Countermeasures for Wrong-Way Driving on Freeways

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Project Webinar – November 21, 2016

AUDIO MUTED - PLEASE USE CHAT BOX FOR QUESTIONS

Webinar Agenda

- **ENTERPRISE Overview**
- **Project Approach and Key Findings -** *Linda Preisen, Athey Creek Consultants*
- **Agency Deployments:**
  - **Iowa DOT: Wrong-Way Driving Testbed** – *Willy Sorenson, Iowa DOT*
  - **Florida DOT: Statewide Efforts and Countermeasures** - *Raj Ponnaluri, Florida DOT*
  - **Arizona DOT: Pilot Deployment of an Integrated Detection and Warning System** - *Jim Windsor, Arizona DOT*
- **Questions/Answers**

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ENTERPRISE Program

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- Facilitate rapid progress in the development and deployment of ITS technologies; and
- Accelerate the systematic advancement of selected ITS projects.

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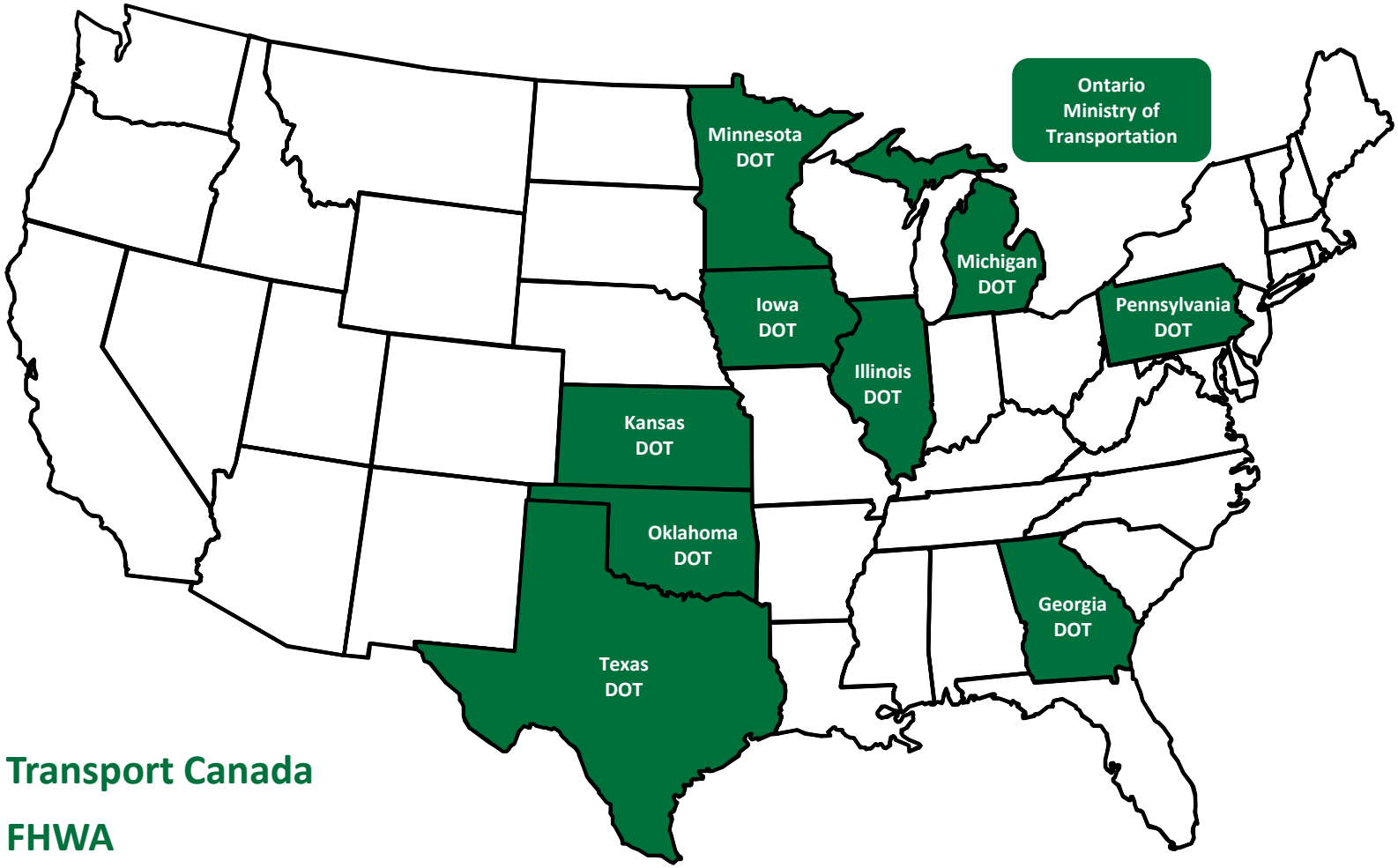

