

Hazard Elimination Project Evaluation

Project Log # 200902135

Hazard Elimination Project W-4001

Widen US 74 Business (Broad Street) from US 1 to US 220 to Convert From a 4-Lane Facility to a 5-Lane Facility with a Two-Way Center Left Turn Lane & Construct Channelization at Caroline Street in Rockingham, Richmond County

Documents Prepared By:

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

Principal Investigator



Carrie L. Simpson, PE

7/15/09

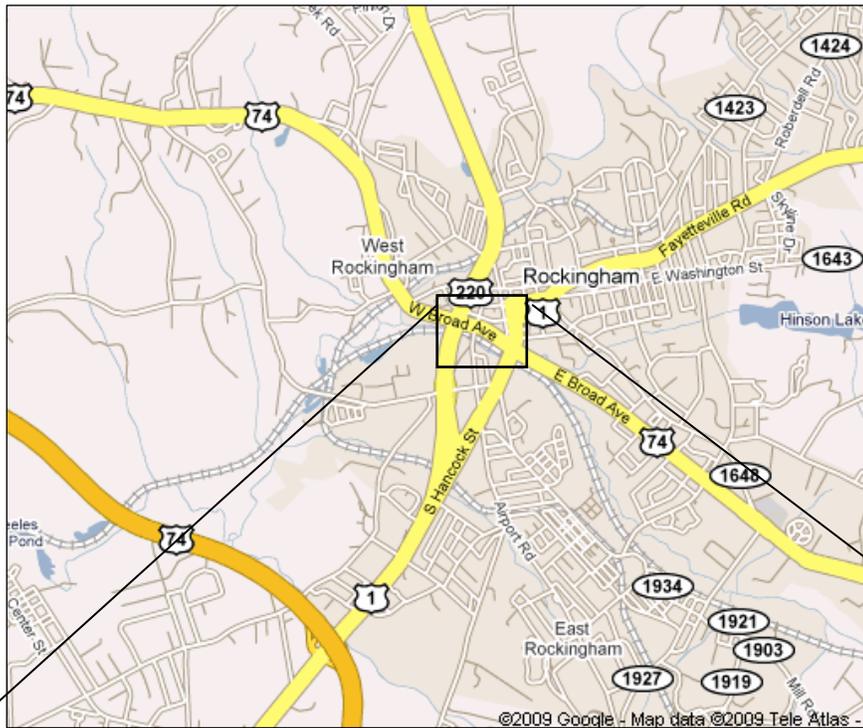
Date

Traffic Safety Project Engineer

Hazard Elimination Project Evaluation Documentation

Subject Location

Evaluation of Hazard Elimination Project W-4001 – On US 74 Business (Broad Street) from US 1 to US 220 in Rockingham, Richmond County



Project Information and Background from the Project File Folder

The safety countermeasures chosen for the subject location were to widen US 74 Business (Broad Street) to provide a Two-Way Left Turn Lane from US 220 to US 1 (S Hancock St); and construct channelizing islands at the Caroline Street intersection. The project widened the roadway from a four-lane undivided curb and gutter section to a five-lane curb and gutter section. This distance between US 220 and US 1 is approximately 0.37 miles in length. The speed limit on this section of Broad Street is 45 mph.

The Project Report in the Project File Folder states that heavy volumes, dense commercial development, and the lack of left turn lane storage contributed to a serious crash potential as vehicles stopped in the thru lane to attempt left turns from Broad Street. Additionally, cross and left turn movements from Caroline Street to Broad Street led to an angle crash pattern.

The initial crash analysis for this location was completed from January 1, 1995 through December 31, 1997 with a total of 68 reported crashes. According to the initial crash analysis, there were 32 Rear End crashes, 10 Left-Turn crashes, 16 Angle crashes, 8 Sideswipe crashes, and 2 Miscellaneous crashes. The project was completed on September 26, 2003 at a cost of \$1,075,000. The expected benefit cost ratio was 23.24:1.

