Evaluation of Intersection Collision Warning Systems

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Minnesota Towards Zero Deaths Conference

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Background

- 9,956 crashes (63 fatalities) at stop controlled intersections in MN (2010, Minnesota Motor ,Vehicle Crash Facts)

- Right angle crashes (high severity) are particularly problematic at high speed

- Most prominent problem – gap acceptance (Donath et al, 2007; Chovan et al, 1994)

- MnDOT making significant investment

Objectives

- Evaluate driver behavior changes at mainline and stop-controlled approaches for intersections with and without ICWS;
- Provide better information to guide future investments in ICWS
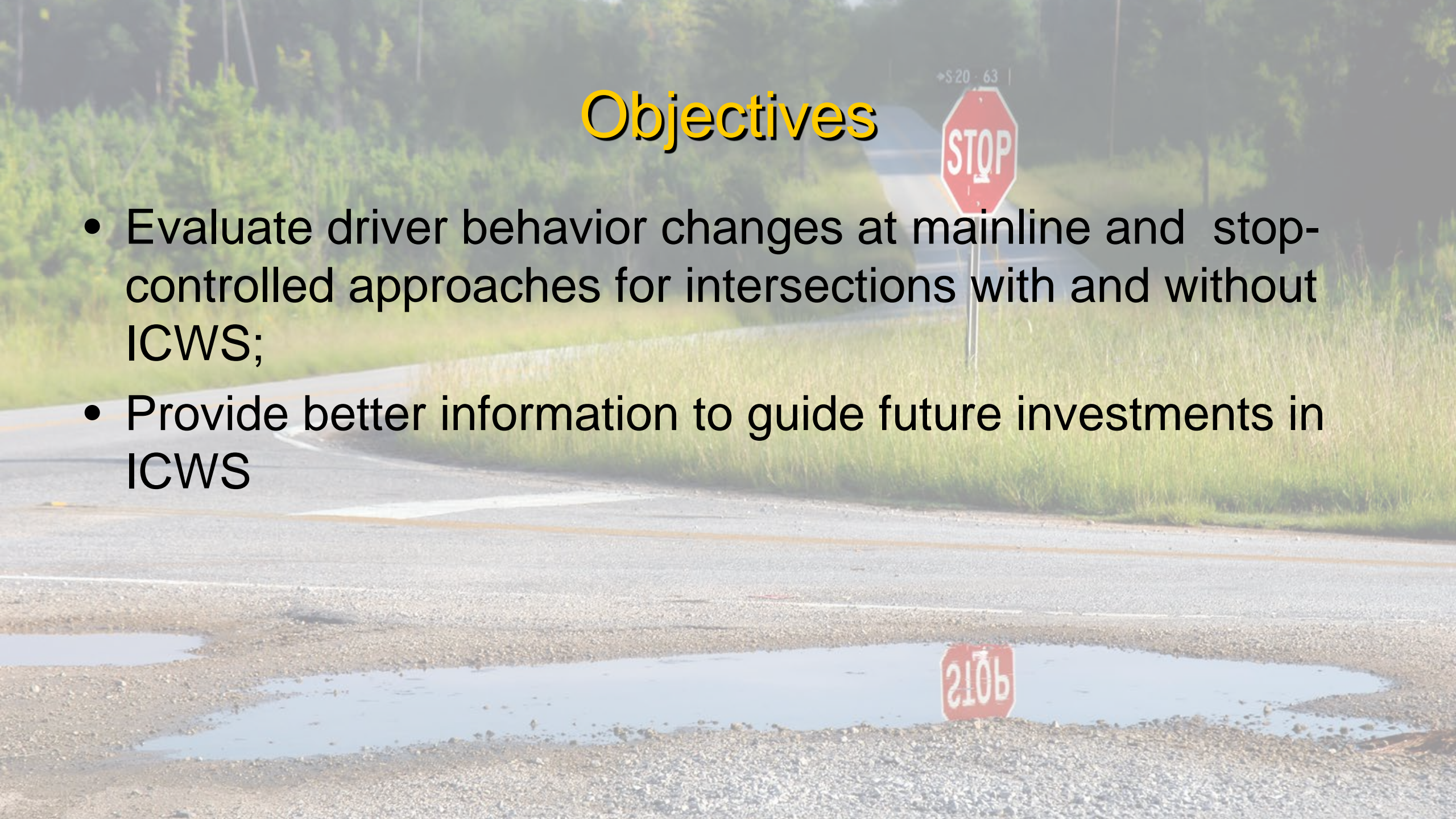
Site Detail

