September 2024

Report No. 24-059

Maura Healey
Governor

Kim Driscoll
Lieutenant Governor

Monica Tibbits-Nutt
MassDOT Secretary & CEO

Speed Management and Emergency Response—A Synthesis Study

Principal Investigator (s)
Francis Tainter
Peter Furth
Michael Knodler
Daniel Dulanski
Cole Fitzpatrick

University of Massachusetts Amherst
Northeastern University

Research and Technology Transfer Section
MassDOT Office of Transportation Planning

U.S. Department of Transportation
Federal Highway Administration

[This blank, unnumbered page will be the back of your front cover]

Technical Report Document Page

1. Report No. 24-058	2. Government Accession No. n/a	3. Recipient's Catalog No. n/a
4. Title and Subtitle Speed Management and Emergency Response—A Synthesis Study		5. Report Date September 2024
		6. Performing Organization Code 24-058
7. Author(s) Dr. Francis Tainter, Dr. Cole Fitzpatrick, Dr. Michael Knodler Jr., Dr. Peter Furth, Dr. Daniel Dulaski		8. Performing Organization Report No.
9. Performing Organization Name and Address University of Massachusetts Amherst 130 Natural Resources Way Amherst, MA 01003 Northeastern University, 360 Huntington Ave, Boston, 02115		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Massachusetts Department of Transportation Office of Transportation Planning Ten Park Plaza, Suite 4150 Boston, MA 02116		13. Type of Report and Period Covered Final Report: September 2024 [March 2023– September 2024]
		14. Sponsoring Agency Code n/a
15. Supplementary Notes Project Champion - Christopher Falcos - MassDOT Technical Representative - Jacqueline DeWolfe - MassDOT		

16. Abstract

The impact of speed on roadways throughout the Commonwealth of Massachusetts continues to be a critical concern in the effort of achieving zero fatalities and reducing serious injuries. Speed management solutions are plentiful, and their impact is known; what is missing is the lack of use—municipal officials may be apprehensive in implementation. The apprehension stems from concerns historically related to first responders and concerns regarding the impact on emergency response times and other metrics. In New England, public works officials are frequently hesitant to implement speed management solutions due to anecdotal challenges related to snow removal. This research project was conducted to enhance the understanding of speed management impacts locally within the Commonwealth of Massachusetts. Using the primary focus of gauging concerns of both emergency (EMS, fire, police) and public works personnel, this project developed recommendations for implementation based on best practices. The current research project was conducted through numerous statewide surveys (both querying effectiveness and inventory), a collection of statewide case studies, and international and industry spotlights. While many local DPW and EMS officials have pushback toward certain measures, the research conducted within this report highlights the advantages of all speed management countermeasures. Future work should continue to inventory the ongoing progress of implementation across Massachusetts, while also integrating before and after data to provide evidence for future design.

17. Key Word speed management countermeasures, municipal, emergency, public works personnel, implementation speed management best practices, surveys		18. Distribution Statement	
19. Security Classif. (of this report) unclassified	20. Security Classif. (of this page) unclassified	21. No. of Pages 100	22. Price n/a

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

This page left blank intentionally.

Speed Management and Emergency Response—A Synthesis Study

Final Report

Prepared By:

Dr. Francis Tainter
Research Assistant Professor

Dr. Cole Fitzpatrick
Research Assistant Professor

Dr. Michael Knodler, Jr
Professor

Dr. Peter Furth
Professor

Dr. Daniel Dulaski
Teaching Professor

University of Massachusetts Amherst
130 Natural Resources Road
Amherst, MA 01003

Prepared For:

Massachusetts Department of Transportation
Office of Transportation Planning
Ten Park Plaza, Suite 4150
Boston, MA 02116

September 2024

This page left blank intentionally.

Acknowledgments

Prepared in cooperation with the Massachusetts Department of Transportation, Office of Transportation Planning, and the United States Department of Transportation, Federal Highway Administration.

The Project Team would like to acknowledge the efforts of Project Champion Christopher Falcos and Technical Representative Jacqueline DeWolfe, who provided guidance and assistance throughout the duration of this project. Additionally, the authors would like to acknowledge Pravar Parashar, Fatemeh Tabatabaei, and Aldo Villani who assisted with various subtasks of this project.

Disclaimer

The contents of this report reflect the views of the author(s), who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Massachusetts Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

This page left blank intentionally.

Executive Summary

This study of Speed Management and Emergency Response—A Synthesis Study was undertaken as part of the Massachusetts Department of Transportation (MassDOT) Research Program. This program is funded with Federal Highway Administration (FHWA) State Planning and Research (SPR) funds. Through this program, applied research is conducted on topics of importance to the Commonwealth of Massachusetts transportation agencies.

The impact of speed on roadways in Massachusetts remains a critical concern in the effort to achieve zero fatalities and reduce serious injuries. Although many speed management solutions are known to be effective, they are underutilized and municipal officials may be apprehensive in implementation. The apprehension stems from concerns historically related to first responders and concerns regarding the impact on emergency response times and other metrics. In New England, public works officials are frequently hesitant to implement speed management solutions due to anecdotal challenges related to snow removal.

This research project was conducted to enhance the understanding of speed management impacts locally within the Commonwealth of Massachusetts. Using the primary focus of gauging concerns of both emergency (EMS, fire, police) and public works personnel, this project developed recommendations for implementation based on best practices. Given the recently released MassDOT Safe Speeds repository, this research provided new local content for practitioners to enhance their potential speed management options. An outline of recommendations was established for roadway treatments that impact roadway speeds, follow design standards, and address the criticality of municipal personnel concerns.

Recently, several states have initiated a deeper dive into speed management within their local municipalities. The Utah Department of Transportation (UtahDOT) developed informational sheets that provide data on statewide speed management measures to guide local engineers in selecting appropriate treatments. These info sheets considered the following measures: radar speed signs, pavement speed limit markings, optical speed bars, road diets, median islands, roundabouts, roadway narrowing (e.g., bike lanes, lane narrowing, on-street parking), curb extensions (e.g., bulb-outs), and roadside gateway features (e.g., street trees, lighting, signage, banners, public art). Alternatively, the Vermont Agency of Transportation (VTrans) recently released a new Traffic Safety Toolbox. Similar to UtahDOT, VTrans developed informational sheets for myriad speed management countermeasures, including lane or street narrowing, lateral shifts, bulb-outs/pinchpoints/chokers, median islands, mini-roundabouts, neighborhood traffic circles, speed humps or cushions, raised crosswalks (speed tables), and raised intersections. In addition to these measures, the following were also included in the toolbox: road diets, radar speed feedback signs, transverse line markings, gateway signing/landscaping, transverse "mumble" strips, and speed limit and "slow" pavement word markings. A total of nine case studies were developed in the VTrans study; however, updated location of implementation was not included on their informational sheets.

The current research project was conducted through numerous statewide surveys (both querying effectiveness and inventory), a collection of statewide case studies, international and industry spotlights. The following present an overview of the findings discovered throughout the project:

- A speed management survey was disseminated to DPW/EMS personnel to determine efficacy of local implementation. As a result, 175 total responses were collected, including 136 unique municipalities across Massachusetts and 7 responses from MassDOT personnel. The results concluded that while many EMS and DPW personnel have a wide range of opinions regarding speed management treatments, their combined opinions may not be as far apart as once expected. Working to continue bridging these conversations between both groups should be the focus moving forward.
- The team reached out to several communities to begin discussing their local speed management implementation efforts. This task kick-started the outreach to inventory statewide countermeasures through another survey effort.
- A statewide speed management inventory survey was disseminated to DPWs to identify implementation efforts. Of 351 Massachusetts cities and towns, 93 municipalities responded to the survey. Of the 93 responses, 68 stated that they have implemented at least one countermeasure on their roadways, while the remaining 25 communities responded that they have not implemented any countermeasures on their roadways. In several instances, 3–4 respondents were collected from the same municipality.
- A set of case studies were developed from municipalities across Massachusetts. The team focused on case studies for the following treatments: speed humps/bumps/cushions, mainline crossing tables, raised intersections, crossing islands, neighborhood traffic circles, road diets (2 to 1 through lanes), other road narrowing, side street crossing tables, and centerline or corner hardening. The case studies reflected both urban and suburban context across Massachusetts and included both low/medium/high volume roadways.
- International case study examples were documented including the Netherlands and Edmonton, Alberta. These examples outside the United States provided perspective to multimodal applications and developing a comprehensive speed management program (Netherlands), as well as identifying strategies to overcome winter maintenance concerns with temporary speed management countermeasures.
- An industry equipment supplier was interviewed to provide perspective on the advantages and considerations for speed management treatments in Massachusetts municipalities.
- A set of speed management cut-sheet documents was generated to help create a more robust marketing platform for sharing information on speed management countermeasures. These cut-sheets were updated to include certain "typical locations" of treatments, as well as information collected during the statewide inventory and case study efforts.
- <u>For emergency response</u>: Vertical deflection measures such as speed humps, continue to yield concerns from emergency personnel regarding delays that increase response time and discomfort both drivers and riders. More so, crossing islands and centerline hardening have not created many challenges for emergency response vehicles, as long as they provide sufficient turning space at intersections. These countermeasures can even be

designed with traversable materials to lessen the burden on emergency vehicles while still forcing passenger vehicles to slow down at the turn.

- Many of the cities and towns noted that beginning with treatment in school zones typically worked in gaining resident support. Once the successes were proven in these locations there was more support to implement other countermeasures within town.
- For winter maintenance: Vertical deflection measures continue to provide the greatest pushback from local officials. That said, cities such as Boston, Somerville, and Salem have found that as long as the winter maintenance personnel are made aware of the location for vertical measures, there have been fewer issues. While temporary speed humps have been applied in certain places, the annual installation and removal of the countermeasures have yielded burden on towns resources.
- Other speed management countermeasures such as neighborhood traffic circles and crossing islands require forethought and communication with both emergency and winter personnel. These treatments that create physical restrictions at intersections have to be laid out to allow snowplows and other large vehicles to turn. Somerville, for instance, invited both their fire department and DPW to the site and tested the proposed layout marked with cones.

Overall, this research project aimed to enhance understanding of the impacts of speed management within the Commonwealth of Massachusetts. By focusing on the concerns of emergency and public works personnel, this project has the potential to guide future implementation based on local best practices. Building on the latest MassDOT efforts to evaluate and implement new strategies statewide, this research draws from the development of the new Safe Speeds repository.

The focus of speed management and traffic calming requires constant attention within each city and town in Massachusetts. While many local DPW and EMS officials have pushback toward certain measures, the research conducted within this report highlights the advantages of all speed management countermeasures. Future work should continue to inventory the ongoing progress of implementation across Massachusetts, while also integrating before and after data to provide evidence for future design.

This page left blank intentionally.

Table of Contents

List of Tables

List of Figures

List of Acronyms

Acronym	Expansion
ADT	Average Daily Traffic
DelDOT	Delaware Department of Transportation
DPW	Department of Public Works
EMS	Emergency Medical Services
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GIS	Geographic Information System
ITE	Institute of Transportation Engineers
kADT	Average Daily Traffic (in 1000s)
MassDOT	Massachusetts Department of Transportation
MMA	Massachusetts Municipal Association
MUTCD	Manual on Uniform Traffic Control Devices
NACTO	National Association of City Transportation Officials
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NYCDOT	New York City Department of Transportation
SPR	State Planning and Research
USDOT	United States Department of Transportation
UtahDOT	Utah Department of Transportation
VTrans	Vermont Agency of Transportation

This page left blank intentionally.

1.0 Introduction

This study of Speed Management and Emergency Response—A Synthesis Study was undertaken as part of the Massachusetts Department of Transportation (MassDOT) Research Program, funded with Federal Highway Administration (FHWA) State Planning and Research (SPR) funds. This program conducts applied research on critical topics for Massachusetts transportation agencies.

The impact of speed on roadways in Massachusetts remains a critical concern in the effort to achieve zero fatalities and reduce serious injuries. Although many speed management solutions are known to be effective, they are underutilized and municipal officials may be apprehensive in implementation. The apprehension stems from concerns historically related to first responders and concerns regarding the impact on emergency response times and other metrics. In New England, public works officials are frequently hesitant to implement speed management solutions due to anecdotal challenges related to snow removal.

In 2022, MassDOT released a new *Safe Speeds* repository that provides information on speed management strategies in an effort to prevent Massachusetts serious injuries and fatalities. This repository includes information on "What is Speed Management" in addition to "Designing for speed control..." and speed limit setting (1). Relative to this research endeavor, MassDOT included a *Safe speeds: Roadway treatment technical toolkit*. This toolkit serves as a reference for local residents and officials to enhance their education on various speed management countermeasures.

According to MassDOT, "A safe system encourages safe speeds through roadway treatments to reduce potential crashes and associated injuries as much as possible. With physical and engineering-related roadway treatments effectively implemented, streets become self-enforcing, reducing speed-related conflicts and serious crashes." The Safe Speeds repository is a significant step in enhancing outreach to communities across the state, providing nationwide information on various speed management countermeasures. Massachusetts cities and towns can now reference this toolkit for information regarding speed management countermeasures, including approximate costs, lessons learned, and best practices for collaborating with inter-city agencies.

During the Summer of 2020, under the Baker-Polito Administration, MassDOT announced a new grant program for local municipalities called the Shared Streets & Spaces program. The objective of this program was to provide funding assistance to municipalities to assist in design and implementation of changes to their streets, curbs, parking, public health related transportation mitigation (initiated due to the COVID-19 pandemic), and safe mobility. The funding was allocated to municipalities that proposed "quick-build" projects as small as $5000 and as big as $300,000. The projects ranged from pilot and temporary projects to permanent implementation to streets and sidewalks. As a result of this grant program hundreds of communities have benefited from additional funding to improve safety on their roadways. Many of these projects have prioritized speed management and traffic calming into their proposals and have successfully implemented them. Figure 1.1 presents the number of communities that received general Shared Streets and Spaces grant funding, and those that specifically asked for speed management–related funding.

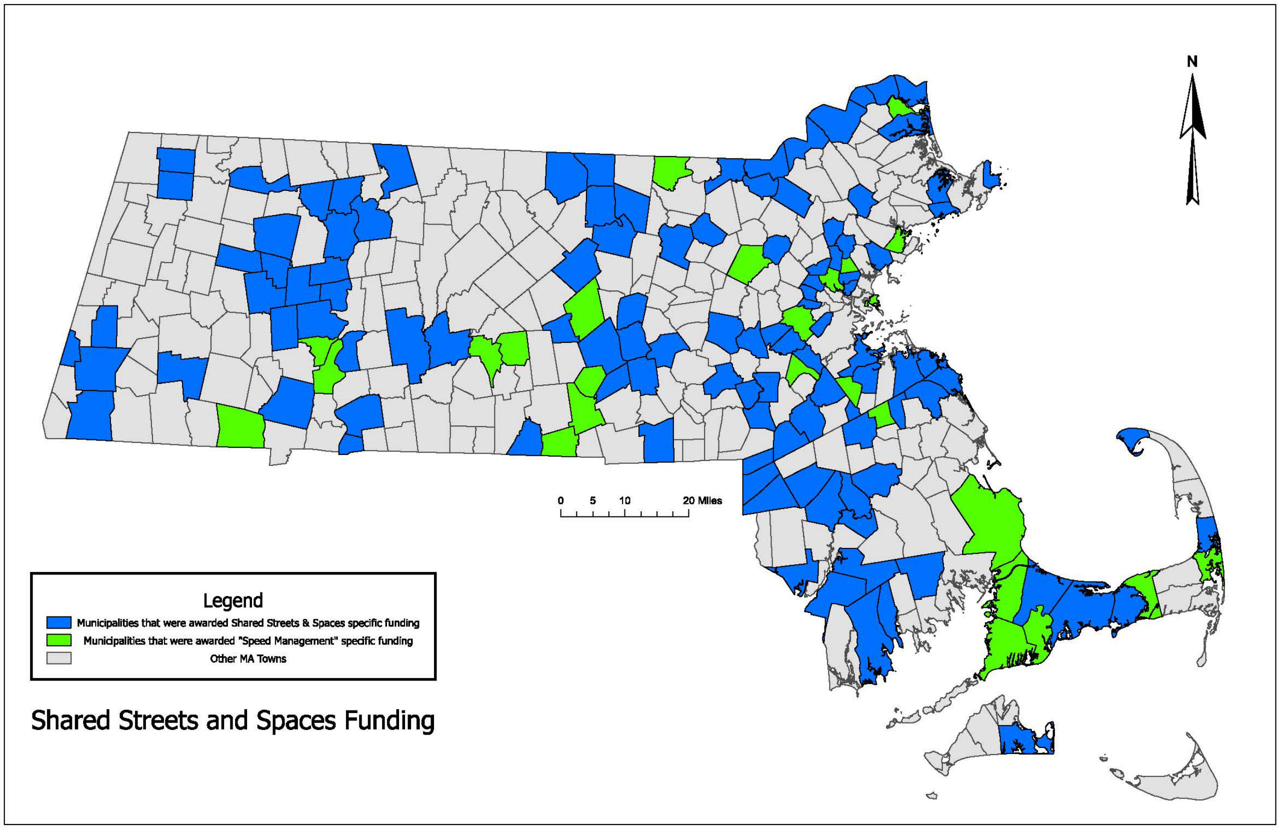


Figure 1.1: MassDOT Shared Streets and Spaces Funding from FY23

Overall, this research project aimed to enhance understanding of the impacts of speed management within the Commonwealth of Massachusetts. By focusing on the concerns of emergency and public works' personnel, this project guides implementation based on local best practices. Building on the latest MassDOT efforts to evaluate and implement new strategies statewide, this research draws from the development of the new Safe Speeds repository. The following report outlines recommendations for roadway treatments that influence speeds, adhere to design standards, and address municipal personnel concerns.

1.1 Background

The following sections provide an up-to-date synthesis of the recent historical literature and policies regarding speed management and the evolution of countermeasure design and treatment implementation.

1.1.1 DOT Policies and Other Resources

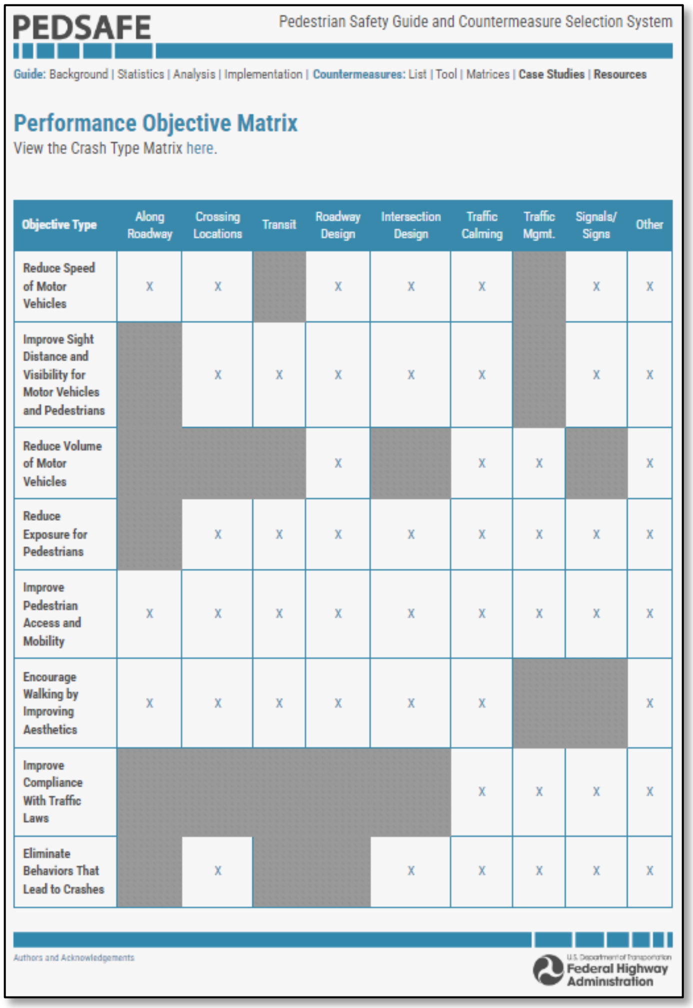
Speed management has remained a critical focus of the United States Department of Transportation (USDOT), and within each state's transportation agencies as well. Back in the early 2000s, the National Highway Traffic Safety Administration (NHTSA) developed guidance documents specifically pertaining to nationwide speed management initiatives. The Highway Safety Program Guideline No. 19 was released in 2006 and focused on the components necessary for each state to develop their own speed management program (2). As a mantra of this guidance, Guideline No. 19 stated "while speed is a national problem, effective solutions must be applied locally." More so, this relates directly to the current research endeavor, aiming to utilize local case study examples as evidence-based solutions for speed management advancements in other Massachusetts municipalities.

In addition to the Highway Safety Program Guidelines, NHTSA partnered with FHWA and the Federal Motor Carrier Safety Administration (FMCSA) to identify specific speed management–related actions that could be taken to reduce speeding-related crashes (3). This document was then updated in 2014 to include new guidance from several Transportation Research Board (TRB) and National Cooperative Highway Research Program (NCHRP) speed management initiatives (4).

