Mid-Hudson Valley TMA
Travel Time Survey

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Prepared For:

Mid-Hudson Valley Transportation Management Area (TMA)

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Introduction

The purpose of this study is to collect reliable Global Positioning System (GPS)-based travel time data on major roadways in the Mid-Hudson Valley Transportation Management Area (TMA) in support of the TMA's Congestion Management Process (CMP) and other transportation planning activities. Eng-Wong, Taub & Associates (EWT) was selected to conduct the study and travel time data was collected in May, September, October, November, and early December of 2010 and January and February of 2011.

The CMP is a federal requirement for TMAs and received increased emphasis in the Safe, Accountable, Flexible, and Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU). The TMA completed its CMP Step 2 Report, which identified congested roads in the region, in June 2006. The Report used volume-to-capacity ratios derived from the Dutchess, Orange, and Ulster Counties' Travel Demand Models to identify congested roadway segments. An issue identified in the Report is that the Travel Demand Models may overlook some areas of congestion due to changes in travel patterns, variations in speed, maneuverability, travel time, or other variables. The Report suggested that using travel time surveys on high-volume roads would help capture a more realistic picture of congestion.

The data collected in this project will allow the TMA to advance the CMP and provide "real-world" travel time data that can be used in developing projects, prioritizing funding, and calibrating the three counties' Travel Demand Models to further improve reliability.

Survey Design

All roadway sections were surveyed during "typical" weekday periods (Tuesdays, Wednesdays, and Thursdays on non-holiday school days) and some were surveyed on weekends. The following time periods were used during the data collection process:

- Weekday Morning (AM) – 6:00 AM to 9:00 AM
- Midday/Off-Peak – 9:00 AM to 11:00 AM
- Evening (PM) – 4:00 PM to 7:00 PM
- Saturday – 9:00 AM to 3:00 PM
- Sunday – 4:00 PM to 7:00 PM

Staff from Ulster, Dutchess and Orange counties, identified the roadway sections and time periods to be surveyed. Each section is identified by a starting point and ending point and is divided into segments in between. The segments are bound by traffic signals or the starting or ending point.

The travel time data was collected via a hybrid of the floating car method and the average speed method. Both methods have been deployed in numerous studies and are acceptable forms of travel time sampling. Eng-Wong, Taub recommended combining the two methodologies to better simulate a "real-life" scenario. With the floating car method, the test vehicle stays in the center or right lane and the driver attempts to pass as many cars as pass the test vehicle. With the average car method, the driver tries to maintain the average speed of traffic by traveling in either lane. The hybrid methodology maintains the average speed of traffic, but if many cars are passing, the driver will pass some cars also. This method is safer because the driver can stay alert to roadway conditions, rather than focusing on passing cars.

Sampling Plan

Eng-Wong, Taub performed a statistical analysis of the roadway sections to estimate the number of runs that were required for a statistically valid sample. The *Travel Time Data Collection Handbook*, published by the Federal Highway Administration in 1998, includes a sampling methodology to calculate the number of survey runs that must be performed. This methodology is based on previous studies conducted over a number of years.

As the *Handbook* demonstrates in Chapter 3 (Test Vehicle Techniques), the minimum sample size (n) can be computed with the formula…

$$n = \left(\frac{t * c.v}{e}\right)^2$$

…where t is the Student's t distribution for (n-1) degrees of freedom, $c.v$ is the average coefficient of variation in travel times, and e is the relative allowable error. The t value was computed with a MS Excel function (TINV) that calculates the t value based on an estimated sample size and a given confidence interval. The $c.v$ value ranges from 9 to 17 percent, which was derived from other studies. Table 1 below shows the average coefficients for different roadway types.

Table 1 – COEFFICIENT OF VARIATION ON FREEWAYS AND ARTERIAL STREETS

Freeways		Arterial Streets	
Average Daily Traffic (ADT) Volume per lane	Average Coefficient of Variation (%)	Traffic Signal Density (signals per mile)	Average Coefficient of Variation (%)
Less than 15,000	9	Less than 3	9
15,000 to 20,000	11	3 to 6	12
Greater than 20,000	17	Greater than 6	15

Source: FHWA Travel Time Data Collection Handbook, 1998

Since the t value depends on an estimated sample size, an iterative calculation was performed to calculate the correct number of samples. Eng-Wong, Taub classified each of the sections into one of these $c.v$ categories, which allowed for the calculation of a sample size. Based on this $c.v$ value and the selected confidence interval of 80 percent, the number of runs needed per section per time period ranged from 3 to 10. The *Handbook* also states that for planning and policy level studies a 10 percent error is commonly used, while a 5 percent error should be used for operations and evaluation. Since the travel time runs will be inputs to a travel demand model, Eng-Wong, Taub recommended that a 10 percent error be used.

