Congestion Management Process

NPMRDS Update

Metropolitan Hartford Area

Capitol Region Council of Governments
Lower Connecticut River Valley Council of Governments
Naugatuck Valley Council of Governments
Northwest Hills Council of Governments

May 23, 2017

Introduction

A Congestion Management Process (CMP) is a systematic approach to measuring transportation system performance and developing proposals to manage traffic congestion. The *Fixing America's Surface Transportation Act* (FAST Act)[1] requires that each metropolitan area, with a population over 200,000, develop and implement a CMP as part of their metropolitan planning process. Hartford's metropolitan area population exceeds 900,000[2], and therefore the Capitol Region Council of Governments (CRCOG), in concert with adjacent regional agencies, has carried out a transportation monitoring and management program since 2005. This report, however, is not intended to represent a full CMP update. Rather, it aims to update the congestion monitoring and assessment portion of the CMP given the recent availability of a more accurate and complete data set, the National Performance Management Research Data Set (NPMRDS).

Objectives

Roadway congestion has been a persistent impediment to the efficient movement of people and goods. According to the 2015 Urban Mobility Report 3 from the Texas Transportation Institute (TTI), congestion caused urban Americans to travel an extra 6.9 billion hours in 2014, resulting in an estimated congestion cost of $160 billion. This represents an increase of $39 billion (32 percent) between 2011 and 2014. The report lists Hartford as 29th out of 101 most congested urban areas, with an average of 45 hours of delay per auto commuter. This translates to a 20 percent increase in average commuting time and an estimated $1,038 of congestion cost per auto commuter. The congestion not only wastes energy and causes delay, it also causes significant negative impact on the public health and environment through increased emissions. Although complete elimination of congestion is not feasible, proper planning, periodic assessment and corrective actions and strategies can mitigate congestion and thus achieve the desired outcome of reducing its effects.

In order to address congestion, CRCOG and its regional partners have engaged in ongoing CMP efforts, with the major objectives being:

1. *To monitor and assess system performance.*
2. *To identify congested locations and causes for congestion.*
3. *To evaluate strategies to reduce or mitigate the impact of congestion.*
4. *To monitor the effectiveness of strategies following implementation.*

The main objective of this report is utilize the NPMRDS to update items 1 and 2. The NPMRDS is a new dataset made available to states in October 2013 for use in measuring System Performance. The dataset currently contains a wealth of travel speed data, mostly along National Highway System roadways. The accuracy and applicability of this dataset for congestion monitoring and assessment represents a major improvement over the datasets used for previous Hartford CMPs. In fact, it has been determined the differences between NPMRDS based and past Hartford CMP congestion reporting are more the consequence of improvements to the underlying data than of actual changes in system performance. Therefore, comparisons of results with those shown in previous Hartford CMP reports are unproductive. Instead, the updated results represent a new benchmark in Hartford congestion reporting which can be used in future CMP efforts including historical comparisons. It should be noted that CMP efforts are a continuously on-going process which the regions will continue

[1] Signed into law on December 4, 2015; CMP was first required under the Safe Accountable Flexible Efficient Transportation Equity Act — A Legacy for the Users (SAFETEA-LU) and built upon the requirements for the Congestion Management. Systems first introduced in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).

[2] Per the 2010 census, Hartford's urbanized area population is 924,859.

[3] http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/mobility-scorecard-2015.pdf

to advance in accordance with any future federal CMP guidance, including potential upcoming federal rulemakings on System Performance Measures.

An additional report objective is to consolidate 2015 system performance reporting to include the entire Hartford Transportation Management Area (TMA). Most recently, two separate CMP documents were created for the Hartford TMA: a June 2013 report was produced by Capitol Region Council of Governments (CRCOG) and Midstate Regional Planning Agency (MRPA) that captured the majority of the TMA, and a May 2012 report was developed independently by Central Connecticut Regional Planning Agency (CCRPA) which focused solely on its seven member municipalities. Connecticut's MPOs underwent federal certification review in the 2013/2014 timeframe, and one of the resulting recommendations for Hartford area MPOs was to apply a more integrated CMP approach that covers the entire TMA. Since that time, regional consolidation efforts have resulted in the elimination of both CCRPA and MRPA, as well as the expansion of three other regions' borders into the Hartford TMA. Therefore, this update effort serves to further CMP coordination between CRCOG and its three new Hartford TMA partners.

Overview of the Study Area

In 2015, Regional Planning Agency (RPA) consolidation efforts were completed in Connecticut, resulting in a reduction of the number of regions from the fifteen (15) to nine (9), and changes to regional boundaries including those that serve the Hartford TMA. This resulted in the elimination of CCRPA and MRPA, and the expansion of remaining RPAs, with the following RPA's borders all now reaching into the Hartford TMA (all with the exception of NHCOG are designated MPOs):

Capitol Region Council of Governments (CRCOG)
Naugatuck Valley Council of Governments (NVCOG)
Lower Connecticut River Valley Council of Governments (RiverCOG)
Northwest Hills Council of Governments (NHCOG)

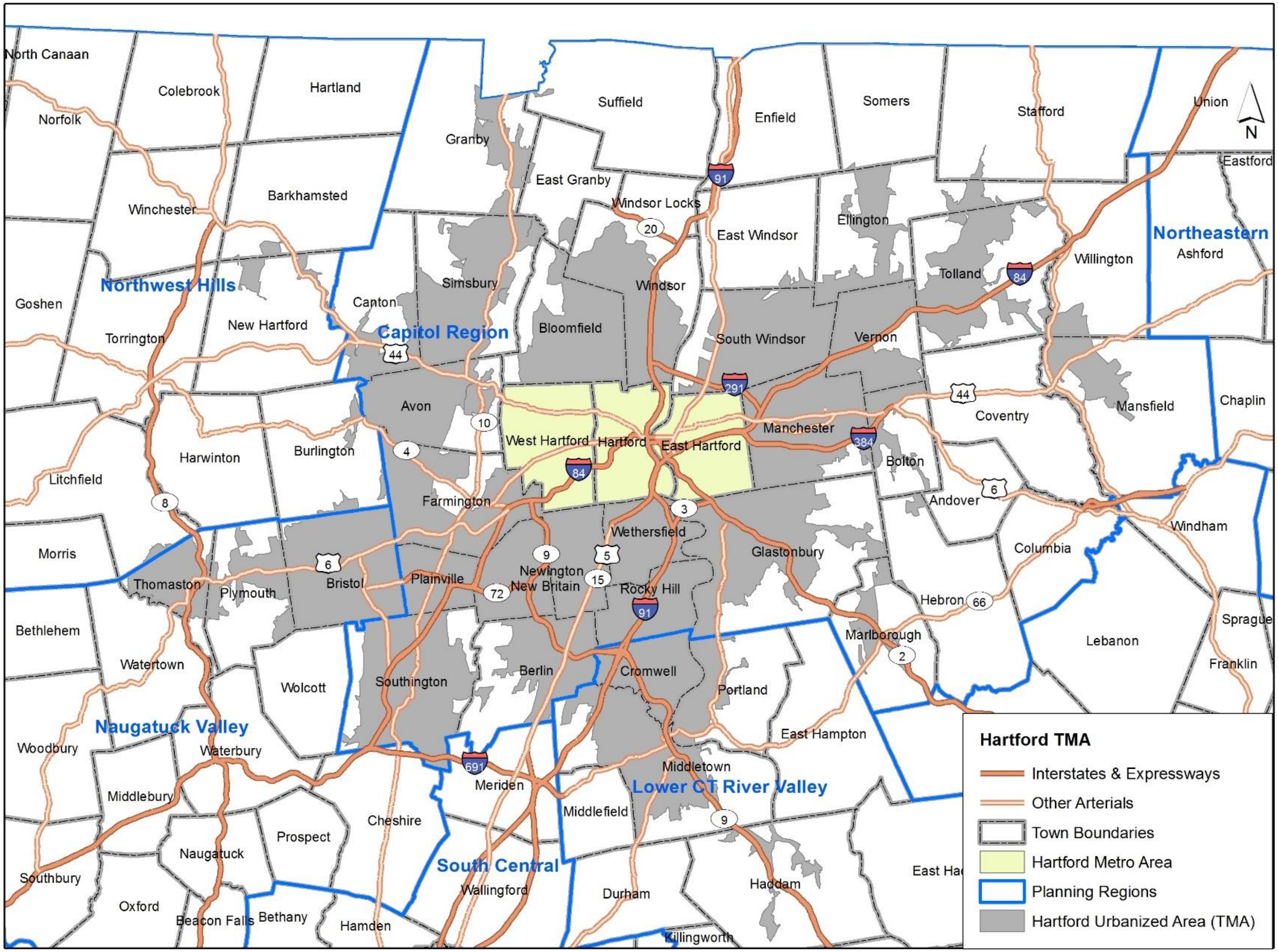
Figure 1 depicts the Hartford TMA, RPA, and municipal boundaries, along with its network of major freeways and arterials. Also highlighted is the Hartford Metro Area, which for the purposes of this report is defined as the area encompassing Hartford, East Hartford, and West Hartford. Previous congestion monitoring suggests that most of the region's freeway congestion occurs within these three municipalities, and therefore the Metro Area has been defined in order to better quantify the severity, extent, and location of roadway congestion.

Extensive efforts were coordinated between planning regions to select Hartford TMA routes for monitoring. The resulting selections, defined below, represent many of the critical main arterials with NPMRDS data that carry commuter traffic between suburban communities and Hartford.

