FHWA Development of Crash Modification Factors (DCMF) Safety Evaluation of ICWS

MnDOT Photo

ENTERPRISE ICWS Webinar Series – Webinar 2

April 23, 2015

Agenda

WEBINAR IS BEING RECORDED

- Introduction
- ENTERPRISE Program
- Featured Presentation
  - FHWA Development of Crash Modification Factors (DCMF) Safety Evaluation of ICWS
- Questions
- Closing Remarks

NCDOT Photo

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Cory Johnson

Minnesota Department of Transportation and

ENTERPRISE Project Champion

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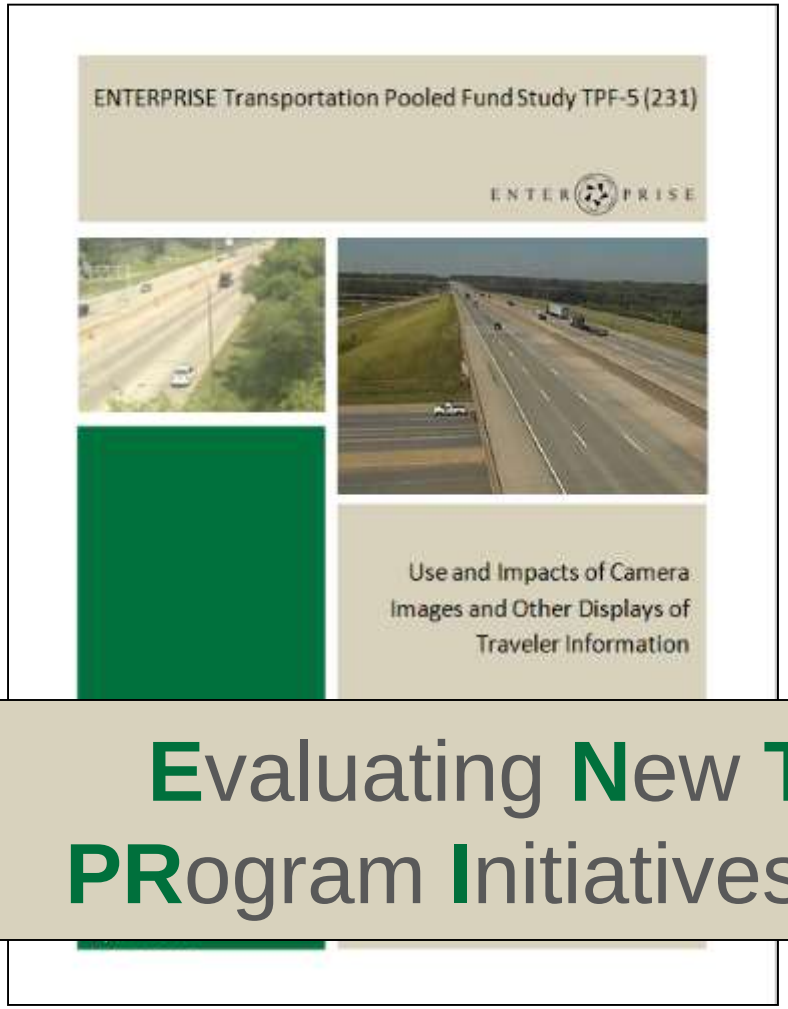

