### Noise Levels

Residents are often concerned that vertical measures—humps, tables, and especially, textured surfaces—will raise noise levels in their neighborhoods. However, experience in the surveyed communities indicates the lower speeds that result from proper design and application of traffic calming measures tend to lower noise levels. The one exception is just downstream of the measures themselves, particularly when cargo-carrying trucks make up a significant fraction of the traffic stream.

Charlotte, NC, took noise readings before and after installation of speed humps in three neighborhoods. Noise levels did not change in two, and showed a slight decrease in the third. San Jose found that average noise levels fell from 77 to 75 A-rated decibels (dBA) after speed humps were installed.

Boulder, CO, conducted what may be the most thorough evaluation of noise impacts to date, at least in the United States (see table 5.10). Traffic circles were perceptibly less noisy than untreated streets. Raised crossings also produced lower and more uniform noise levels than did untreated streets.

Interestingly, since STOP signs are viewed as a panacea for traffic problems by many citizens and elected officials, this option may be the worst from a noise standpoint. Although deceleration is relatively quiet, acceleration from rest or near rest is not. Noise levels rise until drivers shift gears, and then rise again until they shift again.

The Europeans, who have studied noise impacts of traffic calming measures far more thoroughly than have communities in the United States, have reached similar conclusions. The more speeds are reduced, the more noise levels are reduced. Simple mathematical relationships have been estimated. Noise impacts are less favorable where commercial traffic is heavy and where slow points are so far apart that traffic fully accelerates between them.[16]

What is not captured by noise studies is the occasional screeching of tires, clunking of cargo, or in a few communities, honking in protest when vertical measures are first installed. This is one advantage of horizontal measures, and one argument for raised intersections over midblock humps or tables. At least the raised intersections are not directly in front of people's houses.

### Future Research

No information on other impacts of traffic calming—for example, impact on people with disabilities, air quality, or social interactions among neighbors—was uncovered in this review of U.S. practice. Europeans have assessed some of these other impacts in their formal evaluations. These impacts are related to quality of life and should be candidates for future research in the United States.

## Impacts of Education and Enforcement

This section reviews the limited evidence available on the effectiveness of education and enforcement activities (see appendix D for individual study results). The evidence is not encouraging. Yet, these activities cannot be dismissed. There have been successes, and enforcement activities in the communities surveyed seem particularly successful on high-volume collectors and arterials, the streets that are least amenable to restrictive engineering measures.

### Neighborhood Traffic Safety Campaigns

Neighborhood traffic safety campaigns usually consist of personalized letters or general flyers that are distributed to all residents of a neighborhood and that cite statistics on speeding within the neighborhood and appeal for compliance with traffic laws (see figure 5.38). No empirical evidence was uncovered regarding the impacts of such campaigns. Among traffic managers, there is skepticism about their effectiveness.

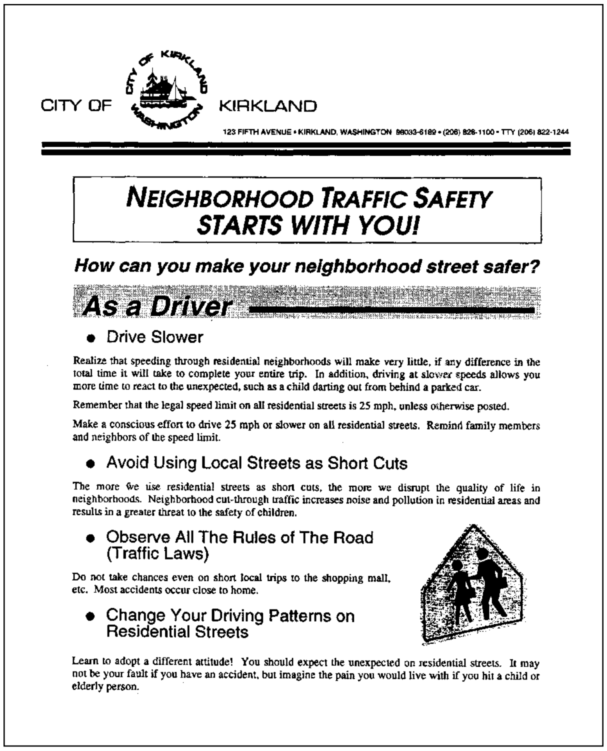
### Radar Speed Display Units

Radar speed display units are rotated from street to street, based on citizen requests. Their purpose is to remind drivers that they are speeding, thus encouraging compliance

