Speed Management

A Manual for Local Rural Road Owners

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16. Abstract

In 2010, 35 percent of the 30,196 fatal crashes on U.S. roadways occurred on local rural roads, with nearly one-third (3,427) of these involving speeding. This document is intended to provide local road practitioners with information on how to address speeding-related crashes through the implementation of a comprehensive Speed Management Program. An effective program addresses all factors that influence speeding through engineering, enforcement, education, and emergency services—known as the four E's of safety.

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1 Introduction

1.1 Background

Speeding is defined as exceeding posted speed limits or driving too fast for conditions. This is a behavior that some drivers engage in without recognizing the risks or seriously considering the consequences. According to the National Highway Traffic Safety Administration (NHTSA), the consequences of excessive speed include the following: [1]

- Greater potential for loss of vehicle control, which may result in a crash.
- Reduced effectiveness of occupant protection equipment.
- Increased stopping distance after the driver perceives a danger.
- Increased degree of crash severity leading to more fatalities and disabling injuries.
- Unexpected economic and even psychological implications of a speed-related crash.
- Increased fuel consumption and cost.

The most serious consequences of speeding are the fatalities and serious injuries that result from crashes. Over the last ten years, speeding has been consistently identified as a contributing factor in nearly one-third of all roadway fatalities nationwide. Crashes involving speeding occur on all road types but are particularly prevalent on the local rural road system. The local road system refers to locally owned and maintained roads in rural areas. Of the 30,196 fatal crashes occurring on all road types in 2010, 35.4 percent—or 10,689—occurred on local rural roads, with nearly one-third (3,427) of these involving speeding.[2] As the speed increases, the likelihood of a crash resulting in a serious injury or fatality also increases.

Addressing this safety issue can be a challenge for local roadway agencies because of their limited resources. Nonetheless, all agencies, regardless of size and resources, can develop a comprehensive and coordinated program to address speeding.

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1 Strategies for Distributing "Speed Shatters Life" Campaign Public Service Advertising Materials (2011). http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/strateg.pdf

2 Fatality Analysis Reporting System (FARS), National Highway Traffic Safety Administration, 2010 Data.

1.2 Purpose

This document provides information on how to develop a Speed Management Program that is tailored to meet the needs of local rural road practitioners. A Speed Management Program can be effective in lowering the number of speeding crashes and the resulting fatalities and serious injuries on local rural roads. This document describes the various elements of a Speed Management Program, including the principles of setting speed limits appropriate for roads within the jurisdiction and various countermeasures that are effective in mitigating speeding as it relates to roadway safety in rural areas.

The following terms are commonly used in speed literature and discussions.[3]

Design Speed – the speed established as part of the geometric design process for a specific roadway.

Operating Speed – the speeds at which vehicles are observed operating during free flow conditions. Free flow conditions occur when vehicles are unimpeded by traffic control devices (e.g. traffic signals) or other vehicles in the traffic stream.

Posted Speed – the maximum lawful vehicle speed for a particular location as displayed on a regulatory sign. Posted speeds are displayed in speed values that are multiples of 5 mph.

Statutory Speed – numerical speed limits (e.g. 25 mph, 55 mph), established by state law that apply to various classes or categories of roads (e.g. rural expressways, residential streets, gravel roads, primary arterials, etc.) in the absence of posted speed limits.

The intended audience is comprised of the local rural practitioners who have responsibility for the operation and maintenance of their road network and the safety of its users. This manual provides basic information to assist local road practitioners in assessing speeding problems and developing appropriate countermeasures. It is not, however, a comprehensive discussion of all aspects of speeding and speed management, and, therefore, local practitioners should seek technical advice from their State Department of Transportation (DOT), Governor's Highway Safety Office (GHSO), or Local or Tribal Technical Assistance Program (LTAP or TTAP). The Federal Highway Administration's (FHWA's) Office of Safety Web site lists numerous resources

[3] Donnell, E., et al., Speed Concepts.: Informational Guide, FHWA Office of Safety (2009), http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa10001/

that provide information on implementing a successful Speed Management Program.[4]

1.3 Speed Management Program

A Speed Management Program is a strategy that addresses the concern of unlawful and undesirable speeds at a specific location, along a corridor, or within a jurisdiction's road network. The program should be comprehensive, addressing all factors that influence speeding: public awareness, user behavior, roadway design, surrounding land uses, traffic conditions, posted speed limits, and enforcement. Therefore, the program should encompass engineering, enforcement, education, and emergency services—known as the four E's of safety—when appropriate.

- **Engineering** is used to accomplish the following:
  - Establish speed limits that are appropriate to the primary purpose of the road, provide a balance between mobility and safety for all roadway users, and meet all state or local legal requirements.
  - Design roads that produce desired speeds.
  - Introduce physical countermeasures to create a self-regulating roadway that induces drivers to travel at the desired speed.
- **Enforcement** encompasses the actions taken by appropriate empowered authorities to check that drivers of motor vehicles are complying with the legal posted speed limit. Various countermeasures are used by law enforcement to deter motorists from speeding.
- **Education** entails providing information to drivers about their travel speeds and safety issues associated with speeding and to heighten their awareness of enforcement countermeasures that are designed to curtail speeding.
- **Emergency Services**, also known as emergency medical services (EMS), include quick response to crash locations and attention to victims to minimize the severity of the crash.

A Speed Management Program will generally follow the four-step process illustrated in Figure 1.

[4] FHWA Office of Safety Web site: http://safety.fhwa.dot.gov

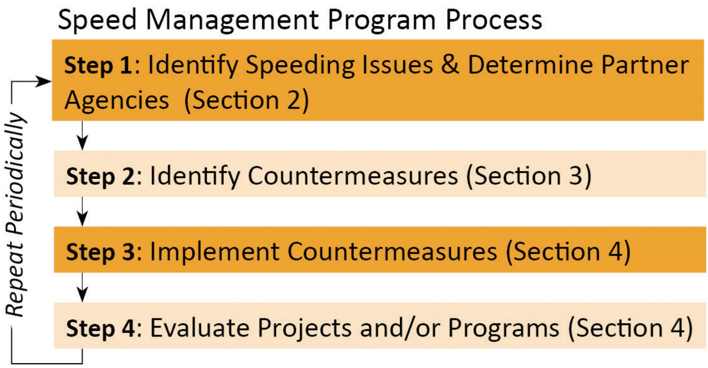

Figure 1. Speed Management Program Process.

- **Step 1—**Identify speeding issues. A review of crash data, coupled with site reviews and public input, is needed to determine if there is a speeding issue and, if so, to what extent and from what causes. Partner agencies will play an integral role in addressing speeding and should be identified for coordination in moving forward with a Speed Management Program. Specific goals should be set once the issue has been identified.
- **Step 2—**Select countermeasures. Identify engineering, enforcement, and education countermeasures that may address the problem.
- **Step 3—**Implement countermeasures. The identified countermeasures will need to be prioritized, funded, and implemented in a systematic way.
- **Step 4—**Evaluate progress. Individual countermeasures or projects should be evaluated to determine the progress being made towards achieving the goals that were established for the entire Speed Management Program.

Steps 1 through 4 are continuously pursued with appropriate adjustments made based on the progress. This four-step process is described in more detail in the subsequent sections of the guide.

Benefits of a Speed Management Program

- Reduced fatalities and serious injuries from speeding-related crashes.
- Greater potential for motorists to avoid a crash.
- Enhanced safety for pedestrians, cyclists, and other vulnerable road users.
- Driving population educated on the risks and consequences of speeding.
- Enhanced community-wide safety culture, where safety is a top priority.

1.4 Agency Partnerships

Collaboration and coordination between agencies are essential in addressing speeding and speed-related crashes at any level of government and even more so at the local community level. With limited resources, pooling resources will benefit the Speed Management Program in addressing the speed-related crashes. Among the agencies to engage at this stage of the process in order to develop partnerships are law enforcement and/or public safety, local and county engineering department, public works department, and State DOT. The level of involvement in the process will depend on the nature of the speeding issue(s) identified. In many instances it may be beneficial to convene a Speed Management working group. Bringing the right agencies or individuals together to be part of a working group will help foster a long-term commitment and build momentum to implement the plan. A successful Speed Management Program will typically have different roles shared by different agencies.

Local rural practitioners may also decide to notify relevant elected officials of the speeding issues and the steps being taken to address them. Elected officials can encourage partner agencies to participate in the process, assist with policy requirements, and obtain funds for the implementation of identified countermeasures. For example, if a village in a rural area identifies a speeding issue on a county road within the village, it should consider partnering with the county highway department and the local police or sheriff's department to address the issue.

