Residential Street Standards & Neighborhood Traffic Control:

A Survey of Cities' Practices and Public Officials' Attitudes

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Abstract

The failure of the local street system to provide livability and safety in the residential environment can be seen in the application of neighborhood traffic management programs by local authorities to mitigate traffic problems. In order to further identify the extent of the conflict associated with "livability" and geometrical design of residential street, the following issues are examined: (1) Existing and proposed residential streets standards and regulations as practiced by various cities and their evaluation by public and city officials. (2) Traffic problems associated with residential streets and their mitigation through traffic management and control programs. Data are collected from Public Works and Traffic Engineering Departments of 56 Californian cities and 19 cities nation-wide. The findings show that most cities are still adhering to published street standards as recommended by different professional and federal organizations. Although some city officials see the need to amend certain aspects of their regulations and create a more flexible framework for street design, most of them believe that the current practice is satisfactory. Yet, the extant of residents' complaints about traffic problems on their streets might indicate an inconsistency between professional practice, as manifested in street design, and its actual performance as experienced by the residents. This can also be seen in the application of traffic control devices used by local authorities to mitigate these problems of which the most common are the installation of speed humps and 4-way stop signs. According to the cities' reports these techniques, as well as traffic diverters have the most effective results.

Acknowledgments

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INTRODUCTION

The concept of the street as a physical and social part of the living environment, as a place simultaneously used for vehicular movement, social contacts and civic activities, has long been argued by many authors such as Kevin Lynch, Jane Jacobs and J.B. Jackson. Local residential streets in particular are central to the feeling of "community" and "belonging" within a neighborhood.

Appleyard (1981) hypothesized that when traffic volumes increase beyond what is considered normal by local residents, or vehicle speeds increase because of street design, social street activities are greatly reduced, and the feeling of well being in the affected neighborhood is threatened. In order to protect livability as well as to provide for efficient movement of motor vehicles streets are given functional classifications. As such The Institute of Transportation Engineers report entitled, *Recommended Guidelines for Subdivision Streets,* establishes the following criteria in the design of local street systems:

- Safety- for both vehicular and pedestrian traffic.
- Efficiency of Service- for all users.
- Livability or Amenities- especially as affected by traffic elements in the circulation system.
- Economy- of land use, construction, and maintenance

It further elaborates and provides the following principles:

- Adequate vehicular and pedestrian access should be provided to all parcels.
- Streets should be designed to minimize through traffic.
- Elements in the local circulation system should not have to rely on extensive traffic regulations in order to function efficiently and safely.
- Planning and construction of residential streets should clearly indicate their local function.
- The local street should be designed for a relatively uniform low volume of traffic.
- Local streets should be designed to discourage excessive speeds.
- Pedestrian-vehicular conflict points should be minimized.
- Minimum amount of space should be devoted to street use.
- There should be a minimum number of intersections.

  (ITE, 1984)

Although, ITE recommended criteria refer to issues of livability and safety on residential streets, many cities are finding themselves under pressure to further address these issues through the reduction of speed and volume of traffic on residential streets. While traffic volume is often the result of a poorly planned street system, safety and excessive speed are related to the street's geometrical design. The practice of constructing relatively wide cross sections in residential streets where there is little traffic (less than 1000 trips per day), permits and encourages high vehicle speeds. High speeds are also encouraged by pavement width, smoothness, flat curves and good sight distance called for in street standards[1] This relationship between design speed and sight distance, curve radius, and width have been established to provide motorized efficiency which is often incompatible with the essence of residential livability.

Published geometrical street standards do not always adhere to the stated principles for residential street systems. The failure of existing local street systems, and the street's physical design, to provide livability and safety associated with the residential environment, can be seen in the application of traffic management strategies and control devices used by local authorities to mitigate these problems. These management programs are generally assigned to the following sequential categories:

1. Establishing, revising, and enforcing laws and ordinances pertaining to traffic regulations such as: speed limits, intersection control and parking regulations.
2. Installing traffic control devices that comply with the Manual on Uniform Traffic Control Devices such as: regulatory and warning signs, markings, traffic signals and traffic islands.
3. Installing physical design features that manage the movement and reduce the speed of vehicles: speed humps, pavement narrowing, shift in pavement, traffic circles and traffic diverters.

Study Objectives

Against this background of issues, a detailed study of existing and proposed regulations, showing their use and results as found in many cities, would be of particular value to those enacting legislation and procedures. It would serve as a compilation of what is being practiced in terms of street standards and traffic management at the neighborhood scale, and as an aid to those studying and drafting subdivision regulations. To further identify the extent of the conflict associated with "livability" and geometrical design of residential streets, the following study objectives are set:

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[1] Farouki (1976) and Moore (1969) show that the mean free speed of cars in suburban roads increases linearly with the roadway width. This linear relationship is particularly apparent between the width of 17 to 37 feet.

Bjørneboe (1990) shows that when the road is narrowed down to 11 feet 55% of the traffic will drive slower than 18 mi/hour. He further shows that minimum road radius is related to the square of velocity. Thus by reducing the horizontal curvature to 50 feet, speed will be at about 13 miles/hour while maintaining access to all vehicles.

- To compile data on existing and proposed residential street standards and regulations as practiced by various cities.
- To inquire about the extent to which authorities have made adaptations to traditional residential streets, what form these adaptations have taken, and their resulting performance.
- To evaluate residential street performance as perceived by public and city officials.
- To inquire about traffic problems associated with residential streets, their causes, and resulting mitigation programs.
- To research current practices in neighborhood traffic management and control and to receive direct input on the success or failure of each traffic control measures.

Procedure

A. Methods:

Data were collected using the following methods:

- Review of Literature. (See References Section)
- Interviews with selected city officials.
- Questionnaire sent to city officials.

The survey focuses on public officials' evaluations and perceptions of suburban street performance. It seeks to find out the process by which residential street standards are initiated, adopted and applied. It also inquires about the extent to which authorities have made adaptations to traditional residential streets, and what form these adaptations have taken.

Main issues covered in the questionnaire are:

- Street standards used, their adequacy and origin.
- Perception of street safety and performance problems.
- Neighborhood traffic management schemes , reasons for implementation, and their initiation process.

B. Sampling Method:

The survey was conducted through a mail distribution of a written questionnaire (see Appendix A). The questionnaire, containing a stamped return envelope, was sent to the head of the Public Works Department (or Transportation Department) of 150 cities (100 in California and 50 nation-wide). From the distribution of questionnaires in the Spring and Summer of 1994, 75 were filled out and returned (56 from California and 19 from the other states). This return accounted for a 50 percent response of the possible sample. (For a list of participating cities and contact addresses see Appendix B).

Residential Street Standards- their Use, Adequacy and Origin

The survey asked city officials to indicate the minimum standards for local (access) residential streets in their jurisdiction. In addition to indicating the minimum dimension on a diagrammatic cross section, (Figure 1), respondents were also asked to rate their overall satisfaction with specific standards and indicate their appropriateness.

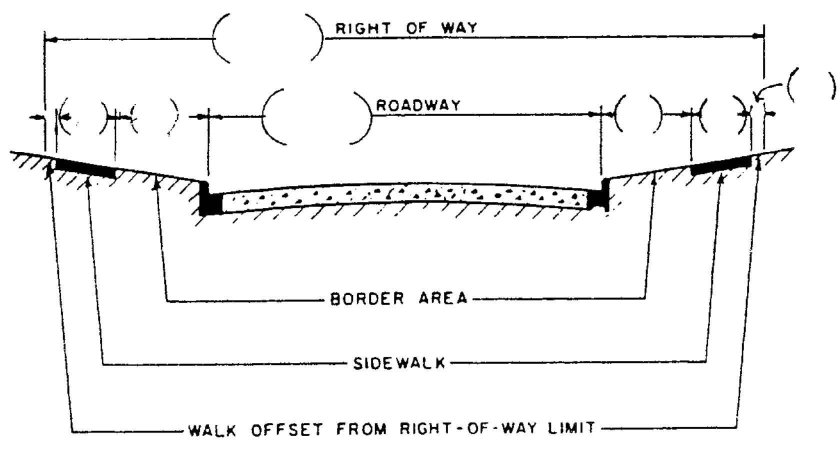


Figure 1. Typical Cross Section

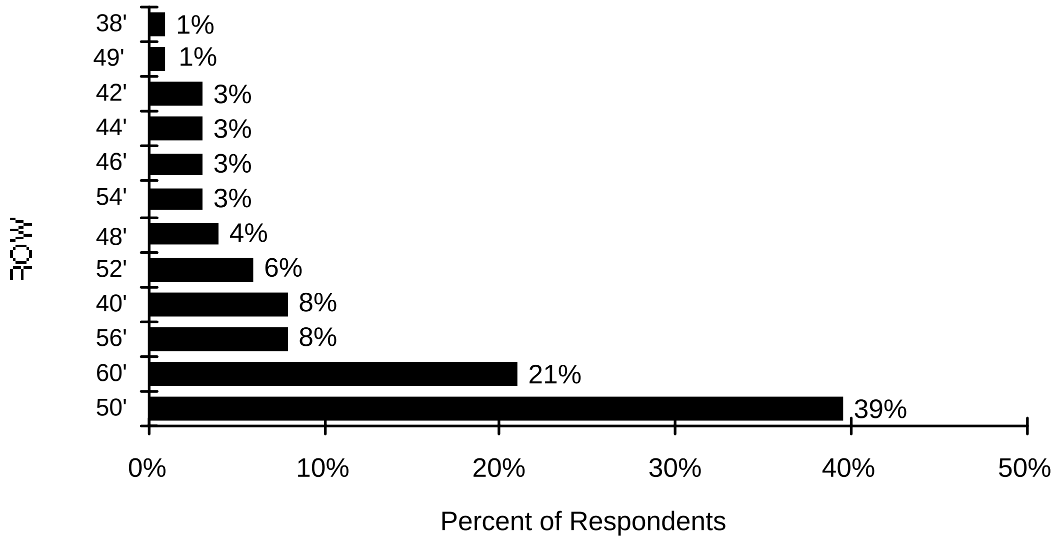
Minimum Standards For Residential Streets

Right of Way Width Right-of-way width is usually required to contain the elements of a street. The Institute of Transportation Engineers Guidelines state that a ROW width must have sufficient width to contain the following elements:

- Pavement and/or curbing.
- Sidewalks where required.
- Street utilities customarily installed in border areas such as: streetlights, traffic signs, street trees, utility lines (overhead and underground).
- A moderate amount of cross-section grading, including shoulders where utilized.
- In extreme northern climates, additional area may be required for extensive retention of snow plowed from roadway. (ITE 1984, 5)

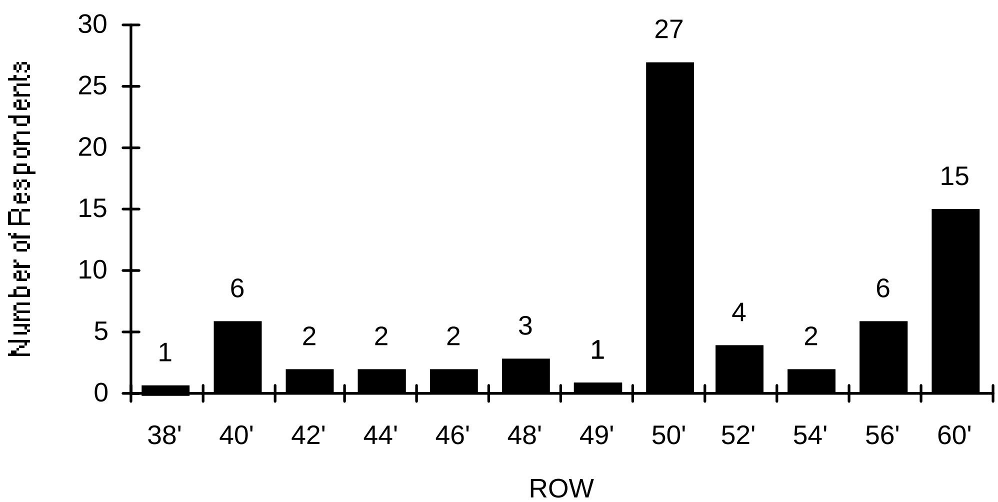
The survey results indicate that the prevalent right-of-way width for a residential subdivision street is 50 feet. While only 39 percent of the surveyed cities use 50 feet as their ROW, 77 percent of the cities are requiring ROW dimensions between 50 to 60 feet. This width (50 to 60 feet) is in accord with the specification set by the Institute of Transportation Engineers since 1967. (Figure 2.)