- **5 Treatment sites**
- Site selected in conjunction with TAP
- Treatment sites selected to represent configuration common in MN
- For data collection, sites with installation date in winter were avoided

- **5 Control sites** (1 for each treatment)
- Selected near-by test or adjacent intersection along the same corridor
- Similar geometric characteristics as the treatment site

TOTAL: 10 SITES

Site Detail

Location	Condition	Intersection
Cottonwood County	Control	Minnesota 60 and 570th Street
	Treatment	Minnesota 60 and County Road 1
Isanti County	Control	Minnesota 47 and County Road 8
	Treatment	Minnesota 47 and County Road 5
Chippewa County	Control	Minnesota 7 and County Road 15
	Treatment	Minnesota 7 and County Road 6
McLeod County	Control	Minnesota 7 and County Road 1
	Treatment	Minnesota 7 and County Road 9
Pipestone County	Control	Minnesota 23 and County Road 16
	Treatment	Minnesota 23 and County Road 8
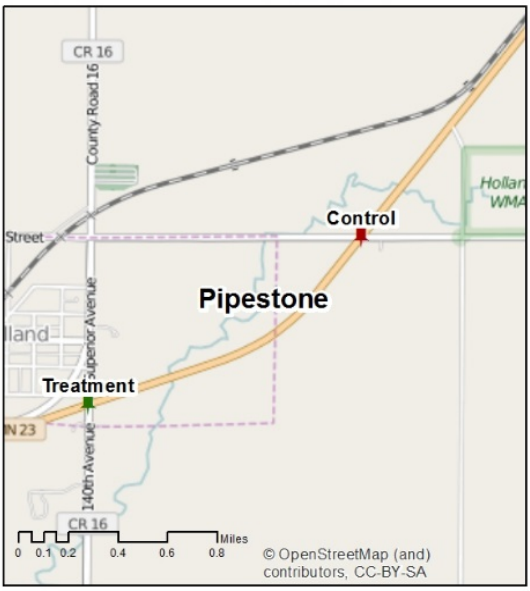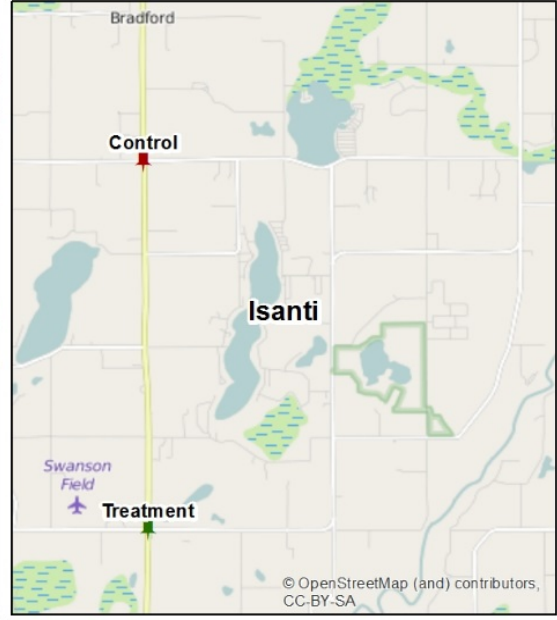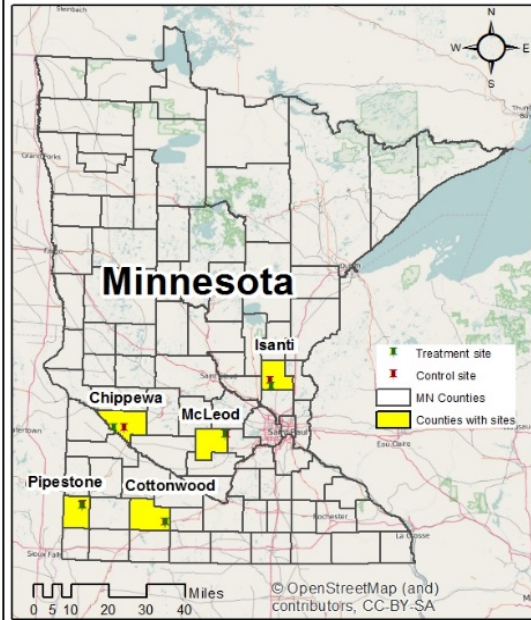
System Layout at Treatment site
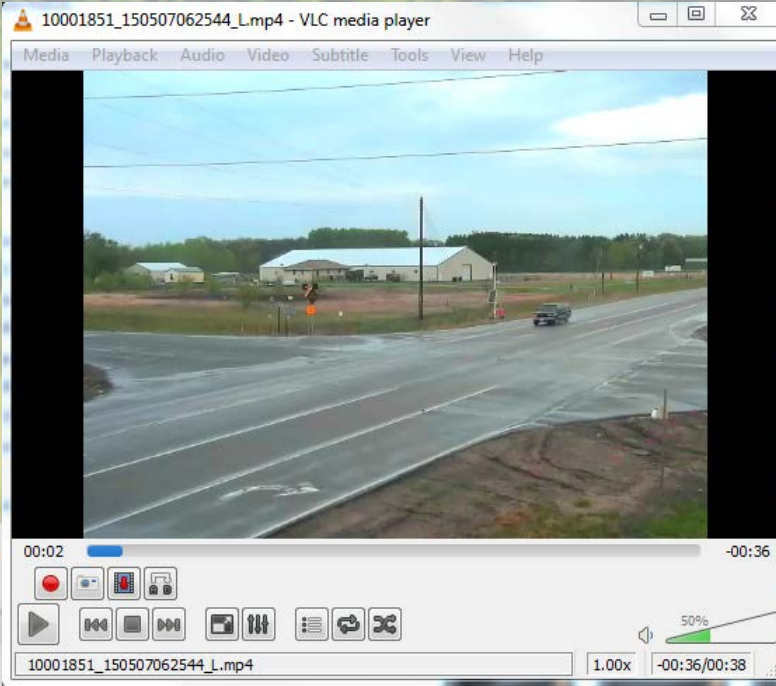
System Activated

