2016
CONGESTION MANAGEMENT PROCESS (CMP) TECHNICAL REPORT

FINAL DRAFT

September 8, 2016

National Capital Region Transportation Planning Board
Metropolitan Washington Council of Governments

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AGENCY:

The Metropolitan Washington Council of Governments (COG) is the regional organization of the Washington area's major local governments and their governing officials. COG works toward solutions to such regional problems as growth, transportation, the environment, economic development, and public safety. The National Capital Region Transportation Planning Board (TPB) conducts the continuing, comprehensive transportation planning process for the National Capital Region under the authority of the Federal-Aid Highway Act of 1962, as amended, in cooperation with the states and local governments.

ABSTRACT:

This report provides technical details and documents the Congestion Management Process in the National Capital Region. It contains updated congestion information and congestion management strategies on the region's transportation systems, as well as the process integrating the Congestion Management Process into the region's Financially Constrained Long-Range Transportation Plan.

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ABBREVIATIONS AND ACRONYMS

AADT	Annual Average Daily Traffic
ACS	American Communities Survey
ART	Arlington Transit
ATIS	Advanced Traveler Information Systems
ATM	Active Traffic Management
ATRI	American Transportation Research Institute
AVL	Automatic Vehicle Location
BRAC	Base Closure and Realignment Commission
BWI	Baltimore/Washington International Thurgood Marshall Airport
CAFE	Corporate Average Fuel Economy
CATT	Center For Advanced Transportation Technology
CCTV	Closed-Circuit Television
CHART	Coordinated Highway Action Response Team
CLRP	Constrained Long-Range Plan
CLV	Critical Lane Volume
CMP	Congestion Management Process
CMS	Congestion Management System
CNG	Compressed Natural Gas
CO	Carbon Monoxide
COC	Commuter Operations Center
CUE	City-University-Energysaver
DASH	Driving Alexandrians Safely Home
DCA	Ronald Reagan Washington National Airport
DMS	Dynamic Message Signs
DOT	Department of Transportation
EPC	Emergency Planning Council
FAF	Freight Analysis Framework
FHWA	Federal Highway Administration
FSCPPE	Federal State Cooperative Program for Population Estimates
GHG	Greenhouse Gas Emissions
MPSTOC	McConnell Public Safety and Transportation Operations Center
MTA	Maryland Transit Administration
MWAA	Metropolitan Washington Airports Authority
MWCOG	Metropolitan Washington Council of Governments
MWRITSA	Metropolitan Washington Regional Intelligent Transportation Systems Architecture
NCHRP	National Cooperative Highway Research Program
NCR	National Capital Region
NEPA	National Environmental Policy Act
NGA	National Geospatial Agency
NHS	National Highway System
NOx	Nitrogen Oxides
NPMRDS	National Performance Management Research Data Set
NPRM	Notice of Proposed Rulemaking
NTOC	National Transportation Operations Coalition
NVRC	Northern Virginia Regional Commission
NVTC	Northern Virginia Transportation Commission
PBPP	Performance-Based Planning and Programming
PM	Particulate Matter
PRTC	Potomac and Rappahannock Transportation Commission
PSTOC	Public Safety Transportation Operations Center
PTI	Planning Time Index
RFC	Region Forward Coalition
RTPP	Regional Transportation Priorities Plan
SAFETEA-LU	Safe Accountable Flexible Efficient Transportation Equity Act - A Legacy for the Users
SIP	State Implementation Plans
SOC	State of the Commute Survey
SOV	Single Occupancy Vehicle
SRTS	Safe Routes to Schools
TARS	Travelers Advisory Radio System
TAZ	Traffic Analysis Zone

GPS	Geographic Positioning System
GRH	Guaranteed Ride Home
HOT	High Occupancy/Toll
HOV	High Occupancy Vehicle
HPMS	Highway Performance Monitoring System
IAD	Washington Dulles International Airport
ICC	Inter-County Connector
ICM	Integrated Corridor Management
IMR	Incident Management and Response
IS	Interstate System
ITS	Intelligent Transportation Systems
IVR	Interactive Voice Response
LATR	Local Area Transportation Review
LAUS	Local Area Unemployment Statistics
LOS	Level of Service
MAP-21	Moving Ahead for Progress in the 21st Century Act
MARC	Maryland Area Rail Commuter
MAROps	Mid-Atlantic Rail Operations
MATOC	Metropolitan Area Transportation Operations Coordination
MATOps	Mid-Atlantic Truck Operations
MDSHA	Maryland State Highway Administration
MNCPPC	Maryland – National Capital Park and Planning Commission
MOITS	Management, Operations, and Intelligent Transportation Systems
MPO	Metropolitan Planning Organization
TCSP	Transportation, Community and System Preservation
TDM	Transportation Demand Management
TE	Transportation Enhancements
TERM	Transportation Emission Reduction Measure
TIGER	Transportation Investment Generating Economic Recovery
TIP	Transportation Improvement Program
TLC	Transportation/Land Use Connections
TMA	Transportation Management Area
TMC	Traffic Management Center; Traffic Message Channel
TOC	Transportation Operations Center
TOD	Transit-Oriented Development
TPB	Transportation Planning Board
TTI	Travel Time Index
TTID	Transportation Technology Innovation and Demonstration
VDRPT	Virginia Department of Rail and Public Transportation
VHD	Vehicle Hours of Delay
VHT	Vehicle Hours of Travel
VMT	Vehicle Miles of Travel
VOC	Volatile Organic Compound
VPL	Variably Priced Lane
VPP	Vehicle Probe Project
VRE	Virginia Railway Express
WMATA	Washington Metropolitan Area Transit Authority

EXECUTIVE SUMMARY

Background

A Congestion Management Process (CMP) has been a requirement since the 2005 Safe Accountable Flexible Efficient Transportation Equity Act - A Legacy for the Users (SAFETEA-LU) federal legislation. The current Fixing America's Surface Transportation (FAST) Act and its supporting federal regulations fully maintain the requirements of the CMP with additional strategies and options. These legislations and regulations are a basis for the CMP component that is wholly incorporated in the region's Constrained Long-Range Plan (CLRP) for transportation. The CMP component of the CLRP constitutes the region's official CMP, and serve to satisfy the federal requirement of having a regional CMP.

This CMP Technical Report serves as a background document to the official CLRP/CMP, providing detailed information on data, strategies, and regional programs involved in congestion management. This 2016 CMP Technical Report is an updated version of the previously published CMP Technical Reports (2014, 2012, 2010 and 2008, respectively).

Components of the CMP

The National Capital Region's Congestion Management Process has four components as described in the CLRP:

- Monitor and evaluate transportation system performance
- Define and analyze strategies
- Implement strategies and assess
- Compile project-specific congestion management information

This report documents and provides technical details of the four components of the CMP. It compiles information from a wide range of metropolitan transportation planning activities, as well as providing some additional CMP specific analyses, particularly travel time reliability and non-recurring congestion analyses.

Congestion on Highways

REGIONAL CONGESTION TRENDS, 2010-2015

Based on the results revealed by the I-95 Corridor Coalition Vehicle Probe Project (VPP)/INRIX traffic monitoring[1], peak period congestion in the Washington region decreased between 2010 and 2012, but more recently has increased moderately.

The congestion intensity, measured by the Travel Time Index (TTI)[2] from a traveler's perspective, decreased 6.7% between 2010 and 2012 and increased by 3.3% from 2012 to 2015 (Figure 1).

[1] I-95 Corridor Coalition Vehicle Probe Project, http://i95coalition.org/projects/vehicle-probe-project/
[2] Travel Time Index (TTI) is an indicator of the intensity of congestion, calculated as the ratio of actual experienced travel time to free flow travel time. A travel time index of 1.00 implies free flow travel without any delays, while a travel time index of 1.30 means one has to spend 30% more time to finish a trip compared to free flow travel.

The spatial extent of congestion, measured by Percent of Congested Miles [3] from a system perspective, varied similarly to the TTI (Figure 2). There were 21% of all monitored roadways congested during peak periods in 2010. This number decreased to 11% in 2012, the lowest in the last six years, and then increased to 18% in 2014 but decreased slightly to 17% in 2015.

Figure 1: Annual Average Travel Time Index by Highway Category: Total AM and PM Peaks

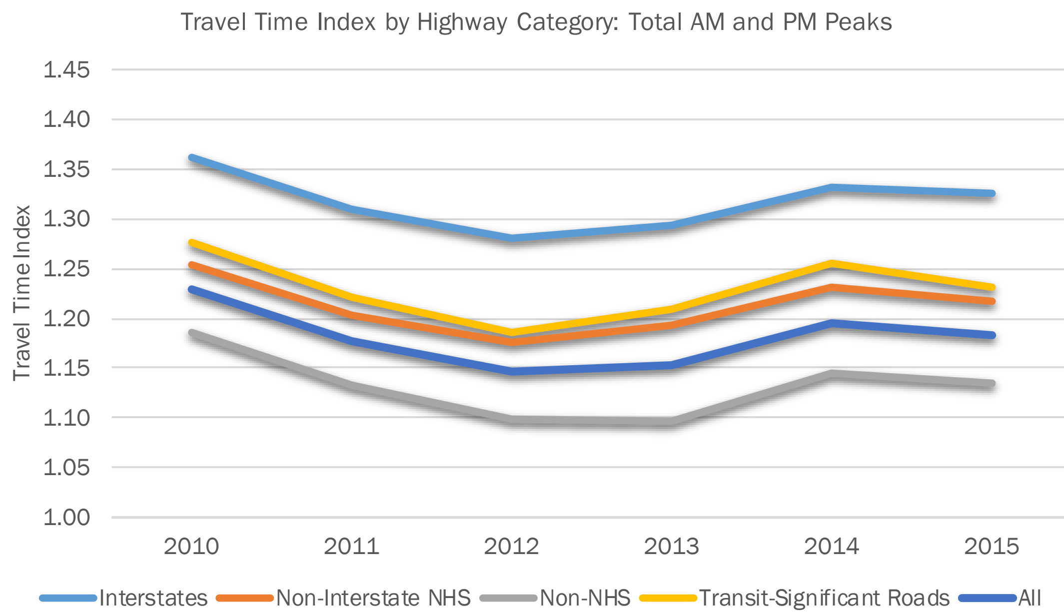
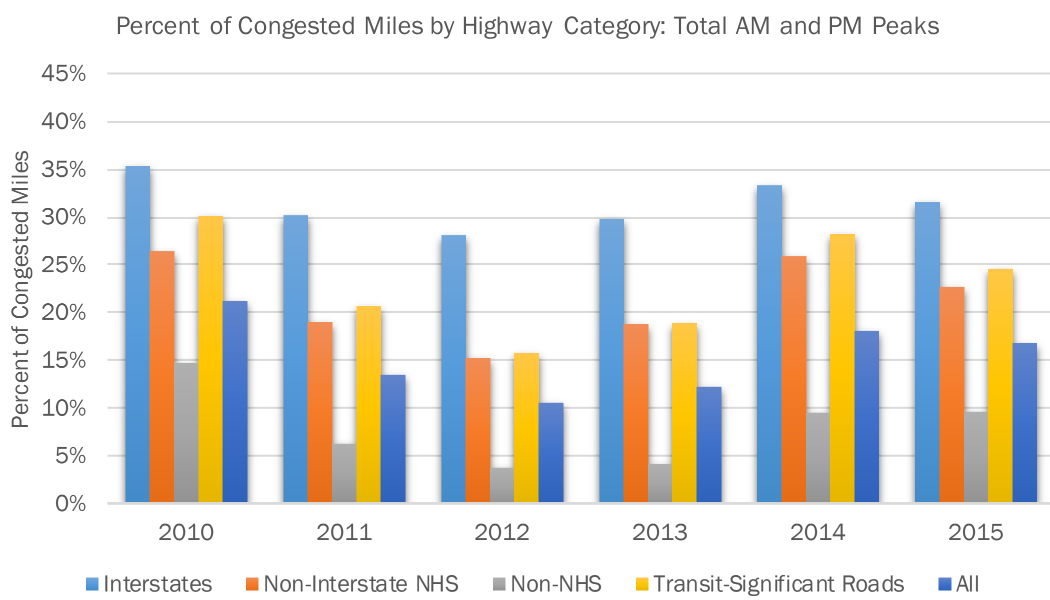


Figure 2: Annual Average Percent of Congested Miles by Highway Category: Total AM and PM Peaks



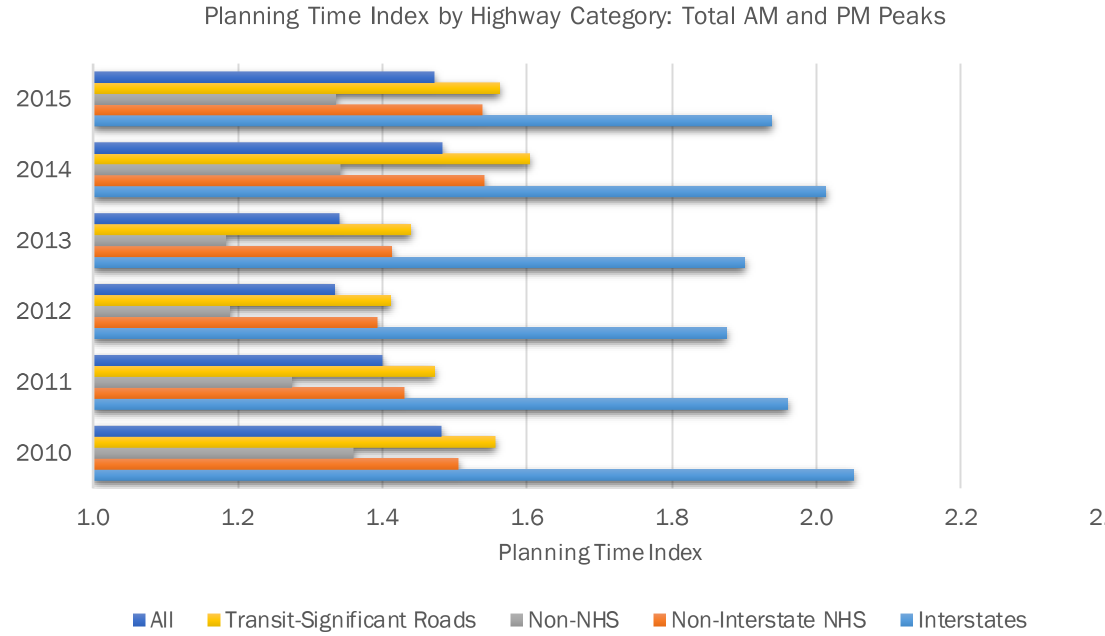
[3] Percent of Congested (Directional) Miles is a system-wide measure that captures the spatial extent of congestion. Congestion is defined if actual travel time is 30% longer than the free-flow travel time[3], i.e., Travel Time Index > 1.3, based on recommendations made by the National Transportation Operations Coalition in 2005.

Regional Travel Time Reliability Trends, 2010-2015

Travelers in the Washington region typically will need to budget about two times of the free flow travel time during peak periods to ensure on-time arrivals. These numbers are based on all directions of travel, therefore for those who traveling in the peak direction would need to even budget more.

Similar to the trends observed in traffic congestion, travel time reliability improved 9.5% between 2010 and 2012 but worsened 9.8 % from 2012 to 2015 (Figure 3). The reliability levels in 2014 and 2015 were very close to 2010.

Figure 3: Annual Average Planning Time Index by Highway Category: Total AM and PM Peaks



Congestion Monthly Variation

Congestion varies from month to month within a year, as shown for 2015 in Figure 4. Monthly variations of congestion were most noticeable on the Interstate System, followed by the Transit-Significant Roads, the Non-Interstate NHS, and the Non-NHS.

The region overall had increasing congestion from January to May, then decreasing congestion through August. September had the highest level of congestion, after that, congestion kept decreasing for the rest of year. Four of the five investigated highway categories followed this trend. The only exception was the Interstates, on which congestion kept increasing from August to November, reaching the highest level in a year.

Congestion Day of Week Variation

Congestion also varies within a week (Figure 5). The middle weekdays – Tuesday, Wednesday and Thursday – were the most congested days of a week. During these three weekdays, the AM Peak had almost identical congestion while the most congested PM Peak occurred on Thursday, followed by Wednesday and Tuesday.

Monday and Friday had unique traffic patterns. Monday morning's traffic was lower than that of the middle weekdays but higher than Friday; Monday afternoon had the least congestion among weekdays. Friday morning had the least congestion in all weekdays; Friday afternoon's congestion was almost as bad as the normal weekdays, but it came about one hour earlier without ending earlier – expanded congested time period.

Weekend days had the lowest traffic in a week and Sunday was even lower than Saturday. During these two days, mid-day traffic (12:00 – 3:00 pm) was the highest.

Figure 4: 2015 Monthly Variation of Congestion: Total AM and PM Peaks

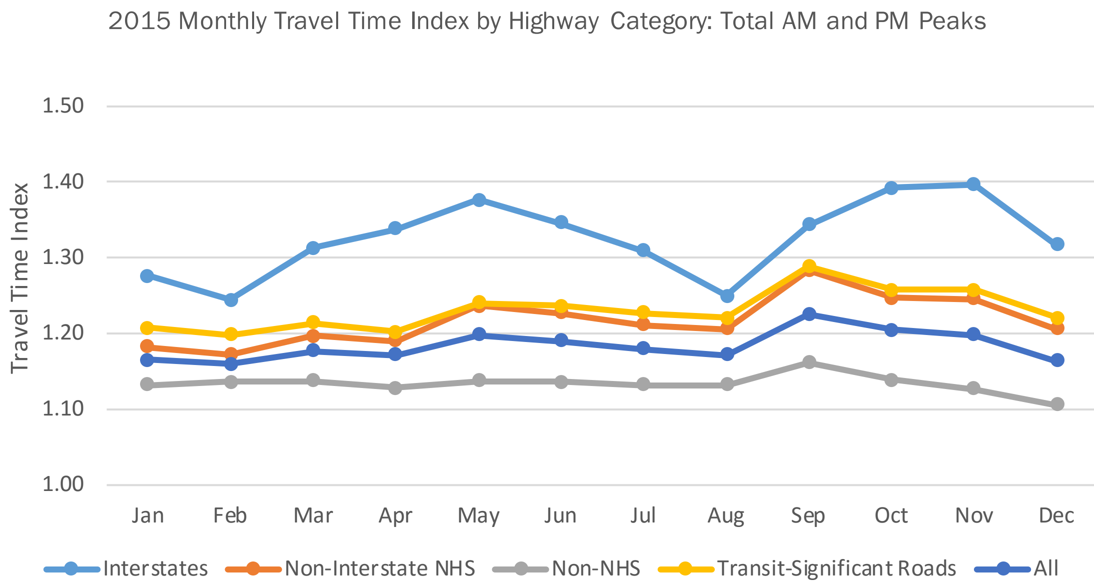
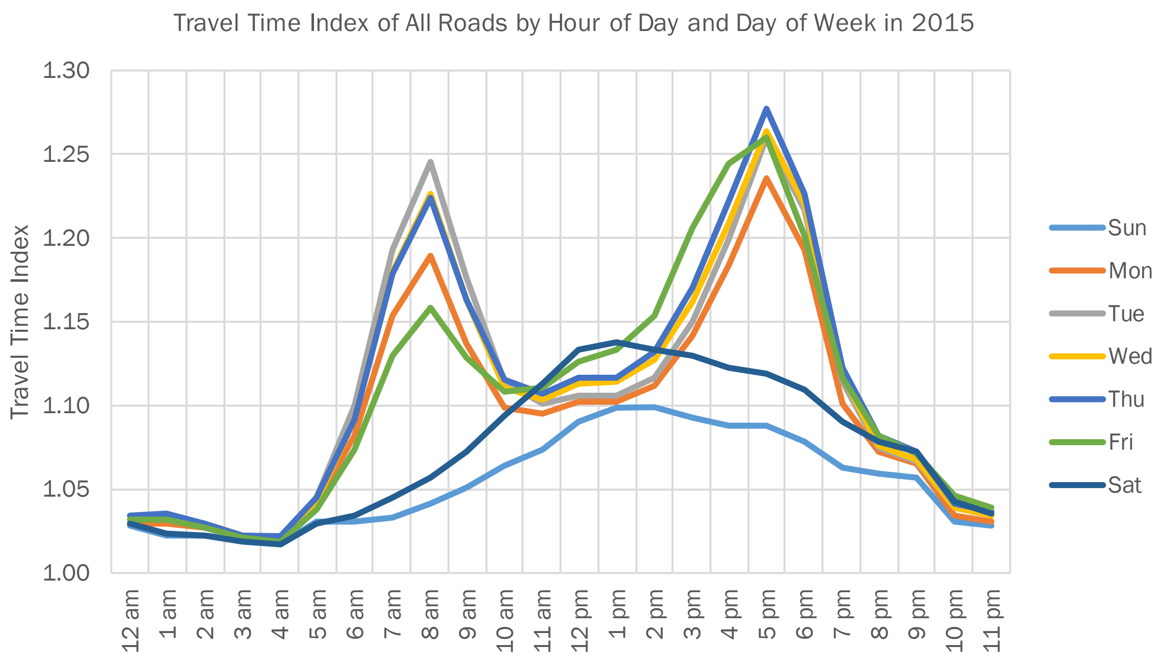


Figure 5: Day of Week Variation of Congestion in 2015



TOP BOTTLENECKS

This report provides two lists of top bottlenecks in the Washington region for 2015: one is based on all time of the year – 24/7/365 (Table 1 and Figure 6), and the other is for peak periods only, i.e., non-holiday weekday 6:00-9:00 am and 4:00-7:00 pm (Table 2 and Figure 7). The bottlenecks are ranked by either the combination of Travel Time Index (TTI) and length or the multiplication of TTI, length and Annual Average Daily Traffic volume (AADT). The former is informative to individual travelers and the latter could be useful from a system-wide perspective.

Table 1: 2015 Top Bottlenecks – All Time

Location	State	Ave. TTI	Length (miles)	TTI*Miles	Rank by TTI*Miles	AADT	AADT*TTI* Miles	Rank by AADT*TTI *Miles
I-495 IL between VA-267 and GW Pkwy	VA	1.75	3.40	5.94	1	94,500	561,509	1
I-95 SB at VA-123	VA	1.88	1.61	3.01	2	104,000	313,445	2
New York Ave. between N. Capitol St. and I-395	DC	1.65	1.61	2.65	3	25,400	67,423	8
DC-295 SB at Benning Rd.	DC	1.71	1.55	2.64	4	60,632	160,142	4
I-495 OL between MD-193 and MD-650	MD	1.52	1.71	2.61	5	104,670	273,222	3
I-270 SPUR SB between Democracy Blvd. and I-495	MD	1.70	1.31	2.23	6	65,406	145,651	5
Constitution Ave WB between 12th St. and 17th St.	DC	1.74	0.91	1.59	7	16,024	25,448	11
DC-295 NB at Pennsylvania Ave	DC	1.68	0.75	1.26	8	49,349	62,225	9
I-395 NB between US-1 and GW Pkwy	VA	1.59	0.74	1.17	9	91,000	106,545	6
I-66 WB at Vaden Dr./Exit 62	VA	1.52	0.64	0.98	10	79,500	77,815	7
I-66 EB at VA-267	VA	1.66	0.25	0.42	14	65,500	27,247	10

Table 2: 2015 Top Bottlenecks – Peak Periods

Location	State	Ave. TTI	Length (miles)	TTI*Miles	Rank by TTI*Miles	AADT	AADT*TTI* Miles	Rank by AADT*TTI *Miles
I-495 IL between VA-267 and I-270 Spur	VA, MD	2.69	8.36	22.47	1	110,376	2,480,129	1
I-495 OL between I-95 and MD-193	MD	2.57	4.35	11.17	2	104,670	1,168,848	2
I-66 EB at VA-267	VA	2.47	2.83	6.99	3	65,500	458,043	6
I-270 SPUR SB	MD	3.21	2.04	6.56	4	65,406	429,242	8
DC-295 SB at Benning Rd.	DC	2.59	2.28	5.89	5	59,376	349,827	10
I-95 SB at VA-123	VA	2.34	2.46	5.75	6	104,000	597,810	4
VA-28 SB between US-50 and I-66	VA	2.32	2.30	5.33	7	50,000	266,469	12
US-15 NB between VA-7 and N. King St.	VA	2.56	2.02	5.19	8	8,800	45,656	26
I-495 OL between I-270 and MD-190	MD	2.26	2.22	5.01	9	122,010	611,335	3
I-495 IL between MD-355 and MD-185	MD	2.23	1.96	4.38	10	110,876	485,635	5
I-66 WB at Vaden Dr./Exit 62	VA	2.17	1.87	4.05	11	79,500	322,083	11
I-495 IL between I-95 and US-1	MD	2.32	1.68	3.91	12	111,740	437,336	7
I-495 OL at Telegraph Rd.	VA	2.33	1.48	3.43	13	76,500	262,657	13
I-495 OL at MD-202/Landover Rd.	MD	2.09	1.54	3.22	14	113,390	364,755	9

Figure 6: 2015 Top Bottlenecks – All Time

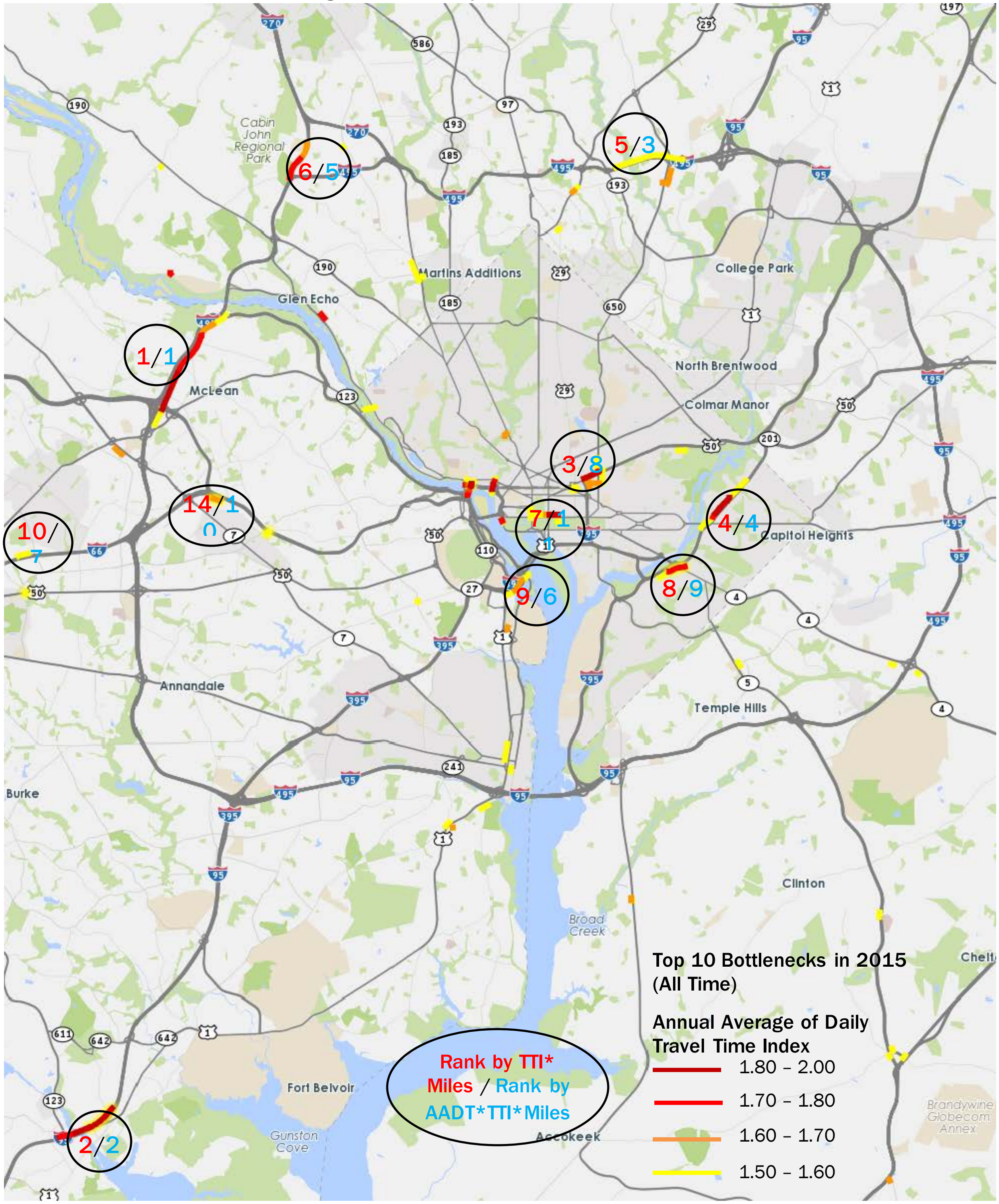
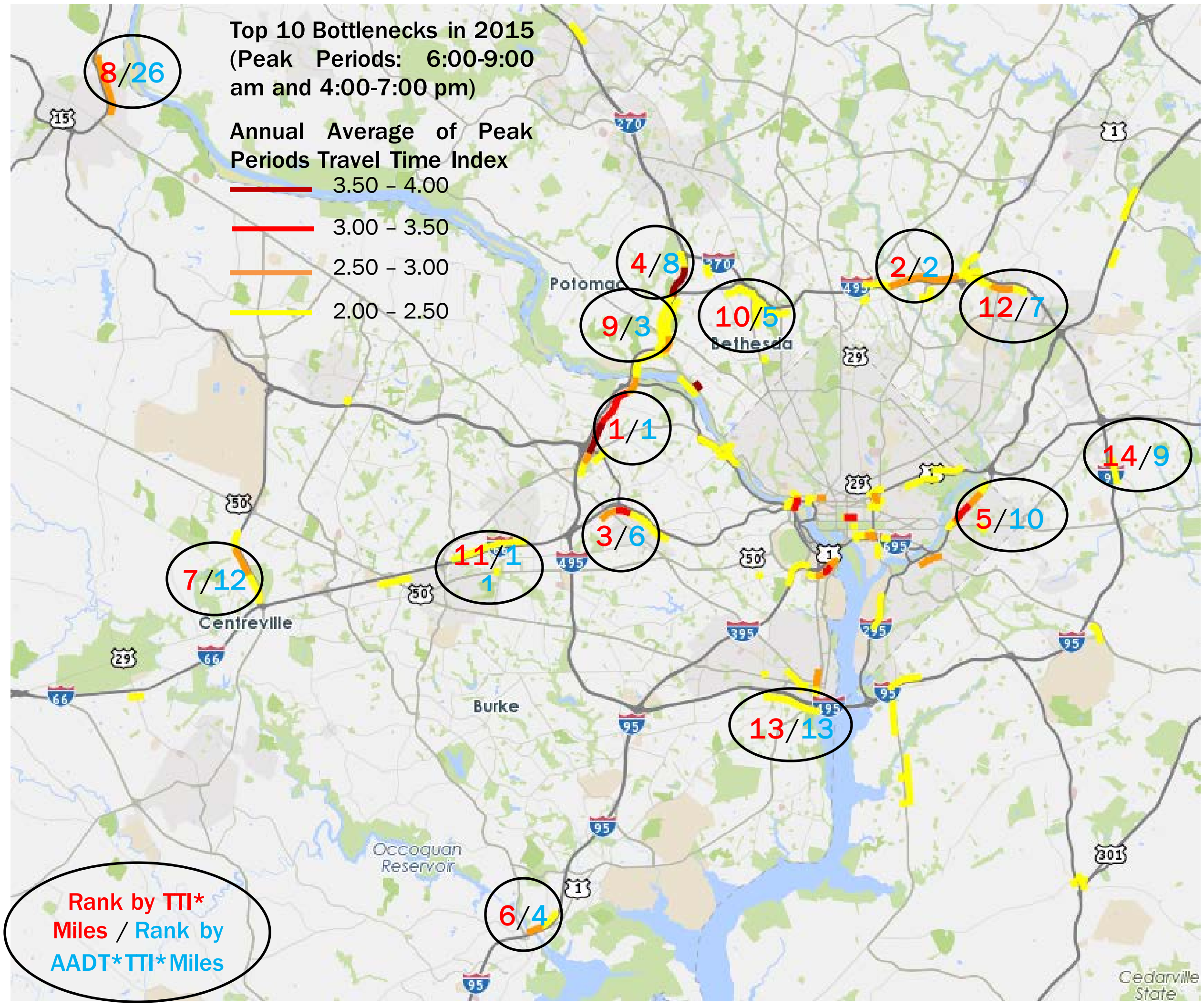


Figure 7: 2015 Top Bottlenecks – Peak Periods



MAJOR FREEWAY COMMUTE ROUTES

In addition to the regional summaries as presented by the above performance measures, route- or corridor-specific analysis has also been carried out in this report. A total of 18 major freeway commute routes are defined between major interchanges and/or major points of interest for each peak period. Travel times along the 18 major commute routes in both directions were plotted by the "Performance Charts" tool of the VPP Suite for every Tuesday, Wednesday and Thursday in 2010 and 2013-2015, as described in Chapter 2 and Appendix C.

CONGESTION ON ARTERIALS

The TPB's arterial monitoring program had been carried out by staff using global positioning system (GPS)-equipped floating vehicles. The last regional survey was conducted in FY[4] 2011, which was summarized in the 2012 CMP Technical Report. In view of emerging data sources such as the

[4] A TPB Fiscal Year (FY) starts on July 1 and ends on June 30 of the next year, e.g., FY 2010 is from 7/1/2009 – 6/30/2010.

VPP/INRIX data, NPMRDS[5] and Bluetooth data, staff has started applying such data in arterial traffic monitoring. Travel Time Index and Planning Time Index on all monitored roads including arterials are provided in great detail in Appendices A and B.

TRAFFIC SIGNAL TIMING

Delays occurred at signalized intersections accounted for a significant portion of overall arterial and urban street delays. Improving traffic signal timing has been identified as a CLRP priority area.

The TPB has conducted three surveys of the status of signal optimization in 2005[6], 2009[7], and 2013[8]. The 2013 survey found that of the total 5,500 signalized intersections in the region, 76 percent were retimed/optimized, 22 percent not retimed/optimized, and no report received for 2 percent. This was a similar but slightly reduced level of optimization compared to the last such survey in 2009, in which 80 percent signals were retimed/optimized.

Since late 2011, the TPB's Traffic Signal Subcommittee has conducted six regional surveys on traffic signals power back-up systems[9]. The last survey was conducted by June 30, 2015 and found that about 27% of the region's 5,500+ signals are already equipped with battery-based power back-up systems, and 58% are equipped with generator-ready back-up systems (most battery-based systems also have generator-ready features). These power back-up systems can improve the resiliency of the transportation network, and are expected to be further enhanced in the future with projects funded by Urban Areas Security Initiative (UASI) grants.

Congestion on Transit and Other Systems

TRANSIT

The National Capital Region possesses a multimodal and diverse transit system, including Metrorail, commuter rail and a variety of bus operations. Congestion on the transit system is always one of the concerns of the CMP.

Congestion on the region's roadway network often has an impact on transit systems, such as rail and bus. The identified congested locations, especially those on the Washington Metropolitan Area Transit Authority's (WMATA) Priority Corridor Network and the Transit-Significant Roads as identified by the TPB's Regional Public Transportation Subcommittee (further discussed in chapter 2.3.1.1) are usually also bottlenecks for bus transit. Relieving roadway congestion will directly have a positive impact on bus operations, such as reducing travelers' delay, reducing bus operations cost, improving bus reliability and increasing ridership.

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[5] National Performance Management Research Data Set (NPMRDS), a national data set procured by FHWA from HERE, LLC. http://www.ops.fhwa.dot.gov/freight/freight_analysis/perform_meas/vpds/npmrdsfaqs.htm

[6] Andrew Meese, Briefing on the Implementation of Traffic Signal Optimization in the Region, a memorandum to the TPB Board Meeting on November 16, 2005. http://www.mwcog.org/uploads/committee-documents/tVtXWlY20051110144208.pdf

[7] Edward Jones and Andrew Meese, Status Report on Traffic Signal Optimization in the Washington Region, a memorandum to the TPB Board Meeting on March 18, 2009. http://www.mwcog.org/uploads/committee-documents/bV5cXFhc20090312161527.pdf

[8] Ling Li and Andrew Meese, Briefing on Traffic Signal Timing/Optimization in the Washington Region, a presentation to the TPB Board Meeting on February 19, 2014. http://www.mwcog.org/uploads/committee-documents/al1ZXFpb20140212133426.pdf

[9] Marco Trigueros, Update on COG Incident Management and Response (IMR) Action Plan Recommendations: Back-Up Power for Traffic Signals, a presentation to the TPB's Traffic Signal Subcommittee on December 8, 2015. http://www.mwcog.org/uploads/committee-documents/k1xeX1xa20151208095114.pdf

Congestion can also be an issue within transit. If the demand for buses, rail and train is high and the capacity cannot keep up with that demand, then transit becomes overcrowded. Metrorail crowdedness are often observed during rush hours along certain stations, such as the maximum load stations recorded in the WMATA's Vital Sign Reports[10], e.g., Orange Line Court House station and Red Line Gallery Place station. Congestion also exists within certain transit stations, especially multimodal transit centers, e.g. Union Station. Station congestion is a congestion of different nature, mostly due to limitations in design and circulation as well as ridership growth. Momentum, Metro's strategic plan for 2013-2025[11] found that there are crowded conditions at peak periods today; without rail fleet expansion, most rail lines will be even more congested by 2025.

Cordon Counts

The cordon count program originated from the desire to assess the impact of the construction of the region's Metrorail system stating in the late 1960's. Thus, a cordon line around the Central Business District (the "core") was determined by the inbound point at which there were more destinations (alighting from transit buses) than origins (loadings onto transit buses). The most recent cordon count study is the 2013 Central Employment Core Cordon Count of Vehicular and Passenger Volumes[12]. Data were only collected from 5:00 A.M. to 10:00 A.M. The study found:

- Total inbound travel decreased in the A.M. peak period from about 463,000 person trips in 2009 to 446,000 in 2013. Trips crossing the revised cordon in 2013 were about 435,000.
- Inbound peak period transit trips were about 211,000, little changed from 2009. Transit trips crossing the revised cordon line were about 197,000.
- Person trips by automobile in 2013 were about 236,000, a decrease of about 21,000 from 2009. Most of the decrease in person trips were in multiple occupant vehicles (2 or more persons per vehicles), which declined by about 21,000 trips.
- The number of automobiles entering the Central Employment Core in the A.M. peak period has declined from 203,000 in 2009 to about 192,500 in 2013. For the five-hour monitoring period, the decline was similar in absolute terms, from about 273,000 in 2009 to 263,000 in 2013.
- Traffic volumes crossing the revised cordon line were only slightly higher, but person trips were lower.
- About 3,500 bicycles entered the Central Employment Core in the A.M. peak period. In the full five hour monitoring period, almost 5,000 trips by bike were observed.

HOV Facilities

COG/TPB has conducted surveys on the high occupancy vehicle (HOV) freeway facilities in 1997, 1998, 1999, 2004, 2007, 2010 and 2014. The most recent survey found that:

- All of the HOV lanes in spring 2014 were observed to carry more persons per lane during the HOV restricted periods than adjacent non-HOV lanes except on US 50;

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[10] WMATA, Scorecard, https://wmata.com/about_metro/scorecard/index.cfm
[11] WMATA, Momentum, http://www.wmata.com/Momentum/
[12] *2013 Central Employment Core Cordon Count of Vehicular and Passenger Volumes*, Draft, December 30, 2013. http://www.mwcog.org/uploads/committee-documents/k11ZXV5e20140127094130.pdf

- Most of the HOV lanes provide savings in travel times when compared to non-HOV alternatives, especially the barrier separated HOV lanes in the I-95/I-395 corridor in Northern Virginia;

- However, the performance of the concurrent-flow HOV lanes in the I-66 lanes (outside I-495) and along I-270 were at certain points between 10 and 25 MPH slower than adjacent non-HOV lanes, as well as sections of the exclusive I-66 HOV facility inside I-495 (staff examined data from the Vehicle Probe Project (VPP) and found recurring congestion along I-66 eastbound from the Dulles Connector Road to a point between Sycamore Street and Va. 120 [North Glebe Road]); and

- Average auto occupancy in 2014 was little-changed from 2010, even though the HOV lanes in Northern Virginia continue to exempt vehicles with "Clean Air" registration plates from the HOV requirement.

PARK-AND-RIDE FACILITIES

There are over 160,000 parking spaces at nearly 400 Park & Ride lots throughout the Washington/Baltimore Metropolitan areas where commuters can conveniently bike, walk or drive to and join up with carpools/vanpools or gain access to public transit. According to the region's Commuter Connections program: two thirds of Park & Ride Lots have bus or rail service available; parking is free at 89% of the Park & Ride Lots; and more than 25% of Park & Ride Lots have bicycle parking facilities.

The 2008 Metrorail Station Access & Capacity Study found Metro presently owns and operates 58,186 parking spaces. On an average weekday, almost all of those spaces are occupied, especially stations at East Falls Church, Van Dorn Street, Naylor Road and Branch Ave. Only a handful of stations—White Flint, Wheaton, College Park-U of MD, Prince George's Plaza, and Minnesota Ave—have a substantial amount of daily unused available capacity.

In 2009, WMATA and VDOT completed the Feasibility Study of Real Time Parking Information at Metrorail Parking Facilities (Virginia Stations) [13], evaluating the feasibility of a real-time parking application for the Metrorail system, with the purpose of improving operations efficiency, reducing operating costs by providing guidance to available parking spaces, encouraging more transit usage and reducing congestion.

AIRPORT ACCESS

The transportation linkage between airports and local activities is a critical component of the transportation system. The Washington region has two major airports – Ronald Reagan Washington National Airport (DCA) in Arlington, VA, and Washington Dulles International Airport (IAD) in Loudoun County, VA. The region is also served by the nearby Baltimore/Washington International Thurgood Marshall Airport (BWI). According to the most recent TPB Air Passenger Survey [14], the majority (92%) of those traveling to the region's airports does so via the highway network (i.e. personal cars, rental cars, taxis, buses). Therefore, understanding ground airport access is important to congestion management.

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[13] Wilbur Smith Associates and Michael Baker Jr., Inc., Feasibility Study of Real Time Parking Information at Metrorail Parking Facilities (Virginia Stations), June 2009.
http://www.wmata.com/pdfs/planning/Real_Time_Parking_Study.pdf

[14] Abdurahman Mohammed, 2013 Washington-Baltimore Regional Air Passenger Survey Data Editing Process, Presentation to the Aviation Technical Subcommittee on January 23, 2014:
http://www.mwcog.org/uploads/committee-documents/b11ZXVpf20140131093313.pdf

The TPB regularly carries out Regional Airport Ground Access Travel Time Studies (1995, 2003, 2011 and 2015) and provides relevant information to congestion management. In aggregate, travel times to the airports, as measured by Travel Time Index (TTI) has not changed substantially from the 2011/2012 period to 2014/2015.

FREIGHT

The National Capital Region has a responsive freight system to support the vitality of economy and quality of life. This region features a consumer and service-based economy and approximately three quarters of freight traveling to, from, or within the region is transported by truck [15]. The interaction between freight movement and passenger travel is high. The following five worst truck bottlenecks[16] are also among the most congested locations for all traffic.

- I- 95 at VA-7100, Virginia
- I- 95 at VA-234, Virginia
- I-95 at I- 495, Maryland
- I- 495 at American Legion Bridge, Virginia
- I-495 at I-66, Virginia

Future Congestion

The 2015 CLRP Performance Analysis [17] forecasts the outlook for growth in the region. One of the cornerstones of plan performance is the forecasting of future congestion. The plan performance looks at where in the region congestion will occur in the future and compares current congestion to future congestion. It looks at criteria that may affect congestion, such as changes in population, employment, transit work trips, vehicle work trips, lane miles, and lane miles of congestion. The analysis also breaks down lane miles of congestion into core, inner suburbs, and outer suburbs, providing information on where, generally, the most lane miles of congestion can be found in 2040 compared to 2015.

From 2015 to 2040, the region is forecast to be home to 24% more residents and 36% more jobs in 2040. To accommodate growth, 7% more lane miles of roadway and 14% more transit rail miles are planned to be constructed. The total number of trips taken is expected to increase by 23%, while transit, walk, and bike trips together are expected to increase at a faster rate than single driver trips. The overall amount of driving (VMT) is expected to grow by 22%. This is slightly less than forecast population growth, which means that VMT per capita is expected to drop by 2%. The increase in demand on the roadways is forecast to out-pace the increase in supply, leading to a significant increase in congestion.

National Comparison of the Washington Region's Congestion

The Washington region is among the most congested metropolitan areas in the nation. Based on annual hours of delay per auto commuter, the region was the most congested city in the nation in

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15 . *Enhancing Consideration of Freight in Regional Transportation Planning,* Cambridge Systematics, Inc., 2007. http://www.mwcog.org/uploads/committee-documents/bF5fW1pX20080222142629.pdf

16 I-95 Corridor Coalition, *Mid-Atlantic Truck Operations study – Final Report*. Cambridge Systematics, Inc. October 2009. http://www.i95coalition.net/i95/Portals/0/Public_Files/pm/reports/DFR1_MATOps_Truck%20Operations%20V3.pdf

17 TPB, Performance Analysis of the Draft 2015 CLRP, a presentation to the TPB Board meeting on September 16, 2015 https://www.mwcog.org/clrp/resources/2015/2015CLRPPerfAnalysis.pdf

Texas A&M Transportation Institute's 2015 Urban Mobility Scorecard [18] (for 2014 data). However, using a different methodology based on annual average hours wasted in traffic, INRIX ranked the Washington region the 2nd in 2015 [19]. And based on extra travel time compared to free flow conditions, TomTom ranked the region the 8th in the United States in 2015 [20].

Congestion Management Strategies

The CMP has been playing an important role in developing strategies, including strategies in association with capacity-expanding projects, to combat congestion or mitigate the impact of congestion. The CLRP and TPB member agencies have pursued many alternatives to capacity increases, with considerations of these strategies informed by the CMP. Implemented or continuing strategies include demand management strategies and operational management strategies, as shown in Figure 8. It should be noted that although strategies are divided into two categories for reporting purposes in this document, demand management and operational management strategies should be designed and implemented to work in cooperation.

DEMAND MANAGEMENT STRATEGIES

Demand Management aims at influencing travelers' behavior for the purpose of redistributing or reducing travel demand. Examples of TPB's demand management strategies include:

- Commuter Connections Program – Including strategies such as Telework, Employer Outreach, Guaranteed Ride Home, Liver Near Your Work, Carpooling, Vanpooling, Ridematching Services, Car Free Day, and Bike To Work Day.
- Promotion of local travel demand management – Local demand management strategies are documented in the main body of the CMP Technical Report.
- Public transportation improvements – The Washington region continues to support a robust transit system as a major alternative to driving alone.
- Pedestrian and bicycle transportation enhancements as promoted and tracked through the Bicycle and Pedestrian Planning program – The number of bicycle and pedestrian facilities in the region has increased in recent years; the regional bikesharing program, Capital Bikeshare can be found in Washington, D.C., Arlington County, the City of Alexandria, and Montgomery County, MD. There are plans to expand Capital Bikeshare to locations County. The City of College Park began its own bikeshare program in 2016.
- Car sharing - Local governments work with private companies to make the region's car sharing market viable.
- Land use strategies – Including those promoted by the Transportation-Land Use Connections (TLC) Program.

OPERATIONAL MANAGEMENT STRATEGIES

Operational management focuses on improvements made to the existing transportation system to keep it functioning effectively. Examples of TPB's operational management strategies include:

- High Occupancy Vehicle (HOV) facilities – Existing HOV facilities include I-66, I-95/I-395, I-270, US-50 and the Dulles Toll Road.

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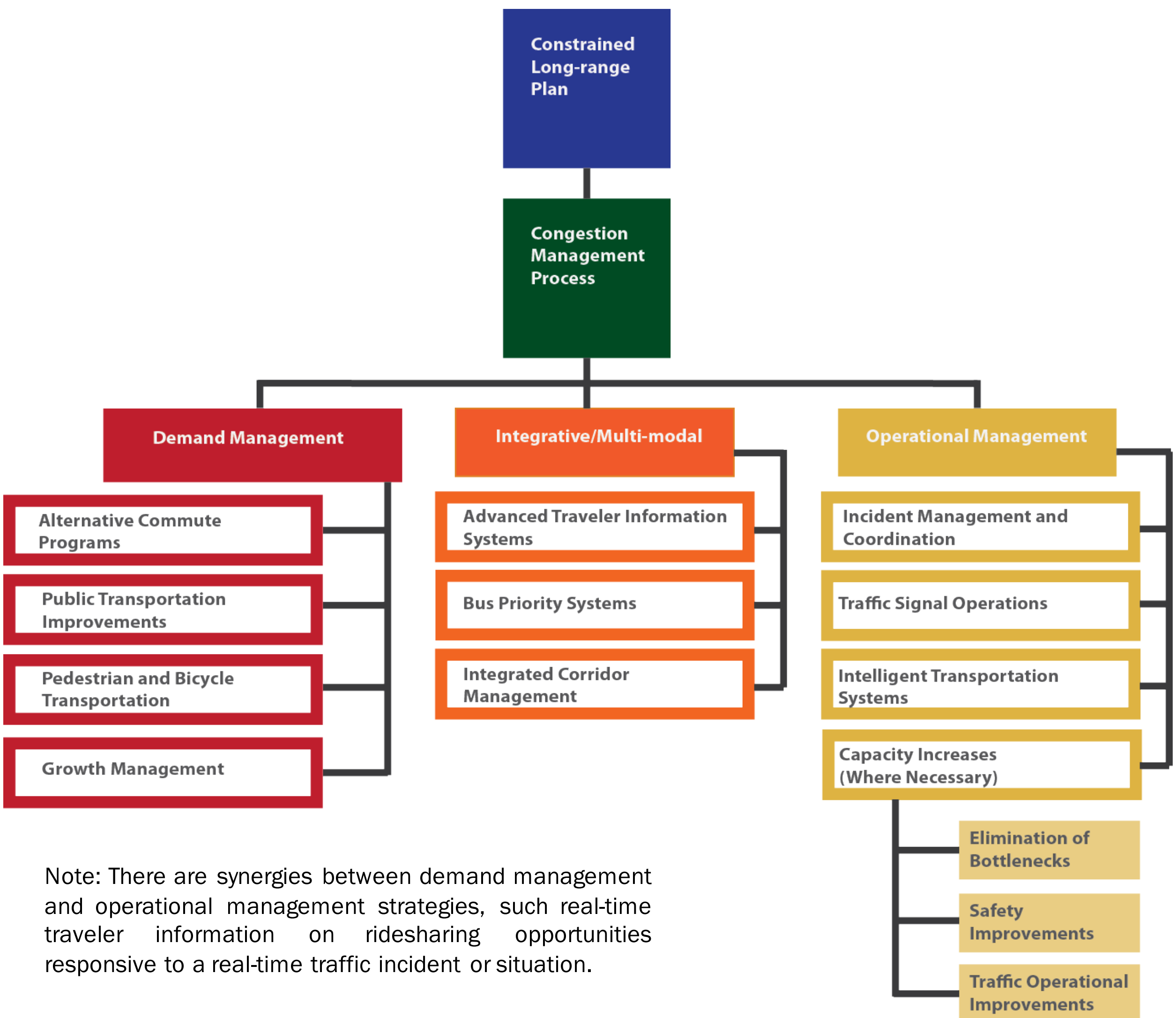
[18] David Schrank, Bill Eisele, Tim Lomax, Jim Bak of the Texas A&M Transportation Institute and INRIX, Inc. *2015 Urban Mobility Scorecard*. August 2015. http://mobility.tamu.edu/ums/
[19] INRIX, Inc., Traffic Scorecard, http://inrix.com/scorecard/
[20] TomTom, Traffic Index, https://www.tomtom.com/en_gb/trafficindex/list

- Variably-Priced Lane Facilities – The 18-mile Inter-county Connector (ICC) in Maryland opened from I-270 to I-95 in November 2011; the 495 Express Lanes in Northern Virginia opened in November 2012; and the 95 Express Lanes project in Northern Virginia opened in 2014.
- Incident Management – The region's state DOTs all pursue strategies for managing their transportation systems, including operation of 24/7 traffic management centers, roadway monitoring, service patrols, and communications interconnections among personnel and systems.
- Regional Transportation Operations Coordination – Notably the Metropolitan Transportation Operations Coordination (MATOC) program, whose development the TPB helped shepherd, uses real-time transportation systems monitoring and information sharing to help mitigate the impacts of non-recurring congestion.
- Intelligent Transportation Systems are considered, particularly through the Management, Operations, and Intelligent Transportation Systems (MOITS) program and committees. Examples include traffic signal optimization, safety service patrols, and traveler information.

Figure 8: Major CMP Strategies



Note: There are synergies between demand management and operational management strategies, such real-time traveler information on ridesharing opportunities responsive to a real-time traffic incident or situation.

INTEGRATED/MULTI-MODAL STRATEGIES

While there is often overlap in demand management and operational management strategies, for example, real-time traveler information on ridesharing opportunities responsive to a real-time traffic incident or situation, there are projects in the region that fully integrate demand and operational management strategies.

- Integrated Corridor Management - VDOT's current ICM project development focuses on I-95 and US-1 corridor from the DC line to Fredericksburg. VDOT launched the first ICM initiative on the corridor in February 2014. VDOT received a grant study ICM in its east-west travel shed.
- Advanced Traveler Information Systems – Travelers have more ways than ever for obtaining trip planning information such as traffic, incidents, real-time transit arrivals, and emergency information. The prevalence of internet capable mobile devices and social media provide new means of communication between travelers and operators.

ADDITIONAL SYSTEM CAPACITY

Federal law and regulations list capacity increases as another possible component of operational management strategies, for consideration in cases of elimination of bottlenecks, safety improvements and/or traffic operational improvements. These capacity increase projects are documented in CLRP or TIP.

There have been relatively few capacity increase projects in recent years, however. This region has an emphasis on demand and operational management strategies, such us transit improvements, the Commuter Connections program and the Management, Operations and Intelligent Transportation Systems (MOITS) program.

Assessment of Congestion Management Strategies

ASSESSMENT OF IMPLEMENTED STRATEGIES

The TPB assesses the implemented congestion management strategies in a variety of ways. Many strategies have specific assessments and the overall effectiveness of all strategies is repeatedly evaluated by congestion monitoring and analysis.

Specific assessments (of individual or several strategies):

- A variety of surveys within the Commuter Connections Program are regularly conducted to provide firsthand data inputs for the assessments, including the Guaranteed Ride Home Customer Satisfaction Survey, Commuter Connections Applicant Placement Rate Survey, State of the Commute Survey, Employee Commute Surveys, Carshare Survey, Vanpool Driver Survey, Employer Telework Assistance Follow-up Survey, and the Bike-to-Work Day Participant Survey.
- Public transportation improvements, pedestrian and bicycle transportation improvements, and land use strategies are assessed in Regional Household Travel Surveys, Regional Bus Surveys, Regional Activity Centers and Regional Activity Clusters Studies, the Regional Travel Trends Report, and Cordon Counts.
- The region's HOV facilities are monitored by the TPB's HOV monitoring and surveys.
- Status of traffic signal timing is assessed by Management, Operations and Intelligent Transportation Systems (MOITS) program's traffic signal timing surveys. Traffic signal power backup system was surveyed by the Traffic Signal Subcommittee of the MOITS program.
- The Metropolitan Area Transportation Operations Coordination (MATOC) program was assessed by a benefit-cost study.

Overall assessments (of all implemented strategies):

- The TPB's aerial photography survey of the region's freeway system congestion conditions (every three years for AM and PM peak periods and every five years for weekend and off-peak period). As of the writing this 2016 CMP Technical Report, the TPB was examining whether additional regional aerial surveys will be performed in the future, and if so, on what extent of geographic coverage and what frequency.
- The TPB's arterial floating car travel time and speed study (every year a sample of major arterials in DC, MD and VA is studied and the same sample was repeated every three years). This study was terminated in FY 2012 and an enhanced arterial monitoring program is provided by the I-95 Corridor Coalition Vehicle Probe Project.
- In addition to the TPB's monitoring activities, the TPB also utilize other regional and national monitoring activities to complement and enhance the congestion monitoring and analysis in the National Capital Region. These utilized "outside" monitoring activities include:
    a) I-95 Corridor Coalition probe-vehicle-based traffic monitoring data.
    b) National Performance Management Research Data Set (NPMRDS).
    c) The FHWA Transportation Technology Innovation and Demonstration (TTID) Program/ Traffic.com traffic monitoring.
    d) Maryland, Virginia and the District of Columbia's Highway Performance Monitoring Systems (HPMS).

Assessment of Potential Strategies Through Scenario Planning

The TPB has a long history of strategy analysis for air quality purposes which focuses on emissions reductions from individual strategies. The two most recent scenario studies, the CLRP Aspirations Scenario and the "What Would it Take?" Scenario looked at groupings of strategies and how they could interact with each other.

The CLRP Aspirations Scenario is an integrated future land use and transportation scenario for building on the key results of previous TPB scenario studies. It includes concentrated land use growth in Regional Activity Centers, a regional network of variably priced lanes, and a high quality bus rapid transit network operating on the VPL network for the current planning horizon year 2040. The most recent version of the CLRP Aspirations Scenario was presented to the TPB in October 2013.

In May 2010, the TPB completed a scenario study examining the role of regional transportation in climate change mitigation in the Washington region, called the "What Would it Take?" scenario. The scenario is a goal-oriented study that specifically asks and tries to answer the question of what it would take in the Washington region to meet aggressive greenhouse gas emissions reduction goals in transportation. The study includes the analysis of over 50 strategies from national level CAFE standards and alternative fuel mandates to regional and local level bicycle plans and congestion reduction strategies to determine their potential to reduce emissions and contribute to the environmental resilience of this region.

In an effort to assist municipalities in implementing strategies suggested by the Scenario Study, the TPB created the Transportation/Land Use Connections (TLC) Program. The TLC Program addresses the "how to" challenges related to improving transportation/land-use coordination and realizing an alternative future for the region, through providing both direct technical assistance and information about best practices and model projects. Through the program, the TPB provides communities with up to $60,000 worth of technical assistance to catalyze or enhance planning efforts. Any local jurisdiction that is a member of the TPB is eligible to apply. The second part of the TLC program is the Clearinghouse, a web-based source of information about transportation/land use coordination, including regional and national experience with transit-oriented development and other key strategies.

Some potential operational congestion management strategies are assessed in the Strategic Plan for the Management, Operations and Intelligent Transportation Systems (MOITS) Planning Program[21].

TPB also assesses special potential strategies on an as-needed basis, such as congestion pricing.

Compiling Project-Specific Congestion Management Information

Pursuant to Federal regulations, the TPB encourages consideration and inclusion of congestion management strategies in all Single Occupancy Vehicle (SOV) capacity-increasing projects. This involves compiling and analyzing information in the Call for Projects documentation forms, which are submitted from regional agencies when the CLRP is developed.

The Call for Projects documentation requests any project-specific information available on congestion that necessitates or impacts the proposed project. Agencies compile this information from various sources, including TPB-published congestion information (if available), internal or other directly measured information, or by conducting engineering estimates of the Level of Service (LOS). TPB compiles and analyzes this submitted information, along with information from other CMP sources.

Specifically for SOV capacity-increasing projects, the TPB requests documentation that the implementing agency considered all appropriate systems and demand management alternatives to the SOV capacity. In the Call for Projects documentation a special set of SOV questions is completed by implementing agencies and the TPB compiles this information.

Congestion Management as a Process in the CLRP

COMPONENTS OF THE CMP FULLY INTEGRATED IN THE CLRP

The four major components of the CMP as described earlier are fully integrated in the CLRP. More specifically:

In monitoring and evaluating transportation system performance, the TPB uses Skycomp aerial photography freeway monitoring and a number of other travel monitoring activities to support both the CMP and travel demand forecast model calibration, complementing operating agencies' own information, and illustrating locations of existing congestion. CLRP travel demand modeling forecasts, in turn, provide information on future congestion locations. This provides an overall picture of current and future congestion in the region, and helps set the stage for agencies to consider and implement CMP strategies, including those integrated into capacity-increasing roadway projects.

The CMP component of the CLRP defines and analyzes a wide range of potential demand management and operations management strategies for consideration. TPB, through its Technical Committee, Travel Management Subcommittee, Travel Forecasting Subcommittee, and other committees, reviews and considers both the locations of congestion and the potential strategies when developing the CLRP.

For planned (CLRP) or programmed (TIP) projects, cross-referencing the locations of planned or programmed improvements with the locations of congestion helps guide decision makers to prioritize areas for current and future projects and associated CMP strategies. Maps in the 2009 CLRP showed a high correlation between the locations of planned or programmed projects and locations where congestion is being experienced or is expected to occur.

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[21] *Strategic Plan for the Management, Operations and Intelligent Transportation Systems (MOITS) Planning Program*, June 16, 2010. http://www.mwcog.org/transportation/activities/operations/moits-strategic.asp

Thus CLRP and TIP project selection is informed by the CMP, and implementation of CMP strategies is encouraged. The region relies particularly on non-capital congestion strategies in the Commuter Connections program of demand management activities, and the Management, Operations, and Intelligent Transportation Systems (MOITS) program of operations management strategies. Assessments of these programs are analyzed, along with regular updates of travel monitoring to look at trends and impacts, to feed back to future CLRP cycles.

The TPB also compiles information pertinent to specific projects in its CMP documentation process (form) within the annual CLRP Call for Projects. This further assures and documents that the planning of federally-funded SOV projects has included considerations of CMP strategy alternatives and integrated components.

Regional Transportation Priorities Plan Facilitates CMP-CLRP Integration

The Regional Transportation Priorities Plan (RTPP), which is a milestone of TPB's Performance-Based Planning approach, facilitates the integration of the CMP and the CLRP. The RTPP was approved by the TPB in January 2014.

Building on the TPB Vision and previous regional transportation planning activities, the RTPP identifies those transportation strategies that offer the greatest potential contributions to addressing continuing regional challenges, and to provide support for efforts to incorporate those strategies into future updates of the CLRP in the form of specific programs and projects. The plan articulates regional priorities for enhancing the performance of the CLRP by advancing six regional goals:

1) Provide a Comprehensive Range of Transportation Options
2) Promote a Strong Regional Economy, Including a Healthy Regional Core and Dynamic Activity Centers
3) Ensure Adequate System Maintenance, Preservation, and Safety
4) Maximize Operational Effectiveness and Safety of the Transportation System
5) Enhance Environmental Quality, and Protect Natural and Cultural Resources
6) Support Inter-Regional and International Travel and Commerce

The TPB established an Unfunded Capital Needs Working Group in 2015 which was renamed the Long-Range Plan Task Force and reconvened on April 20, 2016. The goal of this group's work is to improve the performance levels of the regional transportation system in the TPB's Constrained Long Range Plan. The outcomes of these efforts will be both at the project and policy levels and will be directly linked to the update of the TPB's long range plan in 2018.

Key Findings of the 2016 CMP Technical Report

1. Congestion – Peak period congestion in the Washington region decreased between 2010 and 2012, and then increased moderately in 2014 and 2015, but still remaining lower than that of 2010. The Travel Time Index dropped 6.7% between 2010 and 2012, but climbed 3.3% between 2012 and 2015. The percent of congested road miles was 21% in 2010, 11% in 2012, and 17% in 2015 (Sections 2.2.1.1 and 2.2.1.3).

2. Reliability – Travel time reliability in the region improved between 2010 and 2012, and then worsened in 2014 and 2015, almost back to the 2010 level. The Planning Time Index decreased (improved) by 10% between 2010 and 2012, but increased (worsened) by 10% between 2012 and 2015 (Section 2.2.1.2).

3. Bottlenecks – Three new bottlenecks emerged on the east side of the Beltway in the 2016 CMP Technical Report that were not on the list in the 2014 Report: I-495 inner-loop at MD-214, I-495 outer-loop at US-50, and I-495 inner-loop at MD-4. Additionally, I-95 at VA-123/Exit 160 added two new Top 10 bottlenecks, one on each direction. The Beltway at the American Legion Bridge added a new, outer-loop bottleneck, making both directions to the Top 10 list. I-270 SB at the spur and I-66 WB at VA-234 remained in the Top 10 list. (Section 2.2.1.6).

4. Travel Demand Management – Travel demand management continues to be an important tool for day-to-day congestion management and played a key role in congestion management during the June 2015 Papal visit and the March 16, 2016 Metrorail shutdown. The Commuter Connections program remains the centerpiece to assist and encourage people in the Washington region to use alternatives to the single-occupant automobile. The transit system in the Washington region serves as a major alternative to driving alone – transit mode share is among the highest several metropolitan areas in the country (Section 3.2.1).

5. Regional Transportation Operations Coordination – The Metropolitan Washington Area Transportation Operations Coordination (MATOC) continues to play an important role in coordination and communicating incident information during both typical travel days and special events such as severe weather and construction work (Section 3.3.3.4).

6. Real-time travel information – The increasing availability of technology to monitor, detect, and evaluate travel conditions allows operators to make changes to the transportation network through active travel demand management, traffic signal optimization, and integrative corridor management. For travelers, real-time traffic and transit information are available from a number of sources though mobile applications and mobile versions of websites. Social media provides a mutually beneficial direct connection between transportation providers and users. Mobile applications related to non-auto modes, such as bikesharing and carsharing, allow travelers to be flexible with their mode choices (Section 3.4.6).

7. Variably Priced Lanes (VPLs) - VPLs provide additional options to travelers in the region. Maryland Route 200 (Intercounty Connector (ICC)) was fully opened between I-370/I-270 and US-1 in November 2014; a Before-and-After study identified the ICC improved its adjacent area's traffic by 3-4%. The 495 Express Lanes opened on the Virginia side of the Capital Beltway in November 2012; there were 42,000 average workday trips in the June 2015 quarter, up from 35,000 in the June 2014 quarter, and 29,000 in the June 2013 quarter. The 95 Express Lanes in Northern Virginia opened in December 2014 which had 45,000 average workday trips in the quarter ending in June 2015. (Section 3.3.2).

8. Walking and Bicycling – Walking and bicycling continue to grow in the region in part due to bikesharing and carsharing options and increasing connectivity in the bicycle and pedestrian network (Sections 3.2.4 and 3.2.5).

Recommendations for the Congestion Management Process

The 2016 CMP Technical Report documents the updates of the Congestion Management Process in the Washington region from mid-2014 to mid-2016. Looking forward, the report leads to several important recommendations for future improvements.

1. **Continue the Commuter Connections program.** The Commuter Connections program is a primary key strategy for demand management in the National Capital Region and it is beneficial to have a regional approach. Meanwhile, this program reduces transportation emissions and improves air quality, as identified by the TERMs evaluations.

2. **Continue and enhance the MATOC program and support agency/jurisdictional transportation management activities.** The MATOC program/activities are key strategies of operational management in the National Capital Region. Recent enhancements have including efforts on severe weather mobilization and the construction and coordination. Future enhancements of the MATOC program should be considered when appropriate to expand the function and participation of the program.

3. **Develop a regional Congestion Management Plan (CMPL).** The FAST Act and the new Metropolitan Planning Final Rule call for an optional development of a CMPL that includes projects and strategies that will be considered in the Transportation Improvement Program. Such a CMPL would strengthen the connections between CMP, TIP and CLRP and enable the TPB and its member agencies to better combat congestion in the Washington region.

4. **Incorporate performance measures to be finalized in the final rule on System Performance, Freight Movement, and CMAQ.** The next update of the CMP Technical Report should include those performance measures to assess the performance of the National Highway System, freight movement on the Interstate System, and the Congestion Mitigation and Air Quality (CMAQ) program (traffic congestion only), in addition to existing performance measures that the CMP considers appropriate.

5. **Continue to encourage integration of operations management and travel demand management components of congestion management for more efficient use of the existing transportation network.** State DOTs are encouraged to continue to explore ATM strategies along congested freeways and actively manage arterials along freeways. Transportation agencies (including transit agencies) and stakeholders are encouraged to work collaboratively along congested corridors to explore the feasibility of an ICM system. Ongoing projects on I-95/I-395 and I-66 support these concepts.

6. **Pursue sufficient investment in the existing transportation system, which is important for addressing congestion.** Prioritizing maintenance for the existing transportation system as called for in TPB's Regional Transportation Priorities Plan is critical to congestion management.

7. **Consider variable pricing and other management strategies in conjunction with capacity increasing projects.** Variably priced lanes (VPLs) provide a new option to avoid congestion for travelers and an effective way to manage congestion for agencies.

8. **Continue to encourage transit in the Washington region and explore transit priority strategies.** The transit system in the Washington region serves as a major alternative to driving alone, and it is an important means of getting more out of existing infrastructure. Local jurisdictions are encouraged to work closely with transit agencies to explore appropriate transit priority strategies that could have positive impacts on travelers by all modes.

9. **Encourage implementation of congestion management for major construction projects.** The construction project-related congestion management has been very successful in the past such as for the 11th Street Bridge and Northern Virginia Megaprojects.

10. **Continue to encourage access to non-auto travel modes.** The success of the Capital Bikeshare program and the decrease in automobile registrations in the District of Columbia indicate that there is a shift, at least in the urban areas, to non-automobile transportation.

11. **Continue and enhance providing real-time, historical, and multimodal traveler information.** Providing travelers with information before and during their trips can help them to make decisions to avoid congestion and delays and better utilize the existing road and transit infrastructure. Websites such as MATOC's www.trafficview.org, www.CapitalRegionUpdates.gov, state DOTs' 511 systems, and real-time transit information allow travelers to make more informed decisions for their trips. The value of real-time traveler information can be largely enriched by integrating historical travel information which can provide valuable travel time reliability measures.

12. **Continue to look for ways to safely interface with the public through new technology such as mobile devices and social media.** The increased prevalence of mobile internet-capable devices and social media present a rapidly evolving platform for both disseminating and gathering information. Explore ways to utilize crowdsourced incident information for traffic operations planning.

13. **Encourage connectivity within and between Regional Activity Centers.** The recent refinement of the Regional Activity Centers map, adopted in 2013, helps coordinate transportation and land use planning for future growth. Geographically-focused Household Travel Surveys can collect data which allows planners to see local level travel patterns and behaviors impacting mode shifts.

14. **Continue and enhance the regional congestion monitoring program with multiple data sources.** There are a wealth of sources, both public and private sector, for data related to congestion which have their individual strengths and shortcomings. Private sector probe-based monitoring provides unprecedented spatial and temporal coverage on roadways, but still needs to be supplemented with data from other sources including data on traffic volumes and traffic engineering considerations. There should be continual review of the quality and availability of data provided by different sources and the structuring of a monitoring program in way that is adaptable for potential future changes in data reporting and/or data sources.

15. **Monitor trends in freight, specifically truck travel, as the opening of the Panama Canal expansion nears.** This expansion will allow much larger ships from Asia to serve East Coast ports, including the nearby ones in Baltimore and the Hampton Roads area in Virginia. Much of the new cargo arriving at these ports will pass through the Washington region by truck or rail on its way to inland destinations.

16. **Participate in collaborative planning connected and autonomous vehicle readiness.** These emerging technologies will dramatically alter future transportation planning. Standards and interoperability are critical issues and should be addressed through extensive collaboration with a variety of stakeholders.

17. **Continue to coordinate with providers of shared mobility services.** According to the American Public Transit Association (APTA), people who uses shared modes such as bikesharing, carsharing, and ride hailing own fewer cars and spend less on transportation. Cooperation and communication between the public and private sectors is required to promote safe and beneficial transportation options.

MAIN REPORT

1. INTRODUCTION

1.1 Need for a CMP Technical Report

This report presents a technical review of the Congestion Management Process (CMP), as addressed by the Transportation Planning Board (TPB) of the Metropolitan Washington Council of Governments (COG).

The Fixing America's Surface Transportation (FAST) Act, signed into law by President Obama on December 4, 2015, continued the requirement for the use of the Congestion Management Process (CMP) in Transportation Management Areas (TMA) that was first stipulated in the SAFETEA-LU and maintained in the MAP-21 legislation. The FAST Act added that a Metropolitan Planning Organization (MPO) serving a TMA may develop an optional Congestion Management Plan (CMPL) that includes projects and strategies that will be considered in the MPO's Transportation Improvement Program (TIP).

The federal Metropolitan Transportation Planning final rule released on May 27, 2016 adds a list of examples of travel demand reduction strategies; adds job access projects as a congestion management strategy; and adds a new section regarding the optional development of a congestion management plan. These changes of the regulations will be reflected in future CMP activities and reports.

The CMP is similar to the previous requirements for a Congestion Management System (CMS) introduced in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), except that the change in name and acronym of CMS to CMP is intended to place a greater emphasis on the planning process and environmental review process, while maintaining and developing effective management and operation strategies. Federal regulations state that Metropolitan transportation planning areas with a population of 200,000 or more, designated as a TMA, are required to have a CMP, and that long-range transportation plans developed after July 1, 2007 must contain a CMP component. Also, in metropolitan planning areas classified as non-attainment for Ozone and Carbon Monoxide (CO) under the Clean Air Act, no single occupant vehicle (SOV) capacity expanding project can receive federal funds unless it shows that the CMP has been considered.

Federal regulations state that:

"The transportation planning process … shall address congestion management through a process that provides for safe and effective integrated management and operation of the multimodal transportation system, based on a cooperatively developed and implemented metropolitan-wide strategy, of new and existing transportation facilities…
…through the use of travel demand reduction …, job access projects, and operational management strategies." [22]

Additionally, a previous federal certification of the TPB planning process, dated March 2006, addressed CMS/CMP with the following still-relevant recommendation:

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[22] "Statewide and Nonmetropolitan Transportation Planning; Metropolitan Transportation Planning; Final Rule," *Federal Register*, Vol. 81, No. 103, May 27, 2016, § 450.322 (a) page 34152 – emphasis added.

> *The TPB should develop a comprehensive description of a regional Congestion Management System to demonstrate its application at critical stages of the metropolitan planning process, including the development of the CLRP, TIP, and the development of major projects and policies.*
>
> *The description should be part of the next update to the CLRP or a stand-alone document that is completed in one year from the issuance of this report. The description can build on key elements in place, including monitoring and evaluating alternatives to new capacity (such as for the Mixing Bowl Springfield Exchange and the Woodrow Wilson Bridge) and the range of congestion related strategies (such as the Commuter Connections Program).*[23]

The Congestion Management Process is intended to operate within or in conjunction with the planning process, which is the focal point for consideration of other factors, such as Clean Air Act requirements, transit, funding, land use scenarios, and non-motorized alternatives. The planning process also leads to decisions on which projects are programmed and implemented. The CMP will provide better information to decision-makers, such as the TPB, who consider transportation planning in our region.

This report is a step in the CMP, which is an ongoing activity. Just as there are many causes of congestion, there are also many solutions. While this report documents the region's recent CMP activities, the concept of addressing congestion and meeting regional goals will continue to be an integral part of the metropolitan planning process.

1.2 The Institutional Context of the CMP in the Washington Region

The federally designated Metropolitan Planning Organization (MPO) for the region is the National Capital Region Transportation Planning Board (TPB) at the Metropolitan Washington Council of Governments (MWCOG). The TPB is charged with producing long-range transportation plans and transportation improvement programs (TIPs) for the region, which includes the District of Columbia as well as portions of the States of Maryland and Virginia. The members of the TPB include representatives from state, county, local government agencies, as well as the Washington Metropolitan Area Transit Authority (WMATA), non-voting members of the Metropolitan Washington Airports Authority, and federal agencies.

The TPB is advised by a standing Technical Committee for transportation. The TPB Technical Committee oversees details of transportation planning and engineering studies and efforts required to support the region's transportation decision-making process. The Technical Committee has a number of standing subcommittees that focus on particular aspects of the transportation planning process, such as aviation, bicycle and pedestrian planning, regional public transportation planning, travel forecasting, transportation safety, and management, operations and intelligent transportation systems (MOITS)[24].

The TPB Technical Committee is the oversight committee for the CMP, as the committee that guides long-range plan activity and oversees interaction of the various subcommittees. The Technical

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[23] *Transportation Planning Certification Summary Report* (March 16, 2006). Prepared by Federal Highway Administration and Federal Transit Administration. Page 10. http://www.mwcog.org/uploads/committee-documents/tVpXVls20060405140322.pdf

[24] As of July 2017, under the auspices of the FY2017 Unified Planning Work Program (UPWP), the MOITS Technical Subcommittee has been renamed the Systems Performance, Operations, and Technology Subcommittee (SPOTS), reflecting a focus on both existing and emerging topics.

Committee is also advised by a number of the standing subcommittees who have knowledge about particular aspects of the CMP (for example, MOITS, Commuter Connections, and Travel Forecasting).

Previous CMS/CMP activities of the region were steered by a CMS Task Force, developed in the mid-1990s. Congestion Management System reports were developed in FY 1995 and FY 1996. However, a decision was then made to fully incorporate congestion management information into the CLRP rather than having a stand-alone document, in order to achieve continuity between the CMS and the CLRP. As such, over the years the CMS/CMP process had included data collection and analysis through compilation of information from implementing agencies associated with projects submitted to the CLRP and TIP, and through consideration of management and operations strategies under the Management, Operations, and Intelligent Transportation Systems (MOITS) Policy Task Force and MOITS Technical Subcommittee. The previously published 2008 CMP Technical Report represented a return to the practice of developing a separate congestion management document.

The 2010 CMP Technical Report was the first report incorporated the I-95 Corridor Coalition Vehicle Probe Project (VPP)/INRIX data [25] and developed new performance measures. The 2012 CMP Technical Report utilized even more third-party data than the previous one, including expanded VPP/INRIX data, and traffic volume information from the Transportation Technology Innovation and Demonstration (TTID) Program of the FHWA [26]. The 2014 CMP Technical Report included updates or initiatives taking place between mid-2012 to mid-2014 and adjusted itself toward meeting MAP-21 requirements. This current 2016 CMP Technical Report summaries the region's travel trends including congestion up to the end of 2015 and congestion management strategies up to mid-2016. Section 1.5 summarizes the highlights of the 2016 Report.

1.3 Coverage Area of the CMP

The Washington region CMP covers the TPB Planning Area (Figure 9). As of June 30, 2016, the TPB's planning area covered the District of Columbia and surrounding jurisdictions. In Maryland these jurisdictions include Charles County, Frederick County, Montgomery County, and Prince George's County, plus the cities of Bowie, College Park, Frederick, Gaithersburg, Greenbelt, Rockville, and Takoma Park. In Virginia, the planning area includes Alexandria, Arlington County, the City of Fairfax, Fairfax County, Falls Church, the urbanized area in Fauquier County, Loudoun County, the Cities of Manassas and Manassas Park, and Prince William County.

1.4 Components of the CMP

The Congestion Management Process in the National Capital Region consists of the following four components, all of which are wholly integrated into the CLRP:

1. **Monitoring and Evaluating Transportation System Performance.** This TPB effort includes congestion analyses leveraged by emerging data sources (e.g. I-95 Corridor Coalition/INRIX data), the regional transportation data clearinghouse, special studies, and information from the 2014 and previous Skycomp freeway aerial photography surveys and arterial monitoring programs,

2. **Defining and Analyzing Strategies.** This component involves identifying existing and potential strategies by the TPB Technical Committee, subcommittees, and staff. The TPB considers a number of demand management and operational management strategies.

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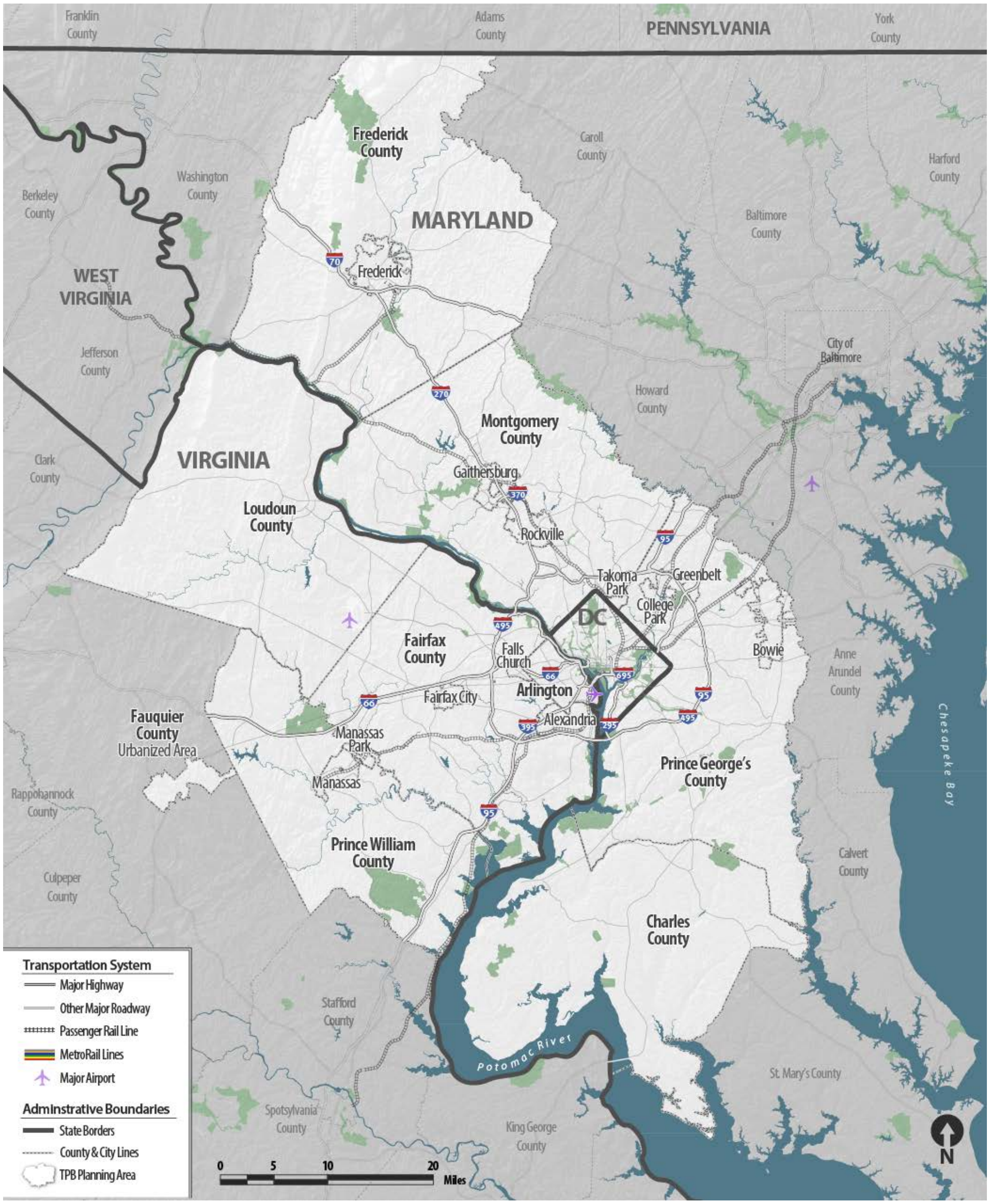
[25] I-95 Corridor Coalition, http://i95coalition.org/projects/vehicle-probe-project/
[26] Transportation Technology Innovation and Demonstration (TTID) Program, FHWA, http://ops.fhwa.dot.gov/travelinfo/ttidprogram/ttidprogram.htm

Figure 9: TPB Planning Area



3. **Implementing Strategies.** This TPB effort is to focus on compiling information on strategies that have been implemented, particularly on a region-level basis. Also, the TPB is exploring how to assess previously implemented strategies. Feedback from the process is beneficial when it comes to updating the CMP and considering additional strategies and technical methods.

4. **Compiling Project-Specific Congestion Management Information.** Pursuant to Federal regulations, the TPB encourages consideration and inclusion of congestion management

strategies in all SOV capacity-increasing projects. This involves compiling and analyzing information in the Call for Projects documentation forms, which are submitted from regional agencies when the CLRP is developed.

1.5 Highlights of the 2016 Update of the CMP Technical Report

The 2016 CMP Technical Report presents more congestion facts and analyses than the previous report while still maintaining a comprehensive and updated documentation of the congestion management strategies that are considered and implemented in the National Capital Region. The highlights of the 2016 update include:

- **FAST Act and New Metropolitan Planning Rule.** The FAST Act signed into law on December 4, 2015 and the new federal Metropolitan Transportation Planning rule promulgated on May 27, 2016 set a new stage for the CMP. Job access projects for the first time will be considered as a congestion management strategy. A MPO serving a TMA may develop a congestion management plan, which has specific requirements. Several examples of travel demand reduction strategies are explicitly listed in the new legislation and regulation. These new requirements will be reflected in future CMP activities and reports.

- **Proposed Rules on System Performance, Freight, and CMAQ Program.** The FHWA published a Notice of Proposed Rulemaking (NPRM) on April 22, 2016 to propose national performance management measures to assess performance of the National Highway System, freight movement on the Interstate System, and the Congestion Mitigation and Air Quality Improvement (CMAQ) program. A total of seven congestion-related performance measures were proposed. Although the current 2016 CMP report will not include all measures from this not-yet-finalized rule, it will summarize the performance of the Interstate System and the non-Interstate National Highway System separately. It is anticipated that future CMP reports will fully incorporate the measures required in the final rule and additional measures desired by the TPB.

- **Enhanced Event-Related Analysis.** Over the past two years, the CMP increased its use of vehicle probe data and other sources to conduct event-related transportation systems performance analysis to better inform planning for operations. Some recent examples include the 2016 Memorial Day holiday traffic looking ahead, March 16, 2016 Metrorail system-wide shutdown, January 2016 snow/ice event and category 4 blizzard, and September 2015 the Pope's visit to Washington, DC. Results of these analysis were published in the TPB Weekly Report, the TPB News, the quarterly Congestion Report (Dashboard), and social media such as the TPB's twitter account. These reports often attracted notable media attention and relays.

- **Disruptive Technologies and Shared Mobility.** The CMP has been monitoring the advancement of disruptive technologies such as autonomous vehicles, connected vehicles and revolutionary mass transit systems and the integration of such technologies with shared mobility such as ride-hailing services. These new technologies along with changed travel behaviors could potentially transform the transportation industry and alter future travel trends predicted by existing models and assumptions. The CMP will continue this monitoring and inform the CLRP and the TIP as needed.

- **Variably Priced Lanes (VPLs) Provide Options to Travelers.** The Intercounty Connector (ICC or MD 200) was opened in November 2011 for the section between I-270 and I-95, and in November 2014 for the final segment between I-95 and US-1. The 495 Express Lanes were opened on the Virginia side of the Capital Beltway in November 2012. The 95 Express Lanes in Northern Virginia were opened in December 2014. There are more express lanes planned for the future, including the I-395 Express Lanes and I-66 Express Lanes.

- **Periodic updates.** Since the release of the 2014 CMP Technical Report, a variety of planning and program periodic updates and outside data sources have been released. This current report uses these updates to provide the most up-to-date information for the CMP. Some critical updates include, but are not limited to:

    - 2015 CLRP and FY 2015-2020 TIP, including searchable online database
    - Round 8.4 Cooperative Forecasts of the region's demographics
    - I-95 Vehicle Probe Project data (through December 31, 2015)
    - 2014 Freeway Aerial Photography Survey
    - 2014 HOV Facility Survey
    - 2015 Airport Ground Access Travel Time Study
    - 2014 Metrobus Survey

2. STATE OF CONGESTION

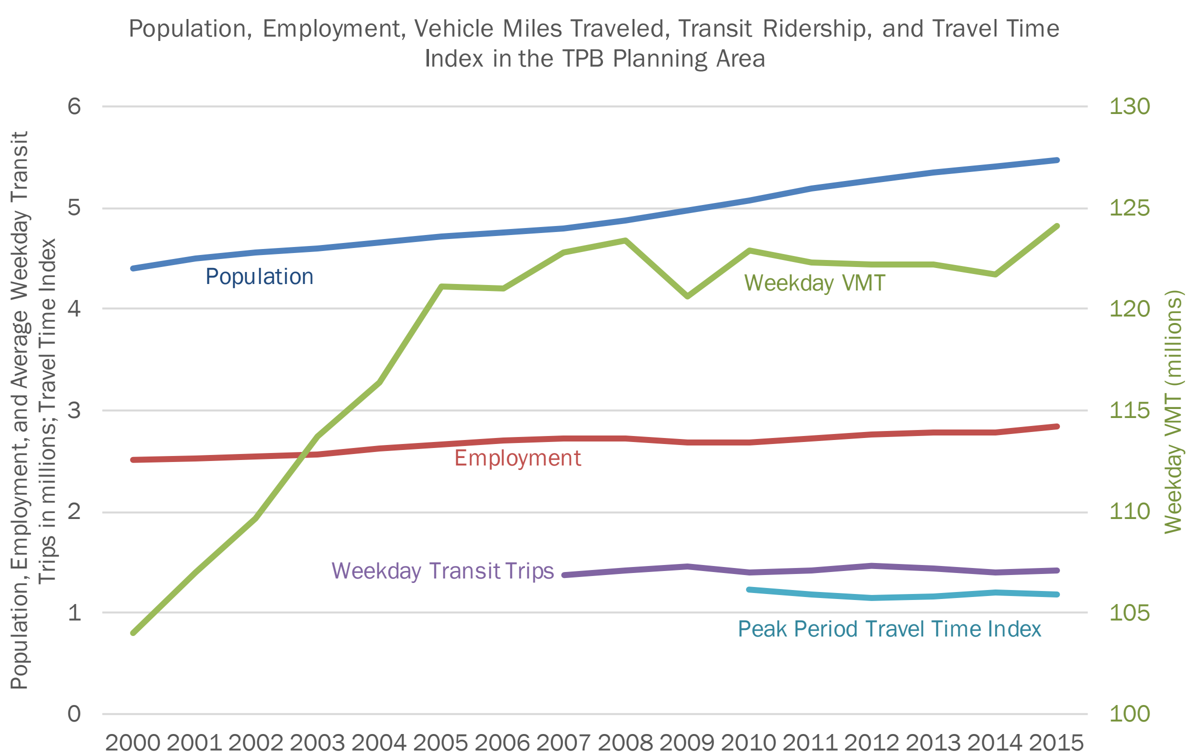
2.1 Regional Travel Trends

The Washington region had robust population growth and overall employment increase between 2000-2015 (Figure 10)[27]. The weekday vehicle miles traveled (VMT) increased rapidly, 18%, between 2000 and 2007, but only slightly, 1%, between 2007 and 2015. This has resulted in declining VMP per capita in recent years.

Peak period congestion, indicated by Travel Time Index, on area's 5,500 directional miles of roadways decreased slightly from 2010 to 2012 but increased since then, and almost went back to the 2010 level in 2015 (discussed in section 2.2).

Weekday transit ridership, including Metrorail, Metrobus, local transit and commuter rail, rose slightly from 2010 to 2012, but went back to the 2010 level in 2015.

Figure 10: Population, Employment, Weekday VMT and Transit Ridership, and Peak Period Travel Time Index in the TPB Planning Area



With these regional trends in mind, the rest of this chapter will discuss congestion on highways, transit systems and other travel monitoring activities. A national comparison of the Washington region's congestion and an outlook of the future's congestion in the Constrained Long-Range Plan (CLRP) will be provided towards the end of this chapter.

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[27] Robert Griffiths, Regional Travel Trends, Presentation to the TPB on April 20, 2016. http://www.mwcog.org/uploads/committee-documents/aFxeVlhd20160421091747.pdf

2.2 Congestion on Highways

On April 22, 2016, the Federal Highway Administration of the U.S. Department of Transportation released a Notice of Proposed Rulemaking (NPRM) to Propose National Performance Management Measures to Assess Performance of the National Highway System, Freight Movement on the Interstate System, and the Congestion Mitigation and Air Quality Improvement Program[28]. Under this NPRM, there are seven performance measures relevant to the CMP:

- Percent of the Interstate System providing for Reliable Travel
- Percent of the Non-Interstate NHS providing for Reliable Travel
- Percent of the Interstate System where peak hour travel times meet expectations
- Percent of the Non-Interstate NHS where peak hour travel times meet expectations
- Percent of the Interstate System Mileage providing for Reliable Truck Travel Time
- Percent of the Interstate System Mileage Uncongested
- Annual Hours of Excessive Delay per Capita

However, the finalization of this proposed rule and the first required performance reporting will take place after the completion of this 2016 CMP Technical Report, therefore this current report will continue to use the performance measures established in the past. In future CMP technical reports, the above measures, as finalized in the final rule, will be included.

The TPB has a multiplicity of traffic monitoring programs on the freeways and arterials in the Washington region. It is advantageous to have monitoring data from a variety of sources and methodologies for the purposes of cross-checking and ensuring resiliency in data sources.

2.2.1 I-95 Corridor Coalition Vehicle Probe Project Traffic Monitoring

Since 2010[29], major roadways in the Metropolitan Washington area have been monitored under the I-95 Corridor Coalition Vehicle Probe Project (VPP)[30]. This project is a groundbreaking initiative and collaborative effort among the Coalition, the University of Maryland and private sector data vendors INRIX, HERE, and TomTom, providing comprehensive and continuous real-time and historical traffic information to members. [31] The objective of this project is to acquire travel times and speeds on freeways and arterials using probe technology. While the dominant source of data is obtained from fleet systems that use GPS to monitor vehicle location, speed, and trajectory, other data sources such as sensors may also be used. The INRIX system fuses data from various sources to present a comprehensive picture of traffic, including vehicle speed and travel time at 5-minute granularity for each road segment

As an affiliate member of the coalition, the TPB was granted gratis access to the historical archive data in 2009. The initial effort to utilize this third-party data for freeway congestion monitoring was summarized in the *2010 Congestion Management Process (CMP) Technical Report*[32]. An enhanced effort that included expanded full coverage of the freeways in the Washington region and a speed-

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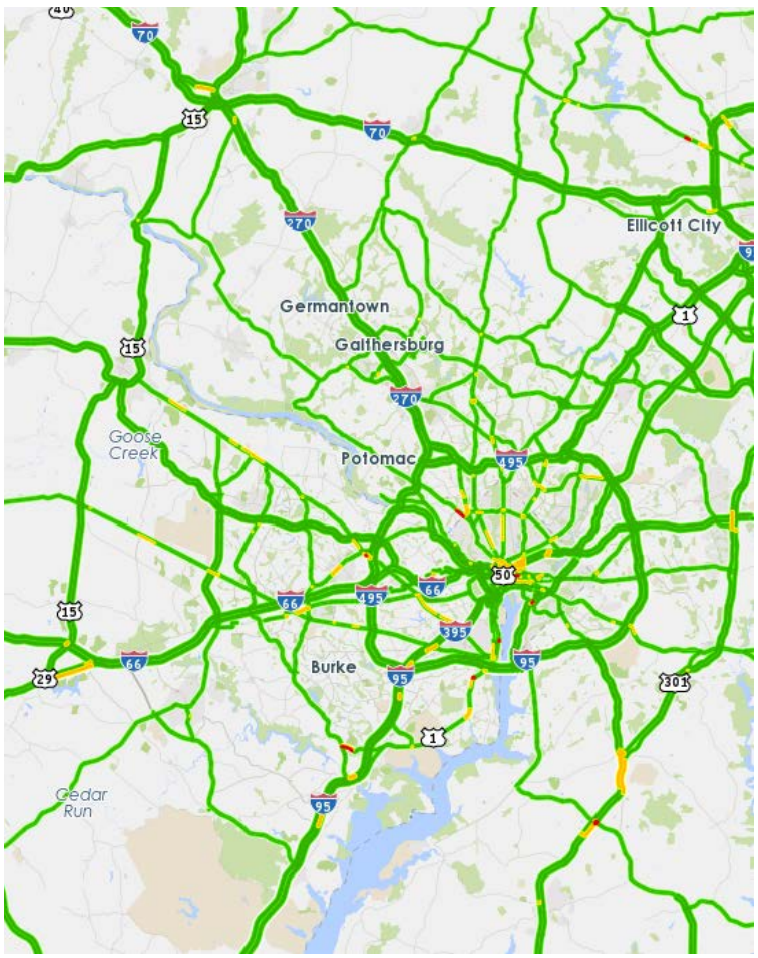
28 Federal Register, Vol. 81. No. 78, April 22, 2016.
29 Data for some roadways are available back to July 1, 2008.
30 I-95 Corridor Coalition, http://i95coalition.net/i95/VehicleProbe/tabid/219/Default.aspx
31 In 2014, the VPP data contract was re-competed by the I-95 Corridor Coalition; HERE and TomTom joined INRIX as data providers. As of this report only data from INRIX among those vendors has been made available gratis to TPB.
32 COG/TPB, http://www.mwcog.org/clrp/elements/cmp/files/CMP_Tech_Report_2010%20FINAL_09032010.pdf

volume data fusion was reported in the *2012 Congestion Management Process (CMP) Technical Report* [33].

As of December 31, 2013, the VPP/INRIX data covers about 5,500 directional miles of roads in the TPB Planning Area (Figure 11), including 520 miles of the Interstate System, 2,160 miles of Non-Interstate NHS, and 2,820 miles of Non-NHS; if categorized by freeway/arterial, this coverage includes 680 miles of freeways and 4,820 miles of arterials.

This VPP/INRIX data source has become the major source of traffic monitoring for both freeways and arterials in the Washington region, transforming the way by which highway congestion and travel time reliability are analyzed and presented.

Figure 11: The I-95 Vehicle Probe Project/INRIX Data Coverage in the Washington Region



(Screenshot captured on the VPP Suite developed by the CATT Lab of University of Maryland.)

[33] COG/TPB, http://www.mwcog.org/clrp/elements/cmp/files/2012%20CMP%20Tech%20Report_FINAL%202012-11-02%20for%20post.pdf

2.2.1.1 Travel Time Index

Travel Time Index (TTI) is an indicator of the intensity of congestion, calculated as the ratio of actual experienced travel time to free flow travel time. A travel time index of 1.00 implies free flow travel without any delays, while a travel time index of 1.30 means one has to spend 30% more time to finish a trip compared to free flow travel. More information about TTI and its calculation can be found in Chapter 4.1.

The annual average Travel Time Index on monitored highways in the TPB Planning Area is shown below. Figure 12 is the average TTI of total AM Peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) on all weekdays in a year, Federal holidays excluded, Figure 13 is the TTI for the AM Peak, and Figure 14 is the TTI for the PM Peak. The TTI is reported by the following five highway categories:

i. Interstate System, about 520 directional miles.
ii. Non-Interstate NHS, about 2,160 directional miles. The NHS designation used in this report was defined on October 1, 2012. The MAP-21 NHS includes all principal arterials[34].
iii. Non-NHS, about 2,820 directional miles. This category mainly includes minor arterials covered by the VPP/INRIX data.
iv. Transit-Significant Roads[35], about 950 directional miles. This category consists of road segments with at least 6 buses in the AM Peak Hour (equivalent to one bus in either direction in every 10 minutes) and the total length is about 1,400 directional miles in the TPB planning area, but only 950 miles of which are covered by the VPP monitoring. This category could include Interstate, Non-Interstate NHS and Non-NHS by definition.
v. All Roads, about 5,500 directional miles. All roads covered by the VPP/INRIX data in the TPB Planning Area.

Observations from examining the regional annual average TTI for 2010-2015 include:

- Overall, the Peak Period congestion in the region decreased between 2010-2012, but has increased slightly in the three years following. The TTI decreased by 6.7% between 2010 and 2012 and increased by 3.3% between 2012 and 2015.

- Among all highway categories, the Interstate was the most congested and the Non-NHS was the least congested roadways. The Transit-Significant Roads was the second most congested category, highlighting the challenges facing transit bus operations.

- The region's PM Peak Period was more congested than the AM Peak Period over the years, especially on Interstates. One exception was on the Non-NHS roads, where the difference between the two peak periods was minimal. The differences in congestion among the five highway categories were more pronounced in the PM peak than the AM peak.

2015 weekday (Monday through Friday) peak hour (8:00-9:00 am; 5:00-6:00 pm) Travel Time Index on the Interstate System and other monitored roads were visualized by the "Trend Map" tool of the I-95 Vehicle Probe Project (VPP) Suite Developed by the CATT Lab of the University of Maryland[36], as provided in Appendix A.

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[34] FHWA, National Highway System, http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/
[35] Pu, W. National Capital Region Congestion Report, 1st Quarter 2015, p.11-12. http://www.mwcog.org/transportation/activities/congestion/files/NCR_Congestion_Report_2015Q1.pdf
[36] Center for Advanced Transportation Technology Laboratory (CATT Lab), University of Maryland, Vehicle Probe Project Suite, https://vpp.ritis.org.