**Table 5.10. Traffic Noise Levels Near an Uncontrolled Intersection, 4-Way Stop, Traffic Circle, and Raised Intersection. (Boulder, CO)**

| Location | Measure | Usual Level (decibels) | Peak Level (decibels) |
|---|---|---|---|
| 17th and Balsam | None | 68–69 | 72 |
| 13th and Balsam | 4-way stop | 66–67 | 69 |
| 14th and Balsam | Traffic circle | 60–64 | 70 |
| Nicholl and Edgewood (extension of Balsam) | Raised crossing | 60–62 | 64 |

Source: City of Boulder, "Environmental Enforcement Department Sound Study," Attachment F, Study Session on the Neighborhood Traffic Mitigation Program, Boulder City Council, April 8, 1997.



CITY OF KIRKLAND

123 FIFTH AVENUE • KIRKLAND, WASHINGTON 98033-6189 • (206) 828-1100 • TTY (206) 822-1244

**NEIGHBORHOOD TRAFFIC SAFETY STARTS WITH YOU!**

***How can you make your neighborhood street safer?***

***As a Driver***

- Drive Slower

Realize that speeding through residential neighborhoods will make very little, if any difference in the total time it will take to complete your entire trip. In addition, driving at slower speeds allows you more time to react to the unexpected, such as a child darting out from behind a parked car.

Remember that the legal speed limit on all residential streets is 25 mph, unless otherwise posted.

Make a conscious effort to drive 25 mph or slower on all residential streets. Remind family members and neighbors of the speed limit.

- Avoid Using Local Streets as Short Cuts

The more we use residential streets as short cuts, the more we disrupt the quality of life in neighborhoods. Neighborhood cut-through traffic increases noise and pollution in residential areas and results in a greater threat to the safety of children.

- Observe All The Rules of The Road (Traffic Laws)

Do not take chances even on short local trips to the shopping mall, etc. Most accidents occur close to home.

- Change Your Driving Patterns on Residential Streets

Learn to adopt a different attitude! You should expect the unexpected on residential streets. It may not be your fault if you have an accident, but imagine the pain you would live with if you hit a child or elderly person.

Figure 5.38. Example of a Neighborhood Safety Flyer. (Kirkland, WA)


Photo Credit: Tony Mazzella

Figure 5.39. Radar Speed Trailer in the Field. (Kirkland, WA)

with the speed limit. The most common form of radar speed display unit is a portable trailer equipped with a radar unit that detects the speed of passing vehicles and displays it on a reader board, often with a speed limit sign next to the display (see figure 5.39).

San Jose has found radar speed trailers effective only while displayed. The residual effect is negligible. Kirkland, WA, reports that radar speed trailers, while displayed, reduce speed by 25 percent.[17] In the longer term (30 days after a series of applications), speeds are reduced by 6 percent on streets with traffic volumes below 600 vehicles per day; on such streets, most traffic is local, and radar speed trailers raise residents' consciousness. On higher volume streets serving through traffic, the long-term effect of radar speed trailers has been found to be negligible.

## Neighborhood Speed Watch

In some communities, speed watch programs lend residents radar guns and have them record the speeds, makes, models, and license plate numbers of all vehicles clocked speeding through their neighborhood. The police department then sends warning letters to the owners of offending vehicles, reminding them of the posted speed limit and the neighborhood's concern for safety.

In San Jose, neighborhood speed watch was dropped for lack of resident interest. There, as elsewhere, the program was hampered by resident fear of confrontation with irate motorists and by a lack of volunteers during hours when traffic speeding is at its worst.

In Phoenix, neighborhood speed watch programs have had marginal impacts on 85th percentile speeds. Among five streets for which measurements are available, the median speed reduction was only 1 mph; one street actually experienced an increase in the 85th percentile speed (see appendix D). The traffic management team in Phoenix refers to neighborhood speed watch as their "resident calming" program, since residents seem to feel better after the experience despite lack of manifest results.

In Kirkland, WA, neighborhood speed watch proved even less effective than the radar speed trailer. Thirty days after speed monitoring, 85th percentile speeds were unchanged at two locations and had fallen by 2 mph at a third. At the third location, the drop in speed may have been due to intensive police enforcement rather than speed watch.[18]

The one reported exception to generally unimpressive results is Gwinnett County's speed watch program in which 85th percentile speeds fell from 45 to 35 mph.[19] Gwinnett County's program, now defunct, was different from others in several respects. Transportation department personnel performed the radar speed checks, avoiding the problems of resident reluctance and unreliability. Offending residents were personally visited by neighborhood committee members who appealed for cooperation. Names of offenders were published in a neighborhood newsletter, and in at least a few cases, membership in a subdivision swim and tennis club was suspended over speeding violations. The labor intensiveness of the program, not its effectiveness, was its downfall. It fell victim to budget cuts.

