WHAT'S AT STAKE?

How Decreasing Driving Miles in Massachusetts Will Save Lives, Money, Injuries, and the Environment

MASSPIRG Education Fund

Transportation for Massachusetts

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Transportation for Massachusetts is a diverse coalition of organizations working together to create safe, convenient, and affordable transportation for everyone. Transportation for Massachusetts advocates for transportation funds to be spent fairly and responsibly, for transportation decisions that are transparent and accountable, and to ensure that our transportation network has sufficient resources to meet tomorrow's needs all throughout the Commonwealth.

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EXECUTIVE SUMMARY

Imagine two futures for the transportation system of the Commonwealth of Massachusetts.

In one, the air is cleaner. It is more convenient to use an improved public transit system and to drive less, so most households only own one car. There are fewer traffic jams because fewer people travel via automobile. There are more sidewalks and bike lanes, so many people walk or bike to their jobs, schools, and other destinations. People feel a little richer with extra money in their pocket, due to less spending on gasoline, parking, and auto maintenance. Bay Staters are healthier as a result of reduced pollution and increased physical activity.

In the second future, imagine the opposite trends. More cars are on the road, increasing traffic congestion, pollution, and emissions that cause global warming. Public transit is less convenient and less available because it is often broken down and hasn't expanded with the economy. Walking and bicycling infrastructure remains unimproved. More collisions result in more deaths and injuries. We spend more filling up our tanks and repairing our vehicles more frequently, and the state spends more to repair the increased wear on roads. Bay Staters have less money, less time, and are less healthy.

The benefits of reduced driving are sometimes difficult to see, but hugely important. Many dramatic gains remain unrecognized because they are indirect, gradual, or result from avoided collisions and health problems that people don't expect will happen to them in the first place. In our daily lives, it is difficult to assess the value of reduced costs that would have been borne by others or consequences that didn't occur.

To make these benefits clear, this report quantifies the gains that would be enjoyed by the Commonwealth and its residents resulting from a one percentage point reduction in the growth rate of driving. Starting with the state's official driving forecasts, a one percentage point reduction in the growth rate of driving from 2015 to 2030 would bring major economic, environmental, and public health benefits, with annual savings increasing each successive year.

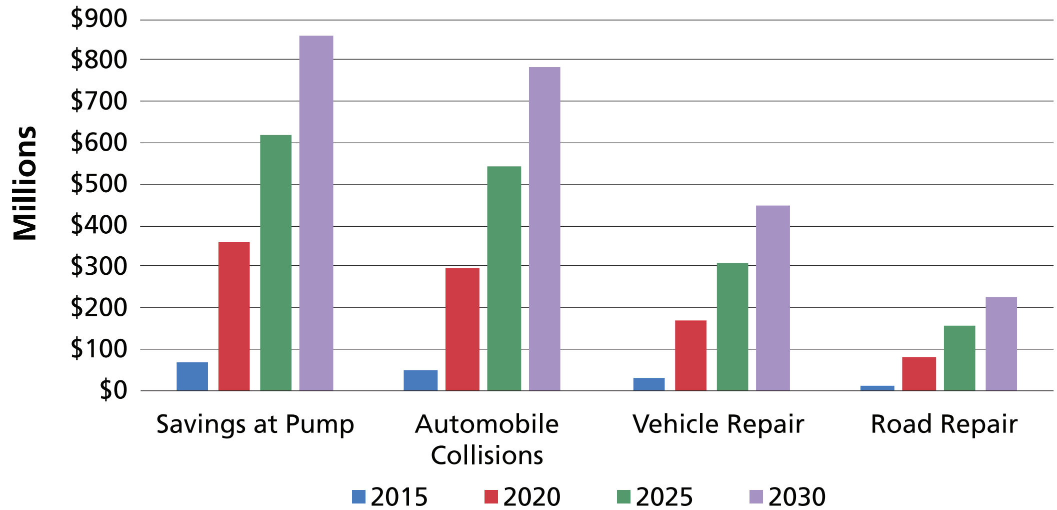
By 2030, the combined savings would reach $2.3 billion annually, consisting of:

- $857 million less spent at the pump
- $785 million less spent on fewer automobile collisions and resulting consequences
- $446 million less spent on vehicle repair
- $224 million less spent on road repair

Figure ES-1 illustrates these annual benefits and how they grow over time.

Tallying up the benefits that would result over the course of the next 15 years, the combined economic savings resulting from a one percentage point reduction in the

Figure ES-1: Annual Economic Savings, 2015-2030



The combined economic savings resulting from a one percentage point reduction in the driving growth rate are estimated to reach $20.1 billion.

driving growth rate below official forecasts are estimated to reach $20.1 billion, consisting of:

- $7.7 billion less spent at the pump
- $6.7 billion less spent on fewer automobile collisions and resulting consequences
- $3.8 billion less spent on vehicle repair
- $1.9 billion less spent on road repair

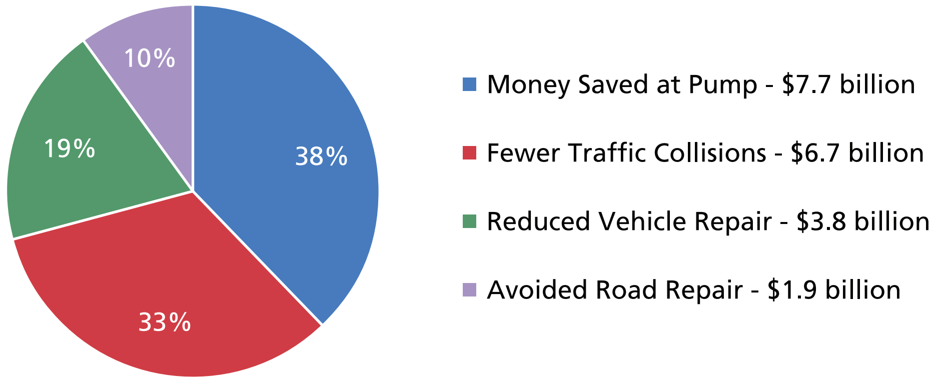
To put these sums in context, the total economic savings of a one percentage point reduction in the VMT growth rate from 2015 to 2030 is enough to provide any one of the following:

- Groceries for 180,455 American households for the entire period;[1] or
- Daycare costs for 81,558 Massachusetts infants in daycare fulltime for the period;[2] or
- Mortgage payments for 92,746 average Massachusetts households for the period.[3]

Figure ES-2 demonstrates where the savings come from. The greatest economic savings are expected to result from avoided gasoline expenses, followed by savings resulting from fewer automobile collisions, reduced vehicle repair costs, and avoided road repairs costs.

A one percentage point reduction in the vehicle-miles traveled (VMT) growth rate would also result in 267.6 million fewer gallons of gas consumed annually by 2030, and 2.6 billion fewer gallons of gas consumed cumulatively over the course of the next 15 years. This is the equivalent of every household in Massachusetts saving nearly a thousand gallons of gasoline over the period.[4]

Figure ES-2: Economic Savings from a One Percentage Point Reduction in the Driving Growth Rate, 2015-2030



All values represent billions of dollars in savings for a 1 percent decrease in the growth rate of vehicle-miles traveled compared to official Massachusetts Department of Transportation forecasts.

This reduction in gasoline consumption would prevent an estimated 2.4 million metric tons of carbon dioxide from being released into the atmosphere annually by 2030, and an estimated 23.3 million metric tons of carbon dioxide cumulatively from being emitted from 2015 to 2030. According to the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator, the annual carbon emissions savings by 2030 would be equivalent to taking more than 500,000 cars off the road that year. [5]

The carbon savings are especially important because the transportation sector has been the biggest and fastest growing source of carbon-related emissions in Massachusetts in recent decades.[6] Addressing transportation sector emissions by reducing the number of driving miles will significantly improve our ability to meet the Commonwealth's commitment to curb global warming, as set forth by the Massachusetts Global Warming Solutions Act of 2008.

Furthermore, there are significant public health benefits from reduced driving miles.

The criteria for selecting which transportation projects receive priority for state investment should be revised to prominently consider the reduction of VMT, to give greater weight to public health and environmental factors, and toensure that the most useful projects receive priority, regardless of the mode of transportation the project utilizes.

Burning less gasoline reduces the amount of pollution released into the atmosphere. Air particulate matter associated with the transportation sector has been linked to nearly 53,000 premature deaths a year in the United States, according to a recent study conducted by the Massachusetts Institute of Technology.[7] As individuals drive less, studies also find they are more physically active and less likely to be obese, or suffer from other chronic illnesses linked to physical inactivity, such as cancer, diabetes, and heart disease.[8] The good news is that increased walking, bicycling, and use of public transportation can help offset these risks.

The State has adopted a goal of tripling the number of public transit, walking, and bicycling trips by 2030. State and local transportation decisions should be oriented around attaining this goal and enabling reduced driving more generally. The criteria for selecting which transportation projects receive priority for state investment should be revised to prominently consider the reduction of VMT, to give greater weight to public health and environmental factors, and to ensure that the most useful projects receive priority, regardless of the mode of transportation the project utilizes.

While it has long been a transportation holy grail to accurately measure the VMT impacts of certain transportation choices, that does not mean it is not a worthwhile endeavor. Capturing the benefits of reduced driving between now and 2030 will require resources and new state and local policies and incentives to enable Bay State residents to drive less and take advantage of other forms of transportation more. Finally, the state should regularly publicly disclose its progress in meeting these goals.

Now, more than ever, it is imperative that we introduce policies that reduce driving miles, as total vehicle miles have drifted upwards recently, after years of decline. This report shows that even a modest reduction in driving miles will deliver large benefits to the economy, the environment, and public health.

A great deal is at stake.

INTRODUCTION

Transportation connects people and places. The transportation choices we make today profoundly shape our quality of life in Massachusetts for decades to come. This is why the Commonwealth has made a commitment to triple the portion of miles people travel by walking, bicycling, and riding public transit by 2030.[9] An improved transportation system will enable Bay State residents to drive fewer miles, but just how significant are the benefits?

This report measures the future improvements to our quality of life in Massachusetts from even a small downward shift in driving trends.

The benefits to Bay Staters from reduced driving have been substantial, but often unrecognized because they represent costs that were *not* incurred. People feel the negative effects from auto crashes and the cost of fueling up on their weekly budget, but notice less when costs are avoided, when costs are borne by others, or when costs take the form of invisible emissions or crashes we think didn't anticipate harm from in the first place.

Recent national and Massachusetts increases in per-capita driving the last few years make clear that the reductions in driving that had occurred since 2005 are not inevitable if smart policies and investments are not pursued.

Many in the Bay State want the ability to choose not to drive, and to live in places where they can walk, bike, or ride public transportation to jobs, recreation, and to run errands. Individuals and businesses seek to reside in places like Massachusetts partly because the Commonwealth provides these options. With greater investments in our transportation system, the Commonwealth will continue to experience dividends, as the brightest minds and most innovative companies will increasingly view Massachusetts as a favorable place to be located.

This report measures the future improvements to our quality of life in Massachusetts from even a small downward shift in driving trends. For a one percentage point of driving below present forecasts, the report measures the expected benefits in terms of reduction in gallons of gas consumed, savings at the pump, fewer auto collisions, reduced road maintenance, and millions of metric tons of avoided CO_2.

THE BENEFITS OF REDUCED DRIVING

There are numerous benefits to achieving reductions in driving. Some are obvious to consumers, such as fewer trips to the pump, but most benefits are not as easy to see. For example, driving fewer miles means:

- Fewer automobile collisions, which not only saves lives and prevents injuries, but also avoids substantial economic costs and lost worker productivity;
- Less gasoline consumed, which saves money at the pump, limits air pollution, and reduces emissions of pollutants that cause global warming; and
- State and municipal governments spend less money repairing roads and bridges.

Since the benefits of fewer driving miles mainly represent costly or damaging outcomes that did *not* happen, they are less readily recognized. Measuring each benefit of reduced driving separately helps demonstrate its full impact.

FEWER GLOBAL WARMING EMISSIONS

Transportation in Massachusetts generates 38 to 48 percent of total carbon dioxide emissions statewide, depending on the measure.

The U.S. Energy Information Administration estimates that 19.64 pounds of CO_2 are released into the atmosphere for every gallon of standard non-ethanol based gasoline burned, and about 22.38 pounds of CO_2 are released for every gallon of diesel fuel burned.[10] The combustion of fossil fuels such as gasoline and diesel to transport people and goods is the second largest source of CO_2 emissions nationwide, accounting for about 27 percent of the United States' total CO_2 emissions in 2013.[11] In Massachusetts, the share of CO_2 emissions from transportation is even higher. The latest available data from the Energy Information Administration show that in Massachusetts, CO_2 emissions totaled 59 million metric tons in 2012, with 28.1 million metric tons coming from the transportation sector—nearly 48 percent.[12]

It is important not to underestimate the role that reducing VMT plays in combating global warming. While there is a tendency to think about global warming chiefly through the lens of the energy sector, or to think of reductions in the burning of petroleum as resulting chiefly from cleaner fuels or more fuel-efficient automobiles, reducing VMT can be centrally important to curbing greenhouse emissions. A study by the President's Council of Economic Advisors recently examined how official projections of petroleum consumption from 1970 out to 2030 have been so much lower than originally anticipated. They found changes in the transportation sector accounted for 80 to 90 percent of the total reduction in anticipated petroleum consumption.[13] Within the transportation sector, reducing VMT accounted for 75 percent of the total shift - three times more than the benefits of improved vehicle fuel efficiency, making reducing VMT the single most important factor in declining petroleum usage.[14]

Taking an active role in reducing greenhouse gas emissions from its residents, the state of Massachusetts passed legislation in 2008, adopting a plan to reduce statewide greenhouse gas emissions to 80 percent less than 1990 levels by 2050.[15] Achieving this goal and intermediary benchmarks will require bold action in every sector, especially transportation.

