An Evaluation of Using Portable Changeable Message Signs (PCMS) To Regulate Speed Limit in the I-95 Workzone Project # I-4913, Northampton County

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_____ 2-18-2008
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INTRODUCTION

The desire to evaluate the use of Portable Changeable Message Signs (PCMS) to regulate speeds in Interstate Workzones came about due to the continuous search for effective measures in keeping our workzone workers safe. Workzone Safety holds a high priority in the ranks of the NC Department of Transportation and this is one more method by which it is predicted we can save time, energy, and lives of our workers and the traveling public.

The MUTCD 2003 (Section 6F.55) states that the primary purpose of Portable Changeable Message Signs in TTC (temporary traffic control) zones are to advice the road user of unexpected situations. Some typical applications include the following:

- Where the speed of vehicular traffic is expected to drop substantially;
- Where significant queuing and delays are expected;
- Where there are changes in alignment or surface conditions;
- Where advance notice of ramp, lane, or roadway closures is needed;

The MUTCD 2003 further states in Section 2B.13 that:

> "A changeable message sign that changes the speed limit for traffic and ambient conditions may be installed provided that the appropriate speed limit is shown at the proper times."
>
> "If a changeable message sign displaying approach speeds is installed, the legend YOUR SPEED XX km/h (MPH) or such similar legend should be shown. The color of the changeable message legend should be a yellow legend on a black background or the reverse of these colors"

From the MUTCD stated standards, the NCDOT Workzone Group is able to set a temporary speed limit in a workzone during a selected period of time using only a Portable Changeable Message Sign as shown in Figure 1 below.

The goal of this project is to determine if temporary speed limits posted on a PCMS in workzones are effective in creating speed limit compliance. The measure of effectiveness for this project will be to collect speed data and review vehicle speeds, average speeds, pace speed, and percentage of vehicles exceeding the speed limit within the collected data sets.

Figure 1: PCMS

METHODOLOGY

Workzone Location & Characteristics

The use of the PCMS for setting temporary workzone speed limits was implemented on I-95 in Northampton County. This resurfacing project consisted of the removal of broken pavement, asphalt patchwork, and an asphalt roadway overlay from MP 176 (north of Roanoke Rapids) to MP 181 (Virginia State Border). Interstate 95 in this area is a four-lane divided freeway with an Average Daily Traffic (ADT) of 36,500 in 2005 and a speed limit of 70 miles per hour. Portions of the section also have W-beam guardrail lining the median roadway edges where the northbound and southbound lanes are not separated by flower or tree medians.

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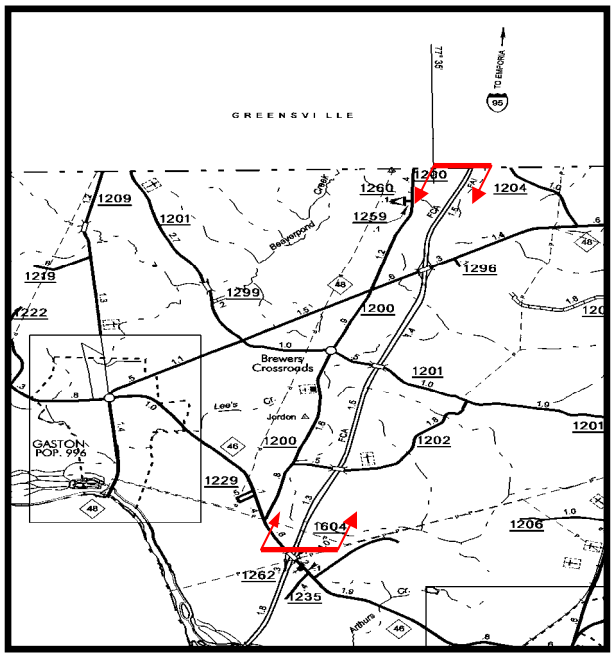


Figure 2: Map of Workzone

The workzone consisted of a single lane closure in one direction of travel during daytime hours of 8am to 7pm. Portable Changeable Message Signs (PCMS) were used to alert drivers of the approaching traffic situation. Multiple signs were used that posted the following messages (multiple messages alternated on each sign):

1. ROAD WORK AHEAD / BE PREPARED TO STOP
2. WORKERS IN ROADWAY / REDUCE SPEED AHEAD
3. WORKERS IN ROADWAY / MERGE LEFT / BEGIN 55 4000 FEET
4. $250.00 SPEEDING PENALTY / **SPEED LIMIT 55**

Each PCMS was spaced between one and two miles apart. For example, a southbound lane closure starting at the border had Sign 1 located at Virginia Exit 4, Sign 2 at mile marker 2 in Virginia, Sign 3 at mile marker 1 in Virginia, and Sign 4 at the edge of the workzone (which designated the reduced speed limit of 55 miles per hour). Photos of this scenario can be found in the Appendix.

