Focus on Reducing Rural Roadway Departures
Systemic Approach: Prioritizing Locations and Projects

Every Day Counts Round 5
Webinar – July 14, 2020
The Rural RwD Component of Fatalities

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

U.S. Traffic Fatalities
35,230

Source: NHTSA FARS (2014 – 2016 Annual Average)

Source: Oregon State Police
30 people will die today from rural roadway departure crashes.

Let’s save the people behind the numbers.
FoRRRwD Overview

• **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.
New Website

https://safety.fhwa.dot.gov/FoRRRwD/

- Pages for each of the 4 Pillars
- Additional Resources
  - Promotional Materials
  - Videos
  - Webinar Recordings
  - Articles
Systemic Approach

- Roadway Departure crashes are a primary crash type every year.
- However, the locations change.
- The Systemic Approach identifies improvement locations based on risk factors rather than crash frequency.
You don’t have to wait until a crash occurs to make improvements!

Follow-Up
Track and evaluate safety improvements. Further remediation can be implemented as needed.

Systemic Safety Steps

Step 1: Identify Focus Crash Types and Risk Factors

Step 2: Screen and Prioritize Candidate Locations

Step 3: Select Countermeasures

Step 4: Prioritize Projects

http://safety.fhwa.dot.gov/systemic
Poll Question

Which of the following is a method that you have used to prioritize systemic improvements? Select all that apply.

A. Systemic (Proactive) Projects are prioritized separately from Hot Spot (Reactive) Projects
B. All locations that are identified with risk factors are analyzed together and a B/C ratio is determined for the entire project
C. Using a B/C of improvements at other locations where the countermeasure was applied.
D. Distribute set amount of funding to jurisdictions based of %KA crashes
E. You can’t calculate benefit/cost ratios for sites that don’t have crashes
F. Other (please elaborate in the chat pod)
FoRRRwD Webinar Series

All Public Roads

• April 16, 2020 - Development of Projects and Using Data
• May 12, 2020 - Innovative Mechanisms to Deliver Safety Projects

Systemic Approach

• June 16, 2020 - Risk Factors for RwD
• July 14, 2020 - Prioritizing Locations/Projects

Countermeasures

• August 11, 2020 – HFST and Continuous Friction Measurement
• September 15, 2020 – Signing, Striping and Maintenance Treatments
• October 20, 2020 – Rumble Strips, SafetyEdgeSM, and Gravel Road Treatments (Tentatively)

Safety Action Plans

• November 2020 – State and Local Safety Plans
Today’s Presenters

You don’t have to wait until a crash occurs to make improvements!

- California Local Highway Safety Improvement Program (HSIP) and Local Roadway Safety Plan (LRSP)
  - Robert Peterson, CalTrans

- Prioritizing Locations and Projects: Oregon’s All Roads Transportation Safety Program (ARTS)
  - Christina McDaniel-Wilson, Oregon DOT

- Maine DOT’s Systemic Approach to Reducing Lane Departure Crashes
  - Ed Hanscom, Maine DOT
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- November 2020 – State and Local Safety Plans
Contact

Dick Albin
FHWA Resource Center
Dick.Albin@dot.gov

Cate Satterfield
FHWA Office of Safety
Cathy.Satterfield@dot.gov
California Local Highway Safety Improvement Program (HSIP) and Local Roadway Safety Plan (LRSP)

For FHWA FoRRRwD Webinar
July 14, 2020

By Robert Peterson

Chief, Office of Federal Programs (OFP)
Caltrans Division of Local Assistance
Outline:

• California Local HSIP Program;
• Systemic Approach;
• Systemic Safety Analysis Report Program (SSARP); and
• Transition to Local Roadway Safety Plan (LRSP).
Local HSIP

- Eligible projects on **all public roads**, including non-State-owned public roads and roads on tribal land
- Over 600+ local agencies are responsible to operate, maintain and upgrade their roads
- Caltrans has no involvement on which safety projects are selected
- However, Caltrans is responsible:
  - For providing guidance and oversight, etc
  - Administering the program
  - Assist local agencies in delivering their projects
  - Holding Local HSIP Advisory Committee meetings
Local HSIP

- HSIP projects:
  - must be based on elements of the Strategic Highway Safety Plan (SHSP);
  - Are identified through a data-driven process;
  - Target identified safety issue;
  - Promote low cost countermeasures (many CMs are 100% HSIP – 23 USC Section 120)
  - Promote systemic approach
## California HSIP Funding for Local Jurisdictions

Local HSIP apportionments: approx. $81 million per year (2016-2020 average)

<table>
<thead>
<tr>
<th>National</th>
<th>California</th>
<th>California Local HSIP</th>
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<tbody>
<tr>
<td>$2.317 billion/year</td>
<td>$204 million/year</td>
<td>$81 million/year</td>
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California Local HSIP Calls-for-Projects

Cycles 4 to 9:
$894 million awarded to 1,258 projects. 459 completed/372 in construction.

