CHAPTER 3

Toolbox of Traffic Calming Measures

In the past, ITE has used the analogy of a toolbox in its informational documents. (For congestion management, ITE published *A Toolbox for Alleviating Traffic Congestion*.[1] For traffic safety, ITE published *The Traffic Safety Toolbox*.[2]) This chapter provides a toolbox of traffic calming measures. For reasons indicated in chapter 1, traffic control devices and streetscape improvements are missing from this toolbox, as are education and enforcement activities that some communities classify as traffic calming. These other measures are defined and discussed in "Traffic Calming Impacts" (chapter 5).

A "Simple" Matter of Choosing the Right Tools

Any job is made easier with the right tools. It is an oversimplification, but not much of one, to say that traffic calming boils down to two things:

- Identifying the nature and extent of traffic-related problems on a given street or in a given area
- Selecting and implementing cost-effective measures for solving identified problems

If cut-through traffic is the problem (as determined by traffic counts), it suggests one set of measures. If speeding is the problem (as determined by speed measurements), it suggests another set. High collision rates, crime, or urban blight may suggest a third set.

This linear (problem → solution) view of traffic calming breaks down when it runs into legal, procedural, and political constraints. These are the subjects of "Legal Authority and Liability" (chapter 6), "Emergency Response and Other Agency Concerns" (chapter 7), and "Warrants, Project Selection Procedures, and Public Involvement" (chapter 8). Here the focus is on performance.

Effective and Ineffective Measures—San Diego, CA, Case Studies

Two case studies from San Diego—the Mira Mesa and Royal Highlands communities—illustrate effective and ineffective choices of traffic calming measures.

Collectors in Mira Mesa

Motorists use Mira Mesa streets to travel between inland and coastal communities (figure 3.1). There are few east-west arterials in that part of San Diego, and those few had become congested enough to cause motorists to divert to alternative routes. Five residential collectors had become problematic, affected not only by high traffic volumes but also by the excessive speeds that often accompany through traffic.

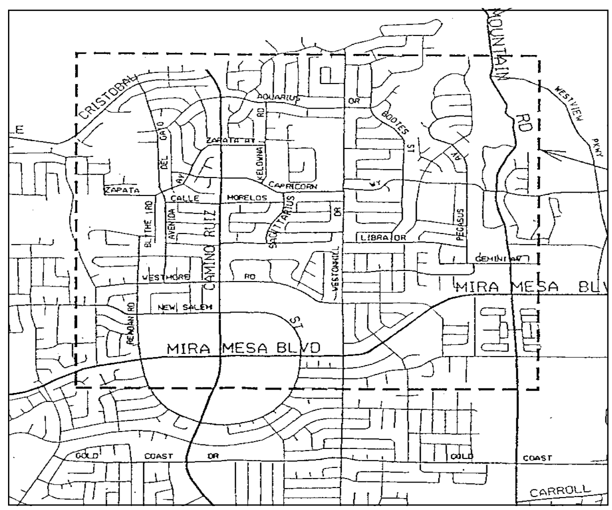


Figure 3.1. Street Network Inviting Cut-Through Traffic. (Mira Mesa, CA)

Source: Traffic Engineering Division, City of San Diego, CA.

At the request of the Mira Mesa Community Planning Committee, the city first tried peak-hour turn restrictions to discourage shortcutting. The restrictions did not work. Motorists found ways to circumvent them through U-turns and other maneuvers.

The city then installed speed humps. The hump profile chosen was the 12-foot parabolic hump (described later in this chapter). ITE guidelines suggest that these humps be used only on local streets, and not be used on primary emergency response routes or bus routes.[3] One or more of the ITE guidelines were violated on each collector treated with 12-foot speed humps (table 3.1).

The humps were successful in the limited sense of reducing through traffic on four collectors and reducing vehicle speeds on all five (table 3.2). They were not successful in a more general sense, however, because new problems were created. Fire response times were degraded by the treatment of Capicorn Way (see chapter 7). Traffic was diverted from collectors to parallel local streets that were less well designed to deal with it. The one local street for which before-and-after data were available experienced a 34 percent rise in traffic volume and a 9 percent increase in its 85th percentile speed (the speed below which 85 percent of vehicles travel).

Local Streets in Royal Highlands

The Royal Highlands neighborhood, sandwiched between two arterials and a freeway in San Diego, also had a cut-through traffic problem (see figure 3.2). Traffic would cut through the neighborhood on one of four local residential streets. The first attempt at traffic calming was the installation of 12-foot speed humps. While closely spaced and severe in profile, the humps were not sufficient to counter the strong incentive to cut through the neighborhood. The main effect of the humps was to divert traffic to the local street closest to the neighborhood's northern entry point, Dellwood Street (see table 3.3). The Dellwood route offered the fewest humps end-to-end.

Table 3.1. 12-foot Speed Hump Guidelines.

Use only where:

- Streets classified as "local"
- No more than two travel lanes or 40-foot pavement width
- Horizontal curve of 300-foot radius or more
- Vertical curve with adequate stopping sight distance
- Grade of 8 percent or less
- Posted speed limit of 30 mph or less
- No more than 5 percent long-wheelbase vehicles
- Not on primary emergency response route or bus route
- Majority of residents support

Source: ITE Traffic Engineering Council Speed Humps Task Force, *Guidelines for the Design and Application of Speed Humps—A Recommended Practice,* Institute of Transportation Engineers, Washington, DC, 1997, pp. 8–10.

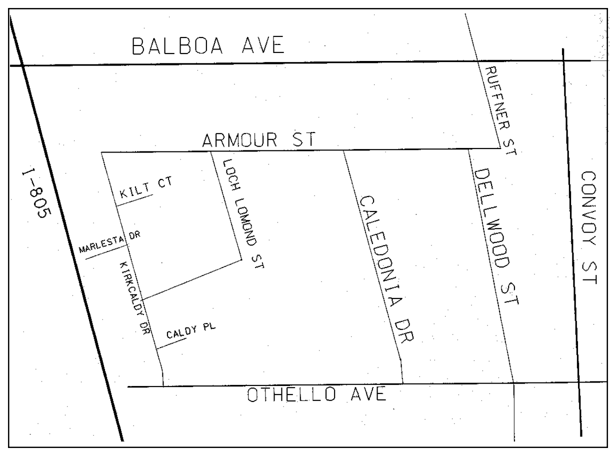


Figure 3.2. Street Network that Once Invited Cut-Through Traffic—Royal Highlands. (San Diego, CA)
Source: Traffic Engineering Division, City of San Diego, CA.

Table 3.2. Traffic on Collectors Before and After Speed Hump Installation. (Mira Mesa, CA)

Traffic-Calmed Collector	Daily Volume (vehicles per day)		85th Percentile Speed (miles per hour)	
	Before	After	Before	After
Aquarius Drive	5,940	3,250	38	25
Avenida Del Gato	2,960	1,250	38	25
Bootes Street	5,710	4,660	36	30
Capicorn Way (Camino Ruiz–Orion Way)	6,870	6,860	34	25
Capicorn Way (Orion Way–Black Mountain Road)	11,540	11,040	36	25
Libra Drive	5,580	2,660	38	27

Source: Traffic Engineering Division, "Mira Mesa Road Humps Analysis/Report," City of San Diego, CA, undated.

The second attempt at traffic calming was more successful. After closing the northern entry point at Armour Street (see figure 3.3), traffic volumes on all local streets fell below their initial levels (table 3.3). The neighborhood now has speed controls (which did not solve the cut-through problem) and a volume control (which apparently was effective).

Measures Defined and Illustrated

Although most traffic calming measures have some effect on both volume and speed, they are usually classified according to their dominant effect. Full and half street closures, diverters of various types, median barriers, and forced turn islands are classified as *volume control measures*. Their primary purpose is to discourage or eliminate through traffic.

Speed humps, speed tables, raised intersections, traffic circles, chicanes, chokers, lateral shifts, and realigned intersections are classified as *speed control measures*. Their primary purpose is to slow traffic.

The pros and cons of different traffic calming measures have been cited in many reports and manuals.[4] These generalized assessments have limited relevance to specific problem streets, each being unique. See, for example, table 3.4. Rather than repeating or attempting to refine earlier assessments, this report will focus on four specific areas:

- Beginning to standardize traffic calming nomenclature
- Presenting photos of exemplary measures for illustrative purposes
- Enumerating measures used in the most innovative U.S. programs
- Identifying trends in the choice of measures as a guide to future practice

Volume Control Measures

Full street closures are barriers placed across a street to close the street completely to through traffic, usually leaving only sidewalks or bicycle paths open. They are also called *cul-de-sacs* or *dead ends*. The barriers may consist of landscaped islands, walls, gates, side-by-side bollards, or

12-foot Speed Humps

Street Closure

Figure 3.3. Traffic Calming Measures in Royal Highlands. (San Diego, CA)

Table 3.3. Traffic Before Humps, After Humps, and After Closure—Royal Highlands. (San Diego, CA)

	Vehicles Per Day		
	Before Speed Humps	**After Speed Humps**	**After Street Closure**
Armour Street	525	350	280
Caledonia Street	215	240	210
Dellwood Street	1,065	1,260	370
Kirkcaldy Street	1,350	820	260
Lochlomond Street	140	180	90
Total traffic within neighborhood	3,295	2,850	1,210
% change in total traffic	base	–14%	– 63%

Source: Traffic Engineering Division, City of San Diego, CA.

Table 3.4. Generalized Assessment of Traffic Calming Measures. (Phoenix, AZ)

Traffic Management Device	Traffic Reduction	Speed Reduction	Noise and Pollution	Safety	Traffic Access Restrictions	Emergency Vehicle Access	Maintenance Problems	Level of Violation	Cost
Speed Humps	Possible	Limited	Increase Noise	No Documented Problems	None	Minor Problems	None	Not Applicable	Low
STOP Signs	Unlikely	None	Increase	Unclear	None	No Problems	None	Potentially High	Low
NO LEFT/RIGHT TURN Signs	Yes	None	Decrease	Improved	No Turn(s)	No Problems	Vandalism	Potentially High	Low
One-Way Street	Yes	None	Decrease	Improved	One Direction	One Direction	None	Low	Low
Chokers	Unlikely	Minor	No Change	Improved For Pedestrians	None	No Problems	Trucks Hit Curbs	Not Applicable	Moderate
Traffic Circle	Possible	Likely	No Change	Unclear	None	Some Constraint	Vandalism	Low	Moderate
Median Barrier	Yes	None	Decrease	Improved	Right Turn Only	Minor Constraint	None	Low	Moderate
Forced Turn Channelization	Yes	Possible	Decrease	Improved	Some	Minor Constraint	Vandalism	Potentially High	Moderate
Semi-Diverter	Yes	Likely	Decrease	Improved	One Direction	Minor Constraint	Vandalism	Potentially High	Moderate
Diagonal Diverters	Yes	Likely	Decrease	Improved	Thru Traffic	Some Constraint	Vandalism	Low	Moderate
Cul-de-Sac	Yes	Likely	Decrease	Improved	Total	Some Constraint	Vandalism	Low	High

Source: Street Transportation Division, City of Phoenix, AZ.

any other obstructions that leave an opening smaller than the width of a passenger car.

Street closures are the most commonly used cure for cut-through traffic. They are also the most controversial.[5] Table 3.5 summarizes street closure policies of featured communities. Nearly all oppose closures in principle. Some no longer permit street closures, or permit them only after other measures have failed. Other communities have set up procedural barriers to discourage street closures. All featured communities worry about the effects of closures on emergency response, street network connectivity and capacity, and parallel local streets that carry diverted traffic. Yet nearly all featured communities can cite a case or two where a street was closed, as a last resort, and it was justified.

Two examples illustrate the potential problem associated with overuse of street closures. West Palm Beach, FL, was closing streets at such a rate in the Old Northwood neighborhood that the connectivity of the street network was threatened. A moratorium was placed on closures, and a neighborhood-wide plan of traffic circles, neckdowns, chokers, and speed humps was instead put in place for the remainder of the Old Northwood neighborhood and the neighborhood to the north, Northboro Park (see figure 3.4).

Ft. Lauderdale, FL, undertook numerous full street closures in the mid 1990's. The extent of the street closures was controversial enough for the city to now require two public hearings and a 65 percent resident approval rating for any measure that diverts traffic (but not for those that merely slow it down). It has been 4 years since Ft. Lauderdale's last permanent street closure. The only closures since then have been temporary measures for crime prevention (see figure 3.5).

Half closures are barriers that block travel in one direction for a short distance on otherwise two-way streets. They are also sometimes called *partial closures* or *one-way closures*. When two half closures are placed across from one another at an intersection, the result is a *semi-diverter*.

