Maryland Department of Transportation
The Secretary's Office

Larry Hogan
Governor

Boyd K. Rutherford
Lt. Governor

Pete K. Rahn
Secretary

October 5, 2016

Secretary Brian Grumbles
Chair
Maryland Commission on Climate Change
1800 Washington Blvd
Baltimore MD 21230

Dear Chair Grumbles:

Attached is the annual report pursuant to §2-1305 of the Environment Article that states the Maryland Department of Transportation (MDOT) shall report annually on the status of programs that support the State's greenhouse gas reduction efforts or address climate change, in accordance with § 2–1246 of the State Government Article, to the Commission and the Governor.

If you have any questions, please contact Ms. Colleen Turner, MDOT Air Quality and Climate Change Program Manager, at 410-865-2273 or cturner@mdot.state.md.us. Of course, you may always contact me directly.

Sincerely,

Pete K. Rahn
Secretary

cc: The Honorable Larry Hogan, Governor, State of Maryland
Ms. Colleen Turner, Manager, Air Quality and Climate Change Program, Office of Planning and Capital Programming, MDOT
Ms. Sarah Albert, Library Associate, Department of Legislative Services, MSAR 10580

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The Honorable Larry Hogan
Governor
State House
100 State Circle
Annapolis MD 21401

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Maryland Department of Transportation

2016 Status Report

Required under the

Maryland Commission on Climate Change Act

[Environment Article §2-1305]

MSAR 10580

September 30, 2016

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Introduction

In 2009, the Maryland Department of Transportation (MDOT) began working with stakeholders to develop a comprehensive approach to reduce Greenhouse Gas (GHG) emissions from the transportation sector by 2020. This was in response to growing concern over the effects posed by climate change and the passage of the Greenhouse Gas Emission Reduction Act of 2009 (GGRA).

- In 2011, MDOT finalized the 2012 Implementation Plan required by the GGRA and subsequently worked with the Maryland Department of the Environment (MDE) and other state partners to develop the 2013 Greenhouse Gas Reduction Plan (2013 GGRP).

- The GGRA required a 2015 update to the 2013 GGRP indicating Maryland's progress in meeting the 2020 GHG emission reduction goal (25 percent below 2006 emissions by 2020). MDOT assisted MDE in development of the report for the transportation sector and, in parallel, developed a transportation-specific report that details MDOT's accomplishments to date, emission trends, and programs and projects planned for implementation that will support GHG emissions reductions through and beyond 2020.

The 2014 Executive Order (01.01.2014.14) and the 2015 Maryland Commission on Climate Change Act (Act) expanded the membership of the MCCC and required it to maintain a comprehensive action plan, with 5-year benchmarks, to achieve science-based reductions in Maryland's GHG emissions. The Maryland Commission on Climate Change (MCCC) submitted its first annually required report per Executive Order in December 2015.

MDOTs Transportation Role

MDOT's mission communicates the importance of a customer-driven transportation system. The mission, along with the six goals identified in the Maryland Transportation Plan, guides MDOT through statewide transportation planning, programming and coordination across its transportation business units (TBUs) to facilitate the strategic development of Maryland's intermodal transportation system.

The Annual Attainment Report on System Performance serves as an annual statewide report on "Transportation System Performance" that explores how MDOT has worked together in the past year and assesses progress towards achieving the goals and objectives of the Maryland Transportation Plan (MTP). Each chapter presents the progress made and the future strategies for each of the six MTP goals: safety & security, system preservation, quality of service, environmental stewardship, community vitality, and economic prosperity.

A number of measures within the Attainment Report are considered indicators for greenhouse gas emissions, such as measures targeting transit ridership, transit service reliability, roadway congestion, traffic safety, quality of the bicycle and pedestrian environment, and fuel consumption. In addition, MDOT documents annual estimates of total GHG emissions from on-road transportation in Maryland, which are based on current vehicle miles traveled (VMT) data and fleet characteristics.

In addition, MDOT is now deploying a new, customer-driven, performance management system, the MDOT Excellerator, which summarizes tangible results of MDOTs performance on a quarterly basis. This program is a living, evolving performance process that is in a constant state of evaluation, analysis and action. The results represent critical data points that drive daily business decisions. Tangible result #9 within the Excellerator, Be a Good Steward of the Environment, notes the following objective: "MDOT will be accountable to our customers for the wise use of limited resources and our impacts on the environment when designing, building, operating and maintaining a transportation system." Measures include total gallons of fuel consumed quarterly by the MDOT fleet.

These goals reflect the diversity of current and future transportation conditions, challenges, and needs. The Consolidated Transportation Program (CTP), the State's six-year capital investment program for transportation, identifies funding for specific road, bridge, transit, aviation, port, pedestrian and bikeway projects based on the priorities established in the MTP. Many of the goal areas identified in the MTP include projects and programs in the CTP that directly or indirectly yield GHG emission reductions from transportation system users or the actual operation of the transportation system itself.

Within the 2015 GHG Reduction Plan as well as prior reports, MDOT has documented the share of CTP funding dedicated to GHG beneficial projects. Within the Fiscal Year (FY) 2015 - 2020 CTP, MDOT estimated that 43 percent of Maryland's $14.434 billion six-year program (approximately $6.247 billion) is associated with investments that could reduce GHG emissions by 2020 and beyond. Note, nearly $4 billion of the six-year program (27 percent) is committed to projects that maintain and preserve the transportation system.

The successful maintenance, operation, and expansion of Maryland's transportation system requires extensive coordination between MDOT and a diversity of Federal, State, regional, and local partners. This coordination is extremely critical given the shared approach between multiple government agencies as well as private entities in delivering Maryland's transportation system. Regulatory, financial, political, legal, and contractual matters, among others, create a complex framework within which MDOT manages Maryland's transportation system. This framework guides how MDOT, other transportation planning agencies, and transportation service providers function. The consideration of climate change is one of many factors embedded within this framework.