Figure 12: Annual Average Travel Time Index by Highway Category: Total AM and PM Peaks

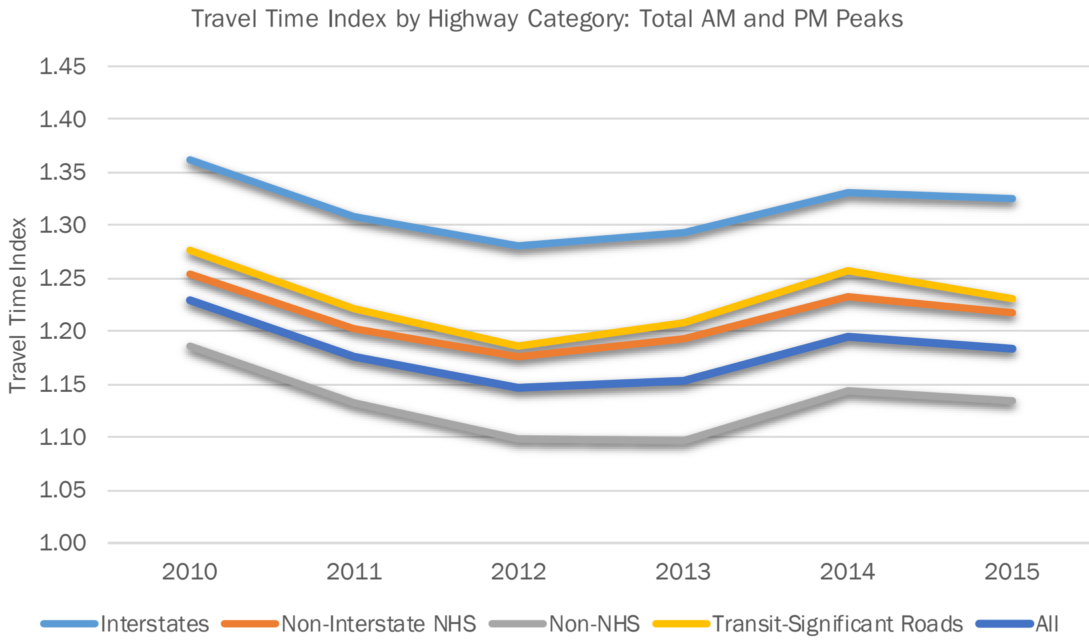


Figure 13: Annual Average Travel Time Index by Highway Category: AM Peak

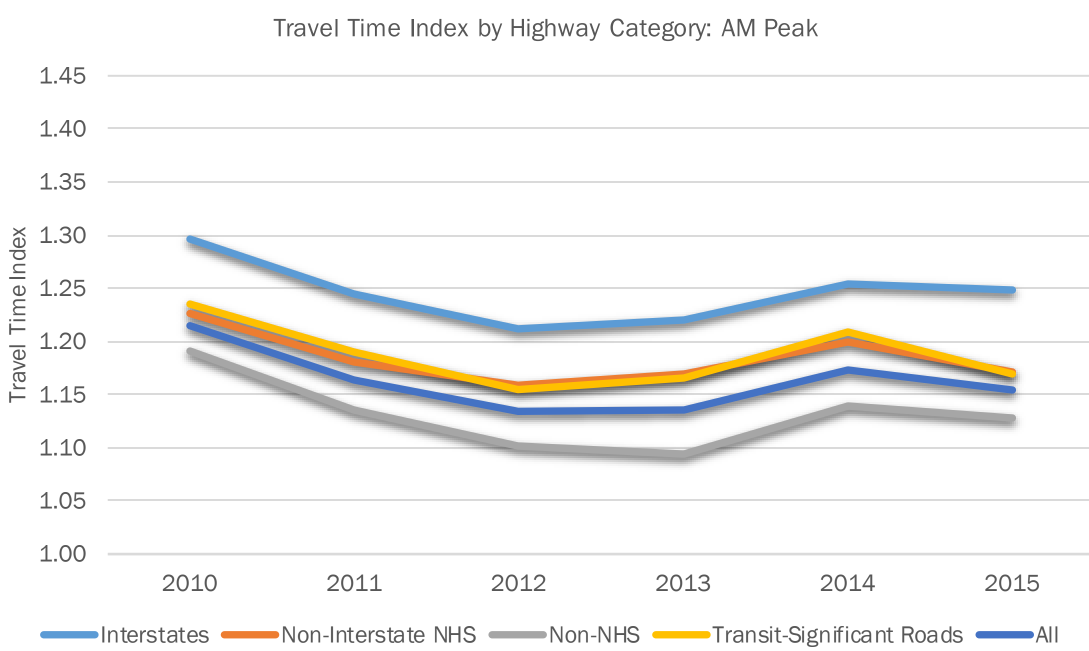
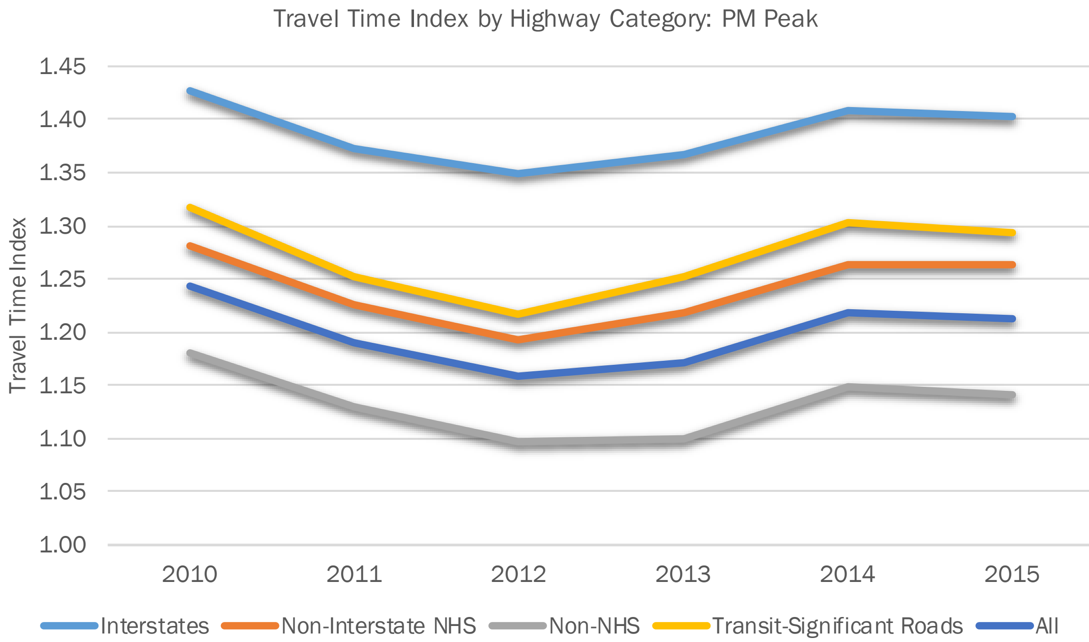


Figure 14: Annual Average Travel Time Index by Highway Category: PM Peak



2.2.1.2 Planning Time Index

To most travelers, everyday congestion, particularly peak period congestion, is common and they often adjust their schedules or plan extra time to allow for the expected delays; what troubles travelers most are unexpected or much-worse-than-expected delays, which can be caused by incidents, inclement weather, work zones, and the like. Travelers thus want travel time reliability - a consistency or dependability in travel times, as measured from day to day or across different times of day[37] - to avoid being late.

To quantify travel time reliability (or unreliability), this report adopts Planning Time Index (PTI), the ratio of 95th percentile travel time over free flow travel time. It expresses the extra time a traveler should budget in addition to free flow travel time in order to arrive on time 95 percent of the time. The difference between 95th percentile travel time and free flow travel time is called Planning Time. For example, a 30-minute free flow travel with a Planning Time Index of 2.00 requires 60 minutes in budget to ensure on-time arrival, and thus the Planning Time is 30 minutes.

The annual Planning Time Index on monitored highways in the TPB Planning Area is shown below. Figure 15 is the average PTI of total AM Peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) on all weekdays in a year, Federal holidays excluded. Figure 16 is the PTI for the AM Peak, and Figure 17 is the PTI for the PM Peak. The PTI is reported by the five highway categories described above in the Travel Time Index section.

Observations from examining the regional annual average PTI for 2010-2015 include:

[37] Federal Highway Administration, *Travel Time Reliability Measures*, http://ops.fhwa.dot.gov/perf_measurement/reliability_measures/index.htm

- On average, this region's travelers should budget 1.42 times of their free-flow travel times to arrive destinations on-time 95% of the times, a little less budget if traveling in the AM peak and a little more in the PM peak. If traveling mostly on freeways, the budgeted time should be about two times of the free-flow travel time – 1.7 times in the AM peak and 2.2 times in the PM peak. These numbers are based on all directions of travel, therefore for those who traveling in the peak direction would need to even budget more.

- Overall, the Peak Period travel time reliability in the region improved by about 10% between 2010-2012, but has gone back to the 2010 level in 2014 and 2015.

- Among all highway categories, the Interstate was the most unreliable and the Non-NHS was the most reliable. The Transit-Significant Roads system was the second most unreliable category, highlighting the reliability challenges facing transit bus operations.

- The region's PM Peak Period was less reliable than the AM Peak Period over the years, especially on Interstates. Only on the Non-NHS roads, the difference between the two peak periods seemed minimal. The differences in congestion among the five highway categories were more pronounced in the PM peak than the AM peak.

The 2015 weekday (Monday through Friday) peak hour (8:00-9:00 am; 5:00-6:00 pm) Planning Time Index on the Interstate System and other monitored roads were visualized by the "Trend Map" tool in the VPP Suite, as provided in Appendix B.

Figure 15: Annual Average Planning Time Index by Highway Category: Total AM and PM Peaks

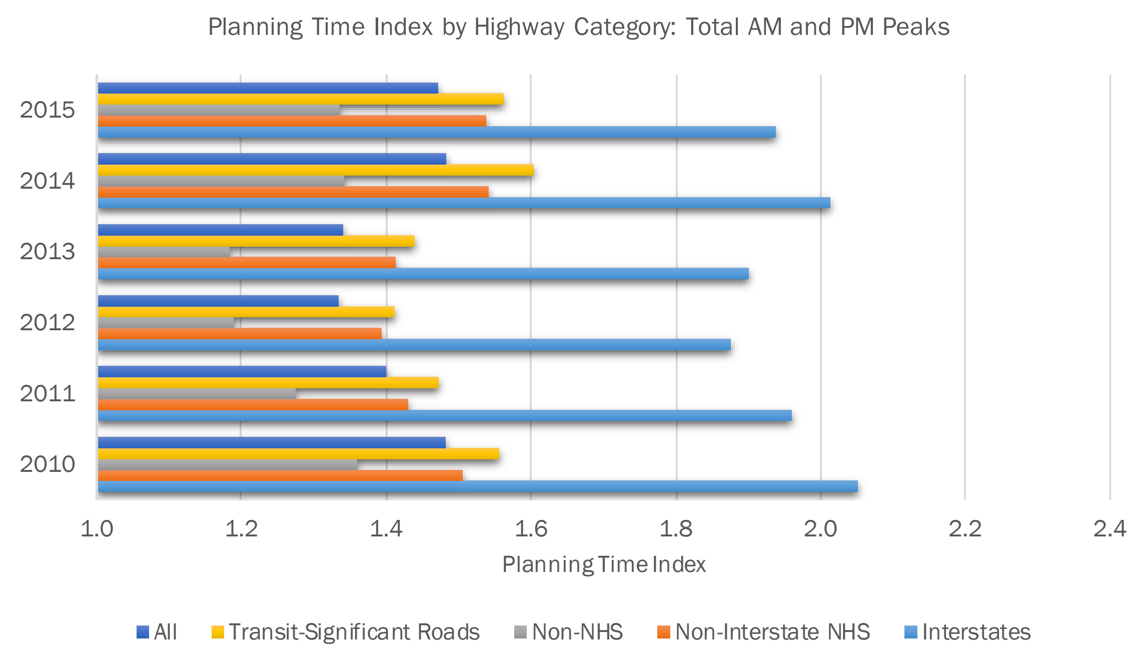


Figure 16: Annual Average Planning Time Index by Highway Category: AM Peak

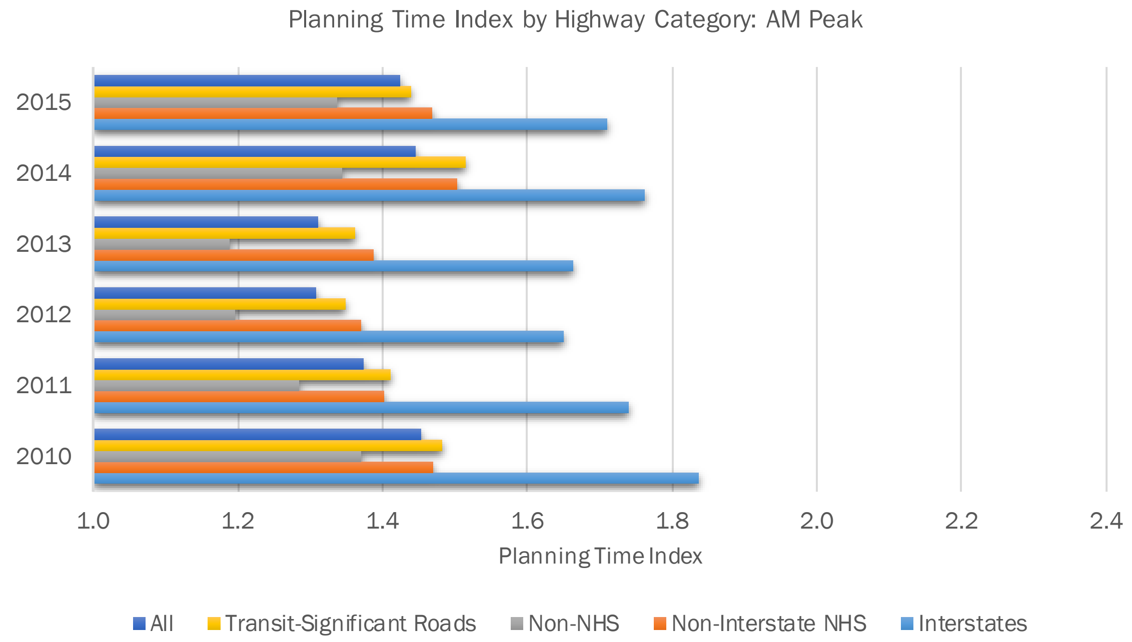
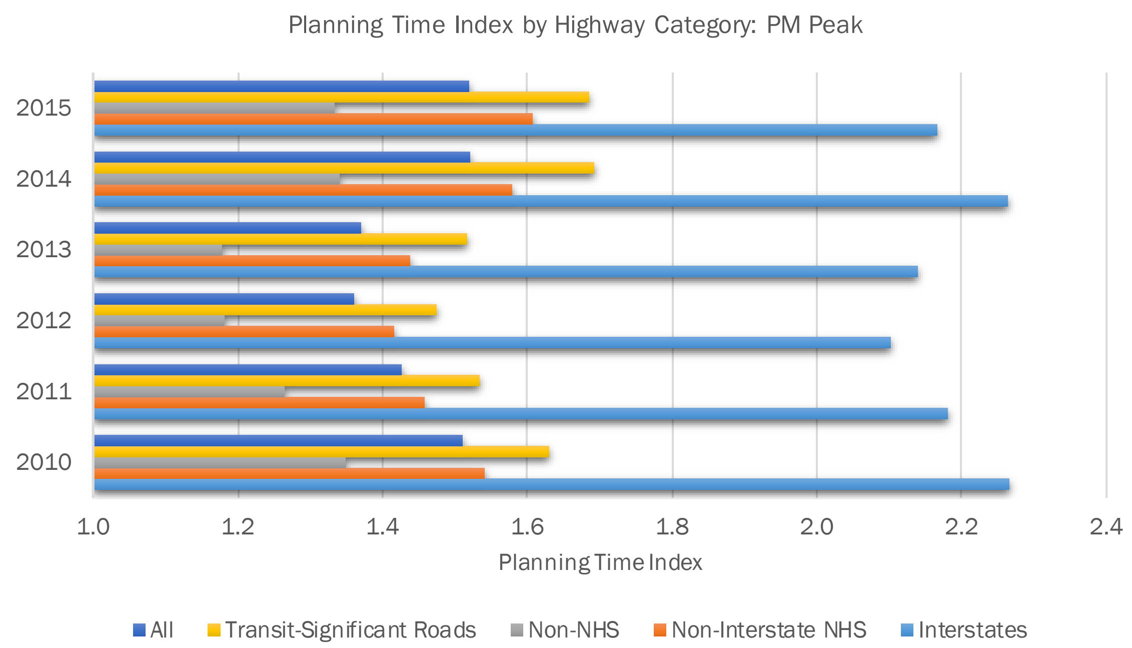


Figure 17: Annual Average Planning Time Index by Highway Category: PM Peak



2.2.1.3 Percent of Congested Miles

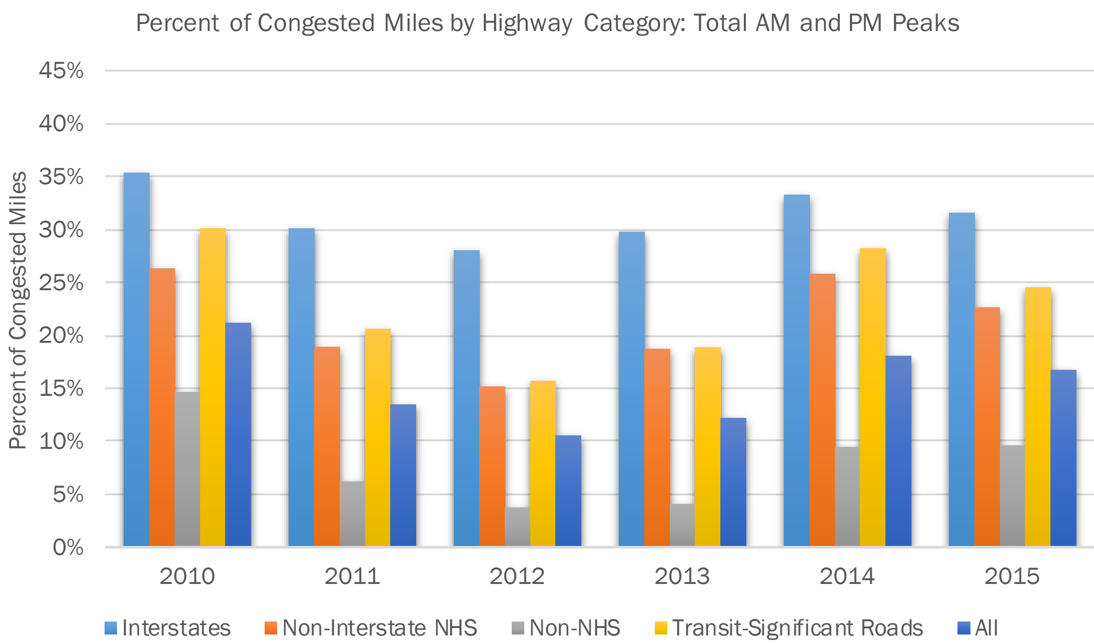
Percent of Congested (Directional) Miles is a system-wide measure that captures the spatial extent of congestion. According to the National Transportation Operations Coalition, if actual travel time is 30% longer than the free-flow travel time, i.e., Travel Time Index > 1.3, congestion is defined[38].

The annual average Percent of Congested Miles on monitored highways in the TPB Planning Area is shown below. Figure 18 is the average percentage of both AM Peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) on all weekdays in a year, Federal holidays excluded, Figure 19 is the percentage for the AM Peak, and Figure 20 is the percentage for the PM Peak. The percentage is reported by five highway categories as described earlier.

Observations from examining the Percent of Congested Miles for 2010-2015 include:

- Overall congestion trends are similar to what was observed in the Travel Time Index as described earlier.
- On average, this region had 15% of roads congested during peak periods between 2010 and 2015. More specifically, 31% of Interstate, 21% of non-Interstate NHS, 8% of non-NHS, and 23% of transit-significant roads were congested.
- There were fewer roads congested in the AM peak period than the PM peak period.

Figure 18: Annual Average Percent of Congested Miles by Highway Category: Total AM and PM Peaks



38 National Transportation Operations Coalition, National Transportation Operations Coalition (NTOC) Performance Measures Initiative, 2005. http://www.ntoctalks.com/action_teams/ntoc_final_report.pdf.

Figure 19: Annual Average Percent of Congested Miles by Highway Category: AM Peak

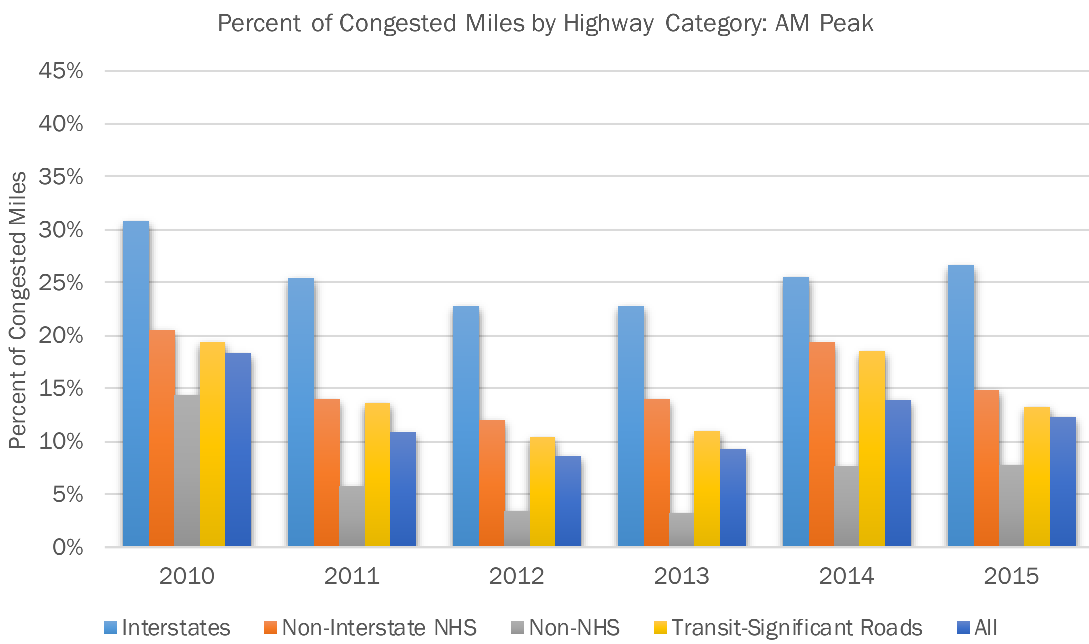
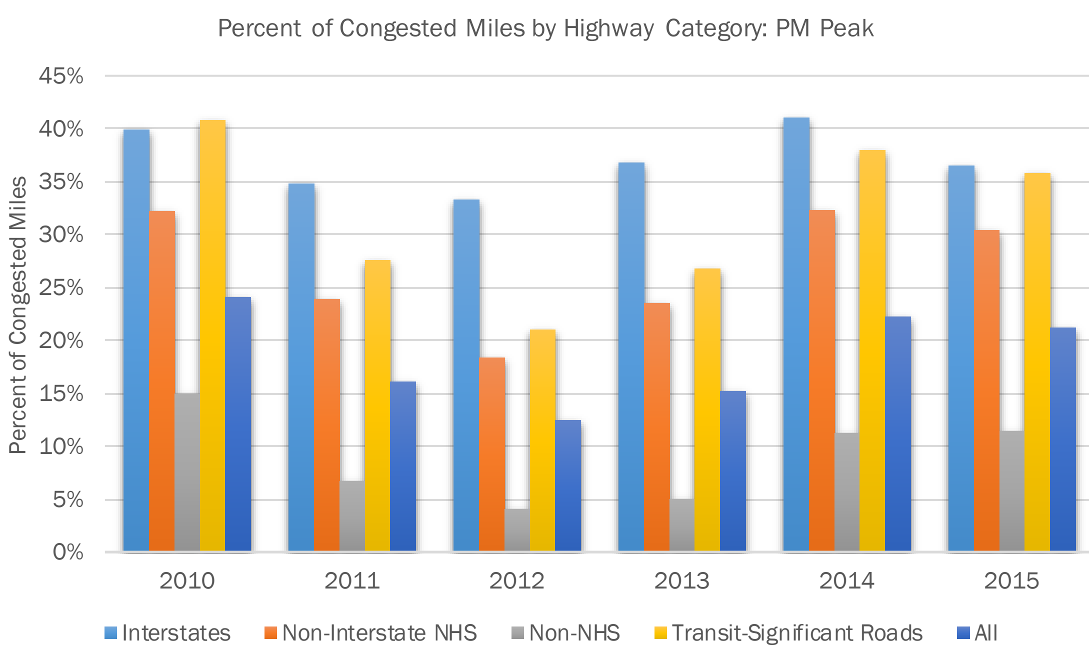


Figure 20: Annual Average Percent of Congested Miles by Highway Category: PM Peak



2.2.1.4 Congestion Monthly Variation in 2015

Congestion varies from month to month within a year, as shown in Figure 21 (total AM and PM peaks), Figure 22 (AM Peak), and Figure 23 (PM Peak). Monthly variation of congestion in 2015 had the following characteristics in the Washington region:

- Monthly variations of congestion were most pronounced on the Interstate System, followed by the Transit-Significant Roads, the Non-Interstate NHS, and the Non-NHS had the least fluctuations.
- The region overall had increasing congestion from January to May, then decreasing congestion through August. September had the highest level of congestion, after that, congestion kept decreasing for the rest of year. Four of the five investigated highway categories followed this trend. The only exception was the Interstates, on which congestion kept increasing from August to November, reaching the highest level.
- Congestion showed a great deal of variation between the AM Peak and PM Peak on the Interstate System during the second half of the year. For the AM Peak, August represented the undoubtedly “low” month (even lower than January) and October was the “high” month; for the PM Peak, the “low” month was January and the “high” was November.

Figure 21: Monthly Variation of Congestion in 2015: Total AM and PM Peaks

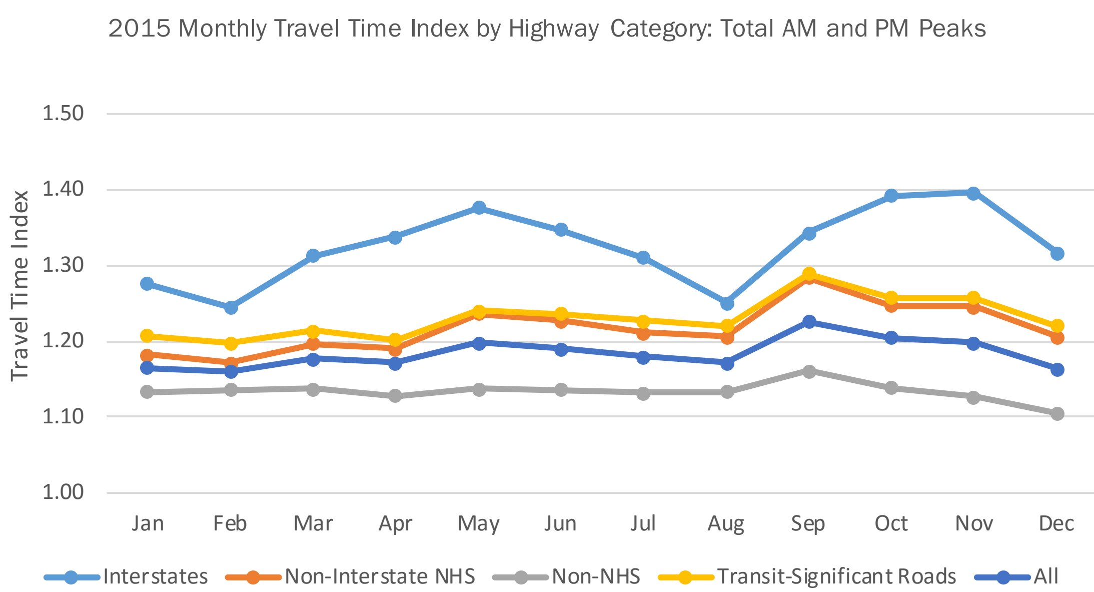


Figure 22: Monthly Variation of Congestion in 2015: AM Peak

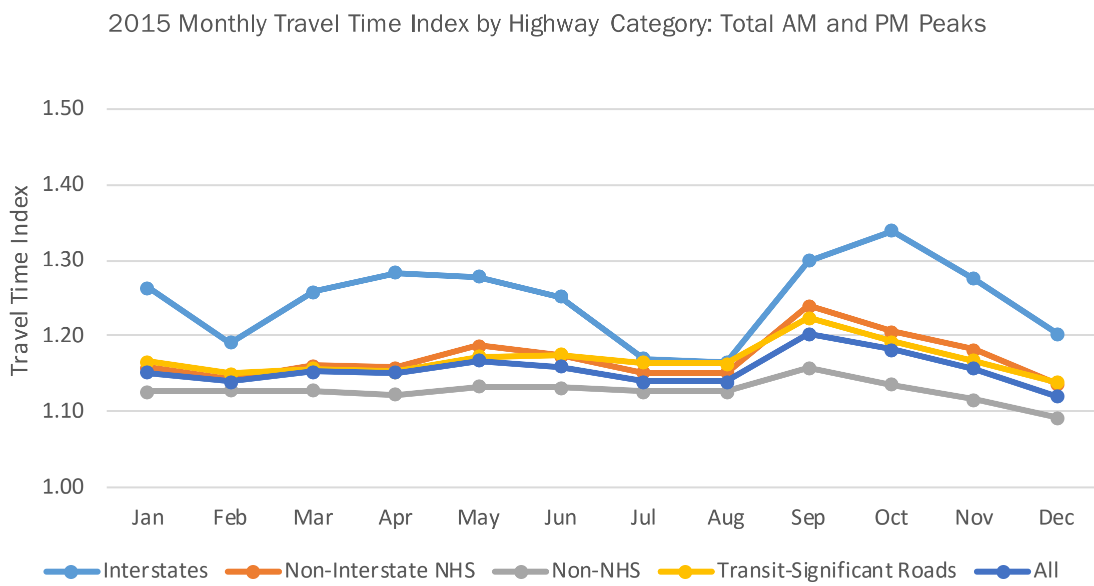
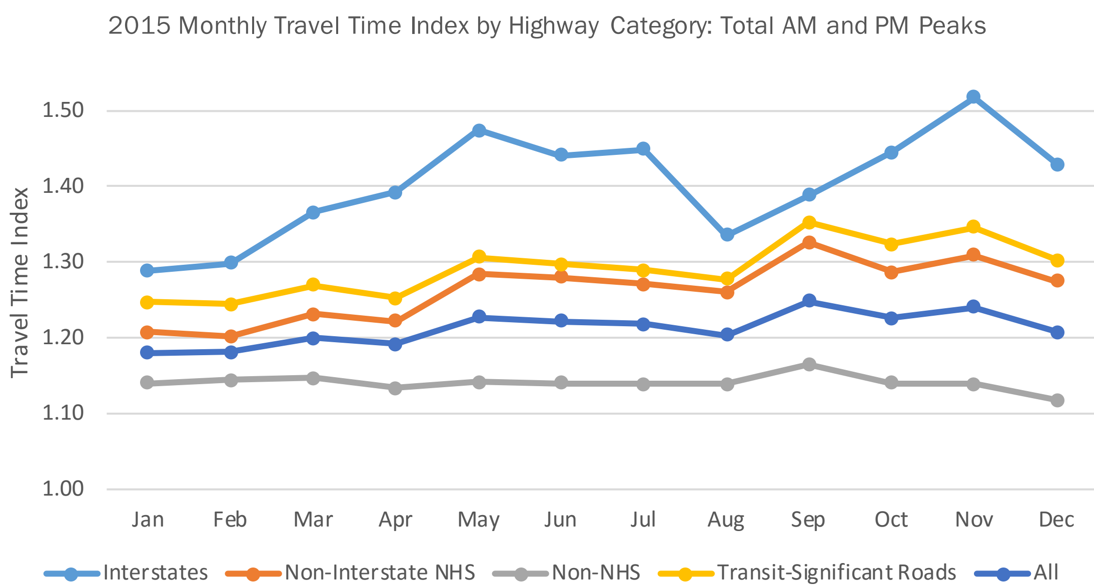


Figure 23: Monthly Variation of Congestion in 2015: PM Peak



2.2.1.5 Congestion Time of Day, Day of Week Variation in 2015

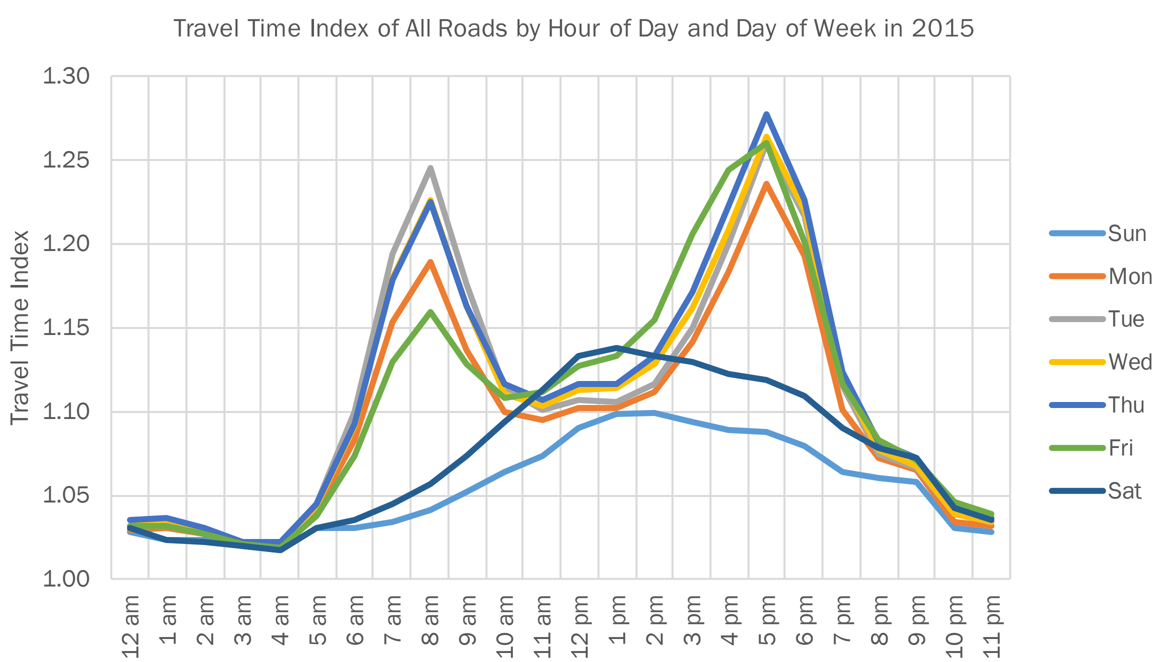
Congestion also varies within a week, as shown in Figure 24. The day of week variation of congestion on the Washington region in 2015 had the following trends. Note that these trends are a summary of all the 5,500 directional miles of roads in the region; different areas, highway facilities and routes may vary differently.

- Middle weekdays – Tuesday, Wednesday and Thursday – were the most congested days of a week. During these three weekdays, the AM Peak had almost identical congestion while the most congested PM Peak occurred on Thursday, followed by Wednesday and Tuesday.

- Monday and Friday had unique traffic patterns. Monday morning's traffic was lower than that of the middle weekdays but higher than Friday; Monday afternoon had the least congestion in all weekdays. Friday morning had the least congestion in all weekdays; Friday afternoon's congestion was almost as bad as the middle weekdays, but it came about one hour earlier without ending earlier – expanded congested time period.

- Weekend days had the lowest traffic in a week and Sunday was even lower than Saturday with no pronounced AM and PM peaks. During these two days, mid-day traffic (12:00 – 3:00 pm) was the highest.

Figure 24: Time of Day and Day of Week Variation of Congestion in 2015



2.2.1.6 Top Bottlenecks

This report takes advantage of the vehicle probe data, which provides continuous minute-by-minute speed information for more than 5,500 directional miles of both freeways and arterials in the region, presents both “all time” and “peak periods” top bottlenecks, regardless of roadway function class. The “all-time” – 24/7/365 – top bottlenecks are provided in Table 3 and Figure 25, and the “peak periods” – non-holiday weekday 6:00-9:00 am and 4:00-7:00 pm – top bottlenecks are presented in Table 4 and Figure 26.

The Travel Time Index – an indicator of the intensity of congestion and the ratio of actual travel time to free flow travel time – is used as the essential factor in ranking the bottlenecks. This method is in line with the TPB’s long-standing, density-based methodology adopted in the aerial photography survey of the region’s freeway system. From a traveler’s perspective, the length of a congested road section also matters, therefore the product of TTI and length was used in the ranking. From a system’s perspective, the number of vehicles affected by a bottleneck also has a role in decision making, so the Annual Average Daily Traffic volume (AADT) is added as another factor for the second ranking list[39].

Table 3: 2015 Top Bottlenecks – All Time

Location	State	Ave. TTI	Length (miles)	TTI*Miles	Rank by TTI*Miles	AADT	AADT*TTI* Miles	Rank by AADT*TTI *Miles
I-495 IL between VA-267 and GW Pkwy	VA	1.75	3.40	5.94	1	94,500	561,509	1
I-95 SB at VA-123	VA	1.88	1.61	3.01	2	104,000	313,445	2
New York Ave. between N. Capitol St. and I-395	DC	1.65	1.61	2.65	3	25,400	67,423	8
DC-295 SB at Benning Rd.	DC	1.71	1.55	2.64	4	60,632	160,142	4
I-495 OL between MD-193 and MD-650	MD	1.52	1.71	2.61	5	104,670	273,222	3
I-270 SPUR SB between Democracy Blvd. and I-495	MD	1.70	1.31	2.23	6	65,406	145,651	5
Constitution Ave WB between 12th St. and 17th St.	DC	1.74	0.91	1.59	7	16,024	25,448	11
DC-295 NB at Pennsylvania Ave	DC	1.68	0.75	1.26	8	49,349	62,225	9
I-395 NB between US-1 and GW Pkwy	VA	1.59	0.74	1.17	9	91,000	106,545	6
I-66 WB at Vaden Dr./Exit 62	VA	1.52	0.64	0.98	10	79,500	77,815	7
I-66 EB at VA-267	VA	1.66	0.25	0.42	14	65,500	27,247	10

[39] The methodology used in this report is different from that of the VPP Suite.

Table 4: 2015 Top Bottlenecks – Peak Periods

Location	State	Ave. TTI	Length (miles)	TTI*Miles	Rank by TTI*Miles	AADT	AADT*TTI* Miles	Rank by AADT*TTI *Miles
I-495 IL between VA-267 and I-270 Spur	VA, MD	2.69	8.36	22.47	1	110,376	2,480,129	1
I-495 OL between I-95 and MD-193	MD	2.57	4.35	11.17	2	104,670	1,168,848	2
I-66 EB at VA-267	VA	2.47	2.83	6.99	3	65,500	458,043	6
I-270 SPUR SB	MD	3.21	2.04	6.56	4	65,406	429,242	8
DC-295 SB at Benning Rd.	DC	2.59	2.28	5.89	5	59,376	349,827	10
I-95 SB at VA-123	VA	2.34	2.46	5.75	6	104,000	597,810	4
VA-28 SB between US-50 and I-66	VA	2.32	2.30	5.33	7	50,000	266,469	12
US-15 NB between VA-7 and N. King St.	VA	2.56	2.02	5.19	8	8,800	45,656	26
I-495 OL between I-270 and MD-190	MD	2.26	2.22	5.01	9	122,010	611,335	3
I-495 IL between MD-355 and MD-185	MD	2.23	1.96	4.38	10	110,876	485,635	5
I-66 WB at Vaden Dr./Exit 62	VA	2.17	1.87	4.05	11	79,500	322,083	11
I-495 IL between I-95 and US-1	MD	2.32	1.68	3.91	12	111,740	437,336	7
I-495 OL at Telegraph Rd.	VA	2.33	1.48	3.43	13	76,500	262,657	13
I-495 OL at MD-202/Landover Rd.	MD	2.09	1.54	3.22	14	113,390	364,755	9

Figure 25: 2015 Top Bottlenecks – All Time

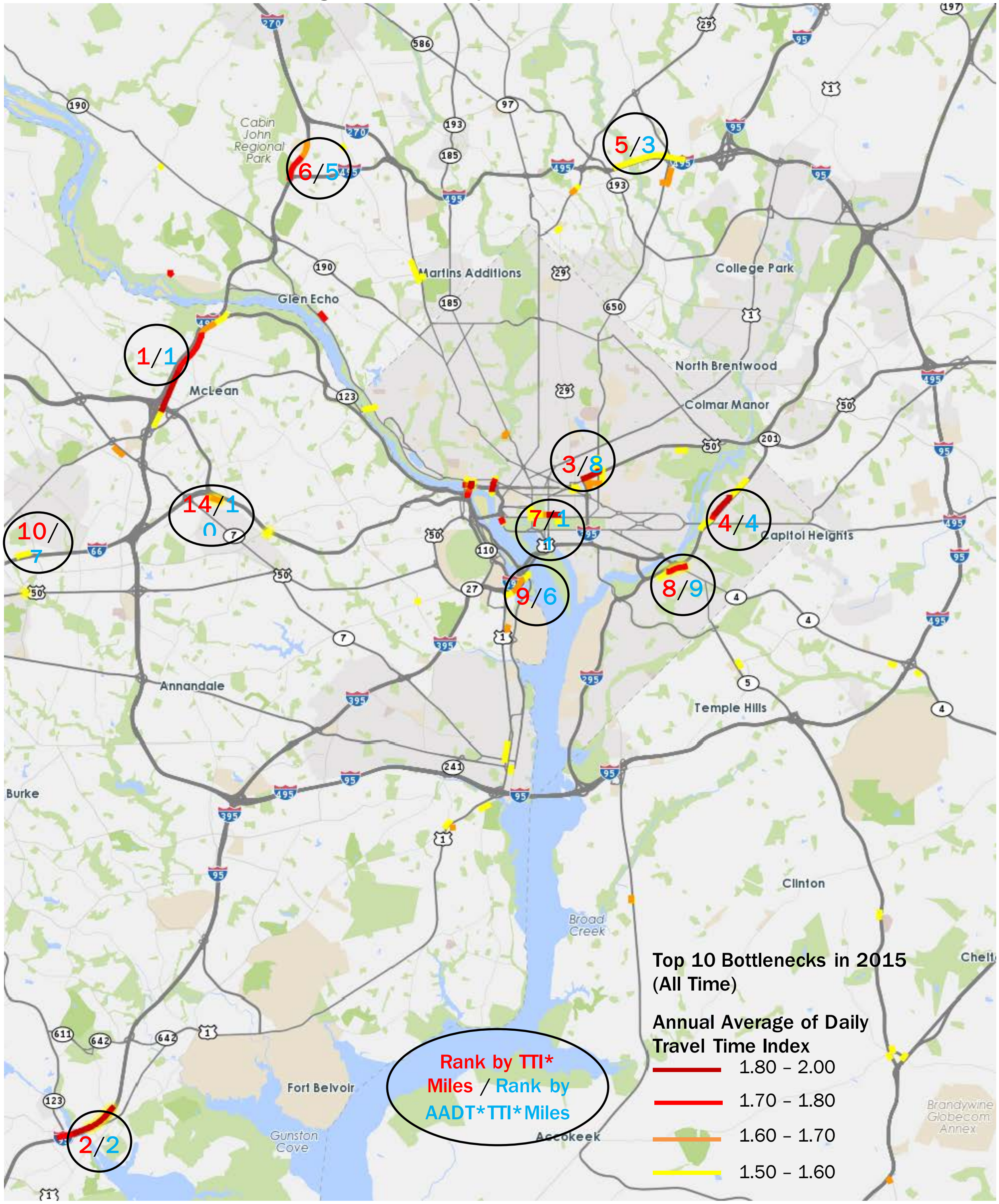
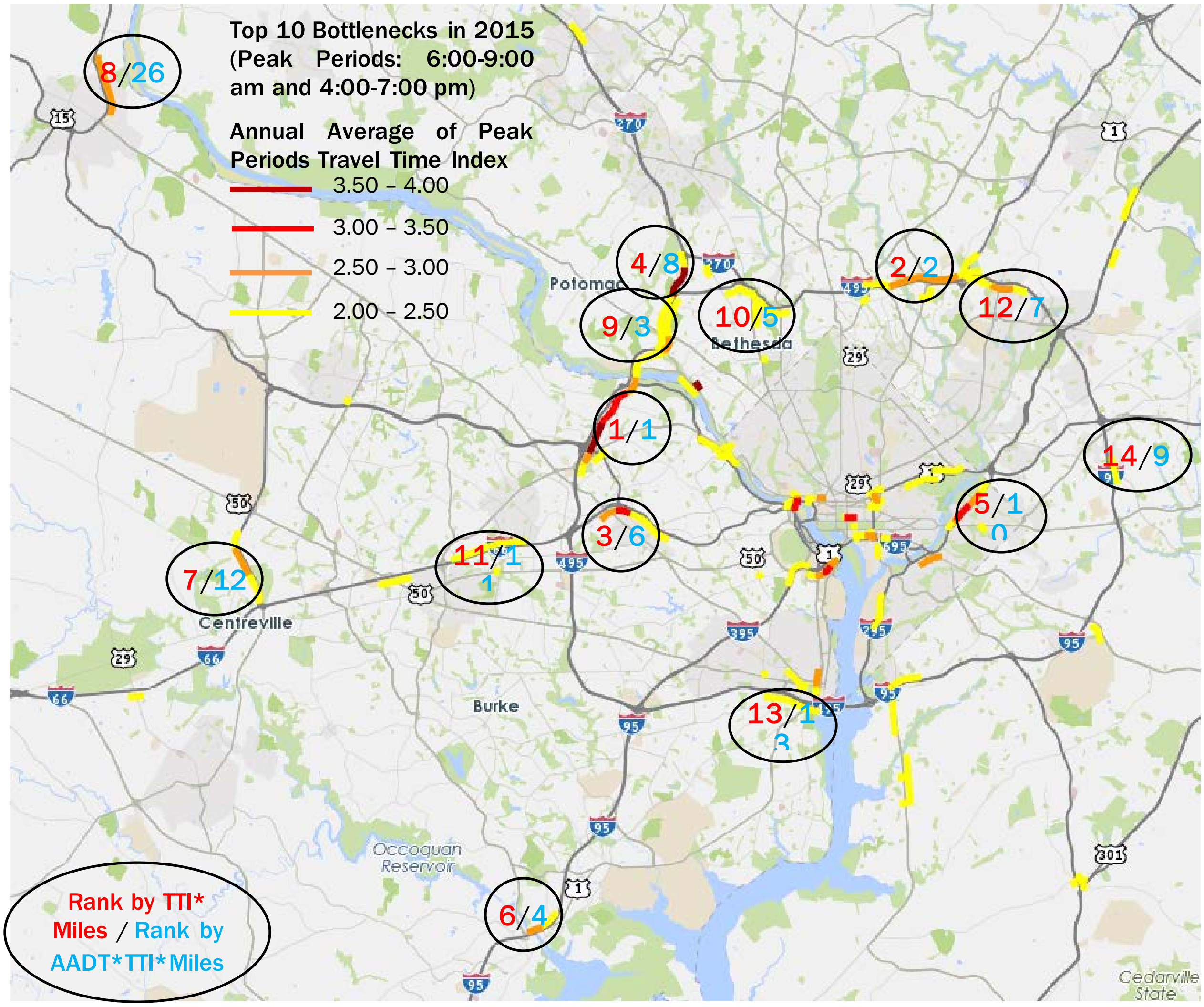


Figure 26: 2015 Top Bottlenecks – Peak Periods



2.2.1.7 Travel Times along Major Freeway Commute Routes

In addition to the regional summaries as presented by the above performance measures, route- or corridor-specific analysis has also been carried out in this report. A total of 18 major freeway commute routes are defined between major interchanges and/or major points of interest, as shown in Table 5 and Figure 27.

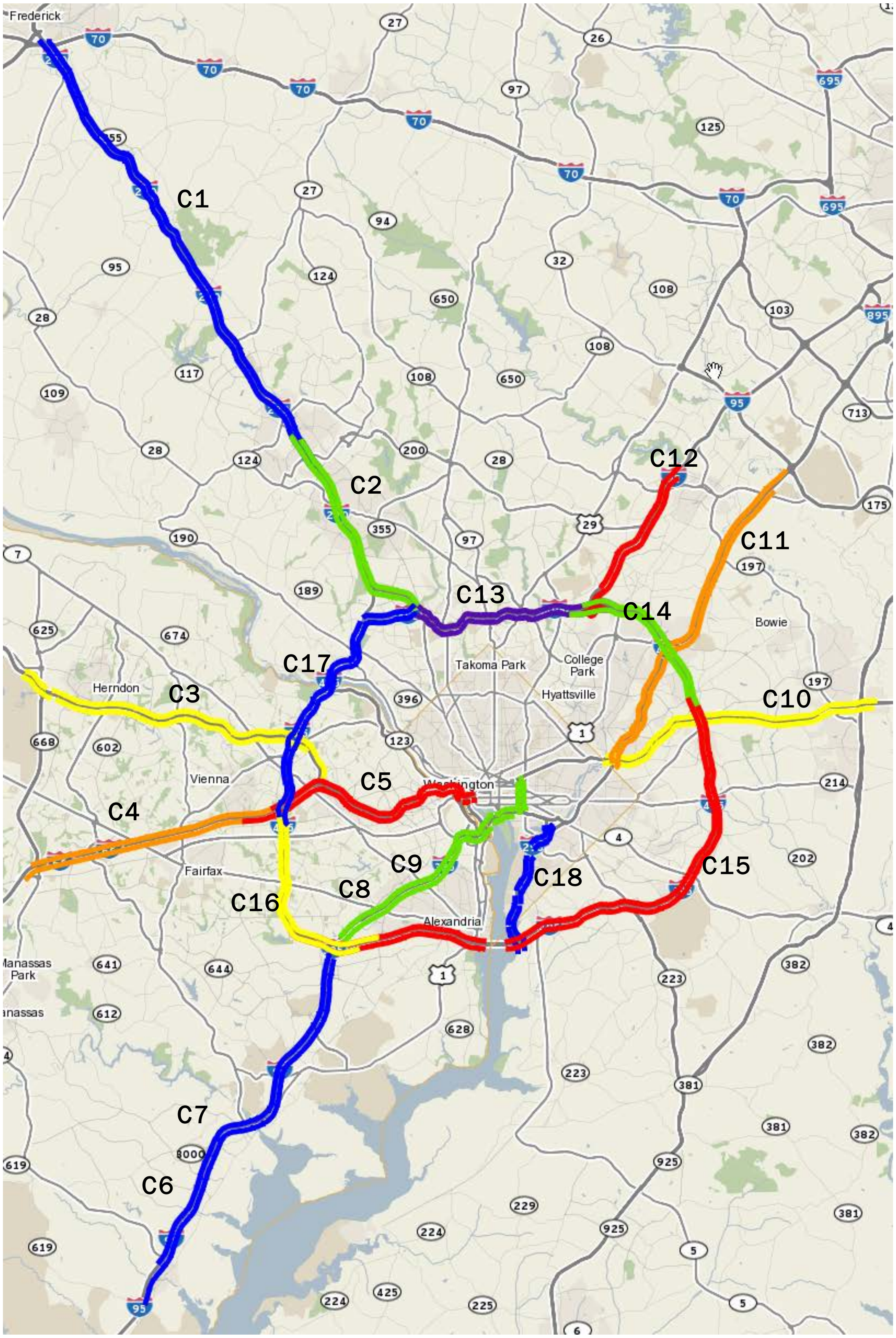
Travel times along the 18 major commute routes in both directions were plotted by the "Performance Charts" tool of the VPP Suite for every Tuesday, Wednesday and Thursday in 2010 and 2013-2015, as shown in Figure 28 below (one example) and Appendix C (all 18 corridors). The travel times and planning times (95th percentile travel times) during AM Peak Hour (8:00-9:00 am) and PM Peak Hour (5:00-6:00 pm) are also provided in Table 6 and Table 7.

One caveat of the method employed in the major commute route analysis is that the route travel time is calculated as *instantaneous travel time* other than *experienced travel time*. Instantaneous travel time is the travel time that would result if prevailing traffic conditions remained unchanged; in other words, the instantaneous route travel time is simply the sum of all segment travel times. The experienced travel time is the travel time of the user who has just completed the considered trip, and is generally not equal to the sum of segment travel times, especially during unstable traffic conditions. This caveat in the methodology merits future improvements.

Table 5: Major Freeway Commute Routes

Route Code	Description
C1	I-270 between I-370/Sam Eig Hwy/Exit 9 and I-70/US-40
C2	I-270 between I-370/Sam Eig Hwy/Exit 9 and I-495/MD-355
C3	VA-267 between VA-28/Exit 9a and VA-123/Exit 19
C4	I-66 between VA-28/Exit 53 and I-495/Exit 64
C5	I-66 between I-495/Exit 64 and Theodore Roosevelt Memorial Bridge
C6	I-95 between VA-234/Exit 152 and Franconia Rd/Exit 169
C7	I-95 HOV between VA-234/Exit 152 and Franconia Rd/Exit 169
C8	I-395 between I-95 and H St
C9	I-395 HOV between I-95 and US-1
C10	US-50 between MD-295/Kenilworth Ave and US-301/Exit 13
C11	MD-295 between US-50/MD-201/Kenilworth Ave and MD-198
C12	I-95 between I-495/Exit 27-25 and MD-198/Exit 33
C13	I-495 between I-270/Exit 35 and I-95/Exit 27
C14	I-495 between I-95/Exit 27 and US-50/Exit 19
C15	I-495 between US-50/Exit 19 and I-95/I-395/Exit 57
C16	I-495 between I-95/I-395/Exit 57 and I-66/Exit 9
C17	I-495 between I-66/Exit 9 and I-270/Exit 35
C18	I-295 between I-495 and 11th St. Bridge

Figure 27: Major Freeway Commute Routes



(Screenshot was captured from vpp.ritis.org in April 2014)

Figure 28: Sample of Travel Times along Major Freeway Commute Routes

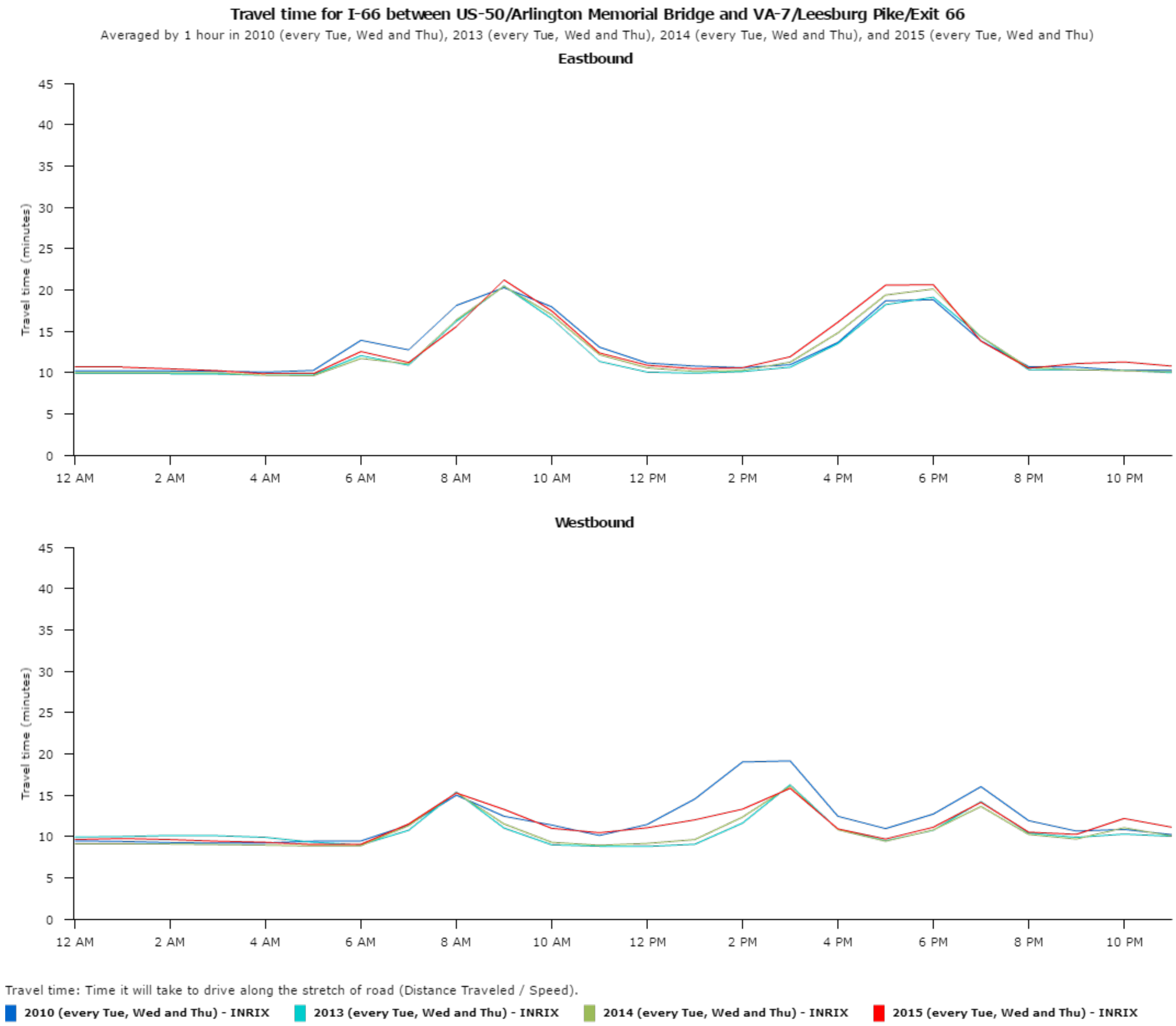


Table 6: Travel Time on Major Freeway Commute Routes in AM Peak Hour (8:00-9:00 am)

Route	Length (miles)	Average Travel Time in AM Peak Hour 8:00-9:00 am (min)				Reliable (95th) Travel Time* in AM Peak Hour 8:00-9:00 am (min)				2015 Changes in Average Travel Time in AM Peak Hour (min)			2015 Changes in 95th Travel Time in AM Peak Hour (min)		
		2010	2013	2014	2015	2010	2013	2014	2015	vs. 2010	vs. 2013	vs. 2014	vs. 2010	vs. 2013	vs. 2014
C1: I-270 SB from I-70 to I-370	24	42	34	36	38	84	63	64	69	-3	4	3	-15	7	5
C2: I-270 SB from I-370 to I-495	10	22	17	18	20	41	32	35	42	-2	3	2	1	10	7
C3: VA-267 EB from VA-28 to VA-123	14	29	21	21	23	65	40	38	39	-5	2	2	-26	-1	1
C4: I-66 EB from VA-28 to I-495	12	29	21	23	22	61	36	41	36	-7	1	-1	-24	1	-5
C5: I-66 EB from I-495 to TR Bridge	13	18	16	16	16	32	32	32	28	-3	-1	-1	-4	-4	-4
C6: I-95 NB from VA-234 to Exit 169	20	28	28	32	23	67	63	69	40	-5	-5	-9	-26	-23	-29
C7: I-95 NB HOV from VA-234 to Exit 169	18	20	17	17	16	26	21	22	17	-4	-1	-1	-9	-3	-5
C8: I-395 NB from I-95 to H St.	13	41	42	41	45	89	94	90	96	3	3	3	7	2	6
C9: I-395 NB HOV from I-495 to US-1	11	16	13	14	15	31	24	26	27	-1	2	1	-3	3	2
C10: US-50 WB from US-301 to MD-295	14	23	21	21	22	40	34	35	37	-1	1	1	-3	3	2
C11: MD-295 SB from MD-198 to US-50	16	29	25	26	29	65	49	47	49	0	3	3	-16	0	2
C12: I-95 SB from MD-198 to I-495	8	13	9	10	13	28	19	20	24	0	4	3	-4	5	4
C13: I-495 IL from I-270 to I-95	10	15	12	13	14	23	19	20	21	-1	1	1	-2	2	2
C14: I-495 IL from I-95 to US-50	9	11	11	11	11	14	13	15	15	0	0	0	1	1	0
C15: I-495 IL from US-50 to I-95	28	31	35	37	42	50	60	68	79	11	7	5	29	19	11
C16: I-495 IL from I-95 to I-66	10	29	13	17	18	49	19	35	31	-11	6	2	-18	11	-4
C17: I-495 IL from I-66 to I-270	14	19	19	26	26	31	35	52	48	7	7	1	17	13	-4
C13: I-495 OL from I-95 to I-270	10	33	30	30	34	53	50	49	56	1	4	3	3	6	6
C14: I-495 OL from US-50 to I-95	10	17	15	15	16	30	25	25	26	-2	1	0	-4	2	2
C15: I-495 OL from I-95 to US-50	29	36	32	36	39	57	50	58	60	2	6	2	3	10	2
C16: I-495 OL from I-66 to I-95	11	11	10	10	11	12	10	12	13	0	1	1	1	3	2
C17: I-495 OL from I-270 to I-66	14	17	14	15	16	26	19	19	21	-2	1	1	-4	3	2
C18: I-295 NB from I-495 to 11th St. Brdg.	6	14	16	13	15	35	33	36	37	1	-1	2	2	3	1

* The majority (95%) of trips spent equal to or less than the reliable (95^{th}) travel time on the specified route. On average, a traveler could successfully complete the travel on the specified route within the reliable travel time during 19 out of 20 trips (only 1 trip could exceed the reliable travel time).

Table 7: Travel Time on Major Freeway Commute Routes in PM Peak Hour (5:00-6:00 pm)

Route	Length (miles)	Average Travel Time in PM Peak Hour 5:00-6:00 pm (min)				Reliable (95th) Travel Time* in PM Peak Hour 5:00-6:00 pm (min)				2015 Changes in Average Travel Time in PM Peak Hour (min)			2015 Changes in 95th Travel Time in PM Peak Hour (min)		
		2010	2013	2014	2015	2010	2013	2014	2015	vs. 2010	vs. 2013	vs. 2014	vs. 2010	vs. 2013	vs. 2014
C1: I-270 NB from I-370 to I-70	24	38	35	36	38	77	60	64	64	0	3	2	-13	4	0
C2: I-270 NB from I-495 to I-370	9	16	14	13	14	28	26	24	25	-2	0	1	-3	-2	1
C3: VA-267 WB from I-66 to VA-28	15	20	18	19	21	33	27	30	33	1	3	2	0	5	3
C4: I-66 WB from I-495 to VA-28	13	26	31	32	31	46	56	59	58	5	0	-1	12	2	-1
C5: I-66 WB from TR Bridge to I-495	11	11	9	9	10	17	13	12	12	-1	0	0	-5	-1	0
C6: I-95 SB from Exit 169 to VA-234	18	49	46	43	29	110	99	89	50	-20	-17	-14	-61	-50	-40
C7: I-95 SB HOV from Exit 169 to VA-234	17	18	18	18	15	27	27	30	17	-3	-3	-3	-10	-10	-13
C8: I-395 SB from H St. to I-95	14	28	29	32	34	48	52	64	63	7	5	3	14	11	-1
C9: I-395 SB HOV from US-1 to I-495	11	11	10	11	11	18	12	16	14	-1	1	0	-3	3	-2
C10: US-50 EB from MD-295 to US-301	13	18	16	16	16	26	22	21	22	-1	0	1	-4	0	1
C11: MD-295 NB from US-50 to MD-198	15	33	30	29	29	59	59	54	54	-4	-1	1	-5	-4	0
C12: I-95 NB from I-495 to MD-198	7	8	9	8	10	14	18	17	20	2	1	2	5	1	3
C13: I-495 IL from I-270 to I-95	10	26	19	22	22	50	45	49	44	-4	3	0	-6	-1	-5
C14: I-495 IL from I-95 to US-50	9	17	17	19	23	31	32	34	38	6	5	3	7	6	4
C15: I-495 IL from US-50 to I-95	28	33	29	32	37	48	37	43	56	4	8	5	8	19	13
C16: I-495 IL from I-95 to I-66	10	13	10	10	10	26	12	12	11	-4	0	-1	-14	-1	-1
C17: I-495 IL from I-66 to I-270	14	43	40	47	44	96	81	107	88	1	4	-3	-8	8	-19
C13: I-495 OL from I-95 to I-270	10	21	14	16	14	50	28	38	27	-7	0	-2	-23	-1	-11
C14: I-495 OL from US-50 to I-95	10	16	15	15	15	30	28	26	25	0	0	0	-5	-2	0
C15: I-495 OL from I-95 to US-50	29	36	39	47	51	64	77	95	96	15	12	4	32	20	1
C16: I-495 OL from I-66 to I-95	11	16	12	15	16	24	18	24	25	0	4	2	1	7	1
C17: I-495 OL from I-270 to I-66	14	35	20	23	31	71	35	46	58	-4	12	8	-13	22	11
C18: I-295 SB from 11th St. Brdg. to I-495	6	14	15	17	20	25	27	30	33	5	5	2	8	6	3

* The majority (95%) of trips spent equal to or less than the reliable (95^{th}) travel time on the specified route. On average, a traveler could successfully complete the travel on the specified route within the reliable travel time during 19 out of 20 trips (only 1 trip could exceed the reliable travel time).

2.2.1.8 Congestion on Arterials

Congestion Characteristics on Arterials

An arterial highway is defined as an interrupted flow roadway. Arterials are different than freeways in that they tend to have multiple ingress and egress points, intersections, fewer lanes, and lower speeds. Due to these characteristics, the congestion on arterials can be caused from reasons different from that of freeways.

As mentioned earlier, the TPB had carried out Arterial Floating Car Travel Time Studies from 2000 – 2011 on selected NHS arterial highways in the region. These studies had identified some common themes and trends about general arterial congestion:

- There are competing demands of traveler mobility and accessibility to adjacent land uses affecting arterial operations.
- Growth and development can contribute to rapid worsening of congestion at specific locations.
- Intersections and driveways can cause slow-downs and backups along arterials.
- Arterials often experience spillover from freeways.
- Arterials tend to be heavily traveled in densely developed corridors.
- Traffic engineering improvements, such as extending a turn lane or traffic signal timing, can help soften the impacts of growth.
- By nature of design and other factors, arterials can be a mix of speeds, depending on things such as number of traffic signals, intersections, and lanes.
- Since the Washington region has a limited number of freeway lane miles, the region is especially dependent upon its arterial highways for mobility.
- Cars share the road with transit and delivery vehicles with frequent stops.

Although congestion occurs on arterials throughout the region, there are also common trends that are generally associated with the land use and urban form surrounding the arterial. For the purposes of this report, we will classify these as metro core, inner suburban and outer suburban arterials.

Arterials in the Inner Core

The characteristics of the inner core of a region, by their urban nature, can greatly impact the flow of traffic on the core's arterials:

- Pedestrian and transit access to densely populated land uses are a major focus of inner core roadways. Traffic speeds must be at a level that ensures pedestrian safety.
- The flow of traffic is more frequently interrupted by a higher concentration of signaled intersections and driveways/alleyways in the inner core.
- Intersections tend to be close together. If traffic is stopped at an intersection, sometimes backups can occur through the intersection behind it. In addition, traffic blocking an intersection could impact the flow of traffic on the cross street.
- There are not always turn lanes present, so drivers may have to wait while a car in front of them makes a turn.
- On-street parking necessitates slower traffic speeds. In addition, some inner core arterials experience worse congestion in the off-peak period because two lanes of capacity are lost due to on-street parking during the day.

- In many older areas, a grid pattern of streets allows for multiple travel routes at moderate speeds.

For example, many of these inner core characteristics play a role in the congestion on Connecticut Ave NW, between K Street NW and Nebraska Ave NW. This segment of Connecticut Ave is a dense corridor of retail and commercial activity which attracts a large number of pedestrians and drivers searching for on-street parking.

Congestion management strategies that can help manage congestion on core arterials include operations management strategies such as optimized traffic signal timing and traffic engineering improvements. Relevant demand management strategies include robust transit services in these densely populated areas, employer outreach of alternative commute programs, as well as improved pedestrian and bicycle facilities.

Arterials in the Inner Suburbs

Arterials in the inner suburbs have characteristics combined from that of the inner core and outer suburban arterials.

- Signalized intersections, especially the intersections of major arterial roadways, have capacity limitations, especially when there are high percentages of turning movements at those intersections.
- Traffic from both nearby offices and residences can cause congestion.
- There can be spillover from adjacent congested freeways.
- Strip retail and other "destination" retail activities are often located along arterials. In the inner suburbs the density of these uses is likely higher than that of the outer suburbs, and ingress/egress points are closer together. This could cause disruptions in traffic flow during peak times.
- Inner suburban areas have been experiencing welcome increases in pedestrians and transit usage in recent years, which must be considered in operations planning for arterials in these areas.

For example, these inner suburban arterial qualities are true of US 29, which extends from Arlington, VA to Centreville, VA. The segment between M Street NW in DC and Harrison Street in Arlington is lined with several strip retail areas.

US 29 is also a major alternative commuting route of I-66, and it provides access to I-66 at several different locations. US 29 experienced spillover from several major freeways in the vicinity, including I-66 and the Beltway.

Georgia Ave, between Eastern Ave NW (DC boundary) and MD 28 also experiences situations typical of inner suburban arterials. Georgia Ave links Aspen Hill area to Silver Spring, serving as one of the major commuting routes to and from DC for the communities between I-270 and I-95 in Montgomery County in Maryland. The southern part of the corridor connects to US 29 in Silver Spring, a major arterial cross the region. Georgia Ave also experienced spillover from the Beltway in Silver Spring.

Congestion management strategies that can help inner suburban arterials include operational management strategies such as optimized traffic signals, operational management improvements on nearby freeways, and traffic engineering improvements. Often off-peak signal timing in inner suburban arterials can be worse than the peak hours, as a high number of people are moving in all directions and not with peak flow movement. Relevant demand management strategies include transit services, bus rapid transit, and Commuter Connections programs (especially employer-based programs).

Arterials in the Outer Suburbs

Arterials in the outer suburbs have their own unique characteristics:

- New development in the outer suburbs may quickly overwhelm the capacities of what were until recently lightly traveled rural roads.
- Because commute distances in the outer suburbs tend to be longer, peaking characteristics of traffic are much sharper.
- Transit services and pedestrian facilities are limited.
- Not unlike the inner suburbs, strip retail and other “destination” retail activities are likely to be located along outer suburban arterials. This could cause disruptions in traffic flow during peak times.
- Outer suburban arterials can also experience spillover from major freeways. This is especially expected during the morning and evening peak period when commuters drive to and from the inner core for work.

For example, MD144 between Waverly Road and Monocacy Boulevard in Frederick County experiences spillover from two major roadways that bypass in Frederick: I-70/I-270 and US 340/US 15 (Catoctin Mountain Highway).

The northern section of VA 7 between Georgetown Pike and VA 653 links Fairfax County to Leesburg. It is a major commuting route which connects to VA 28. The stretch of arterial from the Loudoun County line to Sterling has seen much commercial and retail development over the past several years.

Congestion management strategies that can help outer suburban arterials include operational management strategies such as bottleneck removal, dedicated turn lanes, and other traffic engineering improvements. Relevant demand management strategies include park-and-ride lots, commuter bus and rail services and Commuter Connections programs (especially employee-focused programs).

Congestion on Selected Arterials

Given the availability of the I-95 VPP/INRIX data, the TPB has adopted this third-party probe-based data for arterial travel time monitoring. This new data source enabled more detailed analysis of travels along arterials including travel time reliability. Appendices A and B provide the peak hour Travel Time Index and Planning Time Index on most of the region’s NHS arterials and other probe data monitored roadways for 2015.

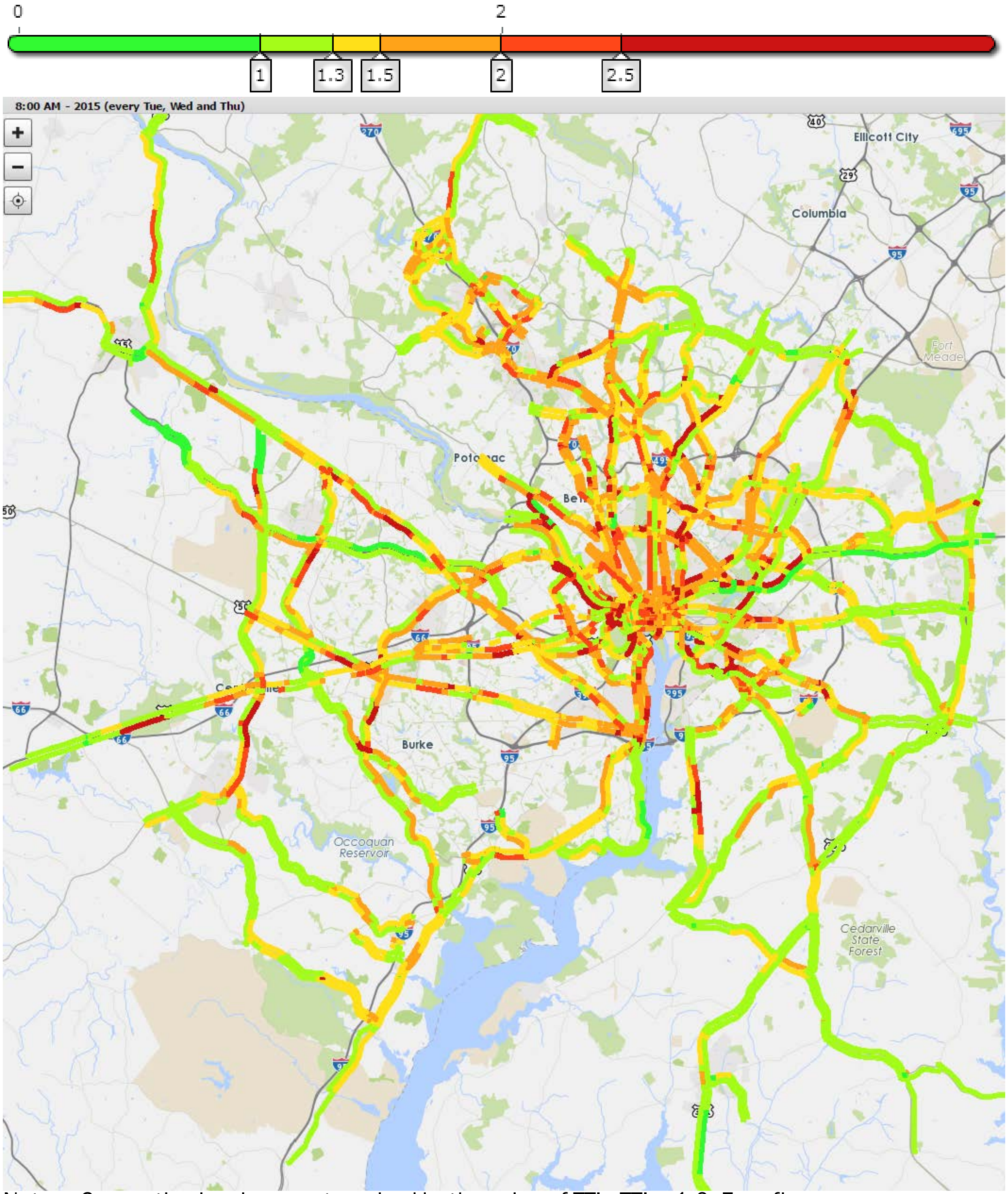
In addition to the regional summaries and congestion mapping on arterials that have been presented earlier in this chapter, this report also investigates the travel times along the study routes under the historical floating car surveys. This includes 58 routes shown in Table 8 below. Travel Time Index of the studied routes and other NHS arterials for middle weekday peak hours (8:00-9:00 am and 5:00-6:00 pm on Tuesdays, Wednesdays, and Thursdays) are mapped in Figure 29 and Figure 30.

Table 8: Arterial Travel Time Study Routes

State	Route	From/To	To/From	Length (miles)
DC	14th St	Independence Ave	K St	1.0
DC	16th St	K St	Eastern Ave	6.1
DC	17th St	Pennsylvania Ave	Independence Ave	0.5
DC	7th St/Georgia Ave Sec. 1	Independence Ave	New Hampshire Ave	2.8
DC	7th St/Georgia Ave Sec. 2	New Hampshire Ave	Eastern Ave	3.5
DC	Canal Rd/M St	30th St	Chain Bridge	3.7
DC	Connecticut Ave	K St	Nebraska Ave	4.0
DC	Constitution Ave	Louisiana Ave	14th St NE	1.5
DC	H St	Pennsylvania Ave	14th St NW	0.6
DC	Independence Ave	17th St	2nd St SE	1.9
DC	K St/New York Ave	21st St NW	Bladensburg Rd	4.2
DC	L St	Pennsylvania Ave	14th St NW	1.1
DC	Military Rd	Connecticut Ave	Georgia Ave	2.5
DC	Pennsylvania Ave	Constitution Ave	15th St NW	0.8
DC	Rhode Island Ave	7th St	Eastern Ave	3.5
DC	South Dakota Ave	Bladensburg Rd	Riggs Rd	3.0
DC	US 50	17th St	T. R. Bridge	0.9
DC	US 29	M St	Whitehurst Fwy	0.5
DC	Wisconsin Ave	M St	Western Ave	4.1
MD	MD 117	Muddy Branch Rd	Clarksburg Rd	6.8
MD	MD 193	Colesville Rd	Adelphi Rd	4.6
MD	MD 198	MD 650	Old Gunpowder Rd	5.2
MD	MD 210	Southern Ave	Livingston Rd	10.5
MD	MD 355 Sec. 1	MD 124	MD 547	10.1
MD	MD 355 Sec. 2	MD 547	Western Ave	5.3
MD	MD 4	Southern Ave	Dowerhouse Rd	7.0
MD	MD 450	US 301	B. W. Pkwy	12.1
MD	MD 586	MD 28	MD 193	5.0
MD	MD 193	US 29	MD 185	4.2
MD	MD 28	Veirs Mill Rd	New Hampshire Ave	9.0
MD	MD 5	Suitland Pkwy	Accokeek Rd	12.2
MD	MD 97 Sec. 1	Eastern Ave	University Blvd	4.2
MD	MD 97 Sec. 2	University Blvd	MD 28	5.3
MD	Randolph Rd	MD 355	Columbia Pike	9.1
MD	US 1 Sec. 1	MD 198	MD 193	8.1
MD	US 1 Sec. 2	MD 193	Eastern Ave	5.3
MD	US 29	East-West Hwy	Fairland Rd	7.1
VA	US 15	VA 7	Lovettsville Rd	12.6
VA	US 50 Sec. 1	VA 28	Nutley St	13.4
VA	US 50 Sec. 2	Nutley St	Fort Myer Dr	12.3

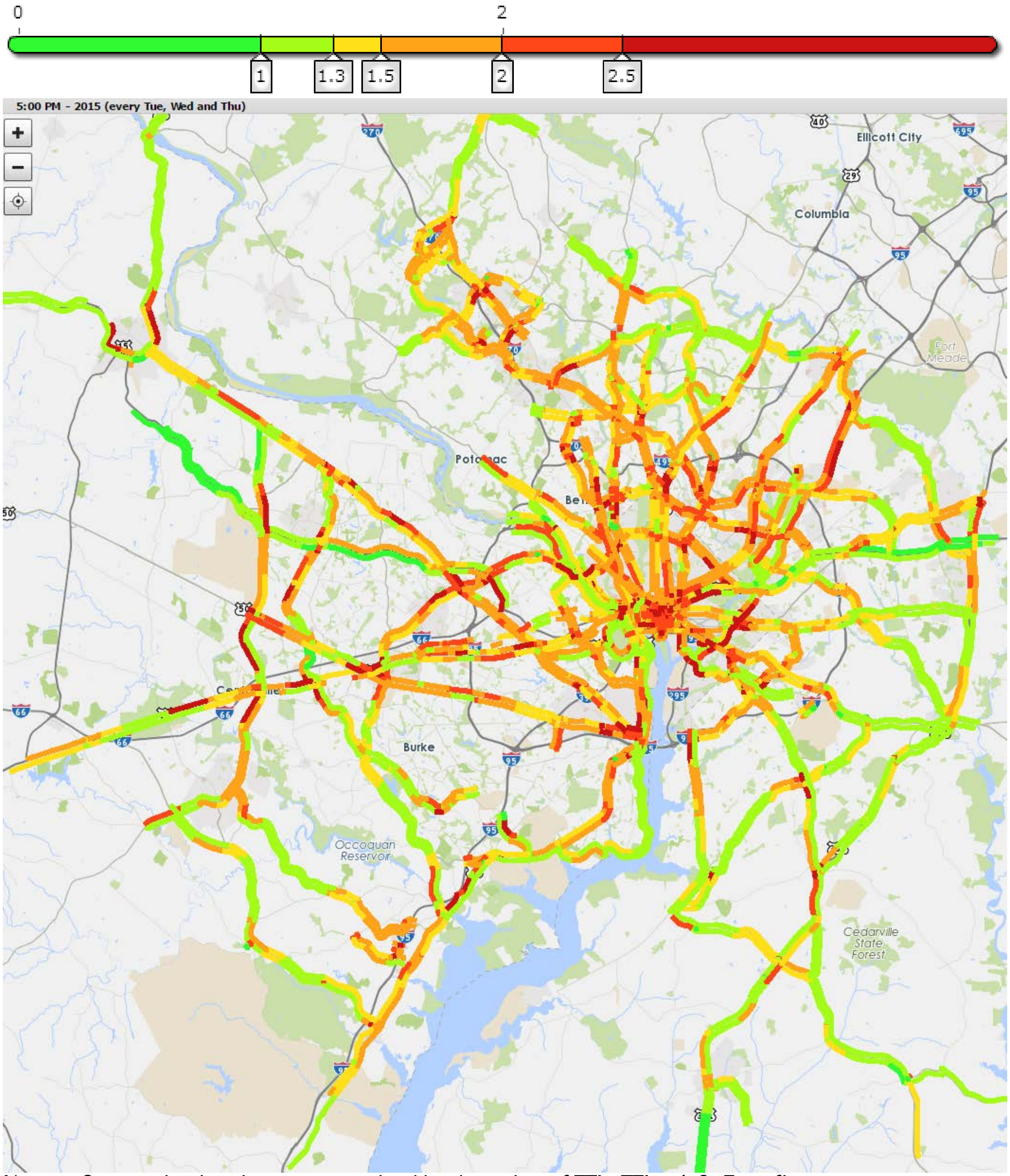
VA	US 1	15th St	VA 123	20.0
VA	US 29 Sec. 1	G.W. Pkwy	Gallows Rd	9.0
VA	US 29 Sec. 2	Gallows Rd	VA 236	8.8
VA	US 29 Sec. 3	VA 236	Bull Run PO Rd	7.5
VA	VA 120	I 395	Chain Bridge	8.3
VA	VA 123 Sec. 1	VA 193	VA 7	5.8
VA	VA 123 Sec. 2	VA 7	VA 236	7.1
VA	VA 123 Sec. 3	VA 236	US 1	14.8
VA	VA 234 Sec. 1	US 1	Hoadley Rd	10.2
VA	VA 234 Sec. 2	Hoadley Rd	US 29	13.2
VA	VA 28 Sec. 1	Wellington Road	Compton Rd	7.0
VA	VA 28 Sec. 2	Compton Rd	VA 7	17.0
VA	VA 7 Sec. 1	Braddock Rd	Gallows Rd	9.5
VA	VA 7 Sec. 2	Gallows Rd	VA 193	10.0
VA	VA 7 Sec. 3	VA 193	VA 28	8.0
VA	VA 286 Sec. 1	Sunrise Valley	US 50	6.2
VA	VA 286 Sec. 2	US 50	Rolling Rd	20.0
VA	Wilson Blvd	Roosevelt Blvd	Fort Myer Dr	4.7
	Total			402.7

Figure 29: Travel Time Index on Selected NHS Arterials during 8:00-9:00 am on Middle Weekdays in 2015



Note: Congestion levels are categorized by the value of TTI: TTI = 1.0: Free flow
1.0<TTI<=1.3: Minimal
1.3<TTI<=1.5: Minor
1.5<TTI<=2.0: Moderate
2.0<TTI<=2.5: Heavy
2.5<TTI: Severe

Figure 30: Travel Time Index on Selected NHS Arterials during 5:00-6:00 pm on Middle Weekdays in 2015



Note: Congestion levels are categorized by the value of TTI: TTI = 1.0: Free flow
1.0<TTI<=1.3: Minimal
1.3<TTI<=1.5: Minor
1.5<TTI<=2.0: Moderate
2.0<TTI<=2.5: Heavy
2.5<TTI: Severe

Future Arterial Congestion Analysis

Using the VPP data for arterial congestion monitoring is considered by many practitioners a challenging task. One major concern is the validity of the data, especially on arterials on which traffic volumes were much less than that of freeways. Unlike the freeways, the VPP currently has no on-going third-party data validation tests to ensure data quality on arterials. The segmentation, based on which the probe data is reported, on arterials is also less straightforward than on freeways. Staff will continue to monitor the quality of arterial probe data and carry out additional studies as needed.

Improving Congestion on Arterials

Adding capacity on arterials to reduce congestion is seldom feasible, as many arterials are already built to capacity with development on either side. However, there are demand management and operational management strategies that could offer solutions. The addition of express bus or other types of public transportation along an arterial could decrease the amount of cars on the road. Pedestrian and bicycle improvements, such as the implementation of a new bike facility along the arterial can provide an alternative option for travelers. Operational improvements can include the addition of turn lanes, to reduce the amount of back-ups at an intersection, or the creation of additional lanes. Traffic signal timing optimization is also important in ensuring the appropriate movement of vehicles at intersections.

2.2.1.9 Quarterly National Capital Region Congestion Report

Inspired by various agency and jurisdictional dashboard efforts around the country (e.g., the Virginia Department of Transportation Dashboard), driven by the MAP-21 and FAST legislations and the emerging probe-based traffic speed data from the I-95 Corridor Coalition Vehicle Probe Project, this quarterly updated National Capital Region Congestion Report takes advantage of the availability of rich data and analytical tools to produce customized, easy-to-communicate, and quarterly updated traffic congestion and travel time reliability performance measures for the Transportation Planning Board (TPB) Planning Area. The goal of this effort is to timely summarize the region’s congestion and the programs of the TPB and its member jurisdictions that would have an impact on congestion, to examine reliability and non-recurring congestion for recent incidents/occurrences, in association with relevant congestion management strategies, and to prepare for the MAP-21 and FAST performance reporting.

This quarterly report includes congestion and travel time reliability analysis, top 10 bottlenecks in a quarter, congestion maps, quarterly spotlight focusing on notable event(s) and its transportation impacts during that quarter, background and methodology information. This repot can be accessed via www.mwcog.cog/congestion. A screenshot of the first page of the 1st Quarter 2016 Report is shown in Figure 31.

Figure 31: National Capital Region Congestion Report (First Page)

CONGESTION – TRAVEL TIME INDEX (TTI)

Interstate System

TTI 1st Quarter 2016:	1.30	↑1.6% or 0.02[1]
TTI Trailing 4 Quarters:	1.33	↑0.3% or 0.004[2]

Non-Interstate NHS[3]

TTI 1st Quarter 2016:	1.18	↑0.0% or 0.00
TTI Trailing 4 Quarters:	1.22	↓0.6% or 0.01

Transit-Significant[4]

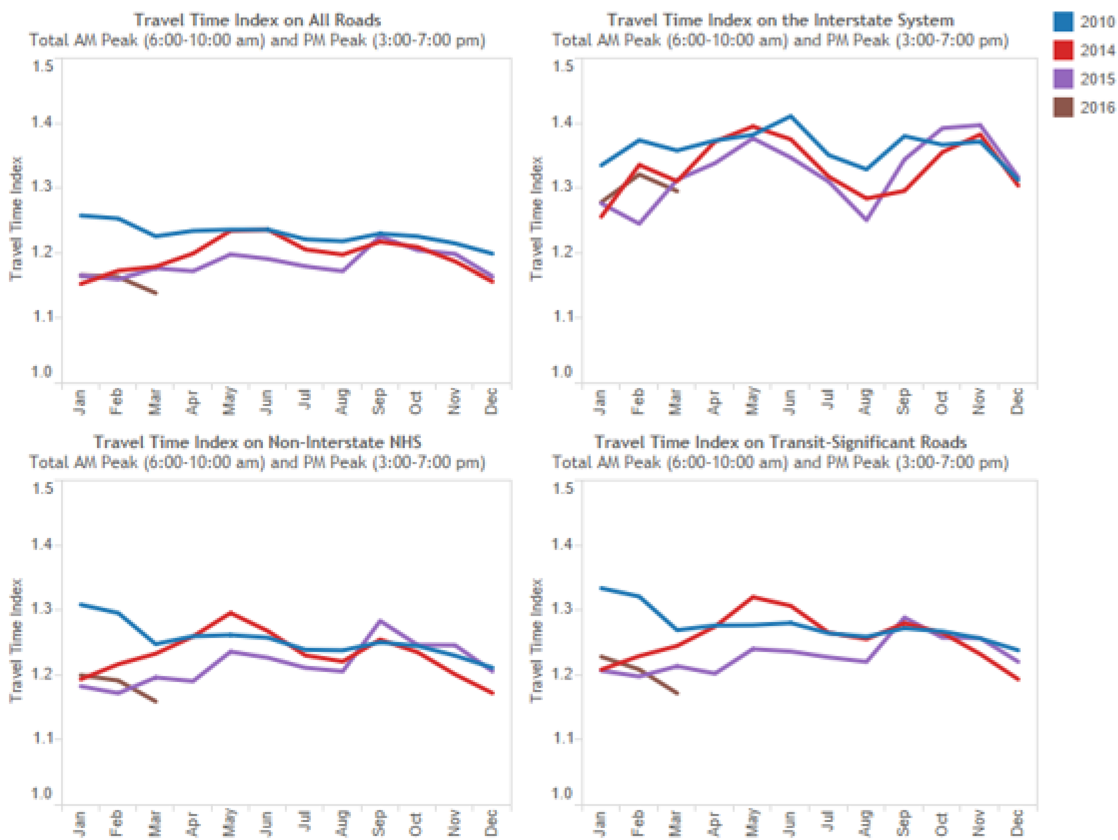
TTI 1st Quarter 2016:	1.20	↓0.3% or 0.003
TTI Trailing 4 Quarters:	1.23	↓1.7% or 0.02

All Roads

TTI 1st Quarter 2016:	1.16	↓1.0% or 0.01
TTI Trailing 4 Quarters:	1.18	↓1.2% or 0.01

[1] Compared to 1st Quarter 2015; [2] Compared to one year earlier; [3] NHS: National Highway System; [4] See "Background" section.

Figure 1. Monthly Travel Time Index for Total AM peak (6:00-10:00 am) and PM peak (3:00-7:00 pm)



***Travel Time Index** (TTI), defined as the ratio of actual travel time to free-flow travel time, measures the intensity of congestion. The higher the index, the more congested traffic conditions it represents, e.g., TTI = 1.00 means free flow conditions, while TTI = 1.30 indicates the actual travel time is 30% longer than the free-flow travel time.*

2.2.2 FREEWAY AERIAL PHOTOGRAPHY SURVEY

The TPB contracted with Skycomp, Inc. to conduct a systematic aerial study of regional freeway congestion beginning in 1993. The most recent survey was completed in Spring 2014 and the report can be downloaded online[40]. The Spring 2011[41] and Spring 2008[42] reports can also be found on COG/TPB's website.[43]

In the aerial photography survey, peak period freeway congestion was monitored on a once-every-three-years cycle during the AM and PM peak periods. It provided a wealth of information on the region's freeways, including the overall conditions of the freeways, specific congested locations, trends over time, and identification of factors associated with the congested conditions.

During a survey period, aircraft followed designated flight patterns along the region's approximately 300 centerline miles of limited-access highways. Survey flights were conducted on weekdays, excluding Monday mornings, Friday evenings, and mornings after holidays, during the following time periods:

- Morning surveying times:
  - 6:00 AM – 9:00 AM outside the Capital Beltway;
  - 6:30 AM – 9:30 AM inside the Capital Beltway.
- Evening surveying times:
  - 4:00 – 7:00 PM inside the Capital Beltway
  - 4:30 – 7:30 PM outside the Capital Beltway

During the survey flights, overlapping photographic coverage was obtained of each designated highway, repeated once an hour over three morning and three evening commuter periods (this means that, altogether, there were nine morning and nine evening observations[44] of each highway segment).

Data were then extracted from the aerial photographs to measure average traffic flow density by link and by time period. The density was further converted to level of service (LOS)[45] using methods

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[40] *Traffic Quality on the Metropolitan Washington Area Freeway System: Spring 20014 Report*. Prepared by: Skycomp, Inc. (Columbia, Maryland). http://www.mwcog.org/uploads/committee-documents/YF1XV1db20150227142340.pdf

[41] *Traffic Quality on the Metropolitan Washington Area Freeway System: Spring 2011 Report*. Prepared by: Skycomp, Inc. (Columbia, Maryland). http://www.mwcog.org/store/item.asp?PUBLICATION_ID=436

[42] *Traffic Quality on the Metropolitan Washington Area Freeway System: Spring 2008 Report.* Prepared by: Skycomp, Inc. (Columbia, Maryland). https://www.mwcog.org/uploads/news-documents/Clte20090521142505.pdf

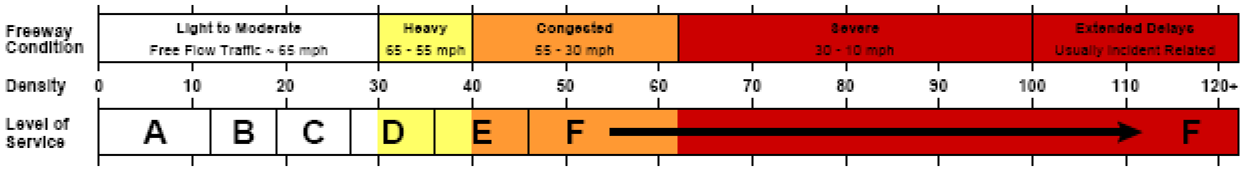
[43] As of the writing this 2016 CMP Technical Report, TPB was examining whether additional regional aerial surveys will be performed in the future, and if so, on what extent of geographic coverage and what frequency.

[44] Prior to the 2014 survey, the total number of observations was 12 for each peak periods. Given the vast availability of the private-sector probe-based traffic data, e.g., the I-95 Vehicle Probe Project data and the National Performance Management Research Data Set (NPMRDS) data, the role of the aerial photography survey has transformed from being the major source of freeway congestion information to being an independent source that can be used to validate and supplement probe data; more importantly, it can provide unique visual imagery of congestion. Therefore a decision was made to reduce the sample size from 12 to 9 for the 2014 survey.

[45] There are generally six levels of service, A through F. Level of service "A" is the best, describing primarily free-flow conditions, while level of service "F" is the worst, describing flow as unstable and significant traffic delay.

presented in the *Highway Capacity Manual 2000*. LOS "A" reflects generally free-flow conditions, and levels "E" and "F" reflect the most severe congestion with extended delays, as illustrated in the following diagram (Figure 32).

Figure 32: Speed, Density and LOS Chart



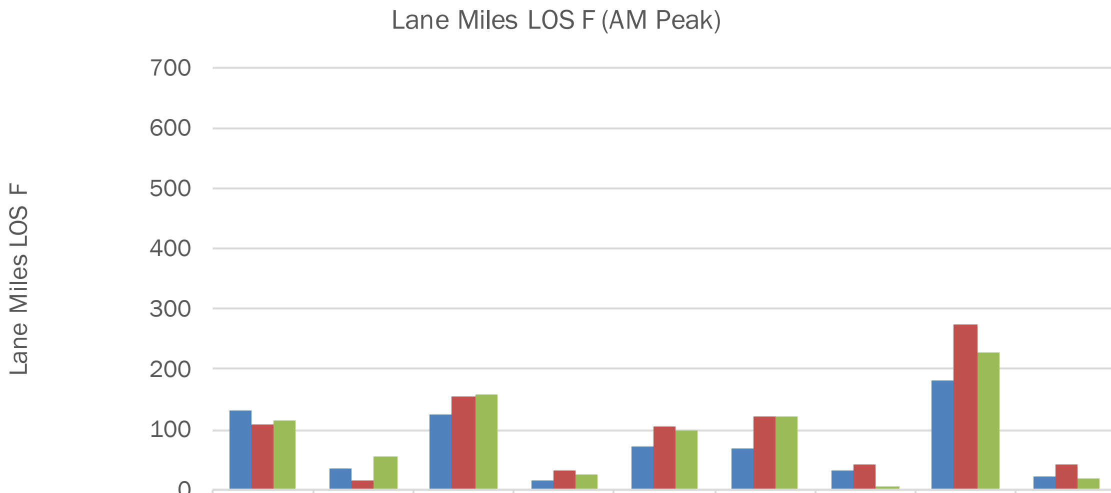
The most recent peak period survey was conducted in Spring 2014 and the following summarizes the highlights of the survey results.

2.2.2.1 Lane Miles of Congestion

Overall, the number of lane miles of congestion (LOS F) in the region in 2014 was 2,249, slightly less than that recorded during the 2011 survey, 2,369. The lane miles of congestion at selected facilities in the past three surveys are given in Figure 33-34 for the AM and PM peak respectively.

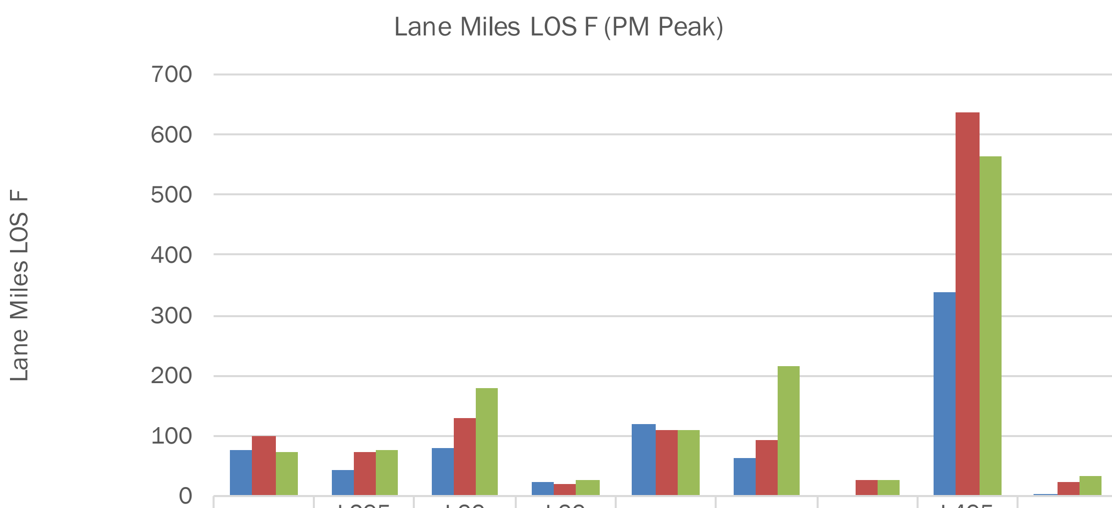
I-66 outside the Beltway and I-95 in Virginia experienced worsening congestion in the past three surveys in both AM and PM peak periods. The Beltway's congestion was the worst during the Spring 2011 survey, a time when the I-495 Express Lanes were under construction; its 2014 congestion was better than 2011 but still worse than 2008.

Figure 33: Lane Miles at LOS F for AM Peak



	I-270	I-295 (Inside Beltway)	I-66 (Outside Beltway)	I-66 (Inside Beltway)	I-395	I-95 VA	I-95 MD	I-495 (Capital Beltway)	GW Parkway
2008 (AM Peak)	130	35	126	14	72	67	33	180	21
2011 (AM Peak)	108	17	155	33	104	120	43	273	41
2014 (AM Peak)	115	56	158	27	100	123	6	227	20

Figure 34: Lane Miles at LOS F for PM Peak



	I-270	I-295 (Inside Beltway)	I-66 (Outside Beltway)	I-66 (Inside Beltway)	I-395	I-95 VA	I-95 MD	I-495 (Capital Beltway)	GW Parkway
2008 (PM Peak)	75	42	79	23	121	64	0	337	1
2011 (PM Peak)	101	73	131	21	108	92	27	638	23
2014 (PM Peak)	74	78	178	27	108	216	27	563	33

2.2.2.2 Improvements Observed in the Spring 2014 Survey

Figure 35 and Figure 36 provide overview maps of significant changes in traffic congestion from 2011 to 2014.There were two major capacity increases to the highway system since the 2011 aerial survey.

The completion of Maryland Route 200, also known as the Intercounty Connector (ICC), linking Prince George's County and Montgomery County provided an alternate east-west route for commuters. Levels-of-service A and B were documented on the ICC throughout the morning and evening survey periods.

On I-495 in Virginia, the I-495 Express Lanes between the I-95/395 and VA 267 Interchanges was completed. This four-lane facility for the most part operated at levels of service A and B. Commuters in the general purpose lanes appeared to benefit to some degree as an improvement in levels of congestion along the corridor. In the evening, conditions on the outer loop along this corridor resembled those documented during the 2008 survey before construction began; severe congestion and extensive delays were found here during the 2011 survey while under construction.

2.2.2.3 Degradation Observed in the Spring 2014 Survey

Degraded levels of service were found on several of the major facilities during the morning and evening commuter periods. In most cases, the primary cause was likely an increase in the volume of traffic.

Morning / I-495 (Beltway): Traffic congestion on the northwest west side of the Beltway (Inner Loop) traveling from Virginia into Maryland was more severe. One factor contributing to the degradation was the left-side merge associated with the termination of the Express Lanes downstream of VA 267. Another significant increase in congestion on the Beltway was renewed congestion on the Inner Loop in Maryland approaching to the rebuilt Woodrow Wilson Bridge; however, the level of services showed less severe congestion in 2014 vs. 2008 levels. Congestion was not found along this section of the Inner Loop during the 2011 aerial survey.

Morning / MD-295, DC-295: A significant decrease in levels of service was found in the southbound direction on DC/MD-295 between Bladensburg and the Anacostia River crossing at Pennsylvania Ave. Improved flow along this section of DC-295 was documented in the 2011 report (attributed to completed construction improvement projects); the 2014 findings show the return of level-of-service F conditions for each of the 3-hours surveyed.

Evening / I-495 (Beltway): A new zone of congestion was found on the outer loop of the Beltway in Prince George's County, Maryland. After crossing into Maryland on the Woodrow Wilson Bridge, traffic flowed freely until encountering congestion in the vicinity of St Barnabas Rd; congestion typically persisted 4-6 miles downstream to MD-4 (Pennsylvania Ave).

Evening / I-95 Virginia: A significant degradation of level of service on I-95 in Virginia was documented during the evening surveys in 2014. This may have been partly attributable to a construction zone where the Express Lanes were being extended from Dumfries Blvd. to Garrisonville Rd. (approximately 10 miles); while all lanes were open during the evening commuter period, the presence of Jersey Barriers may have exacerbated the congestion. Farther south in Stafford County, recurring congestion on the approach to the Rappahannock River increased in both severity and extent since the 2011 survey.