### Targeted Police Enforcement

Communities cannot place a police officer on every corner. In an extensive network of local streets, there are too few officers, too many corners, and too many hours in the day when speeding can occur. Limited personnel can be more cost-effectively deployed on main thoroughfares.

The best that can be offered to those living on low-volume streets is periodic daytime speed enforcement. Boulder tried targeted speed enforcement on streets that had applied for traffic calming measures but were ineligible, having been designated critical emergency response routes. In all, 38 high-enforcement zones (HEZs) were established on 30 individual streets. Results were disappointing. After enforcement, speeds were unchanged in three HEZs for which before-and-after data are available, and speeds actually went up in the fourth (see appendix D).

### Photo-Radar Speed Enforcement

Where authorized by State law, photo-radar is a new speed enforcement option. Photo-radar uses a radar unit to measure the speed of passing vehicles and a camera to take a photograph of any vehicle exceeding the speed limit (see figure 5.40). The photograph usually captures the image of a speeding vehicle with sufficient clarity to read the license plate. The owner of the vehicle is then sent a citation which he or she can either pay or contest. Some states require that citations be issued to drivers and treated as moving violations, with points assessed against drivers' licenses. In such cases, more elaborate camera equipment is required to capture the image of the driver's face.

Photo-radar units can be portable, so they can be moved around from day to day or even hour to hour. In the communities surveyed, each unit is staffed full-time. The staff member drives the unit from place to place, sets it up, and protects it against vandalism. Typically contracted out as a turnkey operation, a photo-radar unit typically costs about $4,000 per month for lease of equipment, $3,000 for program operation, and $20 per citation issued. On top of these costs is the salary of full-time staff assigned to each unit. Photo-radar emerges as a relatively expensive option, though certainly no more so than targeted speed enforcement using commissioned police officers (see table 5.11).

During its trial period, San Jose rotated one photo-radar unit among 20 local streets, resulting in relatively low levels of enforcement. Peak-hour speeds fell on 13 of 20 streets and rose slightly on 5 (see appendix D). Speeding continued to be a problem on evenings and weekends. On the positive side, speed reductions seemed to hold up over time without enforcement, and may have spilled over to nearby streets that were not treated (which is not true of engineering measures). Also, public reaction was positive because only speeders were penalized (which, again, is not true of some engineering measures).

Because it is relatively expensive to operate, photo-radar is most cost-effectively deployed on high-volume streets with speeding and collision problems. These are the streets least amenable to the use of physical measures to slow traffic. So photo-radar may be very complementary to physical measures as part of a comprehensive traffic management program.

**Figure 5.40. Photo-Radar Warning Sign Combined with a Choker. (San Jose, CA)**

**Table 5.11. Cost Comparison—Photo-Radar, Police Enforcement, and Humps. (San Jose, CA)**

| Measure | Initial Cost | Annual Cost | Annual Revenues |
|---|---|---|---|
| Photo-radar (ownership option) | $85,000 | $145,000 | $40,000 |
| Photo-radar (lease option) | 0 | $214,000 | $40,000 |
| Targeted police enforcement | $70,000 | $194,000 | $40,000 |
| Speed humps | $300,000 | $30,000 | $0 |

Source: City of San Jose, "Final Report on the Neighborhood Automated Speed Compliance Program," Report to Mayor and Council, December 12, 1997.

## Impacts of Regulatory Measures

Regulatory measures are generally perceived as less effective at calming traffic than are physical measures that by their nature are self-enforcing. Typical of attitudes among featured communities is this one from San Jose:

> The exclusive use of passive devices (signs and markings) has been proposed in lieu of the combination of both passive and active devices (physical diverters) that were used in Naglee Park. Observation of motorist behavior by city staff during the project period has confirmed our belief that fewer motorists would be discouraged without the physical diverters.[20]

Yet, like education and enforcement programs, all regulatory measures are not equally effective, and all experiences with regulatory measures are not alike (see appendix E). Regulatory measures certainly have a role in neighborhood traffic management, either as a precursor to the use of physical measures or as a complement.

### STOP Signs

The use of STOP signs at low-volume intersections strictly for traffic calming purposes is controversial. The *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)* states explicitly, "...STOP signs should not be used for speed control."[21] The majority of communities surveyed observe this recommendation and follow related STOP sign warrants. The communities reason that drivers will run unwarranted STOP signs or speed to make up for lost time. A minority of engineers break with the *MUTCD*.[22] They view the *MUTCD*'s warrants as too stringent for residential streets, and view STOP signs as a low-cost alternative to slow or divert traffic.