LESS AIR POLLUTION AND FEWER DEATHS FROM POLLUTION

Air pollution from road transportation in the U.S. causes about 53,000 premature deaths a year.

Air pollution and related deaths are another significant cost associated with driving. As cars burn gasoline, potentially dangerous emissions are released into the atmosphere and ultimately inhaled into our lungs.

Researchers from Massachusetts Institute of Technology's Laboratory for Aviation and the Environment have recently released sobering data on air pollution's impact on Americans' health. The study tracked ground-level emissions from sources such as industrial facilities, vehicle tailpipes, marine and rail operations, and commercial and residential heating throughout the United States. They found that such air pollution causes nearly 200,000 early deaths each year. According to the study, emissions from road transportation are the most significant contributor, causing nearly 53,000 premature deaths each year.[16]

FEWER AUTOMOBILE-RELATED DEATHS

Each year, four times more people are killed in auto crashes than the death tolls of U.S. soldiers in the entire Afghanistan and Iraq wars combined.

According to the National Highway Traffic Safety Administration, at least 32,719 people were killed in the United States in automobile related crashes in 2013 alone.[17] In the same year, a Massachusetts resident was killed on the road almost every day, a total of 326 deaths for the year.[18]

Further, a recent study conducted by the Task Force for Child Survival and Development, found that on average, for every road traffic death, there are four cases of "severe, permanent disabilities, typically to the brain, spinal cord or lower limb joints; 10 cases requiring hospital admission and 30 requiring treatment in an ER."[19]

The number of deaths each year on our roads is so high that it is hard to believe the sum is considered "normal." If the carnage occurred from a disaster or attacks from external enemies, the nation would stop to grieve in disbelief over the loss. The annual death toll on the roads is nearly equivalent to the total number of United States combat deaths in the entire Korean War (1950-1953),[20] and is more than half of the total American deaths in the two decades-long Vietnam War (1955-1975).[21] The annual body count is more than four times the total death of United States soldiers in the entire Afghanistan and Iraq wars combined – *and this occurs each year*.

FEWER AUTOMOBILE-RELATED INJURIES

On average, roughly 106 Massachusetts residents are injured in automobile crashes each day.

Reduced fatalities are only a part of the health benefits from reduced driving. According to collision data from National Highway Traffic Safety Administration, there were nearly 5.7 million police reported automobile collisions in the United States in 2013, 1.6 million of which resulted in injuries to some 2.3 million people on public roadways.[22]

While 2.3 million injuries on public roadways is staggering, it is far from a full representation of the number of crash-related injuries. The Congressionally-chartered National Safety Council estimates that when factoring in injuries occurring during crashes on private roadways such as parking lots and driveways, the number of total annual injuries for 2013 was actually closer to 3.8 million in the United States. In other words, in a single year, on average across the United States, one in every 83 residents experiences an injury from an auto collision.[23]

The most recent injury data available for Massachusetts dates back to 2012. That

Other Modes of Transportation Are Comparatively Safer Than Driving

Driving an automobile is far more dangerous than other modes of travel. Research by Todd Litman in the *Journal of Public Transportation* in 2014 examined data on automobile fatalities in the United States, and found that riding a bus is about 60 times safer than driving per mile traveled. Similarly, riding various forms of intercity rail, light rail, or commuter rail is around 20 to 30 times safer than driving per mile traveled.

year, 38,799 people were injured in automobile related incidents, and 4,384 of those resulted in injuries requiring hospitalization.[24] These statistics boil down to approximately 106 injuries each day, 12 of which require hospitalization.[25]

Estimates show that the total cost of auto-related fatalities, injuries, and property damage that occurred in 2013 (factoring in medical expenses, employer costs, lost wages, property damage, and related expenses), tallies up to a whopping $267.5 billion nationally.[26] On an individual level, this adds up to approximately $2,184 per household in the United States each year.[27] As we can see, reductions in VMT, translate into huge savings for Americans every year through avoided collisions.

LESS PROPERTY DAMAGE FROM COLLISIONS

Property damage from auto collisions costs about $240 per person annually in the United States, and drivers in Boston, Worchester, and Springfield file claims at especially high rates.

Reducing VMT decreases the overall number of collisions, and therefore reduces resulting property damage. According to the National Highway Traffic Safety Administration, roughly four million automobile collisions in the United States in 2013 resulted *only* in property damage.[28] Based on an extrapolation of National Highway Traffic Safety Administration's analysis, these collisions [29] resulted in an estimated cost of $73.3 billion in 2013, or approximately $230 per person living in the United States.[30]

Massachusetts is notorious for being a place where drivers get into collisions. This is not just folklore of people complaining about infamous "Boston drivers" or "Massholes" on the road. Allstate Insurance's study of auto insurance claims in 200 major cities found Boston to be the worst in the country, followed by Worchester, with Springfield as the fifth worst in the nation, measured by frequency of claims for collision damage.[31] Boston drivers are about two and a half times as likely to file a claim from a collision than the average American driver.

MONEY SAVED AT THE PUMP

Federal Highway Data Show Massachusetts drivers consumed approximately 2.4 billion gallons of gas in 2014, at an estimated cost of $8.6 billion.

While it may seem obvious, one of the single biggest benefits from reduced driving is the resulting reduction in the total cost of gasoline consumed each year. Purchasing gas costs consumers and businesses thousands of dollars annually.[32] According to the Energy Information Administration, Americans consumed 136.8 billion gallons of gasoline nationwide in 2014.[33] In Massachusetts in 2012, 2.6 billion gallons were consumed at an estimated cost of $9.6 billion.[34] Meaning, that on average, each registered Massachusetts driver consumed an estimated 10.6 gallons of gasoline per week, at an average cost of $39.30.[35]

A major benefit of not consuming all of this gas is that it is less costly for household budgets. The price of gas fluctuates, but it has remained well above the levels that were typical during the 1990s or the early part of the 2000s. From 2006 to 2014, gasoline cost consumers in Massachusetts a total of approximately $74 billion, representing a massive transfer of wealth out of the hands of local consumers and businesses, and into the hands of big oil companies.[36]

REDUCED VEHICLE REPAIR COSTS

The American Automobile Association estimates that, on average, Americans spend over 5 cents per mile on vehicle maintenance.

More driving also leads to additional wear and tear on vehicles. Owning and operating a vehicle is expensive. In 2015, the American Automobile Association estimated that vehicle repair costs the average family as much as $767 a year, or an average of 5.11 cents per mile.[37]

To put the per-mile cost of repairs in perspective, data from the Massachusetts Department of Transportation projects total VMT in the Commonwealth to reach 57.3 billion miles in 2015. Thus, at the national average of approximately 5.11 cents of repairs for each mile driven, Massachusetts drivers will spend roughly $2.9 billion in 2015 on vehicle repair cost alone.[38]

REDUCED ROAD REPAIR

The Commonwealth of Massachusetts spent more than $240 million annually on road repair between 2009 and 2011.

As anyone who has hit a pothole could guess, as people drive more, they do more damage to the roads. More driving means worse roads, and ultimately makes more repair necessary. The more road repair, the higher the cost of maintaining roads.

Repairing our roads is a major expense for state government. A report by Smart Growth America found that in 2011, states would have needed to collectively spend $45.2 billion to bring roads rated in "poor" condition to a state of good repair, while also maintaining their existing systems.[39] This figure is roughly three times the amount that states actually spent repairing and maintaining the road system.

In fact, on a scale of "good," "fair," or "poor," 13 percent of Massachusetts's roads were in "poor" condition in 2011, while only 10 percent of roads were in "good" condition that year.[40] Meanwhile, according to the same report, the Commonwealth spent $241 million annually on average on road repair from 2009 to 2011.[41]

Wellness Benefits of Reduced Driving

Other benefits from reduced driving may be more difficult to quantify on a per-mile basis, but are just as important to the well-being of Massachusetts residents. Those who drive less have lower rates of obesity, and decreased risk of cancer, diabetes, and heart disease.

Reduced health care costs

Weight and physical inactivity related health issues in the United States account for a large percentage of heath care spending each year. Each year, $117 billion, or 11.1 percent of health care costs, are spent treating illnesses associated with inadequate levels of physical activity.[42] When inadequate physical activity is taken to the extreme, that price tag gets even bigger. Obesity in the United States costs an estimated $190.2 billion a year, or nearly 21 percent of annual medical spending in the United States.[43] Childhood obesity alone is responsible for $14.1 billion in direct medical costs.[44]

In a study of 187 American cities and their obesity rates, the direct costs connected with obesity and obesity-related diseases are roughly $500 per resident.[45] If the 10 most obese cities cut their obesity rates down to the 2009 national average (26.5 percent), the combined savings to their communities would be $500 million in health care costs each year.[46] If all 187 cities were able to decrease their obesity rates to 15 percent, it would save the United States roughly $32.6 billion in health care costs each year, calculating out to approximately $102 in savings per person each year.[47]

In considering these numbers, it is important to note that, at 23.6 percent, Massachusetts already has an obesity rate that is far below the national average, and is currently the third least obese state in the nation.[48] While there are a number of factors that contribute to this, the availability of active modes of transportation such as walking, bicycling, and public transit are, at least in part, responsible.[49] Past investments in creating walkable communities, bikeable neighborhoods, and the ready availability of public transit have paid dividends.

Reduced risk of obesity, cancer, diabetes, and heart disease

The average American commuter spends roughly 51.8 minutes a day commuting to and from work.[50] Whether or not people sit in their cars while commuting to work is a serious health concern.

Large amounts of time spent in cars contributes to the high levels of obesity found among Americans. Studies that compare VMT to obesity find a strong correlation among individuals.[51] More driving corresponds to sedentary lifestyles, rather than burning calories from walking or bicycling to a destination. For many people, the short regular walk to and from the bus stop can be their most regular exercise.

Recent studies also link cancer, diabetes, and heart disease to low levels of physical activity, due, in part, to time we spend physically inactive, traveling in automobiles. It is estimated that inadequate physical activity contributes to roughly 200,000 premature deaths in the U.S. each year.[52] The Surgeon General recently issued a call to action on walking and walkability to address the issue of physical inactivity in America. In a report backing the call to action, the Surgeon General states that 117 million Americans are living with chronic diseases, such as coronary heart disease, diabetes, and cancer.[53]

The report advocates physical activity as a way to reduce the risk of chronic disease, stating that engaging in physical activity for roughly 30 minutes per work day can reduce the risk of contracting a chronic disease by 30 percent.[54] The average American walking commute takes 23 minutes per day, and the average bicycling commutes lasts 38.6 minutes per day.[55] If more Americans could commute by walking, bicycling, or public transit, the risk of chronic disease would decrease substantially.

Improved mental health

Beyond the physical benefits that come from an active lifestyle, there are mental health benefits attributed with getting the appropriate amount of exercise. The Surgeon General's call to action states that "physical activity is associated with improved quality of life, emotional well-being, and positive mental health."[56] Further, a study has shown that long commutes in cars tend to lead to negative mental health outcomes, including poor sleep, anxiety, social isolation, and depression.[57] Finally, in the long term, studies that also show that physical activity may postpone cognitive decline in older adults.[58] If commuters could spend less time in their cars and more time commuting by foot, bike, or public transit, they could fulfill the recommended physical activity set forth by the Surgeon General and realize greater physical and mental health impacts.

QUANTIFYING A REDUCTION IN DRIVING

What follows uses Massachusetts Department of Transportation's official forecasts as a baseline, and then examines what a one percentage point reduction in the VMT growth rate would mean.

As the Commonwealth looks to the future, even relatively small reductions in the growth rate of driving volume will offer significant benefits to our economy, our environment, and our quality of life.

