

Hazard Elimination Project Evaluation

Order # 41000006605

Hazard Elimination Project W-4427

Evaluation of the Rumble Strip Installation on I-77 in Iredell County

Documents Prepared By:

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

Principal Investigator



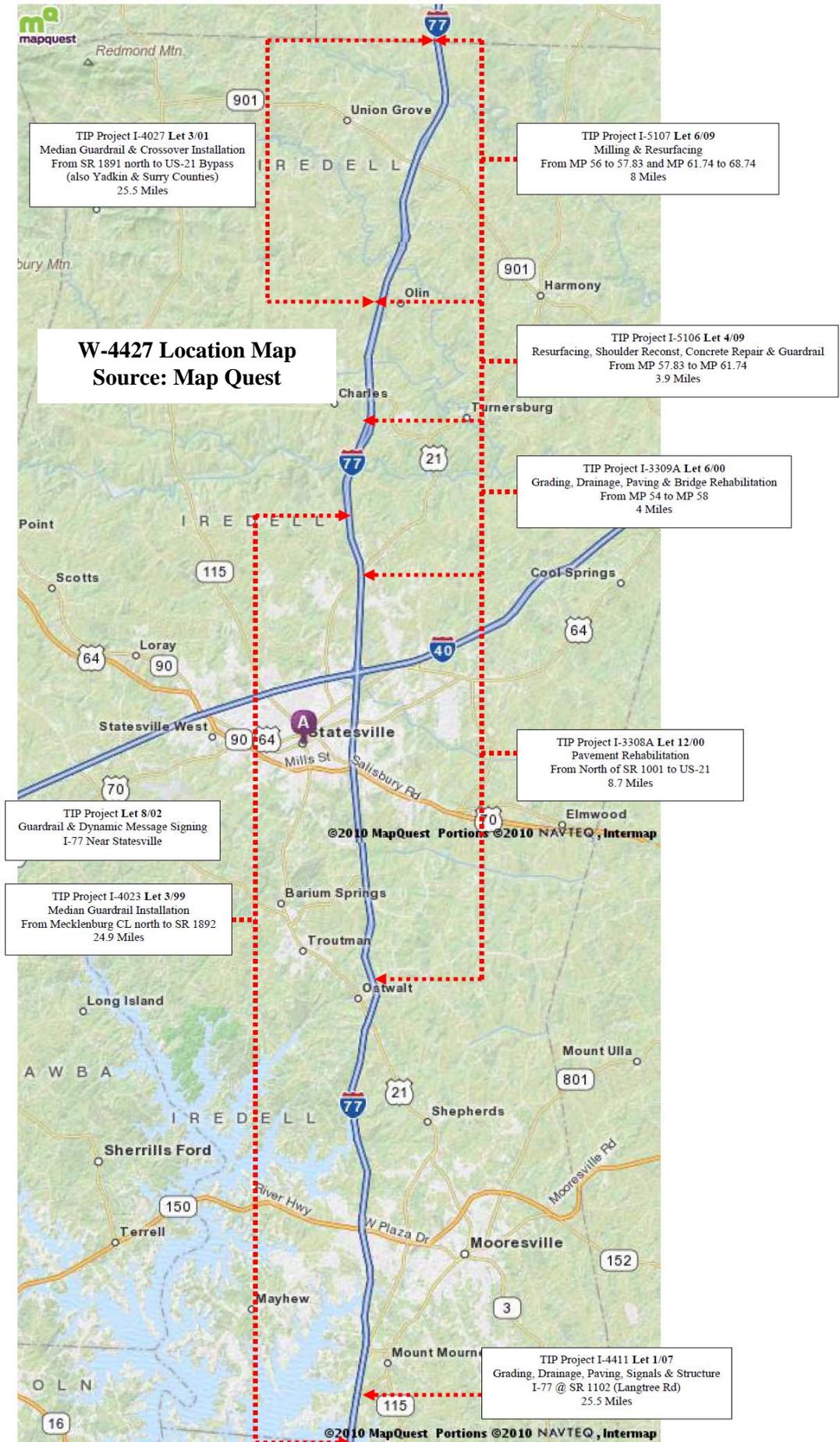
Carrie L. Simpson, PE

8/24/2010

Date

Traffic Safety Project Engineer

Hazard Elimination Project Evaluation Documentation



Subject Location

W-4427 was installed on I-77 in Iredell County. Multiple TIP projects were completed on this section of roadway prior to and after the completion of W-4427. Median guardrail was installed on I-77 for a majority of the county under projects I-4023 (let March 1999) and I-4027 (let March 2001). Due to the number and duration of additional projects, they are noted in the Location Map for your reference but are not accounted for in this evaluation.

Project Information and Background from the Project File Folder

The hazard elimination project improvement chosen was the installation of shoulder rumble strips. The countermeasure was applied to both the northbound and southbound travel lanes for 38.5 miles of I-77. I-77 is a four lane fully controlled access freeway. Median barrier is provided. The posted speed limits range from 55 mph to 70 mph. The intended purpose of the improvement was to alleviate the frequency of run-off-road crashes. The initial crash analysis was completed from May 1, 1997 to April 30, 2000 with 283 Ran Off Road crashes, including 8 fatalities. The improvement was completed on April 1, 2005 with a total cost of \$250,000. The projected B/C Ratio was 121.37.

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 were from May 1, 2004 through April 30, 2005. The before period consisted of reported crashes from May 1, 1999 through April 30, 2004 (5 years); and the after period consisted of reported crashes from May 1, 2005 through April 30, 2010 (5 years). The ending date for this analysis was determined by the date of available crash data at the time of analysis. The before period ADT year was 2001 and the after period ADT year was 2007.

