



## I-95 Corridor Coalition

I-95 Corridor Coalition Vehicle  
Probe Project: Validation of  
INRIX Data on Ramp Segments  
Monthly Report  
New Jersey



*September 2011*

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# **I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT: VALIDATION OF INRIXDATA ON RAMP SEGMENTS SEPTEMBER 2011**

## *Monthly Report*

*Prepared for:*

I-95 Corridor Coalition

*Sponsored by:*

I-95 Corridor Coalition

*Prepared by:*

Ali Haghani, Masoud Hamedi, Kaveh Farokhi Sadabadi  
University of Maryland, College Park

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*September 2011*

# Evaluation Results for the State of New Jersey – Ramps

## Executive Summary

Travel time samples were collected along a total length of nearly six ramp miles and approximately 16 freeway miles from Monday, April 10, 2011 through Friday, April 29, 2011 in New Jersey. The ramp segments studied were interconnecting I-80/I-95/New Jersey Turnpike in Bergen County and included local and express ramps. The results of the freeway data collection are presented in a separate report. Data collected on ramp segments was compared with travel time and speed data reported by INRIX as part of the I-95 Vehicle Probe Project. The ramp validation data below represents nearly 1100 hours of observations along seven ramp segments, totaling approximately six miles.

Note these data sets are unique in that the section under study contained both local and express facilities for each ramp. Ground truth data was collected with Bluetooth™ traffic monitoring (BTM) equipment placed upstream, before the ramp exit, and downstream, after the ramp merge area. If traffic is flowing at substantially different rates on the local and express, two distinct flow patterns would be evident in the BTM travel time data. BTM data collected on the ramps did not exhibit differentiating flow between the local and express facilities for most of the duration of data collection, and when it did, the difference (in terms of MPH) was not substantial. In the following results, the BTM data is compared to both the local and express data reported by INRIX.

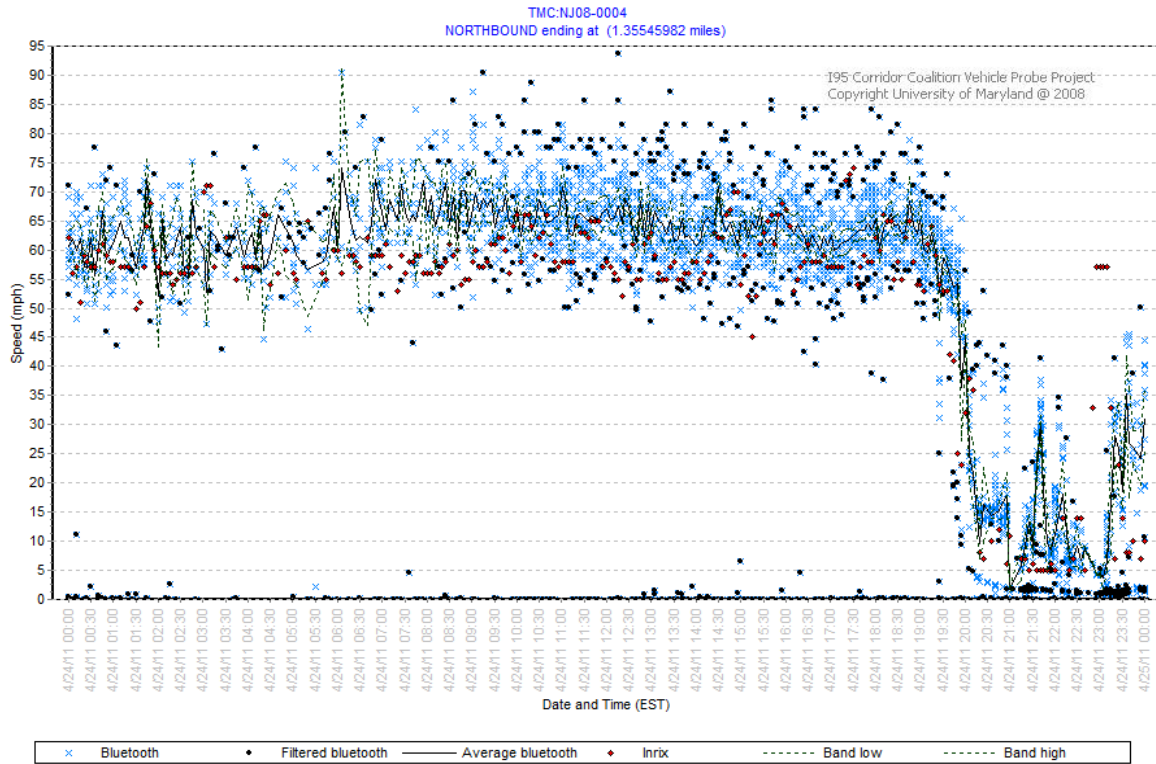
ES Table 1, shows the average absolute speed error (AASE) and speed error bias (SEB) calculated based on the comparison of the BTM data with that reported by INRIX. Ramps data is not subject to the quality specifications in effect for freeways. In all speed bins, INRIX data collected on the seven ramp segments studied meets the data quality specifications set forth in the contract for normal freeway segments except in the 0-30 MPH bin.