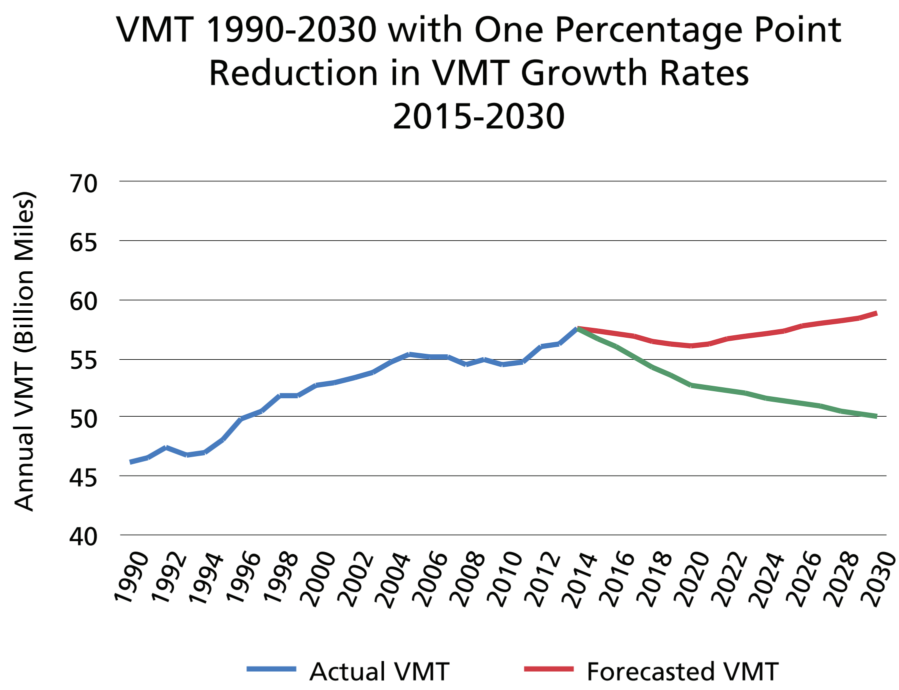
This section examines the expected result of a one percentage point reduction in the VMT growth rate below official forecasts by the Massachusetts Department of Transportation between 2015 and 2030. The Massachusetts Department of Transportation's projections of future driving demand reflect recent socio-economic data, surveys of trip making behavior, and actual traffic count data.

What follows uses Massachusetts Department of Transportation's official forecasts as a baseline, and then examines what a one percentage point reduction in the VMT growth rate would mean. For instance, whereas the Massachusetts Department of Transportation's baseline forecast is for a 0.43 percent reduction in VMT between 2015 and 2016, the one percentage point reduction scenario below forecast instead shows a reduction of 1.43 percent. Likewise, the Massachusetts Department of Transportation forecasts a 0.49 percent increase in VMT between 2020 and 2021, and the one percentage point reduction scenario shows a 0.51 percent reduction in VMT instead.

THE SIGNIFICANT IMPACT OF A 1% REDUCTION IN THE DRIVING GROWTH RATE

A single percentage point reduction in the growth rate of VMT would decrease VMT by 575.5 million miles in 2015, compared to the sum that the Massachusetts Department of Transportation forecast last year. By 2030, a one percentage point reduction below that forecast would result in 8.7 billion fewer miles traveled for that year. Cumulatively, a one percentage point reduction for the 2015-2030 time period would result in 74.5 billion fewer vehicle miles of driving during that span.

Figure 1: Comparing MassDOT Forecast of Future VMT in Massachusetts to a One Percentage Point Growth Reduction Below Forecast



A one-percent reduction would merely represent a return to levels of total VMT observed during the late 1990's.[59] The comparison between the current Massachusetts Department of Transportation forecast of future VMT and an alternative scenario with a one percentage point reduced growth rate is shown in Figure 1.

Table 1: Forecast VMT and Reduction in VMT from a One Percentage Point Reduction in VMT Growth Rate[60]

Year(s)	Forecasted VMT (Billions of Miles)	1 Percentage Point Reduction Scenario (Billions of Miles)	Change (Billion Miles)
2015	57.304	56.728	-0.576
2020	56.060	52.765	-3.295
2025	57.419	51.408	-6.011
2030	58.777	50.057	-8.720
2015-2030	915.636	841.112	-74.524

ENVIRONMENTAL BENEFIT — REDUCED CO_2 EMISSIONS

The combustion of each gallon of gasoline releases 19.64 pounds of CO_2 into the atmosphere.[61] Therefore, a one percentage point reduction in the VMT growth rate below the Massachusetts Department of Transportation's forecasts, when applied to the reduction in gasoline consumed, would result in 226.3 thousand metric tons of CO_2 not emitted in 2015, rising to 2.4 million metric tons in 2030, and 23.3 million metric tons for the period.

The U.S. Environmental Protection Agency provides some needed context. According to the agency's Greenhouse Gas Equivalencies Calculator 2015, estimated annual carbon emissions savings are equivalent to taking 47,653 cars off the road for one year.[62] Similarly, 2030 annual savings are equivalent to taking 501,958 cars of the road for one year.

ECONOMIC BENEFIT — REDUCED GASOLINE CONSUMPTION AND MONEY SAVED AT THE PUMP

As previously discussed, if driving decreases, we would expect similar reductions in the number of gallons of gasoline consumed and the costs of purchasing this gasoline. The rate at which reductions in driving decreases these outcomes depends on the fuel efficiency of cars and the cost of gasoline.[63]

Taking projections of both the fuel efficiency of cars and the cost of gasoline into account, in 2015, a one percentage point reduction in driving growth rate would result in the consumption of 25.4 million fewer gallons of gasoline. That amount of annual savings is calculated to increase steadily over the period. By 2030, we would expect to use 267.6 million fewer gallons than the amount based on currently forecast driving miles, while the total decrease in gas consumption for the period from 2015 to 2030 would equate to 2.6 billion gallons.

Table 2: Reduced CO_2 Emissions Associated with a One Percentage Point Reduction in the VMT Growth Rate

Year	Marginal Reduction in VMT with 1 Percentage Point Decrease in Driving Growth Rate (Billion Miles)	Gasoline Not Consumed (Billion Gallons)	CO2 Not Emitted (Million Metric Tons)
2015	-0.576	0.025	0.226
2020	-3.295	0.131	1.170
2025	-6.011	0.209	1.865
2030	-8.720	0.268	2.384
2015-2030	-74.524	2.612	23.272

Table 3: One Percentage Point Reduction in VMT Growth Rate and Associated Decreases in Gasoline Consumption and Money Spent at the Pump

Year(s)	Marginal Reduction in VMT with 1 Percentage Point Decrease in Driving Growth Rate (Billion Miles)	Resulting Decrease in Gas Consumption (Billion Gallons)	Resulting Decrease in Money Spent at the Pump (EIA Future Price Estimates)
2015	-0.576	0.025	$0.071
2020	-3.295	0.131	$0.360
2025	-6.011	0.209	$0.618
2030	-8.720	0.268	$0.856
2015-2030	-74.524	2.612	$7.698

Using less gasoline would result in big savings for consumers each year at the pump. A one percentage point reduction in driving growth below forecast in 2015 would mean consumers would save an additional $71.1 million on gasoline for the year. By 2030, Massachusetts consumers would save an additional $856.5 million, based on Energy Information Administration forecasts of likely per-gallon prices. For the period from 2015 to 2030 cumulatively, consumers would save an additional $7.7 billion.

To better understand the magnitude of these savings, it is helpful to think about them on a more personal scale. For instance, if the savings were distributed equally among every one of the 4.7 million drivers licensed in to drive in the Commonwealth as of 2012,[64] the savings would equate to roughly $1,628 per driver for the period.[65]

ECONOMIC BENEFIT — REDUCED AUTOMOBILE COLLISION COSTS

The National Safety Council, estimates the total cost of automobile collisions nationwide in 2013 at approximately nine cents per mile.[66] This includes the lifetime cost of medical expenses, employer costs, lost wages, and property damage from automobile collisions occurring in 2013.

Applying this per-mile cost to the decrease in VMT associated with a one percentage point reduction scenario shows decreased costs for 2015 to be $51.8 million, growing to $784.8 million in 2030, and cumulatively reaching $6.7 billion for the period from 2015-2030.

Table 4: Increased Massachusetts Savings on Automobile Related Collisions Associated with a One Percentage Point Reduction in VMT Growth Rate.

Year(s)	Marginal Reduction in VMT with 1 Percentage Point Decrease in Driving Growth Rate (Billion Miles)	Benefits Associated with Fewer Automobile Related Collisions (Billion $)
2015	-0.576	$0.052
2020	-3.295	$0.297
2025	-6.011	$0.541
2030	-8.720	$0.785
2015-2030	-74.524	$6.707

ECONOMIC BENEFIT — REDUCED AUTOMOBILE MAINTENANCE COSTS

In addition to the reduced cost of gasoline, automobile collisions and injuries, and state road repair, reduced driving also means reduced automobile repair for the average Massachusetts automobile owner. The Automobile Association of America found that the average cost of vehicle maintenance is 5.11 cents per mile.[67] Therefore, a one percentage point decrease in the VMT growth rate below the Massachusetts Department of Transportation's forecasts would result in $29.4 million saved on auto repair in 2015,[68] and would climb to $445.6 million in 2030,[69] with $3.81 billion in cumulative savings for the period from 2015-2030.[70]

Table 5: Benefits of Automobile Maintenance Associated with a One Percentage Point Reduction in the VMT Growth Rate in Massachusetts

Year(s)	Marginal Reduction in VMT with 1 Percentage Point Decrease in Driving Growth Rate (Billion Miles)	Benefits Associated with Decreased Auto Repair (Billion $)
2015	-0.576	$0.029
2020	-3.295	$0.168
2025	-6.011	$0.307
2030	-8.720	$0.446
2015-2030	-74.524	$3.808

ECONOMIC BENEFIT — REDUCED STATE ROAD REPAIR COSTS

For the benefits of reduced driving for state road repair in the Commonwealth, this report applies the 2.57 cents per mile estimate, derived from estimates of high and low traffic repair needs on roads by the Federal Highway Administration.[71] With a one percentage point reduction in the VMT growth rate below the Massachusetts Department of Transportation's forecasts, the additional savings to Massachusetts on state road repair would be $14.8 million in 2015,[72] rising to $224.1 million in 2030,[73] and a cumulative $1.9 billion for the period from 2015 to 2030.[74]

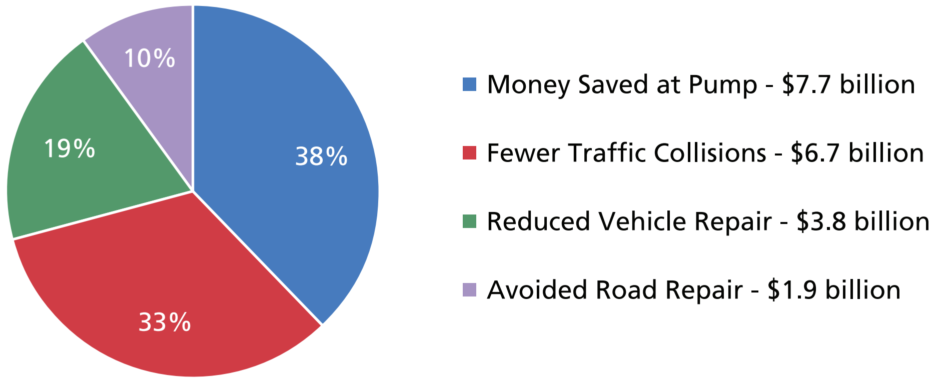
Table 6: Reduced Cost of State Road Repair Associated with a One Percentage Point Reduction in the VMT Growth Rate.

Year(s)	Marginal Reduction in VMT with 1 Percentage Point Decrease in Driving Growth Rate (Billion Miles)	Benefits Associated with Decreased State Road Repair (Billion $)
2015	-0.576	$0.015
2020	-3.295	$0.085
2025	-6.011	$0.154
2030	-8.720	$0.224
2015-2030	-74.524	$1.915

TOTAL COMBINED ECONOMIC BENEFITS

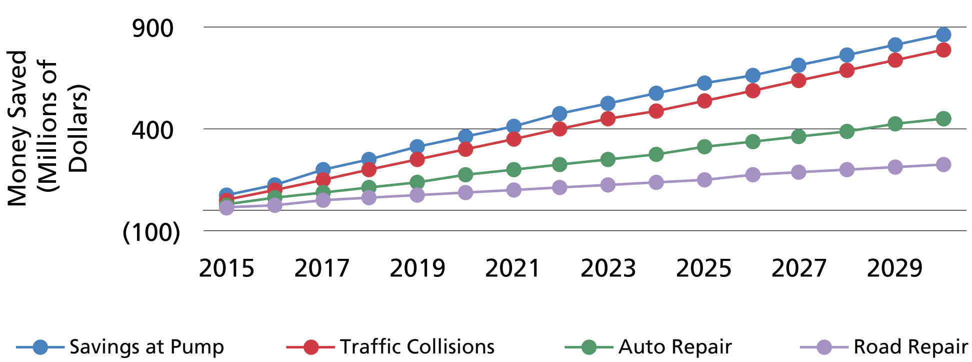
Factoring in the economic cost of gas consumption, automobile related collisions and injuries, automobile repair, and road repair, we can derive a total economic surplus of these driving related costs and externalities. Adding these figures together, we arrive at a combined total savings in 2015 of $167.1 million ($71.1 million in gas consumption $51.8 million in collisions, $29.4 million in auto repair, and $14.8 million in road repair). In 2030, the combined economic cost equates to $2.3 billion ($856.5 million in gas consumption, $784.8 million from automobile collisions, $445.6 million from auto repair, and $224.1 million from road repair). For the period from 2015-2030, cumulative economic savings equates to $20.1 billion ($7.7 billion in gas consumption, $6.7 billion from automobile collisions, $3.8 billion from auto repair, and $1.9 billion from road repair).