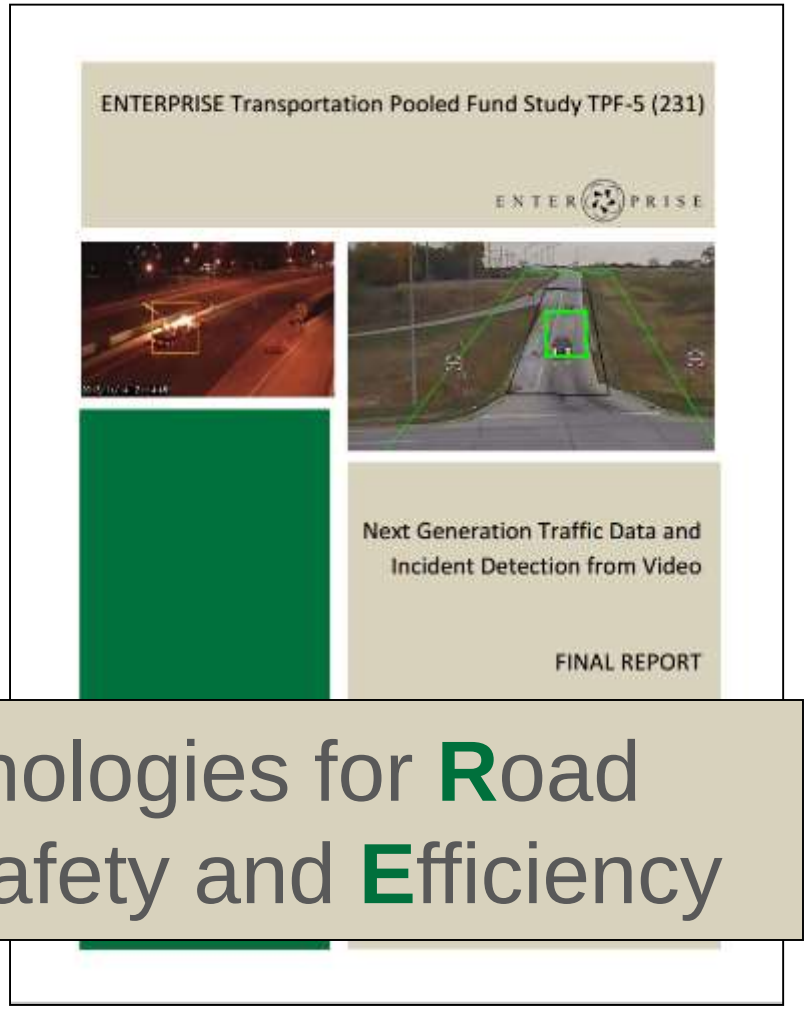

Evaluating **N**ew **TE**chnologies for **R**oad **PR**ogram **I**nitiatives in **S**afety and **E**fficiency

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Members

- Arizona DOT
- Georgia DOT
- Idaho Transportation Department
- Illinois DOT
- Iowa DOT
- Kansas DOT
- Maricopa County, Arizona
- **Michigan DOT**
- Minnesota DOT
- Oklahoma DOT
- Pennsylvania DOT
- Texas DOT
- **Washington State DOT**
- Ministry of Transport Ontario
- Transport Canada
- Dutch Ministry of Transport
- FHWA

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- Recent projects
  - Next Generation Traffic Data and Incident Detection from Video (Video Analytics Evaluation)
  - Synthesis of Intelligent Work Zone Practices
  - Assessment of Telematics Service Provider Data Feeds
  - HAR Best Practices and Future Direction
  - Crashworthiness and Protection of ITS Field Devices
  - **Developing Consistency in ITS Safety Solutions-ICWS**
  - **ICWS Coordination and Systems Engineering**
  - **ICWS Support and Outreach**

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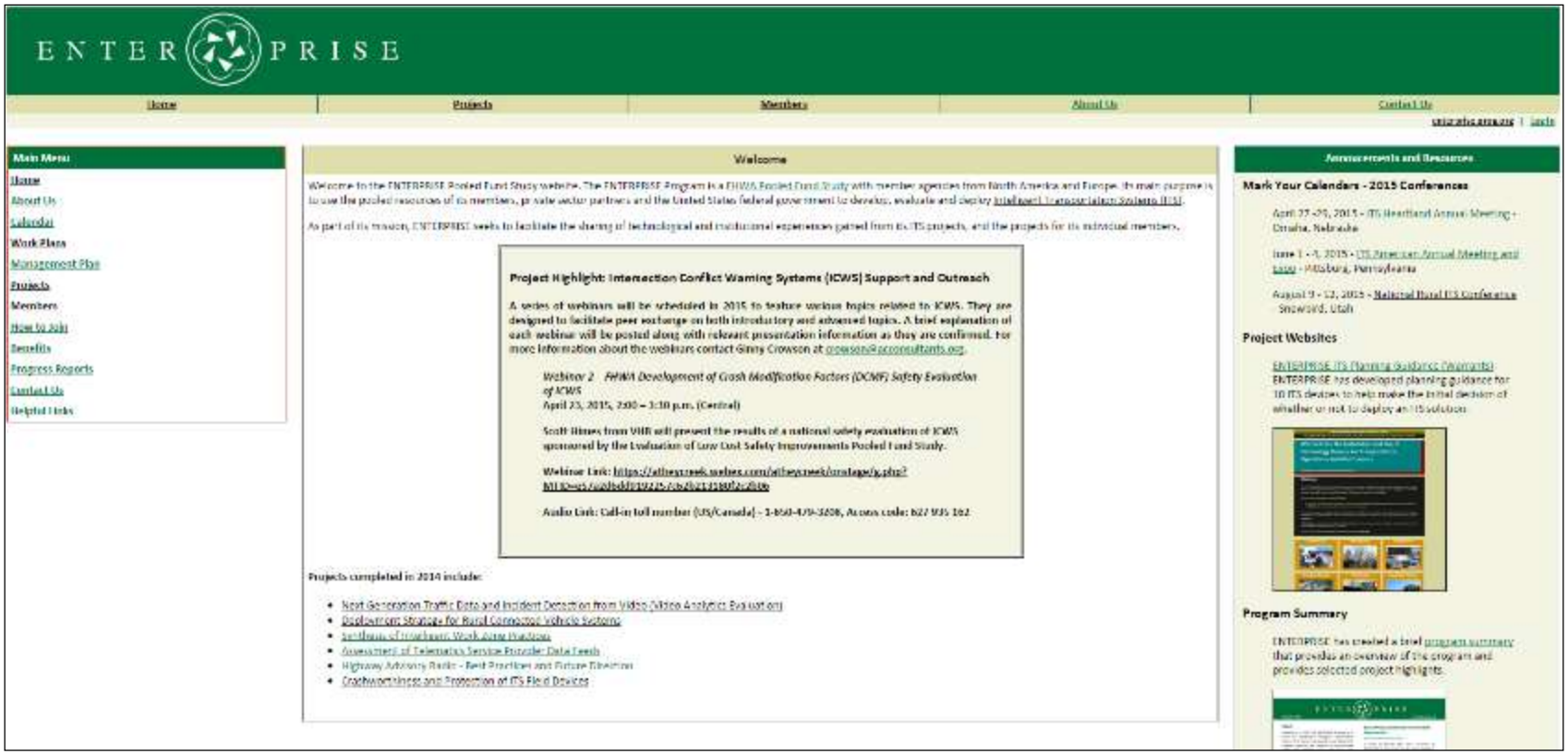

