Executive Summary

Air Pollution

Tra c congestion induced by the Speed Limit Bill would increase the amount of time vehicles spend on the road. Because speed a ects the ways in which vehicles burn fuel, slower average tra c speeds would also change the composition of vehicle emissions. Due to these factors, air pollution emissions are expected to rise slightly as a result of the bill. While air pollution can increase mortality rates and hospitalizations due to asthma, chronic lung disease, heart attacks, ischemic heart disease, and major cardiovascular disease, air pollution increases would be very small, and therefore the air pollution-related health e ects of the bill would be quite modest. Air pollution-related health costs would be approximately $500 per year for the state. The estimated annual number of deaths and hospitalizations due to worsened air quality is extremely close to zero , with statistical models estimating that health e ects would be negligible. [1]

Pedestrian and Bicyclist Perceptions of Safety

Figure 1: Diagram of Highway Functional Classifications (Transportation & Public Facilities, State of Alaska 2011)

The aim of the legislation is to reduce vehicle speeds on local roads to a level that is safer for pedestrians, cyclists, and children. The legislation also allows for municipalities to officially lower speed limits on their roads, which is currently a difficulty for many cities and towns in Massachusetts.

The passage of the proposed legislation could have far-reaching and potentially important public health

- Worked with CTPS to build statewide models that estimated the impact of new traffic speeds on vehicle miles traveled, vehicle hours traveled, and air quality in the region
- Applied findings from peer-reviewed public health literature to the results of the CTPS transportation models to predict likely health outcomes, in consultation with local experts in the fields of transportation safety, environmental health, and active transportation.

It should be noted that because this project was selected for an HIA in spring of 2012, the time frame did not allow for an extensive review and modeling of health impacts. Therefore, the assessment presented in this report is from a "rapid" HIA.

- Collisions, injuries, and fatalities
- Fuel burned and time spent in traffic
- Health effects of air pollution

While we could not quantify expected impacts, we estimate the likely direction and magnitude of effects of the bill on the following:

- Perceived pedestrian and bicycle safety and physical activity
- Property values

