Doña Ana County

SAFETY COUNTERMEASURES TOOLKIT



COMPREHENSIVE ROADWAY SAFETY ACTION PLAN

DOÑA ANA COUNTY

FEBRUARY 2025

This page intentionally left blank

TABLE OF CONTENTS

TABLE OF CONTENTS

INTRODUCTION 4

I. INTERSECTIONS AND CROSSINGS 9

1. CORNER REDESIGN 10
2. CROSSWALK VISIBILITY ENHANCEMENTS 12
3. ENHANCED CROSSINGS 14
4. CONVERT MINOR ROAD STOP CONTROL TO ALL-WAY STOP CONTROL 16
5. ROUNDABOUTS 18

II. CORRIDORS AND TRAVEL LANES 21

6. MEDIANS 22
7. NARROW TRAVEL LANES 24
8. ROAD DIET 26
9. GUARDRAILS 28
10. MULTI-USE TRAIL 29

III. SPEED MANAGEMENT 31

11. HORIZONTAL AND VERTICAL DEFLECTIONS 32
12. CONTEXT SENSITIVE SPEED LIMITS 34
13. DYNAMIC SPEED LIMIT SIGNS 36
14. AUTOMATED SPEED ENFORCEMENT 38
15. ROADSIDE DESIGN IMPROVEMENTS AT CURVES 40
16. SPEED SIGNAGE AND MARKINGS 42
17. OPTICAL SPEED BARS 44

IV. SIGNS AND SIGNALS 47

18. SIGNAGE IMPROVEMENT AT CURVES 48
19. SIGNAL PHASING IMPROVEMENTS 50
20. STOP CONTROL VISIBILITY 52
21. GATEWAY TREATMENTS AT TRANSITION ZONES 54
22. DEAD-END SIGN ASSEMBLY 56

V. ROAD SURFACE TREATMENTS 59

23. WIDER EDGE LINES 60
24. RUMBLE STRIPS 62
25. PAVEMENT FRICTION 64
26. ENHANCED SHOULDERS 66
27. SAFETYEDGE^{SM} 68

VI. VISIBILITY 71

28. LIGHTING 72
29. HIGH VISIBILITY PAVEMENT MARKINGS 74
30. RETROREFLECTIVE TRAFFIC SIGNAL BACKPLATES 76

INTRODUCTION

PURPOSE OF SAFETY COUNTERMEASURES TOOLKIT

The Safety Countermeasures Toolkit outlines a series of techniques and design treatments aimed at mitigating road safety issues and preventing severe and fatal crashes in different contexts across Doña Ana County. The Toolkit supports the strategies and recommendations of the Safety Action Plan, though the Toolkit may also be used by partner agencies in the development of roadway safety improvement projects. In particular, the Toolkit provides evidence-based solutions for a particular road safety problem, risk, type of street and/or type of crash. These solutions can include infrastructure upgrades, traffic calming measures, better signage or modifications to signals.

SAFETY COUNTERMEASURES

The Toolkit is comprised of 29 countermeasures listed under six categories that are specifically intended to reduce likelihood or severity of crashes. It is important to note the countermeasures are organized around the primary applications and benefits, though some techniques cut across multiple categories.

The Toolkit also offers guidance on cost-effectiveness, appropriateness for different contexts, and anticipated safety benefits, including reducing speeds and separating roadway users in space and time.

I. INTERSECTIONS AND CROSSINGS

1. Corner Redesign
2. Crosswalk Visibility Enhancements
3. Enhanced Crossings
4. Convert Minor Road Stop Control to All-Way Stop Control
5. Roundabouts

II. CORRIDORS AND TRAVEL LANES

6. Medians
7. Narrow Travel Lanes
8. Road Diet
9. Guardrail
10. Multi-Use Trail

III. SPEED MANAGEMENT

11. Horizontal and Vertical Deflections
12. Context-Sensitive Speed Limits
13. Dynamic Speed Limit Signs
14. Automated Speed Enforcement
15. Roadside Design Improvements at Curves
16. Speed Signage and Markings
17. Optical Speed Bars

IV. SIGNS AND SIGNALS

18. Signage Improvements at Curves
19. Signal Phasing Improvements
20. Stop Control Visibility
21. Gateway Treatments at Transition Zones
22. Dead-End Sign Assembly

V. ROAD SURFACE TREATMENTS

23. Wider Edge Lines
24. Rumble Strips
25. Pavement Friction
26. Enhanced Shoulders
27. SafetyEdge^{SM}

VI. VISIBILITY

28. Lighting
29. High Visibility Pavement Markings
30. Retroreflective Traffic Signal Backplates

HOW TO USE THE TOOLKIT

The Toolkit indicates the purpose and provides a description for each countermeasure, outlines safety benefits, identifies applicable street types and contexts, lists consideration for implementation, identifies target crash types and primary user groups, summarizes expected crash reduction, lists the range of cost and expected life span, and references where more information about the countermeasure can be found. The Toolkit is organized under the following structure:

[COUNTERMEASURE]

Purpose

Indicates the countermeasure's main safety objective.

Description

Provides a brief depiction of the measure or measures.

Safety Benefits

Lists all the safety benefits that the implementation of the countermeasure could provide.

Street Types and Context

Lists all the applicable street types for the countermeasure and provides guidance on which context they should be implemented.

Considerations for Implementation

Suggests situations, actions, and elements that should be weighed or added when implementing the countermeasure.

Target Crash Types

Identifies crash types the countermeasure relates to, including:

- Speeding-related – Occurs when a driver is traveling above the posted speed limit or too fast for the particular road and/or vehicle conditions.
- Head-on – Occurs when two drivers traveling in opposite directions crash front to front.
- Rear end – Occurs when one driver crashes with the back of another vehicle.
- Intersection-related – Occurs at or near an intersection, often involving drivers turning, failing to yield, or running through red lights.
- Side impact – Occurs when a driver crashes into the side of another vehicle.
- Roadway or lane departure – Occurs when a driver swerves out of the travel lane and crashes with an object, another vehicle, or leaves the roadway.
- Lighting conditions-related – Occurs when the weather or lighting conditions affect the visibility of road, leading to a crash.
- Pedestrian-related and/or bicyclist-related – Occurs when there is a pedestrian or a bicyclist involved in a crash.

Primary User Groups

Refers to the main road users that the countermeasure will be assisting. The users are represented in the Toolkit by icons.



Pedestrians



Bicyclists / Scooters



Cars and sport utility vehicles (SUVS)



Motorcyles



Freight vehicles

Expected Crash Reduction

Refers to the anticipated decrease in the number of crashes resulting from the implementation of the countermeasure. This number is based on research, historical data, and analysis of past interventions. The Toolkit primarily refers to Crash Modification Factors (CMF) used by the Federal Highway Administration (FHWA) to provide a quantitative measure of the expected safety impact of a specific countermeasure. CMFs are often derived from specific contexts and may not be transferable to all locations or conditions.

Cost

Indicates the magnitude of cost for the countermeasure's implementation, taking into account the regular need for maintenance. The cost is represented as a graphic scale from low to high by shading the icons to indicate where the countermeasure falls within the scale. If more than one icon is shaded it means that the cost falls within a range depending on factors such as number of elements and frequency of maintenance.



Expected Life Span

Provides a range of years for the utility of the countermeasure before needing to be updated or requiring major maintenance.

References

These include federal publications and manuals, research papers, and national design guidelines. Links to the relevant documents are included in each countermeasure section in case there is a need for more information and deeper understanding of the safety treatment.


ICO
ear-u-well
SHOES
Hall St
Franklin St
BREWERY
DRUG
26

I. INTERSECTIONS AND CROSSINGS

Intersections and pedestrian crossings are critical points in road safety as conflicts between different road users – including motorists, bicyclists, and pedestrians – are most frequent due to the number of movements, interactions, and decision points in the area.

Countermeasures under this category focus on infrastructure redesign, sign additions, and signal modifications/implementations. The application of these countermeasures can improve the readability of vehicle movements and right-of-way, visibility, and speed management, and help provide safe, clear, and accessible paths.

The following countermeasures present a range of effort, cost, and impacts that can be applied to different intersection and crossing contexts, from small town intersections to rural highways. Whether retrofitting existing infrastructure or designing new intersections, these countermeasures help ensure that roads are safer, more efficient, and equitable for all users.

1. CORNER REDESIGN

Redesigning the corners shortens the crossing distance for people walking, reduces turning speeds, and improves sight distance between drivers and people crossing.

2. CROSSWALK VISIBILITY ENHANCEMENTS

Enhancing crosswalks improves visibility of people in crosswalks for approaching drivers and indicates preferred crossing locations for pedestrians.

3. ENHANCED CROSSINGS

Enhancing crossings increases driver yielding to pedestrians and bicyclists at uncontrolled crossings and improves access to key destinations.

4. CONVERT MINOR WAY STOP CONTROL TO ALL WAY STOP CONTROL

Converting the intersections organizes right of way at intersections and reduces conflicts.

5. ROUNDABOUTS

Implementing roundabouts reduces vehicle speeds and conflicts associated with left turns at intersections.

1. CORNER REDESIGN

PURPOSE

Shorten the crossing distance for people walking, reduce turning speeds, and improve sight distance between drivers and people crossing.

DESCRIPTION

Treatments that narrow the intersection and reduce the radii of corners all contribute to tightening the intersection.

Curb extensions extend the sidewalk into the roadway at intersections.

Corner wedges use pre-cast curbs or flexible delineators and pavement markings on both sides of a crosswalk at an intersection to achieve a similar effect.

When these options are not possible, **reducing corner radii** helps tighten the intersection slightly and is effective to reduce turning speeds.

