I-95 Corridor Coalition

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

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

I-95 CORRIDOR COALITION

June 2016

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT VALIDATION OF HERE 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 3,365 hours of observations along the remained arterial segments, totaling approximately 24 miles. The total number of effective five-minute travel time samples observed was 40,382.

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 the speed bins. 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	4.2	7.2	4.2	7.2	286	24
15-25 MPH	1.3	5.6	1.2	5.0	2766	231
25-35 MPH	0.9	3.8	0.4	0.7	11080	923
>35 MPH	2.3	6.8	-1.9	-4.3	26250	2188
All Speeds	1.8	5.9	-1.0	-2.2	40382	3365

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 signal per mile. The Average Annual Daily Traffic (AADT) is 27,100 along US-1 and the speed limit varies between 40 to 50 MPH.

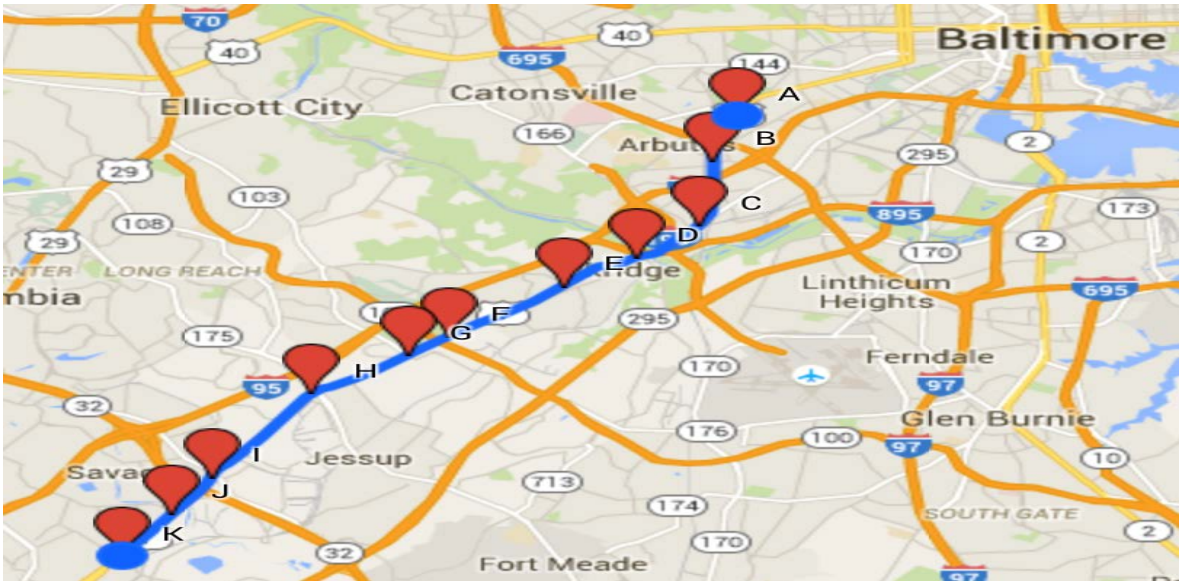

Figure 1 — Locations of all segments selected on US-1 for analysis in Maryland

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.