The USDOT and FHWA have worked to update and improve the latest information regarding speed management countermeasure best practices and applications across the United States. Over the last decade, the USDOT developed a Traffic Calming ePrimer that serves as a free online resource guide for traffic calming tools used nationwide (5). Many of the modules included in this ePrimer aim to assist users with education on speed management measures, including explanations about various strategies working with inter-city agencies. Last, this resource provides some traffic calming case studies as a reference to the work being done by cities across the United States.

Additionally, the FHWA published a *Speed Management Guidebook* in 2012 that provided resources to local practitioners looking to update their speed management programs, primarily focused on local rural road owners (6). Continuous updates to guidance on speed management have been brought forward in more recent years. In 2020, the FHWA partnered with the Institute of Transportation Engineers (ITE) to release a *Noteworthy Speed Management Practices* handbook that was structured as another avenue of information for practitioners to reference in their speed management best practices (7). And most recently, FHWA and ITE partnered in 2023 to publish a *Safe System Approach for Speed Management* report that aimed to assist practitioners in connecting the safe system principles with existing and advanced speed management plans (8). Specifically, this new report highlighted a focus on coordinating locations of speed management implementation, selecting the appropriate countermeasure, and coordinating the data and measurable reductions of speed from these installations.

There are myriad other resources surrounding speed management practices throughout the United States, as this continues to be an evolving focal point. The *PEDSAFE Safety Guide and Countermeasure Selection System* was created through a partnership between the University of North Carolina Highway Safety Research Center, VHB, and Toole Design Group (9). This interactive web-based platform provides both case study examples across the United States for safety treatments, as well as an interactive matrix that allows users to identify potential countermeasure selections based on their core objectives (Figure 1.2) (9).


PEDSAFE

Pedestrian Safety Guide and Countermeasure Selection System

Guide: Background | Statistics | Analysis | Implementation | Countermeasures: List | Tool | Matrices | Case Studies | Resources

Performance Objective Matrix

View the Crash Type Matrix here.

Objective Type	Along Roadway	Crossing Locations	Transit	Roadway Design	Intersection Design	Traffic Calming	Traffic Mgmt.	Signals/ Signs	Other
Reduce Speed of Motor Vehicles	X	X		X	X	X		X	X
Improve Sight Distance and Visibility for Motor Vehicles and Pedestrians		X	X	X	X	X		X	X
Reduce Volume of Motor Vehicles				X		X	X		X
Reduce Exposure for Pedestrians		X	X	X	X	X	X	X	X
Improve Pedestrian Access and Mobility	X	X	X	X	X	X	X	X	X
Encourage Walking by Improving Aesthetics	X	X	X	X	X	X			X
Improve Compliance With Traffic Laws						X	X	X	X
Eliminate Behaviors That Lead to Crashes		X			X	X	X	X	X

Authors and Acknowledgements

U.S. Department of Transportation Federal Highway Administration

Figure 1.2: PEDSAFE Performance Objective Matrix

Other State and local DOTs have developed their own design manuals in recent years, including both Delaware DOT (DelDOT) and New York City DOT (NYC DOT). DelDOT released a *Traffic Calming Design Manual (TCDM)* in 2012, which provided guidance on traffic calming applications and more so, guidance on the geometric design specs for speed management countermeasures (10). For instance, the speed hump and speed cushion represent just two of the many design specs that have been shared through FHWA nationwide, as a primary reference for DOTs and local agencies looking to implement these treatments. NYC DOT released their 3rd edition of the *Street Design Manual* in 2020, as a "living document" that aims to update existing strategies on treatment design and management (11). In comparison, the City of Boston released their *Neighborhood Slow Streets* initiative in recent years which aims to guide local officials to improve safety on local streets by designing for slower traffic speeds. As part of this initiative, the *Making Neighborhood Streets Safer* program was developed with a primary focus on speed hump installations (12). Through this program, the city worked proactively to develop "zones" that were considered eligible for speed humps (Figure 1.3), including an interactive map that allowed residents to identify if their street was considered eligible (12).

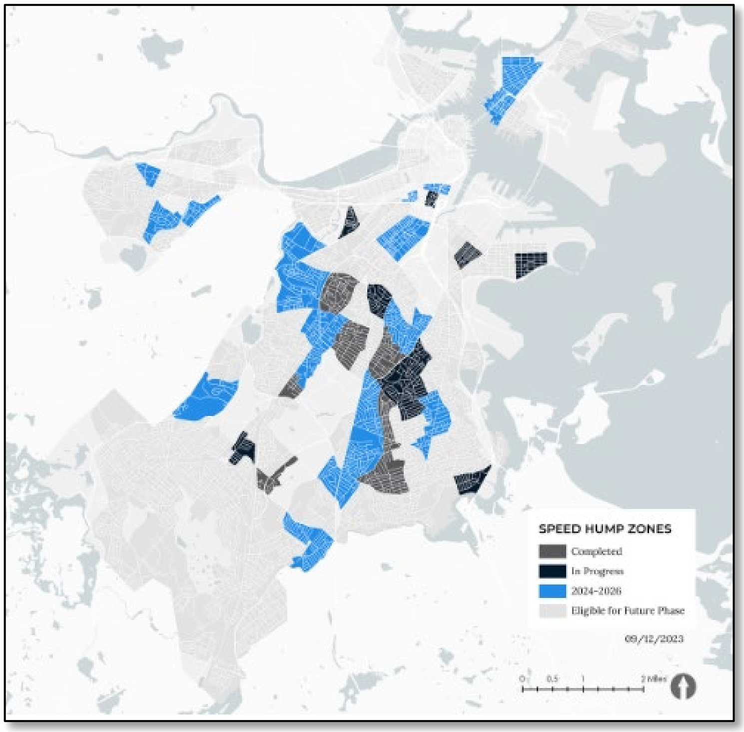


Figure 1.3: Boston's speed hump eligibility zones

The National Association of City Transportation Officials (NACTO) serves as another resource for speed management and traffic calming guidance. Specifically, the NACTO *Urban Street Design Guide* has been used by practitioners across the United States for guidance on street design providing safer design for all users (13). In addition to serving as a resource on design guidance and recommended best practices, the *Urban Street Design Guide* also serves as a repository for countermeasure evaluation and design manuals from around the United States. Both academic research articles, as well as state and local guidance documents represent the data included in this index.

1.1.2 UtahDOT and VTrans Speed Management Initiatives

Recently, several states have initiated a deeper dive into speed management within their local municipalities. While the FHWA and other partner organizations have worked over the last two decades to develop speed management treatments, it remains critical to keep states up-to-date on their current practices.

The Utah Department of Transportation (UtahDOT) sought to develop informational sheets that provided data on statewide speed management measures that would help guide local engineers to select appropriate treatments when necessary (14) (Figure 1.4). These info sheets considered the following measures: radar speed signs, pavement speed limit markings, optical speed bars, road diets, median islands, roundabouts, roadway narrowing (e.g., bike lanes, lane narrowing, on-street parking), curb extensions (e.g., bulb-outs), and roadside gateway features (e.g., street trees, lighting, signage, banners, public art). The info sheet for each of these included facts such as speed reduction (if available), approximate implementation cost, advantages/disadvantages, typical locations across the state, and a list of example locations on state roadways. In addition to these, there were also indications as to the roadway characteristics on which each speed management measure would be best applicable. Such characteristics included roadway speeds, traffic volumes, and number of lanes. An important note on the work from UtahDOT: They emphasize that certain measures that should only be implemented "in situations when safety is a significant concern and must be prioritized over mobility." For instance, their list includes raised crosswalks/intersections and chicanes. UtahDOT identified the impact on mobility as the major concern for implementing these measures.

Figure 1.4: UtahDOT speed management study examples

The Vermont Agency of Transportation (VTrans) recently developed a new Traffic Safety Toolbox, with the assistance of researchers at the University of Vermont (15) (Figure 1.5). Similar to the work from UtahDOT, VTrans included myriad speed management countermeasures in their new report. In doing so, an informational sheet, also referred to as "profile" was created for each of their countermeasures. For horizontal deflection, VTrans evaluated: lane or street narrowing, lateral shifts, bulb-outs/pinchpoints/chokers, median islands, mini-roundabouts, and neighborhood traffic circles. For vertical deflections, VTrans evaluated speed humps or cushions, raised crosswalks (speed tables), and raised intersections. In addition to these measures, the following were also included in the toolbox: road diets, radar speed feedback signs, transverse line markings, gateway signing/landscaping, transverse "mumble" strips, speed limit and "slow" pavement word markings. This report included an evaluation regarding each treatment's frequency of use, snow and ice control, emergency response, speed reduction, proximity to village or town centers, within transition zones, and acceptance on VT highways. Each of these metrics were weighted from "Most favorable" or "Most common" to "Not favorable" or "Not common." Similarly to the UtahDOT speed management study, each treatment profile included a pros and cons list, the applicable use in Vermont, followed by an explanation of context and design considerations. For the latter, VTrans included references to both recent VTrans reports, as well as federal, regional and academic resources to cite their rationale. Most important to note, these fact sheets did not include a list of locations within Vermont, and did not provide clear cost explanations for each speed management countermeasures. That said, the original work by Sullivan et al. highlighted a list of case studies and field tests that were identified (16). A total of nine case studies were conducted in the aforementioned study, with only four that were included in the Toolbox given their willingness to provide a complete interview on their speed management countermeasures.

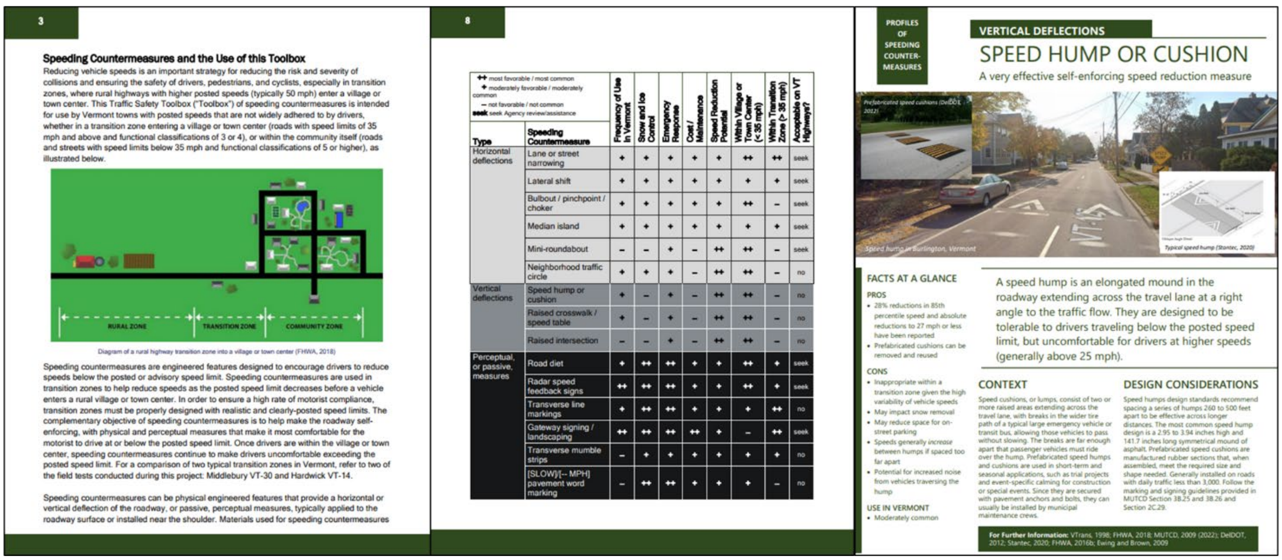


Figure 1.5: VTrans Speed Management Toolbox examples

1.2 Objectives and Project Motivation

A clear link exists between speed and serious injury in crashes, and a Safe System approach is vital to the safety of everyone on the road. A Safe System approach encourages safe speeds through roadway treatments that can decrease the likelihood of crashes and/or associated injuries. In instances when a complete roadway redesign to address speeds is costly and lengthy, communities look for effective solutions that can be easily implemented. The benefits of speed management strategies are significant, with the greatest being a potential reduction in speed-related conflicts including serious crashes and injuries. Installing strategies are extremely effective; however, installing them is sometimes challenging—emergency response access and public works operations are frequently cited as reasons not to implement speed management roadway treatments.

The basis of this research documented and investigated their concerns and identified best practices for speed management without impeding emergency response and public works operations. The current study employed methods to quantity and qualify the existing speed management treatments that were employed across Massachusetts, including the documentation of conversations with local and state officials regarding the challenges and effectiveness of these treatments.

Task 1: Survey of current speed management techniques, their efficacy, and local official implementation challenges. The first task included a survey of current speed management techniques, their efficacy, and local official implementation challenges. The research team partnered with local emergency and public works personnel to identify a list of existing speed management strategies that provided challenges or these personnel, including but not limited to winter weather impacts. This task was completed through two mechanisms.

First, a statewide survey was disseminated to local municipalities in an effort to gauge communities' interest in participating in a statewide forum. In addition, local and regional input was collected to identify strategies on speed management. Through this initial survey, the team gathered preliminary insight into municipal challenges and identified stakeholders while maintaining focus on data-driven solutions. Important considerations included, but were not limited to physical infrastructure, roadway designs, traffic signals and signage for speed control, emergency vehicle signal preemption, and infrastructure impacts on turning vehicles. The second objective within this task was to solicit feedback from statewide stakeholders regarding their "lessons learned" and solutions to overcoming speed management concerns within their locality.

Task 2: Strategize and host regional speed management forums based on municipality feedback. The second task resulted in a number of virtual regional forums, integrating local stakeholders to discuss the speed management concerns, impacts, and solutions from Task 1. These local forums brought together town/city personnel to understand and formalize a common goal understanding local speed management strategies and associated implementation challenges. Our team utilized the contact list vis the Baystate Roads listserv as well as the municipal grant program contacts for this outreach. These forums were termed "Speed Management Conversations" as they established a better understanding of implementing strategies that work for all communities, focused in context importance on design. Last, these tasks provided an open dialogue for these communities to express "what works and what does not" work.

Task 3: Inventory of regional case studies in New England and municipality partnership. The third task identified municipalities that could provide case study evidence regarding speed management strategies. The emphasis of this task was to identify concerns and provide evidence from municipalities of overcoming these concerns with success stories. An effort was made to find municipalities statewide (and outside as necessary) that exhibited lessons learned.

As part of this task, the research team created a matrix of case studies based on an approved treatment list that particularly had a direct impact on speed. The case studies were focused around the following treatments: speed humps, speed cushions, raised crossing across a through road, raised intersections, median island with horizontal deflection, chicanes (other than median island), neighborhood traffic circle, road diet (from 2 to 1 through lanes per direction), other road narrowing (includes shrinking roads with curb extensions or lane markings including striping bike lanes, without a change in number of through lanes), raised crossing across a side street with stop control, centerline or corner hardening at an intersection (other than median islands), and curb extensions at intersections. The case studies regarding these treatments included elements such as sit descriptions, before/after speed results (as available), design specs (as available), support stories, maintenance tips, other lessons, and city/town planning for additional treatments.

Task 4: Inventory of speed control treatments around the state. The fourth task included an additional survey that was created to inventory statewide speed management treatments that involve significant challenges to EMS, winter maintenance, and other city/town officials. The survey was designed to collect statewide treatments from each city/town including the following information by community treatment: how many instances, collected before/after speed, design specs available, and locations of each treatment with preference to those with before/after data and design specs.

Task 5: Findings from international best-practice agencies and from speed management equipment suppliers. The fifth task elicited feedback from international agencies and vendors/distributors of speed management infrastructure that have experience in speed management best practices. Vendors were interviewed and asked to provide information regarding their implementation strategies within Massachusetts and regionally in New England. Lessons learned and best practices were documented and discussed. Additionally, international agencies were evaluated for their recent speed management strategies that have been proven effective, including their potential practicability for implementation in Massachusetts.

Task 6: Lessons learned about overcoming challenges and recommendations for modified treatment test strategies. In the last task, the team synthesized case studies, the results from the Task 1 survey, the regional speed management conversations in Task 2, and the speed management inventory created within Task 4. As part of this task, the research team worked to create outlined templates for speed management treatments, also referred to herein as “cut-sheet” documents for each treatment. Additionally, the research team discussed the gaps/needs to successfully implement treatments on Massachusetts roadways. For instance, highlighting treatments that do not exist (or rarely implemented) and identifying the causal reason for why or why not.

1.3 Organization of Report

The report is organized as follows. Section 1 introduces the background of speed management and its importance in the Safe System Approach and statewide traffic safety, followed by a detailed list of objectives and tasks that were completed for this research project. Section 2 presents the research methodology, including the statewide survey dissemination, speed management conversation summary, local case-study development, and the documentation of lessons learned and best practices from both local, national, and international agencies. Section 3 presents the results from this study, Section 4 presents the implementation and tech transfer applicability specifically highlighting the lessons learned on speed management around the Commonwealth, and Section 5 summarizes the findings of this research project. The Appendices of this report include the following: complete statewide surveys, statewide case studies, international and industry spotlights, and the speed management cut-sheet documents.

2.0 Research Methodology

A clear link exists between speed and serious injury in crashes, and a Safe System approach is vital to the safety of everyone on the road. A Safe System approach encourages safe speeds through roadway treatments that can decrease the likelihood of crashes and/or associated injuries. In instances when a complete roadway redesign to address speeds is costly and lengthy, communities look for effective solutions that can be easily implemented. Speed management strategies benefits are significant—with the greatest being a potential reduction in speed-related conflicts including serious crashes and injuries. Installing strategies are extremely effective; however, installing them is sometimes challenging. Emergency response access and public works operations are frequently cited as reasons not to implement speed management roadway treatments.

The basis of this research documented and investigated their concerns and identified best practices for speed management without impeding emergency response and public works operations. Through this focus, this research endeavor was conducted under the following objectives:

- Conducting surveys of current speed management techniques, their effectiveness, and local official implementation challenges;
- Documenting conversations with statewide transportation stakeholders, including but not limited to, DPW directors, fire and police personnel, and other city/town personnel;
- Establishing an inventory of regional speed management case studies and municipal partnerships; and
- Developing recommendations and future work regarding modified treatment test strategies.

The following sections highlight the methods utilized to develop speed management surveys in evaluating effectiveness and inventory, communicate with statewide stakeholders on speed management best practices, document myriad case studies across Massachusetts, and developing recommendations regarding modified treatment test strategies.

2.1 Speed Management Effectiveness Survey

A survey of current speed management techniques throughout Massachusetts, their efficacy, and local official implementation challenges was conducted in this research endeavor. The survey was designed to target both the Department of Public Works (DPW) and Emergency Personnel (abbreviated herein as EMS). As previously mentioned, these targeted demographics typically yield the largest proportion of speed management limitations regarding their pushback for implementation. While this theory stems from general consensus, the goal of this survey was to identify the exact rationale by which DPW and EMS personnel utilize in their preference for speed management countermeasures. The following sections outline the methods utilized to develop, disseminate, and analyze the speed management effectiveness survey.

2.1.1 Survey Development

The speed management effectiveness survey was developed in Qualtrics, an online-based survey platform. This platform was selected based on its dynamic capability to input logic-based questions within the questionnaire. The survey was designed with the expected completed rate of under 5–7 minutes per response. Figure 2.1 presents a sample section of the questionnaire; however, the effectiveness survey may be seen in full in Appendix A. It remains important to note that the survey was created as a relatively short-duration survey to optimize the response rate while maximizing the information being collected by the research team.

