

The Effectiveness of Non-Engineering Road Safety Countermeasures

Tasks 1-3: Literature Review, Case Studies, and Performance Metrics

Draft

Technical Memorandum No. 1

prepared for

Maricopa Association of Governments

prepared by

Cambridge Systematics, Inc.

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Cambridge Systematics, Inc.
9015 Mountain Ridge Drive, Suite 210
Austin, TX 78759

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1.0 Introduction

Motor vehicle crashes can be attributed to many contributing factors including human behavior, vehicle engineering, and roadway engineering with the resulting outcome dependent on the quality of available medical care. For this reason, focusing solely on improvements in one of these areas will not be sufficient to achieve the crash frequency reductions necessary to proclaim a “safe” system. The maximum results will be achieved through a multidisciplinary approach encompassing the 4Es of safety (engineering, enforcement, education, and emergency response).

The state of the practice in safety has advanced rapidly in recent years with the emergence of new tools and processes for improving the analysis behind investment decisions and across the 4Es of safety. However, the measurement and prioritization of behavioral countermeasures remains a consistent challenge.

The Maricopa Association of Governments (MAG) Transportation Safety Committee (TSC) seeks to identify effective non-engineering safety countermeasures for consideration in the greater Phoenix region. Based on literature reviews, this memorandum summarizes proven or tried countermeasures that have high potential for effectiveness. Additionally, four case studies are presented to show the types of strategies being implemented by peer metropolitan planning organizations (MPOs) and the performance metrics utilized to gauge the success and effectiveness of effective non-engineering safety countermeasures.

1.1 STUDY PURPOSE

The ultimate goal of this study is to recommend non-engineering countermeasures for implementation the MAG region, identify performance metrics for evaluation of these countermeasures, and provide the results in a final report. This study includes six tasks:

1. Literature review on non-engineering safety countermeasures;
2. Case studies documenting success;
3. Identify performance metrics;
4. Recommend potential non-engineering strategies for MAG region;
5. Countermeasure evaluation methods; and
6. Develop final report.

This technical memorandum documents the results of Tasks 1 through 3, which were conducted concurrently.

2.0 Literature Review

This section documents a literature review conducted to identify successful implementation of non-engineering countermeasure projects focused on red light running, intersection crashes, as well as pedestrian and bicycle crashes. Countermeasures, known effectiveness and potential associated performance measures are shown in Table 2.1. The table also lists potential performance measures for each countermeasure; performance measures are discussed further in Section 4.

It is important to recognize that many crashes involve multiple factors. For example, fatal and serious intersection crashes may involve impairment, aggressive driving, distraction, young or old drivers, or other factors. Therefore, as part of its safety analysis, MAG may also wish to identify other contributing factors for these types of crashes and potentially address some of those factors as well.

While many non-engineering countermeasures have been implemented, particularly to increase safety of pedestrians and bicyclists, few have been formally proven effective or have crash reduction factors developed. Additionally, with non-engineering countermeasures, every application will differ somewhat based on the nature of the community, partners, messages and implementation tactics. Therefore, definitive proof of such efforts is difficult to obtain. Additionally, given that non-engineering efforts are often implemented in conjunction with one another (i.e. - education programming and enhanced enforcement), and potentially implemented concurrently with infrastructure improvements, it is challenging to isolate the benefits of specific programs.

For the most part, the list in Table 2.1 includes strategies with some evidence of likely effectiveness. The majority of countermeasures identified in this memorandum are from the following publications.

- Countermeasures that Work, Governors Highway Safety Association, 2011;
- NCHRP 622: Effectiveness of Behavioral Highway Safety Countermeasures, Transportation Research Board, 2008;
- NCHRP 500 Series Report Volume 5: A Guide for Addressing Unsignalized Intersection Collisions, Transportation Research Board, 2003;
- NCHRP 500 Series Report Volume 12: A Guide for Reducing Collisions at Signalized Intersections, Transportation Research Board, 2004;
- NCHRP 500 Series Report Volume 10: A Guide for Reducing Collisions Involving Pedestrians, 2004; and

- NCHRP 500 Series Report Volume 18: A Guide for Reducing Collisions Involving Bicycles, 2008.

The Crash Modification Factors Clearinghouse (Crash Modification Factors Clearinghouse (www.CMFClearinghouse.org) was consulted but none of the countermeasures in the pedestrian, bicycle or intersection categories was non-engineering oriented.

The following provides a distillation of the findings related to intersection crashes (including red light running), pedestrian crashes, and bicycle crashes.

2.1 INTERSECTION CRASHES

The majority of countermeasures proven to reduce crashes at intersections are infrastructure oriented. However a number of behaviors can contribute to intersection crashes. Red-light running is one of the key attributors to serious intersection crashes. Enforcement is a primary strategy to reduce red-light running, and is generally accomplished through automated or traditional law enforcement at key locations. Automated enforcement has been proven effective at reducing red-light running, but in some studies have been shown to increase rear-end crashes.

