

Hazard Elimination Project Evaluation

Order # 41000010445

Hazard Elimination Project W-4835

Evaluation of the Rumble Strip Installation on Two Sections of I-485 in Mecklenburg County

Documents Prepared By:

Safety Evaluation Group
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Principal Investigator



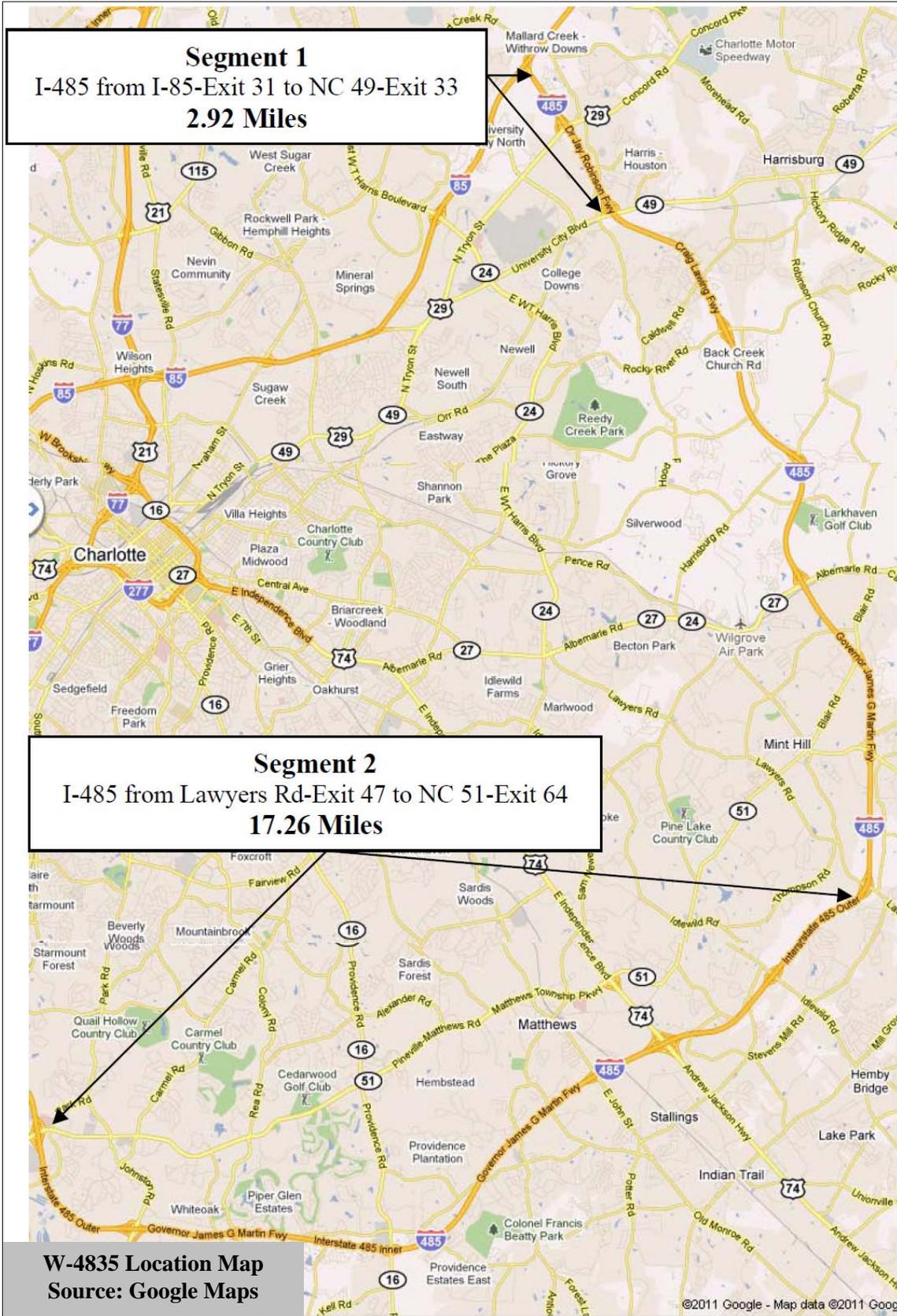
Carrie L. Simpson, PE

Traffic Safety Project Engineer

3/2/2011

Date

Hazard Elimination Project Evaluation Documentation



Subject Location

The treatment location includes two segments on I-485 as shown in the previous map. Per the project request crash analysis, both were constructed by July 2000. The portion of I-485 that connects the two study segments was completed at a later date. The location varies from a 4 to 6 lane fully controlled access freeway with 4', 6', and 10' median shoulders and 10' outside shoulders. The speed limit is 65 mph.

