National Center for Rural Road Safety

Est. Dec. 2014

Rural Roadway Departure Countermeasures – Part 1

Presented by: Dick Albin, FHWA

Keith Knapp, Iowa LTAP / InTrans/Safety Center

Webinar Logistics

- Duration is 11:00 AM - 12:30 PM Mountain
- Webinar – recorded and archived on website. For quality of recording, phone will be muted during presentation
- If listening on the phone, please mute your computer
- To maximize the presentation on your screen click the 4 arrows in the top right of the presentation
- At the end of each section, there will be time for Q&A
- There is a handout pod at the bottom of the screen
- Send group lists to info@ruralsafetycenter.org
- Please complete follow-up surveys; they are vital to assessing the webinar quality

Certificates of Completion/CEUs

- Survey Link –

http://survey.constantcontact.com/survey/a07efqt9y7cjmtley4t/start

  - Survey closes 2 weeks after webinar
  - Expect certificate/CEU form 3-4 weeks after webinar
  - Return CEU form to ContinuingEd@montana.edu **NOT** Safety Center
  - Request a verification of completion form

Certificates of Completion/CEUs

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Course Registration Form

Please PRINT in INK

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128 Barnard Hall/PO Box 173860
Bozeman, MT 59717-3860
Phone: (406) 994-6550/Fax: (406) 994-7856
Email: ContinuingEd@montana.edu
Web: http://eu.montana.edu

Course *cex 280717 Pedestrian Treatments for Uncontrolled Locations - Live* Location *Online*

Date *01/18/18 - 01/18/18* REGISTRATION FEE *$0.00* # OF CEU's *0.150* GENDER: M / F

Name _____ (Last) (First) (Middle Initial) _____ (Maiden/Former Name)

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VERIFICATION OF COMPLETION

February 2, 2018

REGISTRANT: First Last
123 Main St
Town, ST 59123

ID #:		CEU	Hours
18SCEX280717	Pedestrian Treatments for Uncontrolled Locations - Live January 18, 2018	0.150	1.50
18SCEX280720	Primer on the Joint Use of the HSM and the HFG for February 13, 2018 - February 13, 2019	0.150	1.50
TOTAL:		**0.300** CEU's	**9.00** Hours

Co-Hosted by:

U.S. Department of Transportation
Federal Highway Administration

On-Ramp to Innovation
every day counts

NATIONAL ASSOCIATION COUNTY ENGINEERS
NACE

The Voice of
County Road Officials

National
LTAP & TTAP
Association

Today's Presenters

Dick Albin
FHWA

Keith Knapp
Iowa LTAP/InTrans/Safety Center

Goals of this Webinar

Once you have completed this webinar, you will:

- have a summary of the rural roadway departure safety problem, a description of the EDC-5 innovation focused on rural roadway departure reduction, and a discussion about rumble strips - one proven safety countermeasure.

Learning Outcomes

To achieve the webinar goal, you will learn to:

- Summarize the safety problem connected to rural roadway departures
- Describe approaches to reduce rural roadway departures
- Identify proven safety countermeasures to combat rural roadway departures
- List who to speak with in your state, to show your support for joining the EDC-5 innovation
- Describe the potential safety related benefits of rumble strips and stripes
- Identify some of the issues to consider before implementation

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FHWA

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What is *"Every Day Counts"*(EDC)?

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

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

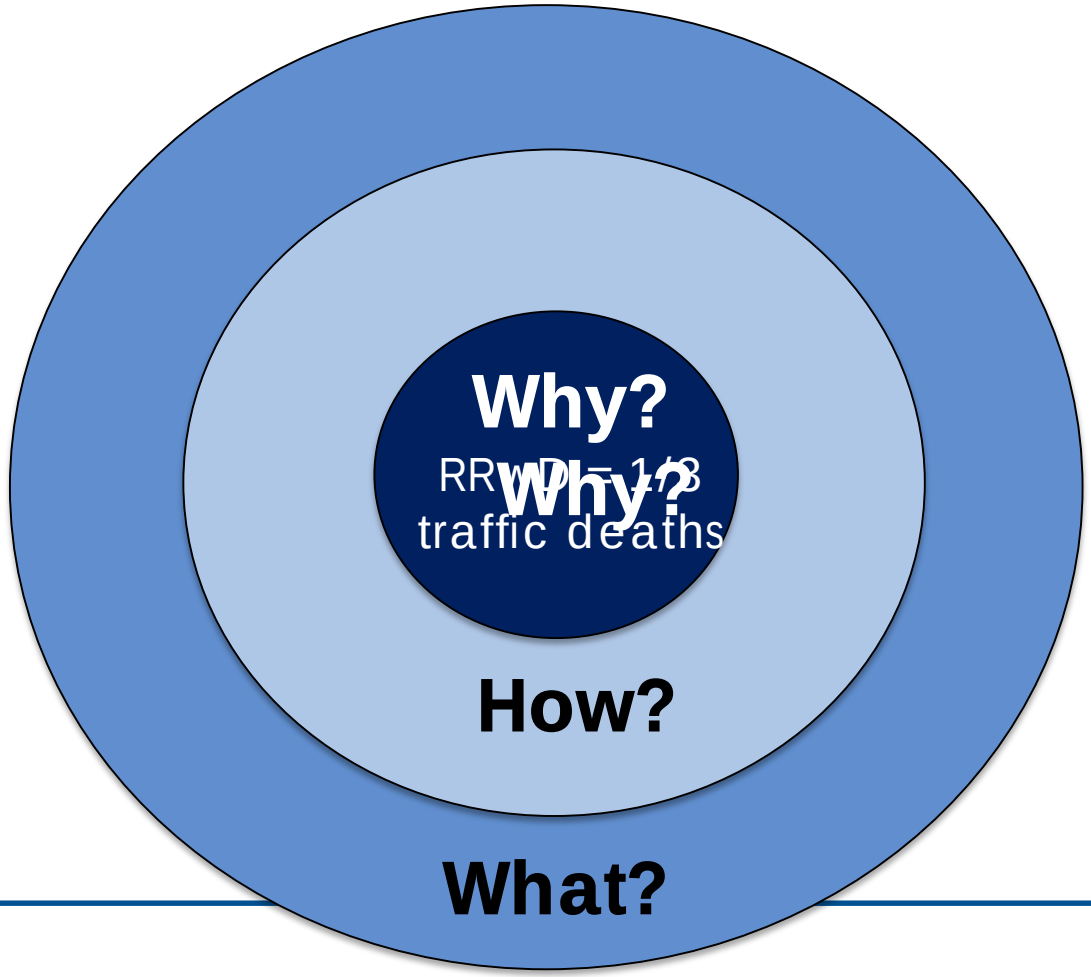
- EDC Rounds: two year cycles
- Initiating 5th Round (2019-2020) - 10 innovations
- To date: 4 Rounds, over 40 innovations

For more information: https://www.fhwa.dot.gov/innovation/

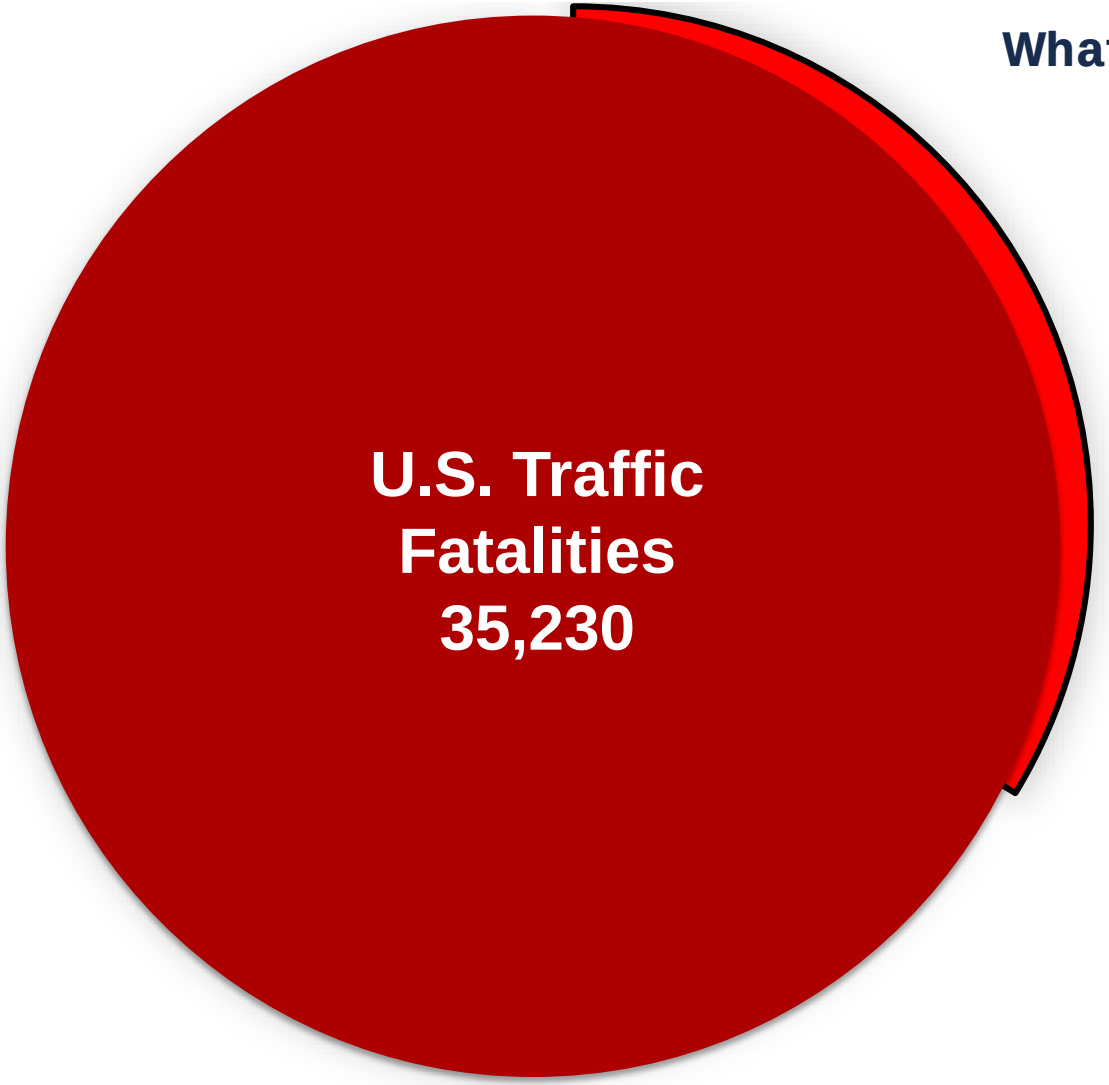
FAST Act, Sec.1444

Reducing Rural Roadway Departures Initiative

Mission - Reduce the potential for serious injury and fatal roadway departure crashes on **all public rural roads** by increasing the systemic deployment of proven countermeasures.



The Rural RwD Component of Fatalities



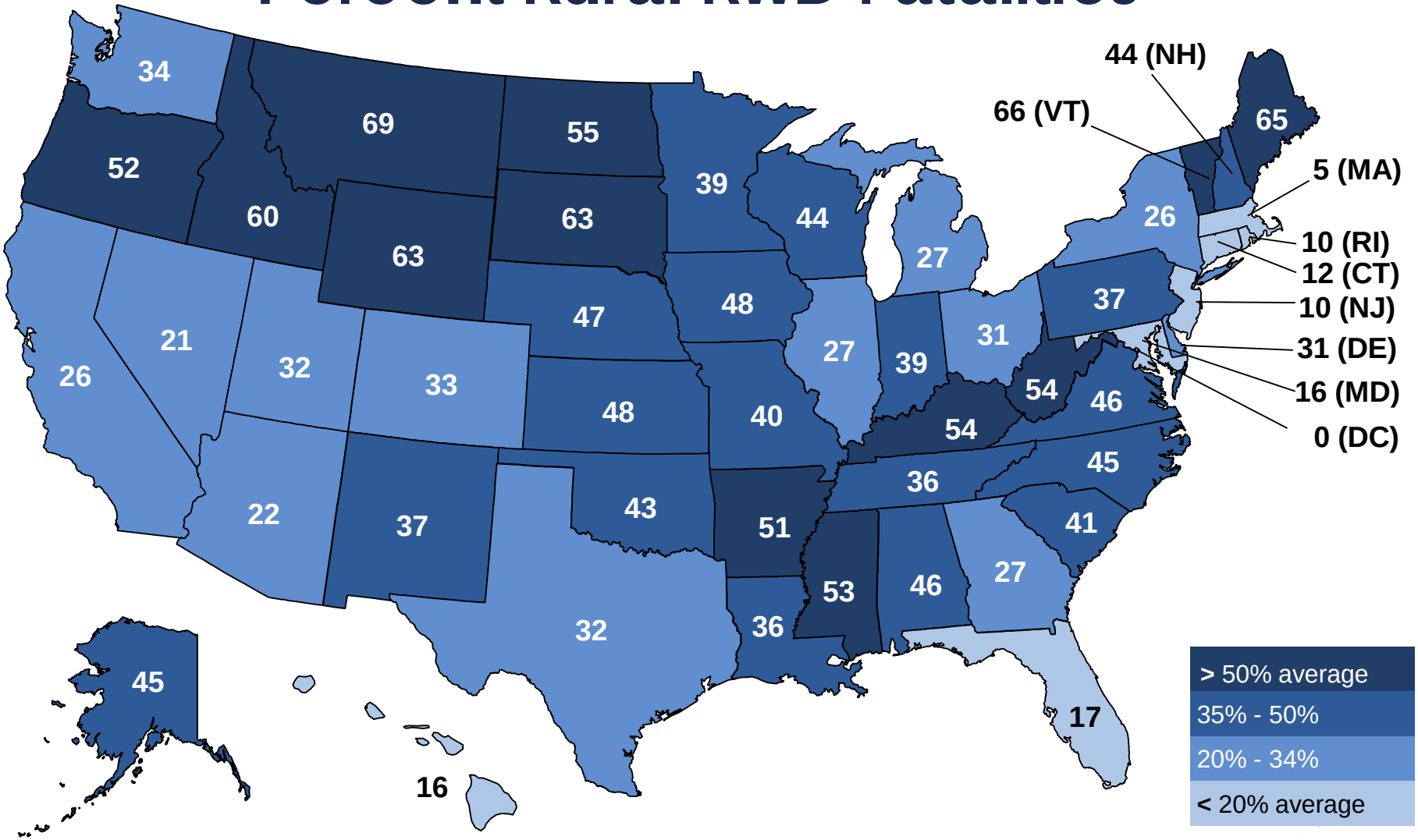
What is a Roadway Departure (RwD)?

