Transportation Monitoring & Management Report

Metropolitan Hartford Area: 2005

December 2007

Capitol Region Council of Governments
Central Connecticut Regional Planning Agency
Midstate Regional Planning Agency

Acknowledgements

FHWA Connecticut Division. Special thanks are owed to the Connecticut Division of the Federal Highway Administration who assisted in the development of the performance monitoring system for arterial roads. The Connecticut Division applied for a $12,000 grant that was used to purchase GPS units and related equipment. The equipment allowed us to develop methods of collecting travel speed data that are less labor intensive and more accurate than traditional speed and delay studies. This was invaluable in the development of our arterial monitoring program.

Connecticut DOT – Highway Operations Center. We are appreciative of the support provided by the Highway Operations Center of the Connecticut Department of Transportation. The Operations Center allowed easy access to their extensive data files from their network of freeway traffic monitoring stations (part of DOT's Regional Traffic Management System.) They also provided special software to help extract the data in summarized format. The extraction and summarization capability was essential to managing the huge volume of information collected by DOT's traffic monitoring stations.

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Chapter 1 - Introduction

This report is part of the joint planning program for Transportation Monitoring and Management in the Hartford metropolitan area. The planning program is conducted cooperatively by the three regional planning agencies and the Connecticut Department of Transportation. The program's goal is to promote the safe and efficient operations and management of intermodal surface transportation systems in the region in order to better serve the mobility needs of people and freight. The program has three major objectives:

1. *To monitor and assess system performance.*
2. *To identify where improvement is needed & establish priorities for corrective actions.*
3. *To monitor the effectiveness of corrective actions.*

This report primarily addresses the first objective – monitoring and assessing system performance. It provides a profile of traffic conditions and operations in the Hartford metropolitan area. As the first Transportation Monitoring and Management report, it represents the start of a continuing program of assessing system performance and using the information gained to guide system management.

The first report is not as comprehensive or complete as future reports will be. The focus is on highway congestion. However, future reports will be expanded to monitor highway safety as well as congestion. They will also include transit operations, which are an important part of our multi-modal transportation system in the metropolitan area.

CONGESTION MONITORING.

The first step in building the transportation system management program for the Hartford area is to develop a congestion-monitoring program. This began in 2005 with two distinct efforts: one focused on the freeway system, and one focused on the arterial system.

Freeway System. The system for monitoring and assessing *freeway* performance is being developed based on data collected through the Regional Traffic Management System (RTMS). This is a system operated by the Connecticut Department of Transportation (ConnDOT) through their Highway Operations Center in Newington. It consists of traffic flow monitors, cameras, variable message signs, and highway advisory radio. It covers nears 50 miles of freeway in the Hartford metropolitan area and includes 144 traffic flow monitors.

The traffic flow monitors are the critical system component for collecting data on system performance. There are 144 monitors that collect data on traffic volume, speed, and occupancy. Each monitor collects the data for 30-second intervals for each individual travel lane. This data is collected 24 hours per day each day of the week, and provides a wealth of information on system performance over time.

The goal of this planning project is to compile the operational data collected from the RTMS and use it to assess system performance. The challenge is to develop a process for easily extracting and compiling such an enormous amount of raw data. The freeway system results are presented in Chapter 2.

Arterial System. The freeway system monitoring process relies on data extracted from an extensive system of permanent field monitoring stations. In contrast, the arterial monitoring system relies on in-vehicle data collection conducted by staff and volunteers who drive selected routes during selected peak and off-peak travel times. This normally labor-intensive method was made less onerous and more accurate by utilizing GPS technology funded by a special FHWA Technology and Innovation grant that was secured through the efforts of the Connecticut Division of FHWA. We are appreciative of FHWA's Connecticut Division Office special assistance in this effort.

The arterial system results are presented in Chapter 3.

GOAL: IMPROVE MONITORING PROCESS INCREMENTALLY

The 2005 report documents our first attempt at developing a congestion monitoring process, and our first attempt to develop meaningful performance measures. Our goal is to continuously improve and refine the performance monitoring process. Improvements will be done incrementally as we conduct more monitoring and analysis, and gain more experience and understanding of the systems and data. Over time and with more experience, we expect to improve and refine our methods, and build a reliable database that can be used to measure current conditions, identify historical and emerging trends, and help identify corrective actions.

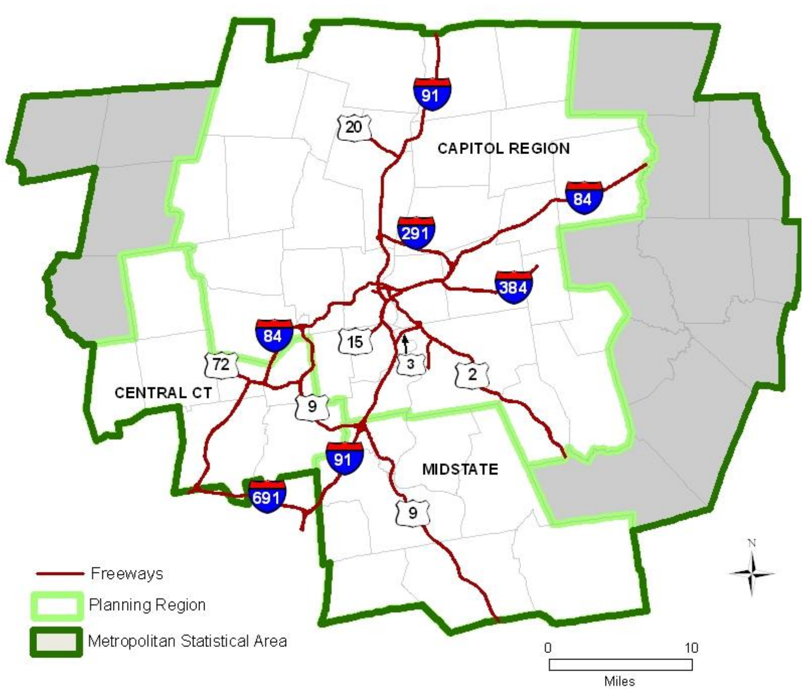
HARTFORD METROPOLITAN AREA

The study area for this report is slightly smaller than the Hartford metropolitan area. It is composed of the three planning regions shown in Figure 1.1, and had a population of 1,052,457 in 2000. The metropolitan area, as defined by the U.S. Census, is slightly larger as illustrated in Figure 1.1. It is composed of 58 towns, and has a 2000 population of 1,183,110.

1,052,457 = pop of 3 regions
1,183,110 = pop of MSA

Figure 1.1

Planning Regions Superimposed on Metropolitan Statistical Area

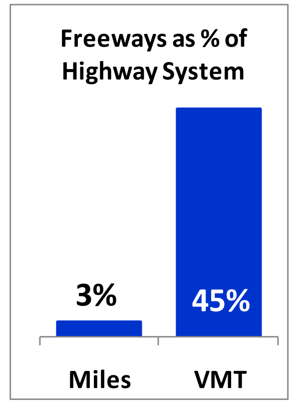


JOINT PROGRAM: 3 PLANNING REGIONS

The report is prepared by the Capitol Region Council of Governments (CRCOG), but is based on monitoring work done by all three planning agencies including Central Connecticut Regional Planning Agency (CCRPA), Midstate Regional Planning Agency (MRPA), and CRCOG. The three agencies collaborated on development of this program and will continue to support it through data collection within each of their respective regions.

Chapter 2 – Freeway System

METRO HARTFORD FREEWAY SYSTEM



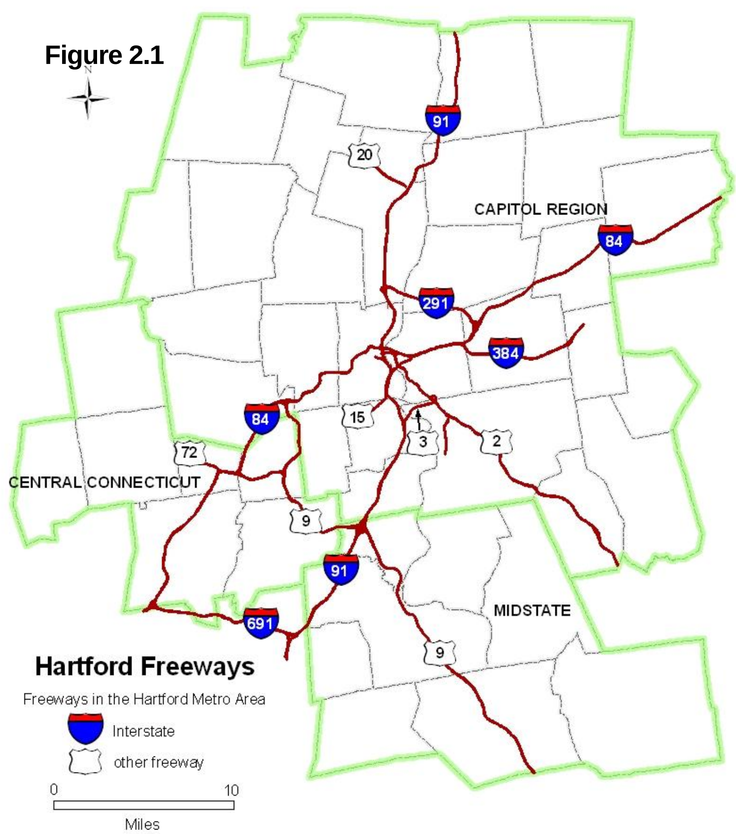
The freeway network serving the Hartford metropolitan area is illustrated in Figure 2.1. There are about 165 route miles including both Interstate routes and non-Interstate freeways. The freeway system accounts for 3 percent of the total roadway network in the area, but it carries about 45 percent of the region's traffic.[1] The freeways are the highest level in the hierarchy of roadway classes, and their importance is reflected in the disproportionately high share of traffic they serve. The Interstate routes are I-84, I-91, I-691, I-291, and I-384. Non-Interstate routes include Route 9, Route 72, Route 2, Route 3, Route 17, Route 20, and Route 5-15.

