Federal Highway Administration

2/1/2018

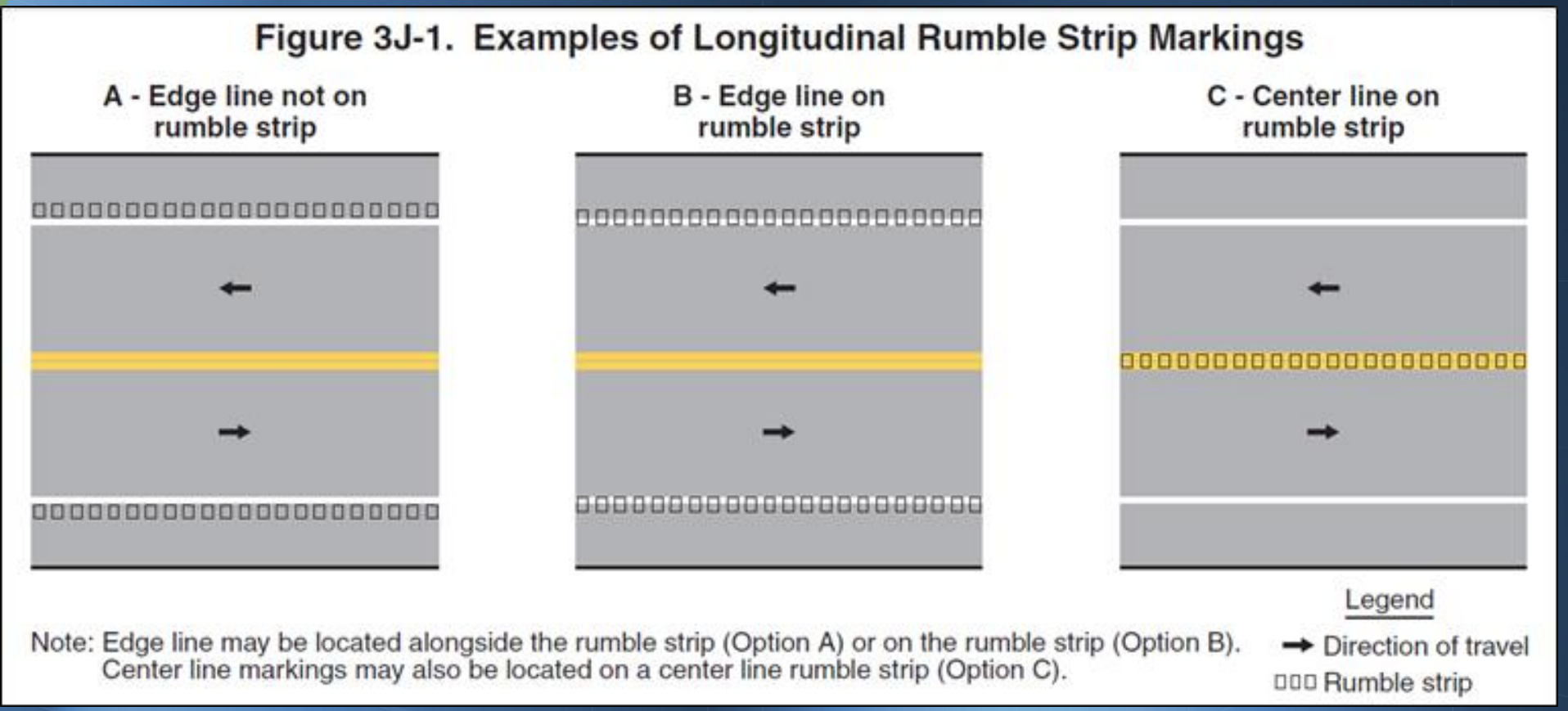
California Division

Nine Proven Safety Countermeasures

Countermeasure	Description	Contact	Cost Range	Data, Benefits and Additional Information
#1 Enhanced Delineation and Friction for Horizontal Curves	Installing chevron signs, curve warning signs, sequential flashing beacons, advisory speed signs or high friction surface treatments can have a positive affect on reducing vehicles from leaving the roadway on horizontal curves.	Ken	**Low-cost:** Safety treatments vary by the number of traffic control devices (TCD) or amount of HFST placed. Typical costs of TCDs range from $30 to $160 and HFST range from $20 to $40 /SY.	Recent data shows that 28% of all fatal crashes occur on horizontal curves and about three times as many crashes occur on curves than in tangential sections of roadways. The listed countermeasures can reduce crashes from 12%-74%. More information can be found at: http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_009.htm
#2 Pedestrian Hybrid Beacon	A pedestrian-activated warning device located on the roadside or on mast arms over midblock pedestrian crossings. (Flashing light intervals and sequences, i.e. red, yellow lights indicate to drivers and pedestrians their clearance time to cross the roadway)	Ken	**Low to Medium cost**: The equipment for a pedestrian hybrid beacon for a spot treatment typically costs about $35,000 to $40,000. Preliminary engineering, labor, and maintenance agreement costs could increase cost.	This is a specialized traffic signal for pedestrian safety. At the local level, community outreach is required to educate and familiarize the public with the new traffic control device. Safety benefits include up to a 69% reduction in pedestrian crashes at midblock crossings, and up to a 29% reduction in total roadway crashes. More information can be found at: http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa14014/
#3 Backplates with Retroreflective Borders	Backplates and retroreflective borders are added to a traffic signal head to improve visibility of the illuminated face of the signal.	Steve	**Low-cost:** Adding backplates or a retroreflective border to an existing signal backplate can be a very low cost safety improvement.	Allowable practice through Section 4D.12 of the CA-MUTCD. May result in a 15% reduction in all crashes at urban, signalized intersections. Increases road user awareness of traffic signal during power outage. Installation time is about two hours per intersection. More information can be found at: http://safety.fhwa.dot.gov/intersection/conventional/signalized/backplates/exec/ http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_007.cfm
#4 Longitudinal Rumble Strips and Stripes On Two-Lane Roads	Most rumble strips and stripes are ground into the pavement and are mainly installed along the centerline or shoulder. The latter are painted over with retroreflective striping to increase visibility.	Steve	**Low-cost:** Cost varies based on the application. Prices range between $0.20 and $3.00 per linear foot.	Over 50% of California's fatal crashes are a result of roadway departure. This application provides an audible warning and physical vibration to alert drivers they are leaving the roadway. The application of rumble strips or stripes has shown good results in reducing run off the road (ROR) crashes. Bicycle conscious designs are available. More information can be found at: http://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/

9 Proven Safety Countermeasures: https://safety.fhwa.dot.gov/provencountermeasures/

Shoulder and center line rumble strips



Shoulder and center line rumble strips

Shoulder Rumble Stripe

SR 84 in bay area
Courtesy of Google

Shoulder and center line rumble strips

- Low-cost: Cost varies based on the application. Prices range between $0.20 and $3.00 per linear foot.
- >250 Crash Modification Factors (CMFs) for longitudinal rumble strips. Range from 0.9 – 0.5.
  - www.cmfclearinghouse.org
  - Ex: Centerline rumble strip
    - rural head on/sideswipe; fatal/injury
    - 2-lane, 20,784 max. ADT, segment
    - A: 20 [crashes/yr] x **0.70** = 14 crashes/yr

"Mumble strip: 14" O.C., sinusoidal profile, p-p depth 5/16"

Caltrans Sinusoidal Rumble Strip (aka mumble strip)

Conventional ground rumble strip: 12" O.C.,

4" Dia Dots: 12" O.C.,

Rumble Strip Conclusions

- Rumble strips can help reduce sideswipe, head-on collisions, and run-off-road crashes
- Caltrans mumble strips achieved goals
  - Lower exterior dB A-weighted levels
  - Provide sufficient driver warning input
- Interior noise & vibration response varied with vehicle type