SAFETY BENEFITS

- Reduce vehicle speeds through visual narrowing and sharper turns
- Shorten pedestrian crossing distances
- Increase pedestrian waiting areas at corners
- Improve sight distances and visibility

STREET TYPES AND CONTEXT

Applicable Street Types

Arterials, major and minor collector roads, and urban and rural local roads

Location Guidance

Curb extensions are appropriate at intersections and can also be installed mid-block to reduce crossing distance and traveling speed. They are usually implemented in developed/higher density areas.

CONSIDERATIONS FOR IMPLEMENTATION

- Consider the turning needs of design vehicles. Corner radii should be as small as practicable, considering the effective radius of the turning vehicles.
- Road diets, daylighting efforts, and road functional class changes all present opportunities to tighten intersections.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Pedestrian-related crashes
- Speeding-related crashes



EXPECTED CRASH REDUCTION

A crash reduction factor has not yet been associated with curb extensions and turn wedges, though research indicates a reduction in crash severity associated with tighter corner radii.

COST

Treatments that narrow the intersection and reduce the radii of corners all contribute to tightening the intersection.



EXPECTED LIFE SPAN

10-20 years

REFERENCES

- FHWA Traffic Calming ePrimer, Module 3, Part 2 https://mutcd.fhwa.dot.gov/
- http://www.pedbikesafe.org/PEDSAFE/



Curb Extension (Source: Toole Design)



Corner Wedges (Source: Toole Design)



Reduced corner radii (Source: Toole Design)

2. CROSSWALK VISIBILITY ENHANCEMENTS

PURPOSE

Improve visibility of people in crosswalks for approaching drivers and indicate preferred crossing locations for pedestrians.

DESCRIPTION

Multiple methods can be used to increase the visibility of crosswalks. **High-visibility crosswalk markings** (e.g. continental or ladder patterns) are more visible to all road users from father away compared to transverse line crosswalks. Reflective and durable materials such as thermoplastic tape should be used.

In-street signing (R1-6) can be added to enhance typical **crossing signs** (W11-2, W16-7P).

SAFETY BENEFITS

- Increase predictability of pedestrian crossing locations for drivers
- Increase visibility of crossing locations for drivers

STREET TYPES AND CONTEXT

Applicable Street Types

Arterials and major and minor collectors

Location Guidance

Follow the Manual on Uniform Traffic Control Devices (MUTCD) guidance for placement of all signs and markings. In-street signs are appropriate on streets with a speed limit of 30 miles per hour or less and 2-3 lanes.

CONSIDERATIONS FOR IMPLEMENTATION

- In-street signs are most appropriate at mid-block locations.
- Typical signs and marking are appropriate both mid-block and at intersections, particularly where the volume of pedestrians is high.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Pedestrian-involved crashes



EXPECTED CRASH REDUCTION

40% reduction in pedestrian injury crashes when implementing high-visibility crosswalks | CMF ID 4123.

42% reduction in pedestrian crashes when implementing advance yield or stop markings and signs | CMF ID 9017.

COST

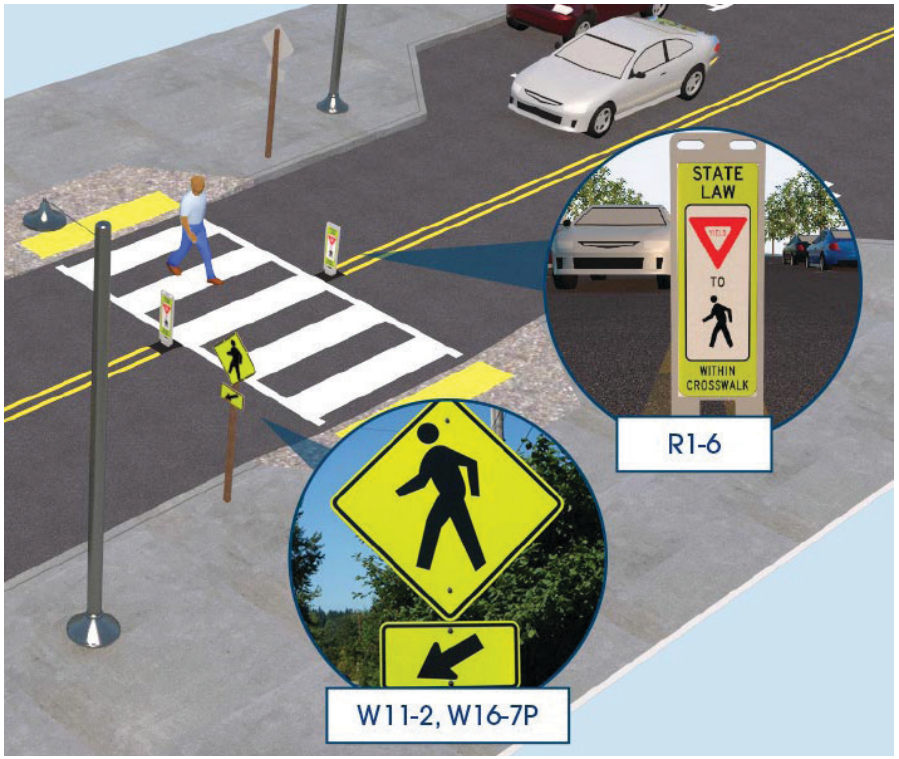


EXPECTED LIFE SPAN

5-10 years

REFERENCES

- FHWA Proven Safety Countermeasures
- Manual of Uniform Traffic Control Devices
- http://www.pedbikesafe.org/PEDSAFE/



High-visibility crosswalk on roadside and in-street signs (Source: FHWA)

3. ENHANCED CROSSINGS

PURPOSE

Increase driver yielding to pedestrians and bicyclists at uncontrolled crossings and improve access to key destinations.

DESCRIPTION

Enhanced crossings include **rectangular rapid flashing beacons (RRFBs)** and **pedestrian hybrid beacons (PHBs)**. RRFBs are irregularly flashing LEDs mounted with pedestrian crossing signs at uncontrolled crossings. PHBs are mast arm-mounted beacons that, when activated, turn yellow and then red to give people walking, rolling, and biking the right of way. RRFBs can be solar powered or hard-wired to the electricity grid while PHBs can only be hard-wired. Both are controlled by a user-activated pushbutton or by a passive detection system that alerts drivers that a person is trying to cross.

Enhanced crossings are typically accompanied by high-visibility crosswalk pavement markings, and can be further enhanced with **advance stop bars or yield markings** placed 20-50 feet in advance of a marked crosswalk.

Additional features that enhance crossings include **pedestrian refuge islands**, which allow people to cross one direction of traffic at a time and stop in the median space.

SAFETY BENEFITS

- Increase driver yielding
- Provide safer opportunities for people to cross busy roads
- Increase pedestrian/bicycle visibility
- Reduce the risk of multiple-threat crashes at crossings on multi-lane road

STREET TYPES AND CONTEXT

Applicable Street Types

RRFBs: Arterials and collectors with modest posted speed (35 mph or lower) and traffic volumes.

PHBs: Highways and arterials acting as village or town main streets.

Advance stop/yield markings and pedestrian refuge islands: All street types where a crossing exists.

Location Guidance

These measures are commonly placed at midblock locations. They are most applicable where there is demand for crossing (e.g., important destinations on either side of the road, at a trail crossing, etc.). PHBs can be placed where a warrant for traffic signals is not met.

PHBs can be implemented at locations with high vehicle speeds or in roads with multiple lanes where it is challenging for pedestrians to cross safely. These crossings are also applicable when multi-use trails intersect with streets, especially at points with high pedestrian or bicyclist flows.

CONSIDERATIONS FOR IMPLEMENTATION

- PHBs are not common in southern New Mexico; consider outreach efforts when implementing PHBs to educate drivers, pedestrians, and bicyclists.
- Other treatments like advance warning signs, refuge islands, or rectangular rapid flashing beacons may be more appropriate in locations with sight distance constraints.
- In more densely populated areas (e.g. town centers), safe crossing opportunities, including enhanced crossings and controlled intersections, should be provided close together (i.e., as frequently as every 200 feet).

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Pedestrian-related crashes
- Bicyclist-related crashes, particularly at trail crossings



EXPECTED CRASH REDUCTION

RRFBs: 47% reduction in pedestrian crashes | CMF ID 9024.

PHBs: 55% reduction in pedestrian crashes | CMF ID 9020.

Advance stop lines: 25% reduction in vehicle/pedestrian crashes | CMF ID 9017.

Pedestrian refuge islands: 32% reduction in pedestrian crashes | CMF ID 8799.

COST

Costs are higher for PHBs compared to RRFBs and vary by site complexity. Advance stop lines are inexpensive and pedestrian refuge island cost can be low if temporary materials are used, or higher for permanent installations.



EXPECTED LIFE SPAN

20 years for permanent pedestrian refuge island; 10 years for all others

REFERENCES

- FHWA Proven Safety Countermeasures
- Manual of Uniform Traffic Control Devices
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations
- National Cooperative Highway Research Program (NCHRP) 562 & Transit Cooperative Research Program (TCRP) 112: Improving Pedestrian Safety at Unsignalized Intersections
- http://www.pedbikesafe.org/PEDSAFE/



Pedestrian Hybrid Beacons (PHB) (Source: City of San Luis Obispo)



Rectangular rapid flashing beacons (RRFBs) and Pedestrian Refuge Island (Source: Toole Design)

4. CONVERT MINOR ROAD STOP CONTROL TO ALL-WAY STOP CONTROL

PURPOSE

Organize right of way at intersections and reduce conflicts between drivers.

DESCRIPTION

Converting a minor road stop control to an all-way stop control involves changing an intersection where only the minor road is stopped to one where drivers from all approaching directions must stop. The measure includes installing stop signs on all approaches and adding pavement markings and warning signs where necessary.

SAFETY BENEFITS

- Reduce side-impact crashes
- Improve pedestrian safety

STREET TYPES AND CONTEXT

Applicable Street Types

Local rural and urban streets

Location Guidance

The control conversion can be applied on roads near schools, parks, or commercial areas or with overall high pedestrian volumes. Intersections with irregular designs can also benefit from an all-way stop control.