Figure 2: Below illustrates the breakdown of total economic saving for the period from 2015-2030.



All values represent billions of dollars in savings for a 1 percent decrease in the growth rate of vehicle-miles traveled compared to official Massachusetts Department of Transportation forecasts.

Figure 3: Reduced Expenses Per Year from a 1 Percentage Point VMT Growth Rate Reduction, 2015-2030



As indicated in Table 8 below, the cumulative savings of a one percentage point reduction in VMT below the current forecast from the Massachusetts Department of Transportation is $20.129 billion for the period from 2015-2030.

For context, the total economic savings of a one percentage point reduction in the VMT growth rate from 2015-2030 is enough to provide for the period any of the following:

- Groceries for almost 180,455 American households;[75]
- Daycare costs for 81,558 Massachusetts infants in daycare fulltime;[76]
- The average Massachusetts mortgage payment for 92,746 households.[77]

Table 8: Annual Benefits of Reduced Automobile Collisions, Auto Repair, State Road Repair, and Gasoline Consumption

Year	Reduced Costs Associated with Gasoline Consumption (Billion $)	Reduced Costs Associated with Auto Related Collisions (Billion $)	Reduced Costs Associated with Auto Repair (Billion $)	Reduced Costs Associated with State Road Repair (Billion $)	Combined Benefits (Billion $)
2015	$0.071	$0.052	$0.029	$0.015	$0.167
2020	$0.360	$0.297	$0.168	$0.085	$0.909
2025	$0.618	$0.541	$0.307	$0.154	$1.620
2030	$0.856	$0.785	$0.446	$0.224	$2.311
2015-2030 Combined	$7.698	$6.707	$3.808	$1.915	$20.129

RECOMMENDATIONS

The choice ahead is clear. Capturing the benefits of reduced driving between now and 2030 will require prompt changes to state and local policies and creating incentives to encourage Bay State residents to drive less, and to use other forms of transportation more. Achieving a one percentage point reduction in the VMT growth rate will require the Commonwealth's project selection process to make VMT reduction a major priority. It will require more adequate funding, preferably from revenue sources that also encourage non-driving modes of transportation. And new systems will need to be established for regular public assessments of the state's success in reducing VMT.

In the past few years, the state has taken some positive steps on which we can build. There is a new state goal of tripling the shares of trips made by transit, walking, and biking between 2012 and 2030. Under the Healthy Transportation Policy Directive, the Massachusetts Department of Transportation incorporates non-driving modes within or adjacent to state projects as much as possible.[78] Massachusetts's Department of Environmental Planning recently set forth regulations that require the Massachusetts Department of Transportation and Metropolitan Planning Organizations to evaluate and track the greenhouse gas emissions and impacts of investment decisions while prioritizing greenhouse gas impacts when making these decisions.[79] The GreenDOT implementation plan has a series of recommendations aimed at fostering a shift from driving to other modes.

Yet, there is more that we should do. The recommendations below identify the top three efforts the state can make to help move us further down the road to reducing VMT, which will lead to the significant environmental, economic, and public health savings outlined in this report.

1) CHOOSE TRANSPORTATION INVESTMENTS THAT REDUCE DRIVING

Decisions about what types of investments to prioritize will greatly influence future levels of driving. The post-World War II era increase in driving partly resulted from heavy investment in new and wider roads and ever more sprawling development. In the Bay State and across the nation, new highways have been constructed over the last half-century in ways that encouraged people to live further from their jobs, the services they need, and their pastimes, leading to increased driving. For decades new off-ramps in previously rural communities fueled real estate development in distant suburbs and exurbs consisting largely of housing subdivisions, office parks, and shopping centers while many older cities were neglected.

The 2013 transportation finance law created a Project Selection Advisory Council to establish criteria for investment decisions.[80] The Council's June 2015 report to the legislature recommended criteria to screen future transportation investments. The Council's report is a great first step. It creates a group of objective criteria for project selection, which is a dramatic improvement over how project decisions were made in the past. The new criteria now include public health, environmental, and social and regional equity factors, yet they are given too little weight in the scoring.

As the criteria are implemented, the state should amend them to explicitly make reducing VMT a major criteria for evaluating which investments should be prioritized for funding.

Investments that would contribute to a reduction in VMT include improving walking and bicycling trails, modernizing and enhancing capacity on public transportation lines, improving and expanding intercity rail service, purchasing newer and more reliable buses, introducing bus rapid transit, and favoring projects that encourage land-use patterns such as compact development that entail shorter auto trips. Private-sector transportation demand management strategies should be encouraged to complement these investments, such as shuttles and carpooling programs. Moreover, scoring projects based on their impact on VMT will help avoid wasteful spending on new and wider highways that would lead to less efficient land use, requiring additional spending on other infrastructure to service far-flung development, and drastically increase the costs stemming from VMT.

The Commonwealth must make new investments to enable better transportation choices, while maintaining a state of good repair of those we already have - including public transportation, sidewalks, bike lanes, and trails and paths. The goal should be to make the combination of multiple modes of transportation serve as more than the sum of their parts to make it viable for households to drive less, or to reduce the number of automobiles they own. Strategies to accomplish this include incorporating car-sharing and bike-sharing into plans and designing bike racks and crosswalks at transit stops. Investments should also support "complete streets" that are designed to enable safe walking, bicycling, and transit use.

2) RAISE REVENUES THAT PAY FOR OUR TRANSPORTATION NEEDS WHILE PREFERABLY ALSO REDUCING DRIVING

Sufficient resources to pay for important investments are necessary. Despite some progress in transportation funding in 2013, most experts agree that more funding is necessary to make the types of investments that our state needs to make. There is no shortage of innovative revenue sources that policy makers can embrace. While gas taxes have waned in recent years due to improved fuel efficiency and inflation, there are other ways of raising transportation revenue that would also encourage reductions in driving. One of these could be a road usage charge, or fee, based on VMT. But whether we use that method or another, the guiding principal should be that we must provide sufficient revenue to address our transportation needs, while doing what we can to disincentive costly over reliance on driving.

Those incentives need not just be public sector based. A private-sector incentive to reduce driving would be to allow "pay-as-you-drive" (PAYD) insurance. Instead of paying auto insurance as a fixed cost, PAYD insurance links the monthly fee that a customer pays for car insurance with the distance that he or she drives. This provides motorists with more insurance options that better reflect actual economic costs, and encourages fewer driving miles.[81] Massachusetts is currently one of only sixteen states that prohibit PAYD insurance.

At the same time, we should encourage transit use by keeping public transit fares low. Large fare hikes would both decrease the mobility of people with low incomes and cause riders with access to an automobile to drive more.

3) SET GOALS AND TRACK PROGRESS

The Commonwealth already evaluates transportation performance using a number of important measures including asset conditions and on-time performance. Yet, a successful investment strategy should also reduce driving. The Massachusetts Department of Transportation should work toward including VMT reduction as an explicit performance measure. Reporting on this measure should be done on a public dashboard on the Massachusetts Department of Transportation's website and included in quarterly and annual performance and accountability reports. The Performance and Asset Management Council established by the 2013 transportation finance law should also include VMT benchmarks in its recommendations.

CONCLUSION

Together the benefits of just a one percentage point reduction in the growth rate of VMT will yield $2.3 billion yearly by 2030, and $20.1 billion combined from 2015-2030, a sum that is understated because it includes only those benefits that can be readily quantified in dollar terms per mile driven excluding benefits such as lower carbon emissions and public health benefits such as reduced obesity.

There is much to gain, with even small reductions in the future number of VMT in Massachusetts. Even relatively small decreases in the growth in the volume of driving translates into large benefits for the people of Massachusetts. As we have seen, these include physical benefits, such as reduction in loss of life or other injury from collisions; economic benefits, such as reduced road and vehicle maintenance, increased work time, and medical savings; environmental benefits, such as reduced CO_2 emissions and reduced air pollution; and public health benefits, such as decreased obesity. Together the benefits of just a one percentage point reduction in the growth rate of VMT will yield $2.3 billion yearly by 2030, and $20.1 billion combined from 2015-2030, a sum that is understated because it includes only those benefits that can be readily quantified in dollar terms per mile driven, excluding benefits such as lower carbon emissions and public health benefits such as reduced obesity.

We can save money, save lives, prevent injury, and protect the environment by focusing on smarter transportation policies, and promoting regulations and incentives that further these choices. There is much at stake, and much to gain.

APPENDIX I - METHODOLOGY

Reduced Vehicle-Miles Traveled (2015-2030)

We calculate the reduction in VMT in Massachusetts between 2015 and 2030 with a one percentage point reduction in the VMT growth rate below the forecast made by the Massachusetts Department of Transportation. In order to calculate this, we take the VMT growth rate for a given year between 2015 and 2030 as predicted by the Massachusetts Department of Transportation, and subtract one percentage point from the growth rate. For instance, if the growth rate was projected to be 0.75 percent, under a one percentage point reduction scenario, the derived growth rate would be -0.25 percent. The report then applies the new, reduced growth rate to the Massachusetts Department of Transportation's VMT estimate for that year. The result is the number of VMT with a one percentage point reduction in the projected VMT growth rate. The annual figures are then summed to calculate the total number of miles driven under a one percentage point reduced growth rate scenario from 2015 to 2030. That number is then subtracted from the sum of the Massachusetts Department of Transportation's projections over the same span of years, which produces the difference in VMT between the two projections. This results in 74.5 billion fewer miles driven in Massachusetts between the years 2015 and 2030 if the VMT growth rate is reduced by one percentage point.

Source:

- Massachusetts Department of Transportation, Travel Demand Model. Office of Transportation Planning. *Massachusetts Vehicle-Miles Traveled Statistics and Projections*, 2014.

Economic Benefit – Decreased Automobile Collisions (2015-2030)

To calculate the economic implications of fewer automobile collisions from 2015 to 2030, we use the process described in the preceding section, "Reduced Vehicle-Miles Traveled (2015-2030)," to determine the number of vehicle-miles not traveled in Massachusetts during that span. This figure is then multiplied by a derived per-mile cost of 9.0 cents per mile for each year. Annual figures are then summed to determine economic savings from avoided automobile collisions for the period. The result is $6.7 billion saved from 2015 to 2030. To determine the per-mile cost of automobile collisions, 9.0 cents per mile, we use data obtained from the National Safety Council, which estimates the total economic cost of automobile collisions nationwide in 2013 at $276.5 billion, and divide that figure by the total VMT that year, 2.972 trillion, to reach a 9.0 cent per mile cost.

Source:

- National Safety Council. *National Safety Council Estimates Traffic Deaths Down Three Percent in 2013*. Retrieved from http://www.nsc.org/NewsDocuments/2014-Press-Release-Archive/2-12-2014-Traffic-Fatality-Report.pdf.
- U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information (2014, November). *Travel Monitoring and Traffic Volume*. Retrieved from https://www.fhwa.dot.gov/policyinformation/travel_monitoring/13dectvt/index.cfm

Economic Benefit – Decreased Automobile Repair (2015-2030)

To calculate the economic implications of a one percentage point reduction in VMT growth rate and the resulting saving from auto repair costs during the 2015 to 2030 period, we first use the process described in the previous section, "Reduced Vehicle-Miles Traveled (2015-2030)," to determine the number of vehicle-miles not traveled in Massachusetts during that span. This figure is then multiplied by a 5.11 cent per vehicle-mile repair cost, as reported by the American Automobile Association in 2015. Resulting annual values are then summed to determine the total economic implications for the period, which comes to $3.8 billion.

Source:

- American Automobile Association (2015, April 28). *Annual Cost to Own and Operate a Vehicle Falls to $8,698, Finds AAA*. Retrieved from http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds-aaa/

Economic Benefit – Decreased Road Repair (2015-2030)

To calculate the economic implications of a one percentage point reduction in VMT growth rate and the resulting savings from road repair costs during the 2015 to 2030 period, we first use the process described in the previous section, "Reduced Vehicle-Miles Traveled (2015-2030)," to determine the number of vehicle-miles not traveled in Massachusetts during that span. This figure is then multiplied by a 2.57 cent per mile road repair cost. Resulting annual values are then summed to determine the total economic benefits for the period, which comes to $1.9 billion not spent on road repair from 2015 to 2030. The 2.57 cent per mile figure is derived first by finding the difference in driving miles for a span of 20 years, from 2010 to 2030, using two scenarios for a change in VMT growth rate (this report uses scenarios with a 1.36 percent increase in VMT growth rate and with a 1.85 percent increase). We then divide the amount of money spent on road repair in that timespan by the difference in VMT for each scenario, which is equal to 2.57 cents per mile.

