



## I-95 Corridor Coalition

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

Monthly Report: Maryland



*April 2013*

# I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT VALIDATION OF INRIX DATA APRIL 2013

## *Monthly Report*

*Prepared for:*

I-95 Corridor Coalition

*Sponsored by:*

I-95 Corridor Coalition

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*April 2013*

# 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. BTMs sensor were deployed on the beginning and ending points of 14 different segments along the I-695 and I-795 freeway corridors in Baltimore County, Maryland. The Bluetooth sensor deployment covers the range from Exit 8/I-895 to Exit 16/I-70 along I-695; and from Exit 1/I-695 to Exit 7/Franklin Blvd along I-795. Travel time data was collected for both directions along the freeways. The data was collected between February 11, 2013 and February 25, 2013 with the assistance of Maryland State Highway Administration (SHA) personnel. The dataset collected represents approximately 2,700 hours of observations along 14 freeway segments, totaling nearly 23 miles. The number of effective five-minute travel time samples observed was 32,316 in total.

ES Table 1, below, summarizes the results of the comparison between the validation data and the INRIX data for freeway segments during the above noted periods. As shown, the average absolute speed error (AASE) and Speed Error Bias (SEB) were within specification for all speed bins. Even when errors are measured against the mean (rather than the SEM band) the data meets contract specifications for the AASE in all speed bins.

<b>ES Table 1 - Maryland Evaluation Summary</b>						
<b>Speed Bin</b>	<b>Absolute Speed Error (&lt;10mph)</b>		<b>Speed Error Bias (&lt;5mph)</b>		<b>Number of 5 Minute Samples</b>	<b>Hours of Data Collection</b>
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	<b>1.90</b>	3.10	<b>1.40</b>	1.90	1671	139.3
30-45 MPH	<b>4.40</b>	6.50	<b>3.50</b>	4.90	1483	123.6
45-60 MPH	<b>2.00</b>	4.20	<b>1.70</b>	3.40	12490	1040.8
> 60 MPH	<b>0.90</b>	3.00	<b>-0.40</b>	-1.10	16672	1389.3
All Speeds	1.54	3.63	0.68	1.07	32316	2693.0

Based upon data collected from February 11, 2013 through February 25, 2013 across 22.5 miles of roadway.

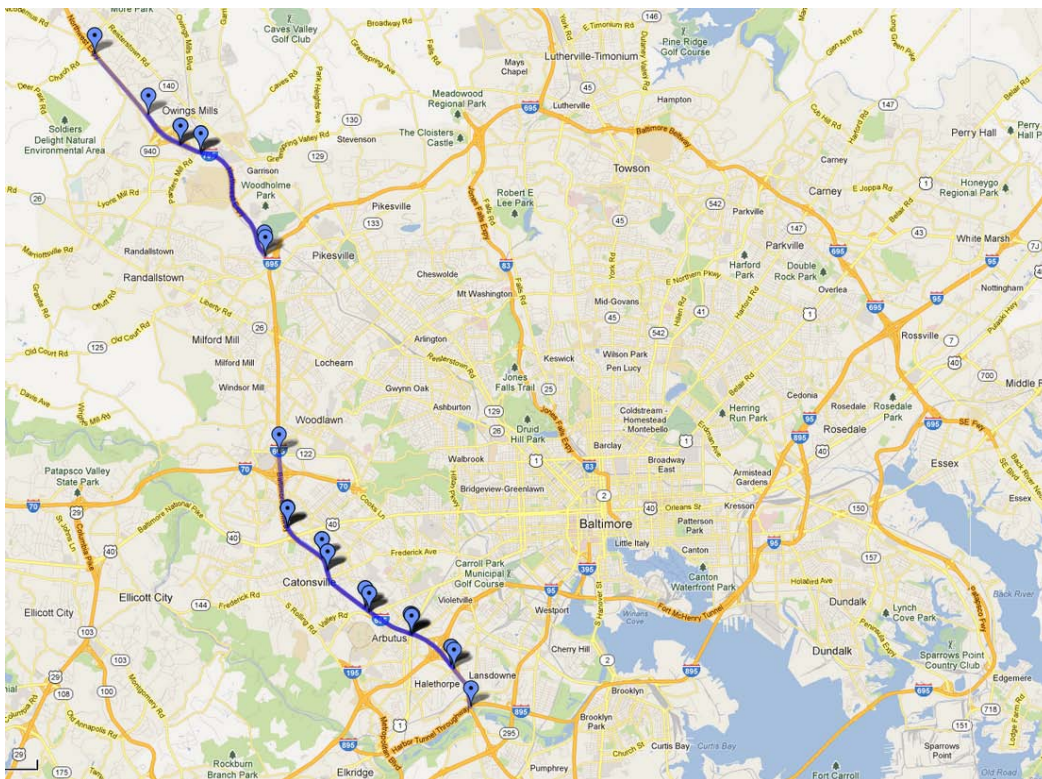
As part of the on-going validation process, vehicle probe data from each state is validated on a rotating basis. Since the inception of the validation process, data on roadways in the State of Maryland were validated on six occasions: July/August 2008, March 2009, February 2010, October 2010, October 2011, and February 2013. This represents more than 6,350 hours of observations along 120 miles of freeway segments in Maryland. ES Table 2 provides a summary of the cumulative validation effort. As shown, the absolute average speed error and speed error bias are within specification for all speed bins.

