I-95 Corridor Coalition

I-95 Corridor Coalition
Vehicle Probe Project: Validation
of TomTom Data

Report for North Carolina (#7)
US-29 and US-74

February 2016

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT VALIDATION OF TOMTOM DATA NOVEMBER 2015

Report for North Carolina (#7)
US-29 and US-74

Masoud Hamedi, Ali Haghani, Kiana Roshan Zamir, Zhongxiang Wang
University of Maryland, College Park

Evaluation Results for the State of North Carolina

Executive Summary

The data from the Vehicle Probe Project is validated using Bluetooth^{TM} Traffic Monitoring (BTM) technology on a near monthly basis. The validation of arterial data is similar to that of freeway data, however the following should be noted. The boundaries of the speed bins used for arterials are different than those used for freeways to accommodate the lower speeds on this type of corridor.

BTMs sensor were deployed at the beginning and ending points of 15 different segments along the US-29 and US-74 corridors. The number of lanes for these corridors varies between 2 and 4 per direction with average signal density of 1 signal per mile. Average Annual Daily Traffic (AADT) along these corridors is 42,500 and the speed limit is 45 MPH.

The Bluetooth sensor deployment covers the range from US-601 to Eastway Dr. along US-29 and I-485 to Briar Creek Rd along US-74. Travel time data was collected for both directions along each arterial, between November 11 and November 25, 2015. The dataset collected represents approximately 2,572 hours of observations along 15 arterial segments, totaling approximately 23 miles. The total number of effective five-minute travel time samples observed was 30,859. Due to data quality considerations, one segment was dropped from final validation.

ES Table 1, below summarizes the results of the comparison between the BTM reference data and the TomTom data for arterial segments during the above noted time period. As shown, the average absolute speed error (AASE) was within specification in all speed bins. The Speed Error Bias (SEB) was within specifications for speed bins 15-25 MPH, 25-35 MPH and >35 MPH when compared with the Standard Error of the Mean (SEM) Band. Although the data are compared to these specifications, caution should be used when using probe data on arterial roadways. Other factors including signal density and traffic volume should be considered.

ES Table 1 – North Carolina Evaluation Summary for Arterial						
Speed Bin	**Average Absolute Speed Error (<10mph)**		**Speed Error Bias (<5mph)**		Number of 5 Minute Samples	Hours of Data Collection
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-15 MPH	5.4	7.5	5.4	7.4	1862	155
15-25 MPH	4.5	7.8	4.5	7.6	4660	388
25-35 MPH	3.8	7.5	3.6	6.9	7156	596
>35 MPH	1.5	3.8	-0.8	-1.2	17181	1432
All Speeds	2.7	5.5	1.4	3.1	30859	2572
Based on data collected from November 11, 2015 through November 25, 2015 across 23 miles of roadway.						

Data Collection

Travel time samples were collected along 15 arterial segments with the assistance of North Carolina Department of Transportation (NCDOT) personnel. Arterial segments studied were located on US-29 corridor from US-601 to Eastway Dr and on US-74 corridor from I-485 to Briar Creek Rd. Travel time data was collected for both directions along US-29 and US-74 between November 11 and November 25, 2015. Segment locations were chosen with a high-likelihood of observing recurrent and non-recurrent congestion during peak and off-peak periods.