Source:

- Massachusetts Department of Transportation, Travel Demand Model. Office of

Transportation Planning. *Massachusetts Vehicle-Miles Traveled Statistics and Projections*, 2014.
- U.S. Department of Transportation, Federal Highway Administration, Policy and Governmental Affairs (2014, November 7). *2013 Conditions and Performance Report, Ch. 7*, exhibit 7-2. Retrieved from http://www.fhwa.dot.gov/policy/2013cpr/chap7.cfm

Economic Benefit – Decreased Gasoline Consumption (2015-2030)

To calculate the decrease in gasoline consumption from of a one percentage point reduction in VMT growth rate during the 2015 to 2030 period, we first use the process described in the previous section, "Reduced Vehicle-Miles Traveled (2015-2030)," to determine the number of vehicle-miles not traveled in Massachusetts during that span. These annual figures are then divided by the Light Duty Stock Fleet Mix MPG, as reported by the Energy Information Administration, for the chosen year of calculation. The result is the number gallons of gasoline that would be consumed in Massachusetts in those years if the projected number of vehicle-miles driven was reduced by one percentage point. Those totals are then subtracted from the gallons of gas which would be consumed based on the Massachusetts Department of Transportation's projected VMT for the same period. The annual totals are summed to provide a total number of gallons of gasoline not consumed as a result of a one percentage point reduction in VMT, 2.6 billion gallons of gasoline.

Source:

- U.S. Energy Information Administration. *Annual Energy Outlook 2015*. Retrieved from http://www.eia.gov/beta/aeo/#/?id=7-AEO2015&region=0-0&cases=ref2015&start=2012&end=2040&f=A&linechart=~7-AEO2015.28.&map=&ctype=linechart

Economic Benefit – Decreased Money Spent at the Pump (2015-2030)

To calculate the economic implications of a one percentage point reduction in VMT growth rate and the resulting reduction in money spent at the pump during the 2015 to 2030 period, we first use the process described in the previous section, "Economic Benefit – Decreased Gasoline Consumption (2015-2030)," to determine the number of gallons of gasoline not consumed during that span. The resulting annual figures were then multiplied by the average annual price per gallon of gasoline as projected by the Energy Information Administration for the chosen year of calculation. Resulting annual values are then summed to determine the total economic implications for the period, which comes to $7.7 billion not spent at the pump from 2015 to 2030.

Source:

- U.S. Energy Information Administration (2015, April 14). *Annual Energy Outlook 2015: Energy Prices*, Fig. 4. Retrieved from http://www.eia.gov/forecasts/aeo/section_prices.cfm.

Total Combined Economic Benefits (2015-2030)

The total economic implications from a decrease in automobile collisions, road repair, automobile repair, and gasoline consumption as a result of a one percentage point reduction in the projected VMT growth rate from 2015 to 2030 is $20.1 billion. We calculated the money saved from fewer collisions, less road repair, and less automobile repair for a given year as described in the previous sections, "Economic Benefit – Decreased Automobile Collisions (2015-2030)," "Economic Benefit – Decreased Automobile Repair (2015-2030)," "Economic Benefit – Decreased Road Repair (2015-2030)," and "Economic Benefit – Decreased Money Spent at the Pump (2015-2030)." The process is repeated for every year between 2015 and 2030, and the final sum is equal to the total amount of money saved due to decreased automobile collisions, automobile repair, road repair, and gasoline consumption, $20.1 billion.

Environmental Benefit – Reduced CO_2 Emissions (2015-2030)

We calculated the reduction in CO_2 emissions from 2015 to 2030 due to a one percentage point reduction in the projected VMT growth rate to be 23.3 million metric tons. To obtain this value, the report first calculates the gallons of gasoline not consumed for a given year between 2015 and 2030 due to a one percentage point reduction in the projected VMT growth rate, as described in the above section, "Decreased Gasoline Consumption (2015-2030)." This number is then multiplied by the standard conversion factor for pounds of CO_2 emitted per gallon of gasoline combusted, 19.64 pounds per gallon, as provided by the Energy Information Administration. This number is then converted from pounds of CO_2 to metric tons of CO_2. The process is then repeated for every year between 2015 and 2030. Finally, the annual figures are summed to provide the final value for the reduction in CO_2 emissions from 2015 to 2030, 23.3 million metric tons.

Source:

- U.S. Energy Information Administration (2015, July 7). *Frequently Asked Questions, How much carbon dioxide is produced by burning gasoline and diesel fuel*. Retrieved from http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=10

APPENDIX II - DATASHEET

Post-Driving Boom (Forecasted)

Year	Annual VMT[1]	Growth Rates in Orginal Forecast[2]	VMT Growth Rate with 1 Percent Lower Growth Scenario[3]	VMT with 1 Percent Lower VMT Growth Rate than Forecast[4]
2015	57,304,000,000	-0.43%	-1.43%	56,728,480,000
2016	57,055,000,000	-0.43%	-1.43%	55,914,695,976
2017	56,806,000,000	-0.44%	-1.44%	55,111,525,543
2018	56,557,000,000	-0.44%	-1.44%	54,318,837,745
2019	56,309,000,000	-0.44%	-1.44%	53,537,463,612
2020	56,060,000,000	-0.44%	-1.44%	52,765,344,788
2021	56,332,000,000	0.49%	-0.51%	52,493,705,857
2022	56,603,000,000	0.48%	-0.52%	52,221,303,668
2023	56,875,000,000	0.48%	-0.52%	51,950,034,832
2024	57,147,000,000	0.48%	-0.52%	51,678,981,244
2025	57,419,000,000	0.48%	-0.52%	51,408,165,549
2026	57,690,000,000	0.47%	-0.53%	51,136,714,606
2027	57,962,000,000	0.47%	-0.53%	50,866,449,668
2028	58,234,000,000	0.47%	-0.53%	50,596,487,671
2029	58,506,000,000	0.47%	-0.53%	50,326,849,419
2030	58,777,000,000	0.46%	-0.54%	50,056,695,070
Cum. 2015-2030	915,636,000,000			841,111,735,247

Post-Driving Boom (Forecasted)

Year	Difference in VMT between - Orginal Forecast vs. 1 Percent Lower VMT Growth Scenario[5]	Avoided Traffic Accidents (Benefits Associated with 1 Percentage Point Reduction in VMT Growth Rate, 2015-2030 ($))[6]	Auto Repair (Benefits Associated with 1 Percentage Point Reduction in VMT Growth Rate, 2015-2030 ($))[7]	State (Not Local) Road Repair (Benefits Associated with 1 Percentage Point Reduction in VMT Growth Rate, 2015-2030 ($))[8]
2015	-575,520,000	-$51,796,800	-$29,409,072	-$14,790,864
2016	-1,140,304,024	-$102,627,362	-$58,269,536	-$29,305,813
2017	-1,694,474,457	-$152,502,701	-$86,587,645	-$43,547,994
2018	-2,238,162,255	-$201,434,603	-$114,370,091	-$57,520,770
2019	-2,771,536,388	-$249,438,275	-$141,625,509	-$71,228,485
2020	-3,294,655,212	-$296,518,969	-$168,356,881	-$84,672,639
2021	-3,838,294,143	-$345,446,473	-$196,136,831	-$98,644,159
2022	-4,381,696,332	-$394,352,670	-$223,904,683	-$112,609,596
2023	-4,924,965,168	-$443,246,865	-$251,665,720	-$126,571,605
2024	-5,468,018,756	-$492,121,688	-$279,415,758	-$140,528,082
2025	-6,010,834,451	-$540,975,101	-$307,153,640	-$154,478,445
2026	-6,553,285,394	-$589,795,685	-$334,872,884	-$168,419,435
2027	-7,095,550,332	-$638,599,530	-$362,582,622	-$182,355,644
2028	-7,637,512,329	-$687,376,110	-$390,276,880	-$196,284,067
2029	-8,179,150,581	-$736,123,552	-$417,954,595	-$210,204,170
2030	-8,720,304,930	-$784,827,444	-$445,607,582	-$224,111,837
Cum. 2015-2030	-74,524,264,753	-$6,707,183,828	-$3,808,189,929	-$1,915,273,604

	Year	Avoided Traffic Accidents, Vehicle Repair, and State Road Repair Combined (Benefits Associated with 1 Percentage Point Reduction in VMT Growth Rate, 2015-2030 ($))[9]	Avoided Traffic Accidents, Vehicle Repair, State Road Repair, and Savings at Pump Combined (Benefits Associated with 1 Percentage Point Reduction in VMT Growth Rate, 2015-2030 ($))[10]	Fleet Mix MPG[11]	Gasoline Consumption (Benefits Associated with 1 Percentage Point Reduction in VMT Growth Rate, 2015-2030 (gallons))[12]
Post-Driving Boom (Forecasted)	**2015**	-$95,996,736	-$167,139,439	22.7	2,504,453,990.34
	2016	-$190,202,711	-$320,291,383	23.1	2,425,431,656.79
	2017	-$282,638,339	-$477,388,050	23.5	2,345,959,242.51
	2018	-$373,325,464	-$625,674,253	23.9	2,268,278,426.47
	2019	-$462,292,270	-$767,695,629	24.5	2,184,978,925.90
	2020	-$549,548,489	-$909,332,468	25.1	2,102,955,416.74
	2021	-$640,227,463	-$1,055,048,516	25.7	2,040,727,298.88
	2022	-$730,866,948	-$1,199,029,640	26.4	1,978,577,776.36
	2023	-$821,484,190	-$1,341,071,882	27.1	1,916,352,958.57
	2024	-$912,065,529	-$1,480,974,296	27.9	1,854,080,461.79
	2025	-$1,002,607,186	-$1,620,108,312	28.7	1,790,247,505.90
	2026	-$1,093,088,004	-$1,758,479,210	29.5	1,730,730,881.26
	2027	-$1,183,537,795	-$1,894,062,672	30.4	1,675,525,513.12
	2028	-$1,273,937,056	-$2,031,904,288	31.1	1,625,026,309.62
	2029	-$1,364,282,317	-$2,169,942,210	31.9	1,578,750,990.78
	2030	-$1,454,546,862	-$2,310,999,078	32.6	1,536,326,989.23
Cum. 2015-2030		-$12,430,647,361	-$20,129,141,327		31,558,404,344.26

	Year	Gasoline Consumption Avoided (Gasoline Conumption Avoided Associated with 1 Percentage Point Reduction in VMT Growth Rate, 2015-2030 (gallons))[13]	Average Annual Price of Gasoline MA Annual Averages (EIA Estimates of Future Gas Prices 2015-2030 (Estimate))[14]	Money Spent at Pump (Projected Money Spent at Pump under 1 Percent Decrease Scenario (EIA estimated gas prices))[15]
Post-Driving Boom (Forecasted)	**2015**	(25,408,108.25)	$2.80	$7,012,471,172.95
	2016	(49,463,373.26)	$2.63	$6,378,885,257.37
	2017	(72,129,522.37)	$2.70	$6,334,089,954.77
	2018	(93,462,514.48)	$2.70	$6,124,351,751.46
	2019	(113,112,355.20)	$2.70	$5,899,443,099.94
	2020	(131,308,021.41)	$2.74	$5,762,097,841.86
	2021	(149,216,206.23)	$2.78	$5,673,221,890.90
	2022	(166,015,138.96)	$2.82	$5,579,589,329.35
	2023	(181,674,018.13)	$2.86	$5,480,769,461.50
	2024	(196,175,437.22)	$2.90	$5,376,833,339.18
	2025	(209,322,415.40)	$2.95	$5,281,230,142.41
	2026	(221,797,068.76)	$3.00	$5,192,192,643.78
	2027	(233,725,288.26)	$3.04	$5,093,597,559.87
	2028	(245,296,838.69)	$3.09	$5,021,331,296.73
	2029	(256,579,583.92)	$3.14	$4,957,278,111.05
	2030	(267,641,317.50)	$3.20	$4,916,246,365.52
Cum. 2015-2030		-2,612,327,208.05	NA	$90,083,629,218.65

	Year	Money Saved At Pump (Projected Savings at Pump under 1 Percent Reduction Scenario (EIA estimated gas prices))[16]	Co2 Emissions (million metric tons) (Reflecting a 1 Percentage Point Reduction in VMT Growth Rate, 2015-2030)[17]	CO2 Avoided/Added (Additional CO2 Associated with 1 Percent Reduction in VMT, 2015-2030 (million metric tons))[18]
Post-Driving Boom (Forecasted)	**2015**	-$71,142,703.09	22,311,090.51	(226,349.78)
	2016	-$130,088,671.67	21,607,114.94	(440,647.66)
	2017	-$194,749,710.40	20,899,129.79	(642,570.52)
	2018	-$252,348,789.09	20,207,105.21	(832,616.86)
	2019	-$305,403,359.04	19,465,026.22	(1,007,668.74)
	2020	-$359,783,978.67	18,734,314.48	(1,169,766.01)
	2021	-$414,821,053.33	18,179,951.26	(1,329,302.23)
	2022	-$468,162,691.86	17,626,288.22	(1,478,956.61)
	2023	-$519,587,691.86	17,071,954.40	(1,618,454.75)
	2024	-$568,908,767.93	16,517,195.83	(1,747,641.58)
	2025	-$617,501,125.44	15,948,535.81	(1,864,762.29)
	2026	-$665,391,206.28	15,418,328.11	(1,975,893.55)
	2027	-$710,524,876.33	14,926,527.51	(2,082,156.86)
	2028	-$757,967,231.56	14,476,652.09	(2,185,242.77)
	2029	-$805,659,893.52	14,064,405.41	(2,285,755.83)
	2030	-$856,452,216.01	13,686,468.45	(2,384,300.00)
Cum. 2015-2030		-$7,698,493,966.07	281,140,088.23	(23,272,086.06)

Appendix II: Notes and Sources

1. The annual Vehicle Miles Traveled (VMT) represented above, show forcasted VMT for the years 2015-2030. Massachusetts Department of Transportation, Office of Project Oriented Planning. (2014). Travel Demand Model. Massachusetts vehicle-miles traveled Statistics and Projections.