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Release Date</th>
<th>Number of Applications</th>
<th>Number of projects selected</th>
<th>Federal funds approved ($M)</th>
<th>Average BCR of selected projects</th>
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<tr>
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<td>2/23/11</td>
<td>357</td>
<td>179</td>
<td>$74.5</td>
<td>7.9</td>
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<td>5</td>
<td>10/19/12</td>
<td>276</td>
<td>221</td>
<td>$111.3</td>
<td>14.6</td>
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<td>6</td>
<td>11/14/13</td>
<td>389</td>
<td>231</td>
<td>$150.0</td>
<td>10.7</td>
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<tr>
<td>7</td>
<td>11/12/15</td>
<td>212</td>
<td>182</td>
<td>$160.5</td>
<td>16.9</td>
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<tr>
<td>8</td>
<td>11/21/16</td>
<td>247</td>
<td>225</td>
<td>$216.9</td>
<td>10.3</td>
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<tr>
<td>9</td>
<td>12/12/18</td>
<td>351</td>
<td>220</td>
<td>$180.8</td>
<td>17.7</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1,832</strong></td>
<td><strong>1,258</strong></td>
<td><strong>$894.0</strong></td>
<td><strong>13.4</strong></td>
</tr>
</tbody>
</table>

Cycle 10 Call-for-projects is ongoing:
California Local HSIP -LRSP Requirement

• **Cycle 10 (current):**
  - The majority of projects (80% of funding) will be selected based on Benefit-Cost-Ratio (BCR);
  - 20% of funding is reserved for set-asides (Guardrail Upgrades; Pedestrian Crossing Enhancements; Installing Edgelines; and Tribes). No BCR is needed for set-asides.
  - Local Roadway Safety Plan (LRSP) or equivalent is not yet required for agencies to be eligible to apply but is recommended for this cycle.
  - Having a LRSP may be a tie break in the selection of set-aside applications.

• **From Cycle 11 (Year 2022):**
  - Applicants must have completed their LRSPs in order to apply for HSIP funding.
Encourage “Systemic Approach” Projects

- Competitive program – not all projects are selected
- Highest B/C projects are selected
- Encourage local agencies to consider systemic low cost CMs as they compete very well in the selection process
- Utilize - 23 USC Section 120 which allows 100% of HSIP with no local match – of the 82 CMs – 45 are eligible
- Allow corridor approach for roadway departure crash types
Encourage “Systemic Approach” Projects

- Multiple applications can be submitted for the same project if “systemic approach” is employed (new for this cycle)

- Locations with similar characteristics and safety risks but not experiencing many crashes can be included in the same project with other locations with crash histories;
  - However, this may lower the BCR and the project risks not being funded. The funded BCR cutoff is unknown at the time of application submittal;
  - Allowing multiple applications (each with a different number of locations) for systemic approach project helps solve this dilemma.
Example: Successful HSIP Application with Systemic Approach

**HSIP Cycle 9, Inyo County**

**Project Locations:**

- Selection criteria:
  High speed; rural roads; with little or no pavement markings.
- 35 roadway sections through the county (250 miles);
- Experienced 4 fatal crashes and 55 injury crashes (from 2013 to 2017);
- 18 of the 35 roadway segments had no crashes.
Example: Successful HSIP Application with Systemic Approach

**HSIP Cycle 9, Inyo County**

Proposed safety improvements:
- Install center lines with reflective markers;
- Install edge lines.

**Total Project Cost:** $461,600

**Total Benefit:** $21.1 million

**BCR = 45.7**
HSIP Analyzer

Version Date: April 2020

HSIP ANALYZER
Cost Estimate, Crash Data and Benefit Cost Ratio (BCR) Calculation for Highway Safety Improvement Program (HSIP) Application

Important: Review and follow the step-by-step instructions in the HSIP Analyzer manual. Completing the HSIP Analyzer without referring to the manual may result in an application with fatal errors that will be disqualified from the soliciting and selection process. All yellow highlighted fields must be filled in. The gray fields are calculated and read-only. The HSIP Analyzer is a dynamic form (i.e., later steps vary depending on the data entered in earlier steps). If any error messages in red appear, fix the errors prior to proceeding to the next steps.