Traffic Barrels were used to designate the lane closure for workzone worker protection. These traffic control devices were placed either on the center-striped line or into the travel lane as a method to "squeeze" traffic for speed reduction. This often forced vehicles, especially tractor-trailers, to use the paved shoulder as part of their driving lane. In order to access the paved shoulder, vehicles had to cross the milled continuous rumble strip. Also, approximately every 30 feet, the same vehicles were striking an outdated thermoplastic intermittent rumble strip forcing them to regulate their traveling speed. Photos are provided showing the "squeezing" of vehicles.

The company doing the resurfacing work in contract with the NCDOT was Barnhill Construction. Their operation of this resurfacing work was very efficient with the correct number of crewmen and an abundance of vehicles, especially asphalt dump trucks. Observations made in the During Data stage included Barnhill dump trucks traveling through the workzone to refill or get in line within the lane closure to dump asphalt. These dump truck drivers helped to regulate speeds within the workzone by traveling the posted 55-mph speed and queuing traffic behind them.

Site Selection

The Before and After Data Collection Site was SR 1202 (Blythe Road) in Northampton County. This overpass bridges the interstate and has no access ramps to I-95. Data was collected from the side of the bridge into a horizontal southbound curve. Distance was too great (over 3000 feet) for drivers to identify us and slow down prior to the obtainment of their traveling speed. Northbound traffic speeds were collected from same location except were shot from the rear through a gap in the tree line. The bridge blocked the driver's view of our location and speeds were not affected.

The During Data was collected in the workzone from the shoulder of the lane closure. The goal was to appear to be apart of the workzone crew and our vehicle was equipped with yellow strobe lights. Speeds were collected from inside the vehicle shooting the rear of passing motorists. We alternated being in front or behind the actual work crew but made sure that free-flow traffic conditions were maintained for data collection.

The Upstream Data Collection Site was in Virginia at VA 639 (Rock Bridge Road). This location is approximately 5 miles north of the workzone area. VA 639 is a bridged roadway over the interstate with no access ramps. Northbound and southbound vehicle speeds were collected from the rear on the corresponding side of the bridge. It did not appear that our presence affected vehicle-traveling speed. Rock Bridge Road had a very small ADT and was surrounded by farmland and trees.

The Downstream Data Collection Site was located at SR 1001 (Justice Branch Road) in Halifax County, closest Exit is number 160 off I-95. This location is approximately 5 miles south of Roanoke Rapids. SR 1001 is a bridged roadway over the interstate with no access ramps. Northbound and southbound vehicle speeds were collected from the rear on the corresponding side of the bridge. The bridge is located on a skew so that we were able to hide from view of approaching motorists. A map showing the three data collection sites is located in the Appendix.

Data Collection

Data was collected using the Lidar Gun. Before data collection began, the accuracy of the Lidar Gun was tested using standard procedure stated in the user manual. The results indicated that the device's speed accuracy and distance measurements were exact.

Data was collected at each location for one (1) hour per direction. Speeds were collected in an inconspicuous manner so as not to influence the driver's speed or lane choice. All data collection took place in off peak hours, between the hours of 9:00 AM and 3:00 PM, when vehicles had the highest potential of maintaining continuous flow and selecting their own desired traveling speed. The Safety Evaluation group collected data Monday through Saturday for an overview of different vehicle grouping and traffic patterns.

Weather was the main factor in maintaining consistent data collection. Required conditions were having a dry roadway with overcast or sunny skies. Wind appeared to minimally affect choice traveling speed mainly with tractor-trailers on certain days in the after period (noted on Appendix Data Overview Sheets).

