Pavement Markings to Support Machine Vision Systems

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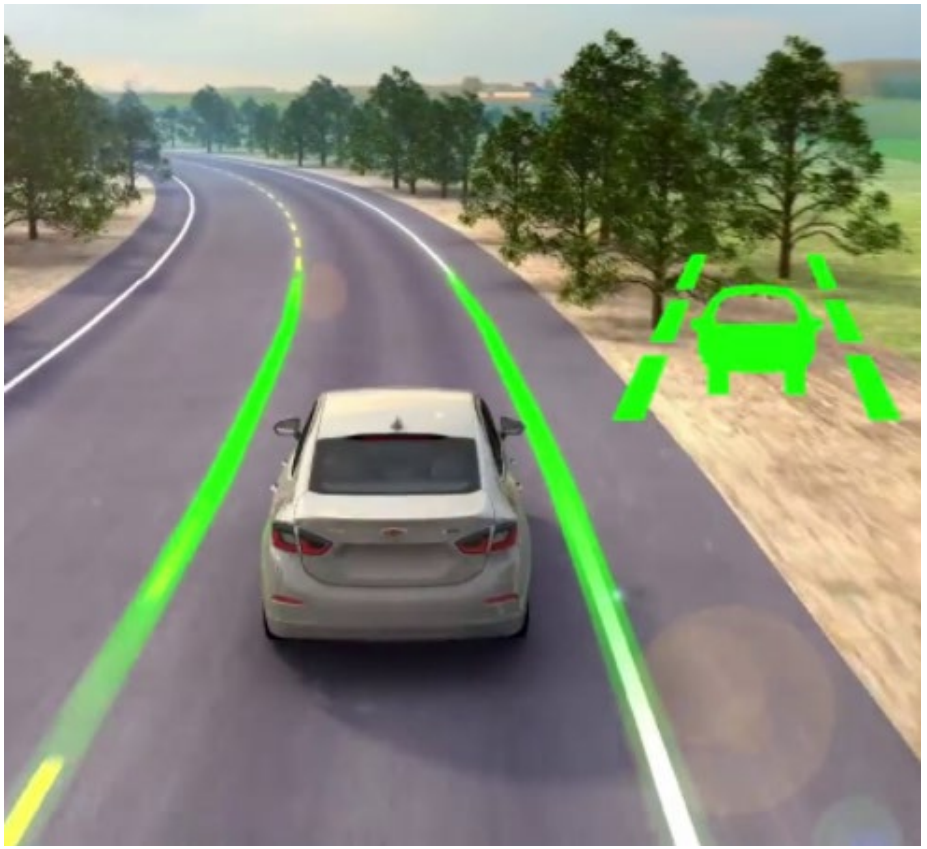
Pavement Markings

Good for Humans and Machine Vision Today

Striping and marking investments are the least cost / highest return investments for keeping driven and automated vehicles safely on the road.

With aging drivers and automated systems, higher quality striping is now an operational need rather than a simple maintenance or preservation task.



Pavement Markings: Exit Ramp Example

Proposed Changes: Manual on Uniform Traffic Control Devices

Figure 3B-8. Examples of Dotted Line and Channelizing Line Applications for Exit Ramp Markings (Sheet 1 of 2)