CONSIDERATIONS FOR IMPLEMENTATION

- Follow MUTCD guidance for implementation guidelines.
- An all-way stop-controlled intersection can increase delays for some users at intersections.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Side-impact crashes
- Pedestrian and cyclist related crashes



EXPECTED CRASH REDUCTION

54% reduction in overall crashes | CMF ID 10524.

COST

$ $$ $$$ $$$$

EXPECTED LIFE SPAN

5-10 years

REFERENCES

- Manual of Uniform Traffic Control Devices



All way stop intersection (Source: Tim Fischer Midland Reporter-Telegram)

5. ROUNDABOUTS

PURPOSE

Reduce drivers' speeds and conflicts associated with left turns at intersections.

DESCRIPTION

A roundabout is a form of intersection with a circular design that helps traffic flow smoothly. Drivers entering the roundabout must yield to traffic already inside.

SAFETY BENEFITS

- Reduce vehicle speeds
- Reduce points of conflict
- Improve safety for pedestrians crossing

STREET TYPES AND CONTEXT

Applicable Street Types

Arterial, collector, and urban and residential local streets

Location Guidance

Roundabouts can replace intersections controlled by signals, two-way stops, or all way stops in both urban and rural settings. They can also be used at transitions from high-speed environments to low-speed roads.

CONSIDERATIONS FOR IMPLEMENTATION

- Implementation of roundabouts at existing intersections may require additional right-of-way.
- Pedestrian crosswalks should be pulled back from the intersection for a safer crossing.
- Destination signage should accompany the entry and exit points.
- Curb radii design should accommodate all vehicles.
- Design should be accompanied by splitter islands or markings at the entry to the roundabout to clarify movements.
- Roundabouts are not intuitive for pedestrians with a visual impairment. This can be addressed through alternative crosswalk placement, sound treatments, or other technologies to alert visually impaired pedestrians when it is safe to cross.
- Roundabouts can feel risky for bicyclists. Where possible provide them with the option to share the lane with drivers or share the sidewalk with pedestrians.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Side-impact crashes
- Pedestrian-related crashes



EXPECTED CRASH REDUCTION

68% reduction in crashes | CMF ID 4697. When converting a high-speed rural intersection (4-leg) to roundabout.

36% reduction in crashes from conversion of stop and signal-controlled intersections into roundabouts | CMF 10084.

COST

$ $$ $$$ $$$$

The cost depends on the type of reconfiguration, construction, and drainage.

EXPECTED LIFE SPAN

20-30 years, depending on the materials

REFERENCES

- NCHRP Roundabouts: An Informational Guide
- FHWA Roundabouts with Pedestrians and Bicycles
- http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=25
- FHWA Proven Safety Countermeasures



Roundabout City of Carmel, Indiana (Source: Curbed)



The configuration of a roadway and the design of travel lanes plays a crucial role in determining safety, traffic flow, and the user experience. Poorly designed or wide travel lanes can promote higher vehicle speeds, contribute to uncertainty of movements, and increase the risk of crashes. Conversely, optimized travel lane design can enhance safety by encouraging appropriate speeds, reducing the likelihood of conflicts, and providing sufficient space for different road users.

Countermeasures focused on travel lanes and the configuration of the roadway aim to improve safety and efficiency by recalibrating lane widths, reconfiguring lane layouts, and implementing medians and other measures that guide drivers effectively. By ensuring that travel lanes are designed with all users in mind, this group of countermeasures help create safer, more balanced roadways that reduce crash risks.

6. MEDIANS

Medians organize opposing traffic and/or road users, determine access points, manage U-turns, and provide refuge for pedestrians crossing.

7. NARROW TRAVEL LANES

Narrowing the lanes encourages drivers to reduce their speed.

8. ROAD DIET

Incorporating road diets reduces traffic speeds, organizes maneuvers, shortens pedestrian crossings, and/or reallocates space to other road users.

9. GUARDRAIL

Incorporating guardrails prevents vehicles from leaving the roadway and colliding with objects or natural features.

10. MULTI-USE TRAIL

Promote the safe interaction of pedestrians, bicyclists, and other non-motorized users between them and motorized vehicle users.

6. MEDIANS

PURPOSE

Organize opposing traffic and/or road users, determine access points, manage U-turns, and provide refuge for pedestrians crossing.

DESCRIPTION

Medians are longitudinal barriers that divide opposing traffic; they can be at road level or raised. Medians can visually break up long stretches of road and provide a sense of narrower lanes, encouraging slower driving. There are various measures that can separate opposing lanes.

A **hardened centerline** is a raised or textured strip running at the center of the road.

A **median barrier** is vertical physical structure designed to redirect vehicles that strike it from either side. Barriers can be cabled, metal-beamed, or concrete.

SAFETY BENEFITS

- Reduce vehicle speeds when turning
- Reduce the impact force and redirect vehicles that bump into the median
- Reduce head-on crashes and/or lane departures
- Reduce pedestrian crash rates on multi-lane intersections and mid-block locations where there is a median refuge

STREET TYPES AND CONTEXT

Applicable Street Types

Urban and rural highways, arterial roads, and collectors

Location Guidance

Medians are usually implemented on roads with high traffic volumes, higher speeds, and areas with a history of head-on collisions or left-turn crashes. They are also effective in urban and suburban areas that can benefit from better access management and organization of traffic flows and pedestrian crossings.

CONSIDERATIONS FOR IMPLEMENTATION

- Consider access and flow management (i.e. turning movements and driveways access).
- Consider road width and accessibility for emergency vehicles.
- Consider accessibility and road legibility for pedestrians at intersections.
- Medians can be complemented by landscaping and lighting to make roads safer and more enjoyable.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Lane departure crashes
- Side impact crashes



EXPECTED CRASH REDUCTION

97% reduction in cross-median crashes on rural four-lane highways where median barriers were implemented | CMF ID 7040 and **8%** reduction in all fatalities due to head-on crashes (Fatality Analysis Reporting System).

39% reduction in all crashes where a raised median was implemented | CMF ID 3034.

COST



EXPECTED LIFE SPAN

10-40 years depending on measure, the material, environmental conditions, and maintenance

REFERENCES

- FHWA Proven Safety Countermeasures
- Hardened Centerlines and Turn Wedges – Official Website of Arlington County Virginia Government (arlingtonva.us)



Raised Median (Source: UTAH DOT)

7. NARROW TRAVEL LANES

PURPOSE

Encourage drivers to reduce their speed.

DESCRIPTION

Reducing the width of travel lanes makes drivers feel more constrained, causing them to slow down and drive more cautiously. This can be achieved through paint or by implementing vertical elements. By narrowing lanes, additional space can be created for other measures that accommodate other road users or infrastructure needs.

SAFETY BENEFITS

- Reduce drivers' speeds
- Reduce severity of crashes
- Reduce crossing exposure for pedestrians at intersections
- Allocate space for other road users

STREET TYPES AND CONTEXT

Applicable Street Types

Urban and rural collector, and local streets

Location Guidance

Narrow lanes are appropriate on roads with lanes that are too wide, or on roads with lower posted speed limits and on multi-lane roads with less traffic flow. Narrower lanes are an important strategy in areas with a high volume of pedestrians and bicyclists.

CONSIDERATIONS FOR IMPLEMENTATION

- Lanes narrower than 11 feet are not recommended for streets with regular transit service and/or high volumes of truck freight.
- Lane widths must align with local ordinances or regulations.
- Narrower lanes can be implemented as part of regular resurfacing and restriping.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Speeding-related crashes
- Pedestrian and cyclist related crashes



EXPECTED CRASH REDUCTION

42% reduction in all crashes when converting 12ft lanes to 10ft | CMF ID 7827.

24% reduction in all crashes when converting 12ft lanes to 11ft | CMF ID 7825.

COST

$ $$ $$$ $$$$

The cost of the countermeasure varies depending on the approach taken for the narrowing (paint, implementation of median or sidewalk extension).

EXPECTED LIFE SPAN

5-20 years depending on if the approach pertains to road markings or rigid elements such as medians and/or curbs

REFERENCES

- FHWA Countermeasures
- NACTO Urban Street Design Guide
- SRTS Guide



Traffic Calming on Main Roads through Rural Communities (Source: FHWA)

8. ROAD DIET

PURPOSE

Reduce traffic speeds, organize maneuvers, shorten pedestrian crossings, and/or reallocate space to other road users.

DESCRIPTION

A road diet entails narrowing or removing one or more travel lanes from a road to make the section more compact and/or multimodal. The reconfiguration aims to have a road that is easier to navigate and that safely accommodates flows and more road users.

SAFETY BENEFITS

- Reduce drivers' speeds
- Reduce conflict points and crashes derived from them
- Reduce crossing exposure for pedestrians at intersections

STREET TYPES AND CONTEXT

Applicable Street Types

Arterial, collector and main streets

Location Guidance

Road diets can be applied to multi-lane roads where there is excess roadway capacity and where there is a demand for pedestrian and bicyclist infrastructure. Road diets can also be located on roads that might benefit from dedicated left-turn lanes.

CONSIDERATIONS FOR IMPLEMENTATION

- Accepted thresholds to determine how travel may be affected on the road and along parallel alternatives routes.
- NMDOT recommends road diets primarily for roads with four general purpose lanes and an average daily traffic of 10,000.
- Ensure that public transportation can still be accommodated.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Rear end crashes
- Intersection-related crashes



EXPECTED CRASH REDUCTION

37% reduction in all crash types when converting a 4-lane undivided road to 2-lanes plus a turning lane | CMF ID 11231.

47% reduction in all crash types when converting a 4-lane road to 3 lanes plus a center turn lane | CMF ID 2841.

