

Hazard Elimination Project Evaluation

Project Log # 200902140

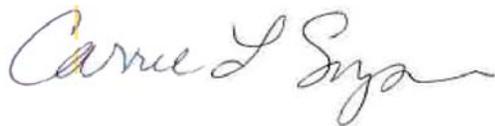
Hazard Elimination Project W-4434

Evaluation of Shoulder Guardrail Installation on US 276 from 3 Miles South of Haywood CL in Transylvania County northward to 4 Miles North of Transylvania CL in Haywood County

Documents Prepared By:

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

Principal Investigator



Carrie L. Simpson, PE

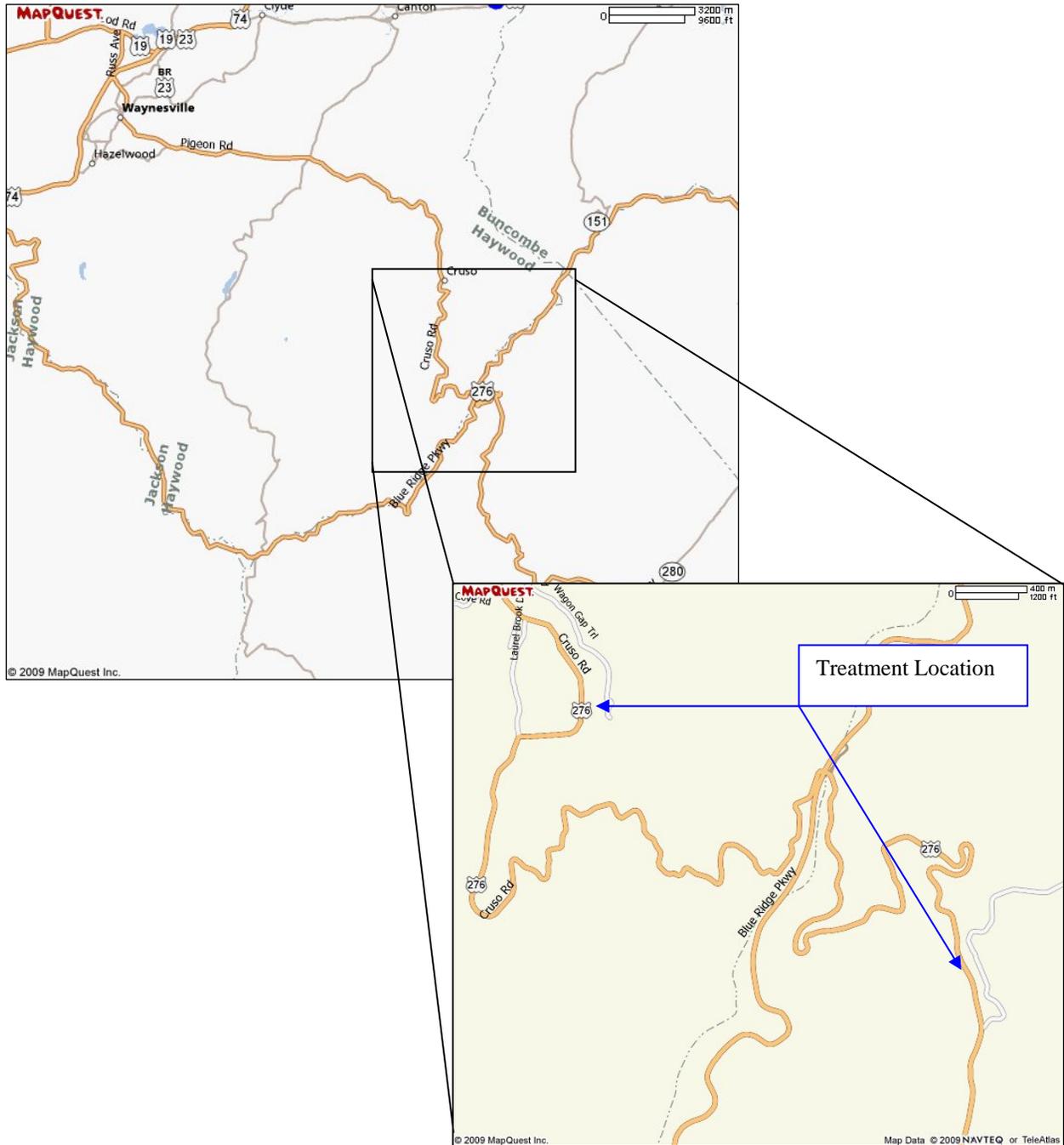
4/28/09
Date

Traffic Safety Project Engineer

Hazard Elimination Project Evaluation Documentation

Subject Location

Evaluation of Hazard Elimination Project W-4434 – Installation of shoulder guardrail on US 276 from 3 Miles South of Haywood CL in Transylvania County northward to 4 Miles North of Transylvania CL in Haywood County



