

Center for Accelerating Innovation



Every Day Counts so  up
(Safe Transportation for Every Pedestrian)

STEP Tech Talk

New Jersey October 30, 2019

Why is pedestrian safety and accessibility important?

Too many people dying on our roadways

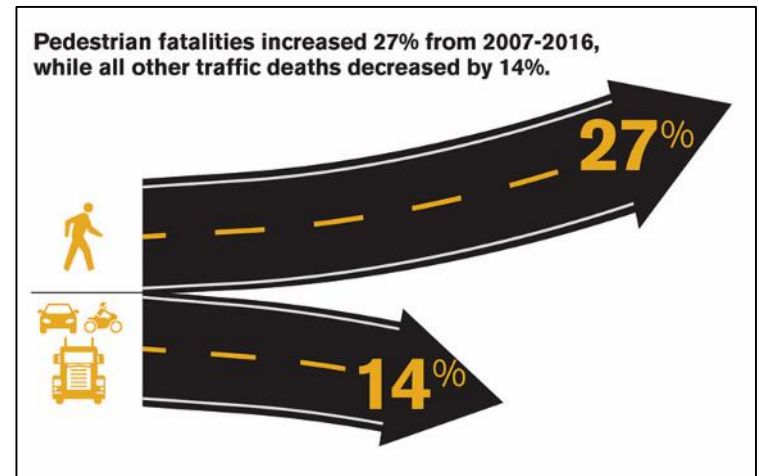
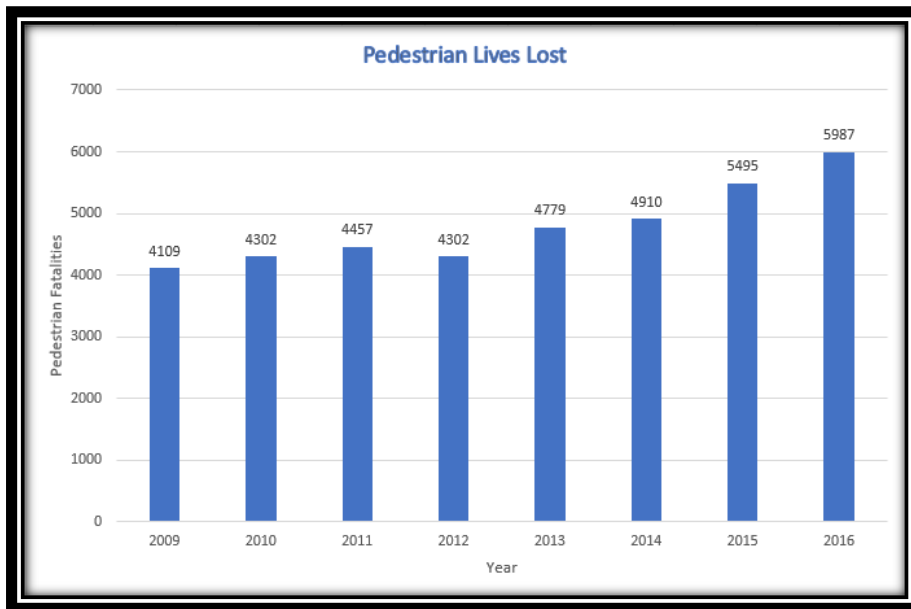


Photo Credit: GHSA

Pedestrians now account for a larger proportion of traffic fatalities (16%) than they have in the past 33 years

NHTSA October 22, 2019 Press Release

- 2018 – 2.4% decline overall fatalities
 - 913 lives saved
 - 2018 - 36,560 people died
 - 2017 - 37,473 people died
- People who walk - more than 3.4% increase
 - 6,283 – deaths
 - most deaths since 1990



Why STEP?

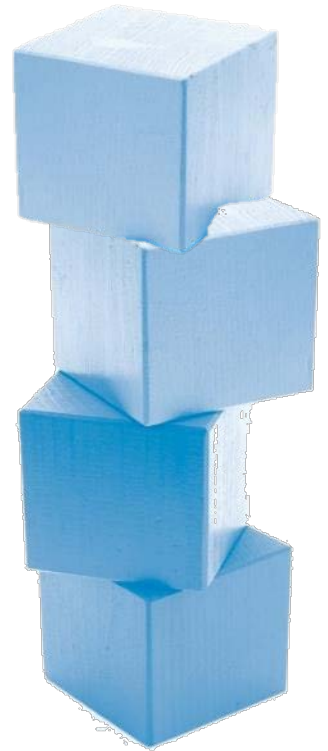
- Over 72% of pedestrian fatalities occur at non-intersection locations
- Roughly 27% of pedestrian fatalities occur at intersections

What is “*Every Day Counts*”(EDC)?

State-based model to identify and rapidly deploy proven but underutilized innovations to:

- ✓ shorten the project delivery process
- ✓ enhance roadway safety
- ✓ reduce congestion
- ✓ improve environmental sustainability

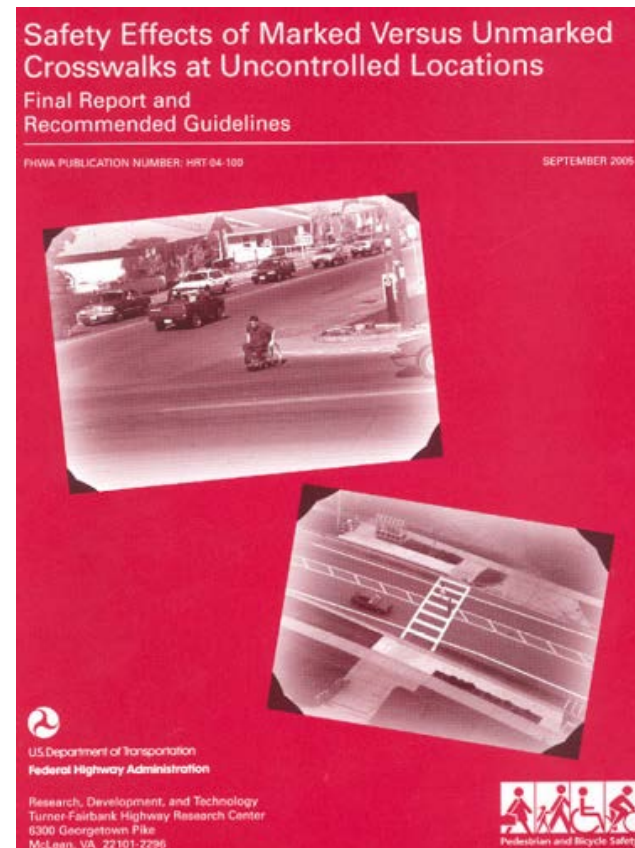
- EDC Rounds: two year cycles
- Initiating 5th Round (2019-2020)



Marked vs. Unmarked Crosswalks at Uncontrolled Locations

Marked vs. Unmarked Analysis Speeds < or = to 40 mph

- Two-lane roads: No significant difference in crash rate
- Multilane roads (3 or more lanes)
 - Under 12,000 ADT: no significant difference in crash rate
 - Over 12,000 ADT w/ no median: crashes marked > crashes unmarked
 - Over 15,000 ADT & w/ median: crashes marked > crashes unmarked



<https://www.fhwa.dot.gov/publications/research/safety/04100/>

One explanation of higher crash rate at marked crosswalks: multiple-threat crash



1st vehicle stops and “masks” visibility for driver in 2nd lane
Solution: advance stop bar (we’ll discuss later...)

MUTCD Section 3B.18 Crosswalk Markings

New marked crosswalks **alone, without other measures** designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways where the speed limit exceeds 40 mph and /or either:

- Has 4 or more lanes without a raised median or island and ADT of 12,000 or more, or
- 4 or more lanes with raised median island and ADT of 15,000 or more



— PEDESTRIAN FATALITY & SERIOUS INJURY RISK +

18%



50%



77%



20
MPH

30
MPH

40
MPH



CONE OF VISION

As motor vehicle speeds increase, the risk of serious injury or fatality for a pedestrian also increases (*AARP Impact Speed and a Pedestrian's Risk of Severe Injury or Death 2011, p. 1*). Also, motorist visual field and peripheral vision is reduced at higher speeds.

Ability to React and Avoid

Australian PSA on Speed

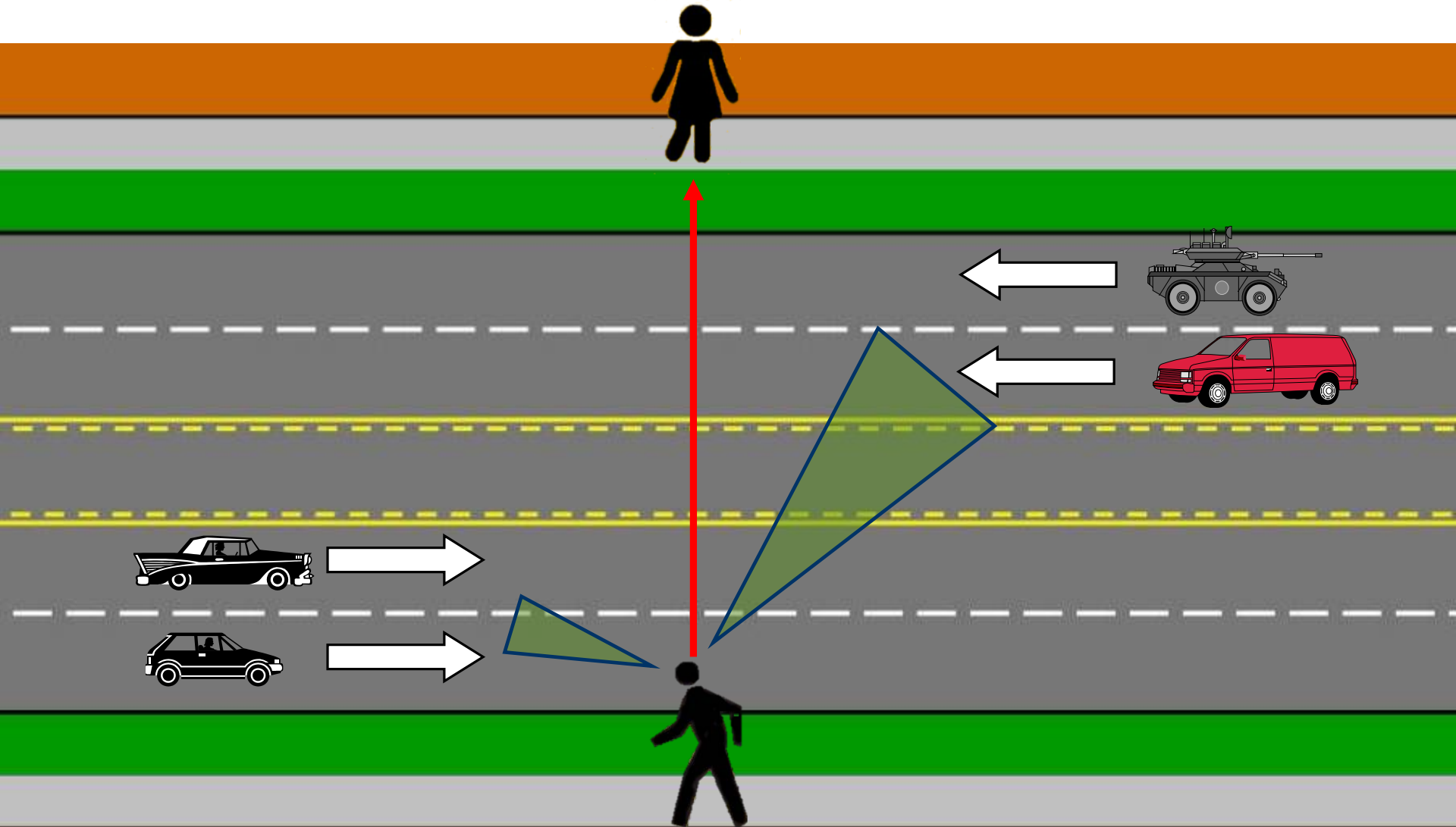
60 kph (37 mph)

vs.

