Hazard Elimination Project Evaluation

Order # 41000019059

Hazard Elimination Project W-5009

Evaluation of the Rumble Strip & Median Guardrail Installation
US-17/74/76 from SR 1722 to the New Hanover County Line
Brunswick County

Documents Prepared By:

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

Principal Investigator

Jason B. Schronce
Traffic Safety Project Engineer

8-21-2013
Date

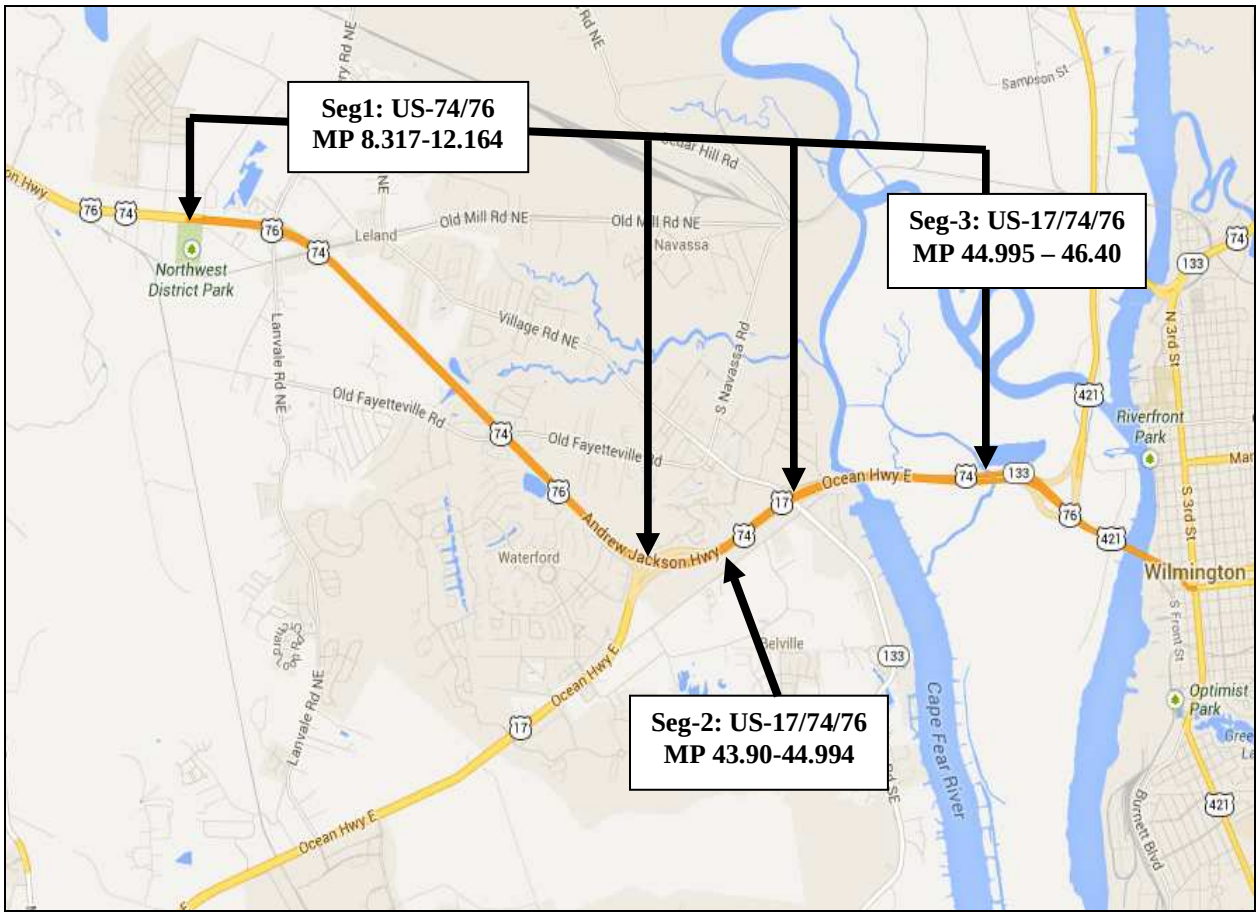
Hazard Elimination Project Evaluation Documentation

Subject Location

Evaluation of Hazard Elimination Project Number W-5009 located along US-74/76 (Andrew Jackson Highway) from SR 1722 (Mercantile Drive), which is the start of the freeway segment, to the US-17 Interchange and US-17/74/76 (Ocean Highway) from the US-17 interchange to the New Hanover County Line in Brunswick County, Town of Leland.

