



U.S. Department of Transportation
Federal Highway Administration



Maine Department of Transportation

ACTION PLAN FOR IMPLEMENTING PEDESTRIAN CROSSING COUNTERMEASURES AT UNCONTROLLED LOCATIONS



Photo: Toole Design Group



Acknowledgments

This Safety Action Plan was developed by a group of individuals that are committed to reducing the number of lives taken prematurely on our nations' roadways.

Working Group Individuals:

MaryAnn Hayes

Jeff Tweedie

Pete Coughlan

Tim Soucie

Aurel Gorneau II

Steve Bodge

Brad Foley

Scott Rollins

Gerry Audibert

Steve Davis

Wayne Emington

Patrick Adams

Brian Keezer

Support From:

Patrick Adams, MaineDOT Bicycle and Pedestrian Coordinator

Wayne Emington, FHWA Division Office, Augusta, Maine

This Safety Action Plan was developed with funding and assistance
from the Federal Highway Administration (FHWA)



U.S. Department of Transportation
Federal Highway Administration



Table of Contents

Executive Summary	iv
Introduction and Background	1
Mission, Goals, and Recommendations	4
Prioritizing Pedestrian Crossing Improvements	6
Marked Crosswalks at Uncontrolled Locations	9
Toolbox: Pedestrian Crossing Countermeasures at Uncontrolled Locations	11
Policy Recommendations	18
Glossary	21
Appendix A: CRF and CMF Summary Table	23
Appendix B: Locations of Pedestrian Crashes	24
Resources	25

List of Figures

Figure 1: Portland Pedestrian Crashes 2008 - 2012: 24

List of Tables

Table 1. Application of pedestrian crash countermeasures by roadway feature. 12

Table 2. Safety issues addressed per countermeasure..... 13

Table 3. CRFs and CMFs by countermeasure..... 23

List of Abbreviations

AADT	Annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	Average daily traffic
CMF	Crash modification factor
CRF	Crash reduction factor
EDC	Every Day Counts
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
GIS	Geographic information system
HSIP	Highway Safety Improvement Program
HSP	Highway Safety Plan
MUTCD	Manual on Uniform Traffic Control Devices
NHTSA	National Highway Traffic Safety Administration
PHB	Pedestrian Hybrid Beacon
RSA	Road Safety Audit
SHSP	Strategic Highway Safety Plan
STBG	Surface Transportation Block Grant
STEP	Safe Transportation for Every Pedestrian
TZD	Toward Zero Deaths
VZ	Vision Zero

Executive Summary

This Plan has been developed as part of the Safe Transportation for Every Pedestrian (STEP) initiative and targets five specific countermeasures for improving pedestrian safety at uncontrolled intersections. STEP is a Federal Highway Administration (FHWA) effort which is part of the Every Day Counts (EDC). The Maine Department of Transportation (MaineDOT) is leading this initiative in the state in coordination with the FHWA Division Office.

This Plan recommends actions that when implemented may reduce the number and rate of pedestrian crashes, fatalities, and injuries on the State highway system. If emulated by local transportation agencies, these benefits may also be realized on local roads. STEP has five stages. Maine was placed in the second stage (Development) with an intent of moving up one stage in the short-term (to Demonstration) through the implementation of the recommendations of this plan.

The plan was developed with direct input from MaineDOT - two work sessions were held with Maine staff to review existing practices and policies impacting crossings, and to develop the recommended actions reflected in this Plan.

One major recommendation was first conceptualized by MaineDOT staff after the first meeting and relates to many of the other recommendations: creation of a countermeasure toolbox which would describe in detail each countermeasure expressing its benefits and providing guidance on how the countermeasure should be used. At first the toolbox would contain the STEP countermeasures, but would be expanded in the future to include proven countermeasures for signalized

intersections and keeping pedestrians safe while they are walking along roadways. In addition, the toolbox will include the multi-step process on how to identify, prioritize, and select the appropriate countermeasures. While this toolbox is intended for use by MaineDOT staff to assist in the decision-making process, it will also have the potential to be an important resource for local communities and planning organizations.

Another priority listed in the plan was the formation of better cost-benefit information to supplement the crash reduction factors (a cornerstone of STEP approach). Having this information will lead to improved knowledge-based decisions on where to best target safety dollars.

MaineDOT also identified several other priorities. The Department is interested in expanding its bicyclist and pedestrian count program. This can be especially beneficial to STEP to measure the before and after usage at intersections featuring newly added pedestrian safety countermeasures.

Of the five specific countermeasures, MaineDOT is currently making widespread use of just one of them – enhancing crosswalks. The plan is recommending that the Department expand the use of the other countermeasures – raised crosswalks, median refuge islands, pedestrian hybrid beacons, and road diets. In the initial stages of the implementation of these four, it is expected that the Department will adopt guidance for their use, seek demonstration locations, and work closely with local governments where their application on local roads might precede their use on the state highway system.

Action Plan for Implementing Pedestrian Crossing Countermeasures at Uncontrolled Locations

The main means of implementation of STEP is through the inclusion of countermeasures as part the design of highway projects. As MaineDOT reviews resurfacing projects (as part of complete streets and Americans with Disabilities Act), STEP crossing measures should be reviewed as part of this process. Of the five countermeasures, enhancing crosswalks are the most universally viable option for resurfacing projects because of the low cost and ease of implementation.

However, if certain state highway projects are considered for road diets, additional small to moderate-scale STEP measures (pedestrian refuge islands and corner bump-outs) may become feasible. Including minor STEP treatments as part of resurfacing projects add only a small fraction of the overall cost of the project and folding in countermeasures can allow the Department to take advantage of lower unit costs at the time of project construction.

1

Introduction and Background

Pedestrians are among the most vulnerable road users, accounting for approximately 16 percent of all roadway fatalities nationally in 2016, per the Fatality Analysis Reporting System (FARS). Pedestrians are especially vulnerable at non-intersection locations where 72 percent of pedestrian fatalities occur.¹ In the State of Maine, pedestrians account for approximately 10 percent of all roadway fatalities. This reflects a significant increase during the past three years. Before 2015, pedestrian fatalities were averaging about eight percent per year.

Why Create this Pedestrian Safety Action Plan?

The purpose of this pedestrian safety action plan (“Plan”) is to provide specific recommendations for improving conditions for walking at uncontrolled pedestrian crossing locations, which occur where sidewalks or designated walkways cross a roadway at a location where no traffic control (e.g., traffic signal or stop sign) is present. These common crossing types occur at intersections (where crosswalks may be marked or unmarked) and at non-intersection or midblock locations (where crosswalks must be marked). Overall, uncontrolled pedestrian crossing locations correspond to higher pedestrian crash rates than controlled locations, often due to inadequate

Every Day Counts (EDC)

The STEP initiative is part of EDC. In 2009, the Federal Highway Administration (FHWA) launched Every Day Counts (EDC) in cooperation with the American Association of State Highway and Transportation Officials (AASHTO) to speed up the delivery of highway projects and to address the challenges presented by limited budgets. EDC is a state-based model to identify and rapidly deploy proven but underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce congestion and improve environmental sustainability.

Proven innovations through EDC facilitate greater efficiency at the state and local levels, saving time and resources that can be used to deliver more projects for the same money. By advancing 21st century solutions, the highway community is making every day count to ensure our roads and bridges are built better, faster and smarter.

HOW IT WORKS

Through the EDC model, FHWA works with state and local transportation agencies and industry stakeholders to identify a new collection of innovations to champion every two years. Innovations are selected collaboratively by stakeholders, taking into consideration market readiness, impacts, benefits and ease of adoption of the innovation. After selecting the EDC technologies for deployment, transportation leaders from across the country gather at regional summits to discuss the innovations and share best practices. These summits begin the process for states, local public agencies and Federal Lands Highway Divisions to focus on the innovations that make the most sense for their unique program needs, establish performance goals and commit to finding opportunities to get those innovations into practice over the next two years.

Throughout the two-year deployment cycle, specifications, best practices, lessons learned and relevant data are shared among stakeholders through case studies, webinars and demonstration projects. The result is rapid technology transfer and accelerated deployment of innovation across the nation.

¹ National Highway Traffic Safety Administration. (2017). Fatality Analysis Reporting System (FARS) Encyclopedia. Retrieved from <https://www-fars.nhtsa.dot.gov/QueryTool/QuerySection/SelectYear.aspx>

pedestrian crossing accommodations.²

By focusing on uncontrolled crossing locations, MaineDOT will address a significant safety problem and improve crossing comfort for pedestrians of all ages and abilities. Recommendations in this Plan follow Safe Transportation for Every Pedestrian (STEP) guidance for implementing lower-cost countermeasures that can be deployed based on specific needs. They have a proven record of reducing crashes and represent underutilized innovations that can have an immediate impact.