Activation threshold time: 6.5 seconds for posted speed limit of 55 mph
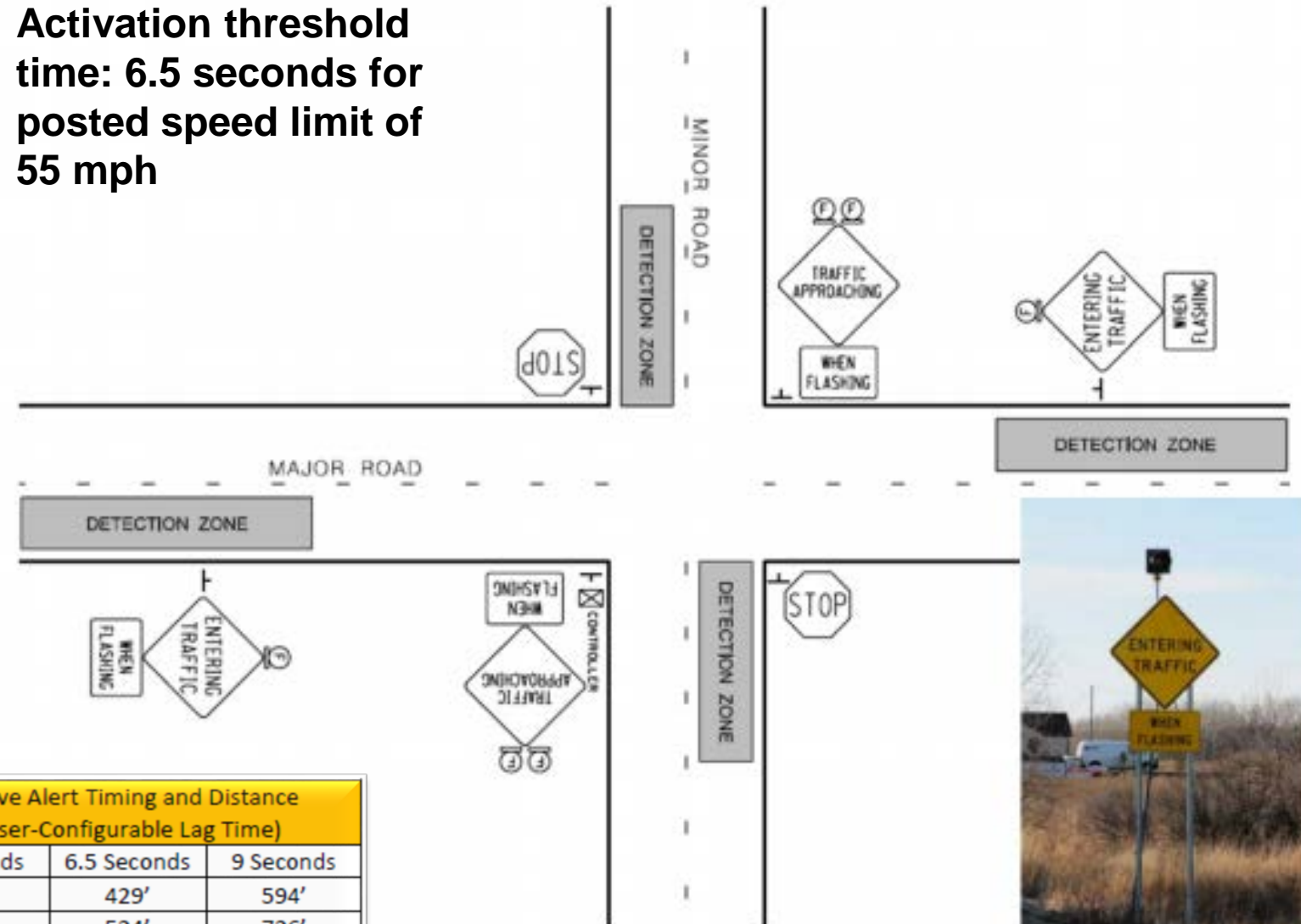
Posted Speed Limit, -10 MPH	Posted Speed Limit	Posted Speed Limit, +10 MPH	Active Alert Timing and Distance (User-Configurable Lag Time)		
			4 Seconds	6.5 Seconds	9 Seconds
45 MPH			264'	429'	594'
	55 MPH		323'	524'	726'
		65 MPH	381'	620'	858'