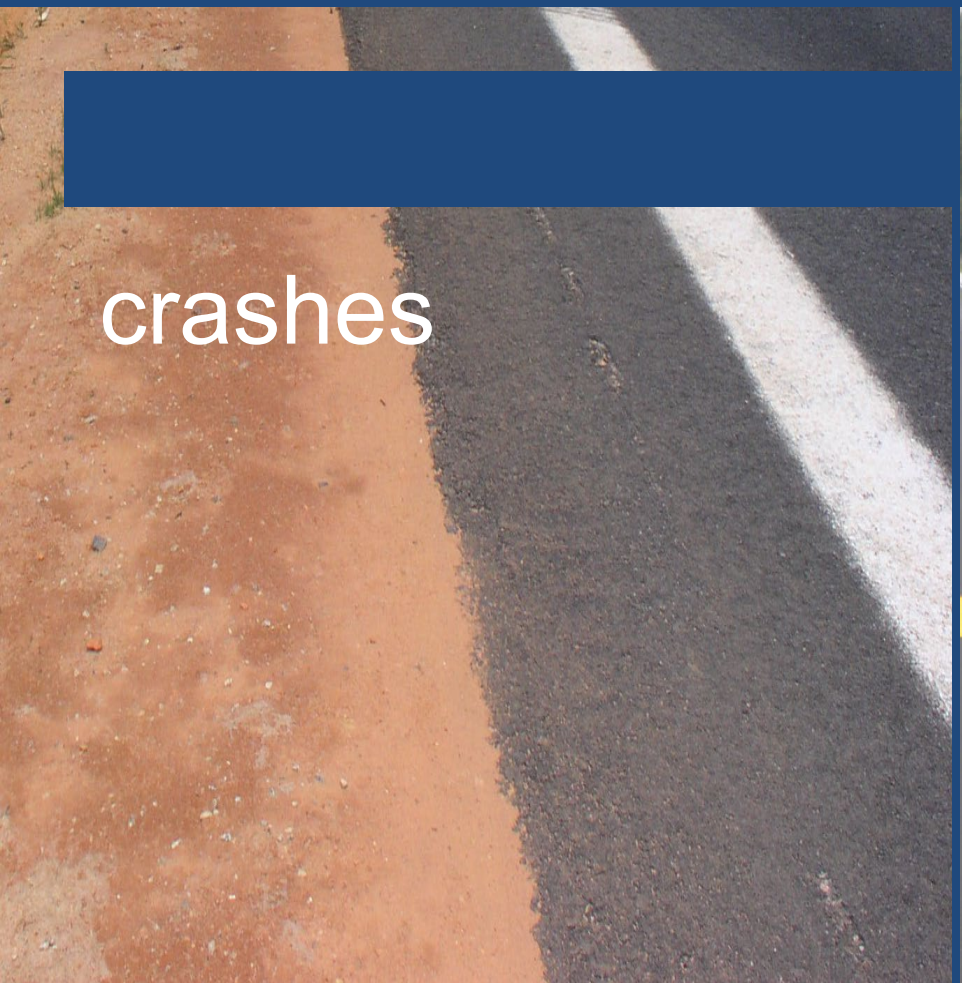
News Alert

- Caltrans moved to 6” striping July 17, 2017
- Both Rt and Lf lane lines
- Better visibility and less maintenance = reduced worker exposure
- CMF of 78 (three star)

What Is the Safety Edge?