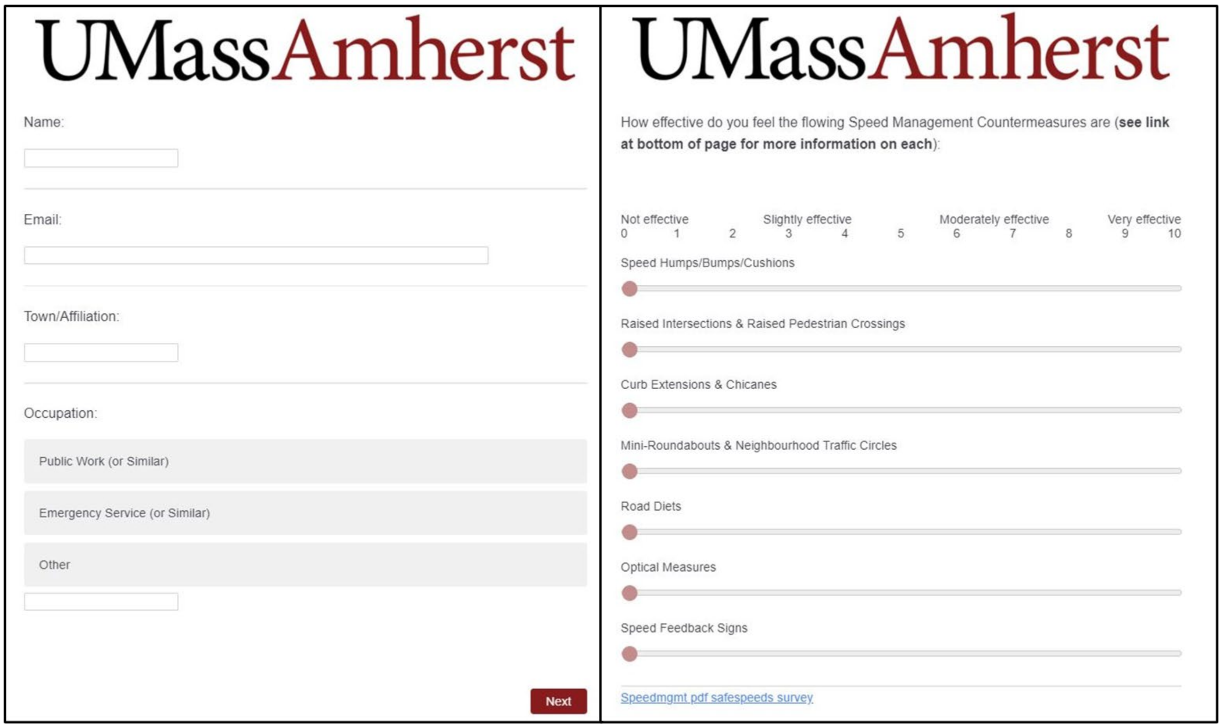


Figure 2.1: Speed Management DPW/EMS Effectiveness Survey

Respondents were provided with the following message to begin their survey:

> "Speed along the road is a critical factor in determining both the frequency and severity of crashes. MassDOT is committed to helping realize safer speeds across the Commonwealth and is actively implementing speed management practices. Please complete this survey and provide feedback related to the implementation of typical seed management measures. Please know that your responses will remain completed anonymous."

Next, respondents were guided to complete a list of demographic questions including their name, email, town/affiliation, and whether they were DPW or EMS personnel.

Survey-based logic was utilized based on the respondent being DPW versus EMS personnel. As explained in Figure 2.2, DPW and EMS personnel both received a question regarding speed management countermeasure effectiveness (Note: this was also presented in Figure 2.1, referring to the Likert scale-based question). As a follow-up, if any of the respondents' selections fell under a rating of 3 or above a rating of 7, they were asked in the survey to explain in a few words their rationale as to why they found that countermeasure less effective or more effective, respectively.

Next, the DPW personnel received a question on speed management countermeasure challenges specific to maintenance concerns, while the EMS personnel were asked a question on speed management countermeasure challenges specific to implementation. Following this, both groups received a series of questions where respondents were instructed to identify the challenges with regard to each of the speed management countermeasures (Figure 2.2). This question served as a "checkbox" type response,

Last, the DPW personnel received a question on speed management countermeasure challenges specific to implementation, while the EMS personnel were asked a question on speed management countermeasure challenges specific to maintenance (Figure 2.3). Following the survey, respondents were asked to state their interest in following-up with the researchers to discuss their results in greater detail, as well as their interest in participating in a regional forum (with virtual option) to discuss countermeasures in Massachusetts.

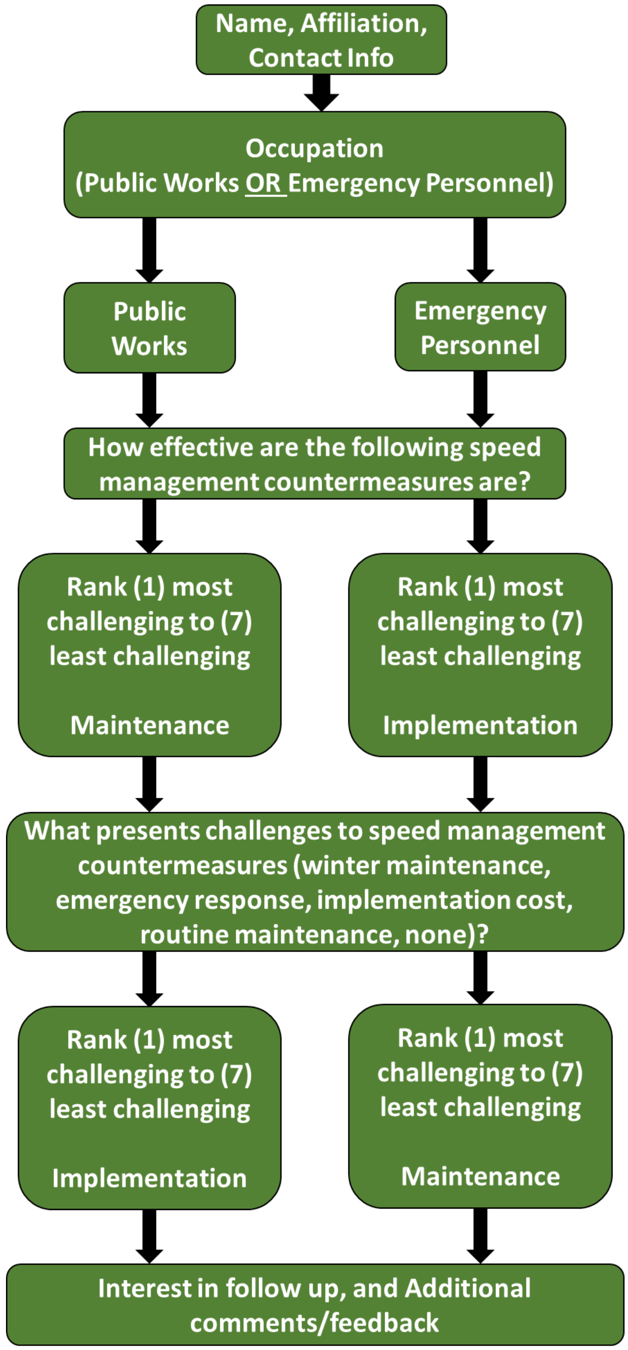
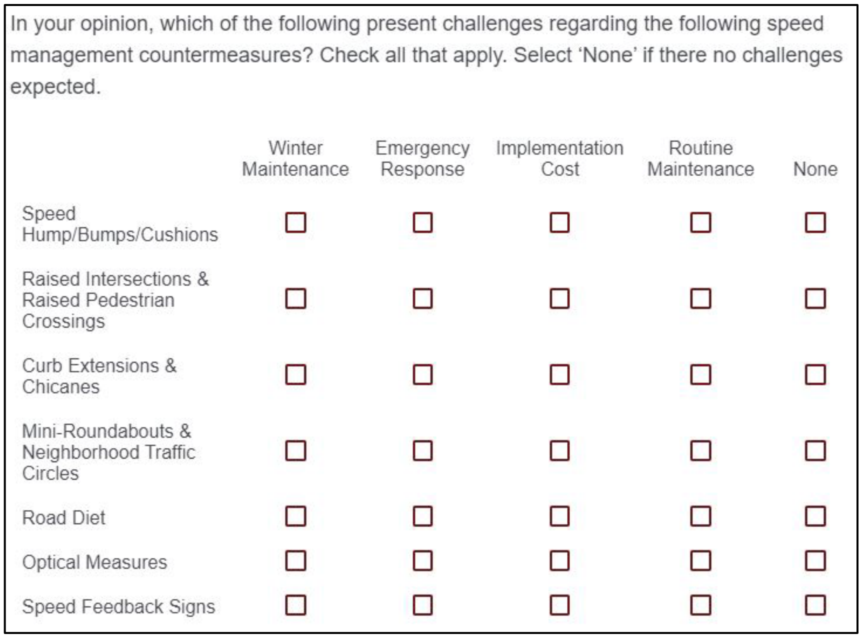


Figure 2.2: Survey structure of DPW/EMS survey



In your opinion, which of the following present challenges regarding the following speed management countermeasures? Check all that apply. Select 'None' if there no challenges expected.

	Winter Maintenance	Emergency Response	Implementation Cost	Routine Maintenance	None
Speed Hump/Bumps/Cushions	☐	☐	☐	☐	☐
Raised Intersections & Raised Pedestrian Crossings	☐	☐	☐	☐	☐
Curb Extensions & Chicanes	☐	☐	☐	☐	☐
Mini-Roundabouts & Neighborhood Traffic Circles	☐	☐	☐	☐	☐
Road Diet	☐	☐	☐	☐	☐
Optical Measures	☐	☐	☐	☐	☐
Speed Feedback Signs	☐	☐	☐	☐	☐

Figure 2.3: Survey: maintenance, emergency response, and implementation cost

2.1.2 Survey Dissemination

Once the survey was developed and approved by the Project Champion, the dissemination was initiated across Massachusetts. Several channels of communication were utilized in disseminating the survey. Primarily, the UMass Transportation Center's Baystate Roads program listserv was used to establish connections with all statewide DPWs. Given the history of Baystate Roads training nearly all statewide municipalities, this listserv was able to reach contacts from nearly all 351 Massachusetts city and town public works departments. The following message provided a brief introduction to the survey purpose and instructions for response (Figure 2.4).

> Hello,
> The UMass Transportation Center is working alongside MassDOT to help create a safe and efficient transportation network by managing vehicle speeds and considering infrastructure maintenance.
> The research team would greatly appreciate you cooperation and assistance in sharing your thoughts on the efficacy of various speed management strategies and their respective pros/cons regarding emergency response.
> Please use the link below to access the Qualtrics survey, which will only take *a few minutes* of your time. If you have any additional questions, or would prefer to submit your responses via email, please feel free to reach back out to [the research team].
> Thank you.

Figure 2.4: Speed survey: Initial message to DPW and EMS

In addition to reaching out to all DPWs around Massachusetts, the research team worked with MassDOT to establish contact lists within statewide EMS, fire, and police agencies. Both EMS and fire agencies were contacted through both the "emergency response agency" contact list (which is publicly available at https://www.mass.gov/info-details/find-an-ambulance-service-in-massachusetts). In addition to this, fire departments across Massachusetts were contacted through the Department of Fire Services (DFS), with direct correspondence from their Director of Operations (https://www.mass.gov/orgs/department-of-fire-services#org-nav-contact-us). Police departments throughout Massachusetts were contacted through the Office of Grants and Research, through their Highway Safety Division Manager. This group had a working listserv with 168 municipal police departments through their municipal road safety grants and were able to forward the research teams dissemination message to their list. Given the lower initial response rate from DPWs, multiple email outreach opportunities were initiated through the Baystate Roads listserv in an attempt to increase response rate statewide.

2.1.3 Survey Data Collection and Analysis

Numerous outreach attempts were made within the Baystate Roads listserv in an effort to target reaching additional communities that had not previously responded to the survey. To increase response rates, a marketing flyer with quick-response (QR) code was created and disseminated via local practitioner and local DPW contacts (Figure 2.5). These additional marketing and outreach opportunities allowed for a larger response rate to the survey.

Figure 2.5: Marketing flyer promoting speed management survey

Ultimately, the research survey was analyzed to understand the effectiveness ratings and challenges presented by both the EMS and DPW personnel. The survey data collection included questions asking respondents *if they would be willing to follow up with the researchers to discuss their responses* (Figure 2.2*)*. The final question of the survey asked if the respondents would be *interested in participating in a regional forum (with virtual option) to discuss the pros/cons of these countermeasures in Massachusetts*. The effectiveness ratings, challenges based on implementation and maintenance, and the respondents willingness for further correspondence were all metrics included in the analysis of the survey, and will be further explained in the Results section of this report.

2.2 Speed Management Conversations

The first task in this research endeavor was to survey statewide DPW and EMS personnel about their speed management treatment preferences including the challenges that they foresee with implementation, winter maintenance, emergency response, and routine maintenance. In addition, the survey asked respondents of their willingness to follow up with the researchers in a more structured conversation surrounding their experiences with speed management countermeasures. This conversation was expected to discuss their lessons learned, best practices, and further considerations with other speed management preferences within their municipalities. As a result, a set of informal speed management forums (conversations) were scheduled in December 2023.

2.2.1 Schedule and Structure of Speed Management Conversations

Respondents to the DPW and EMS Speed Management survey from Task 1 were invited to participate in their virtual Speed Management conversations that were held in December of 2023. The message provided a brief introduction to the survey purpose and requested each participant to sign up for an upcoming information sharing forum (Figure 2.6).

> Hello,
> MassDOT has asked UMass Amherst and Northeastern University to conduct research into how Speed Management projects – many of which are done with funding through MassDOT's Shared Streets & Spaces program – **raise issues with winter maintenance and with emergency response, and how communities are addressing those issues**. From a survey our team has done of Public Works, Emergency Response, and Transportation Planning staff from towns and cities across the Commonwealth, **we know that many town/city staff are concerned about these issues**, and about 75 respondents expressed an interest in participating in a virtual forum to learn more.
> As a city/town **that has expressed interest** in participating in this forum, we would like to **invite you to register** for the following online forums, to be hosted in early December:
> 12/5: (specified zoom link)
> 12/12: (specified zoom link)
> 12/14: (specified zoom link)
> Please feel free to register for whichever forum fits best with your schedule, as you are not limited to only one. However, we will be capping attendance for each of these, so early registration is preferred.
> We are looking forward to having an engaging discussion on Speed Management and the impacts on Winter Maintenance and emergency response. **Please do not hesitate to reach out to us should you have any immediate questions/concerns.**
> Thanks.

Figure 2.6: Speed management request for forum participation

As a result from this outreach, three virtual speed management conversations were hosted during the first weeks of December 2023. Each of the meetings began with a brief presentation from the research team regarding the overall scope of the research project, and the need to identify municipal feedback from speed management countermeasures throughout Massachusetts (Figure 2.7). The presentation included an introduction of the researchers, an overview of the project scope, preliminary results from the survey (as described in Task 1), and a visualization of the speed management treatments for discussion.

Following this presentation, each of the meeting transitioned to dialogue between the researchers and the municipal officials. The conversations were established to provide better understanding of implementing strategies for other communities, while focused in context importance on design. The open dialogue presented during these meetings between statewide communities was documented regarding the "do's" and "don'ts" and summarized later in the report. A summary of the discussions and takeaways from these speed management conversations were documented and will be discussed the results section of this report.

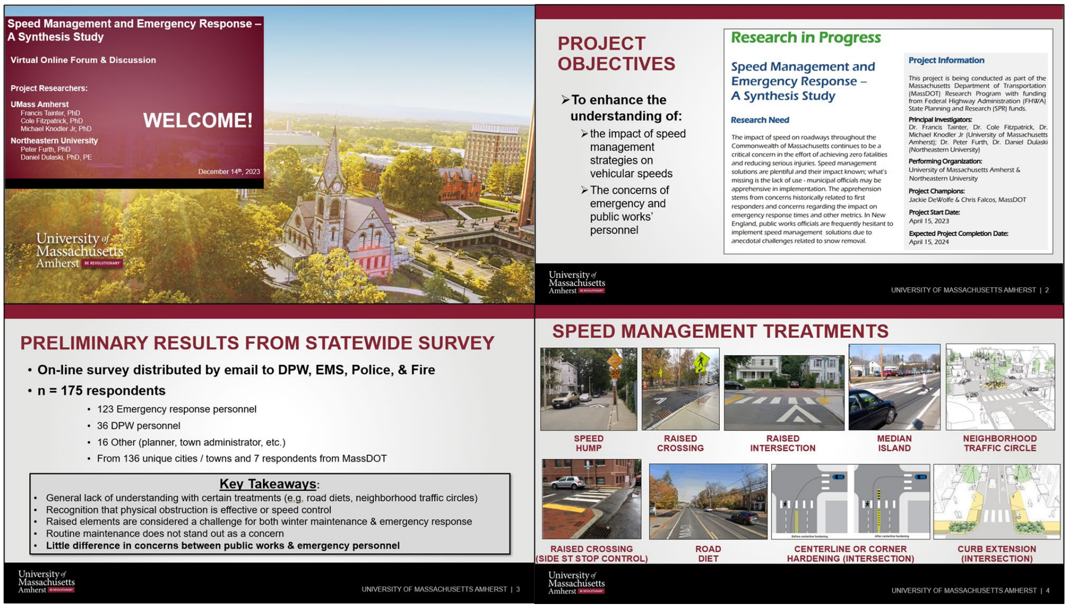


Figure 2.7: Introduction presentation during speed management conversation meetings

2.3 Regional Case Studies

As part of the revised scope, the research team were tasked with identifying municipalities that could provide case study evidence regarding speed management strategies. The emphasis of this task was to identify concerns and provide evidence from municipalities of overcoming these concerns with success stories. It was important to highlight any data-driven solutions that each municipality took to solve their speed management challenges. With this goal in mind, the research team worked with MassDOT and the project champions to develop a revised list of speed management countermeasures to investigate case studies. The following represent the selected speed management countermeasures that were included prior to the case study data collection:

- Speed humps,
- Speed cushions,
- Raised pedestrian crossings (speed table across through road),
- Raised intersection,
- Median island with horizontal deflection,
- Chicane (other than median island or painted hatching),
- Neighborhood traffic circle,
- Road diet (from 2 to 1 through lanes per direction),
- Other road narrowing (includes shrinking roads with curb extensions or lane markings including bike lanes without changing number of through lanes),
- Raised crossing (across a side street),
- Centerline or corner hardening (at an intersection), and
- Curb extensions (at an intersection).

2.3.1 Case Study Speed Management Treatments

Speed humps are raised sections of the roadway that run perpendicular to the flow of traffic (Figure 2.8). Speed humps have become a favorable approach in speed management, both locally and nationwide According to the MassDOT Speed Management repository, these treatments serve well "by deflecting both the wheels and frame of a traveling vehicles, these features encourage drivers to travel at a slow speed in both directions, as well as over the speed bump itself." Speed hump design specs can vary across municipalities; however, it remains important to note that one of the primary benefits of these treatments is that they do not extend from curb to curb. Therefore, drainage considerations are limited in the design of these speed management treatments. Somerville, MA has used speed humps on its streets.

Figure 2.8: Speed hump, Somerville, MA

Speed cushions are raised sections of the roadway that run perpendicular to the flow of traffic that have a flush pavement section in the middle separating the two "cushions" (Figure 2.9). Speed cushions have been experimented with in several municipalities throughout Massachusetts; however, these treatments typically yield the most controversary regarding their design among the emergency response personnel. Similar to speed humps, these speed management countermeasures deflect the traveling vehicle vertically and encourage slower traveling speeds in both directions. The design of speed cushions can vary primarily due to the design vehicle wheelbase. These treatments aim to allow larger vehicles (e.g., fire trucks, ambulances) with wider axels, to traverse these vertical measures without needing to slow down—they can "straddle" the cushion, not reducing speed; unlike personal vehicles that must slow to traverse the cushion. Given these complexities, there remains some controversy over the effectiveness of these treatments. Salem, Massachusetts has used speed cushions on one of its roads.

Figure 2.9: Speed cushion, Salem, MA

Mainline Crossing Tables are raised sections of the roadway that run perpendicular to the flow of traffic that run from curb to curb (Figure 2.10). This treatment is not to be confused with speed tables on a side street (as explained in the "Side Street Crossing Tables" section). Mainline crossing tables across a through road have been implemented in many municipalities throughout Massachusetts; however, their main limitation is the need to account for drainage given the vertical alignment measures that run up against the curb on each side of the roadway. These treatments can be applied in either a 2-lane or 4-lane roadway, and the width of the table can vary depending on the design considerations. Amherst, Massachusetts, has installed a mainline crossing table on one of its busy streets.

Figure 2.10: Mainline crossing table, Amherst, MA

Raised intersections are areas that act as speed tables that cover the entirety of the intersections (Figure 2.11). These treatments cover an entire intersection with ramps on all vehicular approaches to slow vehicle traffic through the intersection and improve safety for pedestrians. Given their extensive change in elevation across an intersection there are many drainage considerations during the design phase that result in inflated cost per treatment. Raised intersections have been installed in a few areas in Massachusetts; Dedham, Massachusetts, has installed a raised intersection.

Figure 2.11: Example of Raised Intersection, Dedham, MA

Median Crossing Islands (with horizontal deflection) provide physical separation between opposing vehicle lanes, and narrow roadways to reduce vehicle speeds (Figure 2.12). Median islands can differ in design, comprising of granite, asphalt curbing, and sometimes no vertical grade separated island. These design elements provide safety and separation for pedestrians that are crossing a multidirectional traffic flow. More importantly, these specific case study elements require horizontal deflection of the roadway, thus requiring vehicles to slow down speeds prior to reaching the median crossing island. Amherst, Massachusetts, has installed a few median crossing island (with horizontal deflection) along a busy high-speed arterial.

Figure 2.12: Example of Median Crossing Island, Amherst, MA

Chicanes (other than median crossing island) serve as a lateral shift in the traveled way that forms s-shaped curves for vehicles to traverse through—the change in direction requires a change in speed (Figure 2.13). These curves narrow the roadway width and create an effect that slows down traffic. In some instances, these speed management treatments appear when a series of curb extensions alternate from one side of the street to the other, or if there is a change in street parking from one side to the other causing the horizontal alignment change. While many horizontal deflections occur on Massachusetts roadways, there are very few that are designed to effectively lower vehicle speeds. More so, many of the designed treatments in Massachusetts include painted hatched islands and lack of raised median islands that cause horizontal deflection.