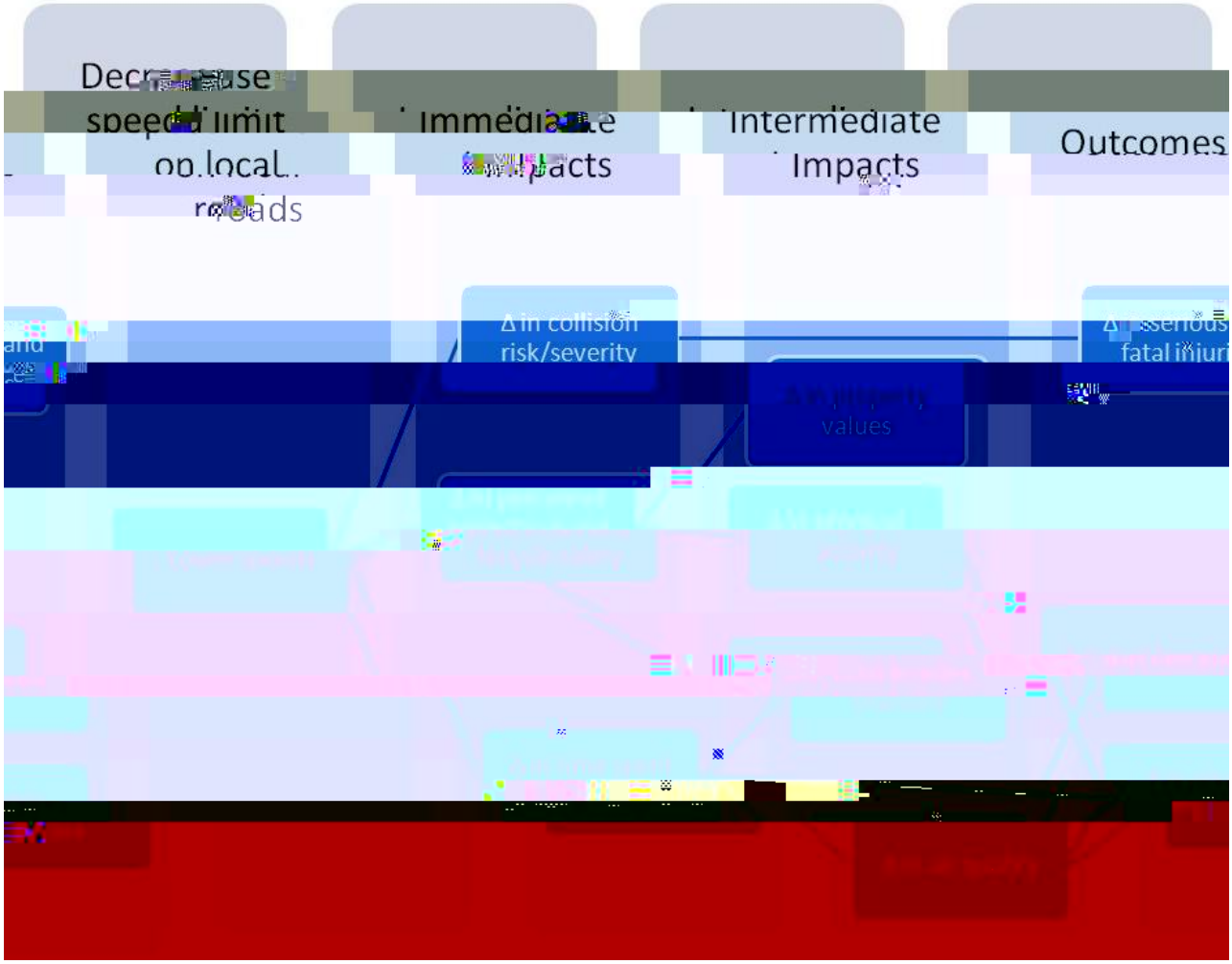

Figure 2: Speed Limits and Health Causal Pathway Diagram

Collisions,Fatalities, and Injuries

Background

Motor vehicle crashes are the top cause of death among people ages 5 to 34 in the United States, and a leading cause of injury among all age groups (Centers for Disease Control and Prevention 2011). Decreasing traffic speeds increases the amount of time drivers have to react to road hazards, potentially averting collisions, and makes crashes that do happen less severe (Rune Elvik 2012). Consistent evidence over the past century has confirmed that lowering traffic speeds decreases the frequency of crashes, as well as rates of fatalities and injuries due to vehicle collisions. This holds true on urban and residential roads (Lindenmann 2005; Kloeden, Woolley, and McLean 2007). This impacts both individuals traveling in vehicles, as well as pedestrians and cyclists who often share roadways with vehicles. Therefore, there is great potential for the Speed Limit Bill to decrease motor vehicle collisions and subsequent fatalities and injuries associated with these crashes.

Methods for Assessment

In order to estimate the effect of lowering the speed limits on functionally classified local roads from 30 mph to 25 mph,

LOCAL SPOTLIGHT: CAMBRIDGE

Table 2: Pedestrian Crashes from 2006-2009 reported by the Registry of Motor Vehicles

	2006	2007	2008	2009	Total	Annual Average

Crashes on Local Roads	34,832	34,953	34,319	32,158	136,262	34,066
Crashes Involving Cyclists on All Roads	1,069	1,069	1,227	1,248	4,613	1,153
Crashes Involving Cyclists on Local Roads	398	393	458	455	1,704	426
Cyclist Fatalities on All Roads	6	11	10	6	33	8
Cyclist Fatalities on Local Roads	1	8	4	1	14	4
Cyclist Injuries on All Roads	753	744	866	882	3,245	

Regional Urban Centers – These municipalities are urban centers outside of the Inner Core and are characterized by an urban scale downtown core with multiple blocks of multi-story, mixed use buildings; and moderately dense residential neighborhoods surrounding this core. Some of these communities are ³ E X L O W R X W ´

Summary

workers, property damage, lowered property values, community fear, law enforcement, judicial, and litigation costs. As such, these are extremely conservative estimates.

Existing Conditions

Recent CDC estimates show that the cost of the death of a child from motor vehicle crashes in Massachusetts was $394 million in 2005

Table 6: Cost of Crashes for a 1.8 mph decrease in traffic speeds from CDC's WISQARS in 2012 dollars

	Fatalities	Pedestrian Fatalities	Cyclist Fatalities
Annual Decrease in Deaths	18	4	1
Medical Cost Avoided	$346,721	$76,699	$18,912
Work Loss Cost Avoided	$29,347,334	$6,521,513	$1,630,641
Combined Cost Savings	$29,694,055	$6,598,212	$1,649,553

Medical Cost Avoided	$133,435	$37,824	$0
Work Loss Cost Avoided	$10,990,016	$3,140,455	$0
Combined Cost Savings	$11,123,451	$3,178,279	$0

	Injured Road Users	Injured Pedestrians	Injured Cyclists
Annual Decrease in Number Hospitalized	460	19	12
Medical Cost Avoided	$23,713,638	$1,027,556	$600,984
Work Loss Cost Avoided	$43,293,937	$1,962,653	$1,370,075
Combined Cost Savings	$67,007,575	$2,990,209	$1,971,058

Limitations to this analysis include the lack of data on costs for collisions that did not result in an injury or fatality. Including these personal damage costs would increase cost savings estimates. This analysis assumes that all injuries prevented by the modeled reduced speeds would have otherwise resulted in a hospital visit. This assumption is based on the fact that our baseline data came from the FARS, which only registers serious crashes.

Summary

Conservative predictions show the Speed Limit Bill would decrease fatalities and injuries by lessening the risk and severity of motor vehicle collisions.

These decreases in fatalities and injuries would also mean financial savings in $11 million up to $30 million for fatalities prevented and $60 million up to $180 million for injuries prevented in costs to society due to medical payments and missed work. These savings would affect those involved in collisions and their families, as well as employers, property owners, and taxpayers across the state.

Using the TTI equations, we found that fuel costs would increase by $21 million per year and the LQFUHDVHG WLPH VSHQW LQ WUDIILF ZRXOG FRVW WKH 0DVVDFK

CTPS also modeled whether participants would shift from commuting by automobile to biking, walking, or public transit as a result of the 1.8 mph decrease on local roads. Their model predicted that there would be no appreciable mode shift due to the 1.8 mph decrease.

Summary

While the Speed Limit Bill is expected to reduce crashes and prevent injuries and fatalities, it would prompt drivers to reduce cut through traffic by seeking faster, though often longer, routes on higher capacity roads, resulting in an additional 55.3 million vehicle miles travelled per year. At the same time, slower travel speeds on local roads and higher traffic volumes on newly preferred, higher capacity roads would result in 5.8 million additional vehicle hours traveled per year. These increases in time spent in traffic would cost approximately $127 million per year, while increases in hours spent in traffic would cost $21 million per year.