Figure 1 and 2 present an overview snapshot of the placement of sensors for the collection of data on the US-29 and US-74 corridors in North Carolina. Blue segments represent arterial segments selected for analysis. The number of lanes for these corridors varies between 2 and 4 per direction with average signal density of 1 signal per mile. Average Annual Daily Traffic (AADT) along these corridors is 42,500 and the speed limit is 45 MPH.
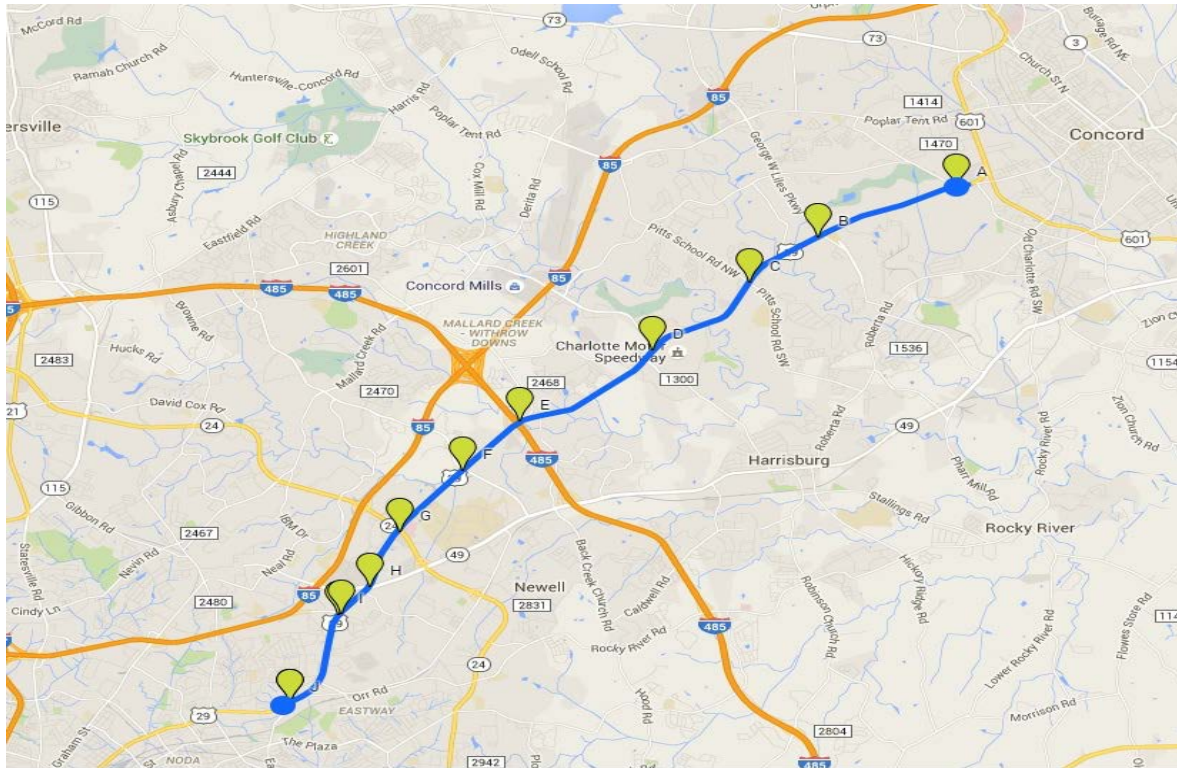

Figure 1 — Locations of all segments selected on US-29 for analysis in North Carolina
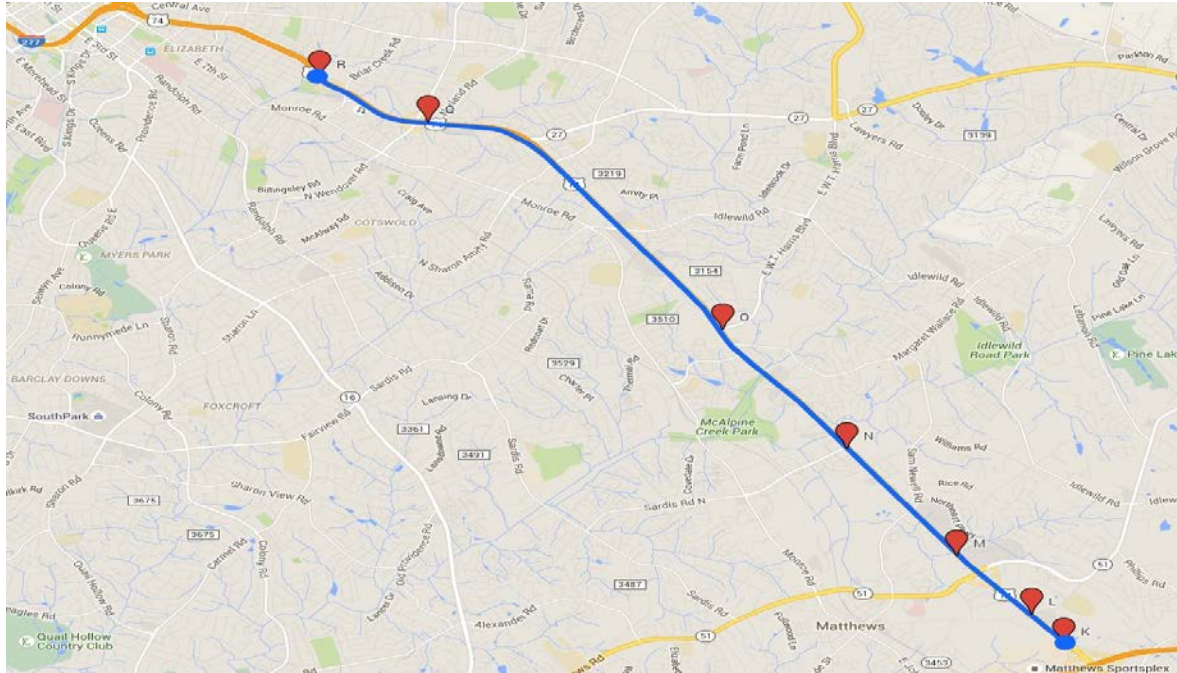
Figure 2 — Locations of all segments selected on US-74 for analysis in North Carolina