I-485 from NC 51-Exit 64 to I-77-Exit 67 was included in the original project; however, this section was overlaid and no rumble strips were reinstalled so it is excluded from our study. As of June 2010, a contract was being let with Spot Safety/MOE funds to replace those rumble strips.

Cable median protection currently exists along the entire section. Note that median guardrail was installed for the entirety of Segment 1 and for the easternmost 4 miles of Segment 2 under project R-1138 let in January 2003. This is noted for your reference but 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 milled rumble strips on the median and outside shoulders of I-485. These sections of I-485 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 July 1, 2000 to June 30, 2003 with 419 Ran-Off-Road crashes. The improvement was completed on November 30, 2005 with a total cost of \$221,000. The projected B/C Ratio was 50.60:1.

Location Photographs



SEGMENT 2: I-485 near MM 54 (south of Weddington Rd)



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 January 1, 2005 through November 30, 2005. The before period consisted of reported crashes from July 1, 2000 through December 31, 2004 (4.5 years); and the after period consisted of reported crashes from December 1, 2005 through November 30, 2010 (5 years). The before date for this analysis was determined by the opening date for these sections of I-485. The ending date was determined by the date of available crash data at the time of analysis. Because there is an unequal number of years in the before and after period, statistics are reported as crashes per year.

The before period ADT year was 2002 and the after period ADT year was 2008. The treatment data consisted of all mainline crashes 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. We did not account for construction periods associated with other projects in the before or after period.

Segments 1 & 2 Combined (20.18 Miles)

Segment 1 & 2 Treatment Information	Before		After		Percent Reduction (-)/ Percent Increase (+)
	<i>4.5 Yrs</i>	<i>Per Yr</i>	<i>5 Yrs</i>	<i>Per Yr</i>	
Total Crashes	1148	255.1	1828	365.6	43.3%
Total Severity Index	3.75		3.17		-15.5%
Lane Departure Crashes	706	156.9	898	179.6	14.5%
Lane Departure Severity Index	4.03		3.16		-21.6%

Segment 1 (From I-85-Exit 31 to NC 49-Exit 33, 2.92 Miles)

<u>Segment 1</u>	Before		After		Percent Reduction (-)/ Percent Increase (+)
	4.5 Yrs	Per Yr	5 Yrs	Per Yr	
Total Crashes	84	18.7	307	61.4	229%
Total Severity Index	4.83		3.42		-29%
 					
Lane Departure Crashes	68	15.1	171	34.2	126%
Lane Departure Severity Index	4.07		3.40		-16%
 					
Volume	13,700		47,300		245%

<u>Segment 1</u>	Before		After		Percent Reduction (-)/ Percent Increase (+)
	4.5 Yrs	Per Yr	5 Yrs	Per Yr	
Injuries					
Fatal Injury Crashes	1	0.22	1	0.20	-10%
Class-A Injury Crashes	1	0.22	1	0.20	-10%
Class-B Injury Crashes	10	2.2	21	4.2	89%
Class-C Injury Crashes	13	2.9	59	11.8	308%
Property Damage Only Crashes	59	13.1	225	45.0	243%
Contributing Factors					
Night Crashes	22	4.9	73	14.6	199%
Wet Road Crashes	41	9.1	126	25.2	177%
Alcohol Related	1	0.2	6	1.2	440%
Lane Departure Crash Types					
Angle Crashes	3	0.7	5	1.0	50%
Fixed Object Crashes	24	5.3	76	15.2	185%
Head On Crashes	2	0.4	0	0.0	-100%
Jackknife Crashes	0	0.0	0	0.0	N/A
Movable Object Crashes	8	1.8	14	2.8	58%
Overturn / Rollover Crashes	8	1.8	4	0.8	-55%
Parked Motor Vehicle Crashes	1	0.2	2	0.4	80%
Ran Off Road (Left) Crashes	9	2.0	29	5.8	190%
Ran Off Road (Right) Crashes	6	1.3	8	1.6	20%
Sideswipe, Same Direction Crashes	7	1.6	33	6.6	324%
Sideswipe, Opposite Direction Crashes	0	0.0	0	0.0	N/A

Segment 2 (From Lawyers Rd-Exit 47 to NC 51-Exit 64, 17.26 Miles)

