Engineering Countermeasures Toolkit

VISION ZERO

CENTRAL FLORIDA

Counting down to zero traffic deaths

Updated April 2024

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Overview

Introduction and How to Use this Toolkit

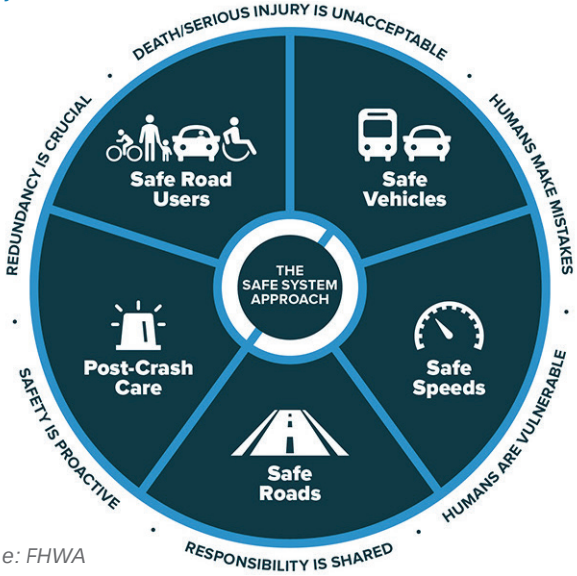
MetroPlan Orlando completed its first comprehensive Vision Zero Action Plan in Spring 2024. The Plan outlines actions that MetroPlan Orlando, including its 3 counties and incorporated cities, will take in the next five years and beyond to eliminate deaths and serious injuries on the region's roadways by 2050. The purpose of this Engineering Countermeasure Toolkit is to establish a shared understanding of key strategies available to address roadway safety issues in our community that align with the Safe System Approach. The key objectives of this Toolkit are to:

1. Inform partner jurisdictions about safety treatment options and their appropriate uses and contexts,
2. Communicate safety tools using easy-to-understand language and graphics,
3. Facilitate coordination between staff, contractors, developers, and the community when discussing transportation safety improvements, and
4. Create a shared understanding and realistic expectations around safety treatments.

The Toolkit describes a variety of engineering countermeasures, how they can be applied to address safety, and their expected effectiveness i.e., crash reduction, when available. The expected crash reduction is based on Crash Modification Factors from the Federal Highway Administration's (FHWA) Crash Modification Clearinghouse or other published studies. The Toolkit also includes general information about each tool's application, typical placement, estimated costs, and delivery timelines.

The Engineering Countermeasure Toolkit is also not intended to be a menu from which community members can request safety tools for their street. Before staff consider a tool or tools to use in a certain situation, they must first conduct an analysis to understand the existing safety issue. Therefore, to achieve desired safety benefits, community-reported concerns should focus on observing and communicating safety issues rather than asking for specific tools. Non-engineering countermeasures are identified in a separate document.

Safe System Framework



Source: FHWA

Systemic Treatments

The implementation of systemic treatments is a common Vision Zero approach that implements low-cost safety measures on a network level to reduce the risk of severe and fatal crashes. The treatments that are typically considered for systemic implementation are relatively effective, lower cost, and well-suited for implementation at multiple locations. Some systemic treatments can be implemented with limited study and design, such as retroreflective signal backplates, high-visibility crosswalks or curb extensions created with paint, bollards, and turn wedges. Although systemic treatments are often discussed in contrast with spot treatments, some treatments may be useful in both spot and systemic safety.

This Toolkit is meant to provide guidance for engineering countermeasures applicable to crashes and safety concerns identified in the MetroPlan Orlando region; it does not provide an exhaustive list of all safety countermeasures. This Toolkit is not meant to replace engineering investigation, feasibility evaluation, and design. The selection of engineering countermeasures for a specific location is always subject to professional judgement and context-sensitive design.

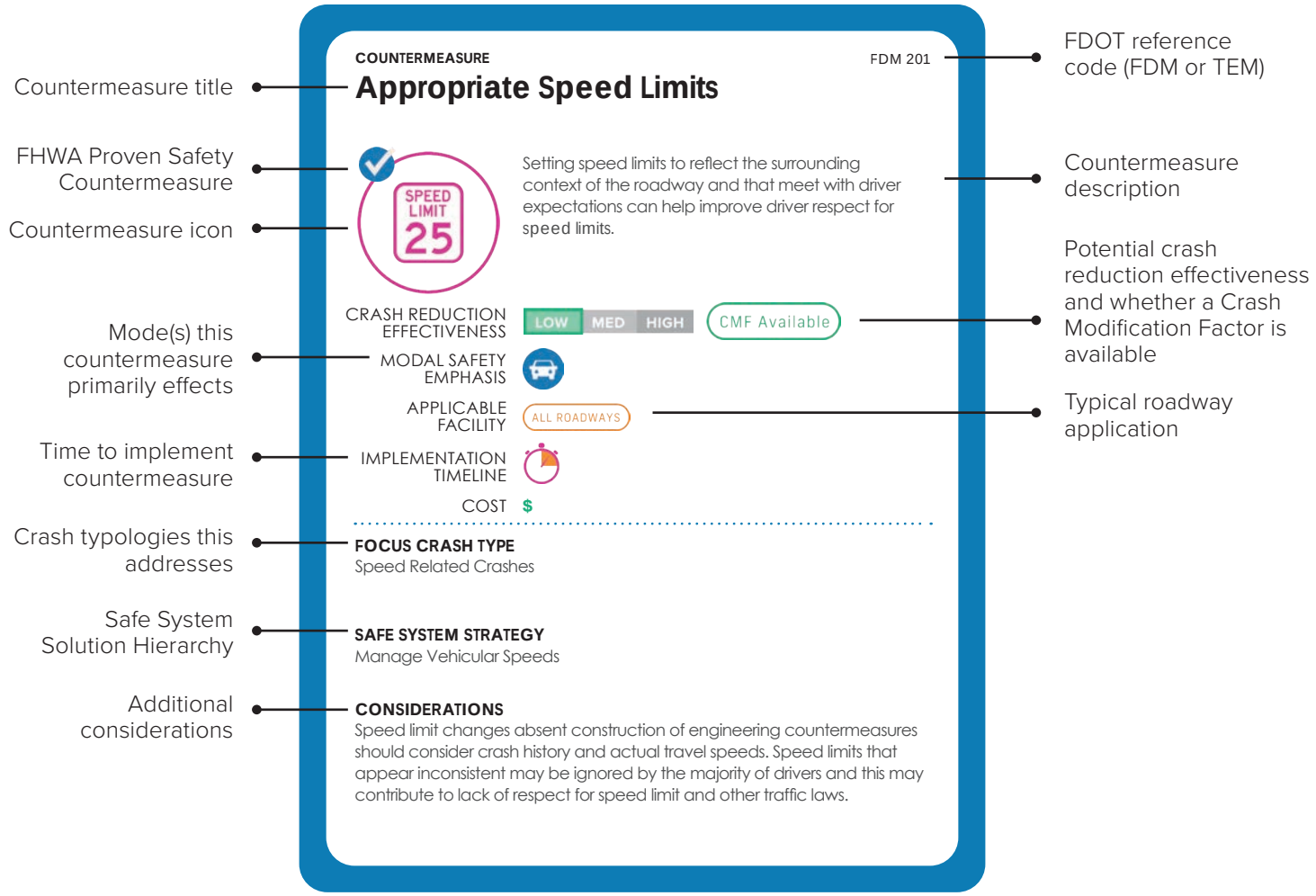
Organization of the Toolkit

The countermeasures are organized into the following categories:

A. Signals
B. Signing and Striping
C. Bikeways
D. Pedestrian Facilities
E. Intersections and Roadways
F. Speed Management
G. Other Engineering Strategies

For each engineering countermeasure, the following information is provided, with a description of select sections provided below.

What You'll See Inside:



Organization of the Toolkit

Modal Safety Emphasis

Closely related to the countermeasure categories is the "Modal Safety Emphasis" which represents the user group that predominantly benefits from the implementation of the countermeasure. The classification of user groups is not meant to include every possible mode with the understanding that certain countermeasures will benefit modes with closely related travel characteristics. For example, a countermeasure that is designed to reduce left-turn crashes at an intersection will benefit motor vehicles and motorcycles alike. The Modal Safety Emphasis areas include the following user groups:

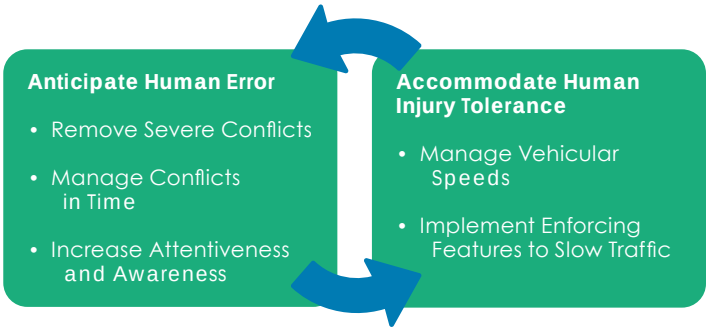
- **Pedestrians**
- **Bicycles**
- **Motor Vehicles**

Safe System Strategy

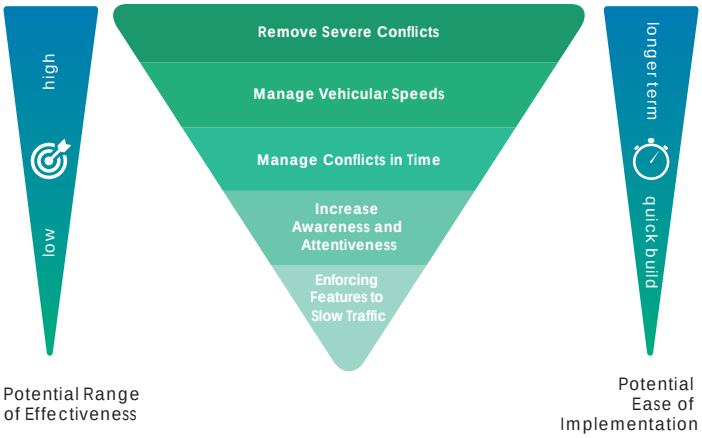
Within the Safe System Approach Framework, how we plan, construct, and operate our roadways should anticipate human error and consider human vulnerabilities. Strategies to achieve those goals are highlighted below.

Roads should be designed to encourage appropriate roadway user behavior for the context.

These principles provide a system with built-in redundancies to eliminate or greatly reduce the likelihood of death or serious injury when a crash occurs. However, strategies have varying levels of effectiveness, feasibility, and implementation timeframes. FHWA has further developed a Safe Systems Solutions Hierarchy (January 2024) within the Safe System element of Safe Roads, as described below. Within that framework, the most effective strategies include removing conflicts and minimizing hazards, and where that is not feasible, better management of the conflict through speed reductions and managing conflicts in time.



- **Remove Severe Conflicts**: Eliminate the most severe conflicts between roadway users, such as through the relocation of a utility pole, construction of a roundabout or provision of a median barrier.
- **Manage Vehicular Speeds**: Reduce the speed of vehicles to align with the context of the roadway, the hazards, and conflicts between roadway users; includes horizontal and vertical deflection elements.
- **Manage Conflicts in Time:** Where conflicts cannot be removed, can they be separated in time, through signal timing strategies or providing dedicated space for other roadway users.
- **Increase Attentiveness and Awareness**: Where conflicts cannot be removed, improve the visibility of the conflicts.
- **Implement Enforcing Features to Slow Traffic**: Similar to managing vehicular speeds, these are roadway features that help enforce the desired speed, like speed feedback signs.



