Countermeasures
Chapter 5

PHOTO BY DAN BURDEN

Pedestrian Facility Design
Roadway Design
Intersection Design
Traffic Calming
Traffic Management
Signals and Signs
Other Measures

A total of 49 engineering, education, and enforcement countermeasures are discussed in this chapter. The treatments and programs selected for inclusion in this document are those that have been in place for an extended period of time and/or have been proven effective at the time the material for this product was being complied. Since that time, new countermeasures continue to be developed, implemented, and evaluated. Thus, practitioners should not necessarily limit their choices to those included here; this material is a starting point. More information on the latest treatments and programs can be found through many of the Web sites and resources included in Chapter 7.

The categories of improvements include:

- Pedestrian Facility Design
- Roadway Design
- Intersection Design
- Traffic Calming
- Traffic Management
- Signals and Signs
- Other Measures

The following index can be used to quickly locate the countermeasure of interest.

PEDESTRIAN FACILITY DESIGN

Walkways are the portion of the public right-of-way that provide a separated area for people traveling on foot. Walkways that are safe, accessible, and aesthetically pleasing attract pedestrians. People walk for many reasons: to go to a neighbor's house, to run errands, for school, or to get to a business meeting. People also walk for recreation and health benefits or for the enjoyment of being outside. Some pedestrians must walk to transit or other destinations if they wish to travel independently. It is a public responsibility to provide a safe, secure, and comfortable system for all people who walk. The countermeasures related to pedestrian facility design include:

- Sidewalks and Walkways
- Curb Ramps
- Marked Crosswalks and Enhancements
- Transit Stop Treatments
- Roadway Lighting Improvements
- Street Furniture/Walking Environment

PHOTO BY DAN BURDEN

1. SIDEWALKS AND WALKWAYS

Sidewalks and walkways are "pedestrian lanes" that provide people with space to travel within the public right-of-way that is separated from roadway vehicles. They also provide places for children to walk, run, skate, ride bikes, and play. Sidewalks are associated with significant reductions in pedestrian collisions with motor vehicles.[1] Such facilities also improve mobility for pedestrians and provide access for all types of pedestrian travel: to and from home, work, parks, schools, shopping areas, transit stops, etc. Walkways should be part of every new and renovated facility and every effort should be made to retrofit streets that currently do not have sidewalks.

PHOTO BY DAN BURDEN

This sidewalk and buffer zone provides a safe place for pedestrians to walk outside of the paths of vehicles in the street.

While sidewalks are typically made of concrete, less expensive walkways may be constructed of asphalt, crushed stone, or other materials if they are properly maintained and accessible (firm, stable, and slip-resistant). In more rural areas, in particular, a "side path" made of one of these materials may be suitable. Both FHWA and the Institute of Transportation Engineers (ITE) recommend a minimum width of 1.5 m (5 ft) for a sidewalk or walkway, which allows two people to pass comfortably or to walk side-by-side. Wider sidewalks should be installed near schools, at transit stops, in downtown areas, or anywhere high concentrations of pedestrians exist. Sidewalks should be continuous along both sides of a street and sidewalks should be fully accessible to all pedestrians, including those in wheelchairs.[2,3]

A buffer zone of 1.2 to 1.8 m (4 to 6 ft) is desirable and should be provided to separate pedestrians from the street. The buffer zone will vary according to the street type. In downtown or commercial districts, a street furniture zone is usually appropriate. Parked cars and/or bicycle lanes can provide an acceptable buffer zone. In more suburban or rural areas, a landscape strip is generally most suitable. Careful planning of sidewalks and walkways is important in a neighborhood or area in order to provide adequate safety and mobility. For example, there should be a flat sidewalk provided in areas where driveways slope to the roadway.

Recommended guidelines and priorities for sidewalks and walkways are given in Appendix C.

Purpose

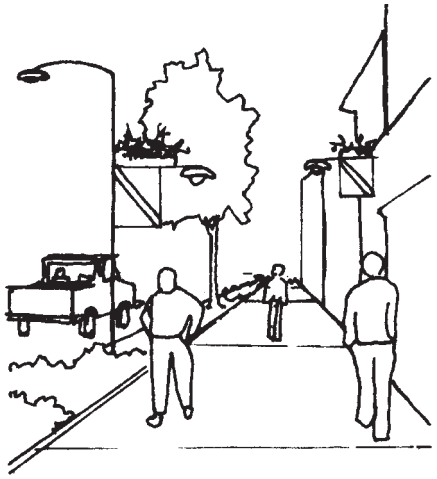
- Create the appropriate facility for the walking area of the public right-of-way.
- Improve pedestrian safety dramatically.

Considerations

- While continuous walkways are the goal, retrofitting areas without them will usually occur in phases. Lack of a seamless system is no excuse not to provide parts of the system.
- In retrofitting streets that do not have a continuous or accessible system, locations near transit stops, schools, parks, public buildings, and other areas with high concentrations of pedestrians should be the highest priority.
- Street furniture placement should not restrict pedestrian flow.

Estimated Cost

The cost for concrete curbs and sidewalks is approximately $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways. Asphalt curbs and walkways are less costly, but require more maintenance, and are somewhat more difficult to walk and roll on for pedestrians with mobility impairments.



Adapted from *Making Streets That Work*, Seattle, 1996

2. CURB RAMPS

Curb ramps provide access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, and also for pedestrians with mobility impairments who have trouble stepping up and down high curbs. Curb ramps must be installed at all intersections and midblock locations where pedestrian crossings exist, as mandated by federal legislation (1973 Rehabilitation Act and ADA 1990). Curb ramps must have a slope of no more than 1:12 (must not exceed 25.4 mm/0.3 m (1 in/ft) or a maximum grade of 8.33 percent), and a maximum slope on any side flares of 1:10. More information on the specifications for curb ramps can be found in the *Draft Guidelines for Accessible Public Rights of Way.*[4]

PHOTO BY MICHAEL RONKIN

A curb ramp should be designed to provide direct access and should have the proper width and slope.

Where feasible, separate curb ramps for each crosswalk at an intersection should be provided rather than having a single ramp at a corner for both crosswalks. This provides improved orientation for visually impaired pedestrians. Similarly, tactile warnings will alert pedestrians to the sidewalk/street edge. All newly constructed and altered roadway projects must include curb ramps. In addition, all agencies should upgrade existing facilities. They can begin by conducting audits of their pedestrian facilities to make sure transit services, schools, public buildings, and parks, etc. are accessible to pedestrians who use wheelchairs.

While curb ramps are needed for use on all types of streets, priority locations are in downtown areas and on streets near transit stops, schools, parks, medical facilities, shopping areas, and near residences with people who use wheelchairs.

For more information about curb ramp design, see *Designing Sidewalks and Trails for Access, Parts I and II*, by the Federal Highway Administration, and *Accessible Rights-of-Way: A Design Guide*, by the U.S. Access Board and the Federal Highway Administration. The Access Board's right-of-way report can be found at www.access-board.gov.

Purpose

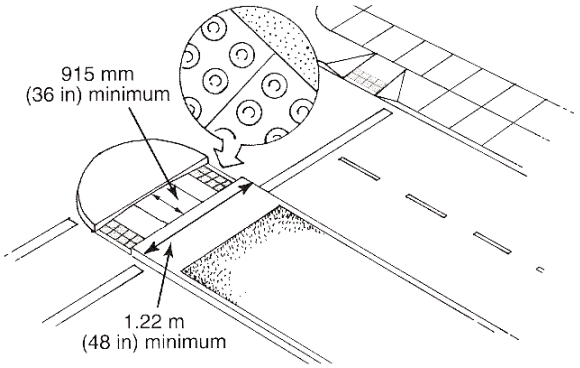
- Provide access to street crossings.

Considerations

- Follow Americans with Disabilities Act (ADA) design guidelines.
- Texture patterns must be detectable to blind pedestrians.

Estimated Cost

The cost is approximately $800 to $1,500 per curb ramp (new or retrofitted).



Adapted from *Designing Sidewalks and Trails for Access, Part II of II*, Washington, DC, 2001

3. MARKED CROSSWALKS AND ENHANCEMENTS

Marked crosswalks indicate optimal or preferred locations for pedestrians to cross and help designate right-of-way for motorists to yield to pedestrians. Crosswalks are often installed at signalized intersections and other selected locations. Various crosswalk marking patterns are given in the MUTCD.[5] Marked crosswalks are desirable at some high pedestrian volume locations (often in conjunction with other measures) to guide pedestrians along a preferred walking path. In some cases, they can be raised and should often be installed in conjunction with other enhancements that physically reinforce crosswalks and reduce vehicle speeds. It is also sometimes useful to supplement crosswalk markings with warning signs for motorists. At some locations, signs can get "lost" in visual clutter, so care must be taken in placement.

PHOTO BY PETER LAGERWEY

The "ladder" pattern shown above is more visible to motorists than parallel lines and requires less maintenance if painted to allow the tires of motor vehicles to track between the painted lines.

Pedestrians are sensitive to out-of-the-way travel, and reasonable accommodation should be made to make crossings both convenient and safe at locations with adequate visibility.

Recommended guidelines and priorities for crosswalk installation at controlled locations are given in Appendix D. These guidelines are based on a major study of 1,000 marked crosswalks and 1,000 unmarked crossings in 30 U.S. cities. Recommendations are also given for providing other pedestrian crossing enhancements at uncontrolled locations with and without a marked crosswalk.[6]

Purpose

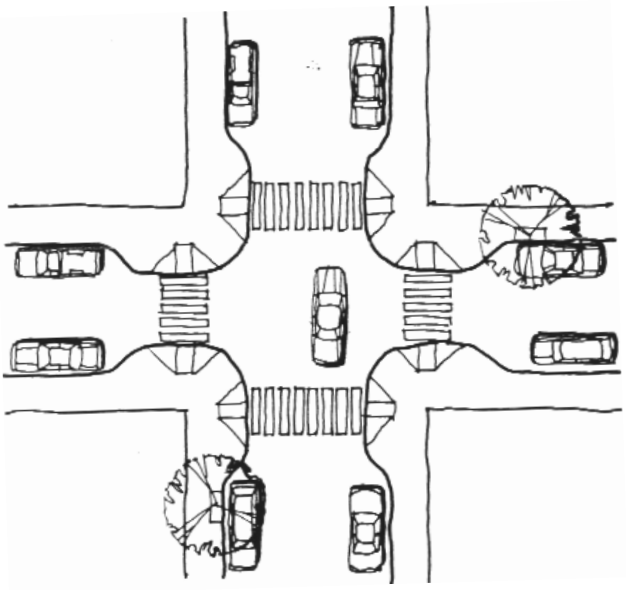
- Warn motorists to expect pedestrian crossings.
- Indicate preferred crossing locations.

Considerations

- Crosswalk locations should be convenient for pedestrian access.
- Crosswalk markings alone are unlikely to benefit pedestrian safety. Ideally, crosswalks should be used in conjunction with other measures, such as curb extensions, to improve the safety of a pedestrian crossing, particularly on multi-lane roads with average daily traffic (ADT) above about 10,000.
- Marked crosswalks are important for pedestrians with vision loss.
- Crosswalk markings must be placed to include the ramp so that a wheelchair does not have to leave the crosswalk to access the ramp.

Estimated Cost

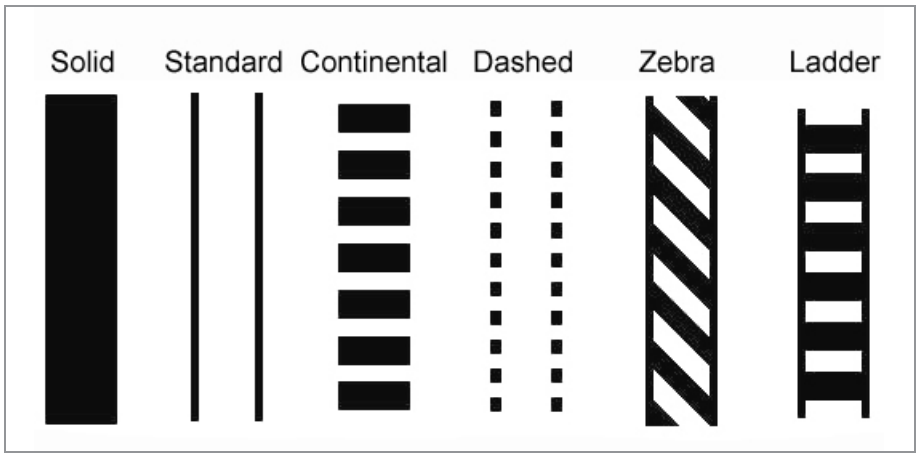
Approximate installation costs are $100 for a regular striped crosswalk, $300 for a ladder crosswalk, and $3,000 for a patterned concrete crosswalk. Maintenance of the markings must also be considered and varies by region of the country and materials used.



City of Cambridge, MA

Crosswalk Materials

It is important to ensure that crosswalk markings are visible to motorists, particularly at night. Crosswalks should not be slippery, create tripping hazards, or be difficult to traverse by those with diminished mobility or visual capabilities. Granite and cobblestones are examples of materials that are aesthetically pleasing, but may become slippery when wet or be difficult to cross by pedestrians who are blind or using wheelchairs. One of the best



Examples of different crosswalk marking patterns.

materials for marking crosswalks is inlay tape, which is installed on new or repaved streets. It is highly reflective, long-lasting, and slip-resistant, and does not require a high level of maintenance. Although initially more costly than paint, both inlay tape and thermoplastic are more cost-effective in the long run. Inlay tape is recommended for new and resurfaced pavement, while thermoplastic may be a better option on rougher pavement surfaces. Both inlay tape and thermoplastic are more visible and less slippery than paint when wet.

PHOTO BY DAN BURDEN

Some crosswalks are angled to the right in the median. This is intended to facilitate a pedestrian's view of oncoming traffic before crossing the second half of the street.

4. TRANSIT STOP TREATMENTS

Good public transportation is as important to the quality of a community as good roads. Well-designed transit routes and accessible stops are essential to a usable system.

PHOTO BY BARBARA GRAY

The transit shelter above is in a lively commercial district. The shelter design reflects the surrounding architecture. Pedestrian-scale lighting and landscaping add visual interest and security.

Bus stops should be located at intervals that are convenient for passengers. The stops should be designed to provide safe and convenient access and should be comfortable places for people to wait. Adequate bus stop signing, lighting, a bus shelter with seating, trash receptacles, and bicycle parking are also desirable features. Bus stops should be highly visible locations that pedestrians can reach easily by means of accessible travel routes. Therefore, a complete sidewalk system is essential to support a public transportation system. Convenient crossings are also important.

Proper placement of bus stops is key to user safety. For example, placing the bus stops on the near side of intersections or crosswalks may block the pedestrians' view of approaching traffic, and the approaching drivers' view of pedestrians. Approaching motorists may be unable to stop in time when a pedestrian steps from in front of a stopped bus into the traffic lanes at the intersection.

Far-side bus stops generally encourage pedestrians to cross behind the bus. Relocating the bus stop to the far side of the intersection can improve pedestrian safety since it eliminates the sight-distance restriction caused by the bus. Placing bus stops at the far side of intersections can also improve motor vehicle operation.

The bus stop location should be fully accessible to pedestrians in wheelchairs, should have paved connections to sidewalks where landscape buffers exist, and should not block pedestrian travel on the sidewalk. Adequate room should exist to operate wheelchair lifts. Yet, it is also useful to install curb ramps at bus stops so that a passenger can board from the street if bus-lift deployment is blocked. Additional information on making bus stops accessible can be found in Chapter 3 of *Accessible Rights-of-Way: A Design Guide*.[7]

Purpose

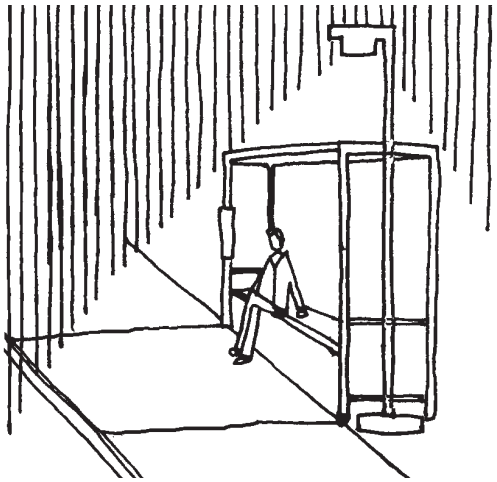
- Provide safe, convenient, and inviting access for transit users.

Considerations

- Ensure that access to and from stops is provided when transit stops are created.
- Ensure adequate room to load wheelchairs.
- Ensure a clear and comfortable path for passing pedestrians when placing transit shelters.
- Locate transit stops on the far side of marked crosswalks.

Estimated Cost

$1,000 to $10,000. Cost varies widely depending on type of improvements.



Adapted from *Making Streets That Work*, Seattle, 1996

5. ROADWAY LIGHTING IMPROVEMENTS

Good quality and placement of lighting can enhance an environment as well as increase comfort and safety. Pedestrians often assume that motorists can see them at night; they are deceived by their own ability to see the oncoming headlights. Without sufficient overhead lighting, motorists may not be able to see pedestrians in time to stop.

PHOTO BY DAN BURDEN

This well-lit commercial district is an attractive place to shop in the evening. The combination of pedestrian-scaled street lighting, holiday lights in the trees, and light from shop windows enhances visibility and creates a secure and festive atmosphere.