Air Pollution

Background

Vehicles emit a number of air pollutants, including particulate matter (PM), carbon dioxide, and nitrogen dioxide. Ozone can also form as secondary pollutant due to vehicle exhaust. An extensive body of epidemiological evidence links air pollution to mortality and hospitalizations due to asthma, chronic lung disease, heart attacks, ischemic heart disease, and major cardiovascular disease (US EPA and Abt Associates, Inc 2010; Roman et al. 2008; Schwartz et al. 2008; Health Effects Institute 2003; Moolgavkar 2000b; Moolgavkar 2000a; Pope et al. 2001). If the Speed Limit Bill leads to more time spent in congested traffic, air pollution emissions may rise. Additionally, vehicles are designed to burn fuel most efficiently at certain speeds, typically around 45-50 mph, though optimal fuel economy is different for every vehicle (US Department of Energy 2011). Because speed affects the ways in which vehicles burn fuel, slower average traffic speeds would change the composition of vehicle emissions.

Methods for Assessment

We developed estimates of health impacts due to vehicular air emissions based on emissions models run by CTPS. Estimates of the public health impacts due to vehicular air emissions were developed using a risk assessment approach, incorporating information from an air quality model used by the U.S. Environmental Protection Agency (EPA) and peer-reviewed research papers.

Emissions Estimates

CTPS estimates of statewide transportation patterns under the baseline and Speed Limit Bill scenarios form the basis of this air quality analysis. CTPS used these estimates as inputs for MOBILE6.2, a veh emissions modeling software formerly used by the U.S. Environmental Protection Agency (EPA) to develop State Implementation Plans under the Cle

&7 3 6¶V 02%,/(RXWSXWV SURYLGHG particulate matter smaller than 2.5 microns in aerodynamic diameter (PM2.5), particulate matter smaller than 10 microns in aerodynamic diameter (PM10), VOCs and NOx; however, SO2 was not included because it is not a requirement for air quality conformity. Additional pollutants, such as ultrafine particles, are not included as an output from MOBILE6.2.

Pollutant Concentrations

Pollutant concentrations were estimated by counting a Source-Receptor Matrix developed by the U.S. EPA to perform regulatory impact analyses for controls on vehicular emissions (USEPA 1999). The Source-Receptor Matrix has also been used in other studies examining the impacts of vehicular emissions, including one examining spatial patterns (Greco et al. 2007), and another estimating the public health impacts, time-spent, and fuel

calculated with the population count in each county, the baseline risk of these health outcomes, the change in air quality, and the relationship between air quality and an increase in the risk of these health endpoints.

These health endpoints were then monetized. The value of statistical life (VSL) of $8.32 million in 2012 USD was used to monetize mortality endpoints (Dockins et al. 2004), as is used in U.S. EPA regulatory impact analyses (US EPA 1999; US EPA 2011). The values of a hospitalization event from the U.S. EPA software BenMAP (US EPA and Abt Associates, Inc 2010) were used to place a monetary value on K R V S L W D O L] D W L R Q V 7 K H W R W D O Y D O X H W R V R F L H W \ R I D Q L Q G thought of as having two components: (1) the cost of illness (COI) to society, which includes the total medical costs plus the value of the lost productivity, as well as (2) the willingness to pay (WTP) of the individual, as well as that of others, to avoid the pain and suffering resulting from the illness. However, BenMAP does not contain estimates of social WTP to avoid hospital admissions, and therefore estimates of total COI are conservative (lower bound) estimates. These COI functions do not include the cost of pain and suffering in the estimate of monetized value.

It should be noted that final estimates do not include the effects of exposure to other pollutants that may change as an impact of the bill, including SO2, CO, ozone, and ultrafine particles. We relied upon air S R O O X W L R Q H V W L P D W H V I U R P & 7 3 6 W K D W X V H W K H (3 $ ¶ V 0 2 % , / (additional emissions that would occur due to stop and go traffic. Additionally, we were not able to calculate effects of air pollution on stroke, premature birth, infant mortality, and childhood asthma. These factors would contribute additional mortality and hospitalizations not calculated here. These aggregated numbers do not demonstrate the distribution of risk among different populations. Finally, our estimates also do not include increased exposures specific to commuters, who may spend more time in traffic in close proximity to elevated concentrations.

Existing Conditions

In general, most monitored air pollutants in the state of Massachusetts are at levels below health based standards, and levels have been declining over time (MassDEP 2012). Concentrations statewide under baseline conditions can be seen in Table 9 below.

Table 9: Statewide Baseline Conditions

	CO	NOx	VOC	PM2.5	PM10
Baseline Levels (kg)	553,185.07	47,895.57	18,026.08	1,121.33	1,852.03

Summary

The Speed Limit Bill would lead to more time spent in congested traffic, and subsequently air pollution emissions will rise.

Small increases in air pollution are expected as a result of the Speed Limit Bill. These increases in air pollution would result in an increase in mortality and hospitalizations due to asthma, chronic lung disease, heart attacks, ischemic heart disease, and major cardiovascular disease although these increases would be negligible.

Air pollution-related health costs would be approximately $500 per year.