- Transport Canada
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Project Goals

"Countermeasures for Wrong-Way Driving on Freeways"

- **Document deployments that aim to mitigate wrong-way way driving**
  - Technology/ITS
  - No Technology
- **Increase understanding of countermeasures**
  - Configurations
  - Effectiveness
  - Public Feedback
  - Lessons Learned

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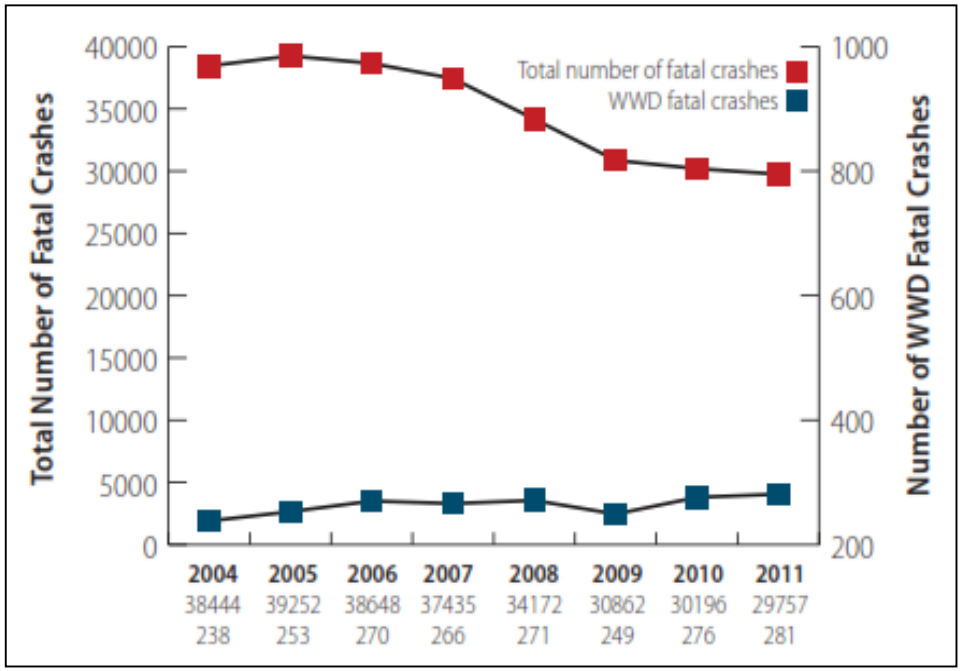
The Problem

- U.S. Wrong-Way Fatalities: **Average 350 per year +/-**
- Wrong-Way Crashes & Fatalities – Trend is "flat" compared to fatalities from other crash types which have steadily decreased



(Baratian-Ghorghi et al., 2014)

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The Problem

Highway Special Investigation Report: Wrong-Way Driving

(National Transportation Safety Board, 2012)

- **Severity**: Wrong Way (WW) collisions tend to have higher fatality rates than other types of collisions
- **Driver Characteristics:** Alcohol-impaired drivers and older drivers are over-represented in WW crashes
- **Origin**: Primary origin of WW movements is entering an exit ramp
- **When:** Increased frequency of WW collisions at night and on the weekends

*WW drivers tend to drive in what they perceive as their right-hand lane, which is the left-hand lane for drivers in the correct direction.