In commercial areas with nighttime pedestrian activity, streetlights and building lights can enhance the ambiance of the area and the visibility of pedestrians by motorists. It is best to place streetlights along both sides of arterial streets and to provide a consistent level of lighting along a roadway. Nighttime pedestrian crossing areas may be supplemented with brighter or additional lighting. This includes lighting pedestrian crosswalks and approaches to the crosswalks.

In commercial areas or in downtown areas, specialty pedestrian-level lighting may be placed over the sidewalks to improve pedestrian comfort, security, and safety. Mercury vapor, incandescent, or less expensive high-pressure sodium lighting is often preferred as pedestrian-level lighting. Low-pressure sodium lights are low energy, but have a high level of color distortion.

Purpose

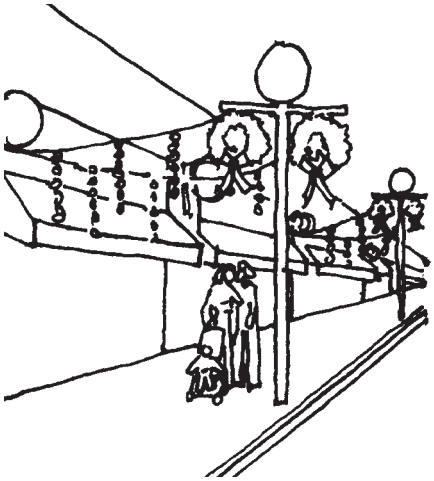
- Enhance safety of all roadway users, particularly pedestrians.
- Enhance commercial districts.
- Improve nighttime security.

Considerations

- Ensure that pedestrian walkways and crosswalks are well lit.
- Install lighting on both sides of wide streets and streets in commercial districts.
- Use uniform lighting levels.

Estimated Cost

Varies depending on fixture type and service agreement with local utility.



Adapted from *Making Streets That Work*, Seattle, 1996

6. PEDESTRIAN OVERPASSES / UNDERPASSES

Pedestrian overpasses and underpasses allow for the uninterrupted flow of pedestrian movement separate from the vehicle traffic. However, they should be a measure of last resort, and it is usually more appropriate to use traffic-calming measures or install a pedestrian-activated signal that is accessible to all pedestrians. This is also an extremely high-cost and visually intrusive measure.

PHOTO BY YAN JIA

This pedestrian overpass takes advantage of existing topography and allows pedestrians to avoid conflicts with traffic at street level.

Such a facility must accommodate all persons, as required by the ADA. More information on the specifications for accessing overpasses and underpasses can be found in the *Draft Guidelines for Accessible Public Rights of Way*.[4] These measures include ramps or elevators. Extensive ramping will accommodate wheelchairs and bicyclists, but results in long crossing distances and steep slopes that discourage use.

Studies have shown that many pedestrians will not use an overpass or underpass if they can cross at street level in about the same amount of time.[8, 9] Overpasses work best when the topography allows for a structure without ramps (e.g., overpass over a sunken freeway). Underpasses work best when designed to feel open and accessible. Grade separation is most feasible and appropriate in extreme cases where pedestrians must cross roadways such as freeways and high-speed, high-volume arterials.

Purpose

- Provide complete separation of pedestrians from motor vehicle traffic.
- Provide crossings where no other pedestrian facility is available.
- Connect off-road trails and paths across major barriers.

Considerations

- Use sparingly and as a measure of last resort. Most appropriate over busy, high-speed highways, railroad tracks, or natural barriers.
- Pedestrians will not use if a more direct route is available.
- Lighting, drainage, graffiti removal, and security are also major concerns with underpasses.
- Must be wheelchair accessible, which generally results in long ramps on either end of the overpass.

Estimated Cost

$500,000 to $4 million, depending on site characteristics.

7. STREET FURNITURE / WALKING ENVIRONMENT

Sidewalks should be continuous and should be part of a system that provides access to goods, services, transit, and homes. Well-designed walking environments are enhanced by urban design elements and street furniture, such as benches, bus shelters, trash receptacles, and water fountains.

PHOTO BY MICHAEL RONKIN

This is a good example of a street furniture zone along the sidewalk on Portland, Oregon's light-rail transit line.

Sidewalks and walkways should be kept clear of poles, signposts, newspaper racks, and other obstacles that could block the path, obscure a driver's view or pedestrian visibility, or become a tripping hazard. Benches, water fountains, bicycle parking racks, and other street furniture should be carefully placed to create an unobstructed path for pedestrians. More information on the requirements for street furniture can be found in the *Draft Guidelines for Accessible Public Rights of Way*.[4] Such areas must also be properly maintained and kept clear of debris, overgrown landscaping, tripping hazards, or areas where water accumulates. Snow removal is also important for maintaining pedestrian safety and mobility. In most areas, local ordinances give property owners the responsibility of removing snow within 12 to 48 hours after a storm.

Walking areas should also be interesting for pedestrians and provide a secure environment. Storefronts should exist at street level and walking areas should be well lit and have good sightlines.

Purpose

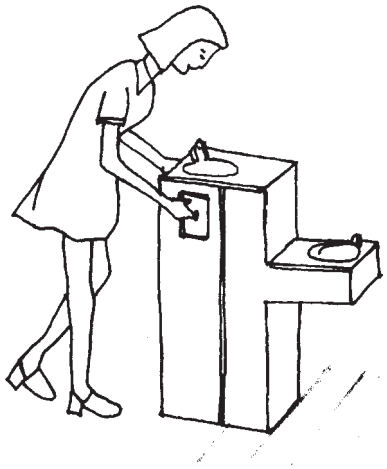
- Enhance the pedestrian environment.
- Enliven commercial districts by fostering community life.

Considerations

- Good-quality street furniture will show that the community values its public spaces and is more cost-effective in the long run.
- Include plans for landscape irrigation and maintenance at the outset.
- Ensure proper placement of furniture; do not block pedestrian walkway or curb ramps or create sightline problems.
- Ensure adequacy of overhead clearances and detectability of protruding objects for pedestrians who are blind or visually impaired.

Estimated Cost

Varies depending on the type of furniture, the material out of which it is constructed, and the amount of planting material used.



Adapted from *Making Streets That Work*, Seattle, 1996

ROADWAY DESIGN

Design and operational elements of the roadway affect the ability of pedestrians to safely and easily cross streets. A geometric element such as street width affects the time needed to cross the street, whereas an operational parameter like traffic direction (one-way vs. two-way) affects the number of potential conflicts between motorists and crossing pedestrians. The countermeasures related to roadway design include:

- Bicycle Lanes
- Roadway Narrowing
- Lane Reduction
- Driveway Improvements
- Raised Medians
- One-way/Two-way Street Conversions
- Curb Radius Reduction
- Improved Right-Turn Slip Lane Design

PHOTO BY DAN BURDEN

8. BICYCLE LANES

Bike lanes indicate a preferential or exclusive space for bicycle travel along an arterial street. Bike lanes have been found to provide more consistent separation between bicyclists and passing motorists. Marking bicycle lanes can also benefit pedestrians—as turning motorists slow and yield more to bicyclists, they will also be doing so for pedestrians.

PHOTO BY CARA SEIDERMAN

A well-marked bicycle lane and bicycle parking in Cambridge, Massachusetts.

Bike lanes are typically designated by striping and/or signing. Colored pavement (e.g., blue or red surfaces) is also used in some locations, although it is not yet an accepted MUTCD standard. If the addition of bike lanes results in fewer motor vehicle lanes, safety may be enhanced for pedestrians crossing the street. Bicycle lanes also provide a buffer between motor vehicle traffic and pedestrians when sidewalks are immediately adjacent to the curb. On high-speed, high-volume roads, it may be more appropriate to provide a multi-use path to physically separate both bicyclists and pedestrians from motor vehicle traffic. However, the application of this treatment requires that care be taken to minimize the conflicts between bicyclists and pedestrians.

Purpose

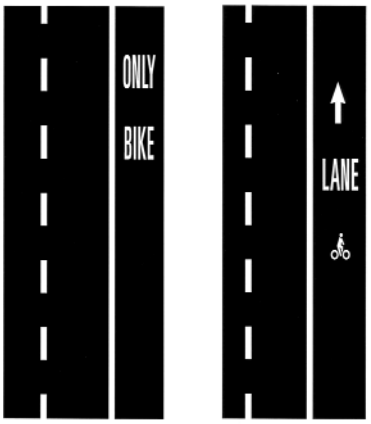
- Create on-street travel facilities for bicyclists.
- Narrow the roadway to encourage lower motor vehicle speeds.
- Provide additional separation between pedestrians and motor vehicles.
- Adding on-street bike lanes reduces the distance pedestrians must travel to cross automobile lanes.

Considerations

- All roads should be evaluated for on-street bicycle facilities.
- Provide adequate space between the bike lane and parked cars so that open doors do not create a hazard for bicyclists.

Estimated Cost

The cost of installing a bike lane is approximately $3,100 to $31,000 per kilometer ($5,000 to $50,000 per mile), depending on the condition of the pavement, the need to remove and repaint the lane lines, the need to adjust signalization, and other factors. It is most cost efficient to create bicycle lanes during street reconstruction, street resurfacing, or at the time of original construction.



ADAPTED FROM MUTCD

Typical optional word and symbol pavement markings for bicycle lanes.

9. ROADWAY NARROWING

Roadway narrowing can be achieved in several different ways:

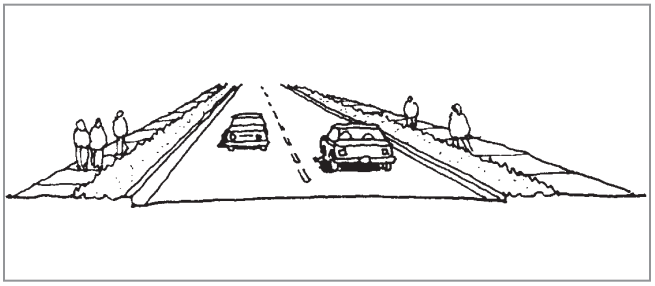
a. Lane widths can be reduced (to 3.0 or 3.4 m [10 or 11 ft]) and excess asphalt striped with a bicycle lane or shoulder.

b. Travel lanes can be removed (see #10).

c. On-street parking lanes can be added.

d. Curbs can be moved to narrow the cross section and extend the width of sidewalks and landscape areas.

This can reduce vehicle speeds along a roadway section and enhance movement and safety for pedestrians. Bicycle travel will also be enhanced and bicyclist safety improved when bicycle lanes are added.



Before

After

SKETCHES BY MICHAEL KIMELBERG

Purpose

- Multiple benefits of lower vehicle speeds, increased safety, and redistributing space to other users.

Considerations

- Bicyclists must be safely accommodated. Bike lanes or wide curb lanes are needed if motor vehicle volumes and/or speeds are high.
- Road narrowing must consider school bus and emergency service access, and truck volumes.
- Evaluate whether narrowing may encourage traffic to divert to other local streets in the neighborhood.

Estimated Cost

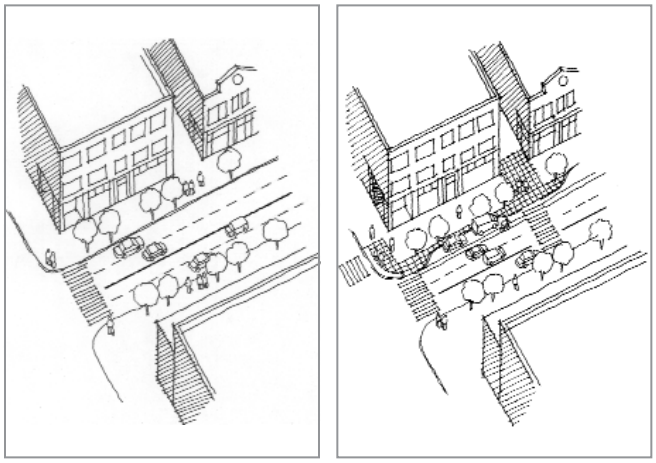
Adding striped shoulders or on-street bike lanes can cost as little as $620 per kilometer ($1,000 per mile) if the old paint does not need to be changed. The cost for restriping a kilometer of street to bike lanes or reducing the number of lanes to add on-street parking is $3,100 to $6,200 ($5,000 to $10,000 per mile), depending on the number of old lane lines to be removed. Constructing a raised median or widening a sidewalk can cost $62,000 or more per kilometer ($100,000 or more per mile).

PHOTO BY DAN BURDEN

Colored asphalt has been used to identify bike lanes on this street in Holland. The bike lanes visually narrow the street and help reduce speeds. Although the curb-to-curb width is more than 9.1 m (30 ft), the motorist only sees 3.4 m (11 ft) of driving space.

10. LANE REDUCTION

Some roads have more travel lanes than necessary and are difficult to cross because of their width. Reducing the number of lanes on a multi-lane roadway can reduce crossing distances for pedestrians and may slow vehicle speeds. A traffic analysis should be done to determine whether the number of lanes on a roadway (many of which were built without such an analysis) is appropriate. Level-of-service analysis for intersections should not dictate the design for the entire length of roadway. For example, a four-lane undivided road can be converted to one through lane in each direction, with a center left-turn lane or with a raised median, and turn pockets and bicycle lanes on both sides of the roadway. Turning pockets may be needed only at specific locations.



Before | After

PHOTO BY CARA SEIDERMAN

This street in Cambridge, Massachusetts, was reduced from four lanes to three. The conversion introduced wider sidewalks, additional space for landscaping, street furniture and cafes, and bicycle lanes.

Purpose

- Remedy a situation where there is excess capacity.
- Provide space for pedestrians, bicyclists, and parked cars.
- Reduce crossing time, which can help optimize signal timing.
- Improve social interaction and neighborhood feel along the street.

Considerations

- Roadway capacity operation and overall road safety need to be considered before reducing the number of lanes.
- Ensure street connections so major arterials can be crossed at controlled intersections.

Estimated Cost

The cost for restriping a kilometer of four-lane street to one lane in each direction plus a two-way, left-turn lane and bike lanes is about $3,100 to $12,400 ($5,000 to $20,000 per mile), depending on the amount of lane lines that need to be repainted. The estimated cost of extending sidewalks or building a raised median is much higher and can cost $62,000 per kilometer ($100,000 per mile) or more.

If a reconfiguration is done after repaving or with an overlay, and curbs do not need to be changed, there is little or no cost for the change.

Depending on conditions, it may also be possible to add on-street parking while allowing for bicycle lanes on both sides of the street—instead of a center turn lane. If no sidewalks exist along the roadway, these should be added. If sidewalks exist, and there is adequate room, a landscaped buffer is desirable to separate pedestrians from the travel lane.

A typical three-lane configuration consisting of two travel lanes and a two-way left-turn lane (TWLTL) also has advantages for motorists. Through traffic can maintain a fairly constant speed, while left-turning drivers can exit the traffic stream and wait in the TWLTL. However, TWLTLs can also create problems for opposing left-turn vehicles and may be used as acceleration lanes by some motorists. Designs that incorporate raised medians and left-turn bays may offer a better solution.

11. DRIVEWAY IMPROVEMENTS

Several driveway designs may cause safety and access problems for pedestrians, including excessively wide and/or sloped driveways, driveways with large turning radii, multiple adjacent driveways, driveways that are not well defined, and driveways where motorist attention is focused on finding a gap in congested traffic. In addition, driveways without a level sidewalk landing may not comply with ADA standards. Refer to Chapter 5 in *Designing Sidewalks and Trails for Access, Part II of II: Best Practices Design Guide* for further guidance.[1]

PHOTOS BY PETER LAGERWEY

The top example shows a driveway with a wide apron to accommodate two adjacent driveways and a landscaped planting strip. The driveway in the lower picture demonstrates how to provide driveway access across a sidewalk while maintaining a continuous, level walkway for pedestrians.

Examples of driveway improvements include narrowing or closing driveways, tightening turning radii, converting driveways to right-in only or right-out only movements, and providing median dividers on wide driveways.

When driveways cross sidewalks, it is necessary to maintain a sidewalk level across the driveway of no more than 2 percent sideslope (see sketch). This is more usable for all pedestrians, especially those in wheelchairs, and makes it clear to motorists that they must watch for pedestrians. It is important to minimize large signs and bushes at driveways to improve the visibility between motorists and pedestrians. The sidewalk material (usually concrete) should be maintained across the driveway as well.

Purpose

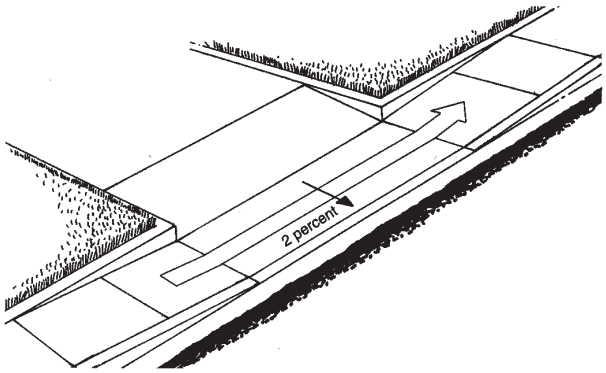
- Reduce pedestrian/motor vehicle conflicts.
- Improve access for people with disabilities.
- Improve visibility between cars and pedestrians at driveways.

Considerations

- It is best to properly design and consolidate driveways at the outset. Local regulations can require appropriate design when driveways are created.

Estimated Cost

No additional cost if part of original construction.



Adapted from *Designing Sidewalks and Trails for Access, Part II of II*, Washington, DC, 2001

12. RAISED MEDIANS

Medians are raised barriers in the center portion of the street or roadway that can serve as a place of refuge for pedestrians who cross a street midblock or at an intersection location. They may provide space for trees and other landscaping that, in turn, can help change the character of a street and reduce speeds. They also have benefits for motorist safety when they replace center turn lanes. Desired turning movements need to be carefully provided so that motorists are not forced to travel on inappropriate routes, such as residential streets, or make unsafe U-turns.