Most published studies of STOP signs show little or no midblock speed reduction and many more rolling than complete stops.[23] At the same time, cut-through traffic appears to be discouraged by STOP signs, and collisions may be less frequent and severe.[24] And, while their impact on speed is limited to the immediate vicinity of intersections, in this respect they differ only in degree from any traffic calming measure, all of which have limited areas of influence (for example, see figure 5.41).

A few featured communities have experience with unwarranted STOP signs, and this experience supplements the published literature. Unwarranted STOP signs are an integral part of neighborhood traffic management programs in at least two communities and have been tested in several others.

In one application, Seattle found that midblock speeds actually increased with unwarranted STOP signs. More typically, midblock speeds decrease but remain well above posted speed limits. Traffic calming effects were found to be very localized, extending no farther than 150 to 200 feet downstream of intersections and even shorter distances upstream.[25]

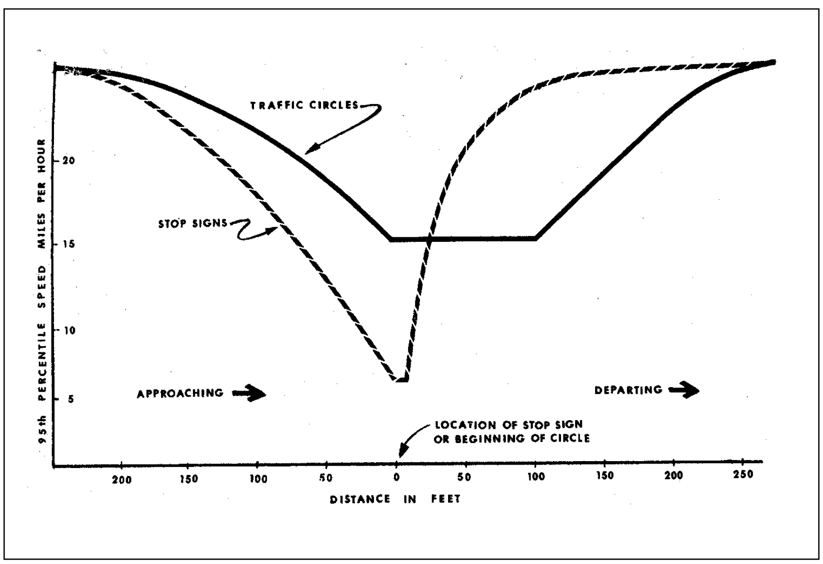



**Figure 5.41. Areas of Influence—STOP Signs versus Traffic Circles.**

Source: W. Marconi, "Speed Control Measures in Residential Areas," *Traffic Engineering*, Vol. 47, March 1977, pp. 28-30.

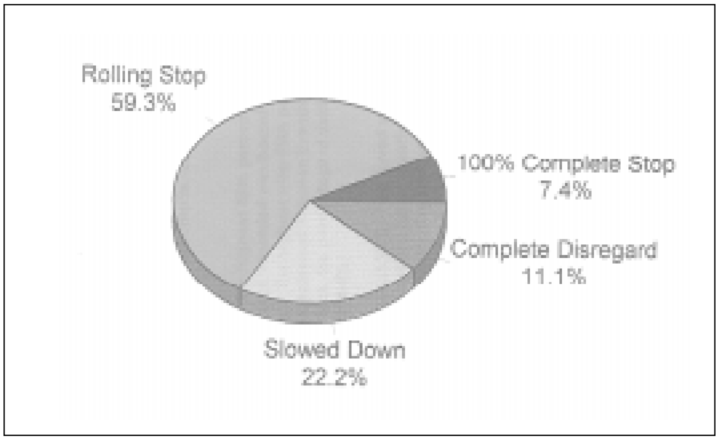



**Figure 5.42. Compliance with All-Way Stops. (Gwinnett County, GA)**

Source: Department of Transportation, "Brentford Lane—Stop Sign Compliance Study," Gwinnett County, GA, September 1997.

**Table 5.12. Performance of All-Way Stops. (Portland, OR)**

| STOP Signs | Speed | Accidents | Compliance |
|---|---|---|---|
| Warranted | reduced 2–10 mph | decrease | good |
| Unwarranted | reduced 2–10 mph | increase | poor |

Source: Citizens Advisory Committee, *Evaluation of the Neighborhood Traffic Management Program (NTMP) for Local Service Streets—Report and Recommendations*, City of Portland, OR, March 1992, p. B-4.