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Countermeasures – No Technology

Low-mounted Static Signs

Source: *Countermeasures for Wrong-Way Movement on Freeways: Overview of Project Activities and Findings* (Cooner et al., 2004)

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Countermeasures – No Technology

Enhanced Static Signs

- Oversized signs
- Additional signs along exit ramps
- Red reflective tape/sheeting on sign posts
- Multiple signs on same post

Source: *Arizona DOT*

Source: *National Wrong Way Driving Summit Proceedings,* 2014

Source: North Texas Toll Authority *(Proceedings of the 2013 National Wrong Way Driving Summi,* 2014)

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Countermeasures – No Technology

Enhanced Pavement Markings

- Wrong way pavement marking arrows
- Raised reflective pavement markings (RPMs)

Source: Illinois DOT (2015 TRB Annual Meeting Session presentation)

Source: North Texas Toll Authority (*Proceedings of the 2013 National Wrong Way Driving Summit,* 2014)

Source: Arizona DOT

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Countermeasures – No technology

Enhanced Pavement Markings

- Pavement marking extensions
- Painted median
- Stop bars at exit ramps

Source: *Public Roads* Magazine, 2012

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Countermeasures – No Technology

Enhanced Pavement Markings

- Route marking shields at beginning of left turn lanes to entrance ramps

(Source: *FDOT SunGuide Disseminator*, Sept. 2014)

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Countermeasures – No technology

Treatments Applied to Infrastructure at Exit Ramps

- Red delineators along exit ramp (on guardrail or on delineator posts)

Source: *Public Roads* Magazine, 2012

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Countermeasures – ITS Strategies

Enhanced Regulatory Signs

Blinking LED lights around WW signs

- Vehicle-activated; or
- Blink continually at night/low light

Source: Texas DOT

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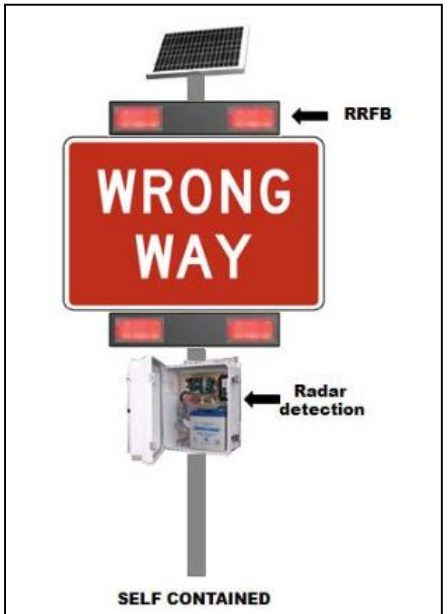
Countermeasures – ITS Strategies

Enhanced Regulatory Signs

Rectangular Rapid Flashing Beacons (RRFBs) attached to WRONG WAY signs



Red RRFBs mounted on "WRONG WAY" sign
(*Revised from WUSF, 2015*)

Source: Ozkul, Lin, Chandler (presentation slides)

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Countermeasures – ITS Strategies

Dynamic Alert Systems

- Detection (radar, video, loop detectors)
- Alerts/messages to wrong way drivers
- Alerts/messages to oncoming traffic
- Alerts to traffic management centers / law enforcement