<b>ES Table 1 - New Jersey Evaluation Summary for Ramps</b>						
<b>Speed Bin</b>	<b>Absolute Speed Error</b>		<b>Speed Error Bias</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>14.70</b>	18.50	<b>9.80</b>	10.70	106	8.8
30-45 MPH	<b>7.80</b>	12.90	<b>5.00</b>	8.80	111	9.3
45-60 MPH	<b>1.00</b>	3.00	<b>0.40</b>	0.80	9137	761.4
> 60 MPH	<b>2.40</b>	5.00	<b>-2.30</b>	-4.60	3786	315.5
All Speeds	1.57	3.78	-0.26	-0.61	13140	1095.0

Based upon data collected from April 10, 2011 through April 29, 2011 across 6 miles of roadway ramps.

The majority of congested conditions (approximately 80%) occurred during late night hours on April 24 as plotted in ES Figure 1. The VPP data is plotted in red circles, and the BTM data is displayed in blue x's. The congested period begins at approximately 7:30 PM and lasts into the next day. Late night congestion has typically been difficult for the VPP

to report accurately due to lack of volume. However, the VPP data tracks the envelope of speeds consistently, except for a few periods near 11 PM where freeflow conditions are reported (as evidenced by Score = 10).



ES Figure 1 Sample plot of ramp validation data from April 24.

### Data Collection

Bluetooth sensor deployments in New Jersey started on Monday, April 10, 2011. The actual deployments in New Jersey were performed with the assistance of New Jersey Department of Transportation (NJDOT) personnel. Sensors remained in the same position until they were retrieved more than two weeks later on Friday, April 29, 2011. This round of data collection in New Jersey was designed to cover segments of the ramps and highway along which both recurrent and non-recurrent congestions could be expected during both peak and off-peak periods.

Figure 1 presents a snapshot of the roadway segments over which Bluetooth sensors were placed in New Jersey. Table 1 presents a list of specific *traffic message channel* (TMC) segments that were selected as the validation sample in New Jersey. These segments cover a total length of approximately six ramp 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. This document includes the results of validation performed on seven ramps segments. The coordinates of the locations at which the Bluetooth traffic monitoring (BTM) sensors were deployed throughout the state of New Jersey 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 BTM 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 BTM measured speeds based on observed travel times. Details of the algorithm used to estimate equivalent path travel times based on INRIX data feeds for individual TMC segments are provided in a separate report. 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.