TMC segments selected for validation in North Carolina

Table 1 presents the data collection segments from North Carolina. As a whole, these segments cover a total length of 23 arterial miles. Data collection segments are comprised of one or more Traffic Message Channel (TMC) base segments, such that the total length of the data collection segment is one mile long or greater in most segments for arterials. When appropriate, consecutive TMC segments are combined to form a data collection segment longer than one mile. The results of the validation performed on 15 bidirectional arterial segments are included in this report. Table 1 contains the summary information on each data collection segment including the latitude/longitude coordinates of the locations at which the Bluetooth sensors were deployed along US-29 and US-74 in North Carolina as well as an active map link to view the data collection segment in detail. Click on the map link to see a detailed map for the respective data collection segment. It should be noted that the configuration of the test segments is often such that the endpoint of one segment coincides with the start point of the next segment, so that one Bluetooth sensor covers both data collection segments.

Table 1 also provides data on the precise length of the TMCs comprising the test segment as compared to the measured length between Bluetooth^{TM} Traffic Monitoring (BTM) sensors placed on the roadway. An algorithm was developed and documented in a separate report[1] as part of the initial VPP project and is being used for the validation of all vendors in VPPII. Details of the algorithm used to estimate equivalent path travel times based on TomTom data feeds for individual data collection segments are provided in this separate report. This algorithm finds an equivalent TomTom travel time (and therefore travel speed) corresponding to each sample BTM travel time observation on the test segment of interest.

---

[1] Ali Haghani, Masoud Hamedi, Kaveh Farokhi Sadabadi, Estimation of Travel Times for Multiple TMC Segments, prepared for I-95 Corridor Coalition, February 2010 (link)

Table 1
Segments selected for validation in North Carolina

SEGMENT	DESCRIPTION			TMC CODES			Deployment		
(Map Link)	Highway North Carolina	State County	Starting at Ending at	Begin End	Length Number		Begin Lat/Lon End Lat/Lon		Length % Diff
Arterials									All Lengths in Miles
A1 NC07-0001	US-29 Southbound	North Carolina Cabarrus	US-601 George W Liles Pkwy	125n08378 125n08378	3.93 1		35.399811 35.381990	-80.608533 -80.648813	2.06 -47.59%
A2 NC07-0002	US-29 Southbound	North Carolina Cabarrus	George W Liles Pkwy Pitts School Rd	125n08378 125n08378	3.93 1		35.381990 35.370183	-80.648813 -80.665625	1.28 -67.43%
A3 NC07-0003	US-29 Southbound	North Carolina Cabarrus	Pitts School Rd Speedway Blvd	125n08377 125n08377	1.86 1		35.370183 35.352531	-80.665625 -80.688302	1.88 1.08%
A4 NC07-0004	US-29 Southbound	North Carolina Mecklenburg	Speedway Blvd I-485	125n08376 125n08375	2.24 2		35.352531 35.334259	-80.688302 -80.719634	2.28 1.79%
A5 NC07-0005	US-29 Southbound	North Carolina Mecklenburg	I-485 Mallard Creek Church Rd	125n08375 125n08374	1.22 2		35.334259 35.321355	-80.719634 -80.733914	1.19 -2.47%
A6 NC07-0006	US-29 Southbound	North Carolina Mecklenburg	Mallard Creek Church Rd Wt Harris Blvd	125n08373 125n08373	1.41 1		35.321355 35.305577	-80.733914 -80.749961	1.40 -0.71%
A7 NC07-0007	US-29 Southbound	North Carolina Mecklenburg	Wt Harris Blvd NC-49/University City Blvd	125n08372 125n08372	1.21 1		35.305577 35.290902	-80.749961 -80.756885	1.08 -10.79%
A8 NC07-0008	US-29 Southbound	North Carolina Mecklenburg	NC-49/University City Blvd US-29	125n08371 125n08370	2.28 2		35.290902 35.285736	-80.756885 -80.762466	0.61 -73.19%
A9 NC07-0009	US-29 Southbound	North Carolina Mecklenburg	US-29 Eastway Dr	125n08370 125n08369	2.02 2		35.285736 35.260209	-80.762466 -80.776593	1.80 -10.89%
A10 NC07-0010	US-29 Northbound	North Carolina Mecklenburg	Eastway Dr US-29	125p08370 125p08371	2.10 2		35.260096 35.286415	-80.776459 -80.761076	1.80 -14.31%
A11 NC07-0011	US-29 Northbound	North Carolina Mecklenburg	US-29 NC-49/University City Blvd	125p08371 125p08372	2.17 2		35.286415 35.290519	-80.761076 -80.756774	0.60 -72.35%