The analysis was shortened to the Alligator Creek Bridge, before the New Hanover County Line, due to roadway naming changes and known vehicle queuing along this route approaching the Cape Fear Memorial Bridge. The following analysis was broken into the following 3 segments:

Seg-1: US-74/76: 150 feet East of SR 1722 to US-17 Interchange
(US-74 Milepost 8.317 – 12.164)
Seg-2: US-17/74/76: US-17 Interchange to NC-133 Interchange
(US-17 Milepost 43.90 – 44.994)
Seg-3: US-17/74/76 / NC-133: NC-133 Interchange to Alligator Creek Bridge
(US-17 Milepost 44.995 – 46.40)



Map Provided by Google Maps

Aerial Map from Google Maps – Segment-1 west of Old Fayetteville Rd Overpass

Project Information and Background from the Project File Folder

The hazard elimination project improvements chosen for the subject corridor were the installation of milled rumble strips along the inside and outside shoulders of this freeway segment and cable guardrail installation from SR 1722 to approximately 0.8 mile east of the NC-133 interchange (between the Brunswick River Bridge and the Alligator Creek Bridge).

US-17/74/76 is mostly a four-lane median divided facility with two lanes in each direction of travel. Roadway photos indicate approximately a 4-foot median paved shoulder and a 10-foot outside paved shoulder. The speed limit is posted at 60-mph. This roadway acts as a gateway entrance into the City of Wilmington from the Towns of Leland, Whiteville, and Elizabethtown. The total analyzed segment length is 6.347 miles.

The original statement of problem mentioned that this controlled access facility had a high number of vehicles involved in ran-off roadway type collisions. There was also the potential for cross median crashes without the presence of a positive median barrier.

The initial crash analysis was completed from December 1, 2001 to November 30, 2006 with 450 reported crashes, with 145 crashes considered correctable Ran-Off Road collisions. The improvement was completed on April 4, 2008 with a total cost of $750,000.

Naive Before and After Analysis

After reviewing the project file folder along with all the crashes along the subject corridor, the crash data omitted from this analysis to consider for an adequate construction period were the months of January through April 2008. The before period consisted of reported crashes from January 1, 2003 through December 31, 2007 (5 years); and the after period consisted of reported crashes from May 1, 2008 through April 30, 2013 (5 years). 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 the US-17/74/76 corridor 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: 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 for this evaluation.

Combined Segments – Total Study	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
Total Crashes – All Segments & Both Directions	223	324	45.3 %
Total Severity Index	4.10	2.72	- 33.7%
Lane Departure Crashes – All Segs & Both Directions	109	145	33.0 %
Lane Departure Severity Index	4.21	2.48	- 41.1 %
Lane Departure WET – All Segs & Both Directions	42	80	90.5 %
LD-WET Severity Index	5.27	1.93	- 63.4 %
Volume (2005, 2010)	34,400	38,700	12.5 %
Total Crash Rate (100 Million Vehicle Miles)	55.93	72.24	29.2 %
Injury Crashes			
Fatal Injury Crashes	2	0	- 100.0%
Class-A Injury Crashes	0	1	100.0 %
Class-B Injury Crashes	17	14	- 17.6 %
Class-C Injury Crashes	57	51	- 10.5%
Property Damage Only Crashes	147	258	75.5 %
Contributing Factors			
Night Crashes	62	81	30.6 %
Animal Crashes	15	25	66.7 %
Wet Road Crashes (From TEAAS)	61	91	49.2 %
Alcohol Related	6	9	50.0 %
Total Cross Median / Guardrail Hits			
Cross Median Crashes	3	1	- 66.7 %
Median Guardrail Barrier Hits	6	50	200+ %
Bridge Barrier Hits	17	26	52.9 %

The naive before and after analysis along the treatment corridor in Brunswick County resulted in a 45 percent increase in Total Crashes, a 33 percent increase in Lane Departure Target Crashes, but a 34 percent reduction in the Total Severity Index. The before period ADT year was 2005 and the after period ADT year was 2010.

