



I-95 Corridor Coalition

I-95 Corridor Coalition Vehicle
Probe Project: Validation of
INRIX Data
Monthly Report
Delaware



July 2010

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT: VALIDATION OF INRIX DATA JULY 2010

Monthly Report

Prepared for:

I-95 Corridor Coalition

Sponsored by:

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July 2010

Evaluation Results for the State of Delaware

Executive Summary

Travel time samples were collected along nearly 15 miles of freeways in Delaware for one week from Monday, April 26, 2010 through Tuesday, May 4, 2010 and compared with travel time and speed data reported by INRIX as part of the I-95 Vehicle Probe project. The validation data represents approximately 1160 hours of observations along nine freeway TMC segments, totaling nearly 15 miles.

ES Table 1, below summarizes the results of the comparison between the validation data and the INRIX data for freeway segments for the same period. As shown, both the average absolute speed error (AASE) and speed error bias were within specification for all speed bins. Furthermore, the 1.90 mph AASE measured for the 30-45 MPH is the lowest observed error in that speed bin since validation began in 2008.

State	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	4.70	7.20	4.00	5.70	272	22.7
30-45 MPH	1.90	5.30	0.70	2.40	695	57.9
45-60 MPH	1.80	4.20	-1.20	-2.30	4028	335.7
> 60 MPH	2.80	5.20	-2.70	-4.70	8945	745.4
All Speeds	2.50	4.96	-1.97	-3.45	13940	1161.7

Based upon data collected from Apr 26, 2010 through May 4, 2010 across 14.5 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 Delaware were validated on four occasions: September 2008, February 2009, August 2009, and April/May 2010. This represents 3300 hours of observations along nearly 43 miles of freeway segments in Delaware. ES Table 2 provides a summary of the cumulative validation effort. As shown, both the absolute average speed error and speed error bias were within specification for all speed bins.

ES Table 2 - Delaware - Cumulative to Date						
State	Absolute Speed Error		Speed Error Bias		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	6.04	7.84	3.73	4.62	911	75.9
30-45 MPH	4.51	7.09	1.50	2.78	1691	140.9
45-60 MPH	1.99	4.28	-0.64	-1.01	11752	979.3
> 60 MPH	2.60	5.25	-2.44	-4.61	25249	2104.1
All Speeds	2.58	5.10	-1.60	-3.01	19678	3300.3

Note: During this validation exercise, data was collection on portions of Delaware Route 1 and Delaware Route 7, which are classified as freeways for contractual purposes of the Vehicle Probe Project. However, the segments tested contained at least one traffic signal. Portions of the results from such segments will be studied as part of the ongoing effort to appropriately specify and measure data quality on arterial roadways.

Data Collection

Bluetooth sensor deployments in Delaware started on Monday, April 26, 2010. The actual deployments in Delaware were performed with the assistance of Delaware Department of Transportation (DelDOT) personnel. Sensors remained in the same position until they were retrieved a week later on Tuesday, May 4, 2010. This round of data collections in Delaware was designed to cover segments of the highways along which both recurrent and non-recurrent congestions could be expected during both peak and off-peak periods.

Figure 1 presents snapshots of the roadway segments over which Bluetooth sensors were deployed in Delaware. Table 1 presents a list of specific TMC segments that were selected as the validation sample in Delaware. These segments cover a total length of approximately 15 freeway miles. Since some TMC segments in this corridor are less than one mile long, when appropriate, consecutive TMC segments are combined to form path segments longer than one mile. In total, in this document results of validation performed on nine freeway segments are reported; two of which are standard TMC segments and the other seven are path segments combined from multiple standard TMC segments. The coordinates of the locations at which the Bluetooth sensors were deployed throughout the state of Delaware are highlighted in Table 2. It should be noted that the configuration of consecutive TMC segments is such that the endpoint of one TMC segment and the start point of the next TMC segment are overlapping, so one Bluetooth sensor in that location is covering both TMC segments.