Figure 2.13: A chicane

Neighborhood Traffic Circles are built at the intersection of local streets to provide traffic calming or aesthetic benefits (Figure 2.13). They operate as two-way or all-way stop-controlled intersections, typically without raised channelization to guide approaching traffic into the circulatory roadway. These speed management measures are typically no more than 12 feet in diameter, but can vary depending on the municipality as many emergency response and winter maintenance folks will have their say in the final design considerations. Neighborhood traffic circles require no change in curbline—making them relatively inexpensive to install. While very few of these installations currently exist in Massachusetts, these speed management countermeasures have been widely popular in the Pacific Northwest. Somerville, Massachusetts, has used a neighborhood traffic circle.

Figure 2.14: Neighborhood traffic circle, Somerville, MA

Road diets (from 2 to 1 through lanes in each direction) eliminate travel lanes on roadways, which lead to calming traffic speeds. Road diets have become popular on roadways that do not have significant volume. In areas where volume is significantly below capacity, a road diet is effective. In some instances, a road diet includes redesigning the roadway cross section from four lanes to two lanes plus (e.g., parking, turn lane). One example is a converted four-lane roadway two lanes in each direction to one lane in each direction and a two-way left-turn lane (Figure 2.15).

Figure 2.15: Road diet

Other road narrowing (including shrinking roads with curb extensions or lane markings including bike lanes without changing number of through lanes) provide various benefits such as reducing lane width or separating opposing traffic through target areas (Figure 2.16). Many municipalities target these treatments given their relatively low-cost, but road narrowing must include physical narrowing measures or an enhanced perceptual measure of narrowing.

Figure 2.16: Other road narrowing, Amherst, MA

Side Street Crossing Tables are raised sections of the roadway that run perpendicular to the flow of traffic and run from curb to curb (Figure 2.17). These speed management treatments are located typically at stop control side street intersections. The location forces drivers to slow down when making a turn—making the crossing safer for pedestrians. While these primarily occur within urban context, the design of raised crossings at side streets can be applied throughout many suburban and rural contexts in Massachusetts.

Figure 2.17: Side street crossing table, Cambridge, MA

Centerline or corner hardening (at an intersection) is a speed management treatment that works to reduce the speed of turning vehicles at an intersection (Figure 2.18). These countermeasures can vary in design, but typically include a raised element that covers the centerline near the stop bar of an intersection approach, thus forcing vehicles to make more of a 90-degree turn and have to traverse the raised element should they “cut the corner.” In some instances, vertical bollards are placed to add additional preventive measures for turning vehicles.

Figure 2.18: Centerline or corner hardening, Boston, MA

Curb extensions (at an intersection) are designed to increase pedestrian visibility and reduce vehicle turning speeds at an intersection (Figure 2.19). Additional impacts include preventing motorists from parking within or too close to a crosswalk (near the intersection) or from blocking a curb ramp.

Figure 2.19: Intersection curb extensions, Beverly, MA

2.3.2 Speed Management Treatments Omitted from Case Studies

The following present speed management treatments that were omitted from the case studies of this research project. These omitted measures were deemed noncontroversial with regard to speed management and therefore did not warrant city/town case studies.

Speed bumps were not considered within the context of this speed management research. While the *Manual on Uniform Traffic Control Devices* (MUTCD) allows for the interchangeable use of "speed bumps" and "speed humps," there remains the potential for challenges with user comprehension in the terminology (17). In an effort to remain consistent with both the FHWA Traffic Calming ePrimer (5) and the FHWA Speed Management Toolkit (6, 18), speed "bumps" were not included in this study. Figure 2.20 below represents the specific design of what would be considered as "speed bumps."

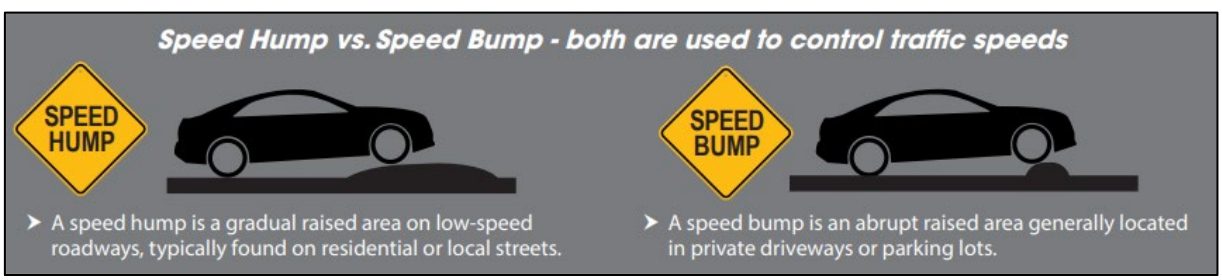


Figure 2.20: Speed bumps versus speed humps

Curb extensions away from intersections (at midblock) were not considered as part of this task. These speed management treatments were included within the *other road narrowing* speed treatment as discussed previously. Given their horizontal deflection in nature, these curb extensions at midblock were included within the category that narrows the roadway via bike lanes, pavement markings, and other narrowing measures.

Mini-roundabouts (fully traversable) were not included in the case-study approach within this research project. These treatments are not typically installed as a speed control element and therefore a speed management case study was not warranted.

Optical measures were not included within the scope of these case studies. While these visual cues have the potential to focus drivers' attention on their speed and draw attention to the need to reduce speed, they were not found to be controversial from the EMS and DPW personnel responses in Task 1.

2.3.3 Case Study Data Collection Techniques

In addition to building case studies based on these conversations, others were a result of speed management countermeasures listed in the inventory (Task 4). The municipalities selected were identified to provide case study evidence regarding their implemented speed management strategies. With an emphasis to identify concerns and provide evidence from municipalities overcoming their concerns with success stories, an effort was made to find cities and towns across the state (and outside if necessary) that exhibited lessons learned.

As a general focus, the research team aimed to have two case studies for each of the treatments listed in Section 2.3.1. Some of the more popular treatments were targeted to have three case studies (e.g., speed humps, raised crossings). An emphasis was placed on including treatments among a variety of roadway contexts, with attention to those municipalities that had readily available design specs and/or speed data. Other elements that were captured in the case study data collection process included site descriptions, before-after speed results (as available), design specs (as available), support story, maintenance tips, other lessons, and plans for the future. A larger discussion around the results of these case studies will be in the results section of the report.

2.4 Inventory of Speed Management Treatments

A second survey was initiated through this project by the research team in an effort to inventory the speed management treatments throughout Massachusetts. The survey was designed to target all statewide municipalities, inquiring on their implementation of speed management countermeasures. The following sections outline the methods utilized to develop, disseminate, and analyze the speed management inventory survey.

2.4.1 Survey Development

The speed management inventory survey was developed in Qualtrics, similarly to the effectiveness survey as explained in Task 1 (Figure 2.21). Again, this platform was selected based on its dynamic capability to input logic-based questions within the questionnaire. The survey was designed with the expected completed rate of under 5–7 minutes per response.

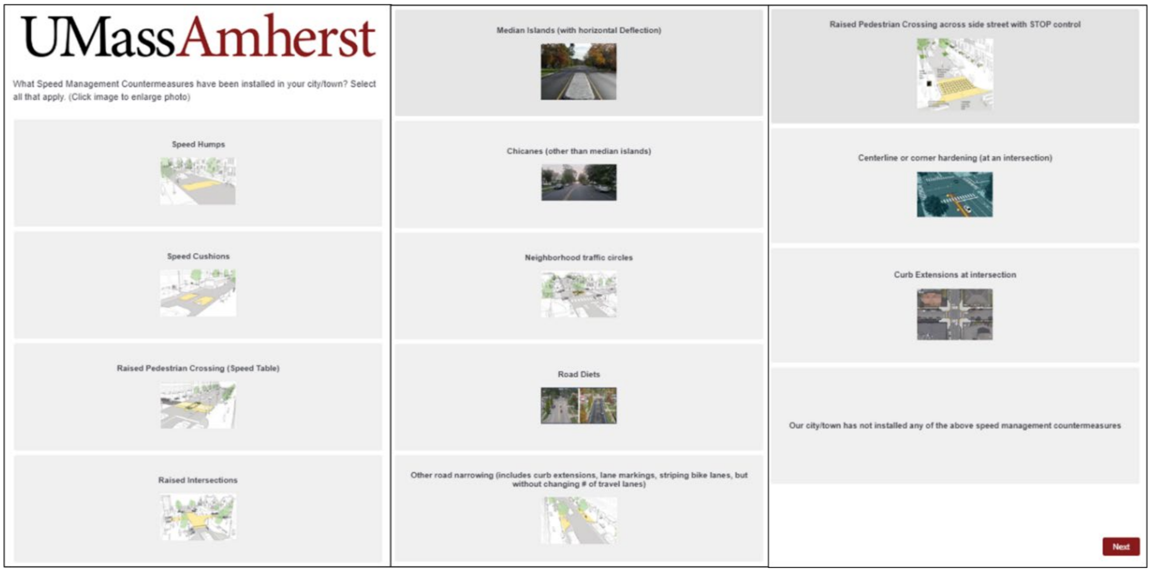


Figure 2.21: Speed management inventory survey

Respondents were provided with the following message to begin their survey: "MassDOT is seeking information regarding the implementation of various Speed Management countermeasures installed throughout Massachusetts. The following presents a short list of questions aimed at identifying the countermeasures that have specifically been implemented in your city/town." Next, respondents were guided to complete a list of simple identification questions including their name, email, and town/affiliation. Note: this survey did not inquire upon the occupancy role for each respondent, as the research team did not want to limit the responses from each municipality and therefore open it up to any town/city constituent.

Survey-based logic was used when asking each respondent to identify which speed management countermeasure existed within their city/town (Figure 2.22). The survey was divided into those responses that stated *zero countermeasures selected* versus *one-or-more countermeasures selected*. If *zero countermeasures selected* were indicated, then the respondent was directed to the last question of the survey which inquired *has your city/town removed any speed management countermeasures in the last 10 years*. Otherwise, the respondent was asked the following two questions: 1) *do you have before/after speed data collected for any of your countermeasures,* and 2) *do you have any design specs available for any of your measures*. For each of the countermeasures that were selected by the respondent, survey-based logic was utilized to inquire on the next set of questions which asked them to state *how many do you have in your city/town*. This question was limited to the answers of *zero, 1 to 5*, and *more than 5*. Additionally, based on the countermeasures that were selected by the respondent, they were asked in the following question to *share locations of (at least) two installations/examples with preference to before/after data, design specs, and higher volume roadway*. Last, these respondents were also asked the question if their *city/town* (*has) removed any speed management countermeasures in the last 10 years*.

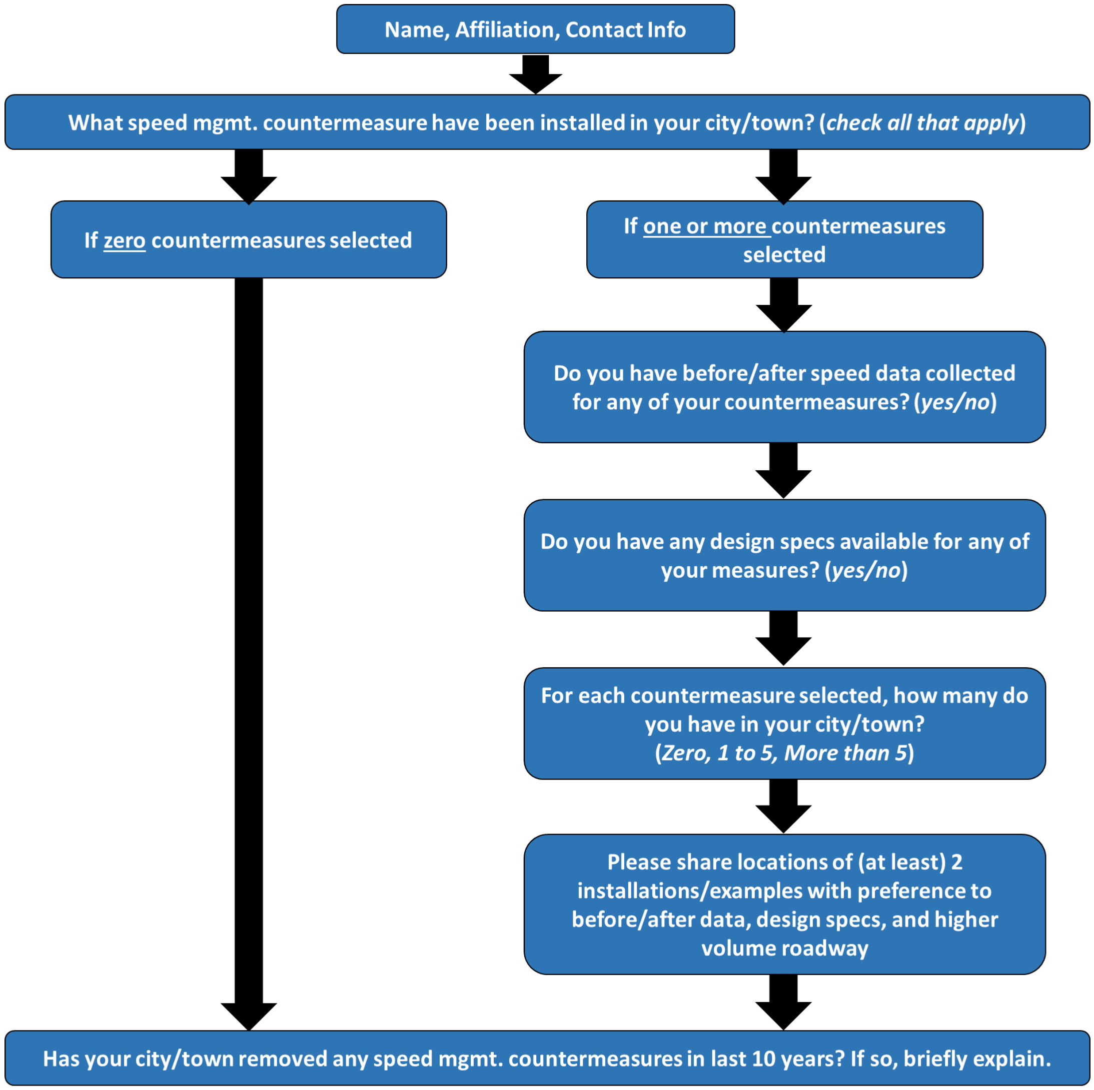


Figure 2.22: Structure of inventory survey

2.4.2 Survey Dissemination

Once the survey was developed and approved by the Project Champion, the dissemination was initiated across Massachusetts. Primarily, the UMass Transportation Center's Baystate Roads program listserv was used to establish connections with all statewide DPWs. Again given the history of Baystate Roads training nearly all statewide municipalities, this listserv was able to reach contract from nearly all 351 Massachusetts cities and towns. In addition to reaching out cities/towns via the Baystate Roads listserv, the research team also utilized a contact list provided by the Massachusetts Municipal Association (MMA), and a contact list including all of the DPW superintendents in Berkshire County. The message provided a brief introduction to the survey purpose and instructions for response as well as motivation to respond (Figure 2.23).

An incentive was provided to any city/town that participated in the statewide survey. With any responses from a city/town across Massachusetts, that municipality received one free attendee to a Baystate Roads course in the upcoming year. This incentive was created in an effort to increase the response rate from the survey. This message was sent out multiple times via the contacts lists stated previously in an attempt to increase response rate statewide.

> Hello,
> The UMass Transportation Center is working with MassDOT to promote a safe and efficient transportation network through the implementation of various Speed Management countermeasures (speed humps, raised crossings, curb extensions, etc.).
> In doing so, we are collecting information regarding the Speed Management countermeasures that have been installed in your city/town. This inventory will be pivotal to enhance Massachusetts roadway safety in the years to come.
> The research team would greatly appreciate your cooperation and assistance by completing the following survey. The survey (linked below) should only take a few minutes of your time.
> **As an added bonus**, the UMass Transportation Center will be offering **1 FREE** attendee registration to any Baystate Roads course. The offer will be valid to one attendee from any city/towns that completes the survey above. Once your city/town has completed the survey (at least once), you will be awarded the offer. (Note: Some restrictions may apply, including but not limited to NHI training, custom classes, etc.).
> If you have additional questions or would prefer to submit your responses via email, please contact us.

Figure 2.23: Initial message to DPW and EMS

2.4.3 Survey Data Collection and Analysis

The speed management inventory survey was disseminated throughout Massachusetts across numerous contact lists. Numerous outreach attempts were made within the Baystate Roads listserv in an effort to target reaching additional communities that had not previously responded to the survey.

Ultimately, the research survey was analyzed to identify the speed management countermeasures that have been implemented across Massachusetts, and to an extent the number of these treatments within each municipality. The municipal responses included whether they had design specs and/or speed data from their speed management implementation, which was tracked accordingly in the analysis. Last, the locations of countermeasures were identified in the data; however, it remains important to note that not all cities/towns were required to submit their treatment locations and therefore the inventory was less inclusive to that effect. The inventory and ongoing database of statewide implementation will be further explained in the results section of this report.

2.4.4 Developing Speed Management Treatment Cut-Sheets

As part of this task, the research team included an additional deliverable based on the inventory results yielded from the statewide survey. Similar to the speed management work conducted at UtahDOT and VTrans (14,15), the team aimed to create MassDOT template cut-sheets that would reinforce the findings from the statewide inventory, including lessons learned and pros/cons from each treatment installation. These cut-sheets will be explained in greater detail in the results section of this report.

2.5 Findings from International Agencies and Equipment Suppliers

This task included findings from international best-practice agencies and from regional speed management equipment suppliers. The research team focused on trying to evaluate local implementation; however, it remained important to include feedback and lessons learned from both international audiences as well as equipment suppliers from the industry. Vendors were interviewed and asked to provide information regarding their implementation strategies within Massachusetts and regionally in New England. Their lessons learned and best practices were discussed and documented based on their latest speed management treatment implementation programs.

In addition to gauging the industry and equipment suppliers, international agencies were evaluated based on their recent speed management strategies that have been proven effective. These included their potential practicability for implementation in Massachusetts. The discussion with these international agencies and equipment suppliers will be discussed further in the results of this report.

2.6 Lessons Learned and Practices Around the Commonwealth

Last, the research team was tasked with developing a comprehensive discussion surrounding the lessons learned and best practices around the Commonwealth of Massachusetts. This discussion included a thorough review of municipal policies, programs, and posture toward speed management from various municipalities statewide. A review of roadway context in speed management implementation was also reviewed, as well as a focus on emergency response and winter maintenance considerations. Each of the speed management countermeasures evaluated within this report were then highlighted with their specific lessons learned. The results of these lessons learned will be discussed further in the results of this report.

3.0 Results and Discussion

The following section presents the results from this Speed Management Synthesis study, including the DPW/EMS preferences around Massachusetts, regional speed management forums, discussion on regional case studies and international agencies, the inventory of statewide speed management treatments, and the overview of the lessons learned and best practices.

3.1 Speed Management DPW/EMS Effectiveness Survey

The speed management DPW/EMS effectiveness survey was designed to determine the efficacy of local implementation including their potential challenges and preferences for speed management countermeasures. The survey was developed with Qualtrics and disseminated across Massachusetts through various channels including the Baystate Roads listserv, emergency response agency list (EMS and fire), the Department of Fire Services (DFS), and through the Office of Grants and Research—Highway Safety Division (municipal police road safety grant program). Each of these lists were contacted on multiple occasions given the low initial survey response rate.

As a result from the survey, there were 175 total respondents ranging from 136 unique cities and towns across Massachusetts and 7 responses from MassDOT personnel (Figure 3.1). The survey results in its entirety will be provided to MassDOT; however, the survey responses were categorized into DPW versus EMS, as this was collected at the beginning of the survey. In total, there were 126 EMS and 36 DPW personnel that responded to the survey. In addition, there were 16 “other” responses which were received from town managers, planning board, and other administrative occupations.

All visualization maps were created in GIS and was developed as a .pkb and .shp file that will be transferred to MassDOT along with this report. The municipalities in light blue are those that had responses from EMS, the municipalities in dark green represent those that had responses from DPW, and the municipalities with both light blue and dark green shading represent those that had responses from both EMS and DPW personnel. The boundaries shaded in light gray represent municipalities that did not provide a response to the survey. Some of the responses were from regional planning agencies; however, those were not visualized in full extent on the GIS graphic to avoid confusion.