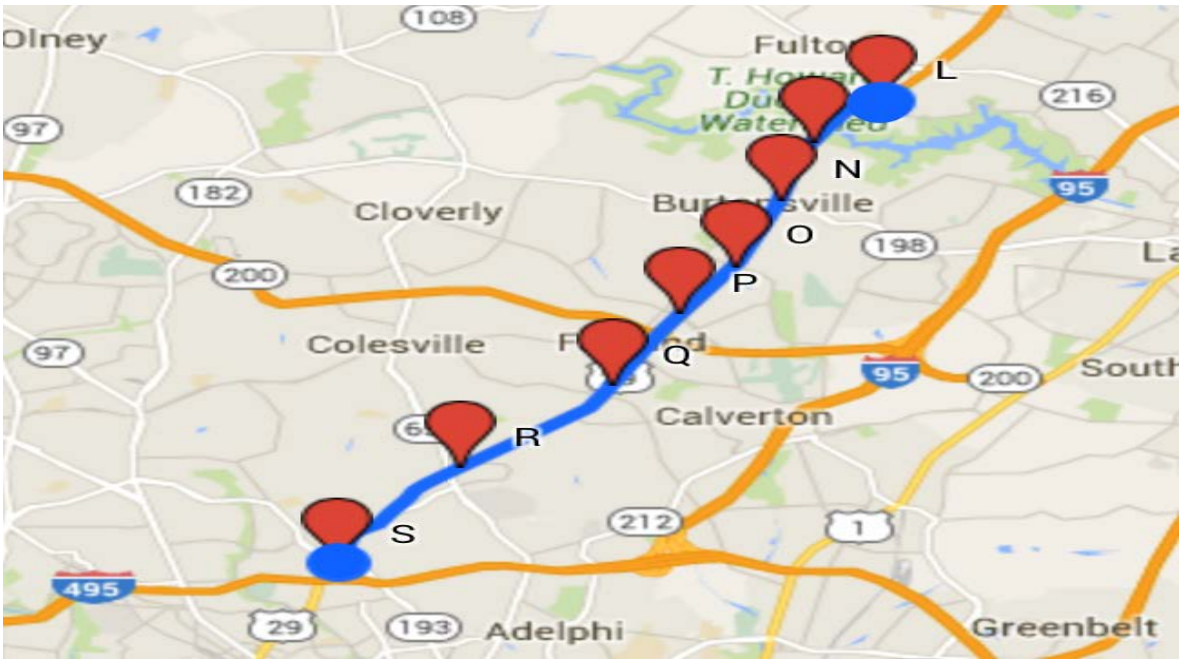

Figure 2 — Locations of all segments selected on US-29 for analysis in Maryland

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 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.

[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)

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.

Table 1
Segments selected for validation in Maryland

SEGMENT (Map Link)	DESCRIPTION Highway Maryland	State County	Starting at Ending at	TMC CODES Begin End	Length Number	Deployment Begin Lat/Lon End Lat/Lon		Length % Diff
Arterials								All Lengths in Miles
A2	US-1	Maryland	Sulphur Spring Rd	110N095576	1.42	39.247925	-76.691477	1.52
MD10-0002	Southbound	Baltimore	US-1/Washington Blvd	110N095575	2	39.227891	-76.694749	6.84%
A3	US-1	Maryland	US-1/Washington Blvd	110N09554	0.93	39.227891	-76.694749	1.13
MD10-0003	Southbound	Baltimore	I-895/Harbor Tunnel Trwy	110N09553	2	39.218047	-76.706175	21.60%
A4	US-1	Maryland	I-895/Harbor Tunnel Trwy	110N09552	1.39	39.218047	-76.706175	1.17
MD10-0004	Southbound	Howard	Montgomery Rd	110N09552	1	39.207073	-76.72717	-15.84%
A5	US-1	Maryland	Montgomery Rd	110N09551	1.85	39.207073	-76.72717	1.87
MD10-0005	Southbound	Howard	MD-100	110N09551	1	39.190565	-76.754239	1.08%
A6	US-1	Maryland	MD-100	110N09551	0.68	39.190565	-76.754239	0.66
MD10-0006	Southbound	Howard	MD-103	110N09550	2	39.183989	-76.763757	-2.93%
A7	US-1	Maryland	MD-103	110N09549	1.50	39.183989	-76.763757	1.52
MD10-0007	Southbound	Howard	MD-175	110N09549	1	39.171306	-76.786147	1.33%
A8	US-1	Maryland	MD-175	110N09548	2.42	39.171306	-76.786147	2.36
MD10-0008	Southbound	Howard	MD-32	110N09548	1	39.142115	-76.810623	-2.48%
A9	US-1	Maryland	MD-32	110N09548	0.93	39.142115	-76.810623	0.99
MD10-0009	Southbound	Howard	Gorman Rd	110N09547	2	39.130643	-76.819313	6.48%
A10	US-1	Maryland	Gorman Rd	110N09546	1.19	39.130643	-76.819313	1.17
MD10-0010	Southbound	Howard	Whiskey Bottom Rd	110N09546	1	39.116275	-76.831489	-1.68%
A11	US-1	Maryland	Whiskey Bottom Rd	110P09547	1.19	39.116275	-76.831489	1.16
MD10-0011	Northbound	Howard	Gorman Rd	110P09547	1	39.130566	-76.819175	-2.52%
A12	US-1	Maryland	Gorman Rd	110P09548	0.96	39.130566	-76.819175	0.98
MD10-0012	Northbound	Howard	MD-32	110P09548	1	39.142571	-76.810257	2.07%