Applicable Facility Type

The applicable facility types represent general characteristics for land use and users where each countermeasure might be appropriate. The applicable facilities are categorized using a preliminary context classification system of:

Organization of the Toolkit

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The applicable facility types represent general characteristics for land use and users where each countermeasure might be appropriate. The applicable facilities are categorized using a preliminary context classification system of:

- **Urban Streets** (FDOT Context Classification C4, C5, C6 and CT2)
- **Suburban Streets** (C4, C3C and C3R)
- **Rural Roads** (C2)

For purposes of this toolkit, countermeasures for both urban and suburban roads could be considered on C4 roads. For strategies related to C1 facilities, please refer to the FDOT Context Classification Guide and the Florida Design Manual (FDM). Some treatments are more appropriate for use on urban arterial streets with higher traffic volumes and a mix of different users, while others are better used on rural roads where speeds tend to be higher. However, choosing the best tool for a location will depend on location-specific characteristics like number of travel lanes, geometry, vehicle speeds, and volumes. The selection of countermeasures should also consider the future road context.

Crash Reduction Effectiveness

The potential effectiveness of each countermeasure was based on published research, including information from FHWA's Crash Modification Factor (CMF) Clearinghouse, FHWA's Proven Safety Countermeasures, and other published references (see complete list of references at end of this section). The CMF Clearinghouse provides peer reviewed studies and a link to the applicable study. As this toolkit is intended to be a quick resource guide to help identify the range of potential countermeasures, the anticipated effectiveness of various treatments was summarized into the following categories:

- **Unknown**: No quantitative data is available
- **Low**: Expected Crash Reduction ≤ 30%
- **Medium**: 31%≤ Expected Crash Reduction ≤ 60%
- **High:** Expected Crash Reduction ≥ 61%

The expected crash reduction represents a multiplicative factor indicating the proportion of crashes that are expected to be reduced after the implementation of a countermeasure with the reduction only applying to crashes affected by the countermeasure. For example, changing left-turn phasing would only apply to left-turn crashes on the approach where the countermeasure is being implemented. For locations where more than one countermeasure is being considered, the interaction between countermeasures should be considered. For more information on the application of multiple CMFs, refer to the "Using CMFs" section of the Crash Modification Clearinghouse (https://www.cmfclearinghouse.org/using_cmfs.php)

Some countermeasures may result in a decrease in some types of crashes and an increase in others. For example, installing a traffic signal may reduce fatal and serious injuries for motorists turning to/from the major roadway, but increase rear end crashes, which tend to result in fewer injuries.

Detailed crash analysis based on the most current crash modification factor is recommended as the intent of the factors provided in this document is to allow for a quick comparison of the expected effectiveness of specific countermeasures relative to their cost as well as highlight the need for additional data to document the effectiveness of specific improvements that may be implemented regionally. The estimated effectiveness of each tool is only applicable to the crash type being mitigated i.e., the Focus Crash Type.

Included in FHWA Proven Safety Countermeasures

This field refers to whether the countermeasure is included in FHWA's Proven Safety Countermeasures Initiative (PSCi). The PSCi is a collection of 28 countermeasures and strategies effective in reducing roadway fatalities and serious injuries. Each countermeasure addresses at least one safety focus area – speed management, intersections, roadway departures, or pedestrians/bicyclists – while others are crosscutting strategies that address multiple safety focus areas.

Cost

The cost information is meant to convey an overall order of magnitude to help compare potential strategies; the cost data does not necessarily reflect the cost of each improvement as a standalone construction project. Most countermeasures would not likely be implemented as a standalone project but incorporated into a larger intersection or corridor enhancement

Organization of the Toolkit

project. For example, many elements could be incorporated into routine resurfacing, restoration, and rehabilitation (RRR) projects. Additionally, costs do not include elements that might be unique to specific projects, such as right-of-way acquisition, need to upgrade drainage systems, retaining walls to facilitate sidewalk construction, need to upgrade other road elements to meet Americans with Disabilities Act (ADA) or Public Rights of Way Access requirements (PROWAG) requirements, and other factors. Therefore, actual costs could vary significantly.

The assigned cost ratings for countermeasures are as follows:

- **Low ($)**: Typically, $10,000 or less
- **Medium ($$)**: Typically, $10,000 to $100,000
- **High ($$$)**: Typically, $100,000 +

The appendix provides more detailed cost estimates for some countermeasures where recent cost data is available from FDOT other local partners; not all countermeasures are included. These costs can be used to develop high-level cost estimates of projects for regional prioritization such that projects across the region can be compared.

Implementation Timeline

This field represents the typical time to implement the countermeasure. It should be noted that there may be some variability in implementation timeline based on whether the countermeasure can be implemented using "Quick Build" materials or permanent materials. The assigned timeline thresholds for implementation are as follows:


Quick Build; Typically, within 1 year


Short: Typically, within 1 to 3 years


Medium: Typically, 3 to 5 years


Long: Typically, 5 years and more

Larger agencies with maintenance teams and sign shops may be able to implement projects faster than smaller agencies, so a

Considerations

This section provides some additional information about the countermeasure that need to be part of the evaluation about whether the countermeasure is appropriate for selection. For example, some countermeasures may affect drainage or require additional maintenance.

Where the countermeasure is included or mentioned in the FDOT Design Manual (FDM) or FDOT's Traffic Engineering Manual, the appropriate section is noted.

Additional sources of the countermeasures include:

- CMF Clearinghouse (Federal Highway Administration, 2023) (http://www.cmfclearinghouse.org/)
- Application of Pedestrian Crossing Treatments for Streets and Highways (NCHRP, 2016) (https://www.researchgate.net/publication/316091509_Application_of_Pedestrian_Crossing_Treatments_for_Streets_and_Highways)
- Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments (NCHRP, 2017) (https://www.nap.edu/catalog/24627/development-of-crash-modification-factors-for-uncontrolled-pedestrian-crossing-treatments)
- Evaluation of Pedestrian-Related Roadway Measures (Pedestrian and Bicycle Information Center, 2014) (http://www.pedbikeinfo.org/cms/downloads/PedestrianLitReview_April2014.pdf)

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Target Speed

The selection of countermeasures should also consider the target speed of the roadway. To establish a target speed based on the road context and the goal of improving transportation safety outcomes, the FDOT Context Based Design Speeds for Arterials and Collectors should be used as a starting point, as presented in Table 1.

Table 1: Allowable Design Speed Range by Context Classification

Context Classification	Allowable Design Speed Range (MPH)	SIS Minimum (MPH)
C1 Natural	55-70	65
C2 Rural	55-70	65
C2T Rural Town	25-45	40
C3 Suburban	35-55	50
C4 Urban General	25-45	45
C5 Urban Center	25-35	35
C6 Urban Core	25-30	30

Source: FDOT Context Classification Guide, February 2022

Guidance from FDOT Central Office related to target speed setting recommends setting an initial target speed on the low end of the allowable range, and then providing justification for increases. From there, the following factors should be used to establish a recommended target speed:

- Fatal and severe injury collision history
- Potential crash risk
- Existing and potential future context classification
- Number of lanes
- Type and density of surrounding land uses
- Number of access points and signal spacing
- Presence and characteristics of on-street parking
- Total pavement width available

Different Types of Speed

Target Speed *is the highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multi-modal activity generated by adjacent land uses, to provide both mobility for motor vehicles and a supportive environment for pedestrians, bicyclists, and public transit users.*

Design Speed *is the speed that is used to determine the geometric features of a road or street, such as curves, slopes, lane width, intersection spacing, sight distance and other features.*

Speed Limits *specify the maximum speed people are permitted to drive on a road, typically shown on signs along the road, and usually determined based on an engineering study that considers the prevailing travel speeds.*

Operating Speed *refers to the speed at which people are observed driving under free-flow conditions.*

Under ideal conditions, target, design, posted and operating speeds all align. When there are discrepancies, roadway design elements may need to be changed to achieve the desired speed outcomes.

- Presence of transit, pedestrian generators, and bicycle activity
- Bicycle facility type
- Posted speeds on surrounding roadways
- Types of travelers (regional or local)
- Level of truck traffic

Additional guidance can be found in the *FDOT Context Classification Guide, February 2022* as well as the Speed Management section of the 2024 FDOT *Design Manual*.

References

Where the countermeasure is included or mentioned in the FDOT Design Manual (FDM) or FDOT's Traffic Engineering Manual, the appropriate section is noted.

Additional sources of the countermeasures include:

- CMF Clearinghouse (Federal Highway Administration, 2023) (http://www.cmfclearinghouse.org/)
- Application of Pedestrian Crossing Treatments for Streets and Highways (NCHRP, 2016) (https://www.researchgate.net/publication/316091509_Application_of_Pedestrian_Crossing_Treatments_for_Streets_and_Highways)
- Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments (NCHRP, 2017) (https://www.nap.edu/catalog/24627/development-of-crash-modification-factors-for-uncontrolled-pedestrian-crossing-treatments)
- Evaluation of Pedestrian-Related Roadway Measures (Pedestrian and Bicycle Information Center, 2014) (http://www.pedbikeinfo.org/cms/downloads/PedestrianLitReview_April2014.pdf)
- Evolution of the Protected Intersection (Alta Planning and Design, December 2015) (https://altago.com/wp-content/uploads/Evolution-of-the-Protected-Intersection_ALTA-2015.pdf)
- Manual for Selecting Safety Improvements on High Risk Rural Roads (FHWA, 2014) (https://safety.fhwa.dot.gov/hsip/hrrr/manual/)
- Pedestrian Safety Guide and Countermeasure Selection System (FHWA) (http://www.pedbikesafe.org/pedsafe/)
- Proven Safety Countermeasures (FHWA), (https://highways.dot.gov/safety/proven-safety-countermeasures)
- National Association of City Transportation Official's Urban Street Design Guide (https://nacto.org/publication/urban-street-design-guide/)

Transportation safety countermeasure information is quickly evolving and users of this document are encouraged to use the most current information available.