Source: Texas DOT

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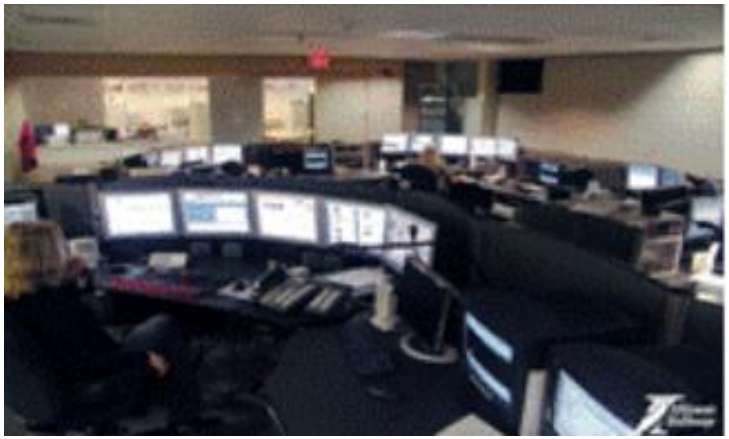
Other Countermeasures

Institutional Coordination

- Multi-agency coordination (DOT, law enforcement, etc.)
- Public education
- Legislative modification
- Field checklists



Source: Illinois Tollway *(National Wrong Way Driving Summit Proceedings,* 2013)

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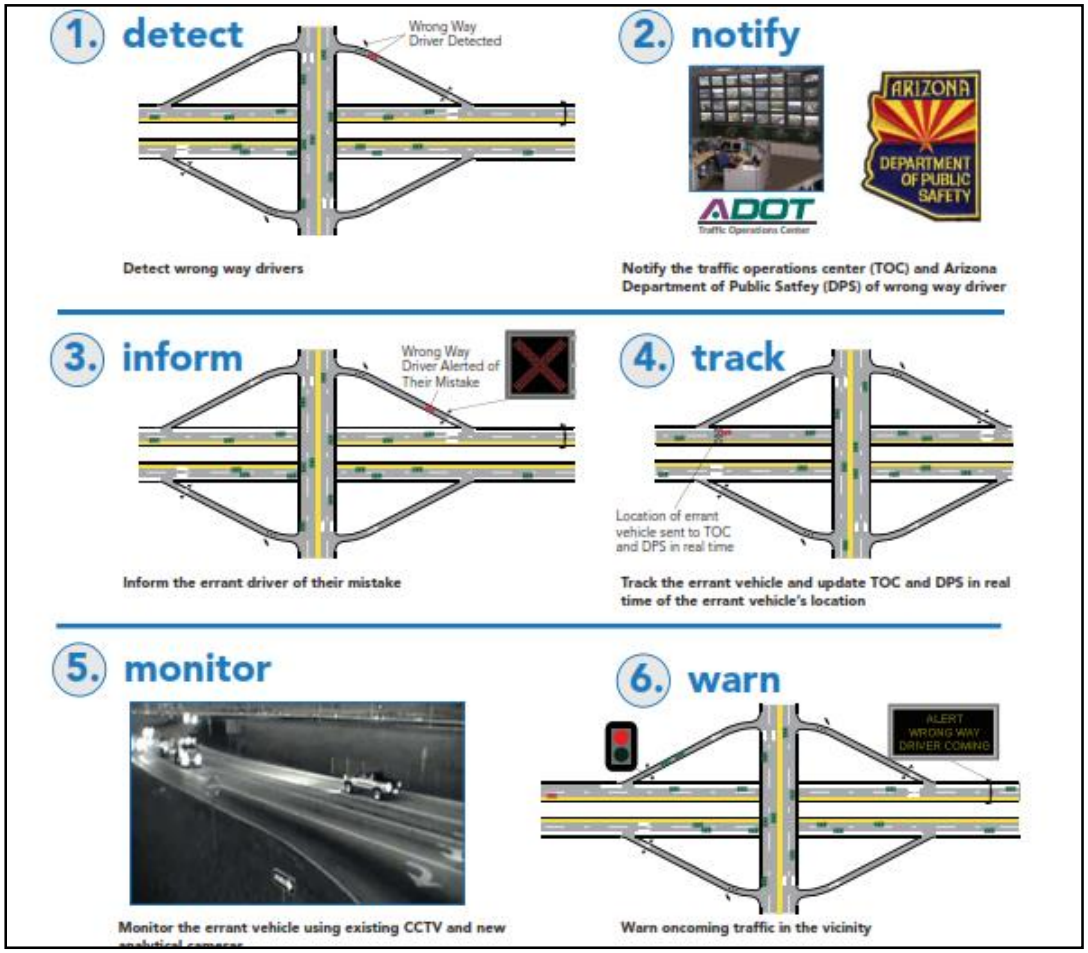
Emerging Approaches

