

**Surf City Speed Bars
Safety Evaluation Speed Study**

Order # 41000003004

**Speed Study of the Speed Reduction Pavement Markings
NC 210 (New River Drive) and
NC 50 (South Topsail Drive / South Shore Drive)
Town of Surf City, Pender 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

11-16-2010
Date

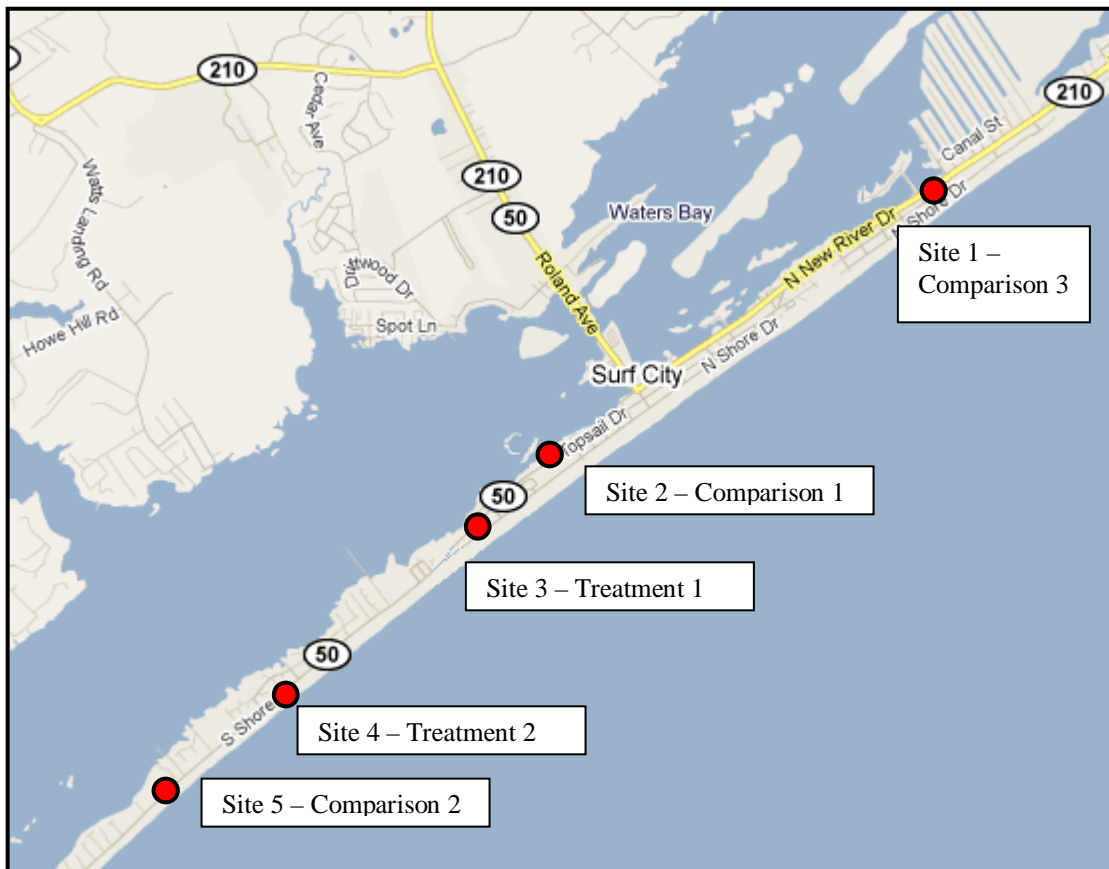
Traffic Safety Project Engineer

Speed Study Evaluation Documentation

Subject Location

Evaluation of Surf City Speed Study located at multiple locations along NC 50 and NC 210 in Pender County, Town of Surf City:

- NCDOT Site 1 (Comparison 3) – NC 210 - New River Drive
Limits: Pender Avenue to Broadway Street (0.29 miles)
- NCDOT Site 2 (Comparison 1) – NC 50 – South Topsail Drive
Limits: Seahorse Avenue to Charlotte Avenue (0.40 miles)
- NCDOT Site 3 (Treatment 1) – NC 50 – South Topsail Drive
Limits: South Shore Drive to Quarterhorse Avenue (0.34 miles)
- NCDOT Site 4 (Treatment 2) – NC 50 – South Shore Drive
Limits: Cutlass Drive to Elizabeth Street (0.33 miles)
- NCDOT Site 5 (Comparison 2) – NC 50 – South Shore Drive
Limits: Bland Drive to Channel Bend Road (0.36 miles)



Project Information and Background

The improvement chosen for these locations were the installation of speed reduction pavement markings. These markings consist of painted lines (approximately 2 feet long) installed horizontally in the travel lane to give the allusion of the lane narrowing. The driver should respond by slowing down their traveling speed. The actual installed countermeasure included painted lines installed at approximately 17 feet spacing with an approach area in each direction (markings starting on white line in single direction) and combining for about 300 feet with markings extending from both white lines on the roadway edge. The pavement markings were installed by the Town of Surf City and completed on April 15, 2010 per email with the Town Manager.

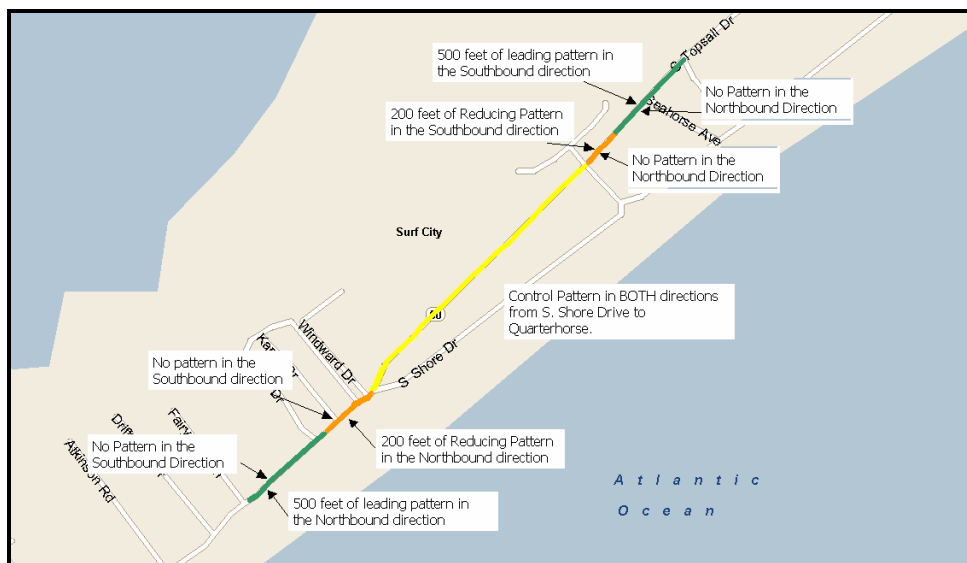
The purpose of the project was stated clearly in the initial work plan:

The Town of Surf City has requested that NCDOT experiment with installing optical speed bumps on state maintained routes where the Town believes there is a speeding problem coupled with the presence of pedestrians crossing these highways. The primary concern is during the summer when there are a lot of tourists in the town both as pedestrians and as motorists. It is believed that the unfamiliarity and the speeding increase the danger to the pedestrians.

