CITY OF ROCKVILLE

Marked Crosswalk Guidelines

Acknowledgements

The development of this document was funded through a Regional Roadway Safety Program (RRSP) grant administered by the Metropolitan Washington Council of Governments (MWCOG). The RRSP provides short-term consultant services to member jurisdictions or agencies to assist with planning or preliminary engineering projects that address roadway safety issues.

Metropolitan Washington Council of Governments

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Marked Crosswalk Guidelines

Introduction

Intersections, marked or unmarked, are legal crosswalks in Maryland (§ 21-101). At mid-block locations, legal crosswalks are only where the road is marked. Crosswalks vary in design based on the location, road type, and usage; the designs can vary from just two white lines running parallel to each other to indicate a crossing to a raised crosswalk with beacons to bring more awareness to road users of the crossing.

This Marked Crosswalk Guidelines serves as a guide to identify when a marked crossing can be considered. The Guidelines are consistent with the Maryland MUTCD. The guidelines are not meant to provide additional guidance to engineering judgement made on a case-by-case basis.

These guidelines have several parts:

- **Marked Crosswalk Decision Flow Chart** – describes how Rockville identifies locations where crosswalks are recommended.
- **Pedestrian Demand Table** – used in conjunction with the flow chart to identify the pedestrian demand that can be used in the flow chart.
- **Crosswalk Design by Roadway Type Table** – used once the flow chart identifies a crosswalk is recommended to provide guidance broadly on the type of crosswalk that should be considered.
- **Pedestrian Crossing Toolkit** – provides more details on the different enhancements that can be implemented at crossings.

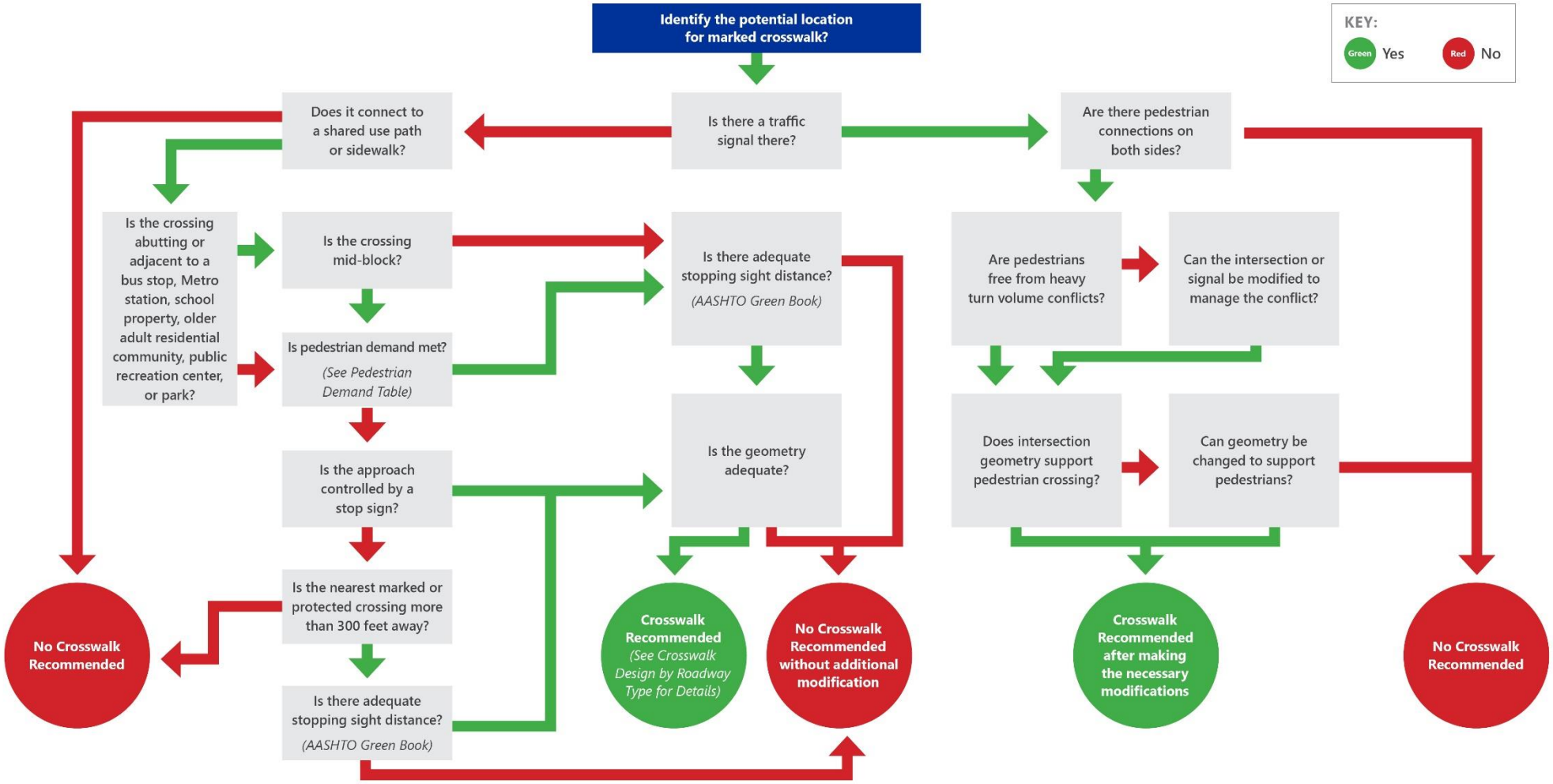
Background

These guidelines were developed after identifying best practices from Federal, State, and local governmental agencies. Many State and local governments use the Federal Highway Administration (FHWA) Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations published in 2018 and NCHRP 562 as a foundation and adjusted the guidelines to meet their needs, which is how these guidelines were developed.

Evaluating Locations

Each potential location for a marked crosswalk is to be identified and the flow chart in **Figure 1** should be used.

Figure 1: Marked Crosswalk Decision Flow Chart



To use the flow chart, start at the top and follow the arrow based on your response to the questions. For instance, the question in the box asks, "Is there a traffic signal there?" If the answer is "Yes", follow the green arrow to the next box and if it is "No" follow the red arrow to the next box. Continue until you have reached a circle; a red circle would mean a crosswalk is not recommended and a green circle would indicate a crosswalk is recommended.

