

# **Hazard Elimination Project Evaluation**

Order # 41000019016

Hazard Elimination Project # W-5005

**Hazard Elimination Project Evaluation of the Shoulder Guardrail  
US 176 from SR 1831 in Henderson County to SR 1102 in Polk County  
Henderson & Polk Counties**

Documents Prepared By:

Safety Evaluation Group  
Traffic Safety Systems Management Section  
Transportation Mobility and Safety Division  
North Carolina Department of Transportation

**Principal Investigator**



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Traffic Safety Project Engineer

6-13-2012  
Date

# *Hazard Elimination Project Evaluation Documentation*

## **Subject Location**

Evaluation of Hazard Elimination Project Number W-5005 located along the segment of US 176 from SR 1001 (Green River Road) in Henderson County (MP 4.924) to the southern intersection of SR 1102 (Pearson Falls Road) in Polk County (MP 3.720). The total segment length is 7.981 miles and a total of 2.60 miles of guardrail segments were installed.



## Project Information and Background from the Project File Folder

The hazard elimination improvement countermeasure chosen for the subject segment was the installation of shoulder guardrail in select segments for a total of 13,728 linear feet. US 176 is a two-lane winding highway with an average road width of 22-feet with 5-foot paved shoulders. Due to the mountainous terrain, steep embankments drop off the shoulder at several locations. The speed limit ranges from 40-mph to 55-mph along this section of roadway.

The original statement of problem was this roadway section was experiencing run-off roadway crashes down steep embankments resulting in fatalities and severe injuries.

The initial crash analysis was completed from July 1, 2000 to June 30, 2005 with fifty-three (53) reported crashes, thirty-four (34) of which were deemed correctable. The final completion date for these improvements was on October 31, 2008 with a total cost of \$380,000.

## Naive Before and After Analysis

After reviewing the spot safety 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 were the months of August through October 2008. The before period consisted of reported crashes from April 1, 2005 through July 31, 2008 (3 years and 4 months); and the after period consisted of reported crashes from November 1, 2008 through February 29, 2012 (3 years and 4 months). The ending date for this analysis was determined by the date of available crash data at the time of analysis.

The treatment data consisted of all crashes on US-176 within the segment mileposts with a zero (0) foot y-line. *Please see attached location map for further details.*

The following data table depicts the Naive Before and After Analysis for the treatment location. Please note that Lane Departure Crashes were the target crashes for the applied countermeasure. The Lane Departure Crash types considered are as follows: Ran-Off Roadway (Right, Straight, Left); Sideswipe (Opposite Direction), Fixed Object, and Head-On.

<b><u>Treatment Information</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-) Percent Increase (+)</b>
Total Crashes – Both Counties	32	33	3.1 %
Total Severity Index	11.11	14.65	31.9 %
Lane Departure Target Crashes	21	22	4.8 %
LD Target Crash Severity Index	8.06	10.58	31.3 %
Volume (2006, 2010)	1,800	1,500	- 16.7 %
Total Crash Rate (100 Mil Veh Miles)	182.88	226.69	24.0 %

<b><u>Additional Overall Information</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Injuries</b>			
Fatal Injury Crashes	1	0	- 100.0 %
Class-A Injury Crashes	2	2	0.0 %
Class-B Injury Crashes	7	4	- 42.9 %
Class-C Injury Crashes	6	7	16.7 %
Property Damage Only Crashes	16	20	25.0 %
<b>Contributing Factors</b>			
Total Night Crashes	11	9	- 18.2 %
Total Animal Crashes	0	0	0.0 %
Total Wet Road Crashes	2	2	0.0 %
Total Alcohol Related Crashes	3	3	0.0 %
<b>Lane Departure Crashes (From Crash Reports)</b>			
Fixed Object	16	10	- 37.5 %
Head-On	2	1	- 50.0 %
Overturn / Rollover	3	5	66.7 %
Ran Off Roadway	0	2	200.0 %
Sideswipe	0	4	400.0 %

The naive before and after analysis at the treatment location resulted in a 3 percent increase in Total Crashes, a 5 percent increase in Target Crashes, and a 32 percent increase in the Total Severity Index. The before period ADT year was 2006 and the after period ADT year was 2010.