Naïve Before and After Analysis

After reviewing the hazard elimination 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 was from June 1, 2002 through October 31, 2003. The before period consisted of reported crashes from December 1, 1996 through May 31, 2002 (5.5 Years) and the after period consisted of reported crashes from November 1, 2003 through April 30, 2009 (5.5 Years). The ending date for this analysis was determined by the available crash data at the time the crash analysis was completed. The before period ADT year was 1999 and the after period ADT year was 2006.

The treatment data consisted of all crashes on US 74 Business (Broad Street) within a 0' Y-Line from 150' east of US 220 to 150' west of US 1. Because the roadway widening did not extend all the way to US 1 and US 220 (in the before period, a left turn lane existed for both signalized intersections), the study limits were cut short at each end in an attempt to remove as many signalized intersection-related crashes as possible.

The following tables depict the Naïve Before and After Analysis for the Total Crashes and Target Crashes at the treatment location. Please note that the Target Crashes for the applied countermeasure include the following crash types:

- Rear End Crashes (in the Left Thru Lane),
- Left-Turn, Same Roadway (LTSR) Crashes,
- Sideswipe Crashes (From the Left), and
- Crashes involving Thru/Left movement from Caroline St.

The target crashes are clearly identified in the before and after period collision diagrams.

<u>Total Treatment Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Total Crashes	108	22	-79.6%
Total Severity Index	8.21	3.69	-55.1%
Target Rear End Crashes	45	4	-91.1%
Target Rear End Severity Index	5.11	2.85	-44.2%
Target LTSR Crashes	4	2	-50.0%
Target LTSR Severity Index	4.70	4.70	0.0%
Target Sideswipe Crashes	13	3	-76.9%
Target Sideswipe Severity Index	3.85	3.47	-9.9%
Target Angle Crashes	19	0	-100.0%
Target Angle Severity Index	12.09	n/a	n/a
Volume	22,000	12,000	-45.5%

<u>Total Crash Information</u>	Before	After	Percent Reduction (-)/ Percent Increase (+)
Fatal Injury Crashes	0	0	N/A
Non-Fatal Injury Crashes	59	8	-86.4%
Total Injury Crashes	59	8	-86.4%
Property Damage Only Crashes	49	14	-71.4%
Night Crashes	23	5	-78.3%
Wet Crashes	32	2	-93.8%