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

SEGMENT (Map Link)	DESCRIPTION Freeway Maryland	State County	Starting at Ending at	TMC CODES Begin End	Length Number	Deployment Begin Lat/Lon End Lat/Lon		Length % Diff
Arterials								All Lengths in Miles
A13	US-1	Maryland	MD-32	110P09549	2.34	39.142571	-76.810257	2.37
MD10-0013	Northbound	Howard	MD-175/Waterloo Rd	110P09549	1	39.170706	-76.786497	1.28%
A14	US-1	Maryland	MD-175/Waterloo Rd	110P09549	1.54	39.170706	-76.786497	1.51
MD10-0014	Northbound	Howard	MD-103	110P09550	2	39.183911	-76.763672	-1.95%
A15	US-1	Maryland	MD-103	110P09551	0.69	39.183911	-76.763672	0.67
MD10-0015	Northbound	Howard	MD-100	110P09551	1	39.190469	-76.754087	-2.92%
A16	US-1	Maryland	MD-100	110P09552	1.85	39.190469	-76.754087	1.87
MD10-0016	Northbound	Howard	Montgomery Rd	110P09552	1	39.207073	-76.72717	1.08%
A17	US-1	Maryland	Montgomery Rd	110P09553	1.43	39.207073	-76.72717	1.17
MD10-0017	Northbound	Baltimore	I-895/Harbor Tunnel Trwy	110P09553	1	39.218202	-76.705371	-18.13%
A18	US-1	Maryland	I-895/Harbor Tunnel Trwy	110P09553	0.84	39.218202	-76.705371	1.13
MD10-0018	Northbound	Baltimore	US-1/Washington Blvd	110P09555	3	39.227318	-76.695168	34.56%
A22	US-29	Maryland	Dustin Rd	110N06887	1.08	39.126873	-76.922937	1.06
MD10-0022	Southbound	Montgomery	MD-198/Sandy Spring Rd	110N05902	2	39.112097	-76.929166	-1.85%
A23	US-29	Maryland	MD-198/Sandy Spring Rd	110N05902	1.23	39.112097	-76.929166	1.25
MD10-0023	Southbound	Montgomery	Greencastle Rd	110N05901	2	39.095646	-76.938143	1.62%
A24	US-29	Maryland	Greencastle Rd	110N05900	1.06	39.095646	-76.938143	0.99
MD10-0024	Southbound	Montgomery	Briggs Chaney Rd	110N05900	1	39.082702	-76.948835	-6.59%
A25	US-29	Maryland	Briggs Chaney Rd	110N05899	1.33	39.082702	-76.948835	1.43
MD10-0025	Southbound	Montgomery	Cherry Hill Rd/Randolph Rd	110N05898	2	39.065812	-76.960838	7.50%
A26	US-29	Maryland	Cherry Hill Rd/Randolph Rd	110N05898	2.12	39.065812	-76.960838	2.13
MD10-0026	Southbound	Montgomery	MD-650	110N05897	2	39.045094	-76.989367	0.47%

