Appendix H: Congestion Management Process

What Is Congestion Management?

Congestion management involves applying strategies to improve transportation system performance and reliability. This helps to reduce the adverse impacts of congestion on the movement of people and goods.

A congestion management process is a systematic and regionally accepted approach for managing congestion. Such an approach can provide accurate, up-to-date information on transportation system performance. This enables transportation planners and decision makers to assess alternative strategies for managing congestion that meet state and local needs. The CMP is intended to move these congestion management strategies into the funding and implementation stages.

Why Is Congestion Management Important?

The congestion management process (CMP), as defined in federal regulations, is intended to serve as a systematic process that provides for safe, effective, and integrated management and operation of the multimodal transportation system. The process includes:

- Developing congestion management objectives
- Establishing measures of multimodal transportation system performance
- Collecting data and monitoring system performance to define the extent and duration of congestion and to determine the causes of congestion
- Identifying congestion management strategies
- Establishing an implementation schedule and identifying possible funding sources for each strategy
- Evaluating the effectiveness of implemented strategies.

Managing Congestion in Larger Metropolitan Areas – Air Quality Concerns

A CMP is required in metropolitan areas with population exceeding 200,000, known as Transportation Management Areas (TMAs). Federal requirements also state that in all TMAs, the CMP shall be developed and implemented as an integrated part of the metropolitan transportation planning process.

In TMAs designated as ozone or carbon monoxide nonattainment areas, the CMP takes on a greater significance. Federal law prohibits projects that result in a significant increase in carrying capacity for single-occupant vehicles (SOVs) from being programmed in these areas unless the project is addressed in the region's CMP.

The CMP must provide an analysis of reasonable travel demand reduction and operational management strategies. If the analysis demonstrates that these strategies cannot fully satisfy the need for additional capacity and additional SOV capacity is warranted, then the CMP must identify strategies to manage the SOV facility safely and effectively, along with other travel demand reduction and operational management strategies appropriate for the corridor.

Although a CMP is required in every TMA, federal regulations are not prescriptive regarding the methods and approaches that must be used to implement a CMP. This flexibility has been provided in recognition that different metropolitan areas may face different conditions regarding traffic congestion and may have different visions of how to deal with congestion. As a result, TMAs across the country have demonstrated compliance with the regulations in different ways.

The flexibility in the development of the CMP allows MPOs to design their own approaches and processes to fit their individual needs. The CMP continuously progresses and adjusts over time as goals and objectives change, new congestion issues arise, new information sources become available, and new strategies are identified and evaluated. As such, the Baltimore region CMP is an ongoing process, with system monitoring as a core activity over the past decade. The following sections describe some of the key elements of the regional CMP.

1. CMP Objectives

Congestion management objectives define what the region wants to achieve regarding congestion management. They are an essential part of an objectives-driven, performance-based approach to planning for operations. Congestion management objectives serve as one of the primary points of connection between the CMP and the metropolitan transportation plan (MTP), and serve as a basis for defining the direction of the CMP and its performance measures.

Following is information on how the *Maximize2040* goals directly relate to the Baltimore region's CMP:

Goal: Improve System Safety

While the emphasis of this goal is to protect the traveling public, reducing the number of crashes will have the secondary effect of easing nonrecurring congestion related to incident delay.

Appendix H: Congestion Management Process

Goal: Improve and Maintain Existing Infrastructure

As with the safety goal, the emphasis of this goal does not directly address congestion management. However, keeping signal and message systems in a state of good repair can help to maintain traffic flow and reduce delay. In addition, maintaining and replacing transit vehicles on a timely basis can help to encourage the use of transit as an alternative to single-occupant vehicles.

Goal: Improve Accessibility

This involves planning for an integrated transportation system that is accessible, equitable, and reliable for all system users and that provides for improved connectivity among all modes and across interjurisdictional and interregional boundaries. Related strategies that have guided transportation investment decisions in the Baltimore region include expanding transit options and providing facilities to better accommodate bicycles and pedestrians.

Goal: Increase Mobility

This involves integrating transportation system management and operations (TSMO) strategies that improve the performance and reliability of the existing transportation infrastructure to relieve congestion and reduce delay. Improving performance and reliability includes addressing these concerns:

- **Recurring delay** – Dealing with recurring delay can involve applying such approaches as intelligent transportation systems (ITS), better signal timing, implementing flextime or telework arrangements at major employment centers, and judicious capacity adding projects. Another approach that might be considered in the future is instituting congestion pricing or tolls.
- **Nonrecurring delay** – This involves incident management and providing information on delays related to incidents, construction, special events, or weather to transportation system users.

Goal: Conserve and Enhance the Environment

This involves establishing policies to reduce the use of single-occupant vehicles, thus reducing emissions from mobile sources as well as energy consumption and the use of fossil fuels. It also encompasses conserving and protecting natural and cultural resources. Programs that relate to this goal and its supporting strategies include:

- Rideshare programs
- High-occupancy vehicle (HOV) lanes
- Land use policies promoting responsible growth (discouraging transportation projects that add capacity outside of designated Priority Funding Areas and encouraging the reduction of VMT)

2. CMP Network

The CMP network involves defining two aspects of the system that will be examined as part of the planning process: (1) the geographic boundaries or area of application and (2) the system components/network of surface transportation facilities.

The primary area covered under the CMP network consists of the jurisdictions under the BRTB's function as the Baltimore region's MPO: Baltimore City, the City of Annapolis, and the counties of Anne Arundel, Baltimore, Carroll, Harford, and Howard. The travel demand model also includes and considers the effects of transportation facilities and operations within areas covered by other MPOs (e.g., Washington, DC metropolitan area; southern Pennsylvania; Cecil County, Maryland).

The system components include:

- Highway system (interstates, arterials)
- Transit system (LRT, MTA bus, MARC, local transit service providers)
- Freight routes / intermodal connections (intermodal terminals, airports, etc.)

3. CMP Performance Measures

Performance measures are a critical component of the CMP. According to Federal regulation, the CMP must include "appropriate performance measures to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods."

Volume-to-Capacity-Based Measures

Measures relying on volume-to-capacity ratios traditionally have been used because: (a) data on traffic volumes are usually relatively easy to obtain and often already exist, (b) travel demand models are designed to estimate future volumes on the transportation network, and (c) estimates of capacity can be derived using documents such as the Highway Capacity Manual (HCM). LOS indicators with a simple standardized A-through-F grading system are assigned to the regional network. The advantage of these measures is that data are generally available from travel models, and there is a large existing body of experience in defining and applying these measures. On the other hand, they are limited in that they traditionally focused on the movement of vehicles, rather than people or goods. Another limitation of volume-to-capacity measures is that they may not be readily understood by the public without a citizen education effort.

Travel Time Measures

Travel time measures focus on the time needed to travel along a selected portion of the transportation system. Common variations of travel time metrics include:

- **travel time** – the amount of time needed to traverse a segment or corridor
- **travel speed** – usually measured in one of two ways: (a) average travel speed: the length of a segment divided by the travel time, or (b) spot speed: the speed of a vehicle or a sample of vehicles over a given time interval passing a point along a roadway

- **delay** – the difference between travel time and acceptable or free-flow travel time
- **travel time index** – ratio of peak-period to non-peak-period travel time.

These measures can be translated, using various assumptions, into other measures such as user costs, and can be used in the process of validating travel demand forecasting models.

Variability of Congestion/Reliability

The variability or change in congestion on a day-to-day basis provides a measure of reliability. Recurring congestion is generally predicable, regularly occurring, and typically caused by excess demand compared to the capacity of the system.

On the other hand, nonrecurring congestion—caused by transient events such as traffic incidents, weather conditions, work zones, or special events—results in unreliable travel times. Nonrecurring congestion, and the unreliable travel times that result, are often the most frustrating form of congestion to travelers. Moreover, FHWA estimates that nonrecurring sources of congestion are responsible for perhaps half of all delay experienced by travelers.