Data Collection

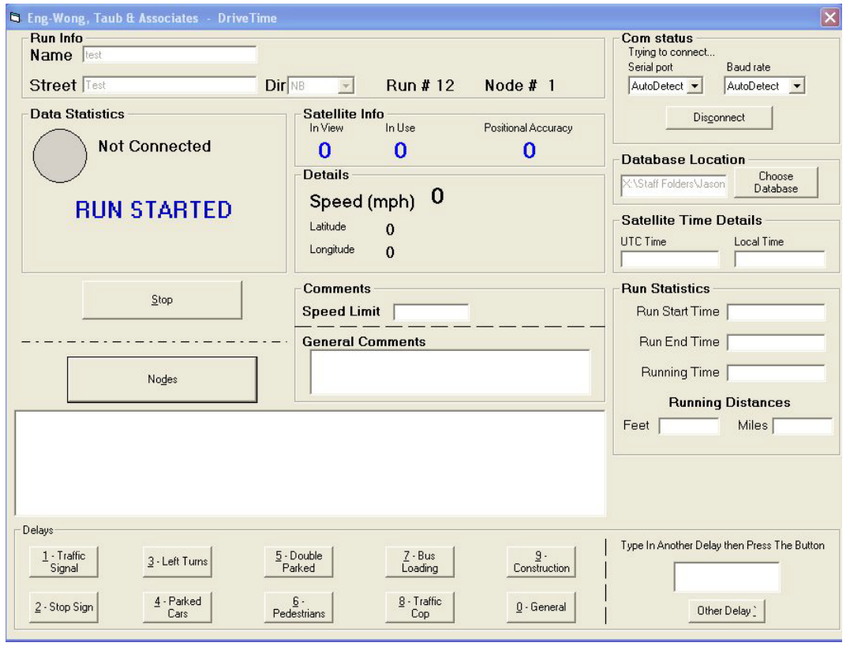
Eng-Wong, Taub, with assistance from Techniquest Corporation, performed all travel time surveys using current global positioning system (GPS) technology and a customized, in-house database application we developed, known internally as *DriveTime* (see Figure 1). Heavy rain and snow days were avoided, but light rain was considered acceptable weather.

Our data collection methodology was as follows. A USB GPS antenna was connected to a laptop computer running *DriveTime*, and the program collected all relevant GPS data, including latitude, longitude, speed, and satellite information.

Since *DriveTime* is an in-house program, it was customized to include collection of posted speed limits, weather, incidents, and field observations including the number of through lanes and turn lanes at each signalized intersection. These observations were made prior to starting the field work. A reconnaissance of all roadway sections was completed to note any unusual activity and to confirm that a valid GPS signal was available. During this reconnaissance a camcorder also videotaped the section for future viewing.

DriveTime allowed Eng-Wong, Taub to deploy one person per car to capture all necessary travel time information. Before the start of the day the driver verified that the GPS had a valid signal and was logging the data. After all checks were completed, the driver began collecting travel time data by driving the assigned section(s) for that day, using the previously discussed methodology. No other inputs were needed by the driver. At the end of each survey period the driver uploaded the database to an ftp site, and an additional copy was automatically saved to the laptop hard drive to help prevent data loss. Supervisors in the office reviewed the data at the end of each day to assure quality control and assess each driver's progress. By reviewing the data on a daily basis, the number of make-up days was reduced; this also ensured that consistent data was being collected.

Figure 1-- DRIVETIME INTERFACE



Data Summarization

To summarize the data, a software program developed in-house sorted through the data and identified each run by looking for a predefined series of nodes for each section. Each roadway segment is bounded by traffic signals which are referred to as "nodes" or the beginning or end of the segment. A "good" run is one where at least one data point from the GPS run is within each node polygon (shaded areas in Figure 2). If traffic is flowing freely there is greater distance between data points so it is possible that a polygon may not include a data point from a particular run. To reconcile this, during the data cleaning process some node polygons are increased in size in order for the GPS data points to be within the polygon and therefore included in the run data (see Figure 2). After the classification of each run a detailed summary of each section by direction was prepared.

Figure 2 --NODES/POLYGONS WITH TRAVEL TIME DATA POINTS

A set of tables, figures and charts for each roadway section surveyed was prepared using key criteria as defined in the Request for Proposals (RFP), including:

- Travel Time: the time to travel from the beginning point of a section until the end point of the section including any signal delays, congestion, stopped time or other delays.
- Congested Time: the time spent traveling slower than 20 miles per hour.
- Stopped Time: the time spent traveling slower than 5 miles per hour.
- Free-Flow Travel Time: the time to travel the section at the posted speed limit.
- Peak Period Travel Time: the time to travel the section during the weekday morning peak (6AM to 9AM), midday/off-peak (9AM to 11AM), evening peak (4PM to 7PM), Saturday peak (9AM to 3PM) or the Sunday peak (4PM to 7PM).
- Travel Time Index: the ratio of the peak period travel time to free-flow travel time.