Project Information and Background from the Project File Folder

The safety countermeasure chosen for the subject location was the installation of shoulder guardrail at select locations. There were 35,000 linear feet of guardrail and 32 anchor units installed. This section of US 276 is a two-lane facility in mountainous terrain. According to the project file, the horizontal alignment of the roadway was a contributing factor to crashes and there were several unprotected drop offs prior to guardrail installation.

The initial crash analysis for this location was completed from January 1, 1997 through December 31, 1999 with a total of 24 reported crashes. The analysis also included a fatal crash that occurred outside of the time frame on April 3, 2000. There was one Fatal Ran-Off-Road Crash, 10 Injury Ran-Off-Road Crashes, and 13 PDO Ran-Off-Road Crashes. The estimated Benefit-Cost Ratio was 18.02. The project was completed on June 30, 2004 at an estimated cost of \$528,500.

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 from March 1, 2002 through June 30, 2004. The before period consisted of reported crashes from September 1, 1997 through February 28, 2002 (4.5 Years) and the after period consisted of reported crashes from July 1, 2004 through December 31, 2008 (4.5 Years). The ending date for this analysis was determined by the available crash data at the time the crash analysis was completed.

The treatment data consisted of all crashes on US 276 from 3 Miles South of Haywood CL in Transylvania Co. northward to 4 Miles North of Transylvania CL in Haywood Co. A 0 feet y-line was used. The before period ADT year was 1999 and the after period ADT year was 2006.

The following tables depict the Naive Before and After Analysis for the Total Crashes, Target Crashes, and Influenced Crashes at the treatment location. Target Crashes are Ran-Off-Road Crashes. Crash reports were reviewed to include all crashes where at least one vehicle ran off the road. The Target Crashes were reviewed and further broken down into Influenced Crashes, crashes where guardrail was struck.

It should be noted that there was no specific information in the project file as to exactly where each run of guardrail was placed in this project; however, aerial photographs confirmed where guardrail exists along the segment at present.

Table 1. Treatment Information

	Before Period	After Period	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	39	34	-12.8
Total Severity Index	15.32	5.57	-63.6
Target Crashes (Ran-Off-Road Crashes)	35	29	-17.1
Target Severity Index	16.53	5.59	-66.2
Influenced Crashes (Guardrail Struck Crashes)	0	7	n/a
Influenced Severity Index	n/a	4.17	n/a
Volume	600	400	-33.3

Table 2. Target Crash Information

	Before Period	After Period	Percent Reduction (-)/ Percent Increase (+)
<i>Target Crashes- Injuries</i>			
Fatal Crashes	1	0	-100.0
Class A Crashes	5	0	-100.0
Class B Crashes	8	12	50.0
Class C Crashes	4	6	50.0
Injury Crashes	18	18	0.0
Property Damage Only Crashes	17	11	-35.3
<i>Target Crashes-Contributing Factors</i>			
Night Crashes	8	5	-37.5
Wet Crashes	6	5	-16.7
Alcohol/ Drug Crashes	1	0	-100.0
<i>Target Crashes- Crash Types</i>			
Ran Off Road - Right	13	1	-92.3
Ran Off Road - Left	3	0	-100.0
Fixed Object	12	23	91.7
Movable Object	1	0	-100.0
Overturn / Rollover	6	5	-16.7

Results and Discussion

The naïve before and after analysis involving the comparison of treatment actual before data versus treatment actual after data resulted in a 13 percent decrease in Total Crashes and a 17 percent decrease in Target Crashes. Total Severity Index decreased by 64 percent and the Target Crash Severity Index decreased by 66 percent from the before to the after period. The summary results above demonstrate that the treatment location appears to have had a decrease in both Total Crashes and Target Crashes and a decrease in the Severity Indexes for both categories from the before to the after period.

The calculated benefit to cost ratio for this project is **9.65** considering total crashes. The benefit to cost ratio considering only target crashes is **9.71**. 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 constructions costs as well as the increase in annual maintenance and utility costs.