Figure 35: Significant Changes (2018-2014) – Morning Peak Period

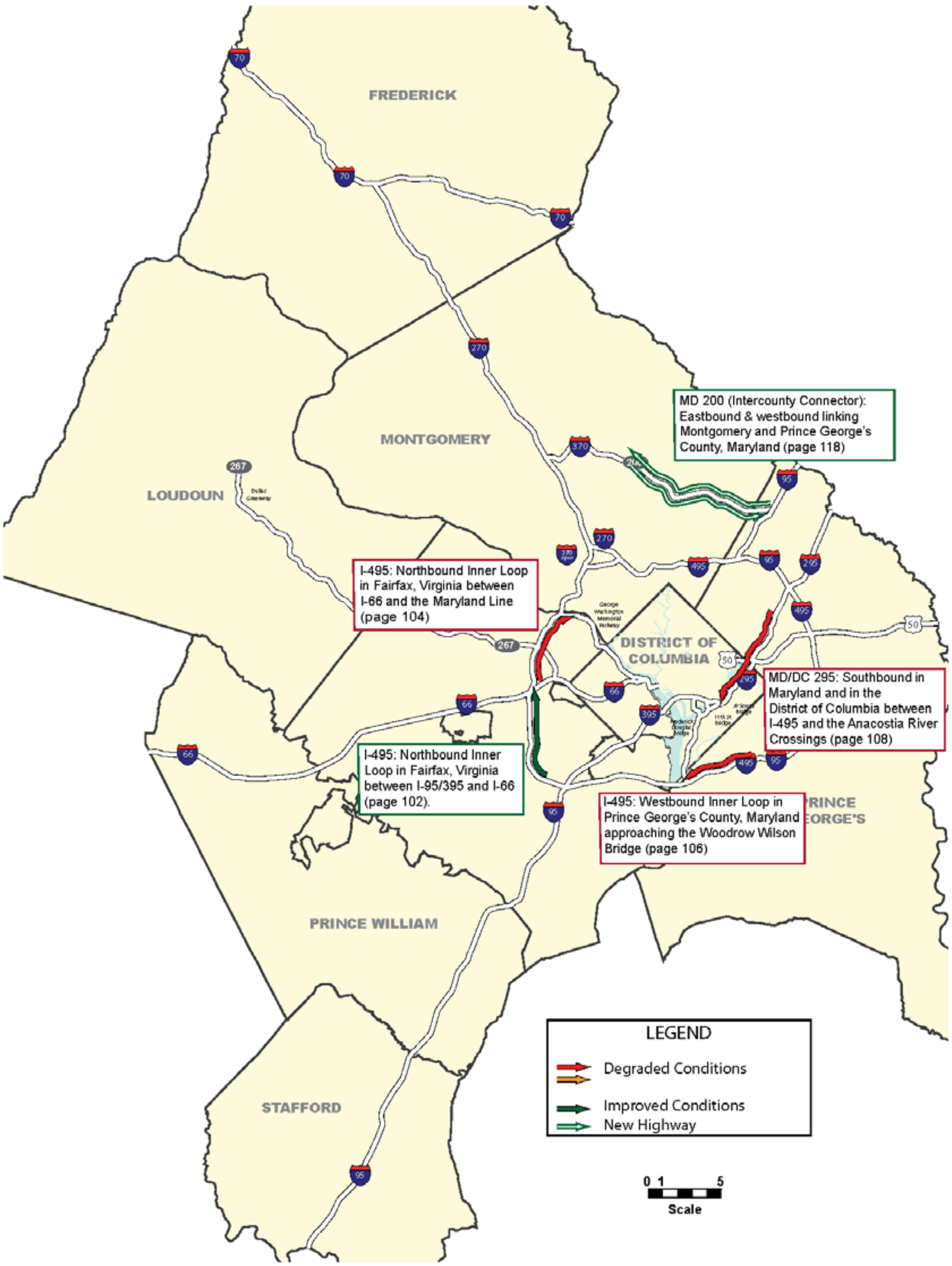
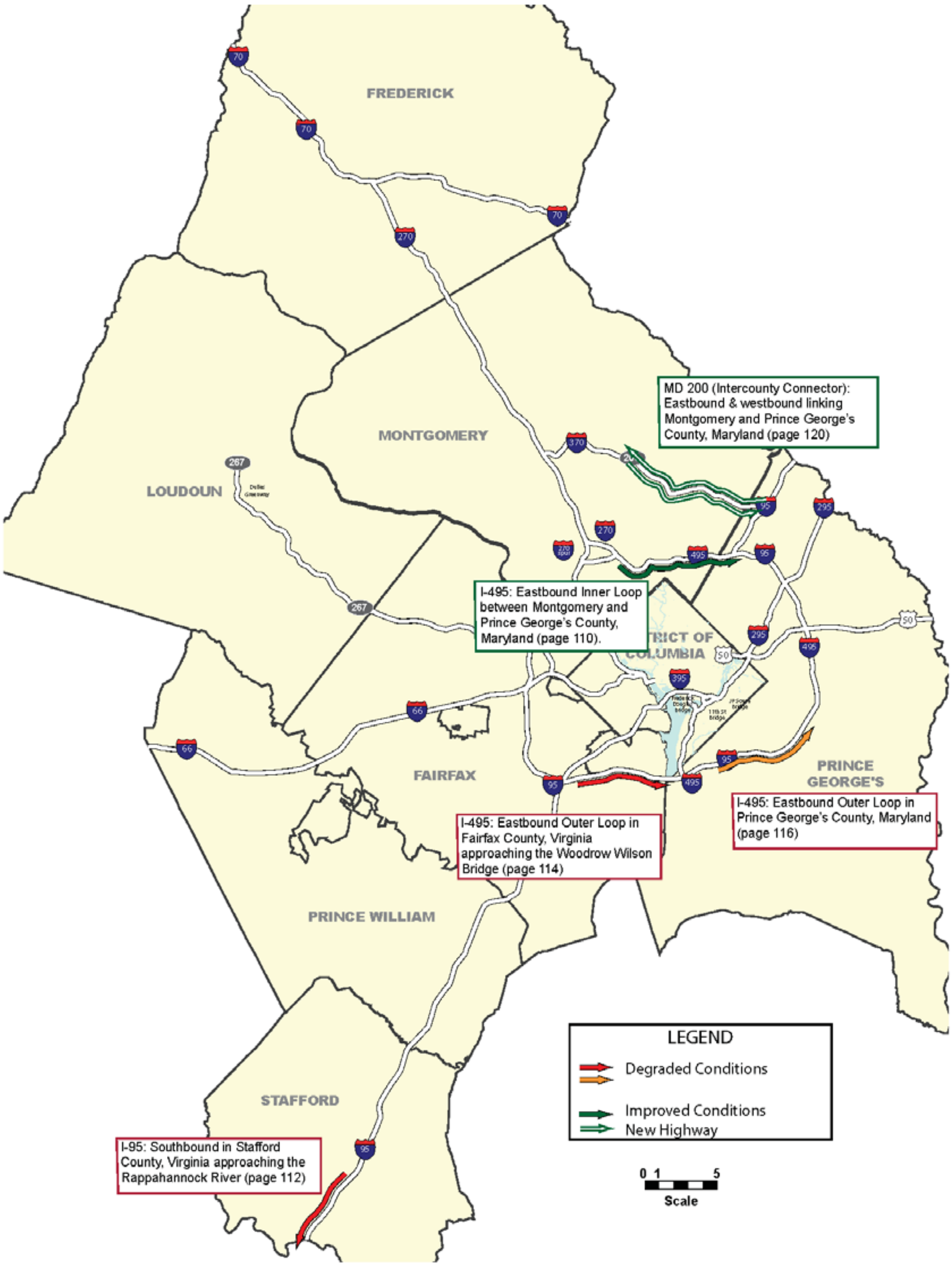


Figure 36: Significant Changes (2008-2014) – Evening Peak Period



2.2.2.4 Summary Congestion Maps of the Spring 2014 Survey

The summary maps of the AM and PM congestion of the Spring 2014 Survey are provided in Figure 37 and Figure 38.

Figure 37: Morning Peak Period Regional Congestion - Spring 2014

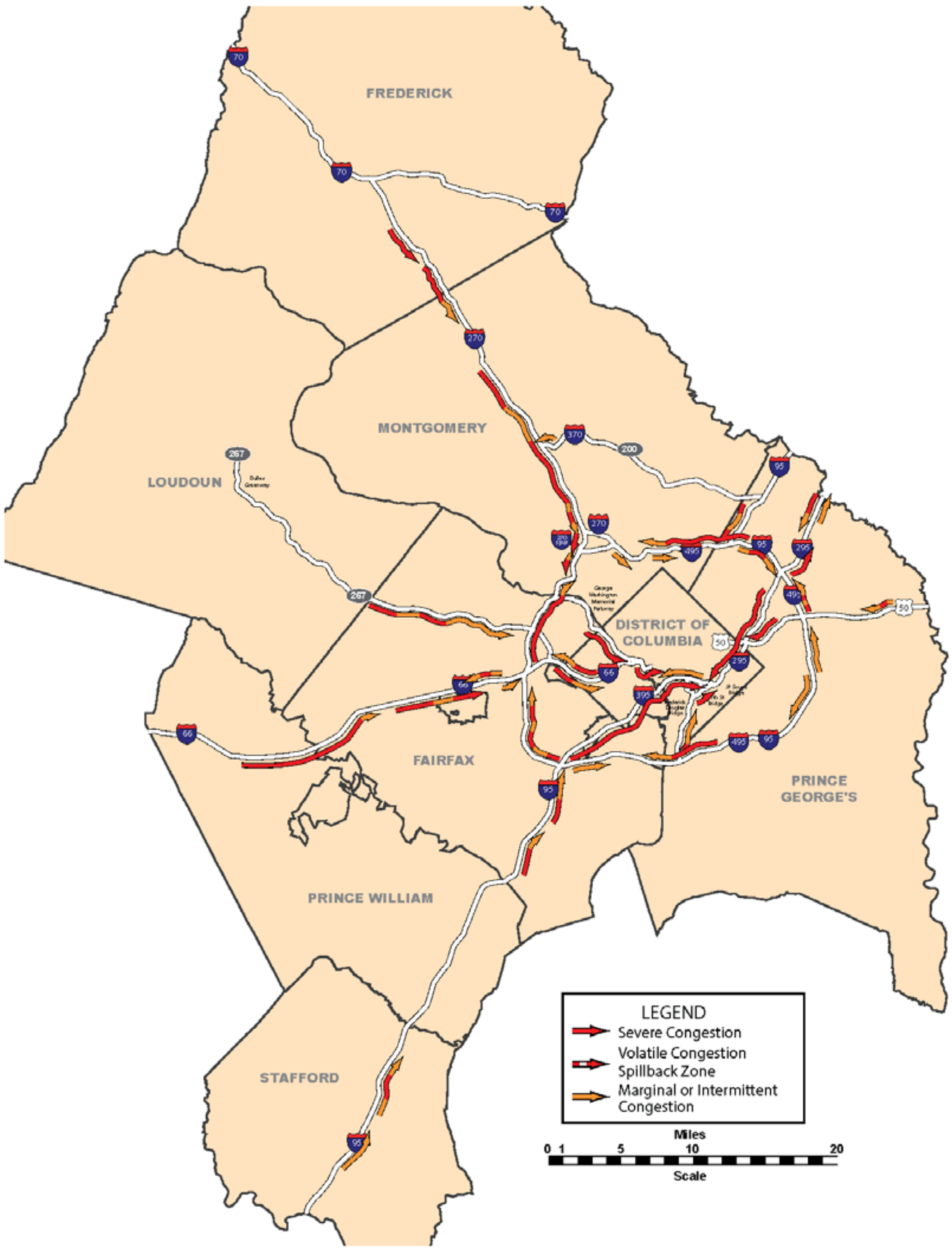
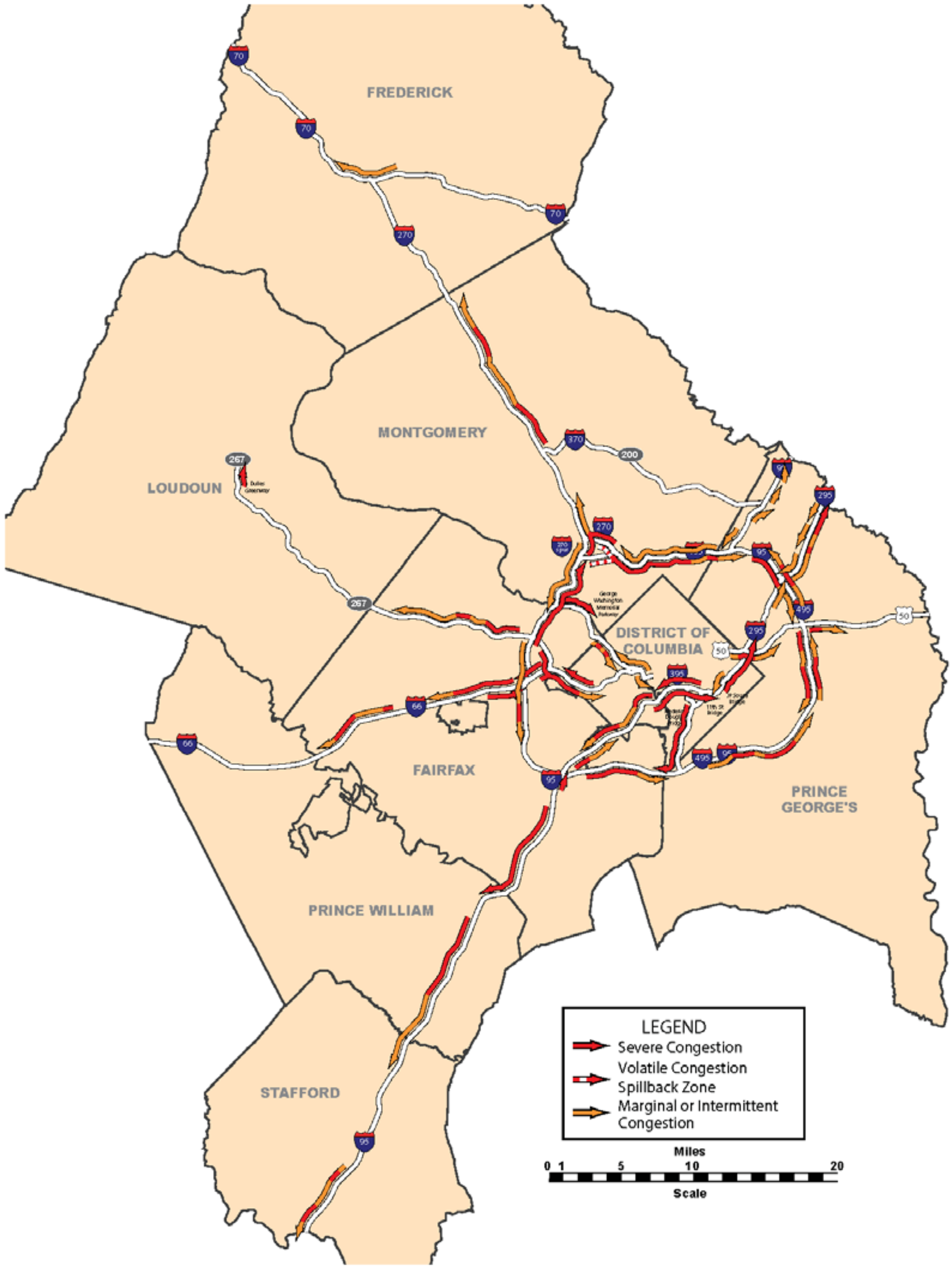


Figure 38: Evening Peak Period Regional Congestion – Spring 2014



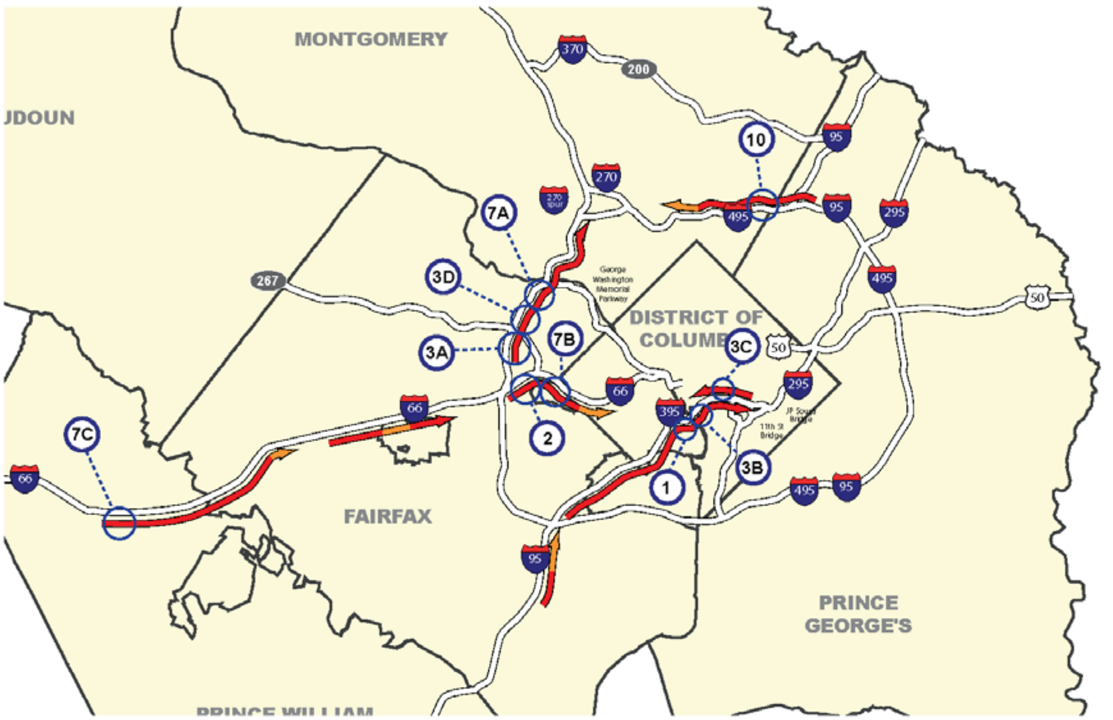
2.2.2.5 Top 10 Congested Locations in the Spring 2014 Survey

Figure 39 maps and lists the most congested locations on the region's freeway system. These locations were obtained by ranking the densities of all segments and picking the top ten irrespective of whether they are congested during the AM or PM peak period.

Figure 39: Top Ten Congested Locations – Spring 2014

Criteria for the top ten congested locations are as follows:

- A location is defined as a congested freeway segment, by direction, between interchanges; this congested location is typically within a larger queue.
- Rankings for the top ten are based on the average hourly density value which corresponds to a speed (see table below).
- Construction-related congestion was not included in the rankings unless the location was historically congested in the absence of construction.
- Congestion caused by traffic signals was not included in the rankings.



Top Ten Congested Segments on the Freeway System (2014)

Rank	Route	From	To	Density	Speed Range
1	NB I-395 (8:30-9:30 AM)	VA 27 (Washinton Blvd)	VA 110 (Jefferson Davis Hwy)	150	5 MPH
2	EB I-66 (6:00-7:00 PM)	VA 7 (Leesburgh Pike)	VA 267	140	5 MPH
3A	Inner Loop I-495 (4:30-5:30 PM)	VA 123 (Chain Bridge Rd)	VA 267	120	5-10 MPH
3B	NB I-395 (8:30-9:30 AM)	VA 110 (Jefferson Davis Hwy)	George Washington Memorial Pkwy	120	5-10 MPH
3C	SB I-395 (5:00-6:00 PM)	4th St	12th St	120	5-10 MPH
3D	Inner Loop I-495 (4:30-5:30 PM)	VA 267	VA 193 (Georgetown Pike)	120	5-10 MPH
7A	Inner Loop I-495 (5:30-6:30 PM)	VA 193 (Georgetown Pike)	George Washington Memorial Pkwy	110	10-15 MPH
7B	EB I-66 (6:00-7:00 PM)	VA 267	Westmoreland St	110	10-15 MPH
7C	EB I-66 (6:00-7:00 AM)	VA 234 Bypass	VA 234 (Sudley Rd)	110	10-15 MPH
10	Outer Loop I-495 (7:00-8:00 AM)	MD 650 (New Hampshire Ave)	MD 193 (University Ave)	105	10-15 MPH

Note: Due to construction at the terminus of the Southeast Freeway, eastbound densities along this corridor were not included in the Top Ten list above.

2.2.2.6 Longest Delay Corridors in the Spring 2014 Survey

Beginning in 2008, the freeway aerial survey introduced a new metric – Longest Delay Corridors. The purpose of this metric was to identify corridors which might not have bottlenecks in the "Top Ten Congested Locations" but were long congested corridors. Delay was calculated by estimating the additional travel time during congested conditions over the free flow travel time. Free flow speed was assumed to be 60 mph. Figure 40 and Figure 41 present the top five congested corridors in the AM and PM peak period.

Figure 40: Longest Delay Corridors - Morning Peak Period (Spring 2014)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-66	7:30 – 8:30	Eastbound	US 29 (Lee Highway)	VA 243 (Nutley St)	18.8	43.3	26	24.5
Site #2	I-95 / I-395	7:00 – 8:00	Northbound	US 1 (Richmond Highway)	George Washington Parkway	18.0	38.2	28	20.2
Site #3	I-495	7:00 – 8:00	Outerloop	I-95	MD 185 (Connectiucut Ave)	7.0	21.7	19	14.7
Site #4	DC 295	8:00 – 9:00	Southbound	MD 450 (Annapolis Rd)	MD 4 (Pennsylvania Ave)	5.7	19.9	17	14.2
Site #5	I-270	7:30 – 8:30	Southbound	Father Hurley Blvd	I-270 Western Spur	13.1	24.6	32	11.5

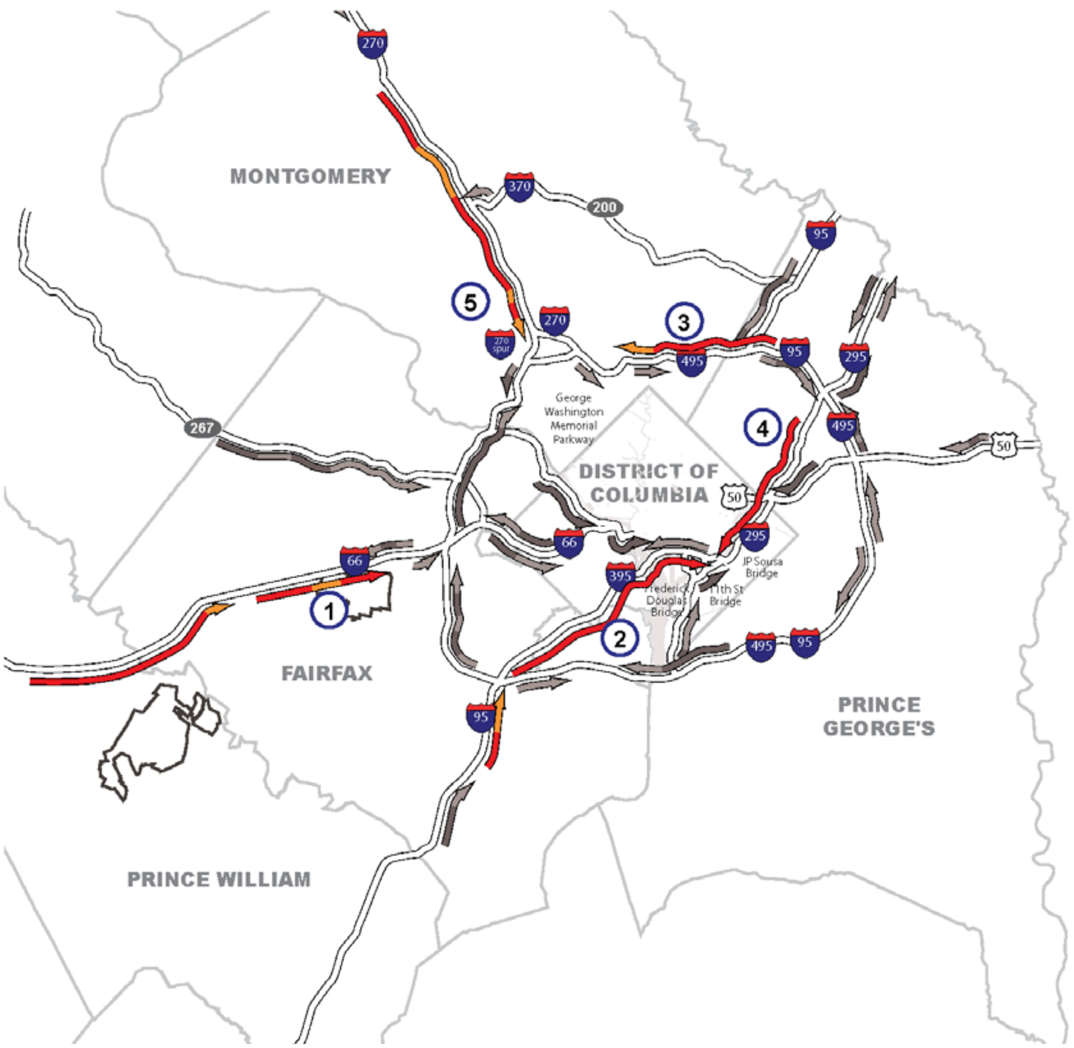
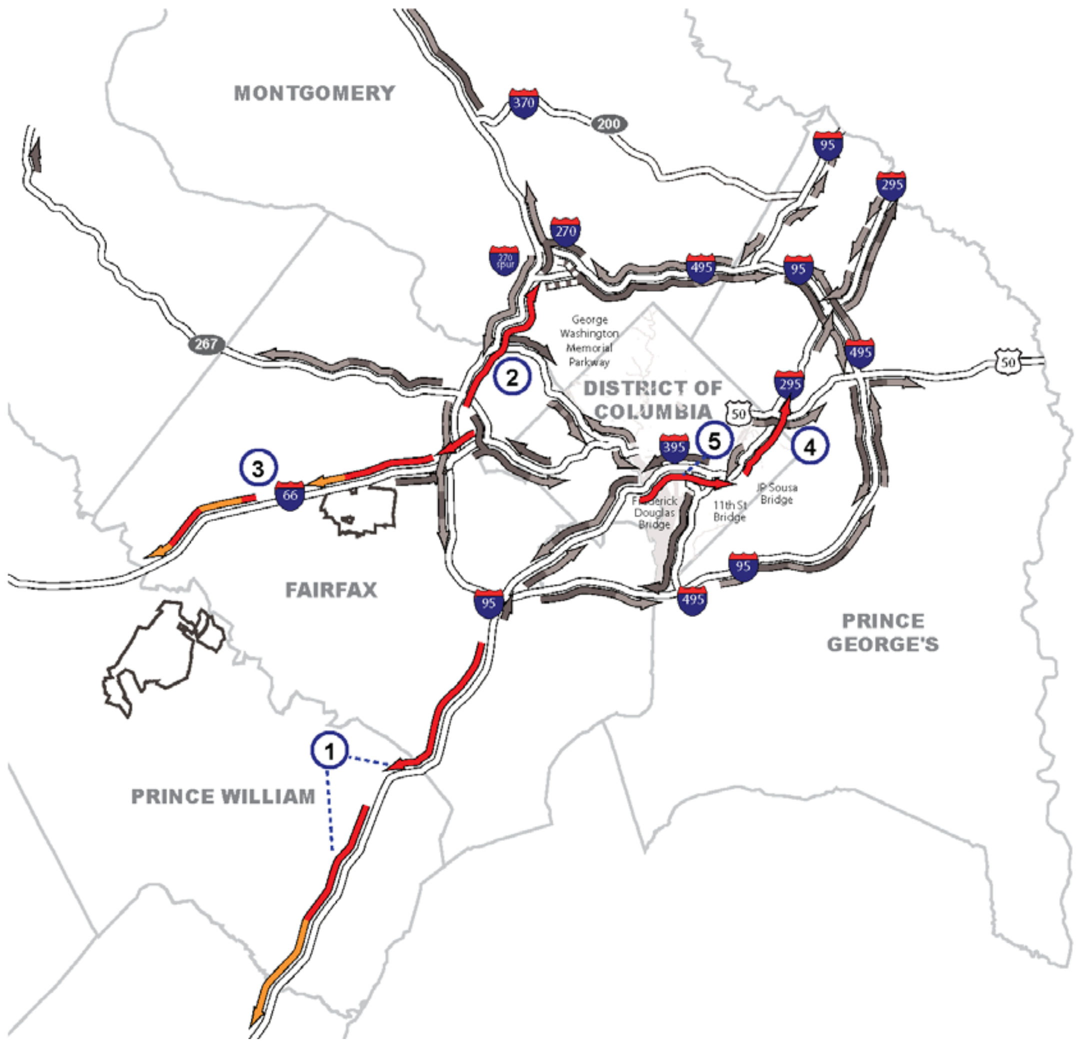


Figure 41: Longest Delay Corridors - Evening Peak Period (Spring 2014)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-95	4:30 – 5:30	Southbound	Fairfax County Parkway	Garrisonvile Rd	23.0	51.5	27	28.5
Site #2	I-495	4:30 – 5:30	Innerloop	VA 7(Leesburg Pike)	I-270 Western Spur	8.4	35.1	14	26.7
Site #3	I-66	4:30 – 5:30	Westbound	VA 7 (Leesburg Pike)	VA 234 (Sudley Rd)	18.3	36.6	30	18.3
Site #4	DC 295	4:30 – 5:30	Northbound	11th Street Bridge	US 50	5.0	19.3	16	14.3
Site #5	I-395	5:00 – 6:00	Northbound	VA 110 (Jeff. Davis Hwy)	11th Street Bridge	3.7	17.5	13	13.8



2.2.3 ARTERIAL FLOATING CAR TRAVEL TIME STUDY

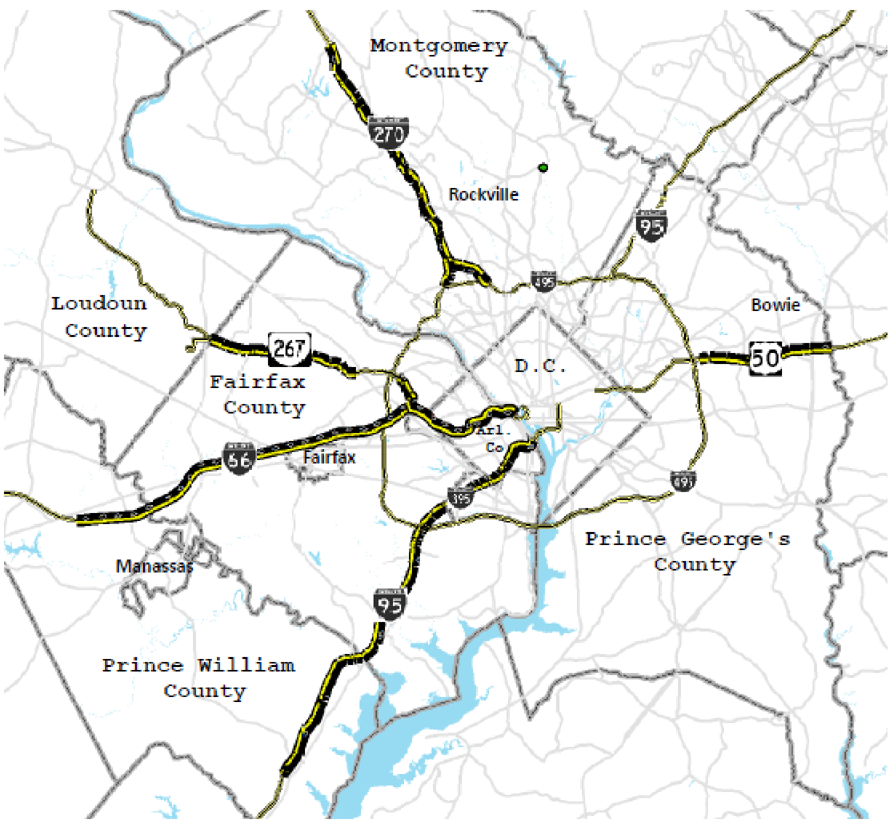
Before the existence of private sector probe-based traffic data, the TPB carried out Arterial Floating Car Travel Time Studies from 2000 – 2011 on selected NHS arterial highways in the region. Staff gathered data regarding travel time, speed, and delay using Geographic Positioning System (GPS) technology, with data collection occurring in three-year cycles (e.g., 2005 routes repeated in 2008 and 2011, etc.). Data were collected between the hours of 1:00 PM and 8:00 PM, on Tuesdays, Wednesdays and Thursdays, avoiding public holidays or the day after a public holiday. By 2011 the last year of this type of survey, 57 major arterial highway routes in the District of Columbia, Maryland, and Virginia, totaling 430 centerline miles were monitored. The level of service (LOS) was used to characterize the extent of congestion during the PM peak hour, PM peak period and PM off-peak period of travel[46]. Summary of the 2008-2011 studies can be found in the *2010 Congestion Management Process (CMP) Technical Report* and the *2012 Congestion Management Process (CMP) Technical Report.* There are no plans to repeat or continue the Arterial Floating Car Travel Time Study as the I-95 VPP traffic monitoring covers the vast majority of arterials in the region with unprecedented spatial and temporal granularity.

2.2.4 HOV Facility Surveys

High occupancy vehicle (HOV) facilities are designed to offer several advantages over conventional lanes and roads, including the increase of person throughput during peak periods. In the Washington area, there are five high occupancy vehicle (HOV) facilities on highways functionally classified as freeways (Figure 42). These are:

- I-95/I-395 in the Northern Virginia counties of Prince William, Fairfax and Arlington, and the City of Alexandria (before conversion to I-95 Express Lanes);
- I-66, also in the Virginia counties of Prince William, Fairfax and Arlington (this HOV system includes a section of the Dulles Connector in McLean, connecting to VA 267's HOV lanes (see below));
- I-270 and the I-270 Spur in Montgomery County, Maryland;
- VA 267, connecting to I-66 via the Dulles Connector; and
- U.S. 50 in Prince George's County, Maryland.

Figure 42: HOV Facilities in the Washington Region (2014)



[46] PM peak hour is 5:00-6:00 pm, PM peak period is 4:00-7:00 pm, and PM off-peak period is 1:00-4:00 pm and 7:00 – 8:00 pm.

The I-95/I-395 and I-66 HOV facilities provide direct access to core employment centers of the region in Arlington County and the District of Columbia. I-270 and the I-270 Spur end at the Capital Beltway (I-495) and the U.S. 50 HOV lanes end just prior to the Beltway. VA 267's HOV system connects directly to I-66, providing access to the regional core from the Dulles Toll Road Corridor. There are arterial HOV lanes and bus only shoulder treatments in the region, but these facilities are beyond the scope of this study. More detailed information about the HOV facilities is provided in Table 9.

Table 9: 2014 HOV Facility Summary

2014 HOV Facility Summary

Facility Route Number(s) and Name	Length	Facility Description	Occupancy Requirement	Hybrid Exemption	A.M. HOV Restricted Period and Direction	Truck Restrictions	Motorcycle Restriction
I-95/I-395 Shirley Highway (see note below)	28 miles	2 lanes, barrier-separated, reversible	3	Yes	6:00 to 9:00 (North)	Permitted with Occupancy Compliance North of Dale City (Exit 156), Prohibited South of Dale City	Permitted on all HOV facilities
I-66	28 miles (HOV lane extension to Va. 234 Bypass opened in 2007 after data collection was completed)	1 Lane Concurrent Flow Outside of the Beltway, 2 Lane exclusive HOV facility inside the Beltway	2	Yes	5:30 to 9:30 AM Outside Beltway; 6:30 to 9:00 AM Inside Beltway (East)	Prohibited	
I-270	9 miles Southbound; 18 miles Northbound	1 Lane Concurrent Flow	2	No	6:00 to 9:00 AM (South)	Prohibited	
Va. 267 Dulles Toll Road	23 miles (includes Dulles Connector Road and I-66 from Rosslyn to Dulles Connector)	1 Lane Concurrent Flow	2	Yes	6:30 to 9:00 AM (East)	Permitted with Occupancy Compliance outside Beltway	
U.S. 50	9 miles	1 Lane Concurrent Flow	2	No	HOV-2 restriction in effect 24 hours/day, 7 days/week (West and East)	Prohibited	

Note: After data collection for this report were completed, the I-95 part of the Shirley Highway reversible HOV facility, as well as the southern part of the I-395 HOV facility were converted to the 95 Express Lanes, a reversible HOV/Toll facility

COG/TPB has conducted surveys on the HOV system in 1997, 1998, 1999, 2004, 2007, 2010 and 2014. Some highlights of the most recent 2014 survey[47] were summarized below; more information can be found in Appendix D.

- All of the HOV lanes in spring 2014 were observed to carry more persons per lane during the HOV restricted periods than adjacent non-HOV lanes except on US 50;

- Most of the HOV lanes provide savings in travel times when compared to non-HOV alternatives, especially the barrier separated HOV lanes in the I-95/I-395 corridor in Northern Virginia;

- However, the performance of the concurrent-flow HOV lanes in the I-66 lanes (outside I-495) and along I-270 were at certain points between 10 and 25 MPH slower than adjacent non-HOV lanes, as well as sections of the exclusive I-66 HOV facility inside I-495 (staff examined data from the Vehicle Probe Project (VPP) and found recurring congestion along I-66 eastbound

[47] *2014 Performance of High-Occupancy Vehicle Facilities on Freeways in the Washington Region*, October 2015. http://www.mwcog.org/uploads/committee-documents/bVxfWlZf20151013093838.pdf

from the Dulles Connector Road to a point between Sycamore Street and Va. 120 [North Glebe Road]); and

- Average auto occupancy in 2014 was little-changed from 2010, even though the HOV lanes in Northern Virginia continue to exempt vehicles with "Clean Air" registration plates from the HOV requirement.

HOV facilities are designed to provide faster travel times and more predictable speeds than parallel non-HOV facilities, which was the general conclusion of this study. It is clear that while HOV facilities aid in improving the operation of the region's roadways, they can also influence traveler behavior and manage the demand of single-occupant travel.

In addition to the HOV facilities, the Washington region also operates three other managed facilities: the Inter-County Connector (MD 200) in Maryland, the I-495 Express Lanes on the Virginia side of the Capital Beltway, and the I-95 Express Lanes [48] in Virginia. Future congestion monitoring activities should also include these facilities.

2.2.5 Airport Ground Access Travel Time Studies

The transportation linkage between airports and local activities is a critical component of the transportation system. The Washington region has two major airports – Ronald Reagan Washington National Airport (DCA) in Arlington, VA, and Washington Dulles International Airport (IAD) in Loudoun County, VA. The region is also served by the nearby Baltimore/Washington International Thurgood Marshall Airport (BWI) (Figure 43). The majority (92%) of those traveling to the region's airports does so via the highway network (i.e. personal cars, rental cars, taxis, buses)[49]. Therefore, understanding ground airport access is important to congestion management for two primary reasons:

- Choice of airport to use and even the decision to fly in general can be based on the quality, cost, and travel time associated with the ground journey to the airport. Traffic conditions can have an impact on these decisions.

- Understanding airport ground access provides a basis for understanding overall congestion on major roadways at peak travel times.

    - Studying airport ground access can provide information on traffic patterns that may have not otherwise been considered, in particular the relationship between travel times and distances. For example, a study can examine and compare trips across the region (e.g. from Maryland to IAD), or shorter trips where the origin and destination are close together.

    - Passengers using the airports may be non-residents of the Washington region, so this airport access information can give us information on trips originating elsewhere.

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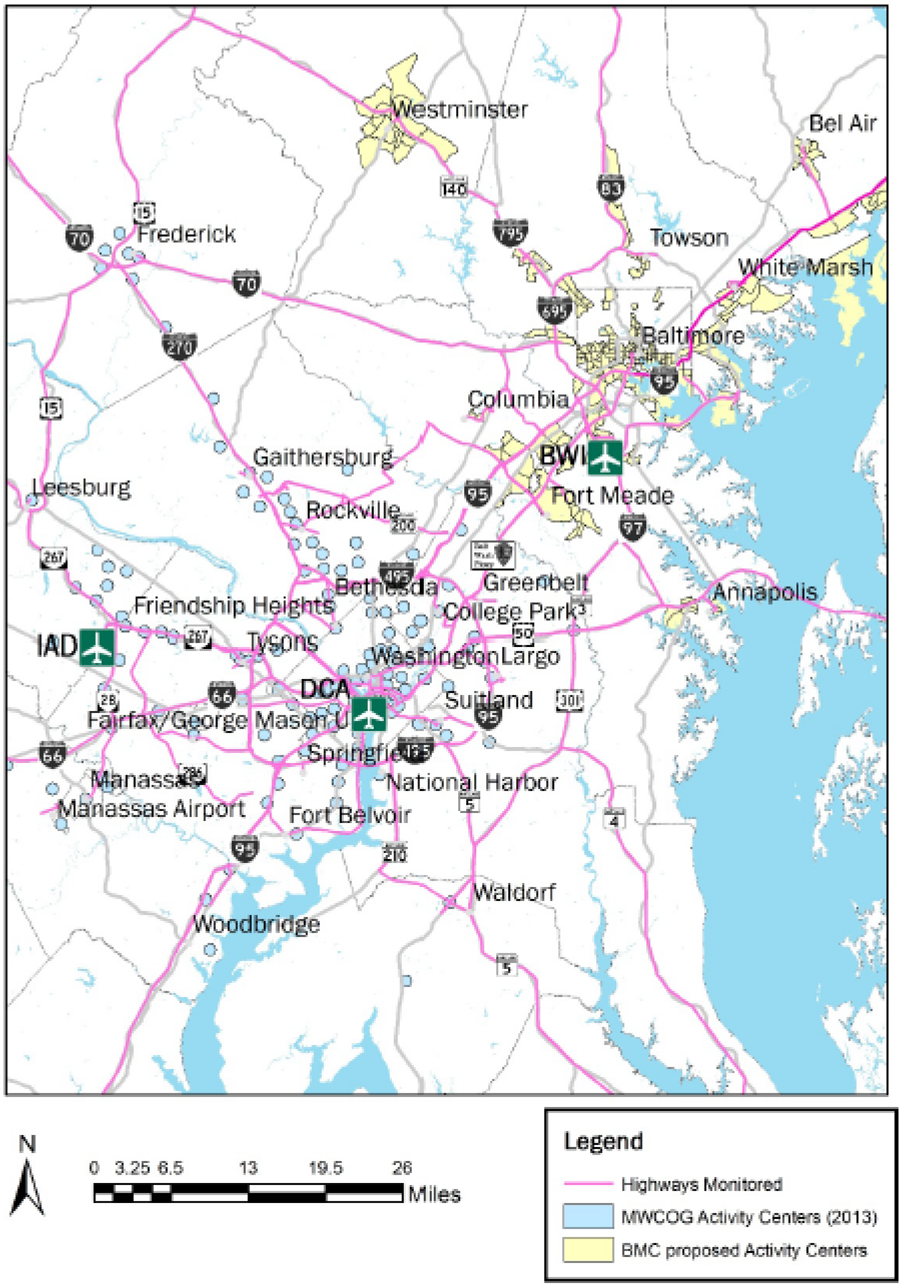
[48] Virginia Mega Projects, 95 Express Lanes, http://www.vamegaprojects.com/about-megaprojects/i-95-hov-hot-lanes/

[49] *2013 Washington-Baltimore Regional Air Passenger Survey Data Editing Process,* 2014-01-23 Aviation Technical Subcommittee: http://www.mwcog.org/uploads/committee-documents/b11ZXVpf20140131093313.pdf

Figure 43: Regional Airports and Highways Monitored in the 2015 Study



The region's Continuous Airport System Planning (CASP) program has so far conducted a total of five Regional Airport Ground Access Travel Time Studies in 1988, 1994, 2003[50], 2011[51] and 2015[52].

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50 Abdurahman Mohammed, Washington-Baltimore Regional Airport 2003 Ground Access Travel Time Study Update, September 2004. http://www.mwcog.org/uploads/committee-documents/tFIcVIY20060622150454.pdf

51 MWCOG/NCRTPB: 2011 Washington - Baltimore Regional Airport Ground Access Travel Time Study. http://www.mwcog.org/uploads/committee-documents/aF1eXlZW20120113141801.pdf

52 C. Patrick Zilliacus and Richard Roisman, 2015 Washington-Baltimore Regional Airport Ground Access Travel Time Study, Draft. http://www.mwcog.org/uploads/committee-documents/ZlxeV1ha20160401084328.pdf

The latest (2015) study had important new features compared to previous ones. For the first time, highway travel between the three regional airports was also analyzed; previous studies only looked at highway travel to/from individual airport. Also for the first time, no field data collection was performed and only vehicle probe data from the I-95 Corridor Coalition Vehicle Project was used.

The 2015 study compared to two one-year periods: 2011/2012 (September 1, 2011 to August 31, 2012) and 2014/2015 (September 1, 2014 to August 31, 2015). Each of these days were classed as a midweek day (Tuesdays, Wednesdays, Thursdays), weekend day (Friday, Saturday, Sunday, Monday) or holiday (both secular holidays such as Independence Day and religious holidays such as Easter, Passover and Eid al-Fitr were categorized as holidays – if a day was classed as a holiday, it was excluded from midweek or weekend analysis).

The 2015 study findings include:

- In aggregate, travel times to the airports, as measured by Travel Time Index (TTI) has not changed substantially from the 2011/2012 period to 2014/2015.

- In aggregate, the highest TTI was observed for travel to Reagan National Airport (DCA) during the midweek morning peak period (6 A.M. to 9 A.M.). The highest TTI to Thurgood Marshall BWI airport was observed during weekday afternoon peak period (3 P.M. to 7 P.M.). Travel to Washington Dulles International Airport (IAD) was also during midweek morning peak, though not as high as to DCA.

- Use of new managed lanes that have opened since 2010 and certain HOV lanes can save time for travelers using the highway network to reach the airports. The highest travel time savings were observed for trips from Fredericksburg to IAD, at 25 minutes, using the 95 Express and 495 Express lanes in the midweek morning peak period. Travel from Rockville to BWI saved about 20 minutes by using MD-200 (Inter-County Connector) instead of I-270 and I-495.

- It is possible to reach all three airports by transit. Transit travel times ranged from about 16 minutes to reach DCA from downtown Washington, D.C. via Metrorail; 30 to 50 minutes from downtown Baltimore to BWI; to between 2 hours and 20 minutes and 3 hours and 30 minutes to reach the airports by way of transit from origins in Charles and St. Mary’s Counties in Southern Maryland and Hagerstown, Washington County, Maryland.

- Congested highways continue to be a problem for travel to and between the three airports.

- Some of the more-congested parts of the Baltimore and Washington highway networks include Outer Loop of I-695 (Baltimore Beltway), both loops of I-495 (Capital Beltway) in Montgomery County and Fairfax County; I-270 and I-270 Spur in Montgomery County; the Baltimore-Washington Parkway in Anne Arundel County and Prince George’s County; U.S. 50 (John Hanson Highway) in Prince George’s County; the conventional lanes of I-95 in Prince William County; the conventional lanes of I-395 in Fairfax County, City of Alexandria and Arlington County; I-66 in Fairfax and Prince William Counties, DC-295, I-695 and I-395 in the District of Columbia.

2.2.6 Freight Movement and Congestion

In addition to congestion's impacts on person movement, congestion in and around major metropolitan regions such as Washington significantly impacts freight movements. While freight movements by other modes are not generally affected to the degree that trucks are by surface transportation congestion, the Washington region is subject to freight rail bottlenecks and congestion.

Traffic congestion on the region's highways and arterials slows freight deliveries and impacts shippers and consumers. Shippers continually adjust their operations in response to congested conditions. Impacts of increased congestion to the freight industry include:

- A shrinking of the delivery area that one driver and vehicle can serve, causing firms to add smaller and more numerous trucks to their fleets to serve existing customers;
- A decrease in the size of the area that can be served from any given distribution facility, impacting the size, number, and dispersion of distribution facilities in the region;
- An increase in the proportion of deliveries scheduled for the very early morning due to increasing afternoon congestion;
- A decrease in delivery reliability, causing firms to increase "on hand" or "just in case" inventory, thereby eroding the economic efficiencies associated with just-in-time inventory systems; and
- An increase in shipper operating costs (time and fuel) which are eventually passed on to consumers.

According to MWCOG analysis of FHWA Freight Analysis Framework data (FAF), approximately 212 million tons of goods worth over $241 billion are transported to, from, or within the Washington region annually. Approximately three-quarters of this freight movement (by weight) is by truck. An additional 363 million tons of goods were estimated to pass through the region annually. It is therefore critical for freight movement to be considered as part of regional and local transportation and land use planning activities.

Employment in the professional and business services, trade and transportation, federal government, and state and local government sectors drives the economy of the Washington region. Because the regional economy is service-based, the region is primarily a consumer rather than a producer of goods. Consumers depend upon trucks to deliver needed goods. This demand puts pressure on the regional surface transportation system as trucks maneuver across the transportation network to make their deliveries on time.

Both national and regional freight forecasts predict significant growth in freight tonnage and value across most transportation modes. Trucks are more flexible than trains, ships, or airplanes; operate on a broader transportation network than any other mode; and are usually required to haul goods shipped by other modes to their final destination. Because of this, trucks will capture much of the projected growth in the freight market. According FAF, the Washington metropolitan region is projected to see the amount of tonnage moving to, from, and within the region increase by 44% and the corresponding value to increase by 146% by 2040.

The Panama Canal Expansion is anticipated to be complete in 2016. This expansion will allow much larger "Post-Panamax" ships from Asia to serve East Coast ports, including the port facilities in Baltimore and the Hampton Roads, Virginia area. A significant portion of the new cargo arriving at these ports will likely pass through the Washington region by truck or rail on its way to inland destinations.

COG/TPB has established a Freight Program with a Freight Subcommittee as a major component of this program. The Freight Subcommittee provides a forum for discussion of freight issues and concerns within the Metropolitan Washington Region. This gives freight stakeholders the opportunity to share concerns and information with the TPB and other decision-makers. The Freight Subcommittee meets regularly to share information and interact with special guest speakers.

Trucks impact congestion and compete for limited space on roadways in congested corridors. Similarly, competition for curb space along streets in urban environments for goods delivery is also a challenge. Discussions with freight movement stakeholders revealed that they are already going to great lengths to schedule deliveries at off-peak hours or to move goods by rail where practicable and economically feasible. Full consideration of non-highway means of freight movement will be continued. However, the projected robust growth in all modes ensures that trucks will remain a major presence on the region's roadways.

Freight congestion is concentrated in urban areas and is most apparent at bottlenecks on highways - especially those serving major international gateways, major domestic freight hubs, and in major urban areas where important national truck flows intersect congested urban areas. In fact, the American Transportation Research Institute (ATRI) ranked congestion in the Washington, DC metropolitan area as fifth in the nation in terms of its contribution to increased operating costs for the trucking industry (see Table x.x below).

Table 10: Cost of Congestion for Trucking by Metropolitan Area - 2013

Rank	Metropolitan Area	Cost to the Trucking Industry (millions of dollars)
1	Los Angeles, CA	1,081.7
2	New York, NY	984.3
3	Chicago, IL	466.9
4	Dallas, TX	406.1
5	**Washington, DC**	**379.4**
6	Houston, TX	373.6
7	Philadelphia, PA	292.1
8	San Francisco, CA	288.6
9	Boston, MA	278.2
10	Atlanta, GA	275.1

Source: ATRI

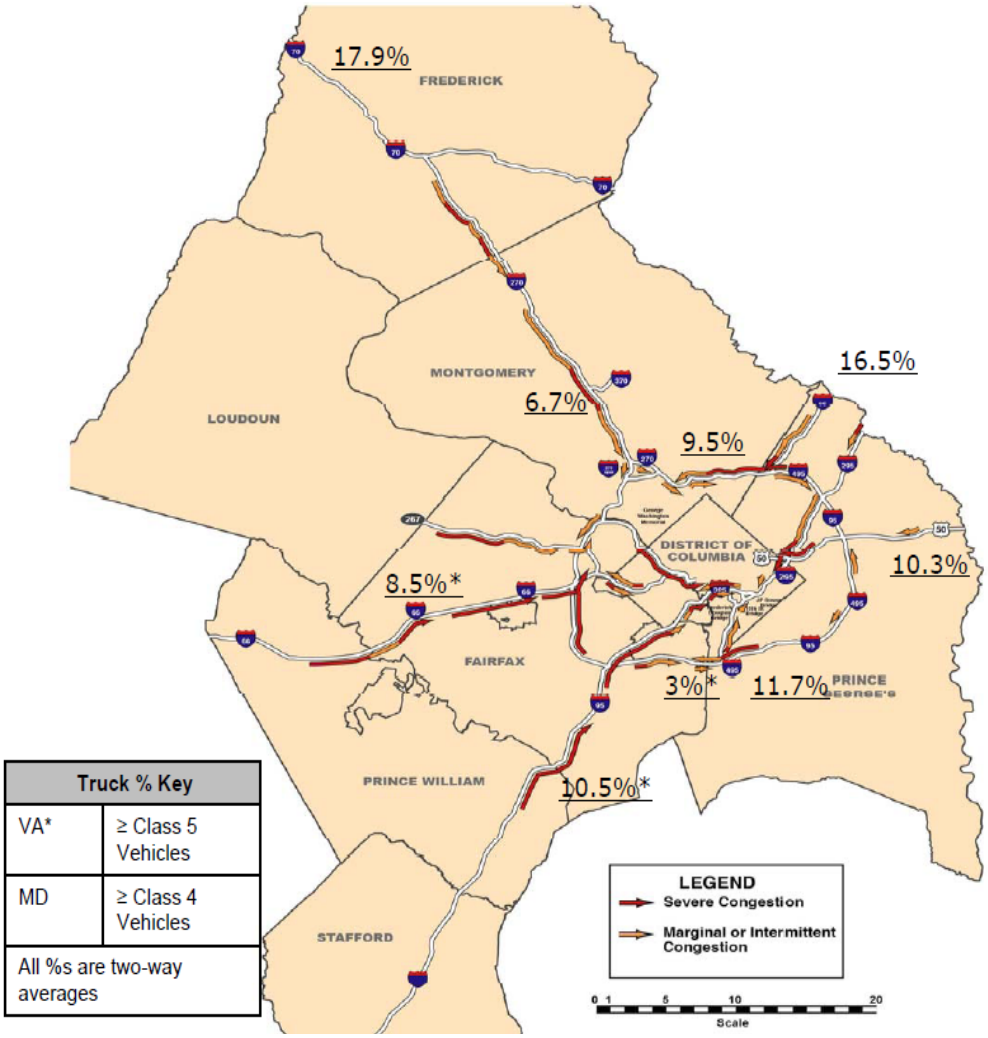
Figure 44 shows truck percentages of total Annual Average Daily Traffic (AADT) on the region's freeway network [53]. The percentages are truck counts averaged from both directions. The congestion on the freeways is for the morning peak period conditions from the spring 2008 TPB aerial survey.

In 2013, the FHWA procured the National Performance Management Research Data Set (NPMRDS) from HERE, LLC [54] and the data can be used by MPOs and state DOTs to conduct performance analysis on the NHS. This data source contains valuable truck speeds information and could be a source for future freight movement analysis for this region.

[53] *Integrated Freight Report*, July 2009. http://www.mwcog.org/uploads/committee-documents/kV5aXl1a20091020140842.pdf

[54] FHWA, National Performance Management Research Data Set (NPMRDS) Technical Frequently Asked Questions. http://www.ops.fhwa.dot.gov/freight/freight_analysis/perform_meas/vpds/npmrdsfaqs.htm

Figure 44: Percentages of Truck Counts on the Region's Morning Peak Period Network



2.2.7 TRAFFIC SIGNALS

2.2.7.1 Traffic Signal Timing Optimization

Delays occurred at signalized intersections accounted for a significant portion of overall arterial and urban street delays. Improving traffic signal timing has been identified as a CLRP priority area.

The TPB has conducted three surveys of the status of signal optimization in 2005[55], 2009[56], and 2013[57]. The 2013 survey found that of the total 5,500 signalized intersections in the region, 76 percent were retimed/optimized, 22 percent not retimed/optimized, and no report received for 2 percent. This was a similar but slightly reduced level of optimization compared to the last such survey in 2009, in which 80 percent signals were retimed/optimized.

This result, however, should be interpreted within the context of the comments below: 1) Regional results overall held to a similar albeit lower level to that of three years ago, in the context of widespread budgetary belt-tightening by involved transportation agencies; it was anticipated that some upcoming anticipated investments will improve the regional picture; 2) DDOT currently has a five-year signal re-timing project. This includes a phased approach, with the intent to touch all signals based on areas of concern. DDOT has also identified three corridors for possible deployment of an adaptive system; 3) signal optimization can help get an arterial closer to its design capacity but cannot increase capacity; 4) techniques are often combined; signals can be optimized using computer software followed by active field management for validation purposes; 5) active management is particularly useful to address non-recurring congestion caused by incidents and special events; and 6) signal equipment must be properly maintained for signal timing to be effective.

TPB member jurisdictions have been actively conducting signal timing optimizations, exploring and implementing the latest technologies to improve the operations of traffic signals. By the end of 2016, DDOT will complete a citywide signal optimization project that initiated in 2012 and will enhance the District's entire traffic signal network of more than 1,650 signals. The central goal of the optimization project is to make DC traffic signals safer and friendlier for pedestrians, improve bus running times, and reduce traffic congestion and vehicular traffic emissions. A project status update[58] in September 2015 found that more than 60% of the signalized intersections had been completed by that time, and the before-and-after studies showed significant improvements.

2.2.7.2 Transit Signal Priority

Under the Transportation Investments Generating Economic Recovery (TIGER) Program, WMATA, City of Alexandria and DDOT are carrying out a Transit Signal Priority (TSP) project along VA-7 (Leesburg Pike)[59]. By the end of April, there were 25 TSP signals installed in Fairfax County, the City of Alexandria, and the City of Falls Church. A WMATA bus fleet of 8 buses has been equipped with the onboard equipment and testing has been ongoing since November. WMATA is evaluating the results of the initial operating period. Additional changes have been submitted to the contractors for implementation. Project completion is anticipated in June.

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[55] Andrew J. Meese, *Briefing on the Implementation of Traffic Signal Optimization in the Region*, a presentation to the TPB on November 10, 2005. http://www.mwcog.org/uploads/committee-documents/tVtXWlY20051110144208.pdf

[56] Edward D. Jones, *Status Report on Traffic Signal Optimization in the Washington Region*, a presentation to the TPB on March 11, 2009. http://www.mwcog.org/uploads/committee-documents/bV5cXFhc20090312161527.pdf

[57] Ling Li, *Briefing on Traffic Signal Timing/Optimization in the Washington Region*, a presentation to the TPB on February 19, 2014. http://www.mwcog.org/uploads/committee-documents/al1ZXFpb20140212133426.pdf

[58] A. Wasim Raja, *District of Columbia Traffic Signal Timing Optimization – Status Update*, a presentation to the TPB Technical Committee on September 4, 2015. http://www.mwcog.org/uploads/committee-documents/alxfXFlX20150904130354.pdf

[59] Eric Randall, Update on the Implementation of the TPB Regional Priority Bus Project under the Transportation Investments Generating Economic Recovery (TIGER) Program, a memorandum to the TPB Board, May 12, 2016. http://www.mwcog.org/uploads/committee-documents/k1xdXl9Z20160512122232.pdf

Phase One of the DDOT TSP Project is up and running at 94 locations throughout the District. On March 24, DDOT conducted the first prototype test, and testing will continue through May. Installation of Phase Two with an additional 101 locations is nearing completion. Onboard bus equipment is being installed by WMATA on 116 Metrobuses; 46 buses have received upgrades, however technology compatibility issues have delayed installation on the remaining planned buses. Work also continues on implementation of the queue jumps, which has required the development of new traffic signal protocols by DDOT. The grant-funded part of the project should be completed in June, though operational testing will continue and implementation will become part of ongoing operations.

The City of Alexandria completed installation at the nine locations along the Van Dorn-Pentagon corridor in February. WMATA is working to get onboard equipment installed on Metrobuses to begin testing. The City and WMATA are also coordinating on central system access and management issues before the system can begin operational testing. The grant-funded part of the project should be completed in July.

2.2.7.3 Traffic Signal Power Back-Up

Traffic signal power back-up systems are critical in the event of an emergency, particularly if the event involves a lack of power. Since late 2011, the TPB's Traffic Signal Subcommittee has conducted six regional surveys on traffic signals power back-up systems [60]. The last survey was conducted by June 30, 2015 and found that about 27% of the region's 5,500+ signals are already equipped with battery-based power back-up systems, and 58% are equipped with generator-ready back-up systems (most battery-based systems also have generator-ready features). These power back-up systems can improve the resiliency of the transportation network, and are expected to be further enhanced in the future with projects funded by Urban Areas Security Initiative (UASI) grants.

2.2.8 Safety and Congestion

2.2.8.1 Overview

Transportation safety is a serious concern in the Washington region. There is shown to be a strong correlation between traffic safety and traffic congestion. Incidents, including those in work zones, secondary incidents, involve adverse weather events, or bicycle and pedestrian incidents, all can contribute to non-recurring congestion. Sources indicate that approximately half of all congestion is caused by non-recurring congestion. [61] Raising awareness about such things as transportation safety can help address an issue at the root of incident management.

Engineering and operational management activities can help improve safety and therefore lessen the impact of crashes and other safety problems on congestion. Many transportation agencies in the region have active incident management programs that quickly respond to incidents, help reduce their duration, and lessen the likelihood of secondary accidents in traffic backups. These programs are further integrated into the Metropolitan Area Transportation Operations Coordination (MATOC) program [62], to undertake day-to-day, real-time multi-agency coordination and information sharing regarding transportation systems conditions during major incidents in the Washington region.

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[60] Marco Trigueros, *Update on COG Incident Management and Response (IMR) Action Plan Recommendations: Back-Up Power for Traffic Signals*, a presentation to the TPB's Traffic Signal Subcommittee on December 8, 2015. http://www.mwcog.org/uploads/committee-documents/k1xeX1xa20151208095114.pdf

[61] Describing the Congestion Problem, Federal Highway Administration: http://www.fhwa.dot.gov/congestion/describing_problem.htm.

[62] See www.matoc.org for more information.

Furthermore, transportation agencies look for ways to improve the safety of the physical roadway infrastructure, again to improve safety and therefore lessening its impacts on congestion. Such engineering improvements may include turn lanes, improvements of site lines, lighting, guardrails, and pedestrian enhancements.

The TPB is addressing transportation safety through a variety of programs and activities:

- Transportation safety is encouraged and tracked by TPB member agencies through the ***Transportation Improvement Program (TIP)***, which provides information on projects to be completed over the next six years. The TIP contains projects whose primary purpose is to enhance safety, and explains how other projects will support transportation safety.

- The ***TPB's transportation safety planning activities*** helps facilitate regional traffic data compilation, sharing this data among member agencies, and identifying regional safety problems.

    - The ***Transportation Safety Subcommittee,*** a subcommittee of the TPB Technical Committee, focuses on advising staff on the federally-required transportation safety portion of the long-range transportation plan. The diversity of the Subcommittee, which is comprised of stakeholders from the State Departments of Transportation Planning, planning staff of the TPB member agencies, law enforcement officials, and public health representatives, is essential to providing a wide-range of safety perspectives. Another key objective of the Subcommittee is exchanging information on ongoing safety activities and best practices.

    - The ***Street Smart Pedestrian and Bicycle Safety*** campaign is an annual region-wide campaign to raise public awareness on pedestrian and bicycle safety.[63] The campaign, created by the TPB's Bicycle and Pedestrian Subcommittee in 2002, uses methods such as radio, newspaper, and transit advertising, public awareness efforts, and law enforcement with an overall goal of changing motorist and pedestrian behavior and reducing pedestrian and bicycle deaths and injuries.

Transportation Safety remains a key focus of transportation planning in the region. The TPB's transportation safety work program acts as a home for facilitating discussion of transportation safety issues in our region, and raising awareness about those issues. Continuing safety planning activities in the Washington region will continue to be important to the CMP.

2.2.8.2 Traffic Safety Facts

The TPB Transportation Safety Subcommittee compiles, summarizes, and reports safety and other information about the region's transportation system. Some of these traffic safety facts observed may help in illustrating the relationship of safety and congestion.[64]

- Decline in overall fatalities, injuries, and crashes over the past ten years has slowed;
- Total traffic fatalities in the Washington region had significantly gone down from 426 in 2005 to 272 in 2013;

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[63] http://www.bestreetsmart.net/

[64] Marco Trigueros, The Regional Transportation Safety Picture, presentation to the TPB's Transportation Safety Subcommittee meeting, April 6, 2015: http://www.mwcog.org/uploads/committee-documents/al1WXVle20150406105215.pdf

- The fatality rate per 100 million VMT for the Washington Metropolitan Statistical Area deceased from 1.20 in 2005 to 0.75 in 2013.
- Traffic deaths per 100,000 population in the Washington region had also significantly gone down from 8.94 in 2005 to 5.108 in 2013, the lowest level since 2002;
- In 2013, the region saw an increase in population and VMT, but fatalities have not increased as drastically – resulting in lower fatality rates;
- 2013 tied with 2012 and 2003 for fewest cyclist and pedestrian fatalities;
- The percentage of pedestrian fatalities in total fatalities decreased constantly from 28% in 2010 to 24% in 2013;
- Total traffic injuries in the Washington region decreased considerably from 45,316 in 2005 to 37,321 in 2013;
- Traffic injuries per 100,000 population declined from 1090 in 2002 to 698 in 2013, the lowest level since 2002;
- Pedestrian and cyclist injuries increased – both in absolute numbers and as a percentage of total; and
- Motorist injuries decreased – both in absolute numbers and as a percentage of total.

The above facts reveal that traffic safety is something that needs to be taken very seriously. The incident-related and non-recurring strategies our region undertakes not only manage congestion that commonly occurs after an incident happens, but these strategies can also prevent subsequent incidents from occurring. Our region's strategies aim at improving safety on our roadways, and ultimately contribute to making a nationwide difference.

2.2.8.3 Incident-Related and Non-Recurring Congestion

Fifty percent of congestion is said to be non-recurring, which is congestion due to incidents such as crashes, disabled vehicles and special events, work zones and bad weather.[65] Typically, there are more than 200 traffic related incidents on the region's roadways every day, the most severe of which can disrupt traffic for hours, cause secondary incidents, and overall cause major disruptions to the transportation system. Heavily-trafficked areas and construction areas are especially prone to incidents. Nonrecurring events dramatically reduce the available capacity and reliability of the entire transportation system. Travelers and shippers are especially sensitive to the unanticipated disruptions to tightly scheduled personal activities and manufacturing distribution procedures.

The Federal Highway Administration breaks down non-recurring congestion into three primary causes: 1) incidents ranging from a flat tire to an overturned hazardous material truck (25%), work zones (10%), and weather (15%).

A number of TPB's member agencies, including DDOT, MDOT, VDOT, and some local jurisdictions operate incident-management programs. These programs are further coordinated and facilitated by the Metropolitan Area Transportation Operations Coordination (MATOC) program, which has more emphasis on regional-significant incidents. The MATOC program and the local jurisdictional programs help minimize the impact the events have on the transportation network and traveler safety. If an incident disrupts traffic, it is important for congestion that normal flow resumes quickly. The TPB compiles and analyzes data associated with these incident management programs.

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[65] Describing the Congestion Problem, Federal Highway Administration: http://www.fhwa.dot.gov/congestion/describing_problem.htm.

2.2.8.4 New Safety Performance Management Final Rules [66]

The Federal Highway Administration (FHWA) published the Highway Safety Improvement Program (HSIP) and Safety Performance Management Measures (Safety PM) Final Rules in the Federal Register on March 15, 2016, with an effective date of April 14, 2016. The HSIP Final Rule updates the HSIP regulation under 23 CFR Part 924 to be consistent with MAP-21 and the FAST Act, and clarifies existing program requirements. The Safety PM Final Rule adds Part 490 to title 23 of the Code of Federal Regulations to implement the performance management requirements in 23 U.S.C. 150.

The Safety PM rule supports the HSIP, as it establishes safety performance measures to carry out the HSIP and to assess serious injuries and fatalities on all public roads. Together, these regulations will improve data; foster transparency and accountability; and allow safety progress to be tracked at the national level. They will inform State DOT and MPO planning, programming, and decision-making for the greatest possible reduction in fatalities and serious injuries.

The Safety PM Final Rule supports the data-driven performance focus of the HSIP. The Safety PM Final Rule establishes five performance measures to carry out the HSIP: the five-year rolling averages for: (1) Number of Fatalities, (2) Rate of Fatalities per 100 million VMT, (3) Number of Serious Injuries, (4) Rate of Serious Injuries per 100 million VMT, and (5) Number of Non-motorized Fatalities and Non-motorized Serious Injuries.

These safety performance measures are applicable to all public roads regardless of ownership or functional classification. The Safety PM Final Rule also establishes a common national definition for serious injuries.

MPOs will establish targets for the same five safety performance measures for all public roads in the MPO planning area within 180 days after the State establishes each target. The targets will be established in coordination with the State, to the maximum extent practicable. The MPO can either agree to support the State DOT target or establish a numerical target specific to the MPO planning area. MPOs' targets are reported to the State DOT, which must be able to provide the targets to FHWA, upon request.

2.3 Congestion on Transit Systems

2.3.1 Impacts of Highway Congestion on Transit Systems

2.3.1.1 Transit-Significant Roads

Often the region's highway congestion will have an impact on transit systems, such as rail and bus. To some extent, transit operations are concentrated in areas of high-density land uses, where traffic congestion may be expected. Bus schedules generally are designed to anticipate and accommodate highway congestion whenever possible. However, there are instances when congestion is unpredictable and can not only impact the timing of one bus, but of the entire bus system and other transit systems the bus connects to (such as commuter rail).

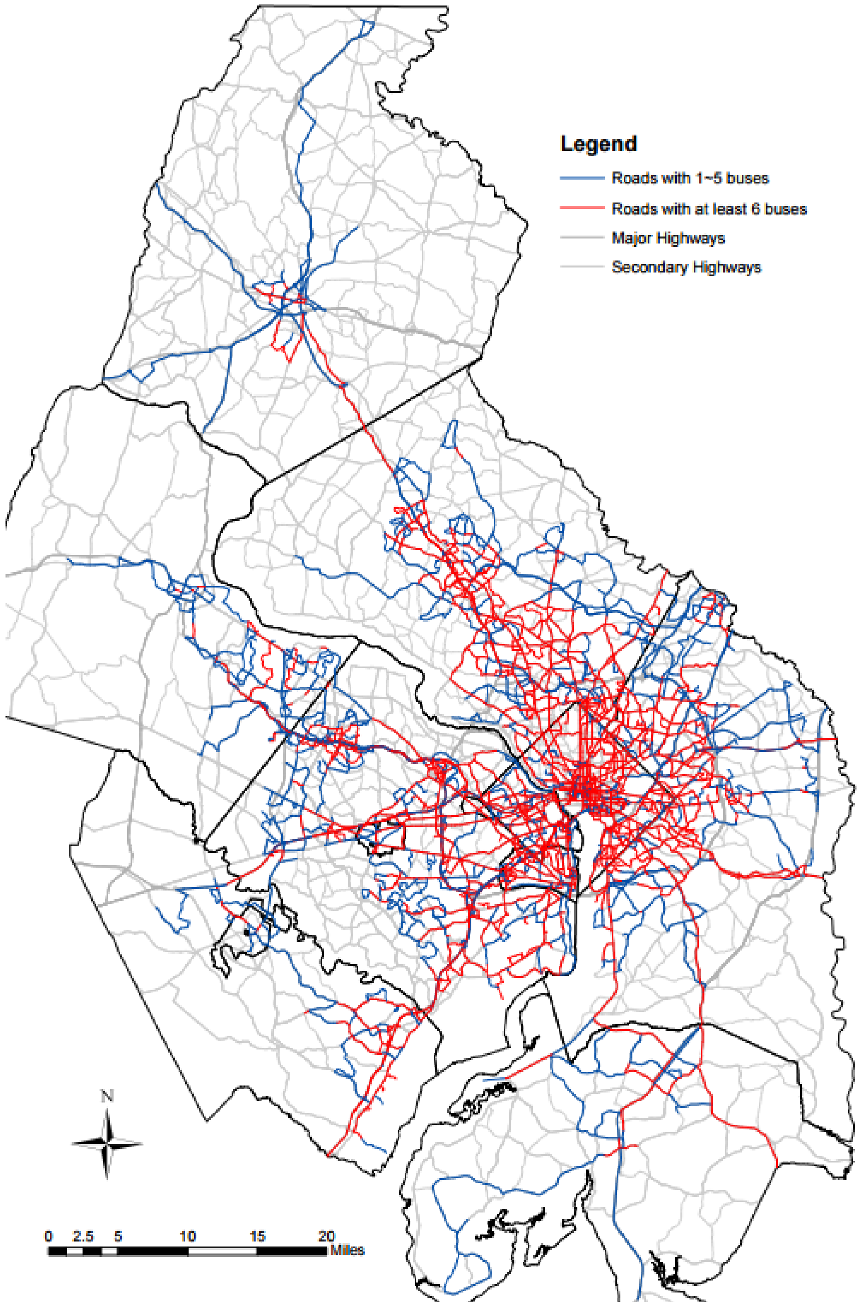
In order to track the differential congestion conditions, between regional overall congestion and

[66] FHWA, HSIP and Safety Performance Management Measures Final Rules Overview, http://safety.fhwa.dot.gov/hsip/spm/measures_final_rules.cfm, Accessed June 28, 2016.

transit-significant routes congestion, the TPB identified a Transit-Significant Road Network in 2014[67] and its performance is now monitored in the quarterly updated National Capital Region Congestion Report and the CMP Technical Report as a separate highway category.

Any road segments with at least 6 buses in the AM Peak Hour (equivalent to one bus in either direction in 10 minutes) are considered as "transit-significant". By this criteria, there is a total of 1,397 miles of transit-significant road segments, as shown in Figure 45.

Figure 45: Transit-Significant Roads in the TPB Planning Area

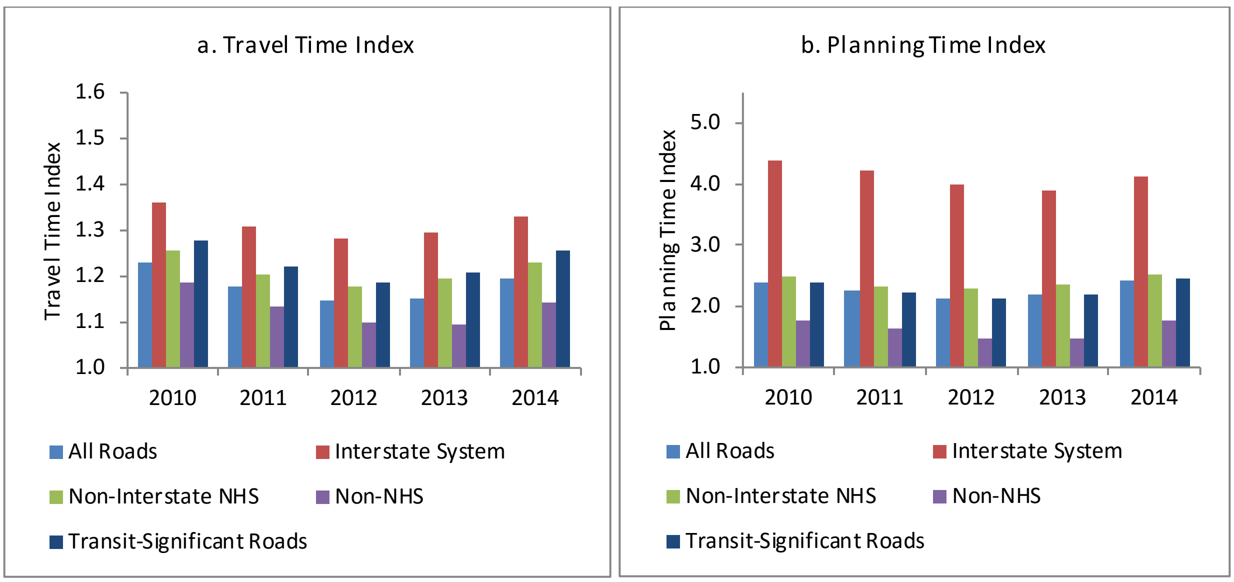


[67] Wenjing Pu, Update on "Transit-Significant Highway Network" Identification, Presentation to the Regional Public Transportation Subcommittee, November 25, 2014. http://www.mwcog.org/uploads/committee-documents/al1XXV1Z20141125094736.pdf

A performance analysis[68] revealed that the Transit-Significant Roads was more congested and more sensitive to change compared to the regional average of all roads.

The transit network's congestion, expressed as annual average Travel Time Index, was 3 to 5 percent worse than the regional average of all roads throughout 2010 -2014 during peak periods, i.e., 6:00-10:00 am and 3:00-7:00 pm (Figure 46 a. and Figure 47 a.). It is not unexpected that the transit-significant network is congested, since buses are often routed in dense, urban corridors as a part of multi-modal transportation strategies. This network was also more congested than the non-Interstate National Highway System (NHS) and the non-NHS roads, but less congested than the Interstate System, which was still the most congested highway category (Figure 46 a.).

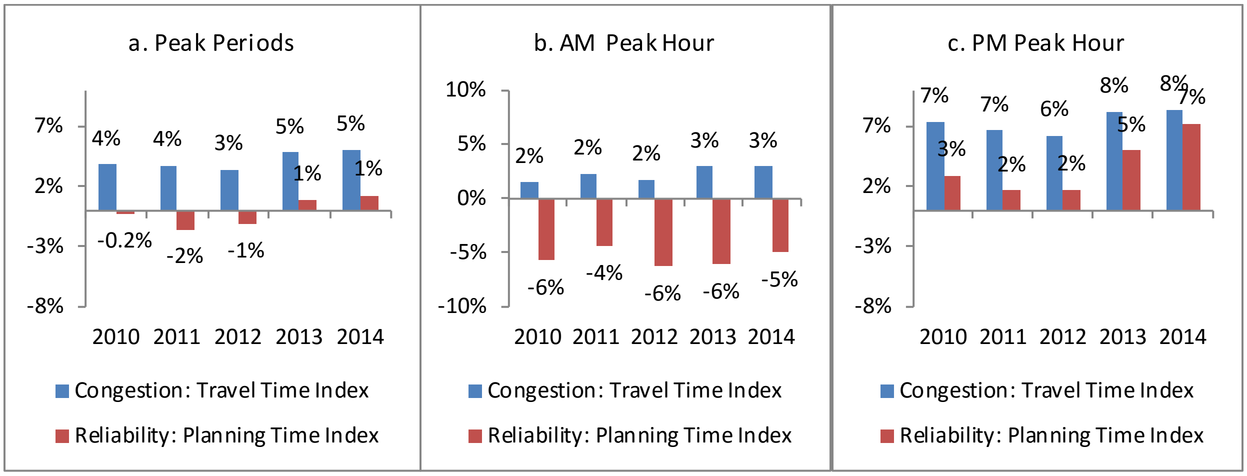
Figure 46: Peak Period Travel Time Index and Planning Time Index of Transit-Significant Roads



The difference in congestion between the transit network and the regional average was more pronounced during PM peak hour, with 6-8 percent difference, compared to the AM peak hour's 2-3 percent divergence (Figure 47 b. and c.).

68 Wenjing Pu, Performance of Transit-Significant Highway Network in the Washington Region, Presentation to the Regional Public Transportation Subcommittee, April 28, 2015. http://www.mwcog.org/uploads/committee-documents/aF1WWV1c20150428073637.pdf

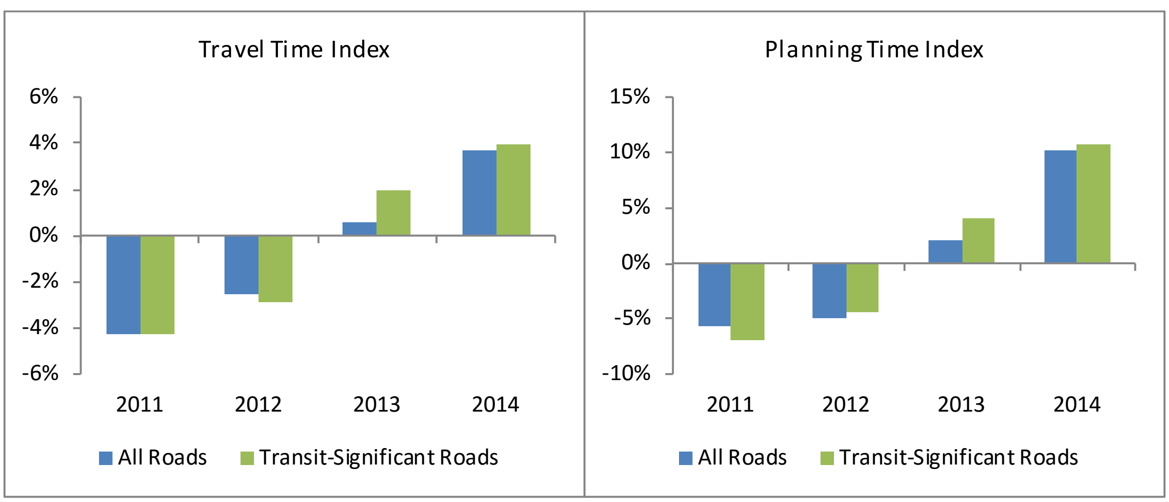
Figure 47: Transit-Significant Roads Compared to All Roads



In terms of travel time relibility, expressed as Planning Time Index, mixed results were found between the transit network and the regional average (Figure 47). The transit bus network was 4-6 percent more reliable than the regional average in the AM peak hour, but 2-7 percent less reliable in PM peak hour.

Performance of the Transit-Significant Network varied in accordance with regional average; but the year-to-year changes in the transit network tended to be slightly larger than that of the regional average (Figure 48).

Figure 48: Congestion and Reliability Year-to-Year Changes of Transit-Significant Roads



2.3.1.2 Bus Travel Speeds

Another way to assess the impacts of highway congestion on transit is to directly investigate bus travel speed along roads carrying both buses and other vehicles. Figure 49, Figure 50, and Figure 51 show region-wide bus speeds observed in the TPB's Multimodal Coordination for Bus Priority Hot Spots

Study[69] carried out in 2011-2012. These maps report average bus travel speeds for 28,172 roadway segments in the region (2,330 miles of roadway). The lines shown on the maps indicate the slower of the two directions during the given period. With few exceptions, this represents “outbound” buses during the PM peak (3:00-6:00 pm) and “inbound” buses during the AM peak (6:00-9:00 am).

The results of this study show that there are numerous roadway segments within the region with average transit operating speeds of less than 10 mph and several with speeds of under 5 mph. The vast majority of these locations are within the District, but some fall in Maryland and Virginia suburban areas (particularly around Silver Spring and several Arlington County locations). The analysis, as shown on the maps, also shows that PM speeds are generally lower than AM speeds, though the differences are small in most cases. For instance, the bridges over the Anacostia River in the District all show a noticeable decline in travel speed during the PM peak. The differences between the peak periods and the all-day speeds are smaller than might typically be expected. This indicates that mid-day congestion is heavy on many routes in the service areas. In addition, because most bus trips occur during the peak periods the all-day averages are naturally weighted toward the peaks.

In general, the results of the analysis show that bus operating conditions vary greatly by location throughout the region. Many locations, particularly in the downtown core, have operating speeds below 10 mph, indicating high amounts of bus delay. Moreover, many of the slowest corridors shown on the map carry very high bus volumes (e.g., I Street in downtown DC has 493 daily WMATA buses with a total ridership of 55,070) suggesting that priority improvements on these corridors could provide significant transportation benefits. In particular, WMATA’s work to develop a network of priority bus routes, and the recent federal Transportation Investment Generating Economic Recovery (TIGER) grant award to implement much of this network, provides a unique opportunity to address the challenges of congestion-related bus delay. In such efforts, support and collaboration from state DOTs and local agencies are vital.

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[69] COG/TPB, Publications, http://www.mwcog.org/store/item.asp?PUBLICATION_ID=445

Figure 49: Region-wide Bus Speeds – All Day

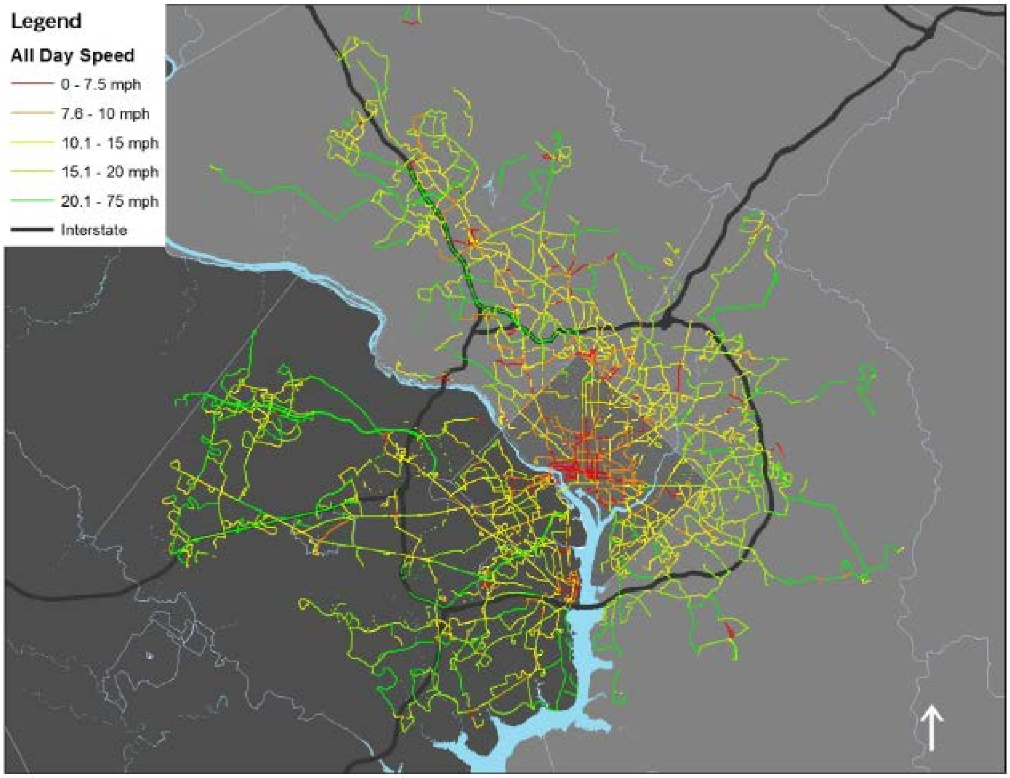


Figure 50: Region-wide Bus Speeds – AM Peak

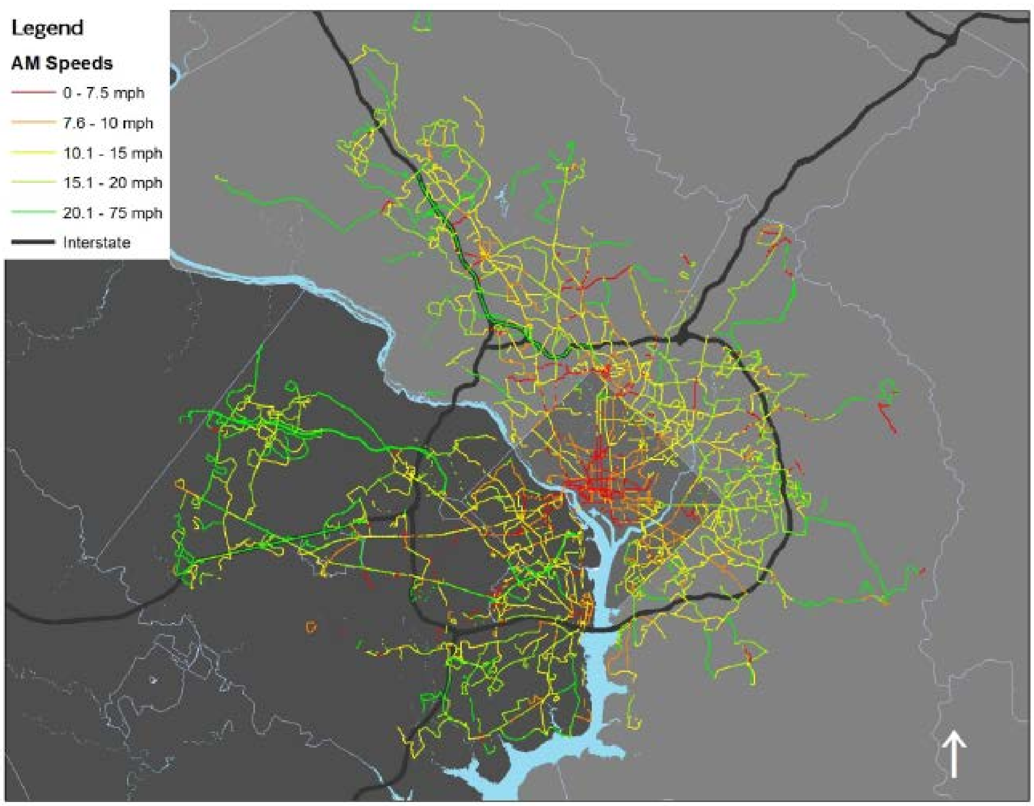
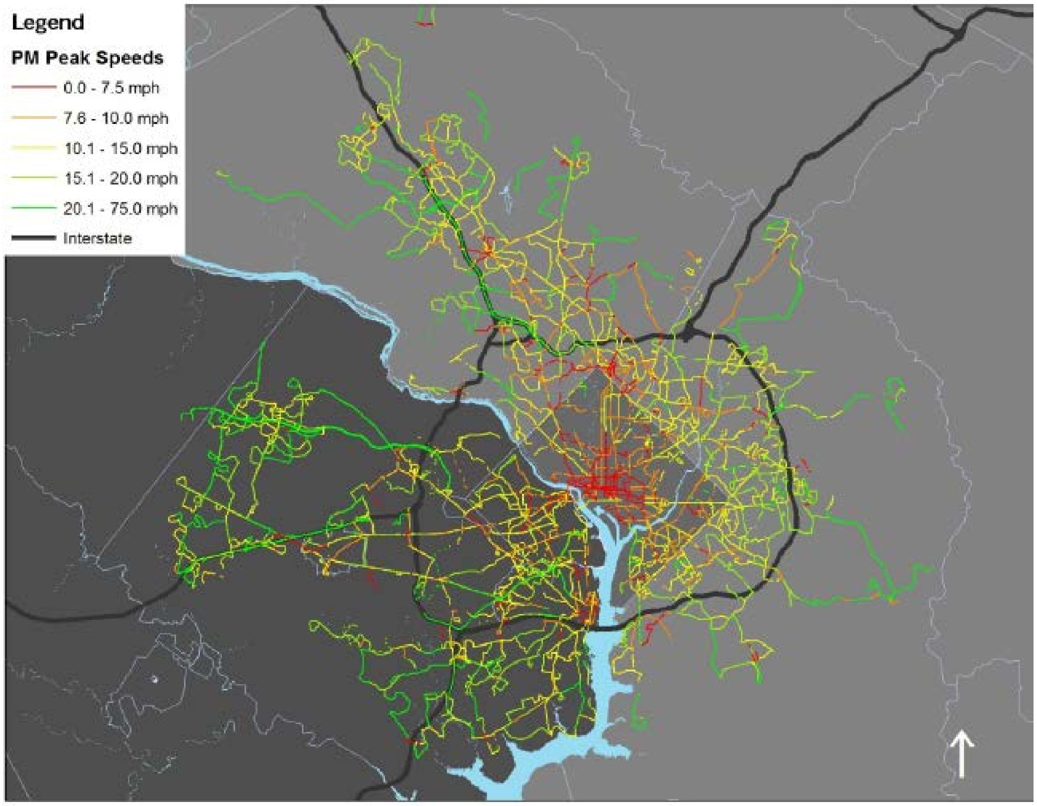


Figure 51: Region-wide Bus Speeds – PM Peak



2.3.1.3 Connections to Transit

The impact of highway congestion on transit systems can also be assessed by identifying and analyzing the key linkages between transit and other modes. In 2008 the TPB conducted a Regional Bus Survey[70] throughout our region. This survey found about 23% of the region's bus passengers accessed bus system via buses or autos and about 67% of all passengers had one or more transfers to reach their final destinations. These passengers were subjected to the impact of highway congestion if it occurs on pertinent routes.

In 2014, WMATA released a three-part series blog, "Solving the Region's Congestion Woes – One Step at a Time", suggesting ways to increase the walkability and connectivity around Metrorail stations[71]. The blog says that "walkable station areas result in fewer motorized trips, fewer miles driven, fewer cars owned, and fewer hours spent traveling. And when we improve the pedestrian and bicycle access and connectivity to Metrorail station areas, ridership goes up, putting a major dent in congestion by taking trips off the roadways."

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70 2008 Regional Bus Survey, Final Technical Report, http://www.mwcog.org/uploads/committee-documents/a15aXldb20091029142551.pdf. The 2014 Metrobus Survey was being carried out as of the writing of this report: http://www.mwcog.org/uploads/committee-documents/a11ZWFtf20140325100202.pdf

71 Shyam, Solving the Region's Congestion Woes – One Step at a Time, http://planitmetro.com/tag/one-step-at-a-time/

2.3.2 Congestion within Transit Facilities or Systems

Congestion can also be an issue within transit. If the demand for rail and buses is high and the capacity cannot keep up with that demand, then transit becomes too crowded. Just as incidents can cause non-recurring incidents on roadways, the same can occur on transit facilities. Even a minor bus or train incident can cause back-ups and delays.

In addition, certain transit facilities may experience more congestion that others. Union Station in the District of Columbia is a station that accommodates Metrorail, Metrobus, DC Circulator buses, Maryland Area Rail Commuter (MARC) trains, Virginia Railway Express (VRE) trains, and AMTRAK. With these various transit options, Union Station has become a primary connection point for commuters/visitors, and the busiest station in the Metrorail system, with 70,000 passengers entering and exiting daily (a passenger congestion simulation can be found on http://planitmetro.com/data)[72]. In response, WMATA and DDOT jointly completed the Union Station Access and Capacity Improvement Study in early 2011[73], and identified improvements that would fit compatibly with Union Station and benefit all transportation service providers and customers.

The TPB's Central Employment Core Cordon Count of Vehicular and Passenger Volumes[74] could be used to measure transit crowding at count stations. Section 2.4.1 will provide more information about the cordon count.

Congestion can not only result on the transit system itself, but on station platforms and around the station. In 2008, WMATA released their findings of the Metrorail Station Access & Capacity Study[75]. This study found that a number of stations need to expand their capacity in order to satisfy the demand imposed by existing large ridership and/or future ridership increases, as listed in Table 11.

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[72] Washington Metropolitan Area Transit Authority, Data Visualization, Union Station Simulation http://planitmetro.com/data

[73] WMATA and DDOT, Union Station Access and Capacity Improvement Study Project Report, February 18, 2011. http://www.wmata.com/about_metro/docs/Final%20Union%20Station%20Project%20Report%20Feb182011.pdf

[74] *2013 Central Employment Core Cordon Count of Vehicular and Passenger Volumes*, Draft, December 30, 2013. http://www.mwcog.org/uploads/committee-documents/k11ZXV5e20140127094130.pdf

[75] Metrorail Station Access & Capacity Study, Washington Metropolitan Area Transit Authority (WMATA), http://www.wmata.com/pdfs/planning/Final%20Report_Station%20Access%20&%20Capacity%20Study%202008%20Apr.pdf.

Table 11: Existing and Future Station Capacity Issues

Station	Mezz	Vertical		Faregate	
		2005	*2030*	*2005*	*2030*
Archives-Navy Memorial-Penn Quarter		⊙	⊙		
Bethesda			⊙		
Branch Ave		⊙	⊙		
Cleveland Park					⊙
Court House			⊙		⊙
Farragut North	SE	◉	◉		
Farragut West	W	⊙	⊙		
Foggy Bottom-GWU		⊙	⊙		
Franconia-Springfield			⊙		
Gallery Pl-Chinatown	N	⊙	◉	⊙	◉
	W				⊙
Judiciary Square	E		⊙		
L'Enfant Plaza	E	⊙	◉		
	W		◉		
Metro Center	N	⊙	◉		⊙
	S	◉	◉		
	W		⊙		
Navy Yard*	E				⊙
Shady Grove		⊙	◉		
Takoma				⊙	⊙
Twinbrook					⊙
White Flint					⊙
Union Station	S	⊙	⊙		
	W	⊙	⊙		

Legend
⊙ Needs study (0.5≤v/c<0.75)
◉ Needs improvement (v/c≥0.75)

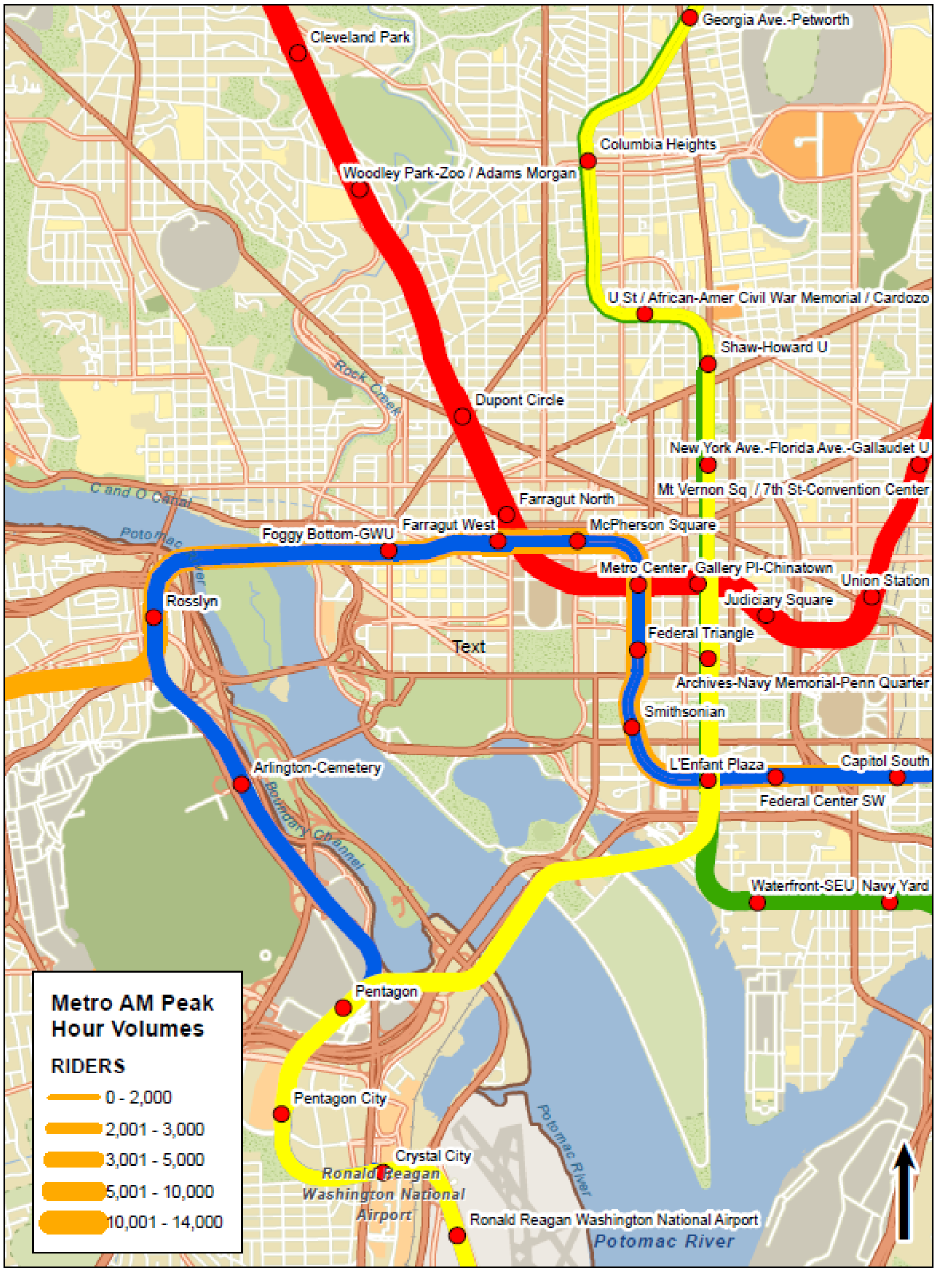
**Note: Both Navy Yard mezzanines will have unique future needs, which may not be reflected in this analysis, due to the opening of the Washington Nationals Ballpark in 2008.*

Source: WMATA, 2008, Metrorail Station Access & Capacity Study.

According to Metro's Office of Long Range Planning, more than two-thirds of Metrorail daily ridership occurs during the morning and evening peak periods[76]. The graphic (Figure 52) provided by this Office shows the AM peak hour (8:00-9:00 AM) passenger volumes by travel direction. Red and Orange/Blue Lines carry the highest passenger volumes in the system morning peak hour, on segments from Woodley Park to Farragut North (eastbound), Gallery Place to Metro Center (westbound), and Rosslyn to Farragut West (eastbound). Please note the 8:00-9:00 AM system graphic does not reflect true max-loads on the Green Line. Unlike the other lines, the Green Line actually reaches peak loads between 7:30 AM and 8:30 AM, ahead of the other lines, with hourly passenger loads exceeding 7,000 from Anacostia to L'Enfant Plaza.

[76] Washington Metropolitan Area Transit Authority, Data Visualization, Peak Hour Passenger Ridership on Metrorail. http://planitmetro.com/data

Figure 52: AM Peak Hour (8:00-9:00 AM) Metrorail Link Passenger Volumes



Source: WMATA; data based on an average of six weekdays in October 2012.

WMATA also built an internal tool, called Line Load App, to monitor the passenger loads and crowdedness on Metrorail systems [77]. One example provided in Figure 53 shows the passenger per car (PPC) on each of the cars on eastbound Red Line at Dupont Circle station during weekday morning hour 8:00-9:00 AM in October 2014.