The tables and charts that were prepared include the following:

Average Travel Time Profiles – includes charts showing stopped time, congested time (speeds below 20 miles per hour), and travel time by direction and roadway segment; charts showing the stopped, congested, and travel time by travel direction and time period, and a map depicting the segments along each section for reference.

Average Speed Profiles – includes maps showing average speeds by segment, by travel direction, and survey time period; charts showing the average speed on the section by direction and time period, and a map of speed limits.

Travel Time Index Profiles – includes maps that show the travel time index (TTI) by travel direction, roadway segment, and time period, and charts showing the TTI for the section by travel direction and time period. The TTI is the ratio of the travel time during the peak period to the time required to make the same trip at free-flow speeds. A value of 1.30, for example, indicates a that 30-minute free-flow trip requires 39 minutes during the peak period. Generally, a roadway is considered congested if the TTI exceeds 1.30. Roadway segments on the TTI Profile maps are highlighted to show if they are congested (TTIs greater than 1.30), approaching a congested state (TTIs from 1.15 to 1.30) or not congested (TTIs less than 1.15).

Box-Whisker Speed Plots – includes charts that show the maximum, 75th percentile, average, 25th, and 15th percentile speeds by roadway segment, direction, and time period. Box-Whisker plots are a convenient way of graphically depicting groups of numerical data. The spacing between the different parts of the box indicates the degree of dispersion (spread) and skew in the data and identifies outliers.

In addition to the graphs, charts, figures, and tables that are included in the report and described above, large (44 x 36 inch) maps were prepared for each county showing the travel time index by section and time period. Static data that was collected, like posted speed limits and the number of lanes, were also mapped using ArcGIS. This process included merging the data onto a roadway shape file for easy referencing. Tables were also created for each county containing the raw speed run data and summary tables by run, time period and section. The large county maps and tables for each county were provided to the client.

Conclusion

The data collected as part of this program provides the Mid-Hudson Valley Transportation Management Area with reliable travel time data to advance its CMP and for the three counties to calibrate their travel demand models. The data can be used to identify congested roadway segments. Those roadway segments could be studied further to determine the root cause of the congestion -- whether it is operational issues, recurring incidents, insufficient capacity, or other causes, and additional studies could be conducted to identify potential roadway improvements. The data from this report could also be used to prioritize Transportation Improvement Program (TIP) projects.

This database provides a baseline of travel time information which should be expanded and maintained in order to support congestion management-related decision making in the future. The database should be updated regularly – about every three to four years, if funding permits. Prior to collecting new data, the roadway sections should be reviewed to determine if any should be added or deleted, and consideration should be given to expanding the survey time periods to obtain a more reliable free flow travel time. Conducting surveys during an overnight period when roadway volumes are lower would provide more accurate free flow travel time data that could be used to determine the travel time index for each roadway.

The next section summarizes the detailed findings for Ulster, Dutchess, and Orange Counties.

Ulster County

Travel time runs were conducted in Ulster County and surveyed during "typical" weekday periods (Tuesdays, Wednesdays, and Thursdays on non-holiday school days) and weekends during the month of May 2010; one section was completed in February 2011 because it was under construction when earlier travel time runs were completed. Table 2 lists the number of runs completed in Ulster County by section, direction and time period. The runs completed for each section meet or exceed the number required to obtain an 80% confidence level with a 10% relative allowable error.

Table 2 -- ULSTER COUNTY TRAVEL TIME SECTION SUMMARY

Sections	Roadway	From	To	Runs Completed by Time Period				
				AM	Midday	PM	Sat	Sun
1-EB	Broadway	Albany Avenue	US 9W	5	4	5		
1-WB				5	5	5		
2-NB	Albany, Ulster Ave.	Broadway	US 9W	4	5	4	4	
2-SB				4	5	4	4	
3-NB	Washington Ave.	SR 32	Thruway Circle	4	4	6		
3-SB				5	4	5		
4-NB	US 9W	Orange County Line	Ulster Ave, Esopus	7	5	6		
4-SB				5	5	7		
5-NB	US 9W	Ulster Ave, Esopus	SR 199	7	5	6		
5-SB				6	6	6		
6-NB	US 9W	SR 199	SR 32	7	4	5		
6-SB				8	6	6		
7-NB	US 9W	SR 32	Overbaugh Street	7	5	6		
7-SB				9	6	6		
8-NB	I-87	Kingston Exit 19	Orange County Line	3	4	3		2
8-SB				3	4	3		3
9-NB	SR 32	Kingston City Line	New Paltz Village Line	6	5	7		
9-SB				6	5	6		
10-NB	SR 32	New Paltz Village Line	Main Street/SR 299	5	4	7	4	
10-SB				6	4	6	4	
11-EB	SR 299 Main Street	I-87	SR 32	5	4	5	4	
11-WB				4	5	7	4	
12-EB	SR 299	US 9W	I-87	5	4	4	4	
12-WB				5	4	7	4	
13-NB	Burt Street/Hill/ Partition /Ulster Ave/SR 212	Overbaugh Street	SR 32	7	5	6		
13-SB				5	5	5		
14-NB	US 209	Eastern Village Line	SR 28	7	5	6		
14-SB				5	6	6		
15-NB	I587	Albany Avenue	US 209				3	
15-SB							4	

Table 3 shows the TTI by section and travel direction for the time periods that were studied. TTIs above 1.3 are shown in red bold.