Results and Discussion

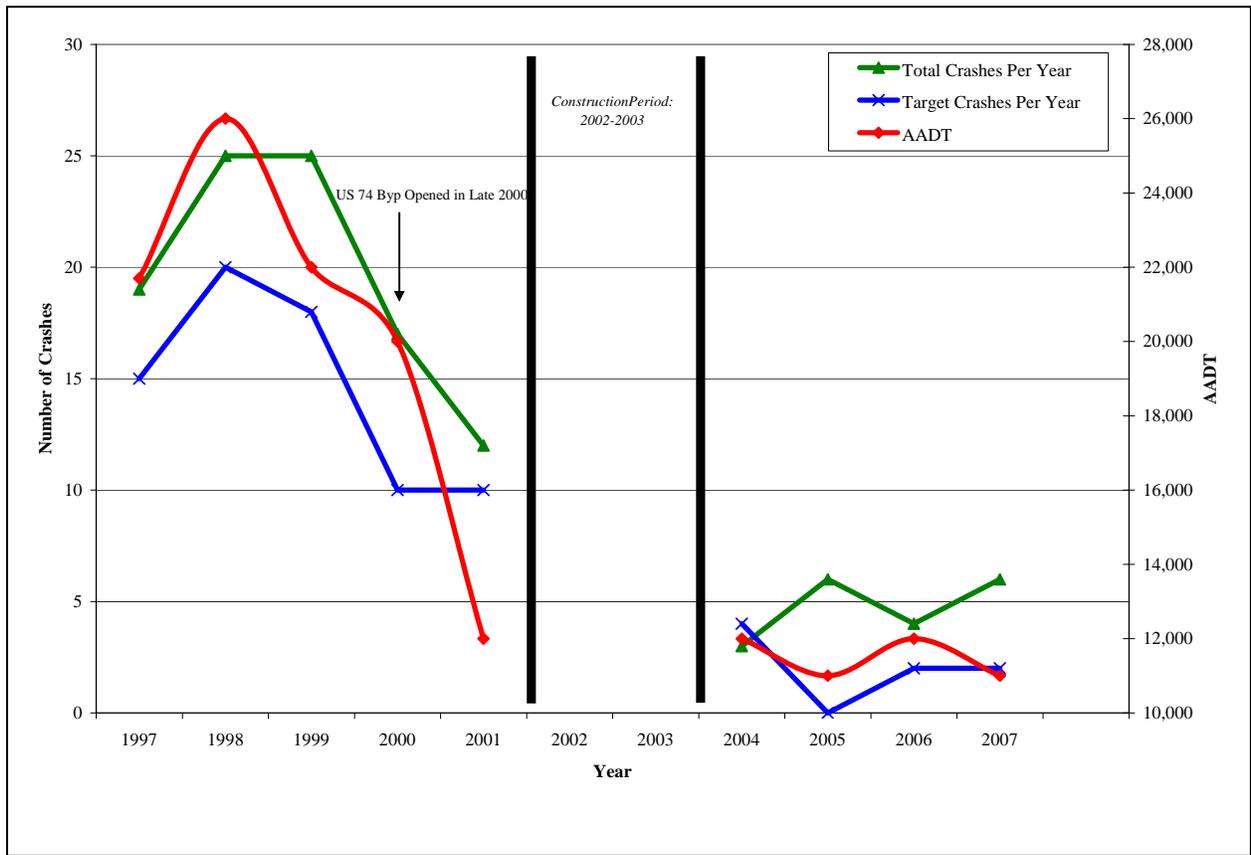
The naïve before and after analysis for the treatment location resulted in an 80 percent decrease in Total Crashes, a 91 percent decrease in Target Rear End Crashes, a 50 percent decrease in Target LTSR Crashes, a 77 percent decrease in Target Sideswipe Crashes, a 100 percent decrease in Target Angle Crashes, and a 46 percent decrease in Average Daily Traffic (ADT). The summary results above demonstrate that the Treatment Location appears to have had a decrease in the number of Total and Target Crashes from the before to the after period using naïve methodologies.

The calculated benefit to cost ratio for this project is **6.88** considering total crashes. The benefit to cost ratio considering only target crashes is **3.49**. 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.

Crash Trends

The following chart depicts the crash trends along the treatment strip. The number of Total and Target Crashes per year are plotted in the before and after period, along with the AADT. It appears that the downward trend in crashes may be correlated with the downward trend in AADT.

According to the Traffic Volume Maps, the AADT along the treatment section decreased from a high of 26,000 vehicles per day in 1998 to a low of 11,000 vehicles per day in 2007. The decrease in AADT may be explained by the opening of US 74 Bypass just south of Rockingham, which opened in 2000. As you can see from the graph, the number of crashes per year was decreasing along with the decreasing AADT, beginning in the before period. Due to the substantial decrease in AADT at the treatment location, the true safety benefits of this project are unclear.



Caroline Street Intersection Channelization

The raised islands constructed at the Caroline Street intersection prevent through and left turn movements from the side street approaches. Motorists wishing to make these movements need to find an alternative route (i.e. potential crash migration occurs). Therefore, the effect of the treatment location on the roadway network must remain in consideration while assessing potential safety benefits. Approximately 80 percent of the before period targeted crashes from Caroline St involved thru/left movements from the Southbound direction. As was shown on the After Period Aerial Photo, Southbound vehicles on Caroline St may still make a left turn onto Broad St from Lee St, the next intersection downstream. As you can see from the After Period Collision Diagram, it appears there was not a major crash migration involving left turning vehicles from the Lee St intersection in the after period.

U-turn crashes along the treatment strip and at the US 1 and US 220 signalized intersections also had the potential to increase in the after period because of the movements prohibited at the Caroline Street intersection. Analysis of the US 1 and US 220 intersections reveals that there were no U-turn related crashes in the after period. There were two after period crashes involving a U-turn movement just west of the Caroline Street intersection.