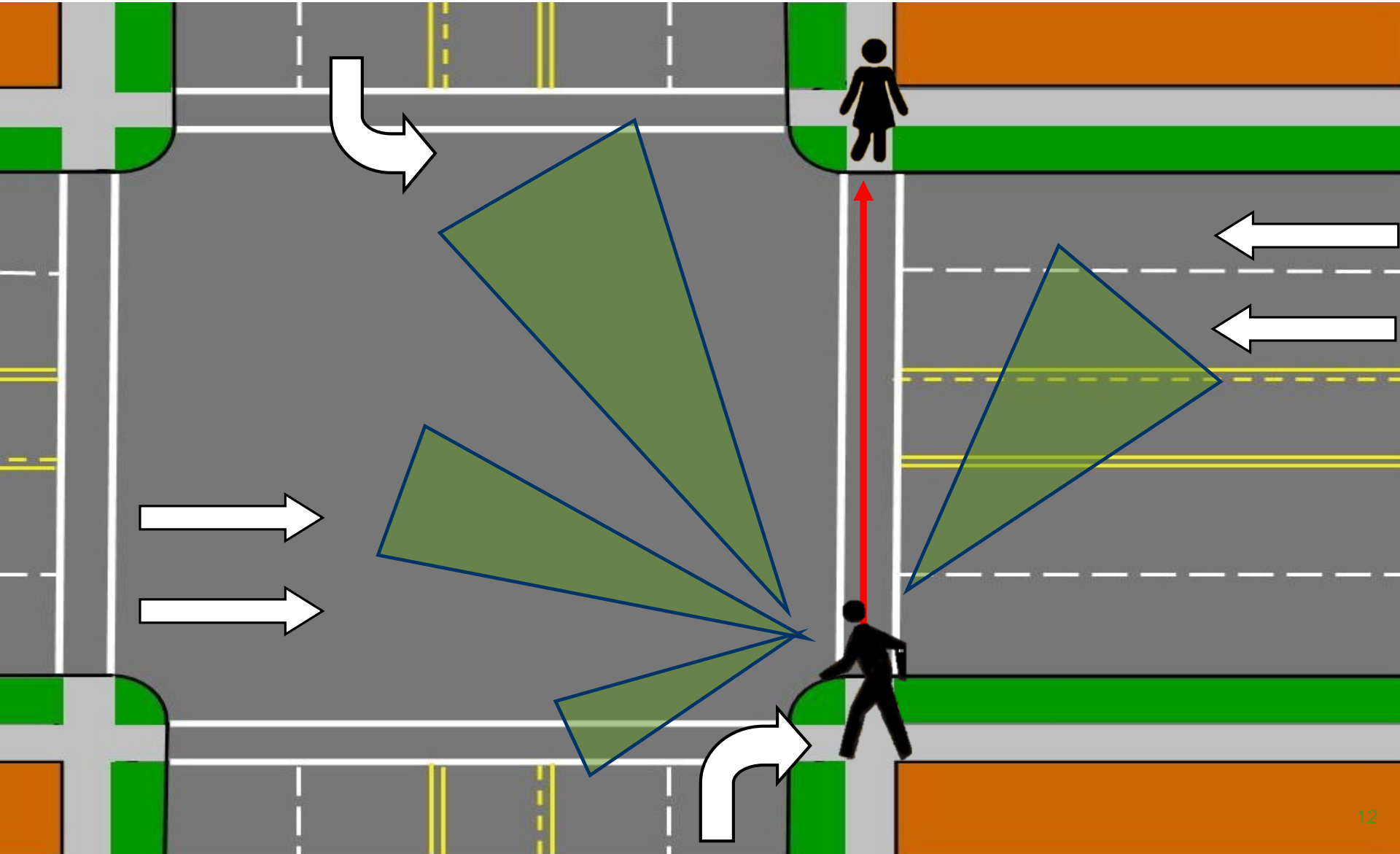
65 kph (40 mph)



Midblock: Pedestrian faces 2 directions of traffic



Intersection: pedestrian faces other conflicts





New Jersey – Crosswalk Laws

NEW JERSEY STATUTE 39:4-36

<https://www.nj.gov/oag/hts/pedestrian.html>

Pedestrian Safety

Motorists who see pedestrian(s) in a marked crosswalk **MUST**:

STOP and stay STOPPED

Old New Jersey Law	Beginning April 1, 2010
<p>STATE LAW</p> <p>WITHIN CROSSWALK</p>	<p>STATE LAW</p> <p>WITHIN CROSSWALK</p>

NEW JERSEY STATUTE 39:4-36

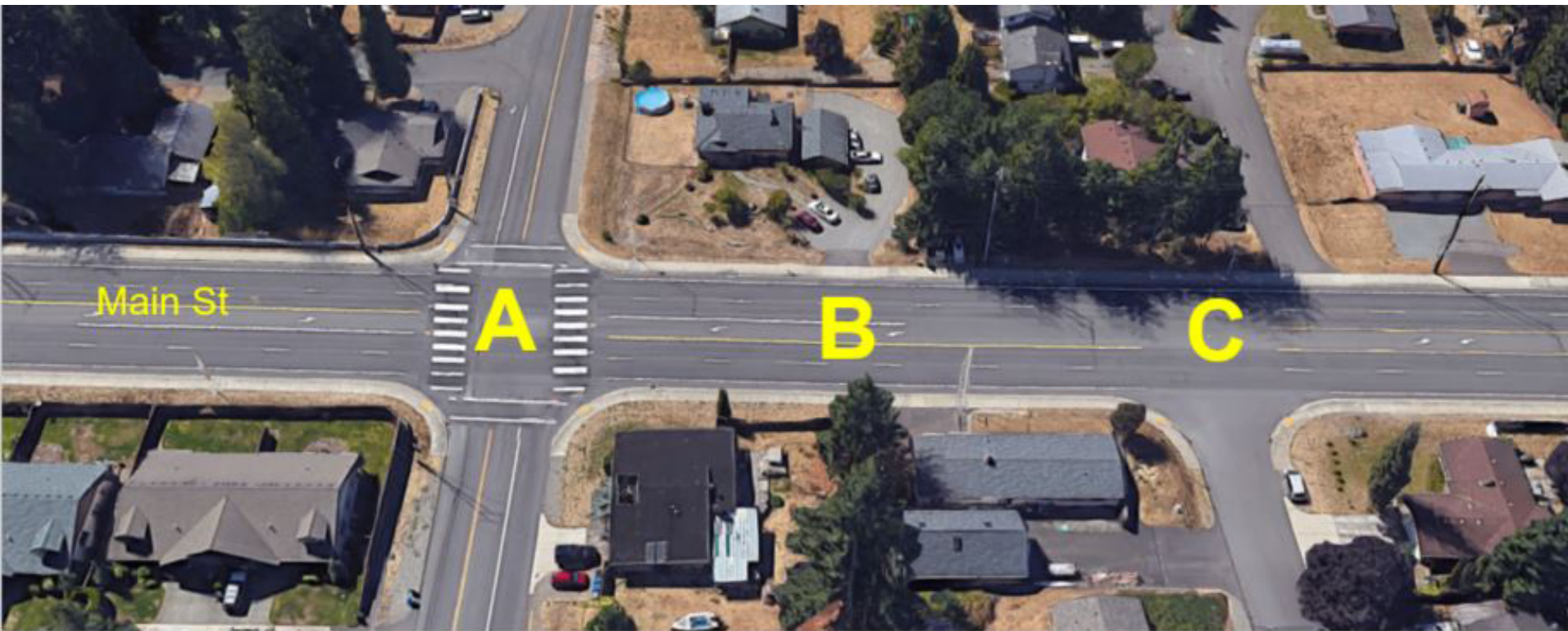
Driver to stop for pedestrian

A. The driver of a vehicle must stop and stay stopped for a pedestrian crossing the roadway within any marked crosswalk, but shall yield the right-of-way to a pedestrian crossing the roadway within an unmarked crosswalk at an intersection, except at crosswalks when the movement of traffic is being regulated by police officers or traffic control signals, or where otherwise prohibited by municipal, county, or State regulation, and except where a pedestrian tunnel or overhead pedestrian crossing has been provided, but no pedestrian shall suddenly leave a curb or other place of safety and walk or run into the path of a vehicle which is so close that it is impossible for the driver to yield.

NEW JERSEY STATUTE 39:4-36 continued

- Whenever any vehicle is stopped to permit a pedestrian to cross the roadway, the driver of any other vehicle approaching from the rear shall not overtake and pass such stopped vehicle.
- Every pedestrian upon a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right-of-way to all vehicles upon the roadway.

Who has the Right of Way at A, B, C crossing Main St?



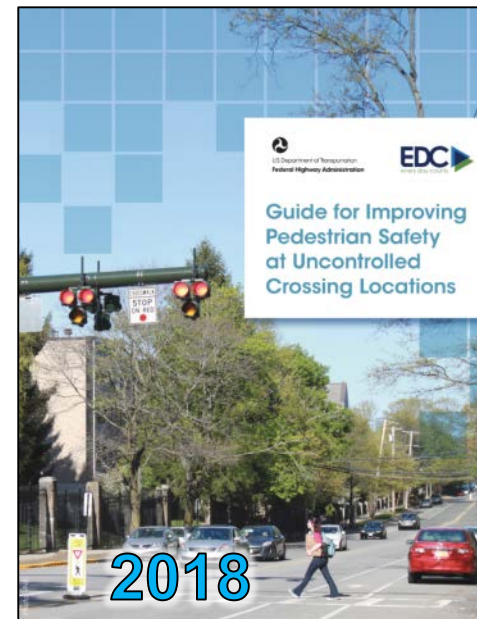
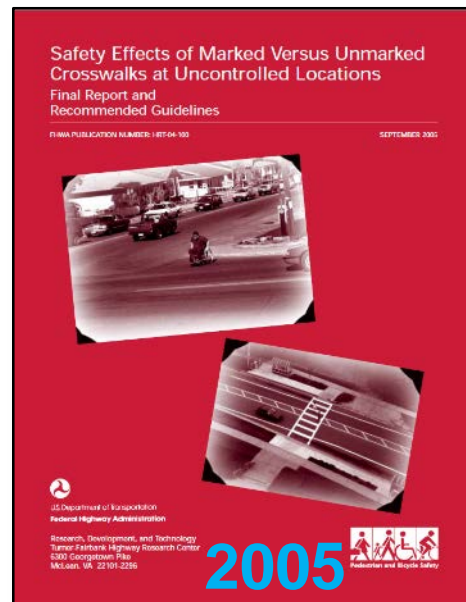


Table 11. Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT >9,000 to 12,000			Vehicle ADT >12,000–15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)
Two lanes	C	C	P	C	C	P	C	C	N	C	P	N
Three lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multilane (four or more lanes) with raised median***	C	C	P	C	P	N	P	P	N	N	N	N
Multilane (four or more lanes) without raised median	C	P	N	P	P	N	N	N	N	N	N	N

* These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could prevent an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.

** Where the speed limit exceeds 64.4 km/h (40 mi/h), marked crosswalks alone should not be used at unsignalized locations.

*** The raised median or crossing island must be at least 1.2 m (4 ft) wide and 1.8 m (6 ft) long to serve adequately as a refuge area for pedestrians, in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

C = Candidate sites for marked crosswalks. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, and other factors may be needed at other sites. It is recommended that a minimum utilization of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) be confirmed at a location before placing a high priority on the installation of a marked crosswalk alone.

P = Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements. These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased by providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.

Table 1. Application of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle ADT <9,000			Vehicle ADT 9,000–15,000			Vehicle ADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	① 2 4 5 6 7 9	① 1 5 6 7 9	① 1 5 6 7 9	① 1 4 5 6 7 9	① 1 5 6 7 9	① 1 5 6 7 9	① 1 4 5 6 7 9	① 1 5 6 7 9	① 1 5 6 7 9
3 lanes with raised median (1 lane in each direction)	① 2 3 4 5 7 9	① 1 2 5 6 7 9	① 1 2 5 6 7 9	① 1 2 4 5 7 9	① 1 2 5 6 7 9	① 1 2 5 6 7 9	① 1 2 4 5 7 9	① 1 2 5 6 7 9	① 1 2 5 6 7 9
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	① 2 3 4 5 6 7 9	① 1 2 5 6 7 9	① 1 2 5 6 7 9	① 1 2 4 5 6 7 9	① 1 2 5 6 7 9	① 1 2 5 6 7 9	① 1 2 4 5 6 7 9	① 1 2 5 6 7 9	① 1 2 5 6 7 9
4+ lanes with raised median (2 or more lanes in each direction)	① 1 2 5 6 7 8 9	① 1 2 5 6 7 8 9	① 1 2 5 6 7 8 9	① 1 2 4 5 7 8 9	① 1 2 5 6 7 8 9	① 1 2 5 6 7 8 9	① 1 2 4 5 7 8 9	① 1 2 5 6 7 8 9	① 1 2 5 6 7 8 9
4+ lanes w/o raised median (2 or more lanes in each direction)	① 1 2 5 6 7 8 9	① 1 2 5 6 7 8 9	① 1 2 5 6 7 8 9	① 1 2 4 5 7 8 9	① 1 2 5 6 7 8 9	① 1 2 5 6 7 8 9	① 1 2 4 5 7 8 9	① 1 2 5 6 7 8 9	① 1 2 5 6 7 8 9

Given the set of conditions in a cell,

● Signifies that the countermeasure is a candidate treatment of a marked uncontrolled crossing location.

● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.

○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

- 1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning sign
- 2 Raised crosswalk
- 3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
- 4 In-Street Pedestrian Crossing sign
- 5 Curb extension
- 6 Pedestrian refuge island
- 7 Octagonal Rapid Flashing Beacon (ORFB)**
- 8 Road Diet
- 9 Pedestrian Hybrid Beacon (PHB)**

*Refer to Chapter 4, Using Table 1 and Table 2 to Select Countermeasures, for more information about using multiple countermeasures.