Pedestrian and Bicyclist Perceptions of Safety

Background

Walking and bicycling for transportation helps people incorporate physical activity into everyday life, reducing the risk of many chronic diseases. A recent study by Lee (2012) estimates that physical inactivity causes 6% of the global burden of disease from coronary heart disease, 7% (range 3.6-9.3) of type 2 diabetes, 10% (range 5.4-16.1) of breast cancer, 10% (range 5.3-15.7) of colon cancer, 9% (range 5.1-12.5) of premature mortality. If inactivity were decreased by 10% to 25%, between 533,000 and 1.3 PLOOLRQ GHDWKV FRXOG EH DYHUWHG HYHU\ \HDU 0HHWLQJ WKH minutes of moderate intensity physical activity on most days of the week reduces risk of all-cause mortality, cardiovascular disease, and type 2 diabetes (de Nazelle et al. 2011; Haskell, Blair, and Hill 2009) 2QH ZD\ WR LQFUHDVH WKH SRSXODWLRQ¶V UDWH RI SK\VLFDO transportation from automobiles to active modes, such as walking and bicycling. For example, a meta-analysis by Hamer and Chida (2008) examined the association between commuting physical activity and cardiovascular risk and found that active commuting that incorporates walking and biking was associated with an 11% reduction in cardiovascular risk. One of the barriers, however, to facilitating this shift to active transportation may be negative perceptions of road safety due to excessive speeds of motorized vehicles.

Methods for Assessment

We conducted a rapid review of peer-UHYLHZHG OLWHUDWXUH RQ LQGLYLGXDOV¶ related to traffic speed and speed limit reductions, and on the health impacts of walking and bicycling. We used U.S. Census and Behavioral Risk Factor Surveillance System (BRFSS) data, from 2010, to describe current conditions in Massachusetts. The BRFSS is an annual telephone survey that collects data on public health issues, health conditions, and risk factors and behaviors.

Existing Conditions

According to the 2010 BRFSS, nearly 200,000 (6%) Massachusetts workers bike or walk to work, however about 20% of Massachusetts residents report engaging in no leisure time physical activity (U.S. Census Bureau 2012). Although higher than the U.S. average, Massachusetts lags behind Europe in

utilizing active means of transportation (Buehler, 2008). For example, in Ireland 15% of commuters bike or walk to work (Bassett et al. 2008). Although Massachusetts is considered one of the healthiest states in the country, 60% of adults are overweight and 24% of adults are obese, highlighting the significance of interventions that help residents become more active (Massachusetts Department of Health and Human Services 2010).

Assessment

Over the past several decades, researchers across disciplines have begun to examine traffic and its relationship with physical inactivity. According to a recent literature review on Urban Traffic Calming and Health by the National Collaborating Centre for Healthy Public Policy in Canada, in urban settings a significant portion of car trips cover short distances, and given favorable conditions, these trips could be made on foot or by bicycle (Morency, Demers, and Lapierre 2007; National Collaboratof cne tion of c

VDIHW\ IRU DOO XVHUV RI WKH VWUHHW :DWNLQV XWLOL]HG D introduction of the traffic calming measures. Fifty-seven percent of respondents believe that pedestrian safety improved after the traffic calming project, as did 33% of cyclist safety, which could lead to an increase in active modes of transportation. As with the previous study, this one has important limitations, including a lack of reported data to determine statistical significance of the findings.

Overall, National Collaborating Centre for Healthy Public Policy (2011) notes that while the mechanisms of action posited by the literature support traffic calming interventions, the method

Summary

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the risk of a number of chronic diseases.

High traffic speeds may deter active transportation trips, such as walking and cycling trips.

Lowering speeds through policy and/or engineering interventions may create safer environments and improve perceptions of safety.

Improved perceptions of safety may lead to increased use of local roads for active transport.

Further traffic calming measures, along with improvements to pedestrian and bicycle infrastructure, may be required to significantly enhance perceptions of safety and increase physical activity.

Parental Safety Perceptions and & K L O G U H Q ¶ V / H Y H O V R I 3 K \ V L F D O $ F W L Y L W \

Background

There is widespread recognition that childhood obesity and diseases related to a lack of physical activity among children, including pre-diabetes, diabetes, and asthma, are major public health challenges in the United States (White House 2012). With a dramatic rise in childhood obesity rates occurring over the past several decades alone, researchers and policy makers have concluded that changes in environmental and contextual factors, rather than innate biological or genetic ones, are likely to blame for the childhood obesity epidemic and may therefore be promising points of intervention (Rahman, Cushing, and Jackson 2011; Garasky et al. 2009; Grow et al. 2010). One modifiable contextual risk factor that has gained considerable attention in recent years in the fight against childhood obesity has been the built environment. National efforts are currently underway to help children be more physically active by improving the quality of the built environment for walking and biking. Examples include Michelle 2 E D P D ¶ V / H W ¶ V 0 R Y H (W h i t e H o u s e 2 0 1 2) and the national Safe Routes to Schools program. Massachusetts also has a statewide program through the Massachusetts Department of Public Health (MDPH) called Mass in Motion. Although it was launched in 2009, Mass in Motion has grown to cover 52 municipalities and about a third R I W K H V W D W H ¶ V S R S X O D W L R Q 7 K L V L Q L W L D W L Y H D L P V
to prevent overweight and obesity with particular focus on healthy eating and activity. All of these initiatives acknowledge the role of the neighborhood built environment in shaping health behaviors and both promote community-based efforts to improve active transportation infrastructure for children.

