



Vehicles Entering When Flashing (VEWF) Evaluation

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NCDOT Traffic Safety Unit

VEWF Evaluation

“Vehicle Entering when Flashing” Configurations

– *Category 1 (24 sites)*

- Overhead Signs and Flashers at Intersection on Major, Loop on Minor



SS 02-01-215 (Greene Co.)

NCDOT Traffic Safety Unit

VEWF Evaluation

“Vehicle Entering when Flashing” Configurations

– *Category 2 (19 sites)*

- Overhead Signs and Flashers at Intersection on Minor, Loop on Major



SS 12-00-008 (Catawba Co.)

NCDOT Traffic Safety Unit

VEWF Evaluation

“Vehicle Entering when Flashing” Configurations

– *Category 3 (23 sites)*

- Post Mounted Signs and Flashers on Major in Advance of Intersection, Loop on Minor



SS 06-01-213 (Bladen Co.)

NCDOT Traffic Safety Unit

VEWF Evaluation

“Vehicle Entering when Flashing” Configurations

- *Category 4 (8 sites)*
 - Combination of Category 1 through Category 3

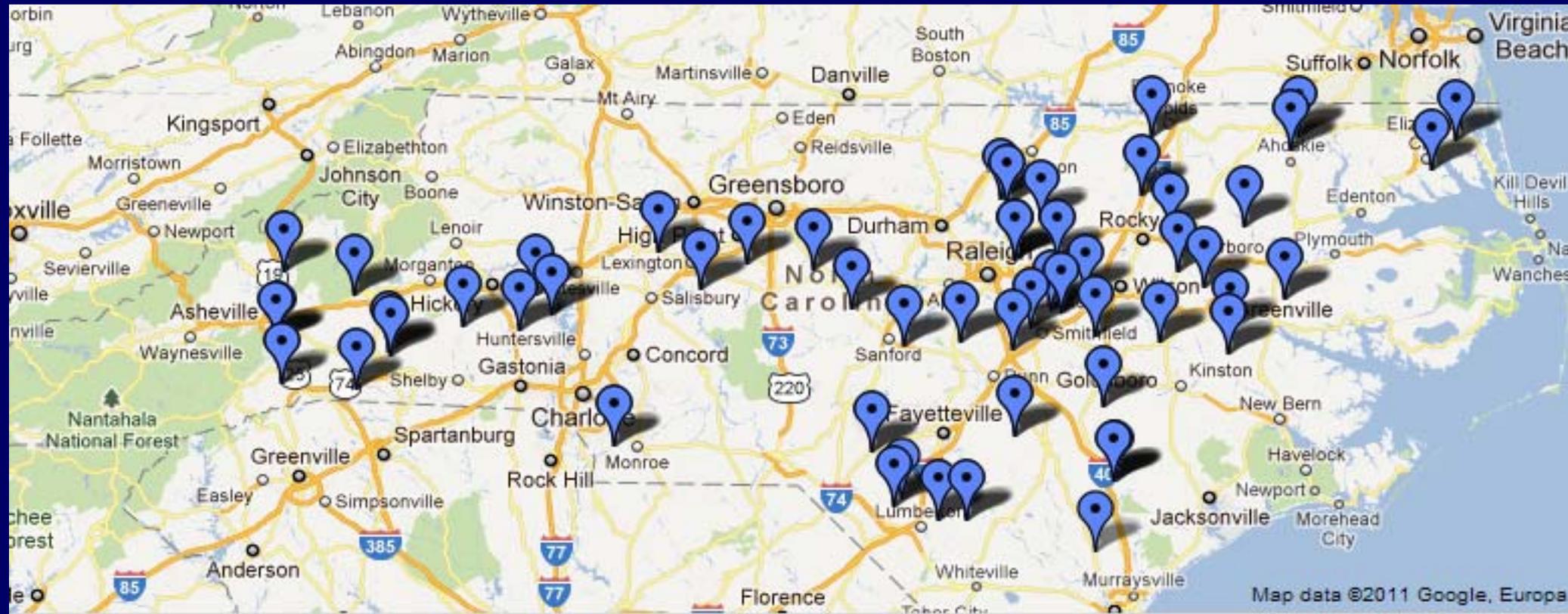


SS 08-06-217 (Randolph Co.)

NCDOT Traffic Safety Unit

VEWF Evaluation

“Vehicle Entering when Flashing” Configurations



TOTAL = 74 SITES

NCDOT Traffic Safety Unit

VEWF Evaluation

Project Scope

Specific evaluation goals include:

- Development of **Overall CMFs** for VEWf systems
- Determine the safety effectiveness of various **Categories** of VEWf systems
- Determine the impact of **Major Road Cross Section** on treatment effectiveness
- Determine the impact of **Other Key Factors** on treatment effectiveness

VEWF Evaluation

Site Selection

- Reviewed completed projects in Spot Safety Database
- Mainline approach speed limits range from 35 mph - 55 mph, although majority are rural, isolated, high speed facilities.
- Intersection AADT range from approx. 3,000 - 30,000 veh/day.
- Flashing beacon present in the before period at 23 locations.
- Intersection geometry includes 2-lane at 2-lane, 4-lane divided at 2-lane, and multilane (3 -5 lanes) undivided at 2-lane.