PHOTO BY DAN BURDEN

This attractive median provides curb ramps and median openings for wheelchair users.

Continuous medians may not be the most appropriate treatment in every situation. In some cases, separating opposing traffic flow and eliminating left-turn friction can increase traffic speeds by decreasing the perceived friction of the roadway. They may also take up space that can be better used for wider sidewalks, bicycle lanes, landscaping buffer strips, or on-street parking and may cause problems for emergency vehicles. In some environments, medians can be constructed in sections, creating an intermittent rather than continuous median. Another good alternative device for two-, three- or four-lane roads is the crossing island, which provides a crossing refuge for pedestrians and, in some designs, aids in decreasing vehicle speeds.

Raised medians are most useful on high-volume, high-speed roads, and they should be designed to provide tactile cues for pedestrians with visual impairments to indicate the border between the pedestrian refuge area and the motorized vehicle roadway. Examples of good and bad designs for raised median crossings can be found in Chapter 8 of *Designing Sidewalks and Trails for Access: Part II of II: Best Practices Design Guide*.[1]

Purpose

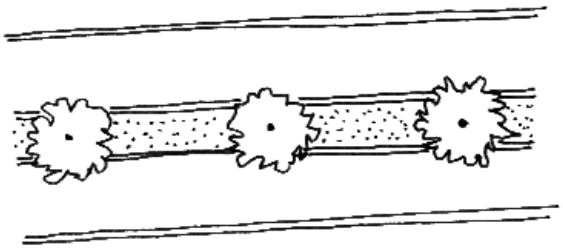
- Manage motor vehicle traffic and provide comfortable left-hand turning pockets with fewer or narrower lanes.
- Provide a refuge for pedestrians crossing the street.
- Provide space for street trees and other landscaping.

Considerations

- Ensure that there is enough room for wider sidewalks, bike lanes, and planting strips before proceeding with construction.
- Landscaping in medians should not obstruct the visibility between pedestrians and approaching motorists.
- Median crossings at midblock and intersection locations must be fully accessible by means of ramps or cut-throughs, with detectable warnings.

Estimated Cost

The cost for adding a raised median is approximately $15,000 to $30,000 per 30 m ($15,000 to $30,000 per 100 ft), depending on the design, site conditions, and whether the median can be added as part of a utility improvement or other street construction project.



Adapted from *Making Streets That Work*, Seattle, 1996

13. ONE-WAY / TWO-WAY STREET CONVERSIONS

One-way streets can simplify crossings for pedestrians, who must look for traffic in only one direction. While studies have shown that conversion of two-way streets to one-way generally reduces pedestrian crashes, one-way streets tend to have higher speeds, which creates new problems. If a street is converted to one-way, it should be evaluated to see if additional changes should be made, especially if the street or lanes are overly wide. Also, traffic circulation in the surrounding area must be carefully considered before conversion to one-way streets.

PHOTO BY CARA SEIDERMAN

Cars are forced to drive slowly on this two-way street with parking.

As a system, one-way streets can increase travel distances of motorists and bicyclists and can create confusion, especially for non-local residents. One-way streets operate best in pairs, separated by no more than 0.4 km (0.25 mi). Conversion costs can be quite high to build crossovers where the one-way streets convert back to two-way streets, and to rebuild traffic signals and revise striping, signing, and parking meters.

One-way streets work best in downtown or very heavily congested areas. One-way streets can offer improved signal timing and accommodate odd-spaced signals; however, signal timing for arterials that cross a one-way street pair is difficult.

Conversions can go the other way as well: some places are returning one-way streets back to two-way to allow better local access to businesses and homes and to slow traffic. Two-way streets tend to be slower due to "friction," especially on residential streets without a marked center line, and they may also eliminate the potential for multiple-threat crashes that exists on multi-lane, one-way streets.

Purpose

- Manage traffic patterns.
- Reduce conflicts.
- A one-way to two-way conversion will generally reduce speeds.

Considerations

- Consider impacts on other streets.
- Be aware that one-way streets may decrease automobile accessibility to businesses.
- Be careful not to create speeding problems where a two-way street is changed to a one-way street. Redesign or traffic-calming measures may be required to address this.
- Will improve signal synchronization on the one-way streets, but will hinder synchronization on cross-streets.
- Generally requires a one-way pair, with two nearby streets being converted to one-way.

Estimated Cost

$12,400 to $124,000 per kilometer ($20,000 to $200,000 per mile), depending on length of treatment and whether the conversion requires modification to signals. If crossovers are needed at the end points of the one-way streets, they may cost millions of dollars.

14. CURB RADIUS REDUCTION

One of the common pedestrian crash types involves a pedestrian who is struck by a right-turning vehicle at an intersection. A wide curb radius typically results in high-speed turning movements by motorists. Reconstructing the turning radius to a tighter turn will reduce turning speeds, shorten the crossing distance for pedestrians, and also improve sight distance between pedestrians and motorists.

PHOTO BY DAN BURDEN

Tight corner radii keep turning vehicle speeds down and minimize crossing distances for pedestrians.

Nearby land uses and types of road users should be considered when designing an intersection so that curb radii are sized appropriately. If a curb radius is made too small, large trucks or buses may ride over the curb, placing pedestrians in danger.

Where there is a parking and/or bicycle lane, curb radii can be even tighter, because the vehicles will have more room to negotiate the turn. Curb radii can, in fact, be tighter than any modern guide would allow: older cities in the Northeast and in Europe frequently have radii of 0.6 to 1.5 m (2 to 5 ft) without suffering any detrimental effects.

More typically, in new construction, the appropriate turning radius is about 4.6 m (15 ft) and about 7.6 m (25 ft) for arterial streets with a substantial volume of turning buses and/or trucks. Tighter turning radii are particularly important where streets intersect at a skew. While the corner characterized by an acute angle may require a slightly larger radius to accommodate the turn moves, the corner with an obtuse angle should be kept very tight, to prevent high-speed turns.

Purpose

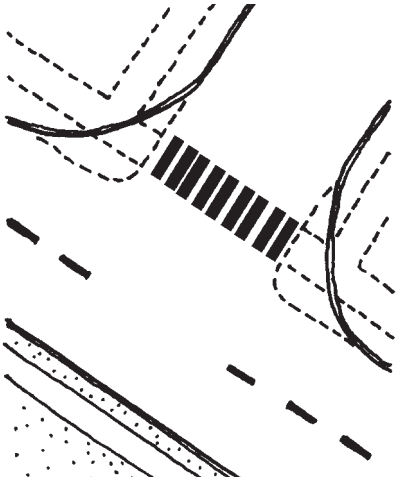
- Safer intersection design.
- Slow right-turning vehicles.
- Reduce crossing distances, improve visibility between drivers and pedestrians, and provide space for accessible curb ramps.
- Shorter crossing distances can lead to improved signal timing.

Considerations

- Consider effective radii by taking into account parking and bicycle lanes.
- Make sure that public maintenance vehicles, school buses, and emergency vehicles are accommodated.
- Large trucks and buses may ride over the curb at intersections with tight radii, creating a danger for pedestrians who are waiting to cross.

Estimated Cost

Construction costs for reconstructing a tighter turning radii are approximately $2,000 to $20,000 per corner, depending on site conditions (e.g., drainage and utilities may need to be relocated).



Adapted from *Making Streets That Work*, Seattle, 1996

15. IMPROVED RIGHT-TURN SLIP-LANE DESIGN

Intersections should be designed to accommodate safe pedestrian crossings using tight curb radii, shorter crossing distances, and other tools as described in this document. While right-turn slip lanes are generally a negative facility from the pedestrian perspective due to the emphasis on easy and fast motor vehicle travel, they can be designed to be less problematic. At many arterial street intersections, pedestrians have difficulty crossing due to right-turn movements and wide crossing distances. Well-designed right-turn slip lanes provide pedestrian crossing islands within the intersection and a right-turn lane that is designed to optimize the right-turning motorist's view of the pedestrian and of vehicles to his or her left. Pedestrians are able to cross the right-turn lane and wait on the refuge island for their walk signal.

PHOTO BY DAN BURDEN

A slip lane designed at the proper angle, as shown on the right side of intersection, provides the driver with greater visibility of pedestrians. The lane on the left creates a higher speed, lower visibility right turn.

The problem for pedestrians is that many slip lanes are designed for unimpeded vehicular movement. The design of corner islands, lane width, and curb radii of right-turn slip lanes should discourage high-speed turns, while accommodating large trucks and buses. The triangular "porkchop" corner island that results should have the "tail" pointing to approaching traffic. Since the traffic signal is timed based on a shorter crossing, the pedestrian crossing time has a much smaller influence on the timing of the signal. This design has an additional advantage for the pedestrian; the crosswalk is located in an area where the driver is still looking ahead. Older designs place the crosswalk too far down, where the driver is already looking left for a break in the traffic.

Channelized right turn-lanes remain a challenge for visually-impaired pedestrians. First, there are difficulties associated with knowing where the crosswalk is located or knowing where to cross. Second, it is difficult for a pedestrian who is visually-impaired to know when a

Purpose

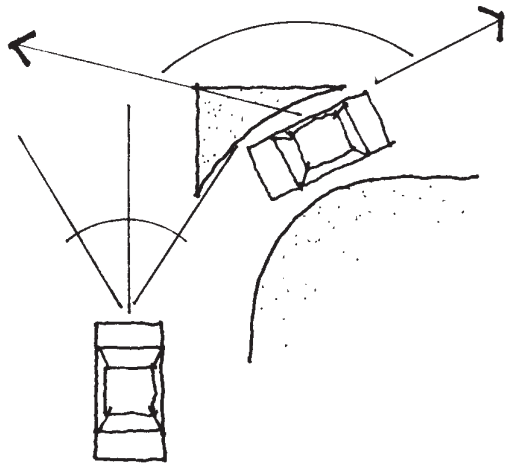
- Separate right-turning traffic.
- Slow turning-vehicle speeds and improve safety.
- Allow drivers to see approaching cross-street traffic more clearly.
- Reduce the crossing distance for pedestrians.

Considerations

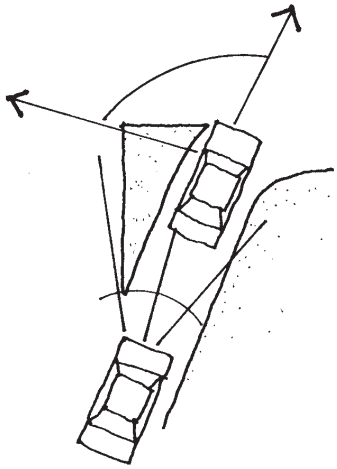
- Evaluate first whether a slip lane is really necessary.

Estimated Cost

Approximately $50,000 to $200,000 to reconfigure roadway, add striping and construct an island, assuming additional right-of-way is not required.



High speed, low visibility, head turner. Current AASHTO standard.



14 to 18 mi/h, good visibility. Recommended design
1mi/h = 1.61 km/h.

SKETCHES BY MICHAEL KIMLEBERG

vehicle has yielded right-of way. While accessible pedestrian signals can help with these issues, more research is currently underway through the National Cooperative Highway Research Program (NCHRP) to further explore the problem and develop potential solutions. Refer to NCHRP Project 3-78, Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities (at www4.trb.org/trb/crp.nsf/NCHRP+projects) for the latest status report.

INTERSECTION DESIGN

There are several countermeasures that are specifically aimed at improving intersection safety and mobility, including many of those described in the sections on roadway design and traffic calming. The countermeasures included in this section are as follows:

- Roundabouts
- Modified T-Intersections
- Intersection Median Barriers

PHOTO BY DAN BURDEN

16. ROUNDABOUTS

A roundabout is a circular intersection that eliminates some of the conflict traffic, such as left turns, that causes crashes at traditional intersections. Traffic maneuvers around the circle in a counterclockwise direction, and then turns right onto the desired street. All traffic yields to motorists in the roundabout and left-turn movements are eliminated. Unlike a signalized intersection, vehicles generally flow and merge through the roundabout from each approaching street without having to stop.

PHOTO BY DAN BURDEN

This Fort Pierce, Florida, roundabout is being constructed to reduce speeding, improve safety, and enhance the aesthetics of the community.

Roundabouts need to accommodate pedestrians and bicyclists. It is important that automobile traffic yields to pedestrians crossing the roundabout. Splitter islands at the approaches slow vehicles and allow pedestrians to cross one direction of travel at a time. Single-lane approaches can be designed to keep speeds down to safer levels and allow pedestrians to cross. Multilane approaches can create multiple threats for pedestrians and are not recommended.

Wayfinding and gap selection cues need to be adequately addressed in the design of roundabouts so that roundabouts are not a barrier to pedestrians with vision impairments. One possible solution is the use of accessible pedestrian signals placed on sidewalks and splitter islands to indicate both where to cross and when to cross. More research is currently underway through the National Cooperative Highway Research Program (NCHRP) to further explore the problem and develop potential solutions. Refer to NCHRP Project 3-78, Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities (at www4.trb.org/trb/crp.nsf/NCHRP+projects) for the latest status report.

Purpose

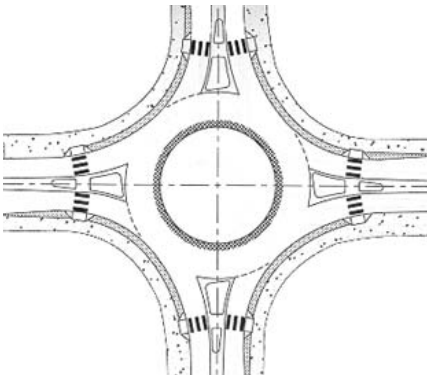
- Improve safety at intersections experiencing a large number of angle collisions.
- Convert signalized intersection to improve traffic flow efficiency.
- Reduce speeds at intersection.
- Create a gateway into an area.

Considerations

- Street widths and/or available right-of-way need to be sufficient to accommodate a properly designed roundabout.
- Roundabouts have a mixed record regarding pedestrian and bicyclist safety—a low design speed is required.
- Roundabouts are generally not appropriate for the intersection of two multilane roads.
- Roundabouts often work best where the traffic flows are balanced on all approaches.
- Deflection on each leg of the intersection must be set to control speeds to 24-29 km/h (15-18 mi/h).

Estimated Cost

The cost for a landscaped roundabout varies widely and can range from $45,000 to $150,000 for neighborhood intersections and up to $250,000 for arterial street intersections, not including additional right-of-way acquisition. Yet, roundabouts have lower ongoing maintenance costs than traffic signals.



SKETCH BY MICHAEL KIMELBERG

Bicyclists also may be disadvantaged by roundabout design. Unless the road is narrow (one lane in each direction), speeds are slow, and traffic very light, bicyclists may not be able to share the road comfortably. Marking bicycle lanes through the roundabout has not been shown to be safer. In larger roundabouts, an off-road bicycle path may be necessary to allow cyclists to

use the pedestrian route. This is inconvenient and takes longer but it will improve safety. Refer to the FHWA report *Roundabouts, An Informational Guide* (online at http://www.tfhrc.gov/safety/00068.htm) for more information related to the design of facilities for both pedestrians and bicyclists.[1]

17. MODIFIED T-INTERSECTIONS

This design treatment is intended for certain T-intersections on lower-volume streets in residential areas where there is a need to reduce the speeds of through traffic. It involves a gradual curb extension or bulb at the top of the T, such that vehicles are deflected slightly as they pass straight through the intersection (see diagram). This type of design can help to discourage cut-through traffic in a neighborhood and can reduce speeds at the intersection. If not properly designed, it can create confusion regarding priority of movement. Consider a mini-circle before installing this treatment.

PHOTO BY DAN BURDEN

This modified T-intersection in Portland, Oregon, is intended to reduce speeds of through traffic as well as restrict left-turning vehicles.

Purpose

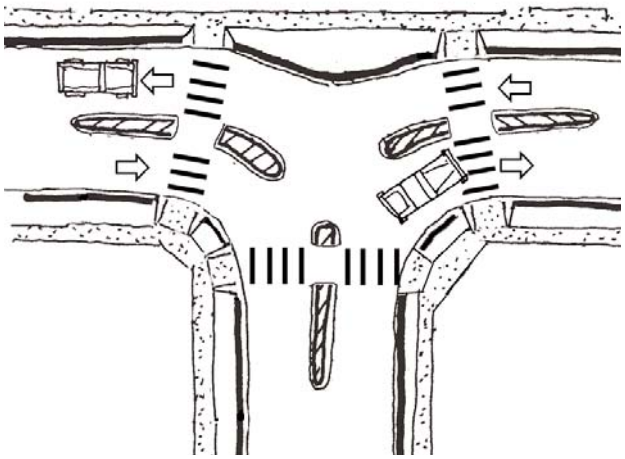
- Reduce vehicle speeds through a T-intersection on a low-volume street.

Considerations

- Used when vehicle volumes are low to moderate.
- A mini-traffic circle may accomplish the same objective and may be less costly and confusing.
- If designed to eliminate some turning movements, the affected neighborhood residents should be consulted for input and an analysis of traffic patterns done to ensure that through traffic would not be diverted inappropriately.
- Pedestrian and bicycle access must be accommodated through the island.

Estimated Cost

$20,000 to $60,000, depending on the design and whether drainage and utilities need to be relocated.



18. INTERSECTION MEDIAN BARRIERS

This shortened version of a raised curb median extends through the intersection to prevent cross-street through movements and left turning movements to cross-streets from the main street.