<u>Segment 2</u>	Before		After		Percent Reduction (-)/ Percent Increase (+)
	4.5 Yrs	Per Yr	5 Yrs	Per Yr	
Total Crashes	1064	236.4	1521	304.0	29%
Total Severity Index	3.66		3.12		-15%
Lane Departure Crashes	638	141.8	727	145.0	3%
Lane Departure Severity Index	4.02		3.1		-23%
Volume	51,000		70,800		39%

<u>Segment 2</u>	Before		After		Percent Reduction (-)/ Percent Increase (+)
	4.5 Yrs	Per Yr	5 Yrs	Per Yr	
Injuries					
Fatal Injury Crashes	2	0.4	4	0.8	80%
Class-A Injury Crashes	10	2.2	6	1.2	-46%
Class-B Injury Crashes	70	15.6	68	14.0	-13%
Class-C Injury Crashes	190	42.2	265	53.0	26%
Property Damage Only Crashes	792	176.0	1178	236.0	34%
Contributing Factors					
Night Crashes	289	64.2	406	81	26%
Wet Road Crashes	245	54.4	275	55	1%
Alcohol Related	57	12.7	46	9.2	-27%
Lane Departure Crash Types					
Angle Crashes	14	3.1	17	3.4	9%
Fixed Object Crashes	261	58.0	226	45.0	-22%
Head On Crashes	3	0.7	7	1.4	110%
Jackknife Crashes	4	0.9	2	0.4	-55%
Movable Object Crashes	84	18.7	128	26.0	37%
Overturn / Rollover Crashes	26	5.8	18	3.6	-38%
Parked Motor Vehicle Crashes	16	3.6	2	0.4	-89%
Ran Off Road (Left) Crashes	92	20.4	84	17.0	-18%
Ran Off Road (Right) Crashes	53	11.8	40	8.0	-32%
Sideswipe, Same Direction Crashes	85	18.9	202	40.0	114%
Sideswipe, Opposite Direction Crashes	0	0.0	1	0.2	N/A

Results and Discussion

Overall, using naïve before and after analysis, the number of Total and Target Crashes per year increased; however, the overall severity index of both Total and Target Crashes decreased. Note there were substantial increases in traffic volume along the treated sections. The results broken down by segment are as follows:

Segment 1 (From I-85-Exit 31 to NC 49-Exit 33, 2.92 Miles) experienced a 229 percent increase in Total Crashes per year and a 126 percent increase in Target Crashes per year. There was a 29 percent decrease in the Total Severity Index and a 16 percent decrease in the Target Severity Index. It must be noted that the volume increased by 245 percent from the before to the after period.

Segment 2 (From Lawyers Rd-Exit 47 to NC 51-Exit 64, 17.26 Miles) experienced a 29 percent increase in Total Crashes per year and a 3 percent increase in Target Crashes per year. There was a 15 percent decrease in the Total Severity Index and a 23 percent decrease in the Target Severity Index. The volume increased by 39 percent from the before to the after period.

For both segments, the overall number of Fatal and Class-A injury crashes decreased from 14 crashes in the 4.5-year before period to 12 crashes in the 5-year after period.

The calculated benefit to cost ratio for W-4835 is **-10.31** considering Total Crashes. The benefit to cost ratio considering only Target Crashes is **17.72**. 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.

Due to 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 true impact of these other projects on crashes is not known.