1. Application ID, Project Location and Project Description (copy from the HSIP Application Form):
   - Application ID:
   - Project Locations:
     - (limited to 250 characters)
   - Project Description:
     - (limited to 250 characters)

2. Application Category (BCR or Set-asides):
   - Benefit Cost Ratio (BCR)

A safety benefit cost analysis is required for this application. This tool will guide through cost estimate, safety benefit evaluation and Benefit Cost Ratio (BCR) calculation.

- Type of project location:
- Number of Intersections/Mile:
- Number of countermeasures for the project:

Any error messages below must be cleared before proceeding to the next page. Please enter project location type, number of intersections/mile, and number of countermeasures.
HSIP Analyzer

- A PDF form based software that streamlines the project cost estimate, safety improvement countermeasure evaluation, crash data input and Benefit Cost Ratio (BCR) calculation. It simplifies the application work by integrating multiple documents.

- HSIP Analyzer is required to use for all local HSIP applications.
Systemic Safety Analysis Report Program (SSARP)

• Funding (2016 & 2017): $17.7 million. Awarded to 20 Counties, 82 Cities and 5 joint agencies.

• Intent:
  Assist local agencies in performing a collision analysis, identifying safety issues on their roadway networks, and developing a list of systemic low-cost countermeasures that can be used to prepare future HSIP and other safety program applications.

• Max $250k per agency; $500k for joint partnership covering multiple jurisdictions

• Must complete the report within 3 years
**Local Roadway Safety Plan (LRSP) Program**

**Why LRSP (from SSARP)?**

<table>
<thead>
<tr>
<th></th>
<th>SSAR</th>
<th>LRSP</th>
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</thead>
<tbody>
<tr>
<td>Goal: reduce traffic fatality and severe injuries</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Data driven approach</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Involve a wide range of stakeholders</td>
<td>Probably not</td>
<td>Yes</td>
</tr>
<tr>
<td>Cover 4 E’s (engineering, enforcement, education, and emergency response)</td>
<td>Engineering only</td>
<td>Yes</td>
</tr>
<tr>
<td>City Council/Board of Supervisors’ approval</td>
<td>Not required</td>
<td>Yes</td>
</tr>
<tr>
<td>Regular update required</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Local Roadway Safety Plan (LRSP) Program

- Funding available in 2019/20: $10 million
- $10 awarded to 21 Counties and 133 Cities in Jan. 2020
  - Max $72,000 per agency;
  - Must complete the LRSP without 3 years;
  - Awarded to agencies without the previous SSARP funding first.
- There was a big demand. Many agencies are still interested.
  - Encourage local agencies to expand their uncompleted SSAR to be LRSP
  - An addition of $8 million just got approved for 2020/21.
California HSIP Website and Contact

Local HSIP Website:

or search: “CA Local HSIP”

Contact: email: robert.peterson@dot.ca.gov
(916) 653-4333
Questions?

Thank you ...
Prioritizing Locations and Projects: Oregon’s All Roads Transportation Safety Program (ARTS)

Focus on Reducing Rural Roadway Departures (FoRRRwD)

Christina McDaniel-Wilson, P.E.- State Traffic Safety Engineer

July 14th, 2020
Overview

• Systemic Approach
  • Identifying locations
• ARTS program
  • Prioritizing safety projects
Systemic Safety Plan

• Developed in 2010 & Updated in 2017
• Statewide analysis of roadway departure crashes
• Identifies countermeasures, deployment levels, and funds needed to achieve a substantial annual reduction in RwD fatalities and serious crashes

Systemic Safety Plan

• Curve signing and marking
• Center line rumble strips
• Edge rumble strips
• Delineation
• High friction surface treatments
• Tree management
• Shoulder Widening

### Table 14: Delineation: State: Rural

<table>
<thead>
<tr>
<th>Threshold Crash Level (8 Years)</th>
<th>Number of Sections</th>
<th>Estimated Number of Crashes in 6 Years (2009-2014)</th>
<th>Construction Costs (Million)</th>
<th>Annual Targeted Crash Reduction</th>
<th>Annual Estimated Fatality Reduction</th>
<th>Annual Estimated Serious Injury Reduction</th>
<th>Cost/Life Saved (Million)</th>
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<tr>
<td>5</td>
<td>205</td>
<td>1,346</td>
<td>164</td>
<td>$1.23</td>
<td>46.66</td>
<td>1.20</td>
<td>2.53</td>
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</tbody>
</table>

**Notes:**
1. Assume 90% of identified segments can be improved.
2. Assume average cost of $7,500 per 0.5-mile segment.
3. Assume CMF of 0.74.