Interstates 84 and 91. I-91 and I-84 **are the two major Interstate routes,** and they carry a large volume of long distance traffic in addition to being important commuter routes. I-84 is a primary east-west route through Connecticut. West of the Hartford metro area, it links to the Connecticut cities of Waterbury and Danbury, the Hudson River valley in New York, and northeastern Pennsylvania. To the east, it links to I-90 (in Sturbridge, Massachusetts), which is a primary route to the Boston metropolitan area. I-91 is a primary north-south route through Connecticut. To the south, it connects to I-95 in New Haven. To the north, it connects to Springfield and Interstate-90. It is also a primary route to destinations further north in Vermont and New Hampshire.

Radial Shaped Freeway Network. A key feature of the freeway network in the Hartford area is its radial configuration with a focus on Hartford. I-84 and I-91 intersect in downtown Hartford, and Route 2 intersects with I-84 just east of the I-84/I-91 junction. This configuration results in five key commuter routes radiating out from Hartford: I-91 to the north, I-84 to the east, Route 2 to the southeast, I-91 to the south, and I-84 to the west.

Incomplete Beltway. Early plans for a set of circumferential freeways to link the radial spokes and create a beltway around Hartford were largely abandoned. Today only three significant segments of the beltway exist: I-291 in the northeast quadrant, Route 3 in the southeast quadrant, and Route 9 in the southwest quadrant. This means the radial network serves the traditional city-suburb commute trips

Figure 2.1

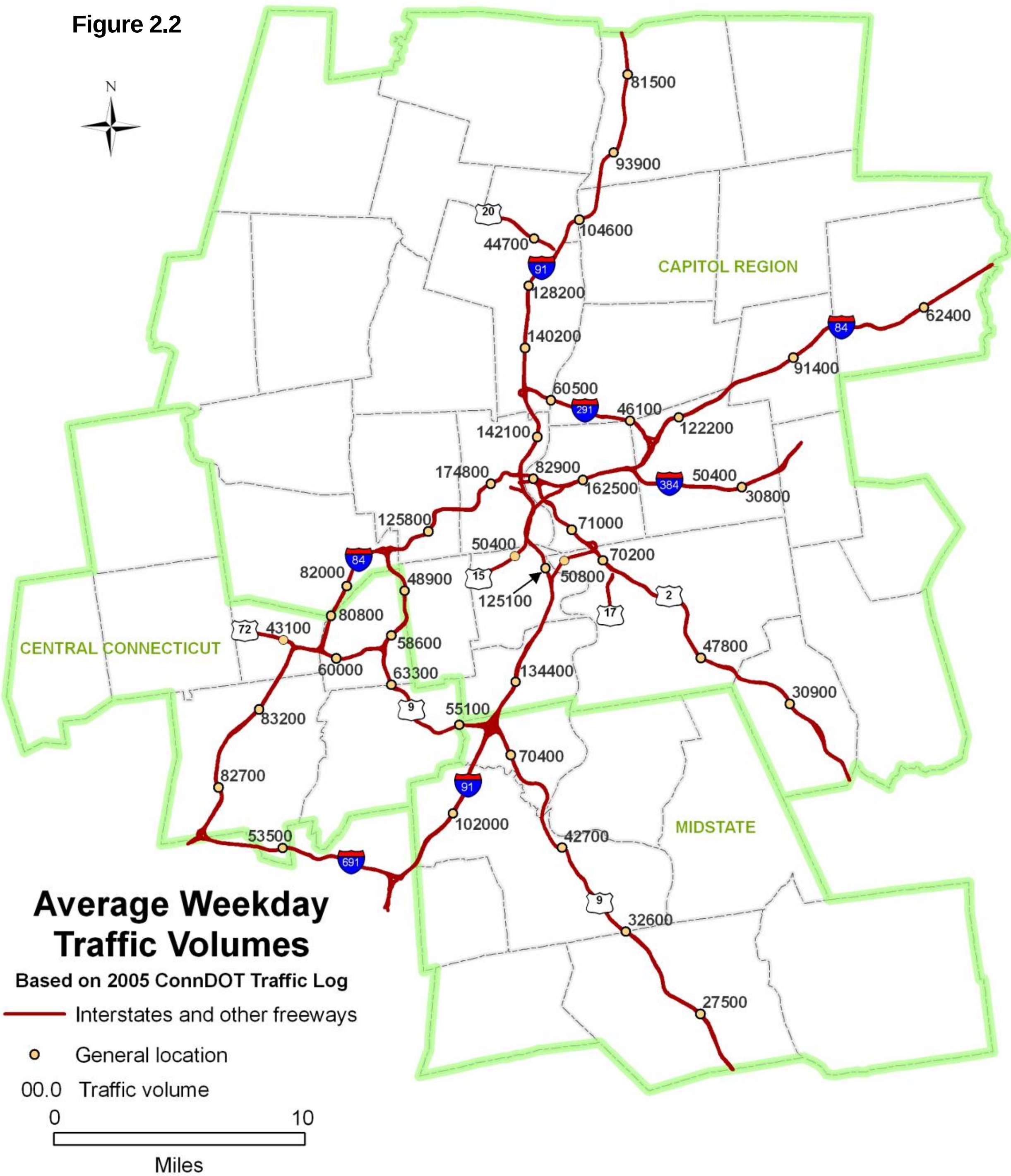


[1] Estimate based on Highway Performance and Monitoring System prepared by CT DOT.

plus some suburb-suburb commute trips that must pass through the central city to reach destinations on another side of Hartford.

Traffic Volumes. Daily traffic volumes are displayed in Figure 2.2. The highest traffic volumes on the freeway system are found near the center of the radial network. Daily traffic volumes on I-84 in downtown Hartford exceed 170,000. On I-91, they exceed 140,000. Volumes remain high on the primary routes radiating out of downtown. Daily volumes exceed 100,000 vehicles on I-91 north to Windsor Locks, on I-84 east to Vernon, on I-91 south to Meriden (I-691), and on I-84 west to

Figure 2.2

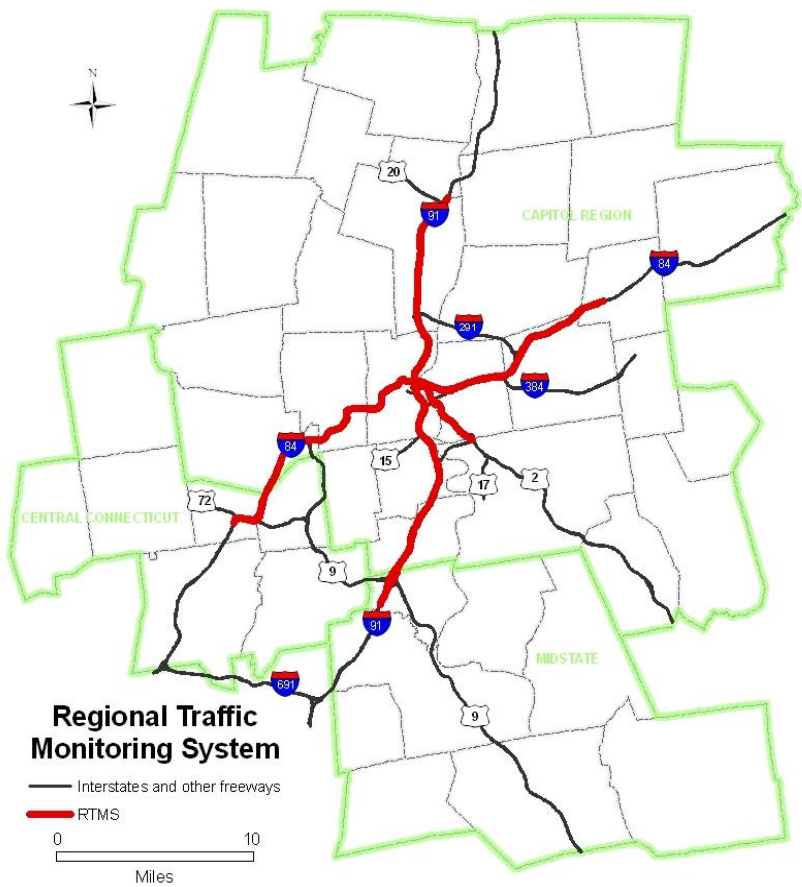


Farmington (Route 9). Even Route 2 carries a volume over 70,000 on the inner segments through East Hartford and Glastonbury.

FREEWAY MONITORING SYSTEM

The freeway monitoring system developed for this report is based on data extracted from DOT's Regional Traffic Management System (RTMS), which is operated by the Highway Operations Center. The RTMS is operated 24 hours a day, seven days a week and consists of a network of cameras, traffic flow (speed) monitoring stations, electronic message signs, and highway advisory radio. The system covers nearly 50 miles of freeway in the Hartford metro area. It is concentrated in the highest traffic volume segments at the urban core of the freeway network. The routes monitored are shown in Figure 2.3 and include I-84, from Farmington to Manchester, I-91 from Cromwell to Windsor Locks, and Route 2 in East Hartford and Glastonbury.