2. The growth rate is calculated by subtracting the forecasted annual VMT for the previous year by the forecasted annual VMT for the current year and then dividing by the forecasted annual VMT for the previous year.

3. To calculate VMT Growth Rate with one percent lower growth, we took the growth rate from the original forecast and subtracted one full percentage point.

4. To calculate one percent lower VMT growth rate, we first started with the actual VMT from 2015 and multiplied by the projected VMT growth rate under the one percent lower scenario for 2015 to achieve a projected one percent lower VMT. We then multiplied each projected VMT with the subsequent year's projected growth rate.

5. To calculated the difference in VMT between original forecast versus the one percent lower VMT growth scenario, we simply subtracted each year's one percent lower scenario from the original forecast to achieve a difference in VMT between the two projections.

6. We derived a per mile cost of 9.0 cents per mile by taking National Safety Council's cost of collisions nationwide in 2013 [267.5 billion], and dividing by Federal Highway Administration's data for total miles driven in 2013 [2.972 trillion]. We then multiplied 9.0 cents per mile to the difference in VMT between the original forecast and the one percent lower VMT scenario to find the avoided traffic accident cost. National Safety Council (2014, February 12). National Safety Council Estimates Traffic Deaths Down Three Percent in 2013, National Safety Council. Retrieved from http://www.nsc.org/NewsDocuments/2014-Press-Release-Archive/2-12-2014-Traffic-Fatality-Report.pdf. See also, U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information (2014, November). Travel Monitoring and Traffic Volume. Retrieved from https://www.fhwa.dot.gov/policyinformation/travel_monitoring/13dectvt/index.cfm.

7. 2015 driving cost study on per-mile costs of operating a sedan foun that it costs 5.11 cents per mile to maintain a vehicle. To calculate auto repair costs avoided, we multiplied 5.11 cents per mile to the difference in VMT between the original forecast and the one percent lower VMT scenario. American Automobile Association (2015, April 28). Annual Cost to Own and Operate a Vehicle Falls to $8,698, Finds AAA. Retrieved from http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds-aaa/. Note: Values reflect average repair costs for sedans of all sizes. AAA's estimates are based upon the cost to maintain a vehicle and perform needed repairs for five years and 75,000 miles, including labor expenses, replacement part prices and the purchase of an extended warranty policy.

8. The 2.57 cents per mile figure for expected cost of existing state road repair is calculated using data from FHWA for both vehicle-miles traveled estimates [4.2 trillion miles from 2010-2030] and expected cost of maintenance [$108 billion], and then extrapolating out a per-mile cost based on total costs of maintenance divided by total miles. For projections between 2015-2030, we multiplied the difference in VMT between original forecast and one percent lower VMT growth scenario to 2.57 cents per mile to derive avoided road repair costs. U.S. Department of Transportation, Federal Highway Administration, Policy and Governmental Affairs (2014, November 7). 2013 Conditions and Performance Report, ch. 7, exhibit 7-2. Retrieved from http://www.fhwa.dot.gov/policy/2013cpr/chap7.cfm

9. This column calculates the total economic benefit of avoided accidents, vehicle repair, and road repair. Totals are based upon summation of component parts i.e. the sum of avoided costs from traffic accidents, avoided vehicle repair costs, and avoided road maintenance costs.

10. This column calculates the total economic benefit of avoided accidents, vehicle repair, road repair and savings at the pump. Totals are based upon summation of component parts i.e. the sum of avoided costs from traffic accidents, avoided vehicle repair costs, avoided road maintenance costs, and money saved at the pump.

11. Fleet Mix numbers reflect values for "Light Duty Stock" MPG - the closest approximation of "on the road" MPG for a typical light duty fleet nationwide. Light Duty Stock reflects the combined "on-the-road" estimate for all types of cars and light trucks. All values come from Energy Information Administration- Annual Outlook Report. Values for 2015 -2030 are estimates provided by EIA in their 2015 AEO.U.S. Energy Information Administration.

12. To calculate gas consumption we took the total miles projected (2015-2030) and divided by annual MPG values for "light duty stock" as the best indicator of real world MPG.

13. To calculate gas consumption avoided we used previously calculated values for VMT avoided since the end of the Driving Boom, and divided by "light duty stock" fleet mix MPG for the corresponding year.

14. Values for 2015 -2030 are estimates provided by EIA in their 2015 AEO.U.S. Energy Information Administration.

15. To calculate values we used EIA's values for the predicted average annual cost of gas and multiplied by our previously calculated number of gallons.

16. For estimates of money saved at pump from 2015-2030, we took values for gasoline consumption avoided under a one percent VMT decrease and multiplied that by the EIA projected gas prices.

17. To calculate projected Co_2 emissions, we calculated the projected gallons of gasoline consumed under a one percent decrease scenario by 19.64 to achieve CO_2 emissions projected, and then divided by 2204.63 million metric tons to achieve projected CO_2 emissions. 1 Gallon of gas equates to 19.64 pounds of Co_2. U.S. Energy Information Administration (2015, July 7). Frequently Asked Questions, How much carbon dioxide is produced by burning gasoline and diesel fuel. Retrieved from http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=10

18. To calculate CO_2 avoided we took values for gasoline consumption avoided and multiplied by 19.64 - the standard 1 gallon of gas to CO_2 conversion, and then divided by 2204.62 to achieve million metric ton units provided by Energy Information Administration. U.S. Energy Information Administration (2015, July 7). Frequently Asked Questions, How much carbon dioxide is produced by burning gasoline and diesel fuel. Retrieved from http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=10

ENDNOTES

1 This figure is derived by dividing the total economic savings from 2015-2030 ($20.1 billion) by the average monthly grocery cost per U.S. household in 2015 ($618.80) over 15 years ($111,385). The resulting figure, 180,455, is the equivalent number of households (as defined above) that could purchase 15 years' worth of monthly groceries. U.S. Department of Agriculture (2015, April). *Official USDA Food Plans: Cost of Food at Home at Four Levels, U.S. Average*. Retrieved from http://www.cnpp.usda.gov/sites/default/files/CostofFoodApr2015.pdf. Note: Data reflects national average monthly grocery bill for a male and female households of two with partners between the ages of 19 and 50.

2 This figure is derived by dividing the total economic savings from a one percentage point decrease in the vehicle-miles traveled growth rate from 2015-2030 ($20.1 billion) by the 2012 average annual infant daycare cost per child in Massachusetts ($16,430) calculated over 15 years ($246,450). The resulting figure (81,558) represents the number of infants that could be provided fulltime daycare for 15 years. Tran, A.B. (2014, July 2) Map: The average cost of child care by state. *Boston Globe.* Retrieved from https://www.bostonglobe.com/2014/07/02/map-the-average-cost-for-child-care-state/LN65rSHXKNjr4eypyxT0WM/story.html.

3 This figure is derived by dividing the total economic savings from a one percentage point decrease in the vehicle-miles traveled growth rate ($20.1 billion) by the average Massachusetts monthly mortgage payment ($1,204) expanded over 15 years ($216,720). The resulting figure (92,746) represents the number of mortgage payers whose mortgages could be paid for 15 years. Grueling, M. (2012, December 1). National Average Monthly Mortgage Payment by State. *LendingTree.com*. Retrieved from https://www.lendingtree.com/mortgage/2011-2012-national-average-monthly-mortgage-payment-article. Note: This figure uses data obtained from 2011-2012.

4 To achieve this figure, we divided the number of gallons of gas to be saved over the next 15 years (2.6 billion gallons) by the number of households in Massachusetts in 2014 (2,828,492) to achieve 923 gallons of gas not consumed per household between the years 2015 and 2030. U.S. Census Bureau (2015). *State & County QuickFacts: Massachusetts*. Retrieved from http://quickfacts.census.gov/qfd/states/25000.html

5 To acquire this data, one must enter the aforementioned metric tons into the "Carbon Dioxide or CO2 Equivalent" form field, then hit "Calculate." This results in a host of equivalents, including equivalent number of greenhouse gas emissions from passenger vehicles. U.S. Environmental Protection Agency. (2015). *Greenhouse Equivalencies Calculator*. Retrieved from http://www.epa.gov/cleanenergy/energy-resources/calculator.html

6 Massachusetts Energy Information Administration. *Massachusetts Carbon Dioxide Emissions from Fossil Fuel Consumption(1980-2012)*. Retrieved from http://www.eia.gov/environment/emissions/state/excel/massachusetts.xlsx

7 Caiazzo, F., Ashok, A., Waitz, I.A., Yim, S.H.L., and Barrett, S.R.H. (2013, May 31). Air pollution and early deaths in the United States. Part I: Quantifying the impact of major sectors in 2005. *Atmospheric Environment Journal*, *79*, 198-208, 203. Retrieved from http://lae.mit.edu/wordpress2/wp-content/uploads/2013/08/US-air-pollution-paper.pdf

8 Jacobson, S.H., King, D.H., Yuan, R. (2011). A note on the relationship between obesity and driving. *Journal of Transport Policy*, 1-5. Retrieved from http://www.ahtd.info/yahoo_site_admin/assets/docs/A_note_on_the_relationship_between_obesity_and_driving.173153035.pdf. Note: The study found that vehicle use (measured in annual vehicle-miles traveled) correlated as high as 99 percent with annual obesity rates

9 Massachusetts Department of Transportation (2012, December 12). *GreenDOT Implementation Plan*. Retrieved from http://www.massdot.state.ma.us/Portals/0/docs/GreenDOT/finalImplementation/FinalGreenDOTImplementationPlan12.12.12.pdf

10 U.S. Energy Information Administration (2015, July 7). *Frequently Asked Questions, How much carbon dioxide is produced by burning gasoline and diesel fuel*. Retrieved from http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=10

11 U.S. Environmental Protection Agency (2015, April 15). *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013*, p. 2-28. Retrieved from http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2015-Main-Text.pdf

12 Massachusetts Energy Information Administration. *Massachusetts Carbon Dioxide Emissions from Fossil Fuel Consumption(1980-2012)*. Retrieved from http://www.eia.gov/environment/emissions/state/excel/massachusetts.xlsx

The Massachusetts Department of Environmental Protection offers a slightly different, but similarly useful analysis that relies on using gross emissions. Its estimate also includes emissions from agriculture and waste, as well as other industrial processes, thereby slightly diluting the transportation sector's share of total emissions. By this method, Massachusetts Department of Environment Protection estimates that the transportation sector will account for 38 percent of all statewide emissions in 2015. Regardless of whether we accept federal or state estimates, what is clear is that the transportation sector is a major contributor to global warming causing emissions both nationally and here in Massachusetts. Without meaningful policy reforms that help reduce the number of vehicle miles traveled (VMT), transportation sector emissions could easily jeopardize gains made in other sectors.

13 President's Council of Economic Advisors. (2015, June). *Explaining the U.S. Petroleum Consumption Surprise*, pg. 2. Retrieved from https://www.whitehouse.gov/sites/default/files/docs/explaining_us_petroleum_consumption_surprise_final.pdf

14 President's Council of Economic Advisors. (2015, June). *Explaining the U.S. Petroleum Consumption Surprise*, pg. 14. Retrieved from https://www.whitehouse.gov/sites/default/files/docs/explaining_us_petroleum_consumption_surprise_final.pdf

15 Greenhouse Gas Emissions Limits. 21N M.G.L.A. § 3(b) (2008).

16 Caiazzo, F., Ashok, A., Waitz, I.A., Yim, S.H.L., and Barrett, S.R.H. (2013, May 31). Air pollution and early deaths in the United States. Part I: Quantifying the impact of major sectors in 2005. *Atmospheric Environment Journal*, *79*, 198-208, 203. Retrieved from http://lae.mit.edu/wordpress2/wp-content/uploads/2013/08/US-air-pollution-paper.pdf. Note: Air pollution causes acute respiratory problems, temporary decreases in lung capacity, and inflammation of lung tissue. In addition, it impairs the body's immune system, reduces the release of oxygen to body tissues, and increases a person's risk of cancer-related death.

17 U.S. Department of Transportation, National Highway Traffic Safety Administration (2014, December). *2013 Motor Vehicle Crash: Overview*, 1-6, 1. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/812101.pdf

18 U.S. Department of Transportation, National Highway Traffic Safety Administration (2014, December). *2013 Motor Vehicle Crash: Overview*, 1-6, 1. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/812101.pdf

19 Giles, L.P, Hayes, E.S., & Rosenberg, M.L. (2005, June 1). Road Traffic Injuries: Can We Stop A Global Epidemic? *The Doctor will see you Now*. http://www.thedoctorwillseeyounow.com/content/emergencies/art2104.html. Note, these statistics represent worldwide data.