2 Identify Speeding Issues

The greater tendency to speed in rural areas may be due to the typically lower traffic volumes there. In some locations, the geometry of the roadway may self-regulate motor vehicle speeds. On the other hand, the geometric and roadside characteristics of a roadway may encourage higher speeds, such as on flat, open areas. Because speed enforcement activities may be sporadic in rural areas, speeding may go undetected or underreported until a severe crash occurs, at which time an immediate reaction may be to reduce the posted speed limit. Studies have shown that lowering the speed limit without justification does not effectively lead to reduced vehicle speeds. Therefore, a systematic process must be employed in addressing speeding.

The first step in such a process is to identify if there is a speeding issue and, if so, determine its magnitude and contributing factors. This entails data collection, an assessment of the posted speed limit, and a determination of whether speeds are excessive. It also involves the review of available crash and roadway data to isolate the factors contributing to the problem. If there is a documented speeding issue, then countermeasures are selected and coordinated with partner agencies and other stakeholders.

2.1 Data Sources

Road owners can become aware of locations with speeding issues through a number of sources:

- Crash records.
- Road conditions.
- Citation history.
- Partner agencies.
- Citizen concerns.

An analysis of crash records provides a solid foundation for identifying speeding problems. In some States, there is a specific data element on the crash report for the police to code the crash as speed-related. As a result, speed-related crashes in those States can be more-readily identified from the crash data. Typically, at least three years of crash data are necessary to be able to identify trends.

Some local agencies may maintain a crash records database. The agency that collects and maintains crash data varies by State and may include the State's DOT, Department of Motor Vehicles, State Police or Highway Patrol, or Department of Public Safety. The appropriate agency can assist a local agency with obtaining crash data. A local practitioner can also contact the local law enforcement agency or the LTAP/TTAP representative to determine the availability of crash data. The Strategic Highway Safety Plans (SHSPs) in some States may include speeding as an emphasis area, so an SHSP may provide background information on the source of the data or identify opportunities to coordinate with other agencies.

The crash analysis can range from creating a simple “push pin” map (on which clusters of crashes attributed to speeding are located) to conducting a more detailed review of crash reports that can be used to identify other speed-related crash issues (e.g., crash type, time of day, weather conditions, and crash severity). For example, a high incidence of run-off-road crashes may be an indicator of speeding as a contributing factor.

In addition, exposure should be considered when analyzing crash data. Considering exposure allows for the more appropriate comparison of roadway segments or intersections. Two common types of exposure elements include crashes by roadway miles and crashes by traffic volume. More information on analyzing crash data is provided in *Roadway Safety Information Analysis: A Manual for Local Rural Road Owners*.

There may be evidence on the roadway that indicates there is a speeding problem. This evidence will not establish whether drivers were exceeding the speed limit or driving too fast for conditions but may provide information on locations where speed is a concern. This can be verified through agency staff actively observing conditions along the roadways that they routinely travel. Physical conditions that may indicate a speeding problem include the following examples:

- **Skid marks** are the result of rapid braking. One set of skid marks is not likely to indicate a chronic problem. However, multiple sets of skid marks could indicate a condition where motorists are choosing an inappropriate speed and are braking suddenly to correct their speed.
- **Rutting on the outside of curves** can indicate that motorists are choosing speeds too fast for the curve design. The ruts indicate a loss of control through the curve.
- **Worn centerline markings** on the inside of curves can indicate that motorists are choosing speeds too fast for the curve design.

- **Sign knockdowns or guardrail/fencing strikes** may indicate speeds too fast for roadway conditions. Evidence of sign knockdowns or guardrail strikes may be coupled with rutting.

Citations for speeding are another source of information about a speeding problem. Law enforcement often collects and maintains citation data that can be used to identify patterns in speeding. Linking these data to crash data provides a good understanding of the extent of the problem.

Concerns raised by a citizen or elected official are often based on personal observations and perceptions and should, therefore, be verified with field evidence. A concern expressed by an employee of a governing agency or law enforcement group is often based on evidence that can be found in the field or in the citation records. Regardless, the Speed Management Program should have a procedure for processing information brought forth by citizens and partner agencies. This information should be verified with crash data and citation records.

2.2 Assessing Speeding

Once an area of concern has been identified, and it has been determined that speeding is occurring, the next step is to determine any site-specific factors in speeding. As a starting point, the agency should address the following questions:

- Has the posted speed limit been set in accordance with accepted procedures for the location?
- Do the accepted procedures consider the types if users, such as vulnerable users like pedestrian and cyclists, and slower vehicles, such as farm equipment? Are other environmental characteristics considered?
- Are unexpected conditions being encountered, such as a transition into a developed area or a change in the geometry of the roadway?
- Are motorists provided with sufficient information regarding an unexpected condition (e.g., a gateway treatment or signage noting a change)?
- Are there any engineering deficiencies in the roadway or roadside, such as inadequate pavement markings or signing, that may be contributing to the observed speeding? For example, in a rural village, speeds may be higher than expected if the travel lanes and parking spaces are not properly marked, creating extremely wide lanes.

Although, a thorough review of police crash reports for an area of concern can provide insights, an agency should conduct a field review of the identified sites under free flow traffic conditions, which are usually observed outside of peak periods. Free flow traffic conditions are essential when studying a location to capture the natural tendencies of motorists unencumbered by traffic. Peak traffic conditions typically occur during the morning commute to work, lunchtime, the evening commute from work, and some special occasions (such as certain holidays). Field reviews can be either informal (e.g., using only an agency's own personnel) or formal (e.g., a road safety audit using an independent multi-disciplinary team).[5]

Understanding the factors in speeding will help identify effective speed management strategies.

2.2.1 Assessing the Speed Limit

Speed limits are only meaningful if the majority of motorists comply voluntarily, and that occurs only if a speed limit is reasonable for the conditions and meets drivers' expectations. There are two methods for establishing speed limits: the first involves applying the statutory speed limit, while the second involves establishing a speed limit through an engineering study.

Statutory speed limits are established by the authority of law in each State. Some State laws provide speed limits for all roads on the basis of functional class (i.e., arterial, collector, or local road) but are not limited to these speed limits if there is an overriding concern. [6] In many cases, these speed limits typically apply in the absence of a posted speed limit and usually do not preclude the establishment of a speed limit based on an engineering analysis of site-specific conditions.

On the other hand, some States may provide reduced prima facie speeds under certain conditions. For example, speed reductions may be warranted based on access point/driveway density (i.e., an indication of how many driveways are located in a specific section of roadway). Local rural practitioners should understand the laws that govern speed limits in their State. If the speed limit is not mandated by State law, then an evaluation of a speeding concern provides an excellent opportunity to review the appropriateness of the posted speed limit.

Research has shown that setting speed limits based on driver behavior and the adjoining land use can reduce the number of speeding citations, speed variance,

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[5] FHWA Road Safety Audit Web site: http://safety.fhwa.dot.gov/rsa

[6] Strategies for Distributing "Speed Shatters Life" Campaign Public Service Advertising Materials (2011). http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/strateg.pdf

and, most importantly, speeding-related crashes.[7] The establishment of a speed limit based on an engineering study allows for consideration of local conditions, such as geometry and crash history. FHWA provides an easy to use tool—USLIMITS, a Web-based expert advisor—for determining speed limits.[8] The following information is needed to conduct a typical speed limit determination using USLIMITS:

- Land use type (e.g., high density, low density, hamlet, or rural).
- Frequency of roadside access (e.g., number of residential and commercial driveways, intersecting roads, etc.).
- Road function (e.g., traffic movement versus access to abutting properties).
- Facility characteristics (e.g., paved width, divided or undivided, lane width and number of lanes, sight restrictions, etc.).
- Current vehicle speed data (e.g., data from a speed study).
- Existing speed limits.
- Special conditions that may exist (e.g., adverse alignment, the presence of pedestrians and cyclists, roadside design, high crash rates, etc.).

Other information on establishing speed limits can be found in *Methods and Practices for Setting Speed Limits: An Informational Report*.[9]

2.2.2 Determining if Speeds are Excessive

A speed study should be conducted in order to assess whether vehicle speeds are in excess of the posted speed limit and/or compatible with conditions. Appendix A (How to Conduct a Speed Study) provides guidance for conducting a speed study. Speed limits are often set by the 85th percentile speed, which is the point in the speed distribution at which 85 percent of vehicles travel at or below.

Use of the 85th percentile speed concept is based on the theory that the vast majority of drivers can be characterized by the following:

- They are reasonable and prudent.
- They do not want to be involved in a crash.
- They desire to reach their destination in the shortest possible time.

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7 NCHRP Report 622 Effectiveness of Behavioral Highway Safety Countermeasures (2008) http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_622.pdf

8 USLIMITS Web site: http://safety.fhwa.dot.gov/uslimits

9 Forbes, G, et al., Methods and Practices for Setting Speed Limits: An Informational Report (2012), http://safety.fhwa.dot.gov/speedmgt/ref_mats/

A speed at or below which 85 percent of people drive at any given location under good weather and visibility conditions may be considered as the maximum safe speed for that location.

