Hazard Elimination Project Evaluation

Order # 41000017687

Hazard Elimination Project W-4811

Evaluation of the Rumble Strip Installation

Durham / Granville Counties

Documents Prepared By:

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Date

Hazard Elimination Project Evaluation Documentation

Subject Location

Evaluation of Hazard Elimination Project Number W-4811 located along five different segments in Durham/Granville Counties, around the City of Durham:

Segment A – I-85 in Durham County from the Orange County Line northward to 6 miles south of the Granville County Line (Durham MP 0.00 – 7.80) – *Total Length 7.80 miles*

Segment B – I-85 from 0.8 mile south of the Granville County Line in Durham County northward to 0.8 mile north of the Durham County Line in Granville County (Durham MP 12.915 – 13.715 / Granville MP 0.00 – 0.80) – *Total Length 1.60 miles*

Segment C – US-70 in Durham County from I-85 southeast to US-70 Business (Miami Boulevard) (Durham MP 6.894 – 9.464) – *Total Length 2.57 miles*

Segment D – US 15/501 in Durham County from 0.2 mile south of SR 1303 (Pickett Road) northward to I-85 (Durham MP 2.774 – 6.794) – *Total Length 4.02 miles*

Segment E – NC 147 (Durham Freeway) in Durham County from 0.25 mile north of SR 2028 (TW Alexander) northward to I-85 (Durham MP 4.527 – 14.671) – *Total Length 10.144 miles*

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 these controlled access freeway roadway segments.

I-85, US-70, US 15/501, and NC 147 are all access controlled multi-lane routes with paved shoulder widths varying between 4 feet and 10 feet. There are portions of US 15/501 and NC 147 where the inside shoulders width is approximately 2 feet. The speed limit on all sections varies between 55-mph and 65-mph; and all roadway sections have consistent median barrier. The total countermeasure improvement distance over all routes is 26.134 miles.

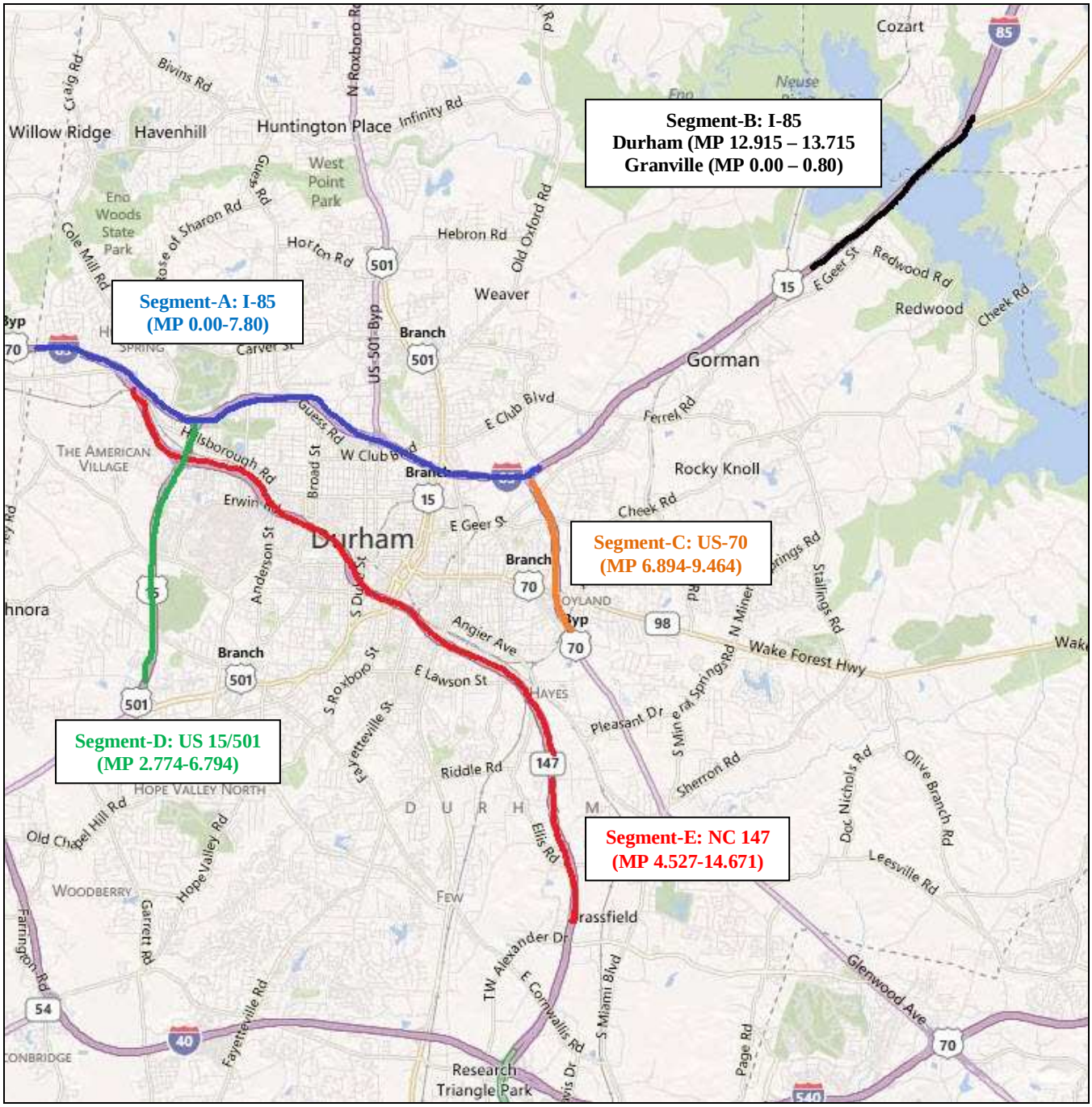
The original statement of problem mentioned that vehicles were running off the road resulting in fatalities, serious injuries, and property damage. Lane departure crashes often result from fatigued or inattentive drivers. Rumble strips provide both noise and vibration as a warning to motorists that they are leaving the travel lane.