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		
0-30 MPH	<b>2.65</b>	3.90	<b>1.39</b>	1.81	4266	355.5
30-45 MPH	<b>4.37</b>	6.64	<b>2.65</b>	3.87	3962	330.2
45-60 MPH	<b>2.01</b>	4.23	<b>1.17</b>	2.53	26714	2226.2
> 60 MPH	<b>1.32</b>	3.61	<b>-0.89</b>	-1.90	41398	3449.8
All Speeds	1.80	4.00	0.14	0.16	76340	6361.7

## Data Collection

The data from the Vehicle Probe Project is validated using Bluetooth™ Traffic Monitoring (BTM) technology on a near monthly basis. BTM sensors were deployed on the beginning and ending points of 14 different segments along the I-695 and I-795 freeway corridors. The Bluetooth sensor deployment covers the range from Exit 8/I-895 to Exit 16/I-70 along I-695; and from Exit 1/I-695 to Exit 7/Franklin Blvd along I-795. Travel time data was collected for both directions along the freeways. The data was collected between February 11, 2013 and February 25, 2013 with the assistance of Maryland State Highway Administration (SHA) personnel. Segment locations are chosen with a high-likelihood of observing recurrent and non-recurrent congestions during peak or off-peak periods.

Figure 1 presents an overview snapshot of the roadway segments over which Bluetooth sensors were deployed. Blue segments represent freeway segments selected for analysis.



**Figure 1** — Locations of all segments selected for analysis in Maryland

### ***TMC segments selected for validation in Maryland***

Table 1 presents a list of data collection segments from Maryland. In total, these segments cover a length of approximately 22.5 freeway miles. Data collection segments are comprised of one or more Traffic Message Channel (TMC) base segments, such that total length of the data collection segment is one mile long or greater for freeways. When appropriate, consecutive TMC segments are combined to form a data collection segment longer than one mile. The results of validation performed on 14 freeway segments are included in this report. Table 1 contains summary information on each data collection segment. The latitude/longitude coordinates of the locations at which the Bluetooth sensors were deployed throughout the state of Maryland 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 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<sup>TM</sup> Traffic Monitoring (BTM) sensors placed on the roadway. Details of the algorithm used to estimate equivalent path travel times based on INRIX data feeds for individual data collection segments are provided in a separate report. This algorithm finds an equivalent INRIX 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			TMC CODES		Deployment		Length % Diff
	Highway Direction	State County	Starting at Ending at	Begin End	Number Length	Begin Lat/Lon End Lat/Lon		
<b>FREEWAYS</b>								All Lengths in Miles
F1 <a href="#">(MD06-0001)</a>	I-695 Counterclockwise	MD Baltimore	I-70/Exit 16 US-40/Exit 15B	110-04520 110-04519	3 1.59	39.312221 -76.744719 39.289431 -76.74138	1.59 0.3%	
F2 <a href="#">(MD06-0002)</a>	I-695 Counterclockwise	MD Baltimore	US-40/Exit 15 Edmondson Ave/Exit 14	110N04519 110N04518	3 1.04	39.289431 -76.74138 39.279571 -76.72718	1.00 -3.4%	
F3 <a href="#">(MD06-0003)</a>	I-695 Counterclockwise	MD Baltimore	Edmondson Ave/Exit 14 MD-372/Wilkens Ave/Exit 12	110-04517 110-04516	3 1.60	39.279571 -76.72718 39.262954 -76.708164	1.67 4.6%	
F4 <a href="#">(MD06-0004)</a>	I-695 Counterclockwise	MD Baltimore	MD-372/Wilkens Ave/Exit 12 US-1/Southwestern Blvd/Exit 12	110N04516 110-04515	2 1.06	39.262954 -76.708164 39.255772 -76.690927	1.1 4.0%	
F5 <a href="#">(MD06-0005)</a>	I-695 Counterclockwise	MD Baltimore	US-1/Southwestern Blvd/Exit 12 US-1 Alt/Washington Blvd/Exit10	110-04514 110-04513	3 1.20	39.255772 -76.690927 39.244919 -76.673952	1.1 -8.7%	
F6 <a href="#">(MD06-0006)</a>	I-695 Clockwise	MD Baltimore	I-895/Exit 8 I-95/Exit 11	110P04511 110+04514	6 1.03	39.232917 -76.666985 39.246083 -76.67485	1.02 -0.9%	
F7 <a href="#">(MD06-0007)</a>	I-695 Clockwise	MD Baltimore	I-95/Exit 11 I-95/Exit 11	110P04514 110P04514	1 1.15	39.246083 -76.67485 39.256136 -76.691398	1.22 6.0%	
F8 <a href="#">(MD06-0008)</a>	I-695 Clockwise	MD Baltimore	US-1/Southwestern Blvd/Exit 12 MD-372/Wilkens Ave/Exit 12	110+04516 110P04516	2 1.17	39.255995 -76.690866 39.264178 -76.709759	1.18 0.9%	
F9 <a href="#">(MD06-0009)</a>	I-695 Clockwise	MD Baltimore	MD-372/Wilkens Ave/Exit 12 MD-144/Frederick Rd/Exit 13	110+04517 110P04517	2 1.19	39.264178 -76.709759 39.275984 -76.724994	1.09 -8.6%	