Full compliance with stop control is rare, but so is complete disregard. In nearly every evaluation, a majority of drivers roll slowly through unwarranted STOP signs (see figure 5.42).

Portland's assessment of all-way stops appears balanced (see table 5.12). Except for the reported increase in collisions at unwarranted STOP signs, it is consistent with most other research. Portland concluded that while unwarranted STOP signs may reduce speeds somewhat, the negative tradeoffs involved make the use of unwarranted STOP signs unwise. Even Dayton, the featured community relying most heavily on unwarranted STOP signs, has made it procedurally more difficult for neighborhoods to qualify, and has taken the extraordinary step of installing speed bumps or "jiggle bumps" at intersections to compel compliance (see figure 5.43).

## Turn Restrictions

Among featured communities, Phoenix and San Jose have made turn restrictions an integral part of their neighborhood traffic management programs. The last of the areawide plans in San Jose—for the Dry Creek Road neighborhood—relied exclusively on turn restrictions and all-way stops. Violation rates for the turn restrictions hovered around 50 percent without enforcement, but were reduced to 20 percent with active enforcement. After active enforcement ended, violation rates rose again but not to their initial levels.

Turn restrictions are popular with neighborhoods in Phoenix, being one of the few measures that cost neighborhoods nothing (see chapter 8). Despite violations, peak-hour turn restrictions in Phoenix cut peak-hour volumes on some neighborhood streets by about half, on average (see figure 5.44).

Turn restrictions appear most effective when limited to peak hours. When applied around the clock, turn restrictions are less effective (for an example, compare results for 37th Street in Phoenix to other streets with turn restrictions shown in appendix E). Communities wanting around-the-clock volume reductions would be better served by half closures.

## One-Way Streets

One-way streets can be used to restrict through traffic, either in isolated applications or in combinations that create maze-like routes through a neighborhood. Historic

Figure 5.43. Intersection Jiggle Bump. (Dayton, OH)

Figure 5.44. Effective Peak-Hour Turn Restriction Despite Violators. (Phoenix, AZ)


Figure 5.45. Restrictive Use of One-Way Streets in a Historic City. (St. Augustine, FL)

cities such as St. Augustine, FL, which need the street capacity to handle tourist traffic but wish to avoid speeding or cut-through problems, combine one-way streets in ways that force turns every block or two (see figure 5.45).

This use of one-way streets is entirely different from the pairing of one-way streets for purposes of improving traffic flow. The latter practice, common in the 1950's and now being undone in some locales as part of downtown

Figure 5.46. Short One-Way Section to Discourage Traffic Through a Neighborhood. (Minneapolis, MN)

revitalization programs, may increase traffic speeds. The return to two-way operation in such settings is a traffic calming measure discussed in chapter 9.

Several featured communities have tried restrictive one-way streets (see figure 5.46). Yet because of inconvenience to residents, enforcement concerns, and speeding problems that cannot be solved with one-way streets, most communities have made limited use of this option. Three communities—Gwinnett County, Phoenix, and Seattle—recommend that half closures be used instead of, or in addition to, restrictive one-way streets to reduce violation rates.

No before-and-after data are available from which to judge the effectiveness of restrictive one-way streets.

### "Rest on Red" and "Rest on Green"

Boulder is testing "rest on red," where all approaches to an intersection face red lights. If advance loops detect an approaching vehicle moving at or below the desired speed, and no other vehicle is being served at the cross street, the signal turns green. If speeding is detected, the green phase is not triggered until the vehicle comes to rest at the stop line.

Boulder will also be testing "rest on green" signal operation, where approaches along a main street will get a green light as long as traffic is moving at or below the desired speed and no one is waiting on the side street. Signals will switch to red if speeding is detected, thus punishing or rewarding based on compliance with speed limits.

No performance data are available as yet for "rest on green" or "rest on red."

## Impacts of Psycho-Perception Controls

A predecessor to this report, a state-of-the-art report produced for FHWA circa 1980, describes psycho-perception controls in these terms:

> Another approach to the problem [of speeding] is to try to play upon ingrained driver responses to certain stimuli to induce or even trick them into a desired behavior pattern or to use materials and messages which heighten driver response.[26]

The psycho-perception controls listed in the FHWA report included transverse lines with increasingly close spacing, odd speed limit signs, unique message signs, and speed-actuated flashing warning signs. None were reported to have had much success in local street applications.

This report adds several cases to the earlier performance database (see appendix F).