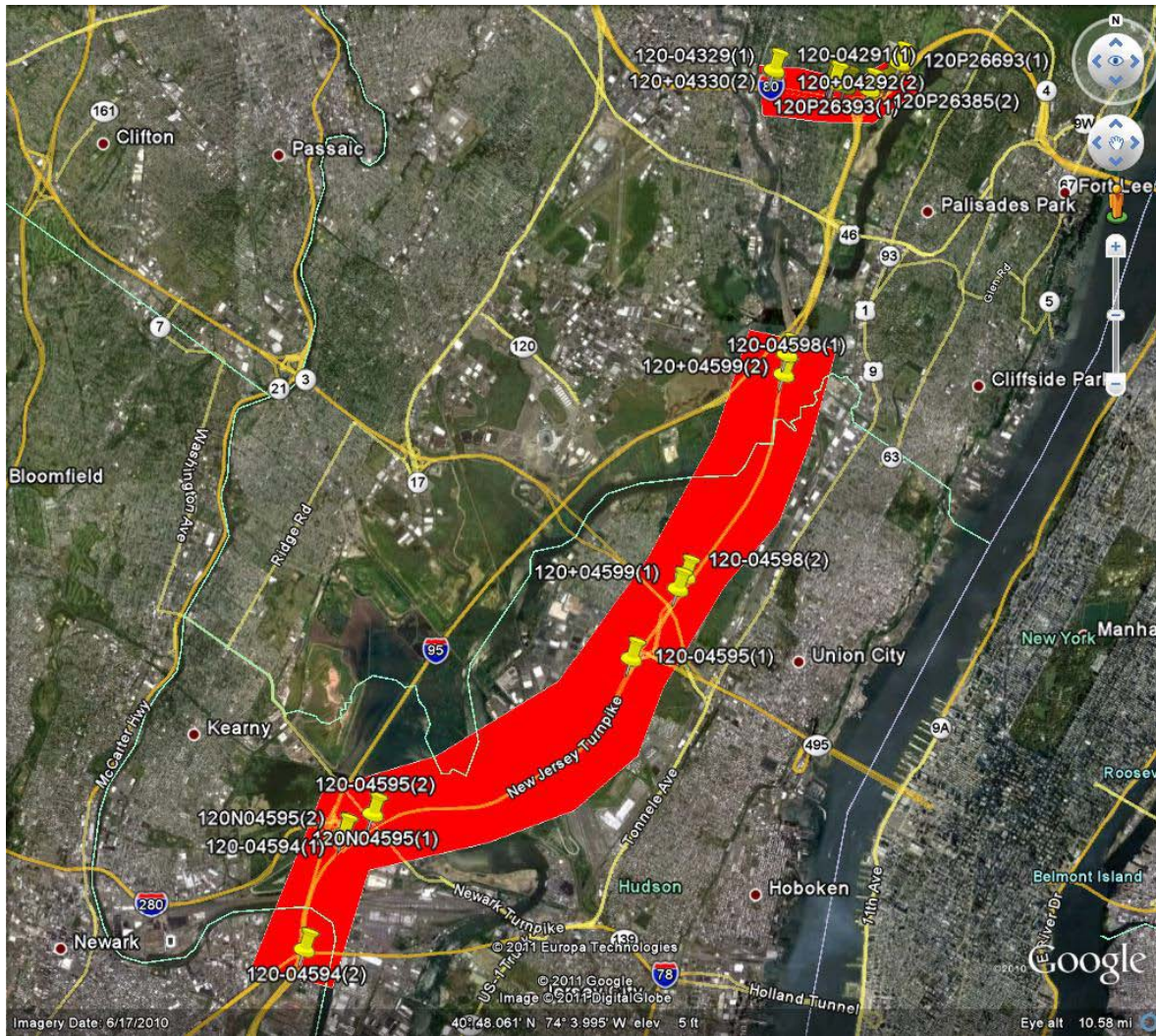
### ***Analysis of Results for Ramps***

Table 4 summarizes the data quality measures obtained as a result of comparison between BTM data and all reported INRIX speeds on seven ramp segments considered in this round of validations. Note these data sets are unique in that the section under study contained both local and express facilities for each ramp. Ground truth data was collected with Bluetooth traffic monitoring (BTM) equipment placed upstream, before the ramp exit, and downstream, after the ramp merge area. If traffic is flowing at substantially different rates on the local and express, two distinct flow patterns would be evident in the BTM travel time data. BTM data collected on the ramps did not exhibit differentiating flow between the facilities most of the time. When it differences did occur, the difference (in terms of MPH) was not substantial. In the following results, the BTM data is compared to both the local and express data reported by INRIX. These sets include NJ-04/05, NJ-06/07, and NJ-13/14. Further insight into the performance of the data can be obtained through direct observation of the scatter plots comparing the BTM data with INRIX data, available from the University of Maryland.

The average absolute speed error (AASE) and speed error bias (SEB) were for the data reported by INRIX and compared to the BTM data. Ramps data is not subject to the quality specifications in effect for freeways. In all speed bins, INRIX data collected on the seven ramp segments studied meets the data quality specifications set forth in the contract for normal freeway segments except in the 0-30 MPH bin.

