I-95 Corridor Coalition

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

Monthly Report: Virginia

I-95 CORRIDOR COALITION

May 2015

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT VALIDATION OF HERE DATA MAY 2015

Monthly Report

Prepared for:

I-95 Corridor Coalition

Sponsored by:

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May 2015

Evaluation Results for the State of Virginia

Executive Summary

The data from the Vehicle Probe Project is validated using Bluetooth™ 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 thirteen different segments along the US-1 corridor. Number of lanes varies between 2 and 3 per direction with average signal density of 3 signal per mile. Average Annual Daily Traffic (AADT) along the corridor is 38,933 and the speed limit is 45 MPH.

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The Bluetooth sensor deployment covers the range from Huntington Avenue to Joplin Road along US-1. Travel time data was collected for both directions along the arterial, between December 4 and December 18, 2014. The dataset collected represents approximately 3200 hours of observations along 13 arterial segments, totaling approximately 49 miles. The total number of effective five-minute travel time samples observed was 38,387.

ES Table 1, below summarizes the results of the comparison between the BTM reference data and the HERE 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 all speed bins 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 - Virginia Evaluation Summary for Arterial

Speed Bin	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	4.8	7.8	4.8	7.8	3185	265
15-25 MPH	1.4	4.6	1.2	3.6	13202	1100
25-35 MPH	1.1	3.9	-0.6	-1.5	13371	1114
>35 MPH	3.8	7.8	-3.8	-7.4	8629	719
All Speeds	2.1	5.4	-0.2	-0.3	38387	3199

Based upon data collected from Dec 4th, 2014 through Dec 18th, 2014 across 49.1 miles of roadway.

Data Collection

Travel time samples were collected along 13 arterial segments with the assistance of Virginia Department of Transportation (VDOT) personnel. Arterial segments studied were located along the US-1 corridor from Huntington Avenue to Joplin Road. Travel time data was collected for both directions along the US-1 arterial between December 4 and December 18, 2014. Segment locations were chosen with a high-likelihood of observing recurrent and non-recurrent congestion during peak and off-peak periods.

Figure 1 presents an overview snapshot of the placement of sensors for the collection of data on the US-1 corridor in Virginia. Red segments represent arterial segments selected for analysis. Number of lanes varies between 2 and 3 per direction with average signal density of 3 signal per mile. Average Annual Daily Traffic (AADT) along the corridor is 38,933 and the speed limit is 45 MPH.

