FOUR

4

Traffic Issues and Operations

4. TRAFFIC ISSUES AND OPERATIONS

Of the over 37,000 U.S. fatalities caused by motor vehicles each year, about 14% are pedestrians, and in major urban areas the share approaches 50%.[10] Pedestrian injuries are correspondingly high. Small errors by either pedestrians or motorists can have large adverse consequences. The causes of these crashes[11] are many, but the crashes could be greatly reduced without impairing the mobility of either motorists or pedestrians.

Although safety is an important reason to resolve pedestrian-vehicle conflicts, it is only one of several goals. Where motor vehicles and pedestrians come into proximity, the vehicles tend to dominate at the expense of pedestrians. Noise, fumes, dust, speed, and bulk all tend to intimidate and to degrade the pedestrian environment. The purpose of this section is to show how a more pedestrian-friendly balance between vehicular and pedestrian activities can be achieved. If the pedestrian environment is attractive and enjoyable, it is easier to encourage people to take some of their trips on foot rather than in a car.

I. General Considerations

A. Levels of Service

When pedestrians are inconvenienced or suffer noise, stress, and intimidation from vehicular traffic, they tend to become uncooperative and heedless of directions. This increases the dangers to both pedestrians and motorists and causes more delay to vehicles than would be the case if pedestrian needs were better met.

One controversial aspect of traffic and pedestrian management is the issue of how much vehicles and pedestrians should be controlled, as opposed to letting them use their own discretion. This issue influences almost every decision regarding vehicles and pedestrians. Decisions about extreme situations are generally easy to make; for example, pedestrians should not be permitted to walk across expressways, but local streets should be easy to cross.

Between the extremes, however, the choices can be complicated. For example, crosswalks can be regulated with a traffic signal to protect pedestrians. A signal requires pedestrians to wait longer than if the cars stopped when they entered the crosswalk but protects them while crossing. An exclusive pedestrian traffic signal (all cars are stopped and pedestrians can cross in any direction) removes any conflicts between vehicles and pedestrians but requires a longer wait for pedestrians than does a concurrent signal (pedestrians can cross, but vehicles can turn into the crosswalk). Because of the longer wait, many pedestrians at intersections with exclusive pedestrian signals cross illegally.

Vehicle levels of service, based on the delay motorists experience at intersections, are used in transportation planning. Pedestrian levels of service based on the delay pedestrians experience at intersections should also be a major criterion of transportation planning (see Appendix VII). This is an issue of safety as well

10 National Highway Traffic Safety Administration, 1998.

11 Because they believe that in the context of motor vehicles the word “accident” to some people implies a chance event that can’t be prevented rather than an unfortunate event that was unintentional and due to carelessness, unawareness, breaking the law, or other causes, federal authorities now use the word “crash.”

as convenience, since studies show that significant numbers of pedestrians do not wait longer than 30 seconds before crossing.[12]

Pedestrians are often regarded as uncooperative and recalcitrant, but their behavior is reasonably predictable. Pedestrians often ignore traffic signals if they feel they have already waited long enough. If most vehicles fail to stop for pedestrians in crosswalks, pedestrians are more likely to cross anywhere they can. They are more likely to go out of their way to use marked crosswalks if they think they will be rewarded by respect from motorists.

B. Children, People with Disabilities, and the Elderly

These groups warrant special consideration both because inexperience or physical limitations put them at a disadvantage as pedestrians and because they are more likely than others to rely on walking to get around.

Children are harder to see than adults, being smaller, and they are more impulsive. Special care should be given to the designs of streets, sidewalks, and traffic control devices where children gather, such as schools and playgrounds.

People who cannot move quickly need sufficient time to cross the street. Increasing walk times may, however, mean longer waits for pedestrian greens and hence greater disregard for the signals. Generally, Cambridge uses the standard of one second for each 4 feet of crossing. The ADA requires curb ramps at all crosswalks. Audible signals corresponding to visual traffic cycles have been developed and used for people who are visually impaired.

C. Special Locations

Some generators of pedestrian activity warrant special attention to enhance pedestrian safety and ease of crossing:

- Schools, before and after school programs, or centers serving children under twelve with twenty or more children in the program
- Intersections where school crossing guards are assigned
- Elderly housing complexes and senior centers
- Transit stations and major bus stops
- Business districts with heavy motor vehicle and pedestrian traffic

Complex intersections such as rotaries and intersections with more than four legs also need special consideration.

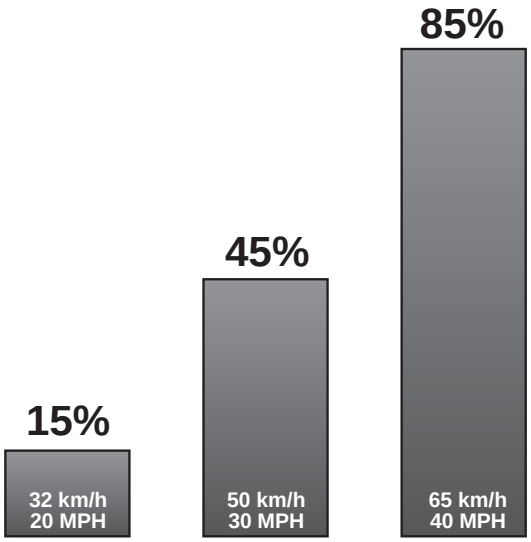
D. Measures for Treating the Pedestrian-Vehicle Interface

Conflict between pedestrians and vehicles has been a concern for a long time, and many ideas have been proposed and tried. Figure 1 lists design and enforcement options that affect pedestrians and vehicles. Some are appropriate in Cambridge; others are not. Many are treated in some detail below.

12 Joseph S. Milazzo, II, et al., "Quality of Service for Interupted Pedestrian Facilities in the *2000 Highway Capacity Manual*," presented at the 1999 Annual Meeting of the Transportation Research Board. Pedestrians are also controlled by intimidation, such as with large volume of traffic or, especially, high speed traffic. Thus pedestrians can be kept on the curb by providing conditions for motorists that encourage them to travel at 35 mph or higher. Only a few of the vehicles need to travel at these speeds to make the street unsafe for pedestrians. Clearly this is not a desirable situation in Cambridge, where walking is an important travel mode and the speed limit is 30 mph or lower.