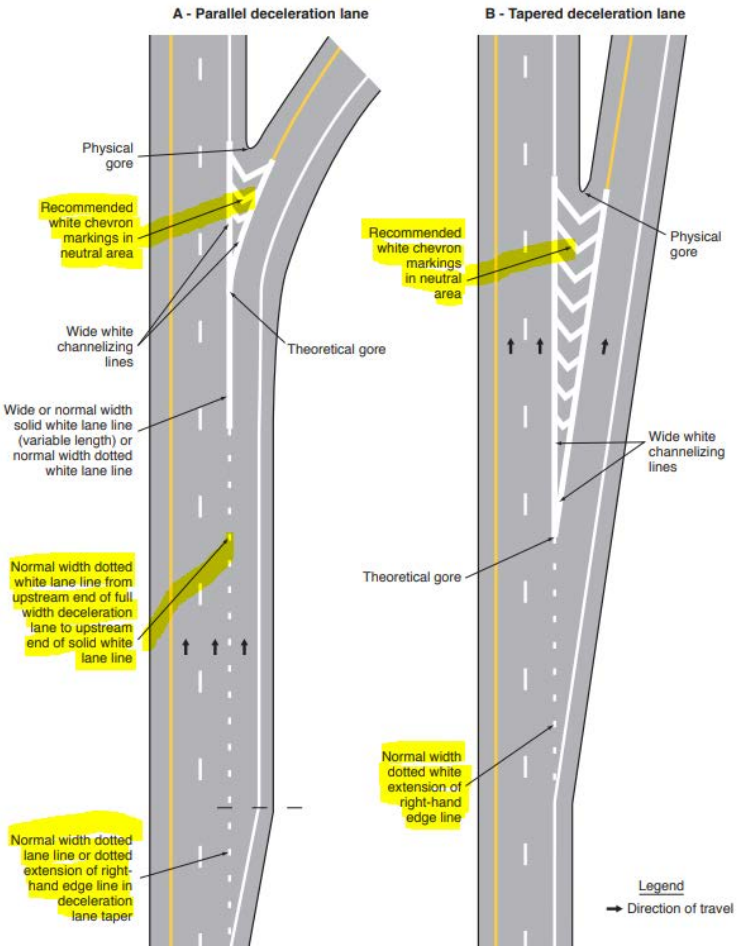
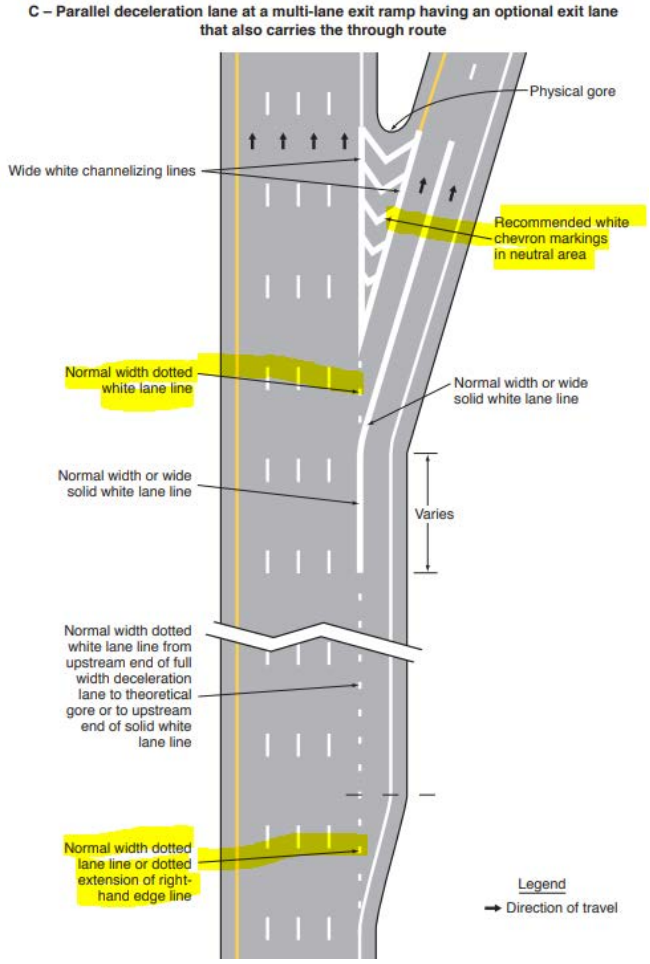


Figure 3B-8. Examples of Dotted Line and Channelizing Line Applications for Exit Ramp Markings (Sheet 2 of 2)



Pavement Markings

Proposed Changes: Manual on Uniform Traffic Control Devices

PART 3. MARKINGS

Section ~~3A.06~~3A.04 Functions, Widths, and Patterns of Longitudinal Pavement Markings

Standard:

The general functions of longitudinal lines shall be as follows:

A. A double line indicates maximum or special restrictions.

B. A solid line discourages or prohibits crossing (depending on the specific application).

C. A broken line indicates a permissive condition.~~; and~~

D. A dotted lane line provides ~~guidance or~~ warning of a downstream change in lane function.

E. A dotted line used as a lane line or edge line extension guides vehicles through an intersection, a taper area, or an interchange ramp area.

