

*TRB Webinar* – April 20, 2016

# **Wrong Way Driving:** **New Focus on a Persistent Problem**

Mark Doctor  
Federal Highway Administration  
Resource Center



# What do we know?

Wrong-way collisions are only about 3% of the crashes on high-speed divided highways

Wrong-way collisions are much more likely to result in fatal and serious injuries than other types of highway crashes



On average, about 360 lives are lost each year in about 260 fatal wrong-way collisions

*FARS Data 2004-2009*

# Is Alcohol a Factor?

About 69% of fatal wrong-way collisions had indications of alcohol involvement

*Source: NTSB Analysis of FARS data*

About 31% of all traffic fatalities involve alcohol impairment

*Source: NHTSA Traffic Safety Facts 2013 data*



# When are Wrong Way Collisions Occurring?

22% between 6:00 a.m. to 6:00 p.m.

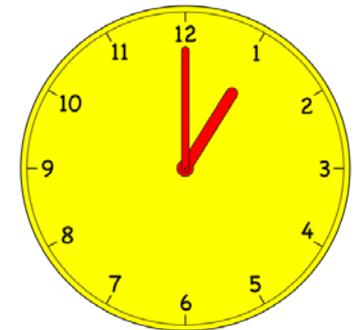
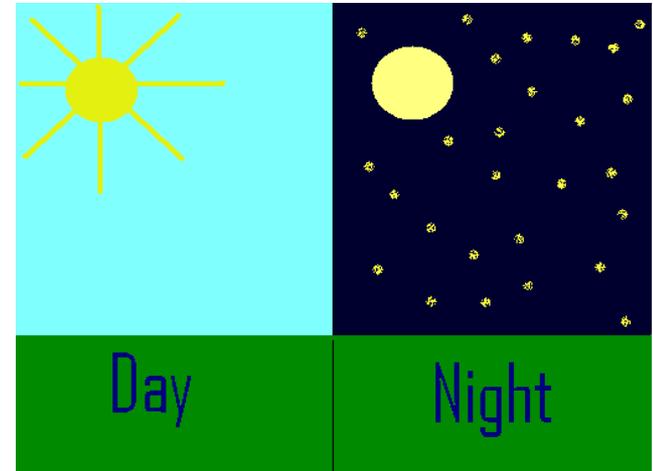
12% between 6:00 p.m. and 9:00 p.m.

18% between 9:00 p.m. and midnight

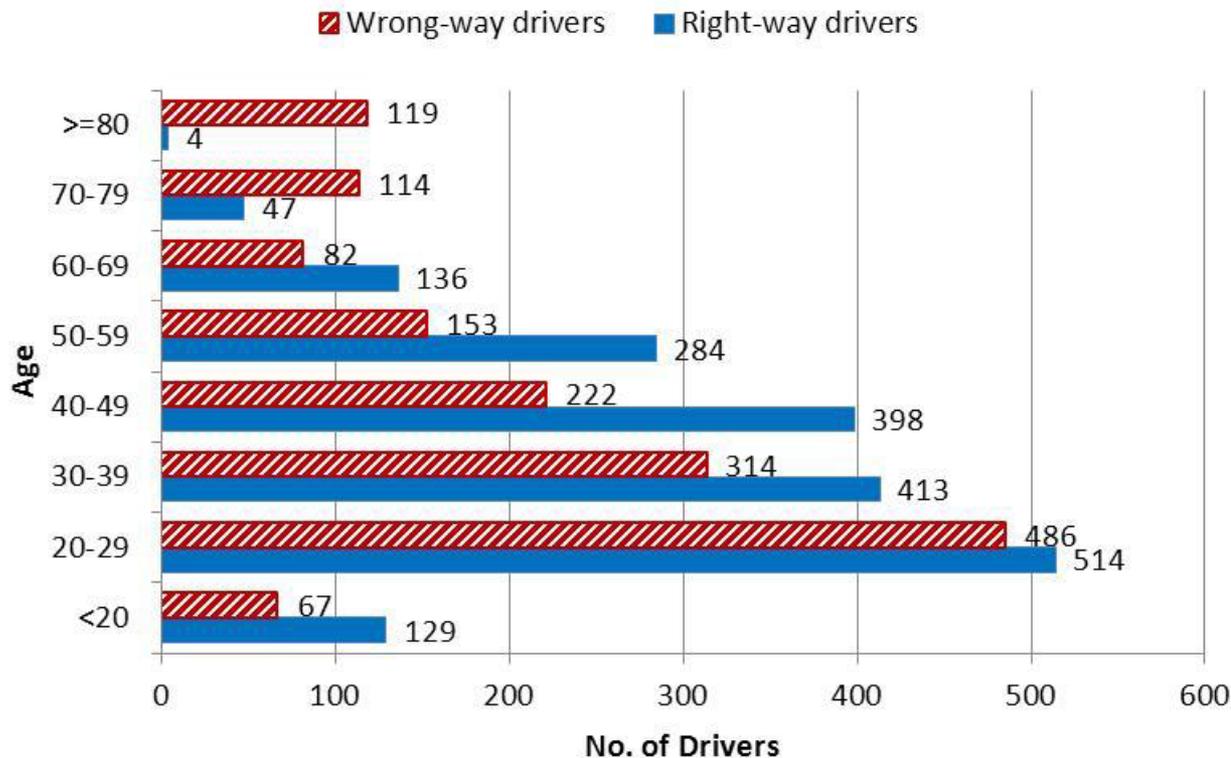
**31% between midnight and 3:00 a.m.**

17% between 3:00 a.m. and 6:00 a.m.

Approximately 57% occurred on the weekends



# Is Age a Factor?



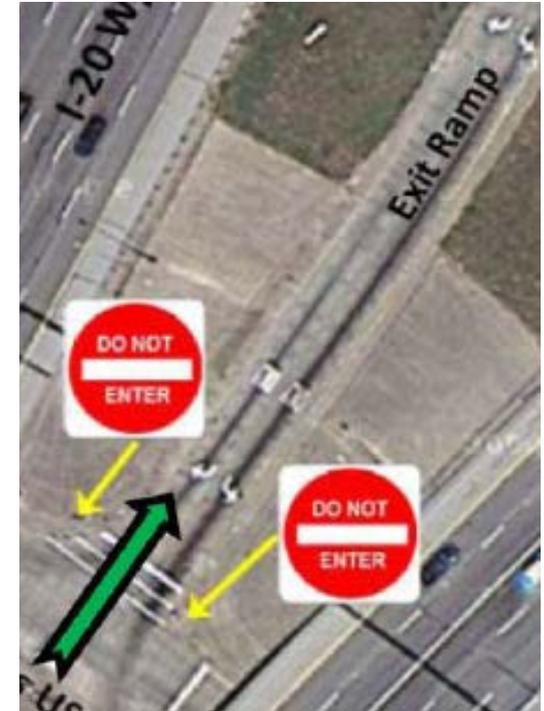
Drivers over the age of 70 constitute about 15% of the at-fault wrong-way drivers

Within the 70+ age group, wrong-way collisions are over-represented compared to other types of controlled-access highway crashes

# How is it happening?

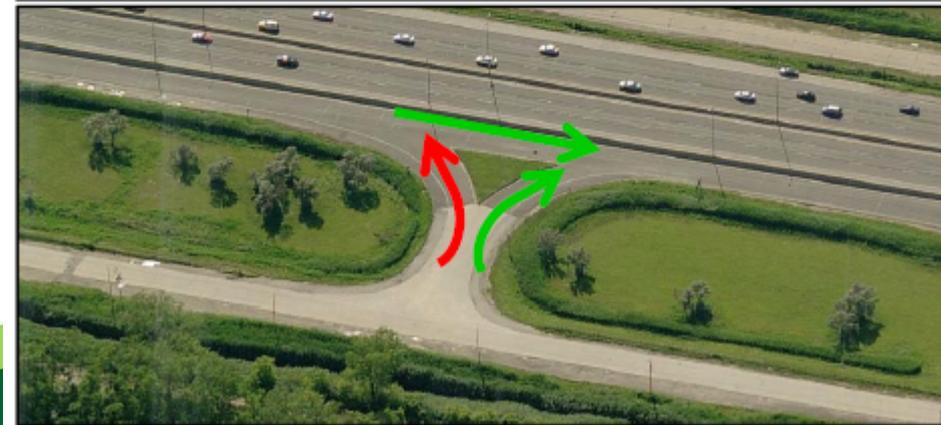
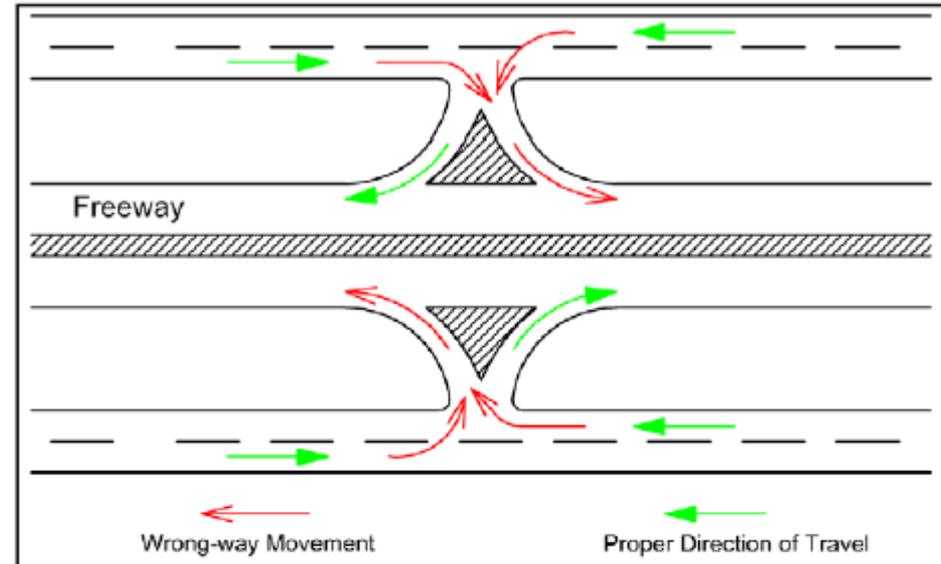
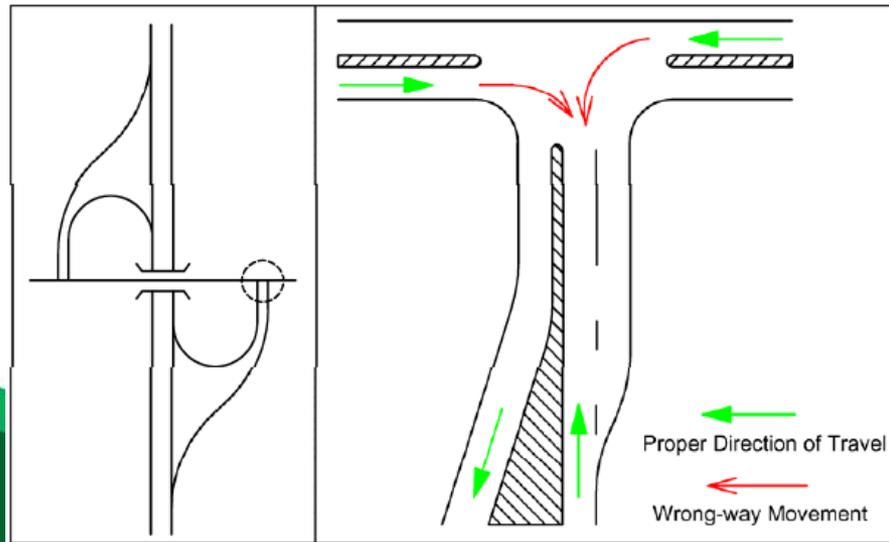
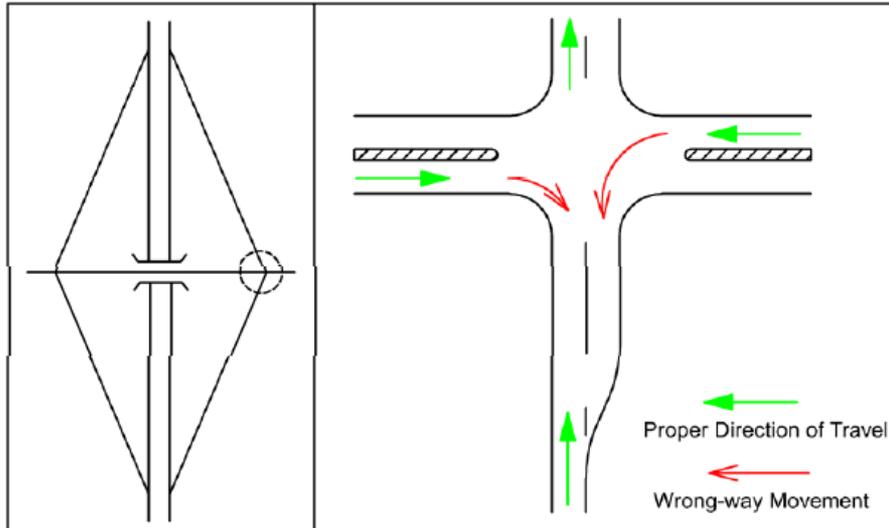
The primary origin of wrong-way movements (when the origin can be determined) is entering the wrong-way at an exit ramp

Other errors resulting in wrong-way movement include making an improper U-turn on the mainline or improperly using the emergency turnaround through the median



# Does the Interchange Type Matter?

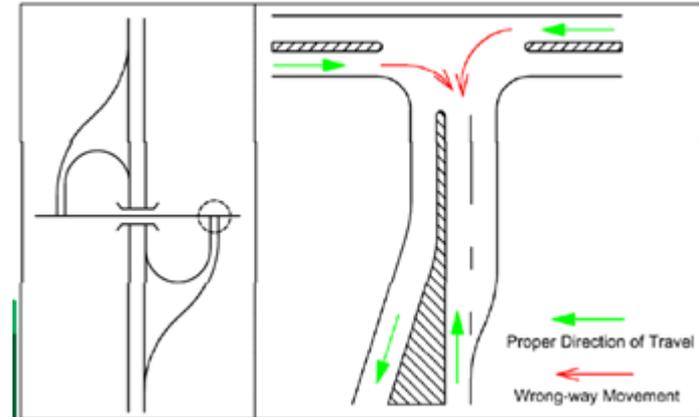
Certain interchange configurations may be more susceptible to WWD



Source: Illinois Guidelines for Reducing Wrong-Way Crashes on Freeways

# Lessons Learned: Michigan

- 60% W-W entries associated with partial cloverleaf interchanges
- Applied a systemic approach



