

Hazard Elimination Project Evaluation

Order # 41000018480

Hazard Elimination Project W-4838

**Evaluation of the Rumble Strip Installation
US-321 Bypass from C. Grier Beam Blvd in Gaston County to US-70 in Hickory
Catawba, Lincoln, and Gaston Counties**

Documents Prepared By:

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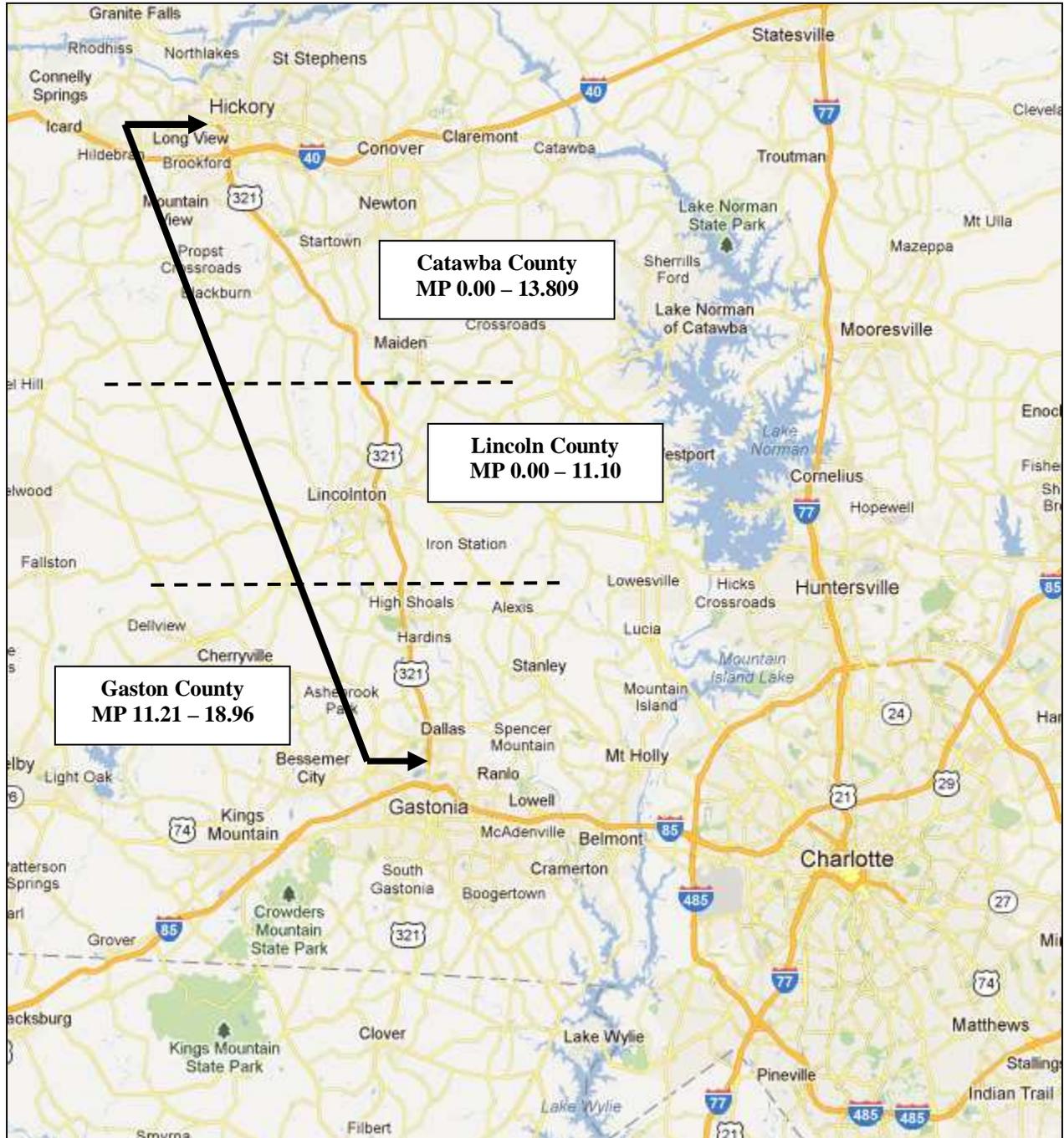
4-18-2012
Date

Hazard Elimination Project Evaluation Documentation

Subject Location

The project included the freeway section of US-321 Bypass through three (3) different counties:

1. Gaston County: C. Grier Beam Interchange to Lincoln County Line (MP 11.21 – 18.96)
2. Lincoln County: Gaston County Line to Catawba County Line (MP 0.00 – 11.10)
3. Catawba County: Lincoln County Line to US-70 in Hickory (MP 0.00 – 13.809)



Project Information and Background from the Project File Folder

The hazard elimination project improvement chosen for the subject locations were the installation of milled rumble strips along the inside and outside shoulders of this freeway segment.