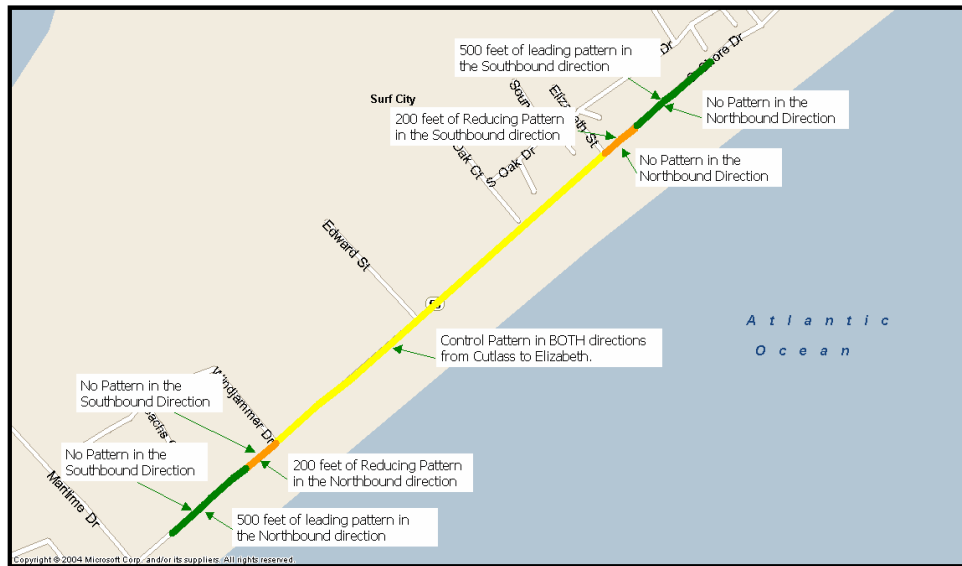
The objectives of this project is two fold; 1) the reduce travel speeds on specific roadways in Surf City and 2) to evaluate the effectiveness of these pavement markings in reducing operating speeds.

The work plan established that the Transportation Mobility and Safety Division would complete the evaluation of the installed countermeasure by collecting before speed data at both treatment and comparison sites and after speed data during the summer months when pedestrian traffic was at the peak.

Please find a copy of the initial design drawing at the end of this report. The following Diagram indicates the implementation plan for Site 3 (Treatment 1):



The following Diagram shows the implementation plan for Site 4 (Treatment 2):



The Before Period Data was collected in April 2009 when this concept was first proposed. The before data collection days were Thursday (0.5 Hour at each site) and Monday, Wednesday, Friday (1 Hour each day at each site).

The Safety Evaluation Group was not alerted to the installation until the end of June 2010. We then proceeded to collect the 3-Month After Data in July 2010. The after data collection days were Monday, Wednesday, and Friday (1 Hour each day at each site).

Also, upon arrival in Surf City, we discovered that the installation was not completed to our initial understanding. We initially designed the speed bars to be painted on the white line and yellow center line of each direction of travel for optimal effectiveness (see example photo below). The following photos demonstrate the actual site implantations at Treatment 1 and 2. Please note the lack of speed bars painted from the yellow center line.



Example Installation Photo

**Removed from Document:
 “Pavement Markings for Speed Reduction
 Final Report” – December 2004”**

Traffic Control Devices Pooled Fund Study

**Prepared by: Bryan J. Katz
 Science Applications International Corp.
 McLean, VA 22101**



**Installed Countermeasure
Site 3 / Treatment 1 (South Topsail Drive)
Combined Area Pavement Markings on Both Sides of Roadway**



**Installed Countermeasure
Site 4 / Treatment 2 – South Shore Drive
Combined Area Pavement Markings on Both Sides of Roadway**



**Photo Showing Mixed Use with Pedestrian Crossing
Site 4 / Treatment 2 – South Shore Drive**

The following tables and graphs represent the collected speed data at these five (5) collection sites during the before, 3-month, and 5-month periods. Data was collected at the 5-month (September 2010) mark to include summer (vacation) vehicular and pedestrian traffic patterns.

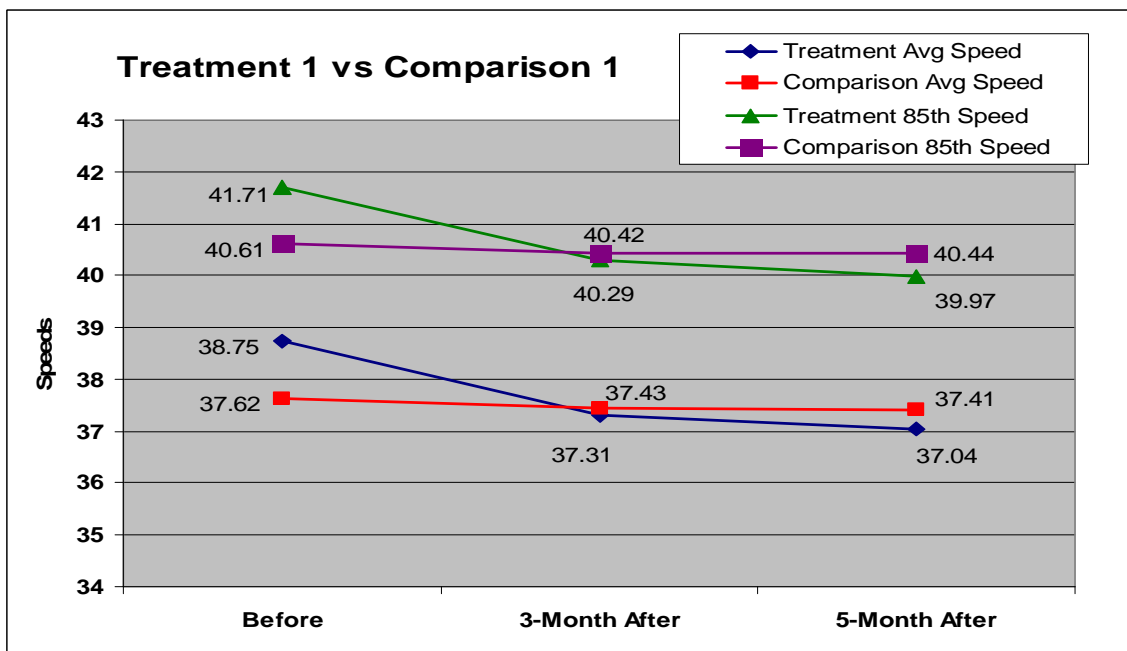
Comparison 3 – NC 210 (New River Drive)

<u>NCDOT Site 1</u> <u>Comparison 3 Information</u> <u>NC 210 – New River Drive</u>	Before	3-Month After	5-Month After
Total Observations	515	759	605
Average Speeds	37.47	36.18	36.54
85th Percentile Speeds	40.39	39.37	39.54
% Vehicles Exceeding Speed Limit			
% Vehicles Exceeding Speed Limit	67.8 %	52.2 %	59.8 %
Pace Speed (10-mph Range)	33 – 42 mph	31 – 40 mph	32 – 41 mph
% Vehicles within Pace Range	83.1 %	84.5 %	84.5 %
Pedestrians Crossing Roadway			
Pedestrians Crossing Roadway	11	111	36
Pedestrians Walking Shoulder			
Pedestrians Walking Shoulder	6	21	0
Bicycle (Lane & Shoulder)			
Bicycle (Lane & Shoulder)	6	18	13

