



## I-95 Corridor Coalition

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



*November 2010*

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

## *Monthly Report*

*Prepared for:*

I-95 Corridor Coalition

*Sponsored by:*

I-95 Corridor Coalition

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*November 2010*

# Evaluation Results for the State of Pennsylvania

## Executive Summary

Travel time samples were collected along approximately 8 freeway miles and 10 miles of arterials from Thursday, August 19, 2010 through Monday, August 30, 2010 in Pennsylvania. Freeway segments were located along I-76, the Schuylkill Expressway mostly within Philadelphia. The arterial data segments were from US Route 1 between I-76 and PA Route 3. Data collected were compared with travel time and speed data reported by INRIX as part of the I-95 Vehicle Probe project. The freeway validation data below represents approximately 965 hours of observations along six freeway segments, totaling approximately 8 miles.

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

<b>ES Table 1 - Pennsylvania Evaluation Summary</b>						
<b>Speed Bin</b>	<b>Avg. Absolute Speed Error</b> ( $<10\text{mph}$ )		<b>Speed Error Bias</b> ( $<5\text{mph}$ )		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>4.70</b>	5.70	<b>2.70</b>	3.00	2414	201.2
30-45 MPH	<b>4.20</b>	5.80	<b>1.40</b>	1.90	926	77.2
45-60 MPH	<b>2.30</b>	3.90	<b>-1.00</b>	-1.20	6947	578.9
> 60 MPH	<b>2.40</b>	5.30	<b>-2.20</b>	-4.90	1284	107.0
All Speeds	2.96	4.58	-0.17	-0.49	11571	964.3

Based upon data collected from August 19, 2010 through August 30, 2010 across 8.2 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 Pennsylvania were validated on two occasions: January 2010, and August 2010. These two validations represent more than 2600 hours of observations along approximately 18 miles of freeway segments in Pennsylvania. 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.

<b>ES Table 2 - Pennsylvania - Cumulative to Date</b>						
<b>Speed Bin</b>	<b>Avg. Absolute Speed Error</b> (<10mph)		<b>Speed Error Bias</b> (<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>4.90</b>	5.92	<b>2.68</b>	2.94	2714	226.2
30-45 MPH	<b>5.07</b>	6.67	<b>1.31</b>	1.75	1340	111.7
45-60 MPH	<b>2.30</b>	4.06	<b>-0.72</b>	-0.72	11523	960.3
> 60 MPH	<b>3.23</b>	5.85	<b>-3.12</b>	-5.45	15860	1321.7
All Speeds	3.11	5.24	-1.55	-2.69	31437	2619.8

Travel time samples collected along US Route 1 were compared with travel time and speed data reported by INRIX as part of this project. The arterial data is included for informational purposes noting that INRIX has volunteered arterial data at no cost to the Coalition for the first three years, and that the method to evaluate quality on arterial roadways has not been fully evaluated. The Coalition is currently in the process of developing appropriate quality metrics and validation methods.

### **Data Collection**

Bluetooth sensor deployments in Pennsylvania started on Thursday, August 19, 2010. The actual deployments in Pennsylvania were performed with the assistance of Pennsylvania Department of Transportation (PennDOT) personnel. Sensors remained in the same position until they were retrieved two weeks later on Monday, August 30, 2010. This round of data collections in Pennsylvania 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 Pennsylvania. In this figure, red segments represent freeway segments while the blue color indicates the arterial segments selected for analysis in this round of validation.

Table 1 presents a list of specific TMC segments that were selected as the validation sample in Pennsylvania. These segments cover a total length of over 8 freeway miles and 10 arterial 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 six freeway segments are reported; all of which 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 Pennsylvania 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.