When used on asphalt pavement, the

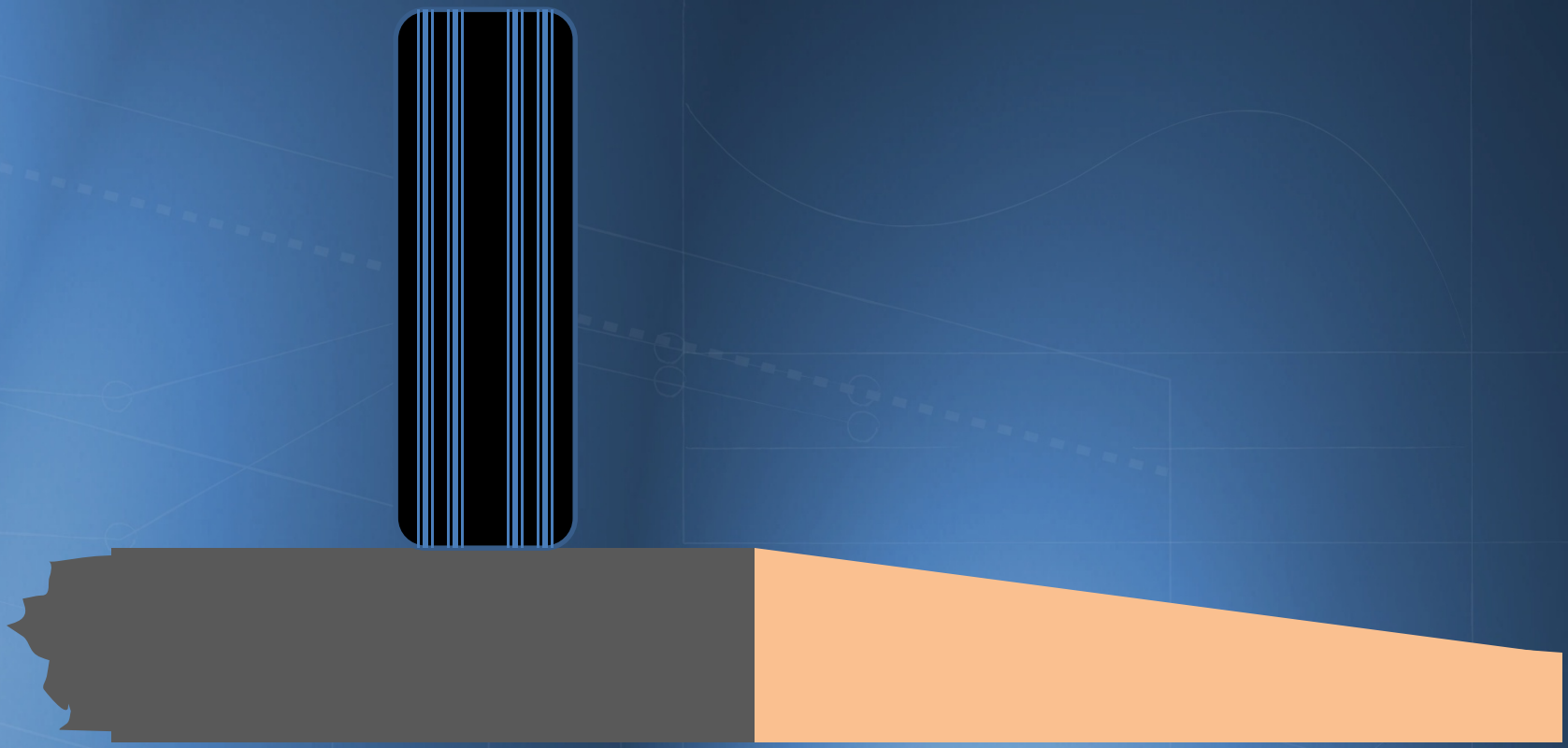
crashes



Key Message

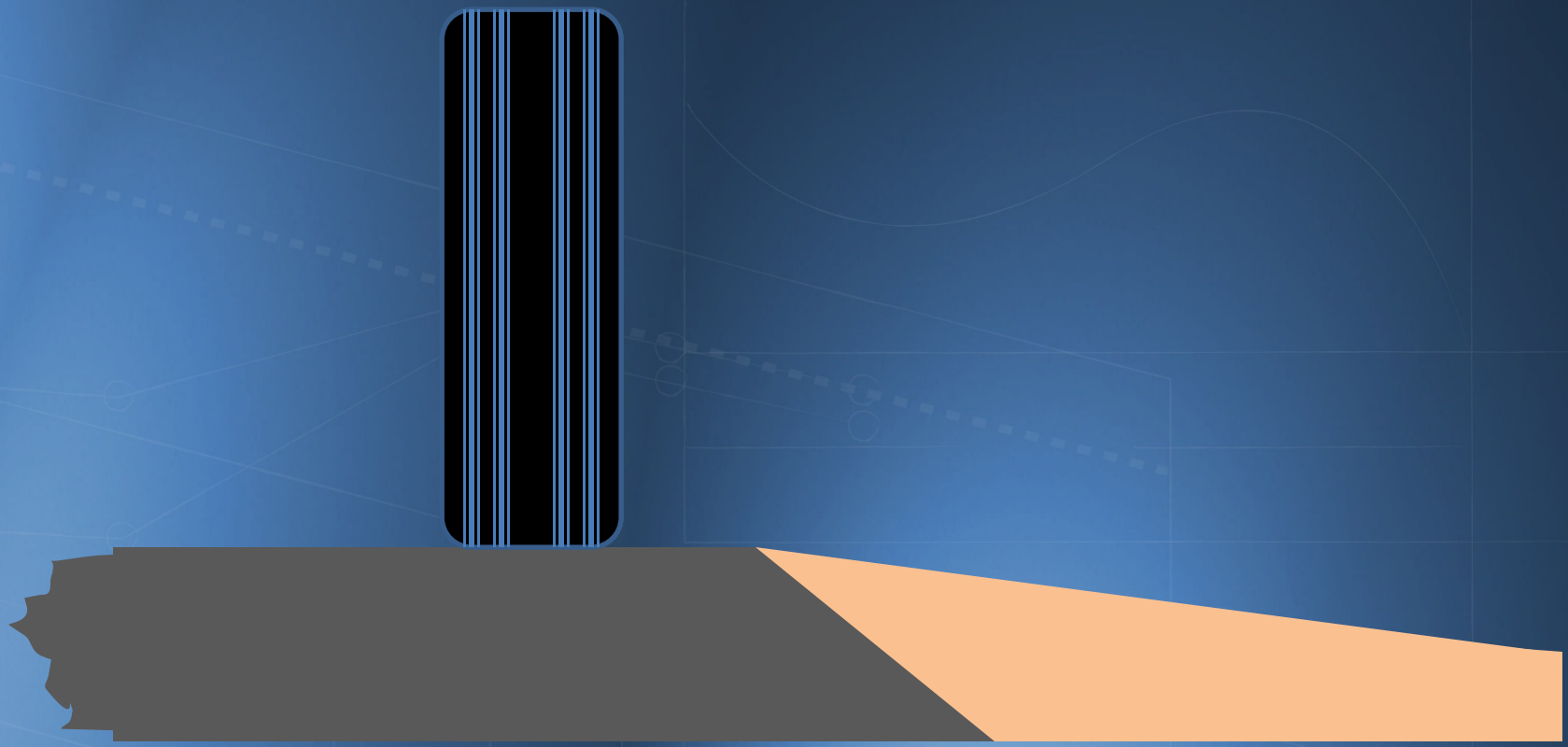
- **Saves Lives**
  - Allows vehicles to safely return to the travel lane
  - CMF for Drop-Off related crashes is 0.655
- **Improves Durability**
  - Reduces edge raveling
- **Low Cost**
  - Minor change to paving operations