US 321 Bypass is a four-lane median divided facility with 2-4 foot paved median shoulders and 4-10 foot paved outside shoulders. The grass median maintains protection with three-strand cable along the entire route. The speed limit varies between 55-mph and 65-mph. This roadway acts as a service corridor connecting the cities of Gastonia to Hickory including the City of Lincolnton. The total segment length is 29.95 miles.

The original statement of problem mentioned that vehicles were running off the road resulting in fatalities, serious injuries, and property damage. Casual factors for vehicles leaving the roadway include driver fatigue and/or inattention. Rumble strips provide both noise and vibration as a warning to motorists that they are leaving the travel lane.

The initial crash analysis was completed from August 1, 2000 to July 31, 2003 with 538 reported crashes, with 175 crashes considered correctable Ran-Off Road collisions. The correctable collisions resulted in four (4) Fatal / A-injury crashes. The improvement was completed on August 1, 2006 with a total cost of \$183,630. The projected B/C Ratio was 80.63

Naive Before and After Analysis

After reviewing the project file folder along with all the crashes along the subject segment, the crash data omitted from this analysis to consider for an adequate construction period were the months of June through August 2006. The before period consisted of reported crashes from January 1, 2001 through May 31, 2006 (5 years, 5 months); and the after period consisted of reported crashes from September 1, 2006 through January 31, 2012 (5 years, 5 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 along US-321 with a zero (0) foot y-line (No Ramps). *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 Freeway Lane Departure Crash types considered are as follows: Angle; Fixed Object; Head-On; Jackknife; Overturn/Rollover; Parked Motor Vehicle; Ran-Off Roadway (Right, Left, Straight); and Sideswipe (Same and Opposite Direction).

<u>Combined Treatment Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – All Counties & Both Directions	891	859	- 3.6 %
Total Severity Index	4.30	4.20	- 2.3 %
LD Crashes – All Counties & Both Directions	701	625	- 10.8 %
Lane Departure Severity Index	4.54	4.31	- 5.1 %

<u>Gaston County (MP 11.21 – 18.96)</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	184	222	20.7 %
Total Severity Index	4.82	5.14	6.6 %
Lane Departure Crashes – Both Directions	130	151	16.2 %
Lane Departure Severity Index	5.14	5.61	9.1 %
Volume (2003, 2009)	30,400	30,400	0.0 %
Total Crash Rate (100 Million Vehicle Miles)	39.50	47.61	20.5 %
Injury Crashes			
Fatal Injury Crashes	3	2	- 33.3 %
Class-A Injury Crashes	1	3	200.0 %
Class-B Injury Crashes	22	24	9.1 %
Class-C Injury Crashes	32	49	53.1 %
Property Damage Only Crashes	126	144	14.3 %
Contributing Factors			
Night Crashes	73	66	- 9.6 %
Wet Road Crashes	52	59	13.5 %
Alcohol Related	15	8	- 46.7 %
Lane Departure Crash Types			
Angle	6	2	- 66.7 %
Fixed Object	65	93	43.1 %
Head On	1	1	0.0 %
Jackknife	0	1	100.0 %
Overturn / Rollover	9	3	- 66.7 %
Parked Motor Vehicle	1	6	500.0 %
Ran Off Road (Left)	6	8	33.3 %
Ran Off Road (Right)	14	8	- 42.9 %
Sideswipe, Same Direction	28	29	3.6 %

<u>Gaston County Northbound Only</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
NB Total Crashes	93	103	10.8 %
NB Total Severity Index	6.33	5.72	- 9.6 %
Contributing Factors			
NB Lane Departure Crashes	66	66	0.0 %
NB Lane Departure Severity Index	6.91	6.10	- 11.7 %

