY

A local shared roadway (AKA, yield street) is a simple road designed to serve pedestrians, bicyclists and motor vehicle traffic within the roadway. Shared roadways are only appropriate where sidewalks are not feasible, practical or desirable or where very aggressive traffic calming measures are implemented. The facility can serve local traffic volumes and maintain aesthetic preferences, and should be considered the typical form for residential local roads in a variety of urban, suburban or rural contexts.



### Typical Application

- On low volume roads, particularly near residential land uses where most traffic is familiar with prevailing road conditions, or on any roadway where the infrastructure is aggressive enough to prevent speeds exceeding 15 mph.
  - Most appropriate on very-low volume roads with  $\leq 400$  vehicles per day.
  - May operate on volumes up to 1,000 ADT (Average Daily Trips). Beyond this threshold, pedestrians shy away from the roadway due to traffic intensity.
  - Maintaining low speed motor vehicle speeds of 15 mph or less are critical for pedestrian safety and comfort.
  - If speeds or volumes are too high, access management and speed reduction tools should be used to create comfortable conditions.
- 4** • See following sections for other aggressive measures to control speeds.

### Design Features

- A** No center lane should be marked, which creates traffic “friction” from two-way traffic operating within one bidirectional travel area.
- B** A travel area width of 12 to 18 ft (3.6 – 5.5 m) is appropriate for low volumes ( $<1,000$  ADT) of two-way traffic and may require queuing or slowing when motor vehicles pass each other.
- C** Narrow road widths  $\leq 14$  ft (4.2 m) will require regular pull-out areas to allow for infrequent meeting and passing events between motor vehicles. Pull out areas may be established in the parking lane, driveway or roadside area.

### Local Shared Roadway



Simple unlaned local roads can support pedestrian travel within the roadway. If pedestrian travel is intended, the roadway should meet accessibility requirements for surface stability, friction and, cross slope.

### Local Shared Roadway



This recently constructed roadway in a suburban neighborhood is designed to work for all road uses, without separation.

#### Further Considerations

- When operating at very-low volumes, pedestrians may be comfortable walking within the travel area of the roadway. As volumes increase, consider providing a sidewalk for increased pedestrian comfort. (AASHTO 2011)
- Trees should be planted within the roadside area at regular intervals to visually and physically narrow the corridor, add to the aesthetic, and encourage slow speeds.
- Edge lines are optional and can help to further slow traffic by giving the perception of a narrower road way.
- Access for fire trucks and emergency vehicles should be provided. This requires adequate width along the road for an emergency response vehicle, and frequent opportunity to park and access equipment from the vehicle. There is no single fire code standards for local roads, however an acceptable range of clear roadway for parking/deploying fire department apparatus is between 16 and 20 ft (5.0 - 6.0 m) (ODOT, 2000). Designers should provide an opening of this width every 200-300 feet (Burden 2000).

#### Maintenance

Local shared roadways have minimal maintenance costs due to limited paved surface. Part of complying with ADA is providing adequate maintenance. The clear widths should remain free and clear of obstructions, including snow, ice, and debris. (Title 28 CFR Sec. 35.133)

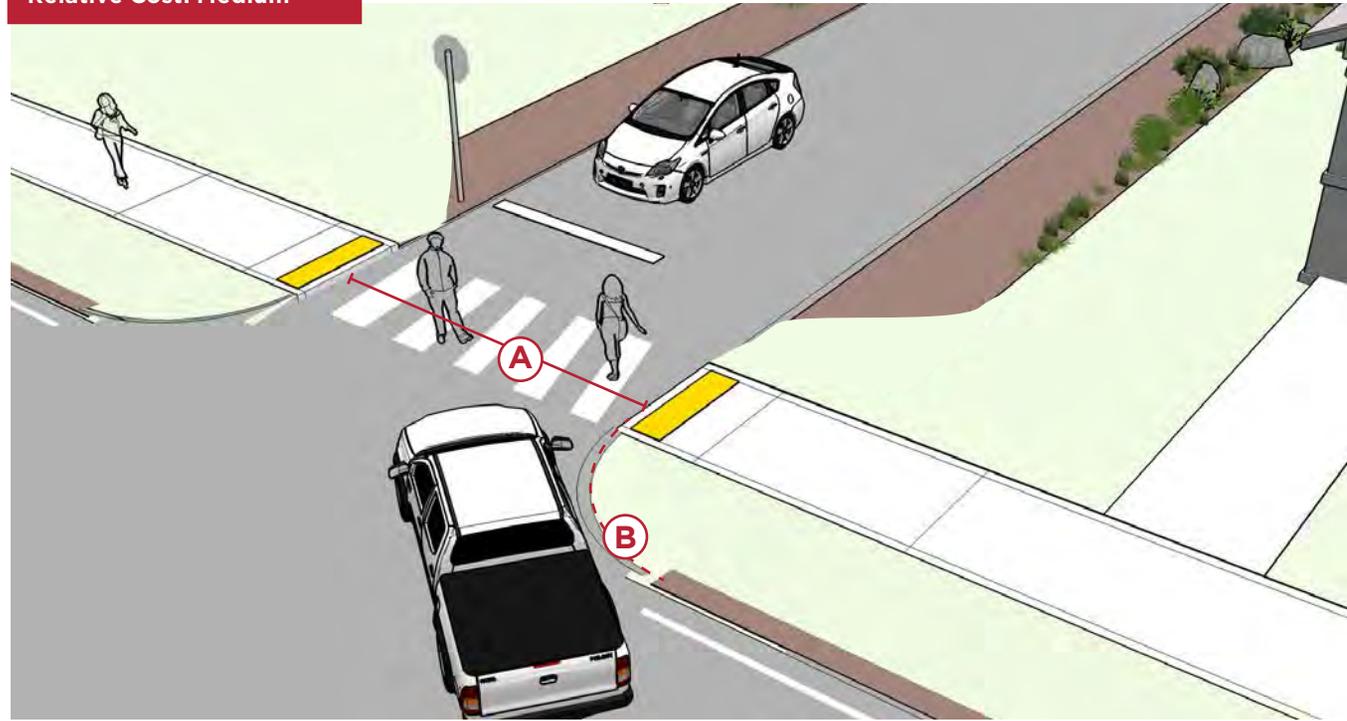
#### References

- American Association of State Highway and Transportation Officials. A Policy on Geometric Design of Highways and Streets. 2011.
- Burden, Dan & Zykofsky, Paul. Emergency Response: Traffic Calming and Traditional Neighborhood Streets. 2000.
- Oregon Department of Transportation (ODOT). Neighborhood Street Design Guidelines: An Oregon Guide for Reducing Street Widths. 2000.

## LOCAL STREET ENTRANCES

The entrance to a neighborhood should signal to motorists that they are entering a slow-speed, residential district where children may be playing and pedestrians may be present.

Relative Cost: Medium



### Typical Application

- Key connections into neighborhood districts from busy streets.

### Design Features

- A** The width of the street entrance should be reduced to 20 ft maximum from road edge to road edge.
- B** A small corner radius of 10 - 15 ft should be used to require slow turning speeds.
  - The crosswalk may be configured as a raised crossing, to further slow entering vehicles.

### Maintenance

Landscaping and trees should be maintained to provide clear sight triangles in advance of intersections.

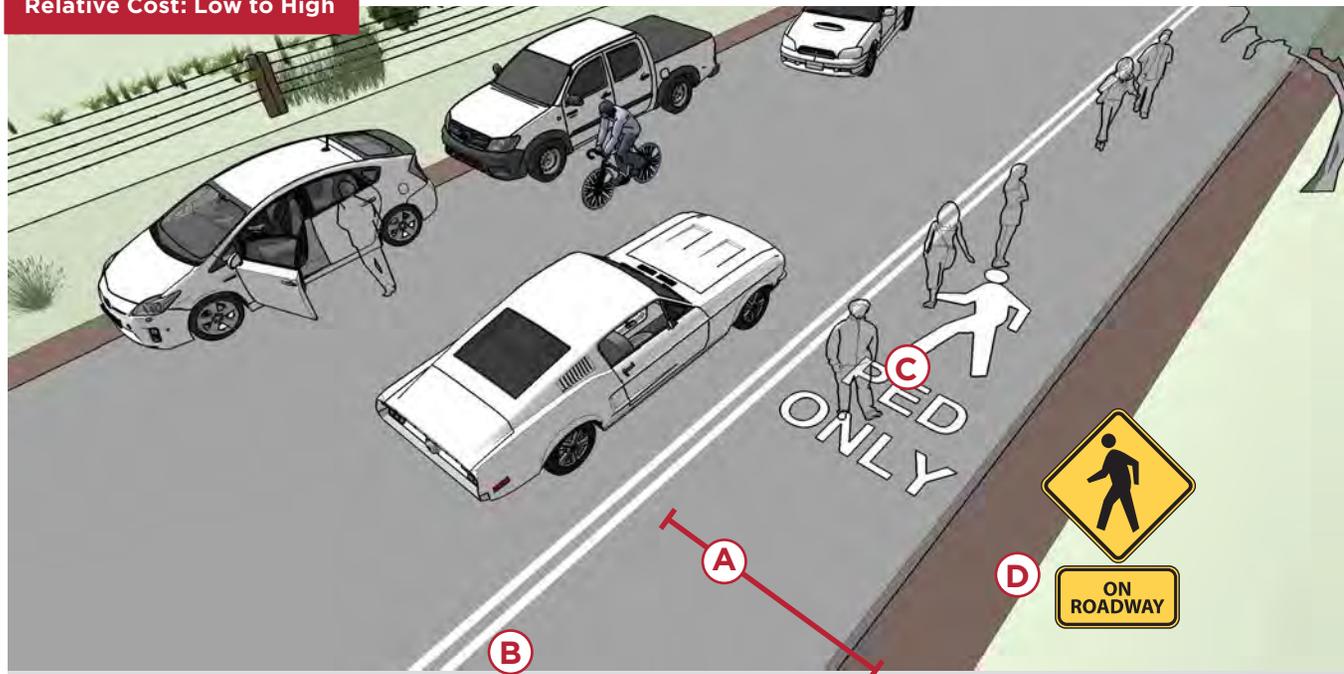
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PEDESTRIAN FACILITIES

# PEDESTRIAN LANE

A pedestrian lane is a low-cost alternative to a separated path or sidewalk and is appropriate on roads with moderate speeds and volumes. Though less effective than a sidewalk, the lane provides a space for pedestrians to walk and separated from motor vehicle traffic by roadway striping.

Relative Cost: Low to High



### Typical Application

- Pedestrian lanes are appropriate where sidewalks are not feasible, practical, or desirable, or where aggressive traffic calming measures are implemented.
- As an affordable alternative to a sidewalk on lower volume roadways. In some suburban and rural communities, sidewalks may not be the appropriate pedestrian facility choice, due to right of way constraints, storm water infrastructure, economic impacts, or other reasons.
- Crosswalks should be considered at intersecting streets, per the discretion of the roadway engineers.
- To accommodate vehicle traffic and pedestrians, roadway width must be 20' minimum on low volume roads, <1,000 ADT and 28' for ADT >1,000.

### Design Features

- Pedestrian lane width of 8 feet is preferred, 5 foot minimum; use of colored asphalt or paint can be used to enhance differentiation.
  - (A)
- A pedestrian lane must be separated from the adjacent travel lanes with some form of lane delineation, such as a 6"-8" white line or a double 4" white line. A marked buffer may also be used to provide additional separation.
  - (B)
- Pedestrian lanes should be marked with the appropriate pavement legend markings in white color, positioned laterally in the center of the lane (MUTCD, 2009, p. 415).
  - (C)
- Pedestrian Warning Sign (W11-2) paired with an "ON ROADWAY" legend sub plaque may be used to indicate to drivers to expect pedestrians within the paved road surface.
  - (D)

## Pedestrian Lane



A painted pedestrian lane provides designated space for walking when there is no sidewalk available. In this photo, the bike lane enhances the pedestrian lane as a type of buffer separation.



Thick lane line markings discourage encroachment into the pedestrian lane space.

### Further Considerations

- In some instances sufficient space to provide a pedestrian lane may already exist or may be created through configuration changes including removing or consolidating on-street parking, or narrowing of travel lanes. Implementing pedestrian lanes may share some strategies with the implementation of bicycle lanes (FHWA Resurfacing Guide, 2016), such as widening a roadway to accommodate both, or incorporating bike and pedestrian facilities into a roadway reconstruction project.
- Although sidewalks are preferable if funding exists, there are documented safety benefits of providing striped shoulders >4' in width. A 2002 study by McMahon, Zeager, Duncan, Knoblauch, Stewart, and Khattak found that the presence of either a sidewalk or shoulder (min. 4' wide) reduced the risk of a pedestrian "walking along roadway" crash by 88%.

