Tempe

September 2026

Transportation Plan

Multimodal Safety Countermeasures Toolkit

2050

Multimodal Safety Countermeasures Toolkit

INTRODUCTION

Tempe's approach to improving street safety aligns with the broader vision and goals outlined in Transportation Plan 2050 and is grounded in the Safe System Approach, which emphasizes roadway designs that anticipate human error and reduce crash severity. This Speed Management and Safety Toolkit is a resource for the implementation of safety strategies to help enhance road safety in Tempe. The toolkit comprises a set of context-sensitive treatments that aim to manage speed, address common crash patterns, and improve safety, comfort, and connectivity along Tempe's arterial corridors.

A major focus of this toolkit is the city's arterial street network. Arterial streets carry high traffic volumes over longer distances and connect destinations across the transportation network. Arterials in Tempe typically feature wide cross-sections, high vehicle speeds, and frequent access points, resulting in complex operations and elevated safety risks for all road users.

The countermeasures in this toolkit are particularly appropriate for Tempe roadway and land use contexts. These treatments may be implemented in response to observed crash patterns or proactively along corridors with street designs associated with elevated crash risk. In accordance with Safe System principles, countermeasures may be applied in combination to reduce the likelihood and severity of crashes.

TOOLKIT ORGANIZATION

Countermeasure Categories

The countermeasures are organized into five categories, though countermeasures may correspond to or provide benefits across more than one category:

1. **Access Management**: *Managing driveways and turning movements*

   Treatments that reduce conflict points along a street by improving how and where drivers make turns to enter and exit site driveways and local streets. These treatments can improve traffic flow and reduce crash frequency by limiting unprotected left turns.

2. **Intersections and Crossings**: *Reducing crash risk and potential severity where conflicts are inevitable*

   Treatments that reduce potential for conflicts at intersections and crossings, where severe crashes have occurred or may occur. Countermeasures include design and signal improvements that enhance visibility and separate drivers and people walking or biking in time and space.

3. **Operations Strategies**: *Adjusting signals and traffic flow*

   Tools that optimize how traffic moves through a corridor, such as signal timing, phasing, coordination, and speed management measures. These strategies target severe crash types like left-turn, angle, and failure to yield crashes.

4. **Roadway Reconfiguration**: *Changing lane configurations and street design elements*

   Design changes that reallocate or reshape space within the roadway to better manage speeds and improve safety for all users.

5. **Infrastructure for Alternative Modes**: *Creating safe places for people to walk, bike, and roll*

   A range of countermeasures, design strategies, and enhancements that improve safety and comfort for people walking, biking, and using micromobility devices.

TOOLKIT CONTENT

Each countermeasure profile contains the following content:

» **Description**: Briefly defines the countermeasure.

» **Safety Benefits**: Identifies the potential safety benefits associated with implementing the countermeasure.

» **Target Crash Types**: Identifies the crash types targeted by each countermeasure.

» **Crash Reduction Factor and Crash Modification Factor ID**: References Federal Highway Adminstration (FHWA) Crash Modification Factors (CMF) quantitatively estimate the expected safety improvement associated with implementing a countermeasure. The Crash Reduction Factor (CRF) is the estimated percentage reduction in crashes that may result from countermeasure implementation, while the **Crash Modification Factor ID (CMF ID) identifies the entry in the FHWA CMF Clearinghouse**. Not all countermeasures have been researched, analyzed, and assigned a CMF.

» **Considerations and Applicability**: Describes the roadway, operational, and contextual factors that should be considered when determining the appropriateness of a countermeasure for a specific location. This section provides common applications, implementation considerations, potential tradeoffs, and conditions that may impact a treatment's effectiveness.

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» **Feasibility**: Describes the perceived complexity of implementing a countermeasure based on cost, contruction effort, right-of-way needs, operational impacts, coordination, and timeframe. Countermeasure feasibility is categorized as Low, Medium, or High.

» **Multimodal Impacts and Benefits**: Describes how a given countermeasure may influence the safety, comfort, accessibility, and operations of non-motorized road users (i.e., pedestrians, bicyclists, transit riders, micromobility users, and individuals using mobility-assisted devices). Low, Medium, or High indicate the perceived likelihood of benefits and unintended tradeoffs a countermeasure may impart to these users.

» **Safe System Goals**: Indicates which Safe System principles each countermeasure supports.

» **Resources**: Includes federal manuals, design guidelines, and research documents where designers and toolkit users may find additional informaiton on the benefits and appropriate application of each countermeasure.

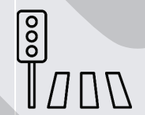
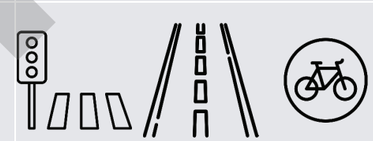
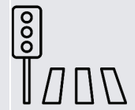
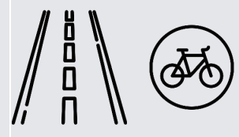
NOTES ON ENFORCEMENT STRATEGIES

Effective speed management combines roadway design, operations, education, and enforcement strategies to create a safer and more predictable operating environment. Roadway design establishes the desired travel speed, while enforcement can reinforce the desired outcomes and support safer driver behavior, especially when changes are made along specific corridors.

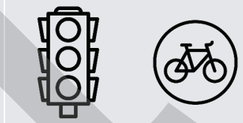
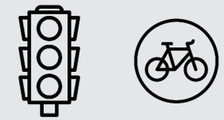
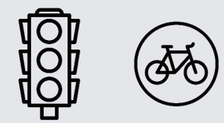
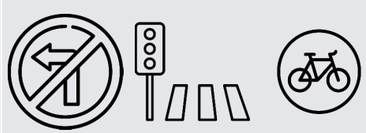
Currently, Tempe uses a range of enforcement strategies, including the Safety Corridor Program, mobile speed feedback signs, and automated enforcement for red-light running and speeding. The existing automated enforcement programs include fixed and mobile cameras. Since these enforcement programs are actively implemented across the City of Tempe, they are not included in the Speed Management Toolkit. However, additional opportunities exist to expand speed management and enforcement efforts through a combination of automated and targeted officer enforcement, especially following countermeasure implementation. These strategies may help ensure consistent travel speeds and reduce speed variability, which can play a significant role in reducing severe crashes. Focused enforcement following countermeasure implementation may also help to reinforce new traffic conditions and encourage desired driver behavior changes.