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Featured Presentation

Dr. Scott Himes

VHB and

Evaluation of Low Cost Safety Improvements Pooled Fund Study

Agenda

- Overview of ELCSI-PFS
- Overview of ICWS Study
- Study Design
- Combined Results
- Economic Analysis
- Questions

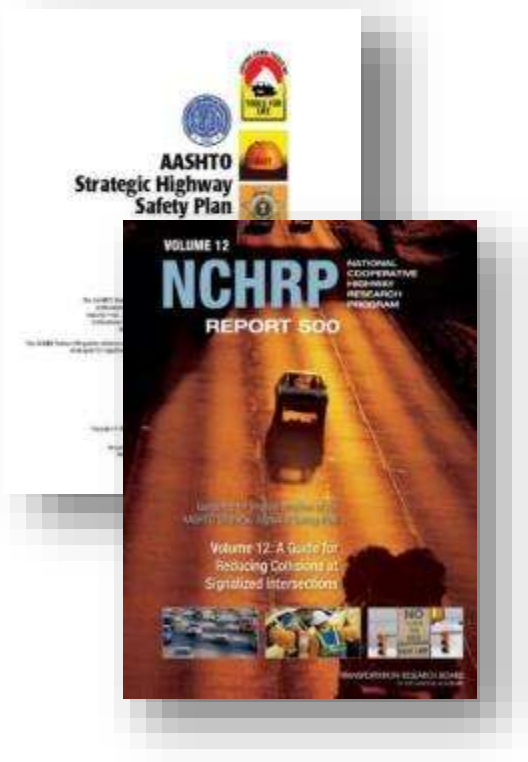




FHWA Evaluation of Low-Cost Safety Improvements Pooled Fund Study


Background

- 1998 National Strategic Highway Safety Plan
  - Critical strategies in 22 key safety areas