Figure 2. Minimum Standards for Residential Streets' Right- Of-Way



One city (Danville, CA) is using 38 feet as a ROW standard while six other cities (Fresno, CA ; Lakwood, CO ; Novato, CA ; Pleasanton, CA ; Tuscon, AZ ; Vallejo, CA) are using 40 feet as their required standard. These are the smallest ROW widths for residential streets recorded by the survey. (Figure 3)

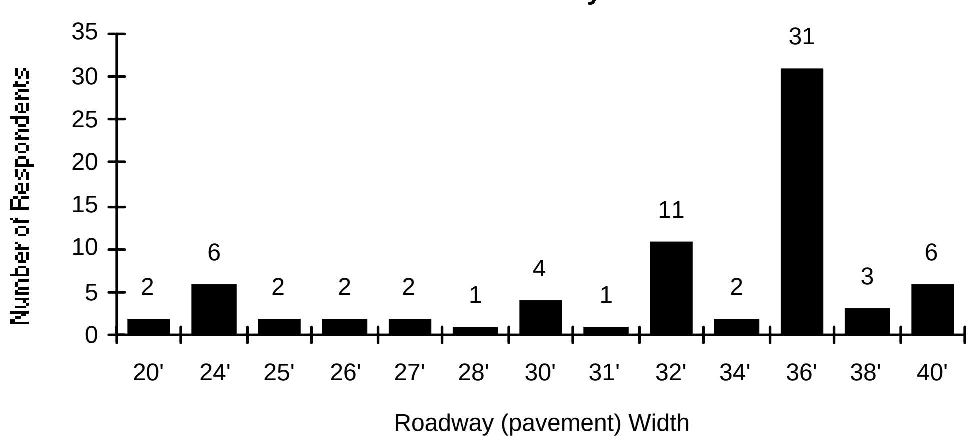
Figure 3. Minimum Standards for Residential Streets' Right- Of-Way



Roadway Width (Curb to Curb) Roadway width for residential streets is currently the most debatable segment of street design requirements. ITE guidelines provide the following criteria for pavement width: "A minimum pavement width must allow safe passage of moving traffic in each direction, exclusive of other interferences, such as conventional curb parking. Curb parking will occur occasionally within all residential subdivisions. The rate of occurrence will be a function of density, off-street parking code requirements, and local ordinances. In very low-density developments, large lots with two-car garages and circular driveways are commonplace. However, vehicle breakdown and occasional overflow parking indicates that even in low-density areas, provisions should be made for the occasional standing vehicle. This can be done by means of a shoulder on one or both sides of the street. Such shoulder development requires that curbs either be omitted or be of the mountable or roll-type, when a narrow- such as 22 foot (7-m) - road is used. . . . An alternative approach for low density development is the provision of a 27-foot (8-m) curbed street. Parking could be prohibited on one side of the street under certain conditions. This is based upon the assumption that the community has required adequate off-street parking at each dwelling unit." (ITE 1984, 5-6)

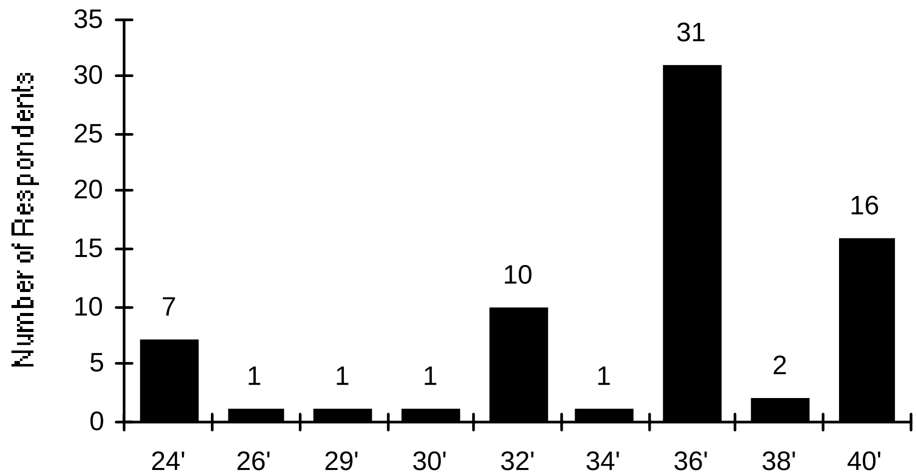
Although the Institute guidelines mention the possibility of using a narrow pavement width with limited on street parking, only 29 percent of the surveyed cities are using these specifications. The majority of the cities (55%) are using 36 to 40 foot pavement as their minimum standard. (Figure 4)

Figure 4. Minimum Standards for Residential Streets' Roadway



When asked to denote their opinion on the most appropriate roadway width (curb to curb) for residential streets, 70 percent of the respondents indicate widths between 36 to 40 feet. The majority of the respondents (44 percent) indicate a 36 foot roadway as the most desirable, with 40 and 32 foot width as second and third choice respectively. (Figure 5)

Figure 5. The Most Appropriate Width (curb to curb) for Residential Streets as Envisioned by Respondents



The survey indicates that a roadway width of 36 feet is most widely used, as well as deemed to be the most appropriate dimension. Most of the respondents explain this dimension as the best in allowing free traffic passage as well as on street parking. This width is indicated to be composed of two 10 foot traffic lanes and two 8 foot parking lanes.

General comments supporting a 36 foot width include:

- Two - 10' wide driving lanes plus two - 8' parking lanes. (Antioch, Claremont, Houston, San Clemente)
- 36' width allows for parking and two-11' lanes. (San-Francisco)
- With on-street parking in a typical subdivision, 36' is a reasonable minimum. (Livermore)
- A 36' width accommodates parking on both sides and one lane in each direction without conflict. (Los Angeles)
- Keeps speed down and allows for adequate on-street parking. (Pittsburg)
- 36' width allows safe travel for two-way traffic, even if cars are parked on each side of the street. (Riverside)

Other comments:

40 foot roadway

- Two - 12' through lanes and two - 8' parking/bike lanes. (Chico)
- Allows adequate room for parking on both sides of the street. (El Cajon)
- Two - 8' parking spaces and 2- 12' through lanes. (Foster City, Irvine, Laguna Niguel, San Bernadino)

38 foot roadway

- Two - 11' travel lanes, two -8' parking lanes. (Gilroy, Miami, FL))

34 foot roadway

- Fire department thinks 34' is too narrow, we use 34' on cul-de-sacs and short residential streets. (Lodi)

32 foot roadway

- This width allows for sporadic parking and tends to reduce speeds. (Poway)
- Used for residential areas with 11-20 dwelling units (Walnut Creek)

30 foot roadway

- Provides parking on both sides and requires traffic to "give and go". (Cupertino)

29 foot roadway

- Used in Neo-Traditional Developments. (Modesto)

20 foot roadway

- 20' width with limited access and no parking restrictions, and very low ADTs. If higher ADTs, 20' with no parking. (Boulder, CO)

Others

- "As in anything, there are pros and cons to any street width. Planners, environmental types and builders try to minimize street width (all for their own reasons). As we try to increase densities to make more efficient use of land, (a generally negative impact on the degree of liability), we create an even denser street scene with narrower streets. It would seem that we could use a combination of wide street right-of-ways and narrow minor streets to maximize densities while providing some openness and an inviting area for both vehicles and pedestrians. Unfortunately, any proposal must be evaluated from an economic feasibility standpoint which tends to extremely limit any creativity." (Clayton)
- "The narrower the streets the better, but liability is an important issue." (Livermore)
- "Residential streets should be designed by keeping the following key criteria in mind: (1) Traffic volumes should be kept below 1000 ADT, (2) Speeds should be controlled at or near 25 mph." (Modesto)
- "The issue of street design in urban areas has become very site and community specific. Hence, Novato has adopted rural street standards. These provide a tool which staff uses in workshop meetings with a neighborhood in order to arrive at street improvement design for a particular street." (Novato)

Sidewalk Width & Location One of the prevalent notions is that suburban subdivision streets usually lack sidewalks. Guidelines usually allow for sidewalk requirements to be waived when it is determined that a specific street will have minimal pedestrian traffic. ITE guidelines further point out that "Sidewalks should ordinarily be provided along streets used for pedestrian access to schools, parks, shopping areas, and transit stops." It continues to state that "In the very low-density subdivisions, walking distance to regular elementary schools is often excessive. In communities where all such travel is by way of school buses, there will be less need for sidewalk constructions as a standard policy." (ITE 1984,7)

The assumption that most new subdivision regulations do not require sidewalks is not supported by the survey findings. Only one city (Bakersfield, CA) does not require sidewalks on its residential streets. (Figure 6) Fifty-three cities, (84%), require sidewalks in all cases, and only nine cities allow for special provisions. Furthermore, almost all the cities that require sidewalks (93%) require their construction both sides of the street. (Figure 7)

Figure 6. Sidewalk Requirements on Residential Streets- A

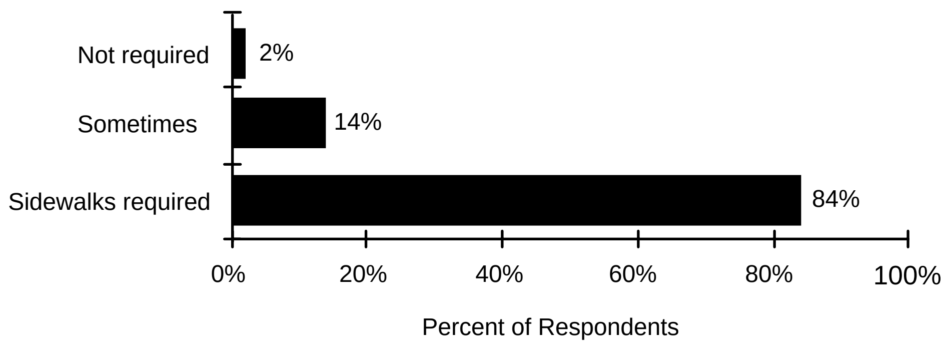
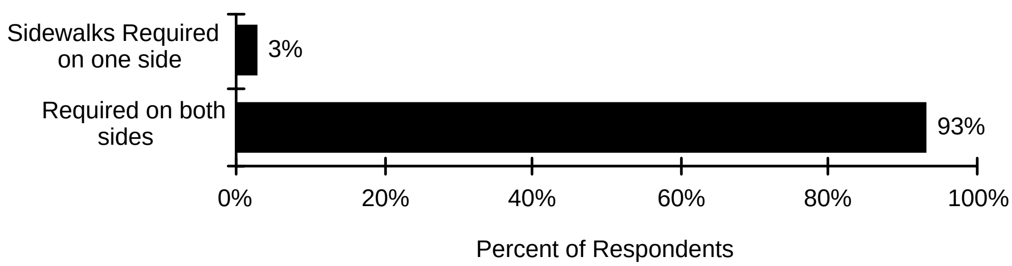
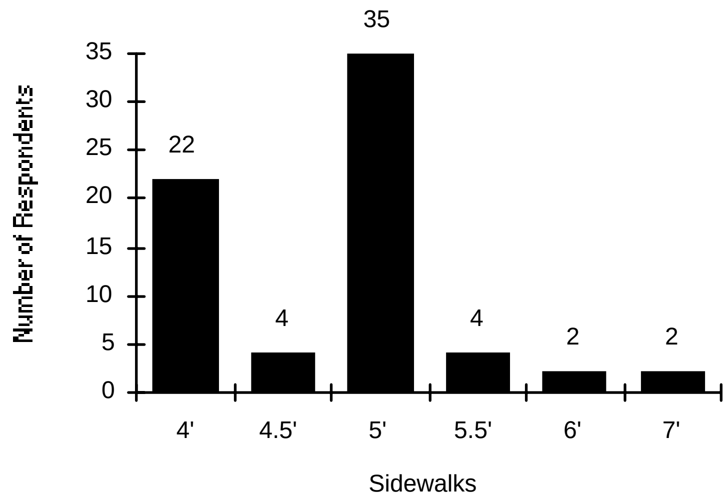


Figure 7. Sidewalk Requirements on Residential Streets - B



ITE guidelines call for sidewalks to be a minimum width of 5 feet. Indeed the majority of the surveyed cities (62%) are prescribing sidewalk widths between 5 and 7 feet (with 51% using the 5 foot dimension). (Figure 8)

Figure 8. Minimum Standards for Sidewalks on Residential Streets

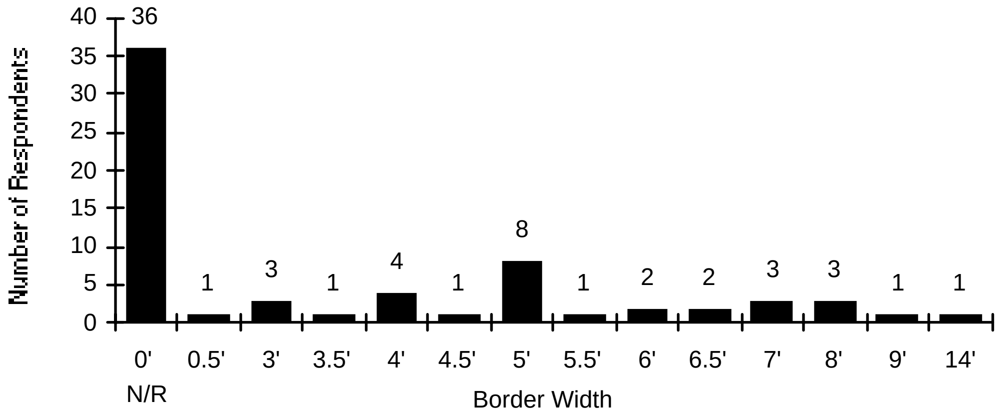


Sidewalk Distance from Curb Face (Planting Strip) The use of a planting strip between roadway and sidewalk has been a common practice in suburban subdivisions. Introduced by Frederick Law Olmsted in 1868 in his design for Riverside, IL. as a visual and physical barrier between cars and pedestrians, it was commonly specified by governmental agencies until the 1960s (Southworth, Ben-Joseph, 1995). ITE guidelines still recommend the utilization of a minimum 5- foot area between the roadway edge and the sidewalks. The guidelines sites the following advantages of a border strip:

- Children walking and playing side-by-side have increased safety from street traffic.
- Conflicts between the pedestrian and garbage or trash cans awaiting pickup at the curb is eliminated by using a border area for such temporary storage.
- The warped area necessary for a proper driveway gradient is minimized by having a major portion of this gradient fall within the border area.
- Danger of collision by runoff vehicles is minimized by placement of the walk at a maximum practical distance from the curb, and with further separation by tree planting.
- Conflict with storage of snow plowed off the roadway is minimized.
- Pedestrians are less likely to be "splashed" by passing vehicles. (ITE 1984, 7)

Even though strong recommendations are made to incorporate a border area, the survey indicates that many cities are moving away from this practice. Thirty-six cities (54%) do not require a planting strip and allow for the sidewalk to be next to the curb. Within those cities that require a border area, a 4 to 5 foot width is the most common. (Figure 9)

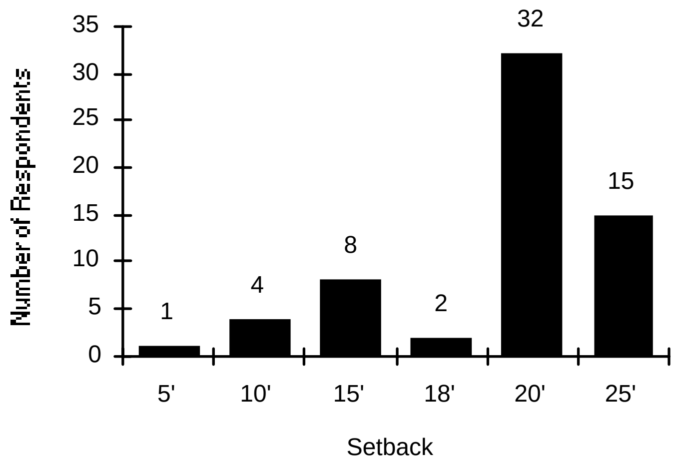
Figure 9. Minimum Standards for Border (Planting Strip) Between Sidewalk & Roadway



Building Setbacks Building setbacks usually are not an integral part of street standards' manuals and guidelines. Yet they influence the appearance of the streets and impact the perception of its width. European studies suggest that a driver's perception of the appropriate driving speed is influenced by the relationship between the width of the street and the height of vertical elements. (Devon 1991) Therefor lower speeds are usually achieved when the height of vertical elements, (such as buildings or trees), along the street are greater than the width of the street. In typical suburban subdivisions, where building heights usually do not exceed 30 feet and the ROW width is typically 50 feet, setbacks increase optical width.