I: Separate Pedestrian Facilities	
Paths through Block Interiors	Walkways
Pedestrian Overpasses/Underpasses	Pedestrian Malls
Skyways	Auto-Restricted Zones (ARZs)
II: Crosswalks and Traffic Controls	
Speed Limits and Enforcement of Traffic Laws	Traffic Signals
Vehicle Channelization	Lighting
Pavement Markings and Treatments	One Way Streets
Signs	Reflective Materials
Median Barriers	Crossing Islands
Sidewalk Barriers	Sidewalk Width and Placement
Parking Design	Turning Movements
Parking Enforcement	Corner Radii
III: Traffic Calming	
Roundabouts	Traversable Barriers
Curb Extensions	Pavement Treatments
Raised Crosswalks and Raised Intersections	Landscape Treatments
Speed Humps/Tables	Woonerfs
Chicanes	Crossing Islands

Figure 1: Pedestrian-Vehicle Control Measures.



Pedestrians' chances of death if hit by a motor vehicle
SOURCE: *Killing Speed and Saving Lives*, UK Department of Transportation

Figure 2: The relationship between speed and the pedestrian fatality rate.

II. Vehicle Volumes and Speeds

The heavier the traffic and the higher the speed, the less favorable the environment for pedestrians. Road design has much to do with determining vehicle speed and the feasibility of pedestrian crossings. Lane width, over-all street width, street curvature, turning radii, sight lines, sight distances, adjacent land use activities, and traffic volumes, especially entering and intersecting traffic, all contribute to establishing the "design" speed for a given street or highway. Speed limits have little effect if they are inconsistent with the design speed of the street, and strenuous enforcement is required if speed limits are to have any effect under such conditions.[13] It is more effective to control speed through roadway design.

13 "Drivers consistently drive at speeds which they perceive as reasonable, comfortable, convenient, and safe under the existing conditions, regardless of posted speed limits." Homburger et al., *Residential Street Design and Traffic Control*, Englewood Cliffs: Prentice Hall (1989), p.39.

Up to about 25 miles per hour, vehicles can stop relatively easily for pedestrians, and explicit or formal control measures are less necessary; from 25 to 35 MPH, however, the danger to pedestrians increases rapidly with speed. Figure 2 shows the relationship of speed and severity of injury. The probability of fatality increases from 3.5% at 15 MPH to 85% at 40 MPH.[14] Stopping distances also increase geometrically with speed.

In Cambridge, the speed limit on all roads except those controlled by the MDC is 30 MPH, unless the City has received state approval to reduce the speed to 25 MPH and has posted it.

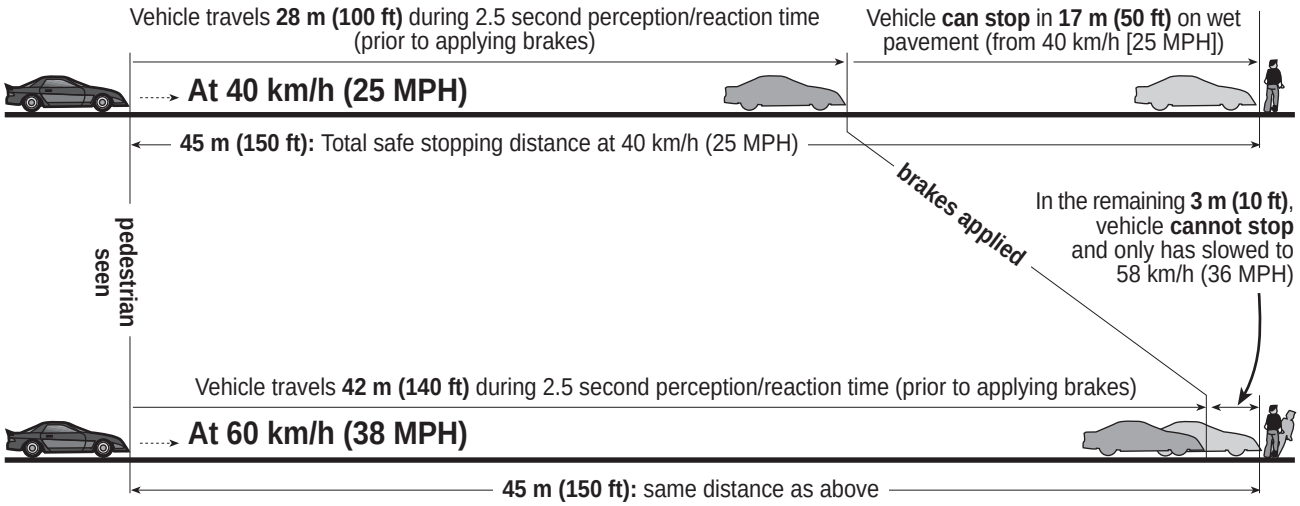


Figure 3: The relationship between safe stopping distance and travel speed.

A. Street Width and Lane Width

Straight streets with wide lanes encourage vehicles to go fast. The wider the street, of course, the longer it takes pedestrians to cross. Since the 1950s, roads in the United States have generally been designed to preset standards; as a result, many of them are wider than necessary. At one time, certain road widths were mandated for projects that received federal funds, but this is no longer the case. See Appendix XV for Cambridge lane width guidelines.

The presence of continuous medians also encourages higher speeds. In some communities, where arterials have a median strip between opposing lanes pedestrian signals are sometimes set so that only half the street can be crossed on one green and pedestrians are stuck on a narrow island with whizzing vehicles on all sides.

Narrower travel lanes tend to reduce speeds, more so if there are parked cars, and more so yet if they are curved. Additional reductions can be achieved by adding bicycle lanes, widening sidewalks, and creating corner curb extensions.

14 This information is from R. Limpert, "Motor Vehicle Accident Reconstruction and Cause Analysis," 4th ed., Charlottesville, VA: Michie Company (1994), as reported in Burrington and Thiebach, *Take Back Your Streets*, 2nd ed., Boston, MA: Conservation Law Foundation (1995).

B. Sightlines

Reducing sightlines—e.g., by planting trees—can slow down vehicles, but needs to be done carefully to ensure that drivers can respond correctly to potential risks. Maintaining good views of pedestrians while slowing vehicle speeds requires special care in roadway design.

C. Curves and Turning Radii

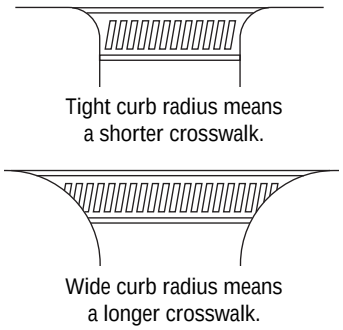


Figure 4A: Curb radii.