Half closures are the most common volume control measure after full street closures. Half closures are often used in sets to make travel through neighborhoods with gridded streets circuitous rather than direct. That is, half closures are not lined up along a border, which would preclude through movement, but instead are staggered, which leaves through movement possible but less attrac-

Table 3.5. Sample Street Closure Policies and Procedures.

Community	Policies and Procedures
Austin, TX	Closures discouraged but not ruled out as part of neighborhood-wide plans
Bellevue, WA	Closures considered only on residential streets with 20 percent or more cut-through traffic and at least 3,000 vehicles per day
Berkeley, CA	Closures discouraged where other measures will address problem—closures and other traffic diversion schemes must be referred by city council or city manager
Boulder, CO	Closures discouraged but listed among program options—planning board policy against additional closures due to effect on network connectivity
Charlotte, NC	Closures not listed among program options—barriers occasionally erected without abandoning street right-of-way
Dayton, OH	Neutral
Eugene, OR	Special study required for closures and other volume control measures
Ft. Lauderdale, FL	Permanent closures discouraged—two public hearings and super-majority of resident support required—temporary closures allowed for crime prevention
Gainesville, FL	Closures discouraged
Gwinnett County, GA	Neutral
Howard County, MD	Unofficial ban on street closures
Montgomery County, MD	Closures difficult to effect under county code
Phoenix, AZ	Closures discouraged but listed among program options—street abandonment process inhibited by a filing fee, public hearing, and likelihood of no action—residents redirected to other options
Portland, OR	Closures discouraged but listed among program options
San Diego, CA	Closures discouraged
San Jose, CA	Closures discouraged
Sarasota, FL	Closures not listed among program options—considered only as a last resort, if an alternative route exists
Seattle, WA	Closures discouraged but listed among program options—larger impact area from which petition signatures must be obtained for volume controls than for speed controls
Tallahassee, FL	Closures discouraged—no closures planned—no formal policy
West Palm Beach, FL	Moratorium in effect

Source: Interviews with staffs of traffic calming programs.

Figure 3.4. Early Closure and Later Traffic Circle. (West Palm Beach, FL)

Figure 3.5. Full Street Closure for Crime Prevention. (Ft. Lauderdale, FL)

tive than alternative routes. While usually located at intersections, half closures are sometimes located internal to blocks between residential and nonresidential land uses. Placing them there has the advantage of buffering residences from business traffic. It is analogous to placing street closures between residences and businesses, a common practice. However, a half closure at midblock is far less effective than a full closure at midblock. If blocked from entering a street entirely, drivers tend to comply with the closure. Once on a street, the strong tendency is to go around a short barrier. This has been a particular problem in Seattle, which has many half closures at midblock. According to a Seattle police officer, drivers violate half closures even when they see police cars (see figure 3.6).

Figure 3.6. Half Closure Requiring Diligent Enforcement. (Seattle, WA)

Ft. Lauderdale, FL

Ft. Lauderdale, FL

Sacramento, CA

Phoenix, AZ

Figure 3.7. Half Closures Designed for Compliance.

Wherever half closures are located, at an intersection or midblock, effective design is the key to compliance (see figure 3.7). When drivers routinely went around narrow barriers at its intersections, Ft. Lauderdale built a half closure that extended 30 feet upstream of an intersection. Drivers are reluctant to travel in the wrong direction for such a distance. Ft. Lauderdale also began to angle its barriers for right turns out of the neighborhood, making turns into the neighborhood awkward and threatening. Half closures elsewhere have been designed with opposing center islands to make through movements more awkward, as well as with extensive signage and markings to make prohibited movements more apparent.

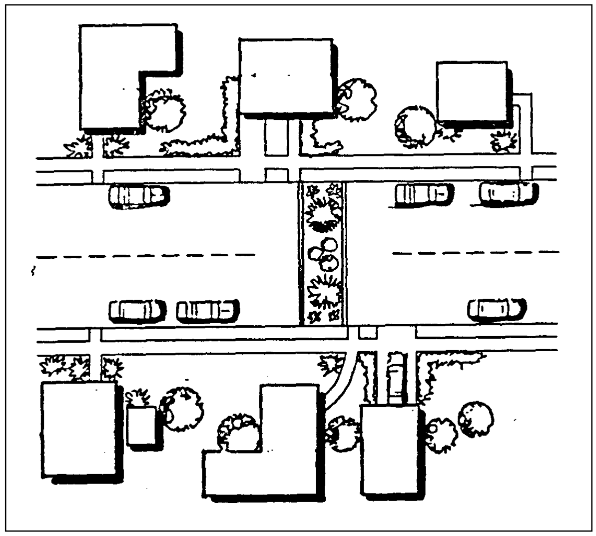
Other volume control measures are much less common. ***Diagonal diverters*** are barriers placed diagonally across an intersection, blocking through movement. They are also called *full diverters* or *diagonal road closures.* Like half closures, diagonal diverters are usually staggered to create circuitous routes through neighborhoods. ***Median barriers*** are raised islands located along the centerline of a street and continuing through an intersection so as to block through movement at a cross street. They are also referred to as *median diverters* or occasionally as *island diverters.* ***Forced turn islands*** are raised islands that block certain movements on approaches to an intersection. They are sometimes called *forced turn channelizations, pork chops,* or in their most common incarnation, *right turn islands.* Finally, there are a few unusual measures such as *star diverters* and *truncated diagonal diverters.*

Because of perennial concerns about traffic being diverted from streets that are calmed to parallel streets that are not, less restrictive forms of volume control are increasingly favored over the more restrictive full street closures. However, less restrictive forms are more easily violated, as when motorists drive around forced turn islands.

Gallery of Volume Control Measures

To help readers picture the various volume control measures, line drawings and photographs are provided on the following seven pages. The line drawings were adapted from the Boulder, CO, *Neighborhood Traffic Mitigation Program Toolkit*.[6] The photographs were chosen to illustrate a range of design options.

FULL CLOSURES
(cul-de-sacs, dead ends)



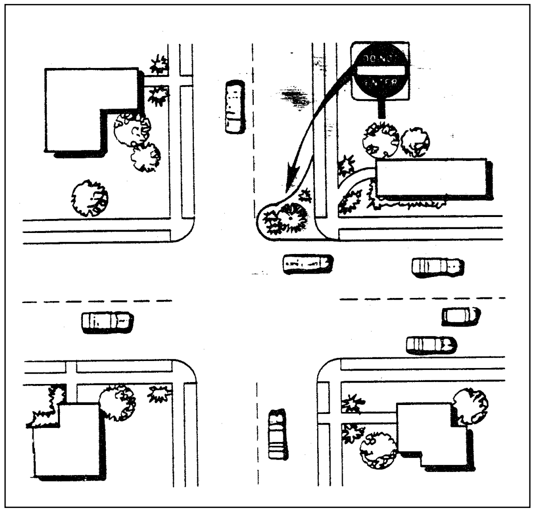
Berkeley, CA

Palo Alto, CA

Gainesville, FL

Coral Gables, FL

HALF CLOSURES
(partial closures, one-way closures)



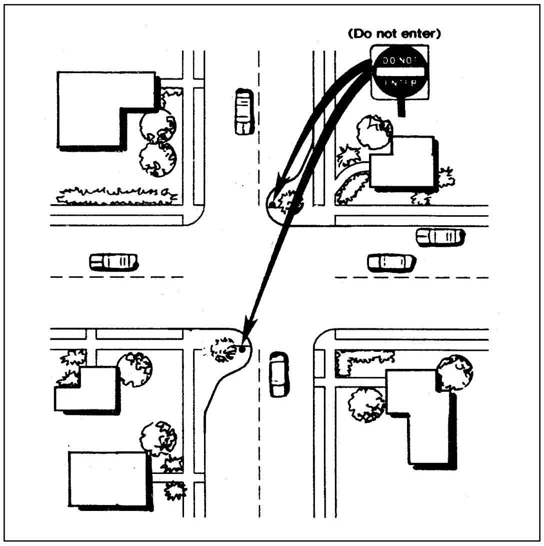
San Jose, CA

Bellevue, WA

Eugene, OR

Phoenix, AZ

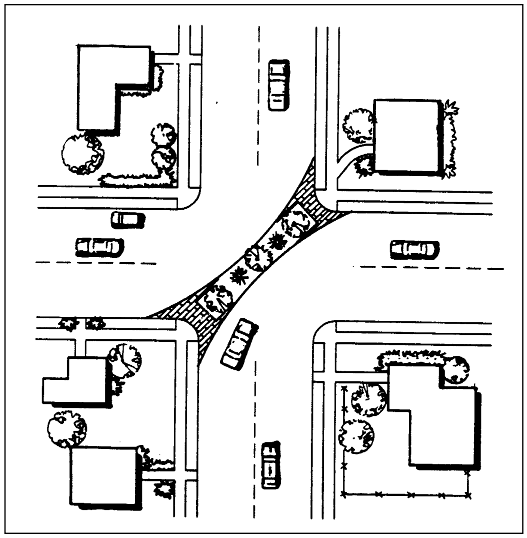
SEMI-DIVERTERS



Sarasota, FL

Gainesville, FL

DIAGONAL DIVERTERS
(full diverters, diagonal road closures)



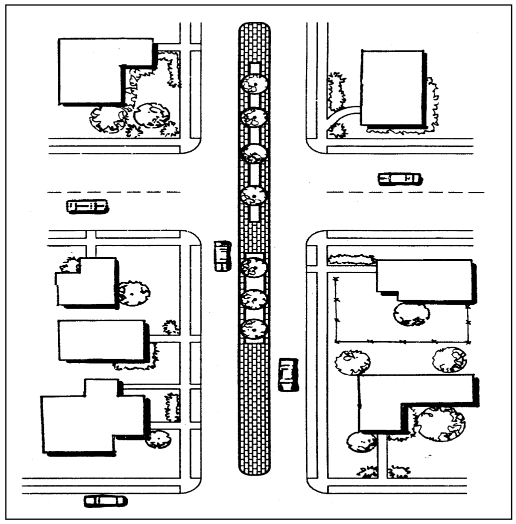
Ft. Lauderdale, FL

Boulder, CO

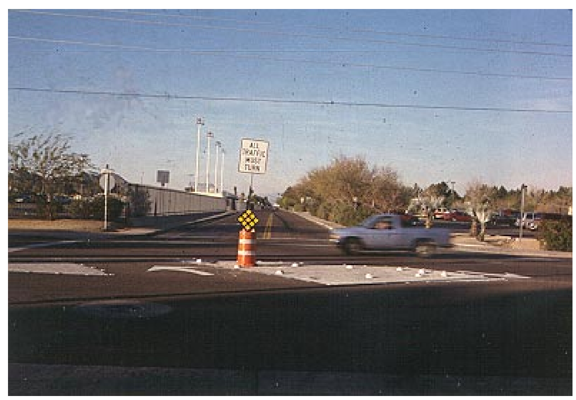
Berkeley, CA

Seattle, WA

MEDIAN BARRIERS
(median diverters, forced turn islands, island diverters)



San Diego, CA

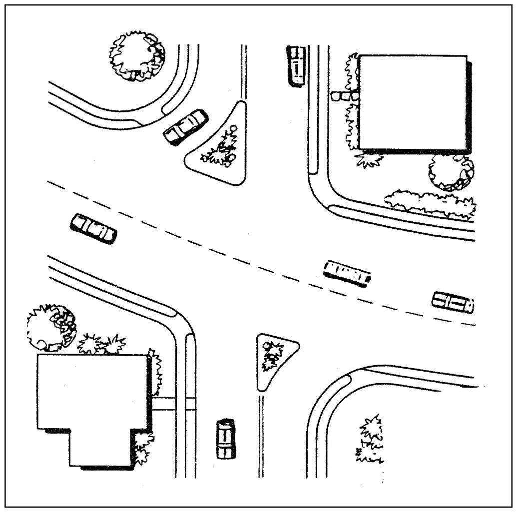


Phoenix, AZ

Montgomery County, MD

Berkeley, CA

FORCED TURN ISLANDS
(forced turn channelizations, pork chops, right turn islands)