The initial crash analysis was completed from July 31, 2000 to June 30, 2003 with 496 reported correctable Ran-Off Road collisions. The improvement was completed on August 31, 2008 with a total cost of $200,000. The projected B/C Ratio was 96.06.

Segment-A (I-85 through Durham) and Segment-C (US-70 Bypass) were only evaluated with After Period data due to the construction of TIP Project I-306 which widen I-85 through the city and built

a new interchange at US-70. The TIP was let under three different project numbers and the construction occurred through the evaluation's before period.

I-306DC (I-85 & US-70 Interchange) – Let 7/20/1999 & Accepted 8/9/2007
I-306DB (Avondale to Broad Street) – Let 1/16/2001 & Accepted 11/1/2007
I-306C (Broad Street to US-15/501) – Let 4/15/2003 & Accepted 7/9/2008



Naive Before and After Analysis

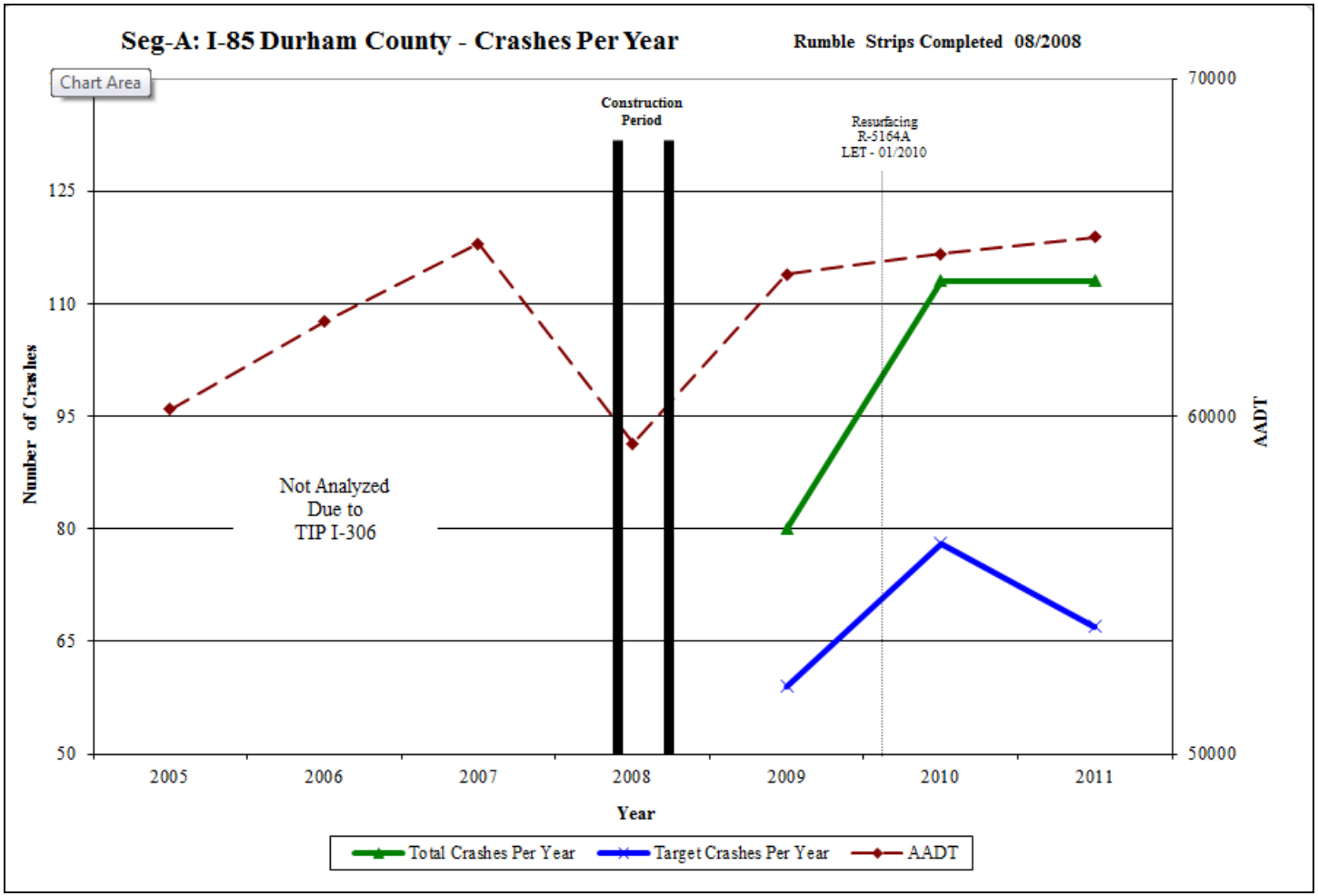
After reviewing the project file folder along with all the crashes along the subject segment, the crash data omitted from this analysis to consider for an adequate construction period were the months of May through August 2008. The before period consisted of reported crashes from November 1, 2004 through April 30, 2008 (3 years, 6 months); and the after period consisted of reported crashes from September 1, 2008 through February 29, 2012 (3 years, 6 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 these segments 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 Freeway 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). All lane departure crashes were independently verified.