The widths and patterns of longitudinal lines shall be as follows:

A. Normal width line ~~4 to 6 inches wide.~~ 6 inches wide for freeways, expressways, and ramps; 6 inches for all other roadways with speed limits > 40 mph, 4 to 6 inches for all other roadways.

B. Wide line ~~at least twice the width of a normal line~~ at least 8 inches in width if 4 inch or 5 inch normal width lines are used and at least 10 inches in width if 6 inch normal width lines are used.

Notice of Proposed Amendments – Part 3 Page 337 of 781 December 2020

- Proposed additions to the MUTCD are shown in blue underline

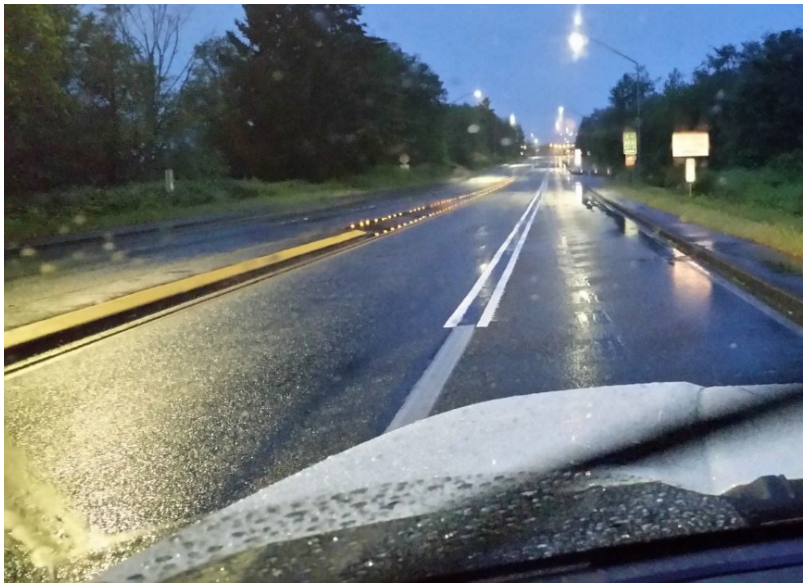
Pavement Markings: Dry Locations (WSDOT)

- *Wider 6-inch lane and edge lines provide increased visibility and contrast over traditional 4-inch lines during day and dry night conditions.*

- Wider 6-inch lines, 15 mil paint, 7 lbs/gal *standard 1.5 glass beads*

Pavement Markings: Wet Locations (WSDOT)

- 4 inch-wide High Build (thicker 17 – 25 mil) paint improves wet performance bead adhesion while bead optics allow for wet night retro-reflectivity.
- 6 inch-wide marking at the standard 15mil thickness with the standard bead would **provide little to no-increase** in nighttime retro-reflectivity during wet conditions. (WSDOT Opinion)



- Standard 4 inch-wide marking, 22.5 mil high build paint, 8 lbs/gal all weather bead mix *(approx. 70% standard 1.5 bead, 30% composite bead)*

Pavement Markings: WSDOT Approach

- WSDOT Annual Long Line Striping Budget (Materials ONLY / Year)

- **Statewide Today:** Standard 4 inch wide, 15 mil paint, 7 lbs / gal, standard bead $5 Million / Year

  (Note: Cost to cover 60-80% of the system on an annual basis, MAP Level B, Painting 100% of the system with the goal of provided presence and retro 247/365 would require additional investment)