*Photo courtesy of Michigan DOT*

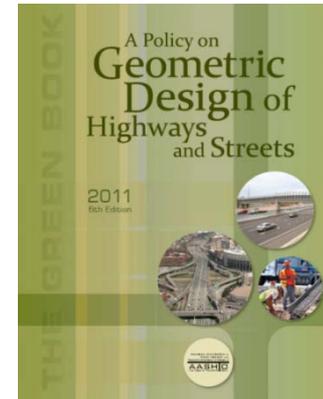
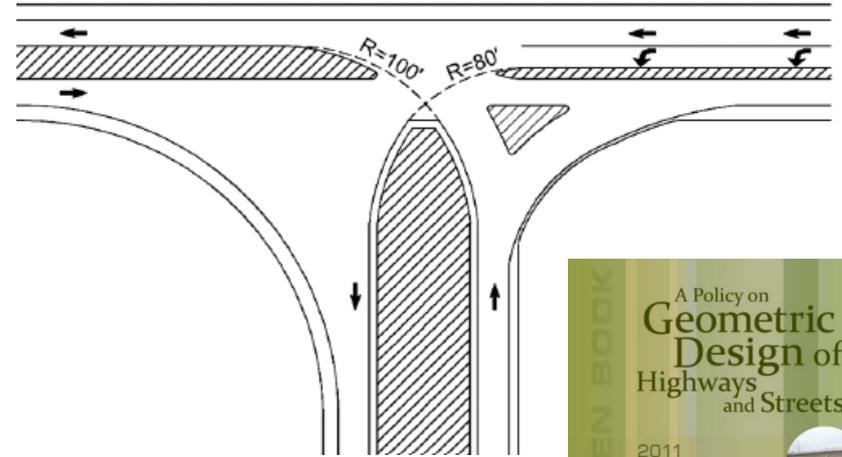
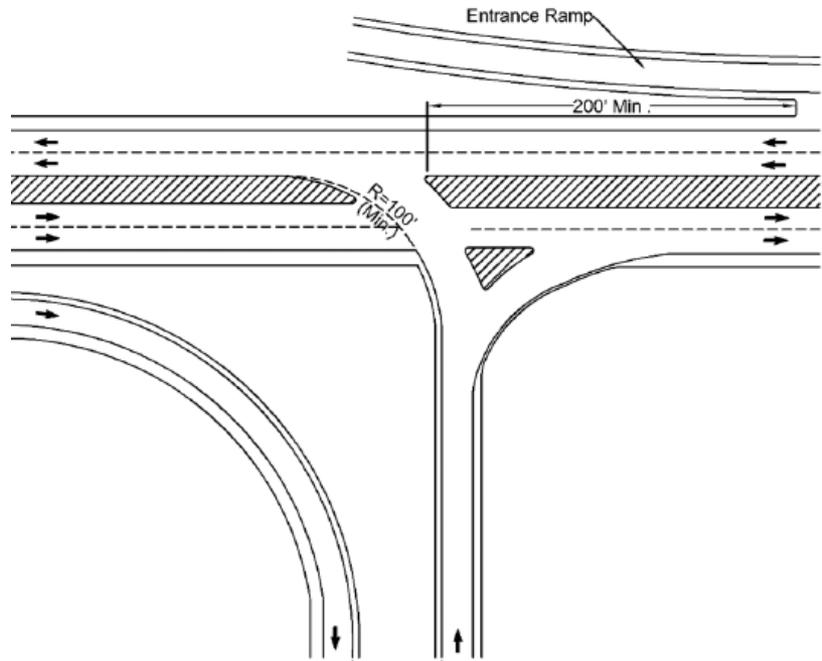
# Lessons Learned: Michigan

- SEVERITY DEPENDS ON THE CRASH LOCATION
  - WW crash on mainline: 42% fatal or severe injury
  - WW crash on ramp: 6% fatal or severe injury

**If you can stop a wrong-way driver along the ramp (before reaching the mainline), there is a much greater chance of lessening the crash severity**



# Ramp Terminal Designs

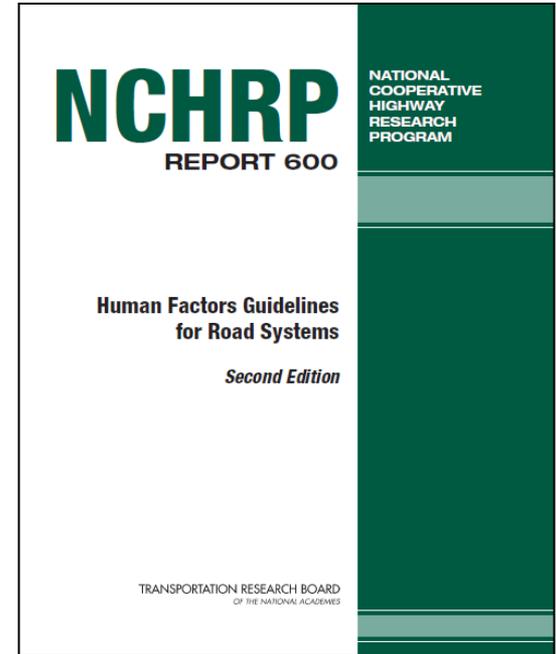


- Raised channelization and islands with angular edges
- Signs and markings to simplify decisions
- Increase/improve roadway lighting

# Human Factors

*“... countermeasures that reduce the affordance of driving the wrong way (such as geometric alterations) may be more effective than those which require the perceptual abilities of the drivers to function at a certain level (such as signage or pavement markings).”*

Source: NCHRP Report 600



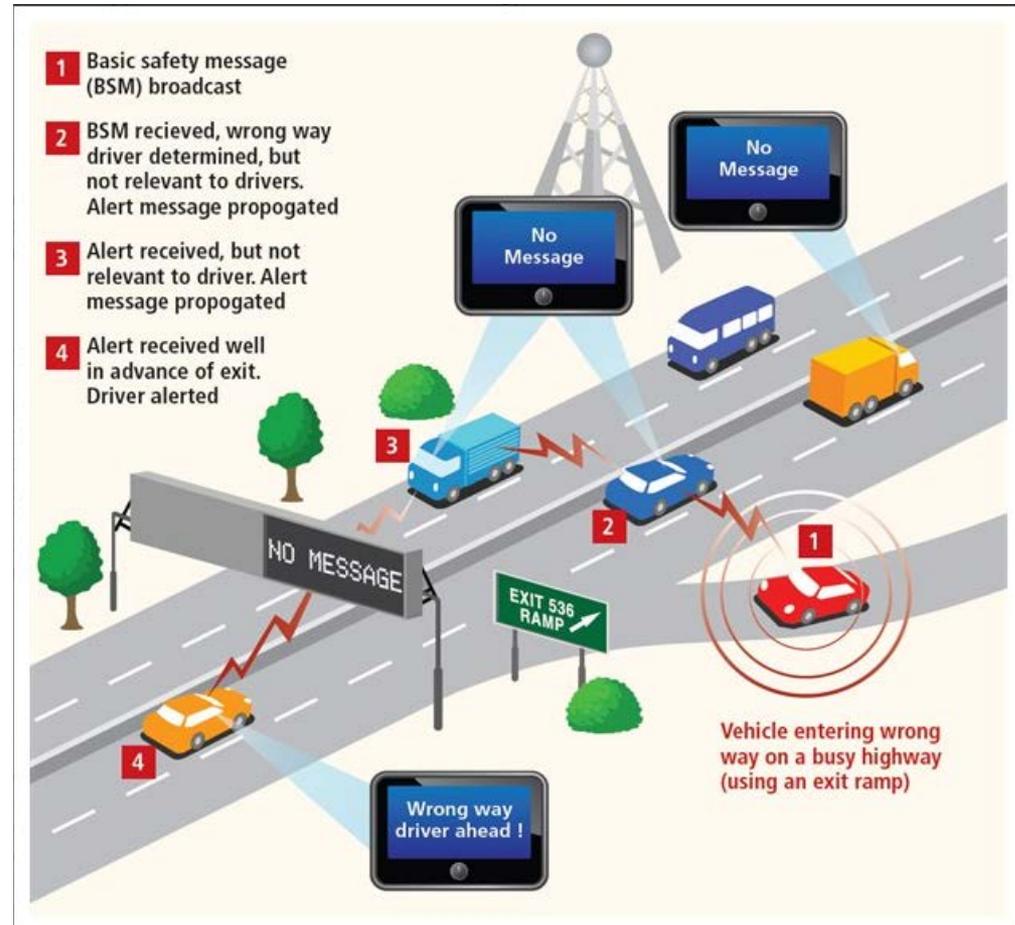
Roundabouts may provide excellent channelization against wrong-way entries



Location: Topeka, KS – I-70 at Rice Road

# Connected Vehicle Technologies

- Possible V2I and V2V applications adapted to address WWD



# Simple Strategies



Double-posted “Do Not Enter” and “Wrong Way” signs on an exit ramp  
(Courtesy of the New York State Department of Transportation)

# Need for a Coordinated Effort



**WRONG WAY DRIVER  
REPORTED -- USE  
EXTREME CAUTION**



# Reframe the Thinking

- Avoid a “drivers fault” mindset
- There are actions that can be taken to address the problem proactively
- Apply pertinent Human Factors knowledge



# Available Resources

safety.fhwa.dot.gov/intersection/other\_topics/wwd/

The screenshot shows the FHWA website interface. At the top, there is a navigation bar with the FHWA logo and text: "U.S. Department of Transportation Federal Highway Administration". To the right of the logo are links for "About", "Programs", "Resources", "Briefing Room", "Contact", and "Search FHWA". Social media icons for Facebook, YouTube, Twitter, and LinkedIn are also present. Below this is a "Safety" section with a sub-navigation bar containing "About", "Office of Safety Programs", "Initiatives", "Resources", and "Contact". A search box labeled "Search Safety" is on the right. The main content area has a breadcrumb trail: "FHWA Home / Safety / Intersection / Intersection Safety" and an "eSubscribe" button. On the left is a vertical menu with categories: "Intersection Safety", "Crash Facts", "Human Factors", "Pedestrians & Bicycles", "Innovative Intersection", "Conventional Intersections", "Rural & Local", "Other Topics", and "Program Contact". The "Wrong-Way Driving" category is highlighted in green. The main content area contains a "Wrong-Way Driving" section with a green header, followed by "Technical Materials", "Other Resources", "State & Federal Research", and "National Partners". A paragraph defines WWD: "Traffic safety and highway design literature has historically defined a wrong-way driving (WWD) crash as one in which a vehicle traveling in a direction opposing the legal flow of traffic on a high-speed divided highway or access ramp collides with a vehicle traveling on the same roadway in the proper direction. This definition typically concerns only controlled-access highways (freeways) and associated entrance and exit ramps, and excludes crashes that result from median crossover encroachments." Another paragraph states: "In the United States, WWD crashes result in 300 to 400 people killed each year on average, representing approximately 1 percent of the total number of traffic related fatalities that occur annually. While this is a small percentage overall, because WWD crashes involve head-on or opposite direction sideswipe crashes at high speeds, they tend to be relatively more severe than other types of crashes. However, there are many strategies and treatments that agencies can consider for implementation that are designed to address wrong-way maneuvers, ranging from geometric design elements, to conventional traffic control devices, to various ITS-based solutions." Below this is a "Technical Materials" section with a green header and a list of two items: "Guidelines for Reducing Wrong-Way Crashes on Freeways (Illinois, 2014) [PDF]" and "Wrong-Way Driving – Road Safety Audit Prompt List (FHWA, 2013) [HTML] [PDF]". An "Other Resources" section with a green header is at the bottom. On the right is a photograph of a red "WRONG WAY" sign on a wooden post, set against a cloudy sky and a road.

U.S. Department of Transportation  
Federal Highway Administration

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Pedestrians & Bicycles

Innovative Intersection

Conventional Intersections

Rural & Local

Other Topics

Program Contact

Jeffrey Shaw  
jeffrey.shaw@dot.gov

Wrong-Way Driving

Technical Materials  
Other Resources  
State & Federal Research  
National Partners

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Technical Materials

- Guidelines for Reducing Wrong-Way Crashes on Freeways (Illinois, 2014) [PDF]
- Wrong-Way Driving – Road Safety Audit Prompt List (FHWA, 2013) [HTML] [PDF]

Other Resources

# Thank You!

Mark Doctor, P.E.

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(404) 562-3732

## FHWA Office of Safety WWD Contact Information

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Intersections Program Manager

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Phone: (708) 283-3524





# WRONG WAY DRIVER PROJECT

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TxDOT San Antonio District – TransGuide  
John Gianotti, P.E.