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 ramp segments in New Jersey. Tables 6 and 7 present detailed data for individual ramp segments in New Jersey in similar format as Tables 4 and 5, respectively. Note that for some segments and 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 considered ramp segments in New Jersey, respectively. These figures correspond to Table 4.



**Figure 1**  
**TMC segments selected for validation in New Jersey**



**Figure 1**  
**TMC segments selected for validation in New Jersey (Cont'd)**

**Table 1**  
**Traffic Message Channel segments picked for validation in New Jersey**

<b>TYPE</b>	<b>TMC</b>	<b>HIGHWAY</b>	<b>STARTING AT</b>	<b>ENDING AT</b>	<b>COUNTY</b>	<b>DIRECTION</b>	<b>LENGTH (mile)</b>
<b>Ramp</b>	120+04793	I-95 Exp	Challenger Rd/Exit 68	I-80 Exp/I-95/I-80	BERGEN	Northbound	0.3
<b>Ramp</b>	120P04783	I-95 Exp	I-80 Exp/I-95/I-80	I-95	BERGEN	Southbound	0.8
<b>Ramp</b>	120+04784	I-95 Exp	I-95	Degraw Ave/Exit 70	BERGEN	Southbound	0.2
<b>Ramp</b>	120+04612	I-95	Challenger Rd/Exit 68	I-80/Exit 69	BERGEN	Northbound	0.8
<b>Ramp</b>	120P04612	I-95	I-80/Exit 69	I-80/Exit 69	BERGEN	Northbound	0.2
<b>Ramp</b>	120+04613	I-95	I-80/Exit 69	Degraw Ave/Exit 70	BERGEN	Northbound	0.2
<b>Ramp</b>	120P26641	I-80 Exp	I-80 Exp/I-95/I-80	I-80 Exp	BERGEN	I-80 Westbound (Express Ln)	0.5
<b>Ramp</b>	120P26639	I-80 Exp	I-80 Exp/I-95/I-80	I-80 Exp	BERGEN	I-80 Westbound	0.6
<b>Ramp</b>	120-04612	I-95	Degraw Ave/Exit 70	I-80/Exit 69	BERGEN	Southbound	0.4
<b>Ramp</b>	120N04612	I-95	I-80/Exit 69	I-80/Exit 69	BERGEN	Southbound	0.2
<b>Ramp</b>	120-04611	I-95	I-80/Exit 69	Challenger Rd/Exit 68	BERGEN	Southbound	0.8
<b>Ramp</b>	120P26387	I-80 Exp	I-95/New Jersey Tpke	Exit 68A	BERGEN	I-95 Southbound	0.3
<b>Ramp</b>	120P26395	I-80	I-95/New Jersey Tpke/Exit 68	Exit 68A	BERGEN	I-95 Southbound	0.5
<b>TOTAL</b>							<b>5.9</b>



**Table 2**  
**TMC segment lengths and distances between sensor deployment locations in the state of New Jersey**

SEGMENT TYPE	TMC	STANDARD TMC					SENSOR DEPLOYMENT			
		Endpoint (1)		Endpoint (2)		Length (mile)	Endpoint (1)		Endpoint (2)	
		Lat	Long	Lat	Long		Lat	Long	Lat	Long
Ramp	120+04793	40.852723	-74.014588	40.8566414	-74.012695	0.3	40.85246	-74.01459		
Ramp	120P04783	40.8566414	-74.012695	40.86649	-74.005952	0.8				
Ramp	120+04784	40.86649	-74.005952	40.868893	-74.002884	0.2			40.86884	-74.0024
Ramp	120+04612	40.852723	-74.014588	40.864236	-74.010468	0.8	40.85246	-74.01459		
Ramp	120P04612	40.864236	-74.010468	40.8658536	-74.006363	0.2				
Ramp	120+04613	40.8658536	-74.006363	40.867673	-74.004018	0.2			40.86884	-74.0024
Ramp	120P26641	40.86133	-74.011584	40.865407	-74.017254	0.5	40.86135	-74.01159		
Ramp	120P26639	40.86133	-74.011584	40.8657004	-74.018131	0.6	40.86135	-74.01159		
Ramp	120-04612	40.869112	-74.003192	40.865907	-74.008555	0.4	40.86892	-74.00361		
Ramp	120N04612	40.865907	-74.008555	40.864176	-74.011659	0.2				
Ramp	120-04611	40.864176	-74.011659	40.8528298	-74.014933	0.8			40.85249	-74.01518
Ramp	120P26387	40.864714	-74.015249	40.860934	-74.012138	0.3			40.86089	-74.0121
Ramp	120P26395	40.865337	-74.017552	40.860934	-74.012138	0.5			40.86089	-74.0121
<b>TOTAL</b>						<b>5.9</b>				