Intersection Collision Warning

- ICWS: Give warning to BOTH minor and major approach vehicles

- message sign: "VEHICLE ENTERING WHEN FLASHING", "CROSSING TRAFFIC WHEN FLASHING," or "WATCH FOR ENTERING TRAFFIC."

- System actuated by vehicles detectors to alert motorist on major and minor street.
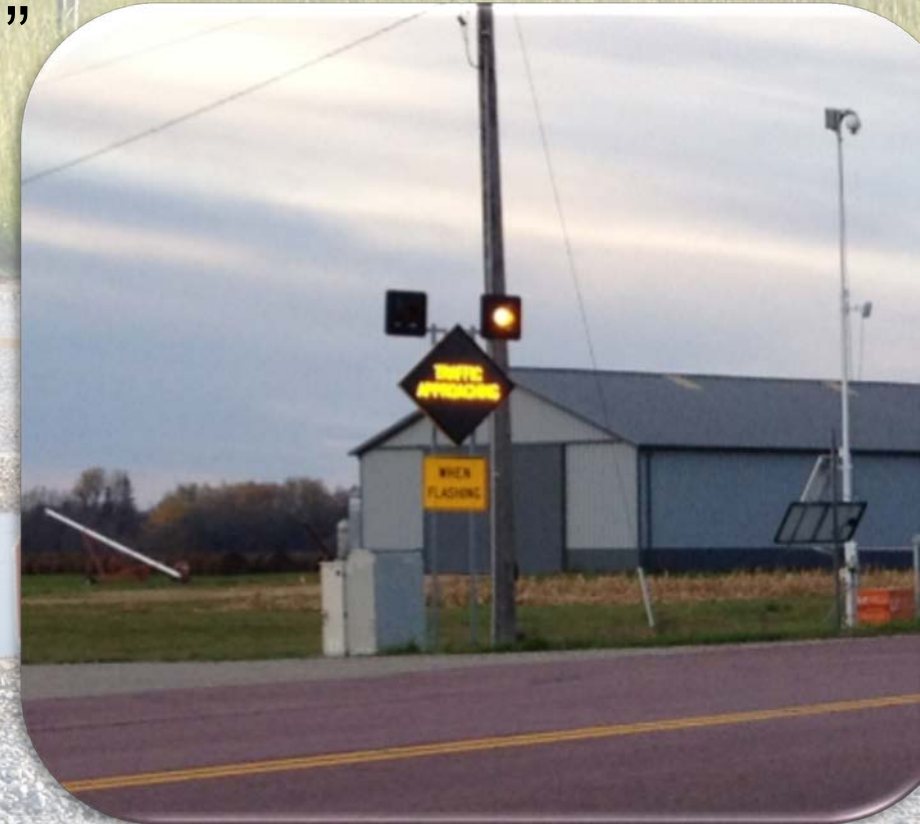
Data Collection