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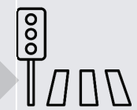
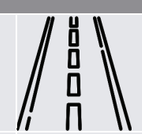
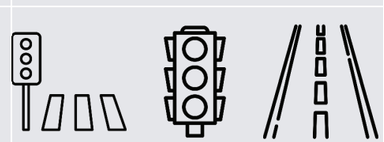
SUMMARY TABLE

Countermeasure (pg #)	Definition & Crash Types Addressed	Secondary Category	Safer Speeds	Safer Roads	Safer People
Access Management					
Raised Medians (61)	A physical barrier that separates opposing traffic and restricts or directs turning movements at designated locations. Target crash types: Angle, fixed-object, head-on, rear-end, sideswipe, and single-vehicle crashes.		✓	✓	
Reduced Conflict Intersections (62)	Geometric design that redirects side-street left-turn and crossing movements to downstream U-turn locations to reduce conflict points. Target crash types: Angle and left-turn crashes at unsignalized intersections.		✓	✓	
Reduced Driveway Density (63)	Consolidation or reduction of driveways along a corridor to reduce vehicle access points and related conflicts. Target crash types: Angle, left-turn, rear-end, and sideswipe crashes.		✓	✓	
Right-In/Right-Out (RIRO) Only Site Access (64)	A restriction of driveway access to right-turn entry and exit, eliminating left-turn and crossing movements. Target crash types: All crash types.		✓	✓	
Intersections and Crossings					
Advanced Signs and Pavement Markings (65)	Signs and pavement markings that increase driver awareness, crossing visibility, and driver yielding compliance. Target crash types: Pedestrian-involved and angle crashes.		✓	✓	✓
Clear Intersection Sight Distance Triangles (66)	The removal of visibility obstructions at intersections and driveways so roadway users can see one another. Target crash types: All crash types.			✓	
Marked Conflict Areas (67)	Pavement markings that highlight locations where bicyclists and drivers may cross paths. Target crash types: Bicycle-involved, turning, and angle crashes.		✓	✓	

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Countermeasure (pg #)	Definition & Crash Types Addressed	Secondary Category	Safer Speeds	Safer Roads	Safer People
Retroreflective Signal Head Treatments (68)	Reflective treatments added to traffic signal heads to improve signal visibility and driver awareness. Target crash types: Rear-end and angle crashes at signalized intersections.			✓	
Active Pedestrian Crossing Treatments (69)	Pedestrian-activated beacons or signals that improve crossing visibility and require drivers to yield or stop. Target crash types: Pedestrian-involved crashes.		✓	✓	✓
High-Visibility Crosswalk Markings (70)	Enhanced pavement markings to increase the visibility and recognition of pedestrian crossing locations. Target crash types: Pedestrian-involved crashes.		✓	✓	✓
Median Refuge Islands (71)	A separated area in the center of the roadway that allows pedestrians to pause and cross in two stages. Target crash types: Pedestrian-involved crashes at unsignalized locations.		✓	✓	✓
Right Turn on Red Restrictions (72)	Prohibition of right turns during the red signal phase to reduce conflicts with crossing pedestrians and bicyclists. Target crash types: Pedestrian- and bicycle-involved, right-turn, and angle crashes.			✓	✓
Leading Pedestrian Intervals (LPIs) (73)	A pedestrian signal phase that gives pedestrians a few second head start before parallel vehicle movements receive a green signal. Target crash types: Pedestrian-involved left-turn and angle crashes.		✓	✓	✓
Operations Strategies					
Dilemma Zone Protection (74)	Signal timing strategy that uses advance detection to extend green or all-red time and reduce abrupt stopping and red-light running. Target crash types: Rear-end and angle crashes.			✓	
Protected Only Left-Turn Signal Phasing (75)	Signal phasing that provides a dedicated phase separating left-turn traffic from opposing through movements. Target crash types: Bicycle-involved and angle crashes.			✓	

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Countermeasure (pg #)	Definition & Crash Types Addressed	Secondary Category	Safer Speeds	Safer Roads	Safer People
Signal Clearance Interval (Yellow + All-Red) (76)	Yellow and all-red signal timing that provides sufficient time for drivers to stop or clear the intersection. Target crash types: Rear-end crashes.			✓	
Roadway Reconfiguration					
Lane Reconfiguration (77)	Reallocation of roadway space that changes the number or arrangement of travel and turn lanes. Target crash types: All crash types.		✓	✓	✓
Narrow Travel Lanes (78)	A reduction in travel-lane width to manage speeds and allow roadway space to be reassigned to other uses. Target crash types: All crash types.		✓	✓	✓
Corner Redesign (79)	Modifications to intersection geometry that reduce curb radii or add curb extensions to slow turning vehicles, shorten crossings, and improve visibility. Target crash types: Intersection-related pedestrian-involved crashes.		✓	✓	✓
Infrastructure for Alternative Modes					
Separated Bike Lanes and Shared Use Paths (80)	Dedicated space for bicyclists that is physically separated from motor vehicle traffic. Target crash types: Bicycle-involved, sideswipe, and angle crashes.		✓	✓	✓
Bicycle Network Gap Completion (81)	The completion of missing bicycle facility segments to create a continuous and predictable network. Target crash types: Bicycle-involved, sideswipe, and angle crashes.		✓	✓	✓
Protected Intersections (82)	Intersection design that continues a separated bikeway through the intersection and separates bicyclists and drivers in time and space. Target crash types: Pedestrian- and bicycle-involved, angle, and left-turn crashes.		✓	✓	✓

Icons via Freepik, Karyative, xnimrodx, and Good Ware

Raised Medians
Access Management

Description:

A physical barrier that divides the roadway, typically curb-height or higher, that separates opposing traffic and may be used to restrict turns or direct drivers to turn at specific location.



Feasibility: Medium

Requires the presence of TWLTLs or a reconfiguration of roadway space. May require community engagement where there are changes in access to private properties and/or driveways.