Table 3 -- ULSTER COUNTY TRAVEL TIME INDEX BY SECTION

Sections	Roadway	From	To	Time Periods				
				AM	Midday	PM	Sat	Sun
1-EB	Broadway	Albany Avenue	US 9W	1.29	**1.34**	**1.37**	-	-
1-WB				**1.76**	**1.69**	**1.91**	-	-
2-NB	Albany, Ulster Ave.	Broadway	US 9W	1.21	**1.31**	1.29	1.30	-
2-SB				1.07	1.23	1.19	1.17	-
3-NB	Washington Ave.	SR 32	Thruway Circle	**2.14**	**1.82**	**2.06**	-	-
3-SB				**1.98**	**2.26**	**2.04**	-	-
4-NB	US 9W	Orange County Line	Ulster Ave, Esopus	1.07	1.11	1.10	-	-
4-SB				1.13	1.12	1.08	-	-
5-NB	US 9W	Ulster Ave, Esopus	SR 199	1.06	1.14	1.23	-	-
5-SB				1.15	1.14	**1.40**	-	-
6-NB	US 9W	SR 199	SR 32	1.04	1.15	1.24	-	-
6-SB				1.15	1.07	1.09	-	-
7-NB	US 9W	SR 32	Overbaugh Street	1.09	1.18	1.28	-	-
7-SB				1.28	1.15	1.24	-	-
8-NB	I-87	Kingston Exit 19	Orange County Line	0.94	0.93	0.94	-	0.96
8-SB				0.93	0.94	0.93	-	0.94
9-NB	SR 32	Kingston City Line	New Paltz Village Line	1.17	1.15	1.11	-	-
9-SB				1.17	1.12	1.15	-	-
10-NB	SR 32	New Paltz Village Line	Main Street/SR 299	0.90	0.94	0.95	1.02	-
10-SB				1.07	1.19	**1.52**	**1.43**	-
11-EB	SR 299 Main Street	I-87	SR 32	1.28	**1.40**	**1.90**	**2.17**	-
11-WB				1.16	**1.53**	**2.19**	**2.34**	-
12-EB	SR 299	US 9W	I-87	**1.41**	1.29	**1.40**	1.27	-
12-WB				1.15	1.18	**1.33**	1.24	-
13-NB	Burt Street/Hill/ Partition /Ulster Ave/SR 212	Overbaugh Street	SR 32	1.29	**1.41**	1.25	-	-
13-SB				**1.57**	1.30	**1.41**	-	-
14-NB	US 209	Eastern Village Line	SR 28	0.87	0.88	0.90		
14-SB				0.90	0.86	0.93		
15-NB	I587	Albany Avenue	US 209	-	-	-	1.00	-
15-SB				-	-	-	**1.53**	-

Nine of the Ulster County sections surveyed have TTIs over 1.3 during at least one of the surveyed time periods. Washington Avenue from State Route 32 to the Thruway Circle has TTIs exceeding 1.3 in both directions during the AM, Midday, & PM peak periods. The Ulster County Average Speed Profiles, Average Travel Time Profiles, Travel Time Index Profiles, and Box-Whisker Speed Plots by section can be found in the Appendix.

Dutchess County

Travel time runs were conducted in Dutchess County and surveyed during "typical" weekday periods (Tuesdays, Wednesdays, and Thursdays on non-holiday school days) and weekends during the months of September and October 2010; one run was completed in February of 2011. Table 4 lists the number of runs completed in Dutchess County by section, direction and time period. The runs completed for each section meet or exceed the number required to obtain an 80% confidence level with a 10% relative allowable error.

