MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

MARYLAND STATE HIGHWAY MOBILITY REPORT 2021

2021

MARYLAND STATE HIGHWAY MOBILITY REPORT

Tenth Edition

AUTHORS

Eric Beckett, Austin Foster, Nicole Katsikides,
Kaveh Farokhi Sadabadi, Lisa Shemer, Matthew Wolniak

CONTENT CONTRIBUTORS/REVIEWERS

Keith Belcher, Tom Costello, Carole Delion, Sepideh Eshragh, Mark Franz, Sarah Gary,
Quentin Goble, Scott Holcomb, William Hwang, Sean Lain, Subrat Mahapatra, Clyde Munz,
Ben Myrick, Abhay Nigam (AC), Scott Pomento, John Rotz

MESSAGE FROM THE ADMINISTRATOR

The Maryland Department of Transportation State Highway Administration (MDOT SHA) continues to deliver on its mission of connecting Marylanders to life's opportunities, even in the face of adversity. The presence of COVID-19 in all facets of life beginning in March 2020 was seen in countless news headlines, policy directives, and behavioral shifts in the public. Stay-at-home orders early in the pandemic and data provided by the University of Maryland support that almost 35% of residents were staying at home in April 2020.

This was reflected at MDOT SHA where a workforce that traditionally had less than 5% of its employees working from home, accelerated this figure overnight to almost 40-50% of its staff working remotely; continuing to provide services like planning, design, and operational monitoring for Maryland's roadways. The MDOT SHA was still able to deliver on its mission to provide for safe and efficient movement of people and goods. The emergency road patrols still responded to approximately 70,000 incidents and vehicular breakdowns which was about the same number as 2019. Despite having to adjust and add new protocols for construction workers, MDOT SHA completed ten capacity improvement projects including new interchanges, widening projects along Interstates and other roadways and intersection improvements. Ten new miles of sidewalks were added which was more than 2019. The improvements were completed during a time of financial instability and, while MDOT SHA could have wavered due to the loss of revenue, they continued to deliver on infrastructure priorities. This was no small feat and it has been an honor to be part of such a dedicated team that kept Maryland mobile during the pandemic.

While acknowledging the disruption caused by the pandemic, the MDOT SHA can also emphasize some unexpected benefits and continued success that occurred during that timeframe. A major concern for this agency is the mitigation of congestion and its associated impacts and Marylanders experienced a significant reduction in congestion in 2020. Initially, traffic volumes in April 2020 dropped by approximately 50% but then increased as the year progressed. Overall, the number of Vehicle Miles Traveled decreased from 60.1 billion in 2019, to 50.6 billion in 2020, an approximate 16% reduction in travel. In turn, this had large implications on congestion costs. In 2020, congestion costs along Maryland roadways amounted to $1.81 billion, a decrease of $3.35 billion from 2019, resulting in a 65% reduction in congestion costs incurred by roadway users. This reduction in congestion allowed for freight to reach its destination quicker during a time when Marylanders needed essential items like groceries. This can be seen by the 80% reduction in freight congestion costs in 2020 from 2019 levels, and the 6% increase in freight volumes experienced during the last four months of 2020, in relation to the same four-month period in 2019. Truck trips have a greater impact on the condition of roadways and bridges and therefore maintenance will be critical both now and in the future.

As COVID-19 variants progressed across the United States, MDOT SHA understood there was no way to predict the future. The continual analysis of data guided decision-making as COVID-19 and travel patterns evolved. MDOT SHA's guide to mobility-related issues is summarized in the Maryland Mobility Report. The 2021 Report analyzes performance and mobility trends from 2020, compares the results to past performance, and highlights key successes and areas for improvement. As congestion returns to near pre-pandemic levels MDOT SHA will continue to adhere to data-driven decisions that improve safety and accessibility to all those who use Maryland's roadways.

Tim Smith, P.E.
MDOT SHA Administrator

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EXECUTIVE SUMMARY

HIGHLIGHTS	
2020 TRENDS	**'20 VS '19**
Traffic volumes at 50.6 billion VMT	16% ↓
Two interstates carry over 200,000 vehicles per day	2 ↓
Total mileage on freeway system experiencing heavy to severe congestion: 12 miles AM/34 miles PM peak hour	165 AM ↓ 252 PM ↓
Statewide congestion costs were $1.81 billion	$3.35 ↓
61,000 responses to incidents and stranded motorists	10,000 ↓
Ten miles of new sidewalk in 21 counties	3 ↑
Ten capacity improvement projects competed	1 ↓
Five new adaptive signal systems	2 ↓

Transportation in 2020 was unlike any previous year. In the first two plus months, travel was trending upward until COVID-19 changed everything. Governor Hogan executed stay-at-home orders and the public adhered. Over the following four-week period, traffic volumes then dropped by 50%. The initial reduction in traffic, also reduced congestion along Maryland roadways but non-recurring events such as crashes still impacted traffic operations. Later in the year as the stay-at-home orders were lifted and our collective knowledge of COVID-19 grew, traffic volumes began to trend upward from this 50% reduction. As we move forward and transportation returns closer to levels of travel that occurred in 2019, Maryland Department of Transportation State Highway Administration (MDOT SHA) will continue to use a performance based approach to address critical and shifting mobility trends each year. These shifts create a need for progressive and cost-effective operations, engineering, and context-sensitive design of the transportation system to ensure safe access for all users. To achieve this, MDOT SHA continuously monitors existing travel trends, accomplishments, and challenges. This helps establish short and long-term strategies for improvement, relevance, and organizational excellence. The following 2021 Maryland Mobility Report summarizes our performance, successes, opportunities, and future strategies based on data and events that transpired over the course of the 2020 calendar year.

CONGESTION AND RELIABILITY TRENDS

The challenge of moving people and goods changes constantly from everyday congestion to non-standard occurrences. These areas of congestion impact travelers and freight movement in terms of cost, time, and efficiency. The following is a summary of mobility and reliability trends on the Maryland highway system in 2020.

Vehicle Miles Traveled (VMT)[1]:

- Travel on Maryland roadways decreased from 60.1 billion VMT in 2019 to 50.6 billion VMT in 2020 resulting in a 16% reduction in travel on all types of roadways.
- Approximately 71% of statewide vehicular travel occurred on MDOT roadways a 1% decrease from 2019.
- All counties experienced at least a 10% reduction in VMT with the highest decrease occurring in Anne Arundel, Baltimore, Montgomery, and Prince George's counties. Each of these counties experienced a reduction of over 1 billion VMT.

1 - See definition pg. 16
2 - See definition pg. 19

Annual Average Daily Traffic (AADT)[2]:

The highest daily volume locations for freeway/expressway and arterial sections include:

HIGHEST ANNUAL AVERAGE DAILY TRAFFIC (AADT) FREEWAY/EXPRESSWAY SECTIONS		
ROUTE	LIMITS	2020 AADT (THOUSANDS)
I-270	I-270 Split to MD 117	185-215
I-495	Virginia State Line to I-270 West Spur	175-205
I-95/I-495	MD 4 to I-95	171-204
I-495	I-270 East Spur to I-95	172-188
I-695	I-95 (South) to I-795	134-175

HIGHEST ANNUAL AVERAGE DAILY TRAFFIC (AADT) ARTERIAL SECTIONS		
ROUTE	LIMITS	2020 AADT (THOUSANDS)
US 301	Charles County Line to MD 5	87
MD 5	US 301 to MD 223	56-71
MD 210	Ft Washington Rd to I-95/I-495	60-70
MD 3	US 50/301 to I-97/MD 32	60-69
MD 650	MD 212 to Mahan Rd	34-67

Freeways

- The percentage of freeway/expressway miles that experienced heavy to severe congestion in the AM peak hour decreased from 11% (177 miles) in 2019 to 1% (12 miles) in 2020. The percentage of freeway/expressway miles that experienced heavy to severe congestion in the PM peak hour decreased from 18% (286 miles) to 2% (34 miles) in 2020.
- Roadway sections with higher volumes and greater VMT on the freeway/expressway system experience greater congestion. In 2020, 2% of the AM peak hour and 4% of the PM peak hour VMT occurred in congested conditions. In 2019, these values were 22% and 31% in the AM and PM peak hour, respectively.
- From 2019 to 2020, freeway/expressway congestion costs decreased from $ 3.58 billion to $ 0.74 billion in total annual cost. This was a $ 2.84 billion decrease.

Arterials

- The percentage of arterial miles that experienced heavy to severe congestion in the AM peak hour decreased from 15% (88 miles) in 2019 to 1% (8 miles) in 2020. The percentage of arterial miles that experienced heavy to severe congestion in the PM peak hour decreased from 34% (201 miles) to 15% (89 miles) in 2020.

Total congestion costs for freeway/expressways and arterials are estimated at $1.81 billion—a decrease of $3.35 billion in comparison to 2019.

Intersections

- Analysis of traffic count data from the last three years determined that 36 state highway intersections operated at a failing level of service (LOS F), including six intersections which failed during both the AM and PM peak hours. On a summer weekend, two additional intersections on the Eastern Shore fail.

The most congested freeway/expressway (three to eight mile) and arterial (two to five mile) corridor sections for AM and PM peak hours (in descending order) are as follows:

2020 MOST CONGESTED FREEWAY/EXPRESSWAY SECTIONS (AVERAGE WEEKDAY)	
AM Peak Hour (8-9 AM)	**PM Peak Hour (5-6 PM)**
I-495 Outer Loop – Prince George's County Line to MD 97	I-495 Inner Loop – I-270 East Spur to MD 97
I-695 Outer Loop – MD 43 to Cromwell Bridge Rd	I-695 Inner Loop – MD 139 to Providence Rd
I-695 Outer Loop – MD 122 to MD 144	MD 295 Northbound- MD 410 to MD 193
I-270 (Local) Southbound – Shady Grove Rd to MD 189	I-895 Northbound – Frankfurst Ave to Holabird Ave
I-270 Southbound – Shady Grove Rd to MD 189	I-695 Inner Loop – I-95 to US 40
US 50 Westbound – MD 410 to Washington DC Line	MD 295 Southbound – MD 175 to MD 198
I-695 Inner Loop – Stevenson Rd to I-83	I-270 (Local) Northbound – I-370 to Watkins Mill Rd
I-895 Northbound- Frankfurst Ave to Holabird Ave	I-95/ I-495 Inner Loop – I-95 to MD 295
MD 295 Southbound – MD 198 to Powder Mill Rd	MD 295 Northbound – MD 198 to MD 175
I-95 Southbound – South of MD 200 to I-495	I-95/I-495 Outer Loop – MD 450 to MD 201

2020 MOST CONGESTED ARTERIAL SECTIONS (AVERAGE WEEKDAY)	
AM Peak Hour (8-9 AM)	**PM Peak Hour (5-6 PM)**
MD 28 Westbound – W Gude Dr to Muddy Branch Rd	US 301 Southbound – MD 381 to McKendree Rd/Cedarville Rd
MD 410 Westbound – MD 650 to MD 390	MD 193 Eastbound – I-495 to MD 650
MD 185 Southbound – I-495 to MD 191	MD 26 Westbound – Washington Ave to Brenbrook Dr
US 301 Southbound – Short Cut Rd to Charles County Line	MD 177 Westbound – MD 100 to Catherine Ave
MD 177 Eastbound – Catherine Rd to Schmidts Lane	MD 26 Eastbound – Brenbrook Dr to I-695
MD 355 Northbound – Beach Drive to Montrose Pkwy	MD 140 Eastbound – Owings Mills Blvd to McDonogh Rd
MD 2 Northbound – College Pkwy to Robinson Rd	MD 650 Westbound – US 29 to Adelphi Rd
MD 28 Eastbound – Baltimore Rd to MD 97	MD 177 Eastbound – Waterford Rd to MD 607
MD 424 Southbound – MD 3 to MD 450	MD 2 Northbound – College Pkwy to Robinson Rd
MD 2 Southbound – MD 665 to Mayo Rd	MD 30 Northbound - MD 30 Business (North) to MD 27

In addition to congested AM/PM peak hours, summer-weekend traffic is substantial along roadways on the Eastern Shore/Northeastern Maryland. For the Friday 4-5 PM, Saturday 1-2 PM, and Sunday 2-3 PM hours, the following locations were identified as most congested sections for that time period:

- US 50 Eastbound – MD 179 to Oceanic Drive: Friday/Saturday (freeway)
- US 50 Westbound – Kent Narrows Rd to MD 8: Sunday (freeway)
- MD 404 Westbound- Delaware Line to MD 313: Sunday (arterial)

CONGESTION REDUCTION ACCOMPLISHMENTS

Various policies, programs and projects have been established to address congestion and improve mobility and reliability. These methods provide benefits for motorists and multi-modal users to yield a safe and modern transportation system. MDOT achieved user cost savings by reducing delays, fuel consumption, and emissions. These combined efforts resulted in more than $1.1 billion in annual user savings.

2020 USER SAVINGS DUE TO MDOT CONGESTION MANAGEMENT	
CHART	$1,081 Million
Traffic Signals	$23 Million
Capital Projects	$60 Million
Total	**$ 1,164 Million**

A summary of accomplishments associated with MDOT mobility improvement efforts include:

CHART

- The Coordinated Highways Action Response Team (CHART) program cleared almost 34,000 incidents and assisted over 27,000 stranded motorists on Maryland roadways.
- CHART services reduced an estimated 23.5 million vehicle hours of delay amounting to approximately $1,081 million in user cost savings.

TRAFFIC SIGNALS

MDOT IMPLEMENTED SMART TRAFFIC SIGNALS
MD 2 in Anne Arundel County
MD 2/ MD 178/MD 450 in Anne Arundel County
MD 26 in Baltimore County
US 301/MD 228/MD 5 in Charles County
US 40 in Howard County

- Fifty-six traffic signal timings were reviewed in seven systems. Traffic signal retiming resulted in almost $23 million in annual user savings and will continue to provide recurring benefits for many years.

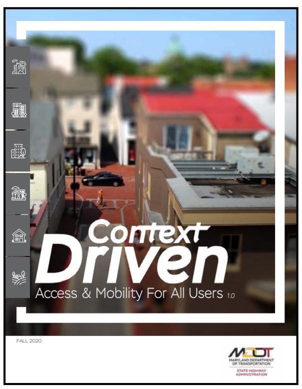
CAPITAL PROJECTS

- Improved mobility resulted from intersection improvement projects at US 50 at MD 589 and MD 346 at US 113 and at Healthway Drive.
- Six roadway widening projects also improved mobility: Widening MD 2/4 from Fox Run Blvd to Commerce Lane, MD 32 from Main Street to Macbeth Way, MD 180 from Swallowtail Dr to US 15/US 340 Ramps, I-81 from south of West Virginia Line to MD 63 and the dualization of US 113 from MD 365 to Five Mile Branch Road.
- MDOT completed two new interchange projects. These were at I-270 and Watkins Mill Road and MD 97 at Randolph Road.
- The above projects resulted in $60 million in annual user savings.
- The I-495 and I-270 Traffic Relief Plan is an ongoing effort to design, build, finance, operate, and maintain improvements along these roadways to reduce congestion in the region.

MAJOR MOBILITY IMPROVEMENT PROJECTS UNDER CONSTRUCTION OR RECENTLY COMPLETED
Widening I-695 from US 40 to MD 144
Widening MD 32 from Linden Church Rd to I-70
Replacing MD 210 intersection at Kerby Hill Rd Livingston Rd with an interchange
I-95 Section 200 ETLs
I-270 Innovative Congestion Management Plan

IMPROVED MOBILITY ACCOMPLISHMENTS

- Pedestrian and bicycle projects are a major emphasis for MDOT SHA. These projects were completed as part of other roadway improvements or stand- alone projects. Almost 10 miles of new sidewalks were constructed in 21 counties. There was an approximate 6 mile increase in directional miles with marked bicycle facilities.
- Statewide, approximately 70% of the sidewalks are ADA compliant.
- The Bicycle & Pedestrian Master Plan 2019 Update and the *"Context Driven: Access and Mobility for All Users"* guide were utilized to improve safety and facilities for all users.



- The I-270 and US 50 corridors provide high occupancy vehicle (HOV) lanes to encourage ridesharing and increased person throughput. The I-270 HOV lanes saved up to 4 minutes in travel time over the other lanes which was about 10 minutes less than last year. The HOV lanes provide person throughput of more than 1,900 people per hour/per lane.
- Despite COVID-19's disruption to traffic patterns, drivers still found the Intercounty Connector MD 200 Managed Facility an attractive option. The AADT between I-370 and I-95 was approximately 39,500 vehicles per day.

FREIGHT MOVEMENT

- Construction on two new virtual weigh stations along I-95 southbound at the Tydings Bridge and I-81 northbound were put on hold due to COVID-19. The US 301 in Charles County site is scheduled to be relocated when funding becomes available.
- Various projects on the National Highway Freight Network through the FAST ACT Freight Formula Fund are under construction including I-83 over Padonia Rd, I-95/I-495 over Suitland Parkway, and I-95/I-495 over MD 214.
- Two at-grade railroad crossings were improved to increase safety. These were located in the City of Salisbury and Wicomico County.
- Statewide Freight Initiatives include:

Analysis of overnight truck parking using INRIX trip data analytics

Improving the Maryland One Permit System

Testing Maryland Roadway Performance Tool (MRPT) to identify bottlenecks

TRANSPORTATION SYSTEMS MANAGEMENT & OPERATIONS (TSMO)

MDOT SHA TSMO ONGOING PROJECTS
SMART adaptive traffic signals along various arterial corridors
I-270 Innovation Congestion Management Plan with ATMS control software
I-270/I-495 Traffic Relief Plan with managed lanes
I-695 part time shoulder use from I-70 to MD 43
US 1 ITS deployment

- In 2020, MDOT made significant strides toward the completion of the US 1 Technology Deployment Corridor which includes a pedestrian I2V pilot, 30% design for the I-70/US 40 Con-Ops, crowd sourcing for operations proof of concept using WAZE data and the development of the TSMO Master Plan and ITS Communications Plan.

MARYLAND MOBILITY STATISTICS

I-495 @ US 29

INTRODUCTION

The year 2020 was vastly different from a travel standpoint than ever before. Normally, a small change occurs in transportation patterns from year to year but starting in Mid-March a drastic reduction in almost all modes of transportation took place. Although 2020 provides a unique case in travel patterns and volumes, this information can provide a valuable insight into how events influence travel. In order to evaluate these changes, the Maryland Department of Transportation State Highway Administration (MDOT SHA) provides an annual comprehensive review of performance and mobility trends from the previous year. The 2021 Maryland Mobility Report summarizes results and accomplishments during the 2020 calendar year. This annual report reviews Maryland's mobility strategies, projects, programs, and initiatives using a goal-oriented, performance-based approach that focuses on: *What is Happening, What is MDOT SHA Doing, and What are the Outcomes*.

The Maryland Mobility Report illustrates:

- The agency's data driven methodologies to identify and address congestion issues.
- The agency's transportation investments to promote safe, efficient, and reliable movement of goods and services.
- The importance of monitoring existing travel trends and the procedures utilized to help identify successes, challenges, and strategies to improve transportation services.

Highlights of the 2021 Maryland Mobility Report include:

- Traffic volume trends.
- Pedestrian and bicycle projects and programs.
- Roadway and freight characteristics.
- Most congested freeway/expressway sections during a normal weekday and summer weekend.
- Most congested arterial sections.
- Freeway/expressway and arterial performance year-to-year comparisons.
- Projects completed in 2020 and their benefits.
- Programs to address mobility and their results.
- Transportation Systems Management and Operations (TSMO) and Connected and Automated Vehicles (CAV) activities.

The Maryland Mobility Report is a joint effort of the MDOT SHA's Office of Preliminary Planning and Engineering (MDOT SHA OPPE) and the Office of Transportation Mobility and Operations (MDOT SHA OTMO).

TRANSPORTATION INFRASTRUCTURE

Maryland is a rather diverse state, with the Appalachian Mountains running through the West, dense urban areas in its center, and marshlands and oceanfront to its East. Consequently, it's no surprise that the transportation needs for the residents and travelers of these areas are various and plentiful. Therefore, the MDOT SHA provides a multi-modal infrastructure network that supports safe and effective access and mobility for all types of transportation statewide **(Figure 1)**. Some examples include:

- Mass transit service is provided through subways, commuter rail, light rail, and buses operated by MDOT Maryland Transit Administration (MDOT MTA), the Washington Metropolitan Area Transit Authority, and local transit operators. An example of this is the Amtrak Northeast Corridor which serves heavy rail passengers and contains major stops in Baltimore at Penn Station and BWI Thurgood Marshall Airport.
- Bicycle and walking facilities are numerous across the state ranging from a series of off-road trails such as the Torrey C. Brown Rail Trail or BWI Marshall Airport Hiker-Biker Trail, sidewalks, or bike paths along highways.
- Baltimore-Washington Thurgood Marshall International Airport (BWI) is a major hub for passenger travel, with 27 million passenger arrivals/departures occurring in 2019. This number dramatically decreased in 2020 to 11.2 million, but the agency adapted, shifted gears, and was able to handle more freight by air, which resulted in a 19% increase from 2019 to 2020.
- The Helen Delich Bentley Port of Baltimore is a cornerstone to Maryland's economic success and consistently ranks first in the nation for its imports of automobiles and light trucks. It is also listed as the 12th largest port in the country based on twenty-foot equivalent units (TEU).
- Maryland has a vast roadway network that contains approximately 31,700 miles of surface transportation infrastructure.

ROADWAYS

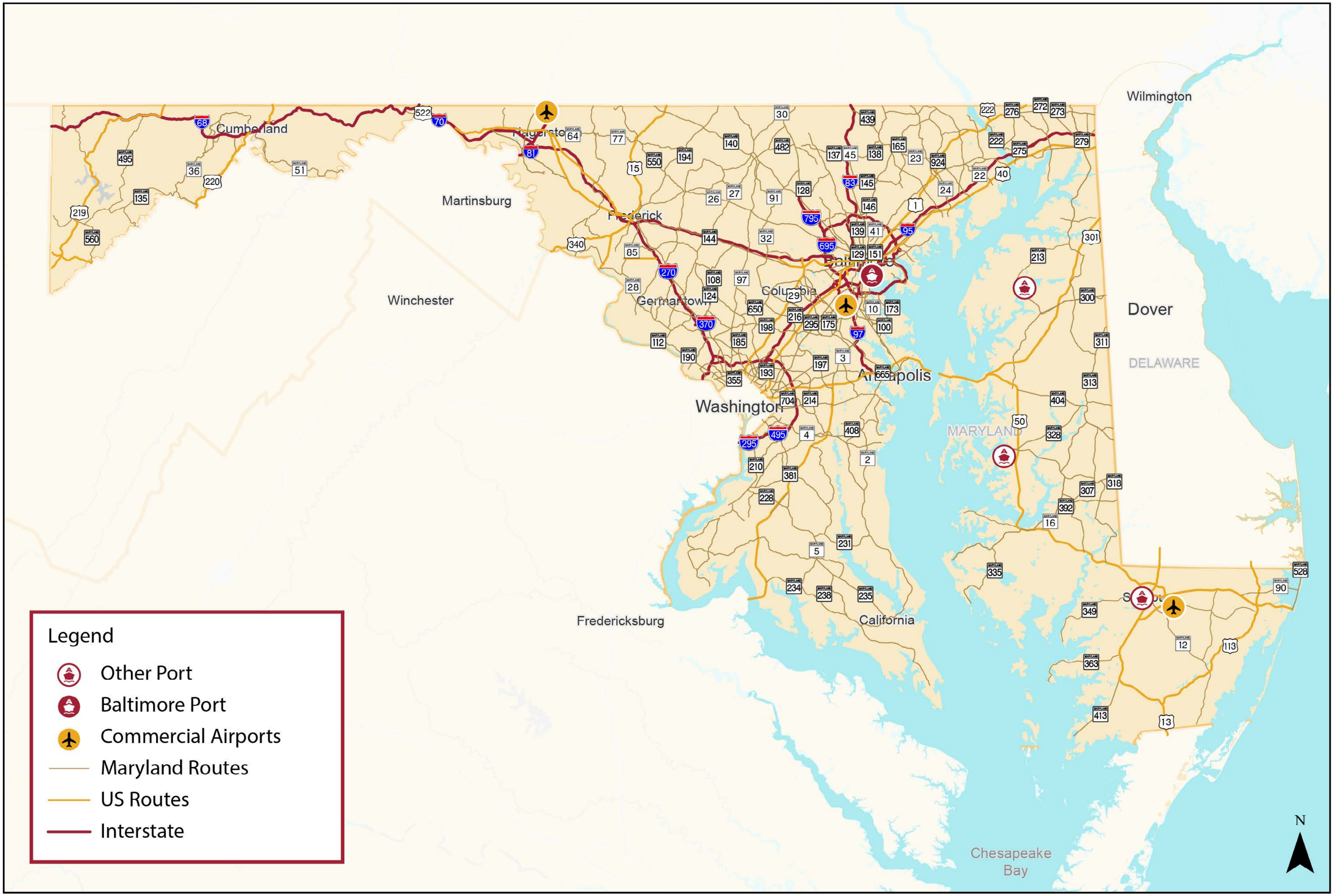
From Pocomoke City to McHenry, roadways provide a means to access cities, towns, and villages throughout the State. The state's major roadway facilities are operated by the Maryland Department of Transportation (MDOT). The MDOT SHA maintains interstates, US routes, and numbered Maryland routes, with the exception of interstates and routes through Baltimore City and portions maintained by the Maryland Transportation Authority (MDTA) which operates all toll facilities. Roadways are classified based on the role they play in moving vehicles throughout a network of highways. This classification system identifies a road's primary use, ranging from freeways to local streets **(Table 1)**.

Table 1

ROADWAY FUNCTIONAL CLASSIFICATION	
CLASSIFICATION	FUNCTION
Freeway/Expressways	Controlled access facilities with limited points of ingress/egress. These facilities are designed for long distance travel at higher speeds.
Arterials	Highest functioning roads normally with traffic signals. These roadways serve as interconnections between major corridors and are used for long-distance trips.
Collectors	Gather traffic from local roads and funnels to an arterial system. Serves both land access and traffic circulation.
Locals	Provide direct access to adjacent land use and does not carry through traffic.

Maryland Statewide Infrastructure

Figure 1



MDOT is responsible for maintaining the majority of Interstate, US and Maryland routes. These facilities have the highest average number of lanes per mile **(Table 2)**. Typically, the highest average number of lanes per mile correlates to the highest volumes and most congestion and mobility challenges.

Table 2

MILEAGE STATISTICS					
ROAD TYPE	ROADWAY MILES	PERCENTAGE OF ROADWAY MILES	MAINLINE LANE MILES[1]	AVERAGE NUMBER OF LANES/MILE	OWNERSHIP
Interstate Routes	488	2%	2,847	5.8	MDOT SHA, MDTA, Baltimore City
US Routes	759	2%	2,706	3.6	MDOT SHA, MDTA, Baltimore City
Maryland Routes	4,231	13%	10,651	2.5	MDOT SHA, MDTA
Other Roadways	26,225	83%	53,640	2.0	Counties, Municipalities

1- Mainline Lane Miles = Roadway Miles x Number of Lanes
Note: Does not include ramp and service road mileage

US 50 @ Bay Bridge

Maryland roads have approximately 70,000 lane miles.

MAJOR STRUCTURES – BRIDGES AND TUNNELS

The Chesapeake Bay and the Patapsco, Patuxent, Potomac, and Susquehanna Rivers provide the backdrop of some of the most signature bridges and tunnels located in Maryland. In addition to these familiar structures, there are more than 5,000 other bridges that provide valuable connections over waterways, around rail, or across highways. These bridges are owned by many different agencies, but MDOT SHA is responsible for the highest number of bridges **(Table 3 and Figure 2)**. The MDTA maintains the two tunnels in Maryland. The eight-lane, 1.4 mile, Fort McHenry Tunnel allows I-95 traffic to pass under the Patapsco River. The I-895 Harbor Tunnel is a four-lane facility approximately 1.4 miles long and is parallel to the Fort McHenry Tunnel.

MARYLAND'S SIGNATURE BRIDGES AND TUNNELS

American Legion Bridge (I-495)	**Fort McHenry Tunnel** (I-95)	**Harbor Tunnel** (I-895)
Harry Nice Bridge (US 301)	**Hatem Bridge** (US 40)	**Key Bridge** (MD 695)
Thomas Johnson Memorial Bridge (MD 4)	**Tydings Memorial Bridge** (I-95)	**William Preston Lane Memorial (Bay) Bridge** (US 50/301)
	Woodrow Wilson Memorial Bridge (I-95/I-495)	

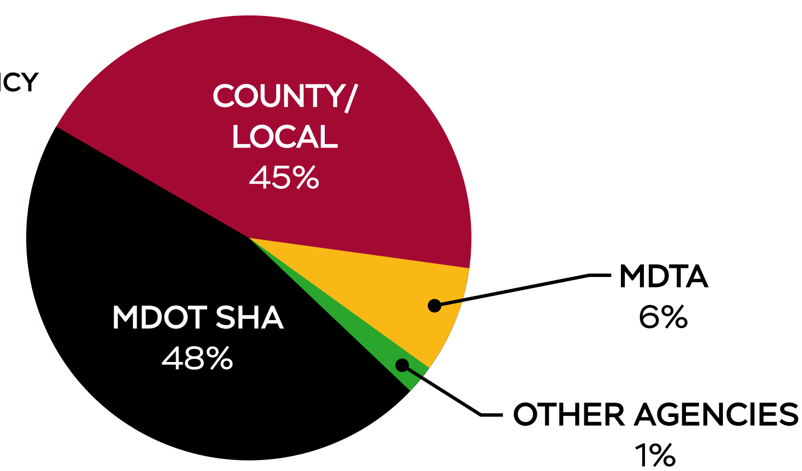
Table 3

MARYLAND BRIDGES BY OWNERSHIP

OWNER	NUMBER OF BRIDGES
MDOT SHA	2,555
County/Local	2,413
MDTA	322
Other Agencies (Federal, Railroad, Other State Agencies)	48

Figure 2

BRIDGE OWNERSHIP BY AGENCY

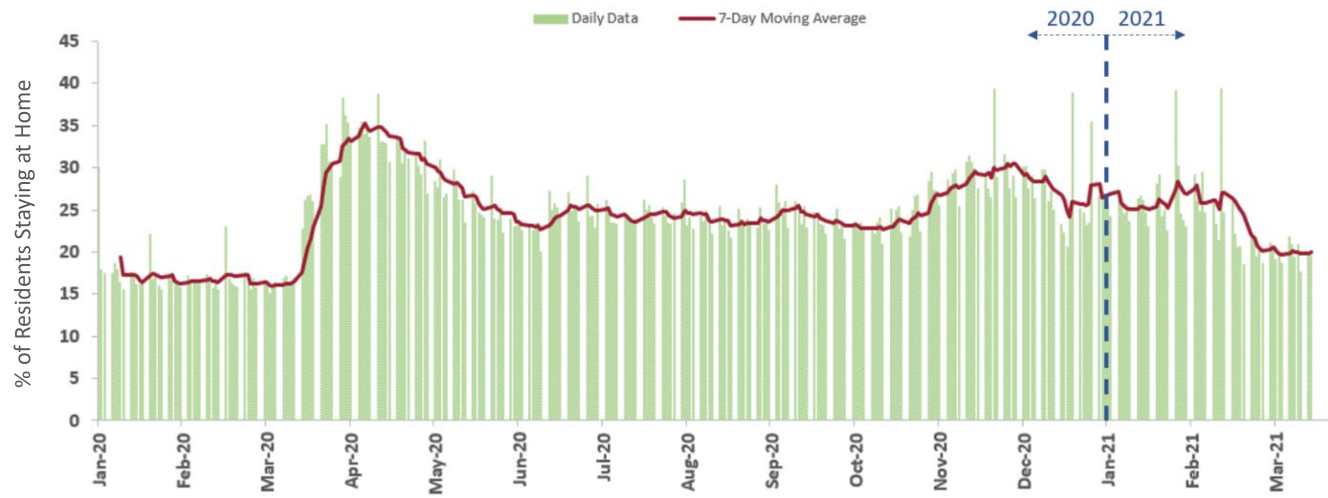


STATEWIDE PATTERNS

To better understand the changes that were taking place in 2020, the Maryland Department of Transportation State Highway Administration (MDOT SHA) used a number of tools in addition to the data typically collected. These were created by the Center for Advanced Transportation Technology (CATT) Lab at the University of Maryland, INRIX, Google, Apple, Facebook, StreetLight, the US Department of Transportation Bureau of Transportation Statistics, and other sources. An example of this data shows how Marylanders stayed home when the pandemic started **(Figure 3)**.

Figure 3

PERCENT OF RESIDENTS STAYING AT HOME IN MARYLAND (NO TRIP MORE THAN 1 MILE)



Figures 4 and 5 identify the number of trips and number of work trips per person (Note: includes all modes of travel). Among the highlights include:

- At the end of the year, Marylanders were staying home at levels about 15% higher than pre-COVID-19.
- The number of daily trips per person decreased from about 3.5 trips per person pre-pandemic to 2.5 during the peak of the pandemic and then back up to close to 3.5 trips per person at the end of the year.
- The number of work trips decreased from approximately 0.65 trips/person to 0.42 trips/person.
- The number of non-work trips stayed relatively flat compared to pre-pandemic numbers.