**Table 3**  
**Path segments identified for validation in New Jersey**

Type	Validation Segment	STANDARD SEGMENTS INCLUDED				STARTING AT	ENDING AT	LENGTH (MILE)		
		TMC(1)	TMC(2)	TMC(3)	TMC(4)			Standard	Deployment	Error (%)
Ramp	NJ08-0004	120+04793	120P04783	120+04784		CHALLENGER RD/EXIT 68	DEGRAW AVE/EXIT 70	1.4	1.38	1.81%
Ramp	NJ08-0005	120+04612	120P04612	120+04613		CHALLENGER RD/EXIT 68	DEGRAW AVE/EXIT 70	1.3	1.38	9.95%
Ramp	NJ08-0006	120P26641	120+04292			I-80 EXP/I-95/I-80	2ND ST/EXIT 67	1.2	1.19	2.89%
Ramp	NJ08-0007	120P26639	120+04330			I-80 EXP/I-95/I-80	2ND ST/EXIT 67	1.2	1.19	2.47%
Ramp	NJ08-0010	120-04612	120N04612	120-04611		DEGRAW AVE/EXIT 70	CHALLENGER RD/EXIT 68	1.4	1.39	0.48%
Ramp	NJ08-0013	120-04329	120P26387			I-95/NEW JERSEY TPKE	EXIT 68A	1.1	1.13	1.57%
Ramp	NJ08-0014	120-04291	120P26395			I-95/NEW JERSEY TPKE/EXIT 68	EXIT 68A	1.1	1.15	1.44%
<b>TOTAL</b>								<b>8.7</b>	<b>8.81</b>	<b>1.62%</b>

**Table 4**  
**Data quality measures for ramp segments greater than one mile in New Jersey**

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	9.8	14.7	10.7	18.5	106
30-45	5.0	7.8	8.8	12.9	111
45-60	0.4	1.0	0.8	3.0	9137
60+	-2.3	2.4	-4.6	5.0	3786

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

**Table 5**  
**Percent observations meeting data quality criteria for ramp segments greater than one mile in New Jersey**

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	11%	40%	0%	27%	106
30-45	8%	25%	0%	5%	111
45-60	58%	95%	0%	83%	9137
60+	29%	84%	0%	53%	3786

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

**Table 6**  
**Data quality measures for individual ramp validation segments greater than one mile in the state of New Jersey**