Cost information based on FDOT cost per mile model reports:

https://www.fdot.gov/programmanagement/estimates/documents/costpermilemodelsreports)

Countermeasure List

SUMMARY OF COUNTERMEASURES

FHWA PROVEN SAFETY COUNTERMEASURE

A. SIGNALS

Accessible Pedestrian Signals
Advanced Dilemma Zone Detection
Bicycle Signal/Exclusive Bike Phase
Bike Detection
Extend Green Time For Bikes
Extend Pedestrian Crossing Time
Extended Time Pushbutton
Extend Yellow and All Red Time ✓
Leading Pedestrian Interval ✓
Pedestrian Countdown Timer
Pedestrian Detection
Pedestrian Recall
Pedestrian Scramble
Prohibit Right-Turn-on-Red
Prohibit Turns During Pedestrian Phase
Protected Left Turns
Red Light Camera
Separate Right-Turn Phasing
Shorten Cycle Length
Signal Interconnectivity and Coordination / Green Wave
Signal Preemption
Supplemental Signal Heads
Traffic Signal
Upgrade Signal Head

B. SIGNING AND STRIPING

Advance Stop Bar
Advance Yield Markings
Chevron Signs on Horizontal Curves ✓
Curve Advance Warning Sign ✓
Flashing Beacon as Advance Warning
LED-Enhanced Sign
Painted Centerline and Raised Pavement Markers at Curves
Pavement Speed Legends
Prohibit Left Turn
Stop for Pedestrian Sign
Striping Through Intersection
Time-Based Turn Restriction
Upgrade Intersection Pavement Markings
Upgrade Signs with Fluorescent Sheeting
Upgrade Striping
Upgrade to Larger Warning Signs
Wayfinding

C. BIKEWAYS

Bicycles May Use Full Lane Sign
Bike Lane/Buffered Bike Lane ✓
Floating Transit Island
Mixing Zone
Parking Buffer
Separated Bikeway ✓
Two-Stage Turn Queue Bike Box

D. PEDESTRIAN FACILITIES

Add Sidewalk ✓
Co-Locate Bus Stops and Pedestrian Crossings
Curb Extensions
High-Visibility Crosswalk
Install/Upgrade Pedestrian Crossing at Uncontrolled Locations
Pedestrian Hybrid Beacon ✓
Rectangular Rapid Flashing Beacon ✓
Restripe Crosswalk
Shared Use Path
Widen Sidewalk

E. INTERSECTIONS AND ROADWAYS

All-Way Stop Control
Bicycle Crossing (Solid Green Paint)
Bike Box
Centerline Hardening
Close Slip Lane
Crosswalk Density
Curb-Return Radius Reduction
Delineators, Reflectors, and/or Object Markers
Directional Median Openings to Restrict Left Turns
Doubled-up, Oversized Stop Signs ✓
Enhanced Daylighting/Slow Turn Wedge
Extend Bike Lane to Intersection
Gateway Treatments
Green Conflict Striping
Guardrail
Hardened Median Nose Extension
High Friction Surface Treatment ✓
Impact Attenuators
Intersection Reconstruction and Tightening
Lane Repurposing ✓
Median Barrier ✓
On-Street Parking
Paint and Plastic Median
Paint and Plastic Mini Circle/Mini Roundabout
Partial Closure/Diverter
Protected Intersection
Raised Crosswalk
Raised Intersection
Raised Median ✓
Reduced Left-Turn Conflict Intersection ✓
Refuge Island ✓
Retroreflective Signal Backplates ✓
Roundabout ✓
Rumble Strips ✓
Safety Edge ✓
Speed Hump, Speed Table or Speed Cushion
Straighten Crosswalk
Superelevation at Horizontal Curve Locations
Widen/Pave Shoulder

F. SPEED MANAGEMENT

Appropriate Speed Limits ✓
Chicane
Landscape Buffer
Lane Narrowing
Speed Cameras ✓
Speed Feedback Sign
Speed Sensitive Rest on Red
Variable Speed Limits ✓

G. OTHER ENGINEERING STRATEGIES

Access Management/Close Driveway ✓
Create or Increase Clear Zone
Far-Side Bus Stop
Intersection Lighting ✓
Relocate Select Hazardous Utility Poles
Remove Obstructions For Sightlines
Segment Lighting ✓
Upgrade Lighting to LED

A. Signals

Under the signal timing and phasing category, strategies relate to changing signal timing based on local context, such as extending the pedestrian time if there are large volumes of pedestrians, or if pedestrians are not able to cross the intersection within the time allotted. Extending yellow and red time can help clear the intersection and reduce the potential for red light running. Additional signal heads can increase visibility. In locations where there are high pedestrian and bicycle volumes, right-turning vehicles may not be able to turn when they have a green light due to pedestrians in the crosswalk. Providing a separate right-turn phase could help clear right-turning vehicles and reduce conflicts with pedestrians.

Sometimes giving people walking a head start can make them more visible to people driving. Installing a new traffic signal or pedestrian signal can help allocate the right-of-way, reduce conflicting movements, and provide pedestrians a protected crossing. In heavy pedestrian areas, installing a pedestrian scramble where all vehicles must stop, and pedestrians can cross diagonally can be a more efficient way to operate the intersection and reduce vehicle conflicts with pedestrians. Pedestrian recall provides a WALK signal each cycle without pedestrians having to push buttons.

Other strategies such as converting permissive lefts to protected lefts (at least when the pedestrian crossing is activated) can be highly effective in reducing conflicts with pedestrians. Reducing cycle length can decrease pedestrian delay which can reduce the occurrence of pedestrians crossing against the signal and red-light running.

Strategies included in this section are:

1. Accessible Pedestrian Signals (APS) Upgrade
2. Advanced Dilemma Zone Detection
3. Bicycle Signal/Exclusive Bike Phase
4. Bike Detection
5. Extend Green Time For Bikes
6. Extend Pedestrian Crossing Time
7. Extended Time Pushbutton
8. Extend Yellow and All Red Time
9. Leading Pedestrian Interval
10. Pedestrian Countdown Timer
11. Pedestrian Detection
12. Pedestrian Recall
13. Pedestrian Scramble
14. Prohibit Right-Turn-on-Red
15. Prohibit Turns During Pedestrian Phase
16. Protected Left Turns
17. Red Light Camera
18. Separate Right-Turn Phasing
19. Shorten Cycle Length
20. Signal Interconnectivity and Coordination / Green Wave
21. Signal Preemption
22. Supplemental Signal Heads
23. Traffic Signal
24. Upgrade Signal Head

TEM 3.7

Accessible Pedestrian Signals (APS) Upgrade

Push buttons must comply with the Americans with Disability Act (ADA) standards and Public Right-of-Way Accessibility Guidelines (PROWAG) for accessibility. Accessible pedestrian signals, including audible push buttons, improve access for pedestrians who are blind or have low vision.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Through vehicles at signalized intersection and pedestrian struck by turning vehicle.

SAFE SYSTEM STRATEGY
Manage conflicts in time, and increase attentiveness and awareness.

CONSIDERATIONS
Once the USDOJ/DOT adopts PROGAG, Accessible Pedestrian Signals (APS) will be required at all new and altered pedestrian signal heads.

Home

Advanced Dilemma Zone Detection

System that adjusts the start time of the yellow-signal phase (i.e. earlier or later) based on observed vehicle locations and speed, improving safety by minimizing the number of drivers that are faced with the dilemma of determining if they should stop or drive through the intersection.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Angle crashes and red-light running crashes.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Drivers could learn this tool and will expect the yellow to be longer and therefore increase red-light running. This treatment could be paired with red-light cameras.

Home

FDM 223.2.4.5

Bicycle Signal/Exclusive Bike Phase

A separate bicycle signal or phase reduces conflicts between motor vehicle, transit vehicles, and pedestrian movements.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Motorist turns left in path of bicyclist, motorist turns right in path of bicyclist, and motorist failed to yield at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Signal phasing strategies should balance delay for all road users.

Home

FDM 223.2.1.5 , TEM 5.2.7.5

Bike Detection

Loops, cameras, or infrared cameras that call green lights for cyclists, discouraging red light running and reducing bicyclist delay.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Motorist turns left in path of bicyclist, motorist turns right in path of bicyclist, motorist failed to yield at signalized intersection and bicyclist violating signal.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
At large intersections, integrate with signal operations to extend all red time when bicyclists are detected.

Home

Extend Green Time For Bikes

Prolonged green light time for cyclists when detected, allowing for more time to cross.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Motorist turns left in path of bicyclist, motorist turns right in path of bicyclist, and motorist failed to yield at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
When used in a coordinated system, different timing plans may be needed. Topography should be considered in clearance time.

Home

Extend Pedestrian Crossing Time

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

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Through vehicle at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
May need to be implemented as part of an overall retiming project.

Home

FDM 232.6

Extended Time Pushbutton

A pushbutton that can be pressed to request extra time for using the crosswalk.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, and through vehicle at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
May require education for full benefit. Candidate locations are in communities with high populations of people with mobility challenges.

Home

Extend Yellow and All Red Time

Extending yellow and all red time provides additional time for drivers, bicyclists and pedestrians to cross through a signalized intersection before conflicting traffic movements are permitted.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Angle crashes and red light running crashes.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
May need to be implemented as part of an overall retiming project.

Home

TEM 3.11.5.2

Leading Pedestrian Interval

Signal timing that allows pedestrians to enter intersections before vehicles are given a green indication allowing them to better establish their presence and increase their visibility.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle and motorist turns right in path of bicyclist.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
The length of the LPI should consider the crossing length and the amount and type of pedestrian traffic (age, ability, etc).

Home

FDM 232.6

Pedestrian Countdown Timer

Displays "countdown" of seconds remaining on the pedestrian signal, discouraging pedestrians from starting a crossing with little time remaining.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, and through vehicle at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Countdown timers are required for all newly installed traffic signals where pedestrian signals are installed.

Home

FDM 232.6, TEM 5.2.7.5

Pedestrian Detection

A device that detects when a pedestrian is waiting at a crosswalk and automatically triggers the pedestrian "WALK" phase.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle and through vehicle at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Selection of appropriate detection system that reduces the potential for false detection is recommended.

Home

TEM 3.11

Pedestrian Recall

Pedestrian recall is a traffic signal timing function that results in a pedestrian phase to be automatically activated every cycle.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle and motorist turns right in path of bicyclist.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
If intersection is part of a coordinated system, consideration should be given to signal timing changes at upstream and downstream intersections. Can be paired with a LPI for increased effectiveness.

Home

TEM 3.11.3

Pedestrian Scramble

A form of pedestrian "WALK" phase at a signalized intersection in which all vehicular traffic is required to stop, allowing pedestrians to cross in any direction.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian crashes.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Significant levels of crossing activity may be required to justify phasing type.

Home

Prohibit Right-Turn-on-Red

Prohibiting right-run-on-red movements can be used in locations where obstructions prevent right-turning vehicles from seeing on-coming traffic or where high pedestrian volumes are present.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, and motorist failed to yield at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
May require provision of right-turn-only lane if there are conflicts between right-turning vehicles and pedestrians.

Home

Prohibit Turns During Pedestrian Phase

Restricts left or right turns during the pedestrian crossing phase at locations where a turning vehicle may conflict with pedestrians in the crosswalk.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, motorist turned left in path of bicyclist, and motorist failed to yield at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
This restriction may be displayed with a blank-out sign. May affect operations for right-turn vehicles. May require extending storage to avoid spillback into adjacent through lane

Home

FDM 232.2

Protected Left Turns

Converting a permissive left-turn to a protected left turn phase can reduce angle crashes involving left turning, opposing through vehicles, and non-motorized road users.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Left turn crashes, pedestrian struck by turning vehicle, and motorist turned left in path of bicyclist.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
May require an increase in left-turn queue storage or green time. If new or modified signal heads are required, or if traffic controller equipment needs to be upgraded, cost could be significantly higher.

Home

Red Light Camera

A red light camera enforces traffic signal compliance by capturing the image of a vehicle that has entered an intersection during the red phase with the photographic evidence used to issue a traffic violation to registered owner of vehicle.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Angle crashes and left turn crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness, and implement enforcing features to slow traffic.

CONSIDERATIONS

Home

FDM 223.2.1.4

Separate Right-Turn Phasing

Provides a green arrow phase for right-turning vehicles, reducing conflicts between right-turning traffic and bicyclists or pedestrians crossing the intersection. Can be paired with no right-turn on-red.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle and motorist failed to yield at signalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
May need to be implemented as part of an overall retiming project. U-Turns may need to be prohibited for movements affected by right-turn phasing.

Home

TEM 3.11.4

Shorten Cycle Length

Shorter cycle lengths can reduce the frequency of violations of the traffic control device.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Dart/dash.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Should be implemented as part of a corridor or area wide traffic signal retiming program. Short cycle lengths of 60–90 seconds are ideal for urban areas.

Home

FDM 201.1.1

Signal Interconnectivity and Coordination/Green Wave

The emphasis of improving signal coordination for this countermeasure is to provide an opportunity for signal coordination for a desired speed outcome.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Manage vehicular speeds and implement enforcing features to slow traffic.

CONSIDERATIONS
Coordinating signals to allow for bicyclist progression, also known as a 'green wave,' gives bicyclists and pedestrians more time to safely cross through the 'green wave' intersections. Emergency vehicle preemption and phasing extensions under other strategies may need to be considered.