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

SEGMENT (Map Link)	DESCRIPTION Highway Maryland	State County	Starting at Ending at	TMC CODES Begin End	Length Number	Deployment Begin Lat/Lon End Lat/Lon		Length % Diff
Arterials								All Lengths in Miles
A27	US-29	Maryland	MD-650	110N05897	2.18	39.045094	-76.989367	2.17
MD10-0027	Southbound	Montgomery	MD-193/University Blvd	110N05896	2	39.020388	-77.012784	-0.46%
A28	US-29	Maryland	MD-193/University Blvd	110P05897	2.21	39.020308	-77.012641	2.17
MD10-0028	Northbound	Montgomery	MD-650	110P05897	1	39.019712	-77.013182	-1.81%
A29	US-29	Maryland	MD-650	110P05898	2.09	39.019712	-77.013182	2.14
MD10-0029	Northbound	Montgomery	Cherry Hill Rd/Randolph Rd	110P05899	2	39.045238	-76.988839	2.39%
A30	US-29	Maryland	Cherry Hill Rd/Randolph Rd	110P05899	1.05	39.045238	-76.988839	1.43
MD10-0030	Northbound	Montgomery	Briggs Chaney Rd	110P05900	2	39.065569	-76.960647	36.08%
A31	US-29	Maryland	Briggs Chaney Rd	110P05900	1.35	39.065569	-76.960647	0.99
MD10-0031	Northbound	Montgomery	Greencastle Rd	110P05901	2	39.065569	-76.960647	-26.61%
A32	US-29	Maryland	Greencastle Rd	110P05902	0.93	39.079051	-76.951499	1.26
MD10-0032	Northbound	Montgomery	MD-198/Sandy Spring Rd	110P05902	1	39.079051	-76.951499	35.44%
A33	US-29	Maryland	MD-198/Sandy Spring Rd	110P05902	1.33	39.095535	-76.937874	1.05
MD10-0033	Northbound	Montgomery	Dustin Rd	110P05241	3	39.095535	-76.937874	-21.06%
A34	US-29	Maryland	Dustin Rd	110P05241	1.04	39.126133	-76.923265	1.03
MD10-0034	Northbound	Howard	Old Columbia Rd	110P05242	2	39.136748	-76.910612	-0.96%

Analysis of Arterial Results

Table 2 summarizes the data quality measures obtained as a result of 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 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 in all speed bins. The Speed Error Bias (SEB) was within specifications for all the speed bins except speed bin 0-15 MPH, when compared to the mean.

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 (contract specifications)	SEB	AASE		
0-15	4.2	4.2	7.2	7.2	286	24
15-25	1.2	1.3	5.0	5.6	2766	231
25-35	0.4	0.9	0.7	3.8	11080	923
35+	-1.9	2.3	-4.3	6.8	26250	2188

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 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	18%	72%	0%	52%	286
15-25	61%	92%	0%	52%	2766
25-35	72%	94%	0%	74%	11080
35+	54%	81%	0%	42%	26250

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	0.6	0.6	2.8	2.9	11*
			35+	-3.6	3.6	-7.1	7.2	470
MD10-0003	0.93	1.13	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	0.1	0.2	0.4	2.4	223
			35+	-1.9	1.9	-6.1	6.2	499
MD10-0004	1.39	1.17	0-15	17.9	17.9	20.8	20.8	2*
			15-25	3.1	3.1	4.4	4.6	7*
			25-35	-0.2	0.3	-1.0	2.7	103
			35+	-3.9	3.9	-9.4	9.4	1051
MD10-0005	1.85	1.87	0-15	17.3	17.3	23.3	23.3	5*
			15-25	2.1	2.1	10.7	10.7	93
			25-35	0.4	0.5	2.2	3.3	400
			35+	-1.3	1.3	-4.2	4.6	223
MD10-0006	0.69	0.66	0-15	-	-	-	-	-
			15-25	0.0	0.4	2.5	4.7	28*
			25-35	-0.3	0.4	-2.2	4.1	397
			35+	-3.8	3.8	-9.5	9.5	911
MD10-0007	1.5	1.52	0-15	3.4	3.4	6.9	6.9	56
			15-25	0.7	0.7	4.4	4.7	267
			25-35	-0.3	0.4	-1.9	3.1	364
			35+	-2.9	2.9	-8.6	8.6	73
MD10-0008	2.42	2.36	0-15	8.9	8.9	17.8	17.8	17*
			15-25	1.6	1.6	9.1	9.1	160
			25-35	0.1	0.3	0.5	3.0	407
			35+	-1.9	1.9	-6.5	6.6	110
MD10-0009	0.92	0.99	0-15	4.1	4.1	7.0	7.0	4*
			15-25	0.8	0.9	3.9	4.7	262
			25-35	-0.2	0.3	-2.3	3.9	633
			35+	-3.8	3.8	-10.7	10.7	339
MD10-0011	1.19	1.16	0-15	7.2	7.2	12.3	12.3	6*
			15-25	1.5	1.5	5.5	5.8	154
			25-35	0.1	0.4	0.6	3.0	1198
			35+	-1.4	1.4	-4.8	5.0	406
MD10-0012	0.96	0.98	0-15	4.3	4.3	7.1	7.1	21*
			15-25	1.0	1.0	2.6	3.8	544
			25-35	-0.2	0.5	-1.7	4.1	559
			35+	-1.6	1.6	-7.9	8.0	163