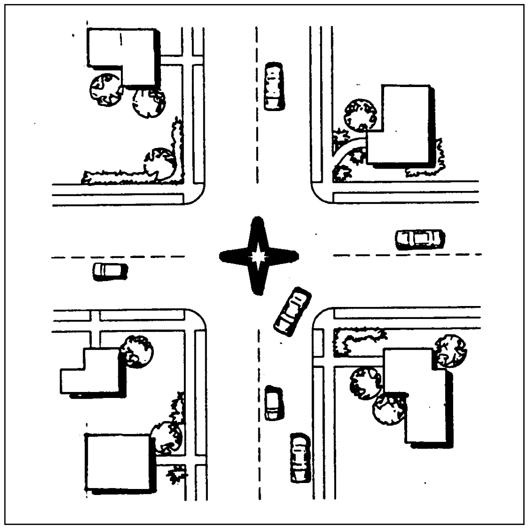
Orlando, FL

Phoenix, AZ

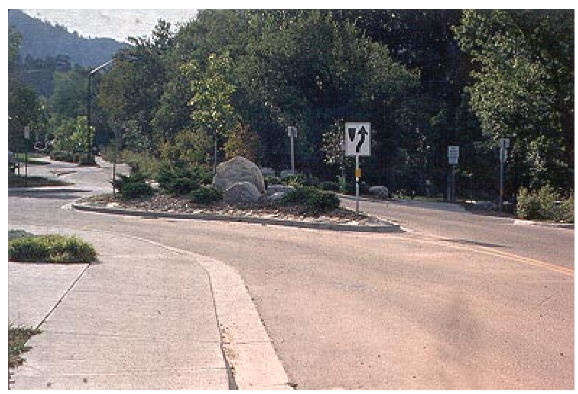
San Jose, CA

Montgomery County, MD

OTHER VOLUME CONTROL MEASURES
(various names and designs)



Star Diverter. (Seattle, WA)



One Way–Two Way. (Boulder, CO)

Truncated Diagonal Diverter. (Seattle, WA)

One Way–Two Way. (Montgomery County, MD)

Speed Control Measures

Speed control measures are of three types: *vertical measures*, which use forces of vertical acceleration to discourage speeding; *horizontal measures*, which use forces of lateral acceleration to discourage speeding; and *narrowings*, which use a psycho-perceptive sense of enclosure to discourage speeding. Because physical forces are more compelling, vertical and horizontal devices tend to be more effective in reducing speeds. Indeed, some traffic calming programs do not even classify narrowings that maintain standard lane widths in each direction as traffic calming measures (see figure 3.8). For example, curb extensions, which shorten pedestrian crossing distances, are often classified and funded as pedestrian improvements rather than traffic calming measures.

Vertical Measures

Speed humps are rounded raised areas placed across the road. They are also referred to as *road humps* and *undulations*. The Watts profile hump, developed and tested by Britain's Transport Research Laboratory, is the most common speed control measure in the United States. ITE has a recommended practice for the design and application of speed humps.[7] Its guidelines specify a speed hump that is 12 feet long (in the direction of travel), 3 to 4 inches high, and parabolic in shape, and that has a design speed of 15 to 20 mph. It is usually constructed with a taper on each side to allow unimpeded drainage between the hump and curb. In some European countries, the space between the hump and curb is wide enough to accommodate bicycles. In the United States, this space is typically kept narrower to discourage motorists from crossing a hump with one wheel on the hump and the other in the gutter.

"Yes" in Howard County, MD

"No" in Dayton, OH

Figure 3.8. Roadway Narrowings—Traffic Calming Measures?

The 12-foot length guarantees that a passenger vehicle cannot straddle a hump, thereby reducing the likelihood of bottoming out. While humps as short as 6 to 8 feet have been tested, they tend to function more like speed bumps. Bumps produce their greatest driver discomfort at relatively low speeds. At higher speeds, the suspension quickly absorbs all impact before the vehicle body has time to react. Also at higher speeds, damage to the suspension or loss of control can result (not a problem with common humps). See "Legal Authority and Liability" (chapter 6) for more on humps versus bumps.

In a survey by the *Urban Transportation Monitor*, speed humps were rated both the "best" traffic control technique and the "worst," depending on who was responding.[8] They were rated best for their relatively low cost and their effectiveness in reducing vehicle operating speed (typically by 5 to 10 mph, if properly spaced). They were rated worst for various reasons, including appearance (see figures 3.9 and 3.10). Orlando, FL, has removed humps from two streets, and no longer considers them an option. Their appearance was believed to detract from the value of residential property. Appearance of humps can be improved with landscaped street edges and moderate marking and signage. With colored and stamped asphalt, humps may even improve on the appearance of uninterrrupted asphalt. The issue of aesthetics is covered in "Engineering and Aesthetic Issues" (chapter 4).

Liability is another issue. A 1986 survey of 407 urban traffic agencies found legal liability to be their greatest concern about speed humps.[9] Lee County and Tampa, FL, have stopped installing speed humps because of liability concerns. Until recently, Gainesville, FL, avoided speed humps at the advice of its city attorney. As shown in chapter 6, no special liability attaches to speed humps.

The rough ride caused by the 4-inch-high, 12-foot-long humps is another issue. Most communities now limit the height to 3 to 3.5 inches. The lower height is less abrupt. Several communities require an extraordinary level

Figure 3.9. Speed Hump. (Ft. Lauderdale, FL)

Figure 3.10. Speed Hump. (Austin, TX)

of neighborhood support before they will consider humps. Sacramento, CA, for example, requires majority support for other traffic calming measures, but a super-majority (two-thirds) for speed humps. The rough ride has an upside—effectiveness in slowing traffic.

The 12-foot hump is one of many hump profiles, varying in height, length, and shape. In 1992 Portland, OR, conducted field tests of different profiles. The 12-foot hump was judged too abrupt. Portland opted instead for 14-foot parabolic humps and 22-foot, flat-topped humps (called speed tables in this report).

Other profiles include a 12-foot hump with a sinusoidal rise being tested in Toronto, ON (see figure 3.11); a 30-foot rounded hump with a textured surface in Beaverton, OR; a 22-foot parabolic hump in Ft. Lauderdale; and a 10-foot rounded hump in New Castle County, DE (all of which typically have heights ranging between 3 and 3.5 inches). The sinusoidal design has long been used in Continental Europe, and the *Canadian Guide to Neighbourhood Traffic Calming* recommends this profile. At least one source expects a proliferation of hump profiles in the United States.[10]

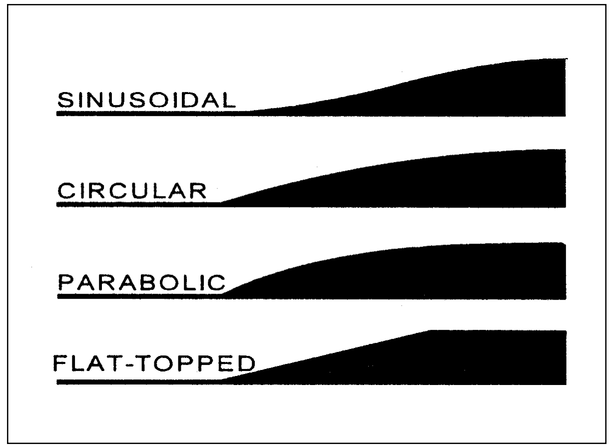


Figure 3.11. Different Hump Profiles.

Source: City of Toronto, "Installation of Speed Humps on City Streets," Toronto, ON, Canada, July 1997.

Speed tables are essentially flat-topped speed humps often constructed with brick or other textured materials on the flat section. They are also called *trapezoidal humps, speed platforms,* and, if marked for pedestrian crossing, *raised crosswalks* or *raised crossings.* Speed tables are typically long enough for the entire wheelbase of a passenger car to rest on top. Their long flat fields, plus ramps that are sometimes more gently sloped than speed humps, give speed tables higher design speeds than humps. The brick or other textured materials improve the appearance of speed tables, draw attention to them, and may enhance safety and speed reduction (a theory, as yet unproven).

The most common type of speed table is the one designed by Seminole County, FL (see figure 3.12). The Seminole County table is 3 to 4 inches high and 22 feet long in the direction of travel, with 6-foot ramps at the ends and a 10-foot field on top. It has an 85th percentile speed of 25 to 30 mph, is less jarring than the standard

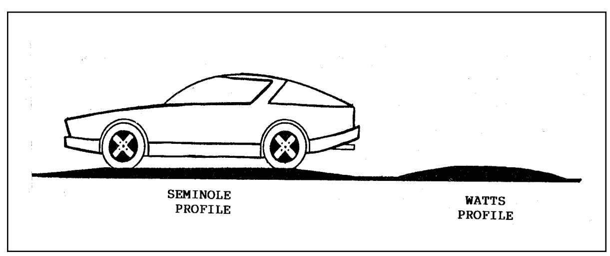


Figure 3.12. Seminole 22-foot Speed Table versus Watts 12-foot Speed Hump.

Source: D.A. Nicodemus, "Safe and Effective Roadway Humps —The Seminole County Profile," *Compendium of Technical Papers 61st Annual Meeting*, Institute of Transportation Engineers, Washington, DC, 1991, pp. 102-105.

12-foot hump, and is considered to be better proportioned for aesthetics.

In Florida, there seems to be a shift from 12-foot humps to 22-foot speed tables. Tallahassee has installed only 22-foot speed tables. Naples is using only this profile with a brick paver top and concrete ramps. Sarasota is so pleased with its speed table design, similar to that of Naples, that it has stopped building humps in favor of speed tables. Ft. Lauderdale now restricts 12-foot humps to streets carrying 500 to 3,000 vehicles per day, while 22-foot tables are currently used on streets carrying up to 6,000 vehicles per day.

Outside Florida, the same shift to speed tables is occurring. Among featured communities, Gwinnett County, GA, has always used only 22-foot tables. Austin, TX, now uses only 22-foot tables after experience with both tables and standard humps. Howard County, MD, favors Seminole County tables, except where limited sight distances demand lower speeds.

The shift from humps to longer speed tables is, in part, to accommodate other public agencies. Austin, Gwinnett County, and Portland are responding to the preferences of their fire departments (see chapter 7, "Emergency Response and Other Agency Concerns"). The shift could also represent attempts to move beyond local streets to collectors and even arterials, where volumes and speeds are too high for standard humps. ITE guidelines limit 12-foot humps to local streets with posted speed limits of 30 mph or less. In Portland, only 22-foot tables (with a 3-inch height) are even considered for use on collector streets.

A third reason for the shift to speed tables is their ability, where appropriately marked and extended from curb to curb, to serve as raised crosswalks. Raised crosswalks bring the street up to sidewalk level, making it pedestrian territory. Slower traffic and better pedestrian visibility add to pedestrian safety. Standard humps are too rounded and too sloped to perform this function. Speed tables are used this way in Bellevue, WA; Boulder; Eugene, OR; Montgomery County, MD; Howard County; and Tallahassee; plus several places not featured in this report.

Lest speed tables appear too good to be true, two drawbacks must be acknowledged. Speed tables are more expensive than standard humps, by about $500 per table when constructed of asphalt. Brickwork, stamped asphalt, concrete ramps, concrete headers, and other add-ons to plain asphalt further inflate the price. Sarasota's speed tables, with concrete pavers and concrete ramps, run close to $10,000 apiece. By using asphalt ramps and stamped asphalt fields, Sarasota hopes to maintain the same look at half the price (see figures 3.13 and 3.14).

Figure 3.13. $10,000 Speed Table. (Sarasota, FL)

$1,700

$2,400

Figure 3.14. Plain (above) and Stamped (below) Asphalt Tables with Cost Estimates. (Charlotte, NC)

Also, 22-foot speed tables may be too gentle to solve certain speeding problems. This was the conclusion in Ft. Lauderdale, after experimentation with a 22-foot speed table (with 3-inch height) in one application. A third profile was subsequently developed, a hump as long as this speed table but with a 4-inch vertical rise and a roughly parabolic profile.

Like speed humps, speed tables have been designed to different specifications. Boulder has designed its speed tables with heights of 5 to 6 inches, ramps of 7.5 to 10 feet, and fields of 18 to 23 feet. By varying dimensions, Boulder is able to achieve a desired target speed for a given application. It can also better accommodate fire trucks with long wheelbases. To accommodate transit buses, Minneapolis, MN, has designed its speed tables with 6-foot ramps and 20-foot fields. (Geometric design is dealt with in chapter 4; emergency response, in chapter 7.)

Other *vertical* traffic calming measures include raised intersections, textured pavements, and several anomalies such as raised crosswalk headers and intersection jiggle bumps. *Raised intersections* are flat raised areas covering entire intersections, with ramps on all approaches and often with brick or other textured materials on the flat section (see figure 3.15). They are also called *raised junctions, intersection humps,* or *plateaus.* They usually rise to sidewalk level, or slightly below to provide a "lip" for the visually impaired. They make entire intersections, crosswalks and all, pedestrian territory. They are particularly useful in dense urban areas, where the loss of on-street parking associated with other traffic calming measures is considered unacceptable.

Textured pavements are roadway surfaces paved with brick, concrete pavers, stamped asphalt, or other surface materials that produce constant small changes in vertical alignment. Though including textured pavements among vertical features may appear a stretch to some readers, one need only observe travel speeds on old cobblestone and brick streets to appreciate the rationale (see figure 3.16). A noted limitation to textured pavements such as cobblestone is that they may present difficulties for pedestrians and bicycles, particularly in wet conditions.