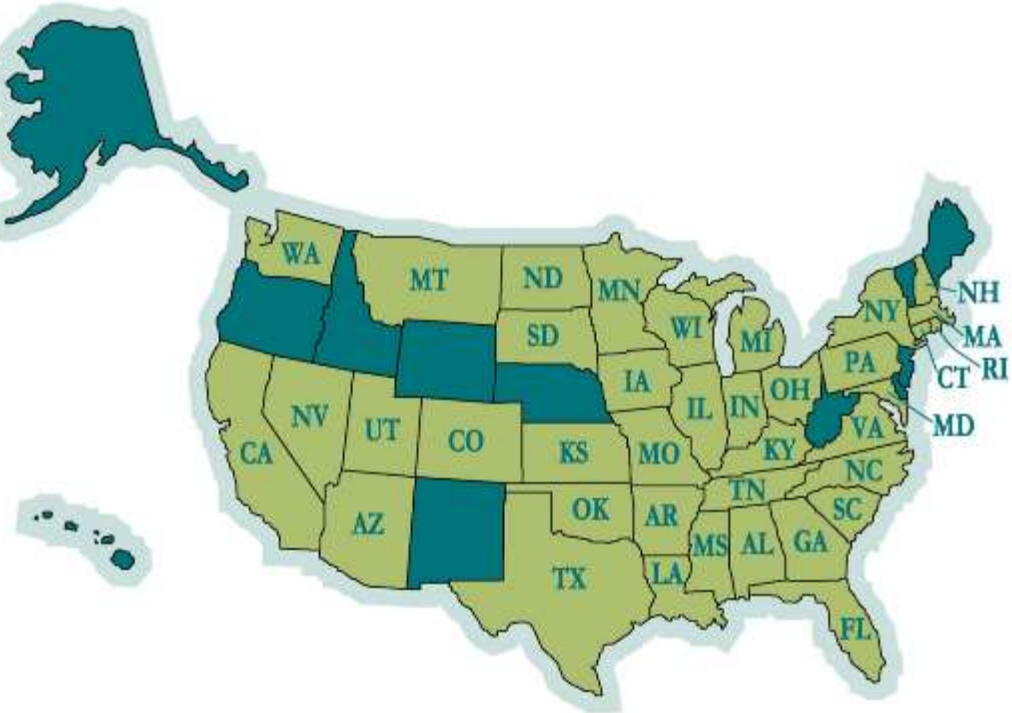
- NCHRP Report 500 Series
  - Published 22 reports to assist in implementation of safety strategies
  - Described potential safety strategies in terms of ***experimental, tried,*** *and* ***proven***
  - Most strategies were experimental or tried

Initial Objectives of ELCSI-PFS Effort

- Develop objective measures of effectiveness to support investing decisions
- Evaluation of Low-Cost Safety Improvements Pooled Fund Study
  - FHWA established in 2005 to move tried and experimental to proven
  - Initially 24 state members and 4 phases.

Expansion of the Effort

- Continued in 2013 as the Development of Crash Modification Factors (DCMF) Program
  - Evaluates higher-cost improvement also
  - Addressing methodological issues in CMFs and SPFs
- 38 States in the Pool – Coast to Coast







Safety Effectiveness of Intersection Conflict Warning System (ICWS)