Typically, one would expect guardrail installation projects to result in an increased number of Ran-Off-Road Crashes and a decrease in the severity of Ran-Off-Road crashes. The increase in Ran-Off-Road Crashes is expected due to the placement of a fixed object (guardrail) near the travel way. The decrease in the severity of Ran-Off-Road Crashes is expected due to the guardrail being more forgiving than the object it is protecting. The results from this project are in concurrence with the expected reduction in crash severity; however, not with the increase in crash frequency. Ran-Off-Road Target Crashes do not provide a completely precise method in which to measure the effectiveness of the guardrail installed under this project. While Target Crashes provide a good

picture of what is happening along the entire section of roadway, they fail to provide data specific to the actual treatment locations. The number of crashes where guardrail was actually struck provides a better measure of effectiveness. This number increased from 0 to 7 crashes, resulting in 3-Class B Injury and 4-PDO crashes in the after period.

Please see the attached Collision Diagrams for more information. Also, Treatment Site Photos are provided for spots with multiple crashes in the after period.

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

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: US 264 - Total Crashes
 COUNTY: Transylvania & Haywood
 FILE NO.: W-4434

BY: CLS
 DATE: 4/15/2009

DETAILED COST: TYPE IMPROVEMENT - Shoulder Guardrail

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$0	0	0.000	\$0
Right-of-Way	\$528,500	10	0.149	\$78,762
	\$0	0	0.000	\$0
TOTALS	\$528,500	10	0.149	\$78,762

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$5,600
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$84,362
 TOTAL COST OF PROJECT= \$528,500

COMPREHENSIVE COST REDUCTION:

ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES				PDO		ANNUAL COSTS
		K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	CRASHES	CRASHES PER YR	
BEFORE	4.50	6	1.33	14	3.11	19	4.22	\$919,956
AFTER	4.50	0	0.00	21	4.67	13	2.89	\$105,467

Annual Benefits from Crash Cost Savings \$814,489

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$730,127

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 9.65

TOTAL COST OF PROJECT - \$528,500 COMPREHENSIVE B/C RATIO - 9.65

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: US 264 - Target Crashes
 COUNTY: Transylvania & Haywood
 FILE NO.: W-4434

BY: CLS
 DATE: 4/15/2009

DETAILED COST: TYPE IMPROVEMENT - Shoulder Guardrail

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$0	0	0.000	\$0
Right-of-Way	\$528,500	10	0.149	\$78,762
	\$0	0	0.000	\$0
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 TOTAL ANNUAL COST= \$84,362
 TOTAL COST OF PROJECT= \$528,500

COMPREHENSIVE COST REDUCTION:

ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES

TIME PERIOD	YEARS	ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES				PDO		ANNUAL COSTS
		K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	CRASHES	CRASHES PER YR	
BEFORE	4.50	6	1.33	12	2.67	17	3.78	\$909,200
AFTER	4.50	0	0.00	18	4.00	11	2.44	\$90,267