Since the transportation planning models used in metropolitan transportation planning are designed to address recurring congestion issues, many regions have found it challenging to incorporate measures of nonrecurring congestion as part of their CMP. Some MPOs have used crash data as a surrogate measure for nonrecurring congestion under the premise that traffic incidents are directly linked to nonrecurring congestion. Others have begun to gather archived real-time traffic data from operating agencies to examine the variability in traffic volumes, speeds, and/or travel times on a daily basis.

BMC staff is working on developing travel time measures using both traditional sources of data and new technologies that take advantage of operations data such as probes and ITS devices.

4. Data Collection and Monitoring System Performance

Data collection and system monitoring are needed to provide information to make effective decisions, and are typically an ongoing activity. According to federal regulation, the CMP must include:

> *establishment of a coordinated program for data collection and system performance monitoring to define the extent and duration of congestion, to contribute in determining the causes of congestion, and evaluate the efficiency and effectiveness of implemented actions. To the extent possible, this data collection program should be coordinated with existing data sources (including archived operational/ITS data) and coordinated with operations managers in the metropolitan area.*

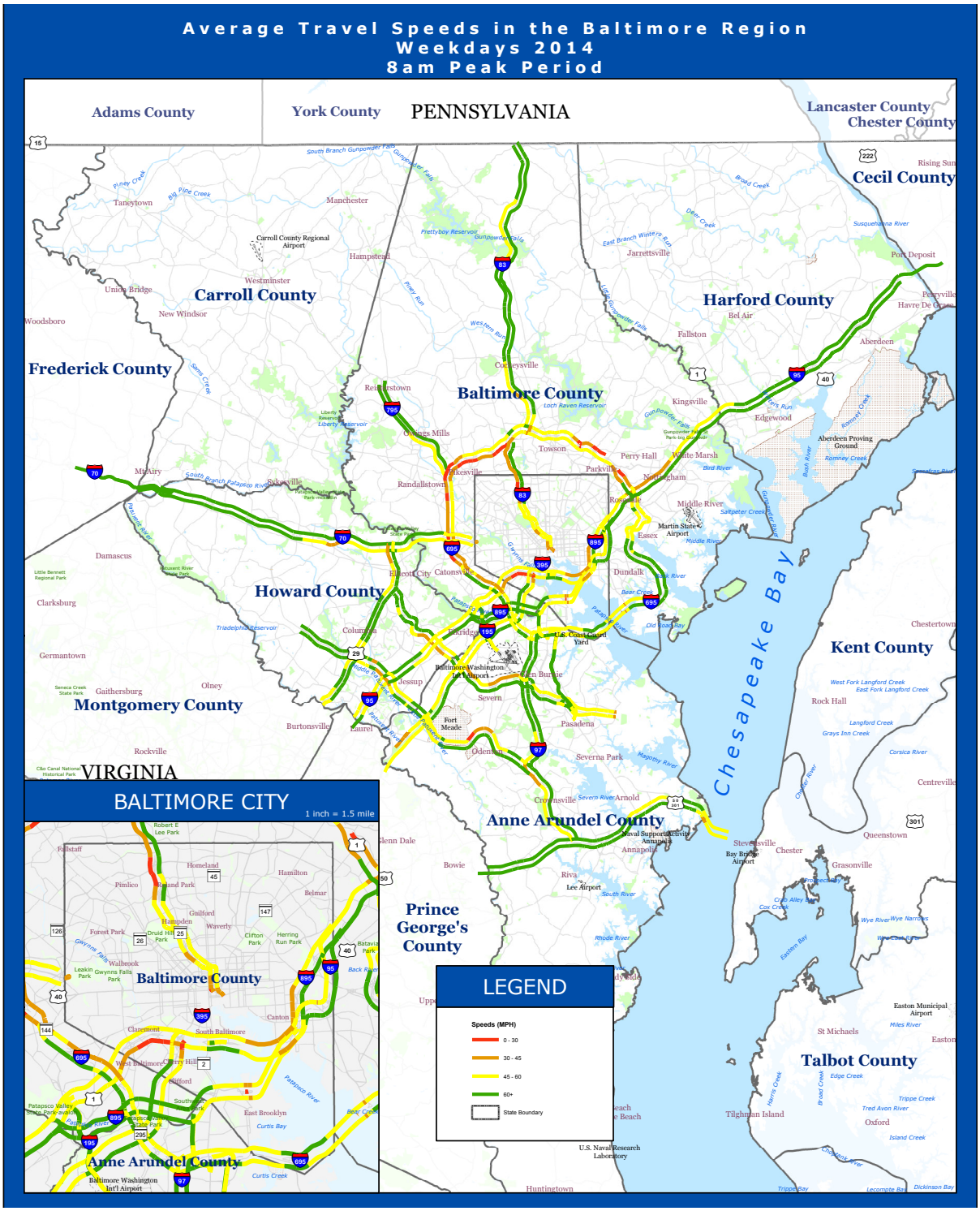
Using Vehicle Probe Data to Monitor Traffic

Since 2013, BMC has been in partnership with the I-95 Corridor Coalition and University of Maryland Center for Advanced Transportation Technology Lab (CATT Lab). This setup enables the agency to have access to continuous (24/7) probe data to monitor traffic conditions throughout the region. Access to the data is through the Vehicle Probe Project Suite, an online set of tools that can be accessed through a web browser . This eliminates the need for the many hours of processing of raw data that BMC's previous approach (collecting GPS speed data) required.

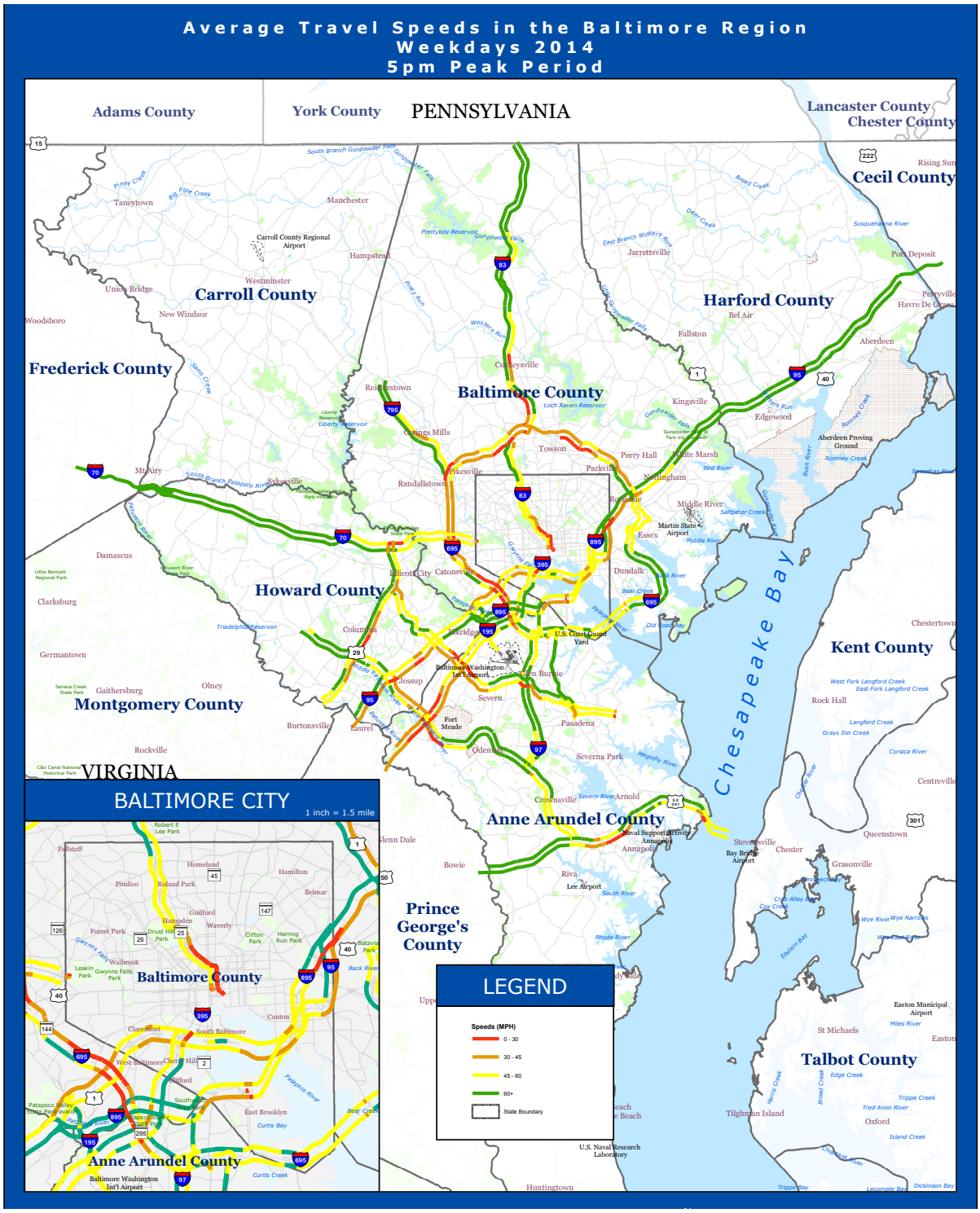
The Vehicle Probe Project (VPP) began in 2008 with the primary goal of enabling Coalition members to acquire reliable travel time and speed data for their roadways without the need for sensors and other hardware. More information on the VPP Suite can be found at the link below:

http://www.i95coalition.org/wp-content/uploads/2015/02/One_Pager_VPP_VPP_Suite-31dec2014-final2.pdf

The following maps show VPP data collected for the a.m. and p.m. peak periods. The first map shows average 2014 travel speeds for the a.m. peak period for freeways and major arterials. The second map shows average 2014 travel speeds for the p.m. peak period for freeways and major arterials.



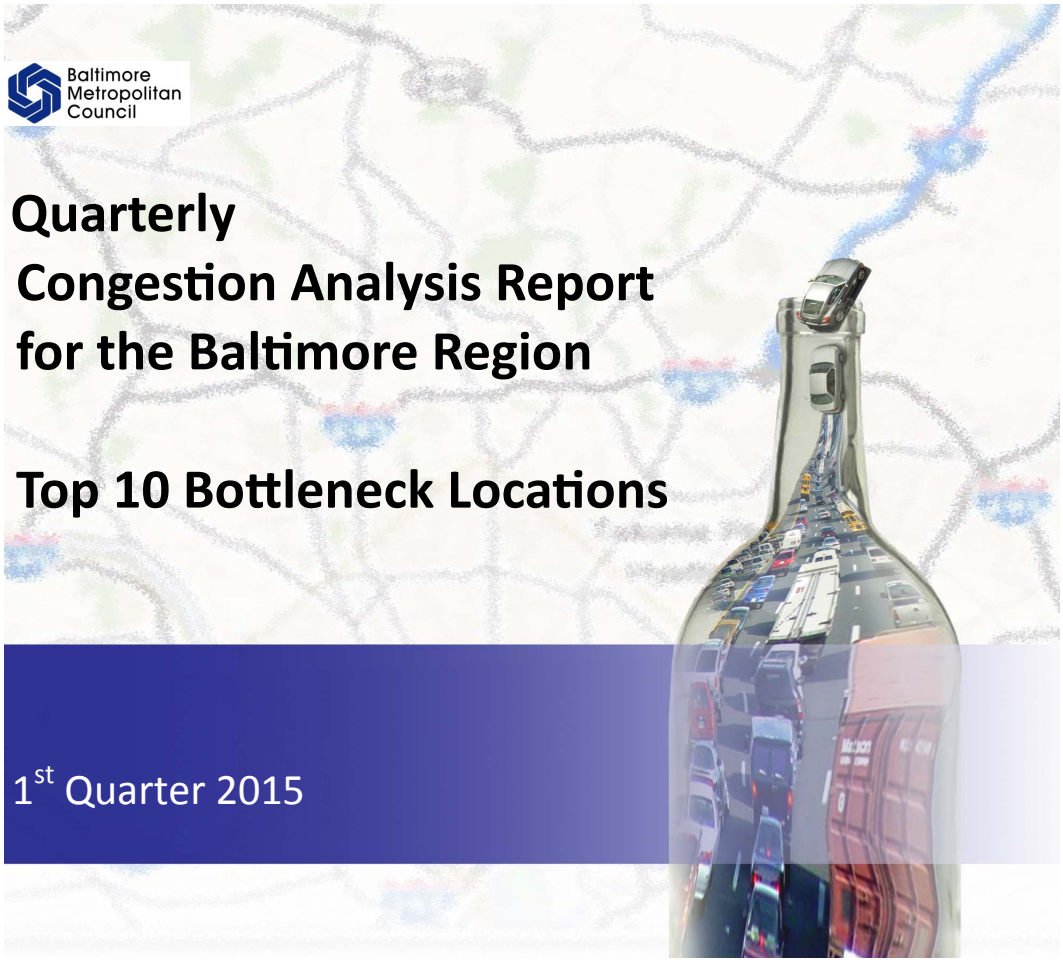
Appendix H: Congestion Management Process



5. Congestion Analysis

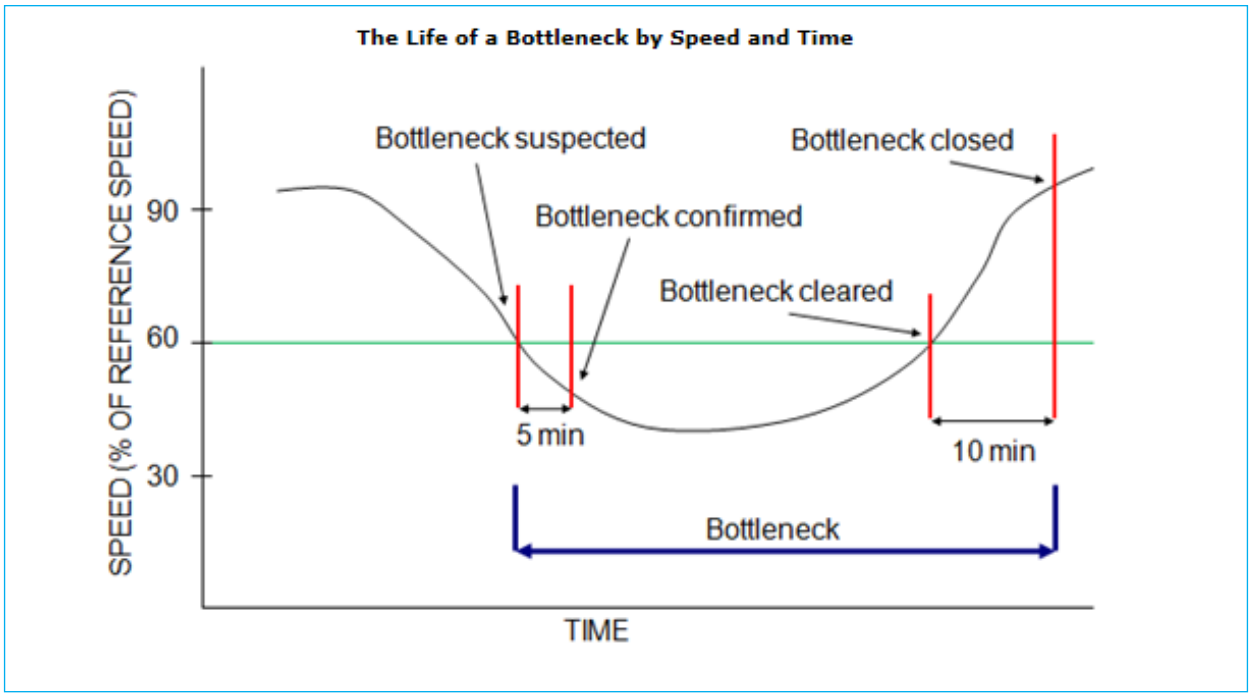
Analysis Based on VPP Data

Using VPP data, beginning in 2013 BMC developed the "Quarterly Congestion Analysis Report" identifying the Top 10 Bottlenecks in the Baltimore Region.