VEWF Evaluation

Crash Reduction Factors – All Sites (67) Empirical Bayes Method with Traffic Factor

	All Sites (n=67)
Total	6.8 (+/-4.3%)
Target	3.2 (+/-5.0)%
Injury	6.4 (+/-5.5)%
K+A Injury	16.4 (+/-15.9)%

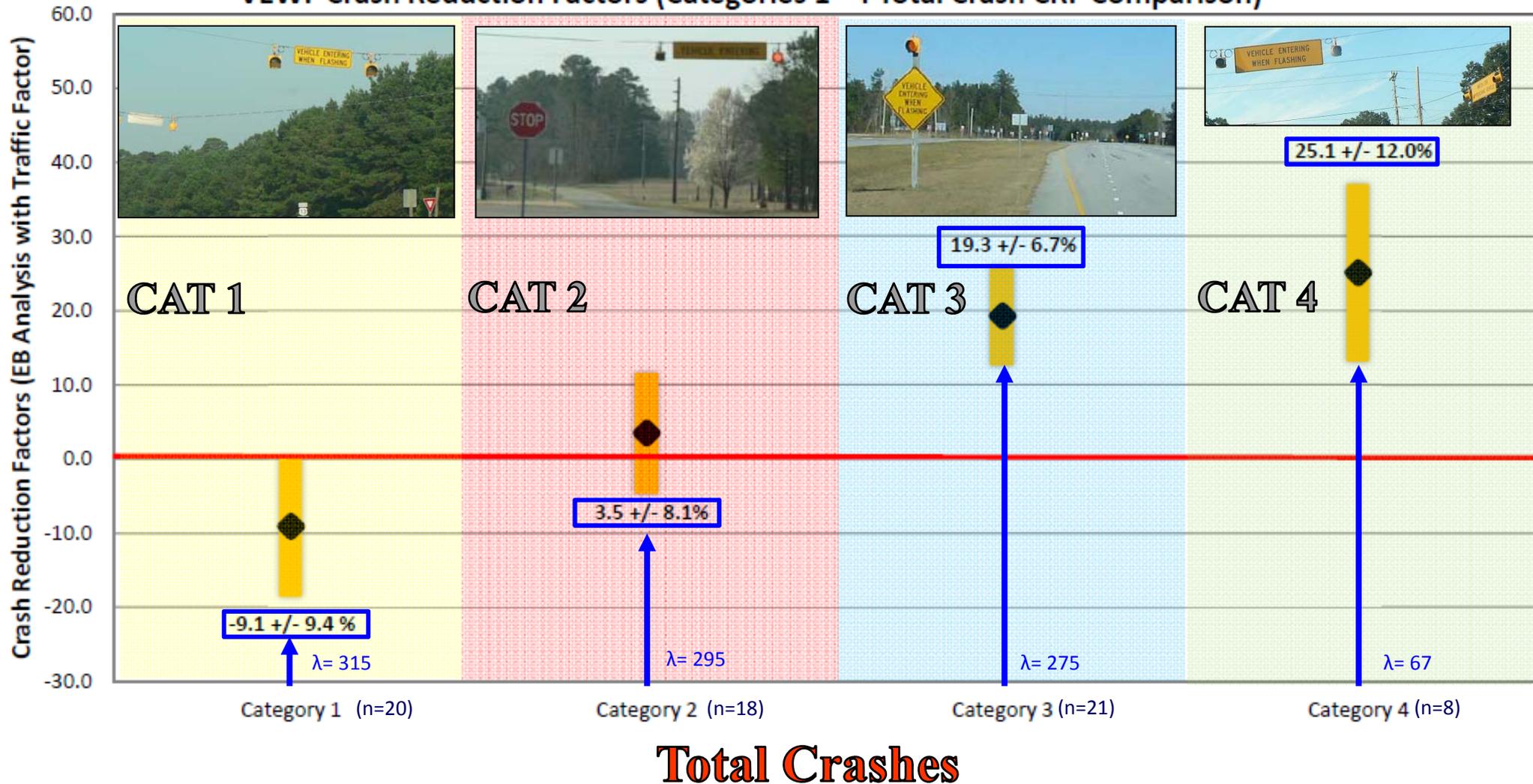
*Note: Negative Results Mean an Increase in Crashes.