<u>Freeway Segments</u>
I-84 West: from the Southington/Cheshire town line west to I-91 in Hartford
I-84 East: from I-91 in Hartford east to the Ashford/Union town line
I-91 South: from the Middletown/Meriden town line north to I-84 in Hartford
I-91 North: from I-84 in Hartford north to the Connecticut/Massachusetts state line
Route 2: from I-84 in East Hartford east to the Marlborough/Colchester town line
Route 9: from Haddam/Chester town line north to I-84 in Farmington

<u>Arterials Segments</u>
Route 4: from Route 69 in Burlington east to SR 508 (I -84 ramps) in Farmington
Route 6: from Route 8 in Thomaston east to I-84 ramps in Farmington
Route 15: from the Wilbur Cross Parkway in Meriden north to Nott Street in Wethersfield
Route 44: from Route 318 in Barkhamsted west to the West Hartford/Hartford line
Route 66: from Route 9 in Middletown west to Route 2 in Marlborough

Figure 1: Hartford TMA Overview



System Performance Measures

As in the 2005 and 2010 CMP reports, three different performance measures are used to evaluate the performance of each corridor: (1) vehicle delay, (2) average speed, and (3) travel time index. Based on the traffic volume and patterns, the periods of 7:00 – 9:00 am and 4:00 – 6:00 pm were identified as the TMA's morning and afternoon peak hours respectively. **Each of the performance measures were calculated utilizing these peak hour weekday commuting periods only.**

Vehicle Delay. This is the time (in hours) that vehicles are delayed when traveling at rates of speed below free-flow or a determined acceptable speed. In the case of freeways, this speed is set to 60 mph. Since arterials vary so much in terms of road geometry, traffic controls, and adjacent land use, the threshold speed is set differently. It is computed separately for each segment of each route by establishing the off-peak or free-flow speed for that segment.

Average Speed. This is the average speed (in miles per hour) of all vehicles traveling on a roadway during a specified timeframe. It is calculated at both the segment and route level.

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.

Hartford TMA Freeway System

Within the Hartford TMA there are about 152 route miles of freeway, including both Interstate and non-Interstate routes. 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 include I-84, I-91, I-691, I-291, and I-384, and Non-Interstate routes include all, or portions of, Route 9, Route 72, Route 2, Route 3, Route 17, Route 20, Route 5-15, and Route 6.

Interstates 84 and 91. I-91 and I-84 **are the two major Interstate routes** in the TMA, and they carry a large volume of long distance traffic. They are also 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 I-90 in Springfield, Massachusetts. 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 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 from 2012 and 2013 CTDOT counts show the highest traffic volumes on the freeway system are found near the interchange between I-84 and I-91. Daily traffic volumes on I-84 in downtown Hartford are about 141,700. On I-91, they are about 152,000. Volumes remain high on the primary routes radiating out of downtown, with highest volumes observed during the weekday peak commute hours of 7:00 – 9:00 am and 4:00 – 6:00 pm. Volumes within these four hours account for about 30 percent of total weekday volumes and represent the time periods used in this document for assessing performance.

Freeway Performance Results

To assess freeway performance, we analyzed four months of data available from the Federal Highway Administration's (FHWA's) NPMRDS program: March, April, September, and October of 2015. These four months 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 – Thursday) excluding holidays was analyzed. Performance measures were quantified both for the entire TMA and for the defined Hartford Metro Area to help to illustrate the heavy concentration of congestion within and around the City of Hartford including the Interstate 84 and 91 interchange.

Overview of Monitored Corridors

Figure 2 provides an overview of the corridors monitored by freeway segment, which represent over 140 miles (or 92 percent) of the 152 miles of freeway in the Hartford TMA. As in the previous monitoring cycle, all the major freeways that intersect in and around Hartford were selected during this cycle as well. Based on CTDOT traffic counting, these freeways serve about 9,946,000 vehicle miles of travel (VMT) on a daily basis. VMT represents the total miles traveled by vehicles on a road (calculated by multiplying the vehicles counted by the length of the segment). The Hartford Metro Area contains only 15 percent of the TMA's monitored freeway miles but serves about 24 percent of its traffic (2,363,000 VMT daily). High daily VMT and traffic volumes illustrate the critical role the freeway system plays in the Hartford Metro Area.

Figure 2: Hartford TMA Highways Daily VMT

	Hartford TMA				Hartford Metro Area			
		Daily VMT				Daily VMT		
Corridor	Miles	In	Out	Total	Miles	In	Out	Total
I-84 West of I-91	22.4	1,115,888	1,148,520	2,264,408	6.7	436,547	433,841	870,388
I-91 North of I-84	19.9	1,137,056	1,120,937	2,257,993	2.8	171,929	183,924	355,852
I-91 South of I-84	17.6	675,328	754,322	1,429,650	2.9	132,704	152,430	285,134
I-84 East of I-91	29.6	1,236,161	1,286,679	2,522,840	4.9	316,953	308,887	625,840
Route 2	20.2	474,621	429,818	904,439	3.8	109,722	116,144	225,866
Route 9	30.6	325,075	242,057	567,132	0.0	-	-	-
All Corridors	140.3	4,964,129	4,982,333	9,946,463	21.1	1,167,855	1,195,225	2,363,080

Corridor Level Performance

1. Vehicle Delay.

Total vehicle delay for each corridor is presented in Figure 3 below. This is the cumulative amount of delay experienced by all vehicles traveling in each corridor during the morning and afternoon weekday peak periods. Additionally, Figure 4 shows delay separately for the entire TMA and the Hartford Metro Area. Although the Hartford Metro Area comprises only about 15 percent of the total freeways miles monitored within the TMA, the total peak hour delay within this area represents over 65 percent of the total observed freeway delay, confirming the perception that most of the regional freeway congestion occurs within the Hartford Metro Area.

Figure 3: Total Peak Hours Delay

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 Peak Hours Delay In	Daily Peak Hours Delay Out	Daily Peak Hours Delay Total	Daily Peak Hours Delay Per Mile
I-84 West of I-91	22.4	1,057	153	1,210	1,193	1,450	2,643	2,250	1,603	3,853	172.0
I-91 North of I-84	19.9	1,172	71	1,243	947	258	1,205	2,119	329	2,448	123.0
I-91 South of I-84	17.6	533	7	540	119	663	782	652	670	1,322	75.1
I-84 East of I-91	29.6	617	10	627	164	141	305	781	151	932	31.5
Route 9	30.6	316	95	411	173	211	384	489	306	795	26.0
Route 2	20.2	435	7	442	26	127	153	461	134	595	29.5
All Corridors	140.3	4,130	343	4,473	2,622	2,850	5,472	6,752	3,193	9,945	70.9

Figure 4: Total Peak Hours Delay (Hartford TMA vs. Hartford Metro Area)

Corridor	Hartford TMA Miles	Hartford TMA Daily Peak Hours Delay In	Out	Total	Per Mile	Hartford Metro Area Miles	Hartford Metro Area Daily Peak Hours Delay In	Out	Total	Per Mile
I-84 West of I-91	22.4	2,250	1,603	3,853	172.0	6.7	2,136	1,590	3,726	556.1
I-91 North of I-84	19.9	2,119	329	2,448	123.0	2.8	830	236	1,067	381.0
I-91 South of I-84	17.6	652	670	1,322	75.1	2.9	202	594	796	274.5
I-84 East of I-91	29.6	781	151	932	31.5	4.9	718	151	869	177.3
Route 9	30.6	489	306	795	26.0	0.0	-	-	-	-
Route 2	20.2	461	134	595	29.5	3.8	273	119	393	103.4
All Corridors	140.3	6,752	3,193	9,945	70.9	21.1	4,160	2,690	6,850	324.6

Further review of Figures 3 and 4, results in the following conclusions:

Total Freeway Delay (9,945 hours). The total delay recorded for the entire monitored freeway network is 9,945 hours. This is the total hours of vehicle delay recorded in all six corridors segments over four peak hours of travel, two hours in the morning and two in the afternoon.

Notable Freeway Congestion. In general, the most congested corridors are ***I-84 West*** and ***I-91 North***, which together account for over 63 percent of monitored freeway congestion, with 76 percent of this congestion (48 percent of all monitored freeway congestion) occurring on these segments within the Hartford Metro Area.

I-84 West – Most Congested. As in the past, I-84 West remains the most congested freeway segment with 3,853 hours of total peak hour delay per day. This is about 39 percent of the total observed freeway delay of 9,945 hours. When averaged over the 22.4 miles in the corridor, this amounts to 172 hours per mile, which drastically increases when the Hartford Metro Area is considered. Although only 6.7 miles out of more than 22 miles fall within the Metro Area, the total delay within this area is about 97 percent of the total peak hour delay. Motorists traveling in and out of Hartford during morning and especially afternoon peak hours experience long delays and travel speeds as low as 10 mph over a six-mile stretch of the highway.

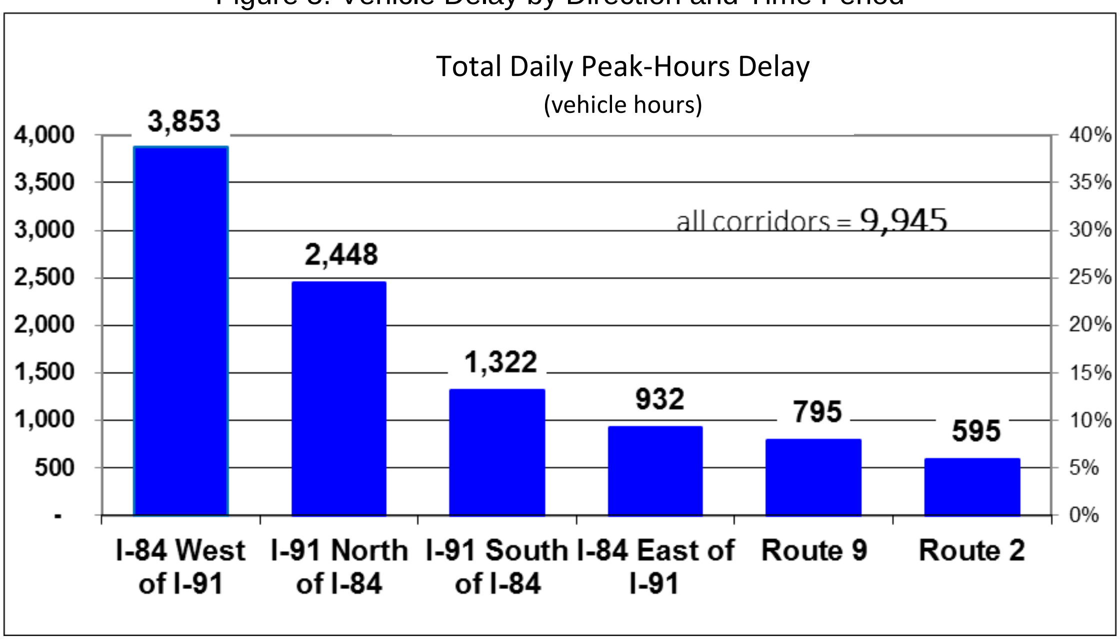
- *Inbound vs. Outbound.* Significant delay on I-84 West is apparent in both the inbound and outbound directions. Inbound accounts for about 2,250 hours of delay, and outbound for 1,603 hours. Most of these delays occur within the Metro Area with peripheral areas not typically experiencing significant delays.
- *AM peak vs. PM peak*. Based on the peak hour data, the total delay in the AM peak hours (1,210 hours) is less than half that in the PM peak hours (2,643 hours).