<b><u>Additional Project Information</u></b>	<b>Before</b>	<b>After</b>	<b>Percent Reduction (-)/ Percent Increase (+)</b>
<b>Henderson County – Total Crashes</b>			
Henderson County – Total Crashes	27	28	3.7 %
<b>Polk County – Total Crashes</b>			
Polk County – Total Crashes	5	5	0.0 %
<b>Henderson County – LD Crashes</b>			
Henderson County – LD Crashes	18	19	5.6 %
<b>Polk County – LD Crashes</b>			
Polk County – LD Crashes	3	3	0.0 %
<b>Both Counties – LD Curve</b>			
Both Counties – LD Curve	17	13	-23.5 %
<b>LD Curve Severity Index</b>			
LD Curve Severity Index	8.94	3.85	- 56.9 %
<b>Guardrail Vehicle Strikes</b>			
Guardrail Vehicle Strikes	3	7	133.3 %
<b>Guardrail Strike Severity Index</b>			
Guardrail Strike Severity Index	1.00	12.89	500+ %

## Results and Discussion

Referencing the *charts above*, the overall analysis resulted in similar crash totals from the before to the after period. Both the Total Crashes and Lane Departure crashes increased by less than 5 percent with a 17 percent decrease in the roadway ADT. The crash totals were nearly identical for both Henderson and Polk Counties from the before and after periods.

From examining the individual crash reports, the collisions that indicated they occurred in a curve reduced from 17 to 13 through the evaluation period with a decrease in crash severity by 57 percent. Without a field visit to this location, the Safety Evaluation Group does not know the exact location of the 13,728 linear feet of guardrail placement.

There were two (2) after period A-injury lane departure crashes. Crash #11 was a single vehicle crash on a straight segment near the SR 1914 intersection where a motorist ran off the road, hit a guardrail, crossed back across the road striking an embankment and overturning. Crash #22 occurred on a straight segment as well and included a single vehicle hitting an embankment and overturning which ejected the driver.

The calculated benefit to cost ratio for this project is **4.27 considering total crashes**. The benefit to cost ratio **considering only Lane Departure crashes is 4.06**. 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 and utility costs.

A photo is provided from Google Street View to show the standard roadway segment of US 176. As the Safety Evaluation Group completes additional spot safety 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 countermeasure.