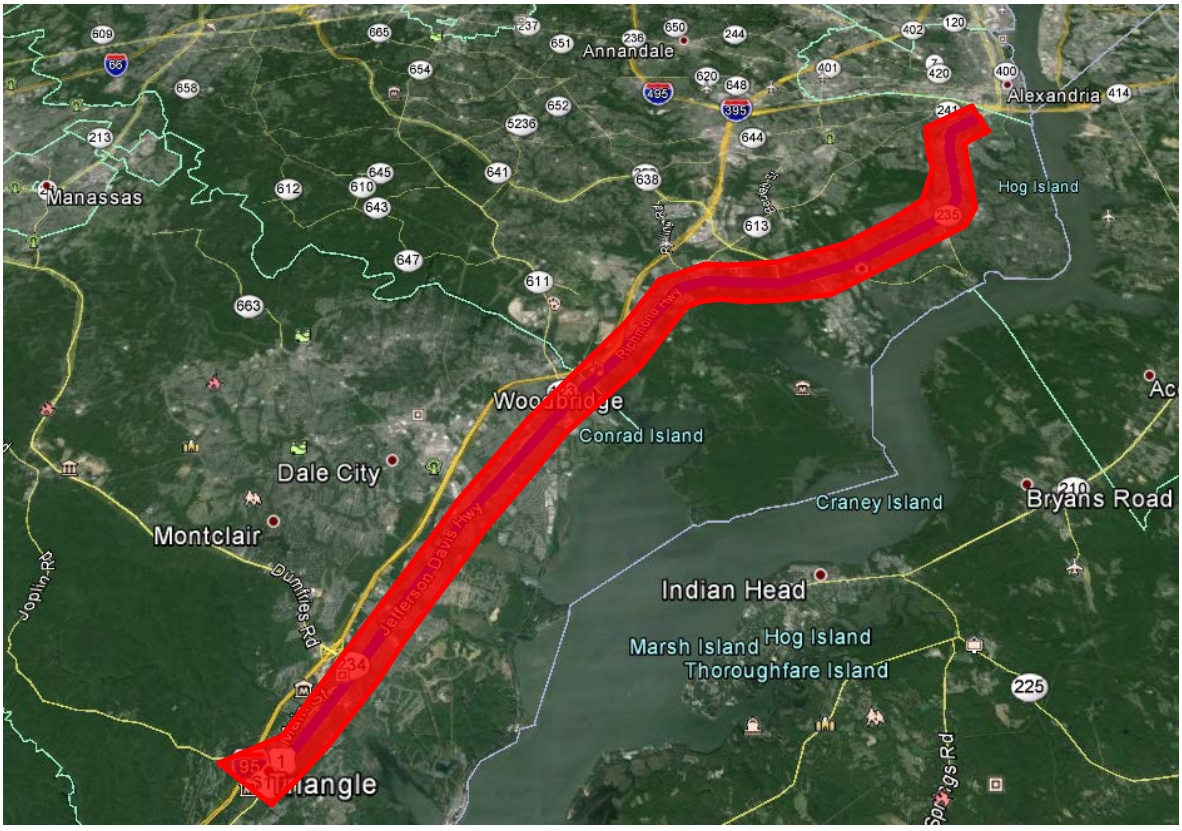

Figure 1 — Locations of all segments selected for analysis in Virginia

TMC segments selected for validation in Virginia

Table 1 presents a list of data collection segments from Virginia. In total, these segments cover a total length of 49.1 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 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 13 arterial segments are included in this report. Table 1 contains the summary information on each data collection segment. The latitude/longitude coordinates of the locations at which the Bluetooth sensors were deployed along the US-1 in Northern Virginia are provided in Table 1 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™ 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 HERE data feeds for individual data collection segments are provided in this separate report. This algorithm finds an equivalent HERE 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 Virginia

SEGMENT	DESCRIPTION			TMC CODES		Deployment		
(Map Link)	Highway	State	Starting at	Begin	Number	Begin Lat/Lon		Length
	Virginia	County	Ending at	End	Length	End Lat/Lon		% Diff
Arterials								All Lengths in Miles
A1	US-1	Virginia	Huntington Ave	110-05646	3	38.789658	-77.063998	1
VA09-0001	Southbound	Fairfax	Kings Hwy	110-05645	0.97	38.781161	-77.078587	3.08%
A2	US-1	Virginia	Kings Hwy	110-05644	1	38.781161	-77.078587	0.63
VA09-0002	Southbound	Fairfax	Beacon Hill Rd	110-05644	0.65	38.772466	-77.081094	-3.10%
A3	US-1	Virginia	Beacon Hill Rd	110-05643	1	38.772466	-77.081094	1.7
VA09-0003	Southbound	Fairfax	Fordson Rd	110-05643	1.68	38.748301	-77.083248	1.19%
A4	US-1	Virginia	Fordson Rd	110-05642	2	38.748301	-77.083248	0.73
VA09-0004	Southbound	Fairfax	VA-235/Mount Vernon Hwy	110-05641	0.72	38.739076	-77.088943	1.39%
A5	US-1	Virginia	VA-235/Mount Vernon Hwy	110N05641	2	38.739076	-77.088943	2.83
VA09-0005	Southbound	Fairfax	VA-235/Mount Vernon Memorial Hwy	110-05640	2.85	38.716995	-77.132755	-0.70%
A6	US-1	Virginia	VA-235/Mount Vernon Memorial Hwy	110N05640	3	38.716995	-77.132755	1.83
VA09-0006	Southbound	Fairfax	VA-7100/Fairfax County Pkwy	110N05639	1.85	38.707844	-77.163858	-1.08%
A9	US-1	Virginia	Lorton Rd	110-05635	3	38.705713	-77.205011	2.4
VA09-0009	Southbound	Fairfax	I-95 (Lorton)	110-05634	2.33	38.677623	-77.230068	3.00%
A10	US-1	Virginia	I-95 (Lorton)	110N05634	3	38.677623	-77.230068	1.51
VA09-0010	Southbound	Prince William	VA-123/Gordon Blvd	110N09532	1.57	38.661743	-77.247195	-3.82%