The following measures of effectiveness (MOEs) were collected / analyzed from the data:

- **Vehicle Speeds** – speed chosen by the lead driver and collected using the Lidar Gun
- **Average Speed** – speeds collected per location and direction averaged
- **Percentage of Vehicles Exceeding Speed Limit** – graphed results showing "Number of Vehicles" vs. "Observed Speed minus Speed Limit"
- **Pace Speed** – set of 10 miles per hour where the largest percentage of speeds fall per data set

The after period data was collected once the entire project was completed and had been in place for at least three weeks. This was done so that any novelty effect caused by the resurfacing would not impact the data.

RESULTS

Figures 3 through 5 below show the results of the speed data collected for our analysis. The data is shown with combined northbound and southbound data because the difference between directions was determined to be small and insignificant. More detailed speed data can be found in the Appendix of this report including breakdown by direction.

I-95 NB & SB Before Totals	
Total Obs	6045
Speed Limit	70
Average	72.63
50th Percentile	72.30
85th Percentile	76.90
Stnd Dev	4.88
Variance	23.98

PACE Speed Calc	
Low Pace	**69**
High Pace	**78**
Vehicle %	**70.48**

Figure 3: BEFORE Data

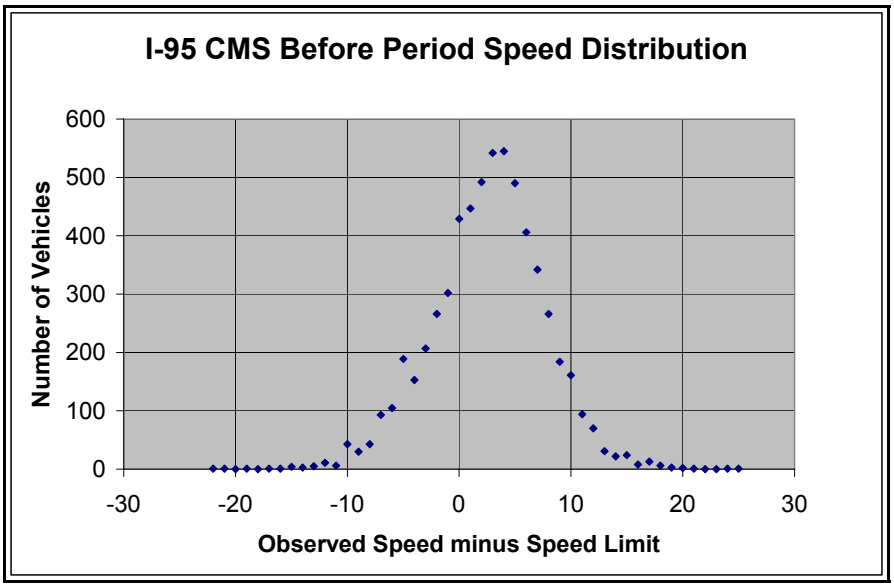
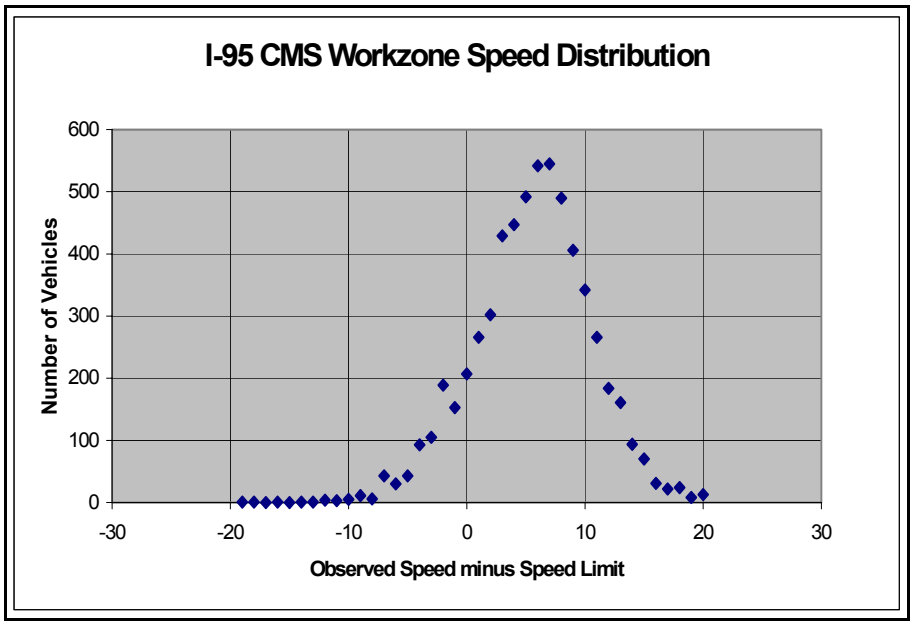