Use the following definitions and instructions in the following sections for using the Marked Crosswalk Decision Flow Chart.

Identify Location

The marked crosswalk decision flow chart begins with a specific location identified. This location can be requested by a member of the public, included as part of a city capital improvement project, or the location of a recent pedestrian or bicyclist crash and recommended for enhancement through the city's Vision Zero Action Plan.

Pedestrian Connections

This concept is noted to indicate that there is a sidewalk or another connection that the pedestrian would access and not be stranded without a sidewalk or a shared use path once the approved American with Disabilities Act (ADA) compliant ramp is installed. A T-intersection with sidewalks on both sides of the intersecting streets would be considered as having a pedestrian connection on both sides.

Heavy Turn Volume Conflicts at Signalized Intersections

The left and right turn volumes that will be crossing at the intersection is to be examined to see if there is a high number of vehicles that would conflict with the pedestrians crossing the street. If there are heavy turn volumes, engineering judgment and review is needed to determine how the conflict can be managed. The Pedestrian Crossing Toolkit provides several options that may be considered to manage the conflict.

Pedestrian Demand

Pedestrian Demand is the highest number of pedestrians that use the crosswalk per hour. To determine if a location meets this criterion a pedestrian count during the anticipated peak hour is to be completed. Count the number of pedestrians at the candidate crosswalk location within the vicinity that pedestrians are likely to use the proposed location. Vulnerable pedestrians, the elderly and disabled persons, count twice towards the volume thresholds when the data is available. Professional judgement is used to identify vulnerable pedestrians.

Table 1. Pedestrian Demand

UNCONTROLLED LOCATIONS DEMAND	PEDESTRIAN DEMAND PER HOUR*	
	INTERSECTION	MIDBLOCK
	20	40

EXCEPTIONS			
FACILITY	DISTANCE	PEDESTRIAN DEMAND PER HOUR*	
		INTERSECTION	MIDBLOCK
School	¼ mile	10 (7)	20 (14)
Park	250 ft	10 (7)	30 (21)
Shopping Center	250 ft	15 (10)	30 (21)
Place of Worship	250 ft	15 (10)	30 (21)
Public Recreation Center	250 ft	15 (10)	30 (21)
Bus Stop	250 ft	15 (10)	30 (21)
Metro Station	250 ft	17 (12)	30 (21)
Equity Zone	In Zone	17 (12)	30 (21)

* On roads with speeds at 35 mph or less (On roads with speeds greater than 35 mph)
Elderly and disabled people are equivalent to 2 pedestrians

The pedestrian demand table uses the FHWA guideline as the default for uncontrolled locations of 20 pedestrians per hour at an intersection and 40 pedestrians per hour for a midblock crossing. The city recognizes that there are facilities that are prone to contribute to high levels of walking and would like to encourage the walking trips made within 250 feet by providing marked crossing at the intersections and reducing the midblock crossing demand. These facilities are schools, parks, shopping centers, places of worship, public recreation centers, bus stops and metro stations and locations within county and state identified equity zones.

There is also a further reduction in demand requirements when the road has a speed limit at or above 35 mph. The reason is that the higher the speeds the higher pedestrians are at the higher risk of serious injuries crossing the street.

Stopping Sight Distance

The American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets manual (also known as the "Green Book") notes that sight distance is "the length of the roadway ahead that is visible to the driver." The Green Book provides equations and tables to identify the sight distance for different design speeds. The stopping sight distance (SSD) is to be calculated to determine if vehicles have adequate time to stop if a pedestrian is in the crosswalk. **Table 2** provides the SSD for various speeds on a level roadway.

Table 2: Stopping Sight Distance on Level Roadways

Design Speed (mph)	Stopping Sight Distance (ft)
15	80
20	115
25	155
30	200
35	250
40	305
45	360
50	425
55	495

Adequate Geometry

The geometry of the location is to be reviewed, and engineering judgment will be needed to identify if the locations support the installation of safe crosswalk that can have adequate ramps and drainage to comply with the City of Rockville standards.

Crosswalk Design by Roadway Type

Once the flow chart has identified if a marked crosswalk is recommended the Crosswalk Design by Roadway Type Table, shown below, will be used to identify what treatment at the marked crosswalk is recommended based on the roadway configuration, annual daily traffic (ADT), and the posted speed limit on the facility.

On roadway types with lower speed limits and lower volumes the risk is reduced and a crosswalk without other improvements is recommended as indicated with a Green Circle with the letter C in it. As the ADT increases and speed increases, a crosswalk with other improvements are recommended, as shown by the Yellow Circle with the letter P. The Pedestrian Crossing Toolkit provides more specific types of crosswalks and other improvements that are possible. As speeds and the ADT increase even more where the risk is high of serious injury there are locations where a marked crosswalk is not sufficient unless a signal or major improvement is done at the location, these instances are identified with the red circle with the letter N.

Table 3. Crosswalk Design by Roadway Type

ROADWAY CONFIGURATION	VEHICLE ADT	< 2,000			2000 - 9,000				9,000-12,000				12,000-15,000				>15,000			
	MPH	≤ 25	30	35	≤ 25	30	35	40 +	≤ 25	30	35	40 +	≤ 25	30	35	40 +	≤ 25	30	35	40 +
Two Lanes		C	C	C	C	C	C	N/A	C	C	C	N/A	C	C	C	N/A	C	C	N	N/A
Three Lanes with Raised Median		C	C	C	C	P	P	P	C	C	P	P	P	P	P	P	P	P	N	N
Three Lanes without Raised Median		C	C	C	C	P	P	P	C	C	P	N	P	P	P	N	P	P	N	N
MultiLane with Raised Median		N/A	N/A	N/A	C	P	P	P	C	C	P	N	P	P	P	N	N	N	N	N
MultiLane without Raised Median		N/A	N/A	N/A	C	P	P	N	P	P	P	N	N	N	N	N	N	N	N	N

C Crosswalk

P Possible Crosswalk with Implementation of Other Improvements

N Not Sufficient for Crosswalk without Signal or Substantial Improvement

Exceptions to Criteria

There may be cases where it is reasonable to allow exceptions to the criteria and these will be determined by the City Traffic Engineer . If the engineer anticipates that a location may meet the 20 pedestrians per hour requirement, the above procedure does not preclude counts from being collected. Engineering judgment is to be exercised in all situations. There will be locations that should or should not be marked due to other factors including frequency of marked crosswalks along a corridor and other corridor characteristics.