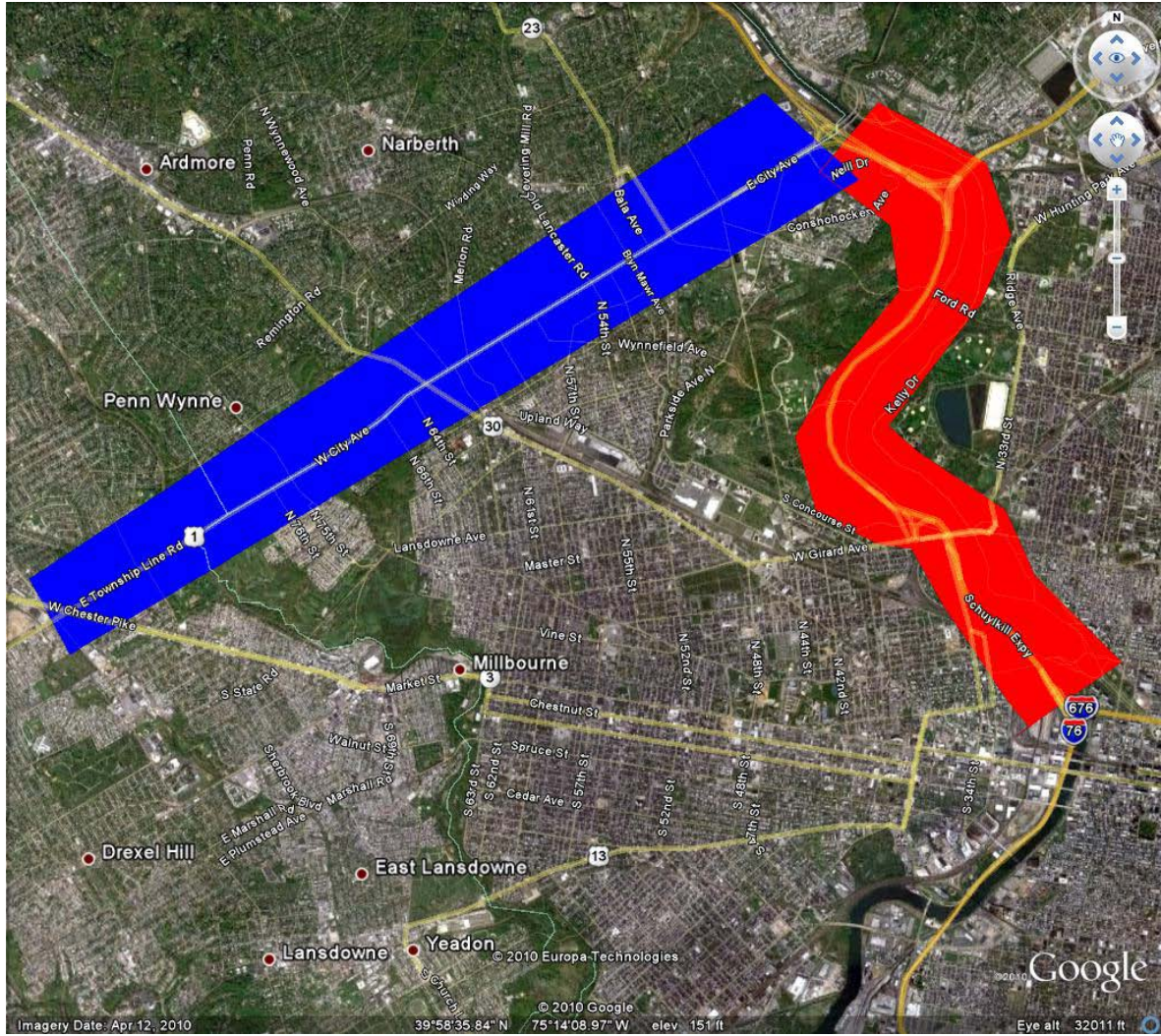
Finally, Table 3 summarizes the segment definitions used in the validation process which also presents the distances that have been used in the estimation of Bluetooth speeds based on travel times. Details of the algorithm used to estimate equivalent path travel times based on INRIX data feeds for individual TMC segments are provided in the November 2009 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***

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.

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 Pennsylvania. Tables 6 and 7 present detailed data for individual TMC segments in Pennsylvania in similar format as Tables 4 and 5, respectively.

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 Pennsylvania, respectively. These figures correspond to Table 4.



**Figure 1**  
**TMC segments selected for validation in Pennsylvania**

**Table 1**  
**Traffic Message Channel segments picked for validation in Pennsylvania**

<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>
Freeway	103+04271	I-76	US-1/CITY AVE/EXIT 340/EXIT 339	US-1/EXIT 340/EXIT 339	PHILADELPHIA	EASTBOUND	0.6
Freeway	103+04272	I-76	US-1/EXIT 340/EXIT 339	MONTGOMERY DR/EXIT 341	PHILADELPHIA	EASTBOUND	1.1
Freeway	103P04272	I-76	MONTGOMERY DR/EXIT 341	MONTGOMERY DR/EXIT 341	PHILADELPHIA	EASTBOUND	0.4
Freeway	103+04273	I-76	MONTGOMERY DR/EXIT 341	US-30/US-13/GIRARD AVE/EXIT 342	PHILADELPHIA	EASTBOUND	0.6
Freeway	103P04273	I-76	US-30/US-13/GIRARD AVE/EXIT 342	US-30/US-13/GIRARD AVE/EXIT 342	PHILADELPHIA	EASTBOUND	0.3
Freeway	103+04274	I-76	US-30/US-13/GIRARD AVE/EXIT 342	SPRING GARDEN ST/EXIT 343	PHILADELPHIA	EASTBOUND	0.9
Freeway	103P04274	I-76	SPRING GARDEN ST/EXIT 343	SPRING GARDEN ST/EXIT 343	PHILADELPHIA	EASTBOUND	0.2
Freeway	103N04274	I-76	SPRING GARDEN ST/EXIT 343	SPRING GARDEN ST/EXIT 343	PHILADELPHIA	WESTBOUND	0.2
Freeway	103-04273	I-76	SPRING GARDEN ST/EXIT 343	US-30/US-13/GIRARD AVE/EXIT 342	PHILADELPHIA	WESTBOUND	1.2
Freeway	103N04273	I-76	US-30/US-13/GIRARD AVE/EXIT 342	US-30/US-13/GIRARD AVE/EXIT 342	PHILADELPHIA	WESTBOUND	0.2
Freeway	103-04272	I-76	US-30/US-13/GIRARD AVE/EXIT 342	MONTGOMERY DR/EXIT 341	PHILADELPHIA	WESTBOUND	0.2
Freeway	103N04272	I-76	MONTGOMERY DR/EXIT 341	MONTGOMERY DR/EXIT 341	PHILADELPHIA	WESTBOUND	0.6
Freeway	103-04271	I-76	MONTGOMERY DR/EXIT 341	US-1/EXIT 340/EXIT 339	PHILADELPHIA	WESTBOUND	1.0
Freeway	103-04270	I-76	US-1/EXIT 340/EXIT 339	US-1/CITY AVE/EXIT 340/EXIT 339	MONTGOMERY	WESTBOUND	0.6
<b>SUBTOTAL</b>							<b>8.2</b>