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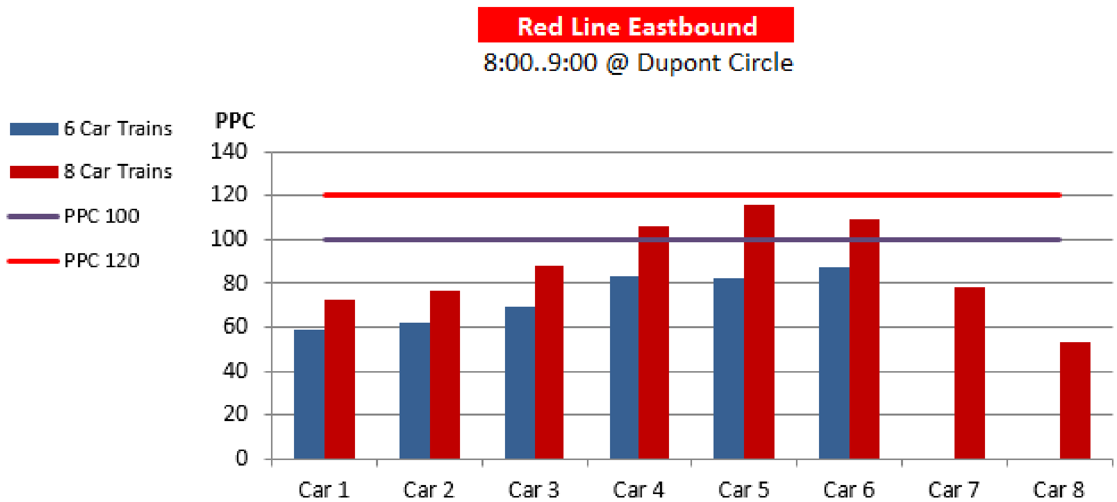
[77] Melissa, Monitoring Passengers Loads on Metrorail – Using New Tools to Examine the Data, January 5, 2016. http://planitmetro.com/2016/01/05/monitoring-passengers-loads-on-metrorail-using-new-tools-to-examine-the-data/

Figure 53: WMATA's Line Load Application Tool



Source: WMATA, Average Car Loads in the AM Peak Hour – October 2014 Weekdays – Modeled Distribution of Passengers at DuPont Circle. The estimated railcar crowding is based on the scheduled Red Line service.

In 2007, an analysis was conducted by TranSystems to gauge the effect traffic congestion and passenger crowding has on WMATA bus operations.[78] The analysis found evidence that traffic congestion imposes a cost on WMATA, as the peak vehicle requirement needs to be increased to maintain a sufficient level of service on certain routes. In addition, growth in passenger demand has the same effect, since additional bus trips need to be added to certain routes to avoid overcrowding.

In 2013, WMATA announced Momentum, Metro's strategic plan for 2013-2025[79]. As shown in Table 12 below from the plan, there are crowded conditions at peak periods today; without rail fleet expansion, most rail lines will be even more congested by 2025. The plan lays out seven Metro 2025 initiatives, including running eight-car trains during peak periods and core station improvements. For riders, Momentum will mean more trains, reduced crowding, faster buses, brighter, safer, easier-to-navigate Metrorail stations, and information when and where you want it. For the region, Momentum will increase capacity throughout the system, enable future expansion, and remove vehicles from our already-crowded roadways.

[78] Memo: Impact of Congestion on Metrobus Operations. March 12, 2007. http://www.mwcog.org/uploads/committee-documents/t1daVl020070509095750.pdf
[79] WMATA, Momentum, http://www.wmata.com/Momentum/

Table 12: Metrorail System Peak Period Capacity by Line without Fleet Expansion

	2012	2020	2025	2040
Red	✔	—	—	✘
Yellow	✔	✔	✔	—
Green	✔	—	—	✘
Blue	✔	—	—	✘
Orange/Silver	—	✘	✘	✘

✔ Acceptable (average passengers per car (PPC <100)
— Crowded (PPC between 100 and 120)
✘ Extremely crowded (PPC >120)

Source: WMATA, 2013, Momentum, Strategic Plan 2013-2025.

The CMP recognizes the growing concern of congestion within our regional transit systems. As the region's population grows and "going green" trends advances, there would be more commuter and residents looking to transit options instead of driving. While increase in transit use is overall a positive trend, it is important that the concern of transit congestion throughout the region be examined further.

Congestion management will benefit from continuing to encourage transit in the Washington region and explore transit priority strategies. The transit system in the Washington region serves as a major alternative to driving alone, and it is an important means of getting more out of existing infrastructure. Additional work with appropriate committees and transit agencies to address related data and performance measure issues would help further support the CMP.

2.4 Other Congestion Monitoring and Data Consolidation Activities

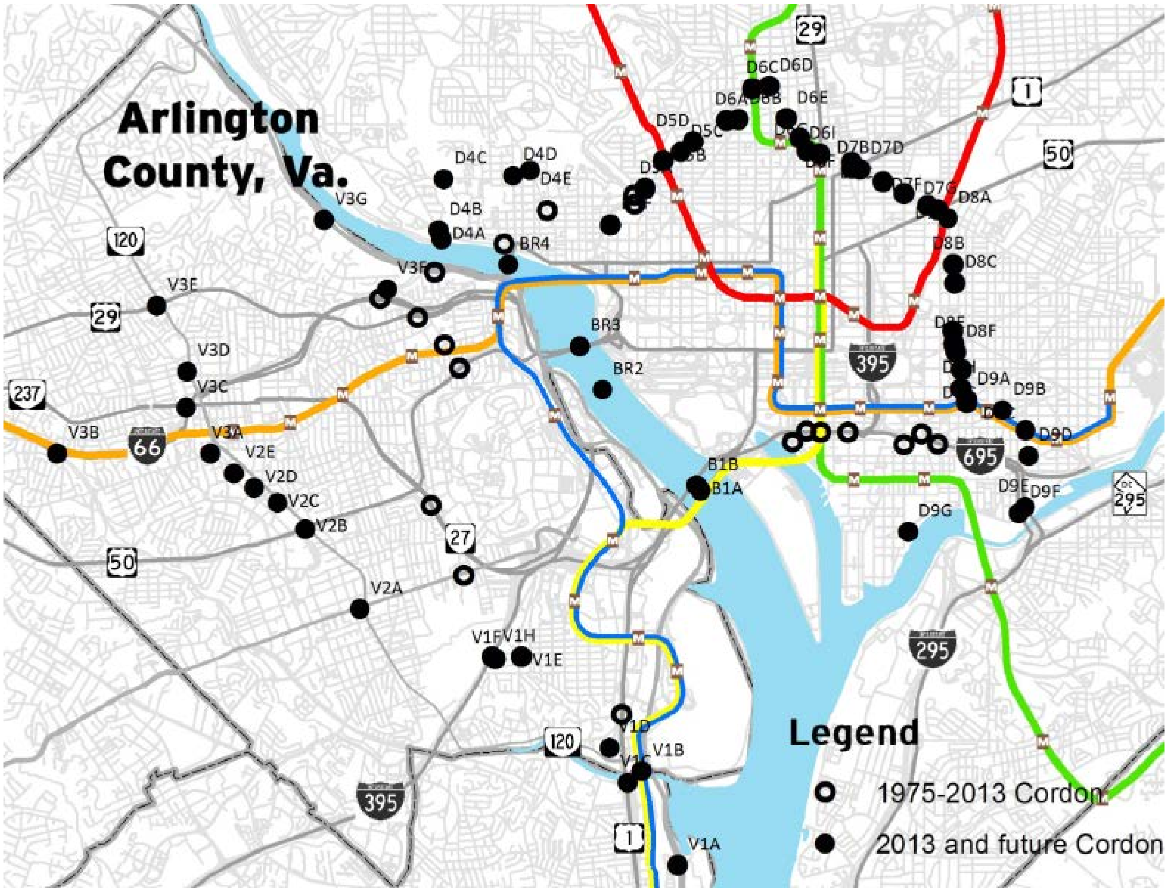
In addition to the congestion monitoring activities presented above in this chapter, the following monitoring and data consolidation activities are also carried out in the Washington region.

2.4.1 Cordon Counts

The cordon count program originated from the desire to assess the impact of the construction of the region's Metrorail system stating in the late 1960's. Thus, a cordon line around the Central Business District (the "core") was determined by the inbound point at which there were more destinations (alighting from transit buses) than origins (loadings onto transit buses). The central business district includes the downtown area of the District of Columbia, Georgetown south of "Q" Street, N.W., the U.S. Capitol, and the nearby sections of Arlington County, Virginia, including Rosslyn, the Pentagon, Pentagon City, Crystal City and Reagan National Airport. In later years, additional cordon counts were added to the program, including:

- Vehicle counts, classification, and occupancy were taken on facilities that cross the region's center core cordon.
- Monitoring of freeway routes in the region with HOV lanes.
- Other data collection projects, including counts of commercial vehicles and roadside truck surveys.
- In 2013, a revised cordon line was used in the count and the expanded cordon include "new" employment that has and will happen between 1975 and 2020, as shown in Figure 54 below.

Figure 54: Cordon Count Stations



These projects help to inform the development of regional travel forecasting computer models and provide an opportunity for trend analysis.

The most recent cordon count study is the 2013 Central Employment Core Cordon Count of Vehicular and Passenger Volumes[80]. This study collected data for the Spring 2013 Central Employment Core Cordon Count of peak period person and vehicle volumes entering the downtown employment area of the District of Columbia and Arlington County, Virginia, designated the Central Employment Core (formerly Metro Employment Core), the largest activity center in the Washington metropolitan region. Data were collected from 5 A.M. to 10 A.M. inbound along two cordon lines, the “traditional” cordon line which dates to the opening of the initial segment of the Metrorail system in 1976, and an revised or expanded cordon.

Most comparisons are made with results obtained from the previous Central Employment Core Cordon Count conducted in Spring 2009, though some are with the Spring 2006 Cordon Count. Between the 2009 and 2013 counts, some demographic and transportation system changes have occurred that may have influenced the numbers of people and how they have commuted into the regional core. Data were not collected during the P.M. peak period for this effort.

Trends and changes in person and vehicle trips by mode are emphasized for the 6:30 - 9:30 A.M. peak period inbound. The following changes were observed:

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[80] *2013 Central Employment Core Cordon Count of Vehicular and Passenger Volumes*, Draft, December 30, 2013. http://www.mwcog.org/uploads/committee-documents/k11ZXV5e20140127094130.pdf

1) Total inbound travel decreased in the A.M. peak period from about 463,000 person trips in 2009 to 446,000 in 2013. Trips crossing the revised cordon in 2013 were about 435,000.
2) Inbound peak period transit trips were about 211,000, little changed from 2009. Transit trips crossing the revised cordon line were about 197,000.
3) Person trips by automobile in 2013 were about 236,000, a decrease of about 21,000 from 2009. Most of the decrease in person trips were in multiple occupant vehicles (2 or more persons per vehicles), which declined by about 21,000 trips.
4) The number of automobiles entering the Central Employment Core in the A.M. peak period has declined from 203,000 in 2009 to about 192,500 in 2013. For the five-hour monitoring period, the decline was similar in absolute terms, from about 273,000 in 2009 to 263,000 in 2013.
5) Traffic volumes crossing the revised cordon line were only slightly higher, but person trips were lower.
6) About 3,500 bicycles entered the Central Employment Core in the A.M. peak period. In the full five hour monitoring period, almost 5,000 trips by bike were observed.

Figure 55 and Figure 56 below contain charts that depict the trends in person trips from 1999 to 2013, in the inbound peak period.

Figure 55: 2013 Cordon Count Trends in Person Trips: 1999-2013, Inbound 6:30-9:30 am

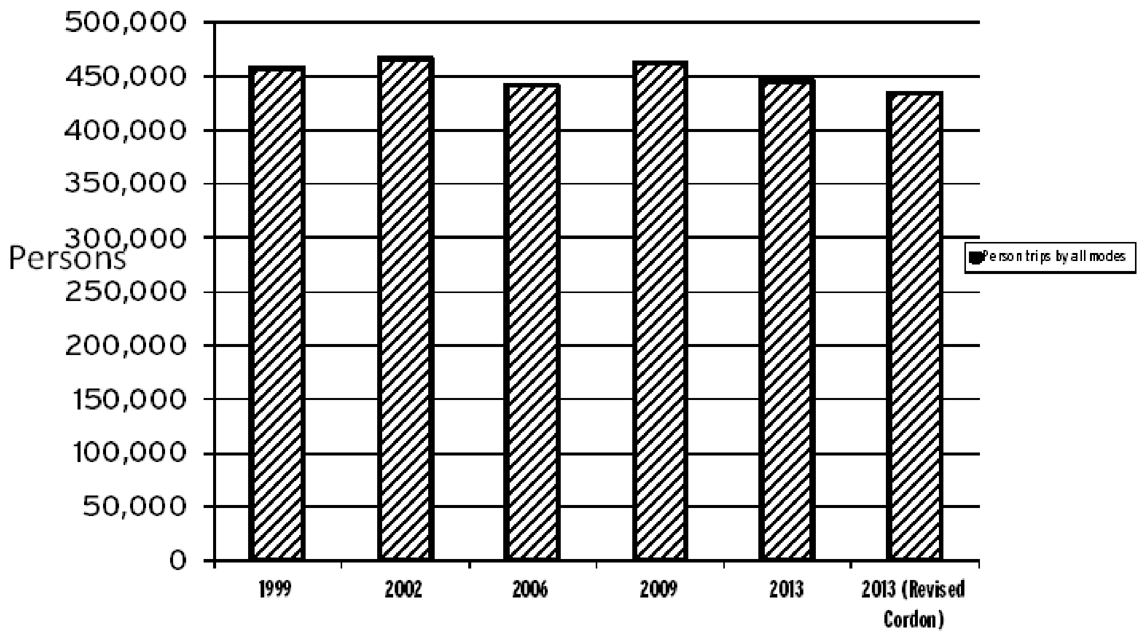
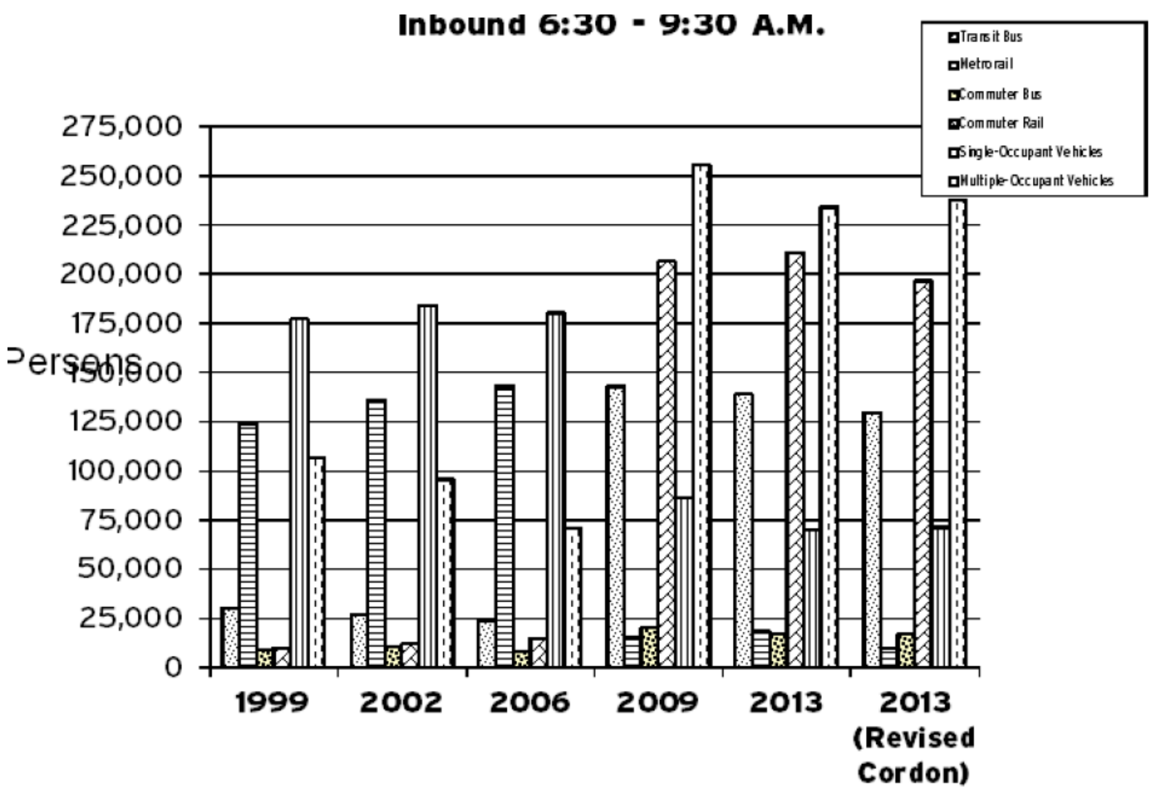


Figure 56: 2013 Cordon Count Trends in Person Trips by Mode: 1999-2013, Inbound 6:30-9:30 am



2.4.2 PARK-AND-RIDE FACILITIES

There are over 160,000 parking spaces at nearly 400 Park & Ride lots throughout the Washington/Baltimore Metropolitan areas where commuters can conveniently bike, walk or drive to and join up with carpools/vanpools or gain access to public transit. The following statistics provide an idea of why park-and-ride lots play such a popular role in the region's transportation system[81]:

- Two thirds of Park & Ride Lots have bus or rail service available.
- Parking is free at 89% of the Park & Ride Lots.
- More than 25% of Park & Ride Lots have bicycle parking facilities.

In addition to the above statistics, Intelligent Transportation Systems (ITS) strategies such as traveler information systems and electronic payment systems can add to the convenience of park-and-ride lots. In 2009, WMATA and VDOT completed the Feasibility Study of Real Time Parking Information at Metrorail Parking Facilities (Virginia Stations)[82], evaluating the feasibility of a real-time parking application for the Metrorail system, with the purpose of improving operations efficiency, reducing operating costs by providing guidance to available parking spaces, encouraging more transit usage and reducing congestion.

Commuter Connections also displays a park-and-ride map on their website, which provides users with the location of lots, transit stations in the vicinity, and the location of Telework centers.

Due to the popularity of park-and-ride lots, some are experiencing overcrowding, where demand exceeds supply. This tends to happen at lots at or near Metrorail and commuter rail service. Over the past several years, Maryland State Highway Administration (MDSHA) has taken inventory of the SHA owned and maintained ridesharing facilities in the state[83]. Maryland has 103 park and ride lots located in 20 counties throughout the State providing a total of 12,572 spaces. In 2012, approximately 7,300 spaces were utilized on a given day which accounts for about 60% usage of the total spaces. It is estimated that providing the park and ride lot facilities resulted in 108 million fewer vehicle miles of travel in 2012.

The most recent TPB study on the usage of park-and-ride lots was conducted in 1996. As the region continues to grow and the demand for park-and-ride lots increases, this is an area that may need to be examined more closely. Remove this.

According to the 2008 WMATA Metrorail Station Access & Capacity Study, Metro presently owns and operates 58,186 parking spaces. On an average weekday, almost all of those spaces are occupied. Only a handful of stations—White Flint, Wheaton, College Park-U of MD, Prince George's Plaza, and Minnesota Ave—have a substantial amount of available capacity. Table 13 shows parking lot utilization as of October 2006.

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[81] Source: Commuter Connections http://76.227.210.32/commuters/transit/park-ride-locations/
[82] Wilbur Smith Associates and Michael Baker Jr., Inc., Feasibility Study of Real Time Parking Information at Metrorail Parking Facilities (Virginia Stations), June 2009.
http://www.wmata.com/pdfs/planning/Real_Time_Parking_Study.pdf
[83] Maryland State Highway Administration, 2013 Maryland State Highway Mobility Report, Sep. 2013. Available: http://sha.maryland.gov/OPPEN/2013_Maryland__Mobility.pdf

Table 13: Metro Parking Lot Utilization, October 2006

Station and Region	Lot Capacity	Average Utilization[12] Mon-Thurs	Average Utilization Fri
MONTGOMERY COUNTY			
Grosvenor	1,894	103%	92%
White Flint	1,158	41%	31%
Twinbrook	1,097	84%	70%
Rockville	524	104%	101%
Shady Grove	5,467	83%	78%
Glenmont	1,781	103%	102%
Wheaton	977	63%	40%
Forest Glen	596	101%	96%
PRINCE GEORGE'S COUNTY			
New Carrollton	3,519	98%	88%
Landover	1,866	76%	49%
Cheverly	530	97%	84%
Addison Road-Seat Pleasant	1,268	91%	71%
Capitol Heights	372	88%	82%
Greenbelt	3,399	99%	85%
College Park-U of MD	1,870	68%	64%
Prince George's Plaza	1,068	67%	60%
West Hyattsville	453	101%	102%
Southern Ave	1,980	98%	89%
Naylor Road	368	110%	107%
Suitland	1,890	100%	91%
Branch Ave	3,072	108%	106%
Morgan Boulevard	635	95%	87%
Largo Town Center	2,200	97%	87%
DISTRICT OF COLUMBIA			
Deanwood	194	95%	82%
Minnesota Ave.	333	52%	44%
Rhode Island Ave.	340	95%	94%
Fort Totten	408	88%	86%
Anacostia	808	89%	71%
NORTHERN VIRGINIA			
Huntington	3,090	99%	93%
West Falls Church-VT/UVA	2,009	103%	89%
Dunn Loring-Merrifield	1,319	107%	105%
Vienna/Fairfax-GMU	5,849	100%	91%
Franconia-Springfield	5,069	96%	88%
Van Dorn Street	361	110%	118%
East Falls Church	422	117%	129%
System Total	**58,186**	**94%**	**85%**

Source: WMATA

2.4.3 HOUSEHOLD TRAVEL SURVEYS

The TPB conducts Household Travel Surveys of households in the Washington region and adjacent areas to gather updated information on area wide travel patterns. These surveys provide information on such important determinants of travel as household demographics, income, employment destinations, and number of vehicles available. This data helps guide future transportation planning as the area continues to grow.

The latest comprehensive regional Household Travel Survey was conducted by TPB staff in 2007-2008, updating the last such survey which was undertaken in 1994. Data is being collected from households across the region and some preliminary results of survey data analysis include:

- The significant increase in the proportion of single person households in the region had a dramatic impact on the average number of daily trips per household.
- Per person daily trip rates decreased moderately for persons from 5 to 34.
- Per person daily trip rates increased significantly for persons 65+.
- The share of daily trips by auto driver vehicle trips decreased 2.2 percentage points, the walk share increased by 1.6 percentage points, and the transit share increased by 0.7 percentage points.
- The biggest modal shifts between auto driver vehicle trips and the transit and walk modes were seen in the 16 to 34 and the 55 to 64 age groups.
- Persons 25 to 34 more likely to live in Regional Activity Centers.

Following the 2007-2008 TPB Regional Household Travel Survey that was primarily conducted for the development of the new travel demand model, geographically-focused house hold travel surveys have been conducted from 2010 to 2013. The objective of the surveys are threefold: (1) analyzing daily travel behavior in communities with different densities, physical characteristics and transportation options, (2) assisting local planners with current local land use and transportation planning efforts, and (3) building a household travel survey database that can measure changes in local community travel behavior over a period of time (Before and After comparisons).

The TPB's first phase of Geographically-Focused Household Travel Surveys was conducted in spring 2010, fall 2011 and spring 2012. Surveys were conducted at five high-density developments (14th St NW/Logan Circle, Crystal City, Friendship Heights, and Shirlington), two planned high-density development areas (White Flint and National Harbor), three areas experiencing growth (New York Avenue Corridor area, St, Charles Urbanized Area, and the Dulles North Area) three areas with emerging transportation options (Woodbridge, VA, Beauregard Avenue Corridor, and Frederick, MD), and five study areas with recent or planned rail transit options (Columbia Pike Corridor; Reston, VA; the University Boulevard corridor in Maryland; and the area around the Largo Metrorail Station, and the Falls Church Area[84]. Results for the first ten locations were presented to the TPB at its May 2012 meeting[85]. Results of the additional seven locations were reported in March 2013[86].

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[84] TPB Weekly Report (5/29/12): In-Depth Surveys Provide New Understanding of Neighborhood-Level Travel Patterns in Region, http://www.mwcog.org/transportation/weeklyreport/2012/05-29.asp

[85] Robert Griffiths, 2011 TPB Geographically-Focused Household Travel Surveys Initial Results, a presentation to the TPB Board Meeting on May 16, 2012. http://www.mwcog.org/uploads/committee-documents/k11dXIle20120517145044.pdf

[86] Robert Griffiths, 2012 TPB Geographically-Focused Household Travel Surveys Initial Results, a presentation to the TPB Travel Forecasting Subcommittee on March 22, 2013. http://www.mwcog.org/uploads/committee-documents/bF1bXVdd20130322143328.pdf

A new, large-scale household travel survey that will target about 12,000 households in the TPB modeled area is budgeted in FY 2017 and it is expected that the full data collection for this survey will be completed in FY 2018[87].

2.4.4 Special Surveys and Studies

The TPB and its member agencies undertake special studies or data collection efforts, on both one-time and recurring bases. Examples include compiling data to form a regional travel trends report, as well as monitoring transit usage, and cordon counts of traffic on specified areas of the region.

2.4.4.1 Regional Bus Survey

A major regional bus survey was conducted in Spring 2008 on behalf of the TPB[88]. The purposes of this survey were to: 1) collect the jurisdiction of residence data of Washington Metropolitan Transit Authority's (WMATA) weekday bus passengers in support of WMATA's bus subsidy allocation formula; 2) collect origin and destination trip patterns of the local jurisdiction bus systems for local bus route planning and regional travel demand model validation; and 3) collect other travel-related and demographic data to update the regional profile of WMATA and local bus system riders and their related bus trips.

Transit systems surveyed were ART (Arlington Transit), The Bus (Prince George's County), CUE (Fairfax, VA), DASH (Alexandria Transit Co.), TransIT (Frederick County Transit), OmniRide/OmniLink (PRTC), Ride On (Montgomery Co.) and Metro Bus (D.C, Virginia, Maryland). Some key findings of this survey include:

- Except for Metrobus, most systems primarily served residents of a particular geographic subarea of the region.
- Except for PTRC and TheBus, more than half the riders access their bus by walking to it.
- The PRTC and TheBus systems have large percentages of riders who park-and-ride, at 22% and 15% respectively.
- Commuting to work accounts for one-half to two-thirds of the trips on each bus system.
- SmarTrip was the predominant payment method used by PRTC (57%) and Metrobus (42%).
- Overall 24% of the surveyed bus riders reported receiving a transit benefit from their employer.
- Choice riders are riders who had a vehicle available to them to make the trip they were making, but "chose" to make the trip by bus instead. The PRTC ART and DASH systems had the greatest percentages of "choice" riders.

An updated survey, the 2014 Metrobus Survey[89] was initiated in late 2013 and completed in 2015[90]. This survey aimed to update ridership by jurisdiction of residence for use in Metrobus's operating subsidy allocation, and collect demographic, travel, and access data for Title VI compliance, system planning, and operation analyses. This was not a customer opinion survey; it focused on ridership and travel characteristics,

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[87] TPB, Unified Planning Work Program, March 2016 (page 47) http://www.mwcog.org/uploads/pub-documents/p15aXV820160504101528.pdf

[88] NuStats, *2008 Regional Bus Survey Technical Report*, June 2009.

[89]Robert E. Griffiths, 2014 Metrobus Survey, Presentation to Regional Bus Subcommittee, March 25, 2014. http://www.mwcog.org/uploads/committee-documents/a11ZWFtf20140325100202.pdf

[90] Melissa, 2014 "Metrobus Survey" Complete, a blog on PlanItMetro: http://planitmetro.com/2015/08/05/2014-metrobus-survey-complete/

Some initial results were posted on the Metro's Planning Blog, PlanItMetro [91], and reported to the TPB's Regional Public Transportation Subcommittee [92]. The survey data and survey instrument can be downloaded from PlanItMetro.

2.4.4.2 Regional Travel Trends Report

The TPB receives updates regarding regional travel trends from time to time, and the latest report was made to the TPB on April 20, 2016 [93]. The rate and spatial pattern of population growth are key to the underlying changes in travel trends. The metropolitan Washington region has seen a fast increase in growth over the last several decades, and with that come major changes in how and why people travel. This is important to congestion management, in that it is important in understanding why congestion may be occurring in particular areas. In addition, travel trends can help predict, and prepare for, future congestion.

General findings of the 2000-2015 regional travel trends include:

- Population and employment in the region increased by 9% between 2000 and 2007. Weekday VMT increased by 18% and Metrorail ridership increased by 25% in this period.
- Between 2007 and 2014 population increased by 13% and employment increased by 2%. Weekday VMT declined by 1% and total transit ridership increased by 2%. Metrorail ridership decreased by 2% in this period. Total bus ridership increased by about 5% and commuter rail ridership increased by 25%.
- VMT per capita increased by 8.5% between 2000 and 2007 and decreased by 10.5% from 2007 to 2014. Peak period congestion decreased by 6.5% between 2010 and 2013.
- The share of commuters teleworking, at least occasionally, increased from 11% in 2001 to 27% in 2013. Commuter Rail and Metrorail commuters are more than Drive Alone and Bus commute to telework, at least occasionally.

2.4.4.3 Local Studies

Sometimes member state and local jurisdictions will conduct studies to analyze and evaluate their own programs, and these studies can be important to congestion management.

An example of one such effort is the Montgomery County Mobility Assessment Report (MAR) produced by the Maryland – National Capital Park and Planning Commission (MNCPPC) [94]. The report is updated annually (with exceptions) with the latest information regarding the status of congestion in Montgomery County, Maryland.

Intersections and arterials are two main focuses of the report. For intersections, observed Critical Lane Volumes (CLVs) is the performance measure and the ratio of CLVs over Local Area Transportation Review (LATR) standard is used to quantify intersection congestion. The report also ranks the most

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[91] Justin, Three Tidbits: What the Metrobus 2014 Survey Can Tell Us, a blog on PlanItMetro, http://planitmetro.com/2015/10/26/three-tidbits-what-the-metrobus-2014-survey-can-tell-us/

[92] WMATA Office of Planning, 2014 Metrobus Survey, Presentation to Regional Public Transportation Subcommittee, October 2015. http://www.mwcog.org/uploads/committee-documents/lVxfWF9f20151027132346.pdf

[93] Robert Griffiths, Regional Travel Trends, a presentation to the TPB Board Meeting on April 20, 2016. https://www.mwcog.org/uploads/committee-documents/aFxeVlhd20160421091747.pdf

[94] Maryland – National Capital Park and Planning Commission (MNCPPC), Mobility Assessment Report (MAR), Draft, April, 2014. http://www.montgomeryplanning.org/transportation/documents/Mobility%20Assessment%20Report%202014%20-%20(6-3-2014).pdf

congested intersections in the county for more detailed analysis. For arterials, the VPP/INRIX data and the VPP Suite were used to analyze traffic congestion. Travel Time Index was the main performance measure and a color scheme of congestion severity was developed.

2.4.5 The Regional Transportation Data Clearinghouse[95]

Over the years, staff at the National Capital Region Transportation Planning Board (TPB) has collected transportation data from various sources, primarily member jurisdictions, state agencies, and transit authorities. These data are packaged into a web-based application, called the Regional Transportation Data Clearinghouse (RTDC). The RTDC was developed to improve access and data sharing between TPB member, jurisdictional partners, as well as other interested parties.

The RTDC contains two web-based components—a project page (data portal) and data viewer. Both of these components are built upon the ArcGIS Online platform, which includes the ArcGIS Open Data model. This flexible platform allows TPB easily share its spatial data resources and allows integration of data, maps and applications.

The RTDC Project Page can be accessed at http://rtdc.mwcog.opendata.arcgis.com/. Users can search for data by keyword or category and can also choose to show all available datasets. Each RTDC dataset has its own content page with metadata, a link to download data, and a summary of dataset attributes. The RTDC project page also contains sections for TPB web maps and applications shared through the Clearinghouse as well as the RTDC data viewer.

Datasets in the RTDC represent various transportation modes (highway, transit, bicycle, aviation). Current 'core' RTDC datasets such as traffic and transit counts are routinely updated as new data become available. Additionally, new content is added periodically, based on data availability, user requests and/or other means of discovery. The outline below summarizes 1) current datasets that have been updated, and 2) new datasets added to the RTDC since 2015.

Updated Data:

- Traffic Counts (annual average)
    - Addition of historical volumes 1986-2014 by count station
- Traffic Counts (hourly volumes) –
    - Added hourly volumes for 2013 and 2014
- Transit Counts (average weekday ridership) –
    - Added FY15 monthly
- Historical Metrorail ridership by year
    - Updated to include 2013-2015
- Metrorail station parking amenities
    - Current as of March 2016

New Data:

- Bicycle Counts – District of Columbia, 2014
- Transportation Performance Management:
    - 2014 & 2015 National Bridge Inventory for the TPB Planning area
    - 2014 Pavement ratings (overall, IRI, cracking, faulting, rutting)
    - 2014 National Highway System, TPB Planning area
- 2014 HPMS links for the TPB Planning area

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[95] Based on information provided by Charlene Howard to the TPB's Travel Forecasting Subcommittee meeting on May 20, 2016. http://www.mwcog.org/uploads/committee-documents/mFxdXV9f20160520135726.pdf

- VMT – Vehicle Miles Traveled, by Jurisdiction, 2007-2014
- COG Cooperative Forecast, Round 8.4 by Transportation Analysis Zone (TAZ)
- COG Regional Activity Centers- as defined by TAZ (TPB and COG TAZ)
- Metrorail – average weekday ridership by time of day, by station
  - Available September 2010 through February 2016
- 2015 CLRP Amendment – data download as a map package
- Air Quality Conformity geographic boundaries

The RTDC Data Viewer (http://gis.mwcog.org/webmaps/tpb/rtdc) provides users with a quick and simple way to explore many of the datasets in the RTDC. This data viewer is intended to provide a high-level glimpse into RTDC datasets and does not provide robust query and analytical capabilities.

Users can turn layers on/off and click on features to open the popup window that display attribute data.
The widgets on the toolbar allow users to interact with specific datasets. Each widget is described below (from left to right). The widget toolbar is located on the bottom center of the application window. (Differences in position and appearance when viewed on mobile and tablet devices may be due the responsive design of the application).

- Query- Search traffic and transit datasets by various means (route name, transit operator, location); results returned on-screen and list format.
- Hourly Traffic Volumes by Station / Year – show hourly traffic volumes for a selected station per year. (hint: turn on hourly count layer to display stations before clicking on the map) Alternately, use the search tool to find a particular geographic area.
- Transit: Summary Charts – show summary-level data for transit datasets in the RTDC (average weekday ridership, Metrorail)
- TAZ Summary Tool – allows users to define an area on the map (click or defining an area freehand) and a buffer distance (optional) and return the number of TAZ in the area of interest as well as sum of TAZ Values for 2015 and 2040 population, households, and employment.
- VMT Non-Local Cumulative Growth, 2007-2014 – line charts for each TPB jurisdiction for which data are available
- Bridge: Summary Charts – provides charts showing the percentage of bridges with a good, fair, poor or missing rating, based on the 2015 National Bridge Inventory (NBI).
- Pavement: Charts – displays charts of pavement ratings (good, fair, poor, missing) for all metrics included in the Pavement dataset
- Pavement: Show Missing Values – provides a quick way to display features labeled ‘Missing’ for metrics included in the Pavement dataset.
- DC Bicycle Counts – Cyclists by Time Period – show number of cyclists by 15 minute time periods recorded at count station in the AM and PM peak periods. (hint: turn on bicycle count layer before clicking on the map) Alternately, use the search tool to find a particular geographic area.
- DC Bicycle Counts – Summary Charts- shows aggregate data for each count location for time of day, cyclist gender, helmet use, and totals number of records.
- Metrorail Average Weekday Ridership – use this tool to select year, month, and time of day to display the selected values for each Metrorail station. Data can be downloaded.
- Metrorail Passenger Survey – use this tool to show results from the 2013 Metrorail Passenger Survey by specified time period. Data can be downloaded.

2.5 National Comparison of the Washington Region's Congestion

Regularly since 1982, the Texas A&M Transportation Institute releases an *Urban Mobility Report*[96], which outlines and compares urban congestion and mobility in all urban areas across the United States. The most recent report was released in August 2015 and was based on 2014 data from the National Highway Performance Monitoring System (HPMS) and INRIX, Inc. Since 2007, INRIX, Inc., an independent live traffic information provider based on GPS units equipped on smartphones, in-vehicle devices and commercial fleets, releases a *INRIX Traffic Scorecard*[97] for the largest 100 metropolitan areas in the U.S. TomTom also releases online TomTom Traffic Index[98] in recent years.

The above three national or international reports use different performance measures, which greatly impacts the rankings of cities (Table 14). The Washington region ranked No. 1, No. 2, and No. 8 in the latest rankings published by the Texas A&M Transportation Institute, INRIX, and TomTom, respectively. Although both the Texas A&M Transportation Institute and INRIX use annual hours of delay per person, the former was based on speed provided by INRIX and traffic volume estimated from AADT provided in the Highway Performance Monitoring System (HPMS), and the latter was calculated from Travel Time Index, typical commute trip length, and the number of trips the typical commuter takes in a month/year, resulting in different numbers of hours of delay and ranking. If based only on extra time compared to free-flow conditions, as used by TomTom, the Washington is only the 8th in the nation.

Table 14: National Comparison of the Washington Region's Congestion

Texas A&M Transportation Institute (2014 data)			INRIX Traffic Scorecard (2015 data)			TomTom Traffic Index (2015 data)		
Annual Hours of Delay per Auto Commuter			Average Hours Wasted in Traffic			Extra Travel Time compared to Free Flow Conditions		
Metro Area	Value	Rank	Metro Area	Value	Rank	Metro Area	Value	Rank
Washington	82	1	Los Angeles	81	1	Los Angeles	41%	1
Los Angeles	80	2	Washington	75	2	San Francisco	36%	2
San Francisco	78	3	San Francisco	75	3	New York	33%	3
New York	74	4	Houston	74	4	Seattle	31%	4
San Jose	67	5	New York	73	5	San Jose	30%	5
Boston	64	6	Seattle	66	6	Honolulu	29%	6
Seattle	63	7	Boston	64	7	Miami	28%	7
Chicago	61	8	Chicago	60	8	Washington	26%	8
Houston	61	8	Atlanta	59	9	Portland	26%	9
Riverside	59	10	Honolulu	49	10	Chicago	26%	10

2.6 Performance and Forecasting Analysis of the 2015 Financially Constrained Long-Range Transportation Plan (CLRP)

The CLRP includes all regionally significant transportation projects and programs planned in the Metropolitan Washington region over the next 25-30 years. Each year the CLRP is updated to include new projects and programs. TPB produces a performance analysis of every CLRP, which examines trends and assesses future levels of congestion and other performance measures. The 2015 CLRP Performance Analysis[99] provides both an overall assessment of the anticipated impacts of the CLRP, as well as an indication of future levels of congestion relevant to the CMP.

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[96] David Schrank, Bill Eisele, Tim Lomax, Jim Bak of the Texas A&M Transportation Institute and INRIX, Inc. *2015 Urban Mobility Scorecard*. August 2015. http://mobility.tamu.edu/ums/

[97] INRIX, Inc., Traffic Scorecard, http://inrix.com/scorecard/

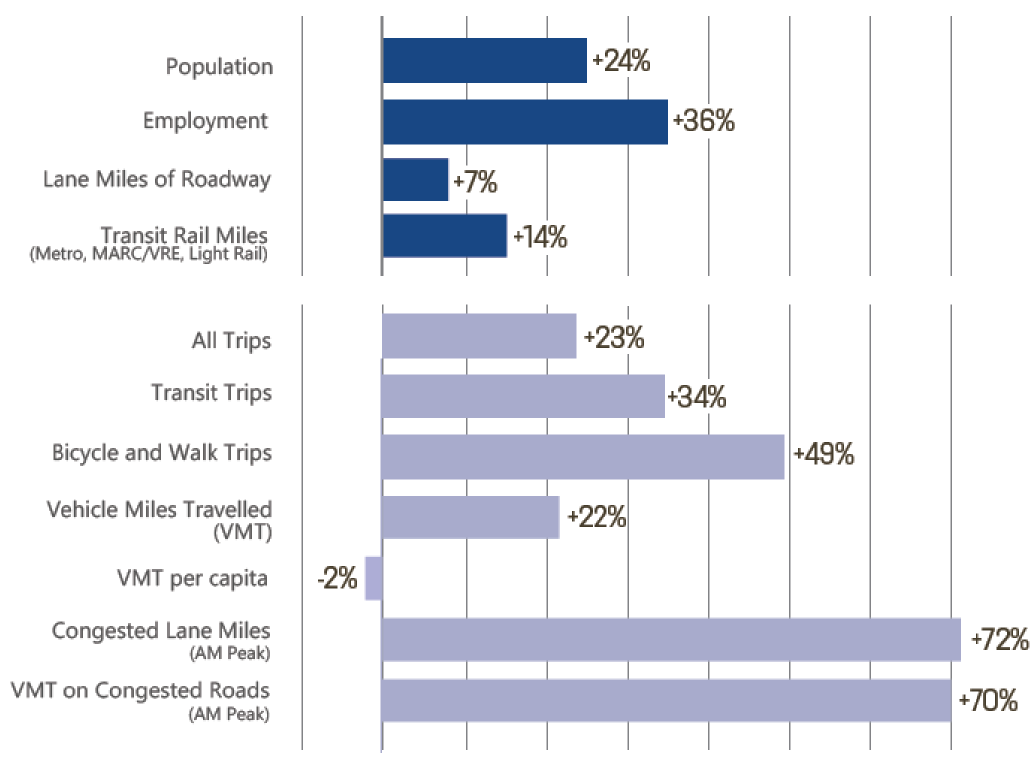
[98] TomTom, Traffic Index, https://www.tomtom.com/en_gb/trafficindex/list

[99] TPB, Performance Analysis of the Draft 2015 CLRP, a presentation to the TPB Board meeting on September 16, 2015 https://www.mwcog.org/clrp/resources/2015/2015CLRPPerfAnalysis.pdf

Plan performance analyzes the outlook for growth in the region. One of the cornerstones of plan performance is the forecasting of future congestion. The plan performance looks at where in the region congestion will occur in the future and compares current congestion to future congestion. It looks at criteria that may affect congestion, such as changes in population, employment, transit work trips, vehicle work trips, lane miles, and lane miles of congestion. The analysis also breaks down lane miles of congestion into core, inner suburbs, and outer suburbs, providing information on where, generally, the most lane miles of congestion can be found in 2040 compared to 2015.

From 2015 to 2040, the region is forecast to be home to 24% more residents and 36% more jobs in 2040 (Figure 57). Towards accommodating that growth, 7% more lane miles of roadway and 14% more transit rail miles are planned to be constructed. The total number of trips taken is expected to increase by 23%, while transit, walk, and bike trips together are expected to increase at a faster rate than single driver trips. The overall amount of driving (VMT) is expected to grow by 22%. This is slightly less than forecast population growth, which means that VMT per capita is expected to drop by 2%. The increase in demand on the roadways is forecast to out-pace the increase in supply, leading to a significant increase in congestion.

Figure 57: 2015 Performance Analysis Summary



Congested lane miles will make up a relatively small proportion of the total lane miles in all areas of the region both today and in 2040 (Figure 58). The total number of congested lane miles is forecast to go up in all 3 sub-areas with the greatest expected increase in the inner suburbs. The share of lane miles that are congested is also expected to increase in all sub-areas, but the highest rate of increase is expected in the outer suburbs.

Though a relatively small share of lane miles will continue to be congested, a higher share of Vehicle Miles Traveled (VMT) will be on congested roadways in all areas of the region (Figure 59). In 2040, VMT on congested roadways will increase the most in the outer suburbs, followed by the regional core, and the least in the inner suburbs.

Though congestion on many segments of the region's major highway system is expected to get worse over this period of time, some segments of highway will see slight relief in congestion thanks to capacity expansions or changes in travel behavior (Figure 60). Major highways seeing improvements in congestion include portions of I-66 East, I-70 East, and VA-267 East.

Figure 58: Share of AM Peak Hour Lane Miles that Are Congested

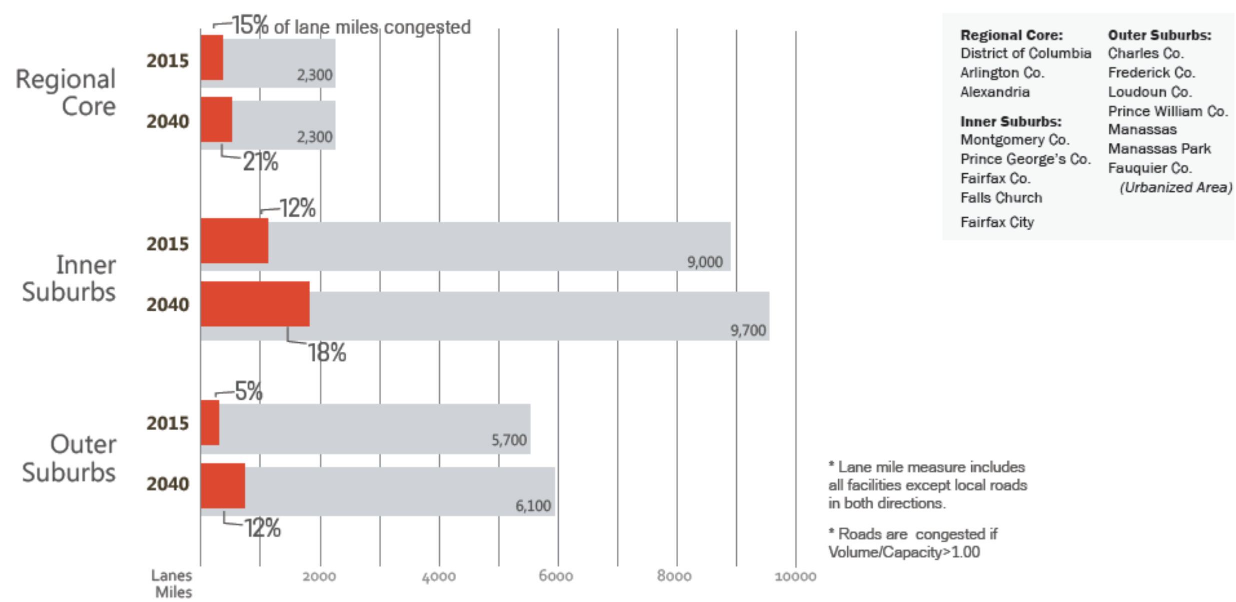


Figure 59: Share of AM Peak Hour Vehicle Miles Traveled (VMT) on Congested Roadways

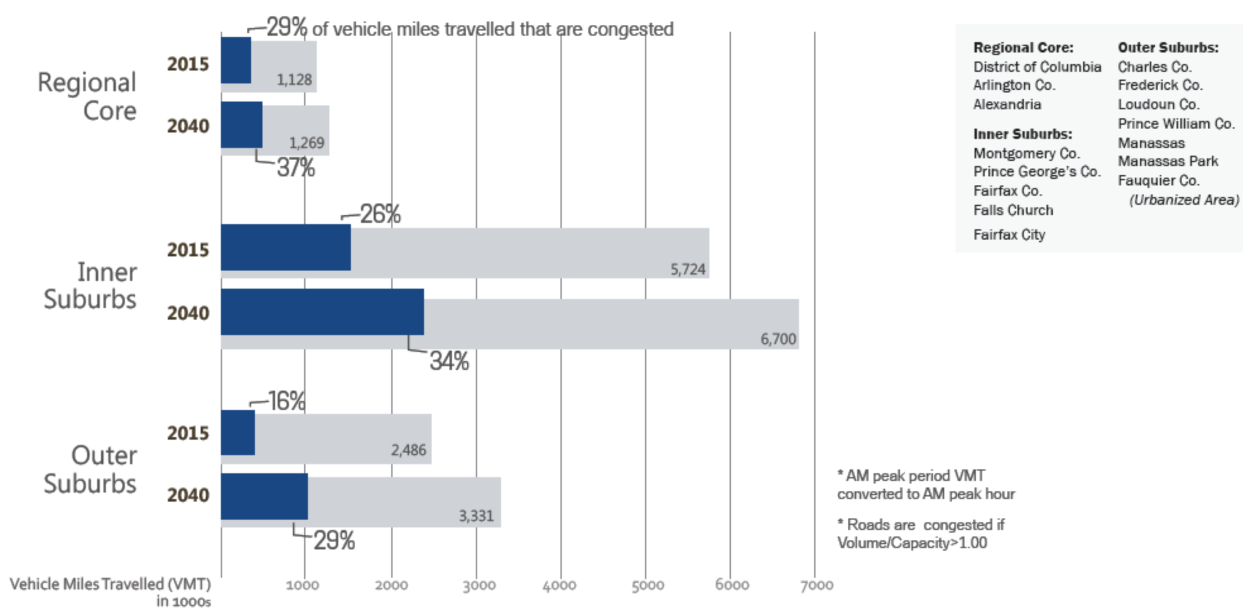
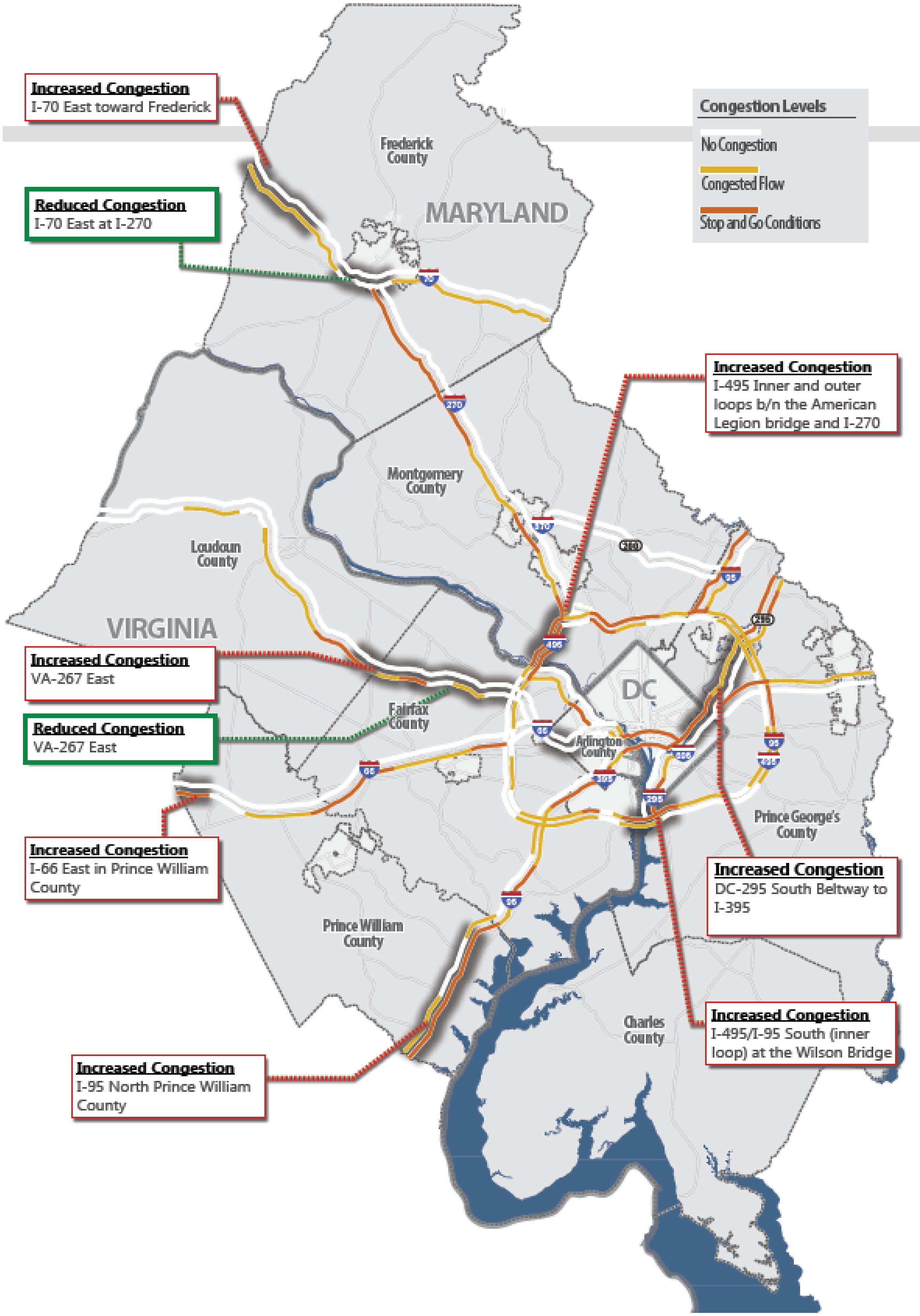
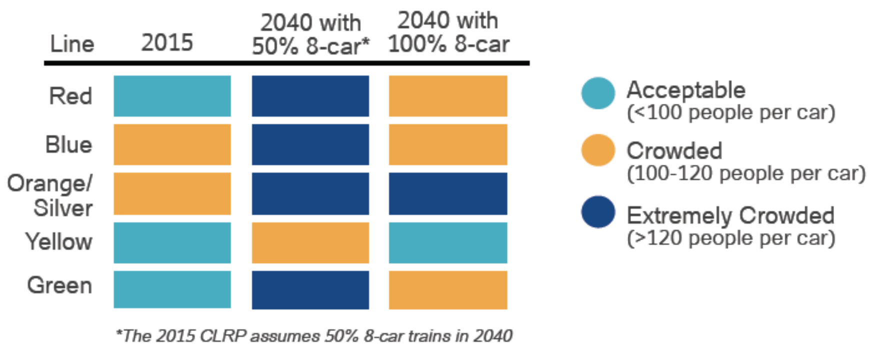


Figure 60: 2040 Major Highway Congestion in AM Peak



With regard to transit congestion, analysis completed by WMATA shows that four out of five lines entering the downtown core are expected to become congested or highly congested by 2040 (Figure 61). Without additional capacity, WMATA estimates that the Metrorail system will reach capacity by 2040 on trips to and through the core.

Figure 61: Metrorail Crowding



Another way to measure the performance of the plan is by residents' accessibility to jobs by auto and transit. Many areas, mainly on the eastern side of the region, will see declines in accessibility (Figure 62). These declines are the result of two important factors: one, anticipated increases in roadway congestion, which make it more difficult to reach other parts of the region by car within 45 minutes, and, two, the fact that more of the new jobs anticipated between now and 2040 are forecast to be located on the western side of the region, more than 45 minutes from those living on the eastern side.

Most places with access to transit, will experience increases in the number of jobs that are accessible within a 45 minute commute (Figure 63). However, in 2040 transit will still not be a viable commute options for many people in the region due to lack of access to transit facilities and potentially long travel times.

Figure 62: Change in Access to Jobs by Automobile, 2015-2040

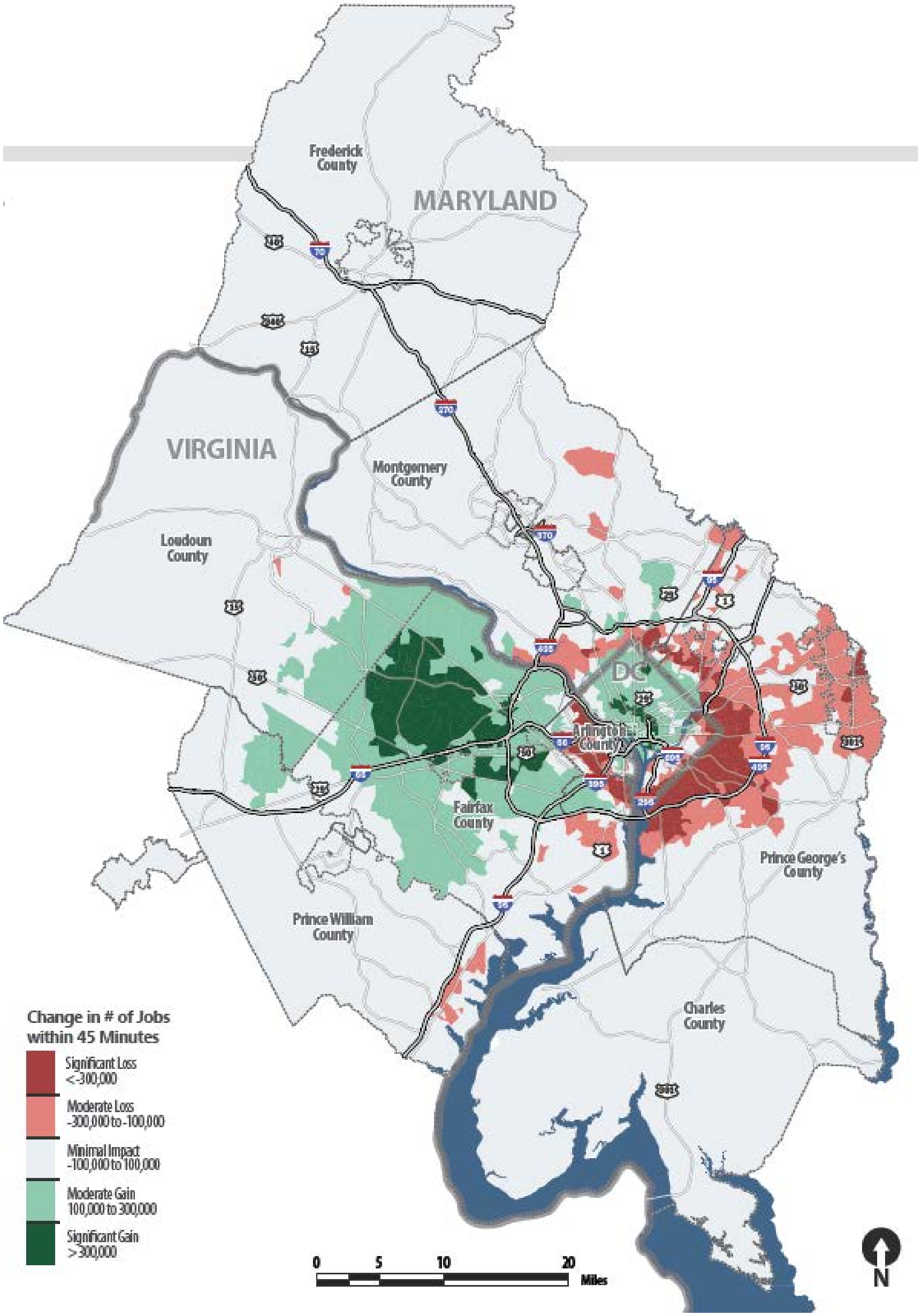
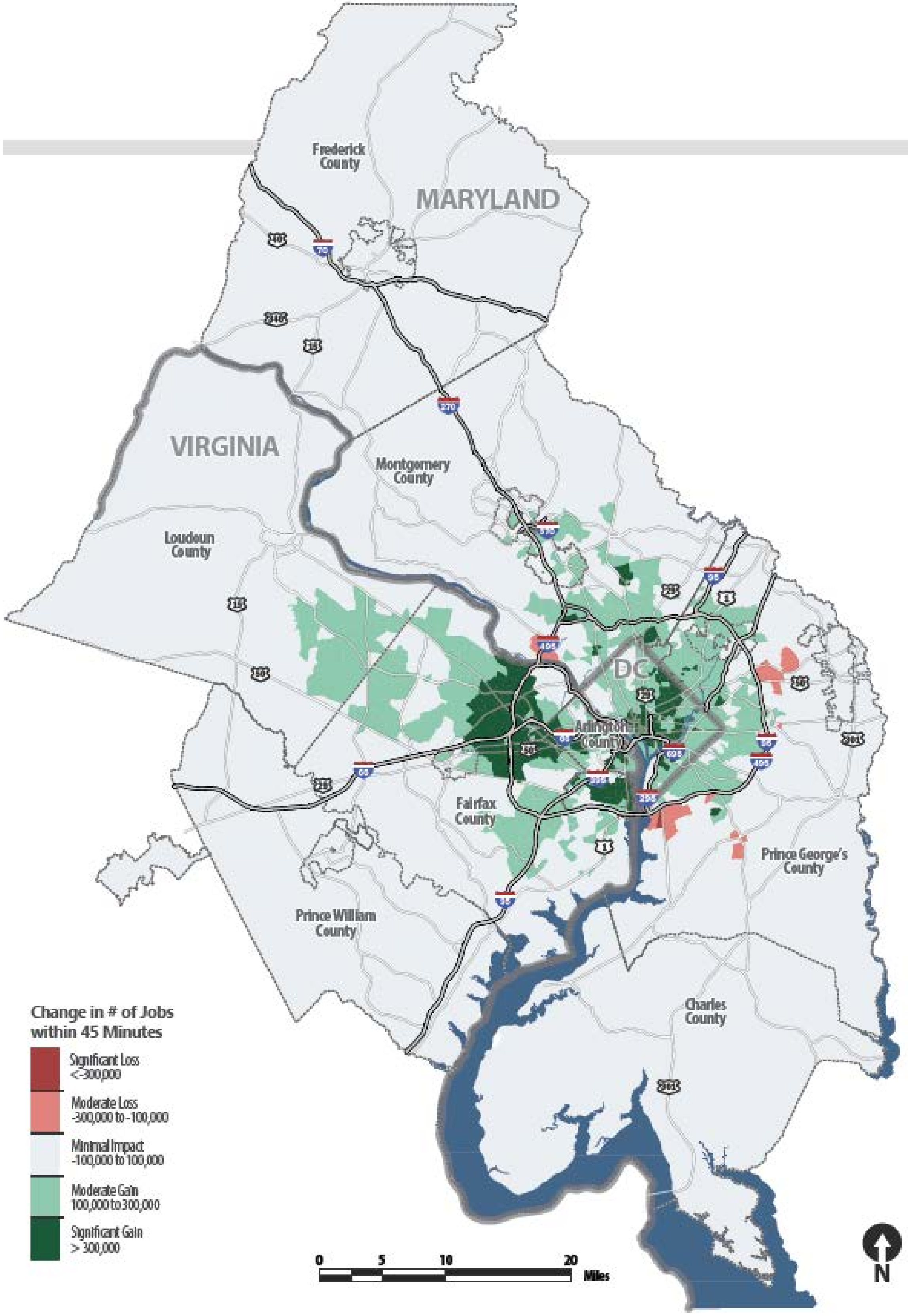


Figure 63: Change in Access to Jobs by Transit, 2015-2040

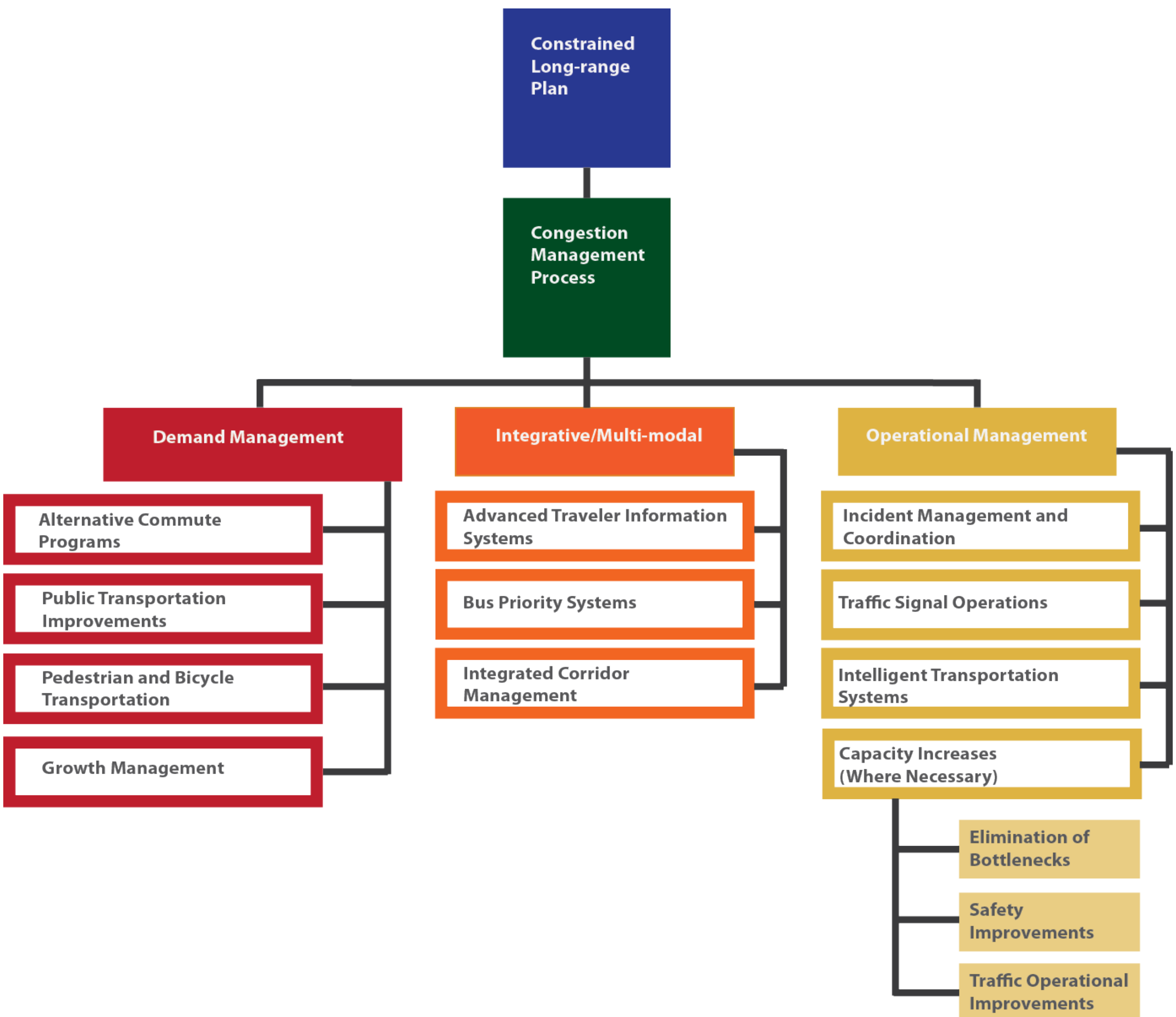


3. CONSIDERATION AND IMPLEMENTATION OF CONGESTION MANAGEMENT STRATEGIES

3.1 Overview of Congestion Management Strategies

Congestion Management Strategies generally can be divided into two types – Demand Management strategies and Operational, or Supply Management strategies. For purposes of this report, a third category, Integrative/Multi-modal, was added to better reflect the integration of demand and operation management in different projects in the region. Figure 64 shows examples of congestion management strategies.

Figure 64: Major CMP Strategies



Note: There are synergies between strategies categorized as demand management or operational management strategies, such as real-time traveler information on ridesharing opportunities responsive to a real-time traffic incident or situation.

Demand Management is aimed at reducing the demand for travel and influencing travelers behavior; either overall or by targeted modes. Demand Management strategies can include carpooling, vanpooling, telework programs that allow people to work from home to reduce the amount of cars on the road, and living near your work as a means of reducing commute travel.

Supply or operational management, on the other hand, is managing and making better use of existing transportation network in order to meet the region's transportation goals and ultimately reduce congestion. Example supply management strategies are High-Occupancy Vehicle (HOV) lanes, variably priced lanes, and traffic management.

Often strategies categorized as either demand management or operational management have components of the other. There are strategies in place the region that take that combination a step further and integrate demand and operational management strategies into larger projects. In this report, these strategies have been categorized in this report as Integrative/Multi-modal strategies. Examples of these strategies include advanced traveler information systems and integrated corridor management.

These strategies, and how they are implemented throughout the Washington region, are explained in further detail below.

3.2 Demand Management Strategies

3.2.1 Commuter Connections Program

Commuter Connections is a regional network, coordinated by COG/TPB, which provides commuter information and commuting assistance services to those living and working in the Washington, DC region. This program has been in existence since the 1970's under different names and has implemented a number of demand management strategies in the region. The Commuter Connections program is designed to inform commuters of the availability and benefits of alternatives to driving alone, and to assist them in finding alternatives to fit their commuting needs. The program is funded by the District of Columbia, Maryland, and Virginia Departments of Transportation, as well as the U.S. Department of Transportation, and all services are provided free to the public and employers. Continuing the Commuter Connections Program is one of the key recommendations of the 2016 CMP Technical Report.

Commuter Connections evaluates the impacts of their programs through the Commuter Connections Transportation Demand Management Evaluation Project. The evaluation process allows for both on-going estimation of program effectiveness and for annual and triennial evaluations. The most recent Transportation Emission Reduction Measure (TERM) Analysis Report covered FY2012-2014. [100]

Both qualitative and quantitative types of performance measures are included in the evaluation process to assess effectiveness. First, measures reflecting commuters' and users' awareness, participation, utilization, and satisfaction with the program, and their attitudes related to transportation options are used to track recognition, output, and service quality. Some of the important performance measures are:

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[100] *Transportation Emission Reduction Measure (TERM) Analysis Report FY 2012-2014*, November 18, 2014. http://www.commuterconnections.org/wp-content/uploads/2014-TERM-Evalaution-Analysis-Report-FINAL-111814.pdf

- Vehicle trips reduced
- Vehicle miles of travel (VMT) reduced
- Emissions reduced: Nitrogen Oxides (NOx), Volatile Organic Compounds (VOC), Particulate Matter (PM2.5), PM 2.5 pre-cursor NOx, and CO_2 emissions (Greenhouse Gas Emissions - GHG)

Particularly of interest to congestion management is the impact on vehicle trips reduced, vehicle miles of travel (VMT) reduced, and cost effectiveness. Appendix E shows the summary of results for individual terms (i.e., how many daily vehicle trips were reduced and the daily VMT reduced compared to the goals set by Commuter Connections).

Commuter Connections also operates the Commuter Operations Center (COC), providing direct commute assistance services, such as carpool and vanpool matching through telephone and internet assistance to commuters. The Commuter Operations Center also provides transit, bicycling, park and ride lot, and telecommuting information to commuters in the region.

In addition, a variety of surveys (the following lists a subset of them) are conducted by Commuter Connections to follow-up with program applicants and assess user satisfaction on TERMs. These surveys provide data used to estimate program impacts. Some of the surveys, such as the Applicant Placement survey and Guaranteed Ride Home (GRH) Survey, also provide information used by Commuter Connections staff to fine tune program operations and policies.

- ***Commuter Connections Applicant Placement Rate Survey*** – Since May 1997 Commuter Connections has conducted commuter applicant placement surveys to assess the effectiveness of the Commuter Operations Center and other program components. The surveys assess users' perceptions of and satisfaction with the services provided.
- ***GRH Applicant Survey*** – Commuters who register with the GRH program or use a one-time exception trip will be surveyed to establish how the availability and use of GRH influenced their decision to use an alternative mode and to maintain that mode. Satisfaction with GRH services also will be polled.
- ***State of the Commute Survey (SOC)*** – The SOC survey, a random sample survey of employed adults in the Washington metropolitan region, serves several purposes. First, it establishes trends in commuting behavior, such as commute mode and distance, and awareness and attitudes about commuting, and awareness and use of transportation services, such as HOV lanes and public transportation, available to commuters in the region.
- ***Employee Commute Surveys*** – Some employers conduct baseline surveys of employees' commute patterns, before they develop commuter assistance programs and follow-up surveys after the programs are in place.
- ***Employer Telework Assistance Follow-up Survey*** – Sent to employers that received telework assistance from Commuter Connections to determine if and how they used the information they received.
- ***Bike-to-Work Day Participant Survey*** – A survey among registered participants in the Bike-to-Work Day event is undertaken to assess travel behavior before and after the Bike-to-Work Day, as well as commute distance and travel on non-bike days.
- ***Carshare Survey*** – A survey about the experiences of carshare users and the impact carsharing has on travel patterns in the region. The survey examines characteristics of carshare trips, travel changes made in response to carshare availability, and auto ownership and use changes in response to carshare availability.

- ***Vanpool Driver Survey*** – a survey that collects data on van ownership and operation, vanpool use and travel patterns, availability and use of vanpool assistance and support services, and issues of potential concern to vanpool drivers.

Transportation Emission Reduction Measures (TERMs) Evaluation

With the introduction of Clean Air Amendments in the 1990's reducing vehicle emissions became important in the region. Analysis showed that enhancing existing and introducing new demand management strategies will have a two-fold impact; reducing congestion and at the same time reducing emissions and clearing the air of ozone causing pollutants. These programs were called Transportation Emissions Reduction Measures (TERMs) and the regional programs were implemented through the Commuter Connections Program, in concert with program partners to meet air quality conformity and federal clean air mandates. Commuter Connections sets goals on TERM programs that impact commute trips [101], and evaluates the TERMs to determine the impact they are having on reducing congestion and vehicle emissions. These TERMs include:

- ***Guaranteed Ride Home (GRH)*** – Eliminates a barrier to use of alternative modes by providing free rides home in the event of an unexpected personal emergency or unscheduled overtime to commuters who use alternative modes.

- ***Employer Outreach*** – Provides regional outreach services to encourage large, private-sector and non-profit employers voluntarily to implement commuter assistance strategies that will contribute to reducing vehicle trips to worksites, including the efforts of jurisdiction sales representatives to foster new and expanded trip reduction programs.

- ***Mass Marketing*** – Involves a large-scale, comprehensive media campaign to inform the region's commuters of services available from Commuter Connections as one way to address commuters' frustration about the commute. Projects associated with this program include a regional Bike to Work Day event, Car free day event, and the 'Pool Rewards rideshare incentive program.

Both the TERM evaluation and associated surveys are keys to assessing the impact these programs have on congestion management and air quality. Following is a more detailed analysis on the above TERMs and other Commuter Connections demand management strategies in the region.

3.2.1.1 Telework

Teleworking, or telecommuting, can be described as a means of using telecommunications and information technology to replace work-related travel. This can be done by working at one's home, or at a designated telework center one or more days a week. There are designated telework centers throughout the region, in the District, Maryland, and Virginia. Phones, wireless communications, fax machines, and computers make teleworking an easy alternative to getting in a car and driving long distances to an office. Teleworking has shown to boost the quality of life, have economic benefits, reduce air pollution, and ease traffic congestion.

Telework is a TERM evaluated by Commuter Connections. Telework Outreach is a resource service to help employers, commuters, and program partners initiate telework programs. In evaluating

[101] The region has adopted and implemented TERMs other than those in the Commuter Connections program. Some other TERMs, such as for Signal Timing Optimization, may also impact congestion. Others, such as for emissions control equipment on heavy-duty diesel vehicles, impact only emissions.

teleworking, several travel changes need to be assessed, including: trip reduction due to teleworking, the mode on non-telework days, and mode and travel distance to telework centers.

Telework impacts are primarily estimated from the State of the Commute survey (SOC) and by surveys conducted of employers directly requesting information from Commuter Connections. The 2013 State of the Commute Technical Report[102] concluded the following regarding teleworking:

- Teleworkers accounted for 27% of all regional commuters. That is, workers who travel to a main work location on non-telework days.[103]
- An additional 18% of commuters, all who do not currently telework, said they “would and could” telework either regularly or occasionally, that is, they have job responsibilities that could be done while teleworking and would be interested in teleworking, if given the opportunity.
- The remaining respondents said they either were not interested in teleworking (11%) or that their jobs could only be performed at their main workplace (44%)
- Over half (57%) of the teleworkers surveyed said they teleworked at least one day a week.

3.2.1.2 Employer Outreach

Employer Outreach is aimed at increasing the number of private and non-profit employers implementing worksite commuter assistance programs, and is ultimately designed to encourage employees of client employers to shift from driving alone to alternative modes.

In this TERM, jurisdiction-based sales representatives contact employers, educate them about the benefits commuter assistance programs offer to employers, employees, and the region and assist them to develop, implement, and monitor worksite commuter assistance programs.

The *TERM Analysis Report for FY 2012-2014* estimated the impacts of employer outreach. The following are some noteworthy statistics from that report:

- Employers participating in Employer Outreach substantially exceeded the goal, with 1,756 participating employers compared to the goal of 581.

- Estimated daily vehicle trip (78,000) and VMT (1.3 million) reduction exceeded the goals for this TERM.

3.2.1.3 Live Near Your Work

Population and employment growth can be considered beneficial for the region, but with it comes the potential for increased congestion. The trend of employees living further from their job is worsening, creating longer commutes. ‘Live Near Your Work’ is a program to help bridge the gap between the workplace and home. The program is primarily geared towards employers in an attempt to improve their employees’ work-life balance. In turn, the results of employees living closer to where they work can reduce the number of cars on the road, which ultimately can ease congestion and have positive environmental impacts.

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[102] *Commuter Connections State of the Commute Survey 2013 Technical Survey Report*. Prepared for Metropolitan Washington Council of Governments. Prepared by: LDA Consulting, Washington, DC. In conjunction with: CIC Research, San Diego, CA. November 19, 2013. http://www.commuterconnections.org/wp-content/uploads/SOC-2013-Main-Publication.pdf
[103] Using this base of commuters excludes workers who are self-employed and for whom home is their only workplace.

To promote the 'Live Near Your Work' initiative, Commuter Connections provides housing information in an online Employer's Resource Guide. The tool highlights various housing programs and resources available for the Washington area workforce and aims to assist employees with moving closer to where they work. This guide also provides a list of flexible commuter options available through Commuter Connections. Used in tandem, employers have a number of ways to provide the information workers need to make living near and getting to work a reality. Employers can work with their internal staff to find and execute the right fit for their employees, and ultimately help everyone feel "more connected." Employers can find that this can have a true impact on their bottom line.

3.2.1.4 Carpooling, Vanpooling, Ridesharing and other Commuter Resources

Commuter Connections provides information on carpooling, vanpooling, and Ridesharing. These alternative commute methods reduce the amount of single occupant vehicles (SOVs) on the road, which is important to congestion management.

- ***Carpooling*** is two or more people traveling together in one vehicle, on a continuing basis.

- ***Vanpooling*** is when a group of individuals (usually long-distance commuters) travel together by van, which is sometimes provided by employers. There are typically three kinds of vanpool arrangements:

    - *Owner-operated vans* — An individual leases or purchases a van and operates the van independently. Riders generally meet at a central location and pay the owner a set monthly fee.

    - *Third-party vans* — A vanpool "vendor" leases the vanpool vehicle for a monthly fee that includes the vehicle operating cost, insurance, and maintenance. The vendor can contract directly with one or more employees. The monthly lease fee is paid by the group of riders.

    - *Employer-provided vans* — The employer (or a group of employers) buys or leases vans for employees' commute use. The employer organizes the vanpool riders and insures and maintains the vehicles. The employer may charge a fee to ride in the van or subsidize the service.

    - ***'Pool Rewards*** - 'Pool Rewards is a special incentive program available through Commuter Connections designed to encourage current drive alone commuters to start ridesharing in the Washington Metropolitan region. Commuters who currently drive alone to work may be eligible for a cash payment through 'Pool Rewards when they start or join a new carpool. If eligible, each carpool member can earn $2 per day ($1 each way) for each day they carpool to work over a consecutive 90-day period. The maximum incentive for the 90-day trial period is $130. Carpools may consist of two or more people. For commuters who drive alone to work and can get between seven and fifteen people together to form a vanpool, they may qualify for a $200 monthly 'Pool Rewards subsidy for the new vanpool. [104]

- ***Ridematching Services*** enables commuters to find other individuals that share the same commute

[104] http://www.commuterconnections.org/commuters/ridesharing/pool-rewards/

route and can carpool/vanpool together. This provides carpooling options for people who may not know of someone to carpool with, thus broadening the carpooling options

3.2.1.5 Bike To Work Day

Each May thousands of area commuters participate in Bike to Work Day, sponsored by Commuter Connections and the Washington Area Bicyclist Association.[105] The TPB has a Bike to Work Day Steering Committee which coordinates the event each year.

Bike to Work Day encourages commuters to try bicycling to work as an alternative to solo driving. The program has grown enormously attracting 17,500 bicyclists in 2015[106].

Biking and other nontraditional modes are expanded upon in Section 3.2.4.

3.2.1.6 Car Free Day

Each year, Commuter Connections implements a regional Car Free Day[107] campaign that encourages residents to leave their cars behind or to take alternative forms of transportation such as public transit, carpools, vanpools, telework, bicycling or walking.

Car Free Day was first held in FY 2009. In FY 2012, evaluation results showed that there were over 11,700 individuals that pledged to go "car-free" for this event, a 70% increase over the previous year. In addition, there were approximately 5,500 vehicle trips reduced and 272,000 vehicle miles of travel reduced as a result of participation in this event. This event will is held on September 22nd each year and is in tandem with the World Car Free Day event. A marketing campaign along with public outreach efforts will be developed to coincide with this worldwide celebrated event.

3.2.2 Local and Other Transportation Demand Management and Traffic Management Activities

Local agencies and organizations, such as local governments and Transportation Management Areas (TMAs) are doing their part to promote alternative commute methods and other demand management strategies. Table 15 provides detailed information on specific ongoing demand management strategies in the Washington region.

[105] http://www.biketoworkmetrodc.org
[106] http://www.biketoworkmetrodc.org/wp-content/uploads/2012/03/Bike-to-Work-Day-Breaks-Regional-Record.pdf
[107] http://www.carfreemetrodc.org/

Table 15: Ongoing State Local Jurisdictional Transportation Demand Management (TDM) Strategies

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
Region-wide	Region-wide	WMATA	Public Transportation Improvements	Demand	Metrobus transit	Public bus service available throughout the region. Connects to other modes: Metrorail, commuter rail, park-and-ride lots, etc.	http://wmata.com/bus/
Region-wide	Region-wide	WMATA	Public Transportation Improvements	Demand	Metrorail transit	Public rail services DC, MD, and VA. Connects to commuter rail, Metrobus and local bus systems.	http://wmata.com/rail/
Region-wide	Region-wide	WMATA	Park-and-ride lot improvements	Demand	Metrorail station park-and-ride lots	Parking offered at 42 Metrorail stations.	http://wmata.com/rail/parking/
State/Multi-jurisdictional	Maryland State-wide	MDOT	Pedestrian, Bicycle, and Multimodal Improvements	Demand	Maryland Bicycle and Pedestrian Advisory Committee (MBPAC)	Provides information on biking, walking. Master Plan guides bike/ped planning in the State.	http://www.mdot.state.md.us/Planning/Bicycle/BikePedPlanIndex
State/Multi-jurisdictional	Maryland State-wide	MDOT	Telecommuting	Demand	MDOT's Telework Partnership with Employers/TeleworkBaltimore.com program	Offers free teleworking consulting services to Maryland employers. Promotes teleworking.	http://www.mdot.state.md.us/Planning/Telework%20Partnership%20Web%20Page/Telework%20Partnership%20with%20Employers
State/Multi-jurisdictional	Maryland State-wide	MTA	Employer outreach / mass marketing	Demand	MDOT's Commuter Choice Maryland	Reaches out to Maryland employers and offers incentives to implement a commuter program.	http://www.commuterchoicemaryland.com/

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	Maryland State-wide	MTA	Public Transportation Improvements	Demand	MDOT's MARC train	Maryland MTAPublic commuter rail serving Montgomery County, Prince William County, Frederick County, and into DC.	https://www.mtamaryland.com/services/marc/index.cfm
State/Multi-jurisdictional	Maryland State-wide	MTA	Public Transportation Improvements	Demand	Local bus	Maryland MTA Public bus service throughout Maryland, primarily around the Baltimore-DC area.	https://www.mtamaryland.com/services/bus/routes/bus/
State/Multi-jurisdictional	Maryland State-wide	MTA	Public Transportation Improvements	Demand	Commuter Bus	Maryland MTA Commuter bus service in Maryland and DC's inner-ring suburbs.	https://www.mtamaryland.com/services/commuterbus/
State/Multi-jurisdictional	District-wide	DDOT	Pedestrian, Bicycle and Multimodal Improvements	Demand	Bicycle and Pedestrian Programs	Committed to providing safe and convenient bicycle and pedestrian access throughout the City.	http://ddot.dc.gov/DC/DDOT/On+Your+Street/Bicycles+and+Pedestrians
State/Multi-jurisdictional	District of Columbia, Arlington County, City of Alexandria, Montgomery County	Partnership of DDOT, Arlington County, City of Alexandria, Montgomery County (Fairfax County – coming soon)	Bicycle Programs	Demand	Capital Bikeshare	A bikesharing program to encourge the use of bicyles.	http://capitalbikeshare.com/
State/Multi-jurisdictional	District-wide	DDOT	Carsharing Programs	Demand	DDOT Carsharing Initiative	A network of vehicles offered for rent to the public. Allows mobility of a car without owning one.	http://ddot.dc.gov/DC/DDOT/On+Your+Street/Car+Sharing?nav=1&vgnextrefresh=1

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	District-wide	DDOT	Public Transportation Improvements	Demand	DDOT Mass transit	DDOT helps coordinate mass transit with agencies and WMATA.	http://ddot.dc.gov/ddot/cwp/view,a,1250,q,638123,ddotNav_GID,1586,ddotNav,%7C32399%7C.asp
State/Multi-jurisdictional	Takoma Park and Takoma Park, MD	DDOT	Growth Management	Demand	DDOT's Takoma Transportation Study	A study done for Takoma area of DC and adjacent Takoma Park, MD. Study recommends pedestrian, bicycle, transit, and road improvements.	http://ddot.washingtondc.gov/ddot/cwp/view,a,1249,q,561963.asp
State/Multi-jurisdictional	District-wide	DDOT	District TDM Program	Demand	goDCgo	goDCgo is an initiative of DDOT that is designed to help reduce congestion and improve air quality in the District through the promotion of sustainable transportation modes.	http://godcgo.com/
State/Multi-jurisdictional	Downtown DC	Partnership of DDOT, WMATA, and DC Surface Transit	Public Transportation Improvements	Demand	DC Circulator	A public bus system serving the District.	http://www.dccirculator.com/DCCirculator.html#home
State/Multi-jurisdictional	Virginia-statewide	VDRPT, VDOT	Telecommuting	Demand	Telework!VA	Primary resource for Virginia's employers to start a telework program in VA, promotes teleworking.	http://www.teleworkva.org/
State/Multi-jurisdictional	Northern Virginia	VDOT	Variably Priced HOT Lanes	Demand/Operational	495 Express Lanes	High occupancy toll (HOT) lanes that use congestion pricing to manage congestion on the Beltway in Virginia	https://www.495expresslanes.com/

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	Northern Virginia	VDOT	Variably Priced HOT Lanes	Demand/ Operational	95 Express Lanes	Construction of high occupancy toll (HOT) lanes that use congestion pricing to manage congestion on the Beltway in Virginia	http://www.vamegaprojects.com
State/Multi-jurisdictional	Northern Virginia	VDOT and VDRPT	Transportation Demand Management Program	Demand/ operational	Virginia Megaprojects Regional, Dulles Rail, and 495 and 95 Express Lanes TMP's	Various targeted TDM and transit improvements to mitigate impacts and delays caused by construction of large scale projects in Northern Virginia	http://www.vamegaprojects.com
State/Multi-jurisdictional	Northern Virginia	NVRC	Laws and Safety Tips Booklet	Demand	Safety/Outreach	Pocket Booklet	www.bikewalkvirginia.org
State/Multi-jurisdictional	Fairfax and Loudoun Co. VA	VDRPT and MWAA	Public Transportation Improvements	Demand	Dulles Corridor Metrorail Project	In cooperation with WMATA and local governments. Construct an extension of Metrorail to Dulles Airport.	http://www.dullesmetro.com
State/Multi-jurisdictional	I-66, I-95/395 HOV lanes	VDOT/NOVA	HOV Lanes	Demand	I-66 HOV Lanes, I-395/I-95 HOV	Lanes available to ridesharers, those carpooling and vanpooling, and transit vehicles	www.VDOT.Virginia.gov
State/Multi-jurisdictional	Virginia Statewide	VDRPT and AMTRAK	Public Outreach	Demand	AMTRAK Virginia	Promotes AMTRAK passenger rail service in Virginia	http://www.amtrakvirginia.com

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	Virginia Statewide	VDOT	Traffic Management	Operational	I-66 ATM	Promote safety and congestion management	none
State/Multi-jurisdictional	Virginia Statewide	VDOT	TDM and Traffic management	Operational	I-95 ICM	Promote safety and congestion management	none
State/Multi-jurisdictional	Loudoun, Fairfax, Arlington, and Prince William Counties	Northern Virginia Transportation Authority	Public Transportation Improvements	Demand	NVTA's TransAction Regional Transportation Plan	Identifies a number of public transit, travel demand management, and other improvements, including new park-and-ride lots throughout Northern VA.	http://www.thenovaauthority.org/projects.html
State/Multi-jurisdictional	Loudoun, Fairfax, Arlington, and Prince William Counties	Northern Virginia Transportation Authority	Alternative Commute Programs	Demand	NVTA's Mission of the Authority	Responsibilities include a general oversight of regional congestion mitigation, including carpooling, vanpooling, and other commute programs	http://www.thenovaauthority.org/mission.html
State/Multi-jurisdictional	Northern VA and the District of Columbia	VRE	Public Transportation Improvements	Demand	Virginia Railway Express (VRE) Train	Commuter rail serving Northern VA and two stations in the District. Connects to local transit.	http://www.vre.org/index.html
State/Multi-jurisdictional	Prince William Co., Manassas, and several locations in VA & DC	PRTC	Public Transportation Improvements	Demand	Potomac and Rappahannock Transportation Commission's (PRTC) OmniRide	Commuter bus service along I-95 and I-66 corridor in Prince William Co., Manassas, and to several locations in VA & DC, including Metrorail stations.	http://www.prtctransit.org/omniride/index.php
State/Multi-jurisdictional	Eastern Prince William Co. and Manassas	PRTC	Public Transportation Improvements	Demand	PRTC's OmniLink	A local bus service in Eastern Prince William Co. and Manassas	http://www.prtctransit.org/omnilink/index.php

Geography	**Location**	**Local Jurisdiction / Organization**	**Strategy Name**	**Operational or Demand Mngt. Strategy**	**Project/Program Name**	**Description**	**Website**
State/Multi-jurisdictional	Prince William Co. and Manassas	PRTC	Ridematching Services	Demand	PRTC's OmniMatch	A free ridematching service for carpooler and vanpoolers originating in Prince William Co and Manassas.	http://www.prtctransit.org/omnimatch/index.php
State/Multi-jurisdictional	Fairfax, Loudoun, and Prince William Counties	VDOT/NOVA	Park-and-Ride Lots	Demand/ operational	Commuter Park-and-Ride lots	Provides and maintains numerous free park-and-ride lots	www.virginiadot.org/travel/pnrlots.asp
State/Multi-jurisdictional	Fairfax, Loudoun, and Prince William Counties	VDOT/NOVA	Bicycle Lockers	Demand/ operational	Bicycle Locker Rental Program	Provides reserved bicycle lockers at several Park-and-Ride lots for an annual rental fee	http://www.virginiadot.org/travel/nova-mainBicycle.asp
State/Multi-jurisdictional	Northern Virginia	MWAA	HOV Lanes	Demand	Dulles Toll Road HOV Lanes	Lanes available to rideshares, Those carpooling and vanpooling, And transit vehicles	www.mwaa.com
State/Multi-jurisdictional	NOVA	DRPT	Transit and TDM	Demand	SuperNOVA Transit and TDM	Transit/TDM vision planning	none
Multi-jurisdictional	Northern Virginia	PRTC in cooporation with NVTC and GWRC	Vanpool Programs	Demand	Vanpool Alliance	Organizes private vanpool providers for NTD reporting. Provides support, ridematching, and general marketing for vanpools in the region.	www.vanpoolalliance.org
Multi-jurisdictional	Prince William County, Cities of Manassas and Manassas Park	PRTC	Employer Outreach	Demand	Omni SmartCommute	Provides outreach and support to area employers seeking to implement employee commute assistance programs.	http://www.prtctransit.org/special-programs/employer-services.php

Geography	**Location**	**Local Jurisdiction / Organization**	**Strategy Name**	**Operational or Demand Mngt. Strategy**	**Project/Program Name**	**Description**	**Website**
State/Local	NOVA	VDOT/Local	Bike Lanes	Demand	Road Diet	Improve safety and mobility	none
County	Throughout Montgomery County	Montgomery County, MD	Park-&-Ride lots: Provision, maintenance & improvements	Demand	Montgomery County Park-and-Ride Lots	Provide park-and-ride lot information in the County.	http://www.montgomerycountymd.gov/tsvtmpl.asp?url=/content/DOT/transit/routesandschedules/brochures/parklots.asp
County	Throughout Montgomery County	Montgomery County, MD	Public Transportation	Demand	Ride On (local bus)	Provides public bus service in Montgomery County. Connects to Metrorail and Metrobus	http://www.montgomerycountymd.gov/dot-transit/
County	Throughout Montgomery County MD	MCDOT/Commuter Services Section	Alternative Commute Programs	Demand	MCDOT TDM Programs & Services - available throughout the County	Provides information on alternative commute options: carpooling, biking, employer incentives, all other TDM services & strategies	http://www.montgomerycountymd.gov/commute
County	Throughout Montgomery County MD	MCDOT/Commuter Services Section & other offices within MCDOT; M-NCPPC	Growth Management	Demand	TDM for Development Review	Coordinates TDM strategies required in new developments	http://www.montgomerycountymd.gov/commute
County	Throughout Montgomery County MD	MCDOT/Commuter Services Section & Traffic Engineering Div./Bikeways	Alternative Commute Programs – Bicycling	Demand	Bicycling Resources	Bike/transit maps for County and individual service areas. Bike resources	http://www.montgomerycountymd.gov/commute http://www2.montgomerycountymd.gov/DOT-DTE/BikeWays/BWHome.aspx

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Montgomery County MD	MCDOT/Commuter Services Section	Telework Incentive Program	Demand	Telework Resources	Laptops and consulting services available to employers exploring or adopting telework	http://www.montgomerycountymd.gov/commute
County	Throughout Prince George's County	Prince George's County Dept. of Public Works and Trans.	Alternative Commute Programs	Demand	Prince George's County Ride Smart Commuter Solutions	Provides information on commuter services available in Prince George's County.	http://www.ridesmartsolutions.com/
County	Throughout Prince George's County	Prince George's County Dept. of Public Works and Trans.	Park-and-ride lot improvements	Demand	Prince George's County Park-and-Ride Lots	There are 15 free park-and-ride lots available in Prince George's County.	http://www.goprincegeorgescounty.com/Government/AgencyIndex/DPW&T/Transit/park_ride.asp?nivel=foldmenu(2)
County	Throughout Prince George's County	Prince George's County Dept. of Public Works and Transport.	Improving accessibility to multimodal options	Demand	Prince George's County Call-A-Bus	Bus service available to all residents of Prince George's County who are not served by existing bus or rail.	http://www.goprincegeorgescounty.com/Government/AgencyIndex/DPW&T/Transit/bus.asp?nivel=foldmenu(2)
County	Throughout Frederick County	Frederick County, MD	Public Transportation Improvements	Demand	Frederick County TransIt	Public bus and paratransit services.	http://frederickcountymd.gov/index.aspx?nid=105
County	Throughout Frederick County	Frederick County, MD	Alternative Commute Programs	Demand	Frederick CountyTransIt	TransIt also offers information on alternative commute programs.	http://www.co.frederick.md.us/index.asp?NID=208
County	Throughout Frederick County	Frederick County, MD	Alternative Commute Programs	Demand	TransIT Services of Frederick County	Help business and employees find best transportation solutions	http://www.frederickcountymd.gov/index.aspx?NID=4609

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Frederick County	Frederick County, MD	Alternative Commute Programs	Demand	Frederick County Rideshare and Employer Outreach	Provides information on alternative commute programs, and local and regional public transit. Work with Employers to develop commute strategies at their locations.	http://frederickcountymd.gov/index.aspx?NID=208
County	Throughout Fairfax County	Fairfax County, VA	Public Transportation Improvements	Demand	Fairfax Connector (local bus)	Public bus system in Fairfax County. Connects to Metrorail and bus.	http://www.fairfaxcounty.gov/connector/
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Fairfax County RideSources Program	Provides information on alternative commute programs.	http://www.fairfaxcounty.gov/fcdot/sources.htm
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Fairfax County Employer Services Program	Help business and employees find best transportation solutions	http://www.fairfaxcounty.gov/fcdot/employer.htm
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Fairfax County Bike Program	A comprehensive bicycle initiative and program committed to making Fairfax County bicycle friendly	http://www.fairfaxcounty.gov/fcdot/bike/
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Fairfax County Pedestrian Program	A comprehensive Pedestrian Program to provide dedicated resources to meet specific pedestrian goals	http://www.fairfaxcounty.gov/fcdot/pedestrian/
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Bicycling Resources	Bike / Transit Maps for County and individual service areas. Bike resources	http://www.fairfaxcounty.gov/fcdot/bike/

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Shuttlepool program	High occupancy shuttle service offered to employers with staff that commute more that 20 miles away	http://www.fairfaxcounty.gov/fcdot/employer.htm
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Commuter-Friendly Communities	Program that works with residential properties to implement TDM programs that are tailored for that location	http://www.fairfaxcounty.gov/fcdot/tdm/cfc.htm
County	Throughout Fairfax County	Fairfax County, VA	Bicycle Programs	Demand	Bike Benefit Match Program	Fairfax employers can receive a 50% match in funding for implementing a new bike benefit program	http://www.fairfaxcounty.gov/fcdot/bike/bikebenefit.htm
County	Throughout Fairfax County	Fairfax County, VA	Vanpool Assistance	Demand	Van Start Van Save	Vanpool funding assistance used to temporarily fill empty seats for start up and vans that are losing ridership	http://www.fairfaxcounty.gov/fcdot/vanassist.htm
County	Throughout Fairfax County	Fairfax County, VA	Rideshare Matching	Demand	Employee Density Plots	GIS density maps that are used to promote ridesharing by identifying staff within a close proximity	http://www.fairfaxcounty.gov/fcdot/employer.htm
County	Throughout Fairfax County	Fairfax County, VA	Employer Outreach	Demand	Transportation Services Group	Reaches out to Fairfax employers and offers incentives to implement a commuter program	http://www.fairfaxcounty.gov/fcdot/employer.htm
County	Throughout Fairfax County	Fairfax County, VA	Employer Outreach	Demand	Employer Lunch and Learn Session	Lunchtime presentations to promote TDM programs to employer staff members.	http://www.fairfaxcounty.gov/fcdot/employer.htm

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Fairfax County	Fairfax County, VA	Parking Management	Demand	Rideshare Preferred Parking	Employer assistance in creating preferred parking for staff members that rideshare to work	http://www.fairfaxcounty.gov/fcdot/employer.htm
County	Throughout Fairfax County	Fairfax County, VA	Residential Commuter Site Awards	Demand	Commuter-Friendly Communities Awards	Bronze, Silver, Gold and Platinum award status for residential sites that have reached specific TDM level status	http://www.fairfaxcounty.gov/fcdot/tdm/cfc.htm
County	Throughout Fairfax County	Fairfax County, VA	Employer Awards	Demand	Fairfax County Best Workplaces for Commuters Awards	National & local recognition awards for Fairfax County employers who have established level 3 or 4 TDM programs	http://www.bestworkplaces.org/employers/fairfax/
County	Throughout Fairfax County	Fairfax County, VA	Transit	Demand	Fairfax Transit	Study countywide transit needs	http://www.fairfaxcounty.gov/FCDOT/2050TransitStudy
County	Throughout Arlington County	Arlington County, VA	Public Transportation Improvements	Demand	Arlington Transit (ART)	Public bus service in Arlington. Connects to Metrorail and bus.	http://www.commuterpage.com/art/
County	Throughout Arlington County	Arlington County, VA	Alternative Commute Programs	Demand	Getting Around Arlington	Provides information on alternative commute programs, and public transit.	http://www.commuterpage.com/art/villages/arl_tran.htm
County	Throughout Arlington County	Arlington County, VA	Pedestrian, Bicycle and Multimodal Improvements	Demand	Arlington's BikeArlington	Initiative to encourage more people to bike often.	http://www.bikearlington.com/about.cfm

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Arlington County	Arlington County, VA	Alternative Commute Programs	Demand	Arlington's Car-Free Diet	Promotes alternative commute methods.	http://www.carfreediet.com/
County	Throughout Arlington County	Arlington County, VA	Promote Alternate Modes	Demand	WALKArlington	Promotes walking as an alternative mode.	http://www.walkarlington.com/about/index.html
County	Throughout Arlington County	Arlington County, VA	Alternative Commute Programs	Demand	Arlington County's CommuterPage.com	Provides information on transportation options in Arlington and the DC area.	http://www.commuterpage.com/
County	Throughout Arlington County	Arlington County, VA	Growth Management	Demand	Arlington County's TDM Management for Site Plan Development	Coordinates site plan development (proposed land use) with commuter and transit services.	http://www.commuterpage.com/TDM/
County	Throughout Loudoun and from Loudoun to DC	Loudoun County, VA	Public Transportation	Demand	Loudoun County Transit	Commuter bus service from Loudoun Co. to Arlington and downtown DC.	http://inter4.loudoun.gov/Default.aspx?tabid=969
County	Throughout Loudoun County	Loudoun County, VA	Park-and-ride lot improvements	Demand	Loudoun's Free Park-and-Ride lots	Free park-and-ride lots are available throughout the County.	http://inter4.loudoun.gov/Default.aspx?tabid=959
County	Throughout Loudoun County	Loudoun County, VA	Alternative Commute Programs	Demand	Loudoun's Commuting options	Provides information on alternative commute programs and transit options.	http://inter4.loudoun.gov/Default.aspx?tabid=789
County	Throughout Loudoun County	Loudoun County, VA	Employer Outreach/Services	Demand	Loudoun's Employer Services	Helps businesses identify commuting solutions for employees in Loudoun County	http://inter4.loudoun.gov/Default.aspx?tabid=984

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Southern Loudoun and in Northern Loudoun to Purcellville	Virginia Regional Transit (in cooperation with Loudoun Co.)	Local Fixed Route Bus Service	Demand	Loudoun County	Public bus service within Loudoun County.	http://inter4.loudoun.gov/Default.aspx?tabid=898
County	Throughout Prince William County	Prince William County, VA	Park-and-ride lot improvements	Demand	Prince William County Commuter Parking Lots	Work with VDOT and provide convenient sites to encourage residents to use transit or carpool.	http://www.pwcgov.org//default.aspx?topic=010017001530000797
City	The length of College Park, MD	City of College Park, MD	Pedestrian, Bicycle and Multimodal Improvements	Demand	College Park Trolley Trail	Trail is to run the length of the City of College Park, in the old trolley right-of-way.	http://www.thewashcycle.com/college_park_trolley_trail/
City	Throughout Greenbelt	City of Greenbelt, MD	Public Transportation Improvements	Demand	Greenbelt Connection	A local bus in Greenbelt; runs upon request.	http://www.greenbeltmd.gov/public_works/connection.htm
City	Throughout City of Frederick	City of Frederick, MD	Pedestrian, Bicycle and Multimodal Improvements	Demand	Frederick Shared use paths	Promotes the use of, and creates new shared use paths.	http://www.cityoffrederick.com/cms/files/maps/shared-use-path.pdf
City	Throughout Falls Church and to the Metro stations	City of Falls Church, VA	Public Transportation Improvements	Demand	Falls Church GEORGE	Local bus system providing service to East and West Falls Church Metrorail stations and throughout the City of Falls Church.	http://www.fallschurchva.gov/Content/CultureRecreation/GEORGEmain.aspx
City	Throughout Alexandria	City of Alexandria, VA	Alternative Commute Programs	Demand	Local Motion	Promotes use of alternative modes.	www.Alexandriava.gov/LocalMotion

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
City	Throughout Alexandria	City of Alexandria, VA	Public Transportation Improvements	Demand	Alexandria DASH	Local bus system. Connects to Metrobus and Metrorail, VRE, and other local bus systems.	http://www.dashbus.com/
City	Throughout Alexandria	City of Alexandria, VA	Growth Management	Demand	Transportation Management Plans for Site Plan Developments	Coordinates site plan development (proposed land uses) with commuter and transit services.	www.Alexandriava.gov/6556
City	Throughout Alexandria	City of Alexandria, VA	Improving accessibility to multimodal options	Demand	Alexandria Transit Store	Provides resources and retail transactions for multimodal travel	www.Alexandriava.gov/11144
City	Throughout City of Fairfax	City of Fairfax, VA	Public Transportation Improvements	Demand	City of Fairfax's CUE	Public bus service within City of Fairfax. Also connects to Vienna Metrorail station.	http://www.fairfaxva.gov/CUEBus/CUEBus.asp
Local / Corridor-based	Along the corridor between Baltimore and DC	BWI Business Partnership	Alternative Commute Programs	Demand	BWI Business Partnership Commuter Resources	Provides information on commuter programs available to the BWI area.	http://www.bwipartner.org/index.php?option=com_content&task=view&id=21&Itemid=59
Local / Corridor-based	Downtown Bethesda Transportation Management District (TMD)	MCDOT/Commuter Services Section with contractor: Bethesda Transportation Solutions (BTS)	Alternative Commute Programs	Demand	Bethesda TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.bethesdatransit.org/

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
Local / Corridor-based	Downtown Bethesda Transportation Management District (TMD)	MCDOT with contractor: Bethesda Urban Partnership (BUP)	Public Transportation Improvements	Demand	Bethesda Circulator	Downtown Bethesda Circulator Bus	http://www.bethesda.org/parking/circulatorinfo.htm
Local / Corridor-based	North Bethesda TMD	MCDOT/Commuter Services Section with contractor: North Bethesda Transportation Center	Alternative Commute Programs	Demand	N. Bethesda TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.nbtc.org
Local / Corridor-based	Friendship Heights TMD	MCDOT/Commuter Services Section (CSS)	Alternative Commute Programs	Demand	Friendship Heights TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.montgomerycountymd.gov/commute
Local / Corridor-based	Silver Spring TMD	MCDOT/Commuter Services Section (CSS)	Alternative Commute Programs	Demand	Silver Spring TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.montgomerycountymd.gov/commute
Local / Corridor-based	Greater Shady Grove TMD	MCDOT/Commuter Services Section (CSS)	Alternative Commute Programs	Demand	Greater Shady Grove TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.montgomerycountymd.gov/commute

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
Local / Corridor-based	Loudoun, Fairfax, and Prince William Counties	Dulles Area Transportation Association (DATA)	Alternative Commute Programs	Demand	DATA Commuter Resources	Advocates for alternative commute programs, transit needs, and transit-oriented development.	http://www.datatrans.org/about.html
Local / Corridor-based	Reston	LINK	Alternative Commute Programs	Demand	Reston's LINK Commuter Resources	Provides information on carpooling, vanpooling, and regional bus schedules.	http://www.linkinfo.org/index.cfm
Local / Corridor-based	Tyson's Corner area	Tyson's Transportation Association (TYTRAN)	Alternative Commute Programs	Demand	TYTRAN's Commuter Resources	Provides information on carpooling, vanpooling, park-and-ride lots, and telework locations.	http://www.tytran.org/index.htm
Local / Corridor-based	Northern VA - Loudoun, Fairfax, Prince William	Northern Virginia Transportation Commission (NVTC)	Public Transportation Improvements	Demand	NVTC Research on public transit and HOV performance	NVTC compiles data on regional transit systems and HOV performance.	http://www.thinkoutsidethecar.org/transit.asp
Local / Corridor-based	Northern VA - Loudoun, Fairfax, Prince William	Northern Virginia Transportation Commission (NVTC)	Alternative Commute Programs	Demand	NVTC Commuter Info	Provides information on how to use the region's transit system, bicycle and pedestrian options, HOV schedules, and park-and-ride lots.	http://www.thinkoutsidethecar.org/info.asp
Local / Corridor-based	Eastern Arlington's Potomac Yard neighborhood	Full Access Solutions in Transportation (FAST) for Potomac Yard	Growth Management	Demand	Non-profit, developer-initiated FAST	Aims at reducing single-occupant trips to the growing Potomac Yard area. Promotes transit, biking, walking. Offers discounted Metrobus shuttle.	http://fastpotomacyard.com/index.html

3.2.3 Transit Systems

Transit systems can improve the operation of existing roadways and systems by carrying more passengers than a single-occupant vehicle. They can also be considered demand management strategies in that they can influence a person's traveling behavior and convince them to leave their car at home. Many of the transit systems in the region are operated by transit agencies or local government agencies, including:

- *Alexandria DASH*, a local bus service in Alexandria, Virginia
- *Arlington Transit (ART)*, a bus service in Arlington County, Virginia
- *Bethesda Circulator*, a downtown Bethesda bus service
- *Central Maryland Regional Transit*, a bus service for the City of Laurel and a portion of Prince George's County, with additional services in Anne Arundel and Howard Counties.
- *CUE in City of Fairfax*, a bus service in City of Fairfax, Virginia
- *DC Circulator* bus, serving downtown District of Columbia
- *Fairfax Connector*, a bus service in Fairfax County, Virginia
- *Frederick County TransIT*, a bus service in Frederick County, Maryland
- *Greenbelt Connection*, bus serving Greenbelt upon request
- *Loudoun County Transit* operates commuter bus services from Loudoun to destinations that include West Falls Church Metro, Rosslyn, the Pentagon, and Washington, D.C., as well as providing services from West Falls Church Metro to and among employment sites in Loudoun County.
- *Maryland Transit Administration (MTA) MARC* train commuter rail, serving District of Columbia and Maryland
- *Montgomery County Ride On*, a local bus service in Montgomery County, Maryland
- *MTA Commuter Bus* provides 19 privately contracted Commuter Bus routes which provide 427 trips throughout Maryland's Washington D.C., suburbs including service from far reaching suburbs in Howard, Anne Arundel, Queen Anne's, and Charles Counties to Washington, D.C.
- *Potomac and Rappahannock Transportation Commission (PRTC)*, providing *OmniLink*, a local bus service in Eastern Prince William County and Manassas, and *OmniRide*, commuter bus services offering service from locations throughout Prince William County and the Manassas and Gainesville areas to destinations that include the Vienna, West Falls Church and Franconia/Springfield Metrorail Stations, the Pentagon, Crystal City, Rosslyn/Ballston, downtown Washington, D.C., Capitol Hill, and the Washington Navy Yard.
- *Prince George's County Call-A-Bus*, serving those in Prince George's County not served by existing bus or rail
- *Prince George's County TheBus*, serving Prince George's County
- *Virginia Railway Express (VRE)* commuter rail serving Virginia and District of Columbia
- *Virginia Regional Transit* (in cooperation with Loudoun County Transit), a bus service in Loudoun County, Virginia
- *Washington Metropolitan Area Transit Authority (WMATA) Metrobus*, serving the entire Washington metropolitan area
- *Washington Metropolitan Area Transit Authority (WMATA) Metrorail*, serving the entire Washington metropolitan area

While these transit systems are individually very important strategies, it is important to note that they work together to form an entire transit network important to our congestion management system. They work well with other strategies as well, such as VPLs and HOV lanes. In addition, with the help of

Intelligent Transportation System (ITS) technologies, Advanced Traveler Information Systems and providing buses with bicycle racks, transit can be even more appealing to travelers.