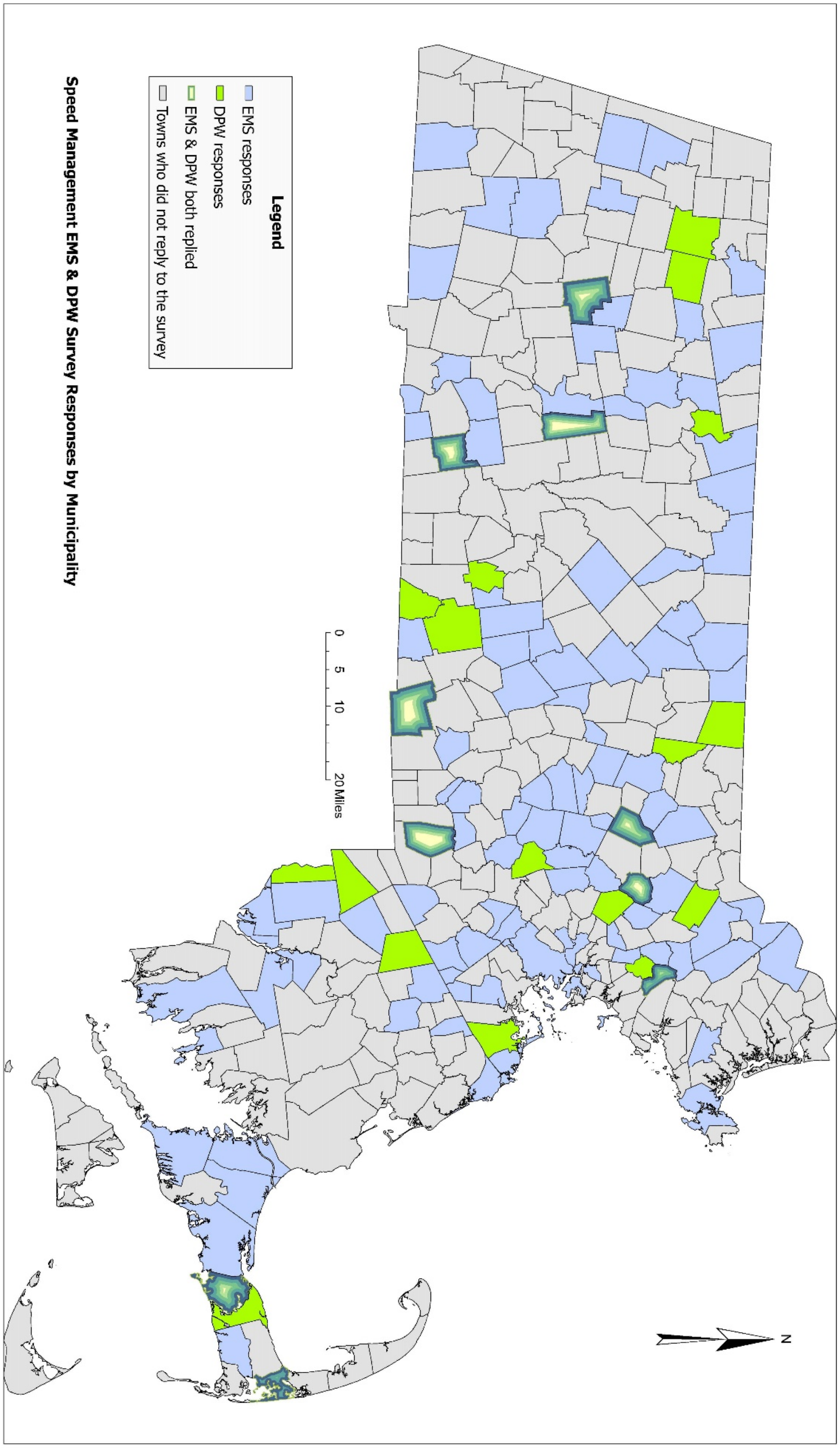


Figure 3.1: EMS versus DPW survey responses by municipality

Survey-based logic was utilized based on the respondent being DPW versus EMS personnel. As explained in Figure 2.22, DPW and EMS personnel both received a question regarding speed management countermeasure effectiveness. As a follow-up, if any of the respondents selections fell under a rating of 3 or above a rating of 7, they were asked in the survey to explain in a few words their rationale as to why they found that countermeasure less effective or more effective, respectively.

The first question asked in the survey asked respondents to rate the effectiveness of each speed management countermeasure, on a Likert-based scale (ranging from 1 to 10). Treatments with vertical deflection (e.g., raised intersections, raised pedestrian crossings, speed humps/bumps/cushions) were considered most effective (Table 3.1). Secondarily, mini-roundabouts and neighborhood traffic circles were considered effective (greater than average). Speed feedback signs were not considered effective nor ineffective with a rating of 5.0 in the survey. Curb extensions, chicanes, optical measures and road diets all slightly lower than average in the survey, with road diets considered the least effective measure based on responses.

According to many of the anecdotal responses from the survey that answered with a rating of less than three, the road diets appeared misunderstood with many comments such as "not sure what these are" and "I am not familiar with these." Alternatively, many responses indicated that there were preconceived notions of induced congestion from road diets, which led to their ineffectiveness rating.

As for the optical measures, many of the responses that were rated ineffective (scored less than three) stated these they were "unfamiliar" with these countermeasures, or they believe these treatments "don't make a big difference." Similarly, the responses regarding curb extensions and chicanes resulted in more of this rhetoric. Much of the pushback (ineffectiveness) from emergency personnel was surrounding their obstruction for large vehicle turning radii. Emergency personnel also stated that these treatments could lead to a "swerving behavior" by vehicles. In addition to this, many of the comments included feedback on "increased congestion" and negative impacts on roadway "drivability." It is important to note that many of these responses were rated low by respondents that have not employed these treatments, nor were familiar with them at the time of the survey.

Table 3.1: Effectiveness rating of each speed management countermeasure

Treatment	Average Rating (out of 10)	Feeling it is Clearly Ineffective (0, 1, or 2) (%)	Feeling it is Clearly Effective (8, 9, or 10) (%)
Raised Intersection and Raised Pedestrian Crossing	5.9	10	25
Speed Humps/Bumps/Cushions	5.7	13	27
Mini-Roundabouts and Neighborhood Traffic Circles	5.7	14	27
Speed Feedback Signs	5.0	13	17
Curb Extensions and Chicanes	4.7	18	10
Optical Measures	4.5	19	7
Road Diets	4.2	32	10

Table 3.2 presents the rationale from respondents that rated certain speed management countermeasures greater than seven. As noted, the following countermeasures were included: raised intersections and raised pedestrian crossings, speed humps/bumps/cushions, mini-roundabout and neighborhood traffic circles, and speed feedback signs. Curb extensions and chicanes, optical measures, and road diets were excluded from this table given their ineffectiveness outweighing the effectiveness rating. Of note, the vertical deflection speed management measures were rated effective mostly because of their physical obstruction and geometry change. These results present the notion that respondents recognized the effectiveness of speed control from vertical deflection treatments.

Table 3.2: Reason for certain speed management effectiveness (rated greater than 7)

Treatment	Their Experience (%)	Physical Obstruction /Geometry (%)	Noticeable (%)	Reminder to Slow Down (%)	Smooth Traffic Flow (%)
Raised Intersection and Raised Pedestrian Crossing	27	54	16	—	—
Speed Humps/Bumps/Cushions	15	74	—	—	—
Mini-Roundabouts and Neighborhood Traffic Circles	36	39	—	—	10
Speed Feedback Signs	31	—	31	31	—

The responses to the final question in the survey included respondents answers to the challenges with regard to each of the speed management countermeasures. The respondents were instructed to "check" any of the following categories that they believed impact each treatment. The categories were winter maintenance, emergency response, implementation cost, and routine maintenance with respondents allowed to select more than one option. As a results, vertical deflection elements were considered a challenge for both winter maintenance and emergency personnel (Table 3.3). Note: These measures were previously rated high in terms of effectiveness based on their physical obstruction and geometry. Routine maintenance was not considered a primary challenge across the board with any of the measures listed, albeit DPW responses stated some of those challenges with their anecdotal responses. Road diets posed the least challenge to winter maintenance and emergency response according to the survey.

Table 3.3: Challenges posed on speed management countermeasures

Treatment	Winter Maintenance (%)	Emergency Response (%)	Implementation Cost (%)	Routine Maintenance (%)
Speed Humps/Bumps/Cushio	64	63	30	30
Raised Intersection and Raised Pedestrian Crossing	51	51	48	27
Curb Extensions and Chicanes	38	33	46	26
Mini-Roundabouts and Neighborhood Traffic Circles	23	31	64	27
Road Diets	13	25	34	18

Comparatively, EMS and DPW responses were compared with regard to their response of challenges with each speed management countermeasures (Figure 3.2). According to the responses, there was little difference in the distribution of concerns between these groups; however, DPW responses yielded an overall higher level of concern sans implementation cost.

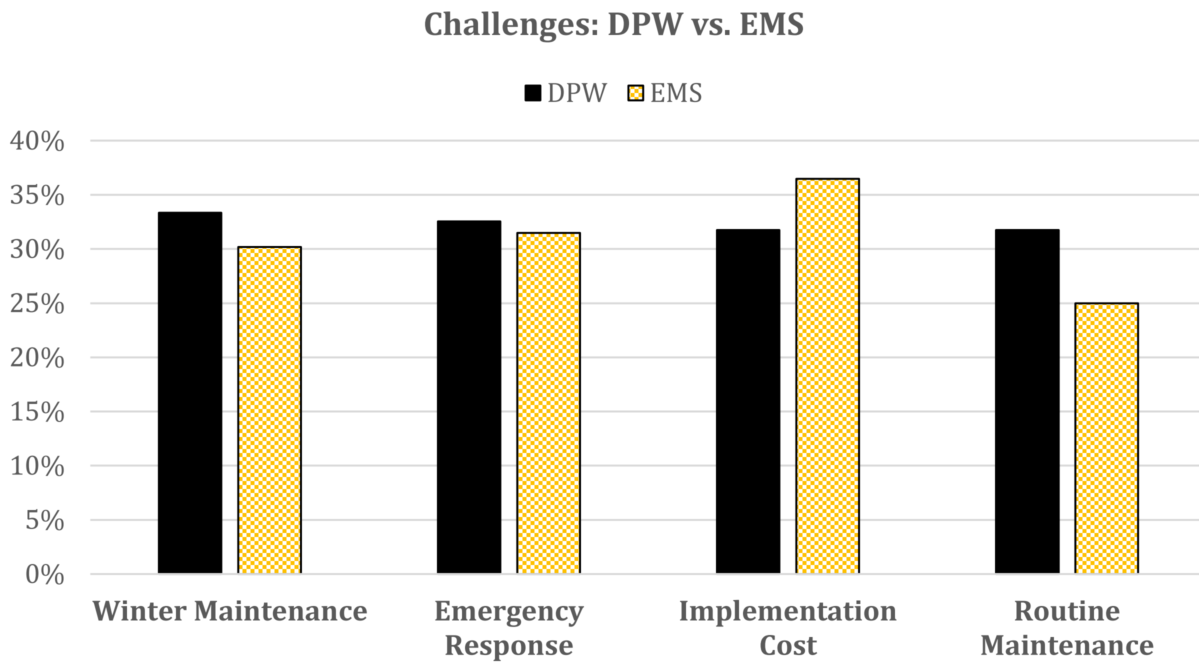


Figure 3.2: Difference between EMS and DPW responses regarding challenges

As noted previously, the survey concluded with an open-ended question inquiring respondents to provide "general feedback and/or comments" regarding speed management countermeasures. The following present a summary of these responses, with majority from EMS personnel:

- *Primary concern is with emergency response and not negatively impacting it*
- *Potential damage to larger vehicle suspension with raised treatments*
- *Narrowing roads can impact emergency response times*
- *Traffic calming is a priority with respect to quality-of-life issues in town*
- *Some public service announcements could help gain traction with some of these treatments*

The results from the speed management countermeasure effectiveness survey concluded that while many EMS and DPW personnel have a wide range of opinions regarding each treatment, their combined opinions may not be as far apart as once expected. Having DPW and EMS personnel that have similar objectives and thoughts regarding these measures is critically important to moving them forward.

3.2 Speed Management Conversations

The objective of the speed management conversations was to highlight the communication that occurred with several communities across Massachusetts. Prior to the scheduled speed management conversations that were hosted virtually, the research team sought out a handful of "active" speed management communities to engage them in a discussion. The cities of Salem, Somerville, and Winchester were interviewed one-on-one to get a sense of their level of speed management within their municipality. As an added note, these municipalities were asked to attend the scheduled forums to assist in presenting some “lessons learned” from their efforts.

As noted, three speed management conversations were hosted in December of 2023. Notices and registrations were sent out several weeks ahead of time, with a reminder email sent out through the Baystate Roads listserv just one week prior. Registrants for Speed Management Conversation #1 on December 5, 2023 (attendees represented in **bold**):

- Agawam
- **Salem**
- Acton
- **Boston**
- Cape Cod Commission
- **Dedham**
- **UMass Amherst**
- Yarmouth
- Dudley
- **Barnstable**
- **Tewksbury**
- **Franklin County Council of Governments**
- West Boylston
- **Falmouth**

Registrants for Speed Management Conversation #2 on December 12, 2023 (attendees represented in **bold**):

- Mashpee
- Holden
- **Boston**
- Hopedale
- **UMass Amherst**
- **Bedford**
- Abington
- **MassDOT**
- **Oxford**
- **Westford**
- Lexington
- Stoughton
- **Montachusett Regional Planning Commission**

Registrants for Speed Management Conversation #3 on December 14, 2023 (attendees represented in **bold**):

- **Chicopee**
- Plymouth
- **Amherst**
- **UMass Amherst**
- **Tewksbury**
- **Medford**

These conversations included a discussion of their lessons learned, best practices, and other future considerations that their respective municipalities were focused on. The dialogue from these conversations was documented and utilized in developing a list of potential case studies across Massachusetts. While this was completed as part of the initial scope, this task jumpstarted the outreach to inventory statewide speed management countermeasures. The dialogue review is included in Appendix C of this report.

3.3 Speed Management Inventory Survey and Case Studies

The following section discusses the results from the statewide speed management inventory as well as case studies that were developed thereafter from the survey output.

A statewide speed management inventory was initiated to identify the implementation effort by municipalities on various speed management countermeasures. A survey was disseminated through the Baystate Roads program listserv, as well as through contact lists of MMA and directly to other DPW regional superintendents. Numerous outreach efforts were made to these contact lists in order to maximize the input of speed management across Massachusetts. Out of the 351 Massachusetts cities and towns, the research team collected input from 93 responding municipalities (Figure 3.3). Many of the 93 responding communities provided multiple sources of input, with 3–4 responses at times for one city/town. Out of these unique municipal responses, less than one-third of them stated that they had not installed any physical speed management countermeasures on their roadways, and did not have any speed management programs in place.

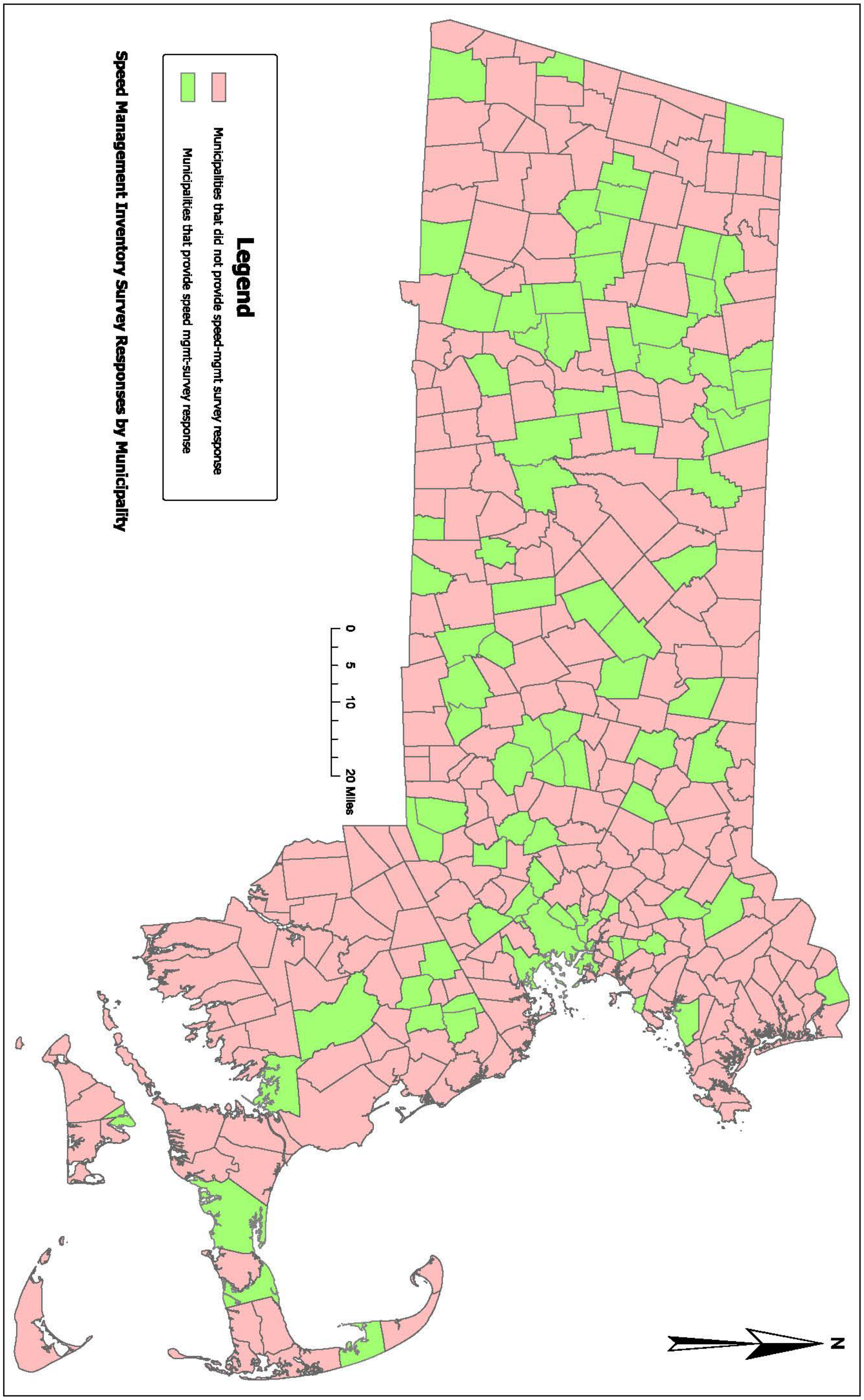


Figure 3.3: Speed management inventory survey responses by municipality

Of the 93 municipal responses to the speed management inventory survey, 68 stated that they have implemented at least one countermeasure on their roadways. The remaining 25 communities that responded indicated they have not implemented any speed management countermeasures on their roadways. Figure 3.4 presents this breakdown, in addition to highlighting municipalities that opened the survey; however, did not complete any of the indicated fields. These were important to note as contact was confirmed with these communities, yet the survey was not completed by them. This group of communities could be targeted again in a future effort to document their implementation of countermeasures (or lack thereof).

Within the inventory survey, respondents were asked to identify which countermeasures were present within their municipality (as applicable). More so, they were asked to identify a rough estimate number for each of them. These were categorized into either *1 to 5* treatments or *more than 5* treatments, for those communities that had these countermeasures implemented in their city/town. As a result, Table 3.4 presents the overall findings for each of the speed management countermeasures, and the categories in which they were selected. It is important to note that incomplete survey responses were categorized as *Other* given that these surveys were not determined to be complete and therefore separated out. In total, the following was identified: 17 municipalities with speed humps, 5 municipalities with speed cushions, 21 municipalities with mainline crossing tables, 5 municipalities with raised intersections, 29 municipalities with median cross islands, 7 municipalities with chicanes, 12 municipalities with neighborhood traffic circles, 24 municipalities with road diets, 38 municipalities with other road narrowing, 2 municipalities with side street crossing tables, 2 municipalities with centerline or corner hardening, and 20 municipalities with curb extensions (at an intersection). The dataset utilized to compile this data will be provided to MassDOT at the conclusion of this research effort. A visualization of these treatment locations was designed and represented in Figure 3.5.

The results from this survey bring with it several caveats that need to be explained further. Twelve municipalities indicated neighborhood traffic circles in their city/town; however, after further verification, many of these towns misconstrued these for mini-roundabouts. That said, these were not removed from the results, as they serve a unique purpose for inventory analysis. Chicanes were indicated in seven municipalities; however, as stated previously in this report, the research team determined that these examples did not fit the design description and design elements according to FHWA. Last, the other road narrowing category resulted in 38 unique responses, indicating a prevalence of this countermeasure across Massachusetts. These examples vary significantly, and should be further looked at in future work.