Finally, Table 3 summarizes the segment definitions used in the validation process which also presents the distances that have been used in the estimation of Bluetooth speeds based on travel times. Details of the algorithm used to estimate equivalent path travel times based

on INRIX feeds for individual TMC segment are provided in a separate report titled “Estimation of Travel Times for Multiple TMC Segments” (dated February 2010) and available on the I-95 Corridor Coalition website. This algorithm finds an equivalent INRIX travel time (and therefore travel speed) corresponding to each sample Bluetooth travel time observation on the path segment of interest.

Analysis of Results

Table 4 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds. In all speed bins, INRIX data meets the data quality measures set forth in the contract when errors are measured as a distance from the 1.96 times the standard error band.

It should be noted that while the total number of observations in the low speed bins across all TMC segments are reasonable, as Table 6 indicates, the number of observations in low speed bins for some individual TMC segments may be low.

Table 5 shows the percentage of the time intervals that fall within 5 mph of the SEM band and the mean for each speed bin for all TMC segments in Delaware. Tables 6 and 7 present detailed data for individual TMC segments in Delaware in similar format as Tables 4 and 5 respectively. Note that for some TMC segments in some speed bins the comparison results may not be reliable due to small number of observations.

Figures 2 and 3 show the overall speed error biases for different speed bins, and the average absolute speed errors for all validation segments in Delaware, respectively. These figures correspond to Table 4.