PHOTO BY DAN BURDEN

Intersection median barriers need to keep walking and bicycling flowing freely through the neighborhood.

This treatment can benefit pedestrians who need to cross any leg of the intersection, but restricts vehicle entry into and out of neighborhoods and can therefore greatly reduce cut-through traffic. However, since this treatment can dramatically influence traffic patterns and have potentially negative consequences caused by shifting traffic, it should be used cautiously. Crossing islands can provide benefits to pedestrians if that is the desire. This is also a traffic management technique.

Cut-throughs must be incorporated into the design for pedestrian and bicyclist use.

Purpose

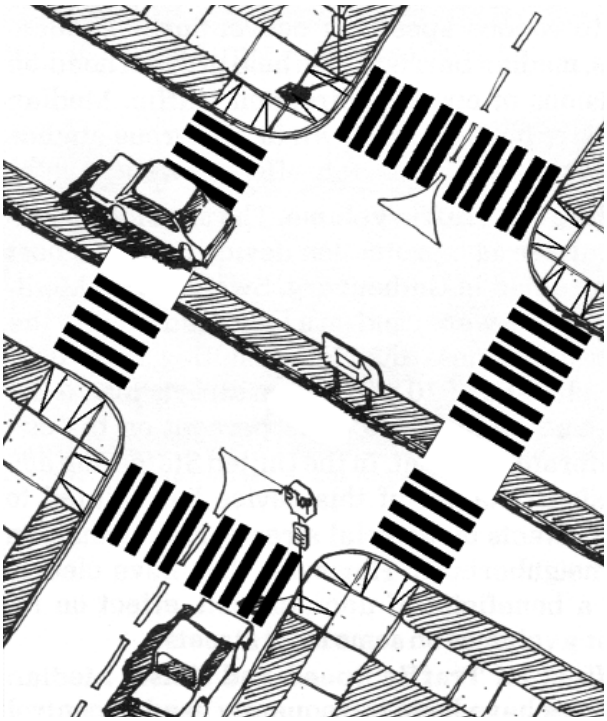
- Reduce cut-through traffic on a neighborhood street.

Considerations

- Local residents need to be provided access so they do not have to drive excessive distances to their homes.
- An analysis of traffic patterns should be done to ensure that cut-through traffic would not be diverted to a nearby street.
- Design should ensure safe and convenient bicycle and pedestrian access.
- Ensure that emergency access is not negatively impacted. Some designs (e.g., high mountable curbs) may allow fire truck access, while inhibiting cars.

Estimated Cost

$10,000 to $20,000.



TRAFFIC CALMING

Traffic calming is a way to design streets, using physical measures, to encourage people to drive more slowly. It creates physical and visual cues that induce drivers to travel at slower speeds. Traffic calming is self-enforcing. The design of the roadway results in the desired effect, without relying on compliance with traffic control devices such as signals, signs, and without enforcement. While elements such as landscaping and lighting do not force a change in driver behavior, they can provide the visual cues that encourage people to drive more slowly.

PHOTO BY DAN BURDEN

The reason traffic calming is such a powerful and compelling tool is that it has proven to be so effective. Some of the effects of traffic calming, such as fewer and less severe crashes, are clearly measurable. Others, such as supporting community livability, are less tangible, but equally important.

Experience throughout Europe, Australia, and North America has shown that traffic calming, if done correctly, reduces traffic speeds, the number and severity of crashes, and noise level. Research on traffic-calming projects in the United States supports their effectiveness at decreasing automobile speeds, reducing the numbers of crashes, and reducing noise levels for specific contexts. Looking at a sample of various speed studies shows that typical speed reductions of 5 to 20 percent at the 85th percentile speed can be realized by the use of traffic-calming measures—including speed tables, mini-circles, speed humps, and other standard traffic-calming devices.[1] Use of several of the traffic-calming measures have also resulted in substantial reductions in motor vehicle crashes. For example, the implementation of traffic mini-circles in Seattle has resulted in a reduction of approximately 80 percent of intersection accidents.[1]

PHOTO BY DAN BURDEN

There are certain overall considerations that are applicable to both traffic management and traffic calming:

- Vehicle speed is more critical than volume in terms of safety and should be addressed first where there are monetary constraints.
- Neighborhood involvement is important to successful implementation. Rationale for traffic-calming and management measures should be explained clearly to community residents and installation of these treatments should incorporate public input. Please see Chapter 7: Implementation and Resources for a discussion of public process.

PHOTO BY CARA SEIDERMAN

- Traffic-calming and management measures should fit into, and preferably enhance, the street environment.
- Traffic-calming designs should be predictable and easy to understand by drivers and other users.
- Devices that meet multiple goals are usually more acceptable. For example, a raised crosswalk may be more understandable to motorists than a speed hump. The former has a clear goal, whereas the latter may be perceived as a nuisance.

PHOTO BY PETER LAGERWEY

This midblock crossing is in Kalamazoo, Michigan. The landscaping and textured crosswalk are visually appealing and provide a clear message about where pedestrians can be expected to cross the street.

- Treatments need to be well designed and based on current available information on their applications and effects. Information on U.S. experiences with various traffic-calming measures can be found in ITE's *Traffic Calming: State of the Practice*.[1]
- Devices should accommodate emergency vehicles.
- Traffic-calming areas or facilities should be adequately signed, marked, and lit to be visible to motorists.
- Treatments need to be spaced appropriately to have the desired effect on speed—too far apart and they will have a limited effect, too close and they will be an unnecessary cost and annoyance. Devices usually need to be spaced about 91 to 152 m (300 to 500 ft) apart. If they are spaced too far apart, motorists may speed up between them. This is particularly the case where the devices are added onto the street (e.g., speed humps). Whole street designs are usually able to create an environment that supports slower speeds for the entire length.
- Facilities should not be underdesigned or they will not work. Keeping the slopes too gradual for a speed table or curves too gentle for a chicane will not solve the problem and will appear as a waste of money and may ruin chances for future projects.
- Traffic-calming measures should accommodate bicyclists and pedestrians with disabilities.
- If a measure is likely to divert traffic onto another local street, the areawide street system should be considered so as not to shift the problem from one place to another.
- Devices should be thought of as elements of a traffic-calming system and be placed to improve pedestrian conditions throughout an area.

Traffic calming treatments may be used in combination and are often most effective this way. The 14 traffic calming countermeasures in this guide include:

- Curb Extensions
- Chokers
- Crossing Islands
- Chicanes
- Mini-Circles
- Speed Humps
- Speed Tables
- Raised Intersections
- Raised Pedestrian Crossings
- Gateways
- Landscaping
- Specific Paving Treatments
- Serpentine Design
- Woonerf

PHOTO BY DAN BURDEN

Traffic-calming improvements need to include input from and coordination with neighborhoods that are impacted.

TRIALS AND TEMPORARY INSTALLATIONS FOR TRAFFIC CALMING

In communities trying traffic calming for the first time, it may be useful to lay out a new design with cones or temporary markings to test it. This provides emergency vehicle drivers, residents, and others with an opportunity to test the design to ensure that they are comfortable with it. Some communities have constructed elaborate temporary devices with concrete or plastic ("jersey") barriers. These can instill a negative reaction in the community due to their unaesthetic appearance and they do not generally have any significant benefits over the simpler test devices. Another option is to install more aesthetic test

devices, such as painted flexible curbs that are bolted into the pavement and can easily be adjusted or removed.

19. CURB EXTENSIONS

Curb extensions—also known as bulb-outs or neckdowns—extend the sidewalk or curb line out into the parking lane, which reduces the effective street width. Curb extensions significantly improve pedestrian crossings by reducing the pedestrian crossing distance, visually and physically narrowing the roadway, improving the ability of pedestrians and motorists to see each other, and reducing the time that pedestrians are in the street.

PHOTO BY DAN BURDEN

This curb extension in Venice, Florida, reduced motorist turning speeds by 9.7 to 12.9 km/h (6 to 8 mi/h). Pedestrian crossing distance and time exposed to traffic was also reduced.

Curb extensions placed at an intersection essentially prevent motorists from parking in or too close to a crosswalk or from blocking a curb ramp or crosswalk. Motor vehicles parked too close to corners present a threat to pedestrian safety, since they block sightlines, obscure visibility of pedestrians and other vehicles, and make turning particularly difficult for emergency vehicles and

PHOTO BY PETER LAGERWEY

A curb extension on an arterial street in Seattle, Washington. The crossing distance for pedestrians is substantially reduced by the installation of this device. The extension is limited to 1.8 m (6 ft) to allow bicyclists to pass safely.

Purpose

- Improve safety for pedestrians and motorists at intersections.
- Increase visibility and reduce speed of turning vehicles.
- Encourage pedestrians to cross at designated locations.
- Prevent motor vehicles from parking at corners.
- Shorten crossing distance and reduce pedestrian exposure.

Considerations

- Curb extensions can provide adequate space on narrow sidewalks for curb ramps and landings.
- Curb extensions should only be used where there is a parking lane, and where transit and bicyclists would be traveling outside the curb edge for the length of the street.
- Midblock extensions provide an opportunity to enhance midblock crossings. Care should be taken to ensure that street furniture and landscaping do not block motorists' views of pedestrians.
- Where intersections are used by significant numbers of trucks or buses, the curb extensions need to be designed to accommodate them. However, it is important to take into consideration that those vehicles should not be going at high speeds, and most can make a tight turn at slow speeds.
- It is not necessary for a roadway to be designed so that a vehicle can turn from a curb lane to a curb lane. Vehicles can often encroach into adjacent lanes safely where volumes are low and/or speeds are slow. Speeds should be slower in a pedestrian environment.
- Emergency access is often improved through the use of curb extensions if intersections are kept clear of parked cars. Fire engines and other emergency vehicles can climb a curb where they would not be able to move a parked car. At midblock locations, curb extensions can keep fire hydrants clear of parked cars and make them more accessible.
- Curb extensions can create additional space for curb ramps, landscaping, and street furniture that are sensitive to motorist and pedestrian sightlines; this is especially beneficial where sidewalks are otherwise too narrow.
- Ensure that curb extension design facilitates adequate drainage.

Estimated Cost

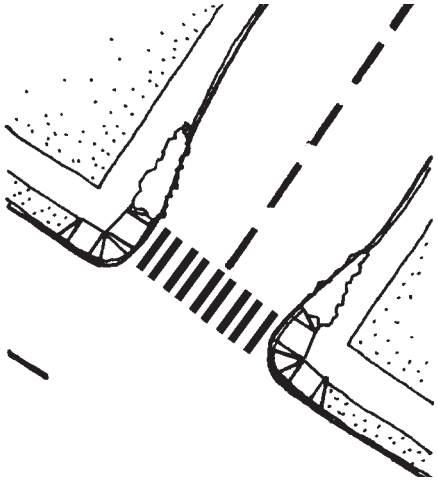
PHOTO BY PETER LAGERWEY

A curb extension on a residential street in Seattle, Washington. In addition to improving pedestrian safety at this intersection, the extension provides additional sidewalk space for a bicycle rack and accessible curb ramp.

trucks. Motorists are encouraged to travel more slowly at intersections or midblock locations with curb extensions, as the restricted street width sends a visual cue to motorists. Turning speeds at intersections can be reduced with curb extensions (curb radii should be as tight as is practicable). Curb extensions also provide additional space for curb ramps and for level sidewalks where existing space is limited.

Curb extensions are only appropriate where there is an on-street parking lane. Curb extensions must not extend into travel lanes, bicycle lanes, or shoulders (curb extensions should not extend more than 1.8 m (6 ft) from the curb). The turning needs of larger vehicles, such as school buses, need to be considered in curb extension design.

Curb extensions cost from $2,000 to $20,000 per corner, depending on design and site conditions. Drainage is usually the most significant determinant of cost. If the curb extension area is large and special pavement and street furnishings and planting are included, costs would also be higher. Costs can go up significantly if something major, such as a utility pole or controller box, is moved.



Adapted from *Making Streets That Work*, Seattle, 1996

20. CHOKERS

Chokers are curb extensions that narrow a street by widening the sidewalks or planting strips, effectively creating a pinch point along the street. Chokers can be created by bringing both curbs in, or they can be done by more dramatically widening one side at a midblock location. They can also be used at intersections, creating a gateway effect when entering a street.

PHOTO BY MICHAEL KING

This choker narrows the street from two lanes to one. Traffic is forced to slow down and, in some cases, wait for an approaching vehicle to pass before proceeding.

Chokers can have a dramatic effect by reducing a two-lane street to one lane at the choker point (or two narrow lanes), requiring motorists to yield to each other or slow down. In order for this to function effectively, the width of the travelway cannot be wide enough for two cars to pass: 4.9 m (16 ft) is generally effective (and will allow emergency vehicles to pass unimpeded). This kind of design is usually only appropriate for low-volume, low-speed streets.

Purpose

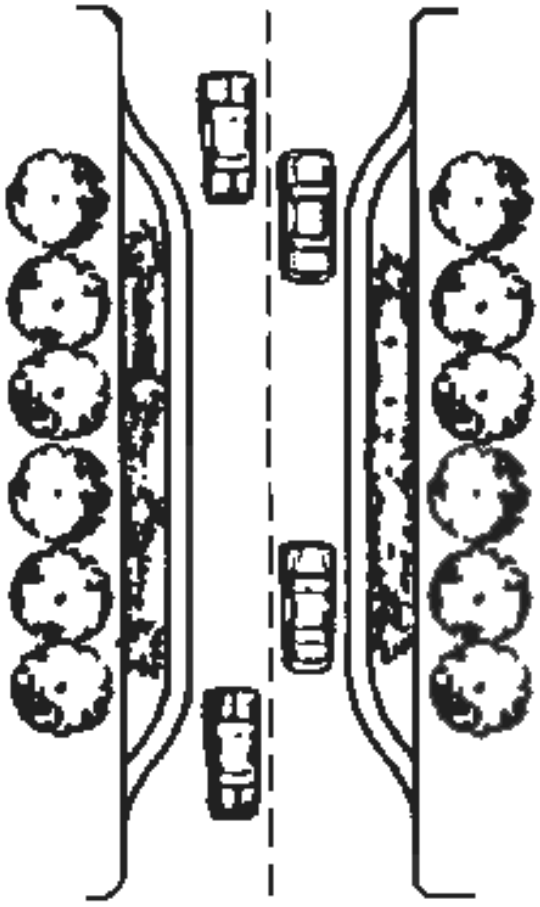
- Slow vehicles at a mid-point along the street.
- Create a clear transition between a commercial and a residential area.
- Narrow overly wide intersections and midblock areas of streets.
- Add room along the sidewalk or planting strip for landscaping or street furniture.

Considerations

- If two travel lanes are maintained on a two-way street and/or the travel-lane widths are unchanged (at the location of the choker), it will have a minimal effect on speed.
- Consult with local fire and sanitation departments before setting minimum width.
- Ensure that bicyclist safety and mobility are not diminished.

Estimated Cost

$5,000 to $20,000, depending on site conditions and landscaping. Drainage may represent a significant cost.



Adapted from *Making Streets That Work*, Seattle, 1996

21. CROSSING ISLANDS

Crossing islands—also known as center islands, refuge islands, pedestrian islands, or median slow points—are raised islands placed in the center of the street at intersections or midblock to help protect crossing pedestrians from motor vehicles. Center crossing islands allow pedestrians to deal with only one direction of traffic at a time, and they enable them to stop partway across the street and wait for an adequate gap in traffic before crossing the second half of the street. Where midblock or intersection crosswalks are installed at uncontrolled locations (i.e., where no traffic signals or stop signs exist), crossing islands should be considered as a supplement to the crosswalk. They are also appropriate at signalized crossings. If there is enough width, center crossing islands and curb extensions can be used together to create a highly improved pedestrian crossing. Detectable warnings are needed at cut-throughs to identify the pedestrian refuge area.

PHOTO BY DAN BURDEN

Crossing islands allow pedestrians to be concerned with one direction of traffic at a time. The roadway markings in the design shown here also help make motorists aware that a pedestrian may be crossing.

This kind of facility has been demonstrated to significantly decrease the percentage of pedestrian crashes.[2] The factors contributing to pedestrian safety include reduced conflicts, reduced vehicle speeds approaching the island (the approach can be designed to force a greater slowing of cars, depending on how dramatic the curvature is), greater attention called to the existence of a pedestrian crossing, opportunities for additional signs in the middle of the road, and reduced exposure time for pedestrians.

Curb extensions may be built in conjunction with center crossing islands where there is on-street parking. Care should be taken to maintain bicycle access. Bicycle lanes (or shoulders, or whatever space is being used for bicycle travel) must not be eliminated or squeezed in order to create the curb extensions or islands.

Purpose

- Enhance pedestrian crossings, particularly at unsignalized crossing points.
- Reduce vehicle speeds approaching pedestrian crossings.
- Highlight pedestrian crossings.

Considerations

- Do not squeeze bicycle access.
- Illuminate or highlight islands with street lights, signs, and/or reflectors to ensure that motorists see them.
- Design islands to accommodate pedestrians in wheelchairs. A cut-through design such as depicted in the photo must include detectable warnings (see figure on p. 53).
- Crossing islands at intersections or near driveways may affect left-turn access.

Estimated Cost

Costs range from $4,000 to $30,000. The cost for an asphalt island or one without landscaping is less than the cost of installing a raised concrete pedestrian island with landscaping.

PHOTO BY DAN BURDEN

22. CHICANES

Chicanes create a horizontal diversion of traffic and can be gentler or more restrictive depending on the design.

Diverting the Path of Travel. Shifting a travel lane has an effect on speeds as long as the taper is not so gradual that motorists can maintain speeds. For traffic calming, the taper lengths may be as much as half of what is suggested in traditional highway engineering.