<u>Gaston County Southbound Only</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
SB Total Crashes	91	119	30.8 %
SB Total Severity Index	3.28	4.64	41.5 %
Contributing Factors			
SB Lane Departure Crashes	64	85	32.8 %
SB Lane Departure Severity Index	3.31	5.22	57.7 %

<u>Lincoln County (MP 0.00 – 11.10)</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	358	310	- 13.4 %
Total Severity Index	4.45	3.60	- 19.1%
Lane Departure Crashes – Both Directions	314	250	- 20.4 %
Lane Departure Severity Index	4.53	3.65	- 19.4 %
Volume (2003, 2009)	25,000	26,000	4.0 %
Total Crash Rate (100 Million Vehicle Miles)	65.25	54.33	- 16.7 %
Injury Crashes			
Fatal Injury Crashes	4	1	- 75.0 %
Class-A Injury Crashes	4	2	- 50.0 %
Class-B Injury Crashes	35	29	- 17.1 %
Class-C Injury Crashes	50	49	- 2.0 %
Property Damage Only Crashes	265	229	- 13.6 %
Contributing Factors			
Night Crashes	108	109	0.9 %
Wet Road Crashes	133	78	- 41.4 %
Alcohol Related	17	11	- 35.3 %
Lane Departure Crash Types			
Angle	4	0	- 100.0 %
Fixed Object	231	162	- 29.9 %
Head On	1	0	- 100.0 %
Jackknife	1	0	- 100.0 %
Overturn / Rollover	25	32	28.0 %
Parked Motor Vehicle	2	2	0.0 %
Ran Off Road (Left)	14	14	0.0 %
Ran Off Road (Right)	9	5	- 44.4 %
Sideswipe, Opposite Direction	2	1	- 50.0 %
Sideswipe, Same Direction	25	34	36.0 %

<u>Lincoln County Northbound Only</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
NB Total Crashes	175	150	- 14.3 %
NB Total Severity Index	4.68	4.13	- 11.8 %
Injury Crashes			
NB Lane Departure Crashes	160	121	- 24.4 %
NB Lane Departure Severity Index	4.50	4.58	1.8 %

<u>Lincoln County Southbound Only</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
SB Total Crashes	183	160	- 12.6 %
SB Total Severity Index	4.23	3.09	- 27.0 %
Injury Crashes			
SB Lane Departure Crashes	154	129	- 16.2 %
SB Lane Departure Severity Index	4.55	2.78	- 38.9 %

<u>Catawba County (MP 0.00 – 13.809)</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	349	327	- 6.3 %
Total Severity Index	3.86	4.13	7.0 %
Lane Departure Crashes – Both Directions	257	224	- 12.8 %
Lane Departure Severity Index	4.25	4.17	- 1.9 %
Volume (2003, 2009)	25,000	27,600	10.4%
Total Crash Rate (100 Million Vehicle Miles)	51.13	43.35	- 15.2 %
Injury Crashes			
Fatal Injury Crashes	1	4	300.0 %
Class-A Injury Crashes	3	2	- 33.3 %
Class-B Injury Crashes	31	23	- 25.8 %
Class-C Injury Crashes	63	54	- 14.3 %
Property Damage Only Crashes	251	244	- 2.8 %
Contributing Factors			
Night Crashes	133	121	- 9.0 %
Wet Road Crashes	88	89	1.1 %
Alcohol Related	19	14	- 26.3 %
Lane Departure Crash Types			
Angle	6	0	- 100.0 %
Fixed Object	157	146	- 7.0 %
Head On	1	1	0.0 %
Jackknife	1	1	0.0 %
Overturn / Rollover	20	12	- 40.0 %
Parked Motor Vehicle	3	2	- 33.3 %
Ran Off Road (Left)	30	23	- 23.3 %
Ran Off Road (Right)	9	8	- 11.1 %
Sideswipe, Opposite Direction	1	0	- 100.0 %
Sideswipe, Same Direction	29	31	6.9 %

<u>Catawba County Northbound Only</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
NB Total Crashes	154	158	2.6 %
NB Total Severity Index	4.10	4.36	6.3 %
Injury Crashes			
NB Lane Departure Crashes	117	103	- 12.0%
NB Lane Departure Severity Index	4.45	5.43	22.0 %

<u>Catawba County Southbound Only</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
SB Total Crashes	195	169	- 13.3 %
SB Total Severity Index	3.67	3.92	6.8 %
Injury Crashes			
SB Lane Departure Crashes	140	121	- 13.6 %
SB Lane Departure Severity Index	4.09	3.09	- 24.4 %

Results and Discussion

Reviewing the tables above, the overall segment (all three counties) reduced crashes slightly and experienced a ten (10) percent reduction in lane departure collisions. In total, Fatal and A-injury crashes both individually reduced from eight (8) to seven (7) crashes through the evaluation study.