Horizontal Measures

Horizontal measures achieve their speed reductions by forcing drivers around horizontal curves and by blocking long views of the road ahead. By far the most common horizontal measure is the traffic circle. *Traffic circles* are raised islands, placed in intersections, around which traffic circulates. They are sometimes called *intersection islands.* They are usually circular in shape and landscaped in their center islands, though not always. They are typically controlled by YIELD signs on all approaches.

Figure 3.15. Raised Intersection. (West Palm Beach, FL)

Charleston, SC

Gainesville, FL

Figure 3.16. Cobblestone and Brick Streets that Discourage Speeding.

Circles prevent drivers from speeding through intersections by impeding the straight-through movement (see figure 3.17) and forcing drivers to slow down to yield. Drivers must first turn to the right, then to the left as they pass the circle, and then back to the right again after clearing the circle.

While not as controversial as speed humps, traffic circles also raise concerns. One is the inability of large vehicles to turn around small-radius curves. One solution used in the featured communities is to make circles partially or wholly mountable by adding outer rings (called truck aprons), building conical-shaped center islands (with "lips"), or paving over the tops of islands with concrete or asphalt (as in figure 3.18). Alternatively, center islands can be designed with cutouts for buses and trucks with wide turning radii (as in figure 3.19).

Figure 3.17. Blocking the Straight-Through Movement. (Tallahassee, FL)

Figure 3.18. Mountable Traffic Circles. (Bellevue, WA, and Howard County, MD)

Figure 3.19. Traffic Circles with Cutouts for Transit Vehicles. (Seattle,WA, and Dayton, OH)

Other concerns relate to bicyclists and pedestrians. The horizontal deflection that occurs at circles may force motor vehicles into pedestrian crossing areas on cross streets or into travel paths of cyclists on main streets. Where streets are designed with separate bicycle lanes, cyclists tend to get cut off or squeezed as these lanes merge with motor vehicle lanes at traffic circles. Signs instructing motorists to yield to merging cyclists are not always heeded. It is such concerns that cause some communities to avoid traffic circles in the vicinity of parks, schools, and other pedestrian and bicyclist traffic generators.

An organized cycling group in Boulder, a mecca of cycling activity, has taken positions on traffic calming measures. Circles rank low on their list of acceptable measures (see table 3.6). More than one-third of all near-accidents reported to Boulder's "Close Call Hotline" in 1996 were at traffic circles on a particular collector, Pine Street (shown in figure 3.20). Most of those near-accidents involved bicyclists.

Yet Boulder and Pine Street are not exactly typical of the national experience. Boulder is known for its political activism and bicycle advocacy. Pine Street has high volumes of both motor vehicle and bicycle traffic (about 9,000 motor vehicles per day and an unknown but large number of cyclists). On other streets outfitted with circles, in

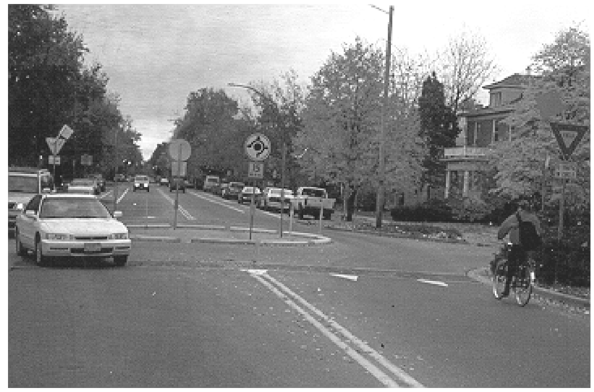


Figure 3.20. Pine Street, with Circles that Were Opposed by Bicyclists. (Boulder, CO)

Boulder and elsewhere, the occasional cyclist seems to comfortably coexist with low-volume, low-speed motor vehicle traffic.

Another concern about circles is their cost (see figure 3.21). Traffic circles generally cost several times as much as speed humps or speed tables. The added cost is due to the size of the features, use of concrete rather than asphalt, need for landscaping, and frequent need for new curb lines at corners. The cost can be brought more in line with

Table 3.6 Boulder Bicycle Commuters' Views on Traffic Calming Measures.

Measure	Views
Street closures	Mildly in favor as long as efficient through connections are maintained for bicyclists
Speed humps	Strongly in favor as long as cross sections are not sloped across bike lanes
Raised crosswalks (speed tables)	Strongly in favor as long as cross sections are not sloped across bike lanes and crosswalks are not textured
Raised intersections	Opposed due to their high cost
Traffic circles	Opposed due to their high cost, danger to merging cyclists, and confusion for motorists—somewhat tolerable at low traffic volumes
Neckdowns	Mildly in favor as long as cyclists are not forced to merge with cars
Medians (center islands)	No consensus—opposed if cyclists are crowded together with fast-moving cars
STOP signs	Mildly in favor
Speed radar trailer	Mildly in favor
Photo-radar	Strongly in favor

Source: Boulder Bicycle Commuter (BCC) meeting minutes, 2 October 1997.

costs of humps and tables by getting neighbors to supply landscape materials, using pre-cast or extruded curbs epoxied in place, and fitting circles to intersection dimensions. Also, the cost may not appear so excessive when compared with raised intersections. This is an appropriate comparison since both circles and raised intersections calm traffic on two streets at once, at the crossing point.

There are concerns about the effectiveness of traffic circles in controlling vehicle operating speeds. Seattle systematically monitors the performance of traffic circles through before-and-after speed studies. Midblock speeds seldom decline greatly, and occasionally even rise. Unlike humps and tables, circles are restricted to intersections, and intersections may be widely spaced. Their areas of influence tend to be limited to a couple hundred feet upstream and downstream of circles. The Seattle studies are a reminder that the main benefit of circles is not midblock speed reduction but intersection safety. Seattle has achieved a 95 percent reduction in intersection collisions (where most collisions occur) with traffic circles (see "Traffic Calming Impacts," chapter 5).

A final concern relating to circles was mentioned in three different featured communities. Where intersections are very tight, too tight for large vehicles to circulate counterclockwise around center islands, left turns must be made in front of center islands. Seattle was the first to allow this practice. Gainesville does as well now, and Dayton allows it selectively, adding a small sign to its circulating arrow (KEEP RIGHT) sign, exempting vehicles over 22 feet in length (see figure 3.22). With its hundreds of traffic circles and decades of experience, Seattle reports only one collision involving a left-turn maneuver. Yet such circles may create confusion for motorists when combined with large traffic circles or roundabouts that require counterclockwise circulation by all vehicles.

Related to neighborhood traffic circles are *roundabouts.* Like neighborhood traffic circles, roundabouts require traffic to circulate counterclockwise around a center island. But unlike circles, roundabouts are used on higher volume streets to allocate rights-of-way among competing movements. They are found primarily on arterial and collector streets, often substituting for traffic signals or all-way STOP signs. They are larger than neighborhood traffic circles and typically have raised splitter islands to channel approaching traffic to the right. Roundabouts are one of the alternatives for traffic calming major thoroughfares featured in "Beyond Residential Traffic Calming" (chapter 9).

There is some debate about whether roundabouts are a traffic calming measure or just another form of intersection control. Because they involve deflection at the entry point (which limits speed) and counterclockwise circulation around a center island (which also limits speed), they calm traffic. Roundabouts are to neighborhood traffic circles what long speed tables are to 12-foot humps—essentially the same geometric feature adapted to higher speeds and higher volumes. The stellar safety record of

$500

$75,000

Figure 3.21. Basic (above) and Enhanced (below) Circles with Cost Estimates. (Gainesville and Naples, FL)

Figure 3.22. KEEP RIGHT—EXCEPT VEHICLES OVER 22 FT. (Dayton, OH)

roundabouts is further evidence that roundabouts calm traffic.[11, 12]

Note that modern roundabouts are distinct from the large traffic circles and rotaries once common in the northeastern United States but out of favor since the 1950's (see figure 3.23). With a modern roundabout, approaching traffic must wait for a gap in the traffic flow before entering the intersection; in contrast, traffic enters an old-fashioned traffic circle at high speeds and then must merge and weave, a more hazardous operation. Also, a modern roundabout always requires yield-at-entry (yield-to-left), while some large traffic circles still operate on yield-to-entering traffic (yield-to-right) basis. Unless such circles are very large, providing long storage distances between successive entries and exits, they tend to "lock up" at high traffic volumes. Finally, modern roundabouts are more compact (e.g., 100-foot outside diameter for a single-lane roundabout) than old traffic circles and rotaries.

Other *horizontal* traffic calming measures include chicanes, realigned intersections, lateral shifts, and uncommon measures such as midblock deflector islands and half circles. *Chicanes* are curb extensions that alternate from one side of the street to the other, forming S-shaped curves. They are also referred to as *deviations, serpentines, reversing curves,* or *twists.* They are less common than circles, partly because of the high costs of curb realignment and landscaping. Also, unless well-designed, chicanes may still permit speeding by drivers cutting straight paths across the center line or testing their skills on the curves. European manuals recommend shifts in alignment of at least one-lane width, deflection angles of at least 45 degrees, and center islands to prevent drivers from taking a straight "racing line" through the feature (see figure 3.24).

A chicane-like effect can be achieved, at a fraction of the cost, by alternating on-street parking from one side of the street to the other. Parallel parking, angled parking, or a combination may be used. This treatment can be as simple as restriping to delineate parking bays. Or it can include landscaped curb extensions to beautify the street, screen unsightly parking, and create protected parking bays (see figure 3.25). Even this more expensive treatment, popular now in Main Street projects, involves less curb work than a standard chicane.

Figure 3.23. Modern Roundabout (left) versus Old-Fashioned Traffic Circle (right). (Dallas, TX, and Sarasota, FL)

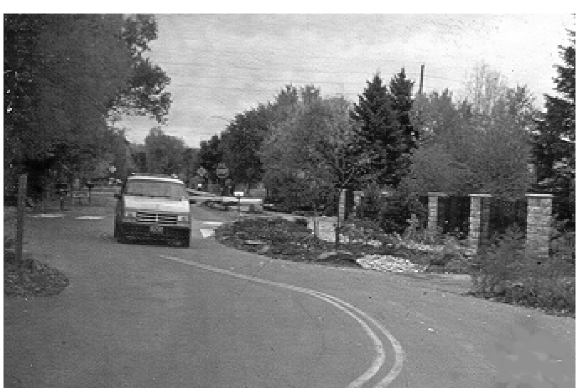


Figure 3.24. Driver Following a Straight "Racing Line" Through a Chicane. (Boulder, CO)

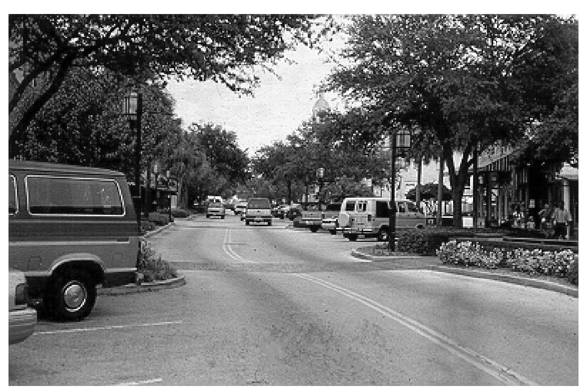


Figure 3.25. Chicane Created with Protected Parking Bays. (Fernadina Beach, FL)

Lateral shifts are curb extensions on otherwise straight streets that cause travel lanes to bend one way and then bend back the other way to the original direction of travel. They are occasionally referred to as *axial shifts, staggerings,* or *jogs.* Lateral shifts, with just the right degree of deflection, are one of the few measures that have been used on collectors or even arterials, where high traffic volumes and high posted speeds preclude more abrupt measures. They are a standard measure in Europe, and have been adopted by U.S. programs—such as those in Beaverton and West Palm Beach—that wish to calm major thoroughfares. Lateral shifts are like chicanes in that they can be created at moderate cost using protected parking bays. Center islands have been added to keep drivers from cutting straight paths across the center line (see figure 3.26). For significant speed reduction, lateral shifts of at least one-lane width and angles of deflection of at least 45 degrees have been used.

Realigned intersections are changes in alignment that convert T-intersections with straight approaches into curving streets that meet at right angles. A former "straight-through" movement along the top of the T becomes a turning movement. Realigned intersections are sometimes called *modified intersections.* While not commonly used, they are one of the few traffic calming measures for T-intersections, because the straight top of the T makes deflection difficult to achieve, as needed for traffic circles.