The latest (2007/2008) regional household travel survey revealed that commuting transit modal share increased from 15.1% in 1994 to 17.7%, and daily transit modal share increased from 5.5% in 1994 to 6.1% [108]. These increases reflect the positive effect of the region's longstanding efforts to promote transit usage.

3.2.3.1 Significant Transit Construction and Capacity Increases

The first phase of Metrorail's Silver Line opened on July 25, 2014. The 11.4-mile segment begins at the existing West Falls Church Station and includes five stations: McLean, Tysons Corner, Greensboro, Spring Hill and Wiehle-Reston East. Phase 2 with service to Dulles Airport is scheduled to begin in several years. [109]

The Crystal City-Potomac Yard Transitway, the region's first bus rapid transit (BRT) lanes, opened the first section in Alexandria on August 23, 2015 and the second section in Arlington on April 17, 2016. [110] The five-mile line is partially funded by an $8.5 million TIGER grant awarded to the TPB in 2010 for construction of the 0.8 mile segment between East Glebe Road and Potomac Avenue. [111] The BRT service will be run by WMATA and feature frequent service, off-board fare collection, and level boarding. [112]

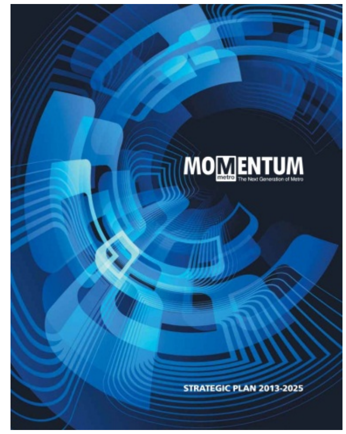
The first line in DDOT's streetcar system opened on February 27, 2016. [113]. The 2.4 mile H/Benning Line has eight stops on H St. NE and Benning Road between Union Station and Oklahoma Ave. [114] The line is the first segment in DDOT's 30-year, 37 mile streetcar vision. No fare will be collected for the first six months and after that the streetcars will feature off-board fare collection and level boarding. As part of the streetcar project, new contraflow bike lanes were installed along G St and I St NE to provide an alternative for cyclists who travel on H St.

Section 3.4.2 discusses technology-related transit projects such as bus priority systems.

3.2.3.2 Future Transit Planning

[108] A presentation of the 2007/2008 Household Travel Survey, May 19, 2009. http://www.mwcog.org/uploads/committee-documents/YV5cV1ZX20090520110217.pdf
[109] http://silverlinemetro.com/sv-about/
[110] http://www.alexandrianews.org/2016/04/new-bus-lanes-in-crystal-city-potomac-yard-open-for-service/
[111] https://www.mwcog.org/transportation/weeklyreport/2012/10-09.asp
[112] https://www.alexandriava.gov/tes/info/default.aspx?id=58644 (Accessed April 10, 2014)
[113] https://www.washingtonpost.com/local/trafficandcommuting/dc-streetcar-makes-its-first-voyages-on-h-street-is-it-really-happening/2016/02/27/bd0c3234-dd5b-11e5-891a-4ed04f4213e8_story.html
[114] http://www.dcstreetcar.com/projects/hbenning/

In 2013, WMATA released *Momentum,* its strategic plan for 2013-2025.[115] The plan is built around four major goals: (1) build and maintain a premier safety culture and system, (2) meet or exceed expectations by consistently delivering quality services, (3) improve regional mobility and connect communities, and (4) ensure financial stability and invest in [its] people and assets. The plan includes Metro 2025, a list of seven "pivotal investments" by 2025 to improve existing service and enhance travel in the region's core. These investments include 8-car trains on all lines during rush hour and new connections between busy stations. WMATA estimates that the increased capacity from Metro 2025 will remove 100,000 car trips from the region's road network daily while providing transit riders with an improved travel experience.[116]



3.2.3.3 University Transit Systems

Many area universities have their own transit systems for students, faculty, staff, and in some cases, visitors. These shuttle systems increase transit options for the university community and help reduce congestion on campus roads. Two examples of university transit systems are Shuttle-UM system at the University of Maryland, College Park and Masons Shuttles at George Mason University. The Shuttle-UM system is one of the nation's largest University transit services[117] with a fleet of 74 vehicles, including hybrid and clean diesel vehicles, and a ridership of 3,304,212 during FY 2015.[118] Mason Shuttles has five routes including connections to the Vienna Metrorail Station and the Burke VRE station. The George Mason shuttle system has an annual ridership of nearly 600,000 per year.[119] Both universities are providing riders with real-time bus arrival information.

3.2.4 PEDESTRIAN AND BICYCLE TRANSPORTATION

Walking and bicycling are garnering more attention as having positive environmental and health benefits. As a part of the region's transportation network, these activities impact congestion management as well. There are a number of things the Washington region is doing to enhance the area of bicycle and pedestrian transportation to encourage non-motorized transportation.

- The TPB adopted an updated "Bicycle and Pedestrian Plan for the National Capital Region" in January 2015.[120] Both the TPB and COG recognize the congestion reductions benefits of bicycling and walking.

- Most of the area's local governments have adopted bicycle, pedestrian, trail plans, and/or policies. Bicycle or pedestrian coordinators and trail planners are now found at most levels of government.

- On May 16, 2012, the TPB approved the "Complete Streets Policy for the National Capital Region" which is a directive to all of the TPB member jurisdictions to ensure safe and adequate

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[115] http://www.wmata.com/momentum/momentum-full.pdf
[116] http://www.mwcog.org/news/press/detail.asp?NEWS_ID=709
[117] http://www.transportation.umd.edu/shuttle.html (Accessed April 301, 2016)
[118] University of Maryland Department of Transportation Services 2015 Annual Report http://www.transportation.umd.edu/about/Annual%20Reports/Annual%20Report%202015_web.pdf
[119] Josh Cantor, "Parking and Transportation Overview," August 2015 http://transportation.gmu.edu/pdfs/2014_2015/PT%20Budget%20and%20Program%20Overview%20Aug%202015%20081015%20final.pdf
[120] http://www.mwcog.org/uploads/pub-documents/pV5bW1420150227152434.pdf

accommodation, in all phases of project planning, development, and operations, of all users of the transportation network in a manner appropriate to the function and context of the relevant facility.[121]

- Most of the region's transit agencies have bike racks on their buses. WMATA allows bikes on rail outside rush hour and on weekends.

- MARC allows collapsible bicycles on all trains. MARC began allowing full-size bicycles on some weekend Penn Line trains in December 2014. In September 2014, that service was expanded to six of nine roundtrip Saturday trains and all six roundtrip Sunday trains. There are 23 racks on board and no additional charge for bicycles.[122]

- VRE allows collapsible bicycles on all trains. VRE allows up to two full size bicycles on the last three northbound trains, the midday train, and the last three southbound trains on each line.[123]

- Secure, covered bicycle parking facilities including Bikestation Washington DC[124] adjacent to Union Station and WMATA's Bike and Ride facility at the College Park Metro Station[125] provide more convenience for multi-mode travelers.

- Local governments are starting to require bicycle parking, as well as provide free on-street racks. DC requires bike parking in all buildings that offer car parking.

- In accordance with federal guidance and new state policies, pedestrian and bicycle facilities are increasingly being provided as part of larger transportation projects. A number of local jurisdictions have implemented transit-oriented developments (TODs) and other walkable communities.

- VDOT has altered its secondary street acceptance requirements to mandate that streets built by private developers connect with adjacent streets and future developments in a manner that enhances pedestrian and bicycle access, and that adds to the capacity of the transportation system. Residential streets may be narrower and incorporate traffic calming features.
- Employers are investing in bike facilities at work sites, and developers are including paths in new construction.

- Specific bicycle/pedestrian campaigns are developing to encourage biking/walking, such as WALKArlington, Localmotion, and GoDCGo.[126]

- The Safe Routes to School program, which is administered through the States, provides funding for both hard and soft improvements and programs to encourage children to walk or bicycle to school, improve safety, and reduce congestion and air pollution near schools. Under the new federal transportation bill, MAP-21, the Safe Routes to School program was combined with two other former federal programs that fund non-motorized transportation, Transportation Enhancement (TE) and Recreational Trails, to form the Transportation Alternatives Program. This program, which is administered by the States and the National Capital Region Transportation

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121 http://www.mwcog.org/uploads/committee-documents/mV1dXl9e20120510092939.pdf
122 http://mta.maryland.gov/news/mta-doubles-bike-car-service-marc-weekend-penn-line
123 http://www.vre.org/service/rider/policies/
124 http://home.bikestation.com/washingtondc
125 http://www.wmata.com/about_metro/news/PressReleaseDetail.cfm?ReleaseID=5225
126 http://www.walkarlington.com/

Planning Board, provides funds for bicycle and pedestrian facilities, complete streets, safe routes to schools, and environmental mitigation.

- More and better on line bike and walk routing resources have become available from the private sector. Google Maps offers both walk and bike routing features. Another bike routing resource for the Washington region is RidetheCity.com/dc, which allows users to choose a preferred safety level.

Bicycle and pedestrian plans and projects are widespread throughout the Washington region. For example, in the District of Columbia, DDOT constructed a record nine miles of bicycle lanes in 2014, four miles in 2015, and plans to construct six miles in 2016.[127] Bicycling and walking have an even greater potential to grow as modes of transportation. Many trips taken by automobile could potentially be taken by bicycle. This is especially true in areas such as Activity Centers where a number of trips are more easily switched from motorized transportation to walking. Many people who live far from their jobs, but closer to transit or a carpool location could walk or bike to transit or the carpool instead of driving. When considering the following statistics, switching from a motor vehicle or bicycling or walking is feasible[128]:

- The median work trip length for all modes in the TPB Planning area is 9.3 miles.
- Twenty-five percent of commute trips are less than 4.3 miles, a distance most people can cover by bicycle.
- The median auto driver trip (for all purposes) is only 4 miles, and 25% of all auto driver trips are less than 1.5 miles.
- Auto passenger trips, often children being taken to school, are even shorter, with a median trip distance of 2.8 miles, and 25% of trips less than 1.2 miles.

In August of 2012, the Transportation Planning Board (TPB) received $200,000 through the Federal Highway Administration's Transportation, Community and System Preservation (TCSP) Grant Program to identify strategic recommendations to increase ridership at underutilized rail stations with strategic bicycle and pedestrian access improvements.. The final product of the project identified a set of pedestrian and bicycle capital projects that could be quickly implemented in the vicinity of rail stations with available ridership capacity that are anticipating employment growth in the near-term future and/or have significant transit-dependent populations living in close proximity. That study identified over 3,000 recommendations for a range of physical infrastructure improvements and policies and programs to encourage multimodal trips.

The Surface Transportation Block Grant Program Set-Aside is a federal program under the 2015 FAST act that provides funding for projects considered alternative to traditional highway capacity expansion. The Set-Aside is the new iteration of the Transportation Alternatives Program from 2012's MAP-21. Similar to the Transportation Alternatives Program, the Set-Aside allows large MPOs, including the Transportation Planning Board, to play a role in project selection for a portion of program funds that will be sub-allocated to large metropolitan regions. For the National Capital Region, this new program offers an opportunity to fund regional priorities and complement regional planning activities. Projects approved for FY 2015 and FY 2016 include expansion of a "Hiker-Biker trail route in Rockville, late

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127 http://wamu.org/news/16/03/21/is_dc_moving_fast_enough_to_build_bike_lanes_six_miles_to_be_added_in_2016

128 Griffiths, R. E. 2007/2008 Household Travel Survey: Presentation of Findings on Weekday Travel. Presentation to the Technical Committee of the National Capital Region Transportation Planning Board on May 1, 2009

stage design funding for the Cinderbed Road Bikeway in Fairfax County, and a trail along the District of Columbia's SE Waterfront connecting to the historic Seafarer's Yacht Club..[129]

Supporting bicycle and pedestrian planning is important to congestion management. Each additional person walking or biking for a trip is one less person on the road, thus easing congestion. Pedestrian and bicycle facility planning is something that will continue to be considered in the realm of congestion management, not only as a stand-alone area, but in conjunction with transit projects and land use planning.

Bikesharing

Capital Bikeshare, opened in September 2010 with 1100 bikes at 110 stations. The public-private partnership has since expanded to Arlington County, the City of Alexandria, and Montgomery County with over 3000 bicycles and over 350 stations.[130] The Spotcycle smartphone app allows users to see bicycle and dock availability. Capital Bikeshare will expand to Fairfax County in the Reston and Tysons areas with 26 new stations and 212 bike in Fall 2016.[131]

The results of a survey[132] of Capital Bikeshare members conducted during November 2014 provided information on travel changes made in response to Capital Bikeshare availability. According to the survey report, bikeshare provides an additional transportation option to members to make trips that they may not have made in the past because it was too far to walk. More than half of Capital Bikeshare members do not have access to a car or personal vehicle. The survey found that bikeshare plays a role on multimodal transportation. When asked about their travel during the previous month, 64% of members used bikeshare to access a Metrorail station, 21% accessed a Metrorail station six or more times, and 24% used bikeshare to access a bus. The availability of bikeshare allows its members to switch trips to bike from other modes.

The City of College Park, in partnership with the University of Maryland, launched its own bikeshare system in partnership with the University of Maryland on May 4, 2016. The bikeshare system is operated by Zagster and has 125 bikes and 14 stations.[133] The city chose Zagster as its bikeshare vendor after plans to join Capital Bikeshare fell through in 2014 due to the bankruptcy filing by Capital Bikeshare's operator, Alta Bicycle Share, in 2014.[134]

3.2.5 Car Sharing

Carsharing is a model of car rental where people rent cars for short periods of time, often by the hour. This supports residents, especially in densely populated urban environments, who make only occasional use of a vehicle, as well as others who would like occasional access to a vehicle of a different type than they use day-to-day. Urban car sharing is often promoted as an alternative to owning a car in dense, walkable, mixed-use development communities, where public transit, walking, and cycling can be used most of the time and a car is only necessary for out-of-town trips, moving large

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[129] www.mwcog.org/tap (Accessed April 30, 2016)
[130] http://capitalbikeshare.com/hom e (Accessed April 30, 2016)
[131] http://www.fairfaxcounty.gov/fcdot/news/2016/16_001.htm
[132] 2014 Capital Bikeshare Member Survey Report prepared by LDA Consulting, April 3, 2015 http://www.capitalbikeshare.com/assets/pdf/cabi-2014surveyreport.pdf
[133] http://zagster.com/mbike/
[134] https://www.washingtonpost.com/local/trafficandcommuting/capital-bikeshare-expansion-hindered-by-bankruptcy-of-montreal-based-bike-vendor/2014/04/12/d42c8a2a-bf23-11e3-b195-dd0c1174052c_story.html?tid=a_inl

items, or special occasions. It can also be an alternative to owning multiple cars for households with more than one driver.[135]

Carshare companies follow one of two basic models. The firsthas designated parking spaces for each vehicle, and the vehicle must be returned to that location at the end of the rental. The second, has a home area defined where users can park the vehicle in any legal public parking space at the end of the rental, allowing for one-way or point-to-point trips. Smartphone apps are available for all of the major carshare companies to locate and reserve cars. The largest carshare company in the region, Zipcar, has over 800 vehicles in the area. Enterprise also operates carsharing in the region. A point-to-point carshare company, Car2Go, has over 300 vehicles in the District of Columbia and Arlington.

Jurisdictions work with the car share companies to arrange for parking permitting. For example, the District of Columbia provides on-street spaces, at a cost, for carshare vehicles, and encourages developers to provide off-street car share spaces in conjunction with new development. In November 2013, the DDOT began a program which allows carshare companies to purchase parking permits which allow their vehicles to be parked in Residential Parking Permit zones.[136] Arlington County provides information on carsharing on its Commuter Page website.[137]

App-based or ridehailing car services, such as Uber and Lyft, are different from carsharing as they operate more like a taxi service.. According to the American Public Transportation Association (APTA), the more people use shared modes, the more likely they are to use public transportation, own fewer cars, and spend less on transportation overall. In addition, shared modes complement public transit and enhance urban mobility. It is unclear at this time how ridehailing services will affect transportation planning or contribute to congestion reduction in the region. The next CMP Technical Report will continue to monito the potential impact of ridehailing services.[138]

3.2.6 Land Use Strategies in the Washington Region

The relationship of land use and transportation often have an important influence on a person's willingness to commute by transit, ridesharing, bicycling, or walking; modes other than driving alone. The TPB is undertaking projects that consider the relationship of land use and transportation, all of which are important components of the CMP. Concentrating activities near transportation facilities helps reduce the number and length of vehicle trips necessary by residents and workers. More trips can be made by walking. Densities can be sufficient to make provision of transit services cost effective.

3.2.6.1 Cooperative Forecasting

TPB coordinates with the regional Cooperative Forecasting process at COG. Cooperative forecasting is a regional process that provides forecasts for demographic information that considers the potential impacts of future transportation facilities. The forecasts are based on national economic trends, local demographic factors, and are closely coordinated with regional travel forecasts.

Local jurisdictions develop independent projections of population, households, and employment based on pipeline development, market conditions, land use plans and zoning, and planned transportation improvements. These local forecasts are also compared and coordinated at the

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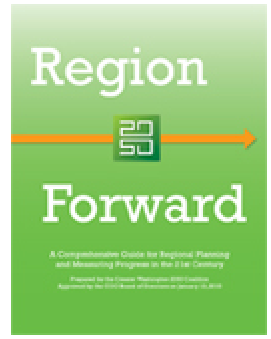
135 Adapted from Wikipedia, “Carsharing”, http://en.wikipedia.org/wiki/Carsharing.
136 http://ddotdish.com/2013/11/25/parking-in-district-now-easier-for-carshare-users/
137 http://www.commuterpage.com/pages/transportation-options/carsharing/ (Accessed April 30, 2016,)
138, “TCRP J-11/Task 21 Shared Mobility and the Transformation of Public Transit Research Analysis.” Prepared for American Public Transportation Association and Submitted to the National Academies Transportation Research Board. March 2016.
(https://www.apta.com/resources/reportsandpublications/Documents/APTA-Shared-Mobility.pdf)

regional level to ensure compatibility. If there is a major change in planned transportation facilities (such as an addition or removal of a planned major facility) the cooperative forecasts are updated to reflect this change. Overall, Metropolitan Washington has strong, well-established processes to ensure transportation planning and land use planning are well-coordinated.

3.2.6.2 Region Forward and Regional Activity Centers



Region Forward is a vision for a more accessible, sustainable, prosperous, and livable National Capital Region. It was developed by the [Greater Washington 2050 Coalition](), a group of public, private, and civic leaders created by the Metropolitan Washington Council of Governments in 2008 to help the region meet future challenges like accommodating two million more people by 2050, maintaining aging infrastructure, growing more sustainably, and including all residents in future prosperity.
The Region Forward Compact seeks effective coordination of land use and transportation planning resulting in an integration of land use, transportation, environmental, and energy decisions. Specifically in the transportation sector, Region Forward:

- Seeks a broad range of public and private transportation choices for our Region which maximizes accessibility and affordability to everyone and minimizes reliance upon single occupancy use of the automobile.
- Seeks a transportation system that maximizes community connectivity and walkability, and minimizes ecological harm to the Region and world beyond. [139]

Regional Activity Centers help coordinate transportation and land use planning in specific areas in the Washington region experiencing and anticipating growth. Focusing growth in Centers is important to congestion management, where transportation options for those who live and work there can be provided. The concentration of activities and location near transportation facilities help reduce vehicle trips, as more trips can be made by walking. Transit services also become more cost effective.

e first map of Regional Activity Centers was created in 1999, and since that time it has been updated several times, based upon current local comprehensive plans and zoning. The most recent map of Activity Centers was developed by the Region Forward Coalition with the COG Planning Directions Technical Advisory Committee, was adopted by the COG Board in January 2013. [140] The development of the 2013 map and used more targeted and specific criteria than in previous version (2007) to designate 141 Activity Centers (Figure 65). The criteria are primarily based on Region Forward. [141]

The Metropolitan Washington Council of Governments (COG) *Board of Directors* and the *Region Forward* Coalition adopted a joint focus on Economic Competiveness for policy makers, planners and business leaders to collectively assess the current economic state and potential of the region. The *State of the Region: Economic Competitiveness Report* builds upon the work of *Region Forward* and subsequent COG reports to benchmark regional performance, The *State of the Region* report examines the region's economic competitiveness through an assessment of cross-cutting targets and indicators

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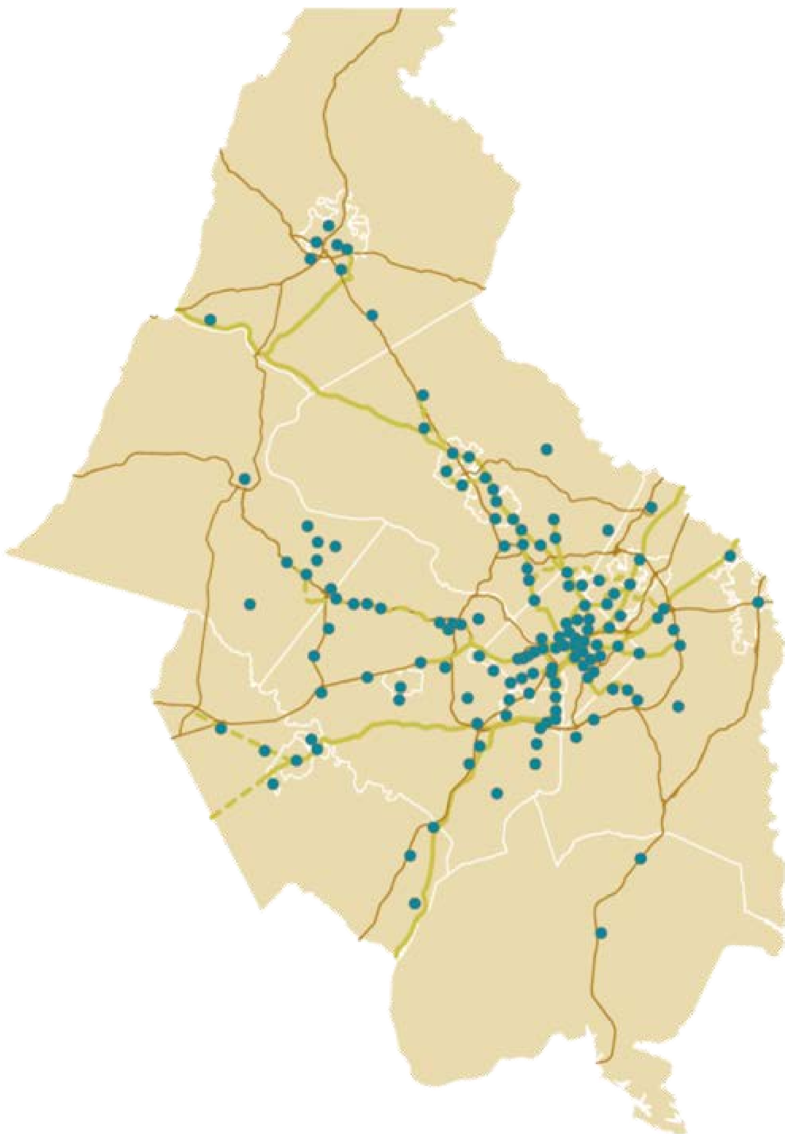
[139] http://www.regionforward.org/compact
[140] Regional Activity Centers Map, January 2013 http://www.mwcog.org/uploads/pub-documents/oV5cXVc20130813171550.pdf
[141] http://www.regionforward.org/activity-centers-where-metropolitan-washington-is-growing

that address our shared economic climate, built infrastructure, human infrastructure, and quality of life. These indicators correspond closely with the four pillars outlined in *Region Forward* that focused on Prosperity, Accessibility, Sustainability, and Livability.[142]

COG's Round 8.4 Cooperative Forecasts indicate that between 2010 and 2040, 75.9% of employment growth, 56.8% of population growth, and 61.9% of household growth projected in the region will occur in Activity Centers.

In-depth surveys of household travel behavior conducted by the Transportation Planning Board in strategically-chosen areas around the Washington region will help planners and local officials better understand travel patterns in Activity Centers and neighborhoods.

Figure 65: 2013 Regional Activity Center Map



142 https://www.mwcog.org/uploads/pub-documents/oF5aX1Y20160120082811.pdf

3.2.6.3 Transportation-Land Use Connection (TLC) Program

The Transportation-Land Use Connection (TLC) program provides support and assistance to local governments in the Washington region as they implement their own strategies to improve coordination between transportation and land use. The program does this in two ways. First, it provides information via the Regional TLC Clearinghouse, which is a web-based source of information and transportation/land use coordination, experiences with transit-oriented development, and key strategies. Secondly, the TLC Technical Assistance Program provides consultant services to local jurisdictions working on projects land use and transportation projects.

Nine projects were approved as part of the FY 2016 TLC program:

- District of Columbia: K Street / Water Street Bikeway and Pedestrian Connectivity Enhancements
- City of College Park: Citywide Bike Boulevards
- City of Gaithersburg: Improving Access to Transit - A Review of Bicycle/Pedestrian Infrastructure
- City of Takoma Park: Parking Takoma Park - Smart Solutions for a Growing Activity Center
- Prince George's County: Central Avenue Connector Trail 30% Design
- Arlington County: Low Stress Bicycle Network Mapping
- Fairfax County: Parking Demand and Trip Generation in Multifamily Development
- Fairfax County: Vienna Metrorail Station Area Bicycle Improvements Prioritization
- Prince William County: Safety and Connectivity in a Planned Community

The TLC program allows for flexibility to study a wide variety of transportation – land use issues. Some projects are more demand management focused, focusing on pedestrian improvements, growth management, and transit-oriented development. Other projects address operational issues, including pedestrian safety improvements and roadway design. The goals among each may be different, but each project is applicable to congestion management.

3.2.6.4 Local Jurisdictional Land Use Planning Activities

Following are some of the major examples of activities going on at the local level that are important to congestion management. Activities range from having a strong comprehensive plan that guides local development, to the implementation of projects that include transportation options and pedestrian and bicycle facilities. Examples of local jurisdictional planning activities (please note: this is not a comprehensive list) include:

- Rockville's Pike Neighborhood Plan[143]
- Dale City, Virginia: Furthering the Vision of a Planned Community[144]
- Charles County Comprehensive Plan[145]
- New Zoning Code for the District of Columbia[146]

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[143] http://www.rockvillemd.gov/index.aspx?nid=206
[144] http://www.pwcgov.org/government/dept/planning/Pages/DaleCitySDAT.aspx
[145] http://www.charlescountyplan.org/
[146] http://planning.dc.gov/sites/default/files/dc/sites/op/release_content/attachments/ZRR%20Featured%20News%20Press%20Release_0.pdf

3.3 Operational Management Strategies

3.3.1 High-Occupancy Vehicle (HOV) Facilities

3.3.1.1 Overview

High Occupancy Vehicle (HOV) lanes are defined as roadways or roadway segments that are restricted to use by vehicles (cars, buses, vanpools) carrying the driver and one or more additional passengers.

HOV facilities offer several advantages over conventional lanes and roads. They increase the number of persons per motor vehicle using a highway over conventional (non-HOV) roadways, they preserve the person-moving capacity of a lane or roadway as demands for transportation capacity increase, and enhance bus transit operations. All of these advantages are important to effectively managing the operations of existing and new capacity on roadways.

However, HOV facilities can also be considered demand management strategies as well, providing predictable travel times even during peak periods of high demand for highway capacity. HOV lanes can help influence travelers' behavior and provide them with additional choices of how, or if, to travel a certain route.

Currently there are five HOV facilities in the Washington region on highways functionally classified as freeways:

- I-66 in the Northern Virginia counties of Prince William, Fairfax, and Arlington (this HOV system includes a section of the Dulles Connector in McLean, connecting to VA 267's HOV lanes – see below);
- Virginia Route 267 (Dulles Toll Road), where operation of concurrent-flow HOV lanes began in December 1998, connecting to I-66 via the Dulles Connector; and,
- I-95/I-395 (Shirley Highway) in the Northern Virginia counties of Prince William, Fairfax, and Arlington, and the City of Alexandria,
- I-270 and the I-270 spur in Montgomery County, Maryland;
- U.S. 50 (John Hanson Highway) in Prince George's County, Maryland.

COG/TPB staff typically studies the performance of HOV facilities every three or four years during the AM and PM peak periods. The most recent data collected and analyzed along these five HOV corridors was in Spring 2010 and the results can be found in the *2014 Performance of Regional High Occupancy Vehicle Facilities on Freeways in the Washington Region*[147]. Major findings from that report are discussed in Section 2.6.2.
Following is a breakdown of each HOV facility in detail with statistics provided from the aforementioned HOV performance report.

3.3.1.2 I-66 (Custis Memorial Parkway)

[147] *2014 Performance of Regional High Occupancy Vehicle Facilities on Freeways in the Washington Region*, May 22, 2015. https://www.mwcog.org/uploads/committee-documents/ZF1WV1tc20150526151650.pdf

Interstate-66 was opened to traffic between the Capital Beltway (I-495) and Rosslyn, in Arlington County, in 1982. Initially the facility was restricted to HOV-4 traffic, meaning four occupants per vehicle. This was lowered to HOV-3 in late 1983 and to HOV-2 in March 1995. During the 1990s, I-66 outside the Beltway was expanded to include a concurrent-flow HOV lane to Virginia Route 234 (Business) in Prince William County just north of Manassas.

The I-66 HOV corridor consists of two distinct sections. One section is between the Capital Beltway (I-495) and Rosslyn. This segment of I-66 is restricted to HOV use only during the peak commute period of the peak direction, due to the large amount of traffic traveling inbound from Northern Virginia in the morning, and outbound from the District of Columbia in the evening. The other section, between Virginia Route 234 (Business) near Manassas and the Capital Beltway, is a concurrent-flow lane HOV facility. The entire HOV corridor is about 27 miles in length, about 9 miles inside the Beltway and 18 miles outside the Beltway.

I-66 is a key commuting corridor, as it connects the District of Columbia with the suburbs of Virginia and beyond. Direct access to employment centers in Washington, D.C. is provided via the Theodore Roosevelt Bridge over the Potomac River. Along the I-66 corridor there are also several Metrorail stations that many commuters drive to everyday. Some of these stations contain Park-and-Ride facilities that allow commuters to drive and connect to other modes, such as rail or bus.

There are changes planed for HOV operations on I-66 which are included in the 2016 CLRP. Inside the Beltway, in 2017, all lanes will become HOT-2 in the peak commute period of the peak direction. In 2020, outside the Beltway, the HOV-2 requirement will increase to HOV-3. In 2021, the new express toll lanes outside the Beltway are scheduled to open. Those lanes will be HOT-3 in both directions all day and I-66 inside the Beltway will become HOT-3 in both directions during the peak periods.

3.3.1.3 I-95/I-395 (Shirley Highway)

The Shirley Highway Corridor is one of the two corridors that provide direct access to the employment centers (the other is I-66). Therefore, understanding congestion on these corridors is crucial.

The HOV/express toll lanes lanes in this corridor are entirely barrier-separated, and reversible, so they accommodate heavy AM peak period northbound traffic and operate southbound in the P.M. peak period. The section inside the Beltway is HOV-3. Outside the Beltway, the HOV lanes have been expanded and converted into express toll lanes from the Prince William County Parkway to Edsall Road. (see Section 3.3.2)

Changes to I-95/I-395 are included in the 2016 CLRP. In 2019, the section of I-395 that is currently HOV-3 will convert to HOT-3. At the southern end of I-95, the extension of the express toll lanes to south of Garrisonville Road are expected to open in 2018 and the extension to VA-17 in Spotsylvania County is expected to open by 2025.

The corridor is also served by the Virginia Railway Express (VRE) Fredericksburg Line. The Metrorail Blue Line terminates in the corridor at Franconia-Springfield. Numerous bus lines serve the corridor, including Metrobus, the City of Alexandria's DASH, Fairfax Connector, PRTC OmniRide and private motor coach companies serving communities in Stafford and Spotsylvania Counties and the City of Fredericksburg.

3.3.1.4 VA 267 (Dulles Toll Road)

Concurrent flow HOV lanes operate along this corridor from a point between Sully Road (VA 28) and Centreville Road (VA 657) to just west of Leesburg Pike (VA 7). There are no HOV lanes through the interchanges at VA 7, the main toll plaza, Spring Hill Road (VA684), I-495 and VA 123. HOV restrictions apply to all lanes of the Dulles Connector road from east of VA 123 to I-66. Metro's Silver Line operates in the median of the Dulles Access Road. Fairfax Connector provides most transit bus service in the corridor, with the Loudoun County Commuter Express providing commuter bus service from Loudoun County to the Metro Core area (including stops in Rosslyn, Arlington County and downtown Washington, D.C.). WMATA operates the route 5A Metrobus service between Washington Dulles International Airport and the L'Enfant Plaza Metrorail station, with intermediate stops at the Herndon/Monroe Park and Ride, and the Rosslyn Metrorail station.

The HOV lanes require at least two persons per vehicle and the requirement is from 6:30A.M. to 9:00 A.M. and from 4:00 P.M. to 6:30 P. M.

3.3.1.5 I-270 HOV Facilities

In the southbound (A.M. peak) direction, the HOV concurrent-flow lane runs from I-370 near Gaithersburg south to the Rockville Pike/Capital Beltway interchange. There is also a concurrent flow HOV lane along the southbound lanes of the I-270 Spur. Together, the A.M. peak-flow direction lanes total about 11 miles in length. The Spur is just less than 2 miles long. In the northbound (P.M. peak) direction, concurrent-flow HOV lanes exist along the entire northbound I-270 Spur, and along I-270 from its southern terminus at I-495/Md. 355 to I-370 (the same sections of the corridor having HOV lanes southbound). Additionally, there are about 7.5 miles of HOV lane between I-370 and Maryland 121 near Clarksburg.

The Metro Red Line serves the I-270 corridor from Shady Grove (I-370), continues south to Bethesda, and on to the downtown area of the District of Columbia. The Mass Transit Administration's (MTA) MARC Brunswick Line also serves several stops in this corridor, and continues south to Silver Spring and on to Union Station in the District of Columbia. Montgomery County Ride On serves areas in the corridor north of I-370, and MTA coach service (between Hagerstown, Frederick and Shady Grove) use the HOV lanes. Express Metrobus service operates on the HOV lanes in the corridor between Bethesda and Gaithersburg.

3.3.1.6 US 50 HOV Facilities

Concurrent-flow HOV lanes operate in the U.S. 50 (John Hanson Highway) Corridor from just west of the Md. 704 Martin Luther King Highway interchange to east of the U.S. 301/Md. 3 interchange in Bowie. Unlike all other HOV lanes in the region, these lanes are HOV-2 restricted at all times (24 hours, 7 days) in both directions.

Buses operated the Washington Metropolitan Area Transit Authority (WMATA) and the Maryland Transit Administration (MTA) run on the U.S. 50 HOV lanes. To the east, the buses serve the City of Bowie in Prince George's County, and the Annapolis and Crofton areas of Anne Arundel County. All WMATA buses terminate at the New Carrollton rail station. Some MTA buses serve the downtown area of the District of Columbia, others terminate at New Carrollton.

3.3.2 Variably Priced Lanes/Systems

Variably Priced Lanes (VPLs), a demand management strategy, is one type of managed lanes where the pricing of roadways to helps reduce congestion and generates revenue for transportation projects. VPLs are an effective way to provide alternatives to travelers willing to pay for travel time reliability. There are several examples of managed lanes in the United States including SR-91 in Orange, California; I-95 in Miami, FL; and I-394 and I-35W in Minneapolis.

There are currently three VPL facilities in operation in the region.. All of these facilities are designed without toll booths. Drivers are required to have an E-ZPass transponder.

- *The Intercounty Connector (MD 200)* – a 6-lane, 18-mile east-west highway in Montgomery County and Prince George's County Maryland that will run between I-270/I-370 and I-95/US 1. The majority of the facility, from I-270/I-370 to I-95 opened in November 2011. The final segment from I-95 to US 1 opened on November 9, 2014. Toll rates vary by time of day. The toll rate for two-axle vehicles in the peak period ranges from $0.22-$0.35 per mile, off-peak from $0.17-$0.30 per mile, and overnight from $0.07-$0.30 per mile. [148] MTA operates four bus routes on the ICC: Gaithersburg to BWI, Gaithersburg to Fort Meade, Columbia to Bethesda, and Frederick to College Park. [149]

- *495 Express Lanes* – Fourteen miles of new high-occupancy toll (HOT) lanes (two in each direction) were constructed on I-495 between the Springfield Interchange and just north of the Dulles Toll Road. The lanes, operating under a public-private partnership between VDOT and Transurban (USA) Development, Inc., opened on November 17, 2012. The express lanes use dynamic pricing, updated approximately every 15 minutes, to ensure that travel remains free-flowing. Vehicles carrying two or fewer people can travel in the lanes if they pay the toll. Buses, carpools and vanpools with three or more people, and motorcycles can ride in the lanes for free. The 495 Express Lanes offer HOV-3 connections with I-95/395, I-66 and the Dulles Toll Road for the first time.

  According to the 495 and 95 Express Lanes Usage Update for July 2015 [150], there were 42,000 average workday trips in the June 2015 quarter, up from 35,000 in the June 2014 quarter, and 29,000 in the June 2013 quarter. The average dynamic toll charged during that quarter was $3.92. The average trip length was 5.6 miles. HOV-3 trips and exempt vehicles make up approximately 13% of all traffic..

  There were approximately 21,000 workday bus trips during the quarter. Omniride's Tysons Express from Woodbridge to Tysons Corner [151] and Fairfax Connector express bus service to Tysons from Lorton, Springfield, and Burke take advantage of the express lanes. [152].

- *95 Express Lanes (Northern Virginia)* – the 95 Express Lanes opened on December 14, 2014 creating approximately 29 miles of Express Lanes on I-95. [153] This project added capacity to the existing HOV Lanes from the Prince William Parkway to the vicinity of Edsall Road; improve the existing two HOV lanes for six miles from Route 234 to the Prince William Parkway. An eight-mile reversible two-lane extension of the existing HOV lanes from Dumfries to Garrisonville Road in Stafford County will help to alleviate the worst traffic bottleneck

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148 http://www.mdta.maryland.gov/ICC/Toll_Rates.html Accessed April 30, 2016
149 http://mta.maryland.gov/commuter-bus/ Accessed April 30, 2016
150 Transurban (USA) Operations, Inc. *495 and 95 Express Lanes Usage Update- July 2015.* https://www.expresslanes.com/uploads/1000/878-495_and_95_Express_Lanes_Usage_Update_July_2015_FINAL.pdf
151 http://www.prtctransit.org/commuter-bus/schedules/tysonscorner-am.html
152 https://www.expresslanes.com/ride-the-bus. Accessed April 30, 2016
153 https://www.washingtonpost.com/local/trafficandcommuting/whats-hot-whats-not-a-users-guide-to-virginias-new-95-express-lanes/2014/12/13/e0b996f4-7afb-11e4-9a27-6fdbc612bff8_story.html

in the region. [154]Vehicles carrying two people would have a choice to ride in the HOT lanes for a toll or travel in the regular lanes for free. According to the 495 and 95 Express Lanes Usage Update for July 2015 [155], the 95 Express Lanes had 45,000 average workday trips in the quarter ending in June 2015. The average dynamic toll charged was $5.48. The average trip length was 12.5 miles. HOV-3 trips and exempt vehicles make up approximately 32% of all traffic.

The TPB has had active interest in VPLs since June 2003 when the TPB, together with the Federal Highway Administration and the Maryland, Virginia, and District Department of Transportation, sponsored a successful one day conference on value pricing in the Washington region. After the conference, in Fall 2003, the TPB created a Task Force on Value Pricing to further examine and consider the subject. Under a grant from the Federal Highway Administration's Value Pricing Program, the TPB Value Pricing Task Force evaluated a regional network of variably priced lanes in the region producing a final report in February 2008. [156] The findings of the VPL study were used in the CLRP Aspirations Scenario Study and the newly adopted Regional Transportation Priorities Plan which are discussed in Chapter 5.

3.3.3 Traffic Management

The topic of Traffic Management, including Incident Management and Intelligent Transportation Systems (ITS) is considered under the Management, Operations, and Intelligent Transportation Systems (MOITS) Policy Task Force and MOITS Technical Subcommittee. MOITS advises the TPB on traffic management matters and provides a regional forum for coordination among TPB member agencies and other stakeholders on these topics.

Investments in operations-oriented strategies have time and again shown good benefit-cost ratios and best enable transportation agencies (for both highways and transit) to provide effective incident management and good customer service, through operations centers and staffs, motorist/safety service patrols, traffic signal optimization, and supporting technologies. Particularly, intersection improvements (signalization timing / geometrics) can provide cost efficient congestion reduction. Also, the Metropolitan Transportation Operations Coordination (MATOC) program, comprising DDOT, MDOT, VDOT, and WMATA, is a regional program to enhance the availability of real-time transportation information and strengthen coordination among transportation agencies.

3.3.3.1 Active Traffic Management (ATM)

As defined by FHWA, active traffic management is the "ability to dynamically manage recurrent and non-recurrent congestion based on prevailing and predicted traffic conditions." [157]

- VDOT's I-66 Active Traffic Management Project from the District of Columbia to Gainsville in Prince William County was brought online on September 16, 2015. [158] ATM components in the corridor will include expanded use of shoulder lanes, new lane control signals, expanded camera and dynamic message sign coverage, and upgrades to the ramp metering system.

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[154] http://www.vamegaprojects.com/about-megaprojects/i-95-hov-hot-lanes/ Accessed April 30, 2016.
[155] https://www.expresslanes.com/uploads/1000/878-495_and_95_Express_Lanes_Usage_Update_July_2015_FINAL.pdf
[156] *Evaluating a Network of Variably Priced Lanes for the Washington Metropolitan Region*, National Capital Region Transportation Planning Board, February 2008.
[157] http://ops.fhwa.dot.gov/atdm/approaches/atm.htm (Accessed June 7, 2016)
[158] http://www.virginiadot.org/newsroom/northern_virginia/2015/i-66_active_traffic_management85954.asp (accessed April 30, 2016)

- Montgomery County has an ATM system which includes strategies such a vehicle detection, video and aerial monitoring, and information outreach including broadcast media, internet,variable message signs, and Travelers Advisory Radio System (TARS). Future strategies will include variable speed limit signs, monitoring parking and weather/pavement sensors, and in-vehicle paging services.[159]
- In July 2012, VDOT issued an RFP to "operate, integrate, and innovate the state's Transportation Operations Centers (TOCs)." [160] One of the proposed outcomes of the project is to develop, implement, and operate a new state-wide ATM system platform across the five TOCs. The contract was award to Serco, Inc. in May 2013.

3.3.3.2 Incident Management

According to the Federal Highway Administration, an estimated 50% of congestion is associated with incidents such as crashes, disabled vehicles, and traffic associated with special events. If an incident disrupts traffic, it is important for congestion that normal flow resumes quickly.

Many successful incident management activities are part of the robust activities undertaken by the Washington region's transportation agencies. The region's state DOTs all pursue strategies for managing their transportation systems, including operation of 24/7 traffic management centers, roadway monitoring, service patrols, and communications interconnections among personnel and systems. All three focus on getting timely word out to the media and public on incidents. Local-level agencies also play an important role in transportation management, particular on local roads and traffic signal optimization.

Specific state-wide and regional incident management strategies include:

- ***Imaging / video for traffic monitoring and detection*** – help detect incidents and allow emergency vehicles to arrive quickly. Also helps travelers negotiate around incidents.
  - State and local DOTs have cameras for traffic monitoring and detection throughout the region. The Regional Integrated Transportation Information System (RITIS) provides a platform for participating agencies to share realtime data feeds and other pertinent information related to realtime situational awareness and incident management.[161]
- ***Service patrols*** – These specially equipped motor vehicles and trained staff help in clearing incidents off a roadway and navigating traffic safely around an incident.
  - MDOT/CHART is now providing 24/7 safety patrols for the Washington region.
  - VDOT and DDOT also provide service patrols
  - Montgomery County became the region's first local jurisdiction to deploy patrols in 2006, concentrating on major arterials rather than freeways.

- ***Road Weather Management*** – Can take the forms of information dissemination, response and treatment, monitoring, prediction, and traffic control.
  - All three state DOTs implement road weather management systems that disseminate information, treat roadways, and monitor conditions, especially during winter snow and ice events.

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- ***Traffic Management Centers (TMCs)*** – These centers collect and analyze traffic data, then disseminate data to the public. Data collection includes CCTVs, cameras, and detectors.

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[159] http://www.montgomerycountymd.gov/DOT-TMC/ATMS/gettmc.html (Accessed April 30, 2016)
[160] http://www.virginiadot.org/business/transportation_operations_centers.asp (Accessed April 30, 2016)
[161] http://i95coalition.org/projects/regional-integrated-transportation-information-system-ritis/

- All three state DOTs have TMCs:
  - *VDOT's McConnell Public Safety Transportation Operation Center (MPSTOC)* operates Northern Region Transportation Operations Center (TOC) and Signal System. The TOC monitors traffic and incidents by using cameras and other information-gathering mechanisms to better manage day-to-day traffic flow and large incidents.
  - *DDOT's Transportation Management Center* gathers and disseminates information to the public using a network of cameras and other devices.
  - *MDOT's Coordinated Highway Action Response Team (CHART)* collects traffic data, disseminates information to the public, and provides emergency motorist assistance.

- ***Curve Speed Warning Systems*** - use roadside detectors and electronic warning signs to warn drivers, typically those in commercial trucks and other heavy vehicles, of potentially dangerous speeds in approach to curves on highways, with the intention of preventing incidents.
  - Curve speed warning systems have been used on the Capital Beltway.

- ***Work zone management*** - uses traffic workers, signs, and temporary road blockers to direct and control traffic during construction activities.
  - All three state DOTs have work zone management programs to temporary implement traffic management and direct traffic. The goal is to reduce incidents by controlling the flow, speed, and direction of traffic.

- ***Automated truck rollover systems*** - detectors deployed on ramps to warn truck drivers if they are about to exceed their rollover threshold, thus helping to reduce incidents.
  - Automated truck rollover systems, similar to the curve speed warning systems, were implemented at the same locations on the Capital Beltway in Virginia and Maryland. This was in response to a high number of truck rollovers on the Beltway in the 1980's.

Studies have shown the impact incident management activities have on reducing congestion, in particular reducing duration of incidents and reducing chances for secondary incidents. An example of this type of study is the yearly analysis of impacts of the Coordinated Highway Action Response Team (CHART) on incident management in Maryland. The focus of the report is to gauge effectiveness of CHART's availability to detect and manage incidents on major freeways and highways.

The *Performance Evaluation and Benefit Analysis for CHART in Year 2012* [162] includes statistics and analysis such as:

- Distribution of incidents an disabled vehicles
  - By day and time
  - By road and location
  - By lane blockage type
  - By blockage duration
  - By nature of incident (accident, disabled vehicle, etc.)

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[162] Chang, G.L & M. Raqib. Performance Evaluation and Benefit Analysis for CHART in Year 2012 (Final Report). http://chartinput.umd.edu/reports/CHART_2012_final.pdf

- Comparison of current year's data with that of previous years
- Benefits from CHART's incident management
    - Assistance to drivers
    - Potential reduction in secondary incidents
    - Estimated benefits due to efficient removal of stationary vehicles
    - Direct benefits to highway users

Analysis and studies such as those conducted by CHART indicate that incident management activities do have a positive impact on congestion. Each minute of reduced duration of incidents, for example, reduces the chances of secondary incidents and has a concomitant reduction in the severity and duration of non-recurring congestion. It is estimated that 218 potential secondary incidents were avoided in 2012 due to shortened incident duration. The 2012 analysis of CHART shows the decrease in incident duration with SHA patrol:

- Duration averaged 22 minutes with SHA patrol, compared to 29 minutes without.
- For incidents blocking the shoulder only, duration averaged 18 minutes with SHA patrol, compared to 28 minutes without.
- For incidents blocking one lane, duration averaged 20 minutes with SHA patrol, compared to 26 minutes without.
- For incidents blocking two lanes, duration averaged 33 minutes with SHA patrol, compared to 40 minutes without.
- For incidents blocking three lanes, duration averaged 43 minutes with SHA patrol, compared to 46 minutes without.

It was estimated that in 2012, 429 potential lane-changing collisions were avoided due to the CHART program. Even a relatively simple activity such as a service patrol assisting a motorist with a flat tire, or one who is out of fuel, might prevent a congestion-inducing crash. Continuing enhancement and investment of incident management activities will support congestion management.

3.3.3.3 Traffic Signal Operations

Traffic Signal Optimization

Under the guidance of the TPB's Traffic Signals Subcommittee, TPB staff conducted a survey of signal timing throughout the region during April/May 2013. There are 21 different agencies that have ownership and/or maintenance responsibilities for the approximately 5,500 signals on public roads in the region. The survey found that an estimated 76% of the eligible traffic signals had been retimed within the past three years, which is a generally accepted guideline. The signals in the region use a variety of retiming methods including computer optimization, engineering judgment, and active management.[163]

DDOT has a comprehensive 5-year plan underway to improve the flow of traffic in the region, including signal timing, and impacts all 1600 traffic signals in the District of Columbia.[164] The project is expected to be complete in 2016. In Anacostia, one of the completed areas, DDOT reports a 13% network-wide travel time savings over all peak periods, a 34% reduction in delays, and a 23% reduction in stops. In

[163] http://www.mwcog.org/uploads/committee-documents/al1ZXFpb20140212133426.pdf
[164] http://ddotdish.com/2013/10/08/signal-optimization-and-improving-traffic-flow-in-the-district/

the downtown area, DDOT reports travel time savings for motorized vehicles during all periods, and reduced stopping for bicycles in the Pennsylvania separated bike lanes. [165]

Advanced Traffic Signal Systems

Advanced Traffic Signal Systems are used for coordination of traffic signal operations in a jurisdiction, or between jurisdictions using detectors to monitor real-time traffic conditions. This is important to congestion, as it reduces delay and improves travel time. It can include active traffic signal management – where traffic signals are managed through a control center, where technicians adjust the length of signal phases based on prevailing traffic conditions – or adaptive signal control – in which the controller automatically adjusts the timing of signals to accommodate changing traffic patterns.

- VDOT actively optimizes traffic signal timing plans and launched a signal/arterial traffic management control center located adjacent to the MPSTOC operating floor to proactively manage the arterial traffic.

- The City of Alexandria has implemented an adaptive traffic signal control system along Duke Street. The system can adapt to real-time traffic situations by changing cycle lengths as traffic flows change while keeping the corridor synchronized.

Traffic Signal Timing

Traffic signal timing plans adjust traffic signals during an incident, during inclement weather, or to improve transit performance. The overall objective is to reduce backups at traffic signals and to increase the level of service.

3.3.3.4 Regional Operations Coordination

Metropolitan Area Transportation Operations Coordination (MATOC)

The Metropolitan Area Transportation Operations Coordination (MATOC) Program is a coordinated partnership between transportation agencies in D.C., Maryland, and Virginia that aims to improve safety and mobility in the region through information sharing, planning, and coordination. Current agencies include the District of Columbia, Maryland, and Virginia Departments of Transportation along with County and City transportation departments and transit providers like WMATA and other local providers. For example, a recent review of the MATOC program showed that coordination between the MATOC family of agencies during a bus crash on I-66 resulted in a savings of over $382,000 for area commuters. This savings was a result of decreased emissions, fuel consumption and lost time. [166]

A benefit-cost study of the MATOC program was undertaken and the results were based on three incidents that were handled by MATOC. The benefit-cost study looked at travelers "modified trips" - trips made at a later time, on another route, by another mode, or not made due to regionally significant incidents. Benefits were estimated from reduced delay, fuel consumption, emissions (including greenhouse gases), and secondary incidents. Three case studies were conducted, two for freeway

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[165] DDOT, District of Columbia Traffic Signal Timing Optimization Status Update, Presented to the TPB Traffic Signals Subcommittee, June 23 2015. http://www.mwcog.org/uploads/committee-documents/b1xfW19X20150910085448.pdf

[166] www.matoc.org

incidents and one for arterial incident. The study found an overall benefit/cost ratio conservatively estimated at 10 to 1. A summary report of this study called the MATOC Benefit Cost Analysis dated June 2010 is available. MATOC also maintains a public use website called Traffic View which can be accessed at www.trafficview.org which uses the RITIS traffic information to inform the public about regional incidents.

MATOC has undertaken two new initiatives. The first, the MATOC Severe Weather Mobilization Coordination Effort, began during the winter of 2012-2013. This effort has led to "the development of consistent terminology to describe roadway and transit conditions throughout the region, protocols for sharing weather information from different agency-specific sources and detection systems, testing of coordinated messaging systems, and better ways to advise the overall regional winter storm decision-making process." [167] The second, the Regional Construction and Work Zone Coordination Study, was activated in 2014 to develop a framework for regional coordination around major construction projects as well as regional work zone-related lane closures.

3.3.3.5 Intelligent Transportation Systems (ITS)

ITS strategies can be defined as electronic technologies and communication devices aimed at monitoring traffic flow, detecting incidents, and providing information to the public and emergency systems on what is happening on our roadways and transit communities. Much of what is done with ITS helps in reducing non-recurring and incident-related congestion.

- ***Electronic Payment Systems*** - These systems can make transit use more convenient by allowing a user to pay for bus, rail, park-and-ride lots, and other transit services with one card. Convenience an appealing factor, and helps increase transit ridership and transfers among different transit modes.
    - SmarTrip cards are used for rail and bus fares (both WMATA and local buses) and for WMATA parking facilities. WMATA discontinued use of paper farecards on March 6, 2016. [168]
    - The region's roadway toll agencies are part of the E-ZPass consortium electronic payment system. The ICC and the 495 and 95 Express Lanes are E-ZPass-only facilities (no toll booths).
    - TransIT (Frederick County) released phone app for payment of TransIT fares. [169].

- ***Freeway Ramp Metering*** - Traffic signals on freeway ramps that alternate between red and green to control the flow of vehicles entering the freeway. This prevents incidents that may occur from vehicles entering the freeway too quickly, and also prevents a backup of traffic on the on-ramp.
    - Ramp meters are used inside the Capital Beltway (I-495) in Virginia on I-66 and I-395.

- ***Automated Enforcement (e.g. red light cameras)*** - Still or video cameras that monitor things such as speed, ramp metering, and the running of red lights, to name a few. They are important to preventing non-recurring and incident related congestion.
    - In the Washington region, the legal ability to deploy these systems is in place in the District of Columbia and Maryland, and pending in Virginia.

[167] http://www.regionforward.org/improving-metro-dcs-transportation-coordination-preparedness-after-snowstorm-produced-nightmare-commutes
[168] http://www.wmata.com/fares/paperless.cfm
[169] https://frederickcountymd.gov/5906/Mobile-App

- ***Reversible Lanes*** - Traffic sensors and lane control signs reverse the flow of traffic and allow travel in the peak direction during rush hours. This is important to alleviating congestion that may occur in one direction during a peak hour. Examples of reversible lanes include Rock Creek Parkway in the District and Colesville Rd./US29 in Maryland.

3.3.3.6 Connected Vehicles

According to FHWA, connected vehicle research has the potential to transform travel by identifying threats and hazards on the roadway and communicating this information over wireless networks to give drivers alerts and warnings. This communication includes communications between vehicles, and communications between infrastructure or handheld devices and vehicles.[170]

VDOT has been active in connected vehicle planning for many years and has been the lead state for the Connected Vehicle Pooled Fund Study. VDOT's FY 2016 Business Plan calls for the development of a Statewide Connected Vehicle Program Plan to "maximize the safety and operational benefits of these emerging technologies." The expected outcomes are:

- A clear vision of the future state of connected vehicle technologies
- Impact of that vision on transportation in the Commonwealth
- Identification of strategies that VDOT will undertake to leverage connected vehicle technologies
- Improve readiness to address changes in the CV industry, such as proposed federal rulemaking and advances in private sector connected vehicle products and services. [171]

3.4 Integrative/Multi-Modal Strategies

3.4.1 Advanced Traveler Information Systems (ATIS)

ATIS are technology-based means of compiling and disseminating transportation systems information on a real-time or near-real-time basis prior to or during tripmaking. The prevalence of smartphones and other mobile internet-capable devices make real-time information more accessible to travelers.

- Virginia operates under a statewide 511 system via telephone, internet (http://www.511virginia.org/), and mobile app.
- The District of Columbia makes traffic information, including live traffic cameras, traffic alerts, and street closures, available on the DDOT website.
- Maryland provides live traffic information on traffic and incidents via the CHART website the MD 511 Interactive Voice Response (IVR) System and Website.
- Dynamic Message Signs (DMS) are used throughout the region including permanently installed signs on freeways and portable signs used on both freeways and arterials.
- WMATA provides real-time transit information (both bus and rail) on the web and on informational screens in the Metrorail stations.
- Real-time bus information is available for many of the region's bus systems (including Montgomery, Arlington, and Prince George's Counties and the City of Fairfax).

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[170] http://ops.fhwa.dot.gov/travelinfo/infostructure/aboutinfo.htm (Accessed June 7, 2016)

[171] http://www.virginiadot.org/projects/resources/2016PlanningProgramming/6_VDOT's_Connected_Vehicle_Program_Plan.pdf
http://www.virginiadot.org/projects/resources/2016PlanningProgramming/6_VDOT's_Connected_Vehicle_Program_Plan.pdf

- TPB is overseeing a TIGER project for Real Time Passenger Information (RTPI). There are 225 proposed locations for electrified signs at bus shelters in nine corridors throughout the region. .
- The MATOC website has links to all three state's traffic information. In addition, there is a link provided to the Traffic View website (www.trafficview.org) which aggregates traveler information including incidents, traffic camera feeds, construction activity and schedules, and variable message sign information for the region.
- Capital Region Updates (CapitalRegionUpdates.gov) was established to be a "one-stop-;shop" where residents can get information during emergencies including real-time news and traffic and transit information. [172]

3.4.2 Bus Priority Systems

Bus priority systems are sensors used to detect approaching transit vehicles and alter signal timings to improve transit performance. For example, some systems extend the duration of green signals for public transportation vehicles when necessary. This is important because improved transit performance, including more reliable arrival times for buses, makes public transit a more appealing option for travelers.

- Montgomery County has co-located traffic management and transit dispatch which enables adjustment of signals (by the centralized signal operations center) if deemed necessary for transit.

- The region, led by TPB, was awarded a $58 million federal Transportation Investment Generating Economic Recovery (TIGER) grant for developing a priority bus corridors network (Figure 66). A total of 13 priority bus corridors are funded in DC, Maryland and Virginia, and one transit center, Takoma/Langley Transit Center, is funded in Maryland. Bus priority improvements include running buses on dedicated lanes, adding queue jump lanes for buses, implementing transit signal priority, and improving bus stops. This regional priority bus network is anticipated to be complete in 2016.

- In September 2013, the TPB released an Assessment of the Feasibility of Bus on Shoulders (BOS) at Select Locations in the National Capital Region. [173] This report presented the findings of the Bus on Shoulder Task Force was formed in in July 2012 to "identify promising locations in the region to operate buses on the shoulders of highways." Three corridors, MD 5/US 301, I-270, and I-66 inside the Beltway, were selected for detailed study which included existing bus service, traffic congestion, and shoulder conditions. VDOT began a one-year pilot BOS operation on I-66 in March 2015. [174]

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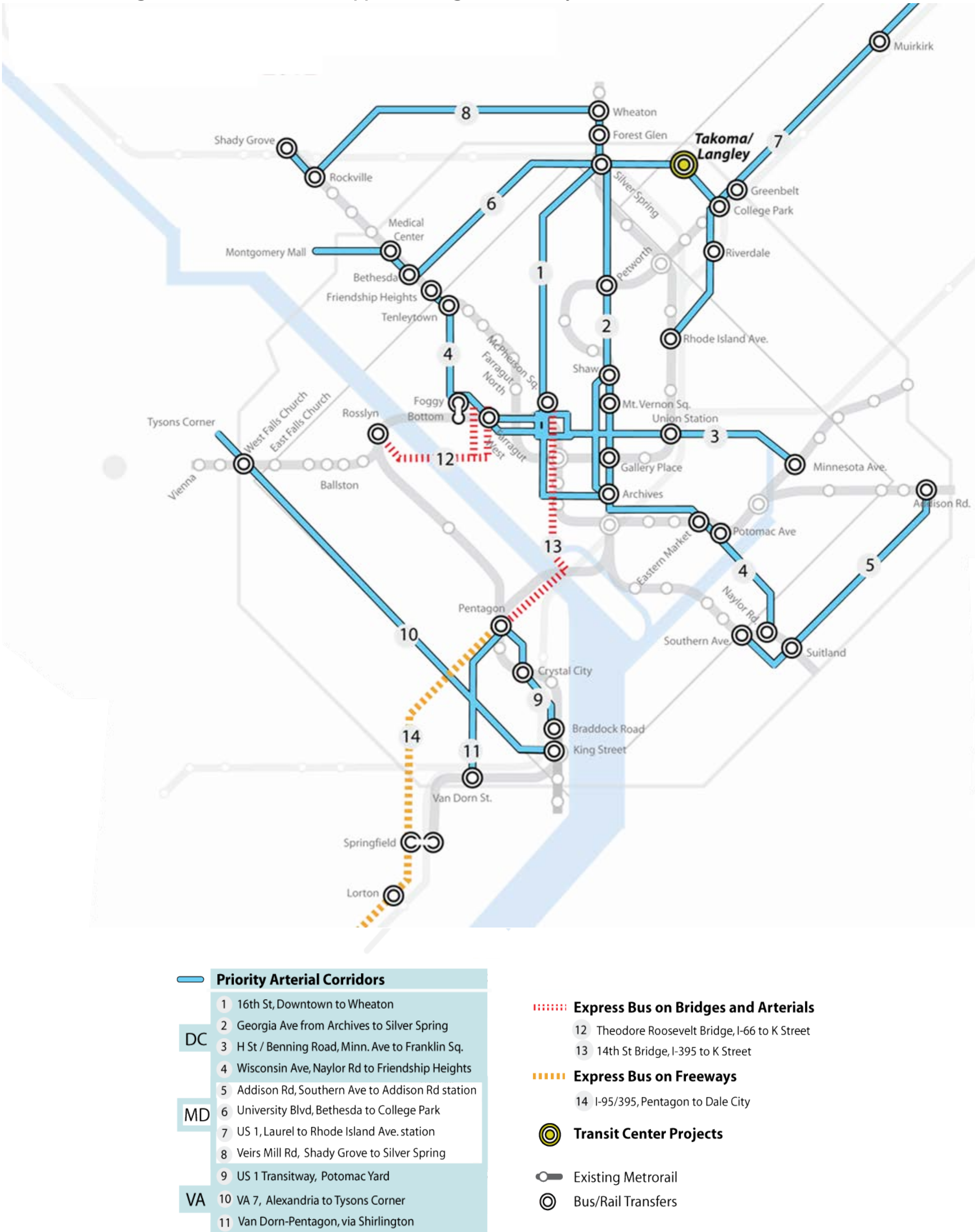
172 http://www.mwcog.org/news/press/detail.asp?NEWS_ID=555
173 https://www.mwcog.org/uploads/committee-documents/bV1aWlxd20130926085957.pdf
174 *http://www.virginiadot.org/projects/northernvirginia/66_bos.asp*

Figure 66: TIGER Grant Supported Regional Priority Bus Network and Transit Center



3.4.3 Regional ITS Architecture

The TPB has developed a regional ITS architecture, the Metropolitan Washington Regional Intelligent Transportation Systems Architecture (MWRITSA)[175]. The Regional Architecture is intended to provide a regional ITS framework for the foreseeable future, to define and validate ITS operations of regional significance, and to address national and statewide conformity in accordance with federal law and guidance. The architecture aims to ensure knowledge of ITS operations across the region, encouraging appropriate systems integration and enhanced technical systems interoperability. In addition to describing the interrelationships among existing transportation technology systems, the MWRITSA can provide a starting point for identifying responsibility for ITS Projects and applicable standards. It can inform business cases for state and federal ITS investment in transportation improvement programs as well as other plans, programs, and projects. The three DOTs have worked collaboratively to bring consistency among their regional ITS architectures. The Regional Architecture is updated periodically to reflect changes in the region and is currently under revision.[176]

3.4.4 Integrated Corridor Management (ICM)

New technologies and concepts have been tested nationally or internationally to integrate operations to manage total corridor capacity including freeways, arterials, bus, rail, and parking systems. The purposes of the initiative include identifying innovative technologies to facilitate multi-modal local, regional, and national corridor travel, and identifying tools to provide information to travelers related to travel times and parking.

- VDOT's has an ICM project on the I-95 and US-1 corridor from the DC line to Fredericksburg. VDOT launched the first ICM initiative on the corridor in February 2014. The 511 website and mobile app now have a link for the I-95/395 corridor where users can see:
  - Current travel times in HOV Lanes versus general purpose lanes
  - Park-and-ride locations and number of spaces available
  - Real-time VRE travel information
  - PRTC bus schedules and stop locations
  - HOV lane open/closed status [177]

- VDOT received a grant in 2015 from FHWA to study ICM in Norther Virginia's East-West Corridor. As part of the 20-month project, a Concept of Operations and Deployment Plan will be developed. The project will include collaboration among partner agencies and engage stakeholders across the study area.[178]

3.4.5 Evaluating Significant Transportation Projects (Virginia)

In September 2013, VDOT and its partners initiated a study to evaluate and rate at least 25 significant transportation projects in Northern Virginia. This study, which was mandated by legislation passed by the Virginia General Assembly in 2012, requires the consideration of operations in capital program.

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[175] The Metropolitan Washington Regional Intelligent Transportation Systems Architecture. http://www.mwcog.org/itsarch/Home.htm

[176] http://www.mwcog.org/itsarch/

[177] http://www.95expresslanes.com/uploads/1000/433-VDOT_LAUNCHES_NEW_NORTHERN_VIRGINIA_COMMUTER_TOOLS_ON_511.pdf

[178] McElwain, Amy, "Northern Virginia's Current Integrated Corridor Management Planning Effort for the East-West Travel Shed." Presentation to the TPB's Management, Operations, and Intelligent Transportation Systems Subcommittee, April 13, 2016.

More specifically, the projects will be evaluated based on the expected ability to reduce congestion and in prove regional mobility. [179]

3.4.6 Mobile Devices and Social Media

3.4.6.1 Mobile Devices

The increasing number of people with mobile internet-capable devices, such as smartphones and tablets, combined with the availability of real-time travel data, is changing the way travelers receive information and make decisions on their choice of mode, route, and/or departure time. Most travelers now carry a mobile device with maps and GPS allowing for information to be tailored to their location. DOTs, transit agencies, private transportation providers, and other third parties have developed mobile versions of websites and mobile applications (apps) to make it easier for travelers to receive information on their devices.

- Both Maryland 511 and Virginia 511 provide a mobile version of their website. Commuters can sign up to get email and text alerts about travel time and incident information on preferred routes.
- WMATA provides real-time rail arrivals on the mobile version of its website.
- Many bus operators make real-time arrival information and/or static schedules available on their mobile websites and/or make data available to third party websites and applications. NextBus is one of the most popular bus information apps.
- MARC provides real time incident and delay alerts through text, and email to commuters. The MARCTracker website provides live GPS train locations.
- Capital Bikeshare,carshare, (ZipCar, Car2Go, and Enterprise), and ridehailing (Uber, Lyft) companies have mobile apps which allow users to make travel decision on the spot.
- Traffic information, based on data sources such as INRIX, is available through a number of apps (INRIX, Google Maps, and WAZE being among some of the most popular. See Section 3.4.6.2 for more information about WAZE.)
- Wireless Emergency Alerts (WEA) are sent by authorized government alerting authorities. These alerts can contain information that is valuable to the traveling public such as extreme weather warnings and local emergencies requiring evacuation or other immediate action. [180]
- Commuter Connections released a mobile version of its website, a mobile app, [181] and is developing a dynamic ridesharing app. [182]

Safety while using the devices while traveling remains a concern; all three states have laws against distracted driving and texting while driving.

3.4.6.2 Social Media

The traveling public is now oriented toward the use of social media for many aspects of their lives. The social media landscape is constantly evolving and it is causing the transportation sector to rethink its model for providing information. Transportation agencies in the region have adopted social media as

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[179] *Evaluation of Significant Transportation Projects in Northern Virginia Transportation District Fact Sheet* Fall 2013 http://www.virginiadot.org/projects/resources/NorthernVirginia/Significant_Projects_-_Fact_Sheet.pdf
[180] http://www.nws.noaa.gov/com/weatherreadynation/wea.html#. Accessed June 7, 2016.
[181] http://www.commuterconnections.org/wp-content/uploads/CommuterConnectionsLaunchesMobileApps.pdf
[182] https://www.mwcog.org/uploads/committee-documents/alxeWFxZ20160311091245.pdf

a means of sharing information with a large segment of the public. Instead of providing information only on a central website that the user has to visit, social media provides a way to deliver that information to users through a forum to which they already subscribe, such as Twitter which is one of the most popular social media sites for the transportation sector. In addition, social media can provide a means for agencies to receive information from users in order to better manage the system.

- MDOT, VDOT, and DDOT all use Twitter to share information.
- Local police departments user Twitter to provide preliminary information and updates on active incidents.
- WMATA uses four different Twitter accounts to share general information, Metrorail information, Metrobus information, and crime prevention tips. Supplemental two-way customer support is provided on the Metrorail and Metrobus feeds from 7 a.m. to 6 p.m.[183]
- WAZE[184] is a community-based traffic and navigation app. WAZE goes beyond other apps that provide traffic data by providing a crowdsourcing component. Users can passively contribute to providing traffic information by having the mobile app open while driving. They can also contribute by sharing information about incidents and other travel conditions.
    - DDOT joined WAZE's Connected Citizens program in 2015 which establishes a two-way partnership for data-sharing.[185]
- MATOC users its own Twitter account to provide updates on incidents. It follows other twitter feeds (including police departments, local jurisdictions, transit agencies, news organizations, etc.) and crowdsourcing websites like WAZE to obtain more timely and accurate information about incidents.

3.4.7 Traffic Management Activities Associated with Defense Base Closure and Realignment Commission (BRAC) Actions

3.4.7.1 Walter Reed

The Walter Reed National Military Medical Center (WRNMMC) is located at 8901 Rockville Pike in Bethesda, Montgomery County. The facility occupies most of the east side of Rockville Pike (MD 355) between Jones Bridge Road and Cedar Lane. Under the BRAC action, this facility represents the absorption of the former Walter Reed Army Medical Center, an Army facility located at 6900 Georgia Avenue, NW in the District of Columbia (now closed), into the Bethesda site previously called the National Naval Medical Center. The Uniformed Services University of Health Sciences (USUHS) is located on the WRNMMC site.

Employment at the site has increased from about 8,000 in 2008 to about 10,200 in 2012. According to the Walter Reed Web site, about 23% of employees "utilize environmentally-friendly transportation modes to come to work each day." A new pedestrian tunnel under Rockville Pike linking the site to the Medical Center stop on the Metrorail Red Line and new elevators from near the hospital entrance to the Metro platform are scheduled for completion by September 2017.[186] Additionally, the Maryland State Highway Administration and Montgomery County Department of Transportation are undertaking major intersection improvements at the intersections of Rockville Pike and Cedar Lane / West Cedar Lane (construction underway), Old Georgetown Road and West Cedar Lane (construction underway), and Connecticut Avenue (MD 185) at Jones Bridge Road (construction on the third phase is expected

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[183] http://www.wmata.com/rider_tools/metro_service_status/connect_with_twitter.cfm (Accessed May 10, 2016).
[184] https://www.waze.com/about (Accessed May 10, 2016).
[185] http://ddot.dc.gov/release/ddot-joins-waze-connected-citizens-program
[186] http://www.montgomerycountymd.gov/dot-dte/projects/355Underpass/index.html (Accessed June 6, 2016

to begin in Spring 2018).[187] For years, these three intersections have consistently been among the most congested in the County. Smaller scale improvements are also being / have been implemented at other intersections along the roads adjacent to the site.

3.4.7.2 Mark Center

The Mark Center (also known as BRAC-133) is located at the southwest quadrant of the interchange of I-395 and Seminary Road in the City of Alexandria. Access to the site is via Mark Center Avenue, which intersects Seminary Road, and Mark Center Drive, which intersects North Beauregard Street. Approximately 6,400 jobs were moved to Mark Center. Adjacent is the Institute for Defense Analysis, which houses about 600 employees. A report with monthly traffic monitoring conducted between August 2011 and November 2013 was released in March 2014.[188]

A new transit bus station with five bus bays, which accommodates service from WMATA Metrobus, Alexandria DASH and private providers was built a short walk from the Mark Center. The Beauregard corridor was one of three corridors studies by the City for high-capacity transit service.[189] The Virginia Department of Transportation (VDOT) is building a new reversible ramp from the I-395 High Occupancy Vehicle (HOV) lanes to enable direct access from those lanes to Seminary Road during the morning peak commute period, and from Seminary Road to the HOV lanes in the afternoon commute period. These lanes are limited to HOV-3 (three-person car-pools, van-pools, buses and motorcycles) while in northbound operation from 6:00 AM to 9:00 AM and southbound from 3:30 PM to 6:00 PM. The ramp opened to traffic in January 2016.[190]

3.4.7.3 Fort Belvoir

Fort Belvoir is located along Richmond Highway (US 1) and I-95 in Fairfax County. It consists of two separate sites, the larger main post (located on the east and west sides of U.S. 1 south of Mount Vernon Highway (VA 235) and the smaller Fort Belvoir North area (the former Engineer Proving Ground), generally bounded by I-95, the Fairfax County Parkway (VA 286) and the neighborhoods just south of the Franconia-Springfield Parkway (VA 289). The National Geospatial Agency (NGA) is the primary tenant at Fort Belvoir North, while the main post hosts a number of Army functions.

In 2006, there were about 23,300 jobs at Fort Belvoir and Fort Belvoir North. As of 2011, there were about 36,400 jobs on the two sites (there will be additional off-base jobs which are not included in this total).

Transportation improvements in the area include:

- Completion of the final section of VA 286 between Newington and VA 289, including a new interchange on the west side of Fort Belvoir North at Barta Road
- A new ramp from the I-95 Express Lanes (HOV-3 restricted during peak commute times) to Heller Road on Fort Belvoir North

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[187] http://apps.roads.maryland.gov/WebProjectLifeCycle/ProjectSchedule.aspx?projectno=MO5932125 (12/23/2015 Status Update, Accessed June 6, 2016)

[188] http://www.vamegaprojects.com/tasks/sites/default/assets/File/pdf/BRAC/MarkCenter/Mark_Center_Traffic_Monitoring_Revised_Final_Report_032014.pdf

[189] Transitway Corridor Feasibility Study Corridor C (Van Dorn / Beauregard) Recommendation by High Capacity Transit Corridor Work Group https://www.alexandriava.gov/uploadedFiles/tes/info/2011-05-19_CWG%20Motion%20on%20Corridor%20C%284%29.pdf

[190] http://www.virginiadot.org/projects/northernvirginia/i-395_hov-transit_ramp.asp (Accessed June 6, 2016)

- Widening US 1 from four to six lanes from VA 611 to VA 235. The projects will also include the addition of left and right turn lanes at intersections and connecting roadways, and provision of a multi-use trail, pedestrian sidewalk, and on-road bicycle accommodations. Construction is scheduled to be completed in late 2016. [191]

3.5 Additional System Capacity

3.5.1 Documentation of Congestion Management for Additional System Capacity

Federal regulations state that any project proposing an increase in Single-Occupant Vehicle Capacity should show that congestion management strategies have been considered. The specific language from the Federal Rule states that Transportation Management Areas (TMAs) shall provide for:

"an appropriate analysis of reasonable (including multimodal) travel demand reduction and operational management strategies for the corridor in which a project that will result in a significant increase in SOVs is proposed to be advanced with Federal Funds. If the analysis demonstrates that travel demand reduction and operational management strategies cannot fully satisfy the need for additional capacity in the corridor, and additional SOV capacity is warranted, then the congestion management process shall identify all reasonable strategies to managed the SOV facility safely and effectively."

In the Washington region, the TPB is ensuring that all proposed SOV capacity increasing projects (except those which are exempt) show that congestion management strategies have been considered to effectively manage the additional capacity. This is being done with agencies completing a "CMP Documentation Form" when submitting a proposal for projects in the long-range plan and Transportation Improvement Program (TIP).

A sample CMP documentation form was developed to provide guidance to agencies completing these forms [192] (Appendix F). Agencies completing these forms are able to cite various ongoing strategies in the region, local jurisdiction, and corridor in the vicinity of their project.

3.5.2 Where Additional System Capacity Is Needed and How the Additional System Capacity Will be Managed Efficiently

The CLRP, updated regularly, identifies where major roadway capacity expansions are planned. The TPB, through the CLRP, asks that congestion management strategies be considered for these capacity increases. In the Washington region, all proposed SOV capacity increasing projects (except those which are exempt), show that congestion management strategies have been considered to effectively manage the additional capacity. These types of strategies could be of demand or operational management, or both, as outlined in this report. Many of these strategies are considered before any capacity-increasing project is adopted.

The CLRP, through the CMP, strongly encourages consideration and implementation of strategies such as the following to manage both existing and future additional roadway capacity:

- Transportation Demand Management (TDM) strategies, such as Commuter Connections programs.
- Traffic Operational Improvements

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[191] http://rte1ftbelvoir.com/project-schedule/ (Accessed June 6, 2016)
[192] TPB, *Call for Projects for the 2013 CLRP and FY 2013-2018*, Approved on October 17, 2012. http://www.mwcog.org/clrp/resources/2013/Call_for_Projects.pdf

- Public Transportation Improvements
- Intelligent Transportation Systems technologies
- Combinations of the above strategies.

Roadway capacity increases may be needed in specific locations for a number of reasons including bottleneck removal, safety improvements, economic development, and other reasons. Managing this capacity through the CMP is key.

3.6 Project-Related Congestion Management

In recent years, the Washington region has successfully implemented project-related congestion management for major construction projects. Strategies include providing incentives for commuters to give up driving alone and try transit, carpooling, vanpooling, and other alternatives, disseminating more information about construction projects and congestion, improving alternative routes, providing fire and rescue equipment and staff for emergency services along with additional police services, adding additional spaces to park-and-ride lots, providing additional shuttle bus services, etc.

Some successful examples of implementing project-related congestion management during construction include the Woodrow Wilson Bridge project, the I-95/I-495 Springfield Interchange project and the South Capitol Street project.

Ongoing major construction projects continue the practice of implementing project-related congestion management. Examples are DDOT 11th Street Bridge project and Northern Virginia Megaprojects.

11th Street Bridges Project

During the construction phases of the DDOT 11th Street Bridge project, which was completed in September 2015, [193] several congestion management approaches were considered and the following was implemented to mitigate congestion and keep traffic moving:

- Maintain three lanes of traffic in each direction across the river;
- Provide additional transit enhancements during peak traffic periods;
- Provide traveler information systems, including low power highway advisory radio, and Intelligent Transportation Systems, including real-time message signs with alternate route suggestions;
- Provide updated freeway guide signing within the immediate project area that reflects temporary access routes during the various phases of construction. Also provide way-finding signage for freeway access points on local roads in the project study area; and event management systems, such as roving tow services.

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193 https://www.anacostiawaterfront.org/awi-transportation-projects/11th-street-bridge/

Northern Virginia Megaprojects

Northern Virginia Megaprojects[194] are a series of large-scale and simultaneous transportation improvements aimed to ease congestion and provide alternatives to travelers. The projects currently underway include 95 Express Lanes, I-95 Auxiliary and Shoulder Improvements, Dulles Metrorail and BRAC Projects.

In 2007, the Virginia Department of Transportation (VDOT) began a new program of congestion management during the construction of megaprojects. The megaproject-related congestion management provides both "Commuter Solutions" and "Employer Solutions".

"Commuter Solutions" include resources on teleworking, vanpooling, carpooling, Guaranteed Ride Home, and walking/bicycling.

"Employer Solutions" provides assistance to employers to help them create new approaches or enhance existing services to keep their employees moving during construction.

SafeTrack

WMATA's SafeTrack is an accelerated track work plan to address safety recommendations and rehabilitate the Metrorail system to improve safety and reliability. The plan condenses approximately three years' worth of work into one year and is doing so by extending maintenance time by expanding maintenance time on weeknights, weekends, and middays periods as well as 15 "Safety Surges" which will be long duration track outages beginning in June 2016 for major projects in key parts of the system.[195]

As of the time of this report, the SafeTrack work plan was just beginning and travel demand management plans had not been finalized. The next CMP Technical Report will discuss the travel impacts of SafeTrack and the travel demand management strategies that were put into place.

194 http://www.vamegaprojects.com/ Accessed June 7, 2016
195 http://www.wmata.com/rail/safetrack.cfm Accessed June 7, 2016

4. STUDIES OF CONGESTION MANAGEMENT STRATEGIES

Defining, analyzing and assessing congestion management strategies are important components of the CMP. This chapter reviews performance measures adopted by the TPB and its subcommittees and the effectiveness of demand and operational management strategies. Several important studies of strategies are also documented in this chapter as examples.

4.1 Review of Performance Measures

4.1.1 Introduction to Performance Measures

A performance measure, or indicator, is a means to gauge and understand the usage of a transportation facility, or the characteristics of particular travelers and their trips. The performance measure/indicator may refer to a particular location or “link” of the transportation system.

Performance measures can be either quantitative or qualitative. It may refer to the experience of a traveler on a trip between a particular origin and a particular destination. It may summarize all trips or trip makers between a particular origin and destination pair. Or, it may describe the operation of one mode of transportation versus another.

Federal regulations [196] state that the CMP should include:

“Definition of <u>congestion management objectives and performance measures</u> to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods.”

The fields of transportation planning have typically used mode-specific performance measures or indicators to gauge conditions on the system. These include motor-vehicle specific performance measures such as traffic volumes, capacities, and level-of-service.

The TPB adopted a set of performance measures in the 1994 Congestion Management System (CMS) Work Plan. Since then, there has been an evolution towards more traveler-oriented metrics in conveying congestion and related information to the general public. Some of the measures are leveraged by emerging highway performance monitoring activities such as the I-95 Corridor Coalition Vehicle Probe Project that provides probe-based continuous monitoring. The FHWA notice of proposed rulemaking (NPRM) on system performance, freight movement, and congestion mitigation and air quality (CMAQ) program released on April 22, 2016 future defines seven speed-based performance measures. The TPB will incorporate all of those measures defined in the final rule, which is expected in early 2017.

4.1.2 MAP-21 Performance Measures

The Moving Ahead for Progress in the 21st Century Act (MAP-21) established new requirements for Metropolitan Planning Organizations (MPOs) towards performance-based planning and programming. The U.S. Department of Transportation is in the process of establishing transportation performance management measures through a rulemaking process as of the writing of this report. The FHWA notice of proposed rulemaking (NPRM) on system performance, freight movement, and congestion mitigation

[196] Federal Register, Vol. 81, No.103, May 27, 2016.

and air quality (CMAQ) program released on April 22, 2016 defines seven speed-based performance measures as summarized in Table 16.

It is possible that these proposed measures including definitions and calculations could be revised in the final rule. The TPB will incorporate all of those measures in the final rule and work with state DOTs to set targets in the future.

Table 16 Proposed Performance Measures in the System Performance, Freight Movement and CMAQ NPRM

Areas	Measures	Metrics	Equations	Thresholds	Time Periods (in a Calendar Year)	Geographic Areas	Data	Target Scope
Performance of the Interstate	Percent of the Interstate System providing for Reliable Travel	Level of Travel Time Reliability (LOTTR)	80^{th} TT / 50^{th} TT	Reliable: LOTTR < 1.50	6:00 am-10:00 am, M-F 10:00 am-4:00 pm, M-F 4:00 pm-8:00 pm, M-F 6:00 am-8:00 pm, S-S	Interstate	1) Travel Time Data Set; 2) Reporting segments	Statewide target; MPO-wide target
	Percent of the Interstate System where peak hour travel times meet expectations	Peak Hour Travel Time Ratio (PHTTR)	Longest PHTT / Desired PHTT in that hour the longest PHTT occurred	Meet expectation: PHTTR < 1.50	Could be any one of the 6 peak hours: 6:00 am-9:00 am, 4:00 pm-7:00pm in non-Federal holiday weekdays	Interstate in urbanized area with population over 1 million	1) Travel Time Data Set; 2) Reporting segments; 3) Desired Peak Period Travel Time	A single urbanized area target
Performance of the Non-Interstate NHS	Percent of the non-Interstate NHS providing for Reliable Travel	Level of Travel Time Reliability (LOTTR)	80^{th} TT / 50^{th} TT	Reliable: LOTTR < 1.50	6:00 am-10:00 am, M-F 10:00 am-4:00 pm, M-F 4:00 pm-8:00 pm, M-F 6:00 am-8:00 pm, S-S	Non-Interstate NHS	1) Travel Time Data Set; 2) Reporting segments	Statewide target; MPO-wide target
	Percent of the non-Interstate NHS where peak hour travel times meet expectations	Peak Hour Travel Time Ratio (PHTTR)	Longest PHTT / Desired PHTT in that hour the longest PHTT occurred	Meet expectation: PHTTR < 1.50	Could be any one of the 6 peak hours: 6:00 am-9:00 am, 4:00 pm-7:00pm in non-Federal holiday weekdays	Non-Interstate NHS in urbanized area with population over 1 million	1) Travel Time Data Set; 2) Reporting segments; 3) Desired Peak Period Travel Time	A single urbanized area target
Freight movement on the Interstate System	Percent of the Interstate System Mileage providing for Reliable Truck Travel Time	Truck Travel Time Reliability	95^{th} Truck TT / 50^{th} Truck TT	Reliable: Annual Average Truck Travel Time Reliability < 1.50	24/7/365	Interstate	1) Travel Time Data Set; 2) Reporting segments	Statewide target; MPO-wide target
	Percent of the Interstate System Mileage Uncongested	Average Truck Speed	Arithmetic mean of Truck Speeds **(leading to inconsistency between average speed and average travel time)**	Uncongested: Truck Speed > 50 mph	24/7/365	Interstate	1) Travel Time Data Set; 2) Reporting segments	Statewide target; MPO-wide target
Traffic Congestion	Annual Hours of Excessive Delay per Capita	Vehicle-hours of delay per capita	Delay * volume	Delay occurs if speed < 35 mph on Interstate (FC1), freeways and expressways (FC2); and < 15 mph on principal arterials (FC3) and all other NHS	24/7/365	NHS in nonattainment or maintenance urbanized area with population over 1 million	1) Travel Time Data Set; 2) Reporting segments; 3) **Hourly traffic volume**	A single urbanized area target

4.1.3 Traveler-oriented CMP Performance Measures

Since the TPB development of the CMP performance measures in 1994 (see Section 4.1.4), there has been an evolution towards more traveler-oriented metrics in conveying congestion and related information to the general public. Some of the measures are leveraged by emerging highway performance monitoring activities such as the I-95 Corridor Coalition's Vehicle Probe Project that provides probe-based continuous monitoring. Earlier in this report, the following four measures were used, with the first two quantifying congestion and the latter two travel time reliability. The 2010 Strategic Plan for the Management, Operations and Intelligent Transportation Systems (MOITS) Program [197] adopted Travel Time Index, Buffer Time Index and Planning Time Index as three regional indices of travel conditions and traveler's experience.

4.1.3.1 Travel Time Index (TTI)

TTI is defined as the ratio of actual travel time to free-flow travel time, measures the intensity of congestion. The higher the index, the more congested traffic conditions it represents, e.g., TTI = 1.00 means free flow conditions, while TTI = 1.30 indicates the actual travel time is 30% longer than the free-flow travel time. For more information, please refer to Travel Time Reliability: Making It There On Time, All The Time, a report published by the Federal Highway Administration and produced by the Texas Transportation Institute with Cambridge Systematics, Inc. This report uses the following method to calculate TTI:

1) Download INRIX 5-minute raw data from the I-95 Traffic Monitoring website (http://i95.inrix.com) or the VPP Suite website (https://vpp.ritis.org).

2) Aggregate the raw data to monthly average data by day of the week and hour of the day. Harmonic Mean was used to average the speeds and reference speeds (Harmonic Mean is only used here; other averages used are all Arithmetic Mean). For each segment (TMC), the monthly data have 168 observations (7 days in a week * 24 hours a day) in a month.

3) Calculate TTI = reference speed / speed in the monthly data. If TTI < 1 then make TTI = 1. If constraint TTI >= 1 was not imposed, some congestion could be cancelled by conditions with TTI < 1.

4) Calculate regional average TTI for the Interstate system, non-Interstate NHS, non-NHS, and all roads for AM peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) respectively, using segment length as the weight.

5) Calculate the average TTI of the AM Peak and PM Peak to obtain an overall congestion indicator.

4.1.3.2 Planning Time Index (PTI)

PTI is defined as the ratio of 95th percentile travel time to free flow travel time, measures travel time reliability. The higher the index, the less reliable traffic conditions it represents, e.g., PTI = 1.30 means a traveler has to budget 30% longer than the uncongested travel time to arrive on time 95% of the times (i.e., 19 out of 20 trips), while TTI = 1.60 indicates that one has to budget 60% longer than the uncongested travel time to arrive on time most of the times. For more information, please refer to

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[197] COG/TPB, http://www.mwcog.org/transportation/activities/operations/plan/MOITS-Strategic-Plan-Final-2010-06-16.pdf

Travel Time Reliability: Making It There On Time, All The Time, a report published by the Federal Highway Administration and produced by the Texas Transportation Institute with Cambridge Systematics, Inc. This report uses the following method to calculate PTI:

1) Calculate TTI = reference speed / speed in the monthly data obtained in step 2 of the above TTI methodology. Do not impose constraint TTI >= 1, since the purpose of this calculation is to rank the TTIs to find the 95th percentile, not to average the TTIs.

2) Calculate monthly average PTI: including sorting the data obtained in step 1 by segment, peak period, and month, finding the 95th percentile TTI and this TTI is PTI by definition, and averaging the PTIs using segment length as the weight to get regional summaries (for the Interstate system, non-Interstate NHS, non-NHS, and all roads for AM peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) respectively).

3) Calculate yearly average PTI: including sorting the data obtained in step 1 by segment and peak period, finding the 95th percentile TTI and this TTI is PTI by definition, and averaging the PTIs using segment length as the weight to get regional summaries.

4) Calculate the average PTI of the AM Peak and PM Peak to obtain an overall travel time reliability indicator.

4.1.4 How Performance Measures/Indicators Were Selected For The 1994 CMS Work Plan

Level of Service has generally been the most widely used performance measure in the Washington region, as can be seen in the Freeway Monitoring Program and Arterial Monitoring Program. However, there are other performance measures that are used, such as Volume/Capacity (V/C) ratio.

In 1993, the CMS Task Force undertook discussion of performance measures/indicators because of the emphasis in federal CMS guidance on this issue, culminating in the publication of performance measures in the 1994 CMS Work Plan[198]. The efforts at the beginning of the process involved a literature search and brainstorming process. An array of possible performance measures were developed based on materials from an FHWA instructional course on CMP. The CMP Task Force worked with these draft lists, adding, deleting, and changing the performance measures to suit the needs of the Washington region. The result was a stratified list of CMP performance measures.

Early in the process, the CMS Task Force was already aware of the gap between the intermodal, locally focused performance measures/indicators available and the multi-modal, wide-area scope desired for congestion management. Other issues were raised, as well, which set the tone of the discussion. The following were taken into consideration:

- Can the particular performance measure/indicator (or the data needed to feed it) be forecast by known tools and capabilities?

- Traditional congestion indicators tended to be precise in scale, addressing a particular link or intersection on the transportation system, yet modeling or forecasting capabilities tended to be rough in scale, forecasting at best, a regional or sub-regional scale. Post processing forecast data would improve the precision at a corridor level. The choice of performance measures may lead or bias the investigator toward only certain kinds of solutions, and eliminate others that may actually be worthy. This was a particular concern expressed by elected officials on the TPB.

[198] *CMS Work Plan for the Washington Region*, approved by the TPB on September 21, 1994.

- The CMP tries to have a layman's term, "congestion" apply to a technical process. Congestion could be characterized by crowdedness, by delay, or by decreases in traffic speeds. Conversely, crowdedness, delay, and slowing are not all the same phenomenon not always experienced, and not always tantamount to congestion.

- Level of Service appeared to be the most promising alternative to using delay. It has been used frequently in the past, and there is a level of understanding and buy-in from regional decision makers and the public. Level-of service does have some drawbacks, including not being multi-modal. Even though LOS E and F are considered as congested, in urban areas some levels of congestion is considered acceptable. In addition, it is difficult to distinguish from the varying severities of Level of Service "F."

The solution proposed and adopted instead was to choose a whole list of indicators, and apply them where and when relevant. The CMS Task Force reviewed over 100 different performance measures in use or suggested for use by States and localities around the country. This list was then narrowed to a manageable few. Some of the major criteria used to rate the utility of prospective performance measures were the following:

- Had to be clear and understandable.
- Had to be sensitive to modes.
- Had to be sensitive to time.
- Based on readily available data.
- Can be forecast.
- Able to gauge the impact of one or more congestion management strategies.

4.1.5 Selected CMP Performance Measures from the 1994 CMS Work Plan

4.1.5.1 Summary List

Following is a list of performance measures selected:[199]

- *Data for Direct Assessment of Current (or future background) Conditions:*
    - Traffic volumes
    - Facility capacity
    - Speed
    - Vehicle density
    - Vehicle classification
    - Vehicle occupancy
    - Transit ridership
    - Accident/Incident data

- *Calculated performance measures/indicators for congestion assessment:*
    - Volume-to-capacity (V/C) ratio
    - Level of Service
    - Person miles of travel/vehicle miles of travel
    - Truck hours of travel
    - Person hours of delay/vehicle hours of delay
    - Modal shares
    - Safety considerations

[199] As originally identified in the 1994 *CMS Work Plan for the Washington Region*.