The previous table also includes crash totals that involved a vehicle either hitting the median barrier or crossing the median into the opposing lanes. There were a couple locations were median barrier (W-beam guardrail) was already present prior to the installation of cable barrier in the after period along the whole segment.

Typically, one would expect guardrail installation projects to result in an increase in the frequency but a decrease in the severity of Lane Departure collisions. This increase in Lane Departure crashes is expected due to the placement of a fixed object (guardrail) near the travel way. The decrease in the severity of these crashes is expected due to the guardrail being more forgiving than the object it is protecting. The median barrier hits are explored more by each segment in the charts below.

The follow two tables separate the entire corridor segment by direction of travel:

Combined Segments - Eastbound	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
Total Crashes – Eastbound Only	141	224	58.9 %
Total Severity Index	3.74	2.52	- 32.6 %
Lane Departure Crashes – Eastbound Only	63	97	54.0 %
LD Severity Index	2.88	2.45	- 14.9 %
Lane Departure WET – Eastbound Only	24	57	137.5 %
LD WET Severity Index	3.16	1.78	- 43.7 %

Combined Segments - Westbound	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
Total Crashes – Westbound Only	82	100	22.0 %
Total Severity Index	4.72	3.16	- 33.1 %
Lane Departure Crashes – Westbound Only	46	48	4.3 %
LD Severity Index	6.03	2.54	- 57.9 %
Lane Departure WET – Westbound Only	18	23	27.8 %
LD WET Severity Index	8.09	2.29	- 71.7 %

From the charts above, the eastbound direction (heading into the City of Wilmington) lane departure wet crashes experienced the greatest increase at 137 percent throughout the analysis. The westbound direction only experienced a 28 percent increase in LD-Wet collisions.

After examining the crashes, Segment-1 (US-74/76 from SR 1722 to the US-17 Interchange) appeared to experience the highest concentration of after period collisions. The following three tables show Segment-1 as a whole and then by direction of travel.

Seg-1: US-74 MP 8.317 – 12.164	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
S1 Total Crashes – Both Directions	53	92	73.6 %
S1 Total Severity Index	4.94	2.53	- 48.8 %
S1 Lane Departure Crashes – Both Directions	32	61	90.6 %
S1 LD Severity Index	6.84	2.70	- 60.5 %
S1 Lane Departure WET – Both Directions	11	39	254.5 %
S1 LD WET Severity Index	11.25	1.95	- 82.7 %
S1 Cross Median Crashes	1	0	- 100.0 %
S1 Cross Median Severity Index	76.80	0.00	- 100.0 %
S1 Median Barrier Hit Crashes	3	30	200+ %
S1 Median Barrier Severity Index	8.40	1.49	- 82.3 %
S1 Bridge Barrier Hit Crashes	0	4	100.0 %
S1 Bridge Barrier Hit Severity Index	0.00	2.85	100.0 %

The naive before and after analysis at the treatment location of Segment-1 (US-74/76 Andrew Jackson Highway) resulted in a 74 percent increase in Total Crashes, a 91 percent increase in Lane Departure Target Crashes, but a 49 percent reduction in the Total Severity Index. The installation of the cable guardrail also eliminated the one (1) Fatal cross median crash from the before period.