I-91 North - 2nd Most Congested. The second most congested freeway segment is I-91 North with 2,448 hours of total delay during the four defined peak hours.

- Inbound vs. Outbound. A large imbalance of delay is observed between the inbound and outbound directions. The inbound direction records more than six times the amount of delay as the outbound direction, with 2,119 hours of inbound delay compared to 329 hours for the outbound direction.
- AM peak vs. PM peak. In contrast to the I-84 West corridor, delay on I-91 North is fairly evenly divided between morning and afternoon peak hours, with 1,243 hours occurring in the morning and 1,205 in the afternoon.

Figure 5 shows the peak hours' delay by corridors and time period.

Figure 5: Vehicle Delay by Direction and Time Period



2. Average Peak Hour Speed.

Figures 7 and 10 through 13 illustrate peak period travel speed data on freeways within the Hartford TMA. Similar to previous figures showing delay, these figures show the most substantial speed reductions occurring in and around the Hartford Metro Area, with their limits at times extending beyond the Metro Area into surrounding towns. Independent of the Hartford centered congestion are substantial speed reductions along Route 9 near downtown Middletown.

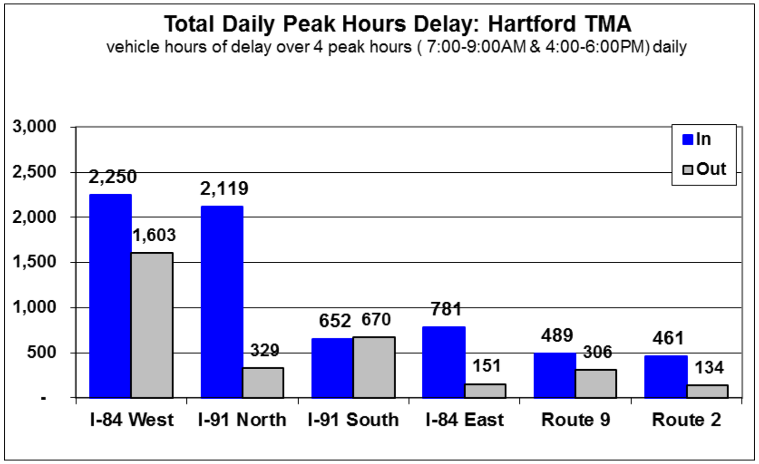
Hartford. In general, the Figures show morning congestion approaching Hartford, but almost no congestion in the outbound direction. In the afternoon, major congestion throughout the Metro Area is apparent in both the inbound and outbound directions. These traffic issues appear heaviest in the defined Hartford Metro Area towns of Hartford, West Hartford, and East Hartford. However, at times congestion also spills into other adjacent towns; most notably inbound along I-91 in southern Windsor in both peaks, and inbound on Route 2 in northern Glastonbury's during the morning peak. Not apparent from the figures is persistent on-and-off again congestion throughout the day on I-91 northbound in Wethersfield stemming from its problematic exit 29 ramp leading to I-84 eastbound via the Charter Oak Bridge.

In the morning peak, slowdowns on I-84 eastbound become most apparent near the Farmington/West Hartford line as inbound traffic from Routes 4, 6, and 9 merge with I-84 eastbound traffic. On I-84 westbound, morning slowdowns appear to become problematic much closer to Hartford, backing up approximately a mile or more from the I-91 interchange through the Route 2 interchange into East Hartford. Morning slowdowns on I-91 are most problematic southbound, typically beginning around the interchange with Day Hill Road in Windsor and continuing into Hartford. Morning traffic slows below free-flow on I-91 northbound entering Hartford, but typically continues moving at or above 40 miles per hour. During the morning, outbound speeds are much higher than inbound in the majority of the corridors, which reflects the inbound/outbound imbalance associated with the Hartford commute.

In the afternoon peak, significant inbound slowdowns are primarily limited to I-84 and I-91 in Harford and in southern Windsor in similar areas as in the morning peak. Outbound however, the major slowdowns are observed on all freeways radiating out from downtown Harford. These are most problematic throughout on I-84 westbound throughout Hartford and West Hartford, and on I-91 southbound throughout Hartford. The lowest average peak-hour speeds are found on the I-84 West corridor within the Metro Area in the evening peak hours for both inbound and outbound directions. The average speed in this area drops below 25 mph in many segments. The I-91 North corridor also experiences major slowdowns in the inbound direction during evening peak hours.

Middletown. In general, the Figures show a mile or more of significant morning and afternoon congestion along Route 9 in both directions adjacent to and approaching downtown Middletown. These speed reductions appear coincident with multiple Route 9 access and egress points located within the mile. These include two signalized and one unsignalized intersection that atypically interrupt Route 9's limited access nature; along with the close proximity of interchanges 12 and 13 which each contain ramps with substandard acceleration and deceleration lengths. Outside the influence of these elements, Route 9 traffic appears to flow acceptably in both directions during each peak.

Figure 6: Total Daily Peak Hour Delay



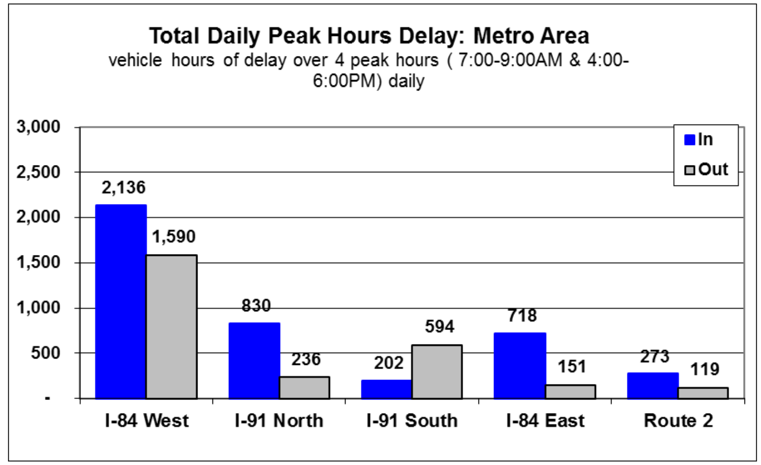
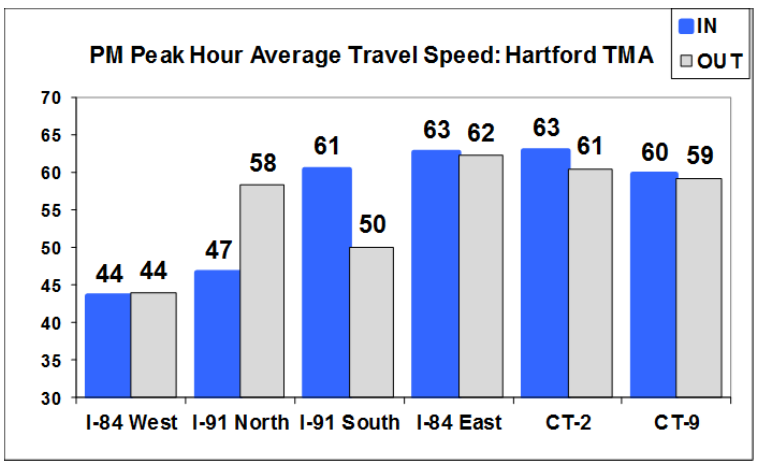
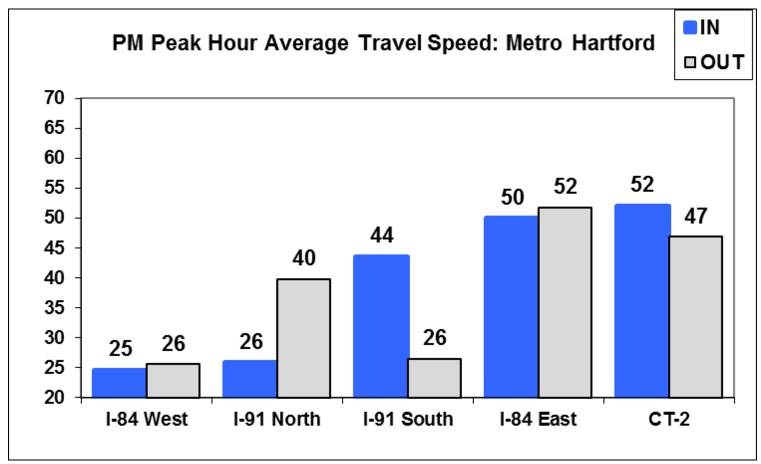


Figure 7: Afternoon Peak Hour (4:00 – 6:00PM) Travel Speed





3. Travel Time Index.

The travel time index (TTI) is a measure of the amount of extra time it takes to travel in a corridor during peak hours versus the time it takes to travel the same distance during off-peak or free-flow conditions. For purposes of this freeway analysis, the off-peak speed is assumed to be 60 mph[4]. The index is a simple ratio of peak travel time to time required to travel the same distance at an uninterrupted 60 mph. <u>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</u>. The minimum ratio is set to 1.0 and means that peak period speeds are equal to or higher than 60 mph. The results are presented in Figures 8 and 9.