The VPP tool determines bottleneck conditions by comparing the current reported speed to the reference speed for each segment of road. INRIX provides reference speed values for each segment. These represent the 85th percentile observed speed for all time periods, with a maximum value of 65 mph. If the reported speed falls below 60 percent of the reference, the road segment is flagged as a potential bottleneck. If the reported speed stays below 60 percent for five minutes, the segment is confirmed as a bottleneck location. Adjacent road segments meeting this condition are joined together to form the bottleneck queue. When reported speeds on every segment associated with a bottleneck queue have returned to values greater than 60 percent of their reference values and have remained that way for 10 minutes, the bottleneck is considered cleared. The process ignores bottlenecks whose total queue length, determined by adding the length of each road segment associated with the bottleneck, is less than 0.3 miles.

Appendix H: Congestion Management Process



The quarterly report identifies the top bottlenecks in the Baltimore region and ranks them by Impact Factor. This is calculated by multiplying the number of times a bottleneck occurred by its average duration by its average length.

Top 10 Bottlenecks in the Baltimore Region
1st Quarter 2014

By Impact Factor

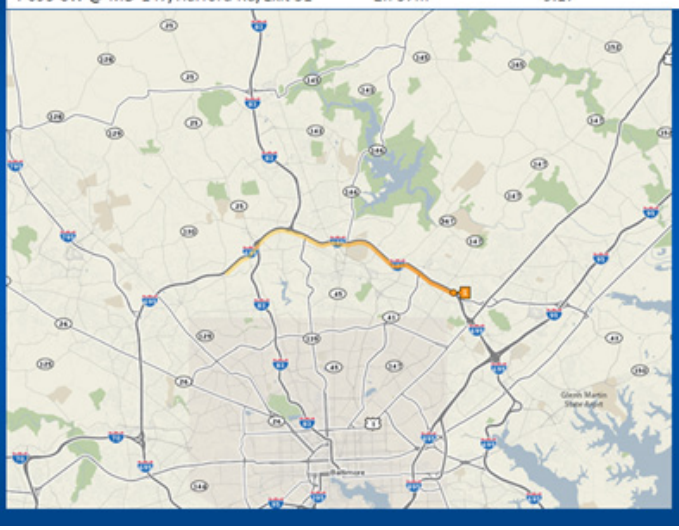
(Number of Occurrences x Average Duration in Minutes x Average Length)

	Location	Average Duration	Average max length (miles)	Occurrences	Impact Factor
1	I-695 CW @ MD-147/Harford Rd/Exit 31	2 h 37 m	9.17	89	128,065
2	US-29 N @ MD-175	1 h 57 m	5.76	164	110,520
3	I-95 N @ MD-100/Exit 43	1 h 39 m	8.07	131	104,596
4	I-695 CCW @ Edmondson Ave/Exit 14	1 h 52 m	5.44	142	86,452
5	I-95 S @ I-495/Exit 27-25	2 h 36 m	20.91	26	84,812
6	I-695 CW @ I-83/MD-25/Exit 23	1 h 26 m	6.59	122	69,193
7	I-83 S @ I-695	58m	3.87	295	66,201
8	MD-295 S @ I-495/I-95	2 h 46 m	12.58	31	64,720
9	I-97 S @ US-301/US-50	1 h 28 m	11.68	58	59,607
10	MD-295 N @ I-195	1 h 40 m	8.71	68	59,222

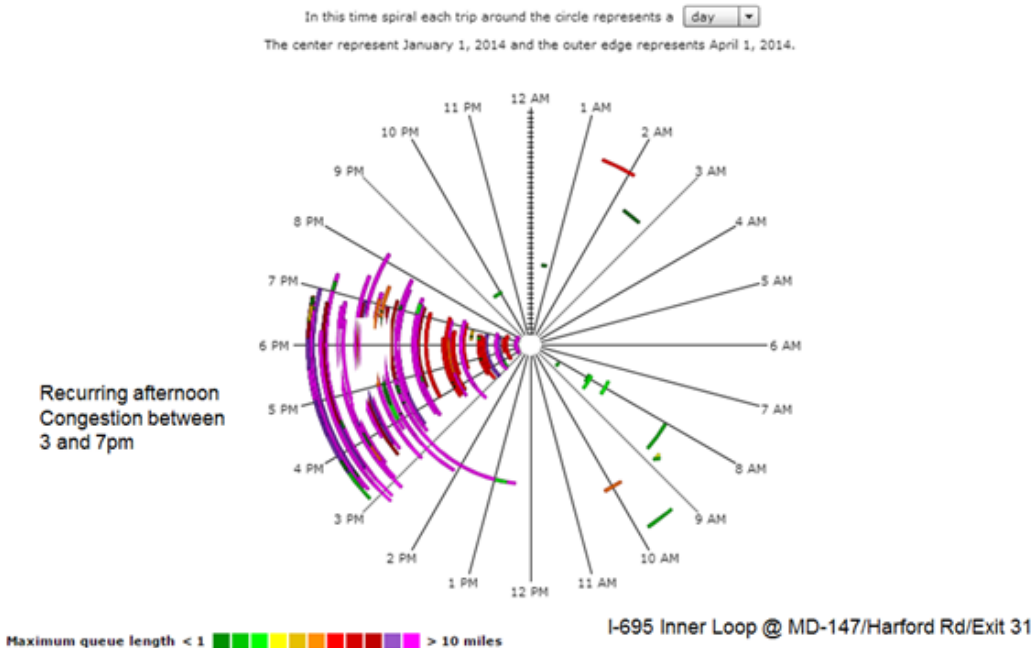
Along with the ranking, staff attempts to assess what is causing the congestion and utilizes tools in the VPP Suite to illustrate what is occurring at each location. The following example uses the top ranked bottleneck from the first quarter of 2014.

#1 Ranked Bottleneck Q1 2014

Location	Average Duration	Average max length (miles)	Occurrences	*Impact Factor
I-695 CW @ MD-147/Harford Rd/Exit 31	2h 37m	9.17	89	128,065



Congestion was most severe between I-83 and Providence Rd. Factors contributing to this long standing and extended congested zone: merging and weaving associated with traffic at each interchange and a lane drop (to 3 lanes) at MD-45/York Rd.

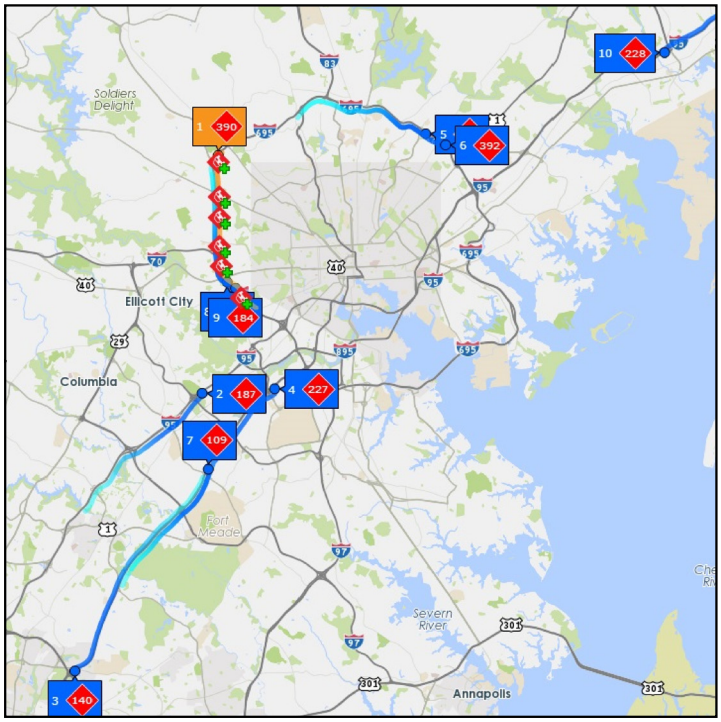


Appendix H: Congestion Management Process

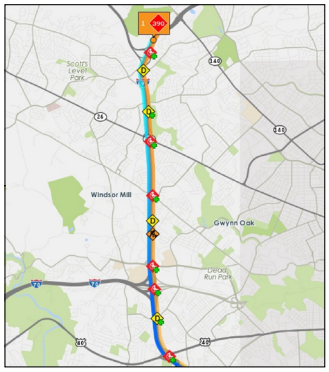
From the bottleneck report, staff can create specialized maps showing congested locations. Following is an example of such a map, this one showing the top 10 congested locations in 2014 based on VPP data.