Scott Himes VHB

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Acknowledgements

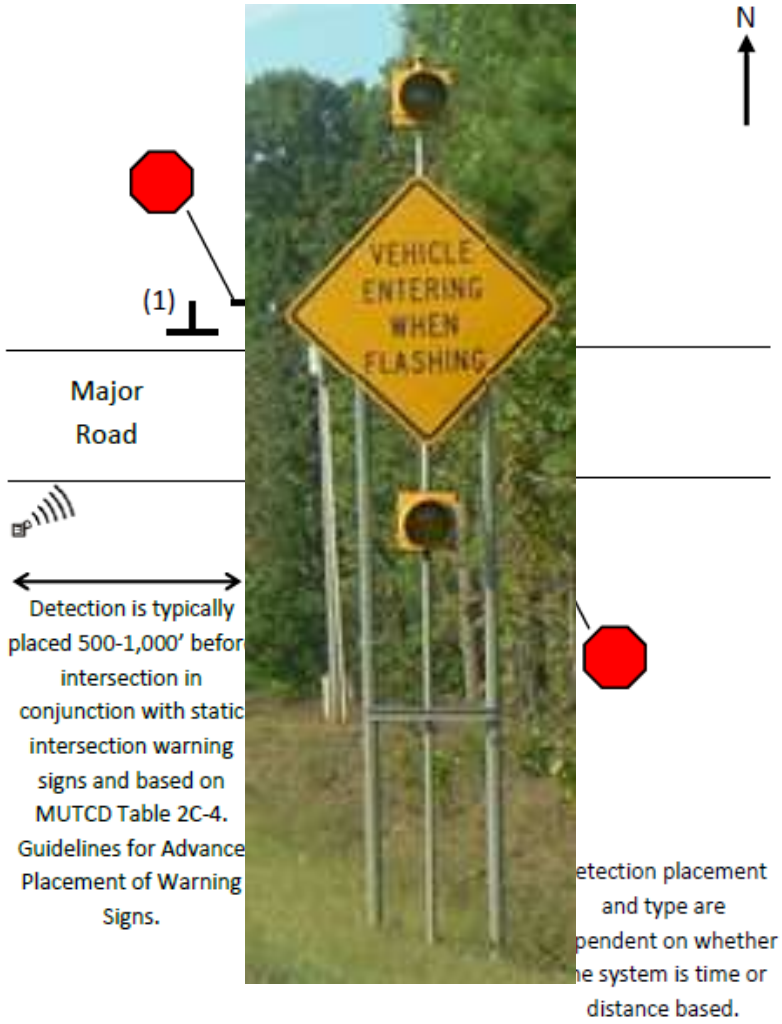
- FHWA – Roya Amjadi

- Panelists
  - Brad Estochen – Minnesota DOT
  - John Miller – Missouri DOT
  - Shawn Troy / Carrie Simpson – North Carolina DOT

- Project Team
  - Bhagwant Persaud – Persaud and Lyon
  - Kim Eccles – VHB
  - Frank Gross – VHB
  - Jonathan Soika – VHB
  - Kara Peach – VHB

Overview of ICWS

- ICWS – Warning signs with flashing beacons activated by conflicting vehicle
  - **Alert drivers on major route** to vehicles entering
  - **Assist minor route drivers** selecting gaps
  - Combination



Crowson and Jackels – December 2010

Overview of ICWS

- Typical Uses
  - Limited ISD
  - Gap-acceptance crash history
- Installation Locations
  - Post-mounted
  - Overhead