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

<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>
Arterial	103-04934	US-1	PRESIDENTIAL BLVD	PRESIDENTIAL BLVD	PHILADELPHIA	SOUTHBOUND	0.0
Arterial	103N04934	US-1	PRESIDENTIAL BLVD	PRESIDENTIAL BLVD	PHILADELPHIA	SOUTHBOUND	0.1
Arterial	103-04826	US-1	PRESIDENTIAL BLVD	BELMONT AVE	MONTGOMERY	SOUTHBOUND	0.6
Arterial	103-04824	US-1	BELMONT AVE	PA-23/CONSHOHOCKEN STATE RD (BALA CYNWYD) (WEST)	MONTGOMERY	SOUTHBOUND	0.4
Arterial	103-04823	US-1	PA-23/CONSHOHOCKEN STATE RD (BALA CYNWYD) (WEST)	54TH ST (BALA CYNWYD) (EAST)	MONTGOMERY	SOUTHBOUND	0.6
Arterial	103-04821	US-1	54TH ST (BALA CYNWYD) (EAST)	US-30/LANCASTER AVE	MONTGOMERY	SOUTHBOUND	1.2
Arterial	103-05623	US-1	US-30/LANCASTER AVE	HAVERTFORD RD/HAVERTFORD AVE	MONTGOMERY	SOUTHBOUND	1.0
Arterial	103-05622	US-1	HAVERTFORD RD/HAVERTFORD AVE	PA-3/W CHESTER PIKE	DELAWARE	SOUTHBOUND	1.5
Arterial	103+05623	US-1	PA-3/W CHESTER PIKE	HAVERTFORD RD/HAVERTFORD AVE	MONTGOMERY	NORTHBOUND	1.6
Arterial	103+04821	US-1	HAVERTFORD RD/HAVERTFORD AVE	US-30/LANCASTER AVE	MONTGOMERY	NORTHBOUND	1.0
Arterial	103+04822	US-1	US-30/LANCASTER AVE	54TH ST (BALA CYNWYD) (WEST)	MONTGOMERY	NORTHBOUND	1.2
Arterial	103+04824	US-1	54TH ST (BALA CYNWYD) (WEST)	PA-23/CONSHOHOCKEN STATE RD (BALA CYNWYD) (WEST)	MONTGOMERY	NORTHBOUND	0.6
Arterial	103+04826	US-1	PA-23/CONSHOHOCKEN STATE RD (BALA CYNWYD) (WEST)	BELMONT AVE	MONTGOMERY	NORTHBOUND	0.4
Arterial	103+04827	US-1	BELMONT AVE	PRESIDENTIAL BLVD	PHILADELPHIA	NORTHBOUND	0.6
Arterial	103P04934	US-1	PRESIDENTIAL BLVD	PRESIDENTIAL BLVD	PHILADELPHIA	NORTHBOUND	0.1
<b>SUBTOTAL</b>							<b>10.5</b>
<b>TOTAL</b>							<b>18.7</b>