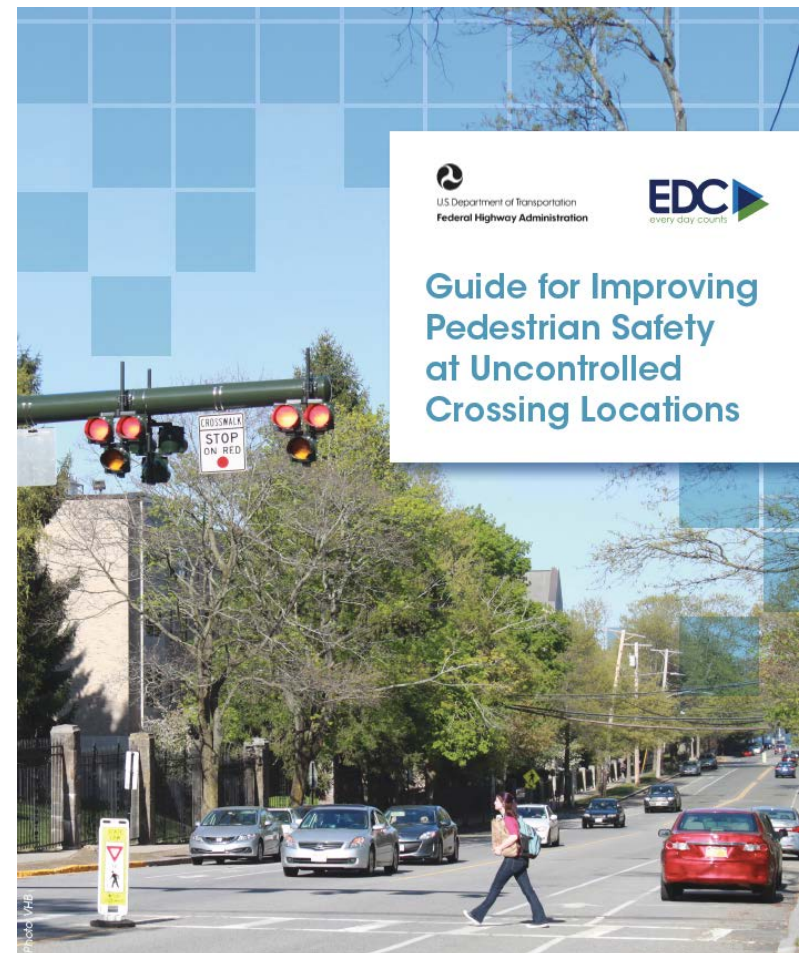
**The ORFB and PHB are not both installed at the same crossing location.



Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations

FHWA Guide

- Provides guidance and suggested process for selecting countermeasures
- Assists agencies in developing a policy to support the installation of countermeasures at uncontrolled pedestrian crossing locations



Countermeasure Selection Process

Following the process suggested in the guide offers countermeasure options based on road conditions, crash causes, and pedestrian safety issues.

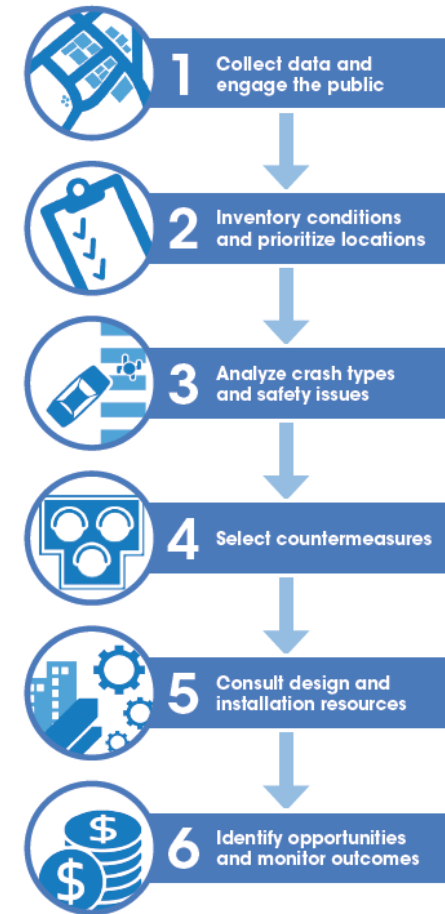


Figure 1. Process diagram for selecting countermeasures at uncontrolled pedestrian crossing locations.



4 Select countermeasures

Review Table 1 (roadway features)

- » AADT
- » Number of lanes
- » Median presence
- » Speed limit

Review Table 2 (safety issues)

- » Conflicts at crossings
- » Excessive speed
- » Visibility issues
- » Other





4

Select countermeasures

of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	① 2 4 5 6	① 5 6 7 9	① 5 6 ⑦ ⑨	① 4 5 6	① 5 6 7 9	① 5 6 ⑦ ⑨	① 4 5 6 7 9	① 5 6 7 9	① 5 6 ⑨
3 lanes with raised median (1 lane in each direction)	① 2 3 4 5	① ③ 5 7 9	① ③ 5 ⑦ ⑨	① 3 4 5 7 9	① ③ 5 ⑦ ⑨	① ③ 5 ⑦ ⑨	① ③ 4 5 7 9	① ③ 5 ⑦ ⑨	① ③ 5 ⑨
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	① 2 3 4 5 6 7 9	① ③ 5 6 7 9	① ③ 5 6 ⑨	① 3 4 5 6 7 9	① ③ 5 6 ⑦ ⑨	① ③ 5 6 ⑨	① ③ 4 5 6 7 9	① ③ 5 6 ⑨	① ③ 5 6 ⑨
4+ lanes with raised median (2 or more lanes in each direction)	① ③ 5 7 8 9	① ③ 5 7 8 9	① ③ 5 8 ⑨	① ③ 5 7 8 9	① ③ 5 ⑦ 8 ⑨	① ③ 5 8 ⑨	① ③ 5 ⑦ 8 ⑨	① ③ 5 8 ⑨	① ③ 5 8 ⑨
4+ lanes w/o raised median (2 or more lanes in each direction)	① ③ ① ③ 5 6 5 ⑥ 7 8 9 7 8 9	① ③ ① ③ 5 ⑥ 5 ⑥ 7 8 9 7 8 9	① ③ ① ③ 5 ⑥ 5 ⑥ 8 ⑨ 8 ⑨	① ③ ① ③ 5 ⑥ 5 ⑥ 7 8 9 ⑦ 8 9	① ③ ① ③ 5 ⑥ 5 ⑥ ⑦ 8 9 8 ⑨	① ③ ① ③ 5 ⑥ 5 ⑥ 8 ⑨ ⑦ 8 ⑨	① ③ ① ③ 5 ⑥ 5 ⑥ ⑦ 8 ⑨ 8 ⑨	① ③ ① ③ 5 ⑥ 5 ⑥ 8 ⑨ 8 ⑨	① ③ ① ③ 5 ⑥ 5 ⑥ 8 ⑨ 8 ⑨
<p>Given the set of conditions in a cell,</p> <p># Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.</p> <p>● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.</p> <p>○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*</p> <p>The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.</p>									
<p>1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning sign</p> <p>2 Raised crosswalk</p> <p>3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line</p> <p>4 In-Street Pedestrian Crossing sign</p> <p>5 Curb extension</p> <p>6 Pedestrian refuge island</p> <p>7 Rectangular Rapid-Flashing Beacon (RRFB)**</p> <p>8 Road Diet</p> <p>9 Pedestrian Hybrid Beacon (PHB)**</p>									

*Refer to Chapter 4, "Using Table 1 and Table 2 to Select Countermeasures," for more information about using multiple countermeasures.

**The PHB and RRFB are not both installed at the same crossing location.

The Spectacular Seven

STEP

Safe Transportation for Every Pedestrian



Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



Rectangular Rapid Flashing Beacon (RRFB)



Pedestrian Hybrid Beacon (PHB)



Road Diets



Leading Pedestrian Interval (LPI)

Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



RRFB



PHB



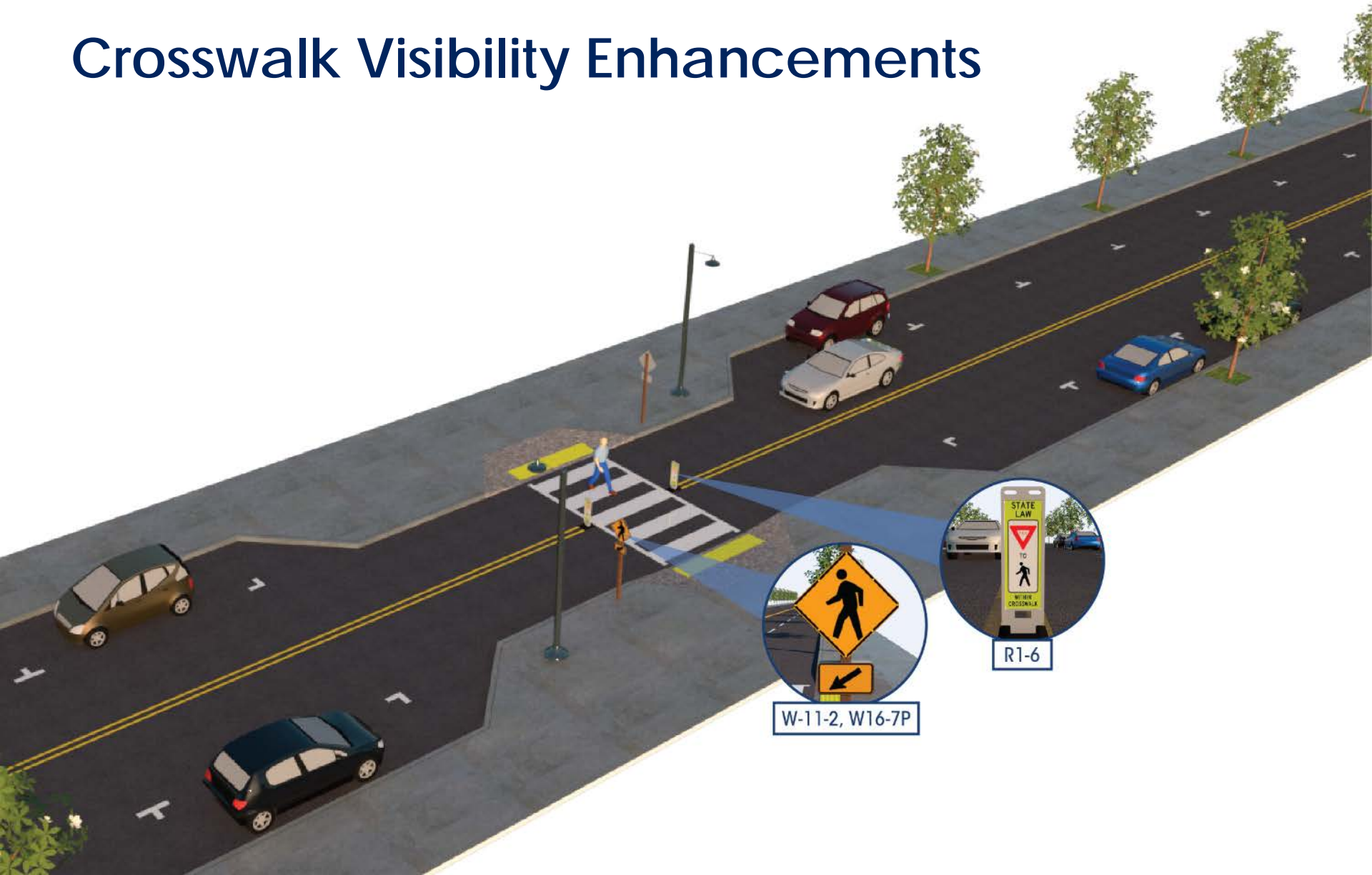
Road Diets



LPI



Crosswalk Visibility Enhancements



Crosswalk Visibility Enhancements

High Visibility Crosswalk

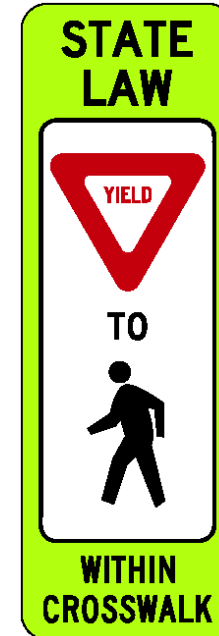
What Pedestrians See



Photo Source all 4: Michael Ronkin

What Drivers See

In-street pedestrian crossing signs



R1-6

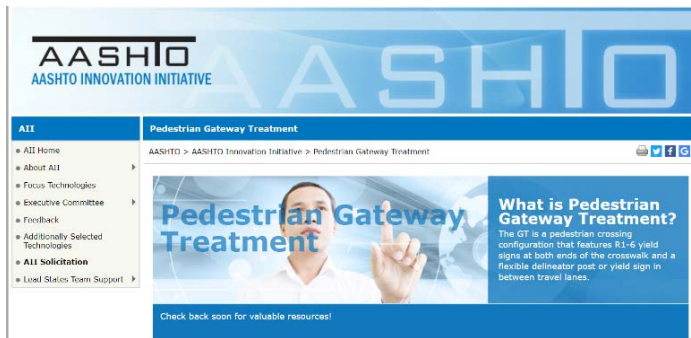


R1-6a

MUTCD signs

Yield or Stop depends
on state law

In Street Gateway Treatment



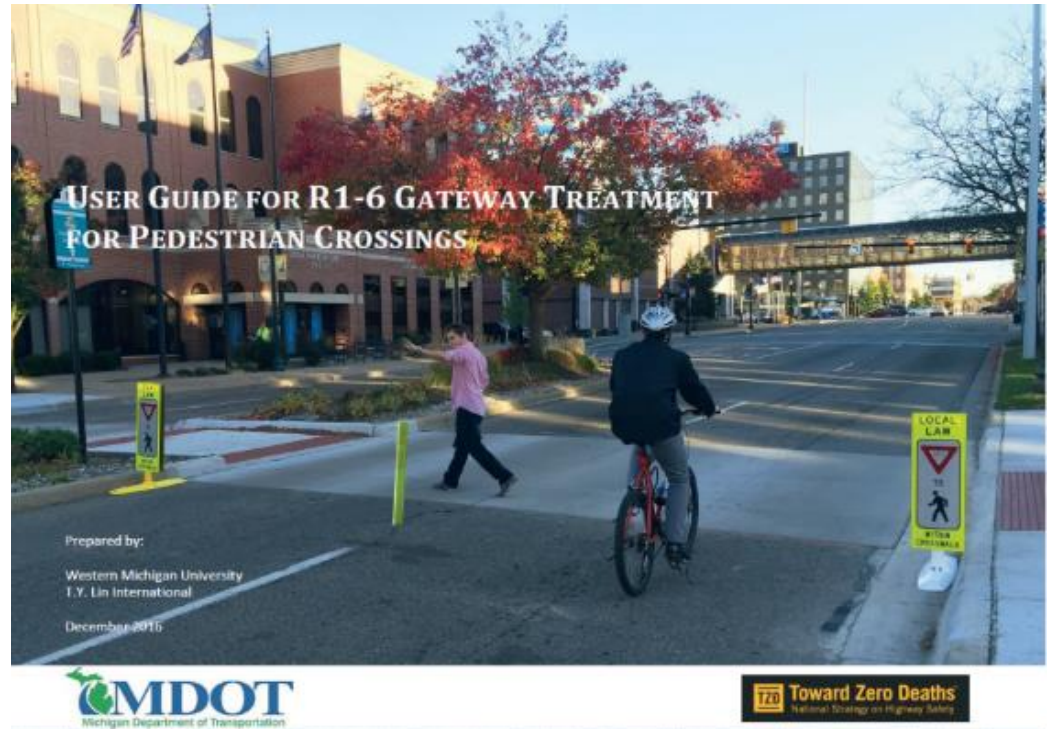
Resources

Pedestrian Gateway Treatment Technical Memo

Gateway Treatment for Pedestrian Crossings Presentation

User Guide for R1-6 Gateway Treatment for Pedestrian Crossing

<http://aii.transportation.org/Pages/Pedestrian-Gateway-Treatment.aspx>



http://aii.transportation.org/documents/User%20Guide_2018_0503_Final_UPDATED%20CDM%20Edgeline%20Clarification.pdf