The results of numerous and extensive “before-and-after” studies substantiates the general value of the 85th percentile criterion. Experience has also proved these findings valid and shows that the 85th percentile speed is the one characteristic of traffic speeds that most closely conforms to a speed limit that is considered safe and reasonable.

The data collected during the speed study is typically plotted on a graph as depicted in Figure 2. The graph plots the cumulative percentage for increases in speed. From this plot, the 85th percentile can be determined, which in this example is 33.2 mph. The curved line depicts the actual speed measurements on the road in question and the horizontal line depicts the 85th percentile speed. More information on how to conduct a speed study is provided in Appendix A or can be found in the *Handbook of Simplified Practice for Traffic Studies*.[10]

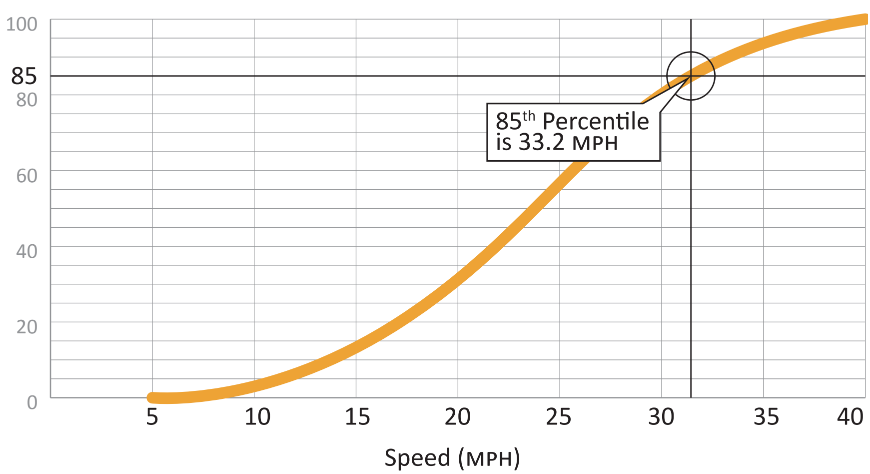


Figure 2. Graphical Depiction of 85th Percentile Speed.

[10] Center for Transportation Research and Education (CTRE). Iowa State University. Handbook of Simplified Practice for Traffic Studies. Iowa DOT project TR-455. CTRE project 01-08. November 2002. Available: www.ctre.iastate.edu/pubs/traffichandbook/index.htm.

2.2.3 Unpaved Roads

There are over 1.4 million miles of unpaved roads in the United States. In many rural areas of the country, local road agencies do not have any paved roads under their jurisdiction. Unpaved roads (e.g., limestone, natural aggregate, dirt, and sand) require special consideration when determining appropriate speed limits.

Unpaved roads frequently do not have posted speed limits.

Although usually low-volume facilities, unpaved roads typically lack adequate delineation, runoff areas, clear zones, and guardrails, making them more prone to injury and fatality-producing crashes. Hence, this type of road may require special consideration if a speed issue is identified.

A 2007 study conducted in Kansas supports the notion that gravel roads are fairly self-regulating with regard to speeds because of physical conditions, such as geometry, road width, and surface. [11] Speeding issues on gravel roads will be best addressed through the use of a combination of engineering, enforcement, and education countermeasures.

[11] Liu, Dissanayake, Speed Limit-Related Issues on Gravel Roads (2007) http://www.intrans.iastate.edu/pubs/midcon2007/LiuLimit.pdf

3 Identifying Countermeasures

A coordinated approach to managing speeding and reducing speed-related crashes based on engineering, enforcement, and education countermeasures is desirable. When identifying countermeasures, practitioners should consider strategies that will minimize the severity of speed-related crashes. This will depend on location characteristics and the contributing factors of crashes identified from crash data and field reviews. One method to evaluate potential engineering countermeasures, and their ability to reduce crashes, is using Crash Modification Factors (CMF's). A CMF is a multiplicative factor used to determine the expected change in the number of crashes after implementing a specific countermeasure at a specific site.[12] This section provides information on engineering, enforcement, and education countermeasures that can be used to address a speeding issue.

3.1 Engineering

Reducing the speed limit alone generally does not result in lower speeds. Several engineering countermeasures have been identified that can be used to influence driver speed choice, and the following sub-sections describe engineering countermeasures that address speeding. They have been grouped into three categories: traffic control devices, road and street design, and traffic calming on lower-speed roadways. Since design details are not presented, the road owner should seek engineering expertise when selecting countermeasures.

3.1.1 Traffic Control Devices to Reduce Speed

Installing or upgrading signs and pavement markings on an affected roadway can be a cost-effective measure to reduce speeding. Such improvements include advisory speed signs and pavement markings, speed activated signs, and optical speed bars.

Advisory speed displayed with curve warning sign.

Advisory speeds are installed with curve warning signs (either on the same sign or as a supplemental plaque) to recommend a safe speed for traversing a horizontal curve. The warrant for when they

12 Unless otherwise noted, CMFs in this document were obtained from the CMF Clearinghouse and are assumed to apply to all crash types. Available at: http://www.cmfclearinghouse.org/index.cfm

should be used are prescribed in the *Manual on Uniform Traffic Control Devices* (MUTCD) (see Section 2C.07)[13] and the procedure for setting advisory speeds on curves can be found in *Procedures for Setting Advisory Speed Limits on Curves*.[14] Advisory speed signs have been found to reduce speeds by two to three mph[15] (CMF = 0.71-0.87).[16]

A pavement speed limit marking displays the posted speed limit on the pavement. It is used to emphasize the speed limit. A **SLOW** curve ahead pavement marking warns the driver of a potentially hazardous curve. This pavement marking is meant to supplement advsiory signs. Because they are exposed to traffic wear, both types of pavement markings require regular maintenance to ensure their continued visibility.

Special pavement marking to encourage speed reduction for impending curve.

A speed activated sign is an electronic sign that is connected to a device that measures the speed of approaching vehicles. If the vehicle is exceeding the legal speed limit, then the electronic sign is activated to display the legal speed limit. This may also be accompanied by the word "SLOW" or other appropriate message. A similar device is a **speed feedback sign.** When connected to a speed-measuring device, a speed feedback sign displays the speed at which a vehicle is traveling. The speed-activated sign and the speed feedback sign can be effective in speed transition areas (e.g., entering a school zone or other area characterized by high volumes of non-motorized traffic). If used too frequently, the effectiveness of these signs is diminished. Speed feedback signs were found to reduce speeds between two and 10 mph[17] (CMF = 0.54).[16]

A solar-powered speed feedback sign.

[13] MUTCD 2009 http://mutcd.fhwa.dot.gov/pdfs/2009/pdf_index.htm

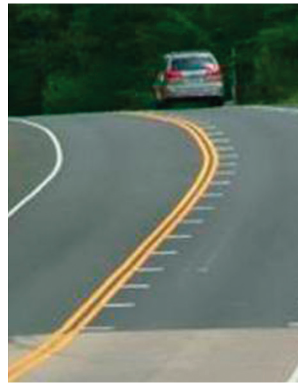
[14] Milstead, R., et al., Procedures for Setting Advisory Speed Limits on Curves (2011), http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa1122/

[15] Vest, A., et al., Effect of Warning Signs on Curve Operating Speeds. Kentucky Transportation Center (2005), http://www.ktc.uky.edu/Reports/KTC_05_20_SPR_259_03_1F.pdf

[16] Elvik, R. and Vaa, T., "Handbook of Road Safety Measures." Oxford, United Kingdom, Elsevier, (2004).

[17] Hallmark, S., et al., Evaluation of Gateway and Low Cost Traffic-Calming Treatments for Major Routes in Small, Rural Communities (2007), http://www.intrans.iastate.edu/reports/traffic-calming-rural.pdf

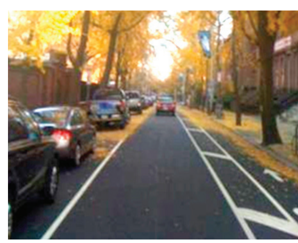
Optical speed bars are used at spot locations or along a corridor to reduce speeding. These are transverse pavement markings across the travel lane or along its edges placed with decreasing spacing in the direction of travel, which makes it appear to drivers that they are traveling faster than their true speed. They are placed in advance of a speed transition zone or other critical location. This treatment should be used sparingly, else it will lose its novelty effect, and should be maintained to ensure its usefulness. Optical speed bars have been found to reduce speeds by an average of two mph. More details can be found in Section 3B.22 of the MUTCD.