## Centerline and Edgeline Striping

Painting an edgeline several feet from the pavement edge has the effect of visually narrowing the roadway. A double yellow line striped down the center of roadway might have a comparable effect, visually limiting drivers to half of the road. In theory, the perceived narrowing could cause a modest speed reduction, just as a real narrowing causes a modest speed reduction.

The theory is not borne out by empirical studies. Results from Howard County, MD, Beaverton, OR, and San Antonio, TX, suggest that vehicle operating speeds are as likely to increase as decrease with striping. One explanation is that centerlines and edgelines define the vehicle travel path more clearly, creating a gun barrel effect.

Results from the aforementioned studies could be dismissed because even with the narrowings, pavement and lane widths remained substantial. Yet, results from Orlando, FL, where travel lanes were taken down to 9 feet, showed speeds to be unaffected (see figure 5.47).[27] This psycho-perception control was not "tricking" anyone and hence was removed from both the centerline and edgelines.

One reported exception is the North Ida Avenue project in Portland (see discussion at beginning of this chapter). Whether this restriping/narrowing proved more effective because it created bicycle lanes rather than shoulders, or because it was coupled with physical measures, is an issue for further study.

## Transverse Markings

At least one study found that a pattern of transverse markings at decreasing intervals across the travel path slows traffic.[28] This pattern supposedly creates the illusion of increasing speed, thus inducing drivers to slow down. If the study is correct, the effect is substantial (see appendix F). However, independent verification of this study's findings could not be found, and it is possible that the novelty of these markings was a primary cause of the initial effectiveness.

A transverse marking pattern is part of the standard 22-foot speed table design, developed by Seminole County (see chapter 3 and figure 5.48). Motorists slow down for these tables. But it is questionable how much of the reported speed reduction is due to the tables and how much is due to the markings.

**Figure 5.47. Remnant of Visual Narrowing that Proved Ineffective. (Orlando, FL)**

**Figure 5.48. Transverse Markings on the Approach to a Speed Hump. (Seminole County, FL)**

Eugene installed a transverse marking pattern on a horizontal curve that had been the site of three run-off-the-road accidents in the year before treatment (see figure 5.49). There have been no similar accidents since then. After the treatment, the 85th percentile speed decreased by 2 mph and the top speed recorded fell by 5 mph. What is not clear from this study, nor from two earlier studies documenting the same effect, is whether transverse markings have a speed reducing effect only if placed on the approaches to sharp curves or only until the novelty wears off.[29]

**Figure 5.49. Transverse Markings on a Horizontal Curve. (Eugene, OR)**

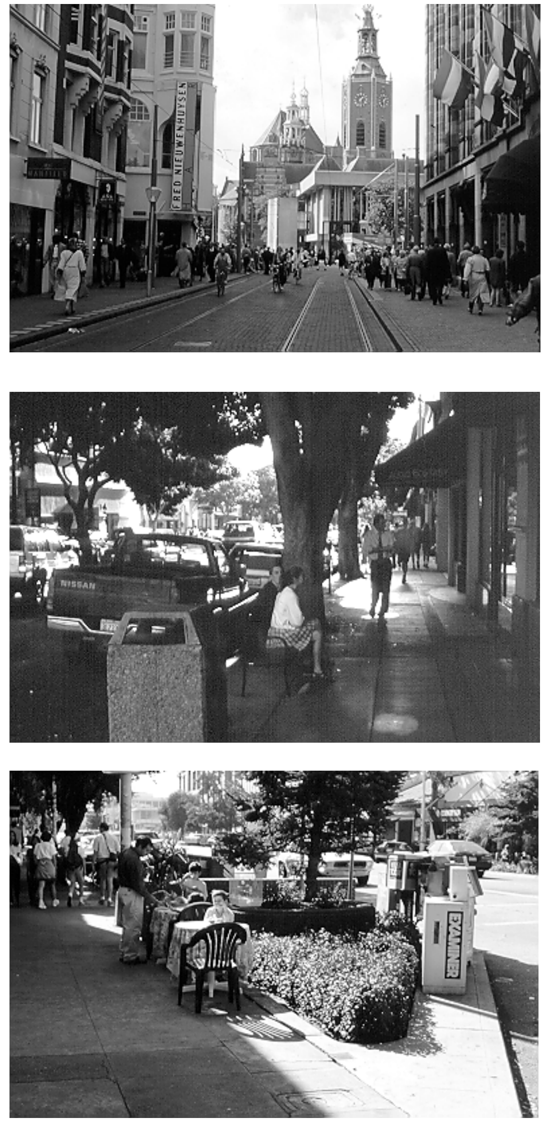


**Figure 5.50. Examples of Semi-Enclosed Street Spaces.**

## Small Setbacks

Trees or buildings at the street edge create a sense of enclosure. A tenet of urban design is that visual enclosure is required to transform streets into pedestrian places (see figure 5.50).