- Vehicle trips
- Emissions reduction benefits

4.1.5.2 Descriptions of the Performance Measures

Direct Assessment

- *Traffic volumes* – number of vehicles crossing a certain point, usually expressed for an average weekday. This indicator would be applicable in corridors or spot locations, and of interest in the assessment of most CMP strategies.
- *Facility capacity* – Typically for highways, and expressed in terms of the number of passenger car equivalents that can pass over a certain point in an hour, given the geometric characteristics and environment of the highway.
- *Speed* – Defined as the average running speed of motor vehicles traversing a section of roadway. Speed as an indicator is applicable in corridors or spot locations, and is of interest in the assessment of most CMP strategies.
- *Vehicle density* – Described as passenger-car-equivalents per lane per mile. It is of interest for highway-oriented CMP strategies such as traffic operations and HOV facilities.
- *Vehicle classification* – Entails determining the proportion of vehicle traffic type passing a given point. Can be passenger cars, trucks, buses, or other vehicle types. It is applicable to spot locations, and is of interest in the assessment of most CMP strategies.
- *Vehicle occupancy* – average number of persons per motor vehicle for a given location. It is applicable region-wide, or on a corridor or spot basis. Can be used in the comparison of corridors.
- *Transit ridership* – average daily volume of passengers on given transit lines or facilities. It is of interest in the assessment of the following CMP strategies: Transportation Demand Management (TDM), transit, congestion pricing, and growth management.
- *Accident/Incident data* – average number of accidents per million vehicle miles of travel by different facility types. Higher accident rates is an indirect indication of congestion.

Calculated

- *Volume-to-Capacity (V/C) Ratio* – ratio of demand flow rate at a given level of vehicle capacity for a roadway. Calculated from available highway data according to national standards in the Highway Capacity Manual. V/C Ratio was analyzed in the 2008-2030 Plan Performance evaluation.
- *Level of Service* – rating of the quality of service provided by a roadway under a given set of operating conditions. A roadway is classified with a letter "A" through "F" with "A" being the least congestion and "F" being the most congested. For LOS F conditions density/speed is used as an indication of the severity of the F. This performance measure is currently used in the Freeway Monitoring Program.
- *Person Miles of Travel/Vehicle Miles of Travel* – sum of all miles of travel by all vehicles for a given area or facility for a given period of time, factored by the vehicle occupancy to gauge person movement.
- *Modal Shares* – indicate the apportioning of person trips among possible transportation modes: single-occupant vehicle (SOV), high-occupancy vehicle (HOV), transit, non-motorized, or other modes of transportation.
- *Safety Considerations* – include empirical or sketch planning evaluation of safety or hazard issues in a given congestion situation or in consideration of potential congestion management strategies.

- *Vehicle Trips* – number of motor vehicle trips from a given origin to a given destination, which may be stratified by mode purpose, time period, vehicle type, or other classifications.
- *Emissions Reductions Benefits* – reductions in criteria pollutant emissions based on reductions in vehicle miles of travel or vehicle trips. Currently, this performance measure is used when analyzing the TERMs for the region.

Other Performance Measures for Consideration

There are a number of performance measures that would be beneficial to congestion management, but the data availability is too limited for use in the CMP. Some of these include:

- *Bicycle usage and pedestrian counts*
  - Very little data on these have been collected in the region, but would be beneficial in areas such as bicycle and pedestrian planning and growth management.
- *Number of congested intersections*
  - Will give an indication of the extent and severity of congestion. Possible sources include traffic volumes, Data Clearinghouse information, and traffic operations models.
- *Hours per day of congestion*
  - Will directly address the need to gauge the extent of congestion on the transportation system. This indicator is dependent upon having travel volumes by time of day.
- *Percent person miles of travel by congestion level*
  - Will allow comparison of the extent of congestion among CMP locations.
- *Percent delay*
  - The total delay (in minutes) divided by the designated threshold (meaning expected, ideal, or free-flow) travel time. For example, a percent delay of 25% would mean that travel time on a certain segment of the transportation system is taking 25% longer than it would be expected to under non-congested conditions.
- *Average duration of incidents*
  - Could be incidents, special events, infrastructure or equipment failures, or other unusual circumstances that lead to a one-time-only or occasional increase in traveler delay.
- *Truck and freight movement involvement with congestion*
  - Impact of truck and freight movement on congestion. Currently the region does not have much data on hand in this area.
- *Percent of person miles of travel by transit load factor*
  - This is the transit analog of highway congestion as described by Level of Service. Load factor indicates the crowdedness of the transit vehicles, thus providing an overall indication of crowdedness on the portion of the transportation system.
- *Person volume-to-person capacity ratio*
  - Used to develop a Level of Service for transportation corridors by taking the sum of automobile and transit capacities. Levels of service are then determined with reference to volume-to-capacity standards.

4.2 Review of Congestion Management Strategies

4.2.1 Introduction

Federal regulations state that the CMP should include:

"Identification and evaluation of the anticipated performance and expected benefits of appropriate congestion management strategies that will contribute to the more effective use and improved safety of existing and future transportation systems based on the established performance measures. The following categories of strategies, or combinations of strategies, are some examples of what should be appropriately considered for each area:

(i) Demand Management measures, including growth management and congestion pricing;
(ii) Traffic operational improvements;
(iii) Public transportation improvements;
(iv) ITS technologies as related to the regional ITS architecture; and
(v) Where, necessary, additional system capacity." [200]

To address this point, strategy lists have been developed as a way of categorizing congestion management strategies and characterizing the current impact, or potential impact, these strategies have throughout our region.

These lists are modeled after the longstanding Transportation Emission Reduction Measure (TERM) process for air quality in the region. The TERM list was formed as a way of developing additional plan and program elements which could be utilized to mitigate emission increases.

Similarly, lists have been developed for strategies under consideration for Congestion Management. At this time the effort is proposed to be qualitative, as the congestion information is not tied to one specific location. In addition, some strategies are regional while others are local , and a qualitative effort better characterizes the impact they have on the region as a whole.

The following section contains background and summary information of how the Strategy Lists were developed.

4.2.2 Descriptions of Strategies

The general characteristics of strategies are provided in Table 17 and Table 18; one for operational management strategies (those strategies contributing to a more effective use of existing systems) and one for demand management strategies (those that influence travel behavior). The qualitative criteria across the top of the lists, and the methodology used to categorize each strategy as "some impact (x)", "significant impact (xx)", and "high impact (xxx)" are the same for both tables. The separate tables are simply for the purpose of distinguishing the two types of strategies. A more detailed review of the strategies is provided in Appendix G.

[200] §450.322(d), Metropolitan Transportation Planning, Final Rule, Federal Register, May 27, 2016 – emphasis added.

Table 17: Congestion Management Process (CMP) Demand Management Strategies Criteria

1. Some Impact (x)
2. Significant Impact (xx)
3. High Impact (xxx)

		QUALITATIVE CRITERIA									
		Impacts on Congestion									
STRATEGY		Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
C.5.0	***Alternative Commute Programs***										
C.5.1	Carpooling	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.2	Ridematching Services	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.3	Vanpooling	xxx	x	x	xxx	xx	xx	xx	x	xxx	xxx
C.5.4	Telecommuting	xx	x	x	xxx	xx	xx	xxx	x	xx	xxx
C.5.5	Promote Alternate Modes	xx	x	xxx	xxx	xxx	xxx	xxx	x	xx	xxx
C.5.6	Compressed/flexible w orkw eeks	xx	x	x	xxx	xxx	xxx	xxx	x	x	xx
C.5.7	Employer outreach/mass marketing	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.5.8	Parking cash-out	xx	x	xxx	x	xxx	x	x	xx	xx	x
C.5.9	Alternative Commute Subsidy Program	xx	x	xxx	xxx	xx	xx	x	x	xxx	xxx
C.6.0	***Managed Facilities***										
C.6.1	HOV	xx	x	xxx	xxx	xx	xx	xx	xxx	xxx	xxx
C.6.2	Variably Priced Lanes (VPL)	xxx	x	xx	xxx	xx	x	x	xxx	xxx	xx
C.6.3	Cordon Pricing	xxx	x	xxx	xxx	x	x	x	xx	xxx	xx
C.6.4	Bridge Tolling	xxx	x	x	xx	xx	x	x	xxx	xx	x
C.7.0	***Public Transportation Improvements***										
C.7.1	Electronic Payment Systems	xx	x	xxx	xx	xx	xxx	xx	xx	xxx	xx
C.7.2	Improvements/added capacity to regional rail and bus transit	xx	xx	xxx	xx	xxx	xx	x	xxx	xxx	xx
C.7.3	Improving accessibility to multi-modal options	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.7.4	Park-and-ride lot improvements	xx	x	xx	xx	xx	xx	xx	xx	xx	xx
C.7.5	Carsharing Programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.8.0	***Pedestrian, bicycle, and multi-modal improvements***										
C.8.1	Improve pedestrian facilities	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.8.2	Creation of new bicycle and pedestrian lanes and facilities	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.8.3	Addition of bicycle racks at public transit stations/stops	x	x	xx	xxx	xxx	xx	xxx	x	x	xxx
C.8.4	Bike sharing programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.9.0	***Growth Management***										
C.9.1	Coordination of Regional Activity Centers	xx	x	xxx	xxx	xxx	xx	x	xxx	xxx	xx
C.9.2	Implementation of TLC program (i.e. coordination of transportation and land use w ith local gov'ts)	xx	x	xxx	xxx	xxx	xx	xxx	x	xxx	xxx
C.9.3	"Live Near Your Work" program	xx	x	xx	xxx	xx	x	xx	x	x	xx

Table 18: Congestion Management Process (CMP) Operational Management Strategies Criteria

1. Some Impact (x)
2. Significant Impact (xx)
3. High Impact (xxx)

		QUALITATIVE CRITERIA									
		Impacts on Congestion									
STRATEGY		Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
C.1.0	***Incident Mngt./Non-recurring***										
C.1.1	Imaging/Video for surveillance and Detection	xx	xxx	xx	xxx	xxx	xx	xx	xx	xxx	xxx
C.1.2	Service patrols	xx	xxx	x	xxx	xxx	xx	xxx	xx	xxx	xxx
C.1.3	Emergency Mngt. Systems (EMS)	x	xx	x	xx	xxx	xxx	xx	xxx	xxx	xxx
C.1.4	Emergency Vehicle Preemption	x	xx	x	x	xxx	xx	xx	xx	x	xx
C.1.5	Road Weather Management	x	xxx	x	xxx	xxx	xx	xx	xx	xx	xx
C.1.6	Traffic Mngt. Centers (TMCs)	xx	xxx	xx	xxx	xx	xx	xx	xx	xxx	xxx
C.1.7	Curve Speed Warning System	xx	xx	x	x	xx	x	xx	xx	xx	x
C.1.8	Work Zone Management	xx	xxx	x	xx	xxx	xx	xx	xx	xx	xx
C.1.9	Automated truck rollover systems	x	xx	x	x	xx	xx	xx	xx	xx	xx
C.2.0	***ITS Technologies***										
C.2.1	Advanced Traffic Signal Systems	xxx	xx	xx	xxx	xxx	xx	xx	xxx	xxx	xxx
C.2.2	Electronic Payment Systems	xxx	x	xx	xxx	xx	xx	xx	xx	xxx	xx
C.2.3	Freeway Ramp Metering	xx	x	x	xx	xx	x	xx	xx	xx	xx
C.2.4	Bus Priority Systems	x	x	xxx	xxx	xxx	x	xx	xxx	xx	xx
C.2.5	Lane Management (e.g. Variable Speed Limits)	xx	xx	x	xx	xxx	x	xx	xx	xx	xx
C.2.6	Automated Enforcement (e.g. red light cameras)	x	x	x	x	xxx	xx	xx	xx	xx	xx
C.2.7	Traffic signal timing	xxx	x	xx	xxx	xxx	xx	xxx	x	xxx	xxx
C.2.8	Reversible Lanes	xx	x	x	xx	xxx	x	x	xx	xx	xx
C.2.9	Parking Management Systems	xx	x	xx	xx	xxx	x	x	xxx	xx	xx
C.2.10	Dynamic Routing/Scheduling	xx	x	xx	xxx	xxx	x	x	xxx	xx	xx
C.2.11	Service Coordination and Fleet Mngt. (e.g. buses and trains sharing real-time information)	xx	x	xxx	xxx	xxx	x	x	xx	xx	xx
C.2.12	Probe Traffic Monitoring	xx	xxx	x	xx	xx	x	xx	xx	xxx	xx
C.3.0	***Advanced Traveler Information Systems***										
C.3.1	511	xx	xxx	xx	xxx	x	xx	xx	xxx	xx	xxx
C.3.2	Variable Message Signs (VMS)	xx	xxx	xx	xx	xxx	xx	xx	xx	xxx	xxx
C.3.3	Highway Advisory Radio (HAR)	x	xx	x	xx	xxx	xx	xxx	xx	x	xx
C.3.4	Transit Information Systems	xx	xx	xxx	xx	xxx	xx	x	xx	xx	xxx
C.4.0	***Traffic Engineering Improvements***										
C.4.1	Safety Improvements	x	xxx	x	x	xxx	xx	xxx	x	xxx	xxx
C.4.2	Turn Lanes	xx	x	x	x	xxx	xx	xx	xx	xx	x
C.4.3	Roundabouts	x	xx	x	x	xxx	x	x	x	xx	xx

4.3 Examples of Strategies Studies

4.3.1 Analysis of Transportation Emissions Reduction Measures (TERMs)

4.3.1.1 Overview

Transportation Emission Reduction Measures (TERMs) are strategies or actions employed to offset increases in nitrogen oxide (NOx) and volatile organic compound (VOC) emissions from mobile sources. The TPB has been adopting TERMs since FY 1995.

The Clean Air Act Amendments of 1990 (CAAA) and SAFETEA-LU requires metropolitan planning organizations and DOTs to perform air quality analyses, to ensure that the transportation plan and program conform to mobile emission budget established in the State Implementation Plans (SIP). Consequently MPOs and DOTs are required to identify TERMs that would provide emission-reduction benefits and other measures intended to modify motor vehicle use.

Selection of the TERMs requires quantitative as well as qualitative assessment. The quantitative assessment includes specific information on the benefits, costs, and expected air-quality benefits. Qualitative criteria includes ranking based on the subjective criteria's such as ease of implementation, how to implement, and synergy with other measures.

As greenhouse gas (GHG) emission becomes a global climate issue, the effects of TERMs on GHG reduction in the Washington region are analyzed in the "What Would It Take" Scenario Study (see Section 4.3.3).

4.3.1.2 Findings and Applications to Congestion Management

Most TERMs are intended to reduce either the number of vehicle trips (VT), vehicle miles traveled (VMT), or both. These strategies may include ridesharing and telecommuting programs, improved transit and bicycling facilities, clean fuel vehicle programs or other possible actions. These TERMs are not only important to offsetting increases in NOx and VOC, but many are important in congestion management by reducing trips and miles of travel.

The Washington region has adopted and implemented several TERMs with the sole aim of reducing emissions, such as the addition of clean diesel bus service, taxicabs with Compressed Natural Gas (CNG) cabs, and CNG buses. However, many TERMs also have an impact on congestion management. Examples of some of these congestion-mitigating TERMs that have been implemented include:

- *Upgraded Signal Systems in Maryland*
  - MD 85 Executive Way to MD 355
  - MD 355, I-70 ramps to Grove Road
  - MD 410, 62nd Avenue to Riverdale Rd
- *Traffic Signal Optimization*
- *Alexandria Telecommuting Program*
- *Cherry Hill VRE access*
- *Bicycle facilities*
- *Additional park-and-ride lots*
  - Shady Grove West park-and-ride
  - White Oak park-and-ride
  - Tacketts Mill park-and-ride

    - Town of Leesburg park-and-ride
- *Pedestrian facilities to Metrorail*
- *Employer outreach/Guaranteed Ride Home*
- *District of Columbia Incident Response and Traffic Management System*
- *Carsharing program*

4.3.2 Scenario Planning

4.3.2.1 "CLRP Aspirations" Scenario

"CLRP Aspirations" scenario is an integrated future land use and transportation scenario for building on the key results of previous TPB scenario studies. It includes concentrated land use growth in Regional Activity Centers, a regional network of variably priced lanes, and a high quality bus rapid transit network operating on the VPL network for the current planning horizon year 2040. The most recent version of the CLRP Aspirations Scenario was presented to the TPB in October 2013. Relative to the 2012 CLRP baseline for 2040, the full CLRP Aspirations Scenario showed increases in trips of all modes (auto person trips, transit trips, and non-motorized trips) due to the increase in population, both auto and transit capacity, and shifts in land use that enable more non-motorized trips. The Scenario showed a slight decrease in VMT, a decrease in VMT per capita, and a significant decrease in regional vehicle-hours of delay. [201]

4.3.2.2 "What Would It Take?" Scenario

"What Would It Take?" scenario starts with the adopted COG non-sector specific goals for reducing mobile source greenhouse gas emissions for 2030 and beyond. It assesses how such goals might be achieved in the transportation sector through different combinations of interventions that include increasing fuel efficiency, reducing the carbon-intensity of fuel, and improving travel efficiency. The study was completed in May 2010. The study found that:

- Strategies analyzed to date do not achieve regional goals of reducing greenhouse gas emissions, and additional strategies can and should be analyzed.
- Goals are difficult to meet and will require emission reductions in all three categories: Vehicle efficiency (CAFE improvement), alternative fuel (cellulosic ethanol), and travel efficiency (strategies aimed at reducing VMT, congestion, and delays).
- While major reductions can come from federal energy policies, local governments can make significant reductions quickly.
- Some strategies may not have major greenhouse gas (GHG) reduction potential, but have multiple benefits worth exploring through benefit-cost analysis (e.g. the MATOC program).

The study also recommended nine potential local actions that can be implemented quickly to reduce GHG. The study has not been updated since 2010. EPA has released a new emissions model (MOVES) and the current version does not reflect the most current fuel efficiency standards. The next update of the model, expected in 2014, will have those standards included.

4.3.3 MATOC Benefit-Cost Analysis

The Metropolitan Area Transportation Operations Coordination (MATOC) Program is a joint program of VDOT, MDOT, DDOT, WMATA and TPB. It aims to provide real-time situational awareness of

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[201] Kirby, R. *Briefing on Update to the CLRP Aspirations Scenario*. Presentation to the National Capital Region Transportation Planning Board, April 17, 2013. http://www.mwcog.org/uploads/committee-documents/kV1bW1xe20130411142653.pdf

transportation operations in the National Capital Region (NCR), especially during emergencies and other incidents with significant impacts on travelers and on the transportation systems of the region.

A benefit-cost study has been carried out to quantify the effectiveness of this program as well as to better advise stakeholders in funding identification.

The benefit-cost study looked at traveler's "modified trips" - trips made at a later time, on another route, by another mode, or not made due to regionally significant incidents. Benefits were estimated from reduced delay, lower fuel consumption, lower emissions (including greenhouse gases), and avoidance of secondary incidents. Three case studies made up of two freeway incidents and one arterial incident was conducted. The study found an overall benefit/cost ratio conservatively estimated at 10 to 1. The study was released in June 2010. MATOC uses the method from that study to report monthly estimated benefits from the program.

4.3.4 MOITS Strategic Plan

The Management, Operations, and Intelligent Transportation Systems (MOITS) program of the TPB developed a strategic plan for the program dated June 16, 2010 and the plan is available on MWCOG website.[202] The Strategic Plan defines and promotes potential regional projects or activities for the management, operations, and application of advanced technology for the region's transportation systems, as well as to advise member agencies on management, operations, and transportation technology deployments for meeting common regional goals and objectives.

The MOITS Strategic Plan builds upon the TPB Vision by identifying four key tactical actions toward achieving and building upon the goals, objectives, and strategies of the Vision. It identifies nine emphasis areas derived from the National ITS Architecture, seven proposed projects out of which three have been implemented, and two are in the planning stage three strategic efforts out of which two are being considered for implementation, and a number of "best practices" for consideration by the member agencies and jurisdictions. The Plan also recommends use of a few key performance measures, including travel time index, buffer time index and planning time index, which are already used in this CMP Technical Report. The Strategic Plan concludes with seven key recommendations for the MOITS Technical Subcommittee and Program.

[202] http://www.mwcog.org/transportation/activities/operations/plan/MOITS-Strategic-Plan-Final-2010-06-16.pdf

5. HOW RESULTS OF THE CMP ARE INTEGRATED INTO THE CLRP

According to federal regulations, the CMP should be an integrated process in the CLRP rather than a standalone product of the regional transportation planning process. This chapter clarifies this integration.

5.1 Components of the CMP Are Integrated in the CLRP

There are four major components of the CMP as described in the CLRP:

- Monitor and evaluate transportation system performance
- Define and analyze strategies
- Implement strategies and assess
- Compile project-specific congestion management information

In monitoring and evaluating transportation system performance, the TPB uses probe vehicle data (INRIX), aerial photography freeway monitoring (Skycomp), and a number of other travel monitoring activities to support both the CMP and travel demand forecast model calibration, complementing operating agencies' own information, and illustrating locations of existing congestion. CLRP travel demand modeling forecasts, in turn, provide information on future congestion locations. This provides an overall picture of current and future congestion in the region, and helps set the stage for agencies to consider and implement CMP strategies, including those integrated into capacity-increasing roadway projects.

The CMP component of the CLRP defines and analyzes a wide range of potential demand management and operations management strategies for consideration. TPB, through its Technical Committee, Travel Management Subcommittee, Travel Forecasting Subcommittee, and other committees, reviews and considers both the locations of congestion and the potential strategies when developing the CLRP.

For planned (CLRP) or programmed (TIP) projects, cross-referencing the locations of planned or programmed improvements with the locations of congestion helps guide decision makers to prioritize areas for current and future projects and associated CMP strategies. Maps in the 2009 CLRP showed a high correlation between the locations of planned or programmed projects and locations where congestion is being experienced or is expected to occur.

Thus CLRP and TIP project selection is informed by the CMP, and implementation of CMP strategies is encouraged. The region relies particularly on non-capital congestion strategies in the Commuter Connections program of demand management activities, and the Management, Operations, and Intelligent Transportation Systems (MOITS) program of operations management strategies. Assessments of these programs are analyzed, along with regular updates of travel monitoring to look at trends and impacts, to feed back to future CLRP cycles.

The TPB also compiles information pertinent to specific projects in its CMP documentation process (form) within the annual CLRP Call for Projects. This further assures and documents that the planning of federally-funded SOV projects has included considerations of CMP strategy alternatives and integrated components.

5.2 Demand Management in the CLRP

Demand Management aims at influencing travelers' behavior for the purpose of redistributing or reducing travel demand. Existing demand management strategies contribute to a more effective use and improved safety of existing and future transportation systems. The long-range plan takes a number of demand management strategies into consideration when planning for the region's transportation infrastructure. Such strategies include alternative commute programs, managed facilities (such as HOV facilities and variably priced lanes), public transportation improvements, pedestrian and bicycle facility improvements, and growth management (implementing transportation and land use activities). These strategies are outlined in detail in Section 3.2

In "Call for Projects" for the CLRP and TIP, for any project providing a significant increase to SOV capacity, it must be documented that the implementing agency considered all appropriate systems and demand management alternatives to the SOV capacity. A Congestion Management Documentation Form is distributed along with the Call for Projects and a special set of SOV congestion management documentation questions must be answered for any project to be included in the Plan or TIP that significantly increases the single occupant vehicle carrying capacity of a highway.

A set of projects included in the CLRP and TIP are exclusively dedicated to (and titled as) transportation demand management (TDM), such as TDM for employer outreach, TDM media program, and implement a TDM program.

Some projects included in the CLRP and TIP are revised as needed to reflect pertinent TDM study results, e.g., the I-95/395 HOV-HOT-Bus Lanes project was revised to reflect the results of the Transit/Transportation Demand Management Study conducted by the Virginia Department of Rail and Public transportation (DRPT) and the Technical Advisory Committee in the 2008 CLRP.

Finally, the TPB certifies demand management of the CMP in the overall certification of the transportation planning process in the National Capital Region. The Board finds the transportation planning process is addressing the major issues in the region and is being conducted in accordance with all applicable requirements.

5.3 Operational Management in the CLRP

Part of the CMP effort focuses on defining the existing operational management strategies that contribute to the more effective use and improved safety of existing and future transportation systems. Such strategies include incident management programs, ITS Technologies, Advanced Traveler Information Systems, and traffic engineering improvements. These strategies are outlined in detail in Section 3.3.

Along with demand management strategies, operational management alternatives must also be considered when SOV capacity expanding projects are submitted to the Call for Projects of the CLRP and TIP. The considerations are documented in the Congestion Management Documentation Form.

The TPB also certifies operational management of the CMP in the overall certification of the transportation planning process in the National Capital Region.

5.4 Capacity Increases in the CLRP and Their CMP Components

Federal law and regulations list capacity increases as another possible component of operational management strategies, for consideration in cases of:

- *Elimination of bottlenecks*, where a modest increase of capacity at a critical chokepoint can relieve congestion affecting a facility or facilities well beyond the chokepoint location. Widening the ramp from I-495 Capital Beltway Outer Loop to westbound VA 267 (Dulles Toll Road) relieved miles of regularly occurring backups on the Beltway and across the American Legion Bridge.

- *Safety improvements*, where safety issues may be worsening congestion, such as at high-crash locations, mitigating the safety issues may help alleviate congestion associated with those locations.

- *Traffic operational improvements*, including adding or lengthening left turn, right turn, or merge lanes or reconfiguring the engineering design of intersections to aid traffic flow while maintaining safety.

These considerations should be included in the Congestion Management Documentation Form in the CLRP and TIP project submissions.

5.5 Regional Transportation Priorities Plan Facilitates CMP-CLRP Integration

The Regional Transportation Priorities Plan (RTPP)[203], which is a milestone of TPB's Performance-Based Planning approach, facilitates the integration of the CMP and the CLRP. The RTPP was approved by the TPB in January 2014. The RTPP is a policy document to help guide implementing agencies (local, state and regional) in the project development process to consider regional needs when identifying transportation improvements for inclusion in the CLRP. The CMP can help inform that process.

Building on the *TPB Vision* and previous regional transportation planning activities, the RTPP identifies those transportation strategies that offer the greatest potential contributions to addressing continuing regional challenges, and to provide support for efforts to incorporate those strategies into future updates of the CLRP in the form of specific programs and projects. The plan articulates regional priorities for enhancing the performance of the CLRP by advancing six regional goals:

1) Provide a Comprehensive Range of Transportation Options
2) Promote a Strong Regional Economy, Including a Healthy Regional Core and Dynamic Activity Centers
3) Ensure Adequate System Maintenance, Preservation, and Safety
4) Maximize Operational Effectiveness and Safety of the Transportation System
5) Enhance Environmental Quality, and Protect Natural and Cultural Resources
6) Support Inter-Regional and International Travel and Commerce

After public review of the challenges the region faces, three regional priorities were defined:

1) Meet Our Existing Obligations: Maintain the Transportation System We Already Have
2) Strengthen Public Confidence and Ensure Fairness: Pursue Greater Accountability, Efficiency, and Accessibility

[203] Regional Transportation Priorities Plan, http://www.mwcog.org/uploads/pub-documents/vF5cWFc20140219085242.pdf

3) Move More People and More Goods More Efficiency: Alleviate Congestion and Crowding and Accommodate Future Growth

The strategies identified in the RTPP for the third priority focus on congestion management, and includes strategies that are have already been introduced in this region and are described in Chapter 3.

- Alleviate roadway bottlenecks
- Increase roadway efficiency
- Promote commute alternatives
- Increase bicycle and pedestrian infrastructure
- Apply priority bus treatments
- More capacity on the existing transit system
- Bus rapid transit (BRT) and other cost-effective transit alternatives
- Express toll lanes

The TPB established an Unfunded Capital Needs Working Group in 2015 which was renamed the Long-Range Plan Task Force and reconvened on April 20, 2016. The goal of this group's work is to improve the performance levels of the regional transportation system in the TPB's Constrained Long Range Plan. The outcomes of these efforts will be both at the project and policy levels and will be directly linked to the update of the TPB's long range plan in 2018. [204]

[204] http://www.mwcog.org/uploads/committee-documents/k1xdXl1b20160512193706.pdf

6. CONCLUSIONS

The 2016 CMP Technical Report hereby concludes with a summary of key findings and important recommendations from throughout the report to improve the Congestion Management Process in the Washington region.

6.1 Key Findings of the 2016 CMP Technical Report

1. Congestion – Peak period congestion in the Washington region decreased between 2010 and 2012, and then increased moderately in 2014 and 2015, but still remaining lower than that of 2010. The Travel Time Index dropped 6.7% between 2010 and 2012, but climbed 3.3% between 2012 and 2015. The percent of congested road miles was 21% in 2010, 11% in 2012, and 17% in 2015 (Sections 2.2.1.1 and 2.2.1.3).

2. Reliability – Travel time reliability in the region improved between 2010 and 2012, and then worsened in 2014 and 2015, almost back to the 2010 level. The Planning Time Index decreased (improved) by 10% between 2010 and 2012, but increased (worsened) by 12% between 2012 and 2015 (Section 2.2.1.2).

3. Bottlenecks – Three new bottlenecks emerged on the east side of the Beltway in the 2016 CMP Technical Report that were not on the list in the 2014 Report: I-495 inner-loop at MD-214, I-495 outer-loop at US-50, and I-495 inner-loop at MD-4. Additionally, I-95 at VA-123/Exit 160 added two new Top 10 bottlenecks, one on each direction. The Beltway at the American Legion Bridge added a new, outer-loop bottleneck, making both directions to the Top 10 list. I-270 SB at the spur and I-66 WB at VA-234 remained in the Top 10 list. (Section 2.2.1.6).

4. Travel Demand Management – Travel demand management continues to be an important tool for day-to-day congestion management and played a key role in congestion management during the June 2015 Papal visit and the March 16, 2016 Metrorail shutdown. The Commuter Connections program remains the centerpiece to assist and encourage people in the Washington region to use alternatives to the single-occupant automobile. The transit system in the Washington region serves as a major alternative to driving alone – transit mode share is among the highest several metropolitan areas in the country (Section 3.2.1).

5. Regional Transportation Operations Coordination – The Metropolitan Washington Area Transportation Operations Coordination (MATOC) continues to play an important role in coordination and communicating incident information during both typical travel days and special events such as severe weather and construction work (Section 3.3.3.4).

6. Real-time travel information – The increasing availability of technology to monitor, detect, and evaluate travel conditions allows operators to make changes to the transportation network through active travel demand management, traffic signal optimization, and integrative corridor management. For travelers, real-time traffic and transit information are available from a number of sources though mobile applications and mobile versions of websites. Social media provides a mutually beneficial direct connection between transportation providers and users. Mobile applications related to non-auto modes, such as bikesharing and carsharing, allow travelers to be flexible with their mode choices (Section 3.4.6).

7. Variably Priced Lanes (VPLs) - VPLs provide additional options to travelers in the region. Maryland Route 200 (Intercounty Connector (ICC)) was fully opened between I-370/I-270 and

US-1 in November 2014; a Before-and-After study identified the ICC improved its adjacent area's traffic by 3-4%. The 495 Express Lanes opened on the Virginia side of the Capital Beltway in November 2012; there were 42,000 average workday trips in the June 2015 quarter, up from 35,000 in the June 2014 quarter, and 29,000 in the June 2013 quarter. The 95 Express Lanes in Northern Virginia opened in December 2014 which had 45,000 average workday trips in the quarter ending in June 2015. (Section 3.3.2).

8. Walking and Bicycling – Walking and bicycling continue to grow in the region in part due to bikesharing and carsharing options and increasing connectivity in the bicycle and pedestrian network (Sections 3.2.4 and 3.2.5).

6.2 Recommendations for the Congestion Management Process

The 2016 CMP Technical Report documents the updates of the Congestion Management Process in the Washington region from mid-2014 to mid-2016. Looking forward, the report leads to several important recommendations for future improvements.

1. **Continue the Commuter Connections program.** The Commuter Connections program is a primary key strategy for demand management in the National Capital Region and it is beneficial to have a regional approach. Meanwhile, this program reduces transportation emissions and improves air quality, as identified by the TERMs evaluations.

2. **Continue and enhance the MATOC program and support agency/jurisdictional transportation management activities.** The MATOC program/activities are key strategies of operational management in the National Capital Region. Recent enhancements have including efforts on severe weather mobilization and the construction and coordination. Future enhancements of the MATOC program should be considered when appropriate to expand the function and participation of the program.

3. **Develop a regional Congestion Management Plan (CMPL).** The FAST Act and the new Metropolitan Planning Final Rule call for an optional development of a CMPL that includes projects and strategies that will be considered in the Transportation Improvement Program. Such a CMPL would strengthen the connections between CMP, TIP and CLRP and enable the TPB and its member agencies to better combat congestion in the Washington region.

4. **Incorporate performance measures to be finalized in the final rule on System Performance, Freight Movement, and CMAQ.** The next update of the CMP Technical Report should include those performance measures to assess the performance of the National Highway System, freight movement on the Interstate System, and the Congestion Mitigation and Air Quality (CMAQ) program (traffic congestion only), in addition to existing performance measures that the CMP considers appropriate.

5. **Continue to encourage integration of operations management and travel demand management components of congestion management for more efficient use of the existing transportation network.** State DOTs are encouraged to continue to explore ATM strategies along congested freeways and actively manage arterials along freeways. Transportation agencies (including transit agencies) and stakeholders are encouraged to work collaboratively along congested corridors to explore the feasibility of an ICM system. Ongoing projects on I-95/I-395 and I-66 support these concepts.

6. **Pursue sufficient investment in the existing transportation system, which is important for addressing congestion.** Prioritizing maintenance for the existing transportation system as

called for in TPB's Regional Transportation Priorities Plan is critical to congestion management.

7. **Consider variable pricing and other management strategies in conjunction with capacity increasing projects.** Variably priced lanes (VPLs) provide a new option to avoid congestion for travelers and an effective way to manage congestion for agencies.

8. **Continue to encourage transit in the Washington region and explore transit priority strategies.** The transit system in the Washington region serves as a major alternative to driving alone, and it is an important means of getting more out of existing infrastructure. Local jurisdictions are encouraged to work closely with transit agencies to explore appropriate transit priority strategies that could have positive impacts on travelers by all modes.

9. **Encourage implementation of congestion management for major construction projects.** The construction project-related congestion management has been very successful in the past such as for the 11th Street Bridge and Northern Virginia Megaprojects.

10. **Continue to encourage access to non-auto travel modes.** The success of the Capital Bikeshare program and the decrease in automobile registrations in the District of Columbia indicate that there is a shift, at least in the urban areas, to non-automobile transportation.

11. **Continue and enhance providing real-time, historical, and multimodal traveler information.** Providing travelers with information before and during their trips can help them to make decisions to avoid congestion and delays and better utilize the existing road and transit infrastructure. Websites such as MATOC's www.trafficview.org, www.CapitalRegionUpdates.gov, state DOTs' 511 systems, and real-time transit information allow travelers to make more informed decisions for their trips. The value of real-time traveler information can be largely enriched by integrating historical travel information which can provide valuable travel time reliability measures.

12. **Continue to look for ways to safely interface with the public through new technology such as mobile devices and social media.** The increased prevalence of mobile internet-capable devices and social media present a rapidly evolving platform for both disseminating and gathering information. Explore ways to utilize crowdsourced incident information for traffic operations planning.

13. **Encourage connectivity within and between Regional Activity Centers.** The recent refinement of the Regional Activity Centers map, adopted in 2013, helps coordinate transportation and land use planning for future growth. Geographically-focused Household Travel Surveys can collect data which allows planners to see local level travel patterns and behaviors impacting mode shifts.

14. **Continue and enhance the regional congestion monitoring program with multiple data sources.** There are a wealth of sources, both public and private sector, for data related to congestion which have their individual strengths and shortcomings. Private sector probe-based monitoring provides unprecedented spatial and temporal coverage on roadways, but still needs to be supplemented with data from other sources including data on traffic volumes and traffic engineering considerations. There should be continual review of the quality and availability of data provided by different sources and the structuring of a monitoring program in way that is adaptable for potential future changes in data reporting and/or data sources.

15. **Monitor trends in freight, specifically truck travel, as the opening of the Panama Canal expansion nears.** This expansion will allow much larger ships from Asia to serve East Coast ports, including the nearby ones in Baltimore and the Hampton Roads area in Virginia. Much of the new cargo arriving at these ports will pass through the Washington region by truck or rail on its way to inland destinations.

16. **Participate in collaborative planning connected and autonomous vehicle readiness.** These emerging technologies will dramatically alter future transportation planning. Standards and interoperability are critical issues and should be addressed through extensive collaboration with a variety of stakeholders.

17. **Continue to coordinate with providers of shared mobility services.** According to the American Public Transit Association (APTA), people who uses shared modes such as bikesharing, carsharing, and ride hailing own fewer cars and spend less on transportation. Cooperation and communication between the public and private sectors is required to promote safe and beneficial transportation options.

APPENDICES

APPENDIX A – 2015 PEAK HOUR TRAVEL TIME INDEX

Note:

1. Calculation and visualization were provided by the "Trend Map" tool of the Vehicle Probe Project Suite developed by the CATT Lab of the University of Maryland, https://vpp.ritis.org/.

2. Peak Hour: 8:00-9:00 am is the regional morning peak hour, and 5:00-6:00 pm is the regional afternoon peak hour, Monday through Friday.

3. Congestion levels are categorized by the value of Travel Time Index:
   TTI = 1.0: Free flow
   1.0<TTI<=1.3: Minimal
   1.3<TTI<=1.5: Minor
   1.5<TTI<=2.0: Moderate
   2.0<TTI<=2.5: Heavy
   2.5<TTI: Severe

Figure A1: Travel Time Index on the Interstates and Freeways during Weekday 8:00-9:00 am, 2015

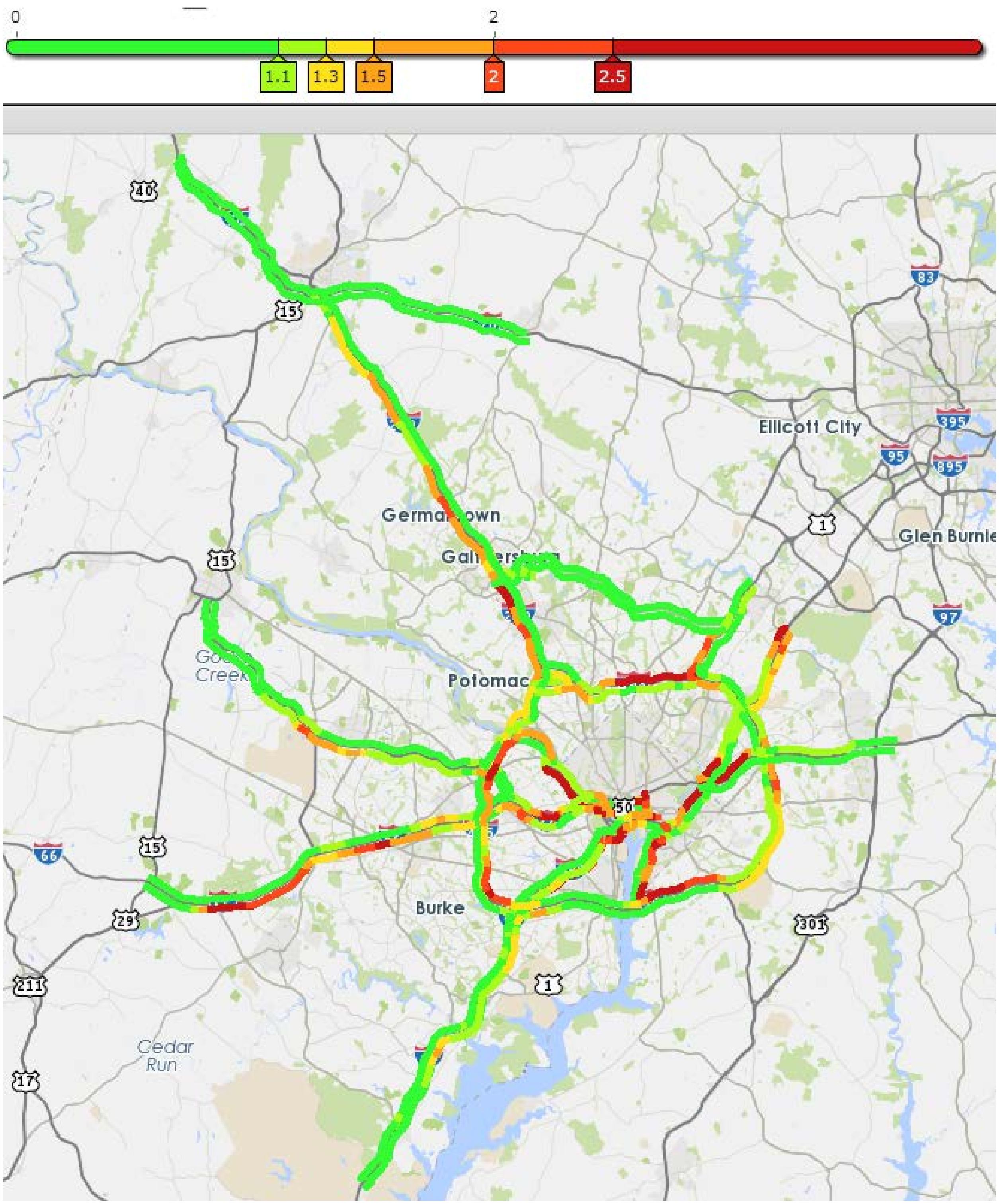


Figure A2: Travel Time Index on the Interstates and Freeways during Weekday 5:00-6:00 pm, 2015

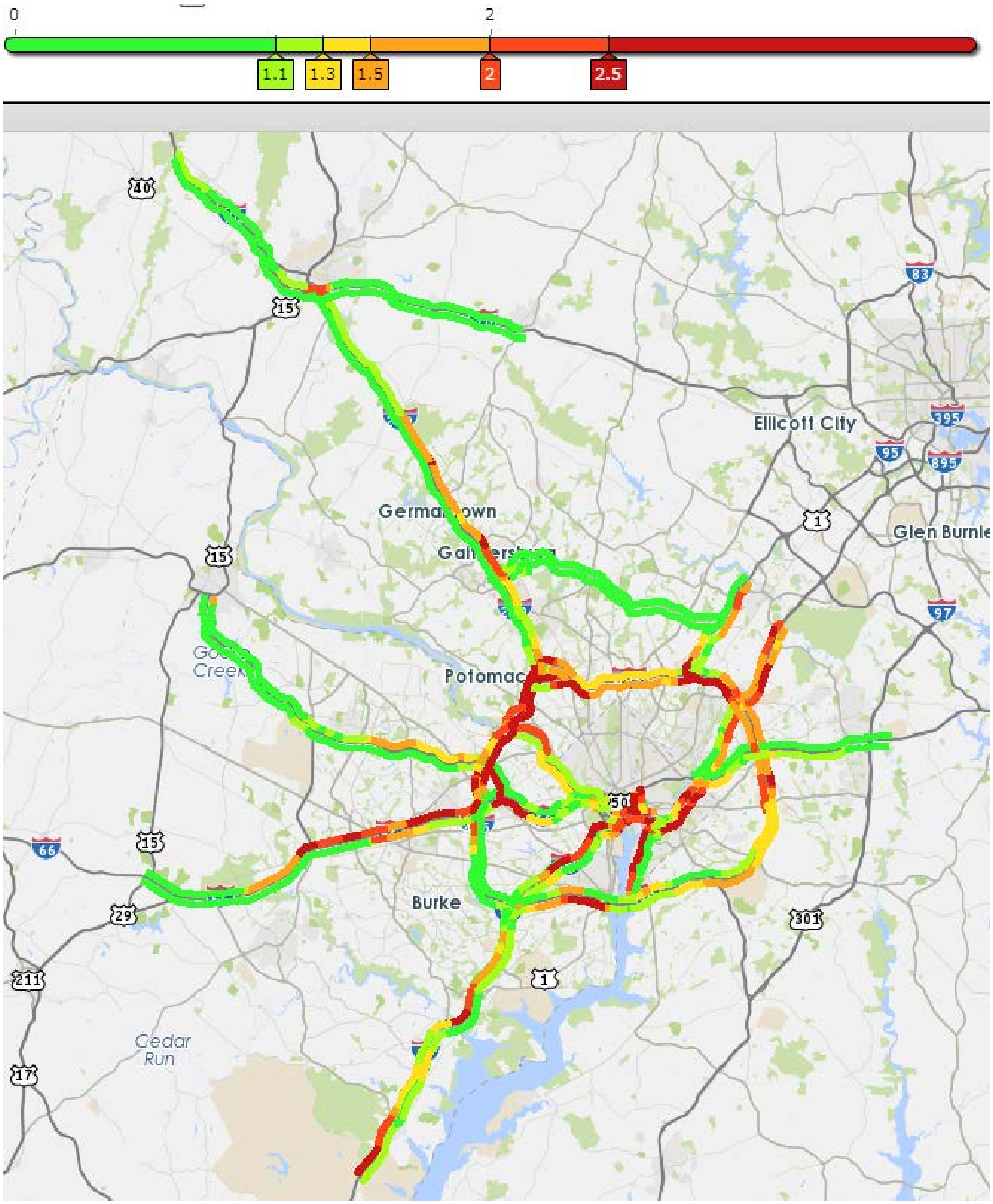


Figure A3: Travel Time Index in DC during Weekday 8:00-9:00 am, 2015

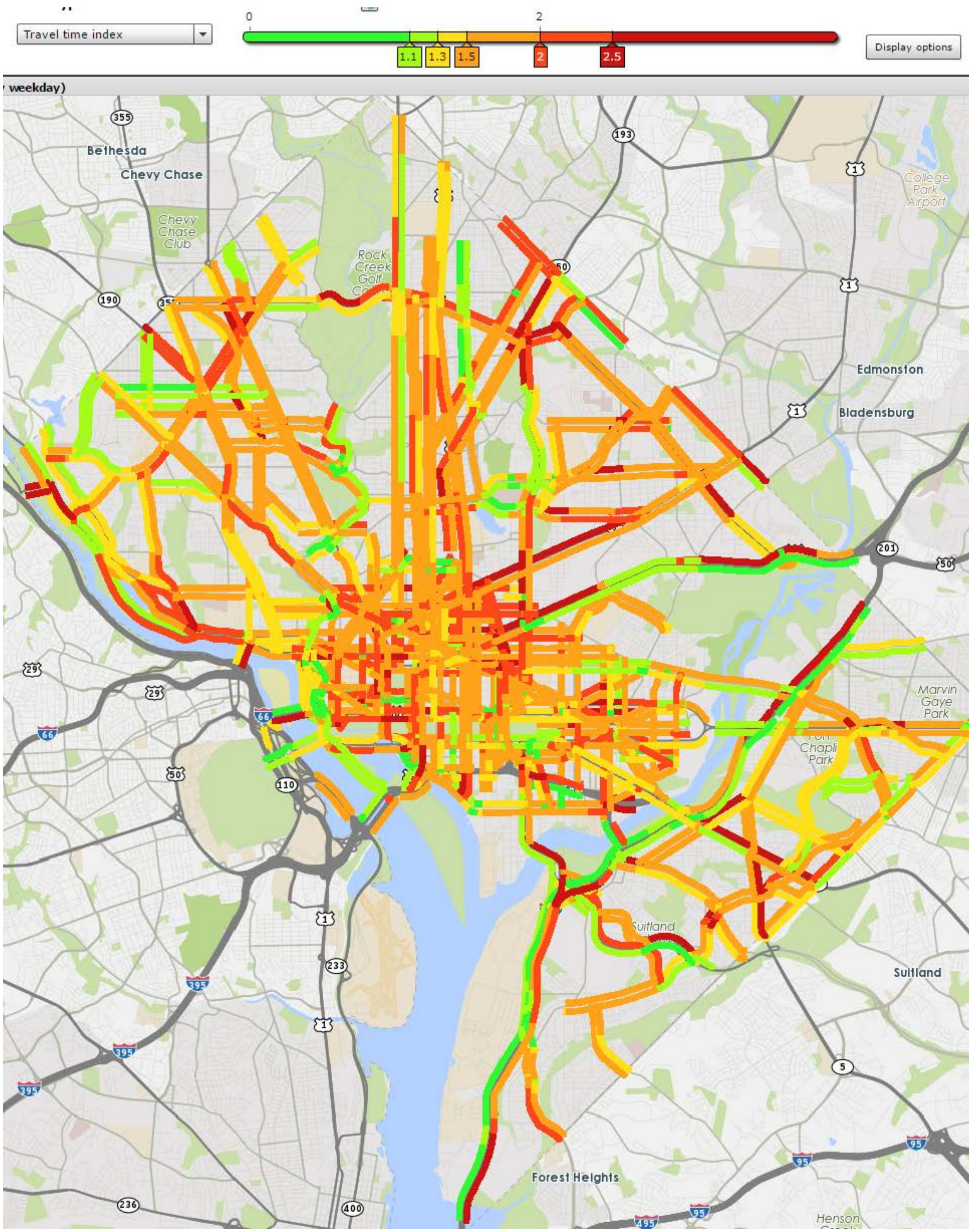


Figure A4: Travel Time Index in DC during Weekday 5:00-6:00 pm, 2015

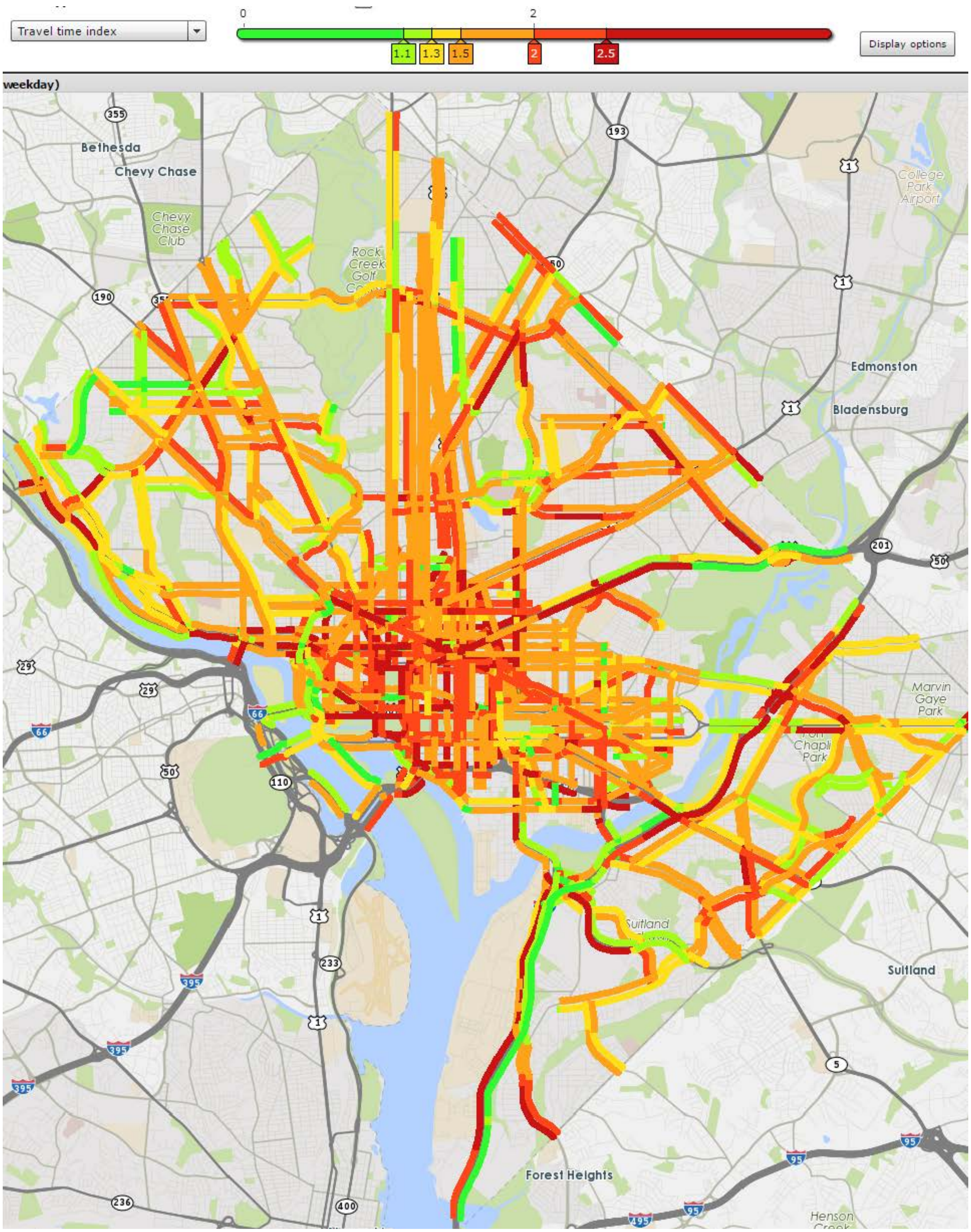


Figure A5: Travel Time Index in Frederick County, MD during Weekday 8:00-9:00 am, 2015

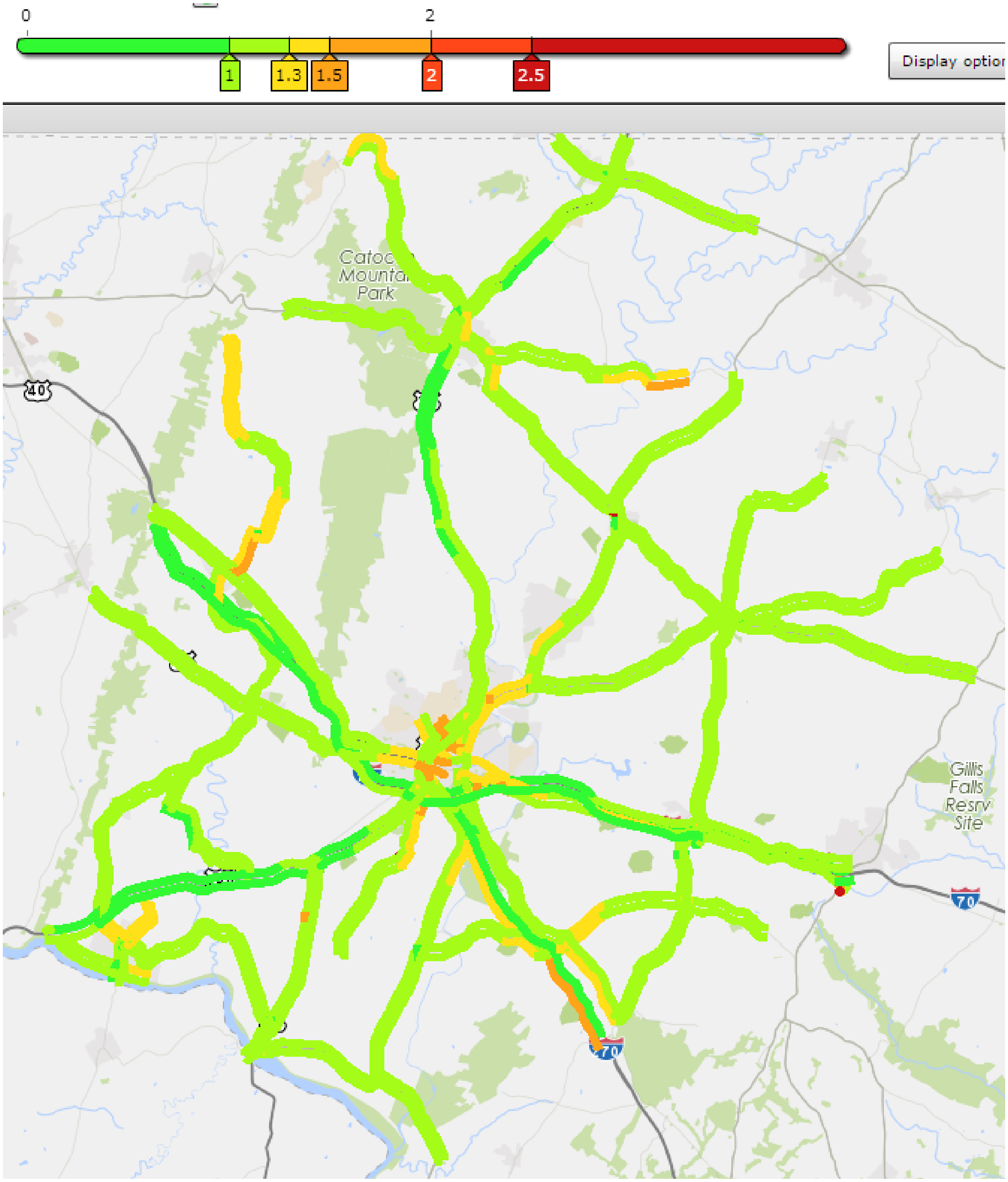


Figure A6: Travel Time Index in Frederick County, MD during Weekday 5:00-6:00 pm, 2015

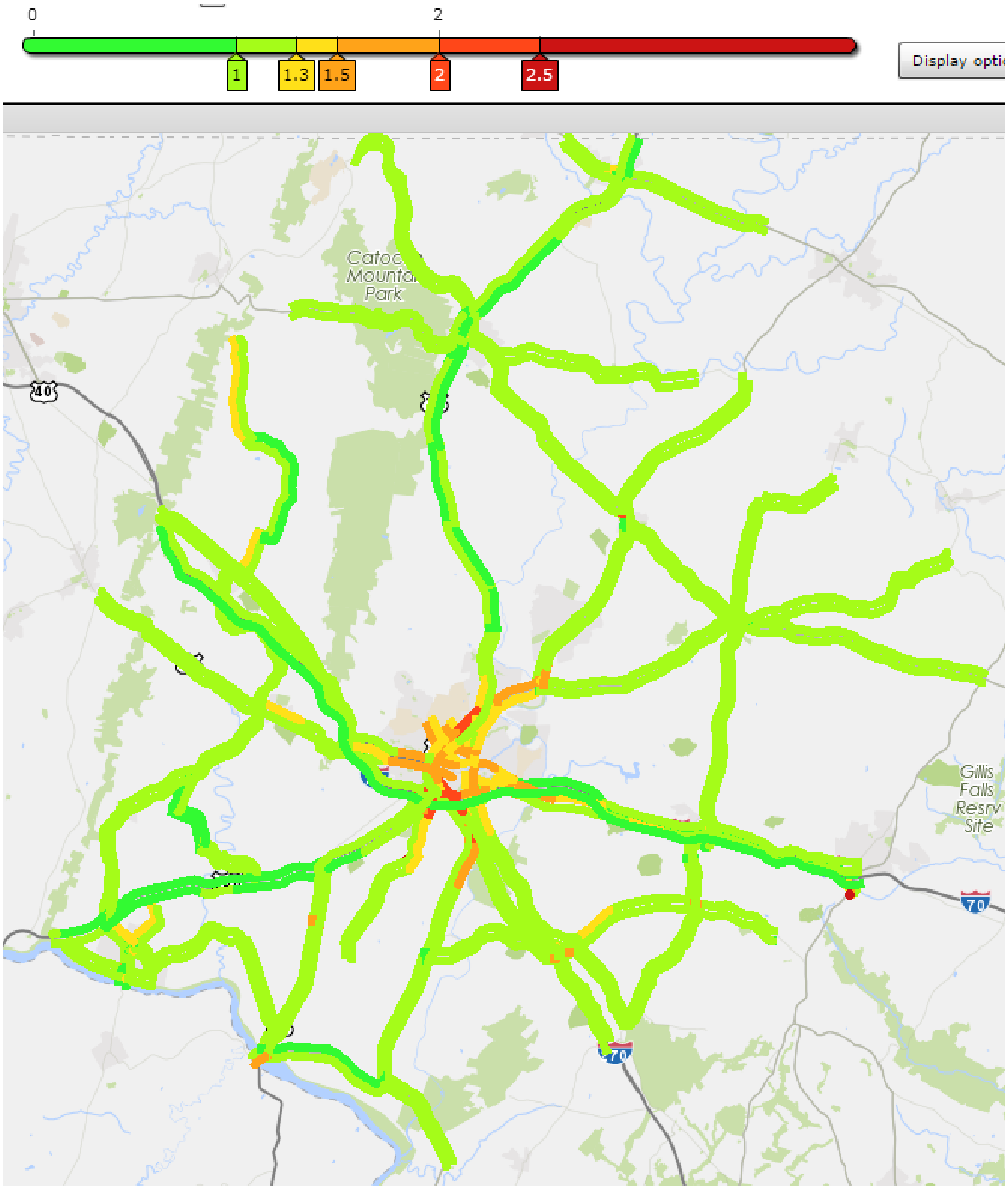


Figure A7: Travel Time Index in Montgomery County, MD during Weekday 8:00-9:00 am, 2015

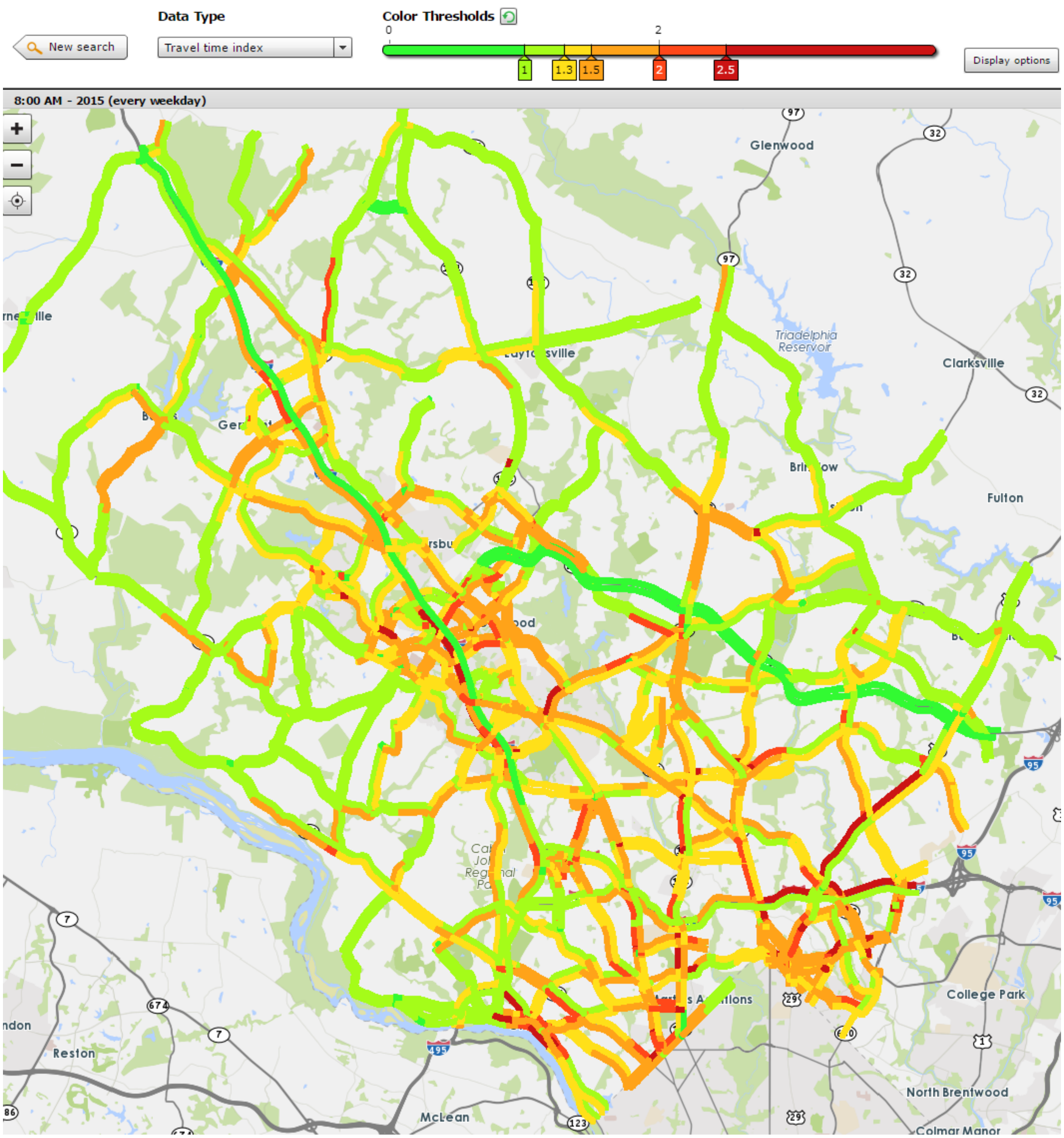


Figure A8: Travel Time Index in Montgomery County, MD during Weekday 5:00-6:00 pm, 2015

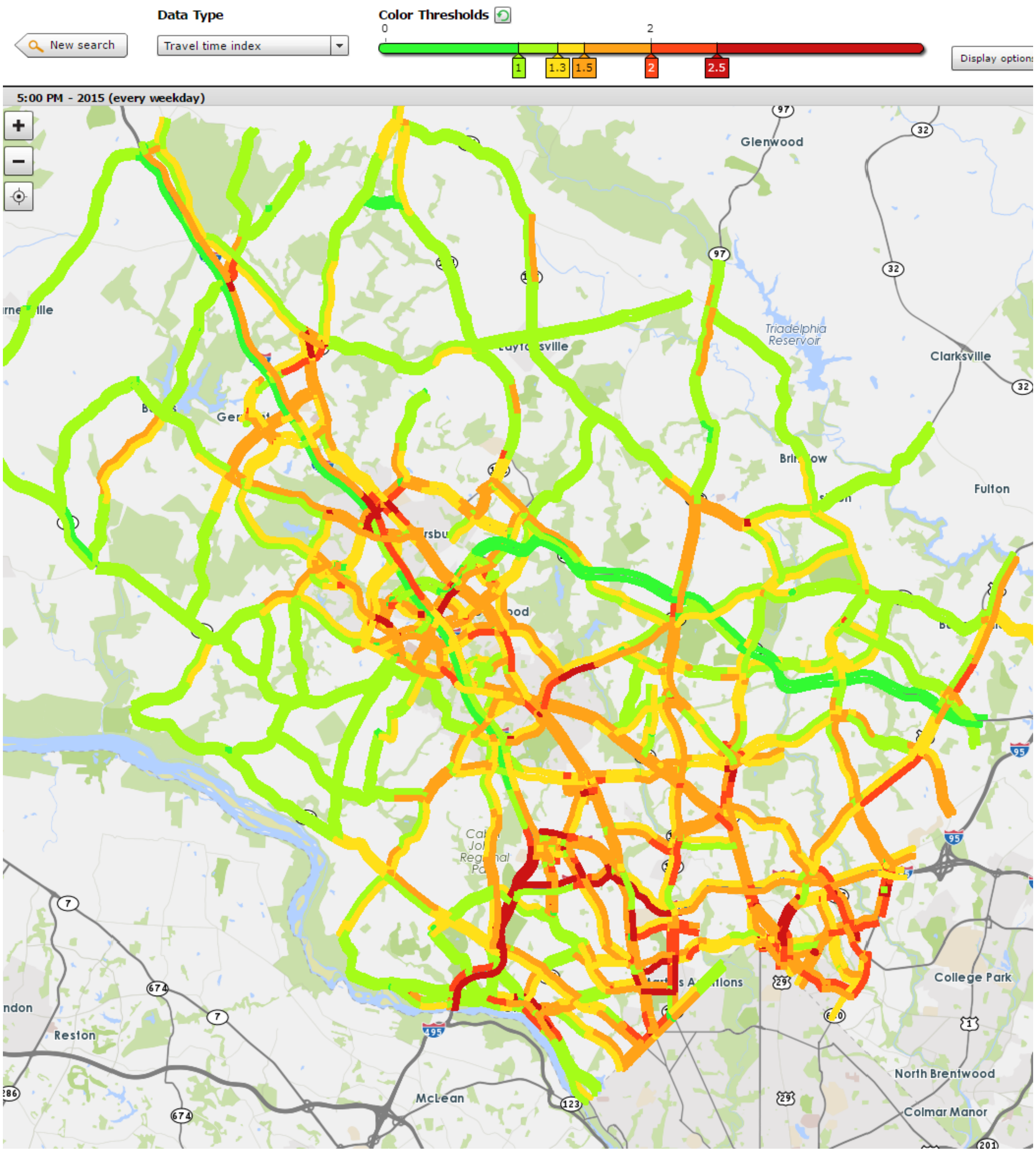


Figure A9: Travel Time Index in Prince George's County, MD during Weekday 8:00-9:00 am, 2015

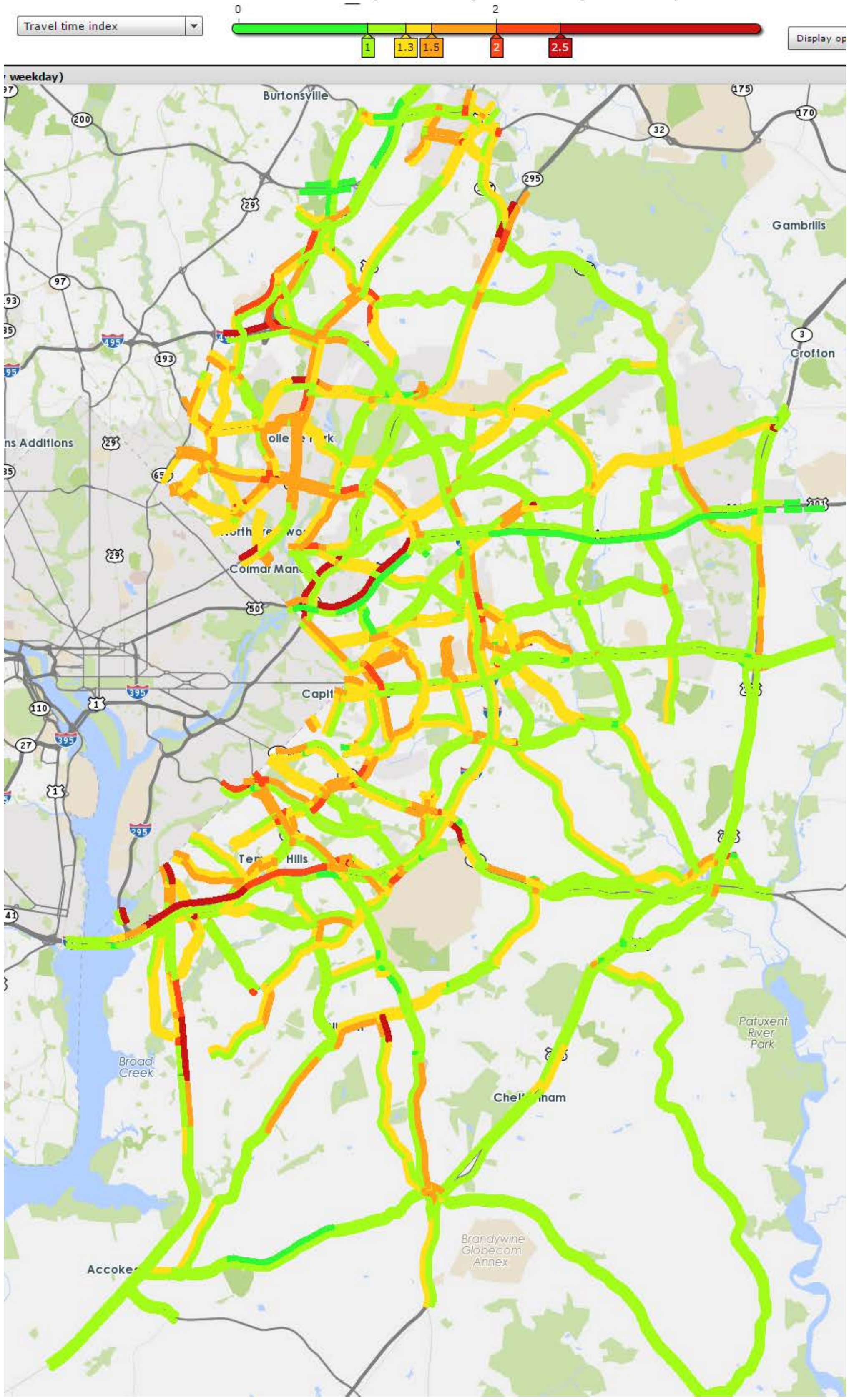


Figure A10: Travel Time Index in Prince George's County, MD during Weekday 5:00-6:00 pm, 2015

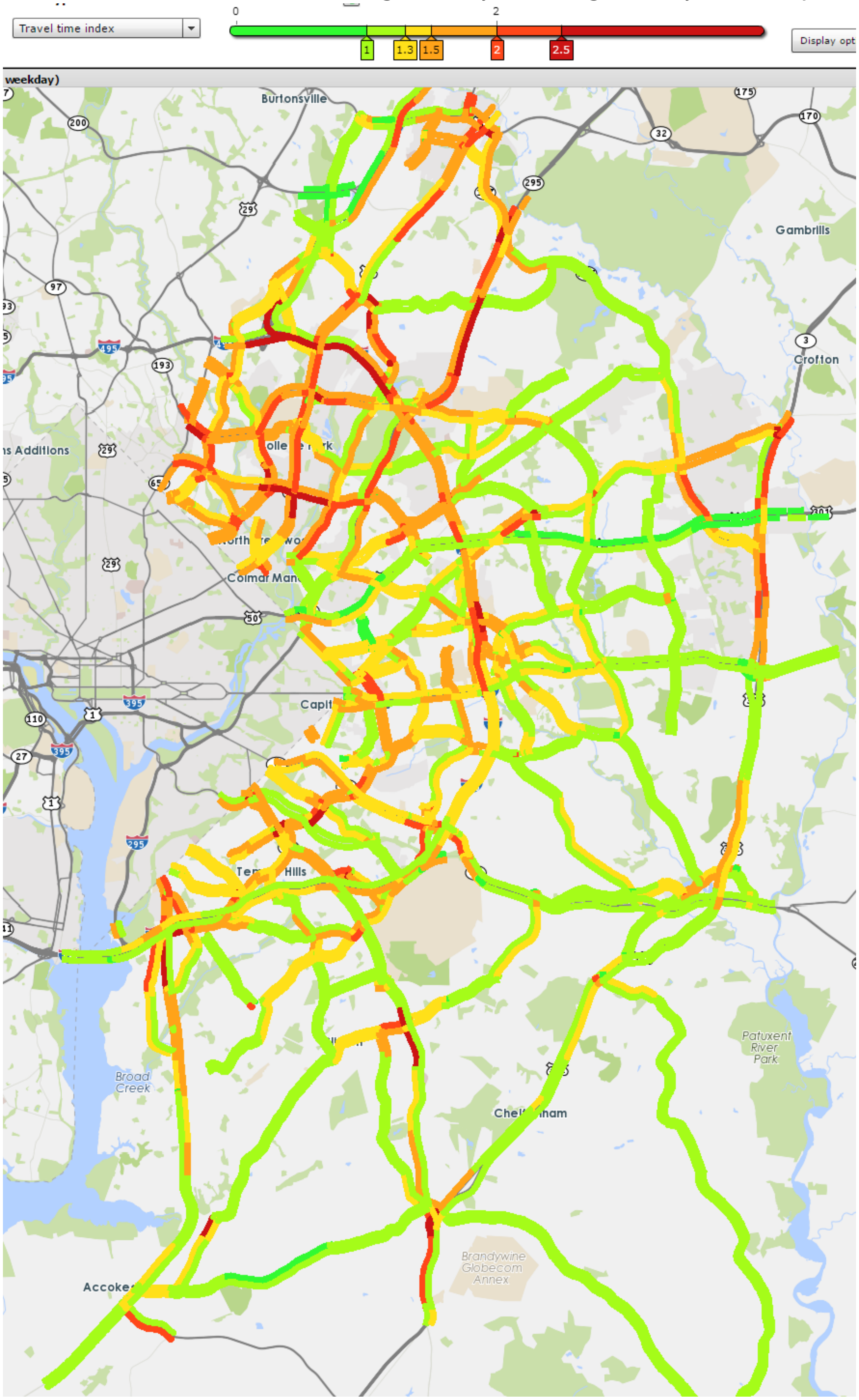


Figure A11: Travel Time Index in Charles County, MD during Weekday 8:00-9:00 am, 2015

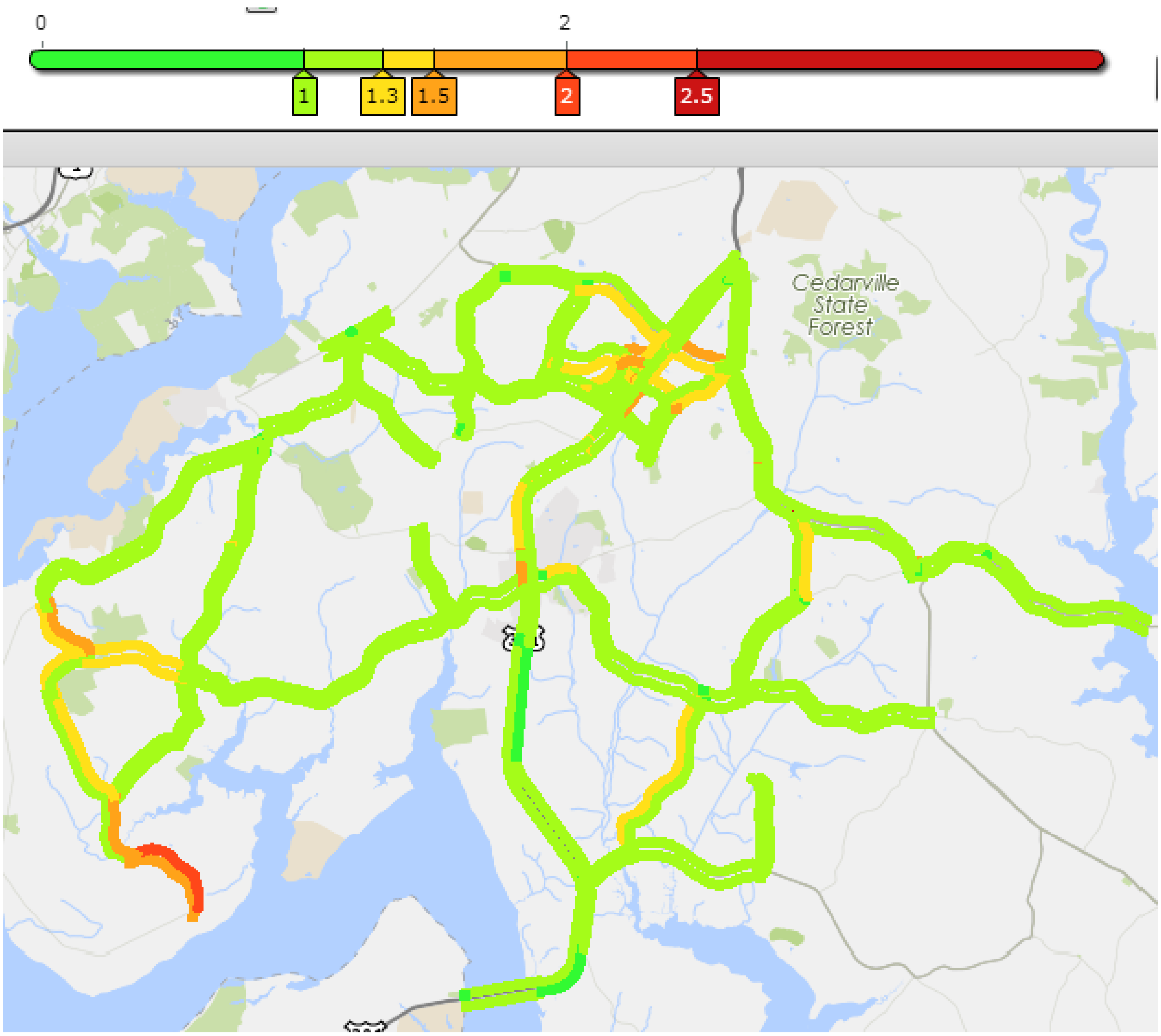


Figure A12: Travel Time Index in Charles County, MD during Weekday 5:00-6:00 pm, 2015

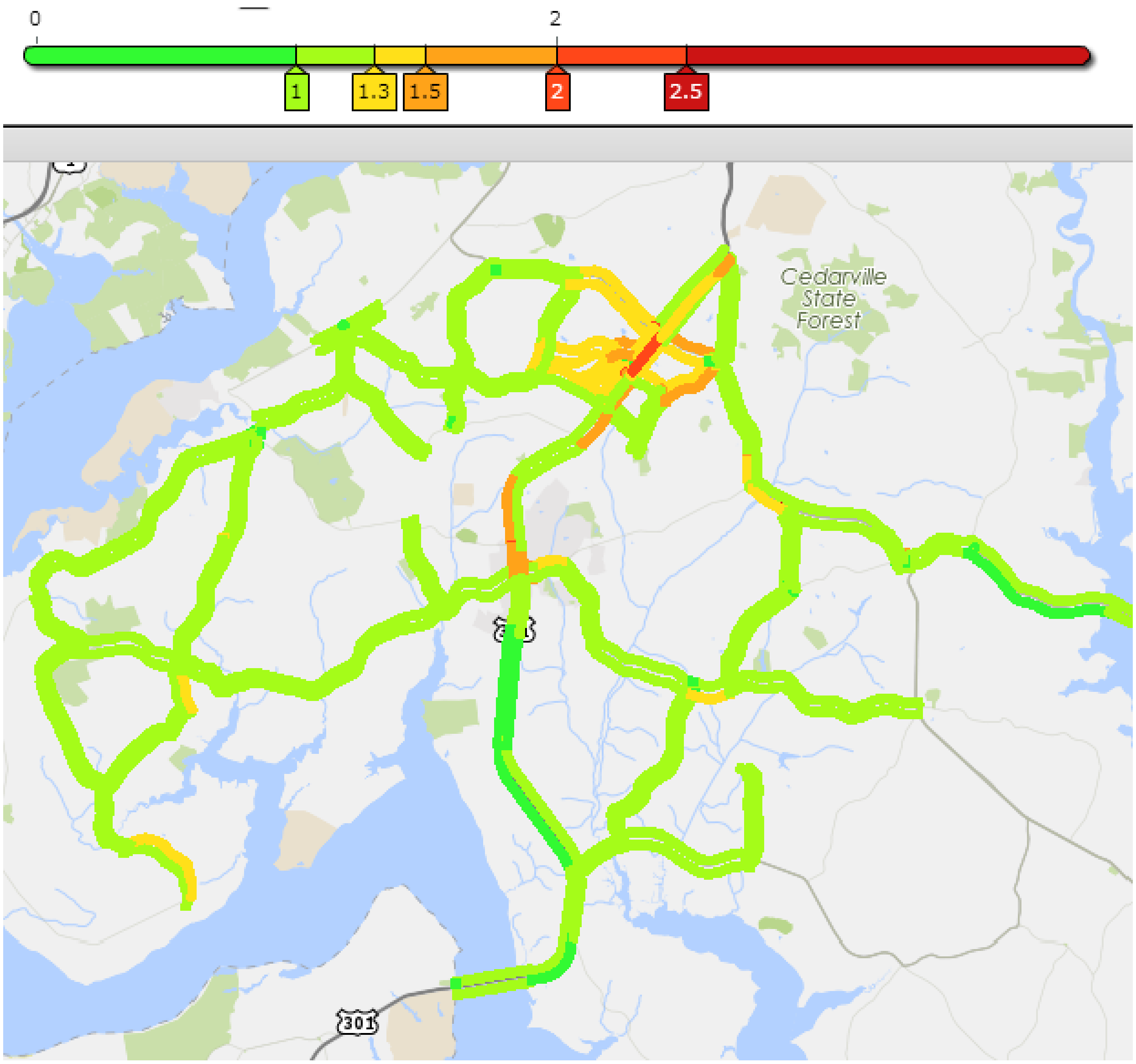


Figure A13: Travel Time Index in Loudoun County, VA during Weekday 8:00-9:00 am, 2015

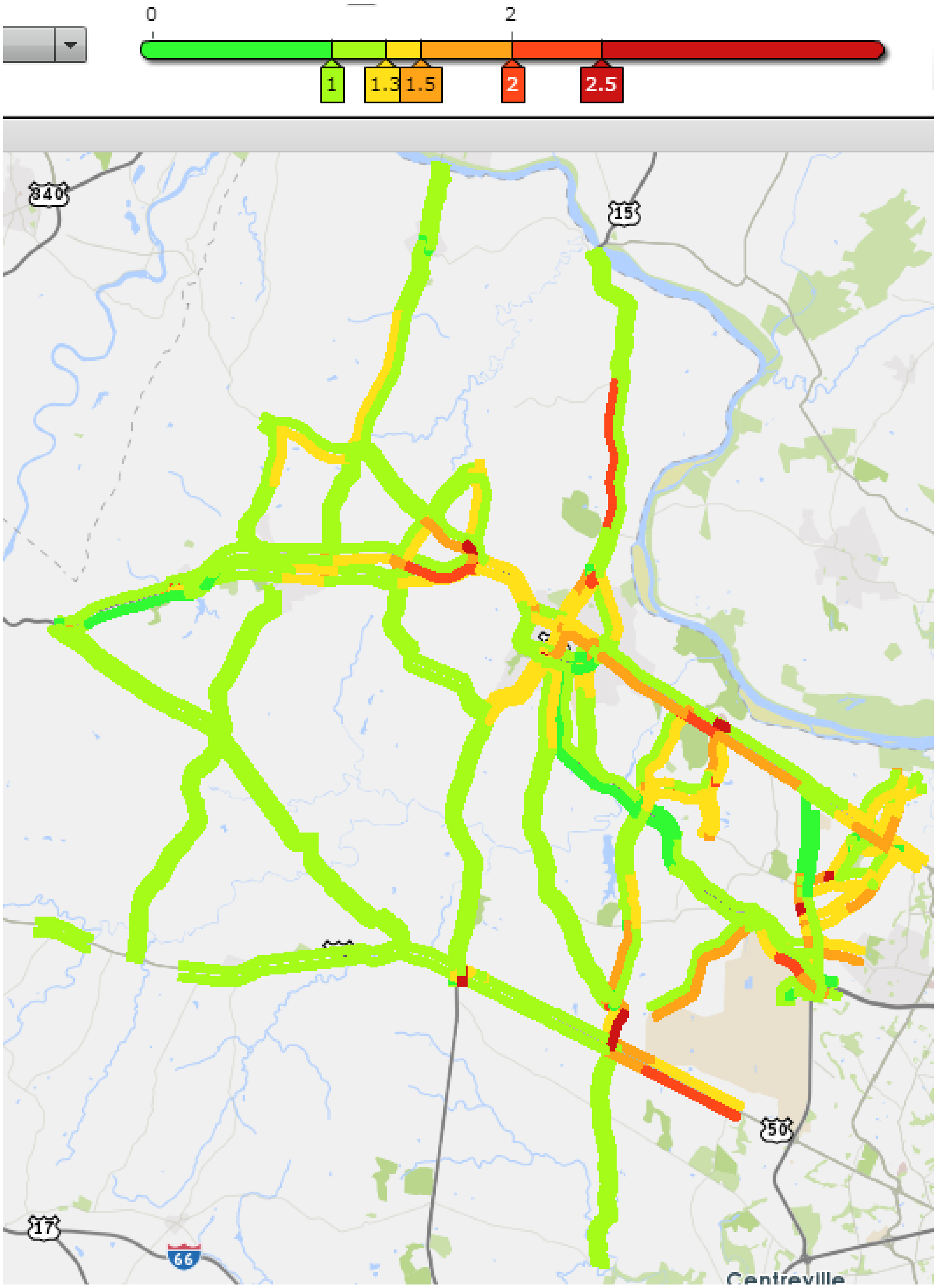


Figure A14: Travel Time Index in Loudoun County, VA during Weekday 5:00-6:00 pm, 2015

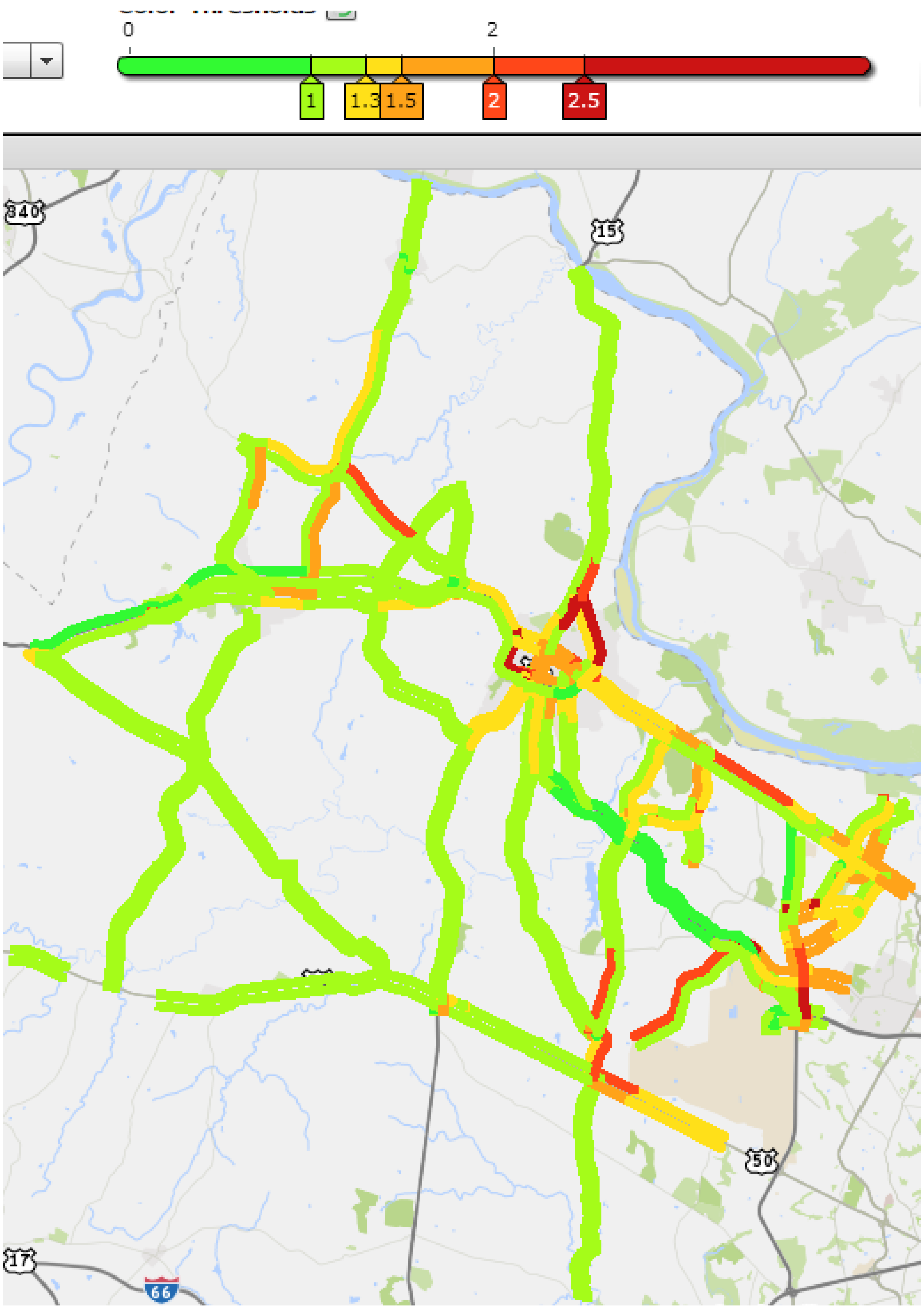


Figure A15: Travel Time Index in Fairfax, Prince William Counties and Cities of Fairfax, Manassas, and Manassas Park, VA during Weekday 8:00-9:00 am, 2015

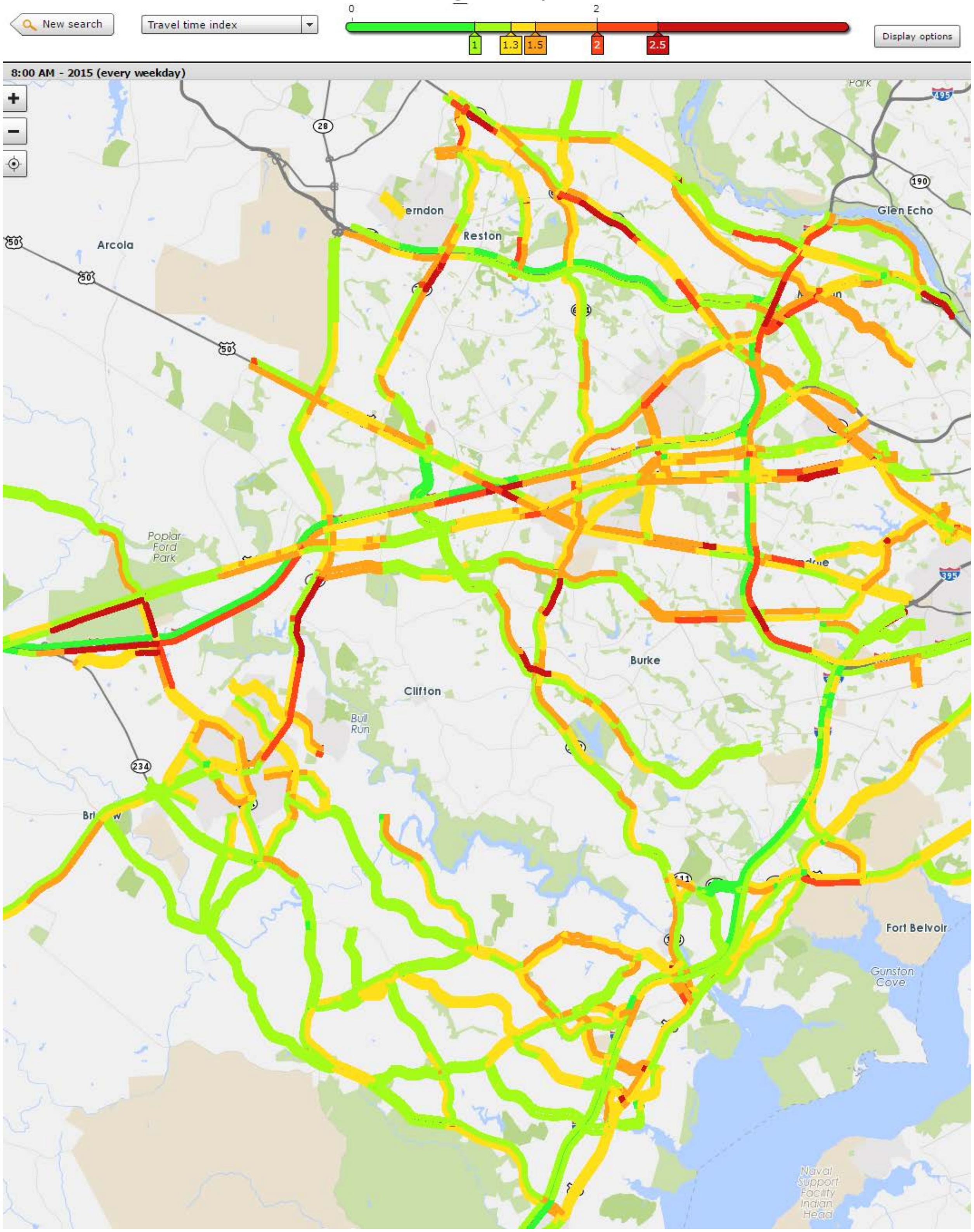


Figure A16: Travel Time Index in Fairfax, Prince William Counties and Cities of Fairfax, Manassas, and Manassas Park, VA during Weekday 5:00-6:00 pm, 2015

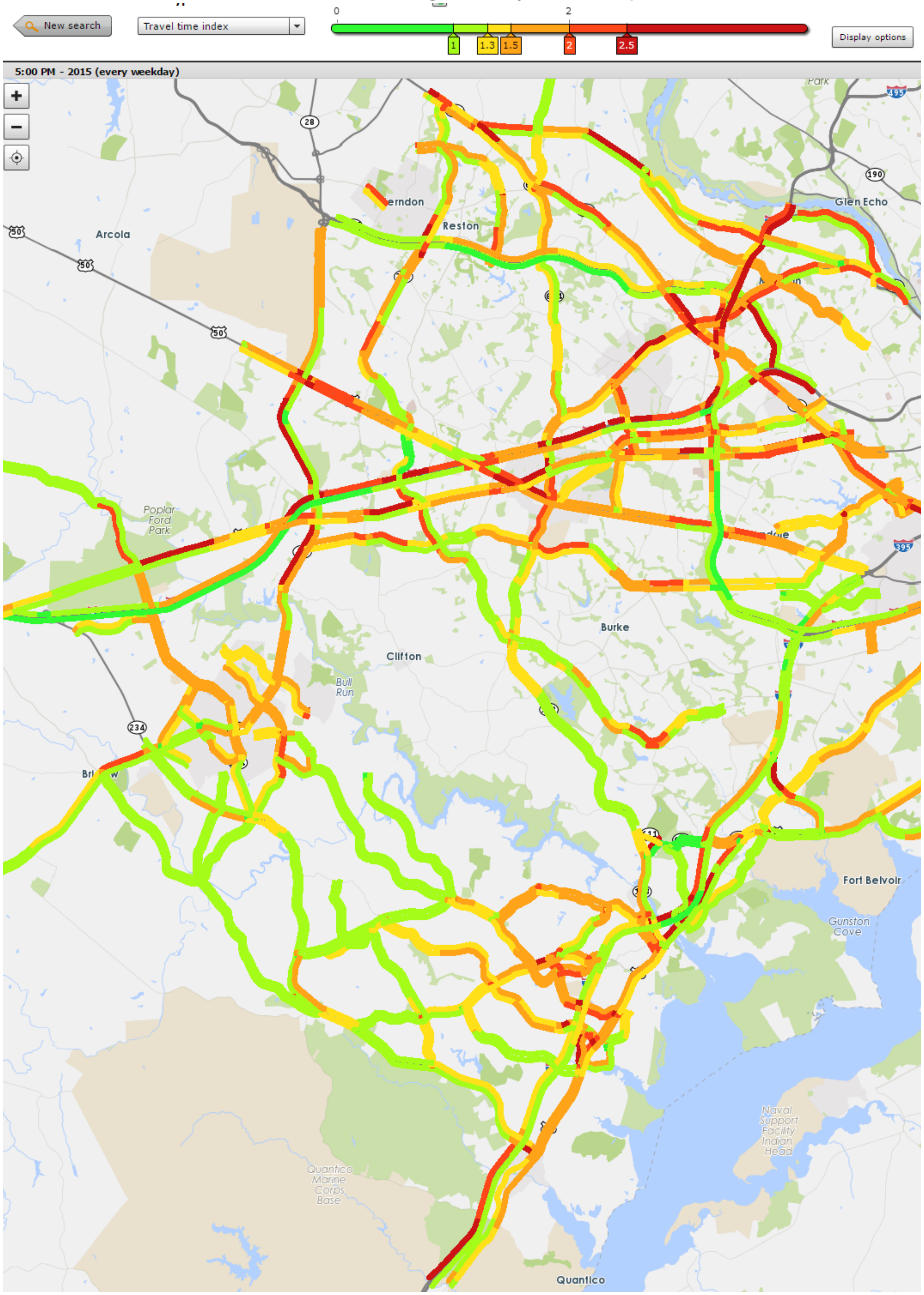


Figure A17: Travel Time Index in Cities of Alexandria, Arlington, and Falls Church, VA during Weekday 8:00-9:00 am, 2015

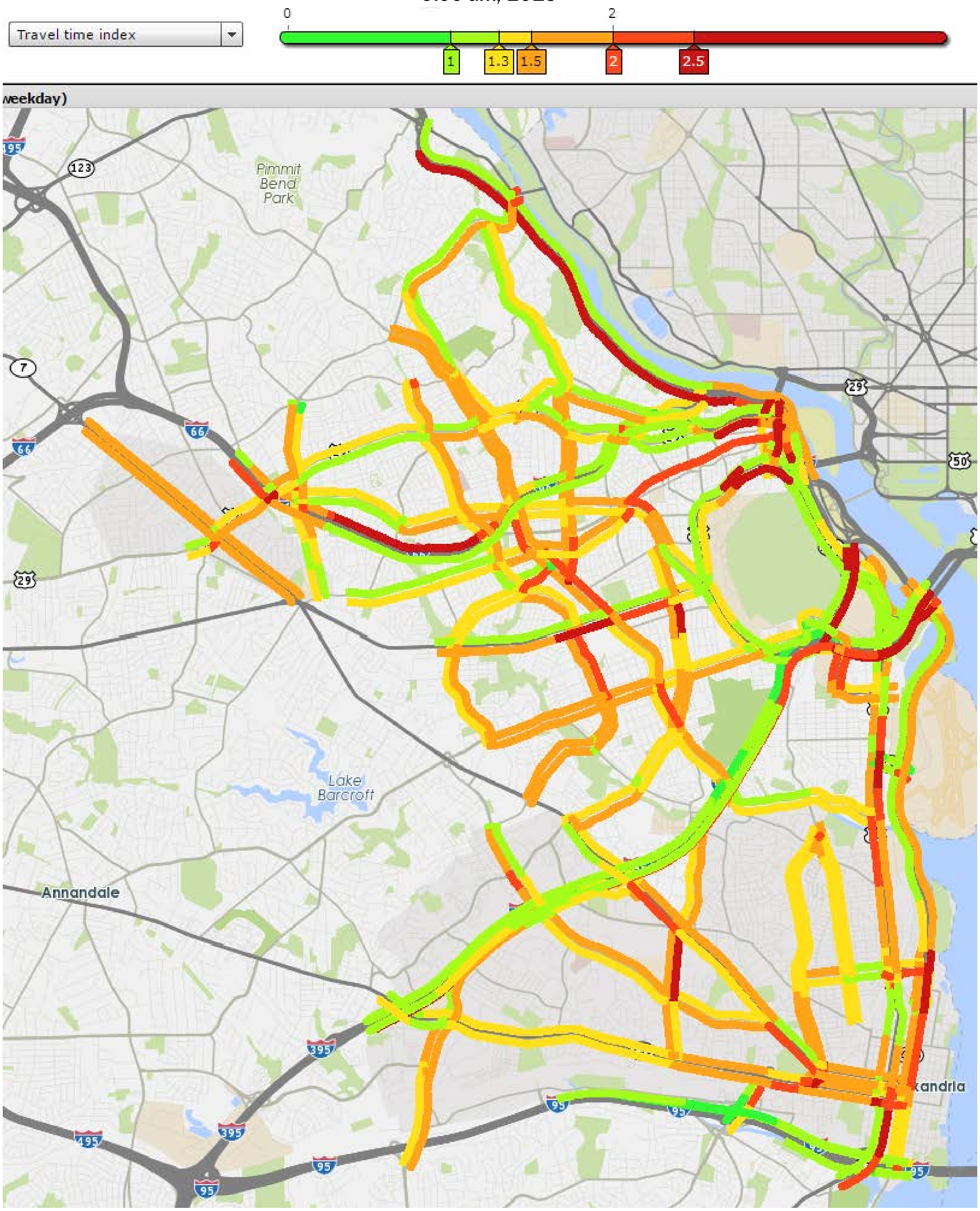
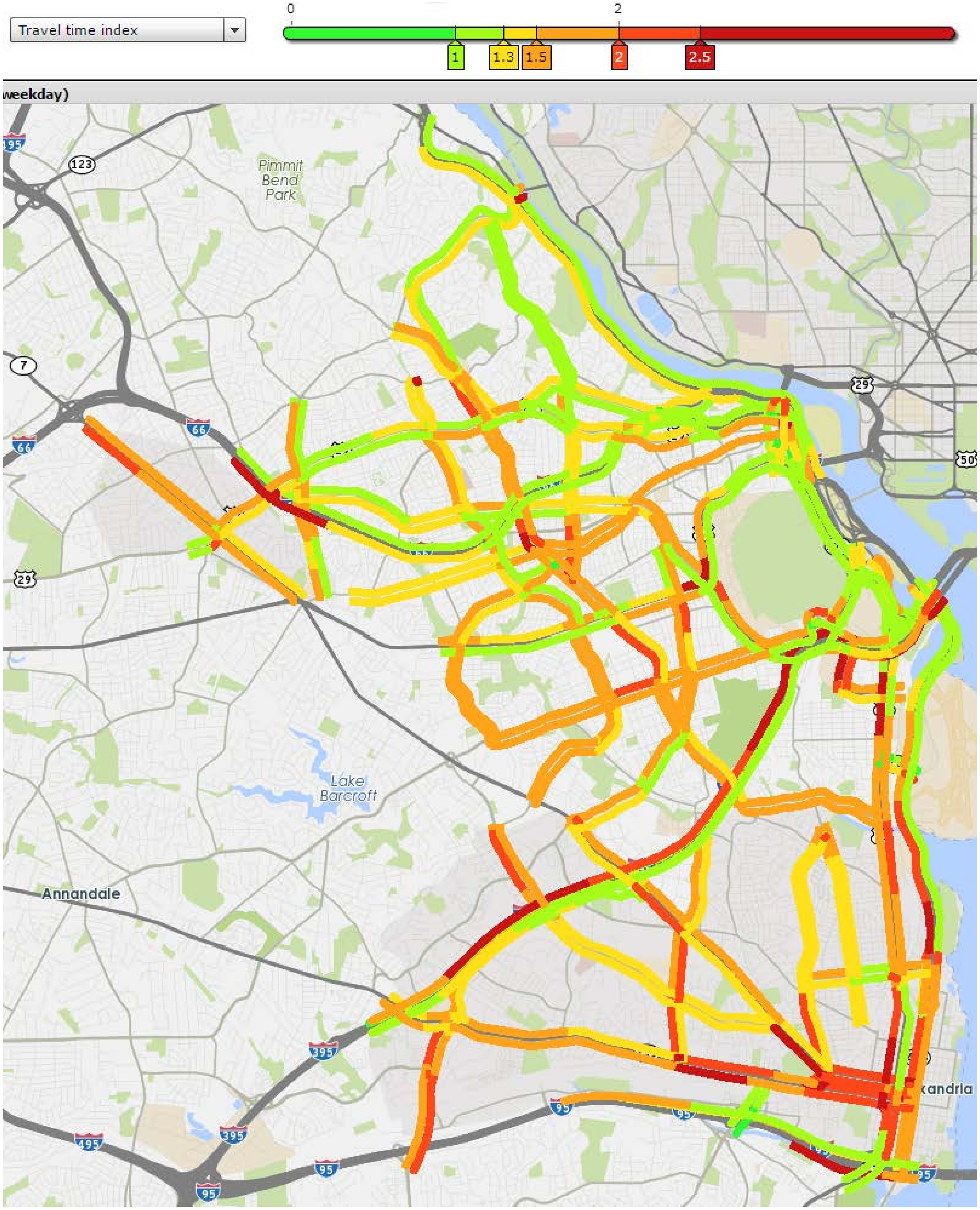


Figure A18: Travel Time Index in Cities of Alexandria, Arlington, and Falls Church, VA during Weekday 5:00-6:00 pm, 2015



APPENDIX B – 2015 PEAK HOUR PLANNING TIME INDEX

Note:

1. Calculation and visualization were provided by the "Trend Map" tool of the Vehicle Probe Project Suite developed by the CATT Lab of the University of Maryland, https://vpp.ritis.org/.