According to the survey, a 20-foot setback from ROW is the most commonly used standard. This dimension, which is derived from a typical length of car, allows for unobstructed parking on the resident's driveway. (Figure 10)

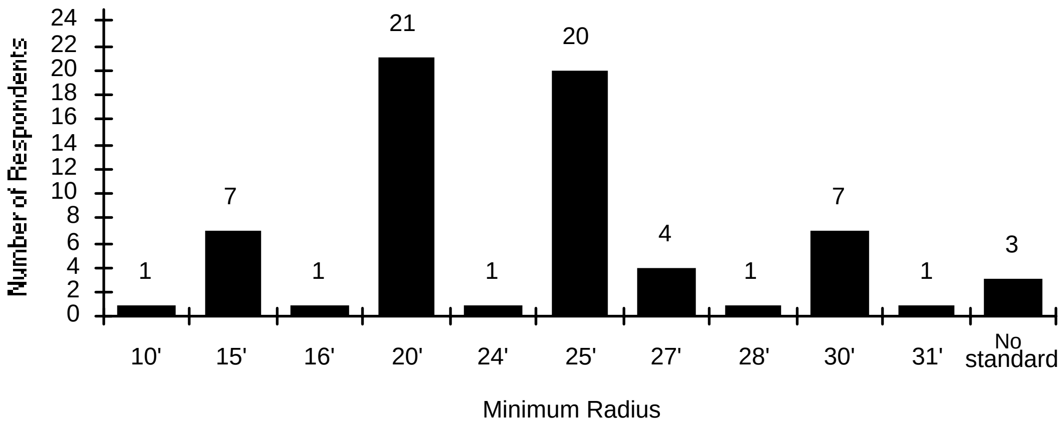
Figure 10. Minimum Standards for Building Setbacks



Corner Radii Corner radii at intersections are typically designed to facilitate easy vehicular turning. The use of a large corner radius does not only allow vehicles to turn the corner fast, but also reduces the pedestrian's right-of-way. Radius selection is often determined according to requirements set by service and emergency agencies, and is usually in excess of 20 feet. European practices show that a reduction in speed while of up to 50 percent can be achieved when a small corner radius is used. Furthermore, the small curb radius ensures a short crossing distance by pedestrians and reduces the danger of vehicles cutting across slower cyclists.

While European guidelines recommend a reduction of corner radii for local residential streets of up to a minimum of 10 feet, most of the surveyed U.S. cities mandate double that dimension. (Devon 1991, 46, Klau 1992, 52-53) Sixty-three percent of the surveyed U.S. cities use a 20 to 25 foot minimum corner radius, 10% use a 30 feet radius and only one city (Santa Barbara, CA) allows a 10 foot radius. (Figure 11)

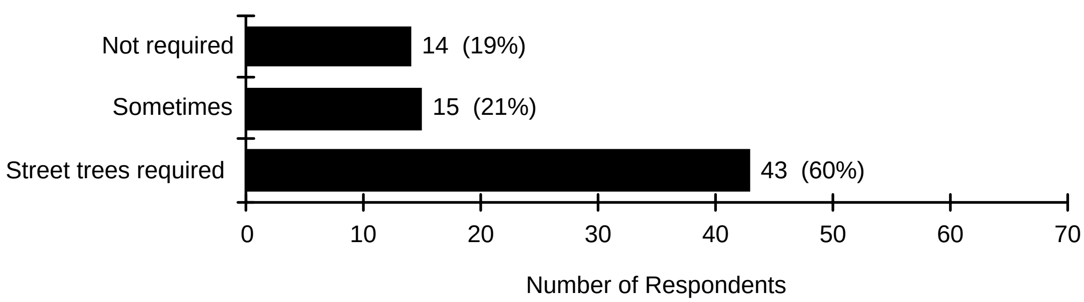
Figure 11. Minimum Corner Radius at Residential Streets' Intersections



Street Trees The use of street trees for ecological and visual benefits are well understood and documented. Street trees also contribute to the reduction of physical and optical width of the street right-of-way. This visual reduction often results in lower driving speeds as noted in the "Building Setbacks" section.

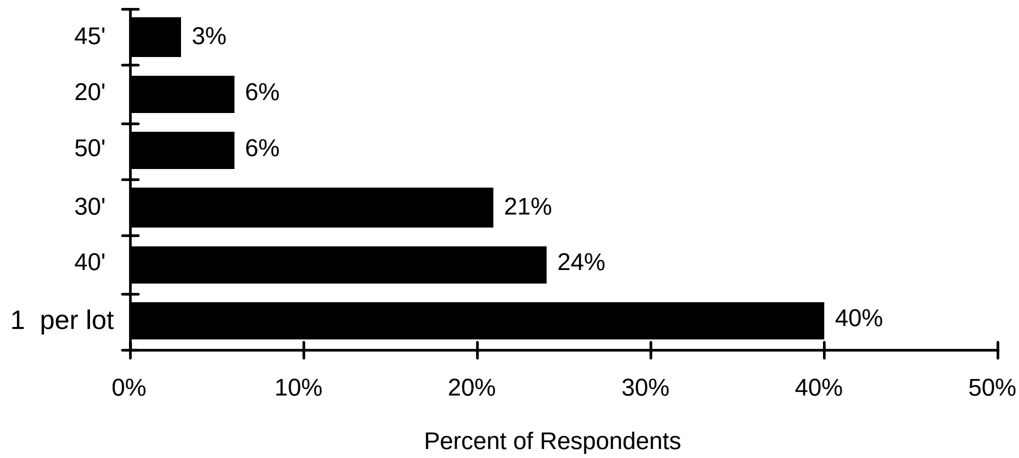
The prevailing notion that most new subdivision streets are bare and lack street trees is not supported by the survey findings. Forty-three cities (60%) require street trees in all cases, in addition, fifteen other cities allow for special provisions. (Figure 12)

Figure 12. Requirement for Street Trees



The most common requirement for minimum street tree spacing, (88% of the cases), is one tree per lot. Considering typical subdivision lot width, this translates to a 35 to 45-foot spacing. (Figure 13)

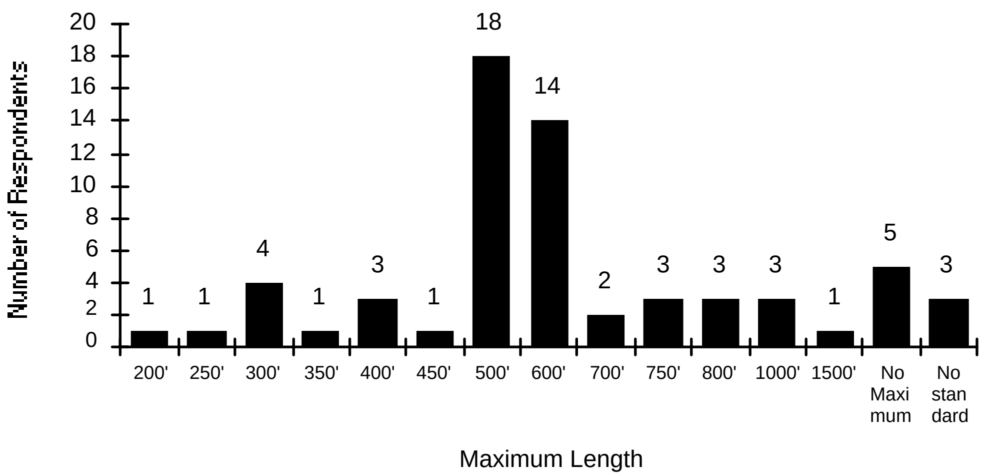
Figure 13. Minimum Spacing Requirement for Street Trees



Maximum Cul-de-Sac Length Typically cul-de-sac length is a function of the number of dwelling units it serves. As the number of units exclusively served by a single roadway increases, the potential hazard for temporary blockage also increases. These potential blockages are viewed as critical due to their effect on emergency access. ITE recommends that the maximum length of a cul-de-sac should be 1000 feet, and serve a maximum of 20 dwellings.

The survey results indicate a lower figure. Most cities (83%) allow a maximum length of 500 to 600 feet. With a typical lot width of 45 feet, these cul-de-sac lengths allow for 12 to 14 dwelling units. (Figure 14)

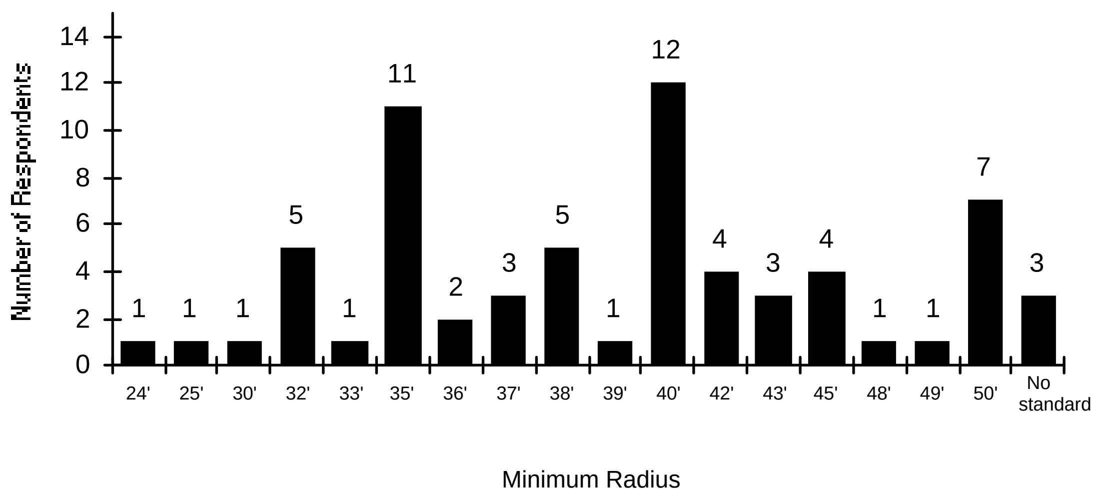
Figure 14. Maximum Length Allowed for a Cul-de-Sac



Minimum Cul-de-Sac Radius Dimensions for right-of-way radii at the end of a cul-de-sac are influenced by the need to accommodate the movement of service trucks and fire equipment.

According to the survey most cities (52%) use a roadway radius between 35 to 40 feet. These dimensions are usually sufficient for the turning of a straight body truck and a small fire apparatus. It is interesting to note that unlike common assumptions, and contrary to the recommendations by ITE guidelines, a 50-foot radius is not commonly used. (Fifty foot radius is the minimum required for a large fire apparatus, such as hook and ladder, to make a practical turn.) (Figure 15)

Figure 15. Minimum Radius Required at a Circular End of a Cul-de-Sac



Alleys in Residential Area Often considered a waste of space and an additional maintenance burden in low density developments, alleys have been largely eliminated from subdivision design in the last fifty years. ITE guidelines specify that a properly designed alley should have a minimum width of 20 feet with 15 to 20-foot radii at street intersections. However, it continues to stress that "certain disadvantages, such as additional pavement to be constructed and maintained, the area removed from the tax rolls, the added mileage of police patrol, and street lighting needs, all suggest alternate solutions to current design problems." (ITE 1984,9)

Yet, alleys have gained some renewed popularity with advocates of Neo-traditional and Transit Oriented Development. Proponent's justification for the use of alleys state that: "In areas where walking is to be encouraged, streets lined with garages are undesirable. Alleys provide an opportunity to put the garage to the rear allowing the more 'social' aspect of the home to front the street. Streets lined with porches, entries and living spaces are safer because of natural surveillance." (San-Diego, City of, 1992, Guideline 8F) The survey findings indicate that alleys are still restricted as a design feature in most residential subdivisions. Among the 25 cities that allow alley construction, seventy-three percent adhere to ITE's 20-foot minimum alley width. (Figure 16;17)

Figure 16. Alleys in Residential Areas

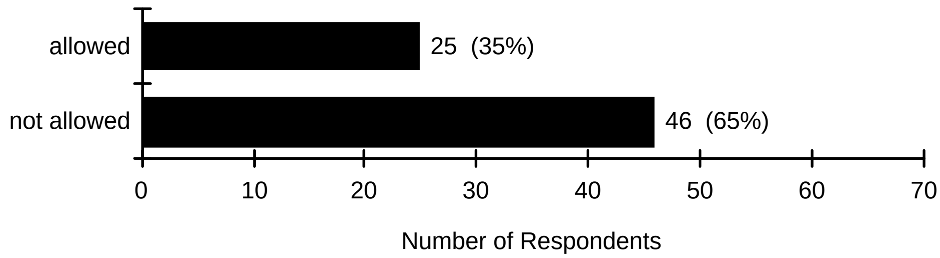
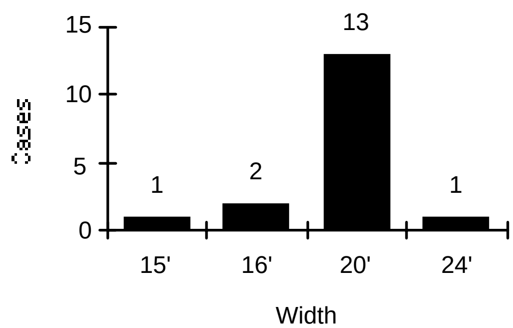


Figure 17. Minimum Requirements for Alley Width



Private Streets A private road or driveway, as defined by the Uniform Vehicle Code, is an "every way or place in private ownership and used for vehicular travel by the owner and those having express or implied permission from the owner, but not by other persons." (1956, Sec. 1-148) In many contemporary subdivisions developers try to utilize the private street option in order to minimize the required geometric design standards and cut down on their costs. As the streets are maintained by the homeowners association the city is typically exculpated from full liability. As such, the city often permits their construction along less rigid standards that results in narrower roadways and smaller building setbacks.