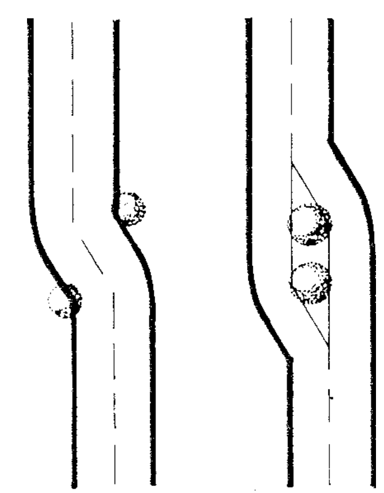


Figure 3.26. Lateral Shifts that Encourage (left) or Discourage (right) Shortcuts.

Source: Devon County Council, *Traffic Calming Guidelines*, Exeter, England, 1991, p. 37.

Narrowings

The final set of traffic calming measures uses roadway narrowing to achieve speed reductions. Narrowing is usually accompanied by plantings, street furniture, or other vertical elements to draw attention to the constriction and visually bound the space. *Neckdowns* are curb extensions at intersections that reduce roadway width curb to curb. They are sometimes called *nubs, bulbouts, knuckles,* or *intersection narrowings.* If coupled with crosswalks, they are referred to as *safe crosses.* Neckdowns are the most common type of street narrowing. As already noted, their effect on vehicle speeds is limited by the absence of pronounced vertical or horizontal deflection. Instead, their primary purpose is to "pedestrianize" intersections. They do this by shortening crossing distances for pedestrians and drawing attention to pedestrians via raised peninsulas (see figure 3.27). By tightening curb radii at the corner, the pedestrian crossing distance is reduced and the speeds of turning vehicles are reduced (see figures 3.28 and 3.29). This increases pedestrian comfort and safety at cross streets.

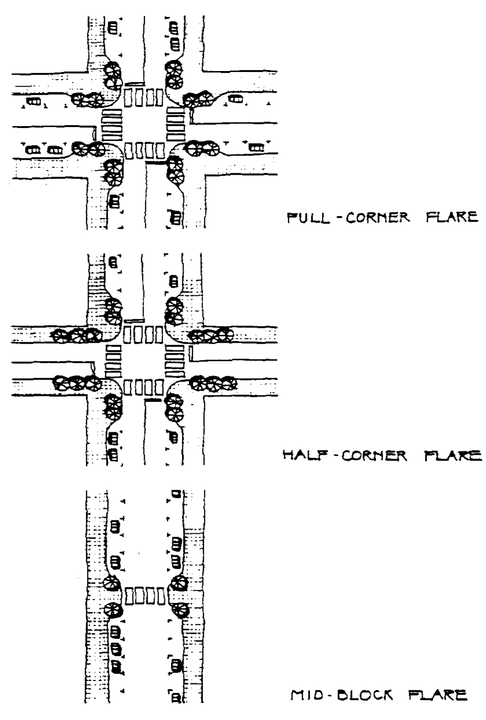
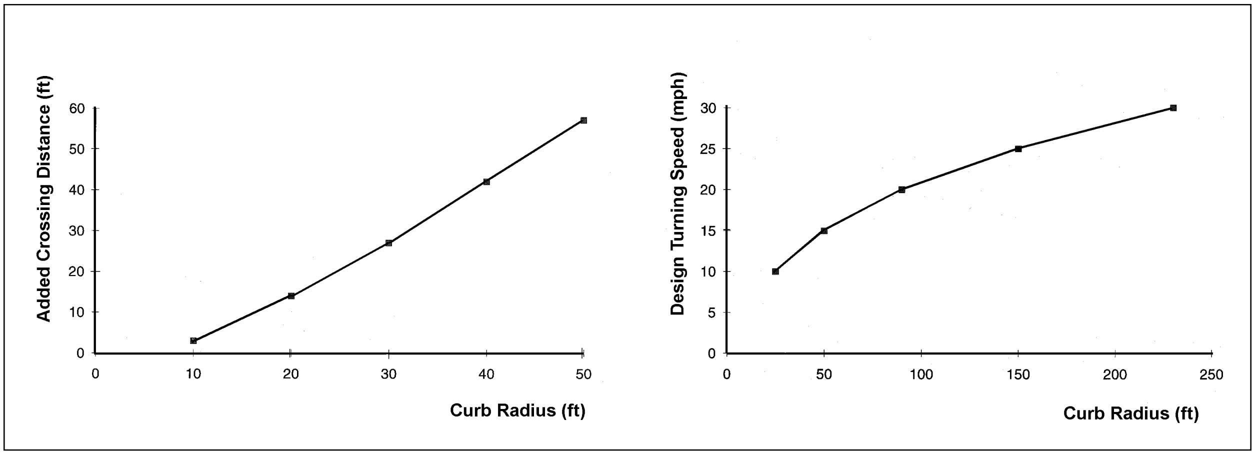


Figure 3.27. Sidewalks Flared to Create Safe Crosses.

Source: City of Toronto, *Urban Design Guidebook—Draft for Discussion*, Toronto, ON, Canada, 1995, p. 25.



Figures 3.28 and 3.29. Crossing Distance and Turning Speed versus Curb Radius.

Source: American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets*, Washington, DC, Copyright 1990 [1994 (metric)], p. 714 (left) and p. 197 (right). Used by permission.

Not surprisingly, the great majority of neckdowns are part of downtown redevelopment projects. Neckdowns go hand-in-hand with on-street parking bays and crosswalks for shoppers (in "safe cross" designs). In a few places, neckdowns are used in residential settings. Howard County, for example, has redesigned some large-radius corners to reduce crossing distances from as much as 66 feet to 30 feet or less. Very few problems have been reported with neckdowns other than the relatively high cost of curb work, drainage modifications, and, frequently, landscaping or decorative pavements.

Other types of narrowings include center island narrowings and chokers. *Center island narrowings* are raised islands located along the centerline of a street that narrow the travel lanes at that location. They are also called *midblock medians, median slow points,* or *median chokers.* They often are nicely landscaped to provide visual amenity and neighborhood identity. Placed at the entrance to a neighborhood, and often combined with textured pavement and monument signs, they are often called *gateways* (see figure 3.30).

Center islands have been used effectively on curves. Such an island was installed on a curve where motorists had a history of speeding in a Bellevue neighborhood (see figure 3.31). Center islands are also effective when placed just downstream of intersections. Turning vehicles cannot swing wide because islands channel them to the right. The Northboro Park neighborhood of West Palm Beach has a center island that was placed at a particular intersection because cut-through drivers were making right turns at high speeds (see figure 3.32).

Center islands may be more effective when they are short interruptions to an otherwise open street cross sec-

Figure 3.30. Gateway Treatment Providing Amenity and Identity. (Ft. Lauderdale, FL)

Figure 3.31. Center Island Discouraging Speeding on a Curve. (Bellevue, WA)

Figure 3.32. Center Island Discouraging High-Speed Turns. (West Palm Beach, FL)

Figure 3.33. Center Island Narrowing with a Break for a Crosswalk. (Montgomery County, MD)

tion, rather than long median islands that channelize traffic and separate opposing flows. The latter have been found to sometimes result in increased running speeds, while the former (perhaps because they appear as obstacles to approaching traffic) reportedly result in slower traffic.

Like other narrowings, center islands can help pedestrianize streets. Center islands provide a refuge for pedestrians crossing half way, waiting for a break in the traffic, and then crossing the other half. They are even more pedestrian-friendly when combined with crosswalks and divided to provide a crossing entirely at street level (as in figure 3.33). This minimizes the number of level changes for walkers, bicyclists, and wheelchair users.

Chokers are curb extensions at midblock that narrow a street by widening the sidewalk or planting strip. In different configurations, they are called *pinch points, midblock narrowings, midblock yield points,* or *constrictions.* If marked as crosswalks, they are also called *safe crosses.* Chokers can leave the street cross section with two lanes, albeit narrower lanes than before, or take it down to one lane. If the roadway is narrowed down to one lane, the lane may be parallel to the alignment or angled to the alignment. The former is called a *parallel choker,* the latter an *angled choker, twisted choker,* or *angle point*.

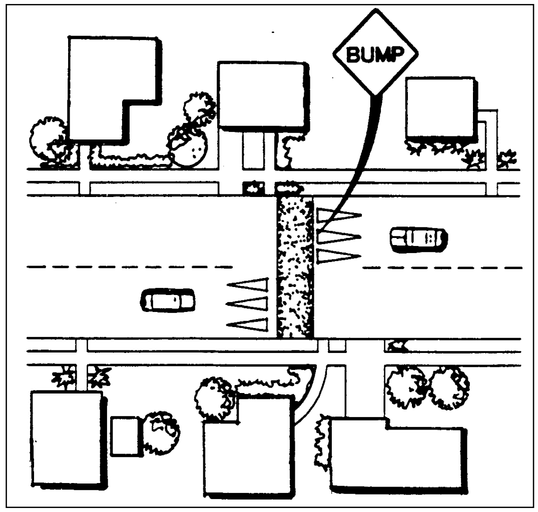
One-lane chokers are common in other countries; but in the United States, city attorneys, police chiefs, and residents have sometimes opposed them. They are perceived to be unsafe because opposing traffic is vying for space in a single lane. In most cases, this perception either discourages testing one-lane chokers or leads to removal of one-lane chokers after brief tests. In a few cases, it leads to a confusing compromise: a choker too wide for one vehicle but not wide enough for two. These one and one-half lane chokers leave opposing drivers uncertain whether they can squeeze through at the same time. One street in Sarasota, with one and one-half lane chokers, is being widened again to two full lanes and outfitted with speed tables instead (see figure 3.34).

Figure 3.34. Unsuccessful One and One-Half Lane Choker. (Sarasota, FL)

Gallery of Speed Control Measures

To help readers picture the various speed control measures just described, line drawings and photographs are provided on the following 16 pages. The line drawings were adapted from the city of Boulder's *Neighborhood Traffic Mitigation Program Toolkit*.[13] The photographs were chosen to illustrate a range of design options.

SPEED HUMPS
(road humps, undulations)



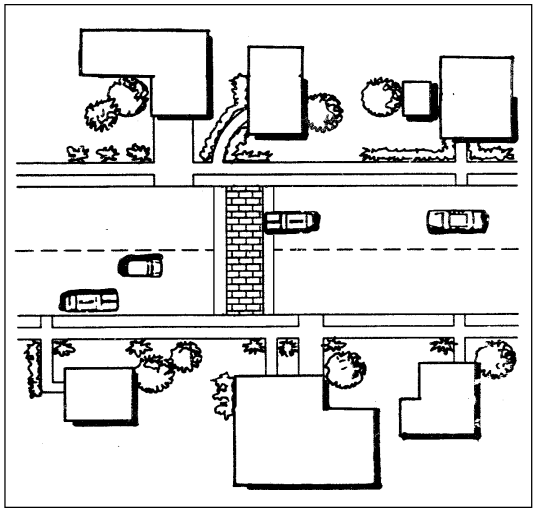
14-foot Hump. (Portland, OR)

12-foot Hump. (West Palm Beach, FL)

22-foot Hump. (Ft. Lauderdale, FL)

30-foot Hump. (Beaverton, OR)

SPEED TABLES
(trapezoidal humps, speed platforms)



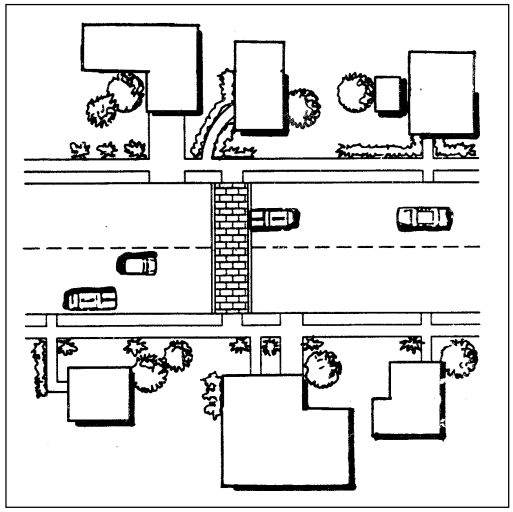
Bellevue, WA

Charlotte, NC

Portland, OR

Naples, FL

RAISED CROSSWALKS
(raised crossings, sidewalk extensions)