Table 4 -- DUTCHESS COUNTY TRAVEL TIME SECTION SUMMARY

Sections	Roadway	From	To	Runs Completed by Time Period				
				AM	Midday	PM	Sat	Sun
16-NB	US 9	I 84	NY 55/US 44	6	7	5	5	
16-SB				6	6	6	5	
17-NB	US 9	US 44/NY 55	NY 9G	6	5	6	5	
17-SB				8	5	6	5	
18-EB	NY 55	NY 9W(Ulster County)	Taconic State Parkway	6	5	8	5	
18-WB				6	5	8	5	
19-NB	Taconic State Parkway	I 84	NY 55/US 44	5	5	6		5
19-SB				5	5	6		5
20-EB	I-84	NY 9W(Ulster County)	Taconic State Parkway	4	4	8		
20-WB				4	3	7		
21-EB	NY 9G & NY 199	US 9	NY 9W (Ulster County)	7	5	8		
21-WB				7	5	8		
22-NB	US 44	NY 55	Taconic State Parkway	8	7	6	5	
22-SB				9	7	5	5	
23-NB	NY 376	NY 52	NY 55	7	5	6	5	
23-SB				7	5	6	5	
24-EB	NY 52	I 84	Taconic State Parkway	5	5	5		
24-WB				5	4	4		
25-NB	NY 9D	I 84	US 9	5	6	5		
25-SB				5	5	6		
26-NB	NY 22	Putnam County Line	NY 343	7	5	6		
26-SB				6	5	5		
27-NB	NY 22	NY 343	NY 199	5	6	6		
27-SB				6	6	6		
28-EB	NY 55	Taconic State Parkway	NY 22	6	6	6		
28-WB				6	5	6		
29-NB	NY 115	NY 55	Taconic State Parkway	5	6	5		
29-SB				5	6	5		
30-NB	NY 9G	US 9	North Road (US 9)	8	5	7		
30-SB				6	5	5		

Table 5 shows the TTI by section and travel direction for the time periods that were studied. TTIs above 1.30 are shown in red bold.

Table 5 -- DUTCHESS COUNTY TRAVEL TIME INDEX BY SECTION

Sections	Roadway	From	To	Time Periods				
				AM	Midday	PM	Sat	Sun
16-NB	US 9	I 84	NY 55/US 44	1.25	**1.35**	**1.54**	**1.42**	
16-SB				1.24	1.30	**1.51**	**1.52**	
17-NB	US 9	US 44/NY 55	NY 9G	1.10	1.17	1.22	**1.42**	
17-SB				1.12	1.10	1.14	**1.53**	
18-EB	NY 55	NY 9W(Ulster County)	Taconic State Parkway	1.04	1.02	1.03	0.93	
18-WB				1.02	0.99	1.08	0.97	
19-NB	Taconic State Parkway	I 84	NY 55/US 44	0.28	0.22	0.23		0.28
19-SB				0.19	0.22	0.18		0.15
20-EB	I-84	NY 9W(Ulster County)	Taconic State Parkway	0.97	0.96	0.97		
20-WB				0.87	0.88	0.89		
21-EB	NY 9G & NY 199	US 9	NY 9W (Ulster County)	1.00	0.98	1.15		
21-WB				0.97	0.99	1.00		
22-NB	US 44	NY 55	Taconic State Parkway	0.92	0.90	0.94	0.91	
22-SB				1.04	1.07	1.14	1.02	
23-NB	NY 376	NY 52	NY 55	1.25	1.19	1.27	1.15	
23-SB				1.22	1.16	1.29	1.22	
24-EB	NY 52	I 84	Taconic State Parkway	1.26	1.30	**1.39**		
24-WB				1.24	1.23	**1.58**		
25-NB	NY 9D	I 84	US 9	**1.31**	1.28	**1.44**		
25-SB				**1.31**	1.24	**1.35**		
26-NB	NY 22	Putnam County Line	NY 343	1.01	1.01	1.04		
26-SB				1.07	1.02	1.10		
27-NB	NY 22	NY 343	NY 199	1.03	1.06	1.04		
27-SB				1.06	1.06	1.08		
28-EB	NY 55	Taconic State Parkway	NY 22	1.09	1.08	1.10		
28-WB				1.10	1.08	1.11		
29-NB	NY 115	NY 55	Taconic State Parkway	1.07	1.05	1.09		
29-SB				0.74	0.71	0.74		
30-NB	NY 9G	US 9	North Road (US 9)	1.16	1.14	1.21		
30-SB				1.02	1.04	1.10		

Four of the 15 Dutchess County sections surveyed have TTIs over 1.3 during at least one surveyed time period. Three sections experience high TTIs during the PM peak period, one during the AM peak period and one during the midday peak period. The Dutchess County Average Speed Profiles, Average Travel Time Profiles, Travel Time Index Profiles, and Box-Whisker Speed Plots by section can be found in the Appendix.

Orange County

Travel time runs were conducted in Orange County and surveyed during "typical" weekday periods (Tuesdays, Wednesdays, and Thursdays on non-holiday school days) and weekends during the months of October and November of 2010 and February of 2011. Table 6 lists the number of runs completed in Orange County by section, direction and time period. The runs completed for each section meet or exceed the number required to obtain an 80% confidence level with a 10% relative allowable error. Route 53 (US Route 9W from Interstate 84 to Route 94) was not completed because of ongoing construction during the survey period.