2. Peak Hour: 8:00-9:00 am is the regional morning peak hour, and 5:00-6:00 pm is the regional afternoon peak hour, Monday through Friday.

Figure B1: Planning Time Index on the Interstates and Freeways during Weekday 8:00-9:00 am, 2015

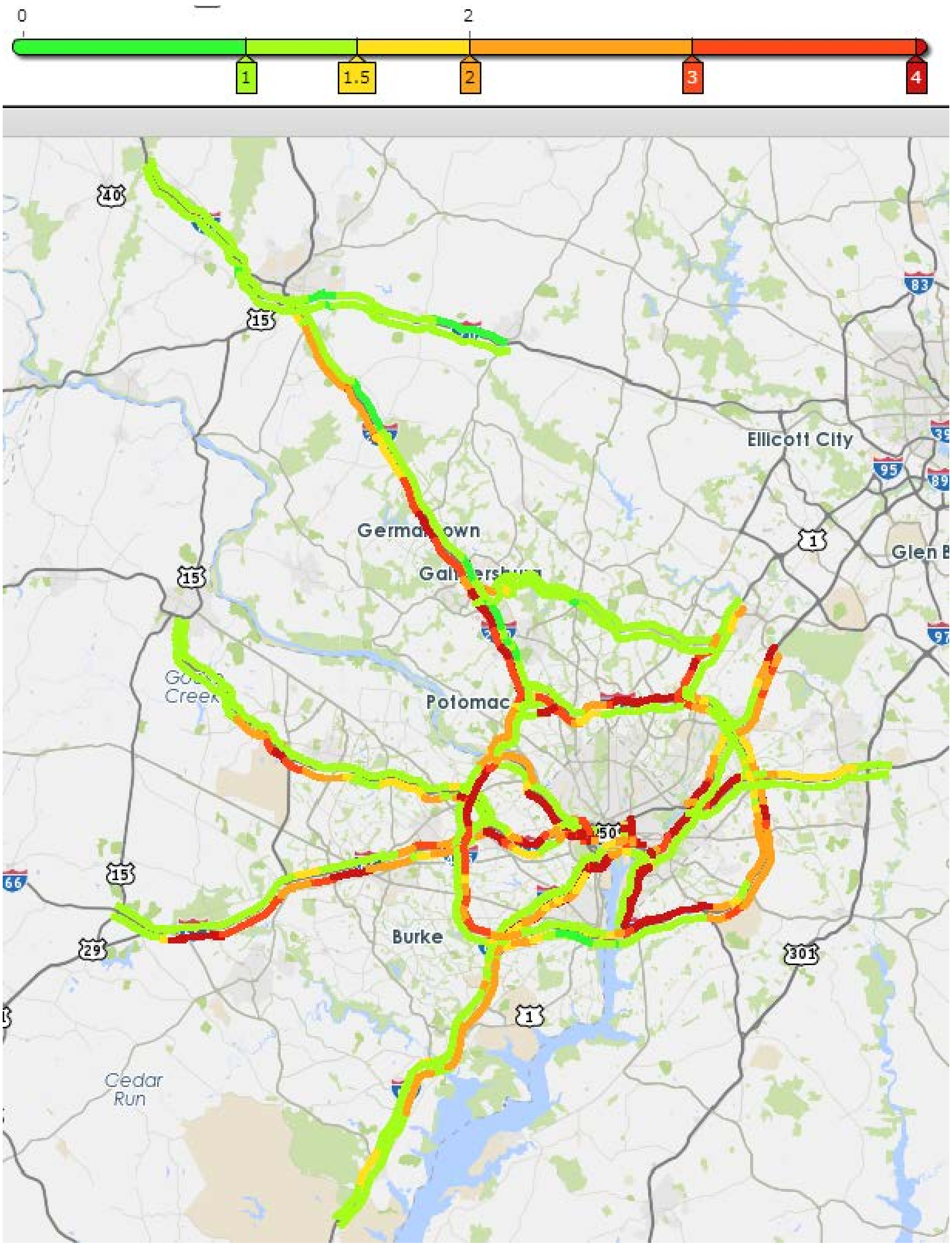


Figure B2: Planning Time Index on the Interstates and Freeways during Weekday 5:00-6:00 pm, 2015

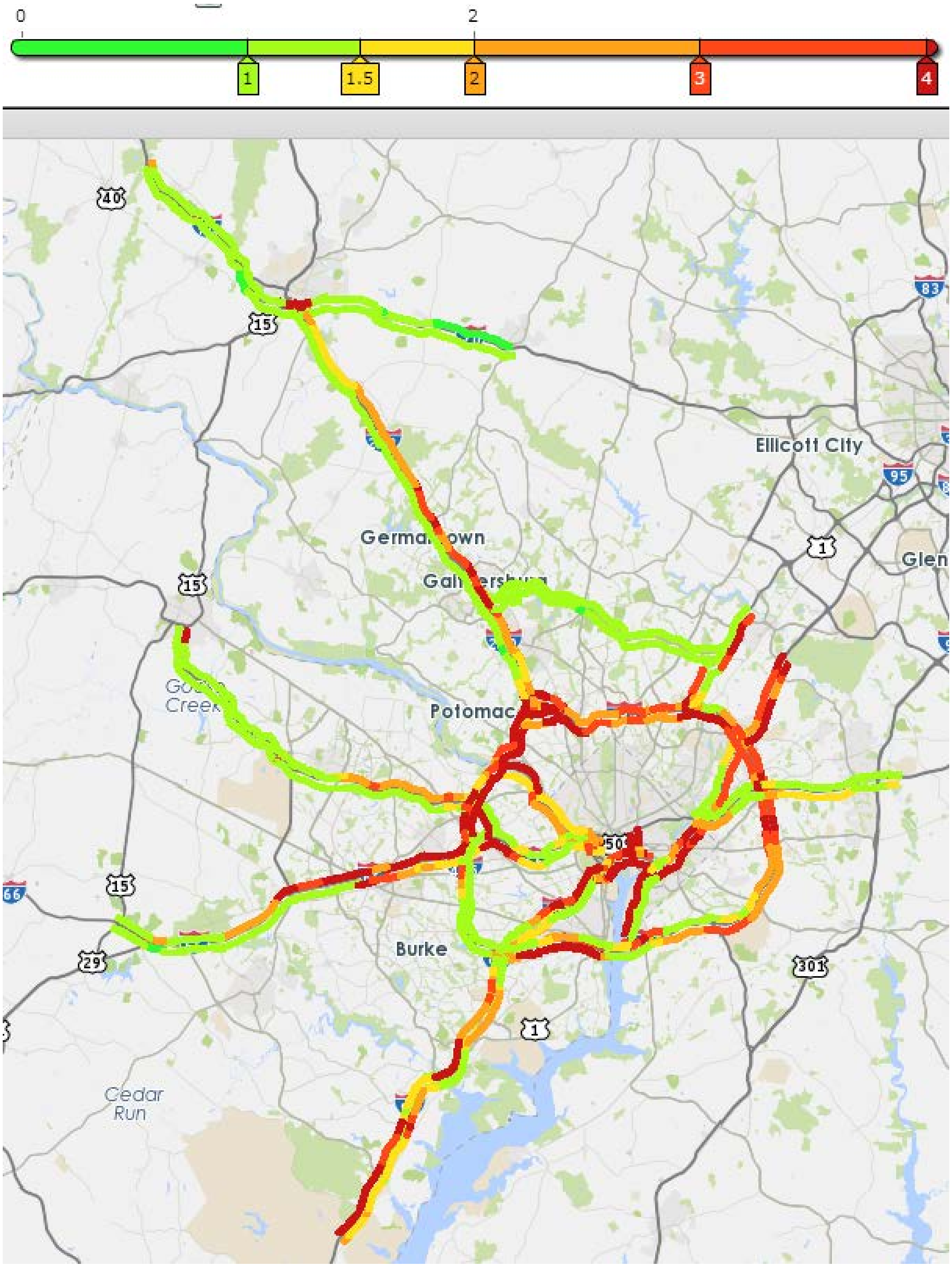


Figure B3: Planning Time Index in DC during Weekday 8:00-9:00 am, 2015

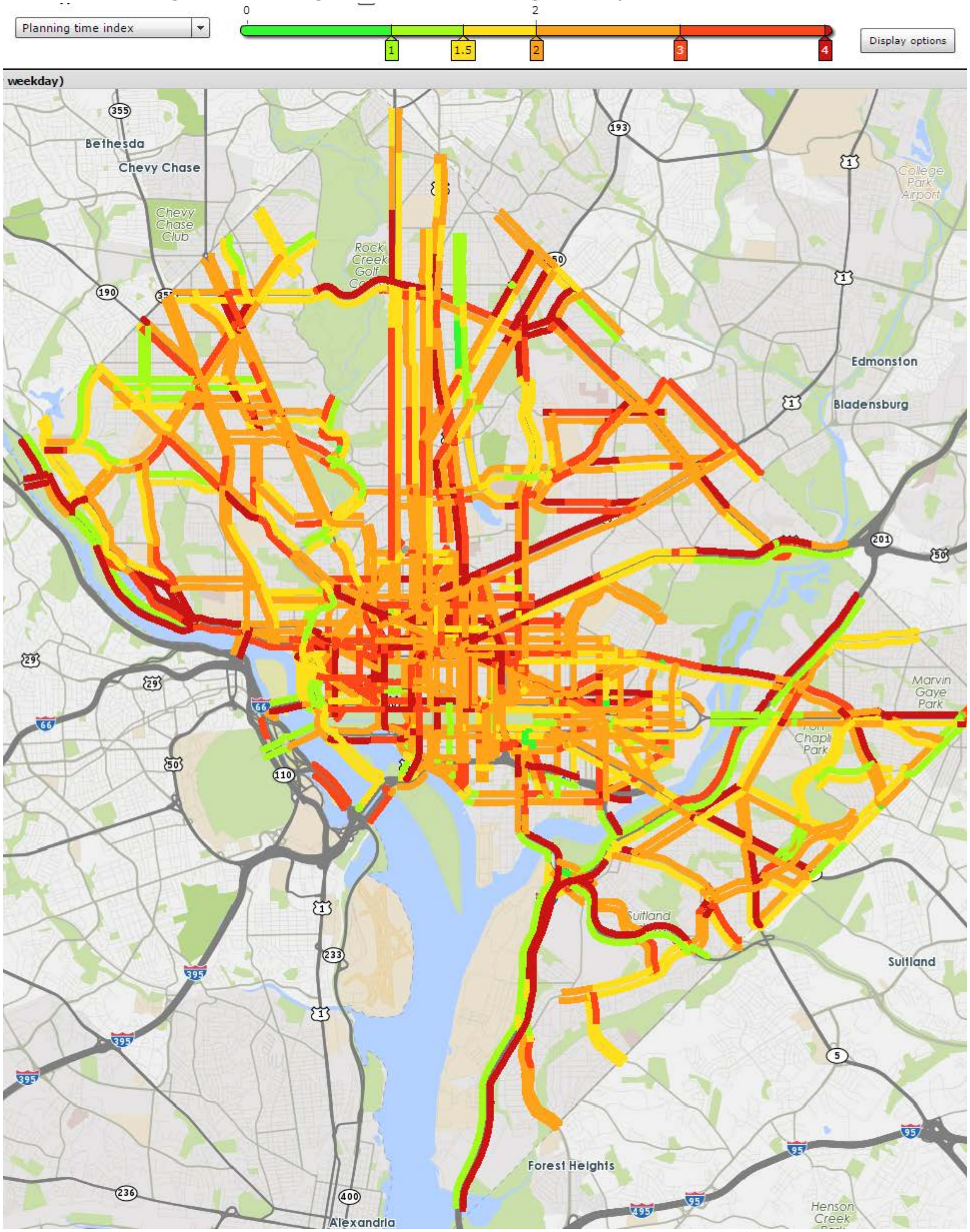


Figure B4: Planning Time Index in DC during Weekday 5:00-6:00 pm, 2015

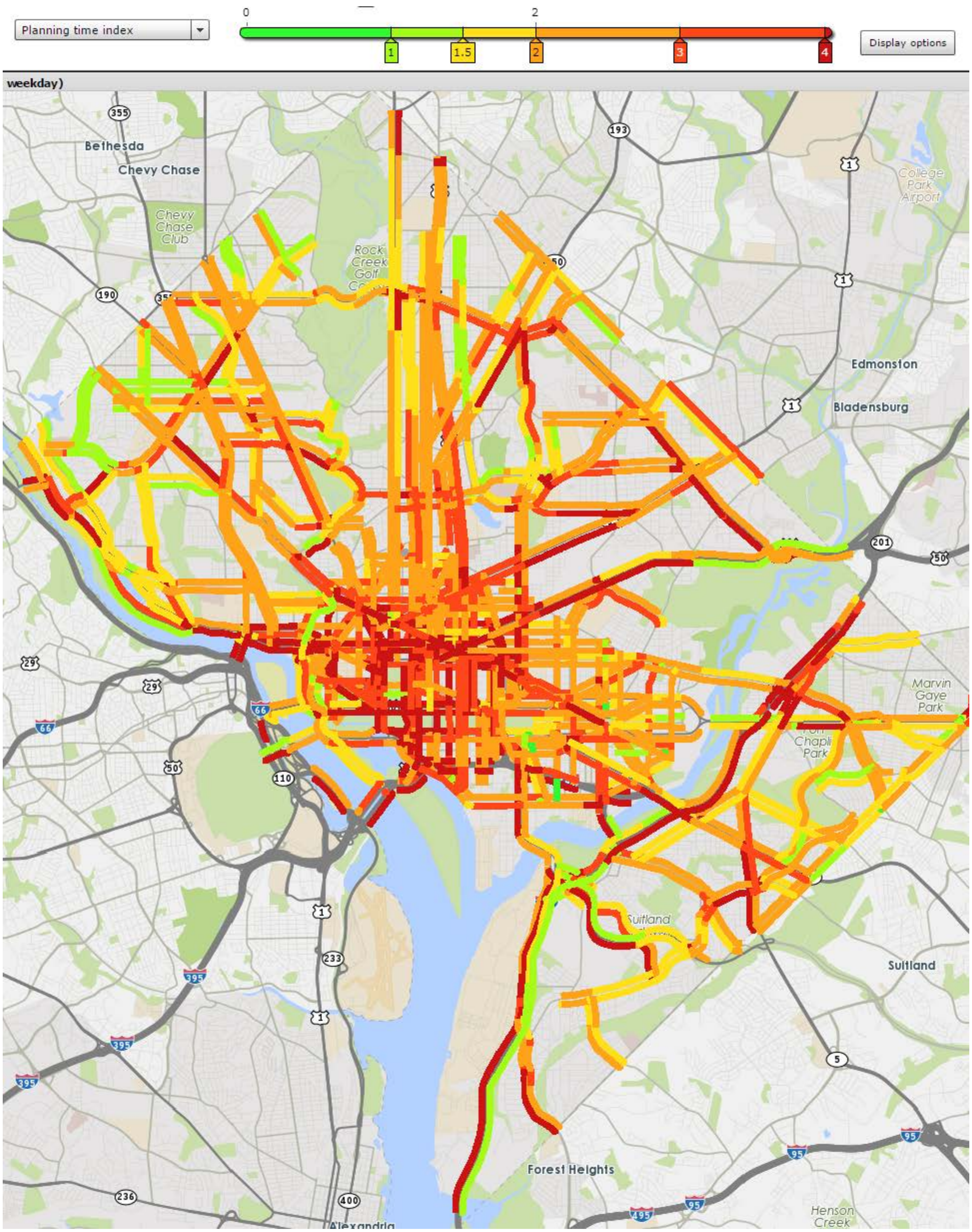


Figure B5: Planning Time in Frederick County, MD during Weekday 8:00-9:00 am, 2015

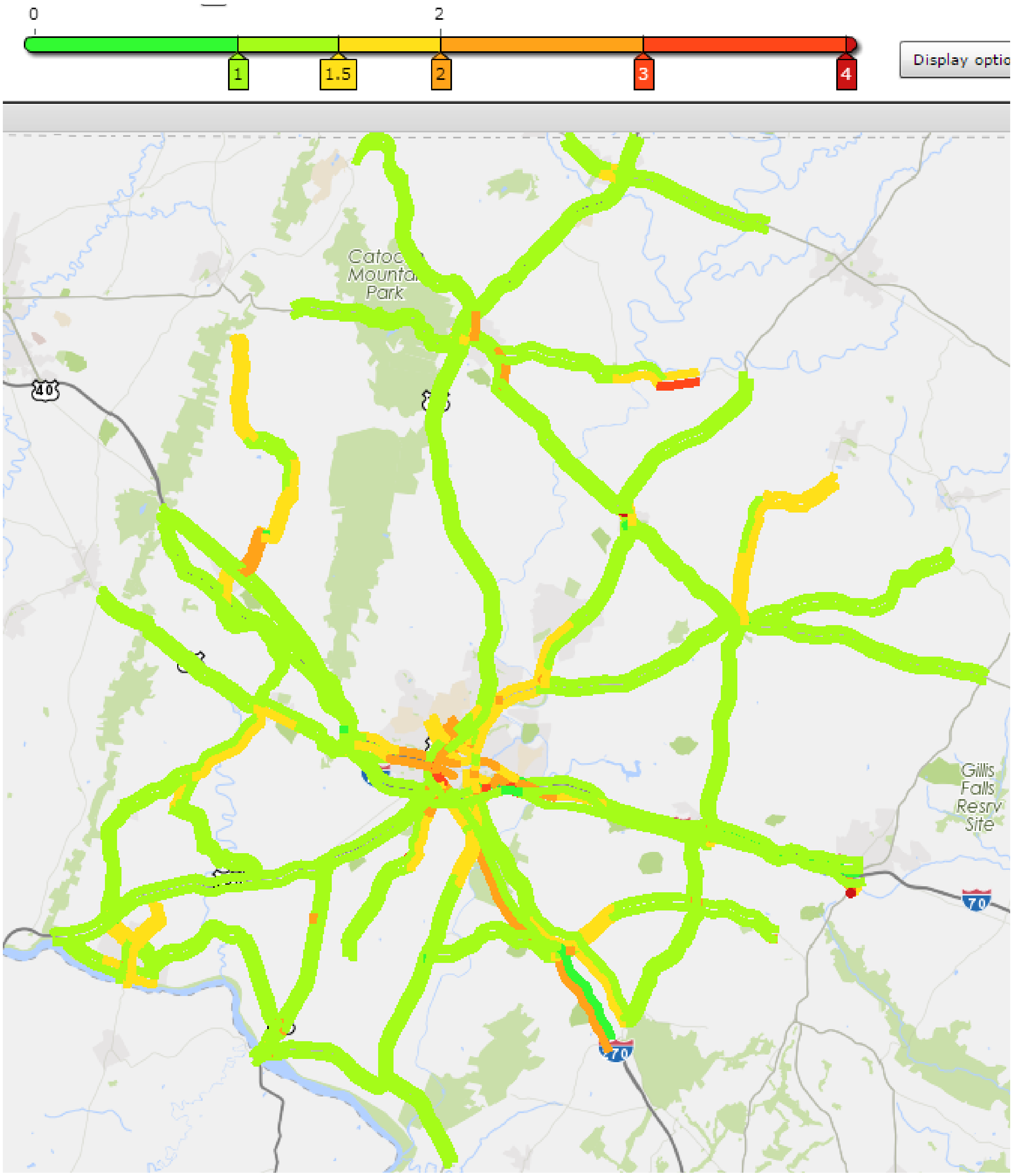


Figure B6: Planning Time Index in Frederick County, MD during Weekday 5:00-6:00 pm, 2015

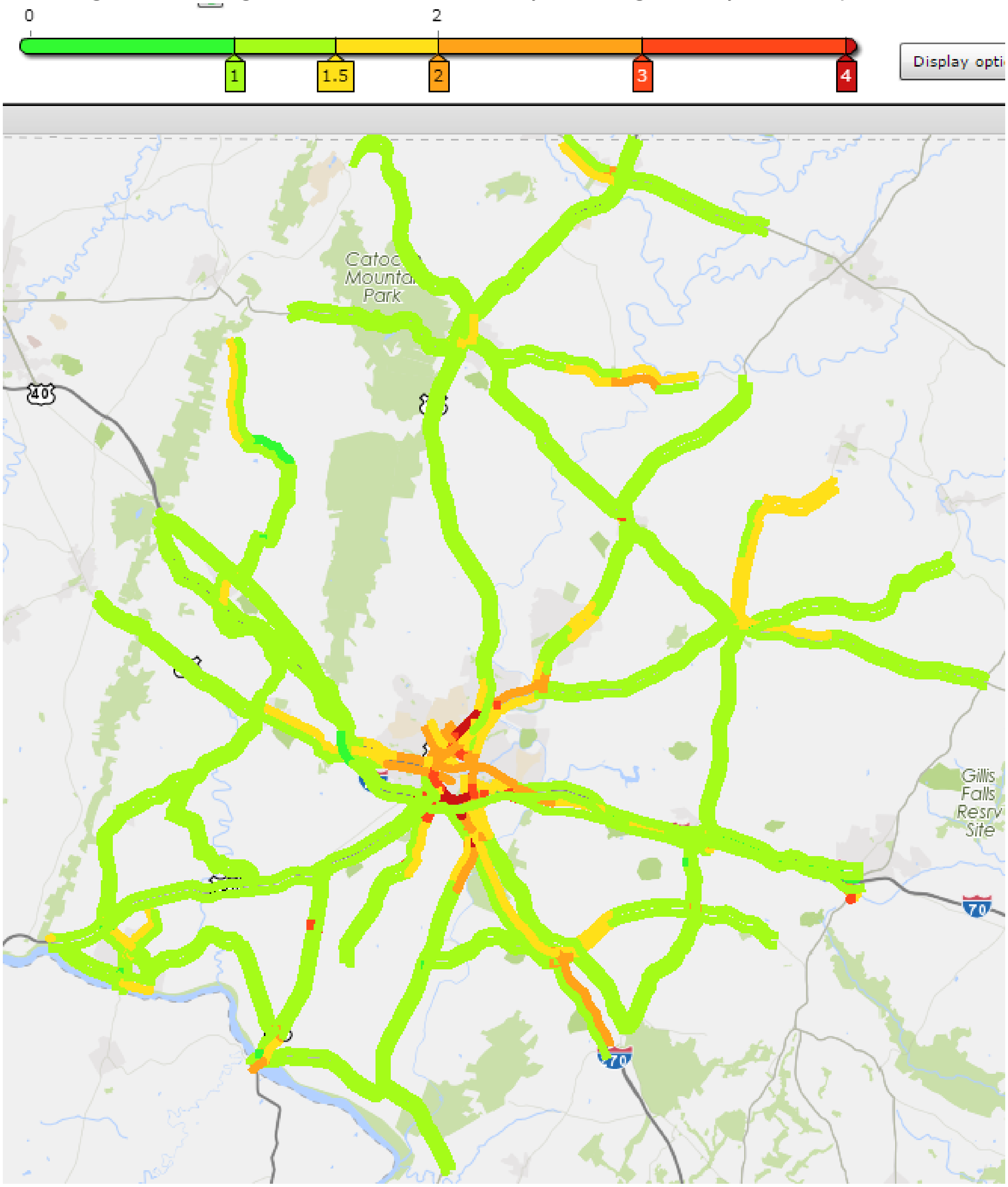
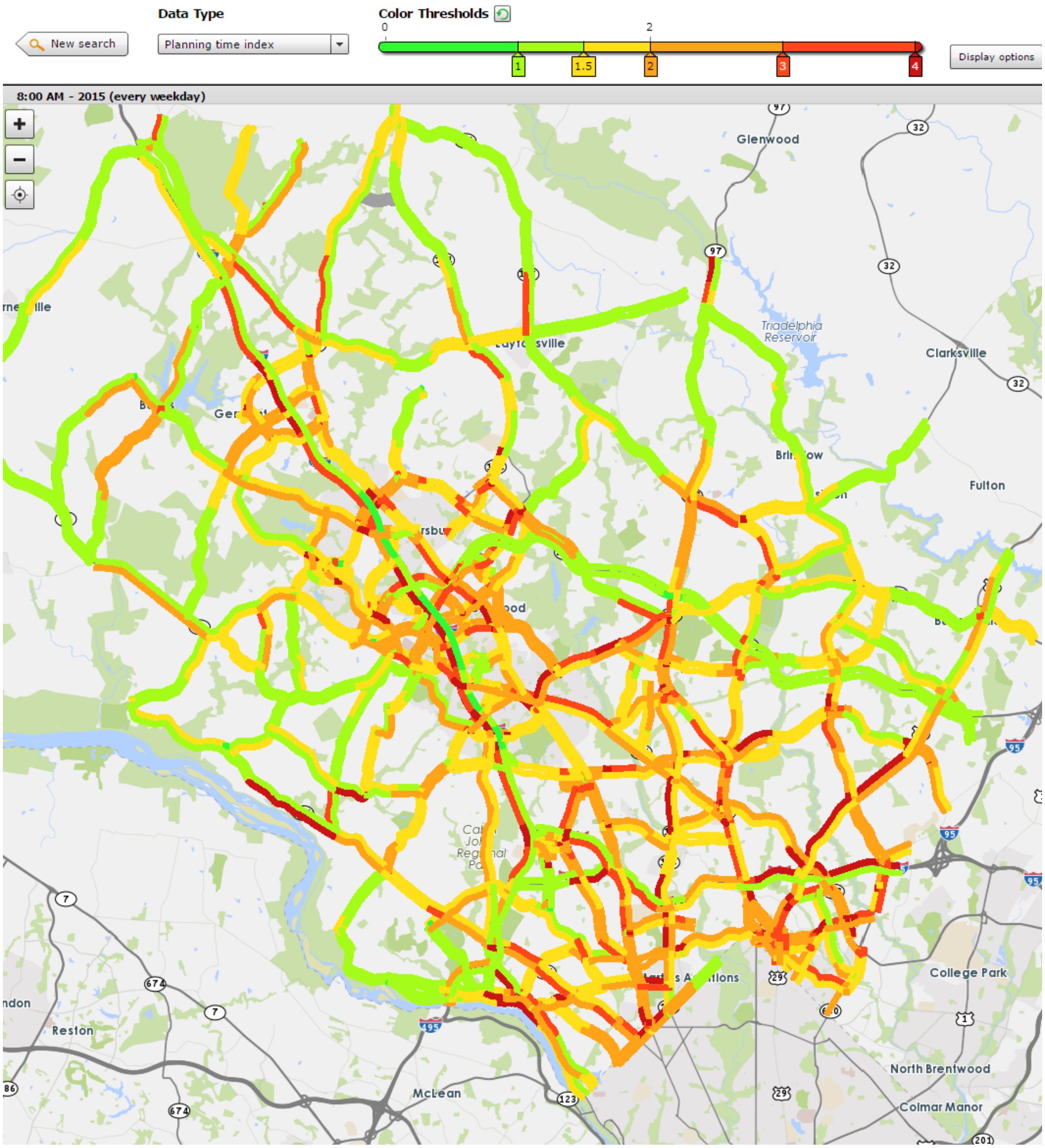


Figure B7: Planning Time Index in Montgomery County, MD during Weekday 8:00-9:00 am, 2015



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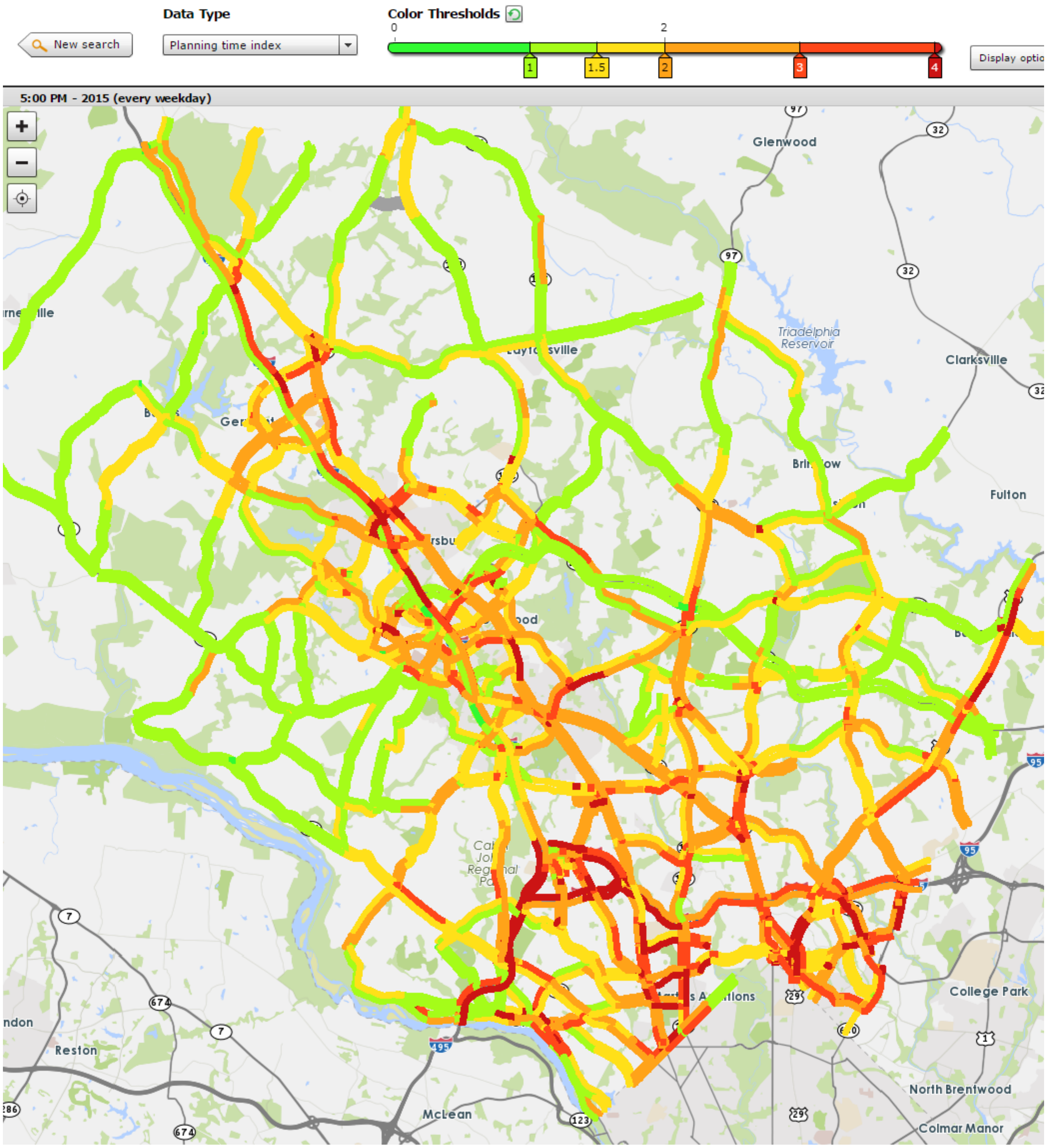


Figure B9: Planning Time Index in Prince George's County, MD during Weekday 8:00-9:00 am, 2015

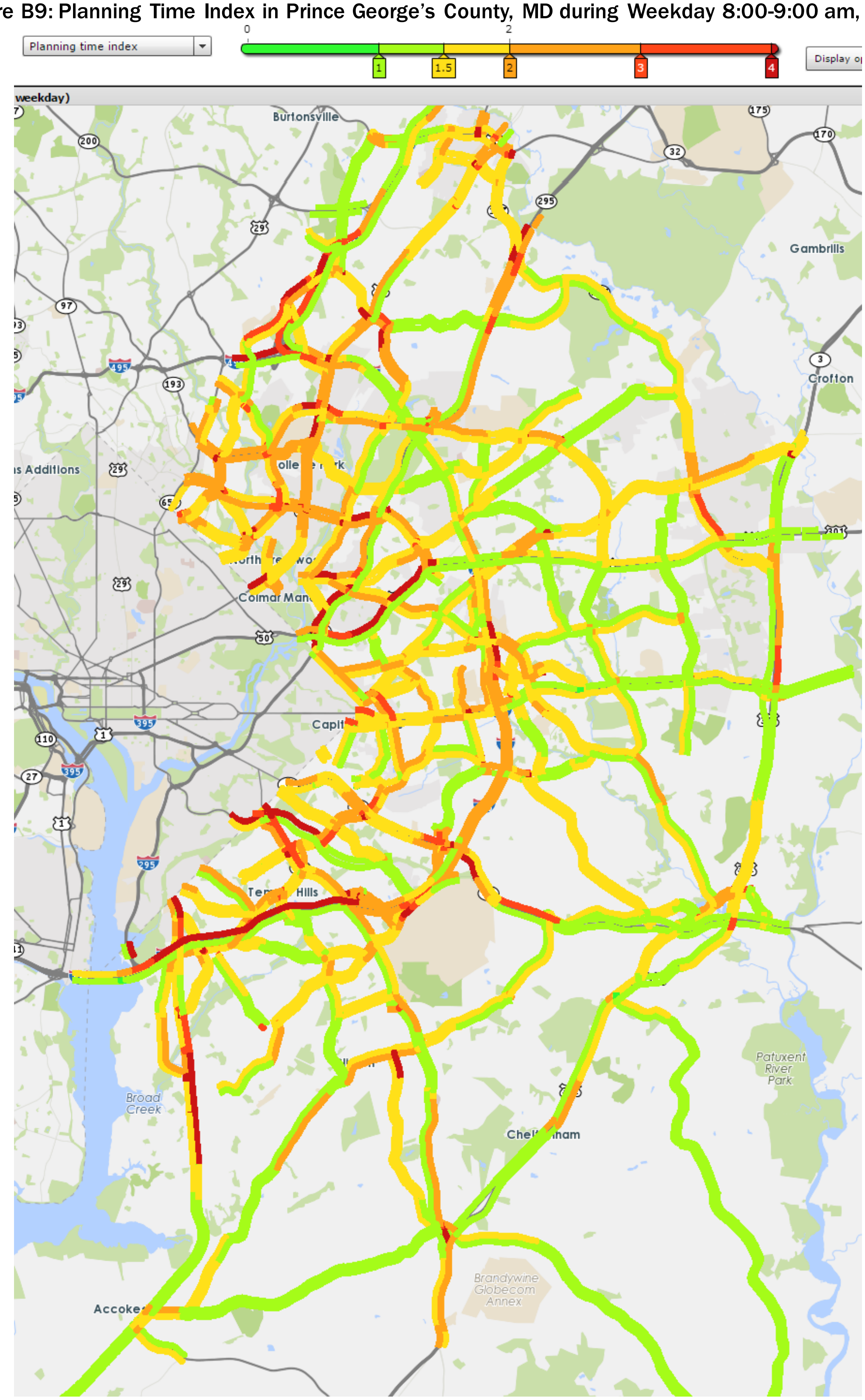


Figure B10: Planning Time Index in Prince George's County, MD during Weekday 5:00-6:00 pm, 2015

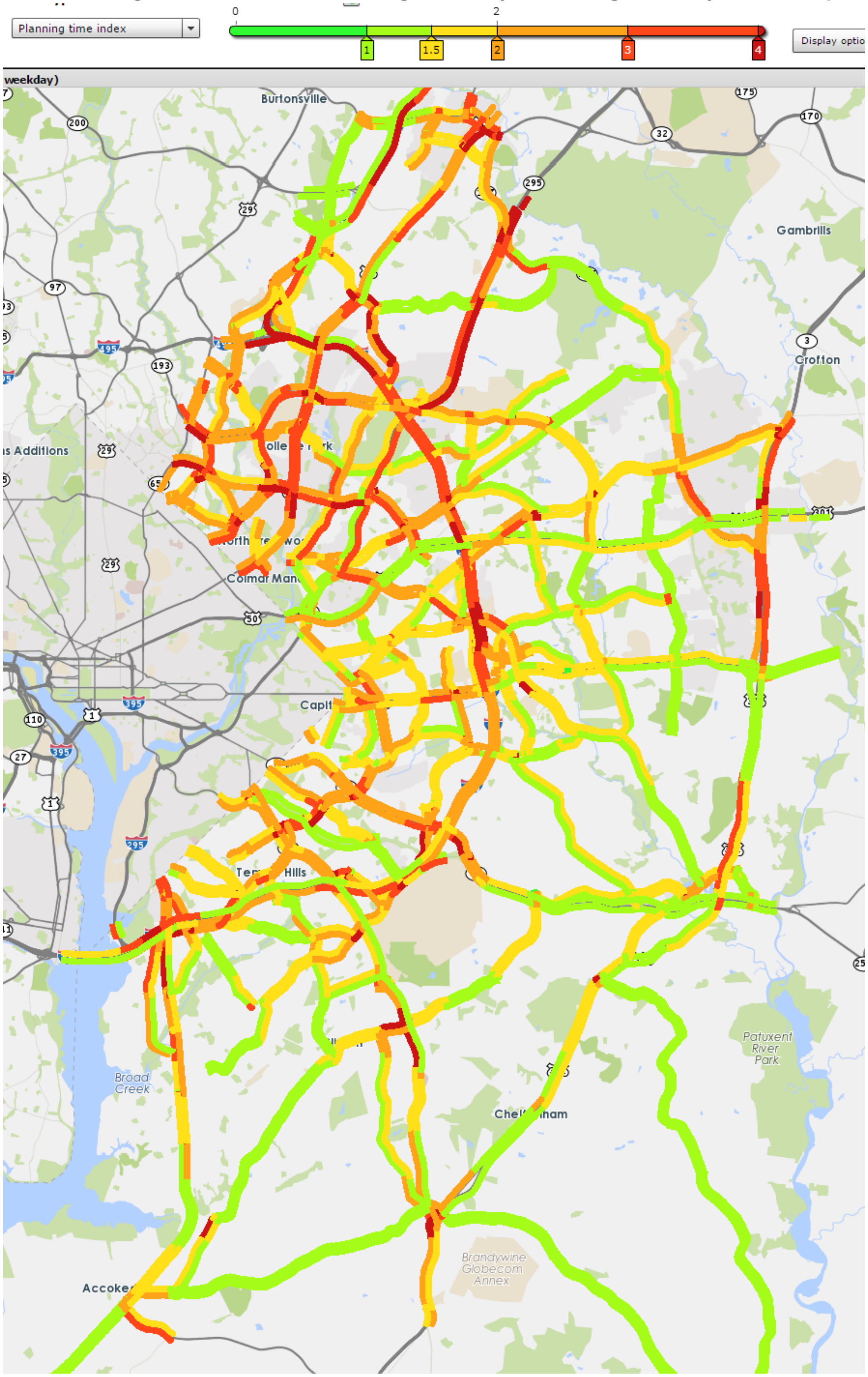


Figure B11: Planning Time Index in Charles County, MD during Weekday 8:00-9:00 am, 2015

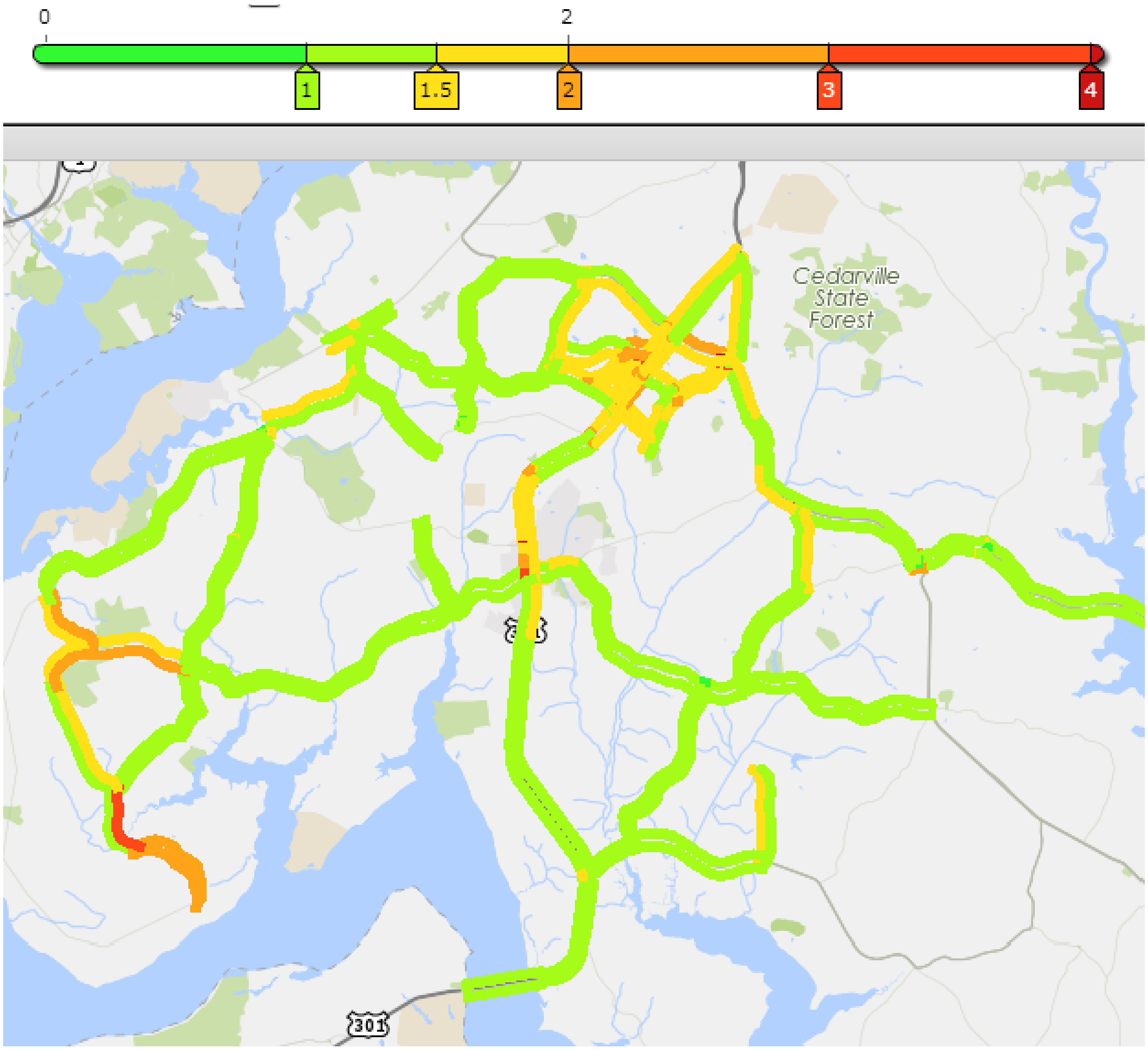


Figure B12: Planning Time Index in Prince Charles County, MD during Weekday 5:00-6:00 pm, 2015

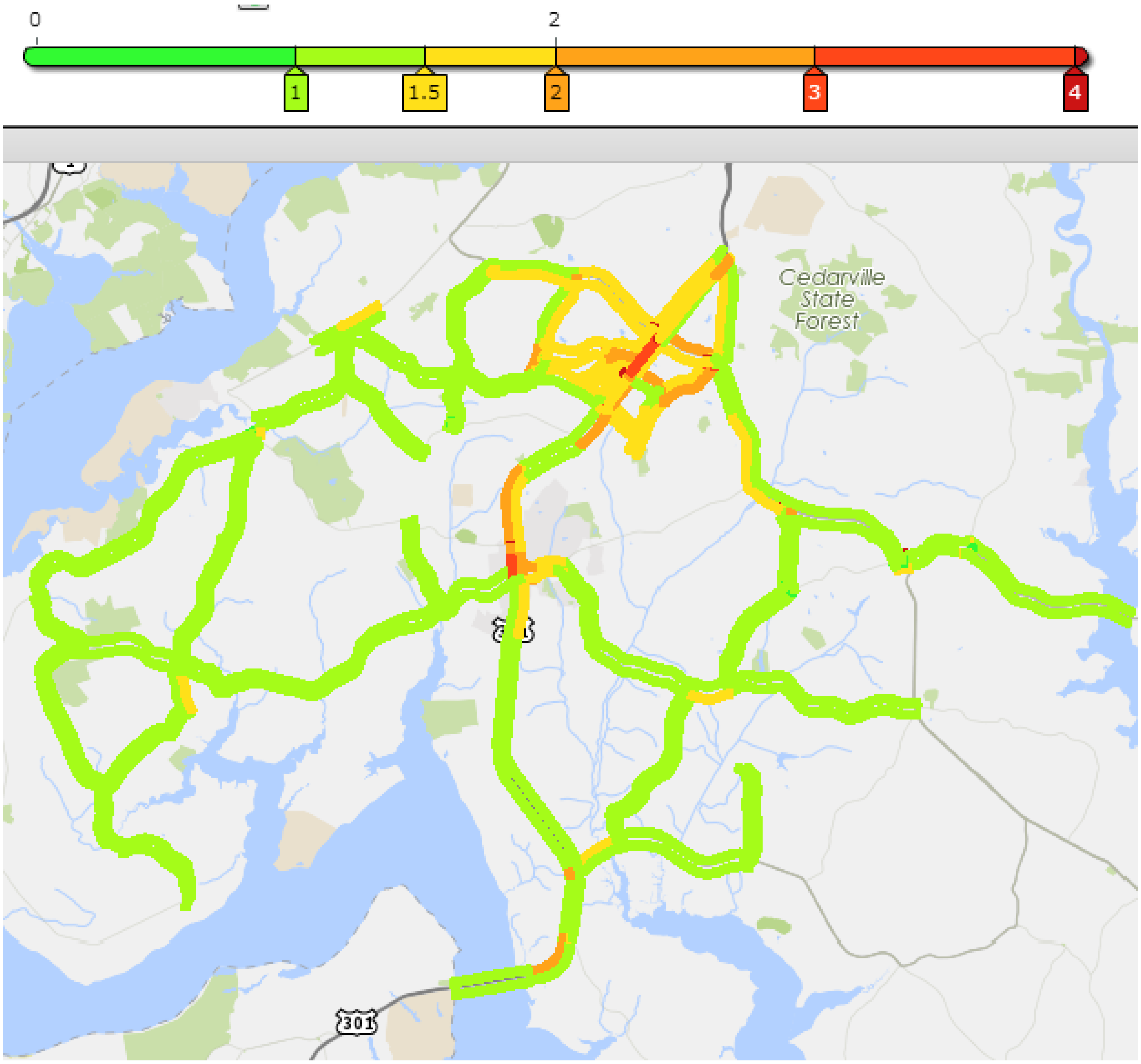


Figure B13: Planning Time Index in Loudoun County, VA during Weekday 8:00-9:00 am, 2015

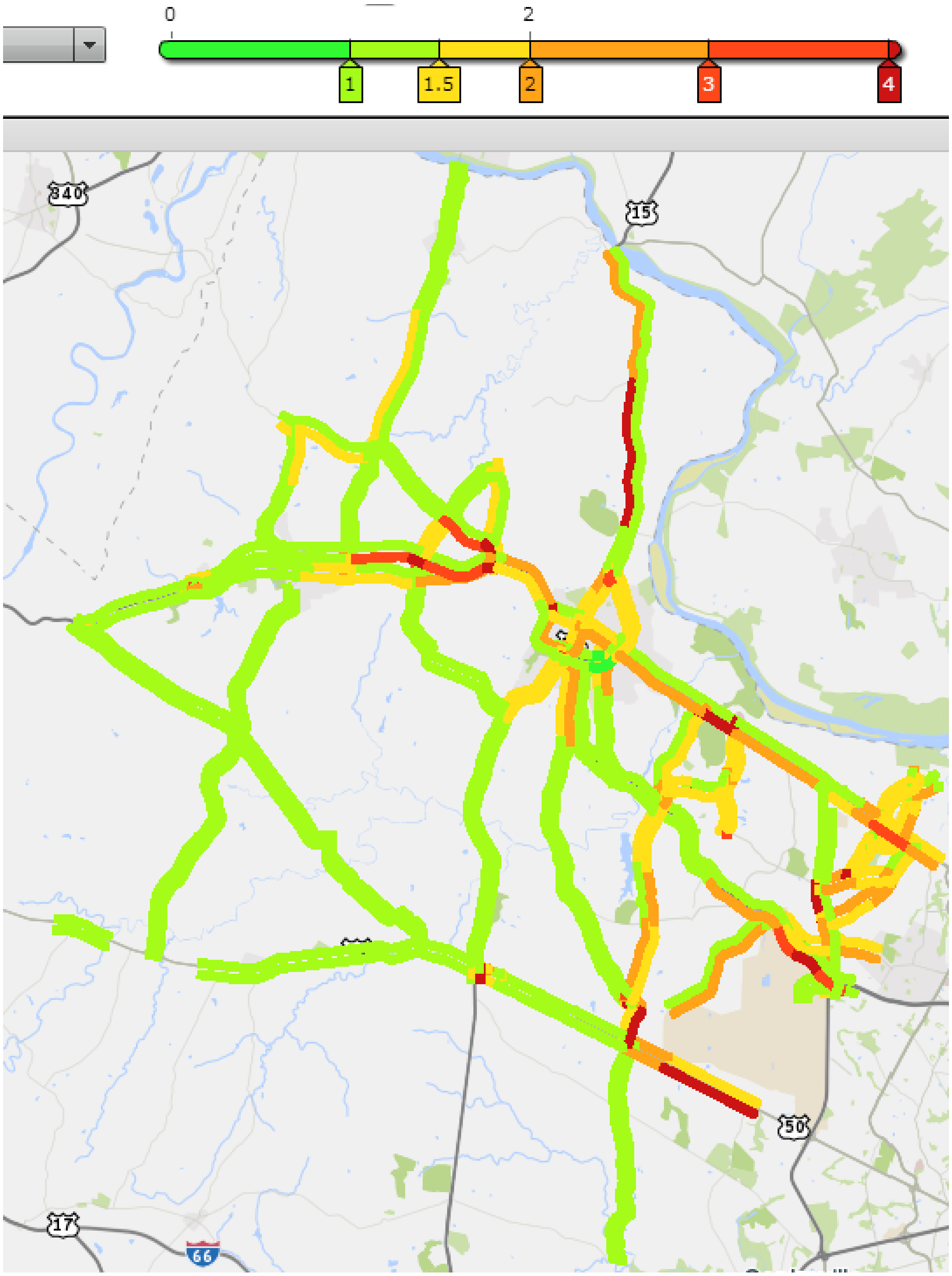


Figure B14: Planning Time Index in Loudoun County, VA during Weekday 5:00-6:00 pm, 2015

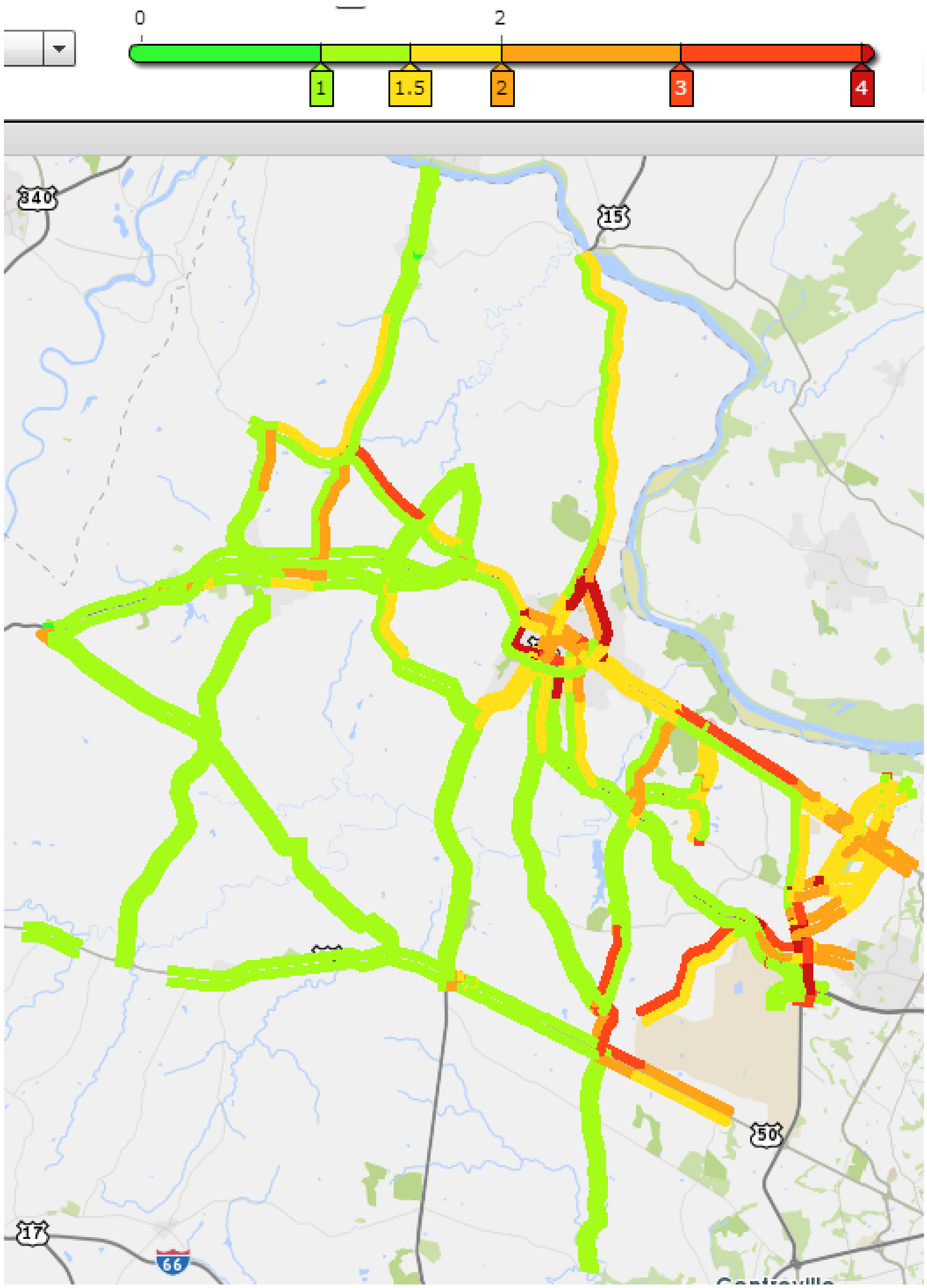


Figure B15: Planning Time Index in Fairfax, Prince William Counties and Cities of Fairfax, Manassas, and Manassas Park, VA during Weekday 8:00-9:00 am, 2015

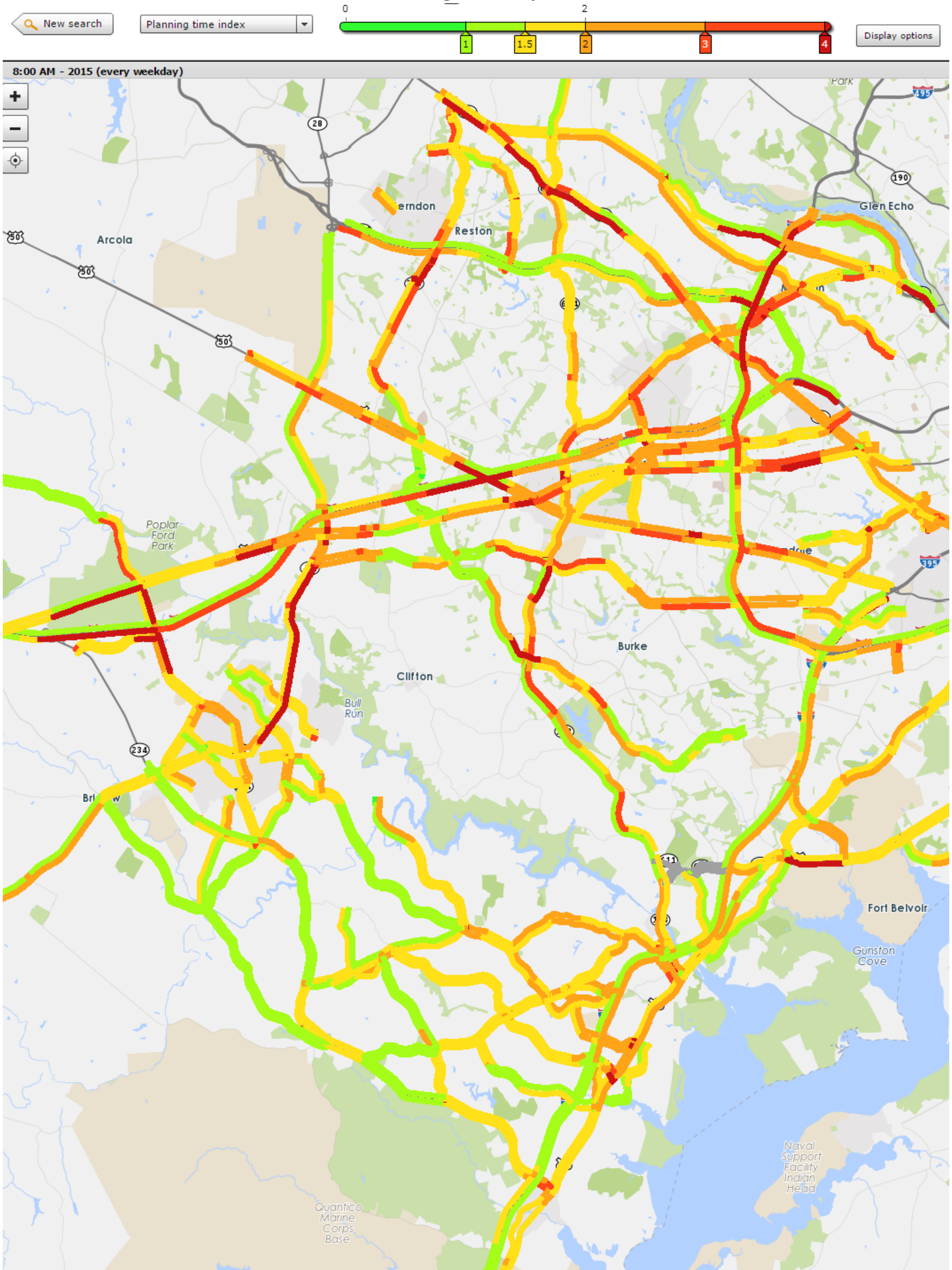


Figure B16: Planning Time Index in Fairfax, Prince William Counties and Cities of Fairfax, Manassas, and Manassas Park, VA during Weekday 5:00-6:00 pm, 2015

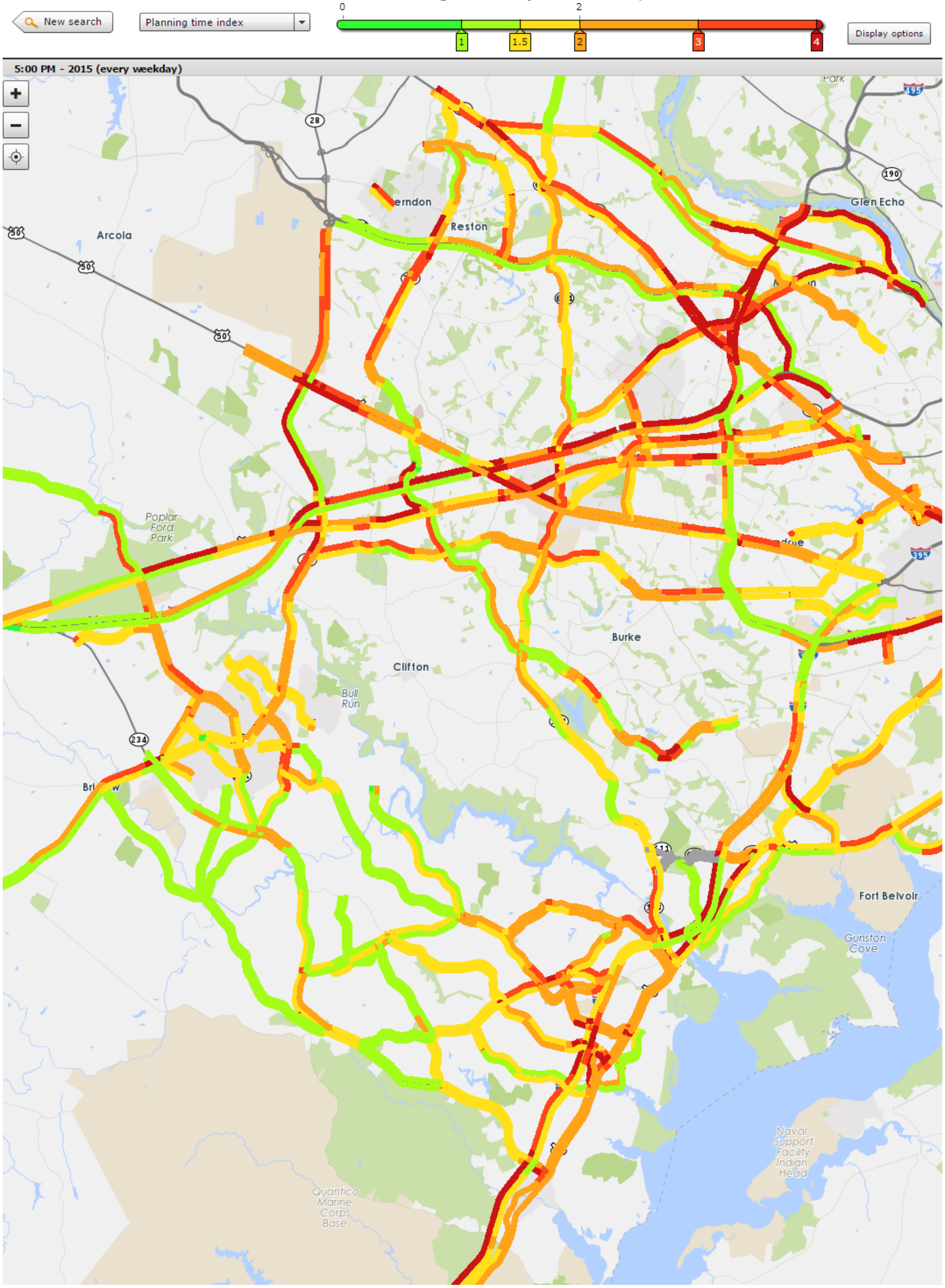


Figure B17: Planning Time Index in Cities of Alexandria, Arlington, and Falls Church, VA during Weekday 8:00-9:00 am, 2015

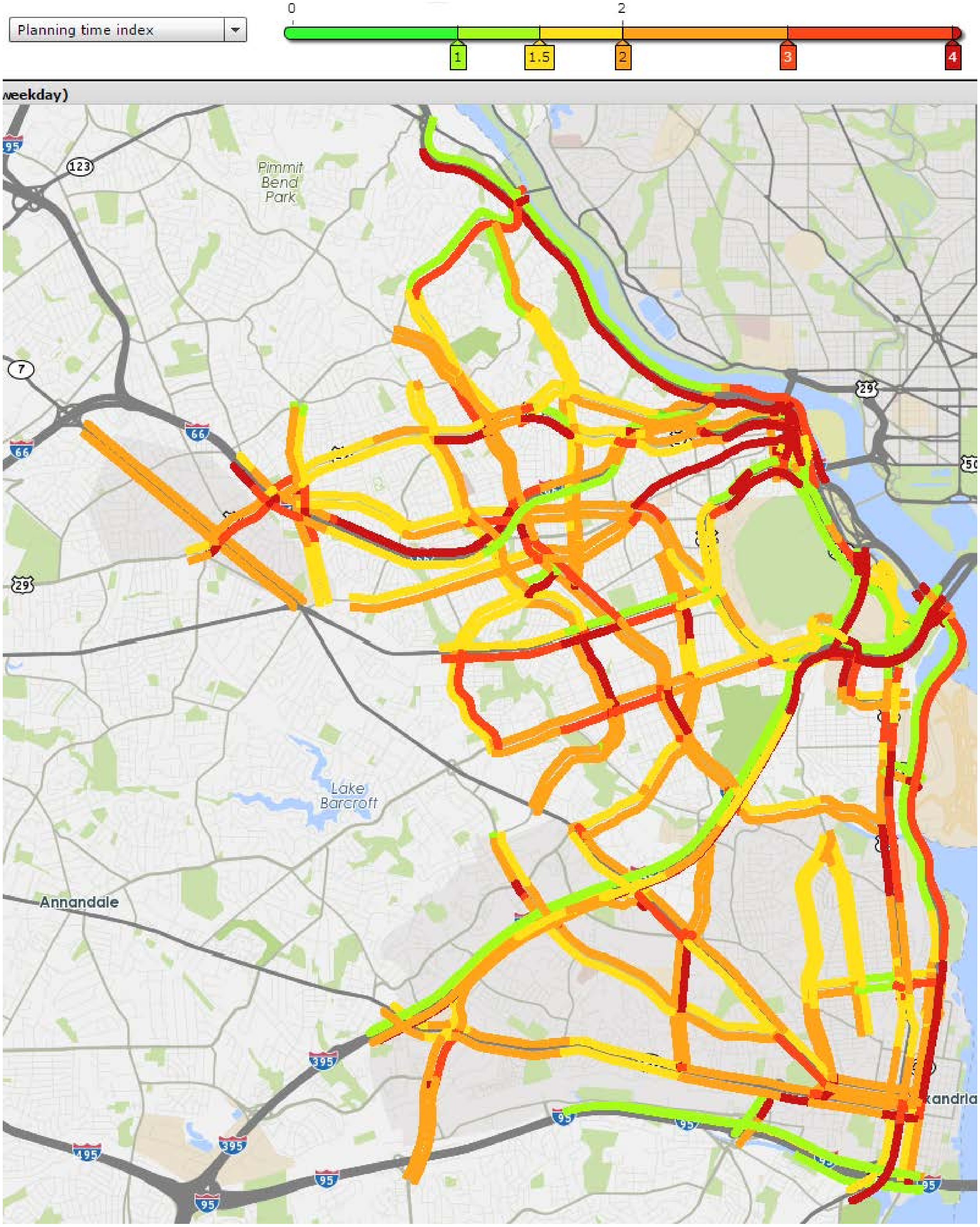
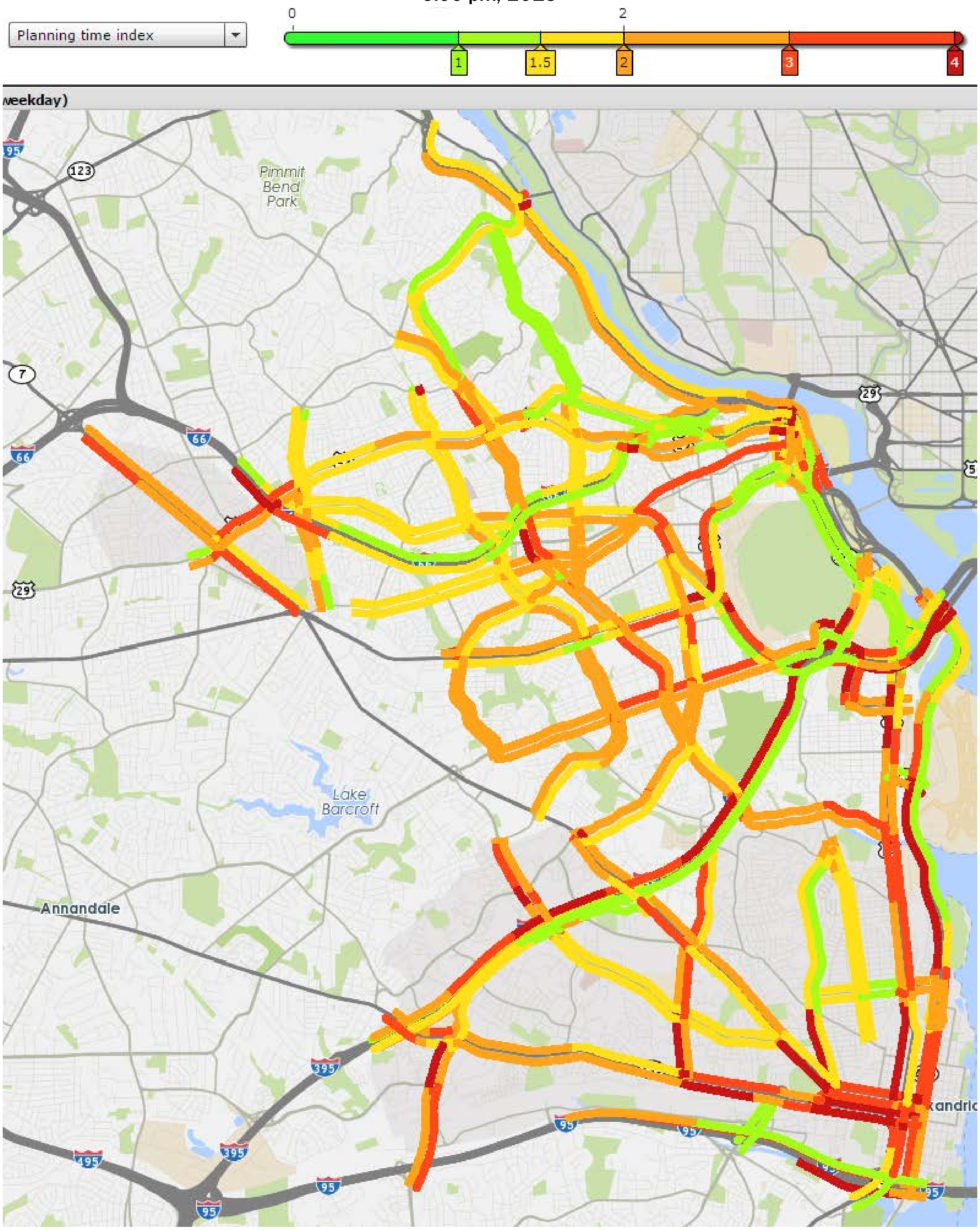


Figure B18: Planning Time Index in Cities of Alexandria, Arlington, and Falls Church, VA during Weekday 5:00-6:00 pm, 2015



APPENDIX C – 2010 AND 2013-2015 TRAVEL TIMES ALONG MAJOR FREEWAY COMMUTE CORRIDORS

Note:

1. Calculation and visualization were provided by the "Performance Charts" tool of the Vehicle Probe Project Suite developed by the CATT Lab of the University of Maryland, https://vpp.ritis.org/.

2. There are 18 major commuter corridors defined in this report:

   C1 I-270 between I-370/Sam Eig Hwy/Exit 9 and I-70/US-40
   C2 I-270 between I-370/Sam Eig Hwy/Exit 9 and I-495/MD-355
   C3 VA-267 between VA-28/Exit 9a and VA-123/Exit 19
   C4 I-66 between VA-28/Exit 53 and I-495/Exit 64
   C5 I-66 between I-495/Exit 64 and Theodore Roosevelt Memorial Bridge
   C6 I-95 between VA-234/Exit 152 and Franconia Rd/Exit 169
   C7 I-95 HOV between VA-234/Exit 152 and Franconia Rd/Exit 169
   C8 I-395 between I-95 and H St
   C9 I-395 HOV between I-95 and US-1
   C10 US-50 between MD-295/Kenilworth Ave and US-301/Exit 13
   C11 MD-295 between US-50/MD-201/Kenilworth Ave and MD-198
   C12 I-95 between I-495/Exit 27-25 and MD-198/Exit 33
   C13 I-495 between I-270/Exit 35 and I-95/Exit 27
   C14 I-495 between I-95/Exit 27 and US-50/Exit 19
   C15 I-495 between US-50/Exit 19 and I-95/I-395/Exit 57
   C16 I-495 between I-95/I-395/Exit 57 and I-66/Exit 9
   C17 I-495 between I-66/Exit 9 and I-270/Exit 35
   C18 I-295 between I-495 and 11th St. Bridge

3. Travel times were drawn for only normal weekdays – Tuesdays, Wednesdays and Thursdays.

Figure C1

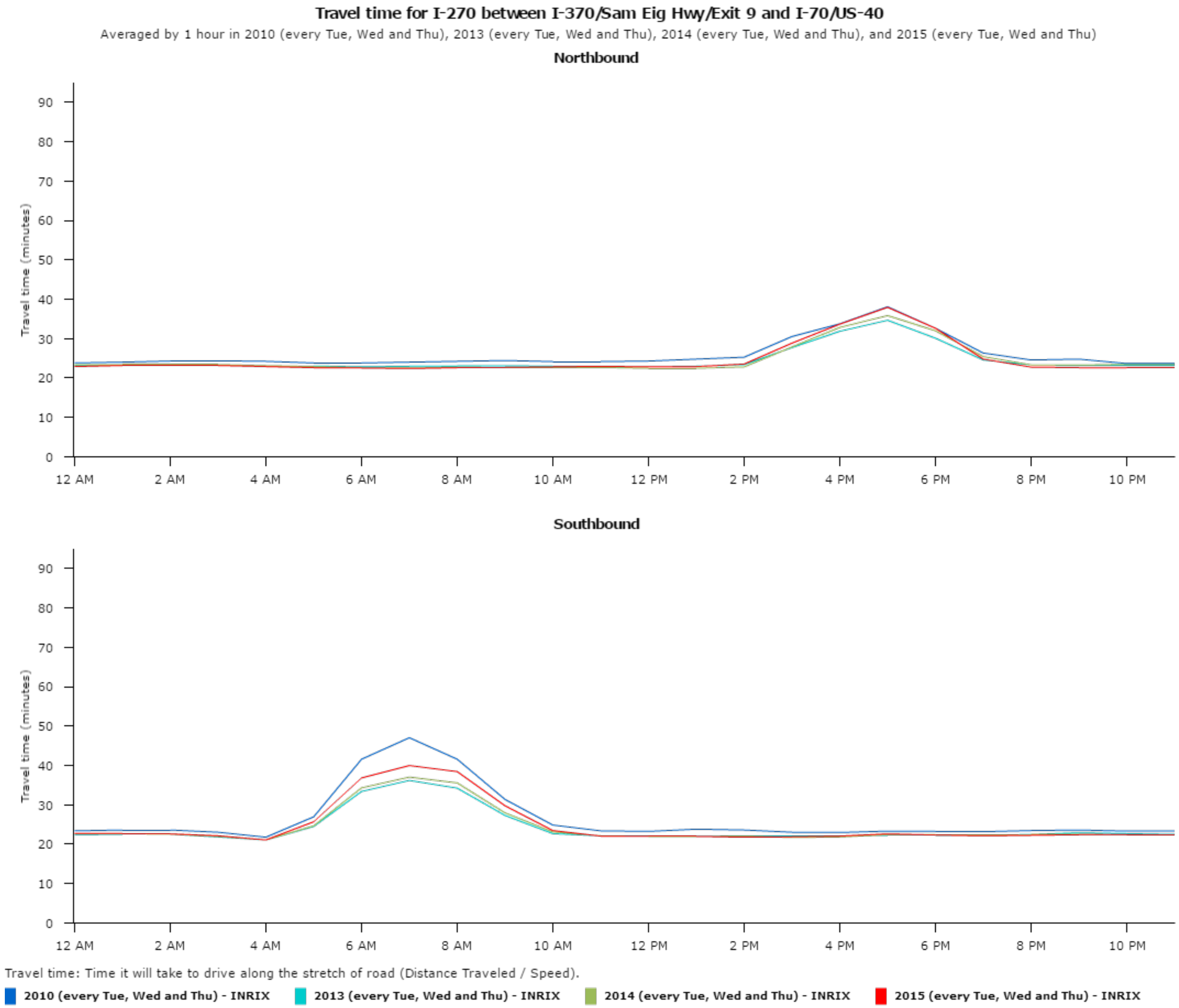

Travel time for I-270 between I-370/Sam Eig Hwy/Exit 9 and I-70/US-40
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Northbound
Travel time (minutes)
0
10
20
30
40
50
60
70
80
90
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Southbound
Travel time (minutes)
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C2

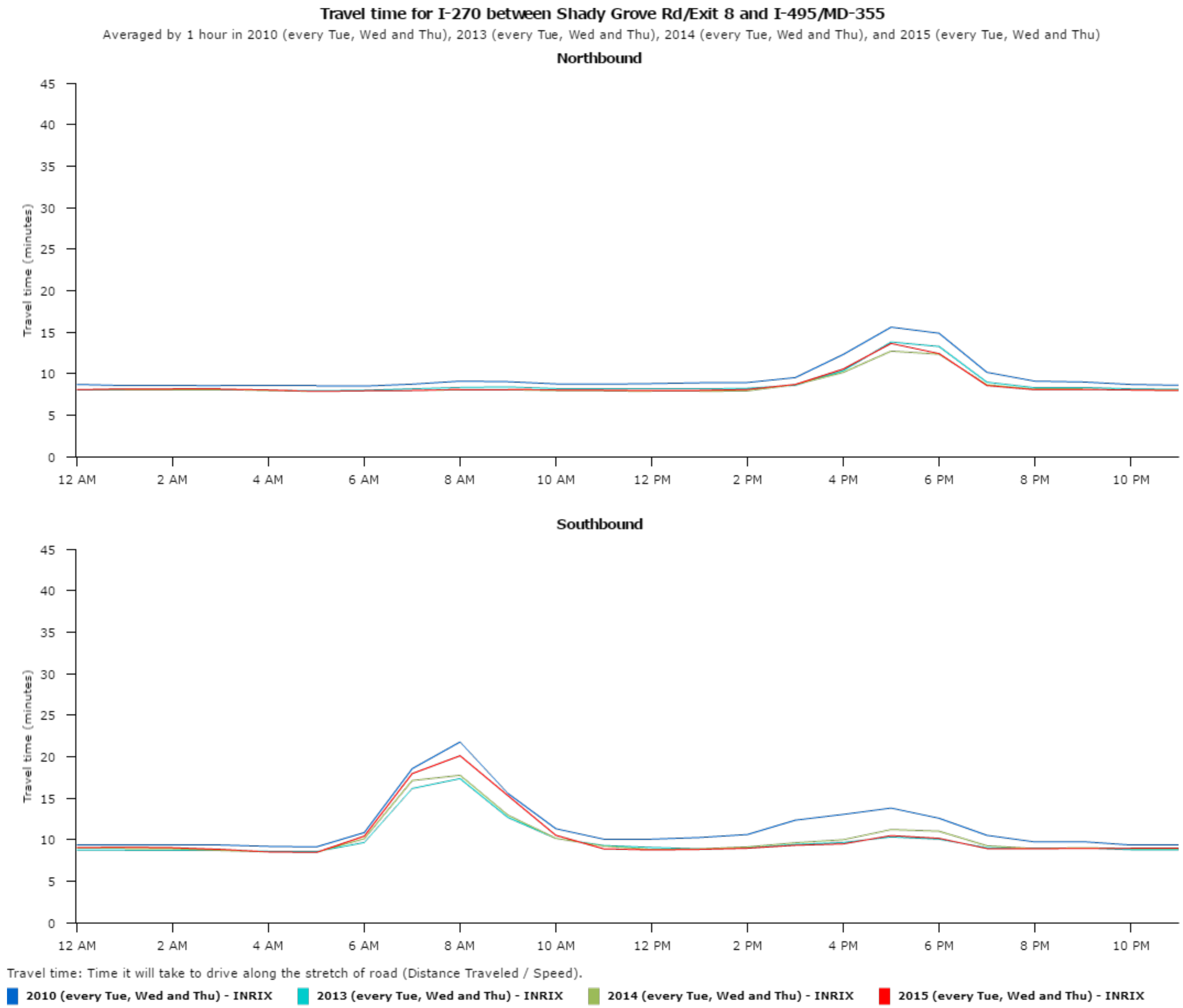

Travel time for I-270 between Shady Grove Rd/Exit 8 and I-495/MD-355
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Northbound
Travel time (minutes)
45
40
35
30
25
20
15
10
5
0
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Southbound
Travel time (minutes)
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C3

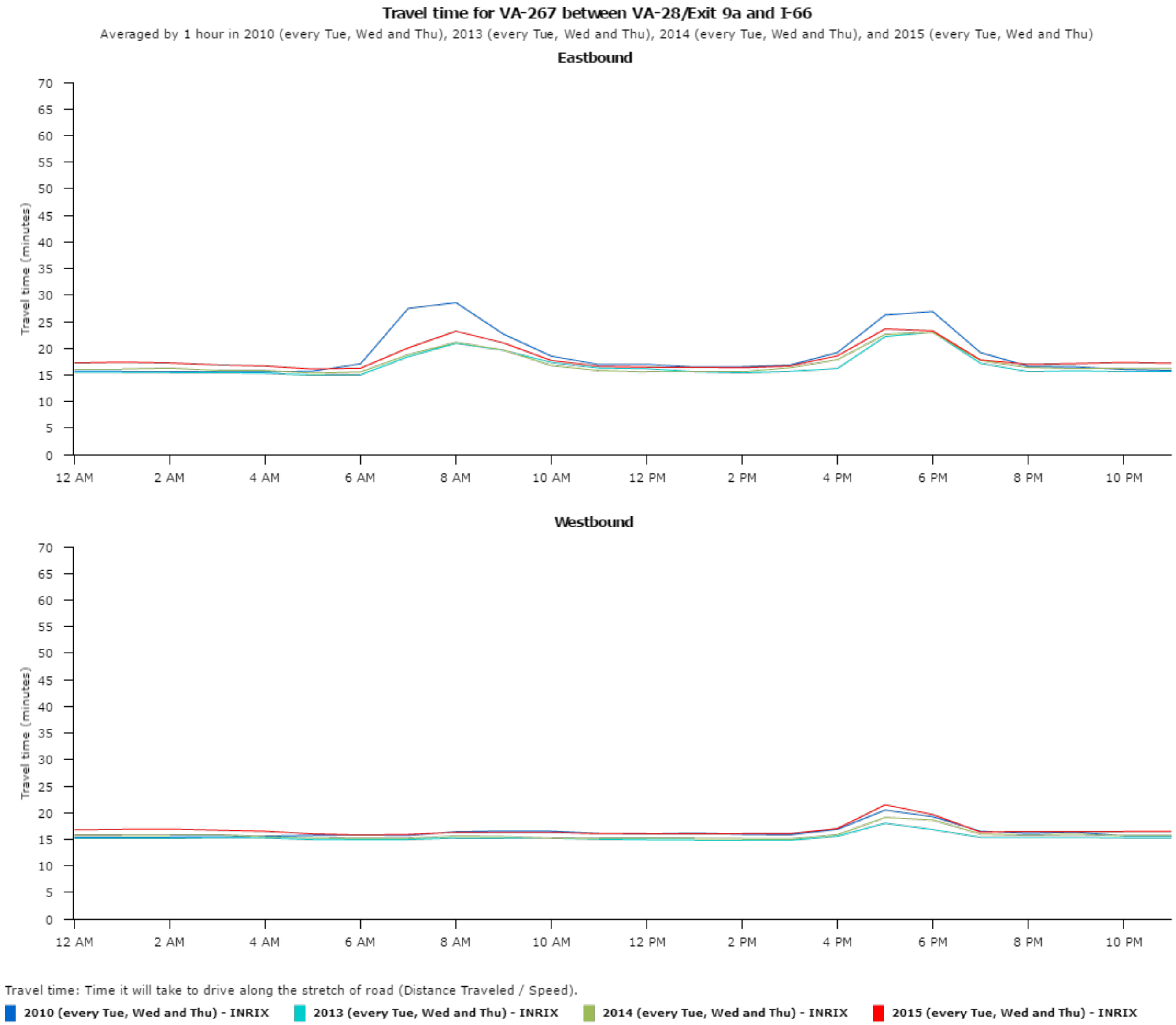

Travel time for VA-267 between VA-28/Exit 9a and I-66
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Eastbound
Westbound
Travel time (minutes)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C4

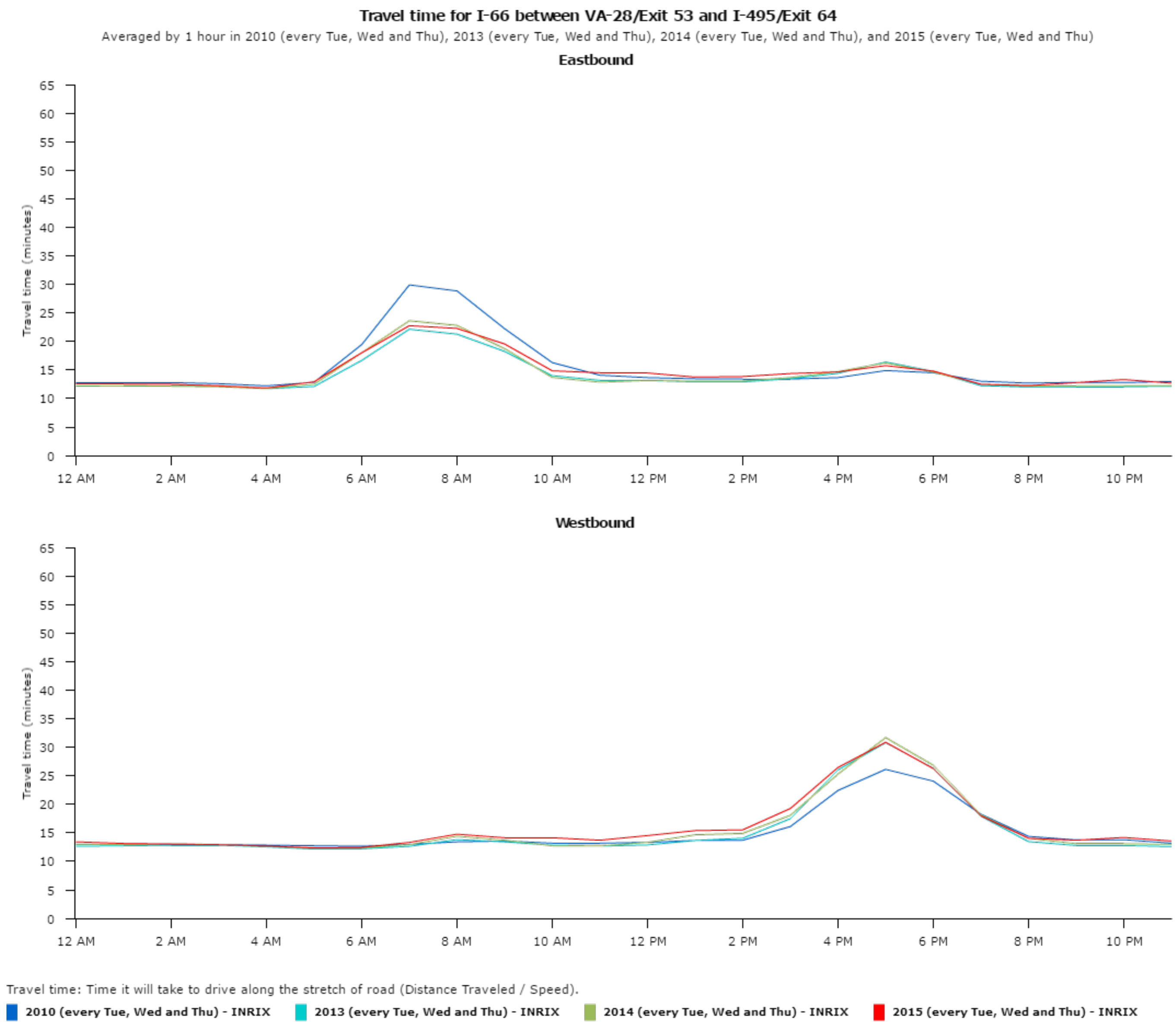

Travel time for I-66 between VA-28/Exit 53 and I-495/Exit 64
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Eastbound
Westbound
Travel time (minutes)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C5

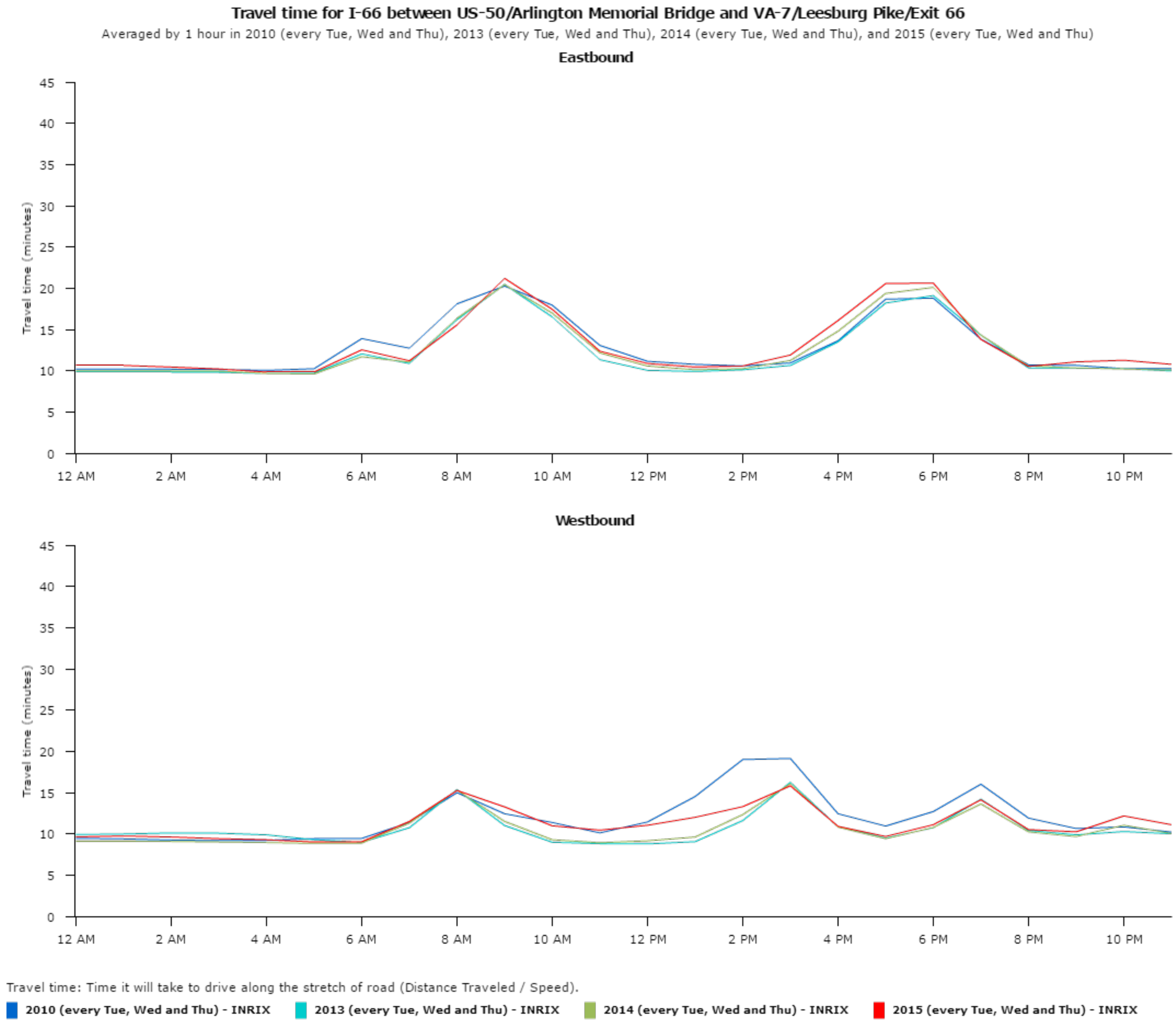

Travel time for I-66 between US-50/Arlington Memorial Bridge and VA-7/Leesburg Pike/Exit 66
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Eastbound
Westbound
Travel time (minutes)
0
5
10
15
20
25
30
35
40
45
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C6

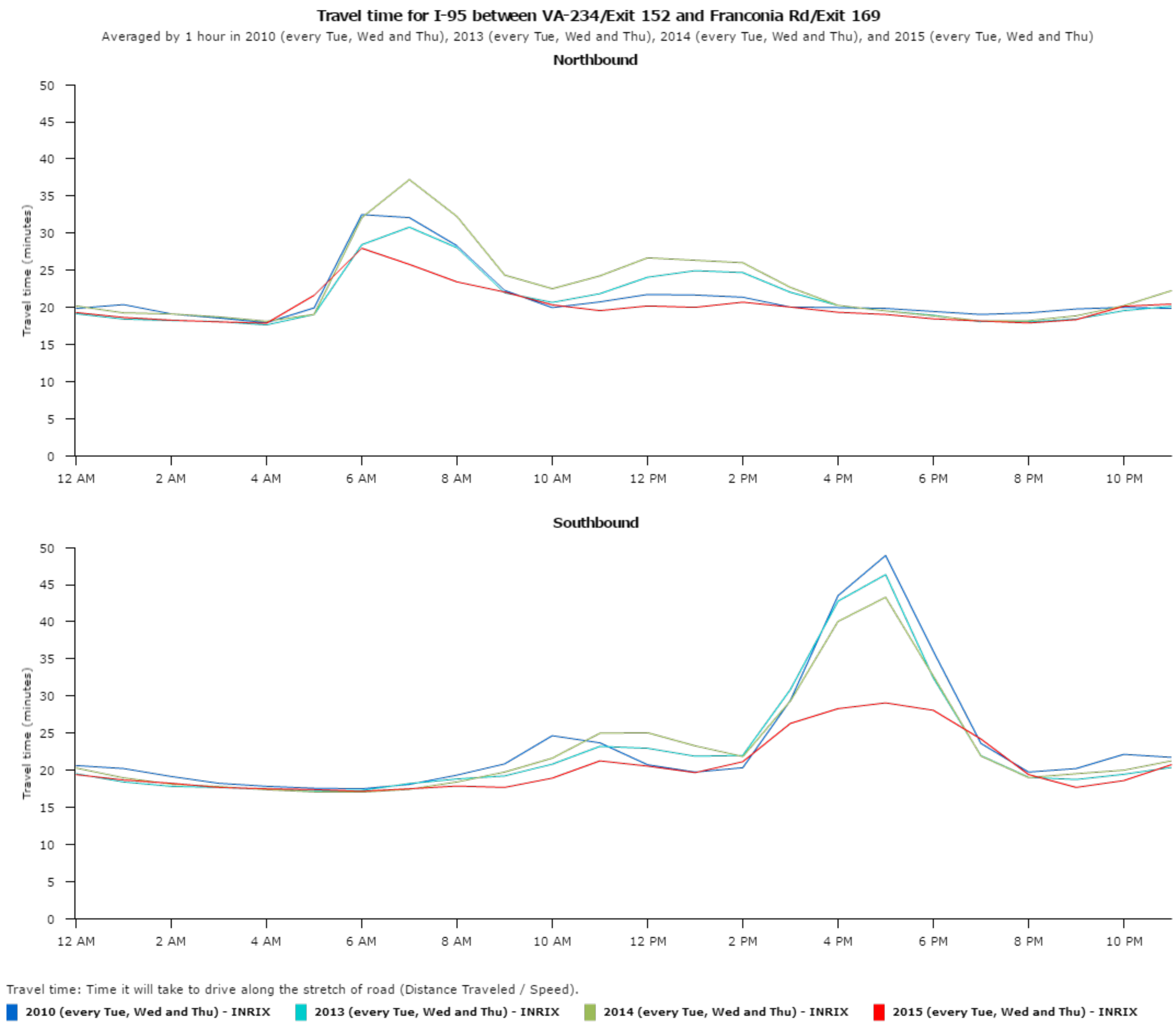

Travel time for I-95 between VA-234/Exit 152 and Franconia Rd/Exit 169
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Northbound
Southbound
Travel time (minutes)
0
5
10
15
20
25
30
35
40
45
50
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C7

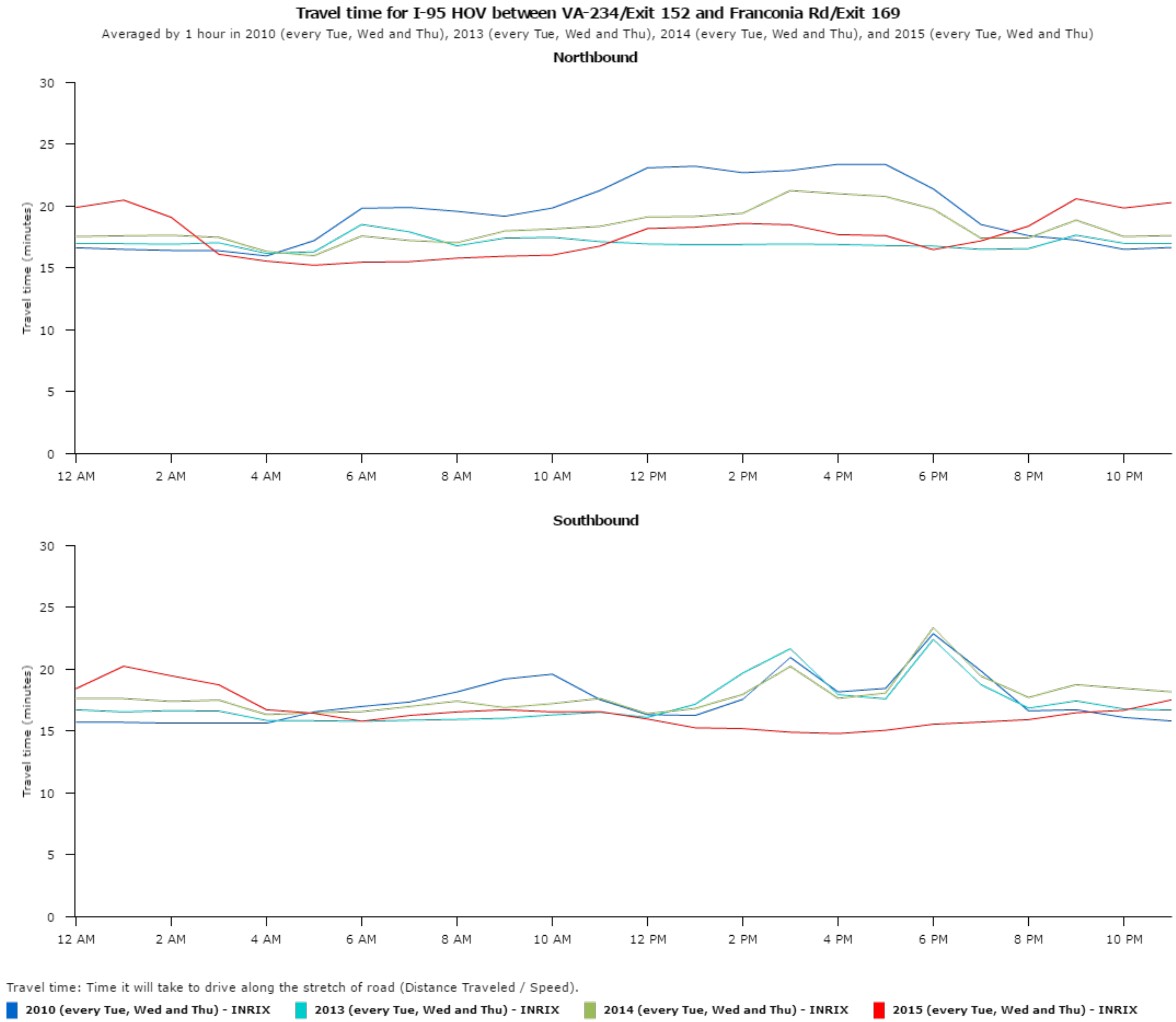

Travel time for I-95 HOV between VA-234/Exit 152 and Franconia Rd/Exit 169
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Northbound
Southbound
Travel time (minutes)
0
5
10
15
20
25
30
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C8