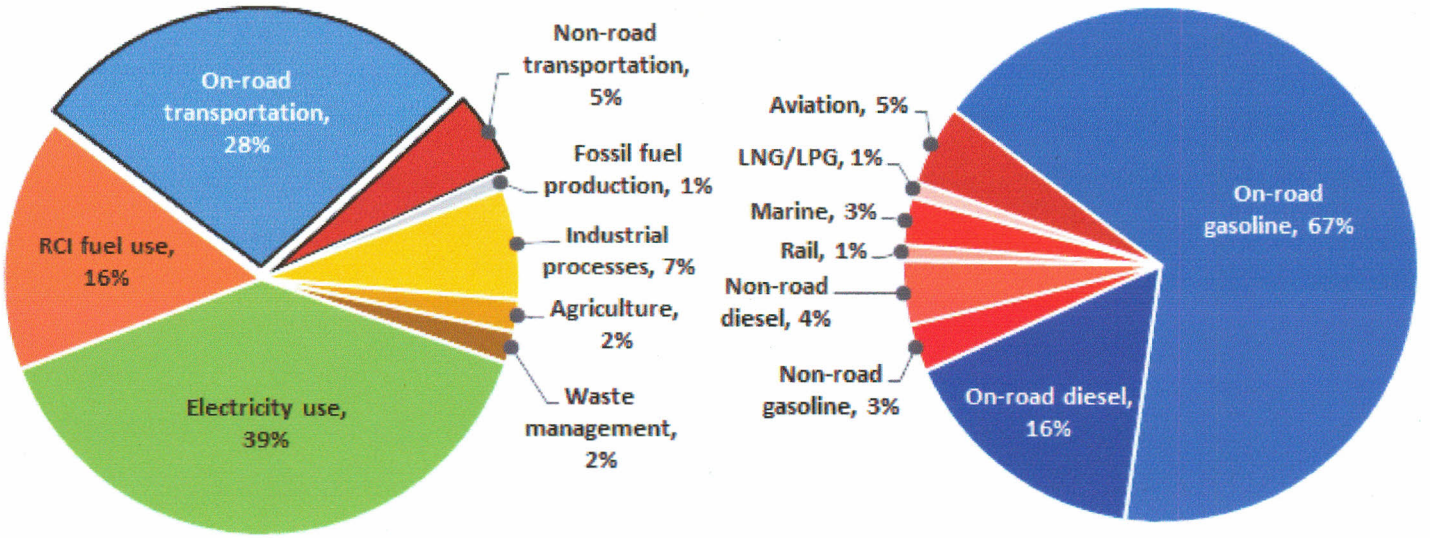
More than any other sector, the performance of Maryland's transportation system as well as MDOTs ability to maintain and enhance the system, is influenced by external social, technological, and economic trends. Building trends toward a "sharing economy" (particularly in transportation), vehicle technology and fuel advancements including electric and autonomous/connected vehicles, and changing logistics and supply chain patterns will greatly impact use of the transportation system. These trends will considerably shape Maryland's ability to reduce GHG emissions from the transportation sector over the coming decades. In many cases Maryland and MDOT specifically, has little control in how these trends will play out.

The Role of Transportation in Maryland GHG Emissions

In 2006, transportation represented 33 percent of Maryland GHG emissions (Figure 1.1). Of the 33 percent, 28 percent is from on-road mobile sources (e.g., cars, buses, and trucks), and the remaining 5 percent is from non-road transportation (e.g., airplanes, boats, locomotives, and construction equipment).

Within the transportation sector, 67 percent of emissions come from on-road gasoline vehicles (e.g., typical passenger cars and light-duty trucks) and 16 percent of emissions come from on-road diesel vehicles (e.g., delivery trucks, combination trucks, and buses). The remaining 17 percent is a split of aviation (5 percent), marine (1 percent), rail (1 percent), non-road gasoline and diesel (7 percent), and liquefied natural gas (LNG) vehicles and off-road equipment (1 percent).

Figure 1.1 Transportation Sector Contribution to Maryland GHG Emissions, 2006



Maryland's transportation sector proportion is above the nationwide average of 28 percent. This is partly attributable to the extensive pass-thru transportation in Maryland, resulting in a higher emissions impact proportional to Maryland's economy.

MDOT programs can directly impact GHG emissions from on-road vehicles. Levers to impact emissions from aviation, marine, rail, and non-road sources are indirect and primarily focus on operations within the boundaries of the Port of Baltimore and Maryland's airports, but not on the remainder of commercial operations, where most of the emissions actually occur.

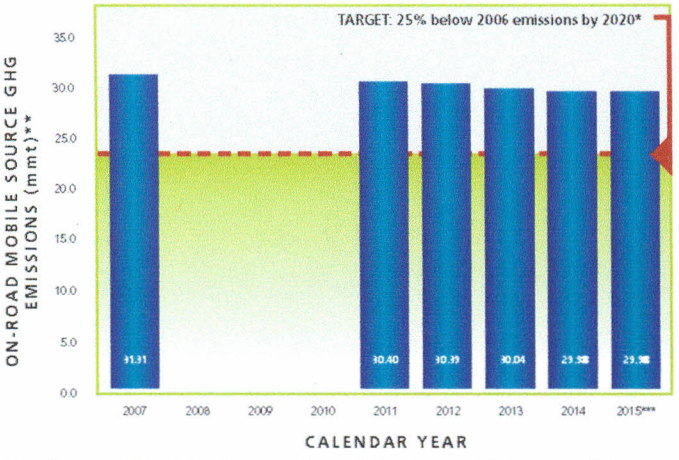
2015 On-Road Transportation Emissions Reductions

Figure 1.2 illustrates the estimate emissions benefits from the on-road mobile source sector from 2011 through 2015 as documented in MDOT's 2016 Annual Attainment Report on System Performance.

Figure 1.2 MDOT Annual Emissions Summary from the 2016 Attainment Report

MDOT: Transportation-Related Greenhouse Gas Emissions

A reduction in the growth of overall VMT is one of several strategies that MDOT is pursuing to address climate change through mitigation of GHG emissions. Reducing growth in VMT through providing transportation alternatives has other potential benefits to Marylanders, such as reduced congestion, reduced travel costs and improved travel time reliability. Other strategies include investing in technologies that minimize GHG, providing alternatives to Single-Occupancy Vehicle (SOV) travel and transitioning to a less carbon-intensive vehicle fleet and lower carbon fuels.



The MDOT selected GHG emission reduction goal (25% below 2006 emissions by 2020) is consistent with the statewide target set in the 2009 Greenhouse Gas Reduction Act. For on-road transportation, the goal equals 23.5 mmt CO2e in 2020.

*** MMT stands for million metric tons, the standard unit of measurement for GHG emissions. Emissions calculated using EPA's MOVES2010b model.*

**** 2015 data is preliminary and subject to change.*

Why Did Performance Change?

- Vehicle GHG emissions have continued to decrease nationwide due to improved vehicle technologies, growing consumer preference and improved price competitiveness for more fuel-efficient vehicles, including hybrid and electric vehicles. There are over 5,000 EVs currently owned by Maryland households, with access to over 610 charging stations across 269 locations.
- MDOT-implemented emission-reduction strategies in non-attainment areas to foster expansion and improved service for alternative modes, including carpooling and transit, for commute trips.
- With new hybrid and clean diesel bus replacements in CY 2014 and 2015, 89% of MTA's current fleet now uses clean technology alternatives to conventional diesel.
- The Port used grants and other funds to update equipment including engine repowers, anti-idling devices, vehicle replacements and electrification of gantries.
- MDOT has conducted planning activities to support the 2009 GGRA, including development of a 2015 GGRA Plan Update, which was legislatively required.
- SHA placed 2,600 tons of foamed asphalt stabilized base (FASB) utilizing 100% recycled asphalt pavement material in highway construction in FY 2015. FASB allows use of significant quantities of recycled asphalt and concrete materials and reduces GHG emissions.

What Are Future Performance Strategies?