Shifts in travelways can be created by shifting parking from one side to the other (if there is only space for one side of parking) or by building landscaped islands (islands can also effectively supplement the parking shift).

PHOTO BY PETER LAGERWAY

The chicanes pictured above narrow this residential street to one lane and require traffic to move slowly.

Diversion Plus Restriction (Angled Slow Points). Diverting the path of travel plus restricting the lanes (as described under "Chokers") usually consists of a series of curb extensions, narrowing the street to two narrow lanes or one lane at selected points and forcing motorists to slow down to maneuver between them. Such treatments are intended for use only on residential streets with low traffic volumes.

If there is no restriction (i.e., the number of lanes is maintained), chicanes can be created on streets with higher volumes, such as collectors or minor arterials.

Purpose

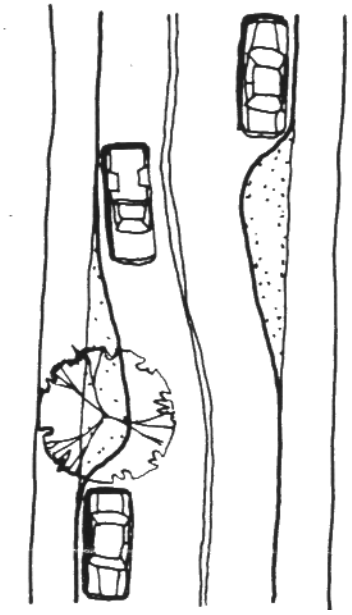
- Reduce vehicle speeds.
- Add more green (landscaping) to a street.

Considerations

- Chicanes may reduce on-street parking.
- Maintain good visibility by planting only low shrubs or trees with high canopies.
- Ensure that bicyclist safety and mobility are not diminished.

Estimated Cost

Costs for landscaped chicanes are approximately $10,000 (for a set of three chicanes) on an asphalt street and $15,000 to $30,000 on a concrete street. Drainage and utility relocation often represents the most significant cost consideration.



CITY OF CAMBRIDGE, MA

23. MINI-CIRCLES

Mini-circles are raised circular islands constructed in the center of residential street intersections (generally not intended for use where one or both streets are arterial streets). They reduce vehicle speeds by forcing motorists to maneuver around them. Mini-circles have been found to reduce motor vehicle crashes by an average of 90 percent in Seattle, WA.[3] Drivers making left turns are directed to go on the far side of the circle (see diagram at right) prior to making the turn. Signs should be installed directing motorists to proceed around the right side of the circle before passing through or making a left turn. Mini-circles are commonly landscaped (bushes, flowers, or grass), most often at locations where the neighborhood has agreed to maintain the plants. In locations where landscaping is not feasible, traffic circles can be enhanced through specific pavement materials.

PHOTO BY DAN BURDEN

A traffic mini-circle helps reduce vehicle speeds, but still allows cars and emergency vehicles to pass through the intersection with little difficulty.

Mini-circles are an intersection improvement as well as a traffic-calming device and can take the place of a signal or four-way stop sign. Many unwarranted four-way stop signs are installed because of the demand for action by the community.

Mini-circles must be properly designed to slow vehicles and benefit pedestrians and bicyclists. Right-turning vehicles are not controlled at an intersection with a mini-circle, potentially putting pedestrians and bicyclists at risk.

Therefore, tight curb radii should complement this treatment to discourage high-speed right-turn maneuvers. The occasional larger vehicle going through an intersection with a traffic circle (e.g., a fire truck or moving van) can be accommodated by creating a mountable curb in the outer portion of the circle.

Purpose

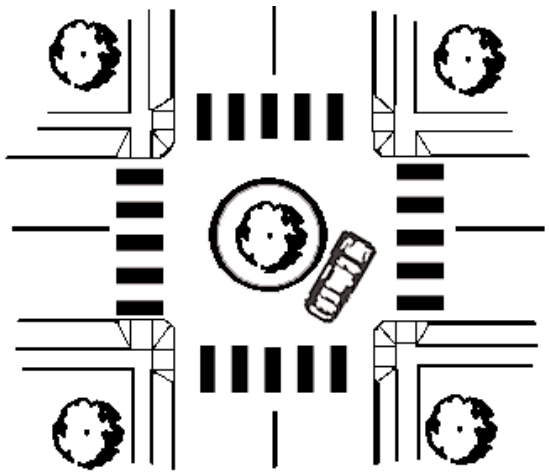
- Manage traffic at intersections where volumes do not warrant a stop sign or a signal.
- Reduce crash problems at the intersection of two local streets.
- Reduce vehicle speeds at the intersection.

Considerations

- Do not make generous allowances for motor vehicles by increasing the turning radii—this compromises pedestrian and bicyclist safety.
- Larger vehicles that need access to streets (e.g., school buses and fire engines) may need to make lefthand turns in front of the circle.
- Use yield, not stop, controls.
- Mini-circle landscaping should not impede the sight distance.
- Treat a series of intersections along a local street as part of a neighborhood traffic improvement program.

Estimated Cost

The cost is approximately $6,000 for a landscaped traffic mini-circle on an asphalt street and about $8,000 to $12,000 for a landscaped mini-circle on a concrete street.



Adapted from *Making Streets That Work*, Seattle, 1996

24. SPEED HUMPS

25. SPEED TABLES

Speed humps are paved (usually asphalt) and approximately 75 to 100 mm (3 to 4 in) high at their center, and extend the full width of the street with height tapering near the drain gutter to allow unimpeded bicycle travel. Speed humps should not be confused with the speed "bump" that is often found in mall parking lots. There are several designs for speed humps. The traditional 3.7-m (12-ft) hump has a design speed of 24 to 32 km/h (15 to 20 mi/h), a 4.3-m (14-ft) hump a few miles per hour higher, and a 6.7-m (22-ft) table has a design speed of 40 to 48 km/h (25 to 30 mi/h). The longer humps are much gentler for larger vehicles.

PHOTO BY SCOTT WAINWRIGHT

Speed humps are frequently used on some residential streets to reduce speeds. However, they can create unwanted noise if they are too severe, or cause motorists to slow down more than is necessary.

A "speed table" is a term used to describe a very long and broad speed hump, or a flat-topped speed hump, where sometimes a pedestrian crossing is provided in the flat portion of the speed table (see countermeasure #27). The speed table can either be parabolic, making it more like a speed hump, or trapezoidal, which is used more frequently in Europe. Speed tables can be used in combination with curb extensions where parking exists.

Purpose

- Reduce vehicle speeds. Raised measures tend to have the most predictable speed reduction impacts.
- Enhance the pedestrian environment at pedestrian crossings.

Considerations

- Do not use if on a sharp curve.
- If the street is a bus route or primary emergency route, the design must be coordinated with operators. Usually, some devices are acceptable if used prudently—one device may be appropriate and may serve the primary need (e.g., if there is a particular location along a street that is most in need of slowing traffic and improving pedestrian conditions).
- The aesthetics of speed humps and speed tables can be improved through the use of color and specialized paving materials.
- Noise may increase, particularly if trucks use the route regularly.
- May create drainage problems on some streets.
- Speed humps and tables should be properly designed and constructed to reduce the chance of back problems or other physical discomfort experienced by vehicle occupants. Tight tolerances are required during construction.

Estimated Cost

The cost for each speed hump is approximately $1,000. Speed tables are $2,000 to $15,000, depending on drainage conditions and materials used.

26. RAISED INTERSECTIONS

27. RAISED PEDESTRIAN CROSSINGS

A raised intersection is essentially a speed table (see photograph below) for the entire intersection. Construction involves providing ramps on each vehicle approach, which elevates the entire intersection to the level of the sidewalk. They can be built with a variety of materials, including asphalt, concrete, stamped concrete, or pavers. The crosswalks on each approach are also elevated as part of the treatment to enable pedestrians to cross the road at the same level as the sidewalk, eliminating the need for curb ramps. Use detectable warnings to mark the boundary between the sidewalk and the street.

PHOTO BY ITE PEDESTRIAN BICYCLE COUNCIL

A raised intersection slows all vehicular movements through the intersection and improves pedestrian crossings in all directions.

PHOTO BY DAN BURDEN

A raised pedestrian crossing provides a continuous route for the pedestrian at the same level as the sidewalk. Pavement markings may be used on the slope to make the crossing visible to motorists.

A raised pedestrian crossing is also essentially a speed table, with a flat portion the width of a crosswalk, usually 3.0 to 4.6 m (10 to 15 ft). Raised intersections and crosswalks encourage motorists to yield. On one street in Cambridge, MA, motorists yielding to pedestrians crossing at the raised devices went from approximately 10 percent before installation of the project to 55 percent after installation.[4]

Purpose

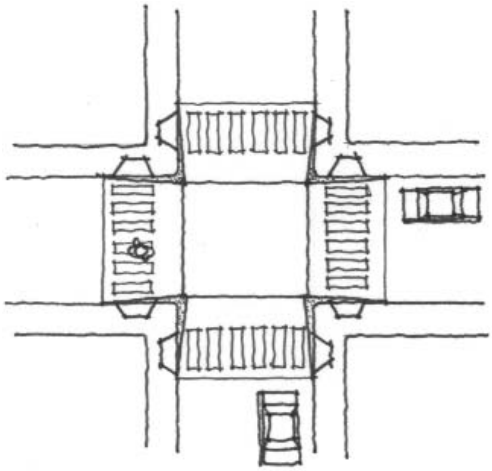
- Reduce vehicle speeds.
- Enhance the pedestrian environment at the crossings.

Considerations:

- Don't use if on a sharp curve or if the street is on a steep grade.
- May not be appropriate if the street is a bus route or emergency route. One device may be necessary and serve the primary need. Several raised devices may be disruptive, so other measures should be considered.
- Speed tables and raised crosswalks and intersections can be an urban design element through the use of special paving materials.
- Detectable warning strips at edges enable pedestrians with vision impairments to detect the crossing.
- Care must be taken to manage drainage.

Estimated Cost

Raised crosswalks are approximately $2,000 to $15,000, depending on drainage conditions and material used. The cost of a raised intersection is highly dependent on the size of the roads. They can cost from $25,000 to $75,000.



Adapted from *Making Streets That Work*, Seattle, 1996

28. GATEWAYS

A gateway is a physical or geometric landmark that indicates a change in environment from a higher speed arterial or collector road to a lower speed residential or commercial district. They often place a higher emphasis on aesthetics and are frequently used to identify neighborhood and commercial areas within a larger urban setting. Gateways may be a combination of street narrowing, medians, signing, archways, roundabouts, or other identifiable feature. Gateways should send a clear message to motorists that they have reached a specific place and must reduce speeds. This can help achieve the goal of meeting expectations and preparing motorists for a different driving environment. Gateways are only an introduction and slower speeds are not likely to be maintained unless the entire area has been redesigned or other traffic-calming features are used.

PHOTO BY DAN BURDEN

The combination of landscaping and a short median create a gateway to this neighborhood.

Purpose

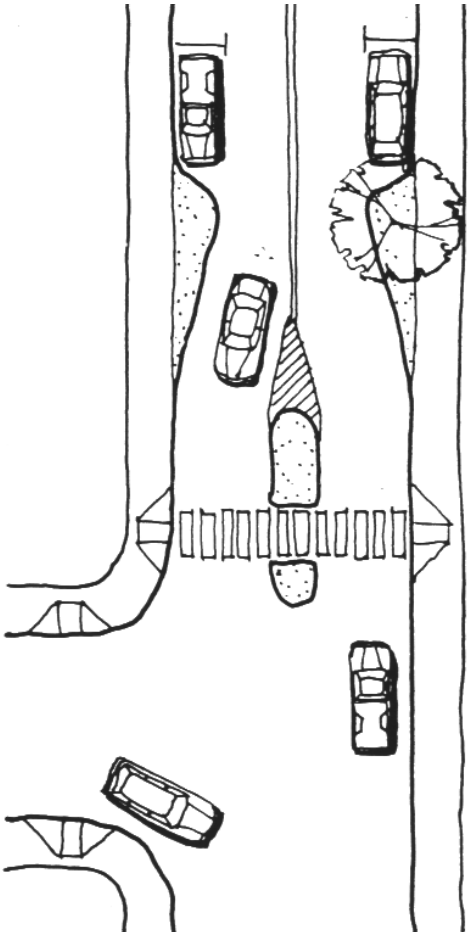
- Create an expectation for motorists to drive more slowly and watch for pedestrians when entering a commercial, business, or residential district from a higher speed roadway.
- Create a unique image for an area.

Considerations

- Traffic-slowing effects will depend upon the device chosen and the overall traffic-calming plan for the area.

Estimated Cost

Varies widely depending on the measures chosen.



CITY OF CAMBRIDGE, MA

29. LANDSCAPING

The careful use of landscaping along a street can provide separation between motorists and pedestrians, reduce the visual width of the roadway (which can help to reduce vehicle speeds), and provide a more pleasant street environment for all. This can include a variety of trees, bushes, and/or flowerpots, which can be planted in the buffer area between the sidewalk or walkway and the street.

PHOTO BY DAN BURDEN

Landscaping with low shrubs, ground cover, and mature trees that are properly pruned can add shade, color, and visual interest to a street.

The most significant issue with any landscaping scheme is ongoing maintenance. Some communities have managed effectively by creating homeowners associations to pay for landscape maintenance or through the volunteer efforts of neighbors. Others have found them to be unreliable and budget for public maintenance instead. Consider adding irrigation systems in areas with extensive planting.

Choosing appropriate plants, providing adequate space for maturation, and preparing the ground can help ensure that they survive with minimal maintenance, and don't buckle the sidewalks as they mature. The following guidelines should be considered: plants should be adapted to the local climate and fit the character of the surrounding area—they should survive without protection or intensive irrigation; and plant's growth patterns should not obscure signs or pedestrians' and motorists' views of each other.

Purpose

- Enhance the street environment.
- Calm traffic by creating a visual narrowing of the roadway.

Considerations

- Maintenance must be considered and agreed to upfront, whether it is the municipality or the neighborhood residents who will take responsibility for maintenance.
- Shrubs should be low-growing and trees should be trimmed up to at least 2.4 to 3.0 m (8 to 10 ft) to ensure that sight distances and head room are maintained and personal security is not compromised.
- Plants and trees should be chosen with care to match the character of the area; be easily maintained; and not create other problems, such as buckling sidewalks.
- Minimum clear widths and heights, as specified in the *Draft Guidelines for Accessible Public Rights-of-Way*, must be maintained.

Estimated Cost

Opportunities for funding landscaping are often more flexible than for major street changes. For example, the cost of the actual landscaping may be paid for by the corresponding neighborhood or business groups. Often, municipalities will pay for the initial installation and homeowners associations, neighborhood residents, or businesses agree to maintain anything more elaborate than basic tree landscaping.

30. SPECIFIC PAVING TREATMENTS

Paving materials are important to the function and look of a street, both in the road and on the sidewalk. Occasionally, paving materials in and of themselves act as a traffic-calming device (e.g., when the street is paved in brick or cobblestone). However, some of these materials may be noisy and unfriendly to bicyclists, pedestrians, wheelchairs, or snowplow blades. In particular, cobblestones should not be used in the expected pedestrian or bicycle path, although they may be used as aesthetic elements in a streetscape design. Smooth travel surfaces are best for all pedestrians.

PHOTO BY CARA SEIDERMAN

Brick or cobblestone streets help slow traffic and create a feeling that the street is not a highway or fast-moving arterial.

The pedestrian walkway material should be firm, planar, and slip-resistant. Concrete is the preferred walking surface. A different look can be achieved by using stamped concrete or concrete pavers, which are available in a variety of colors and shapes; however, jointed surfaces may induce vibration, which can be painful to some pedestrians. They can also be used on the top of raised devices.

It is important to ensure crosswalk visibility. High visibility markings are often best. Textured crosswalks should be marked with reflective lines since these types of crosswalks are not as visible, especially at night or on rainy days.

Colored paving can often enhance the function of portions of the roadway, such as a colored bicycle lane. This can create the perception of street narrowing, in addition to enhancing the travel facility for bicyclists.

Purpose

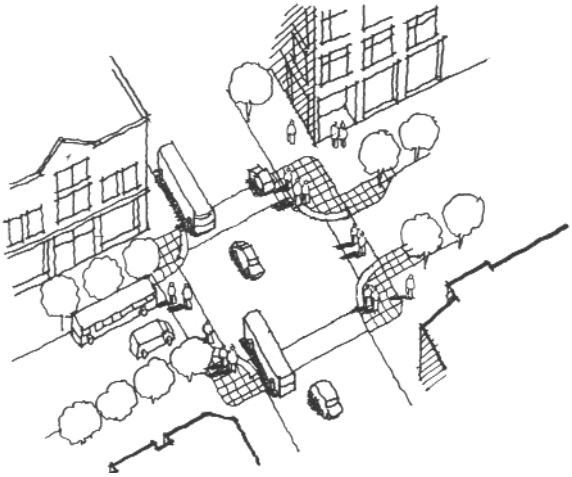
- Send a visual cue about the function of a street.
- Create an aesthetic enhancement of a street.
- Delineate separate space for pedestrians or bicyclists.

Considerations

- Slippery surfaces, such as smooth granite and paint, and uneven surfaces, such as cobblestones and brick, should not be used in the primary pedestrian or bicycle travel paths. Bumpy surfaces may be especially uncomfortable for wheelchair users and a tripping hazard for all pedestrians.
- Coordinate choice and placement of materials with maintenance agencies.
- Design and maintenance must ensure crosswalk visibility over time.
- Using materials such as bricks and cobblestones may increase the cost of construction and maintenance.