- Collected data 1-3 mon before install
- Collect baseline data ~ 1 week
- Nighttime depends on lighting conditions
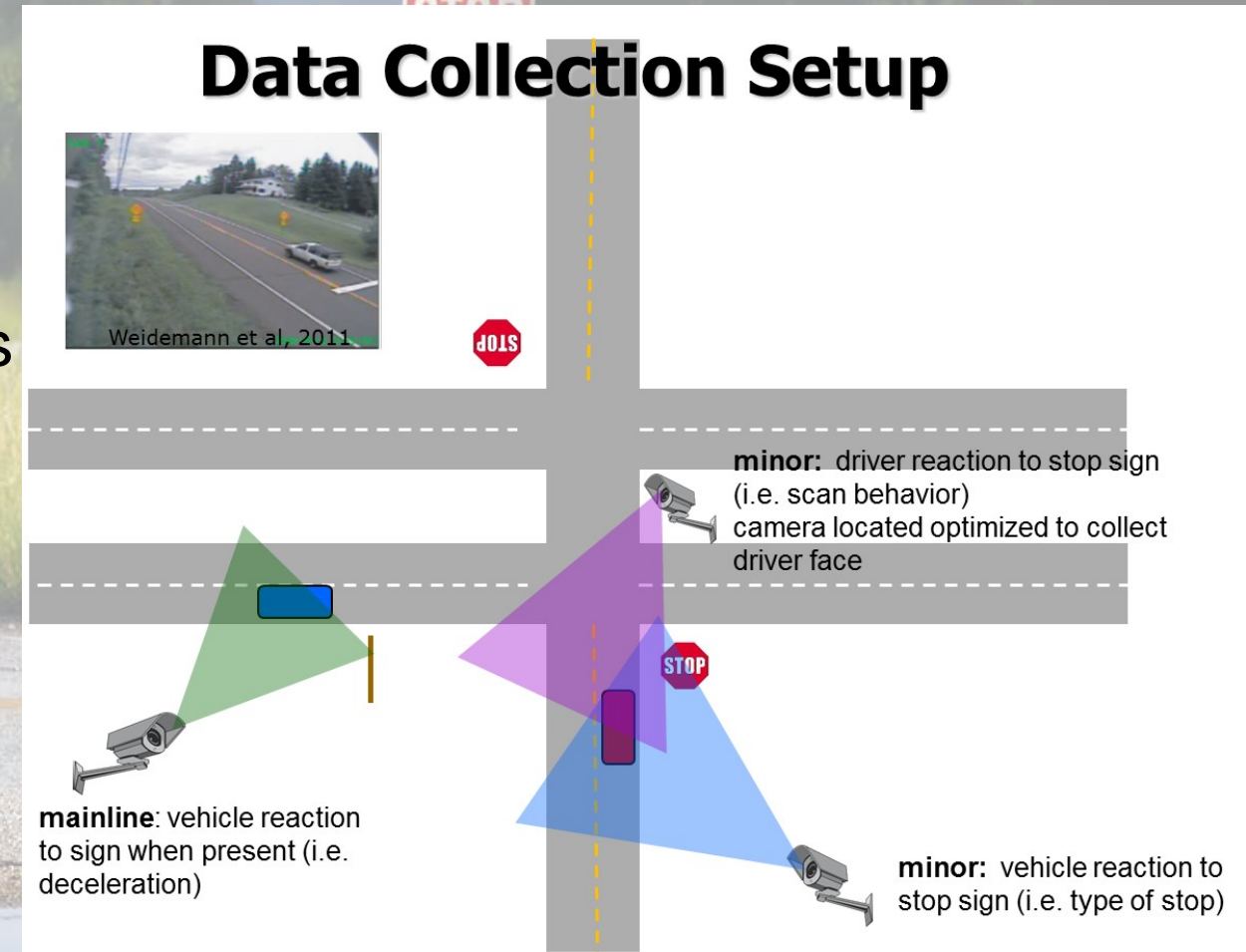- Collect after data
  - 1 to 3 months (novelty effect)
  - 12 to 14 months (habituation)
- Similar weather/traffic conditions as before

Data Collection Setup

Weidemann et al, 2011.