**Non-ODOT Route Implementation**

There are single vehicle dark RWD crashes on non-State roads in Oregon, which are important in addressing local safety needs. Table 15 provides recommended deployment levels and benefits for installing enhanced delineation on non-State road segments.

### Table 15: Delineation: Non-State: Rural

<table>
<thead>
<tr>
<th>Threshold Crash Level (8 Years)</th>
<th>Number of Sections</th>
<th>Estimated Number of Crashes in 6 Years (2009-2014)</th>
<th>Construction Costs (Million)</th>
<th>Annual Targeted Crash Reduction</th>
<th>Annual Estimated Fatality Reduction</th>
<th>Annual Estimated Serious Injury Reduction</th>
<th>Cost/Life Saved (Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>46</td>
<td>460</td>
<td>37</td>
<td>$0.55</td>
<td>15.60</td>
<td>0.45</td>
<td>1.27</td>
</tr>
</tbody>
</table>

**Notes:**
1. Assume 90% of identified areas can be improved.
2. Assume average cost of $15,000 per 1-minute area.
3. Assume CMF of 0.74.
Systemic Safety Plan

• Delineation

Safety Priority Index System (SPIS)

- Annual network screening method to identify potential safety problems

- Typically, sites with the highest ranking (top 5% & 10%) are investigated
SPIS Tool

A 0.10 mile roadway segment becomes a SPIS site if that location has three or more injury crashes or one or more fatal or severe injury crashes over a three year period:

- Crash frequency indicator (25% of SPIS score)
- Crash rate indicator (25% of SPIS score)
- Crash severity Indicator (50% of SPIS score)
- 2017 SPIS evaluates 2014-2016 crash data

Score = \[ N_{freq} = \frac{\text{LOG}(\text{TotalCrashes} + 1)}{\text{LOG}(150 + 1)} \] (25) + \[ N_{rate} = \frac{\text{LOG} \left( \frac{\text{TotalCrashes} \times 1,000,000}{(3\text{yr} \times 365\text{days} \times 4\text{DT}) + 1} \right)}{\text{LOG}(7 + 1)} \] (25) + \[ N_{severity} = \frac{100(\text{FATAL} + \text{INJ} A) + 10(\text{INJ} B + \text{INJ} C)}{300} \] (50)
The Oregon Adjustable Safety Index System (OASIS) was developed as an online safety analysis tool that is capable of performing "SPIS like" safety analysis.

Custom Safety Analysis:
• Specific types of crashes
• Vary parameters such as jurisdiction, segment length, number of crash data years and
• Vary the SPIS formula default weights.

OASIS Tool: [https://zigzag.odot.state.or.us/oasisapp/OasisTool.aspx](https://zigzag.odot.state.or.us/oasisapp/OasisTool.aspx)
OASIS

OASIS Tool: https://zigzag.odot.state.or.us/oasspp/OasisTool.aspx
The goal of the All Roads Transportation Safety (ARTS) program is to reduce the frequency of fatal and serious injuries on all public roads through a data-driven process that is blind to jurisdictional ownership.
ARTS Funding: Targets

- ARTS
  - Hot Spot (50%)
  - Systemic (50%)
    - Roadway Departure (50%)
    - Intersection (35%)
    - Bike/Ped (15%)

Numbers in ( ) represent approximate funding split (Statewide and Region)
ARTS Process

1. Select Locations for Treatments
2. Estimate Project Costs
3. Complete and Submit Application
4. Analyze Crash Data
   - Hot Spots
   - Systemic Corridors
5. Identify Countermeasures
6. Estimate Safety Benefit
   - Benefit-Cost Ratio
   - Cost Effectiveness Index
7. ODOT Develops 300% and 150% Lists
ARTS Application

ALL ROADS TRANSPORTATION SAFETY (ARTS) APPLICATION

Contact Information
PROJECT ENGINEER NAME AND TITLE
PROJECT ENGINEER PHONE
PROJECT ENGINEER EMAIL
PROJECT SPONSOR NAME AND TITLE
PROJECT SPONSOR PHONE
PROJECT SPONSOR EMAIL

Project Information
Is project on a state highway? ☐ Yes ☐ No
STREET NAME
HIGHWAY NAME
INTERSECTING

Scope Description
Be specific and include all intended work, not limited to count

Overlapping scope or location with another project application

Other Stakeholders/Coordination
Examples: Local city, local county, ODOT, school district, ... 