### Treatment Site Photograph (Google Maps)



**US-176 around Milepost 5.80 in Henderson County**

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

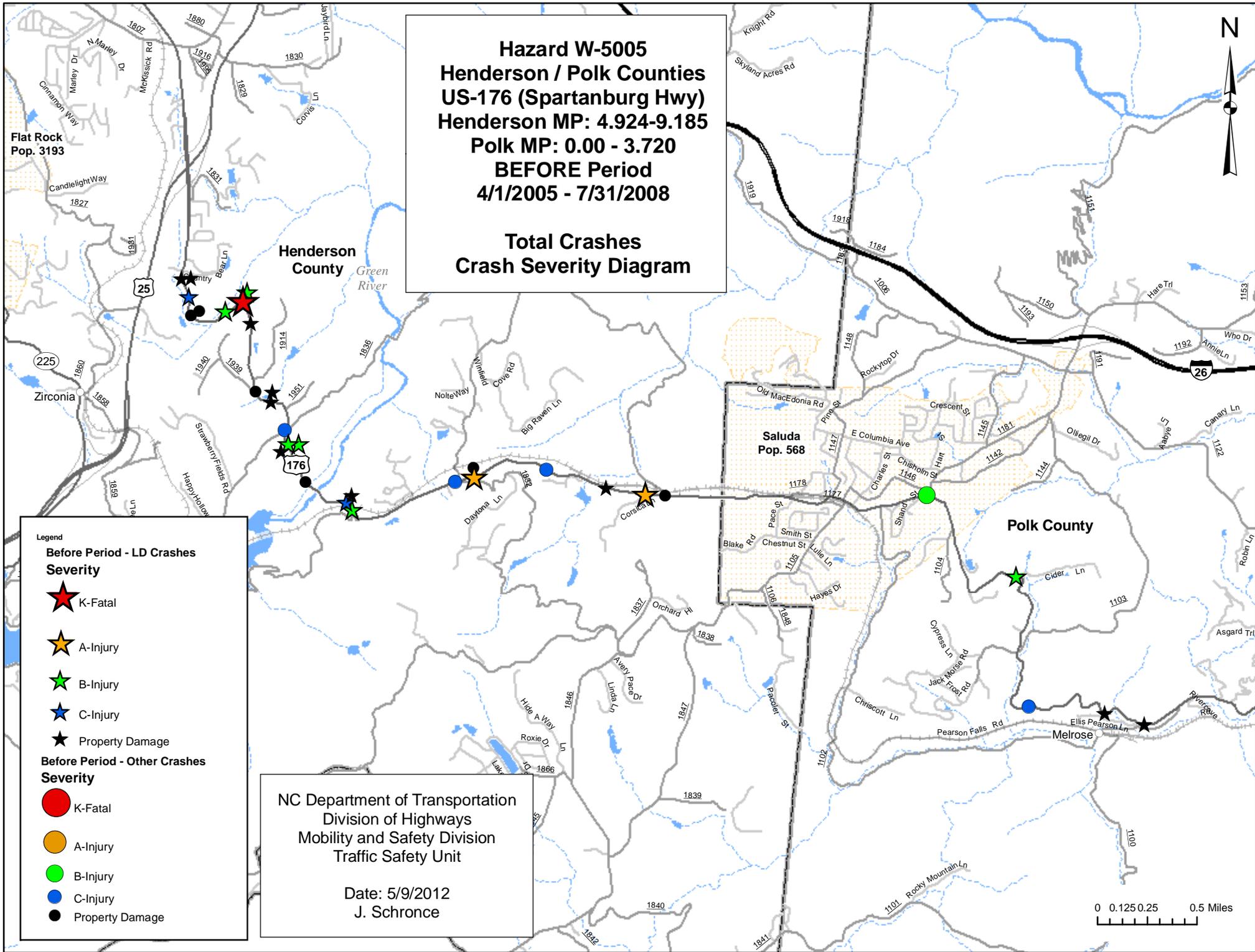
LOCATION: <b>US-176</b>		BY: <b>JBS</b>						
COUNTY: <b>Henderson / Pals</b>		DATE: <b>5/29/2012</b>						
FILE NO.: <b>W-5005</b>								
DETAILED COST:	TYPE IMPROVEMENT - <b>Shoulder Guardrail</b>							
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$380,000	15	0.117	\$44,395			
	Right-of-Way	\$0	0	0.000	\$0			
	TOTALS	\$380,000	15	0.117	\$44,395			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$1,566			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$45,961			
	TOTAL COST OF PROJECT=				\$380,000			
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	3.33	3	0.90	13	3.90	16	4.80	\$666,306
AFTER	3.33	2	0.60	11	3.30	20	6.01	\$470,270
						Annual Benefits from Crash Cost Savings		\$196,036
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST					=	\$150,075		
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST					=	4.27		
TOTAL COST OF PROJECT		-	\$380,000	COMPREHENSIVE B/C RATIO		-	4.27	

**BENEFIT-COST ANALYSIS WORKSHEET - Lane Departure Crashes**

LOCATION: <b>US-176</b>		BY: <b>JBS</b>						
COUNTY: <b>Henderson / Pals</b>		DATE: <b>5/29/2012</b>						
FILE NO.: <b>W-5005</b>								
DETAILED COST:	TYPE IMPROVEMENT - <b>Shoulder Guardrail</b>							
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$380,000	15	0.117	\$44,395			
	Right-of-Way	\$0	0	0.000	\$0			
	TOTALS	\$380,000	15	0.117	\$44,395			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$1,566			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$45,961			
	TOTAL COST OF PROJECT=				\$380,000			
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	3.33	3	0.90	8	2.40	10	3.00	\$628,529
AFTER	3.33	2	0.60	8	2.40	12	3.60	\$441,922
						Annual Benefits from Crash Cost Savings		\$186,607
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST					=	\$140,645		
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST					=	4.06		
TOTAL COST OF PROJECT		-	\$380,000	COMPREHENSIVE B/C RATIO		-	4.06	

**Hazard W-5005  
Henderson / Polk Counties  
US-176 (Spartanburg Hwy)  
Henderson MP: 4.924-9.185  
Polk MP: 0.00 - 3.720  
BEFORE Period  
4/1/2005 - 7/31/2008**

**Total Crashes  
Crash Severity Diagram**



- Legend**
- Before Period - LD Crashes 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