### Maintenance

Signage and striping require routine maintenance. Thermoplastic markings offer increased durability over conventional paint

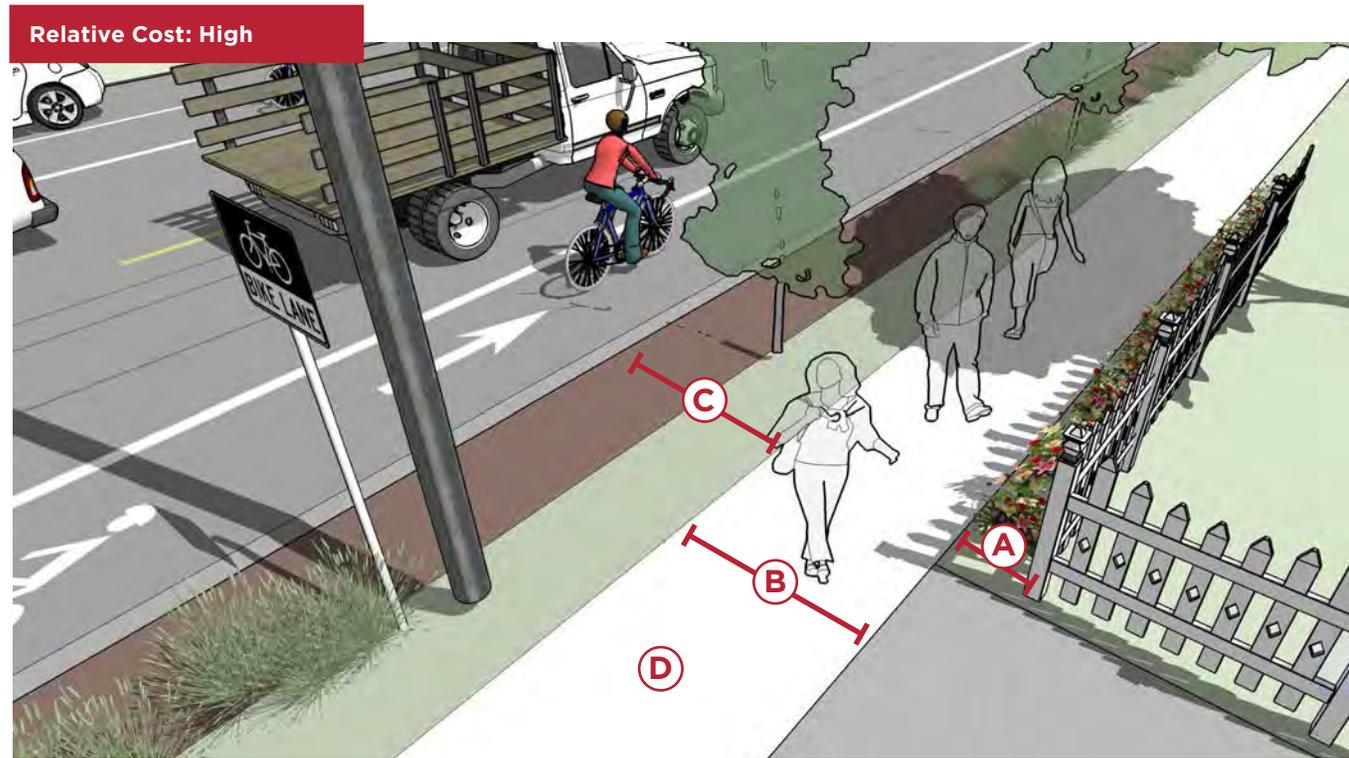
### References

- FHWA. Incorporating On-Road Bicycle Networks into Resurfacing Projects. 2016.
- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- Pedestrian and Bicycle Information Center (PBIC), evaluation of pedestrian-related roadway measures: a summary of available research. 2014.

PEDESTRIAN FACILITIES

# SIDEWALKS

Sidewalks provide a dedicated space intended for use by pedestrians that is safe, comfortable, and accessible to all. Sidewalks are physically separated from the roadway by a curb or unpaved buffer space.

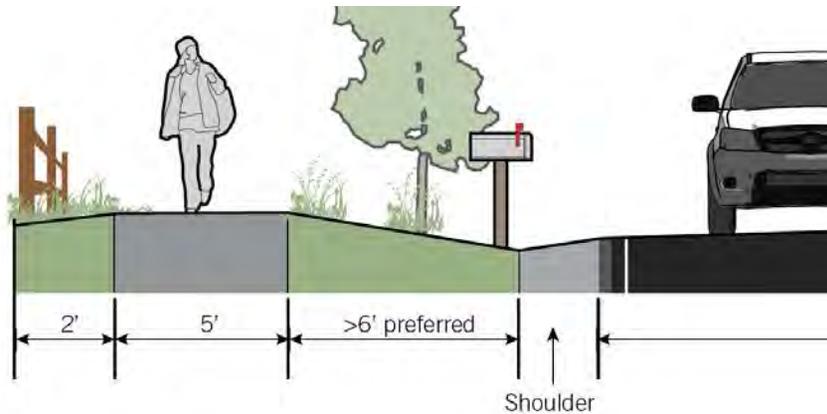


### Typical Application

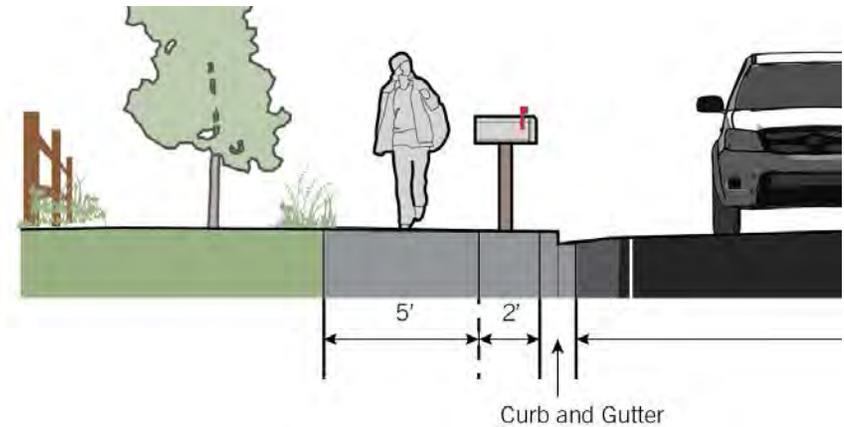
- Appropriate inside of built-up areas and population centers. May serve short distance travel between built up areas. Along or near highways in rural areas near pedestrian-generating development, such as residential development, schools, and businesses.

### Design Features

- A Frontage Zone:** On most sidewalks, a frontage zone of 1 to 2 ft (0.3 - 0.6 m) back from the property line is recommended to provide a shy distance to fences and building walls.
- B Pedestrian Through Zone:** The pedestrian through zone of a sidewalk should be at least 6' wide in any commercial, mixed use, or dense residential area. (Minimum 5' wide in all other places.) This permits side-by-side walking, meeting and passing events, and meets accessibility guidelines for turning and maneuvering.
- C Furnishing Zone (Urban areas) / Tree Belt Zone (Residential areas):** A buffer zone of 6' (1.8 m) or more is desirable for pedestrian comfort. Where ,6' street trees should include structural soil or other elements to promote tree health.
- D** Sidewalks should be constructed out of concrete in any urban, commercial, mixed use, or dense residential areas. Asphalt is not durable but may be appropriate in some suburban and rural areas.

**Sidewalk with Buffer Separation**

Sidewalks with buffer separation are preferred for user comfort and allow for easier implementation of accessible curb ramp and driveway design.

**Sidewalk with Curb Separation**

Sidewalks without buffer separation may be constructed adjacent to a curb or curb and gutter combination. An additional 2 feet of paved sidewalk width should be provided so that furnishings do not encroach upon the sidewalk width.

**Further Considerations**

- Sidewalks may be provided on one or both sides of a street, depending on the location, the adjacent population density, and the location of pedestrian-generating destinations such as schools, parks and community centers.
- On rural arterials, sidewalks may be provided on one or both sides of the road, if demand for walking facilities exists (AASHTO Green Book, 2011, pp. 7-25).
- On arterials that travel through more urbanized and populated areas, streets “need to accommodate both vehicles and pedestrians” and should include sidewalks and crosswalks (AASHTO Green Book, 2011, pp. 7-41).
- Sidewalks may be omitted on one side of a street where that side clearly cannot be developed and where there are no existing or anticipated uses that would degenerate pedestrian trips on that side.

**Maintenance**

Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped space. Colored, patterned, or stamped concrete can add distinctive visual appeal.

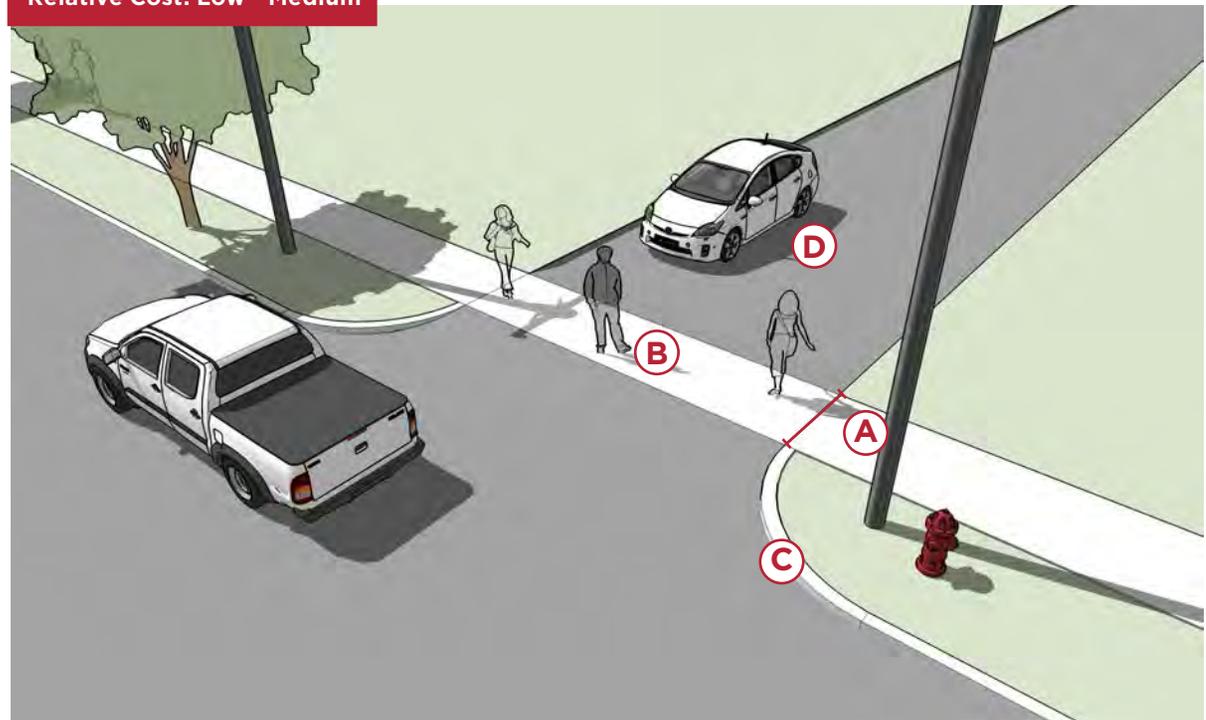
**References**

American Association of State Highway and Transportation Officials. A Policy on Geometric Design of Highways and Streets. 2011.

## SIDEWALK DESIGN AT DRIVEWAYS

Driveways provide vehicle access to businesses and residences located along roadways. However, exiting and turning vehicles create conflict points with pedestrians along sidewalks. Driveway design details at sidewalk locations can help prioritize pedestrian movements, lower vehicle speeds and maximize visibility of all modes.

Relative Cost: Low - Medium



### Typical Application

- All unsignalized driveway entrances which cross a pedestrian sidewalk.
- Driveway entrances for sidewalks running along edge of roadway or separated by a tree belt or planting strip.

### Design Features

- Ⓐ The sidewalk should maintain a minimum 4 ft continuous path along the sidewalk alignment, or providing an area adjacent to the main walk that maintains a maximum two percent cross-slope.
- Ⓑ The portion of the sidewalk crossing any driveway should be concrete or unit pavers on a concrete base, and should maintain its height and grade to provide a physical and visual cue to motorists that they are entering a pedestrian area.
- Ⓒ Minimize corner radii of the curb or use conventional apron-style driveways to reduce vehicle speeds,
- Ⓓ Narrow driveway widths as much as possible to reduce pedestrian exposure.

### Sidewalk Design at Driveways



This driveway uses contrasting sidewalk appropriate construction materials to indicate to drivers that they are crossing a sidewalk area.



This driveway maintains a continuous level path with an ADA compliant sidewalk width behind the driveway apron area.

#### Further Considerations

- Tactile warnings and crosswalk markings are an intersection design feature and should not be used on driveways. At signalized driveways that function as intersections, these elements should be included.
- The total width for two-way driveways should be a maximum of 24 ft. (14 ft. for one-way driveways) unless there is heavy truck traffic that requires wider entry points. Where driveway volumes warrant multiple lanes in each direction, providing a separating median between directions can provide a pedestrian refuge and should be incorporated. (ITE 2010)

#### Maintenance

Driveways should be kept free of debris. Nearby plantings and trees should be trimmed to provide clear visibility of sidewalks in advance of driveways.

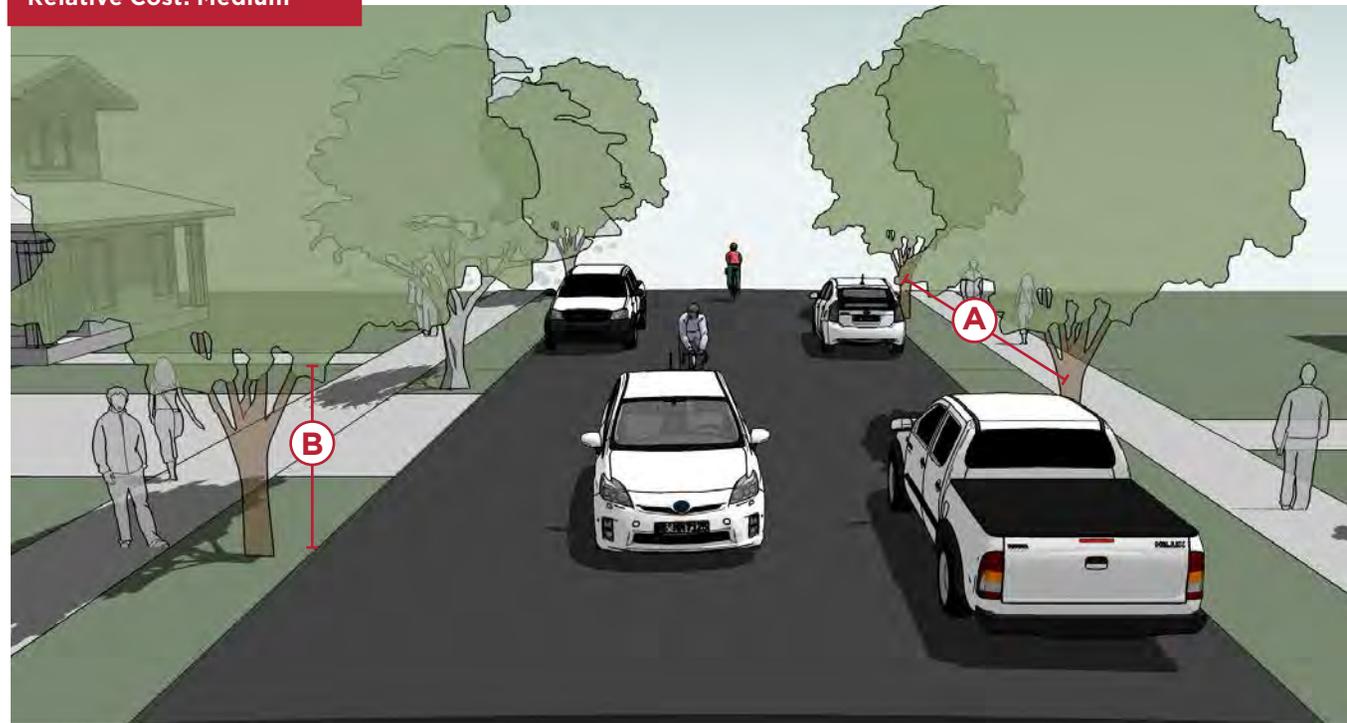
#### References

A Policy on Geometric Design of Highways and Streets, 6th Edition, AASHTO (2011)  
 Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, ITE (2010)  
 Guide for Development of Pedestrian Facilities, AASHTO (2004)  
 NCHRP 659: Guide for the Geometric Design of Driveways. (2010)

## STREET TREES

Allocating roadside space to street trees and landscaping helps improve the aesthetics of the streetscape, provides a buffer between the roadway and sidewalk to improve pedestrian comfort, and can facilitate stormwater management through bioretention features such as planters and swales.