Table 1 (Cont'd)
Segments selected for validation in North Carolina

SEGMENT	DESCRIPTION			TMC CODES		Deployment			
(Map Link)	Highway North Carolina	State County	Starting at Ending at	Begin End	Length Number	Begin Lat/Lon End Lat/Lon		Length % Diff	
Arterials									All Lengths in Miles
A12 NC07-0012	US-29 Northbound	North Carolina Mecklenburg	NC-49/University City Blvd Wt Harris Blvd	125p08373 125p08373	1.11 1	35.290519 35.305389	-80.756774 -80.749874	1.08 -2.71%	
A13 NC07-0013	US-29 Northbound	North Carolina Mecklenburg	Wt Harris Blvd Mallard Creek Church Rd	125p08374 125p08374	1.42 1	35.305389 35.321291	-80.749874 -80.734030	1.40 -1.41%	
A14 NC07-0014	US-29 Northbound	North Carolina Mecklenburg	Mallard Creek Church Rd I-485	125p08375 125p08375	1.21 1	35.321291 35.334150	-80.734030 -80.719522	1.19 -1.65%	
A15 NC07-0015	US-29 Northbound	North Carolina Mecklenburg	I-485 Speedway Blvd	125p08376 125p08377	2.24 2	35.334150 35.352420	-80.719522 -80.688128	2.28 1.79%	
A16 NC07-0016	US-29 Northbound	North Carolina Cabarrus	Speedway Blvd Pitts School Rd	125p08378 125p08378	1.85 1	35.352420 35.370078	-80.688128 -80.665506	1.88 1.62%	
A17 NC07-0017	US-29 Northbound	North Carolina Cabarrus	Pitts School Rd George W Liles Pkwy	125p08379 125p08379	3.94 1	35.370078 35.381990	-80.665506 -80.648813	1.26 -67.99%	
A18 NC07-0018	US-29 Northbound	North Carolina Cabarrus	George W Liles Pkwy US-601	125p08379 125p08379	3.94 1	35.381990 35.399789	-80.648813 -80.608379	2.07 -47.41%	
A19 NC07-0019	US-74 Westbound	North Carolina Mecklenburg	I-485 Matthews Mint Hill Rd	125n05816 125n05816	0.43 1	35.114310 35.118969	-80.692880 -80.697913	0.43 0.00%	
A20 NC07-0020	US-74 Westbound	North Carolina Mecklenburg	Matthews Mint Hill Rd NC-51	125n05815 125n05815	0.97 1	35.118969 35.129748	-80.697913 -80.708904	0.91 -6.18%	
A21 NC07-0021	US-74 Westbound	North Carolina Mecklenburg	NC-51 Sardis Rd	125n05815 125n05813	2.18 3	35.129748 35.147134	-80.708904 -80.724211	1.55 -29.00%	
A22 NC07-0022	US-74 Westbound	North Carolina Mecklenburg	Sardis Rd E Wt Harris Blvd	125n05812 125n05812	1.71 1	35.147134 35.166873	-80.724211 -80.742367	1.72 0.58%	

Table 1 (Cont'd)
Segments selected for validation in North Carolina

SEGMENT (Map Link)	DESCRIPTION			TMC CODES		Deployment			
	Highway North Carolina	State County	Starting at Ending at	Begin End	Length Number	Begin Lat/Lon End Lat/Lon		Length % Diff
Arterials									All Lengths in Miles
A23 NC07-0023	US-74 Westbound	North Carolina Mecklenburg	E Wt Harris Blvd NC-27/NC-24/Albemarle Rd	125n05811 125n05808	3.85 4	35.166873 35.201710	-80.742367 -80.782985	3.57 -7.27%
A24 NC07-0024	US-74 Westbound	North Carolina Mecklenburg	NC-27/NC-24/Albemarle Rd Briar Creek Rd/Television Ln	125n05808 125n10232	1.13 2	35.201710 35.209215	-80.782985 -80.799964	1.06 -6.21%
A25 NC07-0025	US-74 Eastbound	North Carolina Mecklenburg	Briar Creek Rd/Television Ln Eastway Dr/N Wendover Rd	125p10232 125p05808	2.37 2	35.208519 35.201606	-80.799499 -80.784384	1.09 -54.01%
A26 NC07-0026	US-74 Eastbound	North Carolina Mecklenburg	Eastway Dr/N Wendover Rd NC-27/NC-24/Albemarle Rd	125p05809 125p05812	3.54 4	35.201606 35.166762	-80.784384 -80.742552	3.57 0.85%
A27 NC07-0027	US-74 Eastbound	North Carolina Mecklenburg	NC-27/NC-24/Albemarle Rd Sardis Rd	125p05813 125p05813	1.71 1	35.166762 35.147033	-80.742552 -80.724340	1.72 0.58%
A28 NC07-0028	US-74 Eastbound	North Carolina Mecklenburg	Sardis Rd NC-51	125p05814 125p05815	1.86 2	35.147033 35.128707	-80.724340 -80.708461	1.54 -17.17%
A29 NC07-0029	US-74 Eastbound	North Carolina Mecklenburg	NC-51 Matthews Mint Hill Rd	125p05815 125p05816	1.53 2	35.128707 35.118919	-80.708461 -80.698108	0.91 -40.55%

Analysis of Arterial Results

Table 2 summarizes the data quality measures obtained as a result of a comparison between Bluetooth and all reported TomTom speeds. Specifications used for comparison include the Average Absolute Speed Error (AASE) and the Speed Error Bias (SEB).

