Chapter 2:
Factors and Trends

FACTORS AND TRENDS

What Can the Region Expect over the Next 20 Years?

The core of this plan is the list of major projects and programs the region hopes to implement over the next 20+ years, given the amount of funding reasonably expected to be available.

The BRTB did not develop this list in a vacuum. Many factors and trends—some known, some anticipated, and some unknown at this time—will affect the regional transportation network in the future.

This chapter discusses some of these factors and trends. The hope is that this discussion will provide additional context so that readers can better understand why the BRTB made certain decisions as well as how those decisions might better prepare the region to respond to the uncertainties of the future.

Environmental Issues and Challenges

Chapter 1 of this plan describes the federal requirements the region must meet to maintain conformity with national air quality standards. Besides these air quality conformity issues, the region faces several other environmental challenges.

Greenhouse Gas Emissions and Climate Change

There is a strong link between growth in vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions from the transportation sector. More miles traveled directly equates to the combustion of more gallons of fuel and the release of carbon dioxide.

Emissions of carbon dioxide, a key GHG, result from the burning of fossil fuels such as gasoline and diesel fuel. Twenty-eight percent (28%) of the state's GHG emissions result from the on-road transportation sector. The entire transportation sector accounts for thirty-three percent (33%) of emissions in the state, and represents the second largest source sector for GHGs in Maryland, behind electricity consumption.

Environmentally conscientious planning must consider the implications of potential long-term climate change and the role that vehicle emissions play. GHG emissions that result from human activity contribute to global warming, which is the increase in average global temperature.

Since the beginning of the 20th Century, Maryland has experienced an increase in annual average temperature of 1.5 degrees Fahrenheit.

Growth in Vehicle Miles Traveled

According to data from the Federal Highway Administration , the national moving 12-month average VMT saw steady growth throughout the 1990s and most of the 2000s, reaching a peak of nearly 3.024 trillion miles in 2008. At that point, owing primarily to the economic downturn, national VMT began to decline. From 2009 through 2014, the national moving 12-month average VMT remained below 3 trillion miles.

As of 2015, national VMT again topped 3 trillion miles. The table below shows the national moving 12-month average VMT over the past several years. At least some of this growth in VMT can be attributed to increased petroleum supplies, which have led to generally lower fuel prices compared to earlier in the decade of the 2010s.

VMT: National Moving 12-Month Average (rounded to the nearest billion)
- 2015   3.033 trillion miles
- 2016   3.102 trillion miles
- 2017   3.179 trillion miles
- 2018   3.214 trillion miles

Source: U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information, "Traffic Volume Trends," January 2019.

From MDOT's 2019 Attainment Report (Page 7):

According to the U.S. Census, the state's population is expected to increase by 12% from 2017 to 2040 (6.052 million in 2017 to about 6.8 million in 2040). This population growth inevitably means more vehicles and vehicle miles traveled (VMT); 2018 forecasts 60.8 billion annual VMT, an expected 1.5% rise from last year's levels.

The chart below shows annual VMT and VMT per capita for the state of Maryland. As has been the case nationally, VMT has increased in the state in recent years.
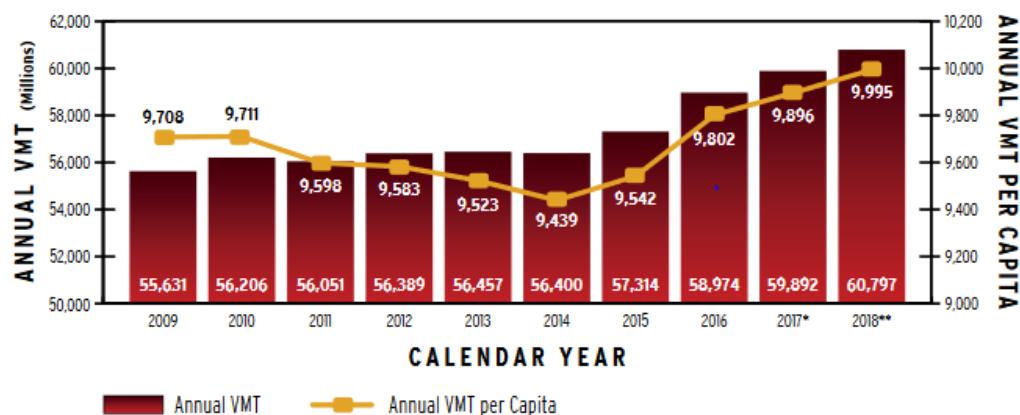
* 2017 VMT data revised from previous report.
** 2018 data is preliminary and subject to change.

Source: Maryland Department of Transportation, 2019 Annual Attainment Report on Transportation System Performance.

Sea Level Rise

Global warming is just one aspect of climate change. Sea level rise, rainfall patterns, snow cover, and ice cover are also changing.

In Annapolis, sea level has risen at a rate of 1.17 feet every 100 years, from 1928 to 2017. The Fort McHenry sea level gauge in Baltimore has recorded sea level rise at the rate of 1.03 feet every 100 years between 1902 and 2017 .

The Maryland Climate Change Commission (Scientific and Technical Working Group) reports projections of sea level rise in Maryland of between 0.9 and 2.1 feet by 2050 and between 2.1 and 5.7 feet by 2100. The Maryland State Highway Administration (SHA) is planning for changes in mean sea level in the Baltimore region of between 2.01 feet (Harford County, Baltimore County and Baltimore City) and 2.08 feet (Anne Arundel County) by 2050 and between 5.59 feet (Harford County, Baltimore County and Baltimore City) and 5.7 feet (Anne Arundel County) by 2100.

In Annapolis, sea level has risen at a rate of 1.17 feet every 100 years, from 1928 to 2017.

Chesapeake Bay

The Chesapeake Bay watershed includes six states and is 64,000 square miles in size. There are excess amounts of nutrients (nitrogen and phosphorus) and sediment being deposited into the Bay. Downstream effects of excess nutrients and sediment include loss of water clarity and algal blooms. Sources of these pollutants include agriculture, urban and suburban runoff, wastewater, and atmospheric deposition.

EPA issued a "pollution diet" in December 2010 across the entire Chesapeake Bay as well as each tidal segment. This pollution diet is in the form of a Total Maximum Daily Load (TMDL), with caps set on levels of nitrogen, phosphorus, and sediment going into the Bay. TMDLs are Clean Water Act regulatory tools that set daily limits on pollutants going into water bodies. There are a series of accountability measures to ensure the TMDL caps are being met.

Maryland developed the Phase I and Phase II Watershed Implementation Plans (WIPs) in 2010 and 2011, to develop a foundation and plan for how to reduce Maryland's share of water pollution in the Chesapeake Bay. The State is now working on the Phase III WIP, which will address needed pollution reductions for 2018 to 2025.

Urban stormwater runoff includes runoff from roadways. There are a number of different ways to mitigate the effects that presence of roadways can have on stormwater runoff pollution, including grass swales, bioswales, stormwater management ponds, infiltration trenches, submerged gravel wetlands, wet swales, sand filters, bioretention, stormwater wetlands, stream restoration, tree planting, and street sweeping.

Sea level rise, increased temperatures, and other aspects of climate change are predicted to hinder efforts to clean up the Chesapeake Bay. According to the Maryland Greenhouse Gas Reduction Act Plan , increased runoff and rainfall events from climate change could affect the Bay through increased erosion and sediment loads. Higher peak stormwater flows also would mean greater amounts of nutrients transported downstream, degrading water quality. Additionally, climate change will likely cause a decline in biodiversity of plants and animals in the forests of Maryland. Increasing summer temperature will likely cause higher ozone levels and more frequent exceedances of the federal ozone air quality standard. Sea level rise will also require costly mitigation measures to protect the region's transportation infrastructure from higher water and damage caused by storm surges.

Highway Safety Concerns

From 2013-2016, the number of traffic fatalities sharply increased on both the national and state level. While the U.S. showed an increase of 15 percent during those years, Maryland traffic fatalities increased only 12 percent. However, the national fatalities decreased in 2017 to 37,133, which is two percent lower than the 2016 figure. Unfortunately, Maryland fatalities continued to increase to 558 in 2017, a seven percent increase from 2016. With the increase in vehicle miles traveled, as illustrated in the environmental section of this report, over the last five years the Maryland fatality rate per VMT has remained below the national rate, close to 25 percent lower.

The figure shows the Maryland fatality trend for close to 60 years and the effects of major interventions.
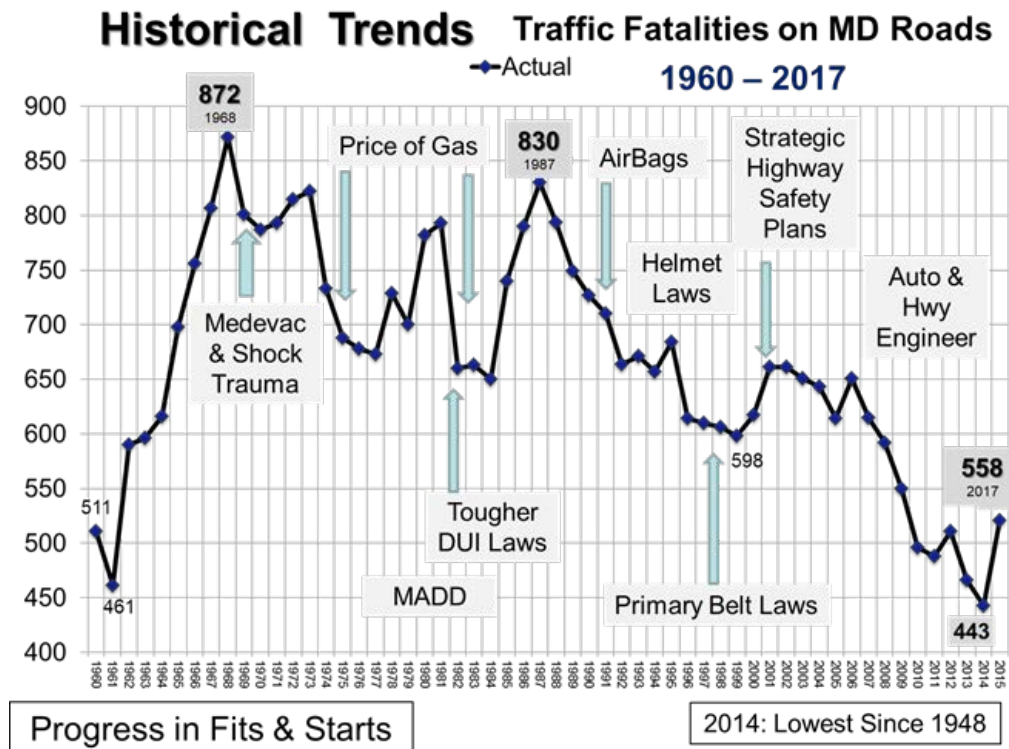
Looking more closely at the recently released 2017 fatality data from the NHTSA FARS report, three-quarters of Maryland traffic fatalities occur on urban roadways, close to 60 percent were passenger vehicle occupants, one-third were in a crash that involved an alcohol-impaired driver, close to 30 percent were in a speeding crash, and approximately 20 percent were pedestrians. The state observed seat belt use rate was 92 percent. However, about 20 percent of all fatalities were unrestrained passenger vehicle occupants. Additionally, using state crash report data, close to 40 percent of fatalities resulted from distracted driving crashes.

