



I-95 Corridor Coalition

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

Report for Maryland (#10)
US-1 and US-29



June 2016

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT VALIDATION OF TOMTOM DATA JUNE 2016

*Report for Maryland (#10)
US-1 and US-29*

Prepared for:

I-95 Corridor Coalition

Sponsored by:

I-95 Corridor Coalition

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Evaluation Results for the State of Maryland

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 17 different segments along the US-1 and US-29 corridors. The number of lanes varies between 1 and 3 per direction for US-1 and between 2 and 3 per direction for US-29. The average signal density is approximately two signals per mile for US-1 and one signal per mile for US-29. Average Annual Daily Traffic (AADT) is 27,100 along US-1 and 61,620 along US-29. The speed limit varies between 40 to 50 MPH for US-1 and between 40 to 55 MPH for US-29.

The Bluetooth sensor deployment covers the range from Leeds Ave to Whiskey Bottom Rd along US-1 and Old Columbia Rd to MD-193 along US-29. Travel time data was collected for both directions along each arterial, between March 25 and April 10, 2016. During this period, the area experienced seven days with precipitation. Due to data quality considerations four segments were dropped from final validation resulting in 13 bidirectional segments and 3 unidirectional segments for analysis. The dataset collected represents approximately 3,379 hours of observations along the remained arterial segments, totaling approximately 24 miles. The total number of effective five-minute travel time samples observed was 40,547.

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 two speed bins where speeds were greater than 25 MPH (25-35 MPH, >35 MPH). 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 – Maryland 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	6.3	9.4	6.3	9.3	286	24
15-25 MPH	6.3	12.6	6.3	12.5	2780	232
25-35 MPH	3.7	8.3	3.6	7.6	11117	926
>35 MPH	2.0	6.5	-0.6	-0.7	26364	2197
All Speeds	2.8	7.5	1.1	2.6	40547	3379

Based upon data collected from March 25, 2016 through April 10, 2016 across 24 miles of roadway.

Data Collection

Travel time samples were collected along 17 bidirectional arterial segments with the assistance of Maryland Department of Transportation (MDOT) personnel. Arterial segments studied were located on the US-1 corridor from Leeds Ave to Whiskey Bottom Rd and on US-29 corridor from Old Columbia Rd to MD-193. Travel time data was collected for both directions along US-1 and US-29 between March 25 and April 10, 2016. 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-1 and US-29 corridors in Maryland respectively. Blue segments represent arterial segments selected for analysis. The number of lanes varies between 1 and 3 per direction for US-1 and the average signal density is approximately two signals per mile. The Average Annual Daily Traffic (AADT) is 27,100 along US-1 and the speed limit varies between 40 to 50 MPH.