Home

Signal Preemption

Allows an authorized operator to override the normal operation of traffic lights, mostly used in the path of an emergency vehicle to reduce conflicts and decrease emergency vehicle response time.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Varies depending on application context.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Other applications include at railroad crossings as well as school zones where there can be high volumes of pedestrians/bicyclists for short periods of time.

Home

FDM 232.1.6, FDM 232.2

Supplemental Signal Heads

Additional signal heads allow drivers to anticipate signal changes farther away from intersections or when there a visibility issues, such as a curve or bridge structure.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Angle crashes and left turn crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
When new signal heads are added, structural analysis may be required due to the added wind load. Supplemental traffic signals may be placed on the near side of an intersection, far-left, far-right, or very high.

Home

FDM 232

Traffic Signal

Traffic signals allocate the right-of-way to different traffic movements and provide controlled crossings for non-motorized users.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Angle crashes and left turn crashes.

SAFE SYSTEM STRATEGY
Remove severe conflicts and manage conflicts in time.

CONSIDERATIONS
While traffic signals have been shown to reduce the most severe types of crashes, they can result in an increase in rear-end collisions.

Home

Upgrade Signal Head

Replacing 8-inch signal heads with 12-inch signal heads improves visibility of signals and aiding drivers' advanced perception of upcoming intersections.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Angle crashes and left turn crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Structural analysis may be required due to the added wind load.

Home

B. Signing and Striping

Installing additional signs and pavement markings can be a low-cost way to improve safety outcomes. However, to be effective, they often need to be implemented with other roadway modifications for maximum effectiveness, and sign clutter should be avoided. These types of projects can often be implemented with planned Resurfacing, Restoration and Rehabilitation (RRR) projects.

Strategies included in this section are:

1. Advance Stop Bar
2. Advance Yield Markings
3. Chevron Signs on Horizontal Curves
4. Curve Advance Warning Sign
5. Flashing Beacon as Advance Warning
6. LED-Enhanced Sign
7. Painted Centerline and Raised Pavement Markers at Curves
8. Pavement Speed Legends
9. Prohibit Left Turn
10. Stop for Pedestrians Sign
11. Striping Through Intersection
12. Time-Based Turn Restriction
13. Upgrade Intersection Pavement Markings
14. Upgrade Signs with Fluorescent Sheeting
15. Upgrade Striping
16. Upgrade to Larger Warning Signs
17. Wayfinding

FDM 230.6

Advance Stop Bar

Stop lines placed in advance of pedestrian crossings increasing visibility of pedestrians and reducing crossing encroachment.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS:

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE:

COST: $

FOCUS CRASH TYPE
Multiple threat/trapped.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Creating a wider stop bar or setting the stop bar further back may be appropriate for locations with known crosswalk encroachment issues.

Home

FDM 230.6

Advance Yield Markings

A yield line placed in advance of pedestrian crossings to indicate where a vehicle stop is intended, increasing visibility of pedestrians and reducing crossing encroachment.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS:

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE:

COST: $

FOCUS CRASH TYPE
Multiple threat/trapped.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Can be paired with other treatments, like RRFBs and/or high visibility crosswalks.

Home

TEM 4.5.4

Chevron Signs on Horizontal Curves

Signs that warn drivers of an approaching curve and provide tracking information.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS:

APPLICABLE FACILITY: SUBURBAN, RURAL

IMPLEMENTATION TIMELINE:

COST: $

FOCUS CRASH TYPE
Collision with fixed objects, and run off the road crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Can be paired with other treatments, like rumble strips.

Home

TEM 2.41.3

Curve Advance Warning Sign

Signage that notifies drivers of an approaching curve providing additional reaction time to slow down.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS:

APPLICABLE FACILITY: SUBURBAN, RURAL

IMPLEMENTATION TIMELINE:

COST: $

FOCUS CRASH TYPE
Collision with fixed objects and run off the road crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
This warning sign is ideally combined with other infrastructure that alerts drivers of the curve, such as chevron signs, delineators, and flashing beacons.

Home

FDM 202.3.13, TEM 3.1

Flashing Beacon as Advance Warning

Device paired with signage can notify motorists of an upcoming intersection or crosswalk, providing additional reaction time.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS:

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE:

COST: $$

FOCUS CRASH TYPE
Angle crashes, through vehicle at signalized intersection, and right turn crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Solar powered units can reduce construction costs associated with providing electricity. Beacon can also be used as an advance warning for red light ahead (typically when visibility to the signal is compromised by horizontal or vertical curve).

Home

LED-Enhanced Sign

Signage with LED lights embedded in the outline increasing sign visibility and are most effective at locations with visibility limitations or with a documented history of drivers failing to see or obey the sign.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS:

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE:

COST: $

FOCUS CRASH TYPE
Angle crashes, motorist failed to yield at unsignalized intersection, and through vehicle at unsignalized intersection.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
The LEDs may be set to flash or operate in a steady mode.

Home

Painted Centerline and Raised Pavement Markers at Curves

A raised pavement marker is a small device attached to the road and used as a positioning guide for drivers.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS:

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE:

COST: $

FOCUS CRASH TYPE
Head on, collision with fixed objects, and run off the road crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS

Home

FDM 202.3.10

Pavement Speed Legends

Speed legends are numerals painted on the roadway indicating the current speed limit in mph, usually placed near speed limit signposts.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS:

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE:

COST: $

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS

Home

Prohibit Left Turn

Prohibitions of left turns at locations where a turning vehicle may conflict with pedestrians in the crosswalk or where opposing traffic volume is high and there is not sufficient room for a separate turn lane.

CRASH REDUCTION EFFECTIVENESS: LOW MED **HIGH** CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Left turn crashes, pedestrian struck by turning vehicle, and motorist turned left in path of bicyclist.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
U-turns may need to be accommodated elsewhere on the corridor.

Home

TEM 2.39

Stop for Pedestrians Sign

"Stop for Pedestrians" signs alert drivers about the presence of pedestrians. These signs are required with advance stop lines. Other sign types can be placed on the centerline in the roadway.

CRASH REDUCTION EFFECTIVENESS: **LOW** MED HIGH CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Through vehicle at unsignalized intersection, motorist failed to yield at unsignalized intersection.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
May need to be paired with education and enforcement.

Home

FDM 230

Striping Through Intersection

Pavement markings that guide vehicles through intersections which helps drivers remain in their lanes throughout an intersection.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Sideswipes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS

Home

Time-Based Turn Restriction

Restricts left-turns or right-turns during certain time periods when there may be increased potential for conflict (e.g., peak periods, school hours).

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, motorist turned left in path of bicyclist, and motorist turned right in path of bicyclist.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
If not enforced, could limit effectiveness.

Home

Upgrade Intersection Pavement Markings

Upgrading intersection pavement markings can improve safety by increasing the visibility of intersections for drivers approaching and at the intersection.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Angle crashes, through vehicle at unsignalized intersection, and motorist failed to yield at unsignalized intersection.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Upgrading intersection pavement marking can include "Stop Ahead" markings and the addition of centerlines and stop bars.

Home

Upgrade Signs with Fluorescent Sheeting

Upgrading to signs with retroreflective sheeting improves safety by increasing visibility of signs to drivers at night.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Nighttime crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Depending on sign locations, a structural/wind analysis may need to be conducted.

Home

Upgrade Striping

Restripe lanes with reflective striping to improve striping visibility and clarify lane assignment, especially where the number of lanes changes.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Sideswipes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS

Home

Upgrade to Larger Warning Signs

Upgrading to larger warning signs improves safety by increasing visibility of the information provided, particularly for older drivers.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Crashes involving older drivers.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS

Home

FDM 223.6, TEM 2.36

Wayfinding

A network of signs that highlight nearby pedestrian and bicycle facilities and guide users to the most appropriate crossing locations.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian and bicycle crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Should be implemented with a route naming system. Can consider including travel time information.

Home

C. Bikeways

In the MetroPlan Orlando region, people bicycling are overrepresented in collisions where someone is seriously injured or killed. Providing dedicated space for cyclists separate from high-speed vehicle traffic can improve safety outcomes. Where dedicated space cannot be provided or there is a high density of conflict areas such as driveways or side streets, managing vehicle speeds, increasing visibility, and improving the predictability of roadway users can help to manage and reduce those conflicts and is critical to improving safety outcomes.

One of the most effective measures is a dedicated pathway separate from vehicle travel. While bike lanes may help to reduce the potential for a collision by making drivers aware of the likely presence of bicyclists, they are not as effective as a separate path with minimal conflicts with side-streets or driveways especially on higher speed roadways. People bicycling are particularly vulnerable in conflict zones.

Some countermeasures aim to increase cyclist visibility in conflict zones and provide clear direction to other roadway users. In areas where there is constrained right-of-way, signing and pavement markings can be effective. However, like most strategies these are context specific. For example, shared lane markings are appropriate on roadways with vehicle travel speeds of less than 25 mph and daily traffic volumes of less than 2,000. As speeds and traffic volumes increase, additional separation should be provided between vehicles and cyclists. The strategies below assume that other roadway design elements are incorporated to manage vehicle speeds to an appropriate level for the proposed bicycle facility.

Strategies included in this section are:

1. Bicycles May Use Full Lane Sign
2. Bike Lane/Buffered Bike Lane
3. Floating Transit Island
4. Mixing Zone
5. Parking Buffer
6. Separated Bikeway
7. Two-Stage Turn Queue Bike Box

TEM 2.11.3

Bicycles May Use Full Lane Sign

Signage that indicates cyclists may use the full lane, discouraging unsafe motorist passage.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Vehicle overtakes bicycle, motorist turns right in path of bicyclist, and bicycle crashes at driveways.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Volumes and number of conflicts need to be considered in the selection of this treatment.

Home

FDM 223.2.1

Bike Lane/Buffered Bike Lane

Lanes marked with symbols and signs specifically for bicycles, reducing bike/vehicle conflicts and slowing vehicle speeds via the road-narrowing effect. May or may not include a painted buffer space.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Vehicle overtakes bicycle.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Consult FHWA Bikeway Selection Guide.

Home

FDM 210.3.2.3

Floating Transit Island

Separates the bike facility and transit boarding area, reducing conflict between the two modes, and lowering the risk of collision.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Bike/pedestrian crashes.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Drainage and ADA requirements should be considered.

Home

Mixing Zone

Lane markings to delineate space for bicyclists and motorists within the same lane and indicate the intended path for bicyclists to reduce conflict with turning motor vehicles.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Motorist turns right in path of bicyclist.

SAFE SYSTEM STRATEGY
Manage conflicts in time, and increase attentiveness and awareness.

CONSIDERATIONS
May not be appropriate at intersections with very high peak automobile right turn demand.

Home

FDM 223.4

Parking Buffer

Pavement markings denoting door zone of parked vehicles to help bicyclists maintain safe positioning on the roadway

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Dooring.

SAFE SYSTEM STRATEGY
Remove severe conflicts, manage conflicts in time, and increase attentiveness and awareness.

CONSIDERATIONS
Door zones should be a minimum of 3 feet.

Home

FDM 223.2.4

Separated Bikeway

A bikeway with physical separation (horizontal and vertical) from vehicle traffic, designated lane markings, pavement legends, and signage, which reduces conflicts between bicycles and vehicles on the road.

CRASH REDUCTION EFFECTIVENESS: LOW, MED, HIGH

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Vehicle overtakes bicycle.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
A raised barrier of plastic posts and painted pavement is a low-cost/ quick build option. Special treatments may be needed at driveways/ intersections.