Treatment 1 vs. Comparison 1 – NC 50 (South Topsail Drive) – Side-by-Side

<u>NCDOT Site 3</u> <u>Treatment 1: NC 50 (S. Topsail Dr)</u>	Before	3-Month After	5-Month After
Total Observations	697	750	641
Average Speeds	38.75	37.31	37.04
85th Percentile Speeds	41.71	40.29	39.97
<hr/>			
% Vehicles Exceeding Speed Limit	84.2 %	70.5 %	65.7 %
Pace Speed (10-mph Range)	35 – 44 mph	33 – 42 mph	33 – 42 mph
% Vehicles within Pace Range	86.4 %	86.3 %	84.4 %
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Pedestrians Crossing Roadway	12	28	13
Pedestrians Walking Shoulder	11	14	7
Bicycle (Lane & Shoulder)	2	9	27

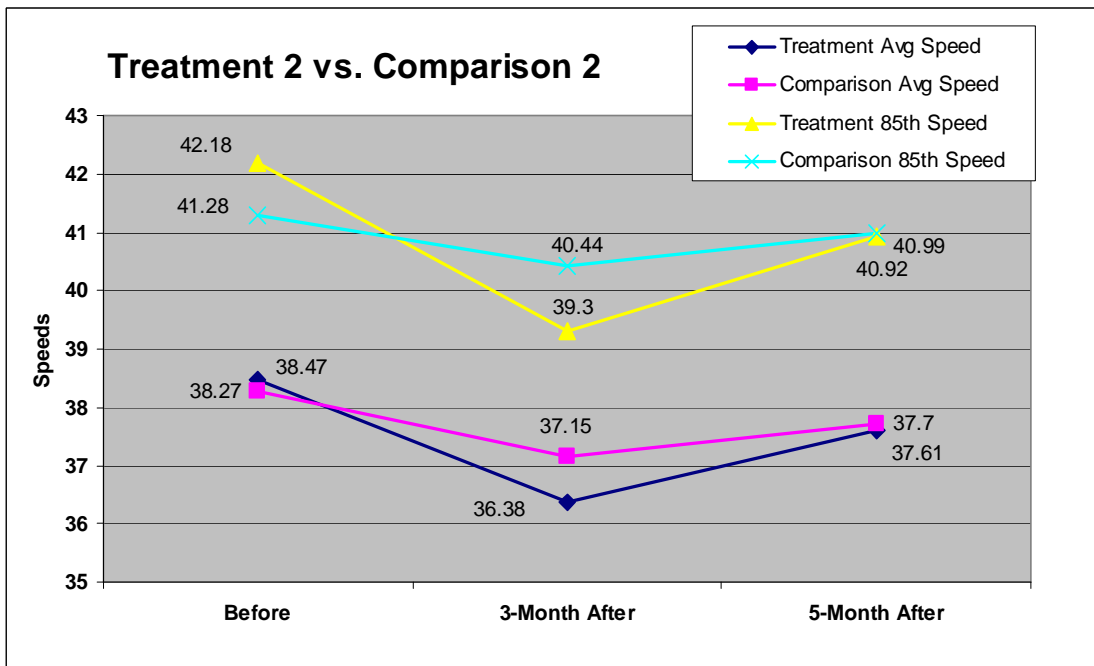
<u>NCDOT Site 2</u> <u>Comparison 1: NC 50 (S. Topsail Dr)</u>	Before	3-Month After	5-Month After
Total Observations	612	874	731
Average Speeds	37.62	37.43	37.41
85th Percentile Speeds	40.61	40.42	40.44
<hr/>			
% Vehicles Exceeding Speed Limit	73.9 %	70.4 %	70.2 %
Pace Speed (10-mph Range)	33 – 42 mph	33 – 42 mph	33 – 42 mph
% Vehicles within Pace Range	87.9 %	84.9 %	86.7 %
<hr/>			
Pedestrians Crossing Roadway	4	11	7
Pedestrians Walking Shoulder	5	11	4
Bicycle (Lane & Shoulder)	3	15	14



Treatment 2 vs. Comparison 2 – NC 50 (South Shore Drive) – Side-by-Side

<u>NCDOT Site 4</u> <u>Treatment 2: NC 50 (S. Shore Dr)</u>	Before	3-Month After	5-Month After
Total Observations	598	812	557
Average Speeds	38.47	36.38	37.61
85th Percentile Speeds	42.18	39.30	40.92
% Vehicles Exceeding Speed Limit	79.1 %	61.7 %	71.5 %
Pace Speed (10-mph Range)	35 – 44 mph	32 – 41 mph	33 – 42 mph
% Vehicles within Pace Range	79.6 %	85.0 %	82.4 %
Pedestrians Crossing Roadway	13	61	63
Pedestrians Walking Shoulder	7	27	8
Bicycle (Lane & Shoulder)	4	38	15

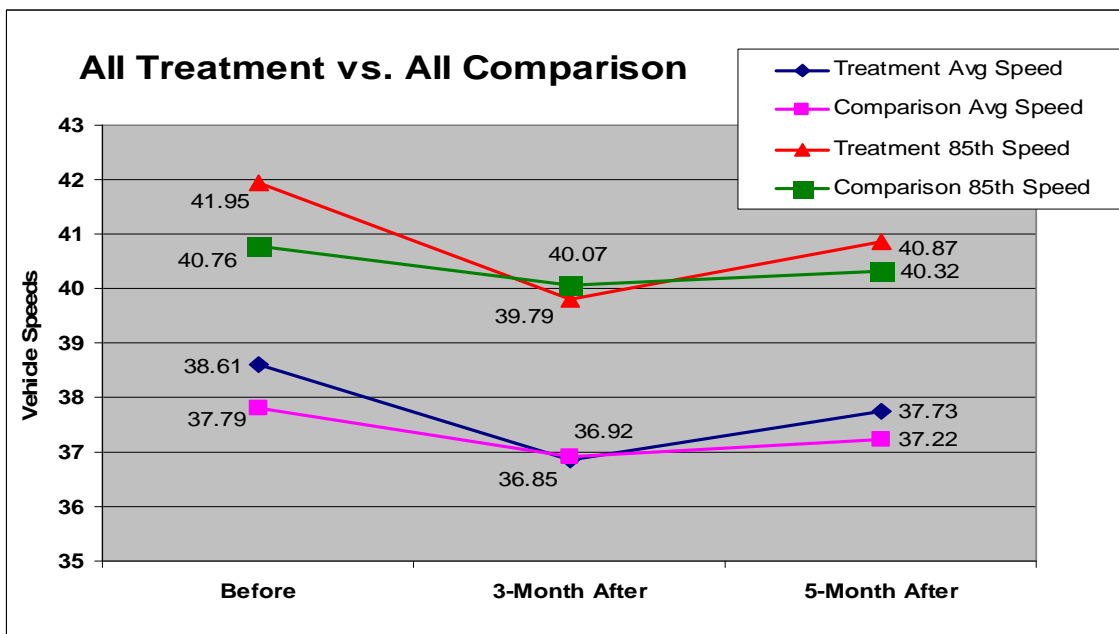
<u>NCDOT Site 5</u> <u>Comparison 2: NC 50 (S. Shore Dr)</u>	Before	3-Month After	5-Month After
Total Observations	502	689	478
Average Speeds	38.27	37.15	37.70
85th Percentile Speeds	41.28	40.44	40.99
% Vehicles Exceeding Speed Limit	75.7 %	66.3 %	74.3 %
Pace Speed (10-mph Range)	34 – 43 mph	33 – 42 mph	33 – 42 mph
% Vehicles within Pace Range	85.5 %	81.7 %	81.4 %
Pedestrians Crossing Roadway	23	51	20
Pedestrians Walking Shoulder	14	29	8
Bicycle (Lane & Shoulder)	4	25	29