Figure 2.3



The RTMS includes 144 traffic flow monitors located approximately every half-mile within the RTMS coverage area. The monitors record traffic volume, speed, and occupancy for each travel lane and for each direction of travel. The data is recorded and stored for each 30-second time period throughout the day. This is done 24 hours per day for 365 days per year. This provides continuous coverage of traffic conditions for the 50 miles of freeway within the busiest sections of Hartford's freeway network.[2] With this wealth of information, we can develop very detailed and accurate information on freeway operations and performance.[3]

Segment-Level Data. For analysis purposes, the freeways within RTMS area are divided into roughly one-half mile long segments. Each segment corresponds to one of the 144 RTMS traffic-monitoring stations. The traffic data recorded at the station is assumed to be representative of conditions throughout the half-mile segment of freeway adjacent to the station. Since stations are

[2] Exceptions occur when equipment at individual stations malfunctions. Data for the individual station will not be available for the period of time that the station is out of commission.

[3] The principal challenge with the RTMS database is how to process a database of this enormous size and level of detail. To aid in this task, CRCOG developed a software program to extract and summarize the data in a more manageable form. This year's report is the first trial of the program, which was successful enough to allow the preparation of the analysis presented here. However, further refinement of the software will be done to address problems identified in the trial.

spaced roughly a half-mile apart; we create an unbroken series of contiguous segments for each freeway route within the RTMS area. These segments are the basic units of measurement used in this report.

The segment-level data is used primarily for map analysis. By mapping measures such as average speed and traffic volume, we can provide a good visual profile of traffic conditions on the freeway network, and how those conditions vary across the network.

Route-Level & System-Level Data. While data is collected at the segment level, it is easily aggregated to other levels. For this report, it is aggregated to the route level and to the system level. For example, the data for all the segments on I-91 can be compiled to provide an assessment of conditions on I-91 as a whole. Likewise, the data for all routes can be aggregated to develop system-level performance measures.

FREEWAY PERFORMANCE MEASURES

Most of the freeway performance measures developed for this first report are basic, but informative, measures. They include vehicle miles of travel (VMT), vehicle hours of travel (VHT), average vehicle speed in peak hour (speed), vehicle hours of delay (delay), and the travel time index (TTI). More performance measures will be developed for future reports.

The long-term goal of this program is to develop a set of measures comparable to those used in the Urban Mobility Report prepared by the Texas Transportation Institute. The Mobility Report established a standard set of measures that they apply for a cities across the United States. The objective is to replicate the measures, but increase the accuracy on the measurements by using the RTMS database and other more direct methods of measurement. In contrast to the Urban Mobility Report, which estimates speed and congestion levels using formulas that *estimate* speed based on recorded traffic volume data, roadway capacity, and assumed relationships between speed, volume, and capacity, the RTMS data allows us to measure speed and congestion directly and continuously throughout the year. Our database allows us to prepare more comprehensive and accurate profiles of freeway operating conditions and performance.

RTMS Database: Segment Level Data. As explained above, each of the 144 RTMS traffic-monitoring stations records information on traffic volume and speed at the station location. This is essentially point-level data, or information describing conditions at that single point on the freeway. To be useful for our purposes, we assume that the same conditions that exist at the station site also extend roughly one-quarter mile before and after the station. The data for the station is assumed to be representative of traffic conditions throughout the roughly half-mile segment of freeway closest to the station. Since the stations are spaced roughly a half-mile apart, this allows the creation of continuous series of segments for each freeway route within the RTMS area. Thus, the basic unit of measurement is the segment, and each segment is roughly one-half mile in length.

> *Vehicle Miles of Travel.* VMT is the total miles traveled by vehicles in a station area or segment. It is calculated at the segment level by multiplying the number of vehicles counted at a station times the length of the station segment. The segment totals can be added across all segments to calculate a RTMS area total.
>
> *Average Speed.* Average speed is the average speed of all vehicles traveling through a station area or segment. For this first report, it is presented only for the morning peak hour (7:30 AM – 8:30 AM), and the afternoon peak hour (4:30 PM – 5:30 PM). It is generally calculated only at the segment level, but is sometimes calculated at the route level to allow comparison of different routes.
>
> *Vehicle Hours of Travel.* VHT is the total time spent by all vehicles traveling through a station area or segment. It is derived from the VMT and average speed.

Hours of Delay. Hours of delay is the total time vehicles spend traveling at rates of speed below 60 miles per hour (mph). Sixty was selected as the threshold speed since it is the threshold speed used in the Urban Mobility Report, and a goal the Hartford monitoring program is to develop measures comparable to the Mobility Report.

Travel Time Index. The travel rate index is a ratio of the average travel time during **peak period** or peak hour conditions versus the travel time during **uncongested periods.** If the index or ratio is 1.0, it means that there is no delay during peak periods. A ratio greater than 1.0 indicates that there is delay or congestion. The amount of delay is indicated by the size of the ratio. For example, a ratio of 1.25 means that it takes 25 percent longer to travel a given distance in the corridor during the peak period than during off-peak periods. This type of 'relative' measure of delay makes it easier to compare different corridors or different segments within a corridor.

To measure delay accurately, the calculations are based on 5-minute time intervals. The standard time interval for many traffic performance measures is one hour or 60 minutes. However in this case, a shorter time interval is needed to assure that we identify and measure even short periods of delay that might be substantially less that an hour. The average speed is calculated for each 5-minute interval, and delay is calculated based on the difference between this 5-minute average speed and the threshold speed of 60 mph.

FREEWAY PERFORMANCE RESULTS

To assess freeway performance, we analyzed four months of data from the RTMS. The months of May, June, September, and October 2005 were selected for analysis purposes. As spring and autumn months, they are generally representative of average annual conditions, and do not include some of the unusual travel patterns found during winter weather conditions and summer vacation periods. Only weekday data (Monday – Friday) was analyzed.

Overview of Corridors

Table 2.1 gives an overview of the corridors monitored by the RTMS. The system covers 49.9 miles of freeway in the central section of the Hartford metropolitan area. It serves about 6,206,000 vehicle miles of travel on a daily basis, and the 'average' traffic volume is 124,000 (VMT/mile). Such high daily VMT and traffic volumes illustrate the critical role the freeway system plays in the Hartford metro area.

Table 2.1

Corridor	Corridor length (miles)	RTMS coverage (miles)	% of corridor covered	VMT daily	VMT per mile
I-84 East of I-91	**22.8**	**11.2**	**49.1%**	1,332,526	118,976
I-84 West of I-91	**21.3**	**13.6**	**63.8%**	1,516,088	111,477
I-91 North of I-84	**19.5**	**9.7**	**49.7%**	1,513,093	155,989
I-91 South of I-84	**19.7**	**11.1**	**56.3%**	1,571,467	141,574
Route 2	**19.2**	**4.3**	**22.4%**	272,840	63,451
All Corridors	**102.5**	**49.9**	**48.7%**	**6,206,014**	**124,369**

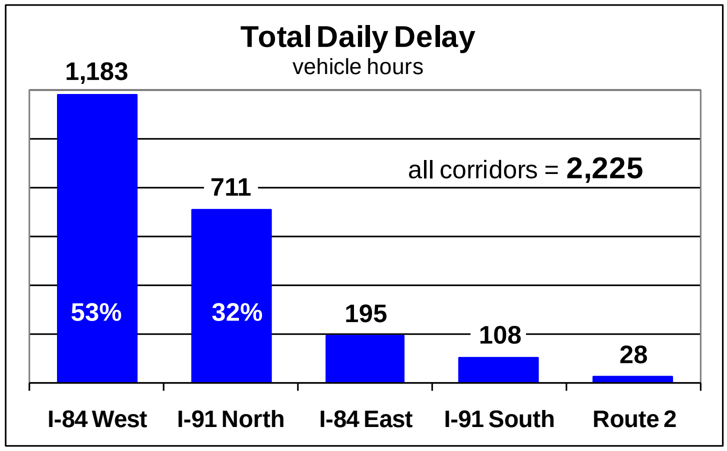
CAUTION: The RTMS system covers only about 50 percent of the network in these five corridors, and the coverage varies substantially by corridor. The <u>differences in coverage</u> affect the results presented in the table, so the data need to be interpreted with caution. Both the total daily VMT and the VMT per mile are affected by the extent of RTMS coverage. The VMT per mile results also represent the 'average' condition for all segments within a corridor. For a more complete record of how traffic volumes vary within a corridor please refer Figure 2.2.

Corridor-Level Performance.

Three different performance measures are used to evaluate the performance of each corridor: (1) vehicle delay, (2) average peak hour speed, and (3) travel time index. The results are discussed below. As with the VMT data, these are corridor-wide measures and do not represent conditions on any individual location within the corridor.

1. Vehicle Delay.

Figure 2.4



Total daily vehicle daily for each corridor is presented in Figure 2.4. This is the cumulative amount of delay experienced by all vehicles traveling in the corridor over a 24-hour period. It is the most general measure of delay, but very helpful in identifying differences among the corridors.

Total Freeway Delay (2,225 hours). The total delay recorded for the entire freeway network monitored by RTMS is 2,225 hours. This is the total hours of vehicle delay recorded in all five corridors over an entire day.

Most Congested Freeways. The most congested corridors are ***I-84 West*** and ***I-91 North***, which together account for 85 percent of all congestion recorded. The congestion in these two corridors far exceeds the congestion in the other three corridors.