This shows that several trends have remained constant over many years. Namely, speeding, impaired driving, and unrestrained occupants. These trends will continue to be safety concerns, while new innovations such as advanced technologies will have an increased effect.

Technology can be both a detriment and a means to improve safety, depending on its use. Cell phone use, both handheld and hands-free, is a major distraction to drivers, as well as in-vehicle interactive technologies. However, advances in connected and autonomous vehicle capabilities and biomechanical innovations will reduce the likelihood of a crash, injury, or fatality. Distracted driving is a behavioral concern that should remain a priority as driving becomes more technically complicated.

Source: Maryland Department of Transportation, 2018 Annual Attainment Report on Transportation System Performance.

Distracted Driving

Drivers can be distracted in many ways, some resulting from technological features meant to improve safety, not increase risk. NHTSA has identified three types of distraction: visual, manual, and cognitive. The most commonly discussed distracted driving activity is the use of handheld cell phones for conversations or texting. Texting or otherwise using an internet-based application on a handheld cell phone engages all three types of distraction, thus maximizing the driver's risk.

Knowing the risk inherent with using a handheld cell phone while operating a vehicle, many states have worked to enact legislation to prevent such an occurrence. As of October 2018, talking on a handheld cell phone is banned in 16 states and the District of Columbia, while texting is banned for all drivers in 47 states and DC . It has been difficult to capture accurate crash report data related to distracted driving and cell phone use because they are not behaviors observed by the law enforcement officers at the scene of a crash, thus making it difficult for them to charge and testify that a driver was distracted prior to crashing. More research needs to be done as cell phone technologies evolve and efforts related to accurate capture of related data by law enforcement need to be enhanced so as to keep up with the technology.

Other forms of distraction have arisen from technologies designed to increase safety; in-vehicle information systems (IVIS) were studied for a report by the AAA Foundation for Traffic Safety . Researchers tested four tasks (audio entertainment, calling and dialing, text messaging, and navigation) and three modes (center stack – dashboard, auditory vocal, and center console) in a naturalistic driving environment. Audio entertainment and calling and dialing were equivalent distractions, while text messaging was a higher level of demand, and navigation was the highest demand. Then using the center stack – dashboard was less demanding than auditory vocal interaction, which were less than using the center console. The main issue identified by the study was that those functions were enabled while the vehicle was in motion, thus creating a

false sense of safety for the drivers (i.e. drivers assume it's safe to use those functions while driving since they're enabled).

In addition to those features that require interaction, as discussed above, advanced safety features meant to prevent crashes may also be distracting to drivers. Oftentimes those features involve an auditory, visual, or tactile alert to the driver which will most likely be unexpected and draw attention from the driving task. Another concern is if drivers don't understand the alert and divert their focus from the roadway to investigating the unexpected alert. To assist with these concerns, the National Safety Council has developed https://mycardoeswhat.org to educate the public on some advanced vehicle technologies. As more advancements are integrated into the vehicle fleet, it will be important to track education and awareness of drivers in properly using the technologies and not being distracted by them.

Regional Growth and the Transportation System

Continued growth in the region depends on strong public infrastructure. Choices about transportation infrastructure affect the livability of the region's communities.

A comprehensive approach requires that planners consider not only the transportation infrastructure but also the uses of the land served by that infrastructure. Land use planning can influence accessibility and mobility across the transportation network as different land use patterns may require distinct transportation strategies to achieve system efficiencies and address specific objectives and needs.

Growth management refers to the policies and procedures that local jurisdictions, regions, and states use to accommodate more residents and workers. While specific policies, regulations, and procedures differ from jurisdiction to jurisdiction, commonalities exist in the form of basic principles shared across the region. An example is a transportation system capable of safely and effectively serving the existing population and any future growth. Other examples include protecting the environment and enhancing community character while supporting the economy.

All local jurisdiction members use their growth management policies, regulations, and procedures to encourage, guide, and support development in areas where public facilities and services are in place or are planned to be in place. Such an approach is intended to maximize social, economic, and environmental benefits and minimize negative impacts and consequences. In addition, growth management is also used to limit the development of land where there may be a particular land use that is valuable to the public. For example, local jurisdictions often use growth management to preserve environmental, historic, and/or economic resources and for future transportation corridors.

Comprehensive Plans and Community Development

Local government members of the BRTB exercise planning and zoning powers and regulate land development. Their comprehensive plans outline strategies, policies, programs, and funding for growth and development, resource conservation, infrastructure, and transportation, integrated across local jurisdictions, the region, and the state.

In developing a comprehensive plan, each local jurisdiction first forecasts the number of new residents and new workers expected in the jurisdiction over a period of 20+ years, and where the new residents and workers might choose to locate. The forecasts, often called "socioeconomic" or "cooperative" forecasts, are then used to plan for the public facilities and services—such as schools, water/sewer lines, roads, police departments, and fire stations—needed to accommodate all residents and workers in the local jurisdiction.

Generally, the transportation element of these local Comprehensive Plans discusses the importance of an interconnected transportation system where all modes—vehicle circulation/parking, transit, and bicycle/pedestrian activities—work together. Typically, they also address access to jobs and other opportunities and destinations. These key objectives are supported by policies that promote the management of growth in traffic on key roadways, provide parking solutions that deal with peak and long-term demands, and enhance local and regional transit systems. Improving the transit system can provide stronger links among neighborhoods, employment locations, shopping destinations, schools, and other local services. It also can provide transportation options for those who are cannot or do not drive, including the physically disabled, the elderly, or people with other special needs.

Many jurisdictions have stand-alone elements or plans that further break out specific goals and strategies for individual communities, issues or modes of travel. For instance, some have bicycle and pedestrian master or area plans.

The commitment to growth management in the Baltimore region dates from the 1960s. That decade saw innovative policies such as the Urban Rural Demarcation Line (URDL) in Baltimore County and ambitious efforts such as the plan for a whole "new" town, Columbia, in Howard County. In addition, the state of Maryland, considered a pioneer in statewide growth management policies, has provided guidance, technical expertise, and regulatory requirements to support these commitments.

State Government

In 1984, to safeguard the Chesapeake Bay from the negative consequences of intense development, the Maryland General Assembly enacted the Chesapeake Bay Critical Area Protection Program, a far-reaching effort to control future land use development in the Chesapeake's watershed. The "critical area" is a ribbon of land within 1000 feet of the tidal influence of the Bay and was determined by the Maryland General Assembly to be crucial because development in this "critical area" has direct and immediate effects on the health of the Chesapeake Bay. The Chesapeake Bay Critical Area Commission was charged with devising a set of criteria to minimize the adverse effects of human activities on water quality and natural habitats and foster consistent, uniform and more sensitive development activity within this sensitive environmental area. In cooperation with the Critical Area Commission, local jurisdictions were required to enact and actively manage growth management programs for their critical area that are partially or entirely within the Critical Area.

Later, the Maryland General Assembly passed a much broader effort to manage the state's growth. Known as the Priority Funding Act of 1997, that Act provided a new approach to statewide growth management, based on fiscal incentives, as opposed to regulations, to managing growth statewide. The legislation created five programs to encourage investment in developed areas and preservation of farmland, forests, and other natural resources.

The Priority Funding Areas (PFA) program provides incentives for jurisdictions and developers by concentrating growth-related projects in PFAs that are existing communities and places where local governments want state funding for future growth. Growth-related projects include most state programs that encourage growth and development, such as highways, sewer and water construction, economic development assistance, and state leases or construction of new office facilities. And the Rural Legacy Areas (RLA) program provides state funds to support the preservation of large, contiguous tracts of land that are designated by local governments and land trusts and are critical to the economy, environment, and quality of life.

The Sustainable Communities Act of 2010 established Sustainable Communities (SCs) to stimulate reinvestment in Maryland's older communities by preserving historic or non-historic properties and refocusing the state's community programs.

The Sustainable Growth and Agricultural Preservation Act of 2012 linked development potential to wastewater treatment. This act established four additional designated areas, or tiers, to encourage development in areas with existing or planned public sewer service and to limit development in areas with private septic systems. Local jurisdictions set the boundaries of all designated areas, which the State then uses to set priorities for infrastructure investment statewide.

Local Government

Each county in the region exercises land use planning authority to guide its growth and development. In 2012, the Maryland General Assembly repealed Article 66B and Article 28 and replaced it with the Land Use Article. The Land Use Article of the Maryland Annotated Code delegates planning and land use regulatory authority to all non-charter counties and all incorporated municipalities. The statute outlines the responsibilities, roles, and functions of the planning commission and sets the ground rules for planning and zoning powers for local jurisdictions exercising these powers.

Forecasting Population and Employment Growth in the Region

As noted, the regional transportation system influences the location of growth and development. Similarly, the type of growth and location of growth influence travel choices. Recognizing this transportation / land use connection, the BRTB strives to coordinate land use planning and transportation decisions among municipal, county, regional, and state partners.

A vital part of this coordination is the work of the Cooperative Forecasting Group (CFG). The CFG consists of representatives of state and local planning agencies. This group follows a cooperative, bottom-up approach to develop population, household, and employment forecasts for the Baltimore metropolitan region. This approach helps to ensure that these forecasts, and the regional transportation plan that relies on the forecasts, are consistent with its members' growth management policies and procedures.

Inputs for Modeling

The Round 9 forecasts provide the spatial location and concentration of population, households, and employment. These serve as key inputs to the region's travel demand model. Planners use this model to simulate individuals' work and non-work travel patterns.

Output from the travel demand model helps to identify regional transportation needs. This informs the decisions the BRTB makes about potential new projects in developing the long-range transportation plan. Appendix C presents additional information about the travel demand model's forecasts with respect to projects in this plan.

Round 9 Forecasts

In June 2018, the BRTB endorsed the Round 9 forecasts developed by the CFG. The Round 9 forecasts replace the Round 8B cooperative forecasts, which the BRTB endorsed in August 2016.