*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	4.1	4.1	10.1	10.2	16*
			15-25	0.9	0.9	6.4	6.5	138
			25-35	-0.4	0.6	-1.7	3.1	400
			35+	-2.8	2.8	-7.6	7.6	134
MD10-0014	1.54	1.51	0-15	4.8	4.8	10.3	10.3	5*
			15-25	0.8	0.9	3.5	4.3	181
			25-35	-0.3	0.5	-2.2	3.5	542
			35+	-2.8	2.8	-8.7	8.7	111
MD10-0015	0.69	0.67	0-15	8.4	8.4	14.8	14.8	12*
			15-25	1.1	1.1	6.1	6.3	444
			25-35	0.0	0.1	0.0	3.1	585
			35+	-2.6	2.6	-8.4	8.5	178
MD10-0016	1.85	1.87	0-15	11.9	11.9	19.6	19.6	5*
			15-25	1.7	1.7	11.7	11.7	56
			25-35	0.1	0.3	1.0	2.6	343
			35+	-1.7	1.7	-4.7	4.9	365
MD10-0017	1.43	1.17	0-15	14.5	14.5	26.1	26.1	1*
			15-25	2.8	2.8	12.6	12.6	39
			25-35	0.5	0.5	4.2	4.6	531
			35+	-1.1	1.1	-3.9	4.5	606
MD10-0018	0.84	1.13	0-15	-	-	-	-	-
			15-25	5.6	5.6	8.1	8.1	3*
			25-35	0.4	0.5	1.9	3.0	258
			35+	-1.5	1.5	-5.0	5.2	377
MD10-0022	1.08	1.06	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	7.7	7.7	12.0	12.0	1*
			35+	-0.2	0.6	-0.5	3.6	2140
MD10-0023	1.23	1.25	0-15	-	-	-	-	-
			15-25	9.3	9.3	12.2	12.2	6*
			25-35	2.5	2.9	4.5	5.2	41
			35+	-2.2	2.3	-6.0	7.1	2037
MD10-0024	1.06	0.99	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	6.8	6.8	16.5	16.5	77
			35+	-0.4	1.1	0.3	6.6	2144
MD10-0025	1.34	1.43	0-15	-	-	-	-	-
			15-25	4.7	4.7	12.1	12.1	2*
			25-35	3.8	3.8	7.5	7.6	203
			35+	-0.8	1.2	-1.8	5.9	1919
MD10-0026	2.12	2.13	0-15	1.1	1.1	1.8	1.9	45
			15-25	4.3	4.4	5.8	6.6	21*
			25-35	0.6	1.7	1.7	4.5	458
			35+	-1.0	1.3	-1.8	3.5	1130