The left turn channelization appears to have been very effective at reducing Target Angle Crashes at the Caroline Street intersection. There was also a substantial decrease in Target Rear End Crashes in the vicinity of Caroline Street due to the left turn lanes provided in the after period.

Two-Way Left Turn Lane

The Target Crashes for the Two-Way Left Turn Lane countermeasure include Rear End Crashes (in the Left Thru Lane), LTSR Crashes, and Sideswipe Crashes (From the Left). Rear End Crashes (in the Left Thru Lane) are considered treatable by the countermeasure because a TWLTL separates turning traffic from the thru traffic. LTSR Crashes are considered treatable by the countermeasure because a TWLTL relieves the pressure for left-turning vehicles to make left turns without acceptable gaps. Finally, Sideswipe Crashes (From the Left) are considered treatable by the countermeasure because a TWLTL will reduce avoidance crashes caused by motorists attempting to avoid turning vehicles.

Target Rear End Crashes were the predominant crash type in the before period. In the before period, there were 45 Target Rear End Crashes at the treatment location, accounting for 42 percent of all crashes. A majority of the Target Rear End Crashes occurred near the Caroline Street intersection. In the after period, there were only 4 Target Rear End crashes at the treatment location.

The number of Total Wet Crashes decreased (by 94 percent) from 32 crashes in the before period to 3 in the after period. The pavement resurfacing may have contributed to this crash decrease, by providing the roadway with better drainage and pavement friction. The number of Total Night Crashes also decreased substantially (by 78 percent), from 23 crashes in the before period to 5 in the after period.

Please see the attached *Treatment Site Photos*, which depict the current TWLTL. As the Safety Evaluation Group completes additional reviews for this type of countermeasure, we will be able to provide more objective and definite information regarding actual crash reduction factors.

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: US 74B from US 1 to US 220
 COUNTY: Richmond
 FILE NO.: W-4001

BY: CLS
 DATE: 6/30/2009
 TOTAL CRASHES

DETAILED COST: TYPE IMPROVEMENT - Center Turn Lane & Directional Crossover

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$1,075,000	20	0.102	\$109,491
	\$0	0	0.000	\$0
Right-of-Way	\$0	0	0.000	\$0
TOTALS	\$1,075,000	20	0.102	\$109,491

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$2,000
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$111,491
 TOTAL COST OF PROJECT= \$1,075,000

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	5.50	5	0.91	54	9.82	49	8.91	\$806,509
AFTER	5.50	0	0.00	8	1.45	14	2.55	\$39,782

Annual Benefits from Crash Cost Savings \$766,727

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$655,236
 BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 6.88

TOTAL COST OF PROJECT - \$1,075,000 COMPREHENSIVE B/C RATIO - 6.88

BENEFIT-COST ANALYSIS WORKSHEET

LOCATION: US 74B from US 1 to US 220
 COUNTY: Richmond
 FILE NO.: W-4001

BY: CLS
 DATE: 6/30/2009
 TARGET CRASHES

DETAILED COST: TYPE IMPROVEMENT - Center Turn Lane & Directional Crossover

ITEMS	TOTAL	SERVICE	CRF	ANNUAL COST
Construction	\$1,075,000	20	0.102	\$109,491
	\$0	0	0.000	\$0
Right-of-Way	\$0	0	0.000	\$0
TOTALS	\$1,075,000	20	0.102	\$109,491

ESTIMATED INCREASE IN ANNUAL MAINT. COST = \$2,000
 ESTIMATED INCREASE IN ANNUAL UTILITY COST = \$0
 TOTAL ANNUAL COST= \$111,491
 TOTAL COST OF PROJECT= \$1,075,000

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	5.50	2	0.36	40	7.27	39	7.09	\$404,327
AFTER	5.50	0	0.00	3	0.55	6	1.09	\$15,491