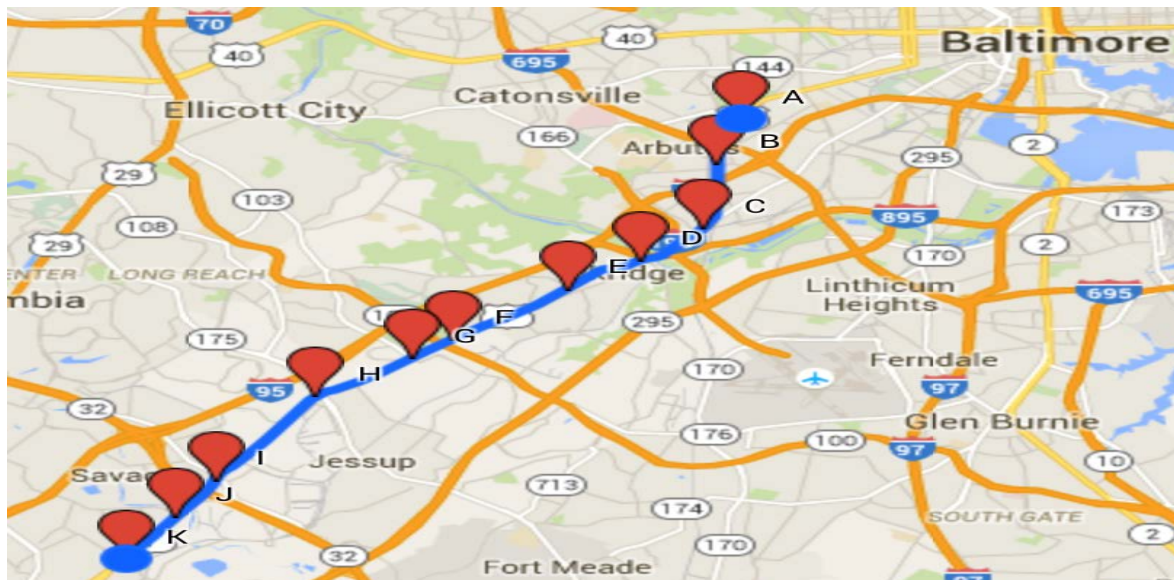


Figure 1 — Locations of all segments selected on US-1 for analysis in Maryland

The number of lanes varies between 2 and 3 per direction for US-29 and the average signal density is approximately one signal per mile for US-29. The Average Annual Daily Traffic (AADT) 61,620 along US-29 and the speed limit varies between 40 to 55 MPH for US-29.

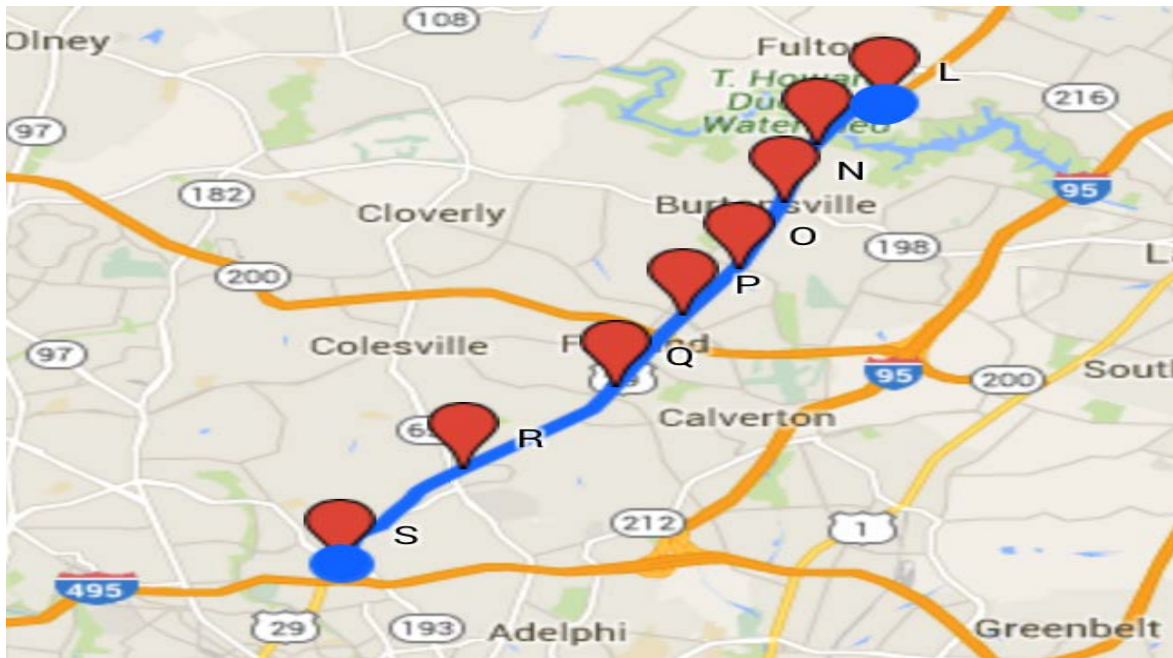


Figure 2 — Locations of all segments selected on US-29 for analysis in Maryland

TMC segments selected for validation in Maryland

Table 1 presents the data collection segments from Maryland. As a whole, these segments cover a total length of 24 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 in most cases one mile long or greater for arterials. When appropriate, consecutive TMC segments are combined to form a data collection segment longer than one mile. Due to data quality considerations four segments were dropped from final validation. The results of the validation performed on 13 bidirectional arterial segments and 3 unidirectional 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-1 and US-29 in Maryland 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 BluetoothTM Traffic Monitoring (BTM) sensors

placed on the roadway. An algorithm was developed and documented in a separate report¹ 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 Hamed, 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 Maryland