This Plan also builds on existing State goals for improving safety, examining existing conditions, and using a data-driven approach to match countermeasures with demonstrated problem locations. Plan recommendations are structured to allow for immediate implementation.

What is STEP

This Plan has been developed as part of the STEP initiative and targets five specific countermeasures (described later in this guide) for improving pedestrian safety at uncontrolled intersections. STEP is a Federal Highway Administration (FHWA) initiative which is part of the Every Day Counts (EDC) Round 4 effort. EDC is a FHWA-State DOT collaboration which focuses on underutilized innovations. Every two years a new set of initiatives is identified. STEP was identified as part of the fourth round of EDC innovations because of the cost-effectiveness of the countermeasures it offers with known safety benefits.

State Participation in STEP

The Maine Department of Transportation (MaineDOT) is leading this initiative in coordination with the FHWA Division Office. This Plan recommends actions that when implemented can help reduce the number and rate of

pedestrian crashes, fatalities, and injuries on the State highway system. If emulated by local transportation agencies, these benefits may also be realized on local roads.

How this Safety Action Plan was Developed

This Plan is intended to be used in conjunction with two US DOT, FHWA publications:

EDC GUIDE FOR IMPROVING PEDESTRIAN SAFETY AT UNCONTROLLED CROSSING LOCATIONS (2018) (EDC GUIDE)

This guide assists State or local transportation or traffic safety departments that are considering developing a policy or guide to support the installation of countermeasures at uncontrolled pedestrian crossing locations. This document provides guidance to agencies, including best practices for each step involved in selecting countermeasures. By focusing on uncontrolled crossing locations, agencies can address a significant national safety problem and improve quality of life for pedestrians of all ages and abilities. Agencies may use this guide to develop a customized policy or to supplement existing local decision-making guidelines.

FHWA HOW TO DEVELOP A PEDESTRIAN AND BICYCLE SAFETY ACTION PLAN (2017)

The purpose of this guide is to assist agencies in developing and implementing a safety action plan to improve conditions for bicycling and walking. The plan lays out a vision for improving safety, examining existing conditions, and using a data-driven approach to match safety programs and improvements with demonstrated safety concerns. This guide will help agencies enhance their existing safety programs and activities, including identifying safety concerns and selecting optimal solutions. It will also serve as a reference for improving pedestrian and bicycle safety through a multidisciplinary and collaborative approach to safety, including street designs and countermeasures, policies, and behavioral programs.

The Plan report also references other FHWA publications, American Association of State Highway Transportation Officials (AASHTO) guides, the

² Federal Highway Administration. Guidebook on Identification of High Pedestrian Crash Locations. (2018). Retrieved from <https://www.fhwa.dot.gov/publications/research/safety/17106/17106.pdf>

Manual of Uniform Traffic Control Devices (MUTCD), and relevant State publications for additional information. The MUTCD will be one of the most important resources since it sets the standards for how transportation engineers will design and apply traffic control devices, including signage, roadway markings, and intersection signal controls. A complete list of referenced documents and other resources is found at the end of this document.

The three-part process used to develop this Plan helps insure that recommended actions represent the best use of agency resources:

1. **Discovery:** Current policies, plans, design guidance, prioritization methodologies, crash data and implementation strategies were identified and assembled with the assistance of MaineDOT and FHWA staff.
2. **Two Work Sessions:** Maine staff along with a FHWA representative met to review materials assembled during the Discovery phase, and to develop the recommended actions reflected in this Plan. One follow-up meeting was held on December 6, 2017 to review results and to discuss crash identification and prioritization techniques. The group also identified key priorities.
3. **Draft and Final Plan:** Based on a review of existing materials and conditions combined with additional details identified during the two

sessions, a draft Action Plan was developed, reviewed by MaineDOT and FHWA Division Office, then revised and finalized. This Plan will allow for consideration of pedestrian safety improvements to be incorporated in other MaineDOT plans; Strategic Highway Safety Plan (SHSP), Long Range Transportation Plan (LRTP), and Complete Streets Policy.

The recommendations in this Plan provide a roadmap for reducing the number and rate of pedestrian crashes, fatalities and injuries. The recommendations identify current policies and practices that should be continued, as well as others that should be modified or added to better facilitate implementation.

Building a safe and connected pedestrian network requires consideration of topics beyond what is included in this Plan. There are other engineering-based countermeasures that exist for signalized intersections and for walking along streets and highways. Pedestrian crossings near schools are not specifically addressed in the Plan and will be subject to other State guidance. Crossing requirements per the Americans with Disabilities Act (ADA) are not specifically addressed in this Plan, although ADA requirements must be addressed as part of any pedestrian crossing improvements project. Resources or further guidance are provided at the end of this Plan.

2

Mission, Goals, and Recommendations

Mission (or Vision)

The transportation system should accommodate people of all ages and abilities, including people too young to drive, people who cannot drive, and people who choose not to drive. Pedestrians can be expected to walk along and across all roadways, except where prohibited. Walking is an important element of a multimodal transportation system that supports all users. Well-designed, well-maintained facilities, with low crash frequencies and severities, are important to creating safe and convenient walking conditions.

MaineDOT is committed to improving safety for all travel modes, including pedestrians. This commitment is reflected in the agency mission:

“To responsibly provide our customers the safest and most reliable transportation system possible, given available resources.”

It is more clearly reflected in its Complete Streets Policy (currently being updated):

“is to help ensure that all users of Maine’s transportation system—our customers—including bicyclists, pedestrians, people of all ages and abilities, transit users, and motor vehicle users, have safe and efficient access to the transportation system.” and

“MaineDOT strongly supports a multimodal transportation system, and recognizes that pedestrian and bicycle infrastructure such as sidewalks, bicycle lanes, separated facilities, transit stops, ADA-accessible routes, and travel lanes are important elements of the transportation system. Such a multimodal system is crucial to the safety and economic vibrancy of businesses, villages, downtowns, neighborhoods, and rural areas.” and

“MaineDOT and its project partners must consider the needs of all users when planning and developing projects.”

RECOMMENDATION: The commitment to this mission should be reiterated in the Strategic Highway Safety Plan (SHSP) using the more specific complete streets language to bolster the commitment. The commitment to pedestrian safety should be reflected in all MaineDOT policies, projects and programs.

Goals

MaineDOT recognizes the importance of setting clear, measurable goals for improving pedestrian safety as a way of monitoring progress in reducing fatalities, injuries, and crashes. This is reflected in the Maine Strategic Highway Safety Plan as the modest reduction of the annual 5-year average of fatalities

and serious injuries of non-motorized traffic from 91.2 to 90 in 2018.¹

RECOMMENDATION: MaineDOT further embraces this goal, but will also integrate this goal and the supporting language and policy of the complete streets policy in other documents.

Performance Measures

Performance measures are a way to measure the effectiveness of agency policies, projects and programs. They can be a measurement of outcomes (e.g., reduction in number of pedestrian injuries and fatalities), or they can be a measurement of production items (e.g., the number of curb ramps installed). They serve as a tool for building agency accountability. Deciding what to measure is important since it will guide the allocation of resources as agencies strive to meet performance measure objectives.

MaineDOT works with FHWA to establish and track safety performance measures as part of the Highway Safety Improvement Program (HSIP). The following performance measures are used to track and measure safety performance as five-year rolling averages:

- » Number of fatalities
- » Rate of Fatalities per 100 million vehicle miles traveled
- » Number of serious injuries
- » Rate of serious injuries per 100 million vehicle miles traveled
- » Number of non-motorized fatalities and serious injuries

RECOMMENDATION: MaineDOT will explore other measures to gauge the effectiveness of agency policies, projects and programs. Additional

performance measures for pedestrian safety essentially involve crashes and fatalities, but additional sources for injury crashes include records produced during hospital emergency room admittances. More sophisticated measures relate the number of crashes to a pedestrian exposure or usage variable. For example, knowing the number of pedestrian trips in a state will allow a more thorough assessment of the rate of pedestrian crashes and fatalities. States conducting household travel surveys will have an estimated number of trips by foot and the miles traveled by pedestrians statewide.

¹ Maine Department of Transportation. Strategic Highway Safety Plan. (2017). Retrieved from www.maine.gov/mdot/safety/docs/Strategic-Highway-Safety-Plan_2017.pdf

3

Prioritizing Pedestrian Crossing Improvements

Data Collection and Analysis Individual Crash Location Analysis

Pedestrian crashes, especially those involving fatalities, are relatively rare at any given individual location. Consequently, to improve pedestrian safety requires identification of problem roadway segments as well as intersection and mid-block locations (note: this is not referring to controlled/uncontrolled crossing locations). A simple mapping of crash locations involving pedestrians will likely identify high crash locations (likely only a few) and corridors. Typically, five years of crash data is appropriate, though in rapidly changing areas three years might be sufficient.