Annual Benefits from Crash Cost Savings \$388,836

NET AVG. ANNUAL BENEFITS = AVG. ANNUAL BENEFITS - TOTAL ANNUAL COST = \$277,345
 BENEFIT-COST RATIO = AVG ANNUAL BENEFITS/TOTAL ANNUAL COST = 3.49

TOTAL COST OF PROJECT - \$1,075,000 COMPREHENSIVE B/C RATIO - 3.49

Location Photographs



Looking West on US 74 Bus near Lee St



Looking West on US 74 Bus near Shell Gas Station

Location Photographs



Looking West on US 74 Bus near Caroline St



Looking West on US 74 Bus near Caroline St

Location Photographs



Looking East on US 74 Bus near Caroline St



Looking East on US 74 Bus near Caroline St

To US 220

Motel

Caroline St

Hardees

Shell Gas

Motel

Caroline St

Quick Stop Gas

Dairy Queen

Lee St

US 74 (Broad Ave)
To US 1

LEGEND

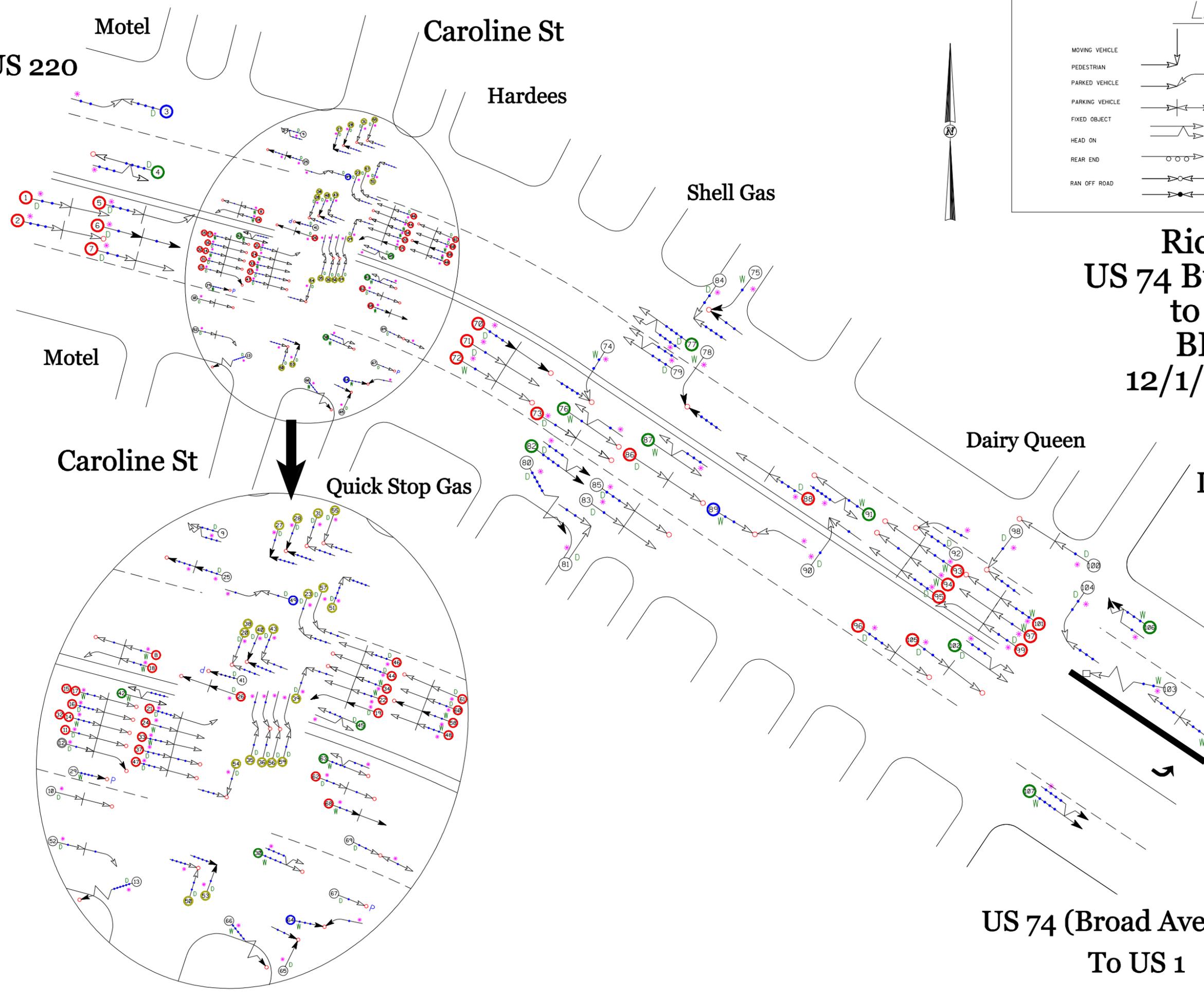
MOVING VEHICLE	ANGLE	9 MPH OR LESS	P PEDESTRIAN
PEDESTRIAN	TURNING	10 MPH TO 19	T TRAIN
PARKED VEHICLE	BACKING	20 MPH TO 29	* DRIVER AT FAULT
PARKING VEHICLE	SIDESWIPE	30 MPH TO 39	D DRY
FIXED OBJECT	OUT OF CONTROL	40 MPH TO 49	W WET
HEAD ON	INJURY	50 MPH TO 59	I ICY OR SNOWY
REAR END	FATALITY	60 MPH TO 69	O OILY
RAN OFF ROAD		70 AND UP	
		SPEED UNKNOWN	