- MDOT will continue to participate on the Maryland Commission on Climate Change and its associated work groups, helping to develop a sustainable approach and action plan to mitigate GHG emissions beyond 2020.
- SHA will continue to use the FHWA Infrastructure Carbon Estimator Tool to estimate life cycle energy and GHG emissions associated with different construction material and roadway maintenance programs.
- SHA is using its Carbon Footprint and Reduction Recommendations Report to further develop agency-wide GHG reduction strategies and is tracking performance in the FY 2016 - FY 2019 SHA Business Plan.
- MTA will continue to make strategic investments in projects and programs, such as BaltimoreLink, to redesign Local and express Bus service, improved passenger information, and fleet vehicle replacements and overhauls, to improve reliability and passenger comfort.
- Continue MTA's green bus fleet service expansion with purchases of clean technology buses to replace buses in service for 12 or more years.
- MDOT will continue to work with multiple State business units and private partners to implement recommendations of the Maryland EVIC. Recent developments include extension of the EV excise tax credit to June 2017 and deployment of 21 fast-charging stations as part of a Maryland Energy Administration (MEA) grant program.
- MPA is committed to continue the purchase of low-emission vehicles and equipment, such as hybrid vehicles and equipment, and is exploring the feasibility of alternative marine power for vessels docking at MPA terminals.
- MDTA is conducting a legislatively required follow-up All Electronic Tolling (AET) and Prioritization Study to identify the potential for a statewide AET program and approach to prioritizing deployment of such a system.
- MVA will continue utilizing various new technologies at their full-service and express branch locations, reducing energy, fuel and water consumption while simultaneously reducing MVA's carbon footprint.

GOAL: ENVIRONMENTAL STEWARDSHIP

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Actions and Recommendations

At this time, MDOT is working on implementing the 2015 recommendations to fully integrate the consideration of Maryland's GHG emission reduction goals within its planning, programming, and implementation processes. In the 2015 report, MDOT extensively documented the current programs and projects that are supporting the GHG reduction goal, as well as the future potential policies and actions where MDOT may further support GHG reduction goals in 2030 and beyond. In 2016, these programs and projects continued to advance and expand, as described in the status reports for each of the four transportation policy options.

MDOT Reporting Approach

The Act identifies MDOT as one of the State Agencies required to submit an annual report that reflects progress toward meeting the GGRA goals. MDOT's 2016 status report includes the following sections:

- **Introduction** – A general summary of MDOTs role and climate change related planning efforts to date. This section includes estimated 2015 emissions reductions from MDOT's Annual Attainment Report on System Performance and actions and recommendations.
    - The introduction generally addresses: 2-1305(A)(1) *"EACH STATE AGENCY SHALL REVIEW ITS PLANNING, REGULATORY, AND FISCAL PROGRAMS TO IDENTIFY AND RECOMMEND ACTIONS TO MORE FULLY INTEGRATE THE CONSIDERATION OF MARYLAND'S GREENHOUSE GAS REDUCTION GOAL"*
- **Impacts of Climate Change/Climate Adaptation** – A description of each transportation business unit's (TBU) efforts regarding transportation system adaptation to climate change and resiliency planning.
    - This section generally addresses: 2-1305(A)(2) *"THE REVIEW SHALL INCLUDE THE CONSIDERATION OF: (I) SEA LEVEL RISE; (II) STORM SURGES AND FLOODING; (III) INCREASED PRECIPITATION AND TEMPERATURE; AND (IV) EXTREME WEATHER EVENTS."*
    - This section also generally addresses annual status reporting required in 2-1305(C)(1)&(2) as it relates to MDOTs efforts to incorporate climate change considerations into planning, regulatory, and fiscal programs.
- **Annual Status Report on Actions to Support Maryland's GHG Reduction Efforts** – This section includes four individual templates for the policy options associated with the transportation sector in the 2015 GGRA Plan.
    - This section generally addresses: *2-1305(C)(1)&(2) "REPORT ANNUALLY ON THE STATUS OF PROGRAMS THAT SUPPORT THE STATE'S GREENHOUSE GAS REDUCTION EFFORTS OR ADDRESS CLIMATE CHANGE"*
    - Each of the four status reports – Transportation Technologies, Public Transportation, Pricing Initiatives, and Other Innovative Transportation Programs – report on accomplishments and ongoing actions to support GHG emission reductions.

Climate Change Adaptation and Resilience

Program Description and Objectives

MDOT is developing vulnerability assessment data and resiliency plans to address the current and future impacts of climate change on the transportation network. MDOT's TBU representatives are members of the Climate Change Commission's Adaptation and Response Workgroup and provide invaluable input as well as coordination with other state agencies. This report contains details for each TBU within MDOT on adaptation and resiliency measures undertaken since the beginning of calendar year 2015 to September 2016.

MDOT State Highway Administration (SHA)

The MDOT State Highway Administration (SHA) prioritizes climate change and resiliency and established the MDOT SHA Climate Change Program to further vulnerability studies with the most recent climate data and to integrate the vulnerability data into all aspects of planning, programming and design to ensure resilient and reliable transportation. As part of this program, MDOT SHA developed the "Climate Change Adaptation Plan with Detailed Vulnerability Assessment" in October 2014 with a grant from the Federal Highway Administration (FHWA). This pilot study report developed approaches to build on FHWA's Climate Change & Extreme Weather Vulnerability Assessment Framework (December 2012). The pilot report studied Anne Arundel and Somerset Counties and includes use of FHWA's Vulnerability Assessment Scoring Tool (VAST) and the creation of the Hazard Vulnerability Index (HVI). VAST was used to score vulnerability of bridges and HVI rated roadway sections for flood impacts under several scenarios. The pilot report also included updated mapping of sea level rise for 2050 and 2100 to better associate the asset life cycle with the projected future impacts of climate change. Since completion of the pilot study, SHA has continued to apply HVI to other counties (state and local roads) and anticipates that an assessment of the vulnerability due to coastal flooding and precipitation in all tidal counties will be complete by the end of 2017. MDOT SHA will then apply HVI to remaining areas of the state. MDOT SHA's goal is to further vulnerability studies with the most recent climate data and to integrate the vulnerability data into all aspects of planning and design to ensure resilient and reliable transportation.

MDOT Maryland Transportation Authority (MDTA)

MDOT MDTA is continuing to develop a framework that creates the process and methodologies to support the identification of vulnerabilities, as well as the development of adaptation measures, for improved infrastructure resiliency. This framework can be used for a variety of climate stressors including sea level rise, storm surge, temperature, precipitation, and extreme weather events.

MDOT Maryland Transit Administration (MTA)

The MDOT MTA Environmental Planning Division (EPD) has completed the development of a Climate Change focused Vulnerability Plan and is continuing to utilize the results in development of adaptation measures and resiliency planning. Once completed, implementation of the adaptation measures will provide security and resilience for MTA assets identified as susceptible to sea level rise, hurricane storm surge, and flooding events.

MDOT Maryland Port Administration (MPA)

Many port structures are water dependent. MDOT MPA has begun development of a resilience program for climate change. This program utilizes the 2010 vulnerability assessment of the port infrastructure and incorporates several Coast Smart best management practices (BMPs) into design engineering for new terminals, structures and dredged material management facilities, such as:

- Include a two-foot freeboard above the floodplain for all new facilities.
- Move terminal functions out of the floodplain, where feasible.
- Use non-corrosive, weather resistant materials for future construction & repair.
- Installation of additional tie-downs for cranes.
- Additional protection from inundation for underground utilities.
- Review of emergency response plans to incorporate updated sea level rise data.