The same qualities that make enclosed street spaces comfortable for pedestrians may make them uncomfortable for speeding motorists. A 1980 FHWA study[30] correlated vehicle operating speeds with pavement width, with pavement width plus building setbacks (distance from building face to building face), and with several other variables (see figure 5.51). The strongest correlation was with pavement width plus building setbacks, indicating the importance of setbacks.

Street trees may or may not have the same effect as buildings near the street. A tree canopy by itself may not signal human presence in the same way as do doors and windows at the street edge. One featured community, Tallahassee, FL, has signed streets with tree canopies for slower speeds, but has no data on the effect of the canopies (see figure 5.52). Another, Portland, has data for a single street that is otherwise comparable along its length except for tree cover (see figure 5.53). The segments of NE 15th Avenue from Broadway to Knott and from Knott to Fremont have a mature tree canopy. The segment from Fremont to Prescott does not. The street showed no variation in speed along its length before or after speed tables were installed.

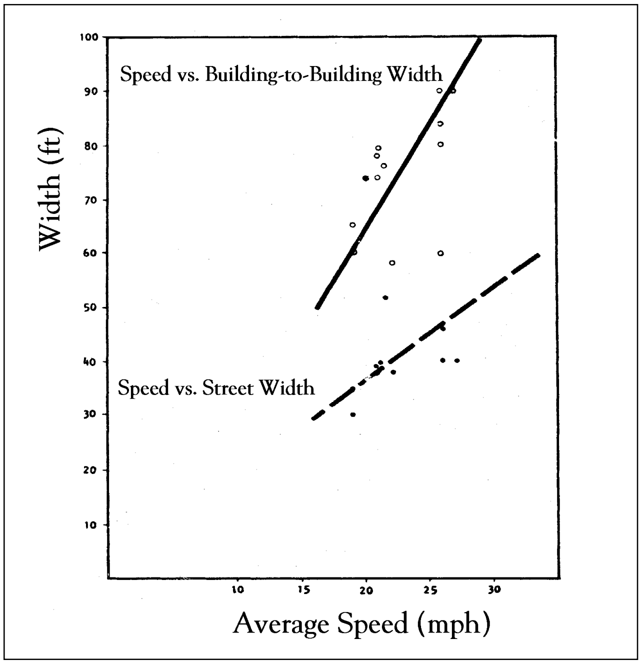



**Figure 5.51. Speed versus Pavement Width and Pavement Width Plus Setbacks.**

Source: D.T. Smith and D. Appleyard, *Improving the Residential Street Environment—Final Report*, Federal Highway Administration, Washington, DC, 1981, p. 127.

**Figure 5.52. Canopied Street Signed for Slower Speeds. (Tallahassee, FL)**

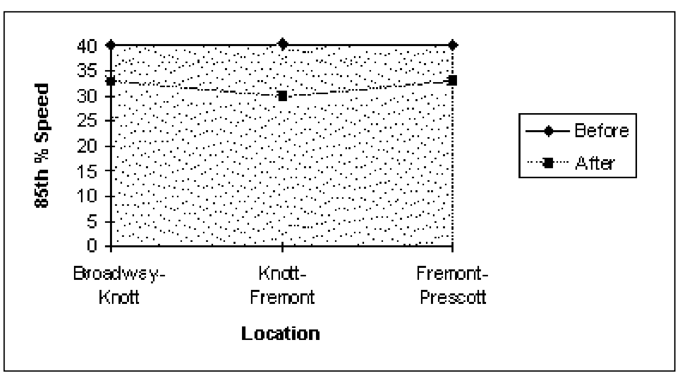



**Figure 5.53. Variation in Speed Along Street with and without Canopy. (Portland, OR)**

Source: Bureau of Traffic Management, City of Portland.