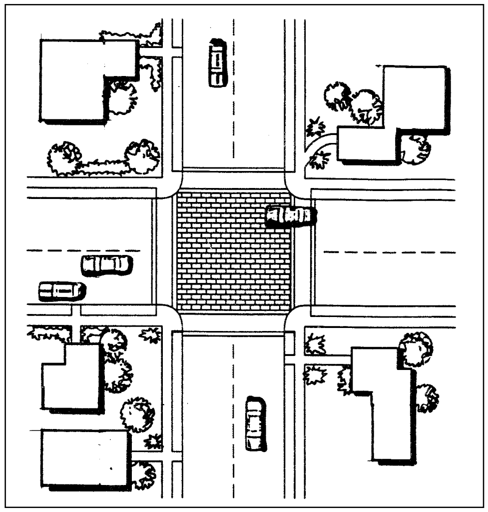
Beaverton, OR

Eugene, OR

Montgomery County, MD

Tallahassee, FL

RAISED INTERSECTIONS
(raised junctions, intersection humps, plateaus)



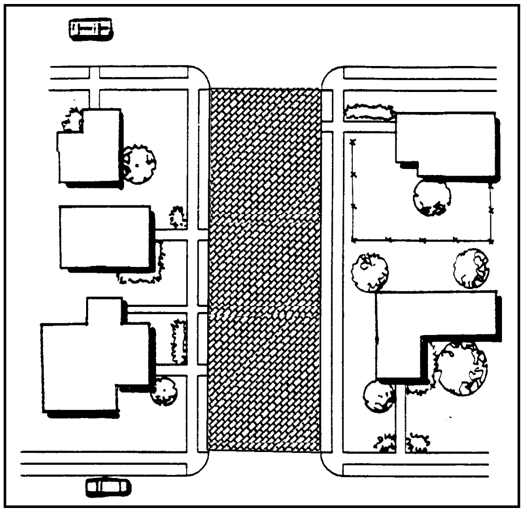
Beaverton, OR

Columbia, MD

Cambridge, MA

West Palm Beach, FL

TEXTURED PAVEMENTS



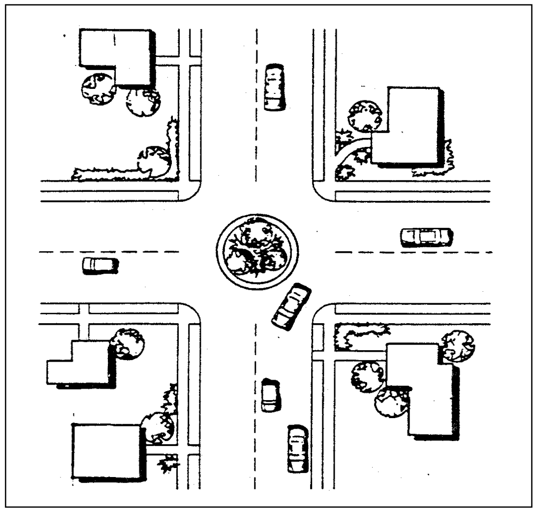
Gainesville, FL

Seattle, WA

Winter Park, FL

Montgomery County, MD

NEIGHBORHOOD TRAFFIC CIRCLES
(intersection islands)



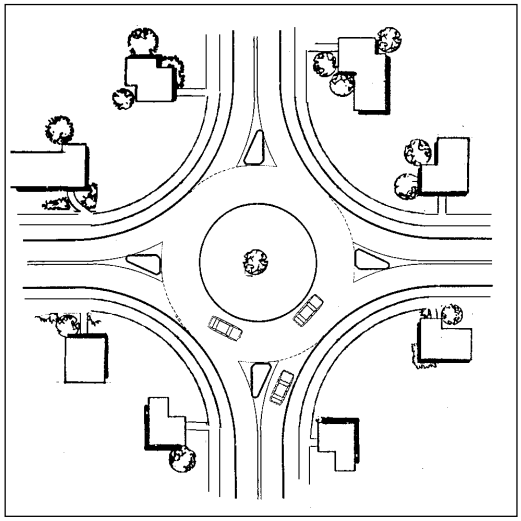
Boulder, CO

Portland, OR

San Jose, CA

Eugene, OR

ROUNDABOUTS
(rotaries)



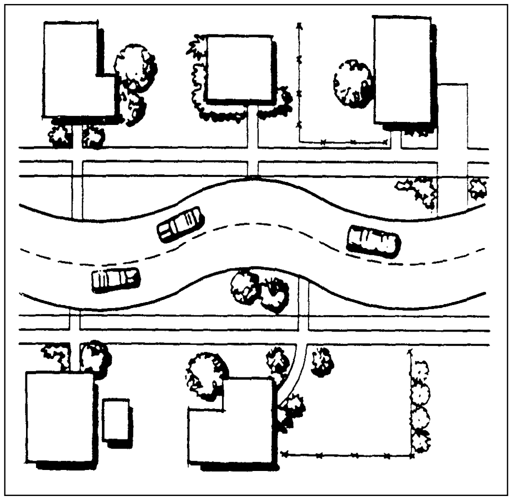
Beaverton, OR

Tallahassee, FL

West Palm Beach, FL

Las Vegas, NV

CHICANES
(deviations, serpentines, reversing curves, twists)



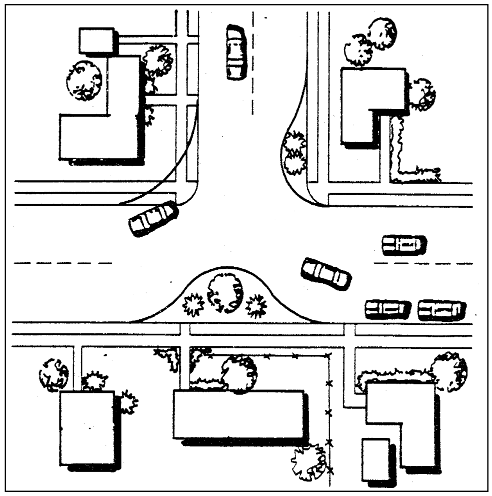
Seattle, WA

Alachua, FL

Tallahassee, FL

Montgomery County, MD

REALIGNED INTERSECTIONS
(modified intersections)



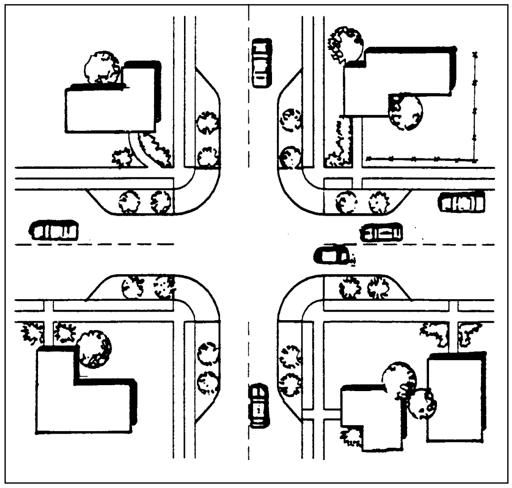
Boulder, CO

Deerfield Beach, FL

Seattle, WA

Tampa, FL

NECKDOWNS
(nubs, bulbouts, knuckles, intersection narrowings, corner bulges, safe crosses)



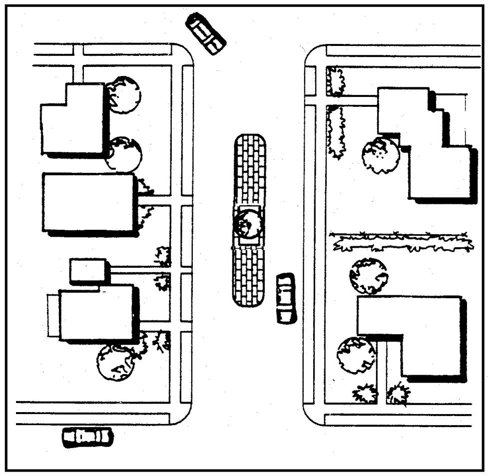
Eugene, OR

Cambridge, MA

Jacksonville, FL

Sarasota, FL

CENTER ISLAND NARROWINGS
(midblock medians, median slowpoints, median chokers)



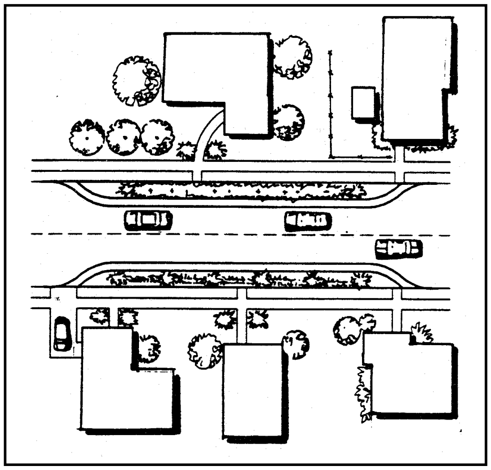
Montgomery County, MD

Tallahassee, FL

Portland, OR

Ft. Lauderdale, FL

CHOKERS
(pinch points, midblock narrowings, midblock yield points, constrictions)



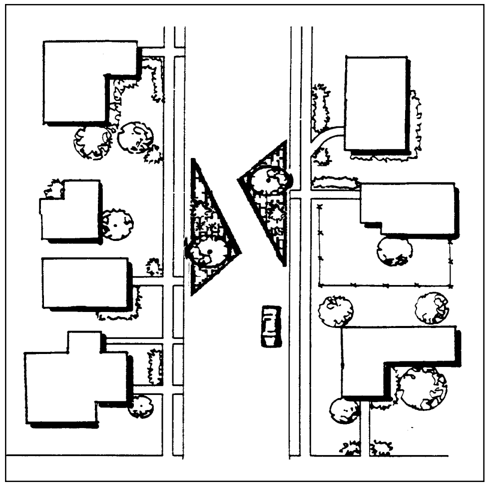
Winter Park, FL

Montgomery County, MD

Howard County, MD

Sarasota, FL

OTHER SPEED CONTROL MEASURES
(various names and designs)



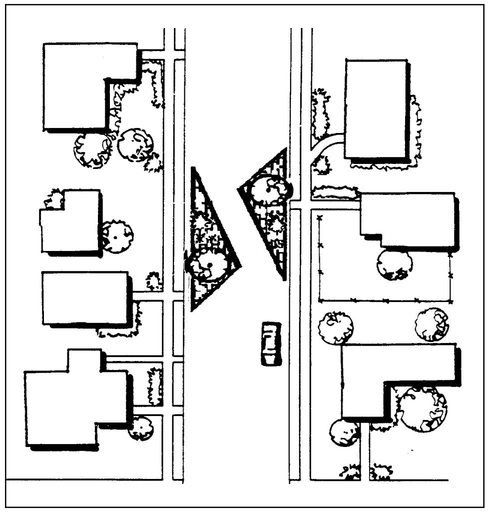
Intersection Jiggle Bumps. (Dayton, OH)

Hammerhead. (Beaverton, OR)

Angle Point. (Bellevue, WA)

Lateral Shift. (West Palm Beach, FL)

OTHER SPEED CONTROL MEASURES
(continued)



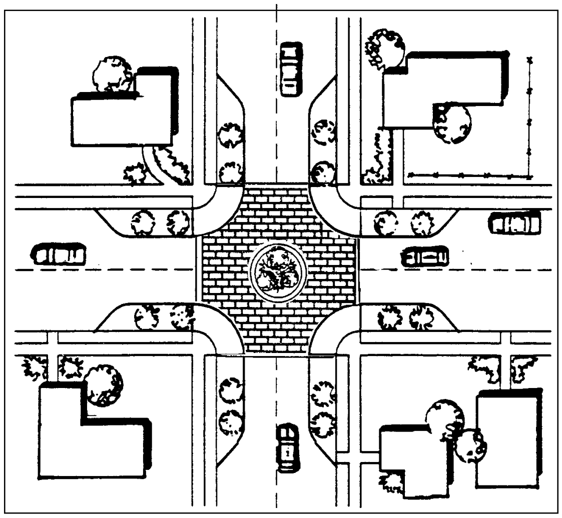
Midblock Deflector Island. (Eugene, OR)

Median Choker. (San Jose, CA)

Split Median. (Portland, OR)

Half Circle. (Williamsburg, VA)

COMBINED MEASURES



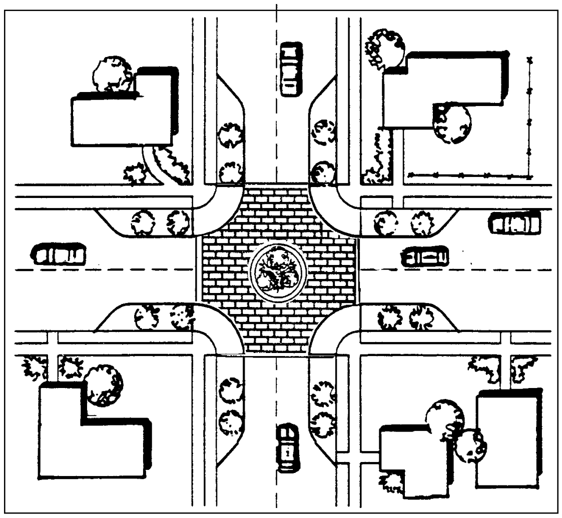
Speed Hump with Choker. (Bellevue, WA)

Diverter-Closure. (San Jose, CA)

Center Island with Neckdown. (Eugene, OR)

Raised Intersection with Neckdown. (Toronto, ON, Canada)

COMBINED MEASURES
(continued)



Center Island with Chokers. (Tallahassee, FL)

Center Island with Tables. (Boulder, CO)

Raised Crosswalk with Choker. (West Palm Beach, FL)

Center Island with Humps. (Montgomery County, MD)

Cost of Traffic Calming Measures

Table 3.7 provides sample cost estimates for various traffic calming measures as reported by selected jurisdictions. These estimates cannot replace detailed cost estimates using quantities and local unit prices for work items associated with specific projects. The cost of a street closure may range from a couple thousand dollars to install a guardrail to well over a hundred thousand dollars to develop a landscaped cul-de-sac. In this sense, there are no "standard" costs.