A: I-85 (MP 0.00 – 7.80) – After Only	**After**
Total Crashes – Both Directions	343
Total Severity Index	4.18
LD Crashes – Both Directions	229
Lane Departure Severity Index	4.06
Volume (2010)	64,800
Total Crash Rate (100 Million Vehicle Miles)	53.14
Injury Crashes	
Fatal Injury Crashes	2
Class-A Injury Crashes	3
Class-B Injury Crashes	29
Class-C Injury Crashes	67
Property Damage Only Crashes	242
Contributing Factors	
Night Crashes	89
Animal Crashes	14
Wet Road Crashes	89
Alcohol / Drug Related	12

Segment-A was only evaluated with After Period data due to the construction of I-306 through the City of Durham during the before period time limits which extremely changed the geometrics of this section of roadway. The after period roadway consists of four to five lanes in each direction and positive concrete median barrier. Also, a TIP search revealed that a portion segment was potentially resurfaced under R-5164A in January 2010. The after period evaluation chart above was for baseline information only and to compare with other segments within the same study.



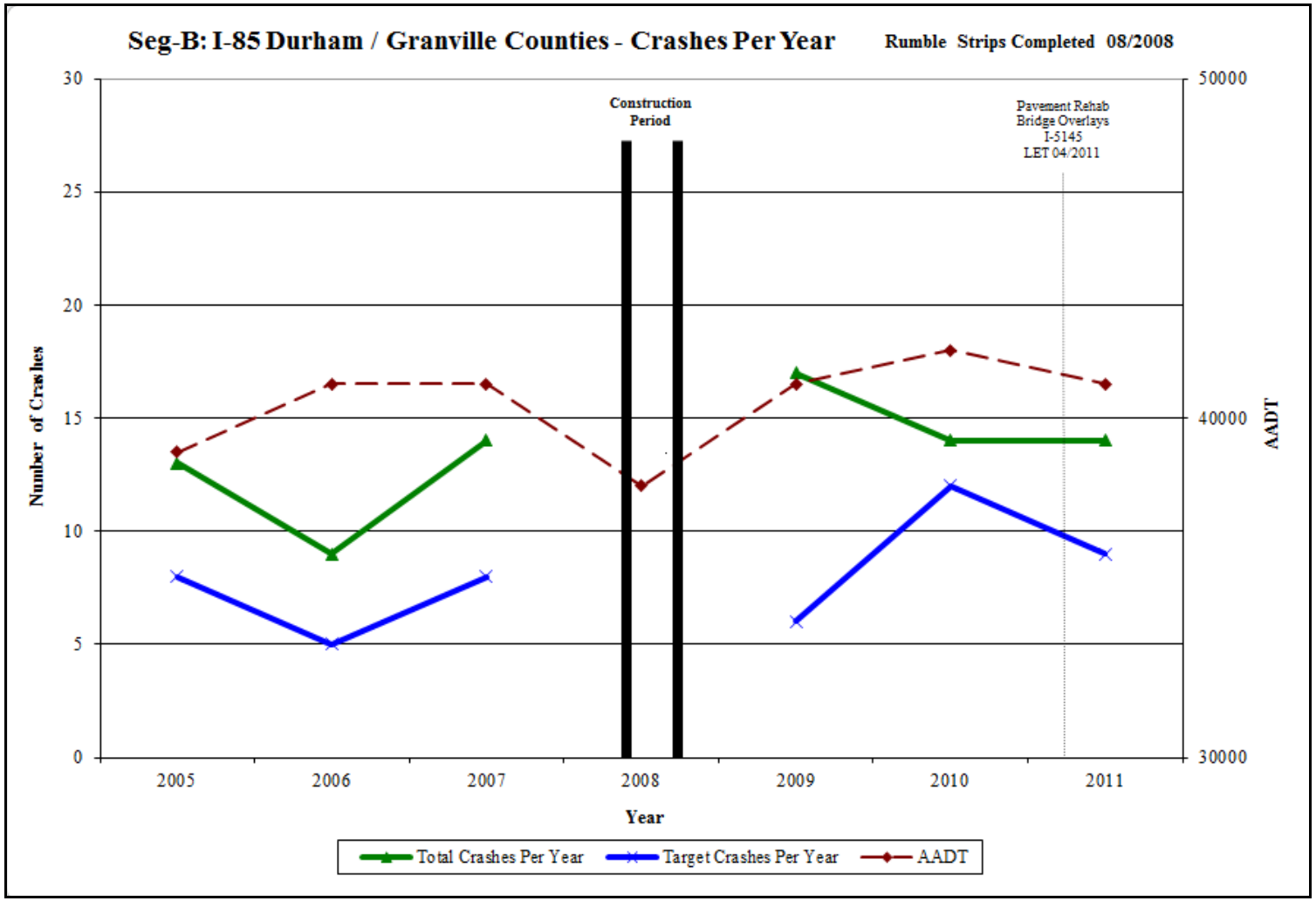
The previous chart depicts the number of Total and Target Crashes per year plotted in the after period only for Segment-A, along with the AADT. Segment-A total and lane departure crashes per year appear to have spiked in 2010 following the resurfacing project. Post the 2010 spike in crashes, the trend reversed for lane departure collisions. The TIP Letting website was searched for projects that were completed along these routes and one is listed post completion of I-306. However, the Safety Evaluation Group cannot conclude that other funds may have been used to complete construction, safety, or resurfacing projects along these roadway segments that may have affected crashes in the after period.

