

# **Hazard Elimination Project Evaluation**

Order # 41000011052

Hazard Elimination Project W-4810

**Evaluation of the Rumble Strip Installation on US 264  
Nash and Wilson Counties**

Documents Prepared By:

Safety Evaluation Group  
Traffic Safety Systems Management Section  
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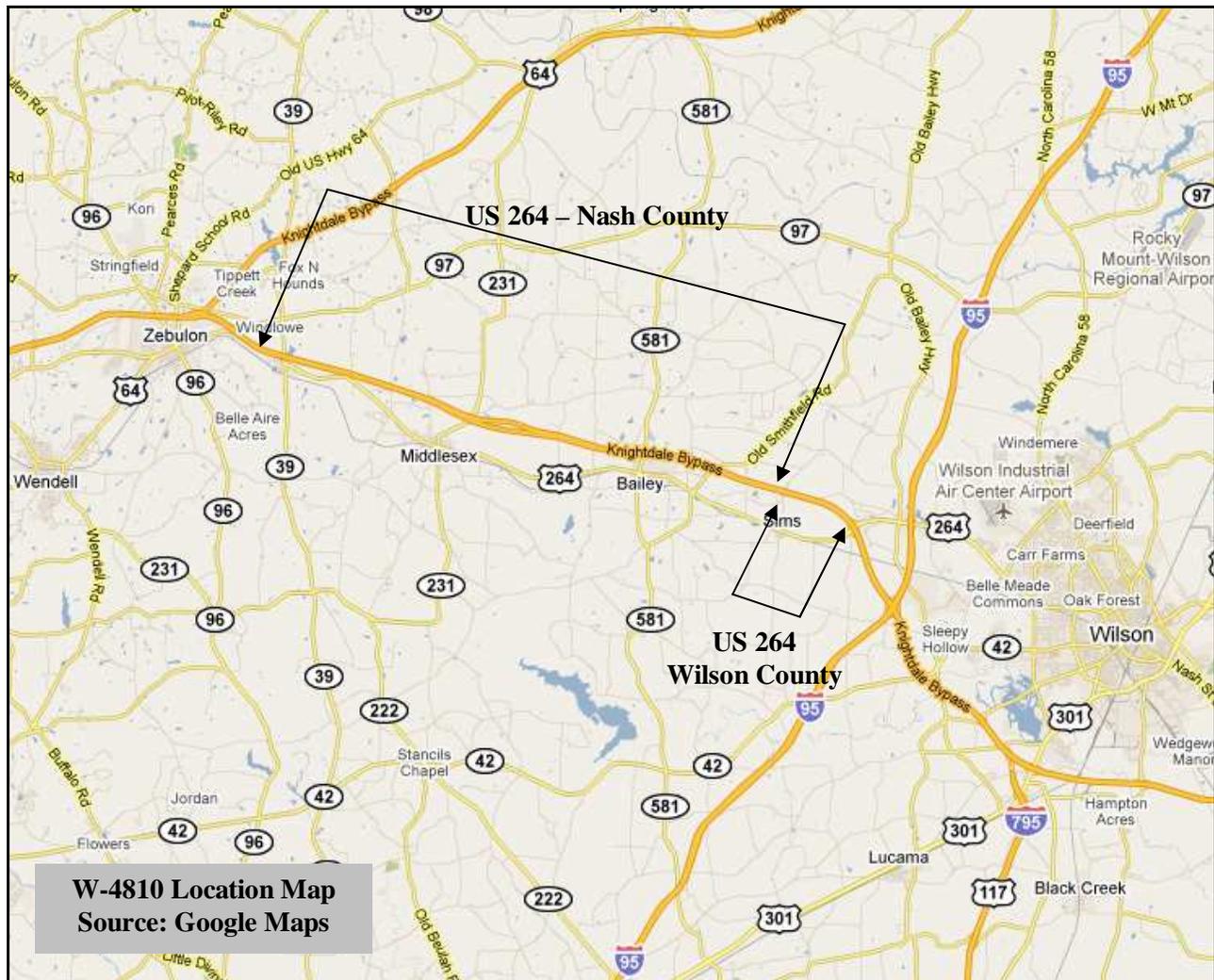
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3-14-2011  
Date

Traffic Safety Project Engineer

# Hazard Elimination Project Evaluation Documentation



## Subject Location

The treatment location includes the US 264 segments as shown above. The study begins at the Wake County Line in Nash County (MP 0.00) and continues to 0.4 mile west of the US 264 Alternate Interchange in Wilson County (MP 2.06). The total segment length is 13.11 miles which consists of 11.05 miles in Nash County and 2.06 miles in Wilson County. US 264 is a 2 lane fully controlled access bi-directional freeway with paved median shoulders and outside shoulders. Wide, more than 100 feet, unprotected medians exist along this section, which varies between clear grass and wooded areas. The speed limit is 70 mph.