Gateway Treatment, Three-Lane Configuration Without Refuge Island

Travel Lanes	2
Passing/Turn Lanes	1
R1-6 Signs	4
Flexible Delineators	0
Yielding Compliance	Between 60% and 90% compliance rate if speed limit is 30mph or less for ADT up to 25,000. If the speed limit is 35 mph expect similar results if ADT is 12,000 or less. UNKNOWN above 12,000 ADT.

Approximate Cost	\$1,200 for materials 20-minute installation 8 minutes to remove for winter 8 minutes to reinstall in spring
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General Description:

Note: By installing the gateway on the near side of the intersection, both crosswalks are covered with only four signs. Data show that a gateway at the near side crosswalk continues to be effective for the far side of the intersection, as the motorist on the far side has already passed through a gateway on the near side.

The signs on the curb side in the gutter pan would have a better chance of survival if they are moved placed between 3 and 50 feet in Advance of the crosswalk markings. This would reduce the chance of the sign being struck by a turning vehicle. Figure 6b shows a typical installation.



Figure 6a

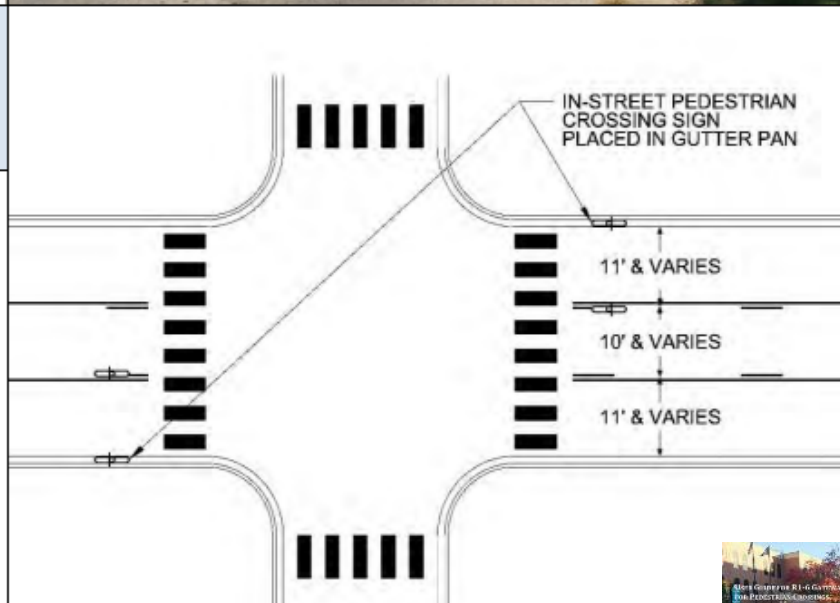


Figure 6b

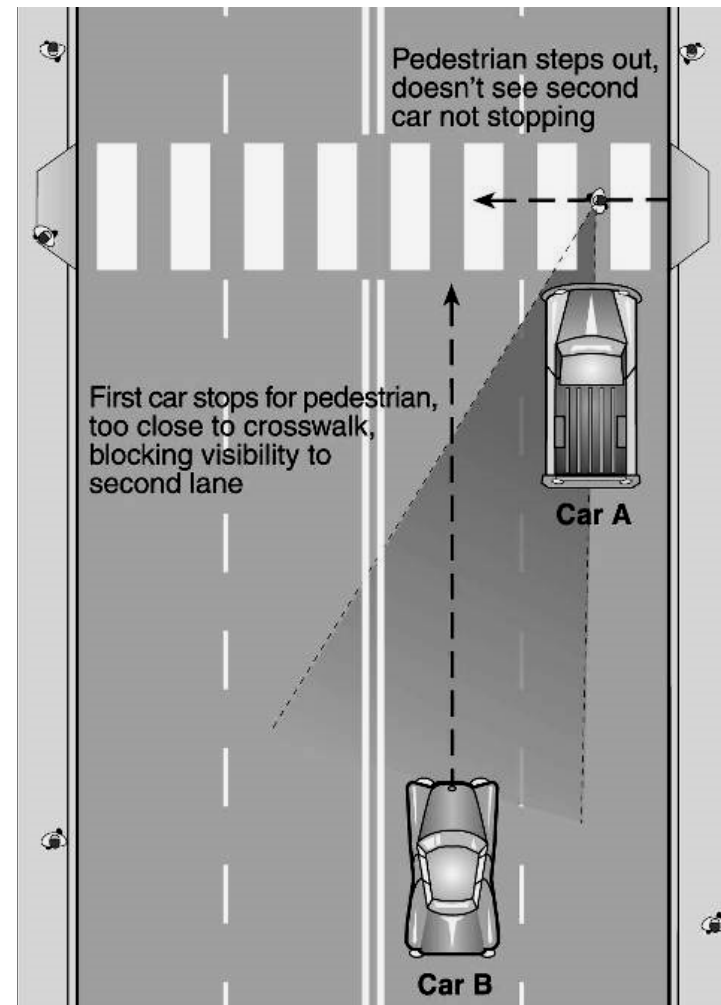


LED Pedestrian Sign



Multiple Threat Crash Problem

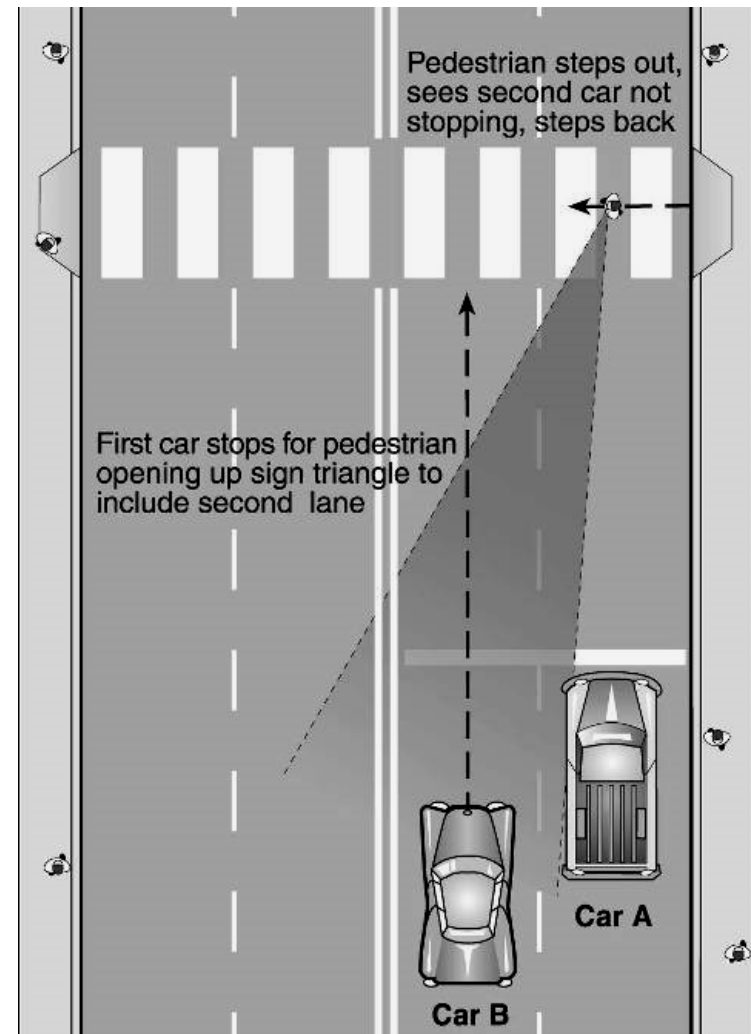
- 1st car stops to let pedestrian cross, blocking sight lines
- 2nd car doesn't stop, hits pedestrian at high speed



Multiple Threat Crash Solution

Advance stop or
yield line

- 1st car stops further back, opening up sight lines
- 2nd car can be seen by pedestrian



Signing to go along with markings



R1-5

(Use where local law says
yield to pedestrians)



R1-5a



R1-5b

(Use where local law says stop
for pedestrians)



R1-5c



- Advance yield line (shark's teeth) & sign
- Consider double white lines for no passing