> Average Absolute Speed Error (AASE)
> The AASE is defined as the mean absolute value of the difference between the mean speed reported from the VPP and the ground truth mean speed for a specified time period. The AASE is the primary accuracy metric. Based on the contract specifications, the speed data from the VPP shall have a maximum average absolute error of 10 miles per hour (MPH) in each of four speed ranges: 0-15 MPH, 15-25 MPH, 25-35 MPH, and > 35 MPH.

> Speed Error Bias (SEB)
> The SEB is defined as the average speed error (not the absolute value) in each speed range. SEB is a measure of whether the speed reported in the VPP consistently under or over estimates speed as compared to ground truth speed. Based on the contract specifications, the VPP data shall have a maximum SEB of +/- 5 MPH in each of speed ranges as defined above.

The results are presented as compared against the mean of the ground truth data as well as the 95th percent confidence interval for the mean, referred to as the Standard Error of the Mean (SEM) band. The SEM band takes into account any uncertainty in the ground truth speed as measured by BTM equipment due to limited samples and/or data variance. Contract specifications are assessed against the SEM band. (See the *Vehicle Probe Project: Data Use and Application Guide* for additional details on the validation process.) The AASE in the lower two speed bands have proven to be the critical specification (and most difficult) to attain. As shown, the average absolute speed error (AASE) was within specification for all the speed bins. The Speed Error Bias (SEB) was within specifications for speed bins 15-25 MPH, 25-35 MPH and >35 MPH when compared with the Standard Error of the Mean (SEM) Band.

TABLE 2 Data quality measures for arterial segments in North Carolina

SPEED BIN	Data Quality Measures for				No. of 5 Minute Samples	Hours of Data Collection
	1.96 SEM Band		Mean			
	SEB 5 mph	AASE 10 mph	SEB	AASE		
	(contract specifications)					
0-15	5.4	5.4	7.4	7.5	1862	155
15-25	4.5	4.5	7.6	7.8	4660	388
25-35	3.6	3.8	6.9	7.5	7156	596
35+	-0.8	1.5	-1.2	3.8	17181	1432

Table 3 shows the percentage of the time TomTom data falls within 5 mph of the SEM band and the mean for each speed bin for all the arterial data segments in this validation report.

Table 3 Percent observations meeting data quality criteria for arterial segments in North Carolina

| SPEED BIN | Data Quality Measures for | | | | No. of Obs. |
| | 1.96 SEM Band | | Mean | | |
	Percentage falling inside the band	Percentage falling within 5 mph of the band	Percentage equal to the mean	Percentage within 5 mph of the mean	
0-15	17%	57%	0%	33%	1862
15-25	32%	61%	0%	27%	4660
25-35	35%	65%	0%	23%	7156
35+	60%	90%	0%	53%	17181

Tables 4 and 5 present detailed data for individual TMC segments in this validation in a similar format as Tables 2 and 3, respectively. Note that for some segments and in some speed bins the comparison results may not be reliable due to the small number of observations.

Table 4
Data quality measures for individual arterial validation segments in the state of North Carolina

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
NC07-0001	2.07	2.06	0-15	19.9	19.9	20.6	20.6	1*
			15-25	3.0	3.0	7.7	7.9	24*
			25-35	1.4	1.7	2.4	4.9	52
			35+	-1.4	2.0	-2.5	5.9	653
NC07-0002	1.26	1.28	0-15	-	-	-	-	-
			15-25	9.6	9.6	14.9	14.9	2*
			25-35	2.9	3.1	5.7	8.4	120
			35+	-1.8	2.1	-3.4	6.7	1075
NC07-0003	1.84	1.88	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	8.8	8.8	14.7	14.7	186
			35+	1.0	1.7	5.2	6.9	710
NC07-0004	2.24	2.28	0-15	26.8	26.8	29.1	29.1	1*
			15-25	0.0	0.0	22.2	22.2	1*
			25-35	3.7	3.7	9.8	9.8	45
			35+	-0.5	1.1	-1.3	4.5	478
NC07-0005	1.20	1.19	0-15	-	-	-	-	-
			15-25	7.9	7.9	14.9	14.9	19*
			25-35	3.4	3.5	9.9	10.4	342
			35+	-0.1	0.8	0.3	5.7	305
NC07-0006	1.36	1.40	0-15	5.7	5.7	11.0	11.0	103
			15-25	4.2	4.3	7.6	8.0	66
			25-35	0.2	0.6	2.0	4.8	19*
			35+	0.0	0.0	-2.7	2.7	1*
NC07-0007	1.01	1.08	0-15	7.2	7.2	11.6	11.6	123
			15-25	2.1	2.1	6.4	7.0	42
			25-35	-1.3	1.3	-2.2	4.9	5*
			35+	-	-	-	-	-
NC07-0008	0.61	0.61	0-15	8.7	8.7	13.2	13.2	94
			15-25	3.5	3.5	11.5	11.6	720
			25-35	0.4	0.4	4.4	6.0	520
			35+	-1.5	1.5	-6.6	6.9	103
NC07-0009	1.74	1.80	0-15	5.4	5.4	11.3	11.3	15*
			15-25	5.4	5.4	9.5	9.7	232
			25-35	2.7	2.9	5.2	6.5	274
			35+	0.0	0.3	-1.5	3.3	8*
NC07-0010	1.76	1.80	0-15	1.8	1.8	3.5	3.8	135
			15-25	1.8	1.9	4.3	5.0	176
			25-35	0.9	1.6	2.2	4.7	151
			35+	-1.6	1.8	-1.9	4.6	22*
NC07-0011	0.60	0.60	0-15	6.7	6.7	10.7	10.7	261
			15-25	3.5	3.6	8.2	9.0	991
			25-35	0.6	1.1	3.3	6.0	170
			35+	-3.0	3.0	-5.9	6.9	14*