SEGMENT (Map Link)	DESCRIPTION			TMC CODES		Deployment		
	Highway Maryland	State County	Starting at Ending at	Begin End	Length Number	Begin Lat/Lon End Lat/Lon	Length % Diff	All Lengths in Miles
Arterials								
A2 MD10-0002	US-1 Southbound	Maryland Baltimore	Sulphur Spring Rd US-1/Washington Blvd	110n09556 110n09555	1.42 2	39.247925 39.227891	-76.691477 -76.694749	1.52 6.84%
A3 MD10-0003	US-1 Southbound	Maryland Baltimore	US-1/Washington Blvd I-895/Harbor Tunnel Trwy	110n09554 110n09553	0.93 2	39.227891 39.218047	-76.694749 -76.706175	1.13 21.60%
A4 MD10-0004	US-1 Southbound	Maryland Howard	I-895/Harbor Tunnel Trwy Montgomery Rd	110n09552 110n09552	1.39 1	39.218047 39.207073	-76.706175 -76.72717	1.17 -15.84%
A5 MD10-0005	US-1 Southbound	Maryland Howard	Montgomery Rd MD-100	110n09551 110n09551	1.85 1	39.207073 39.190565	-76.72717 -76.754239	1.87 1.08%
A6 MD10-0006	US-1 Southbound	Maryland Howard	MD-100 MD-103	110n09551 110n09550	0.68 2	39.190565 39.183989	-76.754239 -76.763757	0.66 -2.93%
A7 MD10-0007	US-1 Southbound	Maryland Howard	MD-103 MD-175	110n09549 110n09549	1.50 1	39.183989 39.171306	-76.763757 -76.786147	1.52 1.33%
A8 MD10-0008	US-1 Southbound	Maryland Howard	MD-175 MD-32	110n09548 110n09548	2.42 1	39.171306 39.142115	-76.786147 -76.810623	2.36 -2.48%
A9 MD10-0009	US-1 Southbound	Maryland Howard	MD-32 Gorman Rd	110n09548 110n09547	0.93 2	39.142115 39.130643	-76.810623 -76.819313	0.99 6.48%
A10 MD10-0010	US-1 Southbound	Maryland Howard	Gorman Rd Whiskey Bottom Rd	110n09546 110n09546	1.19 1	39.130643 39.116275	-76.819313 -76.831489	1.17 -1.68%
A11 MD10-0011	US-1 Northbound	Maryland Howard	Whiskey Bottom Rd Gorman Rd	110p09547 110p09547	1.19 1	39.116275 39.130566	-76.831489 -76.819175	1.16 -2.52%
A12 MD10-0012	US-1 Northbound	Maryland Howard	Gorman Rd MD-32	110p09548 110p09548	0.96 1	39.130566 39.142571	-76.819175 -76.810257	0.98 2.07%