Almost all of the cities surveyed (84%), allow for different street standard configurations in private developments. Among the cities that allow for a construction of a narrower roadway, sixty-four percent require a minimum width of 20 to 25 feet. This width is often stipulated with special parking requirements, but it still substantially less than the typical 36 foot roadway width of the public street. (Figure 18;19)

Figure 18. Exceptions for Street Standards in Private Developments

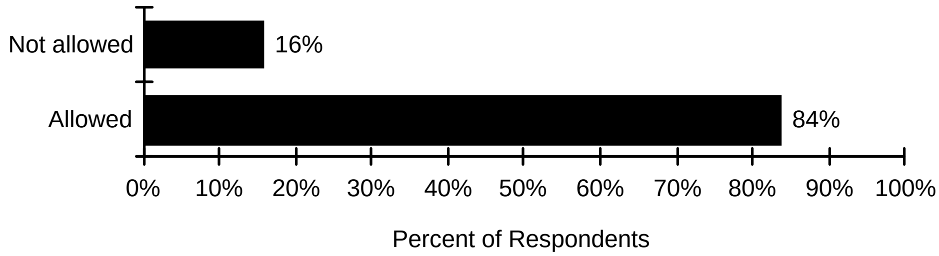
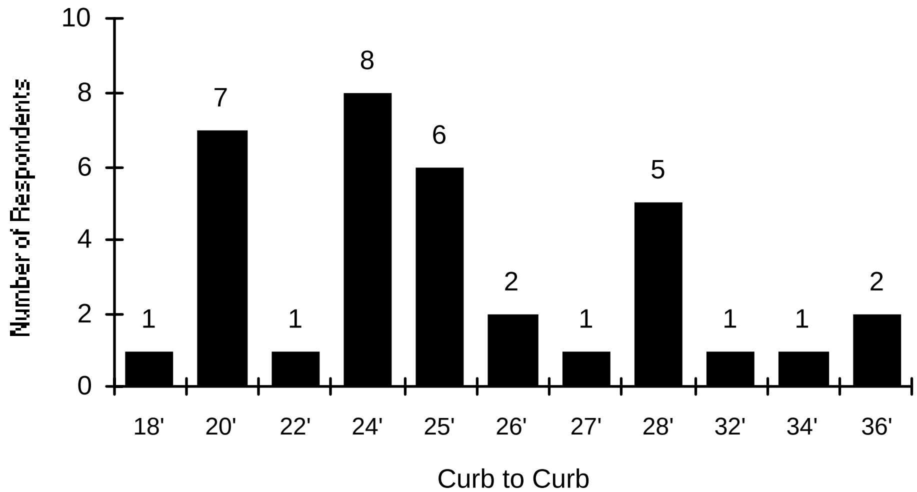


Figure 19. Minimum Requirements for Private Streets Width



Other provisions for private streets allows for the introduction of different paving materials, changes in street configurations, and the employment of traffic calming devices. Some of these provisions are further described in the following survey comments:

General Comments

- No strict requirements, only fire department can require standards relating to safety issues. (Colorado Springs, CO)
- Minor deviations are allowed subject to negotiations with the fire department. (Los Angeles)
- Many complaints on sub-standard width and private roads. for example: no on street parking allowed, and lack of adequate walkways. (Pleasanton)
- According to specific conditions, standards can be somewhat deviated from. (Moraga)
- Minimum street standards apply with some exceptions. (Walnut Creek)

Different Widths and Parking Configurations

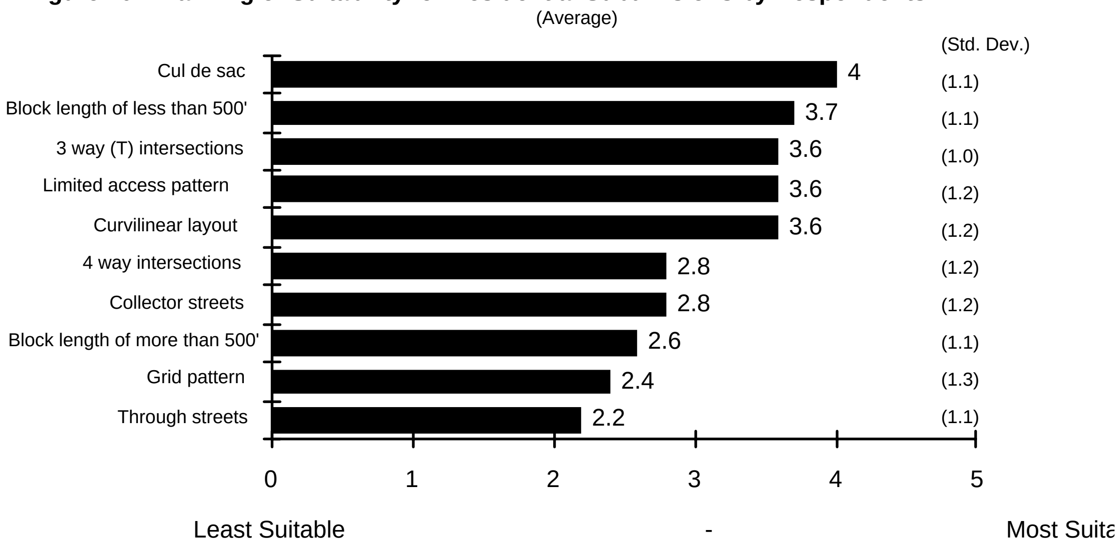
- 24' curb to curb, no parking and no sidewalks. One way loops at 20' curb to curb, no on street parking and no sidewalks. (Danville)

- 25' curb to curb, with no on street parking. Streets not built according to city standards are not permitted to be convert from private to public status. (Denver, CO)
- Rolled curbs are permitted. Sidewalks are not required. (Fresno)
- 26' curb to curb with no on street parking. (Gilroy)
- Minimum 28' without on street parking. (Livermore)
- Special paving allowed. (Mill Valley)
- Pinch points and planters are allowed. (Pittsburg)
- Limited to four dwelling units with no parking on both sides. (San Bernadino)
- 38' ROW, 28' curb to curb, no on street parking. (Vacaville)
- 25' curb to curb, sidewalks can be designed as a path within the development, parking can be handled off the street. Any proposal would be considered. (Watsonville)

Urban Form and Traffic-Suitability of Street Patterns to Residential Subdivisions

City officials were asked to rank the suitability of different road forms and urban forms for residential subdivisions. On a scale of 0 to 5, 'cul-de-sac street' received the highest average ranking (4), with 'short block length', 'T intersections', 'limited access street pattern', and 'curvilinear pattern' at a close second. (Figure 20) These attributes conform with the prevailing principles of subdivision street layout as set forth by most federal and professional agencies in the last sixty years. (Southworth, Ben-Joseph 1995)

Figure 20. Ranking of Suitability for Residential Subdivisions by Respondents



Some of the respondents provided the following comments:

Street Pattern

- "Most problems occur in subdivision layouts (post 1950) with curvilinear streets. The city has re-adopted grid system layout for all future subdivisions. The city uses an alternating stop sign pattern in the residential grid to avoid long uncontrolled segments with excellent success at controlling speeds. Having properly spaced collector streets and controlling non-residential land uses resolves many of the typical problems. We have very few traffic problems in the pure residential grid areas." (Denver, CO)
- "This goes back to initial design philosophy. Correcting the problems of the old grid pattern is what this is all about. It would be difficult to over -emphasize the importance of initial design and (fitting together) of adjacent subdivisions. "(Gilroy)
- "T-intersections are safer, but do not lend to a grid pattern. No developers in our area are currently developing grid neighborhoods. We are saturated with curvilinear design

and cul-de-sacs and virtually no through traffic. However, the primary access into these sub-divisions are where we get 75% of our complaints- speed, safety and children." (Greensboro, NC)

- "For the last 20 years we encouraged circuitous curvilinear street patterns with maximum length of street within a subdivision of 1,500'." (Fresno)
- "Irvine's curvilinear street design for residential streets has prevented many of the typical local street problems with cut-through traffic and high speed." (Irvine)
- "Limiting 4-way intersections improves safety but needs to be balanced with ease of direct access for transit and bicycles. We try to compromise between the true grid pattern and the limited access/curvilinear/ cul-de sac design." (Lodi)
- "Collector streets should border the subdivision and provide connection from neighborhood to neighborhood. Dead-end or cul-de-sac streets often place the connecting street as a through street, while grid patterns distribute traffic load fairly. Each situation must be looked at with all factors in mind. Limited access patterns can be very suitable depending upon adjacent street system." (Orlando, FL)

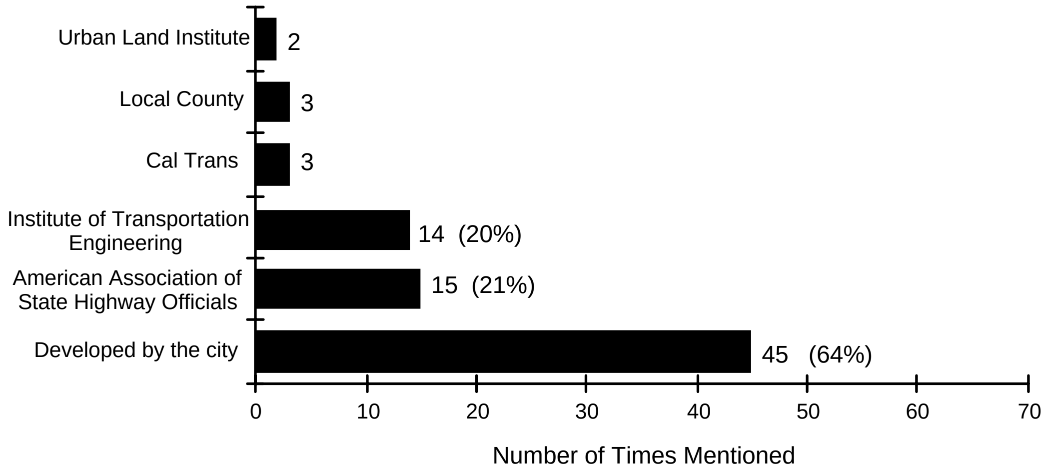
Accessibility

- "Auto access into and through a neighborhood should be limited. Bicycle access should be maximized." (Chico)
- "Public streets should be designed for the safe and efficient movement of vehicular traffic. Pedestrians should be kept separate on sidewalks, playgrounds and residential yards. Building planters and other obstructions in roadways may increase hazard and liability. Streets are safe enough to cross when necessary if children are taught and disciplined properly. American governments do not have enough authority to dictate overall land development design to provide that all streets are safe enough to play on." (Fresno)
- "Pedestrian pathways within residential subdivisions and commercial areas to encourage walking. Provide ample park and recreation facilities so that children will not have to play on streets. Building livable residential streets so that speed can be reduced through design." (San Diego)

Sources and Adequacy of the Cities' Street Standards

The survey indicates that the majority of the cities are developing their own street guidelines and standards. When asked to indicate the sources they have used, the option 'Developed by the city' was checked 45 times out of the 70 responses. Although this might attest to the cities' legislative sovereignty, in reality most of their indicated standards are not different from previously published guidelines, such as those by ITE and the AASHTO. Furthermore only 30 percent of the respondents indicate the possibility of amending their existing city street standards, and only 18 percent proclaim dissatisfaction with them. (Figure 21)

Figure 21. Sources of the Cities' Residential Street Standards



Some of the 21 cities that are considering changes to their residential street standards indicate the following :

- Changing minimum roadway to 20 feet. (Boulder, CO)
- New general plan will incorporate Neo-traditional concepts. (Chico)
- Reviewed and adopted lesser standard of 32' for residential streets in one proposed Neo-traditional neighborhood. Any actual construction using this standard is a few years off and limited to that development. (Chula Vista)
- Most developments are now PUDs which set their own standards- there is little need for formal standards. (Clayton)
- Desire to reestablish setback sidewalk standard with minimum 5' planting and narrow roadway to 32'. (Denver, CO)
- Might consider more narrower standards and eliminating on street parking. (Gilroy)
- Looking at village concept with narrower streets. (Livermore)
- Developing street standards for Neo-traditional neighborhoods with improvement in travel speeds (lower speeds) through residential streets. (Modesto)
- Adopted a new ordinance creating "rural street standards." The attempt of these additions to the Novato Municipal Code is to provide more flexibility in designing a street to meet the rural character of portions of our community. (Novato)
- Adding traffic calming devices. (Tacoma, West Palm Beach, FL)

Others express their desire for change in the following comments:

Flexibility

- Create more flexible standards based on use/design criteria. (Boulder, CO, Fresno, Moraga)
- All private streets should meet some city imposed standards. (Colorado Springs, CO)

Street Width

- "We generally require too much width- resulting in excessive speed problems. Reduction of width and perhaps restricting parking to make street more livable is desirable." (Bakersfield)
- Eliminate standards with parking on one side only (difficult to enforce). Provide sidewalks in residential areas on both sides of the street. (Danville)
- Would like to require wider ROW for landscaping purposes. (Houston, TX)
- Tighter horizontal curvature, narrow width. (Lakewood, CO)
- Narrower local streets - to 36 feet and reduced width on cul-de-sacs. (Livermore)
- Reduce residential street width. (Poway)
- Where large lots are planned and parking could be accommodated on one side of the street the width could be reduced to 32'. (Riverside)
- Completely eliminate reduced width street standard from our city standards. Cannot properly enforce no parking which is required for these types of streets to operate efficiently and safely. (Vacaville)

Street -Form

- Less grid network and more discontinuous design, less inviting for cut-through and speeding. (Austin, TX)
- Instead of narrowing roadway width, increase ROW width to 60' to provide desired planting and setback sidewalk. Original standard until 1940 was 80' ROW with setback sidewalk and 36' to 40' streets. These are the most aesthetically pleasing neighborhoods. (Denver, CO)
- Not to allow residential street to intersect with arterial or major collectors. (Garden Grove)
- Eliminate alternative standards that allow monolithic sidewalks or none at all. Increase planter strip width to provide for adequate shade tree planting and separate sidewalk from roadway for more pleasant streetscape. (Fresno)
- Wider parkway area to provide for meandering sidewalks for a more interesting pedestrian experience. (Los Angeles)

Traffic Calming

- The city is very interested in pursuing residential traffic control programs, but it has been very difficult to achieve community consensus and to deal with the significant liability exposure. (Del-Mar)
- Considering European concepts if installed by developers. (Pleasant Hill)
- Considering some traffic control measures to discourage non-residential traffic. (Watsonville)

Residential Street Safety & Traffic Performance

Problems Associated With Residential Streets

Seventy-one percent of the surveyed cities report some form of a major problem on their residential streets. Twenty-nine percent of the cities report only minor problems, while no city reports the total absence of problems on their residential streets. The most common major problem is speed of traffic, (reported by 50 cities), with safety at intersections and children playing on streets seen as the second most serious problem. (Figure 22;23)

Figure 22. Number of Cities Reporting Problems on Residential Streets and their Type