Safety Benefits: Separates opposing traffic, calms speeds, and enhances turning movement predictability.

Targets: Angle, fixed object, head on, rear-end, sideswipe, single vehicle crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

FHWA Corridor Access Management

Considerations and Applicability:

- » Confirm road is wide enough to accommodate a median and meet travel lane width regulations.
- » Manage access by strategically aligning median gaps with intersections, driveways, turning lanes and desired U-turn locations.
- » Coordinate with the Fire Department and School Districts to maintain access for emergency vehicles, school buses, and public transit.
- » Implement refuge islands at mid-block crossings.
- » Incorporate landscaping to act as a traffic-calming feature by increasing visual friction.

Location Type: Mid-Block

Multimodal Impacts and Benefits: Medium

Can support safe crossing opportunities when paired with refuge islands; without safe crossings, may limit pedestrian access.

CRF: 19-47%

CMF ID: 2514, 2515, 2516, 2517, 2518

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Reduced Conflict Intersections
ACCESS MANAGEMENT

Description: A geometric design that redirects side-street left-turn and crossing movements to downstream U-turn locations to reduce intersection conflicts.



Feasibility: Medium

Requires the presence of TWLTLs or raised medians. May require community engagement where there are changes in access to private properties and/or driveways.

Safety Benefits: Reduces the number and complexity of conflict points, lowering the potential for severe crashes.

Targets: Angle, Left-turn crashes at unsignalized and minor street stop-controlled intersections

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

FHWA Alternative Intersections/Interchanges

FHWA RCUT Informational Guide

Considerations and Applicability:

- Consider opportunities on high-speed multilane roads with regular access points.
- Confirm sufficient median width and downstream intersections that allow U-turn movements.
- Coordinate with the Fire Department and School Districts to maintain access for emergency vehicles, school buses, and public transit.
- Incorporate pedestrian and bicycle crossings.
- Consider corridor access spacing and signal coordination.
- May require additional signing, wayfinding, and guidance.

Location Type: Intersection

Multimodal Impacts and Benefits: Low

May create indirect crossings and affect bicycle routing.

CRF: 54-63%

CMF ID: 4884, 5556

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Reduced Driveway Density
ACCESS MANAGEMENT

Description: Consolidation or reduction of driveways along a corridor to reduce conflict points between drivers and people walking, biking, and rolling.

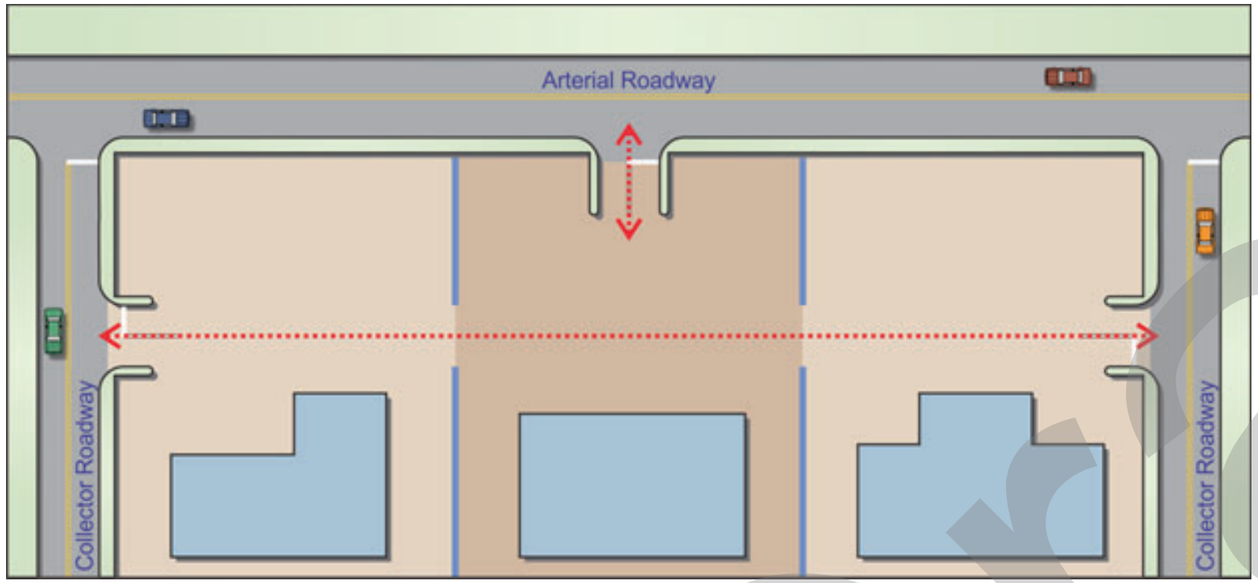


Image source: FHWA

Feasibility: Medium

Likely requires stakeholder coordination, shared access agreements, and public outreach.

Safety Benefits: Decreases the number of vehicle access points, reducing opportunities for conflicts along the corridor.

Targets: Angle, left-turn, rear-end, and sideswipe crashes (26-48 to 10-24 per mile, 10-24 to less than 10 per mile)

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Corridor Access Management

FHWA Proven Safety Countermeasures

Considerations and Applicability:

» Evaluate opportunities along corridors with frequent access and turning activity and in locations with history of turning, angle, or rear-end crash history.

» Coordinate with landowners and local agencies, as access changes may affect adjacent properties.

Location Type: Mid-Block

Multimodal Impacts and Benefits: High

Reduces conflict points and improves comfort for people walking, biking, and rolling.