- **Arizona DOT and Texas DOT**- Integrated detection, tracking, & warning systems



Source: *Automatically Detecting Wrong Way Drivers on the Highway* (Simpson, 2014)

Collected Documented Active Deployments

Deployments	
Signing & Pavement Markings	**Technology/ITS**
• Arizona DOT • Connecticut DOT • Florida DOT • Michigan DOT • Ohio DOT • Rhode Island DOT • Washington State DOT • Wisconsin DOT	• Arizona DOT • Central Florida Expressway • Florida DOT (Tallahassee, Florida Turnpike, & Tampa) • Iowa DOT • Missouri DOT • Ohio DOT • Rhode Island DOT • Texas DOT – San Antonio • Harris County Toll Road Authority (Houston, TX) • Wisconsin DOT

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Deployment Summaries

Information Documented for Each Deployment

- Agency Contact(s)
- Background/Reason for Deployment
- # Sites & Location
- Deployment Dates
- Test/pilot or Long-term Deployment
- Description of Countermeasures
  - Photos, design details (as available)
- Evaluation Efforts/Results
- Coordination
- Guidelines or Standards
- Local/Public Response
- Lessons Learned
- Future Plans

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"Countermeasures for Wrong-Way Driving on Freeways"
Deployment Summary
Ohio Department of Transportation

Agency	Ohio Department of Transportation (Ohio DOT)	
Agency Contacts	Derek Troyer Email: Derek.Troyer@dot.state.oh.us Phone: (614) 387-5164	Mike McNeill Email: Michael.McNeill@dot.state.oh.us Phone: (614) 387-1265
Information Source	• Interview with Mike McNeill on 6/8/2016 • Interview with Derek Troyer and Mike McNeill on 5/10/2015	
Background	Many districts have some sort of signage on exit ramps, but it is currently a mix of DO NOT ENTER (DNE) signs and WRONG WAY (WW) signs. Previous efforts have been primarily reactive, however, Ohio DOT is now attempting to implement signing and pavement marking improvements systematically at a statewide level. During a standardization effort, ODOT researched wrong-way crashes in 2015 and discovered that over the past 12 years, 75% of Ohio's wrong-way crashes occurred within 5 of ODOT's 12 districts. These five districts are largely urban and will be required to upgrade their signage. District 2 has already implemented the changes to its ramps and signage and improvements to urban areas in District 6 are almost complete. ODOT released a new standard construction drawing in 2016 to include revised standardized templates for future upgrades to ramp locations. These new templates and standardized processes will be utilized in rural districts as well as urban areas. This standard construction drawing is shown at the end of this deployment summary.	
Deployment Locations	• District 6 (Central Ohio) • District 2 (Northwest Ohio) • Downtown Columbus, OH	
Number of Sites	Continuing to grow, however the exact number is not known.	
Deployment Dates	• Signing and Pavement Marking Improvements: 2008 and 2013 • Detection with Dynamic Signing and Alerts: September 2015	
Test/Pilot or Long-term	• Signing and Pavement Marking Improvements: Long-term deployments • Detection with Dynamic Signing and alerts: One pilot deployment	
Countermeasure Types	1) Static Signing and Pavement Marking Improvements 2) Detection with Dynamic Signing and Alerts	
Description of Countermeasures	**1) Static Signing and Pavement Marking Improvements** • Two WRONG WAY (WW) signs on the same post, lower sign mounted at 3 ft. • Pavement marking extension lines to guide drivers onto entrance ramp.	