MDOT Maryland Aviation Administration (MAA)

Over the past few years, MDOT MAA participated on the Coast Smart Construction Committee, whose efforts led to the current legislation regarding how the State of Maryland is reacting to projected future sea level rise and inundation. During the Committee meeting process, MAA received sea level rise/inundation mapping from the Maryland Department of Natural Resources (DNR), and included the 2-foot, 5-foot, and 10-foot projected sea level rise as a layer superimposed on the Airport Layout Plan (ALPs) for Martin State Airport to assist with future planning efforts.

MAA is the owner of Martin State Airport, and can report that there have been no projects at Martin State Airport that have occurred in areas of projected sea level rise/inundation.

Implementation Activity

Each MDOT TBU has documented actions undertaken to improve transportation network resiliency to climate change in 2015-2016.

MDOT SHA

- Completed MDOT SHA District 1 and District 5 (Anne Arundel, Calvert, Charles, Somerset, St. Mary's, Wicomico, and Worcester Counties) Flood Depth Grids for 2015,

2050, and 2100 containing two sea level measures (Mean Sea Level and Mean High High Water) and five storm scenarios, 10%, 4%, 2%, 1%, 0.2%, and no-flood. Dorchester County requires additional modeling due to the large size of the county.

- Reviewed methodology for HVI calculations to improve on accuracy and consistency among all counties.
- Developed a template to report HVI findings consistently in each county. Template will include HVI findings and analysis of any unreachable destinations and route alternatives.
- Presented HVI methodology and findings with the Maryland Resiliency Partnership with Maryland Department of the Environment, Maryland Emergency Management Agency (MEMA), Federal Emergency Management Agency (FEMA), and the Department of Natural Resources. Presentations were made at all six of the MEMA regions.
- Reviewed all MDOT SHA-owned facilities for elevation from the 100-floodplain to ensure compliance with Coast Smart and will incorporate findings into the agency's Asset Management Plan.
- Worked with Salisbury University's Eastern Shore Regional GIS Cooperative to develop 2050 and 2100 Sea Level Change (SLC) mapping based on the US Army Corps of Engineers 2013 guidance per FHWA guidance.
- Incorporated the 2050 and 2100 SLC mapping into NEPA/MEPA review of projects to ensure project design engineers are aware of the future conditions and consider SLC in design.
- Incorporated Coast Smart in NEPA/MEPA review of projects to ensure two feet of freeboard from the 100-year floodplain is incorporated into any new or reconstructed building or storage tank.
- Created the new Innovative Planning and Performance Management Division within the Office of Planning and Preliminary Engineering (OPPE) to better integrate vulnerability assessment data with asset management and performance management.

MDOT MDTA

- Coast Smart recommendations are considered and incorporated into design during drainage repair projects and new State projects, most recently the Nice Bridge.
- Floodplain and sea level rise layers are being added to MDTA GIS data.
- MDTA assessed, at high-level, the vulnerability of its nine maintenance facilities for sea level rise, storm surge, precipitation, and temperature for years 2050 and 2100. This vulnerability assessment provided insight on the potentially most vulnerable assets. Overall, this study can provide MDTA with planning level information needed to prioritize and allocate resources.
- MDTA is incorporating the 2050 and 2100 sea level rise mapping into NEPA/MEPA review of projects.

MDOT MTA

- Included identification of infrastructure and assets vulnerable to sea level rise in MTA's Climate Change Vulnerability Assessment. Adaptation of the high risk locations will be conducted through MTA's Asset Management Planning and system preservation program.
- Included identification of infrastructure and assets vulnerable to 100- and 500-year flood events in MTA's Climate Change Vulnerability Assessment. Adaptation of the high risk locations will be conducted through MTA's Asset Management Planning and system preservation program.
- MTA's infrastructure impacted by extreme weather events is inspected, maintained and replaced through MTA's system preservation program.
- A GIS dataset has been developed which includes all MTA assets, current and planned. Layers within the dataset outline the potential impacts of sea level rise at 2, 4 and 6 feet above mean sea level. In addition to depicting MTA assets, the layers outline core transit routes and locations where these routes will be impacted by each of the scenarios.
- MTA is incorporating 2050 and 2100 sea level rise mapping in its conceptual planning for capital projects to ensure relevant design criteria, as outlined in the Coast Smart Construction Program, is taken into consideration in preliminary engineering.

MDOT MPA

Resiliency measures are planned for much of the Port's infrastructure in the near future. The list below demonstrates the variety of projects that will ensure flood resistant infrastructure in the future.

- Construction design for replacement of DMT Building 91C will be elevated to at least +10 feet. Construction will begin shortly.
- Masonville vessel berth was elevated to +10 feet.
- Emergency generators at Dundalk Marine Terminal (DMT) building 91A and Lot 304 stormwater vault were installed above ground level (+10 feet).
- To prevent flooding during a significant rain event at DMT's Lot 304, a stormwater vault was installed as a forced main (similar to sump pump) and does not rely on gravity for discharge; this will reduce the ponding of rainwater and reduce the risk of flooding.
- DMT Lot 304, DMT 11/12 deck upgrades and DMT heavy lift area reinforcement have both durable concrete mix design and corrosion-resistant reinforcement.
- The following projects have the durable concrete mix design: FMT berth 3, DMT berth 4.
- Cox Creek, Poplar Island and Hart Miller Island are armored at or above +10 feet mean high high water (MHHW).
- At World Trade Center, the access ramp floodgates located at the top of the east and west loading dock access ramps were elevated to 11.5 feet from 9.5 feet.
- Designed and procured a flood barrier system for the World Trade Center building that

provides flood protection to 11.5 feet. Both the floodgates and the flood barrier system are installed prior to notice of a significant storm event such as a hurricane with a storm surge.

MDOT MAA

MDOT MAA is the owner of Martin State Airport, and can report that there have been no projects at Martin State Airport that have occurred in areas of projected sea level rise/inundation.

Enhancement Opportunities

MDOT SHA

- Continuing to evaluate HVI for tidal counties and develop county reports on road vulnerability from coastal, rainfall, and sea level rise.
- Participating with the "Maryland Resiliency Partnership" in collaboration with Maryland Department of the Environment, MEMA, FEMA, and the Department of Natural Resources.
- Submitting comments in the AASHTO response to FHWA on consideration of climate change in NEPA per the new White House Center for Environmental Quality Guidance and will continue to provide input as the FHWA guidance is developed.
- Integrating system resiliency into the current planning processes by utilizing vulnerability data in development of a highway project prioritization tool.
- Developing future precipitation projections to integrate with GISHydro data utilized by engineers in hydrology and hydraulic design.
- Utilizing future precipitation data developed for Maryland, United States Geological Service stream data, and Maryland Department of the Environment stream modeling to improve storm event data predictive analysis.
- Coordinating with other states and participating in TRB research to remain on the cutting edge of most recent studies and developments in the climate change adaptation field.