Relative Cost: Medium



### Typical Application

- Street trees and landscaping typically occupies the furnishing zone of the sidewalk corridor, and is most feasible when there is sufficient space to provide an adequate width pedestrian through zone.
- Residential streets and pedestrian oriented business districts are prime candidates for street trees.

### Design Features

- Ⓐ Place trees every 25-30 ft to provide a continuous canopy, enhance the pedestrian experience and help slow traffic.
- Ⓑ Consider the impact of landscaping on visibility for motorists and pedestrians at driveways and intersections. AASHTO recommends a clear vision space from 3 to 10 ft (1.0 – 3.0 m) above roadway grade to facilitate proper sight distance.



Street trees create a visually-pleasing “wall” to separate the sidewalk from adjacent roadway.

### Further Considerations

- On higher speed streets, small caliper trees may be used to alleviate concerns about fixed objects or visual obstructions between the roadway and the pathway. AASHTO does not classify trees that will grow to below 4 inches (100 mm) diameter as a fixed object, and trees of this width may be placed within the clear zone. Trees should, however, be placed outside of the lateral offset of roadways. (AASHTO Green Book pp. 7-6).
- Landscaping and trees may impact the visibility of sidewalk users at driveways and intersections. To promote adequate sight lines, the top of ground cover should not exceed 2 ft (0.6 m). Trees generally should be set back at least 20 to 30 ft (6.0 – 10.0 m) on the approach to intersections and commercial driveways and 10 to 20 ft (3.0 – 6.0 m) on the far side. (NCHRP 659, 2010) Set backs at residential driveways, especially for single family homes, can be reduced to 10’ max.

### Maintenance

Plant and tree selection can impact maintenance costs and aesthetic preferences. Select plants and tree species that are adapted to the local climate and fit the character of the surrounding area.

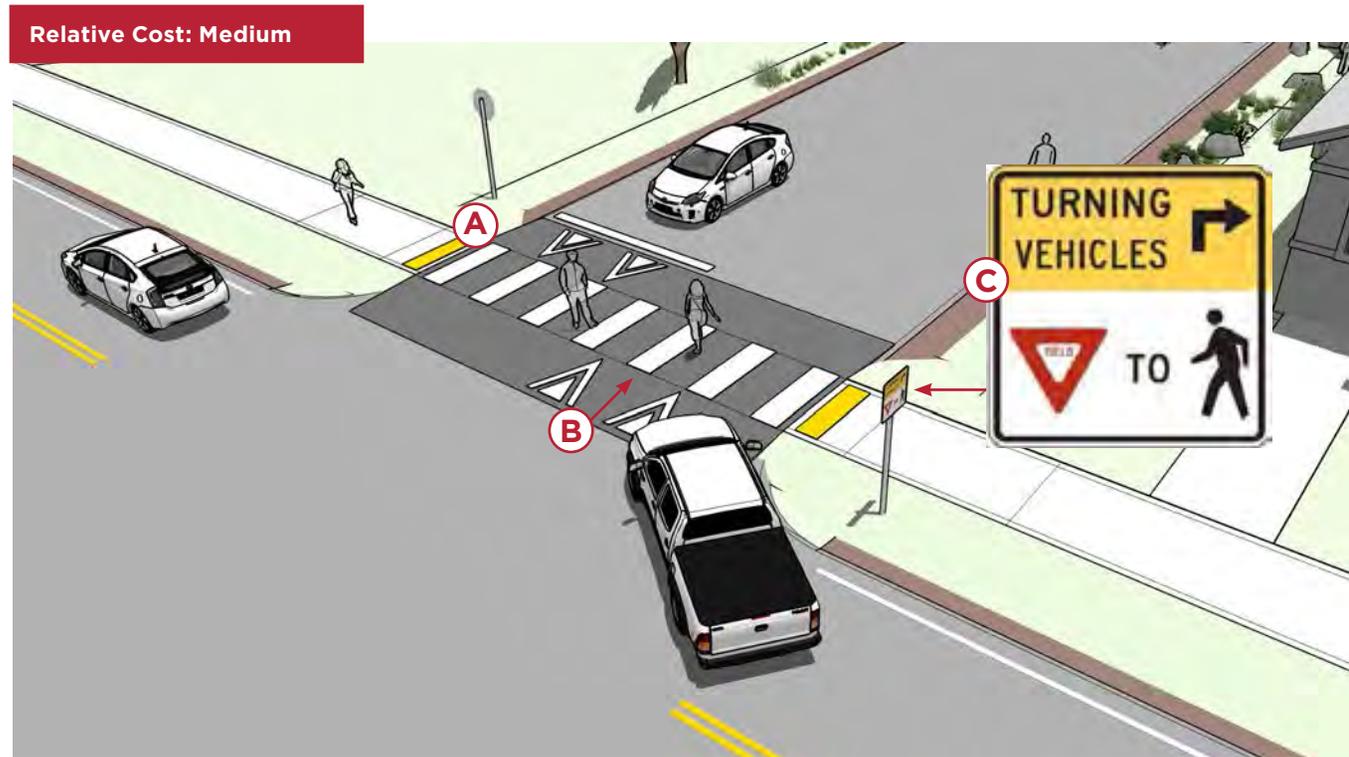
### References

- A Policy on Geometric Design of Highways and Streets, 6th Edition, AASHTO (2011)
- Guide for Development of Pedestrian Facilities, AASHTO (2004)
- NCHRP 659: Guide for the Geometric Design of Driveways. (2010)

## PEDESTRIAN FACILITIES

## RAISED CROSSWALK

A raised crosswalk can eliminate grade changes along the sidewalk and give pedestrians greater prominence as they cross the street. Raised crosswalks should be used where there is moderate to high pedestrian volumes and / or safety concerns.



### Typical Applications

- Raised crosswalks can function as a traffic calming treatment.
- Suitable for high-volume pedestrian crosswalks, especially on mixed-use/commercial streets with high multimodal priority, or where greater motorist yield compliance is desired.
- Provides greater visibility of pedestrians to approaching motorists.
- Constant crossing grade improves accessibility for pedestrians.

### Design Features

- A** Use detectable warnings at the curb edges to alert vision-impaired pedestrians that they are entering the roadway.
- B** Approaches to the raised crosswalk may be designed to be similar to speed humps, which typically feature a 1:12 slope.
  - See MassDOT 2006 Project Development and Design Guide, section 16.7.2 for additional guidance.
- C** For increased awareness of the pedestrian crossing, an R10-15 sign may be used to warn turning vehicles.

## Raised Crosswalks



Raised crossings can act as speed humps, slow motor vehicles in advance of sidewalk and trail crossings.

### Further Considerations

- Traffic calming should be designed to minimize impacts to street cleaners. Maintenance requirements will depend on the durability of materials, such as concrete, asphalt or other paver types.
- Like a speed hump, raised crosswalks have a traffic slowing effect which may be a concern on emergency response routes.
- Raised crosswalks can also be used where a multi-use path crosses a roadway.
- It should be noted that mid-block crossings can add a false sense of security for pedestrians. Mid-block crossings should be accompanied by advance warnings and traffic calming elements (e.g. horizontal or vertical.)

### Maintenance

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority.

Drainage channels can be maintained with the use of a drainage culvert or a depression with ADA compliant curb ramps.

### References

- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- AASHTO. Guide for the Planning, Design, and Operation of Pedestrian Facilities. 2004.
- MassDOT. Project Development and Design Guide, Ch 16. 2006.

PEDESTRIAN FACILITIES

# CENTER ISLANDS

Center islands are raised islands located along the centerline of a street that narrow the travel lanes and/or shoulders at that location. They are sometimes called midblock medians, median slow points, or median chokers and may act as traffic calming to slow motor vehicle traffic.

Relative Cost: High



**Typical Application**

- May be configured as traffic calming to slow traffic in a variety of contexts
- May be nicely landscaped to provide visual amenity and neighborhood identity
- Sometimes used on wide streets to narrow travel lanes
- Work well when combined with crosswalks

**Design Features**

- **A** Preferred width of 6 ft or greater to permit use for landscaping, gateway signs, or use as a pedestrian crossing island.
- Center islands <6 ft may be too narrow to support trees, but may support low impact landscaping.
- Islands <4 ft may function best as a hard surface. Consider pavers or stamped or colored concrete to provide aesthetic benefit.
- See MassDOT 2006 Project Development and Design Guide, section 16.5.8 for additional guidance.

## Center Islands



Mid block center islands may be configured with a pedestrian crosswalk to offer safe and comfortable crossings of busy streets.



Center islands at intersections can simplify bikeway crossings of busy roadways.

### Further Considerations

- Depending on placement, may reduce parking and driveway access
- Bicyclists prefer not to have the travel way narrowed into path of motor vehicles. Provide a bike lane or path outside of the travel lane to offer a separate space for bicyclists.
- Center islands are preferred by fire department/emergency response agencies to most other traffic calming measures.
- Depending on their size, center islands help reduce the amount of stormwater runoff and the overall roadway area that needs to be plowed.

### Maintenance

Traffic calming should be designed to minimize impacts to streetsweepers and snow plows. Vegetation should be regularly trimmed to maintain visibility and attractiveness.

### References

- AASHTO. Guide for the Planning, Design, and Operation of Pedestrian Facilities. 2004.
- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- MassDOT. Project Development and Design Guide, Ch 16. 2006.

## PEDESTRIAN FACILITIES

**PARKLETS**

A parklet is a seasonal or year-round outdoor space typically the size of an on-street parking space. These mini-parks are often designed for passive recreation and may include planters, benches, café tables and chairs. Additionally, parklets can be designed to include bike corrals, fitness equipment, chess boards and other activities.

Relative Cost: Medium

**Typical Application**

- Parklets can enhance commercial district or neighborhood vitality, especially in areas currently lacking public space or in locations where sidewalk space is constrained.
- The nature of a parklet will vary based on factors such as size, location, surrounding land uses and the duration of the installation. Parking availability should be considered when determining the overall benefit of parklet installation against parking loss.
- Parklets are generally located within an on-street parking lane, and does not impede motor vehicle or bicycle through travel.

**Design Features**

- A Parklets are often constructed on custom or pre-fabricated platform that rests on the street pavement. This allows them to meet the grade of adjacent sidewalks, extending the pedestrian zone.
  - Parklet design should comply with ADA standards and be easily accessible from the sidewalk. Avoid placement near intersections and do not block fire hydrants or bus stops.
  - Parklets must be designed and located in areas so as not to restrict stormwater runoff or cause other drainage issues.



Parklets can be implemented on a trial basis using temporary materials to quickly transform a space (sometimes called a “tactical urbanism” project). Simple tables and plants create a pleasant resting environment in this parklet.



Streetscape furnishing manufacturer Dero produces a modular parklet platform for easy deployment.

Photo Source: dero.com

### Further Considerations

- Because parklets may require the removal of an on-street parking space, outreach to adjacent property owners and businesses is critical.
- Most municipalities require a permitting process for both temporary and permanent parklet installations.
- Temporary or permanent placement adjacent to a crosswalk allows the parklet to function as a *de facto* curb extension and can improve pedestrian safety by shortening crossing distances.

### Maintenance

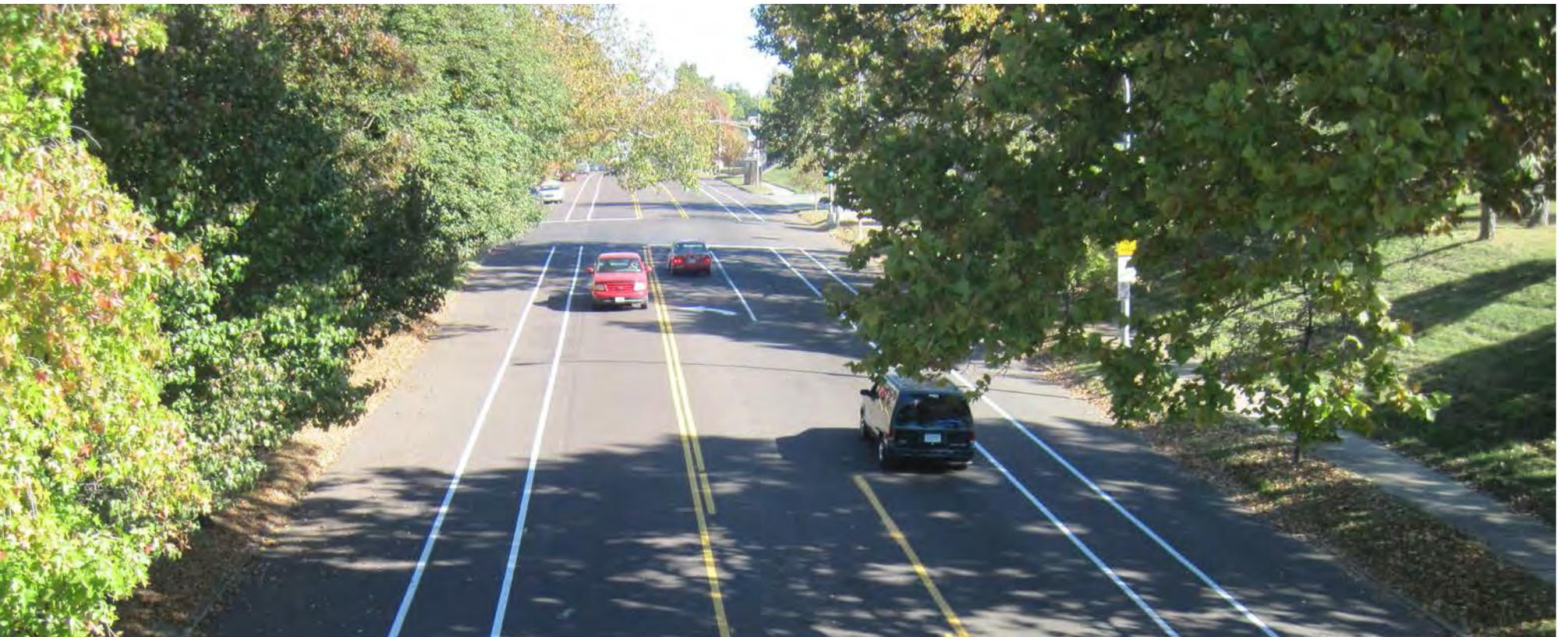
In many communities parklet permit applicants, often business owners or community organizations, agree to maintain the parklet and renew the permit annually. The applicant is usually responsible for daily cleaning, sweeping, and maintenance of plants, in and around the parklet installation, for the season or indefinitely, depending on the agreement.