US-74/76 Segment-1 - Eastbound	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
S1 Total Crashes – Eastbound	29	57	96.6 %
S1 Total Severity Index	2.79	2.43	- 12.9 %
S1 Lane Departure Crashes - Eastbound	20	38	90.0 %
S1 LD Severity Index	3.22	2.75	- 14.6 %
S1 Lane Departure WET - Eastbound	8	28	250.0 %
S1 LD WET Severity Index	3.78	1.79	- 52.6 %
S1 Eastbound Median Barrier Hit Crashes	0	21	100+ %
S1 Eastbound Median Barrier Severity Index	0.00	1.70	100+ %

US-74/73 Segment-1 - Westbound	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
S1 Total Crashes - Westbound	24	35	45.8 %
S1 Total Severity Index	7.55	2.69	- 64.4 %
S1 Lane Departure Crashes – Westbound	12	23	91.7 %
S1 LD Severity Index	12.87	2.61	- 79.7 %
S1 Lane Departure WET - Westbound	3	11	266.7 %
S1 LD WET Severity Index	31.20	2.35	- 92.5 %
S1 Westbound Median Barrier Hit Crashes	3	9	200.0 %
S1 Westbound Median Barrier Severity Index	8.40	1.00	- 88.1%

Both eastbound and westbound directions of Segment-1 indicated an increase of 90 percent in lane departure crashes and over 200 percent increase in lane departure wet collisions from the before period to the after period.

The following two tables show the overall crash representation for Segment-2 (US-17/74/76 from US-17 Interchange to NC-133 Interchange) and Segment-3 (US-17/74/76 / NC-133 from the NC-133 Interchange to the Alligator Creek Bridge). Since lane departure crashes did not increase significantly on these segments, the tables were not further detailed by direction of travel.

Seg-2: US-17 MP 43.90 – 44.994	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
S2 Total Crashes – Both Directions	43	67	55.8 %
S2 Total Severity Index	3.41	2.21	- 35.2 %
S2 Lane Departure Crashes – Both Directions	26	28	3.8 %
S2 LD Severity Index	3.28	2.59	- 21.0 %
S2 Lane Departure WET – Both Directions	10	12	20.0 %
S2 LD WET Severity Index	2.48	2.23	- 10.1 %
S2 Cross Median Crashes	2	0	- 100.0 %
S2 Cross Median Severity Index	4.70	0.00	- 100.0 %
S2 Median Barrier Hit Crashes	2	10	200+ %
S2 Median Barrier Severity Index	1.00	2.48	148.0 %
S2 Bridge Barrier Hit Crashes	0	1	100.0 %
S2 Bridge Barrier Hit Severity Index	0.00	1.00	100.0 %

Seg-3: US-17 MP 44.995 – 46.40	**Before**	**After**	**Percent Reduction (-)/ Percent Increase (+)**
S3 Total Crashes – Both Directions	127	165	29.9 %
S3 Total Severity Index	3.99	3.03	- 24.1 %
S3 Lane Departure Crashes – Both Directions	51	56	9.8 %
S3 LD Severity Index	3.03	2.19	- 27.7 %
S3 Lane Departure WET – Both Directions	21	29	38.1 %
S3 LD WET Severity Index	3.47	1.77	- 49.0 %
S3 Cross Median Crashes	0	1	100.0 %
S3 Cross Median Severity Index	0.00	8.40	100.0 %
S3 Median Barrier Hit Crashes	1	10	200+ %
S3 Median Barrier Severity Index	8.40	2.48	- 70.5 %
S3 Bridge Barrier Hit Crashes	17	21	23.5 %
S3 Bridge Barrier Hit Severity Index	3.61	2.76	- 23.5 %

Weather Data Analysis

Due to increase in the after period wet roadway crashes, weather data was also examined to compare natural rainfall/winter weather events during the analysis that affect roadway conditions. Historical weather data was obtained from the State Climate Office of North Carolina at the closest collection point (Wilmington Airport: 319457). The date ranges match the study periods and days of precipitation equal to or greater than 0.01 inches were recorded.