Community-based interventions to encourage higher levels of physical activity among children via improvements to the built environment frequently focus on reducing traffic speed and volume. Efforts to V O R Z D Q G U H G X F H W K H Q X P E H U R I D X W R P R E L O H V R Q S K \ V L F D O D F W L Y L W \ R D G V R U
among children when changes to the built environment are actually effective in reducing vehicle speeds and volume, thereby preventing crashes and improving safety. Secondly, these changes may lead to increased perceptions of safety, causing parents and schools to encourage walking and biking among F K L O G U H Q D Q G L Q F U H D V L Q J F K L O G K R R G W K U R X J K Z D O N L Q J D Q G E L F \ F O L Q J W R Z D

2004). Not only can this benefit children by increasing their physical activity, it also may make them safer. Data indicates that the likelihood that a given person walking or bicycling will be struck by a motorist varies inversely with the number of individuals walk

Property Values

Background

As well-UHFRJQL]HG ³VRFLDO GHWHUPLQDQWV RI KHDOWK´ VKDSH RXWFRPHV LQFOXGLQJ WKH H[WHQW WR which people get sick or stay healthy (Berkman and Kawachi 2000). This section examines whether property values could be affected by the Speed Limit Bill, in turn impacting health via changes in homeowner wealth or local housing conditions.

Traffic speeds on roads have been linked to adjacent property values, as homebuyers are willing to pay a premium for quieter, safer streets. In a survey of homebuyer preferences, community design with low traffic ranked as the top priority out of 39 attributes used to select a home (National Bicycle and Pedestrian Clearinghouse 1995). Another study showed that a 5 to 10 mph reduction in traffic speeds increased nearby residential property values by approximately 2% (Wendra 1984). Other studies have demonstrated that reducing the volume of traffic on residential streets can also serve to increase property values (Bagby 1980; Eppli and Tu 1999; Hughes and Sirmans 1992). The Speed Limit Bill therefore has the potential to impact residential property values for homes across the state. We assess the potential for the Speed Limit Bill to improve health via changes in property values.

Methods for Assessment

We reviewed the literature on the relationship between household values and traffic speeds and then reviewed 2006-2010 American Community Survey (ACS) from the US Census for estimates on median home values in Massachusetts (American Community Survey 2010). The ACS is a sample done in one-, three- and five-year increments (depending on geography) that provides estimates of housing characteristics, population characteristics, education levels, modes of transportation, age, etc.

E

Summary

Although this literature is sparse, it is consistent in showing that lower traffic speeds are associated with higher values in adjacent residential properties

We cannot predict how the Speed Limit Bill would impact statewide property values, but the literature indicates general preferences for the safety and quiet associated with slower speeds

Table 12: Crashes and Cost of Crashes in 2012 dollars

Estimated Annual Decrease in:	1.8 mph speed reduction	5 mph speed reduction
Total Crashes	2,219 (95% CI 286, 4042)	6,265 (95% CI 855, 10,794)
Fatalities	18 (95% CI -4, 35)	44 (95% CI -11, 67)
Injured Road Users	1,239 (95% CI 369, 2039)	3,336 (95% CI 1,077, 5,088)

Implementation±Dissemination

If passed, the Speed Limit Bill should be accompanied by a public information campaign that includes a P H G L D F D P S D L J Q D Q G L Q F O X V L R Q L Q I R U P D W L R Q D E R X W W K H Q H Z V S H H G H G X F D W limits could be incorporated into RMV mailings or other documents regularly distributed to drivers.

Implementation±Enforcement

Though this bill reduces the default speed limit on local roads by 5 mph, actual speeds are only expected to drop by 1.8 mph. Enforcement policies and policing would help reduce the actual speed of traffic closer to the 25 mph limit. Currently, the bill does not incorporate any elements related to enforcement. A systematic review conducted in 2010 assessed the effectiveness of speed cameras in improving safety across 35 studies and concluded that cameras are a worthwhile intervention that help prevent speeding and prevent crashes (Wilson et al. 2010). Despite the fact the each study on its own suffered methodological challenges, the body of evidence as a whole suggests that cameras may reduce the percentage of drivers speeding by 14-65%, and may reduce crashes resulting in death or serious injury by 30-40% : K L O H W K H V H U D Q J H V U H S U H V H Q W e d v i z e D a Y a l e R U V ¶ E H V W D reductions varied widely across sites

Evidence also suggests that drivers respond more to the threat of enforcement than to the severity of enforcement penalties, and that drivers are bad at guessing how frequently roads are patrolled (Paveglio 2012). Enforcement approaches that remind drivers that roads are patrolled for speeding, or even tell drivers how many hours per month are spent patrolling the roads, may also help raise compliance rates with new, lower speeds.

Despite the positive findings that enforcement can help reduce speeding, research suggests that design-based traffic calming interventions are even more effective. In fact, when the approaches are directly compared, researchers have found that traffic calming is better at reducing speeds than are speed cameras (Mountain, Hirst, and Maher 2005).

Implementation±Road Engineering

To truly maximize the health benefits of this bill, studies and past piloted projects show that passive, self enforcing engineering interventions are most effective. In fact, studies that directly compare the effectiveness of enforcement versus engineering approaches in reducing speeds have come to the same conclusion (Mountain, Hirst, and Maher 2005). New local roads should be designed that support a 25 mph speed limit if the bill passes. If the road design speed differs from the speed limit on existing roads, traffic calming measures could help bring down travel speeds without the need for intensive enforcement. Traffic calming, such as raised intersections, traffic circles, road narrowing, curves, and speed humps, is one population-based and self-enforcing engineering strategy that slows traffic and reduces traffic volume (Pucher and Dijkstra 4(on)11(s, t) 1 471.07 366.43 Tm [( )] TJ 542.94 2

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surface height and forced drivers to slow. Less effective in reducing speeds and preventing injury,
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(Mountain, Hirst, and Maher 2005). Roundabouts, islands, and chicanes are examples of horizontal deflections, while constructing pinch points, removing traffic lanes, and curb bump outs all narrow the road. Low cost road treatments that simply give the appearance of narrowing and alert drivers that they are entering a lower speed area, including painting inward facing teeth on the sides of a traffic lane, can also be effective in reducing speed (HOO ¶$FTXD *DODQWH HW DO