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

SEGMENT (Map Link)	DESCRIPTION Highway Virginia	State County	Starting at Ending at	TMC CODES Begin End	Number Length	Deployment Begin Lat/Lon End Lat/Lon		Length % Diff
Arterials								All Lengths in Miles
A11	US-1	Virginia	VA-123/Gordon Blvd	110-09531	2	38.661743	-77.247195	2.44
VA09-0011	Southbound	Prince William	Opitz Blvd	110N09531	2.43	38.633286	-77.271854	0.41%
A12	US-1	Virginia	Opitz Blvd	110-09530	2	38.633286	-77.271854	1.01
VA09-0012	Southbound	Prince William	Dale Blvd	110N09530	1.14	38.621449	-77.282669	-11.39%
A13	US-1	Virginia	Dale Blvd	110-09529	2	38.621449	-77.282669	1.01
VA09-0013	Southbound	Prince William	Cardinal Dr	110N09529	0.88	38.608768	-77.291518	14.73%
A14	US-1	Virginia	Cardinal Dr	110-09528	2	38.608768	-77.291518	2.68
VA09-0014	Southbound	Prince William	VA-234/Dumfries Rd	110N09528	2.71	38.574986	-77.314884	-1.11%
A15	US-1	Virginia	VA-234/Dumfries Rd	110-09527	2	38.574986	-77.314884	2.53
VA09-0015	Southbound	Prince William	Joplin Rd	110N09527	2.53	38.545718	-77.33684	0.00%
A16	US-1	Virginia	Joplin Rd	110P09527	2	38.545718	-77.33684	2.41
VA09-0016	Northbound	Prince William	VA-234/Dumfries Rd	110+09528	2.43	38.574986	-77.314884	-0.82%
A17	US-1	Virginia	VA-234/Dumfries Rd	110P09528	2	38.574986	-77.314884	2.67
VA09-0017	Northbound	Prince William	Cardinal Dr	110+09529	2.67	38.608768	-77.291518	0.00%
A18	US-1	Virginia	Cardinal Dr	110P09529	3	38.608768	-77.291518	1.01
VA09-0018	Northbound	Prince William	Dale Blvd	110P09530	1.13	38.621449	-77.282669	-9.98%
A19	US-1	Virginia	Dale Blvd	110+09531	1	38.621449	-77.282669	1.01
VA09-0019	Northbound	Prince William	Opitz Blvd	110+09531	0.9	38.633286	-77.271854	12.47%
A20	US-1	Virginia	Opitz Blvd	110P09531	2	38.633286	-77.271854	2.43
VA09-0020	Northbound	Prince William	VA-123/Gordon Blvd	110+09532	2.42	38.661743	-77.247195	0.41%