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

SEGMENT (Map Link)	DESCRIPTION			TMC CODES		Deployment		All Lengths in Miles
	Freeway Maryland	State County	Starting at Ending at	Begin End	Length Number	Begin Lat/Lon End Lat/Lon	Length % Diff	
Arterials								
A13 MD10-0013	US-1 Northbound	Maryland Howard	MD-32 MD-175/Waterloo Rd	110p09549 110p09549	2.34 1	39.142571 39.170706	-76.810257 -76.786497	2.37 1.28%
A14 MD10-0014	US-1 Northbound	Maryland Howard	MD-175/Waterloo Rd MD-103	110p09549 110p09550	1.54 2	39.170706 39.183911	-76.786497 -76.763672	1.51 -1.95%
A15 MD10-0015	US-1 Northbound	Maryland Howard	MD-103 MD-100	110p09551 110p09551	0.69 1	39.183911 39.190469	-76.763672 -76.754087	0.67 -2.92%
A16 MD10-0016	US-1 Northbound	Maryland Howard	MD-100 Montgomery Rd	110p09552 110p09552	1.85 1	39.190469 39.207073	-76.754087 -76.72717	1.87 1.08%
A17 MD10-0017	US-1 Northbound	Maryland Baltimore	Montgomery Rd I-895/Harbor Tunnel Trwy	110p09553 110p09553	1.43 1	39.207073 39.218202	-76.72717 -76.705371	1.17 -18.13%
A18 MD10-0018	US-1 Northbound	Maryland Baltimore	I-895/Harbor Tunnel Trwy US-1/Washington Blvd	110p09553 110p09555	0.84 3	39.218202 39.227318	-76.705371 -76.695168	1.13 34.56%
A22 MD10-0022	US-29 Southbound	Maryland Montgomery	Dustin Rd MD-198/Sandy Spring Rd	110n06887 110n05902	1.08 2	39.126873 39.112097	-76.922937 -76.929166	1.06 -1.85%
A23 MD10-0023	US-29 Southbound	Maryland Montgomery	MD-198/Sandy Spring Rd Greencastle Rd	110n05901 110n05901	1.23 1	39.112097 39.095646	-76.929166 -76.938143	1.25 1.62%
A24 MD10-0024	US-29 Southbound	Maryland Montgomery	Greencastle Rd Briggs Chaney Rd	110n05900 110n05900	1.06 1	39.095646 39.082702	-76.938143 -76.948835	0.99 -6.59%
A25 MD10-0025	US-29 Southbound	Maryland Montgomery	Briggs Chaney Rd Cherry Hill Rd/Randolph Rd	110n05900 110n05898	1.33 3	39.082702 39.065812	-76.948835 -76.960838	1.43 7.50%
A26 MD10-0026	US-29 Southbound	Maryland Montgomery	Cherry Hill Rd/Randolph Rd MD-650	110n05898 110n05897	2.12 2	39.065812 39.045094	-76.960838 -76.989367	2.13 0.47%

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

SEGMENT (Map Link)	DESCRIPTION			TMC CODES		Deployment		All Lengths in Miles
	Highway Maryland	State County	Starting at Ending at	Begin End	Length Number	Begin Lat/Lon End Lat/Lon	Length % Diff	
Arterials								
A27 MD10-0027	US-29 Southbound	Maryland Montgomery	MD-650 MD-193/University Blvd	110n05897 110n05896	2.18 2	39.045094 39.020388	-76.989367 -77.012784	2.17 -0.46%
A28 MD10-0028	US-29 Northbound	Maryland Montgomery	MD-193/University Blvd MD-650	110p05897 110p05897	2.21 1	39.020308 39.019712	-77.012641 -77.013182	2.17 -1.81%
A29 MD10-0029	US-29 Northbound	Maryland Montgomery	MD-650 Cherry Hill Rd/Randolph Rd	110p05898 110p05898	2.09 1	39.019712 39.045238	-77.013182 -76.988839	2.14 2.39%
A30 MD10-0030	US-29 Northbound	Maryland Montgomery	Cherry Hill Rd/Randolph Rd Briggs Chaney Rd	110p05899 110p05900	1.05 2	39.045238 39.065569	-76.988839 -76.960647	1.43 36.08%
A31 MD10-0031	US-29 Northbound	Maryland Montgomery	Briggs Chaney Rd Greencastle Rd	110p05900 110p05901	1.35 2	39.065569 39.065569	-76.960647 -76.960647	0.99 -26.61%
A32 MD10-0032	US-29 Northbound	Maryland Montgomery	Greencastle Rd MD-198/Sandy Spring Rd	110p05902 110p05902	0.93 1	39.079051 39.079051	-76.951499 -76.951499	1.26 35.44%
A33 MD10-0033	US-29 Northbound	Maryland Montgomery	MD-198/Sandy Spring Rd Dustin Rd	110p05902 110p05241	1.33 3	39.095535 39.095535	-76.937874 -76.937874	1.05 -21.06%
A34 MD10-0034	US-29 Northbound	Maryland Howard	Dustin Rd Old Columbia Rd	110p05241 110p05242	1.04 2	39.126133 39.136748	-76.923265 -76.910612	1.03 -0.96%