MaineDOT maintains a database of all motor vehicle crashes, including those involving pedestrians. To better understand state-wide pedestrian safety issues on State roads, the location of crashes involving pedestrians has been studied by the DOT. As part of this a map of the City of Portland is shown (Appendix B) which illustrates which roadway segments have a higher number of fatal and injury crashes.

RECOMMENDATION: MaineDOT will continue to collect and map pedestrian crashes to identify high crash locations and segments. They will also explore ways to help prioritize key intersections.

System-wide Crash Analysis

To conduct more sophisticated analyses of pedestrian crashes, additional data are needed. Detailed data, including crash location, time, demographic information about the individuals involved in the crash, and whether drugs or alcohol were involved, are extremely useful to determine whether there are patterns to pedestrian crashes, and if so, to select the best countermeasures to address them. Analysis of detailed data can provide information on where crashes occur, when they occur, and characteristics of the victims.

It can also be helpful to categorize crashes by type. This is known as pedestrian crash typing and was pioneered by the National Highway Traffic Safety Administration in the 1970s to better define the sequence of events leading up to crashes and the orientation of both the pedestrian and motorist when the crash occurred. While there are over 60 specific pedestrian crash types, pedestrian crashes can generally be sorted into twelve crash type groupings for selecting countermeasures. Crash typing categorizes all crashes based on situational and behavioral circumstances and is a way to target countermeasures in engineering, education and enforcement programs at very specific types of crashes.

Since pedestrian crashes are widely scattered across state highway systems, some DOTs and communities

are taking a systemic approach to anticipating or helping predict where crashes are likely in the future. This approach makes use of roadway characteristics, such as volume of traffic, posted speed, and number of travel lanes, to help identify higher incident intersections and roadway links. More sophisticated models include population variables which identify demand (including latent demand) for the street facilities. This is covered in more detail below on “Systemic Analysis Approach and Prioritization”.

MaineDOT currently does make limited use of system-wide analyses of pedestrian crashes and has created a joint outreach effort with the Bicycle Coalition of Maine. A total of 21 public safety forums have either been held in 2017 or will be held in 2018. In meetings, citizens and local officials assist MaineDOT identify locations and behaviors in their community that impact pedestrian safety. Additionally, participants help prioritize problem or hot spots. Later, a team of individuals will do field reviews of these prioritized locations, or in some cases, meet in another session to closely examine the behaviors and actions of both pedestrians and motorists.

RECOMMENDATION: MaineDOT should continue to analyze data on a system-wide basis and continue its data analysis that supports the community-focused approach to pedestrian safety.

Pedestrian Volume and Behavior Analysis

Pedestrian counts along with field observations (e.g., driver yielding, conflicts, and pedestrian assertiveness) can be very useful in understanding pedestrian behavior and in considering the need for facilities. Counts and behavior studies, when combined with crash data, can also provide insights into specific crash causes and potential countermeasures, and allow the determination of crash rates. On-site observations will often reveal behavior patterns that lead to design changes. Before and after counts can be used to measure success which in turn can be used to help

secure funding for additional improvements at other locations. Pedestrian counts are also important to assess when and where signals, stop signs and marked crosswalks should be installed.

MaineDOT currently conducts a limited number of pedestrian counts as part of specific projects as the need arises. These are “one-off” counts and are not done systematically throughout the state. The Portland Metropolitan Planning Organization (MPO) has done a series of manual counts.

RECOMMENDATIONS: MaineDOT will continue to research different approaches to doing statewide counts as well as potentially supporting a more limited approach of doing before and after counts for bicycle and pedestrian projects. They will continue to support efforts of MPOs and will foster continued coordination with these groups.

Engineering Studies

There are many factors which can affect crossing opportunities including motorist approach speeds and volumes, motorist yielding, roadway configuration (width or roadway, number of travel lanes, etc.), and classification of vehicles, in addition to the volume and assertiveness of pedestrians and bicyclists mentioned above.

As part of the engineering studies, sight distances should also be evaluated. Motorists must be provided sufficient stopping sight distance to be able to see, react, and yield to crossing pedestrians. Likewise, pedestrians require sufficient sight distance to identify and judge gaps in traffic. Where sight distance is limited, efforts should be made to increase it by removing parking or other sight obstructions, or to install curb extensions to allow pedestrians to wait closer to the edge of the roadway. Where sight distance cannot be provided, active warning devices should be provided in advance of the intersection, in conjunction with a pedestrian hybrid beacon or traffic signal.

MaineDOT uses an existing marked crosswalk policy that considers sightlines along with speed and number of lanes.

RECOMMENDATIONS: MaineDOT will update its crosswalk policy and general guidance especially on which type of STEP crossing device to use and establish “triggers” that will be appropriate to use for the cost/benefit determination of the countermeasures. Table 1 on countermeasure choice will be helpful in selecting options that are appropriate, but still maximizing benefits relative to cost.

Prioritizing Pedestrian Crossing Improvements

A pre-defined methodology for prioritizing pedestrian improvements ensures that resources are allocated in a way that best meets goals to reduce pedestrian injuries and fatalities. A prioritization methodology should be:

- » Responsive to MaineDOT and community values: decisions should be based on Maine DOT’s mission and goals.
- » Flexible: Rather than being a rigid, “one-size-fits-all” tool, a prioritization methodology should be flexible and allow practitioners to choose the most appropriate approach that reflects agency goals and resource availability.
- » Transparent: A prioritization process should be broken down into a series of discrete steps, each of which can be easily documented and explained to the public.

MaineDOT currently does not use the guidance in the NCHRP 803 (ActiveTrans Priority Tool (APT)) or other models when prioritizing pedestrian improvements. It is MaineDOT policy and practice to use public processes and meetings to help identify and prioritize pedestrian crossing improvements.

RECOMMENDATIONS: MaineDOT will continue to prioritize crossing improvements through community meetings and field visits and by being responsive to constituents and community officials when problems arise. Consider more proactive methods such as the APT. Sponsor a webinar featuring the tool to educate MaineDOT staff and consultants about the tool and its use (a webinar featuring the tool has been created through the FHWA STEP program to be used by states and communities).

Systemic Analysis Approach and Prioritization

Many areas may have low pedestrian crash rates, but still have a high potential for pedestrian crashes. Emerging methodologies identify these sites based on roadway characteristics combined with land use features of the area. In some cases, it may be possible to select countermeasures to address these high-incident factors before pedestrian crashes occur. Systemic analysis considers factors such as roadway design characteristics and traffic control devices, lighting conditions, vehicle speeds, and nearby pedestrian destinations. Combinations of these factors will also help identify countermeasures to address and prevent pedestrian crashes. Although systemic analyses will always help identify likely crash locations, often the models can be used to also help rate or prioritize locations as well.

RECOMMENDATION: MaineDOT will continue to monitor emerging methodologies for completing a systemic analysis approach to prioritization which should include the consideration of criteria for such analyses (average daily traffic, number of travel lanes, speed of traffic, etc.). Once categorized, they will use this information to select countermeasures, focus resources, and develop a systemic analysis approach (proactive) for identifying and prioritizing locations for improvements. Adoption will depend on efficacy of the methodology, available resources and data.

4

Marked Crosswalks at Uncontrolled Locations

Marked Crosswalk Policy

Marked crosswalks delineate optimal or preferred locations for a pedestrian to cross a street, and indicate to motorists where to expect pedestrians. Pavement markings must follow one of the types as shown in the MUTCD. New marked crosswalk installations at uncontrolled locations require an engineering study.

Marked crosswalks help to improve pedestrian safety and the connectivity of the pedestrian network. A marked crosswalk policy creates a consistent approach for the evaluation and installation of marked crosswalks. Uniform and consistent application of marked crosswalks can help increase predictability for both pedestrians and drivers. A marked crosswalk policy should:

1. Identify what factors are taken into consideration during evaluation (e.g., traffic volume, traffic speeds, crashes, destinations, roadway design, etc.)
2. Establish the primary types of crossing treatments to be considered for any marked crosswalk location (including high visibility crosswalks)
3. Determine a prioritization process for how crosswalk marking is implemented. Inputs to this prioritization may include locational data such as

transit stops, school walking routes, senior walking routes, high collision locations, and midblock locations with high numbers of pedestrians crossing the street.

FHWA's Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018) provides options for crossing improvements, once an agency has determined where to install a marked crosswalk. MaineDOT has a crosswalk policy as an engineering instruction titled DOT Guidelines on Crosswalk, number C6 and revised in 2016. Marking policy is based on number of lanes, sight lines and speed.

Inventory and Evaluation of Marked Crosswalks at Uncontrolled Locations

A systematic inventory of conditions at existing marked crosswalks, and potential locations, is necessary for prioritizing locations and selecting countermeasures. This also will eventually require a complete list of existing marked crosswalks locations (lack of a complete list should not delay making improvements at known problem locations). The review of existing marked crosswalks should be based on the guidelines in the marked crosswalk policy. The results can be used to create a plan for making improvements at marked crosswalks at uncontrolled locations.