Curvature affects the main path of the street as well as turning movements at intersections. Winding streets tend to slow down vehicles, due to the need for cautious maneuvering and to the limited sightlines. Changing the alignment of existing streets is difficult, but there are traffic calming measures that create a winding effect (see Chapter 4, VII).

Curb radii at corners also affect speed, because sharp corners are harder to get around. Figure 4 illustrates the effect of a shorter turning radius that requires vehicles to move more slowly when making turns. The size of trucks and the volume of traffic expected on the street in question affect turning radius requirements for each street.

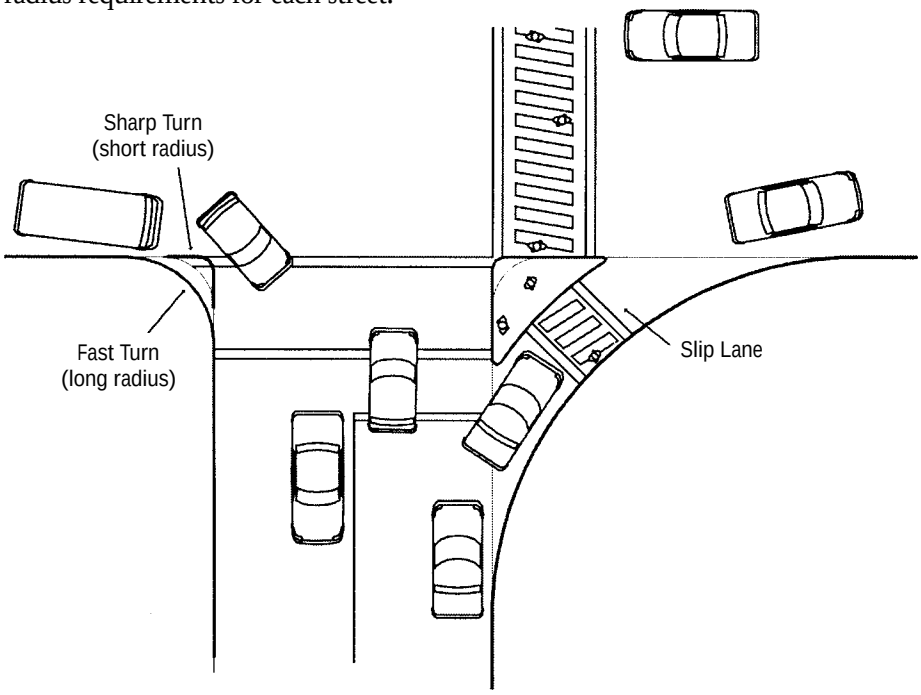


Figure 4: Corner turning radii and slip lanes.

D. Slip Lanes

The opposite effect from slowing traffic is achieved by building right-turn "slip" lanes: vehicle speed is encouraged, often without stopping at red lights, with the only possible pedestrian compensation being a refuge island part way across the intersection. Such special right-turn lanes to facilitate vehicle turning movements are usually undesirable from the pedestrian perspective.[15]

Figure 4 shows a common configuration for a slip lane. Central Square before its 1996 redesign had a slip lane for vehicles turning right onto Mass. Ave. from River Street.

15 In communities where slip lanes are used, they can be designed to allow the free turn in a way that optimizes the motorist's view of the pedestrian and forces a slower turn.

III. Separate Pedestrian Pathways

A pedestrian pathway in Harvard Square.

A. Paths through Block Interiors

Urban redevelopment in many cities includes creating pedestrian walkways through the middle of blocks, perhaps indoors or perhaps not, often passing shops and restaurants. Such paths may provide a shortcut, protection from the weather, useful services along the way, and interesting sights.

Examples can be found in Boston (Copley Place and Prudential Center) and Cambridge (among others, the Marriott Hotel and outdoor walkways near Harvard Square, Kendall, and Lechmere). Walkways exist in residential neighborhoods as well, often as short cuts to parks and playgrounds. It is important that these are preserved and that necessary easements are obtained.

B. Pedestrian Overpasses/Underpasses

Grade separation for pedestrian-highway intersections is often used to get pedestrians out of the way of automobiles. It is often costly and may not be effective, but there are places where it is useful. Underpasses often end up being dirty and dark and may feel unsafe, though good urban design can help.[16]

Pedestrian overpasses are awkward when they require the pedestrian to climb 14 feet or so to clear the road and then descend. Steps on old overpasses can be too steep and slippery with rain or snow. ADA-compliant ramps often require more space than is available. In general, overpasses are inappropriate on city streets.

Crossing an expressway or other very busy road, pedestrians may be induced to use overpasses, especially if the overpass does not take significantly longer than crossing at street level. According to one study, "If an overpass takes 50% longer than crossing at street level, almost nobody will use the overpass." [17]

One Cambridge example of an overpass occurs at Memorial Drive at Magazine Street. Across the river there are several over Storrow Drive.

C. Skyways

Some cities, notably Minneapolis, have constructed enclosed skyway systems (elevated walkways) in their major shopping districts. While skyways offer protection from inclement weather and vehicle traffic, they tend to make the streets seem deserted and uninviting.

A small-scale local example can be found at Copley Place in Boston.

D. Walkways/Bikeways

Pedestrian walkways are often appropriate in greenway corridors. While they can be combined with bicycle paths, this can lead to conflict, especially on heavily used routes. The Dr. Paul Dudley White bicycle path along the Charles River is an example of a heavily used path with different kinds of users, including cyclists, pedestrians, and inline skaters. Whenever possible, pedestrians and bicyclists should have separate paths. If there is

16 Steven A. Smith. "Considering the Pedestrian: Site Planning in the Suburbs," *TR News*, 158 (January-February, 1992), pp. 10-13ff.

17 Institute of Transportation Engineers, *Traffic Safety Toolbox* (1993), p. 192.

not enough space for separate paths, shared use paths should be striped with a center line and should be wide enough to permit cyclists and inline skaters to pass pedestrians at a comfortable distance. Signs or pavement markings may be used to remind people where to travel.

E. Pedestrian Malls/Auto-Restricted Zones (ARZs)

Variations on downtown pedestrian malls have been tried in many places, sometimes successfully and sometimes not. They generally will not turn around a weak retail market, but they have made for some very pleasant and active city centers.