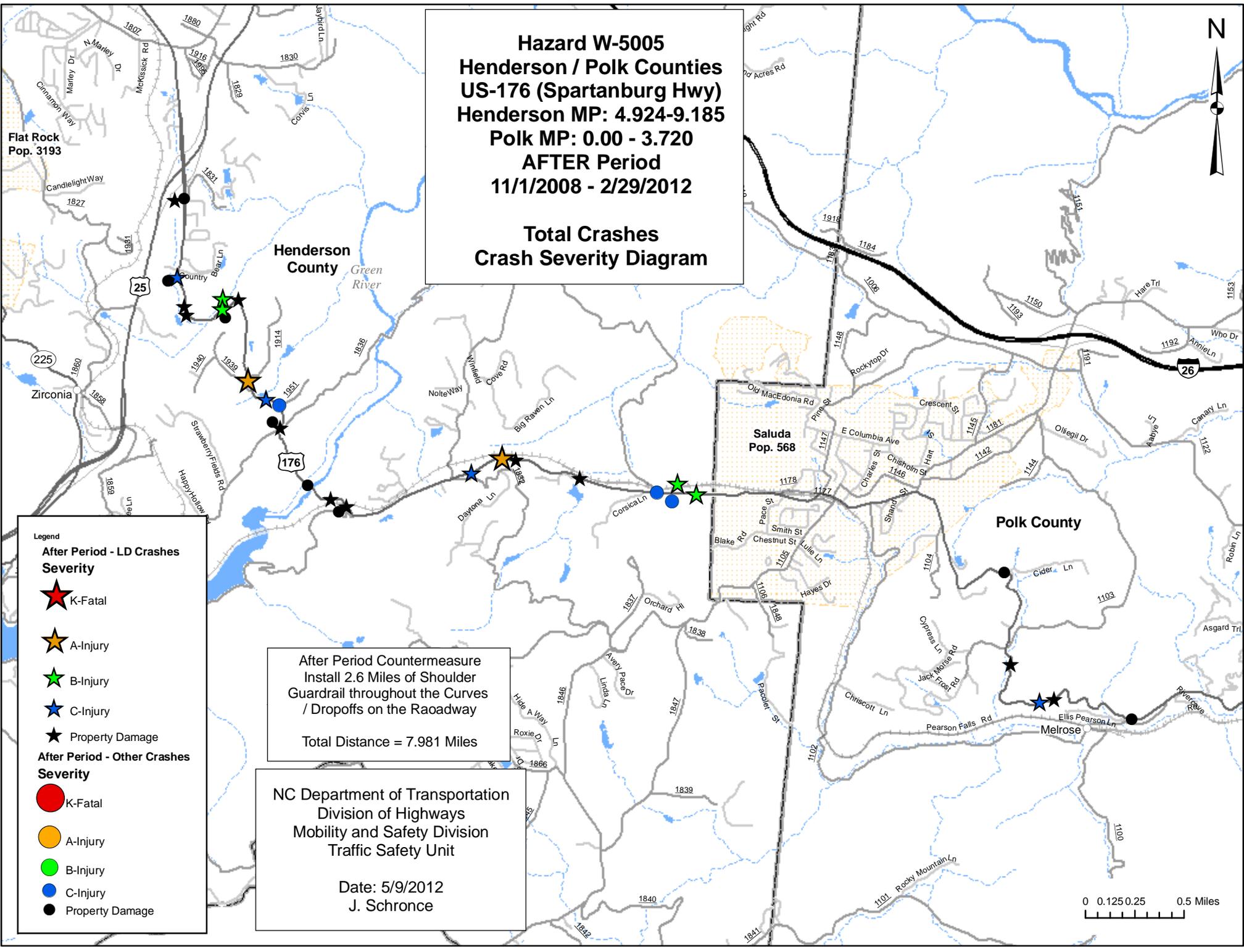
NC Department of Transportation  
Division of Highways  
Mobility and Safety Division  
Traffic Safety Unit

Date: 5/9/2012  
J. Schronce

0 0.125 0.25 0.5 Miles

**Hazard W-5005**  
**Henderson / Polk Counties**  
**US-176 (Spartanburg Hwy)**  
**Henderson MP: 4.924-9.185**  
**Polk MP: 0.00 - 3.720**  
**AFTER Period**  
**11/1/2008 - 2/29/2012**

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



- Legend**
- After Period - LD Crashes 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

After Period Countermeasure  
 Install 2.6 Miles of Shoulder  
 Guardrail throughout the Curves  
 / Dropoffs on the Roadway

Total Distance = 7.981 Miles

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

Date: 5/9/2012  
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0 0.125 0.25 0.5 Miles