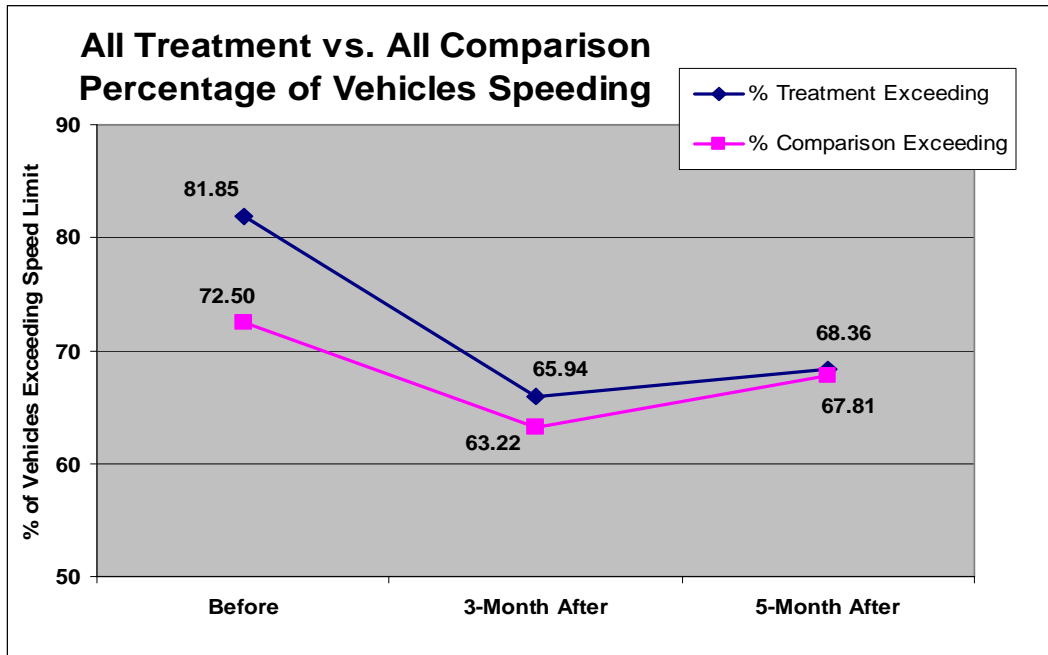


All Treatment vs. All Comparison Sites Combined – Surf City

<u>All Treatment Locations</u> <u>NCDOT Sites 3 & 4</u>	Before	3-Month After	5-Month After
Total Observations	1295	1562	1198
Average Speeds	38.61	36.85	37.32
85th Percentile Speeds	41.95	39.79	40.45
% Vehicles Exceeding Speed Limit	81.9 %	65.9 %	68.4 %
Pace Speed (10-mph Range)	34 – 43 mph	32 – 41 mph	33 – 42 mph
% Vehicles within Pace Range	83.7 %	85.0 %	83.5 %
Pedestrians Crossing Roadway	25	89	76
Pedestrians Walking Shoulder	18	41	15
Bicycle (Lane & Shoulder)	6	47	42

<u>All Comparison Locations</u> <u>NCDOT Sites 1, 2, & 5</u>	Before	3-Month After	5-Month After
Total Observations	1629	2322	1814
Average Speeds	37.79	36.92	37.22
85th Percentile Speeds	40.76	40.07	40.32
% Vehicles Exceeding Speed Limit	72.5 %	63.2 %	67.8 %
Pace Speed (10-mph Range)	33 – 42 mph	32 – 41 mph	33 – 42 mph
% Vehicles within Pace Range	85.3 %	83.4 %	84.5 %
Pedestrians Crossing Roadway	38	173	63
Pedestrians Walking Shoulder	25	61	12
Bicycle (Lane & Shoulder)	13	58	56





Results and Discussion

From the tables and graphs above, the speed bars did appear to have a speed reduction affect on these roadways during the first 3-month evaluation. Since the before period was collected in April 2009 and the after data collected during July 2010, there were many factors to consider. We see in the “All Treatment vs. All Comparison Sites Combined” data that pedestrian crossing usage increased by more than 250 percent at each location and bicycle usage increased by more than 600 percent at the treatment locations. We also observed an increase in parked vehicles at driveways to properties within the analysis area. The increase in parked vehicles, pedestrians, and bicycles along the segments do affect driver behavior and may account for the greatest impact on speed reduction at the treatment locations.

However, at the 5-month evaluation mark the “All Treatment vs. All Comparison” speeds actually reversed. From the previous charts, Treatment Site 1 did continue to experience a slight reduction in both average and 85th percentile speeds by approximately 0.3 mph. Although, Treatment Site 2 experienced a reverse of its speed reduction from the 3-month period with almost identical data compared to the Comparison 2 site alone at the 5-month period.

Additional analysis of the percentage of vehicles exceeding the speed limit graph shows a 15 percent reduction in the number of motorists traveling over the 35-mph posted speed limit at the treatment locations with only a 10 percent reduction at the comparison locations for the 3-month mark. However, there was a slight increase at all locations to a consistent value of 68 percent of vehicles exceeding the speed limit when the 5-month after evaluation was completed.

The Pace Speed analysis, grouping of 10-mph range of highest vehicle speed concentration, experienced the greatest reduction from the before period to the 3-month after period within the treatment locations by two (2) miles per hour. This reduction in speed condensed the pace speed

down to the same range (33 – 42 mph) as the comparison locations for the 5-month evaluation period.

With all items in consideration, the speeds were reduced at a higher percent (nearly doubled) at the treatment locations at the 3-month evaluation mark. In fact, the Treatment 1 location experienced a reduction of slightly more than 3 percent while its connected comparison site only saw at 0.5 percent reduction in average and 85th percentile speeds.

As stated in the project background section, the speed reduction pavement markings were NOT installed in accordance to the initial design drawings. The Safety Evaluation Group feels that the speed evaluation would be more accurate and of higher scientific validity had this been the case. We will continue to monitor other locations where this countermeasure is installed and functioning properly.