MDOT MDTA

- MDTA will utilize the vulnerability data of nine maintenance facilities to provide MDTA with planning level information needed to prioritize and allocate resources.

MDOT MTA

- Information gained from MTA's Climate Change Vulnerability Assessment will be used to develop and implement mitigation or adaptation measures at sites identified as posing a high or very high risk to MTA's services.
- Cost estimates to complete adaptation measures will be developed in coordination with

relevant state agencies including the Maryland Emergency Management Agency.

- Results of the Climate Change Vulnerability Assessment will be incorporated into MTA's Asset Management Plan and system preservation program as appropriate.

MDOT MPA

- In the future, emergency generators will be installed above ground level at +10 feet.
- Under consideration and study is increasing the elevation of DMT Berths 1-3 and Lots 100-300, but wharf likely to only increase to +9' due to operational reasons. Another added benefit to elevation of these berths is that the bottom of the wharf structure would be inundated much less.
- The North Locust Point Marine Terminal auto lot will be elevated to at least +9.0 ft.
- Engineering structural/design consideration for future infrastructure development includes the following for consideration: corrosion resistant reinforcement; concrete mixes that increase durability; and quality control of production and installation of concrete members/components.
- A stormwater vault similar to the one installed at Lot 304, DMT, has been designed for C Street at DMT and will be installed shortly. Its purpose is also to prevent flooding during a significant rain event at DMT.
- The placement of rip rap armor stone at DMT Lot 1501/1602 is being studied as a possibility to increase protection against higher wave action due to increased significant weather events.
- Masonville is currently armored at +6.5 ft. MHHW and needs to be raised to +10 ft. MHHW. MPA will consider armoring to + 10 ft. MHHW during design of the Masonville dike raising.

Funding

SHA has a dedicated position to develop vulnerability studies and integrate infrastructure resiliency throughout the agency, as well as manage greenhouse gas reduction efforts. State DOTs are required to develop risk-based Transportation Asset Management Plans (TAMPs) in in fulfillment of MAP-21 requirements (23 U.S.C. 119(e)(1), MAP-21 § 1106). In addition, the most recent surface transportation law, the FAST Act (23 CFR 450.306) requires improved resiliency and reliability of the transportation system. SHA will address these requirements by incorporating vulnerability data into the asset management program. FHWA is able to use Federal-Aid Highway funding for the State Planning and Research Program to accomplish this planning.

FEMA/MEMA grants may be an option for MDOT projects. MTA has been in consultation with MEMA to identify adaptation and resiliency projects eligible for funding. All TBUs will continue to seek funding opportunities for infrastructure adaptation.

Challenges

MDOT is in various stages of resiliency work. Because of the vulnerability assessments and time required to implement systemic organizational change, some TBUs are still planning and others are already implementing adaptation measures. The increased cost of adaptation is not known for many projects at this time; however, the vulnerability assessments are nearing completion and provide data for the determination of adaptation needs.

Integration of adaptation measures for system resiliency can increase the scope, schedule, and budget of the project. While infrastructure adaptation may increase costs, it could also increase the life span, improve reliability and reduce maintenance to the infrastructure. It is important to consider and quantify all benefits now and in the future. MDOT is thoughtfully approaching the challenges of evaluating and changing current practices. Utilization of new technologies and procedures need to be evaluated and considered in construction, engineering and planning, to include asset management, to operations and maintenance that can reduce potential flood impacts.

GGRA Program Status – Transportation Technologies

Program Description and Objectives

Transportation technologies reduce GHG emissions and other tailpipe pollutants through three primary strategies: (1) cleaner fuels; (2) vehicle emissions technology; and (3) fuel economy proficiencies. The technology advances for the on-road fleet are comprised of state and federal initiatives that set fuel economy standards and reduce tailpipe emissions of both light-duty vehicles, and medium and heavy-duty trucks. The programs under transportation technologies related specifically to vehicle efficiency include the following:

- The Maryland Clean Car Program that incorporates the California low emission vehicle (LEV) standards and zero emissions vehicles (ZEV) mandates
- Corporate Average Fuel Economy Standards (CAFE) standards for model years 2008-2011
- The National Fuel Economy Program – Phase 1 for model years 2012 to 2016
- The National Fuel Economy Program – Phase 2 for model years 2017 to 2025
- Medium/Heavy-duty vehicle (trucks and buses) standards for model years 2014 to 2018 medium and heavy-duty vehicles
- Federal Renewable Fuels and Tier 3 Fuel Standards

This program also includes other technologies that enhance the efficiency of the transportation network such as projects or programs that help address network congestion, bottlenecks, or other inefficiencies through more efficient management of capacity and services, including initiatives like CHART, signal coordination, ITS/ATMS strategies, and traveler information services. These technologies are applicable across the highway and transit modes. In addition, the program includes technologies and efficiency strategies for the Port of Baltimore, aviation, and freight movement in Maryland.

Implementation Milestones

The transportation technology programs are implemented through state and federal regulations. The Maryland Clean Cars Act of 2007 has been fully implemented through regulations and codified in COMAR 26.11.34.

The National Fuel Economy Program standards are implemented and enforced through federal regulations adopted by EPA and the National Highway Traffic Safety Administration (NHTSA). The Phase 1 standards were adopted in 2010 and required manufacturers to meet a 35.5 miles per gallon (mpg) equivalent by model year (MY) 2016. Phase 2 standards were adopted in 2012 and require a 54.5 mpg equivalent by MY 2025. While the newer federal programs supersede NHTSA's pre-existing CAFE standards for model years 2008-2011, those earlier MY vehicles remain in the fleet and are projected to continue to produce benefits in 2020.