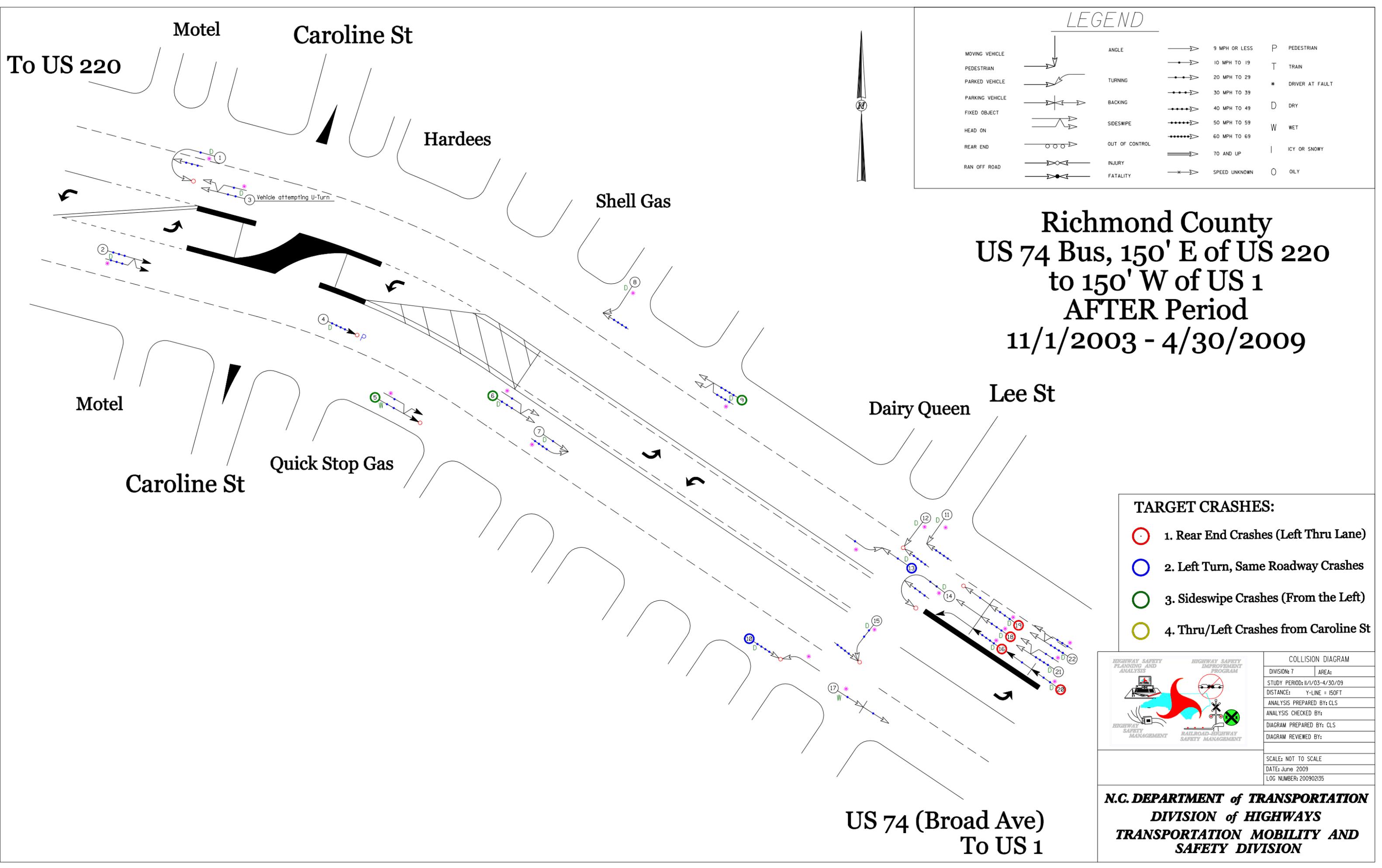
Richmond County
US 74 Bus, 150' E of US 220
to 150' W of US 1
BEFORE Period
12/1/1996 - 5/31/2002