Figure 4

TRIPS PER PERSON IN MARYLAND

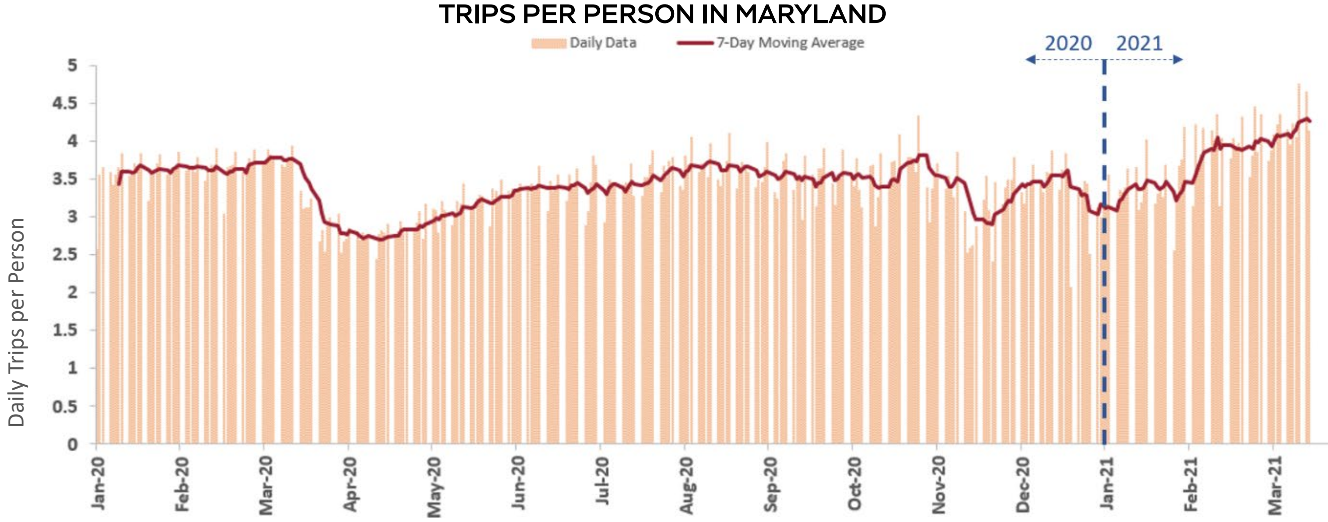
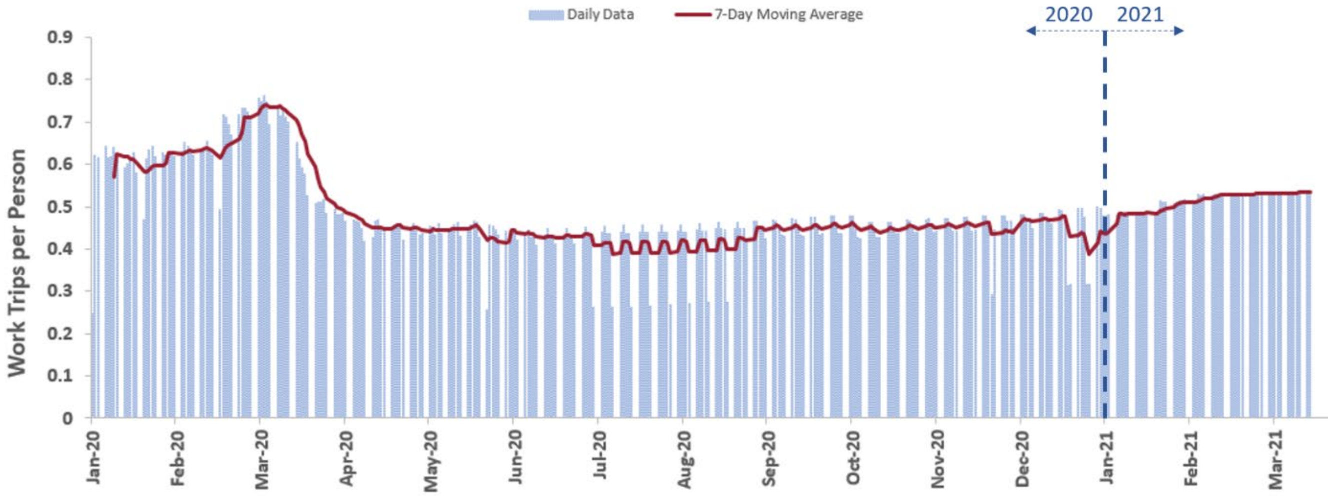


Figure 5
WORK TRIPS PER PERSON IN MARYLAND



Some findings from other data sources near the end of the year include:

- Eleven of Maryland's 23 Counties had 40% or more of their population staying at home[1].
- Transit usage experienced an average 40-50% drop across the state[2].
- Requests for walking routes through Apple maps increased by over 35% in COVID-19 conditions[3].

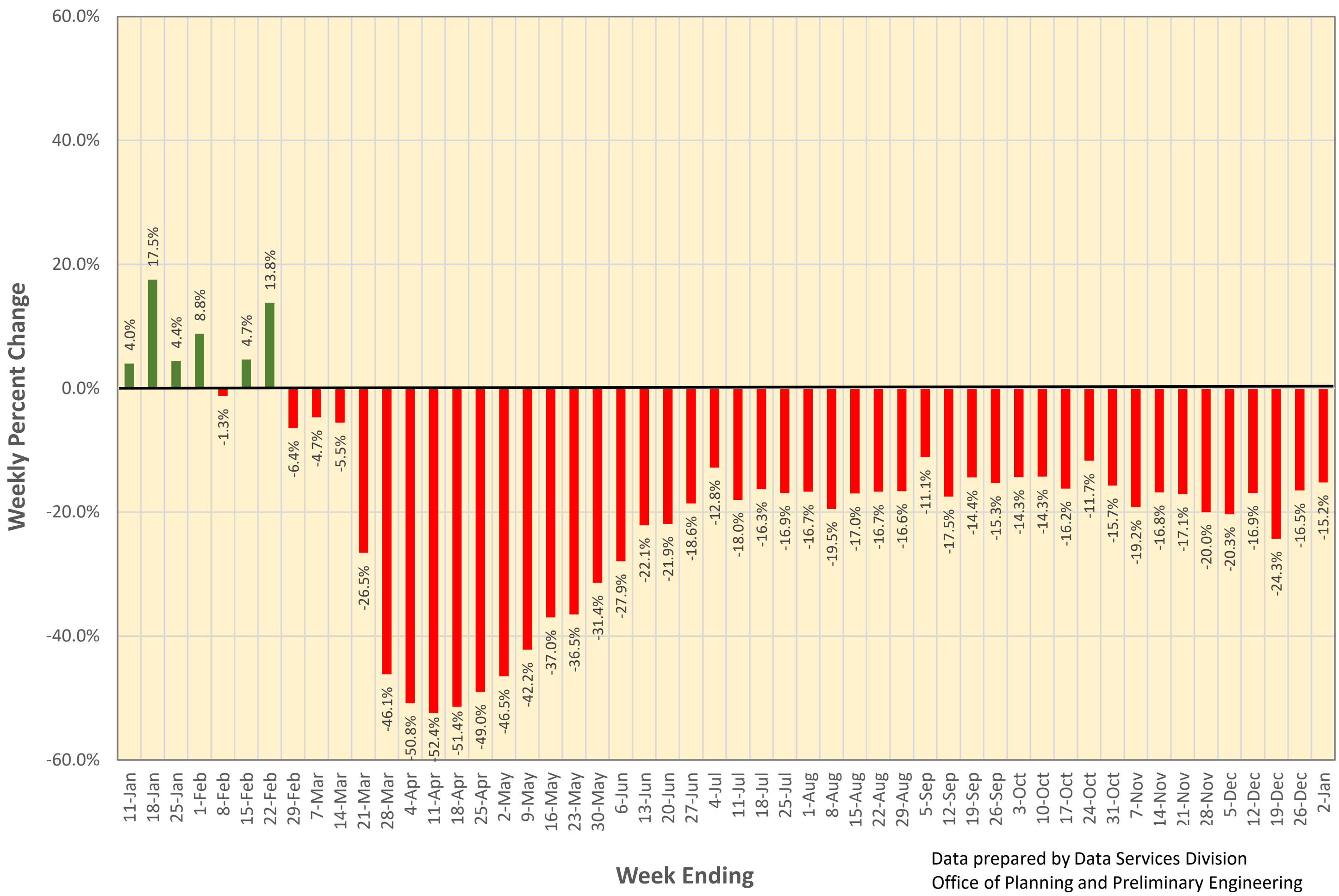
US 15 @ Monocacy Blvd

1 - Facebook Data for Good
2 - Google COVID-19 Community Mobility Report
3 - Apple Mobility Trends

TRAFFIC VOLUMES

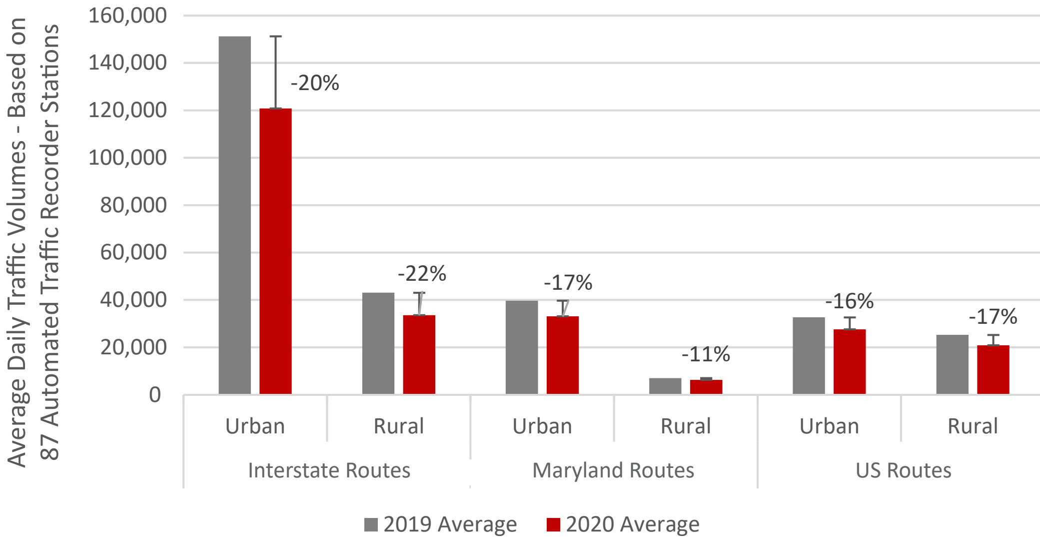
The COVID-19 pandemic had a major impact on travel. Persons were working from home, there were no trips to schools, recreational and shopping trips were greatly reduced and transit was limited. This caused a major reduction in traffic volumes. MDOT SHA monitors traffic through 87 automated traffic recorder stations (ATR) along freeways/expressways, arterials and collector roadways 24 hours a day and 365 days a year. This proved very valuable to identify trends during COVID-19. Volumes along Maryland roadways were trending upward in January and February by up to 17% in relation to 2019, but when COVID-19's US presence was legitimized volumes dropped by approximately 52% from 2019 to 2020 in April **(Figure 6)**.

Figure 6
WEEKLY CHANGES AT PERMANENT COUNTERS (ATR) FROM 2019 TO 2020



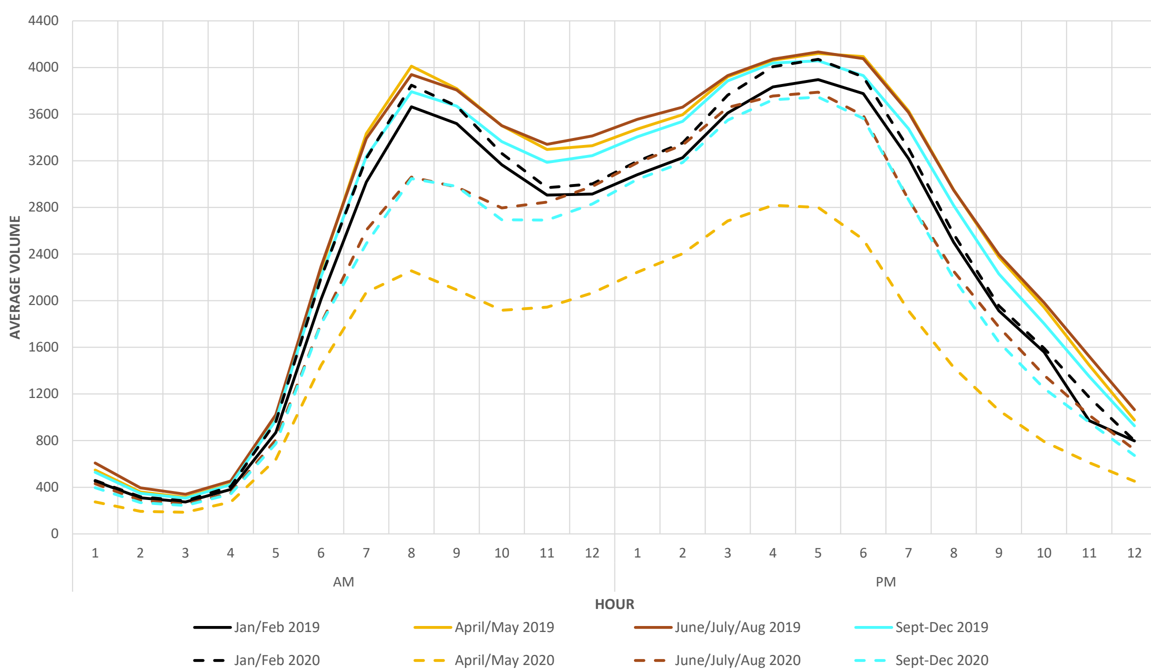
Average daily traffic volumes were measured at 87 automated traffic recorder stations on Interstate, Maryland and US routes by hour by day. On a yearly basis, traffic volumes were compared evaluating changes in location (urban, rural) on the various types of routes showed between an 11% and 20% reduction **(Figure 7)**.

Figure 7
AVERAGE DAILY TRAFFIC VOLUME COMPARISON FOR ATRs BY ROADWAY CLASSIFICATION



Significant changes occurred in the time of day when people made trips. The distribution of trips on a hourly basis at the ATR stations were evaluated over four different time periods comparing 2019 to 2020 **(Figure 8)**. Early in the COVID-19 pandemic, decreased volumes occurred throughout the day while at the end of the year the largest decrease happened in the AM peak period.

Figure 8
COMPARISON OF 2019-2020 WEEKDAY HOURLY TRAFFIC VOLUMES



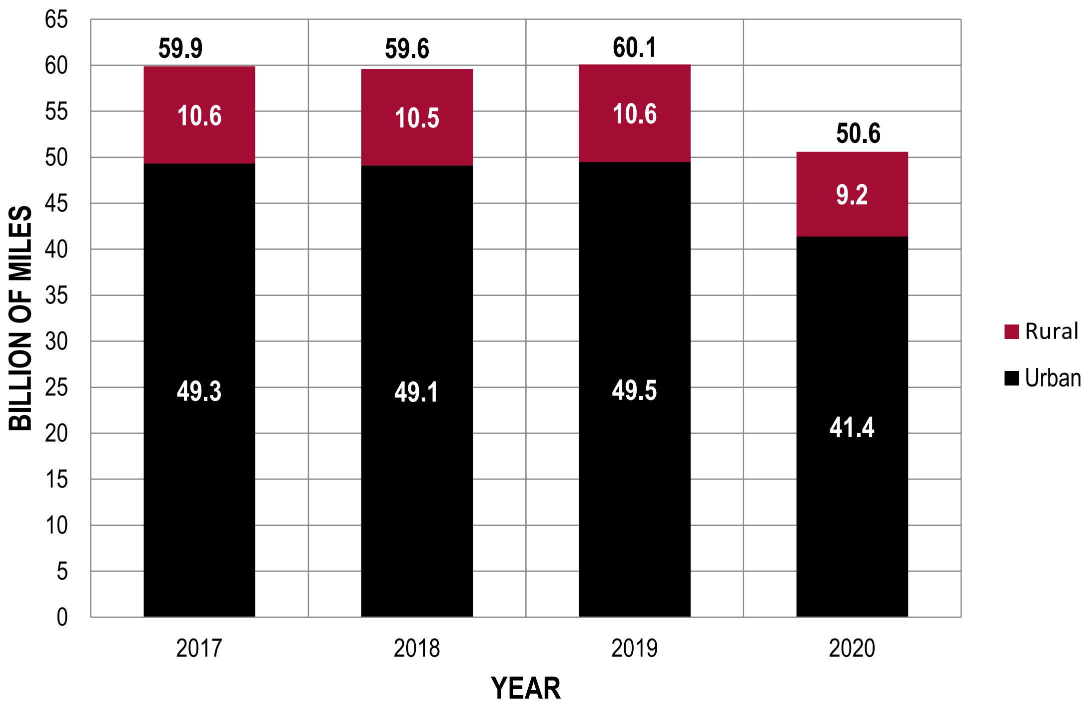
VEHICLE MILES TRAVELED - TOTAL/URBAN/RURAL

In addition to the ATR stations, year to year comparisons are performed on the amount of travel along Maryland's roadways to evaluate trends. A standard performance measure to gauge overall roadway usage is Vehicle Miles Traveled (VMT). VMT is defined as the number of vehicles times the distance traversed along the system and is calculated for various roadway classifications on a local, regional, state, and national level. A comparison of VMT allows for a method to track growth and demands on different roadways.

After setting an all time record in 2019 for VMT, the VMT in 2020 decreased by 9.5 billion miles in relation to 2019, a 16% reduction. This decrease in VMT is in large part occurred on urban roadways **(Figure 9)**.

Figure 9

MARYLAND VEHICLE MILES TRAVELED (BILLIONS)



VMT decreased to its lowest level since 2000 at 50.6 billion.

VEHICLE MILES TRAVELED - BY AGENCY AND FACILITY TYPE

The amount of VMT along MDOT SHA and MDTA roadways far exceeds travel along locally owned roadways. Despite MDOT SHA and MDTA roadways accounting for only 17% of the roadway miles, 71% of the VMT occurs on these roadways **(Table 4 and Figure 10)**. Maryland-numbered routes account for the highest amount of VMT, with over 16 billion miles **(Table 5 and Figure 11)**. The percentage of VMT by agency and by roadway classification remained relatively the same between 2019 and 2020 with no category changing by more than 1%.

Table 4

VMT BY AGENCY

AGENCY	VMT (BILLIONS)
MDOT SHA	32.75
County/Local/Others	14.96
MDOT MDTA	2.88

Figure 10

VMT BY AGENCY

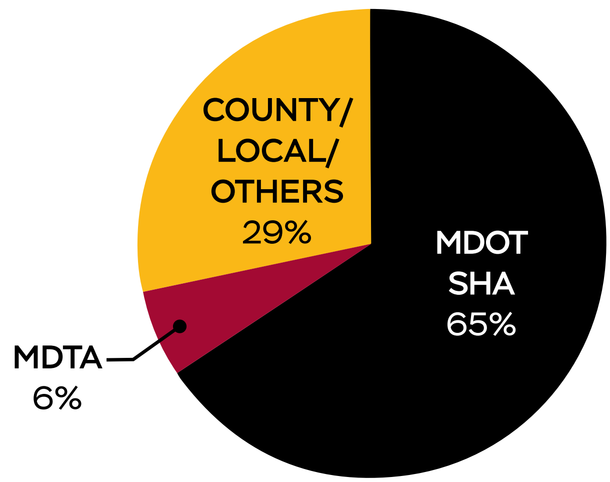


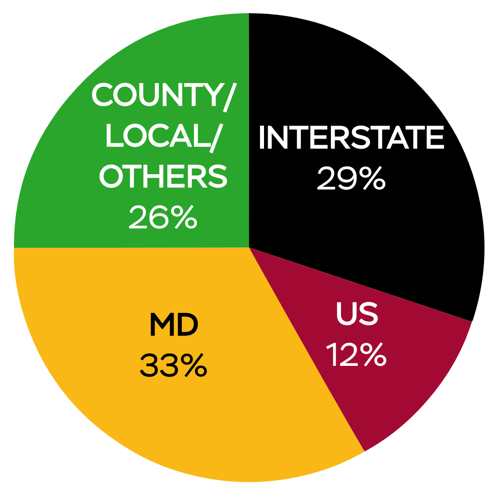
Table 5

VMT BY ROADWAY CLASSIFICATION

ROADWAY DESIGNATION	VMT (BILLIONS)
Maryland Routes	16.65
Interstate Routes	14.65
County/Local/Others	13.38
US Routes	5.92

Figure 11

VMT BY ROADWAY CLASSIFICATION

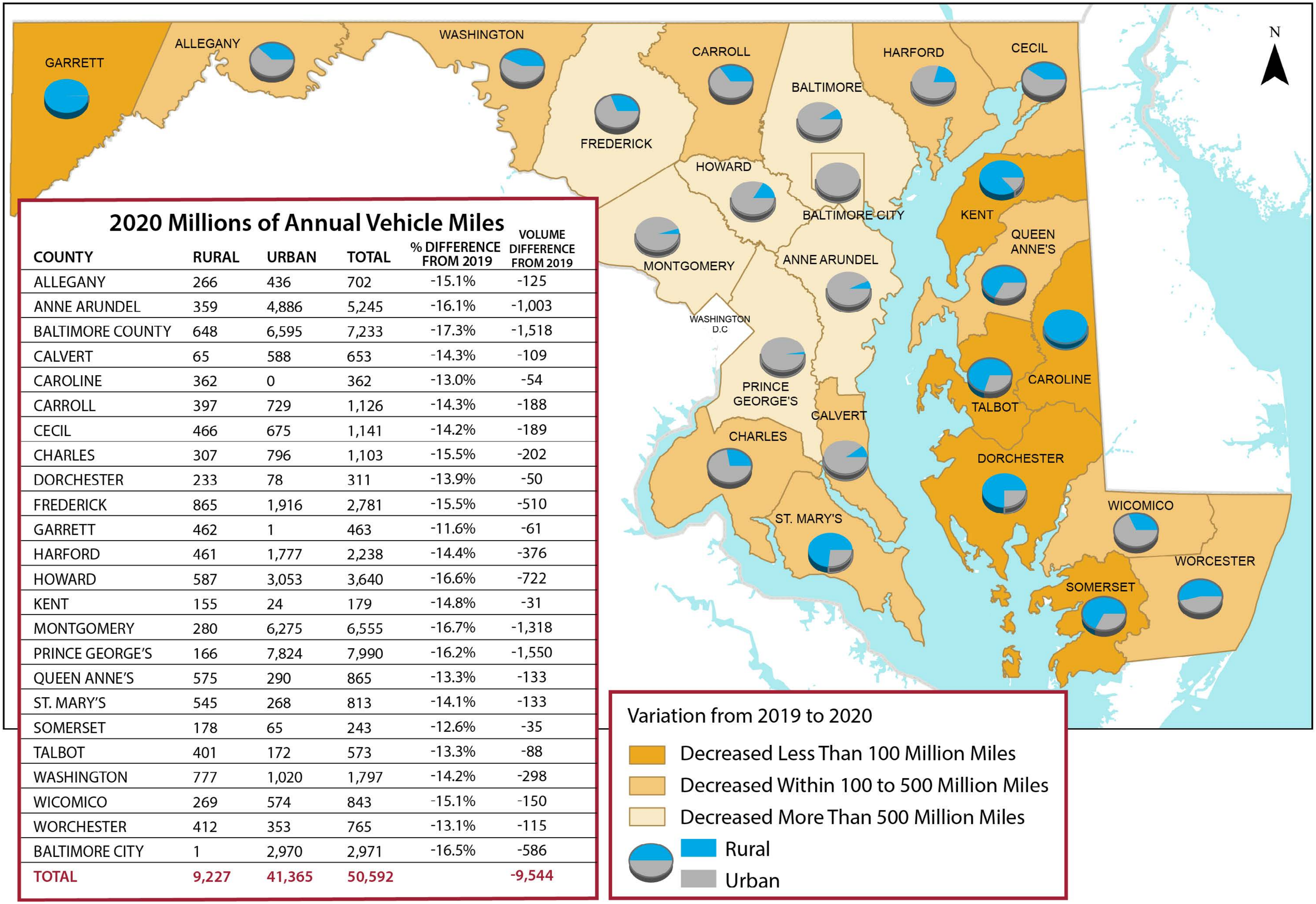


VEHICLE MILES TRAVELED – BY COUNTY

Every county experienced a decrease in VMT from 2019. All counties decreased by at least 10% with the highest being over 17% in Baltimore County. The largest decreases occurred in Anne Arundel, Baltimore, Montgomery and Prince George's Counties. All of these counties experienced a reduction of over 1 billion miles **(Figure 12)**.

2020 Vehicle Miles of Travel - By County

Figure 12



2020 Millions of Annual Vehicle Miles

COUNTY	RURAL	URBAN	TOTAL	% DIFFERENCE FROM 2019	VOLUME DIFFERENCE FROM 2019
ALLEGANY	266	436	702	-15.1%	-125
ANNE ARUNDEL	359	4,886	5,245	-16.1%	-1,003
BALTIMORE COUNTY	648	6,595	7,233	-17.3%	-1,518
CALVERT	65	588	653	-14.3%	-109
CAROLINE	362	0	362	-13.0%	-54
CARROLL	397	729	1,126	-14.3%	-188
CECIL	466	675	1,141	-14.2%	-189
CHARLES	307	796	1,103	-15.5%	-202
DORCHESTER	233	78	311	-13.9%	-50
FREDERICK	865	1,916	2,781	-15.5%	-510
GARRETT	462	1	463	-11.6%	-61
HARFORD	461	1,777	2,238	-14.4%	-376
HOWARD	587	3,053	3,640	-16.6%	-722
KENT	155	24	179	-14.8%	-31
MONTGOMERY	280	6,275	6,555	-16.7%	-1,318
PRINCE GEORGE'S	166	7,824	7,990	-16.2%	-1,550
QUEEN ANNE'S	575	290	865	-13.3%	-133
ST. MARY'S	545	268	813	-14.1%	-133
SOMERSET	178	65	243	-12.6%	-35
TALBOT	401	172	573	-13.3%	-88
WASHINGTON	777	1,020	1,797	-14.2%	-298
WICOMICO	269	574	843	-15.1%	-150
WORCHESTER	412	353	765	-13.1%	-115
BALTIMORE CITY	1	2,970	2,971	-16.5%	-586
TOTAL	9,227	41,365	50,592		-9,544

ANNUAL AVERAGE DAILY TRAFFIC (AADT)

MDOT SHA administers a traffic data collection program along roadways throughout the state. The data is collected with equipment and personnel on numerous sections of roadway. Annual average daily traffic (AADT) measures the volume of traffic for the year, divided by the number of days in a year. Although traffic volumes were lower on all facilities, several sections of freeways/expressways still exceeded 200,000 vehicles per day **(Table 6)**. The highest volume locations remained fairly consistent between 2019 and 2020.

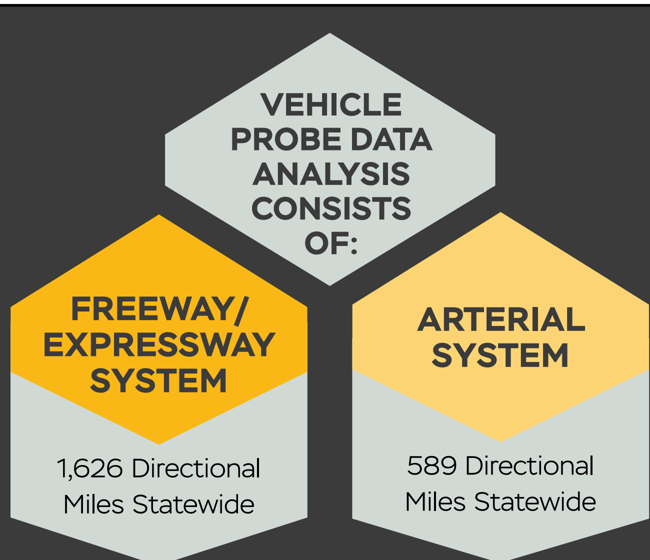
Table 6

HIGHEST ANNUAL AVERAGE DAILY TRAFFIC (AADT) VOLUMES (VEHICLES PER DAY)	
FREEWAY SECTION	2020 AADT
I-270 N of I-270 Split	215,000
I-270 N of Montrose Rd	206,000
I-495 W of I-270	205,000
I-95/I-495 W of US 1	204,000
I-495 American Legion Bridge	204,000
ARTERIAL SECTION	2020 AADT
US 301/MD 5 S of McKendree Rd	87,000
MD 5 S of MD 223	71,000
MD 3 N of Prince George's County Line	69,000
MD 650 S of I-495	67,000
MD 185 S of I-495	65,000
MDTA TOLL FACILITY CROSSINGS	2020 AADT
I-95 Ft. McHenry Tunnel	113,000
I-95 Tydings Bridge	66,000
US 50/US 301 Bay Bridge	63,000
I-895 Harbor Tunnel	39,500

CONGESTION TRENDS

Traffic congestion can be broadly defined into two categories. The first category is called recurring congestion, which occurs daily in the morning (AM) and afternoon (PM) peak periods. This type of congestion is influenced by high automobile and truck traffic volumes, narrow lane and shoulder widths and geometrics of the roadway. Freeway/expressway operations are also influenced by areas where traffic enters and exits the roadway. Whereas, motorists who travel along arterials confront delays at traffic signals, variations in speed and different geometrics such as shoulder widths and lane widths. The second category is called non-recurring congestion; which occurs as a result of incidents including crashes, vehicle breakdowns, work zones, special events, inclement weather; that causes motorists to experience slowing or stop and go traffic conditions.

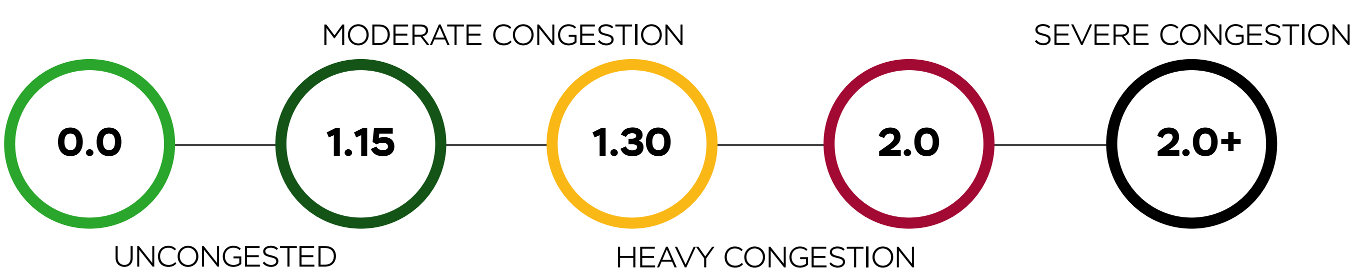
There are various methods to measure congestion ranging from theoretical analysis to field measurements. One such method is vehicle probe data. Probes are vehicles equipped with Global Positioning System (GPS) elements such as navigation devices that transmit real time data. Analyzing this data helps evaluate mobility. Vehicle probe speed datasets are available from a variety of sources on a minute-by-minute basis. The data is provided by INRIX, a company which collects traffic speed data from an estimated 100 million probe vehicles nationwide including commercial vehicle fleets. In addition, MDOT SHA collects traffic volume data on its roadways using automated traffic recorders (ATR). The University of Maryland Center for Advanced Transportation Technology (UMD CATT) uses the vehicle probe speed data and traffic volume data to develop metrics to measure congestion **(Figure 13)**.



With vehicle probe data, the Travel Time Index (TTI) is used as the primary measure of congestion. The TTI compares the 50th percentile travel time on a segment of roadway for a particular hour to the travel time of a trip during the off-peak (off-peak is considered when free flow or uncongested conditions exist). The higher the TTI, the longer the travel time.

Figure 13

METRIC: MEASUREMENT OF CONGESTION (TRAVEL TIME INDEX)



CONGESTION MEASURES

There are various metrics used to evaluate statewide congestion. The first set of metrics are the number of roadway miles and the percent of roadway miles that operate with heavy to severe congestion. This is reported in Table 7 for freeways/expressways and Table 8 for arterials. The last metric, percent of peak hour VMT impacted, measures the amount of VMT that occurs in heavy to severe congestion during the peak hour and is only provided for freeways/expressways. This metric summarizes information about how many motorists experience these conditions, along with the distance they travel during the peak hour.

The 2020 values for the three congestion measures showed a sharp decrease due to COVID-19. The largest decreases occurred in the PM peak hour especially on the freeway system. AM peak hour congestion was very minor on both the arterial and freeway system.

