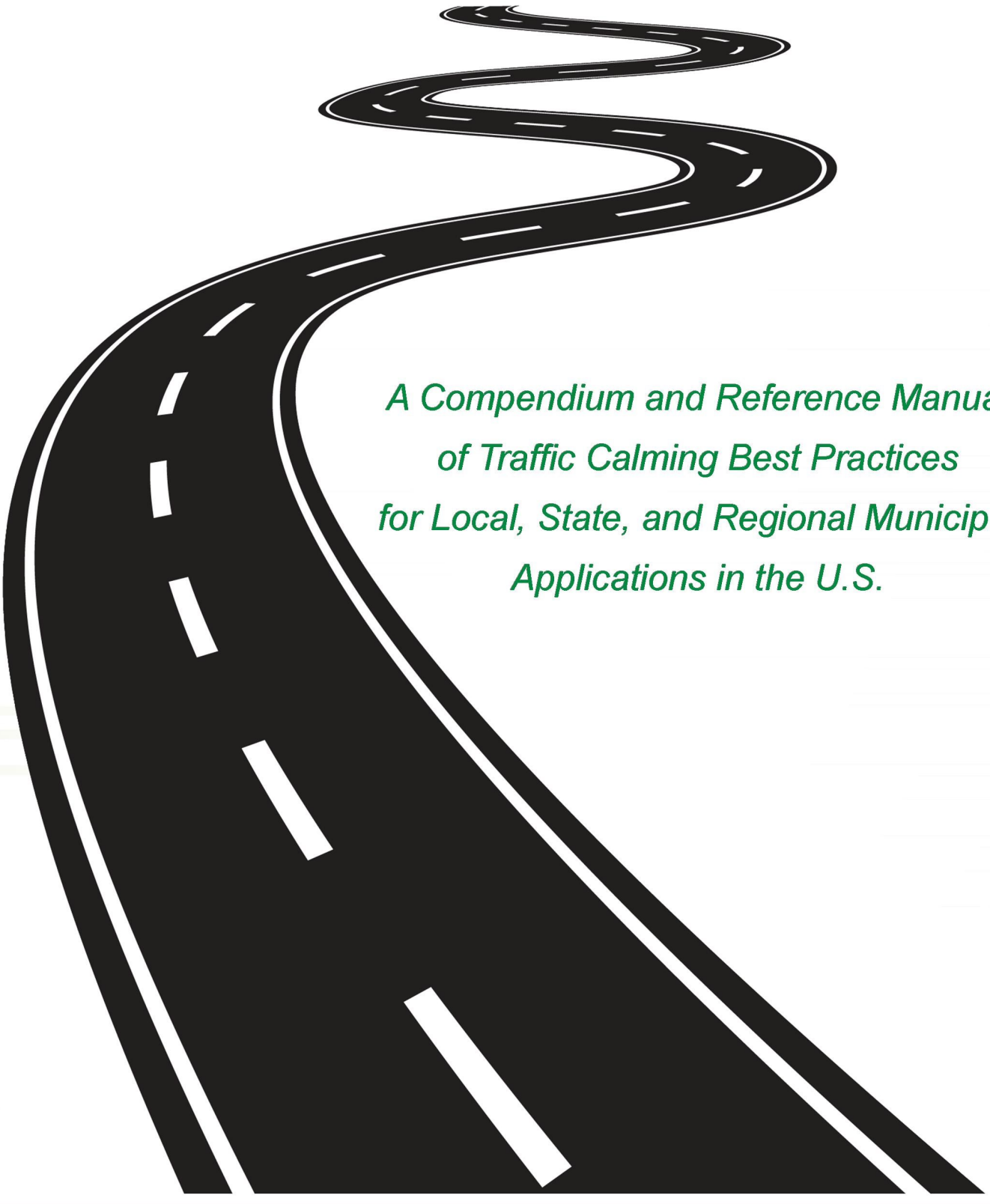
A Traffic Calming Guide for the 21st Century



A Compendium and Reference Manual of Traffic Calming Best Practices for Local, State, and Regional Municipal Applications in the U.S.

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The History of Traffic Calming

Traffic calming, which is a direct translation of the German word “vekehrsberuhigung,” was first established in the Netherlands in the late 1960s. The Dutch city of Delft was experiencing an increased volume of cut-through traffic, which galvanized citizens to band together and resolve what was becoming an unsafe situation. This culminated in streets being transformed into “woonerven” or “living streets.”

The result: a traffic calming plan that gave priority to all users of a street rather than to just motorized vehicles. The grassroots movement spread from the Netherlands into Germany and France. Australia was another early adopter of traffic calming strategies as were parts of the United States, namely Berkeley, CA; Eugene, OR; and Seattle, WA. In 1980, the first national U.S. study of traffic calming was conducted, and during this decade, traffic calming became a guiding feature of transportation and road planning in small towns and urban areas alike.

➔ ***Deaths caused by speeding are on the rise.***

In 2010, 10,530 people died in crashes that were linked to speeding, and since 2000, speeding-related deaths are up 7%. By contrast, during this time period, deaths related to the failure to use seatbelts plummeted by 23%, and alcohol-related deaths dropped by 3%.

GHSA Study, 2010

Today, traffic calming is a mainstay in the world of transportation planning. Traffic engineers and planners, urban developers and municipalities are creating safer roads and communities by implementing industry-approved best practices. When adopting these traffic-calming solutions, municipalities across the U.S. are often required to adhere to local, state and federal mandates (including MUTCD guidelines for signage). They also look to and adopt best practices recommended by professional transportation and traffic industry organizations. However, these are housed in separate locations and many are outdated.

While the digital age has delivered advancements in almost every arena of industry, the most comprehensive reference sources for traffic calming best practices have remained virtually unchanged:

- State of the Art: Residential Traffic Management—Produced in 1980 by the FHWA
- Traffic Calming: State of the Practice—Produced in 1999 by the ITE and FHWA

Now decades old, these guidelines do not address contemporary traffic calming issues facing municipalities today, including:

- **Economic factors**, such as updated initial purchase price, installation and maintenance expenses. This is especially important considering the slowdown of the U.S. economy that began in 2007.
- **Community attitudes** toward and acceptance of various traffic calming solutions.
- **New technology**, including electronic devices
- **The need for temporary and portable options**

The U.S is not alone in its need for updated industry guidelines. The issues surrounding outdated guidelines have also been recognized in a 2010 Canadian ITE (CITE) Convention presentation that identifies gaps in the current Canadian guide, which was prepared in 1998. A related CITE-member survey found:

- 87% of respondents identified a need for updating the current guide. Respondents were comprised of municipal staff (49%), consultants (47%), transit operators (1%) and others (3%).
- 40% of respondents indicated that their agency has developed their own guide (majority indicated that it is based on CITE's guide).

These findings, plus the challenges associated with aggregating disparate information from multiple websites, illuminate the need for an updated guide to traffic calming best practices. The *21st Century Traffic Calming Guide has been created as a:*

1. Convenient single source of industry best practices
2. A living document or repository with links to important source data
3. Source of emerging traffic calming insights through the incorporation of news stories from trusted outlets, which add important context

➔ ***Numbers of speeders have not decreased over time.***

Since 1997, the number of drivers stopped by police for speeding has fluctuated very little, hovering between 9 and 11%. Of those stopped for speeding, drivers receiving tickets has also remained stable, varying between 65 and 70%.

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Methodology and Scope

➔ ***Speeding triples the odds of crashing.***

Probability of a crash increases as a vehicle's travel speed rises above the average travel speed of surrounding vehicles.

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The 21st Century Traffic Calming Guide is a compendium of traffic calming best practices that have been identified and endorsed by trusted and respected companies, organizations and thought leaders focused on advancing the issues surrounding traffic and transportation safety, including:

- **Transportation and traffic planning organizations:** The Institute of Transportation Engineers (ITE), Transportation Research Board (TRB), American Association of State Highway and Transportation Officials (AASHTO), metropolitan planning organizations and state departments of transportation
- **Government agencies:** Federal Highway Administration (FHWA), Governors Highway Safety Association (GHSA), National Highway Traffic Safety Administration (NHTSA) and Federal Transit Administration (FTA)
- **Regional, state and local programs**: Municipalities large and small, state DOTs and regional organizations have traffic calming programs. Some examples including South Carolina DOT (SCDOT), Pennsylvania Department of Transportation (PennDOT),Virginia Department of Transportation (VDOT), Los Altos Traffic Commission, City of Ann Arbor Traffic Calming Project and the Midwest Transportation Consortium (MTC)
- **Law enforcement representatives and organizations:** American Association of State Troopers (AAST), American Association of Motor Vehicle Administrators (AAMVA), International Association of Chiefs of Police (IACP), National Governors Association (NGA) and National Sheriffs Association (NSA)
- **Insurance providers:** State Farm, AllState, USAA and more
- **Transportation industry thought leaders, foundations and organizations:** AAA Foundation for Traffic Safety, Radarsign Foundation for Traffic Safety and AirSage.
- **International entities and programs**: Transportation Association of Canada (TAC), National Roads Authority in Ireland (NRA), SPUR (the traffic calming programs of Zurich, Vienna and Munich) and Denmark's nationwide traffic calming program, "Environmentally Adapted Through Roads" (pages 10-11).

With regard to scope, the information presented here has been specifically prepared to serve traffic and transportation practitioners (engineers, planners, administrators, etc.) and municipalities. The 21st century traffic calming guide:

1. Has been developed from existing research, data and news articles. **The *Traffic Calming Guide for the 21st Century* is the first comprehensive, contemporary collection of traffic calming solutions and best practices that has been produced and publicly distributed since 1999**.
2. Has been designed to be an interactive reference guide for municipalities and counties that want to implement a comprehensive traffic calming program.
3. Focuses exclusively on traffic calming solutions
4. Is designed to serve as a reference tool, only. Before implementing any traffic calming plan, care should be exercised to ensure that each component of the plan meets local, state and national laws/guidelines, and serves the best interests of the community.

➔ ***Speeding is an all too common problem.***

Speeding in residential areas is the most common citizen complaint faced by local police, city councils and HOAs.

U.S. Department of Justice

What is Traffic Calming?
The Controversy and the Solution

The simple, first step in slowing speeding drivers—to define traffic calming—is rooted in controversy. Conflicting opinions as to what qualifies as an authentic "traffic calming measure" has resulted in multiple industry definitions. For example:

> According to the ITE, *"Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users."*
>
> The FHWA uses two descriptors: 1) "*Traffic calming involves changes in street alignment, installation of barriers, and other physical measures to reduce traffic speeds and/or cut-through volumes in the interest of street safety, livability and other public purposes." And, 2) "Traffic calming employs physical changes to the roadway, signage or operation changes, and can be thought of as a 'silent policeman' enforcing speed limits where no law enforcement are present."*
>
> And Wikipedia offers this alternative, *"Traffic calming consists of engineering and other measures put in place on roads for the intention of slowing down or reducing motor-vehicle traffic. This is done in order to improve the living conditions for residents living along the road as well as to improve safety for pedestrians and cyclists. Urban planners and traffic engineers have many strategies for traffic calming."*

Regardless of the definition adopted, traffic calming goals (as defined by the ITE) remain universal:

- Improve quality of life
- Incorporate the preferences and requirements of the people using the area (e.g., working, playing, residing) along the street(s), or at intersection(s)
- Create safe and attractive streets
- Help reduce negative environmental effects of motor vehicles (e.g., pollution, sprawl)
- Promote pedestrian, cycle and transit use

Implemented properly, traffic calming measures can meet these objectives:

- Achieve slow speeds for motor vehicles
- Reduce collision frequency and severity
- Increase safety and perception of safety for non-motorized users of the street(s)
- Reduce the need for police enforcement
- Enhance the street environment (e.g., street scaping)
- Encourage water infiltration into the ground
- Increase access for all modes of transportation
- Reduce cut-through motor vehicle traffic

Traffic Calming Tactics of the 21st Century

Today there are a variety of traffic calming options to slow speeding drivers. From vertical and horizontal options, to enforcement and digital technologies, the pros and cons of each are provided below. While this document focuses primarily on engineered solutions, the most effective traffic calming strategies incorporate a combination of the 3 Es—education, engineering and enforcement.