Figure 4: DURING Data

I-95 NB & SB Totals Workzone Data	
Total Obs	1957
Speed Limit	55
Average	54.65
50th Percentile	54.07
85th Percentile	58.98
Stnd Dev	5.33
Variance	31.97

PACE Speed Calc	
Low Pace	**50**
High Pace	**59**
Vehicle %	**73.94**



I-95 NB & SB Totals Upstream (VA)	
Total Obs	2260
Speed Limit	65
Average	69.52
50th Percentile	68.96
85th Percentile	73.66
Stnd Dev	4.90
Variance	24.15

PACE Speed Calc	
Low Pace	**64**
High Pace	**73**
Vehicle %	**73.01**

I-95 NB & SB Totals Downstream	
Total Obs	1842
Speed Limit	70
Average	72.71
50th Percentile	72.50
85th Percentile	76.71
Stnd Dev	5.23
Variance	27.51

PACE Speed Calc	
Low Pace	**68**
High Pace	**77**
Vehicle %	**71.72**

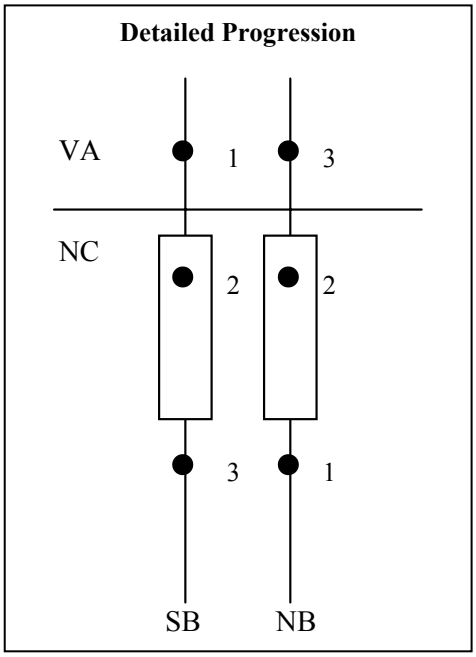
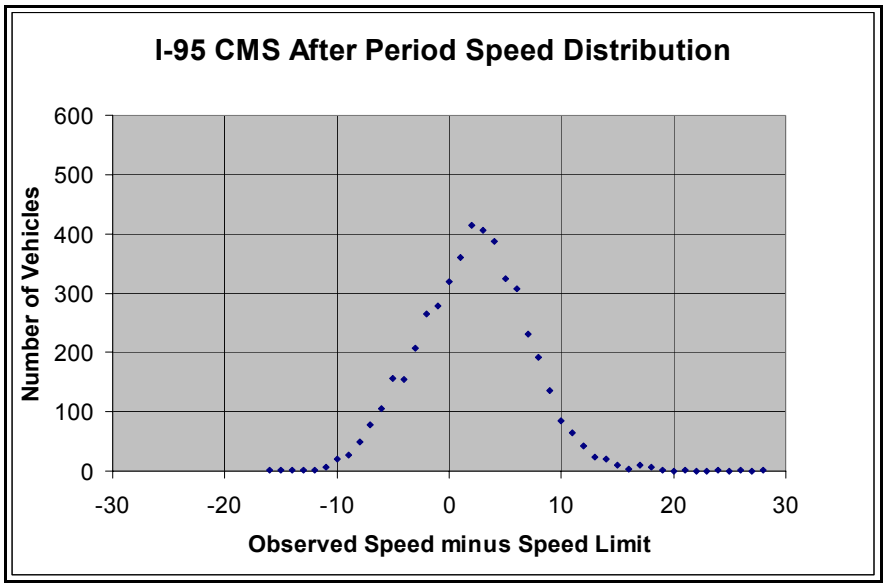


Figure 5: AFTER Data

I-95 NB & SB After Totals	
Total Obs	4707
Speed Limit	70
Average	72.12
50th Percentile	71.73
85th Percentile	76.50
Stnd Dev	4.84
Variance	23.44

PACE Speed Calc	
Low Pace	**68**
High Pace	**77**
Vehicle %	**69.98**



The During Data (figure 4) shows speeds collected in the workzone while the PCMS was being used to set the 55-mph speed limit. We observed a pace speed range of 50 to 59 which places the posted speed directly in the middle. These figures show that over the observation period that the average speeds of motorists traveling in the workzone were in compliance to the temporary speed limit.