# In Memory of Stephanie Brown

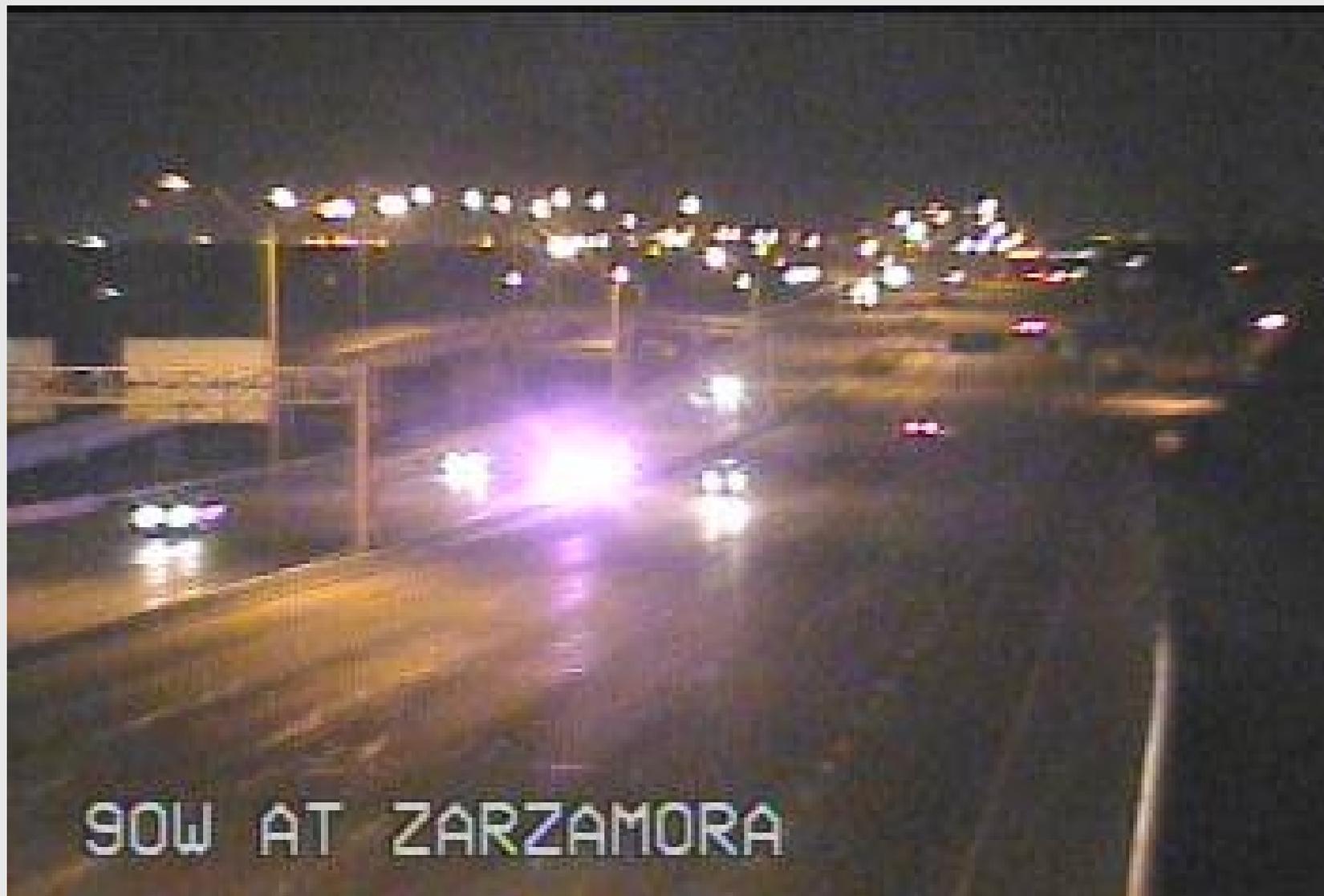


**SAPD Officer Stephanie Brown  
(27 yrs old) killed by a WWD in  
the line of Duty March 15, 2011**

**What do we know ?** WWD on IH 35 at 3 am – 4/1/14



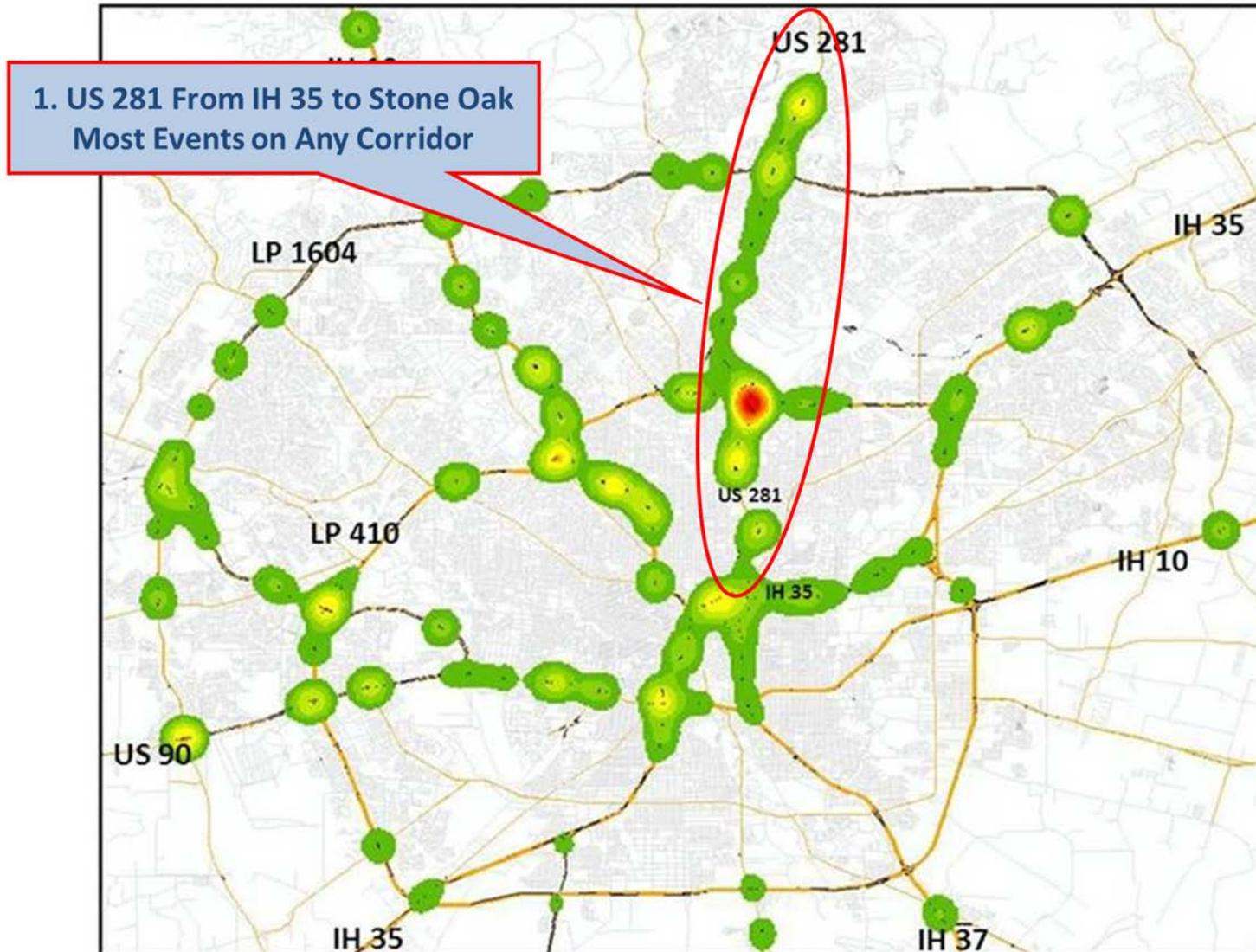
# WWD on US 90 at 3:30 am – 4/19/14



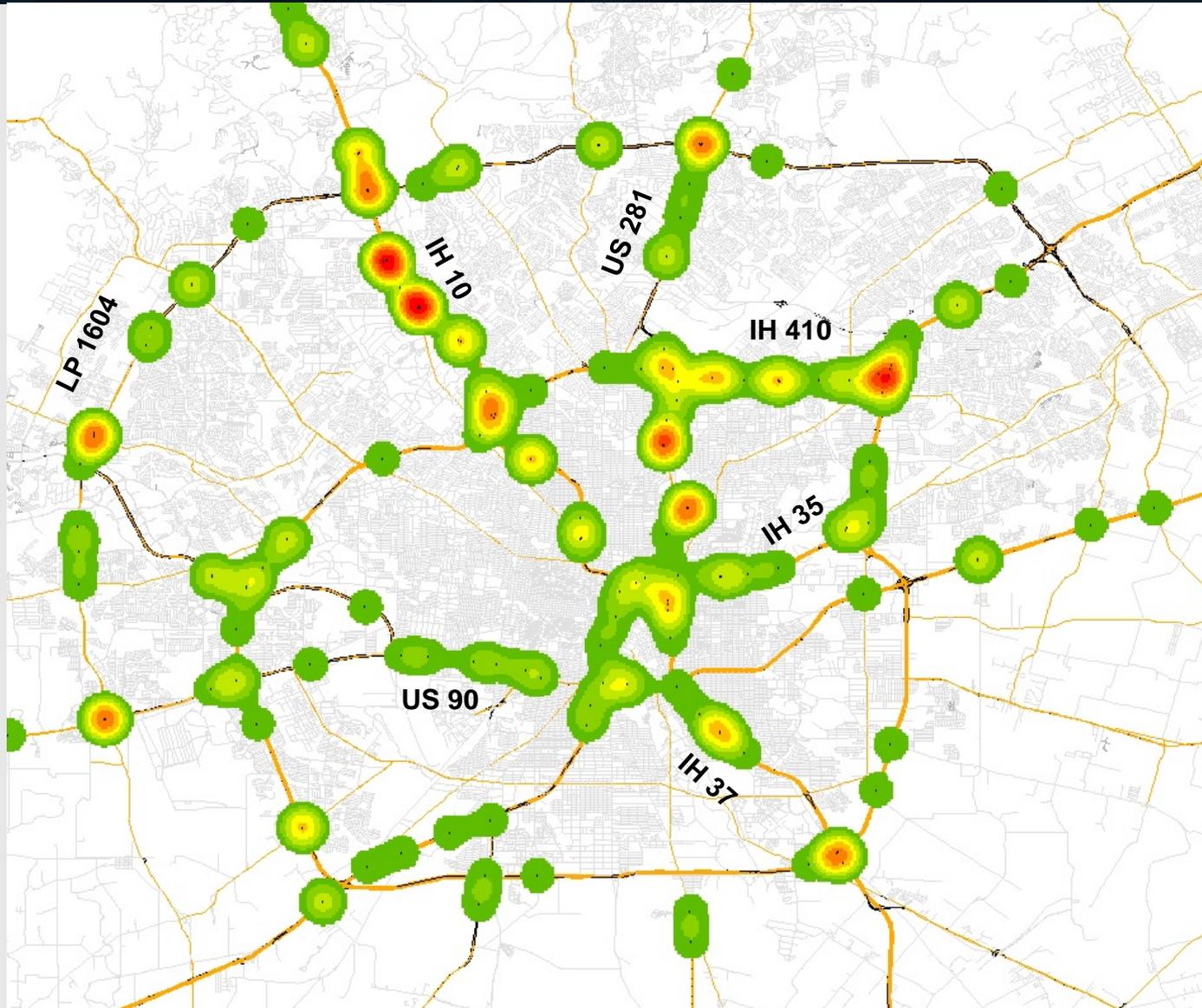
# WWD on IH 35 @ O'Connor, 4-18-15 at 1:55 am



# US 281 Pilot Project – 2011 data

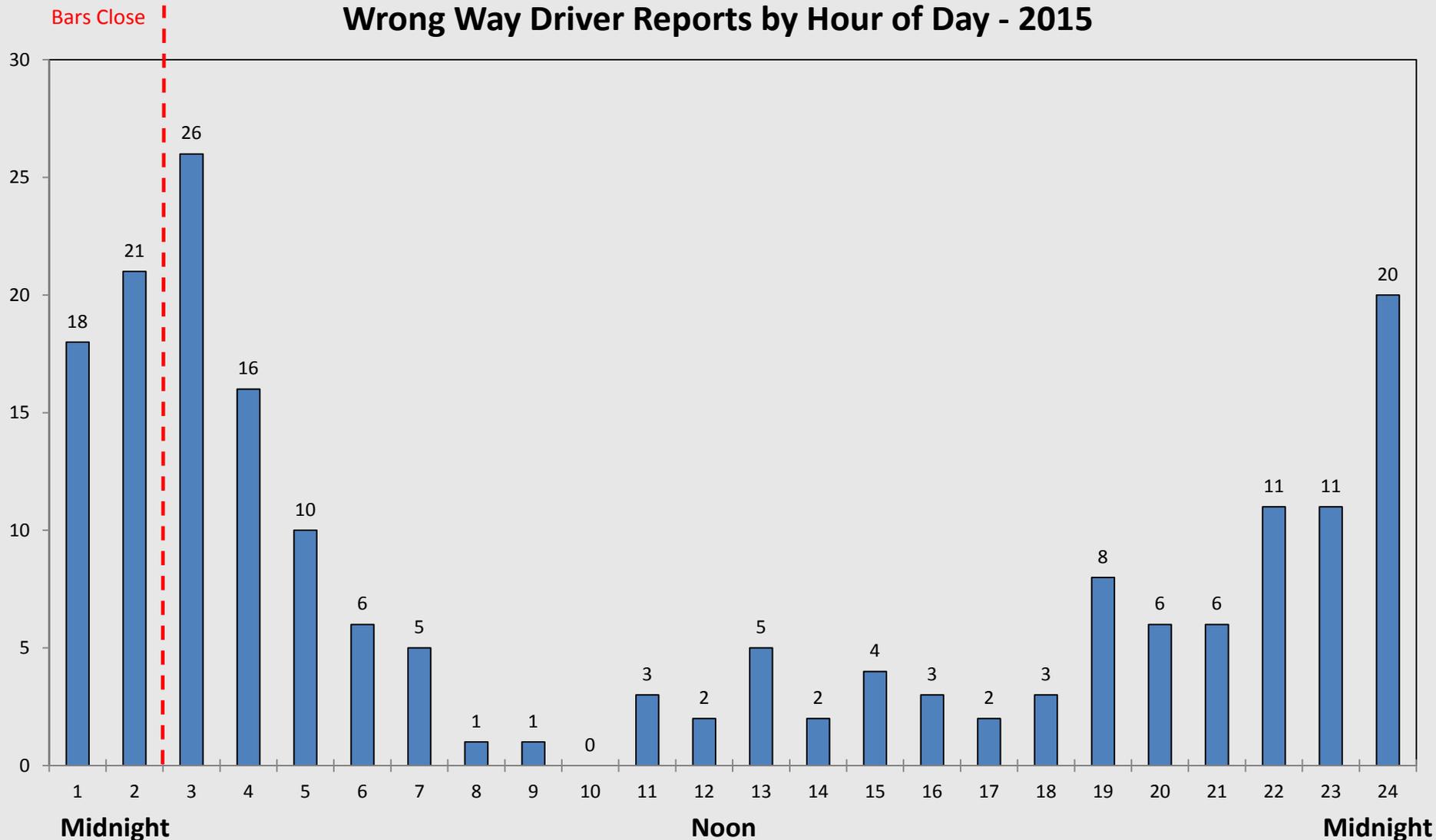


# 2015 GIS Density Map



# 2015 WWD Statistics Reports by Hour of the Day

## Wrong Way Driver Reports by Hour of Day - 2015



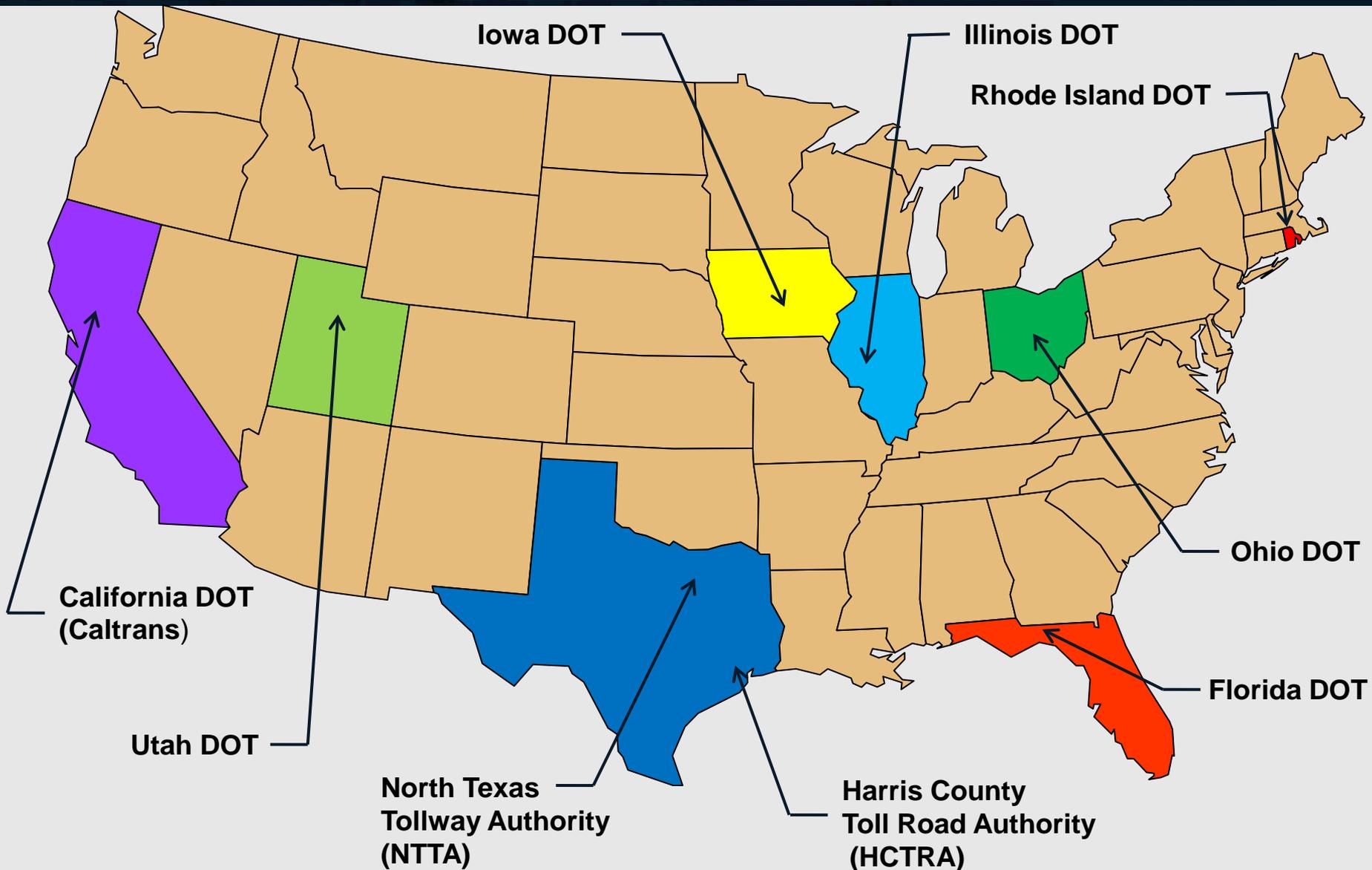
# San Antonio Wrong Way Driver Task Force