20 33,686 U.S. service members died of battle deaths. Rhem, K.T. (2000, June 8). U.S. Department of Defense. Korean War Death Stats Highlight Modern DoD Safety Record. *DoD News*. Retrieved from http://archive.defense.gov/news/newsarticle.aspx?id=45275

21 National Archives (2013, August). *Statistical Information about Fatal Casualties of the Vietnam War*. Retrieved from http://www.archives.gov/research/military/vietnam-war/casualty-statistics.html

22 U.S. Department of Transportation, National Highway Traffic Safety Administration (2014, December). *2013 Motor Vehicle Crash: Overview*, 1-6. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/812101.pdf

23 Using 2013 U.S. Census population data, the number of U.S. citizens experiencing a car crash injury each year (3.8 million) was divided by the population of the U.S. in 2013 (316.5 million) to achieve statistic that one in 83 Americans is injured in a car crash each year. U.S. Census Bureau. *U.S. and World Population Clock*. Retrieved from http://www.census.gov/popclock/

24 Massachusetts Executive Office of Public Safety and Security, Highway Safety Division, *Commonwealth of Massachusetts Highway Safety Plan*, p. 16. Retrieved from http://www.nhtsa.gov/links/StateDocs/FY15/FY15HSPs/MA_FY15HSP.pdf

25 Massachusetts Executive Office of Public Safety and Security, Highway Safety Division, *Commonwealth of Massachusetts Highway Safety Plan*, p. 16. Retrieved from http://www.nhtsa.gov/links/StateDocs/FY15/FY15HSPs/MA_FY15HSP.pdf

26 National Safety Council (2014, February 12). National Safety Council Estimates Traffic Deaths Down Three Percent in 2013, *National Safety Council*. Retrieved from http://www.nsc.org/NewsDocuments/2014-Press-Release-Archive/2-12-2014-Traffic-Fatality-Report.pdf

27 This number is derived by dividing $267.5 billion by 122,459,000 U.S. households in 2013, as reported by the U.S. Census Bureau (2013). *America's Families and Living Arrangements: 2013: Households (H table series) – Households by Type and Tenure of Householder for Selected Characteristics*. Retrieved from https://www.census.gov/hhes/families/data/cps2013H.html

28 U.S. Department of Transportation, National Highway Traffic Safety Administration (2014, December). *2013 Motor Vehicle Crash: Overview*, 1-6, 3. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/812101.pdf

29 These property damage-only collisions can range from simple fender-benders to severe damage that totals a vehicle, damages building exteriors, or creates prolonged traffic congestion. While some crashes may only require minor repairs, others can result in the need to totally replace nearby structures, including neighboring properties, utility poles, guardrails, and more.

30 While National Highway Traffic Safety Administration does not yet have available data on the estimated costs of these 4 million collisions, a 2010 National Highway Traffic Safety Administration study (updated in May of 2015) found that there were 3.9 million property damage-only car crashes that year, resulting in $71.5 billion in estimated costs. Based on this data, 2013 costs would be estimated at $73.3 billion, or approximately $230 per person living in the United States as of 2013. U.S. Department of Transportation, National Highway Traffic Safety Administration. (2015, May). *The Economic and Societal Impact Of Motor Vehicle Crashes, 2010 (Revised)*, p. 2. Retrieved from http://www-nrd.nhtsa.dot.gov/pubs/812013.pdf

31 Based on Allstate customers in 2012 to 2013. Allstate. (2015). *America's Best Divers Report.* Retrieved from https://www.allstate.com/resources/Allstate/attachments/tools-and-resources/ABD-Report-2015.pdf

32 Massachusetts Energy Information Administration. *Massachusetts Carbon Dioxide Emissions from Fossil Fuel Consumption(1980-2012)*. Retrieved from http://www.eia.gov/environment/emissions/state/excel/massachusetts.xlsx U.S. Energy Information Administration. (2014, December 16). *Average annual household expenditures on gasoline and motor oil (2000-2015)*. Retrieved from http://www.eia.gov/todayinenergy/detail.cfm?id=19211

33 U.S. Energy Information Administration (2015, March 12). *Frequently Asked Questions: How much gasoline does the United States Consume?* Retrieved from http://www.eia.gov/tools/faqs/faq.cfm?id=23&t=10

34 Consumption costs are calculated by multiplying the number of gallons of gasoline consumed in 2012 as reported by Massachusetts to the FHWA, an then applying an average cost per gallon of $3.72, which represents the average cost of a gallon of gasoline in Massachusetts in 2012 as reported by Energy Information Administration. *See*, Massachusetts Department of Transportation, Office of Transportation Planning. (2014). Travel Demand Model. *Massachusetts vehicle-miles traveled Statistics and Projections*; U.S. Energy Information Administration, *Weekly Retail Gasoline and Diesel Prices,* Retrieved from http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sma_a.htm. Data is retrieved by selecting "Massachusetts" from the "Area" drop down list, and "Annual" from the "Period" drop down list, then looking to the "2014" column.

35 Number of gallons of gasoline burned per week are derived by dividing the total number of gallons of gasoline consumed in Massachusetts in 2012 (2,600,479,912) as reported by the Federal Highway Administration, by 52 weeks, and further dividing that number by the number of licensed drivers in Massachusetts in 2012 (4,734,000 licensed drivers). *See*, Massachusetts Department of Transportation, Office of Transportation Planning. (2014). Travel Demand Model. *Massachusetts vehicle-miles traveled Statistics and Projections*; Office of Highway Policy Information, Federal Highway Administration, U.S. Department of Transportation (2014). *State Statistical Abstracts 2012*, *Massachusetts*. Retrieved from http://www.fhwa.dot.gov/policyinformation/statistics/abstracts/2012/ma.cfm. Total estimated cost per week is calculated by multiplying the derived number of gallons of gas consumed each week by the average cost of a gallon of gasoline in Massachusetts in 2012 as reported by the Energy Information Administration. *See*, U.S. Energy Information Administration, *Weekly Retail Gasoline and Diesel Prices,* Retrieved from http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sma_a.htm. Data is retrieved by selecting "Massachusetts" from the "Area" drop down list, and "Annual" from the "Period" drop down list, then looking to the "2014" column.

36 To obtain the figure for the total cost of gasoline in Massachusetts from 2006 to 2014, we first calculate the gallons of gasoline consumed each year from 2006 to 2014 and multiply by average prices for those years. This is derived by first calculating vehicle-miles traveled in Massachusetts for each year, as reported by the Massachusetts Department of Transportation, divided by the average number of miles per gallon of the automobile fleet. Fleet MPG is obtained using the "Light Duty Stock Fleet Mix MPG" for each year, as reported by the Energy Information Administration in their 2008, 2011, and 2014 Annual Energy Outlook reports. By this method, the total cost of gasoline in Massachusetts from 2006 to 2014 is $73.2 billion. "Light Duty Stock Fleet Mix MPG" uses the Corporate Average Fuel Efficiency (CAFE) standard. *See* U.S. Energy Information Administration, *Annual Energy Outlook 2008* (Table A7. Transportation Sector Key Indicators and Delivered Energy Consumption. MPG for "Light Duty Stock."). Retrieved from http://www.eia.gov/oiaf/aeo/pdf/tables.pdf; U.S. Energy Information Administration, *Annual Energy Outlook 2011*, *Transportation Sector Key Indicators and Delivered Energy Consumption* (MPG for "Light Duty Stock"). Retrieved from http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2014ER&subject=0-AEO2014ER&table=7-AEO2014ER&region=0-0&cases=full2013-d102312a,ref2014er-d102413a; U.S. Energy Information Administration. *Annual Energy Outlook 2014*, *Transportation Sector Key Indicators and Delivered Energy Consumption* (MPG for "Light Duty Stock"). Retrieved from http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2014ER&subject=0-AEO2014ER&table=7-AEO2014ER&region=0-0&cases=full2013-d102312a,ref2014er-d102413a. For the price of gasoline, we use the annual gas price average as reported by the Energy Information Administration. *See*, U.S. Energy Information Administration, *Petroleum and Other Liquids, Annual Retail Gasoline and Diesel Prices, History 2003-2014*. Retrieved from http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMM_EPM0_PTE_SMA_DPG&f=A. While the future of gas prices is difficult to know, this report uses the forecasts of the federal Energy Information Agency's 2015 Annual Energy Outlook for future years.

37 American Automobile Association (2015, April 28). *Annual Cost to Own and Operate a Vehicle Falls to $8,698, Finds AAA*. Retrieved from http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds-aaa/

38 This figure is derived by taking total projected VMT in 2015 (57.30 billion) and multiplying by 5.11 cents per mile, which represents the nationwide average cost of repair per mile. Massachusetts Department of Transportation, Office of Transportation Planning. (2014). Travel Demand Model. *Massachusetts vehicle-miles traveled Statistics and Projections*.

39 Smart Growth America and Taxpayers for Common Sense (2014, March). *Repair Priorities 2014: Transportation Spending Strategies to Save Taxpayer Money and Improve Roads*. Retrieved from http://www.smartgrowthamerica.org/documents/repair-priorities-2014.pdf

40 Smart Growth America and Taxpayers for Common Sense (2014, March). *Repair Priorities 2014: Transportation Spending Strategies to Save Taxpayer Money and Improve Roads*, p. 18. Retrieved from http://www.smartgrowthamerica.org/documents/repair-priorities-2014.pdf. *Citing* Federal Highway Administration Highway Statistics (2011). *Functional System Length - 2011 Miles By Measured Pavement Roughness*, Tbl. HM-64. Retrieved from http://www.fhwa.dot.gov/policyinformation/statistics/2011/hm64.cfm; Federal Highway Administration Highway Statistics (2011). *Functional System Length - 2011 Miles By Measured Pavement Roughness/Present Serviceability Rating*, Tbl. HM-63. http://www.fhwa.dot.gov/policyinformation/statistics/2011/hm63.cfm

41 Smart Growth America and Taxpayers for Common Sense (2014, March). *Repair Priorities 2014: Transportation Spending Strategies to Save Taxpayer Money and Improve Roads*, p. 9. Retrieved from http://www.smartgrowthamerica.org/documents/repair-priorities-2014.pdf

42 Carlson, S.A., Fulton, J.E., Pratt, M., Yang, Z., & Adams, E.K. (2015). Inadequate Physical Activity and Health Care Expenditures in the United States. *Progress in Cardiovascular Diseases, 57*; 315-327, 317. Retrieved from http://www.onlinepcd.com/article/S0033-0620(14)00123-6/pdf

43 T.H. Chan, Harvard School of Public Health. *Economic Costs*. Retrieved from http://www.hsph.harvard.edu/obesity-prevention-source/obesity-consequences/economic/#references; *citing* Cawley J, Meyerhoefer C. (2012), Journal of Health Economics. *The medical care costs of obesity: an instrumental variables approach*. Accessed at: http://www.sciencedirect.com/science/article/pii/S0167629611001366.

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45 Gallup Business Journal (2011, January 27). The Cost of Obesity to US Cities, *Gallup*. Retrieved from http://businessjournal.gallup.com/content/145778/cost-obesity-cities.aspx#1

46 Gallup Business Journal (2011, January 27). The Cost of Obesity to US Cities, *Gallup*. Retrieved from http://businessjournal.gallup.com/content/145778/cost-obesity-cities.aspx#1

47 Gallup Business Journal (2011, January 27). The Cost of Obesity to US Cities, *Gallup*. Retrieved from http://businessjournal.gallup.com/content/145778/cost-obesity-cities.aspx#1

48 United Health Foundation. (2014). *America's Health Rankings 2014: Massachusetts*. Retrieved from http://cdnfiles.americashealthrankings.org/SiteFiles/StateSummaries/Massachusetts-Health-Summary-2014.pdf

49 Walk Boston. *Walking Agenda*. Retrieved from http://www.walkboston.org/policy-positions/walking-agenda

50 McKenzie, B. (2014, May). Modes Less Traveled – Bicycling and Walking to Work in the United States: 2008-2012. *U.S. Census Bureau*. Retrieved from http://www.census.gov/hhes/commuting/files/2014/acs-25.pdf

51 Jacobson, S.H., King, D.M., Yuan, R. (2011). A note on the relationship between obesity and driving. *Journal of Transport Policy*. Retrieved from http://www.ahtd.info/yahoo_site_admin/assets/docs/A_note_on_the_relationship_between_obesity_and_driving.173153035.pdf. Note: The study found that vehicle use (measured in annual vehicle-miles traveled) correlated as high as 99 percent with annual obesity rates, when measuring VMT/licensed driver over a six year lag period.