	Cat 1 (n=20)	Cat 2 (n=18)	Cat 3 (n=21)	Cat 4 (n=8)
Total	-9.1 (+/-9.4)%	3.5 (+/-8.1)%	19.3 (+/-6.7)%	25.1 (+/-12.0)%
Target	-9.6 (+/-10.5)%	-4.3 (+/-9.7)%	17.3 (+/-7.6)%	20.3 (+/-14.4)%
Injury	5.0 (+/-10.4)%	2.4 (+/-10.5)%	11.0 (+/-9.0)%	13.0 (+/-18.7)%
K+A Injury	31.1 (+/-24.2)%	14.1 (+/-28.2)%	6.8 (+/-27.9)%	75.8 (+/-21.2)%

VEWF Evaluation

CRFs – All Sites (Category Comparison)

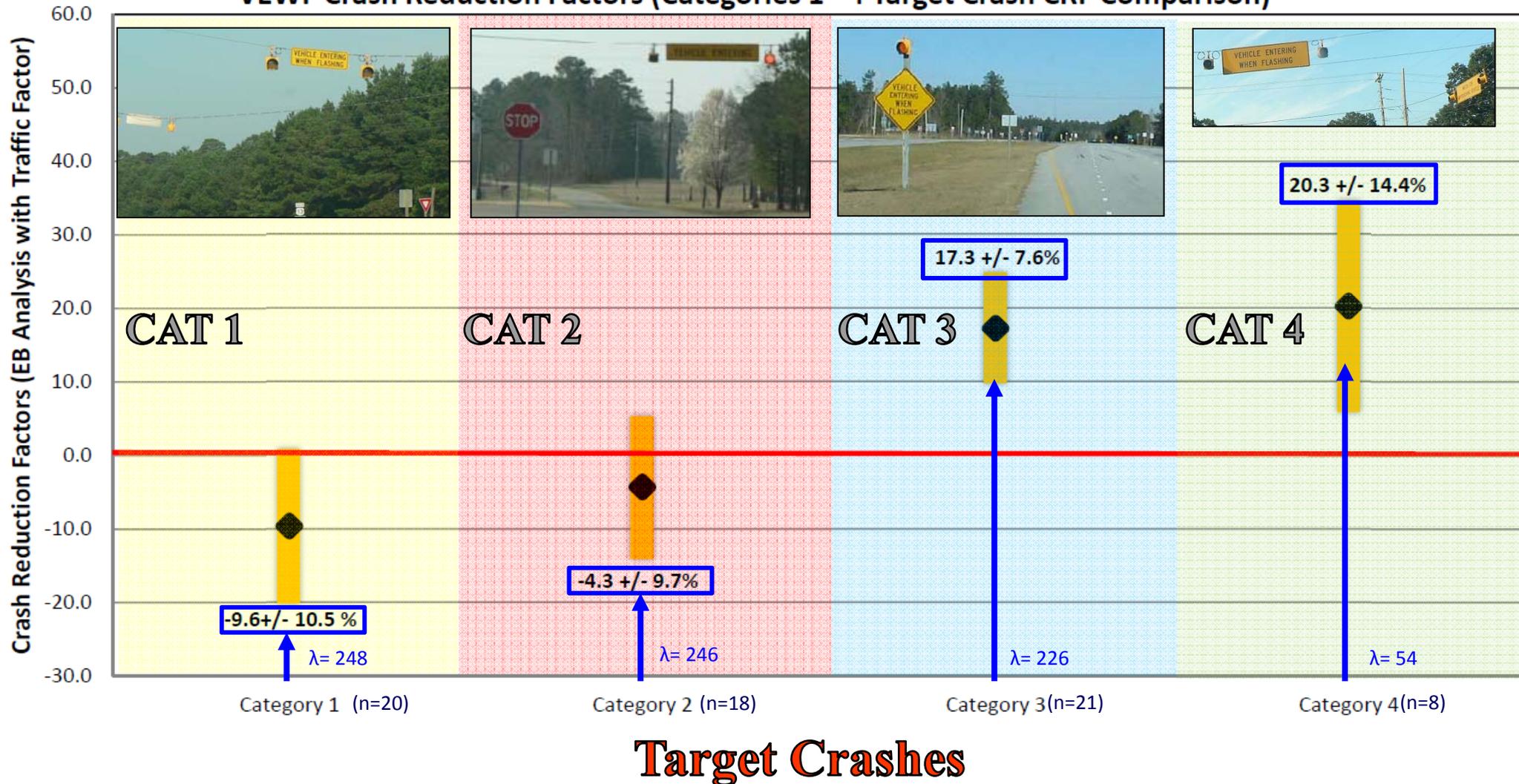
VEWF Crash Reduction Factors (Categories 1 - 4 Total Crash CRF Comparison)