Table 7

STATEWIDE FREEWAY/EXPRESSWAY SYSTEM
(AVERAGE WEEKDAY AM & PM PEAK HOUR HEAVY TO SEVERE CONGESTION SUMMARY)

HEAVY TO SEVERE CONGESTION	2018		2019		2020		CHANGE FROM 2019 TO 2020	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Roadway Miles	155	262	177	286	12	34	-165	-252
Percent of Roadway Miles	10	16	11	18	1	2	-10	-16
Percent of Peak Hour VMT Impacted	19	29	22	31	2	4	-20	-27

Table 8

STATEWIDE MAJOR ARTERIAL SYSTEM
(AVERAGE WEEKDAY AM & PM PEAK HOUR HEAVY TO SEVERE CONGESTION SUMMARY)

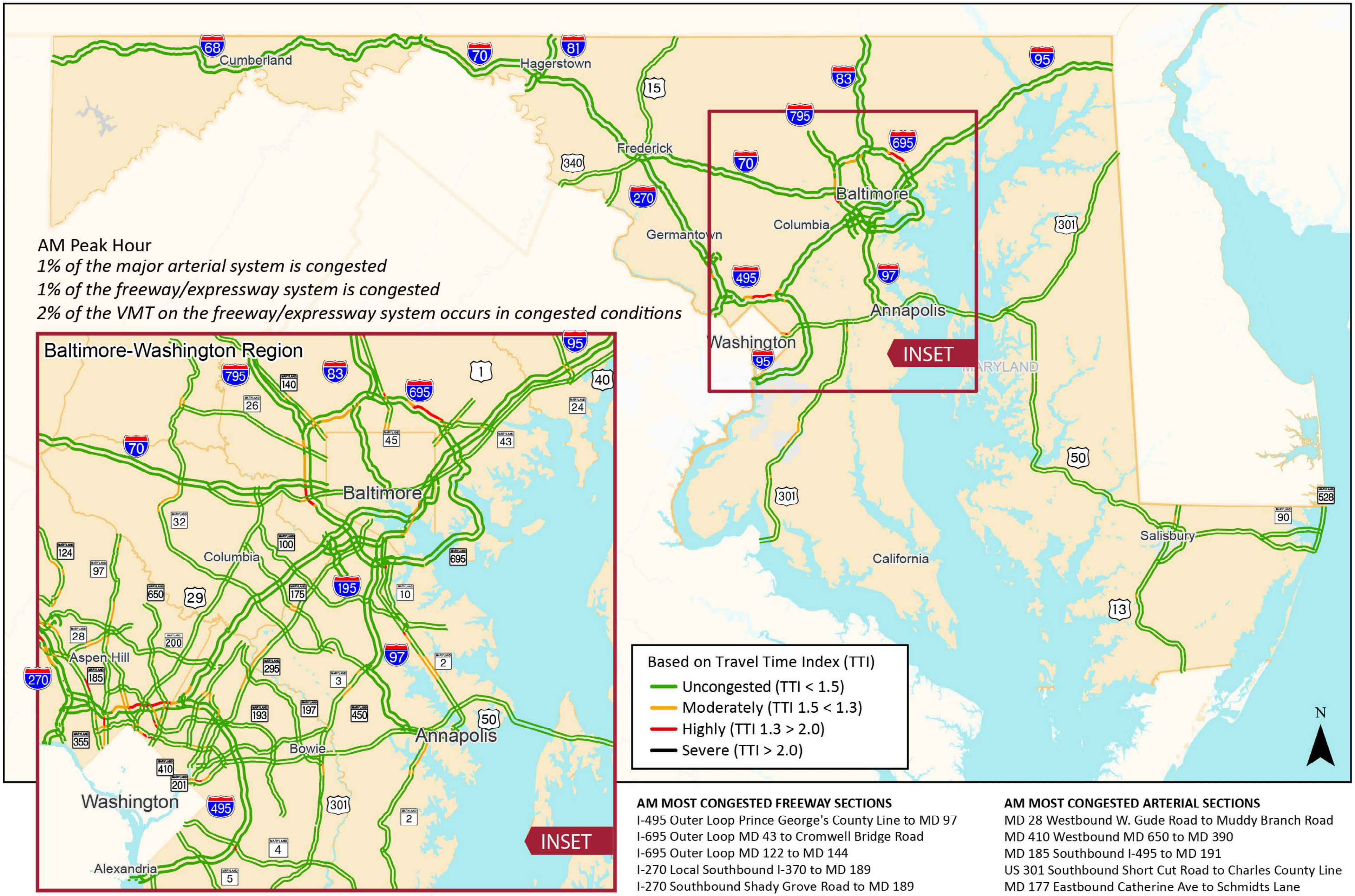
HEAVY TO SEVERE CONGESTION	2018		2019		2020		CHANGE FROM 2019 TO 2020	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Roadway Miles	71	155	88	201	8	89	-80	-112
Percent of Roadway Miles	12	26	15	34	1	15	-14	-19

Statewide congestion (TTI) maps were developed for the freeway/expressway and arterial system for five time periods, including the average weekday AM and PM peak hours. In addition to AM and PM peak hour analysis, it has been noted that certain areas experience much greater congestion on summer weekends. To further explain the congestion trend, maps were also developed for the 4–5 PM Friday, 1–2 PM Saturday, and 2–3 PM Sunday hours. These are as follows:

- AM Peak Hour 8-9 AM - Figure 14
- PM Peak Hour 5–6 PM - Figure 15
- Friday Summer 4–5 PM - Figure 16
- Saturday Summer 1–2 PM - Figure 17
- Sunday Summer 2–3 PM - Figure 18

Maryland Congestion Map: 2020 AM Peak Hour (8-9) AM

Figure 14



AM MOST CONGESTED FREEWAY SECTIONS

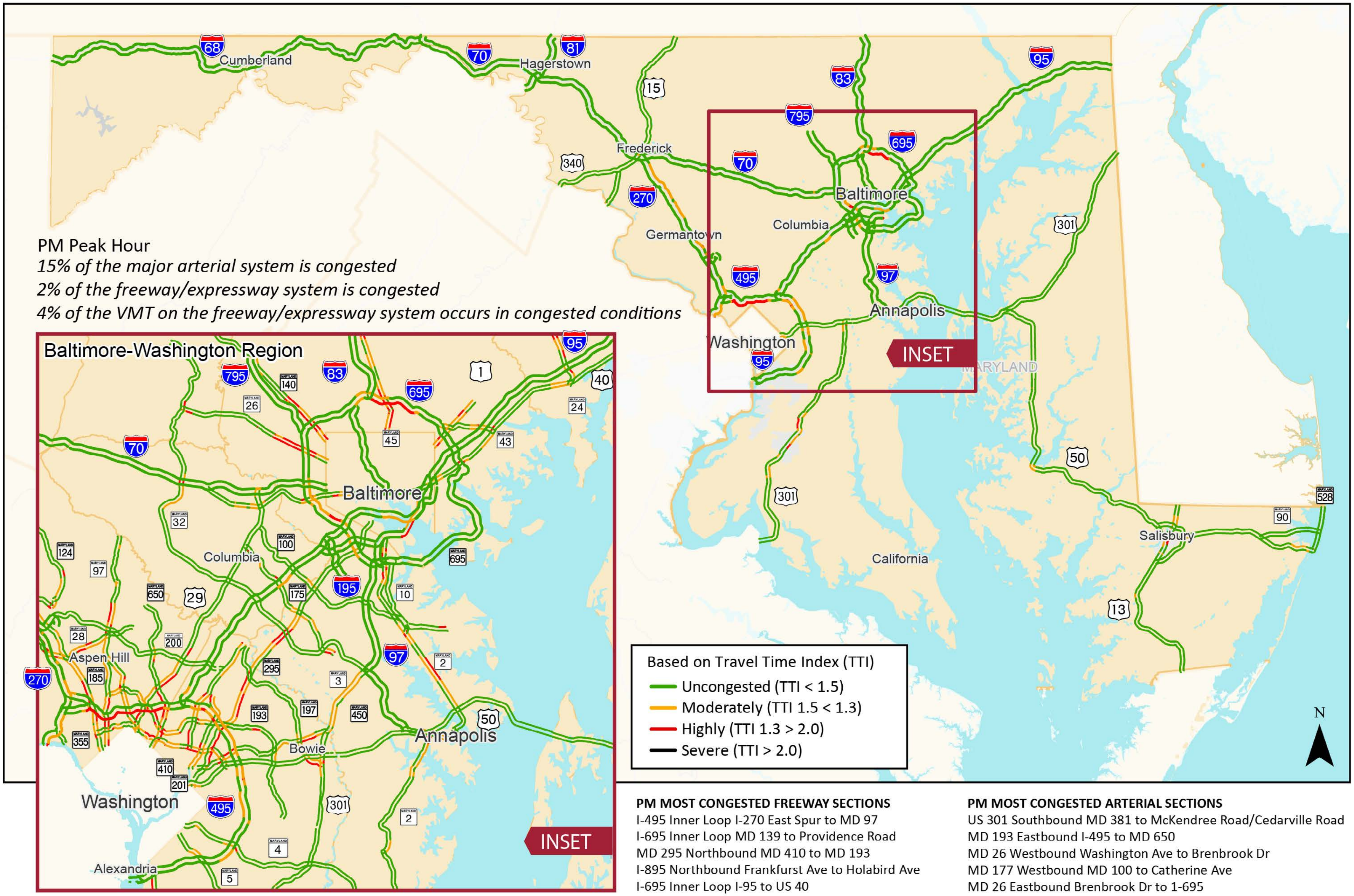
I-495 Outer Loop Prince George's County Line to MD 97
I-695 Outer Loop MD 43 to Cromwell Bridge Road
I-695 Outer Loop MD 122 to MD 144
I-270 Local Southbound I-370 to MD 189
I-270 Southbound Shady Grove Road to MD 189

AM MOST CONGESTED ARTERIAL SECTIONS

MD 28 Westbound W. Gude Road to Muddy Branch Road
MD 410 Westbound MD 650 to MD 390
MD 185 Southbound I-495 to MD 191
US 301 Southbound Short Cut Road to Charles County Line
MD 177 Eastbound Catherine Ave to Schmidts Lane

Maryland Congestion Map: 2020 PM Peak Hour (5-6) PM

Figure 15



PM MOST CONGESTED FREEWAY SECTIONS

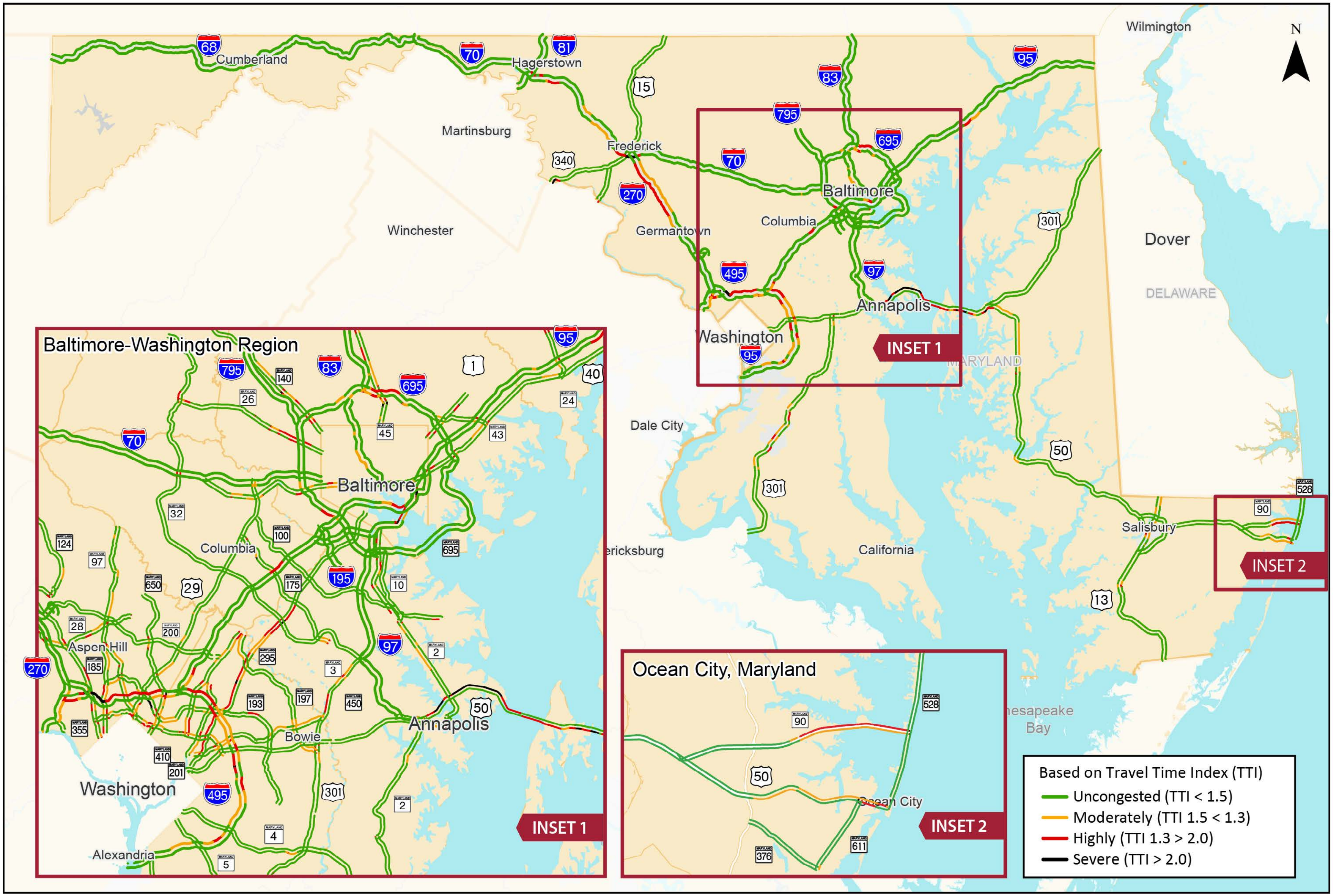
I-495 Inner Loop I-270 East Spur to MD 97
I-695 Inner Loop MD 139 to Providence Road
MD 295 Northbound MD 410 to MD 193
I-895 Northbound Frankfurst Ave to Holabird Ave
I-695 Inner Loop I-95 to US 40

PM MOST CONGESTED ARTERIAL SECTIONS

US 301 Southbound MD 381 to McKendree Road/Cedarville Road
MD 193 Eastbound I-495 to MD 650
MD 26 Westbound Washington Ave to Brenbrook Dr
MD 177 Westbound MD 100 to Catherine Ave
MD 26 Eastbound Brenbrook Dr to 1-695

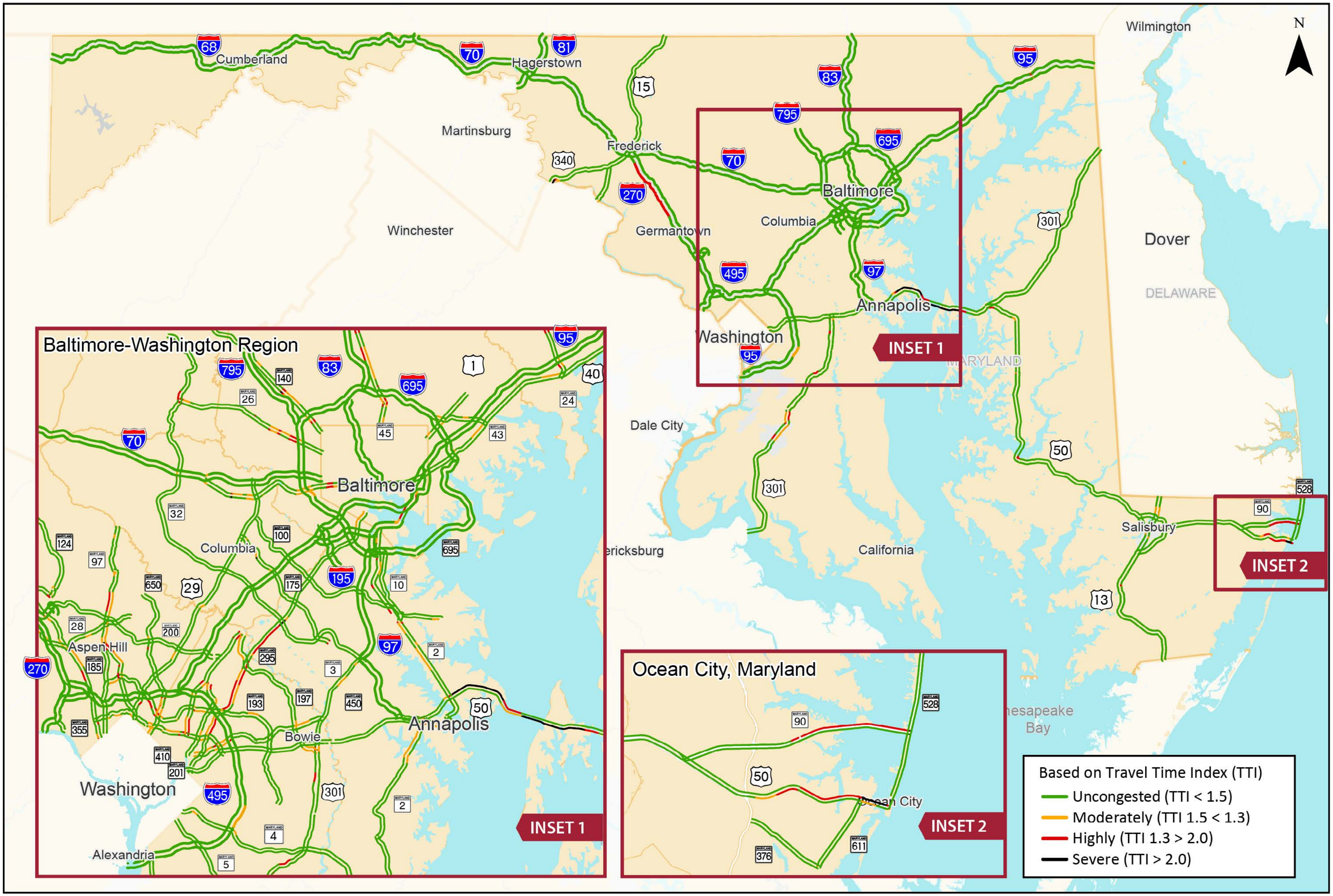
Maryland Congestion Map: 2020 Friday Summer Hour (4-5) PM

Figure 16



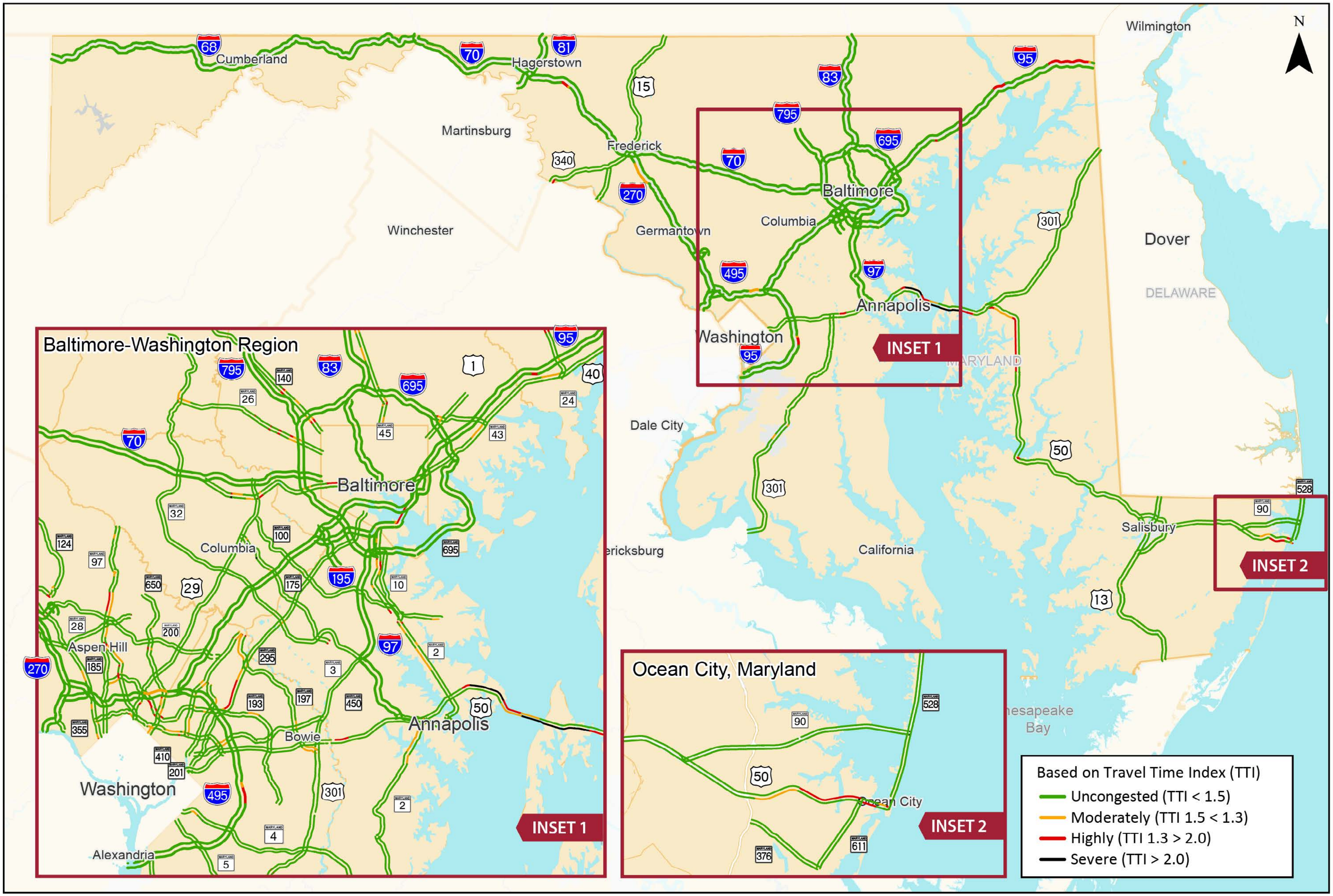
Maryland Congestion Map: 2020 Saturday Summer Hour (1PM - 2PM)

Figure 17



Maryland Congestion Map: 2020 Sunday Summer Hour (2PM - 3PM)

Figure 18



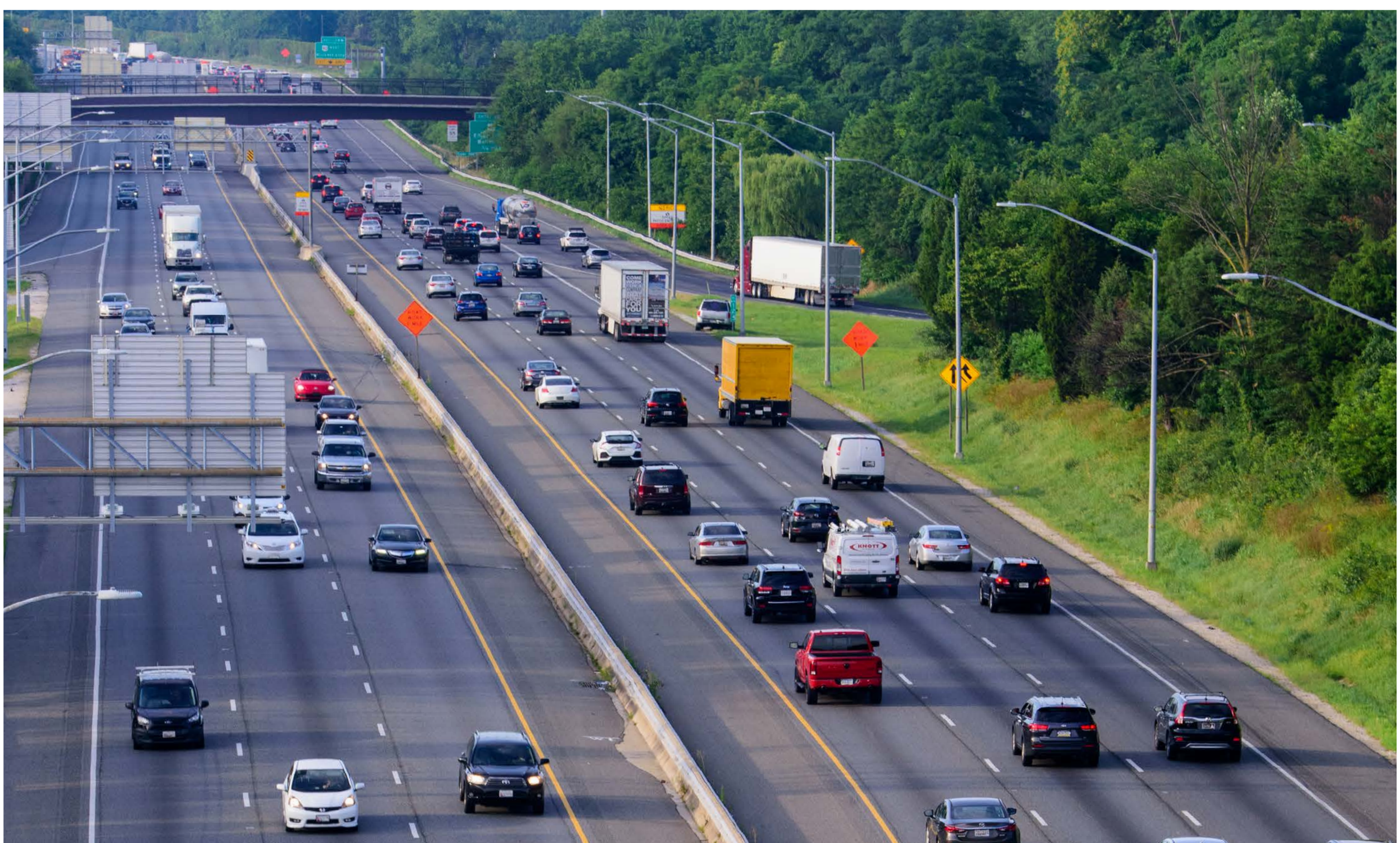
COST OF CONGESTION

There is a cost associated with congestion. The MDOT SHA calculates the statewide cost based on auto delay, truck delay, and wasted fuel and emissions. The statewide cost for congestion has decreased by more than $3.3 billion between 2019 and 2020 **(Table 9)**. The change in congestion costs were driven by the lower volumes of traffic on both the freeway/expressway and arterial system. Over the last ten months of the year, the majority of motorists on roadways operated close to the posted speed even in the AM and PM peak hours. This meant that congestion costs were minimal. This trend was statewide with all regions experiencing a significant decrease in congestion costs.

Table 9

TOTAL COST OF CONGESTION ON FREEWAYS/EXPRESSWAYS AND ARTERIALS ($ MILLIONS)

REGION	2018	2019	2020	CHANGE FROM 2019 TO 2020
Freeways/Expressways	$2,727	$3,584	$744	$-2,840
Arterials	$1,241	$1,576	$1,067	$-509
TOTAL	$3,968	$5,160	$1,811	$-3,349



I-695 @ I-70

TOP 15 CONGESTED CORRIDOR SECTIONS

The TTI scale presented in **Figure 8**, was utilized to develop metrics for individual freeway/expressway and arterial segments. The individual segments were combined to develop the AM and PM top 15 most congested freeways/expressways and arterial sections. Freeway/expressway corridors range from three to eight miles long or include the entire length of a freeway (I-370) or spur (I-270 East or West Spur), while arterial corridors range from two to five miles. The top 15 sections for the worst congestion during the AM and PM peak hours are shown in **Tables 10 through 13**.

- Freeway/Expressway Sections AM Peak Hour - Table 10, Figure 19
- Freeway/Expressway Sections PM Peak Hour - Table 11, Figure 20
- Arterial Sections AM Peak Hour - Table 12, Figure 21
- Arterial Sections PM Peak Hour - Table 13, Figure 22

Most Congested Weighted Average = (ΣIndividual Segment TTI x Section Length)/Total Section Length.

Table 10

2020 MOST CONGESTED FREEWAY/EXPRESSWAY SECTIONS - AM PEAK HOUR					
AM RANK	ROUTE/DIRECTION	LIMITS	MILEAGE	COUNTY	TTI
1	I-495 Outer Loop	Prince George's County Line to MD 97	4.10	Montgomery	1.41
2	I-695 Outer Loop	MD 43 to Cromwell Bridge Road	3.07	Baltimore	1.40
3	I-695 Outer Loop	MD 122 to MD 144	3.13	Baltimore	1.32
4	I-270 Local SB	I-370 to MD 189	3.32	Montgomery	1.25
5	I-270 SB	Shady Grove Rd to MD 189	3.03	Montgomery	1.25
6	US 50 Westbound	MD 410 to DC Line	3.74	Prince George's	1.21
7	I-695 Inner Loop	Stevenson Road to I-83	3.33	Baltimore	1.20
8	I-895 NB	Frankfurst Avenue to Holabird Avenue	3.15	Baltimore (City)	1.19
9	MD 295 SB	MD 198 to Powder Mill Rd	5.60	Anne Arundel	1.15
10	I-95 SB	South of MD 200 to I-495	3.08	Prince George's	1.13
11	MD 295 SB	MD 193 to MD 410	3.13	Prince George's	1.12
12	I-270 SB	MD 80 to MD 109	3.78	Frederick	1.12
13	I-495 Outer Loop	MD 187 to MD 190	3.11	Montgomery	1.12
14	I-95/I-495 Inner Loop	MD 414 to I-295	3.38	Prince George's	1.11
15	I-95/I-495 Inner Loop	I-95 to MD 295	4.10	Prince George's	1.11

Maryland's Most Congested Freeway Corridor Section: 2020 AM Peak Hour (8-9)

Figure 19

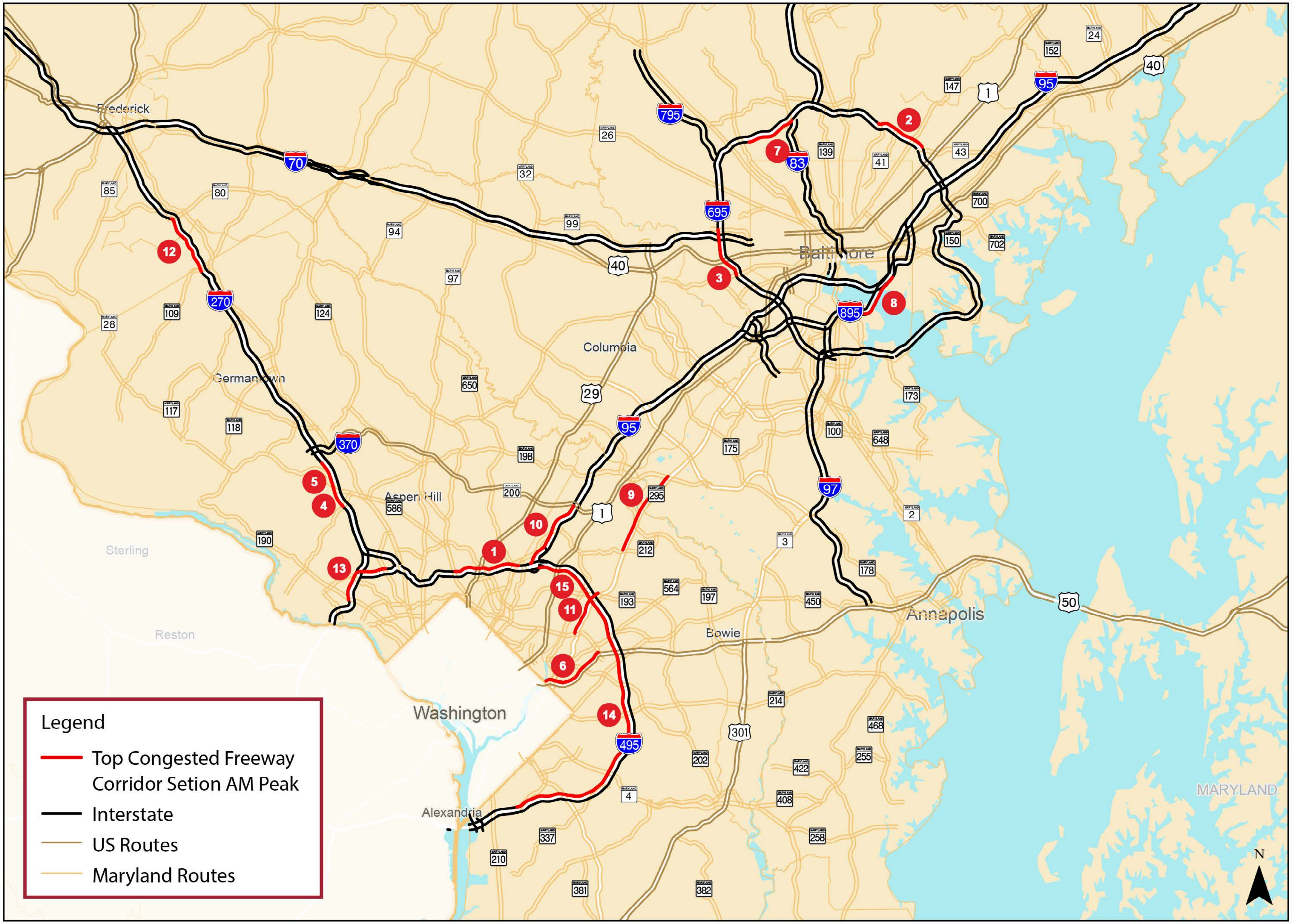


Table 11

2020 MOST CONGESTED FREEWAY/EXPRESSWAY SECTIONS - PM PEAK HOUR					
PM RANK	ROUTE/DIRECTION	LIMITS	MILEAGE	COUNTY	TTI
1	I-495 Inner Loop	I-270 East Spur to MD 97	3.44	Montgomery	1.68
2	I-695 Inner Loop	MD 139 to Providence Rd	3.66	Baltimore	1.67
3	MD 295 NB	MD 410 to MD 193	3.11	Prince George's	1.49
4	I-895 NB	Frankfurst Avenue to Holabird Avenue	3.15	Baltimore City	1.45
5	I-695 Inner Loop	I-95 to US 40	3.45	Baltimore	1.33
6	MD 295 SB	MD 175 to MD 198	3.99	Anne Arundel	1.32
7	I-270 Local NB	I-370 to Watkins Mill Road	2.94	Montgomery	1.32
8	I-95/I-495 Inner Loop	I-95 to MD 295	3.23	Prince George's	1.29
9	MD 295 NB	MD 198 to MD 175	4.06	Anne Arundel	1.29
10	I-95/I-495 Outer Loop	MD 450 to MD 201	3.45	Prince George's	1.26
11	I-270 NB	MD 121 to MD 109	4.09	Montgomery	1.26
12	I-95 NB	MD 2 to Fort McHenry Tunnel East	3.02	Baltimore (City)	1.25
13	I-495 Inner Loop	VA Line to I-270 West Spur	3.90	Montgomery	1.24
14	I-895 SB	MD 150 to Harbor Tunnel West	3.25	Baltimore (City)	1.23
15	I-270 NB	MD 189 to I-370	3.20	Montgomery	1.22

Maryland's Most Congested Freeway Corridor Section: 2020 PM Peak Hour (5-6)