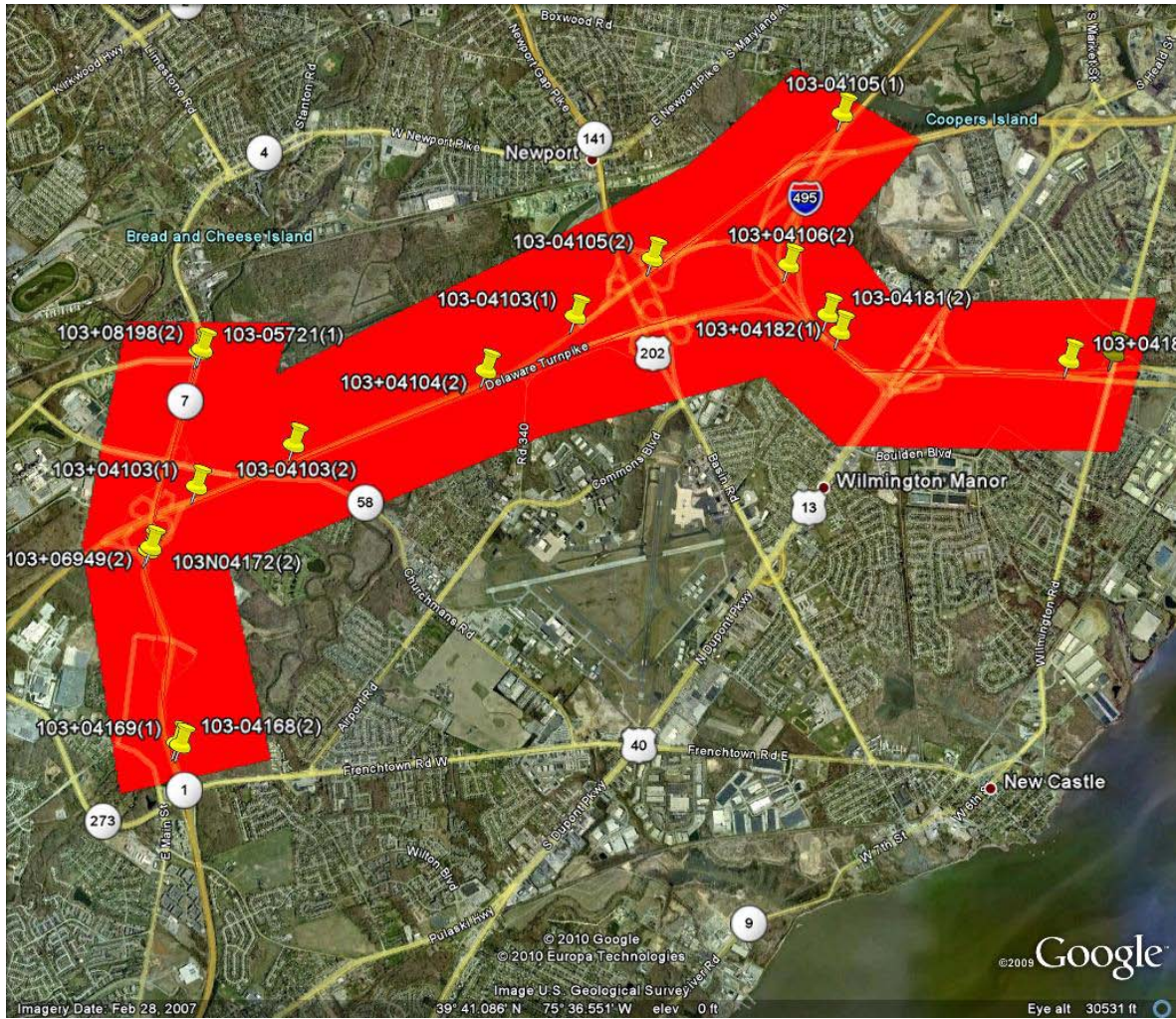


Figure 1
TMC segments selected for validation in Delaware

Table 1
Traffic Message Channel segments picked for validation in Delaware

TYPE	TMC	HIGHWAY	STARTING AT	ENDING AT	COUNTY	DIRECTION	LENGTH (mile)
Freeway	103-05721	DE-7	DE-4	DE-58/CHURCHMANS RD	NEW CASTLE	SOUTHBOUND	0.3
Freeway	103N04172	DE-1	DE-58/CHURCHMANS RD	I-95/EXIT 165/EXIT 101	NEW CASTLE	SOUTHBOUND	0.9
Freeway	103+04169	DE-1	DE-273/EXIT 162	DE-7/EXIT 164	NEW CASTLE	NORTHBOUND	0.4
Freeway	103P04169	DE-1	DE-7/EXIT 164	DE-7/EXIT 164	NEW CASTLE	NORTHBOUND	0.3
Freeway	103+06949	DE-7	DE-7/EXIT 164	I-95/JFK MEMORIAL HWY/EXIT 101B/EXIT 165	NEW CASTLE	NORTHBOUND	0.4
Freeway	103P06949	DE-7	I-95/JFK MEMORIAL HWY/EXIT 101B/EXIT 165	I-95/JFK MEMORIAL HWY/EXIT 101B/EXIT 165	NEW CASTLE	NORTHBOUND	0.4
Freeway	103+05721	DE-7	I-95/JFK MEMORIAL HWY/EXIT 101B/EXIT 165	DE-58/CHURCHMANS RD	NEW CASTLE	NORTHBOUND	0.2
Freeway	103P05721	DE-7	DE-58/CHURCHMANS RD	DE-58/CHURCHMANS RD	NEW CASTLE	NORTHBOUND	0.2
Freeway	103+08198	DE-7	DE-58/CHURCHMANS RD	DE-4	NEW CASTLE	NORTHBOUND	0.3
Freeway	103+04103	I-95	DE-7/DE-1/EXIT 4A	DE-58/EXIT 4	NEW CASTLE	NORTHBOUND	0.4
Freeway	103P04103	I-95	DE-58/EXIT 4	DE-58/EXIT 4	NEW CASTLE	NORTHBOUND	0.4
Freeway	103+04104	I-95	DE-58/EXIT 4	EXIT 5A	NEW CASTLE	NORTHBOUND	0.9
Freeway	103P04104	I-95	EXIT 5A	EXIT 5A	NEW CASTLE	NORTHBOUND	0.0
Freeway	103+04105	I-95	EXIT 5A	I-295/US-202/DE-141/EXIT 5	NEW CASTLE	NORTHBOUND	0.9
Freeway	103P04105	I-95	I-295/US-202/DE-141/EXIT 5	I-295/US-202/DE-141/EXIT 5	NEW CASTLE	NORTHBOUND	0.1
Freeway	103+04106	I-95	I-295/US-202/DE-141/EXIT 5	I-495/I-295/EXIT 5	NEW CASTLE	NORTHBOUND	0.7
Freeway	103-04105	I-95	1954 US-202	I-295/US-202/DE-141/EXIT 5	NEW CASTLE	SOUTHBOUND	1.4
Freeway	103N04105	I-95	I-295/US-202/DE-141/EXIT 5	I-295/US-202/DE-141/EXIT 5	NEW CASTLE	SOUTHBOUND	0.1
Freeway	103-04104	I-95	I-295/US-202/DE-141/EXIT 5	EXIT 5A	NEW CASTLE	SOUTHBOUND	0.4
Freeway	103N04104	I-95	EXIT 5A	EXIT 5A	NEW CASTLE	SOUTHBOUND	0.1