- TARGET CRASHES:**
- 1. Rear End Crashes (Left Thru Lane)
 - 2. Left Turn, Same Roadway Crashes
 - 3. Sideswipe Crashes (From the Left)
 - 4. Thru/Left Crashes from Caroline St

COLLISION DIAGRAM	
DIVISION: 7	AREA:
STUDY PERIOD: 12/1/96-5/31/02	DISTANCE: Y-LINE = 150FT
ANALYSIS PREPARED BY: CLS	
ANALYSIS CHECKED BY:	
DIAGRAM PREPARED BY: CLS	
DIAGRAM REVIEWED BY:	
SCALE: NOT TO SCALE	
DATE: June 2009	
LOG NUMBER: 200902135	

N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRANSPORTATION MOBILITY AND
SAFETY DIVISION





LEGEND

MOVING VEHICLE	ANGLE	9 MPH OR LESS	P PEDESTRIAN
PEDESTRIAN	TURNING	10 MPH TO 19	T TRAIN
PARKED VEHICLE	BACKING	20 MPH TO 29	* DRIVER AT FAULT
PARKING VEHICLE	SIDESWIPE	30 MPH TO 39	D DRY
FIXED OBJECT	OUT OF CONTROL	40 MPH TO 49	W WET
HEAD ON	INJURY	50 MPH TO 59	I ICY OR SNOWY
REAR END	FATALITY	60 MPH TO 69	O OILY
RAN OFF ROAD		70 AND UP	
		SPEED UNKNOWN	

**Richmond County
US 74 Bus, 150' E of US 220
to 150' W of US 1
AFTER Period
11/1/2003 - 4/30/2009**

- TARGET CRASHES:**
- 1. Rear End Crashes (Left Thru Lane)
 - 2. Left Turn, Same Roadway Crashes
 - 3. Sideswipe Crashes (From the Left)
 - 4. Thru/Left Crashes from Caroline St

	COLLISION DIAGRAM	
	DIVISION: 7	AREA:
	STUDY PERIOD: 11/1/03-4/30/09	
	DISTANCE: Y-LINE = 150FT	
	ANALYSIS PREPARED BY: CLS	
	ANALYSIS CHECKED BY:	
DIAGRAM PREPARED BY: CLS		
DIAGRAM REVIEWED BY:		
SCALE: NOT TO SCALE		
DATE: June 2009		
LOG NUMBER: 200902135		

**N.C. DEPARTMENT of TRANSPORTATION
DIVISION of HIGHWAYS
TRANSPORTATION MOBILITY AND
SAFETY DIVISION**

**US 74 (Broad Ave)
To US 1**