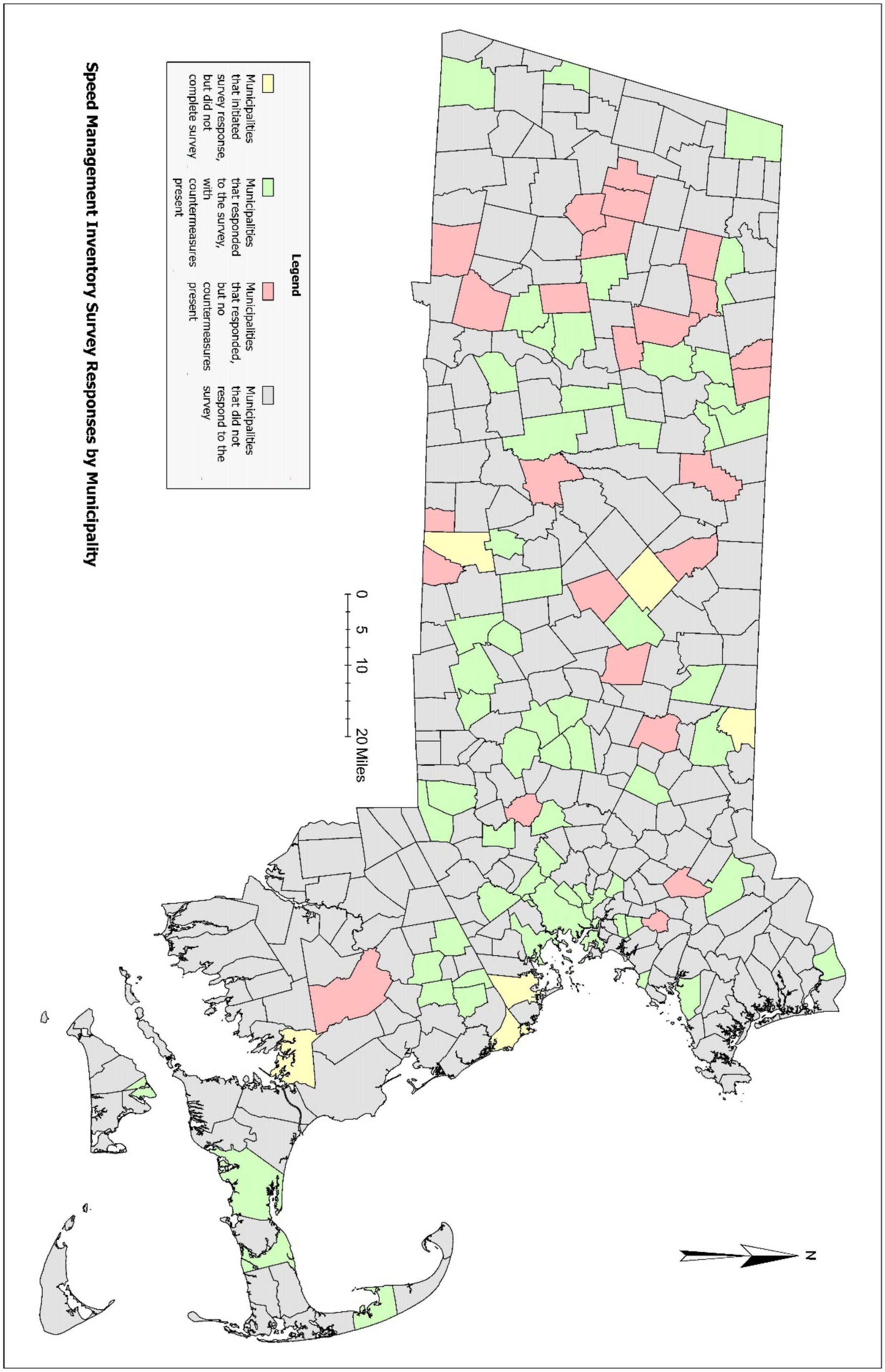


Figure 3.4: Speed management inventory survey responses (detailed)

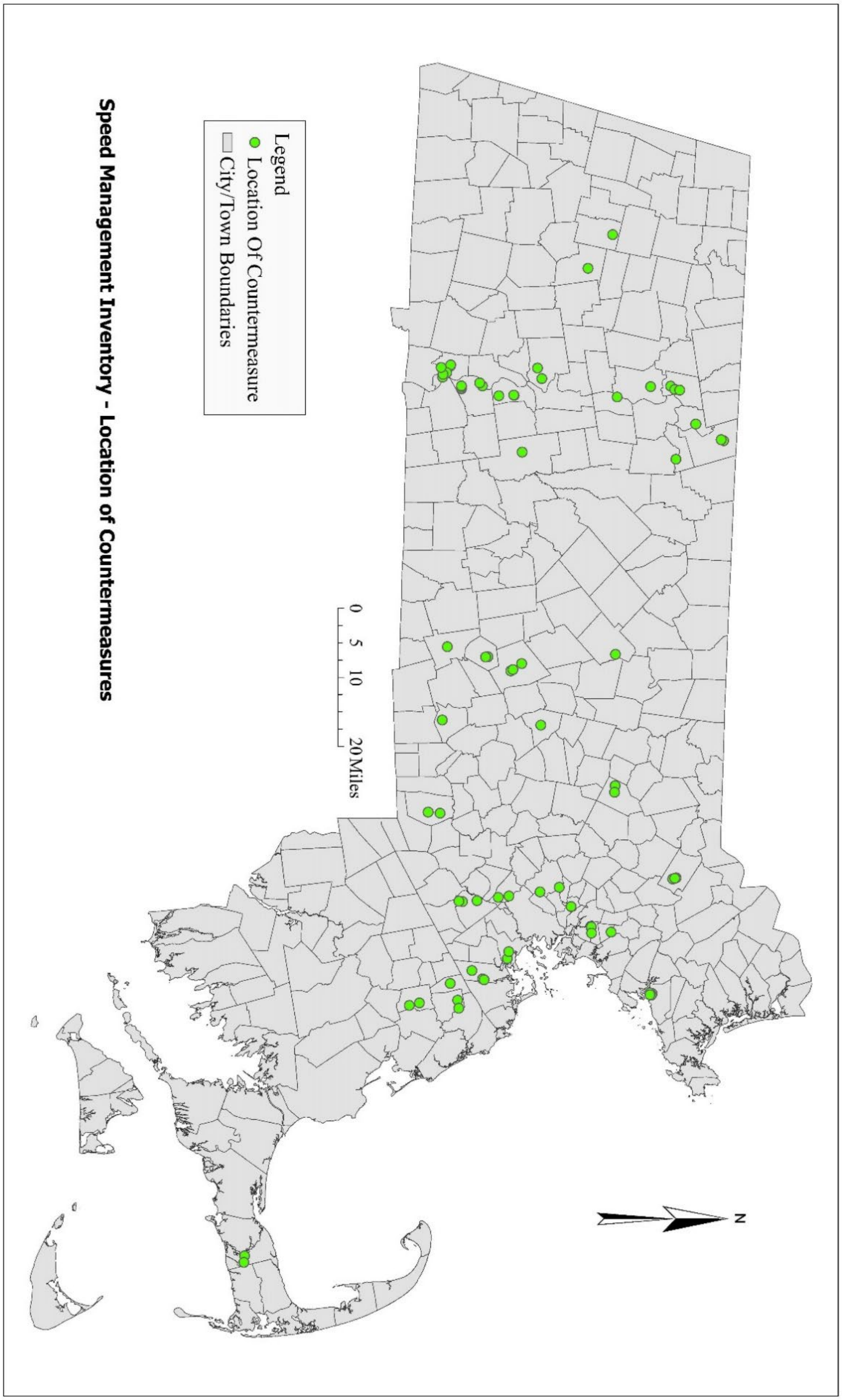


Figure 3.5: Speed management survey inventory: location of countermeasures

Table 3.4: Speed management inventory survey: results from municipalities

Treatment Type	Total	Number of Treatments		
		1 to 5	More than 5	Other
Speed humps	17	9	7	1
Speed cushions	5	1	1	3
Raised pedestrian crossing (speed table)	21	16	5	0
Raised intersections	5	4	1	0
Median Islands (with horizontal Deflection)	29	18	9	2
Chicanes (other than median islands)	7	6	1	0
Neighborhood traffic circles	12	11	0	1
Road diets	24	21	3	0
Other road narrowing (includes curb extensions, lane markings, striping bike lanes, but without changing no. of travel lanes)	38	28	9	1
Raised Pedestrian Crossing across side street with STOP control	2	1	1	0
Centerline or corner hardening (at an intersection)	2	2	0	0
Curb Extensions at intersection	20	10	9	1
Our city/town has not installed any of the above speed management countermeasures	25	—	—	—
TOTAL RESPONSES	93	127	46	5

Aside from the ongoing speed management inventory captured through the statewide survey, a set of case studies were developed based on outreach with municipalities across Massachusetts (Table 3.5). Communication began with the speed management conversations, and continued through responses collected through the statewide inventory survey. The research team worked diligently to reach out to municipalities that stated one-or-more speed management countermeasures in their city/town. It remains important to note that while the research team received feedback from several communities in this process, there were many that were difficult to reach after several attempts of outreach. Additionally, there were two countermeasure types that were ultimately left out of these case studies: curb extensions at intersections and chicanes (other than crossing islands). While many municipalities stated the implementation of chicanes on their roadways, these examples did qualify (per the research team's judgment) as horizontal deflecting chicanes considered by the FHWA traffic calming guidelines (5). Curb extension at intersections were also not included as case studies, as the research team determined that these countermeasures primarily impact vehicle turning behavior in urban context, with a focus not solely on speed but visibility to pedestrians.

Table 3.5: Speed management case study details across Massachusetts

Treatment	Town	Project/Corridor	kADT	Context
Speed bump (temp)	Mansfield	Highland Ave.	0–1.5	suburban
Speed hump	Salem	North Salem	0–1.5	suburban
Speed hump	Amherst	Commonwealth Ave.	>4	suburban
Speed hump	Somerville	Powder House Blvd.	>4	urban
Speed cushion	Salem	Proctor St.	1.5–4	suburban
Mainline crossing table	Belmont	Cross St.	>4	suburban
Raised intersection	Amherst	College St. (Rt 9)	>4	suburban
Raised intersection	Dedham	Needham St.	>4	suburban
Crossing islands	Amherst	S Pleasant St (Rt 116)	>4	suburban
Crossing islands	Boston	Amory St.	>4	urban
Neighborhood traffic circle	Somerville	Pearl St.	1.5–4	urban
Neighborhood traffic circle	Portland, OR	Citywide	1.5–4	urban
Road diet (2 to 1 thru lanes per direction)	Boston	Centre St.	>4	urban
Road diet (2 to 1 thru lanes per direction)	Malden	Centre St.	>4	urban
Other road narrowing	Tewksbury	Shawsheen St.	1.5–4	suburban
Side street crossing table	Cambridge	Western Ave.	>4	urban
Side street crossing table	Boston	Tremont St.	>4	urban
Centerline or corner hardening	Boston	Amory St.	>4	urban

The case studies collected in this research project identified examples across Massachusetts from both suburban and urban context. In addition to roadway context, each of these case studies had a range of average daily traffic (ADT) which were noted in Table 3.5. While some municipalities have integrated more speed management countermeasures than others, this process exemplified the progress being made statewide to improve roadway safety with innovation and novel design approaches. The case studies made available in their entirety in Appendix E.

3.4 Speed Management Cut-Sheets and Lessons Learned

The following sections highlight speed management countermeasure lessons learned and best practices, as discovered through international best practices, industry and equipment supplier spotlight, and other local implementation narratives.

3.4.1 International Best Practices

There are several countries outside of the United States that have been considered successful with their traffic calming measures and implementing speed management on their roadways to reduce traffic fatalities and serious injuries.

A well-known example of international best practices exists with the Netherlands, whom have been a leader in transportation safety and multimodal infrastructure for many decades. The Netherlands have been marked as having one of the best traffic safety records in the world, with much lower traffic fatality rates as compared to the United States. Their policies and practices on speed management have been successful at improving traffic safety, and most importantly lowering speeds on their roadways. A case study on the Netherlands is presented in Appendix D which highlights the progress that they have made, and highlight transferable applications to be taken into consideration here in Massachusetts.

Closer to Massachusetts, Edmonton, Alberta, has become a recent leader in traffic calming and speed management practices in Canada (and around the world). Edmonton has been compared to the "Texas of the North" for its truck dominated vehicle fleet, big city-feel, and mix of rural sprawl. That said, the fatality rate in Edmonton has lessened drastically in recent years as compared to cities in Texas, similar to Dallas as a comparison. Much of this traffic fatality reduction in Edmonton is due in part to their focus on Vision Zero and the push to eliminate fatalities and serious injuries by 2032. A case study on Edmonton, Alberta is presented in Appendix D which highlights the progress they have made in recent years, and the strategic planning in place moving toward lower fatal and serious injuries. Of note, this study highlights a list of speed management countermeasure applications that have been successful in holistically building local camaraderie toward their effectiveness.

3.4.2 Industry and Equipment Supplier Spotlight

In addition to international examples, the research team focused on trying to evaluate local implementation; however, it remained important to include feedback and lessons learned from equipment suppliers in the industry. Equipment suppliers have experience with talking and discussing strategy with various municipalities to best fit their needs in both temporary and permanent installations. The objective was to identify a vendor that participates with speed management traffic calming treatments in Massachusetts. As a result, Treetop Products were interviewed and asked to provide information regarding their implementation strategies within Massachusetts and regionally in New England. Their lessons learned and best practices were documented based on their latest speed management treatment implementation program. AN *Industry Spotlight* is presented in Appendix D that highlights their wide-ranging applicability in the transportation safety infrastructure industry. Through both temporary and permanent installations, Treetop Products has worked with many local communities (Salem, MA), as well as other regional leaders such as Chicago, Washington, DC, and New York City.

3.4.3 Lessons Learned in Massachusetts

The research team was tasked with developing a comprehensive discussion surrounding the lessons learned and best practices around Massachusetts. This discussion includes a thorough review of municipal policies, programs, and posture toward speed management from various municipalities statewide. A review of roadway context in speed management implementation was also reviewed, as well as a focus on emergency response and winter maintenance considerations. Each of the speed management countermeasures evaluated within this report were then highlighted with their specific lessons learned. The discussion from this comprehensive review was best suited within Section 4 of this report within Implementation and Tech Transfer.

3.4.4 Speed Management Cut-Sheets

Based on the results from the statewide case studies, and the lessons learned highlighted through Massachusetts, the research team sought to include an additional deliverable into this report on speed management (Figure 3.6). Similar to the work conducted at UtahDOT and VTrans, the team worked to compile speed management countermeasure cut-sheet templates that highlight the following information:

- "Quick facts" and cost estimates
- Advantages and Considerations
- Typical Locations
- "Experiences Around the Commonwealth"

Figure 3.6: MassDOT speed management cut-sheet

Each of these cut-sheets were created in a flyer format as a way to highlight the findings from across Massachusetts. These cut-sheet flyers are available in Appendix F. Advantages and considerations derived from the statewide case study effort, while the typical locations were summarized from inventory locations across Massachusetts. Experiences from around the Commonwealth was collected from local case studies, and additional locations were noted based on the statewide inventory. The research team inured that the information paralleled the MassDOT Safe Speeds repository and speed management toolkit.

This page left blank intentionally.

4.0 Implementation and Technology Transfer

This section provides recommendations and lessons learned on speed management and traffic calming measures throughout Massachusetts. The recommendations presented in this section have been developed through the analysis of both statewide surveys, the speed management conversations, and the local case studies that were created as part of this research endeavor.

4.1 Lessons Learned about Speed Management Practices Across the Commonwealth

4.1.1 Municipal Policies, Programs, and Posture Toward Speed Management

Across the nation, attitudes toward speed management are in transition across the country, from the historic position in which it was considered a responsibility of drivers only to the position fundamental to Vision Zero that road owners, as part of their duty to ensure the safety of the public, are also responsible for preventing dangerously high speeds. (Vision Zero is the name of the European family of road safety programs initiated in the 1990s, led by Sweden's *Vision Zero* and Netherland's *Sustainable Safety*.) Within Massachusetts, cities and towns exhibit a full spectrum within this transition.

At one end, many municipalities are doing little or nothing to manage speed on their roadways beyond police-based enforcement and setting speed limits. Our survey found that of 93 responding municipalities, about one-third had not installed any physical speed management treatments and had no speed management program.

Next, there are several municipalities with one or multiple speed management treatments, but without a speed management policy or program. The few treatments they have applied were designed and implemented in ad hoc fashion as special, one-of-a-kind projects, usually in response to citizen requests, without clear policy guidance.

As the number of citizen requests increases, municipalities have found it helpful to establish policies regarding which streets are eligible for traffic calming and what contributing factors will be considered in evaluating a request. For example, Dedham has a policy stating that the only streets eligible for traffic calming are local streets and collector streets at school entrances. Its policy, published here, maps the eligible streets and lists six factors that will be considered when evaluating requests: speed, volume, pedestrian route, collisions, pedestrian generators, and residential density. Another dimension of policy regards abutter support, such as a requirement for a certain percentage of abutters to sign a petition or respond positively to a survey. In some instances, abutters contribute financially to the speed management measures, though this practice has been criticized for how it leaves poorer neighborhoods at a disadvantage.

With further growth in citizen requests and number of projects, some municipalities' policies have taken the next step of creating a rubric by which streets are scored based on their contributing factors; this allows streets to be prioritized. An example is Salem, MA, which established a traffic calming program in 2018, inviting applications from residents. By 2020 the staff were overwhelmed by the number of applications and also find themselves in the delicate situation of wanting to deny applications that they considered inappropriate. To avoid the appearance of being arbitrary or politically motivated, they developed a scoring system for prioritizing streets for traffic calming (see Salem's public engagement website for its neighborhood traffic calming program). Because the scoring system needs speed and volume data, transportation planning staff engaged the police department to collect traffic speed and volume data on streets likely to be good candidates for treatment.

In parallel with developments in policy, municipalities taking speed management seriously have had to grow their relevant staff and budget. According to Somerville's head of transportation and infrastructure, until 2019, the city had staff capacity only for treatments that were "lines and signs" such as conventional bike lanes. Only with increased staff could they manage contractors doing projects that involved moving curbs or pouring concrete. Somerville now has a robust traffic calming program delivering multiple projects and dozens of treatments per year. Along with project engineers, their staff includes a data analyst to help with project prioritization and project evaluation.

Finally, one municipality, the City of Boston, has gone beyond inviting resident requests—it will simply do speed management everywhere. Before 2023, under the city's previous speed management program (*Slow Streets*), neighborhood residents had to organize and prepare an application; once chosen, each neighborhood was treated as a special case, with extensive public consultation and multiple iterations of planning and design that left staff with the capacity to treat only a few sites per year. In the new *Safety Surge* program, announced in January 2023, no more applications are needed. By then, city staff had learned that speed humps were the most cost-effective, flexible, and least disruptive treatment (e.g., in terms of losing parking), and so in the *Safety Surge* program, the city will proactively install speed humps on every eligible street in the city.

Boston's *Safety Surge* program is based on the idea that safe speeds on neighborhood streets are a right that every resident deserves, and that local government is responsible to deliver. Neighborhood by neighborhood (streets are treated in neighborhood groups to avoid diverting traffic from one local street to the next), city staff perform speed measurements, and unless they show that the target speed is already met, they have a contractor install speed humps. Whereas about 5% of the city was treated in the 5 years prior to 2023, about 25% more of the city will be treated in the four-year period beginning in 2023, installing 500 speed humps per year. The neighborhoods to be treated in these four years were selected based on population density, crash data, and speed data.

Moving away from an application-based process not only streamlines project planning and management, but also avoids the "squeaky wheel gets the grease" bias that tends to favor wealthier, politically connected neighborhoods.

4.1.2 What Kinds of Streets Get Speed Management Treatments

Local Streets, in Neighborhood Groups

In any municipality with a traffic calming policy, local residential streets always qualify. Most of the street users are immediate residents who favor slower speeds in their neighborhood, and speed humps and similar treatments on local streets are not a serious impediment to emergency response, trucks, buses, or snow plowing.

It is important to treat local streets in groups so that traffic will not simply be diverted from one local street to the next. Salem learned this lesson when, in response to applications, they installed speed humps on Buffum Street (in North Salem) and Fairfield Street (in South Salem). They soon recognized that traffic was diverting to parallel local streets, which then led the city to expand those projects to zones of parallel streets bounded by non-local streets.

Collectors and Arterials

Collector and arterial streets are especially critical for speed management because the majority of crashes and injuries happen on them (as opposed to local streets and freeways); however, they are less amenable to the kinds of interventions allowed on local streets because of their function as emergency response routes, bus routes, or truck routes, and because of their wider user base.

Some municipalities' policy is that only local streets are eligible for traffic calming treatments. Dedham is an example, although its policy has one exception: collector streets at school entrances, such as the raised intersection treatment on Needham Street outside Riverdale Elementary School.

Boston and Somerville, on the other hand, allow speed humps on collector streets unless they are part of a bus route or on an emergency response route. In Boston, the fire chief has given the Transportation Department a map of emergency response routes, and MBTA bus routes are known; all other streets are eligible for speed humps. Some notable collectors that have been treated with speed humps include Powder House Blvd (Somerville), Forest Hills Street (Boston), and Green Street (Boston).