<u>*I-84 West.*</u> The highest TTIs were recorded inbound for both the AM and the PM peak in the I-84 West corridor. A ratio of 1.51 was recorded for the PM peak for the entire freeway segment, but it drastically increases to 2.49 within the Hartford Metro Area. Outbound within the Hartford Metro Area also has a very high TTI of 2.38 in the PM peak.

<u>*Other Corridors.*</u> Similar to the locations of decreased peak speeds, on other corridors higher TTIs are found mostly within the Metro Area in the PM peak hours for both the inbound and outbound directions. Most notable are ***I-91 North*** inbound and ***I-91 South*** outbound during the PM peak, with each being assessed a TTI of 2.33.

In summary, these measures indicate that the corridor with the worst congestion is I-84 West in both the AM (inbound) and the PM (inbound and outbound) peak hours.

Figure 8: Hartford TMA Afternoon Travel Time Index

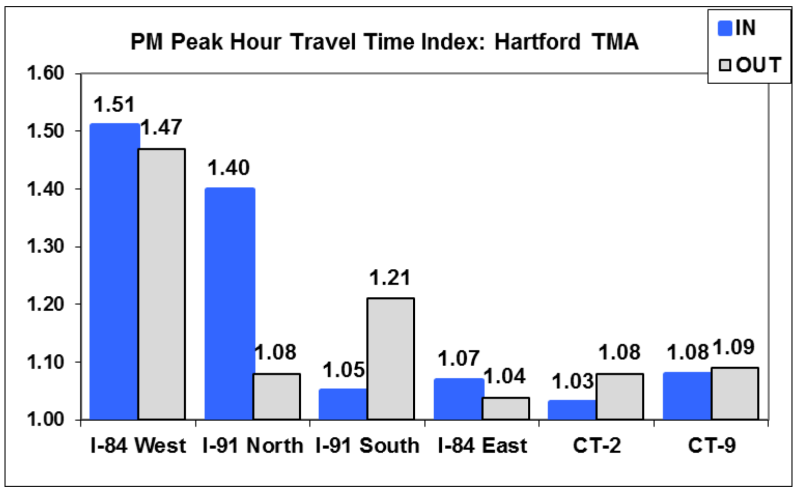
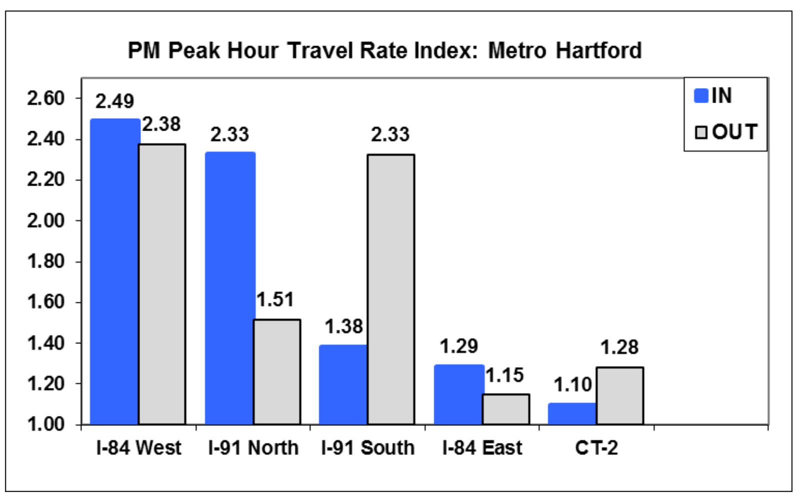


Figure 9: Hartford Metro Afternoon Travel Time Index



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

Figure 10: Morning Peak Hour Average Travel Speed

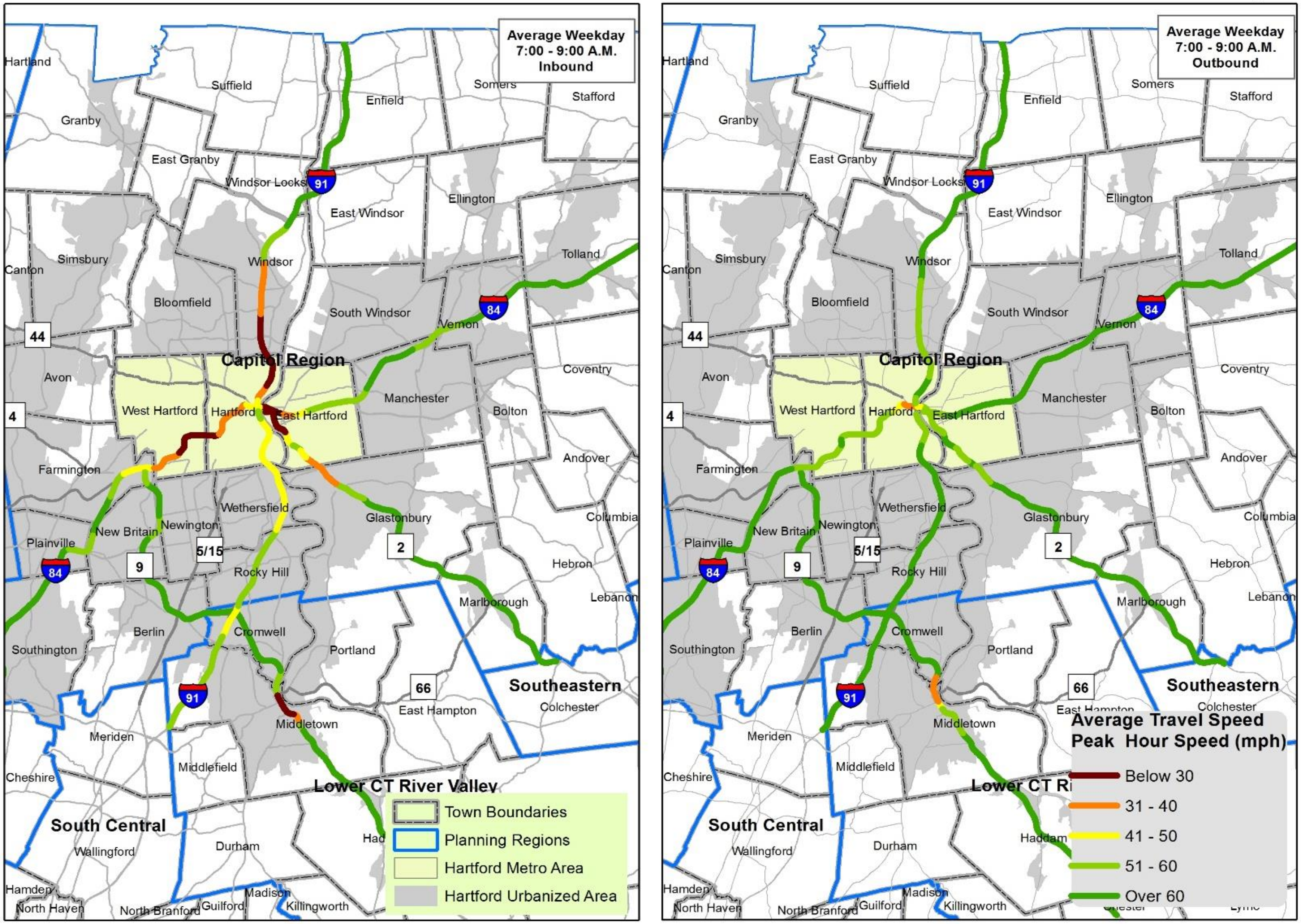
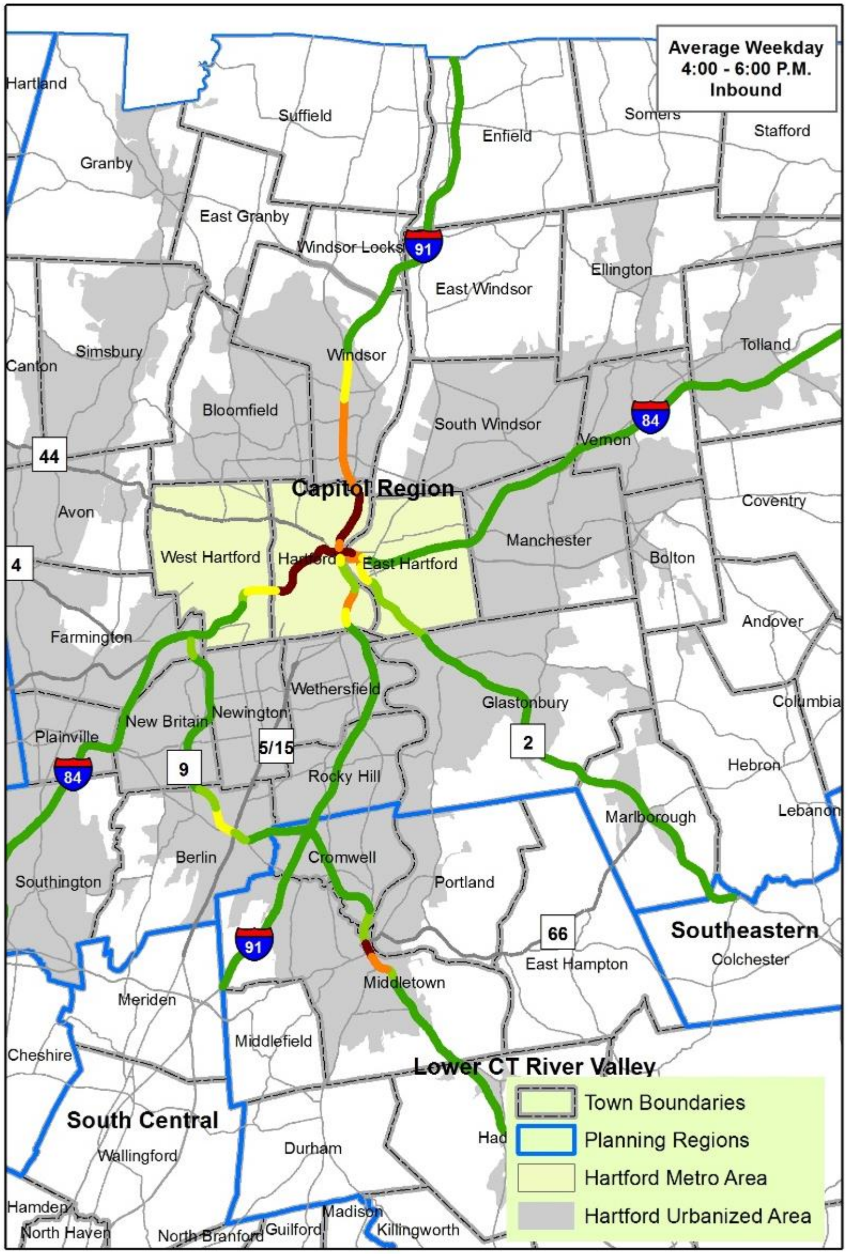