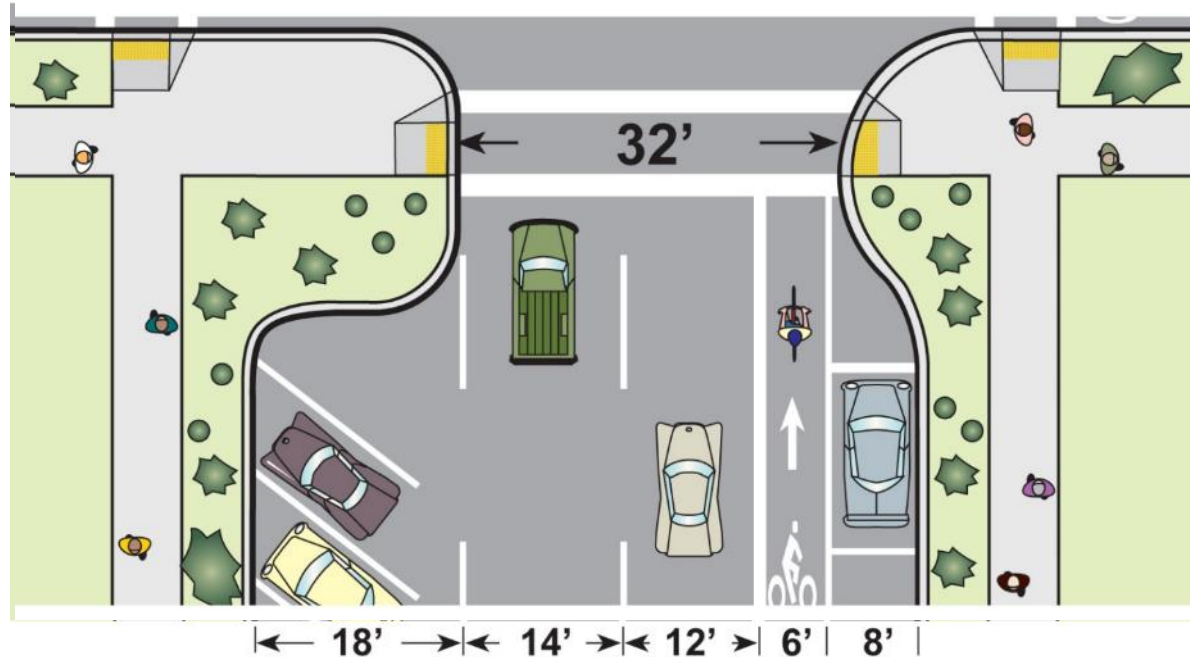
Curb extensions

Most focus is on reduced crossing distance

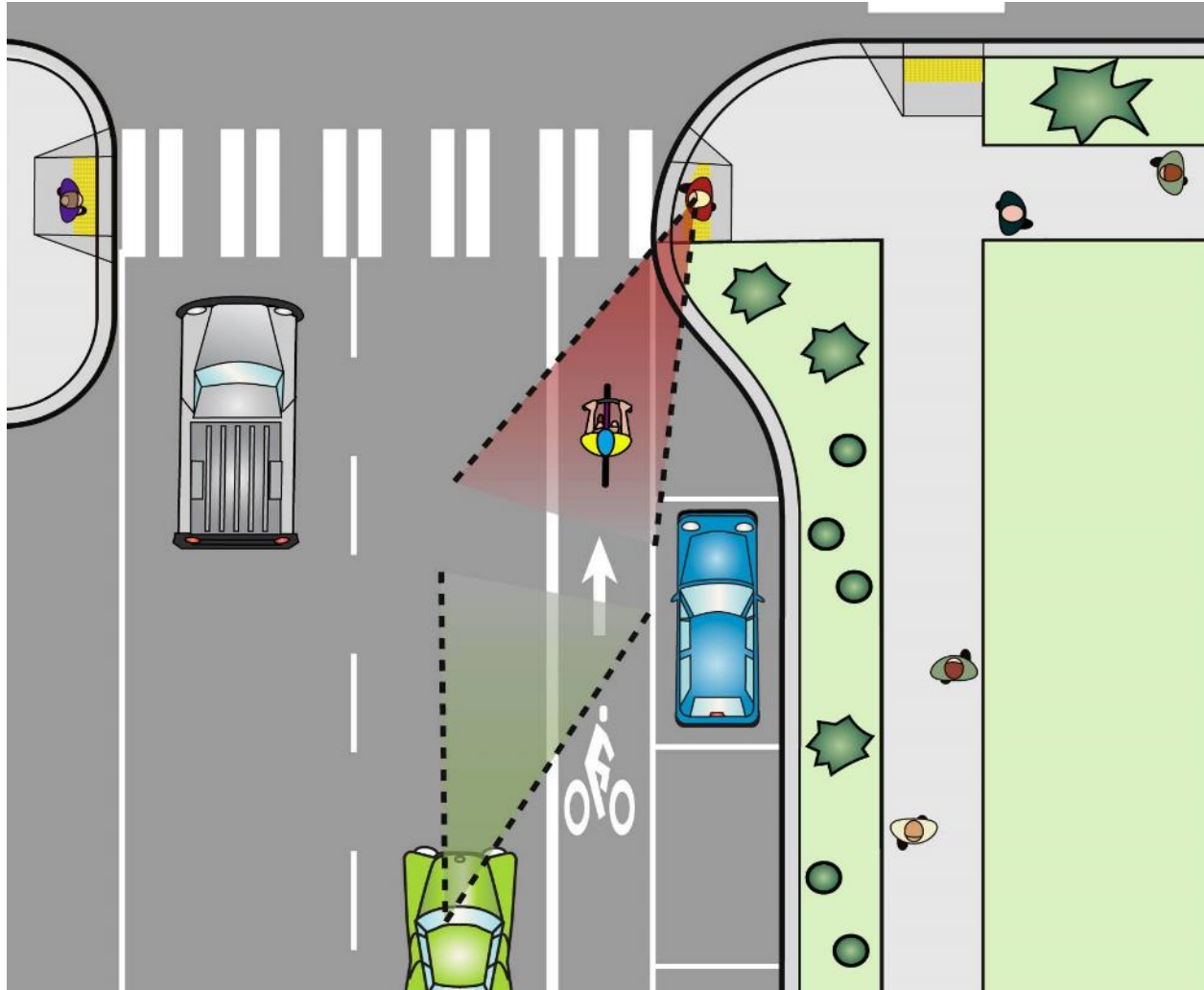
Other advantages:

- Better visibility between peds and motorists
- Traffic calming
- Room for street furniture

Curb extensions should be the width of the parking lane and not encroach on bike lanes or travel lanes



Better Visibility



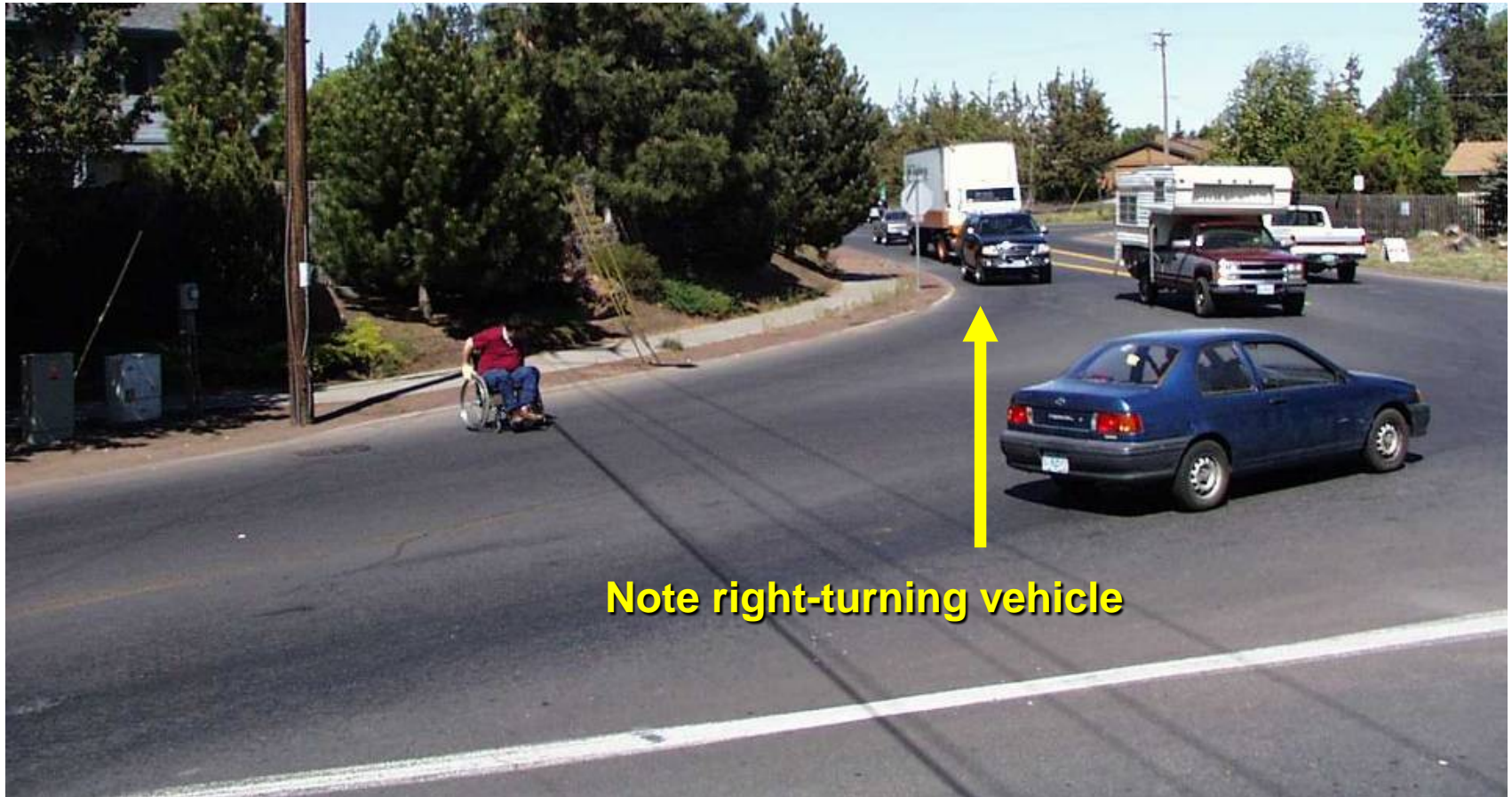


Before: road looks and feels wide



After: curb extension integral to sidewalk
Street looks narrow even with no parked cars

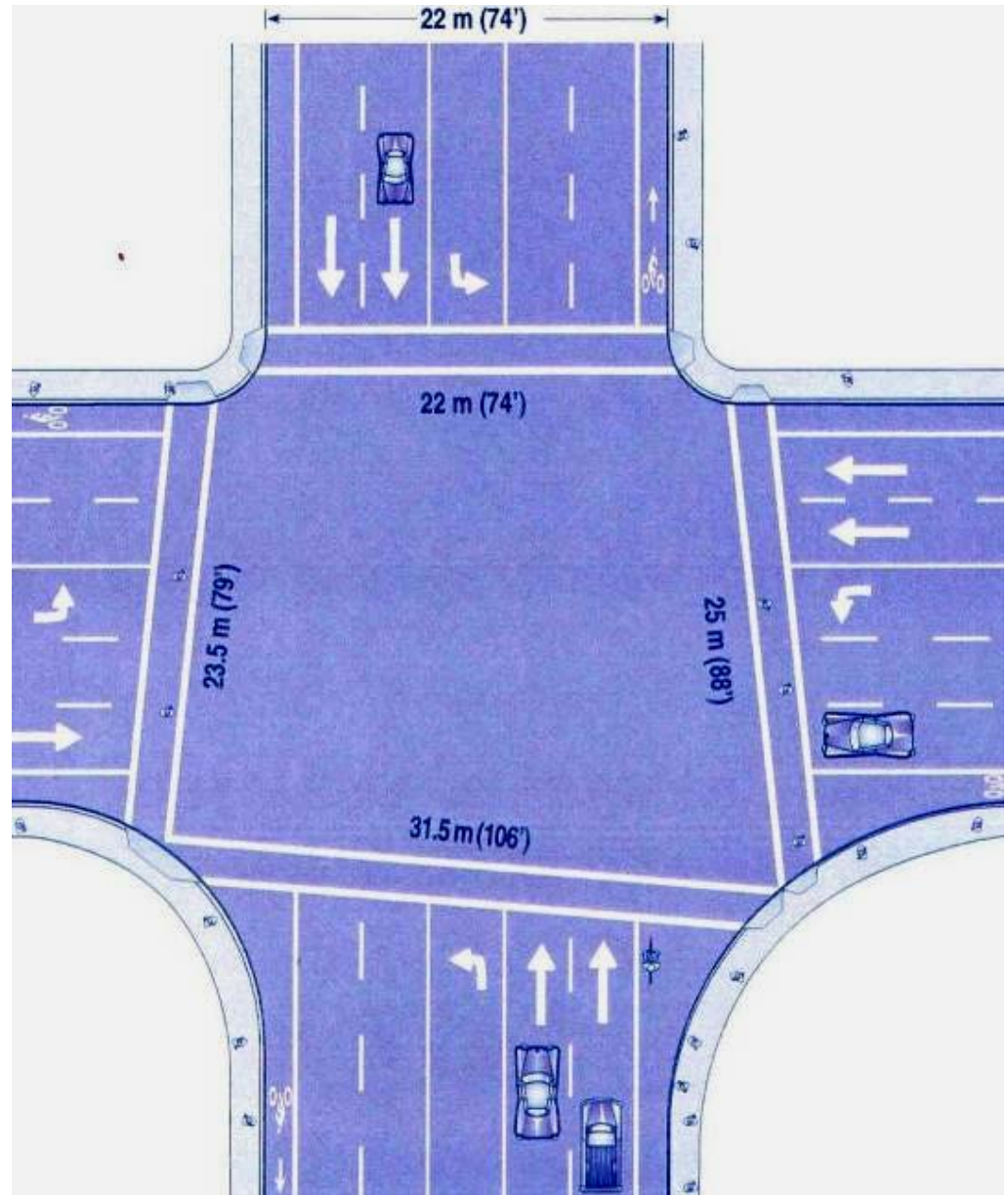
Effect of large radius on crosswalk:



... and makes it hard to figure out where to cross

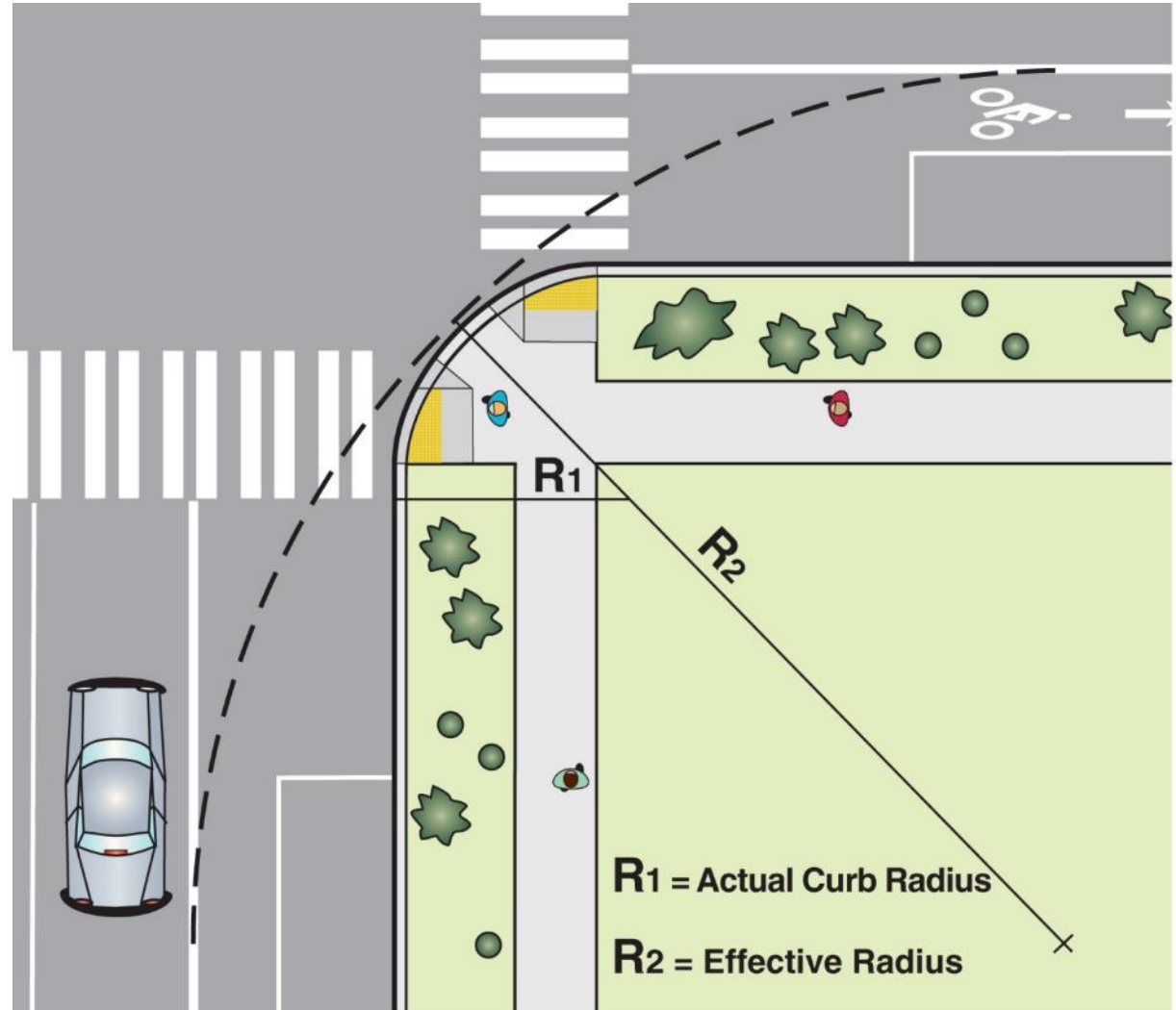
Curb radius –
small radii are
safer for
pedestrians