MaineDOT does not have a complete list of locations

where there are marked crosswalks at uncontrolled locations on State highways, however, it has recently started an inventory of crossings with a primary focus on ADA compliance. Many of these crosswalks are maintained by cities or towns.

RECOMMENDATION: MaineDOT will move to a more systematic evaluation of marked crosswalks/proposed marked crosswalks at uncontrolled locations. This will involve working with cities, towns, and Metropolitan and Regional Planning Organizations. MaineDOT will maintain the marked crosswalk inventory for the state highway system.

Selecting Countermeasures and Prioritizing Locations for Improvements

The goal of this improvement plan is to improve pedestrian crossing facilities at uncontrolled marked crosswalks so that they will operate as they are designed to work, with drivers yielding to pedestrians and pedestrians getting across the road safely. Rather than just deciding whether marked crosswalks should or should not be provided, the improvement plan asks what are the most effective measures that can be used to help pedestrians safely cross the street. Improvement plans are typically divided into three types of interventions: simple measures, moderately complex measures, and complex measures. The more complex the measure the more time, money, and coordination among different divisions may be required.

Simple measures include sign replacement and enhancement, high visibility crosswalk remarking, advance stop bars, curb ramps, and lighting adjustments. Moderately complex measures include pedestrian refuge islands (where no rechannelization of lanes is required), curb extensions, lighting additions, and changes in pedestrian circulation. Complex measures include Pedestrian Hybrid Beacons, Road Diets, crossing islands (where re-channelization is

required), raised crosswalks, and intersection redesign. After prioritizing locations using the prioritization methodology as described in the previous section, they should be further organized according to complexity.

MaineDOT has selected countermeasures and prioritized locations for improving pedestrian crossing facilities at uncontrolled locations through its targeted cities approach and on a one-by-one basis (intersection by intersection).

RECOMMENDATION: MaineDOT will consider a more systemic approach to prioritizing intersections for countermeasures. The use of APT is recommended. MaineDOT can use Table 1 for selecting the appropriate measures for prioritized intersections.

Secondly, MaineDOT will create a countermeasure toolbox which would include this multi-step process on how to identify, prioritize, and select the appropriate countermeasures. The toolbox will also describe each countermeasure expressing its benefits and limitations. While this toolbox is intended for use by MaineDOT staff to assist in the decision-making process, it will also have the potential to be an important resource for local communities and planning organizations.

5

Toolbox: Pedestrian Crossing Countermeasures at Uncontrolled Locations

Introduction - Selecting Countermeasure(s)

The results of the crash analysis, road safety audit, and/or stakeholder input provide a better understanding of the factors affecting safety at uncontrolled crossing locations. The countermeasures listed in this guide can improve the visibility of crossing locations and reduce crashes, and they each address at least one additional safety concern associated with a higher potential of collision and/or severe injury. In all cases, the countermeasures, when implemented, will follow MUTCD and other relevant AASHTO, FHWA and State guidance.

Table 1 from the Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018)¹ includes a comprehensive matrix and list of STEP pedestrian crash countermeasures suggested for application at uncontrolled crossing locations per roadway and traffic features. The countermeasures are assigned to specific matrix cells based on safety research, best practices, and established national guidelines. When a pedestrian crossing is established, the countermeasure options in the cells should be reviewed before selecting the optimal group of crossing treatments. Previously obtained characteristics

such as pedestrian volume, operational speeds, land use context, and other site features should also be considered when selecting countermeasures. MaineDOT will reference the MUTCD and other national, State, and local guidelines when making the final selection of countermeasures.

RECOMMENDATION: A key recommendation covering this entire chapter involves the development of a Maine-specific Pedestrian Countermeasure Toolbox. The toolbox will describe the process of identifying, prioritizing, and selecting the appropriate countermeasure. The toolbox will ultimately cover signalized intersections and countermeasures aimed at reducing crashes for people walking along roadways. Initially it will start with the STEP countermeasures.

1. Enhancements at Marked Crosswalks

Marked crosswalk safety can be increased with high visibility pavement markings, advanced stop bars and warning signs, in-street pedestrian crossing signs, illumination, curb extensions and tighter curb radii.

High Visibility Crosswalk Markings

High visibility crosswalk markings ensure that drivers see the crosswalk, not just the pedestrian. Two parallel

¹ Federal Highway Administration. Guidebook on Identification of High Pedestrian Crash Locations. (2018). Retrieved from <https://www.fhwa.dot.gov/publications/research/safety/17106/17106.pdf>

lines indicating a marked crosswalk can be almost invisible to the motorist at uncontrolled locations. When a decision has been made to use crosswalk markings, high visibility markings such as ladder style (“piano keys”) or continental markings (“zebra”) should be used at locations without positive traffic control, and are advised at locations with positive traffic control (signals, stop signs).

MaineDOT has an engineering instruction which supports the installation of high visibility marked crosswalks at uncontrolled locations.

RECOMMENDATION: Maintain current policy. Current policy/instruction indicates that hi-visibility markings “should” be used for additional conspicuity. The State’s Highway Safety Plan calls for their use. A concern of MaineDOT was the balance between

Table 1. Application of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Speed Limit								
	≤30 mph			35 mph			≥40 mph		
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
2 lanes*	① 2 3 4 5 6	① ③ 5 6 7	① ③ 5 6 7	① 3 4 5 6	① ③ 5 6 7	① ③ 5 6 7	① 3 4 5 6 7	① ③ 5 6 7	① ③ 5 6 7
3 lanes with raised median*	① 2 3 4 5	① ③ 5 7	① ③ 5 7	① 3 4 5 7	① ③ 5 7	① ③ 5 7	① ③ 4 5 7	① ③ 5 7	① ③ 5 7
3 lanes w/o raised median†	① 2 3 4 5 6 7	① ③ 5 6 7	① ③ 5 6 7	① 3 4 5 6 7	① ③ 5 6 7	① ③ 5 6 7	① ③ 4 5 6 7	① ③ 5 6 7	① ③ 5 6 7
4+ lanes with raised median‡	① ③ 5	① ③ 5 7	① ③ 5 7	① ③ 5 7	① ③ 5 7	① ③ 5 7	① ③ 5 7	① ③ 5 7	① ③ 5 7
4+ lanes w/o raised median‡	① ③ 5 6 7 8	① ③ 5 6 7 8	① ③ 5 6 7 8	① ③ 5 6 7 8	① ③ 5 6 7 8	① ③ 5 6 7 8	① ③ 5 6 7 8	① ③ 5 6 7 8	① ③ 5 6 7 8

*One lane in each direction †One lane in each direction with two-way left-turn lane ‡Two or more lanes in each direction

Given the set of conditions in a cell,

- ① Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- ③ Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

- 1 High-visibility crosswalk markings, parking restriction on crosswalk approach, adequate nighttime lighting levels
- 2 Raised crosswalk
- 3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
- 4 In-Street Pedestrian Crossing sign
- 5 Curb extension
- 6 Pedestrian refuge island
- 7 Pedestrian Hybrid Beacon
- 8 Road Diet

This table was developed using information from: Zegeer, C. V., Stewart, J. R., Huang, H. H., Lagerwey, P. A., Feaganes, J., & Campbell, B. J. (2005), Safety effects of marked versus unmarked crosswalks at uncontrolled locations: Final report and recommended guidelines (No. FHWA-HRT-04-100); Manual on Uniform Traffic Control Devices, 2009 Edition, Chapter 4F. Pedestrian Hybrid Beacons; the Crash Modification Factors (CMF) Clearinghouse website (<http://www.cmfclearinghouse.org/>); and the Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE) website (<http://www.pedbikesafe.org/PEDSAFE/>).

crash reduction and cost. Careful consideration of intersection identification, prioritization, and countermeasure selection (there is a wide range of costs for the different countermeasures) will help support this balance.

Advance Yield Bar and Yield Here to Pedestrians Sign

A multiple threat crash results when a car in one lane stops to let the pedestrian cross, blocking the sight lines of the vehicle in the other lane of a multi-lane approach, which advances through the crosswalk and hits the crossing pedestrian. If advance yield or stop

lines and R1-5a or R1-5c signs are used in advance of a crosswalk, they should be placed together and 20 to 50 feet before the nearest crosswalk line; parking should be prohibited in the area between the yield line and the crosswalk. The MUTCD requires R1-5a or R1-5c signs when yield or stop lines are used in advance of a crosswalk with an uncontrolled multi-lane approach.

MaineDOT in practice has used advanced yield lines, but does not have a well-defined policy or memorandum. A concern heard among MaineDOT staff is the need for guidance of when to use these.

Table 2. Safety issues addressed per countermeasure.