VEWF Evaluation

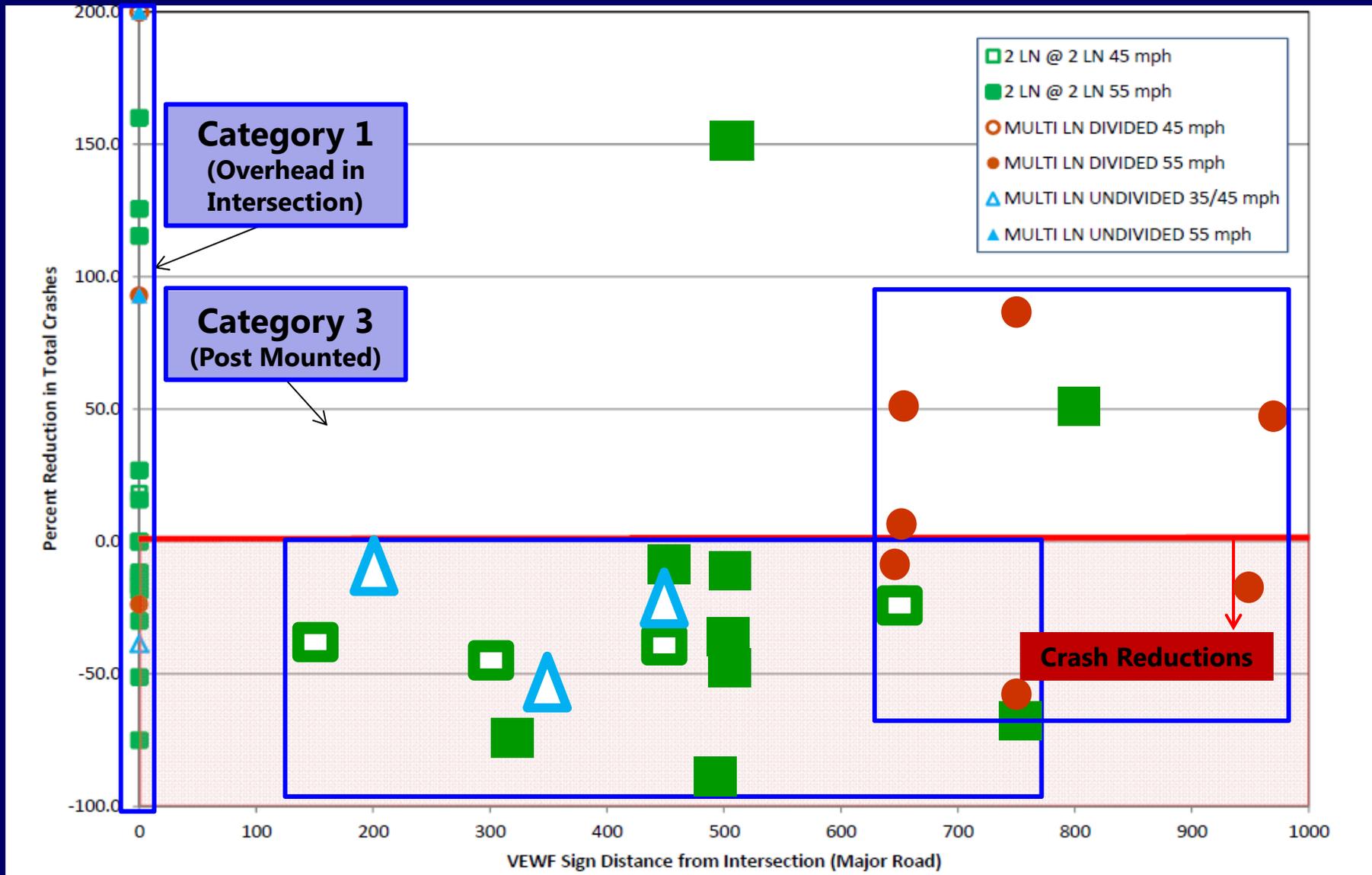
CRFs – All Sites (Category Comparison)

VEWF Crash Reduction Factors (Categories 1 - 4 Target Crash CRF Comparison)



VEWF Evaluation

Crash Reductions by Site (Category Comparison)

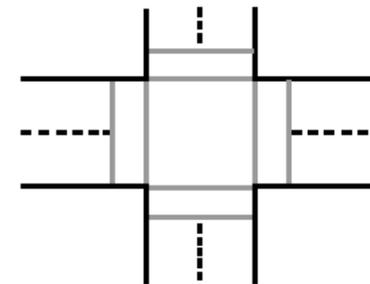


VEWF Evaluation

Crash Reduction Factors – Intersection Type Comparison Empirical Bayes Method with Traffic Factor

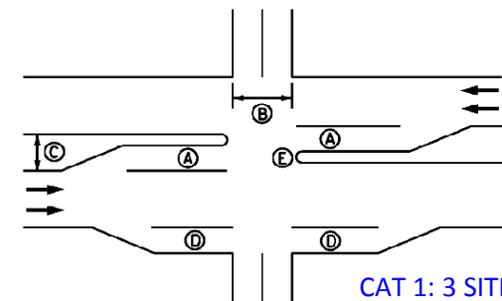
2 Ln @ 2 Ln

	All Sites (n=56)
Total	10.3 (+/-4.7)%
Target	7.1 (+/-5.5)%
Injury	12.2 (+/-5.9)%
K+A Injury	30.3 (+/-15.9)%



4 Ln Divided @ 2 Ln

	All Sites (n=11)
Total	-6.7 (+/-10.8)%
Target	-10.0 (+/-12.1)%
Injury	-14.9 (+/-14.3)%
K+A Injury	-16.9 (+/-39.3)%



CAT 1: 3 SITES
CAT 2: 1 SITE
CAT 3: 7 SITES

*Note: Negative Results Mean an Increase in Crashes.