52 Litman, T. (2010, June 14). *Evaluating Public Transportation Health Benefits*. Retrieved from http://www.apta.com/resources/reportsandpublications/Documents/APTA_Health_Benefits_Litman.pdf. *Citing*, College of Health & Human Performance (2004). Physical Activity Facts and Figures. *East Carolina University.*

53 U.S. Department of Health and Human Services, Office of the Surgeon General. (2015). *Step It Up! The Surgeon General's Call to Action to Promote Walking and Walkable Communities*, p. 3. Retrieved from http://www.surgeongeneral.gov/library/calls/walking-and-walkable-communities/call-to-action-walking-and-walkable-communites.pdf. *Citing*, Ward, B.W., Schiller, J.S., & Goodman, R.A. (2014). Multiple chronic conditions among U.S. adults: a 2012 update. *Prev Chronic Dis*.

54 U.S. Department of Health and Human Services, Office of the Surgeon General. (2015). *Step It Up! The Surgeon General's Call to Action to Promote Walking and Walkable Communities*, p. 4. Retrieved from http://www.surgeongeneral.gov/library/calls/walking-and-walkable-communities/call-to-action-walking-and-walkable-communites.pdf. *Citing,* Physical Activity Guidelines Advisory Committee, U.S. Dept of Health and Human Services (2008). *Physical Activity Guidelines Advisory Committee Report, 2008*. Note: the Surgeon General's Report states that Americans should be walking for 2 hours and 30 minutes over a seven day week. For our purposes, we calculated this number over a five day period, as we are concerned with Americans commuting during the work week.

55 McKenzie, B. (2014, May). Modes Less Traveled – Bicycling and Walking to Work in the United States: 2008-2012. *U.S. Census Bureau.* Retrieved from http://www.census.gov/hhes/commuting/files/2014/acs-25.pdf

56 U.S. Department of Health and Human Services, Office of the Surgeon General. (2015). *Step It Up! The Surgeon General's Call to Action to Promote Walking and Walkable Communities*, p. 5. Retrieved from http://www.surgeongeneral.gov/library/calls/walking-and-walkable-communities/call-to-action-walking-and-walkable-communites.pdf

57 For a review, see Hoehner, C.M., Barlow, C.E., Allen, P., & Schootman, M. (2013, June 1). Commuting Distance, Cardiorespiratory Fitness, and Metabolic Risk. *American Journal of Preventative Medicine, 42(6)*, 571-8. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3360418/

58

59 Massachusetts Department of Transportation, Office of Transportation Planning. (2014). Travel Demand Model. *Massachusetts vehicle-miles traveled Statistics and Projections*.

60 A One-percentage point reduction in VMT is calculated by backing out the current projected growth rate as estimated by MASSDOT, and subtracting one percentage point. For instance, if the current growth rate was positive 0.25 our recalculated reduced growth rate was negative 0.75. This was done for each year. By subtracting one percent from the growth rate rather than subtracting one percent from the forecasted amount of VMT, we seek to measure a relatively constant effort. The policy effort necessary to turn a half-percent increase in the rate of growth into a half-percent decrease in growth rate is likely similar to the policy effort required to move from a half percent decrease to a one and a half percent decrease in the growth rate. By contrast, a one percent reduction of larger increases likely request less effort than turning a small increase into a small decrease in VMT.

61 U.S. Energy Information Administration (2015, July 7). *Frequently Asked Questions, How much carbon dioxide is produced by burning gasoline and diesel fuel*. Retrieved from http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=10

62 U.S. Environmental Protection Agency. (2015). *Greenhouse Equivalencies Calculator*. Retrieved from http://www.epa.gov/cleanenergy/energy-resources/calculator.html

63 Future fuel efficiency of automobiles is expected to increase. To estimate the future fuel efficiency of Massachusetts's automobile fleet, this report relies on nationwide average forecasts provided by the U.S. Energy Information Administration in their 2015 Annual Energy Outlook Report. For 2015, the Energy Information Administration estimates that the "on the road" average fuel efficiency for automobiles and light duty trucks (collectively known as "Light Duty Stock") was 22.7 MPG.

The U.S. Energy Information Agency's forecasts slow increases in gasoline prices through 2040. This report uses the agency's Annual Energy Outlook 2015 reference forecast of future gasoline prices. These values are likely to understate the future cost of gasoline because gasoline in the Bay State tends to be somewhat more expensive than the national average. For 2015, the report uses the Massachusetts price of gasoline for June 2015 ($2.80 per gallon), which has already exceeded the official forecast.

64 Office of Highway Policy Information, Federal Highway Administration, U.S. Department of Transportation (2014). *State Statistical Abstracts 2012*, *Massachusetts*. Retrieved from http://www.fhwa.dot.gov/policyinformation/statistics/abstracts/2012/ma.cfm

65 To calculate the savings per licensed driver for the period, we took the total savings for 2015-2030 (-$7.7 billion), and divided that by the number of licensed drivers in 2012 (4.73 million), which resulted in $1,628 in savings per licensed drivers in Massachusetts for 2015-2030. Office of Highway Policy Information, Federal Highway Administration, U.S. Department of Transportation (2014). *State Statistical Abstracts 2012*, *Massachusetts*. Retrieved from http://www.fhwa.dot.gov/policyinformation/statistics/abstracts/2012/ma.cfm

66 We derived a per mile cost of 9.0 cents per mile by taking National Safety Council's cost of collisions nationwide in 2013 (267.5 billion), and dividing by Federal Highway Administration's data for total miles driven in 2013 (2.972 trillion). National Safety Council (2014, February 12). National Safety Council Estimates Traffic Deaths Down Three Percent in 2013, *National Safety Council*. Retrieved from http://www.nsc.org/NewsDocuments/2014-Press-Release-Archive/2-12-2014-Traffic-Fatality-Report.pdf. *See also*, U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information (2014, November). *Travel Monitoring and Traffic Volume*. Retrieved from https://www.fhwa.dot.gov/policyinformation/travel_monitoring/13dectvt/index.cfm

67 American Automobile Association (2015, April 28). *Annual Cost to Own and Operate a Vehicle Falls to $8,698, Finds AAA*. Retrieved from http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds-aaa/

68 In order to calculate the associated savings on automobile maintenance resulting from a one percentage point decrease in driving volume in 2015, this report takes the marginal decrease in driving volume for 2015 (575.52 million miles, see appendix II) and multiplies this value by a per-mile cost of automobile maintenance (5.11 cents per mile). The resulting figure ($29.41 million) represents the associated savings on reduced automobile maintenance for that year. American Automobile Association (2015, April 28). *Annual Cost to Own and Operate a Vehicle Falls to $8,698, Finds AAA*. Retrieved from http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds-aaa/

69 In order to calculate the associated savings on automobile maintenance resulting from a one percentage point decrease in driving volume in 2030, this report takes the marginal decrease in driving volume for 2030 (8.72 billion miles, see appendix II) and multiplies this value by a per-mile cost of automobile maintenance (5.11 cents per mile). The resulting figure ($445.61 million) represents the associated savings on automobile maintenance for that year. American Automobile Association (2015, April 28). *Annual Cost to Own and Operate a Vehicle Falls to $8,698, Finds AAA*. Retrieved from http://newsroom.aaa.com/2015/04/annual-cost-operate-vehicle-falls-8698-finds-aaa/

70 To calculate the associated savings on automobile maintenance resulting from a one percentage point decrease in driving volume for the period from 2015-2030, this report takes the yearly values calculated using the process described above for each year in the period and sums the values to produce a cumulative total for the period ($3.81 billion).

71 The 2.57 cents per mile figure for expected cost of existing state road repair is calculated using data from FHWA for both vehicle-miles traveled estimates (4.2 trillion miles from 2010-2030) and expected cost of maintenance ($108 billion), and then extrapolating out a per-mile cost based on total costs of maintenance divided by total miles. To calculate the VMT estimate from 2010-2030 (4.2 trillion miles) this report takes the difference between a high VMT growth scenario (1.85 percent growth) and a low VMT growth scenario (1.36 percent growth), and sums the annual differences over a projected 20 year period from 2010-2030. To calculate the expected cost of road maintenance from 2010-2030 ($108 billion) this report takes the expected repair costs associated with a future high VMT growth scenario (1.85 percent growth) and future low VMT growth scenario (1.36 percent growth) which equates to $5.4 billion, and expands that cost estimate over a projected 20 year period from 2010-2030 to reach a total of $108 billion. U.S. Department of Transportation, Federal Highway Administration, Policy and Governmental Affairs (2014, November 7*). 2013 Conditions and Performance Report*, ch. 7, exhibit 7-2. Retrieved from http://www.fhwa.dot.gov/policy/2013cpr/chap7.cfm

72 To calculate the economic benefit of a reduction in state road repair associated with a one percentage point decrease in driving volume in 2015, this report takes the value for the reduction in the amount of miles traveled in 2015 under a one percent decrease scenario (575.52 million miles, see appendix II) and multiplies by the per-mile cost of state road repair (2.57 cents per mile). The resulting figure ($14.79 million) is the associated savings on state road repair for the time period. U.S. Department of Transportation, Federal Highway Administration, Policy and Governmental Affairs (2014, November 7*). 2013 Conditions and Performance Report*, ch. 7, exhibit 7-2. Retrieved from http://www.fhwa.dot.gov/policy/2013cpr/chap7.cfm

73 To calculate the economic benefit of a reduction in state road repair associated with a one percentage point decrease in driving volume in 2030, this report takes the value of the reduction in the amount of miles traveled in 2030 (8.72 billion miles, see appendix)II and multiplies by the per-mile cost of state road repair (2.57 cents per mile). The resulting figure ($224.11 million) is the associated cost of state road repair for the time period. U.S. Department of Transportation, Federal Highway Administration, Policy and Governmental Affairs (2014, November 7*). 2013 Conditions and Performance Report*, ch. 7, exhibit 7-2. Retrieved from http://www.fhwa.dot.gov/policy/2013cpr/chap7.cfm

74 To calculate the economic benefit of a reduction in state road repair associated with a one percentage point decrease in driving volume for the period from 2015-2030, this report calculates the annual values using the process described above and then sums all resulting values for each year. The result is the associated savings on state road repair ($1.92 billion) for the period from 2015-2030.

75 This figure is derived by dividing the total economic savings from 2015-2030 ($20.1 billion) by the average monthly grocery cost per U.S. household in 2015 ($618.80) over 15 years ($111,385). The resulting figure, 180,455, is the equivalent number of households (as defined above) that could purchase 15 years' worth of monthly groceries. U.S. Department of Agriculture (2015, April). *Official USDA Food Plans: Cost of Food at Home at Four Levels, U.S. Average*. Retrieved from http://www.cnpp.usda.gov/sites/default/files/CostofFoodApr2015.pdf. Note: Data reflects national average monthly grocery bill for a male and female households of two with partners between the ages of 19 and 50.

76 This figure is derived by dividing the total economic savings from a one percentage point decrease in the vehicle-miles traveled growth rate from 2015-2030 ($20.1 billion) by the 2012 average annual infant daycare cost per child in Massachusetts ($16,430) calculated over 15 years ($246,450). The resulting figure (81,558) represents the number of infants that could be provided fulltime daycare for 15 years. Tran, A.B. (2014, July 2) Map: The average cost of child care by state. *Boston Globe.* Retrieved from https://www.bostonglobe.com/2014/07/02/map-the-average-cost-for-child-care-state/LN65rSHXKNjr4eypyxT0WM/story.html.

77 This figure is derived by dividing the total economic savings from a one percentage point decrease in the vehicle-miles traveled growth rate ($20.1 billion) by the average Massachusetts monthly mortgage payment ($1,204) expanded over 15 years ($216,720). The resulting figure (92,746) represents the number of mortgage payers whose mortgages could be paid for 15 years. Grueling, M. (2012, December 1). National Average Monthly Mortgage Payment by State. *LendingTree.com*. Retrieved from https://www.lendingtree.com/mortgage/2011-2012-national-average-monthly-mortgage-payment-article. Note: This figure uses data obtained from 2011-2012.

78 MassDOT Implements New Healthy Transportation Policy Directive. Accessed at: https://www.massdot.state.ma.us/main/tabid/1075/ctl/detail/mid/2937/itemid/350/MassDOT-Implements-New-Healthy-Transportation-Policy-Directive--Prioritizes-Inclusion-of-Bicycle--Transit--Walking-Options.aspx

79 Global Warming Solutions Act Requirements for the Transportation Sector and the Massachusetts Department of Transportation (310 CMR 60.05). Accessed at: http://www.mass.gov/eea/docs/dep/air/laws/greendot-fs.pdf

80 Project Selection Advisory Council. Accessed at: https://www.massdot.state.ma.us/BoardsCommittees/ProjectSelectionAdvisoryCouncil.aspx

81 A study conducted at the Massachusetts Institute of Technology estimated a 9.5 percent reduction in vehicle-miles traveled if all drivers in Massachusetts switched to a strictly per-mile PAYD insurance plan. Joseph Ferreira, Jr and Eric Minikel, Massachusetts Institute of Technology, *Pay-As-You-Drive Auto Insurance In Massachusetts: A Risk Assessment and Report On Consumer, Industry And Environmental Benefits.* Accessed at: http://web.mit.edu/jf/www/payd/PAYD_CLF_Study_Nov2010.pdf.

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