Director, Department of Public Works	Date
Chief, Traffic and Transportation Division	Date

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Pedestrian Crossing Toolkit

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CHAPTER 1

Introduction

The Pedestrian Crossing Toolkit is intended to supplement the City of Rockville Marked Crosswalk Guidelines by providing a variety of safety enhancements that can be implemented at crosswalks. This toolkit provides brief descriptions of each enhancement along with information on potential benefits, suitable implementation locations, and considerations for both design and implementation. The enhancements are organized into six main categories: marked crosswalks, pedestrian signage, accessibility improvements, geometric and traffic calming measures, signalization improvements, and street lighting improvements.

Included in the toolkit is the Crosswalk Enhancement Summary Table, presented as Table 1. This table serves as a quick reference to help users determine the suitability of each enhancement based on location, City of Rockville roadway classification, safety concerns, and performance objectives. By enabling the combination of different safety measures, this toolkit offers flexible and effective solutions designed to significantly enhance pedestrian safety throughout the City of Rockville.

Table 1. Crosswalk Enhancement Summary Table

Treatment	Page #	Location				City Of Rockville Roadway Classification								Safety Concerns					Performance Objectives			
		Signalized Intersections	Unsignalized Intersections	Midblock Crossings	Along The Road	Major (Major Arterial)	Arterial (Minor Arterial)	Primary Residential Class I (Major Collector)	Primary Residential Class II (Minor Collector)	Secondary Residential (Access)	Business District (Major/Minor Collector)	Primary Industrial (Major Collector)	Secondary Industrial (Minor Collector)	Turning Vehicle Conflicts with Pedestrians	Through Vehicle Conflicts with Pedestrians	Vehicle Speeds	Pedestrians Not Using Crosswalks	Pedestrian Signal Violations	Reduce Vehicle Speeds	Increase Visibility	Reduce Pedestrian Exposure	Improve Accessibility
CROSSWALK ENHANCEMENTS																						
Marked crosswalks																						
High visibility crosswalks	5	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●			●		
Pedestrian signage																						
Pedestrian warning signs	6		●	●		●	●	●	●	●	●	●	●		●	●				●		
Advance warning signs	7		●	●		●	●	●	●	●	●	●	●		●	●				●		
In-street 'Stop for Pedestrian' signs	7		●	●				●	●	●	●	●	●		●	●			●	●		
Rectangular rapid flashing beacons (RRFBs)	7		●	●		●	●	●	●		●	●	●		●		●			●	●	
Accessibility improvements																						
ADA curb ramps	**9Error! Bookmark not defined.**	●	●	●		●	●	●	●	●	●	●	●				●					●

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Detectable warning surfaces (DWS)	10	●	●	●		●	●	●	●	●	●	●	●				●					●
Pedestrian push buttons	10	●	●	●		●	●	●	●	●	●	●	●				●	●				●
Geometric and traffic calming improvements																						
Pedestrian refuge islands	11	●	●	●		●	●	●	●		●	●	●			●			●	●	●	●
Raised crosswalks and intersections	12		●	●				●	●	●	●	●	●			●			●	●	●	●
"T" intersections (reconfiguring wide or skewed intersections)	13	●	●	●		●	●	●	●	●	●	●	●	●					●	●	●	●
Curb extensions	14	●	●	●		●	●	●	●	●	●	●	●	●		●			●	●	●	●
Lane narrowing	14				●	●	●	●	●	●	●	●	●			●			●		●	
Road diets	15				●	●	●	●	●	●	●	●	●			●			●	●	●	
Speed humps and tables	16				●					●					●	●			●			
Hardened centerlines	16	●				●	●	●	●		●	●	●	●	●	●	●		●			
Daylighting	17	●	●	●		●	●	●	●	●	●	●	●	●		●			●	●	●	●

Table 1. Crosswalk Enhancement Summary Table

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		Signalized Intersections	Unsignalized Intersections	Midblock Crossings	Along The Road	Major (Major Arterial)	Arterial (Minor Arterial)	Primary Residential Class I (Major Collector)	Primary Residential Class II (Minor Collector)	Secondary Residential (Access)	Business District (Major/Minor Collector)	Primary Industrial (Major Collector)	Secondary Industrial (Minor Collector)	Turning Vehicle Conflicts with Pedestrians	Through Vehicle Conflicts with Pedestrians	Vehicle Speeds	Pedestrians Not Using Crosswalks	Pedestrian Signal Violations	Reduce Vehicle Speeds	Increase Visibility	Reduce Pedestrian Exposure	Improve Accessibility
Chicanes	18				●					●						●			●			
Asphalt and pavement art	19	●	●	●				●	●	●	●	●	●							●		
Signalization modifications																						
Leading pedestrian intervals (LPIs)	20	●				●	●	●	●		●	●	●	●				●		●	●	
Extended pedestrian clearance times	20	●				●	●	●	●		●	●	●		●			●				●
Pedestrian recall or passive detection	21	●				●	●	●	●		●	●	●	●				●				
Modified signal cycle lengths	22	●				●	●	●	●		●	●	●					●				
Right Turn on Red restrictions	22	●				●	●	●	●		●	●	●	●							●	
Street lighting improvements																						
Street lighting	23	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●		

CHAPTER 2

Marked Crosswalks

Marked crosswalks are used to guide pedestrians to optimal or preferred locations to cross roadways and indicate to drivers that pedestrians have the right of way.

High visibility crosswalks

While traditional transverse lines-only crosswalks are simple, painted stripes perpendicular to traffic flow, high visibility crosswalks, commonly known as continental, ladder, or zebra striped marked crosswalks, allow drivers to see the crosswalk from a greater distance especially during lowlight conditions. This increased visibility provides drivers with more time to safely stop for pedestrians waiting to cross.