Table 1 (Cont'd)
Traffic Message Channel segments picked for validation in Delaware

TYPE	TMC	HIGHWAY	STARTING AT	ENDING AT	COUNTY	DIRECTION	LENGTH (mile)
Freeway	103-04103	I-95	EXIT 5A	DE-58/EXIT 4	NEW CASTLE	SOUTHBOUND	1.8
Freeway	103N04103	I-95	DE-58/EXIT 4	DE-58/EXIT 4	NEW CASTLE	SOUTHBOUND	0.2
Freeway	103-04102	I-95	DE-58/EXIT 4	DE-7/DE-1/EXIT 4A	NEW CASTLE	SOUTHBOUND	0.3
Freeway	103+04182	I-295	I-95	US-40/US-13	NEW CASTLE	NORTHBOUND	0.2
Freeway	103P04182	I-295	US-40/US-13	US-40/US-13	NEW CASTLE	NORTHBOUND	0.8
Freeway	103+04183	I-295	US-40/US-13	DE-9/NEW CASTLE AVE	NEW CASTLE	NORTHBOUND	0.4
Freeway	103-04182	I-295	DE-9/NEW CASTLE AVE	US-40/US-13	NEW CASTLE	SOUTHBOUND	0.6
Freeway	103N04182	I-295	US-40/US-13	US-40/US-13	NEW CASTLE	SOUTHBOUND	0.8
Freeway	103-04181	I-295	US-40/US-13	I-95	NEW CASTLE	SOUTHBOUND	0.3
TOTAL							14.5

Table 2
TMC segment lengths and distances between sensor deployment locations in the state of Delaware

SEGMENT TYPE	TMC	STANDARD TMC					SENSOR DEPLOYMENT					ERROR IN SEGMENT LENGTH (%)
		Endpoint (1)		Endpoint (2)		Length (mile)	Endpoint (1)		Endpoint (2)		Length (mile)	
		Lat	Long	Lat	Long		Lat	Long	Lat	Long		
Freeway	103-05721	39.696276	-75.651910	39.691802	-75.653444	0.32	39.695790	-75.653327				
Freeway	103N04172	39.691802	-75.653444	39.679865	-75.657233	0.85			39.678878	-75.657303		
Freeway	103+04169	39.663823	-75.653698	39.669429	-75.654909	0.40	39.664890	-75.654202				
Freeway	103P04169	39.669429	-75.654909	39.674377	-75.654308	0.35						
Freeway	103+06949	39.674377	-75.654308	39.680118	-75.656971	0.43			39.680308	-75.656840		
Freeway	103P06949	39.680118	-75.656971	39.685289	-75.655838	0.36	39.680308	-75.656840				
Freeway	103+05721	39.685289	-75.655838	39.688651	-75.654518	0.24						
Freeway	103P05721	39.688651	-75.654518	39.691918	-75.653164	0.24						
Freeway	103+08198	39.691918	-75.653164	39.696444	-75.651623	0.32						
Freeway	103+04103	39.685143	-75.652127	39.687439	-75.644730	0.42	39.685180	-75.651718				
Freeway	103P04103	39.687439	-75.644730	39.689777	-75.637344	0.42						
Freeway	103+04104	39.689777	-75.637344	39.694840	-75.621193	0.93			39.694642	-75.621602		
Freeway	103P04104	39.694840	-75.621193	39.695029	-75.620589	0.03	39.694642	-75.621602				
Freeway	103+04105	39.695029	-75.620589	39.699927	-75.603926	0.95						
Freeway	103P04105	39.699927	-75.603926	39.700462	-75.601400	0.14						
Freeway	103+04106	39.700462	-75.601400	39.703698	-75.588806	0.72			39.705522	-75.587625		
Freeway	103-04105	39.716168	-75.583136	39.704166	-75.603425	1.36	39.717940	-75.581123	39.703385	-75.604855	1.62	18.7%
Freeway	103N04105	39.704166	-75.603425	39.702988	-75.605385	0.13	39.703385	-75.604855				
Freeway	103-04104	39.702988	-75.605385	39.699931	-75.610715	0.35						
Freeway	103N04104	39.699931	-75.610715	39.699375	-75.611638	0.06			39.698007	-75.614092		