Multiple TIP projects were completed on this section of roadway after the completion of W-4810. US 264 was included under Statewide TIP R-4401 which possibly provided guardrail rehabilitation and was let in September 2007. Also, this entire segment was resurfaced and provided shoulder reconstruction by TIP R-5199 let in December 2009. The following before-after analysis has been limited to three years to stop short of the TIP R-5199 installation. The report also includes an independent one-year crash analysis review of the resurfacing project.

## **Project Information and Background from the Project File Folder**

The hazard elimination project improvement chosen was the installation of milled-in rumble strips on the median and outside shoulders of US 264. This section of US 264 had experienced numerous run-off-road crashes resulting in fatalities, serious injury, and property damage. The intended purpose of the improvement was to warn motorists when their vehicle drifts out of the travel lane and to alleviate the frequency of run-off-road crashes.

The initial crash analysis was completed from August 1, 2000 to July 31, 2003 with 125 Total Crashes; 69 of which were Ran-Off-Road crashes. The improvement was completed on December 31, 2006 with a total cost of \$111,000. The projected B/C Ratio was 91.02:1.

## **Location Photographs**



## **Naive Before and After Analysis**

After reviewing the project file folder along with all the crashes at the subject location, the crash data omitted from this analysis to consider for an adequate construction period was the calendar year of 2006. The before period consisted of reported crashes from January 1, 2003 through December 31, 2005 (3 years); and the after period consisted of reported crashes from January 1, 2007 through December 31, 2009 (3 years). The ending date for this analysis was limited by the letting of TIP R-5199. The before period ADT year was 2004 and the after period ADT year was 2008.

For the purposes of this evaluation, we assumed that there were no rumble strips present in the before period and continuous rumble strips present for the duration of the after period. The treatment data consisted of all mainline crashes with a 0' y-line. Target crashes are lane departure crash types.

**US-264: Nash / Wilson Counties, 13.11 Miles**

<b>US-264 Both Directions</b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes – Both Directions	157	152	- 3.2 %
Total Severity Index	8.24	6.74	- 18.2 %
Lane Departure Crashes – Both Directions	96	75	- 21.9 %
Lane Departure Severity Index	10.80	10.94	1.3 %
Volume (2004, 2008)	17,000	22,600	32.9 %

<b>US-264 Both Directions</b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Injuries</b>			
Fatal Injury Crashes	5	4	- 20.0 %
Class-A Injury Crashes	6	4	- 33.3 %
Class-B Injury Crashes	14	18	28.6 %
Class-C Injury Crashes	27	18	- 33.3 %
Property Damage Only Crashes	105	108	2.9 %
<b>Contributing Factors</b>			
Night Crashes	70	75	7.1 %
Wet Road Crashes	33	36	9.1 %
Alcohol Related	6	6	0.0 %
<b>Lane Departure Crash Types</b>			
Angle	1	0	- 100.0 %
Fixed Object	70	56	- 20.0 %
Jackknife	1	0	- 100.0 %
Movable Object	4	3	- 25.0 %
Overturn / Rollover	11	4	- 63.6 %
Parked Motor Vehicle	1	2	100.0 %
Ran Off Road (Right)	4	1	- 75.0 %
Sideswipe, Same Direction	4	9	125.0 %