Pedestrian Crash Countermeasure for Uncontrolled Crossings	Safety Issue Addressed				
	Conflicts at crossing locations	Excessive vehicle speed	Inadequate conspicuity/visibility	Drivers not yielding to pedestrians in crosswalks	Insufficient separation from traffic
Crosswalk visibility enhancement					
High-visibility crosswalk markings*					
Parking restriction on crosswalk approach*					
Improved nighttime lighting*					
Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line*					
In-Street Pedestrian Crossing sign*					
Curb extension*					
Raised crosswalk					
Pedestrian refuge island					
Pedestrian Hybrid Beacon					
Road Diet					

*These countermeasures make up the STEP countermeasure “crosswalk visibility enhancements.” Multiple countermeasures may be implemented at a location as part of crosswalk visibility enhancements.

RECOMMENDATION: Consider the national guidance available² and develop a policy and include this in the Pedestrian Countermeasure Toolbox.

In-street Pedestrian Crossing Sign

In-street signs are placed in the middle of the road at a crossing and are often used in conjunction with refuge islands. These signs may be appropriate on 2-lane or 3-lane roads with speed limits of 30 mph or less. On higher-speed, higher-volume, and/ or multilane roads, this treatment may not be as visually prominent; therefore, it may be less effective (drivers may not notice the signs in time to stop in advance of the crosswalk). For such roadways, more robust treatments will be needed. MUTCD Section 2B.12— In- Street and Overhead Pedestrian Crossing Signs contains additional information about these signs.

MaineDOT does not have a policy or guidance for when and where to install in-street pedestrian crossing signs at uncontrolled locations, but they do have language that directs people on how to install according to the MUTCD when a decision is arrived at to provide them.

RECOMMENDATION: MaineDOT will develop additional design information and location guidance for using the in-street signs and provide this guidance in the Pedestrian Countermeasure Toolbox. In time, place guidance in the Maine Highway Design Guide.

Illumination

Up to half of pedestrian crashes occur at night. Lighting greatly increases the driver’s ability to see pedestrians crossing the road.

MaineDOT does not have a policy or guidance for the provision of appropriate level of lighting at established pedestrian crossings at uncontrolled locations.

RECOMMENDATION: MaineDOT will provide more elaborate design information and location guidance can be provided in the Countermeasure Toolbox. In time, they will place guidance in the Maine Highway Design Guide.

Curb Extensions

Curb extensions extend the sidewalk or curb face into the parking lane or shoulder at an intersection, thus improving sight distance between the driver and pedestrian. They are typically designed to extend no further than the edge of a parking lane or shoulder. They are also known as neckdowns, bumpouts or bulbouts. They are most commonly applied at intersections where they are intended to reduce the pedestrian crossing distance, slow right-turning vehicles, improve visibility between motorists and pedestrians, and provide more space for landscaping or storm water management, among other features. When trees are planted on curb extensions, they can be an effective treatment to visually narrow a street and thus create traffic calming effects.

Of concern to state DOTs is the impact that curb extensions could have on large truck turning movements. Guidance on intersection design - and the resulting effective turning radii - can inform decisions. In addition, DOTs could establish criteria on the type of intersections that would suit the placement of curb extensions.

RECOMMENDATION: Curb extensions were not specifically discussed at either of the two meetings with the staff of MaineDOT. However, the discussion of the benefits and guidance on their placement should be considered as part of the Pedestrian Countermeasure Toolbox.

Tighter Curb Radii

Tighter curb radii can improve sight lines between driver and pedestrian, shorten the crossing distance,

2 See the Pedestrian and Bicycle Information Center (PBIC) and the MUTCD for national guidance. http://www.pedbikeinfo.org/planning/facilities_crossings_advance.cfm

bring crosswalks closer to the intersection, and slow right-turning vehicles. Intersection design will determine whether best practices for meeting ADA requirements can be applied. For example, tight curb radii will usually allow for two ramps at each corner as opposed to just one. The appropriate radius should be calculated for each corner on a case by case basis, taking into account the design vehicle. Some transportation agencies are experimenting with mountable aprons for trucks to use as they round a corner. This still allows a tighter effective radius for other motorists in passenger vehicles.

RECOMMENDATION: Curb Radii were not specifically discussed at either of the two meetings with the staff of MaineDOT. However, the discussion of the benefits and guidance on where tighter radii should be considered would be valuable as part of the Pedestrian Countermeasure Toolbox.

2. Raised Crosswalks

Raised crosswalks function as an extension of the sidewalk and allow a pedestrian to cross the street without stepping down to street level. A raised crosswalk is typically a candidate treatment on 2-lane or 3-lane roads with speed limits of 30 mph or less and annual average daily traffic (AADT) below 9,000. Raised crossings are generally avoided on truck routes, emergency routes, and arterial streets. For retrofit projects, drainage needs to be evaluated and revised as necessary. See MUTCD Section 3B.25—Speed Hump Markings for additional information about markings that can be used alongside raised crosswalks.

MaineDOT does not have a policy or guidelines regarding raised crosswalks at established pedestrian crossings at uncontrolled locations. There is neither permissive or prohibitive language on the use of these on state highways.

RECOMMENDATION: MaineDOT will provide more guidance and advice on how and where to use these, particularly about the appropriate roadway

attributes and land use context where they can be used. Guidance can be provided in both the Maine Highway Design Guide and the proposed Pedestrian Countermeasure Toolbox.

3. Pedestrian Refuge Islands

A pedestrian refuge island is typically constructed in the middle of a 2-way street and provides a place for pedestrians to stand and wait for motorists to stop or yield. This countermeasure is highly desirable for midblock pedestrian crossings on roads with four or more lanes, and should be considered especially for undivided crossings of four or more lanes with speed limits of 35 mph or greater and/or AADTs of 9,000 or greater. Median islands may also be a candidate treatment for uncontrolled pedestrian crossings on 3-lane or 2-lane roads, especially where the street is wide and/or where vehicle speed or volumes are moderate to high. Consideration should be given to creating a two-stage crossing with the island to encourage pedestrians to cross one direction of traffic at a time and look towards oncoming traffic before completing the second part of the crossing. The minimum pedestrian refuge island width is approximately 6 feet. MUTCD Sections 3B.10—Approach Markings for Obstructions, 3B.18—Crosswalk Markings, and 3B.23—Curb Markings provide additional information.

MaineDOT does not have a policy regarding pedestrian refuge islands at established pedestrian crossings at uncontrolled locations.

RECOMMENDATION: MaineDOT will provide guidance on when and how to use pedestrian refuge islands. More elaborate design information and location guidance can be provided in both the proposed Pedestrian Countermeasure Toolbox and the Highway Design Guide.

4. Pedestrian Hybrid Beacons (PHBs)

PHBs are a candidate treatment especially for roads with three or more lanes that generally have AADT above 9,000. PHBs should be strongly considered for all midblock and intersection crossings where the roadway speed limits are equal to or greater than 40 mph. Refer to Table 1 for other conditions where PHBs should be strongly considered. Application guidelines for the PHB are provided in Figure 4F-1 (for speeds of 35 mph or less) and Figure 4F-2 (for speeds greater than 35 mph) of the MUTCD. Chapter 4F—Pedestrian Hybrid Beacons provides additional requirements and information about the use of this device. Figure 6 shows a rendering of a PHB.

MaineDOT does not have a policy regarding Pedestrian Hybrid Beacons at established pedestrian crossings at uncontrolled locations.

RECOMMENDATION: MaineDOT indicated that there is interest in obtaining additional information and guidance on when these should be used especially with regard to speeds. More elaborate design information and location guidance can be provided in the Countermeasure Toolbox initially and later in the Highway Design Guide as the Department becomes more familiar with their use and effectiveness.

5. Road Diet

A frequently-implemented Road Diet involves converting a 4-lane, undivided roadway into a 3-lane roadway with a center turn lane. This is a candidate treatment for any undivided road with wide travel lanes or multiple lanes that can be narrowed or repurposed to improve pedestrian crossing safety.

After conducting a traffic analysis to consider its feasibility, a Road Diet may be a good candidate for use on roads with four or more lanes and traffic volumes of approximately 20,000 or less. In some cases, Road Diets have been implemented on roads

with AADTs of up to 25,000. By reducing the width of the roadway, pedestrians benefit from shorter crossing distances and often bike lanes or streetscape features can be added. Road Diets are often effectively accomplished during pavement resurfacing and enable the implementation of many of the other countermeasures discussed above.

MaineDOT does have a set of guidelines for Road Diets approved in 2016. The guidelines were written primarily to help respond to requests from municipalities for road diets and traffic calming and advise readers on how to make a request. There is an acknowledgement that road diets can be used to benefit pedestrians.

RECOMMENDATION: MaineDOT should provide more detailed language and graphics in its Pedestrian Countermeasure Toolbox on how road diets can be used to improve crossings as part of roadway projects. For example, pedestrian refuge islands could be shown as a mid-block crossing enhancement or shown at a “T” intersection where there is no left turn movement.