➔ ***Driver beliefs***

*91% of **drivers** believe that "Everyone should obey the speed limit because it's the law."*

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EDUCATIONAL SOLUTIONS

The presence of enforcement or engineering measures, like a police officer or a speed hump, usually leads a driver to slow down momentarily. The education component focuses on changing driver behavior for the long term. This is accomplished by intentionally involving the public with transportation safety issues. A traffic calming education program may include:

- Distribution of traffic safety information within neighborhoods, area schools, community organizations and businesses
- Community signage
- Providing the community with accurate traffic data for areas of concern, including actual speeds, traffic volumes and peak periods
- Public service announcements to remind motorists of the consequences of speeding
- Implementation of school zone safety programs, like Safe Routes to School (SRTS), which work to improve the health and well-being of children by enabling and encouraging them to safely walk and bicycle to school
- Establishing a senior safety program, like Safe Streets for Seniors, an initiative from the New York City DOT
- Radar speed signs which notify drivers of their speed in comparison with the posted speed limit
- Adopting a comprehensive traffic safety education program, like Street Smarts, which was developed by the City of San Jose, CA to target driver, pedestrian and bicyclist behavior
- A Neighborhood Pace Car Program, like the City of San Leandro, CA, in which individual drivers pledge to drive courteously and within the speed limit
- Developing a traffic calming guide to inform the public about issues relating to traffic matters and the processes for requesting city assistance, like model examples from the cities of Lafayette, CA; Baton Rouge, LA and Bellevue, WA

When developing comprehensive traffic calming plans, cities regard the educational component as a key to success. Examples of these include Oakley, CA; Rancho Palos Verdes, CA; State College, PA; and Lee's Summit, MO. Making residents aware of the methods and tools to properly address neighborhood traffic concerns encourages and equips the public to participate in creating safer communities. Cultivating this type of engaged community through a well-developed education initiative is critical to establishing a successful traffic calming plan.

Digital & Interactive Technologies

Photo Enforcement Cameras, Pedestrian-Activated Signs and Driver Feedback Signs

The digital age has brought revolutionary advancements to the transportation industry. Lights provide advance warnings and signs can now communicate unique, important and timely messages to motorists as they travel neighborhood streets and major thoroughfares. These new technologies can also act as valuable supplements to law enforcement officers.

➔ ***Most drivers speed***

*81% of **drivers** report driving every day or almost every day. Nearly 3-in-1 say they enjoy driving as fast as possible.*

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PHOTO ENFORCEMENT CAMERAS

These automated enforcement devices are used to detect speeding, the running of red lights, and other traffic violations such as illegal rail crossings, toll violations and school bus stop-arm infractions. While they can be effective, many are controversial.

Usage of photo enforcement cameras has resulted in numerous court cases, and a number of government entities have ultimately ended their programs amid public outcry.

According to the Governors Highway Safety Association as of October 2014, speed cameras are prohibited in 13 U.S. states and red-light cameras are prohibited in 10 states. Only 24 states use photo enforcement cameras, although many are extremely limited in scope and may only be operated within local ordinances or in cities with certain population thresholds.

Speed Cameras

Speed camera systems use a variety of detectors to determine the speed of vehicles. Then, the camera records images of speeding vehicles, along with the date, time, location and other details of the offense. Citations are delivered to the registered owner of the vehicle by mail.

One point of contention regarding the use of speed enforcement cameras is the belief that government agencies implement these programs more as a source of revenue, than a safety mechanism. After the city of Ridgeland, S.C. was labeled a speed trap for its camera enforcement program on I-95, the state passed legislation banning the technology.

Officials in Washington, D.C. were transparent in their plans to use the devices as a revenue stream. To raise an additional $50 million and balance the budget, the D.C. mayor announced

plans in May 2014 to expand the District's speed camera program. However, less than six months later, officials revealed a dramatic decline in traffic camera enforcement revenue, leaving the city with a potential $70 million budget shortfall.

Arizona, the first state to use camera-citation programs, pulled the plug on state operated enforcement cameras in 2010. The governor criticized them as "invasive". And critics of the program pointed out the they had raised only half of the projected $12 million. Independent, municipal-operated programs are still in operation in Arizona.

In 2014, Chicago rolled out a speed camera program dedicated to calming traffic around schools and parks, which are called Children's Safety Zones. In the same year, Nassau County, NY launched its own school zone speed camera program. Yet, six months after the program debut, lawmakers repealed the program in the face of public outrage.

Red-Light Cameras

Red light camera systems are connected to the traffic signal and sensors under the roadway. They often use cameras fixed at the four corners of an intersection to record images of violators, along with the date, time, location and other details of the offense. Citations are delivered to the registered owner of the vehicle by mail.

Before a red-light photo enforcement system is implemented, the Federal Highway Administration (FHWA) recommends the following engineering countermeasures be taken:

- Signal visibility and conspicuity should be improved.
- Line of sight should be improved.
- Signal timing should be improved.
- The need to stop should be eliminated.

If the engineering measures are unsuccessful, only then does the FHWA recommend that enforcement countermeasures, including automated enforcement such as photo enforcement cameras, be used.

One key element to overall intersection safety is the duration of the yellow lights. An equitable red light camera program is dependent on yellow light timing. MUTCD and ITE recommends the yellow-change interval be between 3 and 6 seconds. Yet, yellow light timing at camera-enforced intersections are often found to be too short. The city of Chicago and the state of Florida have been accused of reducing the timing of the yellow lights to increase citation revenue. As a result, many tickets were invalidated and citizens lost confidence in their government.

A major selling point of red-light cameras is a reduction of side impact collisions. While these have diminished at intersections with camera enforcement, rear-end collisions have increased. A December 2014 study revealed that Chicago's camera program is responsible for increasing some types of injury crashes while decreasing others. The study noted that right-angle or "t-bone" crashes that caused injuries were reduced by 15%. Yet, a corresponding 22% increase in rear-end crashes that caused injuries calls into question the benefits of the cameras.

The long-term success of camera enforcement programs is mixed. After a five-year legal challenge, the California Supreme Court upheld the use of red-light camera enforcement systems in June 2014. Still, some California communities like Riverside and Oceanside have

shut down their programs anyway amid resident outrage. New Jersey banned the use of red light cameras effective December 16, 2014. Yet, Fairfax, Va. has expanded its use of red-light cameras

School Bus Stop-Arm Cameras

In recent years, video cameras have been used to catch drivers who illegally pass stopped school buses. Children who ride buses to and from school are at their most vulnerable as pedestrians before boarding and after exiting a school bus. Results from a survey conducted by the National Association of State Directors of Pupil Transportation Services suggest that over 13 million motorists illegally pass a stopped school bus each school year.

More and more school districts are using school bus-mounted video cameras as part of a comprehensive stop-arm enforcement program to reduce the risk of death and injury to school children. After a successful pilot program, Bloomington, Minn. will be adding more stop-arm cameras to their fleet.

Legislative changes are sometimes necessary to allow this new technology to be used for enforcement. South Carolina passed a bill in 2014 to eliminate the requirement that a police officer witness the infraction. A 2014 Wyoming law will require all school buses in the state to have stop-arm cameras by July 2017.

While the cause of protecting school children is a noble one, the use of these cameras—like those used for speeding and traffic lights—can be controversial. Thousands of tickets issued for stop-arm violations in Dallas County have been dismissed or tossed out after they were found to be flawed or unfair. Additionally, revenue from the tickets fell far short of projections, which means it will take several more years for the Dallas County Schools to recoup their costs for the enforcement program.

PEDESTRIAN-ACTIVATED DEVICES

Technology designed to create safer pedestrian crossing sites is seeing rapid growth and development.

Pedestrian Activated Signals

Push-button pedestrian activated signals work in conjunction with traditional green/amber/red traffic lights at intersections. When these devices are present, pedestrians can activate a protected crossing condition in the direction they are traveling. The traffic light signals vehicles to stop, while pedestrians are signaled to safely cross with the international symbol for pedestrians (a solid walking person) or a steady “WALK” light. This system provide the highest level of pedestrian protections.

The MUTCD has established guidelines for the application of these signals.

The cost for a new traffic signal with pedestrian-activated crossing protection can cost approximately $200,000 to $250,000. Ongoing electricity and maintenance can cost an additional $2,000 per year per traffic signal. (Naperville, Ill.)

High-intensity Activated crossWalK (HAWK)

HAWKs, also known as Pedestrian Activated Beacons, are hybrid traffic signal devices used to stop vehicles and allow pedestrians to cross an active street at a marked crosswalk. A three-lens signal beacon is suspended above the roadway facing each vehicular approach. When a pedestrian pushes the beacon button, a yellow light begins to flash. Then, the beacon shifts to flashing red lights notifying drivers to stop, allowing the pedestrian to cross. After the predetermined length of time, the traffic signal reverts to normal operation allowing motorists to resume travel.

The HAWK beacons were developed to address pedestrian crossings in high-speed or wide-crossing conditions where no traffic signals are present. The FHWA studied the safety effectiveness of the HAWK and released its findings in July 2010. The evaluation revealed a 29 percent reduction in total crashes, a 15 percent reduction in severe crashes, and a 69 percent reduction in pedestrian crashes after the installation of a HAWK.

Increasingly, these systems are being installed around the country. The MUTCD has established guidelines for the application of these beacons.

One concern about the HAWK system is that drivers not familiar with it may not understand when they should stop or go.

The total cost of installation for a HAWK crossing ranges between $75,000 and $150,000.

Rectangular Rapid Flashing Beacon (RRFB)

The RRFB is a user-actuated flashing device installed on a road-side post, below a crosswalk sign. The amber lights on these lower-cost alternatives to traffic signals and hybrid signals flash when activated, supplementing other crosswalk alerts. They are designed for use at unsignalized intersections or mid-block crosswalks and can be activated by pedestrians manually with a push button or passively by a pedestrian detection system.

Total cost for purchasing and installing a pair of solar-powered RRFB systems is around $10,000 to $15,000 and includes all signage, solar panels and audio/visual instructions for a unit on each side of the street. This is significantly less expensive than other options.