### References

- City of San Francisco - Pavement to Parks. San Francisco Parklet Manual". 2013.
- Madeline Brozen, Anastasia Loukaitou-Sideris, Colleen Callahan. Reclaiming the Right-of-Way: A Toolkit for Creating and Implementing Parklets. UCLA Luskin School of Public Affairs. 2012.

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# BIKEWAY FACILITIES



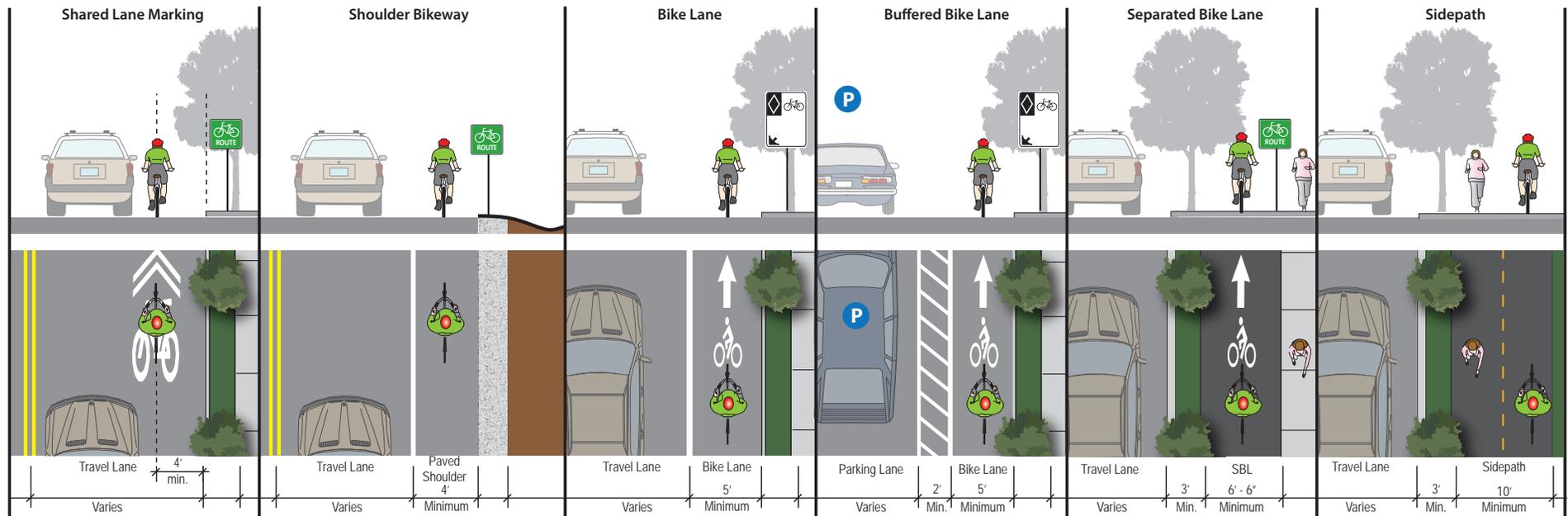
# BIKEWAY FACILITY SELECTION MATRIX

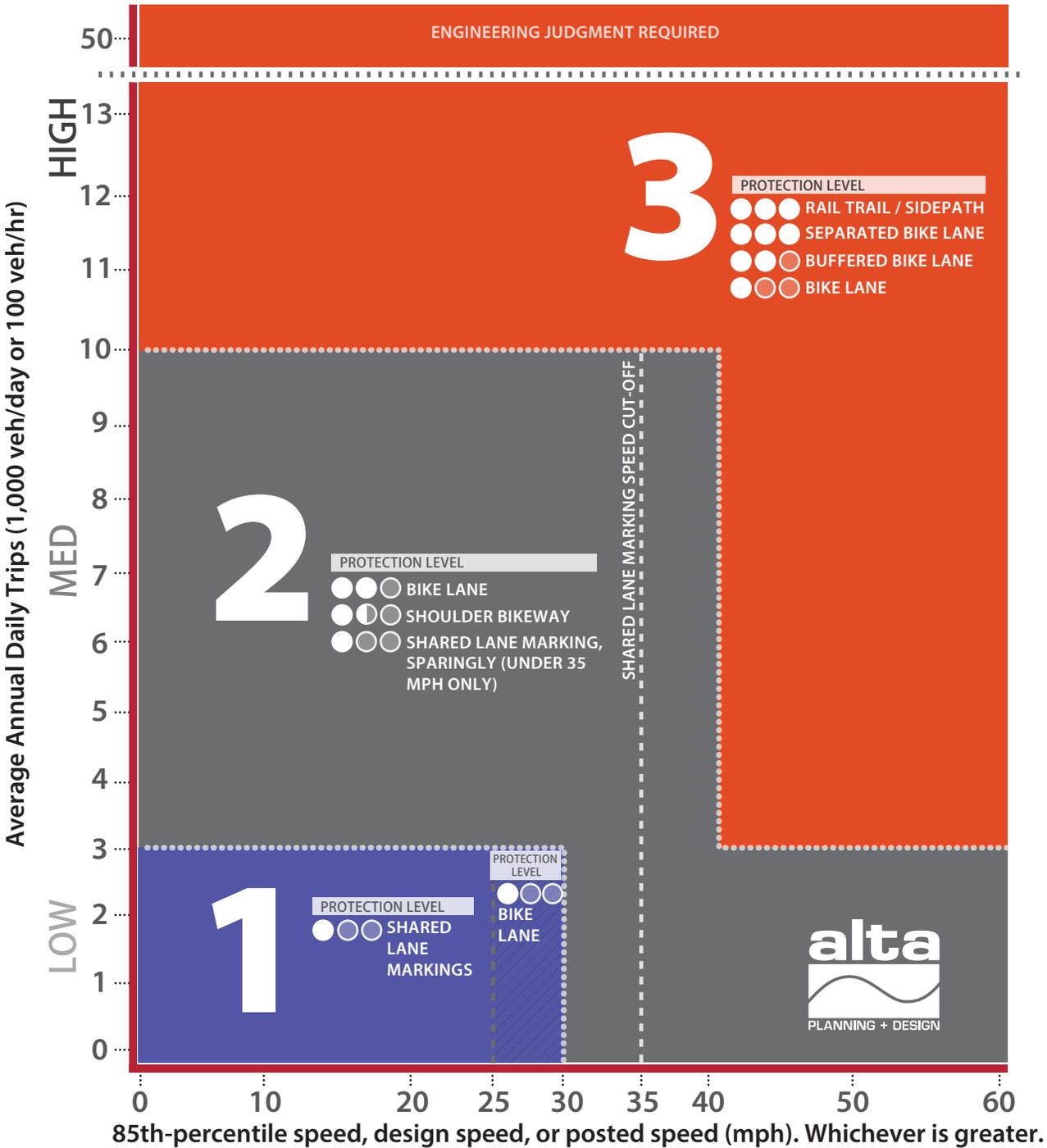
Selecting the best bikeway facility type for a given roadway can be challenging, due to the range of factors that influence the comfort and safety of bicyclists. When motor vehicle traffic volumes are large and speed is high, there is a greater level of discomfort among bicyclists.

The chart on the following page can be used as a general guideline to recommend a facility that will be comfortable for the majority of bicycle users based on motor vehicle speed and volume on the roadway. To use the chart, identify the roadway posted speed limit or the 85th percentile speed and Average Daily Trips and locate the facility types indicated by those variables.

Studies indicate that the most significant factors influencing bicycle use are motor vehicle traffic volume and speeds.

Other factors beyond speed and volume which affect facility selection include the presence and volume of heavy trucks in the traffic mix, the presence of on-street parking, intersection density, surrounding land use, topography, user needs (bicyclists commuting on a highway versus middle-school students riding to school on a residential street), and roadway sight distance. While these factors are not included in the facility selection matrix, they should be considered and weighed in the facility selection and design process.

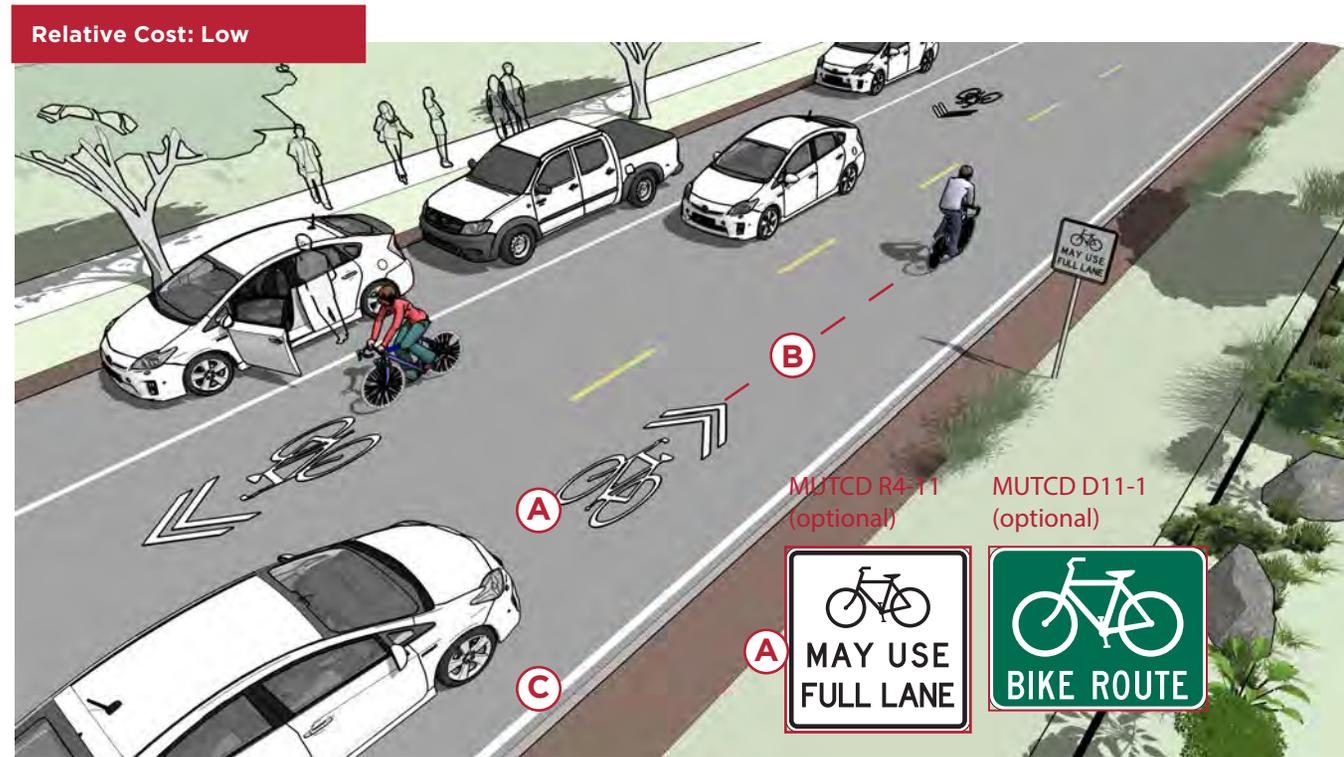




## BIKEWAY FACILITIES

## MARKED SHARED ROADWAYS

Marked shared roadways use shared lane markings, also known as “sharrows”, to designate a shared travel lane. Shared lane markings are used to encourage bicycle travel and proper positioning within the lane and to remind motorists of the potential presence of bicycles. These markings can be paired with “Bike May Use Full Lane” signs.



### Typical Application

- For use on low speed, low volume roadways where an on-street bike lane is not needed. Low-volume is context sensitive based on adjacent land-use characteristics.
- Or for use as an interim measure where an on-street bike lane or separated bikeway is preferred, but is a longer term planning project.
- Most useful on roadways with a speed limit of 30 mph or less (NACTO 2012). Shared lane markings may be used on streets up to 35 mph.
- To fill a gap in an otherwise continuous bike path or bike lane.
- To improve the lifespan of the shared lane marking, considering an epoxy or thermoplastic application.

### Design Features

- A** Shared lane markings (SLM) should be placed immediately after an intersection (MUTCD 9C.07.06) and at intervals of every 50 to 100 feet on busy streets and up to every 250 feet on low traffic bicycle routes (NACTO 2012).
- B** Although MUTCD allows the minimum distance from the curb to be 11 feet when parking is present or 4 feet from the curb when no parking is present, SLM's should be placed in the center. (Per MUTCD, the minimum distance from curb is 11 ft from curb face when parking is present, 4 ft from curb face where no parking is present.)
- C** When SLM's are placed in the center of the travel lane **and** the lane is 12' - 15' in width, an edge line should be placed 1' - 4' from edge of pavement to define an 11' wide travel lane.