Estimated Cost

Variable; materials requiring hand labor (cobblestones or pavers) have a higher cost.



SKETCH BY MICHAEL KIMELBERG

31. SERPENTINE DESIGN

Serpentine design refers to the use of a winding street pattern with built-in visual enhancements through a neighborhood, which allow for through movement while forcing vehicles to slow. The opportunities for significant landscaping can be used to create a park-like atmosphere.

PHOTO BY CARA SEIDERMAN

The serpentine street is a curving roadway that helps slow traffic through the use of curbs and landscaping.

Such designs are usually implemented with construction of a new neighborhood street or during reconstruction of an existing street corridor. This type of design can be more expensive than other traffic-calming options and needs to be coordinated with driveway access.

Purpose

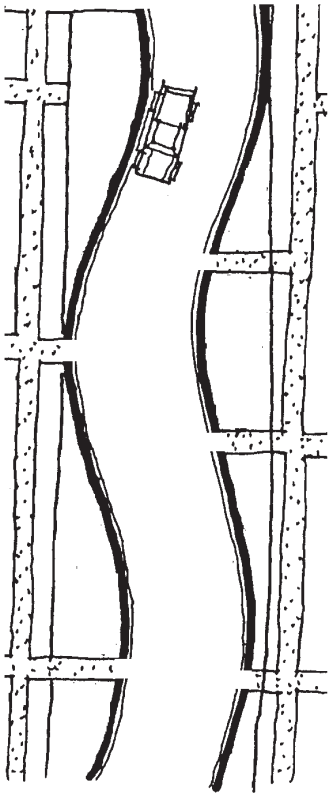
- Change the entire look of a street to send a message to drivers that the road is not for fast driving.

Considerations

- Where costs are a concern, lower cost, equally effective traffic-calming strategies may be preferable.
- Most cost-effective to build as a new street or where a street will soon undergo major reconstruction for utility or other purposes.

Estimated Cost

The cost can be high ($60,000 to $90,000 per block) to retrofit a street, but may be no extra to build a new street with this design if adequate right-of-way is available.



Adapted from *Making Streets That Work*, Seattle, 1996

32. WOONERF

"Woonerf" ("Street for living") is a Dutch term for a common space created to be shared by pedestrians, bicyclists, and low-speed motor vehicles. They are typically narrow streets without curbs and sidewalks, and vehicles are slowed by placing trees, planters, parking areas, and other obstacles in the street. Motorists become the intruders and must travel at very low speeds below 16 km/h (10 mi/h). This makes a street available for public use that is essentially only intended for local residents. A woonerf identification sign is placed at each street entrance.

PHOTO BY DAN BURDEN

Motorists, bicyclists, and pedestrians share the space on this woonerf or "living street" in Asheville, North Carolina.

Consideration must be given to provide access by fire trucks, sanitation vehicles and other service vehicles (school buses and street sweepers), if needed.

Purpose

- Create a very low automobile volume, primarily on local access streets.
- Create a public space for social and possibly commercial activities and play by area children.

Considerations

- A woonerf is generally not appropriate where there is a need to provide nonresident motorists with access to services or through travel.
- The design needs to keep vehicle speeds very low in order to make the streets safe for children.

Estimated Cost

The cost to retrofit a woonerf may be quite high, but there would be no extra cost if designed into the original construction.

TRAFFIC MANAGEMENT

Although they are sometimes lumped together, traffic management and traffic calming are different tools and address different problems. Traffic management includes the use of traditional traffic control devices to manage volumes and routes of traffic. Traffic calming deals with what happens to traffic once it is on a street. For example, limiting access to a street (e.g., diverting traffic from entering a street on one end) may reduce the amount of traffic on that street, but will do nothing to affect the speed of the traffic that travels on that street or others. Traffic management and traffic calming are often complementary, and a plan to retrofit an area often includes a variety of tools.

PHOTO BY MICHAEL CYNECKI

Communities should think about the broader context of traffic. If there is too much traffic on any one street, it may be that there is too much traffic altogether. A more significant plan to reduce overall traffic volumes would be appropriate—encouraging and providing for alternate modes of travel by developing pedestrian and bicycling networks, implementing Transportation Demand Management, enhancing transit systems, improving land-use planning, etc. Comprehensive traffic reduction or mitigation strategies are important; however, these are beyond the scope of this guide. Resources that provide guidance on these issues are included in Chapter 7.

Traffic calming and traffic management should be assessed from an areawide perspective. The problem should not just be shifted from one street to another. Although implementation usually occurs in stages, an overall plan can be developed up-front, involving a larger neighborhood or area of the city.

Traffic calming has also helped reduce motor vehicle traffic volumes and increase walking and bicycling. For example, on one traffic-calmed street in Berkeley, CA,

PHOTO BY DAN BURDEN

This street closure in Charlotte provides needed open space in an urban neighborhood.

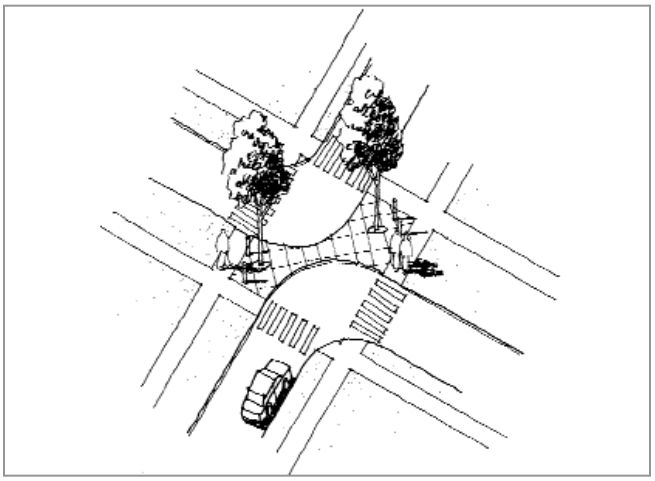
the number of bicyclists and pedestrians more than doubled after the street was reconstructed with traffic-calming tools, and motor vehicle volumes decreased by about 20 percent (see Case Study No. 1; Chapter 6). Traffic volume reduction raises the question: Where does the traffic go? In the Berkeley case, traffic volumes on parallel streets did not account for all of the traffic that disappeared from the traffic-calmed street. Ideally, the reduction in traffic means that some people chose a different mode of travel, such as transit, walking, or bicycling. This is only feasible if a system is in place to support those modes. What is often the case in selective street redesign is that traffic is routed onto other streets. It is desirable to keep traffic on collector and arterial streets and off residential streets. However, in many communities, arterials are already over capacity, and alternate routes may also involve other residential streets.

Traffic management and traffic calming should involve the community. Neighborhood participation and the community involvement process are discussed in Chapter 7. Specific traffic management countermeasures described in this section include:

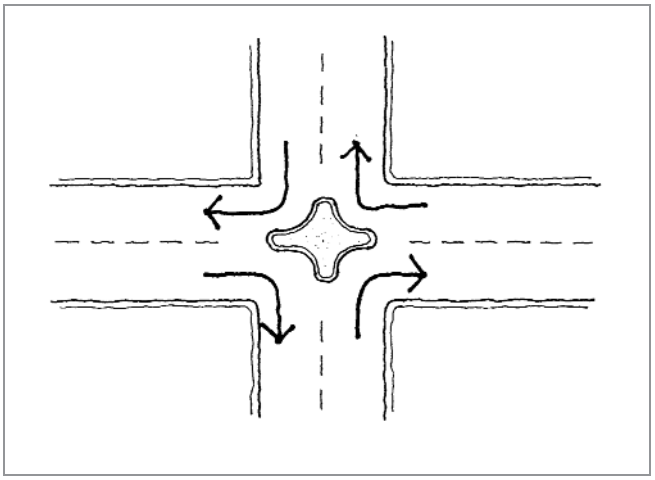
- Diverters
- Full Street Closure
- Partial Street Closure
- Pedestrian Streets/Malls

33. DIVERTERS

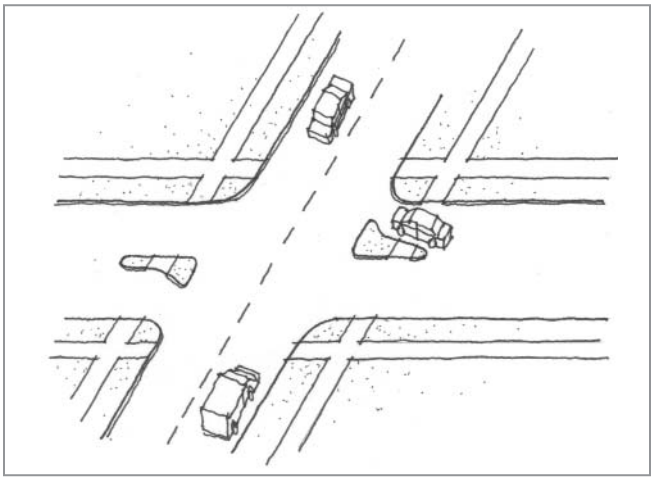
A diverter is an island built at a residential street intersection that prevents certain through and/or turning movements. Diverters affect people living in the neighborhood more than anyone else. Therefore, diverters should be considered only when less restrictive measures are not appropriate.



Diagonal Diverter



Star Diverter



Forced Turn Diverter

Purpose

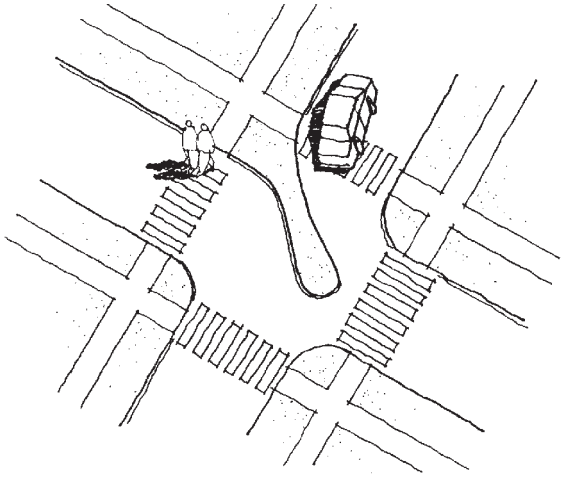
- Discourage or prevent traffic from cutting through a neighborhood.

Considerations

- Impacts residents more than through traffic.
- Consider less restrictive measures first.
- Evaluate traffic patterns to determine whether other streets would be adversely affected.
- Design diverters to allow bicycle, pedestrian, and emergency vehicle access. If this cannot be done and the street is a major bicycle corridor, a diverter should not be used.
- Diverters generally do not effectively address midblock speeding problems.
- Diagonal diverters may be used in conjunction with other traffic management tools and are most effective when applied to the entire neighborhood street network.
- Diverters should have strong neighborhood support.
- The effect of diverters on service vehicles should be considered.

Estimated Cost

$15,000 to $45,000 each, depending on the type of diverter and the need to accommodate drainage.



Truncated Diverter

Four types of diverters are: diagonal, star, forced turn, and truncated. A diagonal diverter breaks up cut-through movements and forces right or left turns in certain directions. A star diverter consists of a star-shaped island placed at the intersection, which forces right turns from each approach. A truncated diagonal diverter is a diverter with one end open to allow additional turning movements. Other types of island diverters can be placed on one or

PHOTO BY DAN BURDEN

Traffic diverters restrict certain traffic movements and should only be considered when less restrictive measures are not appropriate.

more approach legs to prevent through and left-turn movements and force vehicles to turn right.

As with other traffic management tools, diverters must be used in conjunction with other traffic management tools within the neighborhood street network. Any of these diverters can be designed for bicycle and pedestrian access.

34. FULL STREET CLOSURE

A full street closure is accomplished by installing a physical barrier that blocks a street to motor vehicle traffic and provides some means for vehicles to turn around. Full street closures should be used only in the rarest of circumstances. Neighborhoods with cul-de-sac streets require extensive out-of-the-way travel, which is not a mere convenience issue, but has serious implications for impacts on other streets. All traffic is forced to travel on feeder streets, which has negative consequences for the people who live on those streets and forces higher levels of control at critical intersections.

PHOTO BY DAN BURDEN

Access is closed on this residential street.

If a street closure is done, it should always allow for the free through movement of all pedestrians, including wheelchair users, and bicyclists. Emergency vehicles should also be able to access the street; this can be done with a type of barrier or gate that is electronically operated, permitting only large vehicles to traverse it. Examples are mountable curbs or an accessway with a raised element in the center that a low vehicle would hit, though those treatments may not be able to stop pick-ups or sport utility vehicles. This is usually only appropriate for places with no snow (otherwise the device would be covered with snow and the accessway could not be cleared).

Purpose

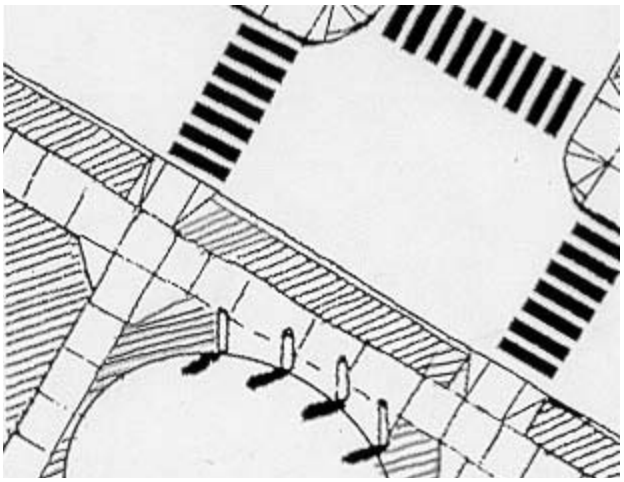
- Ultimate limitation of motor vehicle traffic to certain streets.

Considerations

- Part of an overall traffic management strategy.
- Analyze whether other streets would receive diverted traffic as a result of the street closure, and whether alternative streets exist for through traffic.
- Provide a turnaround area for motor vehicles, including service vehicles, and provide for surface drainage.
- Full street closures may be considered for local streets, but are not appropriate for collector streets.
- Do not use if the street is an emergency or school bus route.
- Do not adversely affect access to destinations in the community by pedestrians and bicyclists.
- Not an appropriate measure for addressing crime or other social problems.

Estimated Cost

The cost for a full, landscaped street closure varies from approximately $30,000 to $100,000, depending on conditions.



SKETCH BY YAN JIA

35. PARTIAL STREET CLOSURE

A partial street closure uses a semi-diverter to physically close or block one direction of motor vehicle travel into or out of an intersection; it could also involve blocking one direction of a two-way street. Partial street closures at the entrance to a neighborhood or area should consider the traffic flow pattern of the surrounding streets as well. The design of this measure should allow for easy access by bicyclists and all pedestrians.

PHOTO BY MIKE CYNECKI

This partial street closure is found in Phoenix, AZ.

A partial closure provides better emergency access than a full closure. Since this design also allows motorists to easily violate the prohibitions, police enforcement may be required. If the partial closure only eliminates an entrance to a street, a turnaround is not needed; closing an exit will generally require a turnaround.

Purpose

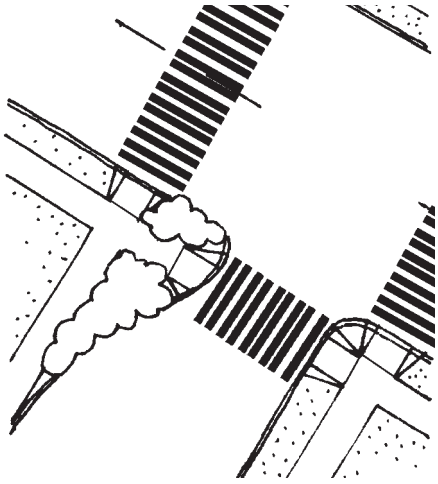
- Prevent turns from an arterial street onto a residential street.
- Reduce cut-through traffic.
- Restrict access to a street without creating one-way streets.

Considerations

- Do not adversely affect access by service vehicles.
- Analyze whether less restrictive measures would work.
- Analyze whether other local streets will be adversely affected and/or access into or out of the neighborhood would not be adequate.
- Will create out-of-the-way travel for residents and put additional traffic on other streets.
- Consider impact on school bus routes, emergency access, and trash pickup.
- Will not solve speeding issues; speeds may increase on the new one-way street.

Estimated Cost

A well-designed, landscaped partial street closure at an intersection typically costs approximately $10,000 to $25,000. They can be installed for less if there are no major drainage issues and landscaping is minimal.



Adapted from *Making Streets That Work*, Seattle, 1996

36. PEDESTRIAN STREETS/MALLS

There are two types of pedestrian streets/malls: (1) those that eliminate motor vehicle traffic (deliveries permitted during off-peak hours) and; (2) those that allow some motor vehicle traffic at very low speeds. The second type can be thought of as a pedestrian street that allows some motor vehicles, as opposed to a motor vehicle street that allows some pedestrians.

PHOTO BY CARA SEIDERMAN

Church Street in Burlington, Vermont, is a successful pedestrian street with market stalls, public art, landscaping, and cafes.

Pedestrian streets have been successful in places that are thriving and have high volumes of pedestrians. Examples of successful pedestrian streets include Church Street in Burlington, VT; Downtown Crossing in Boston, MA; Maiden Lane in San Francisco, CA; Occidental Street in Seattle, WA; Third Street Promenade in Santa Monica, CA; and, Fremont Street in Las Vegas, NV.

Another option is to create a part-time pedestrian street, as is done, for example, in the French Quarter in New Orleans, LA, which uses removable barriers to close the street to motorists at night.