CRF: 25-31%

CMF ID: 178, 179

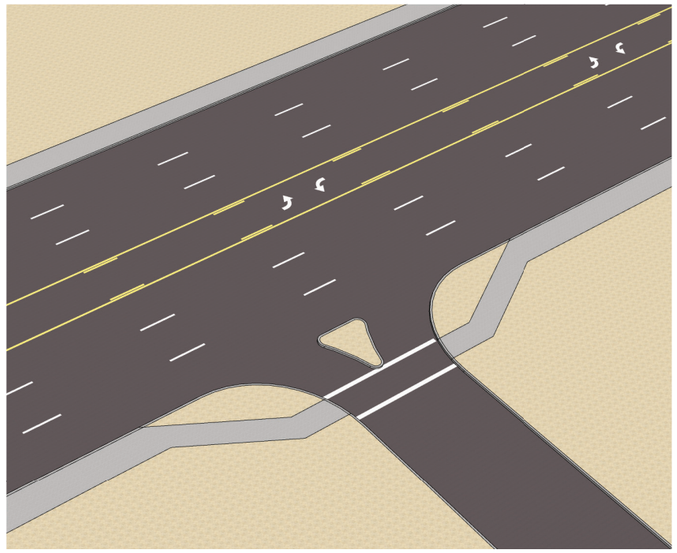
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Right-In/Right-Out (RIRO) Only Site Access

ACCESS MANAGEMENT

Description:

Restriction of driveway entry and exit to right turn movements only, eliminating thru movements and left turn maneuvers across multiple lanes of traffic.





Feasibility: Medium

Requires a raised median; may require stakeholder coordination, shared access agreements, and/or public outreach.

Safety Benefits: Reduces crossing and left-turn conflicts by simplifying driveway access.

Targets: All crash types

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Corridor Access Management

Considerations and Applicability:

- Evaluate opportunities along multilane arterials with frequent driveway access and where left turn access creates operational or safety concerns.
- Consider impacts to adjacent access points and circulation patterns.
- Consider median spacing, driveway spacing, and corridor operations.
- Consider opportunities to reduce corner radii to control turning speeds.
- Evaluate potential for unintended consequences, as it may increase out-of-direction travel and U-turn activity.

Location Type: Mid-Block

Multimodal Impacts and Benefits: Medium

May reduce network connectivity and safety for people walking, biking, and rolling since raised medians can create longer distances between crossings.

CRF: 45%

CMF ID: 9821

Draft

Advanced Signs and Pavement Markings
INTERSECTIONS AND CROSSINGS

Description:

Signs and pavement markings to increase driver awareness and visibility of crossing locations.





Feasibility: High

Requires clear visibility and compliance with MUTCD standards.

Safety Benefits: Increases motorist awareness and yielding compliance at crossing locations. Advanced warning signs provide additional reaction time, helping users anticipate and respond to conditions. 80 percent yielding compliance and traffic calming effect.

Targets: Pedestrian-involved and angle crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

AASHTO Innovative Initiative

FHWA Proven Safety Countermeasures

PEDSAFE

FHWA STEP Program

MUTCD

Considerations and Applicability:

- » Evaluate opportunities at uncontrolled pedestrian crossings and multilane roadways.
- » Consider visibility, lighting, and sign placement.
- » Regularly maintain in-street pedestrian signs, which may experience vehicle strikes.
- » Apply alongside RRFBs, refuge islands, curb extensions, or high-visibility crosswalks where applicable.

Location Type: Intersection/Mid-Block

Multimodal Impacts and Benefits: High

Improves driver yielding and crossing visibility.

CRF:

Advanced yield/stop markings and signs: 25%

Advanced warning signs: 35%

CMF ID:

Advanced yield/stop markings and signs: 9017

Advanced warning signs: 1684

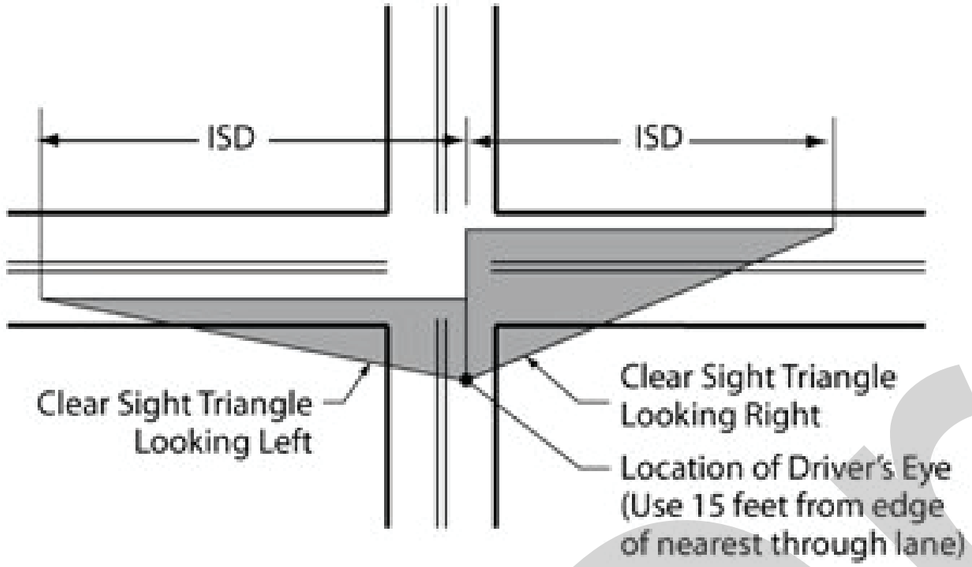
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Clear Intersection Sight Distance Triangles

INTERSECTIONS AND CROSSINGS

Description:

Removes visibility obstructions at intersections and driveways to ensure drivers and people walking, biking, and rolling can see each other.



Considerations and Applicability:

- » Evaluate opportunities at intersections and driveways with limited visibility due to landscaping, signage, utilities, parked vehicles, etc.
- » Consider physically enforcing existing parking restrictions with curb extensions.
- » Evaluate approach speeds, grades, and intersection geometry.
- » Consider both pedestrian and bicyclist visibility as well as driver sight lines.
- » Regularly revisit need to trim back vegetation and enforce parking restrictions.

Location Type: Intersection

Multimodal Impacts and Benefits: High

Improves safety without affecting routing.

CRF: 11-22%

CMF ID: 12106, 12107, 12108

Feasibility: High

Requires field visit and evaluation.

Safety Benefits: Enhances visibility between road users, reducing the likelihood of turning or crossing conflicts.