## Shared Lane Markings



Sharrows can be used on higher-traffic streets as positional guidance and raise bicycle awareness where there isn't space to accommodate a full-width bike lane.

## Bicycle Boulevards



"Bicycle boulevards" or "neighborhood greenways" are a special type of shared roadway with intentionally low motor vehicle volumes and speeds.

### Further Considerations

Signs should be used to support the marked shared roadway facility. Appropriate signs include Bike Route (D11-1) or Bicycles May Use Full Lane (R4-11).

- Bicycles may use Full Lane (R4-11) signs may be used to inform road users that bicyclists might occupy the travel lane. This sign may be used with SLM's where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side.
- Bike Route (D11-1) signs may be used with bikeways to inform bicyclists of bicycle route confirmation.

Shared lane markings on busy streets should be considered an interim measure until more appropriate on-street bike lanes or sidepaths can be constructed. SLM's can be used as a wayfinding element to fill gaps in a bike lane network and/or to provide a transition between a designated bike lane and portion of roadway where bike lanes may not be warranted.

### References

Placement of shared lane marking in the center of the travel lane will prevent wear and reduce maintenance needs.

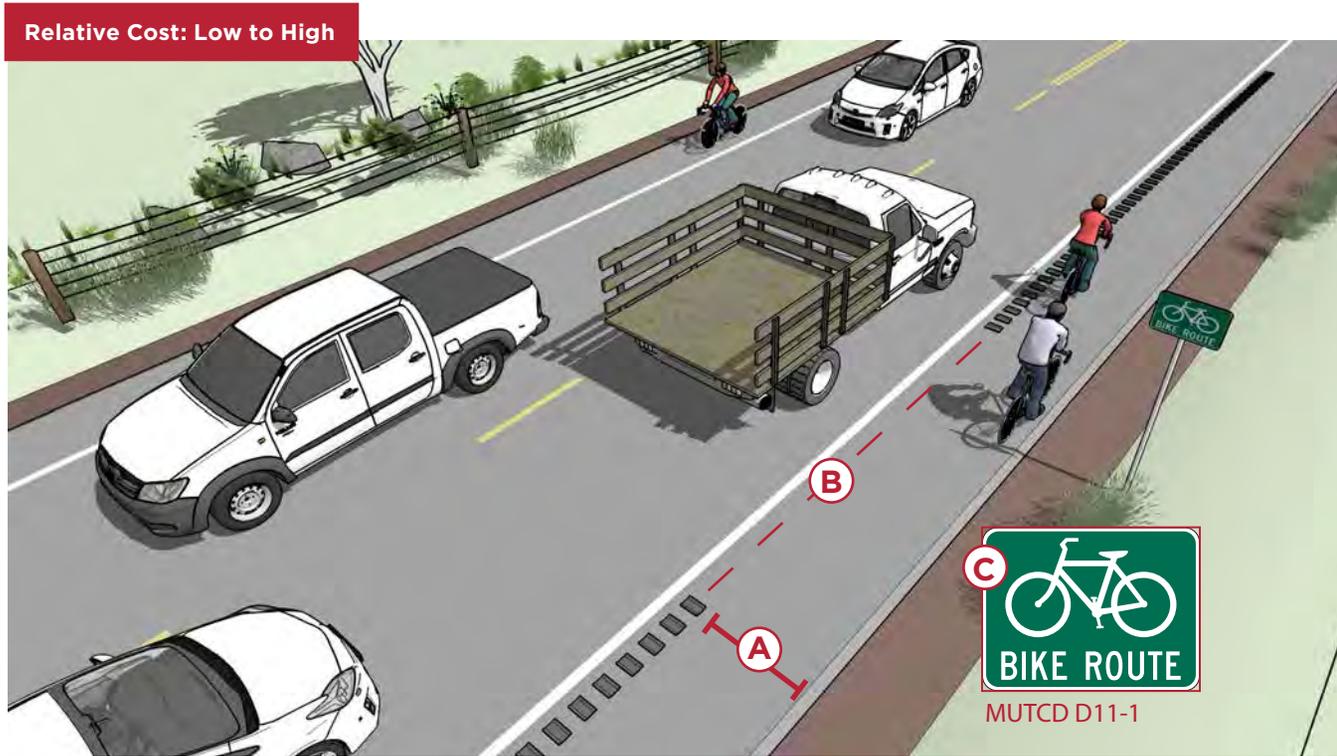
### References

- AASHTO. Guide for the Development of Bicycle Facilities. 2012.
- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- NACTO. Urban Bikeway Design Guide. 2012.

BIKEWAY FACILITIES

# BICYCLE-ACCESSIBLE SHOULDERS

Typically found in less-dense areas, shoulder bikeways are paved, striped shoulders (4' min.) wide enough for bicycle travel. Shoulder bikeways may include signs alerting motorists to expect bicycle travel along the roadway.



**Typical Application**

- Located in more rural environments where there are no curbs or gutters.
- Suitable for roadways with higher speeds and lower bicycle volumes.
- Shoulder bikeways should be considered a temporary treatment, with full bike lanes planned for construction if the roadway is widened or completed with curb and gutter.

**Design Features**

- A** A minimum of 4 feet of rideable surface should be available for bicycle travel, (AASHTO 2012) which does not include the < 1' area closest to the roadway edge where sand and debris accumulate.
- B** Rumble strips are not recommended on shoulders used by bicyclists unless there is a minimum 4 foot clear path. 12 foot gaps every 40-60 feet should be provided to allow access as needed.
- C** MUTCD D11-1 "Bike Route" wayfinding signage is optional.

## Bicycle-Accessible Shoulders



This shoulder provides 6 ft of clear width to allow for safe bicycling on a higher-speed, higher-volume roadway. (Note the bicyclist is riding away from the edge of the roadway where road sand and other debris can accumulate.)

### Further Considerations

- If it is not possible to meet minimum bicycle lane dimensions, a reduced width paved shoulder can still improve conditions for bicyclists on constrained roadways; travel lane widths of 11' or less should be considered to maximize the width of the shoulder.
- If a shoulder width of 4 ft or more is consistently available for bicycle travel along the length of a corridor, the full bike lane treatment of signs, legends, and a 6"- 8" bike lane line should be provided.
- This type of treatment is not typical in urban areas and should only be used where constraints exist.

### Maintenance

Shoulder bikeways should be cleared of snow through routine snow removal operations and sand and other debris through street sweeping.

### References

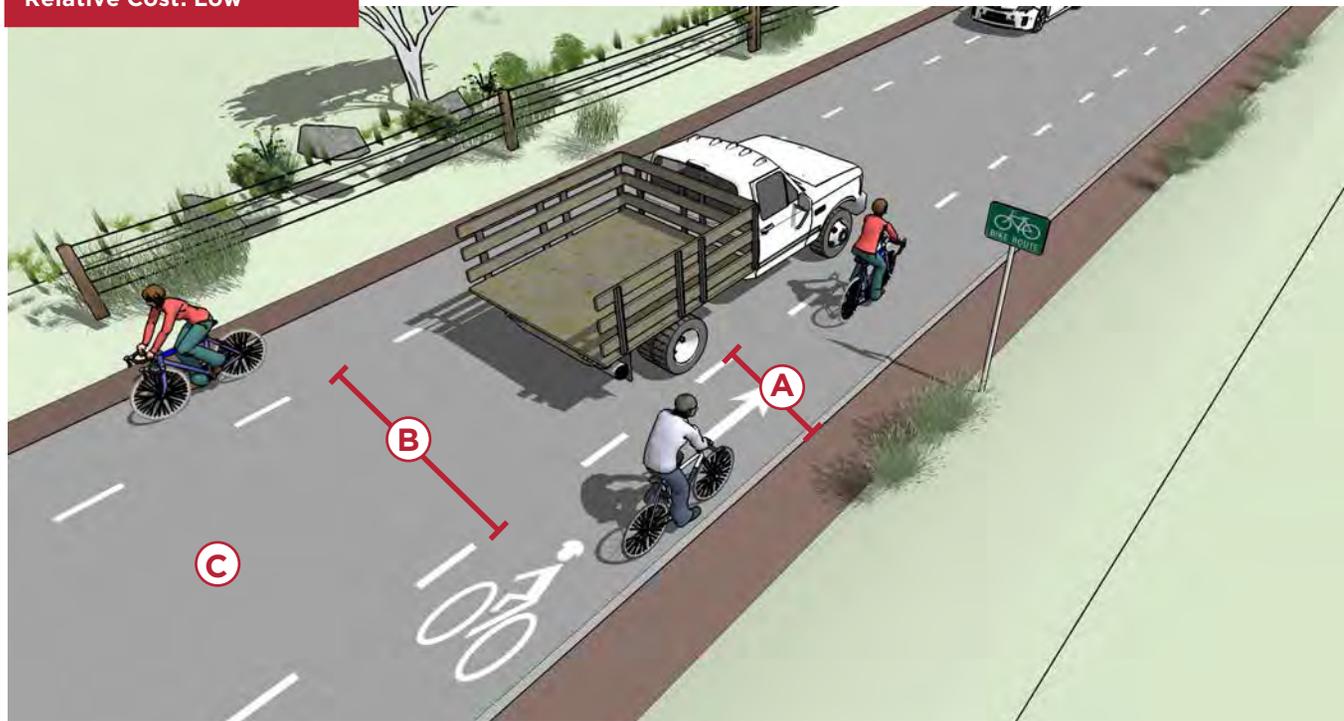
- AASHTO. Guide for the Development of Bicycle Facilities. 2012.
- FHWA. Manual on Uniform Traffic Control Devices. 2009.

BIKEWAY FACILITIES

# ADVISORY BIKE LANES

Advisory bike lanes are bicycle priority areas delineated by broken white lines, separate from a center one-lane two-way travel area. Motorists may only enter the bicycle zone when no bicycles are present. Motorists must overtake bicyclists with caution due to potential oncoming traffic.

Relative Cost: Low



### Typical Application

- Most appropriate on urban and rural streets where motor vehicle traffic volumes are low-moderate (1,500-4,500 ADT), and where there is insufficient room for conventional bicycle lanes.
- If on-street parking is present, parking lanes should be highly utilized or occupied with curb extensions to separate the parking lane from the advisory bike lane.
- This treatment may be appropriate on roadways with low volumes if the road is straight with few bends, inclines or sightline obstructions.

### Design Features

- Ⓐ Advisory bike lane width of 6 ft, 5 ft minimum.
- Ⓑ The automobile zone should be configured narrowly enough so that two cars cannot pass each other in both directions without crossing the advisory lane line. Minimum 2-way motor vehicle travel lane width of 16 ft.
- Ⓒ No centerline on roadway.

### Advisory Bicycle Lane



Advisory bicycle lanes provide dedicated space for bicycles on streets that lack the room for conventional bicycle lanes in both urban contexts with on-street parking and curbs and rural contexts...

### Advisory Bicycle Lane



Photo: Danny Kim, thedartmouth.com

...as well as more rural streets without either.

#### Further Considerations

- This treatment is under experimentation with FHWA, called “dashed bicycle lanes” (FHWA 2016). On federally funded projects, new designs, devices, or applications not covered in or not in compliance with the MUTCD should seek approval for experimentation and study. Section 1A.10 of the MUTCD describes the process of submitting a Request to Experiment. This involves approval by FHWA and followup evaluation and communication as to a treatment’s effectiveness.
- Consider the use of colored pavement within the bicycle priority area to discourage unnecessary encroachment by motorists or parked vehicles.
- It is important to consider the needs of various road users when implementing an advisory bike lane. Required passing widths for truck or emergency vehicles should be considered on routes where such vehicles are anticipated.
- **Because of the experimental nature of advisory bike lanes, any installation should be accompanied by a robust public education campaign and temporary / permanent signage so there is clarity related to expected behavior by motorists and bicyclists.**

#### Maintenance

Bicycle lanes should be cleared of snow through routine snow removal operations.

#### References

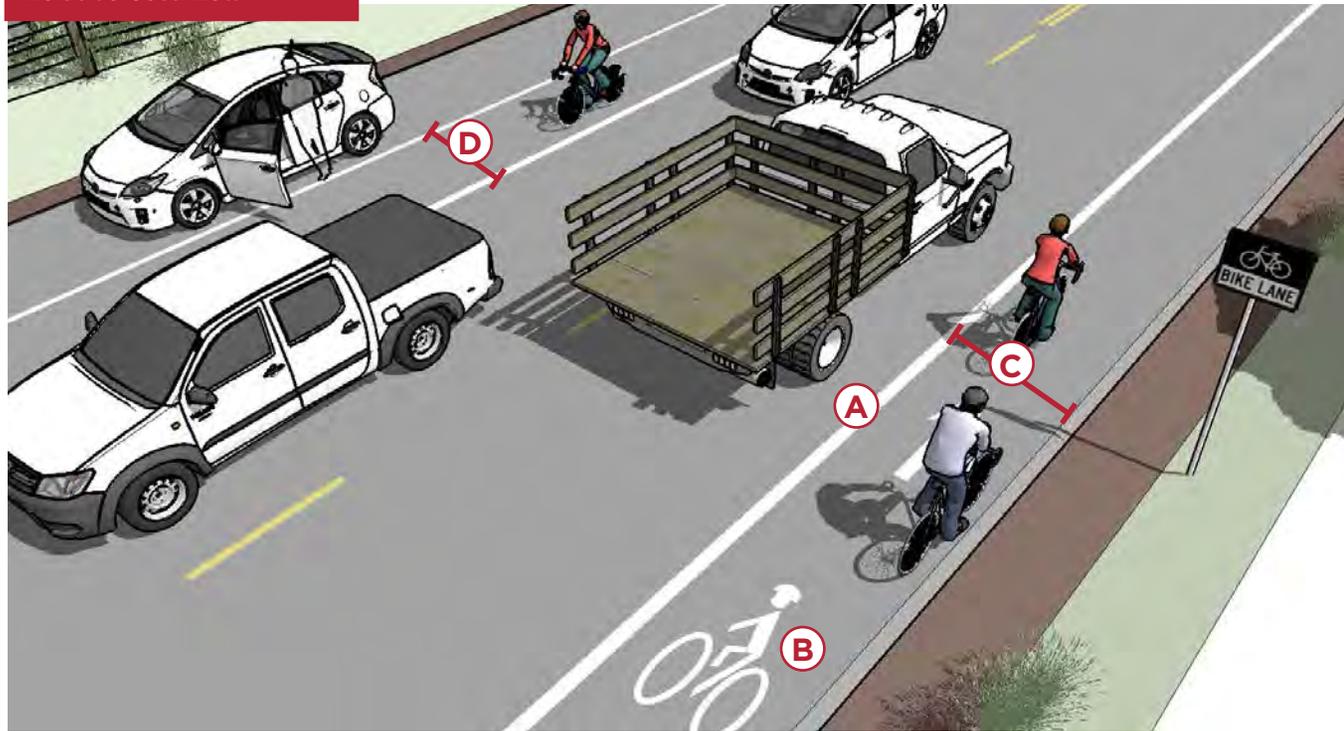
FHWA Bicycle and Pedestrian Program. Dashed Bicycle Lanes. Accessed 2016. [https://www.fhwa.dot.gov/environment/bicycle\\_pedestrian/guidance/mutcd/dashed\\_bike\\_lanes.cfm](https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/mutcd/dashed_bike_lanes.cfm)

BIKEWAY FACILITIES

# ON-STREET BIKE LANES

On-street bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signs. Bike lanes are located directly adjacent to motor vehicle travel lanes and travel in the same direction as motor vehicle traffic.