Purpose

- Create a significant public space in a downtown district, a tourist district, or a special events or marketplace area.
- Enhance the experience for people in a commercial district.

Considerations

- Pedestrian streets (those that eliminate motor vehicles) created with the notion of attracting people in areas that are on the decline have usually been unsuccessful.
- The pedestrian environment can often be enhanced through other measures, including street narrowing/sidewalk widening and the addition of landscaping.

Estimated Cost

A pedestrian street can be created simply by blocking either end of an existing street with nothing more than a few signs. Temporary pedestrian streets can be created for weekends or holidays. If the street is going to be a permanent public space, care should be taken in the design. Depending on the extent of the treatment (one block or several blocks) and the quality of the materials used, a true pedestrian street can cost from $100,000 to several million dollars.

SIGNALS AND SIGNS

Traffic control devices are often used by traffic engineers to improve safety and access for pedestrians. In addition to marked crosswalks (see countermeasure number 3), several other devices are available, including:

- Traffic Signals
- Pedestrian Signals
- Pedestrian Signal Timing
- Traffic Signal Enhancements
- Right-Turn-On-Red Restrictions
- Advanced Stop Lines
- Signing

PHOTO BY CARA SEIDERMAN

37. TRAFFIC SIGNALS

Traffic signals create gaps in the traffic flow, allowing pedestrians to cross the street. They should allow adequate crossing time for pedestrians and an adequate clearance interval based upon a maximum walking speed of 1.2 m/s (4.0 ft/s). In areas where there is a heavy concentration of the elderly or children, a lower speed of less than 1.1 m/s (3.5 ft/s) should be used in determining pedestrian clearance time. Signals are particularly important at high-use, mid-block crossings on higher speed roads, multi-lane roads, or at highly congested intersections. National warrants from the Manual on Uniform Traffic Control Devices are based on the number of pedestrians and vehicles crossing the intersection, among other factors.[1] However, judgment must also be used on a case-by-case basis. For example, a requirement for installing a traffic signal is that there are a certain number of pedestrians present. If a new facility is being built—a park or recreational path, for example—there will be a new demand, and the signal could be installed in conjunction with the new facility based on projected crossing demand. There may also be latent demand if a destination is not currently accessible, but could become so with new facilities or redesign.

PHOTO BY BARBARA GRAY

A traffic signal at a busy intersection with high volumes of pedestrians, bicyclists, and cars.

In downtown areas, signals are often closely spaced, sometimes every block. Timed sequencing of signals may reduce the amount of time allotted per cycle for pedestrian crossing to unsafe lengths. Signals are usually spaced farther apart in suburban or outlying areas, but similar considerations for pedestrian phasing should be made. When high pedestrian traffic exists during a majority of the day, fixed-time signals should be used to consistently allow crossing opportunities. Pedestrian actuation should only be used when pedestrian crossings are intermittent and should be made accessible to all pedestrians, including those with disabilities.

Purpose

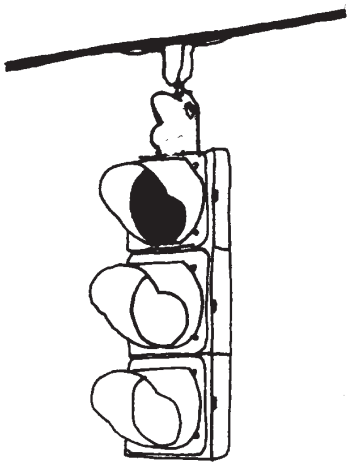
- Provide intervals in a traffic system where pedestrians can cross streets safely.

Considerations

- Where pedestrian traffic is regular and frequent, pedestrian phases should come up automatically. Pedestrian actuation should only be used when pedestrian crossings are intermittent.
- Signal cycles should be kept short (ideally 90 seconds maximum) to reduce pedestrian delay. Pedestrians are very sensitive to delays.
- Marked crosswalks at signals encourage pedestrians to cross at the signal and discourage motorists from encroaching into the crossing area.

Estimated Cost

$30,000 to $140,000.



Adapted from *Making Streets That Work*, Seattle, 1996

38. PEDESTRIAN SIGNALS

Pedestrian signal indications should be used at traffic signals wherever warranted, according to the MUTCD. The use of WALK/DON'T WALK pedestrian signal indications at signal locations are important in many cases, including when vehicle signals are not visible to pedestrians, when signal timing is complex (e.g., there is a dedicated left-turn signal for motorists), at established school zone crossings, when an exclusive pedestrian interval is provided, and for wide streets where pedestrian clearance information is considered helpful.[1]

PHOTO BY ROBERT SCHNEIDER

Pedestrian signals should always be clearly visible to the pedestrian while in the crosswalk and waiting on the far side of the street.

The international pedestrian symbol signal is preferable and is recommended in the MUTCD. Existing WALK and DON'T WALK messages may remain for the rest of their useful life but should not be used for new installations.[1] Pedestrian signals should be clearly visible to the pedestrian at all times when in the crosswalk or waiting on the far side of the street. Larger pedestrian signals can be beneficial in some circumstances (e.g., where the streets are wide). Signals may be supplemented with audible or other messages to make crossing information accessible for all pedestrians, including those with vision impairments. The decision to install audible pedestrian signals should consider the noise impact on the surrounding area. Much more extensive information on the use of accessible pedestrian signals (APS) and the types of APS technologies now available is provided online at www.walkinginfo.org/aps.

Purpose

- Indicate appropriate time for pedestrians to cross.
- Provide pedestrian clearance interval.

Considerations

- Ensure that signals are visible to pedestrians.
- When possible, provide a walk interval for every cycle.
- Pedestrian push buttons must be well positioned and within easy reach for all approaching pedestrians. Section 4E.09 within the MUTCD provides detailed guidance for the placement of push buttons to ensure accessibility.[2]

Estimated Cost

$20,000 to $40,000.

Example of an pedestrian regulatory sign used in conjunction with a pushbutton. The recommended language for such signs can be found in Section 2B.44 of the MUTCD.

39. PEDESTRIAN SIGNAL TIMING

There are several types of signal timing for pedestrian signals, including concurrent, exclusive, "leading pedestrian interval" (LPI), and all-red interval. In general, shorter cycle lengths and longer walk intervals provide better service to pedestrians and encourage better signal compliance. For optimal pedestrian service, fixed-time signal operation usually works best. Pedestrian pushbuttons may be installed at locations where pedestrians are expected intermittently. Quick response to the pushbutton or feedback to the pedestrian should be programmed into the system. When used, pushbuttons should be well-signed and within reach and operable from a flat surface for pedestrians in wheelchairs and with visual disabilities. They should be conveniently placed in the area where pedestrians wait to cross. Section 4E.09 within the MUTCD provides detailed guidance for the placement of push buttons to ensure accessibility.[1]

PHOTO BY BARBARA GRAY

With a leading pedestrian interval, pedestrians get an advance walk signal before motorists get a green. This gives the pedestrians several seconds to establish their presence in the crosswalk before motorists start to turn.

In addition to concurrent pedestrian signal timing (where motorists may turn left or right across pedestrians' paths after yielding to pedestrians), exclusive pedestrian intervals (see Traffic Signal Enhancements) stop traffic in all directions. Exclusive pedestrian timing has been shown to reduce pedestrian crashes by 50 percent in some downtown locations with heavy pedestrian volumes and low vehicle speeds and volumes.[2] With concurrent signals, pedestrians usually have more crossing opportunities and have to wait less. Unless a system is willing to take more time from vehicular phases, pedestrians will often have to wait a long time for an exclusive signal. This is not very pedestrian-friendly, and many pedestrians will simply choose to ignore the signal and cross if and when there is a gap in traffic, negating the potential safety benefits of the exclusive signal.[3] Exclusive pedestrian phases do introduce a problem for pedestrians with visual impairments, as the audible cues associated with surging parallel traffic streams are no longer present,

Purpose

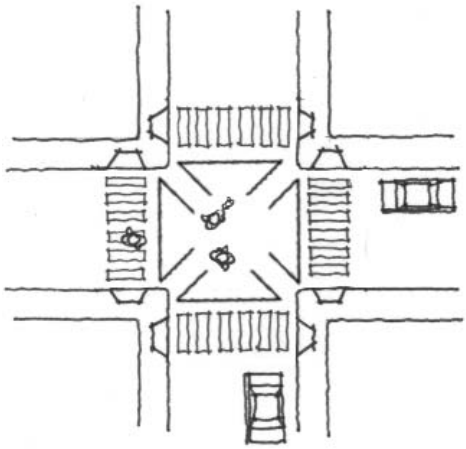
- A "Pedestrian Scramble" provides an exclusive pedestrian crossing phase with no conflicting traffic.
- A short all-red clearance interval provides a better separation between cars and pedestrians.

Considerations

- A "Pedestrian Scramble" usually creates a longer cycle length and a longer wait between crossings.
- The Scramble may eliminate the ability to synchronize timing at adjacent traffic signals.
- Scramble timing is most applicable to downtown areas with high pedestrian volumes (e.g., more than 1,200 pedestrian crossings per day).
- Scramble timing eliminates conflicts with turning vehicles if pedestrians and motorists obey their signals.
- The benefits of this treatment may not extend to vision-impaired pedestrians.
- Wider intersections require longer cycle lengths.
- Longer walk or pedestrian clearance intervals may also lead to longer cycle lengths.
- Use fixed-time operation unless pedestrian arrivals are intermittant.

Estimated Cost

Adjusting signal timing is very low cost and requires a few hours of staff time to accomplish. New signal equipment ranges from $20,000 to $140,000.



SKETCH BY MICHAEL KIMMELBERG

Exclusive walk phase or "Pedestrian Scramble."

PHOTO BY HERMAN HUANG

The pedestrian has a dedicated walk phase at this intersection of a busy street and a trail crossing.

which makes it difficult to know when to begin crossing.

A simple, useful change is the LPI. An LPI gives pedestrians an advance walk signal before the motorists get a green light, giving the pedestrian several seconds to start in the crosswalk where there is a concurrent signal. This makes pedestrians more visible to motorists and motorists more likely to yield to them. This advance crossing phase approach has been used successfully in

PHOTO BY HERMAN HUANG

The pedestrian has a dedicated walk phase and is allowed to cross diagonally at this intersection.

several places, such as New York City, for two decades and studies have demonstrated reduced conflicts for pedestrians.[4] The advance pedestrian phase is particularly effective where there is a two-lane turning movement. To be useful to pedestrians with vision impairments, an LPI needs to be accompanied by an audible signal to indicate the WALK interval.

There are some situations where an exclusive pedestrian phase may be preferable to an LPI. Exclusive phases are desirable where there are high-volume turning movements that conflict with the pedestrians crossing.

40. TRAFFIC SIGNAL ENHANCEMENTS

A variety of traffic signal enhancements that can benefit pedestrians and bicyclists are available. These include automatic pedestrian detectors, providing larger traffic signals to ensure visibility, placing signals so that motorists waiting at a red light can't see the other signals and anticipate the green, and installing countdown signals to provide pedestrians with information about the amount of time remaining in a crossing interval.

PHOTO BY JEFF BAGDADE

This countdown signal indicates to pedestrians the amount of time they have remaining to cross (until the flashing DON'T WALK ends).

Countdown signals may be designed to begin counting down at the beginning of the walk phase or at the beginning of the clearance (flashing DON'T WALK) interval.

Since pedestrian pushbutton devices are not activated by about one-half of pedestrians (even fewer activate them where there are sufficient motor vehicle gaps), new "intelligent" microwave or infrared pedestrian detectors are now being installed and tested in some U.S. cities. These automatically activate the red traffic and WALK signals when pedestrians are detected. Detectors can also be used to extend the crossing time for slower moving pedestrians in the crosswalk. Automatic pedestrian detectors have been found to improve pedestrian signal compliance and also reduce pedestrian conflicts with motor vehicles. However, they are still considered experimental and their reliability may vary under different environmental conditions.[5]

More information on some of these technologies is available online at www.walkinginfo.org/pedsmart. This web site was developed in 1999 and includes information on several types of smart technologies, the problems they may address, and the vendors of the devices. Locations where many of the devices were installed at that time are also included as case studies.

Purpose

- Improve pedestrian accommodation at signalized crossings.

Considerations

- Pedestrian signals need to indicate the crossing interval by visual, audible, and/or tactile means if pedestrians with vision impairments are to take advantage of them.
- The effects of pedestrian countdown signals on pedestrian safety are not well known. Further research is needed to better understand their effects.

Estimated Cost

About $5,000 to add new pedestrian signals and mark crosswalks.

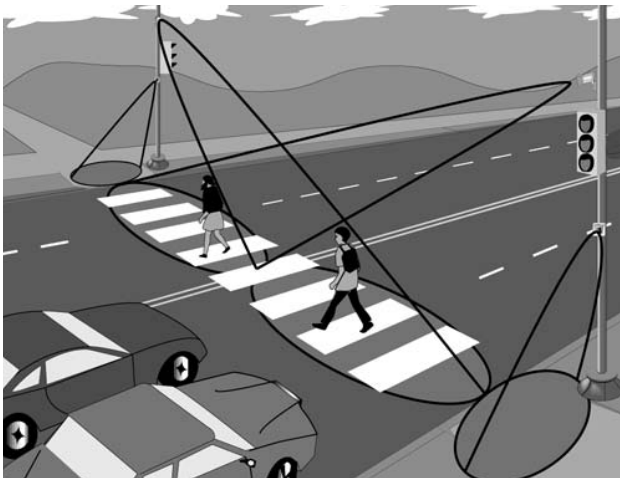


ILLUSTRATION BY CHRISTIAN VALIULIS

An automated pedestrian detection system.

41. RIGHT-TURN-ON-RED RESTRICTIONS

A permissible Right Turn on Red (RTOR) was introduced in the 1970s as a fuel-saving measure and has sometimes had detrimental effects on pedestrians. While the law requires motorists to come to a full stop and yield to cross-street traffic and pedestrians prior to turning right on red, many motorists do not fully comply with the regulations, especially at intersections with wide turning radii. Motorists are so intent on looking for traffic approaching on their left that they may not be alert to pedestrians approaching on their right. In addition, motorists usually pull up into the crosswalk to wait for a gap in traffic, blocking pedestrian crossing movements. In some instances, motorists simply do not come to a full stop.

PHOTO BY CARA SEIDERMAN

Prohibiting right turns can benefit pedestrian safety at some locations.

One concern that comes up when RTOR is prohibited is that this may lead to higher right-turn-on-green conflicts when there are concurrent signals. The use of the leading pedestrian interval (LPI) can usually best address this issue (see Countermeasure No. 39). Where pedestrian volumes are very high, exclusive pedestrian signals should be considered.

Prohibiting RTOR should be considered where and/or when there are high pedestrian volumes. This can be done with a simple sign posting, although there are some options that are more effective than a standard sign. For example, one option is a larger 762-mm by 914-mm (30-in by 36-in) NO TURN ON RED sign, which is more conspicuous. For areas where a right-turn-on-red restriction is needed during certain times, time-of-day restrictions may be appropriate. A variable-message NO TURN ON RED sign is also an option.[6]

Purpose

- Increase pedestrian safety and decrease crashes with right-turning vehicles.

Considerations

- Prohibiting RTOR is a simple, low-cost measure. Together with a leading pedestrian interval, the signal changes can benefit pedestrians with minimal impact on traffic.
- Part-time RTOR prohibitions during the busiest times of the day may be sufficient to address the problem.
- Signs should be clearly visible to right-turning motorists stopped in the curb lane at the crosswalk.

Estimated Cost

$30 to $150 per NO TURN ON RED sign plus installation at $200 per sign. Electronic signs have higher costs.

PHOTO BY SCOTT WAINWRIGHT

Example of an electronic blank-out sign for right-turn prohibition (Burlington, VT).

42. ADVANCED STOP LINES

At signalized intersections and midblock crossings, the vehicle stop line can be moved farther back from the pedestrian crosswalk for an improved factor of safety and for improved visibility of pedestrians. In some places, the stop line has been moved back by 4.6 to 9.1 m (15 to 30 ft) relative to the marked crosswalk with considerable safety benefits for pedestrians. One study found that use of a "Stop Here For Pedestrians" sign alone reduced conflicts between drivers and pedestrians by 67 percent. With the addition of an advanced stop line, this type of conflict was reduced by 90 percent compared to baseline levels.[7]

PHOTO BY CARA SEIDERMAN

Advanced stop lines are used at this signalized crossing to improve sight distances and to give the motorist who initially fails to see the crosswalk more time to stop. The bicyclist can advance ahead, which aids in bicyclist safety, particularly with right-turning motorists.

The advanced stop lines allow pedestrians and drivers to have a clearer view of each other and more time in which to assess each other's intentions. The effectiveness of this tool depends upon whether motorists are likely to obey the stop line, which varies from place to place.

Advanced stop lines are also applicable for non-signalized crosswalks on multi-lane roads to ensure that drivers in all lanes have a clear view of a crossing pedestrian.