*Results in the specified row may not be reliable due to small number of observations

Table 4 (Cont'd)
Data quality measures for individual arterial validation segments in the state of North Carolina

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
NC07-0012	1.10	1.08	0-15	3.5	3.5	7.1	7.2	84
			15-25	1.5	1.8	3.8	6.0	131
			25-35	-1.6	1.9	-3.2	5.4	74
			35+	-3.7	3.7	-7.8	7.8	5*
NC07-0013	1.39	1.40	0-15	4.6	4.6	7.9	7.9	52
			15-25	3.1	3.1	6.9	7.4	218
			25-35	-0.2	1.4	-0.1	5.2	109
			35+	-4.0	4.0	-8.5	8.5	7*
NC07-0014	1.21	1.19	0-15	-	-	-	-	-
			15-25	11.2	11.2	20.1	20.1	65
			25-35	4.1	4.1	12.9	13.1	342
			35+	0.1	0.6	3.4	5.3	241
NC07-0015	2.24	2.28	0-15	-	-	-	-	-
			15-25	5.1	5.1	20.3	20.3	1*
			25-35	5.2	5.2	10.5	10.7	36
			35+	0.3	1.0	1.7	4.3	310
NC07-0016	1.84	1.88	0-15	-	-	-	-	-
			15-25	0.0	0.0	1.5	1.5	1*
			25-35	6.3	6.3	11.6	12.6	37
			35+	0.4	1.0	2.7	5.0	876
NC07-0017	1.26	1.26	0-15	9.2	9.2	11.2	11.2	43
			15-25	4.6	4.6	8.5	8.6	57
			25-35	2.3	2.4	6.9	7.9	191
			35+	-1.3	1.5	-2.2	6.1	846
NC07-0018	2.07	2.07	0-15	8.4	8.4	13.2	13.2	6*
			15-25	3.1	3.1	7.4	8.1	29*
			25-35	1.9	2.8	3.3	6.7	232
			35+	0.0	1.5	1.1	5.0	551
NC07-0019	0.43	0.43	0-15	5.7	5.7	9.2	9.3	380
			15-25	5.1	5.2	10.6	10.8	515
			25-35	2.5	2.6	6.7	8.4	366
			35+	-1.8	1.9	-5.1	6.5	861
NC07-0020	0.91	0.91	0-15	10.1	10.1	10.7	11.4	3*
			15-25	7.8	7.9	16.0	16.6	46
			25-35	3.2	3.3	12.6	13.2	543
			35+	-0.5	0.6	1.1	5.0	1338
NC07-0021	1.48	1.55	0-15	7.7	7.7	9.3	9.5	73
			15-25	7.3	7.3	10.0	10.0	199
			25-35	3.7	3.7	8.6	8.7	599
			35+	-0.4	1.1	-0.2	4.4	711
NC07-0022	1.70	1.72	0-15	2.4	2.4	3.7	3.7	57
			15-25	7.1	7.1	10.3	10.4	161
			25-35	5.0	5.0	9.9	10.1	957
			35+	0.0	0.6	1.6	3.9	460

*Results in the specified row may not be reliable due to small number of observations

Table 4 (Cont'd)
Data quality measures for individual arterial validation segments in the state of North Carolina