Targets: All crash types

Safe System Goals: ☐ Safer Vehicles ☐ Safer Speeds ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

AASHTO Green Book

FHWA Intersection Safety Program

FHWA Signalized Intersections Informational Guide

MUTCD

Draft

Marked Conflict Areas
Intersections and Crossings

Description:

Pavement markings to highlight areas where bicyclists and drivers may cross paths.



Considerations and Applicability:

- » Evaluate opportunities on roads with bicycle facilities at intersections, driveways, and merge areas.
- » Regularly maintain colored pavement markings.
- » Apply alongside bicycle lane markings, signage, and geometric treatments, i.e., reduced corner radii.
- » Consistently apply at bicyclist crossings for drivers to become familiar with the treatment and yield uniformly.

Location Type: Intersection/Mid-Block

Multimodal Impacts and Benefits: Medium

Improves awareness but does not reduce exposure.

CRF: Not in CMF Clearinghouse

CMF ID: n/a

Feasibility: High

Requires bikeways that cross intersections or driveways.

Safety Benefits: Improves visibility of bicycle merging and crossing locations, encouraging cautious and predictable behavior.

Targets: Bicycle-involved, turning, and angle crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Bikeway Selection Guide

NACTO Urban Bikeway Design Guide

AASHTO Bike Guide

MUTCD

NCHRP Report 926

Draft

Retroreflective Signal Head Treatments
Intersections and Crossings

Description:

Addition of reflective borders to traffic signal heads to improve their visibility to oncoming drivers.



Image source: FHWA

Feasibility: High

Safety Benefits: Enhances signal visibility and motorist awareness, reducing the likelihood of missed or late responses and related crashes.

Targets: Rear-end and angle crashes at signalized intersections

Safe System Goals: ☐ Safer Vehicles ☐ Safer Speeds ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

FHWA Signalized Intersections Informational Guide

MUTCD

Considerations and Applicability:

- » Evaluate opportunities on higher speed roadways or high-volume intersections.
- » Apply alongside signal timing and intersection illumination improvements.
- » Revisit installation locations and reapply retroreflectivity as needed.

Location Type: Intersection

Multimodal Impacts and Benefits: High

Improves signal visibility without multimodal tradeoffs.

CRF: 15%

CMF ID: 1410*

**CMF refers to reflective signal backplates*

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Active Pedestrian Crossing Treatments

Intersections and Crossings

Description:

Pedestrian-activated beacons (Rectangular Rapid Flashing Beacons (RRFB) or Pedestrian Hybrid Beacons (PHB)) that improve visibility of crossings and require drivers to yield to or stop for people walking, biking, or rolling.



Feasibility: Medium

Requires access to power and minimum spacing from existing signals; may require nearby signal coordination; must support ADA access.

Safety Benefits: Increases pedestrian visibility and driver yielding compliance at uncontrolled crossings.

Targets: Pedestrian-involved crashes

(highest PHB CRF represents install with advanced yield or stop markings and signs)

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

FHWA Guide for Uncontrolled Crossing Locations

MUTCD

Considerations and Applicability:

- Evaluate opportunities at uncontrolled pedestrian crossings on multilane or high-speed roadways and at locations with limited crossing opportunities.
- Select treatment(s) based on vehicle speed, traffic volume, and crossing distance - multilane, high speed, and high-volume crossings may require more substantial treatments (mid-block pedestrian signal or PHB).
- Apply alongside refuge islands, illumination, high-visibility crosswalk markings, and advance markings to improve effectiveness.

Location Type: Mid-Block

Multimodal Impacts and Benefits: High

Improves driver yielding and crossing visibility.

CRF:

PHB: 55-69%

RRFB: 47%

CMF ID:

PHB: 2922, 9020, 9021

RRFB: 9024

Draft

High-Visibility Crosswalk Markings

INTERSECTIONS AND CROSSINGS

Description:

Enhanced pavement markings that increase visibility of pedestrian crossing locations.



Considerations and Applicability:

- » Evaluate opportunities at marked pedestrian crossings and multilane roadways with high pedestrian activity or pedestrian crash history.
- » Regularly maintain markings and restripe as needed.
- » Apply alongside PHBs, RRFBs, refuge islands, or mid-block pedestrian signals.
- » Prioritize implementation at higher-risk locations based on traffic volume, speed, crash history and the HIN, equity considerations, and pedestrian demand.

Location Type: Intersection/Mid-Block

Multimodal Impacts and Benefits: High

Improves crossing visibility and safety.

CRF: 40%

CMF ID: 4123

Feasibility: High

Must support ADA access.

Safety Benefits: Enhances recognition of crossing locations, supporting driver yielding and pedestrian exposure.

Targets: Pedestrian-involved crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

FHWA STEP Program

MUTCD

AASHTO Pedestrian Facility Guidance

Draft

Median Refuge Islands
INTERSECTIONS AND CROSSINGS

Description:

A horizontally and/or vertically separated area in the center of the roadway that provides a space for pedestrians to pause and safely cross the road in two stages.





Considerations and Applicability:

- » Evaluate opportunities near schools, hospitals, senior living centers, and downtown areas.
- » Align the island with intersections, driveways, and turning lanes.
- » Coordinate with the Fire Department and School Districts to maintain access for emergency vehicles, school buses, and public transit.
- » Design islands according to ADA/PROWAG guidance.

Location Type: Intersection/Mid-Block

Multimodal Impacts and Benefits: High

Creates safer crossings on wide roadways.

CRF: 46%

CMF ID: 175

Feasibility: Medium

Requires the presence of TWLTLs, raised medians, or a reconfiguration of roadway space.

Safety Benefits: Reduces pedestrian exposure and crossing complexity by allowing users to cross one direction at a time.

Targets: Pedestrian-involved crashes at unsignalized locations.

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

Pedsafe Guide

GDCI Global Street Design Guide

Draft

Right Turn on Red Restrictions

Intersections and Crossings

Description:

A prohibition or right turns during the red signal phase to avoid conflicts between turning drivers and pedestrians or bicyclists crossing the street.



Feasibility: Medium

Requires signing for new operations; may require targeted enforcement immediately following implementation.

Safety Benefits: Reduces conflicts between vehicles turning and pedestrians or bicyclists while crossing.