The treatment data consisted of all mainline crashes on I-77 in Iredell County. The analysis was completed with a 0' y-line. Target crashes are lane departure crash types.

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. Due to the number and duration of other TIP projects completed in the before and after periods, we were unable to account for construction periods associated with these.

<u>Treatment Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	1861	2280	22.5%
Total Severity Index	6.04	4.46	-26.2%
Lane Departure Crashes – Both Directions	1133	1297	14.5%
Lane Departure Severity Index	6.25	4.76	-23.8%
Volume	42,500	47,800	12.5%

The following tables divide the crash data by direction of travel, Northbound and Southbound:

<u>Northbound Treatment Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	886	952	7.4%
Total Severity Index	6.12	4.97	-18.8%
Lane Departure Crashes	537	628	16.9%

<u>Northbound Crash Details</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Segment Crashes – Injuries			
Fatal Injury Crashes	8	8	0.0%
Non-Fatal Injury Crashes	282	290	2.8%
Property Damage Only Crashes	596	654	9.7%
Crashes - Contributing Factors			
Night Crashes	269	311	15.6%
Wet Road Crashes	110	150	36.4%
Alcohol Related	45	58	28.9%
Lane Departure Crash Types			
Angle	13	6	-53.8%
Fixed Object	259	321	23.9%
Head On	1	1	0.0%
Jackknife	3	9	200.0%
Movable Object	66	70	6.1%
Overturn / Rollover	23	24	4.3%
Parked Motor Vehicle	14	7	-50.0%
Ran Off Road (Right & Left)	44	18	-59.1%
Sideswipe, Same Direction	112	171	52.7%
Sideswipe, Opposite Direction	2	1	-50.0%

<u>Southbound Treatment Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	975	1328	36.2%
Total Severity Index	5.95	4.10	-31.1%
Lane Departure Crashes	596	669	12.2%