Analysis of Arterial Results

Table 2 summarizes the data quality measures obtained as a result of 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 two speed bins where speeds were greater than 25 MPH (25-35 MPH, >35 MPH).

TABLE 2 Data quality measures for arterial segments in Maryland

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	6.3	6.3	9.3	9.4	286	24
15-25	6.3	6.3	12.5	12.6	2780	232
25-35	3.6	3.7	7.6	8.3	11117	926
35+	-0.6	2.0	-0.7	6.5	26364	2197

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 arterial data segments in this validation report.

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

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	10%	63%	0%	48%	286
15-25	20%	46%	0%	15%	2780
25-35	35%	67%	0%	25%	11117
35+	54%	83%	0%	43%	26364

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 Maryland

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	
MD10-0002	1.42	1.52	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	6.3	6.3	11.5	11.5	11*
			35+	0.2	0.9	1.2	3.4	473
MD10-0003	0.93	1.13	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	0.0	0.2	-0.4	2.1	225
			35+	-3.6	3.6	-9.3	9.3	499
MD10-0004	1.39	1.17	0-15	11.4	11.4	14.3	14.3	2*
			15-25	0.3	0.9	2.0	3.8	7*
			25-35	0.6	0.9	4.1	5.6	103
			35+	-1.5	1.5	-4.6	5.3	1054
MD10-0005	1.85	1.87	0-15	25.7	25.7	31.7	31.7	5*
			15-25	9.5	9.5	19.9	19.9	94
			25-35	5.1	5.1	10.7	10.8	401
			35+	0.5	0.5	3.1	3.8	224
MD10-0006	0.69	0.66	0-15	-	-	-	-	-
			15-25	1.3	1.3	7.6	7.7	28*
			25-35	0.1	0.3	0.1	3.8	398
			35+	-4.6	4.6	-10.4	10.6	915
MD10-0007	1.5	1.52	0-15	3.8	3.8	7.0	7.4	56
			15-25	4.8	4.8	10.6	10.9	267
			25-35	1.3	1.6	4.4	6.5	363
			35+	-2.0	2.0	-5.0	5.4	73
MD10-0008	2.42	2.36	0-15	18.4	18.4	27.3	27.3	17*
			15-25	8.4	8.4	17.7	17.7	160
			25-35	3.8	3.9	9.6	9.9	409
			35+	-0.1	0.4	1.4	3.6	110
MD10-0009	0.92	0.99	0-15	17.4	17.4	20.2	20.2	4*
			15-25	6.7	6.7	13.8	13.8	265
			25-35	1.1	1.1	6.3	6.8	634
			35+	-1.1	1.1	-3.4	4.6	341
MD10-0011	1.19	1.16	0-15	6.4	6.4	9.6	9.6	6*
			15-25	8.1	8.1	13.1	13.2	156
			25-35	3.1	3.1	7.8	8.2	1204
			35+	-0.5	0.6	-0.1	2.9	408
MD10-0012	0.96	0.98	0-15	11.6	11.6	14.6	14.6	21*
			15-25	7.9	7.9	13.5	13.6	546
			25-35	2.3	2.3	7.5	8.1	561
			35+	-0.5	0.6	-1.9	3.8	165