Round 9 Population Forecasts								
Jurisdiction	2015	2020	2025	2030	2035	2040	2045	% Change 2015 - 2045
Anne Arundel County	562,867	572,340	582,566	594,303	608,928	621,771	643,978	14.4%
Baltimore City	615,813	617,018	626,989	627,904	636,723	648,033	647,127	5.1%
Baltimore County	827,758	840,644	846,323	864,974	879,955	893,540	907,126	9.6%
Carroll County	167,550	169,200	171,700	175,150	178,500	181,800	185,150	10.5%
Harford County	250,025	257,680	264,870	271,865	280,570	289,220	294,250	17.7%
Howard County	313,359	336,920	355,696	366,818	369,499	371,846	372,358	18.8%
Queen Anne's County	48,477	51,813	55,434	58,319	61,021	63,533	66,148	36.5%
Baltimore Region	2,785,850	2,845,615	2,903,578	2,959,332	3,015,195	3,069,744	3,116,137	11.9%

Round 9 Household Forecasts								
Jurisdiction	2015	2020	2025	2030	2035	2040	2045	% Change 2015 - 2045
Anne Arundel County	207,338	210,959	217,565	224,575	231,253	237,951	244,998	18.2%
Baltimore City	250,238	254,557	259,667	262,988	269,119	271,327	273,363	9.2%
Baltimore County	322,738	327,457	329,940	337,410	343,323	348,565	353,808	9.6%
Carroll County	61,045	62,667	64,394	66,522	67,975	69,118	70,332	15.2%
Harford County	93,362	97,241	101,021	104,801	108,590	112,380	114,752	22.9%
Howard County	111,753	121,499	130,432	136,125	138,782	139,686	139,851	25.1%
Queen Anne's County	18,645	20,355	22,068	23,413	24,705	25,735	26,807	43.8%
Baltimore Region	1,065,119	1,094,736	1,125,087	1,155,835	1,183,748	1,204,762	1,223,910	14.9%

Round 9 Employment Forecasts								
Jurisdiction	2015	2020	2025	2030	2035	2040	2045	% Change 2015 - 2045
Anne Arundel County	369,580	382,795	397,236	413,039	431,305	451,373	474,511	28.4%
Baltimore City	401,082	418,102	436,252	454,948	466,906	485,731	505,068	25.9%
Baltimore County	462,770	479,680	500,515	515,752	528,684	540,935	550,843	19.0%
Carroll County	74,313	77,411	79,760	82,268	84,419	86,815	89,281	20.1%
Harford County	115,560	125,454	136,745	147,685	158,761	170,668	183,468	58.8%
Howard County	204,050	219,050	234,050	249,050	259,050	269,050	279,050	36.8%
Queen Anne's County	20,748	22,454	24,251	24,790	25,778	26,406	27,050	30.4%
Baltimore Region	1,648,103	1,724,946	1,808,811	1,887,531	1,954,902	2,030,979	2,109,271	28.0%

Transportation Needs of an Aging Population

Following the national trend, the region's population is getting older. This will have profound effects on how long people choose to stay in the workforce, where they will be able to find jobs, where they will live, and the social, health, and transportation services they will need.

Despite a substantial number of births over the past decade, the region's population is growing older due to the aging of the baby boom generation (those born between 1946 and 1964). This aging effect has accelerated and will continue into the immediate future.

The region's population began to age more rapidly after 2010, but significant numbers of births are still expected. The oldest baby boomers reached age 65 in 2011, the tip of the "silver tsunami" that has expanded over the past 10 years. In fact, since January 2011, 10,000 Americans have turned 65 years old each day of the year. By 2030, when all Baby Boomers will have turned 65, fully 18% of the nation's population will be at least that age.[1] Births are expected to be strong, due in part to a younger minority population.

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1 Passel, Jeffrey S. and Cohn, D'Vera,. *U.S. Population Projections: 2005-2050*. Pew Research Center.

Baltimore Region Population by Age in 2020 and in 2045
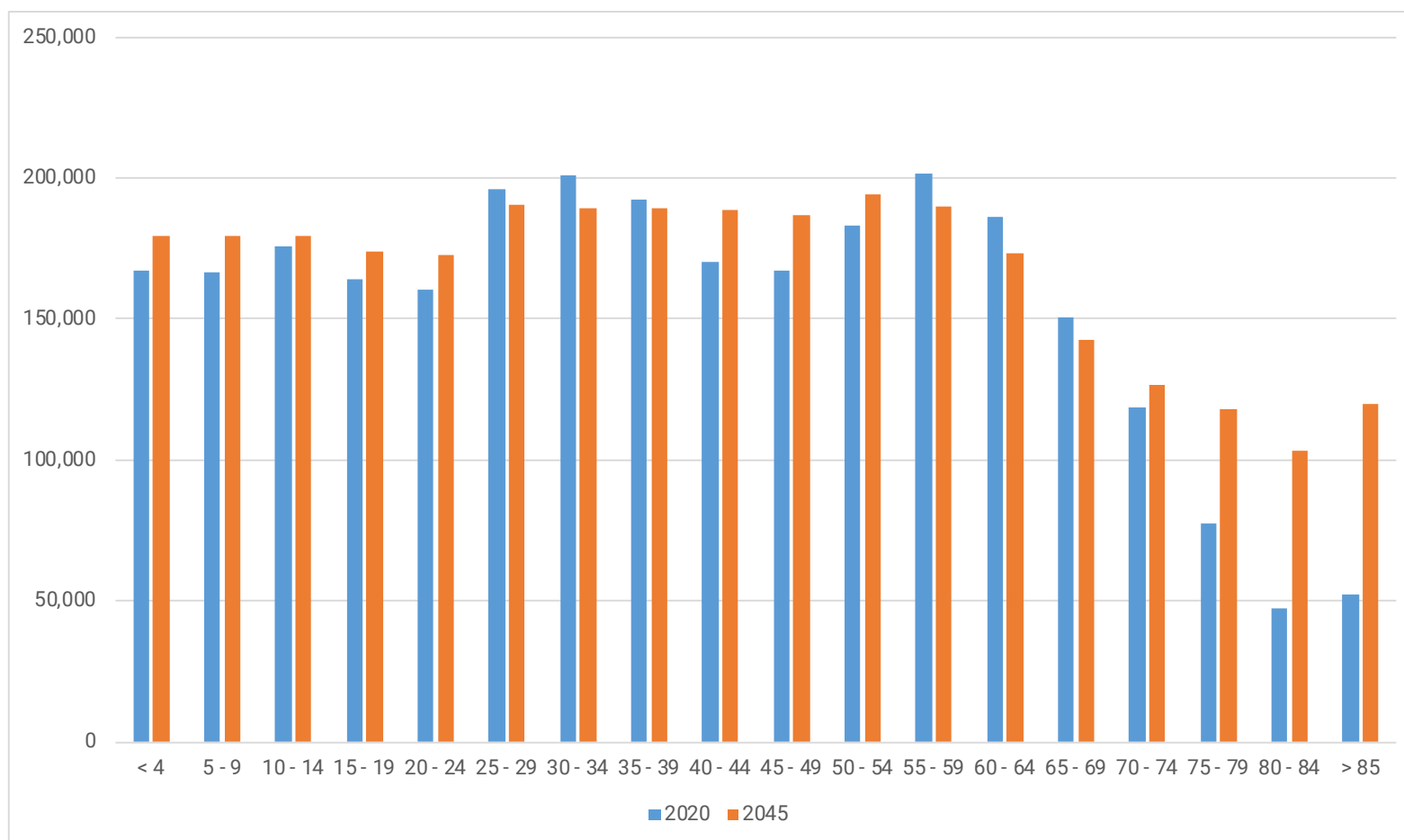
While some elderly do migrate to warmer climates, the vast majority "age in place." A substantial "aging" population will offer a challenge to local governments to successfully service the needs of these communities while at the same time educating the young. For instance, in 2010 the 65-year plus population comprised 14 percent of the total US population, yet they only represented 9 percent of the people who moved in the previous five years.[2] In the Baltimore region, where the 65+ population will represent about 16 percent of the population in 2020, there are no data to indicate that the region's 65+ citizens are any more likely to move than national statistics indicate.

2 David K. Ihrke and Carol S. Faber, "Geographical Mobility: 2005 to 2010 - Population Characteristics", Table 2. Five-Year Mover Rates, by Selected Characteristics: 2005–2010. (U.S. Census Bureau). Calculations by the author.

Transportation Patterns and Challenges for Older Adults

There are more seniors on the nation's roads and highways. The proportion of trips made by seniors ages 65+ increased from 13 percent of all trips in 2009, to 16 percent of all trips in 2017.[3]

The 2017 National Household Travel Survey (NHTS) found that all people younger than age 65 reported significantly fewer trips in 2017 compared to 2009.[4] The 2017 estimates were lower than previous survey estimates, except for people age 65 and older, who, on average, made 3.2 daily trips.

Miles traveled have also increased among people age 65 and older.[5] Daily miles of travel for those age 65 and older increased to 33 miles in 2017 compared to 24 miles in 2009. For every other age group, daily miles of travel either decreased or increased slightly over the same period.

In addition, the travel patterns of older drivers differ from those of younger drivers. The 2007/08 Household Travel Survey conducted by the BMC found that older adults are less likely to travel at night.[6] Only 10 percent of adults age 65-75 began a trip after 6:30 p.m. compared with 24 percent of adults age 35-55. Instead, older adults tend to travel in the mid-day; adults age 75+ make over half of their trips between the a.m. and p.m. peak periods of travel. But older adults do shop and eat out more than younger adults. On an average weekday, 60 percent of adults age 25-35, but nearly 85 percent of adults age 65-75, make a trip to shop or eat out.

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3   FHWA NHTS Report: *Travel Trends For Teens and Seniors – 2017 National Household Travel Survey, 8*. NHTS Publications (https://nhts.ornl.gov/publications).

4   *Summary of Travel Trends: 2017 National Household Travel Survey, Table 13. Trends in the Average Daily Person Trips per Person by Age and Gender*. NHTS Publications (https://nhts.ornl.gov/publications).

5   *Summary of Travel Trends: 2017 National Household Travel Survey, Table 14. Trends in the Average Daily Person Miles of Travel per Person by Age and Gender*. NHTS Publications (https://nhts.ornl.gov/publications).