Home

FDM 223.2.1.5

Two-Stage Turn Queue Bike Box

Roadway treatment for left turns at signalized intersections from the right-side bike lane protecting bicyclists from traffic.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Motorist failed to yield at signalized intersection, and bicyclist turned left into path of motorist.

SAFE SYSTEM STRATEGY
Manage conflicts in time and increase attentiveness and awareness.

CONSIDERATIONS
Prohibition of right turns on red may be required.

Home

D. Pedestrian Facilities

People walking are also overrepresented in collisions in the MetroPlan Orlando region where someone is killed or seriously injured. Providing more visible and frequent marked and controlled crossings, decreasing pedestrian crossing distance, and extending the amount of time to cross the street can help to reduce collisions. Many of these strategies also benefit other modes of travel although the primary benefit is to people walking.

Lighting is also a key element and can improve the visibility of all roadway users. Pedestrian detection can be used at trail crossings where users might not activate the crossing signal. Installing a median barrier can be a way to discourage pedestrian crossings, however a review of the pedestrian desire lines in the area should be conducted as there may be a reason, such as a bus stop on one side of the street and a shopping center or apartment complex on the other side. It is unlikely and unrealistic to expect pedestrians to walk a significant distance out of their way to use a protected crossing, especially in Florida weather. Typically, people are not willing to walk more than 300 to 400 feet to a crossing and while it may not be practical to install a pedestrian crossing every 600 to 800 feet (such that you are never farther than 300 to 400 feet from the nearest crossing), other strategies such as relocating a bus stop could also be part of the solution.

Strategies included in this section are:

1. Add Sidewalk
2. Co-Locate Bus Stops and Pedestrian Crossings
3. Curb Extensions
4. High-Visibility Crosswalk
5. Mark/Upgrade Pedestrian Crossing at Uncontrolled Locations
6. Pedestrian Hybrid Beacon
7. Rectangular Rapid Flashing Beacon
8. Restripe Crosswalk
9. Shared Use Path
10. Widen Sidewalk

FDM 222.2.1

Add Sidewalk

Adding sidewalks provides a separated and continuous facility for people to walk along the roadway, and reduces the potential for people walking in the roadway, conflicting with vehicle travel.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Pedestrian walking along roadway.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
In combination with new sidewalks, appropriate marked and controlled crossing locations should be identified.

Home

FDM 222.2.8

Co-Locate Bus Stops and Pedestrian Crossings

Place bus stops and pedestrian crossings in close proximity to allow transit riders to cross the street safely.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Dart/dash and multiple threat/trapped.

SAFE SYSTEM STRATEGY
Remove severe conflicts, and increase attentiveness and awareness.

CONSIDERATIONS
Could include relocation of existing bus stops, or installation of new crossing treatments.

Home

FDM 202.3.12, TEM 5.2.7.5

Curb Extensions

A traffic calming measure that extends the sidewalk for a short distance at a crossing location to reduces the crossing distance and increase visibility.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN | SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Dart/dash, multiple threat/trapped, pedestrian struck by turning vehicle, through vehicle at unsignalized intersection, and through vehicle at signalized intersection.

SAFE SYSTEM STRATEGY
Manage vehicular speeds, and increase attentiveness and awareness.

CONSIDERATIONS
Drainage and ADA requirements should be considered. Paint and plastic curb extensions are a low-cost/quick build option.

Home

FDM 230.3.1

High-Visibility Crosswalk

Crosswalks made from high-visibility material, such as thermoplastic tape, instead of paint, improving safety by increasing the visibility of marked crosswalks.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, and through vehicle at signalized intersection.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Crosswalk treatments should consider wear patterns and maintenance requirements.

Home

FDM 222.2.3

Mark/Upgrade Pedestrian Crossing at Uncontrolled Locations (Signs and Markings Only)

Marked crossings can channelize pedestrian travel and alert drivers that people may be crossing the roadway.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, and through vehicle at unsignalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time, and increase attentiveness and awareness.

CONSIDERATIONS
Crossing locations should consider pedestrian destinations on both sides of roadway, pedestrian desire lines, as well as vehicle travel patterns.

Home

FDM 215.2.9, TEM 5.2.5.2

Pedestrian Hybrid Beacon

A pedestrian-hybrid beacon (PHB) notifies oncoming motorists to stop with a series of red and yellow lights. Unlike a traffic signal, the PHB rests in dark until a pedestrian activates it via pushbutton or other form of detection.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Dart/dash, multiple threat/trapped, and through vehicle at unsignalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
May require driver and pedestrian education.

Home

FDM 230.2.9, TEM 5.2.5.2

Rectangular Rapid Flashing Beacon

A rectangular rapid flashing beacon (RRFB) is a pedestrian-activated flashing light with signage to alert motorists of a pedestrian crossing. It improves safety by increasing the visibility of marked crosswalks and provides motorists a cue to slow down and yield to pedestrians.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Through vehicle at unsignalized intersection, dart/dash, and multiple threat/trapped.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
RRFBs should be reserved for use at locations with pedestrian safety issues as their overuse could diminish the effectiveness.

Home

Restripe Crosswalk

Periodic restriping of crosswalks is necessary to ensure the traffic markings are visible. Crosswalk may be restriped with high visibility markings.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, through vehicle at signalized intersection, and through vehicle at unsignalized intersection.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Crosswalk treatments should consider wear patterns and maintenance requirements.

Home

FDM 224

Shared Use Path

A 12' foot facility that is separated from the vehicular travel way for use by bicyclists, pedestrians, skaters, wheelchair users, joggers, and other users. When adjacent to a travel lane, these are referred to as side paths.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: SUBURBAN, RURAL

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Vehicle/pedestrian crashes and vehicle/bicyclist crashes.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
May require right-of-way.

Home

FDM 222.2.1.1

Widen Sidewalk

Widening sidewalks provides a more comfortable space for pedestrians and provides space to accommodate people in wheelchairs.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Pedestrian walking along roadway.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
May require right-of-way.

Home

E. Intersections and Roadways

Changing intersection and roadway design features such as eliminating turn lanes where people driving do not have to stop (sometimes known as slip lanes) to slow vehicle turning movements, narrowing travel lanes to promote slower speeds, and constructing sidewalks are some effective methods. Many intersection and roadway design measures may require public outreach and detailed analysis. For example, partially closing a roadway could result in community concerns about increased traffic on other streets or the need to make improvements at other locations.

Some improvements such as a protected intersection where setbacks, dedicated lanes, and curbs protect people walking and bicycling, and force slow turns for people driving, can be expensive and might need to be programmed as a capital improvement project. There are often opportunities to take advantage of reallocating right-of-way, especially as part of planned resurfacing projects. For instance, lane repurposing to add/enhance bicycle and pedestrian facilities are good candidates for inclusion with other planned roadway projects. For many of the roadway design changes noted below, there are opportunities for cost savings when incorporated as part of routine maintenance projects, like resurfacing.

Strategies included in this section are:

1. All-Way Stop Control
2. Bicycle Crossing (Solid Green Paint)
3. Bike Box
4. Centerline Hardening
5. Close Slip Lane
6. Crosswalk Density
7. Curb-Return Radius Reduction
8. Delineators, Reflectors, and/or Object Markers
9. Directional Median Openings to Restrict Left Turns
10. Doubled-up, Oversized Stop Signs
11. Enhanced Daylighting/Slow Turn Wedge
12. Extend Bike Lane to Intersection
13. Gateway Treatments
14. Green Conflict Striping
15. Guardrail
16. Hardened Median Nose Extension
17. High Friction Surface Treatment
18. Impact Attenuators
19. Intersection Reconstruction and Tightening
20. Lane Repurposing
21. Median Barrier
22. On-Street Parking
23. Paint and Plastic Median
24. Paint and Plastic Mini Circle/Mini Roundabout
25. Partial Closure/Diverter
26. Protected Intersection
27. Raised Crosswalk
28. Raised Intersection
29. Raised Median
30. Reduced Left-Turn Conflict Intersection
31. Refuge Island
32. Retroreflective Signal Backplates
33. Roundabout
34. Rumble Strips
35. Safety Edge
36. Speed Hump, Speed Table or Speed Cushion
37. Straighten Crosswalk
38. Superelevation at Horizontal Curve Locations
39. Widen/Pave Shoulder

FDM 212.2.3

All-Way Stop Control

An all-way stop-controlled intersection requires all vehicles to stop before crossing the intersection and better allocates the right-of-way between roadway users.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Angle crashes.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
Consider incorporating with high visibility crosswalks. Advanced signage may be necessary depending on speed and other roadway characteristics. Installation of unwarranted AWSC can lower stopping compliance.

Home

FDM 223.2.1.4, TEM 5.2.7.1

Bicycle Crossing (Solid Green Paint)

Green paint across an intersection that enhances bicycle safety and visibility.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Motorist turns left in path of bicyclist, motorist turns right in path of bicyclist, and motorist failed to yield at signalized intersection.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
In high travel areas, green paint can degrade and a maintenance plan should be developed.

Home

FDM 233.2.1.5

Bike Box

An area at an intersection with a signal where cyclists can move ahead of stopped traffic providing a designated and visible way to get ahead of queuing traffic.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Motorist failed to yield at signalized intersection and bicyclist turned left into path of motorist.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
In high travel areas, green paint can degrade and a maintenance plan should be developed.

Home

Centerline Hardening

Physical elements on the centerline, like bollards and rubber curbs, that encourage slower vehicle turns.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle.

SAFE SYSTEM STRATEGY
Manage vehicular speeds.

CONSIDERATIONS
Design should consider truck volumes and resulting wheel track in placement of hardening features.

Home

Close Slip Lane

Modification of an intersection to remove the sweeping right turn lane resulting in shorter pedestrian crossings, reduced turning speeds, and better sight lines.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Right turn crashes, pedestrian struck by turning vehicle, motorist turns left in path of bicyclist, and motorist turns right in path of bicyclist.

SAFE SYSTEM STRATEGY
Remove severe conflicts, manage vehicular speeds, and increase attentiveness and awareness.

CONSIDERATIONS
Drainage and ADA requirements should be considered.

Home

FDM 202.3.7

Crosswalk Density

Short blocks (500 feet or less) can manage speed by limiting driver acceleration distance between intersections. If used in conjunction with marked crosswalks, short blocks also create engagement. Where short-blocks do not exist, mid-block crosswalks can be used to simulate the short block effect.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, RURAL

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Vehicle/pedestrian crashes and vehicle/bicyclist crashes.

SAFE SYSTEM STRATEGY
Manage conflicts and increase attentiveness and awareness.

CONSIDERATIONS
May be challenging to retrofit buildout areas. Policy framework that requires increased intersection/crossing density as areas redevelop could be considered.

Home

FDM TABLE 212.12.3

Curb-Return Radius Reduction

This refers to the curvature of the curb line when two streets intersect. Reducing the size of the curb return radius can decrease the speed of turning vehicles and reduce the length of crossings.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Speed related crashes, pedestrian struck by turning vehicle, and bicyclist struck by turning vehicle.

SAFE SYSTEM STRATEGY
Manage vehicular speeds.

CONSIDERATIONS
Can create drainage problems, emergency vehicles would need to be considered in design, and may be difficult for large trucks to navigate.

Home

FDM 230.2.7

Delineators, Reflectors, and/or Object Markers

Devices that warn drivers of an approaching curve or fixed object providing additional reaction time to slow down.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Run off the road and collision with fixed objects.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
The selection of adhesive should be carefully considered when installing delineators in hot climates.

Home

FDM 212.14.5

Directional Median Openings to Restrict Left Turns

A median with selective openings that limits the number of turning movement and reduces the number of conflict points.

CRASH REDUCTION EFFECTIVENESS: LOW | **MED** | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Angle crashes, and left turn crashes.