Additional key strategies include reduction of speeding on intersection approaches, which can also be addressed by automated speed enforcement. Intersection crashes involving pedestrians and bicyclists are primarily addressed in the next sections.

2.2 PEDESTRIAN CRASHES

A wide range of activities have been undertaken to improve pedestrian safety; however most of them are not conclusively proven to reduce crashes. Many strategies have been tried and are widely implemented in certain communities, as discussed in the Case Studies in section 3.

Strategies include increasing conspicuity, especially at night, increasing enforcement of laws such as yielding to pedestrians in crosswalks, and education – particularly of children. While Crash Modification Factors were identified for Safe Routes to School programs in the CMF Clearinghouse, these were not included given that the majority of efforts are likely to include infrastructure improvements as a component of the program.

2.3 BICYCLE CRASHES

Implementation of bicycle safety strategies is becoming more prevalent as more communities increase bicycle infrastructure and actively seek to increase the share of trips by bicycle. Bicycle countermeasures include increasing the use of safety equipment such as helmets and lights, enforcement of bicycle related laws,

and bicyclist education. As is the case with pedestrian countermeasures, many strategies seem likely to increase safety and have been tried, but are not yet fully proven to reduce bicycle crashes.

Table 2.1 Non-Engineering Countermeasures – Intersections, Pedestrians, Bicyclists

Strategy	Description	Effectiveness	Process/Performance Measures	Source
Intersections - General				
Eliminate parking that restricts sight distance	This strategy targets crashes related to parking on intersection approaches. The parking, though currently permitted, may present a safety hazard by blocking sight distance (and contributing to angle crashes) or due to parking maneuvers (contributing to rear-end and sideswipe crashes). On-street parking can decrease pedestrian safety if parked vehicles block drivers' and pedestrians' views of each other. Curb extension can be constructed where pedestrians cross streets, and parking should not be permitted on approaches to crosswalks.	The ITE <i>Traffic Engineering Handbook</i> (Pline, 1999) states that based upon a review of crash data, 20 percent of non-freeway crashes in cities are in one way or another related to parking. Midblock crash rates on major streets with parking stalls that are used about 1.6 million hours per year per kilometer could be expected to decrease up to 75 percent after parking is prohibited.	<p>Process Measures:</p> <ul style="list-style-type: none"> • Number of signalized intersections for which parking has been prohibited on the approaches, • Number of approaches on which parking has been restricted, • Number of parking spaces eliminated by restrictions • Percent of problem parking spaces eliminated by restrictions. 	NCHRP Report 500 Volumes 5 and 12.
Provide public information and education	The target for this strategy is crashes related to drivers either being unaware of, or refusing to obey, traffic laws and regulations that impact traffic safety. Crashes related to red-light running, speeding, and not yielding to pedestrians could be reduced with PI&E campaigns. Use of trained public information specialists is important for program success. Establishing good relationships with media representatives will be extremely helpful for maximizing coverage and impact.	Unknown	<p>Process Measures:</p> <ul style="list-style-type: none"> • Number and frequency of different media used (radio ads, brochures, etc.) • Population exposed to the message. • Level of expenditure <p>Performance Measures: Frequency and severity by crash type.</p>	NCHRP Report 500 Volumes 5 and 12.
Intersections – Signalized				
Improve operation of pedestrian and bicycle facilities at signalized intersections	<ul style="list-style-type: none"> • Crossing guards for school children, • Public information or signs that educate pedestrians regarding use of push buttons (specifically, that they will not receive the walk signal immediately), • Technology to show a push button is working 	Unknown	<p>Process Measure</p> <ul style="list-style-type: none"> • Number of locations where strategies are implemented 	NCHRP Report 500 Volume 12: A Guide for Addressing Collisions at Signalized Intersections

Strategy	Description	Effectiveness	Process/Performance Measures	Source
Provide targeted conventional enforcement of traffic laws	<p>(such as a button that lights up, similar to an elevator).</p> <p>Providing pedestrian push buttons may facilitate safe pedestrian roadway crossings at signalized intersections (vs. midblock crossings). However, pedestrian push buttons at an intersection are often obscured by roadside furniture or other items. Providing visible signs alerting pedestrians to the presence of push buttons and anticipated wait time for the crossing signal may increase the use of existing pedestrian push buttons.</p> <p>Traffic law enforcement agencies will often select locations for targeted enforcement when crash, citation, or other sources of information suggest that the site is unusually hazardous due to illegal driving practices, such as speeding or red-light running. It is important to correctly identify intersections that would benefit from enforcement. Care should be taken to first ensure that the existing signals are operating properly, are visible, and meet MUTCD requirements, as well as that timing plans—including clearance intervals—are appropriate. Analysis of crash statistics can help with this process, as can spot speed or conflict studies. In some cases, public input or observations by law enforcement personnel may suggest that a location should be targeted for enforcement. Police officers providing targeted enforcement of red-light running can be aided by “telltale” or “tattle-tale” lights. These lights are placed at traffic signals, but facing away from oncoming traffic. Police officers are able to wait in their vehicles on the downstream side of the traffic signal and view the tattle-tale light. This way, they are able to pursue red-light runners without also running through the red light themselves (and possibly into vehicles entering the intersection from the cross street).</p>	<p>Studies report the reduction of traffic law violations when enforcement is used (<i>Traffic Engineering Handbook</i>, Pline, 1999). Effectiveness is usually short-lived. Periodic enforcement may be necessary to sustain the effectiveness of the strategy</p>	<p>Performance Measure</p> <ul style="list-style-type: none"> • Number and severity of crashes involving bicycles or pedestrians at signalized intersections <p>Process Measure:</p> <ul style="list-style-type: none"> • Number of citations issued at targeted intersections <p>Performance Measures:</p> <ul style="list-style-type: none"> • Number and severity of crashes at targeted locations before and after strategy implementation. 	<p>NCHRP Report 500 Volume 12: A Guide for Addressing Collisions at Signalized Intersections</p>