Top 10 Ranked Bottlenecks in the Baltimore Region 4th Quarter 2014

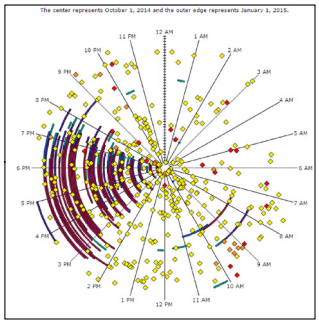
Top 10 Bottlenecks



#1 Ranked Bottleneck



# of Occurrences



Rank	Location	Direction	Average Duration	AVG max length (miles)	Occurrences	Impact Factor	All Events/ Incidents
1	I-695 CW @ I-795/EXIT 19	CLOCKWISE	2 h 16 m	8.68	153	180,532	390
2	I-95 N @ MD-100/EXIT 43	NORTHBOUND	2 h 15 m	8.68	138	161,735	187
3	MD-295 S @ MD-193	SOUTHBOUND	2 h 50 m	11.55	63	123,738	140
4	MD-295 N @ I-195	NORTHBOUND	2 h 25 m	10.17	78	114,982	227
5	I-695 CW @ MD-41/PERRING PKWY/EXIT 30	CLOCKWISE	1 h 47 m	6.01	161	103,602	288
6	I-695 CW @ MD-147/HARFORD RD/EXIT 31	CLOCKWISE	2 h 42 m	8.39	70	95,189	392
7	MD-295 N @ MD-175	NORTHBOUND	2 h 22 m	7.07	92	92,356	109
8	I-695 CCW @ US-40/EXIT 15	COUNTERCLOCKWISE	1 h 30 m	6.68	145	87,182	230
9	I-695 CCW @ EDMONDSON AVE/EXIT 14	COUNTERCLOCKWISE	2 h 14 m	6.44	98	84,580	184
10	I-95 S @ MD-24/EXIT 77	SOUTHBOUND	2 h 06 m	13.13	47	77,767	228

Incident/Event Icons

- Injury
- Police Activity
- Fire
- Closure
- Sports Event
- Delays
- Signal System
- Tornado
- Wind
- Fallen Tree
- Hazmat
- Debris
- Flood
- Animal Struck
- Special Event
- Congestion
- Incident
- Fog
- Fallen Rocks
- Other
- Vehicle Fire
- Collision
- Disabled Vehicle
- Roadwork
- Emergency Roadwork
- Draw Bridge Opening
- Water Main Work
- Medical Emergency
- Overgrown Foliage

Red — Severe events and incidents
- Emergency Roadwork
- Injury
- Medical Emergency

Orange — Roadwork

Yellow — All other events and incidents

Jurisdictional Priority Letters

Each year, the local jurisdictions send so-called "priority letters" to MDOT. These letters list the projects the jurisdictions consider critical to addressing their transportation needs. These needs often include alleviating traffic congestion and addressing safety concerns.

These priority letters are a source of information to help BMC and MDOT staffs identify corridors for additional analysis related to relieving traffic congestion and improving safety. BMC technical analysis would focus on better understanding the extent, duration, and causes of congestion along a corridor and on developing potential operational countermeasures for short-term efficiency and safety. Such analyses would try to capture both recurring and nonrecurring congestion.

Analysis along the selected corridor(s) would help the local jurisdictions better understand the connections among congestion, safety, land use, freight movements, and operations. This process also would establish linkages among local jurisdiction priorities, the regional long-range transportation plan, and the TIP. Data gathered and analyzed by BMC staff also could provide background information for subsequent NEPA analysis.

These types of analyses might be conducted in future years under proposed consultant activities. UPWP funds could be designated for data collection and analysis.

6. Implement/Manage Strategies

Integrated Corridor Management: Focus on MD 295

In 2013, FHWA issued a Request for Applications inviting states, MPOs, and local governments to apply for deployment planning grants to initiate or continue Integrated Corridor Management[1] (ICM) development with their partners, such as arterial management agencies, tolling authorities, and transit authorities. The purpose of this program is to promote the integrated management and operations of the transportation system, thereby improving multimodal transportation system management and operations.

Using the Vehicle Probe Project Suite, BMC staff identified a portion of MD 295 as having the worst bottleneck in 2012. Based on this, staff began developing a congestion brochure to highlight the issues and potential tools that could be used to address the congestion. In the process of gathering information for the brochure, staff learned that the Maryland State Highway Administration (SHA) was also studying this corridor to identify low-cost improvements.

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1 As noted in the TRB RTSMO Committee Glossary of Regional Transportation Systems Management and Operations Terms, "ICM may encompass several activities, such as cooperative and integrated policy among stakeholders, concept of operations for corridor management, communications among network operators and stakeholders, improving the efficiency of cross-network junctions and interfaces, mobility opportunities, including shifts to alternate routes and modes, real-time traffic and transit monitoring, real-time information distribution (including alternate networks), congestion management (recurring and non-recurring), incident management, travel demand management, public awareness programs, transportation pricing and payment, access management, and grown management. Integrated Corridor Management may result in the deployment of an actual transportation management system (ICMS) connecting the individual network-based transportation management systems; or integrated corridor management may just be a set of operational procedures – agree to by the network owners – with appropriate linkages between their respective systems." (See *https://docs.google.com/a/baltometro.org/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnx0cmJydHNtb2NvbW1pdHRlZXxneDo0NWY1OTFjMTg1Nzc3ZTAy*)

Appendix H: Congestion Management Process

MD 295 Congestion Brochure

What Can We Do?

Decision-Makers

We cannot build our way out of congestion. Transportation investments must go toward maintaining the existing system and improving operations to reduce congestion and the effects of incidents. When possible, find dedicated, additional funding for transportation.

Planners, Engineers and Other Partners

- Consider operations strategies, such as emergency traffic patrol, incident management task forces, traffic signal coordination and intersection improvements.
- Incorporate Transportation Demand Management (TDM) by making it more desirable to live near jobs and more convenient to walk, bicycle and take transit; we need to address demand as well as supply of transportation.
- In addition to reducing congestion, review other ways to help freight move reliably.

All of Us

- Check conditions before departing to consider transportation mode, route and least-congested time to travel if you have flexibility.
- Drive safely to reduce the likelihood of a crash.
- Learn about and participate in transportation planning and funding decisions.

Agencies at Work

Baltimore Regional Transportation Board (BRTB) builds consensus among transportation agencies in the Baltimore metropolitan region.

Maryland Department of Transportation (MDOT) mission is to enhance the quality of life for Maryland's citizens by providing a balanced and sustainable multi-modal transportation system for safe, efficient passenger and freight movement.

State Highway Administration (SHA) is responsible for planning, designing, building and maintaining the State's highways and bridges.

Maryland Transportation Authority (MDTA) is responsible for planning, designing, building and maintaining the State's tolled highways and bridges

Maryland Transit Administration (MTA) operates local and commuter buses, light rail, metro subway, commuter rail, and paratransit system.