VEWF Evaluation

Other Treatments Implemented After VEWf

	All Sites	Sites with Additional Treatments Implemented after					Percent of All Sites
		Signal	All-Way Stop	Geometric Revisions*	Additional VEWf Signs	Total	
2 Lane @ 2 Lane							
Category 1	17	3	1	0	1	5	29%
Category 2	17	2	2	2	1	7	41%
Category 3	14	0	0	0	0	0	0%
Category 4	8	1	0	0	0	1	13%
Total	56	6	3	2	2	13	23%
	All Sites	Sites with Additional Treatments Implemented after					Percent of All Sites
		Signal	All-Way Stop	Geometric Revisions*	Additional VEWf Signs	Total	
4 Lane Divided @ 2 Lane							
Category 1	3	2	0	0	0	2	67%
Category 2	1	0	0	1	0	1	100%
Category 3	7	0	0	4	0	4	57%
Category 4	0	0	0	0	0	0	N/A
Total	11	2	0	5	0	7	64%
	All Sites	Sites with Additional Treatments Implemented after					Percent of All Sites
		Signal	All-Way Stop	Geometric Revisions*	Additional VEWf Signs	Total	
Multilane Undivided @ 2 Lane							
Category 1	4	2	0	1	0	3	75%
Category 2	1	0	0	0	0	0	0%
Category 3	2	1	0	0	0	1	50%
Category 4	0	0	0	0	0	0	N/A
Total	7	3	0	1	0	4	57%

VEWF Evaluation

Crash Reduction Factors – 2 Ln @ 2 Ln (56)
Empirical Bayes Method with Traffic Factor