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, and midblock crossings.
- Intersections with relatively high pedestrian and/or motor vehicle volumes.
- Crosswalks with skewed or long crossings.
- Locations where there is a higher concentration of people with vision disabilities.[1]

DESIGN

- High visibility ladder and continental crosswalk styles are preferred over the traditional transverse lines-only crosswalk style.
- At stop controlled and signalized intersections, high-visibility crosswalk markings are paired with stop bars and appropriate signing to encourage drivers to stop in advance of the crosswalk.
- At uncontrolled multilane crossings, a stop bar can be set back 20 to 50 feet from the crosswalk to avoid multiple threat crashes.
- Refer to the MdMUTCD Section 3B.18 for further guidance on crosswalk marking width, spacing, and material.

CONSIDERATIONS

- Ensure adequate sight distance is provided.
- On-street parking should be set back from the crossing for improved visibility.
- Maintenance: Regular maintenance is needed to ensure markings remain visible and effective. Markings that are damaged or faded need to be replaced when they are near or at minimum retro reflectivity levels, or when they are deemed by inspection to be damaged and not effective at communicating to drivers and pedestrians, including pedestrians with low vision.

[1] Source: City of Rockville Pedestrian Master Plan and MCDOT's publication "Planning and Designing Streets to be Safer and More Accessible for People with Vision Disabilities."

CHAPTER 3

Pedestrian Signage

Pedestrian signage, at and in advance of the crossing, enhances pedestrian safety by providing drivers with early visual clues about the presence of a crosswalk, giving them time to reduce their speed and prepare to stop for pedestrians.

Pedestrian warning signs

Consist of a PEDESTRIAN (W11-2), SCHOOL (S1-1), or COMBINATION BIKE AND PEDESTRIAN CROSSING (W11-15) sign, which may be mounted overhead, or post-mounted with a supplemental diagonal downward arrow plaque (W17-7P).

IMPLEMENTATION LOCATIONS

- Unsignalized intersections and midblock crossings.
- All roadway classifications.
- Crosswalks within school zones or other areas with slow moving pedestrians.
- Areas with a need for increased visibility and/or priority.

DESIGN

- Refer to the MdMUTCD Section 2C.50 for guidance on the use and placement at or in advance of pedestrian crossings.

CONSIDERATIONS

- On multilane approaches with a median, pedestrian warning signs are to be placed on both the side of the road and in the median adjacent to the pedestrian curb ramps.
- Maintenance: Periodic maintenance is needed to ensure signs remain in good condition.

Advance warning or regulatory signs

At certain crosswalk locations, additional advance warning signs may be provided where an engineering study or judgment finds it necessary.

Advance warning signs consist of PEDESTRIAN (W11-2), SCHOOL (S1-1), or COMBINATION BIKE AND PEDESTRIAN CROSSING (W11-15) signs, post-mounted with a supplemental AHEAD (W16-9P) sign.

Advance regulatory signs include post-mounted STOP HERE FOR PEDESTIANS (R1-5b or R1-5c) signs and may be accompanied by a stop line.

IMPLEMENTATION LOCATIONS

- Unsignalized intersections and midblock crossings.
- All roadway classifications.
- Roadways with posted speed limits of 35 mph or higher.
- Roadways with multilane approaches.
- Areas with a need for increased visibility and/or priority.

DESIGN

- Refer to the MdMUTCD Section 2C.50 for guidance on the use and placement of advanced warning signs.
- Refer to the MdMUTCD Section 2B.12 for guidance on the use and placement of advanced regulatory signs.

CONSIDERATIONS

- Avoid placing too many signs, as research indicates that an overabundance of signs reduces their effectiveness.
- Maintenance: Periodic maintenance is needed to ensure signs remain in good condition.

In-street pedestrian crossing signs

Supplemental In-street "Stop for Pedestrians" (R1-6a(1)) signs may be installed either in the roadway between travel lanes or on a median to remind drivers the rules of the road.

IMPLEMENTATION LOCATIONS

- Unsignalized intersections and midblock crossings.
- All roadway classifications.
- Roadways with posted speeds 30 mph or less.
- Areas with high pedestrian traffic and a need for increased visibility and/or priority.

DESIGN

- Refer to the MdMUTCD Section 2B.12 for guidance on the use and placement.

CONSIDERATIONS

- Signs installed in roadways on centerlines have a high likelihood of being hit.
- Place signs within medians or refuge islands where possible or consider pavement markings that widen around the signs.
- Placement should consider vehicular turning radii to avoid being hit.
- Maintenance: Regular maintenance is needed to ensure signs remain in good condition.

Rectangular rapid flashing beacons (RRFBs)

RRFBs are pedestrian-activated warning devices used to enhance crosswalk safety and compliance. They consist of two rapidly-flashing rectangular-shaped LEDs used in conjunction with W11-2 (Pedestrian), S1-1 (School), or W11-15 (Trail) crossing warning signs and push button or passive detection actuation. RRFBs alerts drivers to pedestrians who are either waiting to cross or are actively crossing the roadway. These devices are particularly effective in areas with frequent pedestrian crossings on busier roadways where enhanced visual signals are necessary to alert drivers to pedestrians' presence.

IMPLEMENTATION LOCATIONS

- Unsignalized intersections and midblock crossings.
- All roadway classifications except for Secondary Residential
- (Access).
- Areas with a need for increased visibility and safety.

DESIGN

- RRFBs should coincide directly with PEDESTRIAN (W11-2), SCHOOL (S1-1), or COMBINATION BIKE AND PEDESTRIAN CROSSING (W11-15) signs, located at or immediately adjacent to a marked crosswalk.
- If pedestrian push button detectors are used to actuate the RRFB indications, a PUSH BUTTON TO TURN ON WARNING LIGHTS/AWAIT GAP IN TRAFFIC (R10-25) sign shall be installed explaining the purpose and use of the pedestrian push button detector.
- Refer to the 11th Edition of the MUTCD (Chapter 4L) and NCHRP 562 for additional guidance on the use and placement.

CONSIDERATIONS

- Supplementary improvements should be provided for crossings with more than one lane of traffic in the same direction.
- Can be solar powered for flexible and cost-efficient installations.
- The use of audible information devices with RRFBs may be considered to assist pedestrians with vision disabilities.
- Should not be considered on secondary residential streets.