The City of St. Petersburg, Fla. installed RRFBs at 19 crosswalks and evaluated their effectiveness for two years. Vehicle yielding rates at these crosswalks increased dramatically. Daytime compliance at sites with four-beacon systems increased from 18% to 81%. One FHWA study revealed that compliance with the older standard flashing beacons averaged 15.5%. After introducing a two -beacon system, the site produced yielding rates of 78.3%.

DRIVER FEEDBACK SIGNS

Driver feedback signs display a conditional message determined by the presence or speed of a vehicle. These signs are used in combination with traditional road signs to increase driver awareness. The most common sign is in the form of a radar speed sign, alerting drivers to their speed.

The original bulky radar speed signs were mounted on mobile trailers and required a trailer hitch to move them from location to location. Later models were designed to be installed on a post in a permanent capacity. The most recent advancement in these signs is the portable model, which is lighter weight and designed for easy relocation by a single individual.

Radar speed signs are scientifically proven to slow traffic and to effectively do so as a long-term traffic-calming solution. On the market since the early 1990s, the popularity of radar speed signs has accelerated steadily since 2008 as communities have experienced the benefits first hand.

Radar speed signs do not impede traffic like a physical road change does. They are passive behavior modification devices that are effective in changing driver behavior. A radar speed sign leverages a psychological concept called the feedback loop. By providing people with information about their actions in real time and by giving them an opportunity to change their actions, people are likely to choose better behaviors.

Success with Radar Speed Signs

Studies repeatedly show that when alerted by a radar sign, speeders slow down up to 80% of the time. Typical average speed reductions are 10-20%, and overall compliance with the posted speed limit increases by 30-60% (see speed-reduction study results below). Similar successes have also been observed in city streets, construction/work zones and school zones.

One of the most notable reports about the long-term effectiveness of radar speed signs on city streets came out of Bellevue, Wash. One study conducted at ten locations where the feedback signs had been in place for six or more years revealed that not only did the radar signs maintain their level of speed reduction, in most cases, their effectiveness increased.

An FHWA report on traffic calming in highway work zones found the radar speed signs reduced mean vehicle speed an average of 5.2 mph. Additionally, highway workers thought the speed signs increased driver awareness and "significantly lowered speeds" in the area. Separately, a study from the Utah DOT showed that these driver feedback signs improve school zone safety by decreasing speeds and increasing compliance.

Today's radar speed signs have three power options: AC (hardwired), solar or battery. Solar power with a battery back-up is the most commonly installed system. The devices may also be equipped with data tracking software, enabling police departments, municipalities and other agencies to analyze important trends for enforcement and planning purposes.

Guidelines for Radar Speed Signs

The chart below indicates the maximum viewing distance for various LED digit heights. For example, starting at a distance of 600 feet from the radar sign at a speed of 45 mph you have 9.1 seconds to view a sign with 13″ LED display which is ideal for that speed. However, at 75 mph you have only 5.4 seconds to view the sign which is not acceptable.

Display Height in Inches	Maximum Readable Distance in Feet	Maximum Viewing Time in Seconds at Drive by Speeds										
		25 mph	30 mph	35 mph	40 mph	45 mph	50 mph	55 mph	60 mph	65 mph	70 mph	75 mph
9"	300'	8.2	6.8	5.8	5.1	4.5	4.1	3.7	3.4	3.1	2.9	2.7
11"	400'	10.9	9.1	7.8	6.8	6.1	5.5	5.0	4.5	4.2	3.9	3.6
13"	600'	16.4	13.6	11.7	10.2	9.1	8.2	7.4	6.8	6.3	5.8	5.4
17"	1000'	27.3	22.7	19.5	17	15.2	13.6	12.4	11.4	10.5	9.7	9.1

Time to respond to speeding alert is excellent

Time to respond to speeding alert is marginal

Time to respond to speeding alert is not acceptable

NOTE: Inclement weather (rain or snow) can cut radar detection distance by as much as 50%.

Applications for Radar Speed Signs

More and more, radar speed signs are becoming an integral part of any comprehensive traffic calming plan. There are many examples of municipalities and police departments that are successfully using these devices to make their communities safer.

Law enforcement departments and government agencies are no longer the exclusive users of radar speed signs. Corporate entities and homeowners associations are now implementing these devices to slow traffic on private and residential properties.

Corporate Campuses - Clearwater Paper, a world-class manufacturer of high-quality bleached paperboard, is the country's largest provider of private label tissue to retail grocery chains. The rollover of a truck speeding through their Las Vegas manufacturing facility prompted action. Clearwater Paper installed a radar speed sign from Radarsign and, since then, truck drivers have slowed down and there have been no more rollovers.

Residential Homeowner Associations - The Miloli'i Beach Club Association in the South Kona region of the Big Island of Hawaii was receiving regular complaints about speeding from residents who were asking for the installation of speed humps. Management researched traffic -calming options and selected a driver feedback sign rather than speed humps due to concerns about emergency response delays. Almost immediately after installing the signs, complaints about speeding stopped.

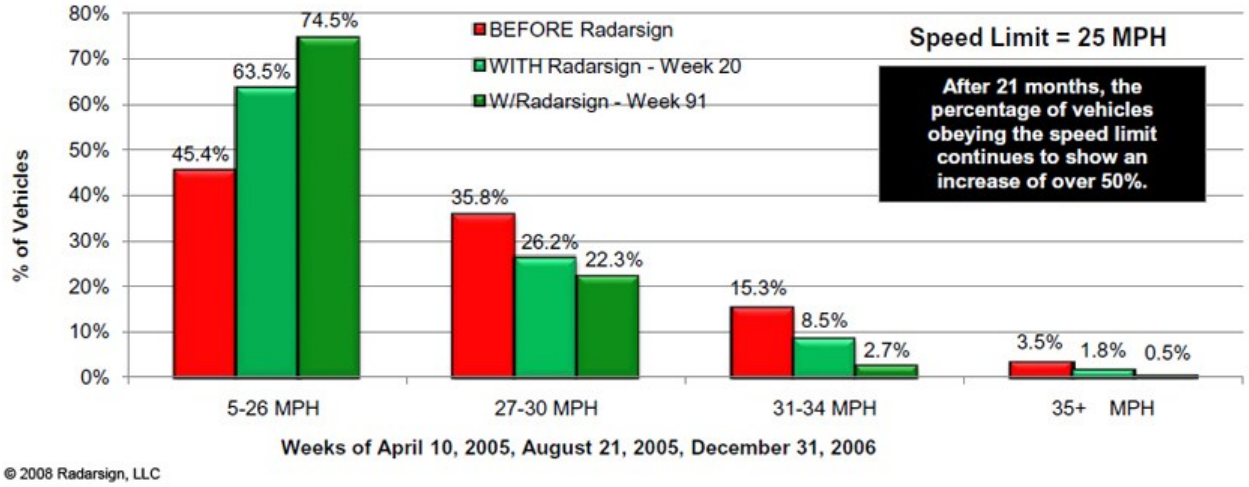
Schools - Excessive speeding during drop-off and pick-up times at The Raleigh School a private institution in Raleigh, N.C. prompted school officials to install a radar speed sign. Afterwards, speeding dropped by 57%.

Pricing for driver feedback signs ranges between $2,500 and $8,000, depending on power choice, optional features, pole selection and installation. Trailer-mounted speed signs can cost in the range of $6,000 to $15,000.

Studies Confirm the Effectiveness of Radar Speed Signs

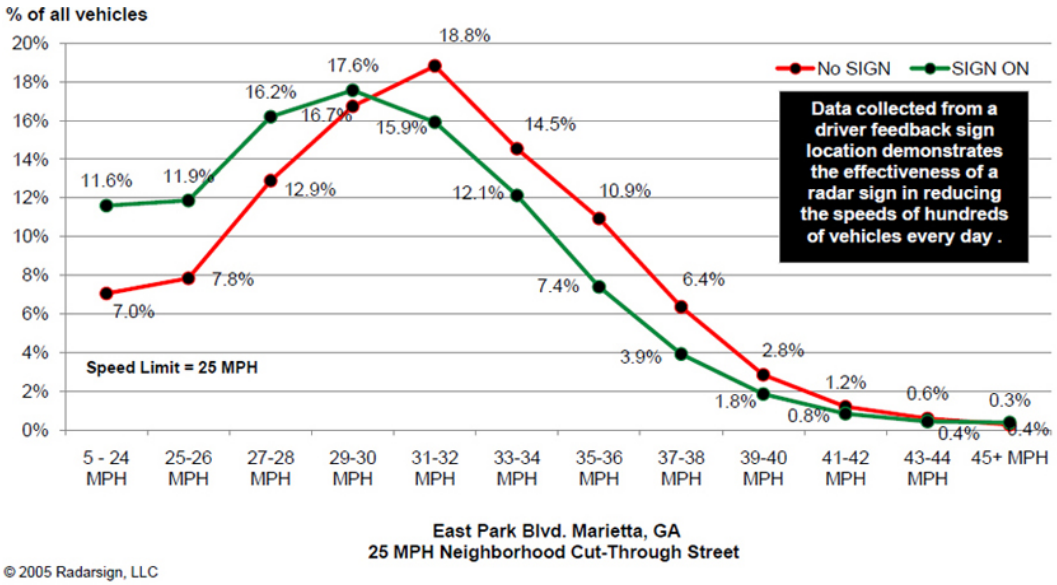
Decline in Average Speeds

In a study conducted by Radarsign, after 21 months of operation, the driver feedback sign continued to be effective in reducing the average speeds in a 25 MPH neighborhood cut-through street.



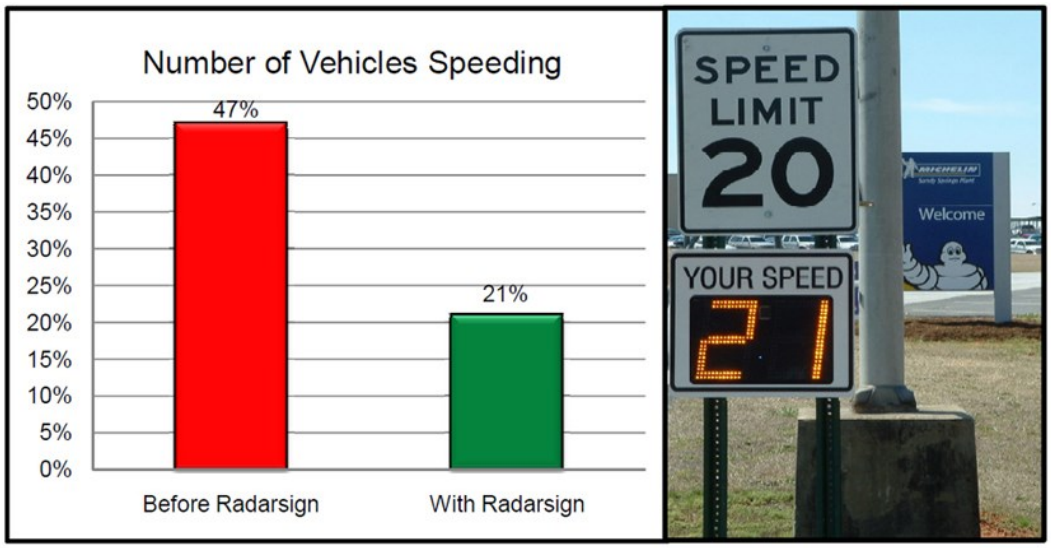
Shift of Peak Speeds to Lower Speeds

Six months of operation of a radar speed sign on a neighborhood cut through street demonstrates the effectiveness of the sign in lowering peak speeds.