<u>*I-84 West – Most Congested*</u>. This is the most congested corridor with 1,183 hours of delay per day. This is about half of the total network delay of 2,225 hours. When averaged over the 13.6 miles in the corridor this amounts to 87 hours per mile, which is slightly higher than I-91 North and <u>*four times as high as any other corridor.*</u>

- *Inbound vs. Outbound.* As can be seen in Table 2.2, the delay on I-84 West is slightly imbalanced between the inbound and outbound directions. There is about 680 hours of delay in the inbound direction, and about 503 hours outbound.
- *PM Peak = Worse*. Based on the peak <u>hour</u> data presented in Table 2.2, it appears that most of the congestion occurs in the afternoon (292 hours) rather than the morning (109 hours). In the PM peak, both the inbound and outbound direction are heavily congested.

Table 2.2 - Vehicle Delay by Direction and Time Period

Corridor	miles	AM peak hour IN	AM peak hour OUT	AM peak hour Total	PM peak hour IN	PM peak hour OUT	PM peak hour Total	Daily Delay IN	Daily Delay OUT	Daily Delay Total	Daily Delay per mile
I-84 West	13.6	75	34	109	199	93	292	680	503	1,183	87.0
I-91 North	9.7	262	4	266	44	48	92	593	118	711	73.3
I-84 East	11.2	110	0	110	5	5	10	178	17	195	17.4
I-91 South	11.1	22	0	22	1	26	27	46	62	108	9.7
Route 2	4.3	15	0	15	0	0	0	27	1	28	6.5
All Corridors	**49.9**	**483**	**38**	**521**	**249**	**172**	**421**	**1,524**	**701**	**2,225**	**44.6**

I-91 North - 2nd Most Congested. The second most congested corridor is I-91 North with 711 hours.

- *Inbound vs. Outbound.* Unlike the I-84 West corridor, there is a large imbalance between the inbound and outbound directions. The inbound direction records nearly five times as much delay with 593 hours as compared to 118 hours for the outbound direction.
- *AM Peak = Worse.* In contrast to I-84 West, most of the congestion occurs in the morning (266 hours) rather than the afternoon (92 hours).

2. Average "Peak Hour" Speed.

The speeds presented in figures 2.5 and 2.6 are the average for the entire corridor. They are an indicator of overall corridor performance and do not reflect conditions at any one location within the corridor. Nonetheless, this general performance measure allows a rough comparison of the performance of all five corridors.

The lowest average peak-hour speeds are found in the ***I-84 West*** and ***I-91 North*** corridors. In the I-91 North corridor, the average speed drops to 45 mph in the AM peak hour in the inbound direction. The outbound speeds are much higher in both the AM and PM peak hours, which reflects the directional imbalance discussed in the prior section. In the I-84 west corridor, PM peak speeds drop to 51 mph inbound and 55 outbound.

The average speeds in the other three corridors are generally much higher. Only in the AM peak and in the inbound direction do speeds drop below 60 mph. The AM inbound speeds are 56 mph in the I-84 East corridor, 57 mph in the Route 2 corridor, and 58 mph in the I-91 south corridor. The highest average speeds tend to be in the AM peak in the outbound or reverse flow direction: I-84 East (63.1 mph), I-91 North (64.1 mph), I-91 South (66.4 mph.)

Figure 2.5 **Average Speed - AM Peak Hr**

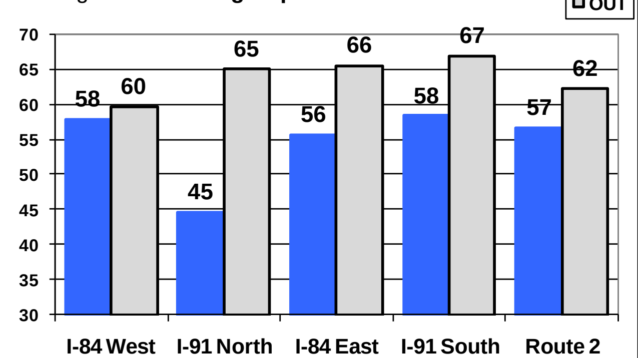
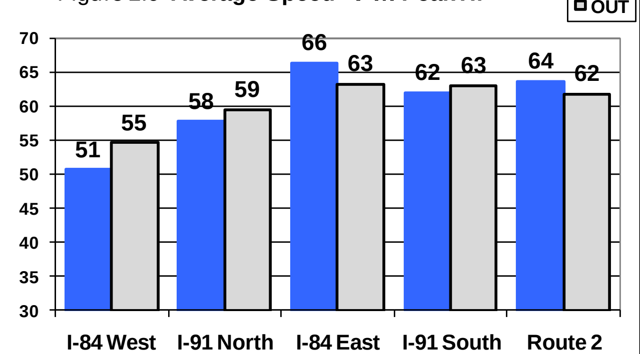


Figure 2.6 **Average Speed - PM Peak Hr**



3. Travel Time Index by Corridor.

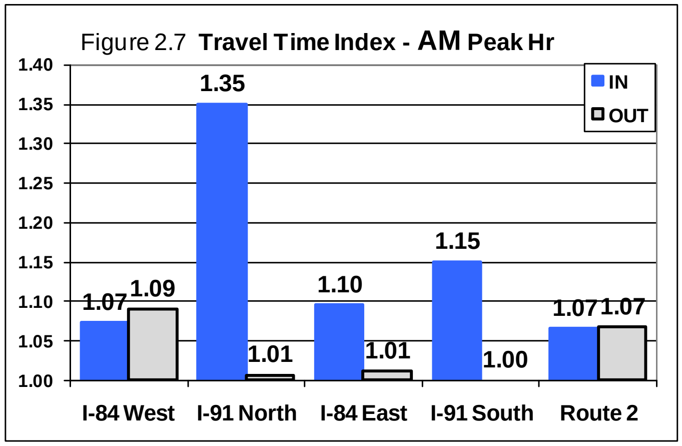
The travel time index (TTI) is a measure of the amount of extra time it takes to travel in a corridor during the peak hour versus during off-peak or free-flow conditions. For purposes of this analysis, the off-peak speed is assumed to be 60 mph.[4] The index is a simple ratio of peak-hour travel time to time required to travel the same distance at an uninterrupted 60 mph. A ratio of **1.25** means that it takes **25 percent longer** to travel in the peak hour than it does in the off-peak period. The minimum ratio is set to 1.0 and means that peak-hour speeds are equal to or higher than 60 mph. The results are presented in Figures 2.7 and 2.8.

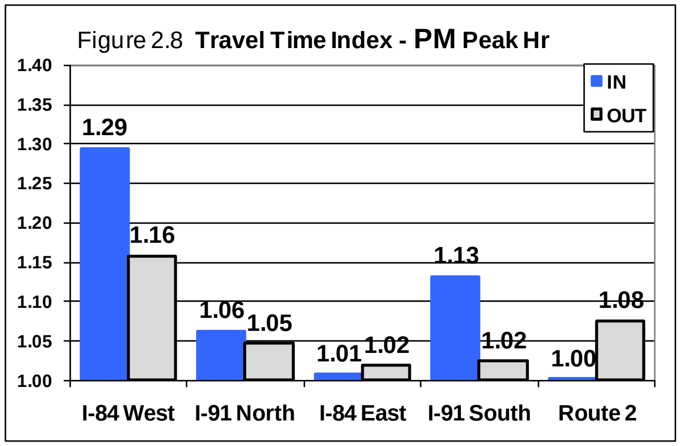
[4] 60 mph is the standard used by the Texas Transportation Institute in their mobility reports.

I-91 North. The single highest ratio is I-91 North in the <u>AM peak</u> and the <u>inbound direction</u>. The TTI of 1.35 means a trip will take 35 percent longer in the peak hour. There is virtually no delay (or extra travel time) in the AM outbound direction. In the PM peak-hour, there is some delay as indicated by ratios of 1.06 inbound and 1.05 outbound.

I-84 West. The second highest TTI was recorded in the I-84 West corridor. A ratio of 1.29 was recorded for the <u>PM peak</u> in the <u>inbound direction</u>.

I-91 South. There is also significant delay in the inbound direction in I-91 South. The TTI results reveal a <u>congestion problem in the I-91 South corridor that was not as apparent in the other two performance measures</u> (total delay and average speed). A problem in the *inbound direction* is indicated by the ratios of 1.15 in the AM peak-hour and 1.13 in the PM peak hour.





Segment-Level Performance. *Average Peak Hour Speeds*

The previous section examined overall corridor performance without attempting to determine where problems occur within the corridor. This section on segment-level performance examines how conditions vary within each corridor.

Average speeds are mapped for each individual monitoring station or segment within a corridor. The average peak-hour speeds for individual freeway segments are reported in Figure 2.9 (AM peak) and Figure 2.10 (PM peak) at the end of the chapter. The mapping of the speed data allows a more detailed assessment of each corridor and where problems are occurring within the corridor.

SPECIAL NOTE: *Speeds displayed are the 'average' over the entire 60-minute peak hour. Speeds vary within the 60-minute period and can be higher or lower than the average during portions of the hour.*

Morning Peak Period.

Figure 2.9 shows the morning inbound and outbound speeds separately in a side-by-side comparison. As expected, there is widespread delay in the inbound direction, and only isolated problems in the outbound direction.

I-84 West of Hartford. *(AM peak)*

Inbound. There are choke points at several locations in the corridor as shown in Figure 2.9. The outermost one is in Farmington at Route 9 where the lanes drop from three to two. The second and most significant is in West Hartford in the vicinity of the Trout Brook curves, where the speed drops below 45 mph. Congestion continues through most of the rest of the corridor through Hartford, but the 'average' speeds are slightly higher at 50-60 mph.

Outbound. In the outbound direction the delay is limited to downtown Hartford immediately west of I-91. Much of this is traffic destined for the Asylum Hill employment district and could be considered as 'inbound' traffic from other corridors.

I-91 North of Hartford. *(AM peak)*

This is the ***worst corridor*** in the morning. Delay is severe in the inbound direction.