FHWA Definition: A crash in which a vehicle crosses an edge line, a center line, or otherwise leaves the traveled way.


Photo credit: Oregon State Police

Source: NHTSA FARS (2014 – 2016 Annual Average)

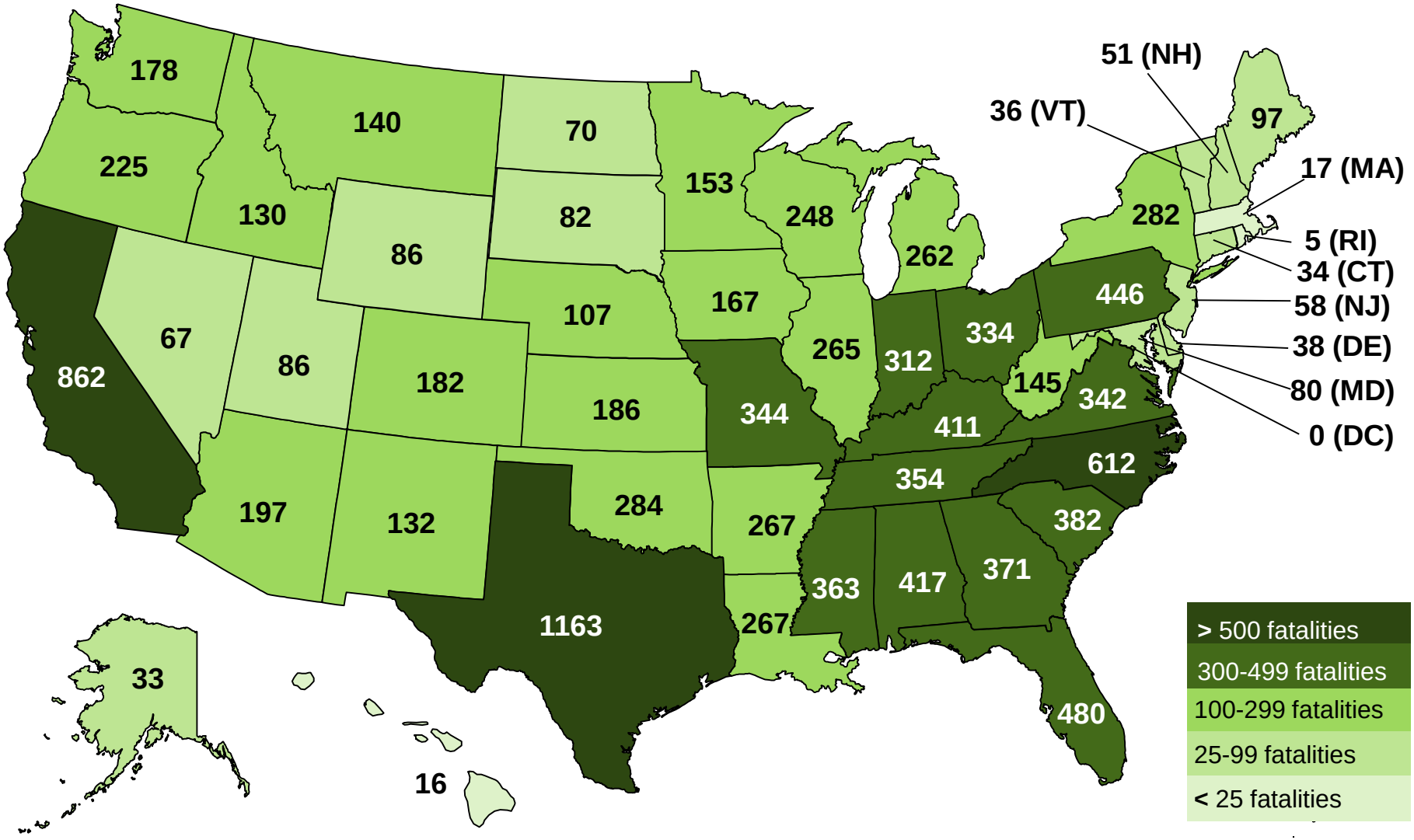
Percent Rural RwD Fatalities



2014-2016 Annual Average of Rural Roadway Departures

Source: FARS

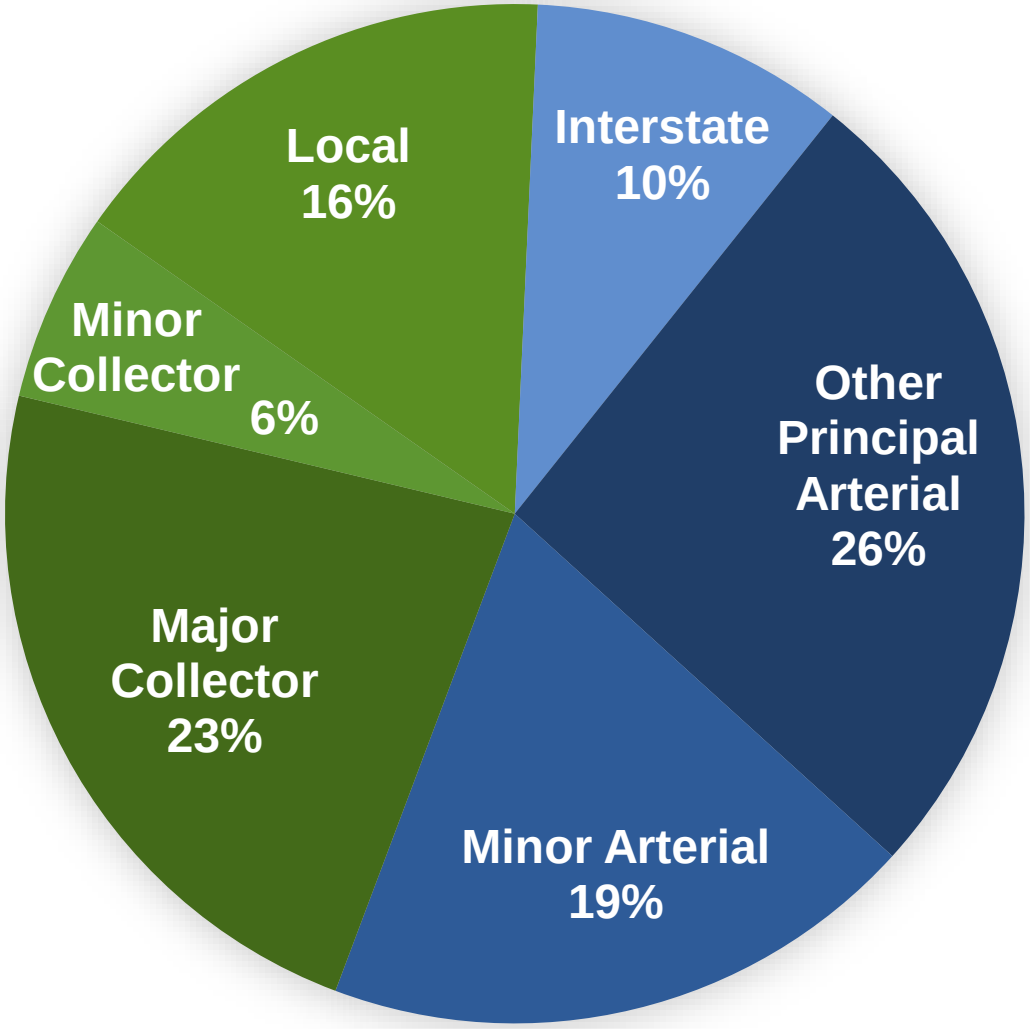
Rural RwD Fatalities



2014-2016 Annual Average of Rural Roadway Departures

Source: FARS

Why all public roads?



Roads typically maintained by states = 55% of Rural RwD fatalities

Roads typically maintained by locals = 45% of Rural RwD fatalities

2014-2016 Annual Average of Rural Roadway Departures

Source: FARS

FY2019 High Risk Rural Roads Special Rule

Section 148(g)(1) of 23 U.S.C.

State	Amount
Alabama	$4,124,978
Alaska	$900,000
Colorado	$2,826,084
Georgia	$6,299,452
Idaho	$1,294,798
Illinois	$6,048,546
Kentucky	$2,879,986
Louisiana	$3,085,174

State	Amount
Montana	$1,389,760
Nevada	$1,487,814
New Mexico	$1,887,424
Oregon	$2,440,120
Pennsylvania	$5,766,894
South Dakota	$1,517,100
Utah	$1,331,318
Virginia	$4,459,774
Washington	$3,144,572

Why do drivers leave the roadway?