Figure 20

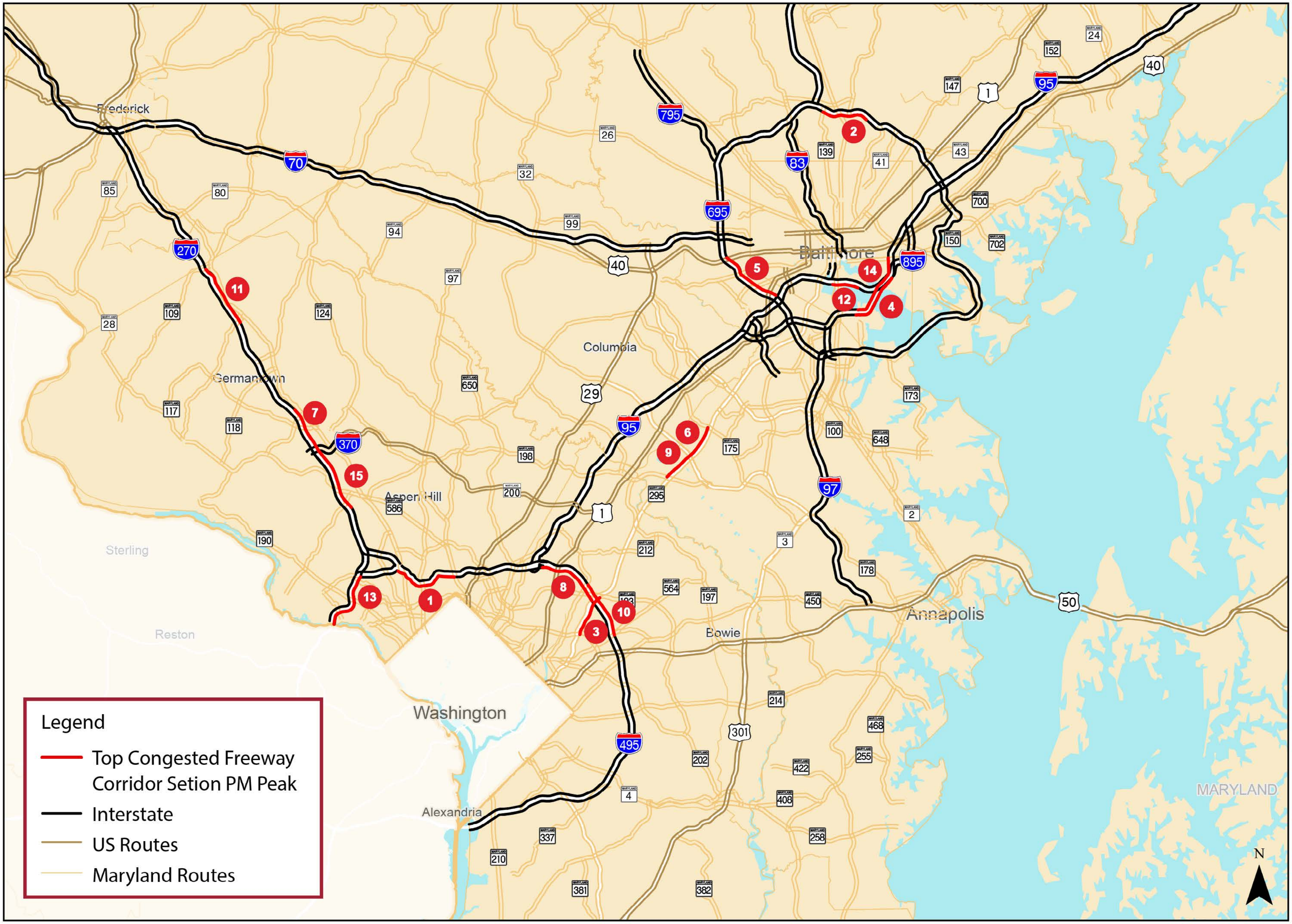


Table 12

2020 MOST CONGESTED ARTERIAL SECTIONS - AM PEAK HOUR					
AM RANK	ROUTE/DIRECTION	LIMITS	MILEAGE	COUNTY	TTI
1	MD 28 WB	W. Gude Road to Muddy Branch Road	2.11	Montgomery	1.32
2	MD 410 WB	MD 650 to MD 390	2.87	Montgomery	1.31
3	MD 185 SB	I-495 to MD 191	2.08	Montgomery	1.31
4	US 301 SB	Short Cut Road to Charles County Line	2.15	Prince George's	1.28
5	MD 177 EB	Catherine Avenue to Schmidts Lane	2.31	Anne Arundel	1.26
6	MD 355 NB	Beach Drive/Grosvenor Lane to Montrose Pkwy	2.11	Montgomery	1.25
7	MD 2 NB	College Parkway to Robinson Road	2.53	Anne Arundel	1.23
8	MD 28 EB	Baltimore Road to MD 97	2.27	Montgomery	1.20
9	MD 424 SB	MD 3 to MD 450	2.42	Anne Arundel	1.20
10	MD 2 SB	MD 665 to Mayo Road	2.61	Anne Arundel	1.20
11	MD 97 SB	MD 586 to MD 390	2.02	Montgomery	1.20
12	MD 108 WB	MD 182 to Bowie Mill Road	2.28	Montgomery	1.19
13	MD 2 SB	MD 10 to Robinson Road	2.88	Anne Arundel	1.19
14	MD 410 WB	Riverdale Road to US 1	2.16	Prince George's	1.19
15	MD 97 NB	MD 390 to MD 586	2.02	Montgomery	1.18

Maryland's Most Congested Arterial Corridor Section: 2020 AM Peak Hour (8-9)

Figure 21

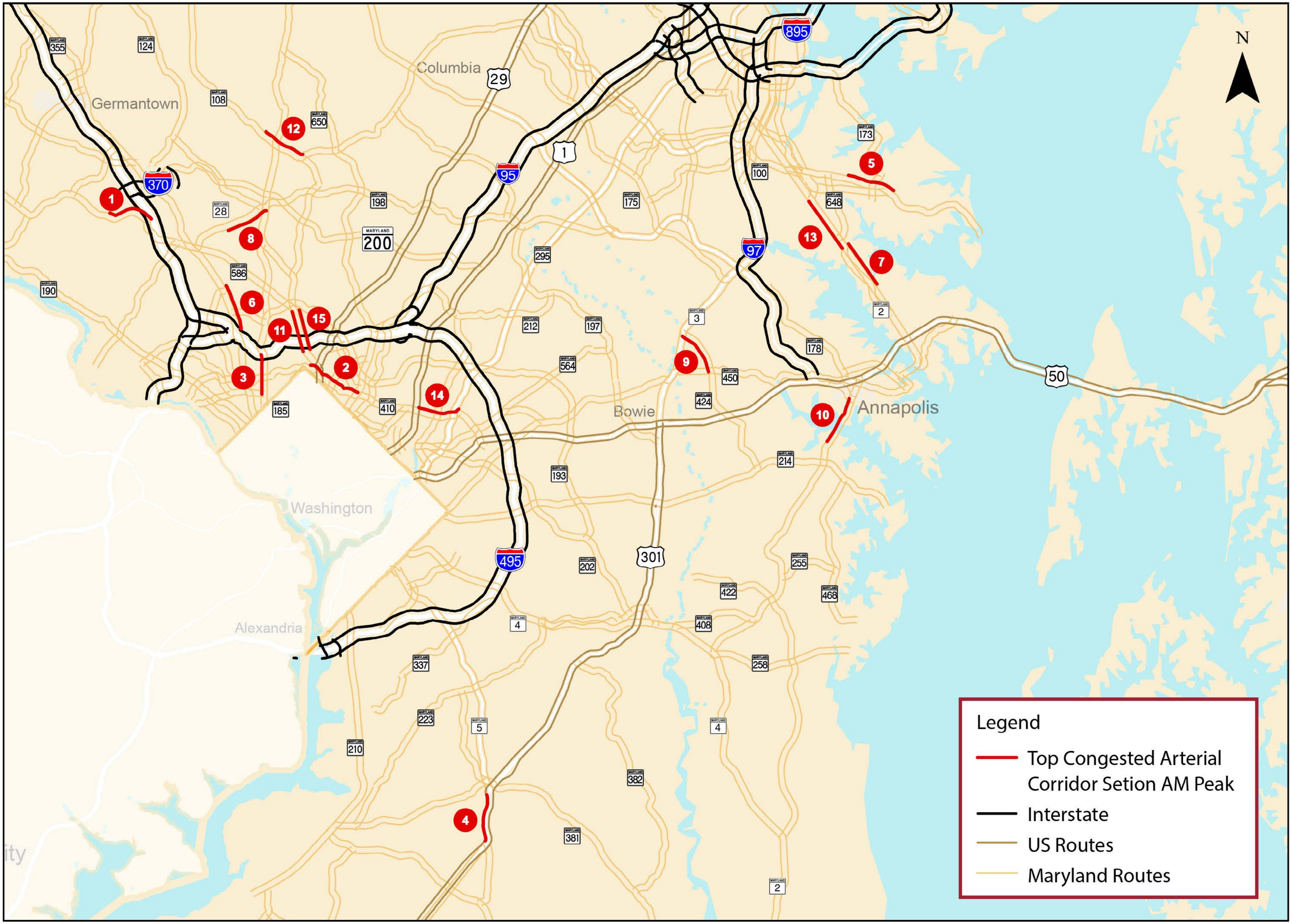
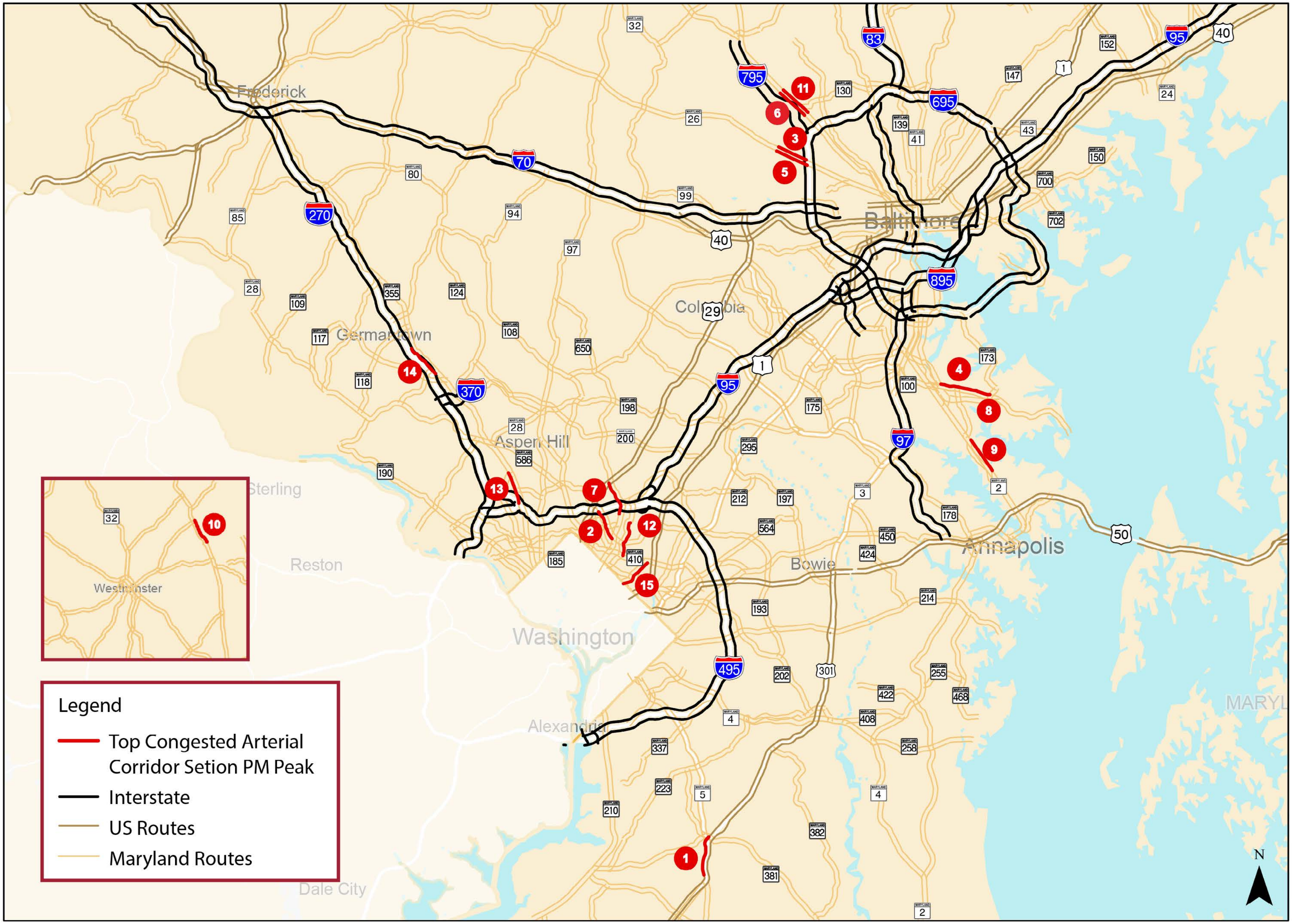


Table 13

2020 MOST CONGESTED ARTERIAL SECTIONS - PM PEAK HOUR					
PM RANK	ROUTE/DIRECTION	LIMITS	MILEAGE	COUNTY	TTI
1	US 301 SB	MD 381 to McKendree Road/ Cedarville Road	2.58	Prince George's	1.62
2	MD 193 EB	I-495 to MD 650	2.03	Montgomery	1.53
3	MD 26 WB	Washington Avenue to Brenbrook Drive	2.02	Baltimore	1.50
4	MD 177 WB	MD 100 to Catherine Avenue	2.03	Anne Arundel	1.49
5	MD 26 EB	Brenbrook Drive to I-695	2.17	Baltimore	1.47
6	MD 140 EB	Owings Mills Boulevard to McDonoghRoad/Craddock Lane	2.14	Baltimore	1.47
7	MD 650 SB	US 29 to Adelphi Road	2.28	Montgomery	1.43
8	MD 177 EB	Waterford Road to MD 607	2.24	Anne Arundel	1.42
9	MD 2 NB	College Parkway to Robinson Road/Leelyn Drive	2.53	Anne Arundel	1.41
10	MD 30 NB	MD 30 Business (North) to MD 27	2.37	Carroll	1.40
11	MD 140 WB	Craddock Lane/McDonogh Road to Owings Mills Blvd	2.10	Baltimore	1.40
12	MD 212 NB	MD 410 to Adelphi Road	2.53	Prince George's	1.39
13	MD 355 SB	Montrose Parkway to Beach Drive/ Grosvenor Lane	2.25	Montgomery	1.38
14	MD 355 SB	Plummer Drive to Odendhal Drive	2.30	Montgomery	1.38
15	MD 500 EB	DC Line to MD 410	2.12	Prince George's	1.37

Maryland's Most Congested Arterial Corridor Section: 2020 PM Peak Hour (5-6)

Figure 22



SUMMER WEEKEND CONGESTION

While traffic was vastly reduced during the AM and PM peak periods, during other time periods motorists experienced similar congestion to pre-COVID conditions. This was especially true during summer weekends. Congestion data (TTI) was analyzed to determine which locations experience the most congestion in the summer months during three different hours: from **4–5 PM on Friday**, **1–2 PM** noon **on Saturday**, and **2–3 PM on Sunday**. The analysis found that the locations with more congestion on the weekends than the weekdays are mainly on the Eastern Shore **(Table 14 and 15)**. The rankings represent the most congested sections of roadway versus similar lengths of roadway statewide for those time periods.

Table 14

2020 MOST CONGESTED SUMMER-WEEKEND FREEWAY LOCATIONS THAT NORMALLY EXPERIENCE MINIMAL CONGESTION ON WEEKDAYS

RANK	DAY	ROUTE/DIRECTION	LIMITS	MILEAGE	COUNTY	TTI
1	Friday	US 50/US 301 EB	MD 179 to Oceanic Drive	2.21	Anne Arundel	3.75
1	Saturday	US 50/US 301 EB	MD 179 to Oceanic Drive	2.21	Anne Arundel	5.57
2	Saturday	US 50/US 301 WB	Chester Station Lane to Bay Bridge	3.24	Queen Anne's	4.37
1	Sunday	US 50/US 301 WB	Castle Marina Road to MD 18	2.02	Queen Anne's	5.14
2	Sunday	US 50/US 301 EB	MD 179 to Oceanic Drive	6.60	Anne Arundel	3.49
5	Sunday	I-95 NB	MD 155 to Tydings Bridge	2.07	Harford/Cecil	1.50

Table 15

2020 MOST CONGESTED SUMMER-WEEKEND ARTERIAL LOCATIONS THAT NORMALLY EXPERIENCE MINIMAL CONGESTION ON WEEKDAYS

RANK	DAY	ROUTE/DIRECTION	LIMITS	MILEAGE	COUNTY	TTI
4	Friday	MD 404 EB	MD 313 to MD 16	2.28	Caroline	1.60
2	Saturday	MD 90 EB	MD 589 to MD 528	5.53	Worcester	1.94
3	Saturday	US 50 EB	MD 589 to MD 528	4.60	Worcester	1.92
1	Sunday	MD 404 WB	Delaware Line to MD 313	4.01	Caroline	1.56
2	Sunday	US 50 WB	MD 456 to US 301	2.21	Queen Anne's	1.43

One of the roadways that experiences congestion on summer weekends is US 50/US 301 from I-97 to US 50/US 301 split. A separate analysis was performed to determine the hours and location where congestion is at the highest levels for that section. Analysis showed Saturday afternoon was the worst condition **(Table 16)**.

Table 16

MOST CONGESTED US 50/US 301 LOCATIONS WEEKEND

RANK	DAY	TIME/DIRECTION	LIMITS	MILEAGE	COUNTY	TTI
1	Saturday	2:00 PM/EB	Buschs Frontage Rd to Toll Plaza	3.09	Anne Arundel	5.75
2	Sunday	3:00 PM/WB	Piney Creek Road to MD 8	3.11	Queen Anne's	5.56
3	Saturday	1:00 PM/WB	Chester Station Lane to Bay Bridge	3.24	Queen Anne's	4.37
4	Friday	3:00 PM/EB	Bay Dale Drive to Oceanic Drive	3.16	Anne Arundel	4.11
5	Sunday	2:00 PM/EB	Bay Dale Drive to Bay Bridge	6.60	Anne Arundel	3.49

FREEWAY/EXPRESSWAY AND ARTERIAL CORRIDOR SUMMARY

Roadways where access is limited to interchanges are termed controlled access facilities. Controlled access facilities include freeways and expressways that are the highest classification of roadways in the state and also indicate the greatest capacity to convey vehicles.

Arterials are the next highest classification of roadways after freeways/expressways. These roadways generally have multi-lanes with traffic signals and carry a large volume of traffic. The freeway/expressway and arterial system were analyzed to determine the various levels of congestion that were experienced by motorists along these roadways on a statewide basis. The number and percentage of miles for each level of congestion were determined for the AM peak hour (8-9 AM) and the PM peak hour (5-6 PM) **(Figure 23 and 24)**.

Among the highlights of the analysis included:

- Roadways saw a significant decrease in the number of congested miles.
- No section of freeway/expressway experienced severe congestion (TTI >2.0). In 2019, there were approximately 50 miles in the AM peak hour and 75 miles in the PM peak hour on freeways/expressways that operated with these conditions.
- In the AM and PM peak hours, less than 30 miles of heavy to severe congestion occurred on freeways/expressways or less than 5% of the system.

Figure 23
NUMBER OF CONGESTED MILES

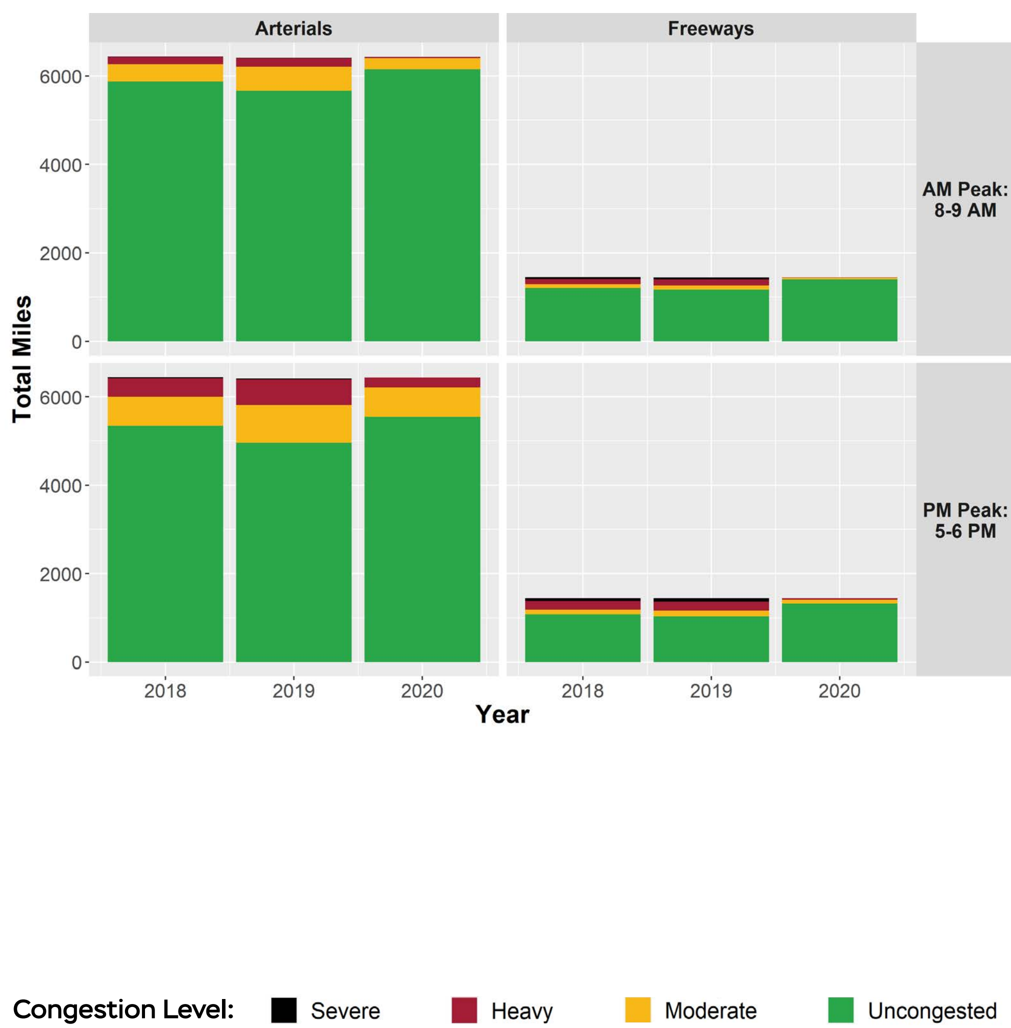
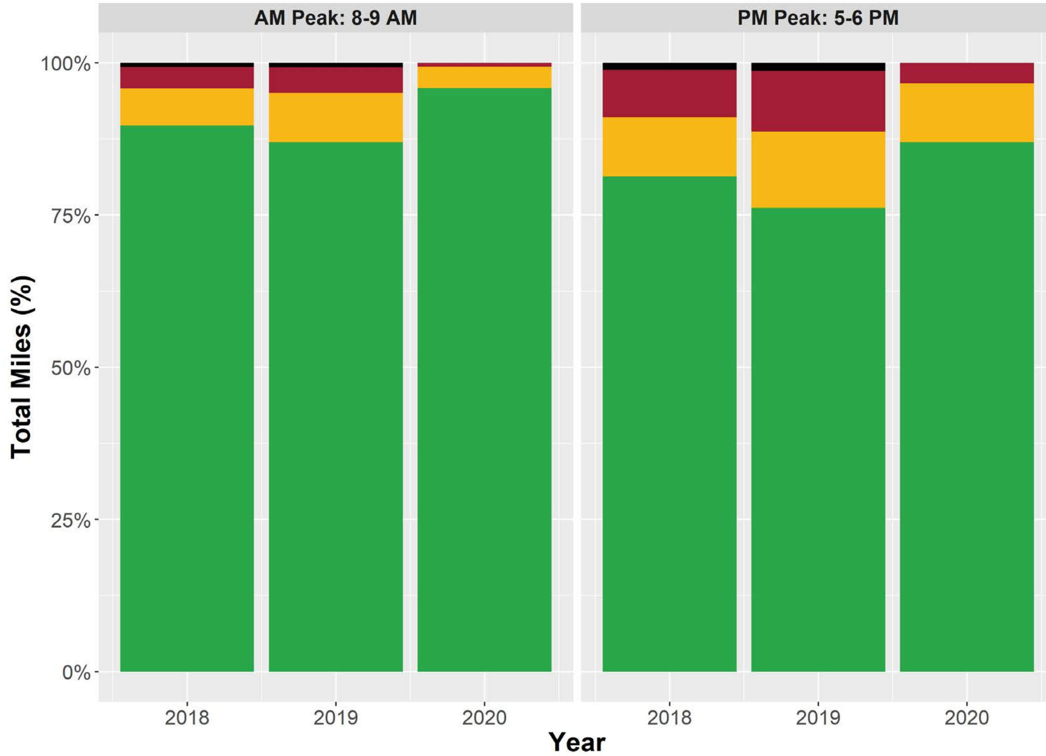


Figure 24

PERCENT OF CONGESTED MILEAGE FREEWAYS AND ARTERIALS



Each freeway/expressway section was analyzed to determine the number of miles that were recorded in the four levels of congestion. The results showed that almost all of the severe congestion occurred on three freeways/expressways. These were I-495, I-695 and MD 295 **(Figure 25)**.

Figure 25

FREEWAY CONGESTION SUMMARY

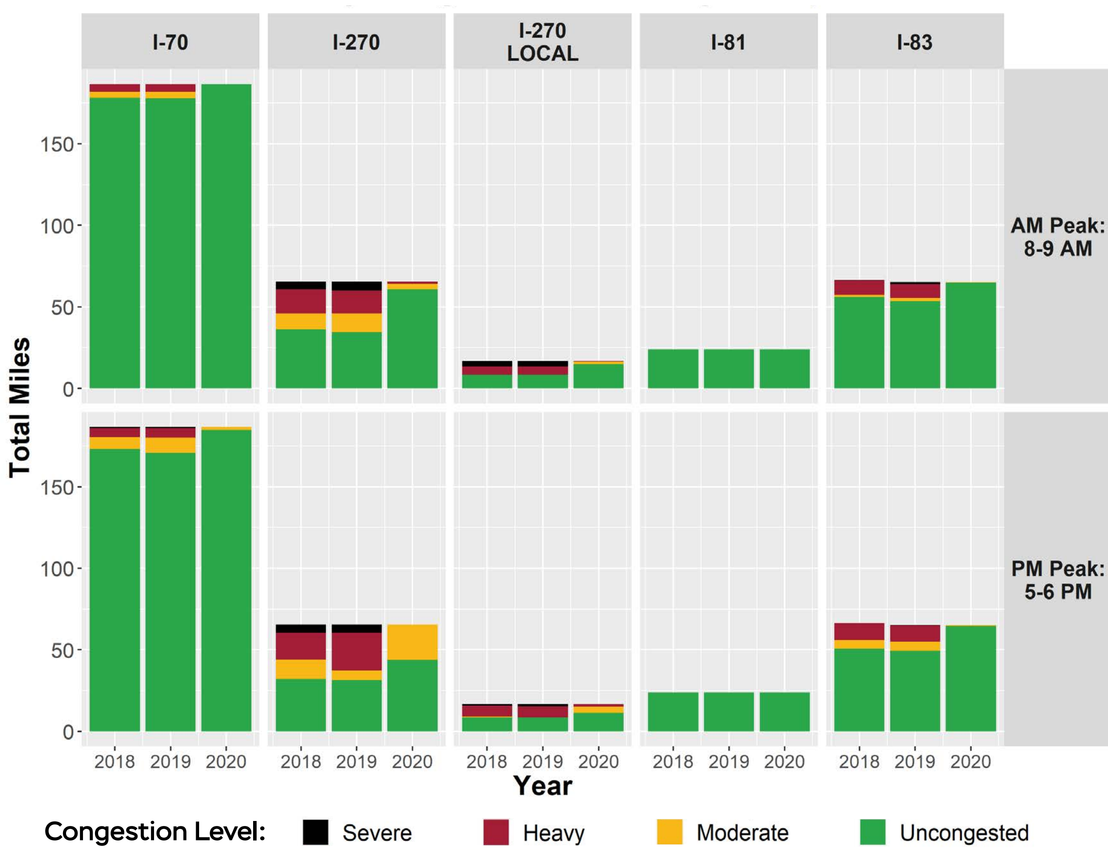
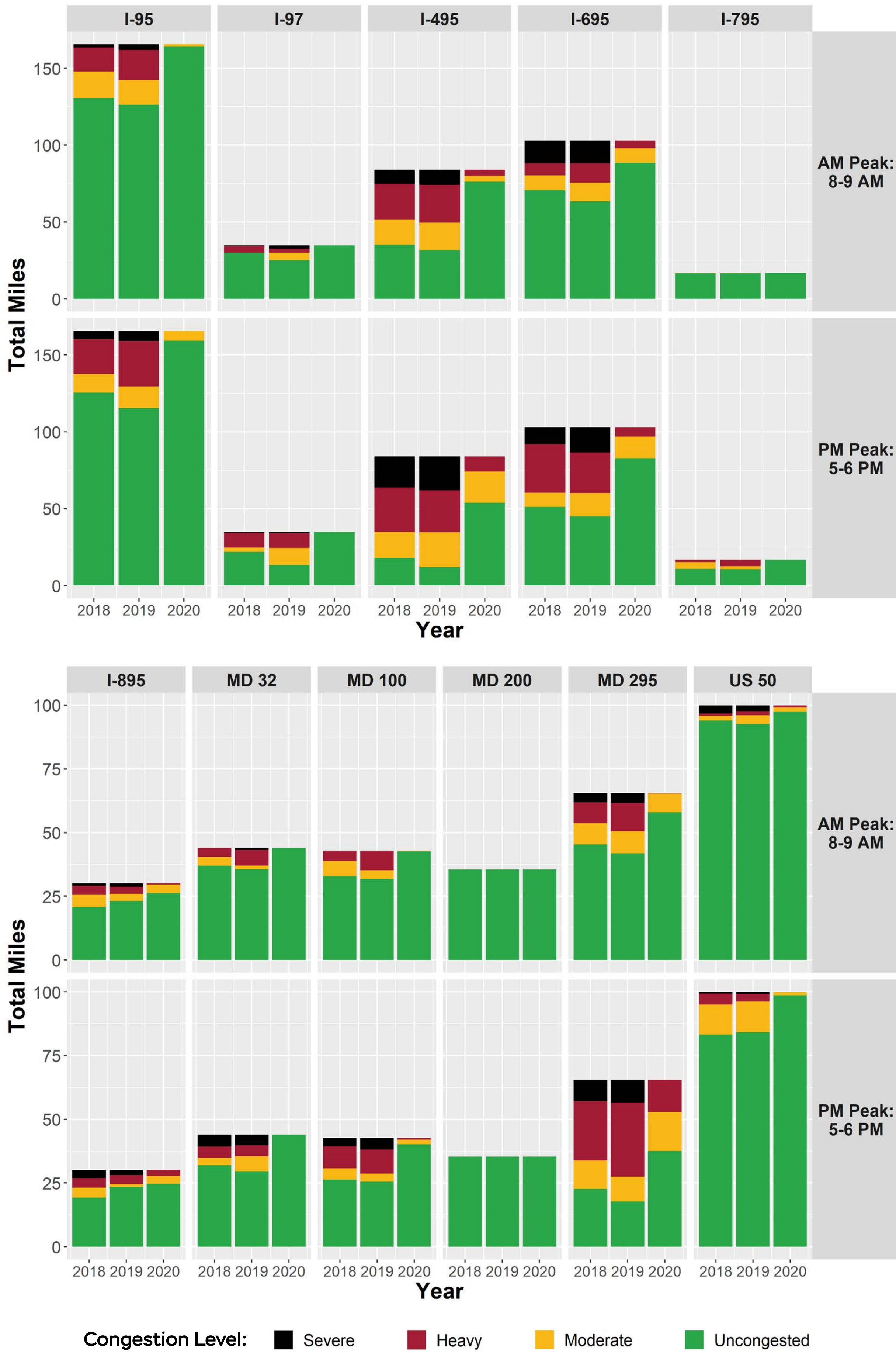


Figure 25 *(Continued)*

FREEWAY CONGESTION SUMMARY



Thirty-five major arterial corridors were selected based on observed traffic operations, traffic volumes, regional significance, and availability of data to analyze in further detail. Traffic analysis was performed to evaluate the changes that took place in these corridors between 2018, 2019 and 2020 based on TTI values. Each corridor showed a significant reduction in the most severe levels of congestion in 2020 **(Figure 26)**.

The overall operation of all freeways/expressways and arterials are depicted in the Peak Hour Statewide Congestion Maps **(Figures 14-15)**. The Maryland Mobility Report Supplement Chapter A provides additional in-depth information about the mobility performance of these corridors including the greatest improvement/reduction in operation over the past year and a detailed analysis of the number of miles operating at each level of congestion.