COST

$ $$ $$$ $$$$

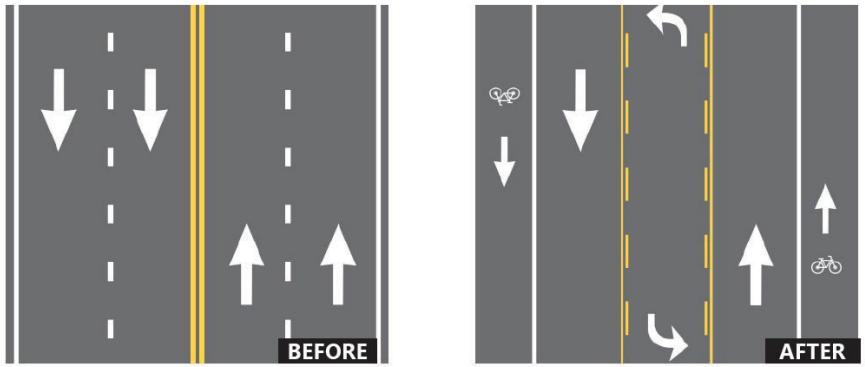
Costs vary depending on the approach taken and the length of the section.

EXPECTED LIFE SPAN

Up to 20 years, depending on the approach

REFERENCES

- FHWA Road Diet Desk Reference
- FHWA Proven Safety Countermeasures
- Pedestrian Safety Guide and Countermeasure Selection System
- NMDOT Design Manual 1250 Road Diet Guide



Road diet diagram (Source: FHWA)

9. GUARDRAILS

PURPOSE

Prevent vehicles from leaving the roadway and colliding with objects or natural features.

DESCRIPTION

A guardrail is a safety barrier that is placed along roadways to guide traffic and prevent vehicles from leaving the lane. Guardrails can be made of steel, wood, or concrete and are designed to absorb the impact of a vehicle if it happens to collide with it.

SAFETY BENEFITS

- Prevent roadway departures
- Minimize crash severity
- Protect vulnerable road users
- Enhance driver guidance

STREET TYPES AND CONTEXT

Applicable Street Types

Highways, freeways, arterials, and rural roads

Location Guidance

Guardrails are commonly placed along sharp curves, roadside areas without shoulders or recovery spaces, bridges and embankments with drop-offs. They should be installed in high-risk areas where vehicles are likely to depart from the roadway.

CONSIDERATIONS FOR IMPLEMENTATION

- Placement should be informed by high-speed and/or high-volume roads.
- Placement should prioritize locations with frequent roadway departures.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Roadway departure crashes



EXPECTED CRASH REDUCTION

8% reduction in all crash types when installing a w-beam guardrail or concrete barrier in principal arterials or freeways | CMF ID 8365.

24% reduction in all crash types when installing a guardrail at a bridge | CMF ID 557.

COST

$ $$ $$$ $$$$

Costs vary depending on the material selection and the length of the guardrail.

EXPECTED LIFE SPAN

20-30 years

REFERENCES

- FHWA Proven Safety Countermeasures
- The Handbook of Road Safety Measures



Guardrail on bridge (Source: Short Span Steel Bridge Alliance)

10. MULTI-USE TRAIL

PURPOSE

Promote the safe travel of pedestrians, bicyclists, and other non-motorized users by creating dedicated facilities that are separate from motorized vehicle users.

DESCRIPTION

A multi-use trail is a dedicated, shared pathway that accommodates non-motorized users, providing continuous and accessible routes. Multi-use trails, also referred to as sidepaths when located adjacent to a roadway, are separated from motor vehicle traffic through spatial and/or vertical barriers.

- High-visibility crosswalks
- Advance warning signs
- Trail user priority signage
- Crossing signals
- Curb extensions and/or refuge islands
- Traffic calming approaching the intersection
- Lighting and clear sightlines

SAFETY BENEFITS

- Minimize conflicts between users
- Protect vulnerable road users

STREET TYPES AND CONTEXT

Applicable Street Types

Arterials, collectors, and rural highways

Location Guidance

Safety countermeasures should be placed both along the trail and at intersections. On the trail, proper signage, pavement markings, and lighting should be installed at entry points, along curves, and at steep grades. At intersections, advance warning signs and high-visibility crosswalks can alert both drivers and users about crossing points.

CONSIDERATIONS FOR IMPLEMENTATION

- Trail design should comply with ADA standards, incorporating tactile warning strips and accessible crossing features.
- Design should incorporate comfort elements such as lighting, smooth pavement surfaces, shade, and water stations.
- The traffic conditions related to speed, volume, and frequency of vehicles should inform the type of trail crossing treatment.
- Amenities such as landscaping and drinking fountains can increase the usability of trails.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Pedestrian-related and/or bicyclist-related



EXPECTED CRASH REDUCTION

A crash reduction factor has not yet been associated with multi-use trails.

59% reduction in all crash resulting in injuries when installing cycle tracks, bike lanes, or on-street cycling | CMF ID 4102.

COST



Costs vary depending on the material selection and the types of amenities included along the trail.

EXPECTED LIFE SPAN

7-10 years

REFERENCES

- FHWA Evaluation of Safety, Design and Operation of Shared-Use Paths
- Albuquerque Bikeways & Trails System Vision, Goals, and Policies



Sidepath along NM 404, Anthony, NM (Source: Toole Design)



Rural Sidepath, Kirtland, NM (Source: Toole Design)


YOUR SPEED
13
SPEED
LIMIT
30

Speed management is one of the most critical aspects of road safety, as excessive speeds significantly increase the likelihood and severity of crashes. The design and operation of a roadway has a direct influence on driver speeds; targeted speed management countermeasures can bring appropriate speeds that match the surrounding environment and road user needs.

The countermeasures under this category encompass a wide array of techniques, from physical interventions to regulatory measures. By introducing design elements that encourage drivers to slow down, and pairing these with appropriate signage, markings, and enforcement, roads become safer and traffic becomes more predictable. Slower speeds not only reduce the frequency of crashes but also mitigate the severity of collisions when they do occur, making streets safer for all road users.

11. HORIZONTAL AND VERTICAL DEFLECTIONS

Having deflections forces drivers to slow down and go at safer speeds.

12. CONTEXT SENSITIVE SPEED LIMITS

Adapting speed limits to their context reduces the risk of fatalities and serious injuries given the roadway type, users present, and the context.

13. DYNAMIC SPEED LIMIT SIGNS

Implementing dynamic speed limit signs helps communicate safe driving speeds to drivers given the current roadway conditions and provides feedback to adjust their speed.

14. AUTOMATED SPEED ENFORCEMENT

Implementing automated speed enforcement elements increase road safety and reduce serious injuries and fatalities caused by speeding.

15. ROADSIDE DESIGN IMPROVEMENTS AT CURVES

Improving roadside design at curves reduces drivers' speeds, enhances safety and visibility at curves, and prevents collisions.

16. SPEED SIGNAGE AND MARKINGS

Having speed signs and markings increases driver awareness of the posted speed limit.

17. OPTICAL SPEED BARS

Having optical speed bars encourages drivers to reduce their speed.

11. HORIZONTAL AND VERTICAL DEFLECTIONS

PURPOSE

Force drivers to slow down and go at safer speeds.

DESCRIPTION

Various traffic calming measures create **horizontal deflections** that guide drivers to make lateral movements.

Pinch points are created by adding curb extensions on opposite sides of a street, creating a yield condition between vehicles mid-block.

Chicanes are introduced by offsetting curb extensions mid-block, introducing a shift in the travel lane.

Traffic circles are small, roundabout-like features installed at unsignalized intersections.

Vertical deflections include **speed humps** and speed tables, which are both raised pavement areas. A speed hump has a dome shape while a speed table has a flat top to limit disturbances to larger vehicles. Large yield triangles are marked on the sloped areas of both vertical deflection types to provide a visual warning for users.

SAFETY BENEFITS

- Reduce drivers' speeds and create a calmer traffic environment
- May improve driver attention as they must navigate shifts in the travel lane
- May reduce the frequency and severity of crashes for all road users
- May improve driver yielding to other road users and provide a more comfortable environment for bicyclists and pedestrians due to reduced speeds

STREET TYPES AND CONTEXT

Applicable Street Types

Local streets

Location Guidance

Horizontal deflections should generally be avoided on truck routes and where there is more than one lane of travel in each direction. Traffic circles can replace stop-controlled intersections and can be useful for transitioning traffic from high to lower speeds.

Vertical deflections are best used on streets with lower vehicle speeds (25 mph and under) and volumes where traffic calming is needed, such as near pedestrian and bicycle activity generators (i.e., schools, parks, trail crossings). They should not be placed on sharp curves.

CONSIDERATIONS FOR IMPLEMENTATION

- Drainage may be an issue at pinch points and chicanes. Curb extensions can be built as islands with a 1–2-foot gap from the curb to facilitate drainage flows.
- The space created by horizontal deflection devices can be planted (e.g., inside traffic circle and extensions) to beautify neighborhoods.
- If the location where a vertical deflection is considered carries frequent emergency or heavy vehicles, speed cushions can be considered. This variation has wheel cutouts to allow large vehicles to pass through unaffected. However, this design may reduce the effectiveness of the countermeasure for other vehicles.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- *Speeding-related crashes*



EXPECTED CRASH REDUCTION

A definitive crash reduction estimate has not been established for speed humps and tables. Research suggests speed humps reduce crash severity | CMF ID 132.

A CMF has not been developed for horizontal deflections, but initial research indicates crashes may be reduced.

COST



EXPECTED LIFE SPAN

10-20 years

REFERENCES

- *NACTO Urban Street Design Guide*
- *FHWA Mini-Roundabouts Technical Summary*
- *https://pedbikesafe.org/PEDSAFE/*
- *ITE, A Guide to Vertical Deflection Speed Reduction Techniques*



Pinch points (Source: Toole Design)



Chicanes (Source: Toole Design)



Speed hump (Source: Toole Design)

12. CONTEXT SENSITIVE SPEED LIMITS

PURPOSE

Reduce the risk of fatalities and serious injuries given the roadway type, users present, and the context.