Speed Limit Compliance At Plant Entrance

One-and-a-half years of radar speed sign operation at a plant entrance showed 55% more vehicles obeying posted speed limit (PSL).

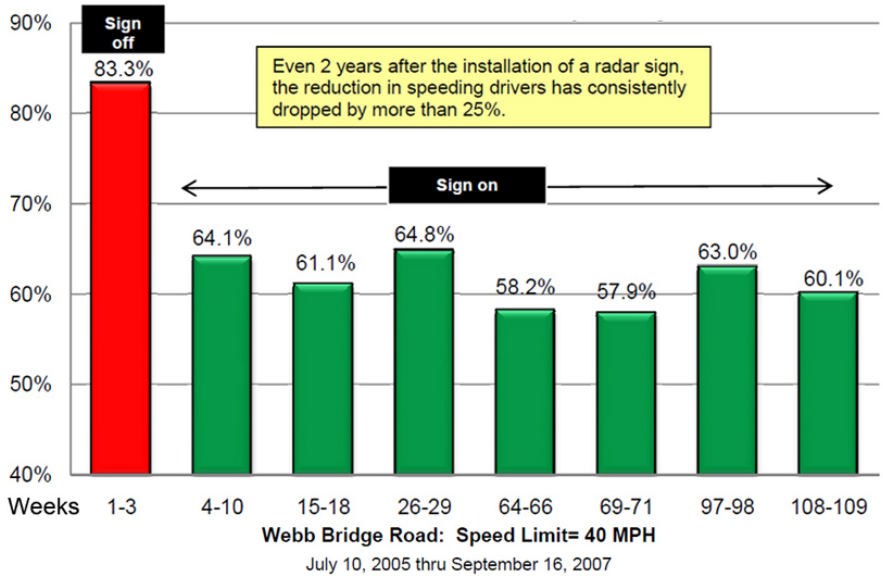


Period of performance: 1.5 years
Average vehicle count per day: 1000
Of remaining speeding vehicles, 95% are in the 21-25 MPH range

Long-Term Reduction In Speeding Drivers

Two years of radar sign operation on a 40 MPH arterial street shows consistent, long-term reduction of speed. The chart below shows the difference a radar sign has made on the peak speeds of vehicles on an arterial street over a 2+ year period. The change is immediate and consistent, even 27 months after implementation.

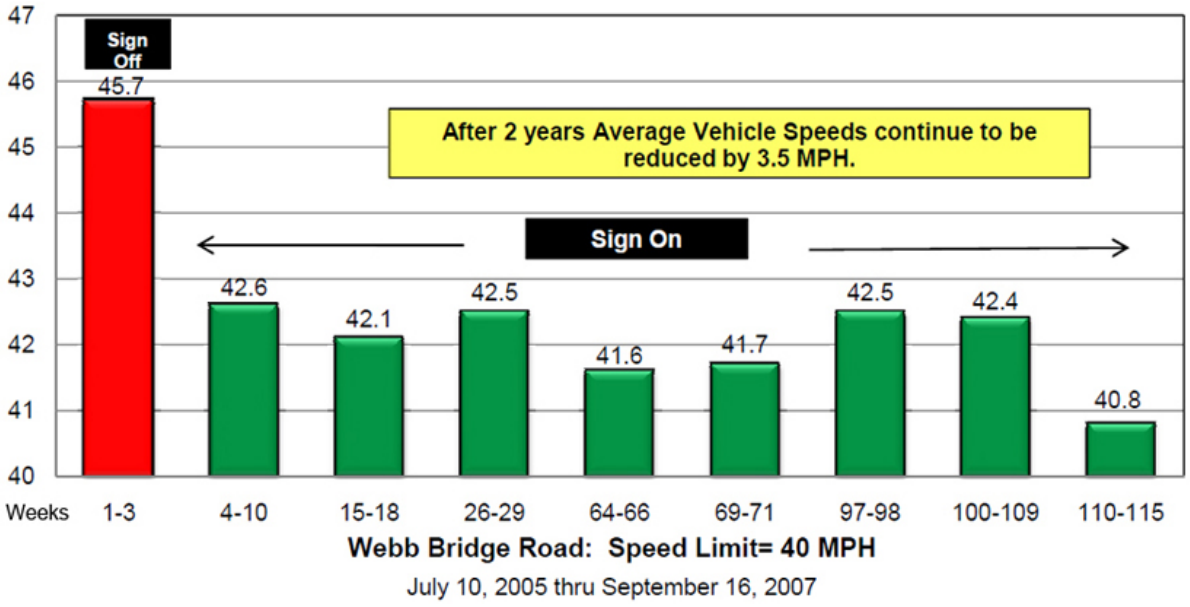
Reduction in Speeding by Percentage



Long-Term Reduction In Average Speeds

Two years of radar sign operation on a 40 MPH arterial street shows average speeds maintain reductions of 3.5 MPH.

Reduction in Average Vehicle Speeds



Vertical Alterations

Speed Humps, Bumps, Tables, Cushions, Raised Intersections and Pedestrian Crossings

Vertical deflection devices are construction-based, vertical alterations to roadways installed for the purpose of slowing traffic. These sections of raised pavement stretch across the full width of a street (generally 12 to 14 feet wide) and range from 3" to 6" high at their center. When driving over these devices, occupants may experience an uncomfortable, jarring sensation if the vehicle travels at speeds greater than the speed limit. This family of six vertical devices—while different in size, shape and application—all fall under the category of speed hump.

While the primary purpose of speed humps, speed bumps, cushions and tables is to slow vehicle traffic, making communities safer. The primary purpose of raised intersections and raised pedestrian crossings is to protect pedestrians. These devices are designed to slow drivers and increase motorists' awareness of any pedestrian presence by making them more visible.

Drivers should be alerted to changes in the road with signage. And, the vertical deflection devices themselves may be painted with zigzags, shark's tooth, chevrons and other conspicuous markings according to MUTCD guidelines (See "Federal Compliance Guidelines for Speed Humps, Bumps, Tables and Cushions" below.)

Known Concerns. Speed humps are particularly controversial. Nationally and internationally, municipalities and communities are beginning to reject them. Around the world, vertical alterations are known to:

- Impede public safety efforts.
  - During the winter months, snow plows cannot operate on streets with speed humps
  - Emergency response time increases with the number of vertical deflection devices
- Motorized street sweeping equipment may be impeded at these locations
- Require costly maintenance
- Increase noise to nearby residents as vehicles traverse the speed humps day and night
- Divert traffic to previously calm neighborhood streets
- Block or impede drainage which may result in flooding
- Create potential hazards to bicyclists and motorcyclists
- Be inappropriate on streets regularly used by buses, heavy duty vehicles or emergency vehicles
- Be difficult to construct precisely
- Require additional signage with associated expenses and maintenance
- Disrupt bicyclists when they cover or cross a bike lane

Potential Benefits. Vertical deflection devices may:

- Reduce speed near the device
- Diminish traffic volume
- Curtail the number of traffic collisions
- Provide continuous service, unlike police enforcement
- Discourage cut-through traffic

In 2006, Hillsborough county invested $2 million installing hundreds of speed humps, cushions and other devices. Within a short period of time, complaints about the speed humps began. In 2009, courts ordered the county to remove the speed humps in Carrollwood Village at a cost of $200,000.

Similarly, in 2013, Los Angeles—the second largest city in the U.S. and one of the nation's early adopters of traffic calming with speed humps—began considering a proposal to ban all new and replacement speed humps due to concerns for public health and safety.

Many states, such as Maine, and cities, such as Minneapolis, publish their own specific guidelines for speed humps that limit usage.

Installation Information

- According to AASHTO's guide, *"A Policy on Geometric Design of Highways and Streets"*, vertical traffic calming alterations such as speed humps, bumps, cushions and tables are generally installed in parking lots or on roadways functionally classified as local streets and neighborhood or residential collector streets.
- Vertical alterations are not for use on major roads, bus routes, primary response routes or intersections.
- When installing, consideration should be given to proximity to driveways, intersections, stop signs, fire hydrants and street lighting

SPEED HUMPS

Speed humps are generally used on residential streets where speed limits are consistently ignored. They are not designed for use on major roads, bus routes or primary response routes. When the hump extends across an entire intersection, it acts as a raised intersection (see those sections below).

Design:

- Often installed in a series, spaced 200 to 600 feet apart, depending on the goal speeds for vehicles passing through.
- For maximum effectiveness:
  - Speed humps should be installed no more than 500 feet apart for goal speeds of 25 - 30 mph
  - Spacing should allow drivers to slow down for one speed hump and be able to see the next one at the same time
  - Shorter roads may require only one speed hump even when two could be installed
- ITE and others categorize shapes and applications of speed humps like this:
  - Circular - completely rounded off, creates a semi-circle from roadway up
  - Parabolic - rounded but has a flattened area on top, without losing its sloped design
  - Sinusoidal - preferred over a circular or parabolic shape because it provides a more gentle transition and is easier for winter maintenance operators and cyclists to negotiate
  - Trapezoidal - also known as flat-topped, due to its squared off flat design
- Most agencies implement speed humps within these parameters:

- Height: 3 to 3.5 inches
- Travel length: 12 to 14 feet

Costs:

- Initial installation: $1,200 (Phoenix, AZ) to $2,500 (Pinal County, AZ)
- Additional cost factors: site drainage, construction materials, street width, signage and other road markings
- Long-term expenses and maintenance will include signage maintenance and replacement, repainting and repairs.
  - Custom construction can include repairs to the cap blocks, asphalt and concrete.
  - There are different maintenance needs for prefabricated humps vs. custom construction humps. Prefabricated humps may need to be replaced rather than repaired.

SPEED BUMPS

Speed bumps differ from speed humps in that they have an abrupt vertical rise. Typically vehicles must slow down to about 5 mph in order to cross over a speed bump. Due to their design, speed bumps are used in private parking lots or driveways, and are not appropriate for street installation. They tend to have the least consistent design parameters.

Design:

- There are a variety of speed bump shapes, which vary depending on installation
- Most agencies implement speed bumps within these parameters:
  - Vertical height: 3 to 6 inches
  - Travel length: 1 to 3 feet

Costs:

- Initial installation: $1,000 to $1,500 each. Islands for split speed bumps add $5,000 to each location.
- Additional cost factors: site drainage, construction materials, street width, signage and other road markings
- Long-term expenses and maintenance will include signage maintenance and replacement, repainting and repairs.
  - Custom construction can require repairs to the cap blocks, asphalt and concrete.
  - There are different maintenance needs for prefabricated bumps vs. custom construction bumps. Prefabricated bumps may need to be replaced rather than repaired.

SPEED TABLES

Speed tables are essentially flat-topped versions of traditional speed humps. The design consists of a longer, broader area of raised roadway that allows a more gradual speed reduction. These sections of raised pavement are characterized by an expanded flat top, which gives pedestrians greater visibility, increasing the likelihood that motorists will yield to them. Speed tables may also be marked as pedestrian crossings.