Large radii:
Increases crossing
distance
Makes crosswalk
& ramp placement
more difficult



Minimize curb radius

Calculate effective radius: Larger than built radius if travel lanes offset from curb with parking and/or bike lane



Effective Curb Radius



Minimize Curb Radius w/Truck Apron



Crosswalk Visibility Enhancements

Crosswalk Lighting



Photo source: Youtube screen capture SWARCO

- CRF 42% to 59%
- Lighting at intersections
- 4 star rating
- Vehicle/ped crashes

Lighting Over Crosswalks

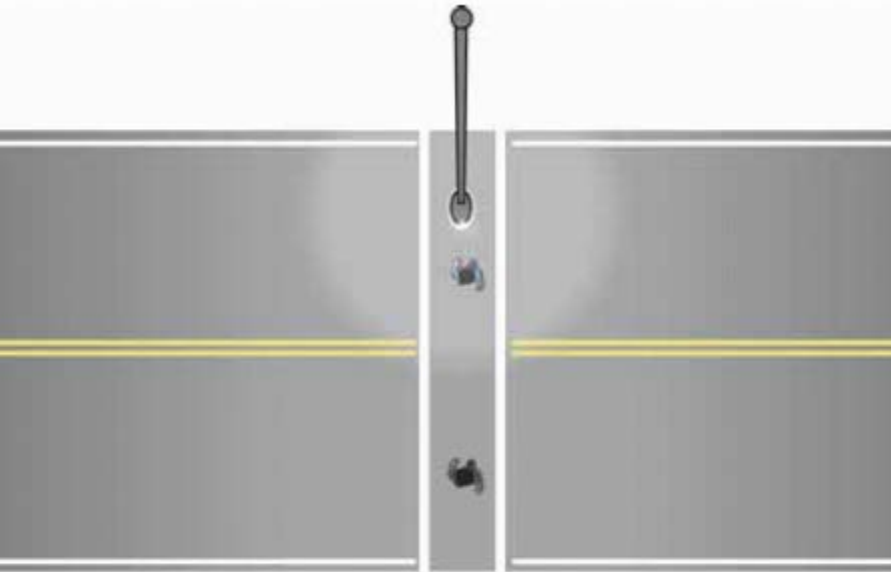


Fig 11. Traditional midblock crosswalk lighting layout

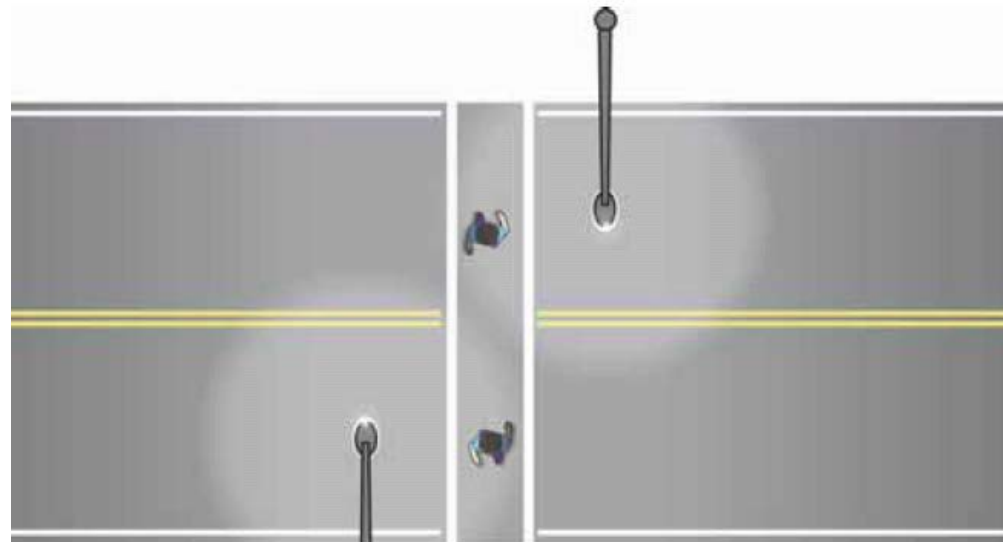
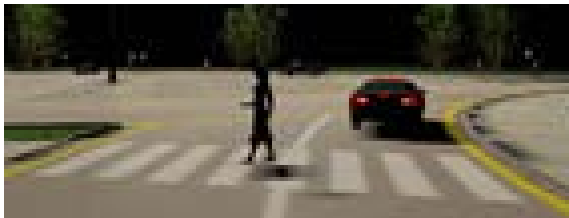


Fig 12. New design for midblock crosswalk lighting layout



Recommended lighting level: 20 lux at 5' above pavement

Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



RRFB



PHB



Road Diets



LPI



Raised Crosswalks

- Typically installed on 2-lane or 3-lane roads
- Speed limits of 30 mph or less
- AADT below about 9,000
- CRF: 45%



Photo Source: SRTS Guide

Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



RRFB



PHB



Road Diets



LPI

Pedestrian Refuge Island

SAFE TRANSPORTATION
FOR EVERY PEDESTRIAN
COUNTERMEASURE TECH SHEET

The combination of a long crossing distance and multiple lanes of oncoming traffic can create an unsafe pedestrian environment.

A pedestrian refuge island can improve safety and comfort by providing pedestrians with the option of waiting in the median area before beginning the next stage of the crossing.

Pedestrian refuge islands can reduce pedestrian crashes by **32%**

FEATURES:

- Median can enhance visibility of the crossing and reduce speed of approaching vehicles.
- Refuge area provides a place to rest and reduces the amount of time a pedestrian is in the roadway

OFTEN USED WITH:

- Crosswalk visibility enhancements
- Curb extensions (where road width allows)

A pedestrian refuge island is a median with a refuge area that is intended to help protect pedestrians who are crossing a multilane road. This countermeasure is sometimes referred to as a crossing island, refuge island, or pedestrian island. The presence of a pedestrian refuge island at a midblock location or intersection allows pedestrians to focus on one direction of traffic at a time as they cross, and gives them a place to wait for an adequate gap in oncoming traffic before finishing the second phase of a crossing.

Refuge islands are highly desirable for midblock pedestrian crossings on roads with four or more travel lanes, especially where speed limits are 35 mph or greater and/or where annual average daily traffic (AADT) is 9,000 or higher. They are also a candidate treatment option for uncontrolled pedestrian crossings on 3-lane or 2-lane roads that have high vehicle speeds or volumes. When installed at a midblock crossing, the island should be supplemented with a marked high-visibility crosswalk.

EDC

Pedestrian Refuge Islands





Phoenix, AZ – W. Van Buren Street. Before: 1/2-mile signal spacing; high-volume, high-speed; marked crosswalks at unsignalized intersections



Phoenix, AZ

Before: No frills marked crosswalk at intersection



After: added RRFB and Advanced Stop Bars

Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



RRFB



PHB



Road Diets



LPI

Rectangular Rapid-Flashing Beacon (RRFB)

SAFE TRANSPORTATION FOR EVERY PEDESTRIAN
COUNTERMEASURE TECH SHEET

High speeds and multiple lanes of traffic create challenges for pedestrians crossing at unsignalized locations.

RRFBs can make crosswalks and/or pedestrians more visible at a marked crosswalk.

RRFBs can reduce pedestrian crashes by **47%**

FEATURES:

- Enhanced warning
- Improves motorist yielding

OFTEN USED WITH:

- Crosswalk visibility enhancements
- Pedestrian refuge island
- Advance STOP or YIELD markings and signs

An RRFB is a pedestrian-actuated conspicuity enhancement used in combination with a pedestrian crossing warning sign to improve safety at uncontrolled crossing locations. The device includes two rectangular-shaped yellow indications, each with an LED-array-based light source, that flash with high frequency when activated.

The RRFB is a treatment option at many types of established pedestrian crossings. For example, an RRFB may be a consideration for crossings of 2 or more lanes with speed limits of 35 mph or above and/or at crossings of 3 or more lanes with any speed limits. However, for high-speed roads (40 mph or greater) combined with high vehicle volumes (annual average daily traffic of 15,000 and above) and/or certain combinations of high-volume and high-speed, the RRFB may not be sufficient, and a Pedestrian Hybrid Beacon is likely a better option.

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Rectangular Rapid Flashing Beacon New IA-21


		<h2>Memorandum</h2>	
<p>Correction issued 3/21/2018</p>			
Subject: <u>INFORMATION:</u> MUTCD – Interim Approval for Optional Use of Pedestrian-Actuated Rectangular Rapid-Flashing Beacons at Uncontrolled Marked Crosswalks (IA-21)		Date: MAR 20 2018	
From: Martin C. Knopp <i>Martin C. Knopp</i> Associate Administrator for Operations		In Reply Refer To: HOTO-1	
To: Federal Lands Highway Division Directors Division Administrators			



Figure 1. Example of an RRFB dark (left) and illuminated during the flash period (center and right) mounted with W11-2 sign and W16-7P plaque at an uncontrolled marked crosswalk.

https://mutcd.fhwa.dot.gov/res-interim_approvals.htm#valid09

Must request and receive permission to use this new Interim Approval (1A-21) even if prior approval had been given for Interim Approval 1A-11

A State may request Interim Approval for all jurisdictions in that State.



St. Petersburg FL

IA-21 3.a For any approach two RRFB required, One on right-hand and one on left-hand of roadway. If divided highway left-hand should be installed on median if practical rather than far left-hand.

RRFB Video IA-21Flash Pattern



IA-21 Beacon Operation

6. e.

- Flash period shall be immediately initiated each and every time a pedestrian is detected through passive detection or pushbutton activated, including when pedestrians are detected while RRFB's are already flashing and when pedestrians are detected immediately after the RRFB's have ceased flashing.

6. f.

- Small pilot light may be installed



Figure 2. View of pilot light to pedestrian at shared-use path crossing with median refuge. Enlargement of pilot light at right.

IA-21 Accessible Pedestrian Features

- 7. a. - If speech pushbutton information message is used locator tone shall be provided
- 7. b. - If speech pushbutton information message is used, the audible information device shall not use vibrotactile indications or percussive indications
- 7. c. - Speech pushbutton message "Yellow lights are flashing". Message should be spoken twice.



Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



RRFB



PHB



Road Diets



LPI

Pedestrian Hybrid Beacon (PHB)

SAFE TRANSPORTATION
FOR EVERY PEDESTRIAN
COUNTERMEASURE TECH SHEET

High speeds and multiple lanes of traffic create challenges for pedestrians crossing at unsignalized locations.

PHBs can warn and control traffic at unsignalized locations and assist pedestrians in crossing a street or highway at a marked crosswalk.

PHBs can reduce pedestrian crashes by **55%**

FEATURES:

- Beacons stop all lanes of traffic, which can reduce pedestrian crashes.

OFTEN USED WITH:

- High-visibility crosswalk markings
- Raised islands
- Advance STOP or YIELD signs and markings

A Pedestrian Hybrid Beacon head consists of two red lenses above a single yellow lens. Unlike a traffic signal, the PHB rests in dark until a pedestrian activates it via pushbutton or other form of detection. When activated, the beacon displays a sequence of flashing and solid lights that indicate the pedestrian walk interval and when it is safe for drivers to proceed (see figure on back page).

The PHB is often considered for installation at locations where pedestrians need to cross and vehicle speeds or volumes are high, but traffic signal warrants are not met. These devices have been successfully used at school crossings, parks, senior centers, and other pedestrian crossings on multilane streets. PHBs are typically installed at the side of the road or on mast arms over midblock pedestrian crossings.

US Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
every day counts

EDC
every day counts

Pedestrian Hybrid Beacon (PHB)
EDC-4 STEP: https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/stop.cfm

Pedestrian Hybrid Beacons (PHB)



CRF: Vehicle/Pedestrian 69%



1
Blank for
drivers



2
Flashing
yellow



3
Steady yellow



4
Steady red



5
Wig-Wag



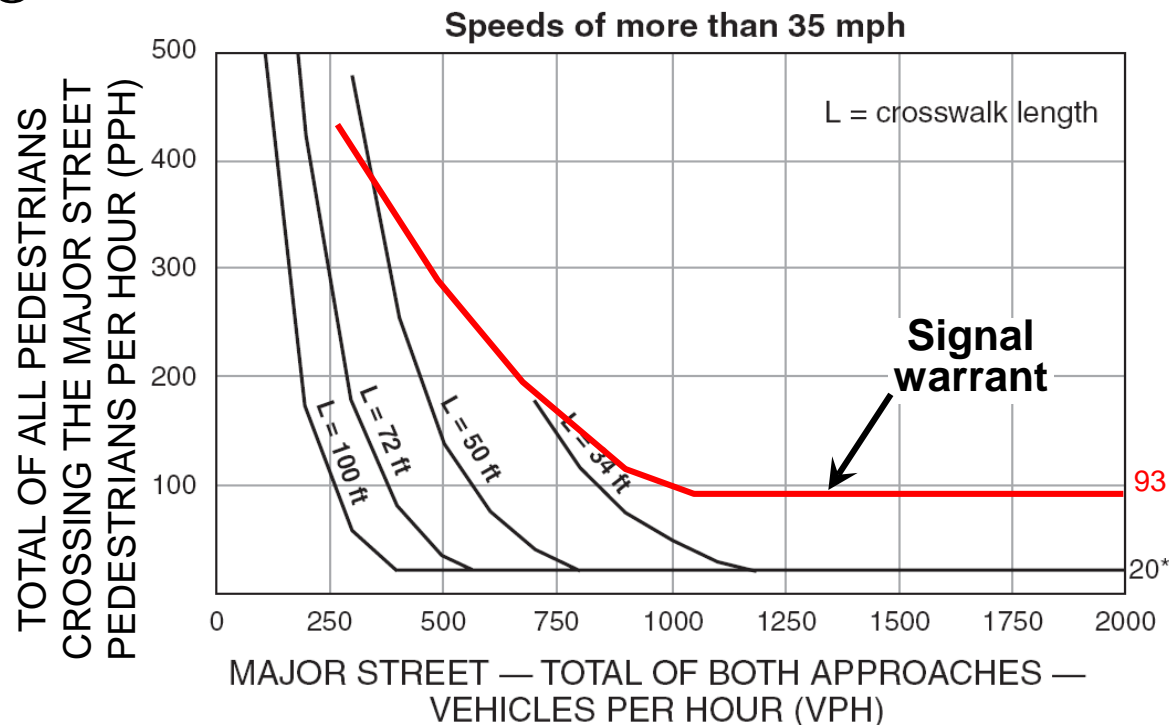
Return
to 1



Excerpts from 2009 MUTCD Chapter 4F For Pedestrian Hybrid Beacons

The CROSSWALK STOP ON RED sign shall be used
There are Guidelines (similar to signal warrants) for Pedestrian Hybrid Beacons – variables include:

- Pedestrian volume
- Traffic speeds
- Traffic volumes
- Crosswalk length



2009 MUTCD mandated sign

Standard:

A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign shall be mounted adjacent to a PHB face on each major street approach.

Option:

- State MUTCD's may allow other appropriate MUTCD approved ped, bike or school crossing signs



Optional Signing

Courtesy: City of Columbus



Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



RRFB



PHB



Road Diets



LPI



Road Diet / Roadway Reconfiguration



- Reduce top end travel speeds
- Buffer sidewalk from travel lanes (parking or bike lane)
- Reclaim street space for “higher and better use” than moving peak hour traffic

Road Diet / Roadway Reconfiguration



- Reduce crossing distance
- Eliminate /reduce “multiple threat” crash types
- Install crossing island to cross in 2 simple steps

General Guidelines for Traffic Volumes

LESS THAN
10,000 ADT

Great
candidate
for Road
Diet

In most instances traffic will likely not be negatively affected.

10,000 –
15,000 ADT

Very good
candidate
for Road
Diet

Agencies should conduct intersection analysis to study potential traffic operational effects and consider signal retiming as needed.

15,000 –
20,000 ADT

Good
candidate
for Road
Diet

Agencies should conduct a corridor analysis since traffic operations may be affected at this volume depending on the “before” condition.

GREATER THAN
20,000 ADT

Potential
candidate
for Road
Diet

Agencies should complete a feasibility study to determine whether this is a good location for a Road Diet. Operations may be affected at this volume.

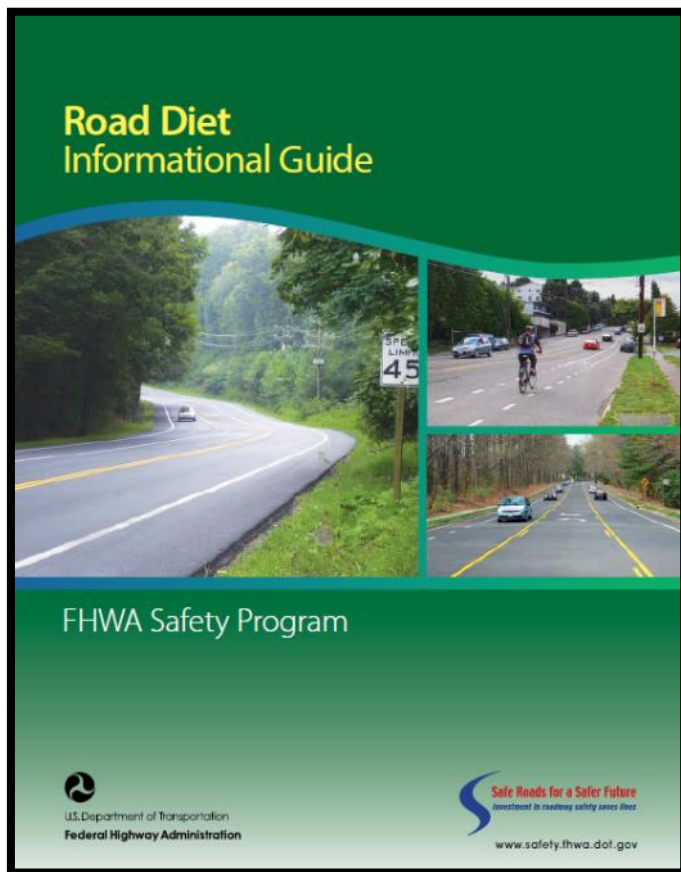
There are examples across the country where Road Diets have been successful with ADTs as high as 26,000

Intersections

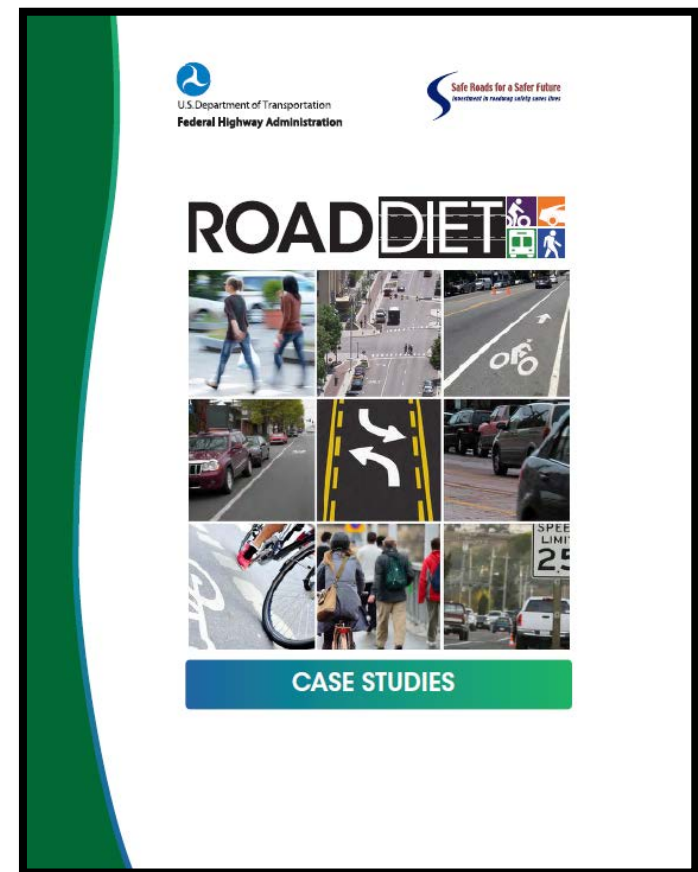
- Signal timing or phasing changes at intersections to optimize operations and safety benefits
- Roundabouts Single Lane
 - ~ 20,000 ADT



Road Diet Informational Guide & Road Diet Case Studies



https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/



https://safety.fhwa.dot.gov/road_diets/case_studies/

New Jersey Road Diet



Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



RRFB



PHB



Road Diets



LPI

Leading Pedestrian Interval (LPI)

SAFE TRANSPORTATION FOR EVERY PEDESTRIAN
COUNTERMEASURE TECH SHEET

LPIs reduce conflicts between pedestrians and vehicles.

LPIs improve visibility of pedestrians in the crosswalk.

LPIs can reduce pedestrian crashes by **59%**

FEATURES:

- Increased likelihood of driver yielding.
- Enhanced safety for slower moving pedestrians.

OFTEN USED WITH:

- Right Turn on Red (RTOR) Restrictions.
- Accessible Pedestrian Signals.

Leading Pedestrian Intervals (LPIs) are low-cost adjustments to signal timing to increase pedestrian safety of signalized intersections. An LPI gives pedestrians a typical 3- to 7-second head start before vehicles in the parallel direction are given the green signal indication. Pedestrians cross several feet into the intersection before turning vehicles with an LPI, increasing likely yielding. LPIs help reduce conflicts between pedestrians and left-turning vehicles. Agencies will often choose to allow right turn on Red (RTOR) in conjunction with LPIs to further control for conflicts with turning vehicles.

The MUTCD Traffic Control Devices (MUTCD) offers guidance on when LPI is used. The MUTCD says LPIs should be at least 3 seconds in duration and should be timed to allow pedestrians to cross at least one lane of traffic or, in the case of a large corner radius, to travel far enough for pedestrians to establish their position ahead of the turning traffic before the turning traffic is released. MUTCD guidance also offers considerations for accessible pedestrian signals when LPIs are used.

U.S. Department of Transportation
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October 2019 / FHWA SE-19-02

Leading Pedestrian Interval

3+ second head start to enter the crosswalk



Source: FHWA

MUTCD Sec. 4E.06, paragraphs 20-21

Guidance:

20 *If a leading pedestrian interval is used, the use of accessible pedestrian signals (see [Sections 4E.09 through 4E.13](#)) should be considered.*

Support:

21 *If a leading pedestrian interval is used without accessible features, pedestrians who are visually impaired can be expected to begin crossing at the onset of the vehicular movement when drivers are not expecting them to begin crossing.*



LPI Guidance in the works (Draft)

	A	B	C	D	E	F	G	H	I	J	K	L
1	Jurisdiction	Toronto	Washington, DC	Portland	Florida	Boulder	Boston	Chicago	St. Paul	Alexandria, VA	Charlotte	New York City
2	Year of Published Guidance	2014	2018	2016	2017	2018	2018	2013	2016	2016	2016	2018
3		internal scoring document	internal scoring document	internal scoring process	warrants	if any are met	if any are met	how to prioritize locations	street design manual recommendations	Complete Streets Design Guidelines	informal internal guidelines	internal policy document
4	Suitability Criteria											
5	Intersections where drivers make left turns without a need to yield to oncoming traffic (i.e. T-intersections and intersections of roads with one-way roads)	x	x	x			x	x				
6	Visibility issues	x	x	x	x		x					
7	Volume of crossing pedestrians	x		x	x		x		x	x	x	x
8	Rate of collisions between pedestrians and turning vehicles or observed non-yield or near-miss incidents	x	x	x	x	x		x	x		x	x
9	Close proximity to elementary schools	x	x	x	x	case	x	x	x	x	x	x
10	Level of activity by elderly residents	x		x		case	x		x	x		x
11	Impact on vehicular traffic (delay, LOS, high volume)	x	x	x	exception	x						
12	Existing Protected Pedestrian Movement		x									
13	Cross-Product of Vehicle and Pedestrian Volumes		x			x						
14	Major Pedestrian Generator		x									
15	Distance between Parallel Curb Line and Crosswalk		x									
16	Pedestrian minimums for minor street split		x									
17	High Cross-Street traffic				case	case						
18	High turning traffic				x		x	x	x			x
19	Improvement to operations with LPI+Concurrent WALK phasing						x					
20	No YELLOW TRAP for vehicle traffic						x					
21												
22	Evaluation Form	x	x									
23												
24	Design Considerations											
25	5 second or formula-based minimum	x										
26	3 second or formula-based minimum		x		x				x	x	x	
27	10 seconds										x schools or RT flashing arrow	for bike facilities
28	7 seconds											
29	RTOR prohibitions for right turn movements	x			case	x	case		x			x

Spectacular Seven



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



Rectangular Rapid Flashing Beacon (RRFB)



Pedestrian Hybrid Beacon (PHB)



Road Diets



Leading Pedestrian Interval (LPI)

Systemic Pedestrian Safety Analysis



Systemic safety improvement means a **proven** safety countermeasure(s) that is widely implemented based on **high-risk** roadway features that are correlated with particular **severe** crash types.

<http://www.trb.org/NCHRP/Blurbs/178087.aspx>

Systemic Safety

- Approach to identify high-risk roadway features correlated with specific or severe crash types
- Data-driven
- Network-wide
- Addresses locations with
 - prior crash occurrence
 - similar roadway or environmental crash characteristics
- Considered more proactive

- Overview
 - Background on a Systemic Process and key features
 - How to use the Guidebook and intended audience
 - Relation to other agency processes
- Process steps



Figure 3. Steps in a systemic pedestrian safety analysis process.