6. Rectangular Rapid Flash Beacons (RRFBs)

At some uncontrolled crossings, particularly those with four or more lanes, it can be difficult to achieve compliance with laws that require motorists to yield to pedestrians. Vehicle speeds create conditions in which very few drivers feel compelled to yield. One type of device proven to be successful in improving yielding compliance at these locations is the Rectangular Rapid Flash Beacon (RRFB). RRFBs are a pedestrian crossing sign combined with an intensely flashing beacon that is only activated when a pedestrian is present.

In December 2017, FHWA terminated the Rectangular Rapid Flashing Beacon Interim Approval IA-11, due to a patent dispute. This curtailed the consideration of RRFBs during the development of this plan. On March 20th, FHWA delivered the news that the patent

dispute has been settled, allowing its production by all manufacturers. This led the Federal Highway Administration to issue Interim Approval (IA-21).

RRFBs are considerably less expensive to install than mast-arm mounted signals. They can also be installed with solar-power panels to eliminate the need for a power source. RRFBs should be used in conjunction with advance yield pavement lines and signs. They are usually implemented at high-volume pedestrian crossings, but may also be considered for priority bicycle route crossings or locations where bike facilities cross roads at mid-block locations.

RRFBs must be in accordance with FHWA's Interim Approval (IA-21), issued on 3-20-18. All agencies must resubmit requests to FHWA to use the RRFB following the standard interim approval process.

MaineDOT has endorsed the use of RRFBs and has made their use a key part of their safety program aimed at pedestrians.

RECOMMENDATION: Maine should continue its implementation and use of RRFBs. It will be helpful to monitor their performance for helping with future applications in the state. More elaborate design information and location guidance can be provided in the Countermeasure Toolbox initially and later in the Highway Design Guide.

6

Policy Recommendations

"Institutionalization" is the integration of pedestrian considerations into agency policies, plans, projects and programs. The intent is to make walking and pedestrian safety a "mainstream" activity.

The following implementation strategies provide a roadmap for implementation of this Plan through institutionalization, with the intent of making pedestrian safety a routine part of all MaineDOT activities.

Policy, Planning, and Design Documents

In addition to FHWA, AASHTO and MUTCD guidance, MaineDOT has developed agency policy and planning guidance for transportation related topics. They define approaches to solving safety problems, setting priorities and providing decision making guidance. Policy and planning documents provide a means to increase awareness of pedestrian safety issues while also providing specific objectives for reducing injuries and fatalities. Planning and policy documents have an impact on design guides and manuals. Guides and manuals are the most used resources for engineers within Departments of Transportation and incorporating countermeasure considerations into these manuals is one of the key steps to institutionalizing their routine use.

At any given time, one or more policy, planning and other agency documents are undergoing revisions and

updates. This is the ideal time to make changes that begin to institutionalize pedestrian considerations.

The following documents are either being revised, are scheduled to be revised, or are completely new documents.

- » Highway Safety Plan and Strategic Highway Safety Plan
- » Maine's Strategic Pedestrian Plan (in use within the Department, but has not been formally adopted)
- » ADA Transition Plan
- » Complete Streets Policy

RECOMMENDATION: For each of these documents, MaineDOT will continue to review and revise for opportunities to include policy and planning guidance for improving pedestrian safety, with the intent of reducing pedestrian injuries and fatalities at uncontrolled intersections. The first opportunity to do so is with the Complete Streets Policy.

MaineDOT Design

MaineDOT's Highway Design Guide provides design guidance and standards that, among other things, ensures roadway crossings at uncontrolled

locations are designed to maximize pedestrian safety and access.

RECOMMENDATION: MaineDOT should develop a pedestrian countermeasure toolbox initially featuring STEP countermeasures, but in time expanding the toolbox to include signalized intersections and pedestrian facilities along roadways. The toolbox should reflect state and national best practices supplemented with crash reduction factors.

This toolbox should inform the MaineDOT Highway Design Guide. MaineDOT should identify relevant sections of the Highway Design Guide and update those sections as appropriate to better inform designers who otherwise might not be using the Countermeasure Toolbox. Even if language is not specifically added to those sections of the Highway Design Guide, there should be links to the Countermeasure Toolbox as appropriate. As MaineDOT moves toward an electronic guide in 2018, the ability to provide links and make pedestrian crossing countermeasures searchable by topic will improve considerably.

Annual Resurfacing Program

Integrating pedestrian facilities into routine reconstruction and resurfacing projects as part of the MaineDOT Highway Improvement Program using Road Diets and other repurposing of roadway space, is a cost-effective way to institutionalize pedestrian facilities into resurfacing projects.

MaineDOT routinely reviews all resurfacing projects for including ADA-related provisions (most curb ramps), but does not necessary consider pedestrian crossing improvements at marked crosswalks at uncontrolled locations.

RECOMMENDATION: As MaineDOT reviews resurfacing projects (as part of complete streets and ADA), STEP crossing measures should be

reviewed as part of this process. Of the five countermeasures, enhancing crosswalks are the most universally viable option for resurfacing projects because of the low cost and ease of implementation. However, if certain state highway projects are considered for road diets, additional small to moderate-scale STEP measures (pedestrian refuge islands and corner bump-outs) may become feasible.

Also, including minor STEP treatments as part of resurfacing projects add only a small fraction of the overall cost of the project and folding in countermeasures can allow DOTs to take advantage of lower unit costs. For example, costs for adding high visibility markings for crosswalks may be relatively low since the resurfacing project already has an extensive marking component tied to the roadway and crosswalks would represent just a small marginal cost increase.

The next step for MaineDOT is develop a process or amend its current process so that STEP-related projects are considered and mainstreamed as part of the project development scoping process.

American Disabilities Act (ADA) Transition Plan

The MaineDOT ADA Transition Plan updated in 2016 ensures that all pedestrian facilities will become accessible over time. Implementation of the ADA Transition Plan also provides an opportunity to make safety improvements that benefit all pedestrians. According to ADA, whenever streets are resurfaced, reconstructed or newly built, ramps and other accessibility improvements must be made which open opportunities for crosswalk countermeasures.

RECOMMENDATION: The ADA review of projects offers an opportunity to consider adding STEP countermeasures as part of projects. This is especially true for low-cost countermeasures such crosswalk enhancements (high visibility crosswalk

markings, crosswalk signage, etc.). Crosswalks are the extension of curb ramps so there is a strong and logical tie between those two facilities. Also, see recommendation under Resurfacing Program.

Public Involvement as an Implementation Strategy

Public involvement is another excellent way to get a better product. It also builds public support for programs and policies to reduce pedestrian crashes. To be effective, stakeholders must feel listened to and heard.

MaineDOT routinely solicits public comment on upcoming projects. The DOT also conducts Community Pedestrian Safety Forums targeted at the 21 focus communities. These will often result in pedestrian safety reviews using Google Earth and in-field observations in the 21 communities. Additionally, safety reviews are done of problem intersections on state highways by the DOT regional offices when approached with a concern by a municipality or citizen(s).¹ MaineDOT will involve communities, interested parties and stakeholders when assessing these problems and considering solutions.

RECOMMENDATION: MaineDOT will continue to use these multiple avenues for public involvement since solutions that unfold often will involve STEP solutions. The DOT should make the Pedestrian Countermeasure Toolbox widely available so that constituents and stakeholders will benefit by the information made available which should lead to greater support for STEP countermeasures.

Ongoing Training

MaineDOT recognizes that the field of pedestrian transportation planning and design is changing rapidly as new research is completed and innovative

approaches are implemented. MaineDOT provides related training as part of the Pedestrian Safety Reviews (people trained through that effort), Safe Routes to School training/workshops, Crosswalk and Sidewalk Training for Local Officials, and the Heads Up! Pedestrian Safety Program.

RECOMMENDATION: As FHWA continues to develop and update training materials on how to improve pedestrian safety (presentations at conferences, virtual and in-person workshops, and written materials), MaineDOT will weave STEP safety measures into these outreach efforts as appropriate.

¹ Requests for site reviews and evaluations can be submitted to the MaineDOT's statewide Bicycle and Pedestrian Program Manager or directly to the MaineDOT regional offices (<http://maine.gov/mdot/about/regions/>)

Glossary

AVERAGE ANNUAL DAILY TRAFFIC (AADT)

The total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year.

AVERAGE DAILY TRAFFIC (ADT)

The average 24-hour volume of traffic passing a point or segment of a highway in both directions.

COMPLETE STREETS

Complete Streets are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. (Smart Growth America, National Complete Streets Coalition.)

CONTROLLED PEDESTRIAN CROSSING

A pedestrian crossing where motorists are required to stop by either a STOP sign, traffic signal, or other traffic control device.

CRASH MODIFICATION FACTOR (CMF)

A multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure. If available, calibrated or locally developed State estimates may provide a better estimate of effects for the State. (Crash Modification Factors Clearinghouse.)

CRASH REDUCTION FACTOR (CRF)

The percentage crash reduction that might be expected after implementing a given countermeasure at a specific site.