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

SEGMENT (Map Link)	DESCRIPTION			TMC CODES		Deployment		
	Highway Direction	State County	Starting at Ending at	Begin End	Number Length	Begin Lat/Lon End Lat/Lon	Length % Diff	
<b>FREEWAYS</b>								All Lengths in Miles
F10 <a href="#">(MD06-0010)</a>	I-695 Clockwise	MD Baltimore	MD-144/Frederick Rd/Exit 13 US-40/Exit 15	110+04518 110P04519	4 1.33	39.275984 -76.724994 39.289689 -76.74124	1.29 -2.8%	
F11 <a href="#">(MD06-0011)</a>	I-795 Northbound	MD Baltimore	I-695/Exit 1B Owings Mills Blvd/Exit 4	110+04491 110+04491	1 2.75	39.375423 -76.750531 39.406415 -76.776275	2.67 -2.8%	
F12 <a href="#">(MD06-0012)</a>	I-795 Northbound	MD Baltimore	Owings Mills Blvd/Exit 4 Owings Mills Blvd/Exit 4	110P04491 110P04491	1 1.43	39.406415 -76.776275 39.418027 -76.797652	1.41 -1.3%	
F13 <a href="#">(MD06-0013)</a>	I-795 Southbound	MD Baltimore	Franklin Blvd/Exit 7 Owings Mills Blvd/Exit 4	110-04491 110N04491	2 2.71	39.437069 -76.819022 39.408716 -76.784586	2.71 0.0%	
F14 <a href="#">(MD06-0014)</a>	I-795 Southbound	MD Baltimore	Owings Mills Blvd/Exit 4 I-695/Exit 1A	110-04490 110-04490	1 3.29	39.408716 -76.784586 39.374136 -76.750247	3.32 0.9%	
TOTALS					34 22.5		22.3 0.7%	



## ***Analysis of Freeway Results***

Table 2 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds. Specifications 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: 0-30 MPH, 30-45 MPH, 45-60 MPH, and > 60 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<sup>th</sup> 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, and are highlighted in Table 2. AASE below 10 MPH meet contract specifications. AASE below 5 MPH are considered exceptional quality. As shown, the average absolute speed error (AASE) and Speed Error Bias (SEB) were within specification for all speed bins.

**Table 2**  
**Data quality measures for freeway 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		
0-30	1.4	1.9	1.9	3.1	1671	139
30-45	3.5	4.4	4.9	6.5	1483	124
45-60	1.7	2.0	3.4	4.2	12490	1041
60+	-0.4	0.9	-1.1	3.0	16672	1389

Table 3 shows the percentage of the time INRIX data falls within 5 mph of the SEM band and the mean for each speed bin for all freeway data segments in Maryland.