APPENDIX

- A. Surf City Speed Evaluation Work Plan (created by Kevin Lacy)
- B. NCDOT Standard Design Drawing for Speed Reduction Bars
- C. NCDOT Site 1 (Comparison 3) Speed Data – Before, 3-Month, 5-Month
- D. NCDOT Site 2 (Comparison 1) Speed Data – Before, 3-Month, 5-Month
- E. NCDOT Site 3 (Treatment 1) Speed Data – Before, 3-Month, 5-Month
- F. NCDOT Site 4 (Treatment 2) Speed Data – Before, 3-Month, 5-Month
- G. NCDOT Site 5 (Comparison 2) Speed Data – Before, 3-Month, 5-Month

APPENDIX A

**Surf City Speed Evaluation Work Plan
(Created by Kevin Lacy)**

Speed Management Pavement Markings in Surf City Pilot Project

I. Background

The Town of Surf City has requested that NCDOT experiment with installing optical speed bumps on state maintained routes where the Town believes there is a speeding problem coupled with the presence of pedestrians crossing these highways. The primary concern is during the summer when there are a lot of tourists in the town both as pedestrians and as motorist. It is believed that the unfamiliarity and the speeding increase the danger to the pedestrians.

The Department of Transportation reviewed the Manual on Uniform Traffic Control Devices (MUTCD) to investigate if the manual allowed the use of optical speed bumps. While this technique has been tried in other countries, the MUTCD does not currently permit the use of such a pavement marking. In addition, there are concerns that the motorist would quickly learn that the pavement marking were not actual speed bumps and become ineffective in managing the speeds of motorist.

The Department identified another option that has been evaluated in several other states. This option requires using a series of pavement marking approximately 1.5 feet long placed perpendicular to the travel lane on both the center and right edge of the pavement. This treatment has demonstrated to reduce the travel speeds on roadways in three other states where the treatment has been tested.

II. Objectives of Project

The objectives of this project is two fold; 1) the reduce travel speeds on specific roadways in Surf City and 2) to evaluate the effectiveness of these pavement markings in reducing operating speeds.

III. Time Frame

The goal will be to have the pavement marking installed prior to the summer season. This will allow the evaluation of the pavement markings on motorist. Ideally the treatment sites and control sites will be identified by the end of March. Speed studies will be conducted at all sites prior to installation of the pavement markings. Speed studies will be collected on a minimum of two different days. The pavement marking should be installed no later than mid-May. Speed studies will be conducted during several occasions during the summer.

IV. Cost and Funding

The cost to implement the pavement markings is approximately \$2,000 per mile. Expect that the two spots that are treated will be roughly 2 miles total or less (total ~\$4,000). This includes materials and labor for installation. The cost of the evaluation will be roughly \$15,000. This will include the data collection before installation at the treated sites as well as two control sites, data collection after installation on two separate times, data analysis and a final report.

The Transportation Mobility and Safety Division can complete the evaluation of the pavement markings. Ideally the Town would either install the markings or pay for their installation, and any maintenance that may be needed.

Tasks

I. Identify Locations

- A. Identify two treatment sites – The Town has suggested two sites, however, these sites need to be narrowed down to specific beginning and ending points. It would be best to identify four to six locations where there is a concern. Two of these sites will have the pavement markings installed. This item should be completed no later than the end of February.
- B. Identify two control sites – Two if the potential sites identified above would serve as the control sites. Control sites are used to validate that any changes, positive or negative, are attributed to the pavement markings and not wide spread or sundry issues. This item should be completed no later than the end of February.
- C. Initiate an encroachment request. The Town will need to submit a written request to the Department to install or have installed the pavement markings. This item should start after Items I-A and I-B are completed and should be finalized prior to installation.

II. Develop Specifications and Installation

- A. The Transportation Mobility and Safety Division (TMSD) will develop the necessary specifications for the experimental pavement markings. This will be completed by the end of March.
- B. Installation of Markings – It is recommended that these pavement markings use paint rather than thermoplastic. The reason for paint, is that it cost less and presents a lower risk in case the pilot project does not have the desired outcome.

III. Data Collection and Analysis

- A. Before Installation -- Travel speeds will be measured on two different days at each of the sites, two treated and two control sites. The TMSD will coordinate this activity with the Division 3 Office and the Town of Surf City. This item should be completed by mid April. It must be completed prior to installation.
- B. After Installation – Travel speeds will be collected at all locations at a minimum of two different days. The ideal conditions will be when drivers have the opportunity to select their speeds. Therefore, it will be necessary to avoid days and times in which traffic is so heavy that it is operating as stop and go. One collection date will be in June and another in August. It

may be desirable to collect additional data; however, this will be determined base upon the findings of the study.

- C. The TMSD will complete the data analyses comparing the before and after data collected for treated sites and control sites.

IV. Reports

- A. An Interim Report will be completed in May to provide information about the status of the project. The TMSD will complete and distribute the report.
- B. The TMSD will complete a draft report with the findings and distribute the draft report to the Division 3 office and well as the Town of Surf City. This will be completed after all the data have been collected and analyzed. It is expected that the draft report will be completed by the end of September 2009.
- C. A final report with findings and recommendations will be completed after comments on the draft report have been received.
- D. A presentation of the findings and recommendations will be prepared and presented if requested.

V. Final Actions

- A. Based upon the findings of the study, the Department and Town will discuss the continuation of the project. Primarily the decision will be continuing the evaluation or not. Continuing will require additional data collection and maintenance of the pavement markings.

Task	Month	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Task 1 Identify Locations												
Task 2 Develop Specifications and Install												
Task 3 Data Collection and Analyze												
Task 4 Reports												
Task 5 Final Actions												

Cost Estimates:

Pavement Marking Material and Installation:	\$4,000
Evaluation	\$15,000
 Total	 \$19,000

APPENDIX B

**NCDOT Standard Design Drawing for
Speed Reduction Bars**

APPENDIX C

**NCDOT Site 1 (Comparison 3) Speed Data
Before, 3-Month, 5-Month**

NCDOT Site 1 (Before Period) - Comparison 3

City	Surf City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound	Northbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	New River Dr	New River Dr	New River Dr	New River Dr
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (10:25a)	1.0 hr (9:15a)	0.5 hr (1:55p)	0.5 hr (1:40p)
Data Set	1	3	5	7
Total Obs	37	107	57	47
Average	38.24	37.45	38.35	37.57
50th Percentile	37.50	36.75	37.21	37.30
85th Percentile	41.61	39.90	40.58	40.95
Stnd Dev	3.46	3.29	3.34	3.90
Variance	11.97	10.80	11.16	15.21

Totals Averaged Northbound
248
37.90
37.19
40.76
3.50
12.28

% Vehicles Exceeding Speed Limit	
Vehicle %	67.76

City	Surf City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound	Southbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	New River Dr	New River Dr	New River Dr	New River Dr
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (10:25a)	1.0 hr (9:15a)	0.5 hr (1:55p)	0.5 hr (1:40p)
Data Set	2	4	6	8
Total Obs	38	120	54	55
Average	38.79	36.48	36.46	36.38
50th Percentile	37.75	35.83	35.33	35.75
85th Percentile	41.15	40.33	39.63	38.95
Stnd Dev	3.88	4.14	3.37	3.27
Variance	15.04	17.13	11.39	10.68

Totals Averaged Southbound
267
37.03
36.17
40.02
3.66
13.56

NB & SB Before Totals	
Total Obs	515
Average	37.47
50th Percentile	36.68
85th Percentile	40.39
Stnd Dev	3.58
Variance	12.92