CHAPTER 4

Accessibility Improvements

ADA curb ramps

Curb ramps, also known as curb cuts, are sloped transitions built into sidewalks or street curbs to facilitate smooth and safe transitions for those with mobility challenges including those with disabilities, elderly individuals, parents with strollers, and anyone else who may face challenges navigating curbs. They typically consist of a gently sloping ramp that connects the elevated sidewalk level to the street level, along with detectable warning surfaces to alert visually impaired pedestrians of the transition between the sidewalk and the roadway. Curb ramps are essential components of accessible pedestrian infrastructure, ensuring that all individuals, regardless of mobility or ability, can navigate urban environments safely and independently.

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, and midblock crossings.
- All roadway classifications.
- At both marked and unmarked crossings where a sidewalk is provided to facilitate accessibility for individuals with mobility impairments.

DESIGN

- Ensure ADA compliance.

CONSIDERATIONS

- Existing geometric constraints may impact ramp locations.
- Roadway widening may be necessary to accommodate curb ramps and ensure proper access for pedestrians.
- The location of curb ramp installations should consider property access and minimize disruptions to adjacent properties.
- Maintenance: Periodic maintenance may be needed due to snow, debris, or vehicle impacts ensuring continued accessibility for pedestrians with disabilities.

Detectable warning surfaces (DWS)

Detectable warning surfaces (DWS) are tactile surfaces installed on pedestrian pathways, such as sidewalks, ramps, and curb ramps, to alert visually impaired pedestrians of potential hazards or transitions in their path. These surfaces provide tactile and visual cues, allowing individuals with visual impairments to navigate safely and independently in urban environments.

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, and midblock crossings.
- All roadway classifications.
- Typically installed in conjunction with curb ramps.
- Install at the edges of pedestrian refuge islands or at marked crosswalks.
- Install at roundabouts to help pedestrians identify safe crossing points and navigate the complex traffic patterns associated with roundabout intersections.
- Install at the edges of bus stops or other transit facilities to facilities to alert passengers of platform edges and potential hazards.

DESIGN

- Ensure ADA compliance.
- Refer to the 11th Edition of the MUTCD (Section 3B.18).

CONSIDERATIONS

- Maintenance: Periodic maintenance may be needed due to snow, debris, or general wear to ensure continued accessibility for pedestrians with disabilities.

Pedestrian push buttons

Pedestrian push buttons are interactive devices installed at signalized intersections to allow pedestrians to request a "walk" signal and safely cross the street. Accessible pedestrian push buttons provide audible, tactile, and visual information to assist pedestrians with disabilities in navigating signal-controlled intersections safely.

IMPLEMENTATION LOCATIONS

- Installed in conjunction with signaled crossings at intersections or midblock locations, including Pedestrian Hybrid Beacons (PHBs).
- Installed at crossing locations equipped with Rectangular Rapid Flashing Beacons (RRFBs).
- All roadway classifications.

DESIGN

- Ensure ADA compliance.
- Refer to the 11th Edition of the MUTCD (Section 4E.10).

CONSIDERATIONS

- Maintenance: Periodic maintenance may be needed due to snow, debris, or general wear to ensure continued accessibility for pedestrians with disabilities.

CHAPTER 5

Geometric and Traffic Calming Improvements

Pedestrian refuge islands

Pedestrian refuge islands enhance pedestrian safety by reducing exposure to incoming vehicles by allowing them to cross one direction of travel at a time. They also may serve as a traffic calming measure, by slowing vehicles down in the vicinity of a crossing.

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, and midblock crossings.
- All roadway classifications except for Secondary Residential
- (Access).
- Areas with a need for increased visibility and safety such as approaches to multi-lane intersections.
- Locations with limited sight distance or where there are concerns about vehicular speeds.

DESIGN

- Minimum width: 4 feet[2].
- At-grade pass through for pedestrians are preferred.
- Ensure ADA compliance.
- Physical raised barriers preferred to provide comfort and protection from vehicles.
- Temporary installation possible with pavement markings and vertical elements (flex posts, temporary curbing).
- Refer to the MdMUTCD for guidance on pavements markings, signage, and pedestrian signalization.

CONSIDERATIONS

- Can be accompanied by additional signage to increase pedestrian visibility.
- Roadway widening or lane narrowing may be needed in the vicinity of the crossing.
- Location of treatment needs to account for property access.
- Maintenance: Periodic maintenance may be needed due to snow, debris, or vehicle impacts.

[2] Pedestrian Safety Islands. https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/pedestrian-safety-islands/

Raised crosswalks and intersections

A raised crosswalk is a traffic-calming feature consisting of a ramped speed table elevated to the level of the sidewalk at a pedestrian crossing, compelling vehicles to slow down as they approach. The crosswalks are marked with paint and/or use special paving materials, while detectible warnings and curb ramps and are provided for those with low vision. Raised crosswalks enhance pedestrian safety by making pedestrians more visible to drivers and providing level, accessible crossings.

A raised intersection is essentially a speed table, covering an entire intersection, with ramps on all approaches. They can be constructed using materials such as asphalt, concrete, or pavers. As part of this design, the crosswalks on each approach are raised to allow pedestrians to cross the road at sidewalk level, providing improved accessibility for those with mobility impairments. Additional benefits include reducing vehicle speeds and discouraging aggressive driving behaviors, such as running stop signs or speeding, making the intersection safer for all users.

IMPLEMENTATION LOCATIONS

- Unsignalized intersections and midblock crossings including trail crossings.
- Local and collector streets with frequent pedestrian traffic and a need for increased visibility, priority, or accessibility.
- Crosswalks within school zones.
- Crosswalks near pedestrian generators (parks and playgrounds, community centers, senior living communities, and public transit stops).
- Channelized right-turn lanes.

DESIGN

- Ensure ADA compliance.
- Height is based on desired speed reduction (typically 10-20 mph for speed humps, 15-30 mph for tables).
- Length should be sufficient to span the entire travel lane(s) and provide a smooth transition.
- Smooth approach and exit ramps are necessary for safety and comfort, typically with slopes between 1:5 and 1:10.
- Provide sufficient speed table width to accommodate pedestrians and other users (10 feet minimum) and accessible ramps (on both sides of the table.
- Include warning signs and pavement markings for approaching drivers.
- Choose materials and design to facilitate proper drainage and snow removal operations.
- Provide appropriate daylighting/parking restrictions.
- Exclusions: streets with steep grades.