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
NC07-0023	3.47	3.57	0-15	2.7	2.9	3.7	4.1	25*
			15-25	4.2	4.2	6.6	6.7	75
			25-35	4.5	4.5	7.5	7.9	165
			35+	1.0	1.2	2.9	4.1	803
NC07-0024	1.06	1.06	0-15	1.4	1.4	2.2	2.6	51
			15-25	2.9	3.2	3.8	4.6	151
			25-35	4.0	4.6	5.1	7.0	82
			35+	-1.2	1.4	-3.2	4.6	1996
NC07-0025	1.08	1.09	0-15	3.2	3.2	5.8	5.8	12*
			15-25	2.2	2.2	4.5	4.6	31
			25-35	1.9	2.8	2.9	5.2	58
			35+	-1.3	1.6	-3.7	4.6	2204
NC07-0026	3.52	3.57	0-15	6.8	6.8	9.8	9.8	5*
			15-25	4.8	4.8	7.4	7.5	155
			25-35	5.3	5.3	8.7	8.7	181
			35+	0.9	1.3	2.8	4.5	322
NC07-0027	1.70	1.72	0-15	1.6	1.6	3.2	3.6	57
			15-25	4.6	4.7	8.4	8.5	272
			25-35	3.8	3.8	9.4	9.8	439
			35+	-0.4	0.8	0.0	5.2	414
NC07-0028	1.55	1.54	0-15	5.0	5.0	6.5	6.5	281
			15-25	8.8	8.8	12.2	12.2	255
			25-35	6.8	6.8	12.4	12.5	718
			35+	0.7	0.9	3.8	5.1	275
NC07-0029	0.89	0.91	0-15	-	-	-	-	-
			15-25	4.3	4.3	8.6	8.8	25*
			25-35	0.9	1.2	4.7	6.6	143
			35+	-2.6	2.6	-6.2	7.3	1592

*Results in the specified row may not be reliable due to small number of observations

Table 5
Observations meeting data quality criteria for individual arterial validation segments
in the state of North Carolina

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SEM Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
NC07-0001	0-15	0	0%	0	0%	0	0%	0	0%	1*
	15-25	2	8%	11	46%	0	0%	10	42%	24*
	25-35	13	25%	40	77%	0	0%	36	69%	52
	35+	108	17%	418	64%	0	0%	337	52%	653
NC07-0002	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	0	0%	2*
	25-35	18	15%	60	50%	0	0%	42	35%	120
	35+	205	19%	634	59%	0	0%	464	43%	1075
NC07-0003	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	1	1%	4	2%	0	0%	4	2%	186
	35+	89	13%	359	51%	0	0%	244	34%	710
NC07-0004	0-15	0	0%	0	0%	0	0%	0	0%	1*
	15-25	0	0%	0	0%	0	0%	0	0%	1*
	25-35	2	4%	6	13%	0	0%	2	4%	45
	35+	120	25%	369	77%	0	0%	313	65%	478
NC07-0005	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	3	16%	0	0%	1	5%	19*
	25-35	30	9%	82	24%	0	0%	60	18%	342
	35+	77	25%	224	73%	0	0%	142	47%	305
NC07-0006	0-15	0	0%	19	18%	0	0%	15	15%	103
	15-25	4	6%	26	39%	0	0%	22	33%	66
	25-35	2	11%	12	63%	0	0%	11	58%	19*
	35+	0	0%	1	100%	0	0%	1	100%	1*
NC07-0007	0-15	2	2%	28	23%	0	0%	24	20%	123
	15-25	5	12%	23	55%	0	0%	17	40%	42
	25-35	1	20%	4	80%	0	0%	2	40%	5*
	35+	-	-	-	-	-	-	-	-	-
NC07-0008	0-15	4	4%	20	21%	0	0%	16	17%	94
	15-25	42	6%	199	28%	0	0%	91	13%	720
	25-35	134	26%	371	71%	0	0%	219	42%	520
	35+	26	25%	64	62%	0	0%	47	46%	103
NC07-0009	0-15	0	0%	4	27%	0	0%	4	27%	15*
	15-25	9	4%	78	34%	0	0%	60	26%	232
	25-35	28	10%	134	49%	1	0%	112	41%	274
	35+	5	63%	7	88%	0	0%	7	88%	8*
NC07-0010	0-15	13	10%	108	80%	0	0%	101	75%	135
	15-25	26	15%	115	65%	0	0%	104	59%	176
	25-35	21	14%	109	72%	0	0%	94	62%	151
	35+	4	18%	18	82%	0	0%	16	73%	22*
NC07-0011	0-15	19	7%	86	33%	0	0%	68	26%	261
	15-25	115	12%	403	41%	1	0%	294	30%	991
	25-35	29	17%	109	64%	0	0%	72	42%	170
	35+	0	0%	8	57%	0	0%	5	36%	14*

*Results in the specified row may not be reliable due to small number of observations