6   2007/2008 Household Travel Survey (Baltimore Metropolitan Council).
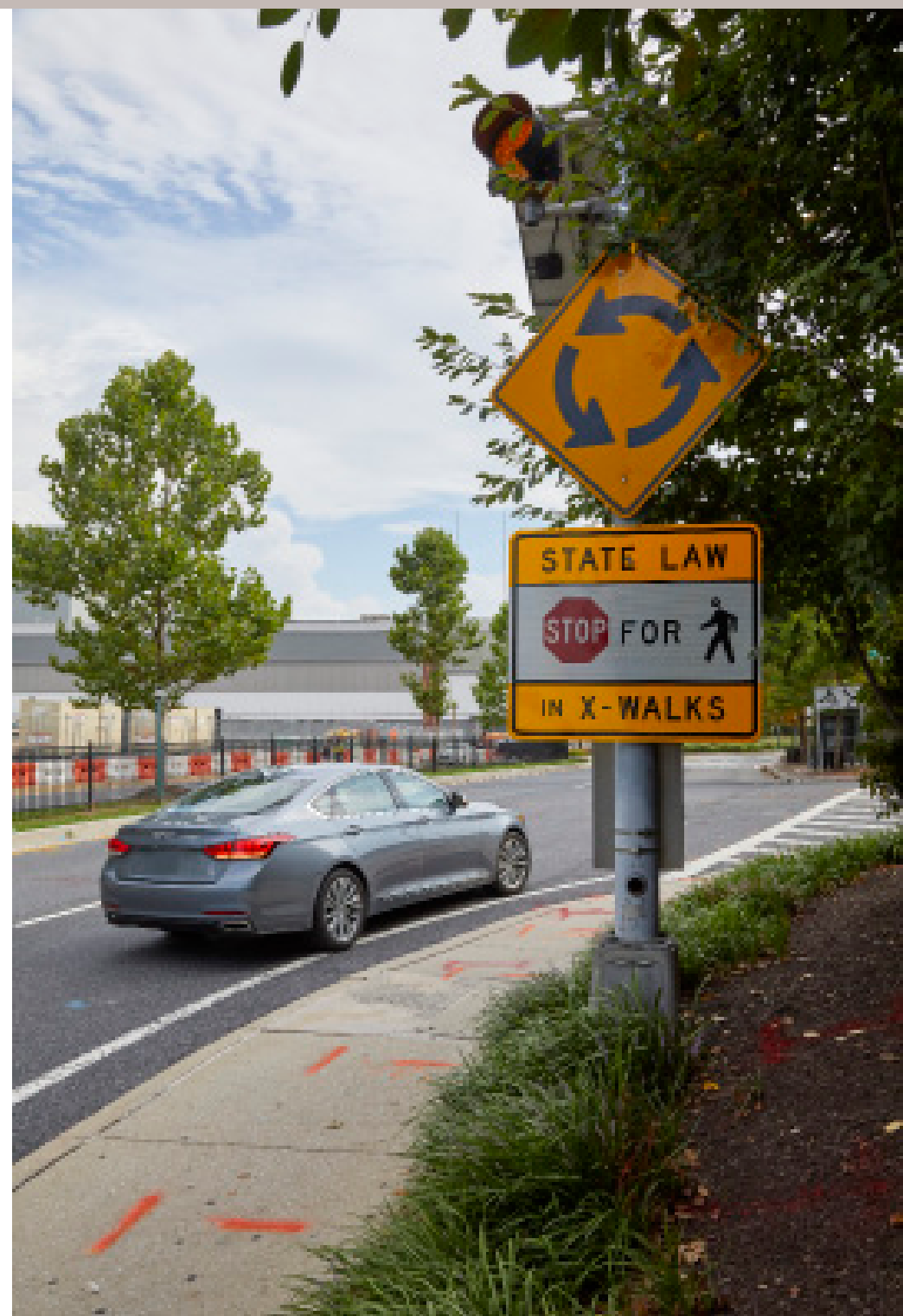
As shown in the table, seniors ages 65-74 and 75+ were most likely to drive themselves, accounting for two-thirds or more of their trips.[7] Trips made as auto passengers (18 percent and 25 percent) was the next most frequent travel mode reported, followed by walking (10 percent). Walking accounted for a greater share of trips than public transportation (1 percent). Older adults who live in urban areas are more likely to ride transit and to walk, especially for work trips.[8]

Percentage of Seniors' Travel by Mode across NHTS Years						
	Ages 65-74			Ages 75+		
Travel Mode	2001	2009	2017	2001	2009	2017
Walk	8%	9%	10%	9%	9%	10%
Bike	0%	1%	1%	0%	0%	0%
Driver*	69%	69%	68%	61%	62%	62%
Passenger	21%	18%	18%	27%	25%	25%
Transit	1%	2%	1%	2%	1%	1%
All other modes	1%	1%	2%	1%	3%	2%

* – The term "driver" refers to trips with a travel mode of "auto driver" on the assigned travel day.

For perspective, among the general population, driver and auto passenger trips together accounted for 83 percent of all trips, walking trips accounted for 10.5 percent, and public transit trips accounted for 2.5 percent of all trips.[9]

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7 FHWA NHTS Report: *Travel Trends For Teens and Seniors – 2017 National Household Travel Survey, 6–7*. NHTS Publications (https://nhts.ornl.gov/publications).

8 McGuckin, Nancy, "Working Retirement: An Update", Travel Behavior Associates (https://www.travelbehavior.us/)

9 *Summary of Travel Trends: 2017 National Household Travel Survey, Table 9b. Trends in the Percent of Person Trips by Mode of Transportation and Trip Purpose*, NHTS Publications (https://nhts.ornl.gov/publications).

Working Retirement

Whether because they have financial reasons or because they desire to stay engaged, many seniors are continuing to work into old age, in some cases after officially retiring from their jobs.

Who are these seniors? Older workers, on average, are better educated than those that stay at home. For both men and women, the nature of work changes with better education. Better educated workers are less likely to work in physically demanding jobs and more likely to have careers that can be kept active as they age. Older workers are also more likely to live in their own home and report higher household income.[10]

Older workers also prefer part-time and flexible work. Half of all workers between 65 and 79 years old work part-time, and by ages 75 and older over two-thirds of workers are part-time.[11]

People who continue to work past age 65 find work close to home – on average their commutes are just 9 miles compared to 12 for younger workers. And these older workers have a very different pattern of commute time. Older workers leave later in the morning, return earlier in the afternoon, and are much more likely to be commuting in the middle of the day.[12] Anecdotal evidence suggests that mid-day traffic congestion has increased around the region. The working retirement trend is likely a factor.

10 McGuckin, Nancy, "Working Retirement: An Update", Travel Behavior Associates (https://www.travelbehavior.us/)

11 McGuckin, Nancy, "Working Retirement: An Update", Travel Behavior Associates (https://www.travelbehavior.us/)

12 McGuckin, Nancy, "Working Retirement: An Update", Travel Behavior Associates (https://www.travelbehavior.us/)

Immobility

Among adults age 65+ who report not having taken a trip outside their home in the past week, a little more than half reported that they would like to get out more often.[13] According to the 2017 NHTS, non-travelers tended to be female, without a medical condition that limited travel, retired, and with a household income less than $50,000.[14]

Conclusions

Given the strong preference for automobile travel among many older adults, it will be necessary to upgrade the region's transportation infrastructure to accommodate the needs of older drivers. These improvements will benefit everyone. For example, in the year since increasing the size of street-name signs, repainting median strips, installing larger and brighter stoplights, upgrading walk lights, and adding left-turn lanes along one busy street, Detroit saw a 35 percent drop in injury crashes for drivers age 65 and older and a 4 percent drop for drivers age 25 to 64.[15]

Finally, to accommodate the mobility needs of an aging population, the focus of transportation planning and policy must shift from increasing road capacity to providing more multimodal solutions. For instance, many communities are adopting plans to "complete the streets" through investments that serve transit users, pedestrians, bicyclists, and drivers of all ages and abilities. (See the discussion on the Accessibility goal in Chapter 4 for more information on the "Complete Streets" approach.). More balanced investment in the nation's transportation system also will provide health benefits as people increase their active transportation.[16]

13 *Fact Sheet: How the Travel Patterns of Older Adults Are Changing: Highlights from the 2009 National Household Travel Survey, 5* (2011) AARP Public Policy Institute.

14 FHWA NHTS Report: *Travel Trends For Teens and Seniors – 2017 National Household Travel Survey, 8*. NHTS Publications (https://nhts.ornl.gov/publications).

15 *Enhancing Mobility Options for Older Americans: A Five Year National Action Agenda, 16*, AARP

16 Bassett Jr., David R; Pucher, John; Buehler, Ralph; Thompson, Dixie L.; and Crouter, Scott. "Walking, Cycling, and Obesity Rates in Europe, North America, and Australia," *Journal of Physical Activity and Health (2008) 5*, 795–814.

Freight Movement, Connections, and Trends

The efficient movement of freight, within and through the region and between modes, is a vital element of the region's economy. Many businesses maintain smaller inventories and rely on "just-in-time" deliveries of materials and goods. Anything that complicates or slows the movement of freight slows the delivery of materials and goods to consumers and businesses.

Regional Freight Network

The greater Baltimore region is Maryland's leading goods movement center. Each year, more than 307 million tons of freight valued at nearly $1 trillion move over Baltimore's highway, rail, port, and airport facilities, serving domestic and international demand for a wide range of goods.

Roads under the operation of the State Highway Administration carry more than 38 billion ton-miles of goods movement a year. In addition, MDOT SHA roads are estimated to carry 219 million tons of freight, representing more than $324 billion in value.

As of 2015, MDOT estimated that by 2030 freight on the region's transportation system would nearly double, with significant percentage increases across the modes and the largest volume increase in truck tonnage. The growth in freight demand, combined with the predicted growth in private vehicle travel, commuter or intercity rail, and passenger air services, will place additional stress on the capacity of the region's transportation system.

Given current levels of congestion, the doubling of freight traffic on the region's infrastructure will create additional challenges for transportation planners. Other trends and challenges include the need to enhance highway safety, a need for improved intermodal connections, the security of goods movement, and lack of sufficient truck parking.

The Fixing America's Surface Transportation (FAST) Act requires the FHWA Administrator to establish a National Highway Freight Network (NHFN) to strategically direct federal resources and policies toward improved performance of the Network. In an urbanized area with a population of 500,000 or more individuals, the MPO, in consultation with the State, may designate a Critical Urban Freight Corridor (CUFC). A public road designated as a CUFC must meet one or more of four criteria:

1. Connects an intermodal facility to: (1) the PHFS, (2) the Interstate System, or (3) an intermodal freight facility

2. Is located within a corridor of a route on the PHFS and provides an alternative highway option important to goods movement