Case Examples

1. Seattle Department of Transportation
2. Oregon Department of Transportation
3. Arizona Department of Transportation
4. California Department of Transportation

Case Example: Seattle

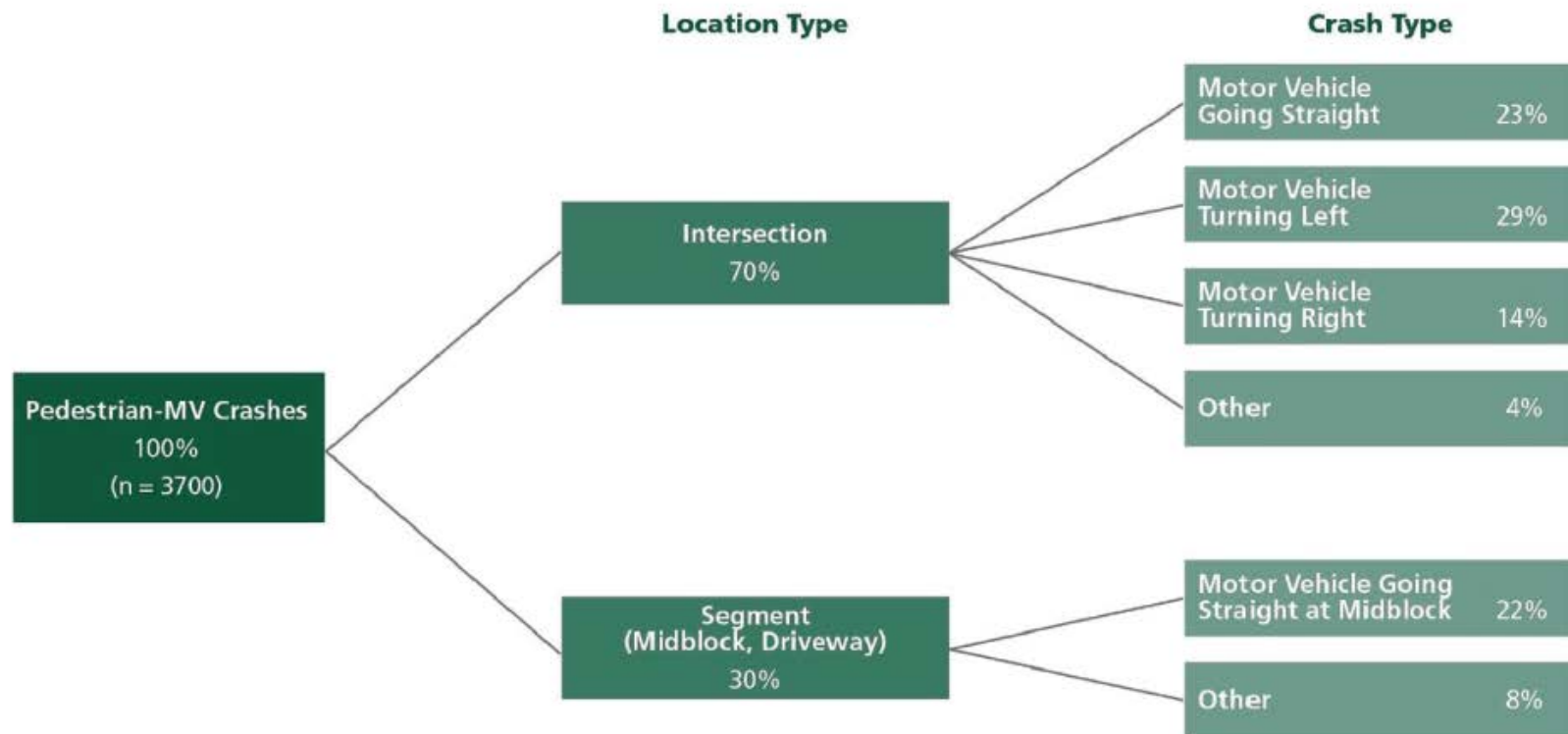


Figure 6. Pedestrian crash distributions by location type and crash type, based on data from 2008–2014 (Adapted from Figure 12 in City of Seattle Bicycle and Pedestrian Safety Analysis 2016).

Case Example: Oregon

Table 20. Oregon DOT–identified pedestrian risk factors.

Pedestrian Risk Factor	Relative Weight	Risk Factor Score
Proximity to signal	1	1 point if at least one signal is located on the segment or within 100 feet of the segment
Proximity to transit stop	2	1 point for segments with one transit stop located on the segment or within 100 feet of the segment; 2 points for two or more transit stops
Pedestrian-activated beacons or flashers	2	1 point subtracted (rewarded) for the presence of an enhanced midblock crossing
Posted speed limit	3	2 points for posted speed limit of 35 or 40 mph 4 points for posted speed limits above 40 mph
Undivided 4-lane segment characteristic	3	2 points if segment is an undivided 4-lane segment
Number of non-severe injuries and pedestrian involved but not injured in crashes	4	2 points if a non-severe injury or pedestrian-involved crash was reported within 100 feet; 1 additional point for each additional injury or pedestrian involved
AADT	4	2 points for AADT between 12,000 and 18,000 4 points awarded for AADT above 18,000
Number of severe injuries resulting from pedestrian-involved crashes	5	4 points if a severe injury was reported; 2 additional points awarded for each additional severe injury
Number of fatalities resulting from pedestrian-involved crashes	5	4 points if a fatality was reported

Case Example: Arizona

Table 21. Pedestrian crash risk factors and corresponding data sources.

Risk Factor Category	Risk Factor	Data Source
Existing conditions	Posted speed limit	Arizona DOT Highway GIS
	Operating environment/number of lanes/roadway width	
	Missing sidewalk link	
	Paved shoulder width	
	Prior crashes	
	Traffic volume	
	Signalized intersection spacing	
Pedestrian demand	Population density	Census Bureau
	Attractors (e.g., convenience stores, schools, parks)	Land use maps and visual inspection (corridor-level only)
	Land use (commercial and high density housing)	
At-risk groups	% Households in poverty	Census Bureau
	% Households with no vehicle	Land use maps and visual inspection (corridor-level only)
	At-risk groups (children, elderly, and handicapped)	

Case Example: California

Location type is based on features of the site.

Example:

Intersection; ADT < 10,000;
speed \leq 45 mph;
3 or 4 lanes; traffic signal not present.

Crash type is based on features of the crash.

Example:

Turning vehicle

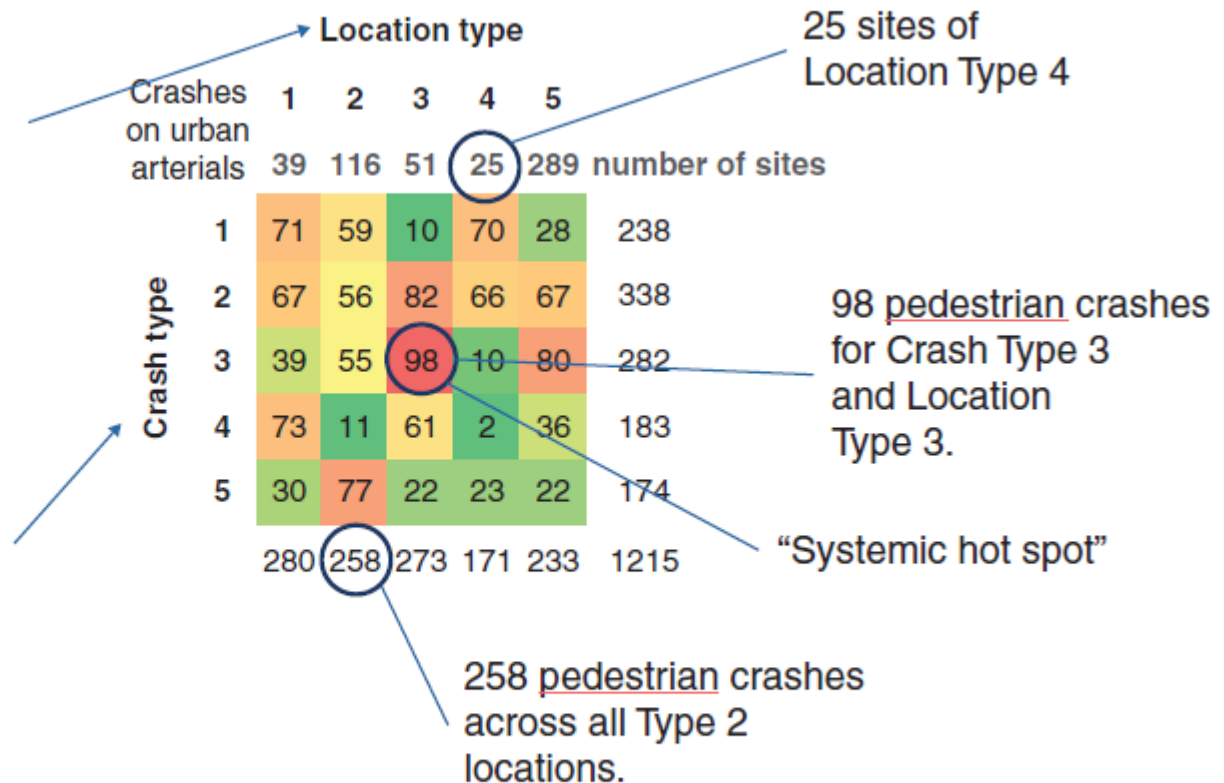


Figure 9. Example of systemic hot spot identification matrix (Grembek et al. 2013).

Case Example: California

Location type is based on features of the site.

Example:

Intersection; ADT < 10,000;
speed \leq 45 mph;
3 or 4 lanes; traffic signal not present.

Crash type is based on features of the crash.

Example:

Turning vehicle

		Location type				
Crash type	Possible countermeasure	1	2	3	4	5
	1	1,2	3,4	1,2	2,6	7,8,9
	2	2	3,5,6	4	6,7	4,7,9
	3	1,3,4	3	2,4	6	4,5
	4	4	5	1,2,3	2,3,6	5,7
	5	2	5,6	3	3,6	5,7

To reduce Type 3 crashes at Type 3 locations, apply countermeasures 2 or 4, across all of the Type 3 locations ($n = 51$) of the arterial (i.e., systemic).

Values in this table represent the possible countermeasures to reduce crash type i for location j .

Figure 10. Example of systemic countermeasure matrix (Grembek et al. 2013).

Webinar http://www.pedbikeinfo.org/webinars/webinar_details.cfm?id=14

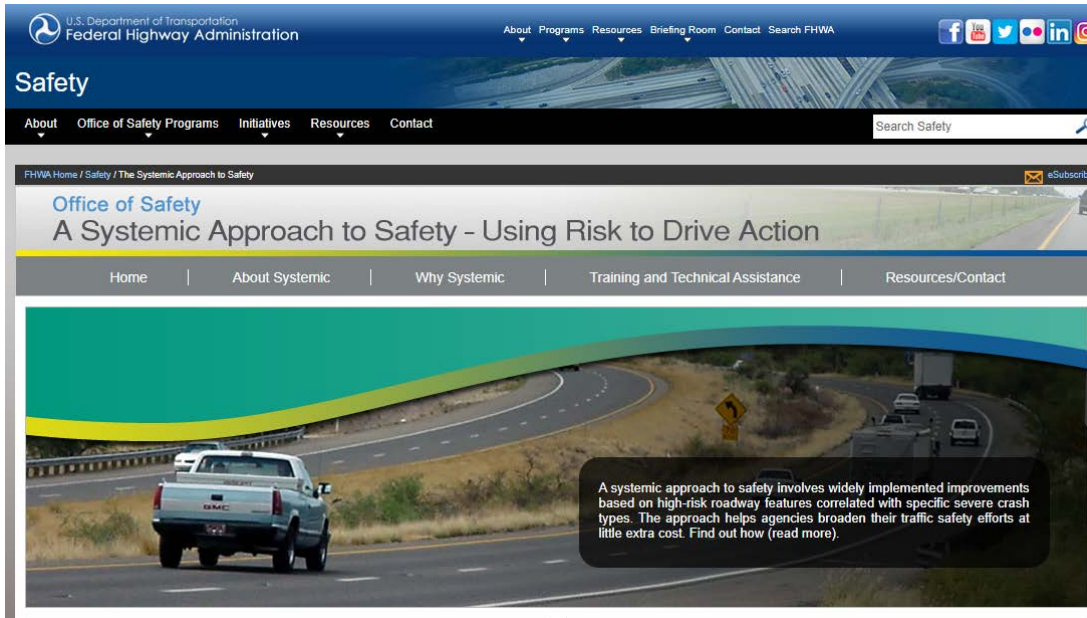
Proactively Addressing Crash Risk with Systemic Safety Analysis - Oct 11, 2018

- Panelists
 - Chris Svolopoulos, Seattle Department of Transportation
 - Rebecca Sanders, Toole Design Group
 - Offer Grembek, Safe Transportation Research and Education Center (SafeTREC), University of California - Berkeley
 - Rachel Carpenter, Caltrans
 - Rodney Brown, Fehr & Peers

Webinar http://www.pedbikeinfo.org/webinars/webinar_details.cfm?id=48

- **Funding and Evaluating Systemic Safety Improvements for Pedestrians - Mar 05, 2019**
- Panelists
 - Karen Scurry, Federal Highway Administration
 - Elissa Goughnour, VHB
 - Tracy Turpin, Virginia Department of Transportation

Systemic Approach Technical Assistance



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<https://safety.fhwa.dot.gov/systemic/>

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Questions