Figure 11: Afternoon Peak Hour Average Travel Speed



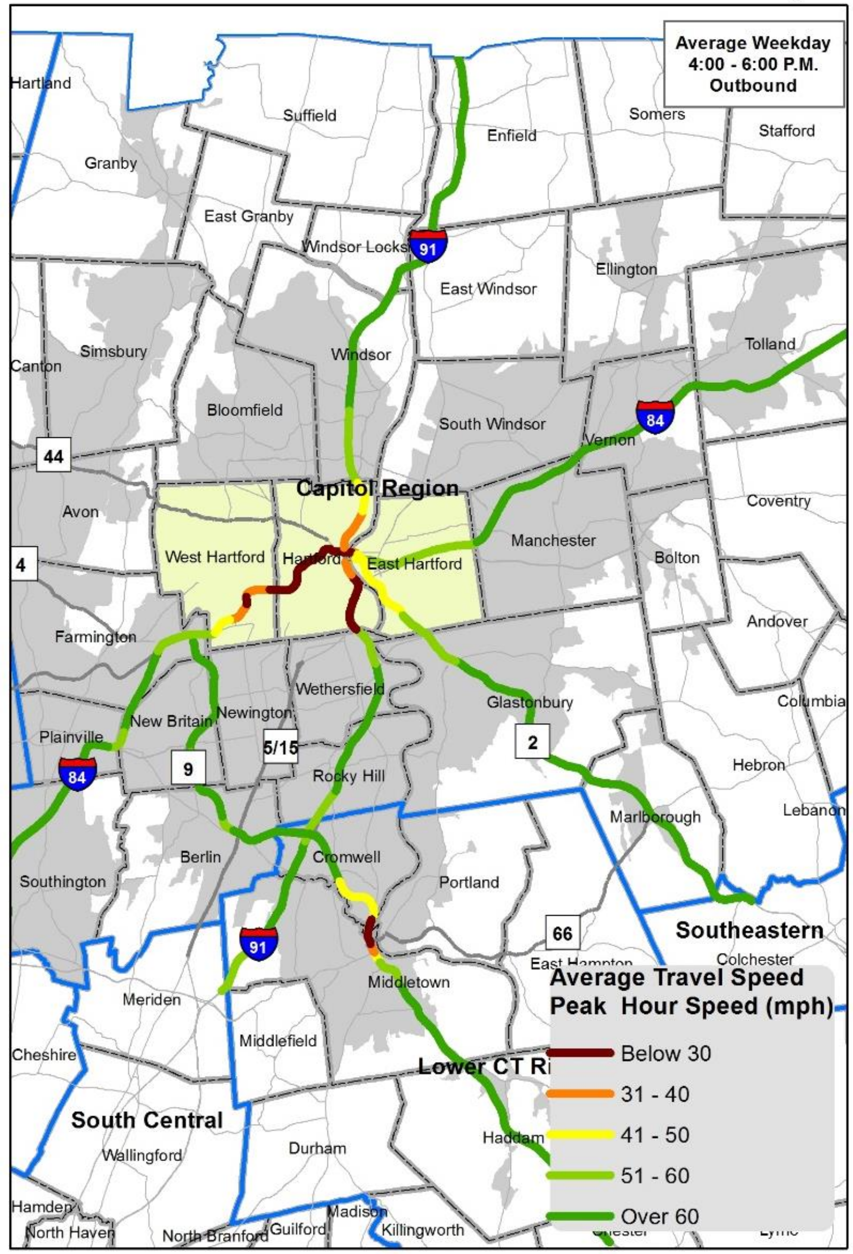
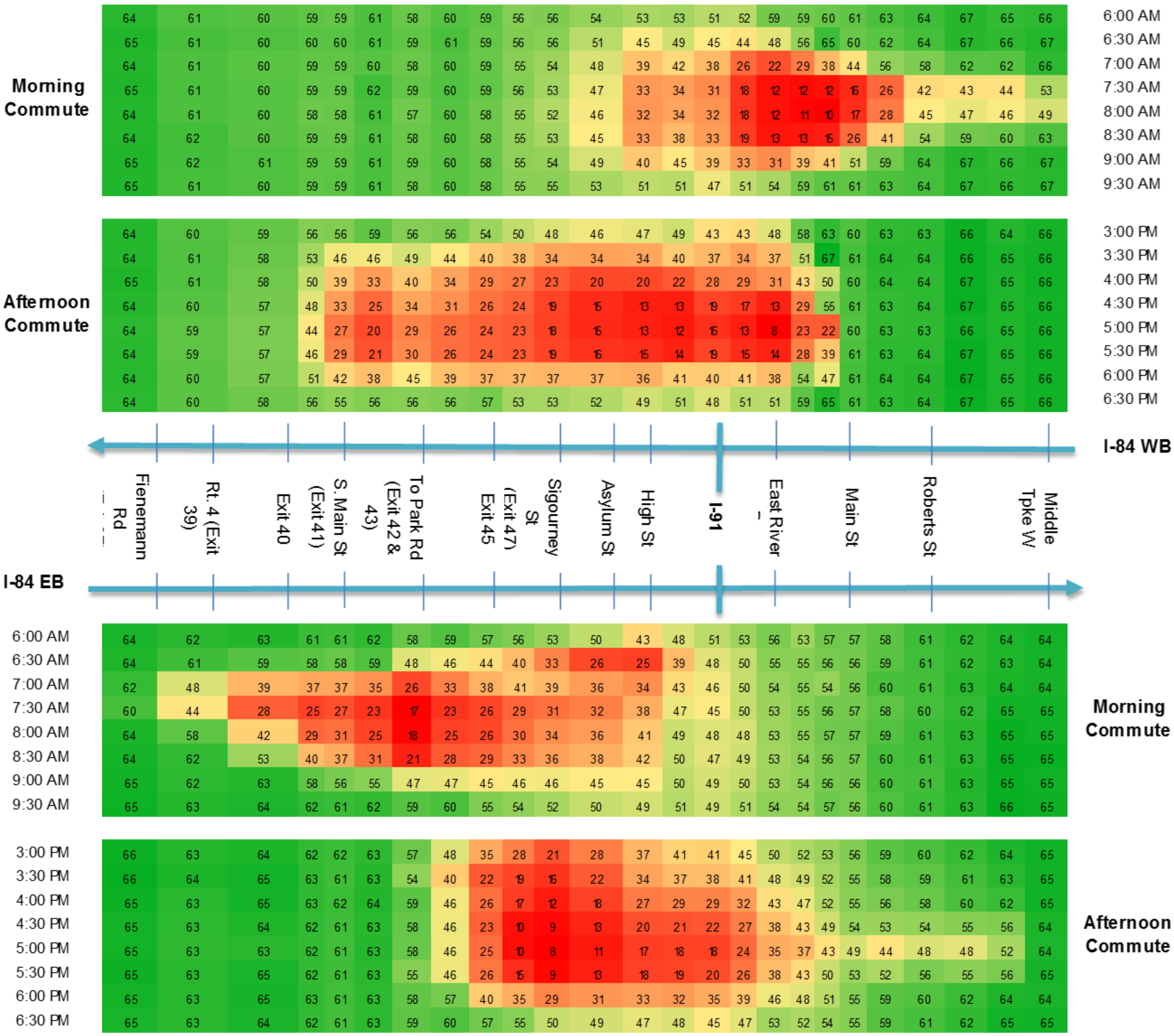


Figure 12: I-84 Morning & Afternoon Commute Speed Heat Map



Note: Numbers in each colored cell represent the average travel speed (in mph) at a particular location and time. Red colored cells indicate slow speeds, yellow cells indicate moderate speeds, and green cells indicate speeds approaching, or at, free-flow.

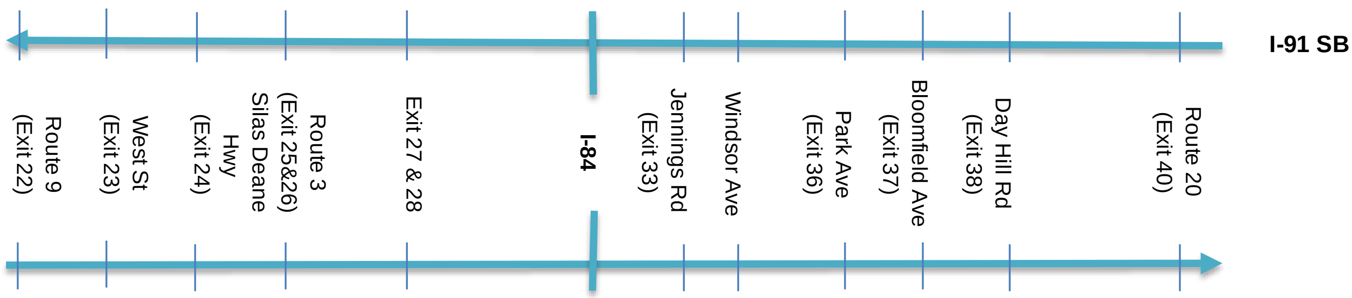
Figure 13: I-91 Morning & Afternoon Commute Speed Heat Map

Morning Commute (I-91 SB)