## ■ Challenges

- Determining points of entry for WWDs
- **More than 400 exit ramps in San Antonio metro area**
- How to get the attention of drivers that are severely impaired
- Manual of Uniform Traffic Control Devices compliance
- **Spike strips are not MUTCD compliant**



# Learn from others



Organized in the spring of 2011 to examine factors contributing to wrong way driving and to identify methods of addressing wrong way drivers

## Task Force Members

- Texas Department of Transportation
- San Antonio Police Department
- San Antonio Transportation and Capital Improvements (TCI)
- Bexar County Sheriff's Office
- Federal Highway Administration
- Texas A&M Transportation Institute

# Enhanced Static Signing & Pavement Markings

- Increased visibility of “WRONG WAY” and “DO NOT ENTER” signs shown to reduce wrong way driving
- TxDOT implemented measures recommended in a prior study:
  - “Countermeasures for Wrong-Way Movement on Freeways: Overview of Project Activities and Findings”, TTI 2003/2004
  - Field Inspection of all ramps using 2004 TTI Study Checklist
  - Ensure all required signs, pavement markings and RPM’s are in place and visible



**Wrong Way Arrows**  
**TxDOT Standard Sheet FPM (1)-12**

# Enhanced Static Signing & Pavement Markings

- Recommend additional (supplemental) measures:
  - **Add reflective tape on sign posts**
  - Increased size of ONE WAY signs
  - Additional WRONG WAY & DO NOT ENTER signs at critical locations
  - Lowered sign heights\*

\* Note: TxDOT now allows a 3 ft lowered sign height



# 2012-14 TTI WWD Study – WRONG WAY Sign Findings

- Takes longer to find sign at BAC 0.12 than at BAC = 0.04 and 0.08
- No difference in the time to identify the sign
  - Among treatments
  - Between sign heights
- Preference data did reveal some differences

Treatments	Thought Difficult to Find Sign
Standard	31%
Oversize	17%
Tape	13%
LED	13%

Treatments	Thought Caught Attention More
Oversize	92%
Tape	88%
LED	85%
2 FT	54%

# DMS Wrong Way Driver Warning Message – May 2011



- No lane instructions given
- Message displayed first, then operator searches for vehicle using cameras
- Displayed Until:
  - 1) WWD stopped,
  - 2) Accident found,
  - or
  - 3) SAPD cancels Alert

- Recommended warning messages

WARNING  
WRONG WAY DRIVER  
REPORTED

> 15 characters per line

WARNING  
WRONG WAY VEH  
REPORTED

< 15 characters per line

- Activate beacons when warning message displayed
  - Catch attention of motorists
  - Distinguish from other messages
- What if the sign does not have beacons?
  - Can flash entire message
  - Do not flash one line
- Post when wrong way driver reported
- Displayed in both directions of travel

# Detection Technologies (Radar Sensors)

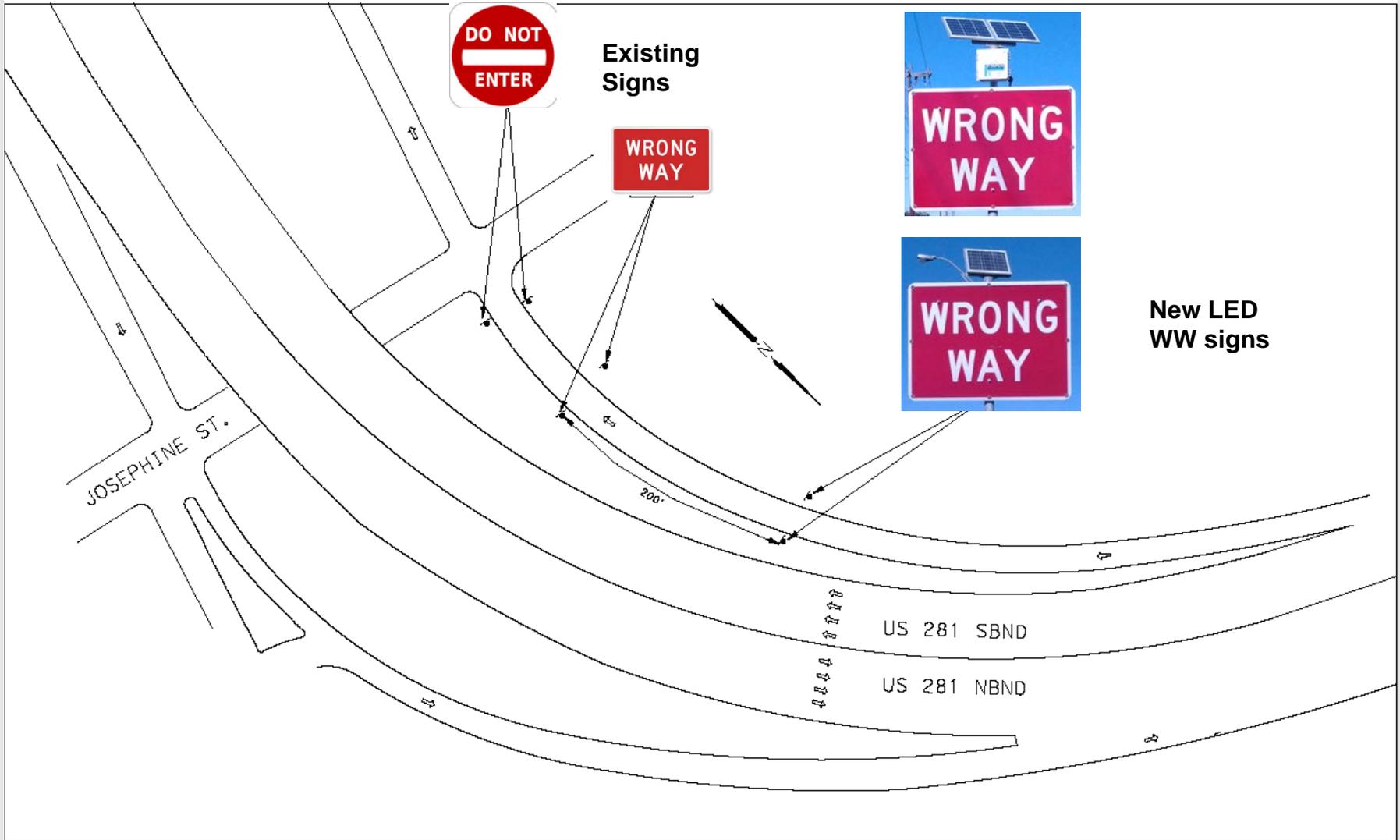
Radar on Exit Ramps



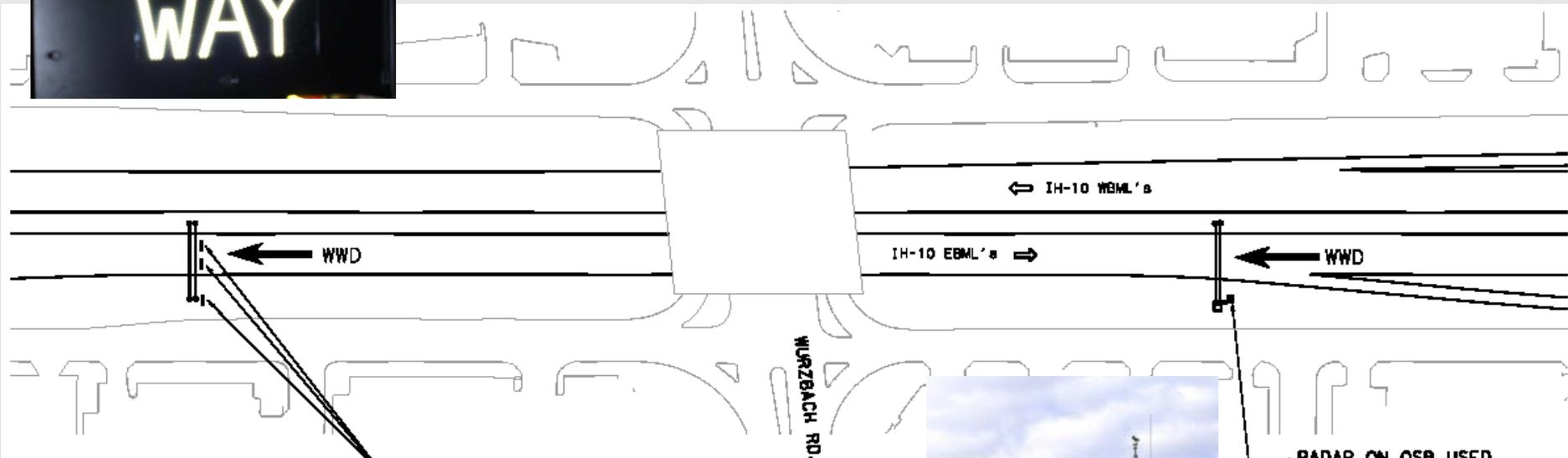
Radar on Mainlanes



# Exit Ramp Counter measures



# Mainlane Counter measures



LED & BLANK-OUT WRONG WAY SIGNS  
ACTIVATED BY CONTACT CLOSURE  
RADIO LINK



RADAR ON OSB USED  
FOR WWD DETECTION

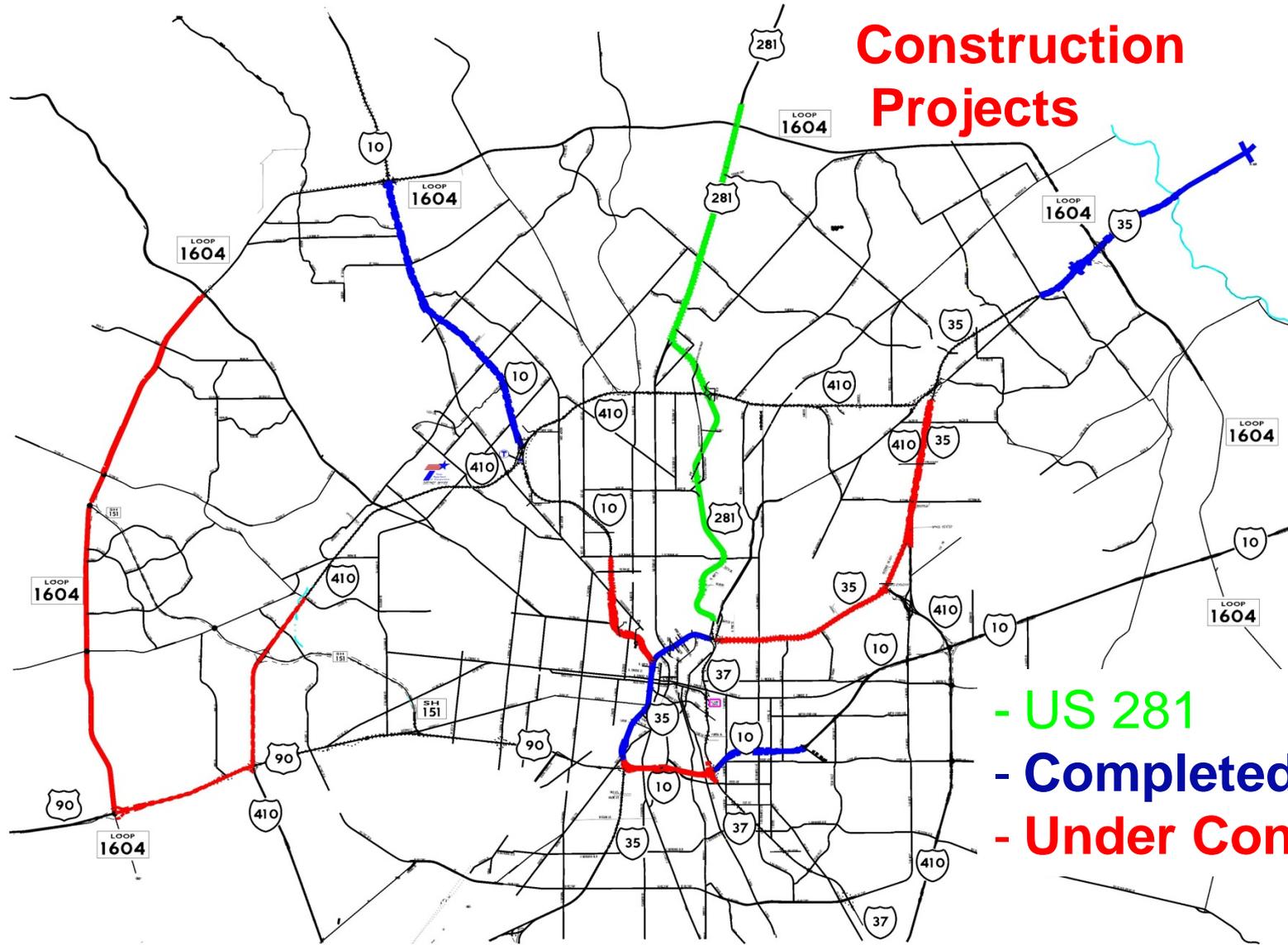
# Mainlane Counter measures



# US 281 Pilot Project - 44 Month Results

	July 2012 to March 2016
Reduction in Avg. Rate of WWD Events (TransGuide Logs)	<b>34.62%</b>
Reduction in Avg. Rate of WWD Events (SAPD 911 Logs)	<b>31.19%</b> (thru May 2014)
Project Cost	\$377,605
Annual Cost Savings – Avg. of SAPD & TxDOT data	\$280,282
Benefit - Cost ratio	14.8 : 1
Cost Recovery Time (yrs)	1.3

# Where are we going ?



## Construction Projects

- US 281
- Completed Projects
- Under Construction

# Detection methods

- Single point radars have proven to be unreliable for detecting WWD – too many false positives.
- Dual radars or detection at two points seem to more effective – TxDOT is just beginning to test the dual radar configuration.

## New detection ideas or methods

- ❖ Dual radars
- ❖ Dual radars with a camera
- ❖ Radar/camera combination device
- ❖ Pods in the pavement for detection
- ❖ Loops in the pavement

# SAVING LIVES

**53**

Serious crashes have been prevented since 2011 by TRANSGUIDE OPERATORS, SAPD DISPATCHERS AND OFFICERS.