Attachments
Check all the attachments included in this application. Attach documents in the field below.

Required Attachments
☐ Cost Estimate
☐ Benefit/Cost or Cost-Effectiveness Index Worksheet(s)
☐ Aerial Vicinity Map/Location Map
☐ Crash Data
☐ Traffic Analysis*

Recommended Attachments
☐ Field Scope Verification**
☐ Conceptual Layout or Project Concept Drawing
☐ Collision Diagram(s)
☐ Additional background information***

* Traffic analysis is required only for applications including traffic control devices such as PHBs, signals, or roundabouts or any application on a state facility requiring the approval of the State Traffic Roadway Engineer, such as those included in the Traffic Manual. For applications requiring approval, the analysis shall be completed as specified in the Traffic Manual.

** Pictures, field observations, user behavior

*** Previous scoping documents such as planning studies, right of way certification, or signal structural sign off
## ARTS Application: Countermeasures

<table>
<thead>
<tr>
<th>Manager or Sponsor</th>
<th>Application Type</th>
<th>Proposed Countermeasure Number</th>
<th>Countermeasure</th>
<th>Crash Type</th>
<th>Injury, PDO or All</th>
<th>Service Life (Years)</th>
<th>Existing Intersection Traffic Count</th>
<th>Urban or Rural</th>
<th>CISN</th>
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</thead>
<tbody>
<tr>
<td>Pedestrian Safety</td>
<td>Prohibit Pedestrian Access</td>
<td>FPD1</td>
<td>Increase Distance to Rural Road Obstacle from 3 ft (1 m) to 8 ft (2.4 m)</td>
<td>All</td>
<td>All</td>
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<td>None</td>
<td>Pedestrian</td>
<td>Rural</td>
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<td>Pedestrian Safety</td>
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<td>Increase Distance to Rural Road Obstacle from I-5 (18 ft (5.5 m))</td>
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<td>20</td>
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<td>Pedestrian</td>
<td>Rural</td>
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<td>Rural</td>
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<tr>
<td>Pedestrian Safety</td>
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<td>FPD4</td>
<td>Increase Pedestrian Visibility by installing High Reflective Surface Treatment reflector in urban segment application</td>
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<td>Urban or Rural</td>
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<td>FPD8</td>
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<td>Pedestrian Safety System</td>
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<td>Pedestrian</td>
<td>Rural</td>
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</table>
ARTS Application: Benefit Cost Worksheet
ARTS Application: Systemic Example

Roadway Departure Application
- Region 5, District 13 & 14
  - Centerline Rumbles
  - Various Highways and sections
ARTS Application: Systemic Example

- Evaluate a single or multiple locations along a highway(s) and use crash reductions for each location or all of them as a group.
## ARTS Application: Prioritize Projects

### Systemic - Roadway Departure

<table>
<thead>
<tr>
<th>Region</th>
<th>App #</th>
<th>Description</th>
<th>Agency</th>
<th>County</th>
<th>Agency Contact Name</th>
<th>Agency Contact E-Mail</th>
<th>Project Cost</th>
<th>B/C Ratio</th>
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<th>Accumulative Cost</th>
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<td>US199 Clear Zone</td>
<td>ODOT</td>
<td>Josephine</td>
<td>Dan Dorrell</td>
<td><a href="mailto:dan.w.dorrell@odot.state.or.us">dan.w.dorrell@odot.state.or.us</a></td>
<td>$435,885.00</td>
<td>49.05</td>
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<td>4 5</td>
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<td>ODOT</td>
<td>Various</td>
<td>Aaron Brooks</td>
<td><a href="mailto:aaron.e.brooks@odot.state.or.us">aaron.e.brooks@odot.state.or.us</a></td>
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<td>Coos</td>
<td>Shon Heen/Lance Hunter</td>
<td><a href="mailto:shon.heen@deakin.com">shon.heen@deakin.com</a>, lance.hunt@deakin</td>
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<td>Jackson</td>
<td>Mike Kuntz</td>
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<td>Tiller Trail Hwy</td>
<td>Douglas County</td>
<td>Douglas</td>
<td>Joshua Heacock</td>
<td><a href="mailto:jheacock@co.douglas.or.us">jheacock@co.douglas.or.us</a></td>
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### Budgets