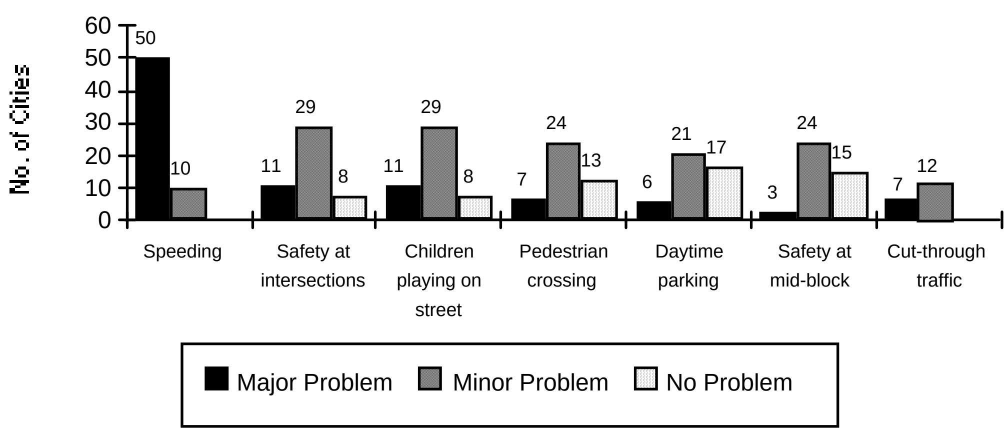
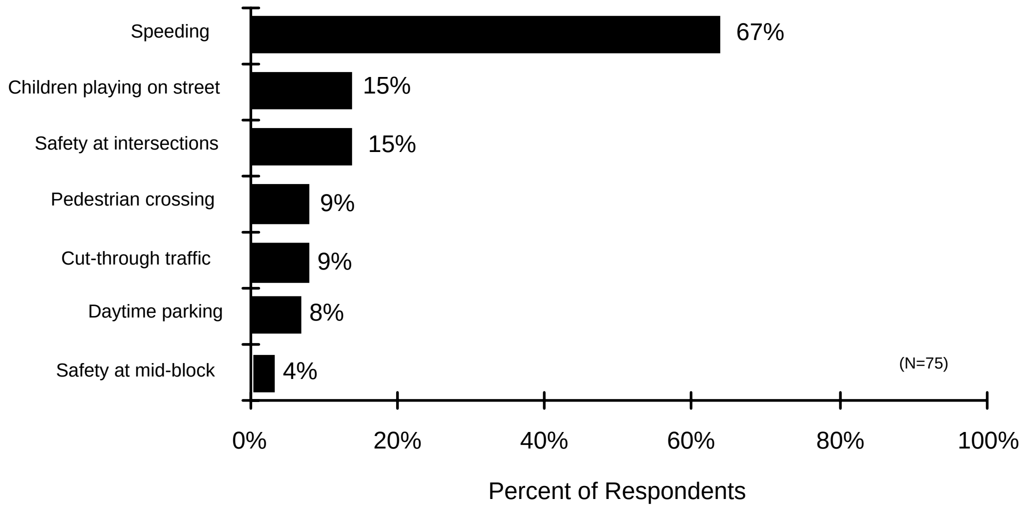


Figure 23. Major Problems on Residential Streets



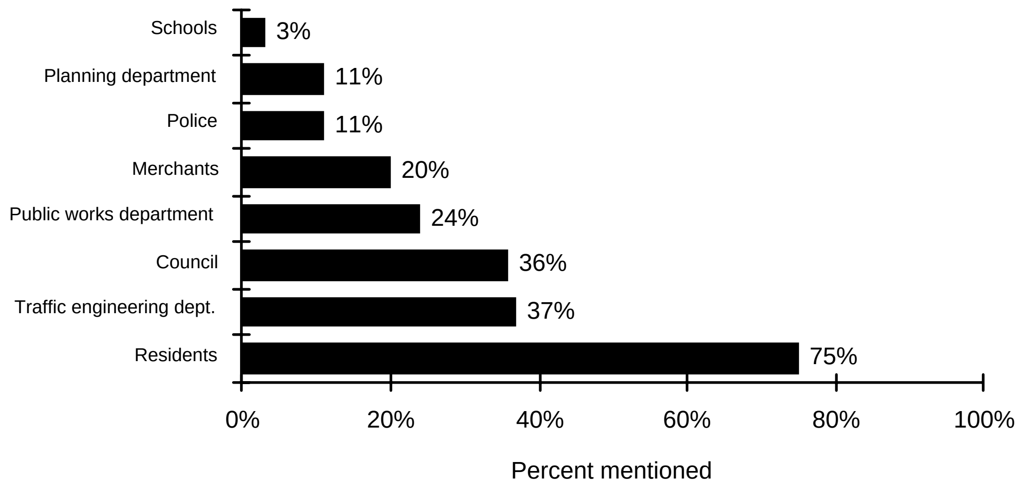
According to city officials, residents of residential neighborhoods are the most aware of traffic problems on their streets. The survey indicates that in the majority of cases (75%) it is the local residents who perceived and complained about traffic related problems. The extent of residents' dissatisfaction might indicate an inconsistency between professional practice, as manifested in street design, and its actual performance as experienced by the residents. (Figure 24)

Some of the survey comments reflect these issues:

- "City has started a neighborhood safety program; this is a three phase program. Phase one- "Garden Grove Slow". This phase lets residents call in vehicle license plates and description for speeders. Letter is sent requiring driver to slow down. Phase two - after phase one, neighborhood meetings are held and signs, striping, and markers may be installed. Phase three- if phase one and two are not effective then phase three looks at installing diverters, street closures, islands, etc." (Garden Grove)
- "In residential areas speeding is perceived to be the number one traffic related safety problem by residents." (Los Angeles)
- "Speeding is often a neighborhood issue and is dealt with increased education and police enforcement." (Novato)
- "One of the most frequent complaints to the Street Transportation Department is speeding on residential streets. The Neighborhood Speed Watch Program has been established to address this issue. Neighborhood Speed Watch is a public awareness program to record vehicle speeds on neighborhood streets and notify the registered owners of those vehicles observed speeding. It is a program in which

concerned citizens can play an active role in helping solve speeding problems in their neighborhood." (Phoenix, AZ)

Figure 24. Those Who Percive Problems on Residential Streets Within the Cities



Neighborhood Traffic Management Schemes

Protection & Control A conflict arises when motorists choose to exit major streets and use local streets for passage through an area. When traffic volumes and speed increase beyond what is considered normal by local residents, the well being and livability in the affected neighborhood is threatened. These neighborhood traffic problems take various forms, and are generally characterized by the following concerns:

- Traffic Safety—The occurrence or expectation that accidents might occur and pedestrians, children in particular, would get hurt.
- Traffic Speed—Excessive speed. The negative reaction to speed is often a translation of concern over safety and high noise levels. Vehicles driven at high speeds are seen as a threat to the peace, safety and quality of life within the neighborhood.
- Traffic Volumes— Excessive amounts of traffic are often a reflection of safety and speed issues. In most cases, "through" traffic is the source of excessive traffic volumes but it can also be generated by certain land uses.
- Traffic Composition—Certain types of vehicles, especially trucks, buses and motorcycles, are a causes of annoyance, and are perceived as more hazardous than automobiles.

- Reduction of the Pedestrians and Social Activities—when traffic volumes increase beyond what is considered normal by local residents, or vehicle speeds increase because of street design, social street activities are greatly reduced, and the feeling of well being in the affected neighborhood is threatened.
- Impacts on and Identity—Excessive traffic problems might lead to increased resident turnover and neighborhood instability. It might also reduce residents' incentive to maintain their properties and invest in their outdoor areas.

The concept of protecting neighborhoods by ensuring that local streets serve their residential function is often supported by local ordinances. For example, the city of Tucson's Ordinance Number 6593 states in part: "All actions with regard to implementation of any feature of the Regional Transportation Plan or land use change proposal adjacent to any feature shall consider as a primary goal, the protection of existing neighborhood environments, cohesion, and integrity". (Tucson, City of 1991, 2)

The failure of existing local street systems, and physical design to provide the social qualities associated with the residential street, can be seen in the extensive application of traffic control devices by local authorities. Seventy-two percent of the 75 surveyed cities have indicated an initiation of some form of traffic control on their residential streets. Furthermore, in almost all the cases (83%), traffic control devices were initiated because of residents' demand due to safety (speeding) and through traffic. (Figure 25;26)

Figure 25. Reasons for Implementing Traffic Calming Techniques

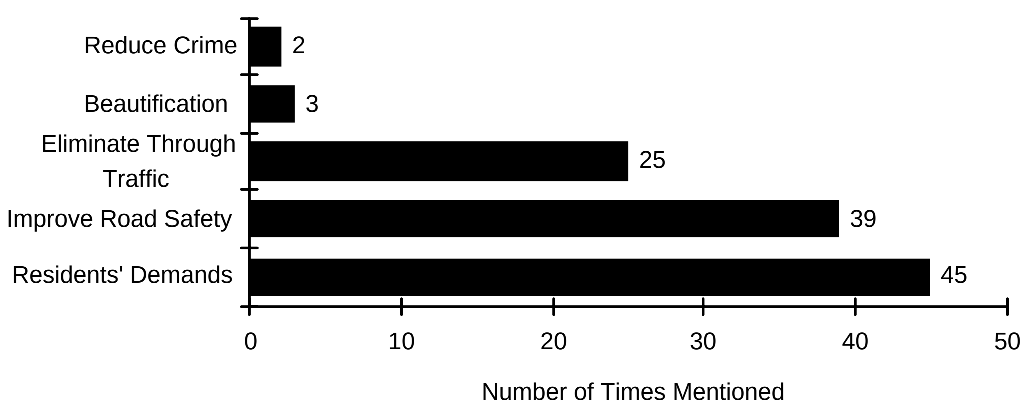
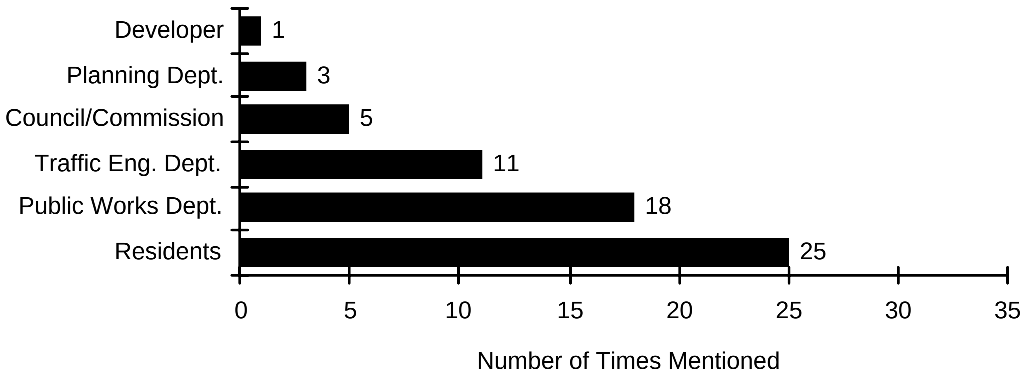


Figure 26. Project Initiation

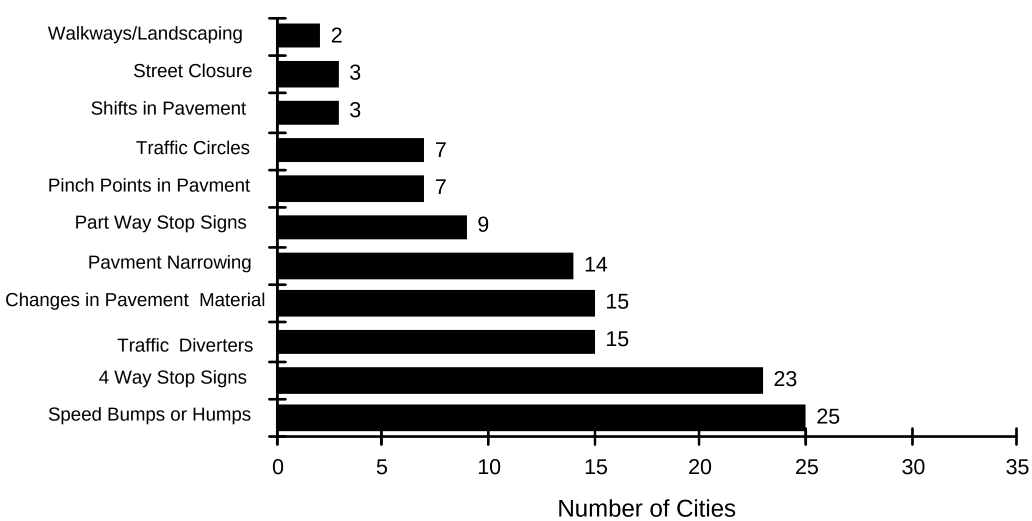


The most common technique utilized by the cities is the installation of speed humps and 4-way stop signs. (Figure 27) According to the cities' reports these techniques, as well as diverters and pavement narrowing have the most effective results. These selected techniques were considered to be effective in controlling at least one of the two major problem associated with neighborhood traffic:

- Reduction of speeds in excess of the posted speed limit.
- Reduction of unwanted traffic volumes (cut-through traffic).

The techniques were also considered to have the potential to enhance the neighborhood environmental quality through the reduction of noise, adverse air quality, beautification (landscaping), and providing a potential deterrent to crime.

Figure. 27 Utilized Traffic Calming Techniques

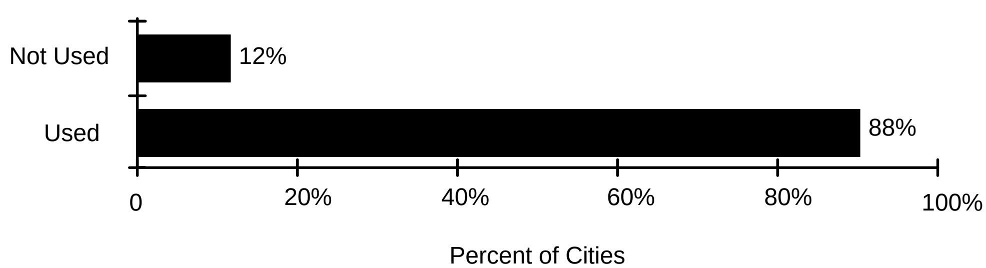


Public Involvement The key to successful implementation of a traffic management program is its acceptance by the local community. This is best achieved through the involvement of the local community in both the design and implementation stages. Most cities require both an initiation stage and a participation stage by the local residents. The city of Omaha, for example, requires that at least 75% of the property owners living at the segment of the street to be mitigated sign a petition agreeing to the traffic control device installation. Other cities establish similar procedures, these are exemplified by the city of Phoenix's requirements for the installation of speed humps:

1. Homeowners contact the Street Transportation Department to identify the streets involved and to name a representative willing to serve as the neighborhood contact.
2. Staff checks the street to determine if humps might be beneficial. The evaluation process includes receiving assurances from the Police and Fire Departments that humps will not create problems for emergency vehicles. If favorable conditions exist, the location and number of humps are determined by the city Traffic Investigator. This information is used to calculate cost estimates and to identify the immediate area of impact. Final hump locations identify where resident signatures, showing approval, are required.
3. To insure those residents most affected want humps installed, and to insure those affected in a broader sense are alerted that humps are being considered, two petitions are needed. One petition must show at least 75% approval from residents in the area that the hump is needed. All residents who live within 50 feet of the hump must approve. The other petition is used to insure that notice is given to other nearby residents who may be affected, that humps are being considered.
4. If the neighborhood collectively wants the humps and the streets meet the criteria, residents need to submit the two completed petitions along with a check to cover the initial and maintenance costs of signing and striping the humps.
5. Should conditions change and the neighborhood no longer wants the humps, a petition requesting the removal (with at least 51% approval) must be submitted. If approved, the neighborhood would be responsible for removal costs.