Deployment Summaries

- Red reflective tape on sign posts: WW and DO NOT ENTER (DNE) signs.
- Dual directional route marker signs at end of ramps.
- Additional signs beyond MUTCD minimums (both sides of ramp).
- Yellow painted island between entrance and exit ramps.
- Wrong-way arrows on exit ramps. (At some locations, this is not standard. Implemented in District 2.)

District 6 (Central Ohio):

- Implemented in approximately 2008
- Implemented signing/pavement markings similar to drawings dated August 2013
- Systematic implementation, at all ramps in the district

District 2 (Northwest Ohio):

- Implemented in August 2013
- At all ramps: Increased the number of DNE and WW signs, now one sign on each side of ramp
- At side-by side partial cloverleaf ramps: Implemented the entire improved design configuration

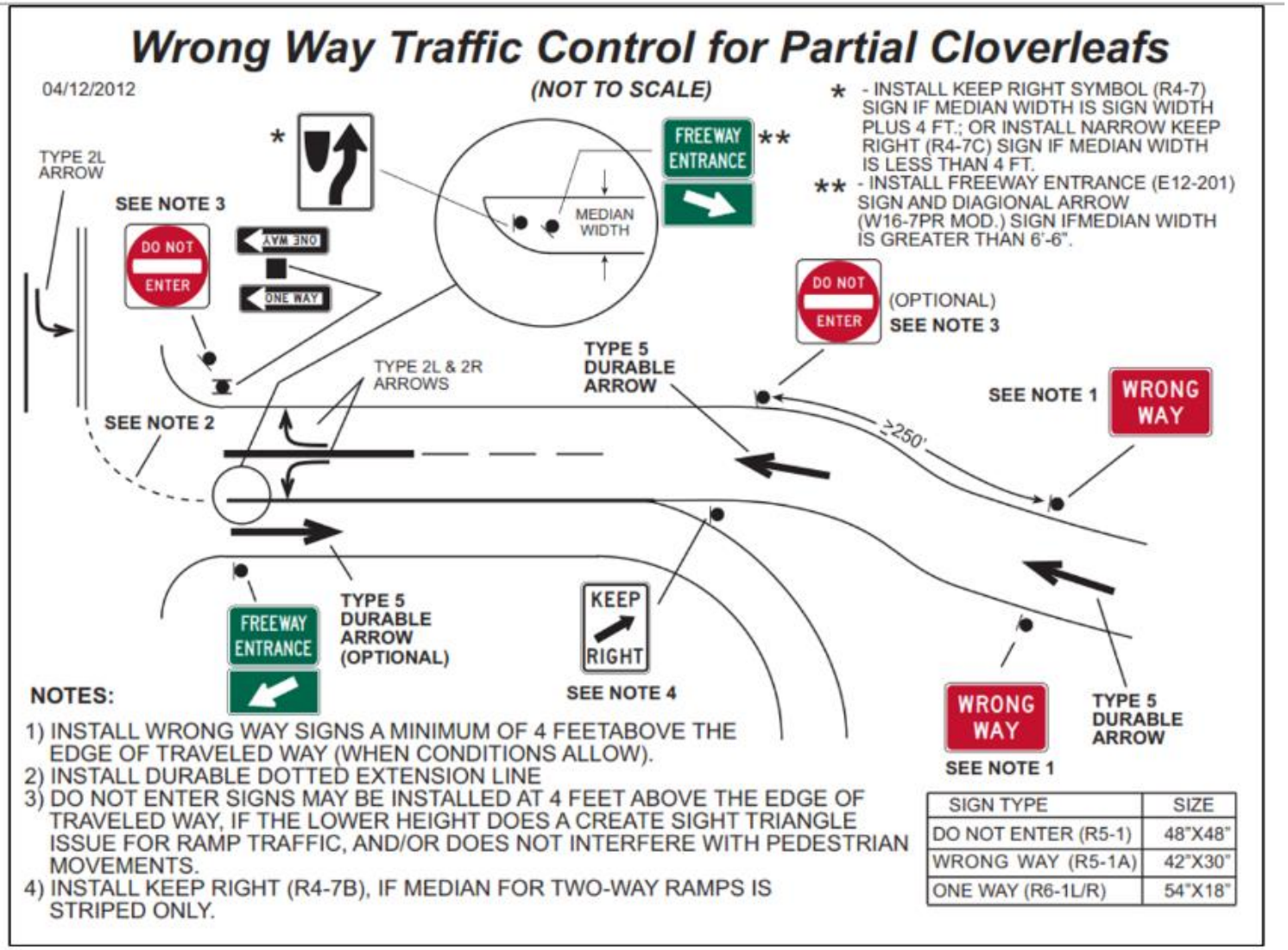
Two WW Signs on Same Post, Both Sides of Ramp, Red Reflective Tape on Posts
(Source: Ohio DOT)