Relative Cost: Low



### Typical Application

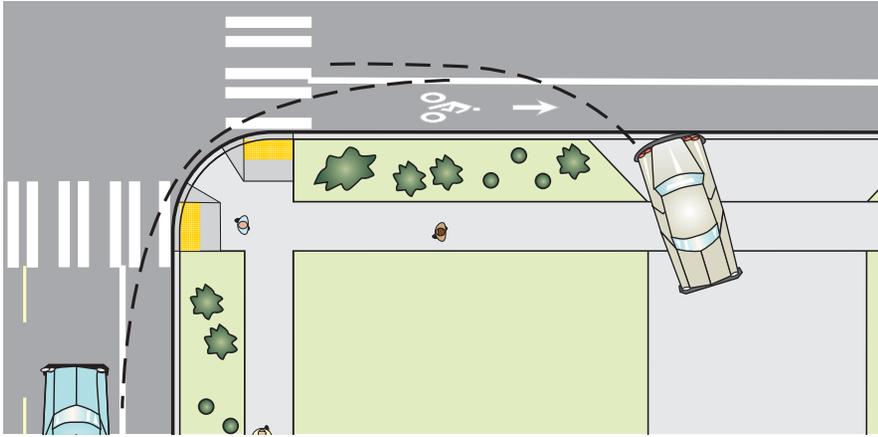
- Bike lanes may be used on any street with adequate space, but are most effective on streets with moderate traffic volumes  $\geq 6,000$  ADT ( $\geq 3,000$  preferred).
- Bike lanes are most appropriate on streets with moderate speeds of 25 - 35 mph.
- Appropriate for moderately-skilled adult riders on most streets.
- May be appropriate for casual users when configured as 6+ ft wide lanes on lower-speed, lower-volume streets with one travel lane in each direction.

### Design Features

- (A)** Mark travel side line with 6" stripe. (MUTCD 9C.04) Parking lane lines or the "T's" that demarcate individual parking stalls can be 4" in width.
- (B)** Include a bicycle lane marking (MUTCD Figure 9C-3) at the beginning of blocks and at regular intervals along the route. (MUTCD 9C.04)
- (C)** 5 foot width adjacent to road edge. (4 foot min. if paved shoulder) (AASHTO 2012)
- (D)** 6 foot width adjacent to on-street parking, (5 foot min.) (AASHTO 2012)

\* There is no standard for parking Ts, and jurisdictions have much flexibility. MUTCD 3B.19 (p. 386) illustrates various parking space markings, including a type of "T" design.

### Place Bike Lane Symbols to Reduce Wear



Bike lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed outside of the motor vehicle tread path in order to minimize wear from the motor vehicle path.

### Separated Bike Lanes

As traffic intensity increases in the form of increased speeds, volumes and number of roadway lanes, so does the desire for increased separation between motor vehicles and bicyclists.

Separated bicycle lanes are on-street bikeway facilities that are physically separated from vehicle traffic by a vertical element. This is seen as highly desirable from a safety point of view and to encourage beginner bicyclists and families. Guidance on the development of this facility type can be found in:

MassDOT Separated Bike Lane Planning and Design Guide (2015).

FHWA Separated Bike Lane Planning and Design Guide (2015).

### Further Considerations

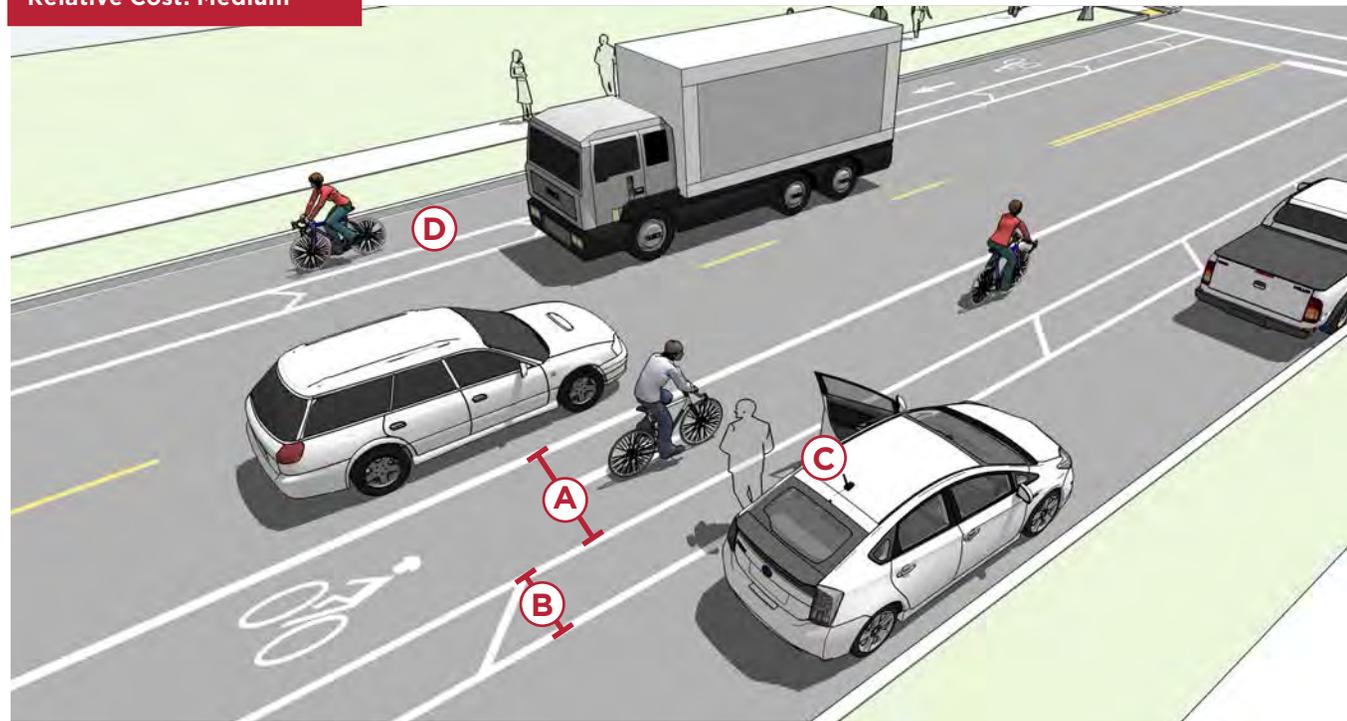
- On streets where bicyclists passing each other is to be expected, where high volumes of bicyclists are present, or where added comfort is desired, consider providing extra wide bike lanes up to 7 feet wide, or configure as a buffered bicycle lane.
- On high speed streets ( $\geq 40$  mph) or multi-lane streets, a physically separated bike lane or sidepath is preferred for user comfort.
- There are many strategies available to implement bicycle lanes into roadway resurfacing projects, including road widening, lane narrowing, travel lane reconfiguration and parking lane reconfiguration (FHWA 2015).
- Narrow parking lane widths as low as 7 ft increase operating space for bicyclists. Reduced width parking lanes should be combined with increased width bicycle lanes. (Furth, 2010).
- For the appropriate interface between the variety of bike lane treatments at bus stops, see the AASHTO Guide to Development of Bicycle Facilities or the NACTO Urban Bikeway Design Guide.

## BIKEWAY FACILITIES

## BUFFERED BIKE LANES

Buffered bike lanes are conventional bicycle lanes paired with a designated striped buffer space, between the bicycle lane and adjacent motor vehicle travel lane and/or parking lane. For enhanced safety and access for bicyclists, see “Separated Bike Lanes” on previous page.

Relative Cost: Medium



### Typical Application

- Anywhere a conventional bike lane is being considered and where additional roadway space exists.
- On streets with high speeds and high volumes or high truck volumes.
- On streets with high rate of parking turnover.
- On streets with extra lanes or lane width.
- Appropriate for skilled adult riders on most streets.

### Design Features

- (A)** The minimum bicycle travel area (not including buffer) is 5 feet wide.
- (B)** Buffers should be at least 2 feet wide. If buffer area is 4 feet or wider, white chevron or diagonal markings should be used. (FHWA 2009)

  - Mark the inside buffer line as a dotted line across driveways or minor street crossings for user clarity.
- (C) Parking Side Buffer:** For use adjacent to on-street parking in commercial districts with high parking turnover. (NACTO 2012).
- (D) Travel Side Buffer:** For use adjacent to high-speed, high-volume traffic lanes.

### Buffered Bicycle Lane



The use of bold, clear pavement markings delineates space for cyclists to ride in a comfortable facility.

### Parking Side Buffer



A 2 foot buffer between the bike lane and the parking lane decreases the likelihood that bicyclists will be impeded by open car doors of parked vehicles.

#### Further Considerations

- A study of buffered bicycle lanes found that, in order to make the facilities successful, there needs to also be driver education, improved signage and proper pavement markings. (Dill, 2011)
- On multi-lane streets with high vehicles speeds, the most appropriate bicycle facility to provide for user comfort may be physically separated bike lanes.
- NCHRP Report #766 recommends, when space is limited, installing a buffer space between the parking lane and bicycle lane where on-street parking is permitted rather than between the bicycle lane and vehicle travel lane. (NCHRP 2016)

#### Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

#### References

- FHWA. Manual on Uniform Traffic Control Devices. 2009.  
 NACTO. Urban Bikeway Design Guide. 2012.
- Dill, J., Monsere, C.; and McNeil, N.; Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track and SW Stark/Oak Street Buffered Bike Lanes. 2011.
- National Cooperative Highway Research Program (NCHRP). Report #766: Recommended Bicycle Lane Widths for Various Roadway Characteristics. 2016.

## BIKE LANES AT INTERSECTIONS

Design strategies for bicycle lanes at intersections emphasize reducing speeds, minimizing exposure, raising awareness, and communicating right-of-way priority.

Relative Cost: Low to Medium



### Typical Application

- A variety of design treatments exist depending on the roadway configuration, available curb-to-curb width, traffic volumes and desire to provide a dedicated turn lane.

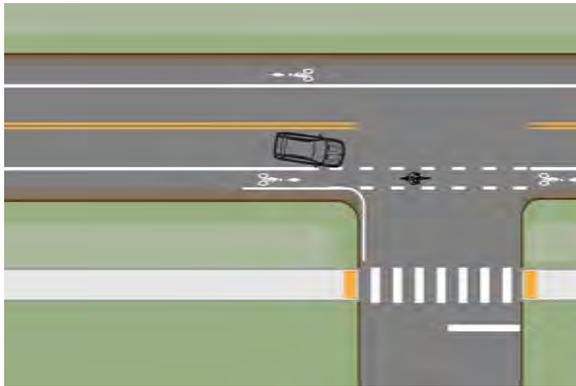


Bike boxes at intersections and green dashed bike lanes through intersections help increase visibility of bicyclists

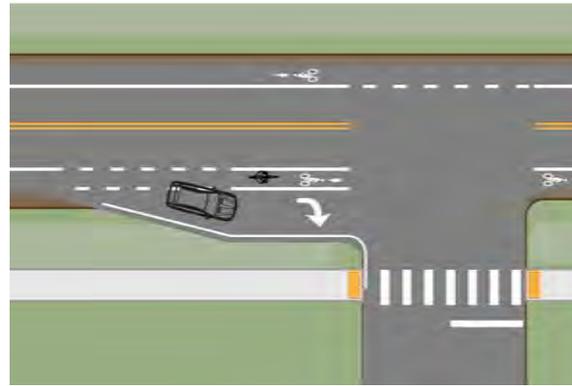
### Design Features

Potential bicycle lane intersection treatments include:

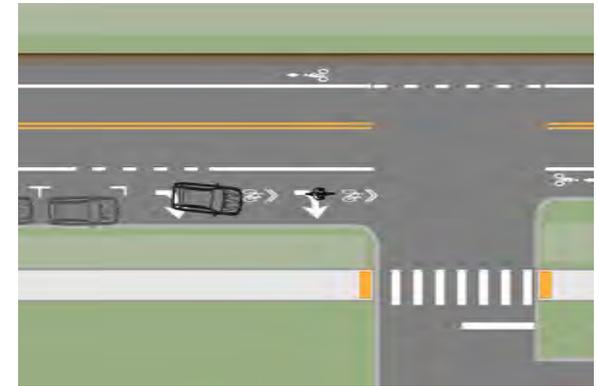
- Intersection crossing markings (see next page)
- Combined bike lane/turn lane (see next page)
- Bike Box (at left)
- Solid or dashed green colored bicycle lanes (at left)
- Exclusive bicycle signal phase

**Intersection Crossing Markings**

Dotted bike lane line extensions through intersections can guide bicyclists and alert motorists to the bike lane path. (FHWA 2009)

**Through Bike Lane**

At intersections with increased right turn volume, an added right turn lane to the right of a bike lane allows users to negotiate potential conflicts before the intersection. (FHWA 2009)

**Combined Bike Lane/Turn Lane**

Where there isn't room to provide both a through bike lane and right turn only lane, a combined bike lane/turn lane creates a shared-lane condition in advance of the intersection. (NACTO 2012)

**Further Considerations**

- Under most conditions, bicyclist have priority over turning traffic. Traffic control markings and signs should support this priority and remind motorists of the obligation to yield.
- Begin Right Turn Lane Yield to Bikes (R4-4) sign reminds motorists to yield to bicyclists in advance of added right turn lanes.
- Where special emphasis is desired, green pavement color (using either water based roadway paint, epoxy or thermoplastic) may be used within bike lanes and at merging or weaving areas where motor vehicles may cross bike lanes. See FHWA Interim Approval 14 (FHWA 2011) for more information.
- At signalized intersections with very high right turn volumes or multiple right-turn-only lanes, a bicycle signal face and protected bicycle signal phase can remove conflicts entirely. See FHWA Interim Approval 16 (FHWA 2013) for more information.