Everyday Resources

MD 511 - www.md511.org

StreetSmart – http://www.bmorestreetsmart.com/

CHART - http://www.chart.state.md.us/

MTA Trip Planner - http://mta.maryland.gov/

Abstract: Congestion is getting harder to manage, but tools to analyze it and cost-effective measures are getting better. This is the first in a series of brochures using archived operations data to understand the causes of congestion and what can be done about it. The focus corridor for this edition is MD 295 in the vicinity of MD 175, however the emphasis on operations, multimodal approaches, and partnerships as realistic approaches to congestion are widely applicable.

The Baltimore Regional Transportation Board is the Metropolitan Planning Organization for the Baltimore region. The BRTB is an 11 member board representing the cities of Annapolis and Baltimore; Anne Arundel, Baltimore, Carroll, Harford and Howard counties; the Maryland Departments of Transportation, Environment,, and Planning; and the Maryland Transit Administration. The Baltimore Metropolitan Council provides technical and staff support to the BRTB.

Photo Credits: Ed Stylc; Baltimore Metropolitan Council; US Park Service Web Page

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BRTB Baltimore Regional Transportation Board
Baltimore Metropolitan Council

Sitting in traffic *again*?

We all have better things to do...

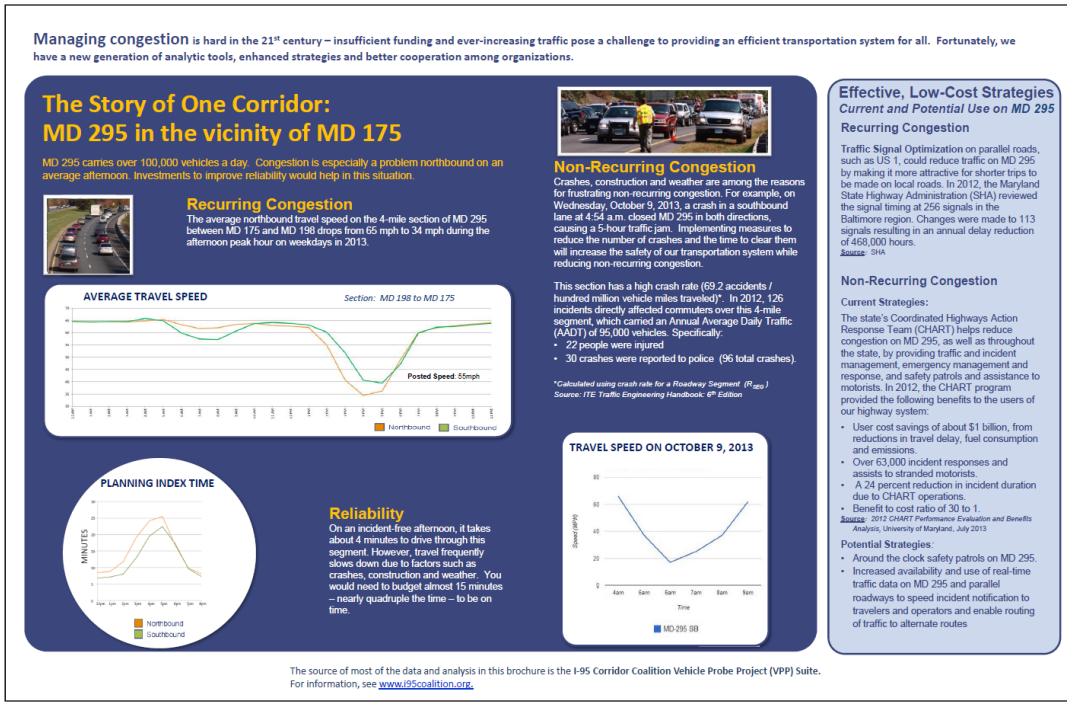
Inside:
New tools and what you can do to reduce congestion

This Edition:
MD 295 in the vicinity of MD 175

Congestion costs each traveler in this 4-mile section $2,400 per year!

BRTB Baltimore Regional Transportation Board

March 2014



Managing congestion is hard in the 21st century – insufficient funding and ever-increasing traffic pose a challenge to providing an efficient transportation system for all. Fortunately, we have a new generation of analytic tools, enhanced strategies and better cooperation among organizations.

The Story of One Corridor: MD 295 in the vicinity of MD 175

MD 295 carries over 100,000 vehicles a day. Congestion is especially a problem northbound on an average afternoon. Investments to improve reliability would help in this situation.

Recurring Congestion

The average northbound travel speed on the 4-mile section of MD 295 between MD 175 and MD 198 drops from 65 mph to 34 mph during the afternoon peak hour on weekdays in 2013.

Reliability

On an incident-free afternoon, it takes about 4 minutes to drive through this segment. However, travel frequently slows down due to factors such as crashes, construction and weather. You would need to budget almost 15 minutes – nearly quadruple the time – to be on time.

Non-Recurring Congestion

Crashes, construction and weather are among the reasons for frustrating non-recurring congestion. For example, on Wednesday, October 9, 2013, a crash in a southbound lane at 4:54 a.m. closed MD 295 in both directions, causing a 5-hour traffic jam. Implementing measures to reduce the number of crashes and the time to clear them will increase the safety of our transportation system while reducing non-recurring congestion.

This section has a high crash rate (69.2 accidents / hundred million vehicle miles traveled)*. In 2012, 126 incidents directly affected commuters over this 4-mile segment, which carried an Annual Average Daily Traffic (AADT) of 95,000 vehicles. Specifically:

- 22 people were injured
- 30 crashes were reported to police (96 total crashes).

**Calculated using crash rate for a Roadway Segment (R_{SEG})*
Source: ITE Traffic Engineering Handbook: 6th Edition

Effective, Low-Cost Strategies

Current and Potential Use on MD 295

Recurring Congestion

Traffic Signal Optimization on parallel roads, such as US 1, could reduce traffic on MD 295 by making it more attractive for shorter trips to be made on local roads. In 2012, the Maryland State Highway Administration (SHA) reviewed the signal timing at 256 signals in the Baltimore region. Changes were made to 113 signals resulting in an annual delay reduction of 468,000 hours.
Source: SHA

Non-Recurring Congestion

Current Strategies:

The state's Coordinated Highways Action Response Team (CHART) helps reduce congestion on MD 295, as well as throughout the state, by providing traffic and incident management, emergency management and response, and safety patrols and assistance to motorists. In 2012, the CHART program provided the following benefits to the users of our highway system:

- User cost savings of about $1 billion, from reductions in travel delay, fuel consumption and emissions.
- Over 63,000 incident responses and assists to stranded motorists.
- A 24 percent reduction in incident duration due to CHART operations.
- Benefit to cost ratio of 30 to 1.

Source: *2012 CHART Performance Evaluation and Benefits Analysis*, University of Maryland, July 2013

Potential Strategies:

- Around the clock safety patrols on MD 295.
- Increased availability and use of real-time traffic data on MD 295 and parallel roadways to speed incident notification to travelers and operators and enable routing of traffic to alternate routes

The source of most of the data and analysis in this brochure is the **I-95 Corridor Coalition Vehicle Probe Project (VPP) Suite.**
For information, see www.i95coalition.org.

As a result of meetings with staff from SHA to discuss the corridor and potential solutions, SHA and BMC staff agreed that the region should apply for the ICM grant to help jump start this approach in the corridor. The grant work will include developing a Concept of Operations for integrated corridor operations; beginning the development of an Analysis, Modeling, and Simulation Plan for the corridor; and developing an ICM deployment approach.

The area selected includes the north-south corridor of MD 295, US 1, and I-95 from I-695 to MD 32. The project will consider roadway and transit alternatives and will include the following groups: SHA; BMC/BRTB and relevant committees; Anne Arundel, Baltimore, and Howard counties; MTA, Central Maryland Regional Transit, the National Park Service, and Fort Meade.

SHA will be the lead for this project, working closely with BMC and the other project stakeholders.