Targets: Pedestrian-and bicycle-involved, right-turn and angle crashes

Safe System Goals: ☐ Safer Vehicles ☐ Safer Speeds ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

ITE Walkable Thoroughfares

Pedsafe Guide

Considerations and Applicability:

- » Evaluate opportunities near schools, hospitals, senior living centers, and Downtown, as well as locations with regular pedestrian activity or pedestrian-involved crash history.
- » Apply alongside additional signing and enforcement, as needed.
- » Consider option to implement only during periods of peak daily pedestrian activity.
- » Consider impacts to transit access and operations.

Location Type: Intersection

Multimodal Impacts and Benefits: High

Improves crossing safety conditions and comfort.

CRF: 10% to 60%

CMF ID: 376

*These crash modification factors indicate an **increase** in crashes with permitted right turn on red.*

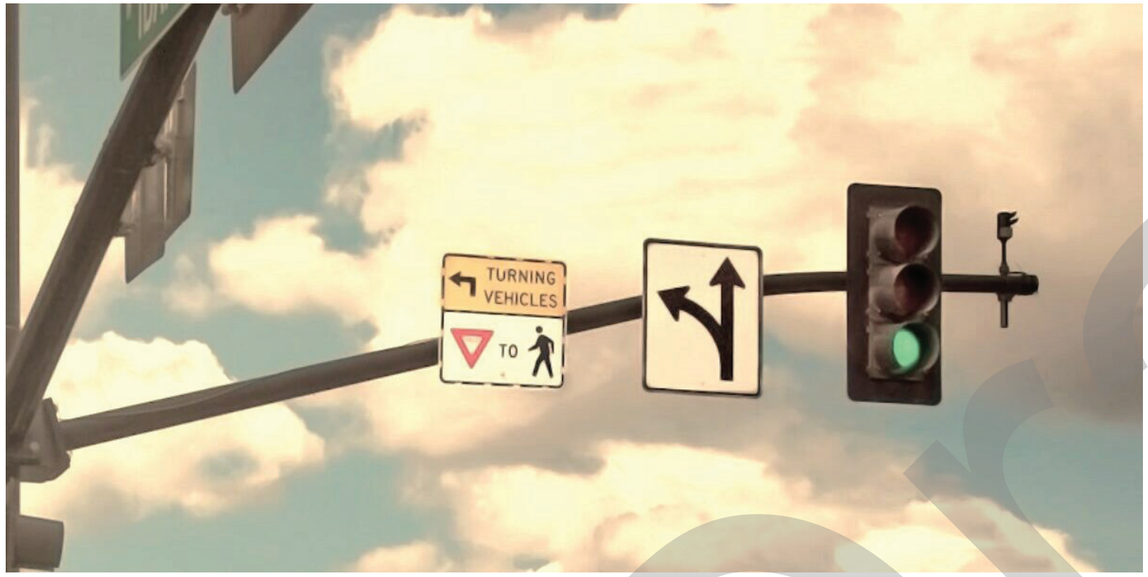
Draft

Leading Pedestrian Intervals

INTERSECTIONS AND CROSSINGS

Description:

An adjustment to pedestrian signal phasing that provides pedestrians with a few second head start to begin crossing before parallel vehicle movements receive a green signal, to further separate drivers and pedestrians in time and space.



Considerations and Applicability:

- Evaluate opportunities at locations with permissive left turning movements and with regular pedestrian activity or pedestrian-involved crash history.
- Consider option to implement only during periods of daily peak pedestrian activity.

Location Type: Intersection

Multimodal Impacts and Benefits: High

Improves pedestrian visibility when crossing.

CRF: 19% - 46%

CMF ID: 9903, 9915

Feasibility: Medium

Requires modern signal controller.

Safety Benefits: Reduces conflicts by increasing visibility and establishing pedestrian presence in crossings before turning movements are allowed.

Targets: Pedestrian-involved left-turn and angle crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

FHWA STEP Program

NACTO Urban Street Design Guide

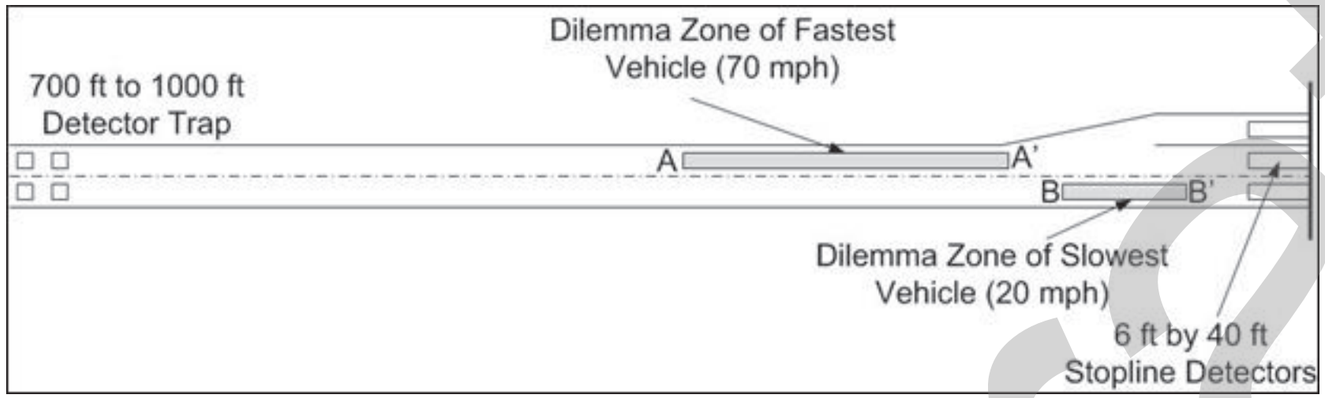
Pedsafe Guide

Draft

Dilemma Zone Protection
Operations Strategies

Description:

Signal timing strategy that uses advanced detection to extend green time or all-red time to reduce rear-end crashes and red light running.



Considerations and Applicability:

- Verify technology is present to perform advanced vehicle detection.
- Coordinate signal with adjacent signalized intersections and consider potential delay from signal configuration.

Location Type: Intersection

Multimodal Impacts and Benefits: High

Improves vehicle operations without impacting multimodal space and exposure.