CURB EXTENSIONS

A roadway edge treatment where a curb line is bulbed out toward the middle of the roadway to narrow the width of the street. Curb extensions are sometimes called “neckdowns.”

HIGHWAY SAFETY IMPROVEMENT PROGRAM (HSIP)

A Federal-aid program with the purpose to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned roads and roads on tribal land. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads with a focus on performance. (FHWA.)

HIGH VISIBILITY CROSSWALK

A pedestrian crossing location marked by patterns such as zebra, ladder, or continental markings as described by the MUTCD.

MARKED CROSSWALK

A pedestrian crossing that is delineated by white crosswalk pavement markings.

PARKING RESTRICTION

Parking restriction can include the removal of parking space markings, installation of new “parking prohibition” pavement markings or curb paint, and signs.

PEDESTRIAN HYBRID BEACON (PHB)

A traffic control device with a face that consists of two red lenses above a single yellow lens. Unlike a traffic signal, the PHB rests in dark until a pedestrian activates it via pushbutton or other form of detection.

RAISED CROSSWALK

Raised crosswalks are ramped speed tables spanning the entire width of the roadway, often placed at midblock crossing locations.

REFUGE ISLAND

A median with a refuge area that is intended to help protect pedestrians who are crossing the road. This countermeasure is sometimes referred to as a crossing island or pedestrian island.

ROAD DIET

A roadway reconfiguration resulting in a reduction in the number of travel lanes. The space gained by eliminating lanes is typically used for other uses and travel modes. (FHWA.)

ROAD SAFETY AUDIT (RSA)

A formal examination of an existing or future road or intersection by a multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users. (FHWA.)

TOWARD ZERO DEATHS (TZD)

TZD is a traffic safety framework that seeks to eliminate highway fatalities by engaging diverse safety partners and technology to address traffic safety culture. (See also: Vision Zero.)

UNCONTROLLED PEDESTRIAN CROSSING

An established pedestrian crossing that does not include a traffic signal, beacon, or STOP sign to require that motor vehicles stop before entering the crosswalk.

VEHICLE QUEUE

A line of stopped vehicles in a single travel lane, commonly caused by traffic control at an intersection.

VISION ZERO (VZ)

Similar to TZD, Vision Zero is a vision to eliminate traffic fatalities and serious injuries within the transportation system. VZ employs comprehensive strategies to address roadway design, traffic behavior, and law enforcement.

Appendix A: CRF and CMF Summary Table

Table 3. CRFs and CMFs by countermeasure.

Countermeasure	CRF	CMF	Basis	Reference
Crosswalk visibility enhancement ¹	—	—	—	—
Advance STOP/YIELD signs and markings	25%	0.75	Pedestrian crashes ²	Zegeer, et. al. 2017
Add overhead lighting	23%	0.77	Total injury crashes	Harkey, et. al. 2008
High-visibility marking ³	48%	0.52	Pedestrian crashes	Chen, et. al., 2012
High-visibility markings (school zone) ³	37%	0.63	Pedestrian crashes	Feldman, et. al. 2010
Parking restriction on crosswalk approach	30%	0.70	Pedestrian crashes	Gan, et. al., 2005
In-street Pedestrian Crossing sign	UNK	UNK	N/A	N/A
Curb extension	UNK	UNK	N/A	N/A
Raised crosswalk (speed tables)	45%	0.55	Pedestrian crashes	Elvik, et. al., 2004
	30%	0.70	Vehicle crashes	
Pedestrian refuge island	32%	0.68	Pedestrian crashes	Zegeer, et. al., 2017
PHB	55%	0.45	Pedestrian crashes	Zegeer, et. al., 2017
Road Diet – Urban area	19%	0.81	Total crashes	Pawlovich, et. al., 2006
Road Diet – Suburban area	47%	0.53	Total crashes	Persaud, et. al., 2010

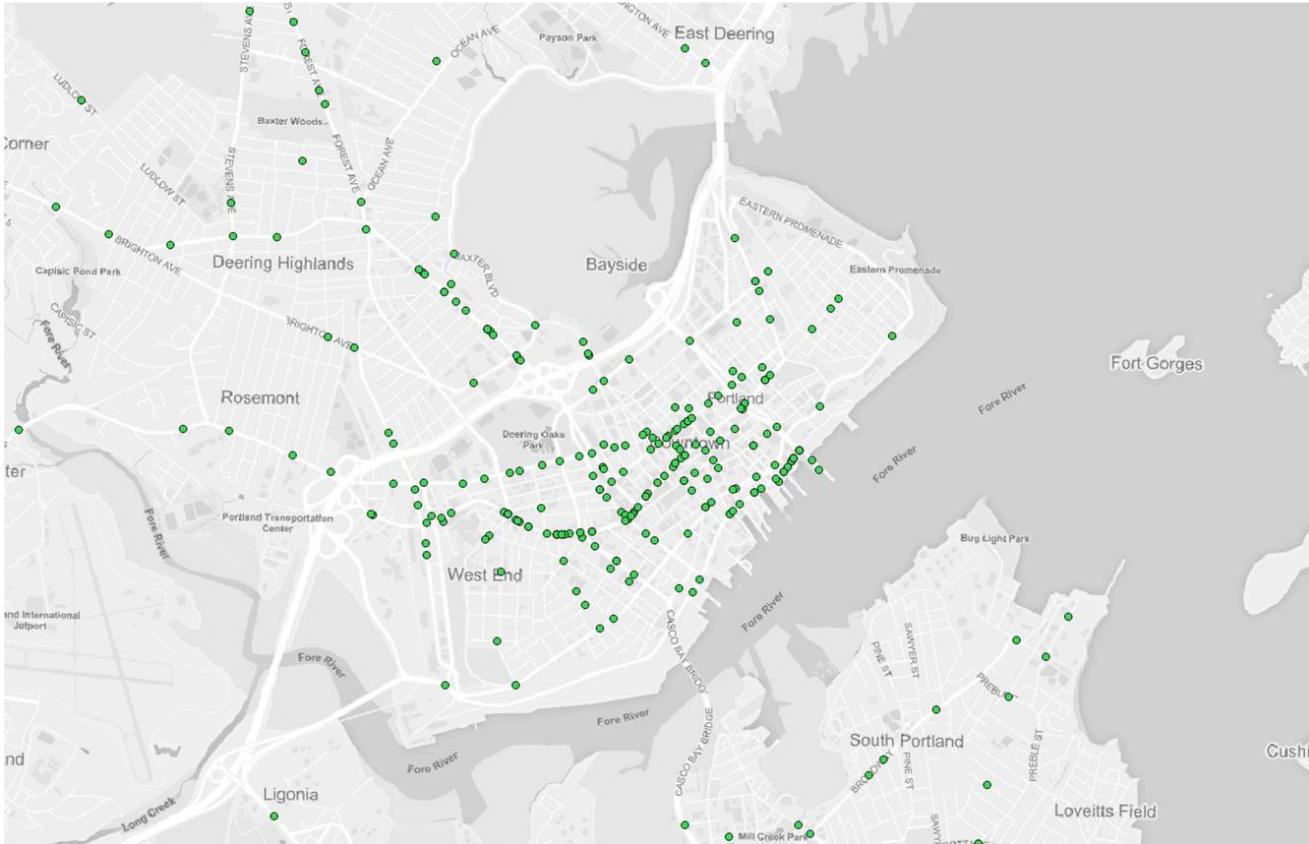
¹This category of countermeasure includes treatments which may improve the visibility between the motorist and the crossing pedestrian.

²Refers to pedestrian street crossing crashes, and does not include pedestrians walking along the road crashes or “unusual” crash types.

³The effects of high-visibility pavement markings (e.g., ladder, continental crosswalk markings) in the “after” period is compared to pedestrian crashes with parallel line markings in the “before” period.

Appendix B: Locations of Pedestrian Crashes

Figure 1: Portland Pedestrian Crashes 2008 - 2012:



References

1. Federal Highway Administration. Guidebook on Identification of High Pedestrian Crash Locations. (2018). Retrieved from <https://www.fhwa.dot.gov/publications/research/safety/17106/17106.pdf>
2. National Highway Traffic Safety Administration. (2017). Fatality Analysis Reporting System (FARS) Encyclopedia. Retrieved from <https://www-fars.nhtsa.dot.gov/QueryTool/QuerySection/SelectYear.aspx>
3. Thomas, L., Lan, B., Sanders, L., Frackleton, A., Gardner, S., and Hintze, M. (2017). In Pursuit of Safety: Systemic Bicycle Crash Analysis in Seattle, WA. TRB 96th Annual Meeting Compendium of Papers. 17-06840. Transportation Research Board. Washington, DC.
4. Zegeer, C., J. Richard Stewart, Herman H. Huang, Peter A. Lagerwey, John Feaganes, and B.J. Campbell. FHWA-HRT-04-100: Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines. Office of Safety Research and Development, Federal Highway Administration, 2005
5. Zegeer, C., R. Srinivasan, B. Lan, D. Carter, S. Smith, C. Sundstrom, N.J. Thirsk, J. Zegeer, C. Lyon, E. Ferguson, and R. Van Houten. NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. NCHRP, Transportation Research Board, Washington, DC, 2017

Resources

[Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations \(2018\)](#)

This guide assists State or local transportation or traffic safety departments that are considering developing a policy or guide to support the installation of countermeasures at uncontrolled pedestrian crossing locations. This document provides guidance to agencies, including best practices for each step involved in selecting countermeasures. By focusing on uncontrolled crossing locations, agencies can address a significant national safety problem and improve quality of life for pedestrians of all ages and abilities. Agencies may use this guide to develop a customized policy or to supplement existing local decision-making guidelines.