Almost all cities surveyed adhere to participatory procedures. Forty-two cities (88%) out of the forty-eight which implemented traffic management plans or controlling devices have consulted with the local residents. (Figure 28)

Figure 28. Participation Procedures with Residents as Part of Traffic Managment Program



Selected Techniques

The following are the most common physical devices used by the cities to control traffic. These devices and their application were of interest in the analysis of this study for the following reasons:

- Their installation changes the character and physical form of the original street.
- With the exception of road humps and traffic diverters, most of the techniques are widely and successfully used in Europe but not in the United States.
- Most of the devices are not covered in the Manual on Uniform Traffic Control Devices (MUTCD), do not have established standards, but are generally accepted by the Institute of Transportation Engineers and U.S. Department of Transportation.

1. Speed Humps

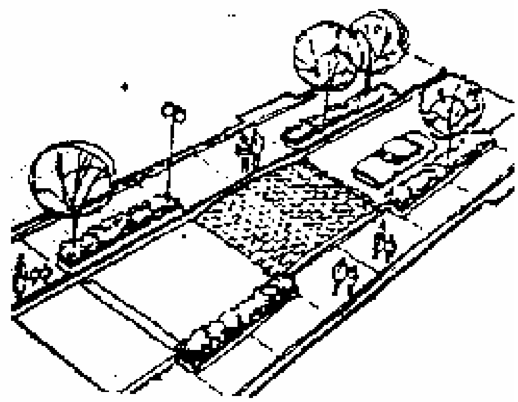


Figure 29. Speed Humps

Typical Application

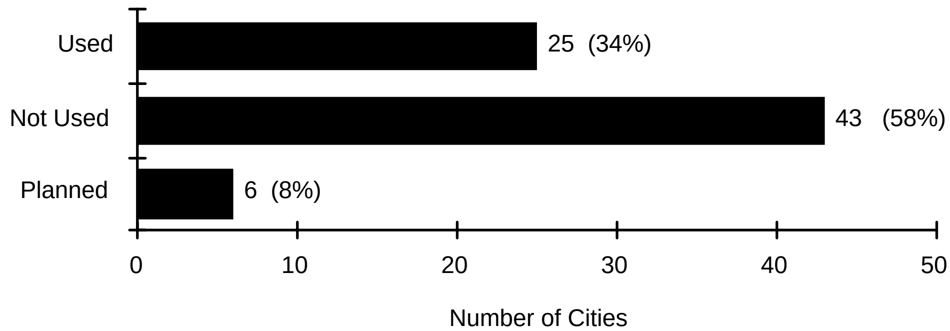
Used as speed and volume reduction technique.

Description

A road hump is a raised section of pavement approximately 12 feet long which gradually rises to a maximum height of 4 inches. It is usually built from curb to curb, or tapered to retain drainage and bicycle passage. The recommended installment of a 12 foot long hump, slows passing vehicles while reducing any potential vehicle damage or extreme driver discomfort that may have been encountered with the older speed bump design. Speed humps are generally not recommended for use on local streets with a high volume of bicycle traffic. Even though they can be designed to taper down to street level, near the curb for bicycle traffic, such a design may encourage automobile drivers to place one set of wheels in the bicycle area to reduce some of the effects of the hump. The same can be said for designs that allow drainage runoff to pass through a lowered section of the hump.

The majority of the cities surveyed, (58%), are not using speed humps citing liability and the lack of uniform standards as their major concerns. Forty-two percent of the cities are using or plan on using speed humps on their streets. (Figure 30)

Figure 30. Application of Speed Humps



The effects or impacts of using this device as noted by the literature and the surveyed cities are:

Speed and Volume Reduction It is generally accepted that when installed in a series, road humps will reduce the operating speeds and volumes of passing traffic. A single hump can reduce the 85 th percentile speed between 14 to 20 mph at the device itself. A series of humps with maximum spacing of 100 feet reportedly have an increased effect on speed reduction.

Survey Comments-

- Effective in reducing traffic speed. (Boulder, CO)
- Road bumps when 85% of traffic reaches 35 mph (Cupertino)
- Speed reductions documented, neighbors like them. (Colorado Springs, CO)
- Very effective, reduces 85% from 35 mph to 25 mph. Increases percentile in traffic pace from 85% to 100%. (Cupertino)

Safety There has been a great deal of debate as to the impact of speed humps on vehicle safety. While felt by some to be a hazard and promote erratic driving behavior, a study by a subcommittee of the California Traffic Control Devices Committee found that with between 150 and 200 million crossings of the state's hundreds of humps, very few claims for damages have been filed due to the undulations, and less than $20 has been awarded for damages. Fire trucks and other large vehicles report significant jolts when passing over the undulations. (JHK 1991, 23)

Survey Comments-

- Still apprehensive as to their safety. Two reported accidents in 3 years. (Poway)
- Not considered safe or effective. (Riverside)
- Installation on experimental basis in mid-1980s, practice has since been discontinued. Found to be a safety hazard to emergency vehicles. (Tampa, FL)

- Too many problems, operational and safety, associated with these. (Vacaville)

Standards and Guidelines Not covered in the Manual on Uniform Traffic Control Devices (MUTCD) but accepted by the Institute of Transportation Engineers through its publication: *Guidelines for the Design and Application of Speed Humps* (1993)

Survey Comments-

- Not approved traffic control device makes city liable for dangerous conditions. (Antioch)
- Concern about liability. (Greensboro, NC)
- Not approved traffic control device- Designed for discomfort. (Irvine)
- Attempting to establish acceptable dimensions for 25 mph before installing. (Pinole)
- Concern about liability. (San Bernadino)
- Tested on one street, awaiting state standards. (San Jose)

Community Reaction Mixed reaction has been noted. They are generally disliked by drivers but liked by local residents.

Survey Comments-

- Speed reductions documented, neighbors like them. (Colorado Springs, CO)
- Very affective in addressing residents' concerns about speeding. (Dallas, TX)
- As pilot project we integrated 10 humps. Got a positive response. Next phase 18 more would be installed. (Modesto)

Survey General Comments-

Positive-

- Initiating pilot programs starting September 1994. (Bakersfield)
- Good but have limited effect. (Clayton)
- Used in townhouse development, private property only (Hercules)
- Has implemented successfully a pilot program and is about to implement on a larger scale. (Los Angeles)
- Not used on public streets, but are used on some private streets. (Moraga)
- Used extensively in residential areas, parks and schools and by-pass. (Sacramento)
- Successfully used. (San Diego)
- Speed Bumps discontinued 8 years ago. Speed Humps now under consideration. (San Francisco)
- Successfully installed. (Tucson, AZ)

Negative-

- City made a comprehensive review and elected not to use. (Claremont)
- Would preclude snow removal. (Denver, CO)
- No longer used as a matter of policy. (Orlando, FL)
- Limited use , not effective. (Petaluma)

- The city has a policy of not installing speed bumps or humps. (Pittsburg)

Others It has been suggested that road humps can be noisy if the distance between them is not correct. This is due to braking before the hump and speeding up between them which increases noise and air pollution.

2. Pinch Points in Pavement

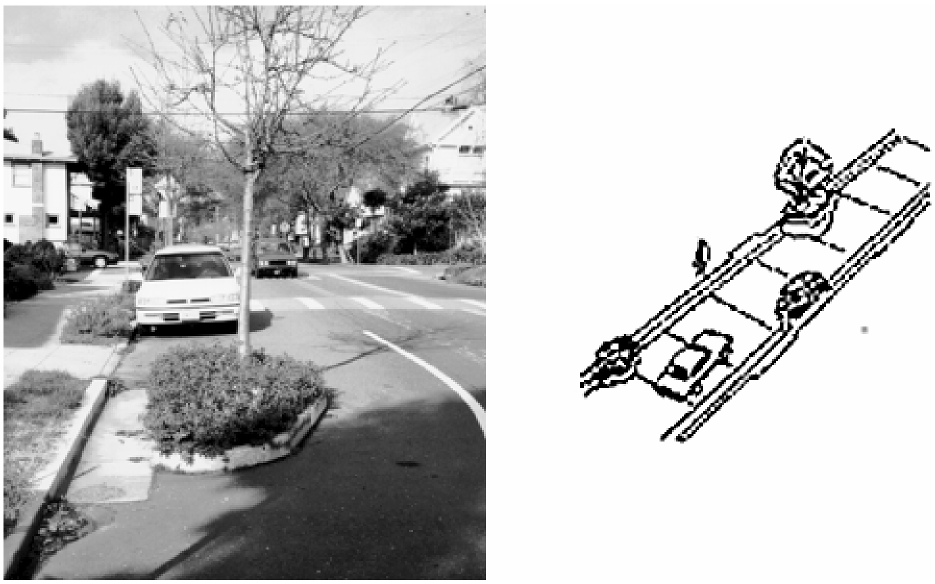


Figure 31. Pinch Points in Pavement

Typical Application

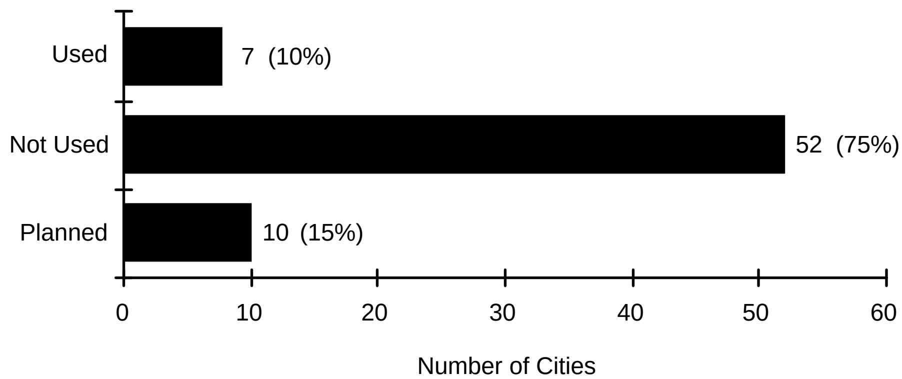
Effective in limiting the ability of cars to pass one another through narrow pavement, and thus reduce speeds.

Description

Constrictions are built in a form of extended planters or sidewalks at intervals along one side or both sides of the street. Width is influenced by various factors such as: traffic volume, provision for large vehicles and one or two-way traffic. Pinch points are usually most effective when combined with other controlling measures such as speed humps. Provisions for cyclists and drainage may be necessary in some cases.

This European technique for controlling traffic is not widely used in the United States. Seven of the surveyed cities indicate actual use of the technique, and ten others show an interest and possible application in future development. The majority of the cities (52) have not used the technique. (Figure 32)

Figure 32. Application of Pinch Points



The effects or impacts of using this device as noted by the cities are:

Speed and Volume Reduction Pinch points are mostly used to reduce traffic volumes by causing delays, but they are less effective as a speed reducing device. In order to maintain a low speed over a longer stretch, pinch points are usually placed at no less than 100 feet apart.

Survey Comments-

- Ineffective at reducing speeds (Colorado Springs, CO ; Cupertino)
- Used at two locations with good results. (Garden Grove)
- Installed in parking lanes. Minimal improvement. (Pinole)

Safety Pinch points pose some maintenance problems in street sweeping and obstruction of drainage. Need sufficient lighting to be seen well in advance.

Standards and Guidelines Not covered in the Manual on Uniform Traffic Control Devices.

Survey General Comments-

- Planned in Neo-Traditional neighborhoods. (Modesto)
- Recently implemented in some new developments. (Petaluma)
- May be considered to control speed. (Vacaville)

3. Shift in Pavement

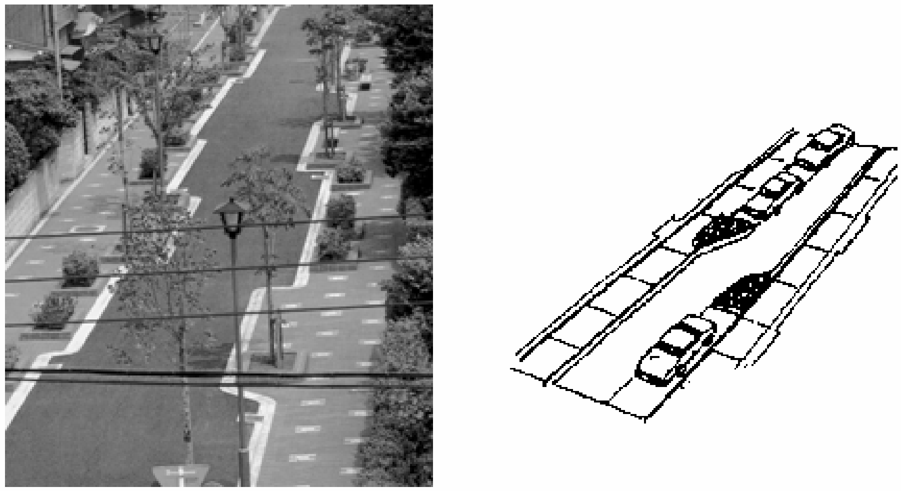


Figure 33. Shift in Pavement

Typical Application

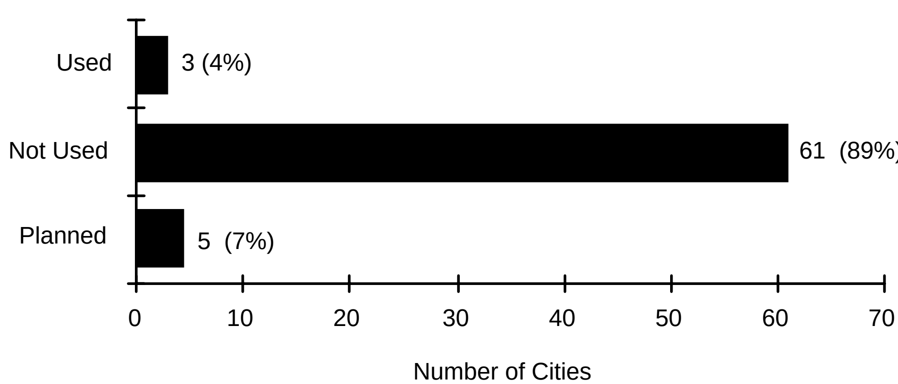
Reduction of traffic speed, and the rearrangement of street space, such as parking and sidewalks.