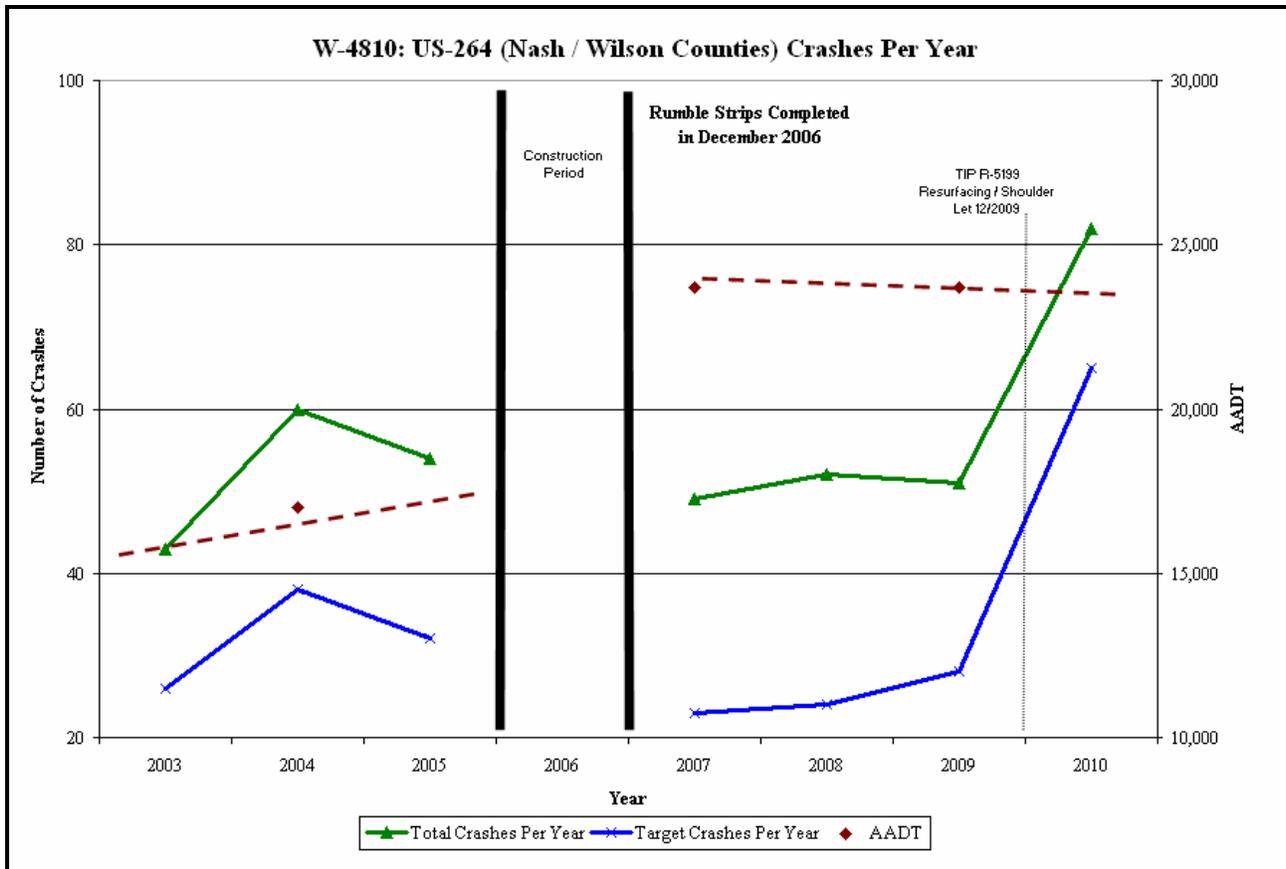
The following two tables divide the crash data for US-264 by direction of travel:

<u>US-264 Eastbound</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	74	91	23.0 %
Total Severity Index	9.67	4.45	- 54.0 %
Wet Crashes	12	26	116.7 %
Lane Departure Crashes	44	43	- 2.3 %

<u>US-264 Westbound</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	83	61	- 26.5 %
Total Severity Index	6.97	10.15	45.6%
Wet Crashes	21	10	- 52.4 %
Lane Departure Crashes	52	32	- 38.5 %

The naive before and after analysis for US 264 in Nash / Wilson Counties resulted in an overall 3 percent decrease in Total Crashes and an 18 percent decrease in the Total Severity Index. There was also a 22 percent decrease in Target Lane Departure Crashes but a 1 percent increase in the Target Severity Index.

The following graph is a representation of the Total / Target Crashes each year and how they relate the growth and decline of the ADT values:



## Results and Discussion

From the tables above, the overall crashes appear to have remained fairly consistent with only a 3 percent decrease in total crashes. However, both lane departure crashes and the total severity index experienced a reduction near 20 percent each. The graph also yields that total crashes and target lane departure crashes per year were reduced in 2007 to 2009 from their peak point in the before period during the calendar year of 2004.