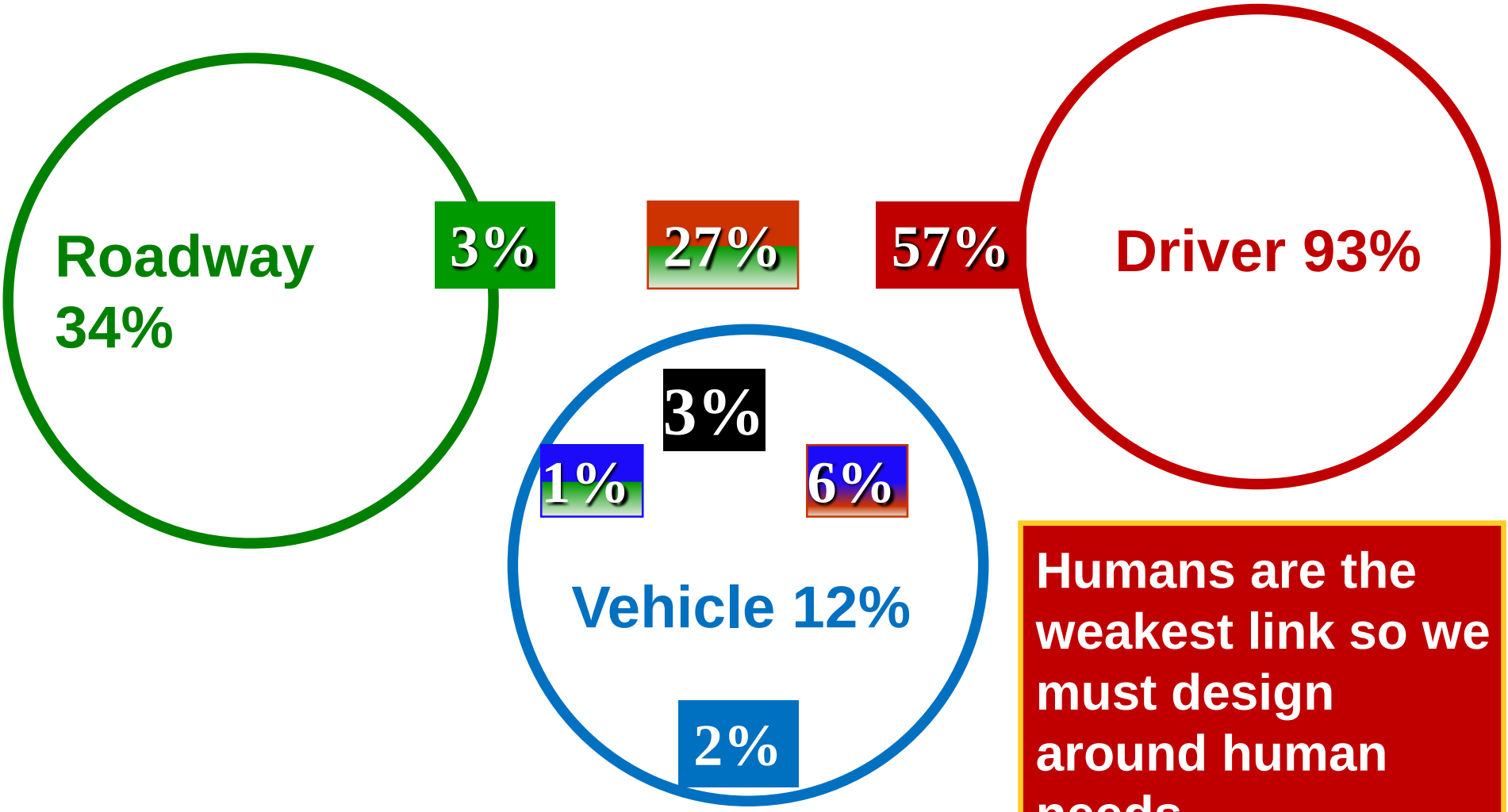
Roadway Condition

Collision Avoidance

Vehicle Component Failure

Driver Error

Crashes Caused by Various Factors

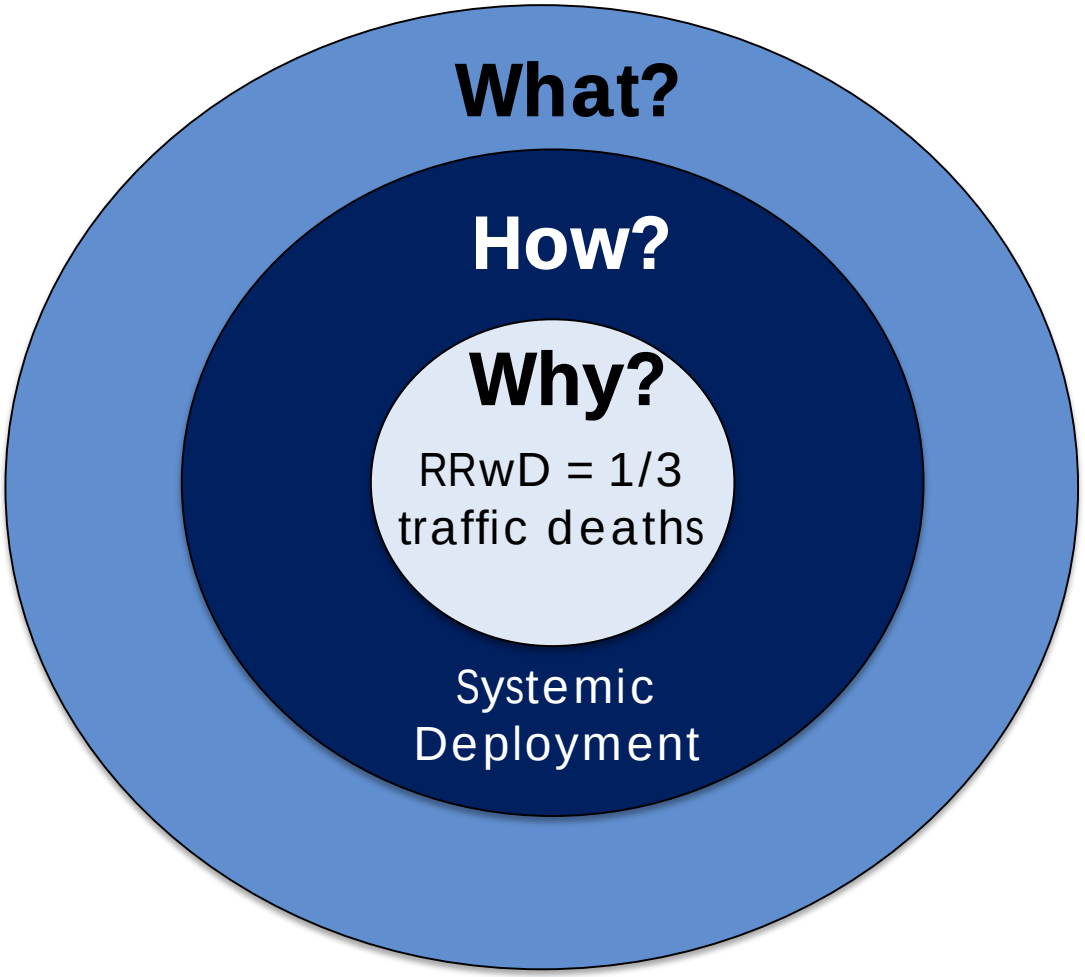


Humans are the weakest link so we must design around human needs.

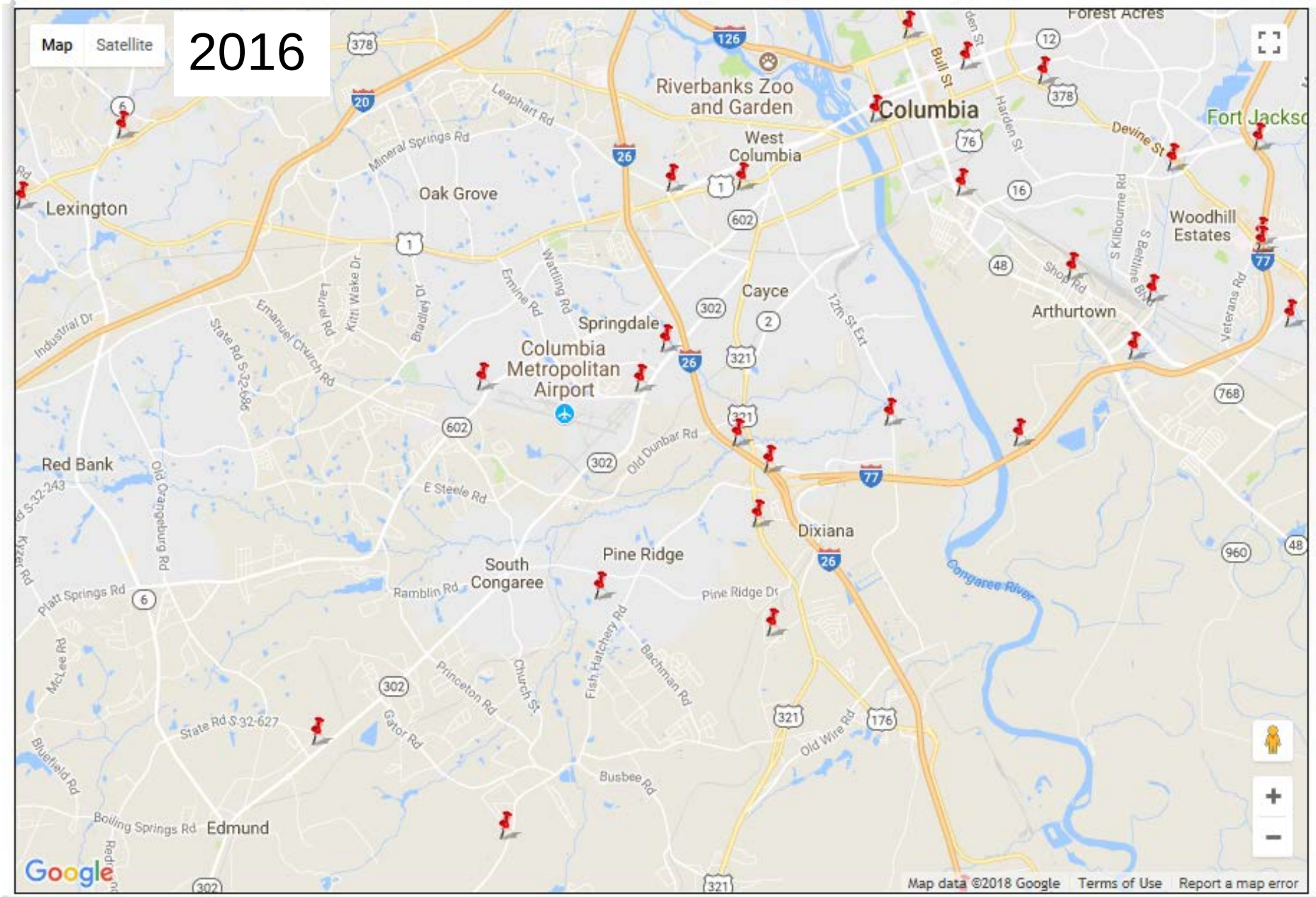
From: Lum & Reagan, Public Roads Magazine, Winter 1995, "Interactive Highway Safety Design Module"

How?

- Systemic Analysis
- Safety action plans
- Deployment based on risk factors



Where would you invest safety funds?



Most Harmful Event

in Fatal Crashes

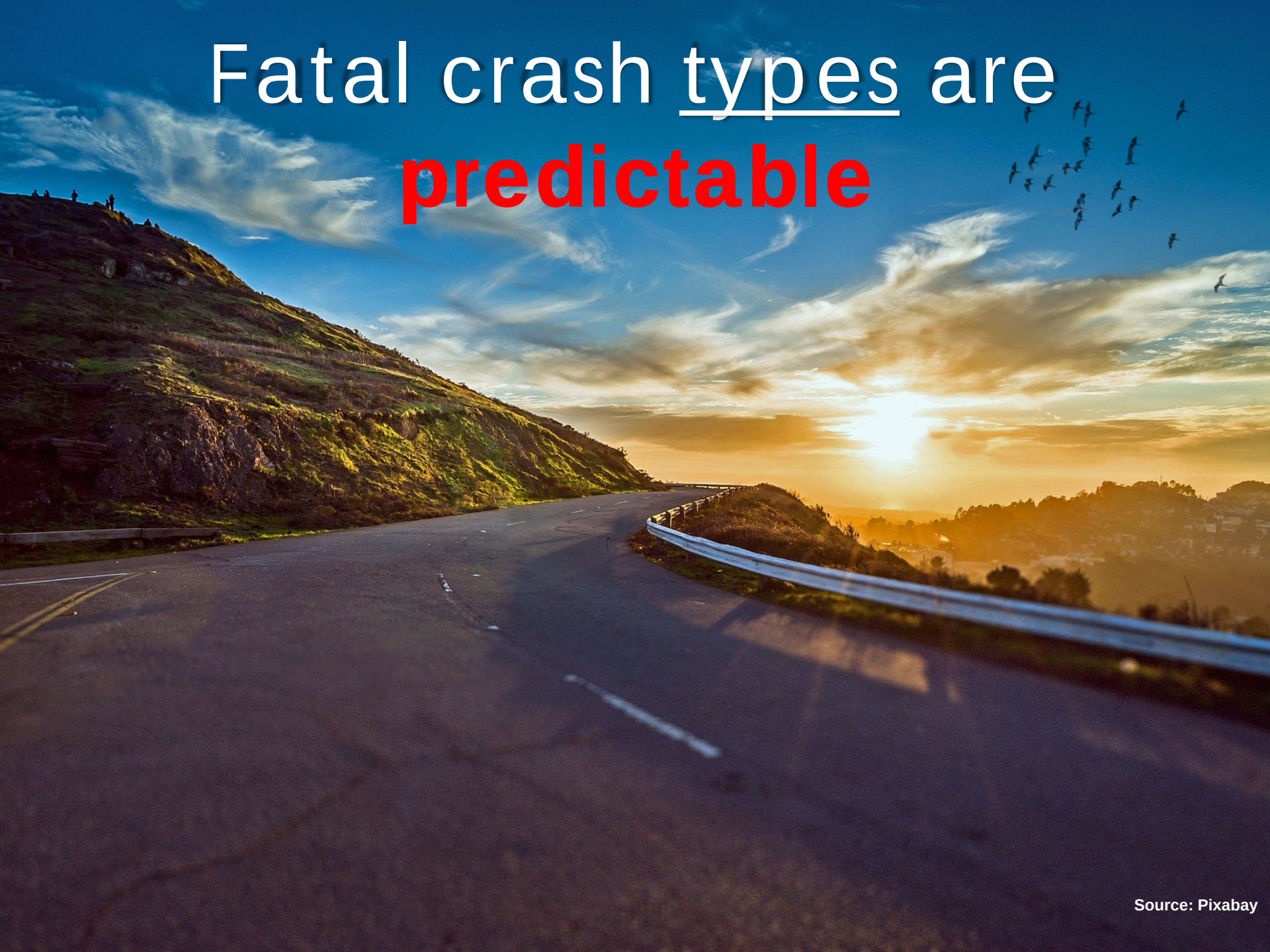
	2012
Motor Vehicle In-Transport	289
Tree & Shrub (Standing Only)	158
Rollover/Overturn	132
Pedestrian	110
Embankment & Ditch	29
Utility Pole/Light & Sign Support	25
Traffic Barrier	16
Fire/Explosion	14
Pedalcyclist	13
Other Object (not fixed)	9
Culvert	8
Other Fixed Object	8
Parked Motor Vehicle	7
Live Animal	5
Curb	5