Strategy	Description	Effectiveness	Process/Performance Measures	Source
Implement automated enforcement of red-light running (cameras)	Successful red-light camera programs have generally begun as safety improvement programs. Programs that are perceived as revenue generators (i.e., through collection of fines) are generally not well-accepted.	<p>The automated enforcement programs in NCHRP Report 500 Volume 12 experienced a range of reduction in violations of 23 to 83 percent.</p> <p>The average annual rate of all fatal crashes at signalized intersections decreased by 14 percent for cities with camera programs and increased slightly (2 percent) for cities without cameras. After controlling for population density and land area, the rate of fatal red light running crashes during 2004-08 for cities with camera programs was an estimated 24 percent lower than what would have been expected without cameras.</p>	<p>Process Measure</p> <ul style="list-style-type: none"> • Number of cameras installed • Number of citations issued <p>Performance Measure</p> <ul style="list-style-type: none"> • Number, type and severity of crashes at targeted intersections 	<p>NCHRP Report 500 Volume 12: A Guide for Addressing Collisions at Signalized Intersections</p> <p>Hu et al., Effects of Red Light Camera Enforcement on Fatal Crashes in Large U.S. Cities, Insurance Institute for Highway Safety, Feb. 2011.</p>
Implement automated enforcement of approach speeds (cameras)	<p>The target for this strategy is drivers who speed on approaches to signalized intersections. Crash types related to these actions include angle and rear-end crashes. Automated enforcement of speeds may provide a longer-term effect than on-site enforcement by police officers. It is not feasible to provide officers to constantly enforce speed limits, but a camera is more flexible regarding the duration it can operate. PI&E is needed to make automated enforcement successful. Public opinion and acceptance can "make or break" an automated enforcement program.</p>	<p>Speed cameras: on average, 20-40% reduction in crashes, based on studies in Canada, Australia, and Europe (Pilkington, P. and Kinra, S. (2005). "Effectiveness of Speed Cameras in Preventing Road Traffic Collisions and Related Casualties: Systematic Review." <i>British Medical Journal</i> 330(7487), 331-334.)</p>	<p>Process Measures:</p> <ul style="list-style-type: none"> • Number of intersection approaches on which automated speed enforcement is applied. • Number of citations issued from the program, and number of traffic convictions resulting. 	<p>NCHRP 622: Effectiveness of Behavioral Countermeasures</p>
		<p>16% reduction in all injury crashes, 24% reduction in right-angle crashes, no significant increase in rear-end crashes (Aeron-Thomas, A.S. and Hess, S. (2005). "Red Light Cameras for the Prevention of Road Traffic Crashes (Review)." <i>The Cochrane Database of Systematic Reviews</i>, 2, Art. No. CD003862.pub2. Hoboken, N.J.: John Wiley & Sons Ltd.</p>		<p>NCHRP 622: Effectiveness of Behavioral Countermeasures</p>