Table 2 (Cont'd)
TMC segment lengths and distances between sensor deployment locations in the state of Delaware

SEGMENT TYPE	TMC	STANDARD TMC					SENSOR DEPLOYMENT					ERROR IN SEGMENT LENGTH (%)
		Endpoint (1)		Endpoint (2)		Length (mile)	Endpoint (1)		Endpoint (2)		Length (mile)	
		Lat	Long	Lat	Long		Lat	Long	Lat	Long		
Freeway	103-04103	39.699375	-75.611638	39.688650	-75.641743	1.77	39.698007	-75.614092	39.688698	-75.641972	1.62	-8.4%
Freeway	103N04103	39.688650	-75.641743	39.687498	-75.645527	0.22	39.688698	-75.641972				
Freeway	103-04102	39.687498	-75.645527	39.685803	-75.650855	0.31						
Freeway	103+04182	39.698202	-75.583275	39.696391	-75.580111	0.21	39.698565	-75.583333				
Freeway	103P04182	39.696391	-75.580111	39.696240	-75.566026	0.78						
Freeway	103+04183	39.696240	-75.566026	39.695936	-75.558702	0.39			39.695807	-75.558078		
Freeway	103-04182	39.696555	-75.553904	39.696433	-75.564683	0.57	39.696882	-75.551890				
Freeway	103N04182	39.696433	-75.564683	39.696707	-75.580266	0.85						
Freeway	103-04181	39.696707	-75.580266	39.699608	-75.584586	0.31			39.698477	-75.583148		
SUBTOTAL						14.44						

Table 3
Path segments identified for validation in Delaware

Type	Validation Segment	STANDARD SEGMENTS INCLUDED				STARTING AT	ENDING AT	LENGTH (MILE)		
		TMC(1)	TMC(2)	TMC(3)	TMC(4)			Standard	Deployment	Error (%)
Freeway	DE03-0001	103-05721	103N04172			DE-4	I-95/EXIT 165/EXIT 101	1.17	1.18	1.15%
Freeway	DE03-0003	103+04169	103P04169	103+06949		DE-273/EXIT 162	I-95/JFK MEMORIAL HWY/EXIT 101B/EXIT 165	1.18	1.11	-5.89%
Freeway	DE03-0004	103P06949	103+05721	103P05721	103+08198	I-95/JFK MEMORIAL HWY/EXIT 101B/EXIT 165	DE-4	1.17	1.09	-6.80%
Freeway	DE03-0005	103+04103	103P04103	103+04104		DE-7/DE-1/EXIT 4A	EXIT 5A	1.77	1.73	-2.46%
Freeway	DE03-0006	103P04104	103+04105	103P04105	103+04106	EXIT 5A	I-495/I-295/EXIT 5	1.84	2.01	8.96%
Freeway	103-04105	103-04105				1954 US-202	I-295/US-202/DE-141/EXIT 5	1.36	1.62	18.68%
Freeway	103-04103	103-04103				EXIT 5A	DE-58/EXIT 4	1.77	1.62	-8.39%
Freeway	DE03-0007	103+04182	103P04182	103+04183		I-95	DE-9/NEW CASTLE AVE	1.38	1.43	4.06%
Freeway	DE03-0008	103-04182	103N04182	103-04181		DE-9/NEW CASTLE AVE	I-95	1.73	1.73	-0.04%
TOTAL								13.37	13.51	1.05%