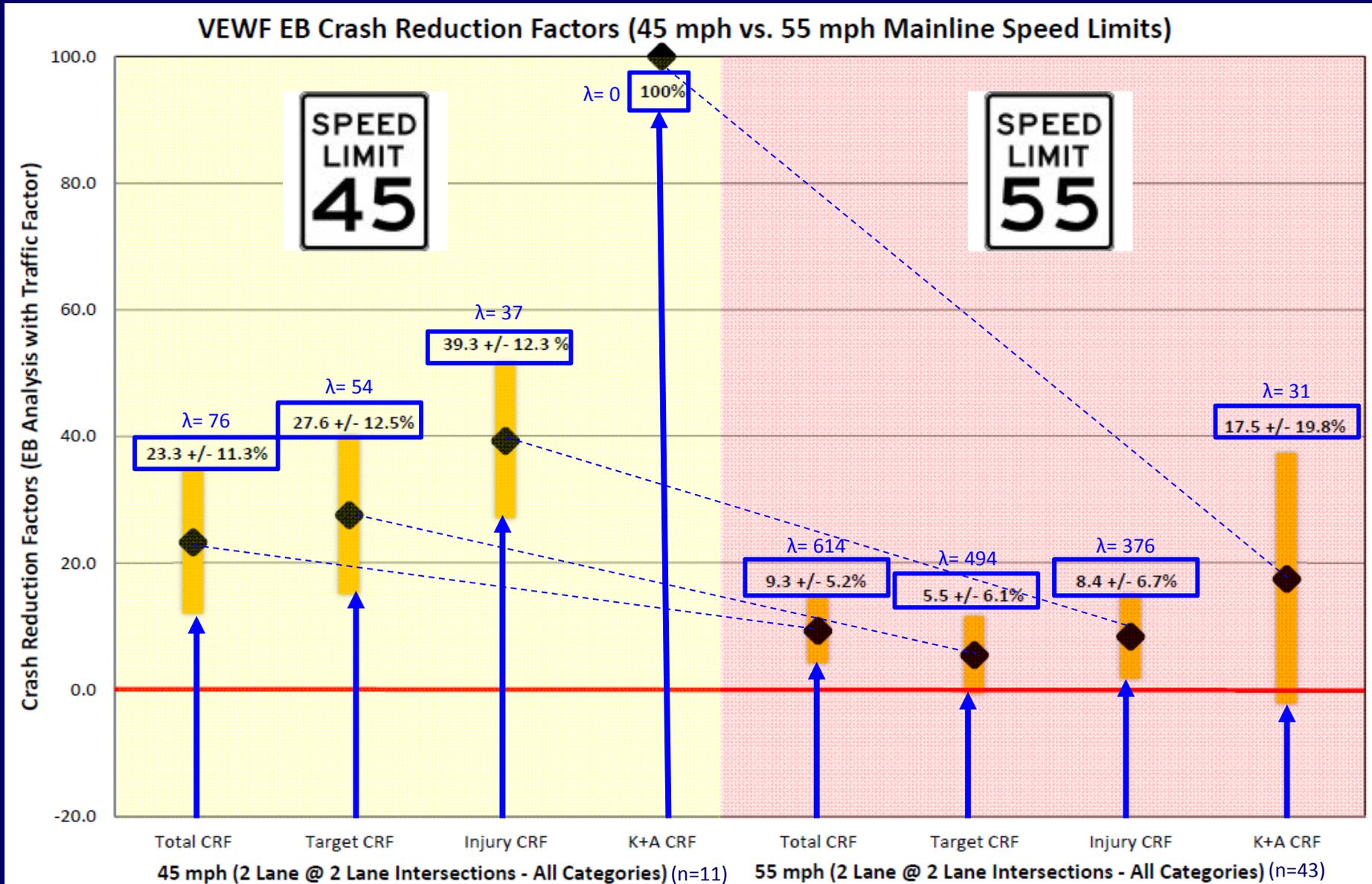
2 Ln @ 2 Ln

	Cat 1 (n=17)	Cat 2 (n=17)	Cat 3 (n=14)	Cat 4 (n=8)
Total	-5.9 (+/-9.8)%	4.7 (+/-8.4)%	32.5 (+/-7.6)%	25.1 (+/-12.0)%
Target	-7.4 (+/-11.2)%	-0.1 (+/-9.6)%	32.1 (+/-8.8)%	20.3 (+/-14.4)%
Injury	8.3 (+/-10.8)%	6.6 (+/-10.6)%	26.8 (+/-10.2)%	13.0 (+/-18.7)%
K+A Injury	38.7 (+/-23.6)%	23.9 (+/-26.8)%	30.1 (+/-30.1)%	75.8 (+/-21.2)%