Basic Principle



Without a Safety Edge

Basic Principle

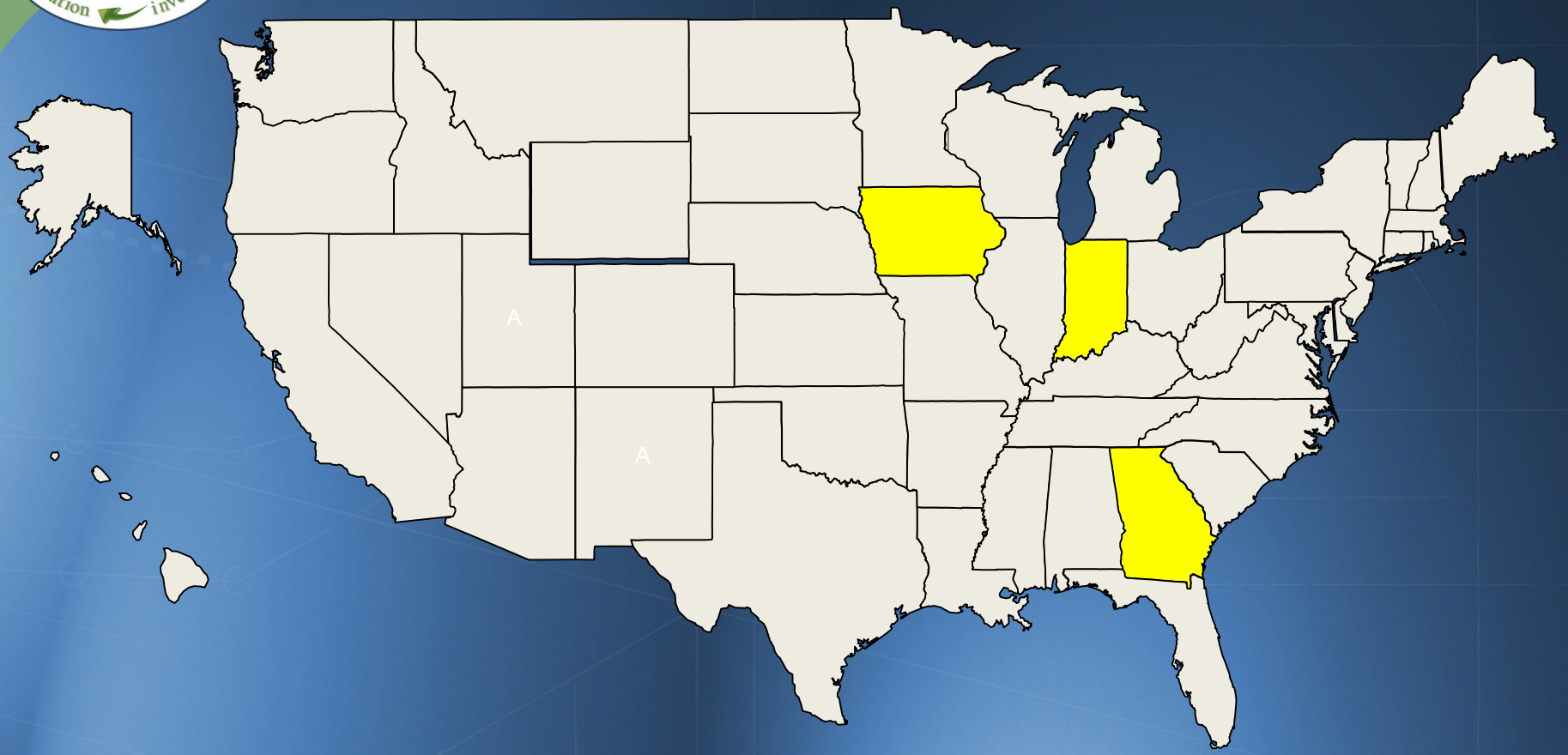


With Safety Edge

Locations at High-Risk for Drop-Offs

- Horizontal Curves
- Near Roadside Mailboxes
- Turnarounds/Unpaved Pull-Outs
- Shaded Areas
- Eroded Areas
- Edge ruts
- Asphalt Pavement Overlays