Table 4
Data quality measures for freeway segments greater than one mile in Delaware

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
0-30	4.0	4.7	5.7	7.2	271
30-45	0.7	1.9	2.4	5.3	695
45-60	-1.2	1.8	-2.3	4.2	4028
60+	-2.7	2.8	-4.7	5.2	8945

Table 5
Percent observations meeting data quality criteria for freeway segments greater than one mile in Delaware

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE 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	33%	71%	0%	55%	271
30-45	55%	85%	0%	55%	695
45-60	46%	88%	0%	68%	4028
60+	30%	79%	0%	55%	8945

Table 6
Data quality measures for individual freeway validation segments greater than one mile in the state of Delaware

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SE Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
103-04103	1.77	1.62	0-30	5.8	5.8	9.8	9.8	2*
			30-45	0.8	2.1	1.9	4.6	35
			45-60	-0.2	1.6	0.2	4.1	109
			60+	-3.6	3.6	-6.1	6.3	2050
103-04105	1.36	1.62	0-30	4.6	4.9	5.5	6.6	35
			30-45	2.2	3.9	3.3	5.6	76
			45-60	0.6	1.4	1.8	3.5	436
			60+	-0.7	0.9	-1.7	2.8	933
DE04-0001	1.17	1.18	0-30	4.7	4.9	7.4	8.1	91
			30-45	0.5	0.9	1.8	4.5	213
			45-60	-3.1	3.2	-6.1	6.5	212
			60+	-13.5	13.5	-15.9	15.9	1*
DE04-0003	1.18	1.11	0-30	3.4	4.0	4.4	5.9	88
			30-45	-0.1	3.5	0.5	6.4	89
			45-60	-1.0	1.3	-2.2	3.6	680
			60+	-3.8	3.8	-7.2	7.3	794
DE04-0004	1.17	1.09	0-30	11.1	11.1	20.5	20.5	4*
			30-45	0.9	1.1	3.8	5.3	231
			45-60	-1.3	1.4	-3.1	4.4	151
			60+					
DE04-0005	1.77	1.73	0-30	-1.2	3.3	-1.4	5.8	13*
			30-45	-0.3	4.4	-0.8	5.9	38
			45-60	-0.6	2.1	-0.1	3.8	40
			60+	-2.1	2.2	-3.8	4.3	2066
DE04-0006	1.84	2.01	0-30					
			30-45	2.1	2.1	25.7	25.7	1*
			45-60	-0.2	2.1	0.4	3.8	242
			60+	-1.7	1.9	-3.0	3.6	1852
DE04-0007	1.38	1.43	0-30	13.2	13.5	17.6	18.3	8*
			30-45	1.2	1.2	8.2	8.4	7*
			45-60	-2.0	2.4	-3.6	4.7	1240
			60+	-5.1	5.1	-7.2	7.6	685
DE04-0008	1.73	1.73	0-30	0.1	1.4	-0.1	2.9	30
			30-45	-3.3	7.6	-1.3	13.0	5*
			45-60	-1.3	1.4	-2.9	3.6	918
			60+	-4.6	4.6	-7.5	7.6	564

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

Table 7
Observations meeting data quality criteria for individual freeway validation segments
greater than one mile in the state of Delaware

