



Rural Roadway Departure Countermeasure Pocket Guide



U.S. Department of Transportation
Federal Highway Administration





Introduction

Each year in the U.S., nearly 12,000 people die when their car leaves its travel lane on a rural road. That is more than 30 people today, and every day.

It is easy to overlook how serious a problem this is because those deadly crashes happen in random locations across vast rural roadway networks. Based on data from the National Highway Traffic Safety Administration's (NHTSA) Fatal Analysis Reporting System, these crashes account for roughly 30 percent of our nation's annual roadway deaths.

Solutions exist. There are many cost-effective countermeasures that are proven to reduce rural roadway departures. This guide is meant to help you make smart choices about the countermeasures that fit best in your community, based on your data and experience. Use it to start reducing rural roadway departure crashes on your roads today.



U.S. Department of Transportation
Federal Highway Administration

Purpose of this Guide

The purpose of this guide is to provide you a quick reference of options for reducing roadway departure crashes in your community. The countermeasures in this guide are organized around three objectives:

- 1. Keep vehicles in their lane.*
- 2. Reduce the potential for crashes if they do leave their lane.*
- 3. Minimize the severity of a crash if there is one.*

Each countermeasure addresses a specific crash type and can be used to accomplish the above goals. There is also information about where to use the countermeasure, crash reduction data, considerations, and ways to enhance their effectiveness.

This guide is not exhaustive but is designed to provide you a menu of common options to choose the countermeasures that work best for you.



Countermeasure Effectiveness

Throughout this guide, you will see references to crash reduction factors (CRF), which are based on crash modification factors (CMFs). The FHWA maintains the Crash Modification Factor Clearinghouse (www.cmfclearinghouse.org) as a searchable source for identifying countermeasure effectiveness and additional resources for using CMFs to estimate project benefits.

A CMF is used to estimate the expected number of crashes at a location after installing a countermeasure. A CRF provides the expected crash reduction for a target crash type and severity when installing the countermeasure.

For example, a countermeasure CMF from the clearinghouse of 0.70 is equivalent to a CRF of 30 percent. The CRFs in this guide are primarily for non-intersection crashes on 2-lane rural roads, and may only apply to certain target crash types, as indicated.

This guide provides the CMF ID for each CRF, if applicable, which may be searched in the CMF Clearinghouse to find more information on applicability and expected effectiveness.



Countermeasure Summary Table by Roadway Departure Objective

Objective	Countermeasure	Target Crash Types				Cost H-M-L	Option on Narrow Roads*	Option on Unpaved Roads	More Details on Page
		Head-On	Roll over	Fixed Object	Curve				
Keep Vehicles in Lane	Edge Line Markings		●	●	●	L	✓		5
	Center Line Markings	●			●	L			5
	Curve Warning Signs		○	○	●	L	✓	✓	7
	Delineators		○	○	●	L	✓	✓	9
	Shoulder Rumbles		●	●	○	L			11
	Center Line Rumbles	●			○	L			11
	HFST				●	M	✓		10
Reduce Potential for a Crash	Shoulder Widening	○	●	●	●	M-H	✓		13
	SafetyEdge SM	●	●		●	L	✓		15
	Center Line Buffer Area	●				L			17
	Removed Fixed Objects			●	○	L-H	✓	✓	14
	Slope Flattening		●		○	M-H	✓	✓	18
Minimize Severity	Roadside Barriers		●	●	○	M-H	✓	✓	19
	Breakway Features		○	●	○	L	✓	✓	21

Table Key

- *Primary countermeasure for this type of crash*
- *Countermeasure to consider*
- L:**
Low-cost – up to \$5,000 per mile or per curve/location
- M:**
Medium-cost – \$5,000 to \$50,000 per mile or per curve/location
- H:**
High-cost – More than \$50,000 per mile or per curve/location

*For the purpose of this guide, narrow roads are defined as a two-way road with less than 20 feet of total traveled way.



Source: Thurston County, WA

Description

Edge and center lines delineate the edges of the lane and provide a preview of alignment changes. They provide a visual reference to guide motorists and help reduce drifting into opposing lanes or onto the shoulder and roadside area.

Markings that must be visible at night are required by the Manual of Uniform Traffic Control Devices (MUTCD) to be retroreflective unless ambient illumination assures they are visible.

Where to Use

The MUTCD Part 3 contains requirements and recommendations for edge lines and center lines. The recommendations vary based on traffic volume, functional class and pavement width. Studies indicate adding edge lines to lower volume roads results in crash reductions as indicated by the CRFs below.