- **Region 3 Budget**: $3,374,742.00
- **150% Budget**: $5,062,115.00
- **500% Budget**: $10,124,328.00
ARTS Webpage

All Roads Transportation Safety

The All Roads Transportation Safety Program is designed to address safety needs on all public roads in Oregon. By collaborating with local road jurisdictions, the Oregon Department of Transportation expects to:

- Increase awareness of safety on all roads.
- Promote best practices for infrastructure safety.
- Complement behavioral safety efforts.
- Focus limited resources to reduce fatal and serious injury crashes in rural areas of Oregon.

This program will be data-driven to achieve the greatest benefits in crash reduction and should be used to improve:

- Key Facts about the ARTS Program
- Frequently Asked Questions about the ARTS Program
- 2019 ARTS Program Summary Report

Memorandum of Understanding
Oregon's Plan
Crash Reduction Factors
Hotspot Approach
Systemic Approach
Analysis Tools and Forms
Resources

Crash Reduction Factors

A crash reduction factor provides an estimate of the percent decrease in crashes for a given countermeasure. ODOT provides a list of CRFs allowing all projects to be evaluated consistently and fairly through the project development process. The CRF list and supplement are listed below. Also listed is a form for submitting proposed CRFs not included in the list:

- Crash Reduction Factor List
- Crash Reduction Factor Supplemental List
- Crash Reduction Factor Appendix
- Project in New CRF

Hotspot Approach

The traditional approach to safety is to identify ‘hotspot’ locations where a high concentration of crashes occur, and then identify and implement countermeasures to reduce the number of crashes occurring at those locations.

ODOT typically uses the Safety Performance Index (SPI) to identify potential hotspots. The SPI is a ranking that compares the number of crashes on the state highway system (SHTS) to a baseline but that takes into account the number of miles of roadway in the core roadway network across Oregon, including city streets, county roads, and state highways.

A generative hotspots project – one highway hotspots and off-highway hotspots – utilizes public roadway segments with a calculated SPI (score) to locate crash-ridden segments that the highest risk of fatal or serious crashes.

Systemic Approach

The systemic approach identifies a few proven countermeasures to prevent crashes at all locations. These countermeasures are often powerful enough to reduce the occurrence of crashes at multiple locations simultaneously.

The process for systemic projects is outlined in the Virginia Tech Transportation Institute’s implementation plan with additional guidance for systemic project planning.

ODOT recommends systemic projects for safety projects in three focus areas:

- Innovative Transportation Implementation Plan
- Prevention and Safety Implementation Plan
- Protection and Bypass Program

Projects are prioritized based on benefit cost ratio for existing, potential, and intersection projects, and cost-effectiveness for planned and ongoing projects.

Analysis Tools and Forms

1. Benefits Cost Analysis Form:
   - Used in the application of cost-sharing programs and performance measures.
   - Benefits-cost analysis is conducted on ARTS projects.
   - This form is used for both federal and state project types.

2. ODOT Report Form:
   - Used for submitting project information.

3. Crash Count Form:
   - Used for recording crash data.

4. Crash Calendar:
   - Used for submitting crashes for all focus areas of systemic projects.

Use the following links to access crash maps and associated crash analysis tools:

- ODOT Crash Report
- ODOT Crash Calendar
- Oregon DOT Traffic Safety Index System
- ODOT TMAPS
ARTS Website and Contact Information:

- ARTS Program: [https://www.oregon.gov/ODOT/Engineering/Pages/ARTS.aspx](https://www.oregon.gov/ODOT/Engineering/Pages/ARTS.aspx)
- Christina McDaniel-Wilson, P.E.- State Traffic Safety Engineer: [Christina.A.MCDANIEL-WILSON@odot.state.or.us](mailto:Christina.A.MCDANIEL-WILSON@odot.state.or.us)
MaineDOT’s Systemic Approach to Reducing Lane Departure Crashes

FoRRRwD with the Systemic Approach:
Prioritizing Locations and Projects
July 14, 2020

Ed Hanscom, P.E.
Maine Department of Transportation
Background

- Maine is a mostly rural state
  - 99% of Maine’s land area is rural
  - 61% of Maine’s population lives in rural areas