**TRANSGUIDE  
OPERATORS**

David Rodrigues, Ben Lopez, Mando Rodriguez, Louis Ugarte, Crystal King, Mike Barker, Ishmael Trevino, Jason Wells, Christine Jauregui, Don Deaton

**SAPD  
DISPATCHERS**

Michael Summers, Stephanie Hovis, Ashley Hard, Dawn Campbell, Scott Arnold

# Thank you

John Gianotti, P.E.

[john.gianotti@txdot.gov](mailto:john.gianotti@txdot.gov)

2015 National Roadway  
Safety Award Winner  
TxDOT San Antonio District  
TransGuide Office  
Wrong Way Driver Program



# Wrong-Way Driving Detection and Prevention System: A Pilot Deployment

Bryan Homayouni, PE  
Manager of Traffic Operations  
Central Florida Expressway Authority

*Transportation Research Board Webinar - April 2016*



## ABOUT US

- Created as OOCEA in 1963
- Became Central Florida Expressway Authority on June 20, 2014
- Orlando metropolitan area
- CFX operates:
  - 109-centerline miles of expressway
  - 13 mainline toll plazas
  - Over 1,300,000 weekly transactions





# WRONG-WAY DRIVING STATISTICS

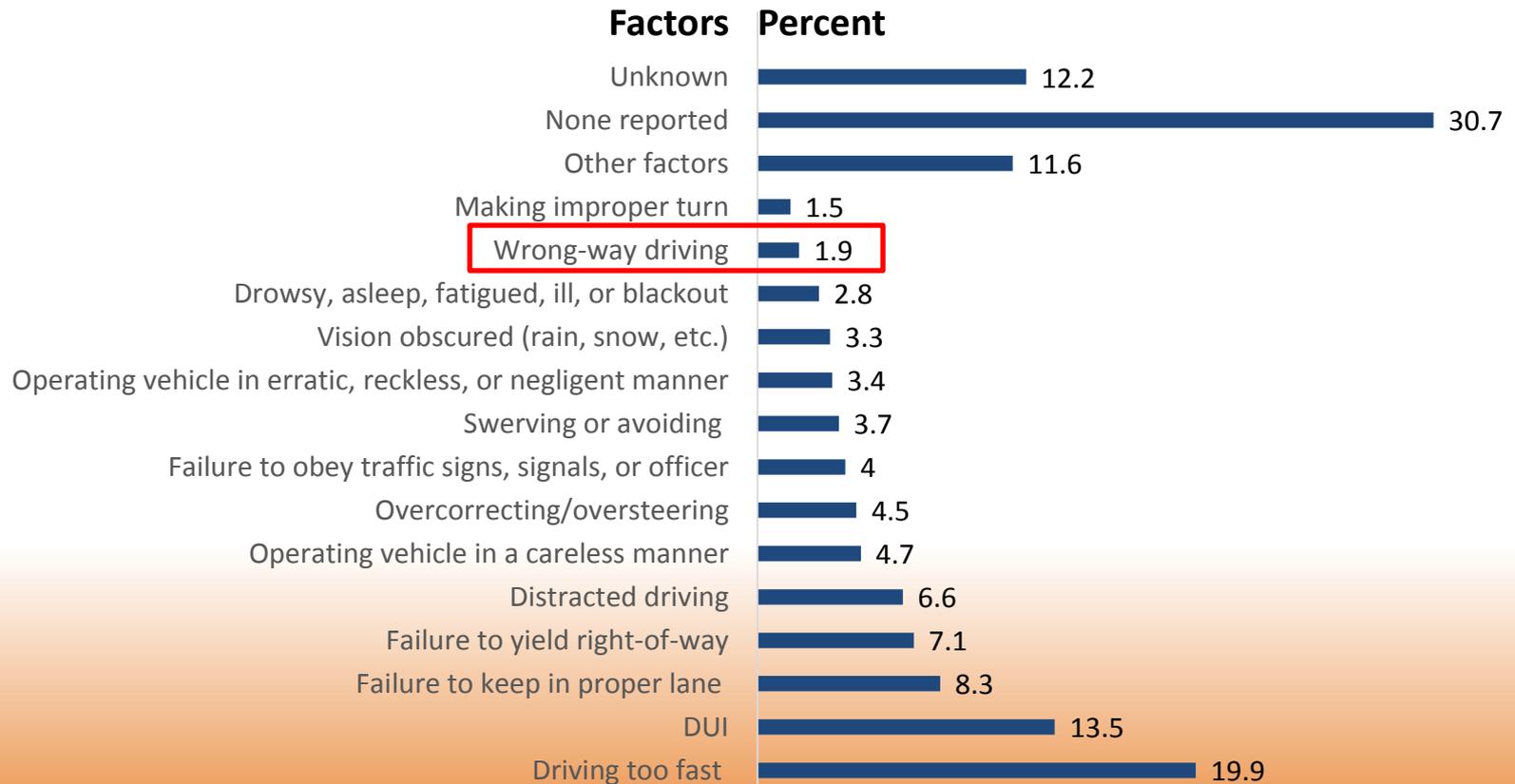
- Wrong-way collisions:
  - 3% of crashes on high-speed divided highways
  - 12-27 times higher fatality rate than other types of accidents
- Nationally:
  - 1,566 fatal wrong-way crashes on limited-access highways (2004-2009)
  - 2,139 fatalities (2004-2009)
  - Averages 261 fatal collisions nationally (2004-1011)
  - Averages 360 fatalities per year (2004-2011)





# WRONG-WAY DRIVING STATISTICS

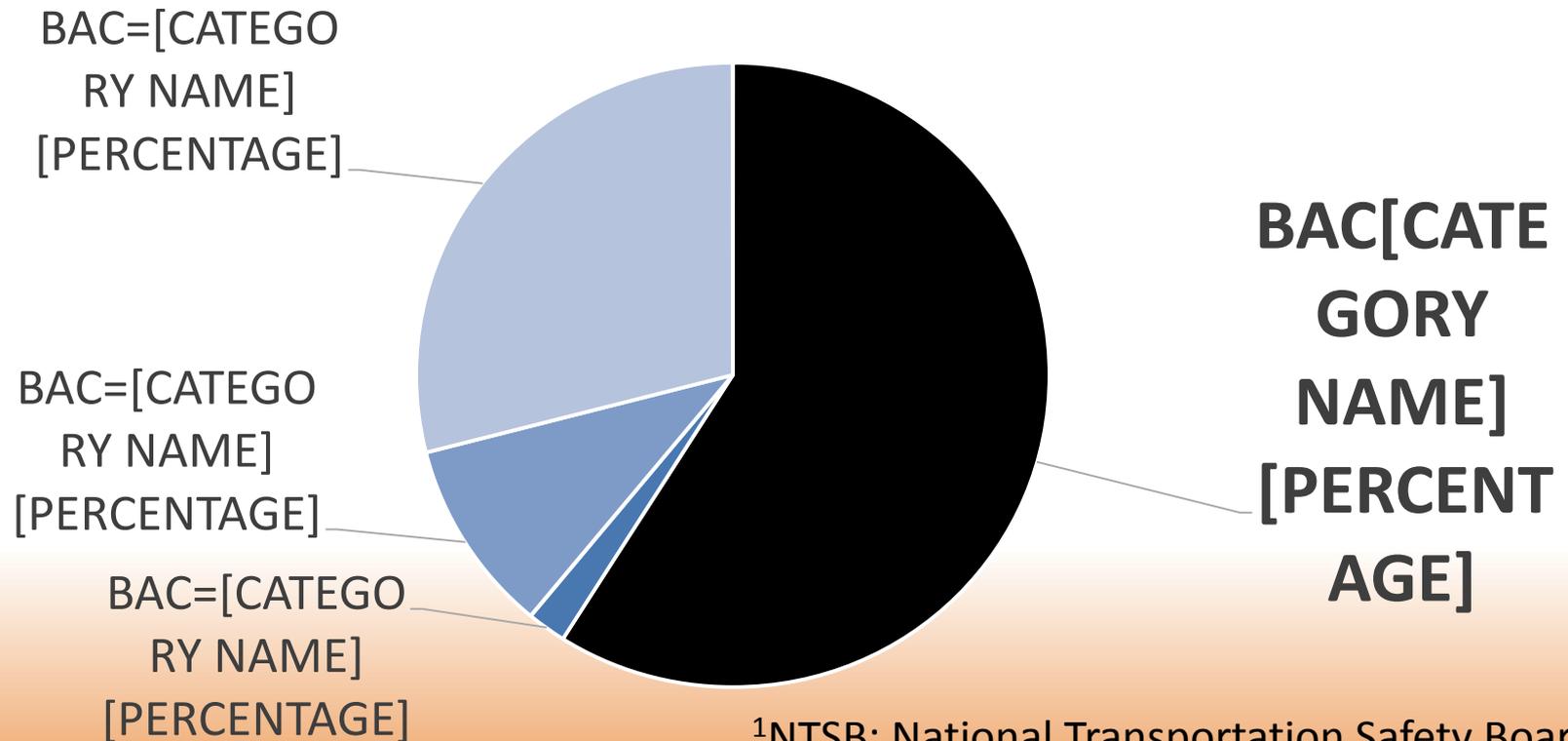
**Related Factors for Drivers and Motorcycle Riders Involved in Fatal Crashes, 2013**  
FARS/GES 2013 Data Summary (USDOT)





# WRONG-WAY DRIVING STATISTICS

NTSB<sup>1</sup> analysis of FARS<sup>2</sup> data (2004-2009) showing reported blood alcohol concentration (BAC) levels of wrong-way drivers



<sup>1</sup>NTSB: National Transportation Safety Board

<sup>2</sup>FARS: Fatality Analysis Reporting System



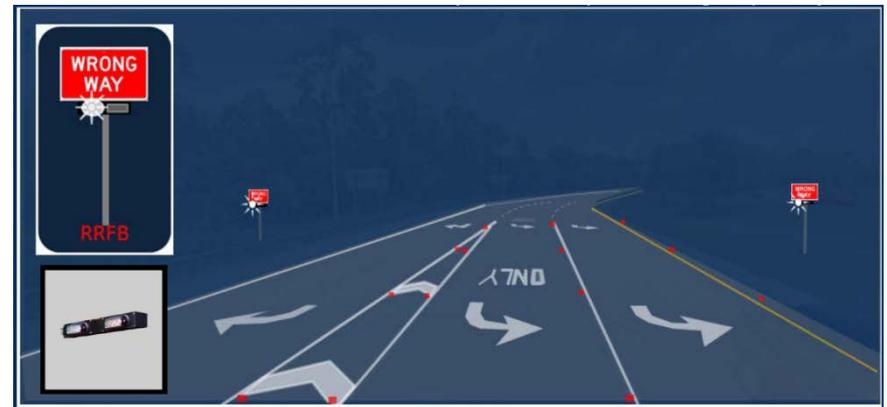
# STUDYING WRONG-WAY DRIVING ON CENTRAL FLORIDA EXPRESSWAYS

- Research study conducted by the University of Central Florida (UCF)
- Examination of:
  - Crash statistics
  - Citations
  - Reported WWD driving activity
  - Telephone survey of CFX customers
- Based on results of telephone survey:
  - Estimated that only 10% of drivers who see WWD activity call 911
  - WWD driving activity may be under-reported
  - Data collection required to determine the full extent of the problem



# STUDYING WRONG-WAY DRIVING ON CENTRAL FLORIDA EXPRESSWAYS

- Study recommended a pilot deployment of WWD countermeasures equipment
- Pilot deployment will:
  - Test RRFB countermeasures
  - Collect data to help CFX determine the extent of WWD activity at the pilot locations
- Study led to a model for predicting number of crashes associated with WWD on CFX network



Picture courtesy of UCF (Concept Slide Produced by UCF and Presented to CFX in Spring 2013)

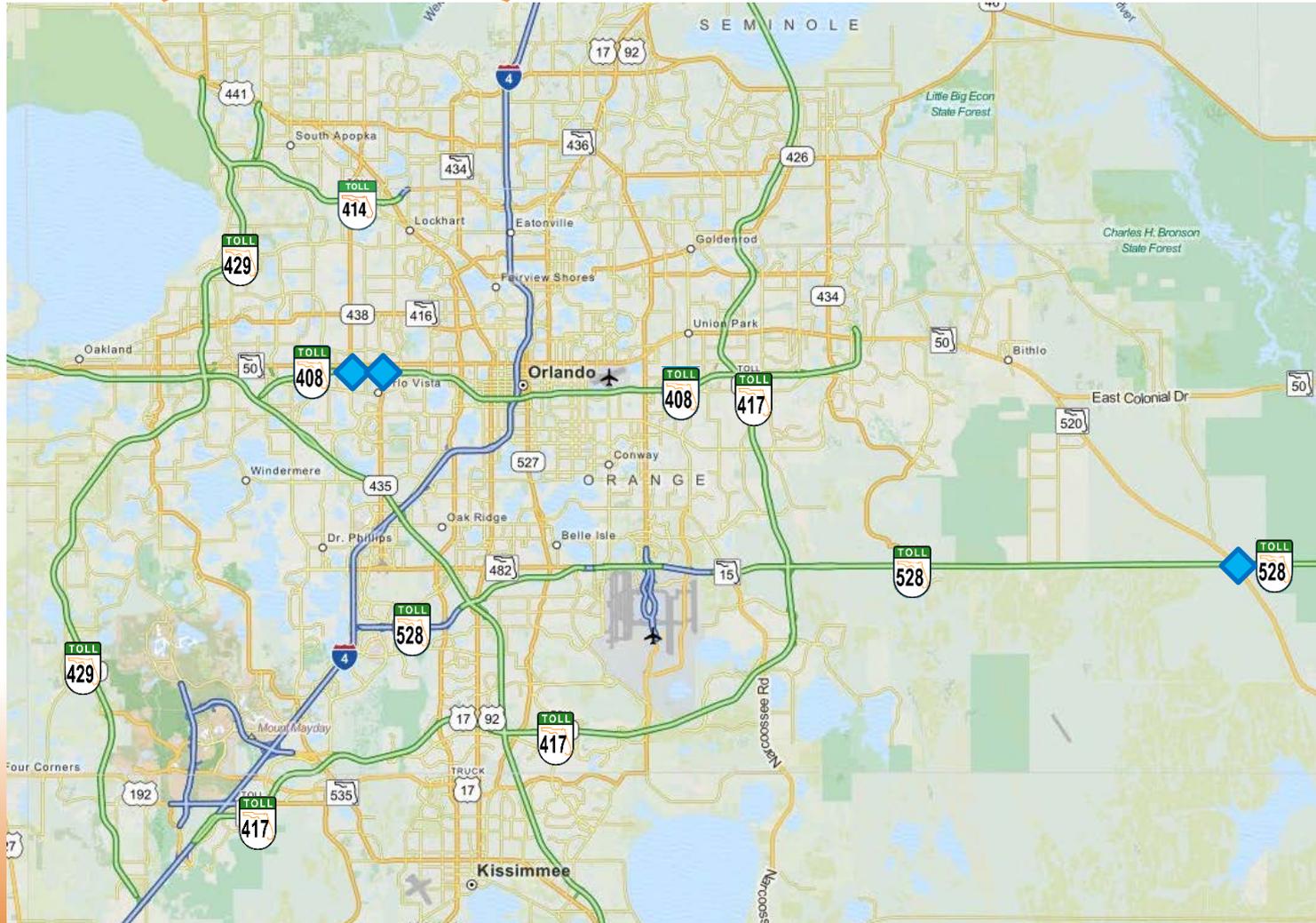


## PARTNERS

- U.S. Department of Transportation Federal Highway Administration
- University of Central Florida (UCF)
- Florida Highway Patrol (FHP)
- Florida Department of Transportation (FDOT)
- Central Florida Expressway Authority (CFX)