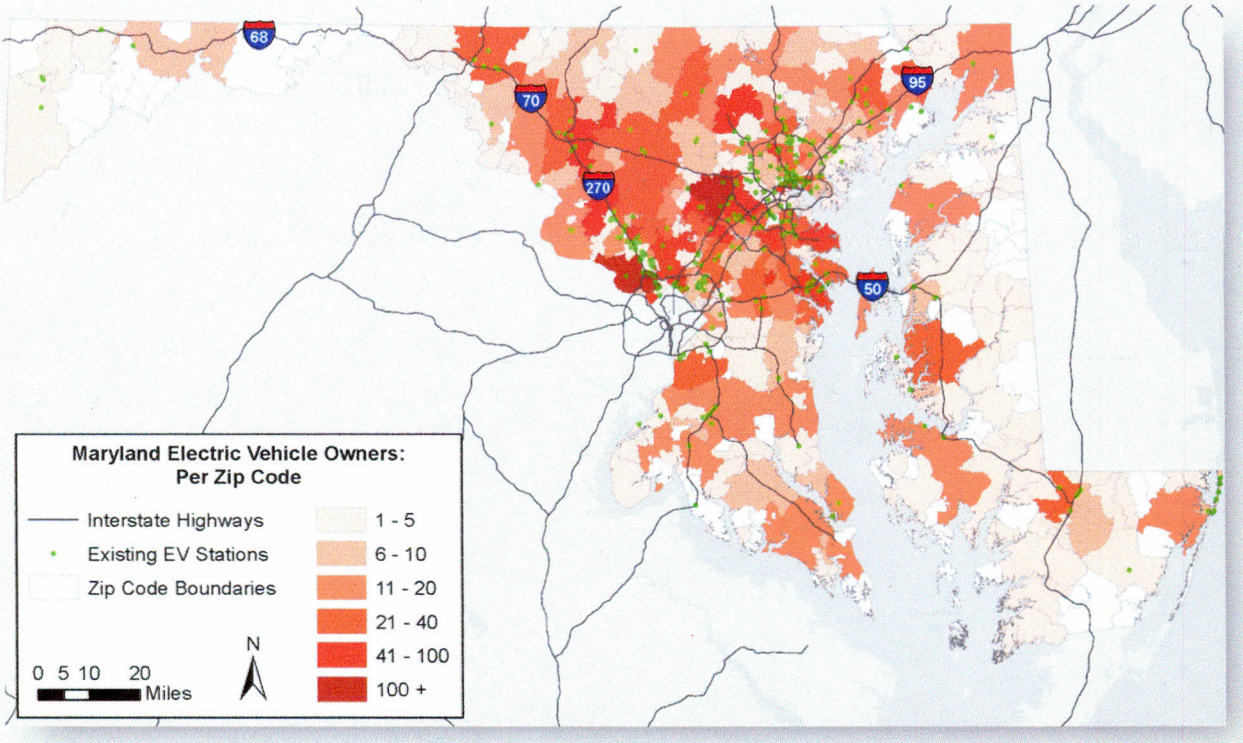
The Medium- and Heavy-duty Vehicle Standards were jointly adopted by EPA and NHSTA in 2011 and apply to semi-trucks, large pick-ups and vans, all types of work and delivery trucks and buses.

As part of the CHART program, MDOT SHA continually installs and upgrades advanced traffic management system (ATMS) and advanced traffic information system (ATIS) technologies on Interstate highways and arterials statewide. Technologies include cameras, traffic detectors, weather sensors, dynamic message signs, highway advisory radios, web sites and telecommunication networks. CHART is comprised of five major components: 1) Traffic and Roadway Monitoring; 2) Incident Management; 3) "511" - Traveler's Information; 4) System Integration and Communication; and, 5) Traffic Management.

The dray truck replacement program at the Port of Baltimore successfully facilitated the replacement of 35 old trucks with newer, cleaner models.

Maryland continues to promote the purchase of electric vehicles (EVs) and the installation of electric vehicle supply equipment (EVSE) in the State. MDOT chairs the Electric Vehicle Infrastructure Council (EVIC), actively participates in the Clean Vehicles and Fuels Workgroup of the Transportation Climate Initiative (TCI), and has submitted a nomination for the designation of alternative fuel / electric vehicle corridors under the Fixing America's Surface Transportation (FAST) Act. All of these efforts, combined with financial incentives, are focused on increasing EV sales and enhancing the availability of EVSE to bolster the State's goals. Figure 1.3 illustrates the existing electric vehicle ownership (battery EVs and plug-in hybrid EVs), charging infrastructure, and the proposed alternative fuel / EV corridors in the State.

Figure 1.3 Existing Maryland Electric Vehicle Density and Charging Station Locations



Enhancement Opportunities

Technology innovations are by far the largest contributor to GHG reductions for the transportation sector. Maryland and other leadership states have played an active role in encouraging technological advances and more stringent national standards. For the light-duty fleet beyond the 2025 national fuel economy standards, MDOT encourages EPA and NHSTA to continue promoting more stringent fuel economy standards.

EPA and NHTSA recently established new standards for medium- and heavy-duty vehicles to reduce GHG and improve fuel efficiency for model years 2018 through 2027. This program is expected to achieve an additional 10 percent GHG reduction and has a favorable payback period of under two-years to recoup the extra cost of the technology in fuel savings.

The ZEV program is part of the California Clean Cars Program that Maryland adopted in 2007. It requires vehicle manufacturers to sell an increasing number of ZEVs in the state. Maryland is currently working with NESCAUM and other ZEV MOU states to re-evaluate the ZEV goals, including Maryland's goal of having 60,000 ZEVs on the road by 2020 and 300,000 ZEVs on the road by 2025. The MOU with seven states and the auto manufacturers was originally signed in October 2013 to help reach our ZEV goals. Additional ZEV sales in the State would provide additional GHG benefits.

Technology enhancements in the non-road sector could also bring additional GHG reductions to include construction equipment, port and airport support vehicles, and marine engines.

MDOT, MDE and MPA have signed an MOU to enhance emissions reductions in Maryland's ports, and in August 2016, EPA finalized the first step to address GHG from aircraft emissions.

In addition, emerging connected and autonomous vehicle technologies have the potential to significantly reduce traffic incidents while enhancing the capacity of the transportation system. As these technologies are more broadly deployed, there are opportunities to reduce GHG emissions associated with recurring and non-recurring congestion.

Funding

The transportation technology standards are implemented by the vehicle manufacturers at no cost to the State of Maryland. There may be additional costs to the consumers purchasing new vehicles, but the costs can be offset by reduced fuel costs over the life span of the vehicle.

In the near-term, it will be beneficial to continue to invest in EV and EVSE incentives. MDOT has been working with MEA, MDE and other EVIC partners on ensuring that new legislation will be proposed in the coming session to continue the Maryland EV Excise Tax Incentive and EVSE Rebate Programs.

Challenges

While technologies offer the most significant GHG emissions reduction potential for the transportation sector, the incorporation of technologies will take time. The federal technology standards will not be fully implemented until model years 2025 and 2027 for light-duty and medium- / heavy-duty vehicles, respectively. Even after auto manufacturers are producing the vehicles and bringing them to market, the retirement of the less efficient, older vehicles will not happen immediately.

Meeting the Maryland Clean Car Program ZEV mandate goals by 2020 and 2025 will be challenging. To date, there are less than 10,000 plug-in electric vehicles registered in the State.

Estimated Greenhouse Gas Reductions

Total on-road transportation system emissions are summarized in the introduction of this report.

As technology advances and the vehicle fleet in Maryland turns over as newer cars and trucks replace older vehicles, the GHG benefits will continue to increase post-2020. Transportation technologies will be a significant contributor to meeting the 40% reduction goal in 2030.

GGRA Program Status – Public Transportation

Program Description and Objectives

Public transportation contributes to GHG emission reductions in Maryland's transportation sector by providing alternatives to travel in personal vehicles, thus reducing VMT. Public transportation emits roughly 40 to 50 percent less GHG emissions per passenger mile than an average single occupancy vehicle (SOV). The programs in this policy option include transit

initiatives that support a goal of increasing public transit ridership and intercity transportation initiatives that support MARC and other intercity transit services such as Amtrak.