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SE 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	
103-04103	0-30	0	0%	1	50%	0	0%	0	0%	2*
	30-45	15	43%	30	86%	0	0%	22	63%	35
	45-60	59	54%	96	88%	0	0%	75	69%	109
	60+	394	19%	1445	70%	0	0%	816	40%	2050
103-04105	0-30	13	37%	26	74%	0	0%	20	57%	35
	30-45	8	11%	52	68%	0	0%	40	53%	76
	45-60	206	47%	402	92%	0	0%	331	76%	436
	60+	574	62%	894	96%	1	0%	798	86%	933
DE04-0001	0-30	26	29%	55	60%	0	0%	38	42%	91
	30-45	163	77%	199	93%	0	0%	139	65%	213
	45-60	91	43%	156	74%	0	0%	98	46%	212
	60+	0	0%	0	0%	0	0%	0	0%	1*
DE04-0003	0-30	39	44%	68	77%	0	0%	56	64%	88
	30-45	29	33%	65	73%	0	0%	42	47%	89
	45-60	391	58%	623	92%	0	0%	520	76%	680
	60+	173	22%	543	68%	0	0%	234	29%	794
DE04-0004	0-30	0	0%	0	0%	0	0%	0	0%	4*
	30-45	160	69%	216	94%	0	0%	118	51%	231
	45-60	93	62%	134	89%	0	0%	101	67%	151
	60+									
DE04-0005	0-30	2	15%	9	69%	0	0%	7	54%	13*
	30-45	7	18%	23	61%	0	0%	21	55%	38
	45-60	16	40%	34	85%	0	0%	28	70%	40
	60+	673	33%	1791	87%	0	0%	1327	64%	2066
DE04-0006	0-30									
	30-45	0	0%	1	100%	0	0%	0	0%	1*
	45-60	85	35%	214	88%	1	0%	176	73%	242
	60+	641	35%	1661	90%	2	0%	1376	74%	1852
DE04-0007	0-30	1	13%	4	50%	0	0%	3	38%	8*
	30-45	3	43%	6	86%	0	0%	1	14%	7*
	45-60	462	37%	1023	83%	1	0%	727	59%	1240
	60+	129	19%	379	55%	0	0%	245	36%	685
DE04-0008	0-30	9	30%	29	97%	0	0%	25	83%	30
	30-45	0	0%	1	20%	0	0%	1	20%	5*
	45-60	440	48%	849	92%	0	0%	681	74%	918
	60+	67	12%	332	59%	0	0%	126	22%	564