While academic research DV QRW EHHQ DEOH WR GLVDJJUHJDWH WKH VHHG
effects of pedestrian-oriented traffic signalization, high visibility crosswalks, speed humps placed in front of crosswalks, pedestrian refuge island, and other design features that use these interventions have been shown to improve safety (Chen et al. 2012; Johansson, Rosander, and Leden 2011). Research suggests WKDW WKH ³OHYHO RI SHGHVWULDQ DQG G\QDPLF VDIHW\ LV LPSURYHG E\ FRQVWUXFWLQJ facilities specifically to serve these users, and overall positive perceptions of the environment are more important determinants of active transportation than is speed

worsen air quality, the benefits outweigh the costs from a health perspective. Studies and past projects show that the lower the vehicle speeds, the stronger the health benefit.

It is possible that this Speed Limit Bill could be the catalyst for promoting alternative modes of W U D Q V S R U W D W L R Q 7 R P D [L P L] H W K H E L O O ¶ V L Q W H Q W L R Q V W D enforce policies and engineer roads that reflect the desired speed limit of a road and simultaneously make concrete efforts to promote alternative modes of transportation, such as walking or biking (Appendix B).

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:+2 5HJLRQDO 2IILFH IRU (XURSH ³7UDQVSRUW (QYLURQPHQ Publications No. 89. http://www.euro.who.int/__data/assets/pdf_file/0003/87573/E72015.pdf.

Wilson, Cecilia, Charlene Willis, Joan K Hendrikz, Robyne Le Brocque, and Nicholas Bellamy. 2010. ³6SHHG &DPHUDV IRU WKH 3UHYHQWLRQ RI 5RDG 7UDIILF ,QMXU Systematic Reviews. John Wiley & Sons, Ltd. http://onlinelibrary.wiley.com.ezp-prod1.hul.harvard.edu/doi/10.1002/14651858.CD004607.pub3/abstract.

:LQWHUV 0HJKDQ 0LFKDHO %UDXHU (OHDQRU 0 6HWWRQ DQG Influences on Healthy Transportation Choices: Bicycling Versus Driving ´ Bulletin of the New York Academy of Medicine 87 (6) (December): 969–993. doi:10.1007/s11524-010-9509-6.

Appendix

Glossary of Terms

ACS	American Community Survey
BenMAP	Benefits Mapping and Analysis Program
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Center for Disease Control and Prevention
CDS	Crash Data System
CMF	Crash Modification Factor
COI	Cost of Illness
COPD	Chronic Obstructive Pulmonary Disease
CTPS	Central Transportation Planning Staff
CVD	Cardiovascular Disease
ED	Emergency Department
EPA	United States Environmental Protection Agency
GIS	Geographic Information Systems
HIA	Health Impact Assessment
IHD	Ischemic Heart Disease
MAPC	Metropolitan Area Planning Council

MARPA	Massachusetts Association of Regional Planning Agencie
MassDOT	Massachusetts Department of Transportation
MDPH	Massachusetts Department of Public Health
MI	Myocardial Infarction
MIT	Massachusetts Institute of Technology
Nox	Nitrogen Oxide
PM	Particulate Matter
RMV	Registry of Motor Vehicles
RPA	Regional Planning Agency
S-R	SourceReceptor
Sox	Sulfur Oxide
SWM	Statewide Model
TAZ	Transportation Analysis Zone
TTI	Texas Transportation Institute
VHT	Vehicle Hours Traveled
VMT	VehicleMiles Traveled
VOC	Volatile Organic Compounds
WISQARS	Web-based Injury Statistics Query and Reporting System

WONDER	Wide-ranging Online Database for Epidemiologic Researc
WTP	Willingness to Pay

Technical Appendix A

Extrapolating data statewide

7 K H %R V W R Q 5H J L R Q 0 3 2 ¶ V U H J L R Q D O W U D Y H O G H P D Q G P R G H O V
However, since this model is focused on eastern Massachusetts, a methodology to extrapolate findings statewide was necessary. As a preliminary step, roadways in the current base year regional model scenario were categorized according to one of four standard functional classes: minor arterial and collector, major arterial, and highway. Centroid connectors, which conceptually represent local road connections in a given TAZ, were assumed as falling into the local roadway category. The regional model works on a set of smaller geographies known as Transportation Analysis Zones (TAZs).

Following the modeling of these two scenarios, functional class summations by TAZ, similar to those prepared for the base year, were calculated for the AM and midday periods. These results (mobile vehicle emissions, VMT, VHT, and congested speeds) from each of these scenarios were individually compared and contrasted to its respective base year scenario output. The percentage change from the base year scenario was calculated for each of these time periods and scenarios. The percentage change for each 7$=¶V LQGLYLGXDO IXQFWLRQDO FODVV FDWHJRU\ LQ WKH $0 SHULRG DQG LQGLYLGXDO functional class category in the PM period. A similar process was performed between the PLGGD\ DQG QLJKWWLPH SHULRGV 7KLV WKHQ DOORZHG IRU WKH classification categories as well as for the entire model region.

The second major extrapolation step occurred by aggregating the regional model TAZ geography into distinct geographic areas, designed to represent 16 possible different typologies of land use and activity densities in the CTPS model area. The two sets of low density categories representing municipal residential populations and municipal employment populations were cross-classified to produce the 16 different types of land use and activity categories. The median percentage change by time period for each of the roadway types for each of the geographic categories was calculated. These results were then used in conjunction with the Statewide Model (SWM) to develop statewide data totals. The portion of Massachusetts lying outside the CTPS model area in the Statewide Model was also divided into these same 16 categories delineated in the CTPS model. A full categorized list of the municipalities can be found in the Tables below.