When the crash data was examined by direction, lane departure crashes remained consistent in the eastbound direction but experienced a 38.5 percent reduction for westbound vehicles. Eastbound vehicles also saw a rise in total crashes and wet roadway collisions.

The calculated benefit to cost ratio for W-4810 is **29.88 considering Total Crashes**. The benefit to cost ratio **considering only Target Crashes is 21.70**. The benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related to the project are not considered in this analysis. The costs of the project include the actual construction costs as well as the increase in annual maintenance costs when applicable.

As the Safety Evaluation Group completes additional hazard elimination reviews for this type of countermeasure, we will be able to provide objective and definite information regarding actual crash reduction factors for this type of treatment.

### TIP R-5199 – 2010 Crash Data

As previously stated TIP R-5199 was let in December 2009 as a resurfacing and shoulder improvement project along this section of roadway. In the following tables, the comparison is made between crash data observed in the W-4810 “After Period” (3.0 year) to “After II Period” (1.0 year). The After II Period consists of data from January 1, 2010 to December 31, 2010 for the same US-264 segment in Nash and Wilson Counties.

<b><u>R-5199: US-264 Both Directions</u></b>	<b>After 3.0 Yrs</b>	<b>After II 1.0 Yr</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes	152	82	N/A
<b>Total Crashes per Year</b>	<b>50.7</b>	<b>82.0</b>	<b>61.7 %</b>
<b>Total Severity Index</b>	<b>6.74</b>	<b>3.55</b>	<b>- 47.3 %</b>
Wet Crashes	36	33	N/A
<b>Wet Crashes per Year</b>	<b>12.0</b>	<b>33.0</b>	<b>175.0 %</b>
Lane Departure Crashes	75	65	N/A
<b>Lane Departure Crashes per Year</b>	<b>25.0</b>	<b>65.0</b>	<b>160.0 %</b>

The naive before and after analysis for US 264 in Nash / Wilson Counties resulted in an overall 62 percent increase in Total Crashes per year, a 175 percent increase in Wet Crashes per year, and 160 percent increase in Lane Departure Crashes per year. From the graph on the previous page, the ADTs along this segment have remained consistent through this four (4) year period.

The data is further examined by direction in the following tables.

<b><u>R-5199: US-264 Eastbound</u></b>	<b>After 3.0 Yrs</b>	<b>After II 1.0 Yr</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes	91	43	N/A
<b>Total Crashes per Year</b>	<b>30.3</b>	<b>43.0</b>	<b>41.9 %</b>
<b>Total Severity Index</b>	<b>4.45</b>	<b>4.48</b>	<b>0.7 %</b>
Wet Crashes	26	19	N/A
<b>Wet Crashes per Year</b>	<b>8.7</b>	<b>19.0</b>	<b>118.4 %</b>
Lane Departure Crashes	43	34	N/A
<b>Lane Departure Crashes per Year</b>	<b>14.3</b>	<b>34.0</b>	<b>137.8 %</b>

<b><u>R-5199: US-264 Westbound</u></b>	<b>After 3.0 Yrs</b>	<b>After II 1.0 Yr</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
Total Crashes	61	39	N/A
<b>Total Crashes per Year</b>	<b>20.3</b>	<b>39.0</b>	<b>92.1 %</b>
<b>Total Severity Index</b>	<b>10.15</b>	<b>2.52</b>	<b>- 75.2%</b>
Wet Crashes	10	14	N/A
<b>Wet Crashes per Year</b>	<b>3.3</b>	<b>14.0</b>	<b>324.2%</b>
Lane Departure Crashes	32	31	N/A
<b>Lane Departure Crashes per Year</b>	<b>10.7</b>	<b>31.0</b>	<b>189.7 %</b>

The one-year (calendar year 2010) crash data for the After II Period indicates a significant increase in crashes. The individual crash reports do not indicate that any collisions occurred in work zone conditions. The data highlights that the amount of crashes per year doubled for lane departure crashes and wet roadway conditions during and since R-5199's construction.