The Gaston County segment was the only county that experienced an increase in crashes with a 20.7 percent increase in total crashes and a 16.2 percent increase in lane departure collisions. From examining the crashes by direction, it appears as if the increase is occurring in the southbound direction. The southbound crash pattern experienced increases of more than 30 percent in both total and lane departure collisions. While, lane departure crashes in the northbound direction saw zero change. The Gaston County crash rate increased by 20.5 percent with no change in the ADT.

The Lincoln County segment presented the largest improvement with a 13.4 percent reduction in total crashes and a 20.4 percent reduction in lane departure collisions. A big factor highlighted from the charts above is the 41.4 percent reduction in wet road crashes from the before to the after period. The Lincoln County crash rate decreased by 16.7 percent with only a 4.0 percent increase in the ADT.

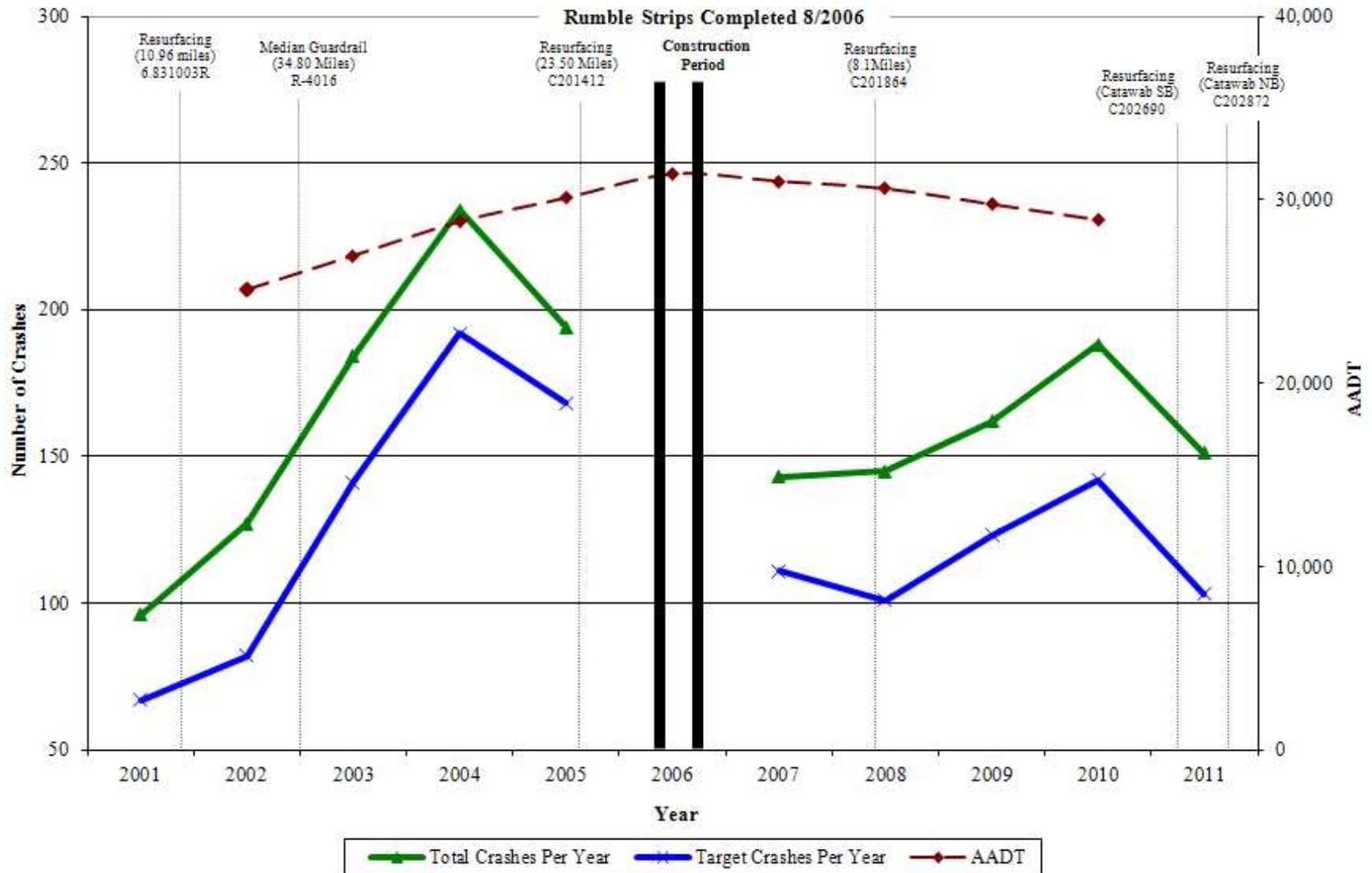
The Catawba County segment showed a slight reduction with a 6.3 percent decrease in total crashes and a 12.8 percent decrease in lane departure crashes. From examining the crashes by direction, the lane departure reduction was consistent in both directions at the 12 to 13 percent range. The Catawba County crash rate decreased by 15.2 percent with a 10.4 percent increase in the ADT.

