In the world of traffic calming, options to reduce speeding drivers, to increase pedestrian and motorist safety, and to improve the quality of life within a community are constantly evolving. This document is the first in a series of 21st Century Traffic Calming guides that analyze engineered traffic-calming solutions.

Part I: 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”-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
- Difficult to construct precisely
- Require additional signage with associated expenses and maintenance
- Bicyclists prefer that they do not 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 the ITE (as defined in AASHTO's "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.
- 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 200-600 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) - $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 / 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 - $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 / 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 – 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: $3,000-5,000 (Hansville, WA) and (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, allowing for seasonal use.
- Most agencies implement speed cushions with a:
  - ➢ Height: 3 to 3.5 inches
  - ➢ Travel length: 10-12 feet
  - ➢ Width: 3 feet or 6.5 feet"

Cost:

- 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/concrete.
  - There are different maintenance needs for prefabricated humps vs. custom construction humps. Prefabricated humps 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 costs 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.

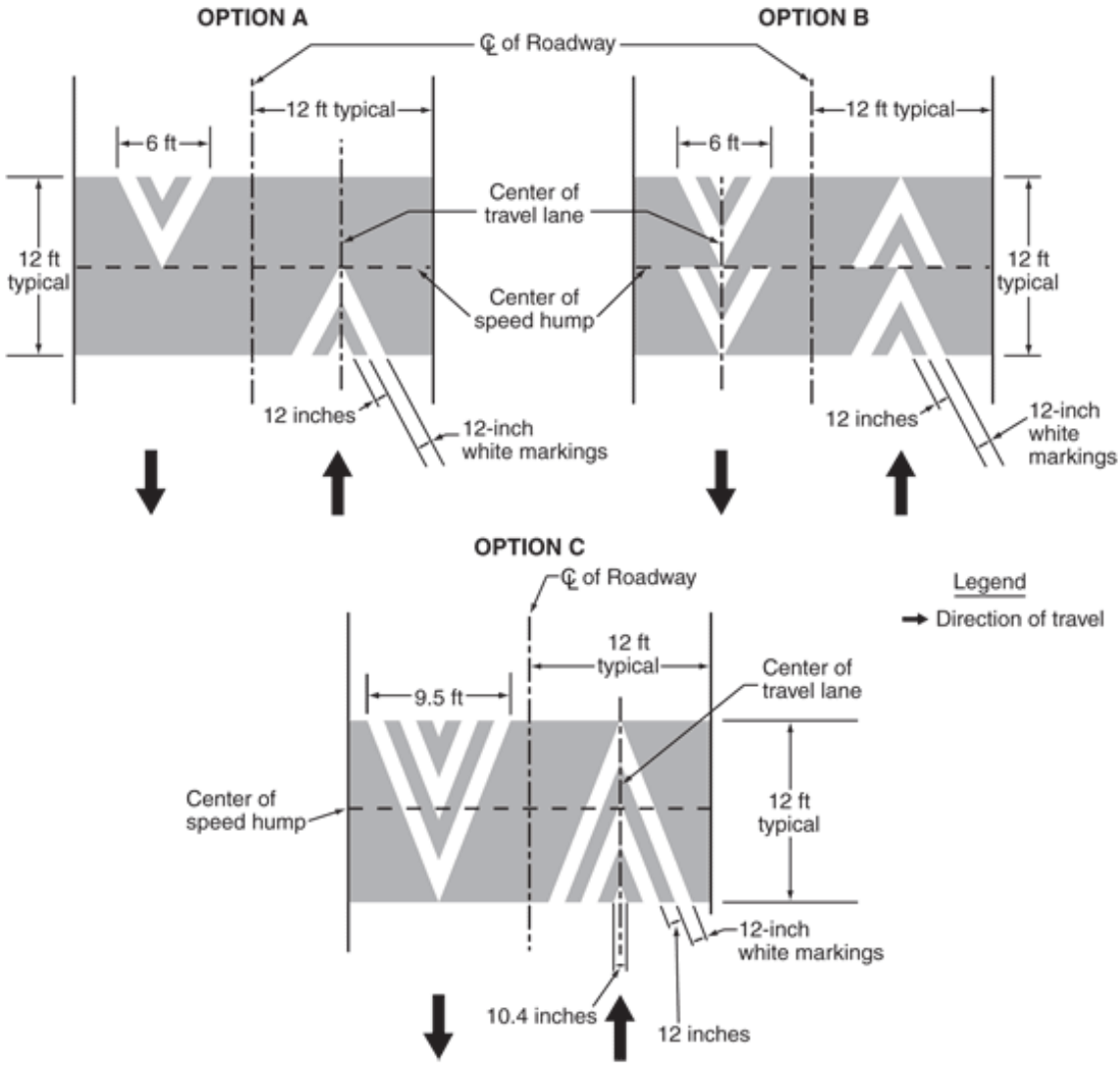
There are differentiating markings for speed humps—with and without crosswalks. There are also markings that serve to alert drivers well in advance of upcoming speed humps or other engineered vertical roadway deflections.