CONSIDERATIONS

- Ensure design accommodates drainage and underground utilities.
- Ensure adequate clearance and maneuverability for emergency vehicles.
- May require coordination with winter maintenance operators along with emergency service providers and transit agencies.
- Maintenance: Ensure regular inspections and maintenance for durability and safety.

“T” intersections (reconfiguring wide or skewed intersections)

Wide or skewed intersections often present challenges such as limited visibility, confusing traffic patterns, and increased likelihood of conflicts between vehicles and pedestrians. By reconfiguring the intersection into a 90-degree "T" shape, the flow of traffic becomes more predictable, making it easier for drivers to navigate and reducing the potential for crashes.

Additionally, creating a "T" intersection can facilitate safer pedestrian crossings by shortening the distance pedestrians need to travel to cross the street and providing clearer sightlines for both pedestrians and drivers.

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, and midblock crossings.
- All roadway classifications.
- Where there is a need to address safety concerns such as excessive speeding or a desire to create a more pedestrian-friendly environment.
- Corridors with pedestrian and bicyclist activity, school zones, commercial districts, and residential neighborhoods.

DESIGN

- Keep corner radii as small as possible while still accommodating the design vehicle.
- Each end of a crosswalk should be complemented with a sidewalk pad and an ADA compliant ramp.
- Temporary reconfigurations can be achieved using pavement markings, flexible delineator posts, or rubber curb, providing flexibility for implementation.

CONSIDERATIONS

- Need to be designed to accommodate bus and large trucks, if present.
- Drainage and underground utility modifications may be necessary.
- Maintenance: Periodic maintenance may be needed due to vehicle impacts when using temporary materials.

Curb extensions

Curb extensions, or bulb-outs, narrow the roadway width to slow traffic and improve visibility between pedestrians and drivers. They may incorporate a reduction in the curb radius at an intersection prompting vehicles to decelerate in order to make the tighter turn. Curb extensions offer larger waiting areas at intersection corners, reduce crossing distances for pedestrians thus minimizing their time on the roadways. Furthermore, curb extensions provide extra space for the installation of curb ramps, especially where existing utilities or other features may obstruct their placement.

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, and midblock crossings.
- All roadway classifications.
- Areas with a need to slow down vehicular traffic or reduce crossing distances for pedestrians.
- Where extra space is needed for the installation of curb ramps.

DESIGN

- Keep corner radii as small as possible while still accommodating the design vehicle.
- Each end of a crosswalk should be complemented with a sidewalk pad and an ADA-compliant ramp.
- Interim curb extensions can be installed using pavement markings, flexible delineator posts, or rubber curb.

CONSIDERATIONS

- Need to be designed to accommodate bus and large trucks, if present.
- Drainage and underground utility modifications may be necessary.
- Maintenance: Periodic maintenance may be needed due to vehicle impacts when using temporary materials.

Lane narrowing

Lane narrowing, involves reducing the width of lanes on a roadway to slow down traffic and enhance safety. By narrowing lanes, drivers tend to reduce their speed. Additionally, narrower lanes can create more space for other road features, such as bike lanes or wider sidewalks.

IMPLEMENTATION LOCATIONS

- Along the roadway.
- All roadway classifications.
- Areas where there is a need to improve safety for pedestrians and bicyclists, such as on roads with high crash rates or where there is a desire to reduce vehicle speeds.
- Areas with high pedestrian activity, school zones, commercial districts, and residential neighborhoods.

DESIGN

- Reduce lane widths to the minimum necessary to accommodate traffic volumes and vehicle types.
- Use road markings and signage to clearly indicate lane reductions to drivers.
- Physical barriers like delineator posts can physically separate narrowed lanes. Additionally, raised pavement markers and traffic calming measures can be utilized to encourage drivers to slow down and maintain safe speeds.

CONSIDERATIONS

- Need to be designed to accommodate the needs of all road users, including buses and emergency vehicles, if present.
- Drainage and underground utility modifications may be necessary.
- Maintenance: Periodic maintenance may be needed due to vehicle impacts when using temporary materials.

Lane reduction (road diet)

Lane reduction, commonly known as a road diet, involves reconfiguring the number of lanes on a roadway to improve safety, traffic flow, and community livability. By reducing the number of travel lanes, road diets can encourage drivers to slow down, enhance pedestrian and bicyclist safety, and create opportunities for additional infrastructure, such as bike lanes, transit lanes, or expanded pedestrian facilities.

IMPLEMENTATION LOCATIONS

- Along the roadway.
- All roadway classifications.
- Areas where there is a need to address safety concerns, improve traffic flow, or enhance the streetscape.
- Corridors with high pedestrian and bicyclist activity, school zones, commercial districts, and residential neighborhoods.
- Roads with excessive speeding, high crash rates, or where there is a desire to create a more pedestrian-friendly environment.

DESIGN

- The reconfiguration of lanes is to be based on an analysis of traffic volumes, speeds, and crash data to determine the most appropriate lane configuration.
- Road markings, signage, and physical barriers to be considered to indicate lane reductions and any new configurations to drivers.
- Interim or pilot road diets can be implemented using materials such as pavement markings, flexible delineator posts, or rubber curb.

CONSIDERATIONS

- Need to be designed to accommodate the needs of all road users, including buses and emergency vehicles, if present.
- Drainage and underground utility modifications may be necessary.
- Maintenance: Periodic maintenance may be needed to ensure that lane markings, signage, and physical barriers remain visible and effective, particularly when using temporary materials during implementation.

Speed humps and tables

Traffic-calming devices designed to reduce vehicle speeds in specific areas, typically at pedestrian crossings or in residential zones. Speed tables are flat-topped, raised platforms that spans the width of the road. Unlike traditional speed humps or bumps, speed tables are wider and flatter, allowing the entire vehicle to pass over without causing a jarring impact. The design of a speed table encourages drivers to slow down while maintaining a continuous flow of traffic.

IMPLEMENTATION LOCATIONS

- Along the roadway.
- Secondary Residential (Access) roadways.
- Roadways within residential neighborhoods, school zones, and other areas with high pedestrian traffic.
- Near pedestrian crossings to slow down vehicles and increase pedestrian safety.