DESCRIPTION

Speed is a fundamental factor in determining the outcomes of a crash, particularly if vulnerable road users are present. Jurisdictions should set appropriate speed limits (which may be different than the statutory speed limit) to reduce the significant risk associated with crashes at higher speeds. The MUTCD no longer requires the 85th percentile speed and supports context sensitive speed limits. Several tools exist to aid in setting appropriate speed limits, including USLIMITS2, the NCHRP 966 report and the Safe System Approach.

SAFETY BENEFITS

- Reduced speed limits (appropriate to the context) can lead to measurable declines in speeds and crashes

STREET TYPES AND CONTEXT

Applicable Street Types

All street types

Location Guidance

Follow MUTCD guidance for placement of all speed limit signs and to conduct a compliant engineering study.

CONSIDERATIONS FOR IMPLEMENTATION

- Coordination with NMDOT is needed for any proposed speed limit reductions along US and NM highways.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Pedestrian and cyclist-involved crashes
- Speeding-related crashes



EXPECTED CRASH REDUCTION

40% reduction in fatal and serious injury crashes on rural roads when setting the speed limit to 5 mph below the engineering study recommendation | CMF ID 10249.

COST

$ **$$** $$$ $$$$

EXPECTED LIFE SPAN

20 years

REFERENCES

- FHWA Proven Safety Countermeasures
- FHWA USLIMITS2
- NCHRP 966: Posted Speed Limit Setting Procedure and Tool
- FHWA Safe System Approach for Speed Management
- http://www.pedbikesafe.org/PEDSAFE/



School Zone Speed Limit (Source: Drivers Education USA)

13. DYNAMIC SPEED LIMIT SIGNS

PURPOSE

Communicate safe driving speeds to drivers given the current roadway conditions and provide feedback to adjust their speed.

DESCRIPTION

Variable speed limit signs use current information on the roadway conditions, like traffic speed, volumes, weather, and road surface conditions, to determine appropriate speed limits and display them to drivers in real-time using electronic signs.

Speed feedback indicator signs measure speed and display feedback to drivers going above the posted speed through a digital messaging sign. Numbers typically flash on the screen if the current driver's speed is faster than the speed limit.

SAFETY BENEFITS

- Modify the speed limit to reflect safe driving speeds for current conditions
- Increase driver awareness of the speed limit and of their own traveling speed

STREET TYPES AND CONTEXT

Applicable Street Types

Variable speed limit signs are appropriate on highways and high-speed arterials with posted speed limits over 40 mph.

Feedback signs are appropriate on all street types.

Location Guidance

Variable speed limit signs are particularly valuable where there is congestion, where there is a history of crashes, in work zones, and on road segments prone to inclement weather.

Speed feedback indicator signs should be placed where speeding issues have been identified.

CONSIDERATIONS FOR IMPLEMENTATION

- Variable speed limit signs can be implemented as a regulatory or an advisory system, whereas feedback signs are regulatory.
- Variable speed limit signs can be incorporated into existing Road Weather Information Systems and Active Traffic Management Plans.
- Feedback signs can be permanently installed or portable.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Speeding-related crashes



EXPECTED CRASH REDUCTION

Variable speed limit signs: 51% reduction in fatal and serious injury crashes for variable speed limit signs | CMF ID 11003.

Feedback indicator signs: 7% reduction in all crashes when implemented at high-crash curve sites | CMF ID 6886.

COST

$ $$ $$$ $$$$

EXPECTED LIFE SPAN

5-10 years

REFERENCES

- FHWA Proven Safety Countermeasures
- NHTSA Countermeasures That Work
- http://www.pedbikesafe.org/PEDSAFE/



Variable Speed Limit Signs (Source: Toole Design)



Speed Feedback Indicator Sign (Source: FHWA)

14. AUTOMATED SPEED ENFORCEMENT

PURPOSE

Communicate safe driving speeds to drivers given the current roadway conditions and provide feedback to adjust their speed.

DESCRIPTION

Speed cameras are a type of automated enforcement technology that detects and records images of vehicles traveling faster than the posted speed limit. Tickets can then be issued to offending vehicle drivers. Several types of enforcement units exist:

- Fixed units are a camera permanently installed at a single location.
- Point-to-point units use multiple cameras to measure the average speed along a stretch of road.
- Mobile units are portable cameras installed in a vehicle or trailer.

The applicability and value of each type of automated enforcement is described in FHWA's *Proven Safety Countermeasures*.

SAFETY BENEFITS

- Reduce speeding
- Reduce speeding-related crashes
- Replace speed enforcement by physical policing and can be more equitable with careful consideration of location choice
- Operate 24/7

STREET TYPES AND CONTEXT

Applicable Street Types

Highways, arterials, and school zones

Location Guidance

Different units are suitable for different location types. Crash, speed, and citation data can help identify if issues are present network-wide (mobile enforcement preferred) or are site-specific (non-mobile preferred).

CONSIDERATIONS FOR IMPLEMENTATION

- Install signage warning drivers in advance of speed cameras.
- Equity impacts of the choice of locations should be reviewed before implementation.
- Automated speed enforcement can be complemented with police enforcement for greater safety outcomes, encouraging speed compliance beyond the location of automated enforcement.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Speeding-related crashes



EXPECTED CRASH REDUCTION

15-35% reduction in fatal and injury crashes depending on the number of cameras in the enforcement zone | CMF ID 10648 and 10654.

COST

$ $$ $$$ $$$$

EXPECTED LIFE SPAN

10 years

REFERENCES

- FHWA Proven Safety Countermeasures
- NHTSA and FHWA Speed Safety Camera Program Planning and Operations Guide
- http://www.pedbikesafe.org/PEDSAFE/



Automated enforcement warning signage (Source: TrafficSign.com)



Speed Cameras in Bernalillo County (Source: KRQE)

15. ROADSIDE DESIGN IMPROVEMENTS AT CURVES

PURPOSE

Reduces drivers' speeds, enhances safety and visibility at curves, and prevents collisions.

DESCRIPTION

Crash cushions soften the impact of a vehicle that crashes into it. They are usually placed at ends of guardrails and/or by stationary objects.

Slope flattening decreases the steepness of the embankments, allowing for drivers to have better control of their vehicles and avoid obstacles.

Clear zones are areas alongside the road that are unobstructed where drivers can safely stop or regain control if lost.

Roadside barriers are structures designed to shield objects and/or prevent vehicles from leaving the roadway. These can be cabled, metal-beamed or concreted.

Delineators are reflective posts or signs placed along the road to enhance visibility, define boundaries, and indicate road alignment changes. Rumble stripes on edge lines add sensational feedback on road delimitation to drivers. The delineators provide clear navigation guidance to drivers

SAFETY BENEFITS

- Help recover vehicle control during runoffs
- Reduce collisions and rollover accidents
- Reduce collision severity by impact mitigation
- Increase visibility by eliminating obstacles and improve decision-making and road navigation

STREET TYPES AND CONTEXT

Applicable Street Types

Highways and rural roads

Location Guidance

These measures can be applied to roads with significant elevation changes and on segments that need speed management. They should also be implemented on curved approaches to intersections to lower speeds and enhance visibility. Environments prone to adverse weather conditions that decrease visibility can also benefit from these measures.

CONSIDERATIONS FOR IMPLEMENTATION

- Ensure proper placement of measures to effectively guide drivers; take into consideration sight distances and surrounding environment.
- Adding reflective materials can support visibility in low-light conditions.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Roadway departure, rollover, and side-impact crashes



EXPECTED CRASH REDUCTION

10% reduction in single-vehicle crashes when flattening side slopes from 1V:2H to 1V:4H | CMF ID 4623.

22% reduction in crashes increasing the distance to roadside features from 3.3ft to 16.7ft (Elvik, R., and Vaa).

44% reduction in crashes increasing the distance to roadside features from 16ft to 30ft (Elvik, R., and Vaa).

COST

$ $$ $$$ $$$$

EXPECTED LIFE SPAN

5-10 years

REFERENCES

- FHWA Proven Safety Countermeasures
- The Handbook of Road Safety Measures



Roadside barrier (Source: SCLTAP)

16. SPEED SIGNAGE AND MARKINGS

PURPOSE

Increase driver awareness of the posted speed limit.

DESCRIPTION

In-road **pavement markings** indicating the speed limit supplement the **speed limit signs** to serve as reminders for drivers to travel at the posted speed limit.

SAFETY BENEFITS

- May reduce drivers' speeds, which can reduce the severity of crashes when they occur

STREET TYPES AND CONTEXT

Applicable Street Types

Highways, arterials, collectors and local streets

Location Guidance

Follow MUTCD guidance for placement of all signs and markings.

Speed pavement markings supplement speed limit signs and should be placed where speeding issues have been identified, particularly if the speed signage visibility may be limited (e.g. seasonally, overgrown vegetation).

CONSIDERATIONS FOR IMPLEMENTATION

- Adding speed pavement markings may be particularly effective at reminding users of the speed limit when a change in speed limit occurs, such as in transition zones.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Speeding-related crashes



EXPECTED CRASH REDUCTION

A crash reduction factor has not yet been associated with in-road speed pavement markings or static speed limit signs.

COST



EXPECTED LIFE SPAN

5-10 years

REFERENCES

- Speed Management: A manual for Local Rural Road Owners
- http://www.pedbikesafe.org/PEDSAFE/



Speed Limit Pavement Marking (Source: FHWA)

17. OPTICAL SPEED BARS

PURPOSE

Encourage drivers to reduce their speed.