Optical speed bars on a rural roadway placed in advance of a horizontal curve.

3.1.2 Road and Street Designs

There are several modifications to the design of a road or street that can induce speed reductions and have other safety and operational benefits for all road users. These include reduced lane widths, road diet, center island or median, and roundabout. Several of these countermeasures can be implemented on higher-speed roadways.

Reducing lane width to as narrow as 10 feet can reduce speeds. This can be accomplished by restriping narrower lanes without reducing pavement width. The remaining space can then be used for non-motorized uses, buffer areas between travel lanes and non-motorized uses,or space for on-street parking. In rural areas, reducing lane width on roadway segments should only be considered on lower-speed roadways in towns or villages. A nationwide study found no increase in crashes or injuries when lanes were narrowed on urban and suburban roadways.[18] Speeds may also decrease by one to three mph for each foot that the roadway is narrowed down to 10 feet.[19] At two way stop controlled,


The lane width for motor vehicle travel in this community was reduced to provide exclusive space for cyclists.

[18] Potts, I., et al., Relationship of Lane Width to Safety for Urban and Suburban Roadways, (2007),

[19] http://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter3/3_lanewidth.htm

rural intersections on high-speed two-lane, two-way roadways lane narrowing through the application of rumble strips on outside shoulders and in a painted yellow median island on major road approaches has been found to significantly reduce speeds and resulted in improved safety performance[20] (CMF= 0.69).[21]

A road diet is a conversion of an existing street cross section to create space for other uses (e.g., bicycle lanes, sidewalks, turn lanes, or on-street parking). Figure 3 is a before-and-after drawing of a typical road diet. The original road was four lanes with two lanes in each direction.

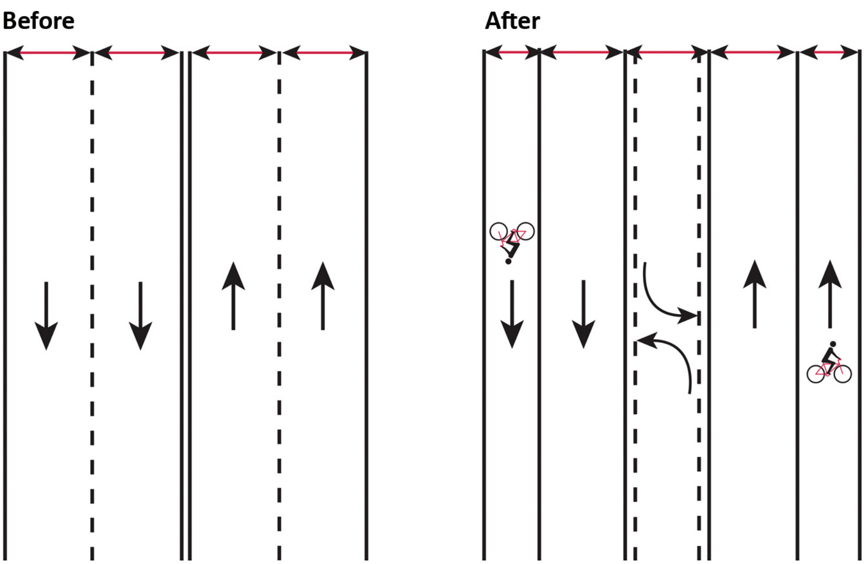


Figure 3. Road Diet Comparison.[22]

The same road width remains after the road diet, but the number of travel lanes for motor vehicles is reduced providing space for bicycle lanes in each direction. Road diets have the potential to reduce speeds due to the percieved narrowing of the roadway, with the extra pavement used for center turn lanes, parking, bicycle lanes, or other uses. Road diets have also been found to reduce crashes

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[20] Bared, J., Hughes, W., Jagannathan, R., and Gross, F. "Two Low Cost Safety Concepts. for Two Way Stop Controlled, Rural Intersections on High Speed Two Lane, Two Way Roadways." Report No. FHWA-HRT-08-063, Federal Highway Administration, Washington, DC. (2008)

[21] Hauer, E., "Lane Width and Safety." (2000)

[22] Huang, H., et al., Summary Report: Evaluation of Lane Reduction "Road Diet" Measures and their Effects on Crashes and Injuries (2004), http://www.fhwa.dot.gov/publications/research/safety/humanfac/04082/index.cfm

(CMF = 0.47-0.71).[23, 24] More detailed information can be found in the *Road Diet Handbook: Setting Trends for Livable Streets*.[25]

A center island raised median.

A center island or raised median can be used to create a shift in the travel path. Shifting traffic is an effective way to reduce speeds. A center island or raised median may also be used to narrow the "optical width" of the roadway, which will make the roadway appear narrower, thereby reducing speeds. Medians have been shown to be effective in lowering operating speeds, especially when they create a deflection in the vehicle path at the beginning of the median. However, attention must be given to the design of the deflection to achieve a speed reduction without compromising safety. For this reason center islands and raised medians are typically applied to developed areas- that is in towns or villages- within the rural context. Another positive aspect of installing medians is that pedestrians' safety is improved by providing a refuge when crossing the street. According to trafficcalming.org installing medians as a measure for narrowing, results in an average speed reduction of 7 percent of the 85th percentile travel speed[26] (CMF 0.29).[27]

A roundabout is an intersection with a raised island in the middle that vehicles must travel around in a counterclockwise direction. In order to enter the roundabout, a driver must yield to vehicles traveling in the circulatory roadway. Roundabouts have become popular for intersection traffic control due to documented safety

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[23] Harkey, D.L., R. Srinivasan, J. Baek, B. Persaud, C. Lyon, F.M. Council, K. Eccles, N. Lefler, F. Gross, E. Hauer, J. Bonneson, "Crash Reduction Factors for Traffic Engineering and ITS Improvements", NCHRP Project 17-25 Final Report, Washington, D.C., National Cooperative Highway Research Program, Transportation Research Board, (2008)

[24] Persaud, B. N., Retting, R. A., Garder, P. E., and Lord, D., "Observational Before-After Study of the Safety Effect of U.S. Roundabout Conversions Using the Empirical Bayes Method." Transportation Research Record, No. 1751, Washington, D.C., Transportation Research Board, National Research Council, (2001)

[25] Gates, T., et al., The Safety and Operational Effects of Road Diet Conversions in Minnesota, 2007 TRB 86th Annual Meeting: Compendium of Papers CD-ROM, Vol. TRB#07-1918, Washington, DC, (2007),

[26] http://trafficcalming.org/measures/center-island-narrowings/

[27] Schultz, G.G., K.T. Braley, and T. Boschert, "Correlating Access Management to Crash Rate, Severity, and Collision Type." TRB 87th Annual Meeting Compendium of Papers CD-ROM. Washington, D.C., (2008).

(CMF 0.213-0.58)[28, 29] and operational benefits. Roundabouts can be extremely effective at improving safety by managing speeds. According to the FHWA's Proven Safety Countermeasures website, converting a two-way stop controlled intersection to a roundabout can reduce severe crashes by 82 percent and overall crashes by 44 percent. Similarly, converting a signalized intersection to roundabout conversion can reduce severe crashes by 78 percent and overall crashes by 48 percent. For more information concerning roundabouts, refer to FHWA's Web site on roundabouts at: http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_005.htm.

A rural roundabout.

3.1.3 Traffic Calming

Traffic calming is the design or retrofit of a roadway to encourage uniform vehicle speeds and improve conditions for non-motorized users. Traffic calming tends to be applied to roads with operating speeds of 30 mph or less, as these roads are typically developed zones along rural roadways. There are numerous traffic calming countermeasures that can be applied on different types of roads and streets, and these are identified in ITE's *Traffic Calming: State of the Practice*[30] and the FHWA's *Engineering Countermeasures to Reduce Speeds*.[31] Some of the measures that can be applied in rural villages are described in this section.

A speed hump is a raised section of asphalt approximately 10 to 14 feet long and 3 to 4 inches high. Speed humps are typically used on lower-speed residential streets in rural areas that are experiencing a high incidence of speeding and/or cut-through traffic.[32] Speed humps are

A speed hump delineated to notify motor vehicles of its presence.

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[28] Fortuijn, L. "Turbo Roundabouts: Design Principles and Safety Performance." TRB 88th Annual Meeting Compendium of Papers CD-ROM. Washington, D.C., 2009.

[29] Schoon, C. and van Minnen, J., "The Safety of Roundabouts in The Netherlands." Traffic Engineering & Control, Vol. 35, No. 3, London, United Kingdom, Hemming Information Services, (1994) pp. 142-148.