66	65	66	65	63	62	62	59	56	59	53	56	57	61	62	64	64	65	65	65	65	6:00 AM
67	66	66	65	63	62	62	59	56	56	51	51	42	48	54	58	60	62	63	63	65	6:30 AM
67	66	66	64	63	62	60	59	55	54	49	50	39	30	30	37	38	41	47	51	60	7:00 AM
66	66	65	64	62	61	60	59	55	55	49	50	37	24	19	23	24	29	41	44	58	7:30 AM
66	66	65	64	62	61	59	58	54	54	48	50	37	25	21	24	27	39	57	64	65	8:00 AM
66	66	66	64	62	61	60	58	54	55	49	51	37	27	26	32	38	51	63	64	66	8:30 AM
67	66	67	65	63	62	62	58	54	55	50	52	44	42	48	55	58	65	65	64	65	9:00 AM
67	66	67	65	63	62	62	59	55	56	50	53	51	57	60	64	65	65	65	64	66	9:30 AM

Afternoon Commute (I-91 SB)

65	65	65	63	61	60	59	58	54	55	49	49	37	34	49	57	55	59	64	64	65	3:00 PM
65	65	65	62	56	54	58	58	54	55	48	46	36	21	30	43	34	36	51	64	66	3:30 PM
64	64	64	61	52	29	36	42	51	53	46	42	34	21	25	42	37	41	58	64	65	4:00 PM
59	62	63	60	51	19	21	21	32	37	39	36	29	20	28	43	41	46	63	64	65	4:30 PM
56	57	62	60	49	19	22	17	25	31	33	32	25	21	34	35	33	45	63	64	66	5:00 PM
59	60	63	61	50	22	25	27	39	44	37	33	28	22	34	35	34	48	64	64	66	5:30 PM
65	65	64	62	56	47	52	57	55	55	46	44	42	36	48	53	54	63	64	64	65	6:00 PM
66	65	65	64	62	62	62	59	55	56	51	51	52	57	62	63	64	64	64	63	64	6:30 PM



Morning Commute (I-91 NB)

6:00 AM	65	66	65	63	63	61	60	59	58	57	58	56	61	61	62	63	62	64	63	62	64
6:30 AM	64	66	64	61	62	60	59	58	57	57	59	58	61	60	61	57	61	65	63	62	65
7:00 AM	61	64	55	51	57	56	54	54	54	56	57	57	60	59	58	55	60	64	63	63	66
7:30 AM	55	50	36	39	43	44	43	46	46	54	57	56	60	59	51	46	58	63	63	63	64
8:00 AM	56	56	37	38	38	42	44	47	49	54	56	56	60	58	51	48	59	64	64	64	66
8:30 AM	59	59	41	41	42	44	43	48	49	54	57	57	61	59	56	51	60	64	64	64	66
9:00 AM	64	66	59	56	58	56	54	54	55	55	58	57	61	60	62	63	63	65	64	64	66
9:30 AM	66	68	66	64	64	62	61	59	57	56	59	59	62	61	63	64	64	65	64	64	66

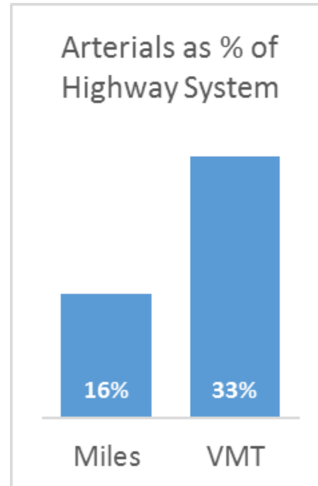
Afternoon Commute (I-91 NB)

3:00 PM	66	68	66	63	62	47	39	40	57	56	58	57	61	58	61	61	62	63	63	63	65
3:30 PM	66	68	65	63	61	47	36	39	57	56	57	54	49	50	59	56	60	63	61	62	66
4:00 PM	67	68	65	63	62	47	33	37	58	55	47	38	37	44	57	53	60	63	62	63	66
4:30 PM	66	67	62	63	62	45	33	35	57	50	42	33	32	44	56	55	60	63	61	63	66
5:00 PM	66	66	57	62	61	38	28	32	57	51	44	37	33	43	57	56	61	64	61	63	66
5:30 PM	66	67	59	62	61	39	30	34	58	55	52	45	44	47	58	59	61	64	62	64	66
6:00 PM	67	68	66	64	64	61	52	49	58	57	58	59	62	61	63	64	63	65	63	64	66
6:30 PM	67	68	66	64	64	62	60	58	59	56	58	58	63	62	63	64	64	65	63	63	65

Note: Numbers in each colored cell represent the average travel speed (in mph) at a particular location and time. Red colored cells indicate slow speeds, yellow cells indicate moderate speeds, and green cells indicate speeds approaching, or at, free-flow.

Hartford TMA Arterial System

Figure 14



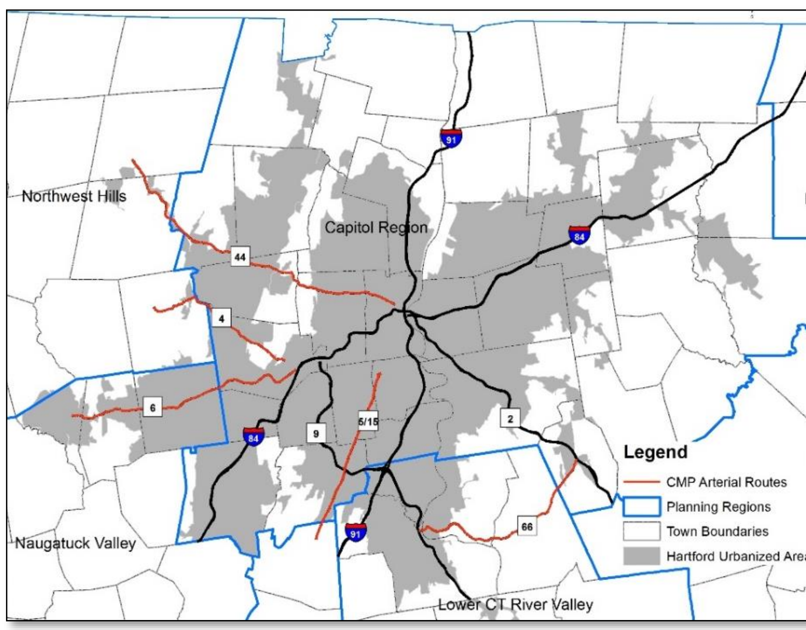
The arterial network serving the Hartford TMA includes about 692 miles of roadway (231 miles of principal arterials and 461 miles of minor arterials). As shown in Figure 14, arterials comprise about 16 percent of the total miles in Hartford TMA's roadway network, but carry about 33 percent of the region's traffic[5]. This is a smaller percent of traffic than the freeway system carries, but still a disproportionately large share of the region's total traffic. Like the freeway system, the arterial system is critical to serving the region's mobility needs.

The NPMRDS currently contains data for just about all of the route miles of the TMA's principal arterials, and a very limited percentage of minor arterial route miles. CRCOG utilized the data to expand its arterial monitoring coverage to include the arterial segments shown in Figure 15. Per Figure 16, the arterials that were monitored represent over 69 miles of the arterial network, which represents about 30 percent of available NPMRDS data for TMA arterials. These segments were selected to favor routes with high regional significance, previously observed (and perceived) congestion, and high commute pattern volumes. Emphasis was also placed on selecting a diversity of routes - including routes that traversed between multiple MPOs.

Arterial Performance Results

To assess arterial performance, we analyzed the same four months of data utilized for freeway monitoring: March, April, September, and October of 2015. These four months 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 (Monday – Thursday) data excluding holidays was analyzed.

Figure 15: Hartford TMA CMP Arterial Routes



<u>Overview of Monitored Corridors</u>

Figure 16 provides the summary of speed, vehicle miles of travel, delay, and Travel Time Index for each arterial corridor that was monitored. Over 69 miles of arterials were included in the monitoring, and a total of 939 hours of delay was identified. The average speed was 31.4 mph, but speeds varied greatly between corridors and even within corridors. The overall travel time index (TTI) was calculated at 1.12 which represents a 12 percent increase in travel time due to delay. A review of the results as a whole revealed unique travel patterns for each corridor. For all five routes combined, there was 523 hours of delay in the PM peak and 416 in the AM peak.

[5] Estimate based on 2015 CTDOT data.

Figure 16: Arterial Congestion Summary

Arterial Summary	Length	Speed			VMT			Delay			TTI		
Routes	(miles)	AM	PM	Both	AM	PM	Both	AM	PM	Both	AM	PM	Both
RT 4	10.3	27.8	27.0	27.4	16,124	15,932	32,056	113	139	252	1.19	1.23	1.21
RT 6	16.1	27.4	26.0	26.7	25,981	30,238	56,220	76	139	215	1.10	1.14	1.12
RT 44	18.2	31.4	33.0	32.2	36,240	37,689	73,929	103	99	202	1.10	1.08	1.09
RT 15	11.2	34.9	34.1	34.5	31,467	34,361	65,828	73	114	187	1.09	1.12	1.10
RT 66	13.5	34.0	36.9	35.5	22,372	25,110	47,482	51	32	83	1.08	1.05	1.07

<u>Corridor-Level Performance.</u>

1. Vehicle Delay

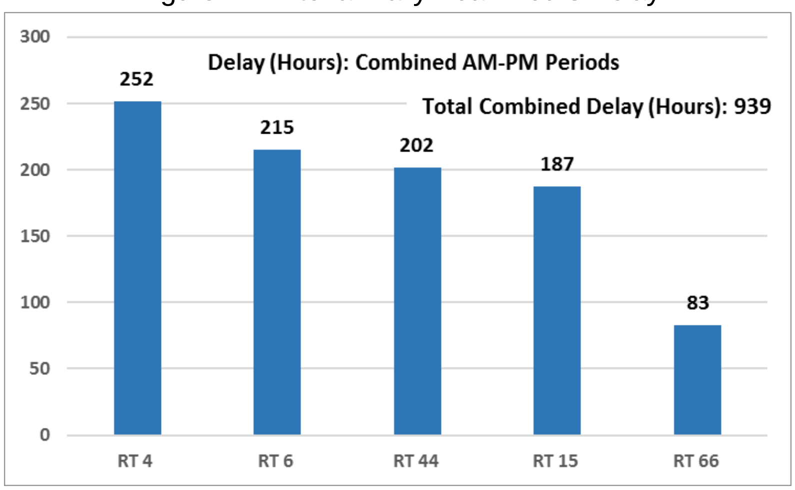
Per Figures 16, 17, and 18, the three corridor segments with the most hours of delay were Route 4, Route 6, and Route 44. All three corridors have some common behaviors and features, as they serve as major retail corridors and major commute routes to Hartford from the western suburbs. Route 44 has various retail activities in the Avon and Canton area. Routes 4 and 6 also provide access to retail and other business activities around major intersections along the corridor.