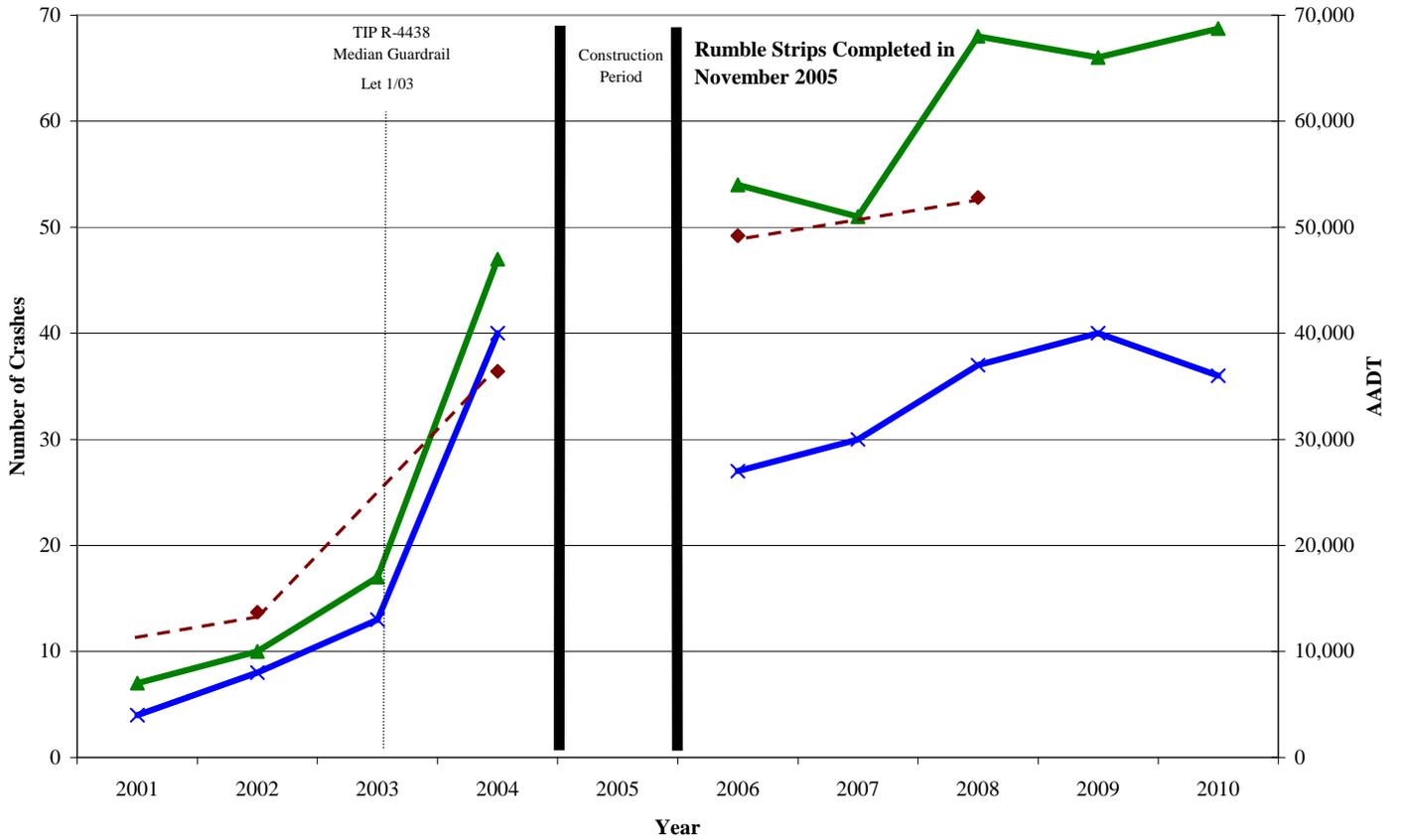
The following charts depict the number of Total and Target Crashes per year plotted in the before and after period, along with the AADT, for Segments 1 and 2. Crashes per year appear to closely follow the volume trends.

For Segment 1, the number of Total Crashes experienced an upward trend from 2001 through 2010, following the steady increases in traffic volume. The number of Target Crashes also followed a generally upward trend, although there was a drop in crashes per year from the end of the before period to the beginning of the after period.