Design:

- ITE and others categorize shapes and applications of speed tables as:
  - Circular - completely rounded off, a semi-circle from roadway up
  - Parabolic - rounded but with a flattened area on top
  - Sinusoidal - similar to round with a more gentle curve and smoother transition
  - Trapezoidal - also known as flat-topped, due to its squared off flat design

- Speed tables typically feature a 10-foot plateau with a 6-foot approach on either side
  - The approach portion can be parabolic or sinusoidal
  - This design allows for speeds of 25 to 30 mph
- Most speed tables are installed within these size parameters
  - ◊ Height: 3 to 4 inches
  - ◊ Travel length: 22 feet (including a 6 foot ramp on each end)

Costs:

- Initial installation: $3,000 (Hansville, WA) to $5,000 (Wauwatosa, WI)
- Additional cost factors: site drainage, construction materials, street width, signage and other road markings.
- Long-term cost considerations should include construction-based maintenance and landscape maintenance.

SPEED CUSHIONS

Speed cushions are speed humps with strategically placed gaps that allow emergency vehicles to pass unhindered.

Design:

- Speed cushions use a series of risers positioned end-to-end, across a roadway. The cushions are strategically placed to leave a channel between each riser, allowing the wheels of emergency vehicles, with their wider axles, to straddle the cushion and maintain their speed. These channels also allow space for water drainage and for cyclists to travel around them.

- Speed cushions can be constructed from asphalt or purchased prefabricated. Prefabricated options may be less expensive to install and require less maintenance, however, they may need replacement in time rather than repair. Some models are removable and allows for seasonal use.

- Most agencies implement speed cushions within these parameters:
  - Height: 3 to 3.5 inches
  - Travel length: 10 to 12 feet
  - Width: 3 feet or 6.5 feet

Costs:

- Initial installation: $2,000 (Mesa, AZ) to $7,000 (Austin, TX)
- Additional cost factors: site drainage, construction materials, street width, signage and other road markings
- Long-term cost considerations should include signage maintenance and replacement, repainting and repairs.
  - Custom construction may require repairs to the cap blocks, asphalt and concrete.
  - There are different maintenance needs for prefabricated cushions vs. custom construction cushions. Prefabricated devices may need to be replaced rather than repaired.

RAISED INTERSECTIONS

Raised intersections, sometimes called raised junctions, intersection humps or plateaus, are formed when an entire intersection is constructed as one large speed table. These vertical alterations allow pedestrians to cross the street at the same level as the sidewalk and force approaching vehicles to slow down.

Design:

- The flat raised areas of the intersections should meet the elevation of the sidewalks.
- Construction includes ramps at each vehicle approach.
- The elevated area can be constructed using asphalt, concrete, stamped concrete, bricks and pavers.
- The boundary between the sidewalk and street must be clearly marked.

Costs:

- Initial installation cost is highly dependent on the size of the intersection: $25,000 to $75,000 and up to $200,000 (South Central Florida)
- Additional cost factors vary based on materials used and the size of the road.
- Long-term expenses are primarily related to drainage and maintenance.

RAISED CROSSWALKS

Raised pedestrian crossings are raised, flat-top humps which include crossing privileges for pedestrians. The elevation of the crosswalk gives pedestrians more visibility while making them more visible to oncoming traffic.

Design:

- Raised crosswalks feature a flat top at the same elevation as the adjacent sidewalk to facilitate pedestrian crossings.
- These devices can be located at intersections or mid-block in high pedestrian travel areas.
- Common construction materials are asphalt, concrete and pavers.

Costs:

- Initial installation: $2,000 (Portland, OR) to $8,000 (Virginia)
- Additional costs factors vary based on materials used and the size of the road.
- Long-term expenses are primarily related to drainage and maintenance.

FEDERAL COMPLIANCE GUIDELINES *for Vertical Devices and Alterations*

Though some states have them, there are no federal guidelines for the application or construction of vertical devices and alterations. The FHWA points to the ITE as the resource for best practices and application of vertical implements, saying, “The Institute of Transportation Engineers (www.ITE.org) publishes technical guidance on criteria, dimensions, spacing, etc.”

There are, however, MUTCD compliance requirements for **signage and markings** for these devices. Overarching guidelines include:

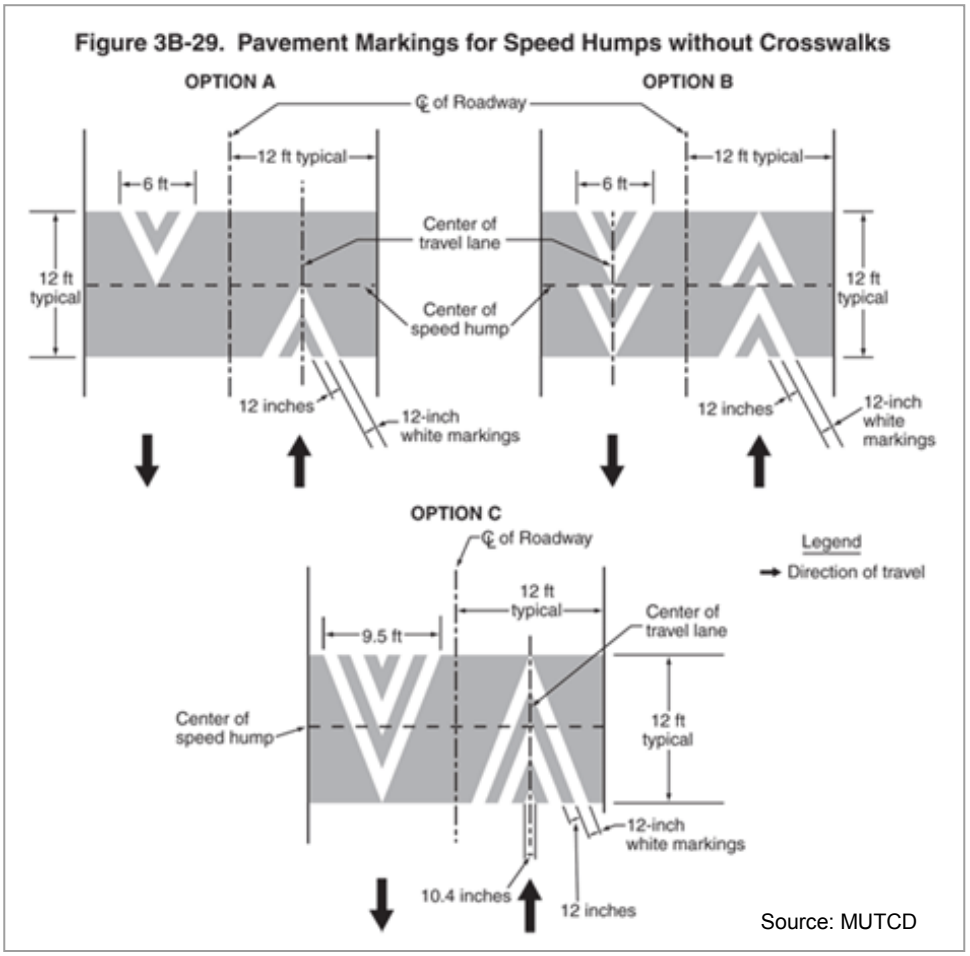
- Markings on speed humps are used to designate whether a speed hump also serves as a crosswalk or speed table. These markings should be white.
- In advance of the speed hump, white markings placed on the roadway should prepare motorists for an upcoming hump or dip in the road.
- In addition to the markings and signage, the word “hump” or “bump” may be marked on the road in white as an additional notification.
- If these markings are used, they should be uniformly displayed in each lane approaching the speed hump.

There are differentiating markings for speed humps—with and without crosswalks. There are also markings that serve to alert drivers well in advance of upcoming speed humps or other engineered vertical roadway deflections.

The specific MUTCD guidelines regarding signage and markings for speed humps **without crosswalks** are as follows:

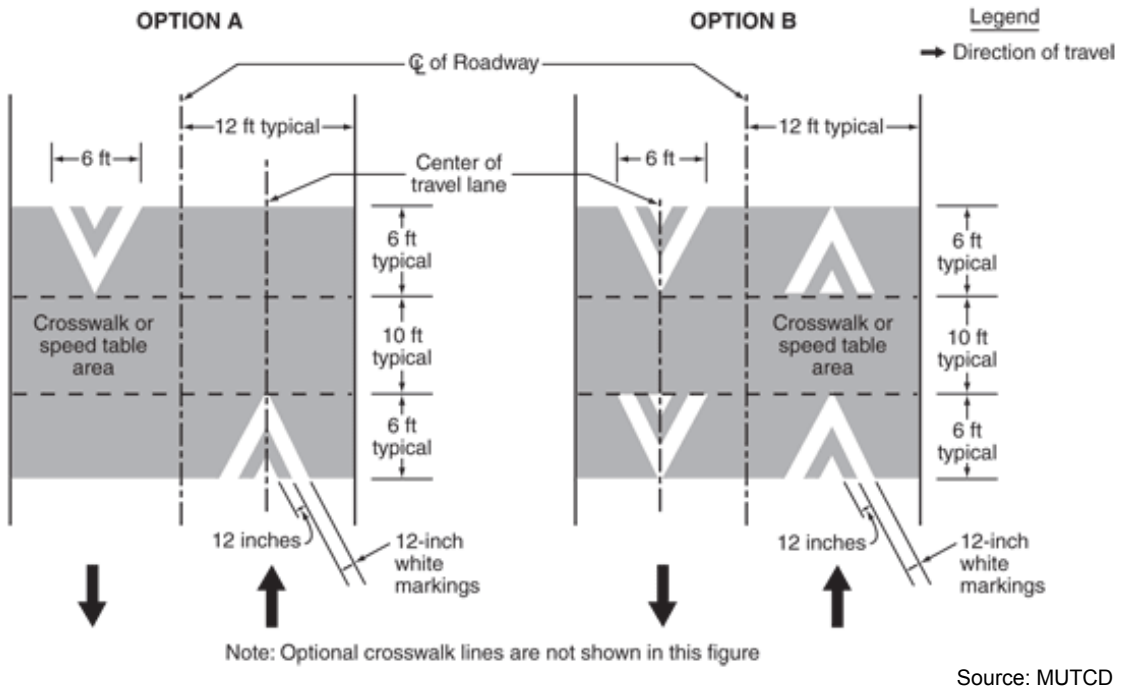
Standard: If used, speed hump markings shall be a series of white markings placed on a speed hump to identify its location.