Salem has addressed the issue of accommodating emergency response needs on collectors by using speed cushions, which can be thought of as speed humps with channels cut out for tires based on the wheelbase of a fire truck or bus. However, Salem has used only temporary speed cushions, which are removed for the winter because of the challenge of clearing snow the channels.

For collectors and arterials not amenable to vertical deflection devices such as speed humps, there are other treatments for managing speed. For 2-lane streets not eligible for speed humps, the most promising approach appears to be crossing islands, sometimes installed in conjunction with centerline hardening, as on Boston's Amory Street. They help control speed without interfering with buses or emergency response by two means: a narrow gateway—especially if flex posts or vertical "Stop for Pedestrians" signs are used—and horizontal deflection. Research by Furth et al. describes the geometric design of crossing islands to force just the right amount of horizontal deflection to achieve a target speed (19).

Speed management options for multilane roads are still more limited. Horizontal deflection will not be effective without an unacceptable increase in sideswipe risk. Creating a narrow gateway is still possible if flex posts and/or vertical "Stop for Pedestrians" signs are installed on every lane line, as described by Hochmuth and Van Houten, although this treatment has not yet been tried in Massachusetts (20).

The most effective speed management tool for multilane roads is a road diet - that is, lane reduction to a single through lane per direction - because if you can pass, you can speed, while with a single lane, one cannot drive any faster than the car ahead. In Boston's West Roxbury, the Centre Street road diet project lowered median speed from 29 to 23 mph and lowered the fraction of motorists driving 5 or more mph above the speed limit from 44% to 6%.

Intersections: Controlling the Speed of Turning Vehicles

An inordinate share of crashes and injuries, particularly pedestrian injuries, involve left-turning vehicles. Treatments to reduce the speed of turning vehicles are sometimes seen as safety treatments, but they are also speed management treatments. New York City has a program that systematically treats intersections to lower the speed of left turns. We are not aware of any such systematic program in Massachusetts, although intersection treatments to lower turning speed have been used here in multiple projects.

4.1.3 Emergency Response and Bus Transit Issues

With respect to speed humps and similar vertical deflection devices, emergency response agencies are concerned with delays that increase response time, discomfort (jolts) for their employees, and, for ambulances, discomfort for transported passengers. Transit agencies have similar discomfort concerns for their bus operators and passengers.

For these reasons, policies often disqualify streets with bus routes or that are emergency response routes from having vertical deflection devices. Elsewhere in the United States, cities have instead used bus-friendly speed hump designs, such as 22-ft long speed table (a 6-ft ramp on each side and a table 10 ft wide in the middle), which vehicles can comfortably traverse at about 25 mph. Speed cushions have also been advanced as a bus-friendly variation of speed humps, as discussed earlier.

Crossing islands and centerline hardening do not create a challenge for emergency response or large vehicles (including buses) as long as they provide sufficient space at the intersection for turns. If constructed from materials that can readily be overrun such as flex posts and low-profile plastic C-section curbs, they create no obstruction for emergency vehicles or other large vehicles.

4.1.4 Winter Maintenance

In areas where snow is a concern, municipalities have developed two common approaches to accommodate the measures. In instances where the measures are permanent, plow operators have been made aware of the measures, and they are typically plowed over or around. In instances where temporary measures are used, they are removed prior to the first plowable snow, stored for the winter, and reinstalled in the spring, after the last plowable snow.

Cities with a large number of permanent speed humps (Boston, Somerville, Salem) have found that they are not a problem for snow clearance. However, plow crews report that it is important to know where humps are since they can disappear under a blanket of snow, both with signs and maps. The same applies to raised crossings and raised intersections.

Temporary speed humps made of rubber are not amenable to snow plowing both because of their material and because they have a small vertical edge. They have to be removed every winter, which renders them effective only for several months per year. Salem's experience is that when the humps are removed for winter, speeds return to pre-hump levels. (In the spring, local residents urge the city to hurry up and install them again.) In addition, the removal/replacement process requires labor (in-house or contracted out) and a place to store the temporary devices over the winter.

Treatments that create physical restrictions at intersections including neighborhood traffic circles and crossing islands have to be laid out in a way that allows snowplows and other large vehicles to turn. As part of the design process, Somerville's fire department tested a proposed layout marked with cones and modified it as necessary.

4.1.5 Lessons on Specific Treatments

<u>Speed Humps</u>

Speed humps have proven to be the king of speed management, at least on local streets. Cities that have tried numerous treatments including neighborhood traffic circles and chicanes, including Portland (OR), Boston, and cities in the Netherlands, have found that speed humps are superior—they are more cost-effective and more flexible in placement.

While speed humps leave the gutter clear for drainage, they should extend nearly all the way to the curb because otherwise drivers will place the vehicle's right tires in the gutter/along the curb and only experience part of the hump. In this instance, the full speed reducing impact is not achieved..

A hump that is 12 ft long and 3 inches high with a parabolic profile appears to be the best at, effectively slowing traffic to 15–20 mph without being too uncomfortable. Other dimensions have been tried; however, they have been removed and reinstalled due to bottoming out.

Somerville had an inadvertent experiment with 5-inch-high humps, and found that while the taller humps lowered drivers' speeds more, they also generated too many complaints from residents and emergency response. Other states have made use of 22-ft long speed tables, which are gentle enough to be used with buses and trucks; to our knowledge, they have not been used in Massachusetts, perhaps because they can be comfortably passed at 25 mph, which means average speed between humps will be around 28 or 29 mph.

Temporary speed humps are smaller than permanent humps in both dimensions. Those used in Salem rise only 2 inches and are only 3 ft long, but have proven just as effective as permanent humps in slowing down traffic. However, they must be removed and stored every winter, making them completely ineffective for almost half the year and involving recurring costs for installation and removal. An advantage of temporary humps is that they can be used to pilot a treatment, and can be shifted to a new location when permanent humps are installed.

The average cost of permanent speed humps, installed, is approximately $2,500. Salem's temporary speed humps cost $1,600 apiece, plus $800 for installation by a contractor.

To effectively manage speed between speed humps, they should be spaced approximately 250 ft apart. Recognizing that intersections, driveways, and other features can prevent that ideal spacing from being realized, Boston's guidelines call for spacing in the range of 150–300 ft. In a series of speed humps, a slow point such as a Stop sign or sharp turn can substitute for a hump.

Speed Bumps

Conventional speed bumps, as typically found in parking lot driveways, do not belong on public streets because they are a hazard to cyclists and other two-wheelers, seriously disturb trucks and buses, create loud bangs when a truck passes over, and can seriously damage motor vehicles unless they slow to a crawl.

However, temporary devices marketed as "speed bumps" but with a much far gentler profile than a conventional speed hump have been effectively used on public streets in Mansfield. With a triangular profile that rises only 2 inches over 6 inches and then falls over the next 6 inches, they operate more like speed humps, allowing vehicles to pass at 15 mph and not presenting a hazard to cyclists.

Mainline Crossing Tables

A speed table is a speed hump consisting of a wide, flat top and two ramps - on each approach in the direction of travel. If a pedestrian or bike crossing is carried across the table, it is a crossing table or a raised crossing. A Mainline Crossing Table is a crossing table across a road whose traffic has right of way, as distinguished from a Side Street Crossing Table, which is across the mouth of a minor street under stop control, where traffic has to be going slow already.

Mainline Crossing Tables improve pedestrian comfort and reinforce their priority at unsignalized crossings. Because they have to extend to the curb, they require adding drains on the uphill side, substantially increasing their cost compared to speed humps. Because curb reveal is typically 5 or 6 inches while the desirable height of a speed table is at most 4 inches to avoid vehicle damage, minor regrading is often needed to match the curb height without making the table too high (on Brookline's Winchester Street, raised crossings installed about 20 years ago matched the curb height without regrading, making them about 6 inches high, and led to a significant pavement gouging as vehicles bottomed out due to the height). Since their flat top allows a vehicle's suspension to partly recover from the shock of the up-ramp before encountering the down-ramp shock, drivers will be comfortable at higher speeds unless the ramp is steeper than that of a typical speed hump.

Raised crossings can be installed midblock as well as at intersections. However, at intersections, if raised crossings are desired for all crosswalks, there is a risk that water will pool between them, and so the raised intersection treatment is preferred.

Raised Intersections

Raised intersections slow traffic where low speed is needed the most - typically at locations with significant pedestrian crossing volume. Only a few such treatments in the Commonwealth are known, in Cambridge and Somerville, several of which are all-way Stop controlled, making them somewhat redundant.

In the Netherlands, where Stop signs are uncommon and local street intersections operate under Yield control (every leg yields to traffic on its right), raised intersections are widely used as a means to control the speed of through traffic. Because they function as a very long speed table, effective speed control can be achieved only by making the ramps rather steep.

Neighborhood Traffic Circles

Neighborhood traffic circles—which differ from roundabouts in that they involve no channelization, but are just a circle placed in the center of a (usually small) intersection—with no changes to the curb line - led to a large decrease in crash rates at local street intersections in Seattle in the 1980s, where they were mostly installed at intersections lacking stop signs entirely. They also reduce speed, but only at the treated intersection; to get effective speed management on a street, slow points have to be spaced about 250 ft apart, and this is usually not practical with neighborhood traffic circles. In addition, at T intersections it can be difficult to get sufficient deflection for traffic passing across the top of the T.

In Portland (OR), where a large number of neighborhood traffic circles were installed before 2000, the city has since concluded that they should be considered a treatment for treating high crash rate intersections while for speed control, speed humps are the preferred treatment. Indeed, in recent years they have installed speed humps on streets with neighborhood traffic circles because the circles are too far apart for effective speed control and force too little deflection at T intersections.

Massachusetts has only a few neighborhood traffic circles. Somerville recently installed three as part of its East Somerville project, they are all at intersections will all-way stop control and therefore play only a secondary role in managing the speed of through traffic (their main function is to improve compliance with the stop sign and to make children crossing the street more confident that approaching vehicles will stop), In Brookline, a neighborhood traffic circle on South Street at Intervale Road helps control speed on South Street (Intervale Road has a stop sign), only near that intersection; elsewhere on South Street, speeding remains a problem.

Crossing Islands

Crossing islands that divide a crossing into two parts are primarily a crossing safety treatment. They are highly effective at reducing pedestrian crashes, improving motorist yielding to pedestrians, and making crossings easier for children and slow walkers. Traditionally, US and Massachusetts road design guides recommended them only for multilane roads, but more and more communities in Massachusetts have been installing them on two-lane roads (as is standard practice in Europe).

On a road with one lane per direction, in addition to being a crossing safety treatment, crossing islands can be an effective speed control treatment, with two mechanisms that slow traffic. One is creating a narrow gateway, which is all the more effective when yellow flex posts and vertical "Yield for Pedestrians" signs are installed on either side of the lane. The other is horizontal deflection. Clear geometric guidance for using crossing islands for speed control is not well documented. The Manual on Uniform Traffic Control Devices (MUTCD) guidance on tapers is sometimes followed (17), but it is intended for highways where drivers are not expected to slow down and the long taper it recommends can be comfortably negotiated at speeds well above the speed limit, as one can observe at crossing islands in Amherst (Rt 116 near Amherst College) and in Cambridge (Mt. Auburn Street at Brewer Street). A long taper is also disruptive in terms of parking removal. Furth et al. published a method for the geometric design of crossing islands to achieve a specified target speed (19). It involves removing just enough parking that the trajectory vehicles will have to follow to get around the island will have the degree of curvature that induces drivers to slow to a target speed.

Islands that are too narrow to be considered a pedestrian refuge can still be effective at controlling speed, as on Boston's Amory Street (since they effectively promote motorist yielding to pedestrians, they make crossing safer and easier in spite of not being a refuge island—if a person walks to the median island, drivers in the other direction almost always stop immediately, so that the person crossing never actually waits in the island).

Chicanes Other than Median Islands

This study has not found chicanes in Massachusetts, other than those involving crossing islands or other median islands, that effectively manage speed. Unless a road is divided by a median into single lanes, it is difficult to impose sufficient horizontal deflection to make a driver slow down, since drivers can flatten the curve by encroaching on the opposing direction lane. Approximately 20 years ago (2000), Cambridge installed chicanes on Columbia Street (one lane per direction plus a single parking lane) by alternating the parking lane from one side of the street to the other at intersections. However, when traffic volume was low, drivers continued without reducing speed by encroaching across the centerline, by ignoring the curves. To manage speed, the city had to install raised crossings and raised intersections along Columbia Street, in addition to the chicanes.

Road Diet or Lane Reduction

If a driver can pass, a driver can speed—and therefore the most effective speed management treatment for a multilane road is to reduce it to a single lane per direction, where this layout can carry the traffic volume. In a recent road diet project in Boston (Centre Street in West Roxbury), median speed fell from 29 to 23 mph and the fraction of vehicles going at least 5 mph above the 25-mph speed limit fell from 44% to 6%.

Road diet projects can engender strong opposition based on the fear that the lane reduction will cause congestion, which can hurt businesses, drive traffic onto neighborhood streets, and make life difficult. In fact, lane reductions often do *not* lead to congestion because the standard 4-lane layout often has little more capacity than a layout with one through lane per direction because the inside lane is so often blocked by vehicles waiting to turn left. Traffic modeling to determine the likely impact is essential, but determined opponents may not accept its results, as was the case for the Centre Street project. Strong leadership may be needed to make a project happen when the facts seem clear, but consensus cannot be reached.

Side Street Crossing Table

Side street crossing tables (SSCTs) are effectively raised intersections across the mouth of a minor street where it meets a major street, and minor street traffic is under stop control. This treatment is not intended to slow through traffic; rather, it is intended to lower the speed of vehicles turning into the minor street and thus improve safety for cyclists and pedestrians traveling along the major street.

In the Netherlands, this treatment began as an innovation around 2005 and soon became immensely popular; by 2020, most major-minor intersections in Dutch cities have had SSCTs installed. In the US, the treatment is still rather new. Cambridge included them in its Western Avenue reconstruction project (2015). Boston has installed them as part of several projects including Tremont Street (South End) and Quincy Street (Dorchester) and is making the treatment more and more routine, including it even as part of repaving projects.

The SSCT treatment is easily confused with raised crossings across a road that has right of way, called Mainline Crossing Tables. However, while the latter expect traffic to approach 25–30 mph and attempt to slow it to around 20 mph, vehicles approaching a SSCT are already going slow—either turning into the minor street or approaching a Stop sign. The SSCT aims to slow them to around 5–6 mph, something that requires a much steeper ramp.

In the Netherlands, this distinction is well understood, as the SSCT treatment has a distinct name ("exit construction"). There, SSCT ramps have a slope of 13% and are made of precast concrete blocks for uniformity in slope and for the structural support that is needed with a large and sudden change in slope. In Massachusetts, in contrast, SSCT ramps are made of the same bituminous paving as the road, and their slope is both smaller and highly variable. At some older SSCTs in greater Boston, the ramp is so gentle it is barely noticeable. In Cambridge, SSCTs along Western Avenue have a slope of only 5%. Boston's spec for SSCTs calls for a ramp slope of 8%, but in practice, ramp slopes are highly variable and are often less steep.

Centerline Hardening

Hardening the centerline means installing curbing or an island in the center of a road where it meets an intersection to force turning vehicles to make a squarer turn. The squarer vehicle trajectory has a sharper curve, which lowers turning speed, and passes through crosswalks at an angle close to 90 degrees, thus improving sight lines to crossing pedestrians and reducing pedestrians' exposure.

Centerline hardening can be accomplished by installing plastic or hard rubber C-sections in the centerline, or by creating a median island either the traditional way (with curbs and concrete) or using plastic C-section curbing, as on Boston's Amory Street. Since this treatment is still rather new to Massachusetts and because the last two winters have had so little snow, the impact of these low-profile treatments on plowing operations has not yet been determined.

This page left blank intentionally.

5.0 Conclusions

This research project was conducted to enhance the understanding of speed management impacts locally within the Commonwealth of Massachusetts. Using the primary focus of gauging concerns of both emergency (EMS, fire, police) and public works' personnel, this project developed recommendations for implementation based on best practices. Given the recently released MassDOT Safe Speeds repository, this research provided new local content for practitioners to enhance their potential speed management options. The following conclusion was developed to outline recommendations for roadway treatments that impact roadway speeds, follow design standards, and address the criticality of municipal personnel concerns.

A speed management DPW/EMS effectiveness survey was designed to determine the efficacy of local implementation including their potential challenges and preferences for speed management countermeasures. The survey was disseminated across Massachusetts through various channels including the Baystate Roads listserv, emergency response agency list (EMS and fire), the Department of Fire Services (DFS), and through the Office of Grants and Research—Highway Safety Division (municipal police road safety grant program). There were 175 total respondents ranging from 136 unique cities and towns across Massachusetts and 7 responses from MassDOT personnel. The results from the speed management countermeasure effectiveness survey concluded that while many EMS and DPW personnel have a wide range of opinions regarding each treatment, their combined opinions may not be as far apart as once expected. Having DPW and EMS personnel that have similar objectives and thoughts regarding these measures is critically important to moving them forward.

Next, the team initiated several outreach opportunities with local municipalities to begin understanding the types of treatments that have been implemented across Massachusetts. Speed management conversations were had with several municipalities across the state to begin collecting inventory on countermeasures. This task kick-started the outreach to inventory statewide countermeasures through another survey mechanism. A statewide speed management inventory was disseminated to identify implementation efforts by municipalities through various speed management countermeasures. Again, the Baystate Roads program listserv, as well as through contact lists of MMA and directly to other DPW regional superintendents, were used to distribute this survey. Out of the 351 Massachusetts cities and towns, the research team collected input from 93 responding municipalities. Many of the 93 responding communities provided multiple sources of input, with 3–4 responses at times for one city/town. Out of the 93 municipal responses to the speed management inventory survey, 68 stated that they have implemented at least one countermeasure on their roadways. The remaining 25 communities that responded indicated they have not implemented any speed management countermeasures on their roadways.

In addition to this statewide speed management countermeasure inventory, a set of case studies were developed from across Massachusetts. The research team worked diligently to reach out to municipalities that stated one-or-more speed management countermeasures in their city/town. The team focused on case studies for the following treatments: speed humps, speed bumps, speed cushions, mainline crossing tables, raised intersections, crossing islands, neighborhood traffic circles, road diets (2 to 1 through lanes), other road narrowing measures, SSCTs, and centerline or corner hardening. Notably, curb extensions at intersections and chicanes were left out of the case study approach. The case studies collected in this research project identified examples across Massachusetts from both suburban and urban context, as well as across both low/medium/high volume roadways. While some municipalities have integrated more speed management countermeasures than others, this process exemplified the progress being made statewide to improve roadway safety with innovation and novel design approaches.

Regarding winter maintenance and emergency response impacts, this research project identified some common themes across Massachusetts:

- For emergency response, vertical deflection measures (such as speed humps/bumps) many emergency personnel have concern with delays that increase response time, discomfort for both drivers and for instance, ambulance passengers. Other cities around the United States have alleviated some of these concerns with longer "bus-friendly" speed humps that still decrease vehicle speed without the sudden up and down movement. More so, crossing islands and centerline hardening have not created many challenges for emergency response vehicles, as long as they provide sufficient turning space at intersections. These countermeasures can even be designed with traversable materials to lessen the burden on emergency vehicles, whiles still forcing passenger vehicles to slow down at the turn. Many of the cities and towns noted that beginning with treatment in school zones typically worked in gaining resident support. Once the successes were proven in these locations there was more support to implement other countermeasures within town.
- For winter maintenance, vertical deflection measures continue to provide the greatest pushback. That said, cities such as Boston, Somerville, and Salem have found that as long as the winter maintenance personnel are made aware of the location for vertical measures, there have been fewer issues. While temporary speed humps have been applied in certain places, the annual installation and removal of the countermeasures have yielded burden on towns resources.
- Other speed management countermeasures such as neighborhood traffic circles and crossing islands require forethought and communication with both emergency and winter personnel. These treatments that create physical restrictions at intersections have to be laid out to allow snowplows and other large vehicles to turn. Somerville, for instance, invited both their fire department and DPW to the site and tested the proposed layout marked with cones.

The focus of speed management and traffic calming requires constant attention within each city and town in Massachusetts. While many local DPW and EMS officials have pushback toward certain measures, the research conducted within this report highlights the advantages of all speed management countermeasures. Future work should continue to inventory the ongoing progress of implementation across Massachusetts, while also obtaining the before and after data to back up the effort.

6.0 References

1. Massachusetts Department of Transportation. (n.d.) *Safe Speeds.* Commonwealth of Massachusetts. https://www.mass.gov/safe-speeds

2. National Highway Traffic Safety Administration. 2006. *Uniform Guidelines for State Highway Safety Programs—Highway Safety Program Guideline No. 19.* Washington D.C. https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/812007g-hspg19-speedmanagement.pdf

3. National Highway Traffic Safety Administration, Federal Highway Administration, and Federal Motor Carrier Safety Administration. 2005. *Speed management strategic initiative*. (Report No. DOT HS 809 924). Washington, DC.