CRF: 44%

CMF ID: 4854

Feasibility: Medium

Requires modern signal controller and advanced vehicle detection.

Safety Benefits: Reduces abrupt stopping and red-light running, lowering rear-end crash risk.

Targets: Rear-end and angle crashes

Safe System Goals: ☐ Safer Vehicles ☐ Safer Speeds ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Traffic Signal Timing Manual

NCHRP Report 812

FHWA Signalized Intersections Informational Guide

Draft

Protected Only Left-Turn Signal Phasing

OPERATIONS STRATEGIES

Description:

Signal phasing that provides a dedicated phase that separates left-turn turning traffic from opposing through traffic.



Considerations and Applicability:

- » Evaluate opportunities at signalized intersections with high left-turn volumes, with a history of left-turn crashes and/or conflicts, and with limited visibility.
- » Consider potential delay or increase in signal cycle length from signal configuration.
- » Replace signal heads and detection systems as needed.
- » Consider option to implement during peak hours only or using protected-permissive phasing (flashing yellow arrow).

Location Type: Intersection

Multimodal Impacts and Benefits: Medium

Improves safety but may increase pedestrian delay.

CRF: 31% - 98%

CMF ID: 2252, 10233

Feasibility: Medium

May require modern signal controller, appropriate left-turn signal heads, and additional vehicle detectors for left-turn lanes.

Safety Benefits: Separates conflicting movements, reducing left-turn crash risk.

Targets: Bicycle-involved and angle crashes

Safe System Goals: ☐ Safer Vehicles ☐ Safer Speeds ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

ITE Guidelines for Determining Traffic Signal Change and Clearance Intervals

NACTO

FHWA Traffic Signal Timing Manual

Draft

Signal Clearance Interval (Yellow + All-Red)

Operations Strategies

Description:

Signal timing strategy that adjusts the length of yellow clearance and all-red intervals to minimize the potential for rear-end crashes and redlight running.



Considerations and Applicability:

- » Consider potential delay or increase in signal cycle length from signal configuration.
- » Consider option to implement different timing plans during different times of day, tailored to traffic conditions.
- » Verify no other detection or signal timing updates required.

Location Type: Intersection

Multimodal Impacts and Benefits: High

Improves safety with minimal impact on pedestrians and bicyclists.

CRF: 20% - 36%

CMF ID: 4211, 4221

Feasibility: High

Requires signal controller adjustments.

Safety Benefits: Aligns timing with real-world conditions, reducing intersection conflict risk.

Targets: Rear-end crashes

Safe System Goals: ☐ Safer Vehicles ☐ Safer Speeds ✓ **Safer Roads** ☐ Safer People ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

ITE Guidelines for Determining Traffic Signal Change and Clearance Intervals

NCHRP Report 731

Draft

Lane Reconfiguration
ROADWAY RECONFIGURATION

Description:

A reassignment of roadway space that changes the number or arrangement of travel and/or turn lanes.

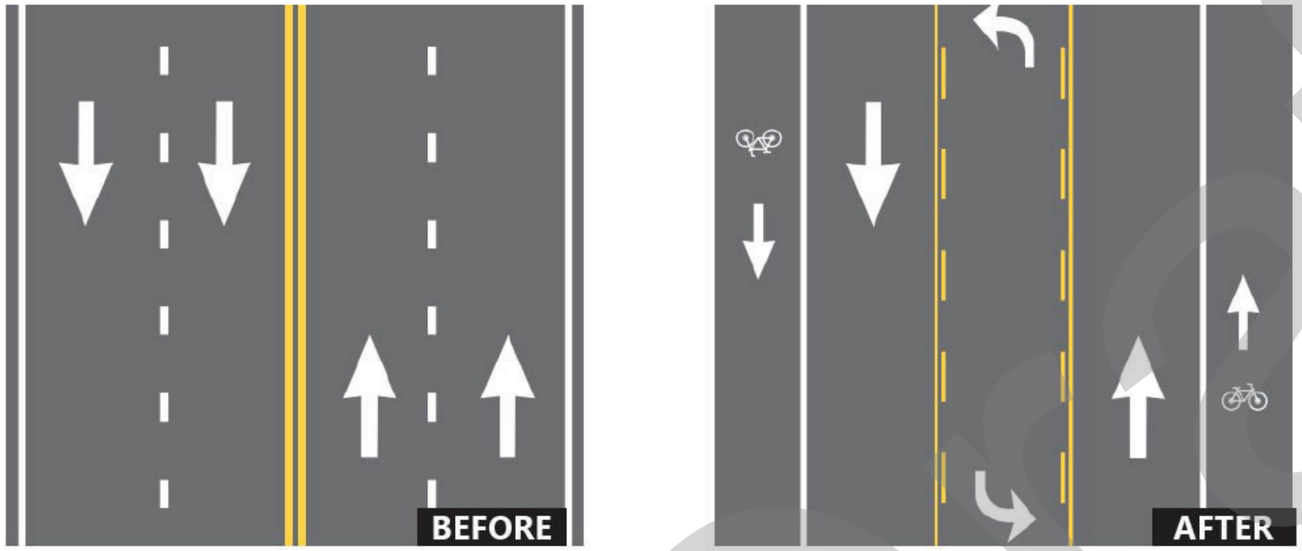


Image source: FHWA

Considerations and Applicability:

- » Ensure widths align with local regulations.
- » Consider capacity and operational needs.
- » Coordinate with the Fire Department and School Districts to maintain access for emergency vehicles, school buses, and public transit.
- » Include multimodal facility enhancements as possible.

Location Type: Mid-Block/Intersection

Multimodal Impacts and Benefits: High

Manages driver speeds while creating opportunities for multimodal improvements.

CRF: 29% - 47%

CMF ID: 10376, 199, 11135

Feasibility: Medium

Dependent on available roadway width and traffic volumes.

Safety Benefits: Encourages slower traffic speeds and simplifies traffic patterns, minimizes crash frequency and severity.

Targets: All crash types

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

FHWA Road Diet Desk Reference

DRAFT

Narrow Travel Lanes
ROADWAY RECONFIGURATION

Description:

A reduction in travel lane width to support speed management and allow for roadway reassignment for other uses; narrow lanes are considered to be 10 feet wide.