Weather Data Information	**Before 5.0 Yrs**	**After 5.0 Yrs**	**Percent Reduction (-) Percent Increase (+)**
Total Recorded Precipitation (inches)	283.83 in	285.09 in	0.4 %
Total Days of Precipitation / WET Road	592 days	588 days	- 0.7 %
Average Precip per Event Day	0.48 in	0.48 in	0.0 %
Average Precip Total per Year	56.77 in	57.02 in	0.4 %
Avg Days of WET Conditions per Year	118.4 days	117.6 days	- 0.7 %

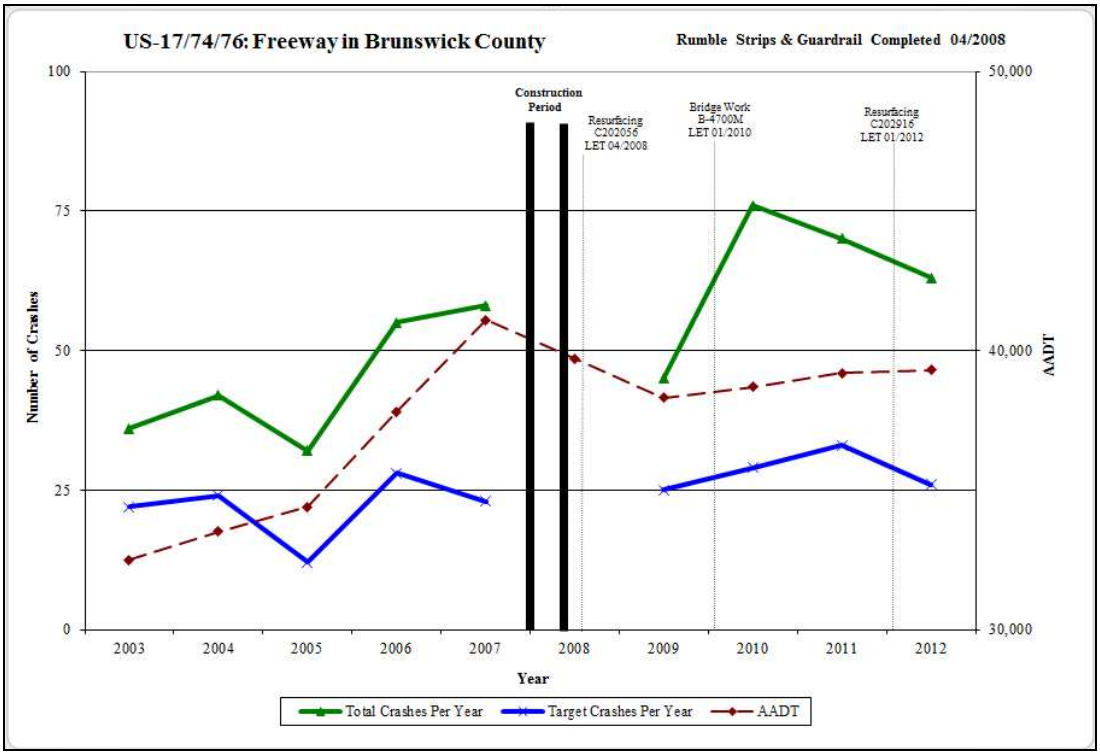
The reviewed weather data indicates that the nearly the identical quantity of wet events days and amount of precipitation were observed in both the before and the after periods. Therefore, the performance of the after period roadway is not connected to a change in regional weather patterns.

Results and Discussion

With the significant increase in collisions on Segment-1 from the tables above, the Safety Evaluation Group has also included GIS plots of Segment-1 (US-74/76) for the before and after periods indicating crash type and severity. The GIS plots show westbound crashes above the roadway and eastbound crashes below the roadway.

As previously discussed, one would expect guardrail installation projects to result in an increase in the frequency but a decrease in the severity of Lane Departure collisions. The results from this cable guardrail installation project seem to be in concurrence with the above mentioned expectations. The greatest benefit from this project are seen when looking specifically at cross median crashes which reduced from three (3) to one (1) throughout the evaluation and included the before period fatal collision.