Data was also collected upstream and downstream of the workzone on the same days that workzone speeds were observed. As these locations are compared to the before data, similarities exists to represent that motorists are returning to their pre-workzone habits almost immediately after exiting the reduced speed zone. It was expected that vehicles may attempt to exceed the posted speed limit in order to "make up time" but this simply does not appear to be the case.

The Before Data (figure 3) represents speeds collected prior to the resurfacing project. The posted speed limit at this data location is 70 MPH. From the pace speed analysis we examine over 70 percent of the vehicles between the speeds of 69 and 78 mph. Commonly accepted engineering practices conclude that safety is enhanced when the 10-mph pace includes a large percentage (more than 70 percent) of all the free-flowing vehicles at a location. The before-after analysis actually shows a reduction in the 10-mph pace by one unit while maintaining the 70 percentage of vehicles.

As it can be seen in the tables above, there was little change in the average and 85th percentile speeds between the before and after data collection periods. The numbers however are statistically significant at the 95% confidence interval but the actual difference is small and not practically significant. The large sample sizes allow for small changes to be detected and declared significant in the statistical tests but the change of one unit in the PACE Speed from the before to the after periods is not enough to affect driver behavior.

The before to after analysis is compared to see if roadway conditions truly affected vehicle speeds. The after period data collection represented a smoother roadway surface and less resistance to the vehicle itself. As previously stated, the average and 85th percentile speeds were not practically different.

Figure 6: Chart of Percentage Exceeding Speed Limit

	Before	During Downstream	During Workzone	During Upstream	After
Speed Limit	70	70	55	65	70
Total Obs	6045	1842	1957	2260	4707
Above Limit	4580	1277	817	1812	3033
% Exceeding	75.77%	69.33%	**41.74%**	80.18%	64.44%

Figure 6 above describes the convincing evidence that speed compliance has been achieved in the workzone compared to the remaining data collection points. By examining these percentages, speed compliance nearly doubled compared to standard free flow conditions on this roadway segment.

Also, observe that the peak on each data collection graph display above occurs when the number of vehicles were traveling between the posted speed limit and plus 10 mph. This corresponds to the 85th percentile measurements that placed motorists traveling between 6 and 8 mph over the posted limits.

Figure 7: During Period Progression Analysis

SB During Progression Analysis

	Upstream	Workzone	Downstream
Speed Limit	65	55	70
Total Obs	1524	1226	1042
Average	69.92	55.11	72.9
85th	73.98	59.31	76.78
% Exceeding	82.61%	43.47%	71.11%

NB During Progression Analysis

	Downstream	Workzone	Upstream
Speed Limit	70	55	65
Total Obs	800	731	736
Average	72.42	53.71	68.73
85th	76.60	58.34	73.03
% Exceeding	66.75%	38.85%	75.00%

The speed progression analysis as shown in figure 7 above demonstrates enhanced workzone speed compliance and a return to consistent driving behavior after the slower driving period. There does not appear to be a pattern of excessive speeding coming out of the workzone to "make up time" that was anticipated going into the data collection period.

FINAL COMMENTS

Workzone speed limit compliance is key in keeping our workzone workers and the traveling public safe. This study shows that the traffic control plan implemented in this workzone was successful in achieving good speed compliance. We feel however, that the use of the Portable Changeable Message Sign posting the 55-mph speed limit does not automatically ensure compliance. This measure along with other commonly used workzone techniques such as squeezing of traffic with barrels, having vehicles use the roadway shoulder as a travel lane, utilizing lead construction vehicles, and forcing drivers to cross rumble strips have yielded the desired result of posted speed limit compliance in the workzone.