*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	1.2	1.3	1.9	2.1	30*
			15-25	0.6	0.9	1.5	2.3	111
			25-35	-0.5	0.7	-1.8	2.6	1020
			35+	-3.1	3.2	-6.6	6.7	336
MD10-0028	1.21	1.17	0-15	3.0	3.0	3.9	3.9	31
			15-25	1.6	1.7	3.2	3.6	85
			25-35	-0.1	0.4	-0.3	2.3	1091
			35+	-1.6	1.7	-4.4	4.8	373
MD10-0029	2.09	2.14	0-15	2.7	2.7	3.4	3.4	21*
			15-25	2.2	2.5	3.6	4.1	95
			25-35	1.4	1.6	3.1	4.4	641
			35+	-0.8	0.9	-2.2	4.4	902
MD10-0030	1.05	1.43	0-15	-	-	-	-	-
			15-25	2.3	2.3	8.0	8.1	7*
			25-35	3.8	3.8	7.3	7.5	314
			35+	0.1	0.8	0.2	4.5	1425
MD10-0031	1.35	0.99	0-15	9.3	9.3	12.0	12.3	9*
			15-25	1.1	1.1	2.9	4.5	25*
			25-35	0.4	0.9	-0.6	4.5	40
			35+	-4.8	4.8	-11.6	11.7	2156
MD10-0032	0.93	1.26	0-15	-	-	-	-	-
			15-25	8.9	8.9	12.6	12.6	10*
			25-35	5.7	5.7	11.6	11.8	168
			35+	1.1	1.4	5.0	6.5	1879
MD10-0033	1.33	1.05	0-15	-	-	-	-	-
			15-25	4.1	4.1	5.7	5.7	27*
			25-35	3.3	3.3	4.8	5.9	23*
			35+	-5.3	5.3	-9.9	9.9	2028
MD10-0034	1.04	1.03	0-15	-	-	-	-	-
			15-25	6.7	6.7	7.6	7.6	1*
			25-35	4.4	4.4	5.8	5.8	49
			35+	-2.2	2.3	-5.6	5.9	1765

*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 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	4	36%	10	91%	0	0%	9	82%	11*
	35+	13	3%	198	42%	0	0%	144	31%	470
MD10-0003	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	77	35%	215	96%	0	0%	200	90%	223
	35+	69	14%	294	59%	0	0%	219	44%	499
MD10-0004	0-15	0	0%	0	0%	0	0%	0	0%	2*
	15-25	4	57%	5	71%	0	0%	5	71%	7*
	25-35	45	44%	97	94%	0	0%	88	85%	103
	35+	39	4%	316	30%	2	0%	172	16%	1051
MD10-0005	0-15	0	0%	0	0%	0	0%	0	0%	5*
	15-25	3	3%	14	15%	0	0%	7	8%	93
	25-35	111	28%	356	89%	0	0%	307	77%	400
	35+	46	21%	161	72%	0	0%	139	62%	223
MD10-0006	0-15	-	-	-	-	-	-	-	-	-
	15-25	6	21%	23	82%	0	0%	15	54%	28*
	25-35	136	34%	338	85%	2	1%	267	67%	397
	35+	52	6%	305	33%	0	0%	172	19%	911
MD10-0007	0-15	2	4%	27	48%	0	0%	24	43%	56
	15-25	57	21%	203	76%	0	0%	156	58%	267
	25-35	141	39%	329	90%	0	0%	296	81%	364
	35+	0	0%	22	30%	0	0%	8	11%	73
MD10-0008	0-15	0	0%	0	0%	0	0%	0	0%	17*
	15-25	7	4%	56	35%	0	0%	33	21%	160
	25-35	138	34%	377	93%	0	0%	341	84%	407
	35+	7	6%	60	55%	0	0%	41	37%	110
MD10-0009	0-15	0	0%	1	25%	0	0%	1	25%	4*
	15-25	60	23%	208	79%	0	0%	159	61%	262
	25-35	265	42%	550	87%	0	0%	453	72%	633
	35+	19	6%	90	27%	0	0%	47	14%	339
MD10-0011	0-15	0	0%	1	17%	0	0%	1	17%	6*
	15-25	13	8%	90	58%	0	0%	67	44%	154
	25-35	428	36%	1104	92%	1	0%	990	83%	1198
	35+	79	19%	289	71%	0	0%	220	54%	406
MD10-0012	0-15	0	0%	9	43%	0	0%	5	24%	21*
	15-25	169	31%	443	81%	0	0%	387	71%	544
	25-35	162	29%	469	84%	0	0%	364	65%	559
	35+	16	10%	79	48%	0	0%	57	35%	163