1. 3000 or more persons per square mile
2. 1000 to 3000 persons per square mile
3. 300 to 1000 persons per square mile
4. Less than 300 persons per square mile

1. 3000 or more jobs per square mile
2. 1000 to 3000 jobs per square mile
3. 300 to 1000 jobs per square mile
4. Less than 300 jobs per square mile

Following this classification, it was assumed that travel behavior on roadways in each of these non-CTPS SWM model geographic areas will be similar to the assigned analogous CTPS geographic area with the reduced speed limit. The median percentage change and the relationships between the different roadway W\SHV LQ WKH &736 GLVWULFW GXH WR WKH ORFDO URDGV¶ VSHHG UHGXFWLRQ WR ¶ 907 LQ WKH SM and midday periods to reflect this impact on roadway behavior. This was done according to time period. Temporal VMT on the roadway types in each of the non-CTPS model municipalities was calculated by applying the daily temporal breakdown of the analogous CTPS model density category by functional class to the daily VMT calculated by functional class for the municipalities in the MassDOT statewide model. Statewide data by functional class was produced by combining the CTPS model data and the aforementioned calculated data for Massachusetts municipalities located outside the CTPS model area.

It is important to note that modeling done by CTPS and other transportation agencies around the country has been frequently criticized for not accounting for induced demand, a phenomenon, whereby reducing capacity or implementing traffic calming on one road has been repeatedly shown to lead not to displacement of the same amount of traffic to other roads, but in fact to

Boylston	Hawley	Plympton *	Westhampton
Brimfield	Heath	Princeton	Westminster
Brookfield	Hinsdale	Rehoboth	Westport
Buckland	Holland	Richmond	Whately
Carver *	Hopkinton *	Rochester	Williamsburg
Charlemont	Hubbardston	Rowe	Williamstown
Charlton	Huntington	Rowley *	Winchendon
Cheshire	Lancaster *	Royalston	Windsor
Chester	Lanesborough	Russell	Worthington
Chesterfield	Lee	Rutland	Essex *
Chilmark	Lenox	Sandisfield	Florida
Clarksburg	Leverett	Savoy	Freetown
Colrain	Leyden	Sheffield	Gill
Conway	Mendon *	Shelburne	New Ashford
Cummington	Middleborough *	Sherborn *	New Braintree
Deerfield	Middlefield	Shutesbury	New Marlborough
Dighton	Monroe	Southampton	New Salem
Douglas	Monson	Southwick	Templeton

Clinton *	Maynard *	Tewksbury *
East Longmeadow	Methuen *	Walpole *
Easthampton	Milford *	Webster
Fairhaven	Milton *	Westwood *
Fitchburg	Nahant *	Whitman *
Franklin *	North Andover *	Yarmouth

MASSACHUSETTS MUNICIPALITIES WITH DENSITIES OF 1000-3000 PERSONS PER SQUARE MILE AND 1000-3000 JOBS PER SQUARE MILE

Andover *	Holyoke *	Danvers *
Avon *	Lexington *	Dedham *
Belmont *	Marlborough *	Fall River
Beverly *	Natick *	Framingham *
Billerica *	Needham *	Saugus *
Braintree *	Newburyport *	Wellesley *
Canton *	Norwood *	West Springfield
Chelmsford *	Peabody *	Wilmington *

MASSACHUSETTS MUNICIPALITIES WITH DENSITIES OF 1000-3000 PERSONS PER SQUARE MILE AND MORE THAN 3000 JOBS PER SQUARE MILE

Burlington *

MASSACHUSETTS MUNICIPALITIES WITH DENSITIES OF MORE THAN 3000 PERSONS PER SQUARE MILE AND 300-1000 JOBS PER SQUARE MILE

Hull *	Marblehead*

MASSACHUSETTS MUNICIPALITIES WITH DENSITIES OF MORE THAN 3000 PERSONS PER SQUARE MILE AND 1000-3000 JOBS PER SQUARE MILE

Arlington *	Revere *
Brockton *	Salem *
Brookline *	Springfield
Lowell *	Stoneham *
Lynn *	Swampscott *
Medford *	Wakefield *
Melrose *	Weymouth *
New Bedford	Winchester *
Newton *	Winthrop *

Fatal Crashes	2.6 (0.3, 4.9)
Fatalities	3.0 (-0.5, 6.5)
Injury Crashes (All)	1.2 (0.7, 1.7)
Inured Road Users (All)	1.4 (0.4, 2.4)
Property Damage Only	0.8 (0.1, 1.5)

Appendix A

Power model results for all 351 municipalities in Vt

AMESBURY	Regional Urban Centers	428	400	7
AMHERST	Regional Urban Centers	83	78	6
ANDOVER	Developing Suburbs	572	535	6

ARLINGTON

BREWSTER	Maturing Suburbs	140	131	6	

CHESHIRE	Developing Suburbs	42	39	7
CHESTER	Rural Towns	7	7	0

		124	116	6
		54	50	7
		87	81	7
		77	72	6
DRACUT	Developing Suburbs	483	452	6
DUDLEY	Developing Suburbs	273	255	7
DUNSTABLE	Developing Suburbs			