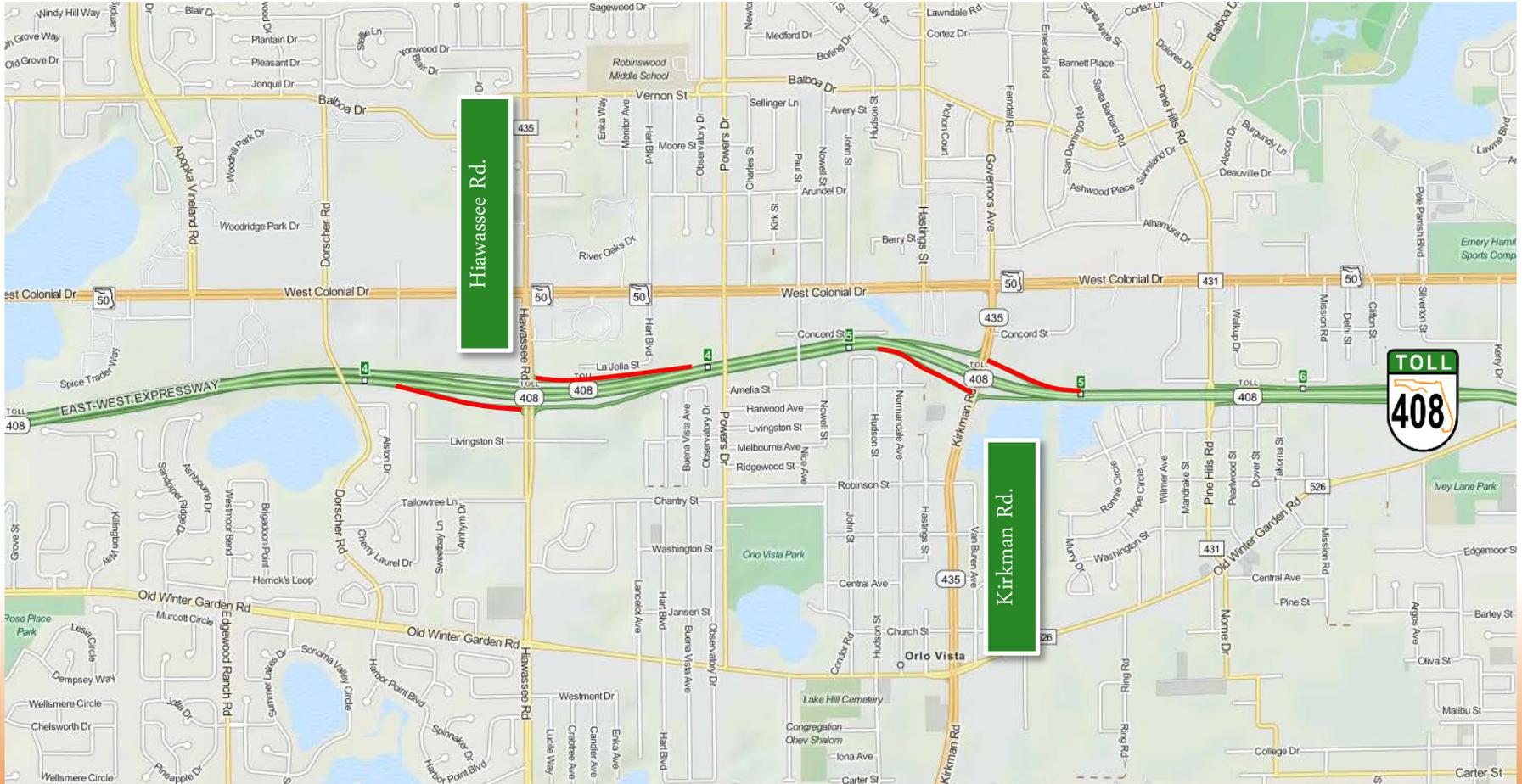


# CURRENT DEPLOYMENT SITES (PHASE 1)





# CURRENT DEPLOYMENT SITES (PHASE 1)





# CURRENT DEPLOYMENT SITES (PHASE 1)





# PARKING LOT TESTING

- Temporary parking lot test conducted to verify technology
- Tested visibility of beacons during day and night conditions
- Experimented with radar detection zones in a controlled environment





# PARKING LOT TESTING





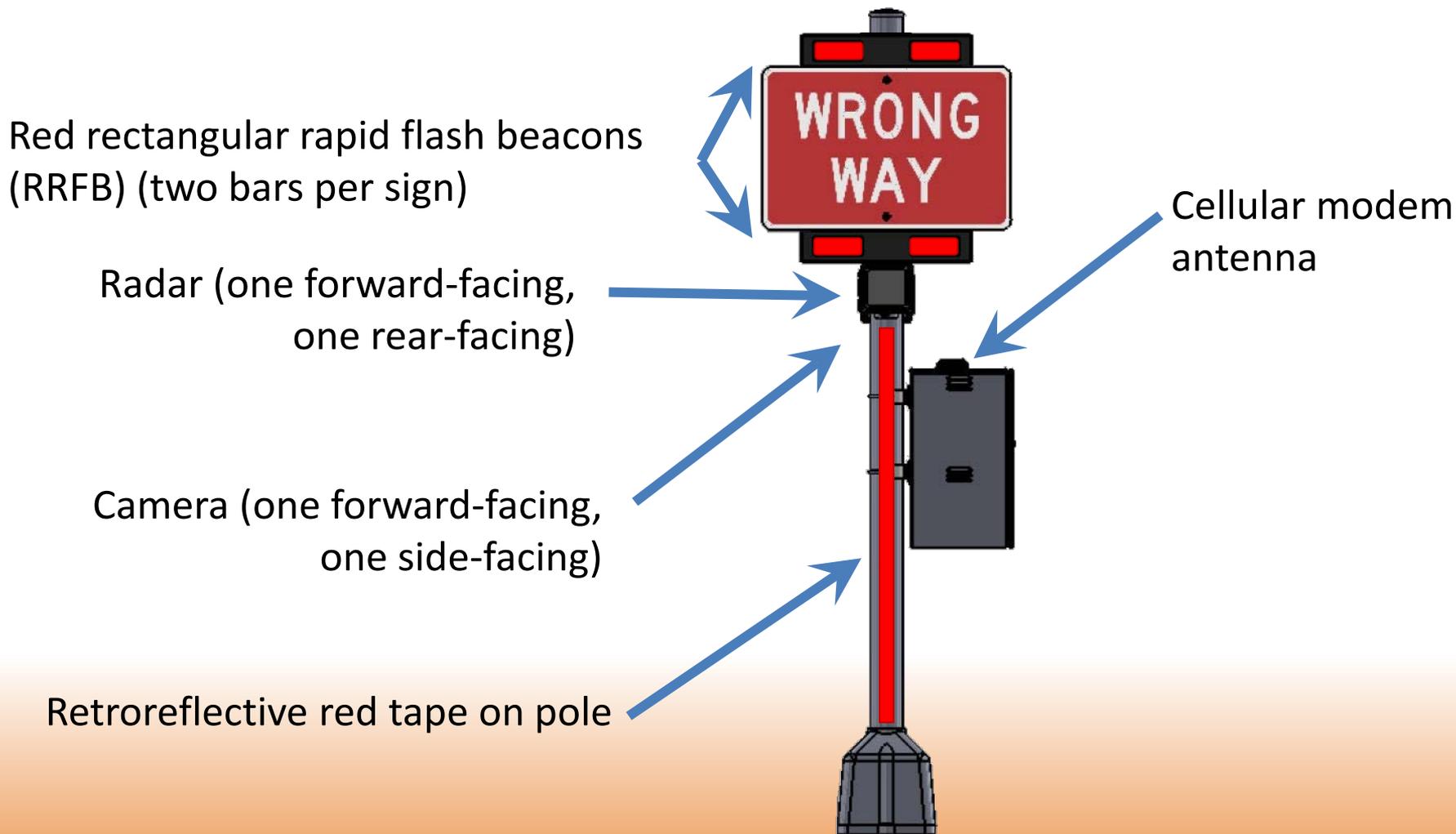
## PRELIMINARY LESSONS-LEARNED

- Two light bars per sign (top and bottom) will be used to improve visibility of beacons
  - Initial test only had one light bar
- Two pairs of signs will be deployed at each ramp (beacons at the remote pair slaved to the first pair)
  - Provides enhanced visibility of warning in the event the driver passes the first sign before beacon activation





# RAMP DETECTION EQUIPMENT

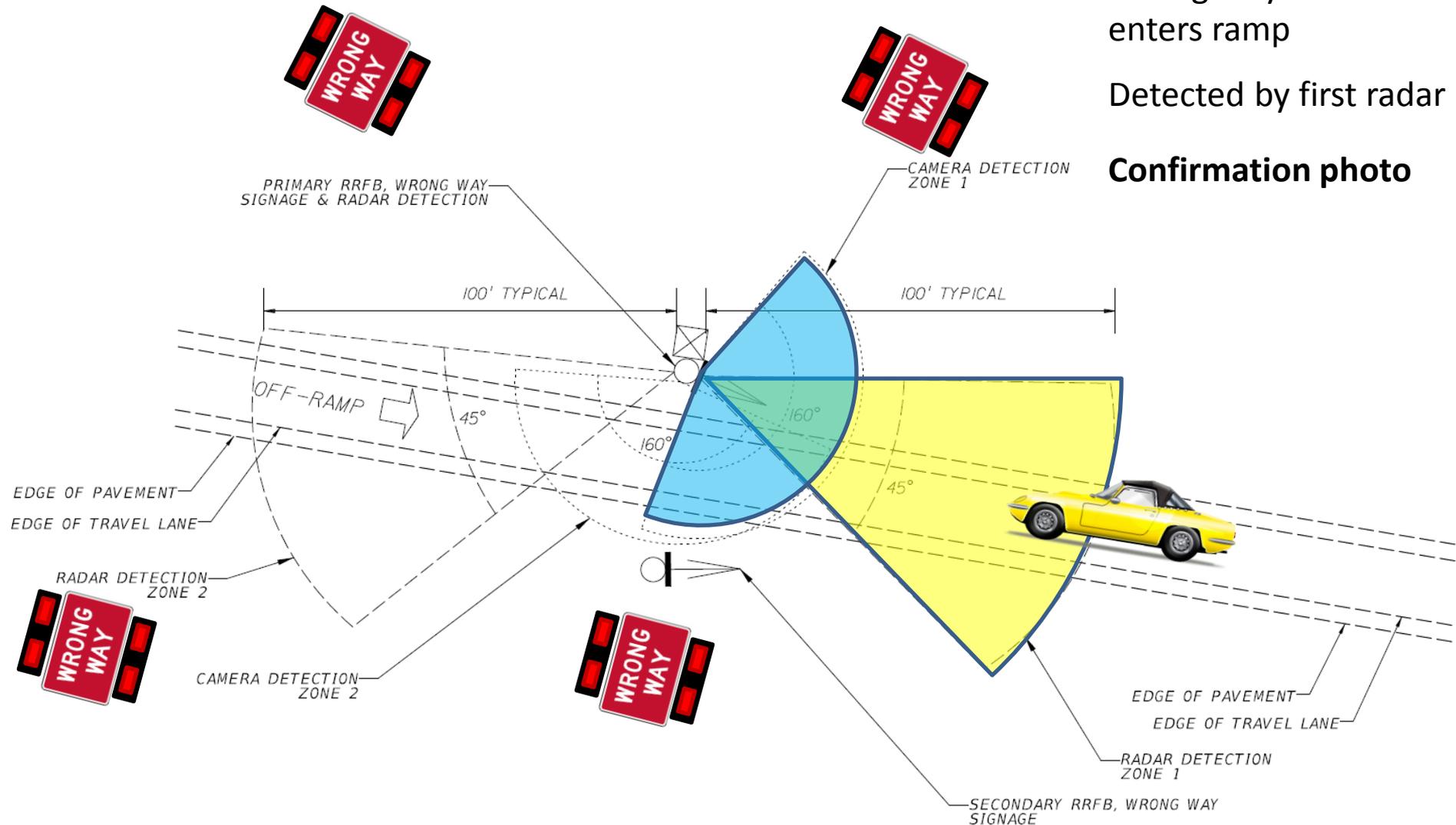




# RAMP DETECTION EQUIPMENT

Wrong-way driver  
enters ramp  
Detected by first radar

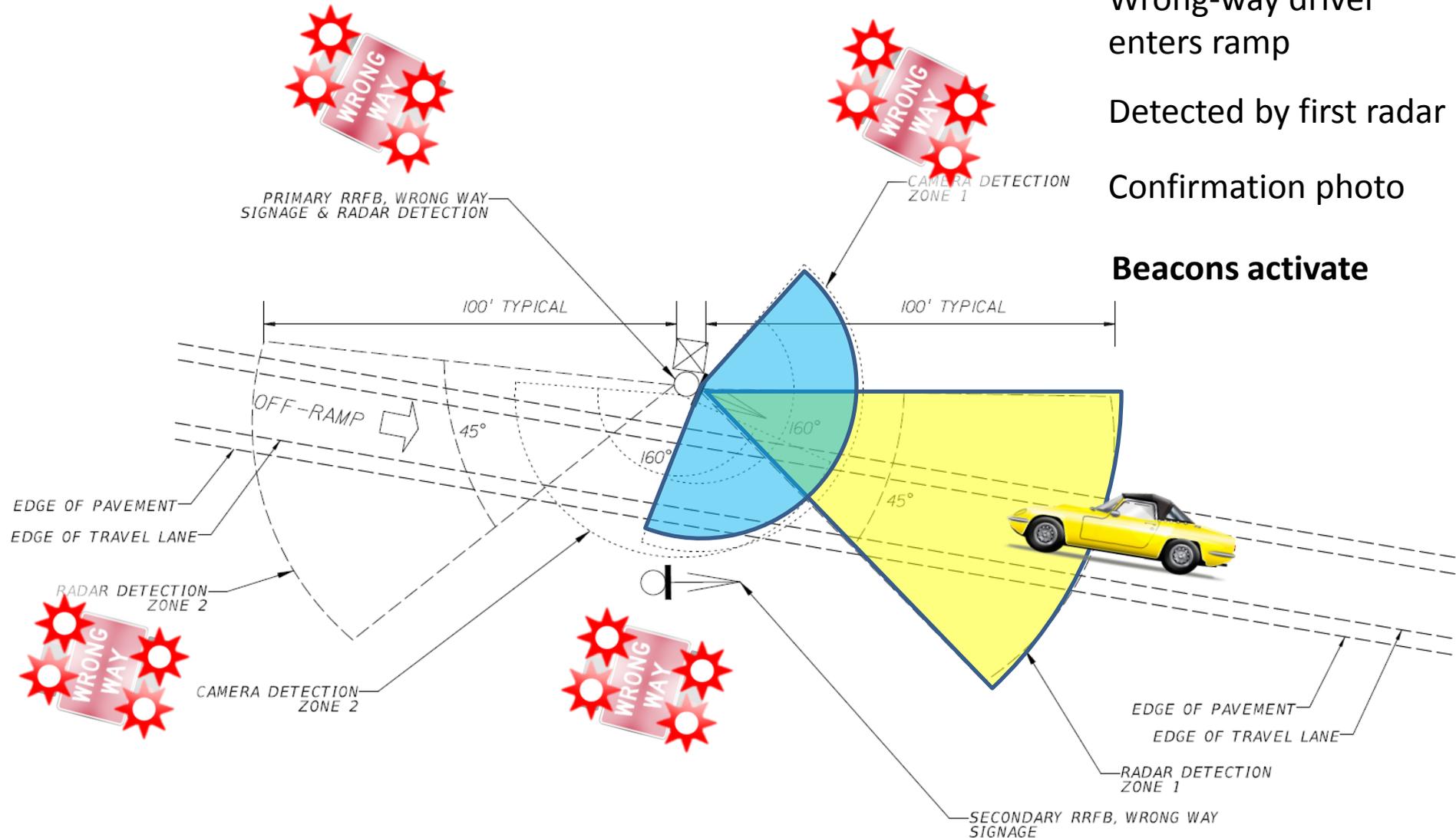
**Confirmation photo**





# RAMP DETECTION EQUIPMENT

- Wrong-way driver enters ramp
- Detected by first radar
- Confirmation photo
- Beacons activate