Effectiveness

Retroreflective edge and center line pavement markings can reduce:

- *Curve crashes*
- *Run-off-road crashes*
- *Nighttime crashes*
- *Head-on Crashes*

Enhancements and Considerations

Wider edge lines (6-inch to 8-inch) reduce injury crashes by 37 percent (CMF ID 4737) compared to 4-inch edge lines.

High-build paint, thermoplastic or other durable marking materials can provide a longer life, thus reducing maintenance and worker exposure.

Raised pavement markers (RPMs) or wet reflective markings can increase nighttime visibility.

CRFs for Rural 2-Lane Roads

Add Edge and Center Lines – 24% (CMF ID 101)

Add Edge Lines – 15% (CMF ID 10243) or
19% for severe crashes (CMF ID 10244)

Add Edge Lines on Curves – 26% (CMF ID 1939)



Curve Warning Signs

Description

Advance curve warning signs alert a driver to changes in the road alignment, advisory speed plaques warn drivers of appropriate speed reduction, and chevrons delineate the curve.

Where to Use

The MUTCD Part 2 contains standards for horizontal alignment warning signs based on functional class, traffic volume, and the difference between the speed limit and advisory speed. The types of signs to which the MUTCD standards and guidance apply include:

- *Advance warning signs, such as curve, turn, and winding road signs*
- *Advisory speed plaques*
- *Chevrons or large arrow signs*



Effectiveness

Advance curve warning signs and chevron alignment signs can reduce:

- *Curve crashes*
- *Run-off-road crashes*
- *Nighttime crashes*

Enhancements and Considerations

A large arrow sign may supplement chevron alignment signs, or be used as an alternative for short curves or where conditions make chevron sign placement difficult.

Options to make warning signs more noticeable include:

- *Oversized or doubled-up signs*
- *Retroreflective strips on sign posts*
- *Fluorescent yellow sheeting (particularly effective at dusk or dawn).
This can reduce injury crashes by 25 percent (CMF ID 2433).*
- *Flashing beacons or dynamic curve warning systems*

CRFs for Rural 2-Lane Roads

Add Chevrons

- 16% for injury crashes (CMF ID 2438)
- 25% for nighttime crashes (CMF ID 2439)



Source: FHWA



Source: FHWA

Effectiveness

Delineators can reduce:

- *Curve crashes*
- *Run-off-road crashes*
- *Nighttime crashes*
- *Wet or snowy weather crashes*

Description

Post mounted delineators are retroreflective devices mounted above the roadway surface and along the side of the road in a series to communicate the roadway alignment to the driver.

Where to Use

Can be used on unpaved roads and on paved roads with or without pavement markings. Can also be used in curves where chevrons are not required.

The MUTCD Part 3 requires the retroreflective delineator to match the color of the edge line. This means white delineators on both sides of two-lane roads.



Source: FHWA

CRFs for Undivided Roads

Installing delineators, center lines and edge lines in combination – 45% reduction in injury crashes (CMF ID 102).

High Friction Surface Treatments (HFST)



Description

HFST provides durable skid resistant properties at high friction demand locations like curves, intersections, and downgrades. HFST is comprised of a special aggregate (calcined bauxite) that is bonded to the pavement with a polymer resin binder.

Where to Use

At locations with poor pavement friction, high friction demand, or a history of wet-pavement related crashes.

Effectiveness

HFSTs can reduce:

- *Curve and intersection crashes*
- *Run-off-road crashes*
- *Wet weather crashes*

CRFs for Rural 2-Lane Roads

Injury – 48% (CMF ID 10333)

Run-off-road – 72% (CMF ID 10334)

Wet road – 83% (CMF ID 10335)



Description

Center line and shoulder rumble strips are milled corrugations in the pavement to alert inattentive drivers that they are leaving the roadway.

Where to Use

Consider center line rumble strips in both passing and no passing zones where risk factors, such as traffic volume, indicate a higher probability of head-on crashes. Consider shoulder rumble strips where risk factors indicate a higher probability of run-off-road crashes.

Effectiveness

Center line and shoulder rumble strips can reduce:

- *Head-on crashes*
- *Run-off-road crashes*
- *Distracted/drowsy driver crashes*
- *Fixed object crashes*
- *Rollovers*

Enhancements and Considerations

Placing pavement markings directly on top of rumble strips can improve nighttime visibility.

Consider adjusting dimensions, offset, and gaps when in noise sensitive areas or when bicycle or other non-motorized vehicle traffic is expected.

Address pavement quality issues prior to installation. If chip sealing is anticipated in the future, a deeper rumble should be considered.

Shoulder rumble strips may be combined with shoulder widening and SafetyEdgeSM to enhance their effectiveness and to improve conditions for non-motorized users.