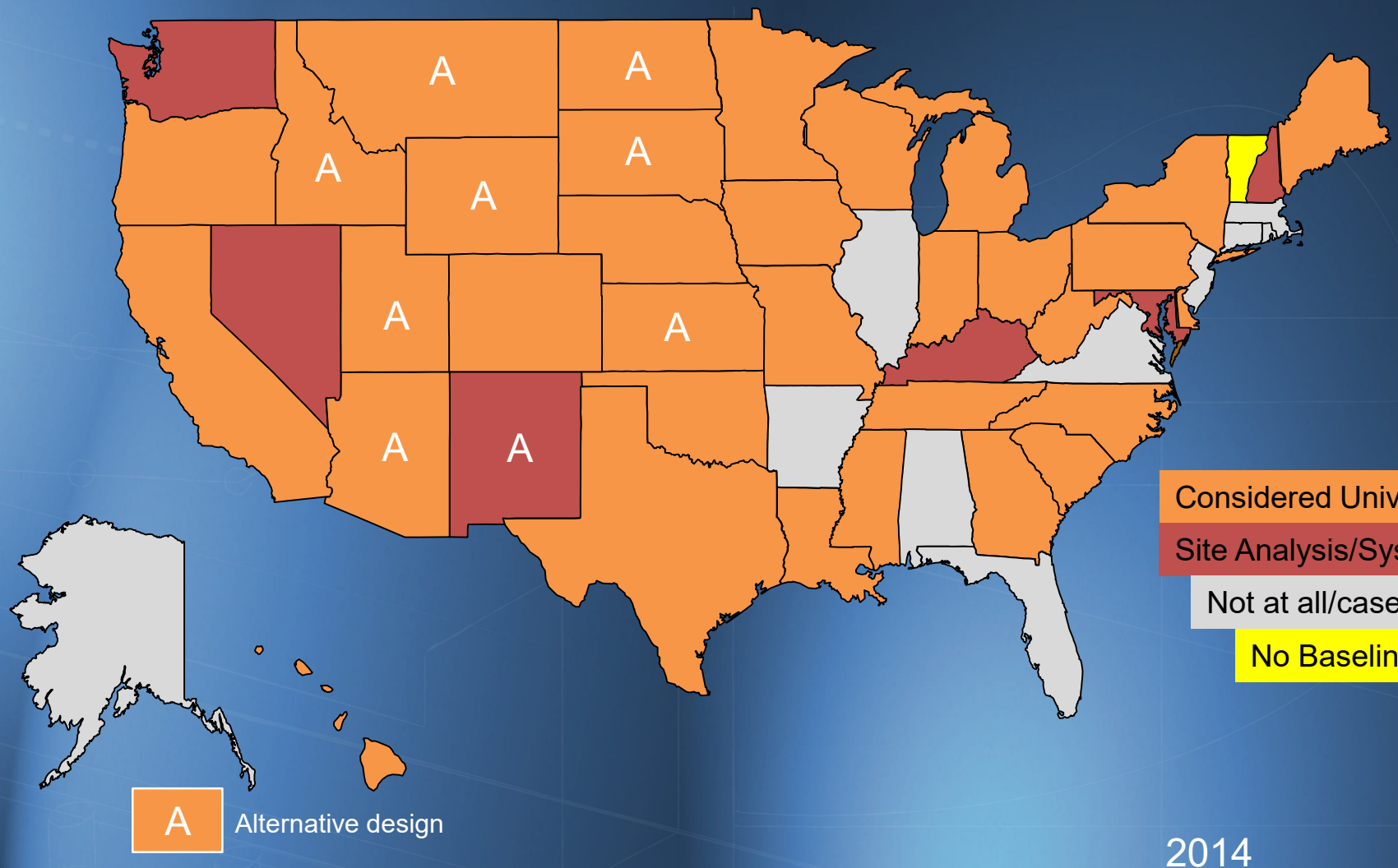
Safety Edge pre EDC



State DOT Projects Built
A = Alternative design

2007

Where We Are: Safety Edge℠



2014

The Hardware

Costs of the Safety Edge

- Hardware
  - Approximately $1400-$4500 per device
  - Reusable
- Material
  - Minor additional asphalt

  (depends on shoulder condition)
- Paving Process
  - No change in paving speed or rolling patterns
  - No additional operation
  - Minimal monitoring
- Surface Details
  - No change in smoothness/ride quality

Enhanced Delineation for Horizontal Curves

- Data collected from states of Connecticut and Washington
- Delineation improvements for horizontal curves on two-lane rural roads
- 117 mile/years of before and after data (228 sites total)
- Chevron, curve ahead, horizontal or suggested speed limit signs
- Fluorescent sheeting, increased size or additional signs