Source: FARS

Fatal crash locations are **random**

Source: Pexels

Fatal crash types are **predictable**



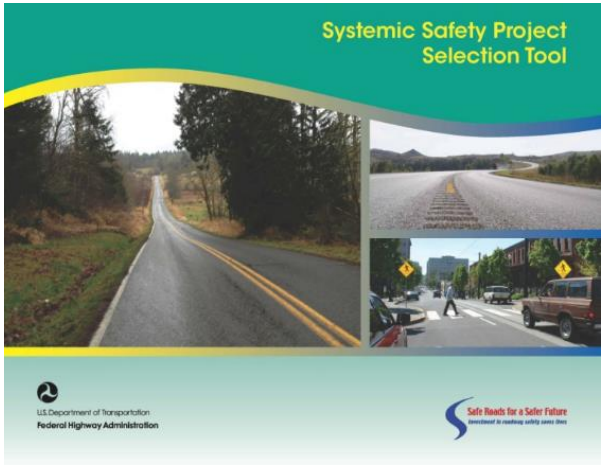
Source: Pixabay

Systemic Safety Improvements

Systemic

- Based on Risk
- Correlated with particular severe crash types

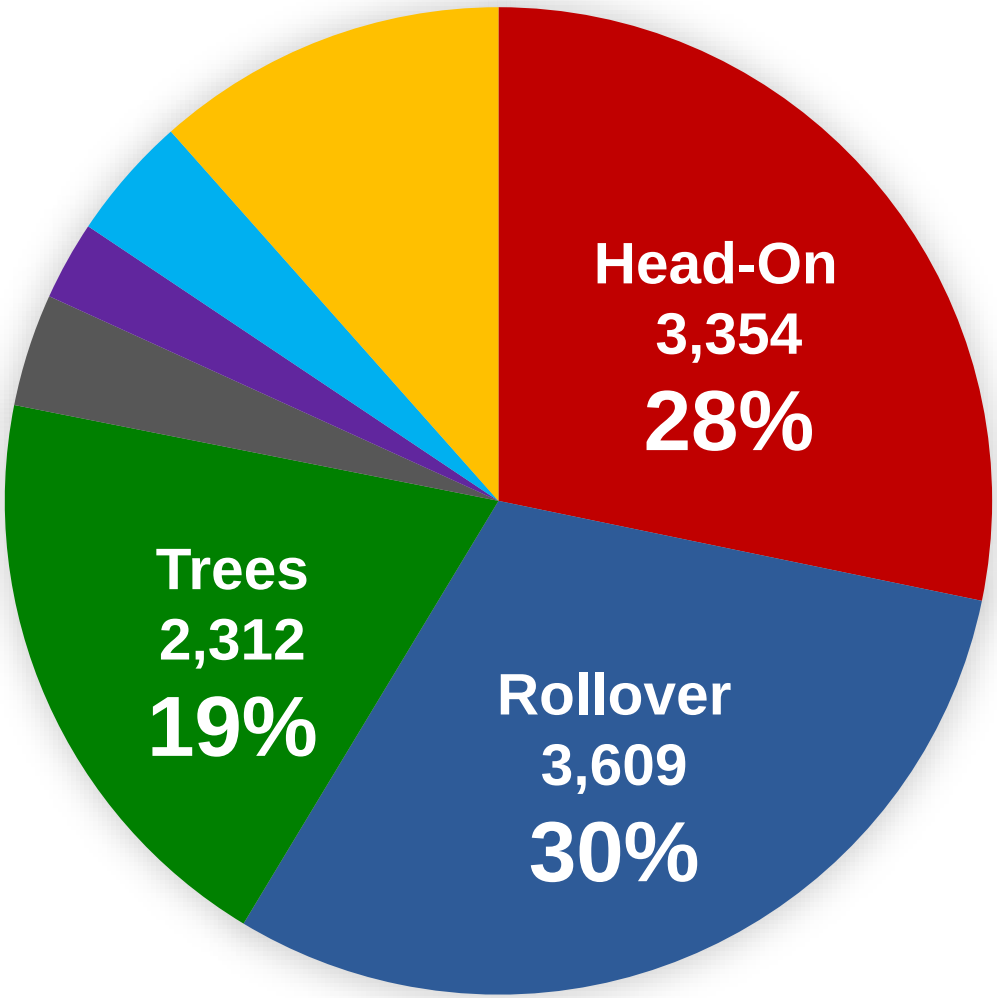
An improvement that is widely implemented based on high-risk roadway features that are correlated with particular severe crash types.