Strategy	Description	Effectiveness	Process/Performance Measures	Source
	<p>Information and awareness efforts and materials typically include the following information: (1) documentation of the problem (in nontechnical terms), (2) objectives of the automated enforcement program, (3) advantages of automated enforcement or conventional enforcement, (4) general locations or areas of automated enforcement systems, (5) uses of revenue generated by automated enforcement, and (6) information on what to do when a citation is received in the mail.</p>		<p>Performance Measure</p> <ul style="list-style-type: none"> • Number and severity of crashes at intersections treated. 	
Unsignalized Intersections				
<p>Provide targeted enforcement to reduce stop sign violations</p>	<p>The target for this strategy should be intersections where stop sign violations and patterns of crashes related to stop sign violations have been observed. Crash types potentially related to stop sign violations include right-angle and turning collisions.</p>	<p>This strategy is known to be effective in reducing traffic law violations. Programs within the United States have been found to result in decreases in violations between 23 and 83 percent (Pline, 1999). However, the safety effectiveness of such decreases in violation rates has not been quantified. Enforcement agencies have generally found that the effectiveness of increased enforcement at specific locations has a relatively short duration of effectiveness—measured in days or weeks, rather than months or years.</p>	<p>Process Measures:</p> <ul style="list-style-type: none"> • Number of intersections where increased enforcement is applied. • Number of officer hours of targeted enforcement provided, • Number of additional citations issued, • Reduction in violation rate • Resulting number of additional convictions. 	<p>NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersections</p>
<p>Provide targeted speed enforcement</p>	<p>The target for this strategy are intersections where speed violations and patterns of crashes related to speed violations are observed. Crash types potentially related to speed violations include right-angle, rear-end, and turning collisions. A key to the success of this strategy is planning the enforcement and prioritizing the intersections demonstrating greatest need (TRB Special Report 254, 1998). Such intersections should have a combination of high speed-violation rates and related crash patterns. In some cases public input, or observations by law enforcement personnel, may suggest that a location</p>	<p>The effectiveness of this strategy has been established by numerous studies (<i>Accident Analysis and Prevention</i>, Volume 126, Issue 6, “An Experimental Study to Evaluate the Effectiveness of Different Methods and Intensities of Law Enforcement on Driving Speed on Motorways”, De Waard and Rooijers, 1994.)</p>	<p>Process Measures:</p> <ul style="list-style-type: none"> • Number of intersections at which targeted speed enforcement is applied. • Number of officer hours of targeted enforcement provided, • Number of additional citations issued, • Resulting number of 	<p>NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersection</p>

Strategy	Description	Effectiveness	Process/Performance Measures	Source
	should be targeted with enforcement.		additional convictions. Performance Measure: <ul style="list-style-type: none"> Number and severity of intersection crashes 	
Pedestrian				
School pedestrian training,	Education of children ages 6 to 12 years old	12% reduction in child pedestrian injuries	Process Measures: <ul style="list-style-type: none"> Number of children participating in program Number of person-hours of training delivered Performance Measure: <ul style="list-style-type: none"> Number and severity of pedestrian crashes involving children ages 6-12 	NCHRP 622: Effectiveness of Behavioral Safety Countermeasures
Pedestrian Safety Zone	The idea is to strive for large decreases in pedestrian crashes and injuries by more effectively targeting resources to problem areas. Specifically, the objective of pedestrian safety zones is to increase efficiency by targeting limited resources to geographic areas and audiences where significant portions of the pedestrian crash problem exist (NHTSA, 2008). Pedestrian zone programs, including education, enforcement, and engineering measures, can target at a full range of pedestrian crash problems within a limited geographic area or focus on particular problems that make up a larger portion of the problem within a limited area.	Properly designed and implemented pedestrian zone programs have been shown effective in reducing crashes and injuries for older pedestrians, for impaired pedestrians, and for child and adult pedestrian crashes in Miami-Dade County	Process Measure: <ul style="list-style-type: none"> Number of pedestrian zones implemented Performance Measure: <ul style="list-style-type: none"> Number of pedestrian crashes in pedestrian zones Number and severity of pedestrian crashes 	Countermeasures that Work, 2011
Conspicuity Enhancement	The purpose of enhancing conspicuity for pedestrians is to increase the opportunity for drivers to see and avoid pedestrians at night. Pedestrians who are more visible are less likely to be struck. Retro-reflective	Widespread use of retro-reflective materials would increase the ability of drivers to detect pedestrians in time to avoid crashes. Pedestrians wearing good retro-reflective	Process Measure: <ul style="list-style-type: none"> Number of retroreflective or lighted items distributed to 	Countermeasures that Work, 2011

Strategy	Description	Effectiveness	Process/Performance Measures	Source
	materials are built into many shoes, including children's and athletic shoes. Other accessories, such as arm or leg bands, gloves, vests, and caps are available from sporting goods stores and other vendors. Light sources, including strobes and other flashing lights, are also available. Many have been designed for bicyclists but are equally applicable to pedestrians. The difficulty with most of these devices is that the user must decide in advance to take and use them. Because of this extra step, and because most of the conspicuity enhancements do not look like "normal" clothing, they are very much underused. Light-colored clothing, a longtime recommended solution, actually does little to improve conspicuity (NCHRP, Vol. 10. (2004). <i>A Guide for Reducing Collisions Involving Pedestrians</i> . Washington, DC: Transportation Research Board)	materials, particularly materials that highlight a person's shape and extremities, can be detected hundreds of feet farther than can pedestrians in normal clothing, even with low-beam illumination	pedestrians Performance Measure: • Number and severity of pedestrian crashes	
Reduced speed limits for pedestrian safety	Reduction in speed limit from 60 km/hr (37mph) to 50 km/h (31 mph) in urban areas	Reduction of 25-30% in pedestrian fatalities	Process measure: • Lane miles of roadways with reduction in speed permitted Performance Measure: • Number and severity of pedestrian crashes	NCHRP 622: Effectiveness of Behavioral Safety Countermeasures
Bicycle				
Restrict right turn on red (RTOR) movements	The primary purpose of this strategy is not to restrict RTOR at all signalized intersections in an area or local jurisdiction. Rather, the purpose is to restrict RTOR movements at certain signalized intersections throughout the entire day or during portions of the day (e.g., during periods of peak bicycle activity). At signalized intersections with a history of bicycle/motor vehicle crashes resulting from RTOR movements, an analysis of the time of day of the crashes may provide	Approximately 3 to 4 percent of all bicycle/motor vehicle crashes occur during a RTOR maneuver, and 6 percent of these crashes result in serious or fatal injuries (Tan, 1996). The expected number of bicycle/motor vehicle crashes that may be reduced by implementing this strategy is difficult to assess because it is an experimental treatment for improving bicycle safety. However, this strategy	Process Measure: • Number of intersections at which RTOR is prohibited during some portion of the day Performance Measure: • Number and severity of	NCHRP Report 500 Volume 18: A Guide for Reducing Collisions Involving Bicycles.