Purpose

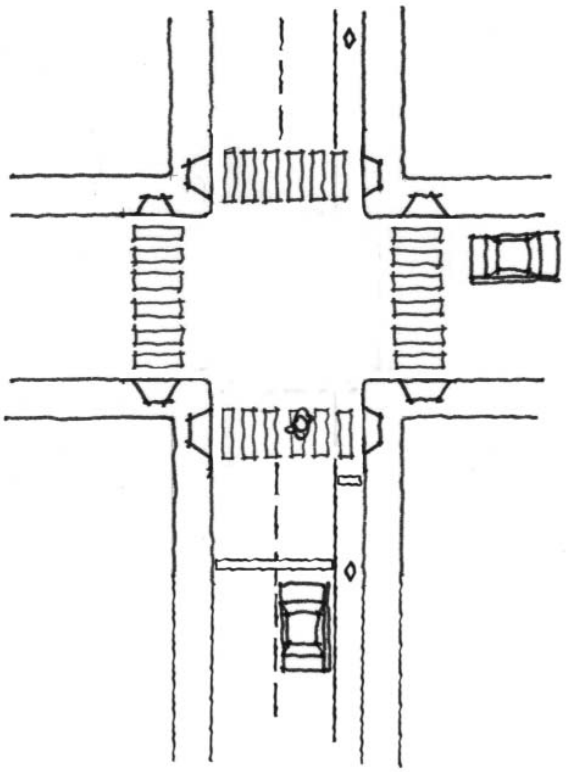
- Improve visibility of pedestrians to motorists.
- Allow pedestrians to advance in a crosswalk before motor vehicles turn.

Considerations

- Effectiveness depends on motorist compliance with the marked stop line.
- If placed too far in advance of the crosswalk, motorists may ignore the line.
- In some locations, a wider crosswalk may be an effective alternative.

Estimated Cost

There is no extra cost when the recessed stop line is installed on new paving or as part of repaving projects. A STOP HERE ON RED (R10-6) sign can be used to supplement the recessed stop line.



SKETCH BY MICHAEL KIMELBERG

43. SIGNING

Signs can provide important information that can improve road safety. By letting people know what to expect, there is a greater chance that they will react and behave appropriately. For example, giving motorists advance warning of an upcoming pedestrian crossing or that they are entering a traffic-calmed area will alert them to modify their speed. Sign use and movement should be done judiciously, as overuse breeds noncompliance and disrespect. Too many signs may also create visual clutter and signs can get lost.

PHOTO BY BARBARA GRAY

This experimental sign instructs drivers to yield to pedestrians when turning at this intersection.

Regulatory signs, such as STOP, YIELD, or turn restrictions require certain driver actions and can be enforced. Warning signs can provide helpful information, especially to motorists and pedestrians unfamiliar with an area. Some examples of signs that affect pedestrians include pedestrian warning signs, motorist warning signs, NO TURN ON RED signs, and guide signs.

Advance pedestrian warning signs should be used where pedestrian crossings may not be expected by motorists, especially if there are many motorists who are unfamiliar with the area. A new fluorescent yellow/green color is approved for pedestrian, bicycle, and school warning signs (Section 2A.11 of the MUTCD).[1] This bright color attracts the attention of drivers because it is unique.

All signs should be periodically checked to make sure that they are in good condition, free from graffiti, reflective at night, and continue to serve a purpose. In unusual cases, signs may be used to prohibit pedestrian crossings at an undesirable location and re-route them to a safer crossing location, or warn pedestrians of unexpected driver maneuvers. It is preferable to create safe crossings where there are clear pedestrian destinations. If unexpected driving maneuvers occur at what is an otherwise legal pedestrian crossing, an evaluation should be done to find ways to remedy or prevent the unsafe motorist maneuvers.

Purpose

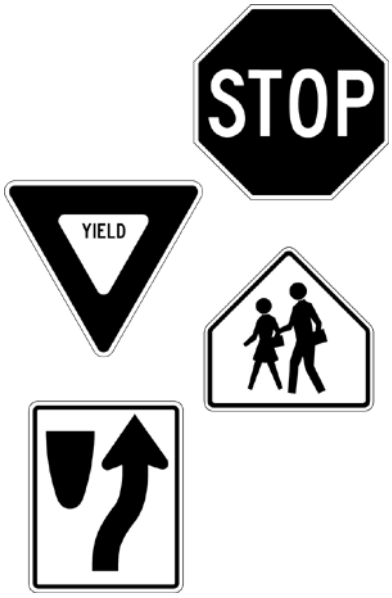
- Provide regulation, warning, or information to road users as to what to expect and how to behave.

Considerations

- Overuse of signs breeds noncompliance and disrespect. Too many signs can lead to visual clutter with the result that a driver is not likely to read or pay attention to any of the signs.
- Traffic signs used on public property must comply with the Manual on Uniform Traffic Control Devices (MUTCD).
- Signs should be checked to assure adequate nighttime reflectivity.

Estimated Cost

$50 to $150 per sign plus installation costs.



Manual on Uniform Traffic Control Devices (MUTCD)

OTHER MEASURES

In addition to the more traditional engineering treatments described in other sections of this chapter, there are several other countermeasures that should be considered under specific circumstances. For example, crossings in the vicinity of a school warrant consideration of the recommendations related to school zone improvements. The countermeasures described in this section include:

- School Zone Improvements
- Neighborhood Identity
- Speed Monitoring Trailer
- On-Street Parking Enhancements
- Pedestrian/Driver Education
- Police Enforcement

PHOTO BY DAN BURDEN

44. SCHOOL ZONE IMPROVEMENTS

A variety of roadway improvements may be used to enhance the safety or mobility of children in school zones. The use of well-trained adult crossing guards has been found to be one of the most effective measures for assisting children in crossing streets safely.[1] Sidewalks or separated walkways and paths are essential for a safe trip from home to school on foot or by bike. Adult crossing guards require training and monitoring and should be equipped with a bright and reflective safety vest and a STOP paddle. Police enforcement in school zones may be needed in situations where drivers are speeding or not yielding to children in crosswalks.

PHOTO BY BARBARA GRAY

Children leaving school in this Honolulu suburb walk their bikes to the intersection where a crossing guard controls movements.

Purpose

- Provide enhanced safety around schools.

Considerations

- Safety must be a combined effort between local traffic officials, police, school officials, parents, and students.

Estimated Cost

Costs would depend on the school zone treatment selected. For example, if signs were chosen, costs might include $50 to $150 per sign plus installation costs.

Manual of Uniform Traffic Control Devices (MUTCD)

Other helpful measures include parking prohibitions near intersections and crosswalks near schools; increased child supervision at crossings; and the use of signs and markings, such as the school advance warning sign (which can be fluorescent yellow/green) and SPEED LIMIT 25 MPH WHEN FLASHING. Schools should develop "safe routes to school" plans and work with local agencies to identify and correct problem areas. Marked crosswalks can help guide children to the best routes to school. School administrators and parent-teacher organizations need to educate students and parents about school safety and access to and from school. Education, enforcement, and well-designed roads must all be in place to encourage motorists to drive appropriately.

One of the biggest safety hazards around schools is parents or caretakers dropping off and picking up their children. There are two immediate solutions: (1) there needs to be a clearly marked area where parents are permitted to drop off and pick up their children, and (2) drop-off/pick-up regulations must be provided to parents on the first day of school. Drop-off areas must be located away from where children on foot cross streets or access the school. Parent drop-off zones must also be separated

PHOTO BY DAN BURDEN

Vehicles must slow down to enter the tight curve of this modern roundabout in a school zone in Montpelier, Vermont. The roundabout creates a safer interaction between vehicles and pedestrians.

from bus drop-off zones. If parents can be trained to do it right at the start of the school year, they are likely to continue good behavior throughout the year.

For a longer term solution, it is preferable to create an environment where children can walk or bicycle safely to school, provided they live within a suitable distance. One concept that has been successful in some communities is the concept of a "walking bus," where an adult accompanies children to school, starting at one location and picking children up along the way. Soon, a fairly sizeable group of children are walking in a regular formation, two by two, under the supervision of a responsible adult, who is mindful of street crossings. The presence of such groups affects drivers' behavior, as they tend to be more watchful of children walking. Parents take turns accompanying the "walking school bus" in ways that fit their schedules.

45. NEIGHBORHOOD IDENTITY

Many neighborhoods or business districts want to be recognized for their unique character. This can enhance the walking environment and sense of community.

PHOTO BY PETER LAGERWEY

An identity sign in Seattle's Wallingford neighborhood marks an entry to the area.

Examples of treatments include gateways, traffic calming, welcome signs, flower planters, banners, decorative street lighting, unique street name signs, and other details. Neighborhood identity treatments rarely provide any direct traffic improvements, but they help develop interest in enhancing the community.

Purpose

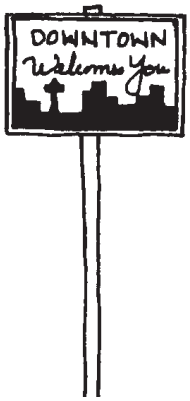
- Increase the visibility of a neighborhood or district and support community efforts to define their neighborhood.

Considerations

- Supports community efforts, but has no direct traffic benefits.

Estimated Cost

$50 to $150 per sign. Some signs may cost more because they are usually custom made.



Adapted from *Making Streets That Work*, Seattle, 1996

46. SPEED-MONITORING TRAILER

Speed-monitoring trailers—sign boards on trailers that display the speed of passing vehicles—are used by police departments and transportation agencies as educational tools that can enhance enforcement efforts directed at speed compliance. Speed radar trailers are best used in residential areas and may be used in conjunction with Neighborhood Speed Watch or other neighborhood safety education programs. They can help raise residents' awareness of how they themselves are often those speeding, not just "outsiders." Speed trailers are not substitutes for permanent actions, such as traffic-calming treatments, to address neighborhood speeding issues.

PHOTO BY DAN BURDEN

Speed-monitoring trailers let motorists know the speed limit and the speed they are traveling.

Speed-monitoring trailers can be used at several locations and should have occasional police monitoring and enforcement to maintain driver respect.

Purpose

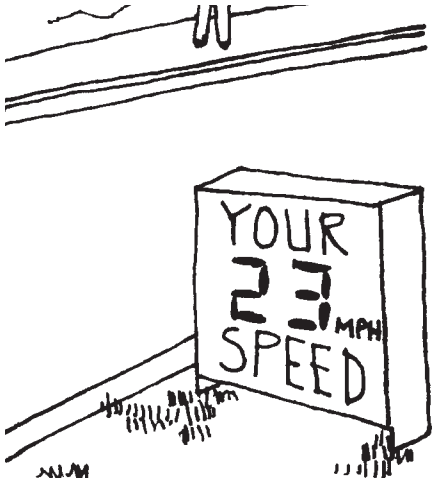
- Enhance enforcement efforts through public education and awareness.

Considerations

- Occasional enforcement is needed to supplement the speed-monitoring trailers.
- Speed-monitoring trailers are not a substitute for engineering measures.
- Should not obstruct pedestrian travelway or sightlines.

Estimated Cost

$10,000 to $15,000 to purchase the speed-monitoring trailer, plus the cost to move the trailer to different locations and to monitor the trailer.



Adapted from *Making Streets That Work*, Seattle, 1996

47. ON-STREET PARKING ENHANCEMENTS

On-street parking can be both a benefit and a detriment to pedestrians. On-street parking does increase positive "friction" along a street and can narrow the effective crossing width, both of which encourage slower speeds; parking can also provide a buffer between moving motor vehicle traffic and pedestrians along a sidewalk. In addition, businesses reliant on on-street parking as opposed to parking lots are more geared toward pedestrian access. This attention can foster a more vibrant pedestrian commercial environment.

PHOTO BY CARA SEIDERMAN

On-street parking in Concord, Massachusetts, shields pedestrians from moving traffic.

On the other hand, parking creates a visual barrier between motor vehicle traffic and crossing pedestrians, especially children and people using wheelchairs. Therefore, where there is parking, curb extensions should be built where pedestrians cross. Parking needs to be removed on the approaches to crosswalks.

At least 6 m (20 ft) of parking should be removed on the approach to a marked or unmarked crosswalk and about 6 m of parking should be removed downstream from the crosswalk. Some agencies require that parking be removed 9 to 15 m (30 to 50 ft) from intersections for pedestrian safety reasons. Well-designed curb extensions can reduce these distances and maximize the number of on-street parking spaces.

Purpose

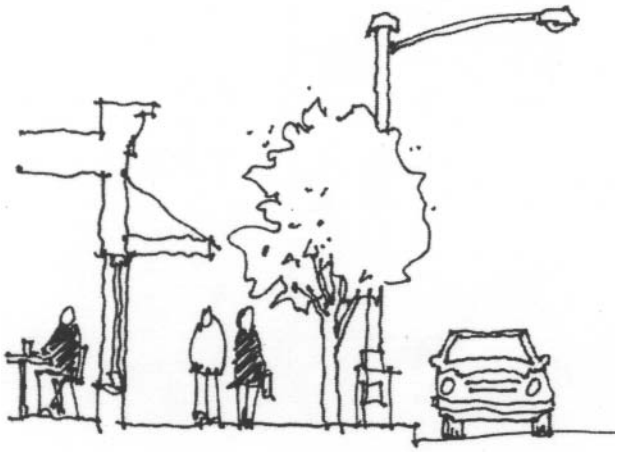
- Provide motorist access to destinations along a street.
- Aid in speed reduction by increasing friction along the street.
- Provide a buffer between sidewalk edge and moving traffic.

Considerations

- Parking may take up space desired for other uses, such as wider sidewalks or bicycle lanes.
- Approaches to crosswalks and intersections should be cleared and curb extensions added at crossing locations for pedestrian safety.
- Parking meters should be used in downtown areas where there is a need for parking turnover. This can generate revenue for the community.

Estimated Cost

$30 to $150 per sign. About $300 per parking meter and installation. Curb paint and stall marks or striping costs are additional (optional).



SKETCH BY MICHAEL KIMELBERG

48. PEDESTRIAN/DRIVER EDUCATION

Providing education, outreach, and training is a key strategy in increasing pedestrian and motorist awareness and behavior. While efforts most certainly provide information, the primary goal of an educational strategy is to motivate people to alter their behavior and reduce reckless actions. To implement the strategy, an integrated, multidisciplinary approach that links hard policies (e.g., changes in infrastructure) and soft policies (e.g., public relations campaigns) and addresses both pedestrians and drivers has the greatest chance of success.

Education oftens starts at an early age with structured programs for elementary school students.

Purpose

- Provide information to roadway users.
- To motivate a change in specific behaviors to reduce the risk of pedestrian injuries.

Considerations

- Educational messages should encourage people to think about their own travel attitudes and behaviors and make more informed choices.
- Pedestrian educational campaigns must be a part of a long-term and ongoing traffic safety program.
- Educational programs and materials should be sensitive of different groups of people.
- Outreach material should be interesting and involve visual as well as written messages.
- Difficulty in gaining political support needed to ensure a comprehensive program.
- Difficulty in introducing safety education within established school system curriculums.

Estimated Cost

Costs vary widely depending on type of educational programs used.

There are several broad approaches to education that can be conducted with moderate resources. They include 1) highlighting pedestrian features when introducing new infrastructure; 2) conducting internal campaigns within the organization to build staff support for pedestrian safety programs; 3) incorporating pedestrian safety messages into public relations efforts; 4) developing relationships with sister state agencies and statewide consumer groups; and 5) marketing alternative travel modes.

There are three specific types of educational campaigns – public awareness, targeted campaigns, and individual campaigns. Public awareness campaigns are a great example of a vehicle used to garner public support. An effective campaign can "lay the groundwork" for subsequent pedestrian safety initiatives and can increase the likelihood of their success. Campaigns to target groups are usually aimed at changing behavior patterns in specific groups of people (e.g., motorists, elderly, school children). Since changing behavior in these groups can be a long and arduous task, these campaigns tend to be ongoing efforts aimed at long-term results. Individual campaigns differ from campaigns at target groups because the audience is reached through an intermediary. Intervention occurs at an individual level through safety guards, doctors and other authority figures. Using these different approaches in concert reaches a broader audience and increases the likelihood of long-term success in changing attitudes and behaviors.

49. POLICE ENFORCEMENT

Police enforcement is a primary component in preserving pedestrian right-of-way and maintaining a safe environment for all modes of travel. Well-publicized enforcement campaigns are often effective in deterring careless and reckless driving and encouraging drivers to share the roadway with pedestrians and bicyclists when combined with strategically installed traffic control devices and public education programs. Most importantly, by enforcing the traffic code, police forces implant a sense of right and wrong in the general public and lend credibility to traffic safety educational programs and traffic control devices.

Police enforcement of motorist yielding behavior at pedestrian crossings is one ingredient needed for creating a safer walking environment.

Over the years, police departments around the country have consistently enforced traffic laws pertaining to driving under the influence, speeding, and running red lights. They have developed effective and socially accepted methods for measuring this behavior and apprehending offenders. However, enforcement of right of way laws has proven more difficult, as police forces have focused attention on more objective violations and/or not provided appropriate training to police officers. Good enforcement requires enforcing traditional traffic laws as well as ensuring equal protection for drivers as well as pedestrians and bicyclists.

There are a number of actions that municipalities can use to implement enforcement campaigns designed to protect pedestrians. These include increased police presence around school zones, residential neighborhoods, and other areas with high pedestrian activity; "pedestrian stings" involving police officers in civilian clothing; and high profile, hard hitting mass media campaigns to sign-post change and help set the public agenda. Some enforcement campaigns require special legislation to provide a legal basis for stricter crosswalk codes or right of way changes while other campaigns operate under existing ordinances.

Purpose

- Increase driver-awareness of the need to share the roadway
- Reduce pedestrian-related traffic crashes

Considerations

- Campaigns must be sensitive to the needs of different neighborhoods, age/ethnic groups, etc.
- To avoid PR problems, police officers need to be trained properly beforehand
- Enforcement should be conducted with the help of staff support and awareness of the courts
- Enforcement operations should be focused on drivers rather than pedestrians
- Enforcement operations should begin with warnings and flyers before moving on to issuing citations for violations

Estimated Cost

Cost varies depending on amount of training, number of officers involved, public relations work, duration of the program, and other factors