[FHWA How to Develop a Pedestrian and Bicycle Safety Action Plan \(2017\)](#)

The purpose of this guide is to assist agencies in developing and implementing a safety action plan to improve conditions for bicycling and walking. The plan lays out a vision for improving safety, examining existing conditions, and using a data-driven approach to match safety programs and improvements with demonstrated safety concerns. This guide will help agencies enhance their existing safety programs and activities, including identifying safety concerns and selecting optimal solutions. It will also serve as a reference for improving pedestrian and bicycle safety through a multidisciplinary and collaborative approach to safety, including street designs and countermeasures, policies, and behavioral programs.

[NCHRP Report 803: Pedestrian and Bicycle Transportation Along Existing Roads—ActiveTrans Priority Tool Guidebook \(2015\)](#)

This resource includes an interactive tool and guidance to help agencies prioritize pedestrian and bicycle improvements, including safety projects, either as standalone or incidental to a roadway project.

[FHWA Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts \(2016\)](#)

This resource focuses on flexibility and options for the design of pedestrian and bicycle networks designed to minimize crash conflicts, including case studies to illustrate various design treatments.

[FHWA State SHSP Resources](#)

The FHWA Office of Safety posts a link to each State's current SHSP. This website also lists noteworthy practices. Many SHSP plans provide an emphasis on pedestrians and contain goals for reducing traffic fatalities and injuries.

[FHWA HSIP Resources](#)

The HSIP includes the projects selected for implementation, an evaluation of past projects, and an annual status report. Projects can include pedestrian safety improvement programs and projects. For example, the 2016 Oregon HSIP Annual Report details how the its All Roads Transportation Safety Program sets aside funding to address systemic pedestrian crash locations.

[State HSP Documents](#)

NHTSA posts the States' current HSP outlining non-infrastructure strategies for improving roadway safety. A State HSP is likely to contain a pedestrian fatality and injury reduction goal, an associated performance measure, and describe non-infrastructure initiatives like enforcement and education programs. For example, Colorado DOT's 2017 HSP (called the 2017 Integrated Safety Plan) supports the Denver Police Department's "Decoy Pedestrian Program" to enforce driver yielding compliance at high-crash pedestrian crossings.

[Manual on Uniform Traffic Control Devices \(MUTCD\)](#)

This manual provides transportation engineers and planners with detailed guidance for the design and application of traffic control devices, including signage, roadway markings, and intersection controls. Refer to the specific sections of the MUTCD listed in the countermeasure descriptions and consult State-level supplements for additional information.

[Pedestrian Safety Guide and Countermeasure Selection System \(PEDSAFE\)](#)

PEDSAFE provides definitions for 12 key pedestrian crash types identified by the software package, the Pedestrian and Bicycle Crash Analysis Tool (PBCAT). PBCAT is still used by many agencies but may not be compatible with some current operating systems.

[NHTSA Pedestrian Safety Information](#)

NHTSA publishes annual reports summarizing the latest pedestrian fatality statistics. These statistics are based on FARS and the reports describe pedestrian fatality trends per different socioeconomic groups and for each State.

[Walkability Checklist](#)

This tool can be used by community leaders during a walkability audit to evaluate pedestrian infrastructure and traffic behavior.

[FHWA Model Road Safety Audit Policy \(2014\)](#)

This resource outlines the steps typically taken to conduct an RSA and the roles of the stakeholders. Identifying safety issues is an element of the RSA that is accompanied by suggestions on how to enhance the specific road's safety.

[Vision Zero Network](#)

This collaborative website posts case studies and tracks cities who are implementing Vision Zero plans or goals. The Vision Zero Network website also notes best practices by agencies who are working to eliminate traffic fatalities and serious injuries. Vision Zero goals

are accompanied by policies, strategies, and target dates. For example, Columbia, Missouri's Vision Zero Action Plan contains an outreach campaign to educate pedestrians and drivers on new and potentially confusing infrastructure improvements like Pedestrian Hybrid Beacons and enhanced pedestrian crosswalks.

[Countermeasure Selection System](#)

This online tool includes links to research studies, crash reduction statistics, and case studies for nearly 70 pedestrian safety countermeasures. Its Countermeasure Selection Tool provides countermeasure recommendations for uncontrolled crossing locations based upon variables such as AADT, vehicle speed, and number of lanes.

[Highway Safety Manual](#)

This manual provides detailed guidance for the collection, analysis, and evaluation of roadway crash data, as well as related CMFs and treatment selection guidance.

[FHWA Road Diet Desk Reference \(2015\)](#)

This resource includes sample policy, case studies, and design guidance for agencies and decision-makers considering Road Diets. The benefits of Road Diets include reducing vehicle speeds, reducing number of lanes to cross, and allocating space for pedestrian refuge island.

[FHWA Design Resource Index](#)

This resource directs practitioners to the specific location of information about pedestrian and bicycle treatments or countermeasures, across various design guidelines published by organizations such as AASHTO, the Institute of Transportation Engineers, and National Association of City Transportation Officials.

[TCRP REPORT 112/NCHRP REPORT 562: Improving Pedestrian Safety at Unsignalized Crossings \(2006\)](#)

This document recommends treatments to improve safety for pedestrians crossing high-volume, high-

speed roadways at unsignalized intersections, with particular focus on roadways served by public transportation.

[AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition \(2004\)](#)

This guide provides recommendations for the planning, design, and operation of accommodations for pedestrians on public rights-of-way. This guide also discusses the impact of land use and site design on pedestrian safety and connectivity

[FHWA Federal-aid Program Administration](#)

This website includes links to guidance for local and State governments administering federally-funded projects, such as those funded by HSIP or STBG.

[Pedestrian RSA Guidelines and Prompt Lists \(2007\)](#)

This resource complements practices for RSAs with additional guidance and a field manual for a pedestrian-focused RSA. An RSA team will use the knowledge of a diverse team, analysis of crash data, and a site visit to identify pedestrian safety issues.

[Pedestrian RSA Case Studies \(2009\)](#)

This website provides links to several examples of RSAs focused on identifying pedestrian safety risks and improvement strategies. For example, the City of Tucson, Arizona conducted an RSA of roadways with PHBs to improve the countermeasures' visibility and usability.

[FHWA Pedestrian and Bicycle Funding Opportunities Summary \(2016\)](#)

This resource includes a matrix comparing eligibility of various federal transportation funding programs for different types of bicycle and pedestrian projects.

[FHWA Guidebook for Developing Pedestrian and Bicycle Performance Measures \(2016\)](#)

This resource identifies a wide variety of potential metrics for setting goals, prioritizing projects and evaluating outcomes of bicycle and pedestrian plans,

including plans for pedestrian safety improvements. Performance measures may include pedestrian levels of service or pedestrian fatality rates.

[NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments \(2017\)](#)

This report describes the safety benefits and CMFs for four types of pedestrian crossing treatments—rectangular rapid-flashing beacons, PHBs, pedestrian refuge islands, and advance crosswalk signs and pavement markings.

[NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways \(2016\)](#)

This is a compilation of existing practices regarding the selection and implementation of pedestrian crossing improvements, as well as a literature review of research on more than 25 pedestrian crossing treatments.

[NHTSA "A Primer for Highway Safety Professionals" \(2016\)](#)

This resource outlines a comprehensive approach to improving safety for bicyclists and pedestrians and offers a summary of the most frequently used engineering, enforcement, and education safety measures. The resource identifies how certain treatments may be placed in relation to other treatments, such as the coordinated installation of a pedestrian refuge island and lighting.

[Small Town and Rural Multi-modal Networks \(2016\)](#)

This report is a resource to help small towns and rural communities support safe, accessible, comfortable, and active travel for people of all ages and abilities. It provides a bridge between existing guidance on bicycle and pedestrian design and rural practice, encourage innovation in the development of safe and appealing networks for bicycling and walking in small towns and rural areas, and show examples of peer communities and project implementation that is appropriate for rural communities.



U.S. Department of Transportation
Federal Highway Administration