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

SEGMENT (Map Link)	DESCRIPTION Highway Virginia	State County	Starting at Ending at	TMC CODES Begin End	Number Length	Deployment Begin Lat/Lon End Lat/Lon		Length % Diff
Arterials								All Lengths in Miles
A21	US-1	Virginia	VA-123/Gordon Blvd	110P09532	3	38.661743	-77.247195	1.43
VA09-0021	Northbound	Fairfax	I-95 (Lorton)	110P05634	1.44	38.677623	-77.230068	-0.69%
A22	US-1	Virginia	I-95 (Lorton)	110+05635	4	38.677623	-77.230068	2.4
VA09-0022	Northbound	Fairfax	Lorton Rd	110P05636	2.39	38.705713	-77.205011	0.51%
A25	US-1	Virginia	VA-7100/Fairfax County Pkwy	110+05640	2	38.707844	-77.163858	1.85
VA09-0025	Northbound	Fairfax	VA-235/Mount Vernon Memorial Hwy	110P05640	1.86	38.716995	-77.132755	-0.54%
A26	US-1	Virginia	VA-235/Mount Vernon Memorial Hwy	110+05641	2	38.716995	-77.132755	2.82
VA09-0026	Northbound	Fairfax	VA-235/Mount Vernon Hwy	110P05641	2.85	38.739076	-77.088943	-1.05%
A27	US-1	Virginia	VA-235/Mount Vernon Hwy	110+05642	2	38.739076	-77.088943	0.73
VA09-0027	Northbound	Fairfax	Fordson Rd	110+05643	0.72	38.748301	-77.083248	1.39%
A28	US-1	Virginia	Fordson Rd	110+05644	1	38.748301	-77.083248	1.7
VA09-0028	Northbound	Fairfax	Beacon Hill Rd	110+05644	1.68	38.772466	-77.081094	1.19%
A29	US-1	Virginia	Beacon Hill Rd	110+05645	1	38.772466	-77.081094	0.62
VA09-0029	Northbound	Fairfax	Kings Hwy	110+05645	0.64	38.781161	-77.078587	-3.12%
A30	US-1	Virginia	Kings Hwy	110+05646	3	38.781161	-77.078587	0.99
VA09-0030	Northbound	Fairfax	Huntington Ave	110+05647	1.00	38.789658	-77.063998	-1.00%

Analysis of Arterial Results

Table 2 summarizes the data quality measures obtained as a result of a comparison between Bluetooth and all reported HERE 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 95^{th} 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 all speed bins when compared with the Standard Error of the Mean (SEM) Band.

TABLE 2 Data quality measures for arterial segments in Virginia

SPEED BIN	Data Quality Measures for				No. of 5 Minute Samples	Hours of Data Collection
	1.96 SEM Band		Mean			
	SEB 5 mph (contract specifications)	AASE 10 mph	SEB	AASE		
0-15	4.8	4.8	7.8	7.8	3185	265
15-25	1.2	1.4	3.6	4.6	13202	1100
25-35	-0.6	1.1	-1.5	3.9	13371	1114
35+	-3.8	3.8	-7.4	7.8	8629	719

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

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

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	16%	62%	0%	31%	3185
15-25	59%	91%	0%	61%	13202
25-35	66%	93%	0%	71%	13371
35+	40%	69%	0%	36%	8629

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 Virginia

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	
VA09-0001	0.97	1.00	0-15	5.4	5.4	8.0	8.0	572
			15-25	1.2	1.2	3.8	4.3	1313
			25-35	-0.7	1.0	-2.2	4.1	424
			35+	-4.1	4.1	-9.2	9.2	68
VA09-0002	0.65	0.63	0-15	4.0	4.0	9.0	9.0	67
			15-25	0.6	0.7	2.6	3.9	952
			25-35	-1.1	1.2	-3.9	4.6	944
			35+	-4.3	4.3	-10.8	10.8	251
VA09-0003	1.68	1.70	0-15	5.4	5.4	10.1	10.1	146
			15-25	1.4	1.4	4.0	4.4	759
			25-35	-0.3	0.7	-1.1	3.1	572
			35+	-3.2	3.2	-6.8	6.8	225
VA09-0004	0.74	0.73	0-15	3.8	3.8	6.4	6.5	399
			15-25	1.2	1.2	3.5	4.3	878
			25-35	-0.5	0.7	-1.9	3.9	301
			35+	-4.2	4.2	-11.1	11.1	50
VA09-0005	2.83	2.83	0-15	8.2	8.2	16.1	16.1	53
			15-25	1.4	1.4	8.0	8.1	296
			25-35	0.1	0.6	0.2	2.5	646
			35+	-2.1	2.1	-5.2	5.4	166
VA09-0006	1.85	1.83	0-15	2.2	2.2	2.8	3.0	48
			15-25	0.3	1.2	0.8	2.8	87
			25-35	0.3	1.1	1.2	3.6	384
			35+	-1.3	1.4	-3.3	4.2	1437
VA09-0009	2.33	2.40	0-15	3.6	3.6	5.3	5.3	76
			15-25	1.6	1.8	3.4	4.0	59
			25-35	-0.2	0.7	0.8	3.2	113
			35+	-2.6	2.6	-5.3	5.7	832