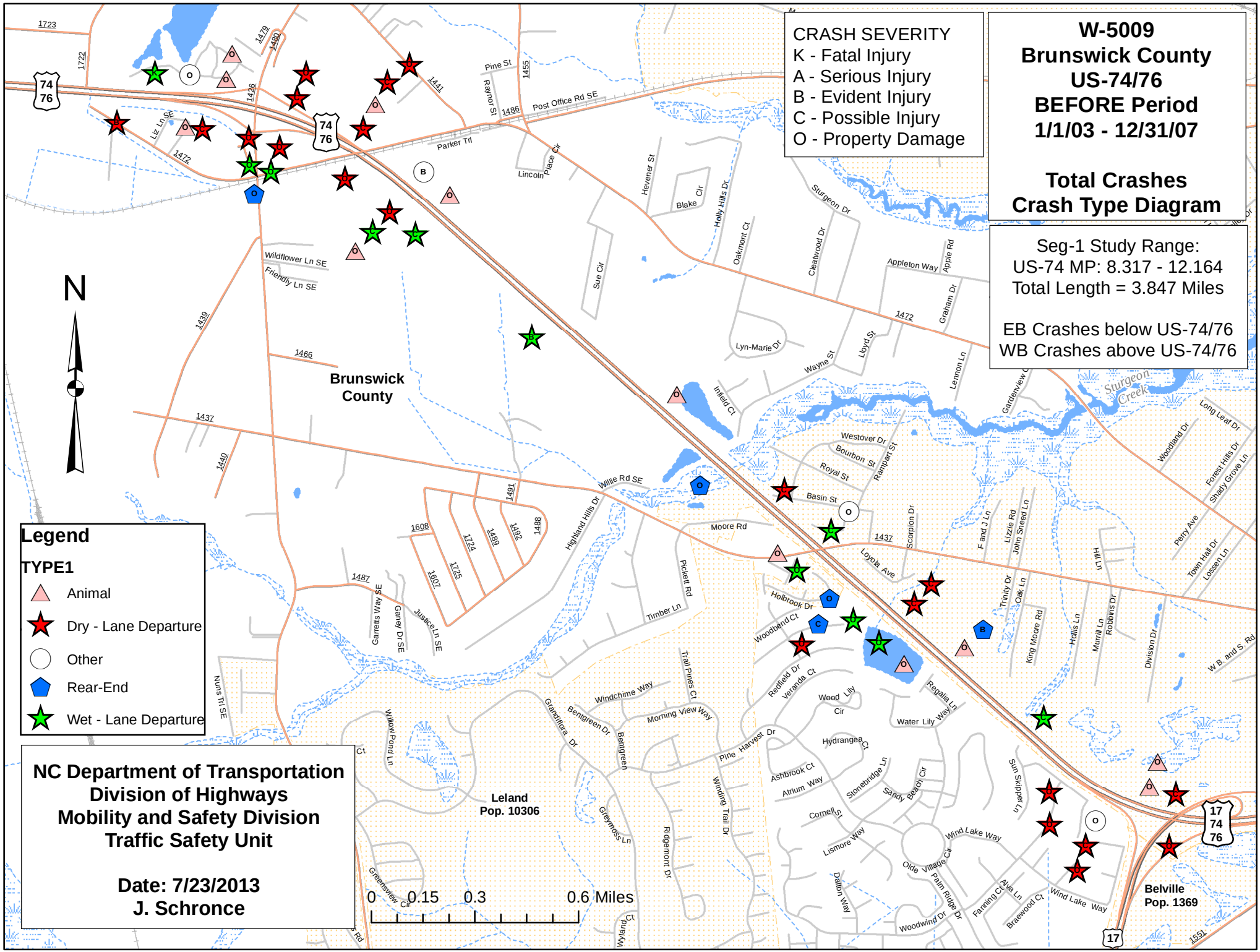
Also, the following chart depicts the number of Total and Target Lane Departure Crashes per year plotted in the before and after period, along with the AADT for all segments combined. Based off the diagrams below, crashes per year have been on a general rise throughout the analysis with Total Crashes spiking in 2010. The lane departure crashes seemed to be on a gradual climb in the after period but reduced following the 2012 resurfacing project. The Safety Evaluation Group may not be fully aware of other projects that were completed on this corridor in our analysis period.