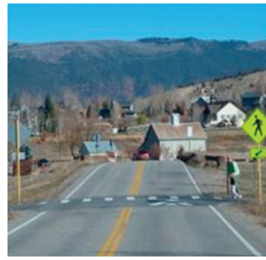
[30] ITE Web site: http://www.ite.org/traffic/tcdevices.asp

[31] FHWA Web site: http://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/

[32] Traffic Calming: Speed Control. Available: http://trafficcalming.org/.

not to be confused with speed bumps, which are much shorter and usually found in parking lots. Speed humps have been found to reduce injury crashes by 40 to 50 percent and speeds by nine mph[33] (CMF = 0.5-0.6).

Speed tables are similar to speed humps but have an extended flat section that can accommodate an entire car. This design allows for speeds of 25 to 30 mph, which are typical for local and collector streets. Speed tables are generally placed on roadways where there is minimal heavy truck and farm vehicle traffic.[34] Information on the design of speed humps and speed tables are available in ITE's *Guidelines for the Design and Application of Speed Humps and Speed Tables* (see www.ite.org). According to trafficcalming.org, speed tables have been found to reduce speed by an average of 7.5 mph.[35]


A speed table at a pedestrian crossing on a rural road.

A mini-roundabout is smaller than a conventional roundabout and has a mountable center island that is either flush with the pavement or slightly mounded. It is typically installed on roadways with speed limits of 35 mph or lower. This measure can reduce speeds by an average of 10 mph, since traffic is required to yield to road users in the mini-roundabout.[35]


A mini roundabout.

A traffic circle is intended for low-volume and low-speed roads, such as those in residential areas. A raised center island is constructed in the intersection. Landscaping can be added to the island for aesthetic value but should not obstruct the view of the intersection. A traffic circle is quite different from a roundabout or


A traffic circle.

[33] Elvik, R. and Vaa, T., "Handbook of Road Safety Measures." Oxford, United Kingdom, Elsevier, (2004), http://www.ite.org/safety/issuebriefs/Intersection%20Issue%20Brief.pdf

[34] Evaluation of Gateway and Low Cost Traffic-Calming Treatments for Major Routes in Small, Rural Communities 2007, http://www.intrans.iastate.edu/reports/traffic-calming-rural.pdf

[35] Traffic Calming: Speed Control. Available: http://trafficcalming.org/.

mini-roundabout, as a yield sign is not mandatory for this intersection. Also, it is permissible to turn left in front of the center island, a maneuver that is prohibited at a conventional roundabout. Traffic circles have been found to reduce speeds by up to 15 mph.[36]

For more information on traffic circles and mini-roundabouts, FHWA has published an informative technical summary on mini-roundabouts that can be found in FHWA's Technical Summary: Mini-Roundabouts or NCHRP 672, *Roundabouts: An Informational Guide*.[37]

3.1.4 Gateway Treatments

A common speeding-related problem occurs when a driver approaches a rural town or village from a higher-speed rural road. Gateway treatments (also called gateways) can be used in rural areas to capture the attention of drivers and inform them that the nature of the roadway is changing, and, as a result, they should reduce their speed.[36] A gateway is a "combination of traditional and nontraditional traffic control treatments, such as enhanced signing, lane reduction, colored pavements, pavement markings, experimental striping, gateway structures, and traditional traffic calming techniques or other identifiable features."[38] A key consideration is the proper use of transitional speed limits and the Reduced Speed Limit Ahead warning signs as prescribed in the MUTCD (see section 2C.38).

A gateway treatment entering a rural community.

The gateway needs to be conspicuous to be effective. It is also important to ensure that devices used as part of a gateway treatment (1) are crashworthy if placed within the clear zone and (2) do not obstruct sight distance, as gateways placed in the roadway may become fixed object hazards. Gateways have been found to reduce speeds by an average of five mph.

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36 Traffic Calming: Speed Control. Available: http://trafficcalming.org/.

37 Technical Summary: Mini-Roundabouts (February 2010) http://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa10007/fhwasa10007.pdf

38 Evaluation of Gateway and Low-Cost Traffic-Calming Treatments for Major Routes in Small, Rural Communities (2007), http://www.ctre.iastate.edu/reports/traffic-calming-rural.pdf

Additional information on the effectiveness of engineering countermeasures is available in the FHWA publication *Engineering Countermeasures for Reducing Speeds*.[39]

3.2 Enforcement

Enforcement is critical in some locations to achieve compliance with posted speed limits. According to the Uniform Guidelines for State Highway Safety Programs, more than half of all traffic stops result from speeding violations, and public support for speed enforcement activities depends on the confidence of the public that the speed enforcement is fair, rational, and motivated by safety concerns.[40]

Speed enforcement that is perceived predominantly as a means to generate revenue will be met with indifference, at a minimum, and active resistance, at worst, from the motoring public. Speed enforcement countermeasures should primarily be at times and locations that can be directly tied to speeding-related crashes and areas of excessive speeding.

Traffic enforcement seeks to generate deterrent effects on speeding that are both specific and general. The specific deterrence is based on the idea that individual drivers who are caught and punished for speeding will be dissuaded from committing further speeding violations in the future. The general deterrence is based on the assumption that the process of apprehending individual violators can influence the behavior of a larger segment of the driving population.

There is an established linkage between speed education efforts and speed enforcement initiatives. Working together, these strategies amplify the impact of each element's contribution to traffic safety. NHTSA's high-visibility model recommends using a strategic combination of public information, education, and targeted speed enforcement at times and locations where excessive speeding and speeding-related crashes have been documented.[41] These efforts are often conducted periodically and last from one to several weeks so that coordinated

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[39] Engineering Countermeasures for Reducing Speeds: A Desktop Reference of Potential Effectiveness (2009), http://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/

[40] Highway Safety Program Guideline No. 19, Uniform Guidelines for State Highway Safety Programs, NHTSA (2006), http://www.nhtsa.gov/nhtsa/whatsup/tea21/tea21programs/pages/SpeedManagementPDF.pdf.

[41] NHTSA'S High-Visibility Model, http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/HS810851.pdf

speed enforcement can take place among multiple law enforcement agencies on a consistent basis.

In many rural areas, individual traffic officers may be responsible for patrolling large areas. Rural law enforcement agencies often do not have resources available to respond to each traffic safety issue identified within their jurisdiction.

It is important that the engineering and law enforcement disciplines form a partnership to address speeding. Regular meetings between engineers and law enforcement officers responsible for traffic enforcement should be scheduled to discuss speeding concerns. Traffic engineers and law enforcement agencies must work closely together to identify roadway locations where engineering countermeasures alone will not address speeding, financial resources are not available to implement robust engineering measures, and speed enforcement strategies are needed.

The relationship between the engineering and enforcement communities will be beneficial to the Speed Management Program through the sharing of knowledge. For example, the engineering community can explain the process of setting speed limits to the police officers charged with enforcing them, and the enforcement community can discuss the need for and the optimal configuration of emergency pull-off areas to the individuals who are responsible for designing the roadway environment. Other community stakeholders (e.g., from schools, emergency services, hospitals, etc.) may also be invited to participate on a regular or as-needed basis. The Mississippi Demonstration Project, detailed in the box on the following page, is an example of a successful partnership between engineers and local law enforcement personnel that was effective in educating the driving population.[42]

3.2.1 Traditional Enforcement

The primary speed enforcement tools used by law enforcement patrol officers include RADAR (RAdio Detection And Ranging), LIDAR (LIght Detection And Ranging), and vehicle pacing. With proper training, these tools constitute effective means to identify and cite speeding violators. Due to the ease of use, accuracy, and steadily decreasing costs, RADAR and LIDAR (or laser) instruments have become the preferred method of speed detection by law enforcement. In some States, grants are available from organizations such as the Govenor's

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[42] Freedman, M., et al., Field Test of the Impact of Setting and Enforcing Rational Speed Limits in Gulfport, Mississippi, National Highway Transportation Safety Administration, Washington, DC. (2007).

Highway Safety Office (GHSO) to purchase or upgrade RADAR and/or LIDAR equipment.

For speed enforcement deployments, rural law enforcement agencies often make greater use of "moving" RADAR equipment (RADAR that can capture the speed of traffic when the patrol vehicle is moving). The size of a typical rural patrol area often requires officers to patrol for speeders in moving mode to allow them to canvas the large geographic areas assigned to them over the course of a work shift. In general, rural and suburban patrol officers are also more likely to work individually on speed enforcement compared to their urban counterparts. Often, when a new Speed Management Program is being unveiled, rural or suburban agencies will combine resources. Officers from several agencies within the same jurisdictional authority (e.g., village, township, county, and/or State agencies) will agree to work together to address specifically-identified stretches of a roadway where speeding and crashes are clearly a problem. These collaborative traffic safety efforts by law enforcement agencies are a means to maximize the impact of scarce resources and heighten awareness of speeding issues experienced by the motoring public. NHTSA provides each State's GHSO with Federal funds that can be used to target specific traffic safety issues—and speeding is being increasingly identified as a priority.