Annual Benefits from Crash Cost Savings \$818,933

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$734,571

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 9.71

TOTAL COST OF PROJECT - \$528,500 COMPREHENSIVE B/C RATIO - 9.71

Location Photos



Location Photos



Location Photos

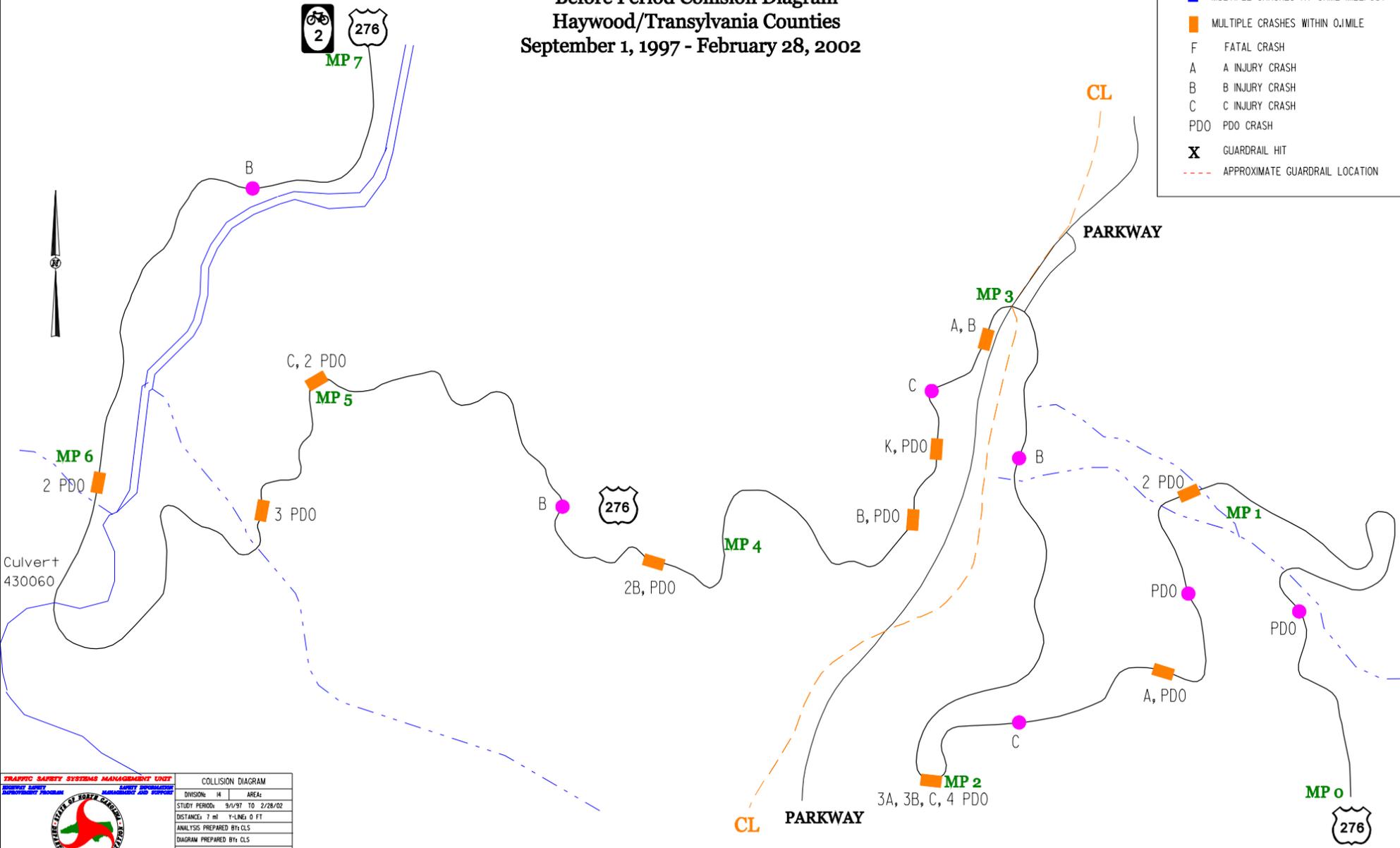


Hazard Elimination Project W-4434

Before Period Collision Diagram
Haywood/Transylvania Counties
September 1, 1997 - February 28, 2002

LEGEND

- SINGLE CRASH
- MULTIPLE CRASHES AT SAME MILEPOST
- MULTIPLE CRASHES WITHIN 0.1 MILE
- F FATAL CRASH
- A A INJURY CRASH
- B B INJURY CRASH
- C C INJURY CRASH
- PDO PDO CRASH
- X GUARDRAIL HIT
- - - APPROXIMATE GUARDRAIL LOCATION



TRAFFIC SAFETY SYSTEMS MANAGEMENT UNIT

COLLISION DIAGRAM

DIVISION: 14	AREA:
STUDY PERIOD: 9/1/97 TO 2/28/02	
DISTANCE: 7 mi	Y-LINE: 0 FT
ANALYSIS PREPARED BY: CLS	
DIAGRAM PREPARED BY: CLS	
DIAGRAM REVIEWED BY:	