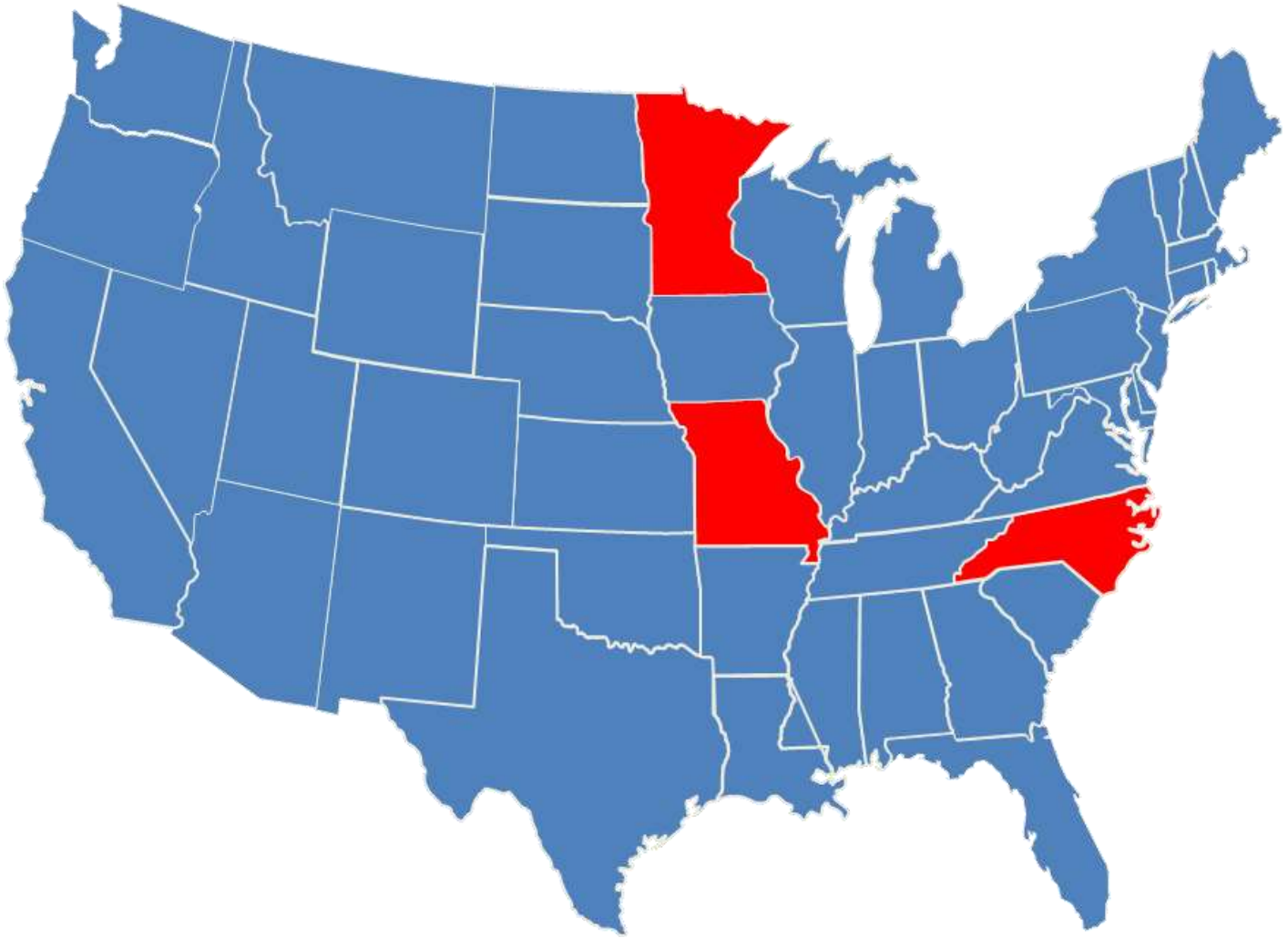
Overview of ICWS

- Overhead versus Post-Mounted
  - Presence of existing overhead flashers / capability
  - Available sight distance
  - Preference of traffic engineers

Study Questions

- Do effects vary by type of treatment?
  - Overhead versus post-mounted
  - Mainline versus minor approach
  - Combination
- Do effects vary by site characteristics?
  - Traffic volume
  - Posted speed limit
  - Geometric characteristics

ICWS Evaluation Volunteer States



Applicable Scenarios

- Four-leg stop-controlled intersections
- Two-lane mainline
- Four-lane mainline

Minnesota – Ten Two-Lane at Two-Lane Sites

- "LOOK FOR TRAFFIC" on minor, "ENTERING TRAFFIC WHEN FLASHING" on major
- "LOOK FOR TRAFFIC WHEN FLASHING" on minor
- "VEHICLES APPROACHING WHEN FLASHING on minor "CROSS TRAFFIC WHEN FLASHING" on major