APPENDIX

A. Upstream Location – Greensville County, Virginia: VA 639 (Rock Bridge Rd)
B. Study Location – Northampton County, North Carolina: SR 1202 (Blythe Rd)
C. Downstream Location – Halifax County, North Carolina: SR 1001 (Justice Branch Rd)

I-95 CMS Speed Study (Before Period)

County	Northampton	Northampton	Northampton	Northampton	Northampton	Northampton	Northampton	
Direction	I-95 NB	I-95 NB	I-95 NB	I-95 NB	I-95 NB	I-95 NB	I-95 NB	
Date	7/30/2007	8/1/2007	8/1/2007	8/3/2007	8/7/2007	8/9/2007	8/11/2007	
Data Loc.	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202	
Conditions	Overcast / Dry	Clear / Sunny	Clear / Sunny	Clear / Sunny	Clear / Sunny	Clear / Sunny	Overcast / Dry	
Time	1 hr (9:20a)	1 hr (9:00a)	1 hr (12:30p)	1 hr (9:00a)	1 hr (10:00a)	1 hr (10:05a)	1 hr (9:50a)	
Data Set	**1**	**3**	**5**	**7**	**10**	**12**	**14**	**Totals Averaged Northbound**
Total Obs	421	448	487	433	483	400	455	**3127**
Average	73.34	73.17	71.72	73.32	70.69	72.94	73.18	**72.62**
50th Percentile	72.97	72.59	71.56	72.82	70.27	72.71	72.90	**72.26**
85th Percentile	77.22	77.09	76.52	77.74	75.53	77.40	76.75	**76.89**
Stnd Dev	4.68	4.59	5.25	5.30	5.23	4.85	4.23	**4.88**
Variance	21.89	21.08	27.54	28.14	27.36	23.51	17.91	**23.92**

County	Northampton	Northampton	Northampton	Northampton	Northampton	Northampton	Northampton	
Direction	I-95 SB	I-95 SB	I-95 SB	I-95 SB	I-95 SB	I-95 SB	I-95 SB	
Date	7/30/2007	8/1/2007	8/1/2007	8/3/2007	8/7/2007	8/9/2007	8/11/2007	
Data Loc.	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202	
Conditions	Overcast / Dry	Clear / Sunny	Clear / Sunny	Clear / Sunny	Clear / Sunny	Clear / Sunny	Overcast / Dry	
Time	1 hr (10:20a)	1 hr (10:00a)	1 hr (1:40p)	1 hr (10:10a)	1 hr (8:50a)	1 hr (9:00a)	1 hr (8:45a)	
Data Set	**2**	**4**	**6**	**8**	**9**	**11**	**13**	**Totals Averaged Southbound**
Total Obs	362	423	443	438	419	443	390	**2918**
Average	73.29	71.47	72.31	72.98	72.44	72.80	73.13	**72.63**
50th Percentile	72.66	71.49	72.18	72.85	72.04	72.48	72.70	**72.34**
85th Percentile	76.86	75.94	76.71	77.51	77.09	77.40	76.89	**76.91**
Stnd Dev	4.30	5.46	5.31	4.87	5.03	4.96	4.26	**4.88**
Variance	18.49	29.78	28.25	23.76	25.30	24.58	18.12	**24.04**

I-95 NB & SB Before Totals	
Total Obs	6045
Average	72.63
50th Percentile	72.30
85th Percentile	76.90
Stnd Dev	4.88
Variance	23.98

PACE Speed Calc	
Low Pace	**69**
High Pace	**78**
Vehicle %	**70.48**

I-95 CMS Speed Study (During Period - in Workzone)

County	Northampton	Northampton
Direction	I-95 NB	I-95 NB
Date	9/18/2007	9/19/2007
Data Loc.	WZ (MM 177.7)	WZ (MM 177.5)
Conditions	Clear / Dry	Overcast / Dry
Time	2 hr (9:45a)	2 hr (9:45a)
Data Set	5	6
Total Obs	334	397
Average	53.64	53.79
50th Percentile	54.26	53.26
85th Percentile	59.66	57.03
Stnd Dev	9.50	4.11
Variance	90.22	16.88