*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 Maryland

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	
MD10-0013	2.34	2.37	0-15	2.9	2.9	8.9	9.1	16*
			15-25	1.1	1.2	6.1	6.3	138
			25-35	-0.3	0.8	-2.1	3.4	401
			35+	-5.7	5.7	-11.4	11.4	139
MD10-0014	1.54	1.51	0-15	4.3	4.3	9.9	9.9	5*
			15-25	3.5	3.6	8.8	8.9	182
			25-35	0.5	0.6	1.9	3.5	543
			35+	-2.2	2.2	-8.0	8.0	111
MD10-0015	0.69	0.67	0-15	14.4	14.4	21.0	21.0	12*
			15-25	7.3	7.3	15.4	15.4	448
			25-35	2.0	2.0	8.8	9.3	586
			35+	-0.6	0.7	-1.0	3.9	179
MD10-0016	1.85	1.87	0-15	21.3	21.3	29.0	29.0	5*
			15-25	7.4	7.4	19.0	19.0	57
			25-35	4.2	4.3	8.7	9.2	344
			35+	0.1	0.9	1.9	4.1	366
MD10-0017	1.43	1.17	0-15	13.5	13.5	25.1	25.1	1*
			15-25	6.2	6.2	17.0	17.0	39
			25-35	1.9	1.9	8.6	8.6	533
			35+	-0.4	0.5	-0.2	3.3	609
MD10-0018	0.84	1.13	0-15	-	-	-	-	-
			15-25	9.3	9.3	11.7	11.7	3*
			25-35	1.4	1.6	5.1	5.7	258
			35+	-0.9	1.0	-2.3	3.5	379
MD10-0022	1.08	1.06	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	6.7	6.7	11.0	11.0	1*
			35+	0.0	0.4	0.4	3.2	2148
MD10-0023	1.23	1.25	0-15	-	-	-	-	-
			15-25	6.3	6.3	9.2	9.2	6*
			25-35	5.6	5.6	8.6	8.6	41
			35+	0.1	1.2	0.6	5.3	2046
MD10-0024	1.06	0.99	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	11.3	11.3	21.5	21.5	77
			35+	0.5	1.1	4.2	7.4	2152
MD10-0025	1.34	1.43	0-15	-	-	-	-	-
			15-25	16.2	16.2	23.6	23.6	2*
			25-35	6.4	6.4	10.4	10.7	204
			35+	0.1	1.1	2.0	6.2	1928
MD10-0026	2.12	2.13	0-15	1.8	1.8	2.7	2.8	45
			15-25	8.6	8.6	11.0	11.1	21*
			25-35	9.5	9.6	13.2	13.3	459
			35+	3.5	3.6	6.5	6.7	1135

*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 Maryland

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	
MD10-0027	2.18	2.17	0-15	4.0	4.0	5.0	5.0	30*
			15-25	4.0	4.0	6.1	6.1	111
			25-35	3.7	3.7	6.6	6.7	1025
			35+	-0.5	0.7	-0.9	3.0	336
MD10-0028	1.21	1.17	0-15	3.5	3.5	4.4	4.4	31
			15-25	5.5	5.5	7.8	7.8	85
			25-35	4.7	4.7	8.3	8.3	1094
			35+	0.1	0.2	1.1	2.3	376
MD10-0029	2.09	2.14	0-15	2.7	2.7	3.5	3.5	21*
			15-25	5.5	5.5	7.4	7.4	95
			25-35	8.7	8.7	13.0	13.1	646
			35+	1.3	1.5	5.6	6.5	905
MD10-0030	1.05	1.43	0-15	-	-	-	-	-
			15-25	7.5	7.5	14.7	14.7	7*
			25-35	8.0	8.0	12.7	12.7	315
			35+	1.5	1.6	5.5	6.6	1430
MD10-0031	1.35	0.99	0-15	4.5	4.5	7.5	7.5	9*
			15-25	1.8	1.8	5.2	5.4	25*
			25-35	2.1	2.1	5.8	6.2	40
			35+	-3.0	3.2	-8.8	9.6	2165
MD10-0032	0.93	1.26	0-15	-	-	-	-	-
			15-25	7.8	7.8	11.4	11.4	10*
			25-35	12.0	12.0	18.5	18.6	169
			35+	2.9	3.0	9.0	9.2	1886
MD10-0033	1.33	1.05	0-15	-	-	-	-	-
			15-25	4.1	4.1	5.8	5.8	27*
			25-35	1.7	1.7	3.2	3.9	23*
			35+	-4.1	4.1	-8.4	8.6	2036
MD10-0034	1.04	1.03	0-15	-	-	-	-	-
			15-25	2.7	2.7	3.6	3.6	1*
			25-35	1.3	1.3	2.2	2.5	49
			35+	-2.6	2.7	-6.4	6.7	1776