Downtown Crossing in Boston is a successful ARZ, with a small amount of traffic passing through, and Portland, OR, has created a transit mall, where bus origins, destinations, and transfers take place.

IV. Crosswalks

The Massachusetts Vehicle Code defines a crosswalk as "that portion of a roadway ordinarily included within the extensions of the sidewalk lines, or, if none, then the footpath lines, and, at any place in a highway clearly indicated for pedestrian crossing by lines or markers upon the roadway surface."

Crosswalks exist where sidewalks intersect the road, whether or not they are marked and whether or not the intersection is signalized. In addition, marked crosswalks can be placed at mid-block locations.

At all marked crosswalks, state law requires that the driver of a vehicle yield the right of way to a pedestrian in the crosswalk, unless the vehicle has a green light and is not turning. Pedestrians should not enter a crosswalk unless it is safe to do so, and they should never assume that a driver will obey the law and stop. Pedestrians should step into the crosswalk to signal their intention to cross, look left, right, then left again, and when vehicles stop, cross.

At all crosswalks, the distance that pedestrians have to cross should be reduced when feasible. For the safety of all modes of travel, streets should intersect at as close to a right angle as possible.

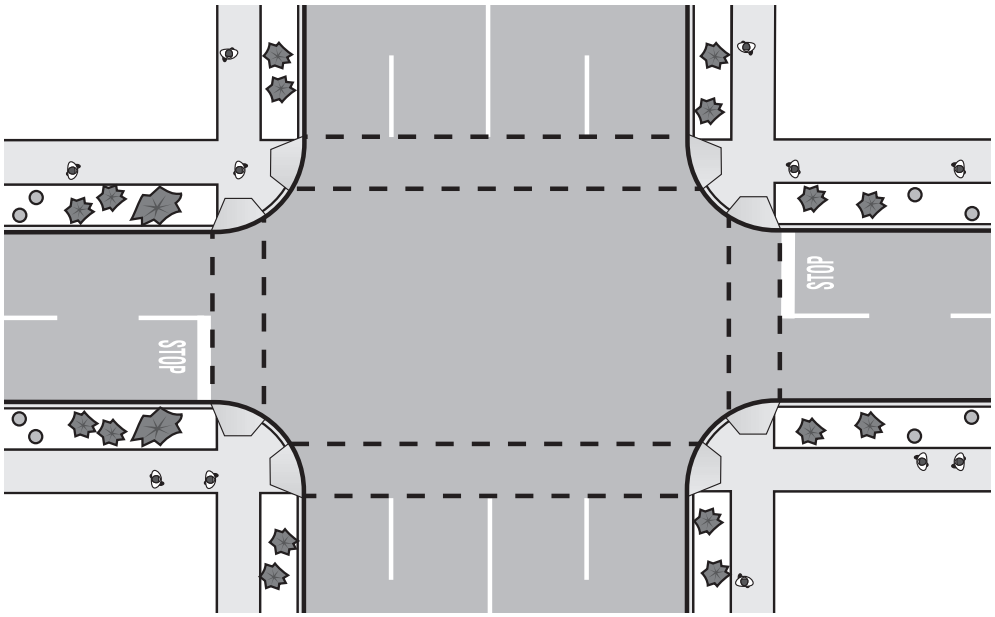


Figure 5: Unmarked crosswalks.

A. Pavement Markings

Crosswalks are marked at intersections where there is substantial conflict between vehicle and pedestrian movements, where significant pedestrian concentrations occur, where pedestrians could not otherwise recognize the proper place to cross, or where motorists need to be reminded to look for pedestrians.

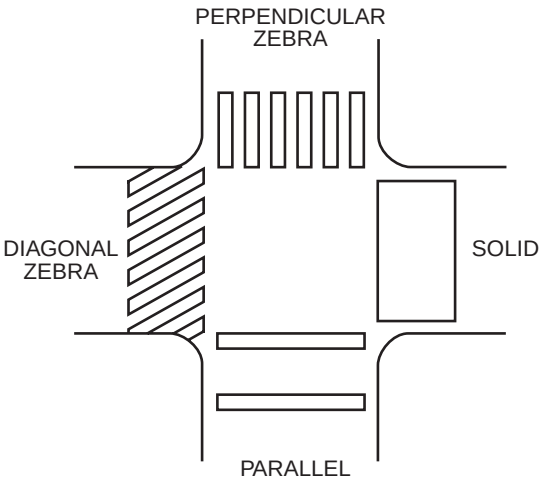


Figure 6: Crosswalk Striping Options.

Cambridge uses two types of pavement marking—parallel lines and perpendicular zebra stripes. At a few locations, crosswalks are marked by special pavement materials. The specifications for crosswalk markings are shown in Appendix VIII. Zebra stripes are more visible than parallel lines. The wider the marked crosswalk, the more readily it can be seen. As streets are repaved, parallel lines are being replaced with zebra stripes. (See Appendix VIII for an illustration.)

The marking materials are paint; thermoplastic; or tape, which can be inlay or overlay. Paint is cheapest to install, but it requires redoing twice a year. Thermoplastic and tape are more visible at night and last three to eight years, depending on type, location, and wear pattern.

For all new paving projects, Cambridge uses inlay tape, which is a retroreflective, skid-resistant paint polymer pavement marking. This kind of marking is long lasting and much less slippery than paint or thermoplastic when wet. Inlay tape cannot be applied to existing pavement. (See Appendix XI for details.)

Special pavement materials for crosswalks should only be used in combination with traffic-calming devices; they need to be highly visible and not be a maintenance burden.

By themselves, pavement markings are not enough. The motorist must be able to see the crosswalk. By law, motorists cannot park within 20 feet of an intersection. Drivers need to be able to see pedestrians who have entered the crosswalk or who are about to step off the curb. Both the motion and the posture of pedestrians provide visual cues to motorists. The increasing popularity of vans and sport utility vehicles has increased visibility problems from cars parked close to intersections, especially for children trying to cross the street.

B. Signs

Figure 7: Standard sign.

Side-mounted "yield to pedestrian" signs will be installed only at locations where visibility, traffic flow, or other circumstances create special safety problems.

"Pedestrian crossing" signs will be installed where the number of pedestrian crossings is high and motorists cannot easily see pedestrians.