http://safety.fhwa.dot.gov/systemic/index.htm

Rural Roadway Departure Fatalities

by Most Harmful Event

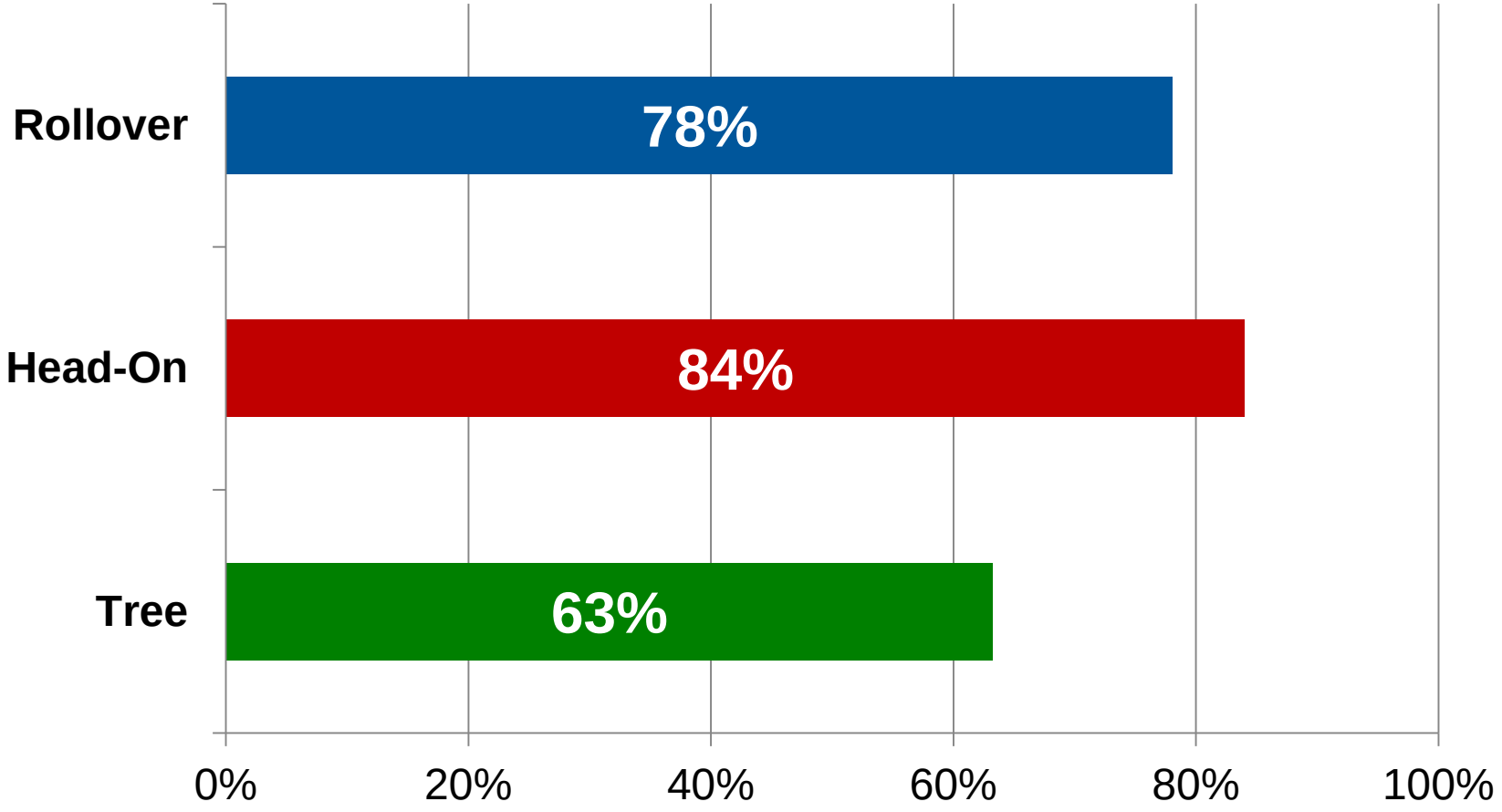


2014-2016 Annual Average of Rural RwDs by MHE

Source: FARS

Higher Speed is a Risk Factor

Rural RwD fatalities where speed limit is ≥ 50 MPH

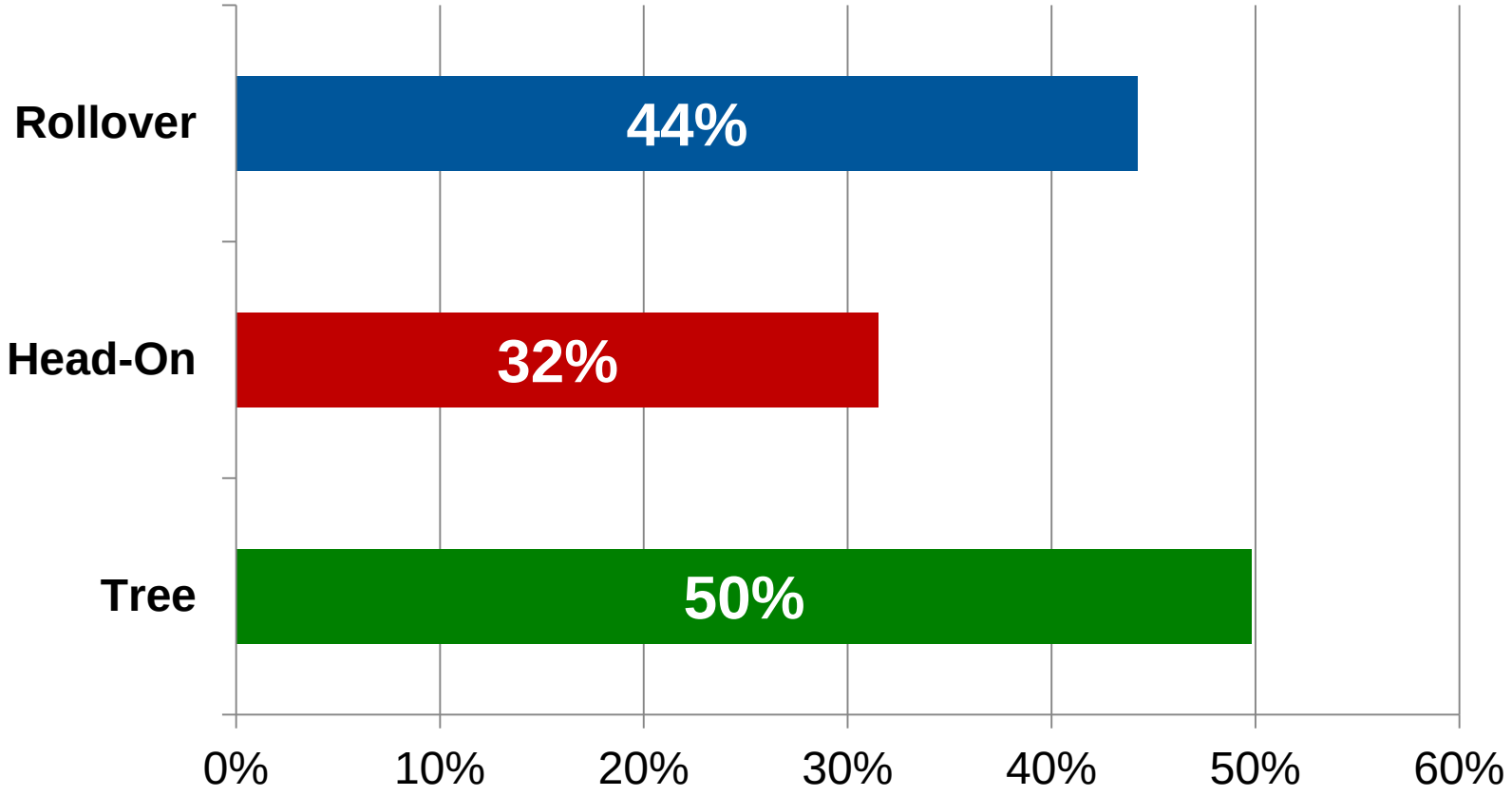


2014-2016 Annual Average of Rural Roadway Departures

Source: FARS

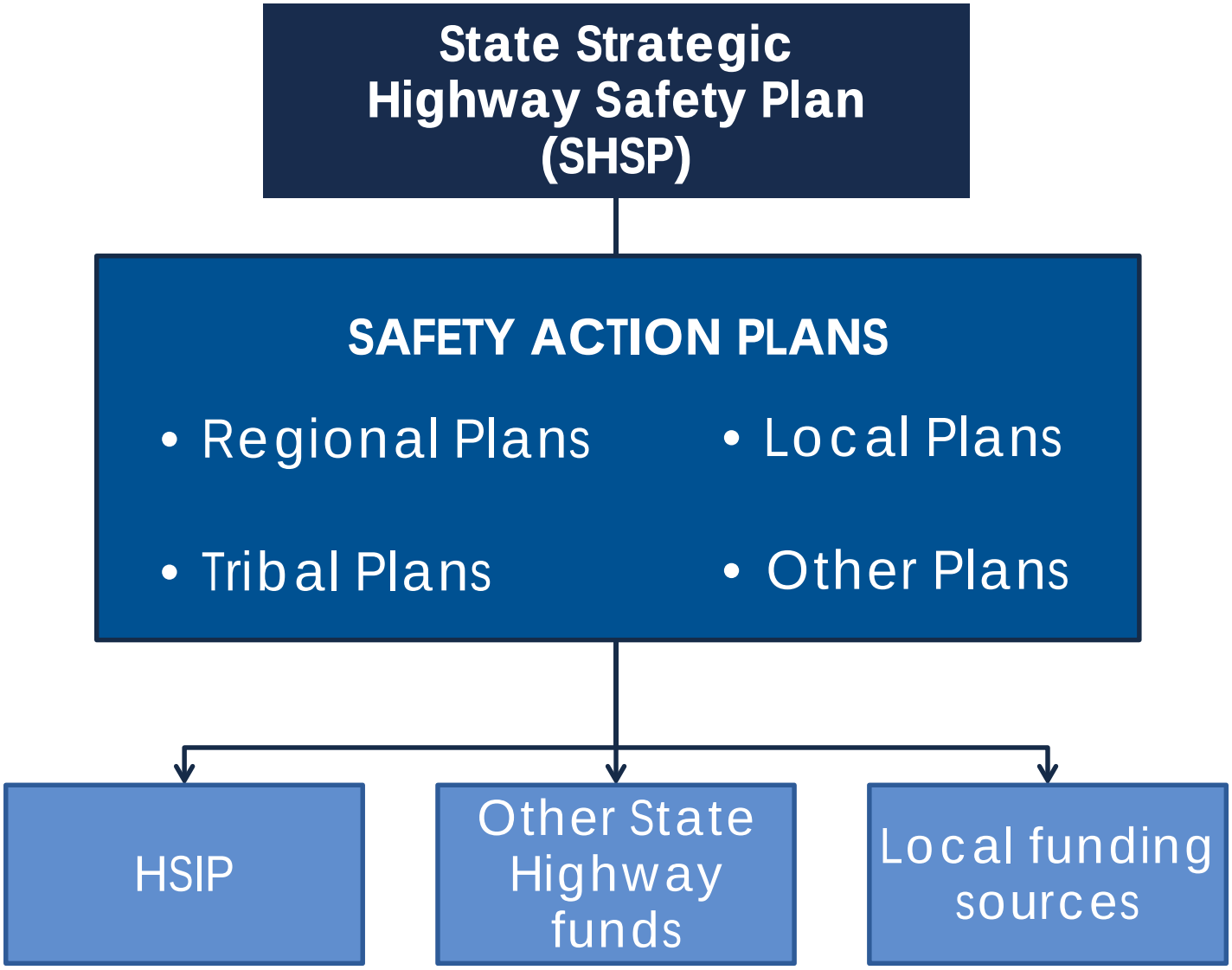
Curves are a Risk Factor

Curve-related Rural RwD Fatalities



2014-2016 Annual Average of Rural Roadway Departures

Source: FARS



HSIP: 23USC 148(c), 23 CFR 924.7

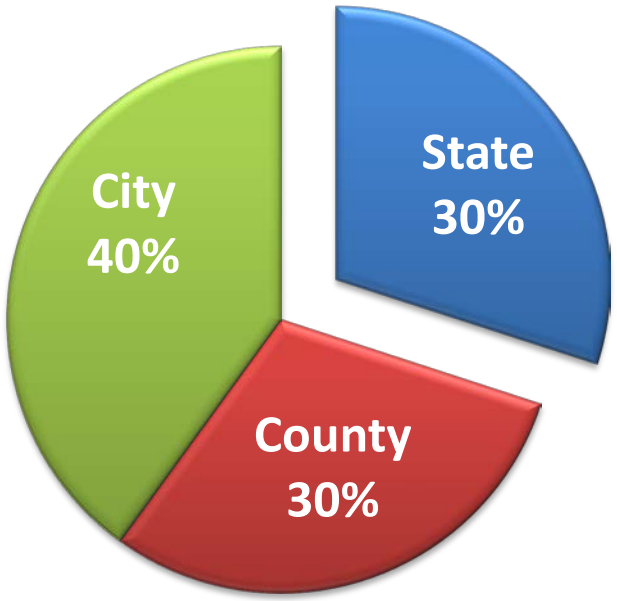
Local Road Safety Plans:

Your Map to Safer Roadways

No matter what your resources, a Local Road Safety Plan will guide you to data-driven solutions and safer roads.

https://safety.fhwa.dot.gov/provencountermeasures/local_road/

Washington State example



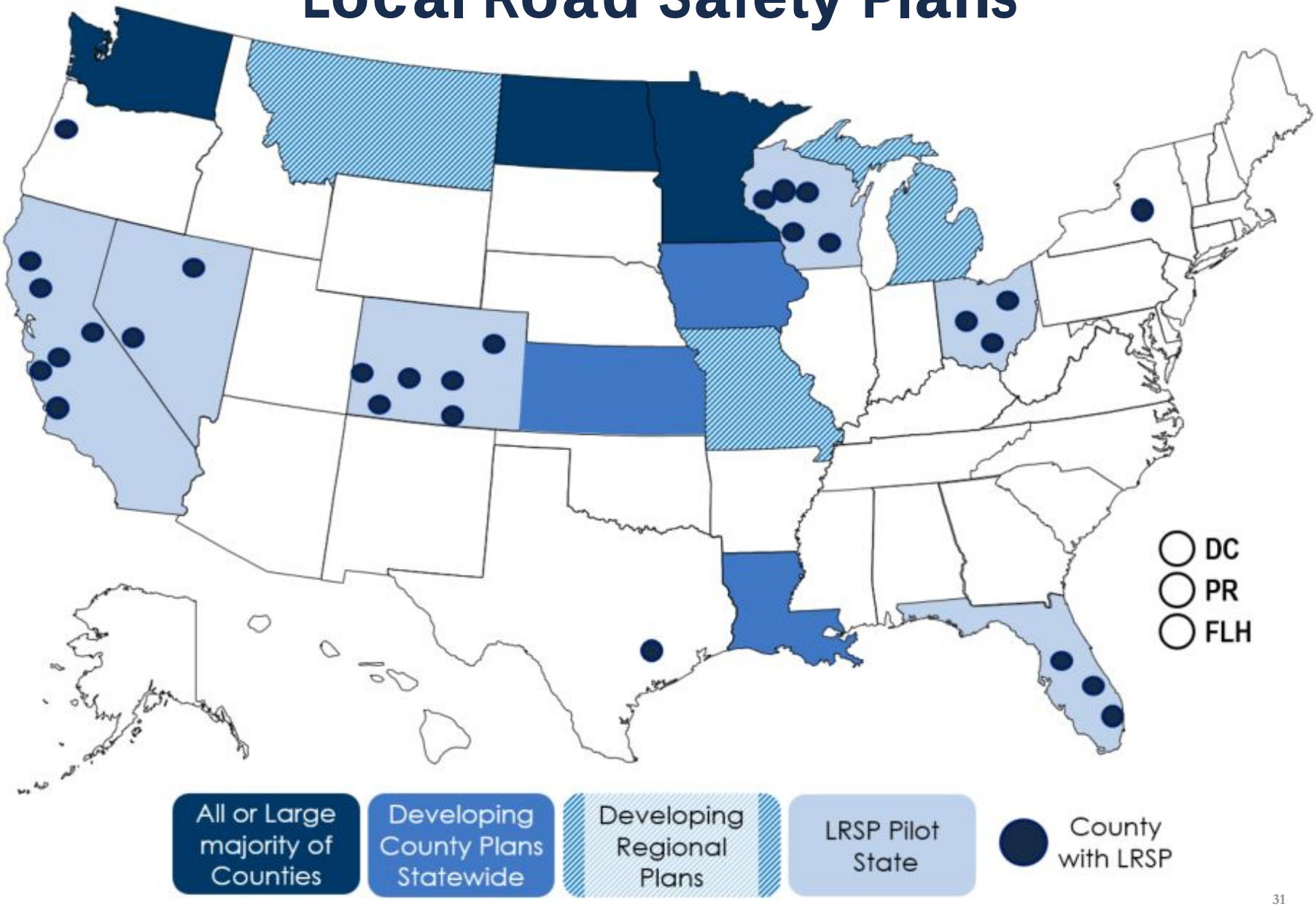
Percent Fatal & Serious Collisions

- State provides 70% of HSIP to local agencies
- State provided training and crash data
- 33 of 39 counties developed safety plans

All the plans were completed by county staff

The fatal crash rate is two times higher on county roads than on state highways.

Local Road Safety Plans



Many Data Sources

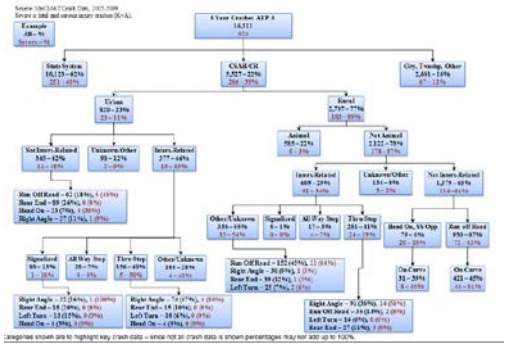
"Do what you can, with what you have, where you are."
– Theodore Roosevelt

Methods to Identify Risk Factors

Quantitative Crash Analysis Methods

- *Spreadsheets*
- *Crash trees*

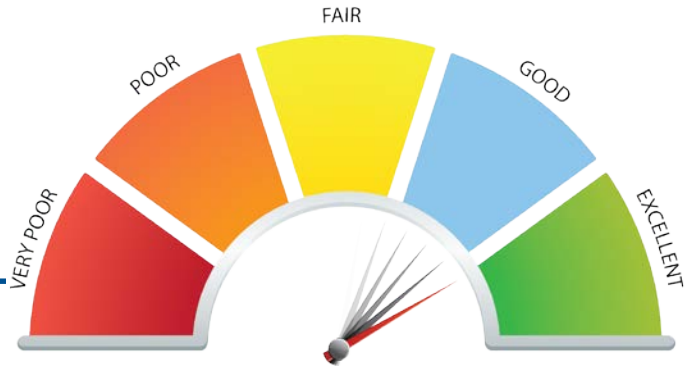
2011-2015 County X Data	Fatal/Serious Injury Crashes Only														
	All Public Roads		All Counties		West Counties		County X								
	2011-2015	%	2011-2015	%	2011-2015	%	2011-2015	%	2015	2014	2013	2012	2011	2010	2009
Overall Numbers															
Total # of Collisions	11,001		2,699		1,951		26		5	4	1	7	9	7	11
# of Fatal Collisions	2,188	19.9%	632	23.4%	412	21.1%	7	26.9%	3	1	0	1	2	1	0
# of Serious Injury Collisions	8,813	80.1%	2,067	76.6%	1,539	78.9%	19	73.1%	2	3	1	6	7	6	11
# of Alcohol-Related Collisions	2,684	24.4%	838	31.0%	573	29.4%	5	19.2%	0	0	1	1	3	3	3
Total # of Fatalities	2,378		679		439		7		3	1	0	1	2	1	0
Total # of Injuries	15,491		3,736		2,727		31		5	4	1	11	10	8	13
By Collision Type															
Hit Fixed Object	3,159	28.7%	1,165	43.2%	837	42.9%	14	53.8%	1	3	0	5	5	5	4
Overturn	965	8.8%	311	11.5%	162	8.3%	3	11.5%	0	1	0	0	2	0	1
Head On	582	5.3%	162	6.0%	122	6.3%	2	7.7%	1	0	0	0	1	0	0
Wildlife	96	0.9%	47	1.7%	25	1.3%	1	3.8%	1	0	0	0	0	1	0



Qualitative Data

- *Good, Fair, Not-So-Good (curve radius, roadside, etc.)*
- *High, Medium, Low (traffic volumes, pedestrian volumes, crash frequency, etc.)*

It is important to include the risk factors that are key to your roadway network



Directing Your Questions via the Chat Pod

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3. Answers will appear here unless addressed verbally