<u>Route 4.</u> The arterial corridor with the largest total delay accumulated by all vehicles during peak hours is Route 4. Although it is shortest amongst the arterial corridors being monitored, the total delay in the combined morning (7:00 am – 9:00 am) and afternoon (4:00 pm – 6:00 pm) peaks is 252 hours. This delay which is mainly caused by lane merges and complex intersections, which create traffic bottlenecks and delay during the peak commute, especially during evening hours. Most of the congestion in this corridor occurs near the intersection of Route 4 and Route 10.

<u>Route 6.</u> The arterial corridor with the second largest total delay during peak hours is Route 6. Combined delay of 215 hours was calculated as a result of congested travel conditions, retail activities, and the large volume of traffic throughout the corridor.

As seen in Figure 18, the evening peak period outbound commute is more delayed than the morning inbound commute. This is likely due to the larger 'background' or non-commute traffic that tends to be more prevalent in the afternoon. Since Route 6 is also a retail destination, there is a heavy volume of retail traffic in the afternoon.

Figure 17: Arterial Daily Peak Hours Delay



<u>Route 44.</u> This arterial corridor is the longest amongst monitored arterials. The total delay in the combined morning (7:00 am – 9:00 am) and afternoon (4:00 pm – 6:00 pm) peaks is 202 hours. From 2008 to 2010, major widening and realignment of Route 44 from Route 10 to the West Hartford town line has been undertaken to address safety concerns in the Avon Mountain area.

2. Average Speed

Average speed along a corridor shows 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 at a particular location. <u>In fact, geometric characteristics probably affect speed as much as congestion does</u>. For example, Route 4 at the intersection of Route 10 in Farmington has a very wide and complex geometry which causes an increased amount of delays at this particular location.

Figures 19 and 20 show the average speed along the arterial corridors. Overall speeds vary from 26.7 mph for Route 6 to 36.9 mph for Route 66. Slower speeds are also found on Route 4 (about 27 mph), while the speeds on the other routes are all over 30 mph. Speeds in the PM peak are generally lower than in the AM peak for Route 4 and Route 6. Most of the slow speeds along all corridors are observed at major intersections and areas where retail activities are located.

Figures 21 and 22 show the range of speeds at different points along each arterial, giving a visual representation of the problematic areas.