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SEM Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
NC07-0012	0-15	4	5%	44	52%	0	0%	29	35%	84
	15-25	20	15%	80	61%	1	1%	66	50%	131
	25-35	11	15%	50	68%	1	1%	40	54%	74
	35+	0	0%	3	60%	0	0%	2	40%	5*
NC07-0013	0-15	0	0%	26	50%	0	0%	22	42%	52
	15-25	28	13%	115	53%	0	0%	97	45%	218
	25-35	15	14%	65	60%	0	0%	57	52%	109
	35+	2	29%	3	43%	0	0%	3	43%	7*
NC07-0014	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	1	2%	0	0%	0	0%	65
	25-35	3	1%	19	6%	0	0%	10	3%	342
	35+	43	18%	176	73%	0	0%	116	48%	241
NC07-0015	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	0	0%	1*
	25-35	2	6%	5	14%	0	0%	4	11%	36
	35+	76	25%	236	76%	0	0%	201	65%	310
NC07-0016	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	1	100%	0	0%	1	100%	1*
	25-35	4	11%	8	22%	0	0%	5	14%	37
	35+	157	18%	612	70%	3	0%	475	54%	876
NC07-0017	0-15	0	0%	0	0%	0	0%	0	0%	43
	15-25	4	7%	17	30%	0	0%	12	21%	57
	25-35	41	21%	84	44%	0	0%	73	38%	191
	35+	195	23%	562	66%	0	0%	401	47%	846
NC07-0018	0-15	0	0%	0	0%	0	0%	0	0%	6*
	15-25	3	10%	14	48%	0	0%	11	38%	29*
	25-35	35	15%	130	56%	0	0%	109	47%	232
	35+	81	15%	369	67%	0	0%	292	53%	551
NC07-0019	0-15	22	6%	120	32%	0	0%	72	19%	380
	15-25	59	11%	211	41%	0	0%	114	22%	515
	25-35	83	23%	177	48%	0	0%	135	37%	366
	35+	157	18%	554	64%	7	1%	414	48%	861
NC07-0020	0-15	0	0%	2	67%	0	0%	2	67%	3*
	15-25	2	4%	10	22%	0	0%	10	22%	46
	25-35	10	2%	32	6%	0	0%	16	3%	543
	35+	302	23%	1051	79%	0	0%	701	52%	1338
NC07-0021	0-15	1	1%	11	15%	0	0%	9	12%	73
	15-25	1	1%	34	17%	0	0%	20	10%	199
	25-35	30	5%	174	29%	0	0%	123	21%	599
	35+	138	19%	566	80%	0	0%	456	64%	711
NC07-0022	0-15	1	2%	51	89%	0	0%	50	88%	57
	15-25	9	6%	50	31%	0	0%	37	23%	161
	25-35	40	4%	142	15%	0	0%	116	12%	957
	35+	99	22%	395	86%	0	0%	287	62%	460

*Results in the specified row may not be reliable due to small number of observations

Table 5 (Cont'd)
Observations meeting data quality criteria for individual arterial validation segments
in the state of North Carolina

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SEM Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
NC07-0023	0-15	0	0%	21	84%	0	0%	19	76%	25*
	15-25	6	8%	36	48%	0	0%	31	41%	75
	25-35	9	5%	47	28%	0	0%	40	24%	165
	35+	125	16%	625	78%	0	0%	530	66%	803
NC07-0024	0-15	19	37%	44	86%	0	0%	42	82%	51
	15-25	23	15%	114	76%	0	0%	104	69%	151
	25-35	14	17%	46	56%	0	0%	40	49%	82
	35+	472	24%	1524	76%	0	0%	1226	61%	1996
NC07-0025	0-15	0	0%	5	42%	0	0%	4	33%	12*
	15-25	9	29%	22	71%	0	0%	20	65%	31
	25-35	14	24%	44	76%	0	0%	36	62%	58
	35+	310	14%	1676	76%	0	0%	1340	61%	2204
NC07-0026	0-15	1	20%	1	20%	0	0%	1	20%	5*
	15-25	1	1%	48	31%	0	0%	36	23%	155
	25-35	1	1%	26	14%	0	0%	20	11%	181
	35+	40	12%	233	72%	0	0%	184	57%	322
NC07-0027	0-15	10	18%	45	79%	0	0%	41	72%	57
	15-25	12	4%	100	37%	0	0%	73	27%	272
	25-35	30	7%	106	24%	0	0%	80	18%	439
	35+	110	27%	330	80%	5	1%	224	54%	414
NC07-0028	0-15	2	1%	101	36%	0	0%	88	31%	281
	15-25	3	1%	36	14%	0	0%	28	11%	255
	25-35	5	1%	55	8%	0	0%	26	4%	718
	35+	42	15%	182	66%	1	0%	124	45%	275
NC07-0029	0-15	-	-	-	-	-	-	-	-	-
	15-25	2	8%	10	40%	0	0%	7	28%	25*
	25-35	31	22%	76	53%	0	0%	60	42%	143
	35+	263	17%	841	53%	0	0%	633	40%	1592

*Results in the specified row may not be reliable due to small number of observations