2. Type your question or comment here

Dick Albin,
FHWA

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- Summarize the safety problem connected to rural roadway departures
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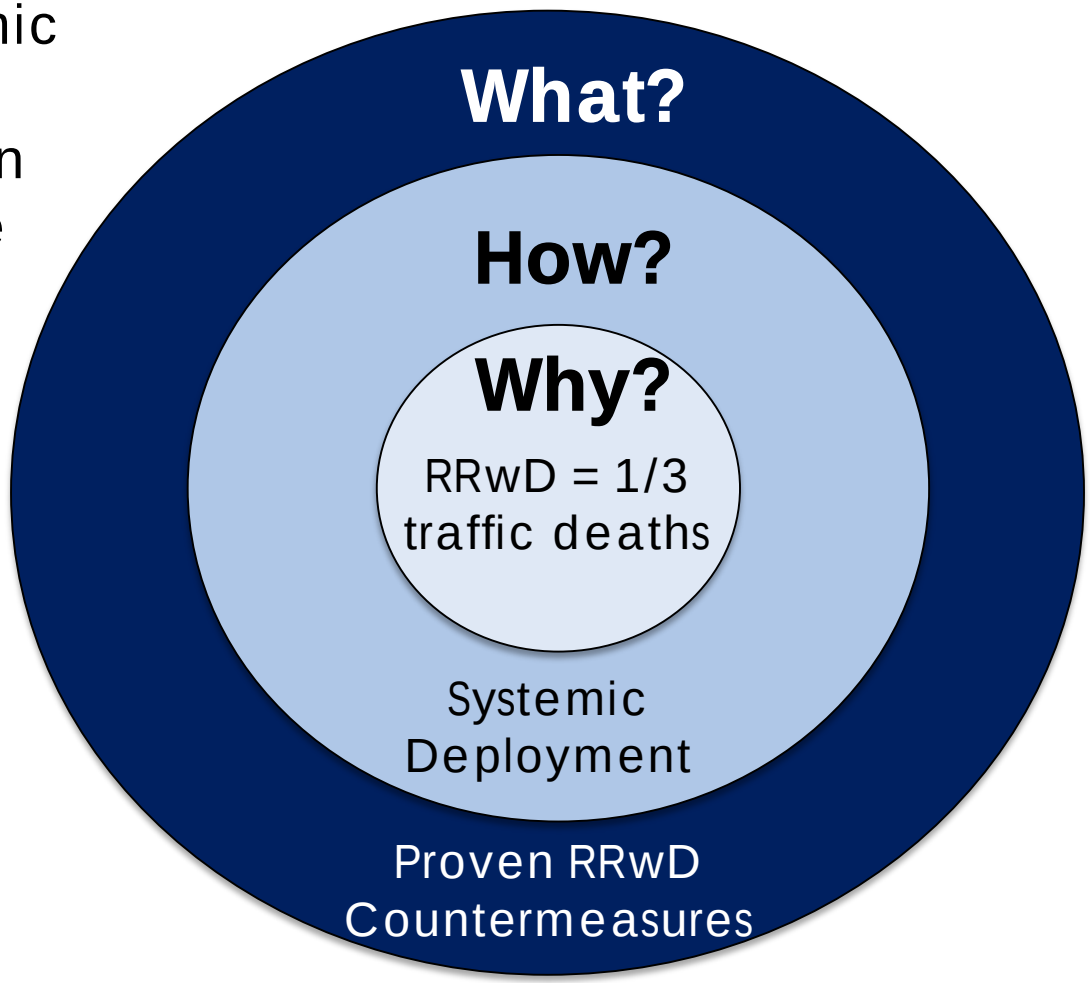
WHAT?

- Widespread, systemic deployment of underutilized proven roadway departure countermeasures



Roadway Departure Objectives

1st - Keep vehicles on the road

2nd - Reduce the potential for crashes

3rd - Minimize the severity

1st - Keep vehicles on the road

Improved curve delineation

Friction treatments in curves and other spot locations

Edge line, shoulder & center line rumble strips.

2nd - Reduce the potential for crashes

SafetyEdge℠

Maintained clear zones

Traversable roadside slopes

3rd - Minimize the severity

Breakaway Features

- Signs and luminaire supports
- Utility poles

Barriers to shield obstacles including:

- Trees and shrubbery
- Other fixed objects
- Slopes

EDC-5 Offerings and Products

Technical Assistance

- Local and Regional Safety Action Plans
- Systemic analysis
- Peer exchanges
- Focus groups on implementation

Training

- Webinars
- Existing, revised, and new training
- Train-the-trainer
- LTAP resource packet

Innovation Deployment News

EDC News Weekly Newsletter

Weekly newsletter

INNOVATOR
Accelerating Innovation for the American Driving Experience

Bi-monthly magazine

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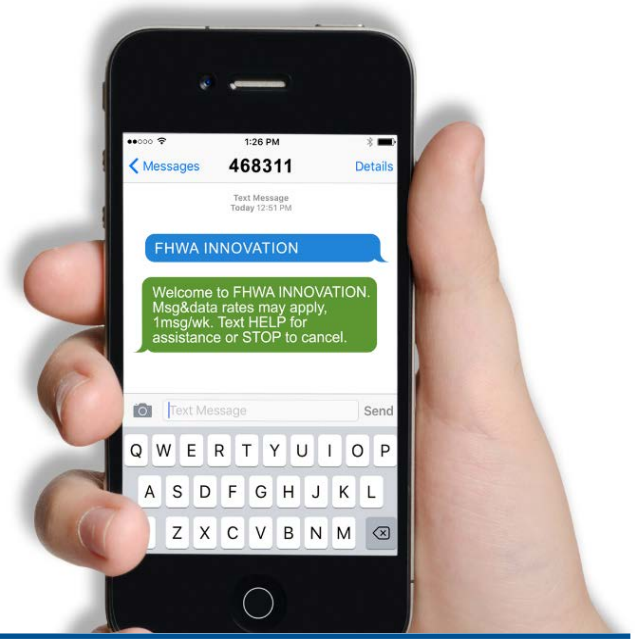

Interested in Participating in this Innovation?

Then contact...

- FHWA Division Office Safety Contact
- State DOT Safety Engineer
- LTAP Center

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Keep Vehicles on the Roadway

Rumble Strips and Stripes

Rumble Strip/Stripe Installations

- Primarily address crashes when roadway departure is a result of a **Distracted or Drowsy Driver**
- On roads with snow cover on the markings, they can help driver with **proper lane placement**

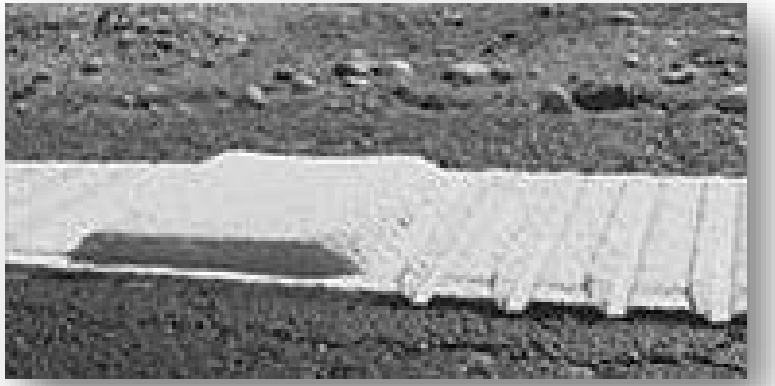
Rumble Locations

- Shoulder
- Edge Line (Rumble Stripe)
- Centerline

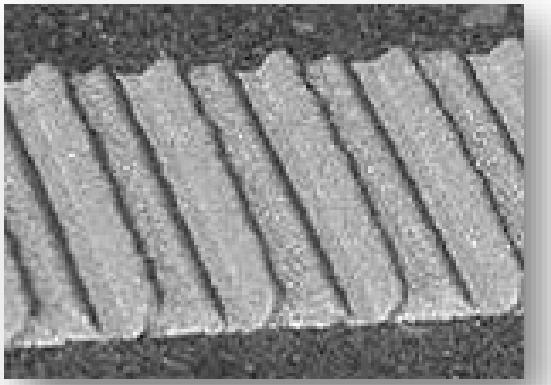
Types of Rumbles

- Past - Rolled
- Milled
- Raised

Profiled Pavement Markings



Raised



Inverted

- Made of thermoplastic
- Enhances visibility
- Creates rumble effect but total effects are undocumented
- May be high maintenance where plowing

FHWA Guidance

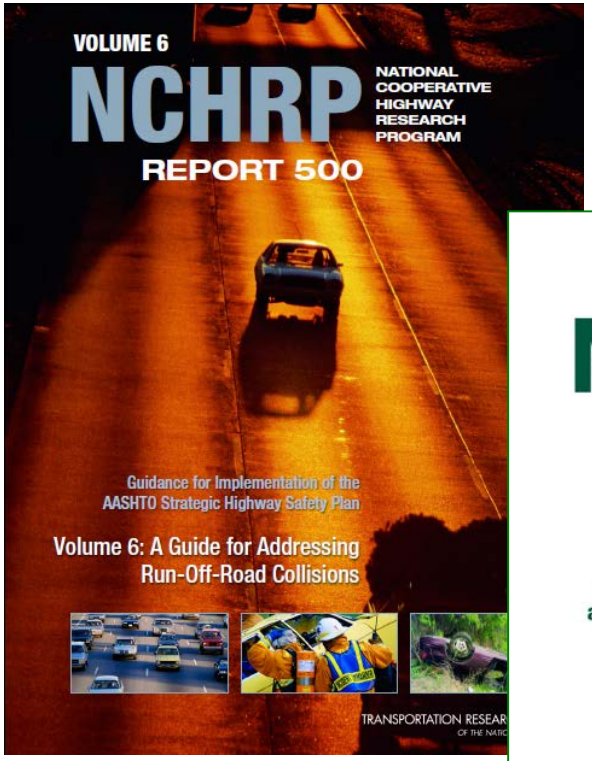
U.S. Department of Transportation
Federal Highway Administration

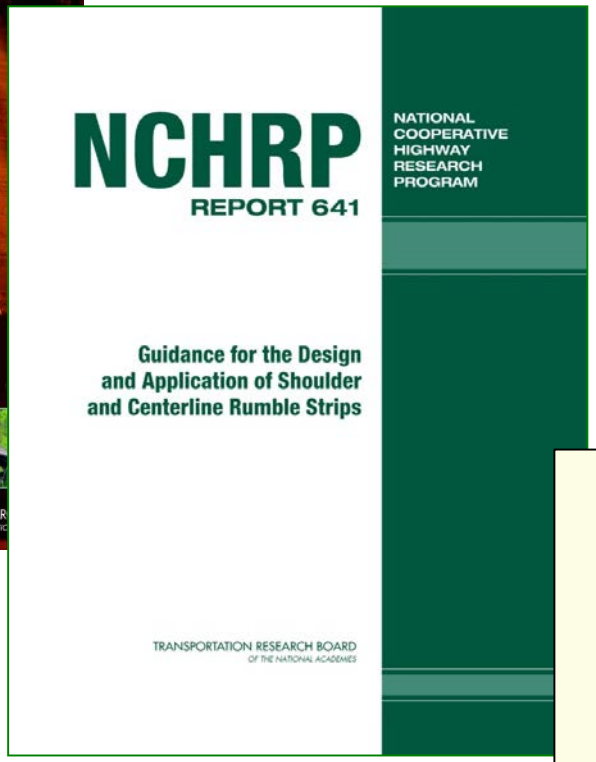
Technical Advisory
Shoulder and Edge Line Rumble Strips
T 5040.39, Revision 1
November 7, 2011

U.S. Department of Transportation
Federal Highway Administration

Technical Advisory
Centerline Rumble Strips
T 5040.40, Revision 1
November 7, 2011

Some Rumble Strip Resources





U.S. Department of Transportation
Federal Highway Administration

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http://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/

About Office of Safety Programs Initiatives Resources Contact

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FHWA Home / Safety / Roadway Departure / Rumble Strips and Stripes

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Rumble Strips and Rumble Stripes

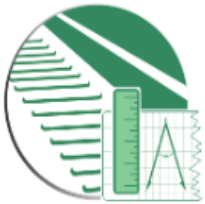
Proven Countermeasure

What's New: There is a Final Report that documents the entire project that resulted in the new Decision Support Guide, which can be used in conjunction with the existing implementation guides. The Minnesota Sinusoidal Rumble Strip Design Optimization Study and an NCHRP Synthesis have been added to the Research links.