# RAMP DETECTION EQUIPMENT



Wrong-way driver continues

Detected by second radar

Confirmation photo

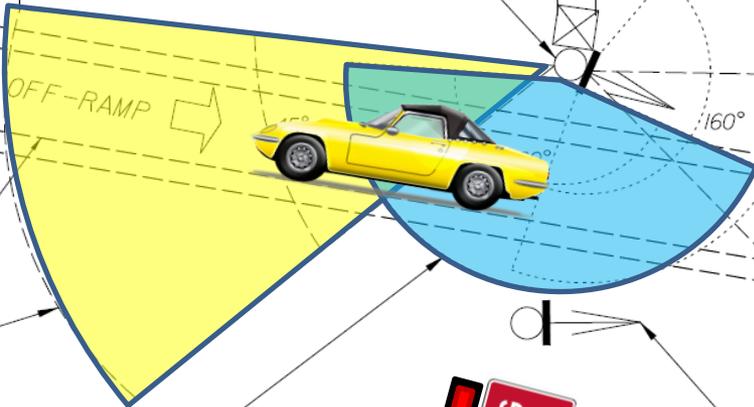
**System alert**

PRIMARY RRFB, WRONG WAY SIGNAGE & RADAR DETECTION

CAMERA DETECTION ZONE 1

100' TYPICAL

100' TYPICAL



EDGE OF PAVEMENT  
EDGE OF TRAVEL LANE

RADAR DETECTION ZONE 2



CAMERA DETECTION ZONE 2



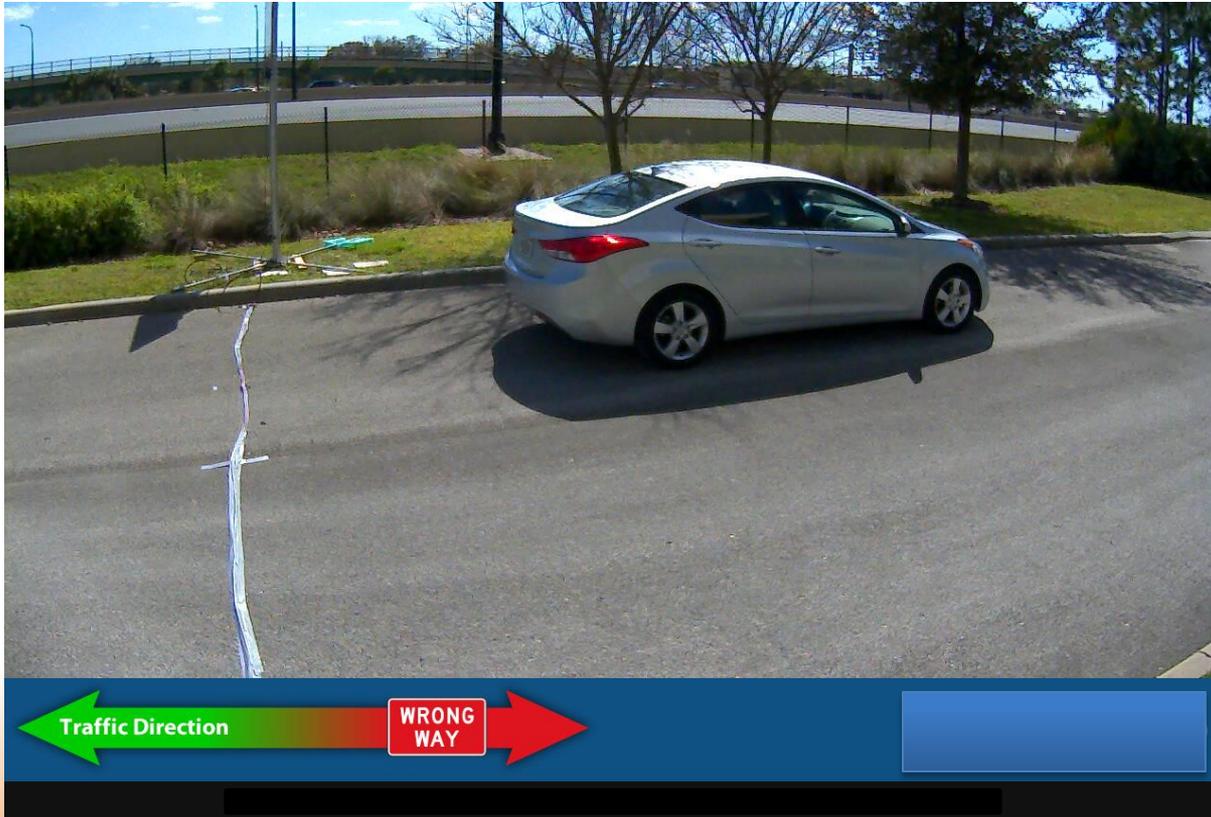
EDGE OF PAVEMENT  
EDGE OF TRAVEL LANE

RADAR DETECTION ZONE 1

SECONDARY RRFB, WRONG WAY SIGNAGE



# WRONG-WAY DRIVER CONFIRMATION ALERT





# STATUS OF PROJECT

- Ramp 1 (Phase 1):
  - Installed January 2015
- Ramps 2-5 (Phase 1):
  - Installed June 2015
- 19 Additional Ramps (Phase 2a):
  - Construction Notice to Proceed in April 2016
  - Anticipated completion by end of summer 2016
- 10 Additional Ramps (Phase 2b):
  - Design complete; advertised for construction in April 2016
  - Construction Notice to Proceed targeted for summer 2016





# ONGOING ACTIVITY

- Coordinating with partners
- Posting messages to CFX dynamic message signs for right-way drivers
  - SR 528 at 520
  - SR 408 at Kirkman and Hiawassee
- Phase 2 deployment underway



# SR 408 TESTING

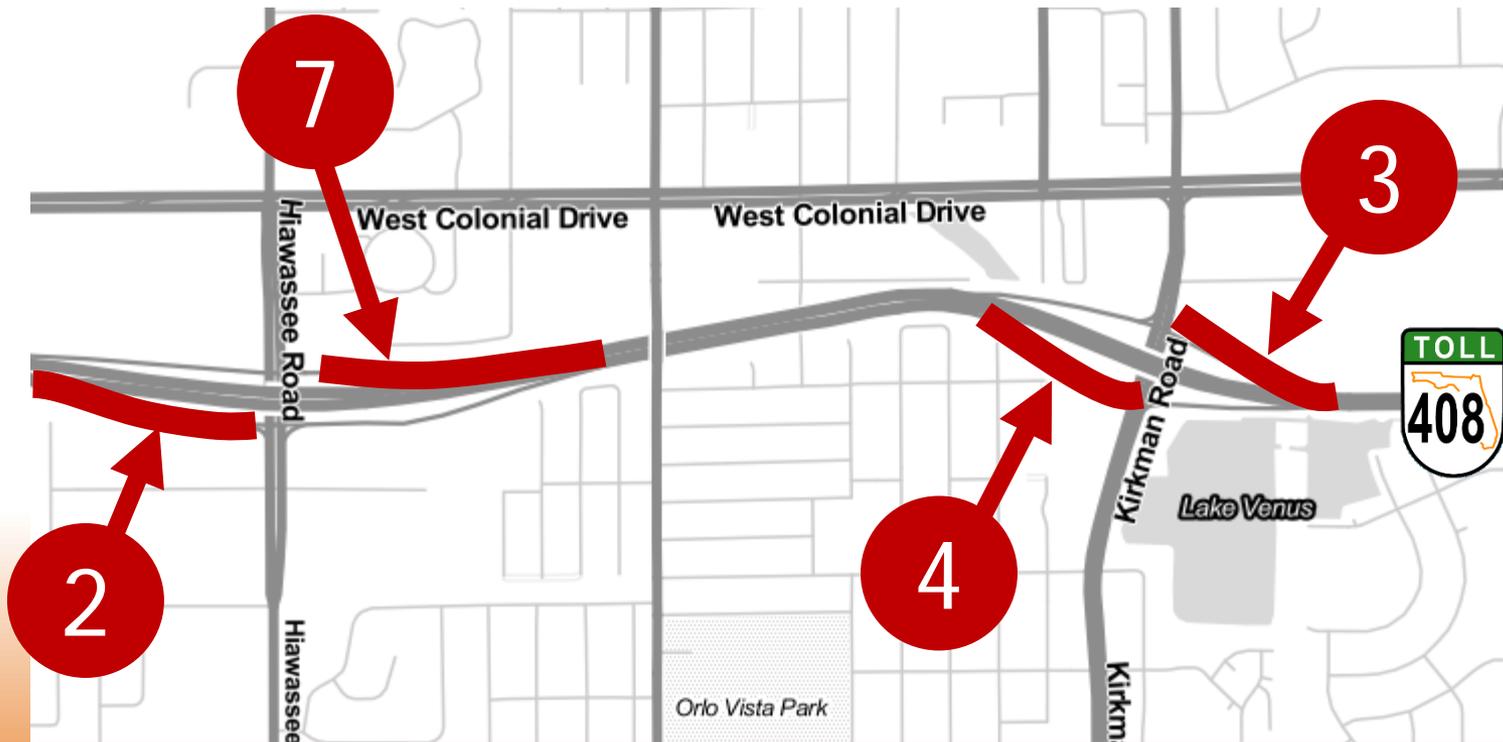




# WRONG-WAY TURNAROUNDS

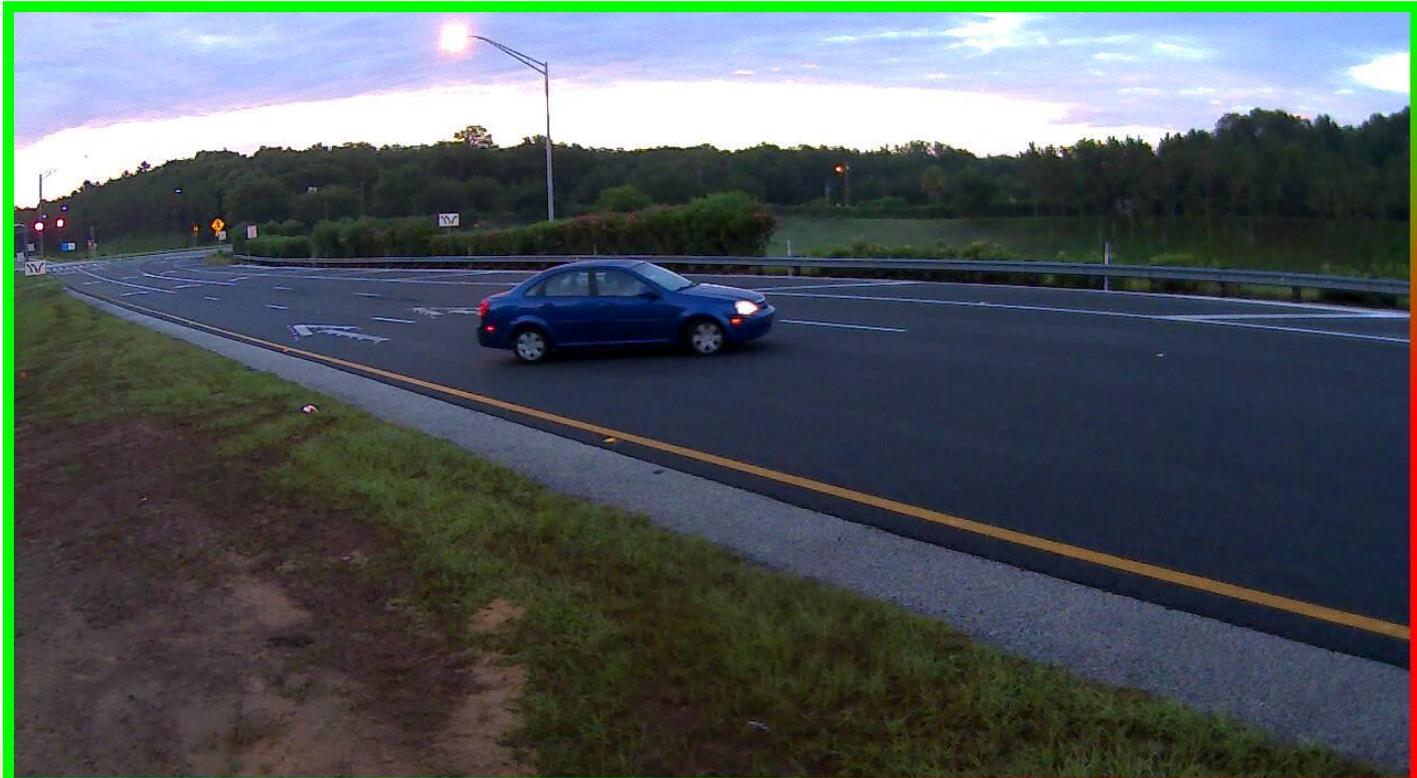
**Eighteen** documented since January 2015:

- Sixteen on SR 408
- Two on SR 528





# ACTUAL TURN-AROUND



Correct Traffic Flow:





# THANK YOU!

**Bryan Homayouni, PE**

Manager of Traffic Operations

[bryan.homayouni@CFXWay.com](mailto:bryan.homayouni@CFXWay.com)

**Corey Quinn, PE**

Chief of Technology / Operations

[corey.quinn@CFXWay.com](mailto:corey.quinn@CFXWay.com)