BEFORE PERIOD

SCALE: NOT TO SCALE
DATE: 3/1/09
LOG NUMBER: 200902140

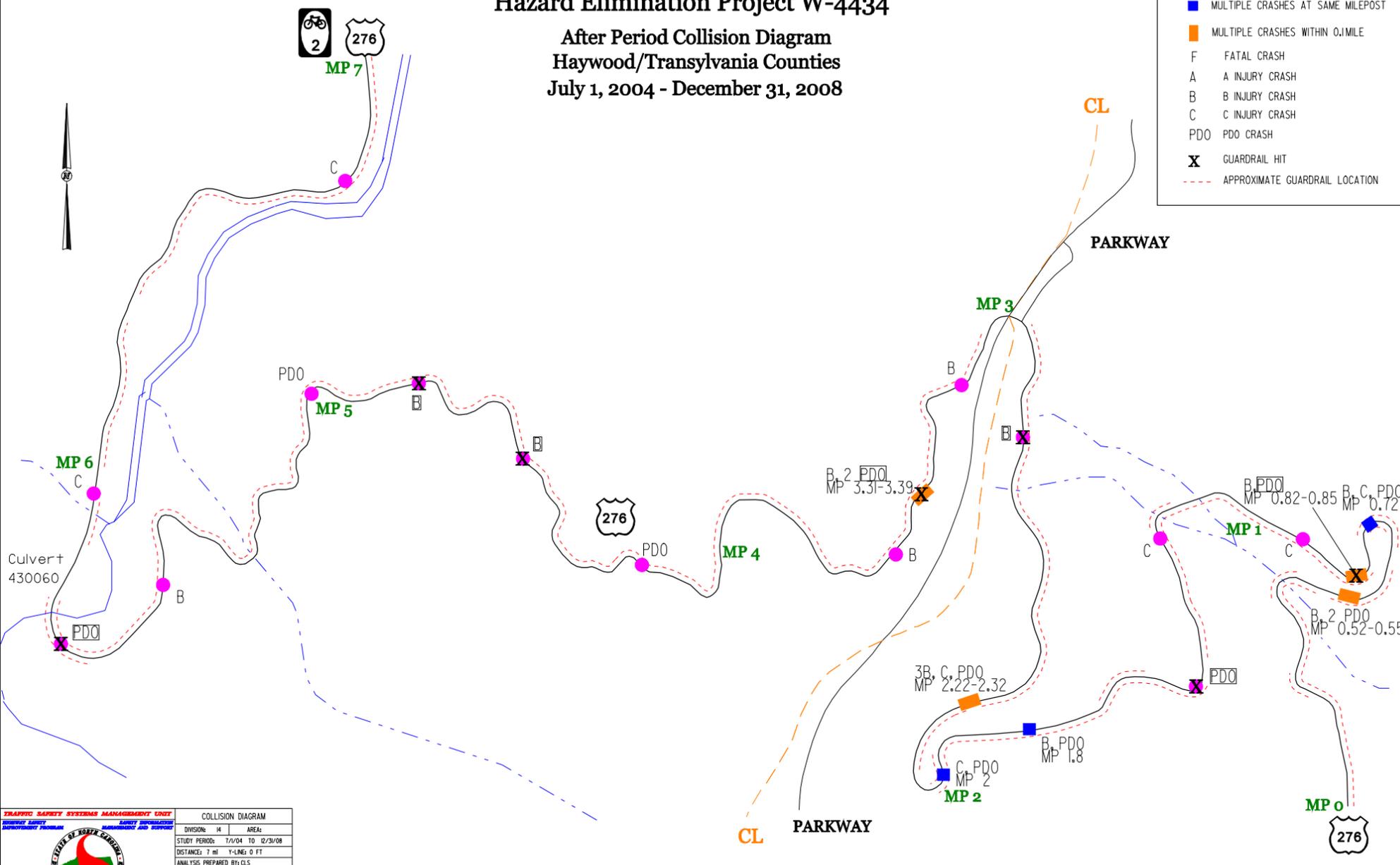
N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRAFFIC ENGINEERING AND SAFETY
SYSTEMS BRANCH

Hazard Elimination Project W-4434

After Period Collision Diagram
Haywood/Transylvania Counties
July 1, 2004 - December 31, 2008

LEGEND

- SINGLE CRASH
- MULTIPLE CRASHES AT SAME MILEPOST
- MULTIPLE CRASHES WITHIN 0.1 MILE
- F FATAL CRASH
- A A INJURY CRASH
- B B INJURY CRASH
- C C INJURY CRASH
- PDO PDO CRASH
- X GUARDRAIL HIT
- - - APPROXIMATE GUARDRAIL LOCATION



TRAFFIC SAFETY SYSTEMS MANAGEMENT UNIT

COLLISION DIAGRAM

DIVISION: 14	AREA:
STUDY PERIOD: 7/1/04 TO 12/31/08	
DISTANCE: 7 mi	Y-LINE: 0 FT
ANALYSIS PREPARED BY: CLS	
DIAGRAM PREPARED BY: CLS	
DIAGRAM REVIEWED BY:	

AFTER PERIOD

SCALE: NOT TO SCALE
DATE: 3/1/09
LOG NUMBER: 200902140

N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRAFFIC ENGINEERING AND SAFETY
SYSTEMS BRANCH