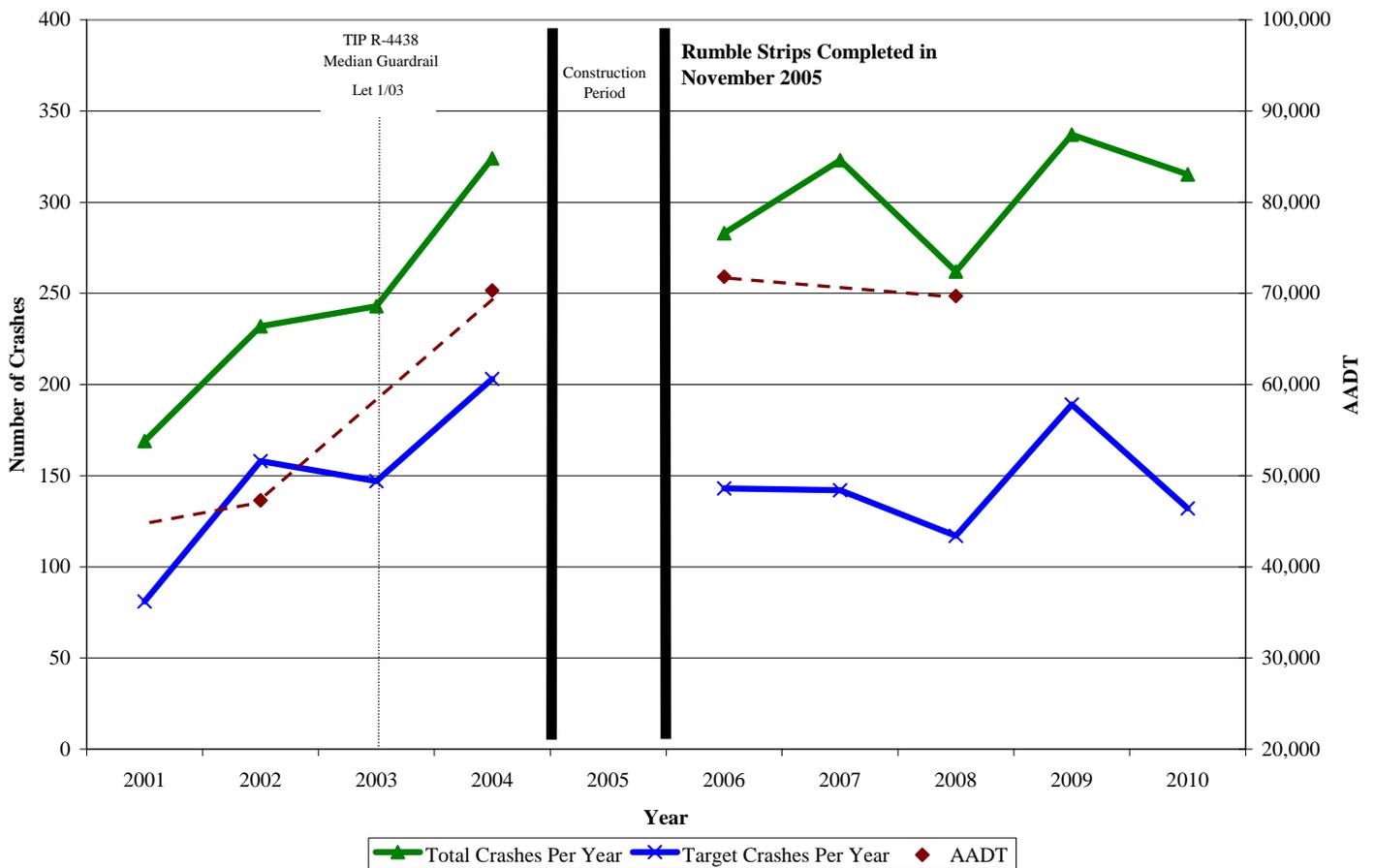
For Segment 2, the number of Total and Target Crashes also closely followed the volume trends. In the before period, steady increases in crashes followed steady increases in volume. From the end of the before period to the beginning of the after period, there was a drop in Total and Target Crashes. In the after period, crashes per year fluctuated and did not show the same upward trends as the before period.

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.

I-485 Mecklenburg County - Segment 1 Crashes Per Year



I-485 Mecklenburg County - Segment 2 Crashes Per Year



▲ Total Crashes Per Year
 ✕ Target Crashes Per Year
 ◆ AADT

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: I-485
 COUNTY: Mecklenburg
 FILE NO.: W-4835
 TOTAL CRASHES

BY: CLS
 DATE: 2/2/2011

DETAILED COST: TYPE IMPROVEMENT - Rumblestrips

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$221,000	10	0.149	\$32,936
		0	0.000	\$0
		0	0.000	\$0
TOTALS	\$221,000	10	0.149	\$32,936

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$0
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$32,936
 TOTAL COST OF PROJECT= \$221,000

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	4.50	14	3.11	283	62.89	851	189.11	\$4,030,956
AFTER	5.00	12	2.40	413	82.60	1403	280.60	\$4,370,580

Annual Benefits from Crash Cost Savings (\$339,624)

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = (\$372,560)

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = -10.31

TOTAL COST OF PROJECT - \$221,000 COMPREHENSIVE B/C RATIO - -10.31

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: I-485
 COUNTY: Mecklenburg
 FILE NO.: W-4835
 TARGET CRASHES

BY: CLS
 DATE: 2/2/2011

DETAILED COST: TYPE IMPROVEMENT - Rumblestrips

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$221,000	10	0.149	\$32,936
		0	0.000	\$0
		0	0.000	\$0
TOTALS	\$221,000	10	0.149	\$32,936

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$0
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$32,936
 TOTAL COST OF PROJECT= \$221,000

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	4.50	12	2.67	166	36.89	528	117.33	\$2,922,311
AFTER	5.00	8	1.60	180	36.00	710	142.00	\$2,338,600

Annual Benefits from Crash Cost Savings \$583,711

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$550,776

BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 17.72

TOTAL COST OF PROJECT - \$221,000 COMPREHENSIVE B/C RATIO - 17.72