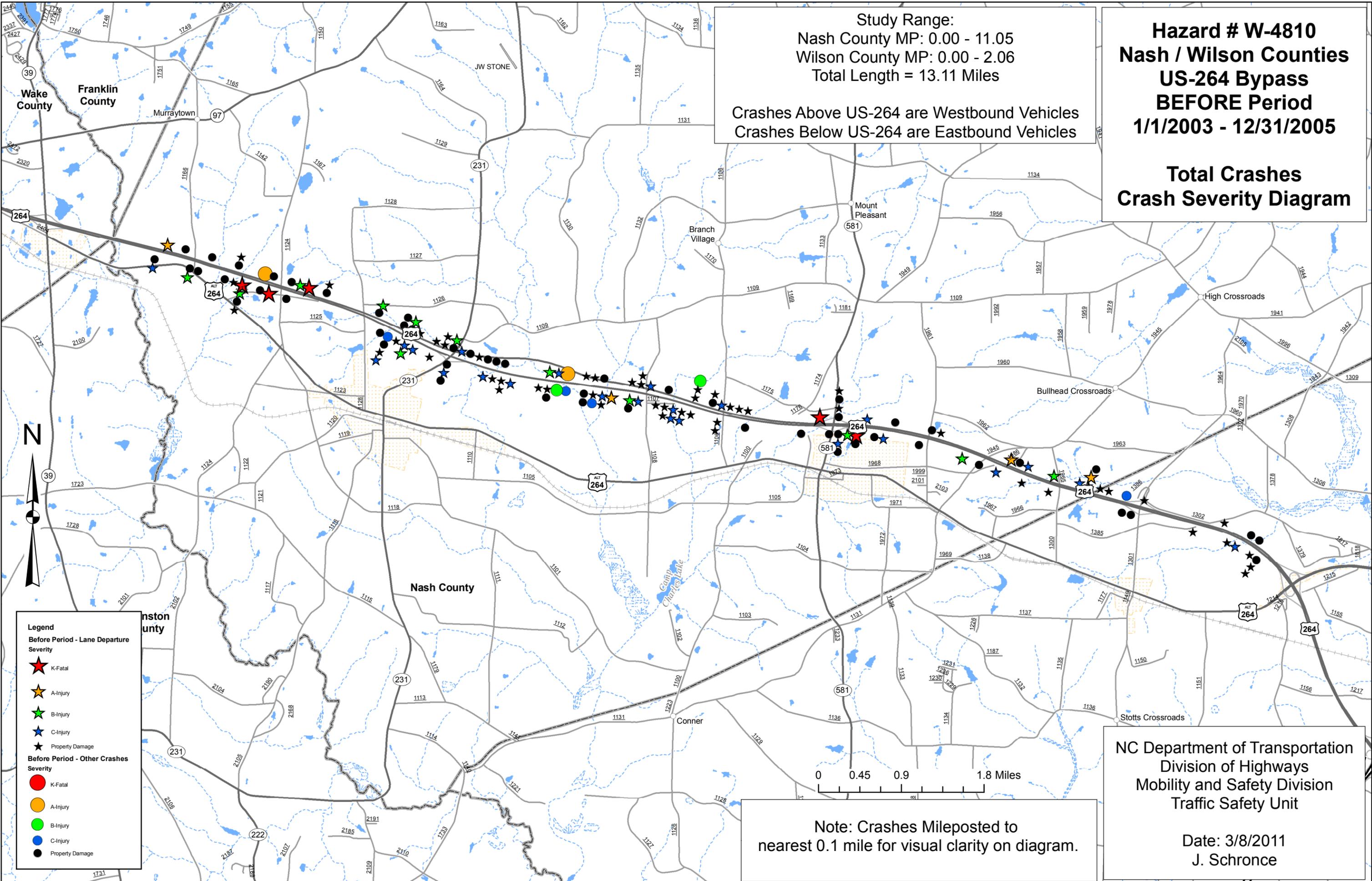
HiCAMs indicates the project as being completed from April through July 2010. The charts above clearly show that lane departure and wet road condition crashes have potentially been negatively affected by the construction of R-5199. However, even with the influx of collisions, the severity index was almost reduced by 50 percent in the After II Period from the W-4810 evaluation.