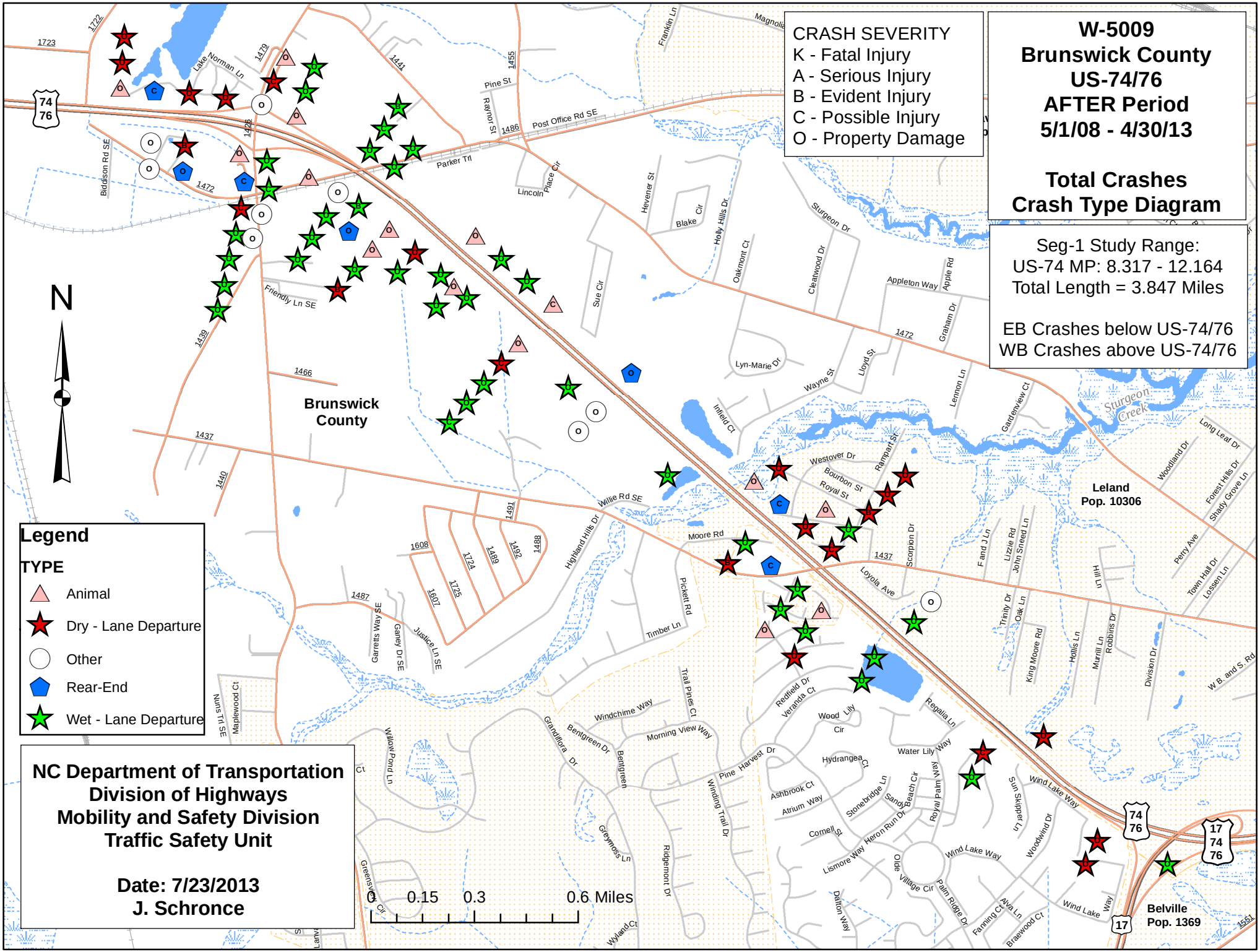


As the Safety Evaluation Group completes additional safety reviews for this type of countermeasure, we will be able to provide objective and definite information regarding actual crash reduction factors for this type of treatment.