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

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	
Freeway	103+04271	40.008051	-75.202680	40.001903	-75.194926	0.63	40.007112	-75.200397	40.001123	-75.195185	
Freeway	103+04272	40.001903	-75.194926	39.989505	-75.206251	1.09	40.001123	-75.195185	39.988680	-75.207245	
Freeway	103P04272	39.989505	-75.206251	39.983748	-75.208294	0.42	39.988680	-75.207245			
Freeway	103+04273	39.983748	-75.208294	39.977270	-75.200158	0.64			39.976917	-75.199192	
Freeway	103P04273	39.977270	-75.200158	39.976132	-75.195617	0.25	39.976917	-75.199192	39.977035	-75.199242	
Freeway	103+04274	39.976132	-75.195617	39.965990	-75.186671	0.89	39.977035	-75.199242			
Freeway	103P04274	39.965990	-75.186671	39.963801	-75.184349	0.20			39.962502	-75.183522	
Freeway	103N04274	39.963765	-75.184112	39.966172	-75.186689	0.22	39.963645	-75.183902	39.967020	-75.187525	
Freeway	103-04273	39.966172	-75.186689	39.977758	-75.201107	1.20	39.967020	-75.187525	39.978733	-75.202563	
Freeway	103N04273	39.977758	-75.201107	39.979898	-75.204722	0.24	39.978733	-75.202563			
Freeway	103-04272	39.979898	-75.204722	39.982587	-75.207779	0.25					
Freeway	103N04272	39.982587	-75.207779	39.990121	-75.205331	0.56			39.990330	-75.204798	
Freeway	103-04271	39.990121	-75.205331	40.001412	-75.194626	1.00	39.990330	-75.204798			
Freeway	103-04270	40.001412	-75.194626	40.007532	-75.200576	0.59			40.008752	-75.203280	
<b>SUBTOTAL</b>						<b>8.19</b>					

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

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	
Arterial	103-04934	40.009255	-75.209691	40.008964	-75.210206	0.03	40.009377	-75.209827			
Arterial	103N04934	40.008964	-75.210206	40.008484	-75.211145	0.06					
Arterial	103-04826	40.008484	-75.211145	40.003936	-75.220712	0.60					
Arterial	103-04824	40.003936	-75.220712	40.001256	-75.226399	0.35					
Arterial	103-04823	40.001256	-75.226399	39.997069	-75.235299	0.55			39.988157	-75.254340	
Arterial	103-04821	39.997069	-75.235299	39.988305	-75.253975	1.16	39.988157	-75.254340	39.980205	-75.269558	
Arterial	103-05623	39.988305	-75.253975	39.980175	-75.269285	0.99	39.980205	-75.269558			
Arterial	103-05622	39.980175	-75.269285	39.968571	-75.294302	1.55			39.968288	-75.295053	
Arterial	103+05623	39.968571	-75.294302	39.980175	-75.269285	1.55	39.968583	-75.293905			
Arterial	103+04821	39.980175	-75.269285	39.988305	-75.253975	0.99			39.988325	-75.253658	
Arterial	103+04822	39.988305	-75.253975	39.997069	-75.235299	1.16	39.988325	-75.253658	39.997070	-75.235040	
Arterial	103+04824	39.997069	-75.235299	40.001256	-75.226399	0.55	39.997070	-75.235040			
Arterial	103+04826	40.001256	-75.226399	40.003936	-75.220712	0.35					
Arterial	103+04827	40.003936	-75.220712	40.008291	-75.211165	0.59					
Arterial	103P04934	40.008291	-75.211165	40.008719	-75.210353	0.05			40.008583	-75.210287	
<b>SUBTOTAL</b>						<b>10.54</b>					
<b>TOTAL</b>						<b>18.73</b>					

**Table 3**  
**Path segments identified for validation in Pennsylvania**

Type	Validation Segment	STANDARD SEGMENTS INCLUDED					STARTING AT	ENDING AT	LENGTH (MILE)		
		TMC(1)	TMC(2)	TMC(3)	TMC(4)	TMC(5)			Standard	Deployment	Error (%)
Freeway	PA02-0001	103+04271	103+04272				US-1/CITY AVE/EXIT 340/EXIT 339	MONTGOMERY DR/EXIT 341	1.7	1.70	-1.36%
Freeway	PA02-0002	103P04272	103+04273	103P04273			MONTGOMERY DR/EXIT 341	US-30/US-13/GIRARD AVE/EXIT 342	1.3	1.31	-0.75%
Freeway	PA02-0003	103+04274	103P04274				US-30/US-13/GIRARD AVE/EXIT 342	SPRING GARDEN ST/EXIT 343	1.1	1.07	-1.26%
Freeway	PA02-0004	103N04274	103-04273				SPRING GARDEN ST/EXIT 343	US-30/US-13/GIRARD AVE/EXIT 342	1.4	1.55	9.59%
Freeway	PA02-0006	103-04271	103-04270				MONTGOMERY DR/EXIT 341	US-1/CITY AVE/EXIT 340/EXIT 339	1.6	1.73	8.73%
Arterial	PA02-0007	103-04934	103N04934	103-04826	103-04824	103-04823	PRESIDENTIAL BLVD	54TH ST (BALA CYNWYD) (EAST)	1.6	1.58	-0.99%
Arterial	103-04821	103-04821					54TH ST (BALA CYNWYD) (EAST)	US-30/LANCASTER AVE	1.2	1.20	3.57%
Arterial	PA02-0008	103-05623	103-05622				US-30/LANCASTER AVE	PA-3/W CHESTER PIKE	2.5	2.56	0.82%
Arterial	103+05623	103+05623					PA-3/W CHESTER PIKE	HVERFORD RD/HVERFORD AVE	1.6	1.53	-1.31%
Arterial	PA02-0009	103+04821	103+04822				HVERFORD RD/HVERFORD AVE	54TH ST (BALA CYNWYD) (WEST)	2.1	2.17	0.99%
Arterial	PA02-0010	103+04824	103+04826	103+04827	103P04934		54TH ST (BALA CYNWYD) (WEST)	PRESIDENTIAL BLVD	1.5	1.53	-1.07%
<b>TOTAL</b>									<b>17.67</b>	<b>17.93</b>	