**BENEFIT-COST ANALYSIS WORKSHEET - Total Crashes**

LOCATION: <b>US-264</b>		BY: <b>JBS</b>						
COUNTY: <b>Nash / Wilson</b>		DATE: <b>3/3/2011</b>						
FILE NO.: <b>W-4810</b>								
DETAILED COST:	TYPE IMPROVEMENT - <b>Rumble Strips</b>							
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$111,000	10	0.149	\$16,542			
	Right-of-Way	\$0	0	0.000	\$0			
		\$0	0	0.000	\$0			
	<b>TOTALS</b>	<b>\$111,000</b>	<b>10</b>	<b>0.149</b>	<b>\$16,542</b>			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$0			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$16,542			
	TOTAL COST OF PROJECT=				\$111,000			
COMPREHENSIVE COST REDUCTION:								
ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES								
TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	4.00	11	2.75	41	10.25	105	26.25	\$2,050,375
AFTER	4.00	8	2.00	36	9.00	108	27.00	\$1,556,100
						Annual Benefits from Crash Cost Savings		\$494,275
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST					=	\$477,733		
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST					=	29.88		
TOTAL COST OF PROJECT		-	\$111,000	COMPREHENSIVE B/C RATIO		-	29.88	

**BENEFIT-COST ANALYSIS WORKSHEET - Target Crashes**

LOCATION: <b>US-264</b>		BY: <b>JBS</b>						
COUNTY: <b>Nash / Wilson</b>		DATE: <b>3/3/2011</b>						
FILE NO.: <b>W-4810</b>								
DETAILED COST:	TYPE IMPROVEMENT - <b>Rumble Strips - Lane Departure Targets</b>							
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$111,000	10	0.149	\$16,542			
	Right-of-Way	\$0	0	0.000	\$0			
		\$0	0	0.000	\$0			
	<b>TOTALS</b>	<b>\$111,000</b>	<b>10</b>	<b>0.149</b>	<b>\$16,542</b>			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$0			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$16,542			
	TOTAL COST OF PROJECT=				\$111,000			
COMPREHENSIVE COST REDUCTION:								
ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES								
TIME PERIOD	YEARS	K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	ANNUAL COSTS
BEFORE	4.00	9	2.25	35	8.75	52	13.00	\$1,648,400
AFTER	4.00	7	1.75	29	7.25	39	9.75	\$1,289,425
						Annual Benefits from Crash Cost Savings		\$358,975
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST					=	\$342,433		
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST					=	21.70		
TOTAL COST OF PROJECT		-	\$111,000	COMPREHENSIVE B/C RATIO		-	21.70	



Study Range:  
 Nash County MP: 0.00 - 11.05  
 Wilson County MP: 0.00 - 2.06  
 Total Length = 13.11 Miles

Crashes Above US-264 are Westbound Vehicles  
 Crashes Below US-264 are Eastbound Vehicles