Pedestals with signs reminding motorists to yield to pedestrians will be installed in the middle of two-way streets at unsignalized pedestrian crossings where gaps in traffic are insufficient to allow pedestrians to cross the street; the travel lanes for vehicles should be at least 11 feet wide for each direction of traffic, and the sign must be visible from a distance of no less than 300 feet.

Signage and signals must conform to the Manual on Uniform Traffic Control Devices.

V. Traffic Signals

Standards for pedestrian treatment at signalized traffic intersections have been developed over a long period of time.

Walk/don't walk signals are often assumed to reduce pedestrian crashes, but research has found no difference between intersections without these signals and those with them.

Exclusive pedestrian phases (all vehicles have a red signal with no turn on red, and pedestrians may cross in any direction) show fewer pedestrian-vehicle crashes but increased pedestrian and vehicle delays, and, typically, a poor level of service for people on foot.[18]

City of Cambridge signal policies are:

1. Whenever possible, total cycle lengths will be a maximum of 90 seconds. When cycle lengths are reduced, the City will examine whether this will divert traffic onto neighborhood streets. When cycle lengths greater than 90 seconds appear to be necessary, the City will assess the impact on pedestrians.
2. The maximum wait for pedestrians between the end of the flashing *don't walk* and the beginning of the next *walk* signal should be no more than 80 seconds. Reduction of wait times for pedestrians is an important element of planning signal timing.
3. Pedestrian buttons at intersections will be phased out wherever possible. Where they exist, they will respond as quickly as possible. In general it is better for pedestrians to be part of the regular traffic signal cycle. Push-button signals generally mean pedestrians wait longer at intersections. Often people push the button, then find an opening in the traffic and cross before the *walk* signal comes up.
4. Concurrent *walk* phases will be used where turning conflicts are well controlled in order to reduce pedestrian wait times. However, some locations will require exclusive *walk* phases due to high vehicular turning volumes. Exclusive *walk* phases will then be used where there is sufficient road capacity for traffic to wait and where the maximum pedestrian wait will not exceed 80 seconds.
5. *Walk* signals will show a continuous permitted *walk* when no vehicle conflicts exist. (In some cases this may require replacing the controller.)
6. Signals will run in progression where groups of signals need to work together to reduce delays and manage traffic volumes effectively.
7. Signals may be traffic semi-actuated where side street volumes are intermittent and light. With this configuration, side street *walks* may be concurrent and exclusive and main street *walks* exclusive with push button actuation.
8. A leading pedestrian interval (LPI) will be considered for concurrent signals to minimize conflict with turning traffic. An LPI is an advance *walk* signal that gives pedestrians a few seconds' head start on vehicles, enabling them to enter the crosswalk before the vehicles begin to turn. This may sometimes require upgrades of traffic signal equipment before it can be implemented.

   Audible pedestrian signals will be considered on a case-by-case basis. Other crossing aids for people who are blind or have low vision are being evaluated.

18 Brian L. Bowman, John J. Fruin and Charles V. Zegeer, *Handbook on Planning, Design, and Maintenance of Pedestrian Facilities*, Federal Highway Administration Report No. FHWA-IP-88-019 (1989), p. 160.

Informational sign posted at Cambridge intersections with push button signals.

A. Pedestrian Signal Phases

The pedestrian signal offers three intervals: *walk*, flashing *don't walk*, and solid *don't walk*. Many people do not know what these phases mean, and some of those who do ignore them. Some people watch the vehicular traffic signal instead. Timing of the pedestrian signals follows the MUTCD.

The flashing *don't walk* phase starts early enough in the cycle to permit slow walkers to cross before the vehicular green if they start before it begins flashing. It assumes a crossing speed of four feet/second to the middle of the last travel lane.

Cambridge has posted pedestrian signal information at intersections.

B. Right Turn on Red

A particular problem at some signalized intersections is right turn on red (RTOR), which permits vehicles to stop at a red light and then turn right if no traffic or pedestrians are in the way. The introduction of RTOR in the 1970s has resulted in an increase in crashes, including crashes involving pedestrians.[19] This is in part because drivers' attention tends to be focused on looking to the left for a chance to turn. In addition, many drivers fail to come to a complete stop before turning right.

At intersections where right-turning vehicle and/or pedestrian volumes are high, the City bans right turns on red to give pedestrians better protection.[20]

C. Pushbutton-Actuated Signals

There are two kinds of pedestrian-actuated signals: those that are not tied into other traffic signal phases and those that are. The former, which are located at midblock crossings where there is heavy vehicle traffic, can be set to respond almost immediately when pushed as long as no one has just finished crossing. One example is on Cambridge St. at Cambridge Rindge and Latin School; another is on Mt. Auburn at the hospital. These tend to work well because pedestrians know that they will be able to cross right away.

A problem with pushbutton signals that are tied into a signal cycle is that the delayed signal response makes pedestrians wonder how long it will take or whether the button is working, and they may decide not to wait. Many pedestrians push the button with the intention of crossing as soon as they can, regardless of the signal. In general it is better for traffic signals to include a pedestrian phase that comes up without pedestrians having to push a button.

D. Intersection Options

If the volume of vehicle or pedestrian traffic at an intersection does not require a traffic signal with timed cycles, there is a range of other options.

For example, Figure 8 shows four lanes of traffic, opposed directions, parallel parking on both sides of the street, and a one-way "T" exiting the arterial. Neither the volume of left turns off the arterial nor the volume of pedestrian traffic requires a stop light, yet both activities occur at significant levels.

19 Paul Zador, Jack Moshman, and Leo Marcus, "Adoption of Right Turn on Red: Effects on Crashes at Signalized Intersections," *Accident Analysis and Prevention*: Vol. 14, No.3, pp. 219-234 (1984); D.F. Preusser, W.A. Leaf, K.B. Debartolo, R.D.Blomberg, "The Effect of Right-Turn-on-Red on Pedestrian and Bicyclist Accidents," US Dept. of Transportation (1981).

20 The City of Chicago takes another approach; it posts signs at most traffic signals banning RTOR from 7AM to 7 PM. New York City bans RTOR altogether.