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

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	2.7	4.7	3.0	5.7	2414
30-45	1.4	4.2	1.9	5.8	926
45-60	-1.0	2.3	-1.2	3.9	6947
60+	-2.2	2.4	-4.9	5.3	1284

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

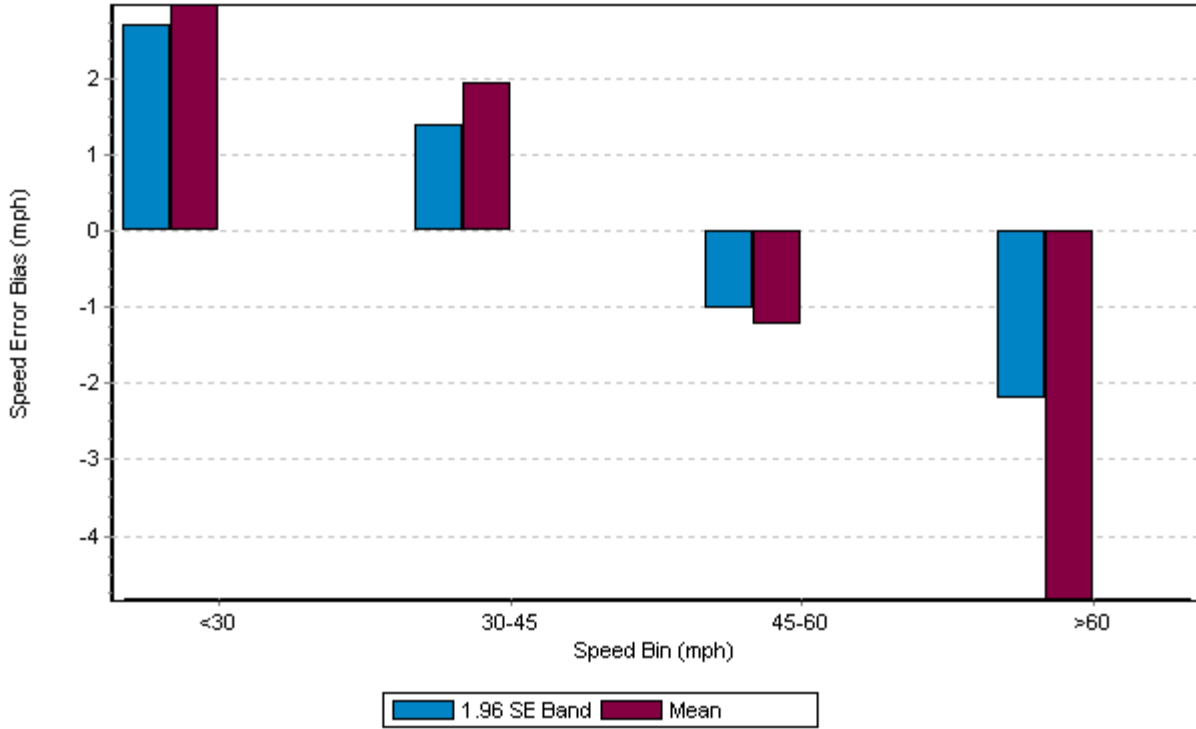
SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Percentage falling inside the band	Percentage falling within 5 mph of the band	Percentage equal to the mean	Percentage within 5 mph of the mean	
0-30	15%	71%	0%	65%	2414
30-45	17%	66%	0%	54%	926
45-60	37%	86%	0%	75%	6947
60+	36%	83%	0%	51%	1284