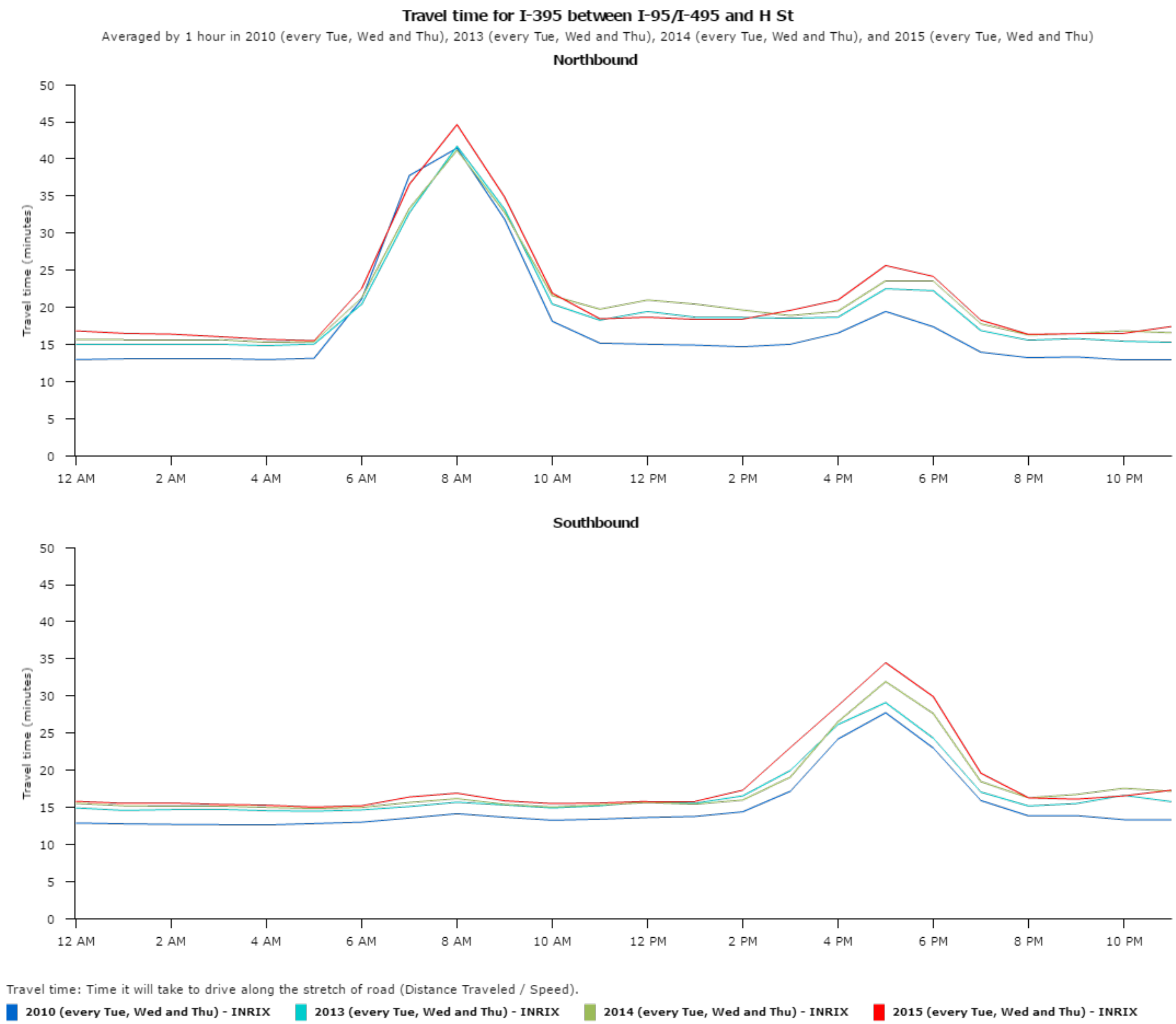

Travel time for I-395 between I-95/I-495 and H St
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Northbound
Southbound
Travel time (minutes)
0
5
10
15
20
25
30
35
40
45
50
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C9

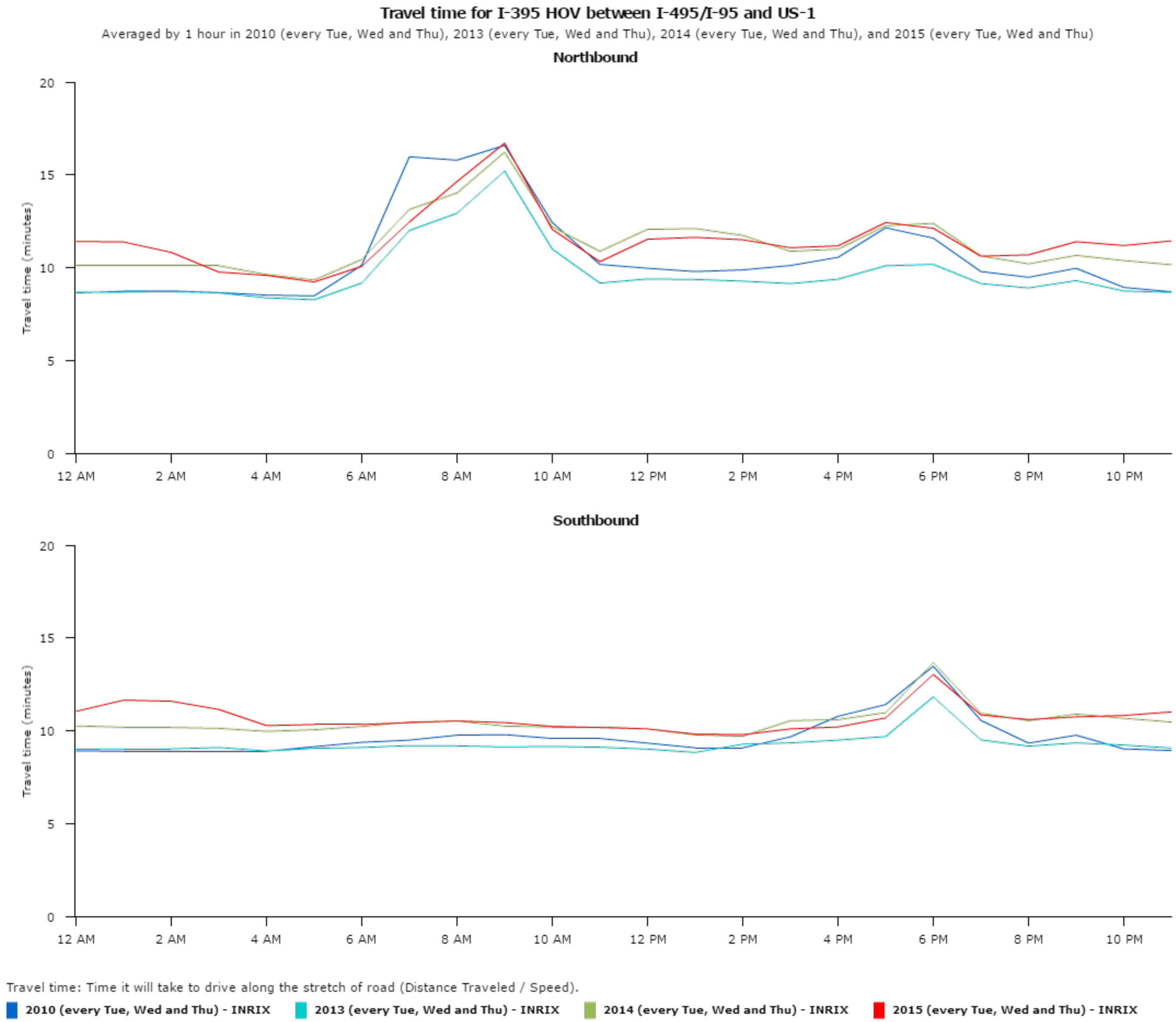

Travel time for I-395 HOV between I-495/I-95 and US-1
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Northbound
Travel time (minutes)
20
15
10
5
0
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Southbound
Travel time (minutes)
20
15
10
5
0
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C10

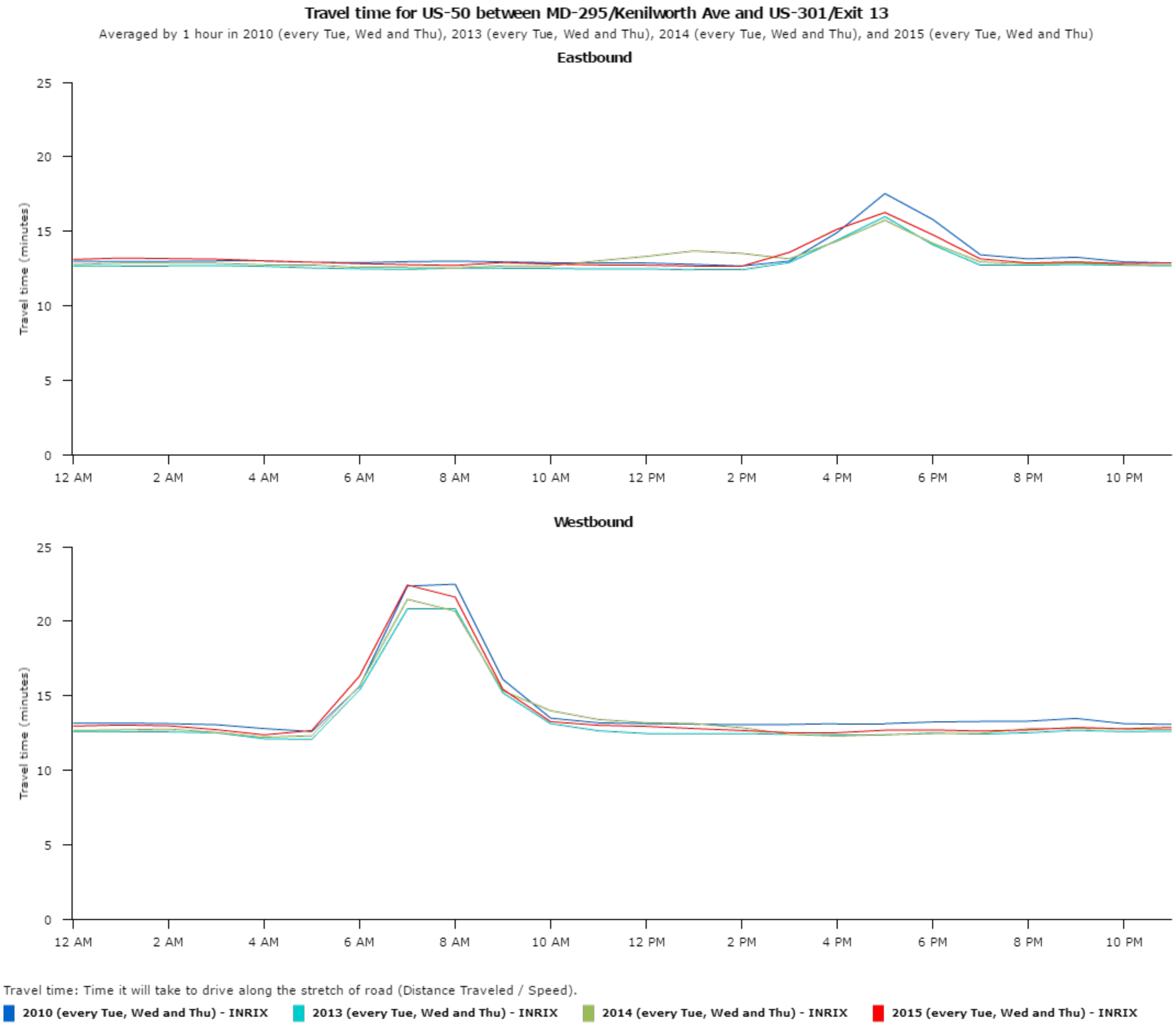

Travel time for US-50 between MD-295/Kenilworth Ave and US-301/Exit 13
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Eastbound
Westbound
Travel time (minutes)
0
5
10
15
20
25
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C11

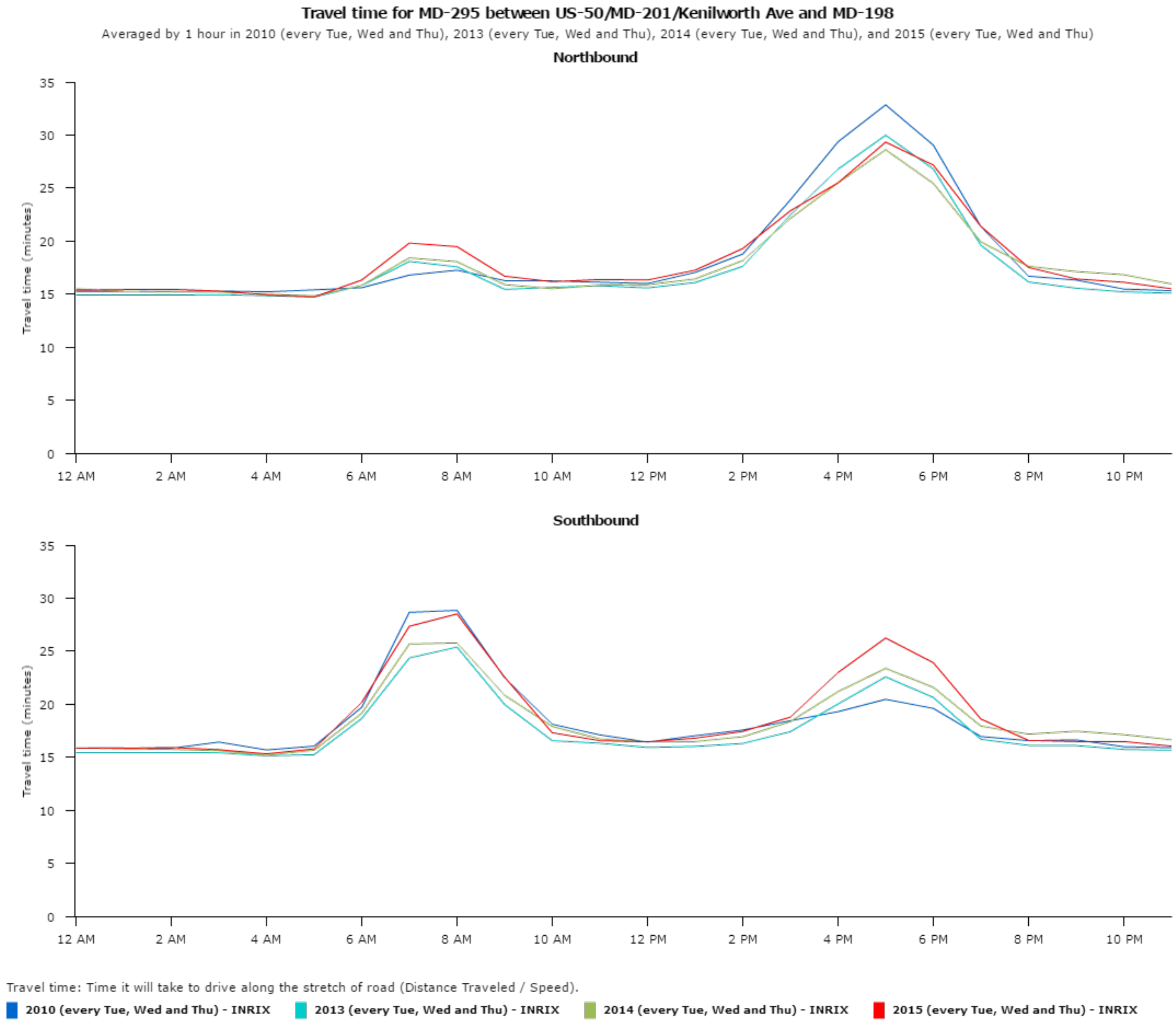
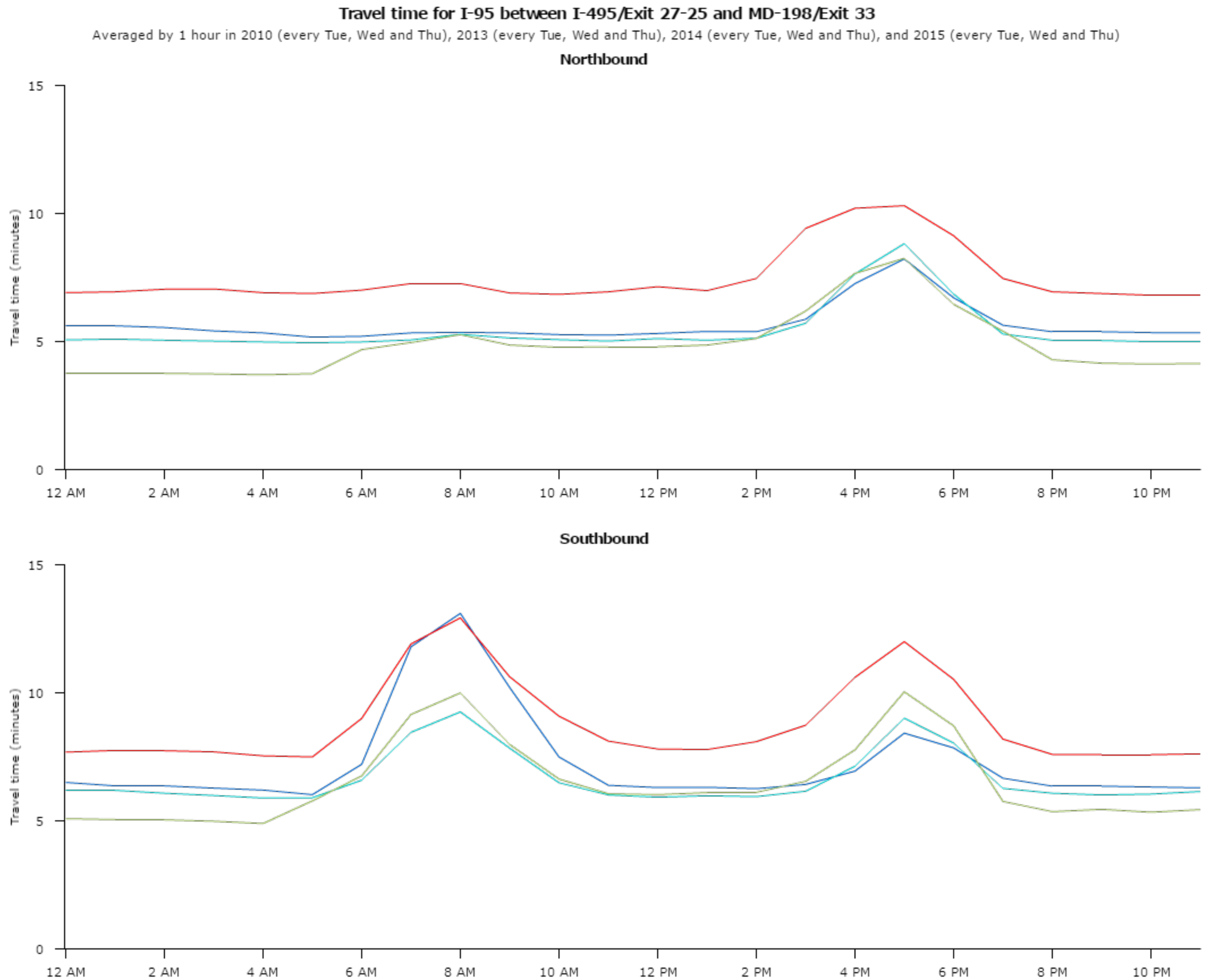

Travel time for MD-295 between US-50/MD-201/Kenilworth Ave and MD-198
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Northbound
Southbound
Travel time (minutes)
0
5
10
15
20
25
30
35
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C12



Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).

2010 (every Tue, Wed and Thu) - INRIX; 2013 (every Tue, Wed and Thu) - INRIX; 2014 (every Tue, Wed and Thu) - INRIX; 2015 (every Tue, Wed and Thu) - INRIX

Figure C13

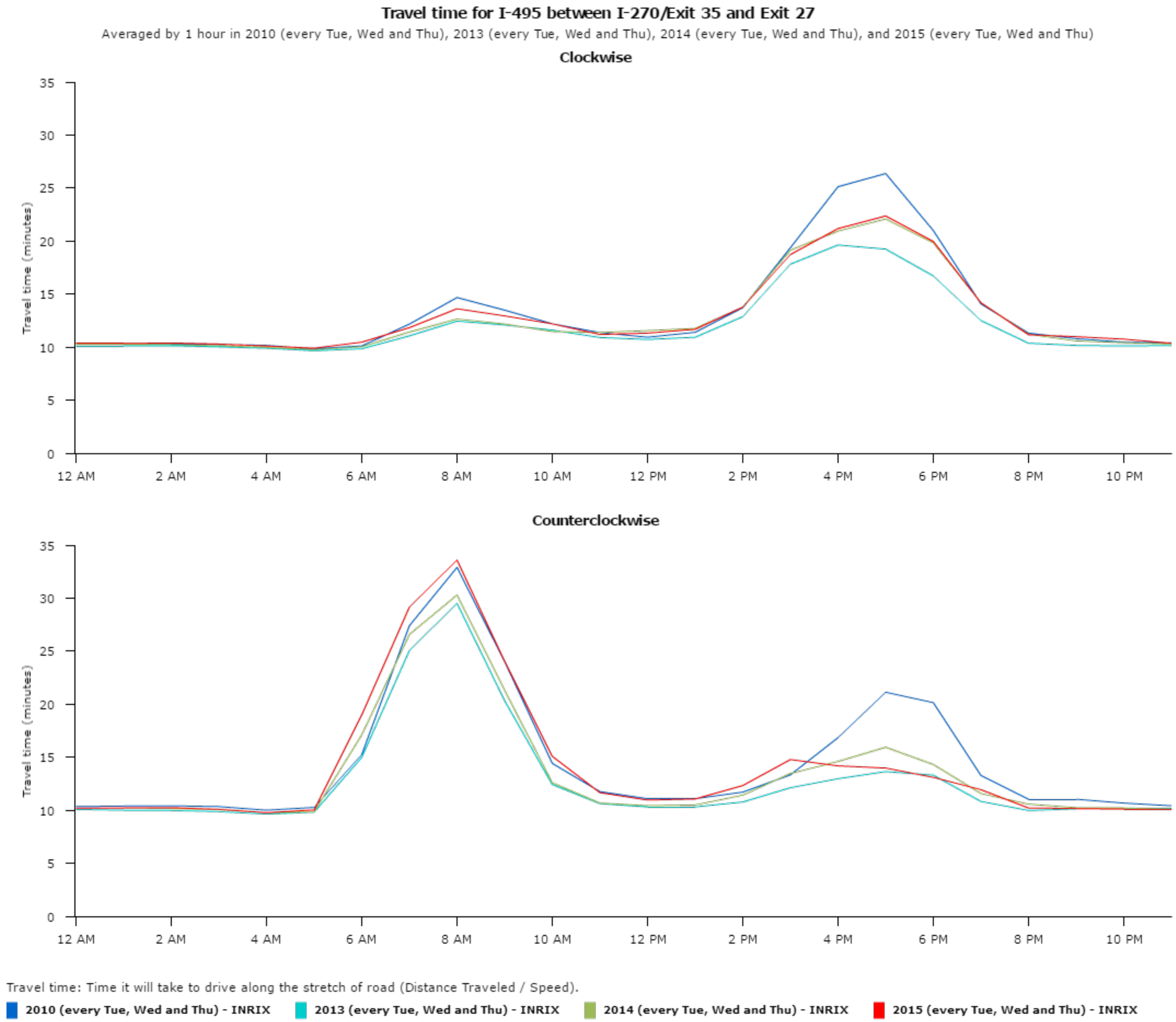
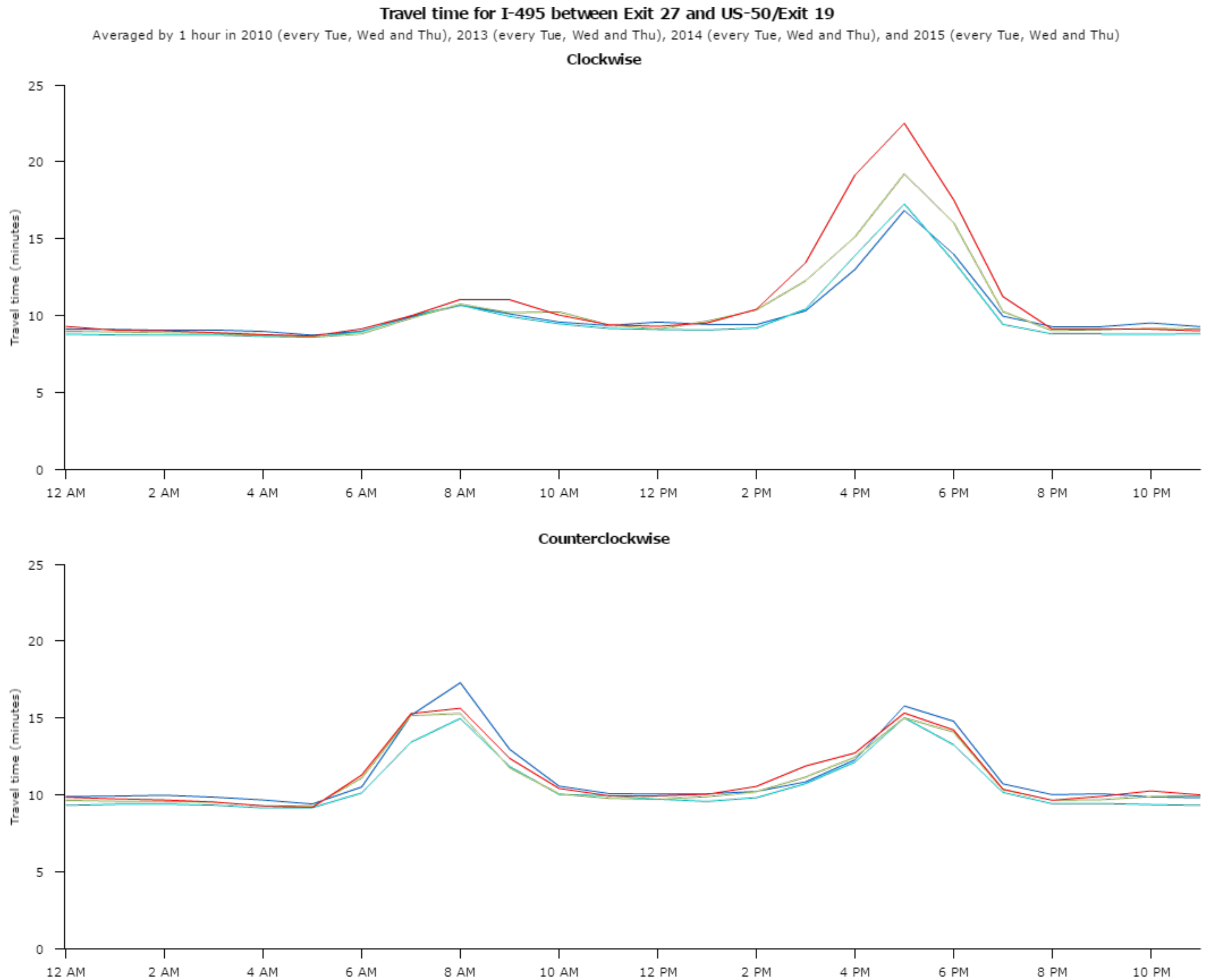

Travel time for I-495 between I-270/Exit 35 and Exit 27
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Clockwise
Counterclockwise
Travel time (minutes)
0
5
10
15
20
25
30
35
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C14



Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).

2010 (every Tue, Wed and Thu) - INRIX | 2013 (every Tue, Wed and Thu) - INRIX | 2014 (every Tue, Wed and Thu) - INRIX | 2015 (every Tue, Wed and Thu) - INRIX

Figure C15

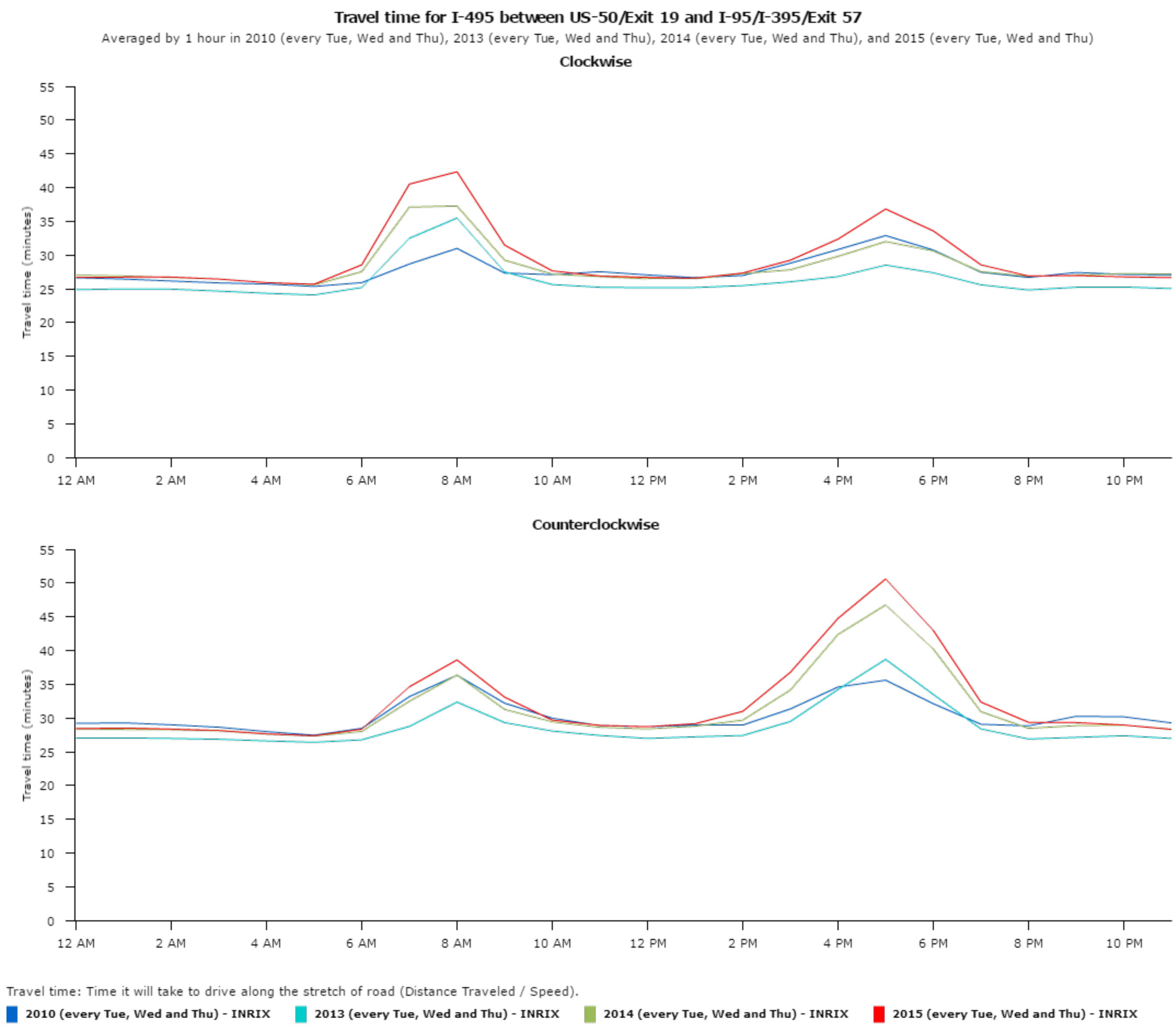

Travel time for I-495 between US-50/Exit 19 and I-95/I-395/Exit 57
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Clockwise
Counterclockwise
Travel time (minutes)
0
5
10
15
20
25
30
35
40
45
50
55
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C16

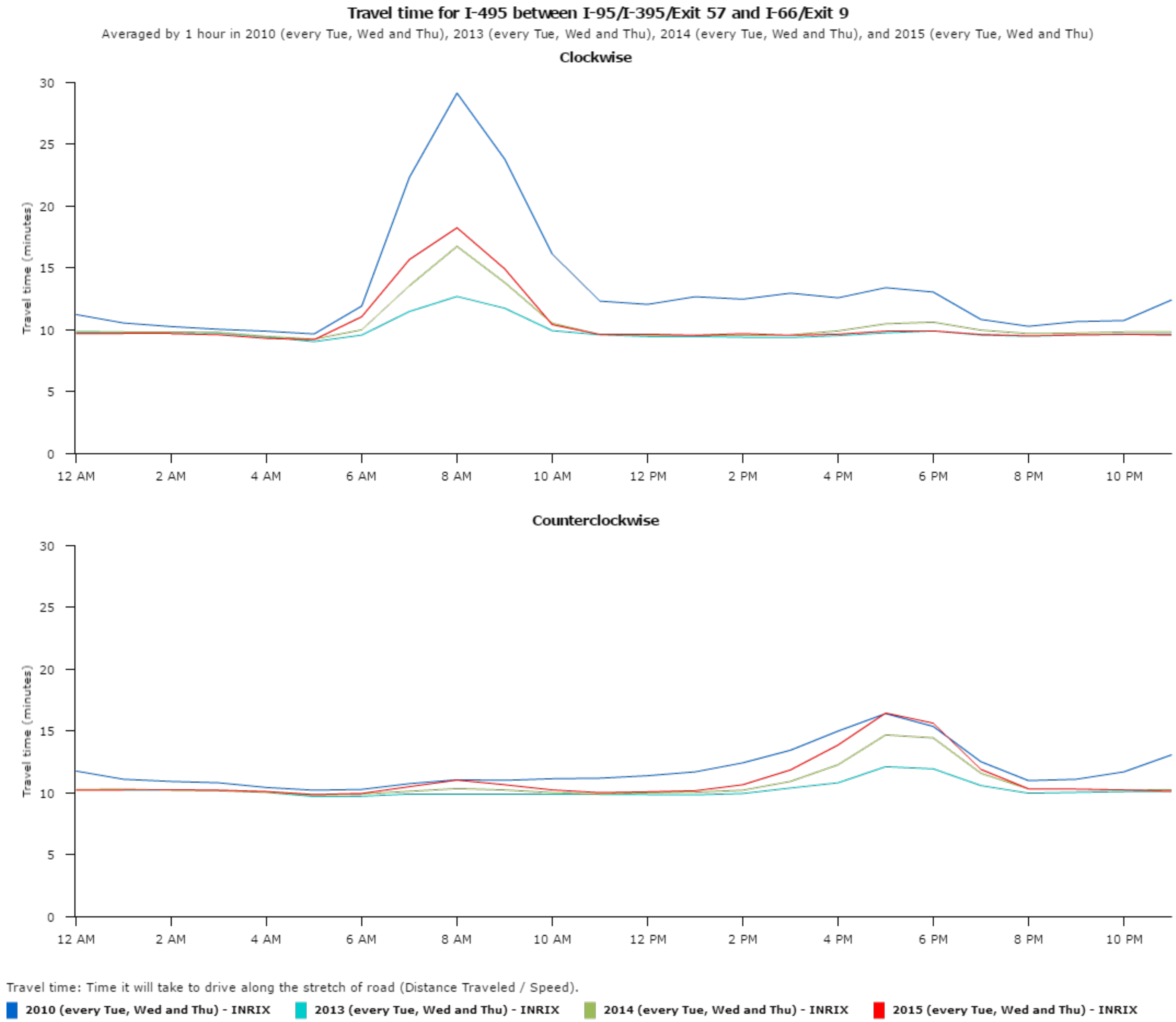

Travel time for I-495 between I-95/I-395/Exit 57 and I-66/Exit 9
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Clockwise
Counterclockwise
Travel time (minutes)
0
5
10
15
20
25
30
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C17

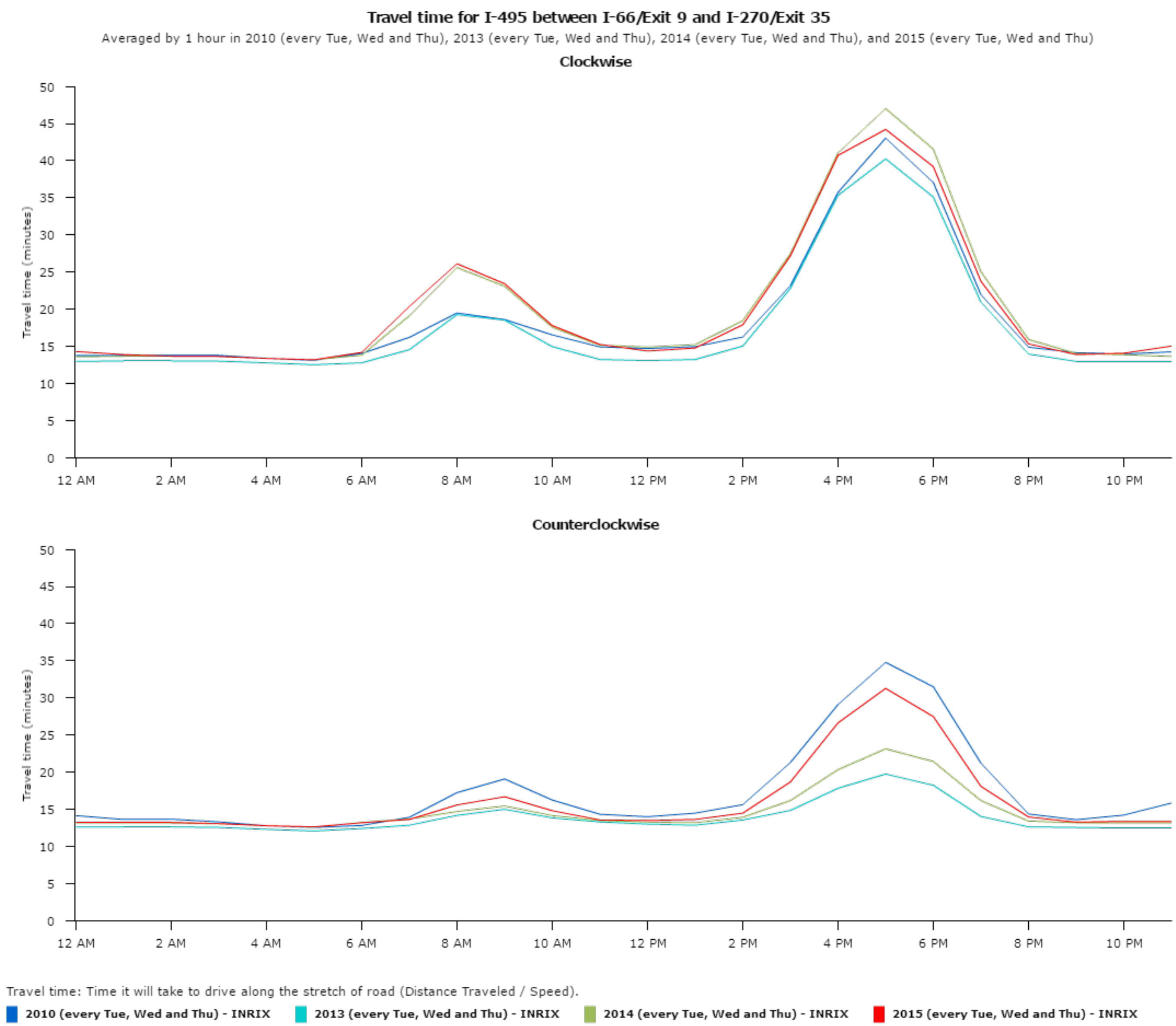
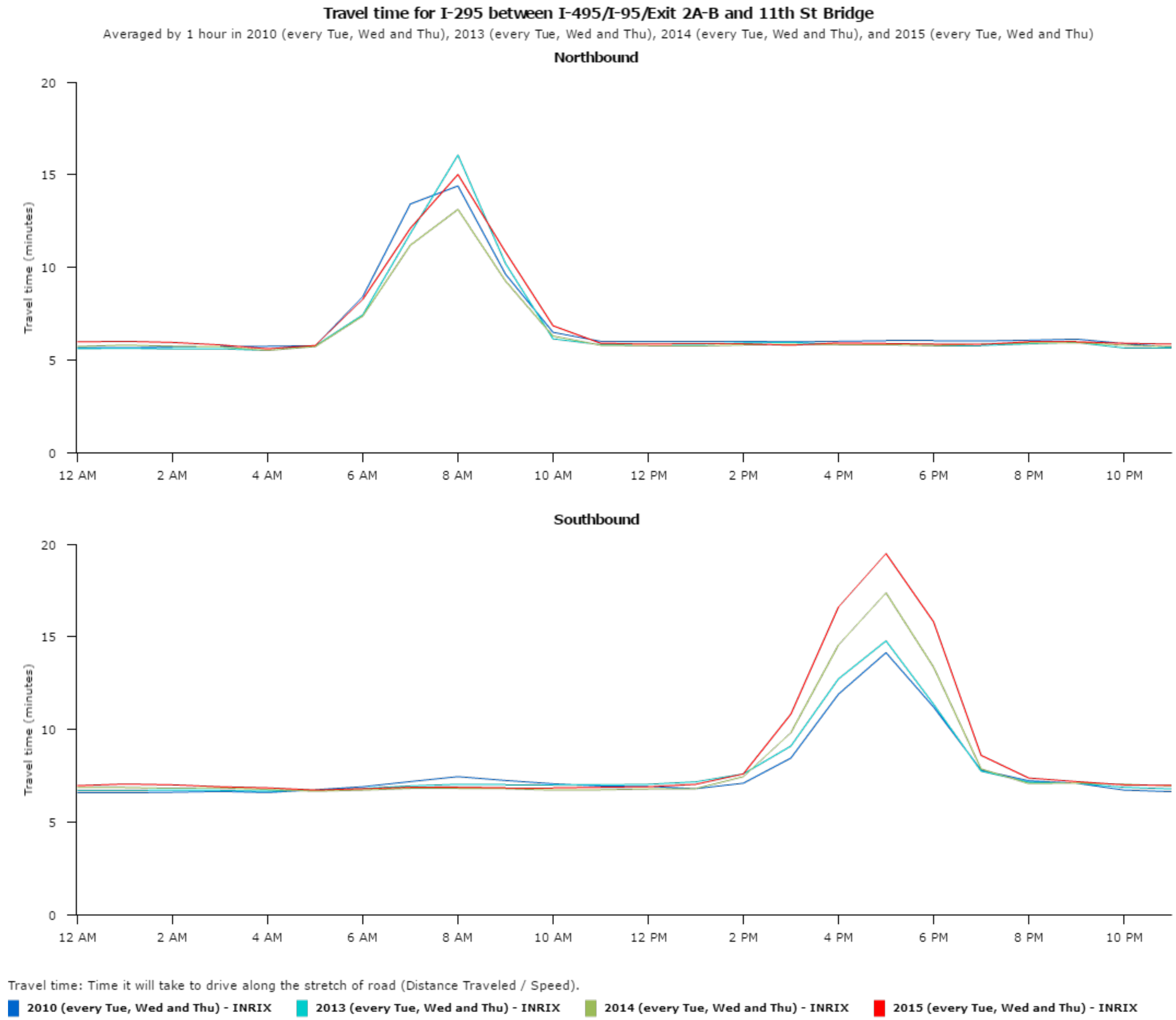

Travel time for I-495 between I-66/Exit 9 and I-270/Exit 35
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Clockwise
Counterclockwise
Travel time (minutes)
0
5
10
15
20
25
30
35
40
45
50
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

Figure C18


Travel time for I-295 between I-495/I-95/Exit 2A-B and 11th St Bridge
Averaged by 1 hour in 2010 (every Tue, Wed and Thu), 2013 (every Tue, Wed and Thu), 2014 (every Tue, Wed and Thu), and 2015 (every Tue, Wed and Thu)
Northbound
Southbound
Travel time (minutes)
0
5
10
15
20
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2010 (every Tue, Wed and Thu) - INRIX
2013 (every Tue, Wed and Thu) - INRIX
2014 (every Tue, Wed and Thu) - INRIX
2015 (every Tue, Wed and Thu) - INRIX

APPENDIX D – 2014 PERFORMANCE OF HIGH-OCCUPANCY VEHICLE FACILITIES ON FREEWAYS IN THE WASHINGTON REGION

Table D1: Observed Average Auto Occupancies in the AM Peak Direction during HOV-Restricted Periods (Spring 2014)

Observed average auto occupancies in the A.M. peak direction during HOV-restricted periods (Spring, 2014)				
Facility	HOV lane average auto occupancies	Number of autos needed to move 1000 persons at HOV occupancy rate	Non-HOV lane average auto occupancies	Number of autos needed to move 1000 persons at non-HOV occupancy - rate
I-395 Shirley Highway between Va. 120 (S. Glebe Road) and Arlington Ridge Road	2. 8	360	1. 1	910
I-95 Shirley Highway between Va. 286 (Fairfax County Parkway) and Va. 289 (Franconia Springfield Parkway)	2. 6	380	1. 1	910
I-66 between Sycamore Street and Va. 120 (North Glebe Road)	1. 7	590	N/ A	N/ A
I-66 between Va. 243 (Nutley Street) and I-495	1. 9	530	1. 1	910
I-270 between the "split" and Rockledge Drive	1. 9	530	1. 0	1000
I-270Y (I-270 Spur) between the "split" and Democracy Boulevard	1. 8	560	1. 0	1000
Va. 267 (Dulles Toll Road) west of Va. 7 (Leesburg Pike)	1. 9	530	1. 1	910
U.S 50 between Md. 197 (Collington Road) and Md. 704 (MLK, Jr. Highway)	1. 6	630	1. 0	1000

1.9

Note:
- Average auto occupancy rounded to nearest 1/10.

Table D2: Observed AM Peak Direction Average HOV Auto Occupancies Over Time

2014 Observed average HOV auto occupancies in the A.M. Peak Direction Over Time							
Facility	Year						
	1997	1998	1999	2004	2007	2010	2014
I-395 Shirley Highway between Va. 120 (S. Glebe Road) and Arlington Ridge Road	2.7	2.6	2.9	2.5	2.5	2.8	2.8
I-95 Shirley Highway between Va. 286 (Fairfax County Parkway) and Va. 289 (Franconia Springfield Parkway)	2.6	2.8	2.8	2.6	2.6	2.5	2.6
I-66 between Sycamore Street and Fairfax Drive	1.8	1.8	1.8	1.7	1.8	1.5	1.7
I-66 between Va. 243 (Nutley Street) and I-495	2.0	1.7	1.9	2.0	1.9	1.8	1.9
I-270 between the "split" and Rockledge Drive	1.9	1.7	1.7	1.9	1.5	2.0	1.9
I-270Y (I-270 Spur) between the "split" and Democracy Boulevard	1.9	1.8	1.8	1.5	1.8	1.9	1.8
I-270 between Montrose Road and the "split"	N/A	N/A	N/A	1.7	1.6	1.9	1.9
Va. 267 (Dulles Toll Road) west of Va. 7 (Leesburg Pike)	N/A	N/A	1.8	1.8	1.8	1.7	1.6
U.S 50 between Md. 197 (Collington Road) and Md. 704 (MLK, Jr. Highway)	N/A	N/A	N/A	1.6	1.9	1.8	1.9

Notes:
- Data in table are rounded.

Table D3: Observed Person Movements in the AM Peak Direction during HOV-Restricted Periods (Spring 2014)

Observed person movements in the A.M. peak direction during HOV-restricted periods (Spring, 2014)						
Facility **And Hours of HOV-restricted operation**	Number of HOV lanes	HOV lane person movements (autos, van-pools, motorcycles and buses) during HOV-restricted period	HOV lane persons per lane per hour	Number of non-HOV lanes	Non-HOV lane person movements during HOV-restricted period	Non-HOV lane persons per lane per hour
I-395 Shirley Hwy. between Va. 120 (S. Glebe Rd.) and Arlington Ridge Rd. 6:00 A.M. to 9:00 A.M.	2	27, 200	4, 500	4	21, 600	1, 800
I-95 Shirley Hwy. between Va. 286 (Fairfax County Pkwy.) and Va. 289 (Franconia Springfield Pkwy.) 6:00 A.M. to 9:00 A.M.	2 *Includes Newington Flyover Ramp*	15, 700	2, 600	4	15, 700	1, 300
I-66 between Sycamore Street and Fairfax Drive 6:30 A.M. to 9:00 A.M.	2	16, 300	3, 300	0 *No non-HOV lanes*	N/ A	N/ A
I-66 between Va. 243 (Nutley Street) and I-495 5:30 A.M. to 9:30 A.M.	1	11, 700	2, 900	3	19, 900	1, 700
Va. 267 (Dulles Toll Road) west of Va. 7 (Leesburg Pike) 6:30 A.M. to 9:00 A.M.	1	6, 900	2, 800	3	11, 000	1, 500
I-270 between Montrose Road and the "split" 6:00 A.M. to 9:00 A.M.	1	10, 700	3, 600	5	24, 600	1, 600
I-270 between the "split" and Rockledge Drive 6:00 A.M. to 9:00 A.M.	1	4, 700	1, 600	3	12, 100	1, 300
I-270Y (I-270 Spur) between the "split" and Democracy Boulevard 6:00 A.M. to 9:00 A.M.	1 *Includes Westlake Drive Ramp*	5, 900	2, 000	3	12, 600	1, 400
U.S 50 between Md. 197 (Collington Road) and Md. 704 (MLK, Jr. Highway) 24 Hours, 7 Days/Week (5:00 A.M. to 10:00 A.M. assumed in calculations)	1	4, 400	900	3	19, 500	1, 300

Note:

- *All person movements rounded to nearest 100*

Table D4: AM Peak Hour Person Movements during HOV-Restricted Periods (Spring 2014)

A.M. peak hour person movements during HOV-restricted periods (Spring 2014)						
Facility **And peak hour within HOV-restricted period**	Number of HOV lanes	HOV lane person movements (autos, van-pools, motorcycles and buses) during peak hour in HOV-restricted period	HOV lane persons per lane per hour	Number of non-HOV lanes	Non-HOV lane person movements during HOV-restricted period	Non-HOV lane persons per lane per hour
I-395 Shirley Hwy. between Va. 120 (S. Glebe Rd.) and Arlington Ridge Rd. 7:00 A.M. to 8:00 A.M.	2	10, 600	5, 300	4	8, 300	2, 100
I-95 Shirley Hwy. between Va. 286 (Fairfax County Pkwy.) and Va. 289 (Franconia Springfield Pkwy.) 6:30 A.M. to 7:30 A.M.	2 *Includes Newington Flyover Ramp*	11, 500	5, 800	4	6, 200	1, 600
I-66 between Sycamore Street and Fairfax Drive 7:45 A.M. to 8:45 A.M.	2	6, 900	3, 500	0 *No non-HOV lanes*	N/ A	N/ A
I-66 between Va. 243 (Nutley Street) and I-495 7:00 A.M. to 8:00 A.M.	1	3, 200	3, 200	3	5, 200	1, 700
Va. 267 (Dulles Toll Road) west of Va. 7 (Leesburg Pike) 7:00 A.M. to 8:00 A.M.	1	3, 200	3, 200	3	4, 800	1, 600
I-270 between the "split" and Rockledge Drive 7:45 A.M. to 8:45 A.M.	1	1, 700	1, 700	3	4, 600	1, 500
I-270Y (I-270 Spur) between the "split" and Democracy Boulevard 8:00 A.M. to 9:00 A.M.	1 *Includes Westlake Drive Ramp*	2, 100	2, 100	3	4, 300	1, 400
I-270 between Montrose Road and the "split" 7:45 A.M. to 8:45 A.M.	1	3, 800	3, 800	5	8, 900	1, 800
U.S 50 between Md. 197 (Collington Road) and Md. 704 (MLK, Jr. Highway) 7:15 A.M. to 8:15 A.M.	1	1, 000	1, 000	3	5, 100	1, 700

Note:
- All person movements rounded to nearest 100

Table D5: Mean AM Peak Period / Peak Direction Travel Times Over Time by Facility

Mean A.M. Peak Period / Peak Direction Travel Times Over Time by Facility
(95% Margin of Error in Parenthesis)

Facility	*HOV route travel time (minutes)*						*Non-HOV route travel time (minutes)*						*Time Savings (HOV Time - Non-HOV Time)*					
	1997	1999	2004	2007	2010	2014 (Methodology Change)	1997	1999	2004	2007	2010	2014 (Methodology Change)	1997	1999	2004	2007	2010	2014 (Methodology Change)
I-95/I-395 (northbound) From Va.234 (Dumfries) to the Pentagon *HOV route is 28.1 miles*	26 *(+/- 1)*	27 *(+/- 1)*	29 *(+/- 4)*	31 *(+/- 6)*	35 *(+/- 8)*	29	65 *(+/- 6)*	58 *(+/- 3)*	66 *(+/- 15)*	82 *(+/- 22)*	76 *(+/- 26)*	184	39	31	37 *	51 *	47 *	155 *
I-66 (eastbound) From Va.234 Business (Manassas) to Va. end of T. Roosevelt Bridge *HOV route is 27.8 miles*	43 *(+/- 3)*	41 *(+/- 8)*	53 *(+/- 8)*	48 *(+/- 9)*	66 *(+/- 17)*	141	71 *(+/- 11)*	69 *(+/- 5)*	70 *(+/- 14)*	76 *(+/- 13)*	102 *(+/- 29)*	193	28	28	17 *	28 *	10 *	52 *
Va.267/I-66 (eastbound) From Va.28 to Va. end of T. Roosevelt Bridge HOV route is 23.4 miles *HOV route is 23.4 miles*	N/ A	31 *(+/- 1)*	28 *(+/- 1)*	26 *(+/- 2)*	47 *(+/- 9)*	54	N/ A	51 *(+/- 5)*	48 *(+/- 2)*	33 *(+/- 5)*	77 *(+/- 17)*	94	N/ A	20	20 *	7	- 14	40
I-270 & East Spur (southbound) From I-370 to Old G'town Road *HOV route is 8.8 miles*	11 *(+/- 1)*	18 *(+/- 1)*	13 *(+/- 2)*	12 *(+/- 4)*	23 *(+/- 3)*	23	16 *(+/- 3)*	22 *(+/- 4)*	19 *(+/- 3)*	20 *(+/- 8)*	18 *(+/- 3)*	23	5	4	6	8	- 3	0
I-270 and West Spur (southbound) From I-370 to S end of I-270 Spur *HOV route is 8.6 miles*	11 *(+/- 2)*	16 *(+/- 3)*	14 *(+/- 7)*	13 *(+/- 3)*	12 *(+/- 3)*	20	17 *(+/- 4)*	23 *(+/- 3)*	22 *(+/- 3)*	18 *(+/- 5)*	16 *(+/- 5)*	44	6	7	8	5	6	24
U.S.50 (westbound) From U.S.301/Md.3 to I-95/I-495 *HOV route is 9.0 miles*	N/ A	N/ A	9 *(+/- 0)*	7 *(+/- 1)*	7 *(+/- 1)*	13	N/ A	13 *(+/- 2)*	12 *(+/- 2)*	8 *(+/- 2)*	8 *(+/- 1)*	20	N/ A	N/ A	3	1	1	7

Notes:
- *Data in table are rounded to whole minutes.*
- *I-66 (eastbound) non-HOV route uses I-66 to I-495 (southbound) to U.S.50 (eastbound) to I-66 on T. Roosevelt Bridge*
- *Va.267 (eastbound) HOV route uses Va. 267 to Dulles Connector Road to I-66 (eastbound)*
- *Va.267 (eastbound) non-HOV route uses Va.267 to I-495 (northbound) to G.Washington Mem. Parkway (southbound) to I-66 on T. Roosevelt Bridge*
- *All travel time runs on Va.267 (HOV and non-HOV) performed with an EZ-Pass transponder.*
- *Travel time savings shown with an asterisk (*) are statistically significant at the 95% confidence level using a Tukey Test for 2004-2010. Time savings without an asterisk are not statistically significant.*
- *Margins of Error computed at 95% confidence level using two-tailed test.*

Table D6: AM Peak Direction Travel Time Summary for HOV and non-HOV Lanes (2014)

2014 Regional HOV Monitoring
A.M. Peak Direction Travel Time Summary for HOV and non-HOV Lanes

					Time Savings		Mean Speeds	
Facility	Facility Section	Length (miles)	HOV Time (mins.)	Non-HOV Time (mins.)	*In Minutes*	*in Min./Mi.*	HOV (MPH)	Non-HOV (MPH)
I-95/I-395	**From Va. 234 to the Pentagon**	27.6	29	184	155	5.6	57	9
	Outside Beltway	*17.5*	18	117	*99*	*5.7*	*57*	*9*
	Inside Beltway	*10.7*	11	36	*25*	*2.3*	*60*	*18*
I-66	**From U.S. 15 to the T. Roosevelt Bridge**	35.3	141	193	52	1.5	15	11
	Outside Beltway	*17.8*	71	97	*26*	*1.5*	*15*	*11*
	Inside Beltway	*10.5*	11	63	*52*	*5.0*	*58*	*10*
Va. 267	**From Va.28 to to the T. Roosevelt Bridge (via Dulles Connector and I-66)**	23.4	45	94	49	2.1	31	15
	Va. 267 only	*14.9*	28	60	*32*	2.1	*32*	*15*
I-270	**From I-370 to I-495 (passing Md. 187)**	9.9	23	23	0	0.0	26	26
	I-270Y (I-270 Spur) From I-370 to I-495 (passing Democracy Blvd.)	11.0	32	44	12	1.1	11	15
U.S. 50	**From U.S. 301/Md. 3 to Capital Beltway**	6.5	13	20	7	1.1	31	20

Notes:
- Facility Length rounded to nearest 1/10 of a mile
- HOV Times, Non-HOV Times and Time Savings in Minutes rounded to nearest whole minute
- Time Savings rounded to nearest 1/10 of a minute

APPENDIX E – SUMMARY OF TRANSPORTATION EMISSION REDUCTION MEASURE (TERM) ANALYSIS FY 2012-2014[205]

Background

This report presents the results of an evaluation of four Transportation Emission Reduction Measures (TERMs), voluntary Transportation Demand Management (TDM) measures implemented by the National Capital Region Transportation Planning Board's (TPB) Commuter Connections program at the Metropolitan Washington Council of Governments (COG) to support the Washington, DC metropolitan region's air quality conformity determination and congestion management process. This evaluation documents transportation and air quality impacts for the three-year evaluation period between July 1, 2011 and June 30, 2014, for the following TERMs:

- Maryland Telework – Provides information and assistance to commuters and employers to further in-home and telework center-based telework programs.

- Guaranteed Ride Home – Eliminates a barrier to use of alternative modes by providing free rides home in the event of an unexpected personal emergency or unscheduled overtime to commuters who use alternative modes.

- Employer Outreach – Provides regional outreach services to encourage large, private-sector and non-profit employers voluntarily to implement commuter assistance strategies that will contribute to reducing vehicle trips to worksites, including the efforts of jurisdiction sales representatives to foster new and expanded trip reduction programs.

- Mass Marketing – Involves a large-scale, comprehensive media campaign to inform the region's commuters of services available from Commuter Connections as one way to address commuters' frustration about the commute.

COG's National Capital Transportation Planning Board (TPB), the designated Metropolitan Planning Organization (MPO) for the Washington, DC metropolitan region, adopted and continues to support these TERMs, among others, as part of the regional Transportation Improvement Program (TIP). The purpose of the TERMs is to help the region reach emission reduction targets that would maintain a positive air quality conformity determination for the region and to meet federal requirements for the congestion management process. The Commuter Connections program is considered integral in regional travel demand management and is included in the region's TERMs technical documentation which was updated in July 2013. Travel parameters prior to the year 2010 were captured by the regional travel demand model. Only the effects of the incremental growth of the Commuter Connections program post 2010 will be accounted for in future analysis years.

COG/TPB's Commuter Connections program, which also operates an ongoing regional rideshare program, is the central administrator of the TERMs noted above. Commuter Connections elected to include a vigorous evaluation element in the implementation plan for each of the adopted TERMs to

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[205] Nicholas Ramfos, Elena Constantine, Lori Diggins, Eric Schreffler and Phillip Winters, National Capital Region Transportation Planning Board (TPB) Commuter Connections 2012-2014 Transportation Emission Reduction Measure Analysis Report, November 18, 2014. http://www.mwcog.org/uploads/pub-documents/vV5bWlc20150521093610.pdf

develop information to guide sound decision-making about the TERMs. This report summarizes the results of the TERM evaluation activities and presents the transportation and air quality impacts of the TERMs and the Commuter Operations Center (COC).

This evaluation represents a comprehensive evaluation for these programs. It should be noted, however, that the evaluation is conservative in the sense that it includes credit only for impacts that can be reasonably documented with accepted measurement methods and tools. Note that many of the calculations used data from surveys that are subject to some statistical error, at rates common to such surveys.

A primary purpose of this evaluation was to develop meaningful information for regional transportation and air quality decision-makers, COG/TPB staff, COG/TPB program funding agencies, and state and local commute assistance program managers to guide sound decision-making about the TERMs. The results of this evaluation will provide valuable information for regional air quality conformity and the region's congestion management process, to improve the structure and implementation procedures of the TERMs themselves, and to refine future data collection methodologies and tools.

Summary of Results

The objective of the evaluation is to estimate reductions in vehicle trips (VT), vehicle miles traveled (VMT), and tons of vehicle pollutants (Nitrogen Oxides (NOx), Volatile Organic Compounds (VOC), Particulate Matter (PM2.5), Particulate Matter NOx precursors (PM and NOx), and Carbon Dioxide (CO2)) resulting from implementation of each TERM and compare the impacts against the goals established for the TERMs. The impact results for these measures are shown in Table A for each TERM individually. Results for all TERMs collectively and for the Commuter Operations Center (COC) are presented in Table B.

As shown in Table A, the TERMs combined exceeded the collective goals for vehicle trips reduced by 10% and exceeded the VMT goal by about 6%. The TERMs did not reach the emission goals; the impact for NOx was about 13% under the goal and VOC impact was 26% under the goal, but this was due entirely to a change in the emission factors. The goals were set in 2006, using 2006 emission factors, but the factors used in the 2014 evaluation were considerably lower, reflecting a cleaner vehicle fleet.

When the COC results are added to the TERM impacts, as presented in Table B, the combined impacts again met both the vehicle trip and VMT reduction goals, in this case by 20% and 14%, respectively. The combined TERM – COC programs fell about 3% short of the NOx goal and 19% under the VOC goal. Again, the change in the emission factors affected the emission results.

Two TERMs, Employer Outreach, and Mass Marketing, easily met their individual participation, travel impact, and emission goals. Employer Outreach, both the overall program and the New/Expanded component, exceeded its vehicle trip and VMT goals by substantial margins. Employer Outreach for Bicycling also met its goals.

The Mass Marketing (MM) TERM generated vehicle trip reduction 33% above its goal and VMT reduction 23% above the goal. These results were due in part to the expansion of the Mass Marketing TERM to include additional components (e.g., Car Free Day), but also due to the shift in additional Mass Marketing credit from GRH and the Commuter Operations Center. Fifteen percent (15%) of the base impacts for each of these programs was assigned to Mass Marketing in 2014, compared with the 2011 Mass Marketing shares of 3% of the COC and 10% of GRH.

The impacts for the other two TERMs were below their goals. The Telework TERM's vehicle trip and VMT reductions fell 18% and 15% short of their goals, due to a change in the TERM during FY 2012 to include only telework impacts generated by Commuter Connections among commuters and employers located in Maryland. Telework impacts generated by Commuter Connections outside of Maryland were still included in the 2014 impacts, but were counted under the Commuter Operations Center, so were not included in the TERM total. Impacts for the Guaranteed Ride Home TERM also were well below the goals for this program, primarily due to declining registrations, compared with 2011 and previous years.

Both the Commuter Operations Center and the Software Upgrades TERM met or exceeded their goals for vehicle trips and VMT reduced. The COC exceeded its goals for these measures by a substantial margin; the vehicle trip reduction was 124% over the goal and the VMT reduction was 65% over the goal, because telework impacts generated by Commuter Connections outside of Maryland, which had been credited to the Telework TERM in 2011, were assigned to the COC in 2014.

Table A
Summary of Daily Impact Results for Individual TERMs (July 2011 – June 2014) and Comparison to Goals

TERM	Participation [1]	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Telework Assistance [2]					
2014 Goal	31,854	11,830	241,208	0.122	0.072
Impacts (7/11 – 6/14)	26,334	9,651	205,511	0.101	0.051
Net Credit or (Deficit)	**(5,520)**	**(2,179)**	**(35,698)**	**(0.021)**	**(0.021)**
Guaranteed Ride Home					
2014 Goal	36,992	12,593	355,136	0.177	0.097
Impacts (7/11 – 6/14)	21,156	7,711	212,834	0.087	0.033
Net Credit or (Deficit)	**(15,836)**	**(4,882)**	**(142,302)**	**(0.090)**	**(0.064)**
Employer Outreach – all employers participating [3]					
2014 Goal	581	64,644	1,065,851	0.549	0.343
Impacts (7/11 – 6/14)	1,756	78,533	1,327,044	0.534	0.305
Net Credit or (Deficit)	1,175	**13,889**	**261,193**	**(0.015)**	**(0.038)**
Employer Outreach – new / expanded employer services since July 2011 [3]					
2014 Goal	96	8,618	140,622	0.072	0.046
Impacts (7/11 – 6/14)	1,130	38,375	568,078	0.267	0.140
Net Credit or (Deficit)	**1,034**	**29,757**	**447,456**	**0.195**	**0.094**
Employer Outreach for Bicycling [3]					
2014 Goal	61	130	567	0.0006	0.0005
Impacts (7/11 – 6/14)	472	323	1,937	0.0013	0.0012
Net Credit or (Deficit)	**411**	**193**	**1,370**	**0.0007**	**0.0007**
Mass Marketing					
2014 Goal	11,023	7,758	141,231	0.072	0.044
Impacts (7/11 – 6/14)	22,065	10,294	173,269	0.081	0.024
Net Credit or (Deficit)	**11,042**	**2,536**	**32,038**	**0.009**	**(0.020)**
TERMS (all TERMs collectively)					
2014 Goal		96,825	1,803,426	0.920	0.556
Impacts (7/11 – 6/14)		106,189	1,918,658	0.803	0.412
Net Credit or (Deficit)		**9,364**	**115,232**	**(0.117)**	**(0.144)**

1) Participation refers to number of commuters participating, except for the Employer Outreach TERM. For this TERM, participation equals the number of employers participating.

2) Impact represents portion of regional telework attributable to TERM-related activities. Total telework credited for conformity is higher than reported for the TERM.

3) Impacts for Employer Outreach - all employers participating includes impacts for Employer Outreach – new / expanded employer services since July 2011 and for Employer Outreach for Bicycling.

Table B
Summary of TERM and COC Results (July 2011 – June 2014) and Comparison to Goals

TERM	Participation	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
TERMS (all TERMs collectively)					
2014 Goal		96,825	1,803,426	0.920	0.556
Impacts (7/11 – 6/14)		106,189	1,918,658	0.803	0.412
Net Credit or (Deficit)		**9,364**	**115,232**	**(0.117)**	**(0.144)**
Commuter Operations Center – Basic Services					
2014 Goal	152,356	10,399	296,635	0.147	0.081
Impacts (7/11 – 6/14)	87,247	23,262	488,226	0.230	0.110
Net Credit or (Deficit)	(65,109)	**12,863**	**191,591**	**0.083**	**0.029**
Commuter Operations Center – Software Upgrades [1)]					
2014 Goal		2,370	62,339	0.031	0.017
Impacts (7/11 – 6/14)	4,681	2,379	66,442	0.028	0.011
Net Credit or (Deficit)		**9**	**4,103**	**(0.003)**	**(0.006)**
All TERMS plus COC					
2014 Goal		109,594	2,162,400	1.098	0.654
Impacts (7/11 – 6/14)		131,830	2,473,326	1.061	0.533
Net Credit or (Deficit)		**22,236**	**310,926**	**(0.037)**	**(0.121)**

1) Impacts for Commuter Operations Center – software Upgrades are in addition to the impacts for the Commuter Operations Center – Basic Services. This project was previously part of the Integrated Rideshare TERM.

Table C, on the following page, presents annual emission reduction results for PM 2.5, PM 2.5 pre-cursor NOx, and CO2 emissions (Greenhouse Gas Emissions - GHG) for each TERM and for the COC. COG/TPB did not establish specific targets for these impacts for the Commuter Connections TERMs. But COG has been measuring these impacts for other TERMs, thus these results are provided.

As shown, the TERMs collectively reduce 9 annual tons of PM 2.5, 215 annual tons of PM 2.5 pre-cursor NOx, and 200,012 annual tons of CO2 (greenhouse gas emissions). When the Commuter Operations Center is included, these emissions impacts rise to 11.8 annual tons of PM 2.5, 280 annual tons of PM 2.5 pre-cursor NOx, and 261,496 annual tons of CO2 (greenhouse gas emissions).

Table C
Summary of Annual PM 2.5 and CO2 (Greenhouse Gas) Emission Results for Individual TERMs

TERM	Annual Tons PM 2.5 Reduced	Annual Tons PM 2.5 Precursor NOx Reduced	Annual Tons CO2 Reduced
Telework Assistance [1)]	1.08	25.40	23,528
Guaranteed Ride Home	0.95	21.60	21,891
Employer Outreach – all employers [2)]	6.14	147.91	135,753
Employer Outreach – new / expanded Employers [2)]	2.79	67.23	61,475
Employer Outreach for Bicycling	0.01	0.35	237
Mass Marketing	0.85	20.28	18,840
TERMS (all TERMs collectively)	9.02	215.19	200,012
Commuter Operations Center – basic services (not including Software Upgrades)	2.43	57.59	54,441
Commuter Operations Center – Software Upgrades	0.31	7.04	7,043
All TERMs plus Commuter Operations Center	11.76	279.82	261,496

1) Impact represents portion of regional telecommuting attributable to TERM-related activities. Total telecommuting credited for conformity is higher than reported for the TERM.

2) Impacts for new / expanded employer programs and Employer Outreach for Bicycling are included in the Employer Outreach – all employers.

Finally, Table D shows comparisons of daily reductions in vehicle trips, VMT, NOx, and VOC from the 2011 TERM analysis to results of the 2014 results. Note that, as described in the footnotes to the table, the emission factors declined between 2011 and 2014, resulting in decreased emission reductions, even though the TERMs achieved greater vehicle trip and VMT reductions in 2014.

The Employer Outreach TERM impacts declined in 2014 compared with 2011, but the coefficients used in the model applied to estimate these impacts were modified in 2014 to be consistent with the updated regional travel model approved by the TPB. The coefficients fell substantially, resulting in lower vehicle trip and VMT reductions in 2014, even though the number of participating employers rose substantially.

Table D
Summary of Results for Individual TERMs 7/11– 6/14 Compared with 7/08 – 6/11

TERM	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Telework Assistance				
July 2011 – June 2014	9,651	205,511	0.101	0.051
July 2008 – June 2011	12,499	241,834	0.099	0.062
Change [1)]	(2,848)	(36,324)	0.002	(0.011)
Guaranteed Ride Home				
July 2011 – June 2014	7,711	212,834	0.087	0.033
July 2008 – June 2011	7,983	208,346	0.076	0.042
Change [1)]	(272)	4,488	0.011	(0.009)
Employer Outreach – All services except Employer Outreach for Bicycling				
July 2011 – June 2014	78,210	1,325,107	0.533	0.304
July 2008 – June 2011	90,170	1,656,727	0.577	0.366
Change [1)]	(11,960)	(331,620)	(0.044)	(0.062)
Employer Outreach for Bicycling				
July 2011 – June 2014	323	1,937	0.001	0.001
July 2008 – June 2011	180	1,083	0.001	0.001
Change [1)]	143	854	0.000	0.000
Mass Marketing				
July 2011 – June 2014	10,294	173,269	0.081	0.024
July 2008 – June 2011	6,922	78,297	0.031	0.021
Change [1)]	3,372	94,973	0.050	0.003
All TERMs				
July 2011 – June 2014	106,189	1,918,658	0.803	0.412
July 2008 – June 2011	117,754	2,186,286	0.784	0.492
Change [1)]	(11,565)	(267,628)	0.019	(0.080)
Commuter Operations Center (Basic Services + Software Upgrades)				
July 2011 – June 2014	25,641	554,668	0.258	0.121
July 2008 – June 2011	7,907	231,978	0.086	0.046
Change [1)]	17,734	322,690	0.172	0.075

1) Change in emissions is due in part to reduction in emission factors from 2011 to 2014.

APPENDIX F – SAMPLE CMP DOCUMENTATION FORM

CONGESTION MANAGEMENT DOCUMENTATION FORM FOR PROJECTS IN THE 2040 CLRP

1. Agency: Secondary Agency:
2. Project Title:

	Prefix	Route	Name	Modifier
4. Facility:				
5. From (_ at):				
6. To:				

7. Jurisdiction(s):

8. Indicate whether the proposed project's location is subject to or benefits significantly from any of the following in-place congestion management strategies:
   _ Metropolitan Washington Commuter Connections program (ridesharing, telecommuting, guaranteed ride home, employer programs)
   _ A Transportation Management Association is in the vicinity
   _ Channelized or grade-separated intersection(s) or roundabouts
   _ Reversible, turning, acceleration/deceleration, or bypass lanes
   _ High occupancy vehicle facilities or systems
   _ Transit stop (rail or bus) within a 1/2 mile radius of the project location
   _ Park-and-ride lot within a one-mile radius of the project location
   _ Real-time surveillance/traffic device controlled by a traffic operations center
   _ Motorist assistance/hazard clearance patrols
   _ Interconnected/coordinated traffic signal system
   _ Other in-place congestion management strategy or strategies (briefly describe below:)

9. List and briefly describe how the following categories of (additional) strategies were considered as full or partial alternatives to single-occupant vehicle capacity expansion in the study or proposal for the project.
   a. Transportation demand management measures, including growth management and congestion pricing

   b. Traffic operational improvements

   c. Public transportation improvements

   d. Intelligent Transportation Systems technologies

CONGESTION MANAGEMENT DOCUMENTATION FORM

e. Other congestion management strategies

f. Combinations of the above strategies

10. Could congestion management alternatives fully eliminate or partially offset the need for the proposed increase in single-occupant vehicle capacity? Explain why or why not.

11. Describe all congestion management strategies that are going to be incorporated into the proposed highway project.

12. Describe the proposed funding and implementation schedule for the congestion management strategies to be incorporated into the proposed highway project. Also describe how the effectiveness of strategies implemented will be monitored and assessed after implementation.

APPENDIX G – REVIEW OF CONGESTION MANAGEMENT STRATEGIES

This appendix references the Table 17 and Table 18 on pages 185 and 186, which are repeated on the next two pages for convenience.

General Characteristics

Strategy Name and Number:

The strategies down the left-hand side of the lists were developed based on the types of strategies being pursued in the region and elsewhere, and could be considered for implementation in our region. Inclusion of any given strategy on the list does not imply endorsement, but rather is included on the list only for consideration and comparison purposes.

Each strategy has a number associated with it (C.1.0, C.1.1, etc.) to make it easier to find and discuss the strategies. The number is not in any way a ranking.

Those listed in bold italics are the strategy categories and underneath them are the specific strategies in that category.

Table G1: Congestion Management Process (CMP) Demand Management Strategies Criteria

1. Some Impact (x)
2. Significant Impact (xx)
3. High Impact (xxx)

		QUALITATIVE CRITERIA									
		Impacts on Congestion									
STRATEGY		Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
C.5.0	***Alternative Commute Programs***										
C.5.1	Carpooling	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.2	Ridematching Services	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.3	Vanpooling	xxx	x	x	xxx	xx	xx	xx	x	xxx	xxx
C.5.4	Telecommuting	xx	x	x	xxx	xx	xx	xxx	x	xx	xxx
C.5.5	Promote Alternate Modes	xx	x	xxx	xxx	xxx	xxx	xxx	x	xx	xxx
C.5.6	Compressed/flexible w orkw eeks	xx	x	x	xxx	xxx	xxx	xxx	x	x	xx
C.5.7	Employer outreach/mass marketing	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.5.8	Parking cash-out	xx	x	xxx	x	xxx	x	x	xx	xx	x
C.5.9	Alternative Commute Subsidy Program	xx	x	xxx	xxx	xx	xx	x	x	xxx	xxx
C.6.0	***Managed Facilities***										
C.6.1	HOV	xx	x	xxx	xxx	xx	xx	xx	xxx	xxx	xxx
C.6.2	Variably Priced Lanes (VPL)	xxx	x	xx	xxx	xx	x	x	xxx	xxx	xx
C.6.3	Cordon Pricing	xxx	x	xxx	xxx	x	x	x	xx	xxx	xx
C.6.4	Bridge Tolling	xxx	x	x	xx	xx	x	x	xxx	xx	x
C.7.0	***Public Transportation Improvements***										
C.7.1	Electronic Payment Systems	xx	x	xxx	xx	xx	xxx	xx	xx	xxx	xx
C.7.2	Improvements/added capacity to regional rail and bus transit	xx	xx	xxx	xx	xxx	xx	x	xxx	xxx	xx
C.7.3	Improving accessibility to multi-modal options	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.7.4	Park-and-ride lot improvements	xx	x	xx	xx	xx	xx	xx	xx	xx	xx
C.7.5	Carsharing Programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.8.0	***Pedestrian, bicycle, and multi-modal improvements***										
C.8.1	Improve pedestrian facilities	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.8.2	Creation of new bicycle and pedestrian lanes and facilities	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.8.3	Addition of bicycle racks at public transit stations/stops	x	x	xx	xxx	xxx	xx	xxx	x	x	xxx
C.8.4	Bike sharing programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.9.0	***Growth Management***										
C.9.1	Coordination of Regional Activity Centers	xx	x	xxx	xxx	xxx	xx	x	xxx	xxx	xx
C.9.2	Implementation of TLC program (i.e. coordination of transportation and land use w ith local gov'ts)	xx	x	xxx	xxx	xxx	xx	xxx	x	xxx	xxx
C.9.3	"Live Near Your Work" program	xx	x	xx	xxx	xx	x	xx	x	x	xx

Table G2: Congestion Management Process (CMP) Operational Management Strategies Criteria

1. Some Impact (x)
2. Significant Impact (xx)
3. High Impact (xxx)

		QUALITATIVE CRITERIA									
		Impacts on Congestion									
STRATEGY		Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
C.1.0	***Incident Mngt./Non-recurring***										
C.1.1	Imaging/Video for surveillance and Detection	xx	xxx	xx	xxx	xxx	xx	xx	xx	xxx	xxx
C.1.2	Service patrols	xx	xxx	x	xxx	xxx	xx	xxx	xx	xxx	xxx
C.1.3	Emergency Mngt. Systems (EMS)	x	xx	x	xx	xxx	xxx	xx	xxx	xxx	xxx
C.1.4	Emergency Vehicle Preemption	x	xx	x	x	xxx	xx	xx	xx	x	xx
C.1.5	Road Weather Management	x	xxx	x	xxx	xxx	xx	xx	xx	xx	xx
C.1.6	Traffic Mngt. Centers (TMCs)	xx	xxx	xx	xxx	xx	xx	xx	xx	xxx	xxx
C.1.7	Curve Speed Warning System	xx	xx	x	x	xx	x	xx	xx	xx	x
C.1.8	Work Zone Management	xx	xxx	x	xx	xxx	xx	xx	xx	xx	xx
C.1.9	Automated truck rollover systems	x	xx	x	x	xx	xx	xx	xx	xx	xx
C.2.0	***ITS Technologies***										
C.2.1	Advanced Traffic Signal Systems	xxx	xx	xx	xxx	xxx	xx	xx	xxx	xxx	xxx
C.2.2	Electronic Payment Systems	xxx	x	xx	xxx	xx	xx	xx	xx	xxx	xx
C.2.3	Freew ay Ramp Metering	xx	x	x	xx	xx	x	xx	xx	xx	xx
C.2.4	Bus Priority Systems	x	x	xxx	xxx	xxx	x	xx	xxx	xx	xx
C.2.5	Lane Management (e.g. Variable Speed Limits)	xx	xx	x	xx	xxx	x	xx	xx	xx	xx
C.2.6	Automated Enforcement (e.g. red light cameras)	x	x	x	x	xxx	xx	xx	xx	xx	xx
C.2.7	Traffic signal timing	xxx	x	xx	xxx	xxx	xx	xxx	x	xxx	xxx
C.2.8	Reversible Lanes	xx	x	x	xx	xxx	x	x	xx	xx	xx
C.2.9	Parking Management Systems	xx	x	xx	xx	xxx	x	x	xxx	xx	xx
C.2.10	Dynamic Routing/Scheduling	xx	x	xx	xxx	xxx	x	x	xxx	xx	xx
C.2.11	Service Coordination and Fleet Mngt. (e.g. buses and trains sharing real-time information)	xx	x	xxx	xxx	xxx	x	x	xx	xx	xx
C.2.12	Probe Traffic Monitoring	xx	xxx	x	xx	xx	x	xx	xx	xxx	xx
C.3.0	***Advanced Traveler Information Systems***										
C.3.1	511	xx	xxx	xx	xxx	x	xx	xx	xxx	xx	xxx
C.3.2	Variable Message Signs (VMS)	xx	xxx	xx	xx	xxx	xx	xx	xx	xxx	xxx
C.3.3	Highw ay Advisory Radio (HAR)	x	xx	x	xx	xxx	xx	xxx	xx	x	xx
C.3.4	Transit Information Systems	xx	xx	xxx	xx	xxx	xx	x	xx	xx	xxx
C.4.0	***Traffic Engineering Improvements***										
C.4.1	Safety Improvements	x	xxx	x	x	xxx	xx	xxx	x	xxx	xxx
C.4.2	Turn Lanes	xx	x	x	x	xxx	xx	xx	xx	xx	x
C.4.3	Roundabouts	x	xx	x	x	xxx	x	x	x	xx	xx

Qualitative Criteria:

The qualitative criteria listed across the top of the lists are used to show what kind of impact strategies have on various areas. The first three criteria listed are all impacts on congestion. However, there are several other criteria that could be looked at to determine if a strategy should be considered. The following is a definition of each criterion, and the questions we may want to ask when giving each strategy a "high," "medium," or "low" indicator:

- ***Reduces Overall Congestion***
  - How much of an impact does a strategy have in reducing overall traffic congestion?
- ***Reduces Incident-related Congestion***
  - How much of an impact does a strategy have in reducing incidents and incident-related congestion?
- ***Support/Promotes Multi-modal Transportation***
  - Does this strategy play a particular role in supporting multi-modal transportation, such as the use of bus, rail, bicycling, or pedestrian facilities?
- ***Regional Applicability***
  - Is this the type of strategy that would be easier to implement at the regional level (e.g. alternative commute programs across the region)?
- ***Local Applicability***
  - Is this the type of strategy that would be easier to implement at the local level (e.g. Automated Enforcement, which depends greatly on the local laws and law enforcement)?
- ***Existing Level of Deployment***
  - Is this strategy implemented anywhere in the region now, and if so, to what extent?
- ***Ease of Implementation***
  - How easy is the strategy to implement? Not only in terms of complexity, but in also in terms of funding, and a local jurisdiction's unique programs and laws. Some strategies are more common and more promising, while others may be more difficult to implement.
- ***Cost***
  - How much does a strategy cost to implement?
- ***Cost Effectiveness***
  - How much does the value outweigh the cost (i.e. how high are the benefits)? This is different than the previous "cost" category. For example, carpooling may be indicated as low in terms of cost, because the cost is generally low to implement. However, carpooling may be indicated as high in terms of cost effectiveness, because the benefits and value gained in the region far outweigh the cost.
- ***Enhance Existing Programs***
  - How well does this strategy fit in with existing strategies in the region? Is it new and something that existing strategies would benefit from? This category, previously broken down into "DC," "MD," and "VA," was collapsed into one category. It was found that when trying to determine if a strategy enhanced existing programs, there was not much variation among the jurisdictions.

Some, Significant, and High Indicators:

Each strategy was given an indicator of "some impact (x)," "significant impact (xx)," or "high impact (xxx)," which was based on a similar nomenclature used in the TERM process. Each indicator was developed from the knowledge and research of what sorts of activities are going on in our region. By nature of various strategies, some will be evaluated with greater or lesser impacts (e.g. a strategy may be listed as "low" for regional applicability but "high" for local applicability"). That being said, some strategies that are "low" in some categories may be of interest for other reasons.

To further explain and clarify the reason for these indicators, let's walk through the indicators of one strategy, *C.8.1 – Improve Pedestrian Facilities*:

- Improving pedestrian facilities was thought to have a medium impact on reducing overall congestion in the region. Improving pedestrian facilities provides an alternative mode of transportation and takes some cars off the road.
- Its contribution to reducing incident-related congestion is limited; therefore it is indicated low in that category.
- Improving pedestrian facilities greatly support and promote multi-modal transportation, therefore indicated high.
- It is something that can be implemented region-wide, but is more likely to be applied more on a local level, given the unique programs and laws of jurisdictions (thus a medium indicator for regional applicability and a high indicator for local applicability).
- It has a fairly good existing level of deployment across the region (although given the high demand for pedestrian facilities in this region, some areas are lacking facilities).
- Ease of implementation for improving pedestrian facilities could be less expensive than building new roadways, and it could be easier to implement than ITS technologies. However, challenges such as local approval, and demand for these facilities, still remain. Indicator: medium.
- Cost is neither extremely low nor especially high, and it really depends on what type of pedestrian facility is being implemented. Cost effectiveness was indicated medium, as pedestrian facilities provide a good benefit for what it costs to implement them.
- Improvement of pedestrian facilities enhance existing programs. Pedestrian facilities support local growth management plans and provide access to transit options. Indicator: high.

Tying It All Together:

The strategy long lists are important to the regional CMP for several reasons:

- The lists outline various existing and potential strategies that could be considered for our region. As congestion is becoming and epidemic here and elsewhere, these strategies will serve as a point of reference to indicate what is being done in this region to address this.
- The "high," "medium," and "low" indicators characterize the impact strategies have. They provide a starting point for discussion show that there are various reasons why one may want to implement a strategy. While something may have a high cost, it may also have a high impact on reducing congestion and a high cost effectiveness.
- The lists address federal requirements, which state that the region should identify and evaluate anticipated performance and expected benefits of existing strategies.

As the region continues to grow these are just some of the strategies that could be considered for our region. Many strategies on these lists are ongoing and will continue to be implemented on a greater scale. For other strategies these lists may act as a starting point for future consideration. Regardless, congestion management strategies will be at the forefront of discussion as the Washington region continues to be a dynamic living and working environment.

Detailed Descriptions of Strategies

Following is a list of congestion management strategies listed in the Strategy Long Lists. The numbers correspond with the numbered strategies in the list.

Operational Management Strategies:

C.1.0 - Incident Management./Non-recurring - This category of strategies are aimed at reducing non-recurring congestion; congestion caused primarily by incidents and events. Many of these incident management systems are aimed at clearing an incident so that traffic can resume its normal flow.

- *C.1.1 – Imaging/Video for Surveillance and Detection*
  - Cameras throughout our transportation system, on roadways, at intersections, and at transit stations. Help detect incidents quickly, help emergency response units arrive quickly and help travelers safely negotiate around incidents.
- *C.1.2 – Service Patrols*
  - Specially equipped motor vehicles and trained staff that help in clearing incidents off a roadway and navigating traffic safely around an incident.
- *C.1.3 – Emergency Management Systems (EMS)*
  - EMS notify, dispatch, and guide emergency responders to an incident. Aid in detecting, tracking, and clearing incidents.
- *C. 1.4 – Emergency Vehicle Preemption*
  - Signal preemption for emergency vehicles use sensors to detect and emergency vehicle and provide a green signal to the vehicle. This is important to incident management in that it allows for emergency vehicles to get to the scene of and incident and clear it so that traffic can resume its normal flow.
- *C.1.5 – Road Weather Management*
  - Can take the forms of information dissemination, response and treatment, surveillance monitoring, and prediction, and traffic control. Helps prevent incidents due to inclement weather (snow, ice).
- *C.1.6 – Traffic Management Centers (TMCs)*
  - Centers that collect and analyze traffic data and then disseminate data to the public. Data collection elements might include CCTVs, cameras, and loop detectors. Might relay information to the public through radio, TV, or the Internet. This is important to the public, as it allows them to get information about existing traffic conditions and plan their route and timing accordingly.
- *C.1.7 – Curve Speed Warning System*
  - GPS and digital devices on a highway that assess and detect the threat of vehicles moving toward a curve too quickly. This is important in preventing incidents and thus preventing non-recurring congestion.
- *C.1.8 – Work Zone Management*
  - Can take the form of traffic workers, signs, and temporary road blockers used to direct traffic during an incident or construction. The temporary implementation of traffic management or incident management capabilities can help direct the flow of traffic, keep traffic moving, and prevent additional incidents.
- *C.1.9 – Automated truck rollover systems*
  - Detectors deployed on ramps to warn trucks if they are about to exceed their rollover threshold. If the data concludes a truck's maximum safe speed is to be exceeded around a turn, then a message sign would flash, "TRUCKS REDUCE SPEED." This is important in preventing incidents caused by large trucks, and thus preventing non-recurring congestion.

C.2.0 – ITS Technologies – This category of strategies can be defined as electronic technologies and communication devices aimed at monitoring traffic flow, detecting incidents, and providing information to the public and emergency systems on what is happening on our roadways and transit communities. Much of what is done with ITS helps in reducing non-recurring and incident-related congestion, and works hand-in-hand with those strategies listed in the above category (C.1.0).

C.2.1 – Advanced Traffic Signal Systems
- The coordination of traffic signal operation in a jurisdiction, or between jurisdictions. This is important to congestion, as it reduces delay and improves travel times.

- *C.2.2 – Electronic Payment Systems*
  - These systems can make transit use more convenient by allowing a user to pay for bus, rail, park-and-ride lots, and other transit services with one card. Convenience an appealing factor, and helps increase transit ridership and transfers among different transit modes.
- *C.2.3 – Freeway Ramp Metering*
  - Traffic signals on freeway ramps that alternate between red and green to control the flow of vehicles entering the freeway. This prevents incidents that may occur from vehicles entering the freeway too quickly, and also prevents a backup of traffic on the on-ramp.
- *C.2.4 – Bus Priority Systems*
  - Bus priority systems are sensors used to detect approaching transit vehicles an alter signal timings to improve transit performance. For example, some systems extend the duration of green signals for public transportation vehicles when necessary. This is important because improved transit performance, including a more precisely predicted time for bus arrivals, makes public transit a more appealing option for travelers.
- *C.2.5 – Lane Management (e.g. Variable Speed Limits)*
  - Variable Speed Limits are sensors used to monitor prevailing weather or traffic conditions, and message signs posting enforceable speed limits. These systems can promote the most effective use of available capacity during emergency evacuations, incidents, construction, and a variety of other traffic and/or weather conditions.
- *C.2.6 – Automated Enforcement (e.g. red light cameras)*
  - Still or video cameras that monitor things such as speed, ramp metering, and the running of red lights, to name a few. They are important to preventing non-recurring and incident related congestion.
- *C.2.7 – Traffic Signal Timing*
  - Traffic signal timing plans adjust traffic signals during an incident, during inclement weather, or to improve transit performance. The overall objective is to reduce backups at traffic signals and to increase the level of service.
- *C.2.8 – Reversible Lanes*
  - Traffic sensors and lane control signs reverse the flow of traffic and allow travel in the peak direction during rush hours. This is important to alleviating congestion that may occur in one direction during a peak hour.
- *C.2.9 – Dynamic Routing/Scheduling*
  - Public transportation routing and scheduling can automatically detect a vehicle’s location, and dispatching and reservation technologies can facilitate the flexibility of routing/scheduling. This is can help increase the timeliness of public transportation, keep transit on schedule, which in turn increases ridership.
- *C.2.11 – Service Coordination and Fleet Management (e.g. buses and trains sharing real-time information*

    - Monitoring and communication technologies in a vehicle that facilitate the coordination of passenger transfers between vehicles or transit systems. This is important and appealing to passengers that use more than one type of transit.
- *C.2.12 – Probe Traffic Monitoring*
    - Using individual vehicles in the traffic stream to measure the time it takes them to travel between two points and also to report abnormal traffic flow caused by incidents. Tracking could be done with the use of cellular phones, and in the future with the installation of a system in the vehicle which would send information to transportation operators. This is important to monitoring recurring and non-recurring congested locations, and travel time.

C.3.0 – Advanced Traveler Information Systems – Provide information to travelers which allow them to adjust the timing of their travels or the route that they take to avoid any incidents, construction, or weather problems.

- *C.3.1 – 511*
    - A variety of applications for travelers to use either before their trip or en-route, such as 511 telephone systems, internet websites, pagers, cell phones, and radio, to obtain up-to-date traveler information. This helps travelers plan their timing and routes accordingly.
- *C.3.2 – Variable Message Signs (VMS)*
    - One way ITS operators can share traffic information with travelers is through a Variable Message Sign (VMS) along the roadway. Such signs could provide information on road closures, emergency messages, weather message, and construction. This helps travelers plan their timing and routes accordingly. These signs can also prevent incidents from occurring as they provide warnings about speed, weather, construction, etc.
- *C.3.3 – Highway Advisory Radio (HAR)*
    - Another way ITS operators can share traffic information with travelers is through Highway Advisory Radio (HAR). The radio can provide information on road closures, emergency messages, weather, and construction (such as the Woodrow Wilson Bridge Project). Travelers can plan their timing and route accordingly.
- *C.3.4 – Transit Information Systems*
    - Can provide up-to-date transit information, such as arrival times for bus and rail. The WMATA Metrorail display signs depicting arrival times for trains are examples of this. Having this type of information available can increase transit ridership, and can also allow riders to make decisions on what type of transit to use based on up-to-date information.

C.4.0 – Traffic Engineering Improvements – Improvements implemented on roadways where congestion problems have occurred in the past or are anticipated to occur in the future. Some of these engineering improvements can be aimed at reducing incidents on a particularly dangerous section of roadway, while others may be attempting to relieve a choke-point or bottleneck.

- *C.4.1 – Safety Improvements*
    - Improvements done to increase safety and reduce incident-related congestion. Examples of some improvements include traffic calming devices, speed bumps, widening or narrowing a roadway, and textured pavement. These safety improvements can prevent incidents and non-recurring congestion resulting from incidents.
- *C.4.2 – Turn lanes*
    - Might be implemented to reduce the queuing of cars waiting to make a right or left turn at an intersection, thus reducing congestion.
- *C.4.3 – Roundabouts*

  - Barriers placed in the middle of an intersection, creating a circle, and thus directing vehicles in the same direction. This can help reduce congestion by slowing the speed of cars on a street and/or preventing thru traffic on a neighborhood street.

Demand Management Strategies:

C.5.0 – Alternative Commute Programs – Provides travelers with options other than the single-occupant vehicle. These programs are aimed in reducing the amount of single-occupant vehicles are on our roadways.

- *C.5.1 – Carpooling*
  - Two or more people traveling together in one vehicle. This reduces the amount of vehicles on the road.
- *C.5.2 – Ridematching Services*
  - Enables commuters to find other individuals that share the same commute route and can carpool/vanpool together. This provides carpooling options for people who may not know of someone to carpool with, thus broadening the carpooling option.
- *C.5.3 – Vanpooling*
  - When a group of individuals (usually long-distance commuters) travel together by van, which is sometimes provided by employers. This reduces the amount of vehicles on the road, which is especially important for long-distance transportation modes.
- *C.5.4 – Telecommuting*
  - Workers either work from home or from a regional telecommute center for one or more days of the week. This reduces the amount of vehicles on the road, especially during rush hour when many commuters are going to work at once.
- *C.5.5 – Promote Alternate Modes*
  - Programs, such as Commuter Connections, or regional Transportation Management Areas (TMAs) provide information to the public on alternative commute programs. This gets the word out about commute options in the region, many who may not have considered alternative commute programs as an option before.
- *C.5.6 – Compressed/flexible workweeks*
  - Employees compressing their work week into a shorter number of days, which allows them to avoid commuting one or more days a week. This reduces the amount of vehicles on the road.
- *C.5.7 – Employer outreach/mass marketing*
  - Organizations, such as Commuter Connections, providing information to employers on the benefits of alternative commute programs for their employees. This allows employers to see the benefits that alternative commute programs can have in their organization.
- *C.5.8 – Parking cash-out*
  - Employees essentially pay their employees not to park at work. The employees receive compensation for the parking space they would have otherwise used if they did not walk, bike, take transit, etc. This encourages more people to leave their car at home in favor of another mode of transportation.
- *C.5.9 – Alternative Commute Subsidy Program*
  - Employees provide a transit subsidy to their employees, which encourages them to use public transit instead of driving to work. This reduces the amount of vehicles on the road.

C.6.0 – Managed Facilities – These facilities have restrictions for use of the roadways. In some cases, only those other than single-occupant vehicles can use the lane or roadway. In other cases, a fee is implemented for single-occupant vehicles. Still, in other case, a fee might be implemented for every car on the roadway entering a city. They all have a common goal of reducing the amount of single-occupant vehicles on the roadways and promoting other forms of transportation.

- *C.6.1 - HOV*
    - High Occupancy Vehicle (HOV) are lanes reserved for vehicles with a driver and one or more passengers. This promotes the use of carpools, which can use a less-congested lane on the highway.
- *C.6.2- Variably Priced Lanes (VPL)*
    - Lanes which are typically used by carpoolers for free, while solo drivers pay tolls that change according to varying congestion levels. This encourages the use of carpooling, but also raises revenue for additional transportation projects that would reduce congestion.
- *C.6.3 – Cordon Pricing*
    - Cordon area congestion pricing is a fee paid by users to enter a restricted area in the city center. This is a way of promoting other alternative modes of transportation, while raising revenue for other transportation projects that would reduce congestion.
- *C.6.4 – Bridge Tolling*
    - Tolling over a bridge, in either one or both directions. This may decrease congestion on a bridge, as people may find an alternative route in lieu of paying the fee. Also, it raises revenue for transportation projects that would help in reducing congestion.

C.7.0 – Public Transportation Improvements – These improvements are done to the region's public transportation to ensure that it remains a safe and viable mode for travelers. Improvements can maintain the amount of users and attract new ones who never considered public transit as an option before.

- *C.7.1 – Electronic Payment Systems*
    - These systems can make transit use more convenient by allowing a user to pay for bus, rail, park-and-ride lots, and other transit services with one card. Convenience an appealing factor, and helps increase transit ridership and ridership between different transit modes.
- *C.7.2 – Improvements/added capacity to regional rail and bus transit*
    - Added capacity and improvements to rail and bus to help keep up with increasing demand on public transportation. This is important in keeping with the growing demand on public transportation as an alternative mode.
- *C.7.3 – Improving accessibility to multi-modal options*
    - Ensuring that connections are provided to multi-modal options, such as bus, rail, and pedestrian and bicycle facilities. More connections makes it easier for people to access multi-modal options, thus increasing use.
- *C.7.4 – Park-and-Ride Lot Improvements*
    - Improvements to park-and-ride lots to keep up with increasing demand and growth in the region. Park-and-Ride lots allow people to access public transportation, who may not be able to access it from their home. Improvements to these lots can ensure that this growing need is met and that people can continue to have transit access.
- *C.7.5 – Carsharing Programs*
    - A convenient and cost-effective mobility option for those that typically do not have a need to own a car. This reduces the amount of cars on the road because generally the car is only used when needed, and public transportation or other modes are used most of the time.

C.8.0 – Pedestrian, Bicycle, and Multi-modal Improvements – Maintaining and creating new pedestrian, bicycle, and multi-modal facilities is improvement in that it improves accessibility. If something is accessible by a walk or bike path, people are more likely to leave their car at home.

- *C.8.1- Improve Pedestrian Facilities*
  - Improvement and addition of new pedestrian and bicycle facilities to keep up with a growing demand and ensure safety for users. This ensures that those using these facilities will continue to do so, and that potential users will find pedestrian facilities more appealing and accessible.
- *C.8.2 – Creation of new bicycle and pedestrian lanes and facilities*
  - Addition of new lanes to keep up with a growing demand and created new connections throughout the region. This will extend the option of bicycle and pedestrian lanes to those that may not already have access to it, as well as provide increased access to employment, recreation, retail, and housing in the region.
- *C.8.3 – Addition of bicycle racks at public transit stations/stops*
  - Allows people who bike to connect to other forms of transportation. This gives people another option for traveling other than a single-occupant vehicle.
- *C.8.4 – Bike sharing Programs*
  - A convenient and cost-effective mobility option for those that typically do not have a need to own a bicycle. This allows people to shift easily from other forms of transport to bicycle and back again.

C.9.0 – Growth Management – Growth Management is the term used in the Federal Rule, but really this term pertains to ensuring the coordination of transportation and land use. In terms of Growth Management we are talking about making sure that everyone has the option to public transportation and alternative modes no matter where they live or work in the region.

- *C.9.1 – Coordination of Regional Activity Centers*
  - Help coordinate transportation and land use planning in specific areas in the Washington region experiencing and anticipating growth. Focusing growth in Regional Activity Centers is important to congestion management, where transportation options for those who live and work there can be provided.
- *C.9.2 – Implementation of TLC program (i.e. coordination of transportation and land use with local governments).*
  - Provides support and assistance to local governments in the Washington region as they implement their own strategies to improve coordination between transportation and land use. The idea is to provide public transit options to everyone in the region.
- *C.9.3 – "Live Near Your Work" program*
  - Supporting the idea that locating jobs and housing closer together can provide alternative commuting options that may not have been options otherwise.