NCDOT Traffic Safety Unit

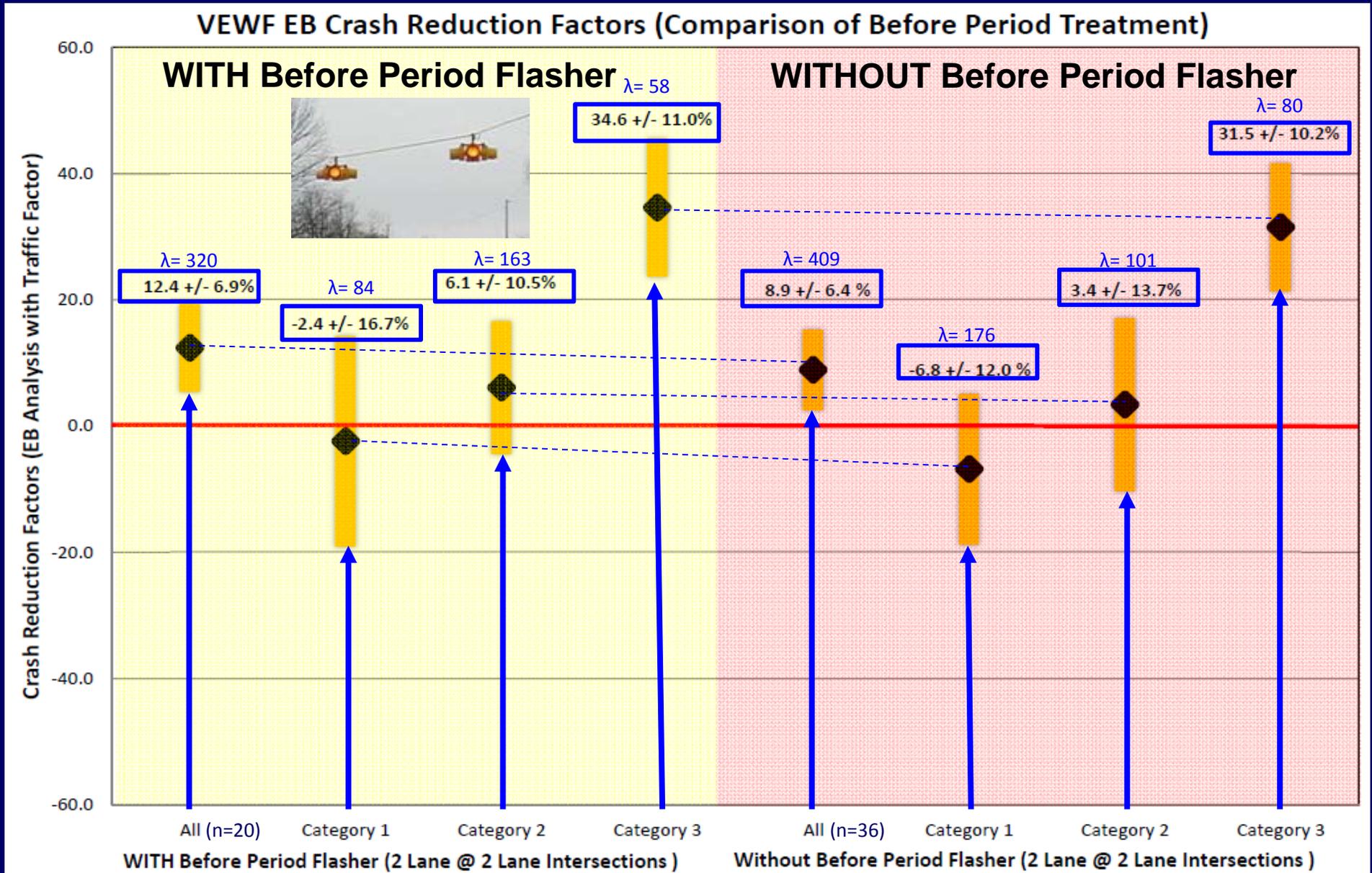
VEWF Evaluation

CRFs - 2 Ln @ 2 Ln (Speed Limit Comparison)



VEWF Evaluation

CRFs - 2 Ln @ 2 Ln (Before Period Treatment)



VEWF Evaluation

Items for Future Research

- Determine how the following contribute to VEWf effectiveness:
 - Sign message & size
 - Combined messaging on both major and minor approaches
 - Distance on major approach from intersection to signs (for sites with advance post mounted signs)
 - Distance on major and/or minor approaches from intersection to loops
 - Number of loops on the minor approach (some have lead in loops)
 - Variability of detector timing setting
 - Other safety treatments used in conjunction with VEWf
 - Sight distance
 - Roadway grade on major and minor approaches
 - Traffic volume thresholds
 - Additional analysis of intersection lane geometry (i.e. 4-lane divided at 2-lane and multilane undivided at 2-lane)

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VEWF Evaluation

Variability in Intersection Geometry & Sign/Flasher Treatments

Category 1 – Overhead Signs and Flashers on Major, Loop on Minor (24 sites)

CATEGORY 1

	Sign Message			Total
	"Vehicle Entering When Flashing"	"Vehicle Entering"	"Watch for Approaching Vehicles"	
<i>Intersection Geometry</i>				
3 Leg - 2 Ln @ 2 Ln	1	0	0	1
4 Leg - 2 Ln @ 2 Ln	15	1	0	16
3 Leg - Multilane Divided @ 2 Ln	1	0	0	1
4 Leg - Multilane Divided @ 2 Ln	2	0	0	2
3 Leg - Multilane Undivided @ 2 Ln	1	0	0	1
4 Leg - Multilane Undivided @ 2 Ln	2	0	1	3
Total	22	1	1	24
<i>Number of Sites using Sign Size</i>				
66" X 20"	1	0	0	1
72" X 12"	1	0	0	1
114" X 36"	15	1	1	17
168" X 48"	2	0	0	2
Unknown	3	0	0	3
<i>Number of Sites using Additional Treatments</i>				
Additional Flasher on Stop Ahead Sign	2	0	0	2
Additional Flasher on Intersection Warning Sign	1	0	0	1
Continuous Flasher in Before Period	4	0	0	4

*Note: VEWf characteristics based on original signal plan designs. Not field verified.

VEWF Evaluation

Variability in Intersection Geometry & Sign/Flasher Treatments

Category 2 – Overhead Signs and Flashers on Minor, Loop on Major (19 sites)

CATEGORY 2	Sign Message				Total
	"Vehicle Entering When Flashing"	"Vehicle Entering"	"Watch for Approaching Vehicles"	"Vehicle Entering from Left when Flashing"	
<i>Intersection Geometry</i>					
3 Leg - 2 Ln @ 2 Ln	1	0	0	0	1
4 Leg - 2 Ln @ 2 Ln	6	9	1	0	16
4 Leg - Multilane Divided @ 2 Ln	0	0	0	1	1
4 Leg - Multilane Undivided @ 2 Ln	1	0	0	0	1
Total	8	9	1	1	19
<i>Number of Sites using Sign Size</i>					
114" X 36"	8	4	0	1	13
125" X 24"	0	1	0	0	1
144" X 24"	0	1	0	0	1
Unknown	0	3	1	0	4
<i>Number of Sites using Additional Treatments</i>					
Additional Flasher on Stop Sign	5	3	1	0	9
Additional Flasher on Intersection Warning Sign	0	0	0	1	1
Continuous Flasher in Before Period	3	5	1	0	9

*Note: VEWF characteristics based on original signal plan designs. Not field verified.