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	83.12

NCDOT Site 1 (3-Month After Period) - Comparison 3

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	New River Dr	New River Dr	New River Dr
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (1:40p)	1 hr (8:05a)	1 hr (12:15p)
Data Set	1	3	5
Total Obs	131	86	131
Average	36.44	38.47	36.34
50th Percentile	35.94	37.38	35.63
85th Percentile	39.45	41.82	39.41
Stnd Dev	3.68	3.92	3.37
Variance	13.57	15.36	11.38

Totals Averaged Northbound
348
37.08
36.31
40.23
3.66
13.44

% Vehicles Exceeding Speed Limit	
Vehicle %	52.17

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	New River Dr	New River Dr	New River Dr
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (1:40p)	1 hr (8:05a)	1 hr (12:15p)
Data Set	2	4	6
Total Obs	144	112	155
Average	34.81	36.13	34.88
50th Percentile	34.17	35.30	34.46
85th Percentile	38.30	39.46	37.78
Stnd Dev	3.70	3.56	3.29
Variance	13.72	12.65	10.82

Totals Averaged Southbound
411
35.27
34.64
38.51
3.52
12.40

NB & SB 3-Month Totals	
Total Obs	759
Average	36.18
50th Percentile	35.48
85th Percentile	39.37
Stnd Dev	3.59
Variance	12.92

PACE Speed Calc	
Low Pace	31
High Pace	40
Vehicle %	84.45

NCDOT Site 1 (5-Month After Period) - Comparison 3

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	New River Dr	New River Dr	New River Dr
Conditions	Cloudy / Dry	Sunny / Hot	Sunny / Dry
Time	1 hr (8:10a)	1 hr (1:15p)	1 hr (10:20a)
Data Set	1	3	5
Total Obs	70	108	118
Average	37.16	37.36	36.81
50th Percentile	35.92	36.38	36.22
85th Percentile	39.56	40.56	39.90
Stnd Dev	3.44	3.53	3.75
Variance	11.82	12.49	14.07

Totals Averaged Northbound
296
37.11
36.17
40.01
3.57
12.79

% Vehicles Exceeding Speed Limit	
Vehicle %	59.83

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	New River Dr	New River Dr	New River Dr
Conditions	Cloudy / Dry	Sunny / Hot	Sunny / Dry
Time	1 hr (8:10a)	1 hr (1:15p)	1 hr (10:20a)
Data Set	2	4	6
Total Obs	87	105	117
Average	36.07	35.90	35.94
50th Percentile	35.93	35.04	35.55
85th Percentile	39.79	38.88	38.58
Stnd Dev	3.72	3.75	3.09
Variance	13.81	14.05	9.54

Totals Averaged Southbound
309
35.97
35.51
39.08
3.52
12.47

NB & SB 5-Month Totals	
Total Obs	605
Average	36.54
50th Percentile	35.84
85th Percentile	39.54
Stnd Dev	3.55
Variance	12.63

PACE Speed Calc	
Low Pace	32
High Pace	41
Vehicle %	84.46

APPENDIX D

**NCDOT Site 2 (Comparison 1) Speed Data
Before, 3-Month, 5-Month**

NCDOT Site 2 (Before Period) - Comparison 1

City	Surf City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound	Northbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	South Topsoil	South Topsoil	South Topsoil	South Topsoil
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (11:10a)	1.0 hr (10:25a)	Cop Pressence	1.0 hr (12:35p)
Data Set	1	3	5	7
Total Obs	46	109	N/A	98
Average	37.39	37.89	N/A	37.21
50th Percentile	36.57	37.04	N/A	37.00
85th Percentile	41.03	40.71	N/A	40.04
Stnd Dev	3.49	3.17	N/A	3.20
Variance	12.15	10.04	N/A	10.25

Totals Averaged Northbound
253
37.50
36.87
40.59
3.29
10.82

% Vehicles Exceeding Speed Limit	
Vehicle %	73.86

City	Surf City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound	Southbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	South Topsoil	South Topsoil	South Topsoil	South Topsoil
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (11:10a)	1.0 hr (10:25a)	1.0 hr (12:50p)	1.0 hr (12:35p)
Data Set	2	4	6	8
Total Obs	48	107	102	102
Average	37.90	37.87	38.08	37.01
50th Percentile	37.75	37.41	37.23	36.78
85th Percentile	40.13	41.28	40.63	40.46
Stnd Dev	2.80	3.41	2.99	4.04
Variance	7.84	11.64	8.92	16.33

Totals Averaged Southbound
359
37.71
37.29
40.63
3.31
11.18

NB & SB Before Totals	
Total Obs	612
Average	37.62
50th Percentile	37.11
85th Percentile	40.61
Stnd Dev	3.30
Variance	11.03

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	87.91

NCDOT Site 2 (3-Month After Period) - Comparison 1

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	South Topsoil	South Topsoil	South Topsoil
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (10:40a)	1 hr (12:35p)	1 hr (8:05a)
Data Set	1	3	5
Total Obs	137	177	131
Average	37.19	36.59	38.08
50th Percentile	36.69	35.97	37.32
85th Percentile	39.88	39.35	41.04
Stnd Dev	3.14	3.22	3.57
Variance	9.86	10.36	12.73

Totals Averaged Northbound
445
37.28
36.66
40.09
3.31
10.98

% Vehicles Exceeding Speed Limit	
Vehicle %	70.37

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	South Topsoil	South Topsoil	South Topsoil
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (10:40a)	1 hr (12:35p)	1 hr (8:05a)
Data Set	2	4	6
Total Obs	160	159	110
Average	37.98	36.94	37.80
50th Percentile	37.61	36.23	37.00
85th Percentile	40.90	40.52	40.81
Stnd Dev	3.61	3.94	3.85
Variance	13.05	15.53	14.82

Totals Averaged Southbound
429
37.57
36.95
40.74
3.80
14.47

NB & SB 3-Month Totals	
Total Obs	874
Average	37.43
50th Percentile	36.80
85th Percentile	40.42
Stnd Dev	3.55
Variance	12.73

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	84.90

NCDOT Site 2 (5-Month After Period) - Comparison 1

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	South Topsoil	South Topsoil	South Topsoil
Conditions	Sunny / Dry	Sunny / Hot	Sunny / Dry
Time	1 hr (9:15a)	1 hr (12:05p)	1 hr (1:20p)
Data Set	1	3	5
Total Obs	132	105	113
Average	36.91	36.46	37.58
50th Percentile	36.53	35.50	36.86
85th Percentile	39.35	39.16	40.58
Stnd Dev	3.03	3.05	3.37
Variance	9.15	9.33	11.35

Totals Averaged Northbound
350
36.98
36.30
39.69
3.15
9.94

% Vehicles Exceeding Speed Limit	
Vehicle %	70.18

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	South Topsoil	South Topsoil	South Topsoil
Conditions	Sunny / Dry	Sunny / Hot	Sunny / Dry
Time	1 hr (9:15a)	1 hr (12:05p)	1 hr (1:20p)
Data Set	2	4	6
Total Obs	106	146	129
Average	37.85	38.34	37.35
50th Percentile	36.94	37.58	36.69
85th Percentile	41.01	42.01	40.51
Stnd Dev	3.59	3.78	3.49
Variance	12.91	14.28	12.18

Totals Averaged Southbound
381
37.85
37.07
41.18
3.62
13.12

NB & SB 5-Month Totals	
Total Obs	731
Average	37.41
50th Percentile	36.68
85th Percentile	40.44
Stnd Dev	3.39
Variance	11.53