<u>Southbound Crash Details</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Segment Crashes – Injuries			
Fatal Injury Crashes	13	5	-61.5%
Non-Fatal Injury Crashes	344	404	17.4%
Property Damage Only Crashes	618	919	48.7%
Crashes - Contributing Factors			
Night Crashes	277	347	25.3%
Wet Road Crashes	187	345	84.5%
Alcohol Related	35	39	11.4%
Lane Departure Crash Types			
Angle	24	11	-54.2%
Fixed Object	247	344	39.3%
Head On	5	2	-60.0%
Jackknife	4	10	150.0%
Movable Object	55	72	30.9%
Overturn / Rollover	27	20	-25.9%
Parked Motor Vehicle	15	7	-53.3%
Ran Off Road (Right & Left)	58	17	-70.7%
Sideswipe, Same Direction	158	183	15.8%
Sideswipe, Opposite Direction	3	3	0.0%

Results and Discussion

Using naïve before and after analysis, the number of Total and Target Crashes appears to have increased on the section of I-77 installed with rumble strips under project W-4427, while the severity of Total and Target Crashes decreased. The naïve before and after analysis for the project resulted in an overall 23 percent increase in Total Crashes and a 26 percent decrease in the Total Severity Index. There was an overall 15 percent increase in Target Crashes and a 24 percent decrease in the Target Severity Index.

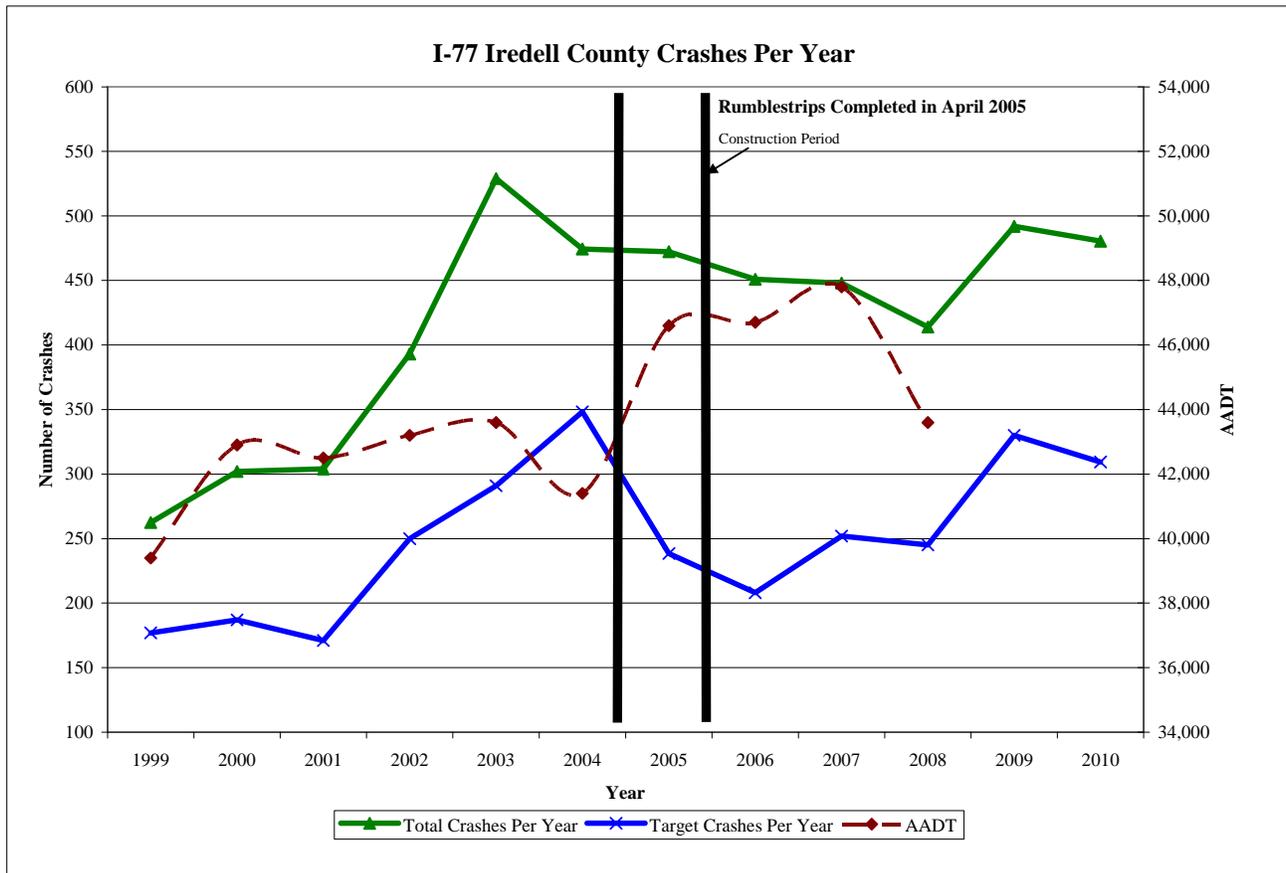
The calculated benefit to cost ratio for W-4427 is **76.96** considering Total Crashes. The benefit to cost ratio considering only Target Crashes is **40.81**. The benefits are calculated using the change in annual crash costs from the before to the after period. Operational and other benefits related 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.