General Information

Safety

Design and Construction



Accommodating All Users

Mitigating Noise

Pavement and Maintenance

Policies, Guidance, and Research

Frequently Asked Questions

Technical Advisories

Shoulder Rumble Strips
Crash Reduction Factors (CRFs)

- Rural freeways (NCHRP 641 & Griffith)
  - 11% reduction in SVROR crashes (SE = 6)
  - 16% reduction in SVROR FI crashes (SE = 8)

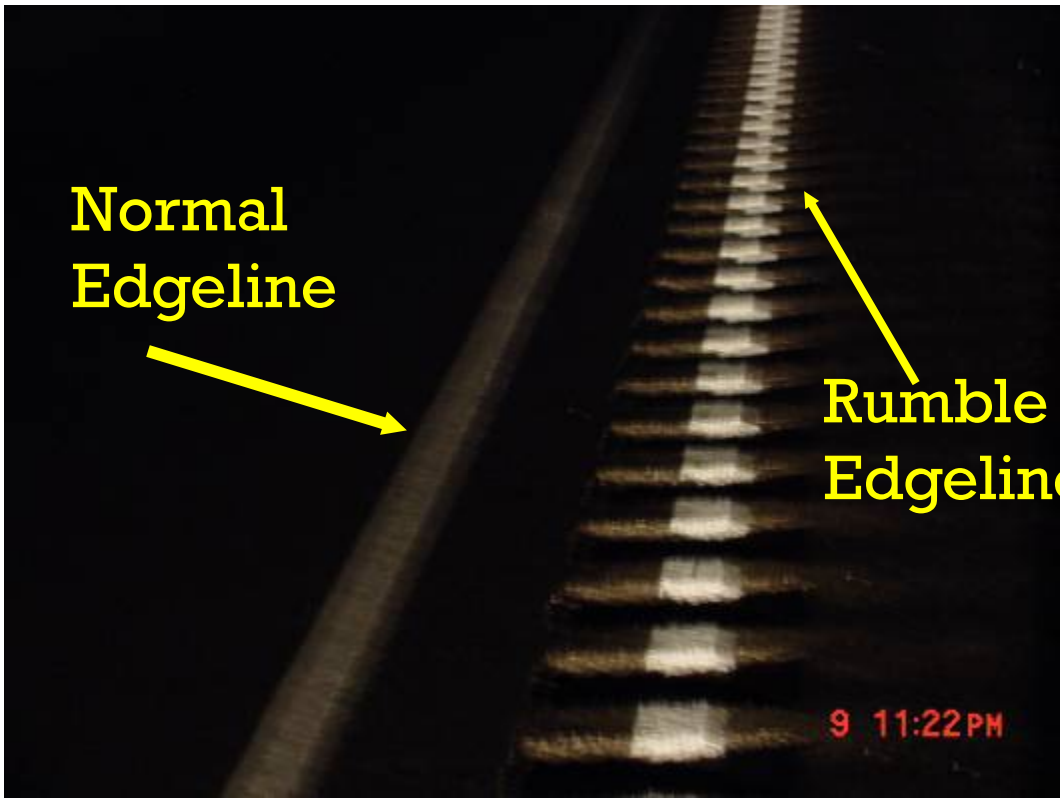
- Rural two-lane roads (NCHRP 641 & Patel, et al.)
  - 15% reduction in SVROR crashes (SE = 7)
  - 29% reduction in SVROR FI crashes (SE =9)

Source: NCHRP Report 641
(Includes data for rolled in and milled in shoulder rumbles)

Shoulder Rumble StripEs

Enhanced Visibility

Michigan initiative with edge line painted over shoulder rumble strip.



Comparison of painted edgeline in rain

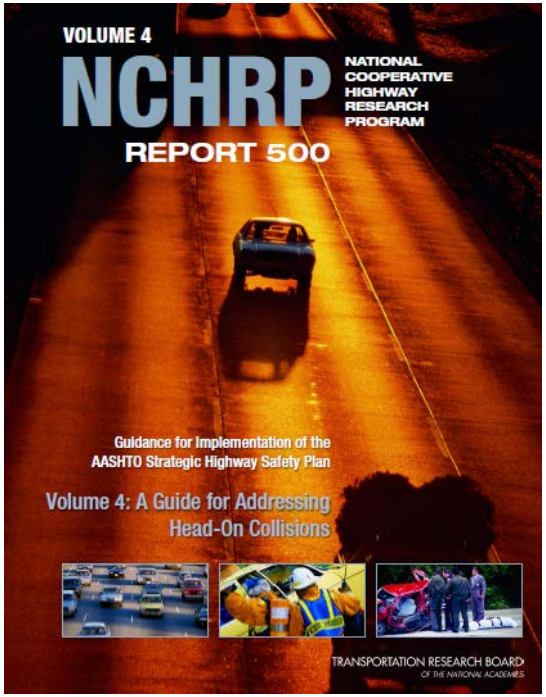
Shoulder Rumble StripEs (cont.)

Enhanced Durability

Michigan initiative with edge line painted over shoulder rumble strip.

Michigan I-75 - After 1st Winter

Centerline Rumble Strips



FHWA Technical Advisory 5040.40

Centerline Rumble Strips

Table 13-46. Potential Crash Effects of Installing Centerline Rumble Strips (14)

Treatment	Setting (Road Type)	Traffic Volume AADT	Crash Type (Severity)	CMF	Std. Error
Install centerline rumble strips	Rural (Two-lane)	5,000 to 22,000	All types (All severities)	**0.86**	**0.05**
			All types (Injury)	**0.85**	**0.08**
			Head-on and opposing-direction sideswipe (All severities)	**0.79**	**0.1**
			Head-on and opposing-direction sideswipe (Injury)	*0.75*	*0.2*
Base Condition: Absence of centerline rumble strips.					

NOTE: Based on centerline rumble strip installation in seven states: California, Colorado, Delaware, Maryland, Minnesota, Oregon, and Washington.
Bold text is used for the most reliable CMFs. These CMFs have a standard error of 0.1 or less.
Italic text is used for less reliable CMFs. These CMFs have standard errors between 0.2 to 0.3.

Centerline Rumble Strips Crash Reduction Factors (CRF's)

- Urban two-lane roads (NCHRP 641)
  - 40% reduction in TOT target crashes (SE = 17)
  - 64% reduction in FI target crashes (SE = 27)
- Rural two-lane roads (NCHRP 641 and Persaud et al. [2003])
  - 9% reduction in TOT crashes (SE = 2)
  - 12% reduction in FI crashes (SE = 3)
  - 30% reduction in TOT target crashes (SE = 5)
  - 44% reduction in FI target crashes (SE = 6)

Source: NCHRP Report 641

Placement of Centerline Rumble Strips

Centerline rumble strips
Milled across markings / joint

Centerline rumble strips on either side of pavement markings (least common)

Centerline rumble strips

Variable spacing

Combining Shoulder and Centerline Rumbles

Bicycle Friendly Shoulder Rumble Strip and Centerline Rumble Stripe
Washington

Combining Shoulder and Centerline Rumbles (cont.)

- "Safety Evaluation of Centerline Plus Shoulder Rumble Strips" (June 2015)
- Crash Modification Factor (CMF) Results
  - Total Crashes = 0.80
  - Total Injury Crashes = 0.771
  - Head-on & Sideswipe Opposite Direction Crashes = 0.70
- Results Suggest that Combinations further Reduce Run-Off-the-Road Crashes in Comparison to just Shoulder Rumbles

Directing Your Questions via the Chat Pod

1. Chat pod is on left side of screen between attendees pod & closed caption pod

3. Answers will appear here unless addressed verbally

2. Type your question or comment here

Keith Knapp, Iowa LTAP/InTrans/ Safety Center

National Center for Rural Road Safety

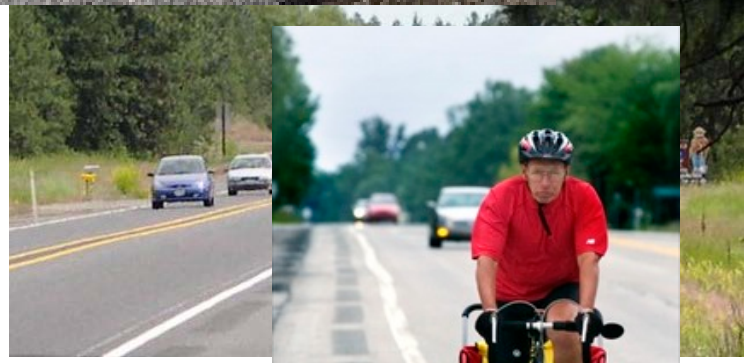
- Summarize the safety problem connected to rural roadway departures
- Describe approaches to reduce rural roadway departures
- Identify proven safety countermeasures to combat rural roadway departures
- List who to speak with in your state, to show your support for joining the EDC-5 innovation
- Describe the potential safety related benefits of rumble strips and stripes
- Identify some of the issues to consider before implementation

Rumble Implementation Issues

- Bicycle
- Motorcycle
- Pavement Thickness/Type /Condition
- Noise

Bicycle Issues

- Will a shoulder application restrict shoulder use?
  - Is there a minimum shoulder width?
  - Can rumbles be placed on edge line?

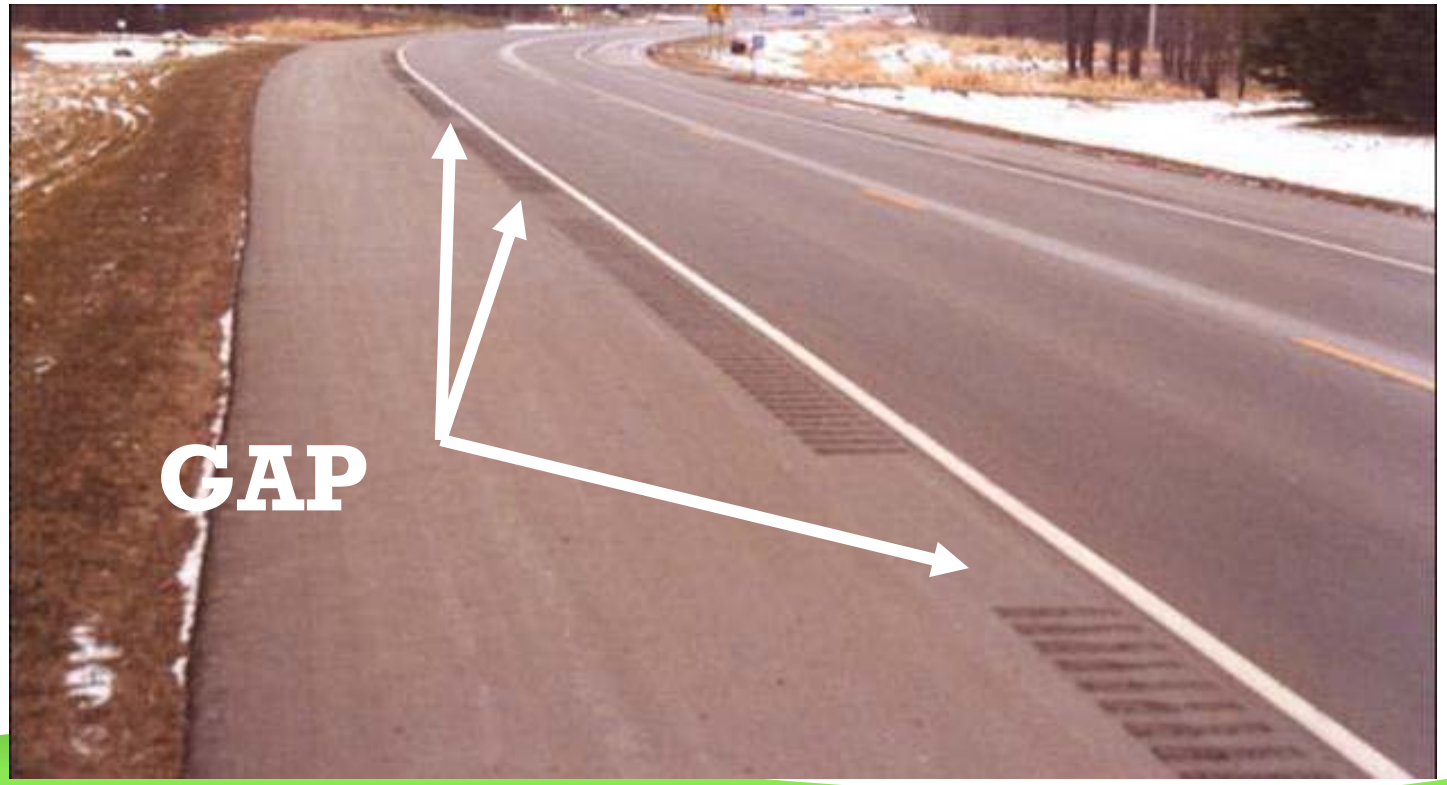


Implementation Fact Sheet and Guide - Bicycles

- Introduction & Basics
- Issues and Considerations
  - Rideable Space
  - Traversing Rumble Strips
  - Collaboration & Outreach
- Case by Case – Flexibility, but Tradeoffs