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	86.73

APPENDIX E

**NCDOT Site 3 (Treatment 1) Speed Data
Before, 3-Month, 5-Month**

NCDOT Site 3 (Before Period) - Treatment 1

City	Surf City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound	Northbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	South Topsoil	South Topsoil	South Topsoil	South Topsoil
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (11:45a)	1.0 hr (12:05p)	1.0 hr (10:55a)	1.0 hr (11:00a)
Data Set	1	3	5	7
Total Obs	54	104	111	101
Average	38.94	38.00	39.02	38.74
50th Percentile	38.17	37.47	38.05	38.05
85th Percentile	41.73	40.40	42.54	41.84
Stnd Dev	3.35	3.20	3.47	3.15
Variance	11.22	10.25	12.07	9.91

Totals Averaged Northbound
370
38.68
37.93
41.63
3.29
10.87

% Vehicles Exceeding Speed Limit	
Vehicle %	84.22

City	Surf City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound	Southbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	South Topsoil	South Topsoil	South Topsoil	South Topsoil
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (11:45a)	1.0 hr (12:05p)	1.0 hr (10:55a)	1.0 hr (11:00a)
Data Set	2	4	6	8
Total Obs	46	99	90	92
Average	38.61	39.01	39.13	38.55
50th Percentile	37.60	38.45	37.94	37.89
85th Percentile	41.70	41.68	42.50	41.28
Stnd Dev	3.88	3.45	3.59	3.25
Variance	15.09	11.89	12.86	10.56

Totals Averaged Southbound
327
38.83
37.97
41.79
3.54
12.60

NB & SB Before Totals	
Total Obs	697
Average	38.75
50th Percentile	37.95
85th Percentile	41.71
Stnd Dev	3.42
Variance	11.73

PACE Speed Calc	
Low Pace	35
High Pace	44
Vehicle %	86.37

NCDOT Site 3 (3 Month After Period) - Treatment 1

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	South Topsoil	South Topsoil	South Topsoil
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (12:35p)	1 hr (9:15a)	1 hr (9:10a)
Data Set	1	3	5
Total Obs	138	119	142
Average	37.25	37.25	37.94
50th Percentile	36.38	36.54	37.20
85th Percentile	39.72	40.45	41.15
Stnd Dev	3.00	3.21	3.53
Variance	9.02	10.27	12.47

Totals Averaged Northbound
399
37.48
36.71
40.44
3.25
10.59

% Vehicles Exceeding Speed Limit	
Vehicle %	70.53

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	South Topsoil	South Topsoil	South Topsoil
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (12:35p)	1 hr (9:15a)	1 hr (9:10a)
Data Set	2	4	6
Total Obs	144	83	124
Average	36.74	37.71	36.98
50th Percentile	36.41	37.06	36.08
85th Percentile	39.87	40.64	39.91
Stnd Dev	3.68	3.59	3.45
Variance	13.51	12.92	11.93

Totals Averaged Southbound
351
37.14
36.52
40.14
3.57
12.78

NB & SB 3-Month Totals	
Total Obs	750
Average	37.31
50th Percentile	36.61
85th Percentile	40.29
Stnd Dev	3.41
Variance	11.69

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	86.27

NCDOT Site 3 (5-Month After Period) - Treatment 1

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	South Topsoil	South Topsoil	South Topsoil
Conditions	Sunny / Dry	Sunny / Dry	Sunny / Dry
Time	1 hr (10:20a)	1 hr (10:15a)	1 hr (7:55a)
Data Set	1	3	5
Total Obs	120	121	113
Average	36.13	36.24	37.09
50th Percentile	35.76	35.39	36.36
85th Percentile	38.50	39.31	40.51
Std Dev	3.02	3.27	3.51
Variance	9.12	10.70	12.30

Totals Averaged Northbound
354
36.49
35.84
39.44
3.27
10.71

% Vehicles Exceeding Speed Limit	
Vehicle %	65.68

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	South Topsoil	South Topsoil	South Topsoil
Conditions	Sunny / Dry	Sunny / Dry	Sunny / Dry
Time	1 hr (10:20a)	1 hr (10:15a)	1 hr (7:55a)
Data Set	2	4	6
Total Obs	111	97	79
Average	37.96	37.09	37.70
50th Percentile	36.95	36.83	36.72
85th Percentile	41.39	39.93	40.19
Std Dev	4.26	3.95	3.28
Variance	18.16	15.59	10.78

Totals Averaged Southbound
287
37.58
36.84
40.50
3.83
14.84

NB & SB 5-Month Totals	
Total Obs	641
Average	37.04
50th Percentile	36.34
85th Percentile	39.97
Std Dev	3.55
Variance	12.77

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	84.40

APPENDIX F

**NCDOT Site 4 (Treatment 2) Speed Data
Before, 3-Month, 5-Month**

NCDOT Site 4 (Before Period) - Treatment 2

City	Surf City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound	Northbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	South Shore	South Shore	South Shore	South Shore
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (1:30p)	1.0 hr (1:10p)	1.0 hr (9:40a)	1.0 hr (9:45a)
Data Set	1	3	5	7
Total Obs	52	90	87	63
Average	37.96	39.26	38.78	39.27
50th Percentile	37.57	38.50	38.50	38.75
85th Percentile	42.60	42.63	41.99	42.85
Std Dev	4.80	4.18	4.06	4.70
Variance	23.02	17.50	16.48	22.10

Totals Averaged Northbound
292
38.82
38.33
42.52
4.44
19.77

% Vehicles Exceeding Speed Limit	
Vehicle %	79.10

City	Surf City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound	Southbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	South Shore	South Shore	South Shore	South Shore
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (1:30p)	1.0 hr (1:10p)	1.0 hr (9:40a)	1.0 hr (9:45a)
Data Set	2	4	6	8
Total Obs	44	107	69	86
Average	37.41	38.62	38.01	38.44
50th Percentile	36.50	37.75	37.90	36.87
85th Percentile	41.47	41.49	42.22	42.22
Std Dev	3.85	3.34	4.55	4.07
Variance	14.85	11.16	20.72	16.56

Totals Averaged Southbound
306
38.12
37.25
41.85
3.95
15.82

NB & SB Before Totals	
Total Obs	598
Average	38.47
50th Percentile	37.79
85th Percentile	42.18
Std Dev	4.19
Variance	17.80

PACE Speed Calc	
Low Pace	35
High Pace	44
Vehicle %	79.60

NCDOT Site 4 (3-Month After Period) - Treatment 2

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	South Shore	South Shore	South Shore
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (9:30a)	1 hr (10:50a)	1 hr (1:30p)
Data Set	1	3	5
Total Obs	153	165	127
Average	37.10	36.18	37.31
50th Percentile	36.10	35.96	36.71
85th Percentile	40.29	39.14	40.14
Std Dev	3.77	3.84	3.34
Variance	14.19	14.72	11.17

Totals Averaged Northbound
445
36.86
36.26
39.86
3.65
13.36

% Vehicles Exceeding Speed Limit	
Vehicle %	61.70

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	South Shore	South Shore	South Shore
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (9:30a)	1 hr (10:50a)	1 hr (1:30p)
Data Set	2	4	6
Total Obs	111	112	144
Average	35.86	35.63	36.22
50th Percentile	35.43	34.75	35.86
85th Percentile	38.48	38.95	38.80
Std Dev	3.62	3.45	3.39
Variance	13.14	11.87	11.48