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

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	
MD10-0002	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	0	0%	0	0%	0	0%	0	0%	11*
	35+	85	18%	406	86%	0	0%	372	79%	473
MD10-0003	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	89	40%	216	96%	0	0%	210	93%	225
	35+	1	0%	169	34%	0	0%	88	18%	499
MD10-0004	0-15	0	0%	1	50%	0	0%	1	50%	2*
	15-25	2	29%	6	86%	0	0%	5	71%	7*
	25-35	11	11%	78	76%	0	0%	48	47%	103
	35+	227	22%	724	69%	4	0%	607	58%	1054
MD10-0005	0-15	0	0%	0	0%	0	0%	0	0%	5*
	15-25	0	0%	0	0%	0	0%	0	0%	94
	25-35	6	2%	21	5%	0	0%	15	4%	401
	35+	44	20%	198	88%	0	0%	141	63%	224
MD10-0006	0-15	-	-	-	-	-	-	-	-	-
	15-25	2	7%	16	57%	0	0%	7	25%	28*
	25-35	149	37%	356	89%	2	1%	307	77%	398
	35+	45	5%	233	25%	0	0%	110	12%	915
MD10-0007	0-15	3	5%	30	54%	0	0%	27	48%	56
	15-25	20	7%	81	30%	0	0%	66	25%	267
	25-35	38	10%	186	51%	0	0%	136	37%	363
	35+	25	34%	49	67%	0	0%	41	56%	73
MD10-0008	0-15	0	0%	0	0%	0	0%	0	0%	17*
	15-25	1	1%	9	6%	0	0%	4	3%	160
	25-35	10	2%	67	16%	0	0%	37	9%	409
	35+	25	23%	103	94%	0	0%	77	70%	110
MD10-0009	0-15	0	0%	0	0%	0	0%	0	0%	4*
	15-25	5	2%	22	8%	0	0%	12	5%	265
	25-35	92	15%	373	59%	0	0%	206	32%	634
	35+	136	40%	262	77%	0	0%	229	67%	341
MD10-0011	0-15	1	17%	3	50%	0	0%	3	50%	6*
	15-25	1	1%	20	13%	0	0%	11	7%	156
	25-35	37	3%	403	33%	0	0%	198	16%	1204
	35+	134	33%	380	93%	0	0%	367	90%	408
MD10-0012	0-15	0	0%	2	10%	0	0%	1	5%	21*
	15-25	17	3%	72	13%	0	0%	46	8%	546
	25-35	55	10%	211	38%	0	0%	119	21%	561
	35+	71	43%	142	86%	0	0%	125	76%	165