Design: Gaps, Offset, & Size

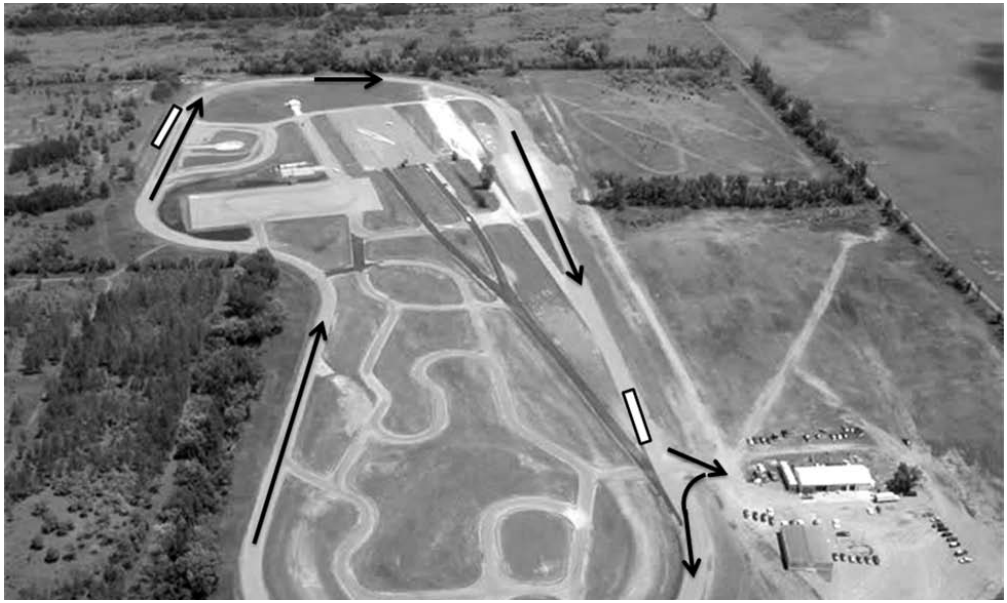
- Gaps to Move Between Lane & Shoulder
- Use of Edgeline Rumbles (i.e., Offset)
- Reduce Length (e.g., 16' to 12") and/or Depth (e.g., 5/8" to 3/8")



Centerline Rumble Strips & Motorcyclists

Minnesota DOT Study - "Effects of Centerline Rumble Strips on Motorcycles"

- Reviewed crash history of locations with CLRS
- Reviewed 44 hours of direct and video recordings of locations with CLRS
- Observed riders on a closed course with CLRS



http://www.lrrb.org/pdf/200807TS.pdf

Centerline Rumble Strips & Motorcyclists (cont.)

- Zero of 9845 motorcycle crash reports mentioned rumble strips as a factor
- 44 hours of observation showed
  - Small number of rumble strip crossings
  - No instances of directional changes or unusual riding behavior during crossing
  - Rumble strips did not seem to inhibit any passing opportunities
- Closed-course examination showed no steering, braking or throttle adjustments during strip crossing
  - Post-ride interviews confirmed these observations
  - No rider expressed difficulty or concern with crossing rumble strips.

Conclusion - no indication that centerline rumble strips pose a hazard to motorcyclists

Implementation Fact Sheet and Guide - Pavement

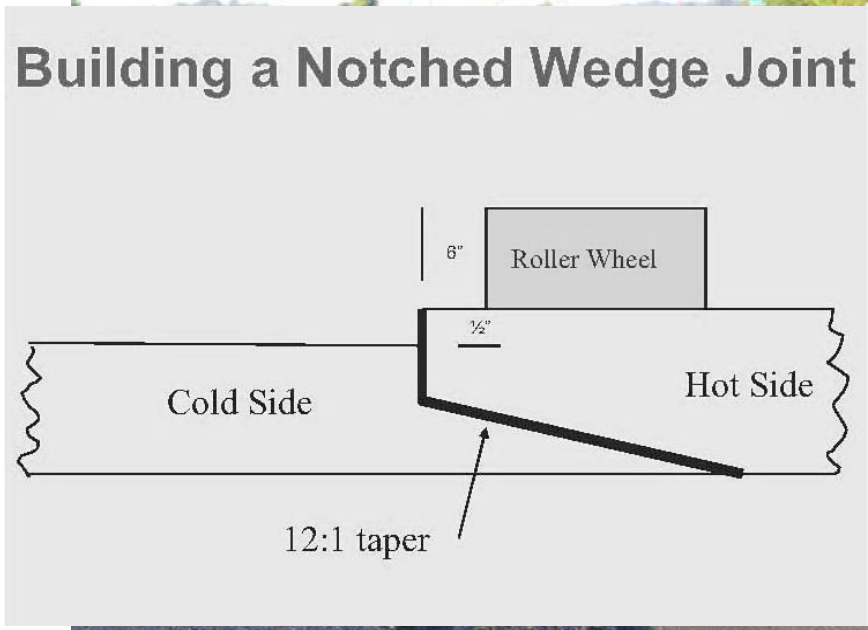
- Introduction and Basics
- Issues and Considerations
  - Pavement Characteristics: Age, Condition, Type, & Thickness
  - Longitudinal Joint Location
  - Rumble Types
  - Rumble Maintenance

Pavement Suitability & Rumbles

- Milled – New/Existing Asphalt and PCC
- Little/No Accelerated Deterioration for Pavement Condition Rating: Fair or Better
- Most States have Minimum Thickness Recommendations (See Guide Also)
- Typically - Overlay Thickness should Exceed Rumble Strip Depth
- Milling into Micro-Surfacing & Ultra-Thin Hot-Mix Asphalt has Occurred without Significant Delamination.
- To Reduce Chance of Delamination, Chip Seals should be Applied after Rumble Installation

Rumbles on Joints

- Concerns for Joint Deterioration with Rumbles
- Experience: Joint Condition Good to Fair Rating Results in no Accelerated Deterioration
- Techniques to Avoid Joint
  - Mill Two Smaller Rumbles on Each Side of the Centerline Joint
  - Offset the Shoulder Rumble Strip
  - Offset the Centerline Joint



Fog Seals

- Some States have Required Fog Seals when Milling into Older Pavements
- Many have Discontinued Use – No Documented Increased Pavement Life
- Fog Seals do not Mix Well with Thermoplastic Markings

Chip Seals and Rumbles

Implementation Fact Sheet and Guide - Noise

RUMBLE STRIP IMPLEMENTATION GUIDE:
ADDRESSING **NOISE** ISSUES ON TWO-LANE ROADS

Rumble Strip Implementation Fact Sheet
NOISE

- Introduction and Basics
- Measuring Rumble Strip Noise
- Issues and Considerations
  - Placement Variations – Curves, Intersections, & Passing Zones
  - Design Variations – Dimensions, Offset, and Alternative/Experimental Designs
- Outreach
- Alerting Noise Considerations for the Driver

Noise Basics

- Noise/Vibration are Used to Alert Drowsy or Distracted Drivers
- Sound Inside the Vehicle Increases with
  - Higher Speeds
  - Shallower Departure Angle
  - Decreased Spacing
  - Increased Depth, Width, and Length

Noise Basics (cont.)

- More Noise Better, but it Can be Disruptive to Nearby Residents/Businesses
- Rumbles Produce Sound of a Different Character (which we can't measure)
- Complaints Sometimes Received from Nearby Residents
- May want to Discontinue in Some Corridors/Areas (e.g., More Suburban than Rural, Driveway Density Increases, and Certain Curve Radii)(See Guide)

Curves and Intersections

- Attention to Placement Detail is Important
- Horizontal Curves
  - Consider Widening Pavement or Using "Spiral Transition" Design
  - Centerline Rumbles – Restripe to Increase Travel Lane Width (or widen "median)
  - Edgeline or Shoulder Rumbles – Greater Offset
- Intersections/Major Driveways: Typically Discontinued

Design and Flexibility

- Most Used: Change Offset of Shoulder Rumble Stripe (but, May have Bicycle Impacts)
- Adjust Rumble Strip Depth (3/8 inch Sometimes Used)
- Adjust Spacing (Experimental)
- Sinusoidal-Shape (i.e., Mumble Strips): New Design Being Studied (see Next Slide)

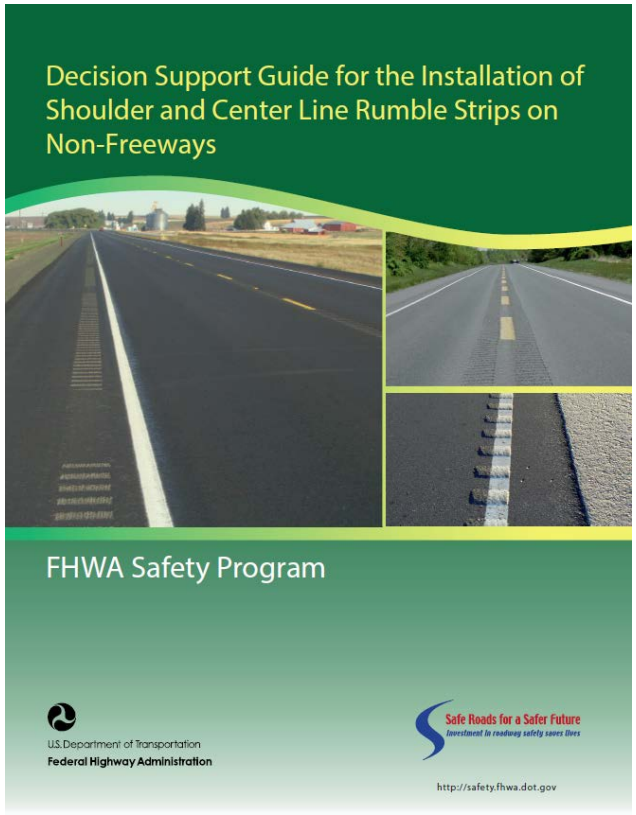
Mumble Strips

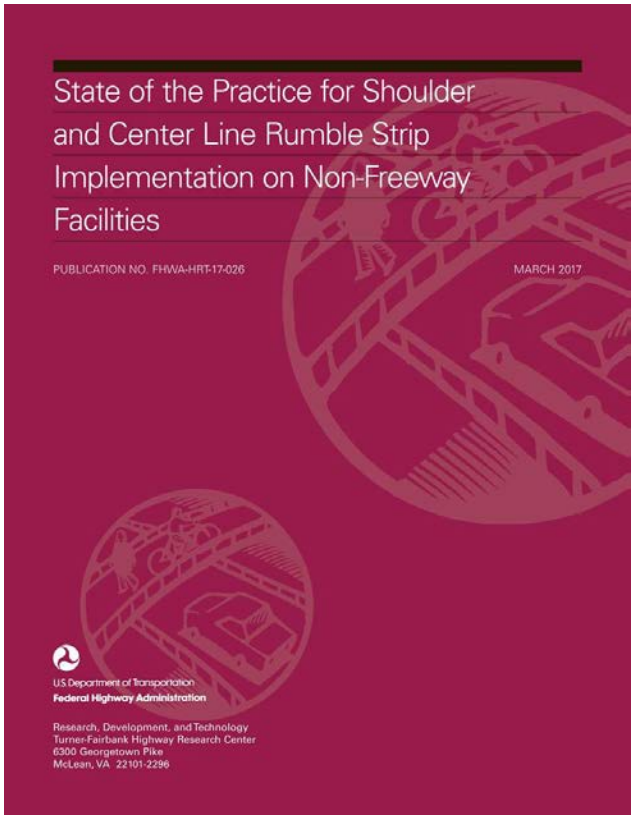
- New Idea
- CA and MN Evaluating/Evaluated
- Preliminary Results show Reduction in External Noise (See Guide)
- Safety Benefits have not yet been Determined

Caltrans, Caltrans 2014 Excellence in Transportation Award Winners, Transportation Innovations Category, "Mumble Strip Installation and Evaluation."

MnDOT

Decision Support Guide for Installation (2016) & State of the Practice (2017)





https://www.fhwa.dot.gov/publications/research/safety/17026/17026.pdf
https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/fhwasa16115/fhwasa16115.pdf

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Learning Outcomes

In this webinar, you have learned to:

- Summarize the safety problem connected to rural roadway departures
- Describe approaches to reduce rural roadway departures
- Identify proven safety countermeasures to combat rural roadway departures
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SC Upcoming 2018 Webinars

- Rural Aging Road User

  Oct. 23rd, 11:00 AM – 12:30 PM Mountain

Archived Webinars

Access the webinar archives

SC Upcoming RwD Webinars

- Rural Roadway Departure Countermeasures–Part 2
  - Roadway Curve Marking/Signing
  - High Friction Surface Treatments

    Tues. Nov. 13 11:00AM-12:30 PM MST/1:00-2:30 PM Eastern
- Rural Roadway Departure Countermeasures–Part 3
  - Clear Zone Treatments
  - Roadside Hardware

    Thurs. Dec. 20 11:00AM-12:30 PM MST/1:00-2:30 PM Eastern

December 4-6, 2018 Savannah, GA

www.ruralsafetycenter.org/news-events/bridging-the-gap-summit/

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The Voice of County Road Officials

National Center for Rural Road Safety

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