**Maintenance**

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

**References**

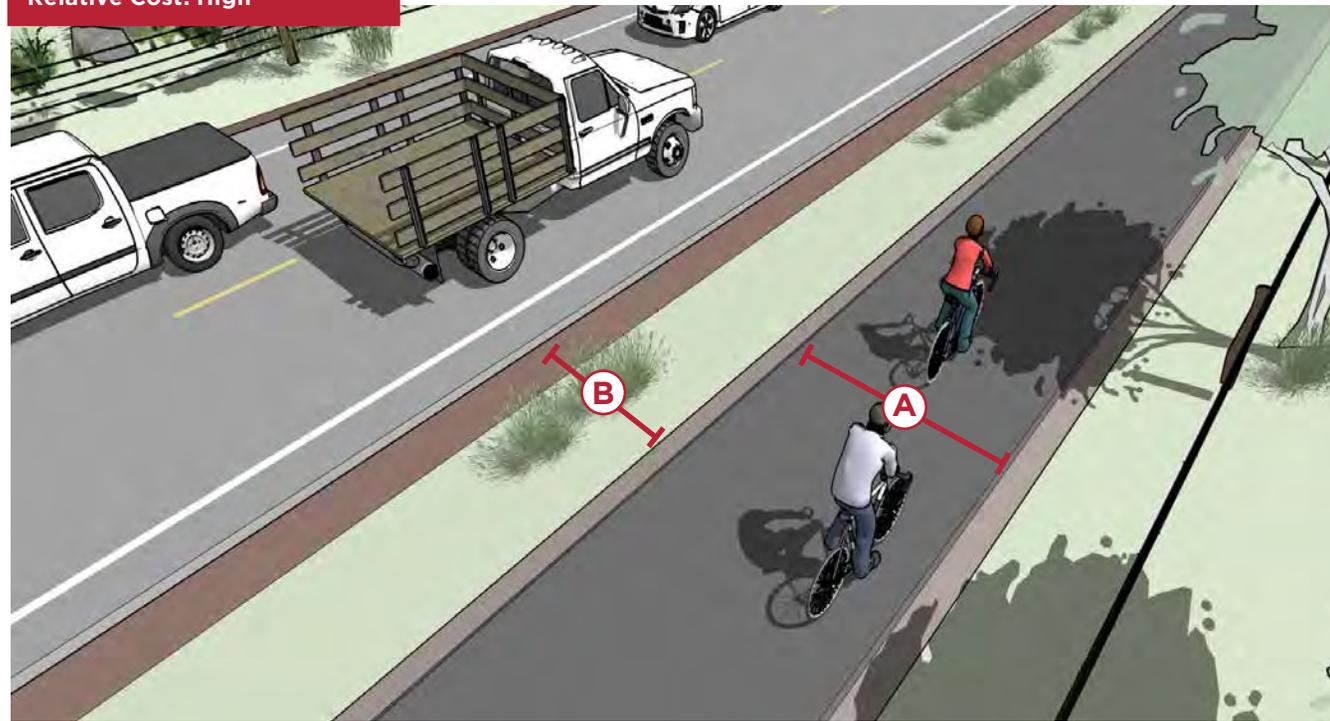
- AASHTO. Guide for the Development of Bicycle Facilities. 2012.
- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- FHWA. Interim Approval for Optional Use of Green Colored Pavement for Bike Lanes (IA-14). 2011.
- FHWA. Interim Approval for Optional Use of a Bicycle Signal Face (IA-16). 2013.
- NACTO. Urban Bikeway Design Guide. 2012.

## BIKEWAY FACILITIES

**SIDEPATHS**

A sidepath is a bidirectional shared use path located immediately adjacent and parallel to a roadway. Sidepaths can offer a high-quality experience for users of all ages and abilities as compared to on-roadway facilities in heavy traffic environments, allow for reduced roadway crossing distances and maintain community character.

Relative Cost: High

**Typical Application**

- For completing networks where existing roads provide the only corridors available.
- To connect sections of independent paths or low-stress local routes such as shared use paths and bicycle boulevards.
- Work best on roadways with high operating speeds and high motor vehicle volumes.

**Design Features**

- Ⓐ Preferred minimum pathway width is 10 ft. In low volume situations, 8 ft minimum may be adequate.
- Ⓑ Preferred minimum roadways separation width is 6.5 ft, with an absolute minimum separation width of 5 ft. Minimum dimension separation is only appropriate on low speed roadways. (AASHTO 2012)
  - Separation narrower than 5 feet is not recommended, but may be accommodated with the use of a physical barrier between the sidepath and the roadway. (AASHTO Bike Guide, 2012, pp. 5-11).
  - See MassDOT 2006 Project Development and Design Guide, section 11.4 for additional guidance.

## Sidepath



Sidepaths typically provide a more comfortable bicycle facility than on-road bikeways, especially for less experienced riders or children.

### Further Considerations

- In extremely constrained conditions, and for short distances, rumble strips and painted buffer striping may be used to separate the pathway from the roadway.
- Depending on community character and surrounding environmental context, use of stonedust (sometimes called crushed limestone) for the sidepath may be preferred.
- Sidepath design needs to carefully consider roadway and driveway crossing to ensure safety through high visibility, warning signage and appropriate offset of the sidepath from the adjacent roadway.

### Maintenance

Asphalt is the most common surface for bicycle paths. The use of concrete for paths has proven to be more durable over the long term. Saw cut concrete joints, rather than troweled, improve the experience of path users.

### References

- AASHTO. Guide for the Development of Bicycle Facilities. 2012.
- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- FHWA. Separated Bike Lane Planning and Design Guide. 2012.
- MassDOT. Project Development and Design Guide, Ch 11. 2006.
- NACTO. Urban Bikeway Design Guide. 2012.

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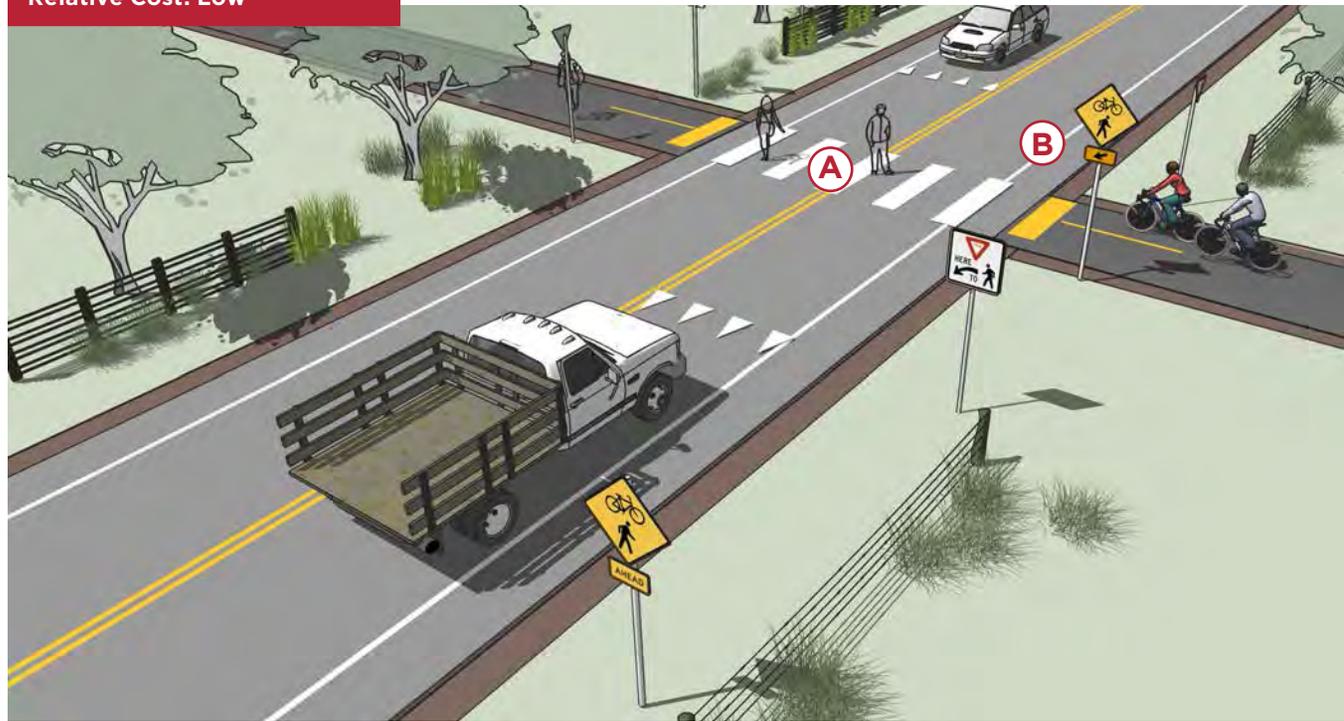
# SHARED USE PATH CROSSINGS



## BASIC PATH CROSSINGS

At non intersection areas, markings must be used to establish a legal crosswalk. Well-designed midblock crossings can provide many safety benefits to path user safety and comfort.

Relative Cost: Low



### Typical Application

- Where shared use paths intersect with collector or minor arterial streets.
- Path crossings should not be provided within approximately 400 feet of an existing signalized intersection. If possible, route path directly to the signal.

### Design Features

- Ⓐ Crosswalk markings legally establish midblock shared use path crossing. (FHWA 2009)
- Ⓑ Crossing assemblies draw attention to the crossing
  - Where feasible, traffic calming features such as speed humps in advance of the crossing, or a raised crossing, or median islands may be integrated into the crossing to improve yielding by motorists.

### Basic Path Crossing



This path crossing includes many enhancements to slow traffic and promote yielding.

### Basic Path Crossing



Along pathways with high volumes of users, and at path crossings in built up areas with crosswalks, path crossings should provide adequate room for path users to wait outside of the path of crossing sidewalks.

#### Further Considerations

- High-visibility crosswalk markings are the preferred marking type at uncontrolled marked crossings. (FHWA 2013)
- On roadways with high speed and high volumes of motor vehicles, crosswalk markings alone are often not a viable safety measure. This should not discourage the implementation of crosswalks, but should rather support the creation of more robust crossing solutions. (Zeeger 2005)
- Rectangular Rapid Flash Beacons (RRFB's) can "enhance safety by reducing crashes between vehicles and pedestrians at unsignalized intersections and mid-block pedestrian crossings by increasing driver awareness of potential pedestrian conflicts."

#### Maintenance

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority. Thermoplastic markings offer increased durability over conventional paint.

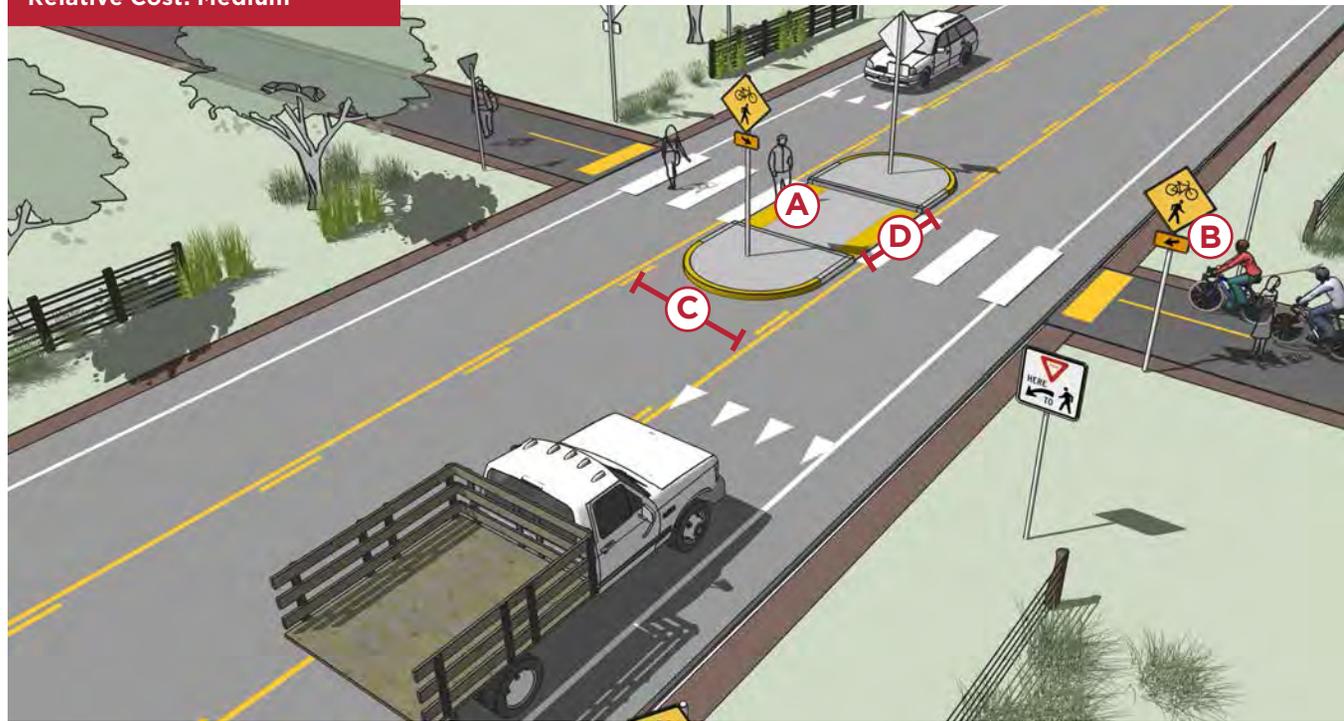
#### References

- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- FHWA. An Overview and Recommendations of High-Visibility Crosswalk Markings Styles. 2013.
- MassDOT. Project Development and Design Guide. Ch 11. 2006.
- Zeeger, C., J. Stewart, and H. Huang. Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations. 2005.