- Rural 2-lane rural roads account for
  - 80% of Maine’s road mileage
  - 50% of Maine’s travel (VMT)
  - 56% of Maine’s crashes
  - 67% of Maine’s severe crashes
Safety Problem: Lane Departure Crashes

- Lane departures are 32% of all crashes
- Lane departures are 72% of fatal crashes

Lane departure = Went-off-Road and Head-on Crashes
System Focus

- 2-lane rural highways
- Highway Corridor Priority (HCP) 1 and 2 (arterials)
- Posted speeds of 40 to 55 (Maine max) mph
- Head-on crashes, then Went-off-road crashes
- Severe crashes
  - Fatal (K) and incapacitating injury (A)
Contributing Factors for Severe Head-on Crashes

- No median
- Higher AADT
- Higher posted speed
Severe Head-On Crashes by AADT

\[
y = 5 \times 10^{-10}x^2 + 4 \times 10^{-6}x
\]

\[
R^2 = 0.9948
\]
Countermeasures for Head-on Crashes

- Install median
  - Too costly to apply systemically

- Centerline Rumble Strips
  - Low cost
  - Noise can be issue
  - Best coordinated with paving
Countermeasure Cost Effectiveness

- 20 miles with 4000 AADT
- Annual severe crash costs of $1,800,000
- Centerline rumble strip installation cost of $200,000
- Crash modification factor of 0.55 (CMF #3360)
- Annual benefit: $800,000
- Benefit/Cost ratio (10 yrs @ 6%): 29.4
Contributing Factors for WOR Crashes

- Horizontal curvature
- Vertical curvature
- Grade
- Posted speed
- Light conditions
- Road surface conditions
- AADT
- Other
## Determining Risk by Comparing Crash Experience to Exposure

<table>
<thead>
<tr>
<th>Crash Experience</th>
<th>Exposure (VMT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: K+A Crash Records</td>
<td>Source: Random sample of road segments on 2-lane rural arterials</td>
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</tbody>
</table>
## Determining Risk by Comparing Crash Experience to Exposure

<table>
<thead>
<tr>
<th>Contributing Factor</th>
<th>Characteristic</th>
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<tbody>
<tr>
<td>Horizontal curvature</td>
<td>=&gt; Curvature ranges</td>
</tr>
<tr>
<td>Vertical curvature</td>
<td>=&gt; Sag, crest, tangent</td>
</tr>
<tr>
<td>Grade</td>
<td>=&gt; % grade ranges</td>
</tr>
<tr>
<td>Posted speed</td>
<td>=&gt; Speed limit in MPH</td>
</tr>
<tr>
<td>Light conditions</td>
<td>=&gt; Daylight, dusk, dark, dawn</td>
</tr>
<tr>
<td>Road surface conditions</td>
<td>=&gt; Dry, wet, other (ice/snow)</td>
</tr>
<tr>
<td>AADT</td>
<td>=&gt; AADT ranges</td>
</tr>
</tbody>
</table>
Characteristic Ranges for Horizontal Curvature

- >8° curve (<700’R)
- 4° to 8° curve (700’-1400’R)
- 2° to 4° curve (1400’-2800’R)
- 1° to 2° curve (2800’-5600’R)
- <1° curve (at or near tangent)
Measuring Risk

Crashes & VMT by Degree of Curve

Degree of Horizontal Curvature

- K+A crashes
- VMT

0-1° (at or near tangent)

>8°

4-8°

2-4°

1-2°
## Measuring Risk

<table>
<thead>
<tr>
<th>Degree of Horizontal Curve</th>
<th>Crashes (K+A)</th>
<th>Exposure (VMT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;8° (&lt;700'R)</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>4-8° (700'-1400'R)</td>
<td>14%</td>
<td>2%</td>
</tr>
<tr>
<td>2-4° (1400'-2800'R)</td>
<td>23%</td>
<td>12%</td>
</tr>
<tr>
<td>1-2° (2800'-5600'R)</td>
<td>6%</td>
<td>16%</td>
</tr>
<tr>
<td>0-1° (at or near tangent)</td>
<td>56%</td>
<td>69%</td>
</tr>
</tbody>
</table>
Risk Ratio