B: I-85 (0.8 mile around County Line)	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
Total Crashes – Both Directions & Counties	45	60	33.3 %
Total Severity Index	2.48	5.13	106.9 %
LD Crashes – Both Directions & Counties	24	36	50.0 %
Lane Departure Severity Index	2.23	7.06	216.6 %
Volume (2006, 2010)	41,000	42,000	2.4 %
Total Crash Rate (100 Million Vehicle Miles)	53.72	69.92	30.2 %
Injury Crashes			
Fatal Injury Crashes	0	1	100.0 %
Class-A Injury Crashes	0	1	100.0 %
Class-B Injury Crashes	1	4	300.0 %
Class-C Injury Crashes	8	9	12.5 %
Property Damage Only Crashes	36	45	25.0 %
Contributing Factors			
Night Crashes	19	22	15.8 %
Animal Crashes	4	9	125.0 %
Wet Road Crashes	10	20	100.0 %
Alcohol / Drug Related	0	3	300.0 %

Seg-B: I -85 Northbound Only	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
NB Total Crashes	24	33	37.5 %
NB Total Severity Index	2.54	5.09	100.4 %
NB Lane Departure Crashes	11	18	63.6 %
NB Lane Departure Severity Index	3.02	7.27	140.7 %

Seg-B: I-85 Southbound Only	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
SB Total Crashes	21	27	28.6 %
SB Total Severity Index	2.41	5.18	114.9 %
SB Lane Departure Crashes	13	18	38.5 %
SB Lane Departure Severity Index	1.57	6.86	336.9 %

Segment-B experienced an increase of 33 percent in Total Crashes with a 50 percent increase in Lane Departure Crashes. In addition, the Total Severity Index saw a 107 percent increase with Severe Injury Crashes (Fatal and A-injury) increased from zero (0) to two (2) from the before to the after period. Contributing factors include a 16 percent increase in night crashes with a significant increase in wet road crashes from ten (10) to twenty (20) through the evaluation.