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

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

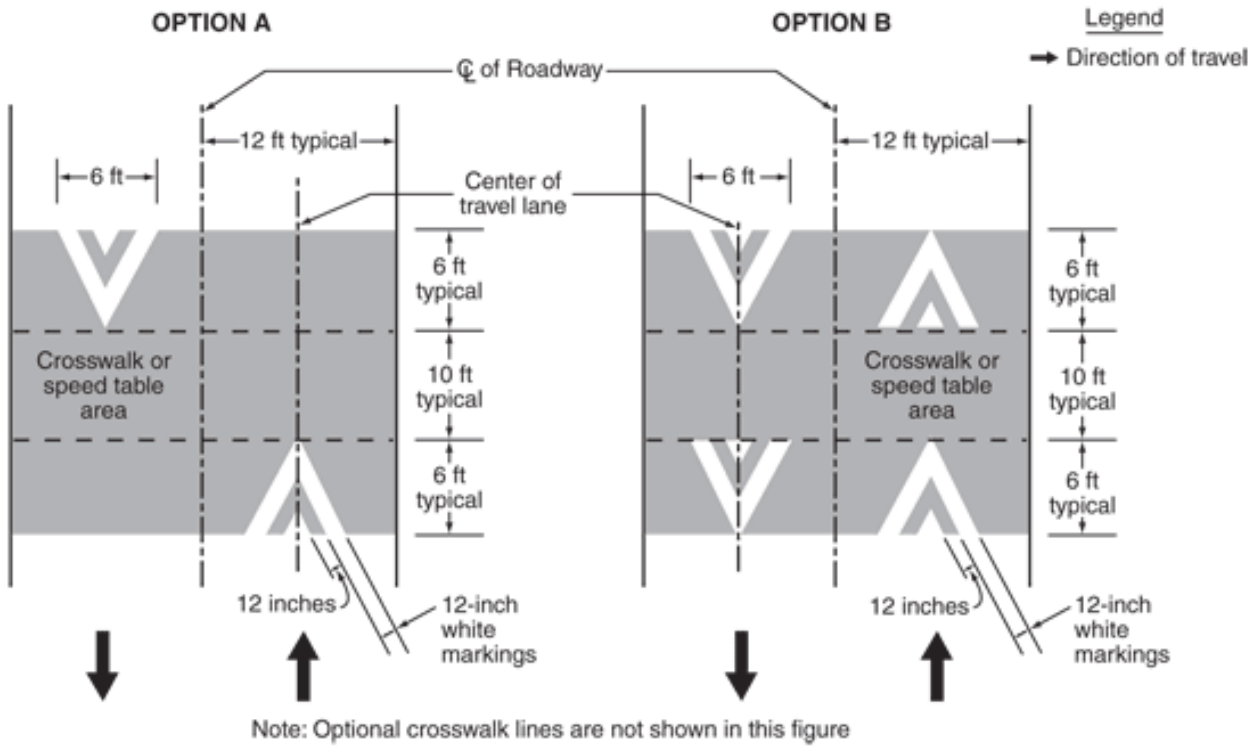
2. **Option:** Speed humps, except those used for crosswalks, may be marked in accordance with Figure 3B-29, *Examples of Pavement Markings for Speed Humps Without Crosswalks*