DESIGN

- Height is based on desired speed reduction (typically 10-20 mph for speed humps, 15-30 mph for tables).
- Length should be sufficient to span the entire travel lane(s) and provide a smooth transition.
- Smooth approach and exit ramps are crucial for safety and comfort, typically with slopes between 1:5 and 1:10.
- When combined with crosswalks, provide sufficient speed table width to accommodate pedestrians and other users (10 feet minimum) and accessible ramps on both sides of the table.
- Include warning signs and pavement markings for approaching drivers.
- Choose materials and design to facilitate proper drainage and snow removal operations.

CONSIDERATIONS

- Ensure adequate clearance and maneuverability for emergency vehicles.
- Consider strategies to enforce speed limits in conjunction with humps and tables.
- Maintenance: Ensure regular inspections and maintenance for durability and safety.

Hardened centerlines

Hardened centerlines are raised barriers or flexible posts placed along the yellow centerlines at intersections. These barriers force drivers to make wider, slower left turns, reducing the risk of collisions with pedestrians and oncoming traffic.

IMPLEMENTATION LOCATIONS

- Signalized intersections.
- All roadway classifications except for Secondary Residential (Access) roadways.
- Intersections where vehicles are observed frequently crossing the centerlines during left-turning movements.
- Crossing locations with observed yielding violations.

DESIGN

- Materials may include any combination of temporary curbing, rubber speed bumps, and flex posts.
- Design must accommodate emergency vehicles.
- Design must accommodate opposing left-turning vehicle paths.

CONSIDERATIONS

- Maintenance: Periodic maintenance may be needed due to snow, debris, or vehicle impacts.

Daylighting

Daylighting refers to the practice of setting back parking, landscaping, trees, and other potential visual obstructions to ensure adequate visibility and sightlines at intersections and driveways. Daylighting enables pedestrians to see approaching vehicles without needing to step into the street and provides drivers and bicyclists a clear view of both the crossing area as well as of any waiting pedestrians.

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, and midblock crossings.
- All roadway classifications with on-street parking. Supported by the Rockville City Code (Section 23-26) which prohibits parking within 20 feet of intersection crosswalks and within five feet of public or private driveways.

DESIGN

Use “No Parking” signs and/or pavement markings to designate daylighting areas. General recommendations for minimum parking setbacks to ensure good visibility at crosswalks include:

- 20 feet: Most crosswalks, especially where pedestrian and cyclist activity is high.
- 30-60 feet: Higher-speed crosswalks or where sightlines are obstructed by buildings, vegetation, or other obstructions.
- 5 feet: Public or private driveways.

CONSIDERATIONS

- Use flexible bollards or curb extensions to prevent vehicles from entering daylighting areas.
- Consider installing asphalt art, decorative planters, or bicycle parking in daylighting areas.
- Maintenance: Regular maintenance is needed to ensure the effectiveness and safety of the daylighting treatments.

Chicanes

Chicanes are a traffic calming measure which create curved paths that force drivers to slow down to navigate around obstructions, creating a safer crossing environment. In downtown areas, chicanes can provide additional public space for benches, bicycle parking, and other amenities.

IMPLEMENTATION LOCATIONS

- Along the road.
- Secondary Residential (Access) roadways.
- Areas with high pedestrian activity, near schools, or on streets with speeding problems
- Not appropriate for streets with frequent bus, truck, or emergency vehicles

DESIGN

- Choose durable and high-visibility materials for delineating the chicane, such as raised pavement markers, curbs, or colored pavement.
- The number and spacing of curves depends on the desired speed reduction, road width, and traffic volume. More curves create a tighter chicane and a greater speed reduction.
- Consider using signage and pavement markings to warn drivers about the approaching chicane and its speed limit.
- Ensure proper lighting conditions, especially at night, to enhance visibility and driver awareness.
- Proper drainage design is necessary to prevent water pooling within the chicane.
- Temporary design can include materials such as pavement markings, flex posts, temporary curb.

CONSIDERATIONS

- Consider the sight distance requirements for drivers approaching and navigating the chicane.
- Consider the needs of pedestrians and cyclists when designing the chicane, potentially incorporating designated crossing areas or shared-use paths.
- Maintenance: Regular maintenance is needed to ensure the effectiveness and safety of the chicane.

Asphalt and pavement art

Asphalt art refers to the application of colorful designs on roadway surfaces, including intersections and crosswalks, to enhance aesthetic appeal and improve pedestrian safety. This treatment utilizes visual elements to capture the attention of drivers and pedestrians, promoting slower driving speeds and increased awareness in high-traffic areas.

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, and midblock crossings.
- All roadway classifications except for Major and Minor Arterials.
- Inside the roadway: intersections, loading areas.
- Outside the roadway: traffic calming areas like curb extensions or chicanes, pedestrian plazas.
- Areas with high pedestrian activity, near schools, or on streets with speeding problems.

DESIGN

- Choose durable and high visibility materials but avoid using retroreflective paint.
- Select design colors that clearly distinguish from other standard road markings, such as bike lanes, crosswalk, or centerlines.
- Avoid using large areas of colors designated by the MUTCD for specific uses, such as green for bike lanes, red for bus lanes, and blue for ADA compliance.
- Refer to the 11th Edition of the MUTCD (Section 3H.03) for additional guidance on the use and placement.

CONSIDERATIONS

- Artwork should not compromise road users' ability to clearly see and understand traditional road signals and markings.
- The scale and complexity of designs should suit the urban context and not overwhelm or confuse drivers.
- Maintenance: Regular maintenance is needed to preserve the integrity and vibrancy of the asphalt art and ensure adequate friction and skid resistance.

CHAPTER 6

Signalization Modifications

Leading Pedestrian Intervals (LPI)

A signal timing strategy that gives pedestrians a "WALK" indication prior to vehicles traveling in the same direction are given the green indication. This head start which is typically 3-7 seconds allows pedestrians to enter the crosswalk and become readily visible to drivers, significantly reducing the risk of conflicts with turning vehicles. LPIs have been shown to reduce pedestrian crashes by 59 percent.

IMPLEMENTATION LOCATIONS

- All signalized intersections.
- All roadway classifications except for Secondary Residential (Access) roadways.
- Crossing locations with observed yielding violations.
- Crossing locations with low pedestrian volumes.
- Crossing locations with moderate to high volumes of turning vehicles conflicting with high pedestrian volumes.
- Crossing locations with long crossing distances.