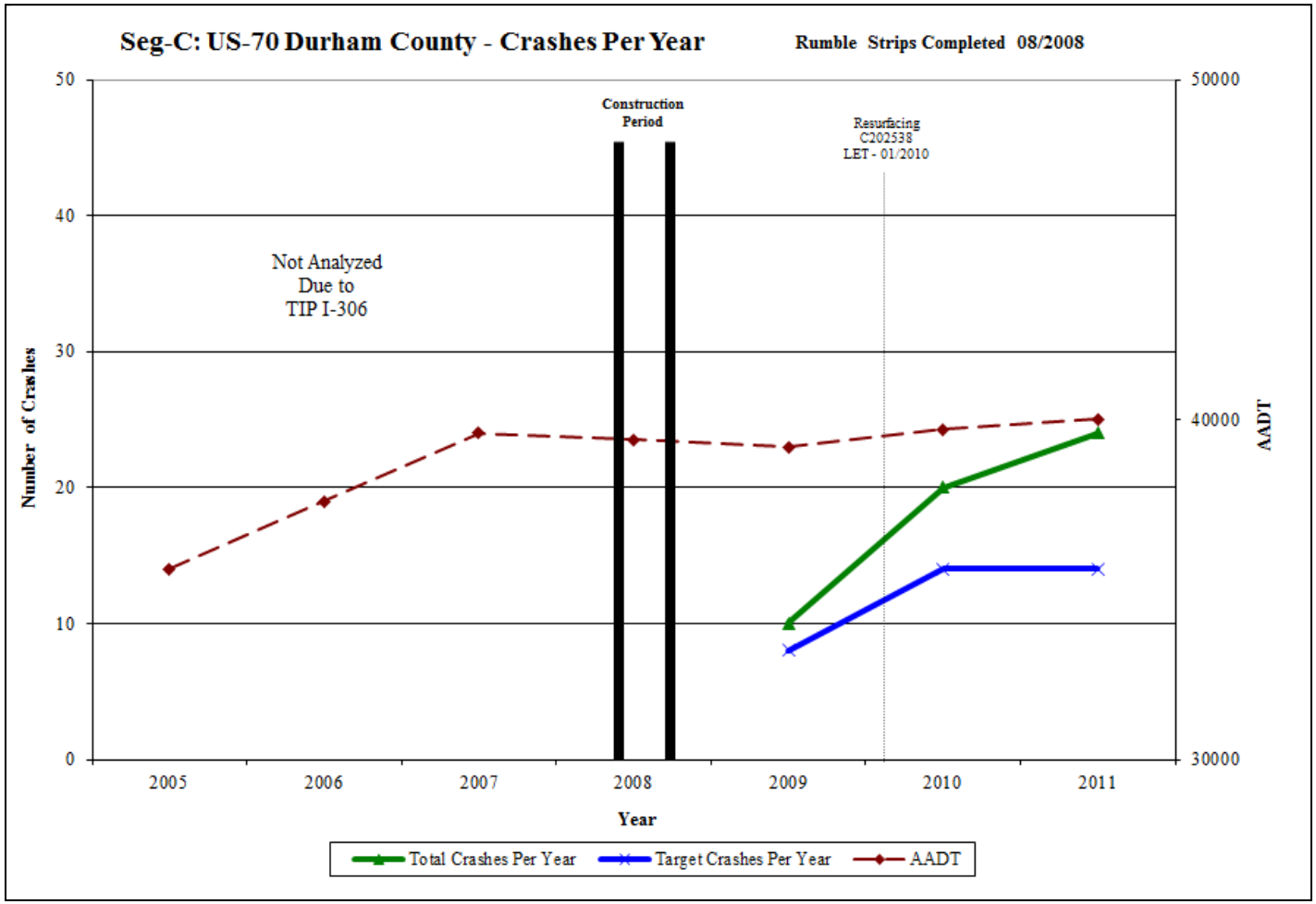
The previous chart depicts the number of Total and Target Crashes per year plotted in the before and after period for Segment-B, along with the AADT. Segment-B lane departure crashes per year appear to have spiked in 2010 for an unknown conclusive reason. The TIP Letting website was searched for projects that were completed along these routes and one is listed above. However, the Safety Evaluation Group cannot conclude that other funds may have been used to complete construction, safety, or resurfacing projects along these roadway segments that may have affected crashes in the after period.

C: I-85 (MP 0.00 – 7.80) – After Only	After
Total Crashes – Both Directions	59
Total Severity Index	4.67
LD Crashes – Both Directions	39
Lane Departure Severity Index	5.60
Volume (2010)	39,200
Total Crash Rate (100 Million Vehicle Miles)	45.86
Injury Crashes	
Fatal Injury Crashes	1
Class-A Injury Crashes	0
Class-B Injury Crashes	6
Class-C Injury Crashes	13
Property Damage Only Crashes	39
Contributing Factors	
Night Crashes	19
Animal Crashes	0
Wet Road Crashes	11
Alcohol / Drug Related	3

Segment-C was only evaluated with After Period data due to the construction of I-306 through the City of Durham including the redesign of the US-70 interchange with I-85. Also, the previous interchange at Geer Street and US-70 was removed and a new interchange at US-70 and Cheek Road was created under the TIP project.

The after period roadway consists of three lanes in each direction and a small grass median protected with w-beam guardrail. Also, a TIP search revealed that a portion segment potentially experienced guardrail rehab under R-4401 in September 2007 and resurfacing under C202538 in January 2010.

The after period evaluation chart above was for baseline information only and to compare with other segments within the same study. The chart above does not include crashes that occurred on the flyover bridge from I-85 southbound accessing US-70 eastbound towards RTP.