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

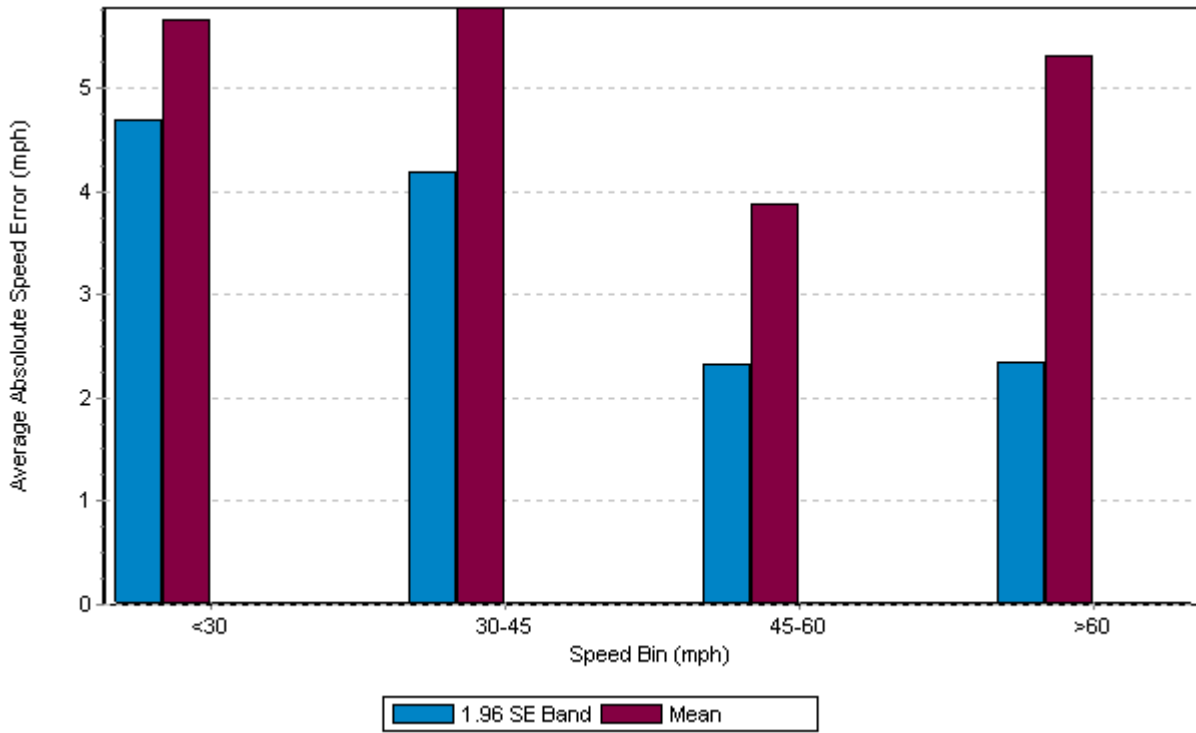
TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SE Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
PA02-0001	1.71	1.70	0-30	2.5	3.7	3.2	5.3	280
			30-45	1.7	4.3	2.9	7.1	133
			45-60	-2.2	3.0	-2.6	4.7	974
			60+	-2.1	2.2	-4.3	4.8	347
PA02-0002	1.31	1.31	0-30	1.9	3.2	2.1	3.9	609
			30-45	1.1	4.2	1.5	5.8	201
			45-60	-2.0	2.6	-2.7	4.4	1324
			60+	-2.1	2.1	-5.1	5.4	418
PA02-0003	1.09	1.07	0-30	0.4	2.5	0.4	3.2	391
			30-45	0.1	3.1	0.2	4.0	269
			45-60	-2.0	2.5	-3.1	4.1	1182
			60+	-3.6	3.7	-6.8	7.2	230
PA02-0004	1.41	1.55	0-30	4.6	6.3	4.7	6.8	425
			30-45	1.4	4.4	1.6	5.6	180
			45-60	-0.7	1.7	-1.0	3.0	1859
			60+	-2.1	2.4	-4.9	5.3	163
PA02-0006	1.61	1.73	0-30	3.6	6.6	4.0	8.0	709
			30-45	4.0	5.8	5.3	8.0	143
			45-60	1.0	2.2	1.9	3.8	1608
			60+	-0.6	1.1	-2.0	3.2	126

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

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	
PA02-0001	0-30	79	28%	220	79%	0	0%	192	69%	280
	30-45	37	28%	88	66%	0	0%	62	47%	133
	45-60	377	39%	787	81%	0	0%	682	70%	974
	60+	141	41%	293	84%	0	0%	212	61%	347
PA02-0002	0-30	89	15%	490	80%	0	0%	460	76%	609
	30-45	36	18%	131	65%	0	0%	100	50%	201
	45-60	565	43%	1115	84%	0	0%	961	73%	1324
	60+	163	39%	362	87%	0	0%	212	51%	418
PA02-0003	0-30	70	18%	324	83%	0	0%	309	79%	391
	30-45	35	13%	210	78%	0	0%	192	71%	269
	45-60	334	28%	1007	85%	0	0%	847	72%	1182
	60+	39	17%	156	68%	0	0%	50	22%	230
PA02-0004	0-30	35	8%	289	68%	0	0%	279	66%	425
	30-45	27	15%	113	63%	0	0%	99	55%	180
	45-60	741	40%	1672	90%	0	0%	1552	83%	1859
	60+	51	31%	138	85%	0	0%	71	44%	163
PA02-0006	0-30	96	14%	401	57%	0	0%	318	45%	709
	30-45	25	17%	65	45%	0	0%	45	31%	143
	45-60	544	34%	1400	87%	1	0%	1166	73%	1608
	60+	73	58%	120	95%	0	0%	109	87%	126



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



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

## ***Analysis of Results for Arterials***

Travel time samples collected along US Route 1 were compared with travel time and speed data reported by INRIX as part of this project. The arterial data is included for informational purposes noting that INRIX has volunteered arterial data at no cost to the Coalition for the first three years, and that the method to evaluate quality on arterial roadways has not been fully evaluated. The Coalition is currently in the process of developing appropriate quality metrics and validation methods.