Totals Averaged Northbound
731
53.71
53.76
58.34
6.80
53.55

County	Northampton	Northampton	Northampton	Northampton
Direction	I-95 SB	I-95 SB	I-95 SB	I-95 SB
Date	8/29/2007	9/10/2007	9/11/2007	9/12/2007
Data Loc.	WZ (MM 179)	WZ (MM 178)	WZ (MM 179)	WZ (MM 179.4)
Conditions	Clear / Sunny	Overcast / Dry	Clear / Dry	Clear / Dry
Time	1 hr (10:40a)	1.5 hr (10:00a)	2 hr (9:40a)	2 hr (9:10a)
Data Set	1	2	3	4
Total Obs	184	223	416	403
Average	56.53	53.00	54.06	56.85
50th Percentile	55.38	52.59	53.20	55.70
85th Percentile	60.93	56.38	58.17	61.73
Stnd Dev	4.36	4.32	4.65	5.05
Variance	18.99	18.65	21.59	25.46

Totals Averaged Southbound
1226
55.11
54.22
59.31
4.59
21.17

I-95 NB & SB Totals Workzone Data	
Total Obs	1957
Average	54.65
50th Percentile	54.07
85th Percentile	58.98
Stnd Dev	5.33
Variance	31.97

PACE Speed Calc	
Low Pace	**50**
High Pace	**59**
Vehicle %	**73.94**

I-95 CMS Speed Study (During Period - Upstream in Virginia)

County	VA - Greensville	VA - Greensville
Direction	I-95 NB	I-95 NB
Date	7/30/2007	8/1/2007
Data Loc.	(VA) SR 639	(VA) SR 639
Conditions	Sunny / Dry	Overcast / Dry
Time	1 hr (2:45p)	1 hr (1:15p)
Data Set	**5**	**6**
Total Obs	389	347
Average	69.52	67.94
50th Percentile	68.87	67.40
85th Percentile	73.84	72.22
Stnd Dev	4.70	5.75
Variance	22.13	33.07

Totals Averaged Northbound
736
68.73
68.13
73.03
5.23
27.60

I-95 NB & SB Totals Upstream	
Total Obs	2260
Average	69.52
50th Percentile	68.96
85th Percentile	73.66
Stnd Dev	4.90
Variance	24.15

County	VA - Greensville	VA - Greensville	VA - Greensville	VA - Greensville
Direction	I-95 SB	I-95 SB	I-95 SB	I-95 SB
Date	8/29/2007	9/10/2007	9/11/2007	9/12/2007
Data Loc.	(VA) SR 639	(VA) SR 639	(VA) SR 639	(VA) SR 639
Conditions	Clear / Sunny	Overcast / Dry	Sunny / Dry	Sunny / Dry
Time	1 hr (1:50p)	1 hr (12:45p)	1 hr (12:45p)	1 hr (12:30p)
Data Set	**1**	**2**	**3**	**4**
Total Obs	374	366	388	396
Average	70.33	70.41	69.51	69.44
50th Percentile	69.71	69.97	68.82	68.97
85th Percentile	74.10	74.59	73.60	73.63
Stnd Dev	4.93	4.82	4.64	4.55
Variance	24.31	23.23	21.49	20.66

Totals Averaged Southbound
1524
69.92
69.37
73.98
4.73
22.42

PACE Speed Calc	
Low Pace	**64**
High Pace	**73**
Vehicle %	**73.01**

I-95 CMS Speed Study (During Period - Downstream)

County	Halifax	Halifax
Direction	I-95 NB	I-95 NB
Date	9/18/2007	9/19/2007
Data Loc.	SR 1001	SR 1001
Conditions	Dry	Overcast / Dry
Time	1 hr (1:00p)	1 hr (3:00p)
Data Set	**4**	**5**
Total Obs	422	378
Average	72.25	72.58
50th Percentile	71.90	72.19
85th Percentile	76.49	76.72
Stnd Dev	5.06	5.35
Variance	25.62	28.66

Totals Averaged Northbound
800
72.42
72.05
76.60
5.21
27.14

County	Halifax	Halifax	Halifax
Direction	I-95 SB	I-95 SB	I-95 SB
Date	9/10/2007	9/11/2007	9/12/2007
Data Loc.	SR 1001	SR 1001	SR 1001
Conditions	Dry	Dry	Dry
Time	1 hr (2:30p)	1 hr (2:40p)	1 hr (2:25p)
Data Set	**1**	**2**	**3**
Total Obs	299	355	388
Average	73.61	72.61	72.47
50th Percentile	73.50	72.54	72.36
85th Percentile	77.53	76.70	76.11
Stnd Dev	5.96	5.14	4.62
Variance	35.51	26.44	21.31