- A measure of the size of the risk in a risk factor

<table>
<thead>
<tr>
<th>Risk Ratio for Horizontal Curves &gt;2° in Degree of Curvature</th>
<th>Crashes (K+A)</th>
<th>Exposure (VMT)</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;2° (&lt;2800'R)</td>
<td>38%</td>
<td>15%</td>
<td>2.5</td>
</tr>
<tr>
<td>&lt;2° (&gt;2800'R)</td>
<td>62%</td>
<td>85%</td>
<td>0.7</td>
</tr>
<tr>
<td>Risk Ratio</td>
<td></td>
<td></td>
<td>3.5:1</td>
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</tbody>
</table>
Contributing Factors with Highest Risk for Severe WOR Crashes in Maine

- **Horizontal Curvature**
  - 9:1 for curves sharper than 1400’ radius (4° curve)
  - 3.5:1 for curves sharper than 2800’ radius (2° curve)

- **Vertical Curvature**
  - 3:1 for sags vs tangents, 2:1 for crests vs tangents

- **Light Conditions**
  - 2.5:1 for dark/dusk/dawn vs daylight

- **Grade**
  - 2:1 for grades steeper than 3%
Crash Costs on Horizontal Curves

- For curves sharper than 1400’ radius (4° curve)
- Crash cost per million VMT: $160,000
- Average curve length: 850 ft
- Average annual crash cost per AADT at curve: $10
  - For curve with 2000 AADT, annual crash cost = $20,000
Countermeasures for WOR Crashes

- Horizontal curvature focus
  - Improved edge line striping
  - Improved curve signing
  - Edge line rumble strips
  - Centerline rumble strips
Countermeasure Effectiveness

- Looking at horizontal curvature
- Edge line rumble strips
- Crash modification factor for edge line rumble strips
  - All WOR crashes: 0.64 (CMF #3454)
  - On horizontal curves: derived from CMF #3454
Went-Off-Road Crashes On Curves
### Rumble Strip Crash Modification Factors

<table>
<thead>
<tr>
<th>Rumble Strip Treatment</th>
<th>Locations</th>
<th>Crash Type</th>
<th>CMF</th>
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<tbody>
<tr>
<td>Centerline</td>
<td>All</td>
<td>Head-On</td>
<td>0.55</td>
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<tr>
<td>Centerline</td>
<td>Curves</td>
<td>Went-Off-Road</td>
<td>0.86</td>
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<tr>
<td>Outside Edge Line</td>
<td>Curves</td>
<td>Went-Off-Road</td>
<td>0.81</td>
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<tr>
<td>Inside Edge Line</td>
<td>Curves</td>
<td>Went-Off-Road</td>
<td>0.97</td>
</tr>
<tr>
<td>Centerline with Outside Edge Line</td>
<td>Curves</td>
<td>Went-Off-Road</td>
<td>0.67</td>
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<tr>
<td>Centerline with Both Edge Lines</td>
<td>All</td>
<td>Went-Off-Road</td>
<td>0.64</td>
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</table>
Outside Curve
Treatment to Reduce Went-Off-Road Crashes

Rumble strips on approaches have the same length as tapers marking a lane shift.

\[
\text{taper length (L, in feet)} = W \times S
\]

where:
- \( W \) = width of shoulder (in feet)
- \( S \) = posted speed (in mph)
Countermeasure Cost Effectiveness

- Curve with 2000 AADT
- Annual severe crash cost of $20,000
- Installation cost for outside edge line rumble strip: $4,000
- Crash modification factor of 0.81
- Annual benefit: $3,800
- Benefit/Cost ratio (10 yrs @ 6%): 7.0
Curve Treatment to Reduce Went-Off-Road Crashes

Rumble strips on approaches have the same length as tapers marking a lane shift.

taper length \( L \) (in feet) = \( W \times S \)

where:
- \( W \) = width of shoulder (in feet)
- \( S \) = posted speed (in mph)
Countermeasure Cost Effectiveness

- Curve with 2000 AADT
- Annual severe crash cost of $20,000
- Installation cost for centerline and outside edge line rumble strip: $8,000
- Crash modification factor of 0.67
- Annual benefit: $6,600
- Benefit/Cost ratio (10 yrs @ 6%): 6.1
### Expected Benefit/Cost Ratios for Rumble Strips

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<th>Location</th>
<th>Centerline</th>
<th>Outside Edge Line on Horizontal Curves</th>
<th>Crash Type</th>
<th>Head-On &amp; WOR</th>
<th>Went-Off-Road</th>
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Prioritizing Projects and Locations

- Define the systemic crash problem
- Find the contributing factors of greatest risk
- Develop B/C functions for countermeasures
- Find the risky locations in system
- Evaluate expected B/C for candidate locations
- Program and schedule projects
Questions ?