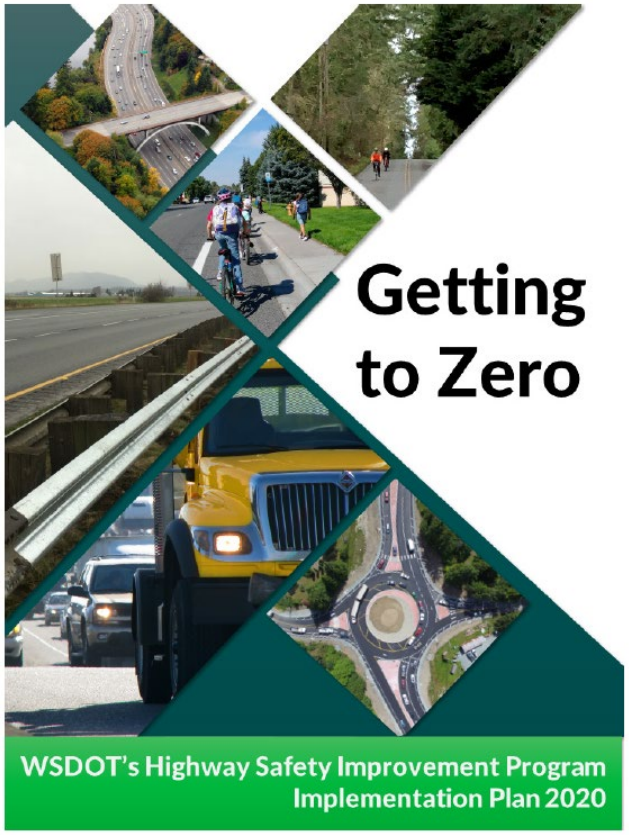
(One) **Proposed Approach:**

- **Eastern Washington (Dryer, Hot/Cold Climate)**
  - Wider 6-inch-wide marking, 15 mil paint, 7 lbs/gal standard bead $4.3 Million / Year
- **Western Washington (Wet, Temperate Climate)**
  - Standard 4-inch-wide, 22.5 mil high build paint, 8 lbs/gal all weather bead mix *(approx. 70% standard bead, 30% composite bead)* $4.2Million / Year

- **Delta between Today and Preparing for AV?** $3.5 Million / Year

Pavement Markings: Crash Reduction Potential

Lane Departure Crashes are associated with nearly 50% of all fatalities in WA state (2003-2017)



High Visibility Edge Lines

Edge lines are the solid white longitudinal markings at the outside edge of roadways. High visibility edge lines increase the driver's ability to see the markings, helping reduce lane departure crashes. The Edge Line Visibility Pilot will potentially reduce run-off-the-road crashes by installing high visibility edge lines on rural highways and freeways in Western Washington.

Introduction

The Edge Line Visibility pilot attempts to reduce lane departure crashes, which is one of the Target Zero focus areas. WSDOT will establish high visibility edge lines in three Western Washington regions. The pilot will focus on rural routes and freeways on the west side of Washington state. Studies have shown that increasing edge line visibility by having wider or thicker lines with high visibility beads can reduce run-off-the-road crashes by up to 35%. This pilot will install high build, or thicker than average, 4-inch wide edge lines on target roadways.

Methodology

Crash Modification Factors (CMF) are used to compute the expected number of crashes after implementing a strategy intended to reduce crash frequency or severity on a road or intersection CMF No. 4792 in the Federal Highway Administration's clearinghouse for crash modification factors increases the edge lines from 4 inches to 6 inches and has a value of 0.70, or a 22% reduction in crashes. The CMF has a rating of 4/5 and used a before/after study with empirical Bayes methodology, a type of statistical estimation that addresses randomness and increases precision compared to using a crash history.

WSDOT will examine the three Western Washington regions in this pilot, with a focus on rural highways and freeways. Urban highways were excluded as many have curbing and no edge line, and potentially have lower travel speeds. All injury lane departure crashes were included in the screening and a 20% crash reduction is assumed.

Key Takeaway

- Assuming a 20% reduction in crashes following edge line visibility treatments, the expected benefit/cost ratio is 78:1.