Treatment Site Photo

Eastbound in Seg-1 (US-74/76) – Between Village & Old Fayetteville
Google Streetview – October 2012


CRASH SEVERITY
K - Fatal Injury
A - Serious Injury
B - Evident Injury
C - Possible Injury
O - Property Damage
W-5009
Brunswick County
US-74/76
BEFORE Period
1/1/03 - 12/31/07
Total Crashes
Crash Type Diagram
Seg-1 Study Range:
US-74 MP: 8.317 - 12.164
Total Length = 3.847 Miles
EB Crashes below US-74/76
WB Crashes above US-74/76
N
Legend
TYPE1
Animal
Dry - Lane Departure
Other
Rear-End
Wet - Lane Departure
Brunswick County
Leland
Pop. 10306
Belville
Pop. 1369
Sturgeon Creek
NC Department of Transportation
Division of Highways
Mobility and Safety Division
Traffic Safety Unit
Date: 7/23/2013
J. Schronce
0 0.15 0.3 0.6 Miles


CRASH SEVERITY
K - Fatal Injury
A - Serious Injury
B - Evident Injury
C - Possible Injury
O - Property Damage
W-5009
Brunswick County
US-74/76
AFTER Period
5/1/08 - 4/30/13
Total Crashes
Crash Type Diagram
Seg-1 Study Range:
US-74 MP: 8.317 - 12.164
Total Length = 3.847 Miles
EB Crashes below US-74/76
WB Crashes above US-74/76
N
Legend
TYPE
Animal
Dry - Lane Departure
Other
Rear-End
Wet - Lane Departure
Brunswick County
Leland
Pop. 10306
Belville
Pop. 1369
Sturgeon Creek
Lake Norman Ln
Pine St
Post Office Rd SE
Parker Trl
Lincoln Place Cir
Hevener St
Blake Cir
Holly Hills Dr
Oakmont Ct
Cleatwood Dr
Sturgeon Dr
Appleton Way
Apple Rd
Graham Dr
Lyn-Marie Dr
Wayne St
Lloyd St
Lennon Ln
Gardenview Ct
Infield Ct
Rampart St
Westover Dr
Bourbon St
Royal St
Willie Rd SE
Moore Rd
Loyola Ave
Scorpion Dr
Highland Hills Dr
Pickett Rd
Timber Ln
Friendly Ln SE
Sue Cir
Garretts Way SE
Garvey Dr SE
Justice Ln SE
Maplewood Ct
Nuns Trl SE
Willow Pond Ln
Windchime Way
Morning View Way
Bentgreen Dr
Bentgreen
Grandiflora Dr
Trail Pines Ct
Pine Harvest Dr
Windring Trail Dr
Greymoss Ln
Ridgemont Dr
Greensward Cir
Wyland Ct
Redfield Dr
Veranda Ct
Wood Lily Cir
Regalia Ln
Water Lily Way
Hydrangea Ct
Ashbrook Ct
Atrium Way
Stonebridge Ln
Sandy Beach Cir
Royal Palm Way
Sun Skipper Ln
Wind Lake Way
Woodwind Dr
Cornell St
Lismore Way
Heron Run Dr
Olde Village Cir
Palm Ridge Dr
Dalton Way
Fanning Ct
Alva Ln
Braewood Ct
Wind Lake Way
Trinity Dr
Oak Ln
King Moore Rd
Hollis Ln
Murrill Ln
Robbins Dr
Division Dr
F and J Ln
Lizzie Rd
John Sneed Ln
Hill Ln
Perry Ave
Town Hall Dr
Lossen Ln
W B. and S. Rd
Woodland Dr
Long Leaf Dr
Forest Hills Dr
Shady Grove Ln
1722
1723
1479
1441
1455
1426
1486
1472
1439
1466
1437
1440
1491
1608
1724
1489
1492
1488
1607
1725
1487
74
76
17
0
0.15
0.3
0.6 Miles
NC Department of Transportation
Division of Highways
Mobility and Safety Division
Traffic Safety Unit
Date: 7/23/2013
J. Schronce