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

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	
VA09-0010	1.57	1.51	0-15	0.8	0.9	1.2	1.5	89
			15-25	0.1	1.4	-0.5	3.3	92
			25-35	-1.7	1.8	-4.3	4.9	294
			35+	-4.9	4.9	-9.4	9.4	378
VA09-0011	2.43	2.44	0-15	1.9	1.9	4.4	4.4	234
			15-25	0.1	0.6	1.0	2.6	366
			25-35	-1.2	1.2	-3.9	4.3	325
			35+	-7.7	7.7	-11.3	11.3	48
VA09-0012	1.14	1.01	0-15	9.0	9.0	12.8	12.8	32
			15-25	2.4	2.4	7.0	7.1	495
			25-35	0.1	0.6	0.5	3.4	618
			35+	-4.1	4.1	-8.6	8.6	211
VA09-0013	0.88	1.01	0-15	3.0	3.0	4.3	4.7	95
			15-25	0.6	1.2	1.6	4.3	390
			25-35	-0.6	1.2	-2.2	4.9	641
			35+	-5.3	5.3	-10.1	10.2	310
VA09-0014	2.71	2.68	0-15	7.4	7.4	10.7	10.7	67
			15-25	1.0	1.1	3.7	4.5	227
			25-35	-0.9	1.2	-2.6	3.8	365
			35+	-5.2	5.2	-8.7	8.7	76
VA09-0015	2.53	2.53	0-15	8.5	8.5	11.9	11.9	38
			15-25	0.9	1.1	3.0	3.8	226
			25-35	-0.6	0.9	-1.9	3.1	376
			35+	-4.2	4.2	-7.4	7.4	30
VA09-0016	2.43	2.41	0-15	7.0	7.0	12.3	12.3	56
			15-25	0.9	1.0	4.6	5.2	171
			25-35	-0.8	1.0	-2.1	3.4	286
			35+	-4.5	4.5	-8.8	8.8	37

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

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	
VA09-0017	2.67	2.67	0-15	7.0	7.0	13.0	13.0	59
			15-25	1.4	1.4	5.6	5.8	258
			25-35	-0.1	0.7	-0.8	2.8	409
			35+	-4.2	4.3	-7.6	7.7	58
VA09-0018	1.13	1.01	0-15	10.7	10.7	14.5	14.5	35
			15-25	2.1	2.1	6.9	7.2	665
			25-35	0.1	0.4	0.3	3.9	671
			35+	-3.7	3.7	-9.5	9.5	226
VA09-0019	1.21	1.01	0-15	6.5	6.5	10.2	10.2	54
			15-25	2.1	2.1	5.1	5.3	792
			25-35	-0.1	0.9	-0.1	3.6	490
			35+	-3.0	3.0	-6.1	6.2	37
VA09-0020	2.42	2.43	0-15	7.9	7.9	9.1	9.2	267
			15-25	2.3	2.6	3.9	4.4	488
			25-35	-2.3	2.7	-3.2	3.8	789
			35+	-10.1	10.1	-11.0	11.0	228
VA09-0021	1.44	1.43	0-15	9.5	9.5	11.1	11.1	11*
			15-25	0.5	0.5	1.6	4.5	3*
			25-35	-1.3	1.4	-3.5	4.2	90
			35+	-7.2	7.2	-12.2	12.2	1086
VA09-0022	2.39	2.40	0-15	-	-	-	-	-
			15-25	1.9	1.9	3.2	3.2	82
			25-35	1.5	1.6	3.3	4.0	108
			35+	-1.2	1.4	-2.9	4.2	709
VA09-0025	1.84	1.85	0-15	9.2	9.2	10.1	10.1	1*
			15-25	3.6	3.6	7.1	7.2	75
			25-35	0.6	0.8	2.1	3.3	1082
			35+	-1.0	1.1	-3.2	4.0	814
VA09-0026	2.85	2.82	0-15	7.6	7.6	15.1	15.1	69
			15-25	2.0	2.0	6.6	6.6	473
			25-35	0.1	0.6	0.5	2.4	553
			35+	-2.5	2.5	-5.5	5.8	82