**Table 3**  
**Percent observations meeting data quality criteria for freeway segments greater than one mile 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	
0-30	34%	91%	0%	85%	1671
30-45	20%	66%	0%	53%	1483
45-60	38%	87%	0%	67%	12490
60+	60%	96%	0%	82%	16672

Tables 4 and 5 present detailed data for individual TMC segments in Maryland 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 small number of observations.

**Table 4**  
**Data quality measures for individual freeway validation segments greater than one mile 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	
MD06-0001	1.59	1.59	0-30	0.5	0.9	0.8	1.7	554
			30-45	2.9	3.9	3.7	5.7	124
			45-60	1.1	1.3	3.0	3.7	528
			60+	-0.6	0.8	-1.8	3.0	1370
MD06-0002	1.04	1.00	0-30	2.6	2.9	3.3	4.3	316
			30-45	3.5	3.9	4.6	5.4	585
			45-60	1.0	1.5	2.6	3.6	1513
			60+	-0.5	0.6	-1.9	2.8	241
MD06-0003	1.60	1.67	0-30	-	-	-	-	0*
			30-45	4.4	5.1	5.3	6.8	95
			45-60	2.3	2.4	4.1	4.2	2592
			60+	0.3	0.5	0.6	2.1	853
MD06-0004	1.06	1.10	0-30	13.0	13.0	23.7	23.7	3*
			30-45	11.1	11.1	16.8	17.9	7*
			45-60	2.7	2.7	5.4	5.4	378
			60+	-0.2	0.9	-0.6	3.0	3202
MD06-0005	1.20	1.10	0-30	2.4	2.5	3.5	3.8	40
			30-45	3.2	5.2	12.3	16.8	10*
			45-60	1.0	1.2	3.8	4.6	142
			60+	-0.7	0.9	-2.1	3.2	1538
MD06-0006	1.03	1.02	0-30	2.3	2.7	3.5	4.9	60
			30-45	2.8	5.0	6.9	10.7	44
			45-60	1.0	1.4	3.2	4.0	1474
			60+	-0.2	0.6	-0.8	2.5	955
MD06-0007	1.15	1.22	0-30	1.2	1.6	1.6	3.1	272
			30-45	1.1	4.3	2.6	7.4	95
			45-60	0.3	1.1	1.3	3.1	930
			60+	-1.7	1.8	-4.1	4.6	1664
MD06-0008	1.17	1.18	0-30	1.5	1.9	1.8	2.7	135
			30-45	4.9	5.4	6.0	6.9	205
			45-60	3.8	3.9	5.8	6.0	1434
			60+	0.0	0.0	-1.6	2.5	3*
MD06-0009	1.19	1.09	0-30	2.0	2.7	2.5	4.0	37
			30-45	1.6	3.2	2.8	5.2	79
			45-60	0.8	1.2	1.9	3.0	1601
			60+	-1.7	2.0	-4.3	4.8	57

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

**Table 4 (Cont'd)**  
**Data quality measures for individual freeway validation segments greater than one mile 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	
MD06-0010	1.33	1.29	0-30	0.3	1.5	0.9	3.0	103
			30-45	0.9	2.6	1.3	4.3	98
			45-60	0.6	1.1	1.7	2.9	1079
			60+	-0.9	1.1	-2.4	3.1	1229
MD06-0011	2.75	2.67	0-30	29.2	29.2	35.2	35.2	1*
			30-45	9.0	9.0	12.9	13.1	30*
			45-60	3.6	3.6	6.1	6.3	379
			60+	0.4	0.8	1.0	2.5	1609
MD06-0012	1.43	1.41	0-30	3.2	3.7	3.8	4.8	58
			30-45	4.6	5.6	6.2	8.0	78
			45-60	2.3	3.1	5.4	6.8	305
			60+	-0.1	0.7	-0.4	2.8	1610
MD06-0013	2.71	2.71	0-30	2.2	2.4	2.7	3.6	38
			30-45	5.0	5.0	19.5	19.5	13*
			45-60	3.3	3.9	6.2	7.1	43
			60+	0.1	0.7	0.3	2.9	704
MD06-0014	3.29	3.32	0-30	1.3	1.8	1.5	2.8	54
			30-45	4.1	4.6	6.9	8.0	20*
			45-60	2.9	3.8	5.8	7.5	92
			60+	-0.3	0.8	-0.9	2.7	1637