Strategy	Description	Effectiveness	Process/Performance Measures	Source
	justification for restricting RTOR movements throughout the entire day or during specified hours of the day.	has been recommended for improving pedestrian safety based upon a field study (Retting, R. A., Nitzburg, M. S., Farmer, C. M., and Knoblauch, R. L. (2002). Field Evaluation of Two Methods for Restricting Right Turn on Red to Promote Pedestrian Safety. <i>ITE Journal</i> . 72)	bicycle crashes involving RTOR movements	
Implement speed enforcement	See <i>Provide Targeted Speed Enforcement</i> strategy			
Provide bicyclist skill education	This strategy is intended to teach bicyclists of all ages safe bicycling skills, including how to interact with motorists in traffic. Education programs should teach bicyclists the importance of having a bike that fits, maintaining a bike in good condition, and always wearing a helmet when riding. Bicycle safety training programs are based on the premise that behavior by bicyclists contributes to the risk of crashes and injuries, and that this behavior can be changed through training programs. Several studies have shown that most crashes were primarily due to some form of human error and very few were due to environmental conditions (Clarke, A., and Tracy, L. (1995). <i>Bicycle Safety-Related Research Synthesis</i> . Report No. FHWA-RD-94-062. Washington, DC: Federal Highway Administration.)	NHTSA's 1993 report indicated that the most common crashes were due to bicyclist's failure to yield (21.8 percent), improper crossing of roadway or intersection (12.6 percent), and failure to obey traffic signs, signals, or a police officer (8.6 percent) (Clarke and Tracy, 1995). Reports on a state level have similar data suggesting that the five leading contributing factors attributed to bicyclists in bicycle/motor-vehicle crashes were: (1) failure to yield right of way, (2) non-motorist error, (3) disregard for traffic control devices, (4) driver inattention/distraction, and (5) improper/unsafe lane use (<i>Minnesota Bicycle Transportation Planning and Design Guidelines</i> Minnesota Department of Public Safety, 2005).	<p>Process Measure:</p> <ul style="list-style-type: none"> Number of educational programs conducted <p>Performance Measure:</p> <ul style="list-style-type: none"> Number and severity of crashes involving bicycles 	NCHRP Report 500 Volume 18: A Guide for Reducing Collisions Involving Bicycles.
Improve enforcement of bicycle-related laws	This strategy directly targets activities of law enforcement officers as they relate to bicycling and indirectly targets behavior of bicyclists and motorists.	The ultimate goal of this strategy is to prevent crashes and enhance traffic safety. Many crashes can be avoided if both bicyclists and motorists follow the rules of the road. Heightened awareness among law officers of these rules can lead to: enforcing of laws, modeling of good behaviors, and recognizing and taking advantage of opportunities to educate both bicycles and motorists.'	<p>Process Measure:</p> <ul style="list-style-type: none"> Number of citations issued for violations of bicycle-related laws <p>Performance Measure:</p> <ul style="list-style-type: none"> Number and severity of crashes involving bicycles 	NCHRP Report 500 Volume 18: A Guide for Reducing Collisions Involving Bicycles

Strategy	Description	Effectiveness	Process/Performance Measures	Source
Bike helmet law for children	Requirement for bike helmet use for children under age 12	15% reduction in fatalities involving children under age 12	<p>Process Measures:</p> <ul style="list-style-type: none"> • Implementation of law • Number of warnings for non-use of helmets among children under 12 <p>Performance Measure:</p> <ul style="list-style-type: none"> • Number of fatal or injury crashes involving unhelmeted juvenile bicyclists 	NCHRP 622: Effectiveness of Behavioral Safety Countermeasures
Bike helmet law for adults	Requirement for bike helmet use for adults	Likely to be effective; actual effectiveness unknown	<p>Process Measures:</p> <ul style="list-style-type: none"> • Implementation of law • Number of citations for non-use of helmets among adults <p>Performance Measure:</p> <ul style="list-style-type: none"> • Number of fatal or injury crashes involving unhelmeted adult bicyclists 	NCHRP 622: Effectiveness of Behavioral Safety Countermeasures
Increase rider and bicycle conspicuity	This strategy targets the behavior of bicyclists who are riding at night near motor vehicle traffic, but also affects motorists by making bicyclists more conspicuous.	Bicyclists that are more visible are expected to be involved in fewer crashes during low light conditions. Although no studies have been identified that indicate this outcome, bicyclists that are more easily seen are likely to be more easily avoidable, as well. In addition, the use of headlights may provide bicyclists with better visibility of roadway conditions.	<p>Process Measure:</p> <ul style="list-style-type: none"> • Number of retroreflective or lights distributed to bikers <p>Performance Measure:</p> <ul style="list-style-type: none"> • Number and severity of bicycle crashes at night 	NCHRP Report 500 Volume 18: A Guide for Reducing Collisions Involving Bicycles.