SAFE SYSTEM STRATEGY
Remove severe conflicts, and increase attentiveness and awareness.

CONSIDERATIONS
Need for U-Turns should be evaluated and accommodated along the corridor.

Home

Doubled-up, Oversized Stop Signs

Treatment provides for left and right, oversized advance intersection warning signs. Retroreflective sheeting on sign posts and enhanced pavement markings that delineate through lane edge lines are typically provided.

CRASH REDUCTION EFFECTIVENESS: **LOW** | MED | HIGH

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Run off the road, collision with fixed objects, angle crashes, and motorist failed to yield at unsignalized intersection.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Can also be paired with flashing beacons.

Home

Enhanced Daylighting/Slow Turn Wedge

Paint and bollards that extend the curb and slow turns at intersections which increases safety by expanding driver field of vision and slowing vehicle travel.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle and motorist turns left in path of bicyclist.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Quick curb and other treatments can be used with minor impacts to drainage under quick build conditions.

Home

FDM 223.2.4.5

Extend Bike Lane to Intersection

Where a bike lane is dropped due to a right turn lane, the intersection approach is restriped to allow for bicyclists to move to the left side of right turning vehicles ahead of reaching the intersection.

CRASH REDUCTION EFFECTIVENESS: **LOW** | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Motorist turns right in path of bicyclist.

SAFE SYSTEM STRATEGY
Manage conflicts in time.

CONSIDERATIONS
In locations with high right-turn volumes, consider bike ramp to sidewalk/side path.

Home

Gateway Treatments

Gateway treatments are intended to alert roadway users that they are entering a different context and that they should expect pedestrians/bicyclists.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Vehicle/pedestrian crashes and vehicle/bicyclist crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness, and implement enforcing features to slow traffic.

CONSIDERATIONS
Examples of gateway treatments include signage, delineators, curb extensions, roundabouts, textured pavements, or other treatments intended to visually signal a changed condition to drivers.

Home

FDM 223.2.1.4

Green Conflict Striping

Dashed green markings in bike lanes near or through intersections increasing bicyclist visibility and identifying potential conflict points so both bicyclists and motorists use caution when traversing the area.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Motorist turns left in path of bicyclist, motorist turns right in path of bicyclist, and motorist failed to yield at signalized intersection.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
In high travel areas, green paint can degrade and a maintenance plan should be developed.

Home

FDM 215

Guardrail

A device that reduces the severity of lane departure crashes by redirecting a vehicle away from embankment slopes or fixed objects and dissipating the energy of an errant vehicle.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Run off the road crashes and collisions with fixed objects.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
There are several different types of guardrail designs that should be considered based on the area context.

Home

FDM 210.3.3

Hardened Median Nose Extension

An extension of the median nose can reduce pedestrian exposure and can improve the crossing experience of multi-lane roadways. Median noses that extend past the crosswalk protect people waiting in the median and slow turning drivers.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Vehicle/pedestrian crashes, vehicle/bicyclist crashes, and left-turn crashes.

SAFE SYSTEM STRATEGY
Manage conflicts and increase attentiveness and awareness.

CONSIDERATIONS
Design should consider truck volumes and resulting wheel track in placement of median nose extension.

Home

High Friction Surface Treatment

High friction surface treatments can improve pavement friction under all conditions and help reduce the frequency of crashes by allowing motorists to stop faster than on non-treated pavement.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Run off the road crashes, and collisions with fixed objects.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Treatments can last for 8-12 years so a maintenance schedule outside the RRR process may need to be developed.

Home

FDM 215.4.3

Impact Attenuators

A device that brings an errant vehicle to a more-controlled stop or redirects the vehicle away from a rigid object, typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Run off the road, and collision with fixed objects.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Can be used in permanent or temporary (construction zone) applications. Attenuators should only be installed where it is impractical for the objects to be removed.

Home

Intersection Reconstruction and Tightening

Reconstructing irregular intersections should can provide better visibility for all road users, and may also reduce high speed turns and pedestrian crossing lengths.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Right turn crashes, pedestrian struck by turning vehicle, and motorist turns right in path of bicyclist.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Drainage and ADA requirements should be considered, in addition to the turn movements of trucks.

Home

FDM 202.1.1

Lane Repurposing

A right of way reallocation can modify the space dedicated to vehicle travel to create space for bicycle facilities, add a buffer to existing bicycle facilities, wider sidewalks, or center turn lanes.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Speed related crashes, pedestrian walking along roadway, and vehicle overtaking bicycle.

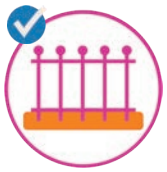
SAFE SYSTEM STRATEGY
Manage vehicular speeds and manage conflicts in time.

CONSIDERATIONS
There may be concerns about traffic diversion to other streets.

Home

FDM 215.4.6.4

Median Barrier



Barrier in the center of the roadway that physically separates opposing vehicular traffic and controls access to and from side streets and driveways, reducing conflict points. This may or may not have the intent of preventing pedestrian crossings. The potential for pedestrian diversion should be a primary factor in determining if this is an appropriate treatment.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Run off the road, collison with fixed objects, head on, and median crossover crashes.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Median breaks should be identified to allow maintenance and emergency vehicles to cross the median at appropriate locations.

Home

FDM 202.3.2, FDM 210.2.3

On-Street Parking

On-street parking can provide a buffer between pedestrians/ bicyclists and the travel lane, increasing safety and comfort. It can also be used to manage speeds when adjacent to a travel lane as parking maneuvers and driving next to parked vehicles creates friction that slows drivers.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Vehicle/pedestrian crashes.

SAFE SYSTEM STRATEGY
Implement enforcing features to slow traffic.

CONSIDERATIONS
If there are bike lanes or high volumes of bicyclists, a minimum of 3 feet should be provided to prevent “dooring”. Providing the appropriate separation between the bicycle facility, travel way, and parking lane is critical.

Home

Paint and Plastic Median

A painted median with plastic posts between the two directions of travel, reducing vehicular speeding and discourages risky turning movements.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle and motorist turns left in path of bicyclist.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness, and implement enforcing features to slow traffic.

CONSIDERATIONS
If posts are routinely being knocked down, a different treatment may be warranted.

Home

Paint and Plastic Mini Circle/ Mini Roundabout

Mini circles use paint and soft hit posts to replace stop-controlled intersections with a circular design that slows traffic and eliminates left turns and reduces conflicts. Mini roundabouts use curb treatments for a more permanent installation.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Angle crashes and left turn crashes.

SAFE SYSTEM STRATEGY
Remove severe conflicts and implement enforcing features to slow traffic.

CONSIDERATIONS
These should only be considered on low volume, low speed streets where trucks are not routinely expected to be.

Home

Partial Closure/Diverter

A roadway treatment that restricts select vehicle movements using physical diversion while allowing bicyclists and pedestrians to proceed.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

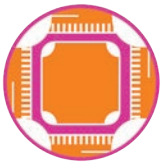
FOCUS CRASH TYPE
Pedestrian and bicycle crashes.

SAFE SYSTEM STRATEGY
Remove severe conflicts and implement enforcing features to slow traffic.

CONSIDERATIONS
Should be implemented as part of a larger traffic calming plan to minimize effects of diverted traffic to residential streets.

Home

Protected Intersection



Protected intersections use corner islands, curb extensions, and colored paint to delineate bicycle and pedestrian movements across an intersection, slowing driving speeds and providing shorter crossing distances.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$-$$$

FOCUS CRASH TYPE
Pedestrian struck by turning vehicle, motorist turns right in path of bicyclist, and motorist failed to yield at signalized intersection.

SAFE SYSTEM STRATEGY
Remove severe conflicts, manage vehicular speeds, manage conflicts in time, and increase attentiveness and awareness.

CONSIDERATIONS
Drainage and ADA requirements should be considered.

Home

FDM 202.3.8, TEM 5.2.7.5

Raised Crosswalk

Raised crosswalks are typically elevated 3-6 inches above the road or at sidewalk level and improves safety by increasing crosswalk and pedestrian visibility and slowing down motorists.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH, CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Through vehicle at signalized intersection, through vehicle at unsignalized intersection, and pedestrian struck by turning vehicle.

SAFE SYSTEM STRATEGY
Manage vehicular speeds, and increase attentiveness and awareness.

CONSIDERATIONS
Drainage and ADA requirements should be considered.

Home

FDM 202.3.8

Raised Intersection

Elevates the intersection to bring vehicles to the sidewalk level. Serves as a traffic calming measure by extending the sidewalk context across the road.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Through vehicle at signalized intersection, through vehicle at unsignalized intersection, and pedestrian struck by turning vehicle.

SAFE SYSTEM STRATEGY
Manage vehicular speeds, and increase attentiveness and awareness.

CONSIDERATIONS
Drainage and ADA requirements should be considered.

Home

TEM 5.2.7.5

Raised Median

Curbed sections in the center of the roadway that are physically separated from vehicular traffic. Raised medians can also help control access to and from side streets and driveways, reducing conflict points.

CRASH REDUCTION EFFECTIVENESS: LOW MED **HIGH** — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Angle crashes, head on, and dart/dash.

SAFE SYSTEM STRATEGY
Manage vehicular speeds.

CONSIDERATIONS
Need for U-Turns should be evaluated and accommodated along the corridor.

Home

FDM 212.1.1

Reduced Left-Turn Conflict Intersection

Geometric designs that alter how left-turn movements occur can simplify decisions and minimize the potential for related crashes.

CRASH REDUCTION EFFECTIVENESS: **LOW** MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: SUBURBAN, RURAL

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Left turn crashes and angle crashes.

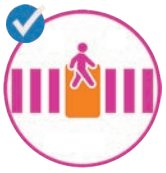
SAFE SYSTEM STRATEGY
Manage conflicts in time, and increase attentiveness and awareness.

CONSIDERATIONS
Two highly effective designs that rely on U-turns to complete certain left-turn movements are known as the restricted crossing U-turn (RCUT) and the median U-turn (MUT). These treatments may require additional ROW.

Home

FDM 210.3.2.3, TEM 5.2.7.5

Refuge Island



Provides a raised barrier in the center of the roadway restricting certain turning movements and providing a place for pedestrians to wait if they are unable to finish crossing the intersection. It reduces the number of potential conflict points and the exposure of pedestrians crossing the roadway.

CRASH REDUCTION EFFECTIVENESS: LOW **MED** HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN, SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Dart/dash, through vehicle at signalized intersection, and through vehicle at unsignalized intersection.

SAFE SYSTEM STRATEGY
Manage conflicts in time, and increase attentiveness and awareness.

CONSIDERATIONS
Pedestrian refuge areas can be constructed from paint and plastic as part of a low-cost/quick build project.

Home

FDM 232.1.5, TEM 3.9

Retroreflective Signal Backplates

Backplates added to a traffic signal head improve the visibility of the illuminated face of the signal by introducing a controlled-contrast background, which can be retroreflective.

CRASH REDUCTION EFFECTIVENESS: **LOW** MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Angle crashes and left turn crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
When an entire backplate is added, structural analysis may be required due to the added wind load.

Home

FDM 231.3.3

Roundabout

A circular non-signalized intersection where traffic flows in one direction that reduces conflict points.

CRASH REDUCTION EFFECTIVENESS: LOW **MED** HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$$

FOCUS CRASH TYPE
Severe crashes, angle crashes, and left turn crashes.

SAFE SYSTEM STRATEGY
Remove severe conflicts and manage vehicular speeds.

CONSIDERATIONS
Typically requires more right-of-way than traditional intersection and can be challenging for visually impaired people to navigate. Additional pedestrian treatments may be needed at some roundabouts.