Figure 26

ARTERIAL CONGESTION SUMMARY

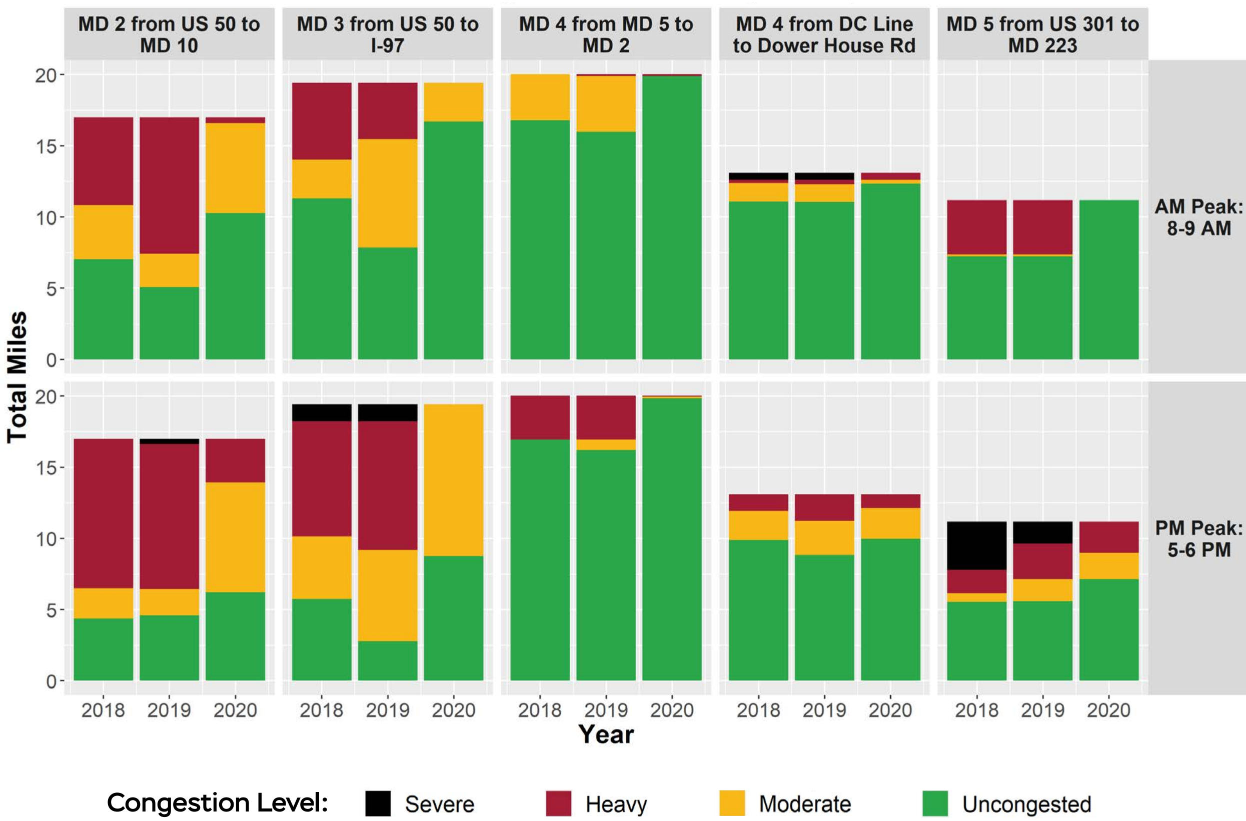
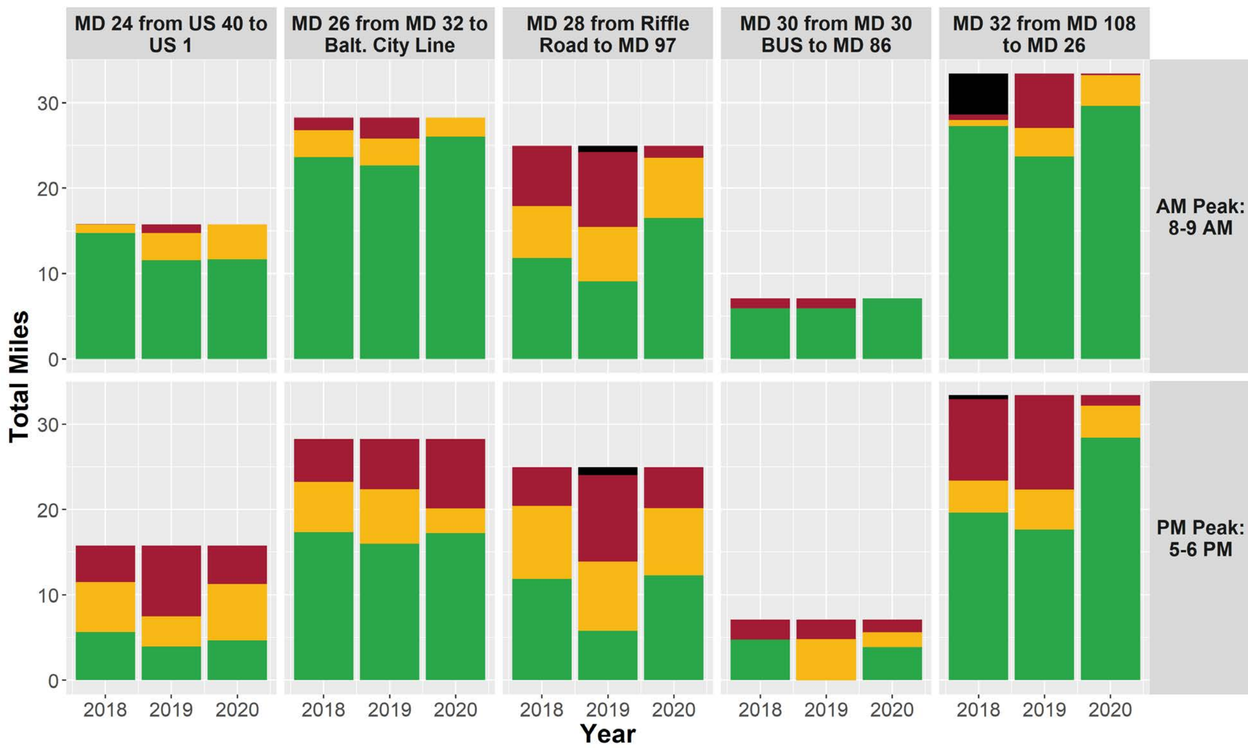
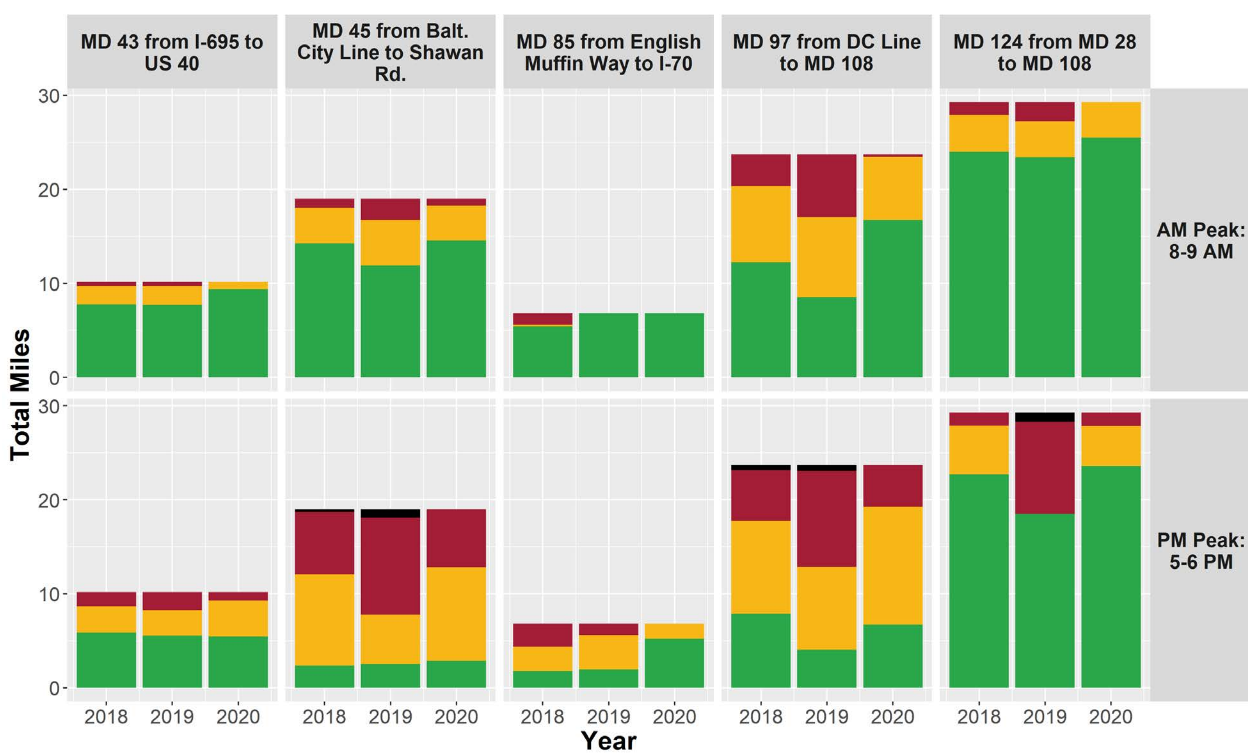


Figure 26 *(Continued)*
ARTERIAL CONGESTION SUMMARY

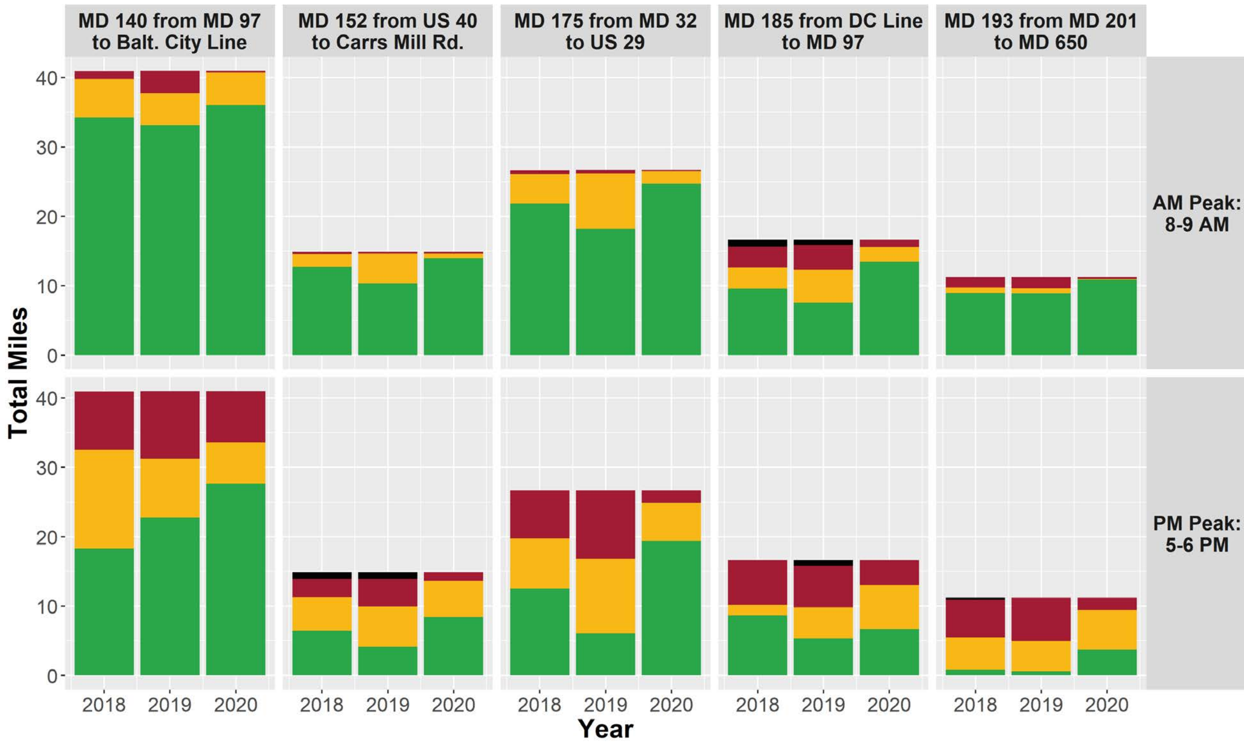


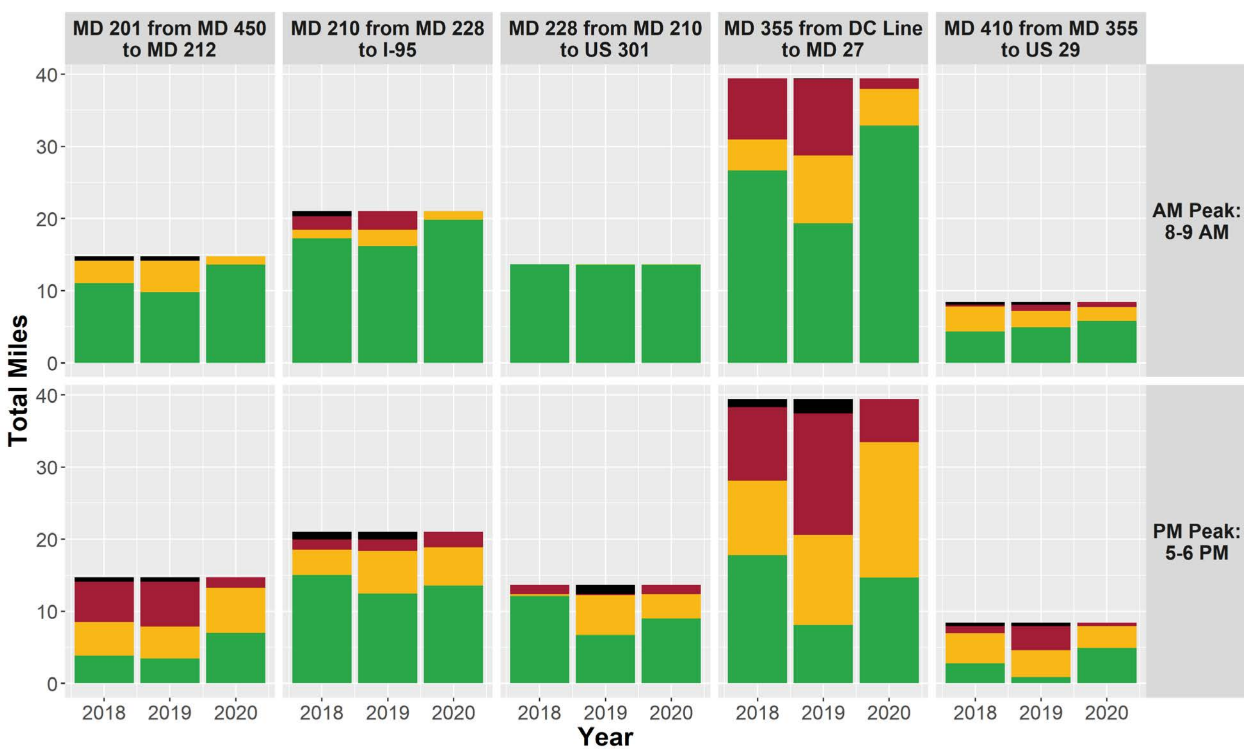


Congestion Level: Severe Heavy Moderate Uncongested

Figure 26 *(Continued)*

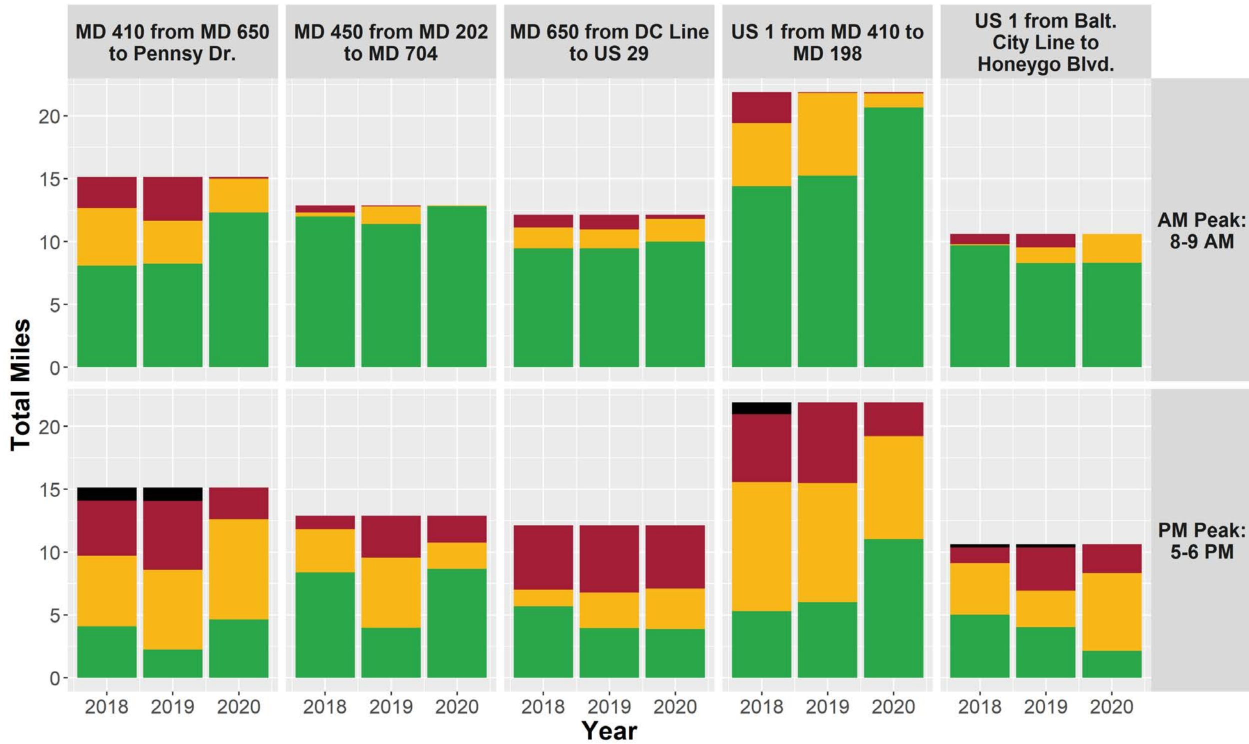
ARTERIAL CONGESTION SUMMARY

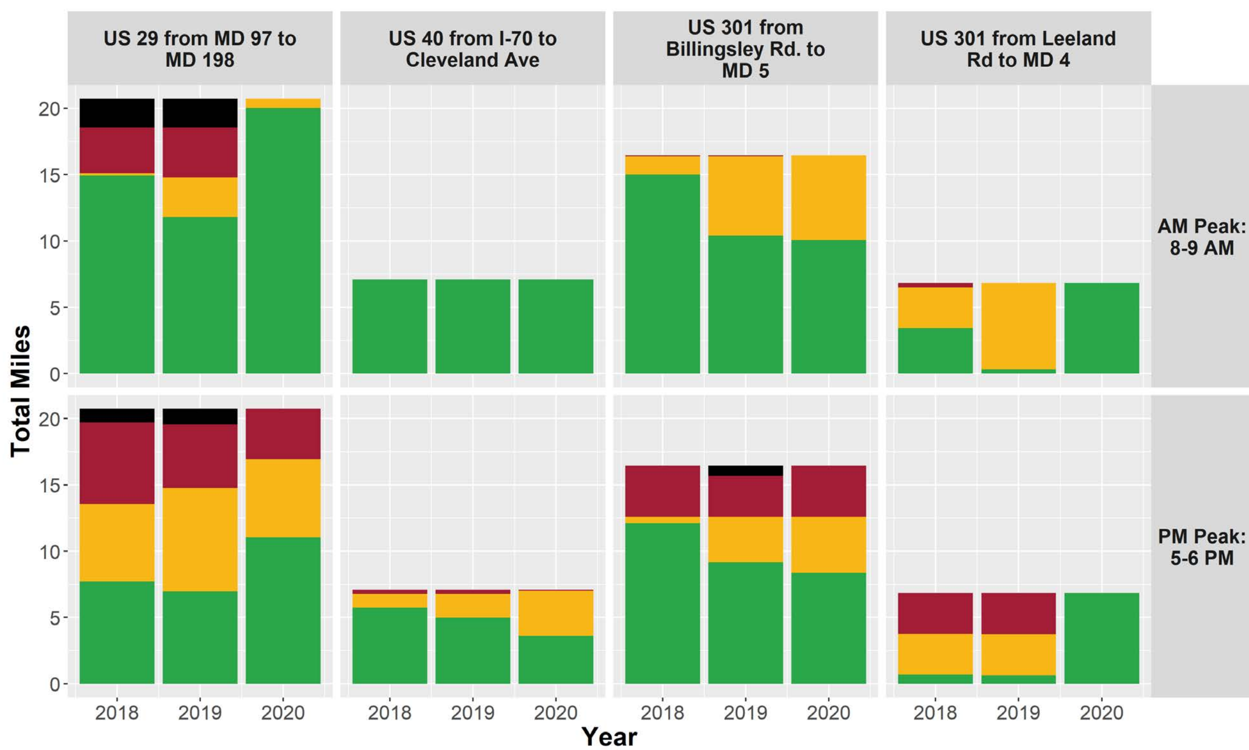




Congestion Level: Severe Heavy Moderate Uncongested

Figure 26 *(Continued)*
ARTERIAL CONGESTION SUMMARY





Congestion Level: Severe Heavy Moderate Uncongested

MD 26 @ Lord Baltimore Dr

INTERSECTIONS

Intersections and roadways segments are analyzed to determine traffic operations. The operations are graded from level of service (LOS) 'A' to 'F', with 'A' being the best and 'F' being the worst **(Table 20)**. For purposes of this report, the intersection analysis is conducted via the critical lane analysis technique. The critical lane analysis technique evaluates the volumes of the highest conflicting movements and number of lanes.

Table 20

INTERSECTION LEVEL OF SERVICE DEFINITION	
LEVEL OF SERVICE	DESCRIPTION
A	Minimal delays
B	Low level of delay and queuing
C	Delays and queues are constant
D	Moderate delays and queues but motorist clear in one green indication
E	Long queues and delays with some motorist having to wait more than one green indication
F	Most motorists having to wait more than one green indication

At the worst performing intersections where LOS 'F' conditions exist, a further measure is developed to determine a more in-depth appraisal of operations. This is the volume/capacity ratio which represents the critical lane volume divided by the theoretical capacity of the intersection which is considered to be 1,600.

Thirty-six (36) intersections **counted in the past three years** operated in the AM peak hour or PM peak hour at LOS F **(Tables 21 and 22)**. Six of these locations failed in both the AM and PM peak hours (yellow highlighted locations). In addition, during the summer weekend US 50 at MD 404 and US 50 at MD 213 failed.

Table 21

LOS "F" INTERSECTIONS AM PEAK HOUR COUNTED IN LAST 3 YEARS		
INTERSECTION	COUNTY	VOLUME/CAPACITY (SORTED HIGHEST TO LOWEST)
MD 4 at MD 337/Presidential Parkway	Prince George's	1.37
MD 26 at Lord Baltimore Dr/ I-695 Outer Loop Off Ramp	Baltimore	1.31
US 29 at Rivers Edge Rd	Howard	1.20
MD 5 @ Surratts Rd	Prince George's	1.18
MD 210 at Livingston Rd/Kerby Hill Rd	Prince George's	1.13
MD 2 at Tarragon Ln	Anne Arundel	1.11
MD 4 at Chaneyville Rd	Calvert	1.05
MD 108 at Old Baltimore Rd	Montgomery	1.04
MD 410 at MD 212	Prince George's	1.04
MD 210 at Wilson Bridge Dr	Prince George's	1.03
MD 4 at Dower House Rd	Prince George's	1.03
MD 124 at Warfield Rd	Montgomery	1.02
MD 450 at 48th Street	Prince George's	1.02
MD 355 at MD 911/Wootten Pkwy	Montgomery	1.01
MD 193 at E. Franklin Ave/Franklin Ave	Montgomery	1.00

Table 22

LOS "F" INTERSECTIONS PM PEAK HOUR COUNTED IN LAST 3 YEARS		
INTERSECTION	COUNTY	VOLUME/CAPACITY (SORTED HIGHEST TO LOWEST)
MD 500 at MD 410/Adelphi Rd	Prince George's	1.27
US 301 at Cedarville Rd/McKendree Rd	Prince George's	1.19
MD 4 at FDR Blvd	St Mary's	1.17
MD 500 at Eastern Ave	Prince George's	1.14
MD 410 at MD 212	Prince George's	1.14
MD 41 at Putty Hill Ave	Baltimore	1.11
MD 5 at MD 637 (Naylor Rd)	Prince George's	1.10
MD 119 at I-370/Sam Eig Hwy	Montgomery	1.09
US 1 at US 1AL/Hamilton St	Prince George's	1.08
MD 4 at MD 337/Presidential Pkwy	Prince George's	1.08
US 15 SB Ramps at Rosemont Ave/Schley Ave	Frederick	1.07
MD 210 at Livingston Rd/Kerby Hill Rd	Prince George's	1.07
MD 414 at Ramp from I-95 WB	Prince George's	1.07
MD 355 at Jones Bridge Rd/Center Dr	Montgomery	1.06
MD 2 at MD 4 (Sunderland)	Calvert	1.04
MD 637 at Suitland Pkwy	Prince George's	1.04
MD 4 at Patuxent Blvd	St. Mary's	1.04
MD 3 at Crawford Blvd/Cronson Blvd	Anne Arundel	1.03
MD 210 at Ft Washington Rd	Prince George's	1.03
MD 26 at Lord Baltimore Dr/I-695 Outer Loop Off Ramp	Baltimore	1.02
MD 2 at Tarragon Ln	Anne Arundel	1.02
MD 214 at Ritchie Rd/Garrett A. Morgan Blvd	Prince George's	1.02
MD 5 at MD 458/Iverson St	Prince George's	1.02
US 301 at Chadds Ford Dr/Timothy Branch Dr	Prince George's	1.01
MD 5 at MD 471/Flat Iron Rd	St. Mary's	1.01
MD 4 at Dower House Rd	Prince George's	1.01
MD 26 at Croyden Rd	Baltimore	1.00

RELIABILITY TRENDS

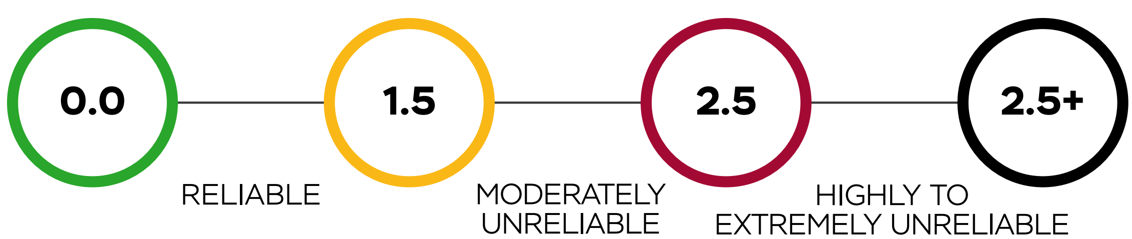
Travel time varies due to many factors. For example, a trip on the same day of the week at the same time on a congested roadway will vary in the amount of time it will take to complete the trip. This variability in travel times from day to day shows the unreliability of the system and often frustrates motorists and transit riders. This unreliability is caused by events such as incidents, special events, vehicular breakdowns, crashes, weather, or lane reductions through work zones and can impact automobiles, trucks and on-street transit services. For all travelers there is a cost associated with the additional travel time due to the unreliability of the network. These motorists must add a buffer to reach their destination on time which takes away from time where they could be accomplishing other tasks. An unreliable system causes an undesirable customer experience for motorists, truck drivers and transit riders.

MDOT SHA understands the significance of providing a reliable transportation system by delivering programs and projects to improve system reliability. By improving reliability, travelers can better plan their trips and daily schedules. The importance of the reliability and the cost associated with it varies by purpose, nature and the importance to that particular motorist. For example, to catch a flight, to have a freight delivery occur on time, or just to be able to attend a child's event may have variable cost implications to that particular person or business.

The MDOT SHA evaluates trip reliability through the use of the Planning Time Index (PTI). Various states utilize different ranges for the PTI analysis with values being between the 80th percentile and the 95th percentile. In Maryland, the 95th percentile travel time is used for a section of roadway and is generalized as the travel time it would take if a major incident or event occurs. For example, a PTI of 2.0 means that if it takes 10 minutes to traverse a roadway segment in free flow conditions, a motorist should allow 20 minutes for travel to ensure a 95% chance of on time arrival. The lower the value the more reliable the trip, while conversely, the higher the value, the longer a trip could take. There are three levels of reliability and their range of values are depicted as follows **(Figure 27)**.

Figure 27

METRIC: MEASUREMENT OF RELIABILITY (PLANNING TIME INDEX)



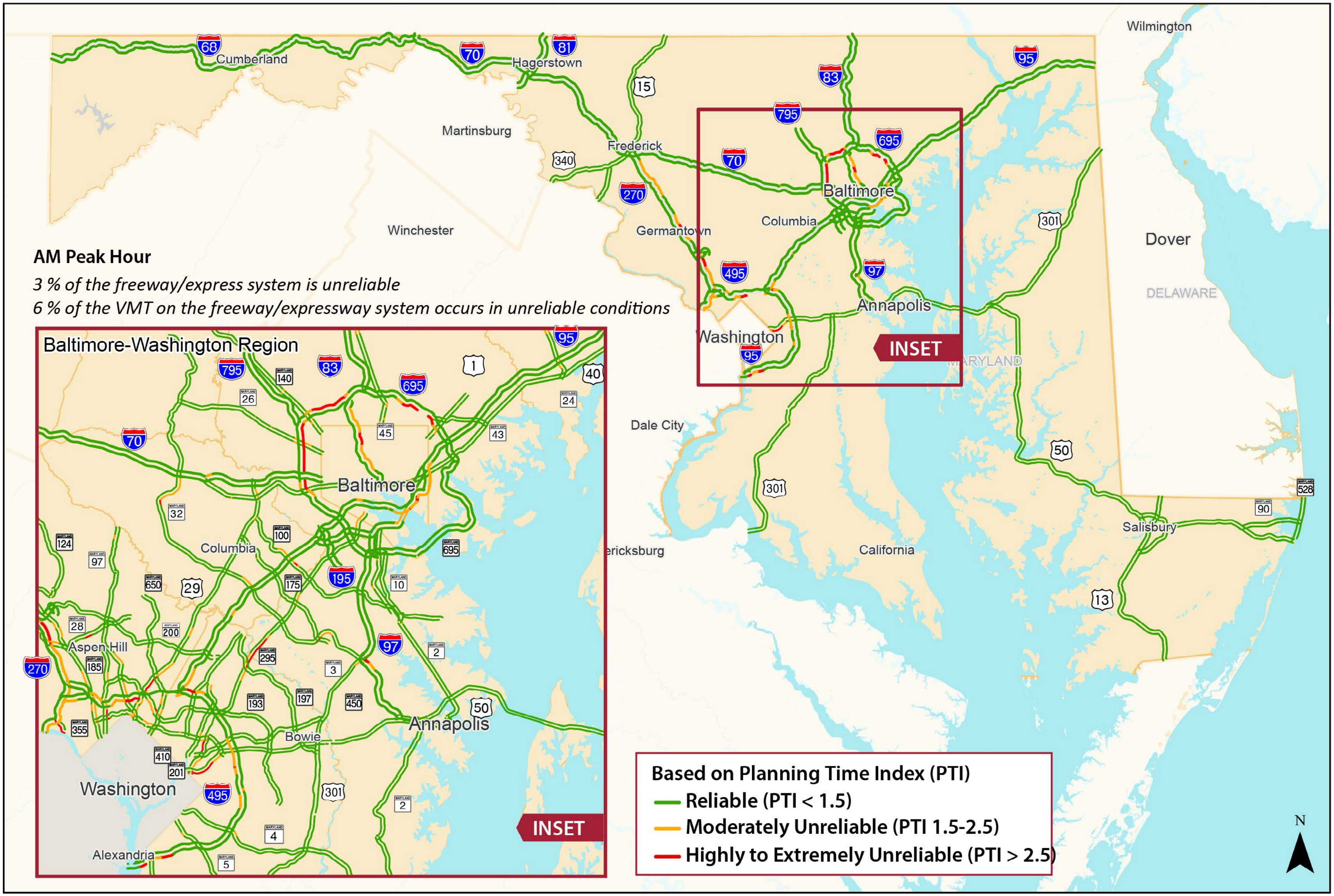
RELIABILITY MEASURES ON THE MARYLAND FREEWAY/ EXPRESSWAY SYSTEM

The average weekday AM peak hour (8-9 AM) and the PM peak hour (5-6 PM) are used as a basis for a yearly comparison on Maryland's freeway/expressway system for three measures associated with reliability. These three measures are (1) the number of freeway/expressway miles that are highly to extremely unreliable, (2) the percent of the total freeway/expressway system that is highly to extremely unreliable, and (3) the percent of the peak hour VMT that is impacted which compares the traffic volumes to the portion of the system that is operating at highly to extremely unreliable conditions. The AM and PM peak hours were evaluated on a statewide basis for reliability as follows:

- AM Peak Hour - Figure 28
- PM Peak Hour - Figure 29

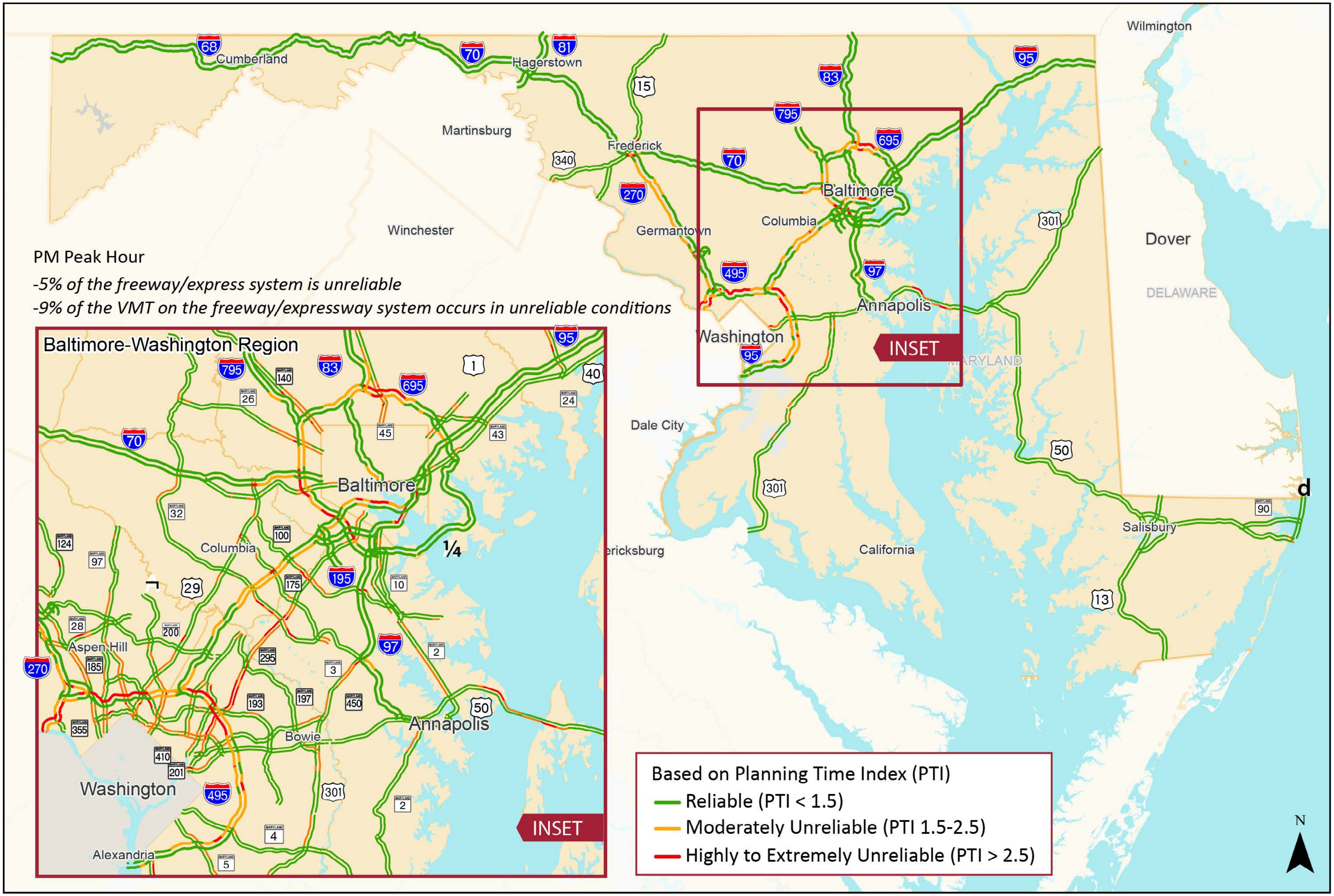
Maryland Reliability Map: 2020 AM Peak Hour (8-9) AM

Figure 28



Maryland Reliability Map: 2020 PM Peak Hour (5-6) PM

Figure 29



Highly to extremely unreliable conditions for motorists on Maryland's freeway/expressway system showed a substantial decrease in the number of roadway miles and percent of peak hour VMT impacted that experience the worst conditions in both the AM and PM peak hours **(Table 23)**.

Table 23

STATEWIDE FREEWAY/ EXPRESSWAY SYSTEM AVERAGE WEEKDAY AM & PM PEAK HOUR RELIABILITY SUMMARY								
HIGHLY TO EXTREMELY UNRELIABLE CONDITIONS	2018		2019		2020		CHANGE FROM 2019 TO 2020	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Number of Roadway Miles	107	200	109	213	46	77	-63	-136
Percent of Roadway Miles	7	12	7	13	3	5	-4	-8
Percent of Peak Hour VMT Impacted	13	22	14	24	6	9	-8	-15

Normally, there is a strong correlation between sections of roadway that experience severe congestion and are highly unreliable. Conversely, some sections of roadway operate acceptably on average days but sometimes experience severe congestion. These locations are often influenced by the congestion that is occurring downstream of these sections or experience issues due to strong peaking characteristics such as related to summer traffic.