3. Serves a major freight generator, logistic center, or manufacturing and warehouse industrial land

4. Is important to the movement of freight within the region, as determined by the MPO or the State.

For each state, a maximum of 75 miles of highway or 10 percent of the PHFS mileage in the state, whichever is greater, can be designated as CUFCs.
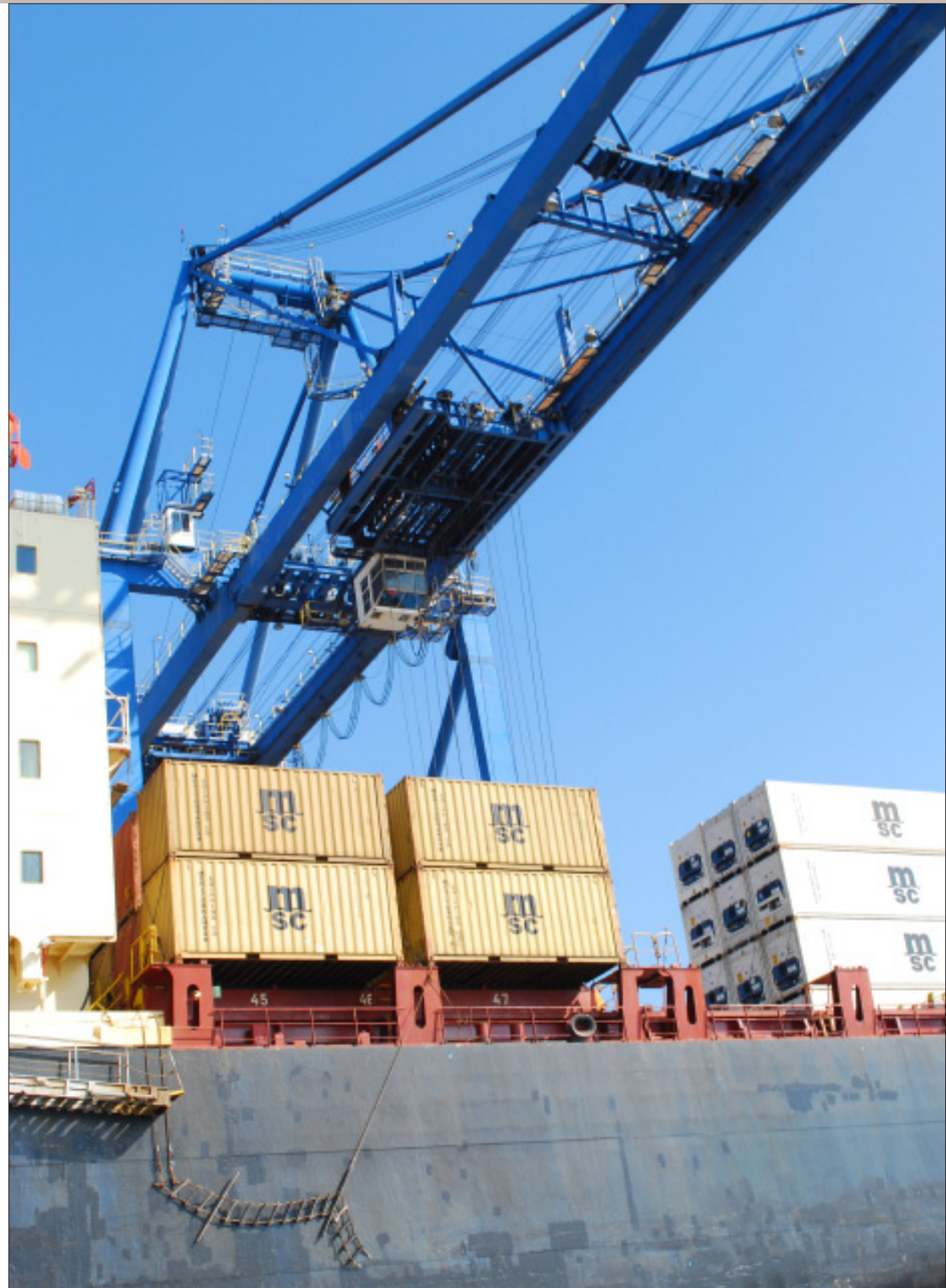
Critical Urban Freight Corridors in the Baltimore Region					
Jurisdiction	Road Name	Starting Point	Ending Point	Miles	Cumulative Total
Anne Arundel County	New Ridge Road	MD 100	Stoney Run Road	1.8	1.8
	MD 100	MD 295	I-97	5.6	7.4
Baltimore City	Broening Highway	Boston Street	Belclare Road	1.9	9.3
	E. Lombard Street	Haven Street	Kane Street	1.0	10.3
	Boston Street	Fleet Street	I-895	1.9	12.2
	O'Donnell Street	S. Conkling Street	Dundalk Avenue	1.7	13.9
	MLK Jr. Boulevard	N. Howard Street	I-395	1.7	15.6
Baltimore County	Rolling Mill Road	Erdman Avenue	Eastern Boulevard	1.3	16.9
	U.S. 40 (Pulaski Highway)	Philadelphia Road	MD 695	2.7	19.6
	Broening Highway	Belclare Road	I-695	2.0	21.6
Carroll County	MD 97	MD 140	Bachmans Valley Road	1.8	23.4
Harford County	MD 543 Interchange *	I-95	I-95	0.0	23.4
Howard County	MD 175	US 1 (Washington Boulevard)	MD 108	1.0	24.4
	U.S. 1	Montevideo Road	Assateague Drive	0.6	25.0

* Because interchanges and ramps are not counted against Interstate mileage, they are not counted as NHFN mileage. The interchanges and ramps are considered to be facilities, which are eligible for NHFP funding.

Growth at the Port of Baltimore

The following press release from the Maryland Port Administration demonstrates the pattern of growth at the Port of Baltimore and the importance of the Port to the city's and the region's economies.

PORT HANDLED MOST CARGO TONNAGE IN 38 YEARS IN 2017 – Record Year for Containers and Cars (BALTIMORE, MD)

The Helen Delich Bentley Port of Baltimore's public and private marine terminals handled 38.4 million tons of cargo in 2017, the most since 1979 and the third-highest tonnage in its history. This record comes on the heels of a record 2017 year for the Port's state-owned public marine terminals. The 38.4 million tons of cargo handled last year was valued at $53.9 billion. The cargo tonnage fell just behind the record of 40.9 million tons in 1974 and 38.5 million tons in 1979. It was the second consecutive year for more than 10 million tons of general cargo from the public terminals. General cargo includes autos and light trucks, containers, roll on/roll off (farm, mining and construction equipment), forest products (rolled paper and wood pulp) and breakbulk cargo. Included in the general cargo number was a record 596,972 containers, an 11 percent jump from the previous record set in 2016. The Port's combined public and private auto terminals also had a record year in 2017 by handling 807,194 cars and light trucks. It was the first time surpassing the 800,000 car/light truck mark and the seventh consecutive year that Maryland had handled more cars and light trucks than any other U.S. port. Among the nation's ports, the Port of Baltimore ranks first for autos and light trucks; first for roll on/roll off heavy farm and construction machinery; first for imported sugar; and second in exported coal. Overall, the Port ranks ninth among all ports for the total dollar value of cargo and 12th in foreign cargo tonnage. Business at the Port of Baltimore generates about 13,650 direct jobs, while about 127,600 jobs in Maryland are linked to Port activities. The Port is responsible for nearly $3 billion in personal wages and salary and more than $300 million in state and local tax revenues.

Source: Maryland Port Administration press release, April 12, 2018.

"Mega-Regional" Projects – Freight Implications

Two "mega-regional" facilities (see more information in a later section) have regional freight implications: (1) B&P Tunnel that carries freight and passenger traffic through Baltimore City and (2) Amtrak/freight rail bridge over the Susquehanna River between Harford and Cecil counties.

Both of these facilities need significant improvements (or replacement) to handle increased rail traffic. MDOT is studying alternatives for improving these facilities to better accommodate current and future rail traffic and has provided periodic updates to the BRTB about findings and developments.

Funding for any possible future improvements to these facilities would be from sources outside the jurisdiction of the BRTB. Nonetheless, regional planners and modelers need to be aware of the potential effects of any improvements (or lack of improvements) on the region's transportation network. The BRTB, supported by BMC staff, will determine these potential effects on regional travel demand and patterns should these projects advance beyond the study phase.

Freight Initiatives

Freight Modeling Initiative

BMC and MDOT SHA are working together under a grant from FHWA to study freight movement in the Baltimore region and to enhance the simulation of freight traffic in their travel demand models. This "C20" freight model project will provide information on the components of freight movement: locations of cargo transfers, type of commodities and characteristics, long-distance freight routing, and local delivery patterns. This information will be incorporated into two simulation tools: a statewide supply chain freight model for use by MDOT SHA and an urban-tour-based commercial vehicle model for use by BMC.

The statewide supply chain freight model seeks to provide insight into suppliers' and distributors' choice in transportation mode, shipment size, and commodity -specific characteristics to simulate long-distance truck traffic. The urban-tour based commercial vehicle model seeks to understand and simulate the local delivery of goods and services to area households.

Tradepoint Atlantic

Sparrows Point in southeast Baltimore County, once the largest iron producer and steel making facility in the world, ceased operations in 2012. Today, under new ownership and what is known as Tradepoint Atlantic, the 3,100-acre industrial site is being transformed into one of the largest intermodal global logistics hubs in the country. Companies such as FedEx, Under Armour, and others have begun construction and operations at this site.

Freight movement between the Seagirt Marine Terminal (SMT) and Tradepoint Atlantic (TPA) is expected to increase over the next 10 years as the development rate at TPA increases. It is also expected that TPA will generate thousands of jobs and play a significant role in improving the economy of Baltimore County and the region. This will likely result in increased truck volumes between the two locations and across the Baltimore region.

Trends in Freight Delivery – Questions to Consider

Planners need to consider some questions related to how goods might be delivered in the future. For example:

- What role might autonomous trucks play in freight delivery over the next 5, 10, or 20 years? The chapter on Emerging Technologies discusses some of the implications of connected and autonomous vehicles. Are there other factors particular to the trucking industry that transportation planners, economists, and regional decision makers should consider?

- How will consumers' changing habits (for example, increases in on-line shopping) continue to shape how goods are delivered? A February 2019 analysis by the American Transportation Research Institute noted that the annual growth of e-commerce has ranged between 13 and 16 percent over the last five years, compared to the 1-5 percent annual growth in traditional retail sales. How will this trend affect the trucking industry?

- How will the changing habits of consumers affect land use decisions about whether and where to place stores and distribution centers? And how will the locations and operating hours of stores and distribution centers affect decisions on how customers, workers, and freight operators will access such facilities?

- Will expectations about the amount of time needed to deliver goods continue to evolve—from next-day to same-day to, potentially, same-hour?

- Could drone deliveries eventually become a viable alternative to traditional shipping, and how might this affect the trucking industry?

These are just some of the questions that planners will need to consider over the next 20 or so years. Planners don't have the answers to these questions yet. But evolving preferences and business models demand at least an awareness of the potential for change. That is, there could be great opportunities to operate more efficiently as well as major disruptions in "business as usual" approaches. The more that planners, businesses, and regional decision makers think about and discuss these types of questions, the more the region will be prepared to accommodate change.

The BRTB and its advisory group, the Freight Movement Task Force (consisting of representatives of freight carriers as well as state and local planners), will continue to stay informed about trends in freight delivery.

Travel and Tourism

Federal law requires that metropolitan regions consider a series of factors when developing their transportation programs and plans. These factors address issues such as supporting the economic vitality of the metropolitan area, increasing the safety of the transportation system for motorized and non-motorized users, and protecting and enhancing the environment, among others. The FAST Act added another factor to this list: enhance travel and tourism.

The conference report prepared during the development of the FAST Act notes that:

1. One out of every nine jobs in the U.S depends on travel and tourism, and the industry supports 15 million jobs in the U.S.

2. The travel and tourism industry employs individuals in all 50 states, the District of Columbia, and all of the territories of the U.S.

3. International travel to the U.S. is the single largest export industry in the country, generating a trade surplus balance of approximately $74 billion.

4. Travel and tourism provide significant economic benefits to the U.S. by generating nearly $2.1 trillion in annual economic output.

5. The U.S. intermodal transportation network facilitates the large-scale movement of business and leisure travelers, and is the most important asset of the travel industry.

Understanding the Context: Enhancing Travel and Tourism

As part of its efforts to understand regional issues and opportunities related to travel and tourism, the Technical Committee that advises the BRTB heard presentations from two organizations charged with promoting tourism in the area: Visit Baltimore and the Maryland State Office of Tourism Development.

Visit Baltimore

During development of this plan, a representative from Visit Baltimore presented information on issues and challenges facing the travel and tourism industry with respect to transportation.

Information included:

- an overview of Visit Baltimore's membership and mission

- data on the effects of tourism on the Baltimore region's economy

- information on how Baltimore compares to other regions in terms of tourism

- information on partnerships that Visit Baltimore has formed with transportation providers in the region (e.g., Amtrak, Uber and Lyft, Baltimore's water taxi service, etc.)