The estimates in table 3.7 may be useful in conceptual planning, as they show order-of-magnitude differences among measures. Speed humps, for example, are consistently the least expensive option and usually cost no more than a couple thousand dollars. Costs increase quickly when measures require landscaping, drainage improvements, or land acquisition.

Important Trends

This section describes trends in the design and application of traffic calming measures as information for use for future practice.

From Simple to Diverse Programs

One traffic manager from a surveyed community noted a curious pattern in the spread of traffic calming across the United States. Communities in the west started with horizontal speed control measures (principally circles) and eventually added vertical measures (principally humps) to their repertoire. Communities in the east did the opposite.

This pattern reflects growing diversification as traffic calming programs mature. Programs seem to start with one or two favorite measures. Through experience, the limitations of the favorites become apparent and other measures are tried. Streets are not all the same. Neighborhood preferences are not all the same. Traffic problems being addressed by traffic calming are not all the same.

By classifying measures in broad categories—such as "humps" and "closures/diverters"—national surveys have missed this trend toward diversification. Longer humps and speed tables were developed as substitutes for 12-foot humps. Realigned intersections were devised, in part, because less expensive options such as traffic circles were not effective at T-intersections.

The search for appropriate, customized treatments has led to clever combinations of traffic calming measures by the featured communities (see table 3.8). For example, Bellevue thought that a standard traffic circle would not control speeds on the top of a T-intersection, so it added curb extensions on the approaches to achieve some horizontal deflection (see figure 3.35). Beaverton thought a choker would not control speeds in the absence of opposing traffic, so it placed a speed table in the gap between the curb extensions (see figure 3.36). Boulder thought that a chicane would not control speeds sufficiently, so it placed a speed table on the tangent (see figure 3.37). Sarasota thought that a center island narrowing would not control speeds on a long tangent section, so it added a speed table alongside (see figure 3.38).

The search for appropriate treatments has also led to combinations of measures at different points along the same street. Streets with at least two measures, and some-

Table 3.7. Sample Cost Estimates for Individual Traffic Calming Measures.

Measure	Sample Cost Estimates ($)		
	Portland, OR (1997)	Sarasota, FL (1997)	Seattle, WA (1998)
Speed humps	2,000–2,500	2,000	2,000
Speed tables	—	2,500	—
Raised intersections	—	12,500	—
Traffic circles	10,000–15,000	3,500	6,000
Chicanes	—	—	14,000
Chokers	7,000–10,000	—	—
Center islands	8,000–15,000	5,000	—
Median barriers	10,000–20,000	—	—
Half closures	40,000	—	35,000
Diagonal diverters	—	—	85,000
Full closures	—	—	120,000

Sources: Staffs of the respective traffic calming programs.

Table 3.8. Combined Measures in Featured Communities.

Community	Measures
Bellevue, WA	Humps and chokers Circles and neckdowns
Boulder, CO	Tables and center islands Tables and chicanes
Eugene, OR	Center island and neckdown
Howard County, MD	Tables and chokers (planned)
Montgomery County, MD	Center islands and humps
Portland, OR	Center islands and chokers
San Jose, CA	Diverter and closure Forced turn island and half closure
Sarasota, FL	Center island and speed table
Seattle, WA	Circles and neckdowns Raised intersection and neckdown Circle and half closure
Tallahassee, FL	Center island and chokers
West Palm Beach, FL	Raised crosswalks and chokers Raised intersections and neckdowns

Figure 3.35. Traffic Circle Combined with Neckdowns. (Bellevue, WA)

Figure 3.36. Speed Table Combined with a Choker. (Beaverton, OR)

Figure 3.37. Speed Table Combined with a Chicane. (Boulder, CO)

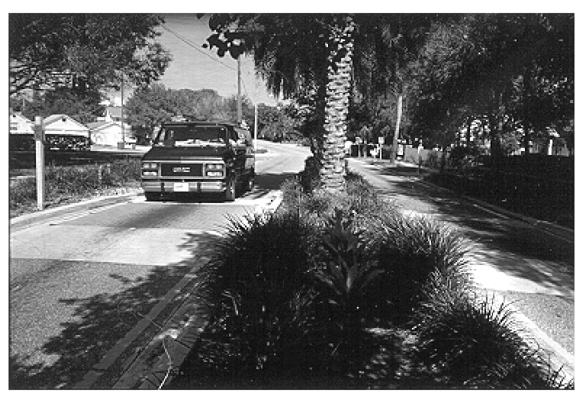


Figure 3.38. Speed Table Combined with a Center Island Narrowing. (Sarasota, FL)

times many more, along their lengths include Norwood Avenue in Boulder; Huntington Parkway in Montgomery County; Northwood Road in West Palm Beach; SW 155th Avenue in Beaverton; Berkshire Street in Cambridge, MA; and Balliol Street in Toronto. Milvia Street in Berkeley, CA, six blocks long, has a mix of neckdowns, chicanes, speed humps, and center islands (see figure 3.39).

From Volume to Speed Controls

Early traffic calming initiatives in the United States relied almost exclusively on volume control measures. The Seattle case study presented in chapter 2 is illustrative. Seattle's original demonstration made use of diagonal diverters, and nothing else. Only after the diverters proved unworkable, when paired on the same street, were two of the diverters replaced with less restrictive traffic circles. In Florida, early efforts were limited to street closures in West Palm Beach; to semi-diverters in Gainesville; and to full closures, half closures, and diagonal diverters in Ft. Lauderdale.

All of these communities, and others, now rely primarily on speed control measures. In places with traditional street grids, like Seattle, there is justified concern about diversion of traffic to parallel local streets. While some diversion often accompanies speed control measures, it is not their primary purpose.

On NW 55th Street in Seattle, a cut-through problem was initially addressed with a street closure. When residents of parallel local streets complained of diverted traffic, the closure was replaced by a severe speed control measure, but a speed control measure nonetheless. Installation of one-lane chicanes on NW 55th Street (and concurrently on NW 56th Street) led to some diversion to parallel streets. However, the effect of the chicanes was to balance traffic volumes somewhat across parallel local streets (see figure 3.40).

In places with curvilinear street networks, such as Seattle's neighbor Bellevue, there is usually little need for volume controls. Branching street hierarchies ending in cul-de-sacs keep cut-through traffic off local streets. Yet, even in such places, speeding can be a problem. Residential subcollectors and collectors, in particular, are long enough, straight enough, and wide enough to accommodate excessive speeds in many cases, thereby resulting in requests for speed control measures (see figure 3.41).

On 128th Avenue NE in Bellevue, a half closure was replaced by a one-lane angled choker (angle point). Traffic volumes are actually lower with the speed control measure (the choker) than with the earlier volume control measure (the half closure) because the latter was violated so frequently (see table 3.9).

Figure 3.39. Milvia "Slow" Street. (Berkeley, CA)

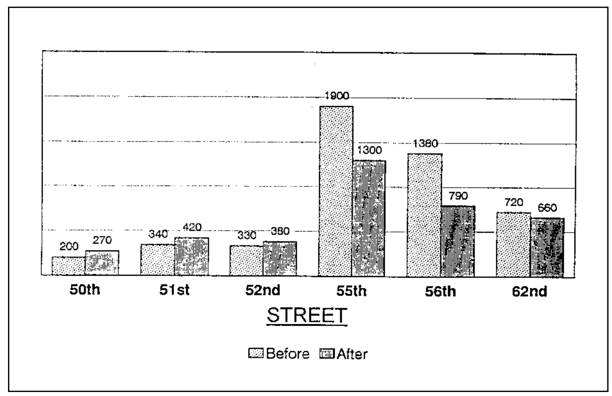


Figure 3.40. Traffic Volumes Before and After Installation of a One-Lane Chicane on NW 55th Street. (Seattle, WA)

Source: Seattle Engineering Department, "Phinney Ridge Traffic Control Project," Seattle, WA, May 1993.

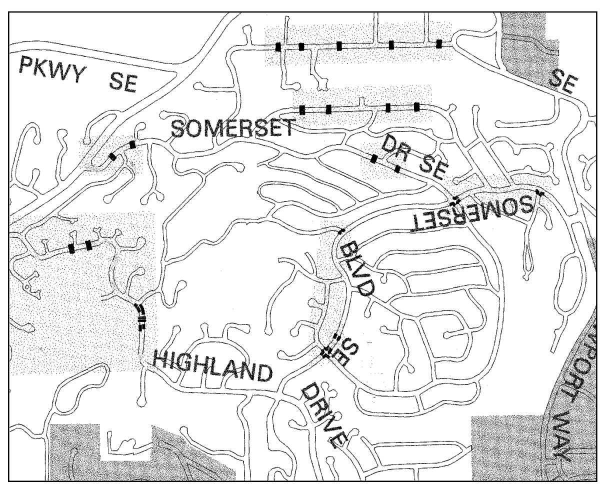


Figure 3.41. Curvilinear Network Generating Excessive Speeds. (Bellevue, WA)

Source: City of Bellevue, Transportation Department, Bellevue, WA.

Table 3.9. Traffic Volumes Before and After Installation of a Half Closure and a One-Lane Angled Choker. (Bellevue, WA)

	Before	After Half Closure	After One-Lane Choker
Northbound traffic	439 vpd	91 vpd	145 vpd
Southbound traffic	331 vpd	351 vpd	186 vpd
Daily traffic volume	770 vpd	442 vpd	331 vpd
85th percentile speed	31–32 mph	Not available	27–30 mph

vpd=vehicles per day; mph=miles per hour

Source: City of Bellevue, Transportation Department, Bellevue, WA.

From Random to Predictable Treatments

Some early traffic calming plans had an element of randomness about them, as if testing many new ideas in a single application. This raises an issue: whether to *mix* or to *match* traffic calming measures on a given street or in a given neighborhood. One view is that each application should employ only one type of measure spaced at regular intervals. The Gwinnett County speed hump program is based on the idea that uniformity aids in the recognition and understanding of traffic calming measures. A single vertical profile is used throughout the county, always designed to the same specifications (see figure 3.42).

The alternative view is that familiarity encourages excessive speeds. Bellevue intentionally mixes and modifies measures to "keep drivers on their toes." The plan for SE 46th Way was based on two concepts (see figure 3.43). The first is to space traffic calming measures at short in-

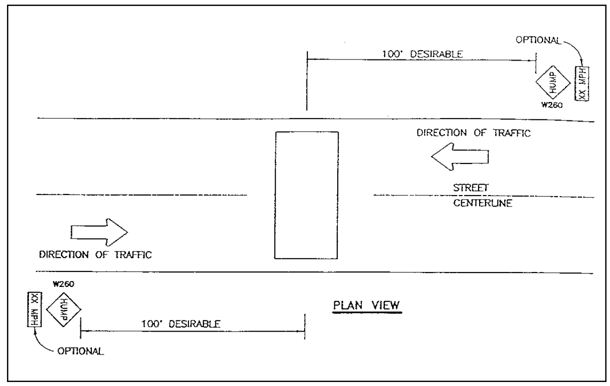


Figure 3.42. Standard Speed Hump Plan. (Gwinnett County, GA)

Source: County Traffic Engineer, "Standard Plan—22' Speed Hump," Gwinnett County, GA.