Example of Enhanced Delineation

Results from Study

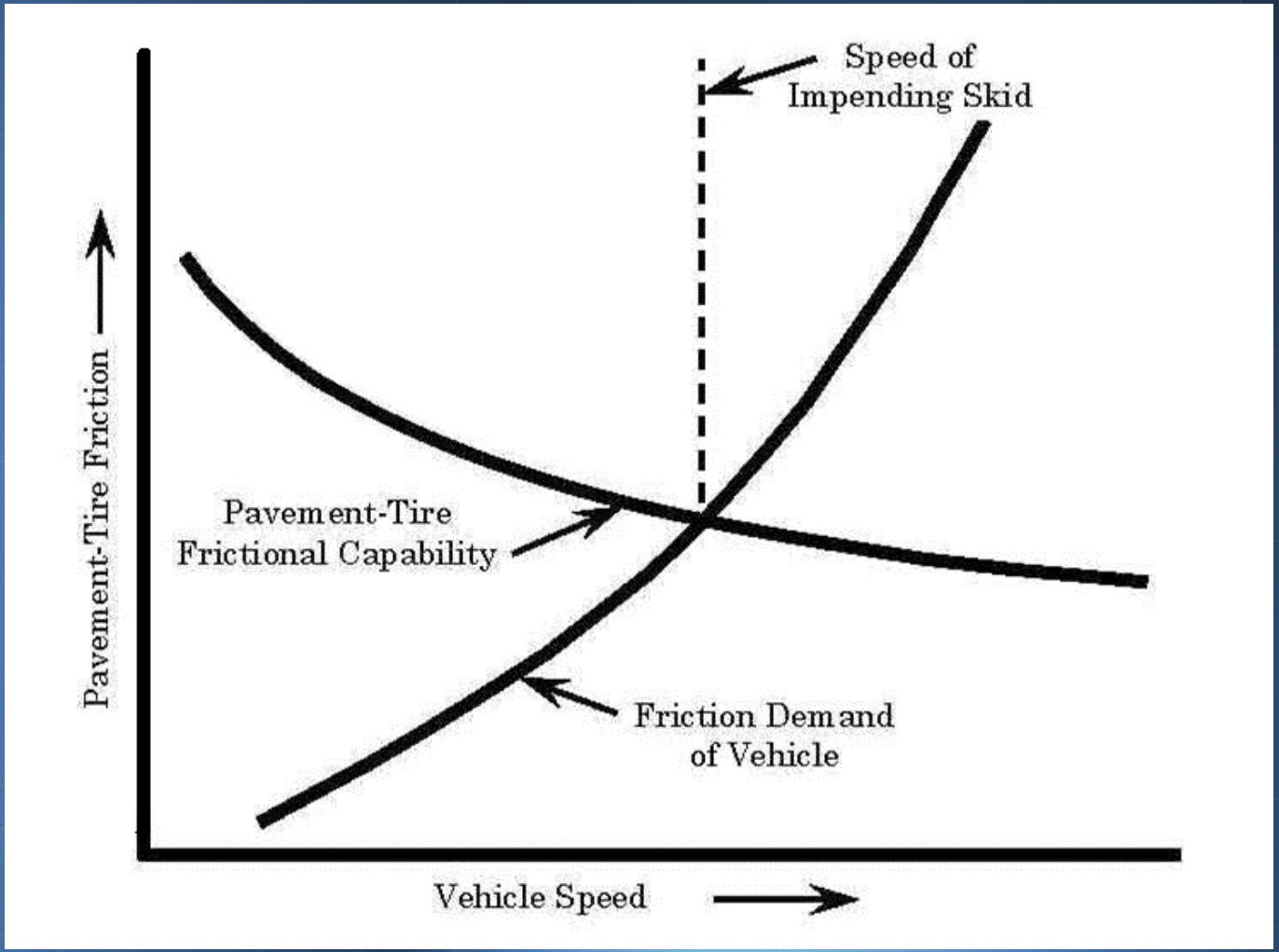
Table 3. Summary of crash reduction factors.

Crash Type	Recommended Crash Reduction Factors (Point Estimate)	Standard Error
Injury and fatal curve crashes	18	8.6
Curve crashes during dark conditions	27.5	7.3
Lane departure crashes on curves during dark conditions	25.4	7.8

* Improving curve delineation with signing improvements, is a very cost-effective treatment with a B/C exceeding 8:1. The greatest enhancements can be seen at locations with more hazardous roadsides, higher volumes and smaller curve radii.

High Friction Surface Treatments

Conceptual Relationship Between Friction Demand, Speed and Friction Availability



Source NCHRP 108

Key Messages

- **HFSTs reduce crashes -> Reduce injuries and fatalities**
- Additional messages include:
  - the durability and longevity of the pavement surface 8 – 10 years
  - $20 - $40 / yd2
  - minimal impact to traffic during construction
  - negligible environmental impact

Case Study: DN-199

- All 28 collisions in 3 years occurred under wet pavement conditions.
- District had used many low cost countermeasures with little change in collision pattern.
- District proposed curve realignment.