minor: driver reaction to stop sign (i.e. scan behavior) camera located optimized to collect driver face

mainline: vehicle reaction to sign when present (i.e. deceleration)

minor: vehicle reaction to stop sign (i.e. type of stop)

Data Collection

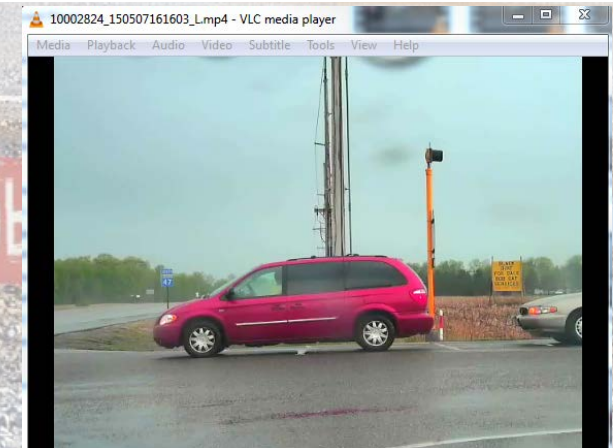- Instrument contracted from "LiveView Technologies"

Data Reduction

- First five vehicles in free flow condition.

- Random time frame sheet used as a reference for start time.

- Only videos from weekdays are used for data reduction

- Videos were mostly reduced from 6 am in the morning to 8 pm in the evening. However, it largely depends on the weather and seasons.

- Maximum days of video used for data reduction: 5 days

- Only conflict data was reduced for a entire time frame.

LIST OF FEW VARIABLES REDUCED
- Arrival Time
- Departure Time
- Type of vehicle
- Color of vehicle
- Type of turning movement: Left / Right / Through
- Type of stop: Complete stop / Rolling / No slow
- Stop location: Before / After / At the stop bar
- ICWS Status at Arrival: Activated / Un-activated / Unknown
- ICWS Status at Departure: Activated / Un-activated / Unknown
- Conflict: Description / Time
- Weather: Sunny / Cloudy / Rain / Snow
- Pavement surface: Dry / Wet / Snow
- Lighting condition: Day / Dawn / Dusk
- Accepted gap
- Neighboring vehicle
- Vehicle platoon
- Size and Number of rejected gap
- Gender
- Distraction details: Cell phone / Passengers
- Number of glances: Between start and end point

10002824_150507161603_L.mp4 - VLC media player

Media   Playback   Audio   Video   Subtitle   Tools   View   Help

Results

- 3 of 5 treatment and 2 of 5 control had increase in full stop

- Majority had decrease in non-stops

Change in non-stop

Stopping Behavior

- Compared stopping when system when was activated/not activated

- Drivers much more likely to come to a stop when activated (also related to on-coming traffic)

- Rolling stop much more likely when not active (71%) versus active (25%)

- Minor change in no stop

	Before	1-mon activated	1-mon not active	12-mon activated	12-mon not active
Complete Stop	48.0%	75.2%	29.0%	70.7%	30.0%
Rolling Stop	51.6%	24.6%	70.5%	29.3%	69.8%
Non Stop	0.4%	0.2%	0.4%	0.0%	0.2%

Gap Distribution

Treatment

	1-month			12-month		
	Left	Thru	Right	Left	Thru	Right
≤ 6 sec	-0.4%	-0.8%	0.0%	-1.8%	-1.2%	-0.4%
7 to 9 sec	-1.1%	0.0%	1.8%	-1.6%	-4.4%	-0.2%
10 to 12 sec	-2.2%	0.6%	1.0%	-2.3%	-2.4%	-1.0%
> 12 sec	3.7%	0.3%	-2.8%	5.8%	8.0%	1.6%

Control

	1-month			12-month		
	Left	Thru	Right	Left	Thru	Right
≤ 6 sec	0.1%	0.5%	-0.2%	-0.9%	-0.6%	-0.5%
7 to 9 sec	-0.2%	4.3%	-0.7%	-4.2%	-4.9%	-0.1%
10 to 12 sec	-2.4%	1.6%	-0.9%	-3.6%	1.1%	-2.6%
> 12 sec	2.5%	-6.3%	1.8%	8.6%	4.4%	3.2%