Home

FDM 210.4.6 , TEM 5.2.7.5

Rumble Strips

Pavement treatments that create noise and vibration inside the vehicle that alert a driver as they cross the center or edge line to get the attention of a distracted or drowsy driver or under low visibility conditions.

CRASH REDUCTION EFFECTIVENESS: LOW **MED** HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Run off the road crashes and collisions with fixed objects.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Can create noise pollution and may not be appropriate near residential uses. May also pose problems for bicyclists and motorcyclists.

Home

Safety Edge

A safety edge is intended to minimize drop-off-related crashes as the shoulder pavement edge is sloped at an angle (30-35 degrees) to make it easier for a driver to safely reenter the roadway after inadvertently driving onto the shoulder.

CRASH REDUCTION EFFECTIVENESS: LOW **MED** HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Run off the road crashes and collisions with fixed objects.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Drainage and added impervious surface would need to be evaluated.

Home

FDM 202.3.8

Speed Hump, Speed Table or Speed Cushion

Vertical deflection device to raise the entire wheelbase of a vehicle and encourage motorists to travel at slower speeds.

CRASH REDUCTION EFFECTIVENESS: LOW **MED** HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Manage vehicular speeds and implement enforcing features to slow traffic.

CONSIDERATIONS
Drainage and emergency vehicle access will need to be considered. Speed cushions may be more appropriate on roadways with frequent emergency response vehicles.

Home

FDM 222.2.3

Straighten Crosswalk

Alignment of crosswalks to be perpendicular to the sidewalk, reducing pedestrian cross time and increasing sight lines.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Pedestrian crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Location of drainage inlets may affect curb ramp placement.

Home

FDM 240.2.1.4

Superelevation at Horizontal Curve Locations

A rotation and rising of pavement as the road curves that offsets sideways vehicular momentum preventing motorists from losing control.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Run off the road crashes and collisions with fixed objects.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Design speed should be evaluated as part of any geometric design change.

Home

FDM 210.4

Widen/Pave Shoulder

Widened and paved shoulders provide a breakdown lane and can help to reduce run-off-road crashes and are most beneficial on rural roads without paved shoulders.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Run off the road, collision with fixed objects, vehicle overtakes bicycle.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Adding paved shoulders within horizontal curve sections may help agencies maximize benefits of the treatment while minimizing costs as opposed to adding paved shoulders to an entire corridor. While widening/paving shoulders can provide a space for bicyclists, it should not be considered a replacement for a designated bicycle facility appropriate for the context.

F. Speed Management

Speed is an overarching contributing factor to many fatal and serious-injury crashes across all collision types in the region, with most fatal and severe injury crashes occurring on high-speed roadways. Therefore, a focus of engineering countermeasures is context appropriate speeds. A variety of proven techniques can be applied to reduce travel speed that are also considered as cross cutting strategies:

- Lane Repurposing – Reallocating the right-of-way to serve all roadway users can result in a reduction in the number of travel lanes on a street, which can enable the slowest driver to set the operating speed on a street, rather than the fastest driver. (See discussion in intersection and roadways)
- Traffic calming – Vertical devices such as speed humps and speed tables, horizontal devices such as bulbouts, chicanes, or mini traffic circles/roundabouts all have documented speed-reduction effects. These treatments are typically limited to local and collector roads, but sometimes are installed on arterial roadways depending on the context. (Traffic calming measures, such as speed humps and raised intersections are provided in the intersection and roadways section)
- Signal Coordination – Traffic signal coordination to maintain desired operating speeds along corridors. This strategy can reduce the incentive for people to drive more than the posted speed limit between intersections as it removes the potential for travel time savings. (See discussion in signals)
- Realigning skewed intersections – Broad, wide-radius turns can be made at high speeds. Tighter turns, closer to 90 degrees with a small radius are made at lower speeds. This strategy can also have the added benefit of reducing intersection crossing distances and increasing overall visibility. (See discussion in intersection and roadways)
- Reducing travel lane widths – Narrower travel lanes encourage lower vehicle speeds. Recent updates to the American Association of State Highway Transportation Official's (AASHTO) A Policy on Geometric Design of Highways and Streets included allowances for narrow travel lanes in recognition of safety research that showed little or no difference in crash history in a variety of contexts.
- Roundabouts – By introducing horizontal deflection onto otherwise straight roadways, roundabouts can reduce operating speeds. Additionally, roundabouts have proven safety benefits compared to standard intersections. (See information related to roundabouts in Intersection and roadway design)

Strategies included in this section are:

1. Appropriate Speed Limits
2. Chicane
3. Landscape Buffer
4. Lane Narrowing
5. Speed Cameras
6. Speed Feedback Sign
7. Speed Sensitive Rest on Red
8. Variable Speed Limits

FDM 201

Appropriate Speed Limits

Setting speed limits to reflect the surrounding context of the roadway and that meet with driver expectations can help improve driver respect for speed limits.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Manage vehicular speeds.

CONSIDERATIONS
Speed limit changes absent construction of engineering countermeasures should consider crash history and actual travel speeds. Speed limits that appear inconsistent may be ignored by the majority of drivers and this may contribute to lack of respect for speed limit and other traffic laws. Cost does not include implementation of engineering countermeasures to achieve desired speeds.

FDM 202.3.3

Chicane

Uses centerline deflection within existing curb by placing vertical barriers (e.g., curbs, on-street parking) to require vehicle operators to make frequent horizontal movements, which typically reduces vehicular speeds.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN | SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Manage vehicular speeds, and implement enforcing features to slow traffic.

CONSIDERATIONS
Can create drainage problems, Potential for head-on collisions increases depending on context , May be difficult for large trucks to navigate

Home

FDM 270.2

Landscape Buffer

Landscape separating drivers from bicyclists and pedestrians increases space between the modes and can produce a traffic calming effect by encouraging drivers to drive at slower speeds.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN | SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Manage vehicular speeds and implement enforcing features to slow traffic.

CONSIDERATIONS
Maintenance plan for landscaping may need to be developed.

Home

FDM 202.3.4

Lane Narrowing

Lane narrowing can encourage motorists to travel at slower speeds, which can reduce the severity of crashes.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN | SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Manage vehicular speeds and implement enforcing features to slow traffic.

CONSIDERATIONS
Lane narrowing through restriping can provide opportunities to widen bike lanes.

Home

Speed Cameras

These devices can capture the speed of a vehicle and a license plate to supplement traditional methods of enforcement. Signage should be installed to warn drivers in advance of the first speed camera on a corridor.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Manage vehicular speeds and implement enforcing features to slow traffic.

CONSIDERATIONS
These are allowed in Florida in school zones.

Home

FDM 202.3.9

Speed Feedback Sign

Notifies drivers of their current speed, usually followed by a reminder of the posted speed limit, providing a cue for drivers to check their speed and slow down.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Implement enforcing features to slow traffic.

CONSIDERATIONS
Some units can collect data to identify the most prevalent times of day/ week for speeding to aim in law enforcement activities.

Home

Speed Sensitive Rest on Red

At certain hours (e.g. late night) a signal remains red for all approaches or certain approaches until a vehicle approaches the intersection. If the vehicle is going faster than the desired speed, the signal will not turn green until after the vehicle stops. If the vehicle is going the desired speed the signal will change to green before the vehicle arrives.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN | SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Speed related crashes.

SAFE SYSTEM STRATEGY
Manage vehicular speeds and implement enforcing features to slow traffic.

CONSIDERATIONS
Can be paired with variable speed warning signs.

Home

SPEED ZONING 10.1

Variable Speed Limits

Variable speed limits (VSLs) can improve safety performance and traffic flow by reducing speed variance (i.e., improving speed harmonization). The speed limit changes according to the current environmental and road conditions and is displayed on an electronic traffic sign.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Speed related crashes, secondary crashes, and work zone.

SAFE SYSTEM STRATEGY
Manage vehicular speeds.

CONSIDERATIONS
VSLs may also improve driver expectation by providing information in advance of slowdowns and potential lane closures, which could reduce the probability for secondary crashes. VSLs can mitigate adverse weather conditions or slow faster-moving traffic as it approaches a queue or bottleneck. Particularly effective on urban and rural freeways and high-speed arterials with posted speed limits greater than 40 mph.

G. Other Engineering Strategies

Several other strategies are not focused on a singular mode and can benefit all roadway users. For example, consolidating driveways and improving lighting can benefit all roadway users. Curbside management is most commonly needed in urban areas where there is high competition for curb space, where effective management strategies can reduce passenger loading from travel lanes, reduce double parked delivery vehicles, and increase transit reliability.

Strategies included in this section are:

1. Access Management/Close Driveway
2. Create or Increase Clear Zone
3. Far-Side Bus Stop
4. Intersection Lighting
5. Relocate Select Hazardous Utility Poles
6. Remove Obstructions For Sightlines
7. Segment Lighting
8. Upgrade Lighting to LED

FDM 223.2.4.5

Access Management/Close Driveway

Driveway movements may create conflicts between pedestrians, bicyclists and vehicles, especially within 250 feet of intersections. Closing or modifying driveways, may reduce potential conflicts.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Driveway related pedestrian crashes, angle crashes, left turn crashes, and right turn crashes.

SAFE SYSTEM STRATEGY
Remove severe conflicts, and increase attentiveness and awareness.

CONSIDERATIONS
Need for U-Turns should be evaluated and accommodated along the corridor, and reciprocal access may be required.

Home

FDM 215.2.3

Create or Increase Clear Zone

A clear zone is an unobstructed roadside area that allows a driver to regain control of a vehicle that has left the road.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Run off the road and collision with fixed objects.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Creating or increasing clear zones within horizontal curve sections may help agencies maximize benefits of the treatment while minimizing costs, as opposed to providing a clear zone throughout an entire corridor.

Home

FDM 225.3

Far-Side Bus Stop

Located immediately after an intersection, allowing the bus to pass through the intersection before stopping, encourages pedestrians to cross behind the bus for greater visibility and can improve transit service reliability.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: URBAN SUBURBAN

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Dart/dash and multiple threat/trapped.

SAFE SYSTEM STRATEGY
Remove severe conflicts, and increase attentiveness and awareness.

CONSIDERATIONS
Bus stops should be located in proximity to marked and controlled crossings, especially in circumstances when destinations are on opposite side of the street. Coordination with transit agency is required.

Home

FDM 231

Intersection Lighting

Lighting improves safety by increasing visibility of all road users, and is most effective at reducing or preventing collisions at night.

CRASH REDUCTION EFFECTIVENESS: LOW MED HIGH CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Nighttime crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Location of landscaping that could affect lighting levels on the street should be evaluated.

Home

FDM 215.4.7

Relocate Select Hazardous Utility Poles

Relocating or removing utility poles from within the clear zone alleviates the potential for fixed-object crashes.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: RURAL

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Run off the road and collisions with fixed objects.

SAFE SYSTEM STRATEGY
Remove severe conflicts.

CONSIDERATIONS
Public Right-of-Way Accessibility Guidelines (PROWAG) require 48-inch pedestrian clear zone which may accelerate the need to relocate utility poles within pedestrian paths of travel.

Home

Remove Obstructions For Sightlines

Remove objects that may prevent drivers and pedestrians from having a clear sightline, such as installing red curb at intersection approaches to remove parked vehicles (also called "daylighting"), trimming or removing landscaping, or removing or relocating large signs.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $

FOCUS CRASH TYPE
Angle crashes, pedestrian struck by turning vehicle, motorist failed to yield at unsignalized intersection, motorist failed to yield at signalized intersection, and bicycle sidewalk crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Landscaping obstructions may require more routine maintained.

Home

FDM 231

Segment Lighting

Lighting along roadways that improves visibility at night.