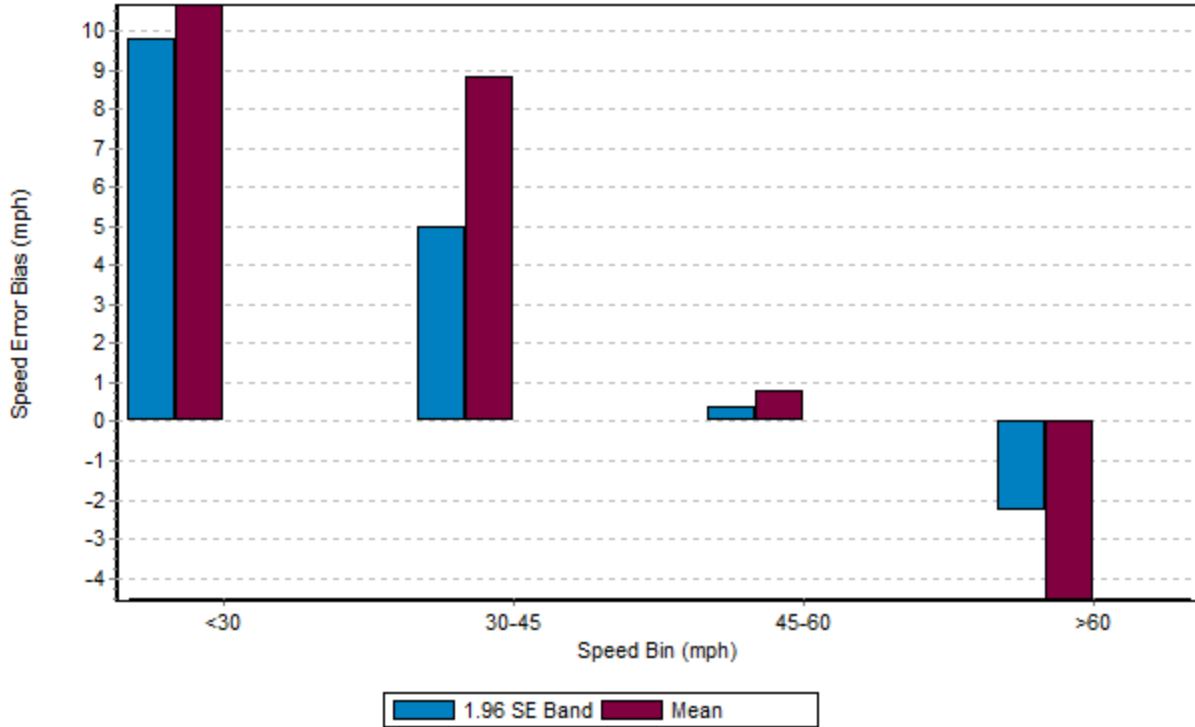
TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SE Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
NJ08-0004	1.36	1.38	0-30	2.3	10.8	1.1	13.7	43
			30-45	-11.5	11.5	-17.0	17.1	9*
			45-60	0.1	0.9	0.0	2.7	1176
			60+	-2.4	2.6	-4.5	5.1	1317
NJ08-0005	1.26	1.38	0-30	11.8	15.3	12.6	18.6	43
			30-45	-3.0	7.9	-0.3	15.1	9*
			45-60	-0.1	0.7	-0.5	2.5	1176
			60+	-2.7	2.8	-4.9	5.3	1317
NJ08-0006	1.16	1.19	0-30	20.5	20.8	24.6	27.0	10*
			30-45	8.8	8.8	15.1	15.1	14*
			45-60	1.4	1.5	3.0	3.7	1474
			60+	-0.9	0.9	-3.7	3.9	106
NJ08-0007	1.16	1.19	0-30	22.9	22.9	29.8	29.8	10*
			30-45	3.4	3.5	8.9	9.4	14*
			45-60	-0.4	1.0	-1.3	3.2	1474
			60+	-3.3	3.3	-7.5	7.5	106
NJ08-0010	1.38	1.39	0-30					
			30-45	8.1	8.1	12.2	12.2	62
			45-60	0.6	0.7	1.2	2.5	1533
			60+	-1.6	1.6	-4.1	4.3	811
NJ08-0013	1.11	1.13	0-30					
			30-45	4.1	4.1	11.5	11.5	2*
			45-60	0.3	0.9	0.6	2.8	1168
			60+	-2.2	2.2	-5.6	5.6	47
NJ08-0014	1.13	1.15	0-30					
			30-45	7.9	7.9	18.5	18.5	1*
			45-60	1.0	1.1	2.6	3.2	1136
			60+	-0.8	0.8	-3.0	3.2	82