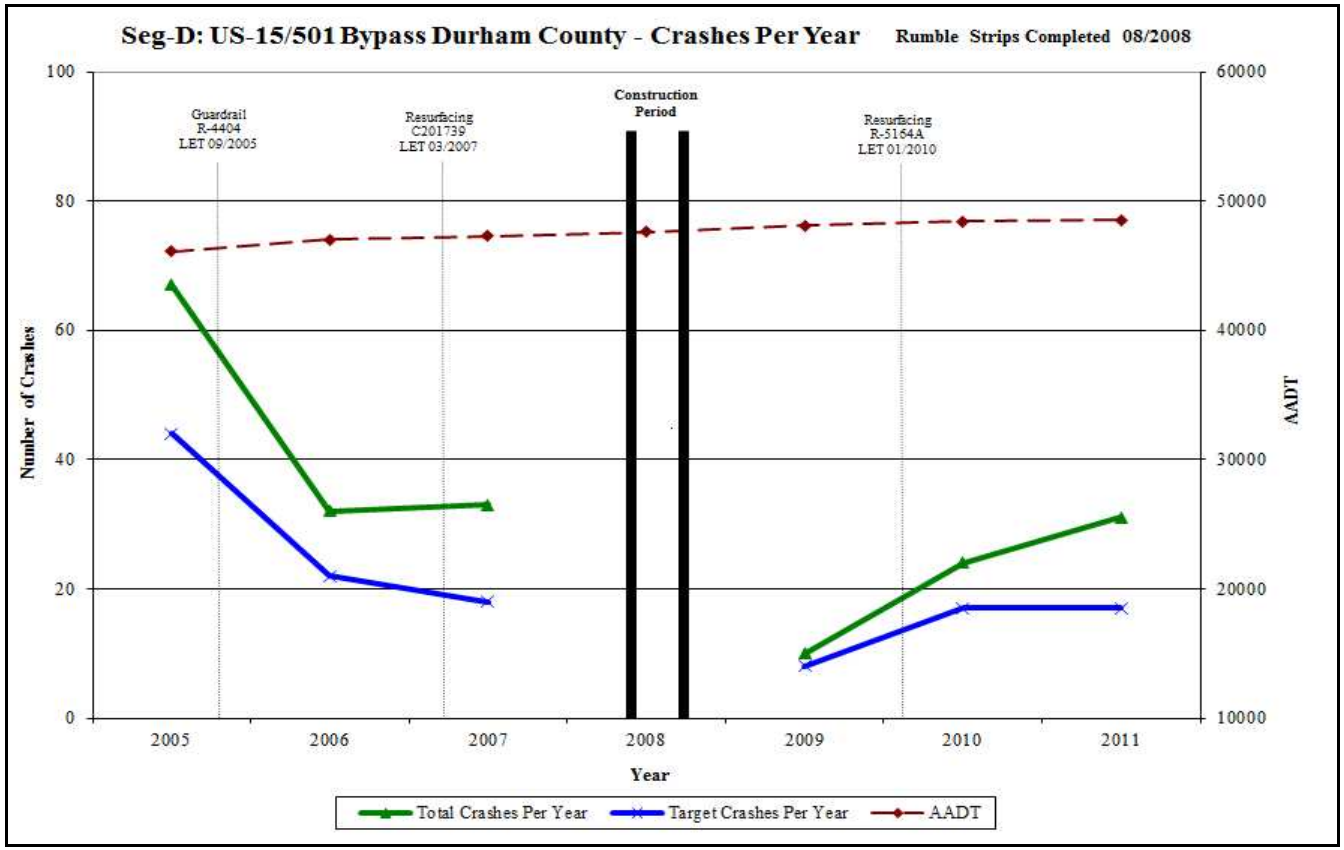
The previous chart depicts the number of Total and Target Crashes per year plotted in the after period only for Segment-c, along with the AADT. Segment-C total and lane departure crashes per year appear to be on an increasing trend in the after period. The TIP Letting website was searched for projects that were completed along these routes and one is listed above. However, the Safety Evaluation Group cannot conclude that other funds may have been used to complete construction, safety, or resurfacing projects along these roadway segments that may have affected crashes in the after period.

D: US-15/501 (MP 2.774 – 6.794)	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	151	77	- 49.0 %
Total Severity Index	4.96	6.09	22.8 %
LD Crashes – Both Directions	93	49	- 47.3 %
Lane Departure Severity Index	4.62	8.24	78.4 %
Volume (2006, 2010)	47,000	48,400	3.0 %
Total Crash Rate (100 Million Vehicle Miles)	62.58	30.99	- 50.5 %
Injury Crashes			
Fatal Injury Crashes	0	2	200.0 %
Class-A Injury Crashes	3	2	- 33.3 %
Class-B Injury Crashes	14	5	- 64.3 %
Class-C Injury Crashes	36	7	- 80.6 %
Property Damage Only Crashes	98	61	- 37.8 %
Contributing Factors			
Night Crashes	45	23	- 48.9 %
Animal Crashes	4	4	0.0 %
Wet Road Crashes	32	15	- 53.1 %
Alcohol / Drug Related	8	6	- 25.0 %

Seg-D: US-15/501 Northbound Only	Before	After	Percent Reduction (-)/ Percent Increase (+)
NB Total Crashes	75	32	- 57.3 %
NB Total Severity Index	5.37	1.93	- 64.1 %
NB Lane Departure Crashes	45	20	- 55.6 %
NB Lane Departure Severity Index	3.47	2.11	- 39.2 %