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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%	81	59%	0	0%	55	40%	138
	25-35	122	31%	357	89%	0	0%	326	82%	400
	35+	4	3%	57	43%	0	0%	39	29%	134
MD10-0014	0-15	0	0%	2	40%	0	0%	2	40%	5*
	15-25	47	26%	143	79%	0	0%	119	66%	181
	25-35	180	33%	476	88%	0	0%	400	74%	542
	35+	3	3%	44	40%	0	0%	26	23%	111
MD10-0015	0-15	0	0%	0	0%	0	0%	0	0%	12*
	15-25	64	14%	291	66%	0	0%	162	36%	444
	25-35	301	51%	550	94%	0	0%	461	79%	585
	35+	16	9%	85	48%	0	0%	43	24%	178
MD10-0016	0-15	0	0%	0	0%	0	0%	0	0%	5*
	15-25	1	2%	7	13%	0	0%	1	2%	56
	25-35	114	33%	322	94%	2	1%	294	86%	343
	35+	44	12%	255	70%	0	0%	207	57%	365
MD10-0017	0-15	0	0%	0	0%	0	0%	0	0%	1*
	15-25	0	0%	4	10%	0	0%	0	0%	39
	25-35	125	24%	427	80%	0	0%	318	60%	531
	35+	197	33%	461	76%	0	0%	385	64%	606
MD10-0018	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	0	0%	3*
	25-35	71	28%	238	92%	0	0%	211	82%	258
	35+	60	16%	253	67%	0	0%	196	52%	377
MD10-0022	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	0	0%	0	0%	0	0%	0	0%	1*
	35+	744	35%	1838	86%	3	0%	1563	73%	2140
MD10-0023	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	1	17%	0	0%	0	0%	6*
	25-35	8	20%	27	66%	0	0%	24	59%	41
	35+	439	22%	1152	57%	1	0%	824	40%	2037
MD10-0024	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	0	0%	5	6%	0	0%	1	1%	77
	35+	664	31%	1472	69%	1	0%	955	45%	2144
MD10-0025	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	0	0%	2*
	25-35	21	10%	91	45%	0	0%	61	30%	203
	35+	644	34%	1384	72%	0	0%	971	51%	1919
MD10-0026	0-15	5	11%	44	98%	0	0%	43	96%	45
	15-25	0	0%	13	62%	0	0%	11	52%	21*
	25-35	60	13%	336	73%	0	0%	281	61%	458
	35+	269	24%	928	82%	0	0%	847	75%	1130

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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	2	7%	28	93%	0	0%	27	90%	30*
	15-25	22	20%	105	95%	0	0%	100	90%	111
	25-35	197	19%	953	93%	0	0%	901	88%	1020
	35+	16	5%	150	45%	0	0%	95	28%	336
MD10-0028	0-15	0	0%	26	84%	0	0%	25	81%	31
	15-25	11	13%	68	80%	0	0%	60	71%	85
	25-35	296	27%	1050	96%	0	0%	1006	92%	1091
	35+	40	11%	266	71%	0	0%	200	54%	373
MD10-0029	0-15	0	0%	19	90%	0	0%	14	67%	21*
	15-25	3	3%	76	80%	0	0%	70	74%	95
	25-35	125	20%	479	75%	0	0%	406	63%	641
	35+	254	28%	723	80%	0	0%	599	66%	902
MD10-0030	0-15	-	-	-	-	-	-	-	-	-
	15-25	2	29%	3	43%	0	0%	3	43%	7*
	25-35	28	9%	133	42%	0	0%	95	30%	314
	35+	459	32%	1113	78%	0	0%	872	61%	1425
MD10-0031	0-15	1	11%	3	33%	0	0%	3	33%	9*
	15-25	12	48%	23	92%	0	0%	19	76%	25*
	25-35	18	45%	35	88%	0	0%	26	65%	40
	35+	136	6%	585	27%	0	0%	283	13%	2156
MD10-0032	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	4	40%	0	0%	4	40%	10*
	25-35	11	7%	42	25%	0	0%	26	15%	168
	35+	339	18%	1127	60%	0	0%	766	41%	1879
MD10-0033	0-15	-	-	-	-	-	-	-	-	-
	15-25	2	7%	14	52%	0	0%	13	48%	27*
	25-35	3	13%	14	61%	0	0%	11	48%	23*
	35+	32	2%	402	20%	0	0%	224	11%	2028
MD10-0034	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	0	0%	1*
	25-35	3	6%	23	47%	0	0%	19	39%	49
	35+	192	11%	1049	59%	0	0%	765	43%	1765