3.0 Case Studies

The study team conducted Internet and telephone research to identify MPOs that had implemented non-engineering safety countermeasures in the areas of intersection, bicycle and pedestrian safety. The majority of efforts were focused on education and enforcement to address bicycle and pedestrian safety. Four case studies are presented here from the MPOs in the Miami, Kansas City, Washington, D.C., and Nashville regions.

3.1 MIAMI-DADE MPO

The Miami Dade MPO has led or coordinated multiple pedestrian oriented safety countermeasures over the past decade to address the high number of pedestrian crashes experienced in the area. In 2001, just before the pedestrian safety efforts began, Florida was the fourth-largest State in terms of population (16.4 million), but ranked first in the number of pedestrian fatalities (489). In Florida, Miami-Dade County (in 2001) led the State in pedestrian deaths and injuries

The most significant pedestrian effort has been the WalkSafe Program, which is a juvenile pedestrian safety education program in partnership with the University of Miami Miller School of Medicine. The MPO used planning resources to help develop the program and transportation enhancement funds for ongoing operation. Initiated in 2003, this program's 3-day curriculum was used to reach 140,000 people in 2010. With its public health model, this is a very research based program. More information is available on the program's website at: www.walksafe.us.

The Miami-Dade MPO has begun to fund and develop a BikeSafe education effort through the school of medicine's public health staff. The agency seeks to do a parks based program in partnership with the parks and recreation department, versus a school based program as was done with WalkSafe. The MPO is seeking to take more of an entrepreneurial approach given that some bicycle education can pay for itself, e.g. the League of American Bicyclists' basic adult class is \$75. The desire is to use MPO resources to establish the program and rely on other resources to sustain the program in the long-term.

The MPO has facilitated police training on enforcement of failure to yield to pedestrians. The training program involved the use of decoy pedestrians. A spotter with a radio flagged violators to officers who stop the vehicles and issues warnings or citations. This effort has proven very successful and garnered significant community support.

Leveraging its relationship with the transit agency, the MPO was able to secure free advertising space to place public service announcements (PSAs) on

pedestrian safety. The MPO developed and printed the materials and coordinated placement.

The MPO has supported enforcement of red-light running violations. Staff educated law enforcement about crash data, and provided data on locations of speeding and red-light running. Law enforcement were then redeployed to high crash locations.

Evaluation and Performance Measures:

In 2008, a study undertaken by NHTSA was published: *Evaluation of the Miami-Dade Pedestrian Safety Demonstration Project*. This study evaluated the multiple pedestrian countermeasures undertaken in the region.

WalkSafe program evaluations have shown that in the nine years since the program was initiated, juvenile emergency room admissions have been reduced by 51 percent.

Generally, the MPO tracks pedestrian crashes and their severity.

Contact:

David Henderson
Bicycle and Pedestrian Specialist
Miami-Dade MPO
Davidh@miamidade.gov
305-375-1647

3.2 MID-AMERICA REGIONAL COUNCIL

From 2005 to 2007, the Kansas City region experienced 699 fatalities and 5,309 disabling injuries associated with motor vehicle crashes. To address the regional safety problem MARC has assembled a coalition of members called Destination Safe to focus on non-infrastructure safety programming. The committee accepts applications for projects and programs on an annual basis. All infrastructure requests for safety projects go through the MPO's program committees.

MARC has developed a Safety Blueprint plan that is updated every three years, to align updates with the states' strategic highway safety plans. The Blueprint identifies emphasis areas and countermeasures, which include Pedestrians and High Risk Users, including red light runners.

Efforts supported through Destination Safe have included:

- Be Bright at Night – distribution of flashing lights for evening walkers/bikers;

- Share the Road Safety Task Force education and enforcement – Task Force identified locations with large numbers of pedestrians and conducted education two to three weeks before an enforcement campaign via distribution of literature to shop owners and all people in area (motorists, pedestrians, bicyclists). Three weeks later, enforcement of vehicles not yielding to pedestrians and other violations was conducted. As part of the effort staff briefed county courts and judges on the rationale for the program so citations were not thrown out of court;
- Radio PSAs with messages on several emphasis areas; and
- Support of legislation and local ordinances that allow the use of red-light-running cameras at high-risk intersections, as well as supported increased law enforcement of these violations at key locations.