DESCRIPTION

Optical speed bars serve as a visual aid to increase drivers' perceived speed. These bars consist of a series of lines placed perpendicular to the direction of travel, with the spacing between them progressively reduced across the area where reduced speeding is desired.

SAFETY BENEFITS

- Reduce drivers' speeds
- Reduce rear-end crashes
- Prevent loss-of-control crashes

STREET TYPES AND CONTEXT

Applicable Street Types

Highways, arterials, collectors, and local rural streets

Location Guidance

Follow MUTCD guidance for placement of markings. Optical speed bars should be located where speed control is critical (i.e., approaching intersections, curves, or urban environments). They should not be used where there are no lane lines.

CONSIDERATIONS FOR IMPLEMENTATION

- Optical speed bars work best when accompanied by a vertical deflection countermeasure.
- They are usually 2 inches to 4 inches wide.
- The overuse of optical speed bars can reduce their effectiveness.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Speeding-related crashes



EXPECTED CRASH REDUCTION

A crash reduction factor has not yet been established for optical speed bars.

COST

$ $$ $$$ $$$$

Low-cost implementation but requires regular maintenance

EXPECTED LIFE SPAN

3-6 years with regular maintenance required

REFERENCES

- FHWA Low Cost Treatments for Horizontal Curve Safety
- NCHRP Speed Reduction Techniques for Rural High-to-Low Speed Transitions
- Manual on Uniform Traffic Control Devices (MUTCD)



Optical Speed Bars, Maryland (Source: Toole)


AHEAD

IV. SIGNS AND SIGNALS

Traffic signs and signals are key for regulating road user behavior, conveying critical information, and ensuring an organized movement of drivers, bicyclists, and pedestrians. Properly designed and maintained signs and signals help reduce confusion, clarify right-of-way, and improve overall safety at intersections and along corridors.

Countermeasures within the category focus on optimizing their visibility and effectiveness to improve road safety. These interventions involve upgrading traffic signal phasing for better coordination and flow and enhancing signs and markings to support speed regulation.

This section of the toolkit presents a variety of strategies aimed at improving the function and effectiveness of signs and signals. By guiding road users more effectively and ensuring compliance with traffic rules, these countermeasures help reduce crashes and enhance the predictability of road interactions.

18. SIGNAGE IMPROVEMENTS AT CURVES

Implementing signs at curves increases driver awareness of horizontal curves, including the direction and sharpness.

19. SIGNAL PHASING IMPROVEMENTS

Modifying signal operations improves safety and efficiency of intersections for vehicles and pedestrians and reduces conflicts between road users.

20. STOP CONTROL VISIBILITY

Enhancing stop control visibility reduces the likelihood of stop sign violations and improves traffic control at intersections.

21. GATEWAY TREATMENTS AT TRANSITION ZONES

Having gateways helps adjust driver behavior and lower speeds as they transition to a new road environment.

22. DEAD-END SIGN ASSEMBLY

Placing a dead-end sign assembly prevents potential crashes or departures from drivers mistakenly continuing down a dead end.

18. SIGNAGE IMPROVEMENT AT CURVES

PURPOSE

Increase driver awareness of curves, including the direction and sharpness.

DESCRIPTION

Signage that alerts drivers to the presence of curves such as advance **curve warning signs** and **chevrons**. Additional signage can include **advisory speed signs**.

SAFETY BENEFITS

- Increase driver awareness of upcoming curves
- Provide visual cue of curve edge
- Increase visibility of curve in dark conditions

STREET TYPES AND CONTEXT

Applicable Street Types

Collectors, arterials, and rural highways with curves

Location Guidance

Follow MUTCD guidance for placement of all signs.

CONSIDERATIONS FOR IMPLEMENTATION

- Oversized chevron signs and LED lights outlining the chevron symbol can be used to increase the conspicuity of signs.
- For greater visibility and crash reduction, use dynamic curve warning signs that light up in sequence as vehicles approach.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Roadway departure crashes



EXPECTED CRASH REDUCTION

16-30% reduction in fatal and injury crashes | CMF ID 2438 and CMF ID 71.

COST

$ $$ $$$ $$$$

Low-cost implementation but requires regular maintenance

EXPECTED LIFE SPAN

5-10 years

REFERENCES

- FHWA Proven Safety Countermeasures
- Manual of Uniform Traffic Control Devices
- http://www.pedbikesafe.org/PEDSAFE/



Chevron Signs at a Horizontal Curve (Source: National Barricade and Sign)

19. SIGNAL PHASING IMPROVEMENTS

PURPOSE

Improve safety and efficiency of intersections for vehicles and pedestrians and reduce conflicts between road users.

DESCRIPTION

Signal phasing modifications can improve the operational function of a street or intersection, making the traffic flow smoother and potentially reducing hazardous behaviors and conflicting movements.

Left turn phase improvements modify traffic signals at intersections to enhance safety and flow of left-turning vehicles.

Flashing yellow arrows (FYA) replace the solid green circles and signalize a permissive left turn, where drivers must yield to oncoming traffic and pedestrians.

Protected turn signals provide a separate phase for turning traffic. This removes any conflicts with pedestrians or other vehicular traffic.

SAFETY BENEFITS

- Reduce movement conflicts
- Reduce speeds of turning vehicles
- Reduce crashes related to turning maneuvers
- Reduce rear-end collisions
- Enhance pedestrian safety by better managing turning vehicles
- Reduce conflicts between different road users
- Reduce potential collisions caused by high-risk behaviors stemming from frustration due to queuing and delay

STREET TYPES AND CONTEXT

Applicable Street Types

All street types with signalized intersections

Location Guidance

Signal phasing modifications should address safety or operational corridor needs. They can be implemented at intersections with a history of left-turn related crashes and/or queuing.

Signal phasing modifications can be used at intersections with a heavy flow of pedestrians and/or bicyclists.

FYA can be implemented when traffic conditions in the oncoming traffic present gaps allowing drivers to make left turns. They should also be implemented where pedestrian flows are low to moderate.

Protected signal phasing is usually applied to major road approaches, two-way multi-lane roads, roads with a high number of left-turning vehicles and to roads with a history of turning-related crashes.

CONSIDERATIONS FOR IMPLEMENTATION

- Follow MUTCD guidance for implementation.
- The road geometry should be able to accommodate an exclusive left turn lane.
- Implementation may reduce intersection vehicle capacity.
- Signal timing changes at one intersection may impact other intersections along a corridor and should be considered holistically.
- Consider driver's knowledge and understanding of FYAs. If these are new to the urban or rural context, it is recommended to accompany them by a "Left Turn Yield" sign.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Intersection-related crashes
- Rear-end crashes
- Side-impact crashes



EXPECTED CRASH REDUCTION

14% reduction in crashes when installing left turn flashing arrow signals and supplemental traffic signs | CMF ID 7730.

35% reduction in crashes when changing left turn phasing from protected-permissive to flashing yellow arrow | CMF 11333.

42% reduction in left turn crashes when changing from permitted to protected only left turn signals during special time-of-day | CMF ID 2108.

14% reduction in overall crashes when changing permissive left-turn

COST



Low-cost implementation but requires regular maintenance

EXPECTED LIFE SPAN

15-20 years depending on environmental conditions, maintenance, and technology

REFERENCES

- FHWA Signalized Intersections Informational Guide
- FHWA Proven Safety Countermeasures
- Manual on Uniform Traffic Control Devices for Streets and Highways
- www.pedbikesafe.org/PEDSAFE
- NHTSA Countermeasures that Work



Signal Phasing Improvements (Source; Unknown)

20. STOP CONTROL VISIBILITY

PURPOSE

Reduce the likelihood of stop sign violations and improve traffic control at intersections.

DESCRIPTION

Enhancing stop control visibility helps drivers clearly see stop signs or signals by making them more noticeable. Measures include:

Stop lines are horizontal road markings that indicate the point where a driver must stop.

Oversized stop signs are signs that are larger than the standard recommended size.

Stop sign beacons are red flashing lights that are attached to stop signs.

Advanced stop warning signs and beacons are placed ahead of an intersection to alert drivers of the upcoming stop.

SAFETY BENEFITS

- Reduce crashes at intersections
- Improve driver compliance
- Increase pedestrian/bicycle safety
- Reduce stop control violations

STREET TYPES AND CONTEXT

Applicable Street Types

Rural roads, local/residential streets

Location Guidance

These measures are commonly placed on roads where drivers may not expect to stop or at intersections with limited visibility.

They can be placed on intersections with complex layouts.

They should be placed at approaching intersections with a railroad crossing.

CONSIDERATIONS FOR IMPLEMENTATION

- Stop control visibility measures work best on lower-traffic streets. Along streets with high traffic volumes, signalized intersections are preferred.
- When installing these measures, assess how the visibility of the signs might be affected by time of day or weather conditions.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Intersection crashes
- Visibility-related crashes



EXPECTED CRASH REDUCTION

Stop sign beacons:13% reduction in all crash types | CMF ID 457.

Advance stop lines: 25% reduction in vehicle/pedestrian crashes | CMF ID 9017.

COST

$ $$ $$$ $$$$

The cost of installation of signs and road markings is low, and the implementation cost of beacons is higher.

EXPECTED LIFE SPAN

5 - 10 years.

REFERENCES

- FHWA Proven Safety Countermeasures
- MUTCD



Stop Sign with Flashing Beacon (Source: 13 Wham)

21. GATEWAY TREATMENTS AT TRANSITION ZONES

PURPOSE

Adjust driver behavior and lower speeds as they transition to a new road environment.

DESCRIPTION

A gateway is a physical and visual cue that marks the transition between different zones. The transition is usually from higher speed roads to lower speed roads. The gateway can be a combination of signs, markings, landscape, or narrowing of the road section.

SAFETY BENEFITS

- Improve driver awareness of the surrounding environment
- Reduce vehicle speeds
- Reduce rear-end crashes due to sudden stops

STREET TYPES AND CONTEXT

Applicable Street Types

Main roads in towns, and urban, suburban and rural streets

Location Guidance

Gateways should be placed at key entry points to lower-speed zones, including areas where pedestrians and bicyclists are present, and to historically significant districts.