An evaluation was performed comparing reliability (PTI) values with congestion (TTI) values. The sections that have the largest difference (PTI value-TTI value) in the AM peak hour were:

- I-895 Southbound from Eastern Ave to O'Donnell St
- MD 295 Southbound from I-95/I-495 to MD 410
- I-695 Outer Loop South of I-70
- I-495 Outer Loop near MD 650
- I-270 Local Southbound near MD 28

For the PM peak hour, the sections that showed the largest difference between the PTI value for reliability and the TTI value for congestion were:

- I-895 Southbound from Eastern Ave to O'Donnell St
- I-495 Inner Loop from MD 355 to MD 185
- I-695 Inner Loop near US 1
- MD 295 Southbound near MD 32
- I-495 Inner Loop near MD 187

TRUCK DATA AND TRENDS

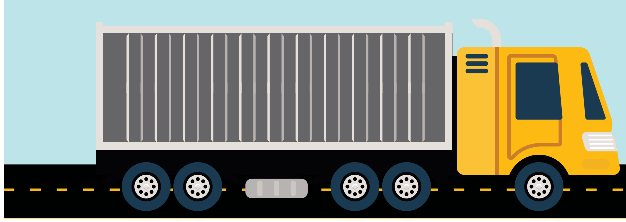
The movement of freight in all forms must travel through Maryland effectively to support our economy. Freight requires a well-connected and maintained network of highways, intermodal connections to ports, airports and rail terminals, and accessibility to industries via first and last mile routes. Maryland's freight infrastructure is nationally significant in that I-95, I-81, I-70, and I-68 are critical freight corridors supporting national freight flows. Trucks are critical, as they carry the bulk of freight and are necessary for the first and last mile connections. In terms of tonnage, trucks haul over 70% of the freight, mostly across MDOT SHA roads. The total freight value moved by trucks was estimated at $304 billion in Maryland. To evaluate truck freight movement, MDOT performs traffic data collection on a three year cycle to identify the number of trucks that use a particular roadway. Among all of the major interstate routes in Maryland, I-95 contains the highest volume of trucks in a particular section **(Table 24)**. The five roadways with the highest percentage of trucks in relation to their total traffic, all have greater than 30% trucks **(Table 25)**.

Table 24

HIGHEST TRUCK VOLUME		
	LOCATION	AVERAGE DAILY TRUCK VOLUME
1	I-95 North of I-695	29,300
2	I-95/I-495 North of US 50	23,200
3	I-81 North of I-70	20,600
4	I-695 West of Greenspring Ave	18,200
5	I-495 East of MD 185	16,200

Table 25

HIGHEST TRUCK PERCENTAGE LOCATIONS		
	LOCATION	TRUCK %
1	MD 159 – South of US 40	36%
2	I-81 – South of Pennsylvania State Line	36%
3	I-81 South of US 11	32%
4	US 522 N of I-70	31%
5	MD 313 – South of US 301	30%



There are over 15,000 tractor trailers that use I-81 and I-95 daily on certain sections.

OVERNIGHT TRUCK PARKING

Truck parking is essential for allowing drivers to receive proper rest and to maintain safety compliance. This has become one of the most critical freight problems in the U.S. Trucks parked in non-designated locations such as ramps and roadway shoulders present major safety and mobility challenges for drivers and other motorists. Maryland currently has a total of approximately 600 publicly supplied spaces and over 2,300 private parking spaces. In 2018, there were three million tractor trailers nationwide, that drove about 4 million miles per day in Maryland, with all commercial drivers subject to rest requirements. The approximate 2,900 parking spaces cannot support the demand. In 2012, Moving Ahead for Progress in the 21st Century Act (MAP-21) required the U.S. Department of Transportation to address three issues related to parking:

- Survey states' capabilities to provide adequate truck parking
- Assess commercial vehicle traffic volumes in each state
- Develop a system of metrics to assess truck parking (MAP-21, 2012)

In a 2015 report, the Federal Highway Administration (FHWA) found that truck parking is a problem every day in every state and at all times of the day, month, and year. This work helped establish the National Coalition for Truck Parking: a group of public and private stakeholders formed to generate truck parking ideas and solutions. It also helped pave the way for the Fixing America's Surface Transportation (FAST) Act in 2015, which included a freight formula fund and made truck parking an eligible use of those funds by state departments of transportation.

In 2020, MDOT released an annual statewide Truck Parking Study, which found clusters of need throughout the state and low parking availability using a combination of INRIX and Trucker Path data. The study identified the top locations where clusters of truck parking exceeded capacity. The top five spots were located in areas where truck parking existed but not enough spaces were available **(Table 26)**.

Table 26

HIGH DEMAND TRUCK PARKING LOCATIONS		
RANK	LOCATION	COUNTY
1	I-95 Welcome Center	Howard
2	I-70 South Mountain Welcome Center	Frederick
3	I-95/I-495 Weigh Station	Prince George's
4	US 1/MD 175	Howard
5	I-95 Maryland House Travel Plaza	Harford

MDOT SHA is currently using INRIX Trips data to assess and understand parking behaviors to identify capital and operational investments that can help increase parking or spread awareness of parking availability. One of the ways to address truck parking is by adding spaces at existing locations and identifying ways to spread awareness about parking availability to drivers. MDOT is considering some TSMO approaches and relationships with existing In-cab information providers to push parking information out to drivers, along with valuable freight traveler information. MDOT SHA is also considering ways to develop more sophisticated traveler and truck parking information systems.

Maryland House Rest Stop

TRUCK CONGESTION

Truck volumes along Maryland roads did not see the same drop-offs in comparison to automobile traffic. Weekly truck volumes were reduced by up to 20% in the peak of the COVID-19 pandemic. By the last four months of 2020, weekly trucks volumes were increasing on average over 6% per week at ATR stations.

In 2020, COVID-19 conditions significantly reduced delay per mile for trucks in Maryland. For most of 2019, averaged delays ranged from 1,000 to 1,200 truck hours per mile. Delays were cut in half with averages dropping to 500 to 600 truck hours in the last three quarters of 2020 **(Figure 28)**.

Figure 28

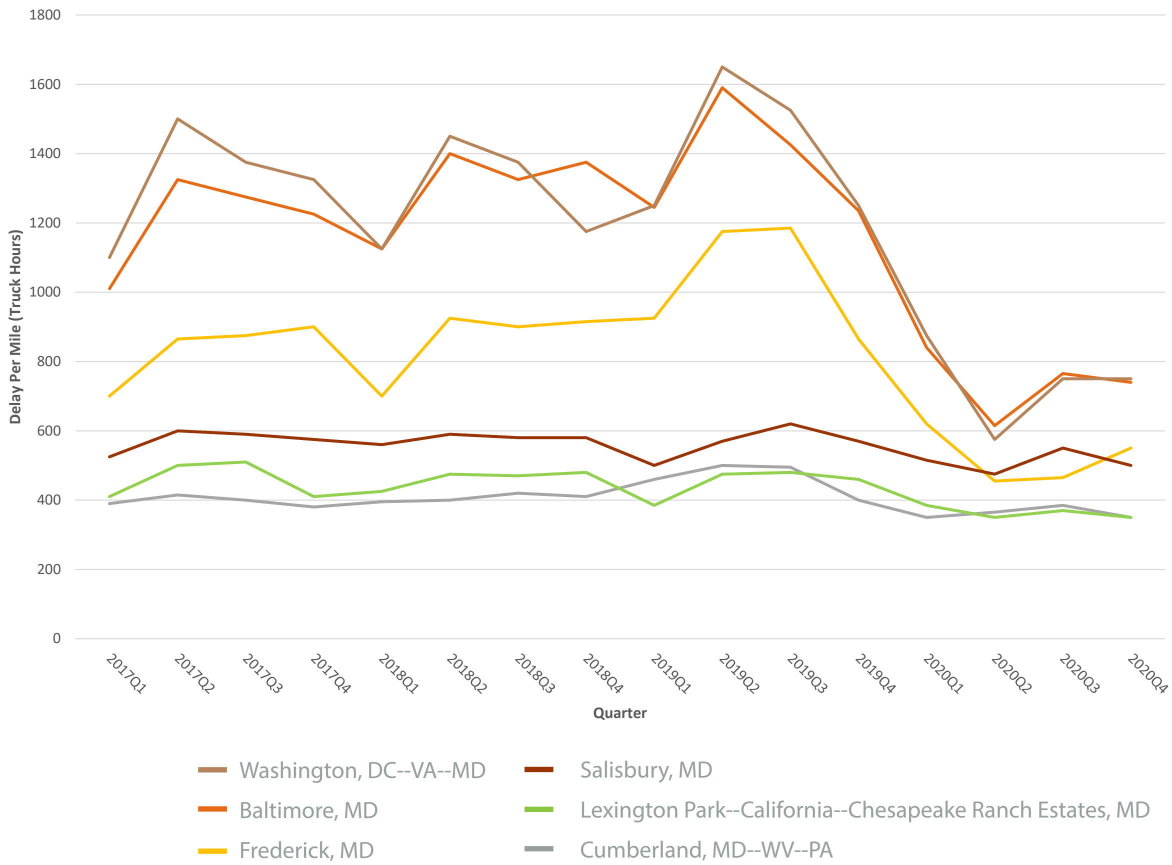
MARYLAND TRUCK DELAY PER MILE (TRUCK HOURS)

Source: FHWA, 2020

Throughout Maryland the delay for trucks per mile varied but all areas showed a decrease in congestion from 2019. The Baltimore and Washington regions experienced the greatest decreases ranging from 1,300 to over 1,600 in 2019 to 600 to 775 for the delay per mile in the number of truck hours in the last three quarters of 2020. Areas such as Salisbury and Hagerstown are back to levels at the end of 2020 that were similar to 2019 levels **(Figure 29)**.

Figure 29

DELAY PER MILE (TRUCK HOURS)



WORST BOTTLENECKS

The roadways with the worst congestion for freight operations are being identified through a new tool that is being tested. The Maryland Roadway Performance Tool (MRPT) will identify top bottlenecks based on delay per mile, which is weighted by traffic volume and normalized by roadway length (in miles). The MRPT tool uses INRIX data conflated to the Maryland's Highway Performance Monitoring System (HPMS) GIS network so performance analytics can be conducted in house.

In addition, the MDOT SHA also identifies bottlenecks using speed-based methodology. The University of Maryland CATT Lab Vehicle Probe Project (VPP) Suite analyzes speed data to identify Maryland freight bottlenecks. Bottlenecks are identified by analyzing each roadway segment to determine when and where the speed drops below 60% of the free flow speed for more than 5 minutes. From that an algorithm is used to determine and rank the bottleneck locations weighted by speed, congestion and total delay. The top five locations in Maryland which trucks use include:

1. US 50 WB at Bay Bridge
2. I-895 NB at Harbor Tunnel
3. I-270 SB @ MD 109
4. I-270 NB at MD 85
5. US 50 EB at Bay Bridge

MARYLAND FREIGHT CONGESTION COSTS

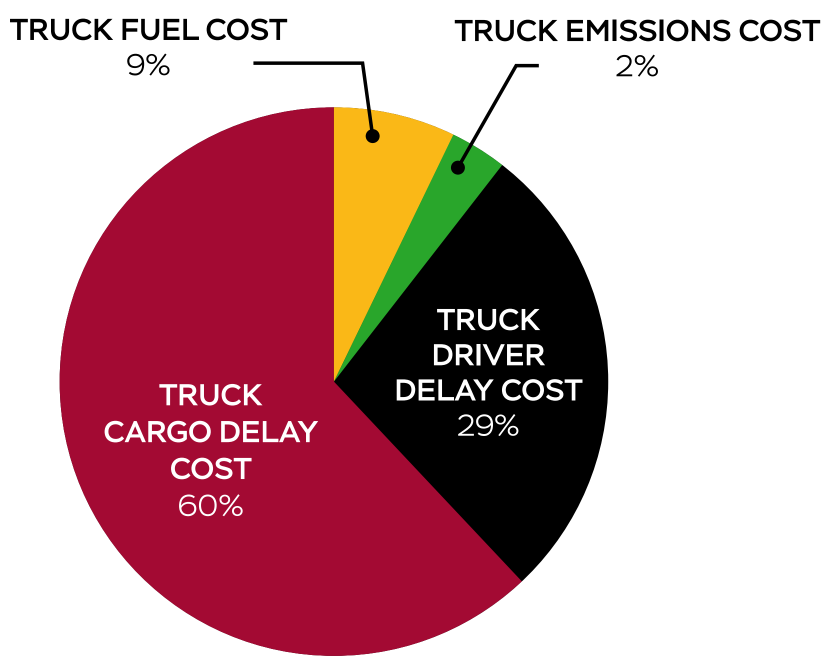
Freight operators experience congestion costs due to truck driver delay, truck cargo delay, additional fuel cost, and emissions cost along the freeway/expressway system. These costs are calculated at the roadway segment level and take into account the price of diesel fuel, value of commercial vehicle time and delay experienced between congested and uncongested conditions for all freeways/expressways in Maryland **(Table 27 and Figure 30)**.

Table 27

2020 FREIGHT CONGESTION COSTS ON MARYLAND'S FREEWAY/EXPRESSWAY SYSTEM	
CONGESTION ELEMENT	COST IN MILLIONS
Truck Cargo Delay	$27
Truck Driver Delay	$13
Truck Fuel	$4
Truck Emissions	$1
TOTAL	$45

Figure 30

2020 FREIGHT CONGESTION COSTS ON MARYLAND'S FREEWAY/EXPRESSWAY SYSTEM
$45 million



Congestion costs for trucks decreased by over 80% from $251 million in 2019.

TRUCK TRAVEL TIME RELIABILITY INDEX

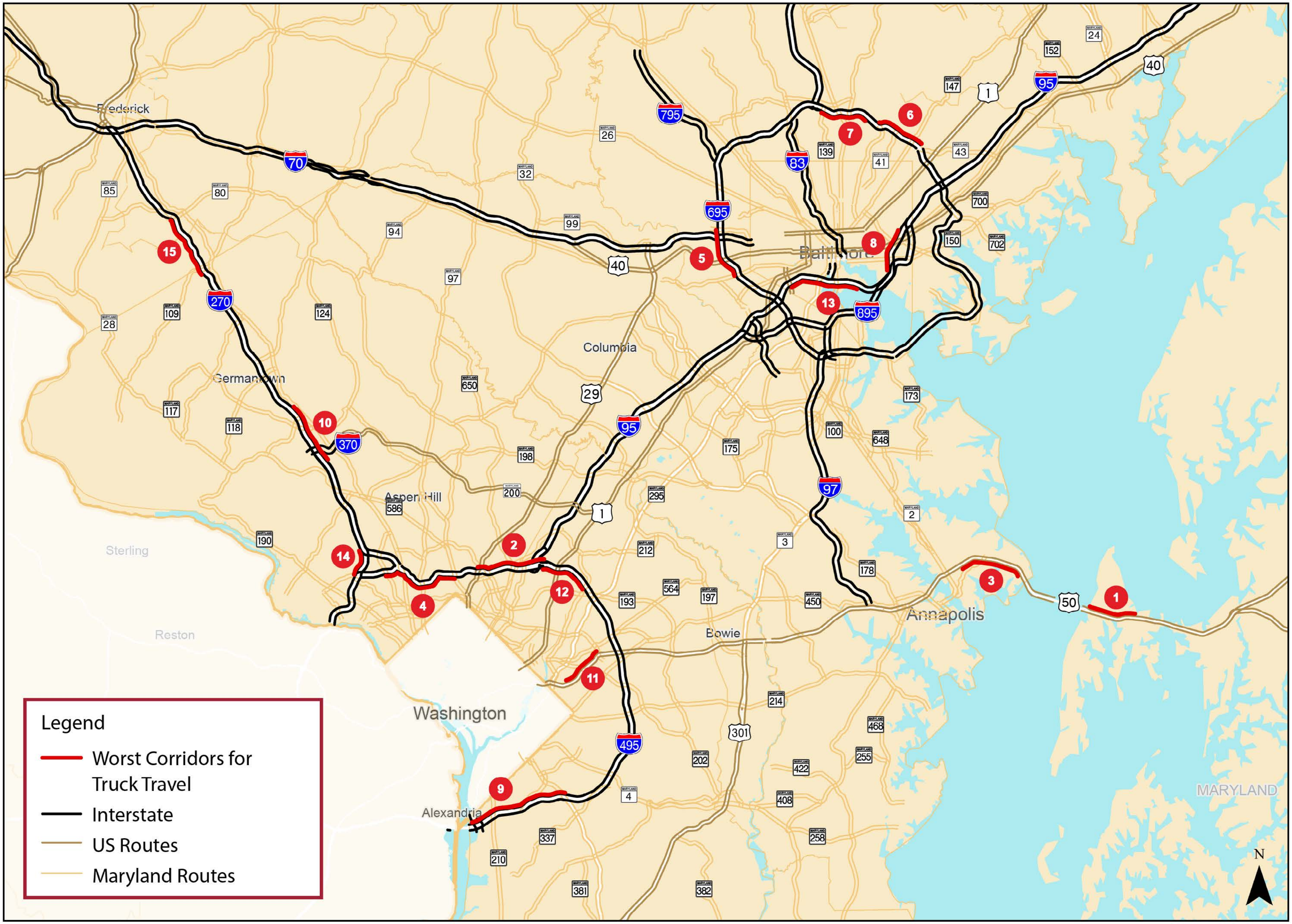
MAP-21 requires states to calculate a truck travel time reliability metric. Although various metrics exist, FHWA requested that each state report a standard level of freight performance. The Truck Travel Time Reliability (TTTR) Index represents the 95th percentile travel time divided by the 50th percentile travel time for each segment. The TTTR is calculated for five time periods; the maximum value determines the final system performance. Each individual TTTR value is combined in three to eight mile segments or complete sections of freeways to develop the limits of the most unreliable corridors on the interstate for trucks **(Table 28 and Figure 31)**. The higher the TTTR value, the worse the operations are in that segment.

Table 28

2020 TOP 15 WORST CORRIDORS FOR TRUCK TRAVEL					
RANK	ROUTE/DIRECTION	LIMITS	COUNTY	MILEAGE	TTTR MAX VALUE
1	US 50/US 301 Westbound	Chester Station Lane to Chesapeake Bay Bridge	Queen Anne's	3.2	6.2
2	I-495 Outer Loop	I-95 to US 29	Prince George's/ Montgomery	3.2	5.2
3	US 50 Eastbound	Bay Dale Drive to Oceanic Drive	Anne Arundel	3.8	4.6
4	I-495 Inner Loop	MD 187 to MD 97	Montgomery	4.5	4.4
5	I-695 Outer Loop	MD 122 to MD 144	Baltimore	3.1	3.9
6	I-695 Outer Loop	MD 43 to Cromwell Bridge Rd	Baltimore	3.1	3.8
7	I-695 Inner Loop	MD 139 to Providence Road	Baltimore	3.3	3.8
8	I-95/ I-495 Inner Loop	MD 5 to Woodrow Wilson Bridge	Prince George's	5.6	3.5
9	I-895 Southbound	I-95 to Ponca Street	Baltimore City	3.2	3.4
10	I-270 Northbound	Shady Grove Road to Watkins Mill Road	Montgomery	3.7	3.2
11	US 50 Westbound	MD 410 to Columbia Park Road	Prince George's	3.1	3.2
12	I-95/I-495 Inner Loop	I-95 to MD 201	Prince George's	3.2	3.0
13	I-95 Northbound	US 1 Alt to Ft McHenry Tunnel	Baltimore City	3.2	2.8
14	I-270 West Spur Southbound	I-270 Split to I-495	Montgomery	1.7	2.8
15	I-270 Southbound	MD 80 to MD 109	Montgomery	3.8	2.8

Maryland's Worst Corridors for Truck Travel: 2020

Figure 31



MDOT SHA MOBILITY PROJECTS

I-270 @ Watkins Mill Rd

CAPITAL PROJECTS

The capital projects program is one of the most recognizable and effective ways MDOT SHA addresses congestion and reliability issues. These projects provide increased capacity and safety improvements throughout the state using a performance-based approach. Project types range from capacity improvements such as constructing interchanges, providing turn lanes at intersections, and implementing roundabouts to improve safety. They also often include pedestrian and bicycle network enhancements. The improvement projects completed in the 2020 calendar year provide congestion relief, improve safety, and enhance multi-modal traffic operations.

These completed capital projects deliver essential benefits to the traveling public; they decrease congestion and reduce fuel usage and increase safety benefits. Furthermore, we can use these benefits as data to estimate and summarize an overall benefit for each capital project **(Table 29)**.

Table 29

CAPITAL IMPROVEMENT PROJECTS OPENING YEAR BENEFITS[1]					
ROUTE	LIMITS	COUNTY	CONGESTION & FUEL SAVINGS	SAFETY SAVINGS	ANNUAL COST SAVINGS
			$ (Thousands)		
MD 2/4	Fox Run Boulevard to Commerce Lane	Calvert	5,851	509	6,360
MD 32	Main Street to Macbeth Way	Carroll	35	335	370
MD 180	Swallowtail Drive to US 15/340 Ramps	Frederick	1,633	1,023	2,656
MD 22	Prospect Mill Road to MD 136	Harford	1,936	1,506	3,442
I-270	Watkins Mill Road	Montgomery	26,677	1,016	27,693
MD 97	Randolph Road	Montgomery	16,027	406	16,433
I-81	Potomac River Bridge to MD 63[2]	Washington	1,700	712	2,412
US 113	MD 365 to North of Five Mile Branch	Worcester	295	109	404
US 50	MD 589	Worcester	752	189	941
MD 346	US 113; Healthway Drive	Worcester	52	154	206
Total			54,958	5,959	60, 917

1 - For more details see Mobility Report Supplement. Benefits based on pre-COVID-19 traffic.

2 - Project extends south into West Virginia. Project benefits only shown for Maryland.

The improvement projects completed in 2020 provide more than $60 million in user cost savings in the opening year or over $6 million per project on average.

PEDESTRIAN PROJECTS

Pedestrians are some of the most vulnerable users of a roadway facility, with fatalities on Maryland roadways exceeding 135 persons in 2020. To address this safety issue, MDOT SHA has prioritized improving pedestrian facilities through projects funded by various sources and which mostly focus on improving safety for pedestrians to walk in their communities. These improvements are often part of a dedicated pedestrian project, or as part of a comprehensive roadway improvement project. They often include improvements related to upgrading sidewalks in poor condition, filling in sidewalk gaps, adding off-road trails, implementing signals (countdown, HAWK) enhancing crosswalks and upgrading ADA-compliant facility upgrades such as ramps and audible pedestrian signals. In fact, in 2020 new sidewalks were constructed in 21 counties **(Table 30)**.

Table 30

NEW SIDEWALK LOCATIONS 2020		
ROUTE	LIMITS	COUNTY
MD 175	at Reece Rd	Anne Arundel
MD 177	at Long Hill Rd	Anne Arundel
MD 177	at Jumpers Hole Rd	Anne Arundel
MD 140	at Painters Mill Rd	Baltimore
MD 151	at Wise Ave	Baltimore
US 1	I-695 to Still Meadow Rd	Baltimore
MD 2	at Solomons Island Rd	Calvert
MD 2-4	at Access Rd	Calvert
MD 2-4	at Armory Rd	Calvert
MD 2-4	at Main St	Calvert
MD 2-4	Fox Run Rd to Commerce Ln	Calvert
MD 765	at Central Square Dr	Calvert
MD 26	at Eldersburg McDonald’s	Carroll
MD 30 BUS	North Wood Trail to CSX Railroad	Carroll
MD 315	Bloomingdale Ave (Federalsburg)	Caroline
MD 480	at Greensboro Elementary School	Caroline
MD 272	North of Rogers Rd to US 40	Cecil
MD 213	at Dollar General	Cecil
US 40	Delaware Ave to Melbourne Blvd	Cecil
MD 254	at Bridge over Neale Sound	Charles
US 301	at Smallwood Dr	Charles
US 301	at Waldorf St Charles Medical Center	Charles
MD 17	at MD 180	Frederick
MD 80	at Landon House Way	Frederick
MD 85	at Sheetz Convenience Store	Frederick
MD 140	over Flat Run	Frederick
MD 180	at Broad Run Rd	Frederick
MD 180	Swallowtail Dr to US 15 Ramps	Frederick

Table 30 - continued

ROUTE	LIMITS	COUNTY
MD 355	N of Stone Barn Dr	Frederick
MD 478	at Potomac Branch	Frederick
Monocacy Blvd	at Monocacy River	Frederick
Rosemont Ave	at W. 2nd St	Frederick
MD 22	Prospect Mill Rd to MD 136	Harford
US 40	at Oak Ave	Harford
US 219	3rd St (Oakland)	Garrett
MD 32	at Broken Land Pkwy Park & Ride	Howard
MD 108	at River Hill Square	Howard
MD 103	at Locust Thicket Way	Howard
MD 219	at MD 313	Kent
MD 28	Norbeck Rd to East Norbeck Park	Montgomery
MD 108	at Norwood Rd	Montgomery
MD 108	at Victory Haven Senior Apartments	Montgomery
MD 115	at Needwood Rd	Montgomery
MD 124	at Quince Orchard Blvd	Montgomery
MD 187	at I-495	Montgomery
MD 355	Stringtown Rd to Brink Rd	Montgomery
US 29	at Fairland Rd	Montgomery
Watkins Mill Rd	over I-270	Montgomery
MD 5	Park & Ride at Spine Rd	Prince George’s
MD 201	at Tilden Rd	Prince George’s
MD 373	W of MD 5	Prince George’s
MD 450	MD 704 to MD 193	Prince George’s
US 1	at Laurel Race Track North Entrance Rd	Prince George’s
Brandywine Rd	at MD 5 NB Off-Ramp	Prince George’s
Spine Rd	over MD 5	Prince George’s
MD 18B	at Fox Point Properties	Queen Anne’s
US 13	at MD 362	Somerset
Trinity Church Rd	W of MD 5	St. Mary’s
MD 65	at Shops at Sharpsburg Pike	Washington
US 11	at Dollar General	Washington
US 40	at MD 67	Washington
US 40	Walnut St to Eastern Blvd	Washington
Pennsylvania Ave	at Haven Rd.	Washington
US 13	at PennTex Properties	Wicomico
MD 346	US 113 to Healthway Dr	Worcester
US 50	MD 611 to Bridge over Sinepuxent Bay	Worcester

There were 9.6 miles of new sidewalks. 70% of sidewalks are ADA compliant along Maryland Routes.

BICYCLE PROJECTS

The concept of Complete Streets utilized by MDOT SHA states that all multi-modal users of a facility must be considered. One of the ever-expanding users of roadway facilities is the bicyclist. The MDOT SHA strives to improve bicycle safety and accessibility while providing transportation equality. Upgrades to a roadway could include bicycle facilities such as shared bike lanes, on-street bike lanes, signing, pavement markings and accommodation improvements at intersections. Standalone bicycle facilities (such as separated bike paths), are also part of bicycle upgrade projects. Capital for these projects is received through a wide variety of sources ranging from money set aside for bicycle facilities to funding dedicated to resurfacing, maintenance, safety and capacity improvement projects. In 2020, MDOT SHA has improved 6 directional miles for bicycle access. Selected bicycle facility upgrades that took place in 2020 depict a number of different improvements **(Table 31)**.

In addition to projects that were completed, a change occurred in one of the bike programs. A strong advocate for improved bicycle facilities was Ms. Kim Lamphier who passed away in 2019. In her honor, the Maryland Bikeways Program was renamed the Kim Lamphier Bikeways Network Program and additional funding was provided.

Table 31

SELECTED BIKE FACILITY UPGRADE LOCATIONS IN 2020

ROUTE	LIMITS	COUNTY	IMPROVEMENT
MD 26	Emerald Ln to Calvert Way	Carroll	0.3 miles of new bike lane
MD 32	Main Street to Macbeth Way	Carroll	0.8 miles of new bike lane
US 15	Orndorff Rd to College Ave	Frederick	1.6 miles of new bike lane
US 1	Kit Kat Rd	Howard	New bike lanes through intersection
MD 187	I-495 to Cedar Lane	Montgomery	Added striped bike lane
MD 500	MD 208 to MD 410	Prince George's	Upgrade for bicycle compatibility
MD 528	Baltimore Ave to N Division St	Worcester	Converted sidewalk to shared use path
MD 589	US 50 to Ocean Downs Entrance	Worcester	0.4 miles of new bike lane

There are over 450 directional miles of marked bike facilities.

FREIGHT PROJECTS

It is vital for the economy of the state to be able to move freight to meet the needs of the population. In order to keep up with increasing freight movement, the roadway network must be able to meet the demand. This requires implementation of freight projects and operational/TSMO solutions. Freight projects are divided into two categories. The first category addresses roadway projects that enhance overall mobility, which provide improvements for freight operators (logistics). The second category encompasses projects that are directly associated with improving trucking operations (systematic efficiency). The ultimate goal of all these projects is to enhance the mobility of trucks while keeping other users of this same network (motorists/ bicyclists/ pedestrians/transit) safe.

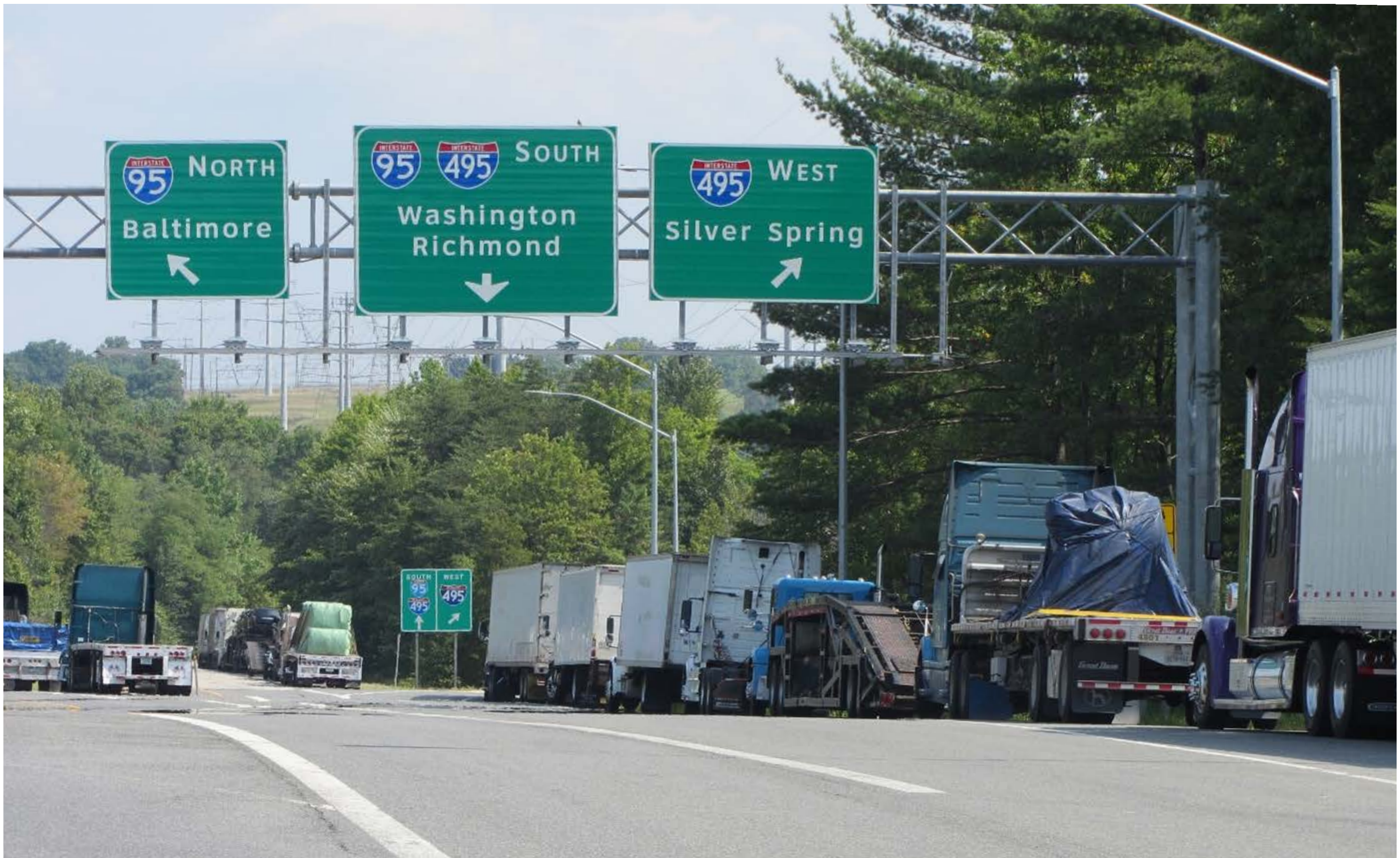
In order to keep freight moving efficiently, there are several on-going projects operated by MDOT SHA's Motor Carrier Division. The “Maryland One Permit System” allows for the state to process applications more effectively for overweight/ over dimensional cargo. Previously, permit approval could take days depending upon the request. The improved automated hauling permit system now auto-issues:

- 82% of all permits for loads up to and including 200,000 pounds, 13’ wide, 14’6” high, and 100’ long, if the route analysis is approved. Of these types of requests, 95% of all permits are issued within 2 hours or less and nearly 100% are issued within 2 days or less.

Megaloads permits (up to 1 million pounds) require coordination between numerous agencies and take a longer period of time to be processed. In addition, system improvements allows users to automatically revise, extend, reprint and process bill payments to expedite service. Testing is on-going for turn by turn directions an driver detail sheets for increased safety.

The Motor Carrier Division is also responsible for the construction and maintenance of Virtual Weigh Stations (VWS). VWS utilize technology through a system of sensors and cameras to record commercial motor vehicles traveling at highway speed. The VWS can record speed, height, weight and every axle without requiring a vehicle to stop. This system improves mobility and assists in limiting damage to roads and bridges by not having overweight trucks on the road. There are currently 19 active VWS sites with the MD 32 site decommissioned at this time due to construction **(Figure 32)**.

Two more VWS sites are on hold at I-95 South (Tydings Bridge) and I-81 North at the West Virginia State line due to COVID-19. The US 301 site in Charles County is slated to be relocated as funds become available.



I-95 @ I-495

One area related to safety for both truck drivers and motorists is overnight truck parking. Truck parking at Rest Areas and Welcome Centers provides safe, off-road locations **(Figure 32)** to reduce the potential for crashes between parked trucks and moving vehicles. Trucks parked along shoulders or entrance/exit ramps can create a safety hazard to other truck and car drivers. Unfortunately, identifying locations for new or expanded truck parking can be challenging. Truck drivers prefer to stop close to their destination, which are often near populated urban centers with limited available right-of-way or where expansions/ new lots are negatively perceived by nearby residents. MDOT SHA's Freight Planning Program is working on truck parking solutions that involve expanding parking capacity at existing locations, partnering with the private sector and using TSMO solutions to provide awareness of truck parking including temporary solutions.