Evaluation and Performance Measures

The primary measure used to track progress is fatal and injury crashes in the emphasis areas. The MPO develops a quarterly safety report to track trends. Overall the trend is that crashes are going down, but it is difficult to isolate the reason for the improvement when simultaneously multiple infrastructure and behavioral efforts may be underway.

Contact:

Aaron Bartlett,
Destination Safe Staff Contact
Mid America Regional Council
816-474-4240 ext. 8238
abartlett@marc.org

3.3 METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS

Approximately 2,700 pedestrians and bicyclists are injured every year in the Washington region, and 89 are killed. Pedestrian and bicyclist fatalities accounted for 25 percent of the total traffic fatalities in the District of Columbia, suburban Maryland and northern Virginia from 2006 to 2010.

Sponsored by the Metropolitan Washington Council of Governments (COG) and the National Capital Region Transportation Planning Board (TPB), the Street Smart public awareness and enforcement campaign is aimed at reducing the

number of pedestrian and cyclist injuries and deaths in the Washington metropolitan area. The campaign uses creative radio and television advertising in English and Spanish to reach drivers, pedestrians and cyclists, while targeting them through outdoor and transit advertising on bus shelters and bus sides. In addition, law enforcement and local, county and state agencies distribute handouts and tip cards to further spread awareness and educate drivers and pedestrians.

The Street Smart pedestrian safety effort focuses on the "three E's:" education, enforcement and evaluation.

- **Education** targets pedestrians and drivers, and uses recurring waves of radio, bus advertising, internet ads, hand-outs and posters to get the message out. Advertising conveys simple messages such as "Stop for Pedestrians" and "Cross Streets Carefully", and while media events help publicize enforcement. A strong focus of the campaign is to reach the area's Hispanic residents through Spanish-language brochures and advertising outreach.
- **Enforcement** provides an incentive for residents to heed the campaign messages, and a focus for media attention.
- **Evaluation** is vital to understanding the awareness level for the message and the future direction of the campaign.

The campaign was created by the Bicycle and Pedestrian Subcommittee of the Transportation Planning Board in 2002. The District of Columbia, Maryland, Virginia, and the Washington Metropolitan Area Transit Authority provide major funding, with contributions from Arlington County, Montgomery County, and the City of Alexandria. More information is available about Street Smart at www.bestreetsmart.net.

Evaluation and Performance Measures

Process measures include the number of warnings and citations issued during enforcement periods.

To validate the campaign and judge effectiveness of the efforts, area motorists are surveyed before and after each campaign. Survey results from spring and fall 2010 show people are hearing and remembering the Street Smart messages.

Contact:

Mike Farrell
MWCOG
202 -962-3760
mfarrell@mwkog.org

3.4 NASHVILLE MPO

Between 2003 and 2007, 2,076 reported crashes involving a pedestrian or bicyclist occurred within the MPO, 107 of which resulted in a fatality. The Nashville MPO has identified in its 2035 long range plan that in addition to developing comprehensive regional bicycle and pedestrian facilities, it will provide support for ongoing education for local law enforcement and the public to increase the safety of walking and bicycling. The region has recently undertaken several bicycle and pedestrian safety programs.

Bicycle Training Program

The Nashville Area MPO in partnership with local bicycle advocacy group Walk/Bike Nashville developed a 2-hour bicycle training program called Bicycle Street Smarts. The training program is designed to teach the basics of bicycle fit, maintenance, laws, hand signals and skills for a bicyclist to ride safely on the roadway or greenway. The class is offered to community groups upon request at no charge, depending on instructor availability. Instructors are certified by the League of American Bicyclists as League Certified Instructors.

Walking and Bicycling Safety Education to P.E. Teachers

In the summer of 2009, the Nashville Area MPO staff worked with the Program Director of Walk/Bike Nashville to develop a two-week Walking and Bicycling Safety curriculum to be taught by elementary school P.E. teachers to their students.

The project was funded by a grant from the Robert Wood Johnson Foundation, Active Living by Design program. The two-week curriculum is written to the Tennessee Department of Education Standards for Physical Education for Elementary School students.

To date, over seventy-five P.E. Teachers in Davidson and Williamson Counties have been taught the curriculum in day-long in-service trainings. Plans are underway for the curriculum to be taught to several hundred additional P.E. Teachers throughout the Nashville Area MPO Region.

The curriculum covers pedestrian laws and safety including how and where to cross the street. The curriculum also covers basic bicycle maintenance, parts of a bicycle, bicycle fit, helmet fit and rules of the road for bicyclists. The training concludes with sessions on the bicycle where teachers learn firsthand the bicycle safety skills drills they will teach to their students.

Law Enforcement Refresher on Bicycle and Pedestrian Laws

In conjunction with the Knoxville Transportation Planning Organization, the Nashville MPO offers one-hour refresher training to law enforcement officers on laws pertaining to pedestrians and bicyclists.