They can be placed on intersections with complex layouts.

They should be placed at approaching intersections with a railroad crossing.

CONSIDERATIONS FOR IMPLEMENTATION

- The gateway should be noticeable to drivers.
- The treatment should be tailored in accordance with the needs and/or character of the area.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Speeding-related crashes
- Pedestrian and cyclist related crashes



EXPECTED CRASH REDUCTION

32% reduction in overall crashes | CMF ID 2430.

COST

$ $$ $$$ $$$$

Costs vary depending on the approach taken and the length of the section.

EXPECTED LIFE SPAN

10-20 years depending on the approach and materials

REFERENCES

- NACTO Urban Street Design
- NCHRP Speed Reduction Techniques for Rural High-to-Low Speed Transitions



Gateway (Source: City of Troutdale, Oregon)

22. DEAD-END SIGN ASSEMBLY

PURPOSE

Prevent potential vehicle crashes or departures from drivers mistakenly continuing down a dead end.

DESCRIPTION

A dead-end sign assembly is a set of signs working together to indicate the termination of a roadway where there is no through route. The assembly of signs usually includes a dead-end sign, street name signs, warning signs, turn signs, and reflective markers.

SAFETY BENEFITS

- Reduce risk of crashes
- Improve driver awareness
- Prevent unintended maneuver

STREET TYPES AND CONTEXT

Applicable Street Types

Rural roads and local/residential streets

Location Guidance

Dead-end sign assemblies should be placed near the termination point and at the intersection.

CONSIDERATIONS FOR IMPLEMENTATION

- Signs should be placed at both sides of the road in multi-lane traffic to ensure visibility.
- Signs should be placed at the entrance of private road with dead ends.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Rear-end crashes
- Intersection crashes



EXPECTED CRASH REDUCTION

A crash reduction factor has not yet been associated with dead-end sign assemblies.

COST



EXPECTED LIFE SPAN

5-10 years

REFERENCES

- FHWA Proven Safety Countermeasures
- MUTCD



Dead-end sign (Source: Toole Design)


The Chocolate Lady
Fine Hand Dipped Chocolates and Home Made Ice Cream
WILD WEST
La Posta

Road surface treatments, in addition to maintaining performance and longevity of pavement, enhance road safety as the features and condition of the road surface affects vehicle handling and braking.

Countermeasures focused on road surface treatments are designed to correct the course of vehicles that may be drifting out of their lane, enhance grip for vehicles, and reduce the likelihood of skidding or loss of control. Treatments that improve traction are particularly important during adverse weather conditions.

This section of the toolkit outlines effective road surface treatment strategies that help create safer driving conditions, reduce crash risk, and provide a more reliable and comfortable experience for all road users.

23. WIDER EDGE LINES

Having wider edge lines improves visibility of travel lane boundaries.

24. RUMBLE STRIPS

Longitudinal rumble strips alert drivers who have drifted from their lane due to distraction, drowsiness, or inattentiveness. Transverse rumble strips enhance drivers' decision-making and encourage them to lower their speeds.

25. PAVEMENT FRICTION

Creating friction on pavement creates better adherence between the vehicle tires and the roadway.

26. ENHANCED SHOULDERS

Enhanced shoulders create a space for non-motorized users where a fully separated facility is not possible.

27. SAFETYEDGE

Implementing SafetyEdge minimizes potential drop-off of vehicles at pavement edges.

23. WIDER EDGE LINES

PURPOSE

Improve visibility of travel lane boundaries.

DESCRIPTION

Six-inch edge lines, rather than the minimum four-inch edge lines, can be applied to indicate the edge of the travel lane.

SAFETY BENEFITS

- Increase the visibility the travel lane boundary
- Reduce the risk of roadway departure

STREET TYPES AND CONTEXT

Applicable Street Types

Multilane divided and undivided highways, two-lane highways and roads.

Location Guidance

Wider edge lines can be applied everywhere edge lines are required.

CONSIDERATIONS FOR IMPLEMENTATION

- Can be implemented in conjunction with other road surface improvements.
- Can be installed over rumble strips to improve marking longevity.
- Reflective markings will increase effectiveness in wet and dark conditions.
- Six inches is the maximum normal line width per FHWA regulations.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Roadway departure crashes



EXPECTED CRASH REDUCTION

37% reduction in fatal and injury crashes on rural two-lane roads | CMF ID 4737.

COST



The cost of the countermeasure is low and can be lowered by integrating its implementation with ongoing marking maintenance and other resurfacing projects.

EXPECTED LIFE SPAN

1-5 years depending on the marking type

REFERENCES

- FHWA Proven Safety Countermeasures



Wider Edge Line (Source: Texas Transportation Institute)

24. RUMBLE STRIPS

PURPOSE

Alert drivers who have drifted from their lane due to distraction, drowsiness, or inattentiveness, enhance drivers' decision-making, and encourage them to lower their speeds.

DESCRIPTION

Rumble strips are milled or raised elements on the pavement. **Longitudinal rumble strips** are placed along the shoulder, the edge line, or at the center line of an undivided highway. Vibration and sound are created when rolled on with a vehicle that alerts the driver their vehicle has left the travel lane.

Transverse rumble strips are placed across the roadway, perpendicular to the direction of travel. They offer audible and tactile speed feedback to drivers approaching a decision or conflict point further down the road.

SAFETY BENEFITS

- Enhance drivers' awareness
- Reduce lane departure crashes
- Reduce risk of encroachment into bike lanes
- Reduce vehicle speeds

STREET TYPES AND CONTEXT

Applicable Street Types

Rural highways. Center line rumble strips are appropriate on undivided facilities.

Location Guidance

Rumble strips can be co-located with pavement markings. They are most effective when systematically applied. If systemic application is not immediately possible, a crash analysis should inform priority locations.

CONSIDERATIONS FOR IMPLEMENTATION

- In locations where bicyclists are expected, gaps between segments of rumble strips allow safe crossing of the edge line.
- Studies indicate no particular maintenance practices are required.
- In snowy environments, add signage to alert snowplow operators about the presence of strips.
- If the strips are white, instead of the pavement color, they should not be placed in locations where they can be confused with other road markings.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Roadway departure crashes (edge line)
- Head-on crashes (center line)
- Speed-related crashes
- Intersection and decision points-related crashes



EXPECTED CRASH REDUCTION

23-44% reduction in fatal and injury crashes on 2-lane rural roads when installing a centerline and shoulder strips | CMF ID 6851 and 6946.

COST

$ $$ $$$ $$$$

Rumble strips are a low-cost countermeasure that can be applied along with other corridor safety improvements and as part of reconstruction or resurfacing projects.

EXPECTED LIFE SPAN

10 years

REFERENCES

- FHWA Proven Safety Countermeasures
- FHWA Decision Support Guide for the Installation of Shoulder and Center Line Rumble Strips on Non-Freeways
- FHWA Factors Influencing Operating Speeds and Safety on Rural and Suburban Roads



Longitudinal Rumble Strips (Source: FHWA)



Transverse Rumble Strips (Source: Safe Systems Solutions)

25. PAVEMENT FRICTION

PURPOSE

Increase the friction of the pavement for better adherence between the vehicle tires and the roadway.

DESCRIPTION

Pavement friction treatments, such as **High Friction Surface Treatment (HFST)**, can increase friction and skid resistance by applying a layer of durable, anti-abrasion, and polish-resistant aggregate.

Pavement frictions should be measured, monitored and maintained over time.

SAFETY BENEFITS

- Improves tire contact with roadway
- Addresses various types of crashes, acting as a cross-cutting measure

STREET TYPES AND CONTEXT

Applicable Street Types

All street types

Location Guidance

The most critical locations for enhanced friction and monitoring are where drivers are frequently turning, slowing, and stopping. Horizontal curves, interchange ramps, and approaches to intersections and crossings should be the primary targets.

CONSIDERATIONS FOR IMPLEMENTATION

- HFST is applied on existing pavement, which should therefore be structurally stable to ensure longevity of the treatment.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Roadway departure crashes
- Pedestrian-related crashes



EXPECTED CRASH REDUCTION

49% reduction in injury crashes along horizontal curves | CMF ID 10333.

COST

$ $$ $$$ $$$$

EXPECTED LIFE SPAN

10 years

REFERENCES

- FHWA Proven Safety Countermeasures
- http://www.pedbikesafe.org/PEDSAFE/



High Friction Surface Treatment (Source: FHWA)

26. ENHANCED SHOULDERS

PURPOSE

Create a space for non-motorized users where a fully separated facility is not possible.

DESCRIPTION

A **paved shoulder** on the edge of a roadway enhanced with paint **markings** to serve as a dedicated space for people walking and biking in rural environments. The recommended minimum clear width varies from 5 feet to 8 feet depending on the posted speed and traffic volume. The shoulder can be defined with an additional **buffer** space (18 inches to >4 feet), **rumble strips**, or **colored/stamped pavement**.

SAFETY BENEFITS

- Designates a space for non-motorized users, reducing crashes where pedestrians and bicyclists are struck from behind on rural roadways

STREET TYPES AND CONTEXT

Applicable Street Types

Principal arterials to minor collectors and rural highways

Location Guidance

Use where a rural cross-section currently exists and fully separated facilities (such as a shared use path or sidewalk) are not practical or possible due to current constraints.

CONSIDERATIONS FOR IMPLEMENTATION

- Paint must not obstruct visibility or interfere with traffic control devises, or be confused with lane markings/
- Markings should not interfere with the intended function of the shoulder.