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

**Table 5**  
**Observations meeting data quality criteria for individual freeway validation segments**  
**greater than one mile 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	
MD06-0001	0-30	216	39%	536	97%	1	0%	528	95%	554
	30-45	27	22%	85	69%	0	0%	68	55%	124
	45-60	281	53%	490	93%	0	0%	388	73%	528
	60+	869	63%	1314	96%	0	0%	1130	82%	1370
MD06-0002	0-30	99	31%	263	83%	0	0%	241	76%	316
	30-45	114	19%	418	71%	0	0%	370	63%	585
	45-60	746	49%	1395	92%	3	0%	1145	76%	1513
	60+	162	67%	236	98%	0	0%	211	88%	241
MD06-0003	0-30	-	-	-	-	-	-	-	-	0*
	30-45	24	25%	61	64%	0	0%	48	51%	95
	45-60	515	20%	2282	88%	0	0%	1740	67%	2592
	60+	552	65%	835	98%	0	0%	791	93%	853
MD06-0004	0-30	0	0%	1	33%	0	0%	0	0%	3*
	30-45	0	0%	2	29%	0	0%	1	14%	7*
	45-60	88	23%	312	83%	0	0%	168	44%	378
	60+	1803	56%	3094	97%	3	0%	2654	83%	3202
MD06-0005	0-30	13	33%	31	78%	0	0%	27	68%	40
	30-45	3	30%	5	50%	0	0%	1	10%	10*
	45-60	75	53%	133	94%	1	1%	93	65%	142
	60+	972	63%	1479	96%	3	0%	1232	80%	1538
MD06-0006	0-30	15	25%	49	82%	0	0%	43	72%	60
	30-45	9	20%	26	59%	0	0%	12	27%	44
	45-60	721	49%	1365	93%	2	0%	1039	70%	1474
	60+	678	71%	932	98%	0	0%	841	88%	955
MD06-0007	0-30	103	38%	254	93%	0	0%	220	81%	272
	30-45	24	25%	56	59%	0	0%	37	39%	95
	45-60	580	62%	873	94%	0	0%	756	81%	930
	60+	791	48%	1462	88%	4	0%	1057	64%	1664
MD06-0008	0-30	30	22%	124	92%	0	0%	115	85%	135
	30-45	24	12%	108	53%	0	0%	88	43%	205
	45-60	163	11%	950	66%	0	0%	504	35%	1434
	60+	3	100%	3	100%	0	0%	3	100%	3*
MD06-0009	0-30	10	27%	34	92%	0	0%	31	84%	37
	30-45	16	20%	55	70%	0	0%	48	61%	79
	45-60	792	49%	1516	95%	0	0%	1327	83%	1601
	60+	19	33%	50	88%	0	0%	33	58%	57

\*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 freeway validation segments**  
**greater than one mile 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	
MD06-0010	0-30	39	38%	95	92%	0	0%	94	91%	103
	30-45	21	21%	81	83%	0	0%	67	68%	98
	45-60	596	55%	1015	94%	0	0%	887	82%	1079
	60+	674	55%	1169	95%	0	0%	1003	82%	1229
MD06-0011	0-30	0	0%	0	0%	0	0%	0	0%	1*
	30-45	4	13%	10	33%	0	0%	6	20%	30*
	45-60	64	17%	266	70%	0	0%	150	40%	379
	60+	903	56%	1576	98%	0	0%	1446	90%	1609
MD06-0012	0-30	14	24%	47	81%	0	0%	44	76%	58
	30-45	17	22%	46	59%	0	0%	35	45%	78
	45-60	97	32%	238	78%	0	0%	100	33%	305
	60+	1114	69%	1566	97%	0	0%	1358	84%	1610
MD06-0013	0-30	11	29%	33	87%	0	0%	30	79%	38
	30-45	4	31%	7	54%	0	0%	1	8%	13*
	45-60	8	19%	28	65%	0	0%	10	23%	43
	60+	456	65%	689	98%	0	0%	573	81%	704
MD06-0014	0-30	22	41%	51	94%	0	0%	48	89%	54
	30-45	6	30%	13	65%	0	0%	10	50%	20*
	45-60	17	18%	65	71%	0	0%	23	25%	92
	60+	968.0	59%	1589.0	97%	0.0	0%	1403.0	86%	1637

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