Inbound. The most extensive morning problem of all corridors is found in the inbound direction of this corridor. The entire 9.7 mile corridor operates at speeds below 60 miles per hour. About 70 percent is below 50 mph, and 25 percent below 40 mph.

Outbound. The outbound direction operates relatively free of delay in the morning.

I-91 South of Hartford. *(AM peak)*

Inbound. Speeds remain above 55 mph in most sections.

Outbound. The outbound direction operates free of delay in the morning.

I-84 East of Hartford. *(AM peak)*

Inbound. While speeds drop below 60 mph in some outlying segments, the only critical delay occurs on the inner sections near the I-84/Route 15 split and the Connecticut River crossing. Here speeds drop below 50 mph, and in one case below 40 mph.

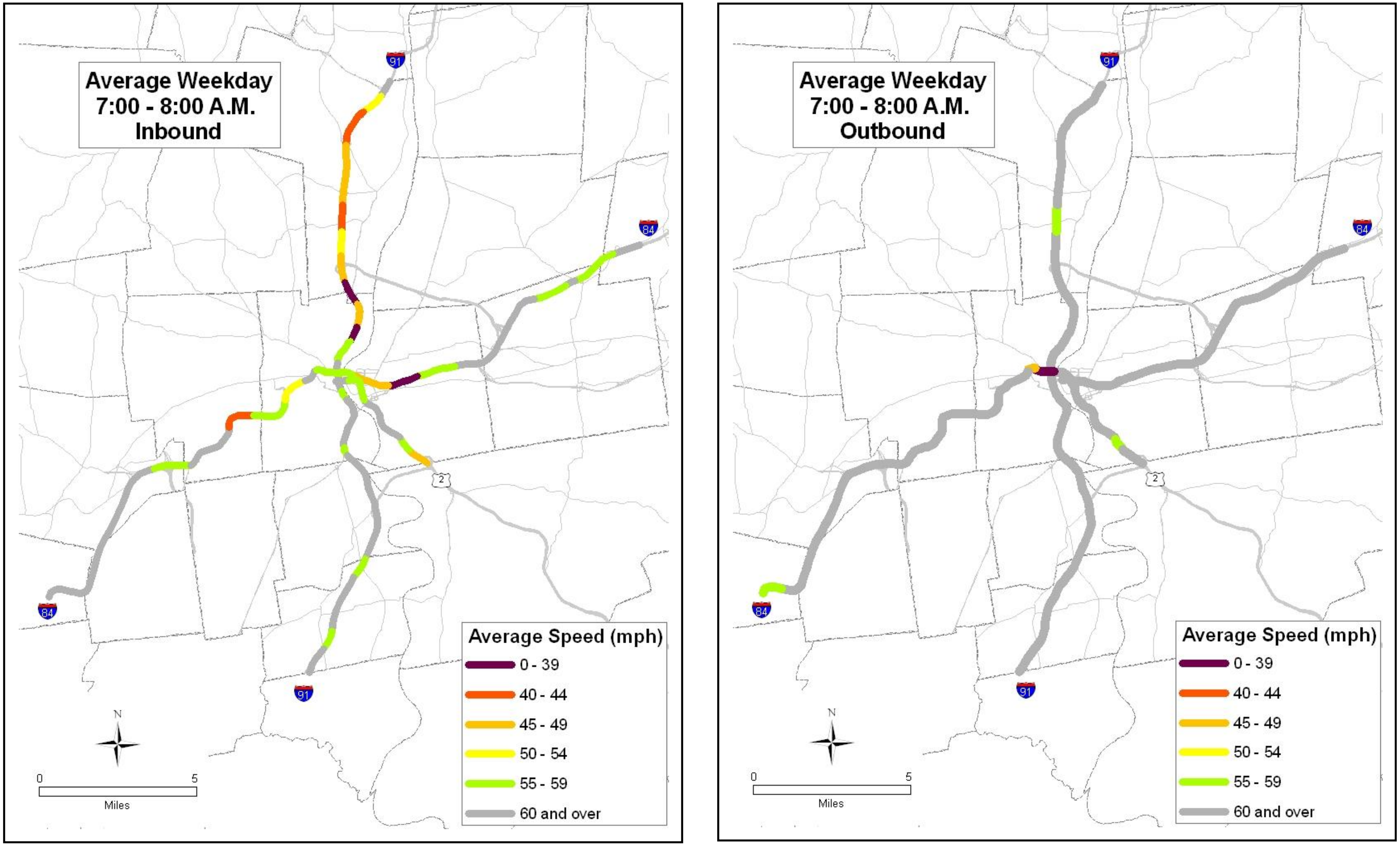
Outbound. The outbound direction operates free of delay in the morning.

Route 2. *(AM peak)*

Inbound. There are traffic slowdowns near the junction with Route 2 and again near the approaches to the Founders Bridge and to the Buckeley Bridge (I-84).

Outbound. The outbound direction operates mostly free of delay in the morning.

Figure 2.9: Average Speeds During Morning Peak Hour



Afternoon Peak Period.

Figure 2.10 shows the afternoon inbound and outbound speeds in a side-by-side comparison.

Reverse (Inbound) Flows. Unlike the morning peak hour when there were stark differences between inbound and outbound conditions, there is substantial delay in both directions in the afternoon. During the PM commute we expect congestion in the outbound flow as commuters leave Hartford. While this is true for most corridors, we also find major delays in the 'inbound' direction in most corridors. This reflects the higher levels of background traffic in the afternoon and the large volume of suburb-suburb commuting that the radial network must accommodate.

I-84 West of Hartford.

This is the ***worst corridor*** in the afternoon. Delay is severe in both directions.

Inbound. In the inbound direction, congestion begins at the Trout Brook curves in West Hartford and builds all the way to downtown Hartford. In Hartford speeds are mostly below 40 mph and approach 20 mph in one section. Much of this delay appears to be due to the restricted capacity on I-84 in the area of the 'tunnel' in downtown (at the I-91 interchange).

Outbound (peak direction): Congestion is continuous from downtown all the way through Hartford and West Hartford. It is most severe in Hartford where speeds drop below 45 mph. Speeds remain below 55 mph until the Trout Brook curves in West Hartford.

I-91 North of Hartford.

Afternoon congestion appears less severe than morning congestion, but occurs in both the outbound (peak) direction and inbound (reverse) direction.

Inbound. Delays occur regularly in the inbound (reverse) direction. The most significant delays occur in the same two sections as the outbound: North Meadows in Hartford and north of I-291 in Windsor.

Outbound (peak direction): The most severe speed reductions occur in the North Meadows area of Hartford just north of downtown where speeds drop below 40 mph Speeds drop again in the section of Windsor north of I-291 and south of the Day Hill corporate area.

I-91 South of Hartford.

Inbound. Inbound delays are minor or not a regular occurrence.

Outbound (peak direction): Delays are moderate from downtown south to the Hartford-Wethersfield town line.

I-84 East of Hartford.

Inbound. There little delay except for the innermost section from Main Street in East Hartford to I-84/I-91 interchange.

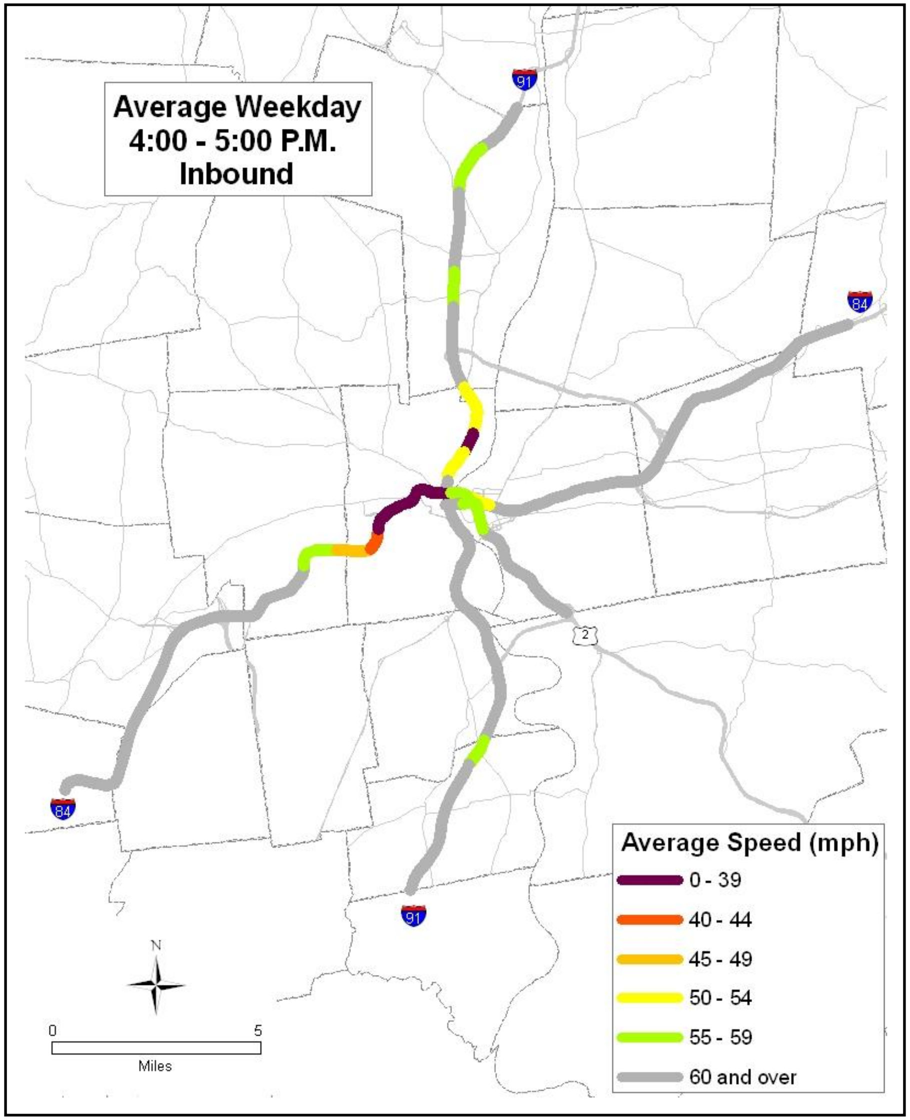
Outbound (peak direction): There are minor delays near the I-84/Route 15.