30
30
NB 01-DN-199 PM 8.2

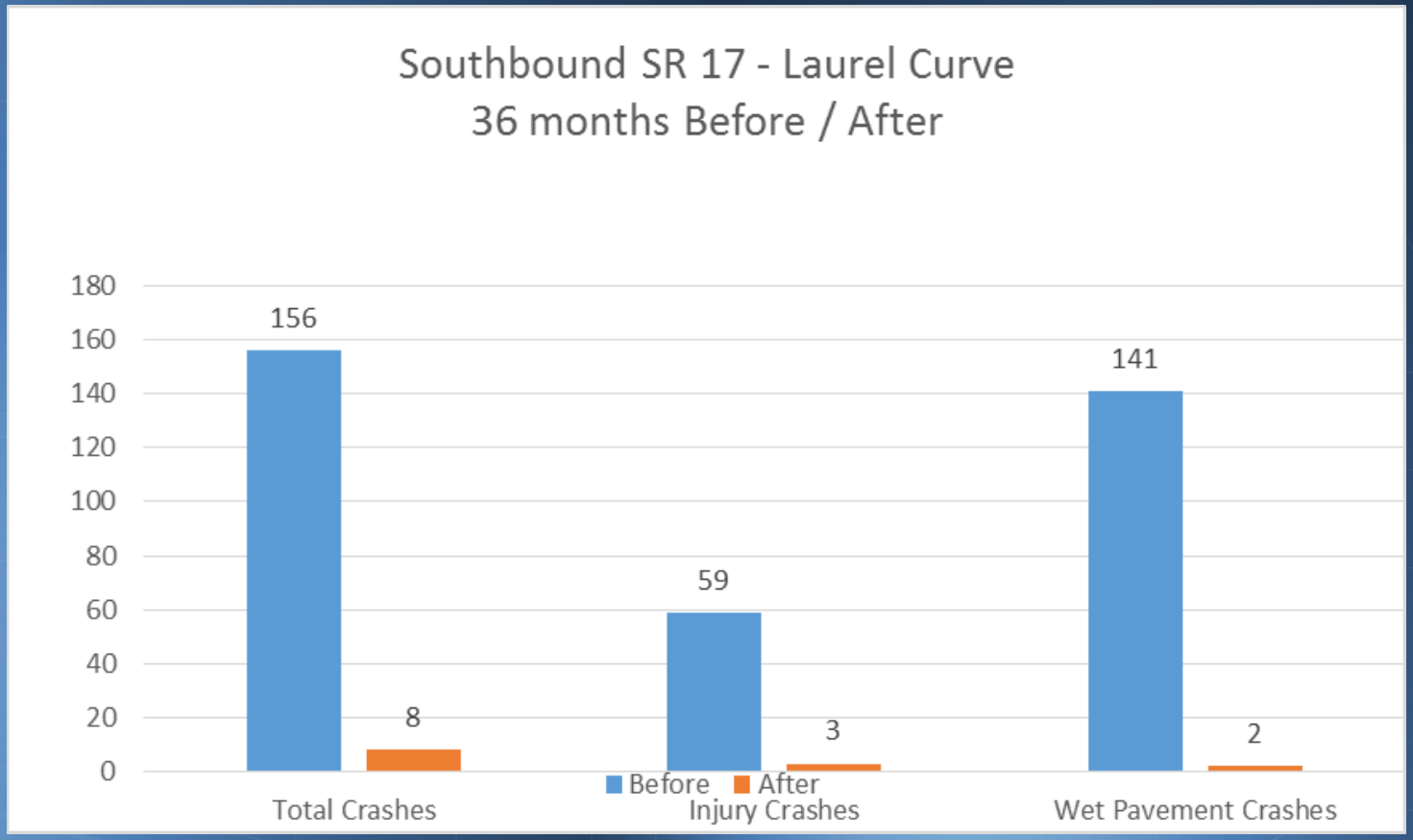
Case Study: DN-199

- Initial proposed project was to realign curve
  - $14 M project; approx. 5 years for environmental, design and construction
- Realignment project put on hold to install HFST
  - $250 K project; approx. 6 months for environmental, design and construction
- No crashes since installation (Summer 2012)

Case Study: Hwy. 17 at Laurel Canyon

SR-17, Laurel Curve near Santa Cruz (July 2012)

Study: Hwy. 17 at Laurel Canyon



94.8% collision reduction!!

B/C – 183 to 1