## Endnotes

1. A recent study suggests that the proportion of through traffic is a more important determinant of running speed than previously realized, even more important, for example, than street width. See J.L. Gattis and A. Watts, "Urban Street Speed Related to Width and Functional Class," *Journal of Transportation Engineering*, Vol. 125, No. 3, pp. 193–200, May-June 1999.
2. The most similar application we came across was the use of NETSIM, a widely accepted traffic simulation program, to analyze the impacts of a street closure in San Diego. NETSIM does not assign traffic to the network; it only analyzes traffic operations given assigned volumes. The program can be of assistance in predicting speeds posttreatment, but not traffic volumes.
3. For more on MCA and its advantages, see the pioneering application of MCA to trip generation by Stopher and McDonald. P.R. Stopher and K.G. McDonald, "Trip Generation by Cross-Classification: An Alternative Methodology," *Transportation Research Record 944*, 1983, pp. 84–91. Also see F.M. Andrew et al., *Multiple Classification Analysis—A Report on a Computer Program for Multiple Regression Using Categorical Predictors*, Institute for Social Research, University of Michigan, Ann Arbor, 1973.
4. E. Geddes et al., *Safety Benefits of Traffic Calming*, Insurance Corporation of British Columbia, Vancouver, BC, Canada, 1996.
5. M. Jenks, "Residential Roads Researched: Are Innovative Estates Safer?" *Architects' Journal*, Vol. 177, June 1983, pp. 46–49; Transport and Road Research Laboratory (TRRL), *Urban Safety Project—Interim Results for Area-Wide Schemes*, Digest of Research Report 154, London, England, 1988 (plus other reports in the same series); various chapters in R. Tolley, *Calming Traffic in Residential Areas*, Brefi Press, Brefi, England, 1990; H.H. Topp, "Traffic Safety, Usability, and Streetscape Effects of New Design Principles for Major Urban Roads," *Transportation*, Vol. 16, 1990, pp. 297–310; S.T. Janssen, "Road Safety in Urban Districts—Final Results of Accident Studies in the Dutch Demonstration Projects of the 1970s," *Traffic Engineering + Control*, 1991, pp. 292–296; S.J. Thompson and S. Heydon, "Improving Pedestrian Conspicuity by the Use of a Promontory," *Traffic Engineering + Control*, Vol. 32, 1991, 370–371; S.D. Challis, "North Earlham Estate, Worwich: The First UK 20 mph Zone," in *Traffic Management and Road Safety*, PTRC Education and Research Services Ltd., London, England, 1992, pp. 61–72; C. Hass-Klau et al., *Civilised Streets—A Guide to Traffic Calming*, *Environment & Transport Planning*, Brighton, England, 1992, pp. 71–72; R. Schnull and J. Lange, "Speed

Reduction on Through Roads in Nordrhein-Westfalen," *Accident Analysis & Prevention*, Vol. 24, 1992, pp. 67–74; W. Brilon and H. Blanke, "Extensive Traffic Calming: Results of the Accident Analyses in Six Model Towns," in *1993 Compendium of Technical Papers*, Institute of Transportation Engineers, Washington, DC, 1993, pp. 119–123; various case studies in L. Herrstedt et al., *An Improved Traffic Environment—A Catalogue of Ideas*, Danish Road Directorate, Copenhagen, Denmark, 1993; various case studies in County Surveyors Society, *Traffic Calming in Practice*, Landor Publishing, London, England, 1994; P. Hidas, K. Weerasekera, and M. Dunne, "Negative Effects of Mid-Block Speed Control Devices and Their Importance in the Overall Impact of Traffic Calming on the Environment," *Transportation Research D*, Vol. 3D, 1998, pp. 41–50; and L. Leden, P. Garder, and U. Pulkkinen, "Measuring the Safety Effect of Raised Bicycle Crossings Using a New Research Methodology," paper presented at the 77th Annual Meeting, Transportation Research Board, Washington, DC, 1998.

6. Engel and Thompson, "Safety Effects of Speed Reducing Measures," *Accident Analysis & Prevention*, Vol. 24, No. 1, 1992.
7. Hass-Klau et al., op. cit.; Herrstedt et al., op. cit.; County Surveyors Society, *Traffic Calming in Practice*, Landor Publishing, London, England, 1994.
8. The two perspectives are depicted, and the evidence is reviewed, in S.W. Greenberg and W.M. Rohe, "Neighborhood Design and Crime—A Test of Two Perspectives," *Journal of the American Planning Association*, Vol. 50, 1984, pp. 48–61; and B. Hillier, "Against Enclosure," in N. Teymur, T.A. Markus, and T. Woolley (eds.), *Rehumanizing Housing*, Butterworths, London, 1988, pp. 63–88.
9. R. Szymanski, *Can Changing Neighborhood Traffic Circulation Patterns Reduce Crime and Improve Personal Safety? A Quantitative Analysis of One Neighborhood's Efforts*, Master's Thesis, Florida International University, Ft. Lauderdale, FL, 1994.
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