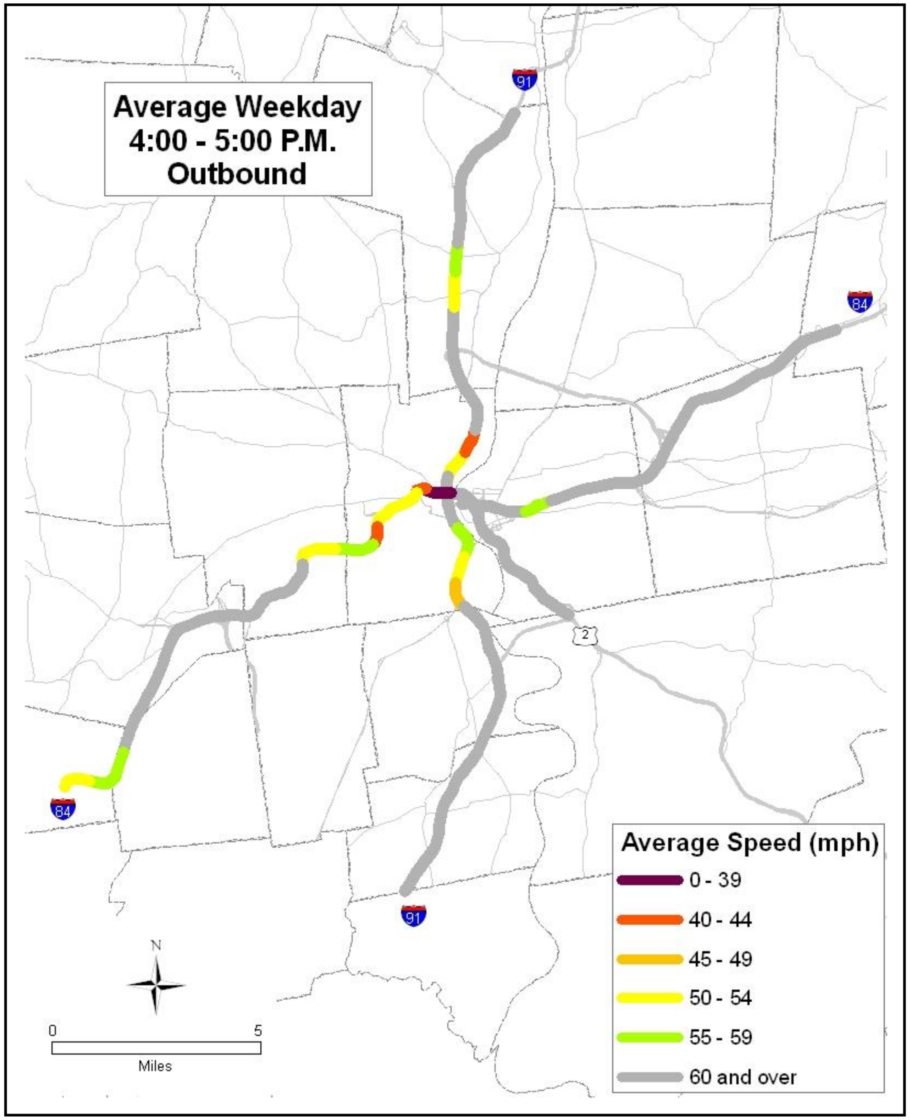
Route 2.

Inbound. There some congestion near the approach to I-84 westbound and the Founders Bridge to downtown Hartford.

Outbound (peak direction): Delays are minor or not a regular occurrence.

Figure 2.10: Average Speeds During Afternoon Peak Hour





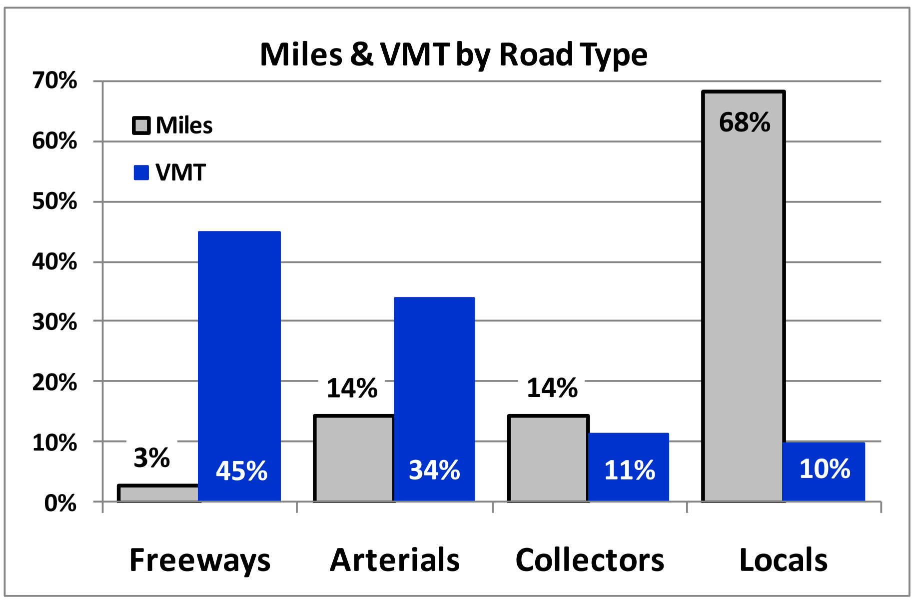
Chapter 3 – Arterial System

The monitoring system for arterials covers only a very small portion all the arterials in the Hartford metropolitan area. Without the advantage of an electronic surveillance system like the freeway RTMS, it is not practical to develop an extensive monitoring program. While GPS technology assists the process, data collection stills relies on individual drivers travelling the arterial routes to gather traffic speed data. This severely limits our ability to monitor conditions. Surveys are limited to a small number of roads and a few select periods of time during the day.

METRO HARTFORD ARTERIAL SYSTEM

The arterial network serving the Hartford metropolitan includes about 830 miles of road. Arterials comprise about 14 percent of the total roadway network (miles), carry about 34 percent of the region's traffic. [5] This is a smaller percent of the traffic than the freeway system, but still a disproportionately large share of total traffic. Like the freeway system, the arterial system is critical to serving the region's mobility needs.

Figure 3.1



ARTERIAL MONITORING SYSTEM

The arterial monitoring system developed for this report is less extensive and less accurate than the monitoring system developed for freeways. As noted above, the monitoring relies on more labor-intensive methods. These are explained below.

Speed & Travel Time Surveys. The monitoring process is based on driving over a small number of pre-selected arterial routes to collect data on traffic speed and travel times. It is a labor-intensive process that requires surveyors to travel the selected routes during the selected times.

For purposes of this report, the selected routes were surveyed during the morning peak period, the afternoon peak period, and during the midday or off-peak period. Surveys were also limited to the

[5] Estimate based on Highway Performance and Monitoring System prepared by CT DOT.

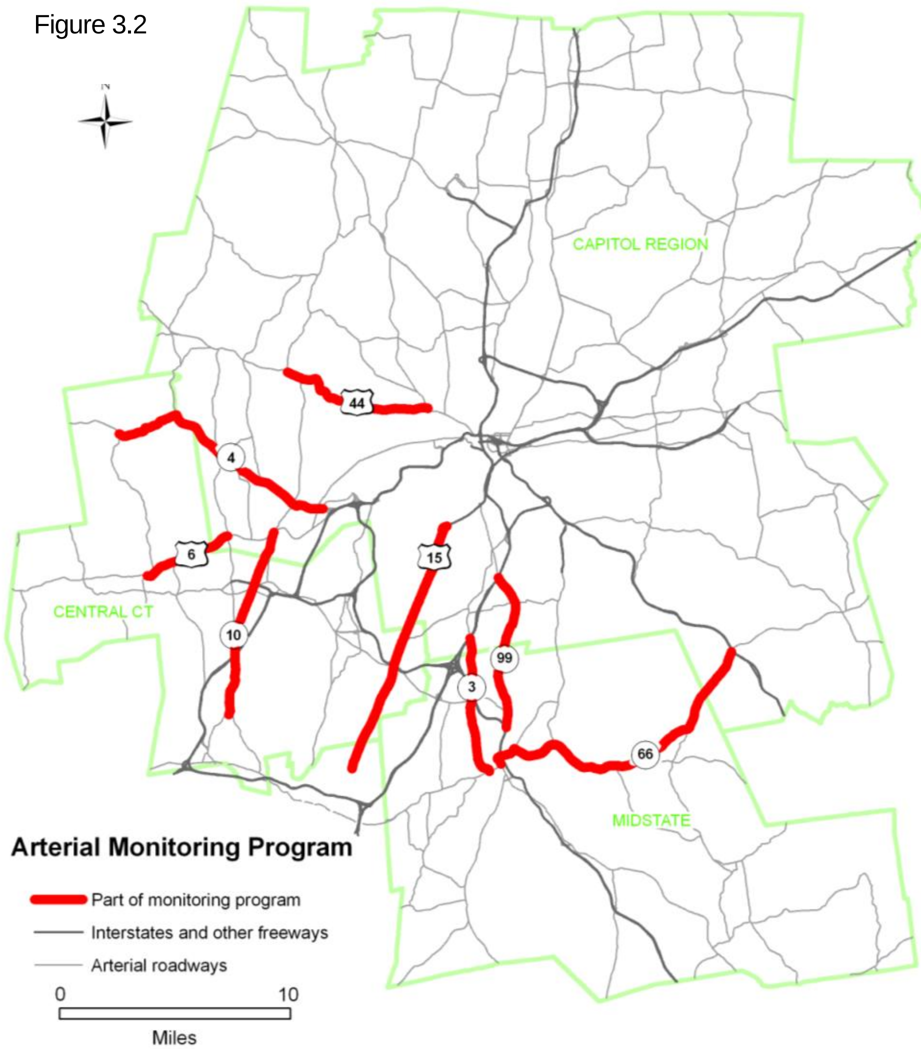
peak direction, which is the inbound direction in the morning and the outbound direction in the afternoon. In each case, we tried to conduct at least 5-10 trials during each trial period.