Feasibility: High

Requires suitable pavement conditions.

Safety Benefits: Encourages lower operating speeds, contributing to reduced likelihood and severity of crashes.

Targets: All crash types

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

FHWA Proven Safety Countermeasures

NACTO Urban Street Design Guide

Considerations and Applicability:

- Ensure that lane widths align with local regulations (nine-foot travel lanes are usually only feasible where striping, mountable features, or operational treatments are provided to accommodate larger vehicles such as emergency responders and transit vehicles).
- Coordinate with the Fire Department and School Districts to maintain access for emergency vehicles, school buses, and public transit.
- Consider capacity and operational needs.
- Include multimodal facility enhancements as possible.

Location Type: Mid-Block

Multimodal Impacts and Benefits: High

Manages driver speeds, reduces crossing exposure, and creates opportunities for multimodal improvements.

CRF: 24% when converting 12’ lanes to 11’; 42% when converting 12’ to 10’ lanes

CMF ID: 7825; 7827

Draft

Corner Redesign
Roadway Reconfiguration

Description:

Modifications to intersection geometry that reduce curb radii and/or installs curb extensions at corners to limit turning speeds, narrow crossing distances, and enhance visibility between drivers and people walking, biking, and rolling.



Feasibility: Medium

Dependent on available right-of-way; requires ADA-compliant design.

Safety Benefits: Slows turning vehicles, improves visibility and crossing conditions, while reducing pedestrian and bicyclist exposure to vehicle conflicts.

Targets: Intersection-related pedestrian involved crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

Pedsafe Guide

NCHRP 926 Guidance to Improve Pedestrian and Bicyclist Safety at Intersections

FHWA Traffic Calming ePrimer, Module 3, Part 2

Considerations and Applicability:

- Install directional curb ramps to improve ADA accessibility concurrently.
- Determine vehicle turning needs, not every corner needs to be designed for the largest design vehicle.
- Consider the presence of bicycle facilities.
- Avoid large curb radii at local street intersections.
- Consider at locations with on-street parking or with long crossing distances.

Location Type: Intersection

Multimodal Impacts and Benefits: High

Manages driver turning speeds and reduces crossing exposure.

CRF: 18% to 59% (20 ft. radius to 70 ft. radius)

CMF ID: 11215, 11216, 11217, 11218, 11219, 11220

*These crash modification factors indicate an **increase** in crashes with radii larger than 10 feet.*

AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities

FHWA Traffic Calming e-Primer: Corner Extension/Bulbout

NACTO Urban Street Design Guide: Curb Extensions

NACTO Urban Street Design Guide: Corner Radii

Draft

Separated Bicycle Lanes and Shared Use Paths

INFRASTRUCTURE FOR ALTERNATIVE MODES

Description:

Dedicated space for bicyclists, physically separated from motor vehicle traffic.





Considerations and Applicability:

- » Evaluate opportunities along multilane urban corridors.
- » Consider right-of-way width, driveway density, transit operations, and intersection spacing.
- » Mark conflict areas through intersections and driveways.
- » Coordinate with the Fire Department and School Districts to maintain access for emergency vehicles, school buses, and public transit.

Location Type: Mid-Block

Multimodal Impacts and Benefits: High

Separates drivers and people biking, reducing exposure.

CRF: 45%

CMF ID: 11552

Feasibility: Medium

Dependent on available right-of-way; requires low driveway density.

Safety Benefits: Minimizes interaction between modes, reducing conflict frequency and severity.

Targets: Bicycle-involved, sideswipe, and angle crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

FHWA Bikeway Selection Guide

NACTO Urban Bikeway Design Guide

AASHTO Bike Guide

FHWA Separated Bike Lane Guide

DRAFT

Bicycle Network Gap Completion

INFRASTRUCTURE FOR ALTERNATIVE MODES

Description:

Completion of missing segments of bicycle facilities to create a complete and predictable network.



Considerations and Applicability:

- » Evaluate opportunities at intersections where bicycle lanes end in advance of an intersection and bicyclists must abruptly merge into mixed traffic and at intersections with bicycle-involved crash history.
- » Evaluate the safest alignment with dedicated left- and right turn lanes and transit pull-outs.
- » Consider network connectivity and desire paths.
- » Complete gaps identified in existing multimodal plans.

Location Type: Mid-Block

Multimodal Impacts and Benefits: High

Improves connectivity and bicyclist comfort.

CRF: 20-37%

CMF ID: 3247, 3248

Feasibility: Medium

Dependent on available right-of-way.

Safety Benefits: Improves multimodal connectivity, clarifies expected movement associated with abrupt facility transitions.

Targets: Bicycle-involved, sideswipe, and angle crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

NACTO Don't Give Up at the Intersection

NACTO Urban Street Design Guide

AASHTO Bike Guide

Draft

Protected Intersections
Infrastructure for Alternative Modes

Description: An intersection design that continues a separated bikeway through the intersection using physical barriers and bicycle signals to separate drivers and people biking in time and space.



Feasibility: Medium

Dependent on available right-of -way and presence of protected bikeways on all approaches.

Safety Benefits: Reduces crash severity and likelihood by enhancing visibility and reducing conflicts between modes through clear separation.

Targets: Pedestrian- and bicycle-involved, angle, and left-turn crashes

Safe System Goals: ☐ Safer Vehicles ✓ **Safer Speeds** ✓ **Safer Roads** ✓ **Safer People** ☐ Post-Crash Care

Sources:

NACTO Urban Street Design Guide

AASHTO Bike Guide

Considerations and Applicability:

- » Evaluate opportunities where separated bicycle lanes cross.
- » Verify that adequate space is available for the redesign of the intersection.
- » Modify signal timing and phasing.
- » Coordinate with the Fire Department and School Districts to maintain access for emergency vehicles, school buses, and public transit.

Location Type: Intersection

Multimodal Impacts and Benefits: High

Improves safety and comfort for people walking, biking, and rolling.

CRF: Not in CMF Clearinghouse

CMF ID: n/a

Draft