4. National Highway Traffic Safety Administration, Federal Highway Administration, and Federal Motor Carrier Safety Administration. 2014. *Speed management program plan*. (Report No. DOT HS 812 028). Washington, DC. https://doi.org/10.21949/1525819

5. USDOT. (n.d) *Traffic Calming ePrimer. Speed Management*, FHWA. Washington, D.C. https://highways.dot.gov/safety/speed-management/traffic-calming-eprimer

6. Bagdade, J., Nabors, D., McGee, H., Miller, R., and Retting, R. 2012. *Speed Management: A Manual for Local Rural Road Owners*. Publication FHWA-SA-12-027. Federal Highway Administration, Office of Safety, Washington D.C. https://safety.fhwa.dot.gov/local_rural/training/fhwasa010413spmgmt/speedmanagementguide.pdf

7. Institute of Transportation Engineers. 2020. *Noteworthy Speed Management Practices*. Publication FHWA-SA-20-047. Federal Highway Administration, Office of Safety, Washington, D.C. https://www.ite.org/pub/?id=BCD0260A-BF52-D7D0-44BD-1C3CBE531AE8

8. Institute of Transportation Engineers. 2023. *Safe System Approach for Speed Management.* Publication FHWA-SA-23-002. USDOT, Federal Highway Administration, Washington, D.C. https://highways.dot.gov/sites/fhwa.dot.gov/files/Safe_System_Approach_for_Speed_Management.pdf

9. North Carolina Highway Safety Research Center, VHB, and Toole Design Group. 2013. *Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE).* Federal Highway Administration, Office of Safety, Washington D.C. http://www.pedbikesafe.org/pedsafe/index.cfm

10. Delaware Department of Transportation. 2012. *Delaware Traffic Calming Design*

Guide—2012 Edition. DelDOT Traffic Section. https://deldot.gov/Publications/manuals/traffic_calming/pdfs/Delaware_TrafficCalmingDesignManual.pdf?cache=1676317889580

11. New York City Department of Transportation. 2020. *NYC DOT Street Design Manual—Third Edition.* https://www.nycstreetdesign.info/sites/default/files/2020-03/FULL-MANUAL_SDM_v3_2020.pdf

12. City of Boston. (n.d.) *Making Neighborhood Streets Safer*. Boston Transportation Department, Boston, MA. https://www.boston.gov/departments/transportation/making-neighborhood-streets-safer

13. National Association of City Transportation Officials (NACTO). Urban Street Design Guide. 2013. Available online: https://nacto.org/publication/urban-street-design-guide/

14. Utah Department of Transportation (UtahDOT). 2021. Speed Management Studies. [Fact Sheet]. https://maps.udot.utah.gov/wadocuments/Data/Region4/SR_258_and_SR_118_Corridor_Study/Speed%20Management%20Info%20Sheets_2021_06_24.pdf.

15. Vermont Agency of Transportation (VTrans). 2023. *Traffic Safety Toolbox—Speeding Countermeasures Toolbox for Vermont.* VTrans Research Section. https://vtrans.vermont.gov/sites/aot/files/documents/20230606%20Toolbox.pdf

16. Sullivan, J., and Rowangould. D. 2023. Speeding Countermeasures for Vermont. Vermont Agency of Transportation (VTrans), SPR Research Section, Barre, VT. https://vtrans.vermont.gov/sites/aot/files/documents/20230606%20Speeding%20Countermeasures%20for%20Vermont%20Final%20Report.pdf.

17. *Manual on Uniform Traffic Control Devices, 2009 Edition*. Federal Highway Administration, U.S. Department of Transportation, Washington, D.C., 2009.

18. Federal Highway Administration. 2017. *Speed Management Countermeasures—More than Just Speed Humps.* USDOT, Washington, D.C. https://highways.dot.gov/sites/fhwa.dot.gov/files/2022-06/fhwasa16077.pdf

19. Furth, P.G., Tahmasebi, M., Shekari, S., Jackson, J., Sha, Z., Alsharif, Y., 2021. Designing Crossing Islands for Speed Control and Intersection Safety on Two-Lane Collectors and Arterials. Transp. Res. Rec. J. Transp. Res. Board 2675, 898–909. https://doi.org/10.1177/03611981211004978

20. Hochmuth, J., Van Houten, R., 2018. Influence of Advanced Placement of the In-Street Sign Gateway on Distance of Yielding from the Crosswalk. Transp. Res. Rec. 2672, 13–20. https://doi.org/10.1177/0361198118776480

7.0 Appendices

The pages in this section contain the following information as appendices:

- Appendix A. Survey #1: Effectiveness
- Appendix B. Survey #2: Inventory
- Appendix C. Speed Management Conversation Dialogue
- Appendix D. International Case Studies and Industry Spotlight (https://www.umasstransportationcenter.org/Document.asp?DocID=1363)
- Appendix E. Statewide Case Studies (https://www.umasstransportationcenter.org/Document.asp?DocID=1363)
- Appendix F. Speed Management Cut-Sheets (https://www.umasstransportationcenter.org/Document.asp?DocID=1363)

Appendix A: Survey #1 Effectiveness

UMass Amherst

Default Question Block

Speed along the road is a critical factor in determining both the frequency and severity of crashes. MassDOT is committed to helping realize safer speeds across the Commonwealth and is actively implementing speed management practices. Please complete this survey and provide feedback related to the implementation of typical speed management measures. Please know that your responses will remain completely anonymous.

Name:

Email:

Town/Affiliation:

Occupation:

Public Work (or Similar)

Emergency Service (or Similar)

Other

How effective do you feel the flowing Speed Management Countermeasures are (**see link at bottom of page for more information on each**):

	Not effective	Slightly effective	Moderately effective	Very effective
	0 1 2	3 4 5	6 7	8 9 10
Speed Humps/Bumps/Cushions				
Raised Intersections & Raised Pedestrian Crossings				
Curb Extensions & Chicanes				
Mini-Roundabouts & Neighbourhood Traffic Circles				
Road Diets				
Optical Measures				
Speed Feedback Signs				

[Speedmgmt pdf safespeeds survey]

In a few words, please explain why you found Speed Humps/Bumps/Cushions less effective.

In a few words, please explain why you found Speed Feedback Signs less effective.

In a few words, please explain why you found Curb Extensions & Chicanes less effective.

In a few words, please explain why you found Mini-Roundabouts & Neighbourhood Traffic Circles less effective.

In a few words, please explain why you found Road Diets less effective.

In a few words, please explain why you found Raised Intersections & Raised Pedestrian Crossings less effective.

In a few words, please explain why you found Optical Measures less effective.

In a few words, please explain why you found Speed Humps/Bumps/Cushions more effective

In a few words, please explain why you found Speed Feedback Signs more effective.

In a few words, please explain why you found Curb Extensions & Chicanes more effective.

In a few words, please explain why you found Mini-Roundabouts & Neighborhood Traffic Circles more effective.

In a few words, please explain why you found Road Diets more effective.

In a few words, please explain why you found Raised Intersections & Raised Pedestrian Crossings more effective.

In a few words, please explain why you found Optical Measures more effective.

Please rank the following Speed Management Countermeasure in regard of maintenance from most challenging (1) to least challenging (7).

Speed Hump/Bumps/Cushion

Raised Intersections & Raised Pedestrian Crossings

Curb Extensions & Chicanes

Mini-Roundabouts & Neighbourhood Traffic Circles

Road Diets

Optical Measures

Speed Feedback Signs

Please rank the following Speed Management Countermeasure in the order of implementation from most challenging (1) to least challenging (7).

Speed Hump/Bumps/Cushion

Raised Intersections & Raised Pedestrian Crossings

Curb Extensions & Chicanes

Mini-Roundabouts & Neighbourhood Traffic Circles

Road Diets

Optical Measures

Speed Feedback Signs

Please rank the following Speed Management Countermeasure in the order of implementation from most challenging (1) to least challenging (7).

Speed Hump/Bumps/Cushion

Raised Intersections & Raised Pedestrian Crossings

Curb Extensions & Chicanes

Mini-Roundabouts & Neighbourhood Traffic Circles

Road Diets

Optical Measures

Speed Feedback Signs

In your opinion, which of the following present challenges regarding the following speed management countermeasures? Check all that apply. Select 'None' if there no challenges expected.

	Winter Maintenance	Emergency Response	Implementation Cost	Routine Maintenance	None
Speed Hump/Bumps/Cushions	☐	☐	☐	☐	☐
Raised Intersections & Raised Pedestrian Crossings	☐	☐	☐	☐	☐
Curb Extensions & Chicanes	☐	☐	☐	☐	☐
Mini-Roundabouts & Neighborhood Traffic Circles	☐	☐	☐	☐	☐
Road Diet	☐	☐	☐	☐	☐
Optical Measures	☐	☐	☐	☐	☐
Speed Feedback Signs	☐	☐	☐	☐	☐

Please rank the following Speed Management Countermeasure in regard of maintenance from most challenging (1) to least challenging (7).

Speed Hump/Bumps/Cushion

Raised Intersections & Raised Pedestrian Crossings

Curb Extensions & Chicanes

Mini-Roundabouts & Neighbourhood Traffic Circles

Road Diets

Optical Measures

Speed Feedback Signs

Please rank the following Speed Management Countermeasure in regard of maintenance from most challenging (1) to least challenging (7).

Speed Hump/Bumps/Cushion

Raised Intersections & Raised Pedestrian Crossings

Curb Extensions & Chicanes

Mini-Roundabouts & Neighbourhood Traffic Circles

Road Diets

Optical Measures

Speed Feedback Signs

Please rank the following Speed Management Countermeasure in the order of implementation from most challenging (1) to least challenging (7).

Speed Hump/Bumps/Cushion

Raised Intersections & Raised Pedestrian Crossings

Curb Extensions & Chicanes

Mini-Roundabouts & Neighbourhood Traffic Circles

Road Diets

Optical Measures

Speed Feedback Signs

Would you be interested in following up with the researchers to discuss more about these topics?

Would you be interested in participating in a regional forum (with virtual option) to discuss the pros/cons of these countermeasures in Massachusetts

Any additional comments or feedback you would like to provide?

Powered by Qualtrics

Appendix B: Survey #2 Inventory

UMass Amherst

Default Question Block

MassDOT is seeking information regarding the implementation of various Speed Management countermeasures installed throughout Massachusetts. The following presents a short list of questions aimed at identifying the countermeasures that have specifically been implemented in your city/town.

Name:

Email:

Town/City:

What Speed Management Countermeasures have been installed in your city/town? Select all that apply. (Click image to enlarge photo)

Speed Humps

Speed Cushions

Raised Pedestrian Crossing (Speed Table)

Raised Intersections

Median Islands (with horizontal Deflection)

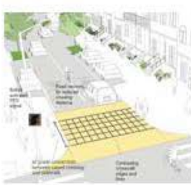
Chicanes (other than median islands)

Neighborhood traffic circles

Road Diets

Other road narrowing (includes curb extensions, lane markings, striping bike lanes, but without changing # of travel lanes)

Raised Pedestrian Crossing across side street with STOP control



Centerline or corner hardening (at an intersection)

Curb Extensions at intersection

Our city/town has not installed any of the above speed management countermeasures

---

Do you have before/after speed data collected from any of your speed management countermeasures?

Yes

No

Other

Do you have any design specs available for your speed management countermeasures?

Yes

No

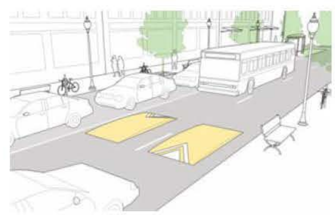
How many installations/examples of **Speed Humps** do you have in your city/town?

Zero

1 to 5

More than 5

How many installations/examples of **Speed Cushions** do you have in your city/town?



Zero

1 to 5

More than 5

How many installations/examples of **Raised Pedestrian Crossings** do you have in your city/town?

Zero

1 to 5

More than 5

How many installations/examples of **Raised Intersections** do you have in your city/town?

Zero

1 to 5

More than 5

How many installations/examples of **Median Islands** do you have in your city/town?

Zero

1 to 5

More than 5

Other

How many installations/examples of **Chicanes** do you have in your city/town?

Zero

1 to 5

More than 5

How many installations/examples of **Neighborhood Traffic Circles** do you have in your city/town?

Zero

1 to 5

More than 5

How many installations/examples of **Road Diets** do you have in your city/town?

Zero

1 to 5

More than 5

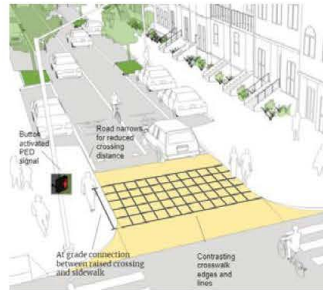
How many installations/examples of **Other Road Narrowing** do you have in your city/town? (For example, curb extensions along a corridor, lane markings or striping without changing # of travel lanes)

Zero

1 to 5

More than 5

How many installations/examples of **Raised Pedestrian Crossings (side street with STOP control)** do you have in your city/town?



Zero

1 to 5

More than 5

How many installations/examples of **Centerline Hardening** do you have in your city/town?

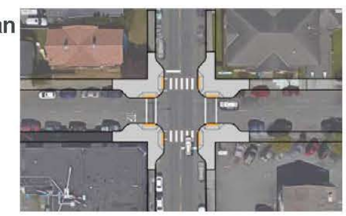
Zero

1 to 5

More than 5

Other

How many installations/examples of **Curb Extensions (at an intersection)** do you have in your city/town?



Zero

1 to 5

More than 5

Please share below the location of two installations/examples (of any/all measures), with a preference for (1) those with before/after data, (2) those with design specs, and (3) those on a higher traffic street.

Please clarify street address and/or Google imagery link for each example.

Has your city/town removed any speed mgmt countermeasures in the last 10 years? If so, please briefly explain the location and reason.

Yes

No

Appendix C: Speed Management Conversations

Speed Management Conversation Guide Summary

Conversation Details	City of Salem Nov 22, 2023 Via Zoom
Conversation Attendees	Christina Hodge (City of Salem, Asst Transportation Director) Francis Tainter

The following is a summary of the dialogue with the city of Salem on November 22, 2023. The city of Salem was awarded $100,000 through the Shared Streets Grant to provide the following:

The project will introduce **protected bicycle lanes**, **traffic calming elements** (such as **chicanes** and **lane narrowing**), an **additional crosswalk**, and **improved access to bus stops** on North Street between Highland Street and Franklin Street. These, **along with other striping and tactical elements**, will help to reduce vehicle speeds, improve pedestrian and cyclist comfort and safety, and increase access for nonvehicular modes of travel between North Salem and the Downtown core. The project will also include the potential installation of a BlueBikes station at the corner of North Street at Liberty Hill Avenue and Symonds Street to better connect this neighborhood with the surrounding BlueBikes network.

Details from Discussion:
Salem is working to better connect North Salem to the downtown core through a revitalization of the North Street Corridor (starting from the Peabody town line). Roughly a 1-mile corridor of road diet, adding a bike lane in each direction, painted parking and hatch marks to narrow travel lanes. That said, 1 travel lane was still kept in each direction. The final design specs, including the various strategies for paint, post, and curb designs around intersections and parking.

Salem developed a "traffic calming working group" several years ago, mainly assisting with the coordination of paint and post jobs (small $$$ projects). While it was initially application based, it quickly become a overwhelmingly burdensome process. The team is working to establish a prioritization tool that will allow for more equitable improvements city-wide. There has been some emergency personnel push back from installation of flex posts (and the city mentioned that they can actually be quite costly[?]).

Salem has a temp traffic calming program that allows for speed humps/bumps to be installed during the spring/summer and removed in fall/winter. Work with the company Neighborways to help prioritize locations where these installations are needed. Costly maintenance though, with need to install and tear-down, and looking for more permanent installations, but there may be some push back from EMS folks on where they go.

Speed Management
Conversation Guide Summary

Conversation Details	City of Somerville Nov 29, 2023 (Via Zoom)
Conversation Attendees	Brad Rawson (City of Somerville, Director of Transportation and Infrastructure) Francis Tainter and Peter Furth

The following presents a summary of the dialogue had with the City of Somerville on November 29, 2023:

Somerville's newest development in traffic calming is Neighborhood traffic circles. Flagship project for the year has been Pearl St (0.5 mi, in E Somerville, Rt 16 to Mt Vernon). Along with it, Cross Street (perpendicular to Pearl). Safe Routes to School was imperative. 3 neighborhood circles. Purpose of a n-hood circle: to reinforce all-way stop. Not mini-roundabouts; no need to go counterclockwise. Installed in the last 3 months; no after data yet. The circle on Cross St has a manhole in the middle, so no plantings; the two circles on Pearl have plantings in the center.

Brought in Fire dept with cones and spray paint and tested how apparatus went around; that informed design. DPW also came out, and, for instance, informed of need for 12 ft clear at a certain spot for snow equipment. After it was constructed, DPW said they'd been mistaken, needed 14 ft clear. The contractor came out, moved curbs to achieve 14 ft clear. They plan to make more neighborhood traffic circles. Can provide standard details, updated to the input described earlier from FD and DPW (see Pearl Street case study). There was some controversy with operations professionals (EMS, DPW). It was not a question of IF they would install speed management devices (because they are vital to the City's Vision Zero goals), but HOW. So they worked productively with those professionals. Also, some negative press, but they navigated their way through. Public support is critical; they work hard at preventing backlash. In recent elections, candidates supporting Safe Streets policies outpolled those against the policies by a margin of 4 to 1.

Online there's a map of permanent traffic calming measures, built and planned: Includes only stuff from 2021 and later. Until 2019, didn't have staff to do anything beyond lines and signs, which still do a lot to reduce speed. Now, they have scaled up so they can manage contractors that move granite and asphalt. More than 50 solutions per year in a city of 4 sq miles. Speed hump speed effect (measured about 100 ft after). Added speed humps to PH Blvd, one that's 3" high, one that's 5". First responders & plowers push against 5-inch humps where we asked. The 3" is from 2 months ago. ADT = 8000. 9.5 ft lanes with bike lanes.

Policy on Collectors: FD said, Morrison (2500 ADT) is not a primary response route, so 5" hump, while is said Central is, so 3" hump. No humps on bus routes (uncomfortable), but they will do raised crosswalks, even with low spacing (200 ft). Can provide raw data on these and other measures. They have an analytics team in house, working on reporting on policy development; annual reports will be coming out in next 2–3 months. Older one with lines & signs era. City VZ home page.

Speed Management
Conversation Guide Summary

Conversation Details	City of Winchester Nov 22, 2023 (Via Zoom)
Conversation Attendees	Matthew Shuman (Town of Winchester, Town Engineer) - previously w/Watertown Francis Tainter Peter Furth

The following presents a summary of the dialogue had with the City of Winchester on November 22, 2023:

In Watertown (formerly), set up a working group for all the concerned officials (police, fire, …); trying to set up the same in Winchester. Police have a different perspective, thinks of things I had not thought of such as solar glare being a historic issue at a location, knowing the history of speed enforcement.

Roundabout at Common Street (5 legs), Watertown: had to revise curbs so that fire apparatus could get through. In another place, FD objected to an intersection design, saying that be hard for them to get through in a certain direction, but in discussion admitted that they would never use that route because the approach roadway was even tighter than the proposed intersection.
What Winchester has done: Speed humps on one street (a pair); T-ing up an intersection (1 was done recently; some others have been done in the past). They are now planning projects around Lynch School—when a school is renovated, they do traffic calming around it as well. That will include a lot of elements: speed humps, raised crossings, etc. There's a working group with DPW, fire, police. Humps are new, so no feedback yet for plowing. Expecting it will be as it was in Watertown with curb extensions—snowplow operators object at first, but they become good at it and in the end is not a problem. They changed bollard spacing for one project so that a loader could get through to the sidewalk for snow removal.

Citizens pushing for traffic calming point out that Medford put in speed tables on Rt 38, which is a bus route. Winchester has adopted a 10 ft lane, which allows bike lanes. Before that policy change, they required 11 ft lanes, and could not do bike lanes on Main Street. Now they have bike lanes and 10 ft lanes. MBTA has not complained.

There used to be median islands on Highland Street outside the hospital. Note that in smaller communities like Winchester, road commissioners are the selectboard, not highway experts. Selectboard had doubts; ultimately, got denied at Town Meeting. Cyclists objected, saying they would be pushed bikes into traffic (the street has narrow shoulders that bikes use)—had a big influence at Town Meeting.

Appendix D: International Case Studies and Industry Supplier Spotlight

Appendix D may be downloaded from the following link:
https://www.umasstransportationcenter.org/Document.asp?DocID=1363.

Appendix E: Speed Management Case Studies across Massachusetts

Appendix E may be downloaded from the following link:
https://www.umasstransportationcenter.org/Document.asp?DocID=1363.

Appendix F: Speed Management Cut-Sheets

Appendix F may be downloaded from the following link:
https://www.umasstransportationcenter.org/Document.asp?DocID=1363.