Description

Speed reduction is achieved by enforced turns and the interruption of drivers' forward views. Lateral shifts enforce the driver to make at least a 45 degree turn thus reducing speed. The lateral shift is often created by building alternating extensions in the pavement area. Alternate angle parking defined by permanent planters is another method used to achieve the lateral shift. The shift must be no less than the width of the traffic lane, in a two-way street, the provision of sufficient roadway width at the shift might enable drivers to take the middle line, and thus avoid the speed reducing effect. This problem may be negated by dividing the roadway at the shift.

This European method of controlling traffic speed is still unpopular in the United States. Only three of the surveyed cites have used this device on their streets. Five cities indicate an interest and possible application in the future. (Figure 34)

Figure 34. Application of Shift in Pavment



The effects or impacts of using this device as noted by literature and the surveyed cities are:

Speed and Volume Reduction European Studies show substantial decreases in speed at the shift. Results are compatible with those of speed humps.

Survey Comments-

- Ineffective at reducing speeds (Cupertino)
- This method reduced speeds and traffic volumes. (Garden Grove)

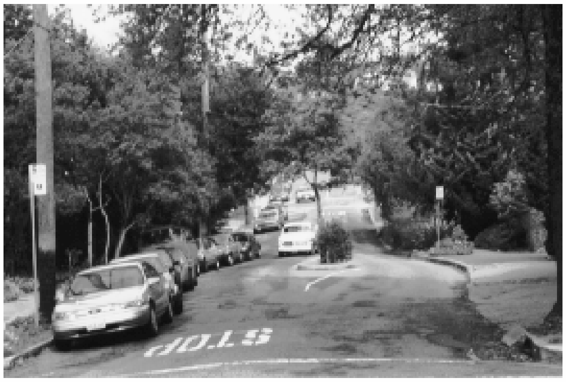
Safety The design alters the linear character of the street and therefore requires proper signs and a high standard of street lighting. Planting is desirable to lessen the impact of the extended islands. The extended non-vehicular space allows for interesting street design and increased pedestrian utilization of the street.

Standards and Guidelines Not covered in the Manual on Uniform Traffic Control Devices (MUTCD)

Survey General Comments-

- Have been considered- funding has been a problem as well as public acceptance. (Danville)
- May be considered. (Sacramento)
- Not used on public streets, but is used on some private streets. (Moraga)
- Would consider. (Livermore)

4. Pavement Narrowing (Chokers)



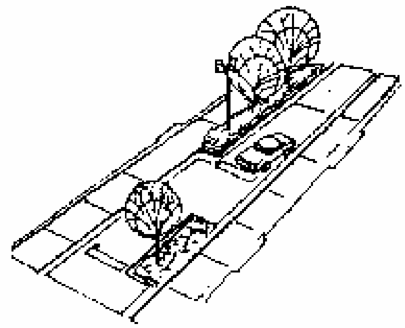


Figure 35. Pavement Narrowing

Typical Application

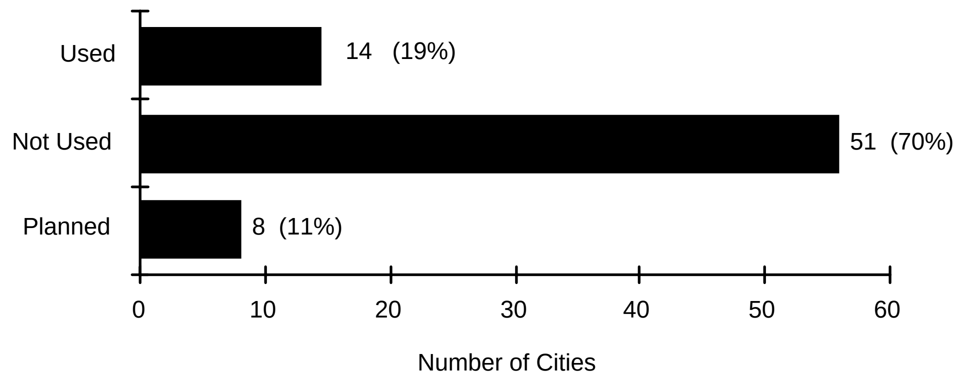
Speed reduction through extended narrow driving lane at mid-block.

Description

Extended concrete planters are constructed along both sides of the street at the parking lane. In contrast to pinch points, pavement narrowing is carried out over a longer stretch of the road. Some application of pavement narrowing can also be achieved through striping and road marking. Such application have the advantage of a narrow driving lane with an overrun lane for emergency use. This type of application has a limited effect on speed reduction if used by itself. European practices also apply pavement narrowing in the form of an extended middle island, reducing the street to narrow traffic lanes on both sides, (usually at a maximum width of 13 ft (4 m) for each lane. (Devon 1991, 50, Klau 1992, 38-39)

As with the application of Pinch Points, and Shift in Pavement, this method is not widely utilized in American cities. Fourteen of the surveyed cities use this device on their streets, while eight cities indicate future plans for implementation. Most of the applications are limited to private developments, with authorities reporting satisfactory results. In two of the cases, pavement narrowing was achieved through striping only. (Figure 36)

Figure 36. Application of Pavment Narrowing (Chokers)



The effects or impacts of using this device as noted by the cities are:

Speed and Volume Reduction

Survey Comments-

- This has reduced speeds and reduced traffic volumes. (Garden Grove)
- Does show some positive results. (Colorado Springs)

Standards and Guidelines Not covered in the Manual on Uniform Traffic Control Devices (MUTCD)

Survey General Comments-

- Limited to new developments. Partially for aesthetic reasons. (Petaluma)
- Limited to private streets and PUD. (San Jose)

5. Changes in Pavement Material

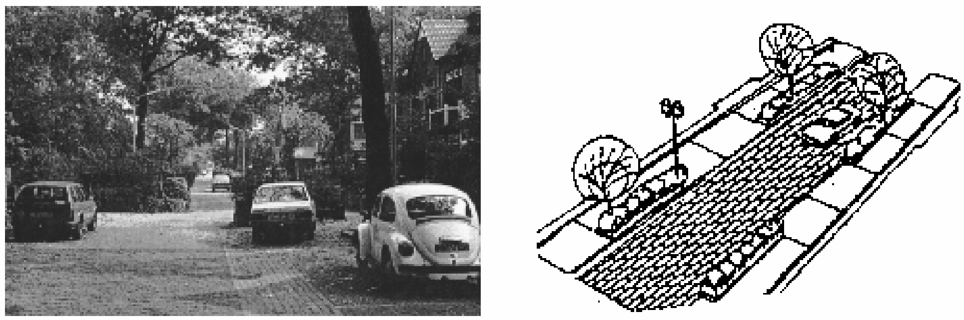


Figure 37. Changes in Pavement Material

Typical Application

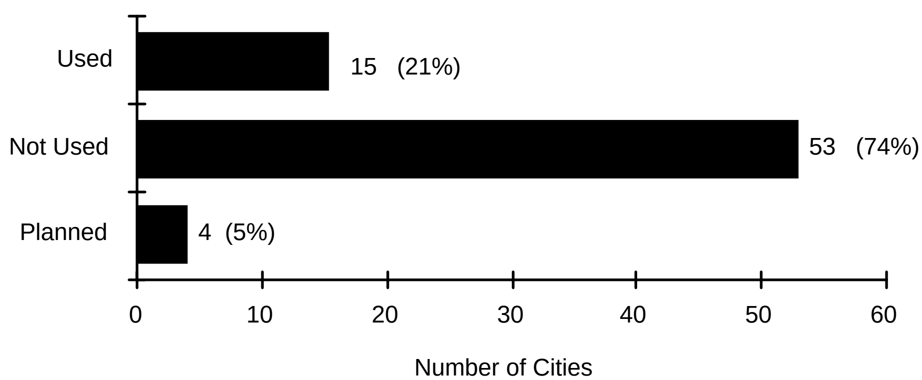
Defines special areas; useful in reinforcing other speed reduction measures.

Description

Pavement changes which result in a rougher driving area produces a visual and sensory reinforcement. It is often used to define entrances, crosswalks and improve street appearance. It may be useful in reinforcing speed reduction measures and to distinguish between different surface functions.

The use of paving material other than asphalt is usually confined to limited areas within a development. In all of the 15 cities that use this technique it is applied either in private or Planned Unit Developments or at special points to accentuate cross-walks. Most cities cite the cost as the major impedance of further implementation. (Figure 38)

Figure 38. Application of Changes in Pavement Material



The effects or impacts of using this device as noted by the cities are:

Speed and Volume Reduction Minor reduction of speed due to the rough surface. Better results can be achieved if accompanied by other measures.

Standards and Guidelines Not covered in the Manual on Uniform Traffic Control Devices (MUTCD) but generally accepted if applied according to uniform paving codes and standards.

Survey General Comments-

Positive-

- Used at entrences to new subdivision. (Antioch ; Livermore)
- Not used on public streets, but is used on some private streets. (Moraga)
- Use for crosswalk details. (Colorado Springs, CO)
- Good solution but expensive (Pleasant Hill)
- Used at the entrance of private streets. (San Clemente)
- Limited to private streets and PUD. (San Jose)
- Generally used at intersection/entries points to PUDs. (San Bernadino)
- Used to enhanced crosswalk area. (Tucson, AZ)

Negative-

- Limited use in intersections- Becomes a maintenance problem. (Irvine)
- Expensive alternative. (Modesto)

6. Traffic Diverters/ Barriers

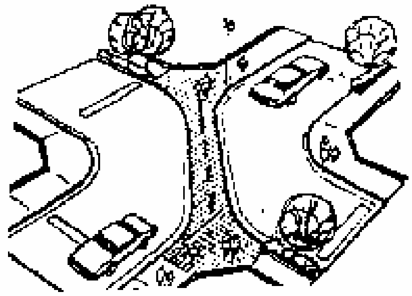


Figure 39. Traffic Diverters/ Barriers

Typical Application

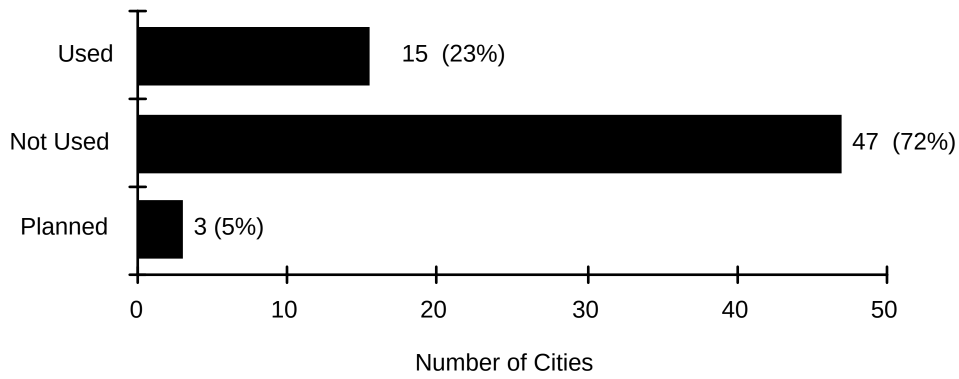
Discourage or preclude travel through a neighborhood by breaking up traffic patterns associated with a grid street system. Should be used as part of a comprehensive system. Limited use will cause traffic to shift to another street or neighborhood.

Description

A barrier diagonally placed through an intersection converts it into two unconnected streets. This eliminates direct uninterrupted movement by forcing a turn at the barrier. Non local traffic must travel a longer distance through the neighborhood, reducing the local neighborhood streets' potential as through ways. It has an advantage over cul-de-spacing in that traffic is not "trapped" on the street, making the installation more acceptable to local residents and the streets more accessible to emergency vehicles. Through proper design, landscaping, advance signing, and pavement markings safety and aesthetic impacts are minimized. The installation of diverters must be part of a comprehensive neighborhood traffic control system. The use of a diverter on a single street will divert traffic to other local streets.

This device is frequently utilized by cities that have residential grid neighborhoods. Twenty-eight percent of the cities surveyed indicate the use of diverters or are planning to use them. Application of the device is usually in response to the elimination of through traffic requested by local residents. Recently it has also been use to deter criminal action such as drive-by shootings and drug related activities in inner city residential neighborhoods, (Oakland, CA, and Miami, FL). (Figure 40)

Figure 40. Application of Traffic Diverters/Barriers



The effects or impacts of using this device as noted by the cities are:

Speed and Volume Reduction Studies have shown that traffic volumes can be reduced from 20 to 70 percent when used in conjunction with other diverter systems. Speed reduction is achieved only at the immediate vicinity of the diverter. However, general reductions in speed may be noticed if the diverters cause a breakup of typical higher speeds associated with linear through routes.

Safety Before and after studies of accident rates on streets with diverters show a substantial reduction in accidents after the installation of diverters. System wide accident experiences, however, reportedly remain the same. Some concerns have been expressed over emergency vehicle access and the aesthetic appearance of the diverters.

Survey Comments-

- Results have been mixed, police and fire have problems with access. (Garden Grove)
- Problem for emergency vehicles (Hercules)

Standards and Guidelines Not listed in the MUTCD. However, diverters may be considered as a channeling island, if constructed and marked as such.

Community Reaction While residents of areas where diverter systems are used are generally in favor of them, residents in other areas are generally opposed. This is exemplified by a vote in Berkeley, California where areas of the city that had no diverters voted for the removal of them in other parts of the city, while voters in areas with diverters voted to retain them.

Survey Comments-

- Successful at some locations, not at others. Usually installed due to neighborhood demand. (Perception of crime reduction). (Miami, FL)

Survey General Comments-

Positive-

- Creates a curvilinear street design over grid pattern. Creates natural diversion and eliminates cut-through trips. (Irvine)

- Used as necessary to prohibit left turns onto a major street. (Riverside)
- Effective if properly placed. Good subdivision design and planning avoids this problem. (Gilroy)
- One installation successfully completed. (Tucson, AZ)

Negative-

- Trial installation in inner Richmond district was not successful. (San Francisco)
- Limited areas, requires major traffic study. (San Jose)

Shared Streets (Woonerf)

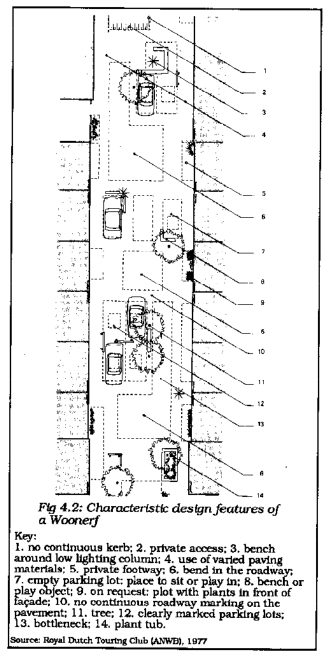


Figure 41. Shared Streets (Woonerf)

Description

The shared street concept (Woonerf) is the prevalent technique for residential neighborhood traffic control in Europe. Its fundamental concept is an antithesis to the notion of segregating pedestrians and vehicles. It is defined by the elimination of the traditional division between roadway and sidewalks. One road surface is created and the maximum vehicle speed is restricted to a walking pace. Thus pedestrians, children at play, bicyclists, parked cars and moving cars all share the same surface. Though it seems these uses conflict with each other, the physical design is such that the pedestrian has primary rights while the driver is the intruder. Various studies and surveys conducted in the last twenty years indicate a considerable reduction in traffic speed and accidents. They also show an increase of street's social interaction, play, and a high degree of satisfaction by the residents.