Option: Speed humps, except those used for crosswalks, may be marked in accordance with Figure 3B-29 from the MUTCD guide (below), *Examples of Pavement Markings for Speed Humps Without Crosswalks.*



The specific MUTCD guidelines regarding markings for speed tables or humps **with crosswalks** may be used where the speed hump functions as a crosswalk or speed table. Figure 3B-30 from the MUTCD guide (below) provides: *Examples of Pavement Markings for Speed Tables or Speed Humps with Crosswalks*

Figure 3B-30. Pavement Markings for Speed Tables or Speed Humps with Crosswalks



Note: Optional crosswalk lines are not shown in this figure

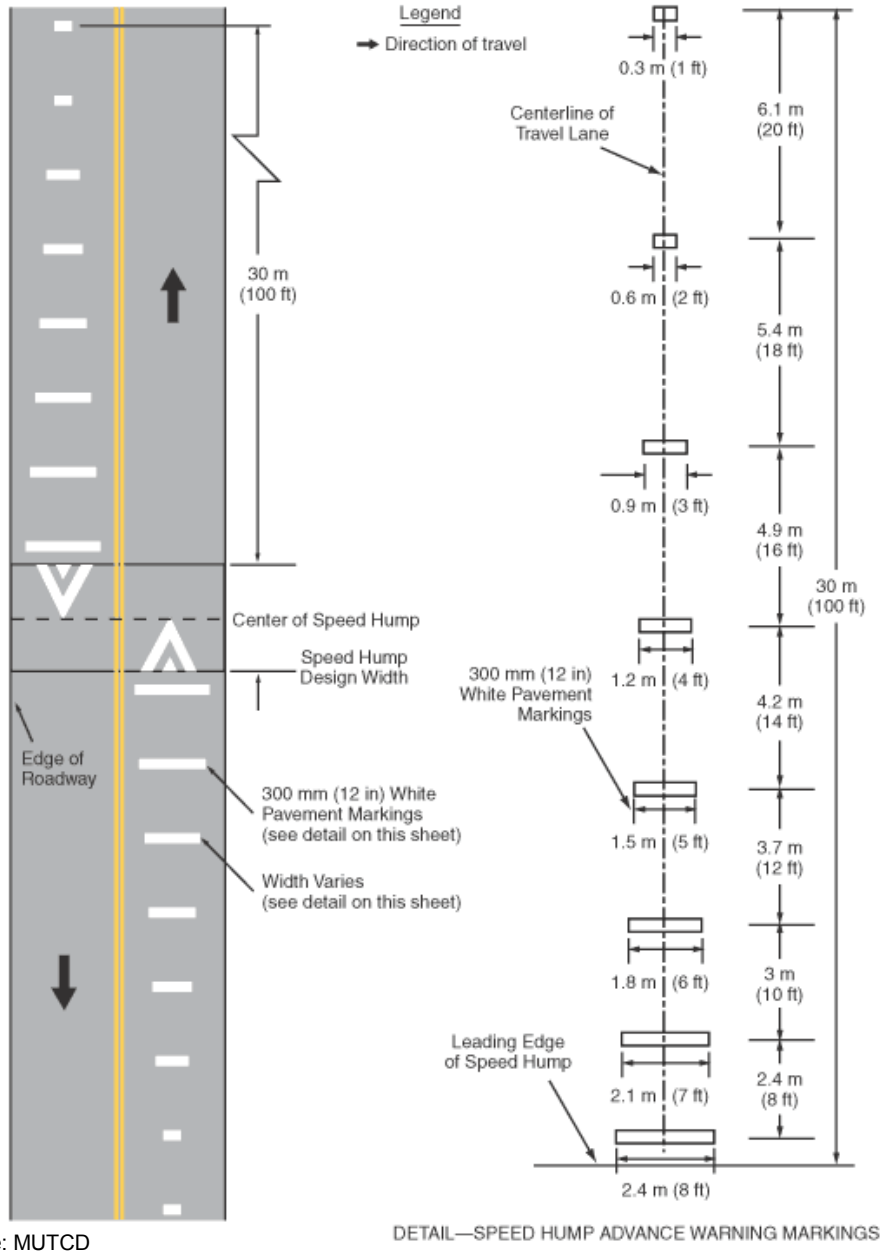
Source: MUTCD

Specific MUTCD guidelines regarding signage and markings in advance of speed humps are as follows:

Standard: If used, advance speed hump markings shall be a special white marking placed in advance of speed humps or other engineered vertical roadway deflections such as dips.

Option: Warning markings for speed humps may be used in advance of an engineered vertical roadway deflection, where additional visibility is desired or where this type of deflection may not be expected. For examples of this, see Figure 3B-31 from the MUTCD guide (below).

Figure 3B-31. Examples of Advance Warning Markings for Speed Humps



Source: MUTCD

Horizontal Alterations

Chicanes, Roundabouts and Traffic Circles

➔ ***Why speed limits don't always work.***

Speed limits do not have significant impact on driving speeds. Drivers tend to base their speed on the road conditions and the driving environment.

Grand Forks Herald

Horizontal deflections include any device or roadway deviation designed to change driver behavior through a change of path, often to discourage cut-through traffic. In recent years, traffic planners have focused less on vertical deflection devices, like speed bumps, to reduce traffic speed, in favor of many of these horizontal devices. Still, horizontal alterations are not without controversy (see below).

CHICANES

Chicanes are best suited for installation on streets that offer flexible use of the width of the road. Chicanes, which have multiple forms, shift the travel pathway of motor vehicles in a serpentine manner, forcing drivers to reduce their speed. Most chicanes are created by building curb extensions or bulb outs that alternate from one side of the street to the other. The distance between the curb extensions impact the ease and speed which motorists can maneuver through the street.

Design:

- Application is appropriate for straight streets with long blocks.
- Single-lane chicanes restrict two-way traffic by requiring traffic from one direction to give way to opposing traffic.
- Two-way chicanes allow vehicles to pass one another while traveling in opposite directions.
- Space for parking can be included on alternate sides of the street
- Curb extensions can be formed using landscaping to enhance the community's appearance.
- Best used on narrow roads so that motorists do not straddle the roadway to avoid negotiating the chicanes.

Known Concerns:

- Can slow travel and response times—although not as much as speed humps—so they should not be installed on roads used by mass transit or emergency response vehicles. It is worthy to note that emergency/first responders often prefer chicanes to speed humps.

- Parking and driveway access can be affected.
- Driver visibility can be obstructed by planted vegetation.
- Must be well-designed to prevent drivers from cutting straight through the center line to maintain unsafe speeds.
- Bicyclist safety is jeopardized by chicane-alterations on steep, uphill streets; avoid development on this terrain.
- May require manual street cleaning due to their irregular shape.

Costs:

- Initial installation (for a set of three): $15,000 to $30,000 (concrete) or $10,000 (asphalt)
- $10,000 to $20,000 for a set of 3 (Alameda, CA)
- Additional cost factors vary based on whether the street is asphalt or concrete, drainage concerns, road width and the presence of vegetation.
- Long-term expenses include maintenance on both construction and landscaping.

Federal Compliance Guidelines for Chicanes

There are no federal guidelines for chicanes, although some local and state municipalities may require compliance with certain codes. MUTCD guidelines provide only two recommendation for chicane markings:

1. Utilize “Road Narrows” word message signs to alert drivers to changes in road width, such as the presence of curb extensions, bulb outs or chicanes.
2. Utilize painted lines to identify street edges on narrowed roadways.

ROUNDABOUTS and TRAFFIC CIRCLES

Roundabouts are one-way circular intersections in which traffic flows around a raised island in the center. Roundabouts are often confused with traffic circles. Traffic circles, which were introduced to the U.S. more than a century ago, were designed for vehicles to enter, merge, circulate and exit at relatively high speeds. As traffic increased and cars became faster, a higher incidence of crashes occurred at traffic circles, and these types of intersections fell out of favor. Modern roundabouts, which are smaller than traffic circles, require motorists entering the circle to yield to circulating traffic. Roundabouts can handle a high volume of traffic and have been proven to safely decrease traffic delays and congestion. Traffic circles have been successful worldwide by reducing car crashes and are appropriate for both residential and nonresidential areas.

Design:

- Yield control on all entries
- Typically circular in shape, though not always
- May be paved with no vegetation or can be landscaped with low-growing bushes, flowers or grass

- Pedestrian access only allowed across the legs of the roundabout, well behind the yield point
- May include a raised, traversable truck apron which acts as an extra lane, allowing large vehicles to pass through. Aprons are usually constructed of a material other than asphalt and should be textured to discourage other motorist from using them.

Known Concerns:

- Without traffic signals, emergency vehicles cannot preempt other traffic.
- Fire trucks must maneuver around traffic circles at slow speeds (provided vehicles are not parked near the circle).
- Unsafe if high volumes of large vehicles need to turn left in front of the circle.
- All landscaping must be designed to allow adequate sight distance.
- Avoid routing vehicles through unmarked crosswalks on side-street approach.
- Maneuverability of large vehicles is potentially obstructed by radii of turns.

Cost:

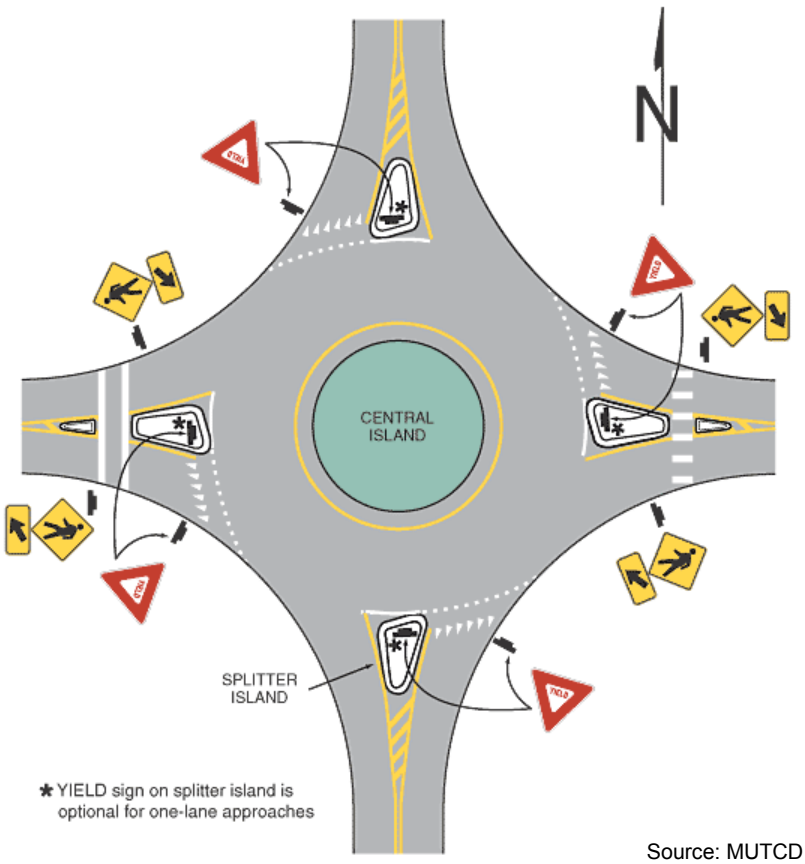
- Initial installation: $200,000 to $500,000. (Maryland)
- Installation costs of roundabouts are $150,000 less than signalized intersections. (Carmel, IN)
- The annual maintenance costs of roundabouts are lower than signalized intersections: $2000 per year versus $5,000. (Shawnee, KS)
- Additional cost factors vary based primarily on street width, drainage needs and landscaping.

Federal Compliance Guidelines for Roundabout Intersections

There are no federal guidelines for roundabouts, although some local and state municipalities may require compliance with certain codes. MUTCD guidelines provide recommendations for markings and signage affiliated with roundabout intersections, which can be found in Section 3B.24, Markings for Roundabout Intersections.