Totals Averaged Southbound
1042
72.90
72.80
76.78
5.24
27.75

I-95 NB & SB Totals Downstream	
Total Obs	1842
Average	72.71
50th Percentile	72.50
85th Percentile	76.71
Stnd Dev	5.23
Variance	27.51

PACE Speed Calc	
Low Pace	**68**
High Pace	**77**
Vehicle %	**71.72**

I-95 CMS Speed Study (After Period)

County	Northampton	Northampton	Northampton	Northampton	Northampton	Northampton
Direction	I-95 NB	I-95 NB	I-95 NB	I-95 NB	I-95 NB	I-95 NB
Date	11/6/2007	11/9/2007	11/10/2007	11/14/2007	11/29/2007	12/3/2007
Data Loc.	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202
Conditions	Cloudy / Dry	Overcast / Dry	Overcast / Damp	Sunny / Dry	Cloudy / Dry	Sunndy / Windy
Time	1 hr (10:30a)	1 hr (9:10a)	1 hr (9:05p)	1 hr (10:15a)	1 hr (10:30a)	1 hr (10:10a)
Data Set	2	3	6	8	10	12
Total Obs	351	422	345	391	418	457
Average	70.85	73.05	71.81	71.29	71.58	72.06
50th Percentile	70.47	72.74	71.55	70.95	71.24	71.48
85th Percentile	75.77	77.03	75.92	75.61	75.49	77.26
Stnd Dev	4.88	4.74	4.85	4.50	4.52	5.14
Variance	23.80	22.45	23.56	20.28	20.45	26.41

Totals Averaged Northbound
2384
61.52
61.20
65.30
4.09
19.57

County	Northampton	Northampton	Northampton	Northampton	Northampton	Northampton
Direction	I-95 SB	I-95 SB	I-95 SB	I-95 SB	I-95 SB	I-95 SB
Date	11/6/2007	11/9/2007	11/10/2007	11/14/2007	11/29/2007	12/3/2007
Data Loc.	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202	SR 1202
Conditions	Cloudy / Dry	Overcast / Dry	Overcast / Damp	Sunny / Dry	Cloudy / Dry	Sunny / Windy
Time	1 hr (9:20a)	1 hr (10:20a)	1 hr (8:35a)	1 hr (9:10a)	1 hr (9:20a)	1 hr (9:00a)
Data Set	1	4	5	7	9	11
Total Obs	366	407	401	364	393	392
Average	71.19	72.79	73.60	72.96	72.23	72.08
50th Percentile	70.97	72.45	73.06	72.54	71.87	71.41
85th Percentile	75.60	77.08	77.79	77.67	76.17	76.61
Stnd Dev	5.03	4.63	5.04	4.97	4.76	4.97
Variance	25.34	21.46	25.37	24.73	22.63	24.74

Totals Averaged Southbound
2323
72.47
72.05
76.82
4.90
24.05

I-95 NB & SB After Totals	
Total Obs	4707
Average	72.12
50th Percentile	71.73
85th Percentile	76.50
Stnd Dev	4.84
Variance	23.44

PACE Speed Calc	
Low Pace	68
High Pace	77
Vehicle %	69.98

Before Period Photos – Data Collection Site
(Same Collection Site as After Period)

I-95 CMS Speed Study Photos (8-29-2007 Data Collection)

CMS Sign (near Exit 4 in Virginia)

CMS indicating Speed Reduction Ahead

Speed Reduction CMS at beginning of Workzone

Second Message on Entrance CMS

Data Collection Location – Free Flow, Full Lane to Travel

Dump Truck led platoons – assisted in regulating speeds

Squeezing of Traffic, Riding on Rubble Strips near WZ Workers

I-95 CMS COMPLETED PROJECT
TREATMENT SITE PHOTOS TAKEN 11/29/2007

Beginning of Resurfacing Project (Traveling NB)

End of Resurfacing Project at Virginia Border (Traveling NB)

Traveling South on I-95 at SR 1202 Bridge

Traveling South on I-95