*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 Virginia

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	
VA09-0027	0.77	0.73	0-15	3.0	3.0	6.4	6.4	420
			15-25	0.8	0.9	3.2	3.9	761
			25-35	-0.5	0.6	-2.5	4.1	361
			35+	-4.8	4.8	-10.8	10.8	147
VA09-0028	1.68	1.70	0-15	4.0	4.0	8.1	8.1	117
			15-25	1.2	1.3	3.5	3.9	1064
			25-35	0.0	0.5	-0.2	2.8	528
			35+	-2.3	2.3	-6.1	6.1	111
VA09-0029	0.64	0.62	0-15	5.5	5.5	8.6	8.6	87
			15-25	1.2	1.2	3.7	4.3	1179
			25-35	-0.2	0.4	-1.6	3.7	834
			35+	-3.8	3.8	-11.2	11.2	442
VA09-0030	0.99	1.0	0-15	2.8	2.9	4.5	5.1	93
			15-25	-0.3	1.0	-1.2	3.8	1051
			25-35	-2.0	2.1	-6.1	6.8	1167
			35+	-7.9	7.9	-12.9	12.9	570

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

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	
VA09-0001	0-15	0	0%	113	20%	9	2%	167	29%	572
	15-25	276	21%	1010	77%	501	38%	1112	85%	1313
	25-35	97	23%	343	81%	185	44%	366	86%	424
	35+	0	0%	20	29%	6	9%	29	43%	68
VA09-0002	0-15	0	0%	15	22%	6	9%	29	43%	67
	15-25	312	33%	784	82%	535	56%	854	90%	952
	25-35	223	24%	699	74%	403	43%	785	83%	944
	35+	1	0%	46	18%	14	6%	80	32%	251
VA09-0003	0-15	1	1%	14	10%	1	1%	27	18%	146
	15-25	114	15%	556	73%	225	30%	641	84%	759
	25-35	163	29%	508	89%	299	52%	531	93%	572
	35+	10	4%	104	46%	29	13%	122	54%	225
VA09-0004	0-15	9	2%	182	46%	24	6%	220	55%	399
	15-25	211	24%	682	78%	392	45%	727	83%	878
	25-35	94	31%	243	81%	176	58%	266	88%	301
	35+	0	0%	10	20%	2	4%	23	46%	50
VA09-0005	0-15	0	0%	0	0%	0	0%	1	2%	53
	15-25	7	2%	128	43%	40	14%	192	65%	296
	25-35	139	22%	604	94%	261	40%	624	97%	646
	35+	10	6%	101	61%	33	20%	114	69%	166
VA09-0006	0-15	5	10%	42	88%	5	10%	43	90%	48
	15-25	9	10%	78	90%	18	21%	80	92%	87
	25-35	83	22%	315	82%	169	44%	334	87%	384
	35+	302	21%	1095	76%	547	38%	1187	83%	1437
VA09-0009	0-15	0	0%	54	71%	1	1%	60	79%	76
	15-25	5	8%	43	73%	13	22%	48	81%	59
	25-35	28	25%	98	87%	52	46%	105	93%	113
	35+	96	12%	464	56%	183	22%	528	63%	832
VA09-0010	0-15	3	3%	89	100%	11	12%	89	100%	89
	15-25	8	9%	74	80%	22	24%	78	85%	92
	25-35	33	11%	191	65%	70	24%	219	74%	294
	35+	6	2%	95	25%	26	7%	126	33%	378