Figure 3B-27 of the MUTCD guide (below) illustrates the markings for roundabout intersections with **one-lane approaches**.

Figure 3B-27. Examples of Markings for Roundabout Intersections with One-Lane Approaches



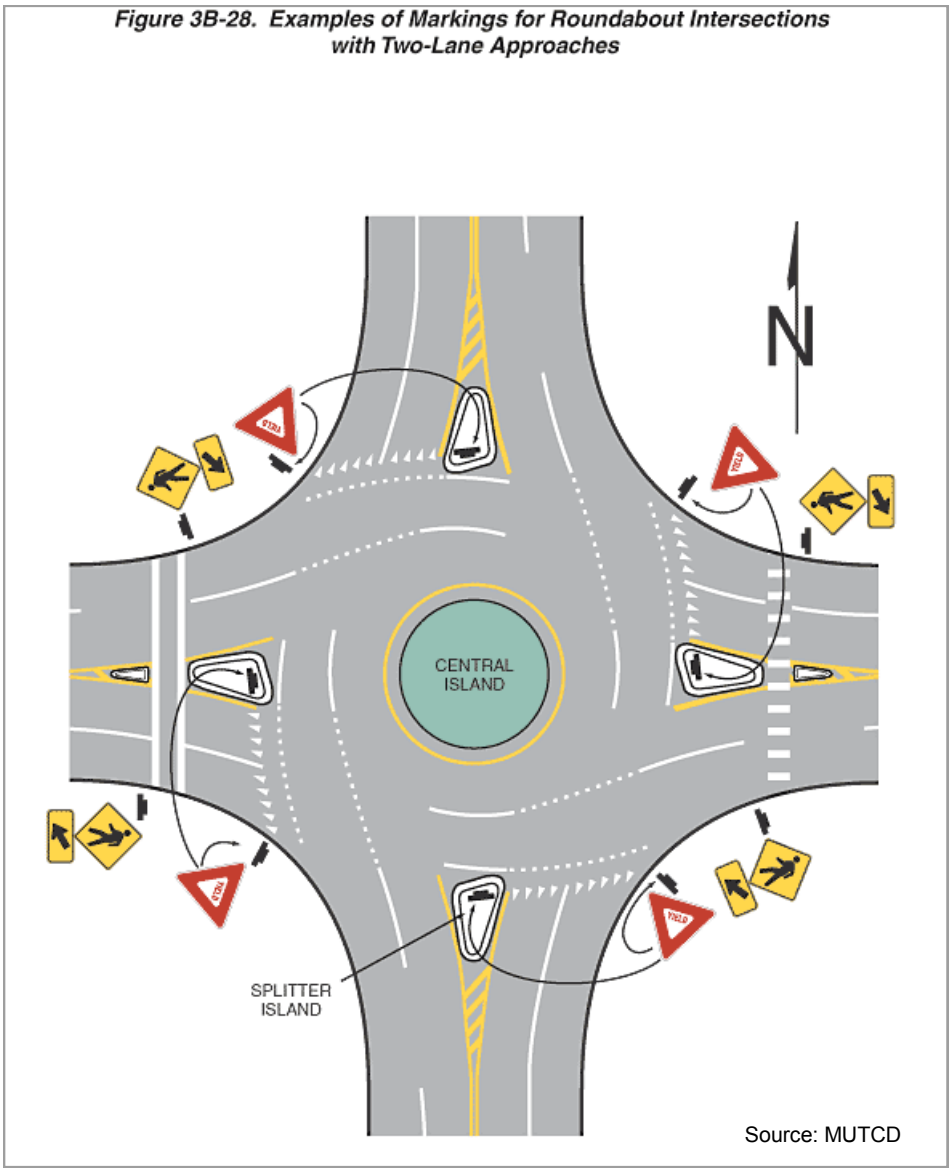
Source: MUTCD

The figure shows a central island surrounded by a circular roadway, which is created with four streets that enter/exit the roundabout. Triangular splitter islands separate oppositional traffic directions. Markings include:

- A solid yellow line to identify the inner edge of the roadway.
- Outer edges of the roadway are designated with 1) a solid white line at the wide end/ outer edge of the splitter islands which is connected with 2) a white dotted line across the lane of in-bound traffic. Edge line extensions should not be placed across the exit lanes.
- Yield is designated with a line of white triangles AND a yield sign for entering traffic. The white triangles appear on the pavement in advance of—and parallel to—the dotted white line (the outer edge of the roadway). Optional: add yield signs to each splitter island for one-lane approaches. More on yield markings can be found here.
- Opposing directions of traffic on all roadways entering/exiting the roundabout are separated by a solid, double yellow lines. These diverge to go around the sides of the splitter islands. Diagonal yellow lines identify the beginning/end of the splitter island.
- Crosswalks are designated in three ways:
    1. Two parallel white lines (solid yellow lines and yellow diagonal lines associated with the splitter islands are omitted within the crosswalk)
    2. A row of closely spaced white lines parallel to the flow of traffic (solid yellow lines and yellow diagonal lines associated with the splitter islands are omitted within the crosswalk).
    3. Crosswalk/pedestrian signage (diamond-shaped person walking sign) placed over a downward, diagonal-arrow sign, installed just in advance of the crosswalk.

Note: crosswalk markings should be located a minimum of 7.6 m (25 ft) upstream from the yield line, or, if none, from the dotted white line.

Figure 3B-28 of the MUTCD guide (below) illustrates markings for roundabout intersections with **two-lane approaches**.



Markings for the two-lane entry roundabout are the same as those for the one-lane entry with one addition:

- Lane lines may be used if there is more than one lane.

Narrowing Measures

Curb Extensions and Center Islands

➔ ***Exceeding limits vs. too fast for conditions***

In fatal crashes, about 55% of all speeding-related crashes were due to "exceeding posted speed limits" as compared to the 45% that were due to "driving too fast for conditions."

NHTSA

Studies show that wider residential streets experience higher speeds. By reducing the "effective" street width, excessive speeds can be reduced. Curb extensions and island narrowing are the fundamental street narrowing tools. Properly installed, narrowing measures reduce speeds (near the device), diminish traffic volume, make pedestrians more visible and offer pedestrians protection from vehicle traffic.

CURB EXTENSIONS

Curb extensions extend the sidewalk into the street, reallocating a portion of the roadway to pedestrians. By reducing the roadway width from curb to curb, curb extensions slow motorists and benefit pedestrians by providing shorter crossing distances. In some cases, these devices may also provide a protected street parking zone.

Also called bulbouts and popouts, these traffic-calming tools can be located at an intersection or mid-block. When placed at an intersection, curb extensions are often called neckdowns. Mid-block they are sometimes referred to as chokers.

Design:

- Must consider site drainage needs.
- Landscaping can be incorporated as part of a community beautification project.

Known Concerns:

- Right turns may be difficult to maneuver by large vehicles.
- On-street parking may be diminished, depending on design.
- Poorly designed curb extensions can pose a hazard to cyclists.

Costs:

- Initial installation: $10,000 to $40,000 per corner (Sparks, NV)

- Mid-block installation may cost less: $4,000 (Harrisburg, PA)
- To retrofit an existing four-leg intersection: $100,960 (FHWA)
- Additional initial costs vary based on design and site conditions. Drainage tends to be the most significant cost determinant. Other factors include size of extension area, pavement type, street furnishings, vegetation and landscaping. If movement of utility pole or controller box is required, this will substantially increase installation costs.
- Long-term expenses focus primarily on the maintenance of the vegetation.

Federal Compliance Guidelines for Curb Extensions

There are no federal guidelines for curb extensions though there may be local and state requirements for compliance with certain construction codes. While MUTCD guidelines do not directly address these, there are a number of transferrable recommendations:

1. Utilize "Road Narrows" word message signs to alert drivers to changes in road width, such as the presence of curb extensions, bulb outs or chicanes
2. Utilize painted lines to identify street edges with on narrowed roadways
3. Incorporate appropriate markings and signage if crosswalks are part of the curb extension.

CENTER ISLANDS

Center islands—also known as crossing islands, pedestrian islands and refuge islands—are raised alterations found in the median of a street between opposing lanes of traffic. Located at an intersection or mid-block, these devices increase protection for pedestrians as they cross the street. These refuge areas complement crosswalks by reducing the time that a pedestrian is exposed to the roadway and by drawing drivers' attentions to the presence of the crosswalk. Properly utilized, crossing islands reduce pedestrian injuries and vehicle crashes.

Design:

- Most appropriate for wide or multi-lane streets
- Must consider wheelchair access at the median when constructing a cut-through design
- Must be clearly visible to traffic both day and night
- The minimum widths for accessible refuge islands and for design and placement of detectable warning surfaces are provided in the *Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG,* Section 1A.11).

Known Concerns:

- May impede cyclists when the refuge island narrows the driving lanes too much
- May impact left-hand turning

Costs:

- Initial installation: $10,000 to $40,000 (FHWA)
- Additional cost factors vary based on the materials used, presence of vegetation / landscaping and drainage factors.
- Long-term expenses include maintenance, construction and landscape.

➔ ***Numbers of speeders have not decreased over time***

Since 1997, the number of drivers stopped by police for speeding has fluctuated very little, hovering between nine and 11% Of those stopped for speeding, drivers receiving tickets has also remained stable, varying between 65 and 70%.