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

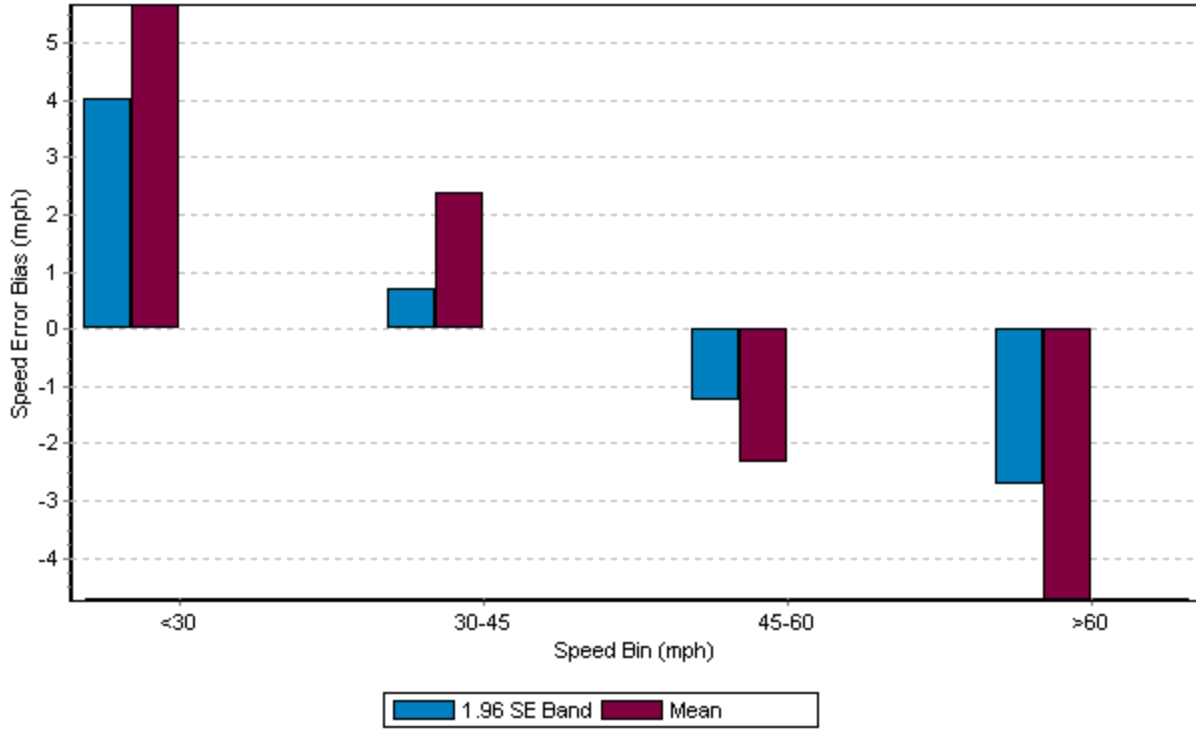


Figure 2
Speed error bias for freeway segments greater than one mile in Delaware

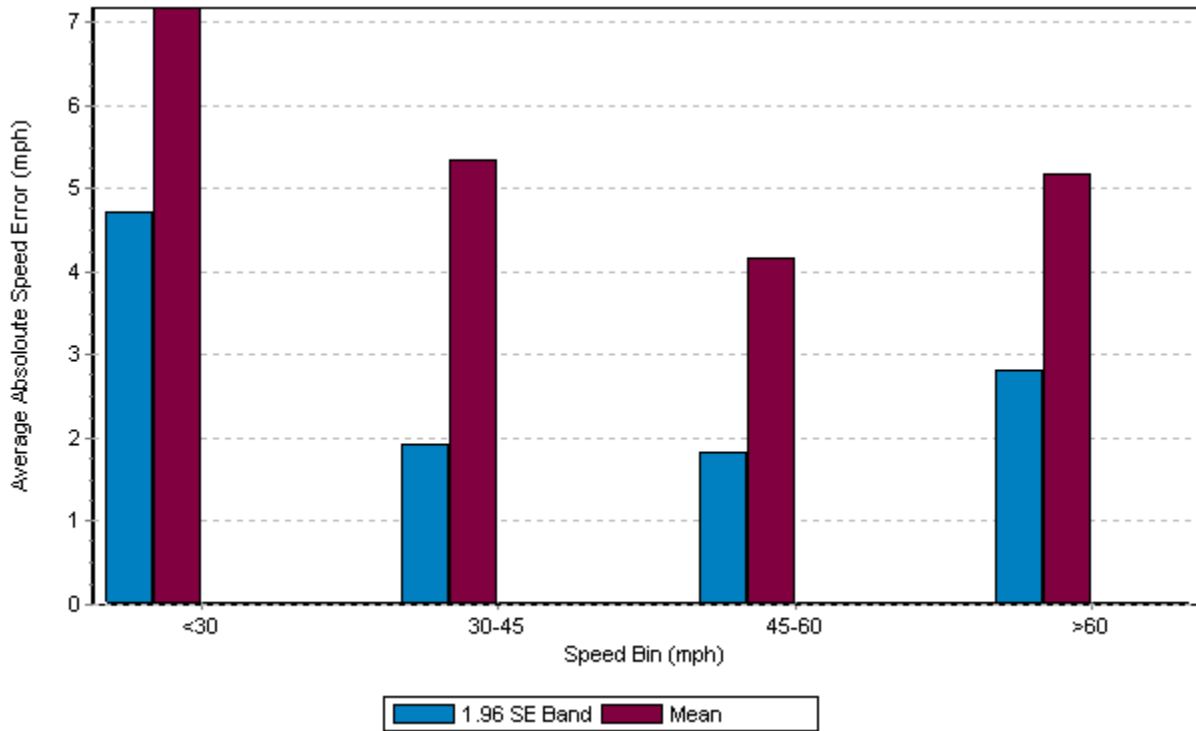


Figure 3
Average absolute speed error for freeway segments greater than one mile in Delaware