Minnesota – Three Four-Lane at Two-Lane Sites

- Visual Display on minor

Missouri – Six Two-Lane at Two-Lane Sites

Missouri – Eight Four-Lane at Two-Lane Sites

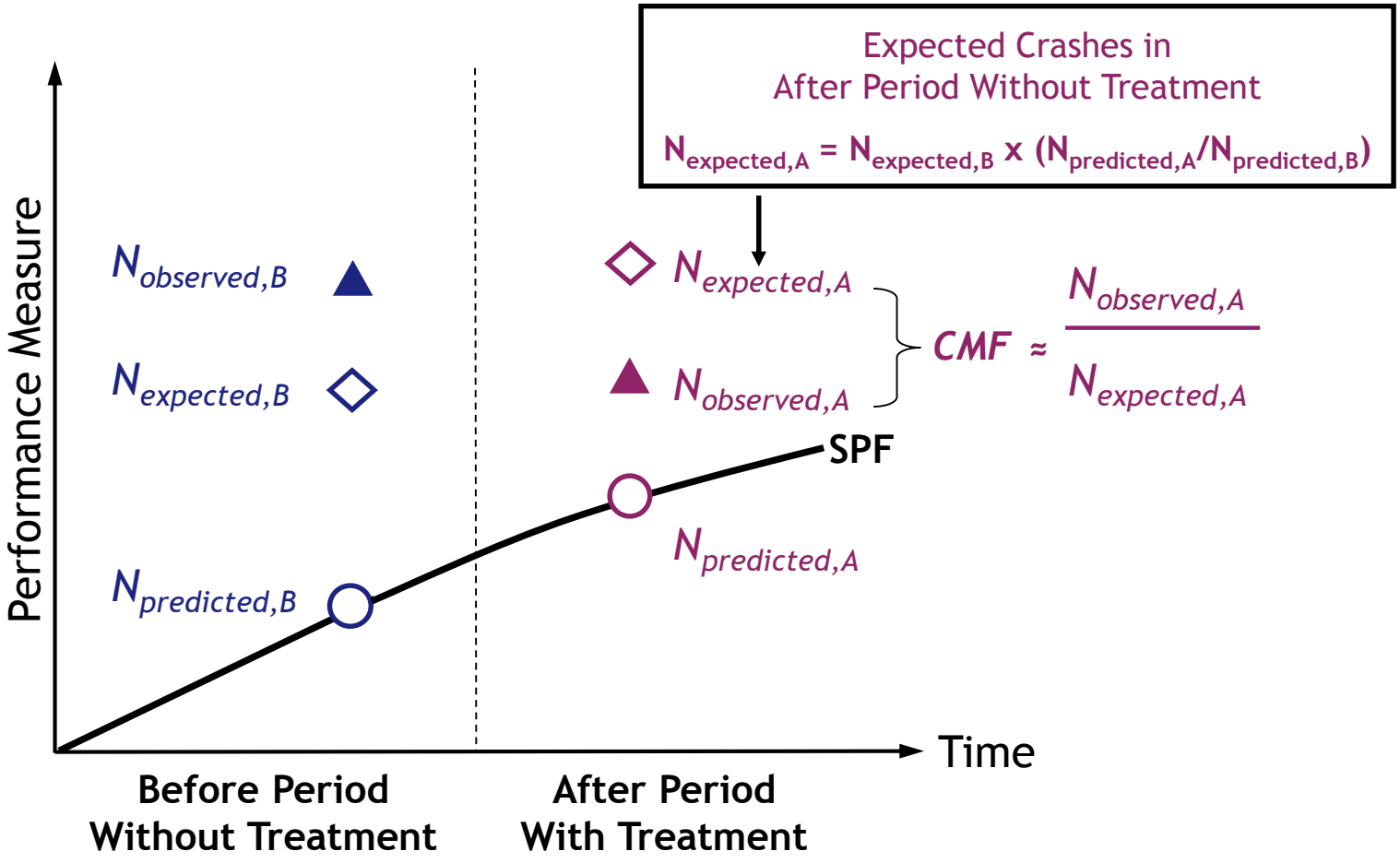
North Carolina

- Two-lane mainline – 41 sites
- Four-lane mainline – 10 sites
- Post-mounted and overhead
- Split between major and/or minor approaches

North Carolina - Messages

- VEHICLE ENTERING WHEN FLASHING
- VEHICLE ENTERING
- WATCH FOR APPROACHING VEHICLE
- WATCH FOR APPROACHING VEHICLE WHEN FLASHING

Study Design – Empirical Bayes Before-After



Reference Groups

- Similar to treatment sites
  - Same before and after periods
  - Safety performance not affected by treatment
- Account for potential biases
  - Annual factors account for unobserved (weather, drivers, vehicles, etc.)
  - Average crash frequency – regression to the mean
  - Facility types
  - Regional differences

Safety Performance Functions

- Developed separately by State and number of major route lanes
- Considered Traffic, Geometry, and TCDs

Combined Results – Two-Lane at Two-Lane

Crash Type	Total	Fatal and Injury	Right Angle	Rear-end	Night time
EB estimate without strategy	912.8	515.6	522.2	100.5	128.8
Observed crashes with strategy	670	362	420	43	116
CMF	**0.73**	**0.70**	**0.80**	**0.43**	0.90
Standard error	0.04	0.05	0.05	0.07	0.10

Combined Results – Four-Lane at Two-Lane

Crash Type	Total	Fatal and Injury	Right Angle	Rear-end	Night time
EB estimate without strategy	464.5	263.6	295.5	33.1	85.5
Observed crashes with strategy	385	212	252	33	53
CMF	**0.83**	**0.80**	**0.85**	0.97	**0.61**
Standard error	0.06	0.07	0.08	0.22	0.11

Treatment Category – NCDOT

- Category 1 – Overhead signs and flashers on major; loop on minor
- Category 2 – Overhead signs and flashers on minor; loop on major
- Category 3a – Post-mounted signs and flashers on major; loop on minor
- Category 3b – Post-mounted signs and flashers on minor; loop on major
- Category 4 – Other

Results by Category – Two-Lane at Two-Lane

Category		1 OH-Maj	2 OH-Min	3a PM-Maj	3b PM-Min	4 Combo
Sites		16	15	14	8	16
Total	CMF (SE)	**0.74 (0.07)**	0.89 (0.08)	**0.52 (0.06)**	0.89 (0.16)	**0.70 (0.09)**
	N	173	241	120	42	94

Results by Category – Two-Lane at Two-Lane

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Total	CMF (SE)	**0.74 (0.07)**	0.89 (0.08)	**0.52 (0.06)**	0.89 (0.16)	**0.70 (0.09)**
	N	173	241	120	42	94
Fatal and Injury	CMF (SE)	**0.60 (0.08)**	0.94 (0.10)	**0.45 (0.07)**	1.06 (0.29)	**0.74 (0.12)**
	N	91	144	58	18	51
Right Angle	CMF (SE)	**0.81 (0.10)**	1.08 (0.11)	**0.45 (0.07)**	1.25 (0.30)	**0.70 (0.11)**
	N	111	169	61	25	54