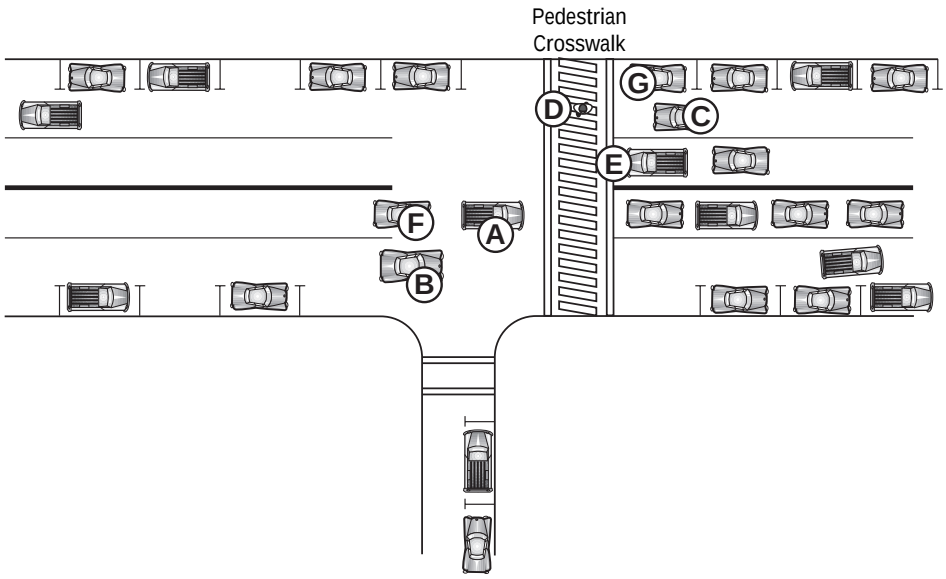


Figure 8: Pedestrian Crosswalk on Multi-Lane Arterial.

Many problems are due entirely or in part to the multiple lanes. Motorists (e.g., at A, B and E) may not be inclined to stop for pedestrians who are in the crosswalk but not in the same vehicle lane, especially if the pedestrians are on the opposite side of the street. Also, motorists may not realize that a vehicle has stopped for pedestrians and may pass the vehicle on the right or left (B and C). A vehicle waiting to make a left turn (at E) can be in the same position as a vehicle stopped for pedestrians, so that an opposing vehicle may make the wrong response to the situation, creating danger for pedestrians or traffic obstruction.

Several traffic signal options can be applied to this situation, none of them completely satisfactory:

A fixed-cycle traffic signal forces vehicles to wait when there are no pedestrians and forces pedestrians to wait longer than if vehicles stopped for pedestrians in the crosswalk.

A push-button signal forces pedestrians to wait until their cycle comes up. Many pedestrians are too impatient to wait, but if used correctly the signal provides better safety for children and elderly walkers.

A blinking yellow light is not a satisfactory solution; it means nothing to motorists and gets lost in the confusion of an urban environment.

Changes to the street such as curb extensions and crossing islands help increase motorists' awareness of pedestrians. It is also important to educate drivers to recognize crosswalks and stop when pedestrians are in them.

VI. Other Intersection Issues

A. Stop Sign Intersections

An advantage of stop signs over traffic signals for pedestrians is that vehicles slow down as they approach the intersection when they have a stop sign. At signalized intersections, many vehicles speed up to "make the light."[21] It is important to evaluate what traffic control device is appropriate for each intersection.

21 For this reason, Philadelphia has replaced some traffic signals with stop signs. Cambridge did this at the intersection of Granite and Pearl streets in 1998.

B. Mid-Block Crossings on Collectors and Minor Arterials

The effectiveness of pedestrian crosswalks depends on how well the design of the crosswalk matches the specific traffic and road circumstances. Mid-block crosswalks are challenging and require careful review before they are installed.

Midblock crossings should be consistent with MUTCD standards. They can be signalized or unsignalized and marked with zebra stripes; they should only be constructed when pedestrian volumes are high. In general, they should not be less than 300 feet from the nearest intersection.

Midblock crossings are usually on collector streets and minor arterial highways. On local streets they are seldom necessary, and on major arterials it is difficult to interrupt heavy traffic for pedestrians, so they are not generally used unless the blocks are especially long or there is an especially large pedestrian flow at some mid-block point. Figure 9 shows a crossing on a two-way street with two lanes of traffic and parking on both sides. Parking is cleared back twenty feet from the edge of the crosswalk in each direction.

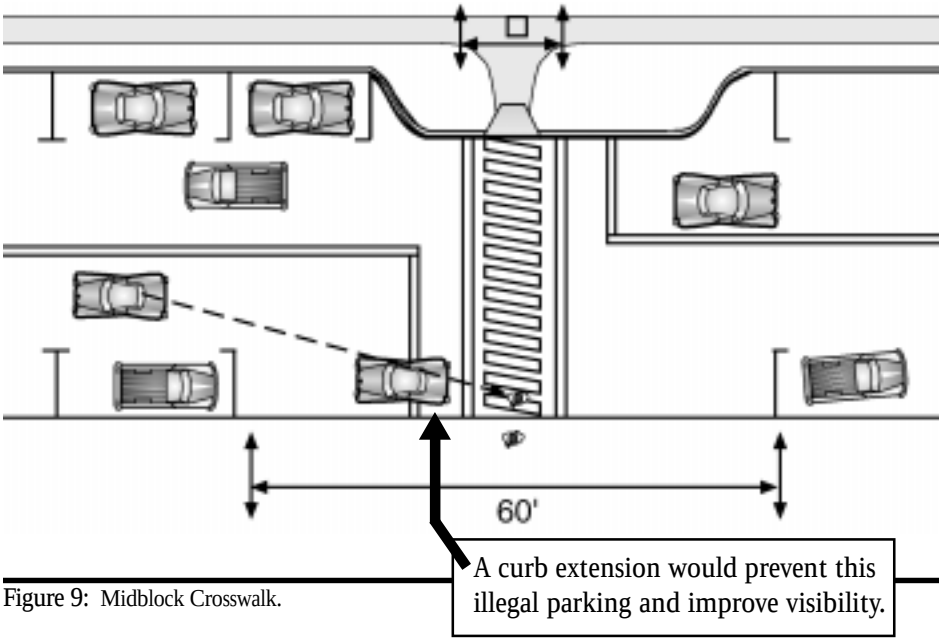


Figure 9: Midblock Crosswalk.

C. Signing and Lighting

Movable stanchions and permanent signs can be used under some circumstances (see Section IV B above). Strong street lighting is effective at night, if distinct from nearby lighting, and is essential if vehicles are expected to stop for pedestrians at night.