**Hazard # W-4810**  
**Nash / Wilson Counties**  
**US-264 Bypass**  
**BEFORE Period**  
**1/1/2003 - 12/31/2005**

**Total Crashes**  
**Crash Severity Diagram**

**Legend**

**Before Period - Lane Departure Severity**

- ★ K-Fatal
- ★ A-Injury
- ★ B-Injury
- ★ C-Injury
- ★ Property Damage

**Before Period - Other Crashes Severity**

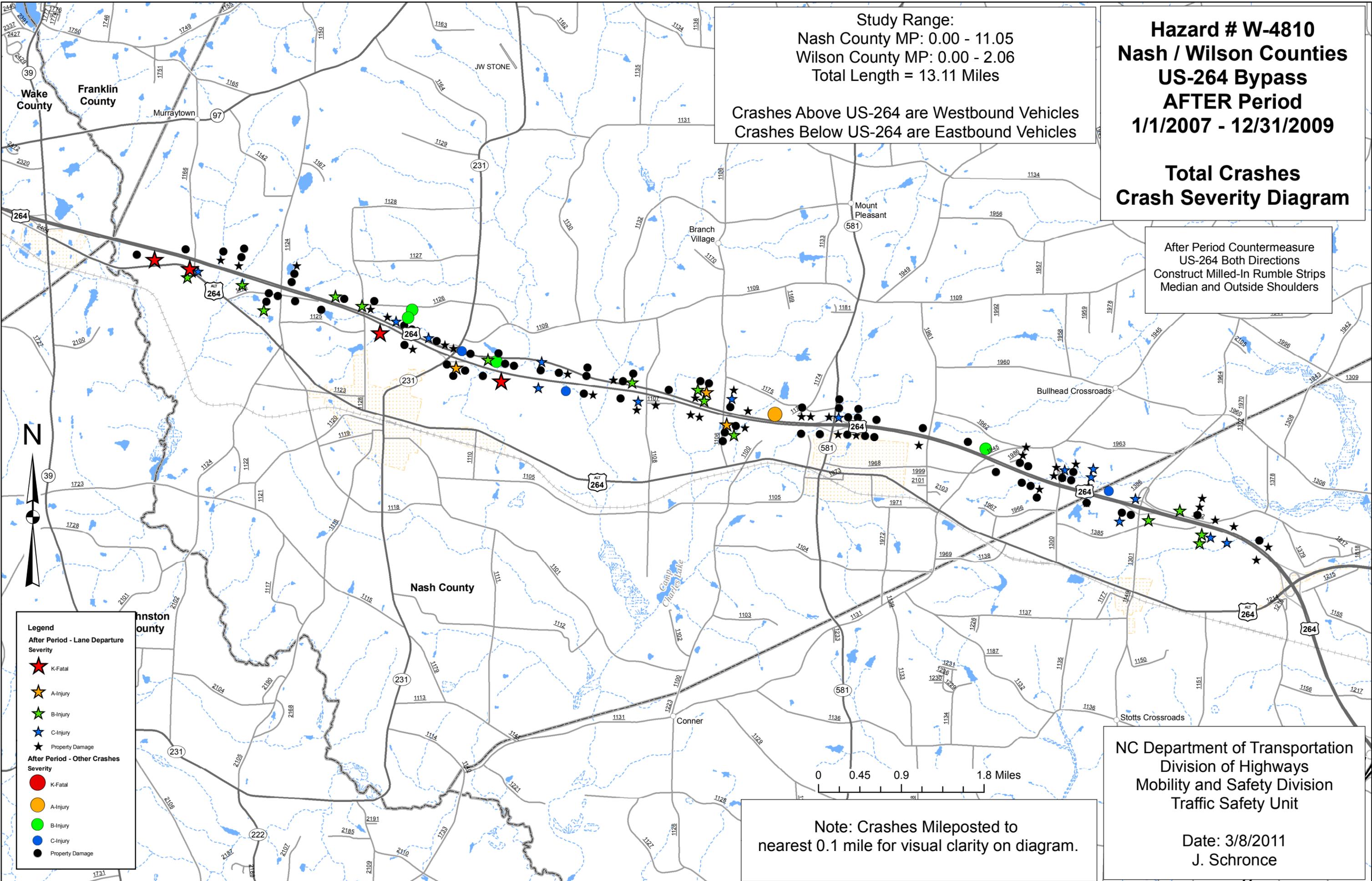
- K-Fatal
- A-Injury
- B-Injury
- C-Injury
- Property Damage

0 0.45 0.9 1.8 Miles

Note: Crashes Mileposted to nearest 0.1 mile for visual clarity on diagram.

NC Department of Transportation  
 Division of Highways  
 Mobility and Safety Division  
 Traffic Safety Unit

Date: 3/8/2011  
 J. Schronce



Study Range:  
 Nash County MP: 0.00 - 11.05  
 Wilson County MP: 0.00 - 2.06  
 Total Length = 13.11 Miles

Crashes Above US-264 are Westbound Vehicles  
 Crashes Below US-264 are Eastbound Vehicles

**Hazard # W-4810**  
**Nash / Wilson Counties**  
**US-264 Bypass**  
**AFTER Period**  
**1/1/2007 - 12/31/2009**

**Total Crashes**  
**Crash Severity Diagram**

After Period Countermeasure  
 US-264 Both Directions  
 Construct Milled-In Rumble Strips  
 Median and Outside Shoulders