Central Florida Expressway Authority

(407) 690-5000

# Mitigating Wrong-Way Driving (WWD) Using Connected Vehicles (CV)

Melisa D. Finley

Research Engineer

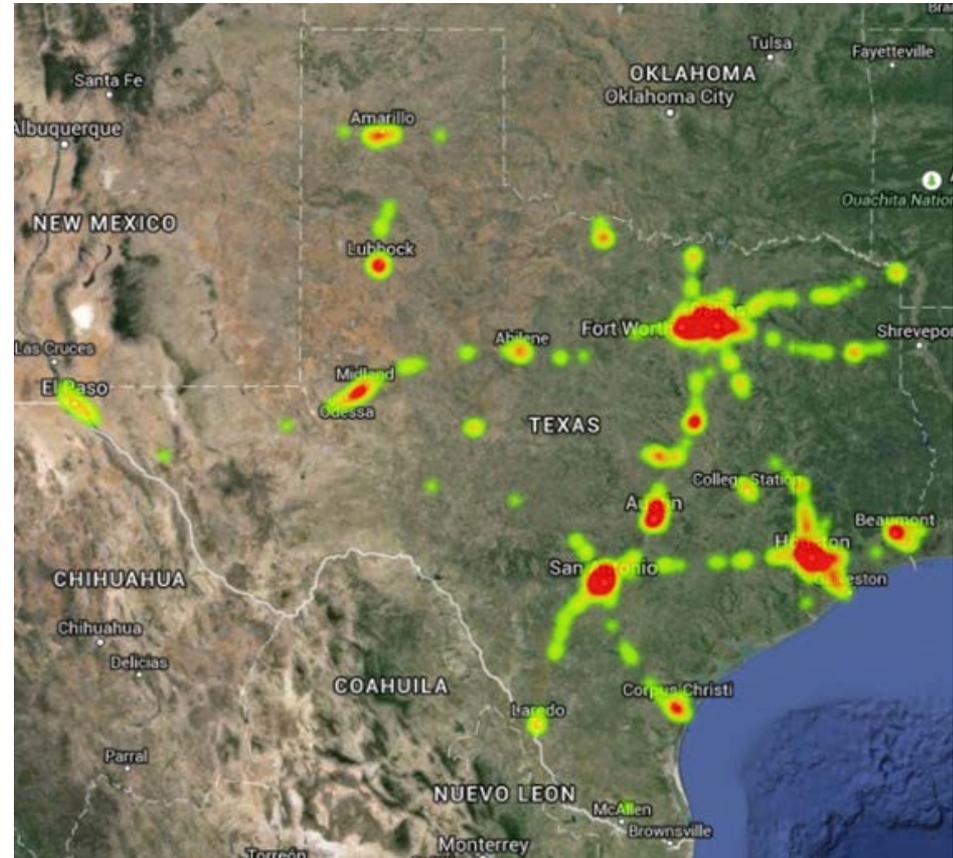
Texas A&M Transportation Institute

TRB Webinar  
April 20, 2016



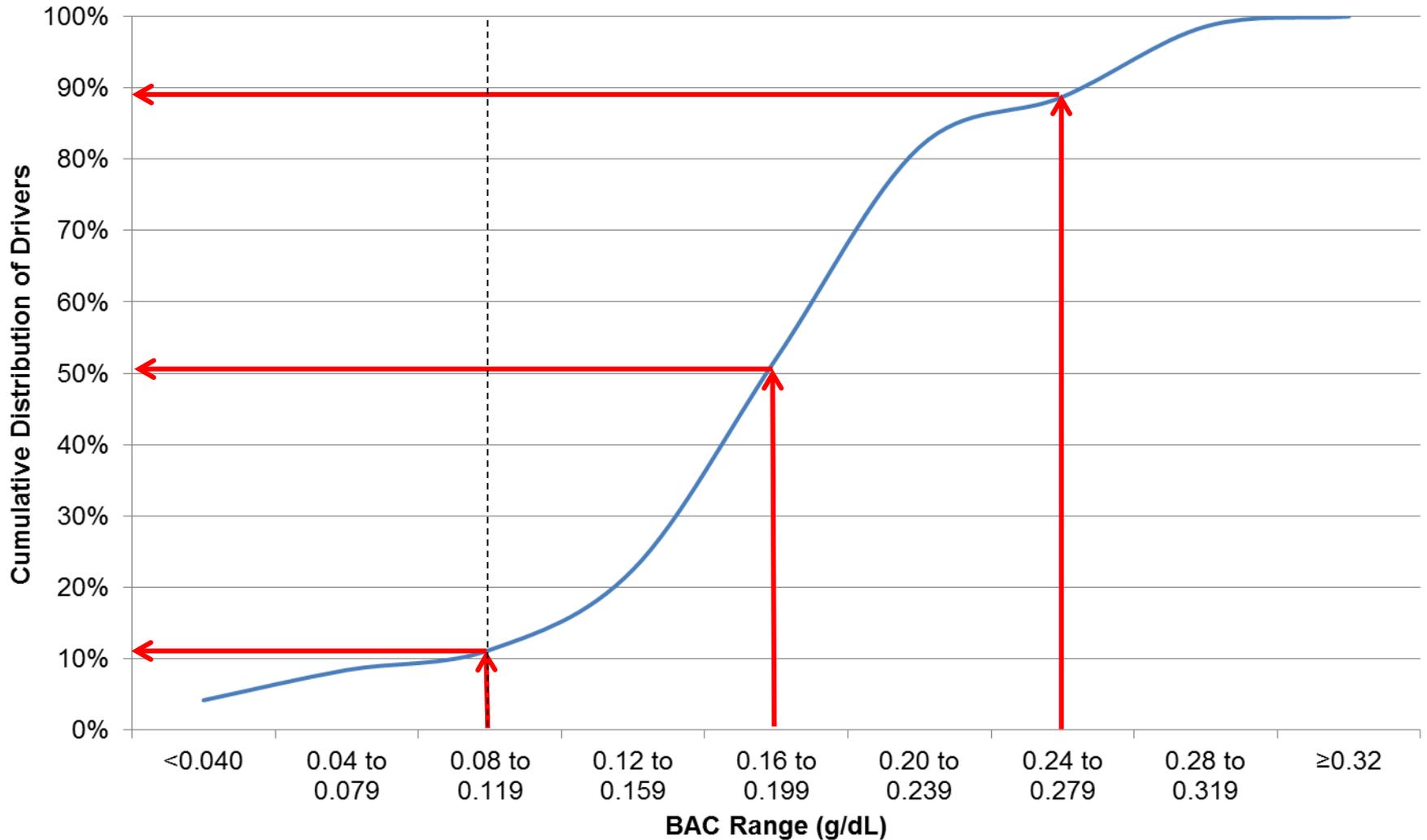
# Texas WWD Crashes on Freeways\*

- 1187 crashes
  - 2551 vehicles
  - 3726 people
- Severity
  - 10% fatal crashes
  - 46% injury crashes
- 86% in urban areas
- Primary cause = alcohol



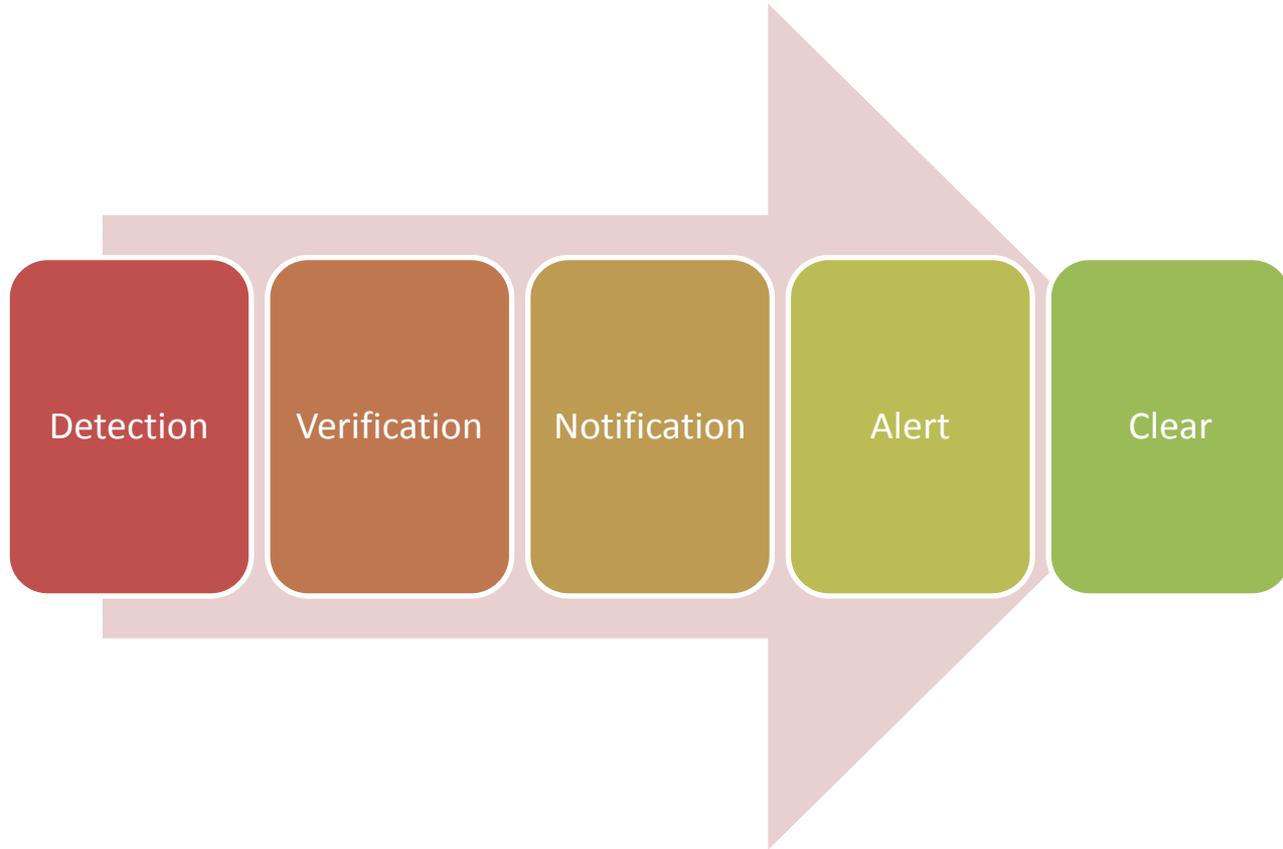
\* 2010 to 2014

# Blood Alcohol Concentration\*



\* 2007 to 2011 on freeways

# CV WWD System



# Phase 1

- February 2015 – December 2015
- Research tasks
  - Summarized state-of-the-practice
  - Conducted needs assessment
    - Traffic management entity
    - Law enforcement
    - Drivers (CV and non-CV)
  - Developed concept of operations, functional requirements, and high-level system design
  - Assessed fixed signing and in-vehicle warning messages

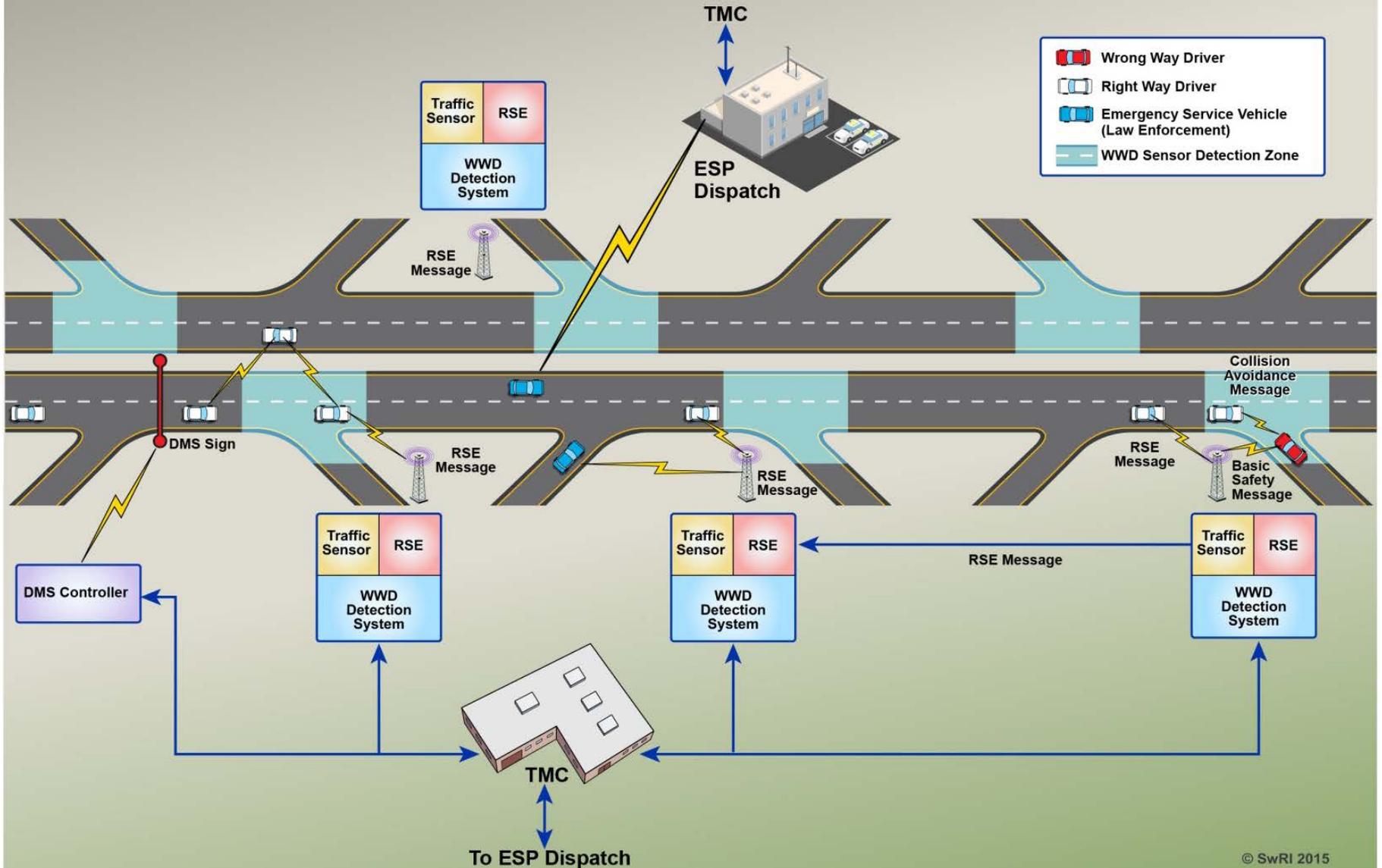


# Purpose of ConOps

- High-level goals and objectives of the system
- Identifies user needs for the system
- Details design criteria for the system
- Describes the needs for a WWD system from the stakeholder perspectives

*Who, what, why,  
where, when, and how!*

# WWD System Perspective



# Warning Messages for DMS

WARNING  
WRONG WAY DRIVER  
REPORTED

WARNING  
WRONG WAY VEH  
REPORTED

WARNING  
WRONG WAY DRIVER  
REPORTED

WARNING  
WRONG WAY  
DRIVER

- Some evidence VEH initially misunderstood
- “Ahead” implied
- Non-specific driving actions inferred

# In-Vehicle Warning

- Roadside Alert (RSA) messages
  - Provide warning information to drivers of nearby hazards
  - Not just any information can be sent
  - Rigid structure and integer codes must be used
- Does not represent final form of message



# Phase 2

- April 2016 – October 2017
- Research tasks
  - Finalize design
  - Develop validation test plan
  - Procure equipment
  - Deploy prototype system on closed-course
  - Conduct validation testing
  - Identify information needs of right-way drivers
  - Consider Phase 3 model field deployment



# Contact Information

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