Maximize2040 Strategies

The BRTB approved the following strategies under the goal of Improve Mobility. These strategies will help the region reduce congestion and improve traffic flow.

- Continue to refine and implement a Congestion Management Process (CMP), incorporating the statewide Intelligent Transportation System architecture and transportation systems management and operations (TSMO) strategies.
- Prepare congestion mitigation plans, including the consideration of congestion pricing, for corridors and locations experiencing recurring high congestion levels.
- Balance capacity in the highway, transit, and freight rail systems and pedestrian and bicycle networks, including the consideration of expanded transit service coverage and hours of operation.
- Increase mobility, including traffic and transit incident response and recovery, through traffic and transit system management and operations techniques.
- Improve transportation system reliability by developing better methods of reporting delays and incidents among modal agencies and through broad-based public information distribution for interstate highways, surface streets, and the transit network.

Other strategies that might be considered in the future to help the region ease congestion are:

- Work more closely with other adjacent metropolitan areas to develop interregional approaches to measuring and managing congestion, including performance measures adopted and applied on an interregional basis. As noted previously, the Baltimore region has taken some initial steps in this area by meeting periodically with traffic and operations staff from adjacent MPOs and other state DOTs to discuss interregional approaches to improving mobility and managing congestion.
- Select relatively low-cost, "low-hanging fruit" congestion management projects ("spot" improvements, signal timing) that could be funded with CMAQ or, potentially, PL or STP funds.

Specific Strategies – Preferred Alternative Projects

BMC staff requested some detailed information from local jurisdictions submitting projects for consideration for *Maximize2040*. Some of this information relates to strategies, either in place or under consideration, that could provide congestion management benefits for each proposed project. The following chart shows the strategies proposed for each project in the preferred alternative:

Appendix H: Congestion Management Process

Congestion Management Strategies – Projects in the Preferred Alternative

Project Name	Project Limits	Improvement	Likely Congestion Management Strategies*
Regional			
MARC Growth and Investment Phases 1 and 2		Improvements to MARC mainline capacity, maintenance facilities, and station areas, 2020-2040	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.) • Public Transportation – Capacity Strategies (i.e., reserved travel lanes or rights-of-way for transit operators, more frequent service, expanded hours of service, expanded coverage network, etc.)
MTA Bus Expansion Program Phases 1 and 2		Purchase of buses to meet increasing ridership demands (beyond replacement needs), 2020-2040	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.) • Public Transportation – Capacity Strategies (i.e., reserved travel lanes or rights-of-way for transit operators, more frequent service, expanded hours of service, expanded coverage network, etc.)
Anne Arundel County			
U.S. 50 Bus Rapid Transit	Proposed Annapolis-Parole Intermodal Center to Prince George's County line	New bus rapid transit service	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.) • Public Transportation – Capacity Strategies (i.e., reserved travel lanes or rights-of-way for transit operators, more frequent service, expanded hours of service, expanded coverage network, etc.)
MD 175	Howard County line to MD 170	Widen from 2 to 3 lanes from Howard County line to MD 295 Widen from 4 to 6 lanes from MD 295 to MD 170	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes • Remove bottlenecks
MD 100	Howard County line to I-97	Widen from 4 to 6 lanes	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes • Remove bottlenecks

* Congestion management strategies listed in this table are based on information provided by the local jurisdictions and operating agencies, as well as staff knowledge of existing operational characteristics along these project corridors.

Congestion Management Strategies – Projects in the Preferred Alternative

Project Name	Project Limits	Improvement	Likely Congestion Management Strategies*
MD 198	MD 295 to MD 32	Widen from 2 to 4 lanes to provide easier access to Ft. Meade and Odenton Town Center	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes • Remove bottlenecks
MD 295	I-195 to MD 100	Widen from 4 to 6 lanes	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes • Remove bottlenecks
MD 713	MD 175 to MD 176	Widen from 2 to 4 lanes: MD 175 to Arundel Mills Boulevard; widen from 4 to 6 lanes: Arundel Mills Boulevard to MD 176	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes • Remove bottlenecks
U.S. 50/301	I-97 to MD 2	Bridge reconstruction/ widening; movable barrier on bridge	• Construct new lanes
Anne Arundel County / Howard County			
Bus Rapid Transit to BWI Airport	Dorsey MARC station to BWI light rail station	New bus rapid transit service: Dorsey MARC station to Arundel Mills to BWI consolidated rental car facility to BWI light rail station	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.) • Public Transportation – Capacity Strategies (i.e., reserved travel lanes or rights-of-way for transit operators, more frequent service, expanded hours of service, expanded coverage network, etc.)
Baltimore City			
Bayview MARC and Intermodal Station	Lombard Street at Bayview Boulevard	New station	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.) • Accessibility Strategies (i.e., improvements to bicycle and pedestrian facilities to provide access to transit stops, provisions for bicycles on transit vehicles and at transit stops, etc.)

Congestion Management Strategies – Projects in the Preferred Alternative

Project Name	Project Limits	Improvement	Likely Congestion Management Strategies*
Green Line	Johns Hopkins Hospital to North Avenue	Extension of Metro line, including two new stations (at Amtrak line and North Avenue)	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.) • Public Transportation – Capacity Strategies (i.e., reserved travel lanes or rights-of-way for transit operators, more frequent service, expanded hours of service, expanded coverage network, etc.)
West Baltimore MARC Station		Station upgrades	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.)
Moravia Road	Belair Road to Sinclair Lane	Roadway, curb, and sidewalk rehabilitation; ADA Improvements; streetscape elements	• Accessibility Strategies (i.e., improvements to bicycle and pedestrian facilities to provide access to transit stops, provisions for bicycles on transit vehicles and at transit stops, etc.)
Baltimore County			
I-695	I-95 to MD 122	Widen from 6 to 8 lanes	• Traffic Operations Strategies (i.e., controlled by Traffic Management Center, Traffic Incident Management, Traveler Information Systems, Work Zone Management, Special Event (planned and unplanned) Coordination, etc.) • Construct new lanes • Remove bottlenecks
I-695	I-95 to I-83	Widen from 6 to 8 lanes; allows for future lanes from I-95 SW to I-95 NE	• Traffic Operations Strategies (i.e., controlled by Traffic Management Center, Traffic Incident Management, Traveler Information Systems, Work Zone Management, Special Event (planned and unplanned) Coordination, etc.) • Construct new lanes • Remove bottlenecks
I-695 / Broening Highway		Full interchange at Exit 44 of I-695 to support redevelopment at Sparrows Point	• Traffic Operations Strategies (i.e., controlled by Traffic Management Center, Traffic Incident Management, Traveler Information Systems, Work Zone Management, Special Event (planned and unplanned) Coordination, etc.) • Add interchange

Congestion Management Strategies – Projects in the Preferred Alternative

Project Name	Project Limits	Improvement	Likely Congestion Management Strategies*
I-795	Franklin Boulevard to Owings Mills Boulevard	Widen from 4 to 6 lanes, including addition of auxiliary lanes to Owings Mills Boulevard; includes new interchange at Dolfield Boulevard	• Traffic Operations Strategies (i.e., controlled by Traffic Management Center, Traffic Incident Management, Traveler Information Systems, Work Zone Management, Special Event (planned and unplanned) Coordination, etc.) • Construct new lanes • Remove bottlenecks • TMA is in the vicinity
I-83 over Padonia Road		Reconstruct I-83 bridge; pedestrian and bike improvements to Padonia Road	• Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.)
MD 26	Rolling Road to Courtleigh Drive	Roadway, curb, sidewalk, bicycle, ADA, and pedestrian improvements	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Accessibility Strategies (i.e., improvements to bicycle and pedestrian facilities to provide access to transit stops, provisions for bicycles on transit vehicles and at transit stops, etc.)
MD 140	Garrison View Road to Owings Mills Road	Widen from 4 to 6 lanes; northbound third lane drops north of Owings Mills Boulevard	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes • Remove bottlenecks • TMA is in the vicinity
MD 140 / Painters Mill Road	MD 140 / Painters Mill intersection; access roads east and west of MD 140	Intersection improvements, additional left turn lane, and parallel access roads	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.)
Carroll County			
TrailBlazer Transit Hub	Westminster area	Centrally located facility to enable transfers and travel training for TrailBlazer riders	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.)