CRFs for Rural 2-Lane Roads

Add Center Line Rumble Strips

– 45% Injury Roadway Departures (CMF ID 3360)

Add Shoulder Rumble Strips

– 36% Injury Roadway Departures (CMF ID 3454)



Shoulder Widening



Description

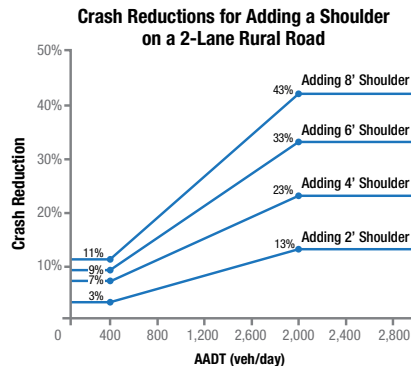
Adding a paved shoulder provides an errant driver an opportunity to regain control.

Where to Use

Corridors with no shoulders or with narrow shoulders where risk factors, such as traffic volume, indicate a higher probability of roadway departure crashes. Can also be used for specific locations such as horizontal curves.

Effectiveness

Shoulders can reduce all roadway departure crash types.



Adapted from the AASHTO Highway Safety Manual (HSM) for 2 lane rural roads with no existing shoulder. For existing shoulders to be widened, see the HSM.

Remove Fixed Objects



Description

Establishing and maintaining a clear zone provides an unobstructed, traversable area where an errant driver can recover to reduce fixed object crashes.

Where to Use

Where there are fixed objects located close to the edge of the traveled way, particularly on the outside of horizontal curves, or where risk factors such as speed and traffic volume indicate a higher probability of roadway departure crashes.



Effectiveness

Removing trees, poles, fences, mailboxes, headwalls, and guardrail have been proven to reduce fixed object crashes.

CRFs on Rural 2-Lane Roads

Tree Crashes

- increase 3 ft, 22%
- increase 5 ft, 34%
- increase 10 ft, 57%
- increase 15 ft, 71%

Source: NCHRP Report 440



Source: FHWA

Effectiveness

SafetyEdgeSM can reduce:

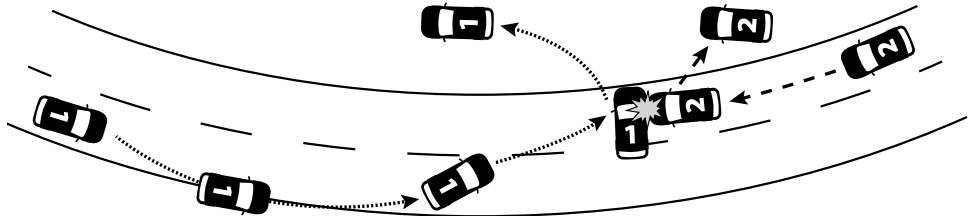
- Run-off-road crashes
- Head-on crashes
- Rollovers

Description

SafetyEdgeSM eliminates tire scrubbing due to vertical edge drop-offs, improving driver control as the vehicle returns to the pavement after a roadway departure. A paver attachment forms the SafetyEdgeSM – a consolidated 30 degree edge.

Where to Use

Paving projects where curbs are not present.



Typical drop-off crash with tire scrubbing

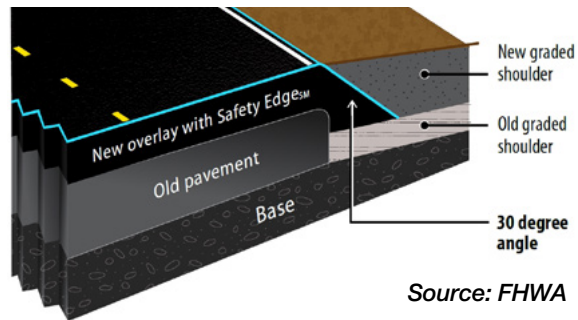
CRFs on Rural 2-Lane Roads

Drop-Off Crashes – 35% (CMF ID 9671)

Run-off-Road – 21% (CMF ID 9661)

Head-On – 19% (CMF ID 9662)

Injury Crashes – 11% (CMF ID 9660)



Source: FHWA

Considerations and Enhancements

Cost is negligible for asphalt overlays and it improves pavement edge durability. There is additional cost when installing on concrete pavement.

After paving, the adjacent graded material should be brought back up flush with the pavement surface.

This treatment can be combined with shoulder widening and rumble strips to enhance effectiveness.



Source: FHWA

Description

A center line buffer area provides extra space between the two solid center line markings, further separating opposing directions of traffic.