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

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	
MD10-0013	0-15	2	13%	5	31%	0	0%	5	31%	16*
	15-25	13	9%	90	65%	0	0%	60	43%	138
	25-35	109	27%	338	84%	0	0%	296	74%	401
	35+	1	1%	3	2%	0	0%	2	1%	139
MD10-0014	0-15	0	0%	3	60%	0	0%	3	60%	5*
	15-25	3	2%	64	35%	0	0%	18	10%	182
	25-35	183	34%	479	88%	0	0%	424	78%	543
	35+	1	1%	48	43%	0	0%	19	17%	111
MD10-0015	0-15	0	0%	0	0%	0	0%	0	0%	12*
	15-25	15	3%	54	12%	0	0%	29	6%	448
	25-35	52	9%	171	29%	0	0%	84	14%	586
	35+	70	39%	156	87%	0	0%	149	83%	179
MD10-0016	0-15	0	0%	0	0%	0	0%	0	0%	5*
	15-25	0	0%	1	2%	0	0%	0	0%	57
	25-35	13	4%	54	16%	0	0%	41	12%	344
	35+	34	9%	307	84%	0	0%	241	66%	366
MD10-0017	0-15	0	0%	0	0%	0	0%	0	0%	1*
	15-25	0	0%	1	3%	0	0%	0	0%	39
	25-35	3	1%	187	35%	0	0%	11	2%	533
	35+	218	36%	551	90%	0	0%	531	87%	609
MD10-0018	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	0	0%	3*
	25-35	20	8%	166	64%	0	0%	106	41%	258
	35+	114	30%	322	85%	0	0%	299	79%	379
MD10-0022	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	0	0%	0	0%	0	0%	0	0%	1*
	35+	806	38%	1956	91%	0	0%	1711	80%	2148
MD10-0023	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	5	83%	0	0%	2	33%	6*
	25-35	1	2%	21	51%	0	0%	13	32%	41
	35+	557	27%	1477	72%	0	0%	1097	54%	2046
MD10-0024	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	0	0%	0	0%	0	0%	0	0%	77
	35+	521	24%	1310	61%	2	0%	788	37%	2152
MD10-0025	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	0	0%	2*
	25-35	14	7%	64	31%	0	0%	44	22%	204
	35+	573	30%	1319	68%	0	0%	889	46%	1928
MD10-0026	0-15	1	2%	40	89%	0	0%	38	84%	45
	15-25	1	5%	5	24%	0	0%	4	19%	21*
	25-35	1	0%	13	3%	0	0%	5	1%	459
	35+	39	3%	390	34%	0	0%	254	22%	1135

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

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	
MD10-0027	0-15	0	0%	18	60%	0	0%	17	57%	30*
	15-25	0	0%	67	60%	0	0%	52	47%	111
	25-35	27	3%	415	40%	0	0%	281	27%	1025
	35+	76	23%	304	90%	0	0%	289	86%	336
MD10-0028	0-15	0	0%	25	81%	0	0%	22	71%	31
	15-25	0	0%	42	49%	0	0%	34	40%	85
	25-35	0	0%	242	22%	0	0%	111	10%	1094
	35+	88	23%	373	99%	0	0%	368	98%	376
MD10-0029	0-15	0	0%	17	81%	0	0%	15	71%	21*
	15-25	0	0%	38	40%	0	0%	33	35%	95
	25-35	5	1%	59	9%	0	0%	46	7%	646
	35+	104	11%	477	53%	0	0%	325	36%	905
MD10-0030	0-15	-	-	-	-	-	-	-	-	-
	15-25	1	14%	2	29%	0	0%	2	29%	7*
	25-35	1	0%	14	4%	0	0%	3	1%	315
	35+	238	17%	819	57%	0	0%	509	36%	1430
MD10-0031	0-15	0	0%	6	67%	0	0%	5	56%	9*
	15-25	7	28%	22	88%	0	0%	16	64%	25*
	25-35	13	33%	31	78%	0	0%	19	48%	40
	35+	250	12%	810	37%	0	0%	456	21%	2165
MD10-0032	0-15	-	-	-	-	-	-	-	-	-
	15-25	1	10%	7	70%	0	0%	7	70%	10*
	25-35	4	2%	11	7%	0	0%	10	6%	169
	35+	125	7%	663	35%	0	0%	389	21%	1886
MD10-0033	0-15	-	-	-	-	-	-	-	-	-
	15-25	1	4%	14	52%	0	0%	10	37%	27*
	25-35	5	22%	19	83%	0	0%	18	78%	23*
	35+	63	3%	573	28%	0	0%	341	17%	2036
MD10-0034	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	1	100%	0	0%	1	100%	1*
	25-35	10	20%	45	92%	0	0%	45	92%	49
	35+	105	6%	879	49%	0	0%	554	31%	1776