Congestion Management Strategies – Projects in the Preferred Alternative

Project Name	Project Limits	Improvement	Likely Congestion Management Strategies*
MD 26	MD 32 to Reservoir	Widen from 4 to 6 lanes; addition of pedestrian and bicycle facilities	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes
MD 31 (New Windsor Main Street / High Street)	Church Street to Coe Drive	Infrastructure improvements and pavement rehabilitation	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.)
MD 32	MD 26 to Howard County line	Widen from 2 to 4 lanes; addition of pedestrian and bicycle facilities	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes • Remove bottlenecks
MD 97 North	MD 140 overpass to Bachmans Valley Road	Widen from 2 to 5 lanes, including interchange at Meadow Branch Road; addition of pedestrian and bicycle facilities	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes • Remove bottlenecks
MD 140	Market Street to Sullivan Road	Widen from 6 to 8 lanes, full interchange at MD 97 (Malcolm Drive), Continuous Flow Intersection (CFI) at Center Street and Englar Road, addition of pedestrian and bicycle facilities	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes • Remove bottlenecks

Congestion Management Strategies – Projects in the Preferred Alternative

Project Name	Project Limits	Improvement	Likely Congestion Management Strategies*
MD 140 at MD 91	Baltimore County line to Kays Mill Road	Divided highway with new interchange at MD 91 and intersection improvements, addition of pedestrian and bicycle facilities	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes • Remove bottlenecks
MD 851 (Sykesville Main Street / Springfield Avenue)	Howard County line to Cooper Drive	Infrastructure improvements and pavement rehabilitation	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.)
Harford County			
Aberdeen MARC Station Transit Oriented Development (TOD)	U.S. 40 at MD 132 / Bel Air Road	New train station, additional parking, U.S. 40 "Green Boulevard," Station Square Plaza	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.) • Accessibility Strategies (i.e., improvements to bicycle and pedestrian facilities to provide access to transit stops, provisions for bicycles on transit vehicles and at transit stops, etc.)
MD 22	MD 543 to APG Gate	Widen existing 2- and 3-lane section to 4 and 5 lanes; include HOV lane from Old Post Road to APG gate; bicycle and pedestrian access and transit queue jump lanes where applicable	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Accessibility Strategies (i.e., improvements to bicycle and pedestrian facilities to provide access to transit stops, provisions for bicycles on transit vehicles and at transit stops, etc.) • Construct new lanes

Congestion Management Strategies – Projects in the Preferred Alternative

Project Name	Project Limits	Improvement	Likely Congestion Management Strategies*
MD 24	U.S. 1 Bypass to south of Singer Road	Widen from 4 to 6 lanes; includes sidewalks and bicycle accommodations where appropriate	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes
MD 24 – Section G	900 feet south of Sharon Road to 1,700 feet north of Ferncliff Lane	Resurfacing and reconstruction, including slope repair and guardrail replacement	
U.S. 1 Bypass	MD 147 / U.S. 1 Business to north of MD 24 / MD 924	Widen from 2 to 4 lanes; improve U.S. 1 / MD 24 and U.S. 1 / MD 924 interchanges	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes
U.S. 1	MD 152 to MD 147 / U.S. 1 Business	Widen from 4 to 6 lanes, including bicycle and pedestrian accommodations	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes
Harford County / Baltimore City			
MTA Commuter Bus Service	Harford County to downtown Baltimore and Harbor East; from Baltimore to Aberdeen Proving Ground (APG)	Additional service to downtown Baltimore / Harbor East; reverse commute from Baltimore to APG; connection of U.S. 40 service with Harford Transit	• Public Transportation – Capacity Strategies (i.e., reserved travel lanes or rights-of-way for transit operators, more frequent service, expanded hours of service, expanded coverage network, etc.)
Howard County			
U.S. 29 Bus Rapid Transit	U.S. 29 at Mount Hebron to MD 198 / U.S. 29 (Burtonsville)	New bus rapid transit service	• Public Transportation – Operations Strategies (i.e., providing real time arrival information, enhanced transit amenities and safety, transit signal priority, bus rapid transit, etc.) • Public Transportation – Capacity Strategies (i.e., reserved travel lanes or rights-of-way for transit operators, more frequent service, expanded hours of service, expanded coverage network, etc.)

Congestion Management Strategies – Projects in the Preferred Alternative

Project Name	Project Limits	Improvement	Likely Congestion Management Strategies*
I-70	U.S. 29 to U.S. 40 (near MD 32)	Widen from 4 to 6 lanes; includes reconstruction of I-70 / Marriottsville Road interchange and upgrading of I-70 / U.S. 29 interchange	• Traffic Operations Strategies (i.e., controlled by Traffic Management Center, Traffic Incident Management, Traveler Information Systems, Work Zone Management, Special Event (planned and unplanned) Coordination, etc.) • Construct new lanes • Remove bottlenecks
MD 32	MD 108 to I-70	Widen from 2 to 4 lanes; includes new interchanges at Rosemary Lane and MD 144 and upgrades to I-70 interchange	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes • Remove bottlenecks
MD 32	North of I-70	Widen from 2 to 4 lanes; safety, operational, and access improvements	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes
MD 108	Trotter Road to Guilford Road	Widen roadway where needed/ possible to 4 lanes; includes 8- to 10-foot pedestrian/ bicycle pathways and new signalized intersections (including pedestrian actuation)	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes
Snowden River Parkway	Oakland Mills Road to Broken Land Parkway	Widen from 4 to 6 lanes; includes auxiliary lanes and pedestrian, bicycle, and transit improvements on both sides of road	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes

Congestion Management Strategies – Projects in the Preferred Alternative			
Project Name	**Project Limits**	**Improvement**	**Likely Congestion Management Strategies***
U.S. 1 Typical Section	Montevideo Road north to MD 100	Widen from 4 to 6 lanes; construct typical section as defined in State/ County MOU for U.S. 1 revitalization	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Promoting alternatives to single-occupant vehicle travel (i.e., transit, ridesharing, bicycling, walking, park and ride lot, etc.) • Construct new lanes
U.S. 1 / MD 175 Interchange		Grade separation at U.S. 1 / MD 175 coordinated with I-95 / MD 175 improvements	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.)
U.S. 29	Patuxent River Bridge to Seneca Drive	Widen from 4 to 6 lanes; includes auxiliary lanes and grade-separated access to community of Rivers Edge	• Arterial and Local Road Operations (i.e., signal timing optimization, coordinated intersection signal timing, turn restrictions, geometric improvements, transit signal priority, road diet, etc.) • Construct new lanes

CHART

The Coordinated Highways Action Response Team (CHART) program is a statewide program operated jointly by MDOT, SHA, MDTA, and Maryland State Police. CHART focuses its operations on nonrecurring congestion, such as crashes. The Statewide Operations Center, Authority Operations Center, and the two satellite Operations Centers in the region survey the state's roadways to quickly identify incidents. CHART also includes traffic patrols, which operate 24 hours / 7 days per week on many of the state highways in the region. The patrols play a key part in guiding traffic around the incidents and in clearing the scene more quickly. The faster broken-down or crashed vehicles are cleared, the less time travelers spend in their cars due to lane blockages. Besides mitigating congestion and reducing delay, CHART operations save many gallons of fuel that otherwise would be burned and polluting the air.

7. Monitor Effectiveness of Strategies

As noted in the discussions under steps 4 and 5, data from the VPP Suite and analyses using VPP and other data provide information on congestion problem areas. The ongoing program provides BMC staff and other planners with feedback on the performance of transportation investments and provides insight for future decisions.