The calculated benefit to cost ratio for this project is **9.91 considering total crashes**. The benefit to cost ratio **considering only target crashes is 20.70**. 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 and utility costs.

The following chart depicts the number of Total and Target Crashes per year plotted in the before and after period, along with the AADT. Crashes per year appear to have dropped initially when the rumble strip installation occurred. Due to the number of other projects that likely influenced crashes during the study period, the change in crashes cannot be attributed solely to the rumble strip installations.

As the Safety Evaluation Group completes additional 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.

W-4838: US-321 through Gaston / Lincoln/ Catawba Counties - Crashes Per Year



BENEFIT-COST ANALYSIS WORKSHEET - Total Crashes

LOCATION: US-321 Bypass		BY: JBS						
COUNTY: Gaston, Lincoln, Catawba		DATE: 4/4/2012						
FILE NO.: W-4838								
DETAILED COST:	TYPE IMPROVEMENT - Shoulder Rumble Strips							
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$183,630	10	0.149	\$27,366			
	Right-of-Way	\$0	0	0.000	\$0			
	TOTALS	\$183,630	10	0.149	\$27,366			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$0			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$27,366			
	TOTAL COST OF PROJECT=				\$183,630			
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	5.41	16	2.96	233	43.07	642	118.67	\$3,234,861
AFTER	5.41	14	2.59	228	42.14	617	114.05	\$2,963,604
						Annual Benefits from Crash Cost Savings		\$271,257
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST						=	\$243,891	
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST						=	9.91	
TOTAL COST OF PROJECT		-	\$183,630	COMPREHENSIVE B/C RATIO		-	9.91	

BENEFIT-COST ANALYSIS WORKSHEET - Lane Departure Crashes

LOCATION: US-321 Bypass		BY: JBS						
COUNTY: Gaston, Lincoln, Catawba		DATE: 4/4/2012						
FILE NO.: W-4838		Lane Departure Target Crashes						
DETAILED COST:	TYPE IMPROVEMENT - Shoulder Rumble Strips							
	ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST			
	Construction	\$183,630	10	0.149	\$27,366			
	Right-of-Way	\$0	0	0.000	\$0			
	TOTALS	\$183,630	10	0.149	\$27,366			
	ESTIMATED INCREASE IN ANNUAL MAINT. COST =				\$0			
	ESTIMATED INCREASE IN ANNUAL UTILITY COST =				\$0			
	TOTAL ANNUAL COST=				\$27,366			
	TOTAL COST OF PROJECT=				\$183,630			
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	5.41	14	2.59	192	35.49	495	91.50	\$2,733,549
AFTER	5.41	10	1.85	177	32.72	438	80.96	\$2,166,987
						Annual Benefits from Crash Cost Savings		\$566,562
NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST						=	\$539,196	
BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST						=	20.70	
TOTAL COST OF PROJECT		-	\$183,630	COMPREHENSIVE B/C RATIO		-	20.70	