Public Transportation Initiatives

Program Description and Objectives

Land development patterns over the past 40 to 50 years have put more people living beyond the reach of convenient access to transit facilities, increasing reliance on autos to complete trips leading to increased tailpipe emissions of GHGs and other air pollutants. As a result, through the late 2000's, VMT grew faster than the increase in population in Maryland and nationwide. This trend changed in 2008 in part associated with the economic recession as well as in response to volatile fuel prices. From 2008 through 2015, VMT in Maryland has slightly decreased or remained constant (less than a 1 percent increase), while transit ridership has continued to grow (greater than a 4 percent increase).

In order to maintain and enhance operations of the current system, while strategically expanding services to support more Marylanders, actions are needed to increase the availability, attractiveness and convenience of public transportation, improve the operational efficiency of the system, and increase system capacity. Actions related to land use planning, incentives for riding transit, and bike and pedestrian access improvements, are also necessary to continue to enable Maryland's residents and commuters to have safe, efficient and affordable transportation options.

Intercity Transportation Initiatives

Program Description and Objectives

Traffic congestion along Maryland's interstate corridors, particularly the I-95 corridor between the Wilmington region, Baltimore, and Washington, D.C. and the I-270 corridor between Frederick and I-495 has been steadily increasing. One of primary approaches to address congestion in these corridors, and on parallel routes, is continuing improvements to Maryland's intercity transportation systems. Improvements to MARC are helping to enhance connectivity, reliability, and access to intercity passenger rail, for both commuting and leisure trips for Maryland residents, employees, and visitors. In addition, through coordination with the Northeast Corridor Coalition, the Federal Railroad Administration, and Amtrak, Maryland is supporting planning to address key bottlenecks to enhance the reliability of high-speed rail. Overall, this program includes the continued maintenance, operations, and expansion of intercity passenger rail, high-speed rail, and intercity bus services in Maryland as well as improved connections between air, rail, intercity bus, and regional or local transit systems.

Implementation Milestones

Support for transit investments can be found in MDOT's annual capital program, the Consolidated Transportation Program (CTP). These investments support a sustained increase in

transit ridership by providing quality transit services for both local and long distance travelers. Example projects completed in FY 2016 include:

- Opening of the Silver Spring Transit Center
- Improved technologies supporting MTA bus system operations and reliability including automatic vehicle locator system deployment, enhancements to MTAs Central Control Center, and improvements and expansion to camera systems for safety and security.
- Completion of the Southern Maryland Commuter Bus Initiative, expanding park-and-ride lots and adding new MTA Commuter Bus routes.

Projects planned for implementation through 2020 include:

- Included in the Governor Hogan BaltimoreLink initiative are various improvements throughout the MTA bus network including planning, design, and construction for transitways (dedicated bus lanes), transit hubs, and Transit Signal Prioritization (TSP).
- Construction of an off-street covered transit center at the intersection of MD 193 and MD 650 in the Takoma/Langley Park community intended to accommodate enhanced connections between Metro bus and Montgomery County Ride-On buses. The project is planned for completion in early FY 2017.
- Support for the ongoing MARC Camden, Brunswick, and Penn lines improvement program to ensure safety and quality of service. The program is implemented through CSX and Amtrak construction agreements. CSX efforts include projects such as interlocking replacements and other track improvements. Amtrak efforts include projects such as passenger upgrades at Baltimore Penn Station and Washington Union Station, interlocking work, and other track improvements.

Enhancement Opportunities

Enhancement to public transportation programs would require resource infusion in the form of capital or operating investments. MDOT is continuing to work with private partners on implementing the Purple Line Transitway in Montgomery and Prince George's Counties.

Additional areas could be targeted for more aggressive measures, which would require additional federal, state, and innovative funding sources. These include additional sites for transit oriented development (TOD), expansion of transportation demand management, including Commuter Connections programs and tax credits for employers for participation.

Funding

Transit investments are strongly supported in the Draft FY 2017–FY 2022 CTP, including MARC service expansion, Baltimore Metro operations, support of Washington Metropolitan Area Transit Authority (WMATA) in the Capital Region, and support of Locally Operated Transit Services (LOTS) across Maryland. MTA directs funding and statewide assistance to LOTS serving each of Maryland's 23 counties, providing approximately $133.9 million in federal and state grants in FY 2015. MTA continues to invest in transit infrastructure statewide, enabling

Maryland's residents and commuters to enjoy safe, efficient and affordable transportation options.

Challenges

MDOT strives to maintain a balanced and multi-modal approach to the state's transportation system to provide users with an array of transportation options including public transit. It is important to note that alternative choices like bicycling and pedestrian modes should be developed to supplement use of public transit due to their key role in last-mile connectivity. This is an area that continues to evolve as the state advances its design standards to implement a "complete streets policy". MDOT facilitates partnership among the transit agencies in the region to maintain and enhance a comprehensive transit network through the region.

Estimated Greenhouse Gas Reductions

Total on-road transportation system emissions are summarized in the introduction of this report.

MDOT's Annual Attainment Report includes measures presenting transit ridership, commute mode share, total passenger and revenue miles of service, total transit investment, and on-time performance that serve as key indicators of progress towards the program goals and resulting greenhouse gas benefits. The 2016 Attainment Report is available here.

GGRA Program Status – Pricing

Program Description and Objectives

This program includes transportation pricing disincentives and travel demand management incentive programs. Projects are tied to commute alternatives and programs including ride sharing, guaranteed ride home, transportation demand program management and marketing (Commuter Connections and Commuter Choice Maryland), outreach and education programs (Clean Air Partners), parking cash-out subsidies, transportation information kiosks, local car sharing programs, telework partnerships, parking fees, and vanpool programs. The pricing program also includes expanded and enhanced technologies for electronic toll collection on tolled facilities operated by the Maryland Transportation Authority

Implementation Milestones

Operational, management, and financial support for a broad range of travel demand management program (also known as Transportation Emission Reduction Measures (TERMs)) is documented in the CTP. These investments support the Commuter Connections program (managed by Metropolitan Washington Council of Governments) and the Commuter Choice Maryland program (managed by the Maryland Transit Administration), both offer commuters and students in the Washington and Baltimore regions access to financial incentives, ride sharing, guaranteed ride home, and traveler information to support carpooling and transit use.

Electronic toll collection systems expedite the toll collection process, reduce delays at toll plazas, decrease emissions, and are available at all eight toll facilities across the state. GHG emissions are significantly reduced when tolls are collected electronically, due to reduced queuing and idling at toll collection plazas. In January, 2016 MDTA submitted a report to the Legislature as required by HB 389 All-Electronic Tolling (AET) Legislative Follow-Up Study that analyzes the potential of AET on MDTA's current toll facilities before further implementation activities.

- The result of the study indicated that MDTA will delay any implementation of AET until 2019 at the earliest, after the contract for the next generation of its toll system is executed. The next generation tolling system will significantly enhance the capacity for handling video tolling and citations.

Enhancement Opportunities

Expansion of Maryland's TDM program offerings, geographic scope, and incentives would require additional funding and potential legislation regarding tax credits and incentives. Other opportunities, such as expanded coordination with services such as Uber and Lyft, to enhance access to transit and encourage ridesharing, are emerging possibilities to expand the scope of traditional TDM programs.