Trials were conducted during the spring of 2005 and the fall of 2005 on days and weeks considered most typical of average annual conditions.

GPS Tracking. The survey process was aided by GPS tracking equipment that reduced the labor required, (from a driver plus a recorder to just the driver), improved the data accuracy, and permitted more automation of the analysis.

Routes Included in Survey. Each of the three metropolitan planning organizations chose a few routes to survey. Generally, these were important arterials of special interest to the respective agency. For example, the Capitol Region selected three of the most important arterial commuting routes: Route 4, Route 44, and the Berlin Turnpike. In each case commuters must rely on the arterial since there is no parallel freeway in the corridor.

Figure 3.2



A total of eight routes were surveyed. They are shown in Figure 3.2.

ARTERIAL PERFORMANCE MEASURES

The arterial performance measures developed for this first report are the same basic measures developed for the freeway system. They include vehicle miles of travel (VMT), vehicle hours of travel (VHT), average vehicle speed in peak hour (speed), vehicle hours of delay (delay), and the travel time index (TTI). However, they are limited to the routes surveyed, and they are much less accurate since they are based on a smaller sample of days and time periods.

Vehicle Miles of Travel. VMT is the total miles traveled by vehicles on a road. It is calculated at the segment level by multiplying the number of vehicles counted on that segment of road times the length of the segment. The segment totals can be added across all segments to calculate a route total. The traffic counts are collected separately by ConnDOT as part of the regular traffic counting.

Average Speed. This is the average speed of all vehicles traveling on a road. For this first arterial report, it is presented only for two hours in the morning peak (7:00 am – 9:00 am), and two hours in the afternoon peak (4:00 pm – 6:00 pm.) It is calculated at both the segment and route level.

Vehicle Hours of Travel. VHT is the total time spent by all vehicles traveling through a station area or segment. It is derived from the VMT and average speed.

Hours of Delay. This is the time vehicles spend traveling at rates of speed below an acceptable threshold speed. In the case of freeways, this was set to 60 mph. Since arterials vary so much in terms of road geometry, traffic controls, and adjacent land use, the threshold speed was set differently. It was set separately for each segment of each route by establishing the off-peak or free-flow speed for that segment. This required a travel time and speed survey during the off-peak period in addition to the peak period.

Travel Time Index. The travel time index (TTI) is a ratio of the average travel time during peak period conditions versus the travel time during uncongested periods. If the index or ratio is 1.0, it means that there is no delay during peak periods. A ratio greater than 1.0 indicates that there is delay or congestion. The amount of delay is indicated by the size of the ratio. For example, a ratio of 1.25 means that it takes 25 percent longer to travel a given distance in the corridor during the peak period than during off-peak periods.

ARTERIAL PERFORMANCE RESULTS

A summary of the results is presented in Table 3.1. A total of 68 miles of road were surveyed and a total of 1,532 hours of delay was identified. The average speed was 31.9 mph, but speeds varied greatly between corridors and even within corridors. The overall travel time index (TTI) was 1.17 which represents a 17 percent increase in travel time due to delay.

PM Peak More Congested. Congestion is worse in the afternoon peak than in the morning peak. In all eight corridors, the TTI was worse in the afternoon and the hours of delay was greater. For all eight routes combined, there was **1,119** hours of delay in the PM peak and only **413** in the AM peak.

Table 3.1

Arterial Summary

AM = **Inbound (**7am to 9am) **PM** = **Outbound** (4pm to 6pm)

	Length	Average Speed			VMT			Delay (Hours)			Travel Time Index		
Route	(mile)	AM	PM	Both	AM	PM	Both	AM	PM	Both	AM	PM	Both
RT 15	11.3	40.7	31.0	35.9	27,391	33,231	60,622	82	385	467	1.13	1.47	1.32
RT 4	10.7	27.9	27.8	27.9	16,636	15,650	32,286	168	203	371	1.30	1.43	1.36
RT 6	4.0	22.4	23.8	23.1	19,468	24,946	44,414	85	254	339	1.11	1.35	1.24
RT 44	7.3	32.2	28.2	30.2	20,153	17,103	37,256	34	92	126	1.06	1.16	1.10
RT 10	8.8	29.0	24.9	27.0	34,528	34,528	69,056	0	91	91	1.00	1.08	1.04
RT 66	13.5	41.9	40.8	41.4	20,730	26,447	47,177	32	55	87	1.07	1.09	1.08
RT 9	6.1	32.4	32.3	32.3	5,902	7,181	13,083	12	26	38	1.06	1.12	1.09
RT 99	6.8	38.5	37.1	37.8	4,346	5,297	9,643	1	12	13	1.01	1.09	1.05
ALL	**68.5**	**33.1**	**30.7**	**31.9**	**149,154**	**164,383**	**313,537**	**413**	**1,119**	**1,532**	**1.09**	**1.25**	**1.17**

A more in depth review of corridor performance is provided below. Separate reviews are presented for each of three performance measures:

- **Delay** (total vehicle delay in peak periods)
- **Travel Time Index** (TTI)
- **Speed** (average speed in peak periods)

Delay by Corridor

The three corridors with the largest volume of delay are:

- Route 15 (Berlin Turnpike)
- Route 4
- Route 6

Each one of these corridors accumulates about 3-4 times the delay of any other corridor. This is illustrated in Figure 3.3.

Route 15. The arterial corridor with the largest total delay accumulated by all vehicles during the day is Route 15. Total delay in the combined morning (7:00 am – 9:00 am) and afternoon peaks (4:00 pm – 6:00 pm) is 467 hours. The large volume of delay is a function of both the congested travel conditions, but also the large volume of traffic and the long length of the corridor.

As seen in Figure 3.4, there is much more delay on Route 15 in the PM peak than in the AM peak. This is likely due to the larger 'background' or non-commute traffic that tends to be more prevalent in the afternoon. Since the Berlin Turnpike is also a retail destination, there is also a heavy volume of retail traffic in the afternoon.

Figure 3.3

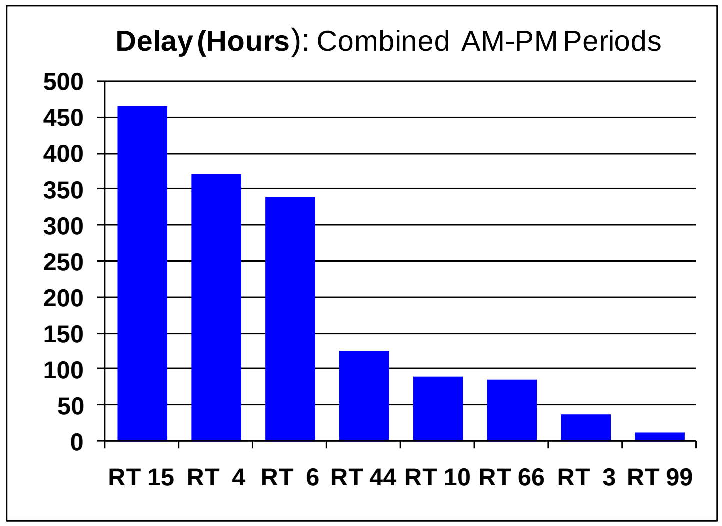
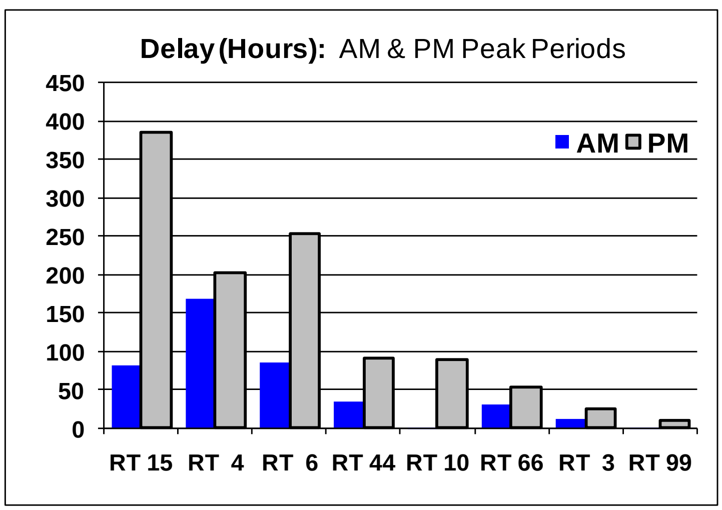


Figure 3.4



Route 4. Route 4 has the second highest volume of delay with 371 hours. Unlike Route 15, the delay is relatively equally balanced between the morning and afternoon peak periods. This is partly a function of the lesser retail activity on Route 4. But, it is also due to the fact that Route 4 operates at close to capacity for much of both peak periods, so it cannot process much more traffic in either peak period.