Using the proposed high build 4-inch edge lines will provide benefits for all conditions, according to the research cited in the introduction. Other benefits may include improved readability by smart vehicle technology and road stripes maintaining visibility over longer periods of time. Based on the available research and CMFs cited above, a 20% reduction in lane departure crashes is a reasonable estimate.

WSDOT

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WA State AV Policy: Decision Making Process

04 - Governor & Legislature

03 - Transportation Commission

02 - AV Work Group Executive Committee

WASHINGTON STATE
AUTONOMOUS VEHICLE
WORK GROUP

01 - Subcommittees

Health & Equity

DOH Lead Agency

Chair: Dr. Andrew Dannenberg, UW School of Public Health

- Health and equity considerations related to autonomous vehicles, such as air quality, water quality, noise, green space, mental well-being, physical activity, safety, and social connections
- Engagement from communities, prioritizing communities of color

Infrastructure & Systems

WSDOT Lead Agency

Co-Chairs: Roger Millar, WSDOT; Mike Ennis, Association of Washington Business

- Roadway infrastructure
- Traffic management
- Transit service & vehicles
- Advertising
- Right of way
- Multi-modal transportation Mobility as a service

Liability

Insurance Comm. Lead Agency

Co-Chairs: David Forte, Office of the Insurance Commissioner; Harris Clarke, PEMCO

- Insurance
- Tort liability
- Criminal law
- Judiciary

Licensing

DOL Lead Agency

Co-Chairs: Beau Perschbacher, DOL; Drew Wilder, Vicarious Liability Risk Management LLC

- Manufacturer Vehicle Testing
- Pilot certification
- Vehicle registration
- Driver's licensing
- Rules of the road

Safety

WTSC & WSP Lead Agency

Co-Chairs: Captain Tom Foster, Washington State Patrol; Manuela Papadopol, Designated Driver

- Traffic safety
- Law enforcement
- Synchronization with other safety priorities
- Traffic incident management

System Tech & Data Security

State CIO Lead Agency

Co-Chairs: Kathryn Ruckle, Office of the Chief Information Officer; Michael Schutzler, Washington Technology Industry Association

- Data & information management
- Cybersecurity
- Privacy protection

Workforce

ESD and L&I Lead Agency

Co-Chairs: Brenda Weist, Teamsters; Nick Streuli, Washington State Employment Security Department; Maggie Leland, Washington State Department of Labor & Industries

- Worker safety & worker rights
- Worker displacement/job loss
- Worker retraining and transition
- Industry impacts

2020 Infrastructure & Systems Subcommittee Recommendation #1: Pavement Markings

- Request for the Legislature to consider **increased ongoing investment in enhanced roadway pavement markings during future, new revenue discussions** to increase traveler safety and support Advanced Driver Assistive Systems deployed on Washington's roads today (SAE Levels 0-2) and Automated Driving Systems (SAE Levels 3-5) Technologies that are currently being tested on public roads.
- These enhanced markings have the potential for significant crash reductions and reduced societal costs.

Benefit / Cost 78:1

Next Steps

- Review/Comment on MUTCD Notice of Proposed Rulemaking
  - Compare MUTCD Pavement Marking Recommendations with current WA State Recommendations
  - Assess Local Agency Impacts
  - Assess Alignment with State Statues
- WA State MUTCD Adoption Process
  - Washington Administrative Code (WAC)
- In-depth review of current Pavement Marking Maintenance and Asset Management
  - Review Implementation Costs (Materials and Labor) / Workforce & Equipment Needs
  - Implementation Timing
  - Resourcing (State/Federal Fund) Allocations

Benefit / Cost 78:1

For More Information

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Washington State Department of Transportation

Cooperative Automated Transportation Program
https://www.wsdot.wa.gov/travel/automated-connected/home

WASHINGTON STATE AUTONOMOUS VEHICLE WORK GROUP

WA State Autonomous Vehicle Work Group
https://avworkgroupwa.org/

A desire to do the right thing at the right time
(mandate or not) still requires the funding to do it

Questions?