Figure 18: Arterial AM & PM Peak Hours Delay

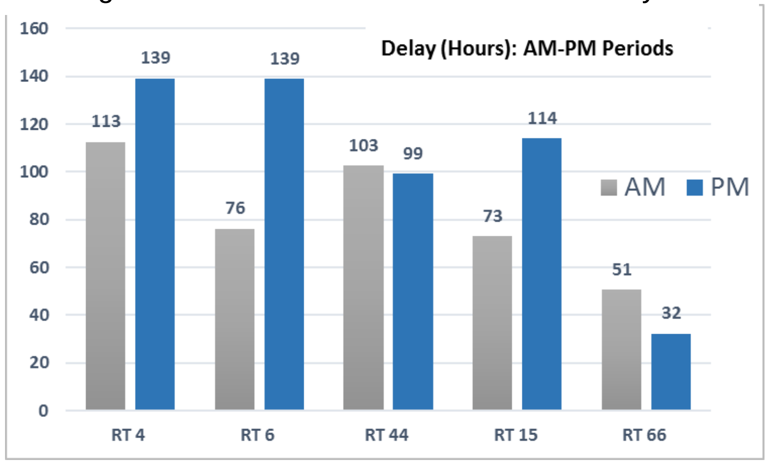


Figure 19: Arterial Daily Peak Hours Average Speed

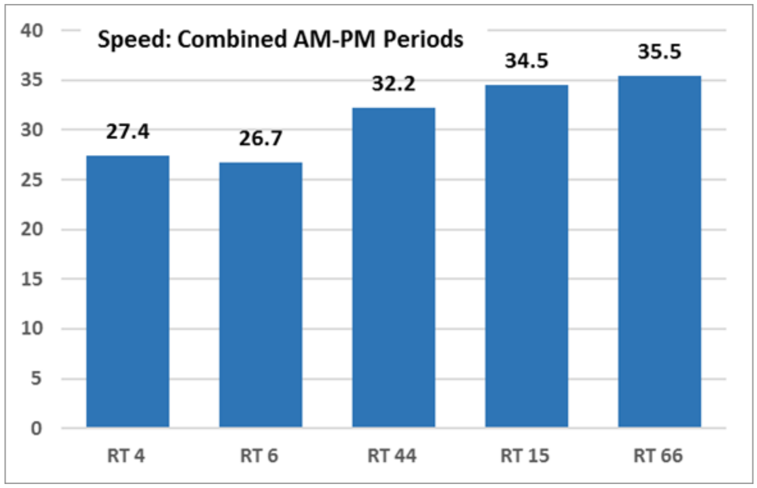


Figure 20: Arterial AM & PM Peak Hours Average Speed

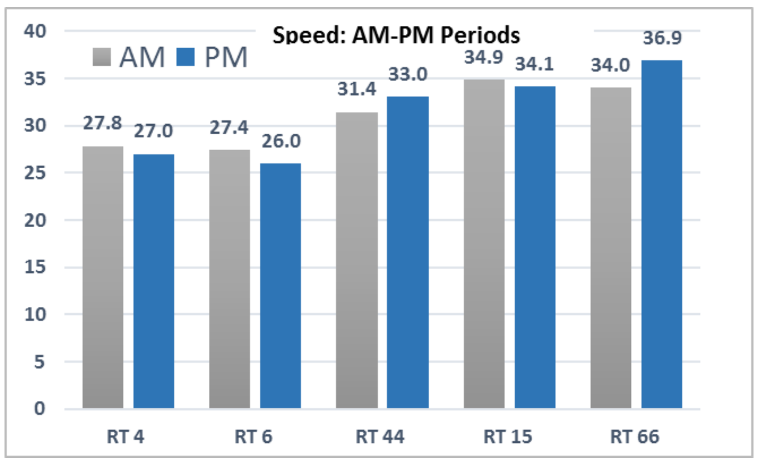


Figure 21: Arterial Morning Peak Hour Average Travel Speed

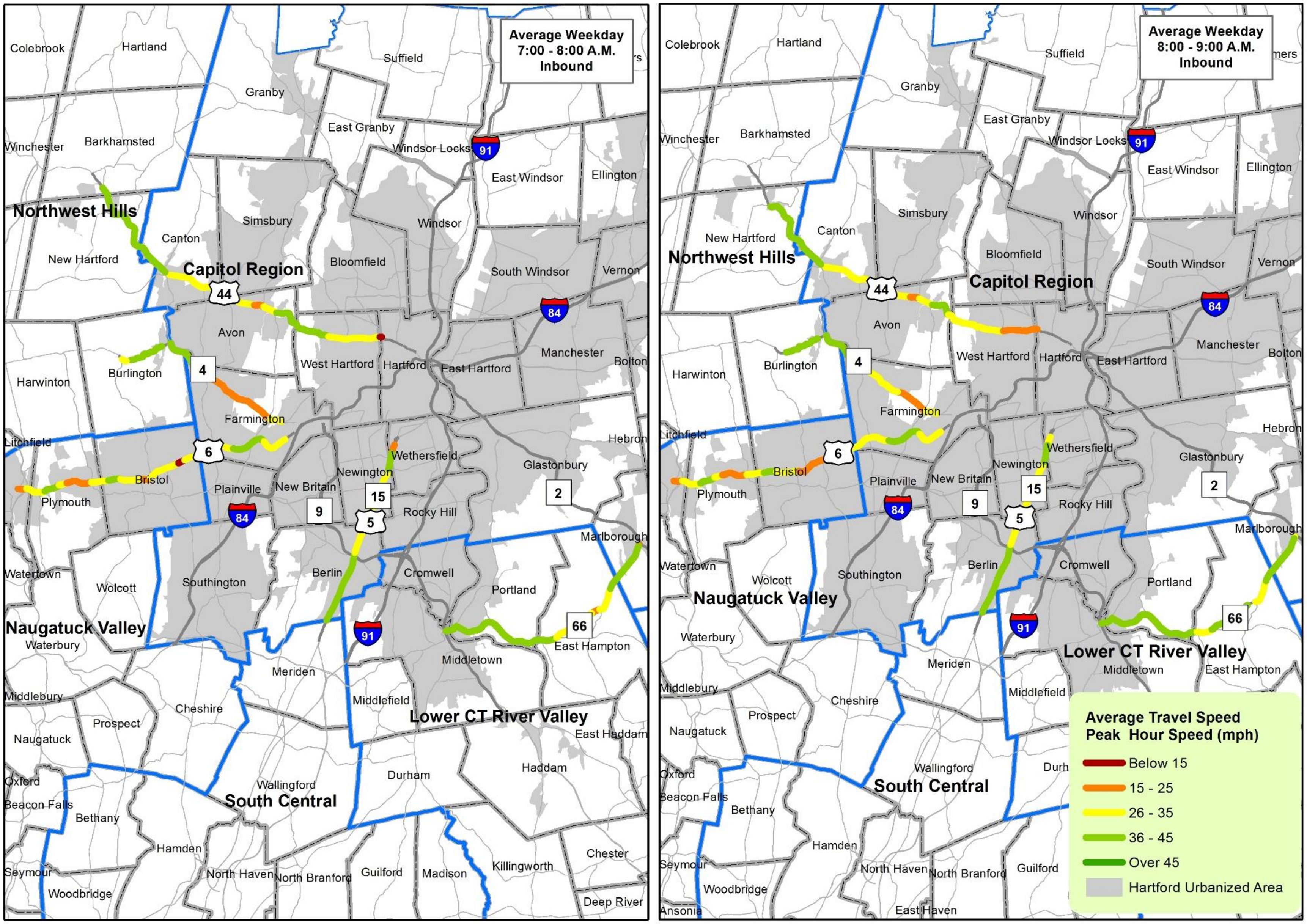
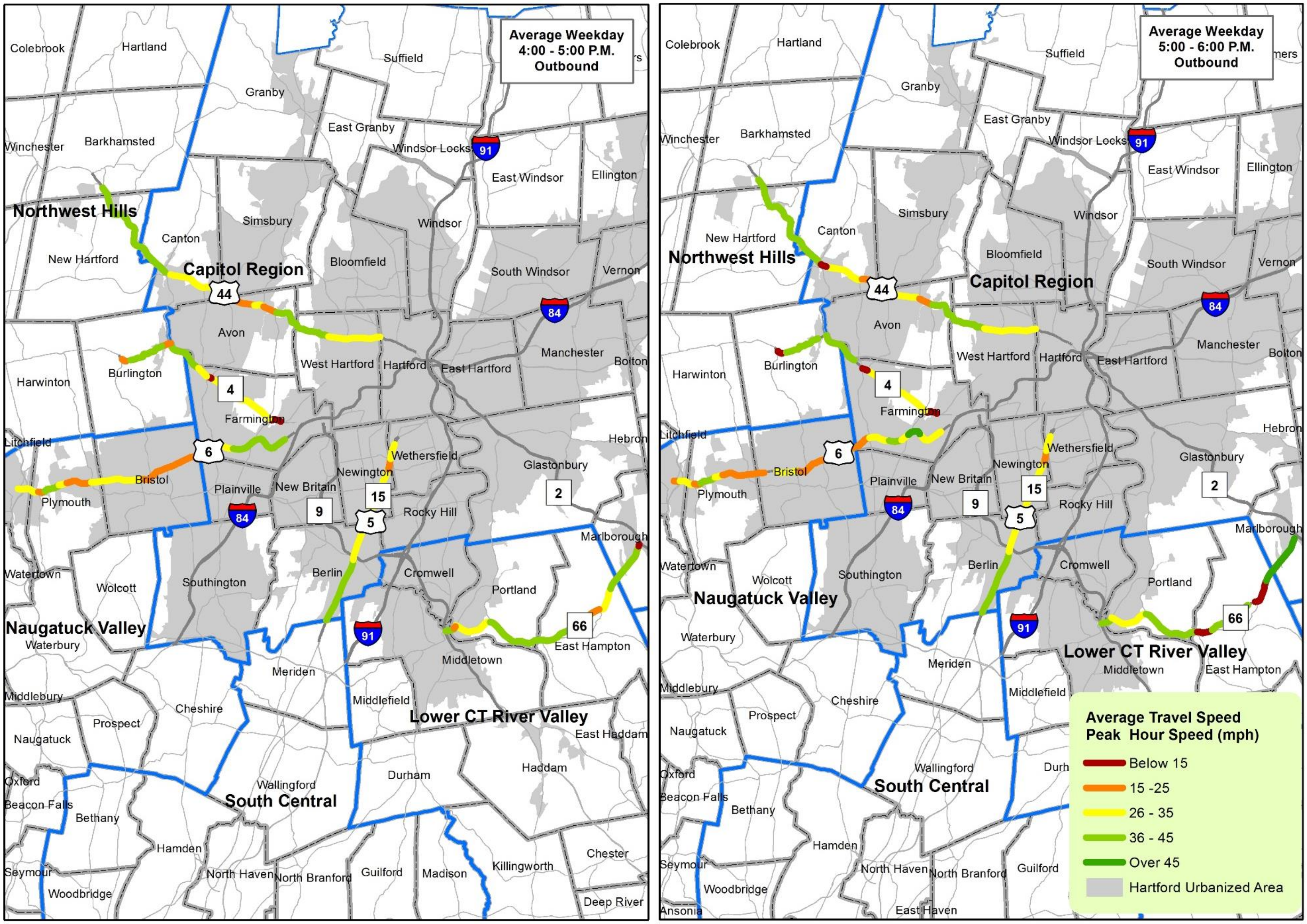


Figure 22: Arterial Afternoon Peak Hour Average Travel Speed



Along arterials, operations are typically controlled by the signalized and unsignalized intersections located along their routes. For signalized locations, high traffic volumes from any (or any combination of) intersection approaches that strain intersection capacity will impact the operations of the intersection as a whole, including the approaches where volumes may be lighter. As a result, the time and locations of slowdowns on arterials are similar for inbound and outbound traffic regardless of the direction of peak hour commuter flow. This similarity between arterial inbound and outbound traffic operations in each peak is evident in the figures. Also evident is the coincidental location of peak hour slowdowns with stretches of arterials that include frequently spaced intersections and access points. These are most prevalent along commercial/retail areas where there are many signalized and unsignalized locations, including:

- Route 4: throughout Farmington, but especially at Farmington Center (near Route 10) and in Unionville Village (near Route 177)
- Route 5/15: between Nott Street in Wethersfield and the Route 9 interchange in Berlin
- Route 6: through eastern Plymouth and throughout Bristol
- Route 44: in West Hartford between Bishops corner and Hartford in the morning peak, and throughout Avon and Canton in the afternoon peak
- Route 66: mainly through Portland and East Hampton Centers

3. *Travel Time Index*

As shown in Figures 23 and 24, the three corridors with the highest Travel Time Indices (TTI) are Route 4, Route 6, and Route 15 (Berlin Turnpike)

Route 4. In addition to experiencing the most accumulated delay, Route 4 has both the highest TTI at 1.21. Construction along portions of Route 4 could have impacted data to be a contributing factor for this TTI.

Route 6. At 1.12, Route 6 has the second highest TTI of the arterial corridors. Its afternoon peak of 1.14 exceeds its morning peak of 1.10.

Route 15. Route 15 had the third highest overall TTI with a rating of 1.10.

Figure 23: Arterial Combined Peak Hours Travel Time Index (TTI)

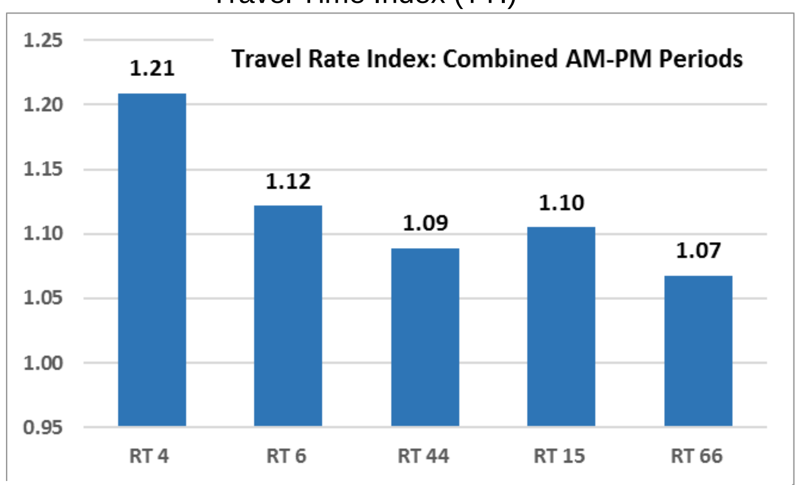
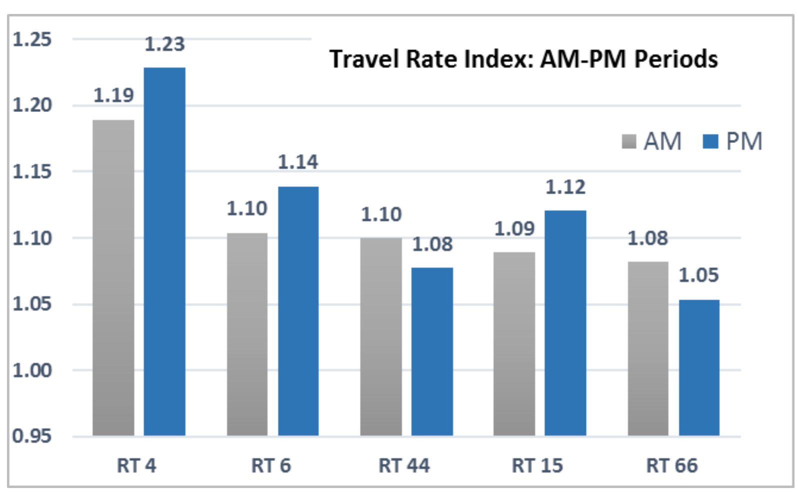


Figure 24: Arterial AM & PM Peak Hours Travel Time Index



Summary and Next Steps

This report is a result of ongoing CMP efforts and aims to build on the past Hartford TMA CMP efforts undertaken CRCOG, MidState, and CCRPA. This report represents an update to performance monitoring and assessment efforts for the entire Hartford Metropolitan Area transportation system. It presents the results of the system assessment utilizing newly available NPMRDS data, identifies congested locations and causes for congestion, and represents a foundation for future CMP efforts between the four planning agencies that encompass the Hartford TMA. Each of these planning agency's borders were recently redefined as the result of regional consolidation efforts, with CRCOG representing the only region that was previously responsible for Hartford TMA reporting (CCRPA and MidState regions were previously part of the Hartford TMA, but have been disbanded and absorbed into adjacent regions). It is anticipated that upon full review of this report's findings, subsequent coordination between the four newly redefined regions will result in the outlining the next steps in ongoing CMP efforts for the Hartford TMA. These steps as currently envisioned will likely focus on establishing further strategies to reduce congestion and evaluating the effectiveness of these strategies.

The CMP is an ongoing process, and thus additional revisions to this system assessment will likely also be contemplated as NPMRDS data and federal system performance measures become more refined. Additionally, CRCOG is in the midst of multiple comprehensive transit initiatives which will affect CMP reporting, and thus revisions to prior CMP transit reporting are awaiting the outcomes of these efforts.