Table 8 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds on six arterial segments considered in this round of validations. In speed bin below 45mph, INRIX data meets the freeway data quality measures set forth in the contract when errors are measured as a distance from the 1.96 times the standard error band. In addition, data quality measures in the 45 to 60 mph speed bin are based on a very small number of observations which is compatible with the posted speed limits on the arterial segments in question.

Table 9 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 arterial segments in Pennsylvania. Tables 10 and 11 present detailed data for individual arterial segments in Pennsylvania in similar format as Tables 8 and 9, 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 4 and 5 show the overall speed error biases for different speed bins, and the average absolute speed errors for all considered arterial segments in Pennsylvania, respectively. These figures correspond to Table 8.

**Table 8**  
**Data quality measures for arterial segments greater than one mile in Pennsylvania**

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	2.1	2.3	4.1	4.8	5221
30-45	-7.3	7.4	-9.9	10.1	1982
45-60	-13.7	13.7	-16.6	16.6	3*
60+					

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

**Table 9**  
**Percent observations meeting data quality criteria for arterial segments greater than one mile in Pennsylvania**

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	36%	84%	0%	60%	5221
30-45	17%	39%	0%	24%	1982
45-60	0%	0%	0%	0%	3*
60+					

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

**Table 10**  
**Data quality measures for individual arterial validation segments greater than one mile in the state of Pennsylvania**

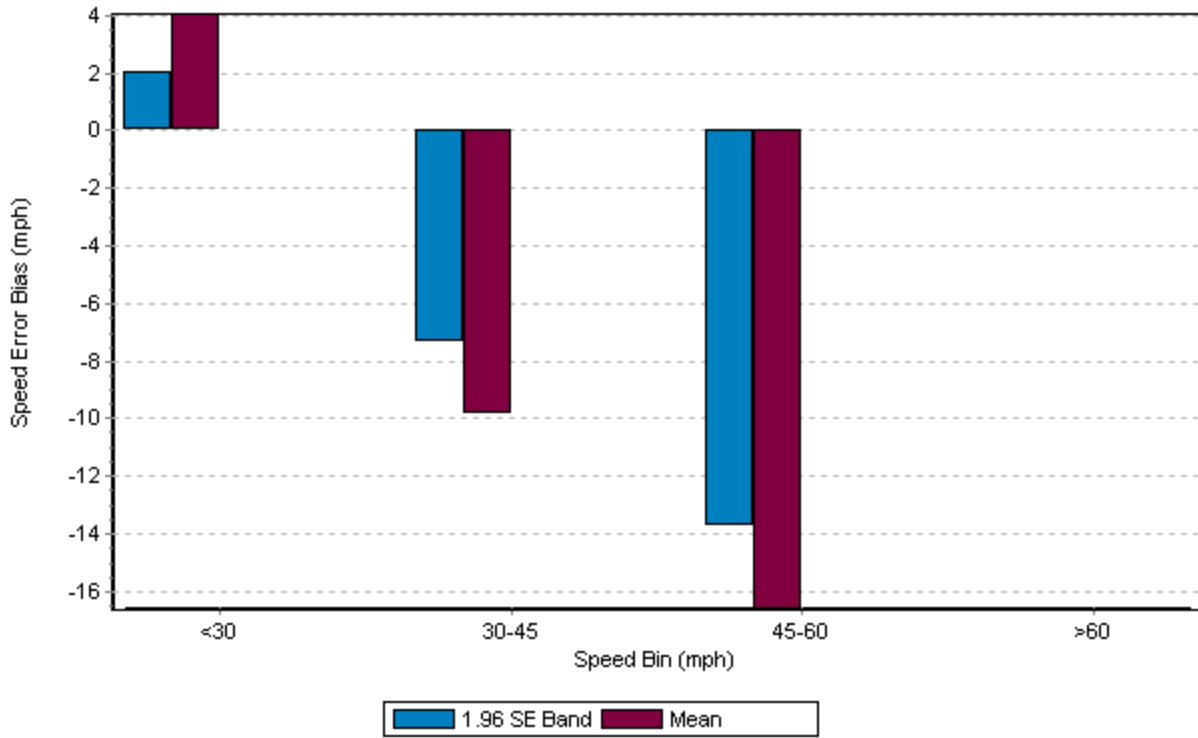
TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SE Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
103+05623	1.55	1.53	0-30	0.9	1.1	3.4	4.3	660
			30-45	-1.1	1.3	-2.7	3.8	332
			45-60					
			60+					
103-04821	1.16	1.20	0-30	-2.4	2.5	-3.2	6.3	91
			30-45	-9.3	9.3	-12.1	12.1	1498
			45-60	-13.7	13.7	-16.6	16.6	3*
			60+					
PA02-0007	1.60	1.58	0-30	3.3	3.4	5.3	5.5	1399
			30-45					
			45-60					
			60+					
PA02-0008	2.53	2.56	0-30	0.4	0.7	2.0	3.4	533
			30-45	-1.8	1.9	-3.4	3.6	145
			45-60					
			60+					
PA02-0009	2.15	2.17	0-30	2.3	2.5	4.2	4.6	1048
			30-45	-0.1	0.1	-0.4	0.7	3*
			45-60					
			60+					
PA02-0010	1.54	1.53	0-30	2.1	2.3	4.3	5.0	1490
			30-45	-7.7	7.7	-9.0	9.0	4*
			45-60					
			60+					