In general, gap size increased after installation

Critical Gap
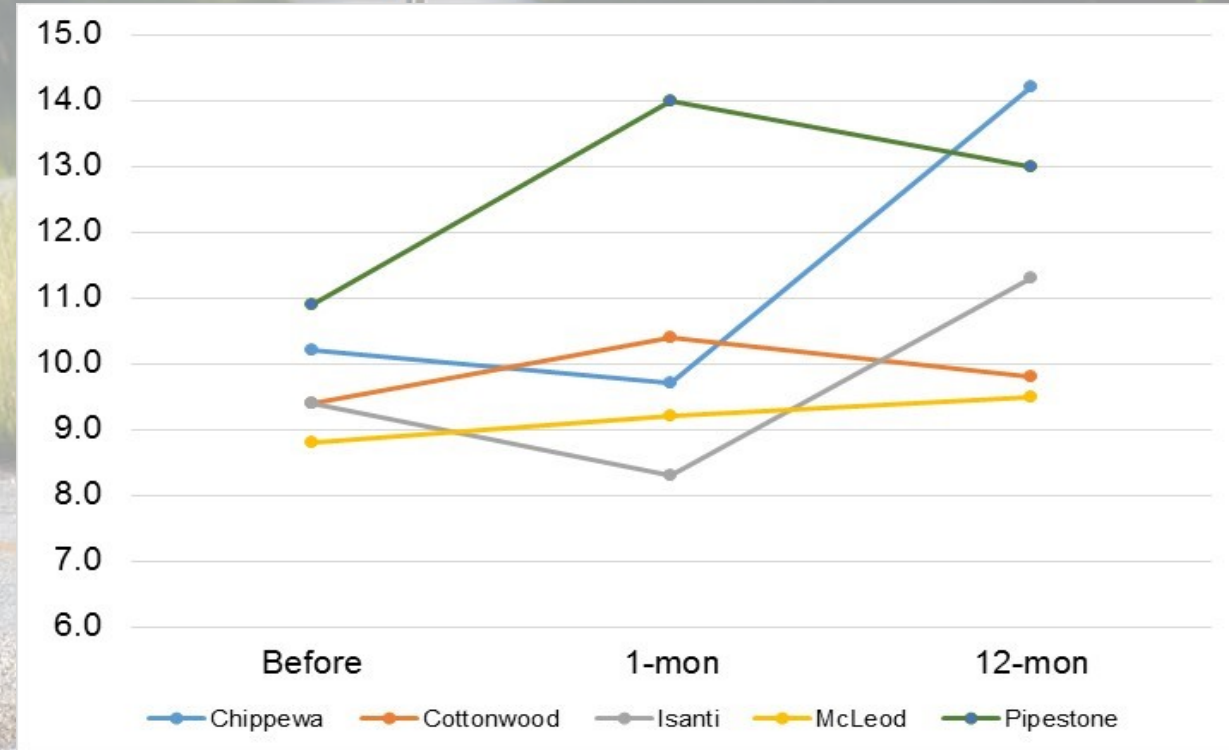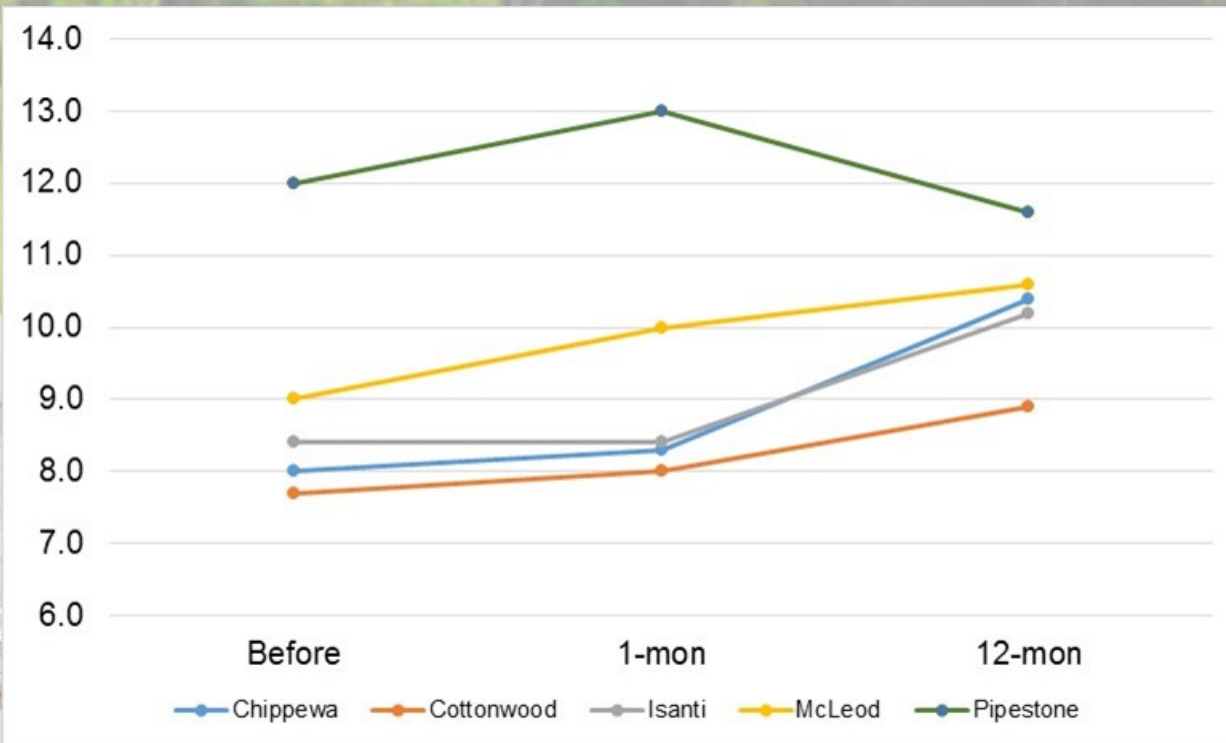