- data on visitor travel trends

- a summary of challenges and opportunities facing the travel and tourism industry in the region, including: dealing with increasing traffic congestion, improving connections between modes, and taking advantage of new transportation technologies to improve mobility for travelers.

The presentation noted that visitors and visitor spending set new records in 2014, thanks in part to the culmination of a 3-year period celebrating the bicentennial of the War of 1812. Relevant data from 2014 follow:

- 25 million visitors

- approximately 56 percent stayed only for the day, while the remaining 44 percent stayed overnight; of the overnight visitors, approximately 17% were traveling for business

- tourism accounted for $5.2 billion in direct visitor spending

- this led to $630 in tax savings generated per each Baltimore household

- tourism accounted for more than 82,000 jobs created or sustained.

This information about tourist activity in Baltimore City was from 2014. It's fair to wonder about the effect the riots of 2015 had on tourism in the city. A recent article[17] noted that nearly 26 million people visited Baltimore in 2016, a 2.8 percent increase over 2015. According to this article, Visit Baltimore attributes this increase to the "power of good press about the city." The article also noted that visits to the city in 2016 generated $5.6 billion in direct spending, which added $705 million in city and state tax revenues and helped to sustain 85,000 jobs.

Maryland State Office of Tourism Development

The Technical Committee also heard from a representative of the Maryland State Office of Tourism Development. The state measures the effects of tourism on the economy in terms of sales tax revenue. The objective is to get tourists to visit and, once they're here, to get them to stay longer and to visit other sites.

Tourism statewide has increased every year since 2009. The presentation included information about tourist travel on all facilities, including state and local roads, scenic byways, and bike trails. The presentation ended with a video showing the attractions along Charles Street in Baltimore County and Baltimore City and the transportation modes a typical pair of tourists might use to reach each destination along this corridor.

The state tourism agency has four focus areas related to transportation:

1. providing and maintaining signage

2. keeping roads in a state of good repair

3. providing and maintaining bike lanes

4. maintaining scenic views.

Another concern relates to on-line information for tourists, including customized trip planning tools, and smartphone apps.

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17 *The Baltimore Business Journal*, October 3, 2017.

Enhancing Travel and Tourism – Input from BRTB Advisory Committees

Building on this input, the Technical Committee recommended some additional language related to travel and tourism to support the BRTB's regional transportation goals and to address the new planning factor. In addition, the BRTB's Public Advisory Committee, consisting of members of the public and stakeholder groups, commented on this recommended language.

New Implementation Strategy

Based on these recommended additions and comments, the BRTB adopted a new implementation strategy in support of the regional goal to Promote Prosperity and Economic Opportunity. This goal is one of the overarching principles informing the regional transportation plan. As noted, the BRTB adopted this strategy with review and input by its Technical Committee and its Public Advisory Committee.

New strategy: "Invest in upgrading transportation assets and facilities that promote tourism and the movement of tourists within and through the region. This includes: (1) improving roadway, transit, pedestrian, and bicycle access to regional and local tourist attractions, (2) analyzing peak travel volumes and times in key tourism corridors, and (3) improving and promoting information systems (e.g., signage, bus service information, smartphone applications) that visitors can use to reach destinations easily and safely."

"Mega-Regional" Projects

The projects listed below are outside the scope of this regional transportation plan. Currently, these projects are under study, but as of yet they have not progressed to the point where their sponsors have identified funds reasonably anticipated to be available during the 2024-2045 period. Partly for this fiscal constraint reason, the preferred alternative does not include these projects.

Even if these projects were to be funded some time in the future, at least some of the funding would need to come from the Federal Railroad Administration (FRA). The regional long-range transportation plan over which the BRTB has jurisdiction does not cover FRA-funded projects. Additionally, projects may be funded by the private sector and are not considered with our analysis of fiscal constraint. If any of these projects move forward in the future there would be an assessment of their impact on air quality in the region.

Nonetheless, it is good policy for the region to be aware of these projects and to be prepared to determine their potential effects on regional travel demand and regional travel patterns should they progress beyond the study phase. Below is a list of projects and a brief description.

B&P Tunnel

The 144-year-old, two-track B&P Tunnel is located between the West Baltimore MARC Station and Penn Station in Baltimore, Maryland. The tunnel is owned by Amtrak and also used by MARC trains and Norfolk Southern Railway freight trains.

To improve rail service and reliability on the Northeast Corridor (NEC), and address a longstanding bottleneck, the Federal Railroad Administration (FRA) issued a Record of Decision (ROD) for the B&P Tunnel Project. The federally funded engineering and environmental study identifies a new tunnel to replace the existing B&P Tunnel. The estimated cost, which has not changed since the Final Environmental Impact Statement (FEIS), is $4.5 billion. The project is not currently funded for construction.

Howard Street Tunnel

The Howard Street Tunnel was built 121 years ago to connect Baltimore with the nation. Height restrictions within CSX's Howard Street Tunnel currently prevent the shipment of double-stacked intermodal containers (two shipping containers stacked on top of each other) by rail to and from the Port of Baltimore and up and down the East Coast. Double-stack provides a more cost effective way to transport freight by rail than by truck. The added benefit is that it also will take more trucks off our interstates and reduce congestion along the entire I-95 corridor.

By utilizing recent advances in construction technology including a technique that involves lowering the floor and notching the crown of the tunnel, it is now possible to provide double-stack clearance in the tunnel and under nine bridges for $445 million with minimal impact to the community.

Amtrak / Freight Rail Bridge over the Susquehanna River

The Susquehanna River Rail Bridge is a two-track bridge located in the City of Havre de Grace in Harford County, Maryland and the Town of Perryville in Cecil County, Maryland. The 110-year-old bridge is owned by the National Railroad Passenger Corporation (Amtrak). It is used by Amtrak, Maryland's MARC Commuter Rail and Norfolk Southern Railway to carry passenger and freight trains across the Susquehanna River.

The Federal Railroad Administration (FRA) issued a Finding of No Significant Impact (FONSI), for the Susquehanna River Rail Bridge Project. The FONSI completes the National Environmental Policy Act (NEPA) process and this phase of the project.

Northeast Corridor (NEC)

In response to strong and continued demand for rail travel in the Northeast Corridor, Amtrak has developed a vision for Next Generation high-speed rail service on the NEC. The first of many phased improvements – the introduction of new high-speed trainsets that will supplement and ultimately replace the Acela Express fleet – is expected to be introduced into revenue service in 2021.

MagLev Train

The Baltimore-Washington Superconducting MagLev (SCMagLev) project is a privately sponsored initiative led by Baltimore-Washington Rapid Rail. The vision is to provide a 15-minute ride between downtown Baltimore and downtown Washington, D.C., with an interim stop at Baltimore/ Washington International Thurgood Marshall Airport.

The SCMagLev would not be a typical train. Rather, it would be a magnetic levitation system relying on powerful magnetic forces for all aspects of operation: acceleration, deceleration, guidance, and levitation. The system is expected to operate at speeds of more than 300 miles per hour in everyday service, resulting in travel times unlike anything traditional trains can achieve. SCMaglev is in full operation in Japan along a 26-mile long line that has been operating since 2013 and has carried over 270,000 passengers. Full build-out of this 175-mile Japanese line will be in 2027.

The Federal Railroad Administration and MDOT are preparing an Environmental Impact Statement (EIS) to evaluate the potential impacts of constructing and operating the SCMagLev system. The EIS is being prepared in compliance with NEPA and other applicable regulations and procedures. The draft EIS is expected to be published in fall 2019. The Alternatives Report is anticipated to be published in summer 2019.

Chesapeake Bay Bridge - widen or construct additional bridge

The Maryland Transportation Authority (MDTA) owns, finances, operates, and maintains the William Preston Lane, Jr. Memorial (Bay) Bridge and is conducting the $5 million Bay Crossing Study. The study area is a broad geographic area that includes the entire length of the Chesapeake Bay in Maryland, spanning approximately 100 miles from the northern end near Havre de Grace to the southern border with Virginia between St. Mary's and Somerset counties.

The Chesapeake Bay Crossing Study is a Tier 1 National Environmental Policy Act (NEPA) study that will result in the identification of a preferred corridor alternative to address congestion at the Chesapeake Bay Bridge and evaluation of its financial feasibility. The Bay Crossing Study will evaluate current and future traffic demand across the Chesapeake Bay.

Potential Chesapeake Bay crossing projects are included in the list of illustrative projects in Chapter 7.

Chapter 3:
Emerging Technologies

EMERGING TECHNOLOGIES

The rapid development and deployment of technology is affecting all parts of our lives, especially how we get around and how freight is moved. A variety of technologies are rapidly advancing and are already affecting the transportation industry and challenging transportation planners and policymakers in the Baltimore region.

Currently, technologies poised to have the greatest effects include:

1. Electrification of vehicles

- An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. Electricity is stored in an energy storage device, such as a battery.

- Widespread use can significantly improve air quality through reduced fossil fuel consumption and decreased emissions of greenhouse gases (GHGs) and other harmful air pollutants.

- This technology will provide benefits to personal vehicles, transit vehicles, and freight vehicles.

- Maryland has made significant progress in the past several years and expects to see registration of 60,000 EVs by 2020, approximately 300,000 EVs by 2025, and nearly 1.5 million EVs by 2040, with the infrastructure in place to accommodate those vehicles.

2. Shared Mobility / Mobility-as-a-Service (MaaS)

- MaaS is the integration of various forms of transport services into a single mobility service accessible on demand. Such services can offer a diverse menu of transport options such as public transport, ride sharing and car sharing/hailing, bike sharing, Escooters, taxi (land and water), or car rental/lease. These also can provide added value through use of a single application to afford access to mobility with a single payment channel instead of multiple ticketing and payment operations.

- A robust MaaS market (often called a "transportation ecosystem") should provide a range of safe and inexpensive alternatives to the use of the private car that may be as convenient as well as more sustainable, helping to reduce congestion and constraints in transportation capacity.

- Ridehailing and ridesharing options such as Transportation Network Companies (e.g., Lyft, Uber), car sharing (e.g., Zipcar), bike sharing (e.g. Lime, Spin) exist now in the region.

- Microtransit (e.g. the Annapolis Circulator, Chariot) is defined as a privately or publicly operated, technology-enabled transit service that typically uses multipassenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing.