Results by Category – Four-Lane at Two-Lane

Category		1	2	3a PM-Maj	3b PM-Min	4
Sites				12	7	
Total	CMF (SE)			**0.75 (0.07)**	**0.69 (0.13)**	
	N			243	35	
Fatal and Injury	CMF (SE)			**0.73 (0.08)**	0.90 (0.21)	
	N			138	22	
Right Angle	CMF (SE)			**0.77 (0.08)**	0.76 (0.17)	
	N			174	23	

Results by "When Flashing" Presence – Two-Lane at Two-Lane

Crash Type	Message	Expected	Observed	CMF	SE
Total Crashes	When Flashing	656.2	458	**0.70**	0.04
	Not Present	256.6	212	**0.82**	0.07
Fatal & Injury Crashes	When Flashing	373.7	242	**0.65**	0.05
	Not Present	141.9	120	0.84	0.10
Right-Angle Crashes	When Flashing	364.8	275	**0.75**	0.06
	Not Present	157.4	145	0.92	0.10

Results by Intersection Lighting Presence – Four-Lane at Two-Lane

Crash Type	Lighting	Expected	Observed	CMF	SE
Total Crashes	Present	169.5	119	**0.70**	0.09
	Not Present	295.0	266	0.90	0.08
Fatal & Injury Crashes	Present	87.3	48	**0.55**	0.09
	Not Present	176.3	164	0.93	0.10
Right-Angle Crashes	Present	78.9	62	0.78	0.13
	Not Present	216.6	190	0.87	0.09

Results by Before Period Expected Crash Frequency – Four-Lane at Two-Lane

Crash Type	Crashes/Year	Expected	Observed	CMF	SE
Total Crashes	≤ 3	114.2	121	1.05	0.15
	> 3	350.3	264	**0.75**	0.06
Fatal & Injury Crashes	≤ 2	66.3	74	1.10	0.18
	> 2	197.3	138	**0.70**	0.08
Right-Angle Crashes	≤ 2.5	93.3	116	1.23	0.18
	> 2.5	202.2	136	**0.67**	0.08

Economic Analysis – Installation Costs

- Installation costs
  - Two-lane at two-lane
    - Minimum: $9,000
    - Average: $41,500
    - Maximum: $109,500
  - Four-lane at two-lane
    - Minimum: $49,000
    - Average: $106,200
    - Maximum: $142,500
- Average installation costs consider
  - Costs provided by States
  - Type of treatment (overhead vs. post-mounted)
  - Number of treated approaches

Economic Analysis – Maintenance and Operations

- Maintenance and operations costs (annual)
  - Minimum: $625
  - Average:
    - $1,074 two-lane at two-lane
    - $1,933 four-lane at two-lane
  - Maximum: $3,400
    - Intersections with probes or microwave and wireless communication
- Lifespan
  - System 10 years
  - Loops 5 years

Economic Analysis – Crash Costs

- Identified crash costs by type and severity from FHWA's Crash Cost Estimates by Maximum Police-Reported Injury Severity Within Selected Crash Geometries
- Converted to 2014 costs using ratio of 2014 value of statistical life to 2001 value of statistical life = 2.42
- Average crash cost $202,000 for two-lane at two-lane intersections
- Average crash cost $220,000 for four-lane at two-lane intersections

Economic Analysis – B/C Ratio

- Two-lane at two-lane intersections
  - 35:1
  - Sensitivity analysis showed 20:1 to 50:1
- Four-lane at two-lane intersections
  - 13:1
  - Sensitivity analysis showed 8:1 to 19:1

Summary

- The CMFs below are recommended
- The results suggest ICWS can be highly cost-effective as a safety treatment

Crash Type	Total	Fatal and Injury	Right Angle	Rear-end	Night time
Two-Lane at Two-Lane					
CMF	**0.73**	**0.70**	**0.80**	**0.43**	0.90
Standard error	0.04	0.05	0.05	0.07	0.10
Four-Lane at Two-Lane					
CMF	**0.83**	**0.80**	**0.85**	0.97	**0.61**
Standard error	0.06	0.07	0.08	0.22	0.11

Final Report

- Will be available on ELCSI-PFS website
  - (Search “FHWA ELCSI-PFS” in internet browser)





Thank you!

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Questions?

Access the WebEx Q&A box on the right side of your screen. Type your question and send to all participants.

Moderator will read questions aloud and presenter will respond verbally.

Closing Remarks

Next Webinar:

Liability, Reliability and Credibility – Challenges for ICWS

June 25, 2015
2:00 – 3:30PM (Central)

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Closing Remarks

- For more information...
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