> In 2001, NHTSA, FHWA, and the Mississippi DOT teamed up with the Cities of Gulfport and Southaven to carry out an assessment of setting rational speed limits, enforcing those limits, and educating the public on speeding-related issues. Gulfport used the engineering process of setting speed limits to the 85th percentile, as well as strict enforcement and plenty of public education. Southaven was monitored, as well, although there were no changes in the speed limits, enforcement, or public education. Improvements were noted in Gulfport in drivers' compliance with the newly-introduced rational speed limits (based on the 85th percentile) as compared to Southaven, which kept the same speed limits as before.

3.2.2 Automated Enforcement

Automated Speed Enforcement (ASE) systems are also effective methods to prevent speeding-related crashes. ASE combines RADAR or LIDAR with sophisticated digital camera systems and computer technology to detect speeding violations and record identifying information about the vehicle and/or driver. ASE is a supplement to traditional speed enforcement countermeasures.

By utilizing ASE, an agency will be able to do the following:

- Conduct speed enforcement in areas where traditional traffic stops are dangerous or infeasible due to the roadway design.
- Continuously conduct speed enforcement on roadways identified as high-crash locations where traditional law enforcement is not practical.
- Reduce the impacts of driver distraction and congestion that often result during traditional traffic stops made by law enforcement, especially during peak travel periods.

Agencies should check for ASE laws or regulations within their State when considering the implementation of ASE. Communities considering ASE as an option should review the USDOT Speed Enforcement Camera Systems Operational Guidelines (March 2008) for information on implementing and operating an ASE program.[43]

The equipment within an automated speed enforcement van.

3.2.3 Vehicle Pacing

Officers in some jurisdictions may also use pacing. Pacing is an enforcement method in which the officer observes traffic speeds from a moving vehicle and then pursues a violator.[44] To apply this method, a police vehicle's speed is matched to that of a target vehicle, and the calibrated speedometer of the patrol car is used to infer the other vehicle's speed. Pacing can be an effective, convenient alternative method of identifying a vehicle's speed if a more convenient speed-measuring device is not available.

3.3 Education

Citizen concerns and behavior often drive speed management policies and any associated education efforts. A comprehensive Speed Management

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[43] USDOT Speed Team Enforcement Camera Systems Operational Guidelines (March 2008), http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810916.pdf

[44] Rural Initiatives for Traffic Safety: A Guide for the Office of Sheriff and Other Law Enforcement Officials in Rural Communities, NHTSA and National Sheriff's Association, http://www.nhtsa.gov/people/injury/enforce/ruralinit.html

Program attempts. to address these concerns and behaviors through a data-driven approach.

NHTSA has developed a Speed Campaign Toolkit for public information and education outreach that has been tested and validated in programs across the United States.[45] This toolkit provides example marketing materials that can be used or distributed to fit local needs and objectives while partnering with other local or national communities and organizations on developing a speed management strategy. More information on the toolkit can be found at http://www.trafficsafetymarketing.gov.

NHTSA advises that traffic safety education campaigns should include participation from stakeholders representing law enforcement, engineering, public health, the judiciary, and prosecutors to ensure that agencies directly impacted by enforcement countermeasures are "in the loop" and have input into the proposed effort.[46] This also includes private partners, such as hospitals, news organizations (newspaper, radio, and/or TV), major employers, and local businesses.

[45] Speed Campaign Toolkit, http://trafficsafetymarketing.gov/speed/toolkit/

[46] Strategies for Distributing "Speed Shatters Life" Campaign Public Service Advertising Materials (2011) http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/strateg.pdf

4 Implementing Countermeasures

4.1 Preparing for Implementation

After selecting the appropriate engineering, education, and enforcement countermeasures, the next step is to implement them. This will involve seeking support, prioritizing the countermeasures, identifying sources of funding, and implementing pilot projects.

4.1.1 Seeking Support

Seeking support for speed-related countermeasures will require engaging the appropriate stakeholders. Stakeholders may be anyone affected by the Speed Management Program, which could include appropriate agencies, community groups, or individuals. Enlisting stakeholder support may include holding a meeting and making a short presentation or providing a short written report to the stakeholders on the design and expected impact of the engineering countermeasure or on the plan for implementing enforcement and education campaigns to the group. When communicating with stakeholders it is essential that local practitioners understand their perspective and possible role in implementation of the program. Other methods of seeking support for a program may include hosting a public information meeting or establishing an electronic presence (e.g., Web page, Facebook page, etc.) that can be used to disseminate information and solicit feedback on the proposed countermeasures.

4.1.2 Prioritization of Countermeasures

With practically every agency being constrained by limited resources, countermeasures will need to be prioritized. Most often, the countermeasures proven to provide the most impact for the investment are given the highest priority. The following qualities of each countermeasure should be considered when establishing priorities:

- **Ability to reduce crashes—**Countermeasures with greater benefits should be prioritized higher. Information on the effectiveness of various engineering strategies can be found on the FHWA CMF Clearinghouse Web site.[47] Enforcement and educational countermeasures can be found in the NHTSA publication, *Countermeasures that Work*.[48]

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[47] www.cmfclearinghouse.com

[48] NHTSA, Countermeasures that Work: A Highway Safety Countermeasures Guide for State Highway Safety Offices, Sixth Edition (2011).

- **Potential for quick implementation—**Countermeasures that can be implemented quickly (within a year) should have a higher priority. By giving greater priority to countermeasures that can be implemented quickly, an agency can ensure that the issue does not go unaddressed for several years while waiting for the implementation. Signing, pavement markings, and traditional enforcement are examples of countermeasures that can be implemented quickly.
- **Benefit/cost results—**Countermeasures with a greater lifecycle benefit/cost (B/C) ratio should have a higher priority, as they represent the most cost effective solutions. Calculating a B/C ratio requires information on the effectiveness and costs of the speed management strategy.
- **Potential to reduce speeds—**Countermeasures that are expected to result in significant reductions in vehicle speeds should have a higher priority.

For example, The Pennsylvania DOT (PennDOT) has a system to prioritize traffic calming measures in which points are assigned to locations based on criteria that include speed, volume, crashes, proximity to a school, and pedestrian facilities/generators; the greater the number of points, the greater the priority that is given to that location.[49] Table 1 outlines the ranking system used with the PennDOT program.

Table 1. Example Project Ranking System.

Criteria	Pts.	Basis for Point Assignment
Speed	0 to 30	Extent by which 85th percentile speeds exceed posted speed limit; 2 pts. assigned for every 1 mph
Volume	0 to 5	Average daily traffic volumes (1 pt for every 120 vehicles)
Crashes	0 to 10	1 pt assigned for each crash reported within the past three years
Elementary or Middle Schools	0 to 10	5 pts. for each school crossing along the project street
Pedestrian Generators	0 to 15	5 pts. for each public facility (such as parks, community centers, and schools) or commercial use that generates a significant number of pedestrians
Pedestrian Facilities	0 to 10	5 pts. if there are no continuous sidewalks on one side of the street; 10 pts. if sidewalk is missing on both sides.

Total Possible Points is 100

[49] Pennsylvania Traffic Calming Handbook, PennDOT, http://www.dot.state.pa.us/Internet/pdHwyIntHS.nsf/HomePageTrafficCalming?OpenForm&BaseTarget=main

4.1.3 Funding

Identifying funding for each of the proposed countermeasures is essential to ensuring its implementation. There are a variety of different sources that can be used to implement the countermeasures. For engineering countermeasures, the Highway Safety Improvement Program (HSIP)[50] program is a good place to start, as it is a source of Federal funds that are typically administered by the State DOT. Because States use various methodologies to administer these funds, the practitioner should check with the State DOT on their availability.

For enforcement, education, and emergency services strategies, Section 402 funds should be considered. Section 402 funds are typically administered by each State's GHSO.[51] Other State, local, and tribal funds may also be available for the implementation of selected countermeasures. Working with stakeholder agencies to develop speed management program can result in the pooling of resources for an effective program.

4.1.4 Planning and Using Pilot Projects

Implementing new strategies can be a challenge for an agency or community. It may be helpful to conduct a pilot project to introduce a new engineering strategy (e.g., a roundabout) or an enforcement strategy (e.g., ASE method). Consider starting small by selecting a pilot location, or use a similar project located in a nearby location to demonstrate the effectiveness of the strategy. Effectiveness can be assessed by collecting data (e.g., speed and/or crash data) both before and after the installation of the countermeasure.

4.2 Evaluate Progress

Once a selected strategy has been implemented, it is important to evaluate its safety effectiveness. If it has been successful in reducing crashes and fatalities, then the evaluation will provide justification to potentially expand the use of the countermeasure. This section summarizes how to evaluate a speed management strategy that can be used for either one individual project or as part of a community-wide program. Each evaluation should be tailored to address specific countermeasures and conditions through analyses of the available data.