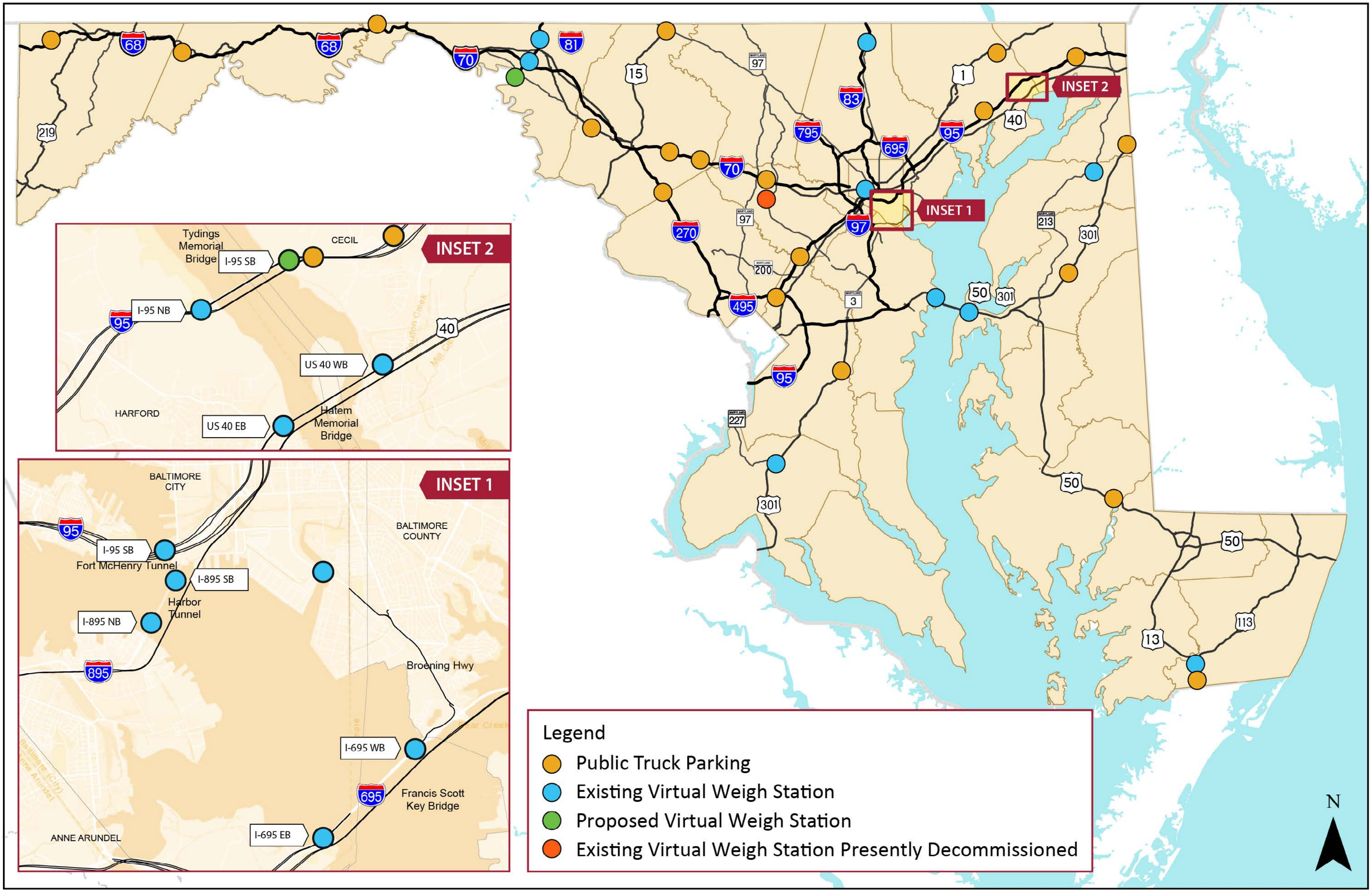
In addition, MDOT SHA's Office of Transportation Mobility and Operations (OTMO) is working on solutions to help drivers become aware of parking availability. This includes using the INRIX Trips data analytics and the development of a truck parking visual dashboard to identify locations where parking is needed and to identify state-owned property that can support parking easily and safely. Other efforts include working to establish freight traveler and truck parking information systems that can alert drivers to available parking and to determine how to push existing data available from MDOT SHA OTMO to the freight community.

OVERNIGHT TRUCK PARKING EXPANSION	**I-70 Westbound Welcome Center Frederick County** - Up to 10 added spaces under design[1] **I-70 Eastbound Welcome Center Frederick County** - Up to 10 added spaces under design[1]

1 - Presently on hold due to funding

Public Truck Parking and Virtual Weigh Station Locations

Figure 32



RAILROAD GRADE CROSSING PROJECTS

Motorists and trains interact at locations where at-grade crossings exist. These locations can present a safety issue for all transportation users. Each year MDOT SHA provides safety improvements for locations with at-grade railroad crossings to either eliminate hazards or improve traffic control devices. These improvements include, but not limited to installing new flashing light signals (with or without gates), updating the components at existing active warning devices and improving crossing surfaces. In 2020, MDOT SHA completed two projects to improve at-grade crossings.

- Naylor Mill Road – Wicomico County
- Naylor Street – City of Salisbury

Naylor Mill Rd

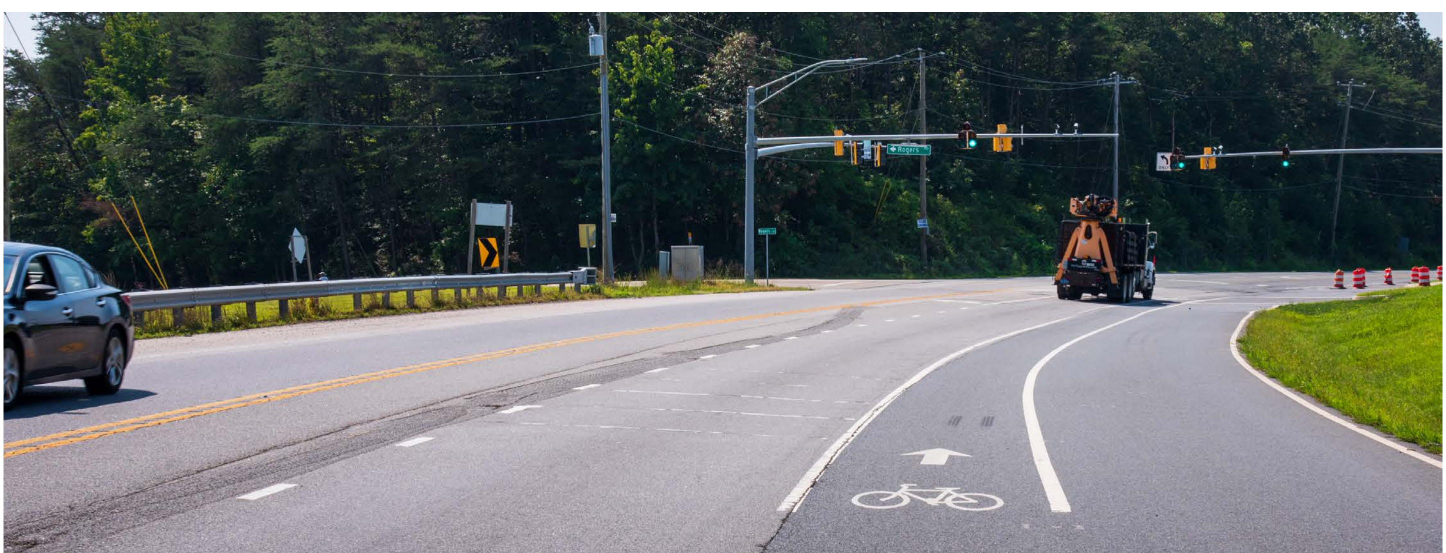
There are 633 public at-grade and 26 separate pedestrian crossings of railroads in Maryland.

DEVELOPER PROJECTS

There are numerous types of developments occurring throughout the State. These developments could include new residential units, commercial centers, office buildings, warehouses or the redevelopment of an existing site. As a result, the roadways around these sites will experience the additional traffic they generate; therefore developers are often required to mitigate the additional volume. In 2020, these improvements ranged from minor to major intersection modifications, pedestrian, bicycle and transit enhancements, interchange improvements, as well as, access improvements (such as acceleration and deceleration lanes) **(Table 32)**. MDOT SHA pedestrian, bicycle, and transit facilities through a joint permitting process works to offset the traffic impacts of developments with improvements that are beneficial throughout the corridor. Without these improvements, operational issues can exist such as traffic from turn lanes extending into through lanes, thus blocking through traffic and causing safety issues.

Table 32

SELECTED DEVELOPER IMPROVEMENT PROJECTS			
ROUTE	LIMITS	COUNTY	IMPROVEMENT
MD 175	Wigley Ave	Anne Arundel	Turn lane addition
MD 424	Crofton High School	Anne Arundel	Turn lane addition
MD 272	Rogers Rd	Cecil	Turn lane addition, bicycle lane and signal modification
I-95 SB Ramp	MD 543	Harford	Turn lane addition
MD 7	MD 543	Harford	Turn lane addition
MD 22	MD 543	Harford	Turn lane addition
MD 103	Wesley Lane	Howard	Turn lane addition
MD 355	Twinbrook Parkway	Montgomery	Turn lane addition



MD 272 @ Rogers Rd

MDOT PROGRAMS TO IMPROVE MOBILITY 2020 RESULTS

MD 26 @ East of I-695

COORDINATED HIGHWAYS ACTION RESPONSE TEAM (CHART)

The cost, right-of-way and environmental impacts of completing capacity related improvement projects limit the ability of MDOT SHA to address all the needs of the transportation system. In order to deal with mobility issues, other programs have been established to improve traffic flow and reduce congestion through a variety of methods including reducing the demand on the roadway and making better use of the existing pavement. One such program includes the use of **Transportation Systems Management and Operations (TSMO)** through the Coordinated Highways Action Response Team (CHART). CHART is a multi-agency effort to improve mobility for the Maryland highway system through its Advanced Traffic Management System (ATMS), service patrols, communications, systems integration and incident response and management.

The CHART program focuses on non-recurring congestion. Non-recurring congestion could be caused by crashes, vehicle breakdowns, work zones, special events, and weather events. These non-recurring congestion events affect mobility, safety, and reliability of the roadway system. Mobility and reliability are influenced by the time motorists spend waiting for the incident to clear. Safety is impacted by secondary incidents or those crashes that occur by the sudden slowing of traffic caused by the original incident. The CHART program identifies incidents quickly, allows emergency personnel to be alerted, and minimizes time motorists spend in congestion; and thereby, saves motorists time and money. The improved response time reduces the potential for secondary collisions and decreases the amount of time motorists are in traffic; and thereby, lowers the cost impact of these incidents. The typical approach of CHART incident management is shown below.

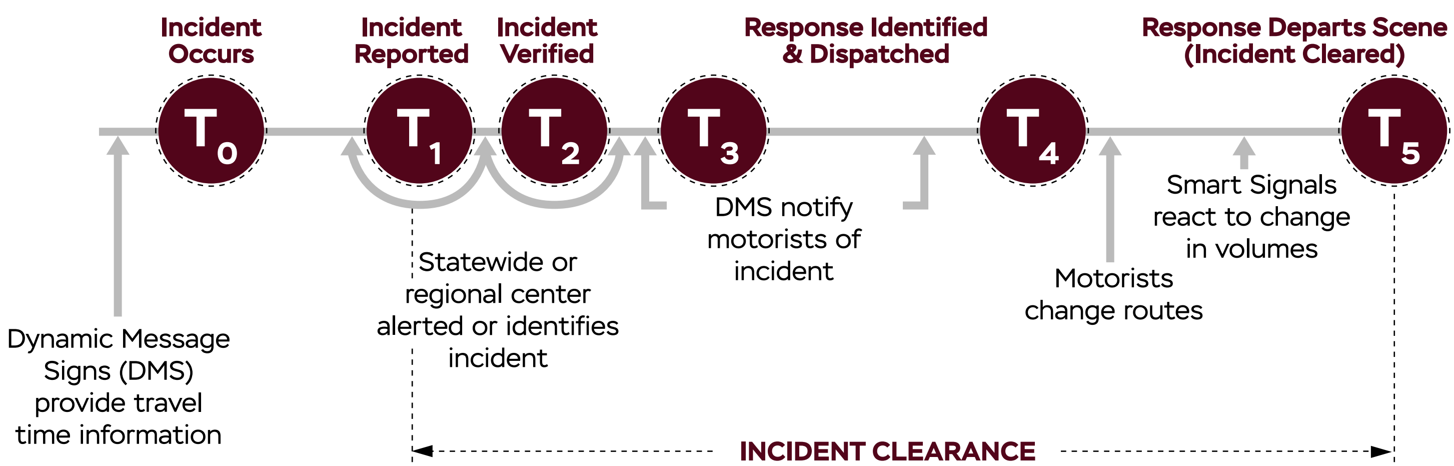


CHART is involved in the following core functions to address non-recurring congestion:

- Emergency Preparedness
- Emergency Weather Operations
- Incident Management
- Traffic Management
- Traffic and Roadway Monitoring
- Traveler Information

CHART has many different resources dedicated to traffic management including:

- Emergency Traffic Patrols
- Emergency Response Units
- Freeway Incident Traffic Management Plans and Response Trailers
- Intelligent Transportation Systems (ITS) Equipment
- Clear the Road Policy and Move It Law
- Information Exchange Network Clearinghouse
- Traffic Incident Management Training to First Responders and Partner Agencies

CHART incorporates many different types of data to evaluate how the roadway system is operating. This data is collected from a wide variety of ITS equipment that are strategically located throughout the State. Travel time information is made available based on the analysis of INRIX probe speed data and displayed on more than 200 DMS. The Maryland 511 Travel Information Service continues to provide useful, high-quality, and timely travel information. Presently CHART have access to:

- 1000+ Closed Circuit Television (CCTV) Cameras Statewide (200 + MDOT SHA controlled)
- 300+ Speed Detectors
- 200+ DMS
- 40+ Roadway Weather Information Systems (RWIS)
- 10+ Traveler Advisory Radios
- 15+ Variable Toll Rate Signs

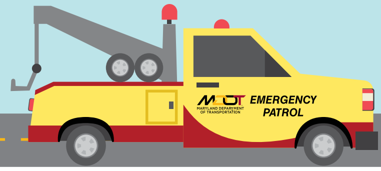
The information from these devices is coordinated through the Statewide Operations Center and three strategically located Traffic Operations Centers at:

- Hanover (Statewide Operations Center)
- College Park
- Essex
- Frederick

Emergency Traffic Patrols (ETPs) assist drivers when their vehicles become disabled or when involved in a crash. These ETPs are assigned to high volume/high incident routes to boost the efficiency of the emergency response program. Areas served by ETPs include:

- Annapolis, Baltimore, Frederick and National Capital Region (Full Time 24/7 Patrols)
- Eastern Shore

I-695 E of MD 144

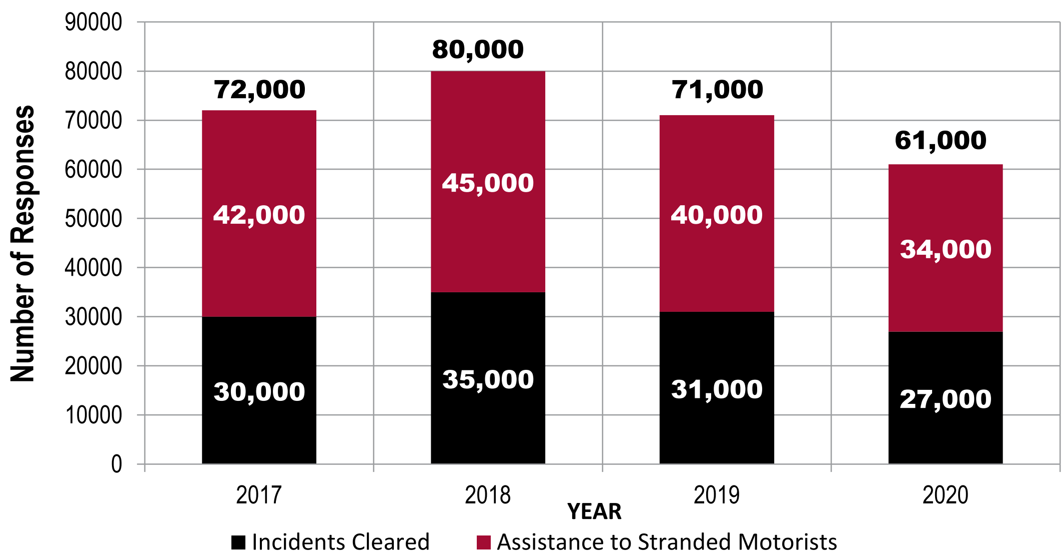


There are 46 full time emergency traffic patrols that operate 24 hours a day seven days a week.

In 2020, ETPs responded to over 61,000 service calls to address motorist and emergency response agency needs along Maryland's highways. This included responding to approximately 27,000 incidents along Maryland roadways and approximately 34,000 service calls for assistance to motorists **(Figure 33)**. Assistance to stranded motorists included changing flat tires, providing hotshots and delivering fuel. Although this figure was lower in 2019, it is still a substancial number considering the reduction in volume of traffic.

Figure 33

EMERGENCY TRAFFIC PATROL RESPONSES



State Farm Sponsored Emergency Patrol Truck

A decrease in response and incident clearance time translates into a reduction in delay. CHART services reduce the amount of delay and ultimately provide annual user cost savings. The annual vehicle hours of delay savings and the average incident duration for the last four years are identified **(Figures 34 and 35)**. The annual vehicle hours of delay savings decreased due to less congestion on the roadway meaning less waiting time for motorists.

Figure 34

ANNUAL VEHICLE HOURS OF DELAY SAVINGS

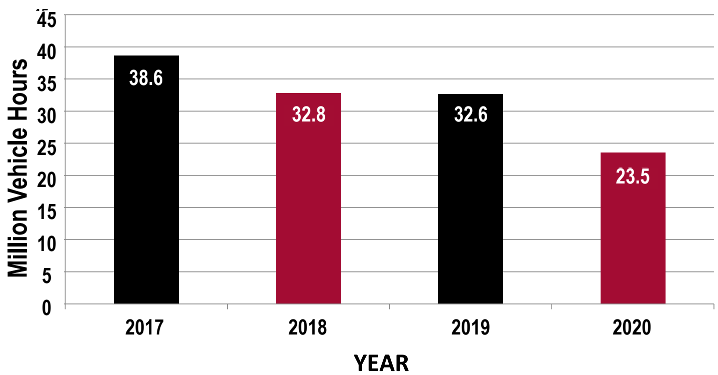
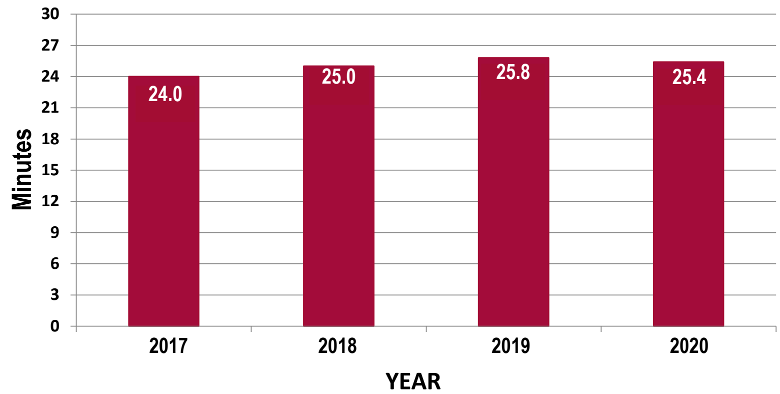


Figure 35

AVERAGE INCIDENT DURATION



Every minute saved through reductions in delay translates into savings in annual user costs. The annual user cost savings to Maryland travelers amounted to $1.08 billion dollars in 2020 **(Figure 36)**. Annual user cost savings includes reduction in delay, savings in fuel and emissions.

Figure 36

ANNUAL USER COST SAVINGS BY CHART

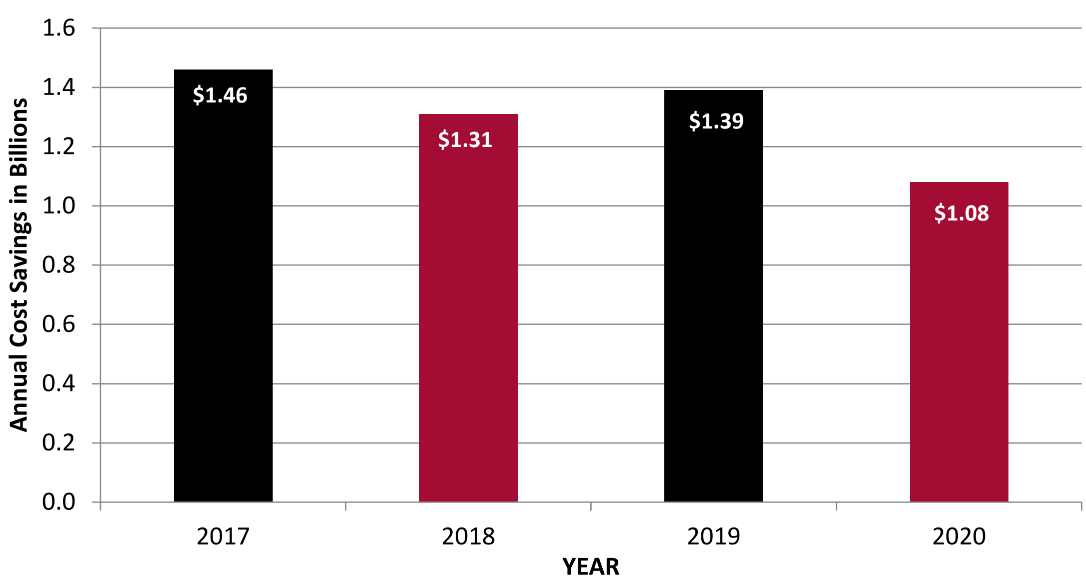


CHART services provided an annual benefit of $ 1.08 billion and reduced delay by 23.5 million hours.

SIGNAL OPERATIONS

Traffic signals that are poorly timed can cause additional delay and frustrate motorists leading to red light running. They often feel they have to wait too long to receive the green indication or get stopped at every signal. In order to reduce delay and improve mobility, optimizing traffic signal timing is one of the most cost effective methods to address recurring and non- recurring congestion. Signal timing improvements can reduce delay, decrease emissions and provide for a more walkable environment. Individual signals that are adjacent to each other are often grouped together into a signal system that allow motorists to progress along an entire corridor more efficiently. Overall, MDOT SHA is responsible for:

- 1,581 Traffic Signals
- 262 Signal Systems

In 2020, the timings for 56 signals in 7 systems were reviewed to improve progression and operations. Other areas addressed with signal operation efforts are: timing modifications, new signal testing, phase modifications, reviewing proposed signals constructed by developers, innovation support such as ramp metering and network integration and project reviews. The overall Improvements for the 7 systems resulted in:

- Reduced over 550,000 Hours of Delay
- Saved over 109,000 Gallons of fuel
- Reduced delay by almost 13%
- Annual User Savings was $22.7 million

In 2020, MDOT SHA's signal system upgrades were implemented in 7 corridors and resulted in delay savings **(Table 33)**.

Table 33

2020 NETWORK DELAY SAVINGS FOR MDOT SHA SIGNAL SYSTEMS UPGRADES

ROUTE	LIMITS	COUNTY	NO. OF SIGNALS	DELAY SAVINGS (VEH-HRS)
MD 140	Market St to Hughes Shop Rd	Carroll	13	221,000
MD 2/MD 178/ MD 450	MD 2 Forest Dr to MD 450; MD 178/MD 450 MD 2 to Bestgate Rd	Anne Arundel	10	117,000
US 40	Golden Ring Center to Rossville Blvd	Baltimore	2	90,000
MD 26	Kelox Rd to Offut Rd	Baltimore	20	88,000
MD 43	I-95 Ramps	Baltimore	3	49,000
MD 5	MD 381 Interchange	Prince George's	3	New System
MD 589	Manklin Creek Rd to Ocean Pkwy	Worcester	5	N/A
		TOTAL	**56**	**565,000**

N/A - Delay savings were anticipated to be calculated in 2020, but not completed due to COVID-19.

The highest overall delay reductions by percentage were:

- MD 43 – I-95 Ramps (33%)
- US 40 – (17%)
- MD 140 – (17%)

TRANSIT SIGNAL PRIORITY

Transit signal priority (TSP) at signalized intersections allows for buses to gain a time advantage to encourage more riders and improve on-time performance and reliability. TSP allows transit vehicles to jump in front of the queue or extend the green time before the particular approach turns yellow. The following systems are operating or planned:

Ride On extRa service (Montgomery County)

- MD 355 – Lakeforest Mall to Medical Center METRO Station - 30 signals (Service halted late March to August 2020)
- In 2020, buses operating on the corridor made over 326,000 TSP requests at signalized intersections

Ride On FLASH service (Operational in October 2020 in Montgomery County)

- US 29 – Burtonsville to Silver Spring METRO - 15 signals
- Service start date was delayed from mid-2020 due to COVID-19 service reductions
- Data is unavailable for TSP requests in 2020 due to limited operation

US 29 Ride on FLASH Transit Signal Priority

SMART/ADAPTIVE SIGNAL SYSTEMS

MDOT SHA has undertaken a program in some of the State's most congested corridors to upgrade signal systems, deploying innovative Smart/adaptive signal technology that supports real-time signal timing adjustments. Smart signals use computer software that respond to real-time traffic conditions, effectively deploying artificial intelligence to keep traffic moving. These systems maximize the green time for the major roadway, while taking into account operation of the minor street. Linking the Smart signals at multiple intersections along a major roadway corridor can improve normal traffic flow, and dynamically respond to non-recurring congestion such as from special events or incidents. Adaptive signals differ from standard signal timing improvements by allowing for timing modifications to occur instantly as traffic flow changes throughout the network.

In 2020, adaptive signal systems were implemented in seven corridors containing 66 signals **(Table 34)**. This increases the total number of adaptive signal systems in operation statewide to 18. Delay savings for these corridors was conducted based on the PTI **(Table 35)**. The systems implemented in 2019 are also included to give a relative comparison of the impacts of COVID-19.

MD 2 @ West Campus Dr

Table 34

2020 ADAPTIVE SIGNAL IMPLEMENTATION CORRIDORS			
ROUTE	LIMITS	COUNTY	# OF SIGNALS
MD 2	MD 10 Ramp to Arnold Rd	Anne Arundel	11
MD 2/MD 178/ MD 450	MD 2 Forest Dr to MD 450; MD 178/MD 450 MD 2 to Bestgate Rd	Anne Arundel	10
MD 26	Kelox Rd to Offut Rd	Baltimore	20
US 301/MD 228/ MD 5	US 301-Chadds Ford Rd to Smallwood Dr; MD 228/MD 5 Business Western Parkway to Post Office Rd	Charles	20
US 40	Chatham Rd to Normandy Center	Howard	5

Table 35

2020 ADAPTIVE SIGNAL IMPLEMENTATION CORRIDORS BENEFITS				
ROUTE	LIMITS	COUNTY	% IMPROVEMENT 2019	% IMPROVEMENT 2020
MD 2	MD 10 Ramp to Arnold Rd	Anne Arundel	N/A	38%
MD 2/MD 178/ MD 450	MD 2 Forest Dr to MD 450; MD 178/MD 450 MD 2 to Bestgate Rd	Anne Arundel	N/A	13%
MD 26	Kelox Rd to Offut Rd	Baltimore	N/A	7%
US 301/ MD 228/MD 5	US 301-Chadds Ford Rd to Smallwood Dr; MD 228/MD 5 Business Western Parkway to Post Office Rd	Charles	N/A	6%
US 40	Chatham Rd to Normandy Center	Howard	N/A	3%
MD 2	Hammond Ln to 11th Ave	Anne Arundel	13%	39%
US 40	Nuwood Dr to Coleridge Rd	Baltimore	26%	34%
MD 24	Singer Rd to Bouton Rd	Harford	13%	24%
US 1	Montgomery Rd to MD 175	Howard	19%	41%
US 301	Governor Bridge Rd to Powder Ridge Rd	Prince George's	21%	38%
MD 198	Sweitzer Rd to Old Gunpowder Rd	Prince George's	13%	27%

HIGH OCCUPANCY VEHICLES (HOV) LANES

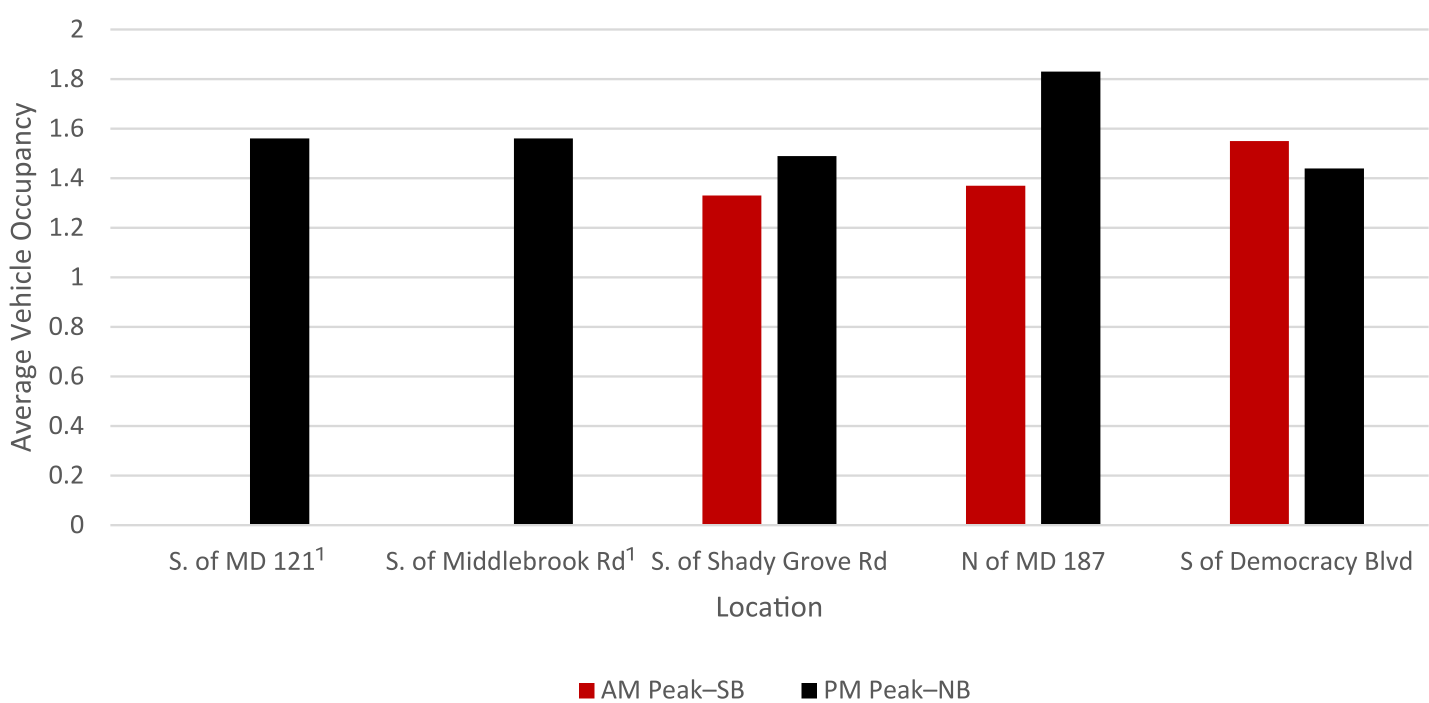
A strategy to maximize usage of the existing pavement along freeways/expressways is to provide for high occupancy vehicle (HOV) lanes. This strategy encourages carpooling and increases the number of persons (person throughput) that use a roadway without expanding the number of lanes. These lanes provide a travel time advantage savings to multi-occupant vehicles. Maryland has two corridors served by HOV lanes. Only vehicles with two or more occupants, transit vehicles, motorcycles or plug-in electric vehicles may use these lanes during the directional operating hours listed below.

- I-270 Southbound – North of I-370 to North of I-495 (East and West Spurs) [6:00 to 9:00 AM]
- I-270 Northbound – North of I-495 (East and West Spur) to MD 121 [3:30 to 6:30 PM]
- US 50 Eastbound and Westbound- West of US 301 to east of I-95/I-495 [All Day]

An evaluation was performed of the operations in 2020 associated with the HOV and general purpose or non-HOV lanes along I-270 and US 50. This was accomplished by performing vehicle occupancy counts for the HOV lanes at multiple sites and performing travel time studies using GPS. Person throughput evaluates the total number of people moved in each lane versus the total number of vehicles. On I-270, the person throughput in the HOV lanes was as much as 1,900 people per lane per hour which is consistently higher than the non-HOV lanes. The average vehicle occupancy in the HOV lane range from 1.33 to 1.83 **(Figure 37)**. Non-HOV average vehicle occupancy is 1.2 or less.