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

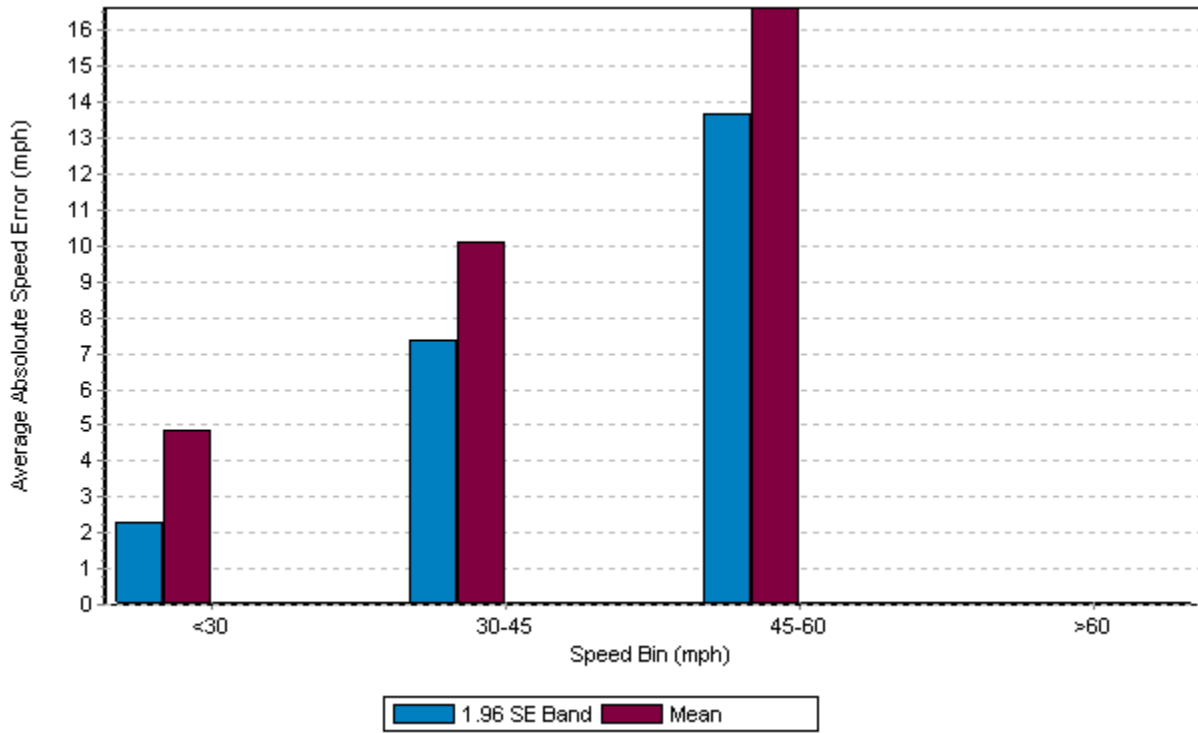
**Table 11**  
**Observations meeting data quality criteria for individual arterial validation segments**  
**greater than one mile in the state of Pennsylvania**

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+05623	0-30	393	60%	624	95%	1	0%	453	69%	660
	30-45	184	55%	305	92%	0	0%	242	73%	332
	45-60									
	60+									
103-04821	0-30	44	48%	70	77%	0	0%	34	37%	91
	30-45	88	6%	324	22%	0	0%	118	8%	1498
	45-60	0	0%	0	0%	0	0%	0	0%	3*
	60+									
PA02-0007	0-30	240	17%	1021	73%	1	0%	681	49%	1399
	30-45									
	45-60									
	60+									
PA02-0008	0-30	346	65%	526	99%	0	0%	419	79%	533
	30-45	56	39%	131	90%	0	0%	107	74%	145
	45-60									
	60+									
PA02-0009	0-30	291	28%	886	85%	0	0%	707	67%	1048
	30-45	1	33%	3	100%	0	0%	3	100%	3*
	45-60									
	60+									
PA02-0010	0-30	541	36%	1244	83%	1	0%	855	57%	1490
	30-45	0	0%	1	25%	0	0%	0	0%	4*
	45-60									
	60+									

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



**Figure 4**  
**Speed error bias for arterial segments greater than one mile in Pennsylvania**



**Figure 5**  
**Average absolute speed error for arterial segments greater than one mile in Pennsylvania**