Totals Averaged Southbound
367
35.90
35.35
38.74
3.49
12.16

NB & SB 3-Month Totals	
Total Obs	812
Average	36.38
50th Percentile	35.80
85th Percentile	39.30
Std Dev	3.57
Variance	12.76

PACE Speed Calc	
Low Pace	32
High Pace	41
Vehicle %	84.98

NCDOT Site 4 (5-Month After Period) - Treatment 2

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	South Shore	South Shore	South Shore
Conditions	Sunny / Dry	Sunny / Dry	Sunny / Dry
Time	1 hr (12:10p)	1 hr (9:00a)	1 hr (12:15p)
Data Set	1	3	5
Total Obs	77	93	102
Average	37.61	37.76	38.52
50th Percentile	36.50	37.54	37.62
85th Percentile	41.78	41.01	41.78
Stnd Dev	4.37	3.92	3.82
Variance	19.11	15.40	14.63

Totals Averaged Northbound
272
37.96
37.22
41.52
4.04
16.38

% Vehicles Exceeding Speed Limit	
Vehicle %	71.45

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	South Shore	South Shore	South Shore
Conditions	Sunny / Dry	Sunny / Dry	Sunny / Dry
Time	1 hr (12:10p)	1 hr (9:00a)	1 hr (12:15p)
Data Set	2	4	6
Total Obs	90	85	110
Average	37.32	37.07	37.35
50th Percentile	36.42	36.36	36.33
85th Percentile	40.88	39.36	40.70
Stnd Dev	3.66	3.39	3.70
Variance	13.41	11.49	13.72

Totals Averaged Southbound
285
37.25
36.37
40.31
3.59
12.87

NB & SB 5-Month Totals	
Total Obs	557
Average	37.61
50th Percentile	36.79
85th Percentile	40.92
Stnd Dev	3.81
Variance	14.63

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	82.41

APPENDIX G

**NCDOT Site 5 (Comparison 2) Speed Data
Before, 3-Month, 5-Month**

NCDOT Site 5 (Before Period) - Comparison 2

City	Surf City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound	Northbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	South Shore	South Shore	South Shore	South Shore
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (2:05p)	1.0 hr (2:15p)	1.0 hr (8:35a)	1.0 hr (8:40a)
Data Set	1	3	5	7
Total Obs	37	89	76	67
Average	37.54	36.75	37.87	38.03
50th Percentile	36.58	36.05	37.50	37.36
85th Percentile	41.23	40.13	41.70	41.59
Stnd Dev	3.08	3.80	4.14	4.31
Variance	9.48	14.42	17.16	18.57

Totals Averaged Northbound
269
37.55
36.87
41.16
3.83
14.91

% Vehicles Exceeding Speed Limit	
Vehicle %	75.70

City	Surf City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound	Southbound
Date	4/16/2009	4/24/2009	4/27/2009	4/29/2009
Data Loc.	South Shore	South Shore	South Shore	South Shore
Conditions	Clear / Sunny	Clear / Sunny	Clear / Sunny	Cloudy / Sunny
Time	0.5 hr (2:05p)	1.0 hr (2:15p)	1.0 hr (8:35a)	1.0 hr (8:40a)
Data Set	2	4	6	8
Total Obs	36	85	59	53
Average	39.42	39.93	37.73	38.92
50th Percentile	39.33	39.32	37.23	38.69
85th Percentile	41.87	42.42	40.29	41.01
Stnd Dev	3.64	3.98	2.86	3.14
Variance	13.22	15.80	8.17	9.84

Totals Averaged Southbound
233
39.00
38.64
41.40
3.40
11.76

NB & SB Before Totals	
Total Obs	502
Average	38.27
50th Percentile	37.76
85th Percentile	41.28
Stnd Dev	3.62
Variance	13.33

PACE Speed Calc	
Low Pace	34
High Pace	43
Vehicle %	85.46

NCDOT Site 5 (3-Month After Period) - Comparison 2

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	South Shore	South Shore	South Shore
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (8:10a)	1 hr (1:40p)	1 hr (10:20a)
Data Set	1	3	5
Total Obs	128	137	135
Average	37.27	37.26	36.85
50th Percentile	36.38	36.56	36.18
85th Percentile	40.35	41.05	40.29
Std Dev	4.06	3.73	3.95
Variance	16.50	13.93	15.57

Totals Averaged Northbound
400
37.13
36.38
40.56
3.91
15.33

% Vehicles Exceeding Speed Limit	
Vehicle %	66.33

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	7/12/2010	7/14/2010	7/16/2010
Data Loc.	South Shore	South Shore	South Shore
Conditions	Sunny / Hot	Cloudy / Dry	Sunny / Dry
Time	1 hr (8:10a)	1 hr (1:40p)	1 hr (10:20a)
Data Set	2	4	6
Total Obs	70	121	98
Average	36.79	37.57	37.14
50th Percentile	36.20	36.89	36.54
85th Percentile	40.10	40.76	40.08
Std Dev	4.07	3.98	3.27
Variance	16.61	15.83	10.72

Totals Averaged Southbound
289
37.17
36.54
40.31
3.78
14.39

NB & SB 3-Month Totals	
Total Obs	689
Average	37.15
50th Percentile	36.46
85th Percentile	40.44
Std Dev	3.84
Variance	14.86

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	81.71

NCDOT Site 5 (5-Month After Period) - Comparison 2

City	Surf City	Surf City	Surf City
Direction	Northbound	Northbound	Northbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	South Shore	South Shore	South Shore
Conditions	Sunny / Dry	Sunny / Dry	Sunny / Dry
Time	1 hr (1:25p)	1 hr (7:55a)	1 hr (9:00a)
Data Set	1	3	5
Total Obs	97	67	104
Average	36.45	37.10	38.43
50th Percentile	36.17	36.88	37.67
85th Percentile	40.21	39.87	41.49
Std Dev	3.92	4.13	3.40
Variance	15.38	17.03	11.53

Totals Averaged Northbound
268
37.33
36.90
40.52
3.81
14.65

% Vehicles Exceeding Speed Limit	
Vehicle %	74.27

City	Surf City	Surf City	Surf City
Direction	Southbound	Southbound	Southbound
Date	9/13/2010	9/15/2010	9/17/2010
Data Loc.	South Shore	South Shore	South Shore
Conditions	Sunny / Dry	Sunny / Dry	Sunny / Dry
Time	1 hr (1:25p)	1 hr (7:55a)	1 hr (9:00a)
Data Set	2	4	6
Total Obs	70	65	75
Average	37.64	38.03	38.56
50th Percentile	36.90	37.36	37.50
85th Percentile	40.94	41.06	42.38
Std Dev	3.71	3.26	3.48
Variance	13.77	10.66	12.09

Totals Averaged Southbound
210
38.08
37.25
41.46
3.48
12.17

NB & SB 5-Month Totals	
Total Obs	478
Average	37.70
50th Percentile	37.08
85th Percentile	40.99
Std Dev	3.65
Variance	13.41

PACE Speed Calc	
Low Pace	33
High Pace	42
Vehicle %	81.38