The training covers Tennessee State law and provides a review of rules of the road pertaining to walking and bicycling. The session includes pedestrian rights at unmarked crosswalks, how bicyclist signal lane changes and turns, and where a bicyclist is legally allowed to ride on the roadway. The training also covers tips for law enforcement officers when citing either vehicular motorists who violate the rights of pedestrians or bicyclists, or who cite pedestrians and bicyclists for failing to follow the laws and rules of the road for their particular mode of travel.

The training, which started in 2009, has been offered to officers from across Tennessee at the Tennessee Lifesavers Conference, and through the Franklin Police Department Bicycle Police Training Academy, including Franklin Police, Rutherford County Sheriffs Department and Murfreesboro Police Department.

Performance Measures:

The MPO tracks total and fatal crashes involving pedestrians and bicyclists.

Contact:

Leslie Meehan, AICP
Bicycle & Pedestrian Coordinator,
Senior Transportation Planner
615-862-7211
meehan@nashvillempo.org

4.0 Performance Measures

General performance measures are indicators that enable decision-makers and other stakeholders to monitor changes in system condition and performance. Typical safety performance measures relate to the number and rate of fatalities and/or crashes and incidents, emergency response times, public perceptions of safety, etc. for the various transportation modes. Performance measures are typically tracked for an emphasis area generally, e.g. number of pedestrian fatal and serious injury crashes.

Given the temporal nature of many non-engineering countermeasures, the fact that they may not be targeted to a specific geographic location, and that they may be undertaken in combination with other strategies, it can be challenging to isolate the results of a single non-engineering countermeasure in terms of reduction in number or severity of crashes. In some cases, however it may be possible to conduct before and after surveys about awareness of public education or conduct other measurements before and after implementation to gauge effectiveness. For example if a program is targeted at a specific age group in one emphasis area, e.g. bicycle helmet use by children, it could be possible to track fatal and serious bicycle crashes involving helmet non-use among those age 12 and under.

Process measures are helpful to ensure that the countermeasure is being properly implemented and the audience is being reached. For the most part these measures do not directly measure effectiveness in terms of crash reduction but may measure an interim level of effectiveness. For example, for an enforcement effort, the number of citations can be measured, which would be expected to result in a reduction future violations and improved public awareness of a safety issue, and consequently reduced crashes. Other process measures are those that track the number of people reached with a specific effort, such as the number of people participating in a training course, the number of public service announcements placed, or the number of materials distributed. As noted in Table 2.1, process measures can be identified for most efforts.

5.0 Next Steps

Given the limited number of non-engineering countermeasures proven effective, NCHRP 622 notes that an agency may wish to engage in countermeasures that have not been fully developed or widely implemented, and consequently have not been evaluated. Potential strategies may be categorized as Voluntary Actions; Laws, Regulations, Policies; Laws Plus Enhancements; or Sanctions and Treatments. Then, applying the same principles as for known existing countermeasures, an agency can estimate how the implementation of such countermeasures is likely to affect the fatality, injury, and cost aspects of its traffic safety problem. As described in NCHRP 622, some of the most important characteristics, requirements, and opportunities associated with the above listed categories are as follows:

Voluntary Action

- Must be of high quality and intensity;
- Works best when:
 - Targeting children;
 - Allowing communicator some control over audience;
 - Communicating new knowledge; and
 - Serving as part of some larger community-based effort.

Laws, Regulations, Policies

- Must be well known to the public;
- Must be enforceable, based on easily observable and objective criteria; and
- Must apply to entire targeted population, not to just a subset of the population.

Laws Plus Enhancements

- Enhancement must be well publicized;
- May involve special equipment to aid officers, prosecutors, probation officers, etc.; and
- Generally involves intense selective and concentrated enforcement.

Sanctions and Treatments

- Sanction must be well known to violators;
- There must be an immediacy and certainty to imposition of the sanction; and
- There should be a high degree of intrusiveness to the violator (either through penalty or extent of mandated treatment).

Additionally, it is likely that further analysis will reveal that additional factors are involved in substantial number of intersection, bicycle, and pedestrian crashes. For example, it is likely that distraction may play a role in intersection crashes given the rise in use of electronic devices in vehicles. Impairment may play a role in intersection and pedestrian crashes. If such determinations are made, MAG may wish to consider a broader range of countermeasures to address these crashes.

5.1 RESOURCES

Several recent safety plans have been developed that serve as excellent resources for identifying analytical methods and for identifying potential future strategies, although many strategies are thus far unproven.

- *The New York City Pedestrian Safety Study & Action Plan*, New York City Department of Transportation, August 2010
- *Hillsborough County Bicycle Safety Action Plan*, April 2011
- *Pedestrian Safety in the NYMTC Region*, New York Metropolitan Transportation Council, September 2007
- *Kansas City Regional Transportation Blueprint*, Mid-America Regional Council Transportation Department, 2009

6.0 References

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Garber, N., Miller, J., Abel E., Eslambolchi S., and Korunkonda S., "The Impact of Red Light Cameras (Photo-Red Enforcement) on Crashes in Virginia", Virginia Transportation Research Council, 2007.

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