NHTSA

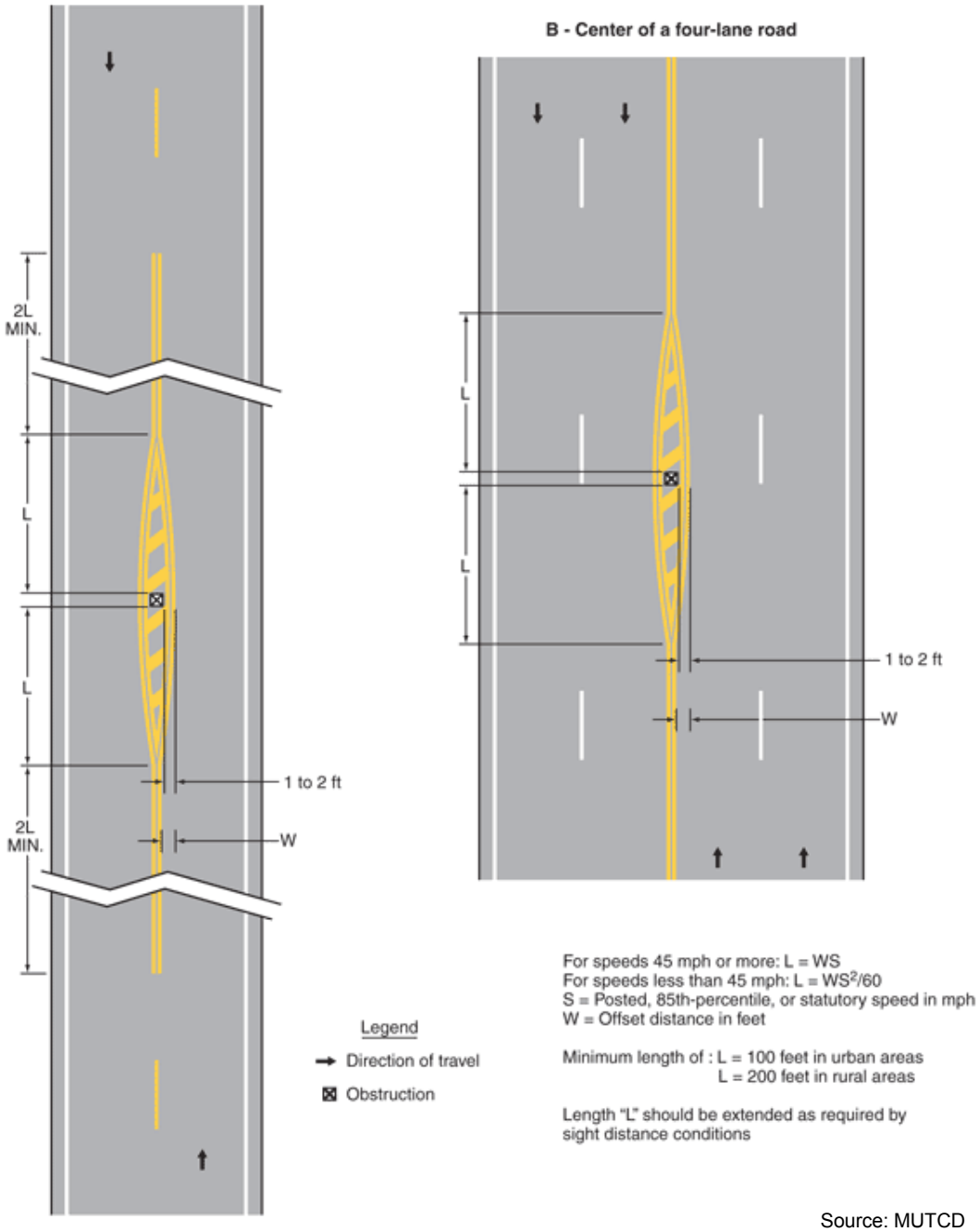
Federal Compliance Guidelines for Center Islands

There are no federal guidelines for center islands though there may be local or state requirements for compliance with certain construction codes. MUTCD guidelines are limited to pavement and curb markings, channelizing devices and delineators.

(continued on page 34)

Markings shall consist of a tapered line or lines extending from the center line or the lane line to a point 1 to 2 feet to the right-hand side, or to both sides, of the approach end of the obstruction (see Figure 3B-15 of the MUTCD guide below).

Figure 3B-15. Examples of Applications of Markings for Obstructions in the Roadway
(Sheet 1 of 2)



Source: MUTCD

NOTE: This approach to an obstruction for a particular island (Section 3B.10) may be omitted based on engineering judgment.

Island Marking Colors

1. Islands outlined by curbs or pavement markings should be marked with retro reflective white or yellow material as determined by the direction or directions of travel they separate (see Section 3A.05 of the MUTCD guide).
2. The retro-reflective area should be of sufficient length to denote the general alignment of the edge of the island along which vehicles travel, including the approach end, when viewed from the approach to the island.

   Option: On long islands, curb retro-reflection may be discontinued such that it does not extend for the entire length of the curb, especially if the island is illuminated or marked with delineators or edge lines.

Island Delineation

1. Delineators installed on islands shall be the same colors as the related edge lines except when facing wrong-way traffic, they shall be red (see Section 3F.03 of the MUTCD guide).
2. Each roadway through an intersection shall be considered separately in positioning delineators to assure maximum effectiveness.

   Option: Retro-reflective or internally illuminated raised pavement markers of the appropriate color may be placed on the pavement in front of the curb and/or on the top of curbed approach ends of raised medians and curbs of islands, as a supplement to or as a substitute for retro-reflective curb markings.

Signage and Pavement Markings

Critical Information

Well-placed signs and pavement markings provide critical information to drivers. The Federal Highway Administration (FHWA) has developed minimum uniform standards for traffic control devices which include signs, signals and pavement markings to promote safety on the nation's highways and streets. These guidelines are compiled in the 2009 Manual on Uniform Traffic Control Devices MUTCD. Some jurisdictions have established requirements beyond those of the MUTCD, so signage and markings must comply with federal standards as well as local ones.

Using signage can be a low-cost, first-step form of traffic calming that may serve as a fast fix for increased safety in residential, public and business environments. However, caution must be used when considering signage as a traffic calming solution. Contrary to commonly held beliefs, a number of sign options fail to slow speeding drivers and may actually increase hazardous conditions. Here are the true facts surrounding the most commonly misused signs for traffic calming:

Stop signs are not an effective traffic calming measure. The MUTCD has established criteria (see Section 2B) for the placement of stop signs. The guide directly states, "STOP signs should not be used for speed control."

Numerous studies have found that, multi-way stop signs—in most situations—are not effective at slowing speeding drivers. In truth, unwarranted stop signs can actually put pedestrians and other drivers at greater risk. Impatient drivers, frustrated by the delay of the stop signs, often increase their speed to make up for lost time. When unwarranted, stop signs are increasingly ignored by motorists who consider them unreasonable.

Across the nation, transportation departments have recognized the deficiency of stop signs as a traffic calming device. As a result, many have incorporated standards into their transportation policy that restrict their application. (Oregon State DOT, Des Moines, IA, Portland, OR , Northampton, MA and Virginia Beach, VA)

Warning signs, such as "Children At Play", are ineffective traffic calming devices. MUTCD guidelines for the application of warning signs can be found in Section 2C. "Children at Play" signs are not listed. Therefore, they are nonstandard. The manual cautions, "The use of warning signs should be kept to a minimum as the unnecessary use of warning signs tends to breed disrespect for all signs." The guide does provide standards for signs warning motorists that they are approaching parks and playgrounds.

The FHWA advises that **"Caution-Children at Play"** or **"Slow Children"** signs should not be used. These signs are ambiguous and provide no guidance to motorists in terms of a safe speed. Additionally, they could lead to more dangerous behavior.

While parents often request these signs be installed near their homes, research solidly confirms that warning signs do not slow motorists. These alerts can lead drivers to believe that, if no such sign is present, children are not playing in that area. This wrong thinking could encourage speeding. Motorists should always expect that children will be at play in residential areas.

Additionally, the signs could encourage parents and children to be less vigilant. Parents should always supervise young children who are playing outside. And older children should never assume that playing in the street is a secure activity.

The transportation departments of Phoenix, AZ; Ada County, ID; DesMoines, IA and North Dakota all outline the rationale for their policy which prohibits "Children at Play" signs.

Other warning signs intended to protect the most vulnerable have also proven ineffective. A small-sample trial to test a **"Deaf/Blind Pedestrian"** warning plaque indicated that there was no improvement in yielding rates when the sign was present as compared to when it was not present. Many cities, including Fort Collins, CO, will not install these signs.

Collisions with wildlife are becoming more frequent in urban areas and can result in serious injury to drivers and passengers. Yet, **"Deer Crossing"** signs should be used judiciously. The *Iowa Manual for Traffic Control Devices and Pavement Markings* and the *Missouri Guidebook for Traffic Practices* both include this counsel: "The installation of warning signs for deer crossings should be considered carefully, since occurrence of deer on the roadway is occasional and overuse of deer warning signs leads to general disregard of the signs by the driving public."

Both the Ohio DOT and the North Carolina DOT have recognized the ineffectiveness of **"Hidden Driveway"** and **"Blind Driveway"** signs and will not install them.

Posting unusual speed limits is an ineffective traffic calming strategy. The concept behind this scheme is the belief that an unusual speed limit will capture the attention of motorists who will respond by slowing down. Initially, this may work. But the ITE says that, over time, as drivers become accustomed to the signs, they will have no further effect on speeds.

The FHWA states, "the primary purpose of the speed limit is to advise drivers of the maximum reasonable and safe operating speed under favorable conditions." Setting an appropriate speed limit is vital for compliance and enforcement. Speed limits should not be posted with the intent to disorient a driver.

Additionally, these non-standard signs are not MUTCD compliant. The MUTCD guidelines for speed limits establish that they shall be in multiples of 5 mph (10 km/h for jurisdictions that employ metric).

In 2013, city officials in Aspen, CO considered setting speed limits of 14 and 18 mph on the resort town's residential streets in hopes that the odd limits would grab the attention of drivers. The idea was scrapped after the city council learned that the state had adopted the federal guideline restricting speed limits to increments of 5 mph. Council members were also concerned that the signs might confusing motorists.

The Neighborhood Traffic Management Program of Collier County, FL points out that, in addition to their lack of MUTCD compliance, the odd speed limits place a high dependence on police to monitor speeders.

Sources

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AllState - allstate.com
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American Association of State Highway and Transportation Officials (AASHTO) - transportation.org
American Association of State Troopers (AAST) - statetroopers.org
City of San Jose Traffic Safety Education Program - www.getstreetsmarts.org
Clearwater Paper Corporation - clearwaterpaper.com
Governors Highway Safety Association (GHSA) - ghsa.org
The Institute for Social Sustainability (ISTP), Murdoch University - murdoch.edu.au
Institute of Transportation Engineers (ITE) - ite.org
International Association of Chiefs of Police (IACP) - theiacp.org
Midwest Transportation Consortium (MTC) - intrans.iastate.edu/mtc
Milolii Beach Club Association - milolii.org
National Association of State Directors of Pupil Transportation Services, Department of Transportation, National Transportation Safety Board - nasdpts.org
National Governors Association (NGA) - nga.org
National Roads Authority (NRA) - nra.ie
Radarsign - radarsign.com
The Raleigh School - raleighschool.org
Safe Routes. National Center for Safe Routes to School - saferoutesinfo.org
State Farm learningcenter - statefarm.com
Transportation Association of Canada (TAC-ATC) - tac-atc.ca
Transportation Research Board (TRB) - trb.org
United States Automobile Association (USAA) - usaa.com

Government Agencies

Federal Highway Administration (FHWA) - fhwa.dot.gov
Federal Transit Administration (FTA) - fta.gov
Manual on Uniform Traffic Control Devices (MUTCD) - mutcd.fhwa.dot.gov
National Highway Traffic Safety Association (NHTSA) - nhtsa.gov
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Created by Radarsign, the *Traffic Calming Guide for the 21st Century* is a compendium of traffic calming best practices that have been identified and endorsed by trusted and respected companies, organizations and thought leaders focused on advancing the issues surrounding traffic and transportation safety. Information was researched and gathered during 2014 and 2015. Updated stats, charts and findings may be eligible for inclusion. Please submit those by email to info@radarsign.com.

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In 2004, Atlanta-based Radarsign™ established new industry standards for traffic-calming solutions with the debut of the world's first armored radar speed signs, which are vandal, weather and bullet-resistant. The industry's most durable radar speed signs are also the most ecological and energy efficient. Engineered and manufactured in the USA, Radarsign products are MUTCD-compliant and utilize recycled aluminum, innovative LED reflector technology, minimal battery power and solar panels to deliver bright, easy-to-read feedback to drivers. Radarsign products are scientifically proven to reduce drivers' speeds and have been entrusted to provide safe and effective traffic-calming solutions for: municipalities, treasured national parks, schools, neighborhoods, military bases, and private and public development projects across the U.S., Canada and overseas. www.Radarsign.com.