Table 6 -- ORANGE COUNTY TRAVEL TIME SECTION SUMMARY

Sections	Roadway	From	To	Runs Completed by Time Period				
				AM	Midday	PM	Sat	Sun
31-NB	Palisades	Rockland County Line	Bear Mountain Bridge	7	6	5		
31-SB				7	6	5		
32-EB	Palisades/US Rte 6	Rockland County Line	Rte 17	3	3	3		
32-WB				4	3	3		
33-NB	I87	Rockland County Line	Harriman Toll	4	3	4		3
33-SB				3	3	3		4
34-NB	Rte 17/32	Larkin Dr.	CR 105	5	6	5	5	
34-SB				6	5	5	5	
35-NB	Rte 17M/208	Rte 17	Rte 17	6	6	5	5	
35-SB				6	5	5	5	
36-NB	Rte 208	Rte 17	Rte 94	6	6	5		
36-SB				6	5	5		
37-EB	Rte 17M	Rte 17	I84	5	5	5		
37-WB				5	5	5		
38-NB	Rte 17M	Rte 17	I84	5	5	5	5	
38-SB				5	5	5	6	
39-NB	Rte 211	Scotchtown Ave.(CR 83)	Wisner St Middletown	5	5	5	5	
39-SB				5	5	5	6	
40-EB	Crystal Run Rd/ East Main St	Ballard	Carpenter (CR 96)	4	5	6		
40-WB				5	5	5		
41-EB	Rt 17 (I86)	Harriman Toll	Chester Exit 126 (Rte 94)	5	4	6		3
41-WB				5	4	6		3
42-NB	Rt 17 (I86)	Chester Exit 126	Wallkill Exit 120 (Rte 211)	5	4	6		3
42-SB				5	4	6		3
43-NB	Rte 208	Neelytown Rd (CR99)	Rte 17	8	5	5	5	
43-SB				7	5	5	5	
44-NB	Rte 208	Scofield St.	William St	5	4	5		
44-SB				5	4	5		
45-EB	Rte 52	Elm St	Montgomery St	5	5	5		
45-WB				6	5	5		
46-EB	Rte 17K	Rte 300	Rte 747	6	4	4		
46-WB				5	4	5		
47-EB	Broadway/Rte 17K	William St	Rte 300	4	4	4	5	
47-WB				5	4	5	4	
48-EB	Rte 207/Rte 300	Bruenig rd	Union Ave (CR 69)	9	5	7		
48-WB				10	4	7		
49-NB	Rte 300	Rte 207	I84	8	5	6	5	
49-SB				9	5	7	5	
50-NB	Rte 300	I84	Rte 52	9	5	6	5	
50-SB				9	5	7	4	
51-NB	I84	Newburgh Beacon Bridge	I87 (Exit 7)	4	3	8		
51-SB				4	3	7		
52-NB	US Rte 9W	I84	Ulster County Line	5	5	5		
52-SB				5	5	5		
54-NB	Rte 32	Rte 94	Rte 17K	5	5	5	5	
54-SB				6	5	5	5	
55-NB	US Rte 6	I84 Exit 1 Ramps	Jersey Ave.	4	5	5		
55-SB				4	5	5		
56-NB	Rte 17	Exit 120 Rte 211	Sullivan County Line	5	4	6		
56-SB				5	2			
57-NB	I87	Woodbury Toll	Newburgh Exit 17	4	3	4		3
57-SB				3	3	3		4
58-NB	I87	Newburgh Exit 17	Ulster County Line	4	3	4		3
58-SB				3	3	3		4
59-EB	I84	I87	Rte 17K Exit 6	4	3	8		
59-WB				4	3	8		
60-EB	I84	Rte 17K Exit 6	Rte 747 Exit 5A	4	3	8		
60-WB				4	3	8		
61-NB	I84	Rte 747 Exit 5A	Rte 208 Exit 5	4	3	8		
61-SB				4	3	8		
62-NB	I84	Rte 208 Exit 5	Rte 17 Exit 4	4	3	8		
62-SB				4	3	6		
63-NB	I84	Rte 17 Exit 4	Rte 17M Exit 3	4	3	8		
63-SB				4	3	6		
64-NB	I84	Rte 17 Exit 3	Greenville Tpke (CR 35)	4	3	9		
64-SB				4	3	6		
65-NB	I84	Greenville Tpke (CR 35)	Pennsylvania State Line	4	3	8		
65-SB				4	3	6		