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

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	
VA09-0011	0-15	3	1%	177	76%	16	7%	194	83%	234
	15-25	74	20%	334	91%	133	36%	348	95%	366
	25-35	36	11%	238	73%	77	24%	261	80%	325
	35+	0	0%	4	8%	0	0%	8	17%	48
VA09-0012	0-15	0	0%	5	16%	0	0%	6	19%	32
	15-25	43	9%	237	48%	114	23%	295	60%	495
	25-35	203	33%	551	89%	344	56%	574	93%	618
	35+	3	1%	70	33%	16	8%	90	43%	211
VA09-0013	0-15	8	8%	72	76%	20	21%	73	77%	95
	15-25	99	25%	306	78%	177	45%	339	87%	390
	25-35	180	28%	467	73%	316	49%	524	82%	641
	35+	19	6%	81	26%	33	11%	116	37%	310
VA09-0014	0-15	1	1%	9	13%	1	1%	15	22%	67
	15-25	27	12%	172	76%	62	27%	192	85%	227
	25-35	61	17%	298	82%	116	32%	318	87%	365
	35+	1	1%	25	33%	4	5%	30	39%	76
VA09-0015	0-15	0	0%	3	8%	0	0%	5	13%	38
	15-25	38	17%	178	79%	80	35%	199	88%	226
	25-35	75	20%	327	87%	144	38%	343	91%	376
	35+	0	0%	8	27%	3	10%	10	33%	30
VA09-0016	0-15	0	0%	7	13%	1	2%	13	23%	56
	15-25	29	17%	117	68%	53	31%	136	80%	171
	25-35	53	19%	249	87%	97	34%	257	90%	286
	35+	0	0%	8	22%	1	3%	13	35%	37
VA09-0017	0-15	0	0%	1	2%	0	0%	5	8%	59
	15-25	20	8%	160	62%	47	18%	193	75%	258
	25-35	80	20%	368	90%	161	39%	382	93%	409
	35+	5	9%	23	40%	10	17%	28	48%	58
VA09-0018	0-15	0	0%	3	9%	0	0%	5	14%	35
	15-25	91	14%	358	54%	204	31%	454	68%	665
	25-35	265	39%	583	87%	455	68%	628	94%	671
	35+	31	14%	92	41%	58	26%	121	54%	226

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

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	
VA09-0019	0-15	1	2%	7	13%	2	4%	8	15%	54
	15-25	86	11%	487	61%	178	22%	560	71%	792
	25-35	122	25%	413	84%	205	42%	438	89%	490
	35+	7	19%	17	46%	9	24%	20	54%	37
VA09-0020	0-15	4	2%	101	38%	5	2%	111	42%	267
	15-25	41	8%	365	75%	108	22%	391	80%	488
	25-35	52	7%	593	75%	104	13%	615	78%	789
	35+	0	0%	24	11%	0	0%	24	11%	228
VA09-0021	0-15	1	9%	2	18%	2	18%	2	18%	11*
	15-25	0	0%	3	100%	1	33%	3	100%	3*
	25-35	18	20%	67	74%	31	34%	78	87%	90
	35+	7	1%	136	13%	28	3%	201	19%	1086
VA09-0022	0-15	-	-	-	-	-	-	-	-	-
	15-25	5	6%	72	88%	6	7%	73	89%	82
	25-35	14	13%	85	79%	29	27%	91	84%	108
	35+	132	19%	540	76%	229	32%	575	81%	709
VA09-0025	0-15	0	0%	0	0%	0	0%	0	0%	1*
	15-25	4	5%	29	39%	8	11%	38	51%	75
	25-35	266	25%	938	87%	483	45%	987	91%	1082
	35+	145	18%	640	79%	279	34%	689	85%	814
VA09-0026	0-15	0	0%	0	0%	0	0%	1	1%	69
	15-25	20	4%	228	48%	45	10%	299	63%	473
	25-35	107	19%	519	94%	216	39%	533	96%	553
	35+	12	15%	46	56%	21	26%	53	65%	82
VA09-0027	0-15	10	2%	197	47%	35	8%	259	62%	420
	15-25	217	29%	622	82%	370	49%	673	88%	761
	25-35	110	30%	298	83%	202	56%	329	91%	361
	35+	2	1%	35	24%	18	12%	60	41%	147

*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 Virginia

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	
VA09-0028	0-15	0	0%	46	39%	1	1%	54	46%	117
	15-25	145	14%	854	80%	299	28%	931	88%	1064
	25-35	158	30%	480	91%	276	52%	500	95%	528
	35+	9	8%	64	58%	22	20%	74	67%	111
VA09-0029	0-15	3	3%	22	25%	4	5%	39	45%	87
	15-25	359	30%	925	78%	598	51%	1013	86%	1179
	25-35	339	41%	744	89%	561	67%	798	96%	834
	35+	46	10%	156	35%	113	26%	225	51%	442