D. Barriers

Barriers such as railings that prevent pedestrians from stepping off the curb at points where satisfactory conditions for street crossings cannot or have not been made or barriers along the median of a street are generally to be avoided. They can be unfriendly and unattractive. It is better to design intersections that channel pedestrians by providing convenient crossings where they are safest.

E. Illegal Parking

Double parking and parking within the 20-foot corner clearance are especially dangerous for pedestrians because they block vehicle sight lines. Rigorous enforce-

ment of parking regulations ensures emergency vehicle access as well as enhancing pedestrian and motorist safety. Prevention of parking too close to the corner is one of the benefits of curb extensions.

VII. Traffic Calming

About 90% of automobile/pedestrian collisions involve a pedestrian crossing the street. Traffic calming measures are intended to reduce vehicle speeds and encourage drivers to be sensitive to pedestrians and other non-motorized street users. Its "basic objective is to reduce the adverse effects of road traffic. The approach is to adapt the volume, speed, and behavior of traffic to the primary functions of the streets through which it passes, rather than to adapt streets to the unbridled demands of motor vehicles."[22]

In 1997 Cambridge created a staff position for a traffic calming project manager and identified funds for traffic calming projects. As the City undertakes road reconstruction projects, it introduces traffic calming measures where technically and financially feasible and where they would not create congestion elsewhere.

Various traffic calming measures to slow motorists down in residential or commercial districts have been widely and successfully adopted in parts of Europe and, to a more limited—but increasing—extent, in North America.

Early Cambridge examples include the traffic calming measures taken at Arsenal Square and at Berkshire and York streets. The Arsenal Square project was designed to help pedestrians and bicyclists, as well as cars, navigate what was a difficult intersection. The project at Berkshire and York was designed to slow down traffic in a residential neighborhood with many pedestrians and make it safer for children to get to and from Donnelly Field and the Harrington School.

There are three basic types of traffic calming measures:

- Horizontal shifts in the roadway
- Vertical shifts in the roadway
- Actual or visual narrowing of the roadway

Generally, the best results are achieved when a combination of measures is used.

In residential neighborhoods, local streets can be expected to have low traffic volumes. Under such conditions, pedestrians and vehicles can sometimes share the same space. The nature of the design should be such, however, that vehicles are forced to adapt to the behavior of pedestrians. This is the objective of the *Woonerf*, which originated in Holland in the 1970s. A *Woonerf*, or "street for living," is a street where pedestrian activities take precedence. Vehicles, though allowed on the streets, are slowed to a walking pace, through various devices. The street can then be used for neighborhood activities with community play space, planting, benches, etc. Variants on the *Woonerf* have been used with success elsewhere in Europe.

A. Curb Extensions

Curb extensions are a narrowing or "necking down" of the opening to a street by extending the curb out from one or both sides. They are also called chokers, neckdowns, or bulbouts. An example is shown in Figure 10.

22 Devon County Council Engineering and Planning, *Traffic Calming Guidelines*, Devon County Council, UK (1991), p. 27.

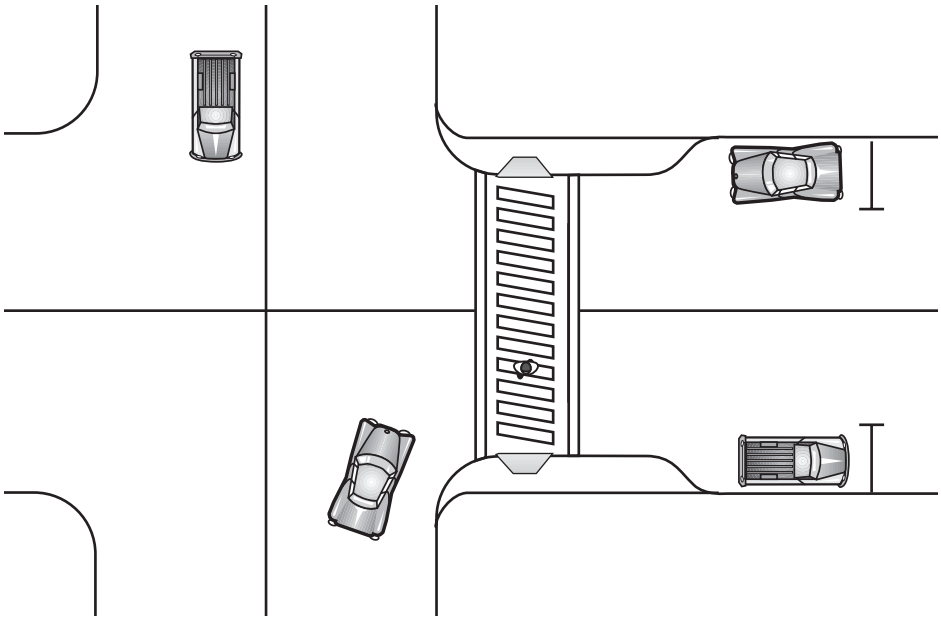


Figure 10: Curb Extension.

Curb extensions have several benefits:

- Vehicles slow down when they approach the narrower passage.
- The distance over which pedestrians are exposed to motor vehicles is reduced.
- Motorists and pedestrians can see each other better.
- Vehicles cannot park illegally at the corner, where they would make it harder for motorists to see pedestrians crossing the street.

Curb extensions must be designed so they do not interfere with bicycle traffic. Generally, because Cambridge has so much on-street parking, bicycle lanes or guidelines can be maintained, as curb extensions do not extend further into the roadway than the parking lane. As roads are reconstructed, the City will continue to seek opportunities to construct curb extensions.

B. Traffic Circles

Traffic circles come in three basic types:

Traffic mini-circles – Mini-circles are raised islands constructed in the center of residential street intersections to reduce vehicle speeds. They force motorists to maneuver around them and have been found to reduce motor vehicle crashes significantly.

Mini-circles can often replace a four-way stop sign, or even a signal. They must be properly designed to benefit pedestrians and cyclists. Adding crossing islands helps pedestrians and controls vehicles entering the intersection but requires more space. The occasional large vehicle going through an intersection with a mini-circle—e.g., a fire truck or moving van—can be accommodated with a mountable curb at the edge of the circle.