- Cashless or electronic payment methods (e.g., E-ZPass, Moovel/ReachNow) enable the use of MaaS, requiring users to have a credit card and often a smart phone. This could be a barrier for some travelers.
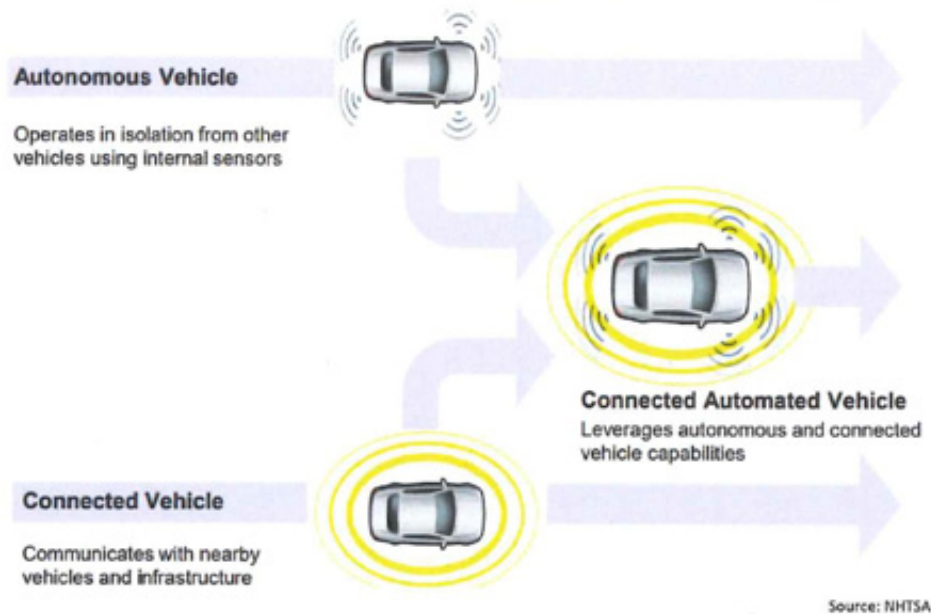
3. Big Data and Artificial Intelligence (AI)

- Improvements in manipulating, analyzing, and learning from very large and diverse data sets (Big Data), improvements to connectivity, and machine learning have enabled significant advancements in transportation services.

- Enhanced on-line communication (e.g., telecommuting, telemedicine, and e-commerce) is affecting travel demand and logistics for both passengers and freight.

- As more devices are connected to the Internet (the "Internet of Things" (IoT)), the ability to continuously send and receive data also will increase.

- "Smart" sensors enable remote monitoring and management of pavement and bridges, smart street lights, and other transportation infrastructure.

- Increases in data and connectivity have enabled new transportation service models and improved traveler and system operation information.

4. Autonomous Vehicle Technology

- Connected Vehicles (CVs): These have communications technology that enables them to share data with other vehicles and roadside infrastructure.

- Autonomous Vehicles (AVs): Technology most sought after because of the range of benefits it can offer. This technology uses sensors, cameras, and GPS to allow a vehicle to operate independent of a human operator. For discussion purposes, this includes both connected (vehicles that communicate between one another and/or a system) and unconnected autonomous vehicles.

- This technology will provide benefits to personal vehicles, transit vehicles, and freight vehicles. Freight transporters could reap significant benefits from truck platooning and automation as well as on-demand freight and delivery services.

Connected Automation for the Greatest Benefit

Source: NHTSA

Increases in data and connectivity have enabled new transportation service models and improved traveler and system operation information.

5. 3D Printing / Improvements to Building Materials

- Changes in 3D printing and building material technology could have the most significant effects on the transportation network. 3D printing technology is expected to affect all aspects of transportation: planning, maintenance and operations, capital development and finance, and human resources and legal issues. Understanding the technology and its effect on the transportation network will be critical to making near-term and future business and capital decisions.

- 3D printing is a new, efficient manufacturing method that promises more freedom in design. This technology is being used to speed up repairs, cut manufacturing costs, improve quality control, and also reduce material waste while producing prototypes and multiple precise copies. With the ability to prototyp everything from vehicles to bridges and other transportation uses, 3D printing construction methods are using an ever widening variety of materials to allow many iterations at a lower cost, promising to improve product design.

- 3D printing technology is likely to pose many challenges to the way transportation agencies plan and conduct business. For example, time frames for decision making and planning horizons will shrink, affecting the viability of long-range planning and requiring transportation decision makers to become more responsive and decisive.

- This technology also likely will affect supply chain logistics,. For example, locally produced service parts could mean changes in manufacturing and construction distribution, with less of a need to import and/or export parts. Production and manufacturing could be vastly decentralized and customized, enabling small manufacturing hubs near end users and/or businesses to fill their own product needs. This could affect truck traffic patterns and the type of trucks needed. Such changes could ripple throughout the current transportation industry and disrupt it in ways we have yet to understand.

6. Unmanned Aerial Systems

- Unmanned aerial systems (UASs), sometimes called "drones," are aircraft outfitted with sensors such as cameras and LiDAR and controlled by a licensed operator on the ground.

- UASs can provide substantial benefits: increased safety, increased efficiency, and reduced costs.

- Transportation agencies are using UASs to perform activities related to structural inspection, construction inspection, geologic analysis, environmental analysis, and emergency response.

- MDOT and local jurisdictions already are using UASs for some of these activities. As a result of the benefits already realized, use of UASs is expected to continue to expand in the region.

7. Underground Tube Transport Systems

One intriguing emerging technology would use autonomous electric "skates" traveling underground through tubes at 125-150 miles per hour. Such a system could carry between 8 and 16 passengers, or a single passenger vehicle. One configuration of such a system would consist of a set of twin tunnels running in parallel. The ultimate objective is that this system would serve as the central artery for a potential future transportation network connecting metropolitan areas along the East Coast.

Another somewhat related technology is a proposed mode of passenger and/or freight transportation in a pressurized/sealed tube or system of tubes. This system would convey people or objects at high speed via pods traveling free of air resistance or friction. One version of this concept incorporates reduced-pressure tubes in which pressurized capsules ride on air bearings driven by linear induction motors and axial compressors. This system would propel passengers at speeds of up to 760 mph, considerably faster than conventional rail or air travel.

What Is the Industry's Vision of the Future?

Together these advancements are enabling new ways to move people and goods with on-demand mobility options and services. These offer the potential to improve dramatically the safety, reliability, accessibility, and environmental footprint of our transportation networks across modes. However, these technologies may also significantly affect travel demands and modes used by passengers and freight, land use patterns, and future transportation investment needs in ways that are not fully understood. Technology is as likely to improve performance as it is possibly to create unintended or adverse consequences.

Many of these technologies are in use to some degree today, but the level of use varies greatly. Many of us have used a Lyft or Uber service, a few of us may have a fully-electric vehicle or ridden in one, while some of us have vehicles with advanced technologies such as lane keeping or automatic braking. However, most of us have never been in a self-driving vehicle. Automation is central to how many new investors in transportation technology see the future transportation sector. This figure illustrates the interdependencies of vehicle technology, electrification, and sharing, as envisioned by industry:
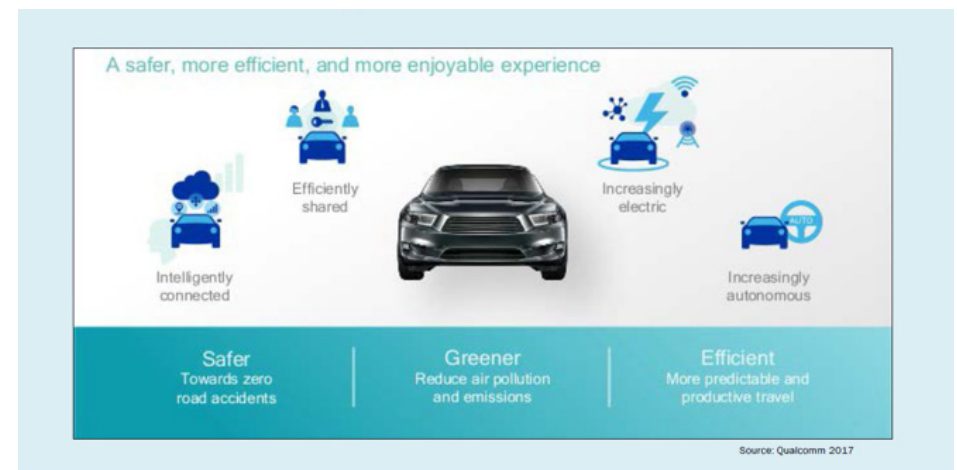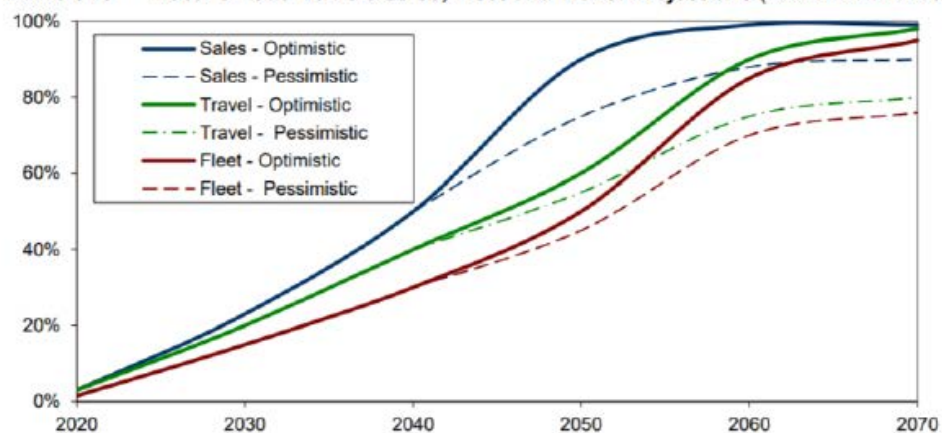

Source: Future Mobility Research Program, Metropolitan Transportation Commission, San Francisco Bay Area, October 2017. Accessed April 5, 2018.
https://mtc.ca.gov/sites/default/files/5a_Future%20Mobility%20Research%20Program%20%E2%80%93%20Update.pdf

While there are many announcements that companies will be introducing AV products into the market in the near term, there currently is no consensus on a schedule for significant penetration of autonomous or automated vehicles into the vehicle fleet. The figure below provides projections for sales, travel, and fleet that estimate it will be more than two decades until autonomous vehicles account for half of vehicle travel. It is clear from this graphic that through the planning period there will be significant changes, both challenges and opportunities, through the planning horizon.

Exhibit 13   Autonomous Vehicle Sales, Fleet and Travel Projections (Based on Table 6)

Legend:
- Sales - Optimistic
- Sales - Pessimistic
- Travel - Optimistic
- Travel - Pessimistic
- Fleet - Optimistic
- Fleet - Pessimistic

If they follow previous vehicle technologies autonomous vehicles it will take one to three decades to dominate vehicle sales, and one or two more decades to dominate vehicle travel, and even at saturation a significant portion of vehicle travel may continue to be human operated, indicated by the dashed lines.