VEWF Evaluation

Variability in Intersection Geometry & Sign/Flasher Treatments

Category 3 – Post Mounted Signs and Flashers on Major, Loop on Minor (23 sites)

CATEGORY 3	Sign Message			Total
	"Vehicle Entering When Flashing"	"Vehicle Entering"	"Watch for Approaching Vehicles"	
<i>Intersection Geometry</i>				
4 Leg - 2 Ln @ 2 Ln	10	3	1	14
4 Leg - Multilane Divided @ 2 Ln	4	0	0	4
4 Leg - Multilane Undivided @ 2 Ln	2	3	0	5
Total	16	6	1	23
<i>Number of Sites using Sign Size</i>				
48" x 48"	14	6	1	21
Unknown	2	0	0	2
<i>Number of Sites using Additional Treatments</i>				
Additional Flasher on Stop Sign	1	1	0	2
Additional Flasher on Stop Ahead Sign	1	0	0	1
Continuous Flasher in Before Period	8	0	0	8

*Note: VEWf characteristics based on original signal plan designs. Not field verified.

VEWF Evaluation

Variability in Intersection Geometry & Sign/Flasher Treatments

Category 4 – Locations with Combination of Category 1 through Category 3 (8 sites)

CATEGORY 4

	Sign Messages						Total
	Overhead Major: "Vehicle Entering When Flashing" Overhead Minor: "Watch for Approaching Vehicle"	Overhead Major: "Vehicle Entering" Overhead Minor: "Watch for Approaching Vehicle"	Overhead & Post Mounted Major: "Vehicle Entering when Flashing" Overhead Minor: "Watch for Approaching Vehicle"	Overhead & Post Mounted Major: "Vehicle Entering When Flashing"	Overhead Major: "Vehicle Entering When Flashing" Overhead Minor: "Vehicle Entering When Flashing"	Post Mounted Major: "Vehicle Entering When Flashing" Post Mounted Minor: "Watch for Approaching Vehicle"	
<i>Intersection Geometry</i>							
3 Leg - 2 Ln @ 2 Ln	0	0	0	1	0	1	1
4 Leg - 2 Ln @ 2 Ln	2	2	1	1	1	0	7
Total	2	2	1	1	1	1	8
<i>Number of Sites using Sign Size</i>							
48" x 48" (Post)	0	0	1	1	0	1	3
72" X 12" (Overhead)	0	0	0	1	0	0	1
114" X 36" (Overhead)	1	2	1	0	1	0	5
Unknown	1	0	0	0	0	0	1
<i>Number of Sites using Additional Treatments</i>							
Additional Flasher on Stop Sign	1	0	0	0	1	0	2
Additional Flasher on Stop Ahead Sign	0	1	0	0	0	0	1
Continuous Flasher in Before Period	1	1	0	0	0	0	2

*Note: VEVF characteristics based on original signal plan designs. Not field verified.

VEWF Evaluation

Variability in Loop Placement & Detector Timing

Category 3 – Post Mounted Signs and Flashers on Major, Loop on Minor (23 sites)

	# Sites	Minor Distance from Intersection to First Loop (ft)	Detector Timing (extension in sec)	Minor Distance from Intersection to Second Loop (ft)	Detector Timing (extension in sec)	Major Distance from Intersection to Sign (ft)	Intersection AADT Range (entering veh/day)
35 mph	1	450	15	0	3	350	10,600
45 mph	5	0-105	5-11	0-5	0-5	150-150	2,900-28,600
55 mph	17	0-1000	3-17	0-6	0-5	325-975	2,800-10,200

***Note: VEWf characteristics based on original signal plan designs. Not field verified.**

VEWF Evaluation

Treatment Toolbox

COMPARISON OF SEVERAL LOW COST TREATMENTS FOR 2 LN @ 2 LN INTERSECTIONS	TOTAL CRF	INJURY CRF	AVERAGE COST*	INTERSECTION AADT**
All Way Stop (Installed with Overhead Flashing Beacons)	82 (+/-4)%	87 (+/-4)%	\$20,000	1,400-9,900
All Way Stop (Signs Only)	61 (+/-3)%	72 (+/-4)%	\$5,000	680 - 15,100
VEWF Category 3	32 (+/-8)%	27 (+/-10)%	\$21,200	2,800-9,700
VEWF Category 4	25 (+/-12)%	13 (+/-19)%	\$28,000	2,400-9,300
Overhead Flashing Beacon	12 (+/-6)%	9 (+/-8)%	\$20,000	1,100-14,000
VEWF Category 2	5 (+/-8)%	7 (+/-11)%	\$21,900	3,200-12,100
VEWF Category 1	-6 (+/-10)%	8 (+/-11)%	\$22,800	1,500-12,200

*VEWF costs obtained from sites with available project information in spot safety files. All way stop and flasher costs obtained from prior Statewide evaluations.

** Range of intersection AADTs for locations used in study



Questions?

NCDOT Traffic Safety Unit