Sections	Roadway	From	To	Runs Completed by Time Period				
				AM	Midday	PM	Sat	Sun
66-NB	Ballard Rd	Rte 211	Crystal Run Rd	5	5	6		
66-SB				5	5	6		
67-NB	Dunning Rd (CR 94)	East Main St (CR 65)	Rte 211	6	6	5		
67-SB				6	5	5		
68-NB	Rte 94	Rte 17	Rte 208	5	4	5		
68-SB				5	4	5		
69-EB	Rte 94	Rte 17	Rte 17A	5	5	5		
69-WB				5	5	5		
70-NB	Rte 207/17A	Sarah Wells Trail (CR18)	Coates Dr	5	5	6		
70-SB				6	5	5		
71-NB	Rte 17A	Coates Dr.	Rte 94	8	6	5		
71-SB				6	5	5		
72-NB	Rte 17A	Rte 94	CR 1A	5	5	5		
72-SB				5	5	5		
73-NB	Kings Hwy (CR13)	Rte 17M	Rte 94	5	5	5		
73-SB				5	5	5		
74-NB	Rte 94	I87	Quassaick Ave	4	4	5		
74-SB				5	5	5		
75-NB	Rte 211	Rte 416	Rte 17K	12	7	8		
75-SB				12	7	8		
76-EB	Rte 17K	Factory St	Albany Post Rd (CR 14)	12	7	8		
76-WB				12	7	7		

Table 7 shows the TTI by section and travel direction for the time periods that were studied. TTIs above 1.30 are shown in red bold.

Table 7 – ORANGE COUNTY TRAVEL TIME INDEX BY SECTION

Sections	Roadway	From	To	Time Periods				
				AM	Midday	PM	Sat	Sun
31-NB	Palisades	Rockland County Line	Bear Mountain Bridge	1.00	1.01	1.07		
31-SB				1.04	1.07	1.12		
32-EB	Palisades/US Rte 6	Rockland County Line	Rte 17	1.12	1.10	1.48		
32-WB				1.20	0.98	0.95		
33-NB	I87	Rockland County Line	Harriman Toll	0.94	0.95	0.95		0.95
33-SB				0.99	0.98	0.99		0.96
34-NB	Rte 17/32	Larkin Dr.	CR 105	1.24	**1.39**	**1.56**	**1.37**	
34-SB				**1.45**	**1.34**	**1.77**	**1.45**	
35-NB	Rte 17M/208	Rte 17	Rte 17	1.25	**1.34**	**1.63**	**1.50**	
35-SB				1.28	**1.33**	**1.51**	**1.52**	

Sections	Roadway	From	To	Time Periods				
				AM	Midday	PM	Sat	Sun
36-NB	Rte 208	Rte 17	Rte 94	1.26	1.17	**1.85**		
36-SB				1.15	1.16	1.20		
37-EB	Rte 17M	Rte 17	I84	**1.41**	**1.31**	**1.38**		
37-WB				1.20	1.27	1.65		
38-NB	Rte 17M	Rte 17	I84	**1.48**	**1.79**	**1.61**	**1.82**	
38-SB				**1.71**	**1.69**	**1.73**	**1.66**	
39-EB	Rte 211	Scotchtown Ave.(CR 83)	Wisner St Middletown	**1.39**	**1.43**	**1.43**	**1.44**	
39-WB				1.13	**1.45**	**1.35**	**1.47**	
40-EB	Crystal Run Rd/ East Main St	Ballard	Carpenter (CR 96)	**1.39**	**1.43**	**1.51**		
40-WB				**1.49**	**1.47**	**1.55**		
41-EB	Rt 17 (I86)	Harriman Toll	Chester Exit 126 (Rte 94)	0.80	0.72	0.75		0.83
41-WB				0.68	0.69	0.70		0.75
42-NB	Rt 17 (I86)	Chester Exit 126	Wallkill Exit 120 (Rte 211)	0.69	0.70	0.74		0.77
42-SB				0.70	0.70	0.71		0.76
43-NB	Rte 208	Neelytown Rd (CR99)	Rte 17	**1.68**	**1.46**	**1.92**	**1.36**	
43-SB				**1.72**	**1.90**	**1.86**	1.30	
44-NB	Rte 208	Scofield St.	William St	**2.14**	**2.31**	**2.81**		
44-SB				**1.39**	**1.42**	**2.27**		
45-EB	Rte 52	Elm St	Montgomery St	**1.37**	**2.37**	**1.76**		
45-WB				**1.69**	**1.77**	**2.37**		
46-EB	Rte 17K	Rte 300	Rte 747	**1.65**	**1.44**	**1.39**		
46-WB				**1.46**	**1.42**	**1.59**		
47-EB	Broadway/Rte 17K	William St	Rte 300	**1.35**	**1.43**	**1.69**	**1.58**	
47-WB				**1.55**	**1.86**	**2.16**	**1.79**	
48-EB	Rte 207/Rte 300	Bruenig rd	Union Ave (CR 69)	**1.97**	**2.12**	**2.90**		
48-WB				**2.05**	**2.18**	**2.54**		
49-NB	Rte 300	Rte 207	I84	**1.40**	**1.86**	**1.68**	**1.88**	
49-SB				**1.54**	**2.00**	**1.70**	**1.69**	
50-NB	Rte 300	I84	Rte 52	**1.68**	**1.71**	**2.42**	**1.76**	
50-SB				**1.36**	**1.74**	**2.19**	**1.72**	
51-EB	I84	Newburgh Beacon Bridge	I87 (Exit 7)	0.95	0.94	0.96		
51-WB				0.95	0.94	0.96		
52-NB	US Rte 9W	I84	Ulster County Line	1.18	1.23	**1.42**		
52-SB				1.02	1.10	1.21		
54-NB	Rte 32	Rte 94	Rte 17K	1.11	1.11	**1.34**	1.14	
54-SB				1.15	1.10	**1.39**	1.16	
55-NB	US Rte 6	I84 Exit 1 Ramps	Jersey Ave.	1.24	**1.86**	**2.47**		
55-SB				1.13	**1.54**	**1.55**		