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

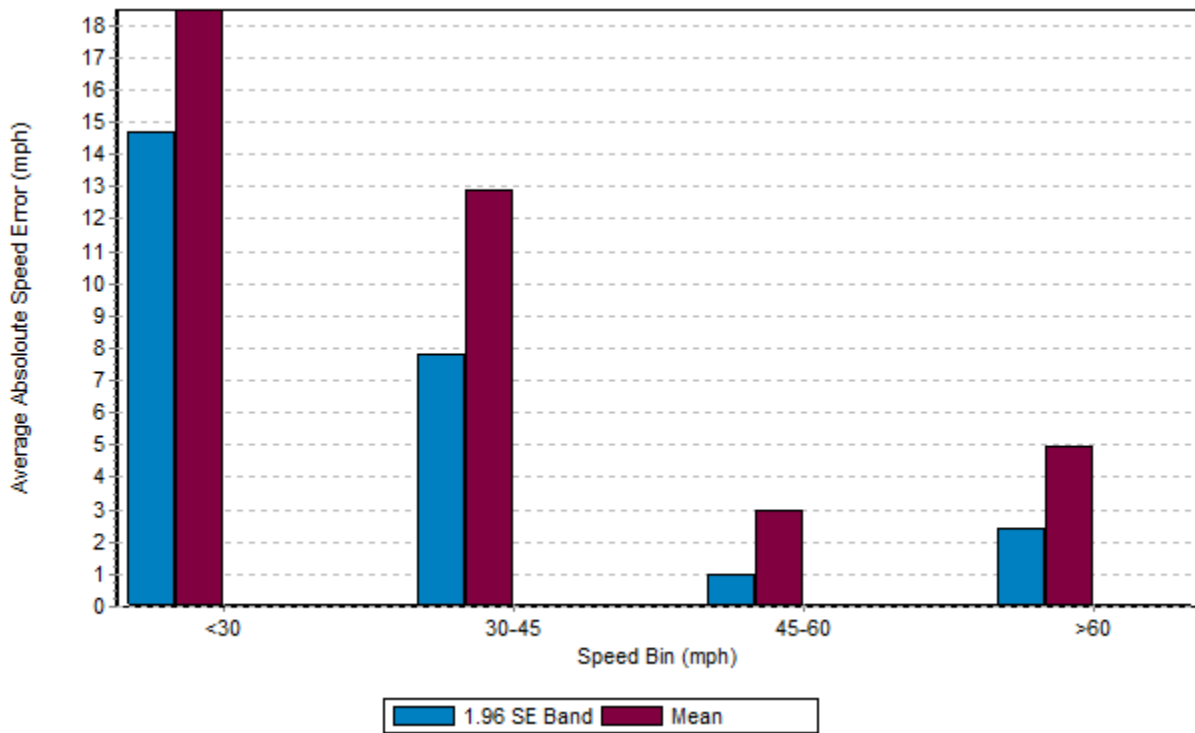
**Table 7**  
**Observations meeting data quality criteria for individual ramp validation segments greater than one mile in the state of New Jersey**

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	
NJ08-0004	0-30	7	16%	21	49%	0	0%	17	40%	43
	30-45	1	11%	3	33%	0	0%	1	11%	9*
	45-60	730	62%	1129	96%	0	0%	1060	90%	1176
	60+	347	26%	1074	82%	0	0%	702	53%	1317
NJ08-0005	0-30	4	9%	16	37%	0	0%	9	21%	43
	30-45	2	22%	3	33%	0	0%	1	11%	9*
	45-60	699	59%	1150	98%	0	0%	1073	91%	1176
	60+	284	22%	1069	81%	0	0%	611	46%	1317
NJ08-0006	0-30	1	10%	4	40%	0	0%	3	30%	10*
	30-45	1	7%	2	14%	0	0%	0	0%	14*
	45-60	741	50%	1334	91%	1	0%	1073	73%	1474
	60+	66	62%	104	98%	0	0%	70	66%	106
NJ08-0007	0-30	0	0%	1	10%	0	0%	0	0%	10*
	30-45	3	21%	10	71%	0	0%	2	14%	14*
	45-60	817	55%	1413	96%	2	0%	1173	80%	1474
	60+	24	23%	79	75%	0	0%	21	20%	106
NJ08-0010	0-30									
	30-45	2	3%	8	13%	0	0%	2	3%	62
	45-60	984	64%	1479	96%	0	0%	1349	88%	1533
	60+	296	37%	755	93%	0	0%	507	63%	811
NJ08-0013	0-30									
	30-45	0	0%	2	100%	0	0%	0	0%	2*
	45-60	714	61%	1124	96%	0	0%	990	85%	1168
	60+	14	30%	38	81%	0	0%	19	40%	47
NJ08-0014	0-30									
	30-45	0	0%	0	0%	0	0%	0	0%	1*
	45-60	617	54%	1074	95%	1	0%	893	79%	1136
	60+	54	66%	78	95%	0	0%	65	79%	82

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



**Figure 2**  
Speed error bias for ramp segments greater than one mile in New Jersey



**Figure 3**  
Average absolute speed error for ramp segments greater than one mile in New Jersey