Route 6. Route 6 behaves much like Route 15, but the total delay recorded is slightly less (339 hours rather than 467 hours). There is much more delay in the afternoon peak, which reflects the large amount of retail activity in the Route 6 corridor.

Travel Time Index by Corridor

The three corridors with the largest Travel Time Indices are:

- Route 4
- Route 15 (Berlin Turnpike)
- Route 6

Each one of these corridors has indices that are 3-4 times that of any other corridor. While the top three corridors are the same as for total delay, the order of the first two corridors is reversed. Route 4 has a higher TTI than Route 4. This is likely reflective of the more congested conditions on Route 4.

Route 4. Route 4 has the highest Travel Time Index of the arterial corridors. Its overall TTI of 1.36 means that it takes about 36 percent more time to travel a given distance in the corridor during peak periods than during off-peak periods. The index is higher in the PM peak (1.43) than during the AM peak (1.30).

Route 15. Route 15 has the second highest overall TTI of 1.32. This means that on average it takes 32 percent more time to travel during peak periods than off-peak periods.

As noted in the previous section, congestion is worse on the Berlin Turnpike in the afternoon than in the morning. The PM peak TTI is 1.47, while the AM peak TTI is 1.13.

Route 6. The overall TTI for Route 6 is 1.24. PM peak conditions are worse with a TTI of 1.35, while the AM peak TTI is 1.11. As stated previously, the imbalance between the AM and PM peaks partly reflects the concentration of retail activity in the corridor.

Figure 3.5

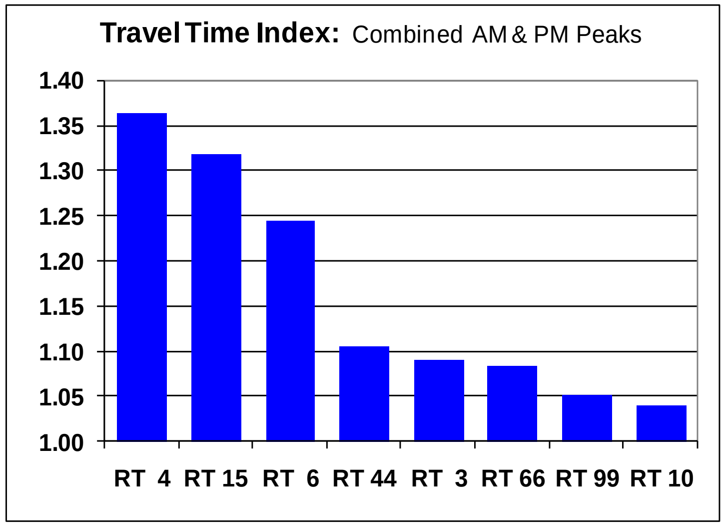
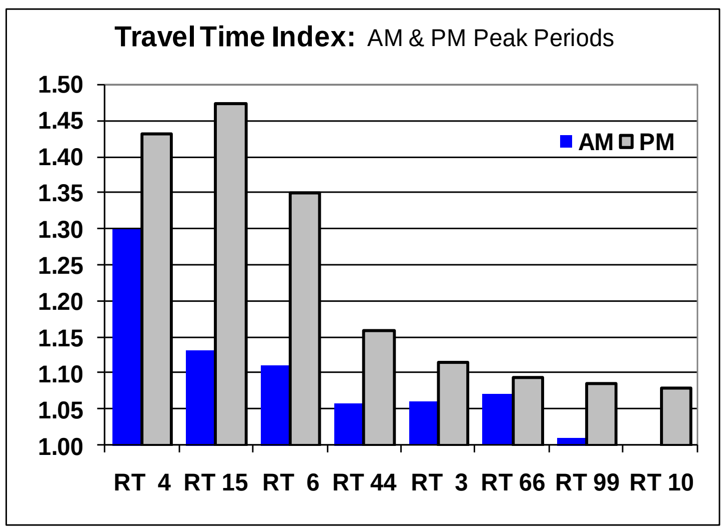


Figure 3.6



Average Speed by Corridor

Average speed yields much different results than any other performance measure. The reason for this difference has to do with both (1) the type and geometric characteristics of a roadway, and (2) congestion. <u>In fact, geometric characteristics probably affect speed more than congestion does</u>. For example, Route 15 is a divided roadway with a wide median with some grade separated roadway crossings. It is designed to function as a higher speed roadway and the recorded speeds reflect this.

Since average speed reflects the facility type and geometry, it is <u>not as good a measure of congestion</u> as total delay or the travel time index. Therefore, the results are presented below without any interpretation.

Overall speeds vary from 22 mph for Route 6 to 42 mph for Route 66. The slowest speeds are found on the three following routes.

- Route 6
- Route 4
- Route 10

The highest speeds are found on the three following routes.

- Route 66
- Route 15
- Route 99

Figure 3.7

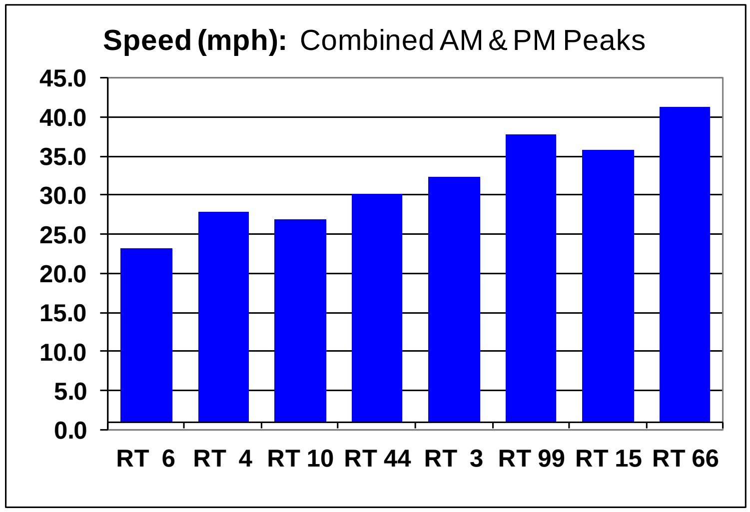
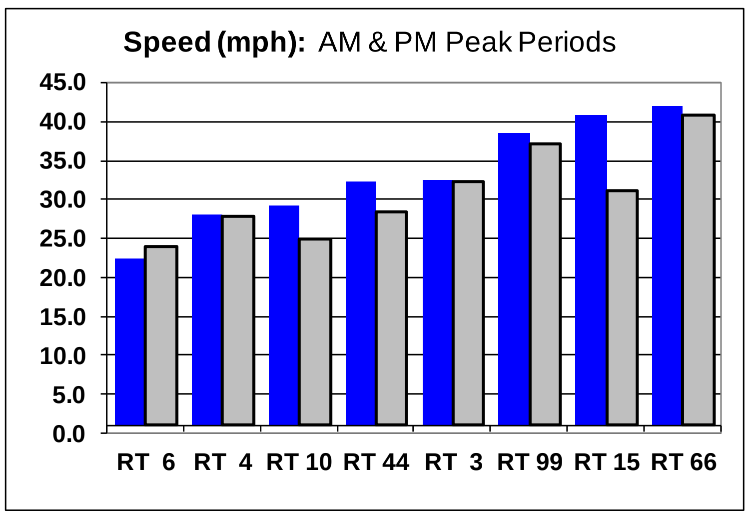


Figure 3.8



Chapter 4 – Conclusions & Next Steps

The preparation of this first traffic monitoring report required the development of many new tools to both manage and analyze the data from the Regional Traffic Management System operated by ConnDOT's Newington Operations Center. It also required the development of new techniques to compile and analyze GPS and arterial travel time data collected by RPO staff members. The technical challenges were large and caused a delay in the publication of this report. However, the final results demonstrate that the resultant monitoring systems can yield substantial insight into the traffic conditions in the Hartford metro area. More importantly, the continuation of the monitoring process, combined with the refinement of methods, holds the promise of being able to track trends, obtain greater insights, and measure the benefits of major roadway improvement projects to be implemented in the region.

Next Steps

To gain these benefits we must continue to conduct the monitoring process and to refine the tools and methods used. The major goals for the next year or two are described below.

Refine & Improve Techniques

- Develop a method to separate total delay into two major categories:
  - Recurring delay caused by normal heavy traffic volumes
  - Non-recurring delay caused by accidents, weather, or other incidents
- Add a reliability measure for the freeway monitoring system.
- Increase and improve sampling techniques for arterial roads.

  We need to increase the number of travel time runs during the AM and PM peak periods. The limited number of samples for the current report caused us to restrict the reporting to just a 2-hour peak period. For some of the routes we surveyed, we had fewer than 10 complete runs.

Track Trends over Time

- Starting with the next report, we will have survey data from two different time periods (2005 and 2008). This will allow us to begin to track changes over time and identify emerging trends.

Before & After Analysis

- Now that we have established a baseline with the 2005 data, we can begin to measure changes that occur due to the implementation of major projects, such as the reconstruction of I-84 in Farmington (project 51-259). In the 2005 report, we observed a significant amount of delay in the same area where project 51-259 is scheduled to take place in 2009 and 2010.

Add Safety Element

- We also expect to add a safety element to the next report. The development of a safety management program was a goal of the most recent regional transportation plan, and we will implement it as part of the traffic monitoring report.