## MEDIAN CROSSINGS

Median safety islands are located at the mid-point of a marked crossing and help improve path user safety by allowing pedestrians to cross one direction of traffic at a time. Safety islands minimize pedestrian exposure by shortening crossing distance and increasing the number of available gaps for crossing.

Relative Cost: Medium



### Typical Application

- Can be applied on any roadway with a left turn center lane or median that is at least 8' wide, or where wide traffic lanes and/or shoulders can be narrowed enough to provide at least 8' of space for the crossing island.
- May be appropriate on multi-lane roadways depending on speeds and volumes. Consider configuration with active warning beacons for improved yielding compliance.
- Appropriate at signalized or unsignalized crosswalks. Where unsignalized, refuge areas are recommended when pedestrians cross two or more through traffic lanes in one direction.

### Design Features

- A** The island must be accessible, preferably with at-grade passage through the island rather than ramps and landings. Detectable warning surfaces must be full-width and 2 ft deep to warn blind pedestrians.
- B** Pair MUTCD W11-15 and W16-7P crossing sign assembly.
- C** Requires 8' width between travel lanes and 20 ft length (40' preferred). (AASHTO 2012)
- D** The path through the median should be the same width of the crosswalk. Minimum clear width of 4 ft required.

### Path Crossing with Safety Island



This trail crossing combines a median safety island with raised crosswalk.



Side mounted rectangular rapid flashing beacon installation with median safety island.

#### Further Considerations

- Unsignalized crossings of multi-lane arterials over 15,000 ADT may be possible with features such as sufficient crossing gaps (more than 60 per hour), median refuges, and/or active warning devices like rectangular rapid flash beacons or in-pavement flashers, and excellent sight distance. (FHWA 2009)
- If a refuge island is landscaped, the landscaping should not compromise the visibility of pedestrians crossing in the crosswalk. Shrubs and ground plantings should be no higher than 1 ft 6 in.
- On multi-lane roadways, consider configuration with active warning beacons for improved yielding compliance.

#### Maintenance

Refuge islands may collect road debris and may require somewhat frequent maintenance. Trees and plantings must be maintained so as not to impair visibility. Refuge islands should be visible to snow plow crews and should be kept free of snow berms that block access.

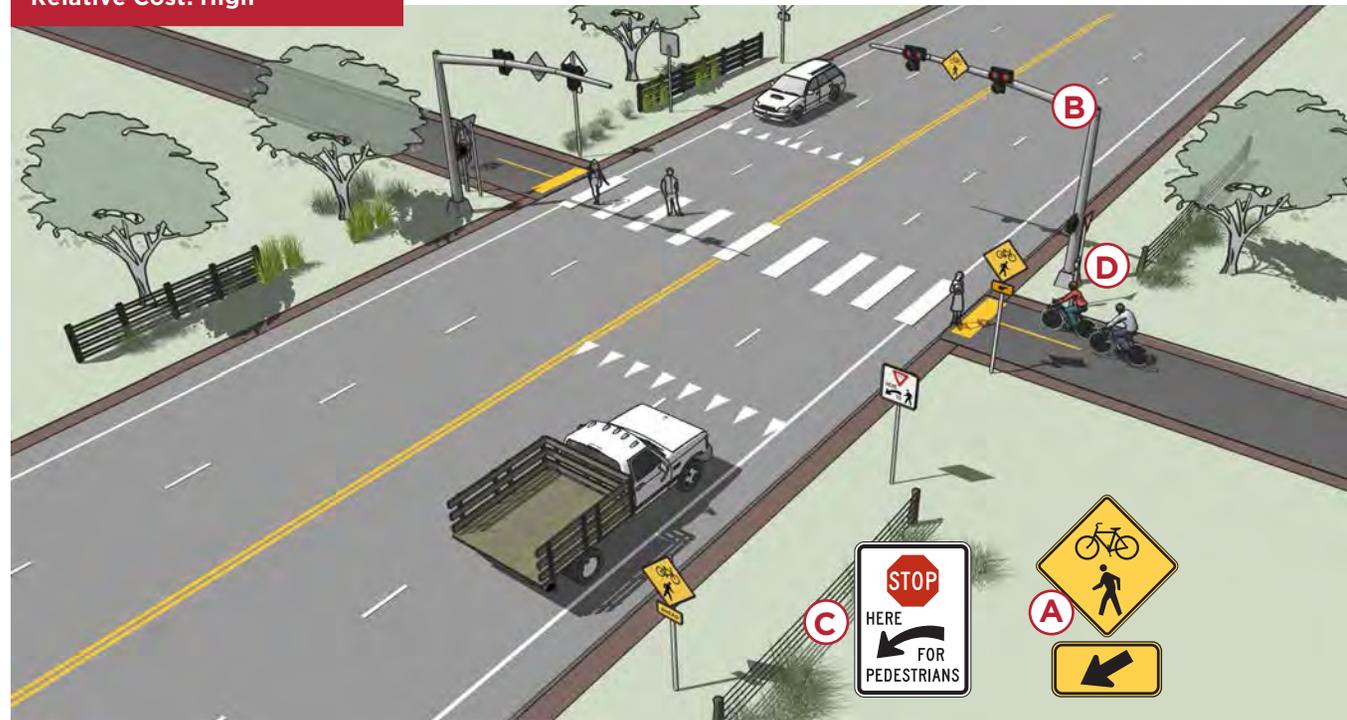
#### References

- AASHTO. Guide for the Development of Bicycle Facilities. 2012.
- FHWA. Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11). 2008.
- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- MassDOT. Project Development and Design Guide. Ch 11. 2006.

## ACTIVE ENHANCED CROSSINGS

Active enhanced crossings feature user-actuated warning beacons to increase motor vehicle yielding compliance at crossings of multi lane or high volume roadways. Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or Rectangular Rapid Flash Beacons (RRFB) or pedestrian hybrid beacons.

Relative Cost: High



### Typical Application

- Located at high-volume pedestrian crossings, or at priority bicycle route crossings, including shared-use paths.
- Implemented at mid-block locations or at intersections where signals are not warranted or desired.
- Where driver yield compliance at shared use path crossings is low.

### Design Features

- (A) Includes MUTCD W11-15 and W16-7P signage.
- (B) Providing multi-beacon installations on mast arms or center islands improves driver yielding behavior
- (C) Painted yield line markings with MUTCD R1-5 signage at yield location.
- (D) Pushbuttons should be easy to identify and access and be user-responsive.



On multilane streets, overhead and multiple beacon installations are critical for awareness by motorists in all approach lanes.



A Pedestrian Hybrid Beacon (PHB) (approved for installation by MassDOT) can provide a more effective means to stop vehicles on multi-lane streets than RRFB. This is also known as a Pedestrian HAWK signal.

### Further Considerations

- Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity and safety.
- A pedestrian hybrid beacon is an actuated warning device which uses red signal indications and a noticeable wig-wag pattern to achieve high yielding rates at crosswalk.
- A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88 percent. Additional studies over long term installations show little to no decrease in yielding behavior over time.

### Maintenance

Depending on power supply, maintenance can be minimal. If solar power is used, active warning beacons can run for years without issue.

RRFBs should be regularly maintained to ensure that all lights and detection hardware are functional.

### References

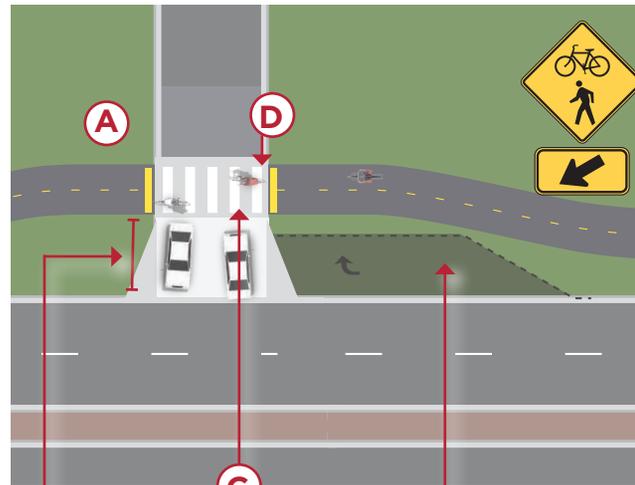
- NACTO. Urban Bikeway Design Guide. 2012.
- FHWA. Manual on Uniform Traffic Control Devices. 2009.
- FHWA. MUTCD - Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11). 2008.
- MassDOT. Project Development and Design Guide. Ch 11. 2006.

## SIDEPATH CROSSINGS

Sidepaths provide a high degree of comfort on long uninterrupted roadway segments, but have operational and safety concerns at driveways and intersections with secondary streets. Crossings should be designed to promote awareness, and facilitate proper yielding of motorists to bicyclists and pedestrians.

Relative Cost: Medium

### High Speed Conditions

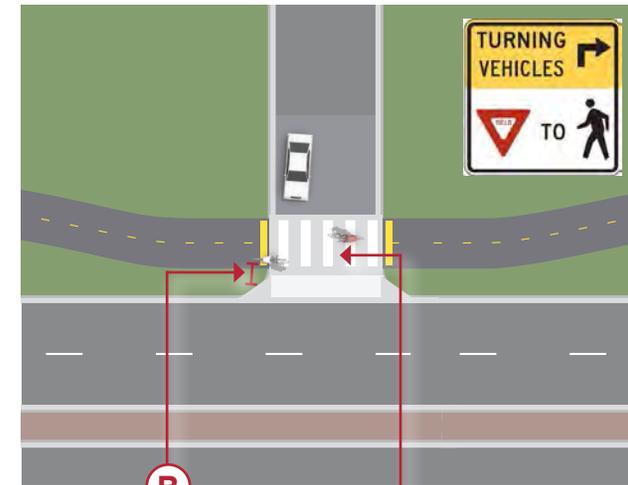


25 ft separation from roadway

Bikeway is flat and level along crossing

Optional right turn deceleration lane.

### Low/Intermediate Speed Conditions



6.5 ft minimum separation from roadway

Bikeway is flat and level along crossing

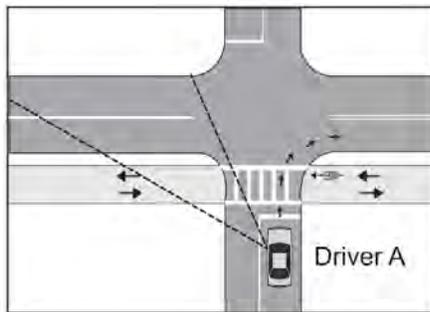
### Typical Application

- At controlled and uncontrolled sidepath crossings of driveways or minor streets.
- Used to provide for visibility and awareness of the crossing by motorist in advance of the crossing.
- Increases the predictability of sidepath and road user behavior through clear, unambiguous right of way priority.

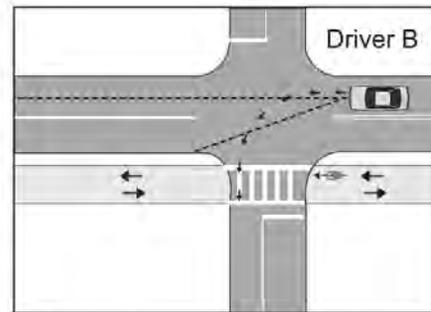
### Design Features

- (A) The sidepath should be given the same priority as the parallel roadway at all crossings.
- (A) Provide clear sight triangles for all approaches of the crossing.
- (B) Maintain physical separation to the crossing of 6.5 to 25 ft. (Scheppers 2011). As speeds on the parallel roadway increase, so does the preference for wider separation distance. (FDOT 2005).
- (C) Configure crossings with raised speed table and median safety island
- (D) Use high visibility crosswalk markings to indicate the through area of the crosswalk.

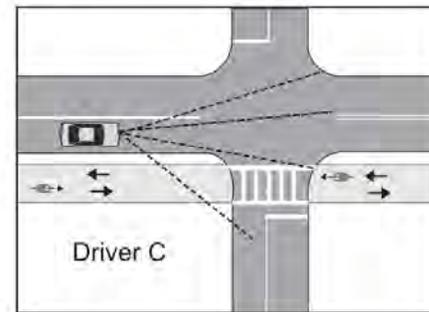
**Potential conflicts along sidepath crossings of side streets or driveways include the following (AASHTO 2012):**



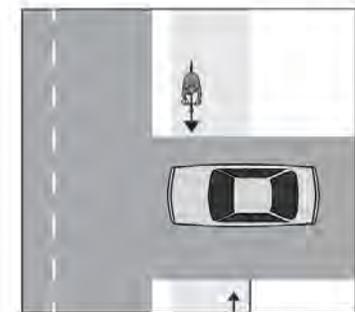
Right turning Driver A is looking for traffic on the left. A contraflow bicyclist is not in the driver's main field of vision.



Left turning Driver B is looking for traffic ahead. A contraflow bicyclist is not in the driver's main field of vision.



Right turning Driver C is looking for left turning traffic on the main road and traffic on the minor road. A bicyclist riding with traffic is not in the driver's main field of vision.



Stopped motor vehicles on side streets or driveways may block the path.

### Further Considerations

- Sidepaths running for long distances in suburban areas with many driveways or street crossings can create operational concerns. See the figure above for potential conflicts associated with sidepath crossings. (AASHTO 2012)
- Along roadways, these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in wrong-way riding where bicyclists enter or leave the path.
- The provision of a shared use path adjacent to a road is not a substitute for the provision of on-road accommodation such as paved shoulders or bike lanes, but may be considered in some locations in addition to on-road bicycle facilities.
- To reduce potential conflicts in some situations, it may be better to place one-way sidepaths on both sides of the street. (AASHTO 2012)

### Maintenance

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority. Thermoplastic or epoxy markings offer increased durability over conventional paint.

### References

- AASHTO. Guide for the Development of Bicycle Facilities. 2012.
- Schepers et al. Road factors and bicycle—motor vehicle crashes at unsignalized priority intersections. *Accident Analysis & Prevention*. Volume 43, Issue 2, 2011.
- Florida Department of Transportation (FDOT). Sidepath Facility Selection and Design. 2005.