Figure 37

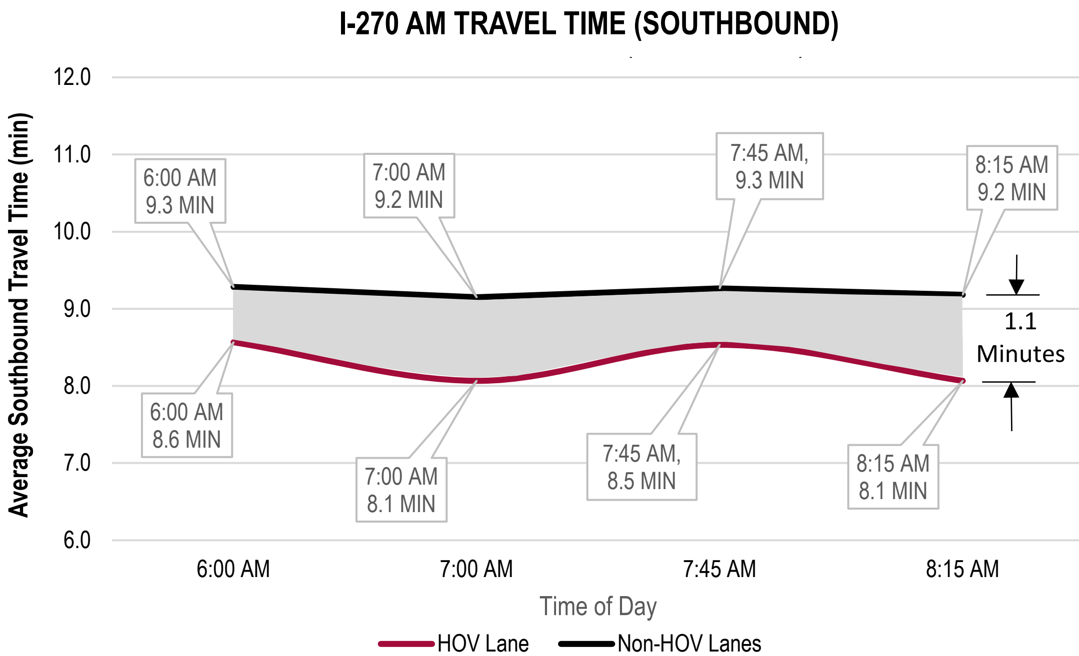
I-270 AVERAGE VEHICLE OCCUPANCY - HOV LANE

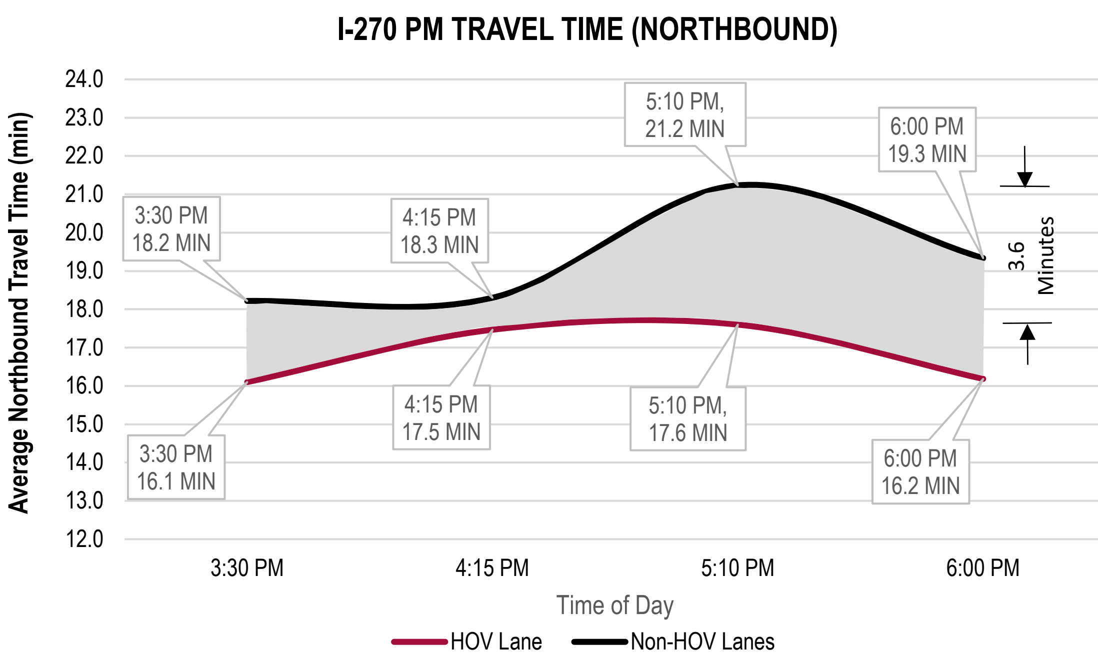


1 - Southbound HOV Lanes are not located in these sections

The travel time studies determined the travel time in the HOV lanes versus the general purpose lanes or non-HOV travel lanes. The lower volumes on I-270 allowed for faster speeds in the non-HOV lanes thereby, minimizing the travel time advantage of the HOV lanes. In 2019, travel time savings was up to 14 minutes in the HOV lanes versus the non-HOV lanes. The savings in 2020 was limited to approximately one to four minutes **(Figure 38)**. On US 50 travel time savings was less than one minute in both the AM and PM peak periods by motorists using the HOV lane.

Figure 38





The travel time savings for the HOV lane on I-270 was approximately 10 minutes less in 2020 versus 2019 pre-COVID conditions due to the lower volumes in the non-HOV lanes.

REVERSIBLE LANES

In many areas, commuting patterns are very directional with motorists mostly traveling one way in the morning and the opposite direction in the afternoon. At such locations, one strategy to make for a more efficient use of the existing pavement is to provide for reversible lanes. Reversible lanes allow for one or more lanes of a roadway to be converted from one direction to the opposite direction to accommodate for the increase in peak hour volumes. The conversion mainly occurs for defined hours. This Active Transportation Demand Management (ATDM) Strategy better serves the higher volume of traffic without widening the road. There are four reversible lane locations along MDOT roadways **(Table 36)**.

Table 36

REVERSIBLE LANE LOCATIONS ALONG MDOT ROADWAYS

LOCATION	LIMITS	COUNTY	LENGTH (MILES)
US 50/US 301	Chesapeake Bay Bridge	Anne Arundel/ Queen Anne's	4.5
MD 177	MD 100 to West of South Carolina Ave	Anne Arundel	1.6
US 29	Sligo Creek Pkwy to MD 97	Montgomery	1.0
MD 97	I-495 to MD 390	Montgomery	0.5

The MD 177, US 29 and MD 97 reversible lanes are operated to improve the standard AM and PM peak period commuting traffic flows. The most recognizable and most utilized is the five lane Chesapeake Bay Bridge (US 50/301). On the Chesapeake Bay Bridge, the lanes are reversed through the use of overhead lane signing in the PM peak period and during the summer on Saturday morning and Friday evenings. This allows for the two eastbound and three westbound lanes to be converted to three eastbound and two westbound lanes. The reduction in overall traffic volumes meant less congestion on the general purpose lanes thereby, reducing the number of motorists using the reversible lanes by at least 50% from 2019. Volumes on the reversible lanes range up to 500 vehicles per hour **(Table 37)**.

Table 37

REVERSIBLE LANE VOLUMES AND NUMBER OF LANES

LOCATION	VOLUME OF PEAK DIRECTION FOR NON-REVERSIBLE LANES (VEHICLES PER HOUR)		NUMBER OF NON-REVERSIBLE LANES		VOLUME OF PEAK DIRECTION FOR REVERSIBLE LANE(S) (VEHICLES PER HOUR)		NUMBER OF REVERSIBLE LANES	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
US 50/301	N/A	2,790[I]	N/A	2	N/A	1,065[I]	N/A	1
MD 177	610	880	1	1	25	90	1	1
US 29	870	1,045	2	2	400	495	2	2
MD 97	2,045	2,310	3	3	265	290	1	1

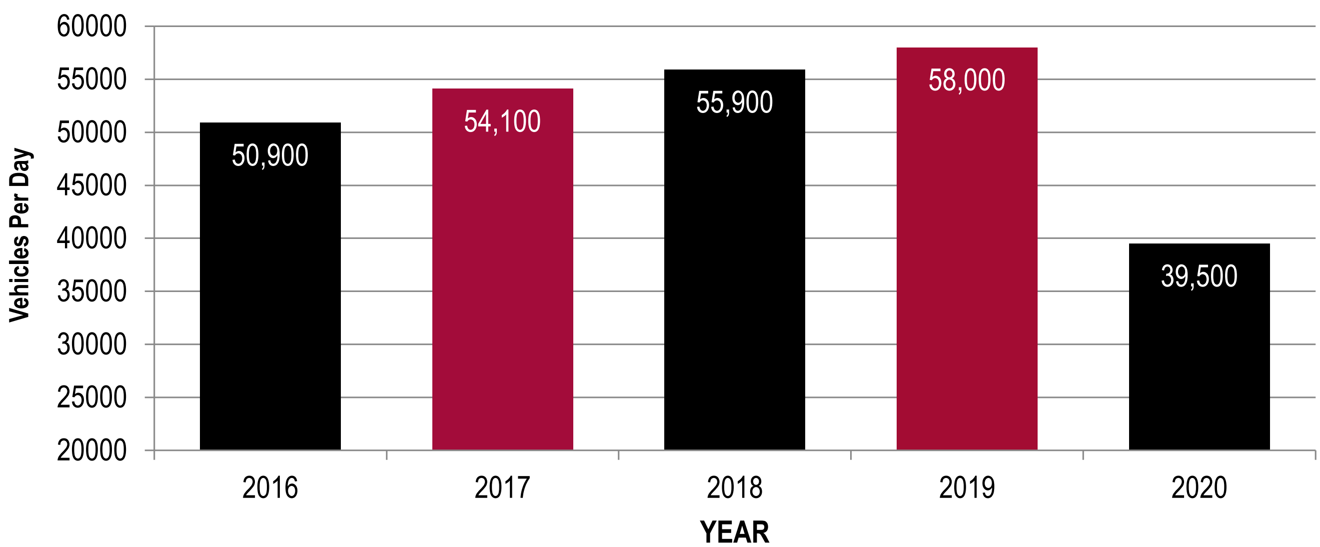
I - Volumes represent Friday peak hour

MANAGED LANE FACILITIES AND EXPRESS TOLL LANES

Projects to increase capacity can involve a number of different strategies. Along freeways/expressways this could include separated lanes or a separate facility that would operate at acceptable speeds without experiencing delays. These separate or managed lanes could include high occupancy vehicle lanes, truck lanes or various tolling strategies. In Maryland, two projects have been in operation since 2014 that were developed to improve traffic flow by utilizing tolls. The first project, MD 200 (Intercounty Connector), was the first all-electronic toll collection facility in Maryland where tolls are collected at highway speed either with E-ZPass® or through video tolling. Toll rates vary by the time of day. MD 200 extends from I-370 in Montgomery County to US 1 in Prince George's County for approximately 19 miles. Traffic volumes on MD 200 decreased from 58,000 vehicles per day in 2019 to 39,500 vehicles per day in 2020 between I-370 and I-95 **(Figure 39)**.

Figure 39

MD 200 AVERAGE DAILY TRAFFIC VOLUMES BETWEEN I-370 AND I-95 FOR FIVE SEGMENTS



A second type of managed lane project was introduced in December 2014 along I-95 from south of I-895 in Baltimore City to north of MD 43 in Baltimore County. Instead of the entire facility being tolled as with MD 200, motorists are given an option. They can either utilize the four free general purpose lanes or pay a toll using E-ZPass® based on the time of day to travel in the free flow express toll lanes. Transit vehicles may use the express toll lanes at all times for free. This improves transit time reliability to better meet schedules for routes in the corridor. In 2019, just over 26,500 motorists per day used the express toll lanes (Data was not available for 2020). The second section of express toll lanes along I-95 from north of MD 43 to south of MD 543 is now under construction.

Traffic Volumes decreased by almost 19,000 vehicles per day on MD 200 due to COVID-19 from an all time high of 58,000 vehicles per day.

MOBILITY INITIATIVES

MD 193

BICYCLE AND PEDESTRIAN

MDOT SHA developed the "*Context Driven: Access and Mobility For All Users*" guide in 2019 to address pedestrian and bicycle safety and provide for a balanced and sustainable multi-modal transportation system. Using innovative treatments and strategic investments, framed by Complete Streets and Practical Design principles, this guide helps MDOT SHA improve safety, accessibility, and mobility for multi-modal users. In addition, MDOT SHA incorporates bicycle and pedestrian facilities into roadway projects and provides grants for the planning, design, and construction of bicycle and pedestrian facilities on non-state-owned facilities.

PROGRAMS

MDOT and other state agencies are committed to improving and providing safer facilities for pedestrians and bicyclists. Programs have been established to implement the planning, design and construction of bicycle and pedestrian facilities throughout the State. These range from enforcement campaigns to increase the safe usage of existing facilities, student/pedestrian/bicycle safety education, and engineering solutions such as the construction of sidewalks, trails, cycle tracks, curb ramps and signing and pavement marking upgrades. These initiatives provide funding in the following programs: (2021-2026 $ in millions[1])

- Bicycle Retrofit Program ($34.7)
- Retrofit Sidewalk Program ($32.7)
- ADA Program ($ 34.2)
- Recreational Trails Program ($5.6)
- Kim Lamphier Bikeways Network Program ($12.1)
- Transportation Alternatives Program ($44.7)
- Primary / Secondary Program ($3.4)
- Neighborhood Conservation Program ($7.6)
- Maryland Highway Safety Office Bicycle Programs ($0.1)
- Other State/Federal grant programs include the Community Legacy Program, Program Open Space, Maryland Heritage Areas Program, Community Parks and Playgrounds, BUILD, Rivers, Trails and Conservation Assistance Program, Federal Lands Access Program, the Transportation Land Use Connections Program and Statewide Transit Innovation grants.

1 - Consolidated Transportation Program 2021-2026

Bicycle and pedestrian project funding for the fiscal year 2021-2026 amounts to over $175 million.

BICYCLE AND PEDESTRIAN MASTER PLAN

In January 2019, MDOT released "The 2040 Maryland Bicycle and Pedestrian Master Plan 2019 Update". The plan provides a vision to encourage active transportation and to offer solutions to Maryland's current challenges regarding bicycle/pedestrian facilities and safety. The 2040 Maryland Bicycle and Pedestrian Plan 2019 Update documents the review of existing conditions, development of strategies and objectives and key initiatives to encourage increase bicycle and pedestrian usage. The major goals of the plan include:

- Improve Safety
- Provide Connected Networks
- Develop Data Driven Tools for Analysis and Planning
- Form Partnerships
- Encourage Economic Development

The 2040 Maryland Pedestrian and Bicycle Master Plan 2019 Update ties into the goals of the Towards Zero Deaths campaign to enhance safety for bicyclists and pedestrians. In 2020, there were over 130 pedestrians and 15 bicyclists involved in fatal crashes in Maryland. This was an increase of over 10 pedestrian fatalities and 5 bicyclists over 2019. In order to reduce the number of fatalities and injuries, the plan identifies the following strategies:

- Install bicycle improvements such as marked bike lanes
- Perform Pedestrian Road Safety Audits
- Perform Educational Outreach with programs such as "A Cyclist Could Be Someone You Know" and "Look Alive"
- Evaluate Innovative Treatments such as green pavement, cycle tracks and bicycle signal heads
- Promote use of connected vehicle technology and technology for emergency response personnel to prevent and reduce severity of collisions
- Implement Legislation and Training

A sample of MDOT and local agency initiatives to improve the safety and mobility of bicyclists and pedestrians and encourage their use include:

- Created various resources including Tips for Safe Bicycling, Tips for Bicyclists and A Motorists Guide to Sharing the Road Safely with Bicyclists
- Incorporating "*Context Driven: Accessibility and Mobility for all Users*" guide into projects and development of a web portal for resources and a statewide progress project map
- Initiated the Be Street Wise outreach campaign
- Reduced speed limits and reduced lane widths on several corridors
- Introduced crosswalks treatments at various intersections
- Installed safety improvements including accessible pedestrian signals, countdown signals, ADA improvements, lighting enhancements and signing and pavement marking upgrades
- Supporting the passing of legislation that allowed for a driver of a vehicle to travel to the left of the center line of the roadway to pass a bicyclist when safe to do so

TRANSIT ORIENTED DEVELOPMENT (TOD)

The State of Maryland has encouraged development near transit stations as an important part of Maryland's strategy to address traffic congestion, environmental issues, and sprawl since the passing of legislation in 2008. The State of Maryland had defined Transit-Oriented Development (TOD) as a place of relatively higher density development that allow for people to live, work and play and is designed to encourage multi-modal access to the station area. The MDOT has actively sought to promote TOD as a tool to support economic development, to promote transit ridership, and to maximize the efficient use of transportation infrastructure and has designated 17 TOD sites along the major fixed rail transit lines of the Baltimore/Washington, D.C. region **(Figure 40)** with Bowie State University and Martin State Airport anticipated to be added in 2021.

LOCATIONS (TRANSIT SERVICE PROVIDED)

- Aberdeen (MARC)
- Owings Mills (Baltimore METRO)
- Reisterstown (Baltimore METRO)
- State Center (Baltimore METRO)
- Westport (Baltimore Light Rail)
- Savage (MARC)
- Odenton (MARC)
- Laurel (MARC)
- Dorsey (MARC)
- Shady Grove (Washington METRO)
- Twinbrook (Washington METRO)
- White Flint (Washington METRO)
- Wheaton (Washington METRO)
- Greenbelt (Washington METRO)
- New Carrolton (Washington METRO)
- Branch Avenue (Washington METRO)
- Naylor Road (Washington METRO)

The level of development at each of the sites varies throughout the State. Certain locations are much more active with on-going construction while market conditions will determine when development will occur at other sites. The most active sites included a combination of retail, residential, and office uses **(Table 38)**.

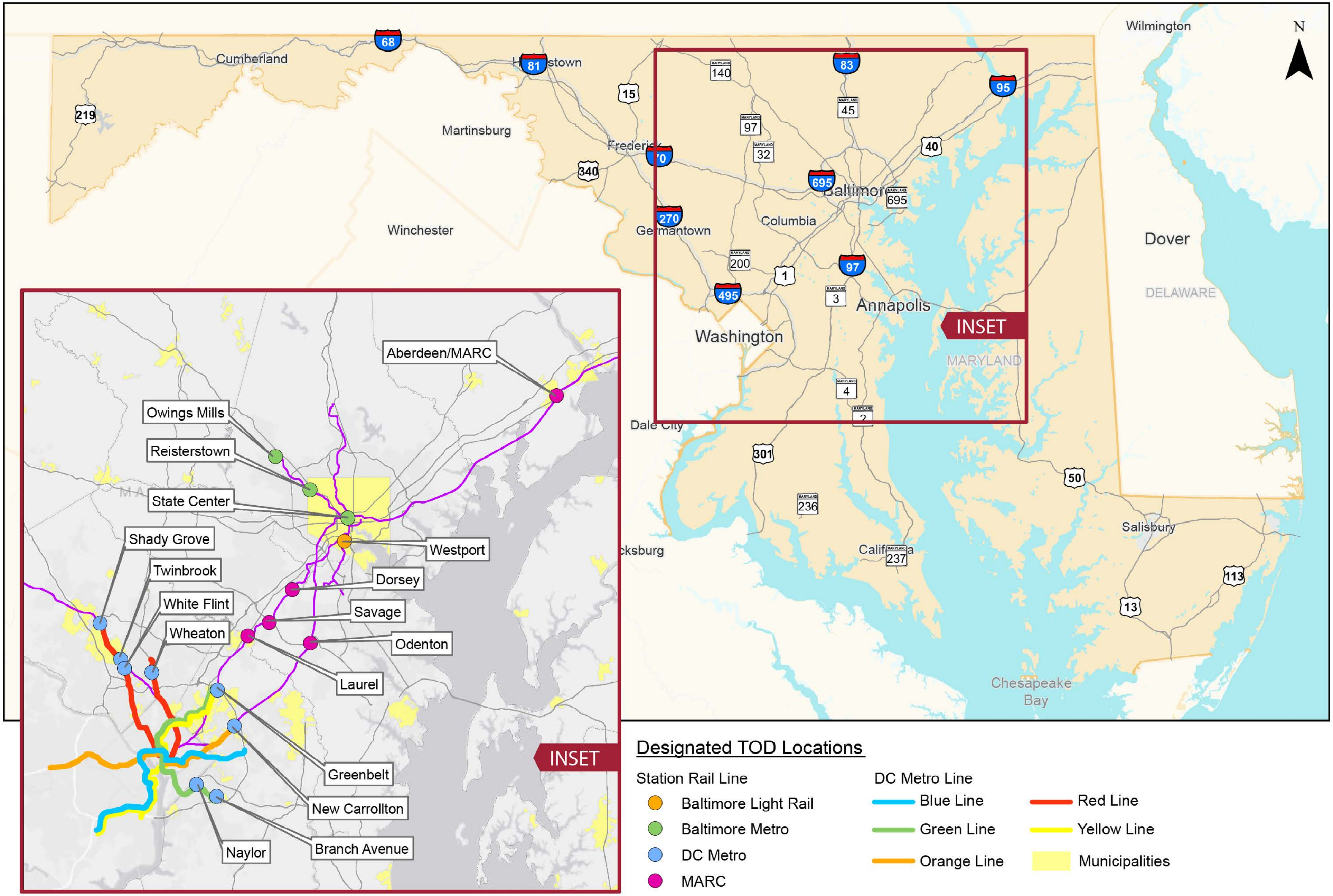
Table 38

ACTIVE DEVELOPMENT AT TODS		
TOD LOCATION	MULTI-MODAL CONNECTION	DEVELOPMENT STATUS
Metro Centre @ Owings Mills	MDOT MTA-METRO	229 room hotel schedules for completion in fall 2021. 227 unit residential building planned for completion in the fall/winter 2021.
Annapolis Junction/ Savage	MARC	280 apartment units will begin construction soon; Planning underway for a 110 room hotel.
New Carrollton	WMATA-METRO	282 unit multi-family residential building recently completed; WMATA's 275,000 sf office building under construction including a 1,900 space garage; Planning underway for a 286 unit multi-family building.
White Flint	WMATA-METRO	Additional residential building is planned; Montgomery County and WMATA have entered into a MOU to develop 2 to 3.9 million square feet of a mixed use life sciences community.

TOD sites are located in six counties and Baltimore City.

Transit Oriented Development Locations

Figure 40



FREIGHT

Freight travels by several modes including truck, airplane, ship, train, or pipeline. In order to meet the needs of the public and demands of businesses, the MDOT SHA is leading the nation to understand the magnitude of freight-related issues by assessing freight performance and system needs through the use of truck probe data and TSMO methods. Trucks are the major conveyor of freight in Maryland. This is accomplished through the establishment of a designated system of roadways that are conducive to commercial vehicles and that link to multi-modal connections. MAP-21 established a National Freight Network and the requirement that states measure freight performance. This network was further refined by the Fixing America's Surface Transportation (FAST) Act. The FAST Act set forth a National Highway Freight Network (NHFN) that consists of:

- The Primary Highway Freight System (PHFS) – Interstates selected by FHWA as a primary freight network for the entire United States.
- Other Interstates not on the PHFS – Non-PHFS Interstates are part of the NHFN even though they are not considered primary for freight.
- Critical Urban Freight Corridors (CUFC) – 75 miles of Metropolitan Planning Organization (MPO) designated urban roadways.
- Critical Rural Freight Corridors (CRFC) – 150 miles of state designated roadways.

The CUFC routes were determined by a joint effort between MDOT SHA and the State's MPOs based on methodology developed by the Metropolitan Washington Council of Governments (MWCOG). Twenty-five miles of the CUFCs occur in both the MWCOG and the Baltimore Metropolitan Council MPO areas and the remaining miles are split between the five other MPOs in Maryland.

The CRFCs were selected based on criteria developed by MDOT SHA. The criteria considered FHWA guidance and additional freight data developed during the state freight planning process to identify the most critical corridors.

I-95 SB @ MD 43

Together the PHFS, Interstates, CUFCs, and CRFCs comprise Maryland's Highway Freight Networks, along with the freight planning network which was developed as required by MAP-21. The freight networks encompass roadways in Western Maryland, Central Maryland, Southern Maryland, and the Eastern Shore **(Figure 41)**.

To improve awareness of performance of freight on the Maryland Freight Network, MDOT SHA uses the Maryland Roadway Performance Tool (MRPT). MRPT aligns INRIX probe data with the Maryland highway network and other data such as safety and asset conditions are also aligned with the same network for a comprehensive assessment of conditions on the network. The MRPT helps identify top bottlenecks on the system using a delay per mile measure that incorporates truck volumes and provides other performance information such as the cost of congestion for freight and the value of freight moving on the network. This type of intel from MRPT can help MDOT SHA to pinpoint the investments that are most critical to the freight community to support solutions (capacity or TSMO) to efficiently move freight within Maryland.

Maryland receives an apportionment of freight formula funds from FHWA that can support capital projects on the defined NHFN. MDOT has programmed these federal funds for projects to support freight on the NHFN including:

- I-695 from US 40 to MD 144
- I-83 Bridge over Padonia Road
- I-95 Bridges over MD 214
- I-95/I-495 Bridges over Suitland Parkway
- MD 4 - New Interchange at Suitland Parkway
- I-81 - US 11 to West Virginia State Line
- MD 175 - Widening from National Business Parkway to McCarron Court
- US 219 - Bridge replacements over Youghiogheny River
- MD 32 - Capacity and safety improvements from north of Linden Church Rd to I-70
- US 13BU - Bridge replacements over East Branch Wicomico River

In order to address the continued growth in freight movement on Maryland roadways, MDOT uses the freight formula program and other resources to support various projects and planning efforts. Projects completed or underway in 2020 include:

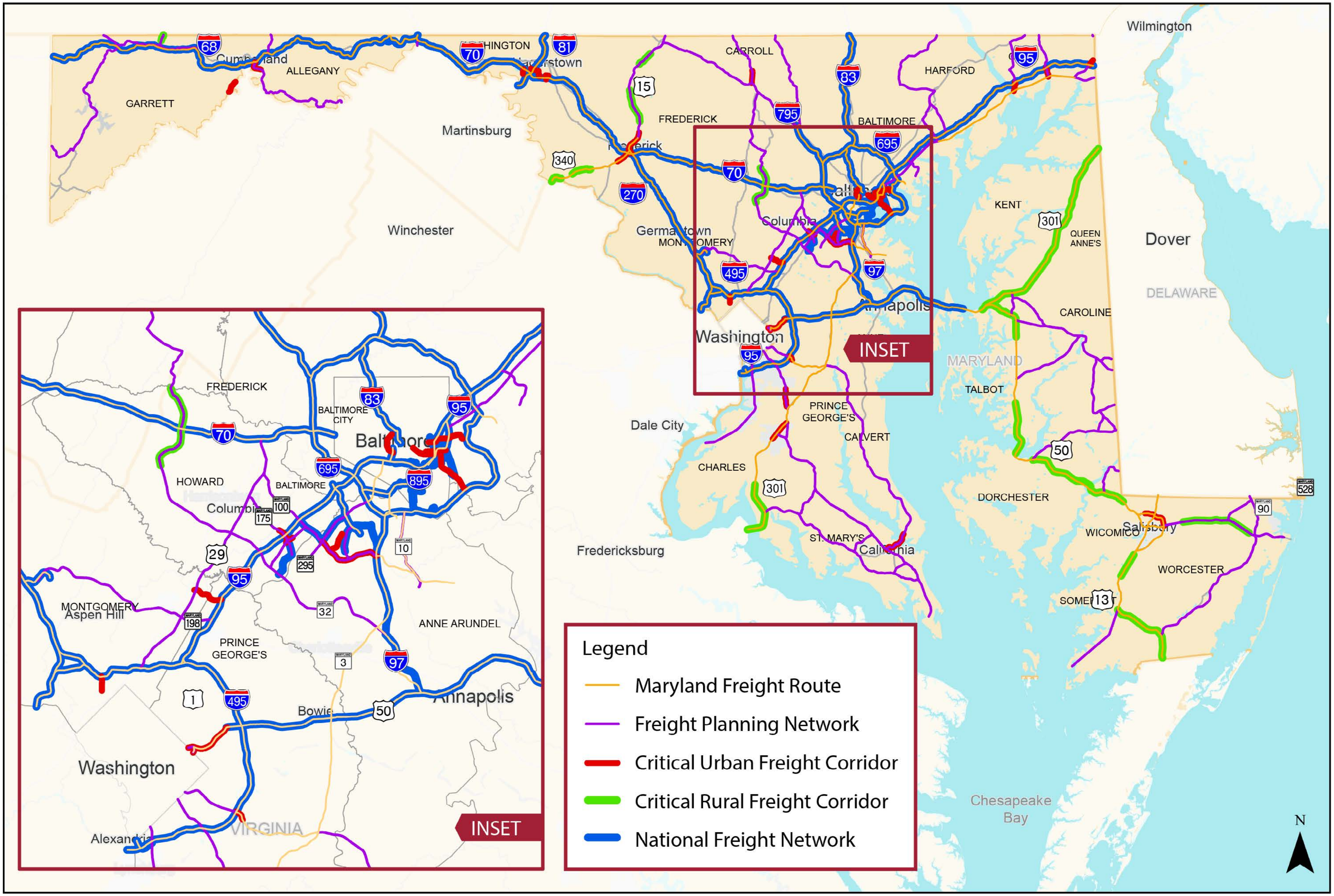
- Maryland Statewide Truck Parking Study
- Expansion of Virtual Weigh Stations
- Operating and refining the Maryland One Hauling Permit System
- Innovative Technology Deployment including the use of the Drivewyze geofencing application for commercial vehicle preclearance at truck weigh and inspection stations

Ongoing planning efforts include:

- Implementation of the Maryland Statewide Truck Parking Study which evaluated existing parking demand, needs and gaps in the system, linked challenges and opportunities while identifying funding and grant options for innovative areas such as Public-Private Partnerships, Electric Vehicles and Connected and Automated Vehicles
- Development of an update to the Strategic Goods Movement Plan
- Creation of TSMO concept of operations for freight movement
- Update of Maryland Freight Story Map to provide a visual overview of the Strategic Goods Movement Plan
- Advanced Data Viewer for planning purposes
- Multimodal freight coordination
- State Freight Advisory Committee meetings and collaboration

Freight Network

Figure 41



TRANSPORTATION SYSTEMS MANAGEMENT & OPERATIONS (TSMO)

Transportation Systems Management and Operations (TSMO) is an integrated approach to effectively manage and operate existing facilities and systems to maximize their full service potential. In order to accomplish this, all aspects of a project ranging from planning and engineering to operations and maintenance are involved with the goal of improving the reliability, safety, and security of the transportation system. MDOT SHA's TSMO program is managing a System of Systems through modern innovative solutions (focused on managing the system as a whole), which combines traffic management strategies, technologies, roadway improvements, and partnerships to take advantage of the network, optimize traffic flow, and improve safety. The overall goals of the program are:

GOAL 1

BUSINESS PROCESSES & COLLABORATION

GOAL 2

SYSTEMS & TECHNOLOGY

GOAL 3

DATA ANALYSIS & PERFORMANCE MANAGEMENT

GOAL 4

CUSTOMER EXPERIENCE & ENGAGEMENT

In order to achieve the goals of the program, various TSMO strategies are utilized by MDOT SHA to actively manage the multimodal transportation network. These strategies include:

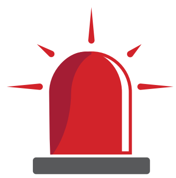
Homeland Security Preparedness

Transit Priority/Integration

Connected and Automated Vehicle Technology

Work Zone Management

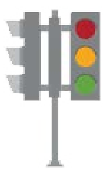
Emergency Response



Road Weather Management

Traffic Incident Management

Traffic Signal Coordination



Maintenance Fleet Management

Electronic Payment/Toll Collection

Freeway/Arterial Management

Freight Management

A key aspect of TSMO is better utilization of the existing system. In order to accomplish this, technology plays a crucial role by meeting customers' needs for providing real-time travel information and advancing the ability of MDOT SHA to react quickly to trends and changes in travel patterns. The data technology that supports TSMO are:

Real Time Applications

Archived Data Applications

Inhouse-tools with support from the University of Maryland CATT Lab

MDOT Common Operating Picture

Priorities for system enhancement using TSMO strategies were established and identified as follows:

- Improving coordination during incident management
- Decreasing incident duration and delay
- Allowing the traveling public to make better informed decisions
- Offering active traffic management and integrated corridor management solutions
- Enhancing coordination between MDOT SHA and local signal operators to optimize signal timings
- Managing traffic and increasing safety for work zones and special events

In 2020, various initiatives were undertaken and several were completed. A major effort involved completion of the TSMO Master Plan and portal and the development of the ITS Communications Plan. In addition to the development of these plans, other 2020 accomplishments include:

Premiered the TSMO Strategies Toolbox

Construction is underway on the US 1 ITS deployment project that will improve traffic monitoring and response through CCTV, DMS and TT/O-D sensors

Refocusing efforts on ATMS at TMC with upgrades to the center

The I-270 ICM corridor southbound ramp metering is under construction

Prepared 30% design of TSMO System 1 (I-70/US 29/US 40/MD 144/MD 99) which includes traffic monitoring and detection, communications network and signal upgrade, secondary route management, queue warning and dynamic speed advise

Completed proof-of-concept testing with FHWA using Waze data for crowd sourcing for operations related to faster incident detection

Received a $200,000 FHWA grant to advance the Work Zone data exchange program

MOBILITY ON DEMAND

An alternative to using your own vehicle, walking or taking transit to move from one place to another is through shared mobility on demand services. The range of alternative modes to supplement the traditional model include bicycles, electric bikes, scooters, car sharing and ride sharing services. The use of these services provide challenges and opportunities for the transportation system. The challenges include a rise in curbside demand making it more difficult especially in urban areas for competing interests wanting the same space such as transit vehicles, motorists parking and drop-offs/pick-ups from mobility service providers. Another issue from these services is providing safe operations for all users. These services can reduce demand for parking and rental cars which can impact revenues at airports but also make better use of urban space. In Maryland, the following services exist:

- Uber – Throughout most of Maryland; Ride Sharing Service
- Lyft- Throughout most of Maryland; Ride Sharing Service
- Zipcar – Throughout the Baltimore -Washington area; Ride Sharing Vehicles
- Lime – Baltimore City and Montgomery County including Silver Spring; Scooters, Bikes and Mopeds
- Bird – Montgomery County and University of Maryland; Scooters
- Jump – Baltimore City; Electronic Bikes and Scooters
- Spin – Montgomery County and Baltimore City (Howard County 2021); Electronic Scooters and Bikes
- Capital Bikeshare – Montgomery and Prince George's Counties; Electronic Bikes and Scooters
- Howard County – Bike Sharing Service

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MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

LARRY HOGAN
Governor

BOYD K. RUTHERFORD
Lt. Governor

JAMES F. PORTS JR.
MDOT Secretary

TIM SMITH, P.E.
MDOT SHA Administrator

FOR FURTHER INFORMATION, PLEASE CONTACT:

ERIC BECKETT

DEPUTY DIRECTOR
Office of Planning
& Preliminary Engineering
707 N. Calvert Street
Baltimore, MD 21202
ebeckett@mdot.maryland.gov

LISA SHEMER, P.E.

DIVISION CHIEF
Office of Planning & Preliminary Engineering
Travel Forecasting & Analysis Division
707 N. Calvert Street
Baltimore, MD 21202
lshemer@mdot.maryland.gov

800-323-MSHA
TTY 800-735-2258

roads.maryland.gov

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alternative formats upon request.