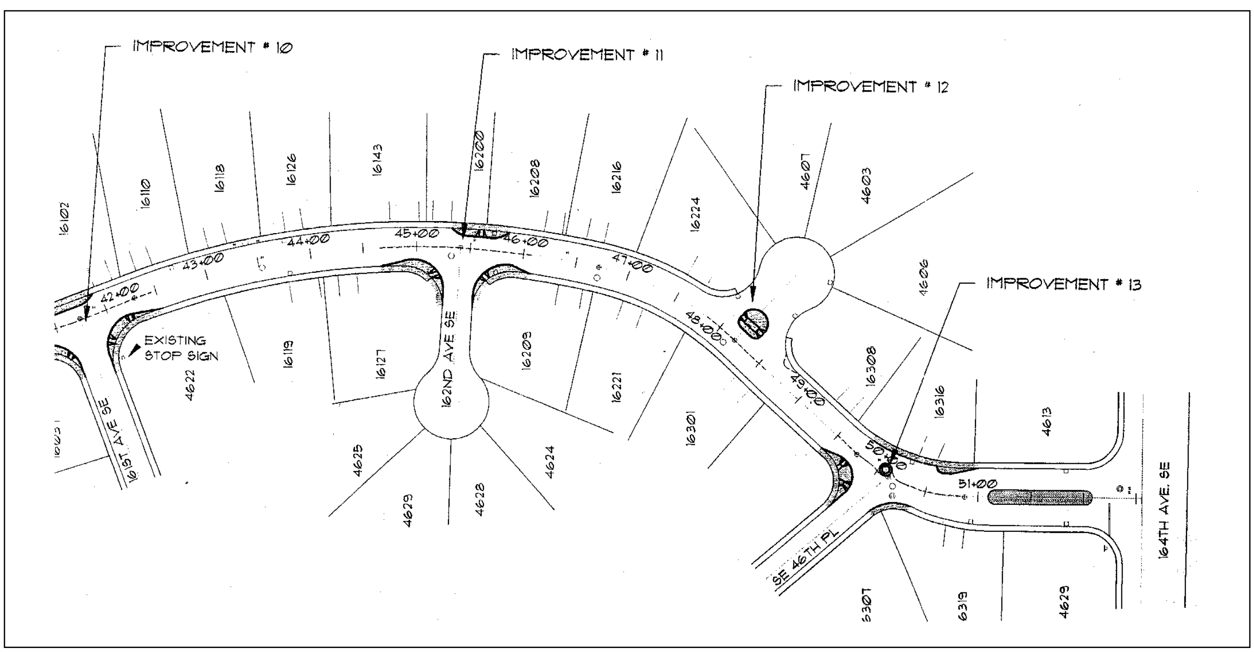


Figure 3.43. Varied Measures Along SE 46th Way. (Bellevue, WA)

Source: KPG, Inc., *Design Report for SE 46th Way Traffic Control Improvements*, City of Bellevue, WA, 1994.

tervals to discourage speeding between them. That was not controversial. The second concept is to vary the types of devices so that the driver cannot become accustomed to the same movement at each slow point.

In the absence of empirical evidence, an analogy to the treatment of sight distances has led some practitioners to the conclusion that predictability is preferable to surprise. Restricting sight distances may cause responsible drivers to use more caution because of the possibility of striking a pedestrian previously hidden by landscaping or hitting a vehicle pulling out on a blind curve. But such changes may invite problems with less responsible drivers. Many feel that if traffic calming measures are properly designed, forces of acceleration produced by changes in alignment should give drivers sufficient reason to slow down.

Another analogy is to traffic control devices, which have been standardized through the Federal Highway Administration's *Manual on Uniform Traffic Control Devices for Streets and Highways*. Standardization ensures that every installation is recognizable and requires the same action on the part of motorists, regardless of where it is encountered.

Denmark, decades ahead of the United States in its application of traffic calming measures, advocates "a reasonable balance between uniformity and variation."[14] The balance it supports seems slightly tipped toward uniformity.

> A certain consistency is also important as regards the technical content of the traffic calming. The speed reducing elements should be of the same kinds so that drivers are not constantly surprised by new designs, which would result in inappropriate behavior. For example, the first speed reducer that a driver encounters on his way into a local traffic area should preferably be designed so as to give the driver a hint about the nature of other measures in the area.[15]

From Narrowing to Deflection

Boulder's traffic calming toolkit presents the following hypothetical responses to a speeding problem.[16] The first is labeled unsafe and ineffective:

> One midblock neckdown is constructed, with hopes of reducing traffic speed and making it easier for pedestrians to cross the street. Unfortunately, the neckdown is too small to actually slow traffic. The neckdown becomes a new danger zone, where cyclists must merge with vehicles traveling much faster.

An alternative response is labeled safe and effective:

> A midblock neckdown is constructed, with speed humps installed approximately 100 feet before and after. The speed humps slow the motor vehicles so that the cyclists can merge more safely.

These hypothetical situations illustrate an important point. Any narrowing that provides adequate clearance may not bring speeds down appreciably. For this reason, there seems to be a trend from straight narrowings to hybrid measures that involve both narrowing and deflection. Circles at T-intersections are being designed with curb indentations at the top of the T to make them function more like circles at cross streets. Center islands are being designed wider, with corresponding widening at the street edges, to make them function more like traffic circles. Chokers and center islands are being used in series to make them function more like chicanes (see figure 3.44).

Seattle, WA

Eugene, OR

Figure 3.44. Introducing Deflection.

Spacing of Measures

Early traffic calming initiatives in the United States tended to space slow points far apart. Humps were often spaced at intervals of well over 500 feet. An early study of speed humps in Phoenix found almost no midblock speed reduction when humps were spaced so far apart.

There were also a few early cases of spacing slow points close together, to the dismay of even residents who usually support speed control measures on their streets. Traffic managers must remember that residents are also motorists and are inconvenienced by traffic calming measures many times over for every time the targeted cut-through driver is inconvenienced.

Bellevue provides good examples of both spacing problems. Every other hump originally spaced 150 feet apart on Somerset Drive had to be removed to produce a more satisfactory 300-foot spacing. Conversely, humps spaced 1,000 feet apart on SE 63rd Street had to be supplemented to bring the spacing down to 500 feet.

Figure 3.45, based on data from outside the United States, shows midpoint speeds plotted as a function of the spacing of slow points. For a midpoint speed of 20 mph, slow points were typically spaced no more than 200 to 250 feet apart. For 25 mph, the typical spacing increased to about 400 feet, and for 30 mph, typical spacing was 600 feet or greater. The types of roadways (local versus collector) and the types of traffic calming measures were not specified.

Spacing guidelines of featured communities are presented in table 3.10. They can be compared with points in figure 3.45 to see what speeds will likely result. The likely speeds are generally consistent with posted speed limits in these same communities.

Gwinnett County goes beyond basic spacing guidelines to consider sequencing. The county wants to avoid having the first hump in a series approached at high speeds. Therefore, the county positions the first hump at a point 100 to 200 feet downstream of a tight curve or a STOP sign.

From Spot to Areawide Treatments

Traffic calming efforts in most communities begin with spot treatments of problem streets. When problems reappear at nearby locations, traffic managers often switch from volume to speed controls, or from speed controls with more diversion potential (standard humps) to those with less diversion potential (traffic circles, for example). When even the speed control measures produce diversion, program managers begin to rethink their whole approach.

The national experience suggests that traffic calming should be planned on an areawide basis, but not over such a wide area that it becomes difficult to achieve consensus on a plan. Having prepared plans for individual streets and for large subareas of the city, Portland has settled on the individual neighborhood as the optimal scale for planning purposes.

The case for areawide traffic calming is clear from several examples. In Gainesville, all-way STOP signs were installed on one neighborhood street. They created a problem by diverting cut-through traffic to another street as drivers sought to avoid the STOP signs. Many drivers also ran the STOP signs, a common problem when unwarranted STOP signs are used simply to slow traffic. The cut-through problem was solved only by closing another street to create a circuitous route through the neighborhood. Austin, Bellevue, Sarasota (see figure 3.46), Seattle, West Palm Beach, and other featured communities have experience with both spot and areawide traffic calming. Lessons from these places are reviewed in "Warrants, Project Selection Procedures, and Public Involvement" (chapter 8).

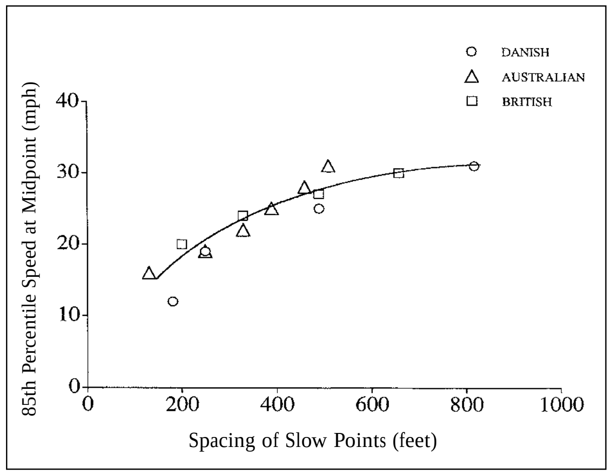


Figure 3.45. Midpoint Speed versus Distance Between Slow Points.

Source: R. Ewing, *Best Development Practices*, American Planning Association (in cooperation with the Urban Land Institute), Chicago, IL, 1996, p.64.

Table 3.10. Spacing Guidelines for Speed Humps in Featured Communities.

Community	Spacing (feet)
Bellevue, WA	200–300
Berkeley, CA	150–400
Boulder, CO	150–800
Gwinnett County, GA	350–500
Howard County, MD	400–600
Montgomery County, MD	400–600
Phoenix, AZ	500 or less
Portland, OR	300–600

Sources: Memos and reports of respective traffic calming programs; interviews with staffs.

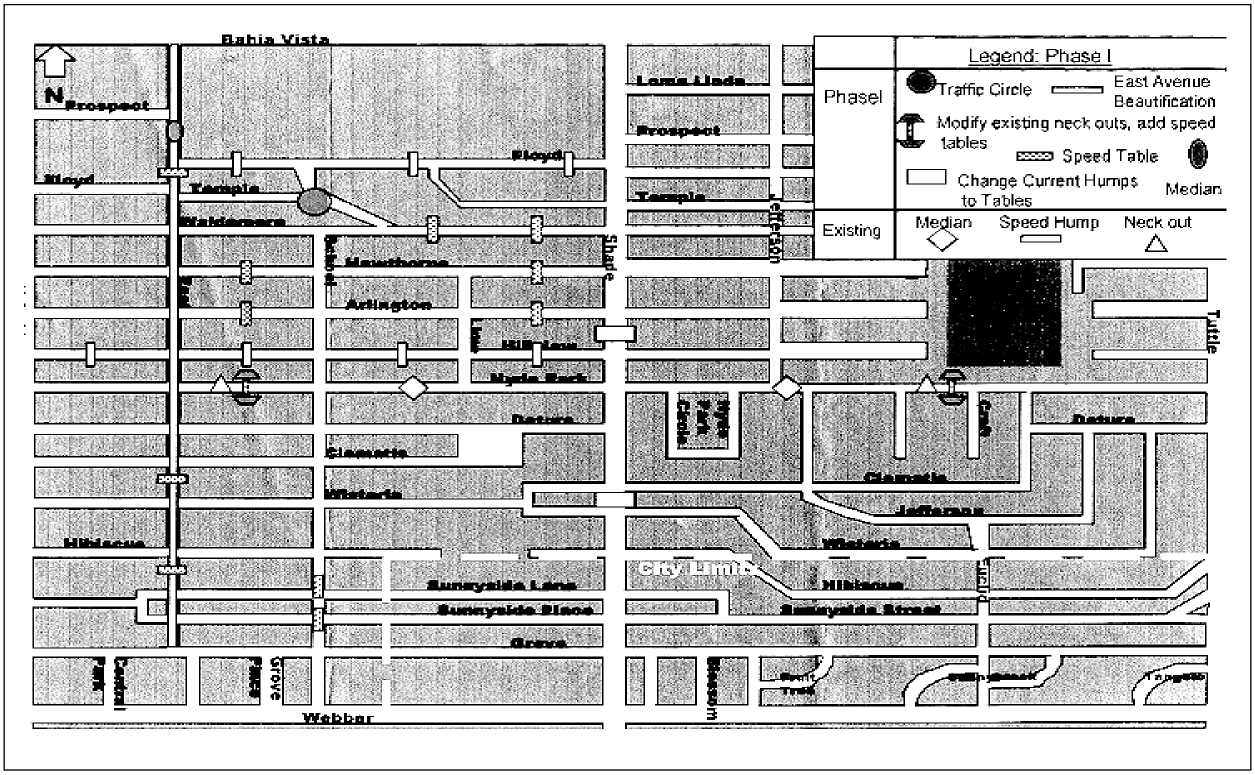


Figure 3.46. Southeast Sarasota Traffic Calming Plan.

Source: Engineering Department, "Southeast Sarasota Neighborhood Traffic Calming Project," City of Sarasota, FL, undated.

Endnotes

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16. Boulder, CO, op. cit.