**Legend**

**After Period - Lane Departure Severity**

- ★ K-Fatal
- ★ A-Injury
- ★ B-Injury
- ★ C-Injury
- ★ Property Damage

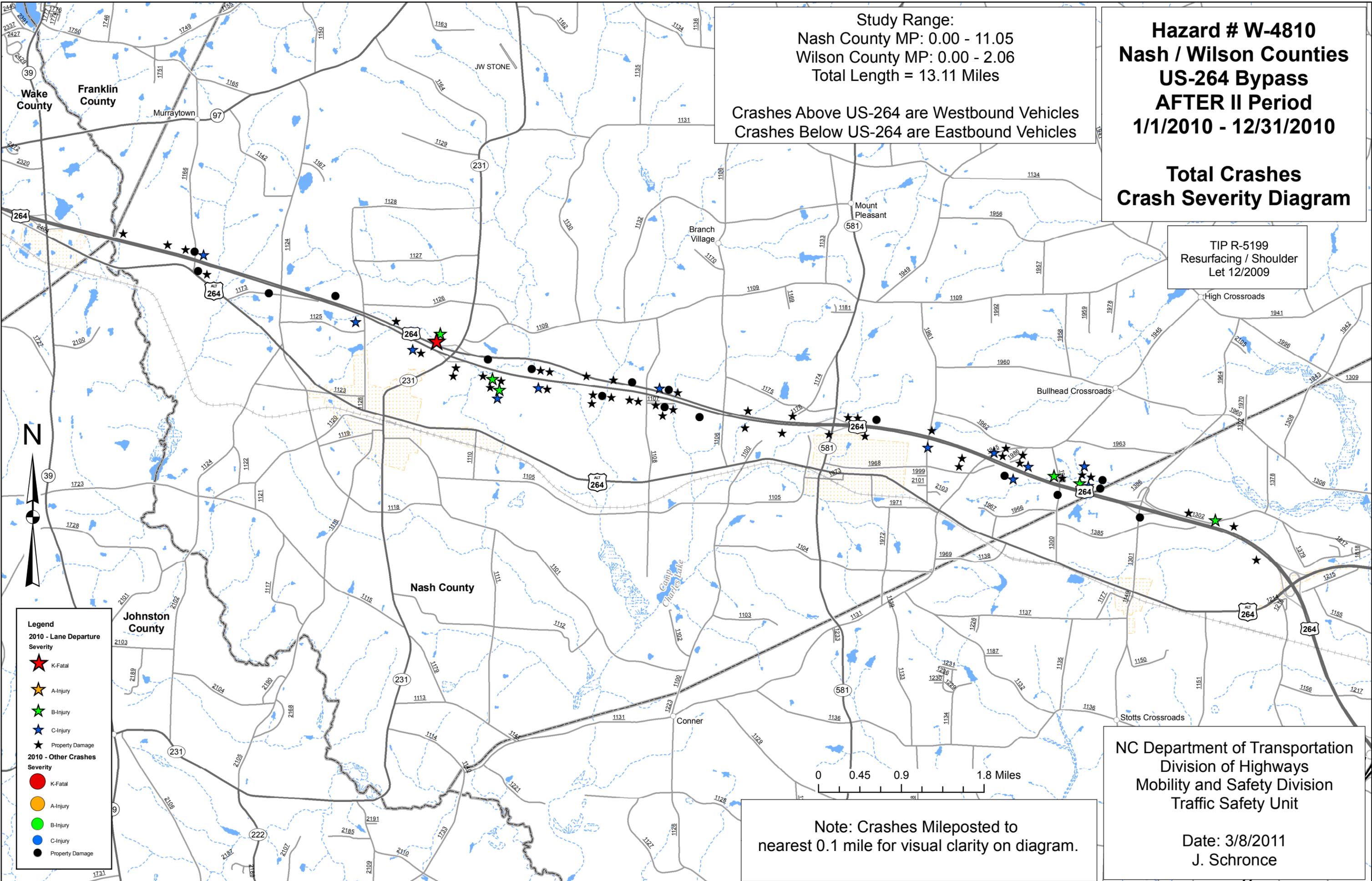
**After Period - Other Crashes Severity**

- K-Fatal
- A-Injury
- B-Injury
- C-Injury
- Property Damage

Note: Crashes Mileposted to nearest 0.1 mile for visual clarity on diagram.

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Crashes Above US-264 are Westbound Vehicles  
 Crashes Below US-264 are Eastbound Vehicles

**Hazard # W-4810**  
**Nash / Wilson Counties**  
**US-264 Bypass**  
**AFTER II Period**  
**1/1/2010 - 12/31/2010**

**Total Crashes**  
**Crash Severity Diagram**

TIP R-5199  
 Resurfacing / Shoulder  
 Let 12/2009

- Legend**
- 2010 - Lane Departure Severity**
- ★ K-Fatal
  - ★ A-Injury
  - ★ B-Injury
  - ★ C-Injury
  - ★ Property Damage
- 2010 - Other Crashes Severity**
- K-Fatal
  - A-Injury
  - B-Injury
  - C-Injury
  - Property Damage

0 0.45 0.9 1.8 Miles

Note: Crashes Mileposted to nearest 0.1 mile for visual clarity on diagram.

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