Figure 3B-29. Pavement Markings for Speed Humps without Crosswalks



The specific MUTCD guidelines regarding markings for speed tables or humps **with** crosswalks are may be used where the speed hump functions as a crosswalk or speed table. Figure 3B-30, 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

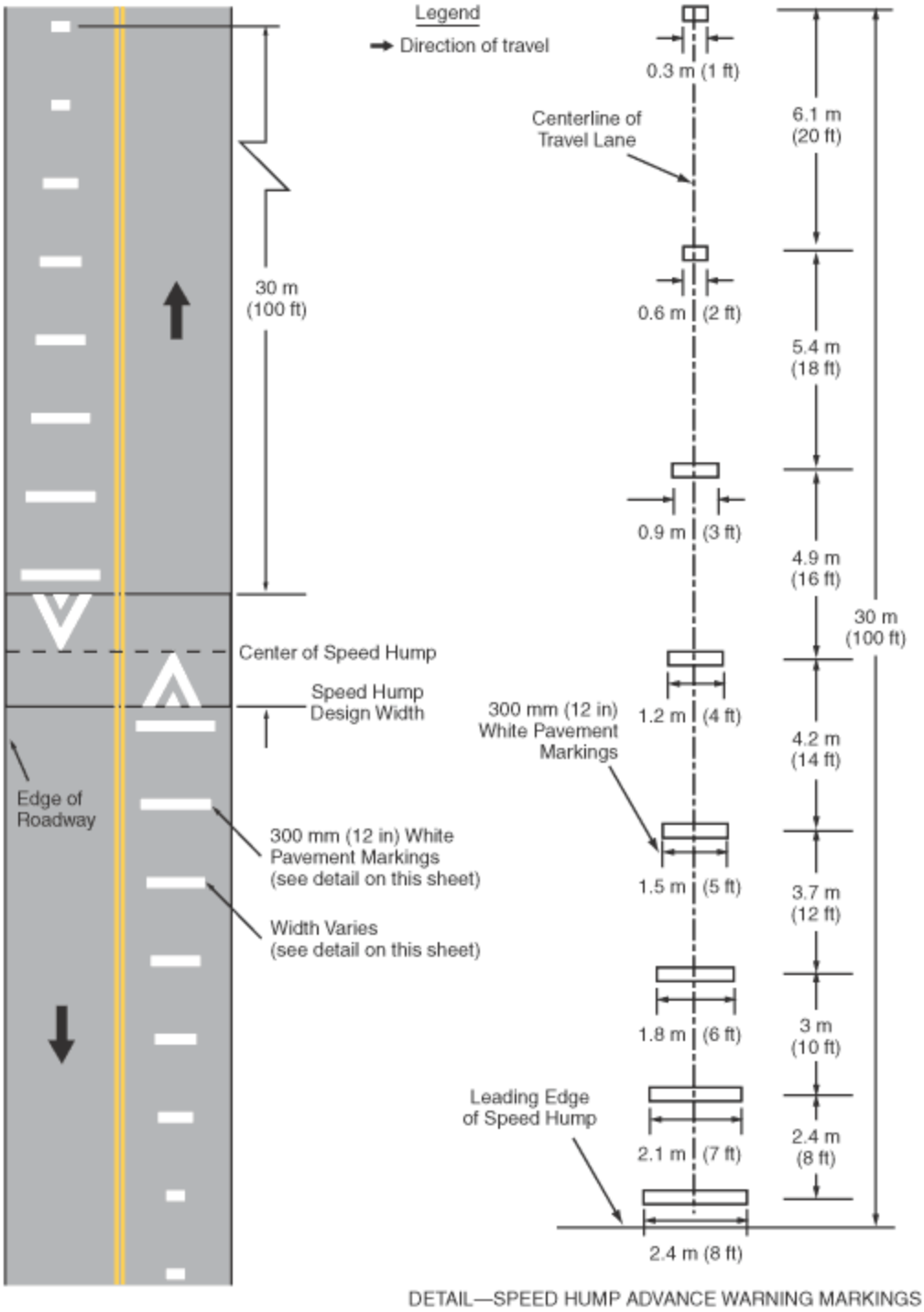


Specific MUTCD guidelines regarding signage and markings in advance of speed humps:

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 in Section 2C.24.

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



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