DESIGN

- Refer to the MdMUTCD (Section 4E.06) for further guidance on LPIs.

CONSIDERATIONS

- Conflicting right-turn movements may be restricted with a No Turn on Red.
- Include audible cues for visually impaired pedestrians.
- Curb extensions at high-conflict intersections enhance LPI effectiveness and pedestrian visibility.
- Intersections with heavy pedestrian traffic or extended crossing distances benefit from longer head start times.

Extended Pedestrian Clearance Times

Increases time for pedestrian walk phases, especially to accommodate vulnerable populations, such as children and the elderly.

IMPLEMENTATION LOCATIONS

- All signalized intersections.
- All roadway classifications except for Secondary Residential (Access) roadways.
- Crossing locations near schools.
- Crossing locations with increased elderly populations or those with mobility challenges.

DESIGN

- Account for different walking speeds and abilities of pedestrians, including children, older adults, and people with disabilities. Use appropriate walking speed assumptions in calculations.
- Consider the length and complexity of the crossing (multiple lanes, turning vehicles) when determining needed clearance time.
- Refer to the MdMUTCD (Section 4E.06) for further guidance on extending pedestrian crossing intervals.

CONSIDERATIONS

- Consider population demographics of potential pedestrians.
- Ensure extended clearance times at one intersection do not negatively impact signal timing and coordination at nearby intersections.

Pedestrian recall or passive detection

Pedestrian recall is a traffic signal feature that initiates a pedestrian “WALK” signal every cycle, allowing pedestrians to cross without having to push a button. Signals can be set to "recall" mode either full time or during specific periods of the day, such as school drop-off/pick-up times or peak business hours. At locations with pedestrian recall, pushbuttons are used to initiate accessibility features rather than to activate the "WALK" signal.

Passive pedestrian detection utilizes sensors like infrared or video detection to automatically detect pedestrians waiting to cross at intersections, without the need to press a pushbutton improving convenience and accessibility. Passive detection can be used to both call the pedestrian phase and extend the clearance interval.

IMPLEMENTATION LOCATIONS

- All signalized intersections.
- All roadway classifications except for Secondary Residential (Access) roadways.
- Crosswalks within school zones, commercials districts, or areas with slow moving pedestrians.
- Crosswalks with long crossing distances or complex geometry.

DESIGN

- Refer to the MdMUTCD for further guidance on pedestrian recall and passive detection.

CONSIDERATIONS

- Consider pedestrian volumes during the phase in question, and how they may differ by time of day period.
- Automatic pedestrian recall is to be considered where concurrent phasing is used in areas with high pedestrian traffic such as commercial areas and near bus routes or transit stations.
- May increase delay for general traffic.

Shorter signal cycle lengths

In general, a shorter signal cycle length is recommended to reduce wait time and promote pedestrian and vehicle compliance. If needed, a signal coordination is recommended below the speed limit to avoid incentivizing drivers to rush and catch green waves.

IMPLEMENTATION LOCATIONS

- All signalized intersections.
- All roadway classifications except for Secondary Residential (Access) roadways.

DESIGN

- Cycle lengths of 60–90 seconds are ideal.
- Cycle lengths must be long enough to accommodate pedestrian crossings.

CONSIDERATIONS

- Longer cycle lengths result in more people waiting in the street.
- For urban areas, minimum cycle length is often dictated by required pedestrian walk and clearance times.

Right turn on red restrictions

When making a turn on red, drivers often focus on potential conflicts with other vehicles and may overlook pedestrians and bicyclists in, or preparing to cross, the street. They also frequently encroach upon or obstruct crosswalks. Restricting right turns on red is a cost-effective strategy in reducing conflicts between turning vehicles and pedestrians or bicyclists at signal-controlled intersections.

IMPLEMENTATION LOCATIONS

- All signalized intersections.
- All roadway classifications except for Secondary Residential (Access) roadways.
- Crosswalks with significant pedestrian traffic.
- Crosswalks within school zones or other areas with slow moving pedestrians.
- Crosswalks where sight distance may be limited.
- Intersections with separated bike lanes.

DESIGN

- Can be implemented with the installation of a regulatory sign such as a NO TURN ON RED (R10-11b) sign.
- Restrictions can be limited to certain times or days of the week.
- Refer to the MdMUTCD for further guidance on right turn on red restriction signage and signal indications.

CONSIDERATIONS

- May have a negative impact on overall intersection operations, particularly during peak hours.
- May increase the number of right turn on green conflicts. Therefore, recommend use in conjunction with LPIs.
- An engineering study should be conducted prior to implementing right turn on red restrictions to understand potential impacts.

CHAPTER 7

Street Lighting Improvements

Street lighting

Adequate lighting not only mitigates risks but also boosts pedestrians' confidence in executing various tasks, such as observing approaching vehicles and navigating signalized and unsignalized intersections[3]. Studies have shown intersection lighting to reduce nighttime crashes by approximately 12 percent[4] and nighttime pedestrian crashes by 42 percent[5].

IMPLEMENTATION LOCATIONS

- Signalized intersections, unsignalized intersections, midblock crossings, and along the road.
- All roadway classifications.
- Crosswalks within school zones.
- Crosswalks within pedestrian generators (parks, playgrounds, community centers, senior living communities, and public transit stops).
- At intersections within bicycle and pedestrian priority areas.
- At intersections within transit-oriented development areas.
- Along multiuse trails.

DESIGN

- Evaluation of existing lighting levels is required.
- Additional guidance can be found in FHWA's Pedestrian Lighting Primer.[6]

CONSIDERATIONS

- Requires a power source.

[3] Lighting for Pedestrian Safety. https://safety.fhwa.dot.gov/roadway_dept/night_visib/docs/Lighting_for_Pedestrian_Safety_2pager.pdf
[4] Donnell, E.T., R.J. Porter, and V.N. Shankar. "A Framework for Estimating the Safety Effects of Roadway Lighting at Intersections." Safety Science, Vol. 48(10), pp. 1436-1444, 2010.
[5] Elvik, R. and Vaa, T., "Handbook of Road Safety Measures." Oxford, United Kingdom, Elsevier, (2004)
[6] Pedestrian Lighting Primer. https://highways.dot.gov/sites/fhwa.dot.gov/files/2022-09/Pedestrian_Lighting_Primer_Final.pdf

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