None of the surveyed cities have implemented such a concept, and only half (49%) were aware of its existence. Yet sixteen of the cities indicated interest and would consider possible application in the future.

Most of the cities voiced the following concerns in applying the concept to the American setting:

- Lack of approved guidelines and standards.
- Fear of liability.
- Problems with service and emergency access/approval.
- Cost and Maintenance

Survey Comments

Negative-

- Appears to give no consideration to traffic volume or safety, nor pedestrian safety. Ridiculous idea for a public street. (Antioch)
- Cleaning could be expensive if done by local agency. (Bakersfield)
- America uses larger trucks for local trips. Compounds danger of worst drivers. (Chico)
- Liability risk (Claremont)
- While residents are concerned about speed (Especially from vehicles outside the neighborhood), the inconvenience of this type of proposal would bother them more. (Clayton)
- The concept is appealing, but the liability concerns are very significant. (Del Mar)
- Appears that it would significantly increase maintenance cost. (Gilroy)
- Could be a problem for emergency vehicles. (Hercules)
- Looks disjointed with numerous conflict points. (Irvine)
- Liability and financing concerns would have to be resolved for this concept to be viable. (Los Angeles)
- Too many potential liability issues. Insufficient ROW width on most of our residential streets. (Miami, FL)
- Hinders maintenance and cleaning. Could cause liability problems if accidents occur. (Pittsburg)
- Mixed pedestrian and auto areas creates safety problems. (Pleasanton)
- Not appropriate. (Riverside)
- Too expensive (initial cost and maintenance) liability concern over some elements. Significant resident opposition to extreme measures. (San Jose)
- Expensive, eliminates certain number of parking spaces abutting residences. (San Francisco)
- Difficult to implement due to emergency service needs. (Tuscon, AZ)
- Can work in situations with 1,000 or less ADT. Not well received by the citizens. (Orlando, AZ)
- Not appropriate for our city. (Walnut Creek)

Positive-

- For higher density, 10+ units per acre, this type of street seems appropriate. The City of Boulder is going to try this concept on a limited basis. (Boulder)
- Appropriate for dense urban areas. (Cupertino)
- We would like to try this concept in several neighborhoods when the opportunity to do so presents itself. (Danville)
- This concept may be appropriate to some streets but we have no plans for installation. (Foster City)
- Could be used on private streets, cluster homes, PUDs, etc. (Greensboro, NC)
- We are considering a new program that will establish criteria to implement some of these ideas to determine benefits and appropriateness. (Sacramento)
- We would like to try this concept but the city is unable to fund it. (Lakewood, CO)
- Interested in pursuing this concept. (Littleton, CO)
- We would consider for very low volume streets. We are concern about liability issues. (Livermore)
- This would be acceptable in PUD with private streets. (Moraga)
- Appropriate for low volume residential street with less than 500 ADT. (San Clemente)
- Difficult to retrofit, loss of on-street parking. (San Diego)
- May be possible to implement for short streets. (Santa Barbara)
- This concept may be used in our mixed-use areas but probably not in residential areas. We may use some of these elements in our new residential streets. (Tacoma, WA)
- Because of high maintenance we would only consider it for private streets. (Watsonville)

Summary of Devices Use

The following charts summarize the survey and literature findings about traffic control techniques.

Table 2. Devices Characteristics and Potential- Summary

Device	Traffic Reduction	Speed Reduction	Noise & Pollution	Safety	Access Restrictions	Emergency Access	Maintenance Problems	Level of Violation	Cost
Speed Humps	Possible	Limited	Increase	Improved	None	Minor Problems	None	Low	Low
Pinch Points	Possible	Limited	No Change	Improved	None	No Problems	Vandalism	None	Moderate
Shift in Pavement	Possible	Likely	No Change	Improved	None	Minor Problems	None	None	Moderate
Pavement narrowing	Possible	Likely	No Change	Improved	None	Minor Problems	None	None	Moderate
Pavement material	No	Minor	No Change	Unclear	None	No Problems	None	None	Moderate
Shared Space (Woonerf)	Yes	Likely	Decrease	Improved	Some	Minor Problems	Vandalism	Low	High
Other Devices Mentioned									
Rumbling Strips	Unlikely	Limited	Increase	Unclear	None	Minor Problems	None	Low	Low
Stop Signs	Unlikely	None	Increase	Improved	None	No Problems	None	Potentially High	Low
Street Closure	Yes	Yes	Decrease	Improved	Yes	Some Constraints	None	Low	Moderate
Traffic Circle	Possible	Likely	No Change	Unclear	None	No Problems	None	Low	Moderate
Traffic diverters-barriers	Yes	Likely	Decrease	Improved	Yes	Minor Problems	Vandalism	Low	Moderate
Entrance Treatment	Possible	Limited	No Change	Improved	Some	Minor Problems	Vandalism	None	Moderate
Force Turn	Yes	Possible	Decrease	Improved	some	Minor Problems	None	Potentially High	Low

CONCLUSIONS & PROSPECTS

As a result of the study findings, the following general conclusions can be drawn:

- Most cities are still adhering to published street standards as recommended by different professional organizations.
- Even though most of the cities develop and inscribe their own sets of guidelines and standards, these are often no different than those published by professional and government institutions.
- Although many city officials acknowledge the need to amend certain aspects of their regulations and create a more flexible framework for street design, most hold that the current practice is satisfactory.
- The prevalent minimum street standards set by cities are:
  - ROW- 50 feet
  - Roadway width (curb to curb)- 36 feet - (two- 10 foot driving lanes, two -8 foot parking lanes). This dimension is also deemed to be the most appropriate roadway width by the majority of the respondents.
  - Sidewalks- 5 feet (Required by 84% of the cities).
  - Planting Strip (between curb and sidewalk), not required.
  - Building Setback- 20 feet
  - Street Trees- 1 per lot

- The desire to accommodate a "worst case design scenario" such as: cars parked on both sides of the street, an emergency vehicle with its outriggers, and one open travel lane on a residential street, often leads to an excessive width, higher travel speeds and probably fewer pedestrians.
- One of the prevalent reasons for not implementing different street configurations and standards is due to liability concerns. The fact that public street standards are rigid and less bound to be changed can be seen when compared to private street configurations. When the burden of liability is transferred from the city to the homeowners association, typical street guidelines and standards are categorically changed. The majority of cities (84%) allow for such changes, with most permitting different widths and parking configurations.
- With regard to the street system, cul-de-sacs are seen by the respondents as the most appropriate form of street for residential neighborhoods, while grid patterns and through streets are considered less suitable.
- A discrepancy exists between the officials' satisfaction with their cities' street standards and the share of traffic problems associated with the streets.

- This discrepancy can also be seen in the application of traffic control devices used by local authorities to mitigate these problems.
- Residents of residential neighborhoods are the most aware of traffic problems on their streets. In the majority of cases (75%), it is the local residents who perceive and complain about traffic related problems. The extent of the residents' complaints might indicate an inconsistency between professional views, as manifested in street design, and the street actual traffic performance as experienced by the residents.
- Speed of traffic is the most common problem associated with residential streets.
- The most common technique utilized by the cities to control speed is the installation of speed humps and 4-way stop signs. According to the cities' reports these techniques, as well as diverters and pavement narrowing, have the most effective results.

Prospects

The independence of local agencies, and their ability to perform away from the government's yardstick is key to changing regulations and standards. In many parts of the United States such trends are beginning to emerge. As more communities are wrestling with quality-of-life problems due to uncontrolled growth, environmental pollution and failure of existing infrastructure, they begin to take a stronger interest in their local power. The importance of local decision making and its self-empowerment has also been acknowledged by the federal government. An example of such can be seen in the federal Inter Model Surface Transportation Efficiency act of 1991. ISTAE, for the first time, re-authorized the federal-aid highway and transit funds to be distributed at the discretion of state and local agencies. This act opens the possibility for local communities to establish their own initiatives, and be supported legally and financially by favorable agencies.

It is important for city officials to realize that courts have usually ruled in favor of local jurisdictions that approved lower design standards for local roads, as long as the standards were set in writing. (Mercier 1987) In California, as well as in other states, under statutory immunities titled "design immunity", a public entity is generally not liable for injuries caused by a dangerous condition of public property if the following three essential elements are satisfied:

(1) a causal relationship between the plan or design and the accident.

(2) discretionary approval of the plan or design prior to construction or improvement.

(3) substantial evidence supporting the reasonableness of the plan or design.

As stated by the courts in several cases, this type of immunity reflects a legislative intent to insulate discretionary planning and design decisions by responsible public officials from review in tort litigation. (Freiser 1992, 367-372) These acts are particularly important as liability and legal issues are cited by cities' transportation and public works departments as the most critical issue associated with the implementation of different street configurations and reduced standards.

It seems that in the near future the most probable venue for implementing change in residential street standards and regulations will be in the private domain. As seen in this study, most cities allow for a different, more flexible, set of standards to be implemented on private streets. A successful example of this approach can be seen at Seaside, Florida. In this private development the residential streets are composed of one paved surface shared by pedestrians and cars. There are no raised sidewalks or curbs, and automobile speed is controlled by the narrow driveway and the short street block. Yet, the private street should only serve as an interim solution leading to changes of standards for public streets. City officials should realize that the current practice of allowing a different set of standards on private streets, acknowledges the inadequacy of their public street standards, and validates the assumption that liability issues guide change rather than actual performance.

Finally, it is crucial that public and professional agencies and associations such as the Institute of Traffic Engineers, the American Association of State Highway and Transportation Officials, and the National Committee on Uniform Traffic Laws and Ordinances, will periodically review, revise and make their guidelines versatile. The publications of such official documents provides the local jurisdictions with the necessary support to justify decision contrary to conventional practice.

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Appendix A.- Survey Sample
Appendix B.- Participating Cities

City	Department	Telephone
Albany, CA	Public Works	(510) 528-5759
Antioch, CA	Public Works	(510) 779-7050
Austin, TX	Transportation Division	(512) 499-7010
Bakersfield, CA	Public Works	(805) 326-3724
Boulder, CO	Public Works	(303) 441-3240
Brentwood, CA	Public Works	(510) 634-6920
Burlingame, CA	Public Works	(415) 696-7236
Chico, CA	General Services	(916) 895-4989
Chula Vista, CA	Public Works	(619) 691-5116
Claremont, CA	Public Works	(909) 399-5474
Clayton, CA	Engineering	(510) 672-9700
Col. Springs, CO	Transportation	(719) 578-6663
Cupertino, CA	Public Works	(408) 777-3240
Dallas, TX	Transportation	(214) 670-5035
Danville, CA	Development Services	(510) 820-1080
Del Mar, CA	Public Works	(619) 755-3294
Denver, CO	Public Works	(303) 640-3958
Dublin, CA	Public Works	(510) 833-6630
El Cajon, CA	Public Works	(619) 441-1651
Foster City, CA	Public Works	(415) 349-1200
Fresno, CA	Public Works	(209) 498-1461
Garden Grove, CA	Development Services	(714) 741-5190
Gilroy, CA	Public Works	(408) 848-0450
Greensboro, NC	Transportation	(910) 373-2229
Hercules, CA	Public Works	(510) 799-8242
Houston, TX	Public Works	(913) 658-4334
Irvine, CA	Public Works	(714) 724-6425

La Mesa, CA	Public Works	(619) 463-6611
City	Department	Telephone
Laguna Niguel, CA	Public Works	(714) 362-4377
Lakewood, CO	Traffic Engineering	(303) 987-7984
Littleton, CO	Public Services	(303) 795-3863
Livermore, CA	Public Works	(510) 373-5263
Lodi, CA	Public Works	(209) 333-6706
Los Altos, CA	Public Works	(415) 948-1491
Los Angeles, CA	Transportation	(213) 485-6193
Martinez, CA	Community Development	(510) 372-3562
Miami, FL	Public Works	N/A
Mill Valley, CA	Public Works	(415) 383-6020
Modesto, CA	Public Works	(209) 577-5430
Moraga, CA	Town Engineer	(510) 546-7111
Morgan Hill, CA	Public Works	(408) 776-7337
Novato, CA	City Engineer	(415) 897-4354
Omaha, NB	Public Works	(402) 444-5251
Orlando, FL	Public Works	(407) 246-3262
Pasadena, CA	Public Works	(818) 405-4266
Pasadena, TX	Public Works	(713) 475-7836
Petaluma, CA	Public Works	(707) 778-4345
Phoenix, AZ	Street Transportation	(602) 262-6136
Pinole, CA	Public Works	(510) 724-9010
Pittsburg, CA	Engineering	(510) 439-4930
Pleasant Hill, CA	Public Works	(510) 671-5252
Pleasanton, CA	Traffic Engineering	(510) 484-8313
Poway, CA	Engineering Services	(619) 679-4353
Riverside, CA	Public Works	(909) 782-5327
Sacramento, CA	Public Works	(916) 264-7508
San Bernadino, CA	Public Works	(909) 384-5213

City	Department	Telephone
San Clemente, CA	Public Works	(714) 498-2533
San Diego, CA	Traffic Engineering	(619) 533-3181
San Francisco, CA	Parking and Traffic	(415) 554-2307
San Jose, CA	Public Works	(408) 277-4304
San Mateo, CA	Public Works	(415) 377-3323
Santa Barbara, CA	Transportation and Parking	(805) 564-5385
Simi Valley, CA	Public Works	(805) 583-6808
St. Petersburg, FL	Traffic Engineering	(813) 893-7421
Stockton, CA	Public Works	(209) 937-8428
Tacoma, WA	Public Works	(206) 591-5269
Tampa, FL	Public Works	(813) 274-8338
Tracy, CA	Public Works	(209) 836-4420
Tucson, AZ	Transportation	(602) 791-4259
Union City, CA	Public Works	(510) 471-3232
Vacaville, CA	Public Works	(707) 449-5170
Vallejo, CA	Public Works	(707) 648-4315
W. Palm Beach, FL	Public Works	N/A
Walnut Creek, CA	Development	(510) 256-3529
Watsonville, CA	Public Works	(408) 728-6095