Where to Use

In no-passing zones with enough right-of-way, where risk factors such as traffic volume indicate higher probability of head-on crashes.

Source: FHWA



Enhancements and Considerations

Center line rumble strips may be provided within the buffer area.

Consider impacts of pavement and shoulder width as well as edge drop-offs and other roadside conditions when restriping existing pavement to add or widen center line buffer area.

Effectiveness

Center Line Buffer Areas can reduce head-on crashes.

Crash Reduction on Rural 2-Lane Roads

Head-on Crashes

- 2 ft buffer, 35%
- 4 ft buffer, 64%
- 10 ft buffer, 90%

Source: NCHRP Project 17-66

Slope Flattening



Description

Flattening steep sideslopes increases driver ability to keep the vehicle stable, regain control of the vehicle, and avoid obstacles.

Where to Use

Roadsides with non-traversable sideslopes located close to the edge of the traveled way where risk factors, such as traffic volume, indicate a higher probability of roadway departure crashes. Slope flattening on the outside of curves is particularly important. Consider grading barn-roof designs to one consistent, recoverable slope.

Effectiveness

Slope flattening can reduce:

- *Rollovers*
- *Run-off-road crashes*

Crash Reductions (%) for Single Vehicle Crashes			
Before Sideslope	After Sideslopes		
	1V:4H	1V:5H	1V:6H
1V:2H	10	15	21
1V:3H	8	14	19
1V:4H	-	6	12
1V:5H	-	-	6

Source: AASHTO Highway Safety Manual



Source: FHWA

Effectiveness

Roadside barriers can reduce the severity of:

- *Rollovers*
- *Fixed object crashes*
- *Other run-off-road crashes*

Description

Roadside barriers are designed to redirect and slow vehicles while shielding them from obstacles likely to result in a more severe crash, such as rigid fixed objects, steep slopes, or bodies of water.

Where to Use

Roadsides with non-traversable slopes or fixed objects located close to the edge of the traveled way where risk factors, such as traffic volume, indicate a higher probability of roadway departure crashes. Typically provided when delineation and signing are not sufficient, it is not feasible to clear obstacles or flatten side slopes, and the likelihood of harm from striking the shielded object is greater than the harm from striking the barrier system.

Enhancements and Considerations

The crashworthiness of barriers is evaluated through crash testing. AASHTO and FHWA encourage developers of safety hardware to use the AASHTO Manual for Assessing Safety Hardware (MASH) 2016.

Consideration should be given to barrier type. More flexible barrier types may result in less severe crashes; however, more rigid barriers require less maintenance. Additionally, barrier deflection should be considered when shielding fixed objects.

Barriers can be enhanced with supplemental delineators. This can reduce nighttime crashes on horizontal curves by 14 percent (CMF 10307).

Crash Reduction on Rural 2-Lane Roads

Injury Crashes – 48% (FHWA-HRT-21-076)



Source: Kitsap County, WA



Description

Roadside signs, luminaire supports, and utility poles can be designed to have features that will allow them to breakaway in a controlled manner when hit by a vehicle in a roadway departure.



Where to Use

Roadsides, within the clear zone, where the sign or support is not shielded and cannot be removed or relocated. Supports should be designed properly and carefully located to minimize the likelihood of impact by errant vehicles or that the breakaway mechanism is not impacted by environmental conditions.

Effectiveness

No reliable safety effectiveness evaluations have been conducted to date that indicate the amount of crash reduction to be expected.

Links for More Information

Scan the QR Code for each URL



Edge and Center Line Striping: https://safety.fhwa.dot.gov/roadway_dept/night_visib/pavement-markings.cfm



Curve Warning Signs: https://safety.fhwa.dot.gov/provencountermeasures/enhanced_delineation



Center Line and Shoulder Rumble Strips: https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips



High Friction Surface Treatment: https://safety.fhwa.dot.gov/roadway_dept/pavement_friction



Remove Fixed Objects: https://safety.fhwa.dot.gov/roadway_dept/countermeasures/safe_recovery/clear_zones



SafetyEdgeSM: <https://safety.fhwa.dot.gov/safetyEdge>



Barriers: https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/



Manual on Uniform Traffic Control Devices: <https://mutcd.fhwa.dot.gov/>



Notice

This document is disseminated under the sponsorship of the U.S. Department of Transportation (USDOT) in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document.

Unless otherwise indicated, the source of all tables, graphics, and photos in this document is FHWA.

Use of the countermeasures in this guide are voluntary and are not required under federal regulations except as provided in the MUTCD.

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide information to the public regarding existing requirements under the law or agency policies.

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.