Seg-D: US-15/501 Southbound Only	Before	After	Percent Reduction (-)/ Percent Increase (+)
SB Total Crashes	76	45	- 40.8 %
SB Total Severity Index	4.55	9.05	98.9 %
SB Lane Departure Crashes	48	29	- 39.6 %
SB Lane Departure Severity Index	5.70	12.48	118.9 %

Segment-D experienced a 49 percent reduction in Total Crashes and a 47 percent reduction in Lane Departure Crashes through the evaluation periods. The Total Severity Index increased by 23 percent with an increase in Severe Injury Crashes (Fatals and A-injury) from three (3) to four (4) from the before to the after periods.



The previous chart depicts the number of Total and Target Crashes per year plotted in the before and after period for Segment-D, along with the AADT. Segment-D total and lane departure crashes per year appear to have dropped significantly (nearly half) in 2006 for an unknown conclusive reason. The drop remained consistent along with the AADTs through the study. The TIP Letting website was searched for projects that were completed along these routes and three are listed above. However, the Safety Evaluation Group cannot conclude that other funds may have been used to complete construction, safety, or resurfacing projects along these roadway segments that may have affected crashes in the study periods.

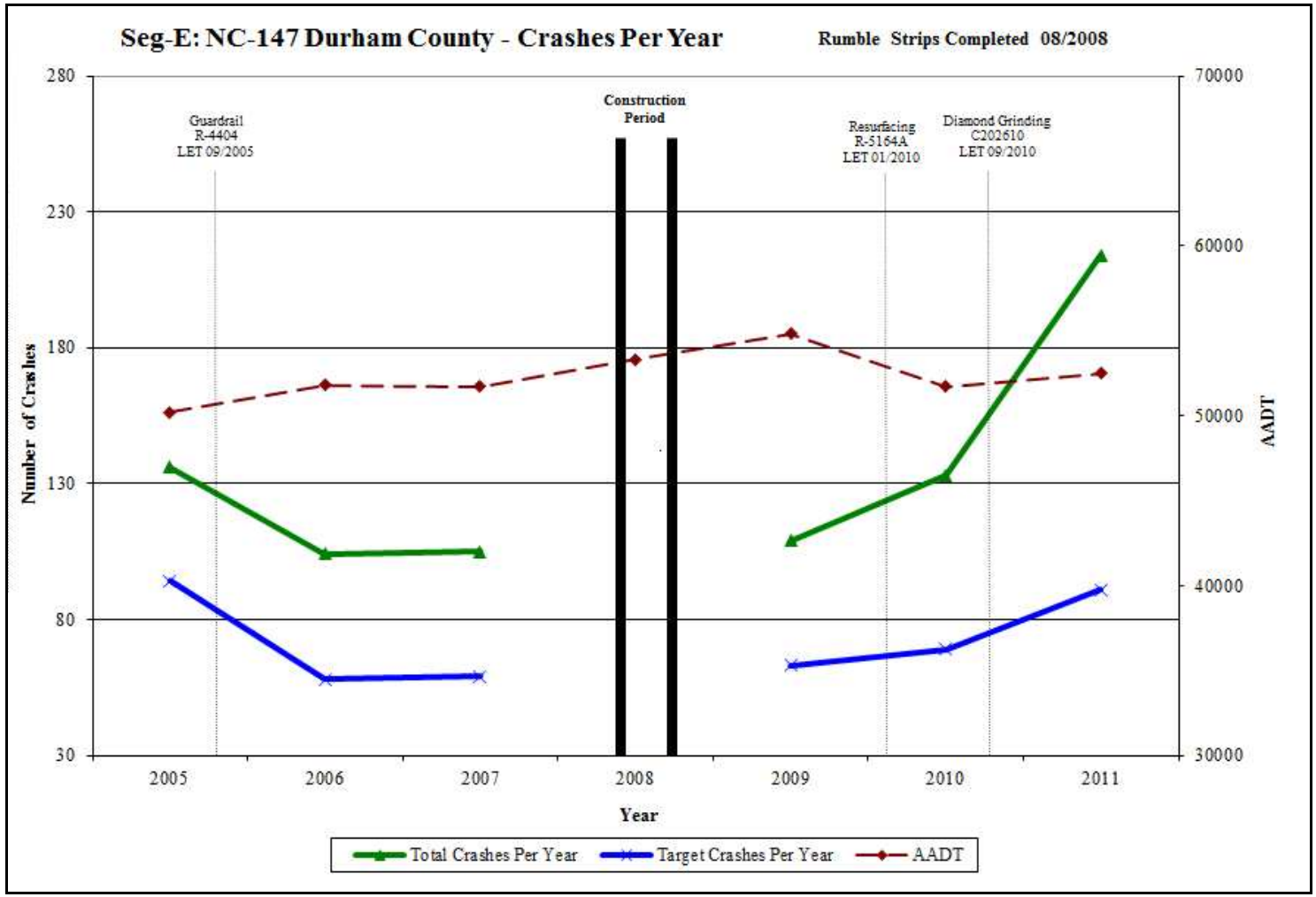
The strong reduction in crashes seems inconsistent with the other data of this evaluation and could be contributed to different construction projects around this segment. In the before period, I-85 was being worked on under TIP I-306 and segment-D was a primary detour route while the after period experienced heavy construction south of the segment on US-15/501 during a bridge replacement near Interstate 40.