- Critical gap (accepted gaps = rejected gaps)
- Decreased slightly after installation but increased

Driver Glances

	Treatment			Control		
	Before	**1-mon**	**Change**	**Before**	**1-mon**	**Change**
	Complete stop					
Left glances	1.61	2.12	0.52	1.68	1.48	-0.19
Right glances	1.38	2.00	0.62	1.47	1.92	0.45
	Rolling stop					
Left glances	1.06	1.17	0.12	0.97	1.10	0.13
Right glances	0.71	1.01	0.30	0.82	1.06	0.24

Average number of glances increased after installation
Suggests improved scanning
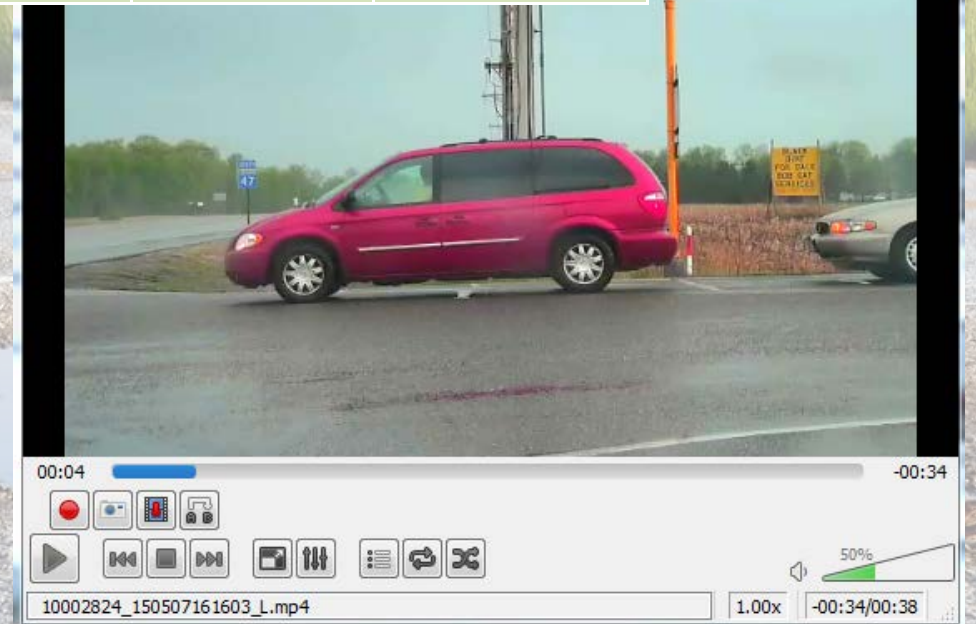
Conflicts

		Near-crash	Applied brakes/slowed	Change lanes/other evasive maneuver
Treatment	Before	34	22	17
	1-month	26	22	6
	Change at 1-month	-8	0	-11
	12-month	25	49	2
	Change at 12-month	-9	27	-15
Control	Before	22	8	8
	1-month	35	28	8
	Change at 1-month	13	20	0
	12-month	22	39	1
	Change at 12-month	0	31	-7

Questions