Sections	Roadway	From	To	Time Periods				
				AM	Midday	PM	Sat	Sun
56-NB	Rte 17	Exit 120 Rte 211	Sullivan County Line	1.07	0.77	0.75		
56-SB				1.19	0.86	0.83		
57-NB	I87	Woodbury Toll	Newburgh Exit 17	0.91	0.91	0.88		0.94
57-SB				0.91	0.89	0.94		0.97
58-NB	I87	Newburgh Exit 17	Ulster County Line	0.91	0.88	0.87		0.94
58-SB				0.90	0.88	0.92		0.94
59-EB	I84	I87	Rte 17K Exit 6	1.00	0.94	0.96		
59-WB				0.98	0.94	0.96		
60-EB	I84	Rte 17K Exit 6	Rte 747 Exit 5A	0.97	0.95	0.96		
60-WB				0.98	0.93	0.92		
61-EB	I84	Rte 747 Exit 5A	Rte 208 Exit 5	0.95	0.94	0.94		
61-WB				0.94	0.93	0.92		
62-EB	I84	Rte 208 Exit 5	Rte 17 Exit 4	0.94	0.91	0.92		
62-WB				0.92	0.91	0.91		
63-EB	I84	Rte 17 Exit 4	Rte 17M Exit 3	0.92	0.93	0.93		
63-WB				0.94	0.92	0.92		
64-EB	I84	Rte 17 Exit 3	Greenville Tpke (CR 35)	0.90	0.92	0.91		
64-WB				0.95	0.91	0.92		
65-NB	I84	Greenville Tpke (CR 35)	Pennsylvania State Line	0.94	0.95	0.96		
65-SB				0.94	0.92	0.93		
66-NB	Ballard Rd	Rte 211	Crystal Run Rd	0.95	1.00	0.97		
66-SB				0.99	1.04	0.98		
67-NB	Dunning Rd (CR 94)	East Main St (CR 65)	Rte 211	**2.20**	**2.58**	**2.01**		
67-SB				**1.67**	**1.74**	**1.68**		
68-NB	Rte 94	Rte 17	Rte 208	**1.45**	**1.41**	**1.60**		
68-SB				1.11	1.00	1.04		
69-EB	Rte 94	Rte 17	Rte 17A	0.89	0.94	0.99		
69-WB				1.22	1.28	**1.36**		
70-NB	Rte 207/17A	Sarah Wells Trail (CR18)	Coates Dr	**1.42**	**1.43**	**1.48**		
70-SB				**1.31**	**1.36**	**1.39**		
71-NB	Rte 17A	Coates Dr.	Rte 94	1.23	**1.32**	1.25		
71-SB				**1.38**	1.21	**1.41**		
72-NB	Rte 17A	Rte 94	CR 1A	1.28	1.30	**1.37**		
72-SB				0.92	0.90	1.01		
73-NB	Kings Hwy (CR13)	Rte 17M	Rte 94	1.17	1.17	1.25		
73-SB				1.16	1.25	1.19		
74-NB	Rte 94	I87	Quassaick Ave	**1.45**	**1.47**	**1.67**		
74-SB				1.26	**1.31**	**1.68**		

Sections	Roadway	From	To	Time Periods				
				AM	Midday	PM	Sat	Sun
75-NB	Rte 211	Rte 416	Rte 17K	**1.99**	**2.24**	**2.02**		
75-SB				**1.93**	**1.96**	**1.70**		
76-EB	Rte 17K	Factory St	Albany Post Rd (CR 14)	**2.92**	**2.33**	**2.42**		
76-WB				**1.59**	**1.46**	**1.80**		

Twenty-eight of the forty-four Orange County sections surveyed have TTIs over 1.3 during at least one of the surveyed time periods. Thirteen sections experience TTIs over 1.3 during all of the surveyed time periods. The Orange County Average Speed Profiles, Average Travel Time Profiles, Travel Time Index Profiles, and Box-Whisker Speed Plots by section can be found in the Appendix.