Red Reflective Tape on Posts
(Source: Ohio DOT)

	Drawings/Details: See the following pages • Wrong-Way Traffic Control for Partial Cloverleaf Interchanges (Single Lane Exit) • Wrong-Way Traffic Control for Diamond Interchanges (Single Lane Exit) **2) Flashing LEDs Around WW Sign and Alerts** • Single pilot site at one ramp in downtown Columbus (District 6, Neil Avenue) • Installed in September 2015 • Vehicle-activated flashing LEDs around border of WW sign • Alert to Transportation Management Center (TMC) and law enforcement • Two sets of detection plus a camera for verification: One at the bottom of the ramp and another at the top of the ramp. If a vehicle is detected at the first detection site, the LED signs will flash. If the vehicle is detected at the second detection site, the Ohio DOT Traffic Management Center and Columbus Police Department dispatchers are notified.
Evaluation Efforts/Results	An evaluation is not planned due to the random nature of wrong-way crashes. • Video captured by traffic cameras have been used to verify that the system has been effective in instances where violators have self-corrected and turned around after reaching the flashing signs.
Coordination	ODOT plans to engage law enforcement in future efforts to help identify locations where wrong-way reports are occurring in order to target potential corridors for future improvements. See "Lessons Learned" section for additional information.
Guidelines or Standards	• Ohio DOT created drawings for partial cloverleaf interchanges (single lane exit) and diamond interchanges (single lane exit). See the following pages for drawings. • Ramp improvements per these drawings are anticipated to be standard statewide in summer 2016 following inclusion in the Traffic Engineering Manual; 2 of 12 Districts have already implemented improvements.
Local/Public Response	A local news story pointed out that Ohio DOT has implemented signing and pavement marking improvements: http://www.springfieldnewssun.com/news/news/transportation/wrong-way-crashes-often-deadly-hard-to-prevent/nk2m4/
Lessons Learned	Ohio continues to experience wrong-way fatalities and is working with law enforcement and looking at video from traffic cameras to determine entry points and trends of wrong-way drivers. Through this process ODOT hopes to identify potential corridors and implement additional detection with dynamic sign systems.
Future Plans	• ODOT has standardized the process of upgrading ramps by developing a standard construction drawing for wrong-way traffic control at ramps. See the following page for this drawing. • ODOT is considering additional detection with dynamic sign systems and possibly selecting potential corridors for additional implementation, especially in urban areas.