In the Northbound direction, Total Crashes increased by 7 percent and Lane Departure Crashes increased by 17 percent. In the Southbound direction, Total Crashes increased by 36 percent and Lane Departure Crashes increased by 12 percent. While the increase in Lane Departure Crashes is relatively even between directions, the increase in Total Crashes is more heavily weighted to the SB direction. A substantial increase in the number of SB Wet Road Crashes (85% increase) may help explain the greater number of after period crashes in this direction.

Due to the number of other projects that may have influenced crashes in our before and after periods but that we are unable to account for in the analysis, the change in crashes cannot be attributed solely to the rumble strip installations. The impact of these other projects on crashes is not known.

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 treatment.

The following charts depict the crash trends along I-77 in Iredell County. The number of Total and Target Crashes per year are plotted in the before and after period, along with the AADT.



BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: I-77
 COUNTY: Iredell
 FILE NO.: W-4427

BY: CLS
 DATE: 7/9/2010

TOTAL CRASHES

DETAILED COST: TYPE IMPROVEMENT - Rumblestrips

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$250,000	10	0.149	\$37,257
		0	0.000	\$0
		0	0.000	\$0
TOTALS	\$250,000	10	0.149	\$37,257

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$0
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$37,257
 TOTAL COST OF PROJECT= \$250,000

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	5.00	67	13.40	580	116.00	1214	242.80	\$11,806,040
AFTER	5.00	39	7.80	668	133.60	1573	314.60	\$8,938,780

Annual Benefits from Crash Cost Savings \$2,867,260

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$2,830,003

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 76.96

TOTAL COST OF PROJECT - \$250,000 COMPREHENSIVE B/C RATIO - 76.96

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: I-77
 COUNTY: Iredell
 FILE NO.: W-4427

BY: CLS
 DATE: 7/9/2010

TARGET CRASHES

DETAILED COST: TYPE IMPROVEMENT - Rumblestrips

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$250,000	10	0.149	\$37,257
		0	0.000	\$0
		0	0.000	\$0
TOTALS	\$250,000	10	0.149	\$37,257

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$0
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$37,257
 TOTAL COST OF PROJECT= \$250,000

COMPREHENSIVE COST REDUCTION:

TIME PERIOD	YEARS	ESTIMATED NUMBER OF ANNUAL ACCIDENT DECREASES						ANNUAL COSTS
		K & A CRASHES	K & A CRASHES PER YR	B & C CRASHES	B & C CRASHES PER YR	PDO CRASHES	PDO CRASHES PER YR	
BEFORE	5.00	45	9.00	343	68.60	745	149.00	\$7,682,700
AFTER	5.00	32	6.40	332	66.40	933	186.60	\$6,162,380

Annual Benefits from Crash Cost Savings \$1,520,320

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$1,483,063

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 40.81

TOTAL COST OF PROJECT - \$250,000 COMPREHENSIVE B/C RATIO - 40.81