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[50] http://safety.fhwa.dot.gov/hsip

[51] http://www.ghsa.org/html/links/shsos.html

An evaluation of the impact on crash history should not be conducted until at least one year of post-installation data is available, and a minimum of three years of crash data are desirable to provide a larger sample size. The purpose of an effectiveness study is to determine if there has been a significant impact on the frequency or severity of crashes as a result of the installed countermeasure.

The recommended timeframe for a speed evaluation after a major engineering change (e.g., a new speed limit or road design element) is also one year. Waiting a full year will allow motorists to get acclimated to the new treatment and environment and will allow it to be encountered in all types of weather conditions.

The evaluation timeframe will depend on the type of countermeasure strategy pursued and the project types. The strategy must be evaluated to determine if it has been effective, partially effective, or not effective.

The simplest method for evaluating speed management strategies involves a comparison of the speed data collected before and after implementation, although it can lead to misleading results. One source of information on vehicle speeds is a full speed study conducted specifically for the purpose of evaluating speed management strategies. A formal speed study will provide the complete speed profile for the subject roadway segment and will allow a direct comparison of the observed 85th percentile speeds both before and after implementation. Additional information on how to conduct a speed study is provided in the appendix.

If an agency does not have adequate resources to execute a full speed study in conjunction with the evaluation, it may also look to some existing databases for information on vehicle speeds. For instance, the number of speeding citations issued during the before- and after-periods may be available from the files of a local law enforcement group. While the number of citations issued will not provide a complete speed profile for the subject roadway, it may still serve as a basic indicator of how successful a strategy was in mitigating a noted speeding problem. When resources other than a full speed study are used to gather speed information, one should consider any potential biases that could be introduced by those resources. For this example of using the number of citations issued, the evaluation should consider whether or not the intensity of the enforcement activities before the strategy implementation was significantly different than that afterward; i.e., did the number of citations issued increase or decrease simply because of changes in the nature of the enforcement practices.

After countermeasures have been in place for at least one year, an interim evaluation can take place. However, at least three years of after data are required for a comprehensive evaluation of implemented strategies. A before-and-after crash study can be conducted to evaluate the effectiveness of implemented strategies in improving safety when sufficient data are available. Details on creating a well-designed and executed before-and-after crash study can be found in *A Guide to Developing Quality Crash Modification Factors*[52] or in the *Highway Safety Manual* (HSM).

[52] Gross, F., et al., A Guide for Developing Quality Crash Modification Factors, FHWA Office of Safety (2010), http://safety.fhwa.dot.gov/tools/crf/resources/fhwasa10032/

5 Summary

Speeding is defined as exceeding the posted speed limit or driving too fast for conditions. Crashes involving speeding occur on all road types but are particularly prevalent on the local rural road system. Of the fatal crashes occurring on local rural roads, nearly one-third involved speeding. As the speed increases, the likelihood of a crash resulting in a serious injury or fatality also increases.

Addressing this safety issue can be a challenge for local roadway agencies because of limited resources. Nonetheless, all agencies, regardless of size and resources, can develop a Speed Management Program that provides a comprehensive strategy to address the concern of unlawful and undesirable speeds. Accordingly, the program should encompass engineering, enforcement, education, and emergency services strategies—the four E's of safety—to address speeding and speed-related crashes that result in fatalities and serious injuries. In general, developing a Speed Management Program involves four steps:

- **Step 1. Identify speeding issues and partner agencies.**
- **Step 2. Select countermeasures.**
- **Step 3. Implement countermeasures.**
- **Step 4. Evaluate progress.**

Successful development of a Speed Management Program begins with identifying the speeding issue through data. A variety of data—including crash (at least three years of data), citation, roadway and conditions, citation, and input from partner agencies—can be used to identify areas where speeding is an issue. Once the data have been analyzed and a location has been identified, local practitioners should coordinate with partner agencies such as law enforcement, other road agencies (if applicable), and other stakeholders to identify program goals and determine the specific causes of the speeding issue. This usually entails a field assessment and evaluation. These partnerships will not only help with gaining a more thorough understanding of the problem, but they will also be essential in supporting and implementing the Speed Management Program.

Once the causes of the speeding issue have been identified, countermeasures are selected that comprehensively address the issues. Engineering, enforcement, and education countermeasures may be selected, and a combination of these strategies will often bring greater impact in addressing the speeding issue. Engineering countermeasures can range from upgrades to the signing and pavement markings to modifications to the geometric configuration of the roadway. Other countermeasures may include targeted enforcement campaigns, automated speed enforcement, or public information and education campaigns. The measures selected will then have to be communicated to the various stakeholders to gain support in implementing the program.

Resources to address speeding are generally limited. Therefore, countermeasures that address speeding issues will need to be prioritized and funded for implementation in a systematic way. Prioritization can be based on those strategies most likely to impact the issue or on the cost relative to the safety benefit or implementation time.

The individual countermeasures or projects should be evaluated to determine the progress being made towards achieving the goals established for the entire Speed Management Program. The evaluation will also determine the effectiveness of the countermeasure within the jurisdiction to determine if it should be applied at other areas.

Elements of this model Speed Management Program can be followed by all agencies, regardless of size and resources. In developing such a program, assistance should be sought from such organizations as the State DOT, LTAP, and TTAP. By following this process, local rural road practitioners can implement a comprehensive program that addresses the safety issues associated with speeding in their communities, and this, in turn, will help to protect the lives and improve the safety of all road users.

Appendix: How to Conduct a Speed Study

In conducting a speed study, there are three primary techniques by which vehicle speeds are routinely collected:

1. Traffic counter method.
2. Time-measured zone method.
3. RADAR/LIDAR method.

The recommended minimum sample size is 100 free-flow vehicles. If a study is being conducted on a very low-volume roadway, then it is acceptable to collect speeds for two hours, regardless of how many vehicles are observed. Environmental conditions must be considered, as well, as drivers typically do not travel at a normal speed while the roadway is wet or snow covered.

Another important consideration for the speed study is the time of day during which the data will be collected. For a low-volume roadway, the peak hours of the morning (typically from 7:00 to 9:00 AM) and the afternoon (typically from 4:00 to 6:00 PM) are time periods when the study should be conducted in order to increase the likelihood of observing a minimum of 100 vehicles. On more heavily-traveled roadways, however, the morning and afternoon peak periods are times when speed studies should not be conducted, since the speeds observed while the traffic volumes are at or near capacity are unlikely to be an accurate reflection of free-flow speeds.

Traffic Counter Method


Traffic Counters.

One of the most common types of traffic counter is the portable traffic count station that is used routinely by State DOTs and other agencies to procure traffic volumes at various locations within their jurisdiction. These traffic counters are characterized by two hoses that are placed a short distance from one another across the travel lane(s) of interest. Many of these devices have the capability to collect multiple data variables, including vehicle speeds. If an agency's traffic counters are so equipped, set the control unit to collect vehicle speeds and deploy the apparatus as specified by the traffic counter manual. The data will be stored in the field unit and can later be downloaded into a spreadsheet and analyzed to compute various measures of speed.

Time-Measured Zone Method

A second method of conducting a speed study involves recording the length of time that it takes vehicles to traverse a known distance along the roadway. This process is a relatively straightforward one and begins by establishing a zone within the segment of interest having the length specified in Table 2. (The appropriate zone length is dependent upon the posted speed limit.) The zone should be an area in which both entering and exiting vehicles are clearly visible to a field observer. It will be helpful to mark the beginning and ending limits of the zone with some reference indicator (e.g., a sign, crack in the pavement, cone on the side of the road,etc.).

Table 2. Length of Measured Zone per Speed Limit.

Speed Limit (mph)	Conventional Distance to Measure (ft)
Below 25	88
25-40	176
40 and Above	264

Source: http://www.ctre.iastate.edu/PUBS/traffichandbook/2SpotSpeed.pdf

A vehicle reference point should be identified to be used in determining the instant at which the observer will start and stop the stopwatch. This is typically the vehicle's front or rear tire, and either can be selected as long as the same reference point is used at both the entrance to and the exit from the zone. It is extremely important to be consistent in using the same reference point at each end of the zone, as failing to do so will render the recorded times (and corresponding vehicle speeds) inaccurate.

While conducting the survey, the observer should stand at a safe location on the side of the road where a vehicle will exit the measured zone, having a clear view of the beginning of the zone. The observer should start the stop watch at the instant the reference point on the vehicle reaches the beginning limit of the zone and stop the timer the instant that same vehicle reference point reaches the end of the zone. After each vehicle travels through the zone, its time should be recorded by the observer. When two hours have lapsed (or, if pressed for time, when 100 vehicles have passed), the recorded times can be converted into the observed vehicle speeds. Table 3 displays the speeds corresponding to the times (in seconds) recorded for the vehicles to travel the measured distance (in feet) defined by the zone.