Deployment Summaries

Washington State DOT Design Detail (1 of 5)



Key Findings

- Design Considerations
- Effectiveness
- ITS/Technology Countermeasures
- Posting Messages to DMS – oncoming traffic
- Feedback from Local Motorists
- Coordination and Education

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Key Findings: Design Considerations

Non-Technology Improvements:

- Most common countermeasures:
  - Red reflective tape on sign posts
  - Oversized signs
  - Additional signs beyond MUTCD standards
  - Low-mounted signs
  - Pavement marking arrows
  - Skip lines to guide drivers onto entrance ramp
- Low-mounted signs range from 2 ft. to 5 ft.
  - Snow maintenance considerations
- Statewide standards vs. saturated deployments

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Key Findings: ITS/Technology

Technology Deployments:

- Nearly all have detection with alert to TMC
- Detection: Dual radar with camera, high definition radar, loops, video analytics
  - Success with redundancy
  - Many agencies reported decrease of false positives over project period
  - Single, side-fire HD radar: High number of false positives
- Passive vs. Reactive Alerts to WW Drivers
  - Vehicle-activated (active)
  - Flash continuously at night (passive)
  - Flash continuously day and night (passive)

* Passive systems do not require detection; less costly.

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Key Findings: ITS/Technology

Technology Deployments:

- In-pavement Lighting (appearance of stop bar)
  - FDOT - 4 pilot sites in rural areas
  - HCTRA phasing out in-pavement lighting due to maintenance issues
- RRFBs on WRONG WAY Signs
  - FDOT (Tampa) and Central Florida Expressway Authority
  - Technology evaluations underway
- Automated Functions in AMTS
  - HCTRA: Cameras automatically pan toward detection site upon detection, GIS-based map shows vehicle's direction of travel; one button to active nearby DMS

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Findings: Effectiveness

Effectiveness:

- Many deployments are quite recent
  - Will take time to have enough “after” data
- Difficult to evaluate
  - Low number of crashes; random patterns
  - Deployments not concentrated
  - Not tracking # of WW occurrences, just crash data
- Advancements in overall state of knowledge
  - Lessons learned, new research/evaluations, peer exchange

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Key Findings: Effectiveness

Effectiveness:

- **TxDOT San Antonio District:** WRONG WAY signs continuously blink at night/low light
  - 34% reduction in avg monthly WW events
  - 45 months of data (July 2012-March 2016)
- **Harris County Toll Road Authority (Texas):** WRONG WAY signs continuously blink at night/low light
  - 2015: Verified that 28 of 40 wrong-way drivers self-corrected
- **Anecdotal Reports:** Several agencies reported observing drivers self-correcting when encountering flashing signs (LEDs around sign border and RRFBs on signs)

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Key Findings: Messages on DMS

Message Content:

- Varies Widely Among Agencies

Rhode Island DOT:

Florida DOT (Tampa):

WRONG-WAY
DRIVER ALERT USE
EXTREME CAUTION

Florida DOT (Florida Turnpike – Miami):

WRONG WAY
DRIVER REPORTED
USE CAUTION

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Key Findings: Messages on DMS

Message Content:

HCTRA (Texas):

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Draft Key Findings: Messages on DMS

Message Content:

Texas DOT (San Antonio District):

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Key Findings: Messages on DMS

Message Content:

Texas DOT (San Antonio District): Plans to Change

Recommended

Alternative 15-character message

(Source: Finley, et al., 2016)

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Key Findings: Feedback from Local Motorists

- **Limited Public Response:**
  - Most reported very limited or no feedback from motorists after implementing countermeasures
- **Potential Influences from Media Coverage:**
  - Media coverage following wrong-way crashes - draws attention to the issue
  - Rhode Island DOT: Anecdotal observation that wrong-way driving events tend to decrease after media stories, suggesting that public education campaigns may have a positive effect

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Key Findings: Coordination and Education

- **Many agencies: Targeted efforts to address wrong-way driving have improved coordination with law enforcement**
  - San Antonio Wrong Way Task Force (formed in 2011)
    - Outreach to bar owners, e-tone on police radio
  - Missouri DOT: Multi-agency coalition selected I-44 in St. Louis for pilot corridor
  - Florida DOT: DUI education efforts underway

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Lessons Learned

Additional Lessons Learned:

See Deployment Summaries in the Final Report

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“Countermeasures for Wrong-Way Driving on Freeways”

Final Report: posted at www.enterprise.prog.org

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