ERVING Rural Towns

HARWICH	Developing Suburbs	115	108	6
HAVERHILL	Regional Urban Centers	1,878	1,756	6
HAWLEY	Rural Towns	2	2	0
HEATH	Rural Towns	12	11	8
HINGHAM	Maturing Suburbs	578	540	7
HINSDALE	Rural Towns	5	5	0
HOLBROOK	Maturing Suburbs	113	106	6
HOLDEN	Developing Suburbs	[redacted]	156	7
HOLLAND	Developing Suburbs	13	12	8
[redacted]	[redacted]eveloping Suburbs	[redacted]48	138	[redacted]
[redacted]	[redacted]egional Urban [redacted]enters	1,445	1,351	7
HOPEDALE	Developing Suburbs	54	50	7
HOPKINTON	[redacted]	[redacted]	[redacted]	[redacted]
HUBBARDSTON				
HUDSON	Developing Suburbs	186	174	6

BROOKFIELD					
NORTH READING	Maturing Suburbs				

READING	Maturing Suburbs	365	341	7	

TOLLAND	Rural Towns	2	2	0
TOPSFIELD	Developing Suburbs	54	50	7
TOWNSEND	Developing Suburbs	183	171	7
TRURO	Rural Towns	34	32	6
TYNGSBOROUGH	Developing Suburbs	160	150	6
TYRINGHAM	Rural Towns	2	2	0
UPTON	Developing Suburbs	108	101	6
UXBRIDGE	Developing Suburbs	160	150	6
WAKEFIELD	Maturing Suburbs	493	461	6
WALES	Rural Towns	7	7	0
WALPOLE	Developing Suburbs	275	257	7
WALTHAM	Inner Core	1,876	1,754	6
WARE	Developing Suburbs	167	156	7
WAREHAM	Developing Suburbs	597	558	7
WARREN	Developing Suburbs	35	33	6
WARWICK	Rural Towns	4	4	0
WASHINGTON	Rural Towns	2	2	0
WATERTOWN	Inner Core	1,005	940	6

WAYLAND	Maturing Suburbs	72	67	7
WEBSTER	Regional Urban Centers	241	225	7
WELLESLEY	Maturing Suburbs	1,463	1,368	6
WELLFLEET	Maturing Suburbs	67	63	6
WENDELL	Rural Towns	8	7	13
WENHAM	Developing Suburbs	64	60	6
WEST BOYLSTON	Developing Suburbs	142	133	6
WEST BRIDGEWATER	Developing Suburbs	55	51	7
WEST BROOKFIELD	Developing Suburbs	27	25	7
WEST NEWBURY	Developing Suburbs	30	28	7
WEST SPRINGFIELD	Regional Urban Centers	136	127	7
WEST STOCKBRIDGE	Rural Towns	9	8	11
WEST TISBURY	Rural Towns	13	12	8
WESTBOROUGH	Developing Suburbs	439	410	7
WESTFIELD	Regional Urban Centers	723	676	7

WESTFORD	Developing Suburbs	431	403	6	

WESTHAMPTON

Bike box/
Sas vélo. Sas cvclable

A bike box is a facility that
to position themselves in front of vehicles
tion with traffic lights.
This pavement
makes cyclists more visible

using the road, a bike lane is delimited by
road markings. The space needed for the
bike lane is g obtained by
elimin

Choker,

Full closure, Full street closure, Cul-de-sac, Dead-end/ ...

Fermeture de rue, Impasse, Cul-de-sac

Full closure

to

indicate entrance to a calmed area.

...keimages.org.
Photographer: Dan Burden.

Mini-roundabout, Mini-traffic circle

Intersection islands/ ...

...ction with ...

...ge to those already inside and ...

One-way street/
Rue à sens unique

A one-way street is a street on which vehicles are authorized to travel in only one direction. One-way streets can be used, with minimal cost, to prevent through traffic from using local residential streets instead of roads designed to handle larger

Pedestrian refuge, Median refuge/
Refuge piéton

Raised crosswalk, Raised zebra crossing, Raised crossing, Hump pelican/

Passage piéton surélevé, Traversée surélevée

A raised crosswalk is a facility designed to make crossing the road easier for pedestrians and which vertically raises the

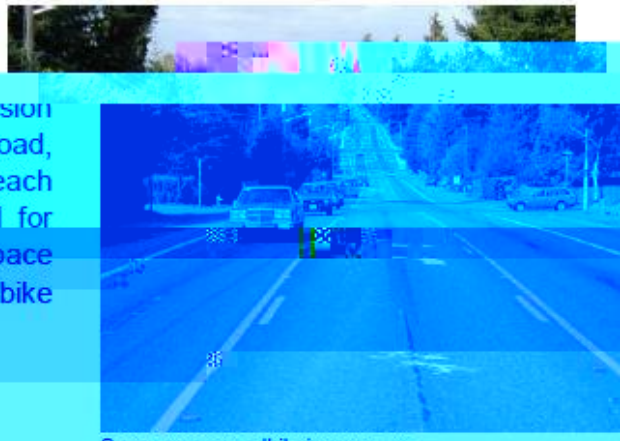
Source: www.cycle[illegible]ets.net.
Photographer: unknown.

Raised media[illegible]

educe lane widths.

Source: www.pedbikeimages.org.

Road diet, Lane reduction/
Régime routier



A road diet usually refers to the conversion of a four-lane road into a three-lane road, with one lane for traffic going in each direction and a central lane reserved for left turns from either direction. The space recuperated can be used to add bike lanes, sidewalks, or vegetation.

Source: www.[illegible]bikeimages.org. Photographer: Allan Burden.

Roundabout/
Carrefour giratoire. Giratoire

A roundabout is an intersection at which vehicles entering


osswalk is a facility designed
to make