Source: Victoria Transport Policy Institute, Autonomous Vehicle Implementation Predictions, March 23, 2018. Accessed April 5, 2018.
https://www.vtpi.org/avip.pdf
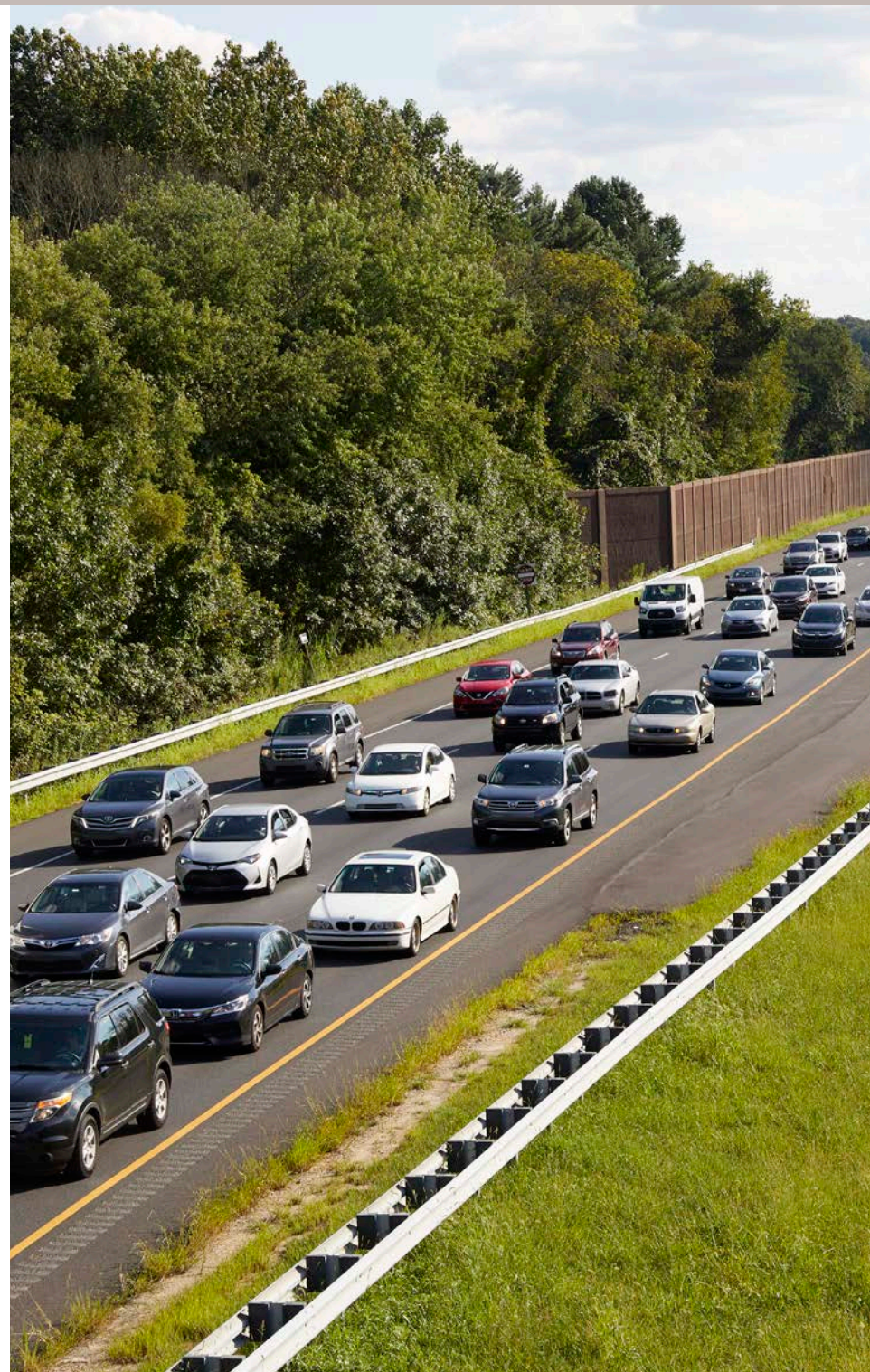
Uncertainties about the Effects of Emerging Technologies

As noted previously, there is significant uncertainty about the effects of emerging technologies, particularly CV/AVs: Will more congestion result from more vehicles on the road since automated vehicles will open opportunities for people who currently are not able to drive? Or will there be less congestion because vehicles can operate at peak efficiency? The following figure, from the Future Mobility Research Program, provides an overview of potential effects of automated vehicles:

Source: Future Mobility Research Program

Another slide from the same study shows impact ranges for some key variables.

Literature Review Ranges for Key Variables

Timing	**3 to 13**	years until fully driverless vehicles available for purchase
Safety	**+40% to +90%**	increase in safety
Capacity	**0% to +45%**	increase in roadway capacity
Demand	**+5% to +40%**	increase in vehicle miles traveled (VMT)
Energy/Emissions	**-50% to + 100%**	change in greenhouse gas (GHGs) emissions

Source: Future Mobility Research Program

Emerging Technologies – Maryland-Specific Activities

Maryland DOT has taken on a leadership role on CV/AV deployment. The Maryland C/AV Working Group, which is chaired by the Administrator of the Motor Vehicle Administration, meets several times a year and includes a wide array of public and private sector stakeholders, including MPOs. The MDOT Transportation Business Units (TBUs) are also working individually on their own CV/AV planning.

Maryland DOT and its TBUs have undertaken several CV/AV pilot projects, and MDOT has created a process for companies to register to test AVs in Maryland. The BRTB will track the status of the pilots, as data is available. In addition, BRTB and staff will continue to work closely with MDOT and its TBUs to support the deployment of emerging technologies.

Emerging Technologies – Role of the BRTB

As part of the development of this plan, the Technical Committee that advises the BRTB looked at potential new strategies to help the region achieve some of the region's transportation goals. In this capacity, the Technical Committee recommended some additional language to address emerging technologies. In addition, the BRTB's Public Advisory Committee, consisting of members of the public and stakeholder groups, commented on this recommended language.

New Implementation Strategies

Based on these recommended additions and comments, the BRTB adopted several new implementation strategies in support of the regional goal to Promote Informed Decision Making. As noted, the BRTB adopted these strategies with review and input by its Technical Committee and its Public Advisory Committee.

New strategies related to emerging technologies:

- Plan for the effects of emerging technologies and increasing vehicle/infrastructure connectivity when moving projects through the project development process. For example, consider the long-term effects of, and infrastructure needs related to, connected and automated vehicle use on traveler safety, roadway congestion, and land use when planning for new and improved transportation facilities. Make project scopes more flexible as needed to accommodate the potential effects of such emerging technologies.

- Plan for the effects of alternative means of travel (e.g., ride hailing services, micro-transit services, ridesharing, etc.) on traveler safety and security, roadway congestion, and land use.

- Improve information systems (e.g., signage, bus service information, smartphone applications) that all travelers can use to reach destinations easily and safely.

Continued Monitoring

As use of these emerging technologies becomes more widespread, the BRTB will continue to monitor potential risks and impacts and identify actions to take. Understanding the potential and consequences of technologies is important to help to ensure the region harnesses the positive effects of technology and avoids or minimizes potential negative effects.

Specific actions of the BRTB will include:

• Tracking technology development and deployment within the region, nationally and internationally to understand and plan to take full advantage of the technology benefits and minimize disadvantages from new and emerging technologies

• Investigating how to use newly available data to enhance transportation planning

• Working with stakeholders, especially elected officials and the public, to manage expectations and perceptions, minimize future problems, and leverage opportunities

• Building technical, institutional, and policy capacity, and including new partners as necessary

• Working to monitor deployment throughout the region to ensure equitable distribution of the benefits technology can offer
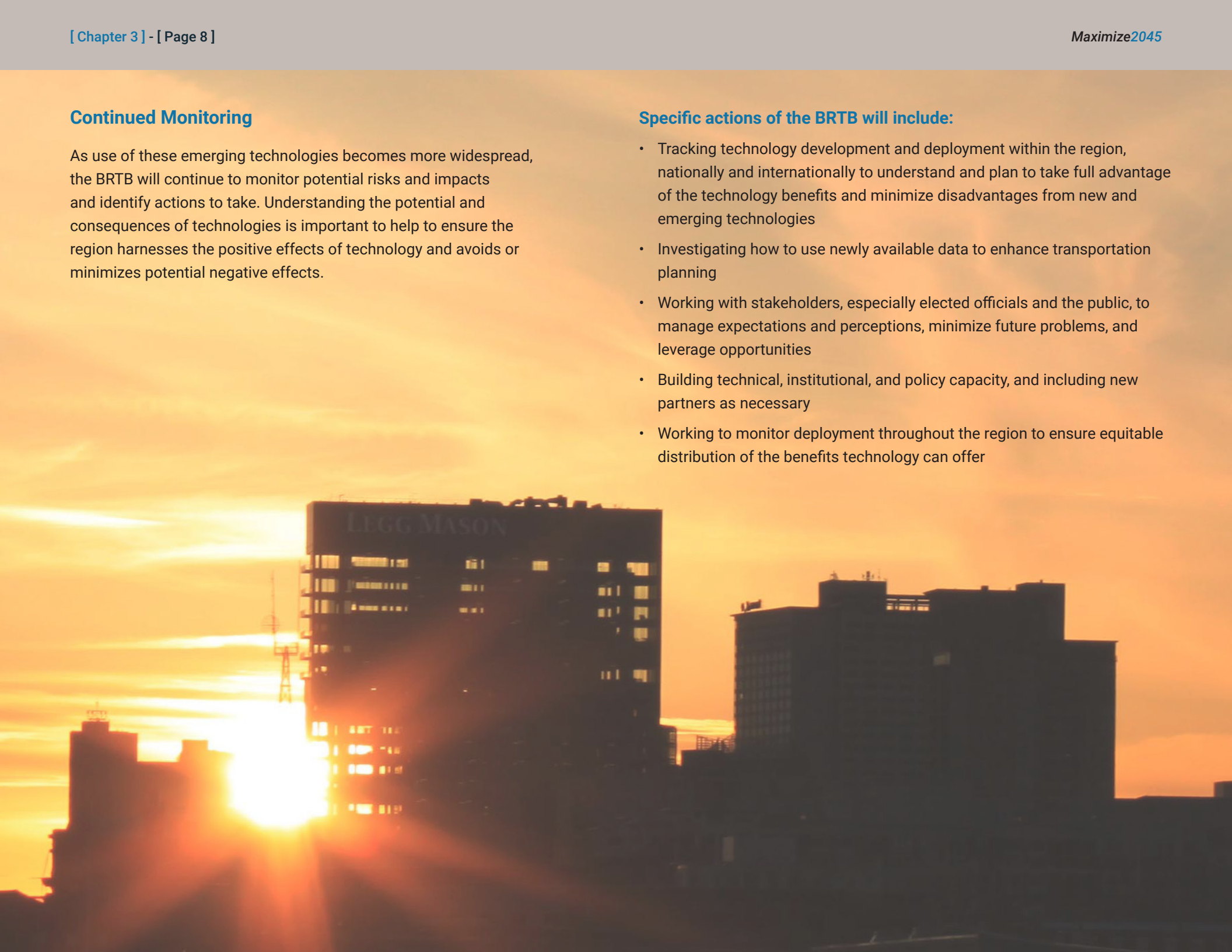
The region is in the early stages of implementing these emerging technologies, with rapid advances being discussed or occurring seemingly every day. However, the BRTB's mission and goals remain constant, and the region will continue to make investment decisions and develop programs and projects that support a safe, efficient, accessible, equitable, and environmentally responsible transportation system for all users.