Within the FAST Act, The Surface Transportation System Funding Alternatives (STSFA) grant program[1] will fund projects to test the design, implementation and acceptance of user-based alternative revenue mechanisms. The program will help address some of the concerns outlined in Beyond Traffic, the USDOT report issued last year that examines the challenges facing America's transportation infrastructure over the next three decades, such as a rapidly growing population and increasing traffic. USDOT announced funding for eight projects in August 2016 that will pilot a variety of options to raise revenue, including on-board vehicle technologies to charge drivers based on miles traveled and multi-state or regional approaches to road user charges. The projects will address common challenges involved with implementing user-based fees such as public acceptance, privacy protection, equity and geographic diversity. MDOT will monitor the progress of these studies, future grant funding opportunities, and other emerging road pricing technologies.

Funding

MDOT sets aside nearly $25 million in the CTP over the next six years to support programs that fall under the pricing policy option.

The original AET Conversion and Prioritization Study, completed in 2014, estimated total costs to fully convert MDTA's seven legacy toll facilities (not including the Intercounty Connector) from $145 to $177.5 million (in 2013 dollars). The CTP identifies $63.7 million in funding over the next six years to implement the next generation electronic tolling system which would represent the technology platform enabling a conversion to AET across the entire system (not yet funded in the CTP).

[1] http://www.fhwa.dot.gov/pressroom/fhwa1648.cfm

Challenges

Travel Demand Management (TDM) offsets vehicle congestion by offering incentives for Marylanders to use public transit, carpool, walk or bicycle instead of driving alone. Other ways that roadway demand can be reduced is the promotion of telecommuting and flexible work hours as a way to reduce or shift trips to times when roadway capacity is less constrained. Expansion of employers offering these incentives and employees actually using them are associated with a number of business and personal cost and convenience considerations. Ensuring that information is available to employers and employees regarding program details is key to enhancing participation.

Conversion to AET brings a number of feasibility considerations including interoperability, leakage and reciprocity, business rules, account setup and conversion, and long-term policy implications. Note, ongoing FHWA studies and research on innovative financing options include broad policy and technical review of mileage-based road user fees as a mechanism to replace the federal gas tax. The FAST Act commits additional resources to building the framework to eventually move in this direction.

Estimated Greenhouse Gas Reductions

Total on-road transportation system emissions are summarized in the introduction of this report.

MDOT's Annual Attainment Report includes measures presenting transit ridership, commute mode share, and annual estimates of total VMT reduction associated with TDM programs. The Annual Attainment Report also tracks percent of toll transactions collected electronically, estimated at 79 percent in FY 2015. The 2016 Attainment Report is available here.

GGRA Program Status – Bike and Pedestrian Initiatives

Program Description and Objectives

This program is part of the State's effort to reduce GHG and other tailpipe emissions from passenger vehicles by providing alternatives to single occupant vehicle use. Building appropriate infrastructure for additional bicycle and pedestrian travel in urban areas also increases access to and use of public transit and supports the State's goal of increasing transit ridership.

Implementation Milestones

MDOT's Bicycle and Pedestrian Master Plan (2014) lays out a 20-year vision to support cycling and walking as modes of transportation in Maryland. The following implementation elements have been identified in the 2015 GGRA plan update:

1. Bike Shelters & Bike Sharing - Bike sharing programs are underway.

2. Consider Bike Accommodations for all applicable Roadway Projects - 77 roadway capacity or bridge upgrade projects in MDOT's CTP include accommodations for bicycles and pedestrians.
3. Twenty-four (24) bike network projects were funded in FY 2015 under the Bikeways Program. The Bikeshare Program receives ongoing awards supporting successful implementation in Baltimore City, College Park/UMD, and Montgomery County. A total of 97 bikeways projects have been awarded in four grant cycles to date. Approximately 26 bikeways projects are complete. Additional projects will be solicited through annual grant cycles.
4. SHA manages the Sidewalk Construction for Pedestrian Access Program, Retrofit Bicycle Program, and the Community Safety and Enhancement Program.
5. Cycle Maryland aims to make bicycling a viable transportation alternative.

Enhancement Opportunities

MDOT continues to advance comprehensive design standards for roadways that consider all users of the roadway, including pedestrians and bicyclists. The Complete Streets Policy, adopted by SHA in 2012, impacts all divisions and influences how projects are developed from concept to final design. In 2015, $15.0 million in reimbursable grant funding was made available for projects that enhance walking, biking, pedestrian safety and recreational trail access.

MDOT recognizes bicycle and pedestrian travel as integral elements of the broader transportation network, and supports investments in local bicycle transportation projects that provide access to transit.

Funding

Total greenhouse gas-beneficial funding for bike and pedestrian projects totals $160.1 million in the FY 2015 – FY 2020 CTP and includes 99 funded projects with pedestrian and bicycle elements. From a programmatic perspective, MDOT manages several ongoing programs that provide funding for pedestrian and bicycle improvements, including: Maryland Bikeshare Program, Maryland Bikeways Program, ADA Retrofit Program, Sidewalk Retrofit Program, Bicycle Retrofit Program, Community Safety and Enhancement Program, and management of the FHWA transportation alternatives (TA) Set-Aside funds.

Bikeways Program: MDOT's Bikeways Program supports local bicycle transportation projects, providing necessary funding to implement the Statewide Trails Plan and the Bicycle and Pedestrian Master Plan. The Secretary's Office (TSO) FY 2016 capital budget includes $4.5 million for this program, including on- and off-road bicycle route connections, bike route signage, bike parking racks and safety improvements. The FY 2017–FY 2022 Draft CTP dedicates $184.5 million for bicycle and pedestrian projects, including $13.8 million for future Bikeways Program grant awards.

Bikeshare Program: The Maryland Bikeshare program is a key component of the Cycle Maryland initiative, providing reimbursable grant funding to Maryland communities to establish or expand bikesharing programs. In 2014, Maryland opened its first bikeshare station in Montgomery County, which has since grown to 50 stations. A total of $1,356,300 was

dedicated to the Maryland Bikeshare program in 2015, of which $881,300 was dedicated to establishing bikeshare in the City of Baltimore.

Challenges

In addition to ramping up implementation of Maryland's Statewide Complete Streets policy, provision of bicycle infrastructure needs to be matched with favorable land-use decisions and a conducive planning landscape, like supporting transit oriented development (TOD), provide for new opportunities for increasing walking and bicycling activities. Collaboration at the State and local level is also essential to ensuring that local jurisdictions continue to invest in bike and pedestrian connections that support short-distance trips in urban areas.

Estimated Greenhouse Gas Reductions

Total on-road transportation system emissions are summarized in the introduction of this report.

Under the goal of Community Vitality, MDOT's Annual Attainment Report documents the number of additional directional miles of bicycle lanes and shared use lanes, which steadily helps to increase the bicycle level of comfort (BLOC) on Maryland's roads. SHA also updated the methodology used to measure BLOC in 2015, which resulted in promoting bicycling as a mode of travel. The 2016 Attainment Report is available here.