Table 3. Speed of Vehicle Over Distance for Various Times.

Time (sec)	Speed by Distance (MPH)			Time (sec)	Speed by Distance (MPH)		
	88	176	264		88	176	264
1	60	--	--	3.6	16.7	33.3	50
1.2	50	--	--	3.8	15.8	31.6	47.4
1.4	42.9	--	--	4	15	30	45
1.6	37.5	--	--	4.2	14.3	28.6	42.9
1.8	33.3	--	--	4.4	13.6	27.3	40.9
2	30	60	90	4.6	13	26.1	39.1
2.2	27.3	54.5	81.8	4.8	12.5	25	37.5
2.4	25	50	75	5	12	24	36
2.6	23.1	46.2	69.2	5.2	11.5	23.1	34.6
2.8	21.4	42.9	64.3	5.4	11.1	22.2	33.3
3	20	40	60	5.6	10.7	21.4	32.1
3.2	18.8	37.5	56.3	5.8	10.3	20.7	31
3.4	17.6	35.3	52.9	6	10	20	30

Radar/Laser Method

Another method to conduct a speed study is by the use of RADAR or LIDAR. Observers select a safe location on the side of the roadway that is hidden from approaching traffic so as to not impact driver behavior and disturb the flow of traffic.

The observer must record the highest free flow speed of vehicles. If there is a large platoon of vehicles, only the first vehicle in the platoon should be measured for speed. The observer must also target subject vehicles so as to lessen the angle between the observer and the traveling vehicle. If there is a substantial angle between the observer and the vehicle, there speed measurement may be inaccurate. Any radar/laser equipment used to conduct speed studies should be calibrated, and users of the equipment should be properly trained.

Figure 4 provides a sample data collection sheet that may be used to conduct a speed study. Conditions such as weather, location, date, time, and the posted speed limit should be recorded on the sheet. It is important to accurately record this data for comparison to other studies. As a vehicle travels past the observer the maximum speed is marked on the data collection form. Each row starts at the left side of the page and each successive box is marked as speeds are observed.

Figure 5 provides an example of a completed data collection sheet.

Speed Survey Field Sheet

Speed Limit:______________________ Name:______________________

Direction:______________________ Address:______________________

Time:______________________ Area of Roadway Studied:______________________

Date:______________________ ______________________

Weather:______________________

Speed	Number of Vehicles																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
75																									
70																									
65																									
60																									
55																									
50																									
45																									
40																									
35																									
30																									
25																									
20																									
15																									

Figure 4. Blank Speed Survey Field Sheet.

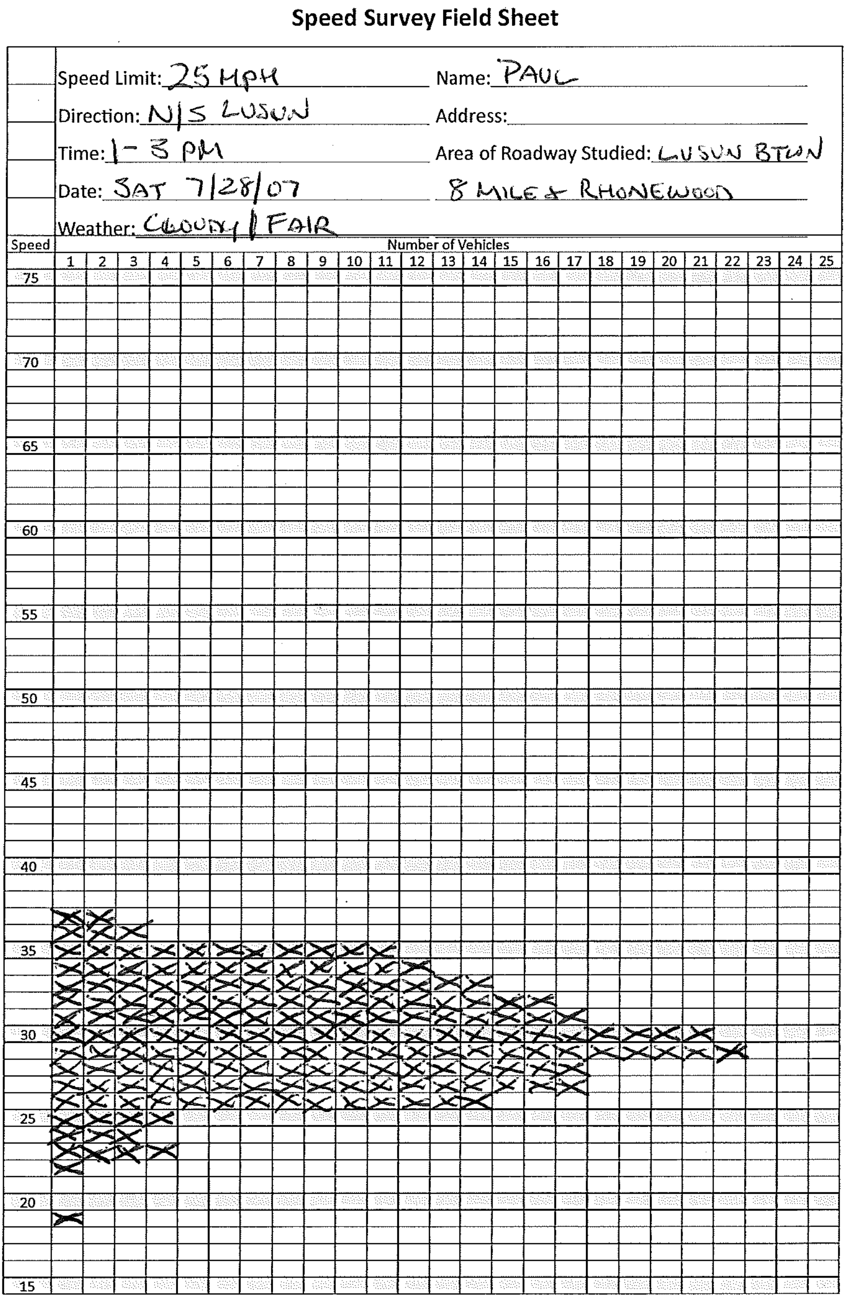

Figure 5. Sample Speed Survey Field Sheet.

Post Data Collection

Once speeds are collected by any of the three methods it is then essential to determine the 85th percentile speed to compare to the posted speed limit. The 85th percentile speed is computed by finding the cumulative frequency percentage. As seen in Figure 6, common spreadsheet programs can be utilized to automatically perform this computation.

A technique to graphically depict the 85th percentile speed is to graph the speed along the x-axis and the cumulative percentage along the y-axis. A line can be drawn at 85 percent horizontally across until it intersects the line for the recorded speeds. At that point, a line can be drawn from that intersection point to the x-axis providing the 85th percentile speed.

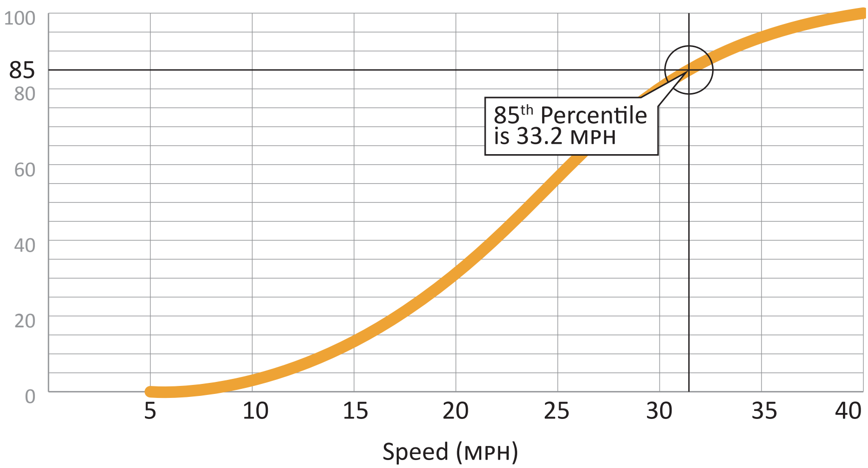

Figure 6. Graphical depiction of 85th percentile speed.

When evaluating the 85th percentile speed and readjusting the posted speed limit of the roadway, the speed limit can only be posted in increments of five miles per hour (i.e., 25, 30, or 35 mph). In the example above the 85th percentile is 33.2 mph, since this speed cannot be chosen as the speed limit it is advised to round the speed limit up to the nearest 5 mph increment, which would be 35 mph.

For More Information

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