CRASH REDUCTION EFFECTIVENESS: LOW | MED | HIGH — CMF Available

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Nighttime crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
Location of landscaping that could affect lighting levels on the street should be evaluated.

Home

FDM 231.3.2.1.1

Upgrade Lighting to LED

Replacing high-pressure sodium light bulbs with LED lights improves safety by increasing the visibility of pedestrians in crosswalks through greater color contrast and larger areas of light distribution.

CRASH REDUCTION EFFECTIVENESS: UNKNOWN

MODAL SAFETY EMPHASIS

APPLICABLE FACILITY: ALL ROADWAYS

IMPLEMENTATION TIMELINE

COST: $$

FOCUS CRASH TYPE
Nighttime crashes.

SAFE SYSTEM STRATEGY
Increase attentiveness and awareness.

CONSIDERATIONS
May require installation of additional lighting fixtures to meet lighting goals.

Home

VISION ZERO
CENTRAL FLORIDA

Counting down to zero traffic deaths

VISION ZERO
CENTRAL FLORIDA
Counting down to zero traffic deaths

Appendix A - Cost Estimate Details

Primary Safe System Strategy	Secondary Safe System Strategy (if applicable)	Countermeasure	Cost Considerations	Cost Estimate Range
Remove severe conflicts	Enforcing feature to slow traffic	Roundabout/Mini Roundabout	Extent of overall roadway reconstruction, drainage, landscaping and pedestrian amenities can affect overall cost. Does not include Right of Way.	"Neighborhood: $25-100K Collector: $150-$250k Arterial: $250k+ Multilane: $500k+"
Remove severe conflicts	Enforcing feature to slow traffic	Mini Traffic Circle	Drainage, landscaping and pedestrian amenities can affect overall cost.	$8,000-$15,000
Remove severe conflicts	-	Sidewalk Network Enhancements (close gaps)	Does not include utility relocation/ drainage.	$226,150/mile (5' one side, 4" depth)
Remove severe conflicts	Increase attentiveness and awareness	Corridor Access Management	Cost varies depending on strategies, such as median construction, closing/ reconfiguring driveways, etc.	Varies
Remove severe conflicts	Increase attentiveness and awareness	Median U-turn	Costs of the lower end of range if a minor modification; costs on the upper end of the range roadway if reconstruction is required.	$50,000-$1,000,000
Remove severe conflicts	-	Shared Use Path	Depending on number of driveways, additional treatments may be necessary to increase visibility of people on path at conflict locations. May require right-of-way, drainage improvements, and a landscaping plan.	$410,483/mile, 12' path, bidirectional
Remove severe conflicts	-	Buffered/Separated Bike Lanes	Cost of Paint Only; other treatments may be needed.	$11.50/sf
Remove severe conflicts	-	Median Barriers	Depends on materials selected - cable barrier can be about a third of the cost as a concrete barrier	$10,000-20,000 per 100 ft
	-	High Friction Surface Treatment	Depends on the overall composition of the overlay.	$42,000-$190,000/lane/ mile
Manage speed	-	Appropriate Speed Limits	Cost considerations include engineering study to target speed, identifying appropriate countermeasures to achieve desired speed, and implementing engineering countermeasures as applicable.	Varies
Manage speed	Enforcing feature to slow traffic	Speed Cameras	Depends on existing infrastructure along corridor. Currently these are only allowed in school zones and upgrades to school zone extents, signage and other equipment may be necessary. Does not include educational outreach campaign costs.	$60,000-$80,000

APPENDIX A - COST ESTIMATE DETAILS

Primary Safe System Strategy	Secondary Safe System Strategy (if applicable)	Countermeasure	Cost Considerations	Cost Estimate Range
Manage speed	-	Variable Speed Limits	Often implemented as part of a TSMO program; cost for signage only. Should roadway reconstruction be required, cost could be significantly higher.	$25,000-$30,000/mile
Manage speed	Enforcing feature to slow traffic	Speed Hump	Drainage could affect overall cost.	$1,500-5,500
Manage speed	Enforcing feature to slow traffic	Speed Table	Drainage could affect overall cost.	$2,000-20,000
Manage speed	Enforcing feature to slow traffic	Chicanes	Drainage could affect overall cost.	$2,500-16,000
Manage speed	-	Curb-Return Radius Reduction	Drainage and ADA requirements could affect overall cost.	$15,000-40,000
Manage speed	Increase attentiveness and awareness	Raised Crossing	Drainage and ADA requirements could affect overall cost.	$39,000 - $45,500
Manage speed	Increase attentiveness and awareness	Raised Intersection	Drainage and ADA requirements could affect overall cost.	$106,500 - $124,000
Manage speed	Enforcing feature to slow traffic	Lane Narrowing	Based on cost to mill and restripe roadway to provide marked parking. Actual cost could be lower if milling and resurfacing are not required.	$334,500/lane/mile
Manage speed	Enforcing feature to slow traffic	Landscape Buffer	Maintenance plan for landscaping may need to be developed. Cost considerations include right-of-way, drainage, irrigation, and maintenance.	Varies
Manage speed	Manage conflicts	Signal Retiming	Depends on existing signal hardware/ software and if it is implemented as part of a larger retiming program.	$0-$5,440
Manage speed	Manage conflicts	Lane Repurposing	Cost could be significantly higher if curbs are being moved and drainage is affected.	$334,500/lane/mile
Manage speed	-	Corner Radius Reduction	Drainage and ADA requirements can affect overall cost.	$15,000-40,000
Manage speed	Increase attentiveness and awareness	Curb Extension	Materials (concrete vs asphalt), landscaping, drainage, ADA requirements, and extent of other required roadway changes can affect overall cost; cost is for one corner; may be economies of scale if constructed at all corners of the intersection.	$2,000-20,000
Manage conflicts in time	Increase attentiveness and awareness	Crosswalk Density	If new RRFBs or other treatments are being considered, please consult those items for cost.	$100 for a regular striped cross-walk, $300 for a ladder crosswalk and $3,000 for patterned concrete crosswalk.
Manage conflicts in time	Increase attentiveness and awareness	Medians and Pedestrian Refuge Islands	Materials (concrete vs asphalt), landscaping, drainage, ADA requirements, and extent of other required roadway changes can affect overall cost; cost is for one refuge; may be economies of scale if constructed at multiple locations along the same corridor.	$10,000-$40,000

APPENDIX A - COST ESTIMATE DETAILS

Primary Safe System Strategy	Secondary Safe System Strategy (if applicable)	Countermeasure	Cost Considerations	Cost Estimate Range
Manage conflicts in time	Increase attentiveness and awareness	Median Nose Extension	Cost can very significantly depending on linear feet, materials (paint vs asphalt), drainage requirements, ADA requirements and other site specific factors. Cost is per leg.	$500-20,000
Manage conflicts in time	-	Leading Pedestrian Intervals (LPI)	Depends on existing signal hardware/ software and if it is implemented as part of a larger retiming program.	$0-$5,440
Manage conflicts in time	-	No Right Turn on Red blank-out signs	Cost depends on existing signal hardware/ software. Cost per sign.	$4,500-$15,000
Manage conflicts in time	-	Pedestrian Hybrid Beacons (PHBs)	Depends on the size of crossing, type of mast arm required, and other site specific features.	$75,000-$265,000/unit
Manage conflicts in time	-	Rectangular Rapid Flashing Beacons (RRFBs)	Solar powered units can reduce cost of running electricity. Costs only include RRFB system. If implemented in conjunction with high visibility crosswalks, median refuge and other elements, costs would be higher.	$4,500-$52,00
Manage conflicts in time	Increase attentiveness and awareness	Restricted Crossing U-turn	Costs of the lower end of range if a minor modification; costs on the upper end of the range roadway if reconstruction is required.	$50,000-$1,000,000
Manage conflicts in time	Increase attentiveness and awareness	Hardened Centerlines and Turn Wedges	Cost depends on selected treatments/ materials, size of intersection and number of approaches where countermeasure is installed. Cost is per approach.	$1,000 - $2,000
Manage conflicts in time	-	Retime Signals: Yellow Change Intervals	Depends on existing signal hardware/ software and if it is implemented as part of a larger retiming program.	$0-$5,440
Increase attentiveness and awareness	Enforcing feature to slow traffic	Gateway Treatments	Cost depends on extent of treatments	$10,000-65,000
Increase attentiveness and awareness	-	High Visibility Crosswalk	Depends on the size the size the crosswalk, and the paint used.	$600-5,700
Increase attentiveness and awareness	-	Bike Box	Cost of Paint Only; other treatments may be needed.	$11.50/sf
Increase attentiveness and awareness	-	Lighting	Cost depends on a number of variables, including type of fixtures, frequency of lighting,, and presence of electricity in corridor.	Varies
Increase attentiveness and awareness	-	Improving Sight Lines	Cost depends on type of strategy, such as landscaping maintenance, closing of slip lanes, removal of on-street parking or straightening of crosswalk.	Varies
Increase attentiveness and awareness	-	Backplates with Retroreflective Borders	A structural/wind analysis should be conducted.	"$35/head to add reflective tape to existing backplates $110/head to install new backplates with integrated retroreflective material"

APPENDIX A - COST ESTIMATE DETAILS

Primary Safe System Strategy	Secondary Safe System Strategy (if applicable)	Countermeasure	Cost Considerations	Cost Estimate Range
Increase attentiveness and awareness	-	Enhanced Signing and Pavement Markings	Cost depends on the types of signage and pavement marking treatments.	$800 - $1,300 per location
Increase attentiveness and awareness	Remove conflicts	Bicycle Lanes Enhancements	Cost depends on the range of treatments applied and if right-of-way is needed.	Varies
Increase attentiveness and awareness	-	Refresh pavement markings	Overall cost per location can be reduced when implemented along a corridor or areawide.	$22-600 each ($180 avg)
Increase attentiveness and awareness	-	Doubled-up (left and right), oversized advance intersection warning signs, with supplemental street name plaques (can also include flashing beacon).	Flashing beacon cost is not included.	$50-150/sign
Increase attentiveness and awareness	-	Retroreflective sheeting on sign posts.	Depends on size of sign.	$50-250/sign
Increase attentiveness and awareness	-	Enhanced pavement markings that delineate through lane edge lines.	Overall cost per location can be reduced when implemented along a corridor or areawide.	$1-10/linear foot
Increase attentiveness and awareness	-	Doubled-up (left and right), oversized Stop signs.	Can also be paired with flashing beacons that are not included in cost estimate.	$50-150/sign
Increase attentiveness and awareness	-	Properly placed stop bar / Advance stop bar	Not limited to stop control intersections.	$500
Increase attentiveness and awareness	-	Removal of vegetation, parking, or obstructions that limit sight distance.	Similar to improving sight-lines. Cost can vary depending on elements included.	Varies
Increase attentiveness and awareness	-	Double arrow warning sign at stem of T-intersections.	Depends on size of sign.	$50-150/sign
Increase attentiveness and awareness	-	Chevron Signs for Horizontal Curves or other advanced delineation.	Can be paired with other treatments, like rumble strips.	$1-10/linear foot
Increase attentiveness and awareness	-	Longitudinal Rumble Strips and Stripes on Two-Lane Roads	Best when implemented as part of an overall resurfacing project for cost effectiveness.	$5000-$6,000/mile
Enforcing feature to slow traffic	-	Mobile Speed Feedback Signs	Solar powered units can reduce cost of running electricity.	$7,000-18,000
Enforcing feature to slow traffic	-	On-Street Parking	Based on cost to mill and restripe roadway to provide marked parking. Actual cost could be lower if milling and resurfacing are not required.	$334,500/lane/mile