If the shoulder is meant to accommodate bicyclists, additional considerations exist:

- Edge line markings may be extended through intersections and major driveways to bring additional awareness to the presence of pedestrians and bicyclists.
- If rumble strips are used, ensure a gap pattern is introduced to allow safe access into and out of the shoulder.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Pedestrian and cyclist-involved crashes



EXPECTED CRASH REDUCTION

Adding shoulders and rumble strips are both Proven Safety Countermeasures for vehicle crashes. No conclusive evidence exists yet of the crash reduction for pedestrians and bicyclists specifically.

COST



EXPECTED LIFE SPAN

20 years (shoulder) 10 years (markings)

REFERENCES

- FHWA Proven Safety Countermeasures
- http://www.pedbikesafe.org/PEDSAFE/



Enhanced Shoulder with Buffer (Source: Alta Planning + Design)



Stamped Colored Pavement (Source: Alta Planning + Design)

27. SAFETYEDGE[SM]

PURPOSE

Minimizes potential drop-off of vehicles at pavement edges.

DESCRIPTION

SafetyEdge[SM] is a pavement technique used to create a 30 degree slope at the edge of the road. This eliminates the sharp vertical drop-off, creating a smoother transition between the off-road and the road.

SAFETY BENEFITS

- Helps drivers recover control of vehicles and returning to the road if they accidentally departed from it
- Reduce lane departure crashes
- Reduce fatalities derived from edge drop-offs

STREET TYPES AND CONTEXT

Applicable Street Types

Highways and rural arterial streets

Location Guidance

The SafetyEdge[SM] technology should be implemented on roads without curbs or guardrails. It is recommended to apply a systemic approach on rural roads undergoing resurfacing.

CONSIDERATIONS FOR IMPLEMENTATION

- Implement on new asphalt paving and with resurfacing projects.
- Should have regular maintenance.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Roadway departure crashes



EXPECTED CRASH REDUCTION

11% reduction in all severe crashes on rural roads | CMF ID 9205.

COST

$ $$ $$$ $$$$

SafetyEdge[SM] is a low-cost countermeasure when included with resurfacing projects

EXPECTED LIFE SPAN

10-15 years

REFERENCES

- FHWA Small Town and Rural Multimodal Networks
- FHWA Center for Accelerating Innovation



SafetyEdge[SM] (Source: Wisconsin Department of Transportation)


M
54

VI. VISIBILITY

Visibility influences how well road users can see and respond to the road's layout and configuration and to other road users. Poor visibility resulting from weather conditions, poor lighting, low contrast markings, or obstructed sightlines can lead to delayed reactions from road users, increasing crash risk.

Countermeasures in this section are designed to enhance how road users perceive and navigate the streets and their surroundings. The measures range from improving lighting to enhancing road markings and signs. These techniques enhance guidance and awareness, especially during adverse weather conditions or nighttime, making interactions on the road safer.

28. LIGHTING

More and better lighting increases visibility on the roadway for all users, particularly at crossings and intersections.

29. HIGH VISIBILITY PAVEMENT MARKINGS

Implementing markings improves guidance information by enhancing the visibility of lane markings and striping.

30. RETROREFLECTIVE TRAFFIC SIGNAL BACKPLATES

Implementing retroreflective backplates improves visibility of traffic signals.

28. LIGHTING

PURPOSE

Increasing visibility on the roadway for all users, particularly at crossings and intersections.

DESCRIPTION

Rural **highway lighting** increases the visibility of potential hazards or other users along roadway segments. **Intersection lighting** illuminates spot locations at intersections or pedestrian crossings and can increase personal safety in addition to increasing visibility.

SAFETY BENEFITS

- Increase the visibility of road users and hazards within the lighting coverage area

STREET TYPES AND CONTEXT

Applicable Street Types

All street types

Location Guidance

Light posts must be placed outside of the clear zone on high-speed roadways to reduce the risk of fixed-object crashes. Light posts within the clear zone should be equipped with breakaway features or shields.

Lighting is most important at intersections and crossings where users make decisions and have a higher degree of interaction. When illuminating crosswalks, place luminaries in a forward position to avoid back-lighting pedestrians and creating a silhouette effect.

CONSIDERATIONS FOR IMPLEMENTATION

- Consider engaging with underserved communities to identify locations where lighting would most advance wider community goals, such as personal safety or increasing access to destinations.
- Evaluate electrical connections and utilities needs and options for solar lighting.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Lighting conditions-related crashes



EXPECTED CRASH REDUCTION

42% reduction in pedestrian injury and fatal crashes | CMF ID 436.

38% reduction in nighttime injury crashes at intersections | CMF ID 433.

COST

$ $$ $$$ $$$$

The cost of the countermeasure is low and can be lowered by integrating its implementation with ongoing marking maintenance and other resurfacing projects.

EXPECTED LIFE SPAN

15 years

REFERENCES

- FHWA Proven Safety Countermeasures



Lighting (Source: Toole Design)

29. HIGH VISIBILITY PAVEMENT MARKINGS

PURPOSE

Improve guidance information by enhancing visibility of lane delimitations and markings.

DESCRIPTION

Reflective pavement markings are a type of road marking that is more durable than regular paint. The markings are bright and reflective, improving the visibility for road users, and provide a rumble effect when drivers deviate from their lane.

Raised pavement markers (RMPs) are small, often reflective devices used to mark lane boundaries and other areas that need to be highlighted.

SAFETY BENEFITS

- Reduce risk of crashes caused by poor visibility by facilitating navigation at nighttime and in adverse weather conditions
- Moderately reduce vehicle speeds on curves
- Reduce crashes by roadway departure

STREET TYPES AND CONTEXT

Applicable Street Types

Highways, arterials, expressways, rural roads, and school zones

Location Guidance

Follow MUTCD guidance for placement of road markings. RMPs should be placed on roads with poor light, with a history of crashes, and on curves, and should supplement centerlines and edge lines.

CONSIDERATIONS FOR IMPLEMENTATION

- Visibility markings require regular maintenance to remain visible.
- RMPs should match the color of the lines.
- Spacing between RPMs varies based on street type and speed limit.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Lane departure crashes
- Intersection-related crashes
- Lighting conditions-related crashes



EXPECTED CRASH REDUCTION

24% reduction in nighttime crashes on rural areas where RMPs were implemented | CMF ID 5502.

10% reduction in crashes where thermoplastic markings were applied | CMF ID 9812.

COST



The cost of the implementation of the countermeasure is low, but the cost of maintenance adds up over time

EXPECTED LIFE SPAN

15 years

REFERENCES

- FHWA Guidelines for the Use of Raised Pavement Markers
- Manual of Uniform Traffic Control Devices



Raised pavement markers (Source: Transline Industries)

30. RETROREFLECTIVE TRAFFIC SIGNAL BACKPLATES

PURPOSE

Improve visibility of traffic signals.

DESCRIPTION

A retroreflective backplate creates a yellow border (1 to 3 inches wide) on the signal's backplate to enhance the visibility for drivers.

SAFETY BENEFITS

- Improve visibility of signals at night and/or in adverse weather conditions
- Makes signals more visible at a distance, giving drivers more time to react
- Reduce crashes at intersections

STREET TYPES AND CONTEXT

Applicable Street Types

All streets with signalized intersections

Location Guidance

Retroreflective traffic signal backplates are most effective in low-light environments, high-speed roads, and at intersections with high crash rates.

CONSIDERATIONS FOR IMPLEMENTATION

- This measure is most effective as part of a comprehensive approach to safety improvements.
- Not all signal structures support the implementation of the retroreflective border.

TARGET CRASH TYPES AND PRIMARY USER GROUPS

- Lighting conditions-related crashes



EXPECTED CRASH REDUCTION

15% reduction in all crashes | CMF ID 1410.

COST

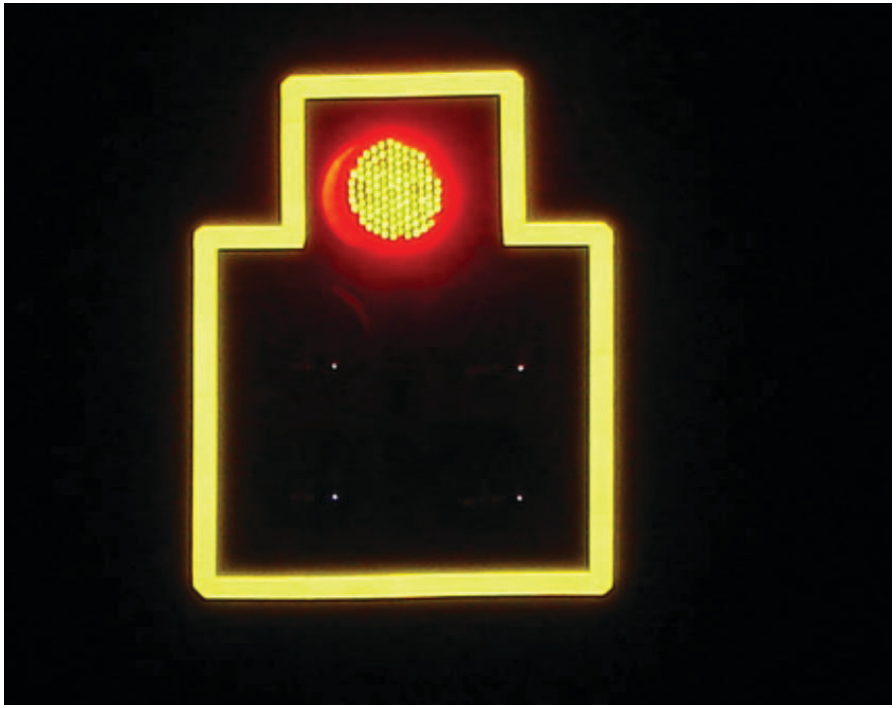
$ $$ $$$ $$$$

EXPECTED LIFE SPAN

15 years

REFERENCES

- FHWA Proven Safety Countermeasures



Retroreflective backplate at night (Source: FHWA)