E: NC-147 (MP 4.527 – 14.671)	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes – Both Directions	411	531	29.2 %
Total Severity Index	3.45	2.73	- 20.9 %
LD Crashes – Both Directions	242	245	1.2 %
Lane Departure Severity Index	3.49	3.02	- 13.5 %
Volume (2006, 2010)	51,800	51,700	- 0.2 %
Total Crash Rate (100 Million Vehicle Miles)	61.25	79.29	29.5 %
Injury Crashes			
Fatal Injury Crashes	2	0	- 100.0 %
Class-A Injury Crashes	2	0	- 100.0 %
Class-B Injury Crashes	33	33	0.0 %
Class-C Injury Crashes	62	91	46.8 %
Property Damage Only Crashes	312	407	30.4 %
Contributing Factors			
Night Crashes	85	103	21.2%
Animal Crashes	16	11	- 31.3 %
Wet Road Crashes	97	105	8.2 %
Alcohol / Drug Related	9	14	55.6 %

Seg-E: NC-147 Northbound Only	Before	After	Percent Reduction (-)/ Percent Increase (+)
NB Total Crashes	210	292	39.0 %
NB Total Severity Index	3.05	2.55	- 16.4 %
NB Lane Departure Crashes	119	119	0.0 %
NB Lane Departure Severity Index	2.87	2.87	0.0 %

Seg-E: NC-147 Southbound Only	Before	After	Percent Reduction (-)/ Percent Increase (+)
SB Total Crashes	201	239	18.9 %
SB Total Severity Index	3.86	2.95	- 23.6 %
SB Lane Departure Crashes	123	126	2.4 %
SB Lane Departure Severity Index	4.10	3.17	- 22.7 %

Segment-E experienced a 29 percent increase in Total Crashes and a 1 percent increase in Lane Departure Crashes through the evaluation periods. The Total Severity Index reduced by 21 percent with an decrease in Severe Injury Crashes (Fatals and A-injury) from four (4) to zero (0) from the before to the after periods.



The previous chart depicts the number of Total and Target Crashes per year plotted in the before and after period for Segment-E, along with the AADT. Segment-E total and lane departure crashes per year appear to have increased significantly in 2010 following two different TIP projects: resurfacing and bridge repair. The TIP Letting website was searched for projects that were completed along these routes and three are listed below. However, the Safety Evaluation Group cannot conclude that other funds may have been used to complete construction, safety, or resurfacing projects along these roadway segments that may have affected crashes in the study periods.

Results and Discussion

As previously mentioned, segments A and C were not evaluated in the before period due to major construction conflicts with TIP I-306. However, data was analyzed and rumble graphs were created to show the trend in crashes for the after periods.

The crash data above has been combined into the following table for the three segments (B/D/E) that were evaluated with both before and after data:

Segments B/D/E Combined	**Before**	**After**	**Percent Reduction (-) Percent Increase (+)**
Total Crashes	607	668	10.0 %
Total Severity Index	3.75	3.33	- 11.2 %
Target Crashes – Lane Departure	359	330	- 8.1 %
Target Crash Severity Index	3.70	4.24	14.6 %

Segment-B, I-85 around the Durham / Granville County Line experienced a 33 percent increase in total crashes and a 50 percent increase in lane departure collisions. Wet road crashes did double and there was one (1) fatal and one (1) A-injury crash in the after period. From the directional analysis, we observe that both the southbound and northbound directions increased systematically.

Segment-D, US 15/501 in Durham County observed a nearly 50 percent reduction in both total and lane departure target crashes through the evaluation. As previously discussed, construction activity around this segment may have influenced driver behavior. The Rumble Graph indicates the significant drop in crashes per year between 2005 and 2006 in the before period. The TIP search did show that guardrail was installed under R-4404 during this time but the results are counter-intuitive to guardrail installation. However, the directional analysis shows that both directions saw the decrease in crash frequency while southbound crash severity increased due to two (2) after period fatal collisions.

Segment-E, NC-147 through the City of Durham experienced an increase in total crashes by 30 percent but nearly no change in lane departure crashes. This segment eliminated severe injury crashes from four to zero throughout the study. However, the Rumble Graph indicates a strong spike in total crashes during the 2011 calendar year after two TIP projects were completed along this segment.

The calculated benefit to cost ratio for this project was not calculated since Segments A and C were not completed with before period data due to construction conflicts. 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.