Roundabout – A roundabout is a large island located where an arterial street intersects one or more crossing roads. It may replace a traffic signal. As with a mini-circle, vehicles are deflected from their path and must slow down as they

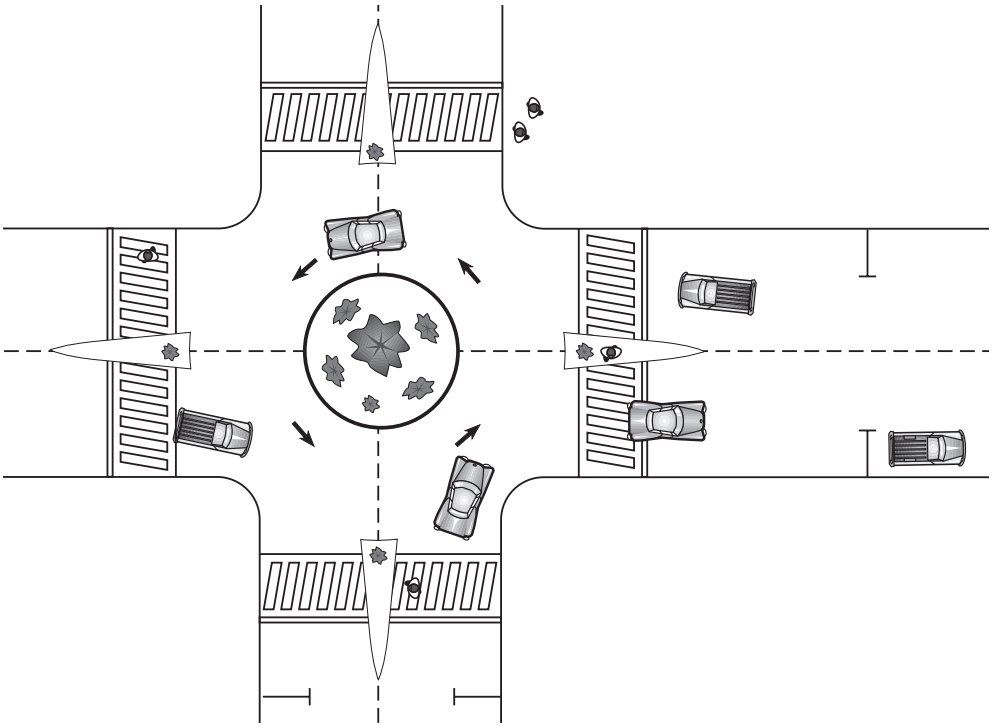


Figure 11: Traffic Roundabout.

turn into the circle but generally do not have to stop. Crossing islands at the approaches help slow down vehicles and allow pedestrians to cross.

Roundabouts should be constructed to accommodate pedestrians and bicyclists. Pedestrians must travel out of their way to cross the streets but often have a shorter wait than with a signal and have only one direction of traffic to watch for. However, visually impaired people have difficulty with roundabouts, and this issue has not yet been adequately addressed.

Rotaries are old-style circular intersections found throughout New England. They are larger than roundabouts and provide little or no deflection for through traffic, leading to excessive vehicle speeds. They also have no provision for pedestrians. Rotaries are no longer considered appropriate roadway design.

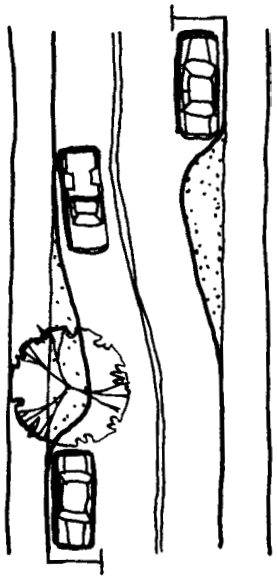


Figure 12: An example of a chicane.

C. Chicanes

A chicane is a lateral shift in the roadway alignment. This can be done by altering the side of the street on which parking is permitted, or by installing plantings or other obstructions to travel on alternating sides of the street.

D. Landscaping Treatments

Trees and other plantings can make a roadway seem narrower, which encourages motorists to travel more slowly. They can also make an area seem less dominated by paving and make a road seem less like an arterial.

E. Speed Tables/Raised Crosswalks

Speed tables, or speed humps, are improved versions of the old speed bump. They are broader and flatter so vehicles do not straddle them. They can be used as raised crosswalks. These have several advantages: They slow traffic, they remind drivers of the crosswalk, they encourage pedestrians to use the crosswalk, and pedestrians do not have to contend with curbs.

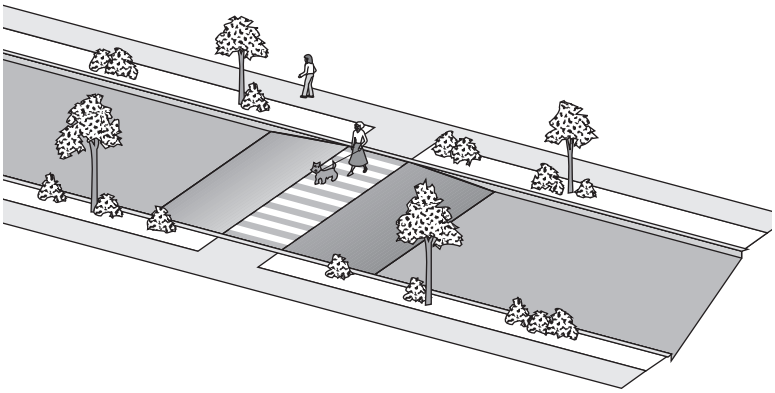


Figure 13: Raised crosswalk also acts as speed hump.

F. Barriers

The most familiar barriers are the posts planted in a street or path that permit pedestrians and bicycles to pass but not cars or trucks. Low barriers can also be used that do not obstruct vehicles with a high undercarriage (such as a fire engine) but do impede automobiles. These latter devices require careful design and installation, including proper warnings. They must be plowable in winter.

Because of concerns about traffic diversion, Cambridge does not close streets to traffic except to address significant safety issues.

G. Emergency Vehicles

The Fire Department is consulted before installing traffic calming devices to ensure that emergency access is not compromised. There is enough experience with traffic calming measures to design good emergency access. Some devices, e.g., curb extensions, can improve emergency access by keeping intersections clear of parked cars.

VIII. Parking Lots

The large expanses of uninterrupted paving found in many parking lots create a visually unpleasant area for people to walk past or through. These parking lots also have negative microclimate effects, often making places windier, therefore colder, in winter, and hotter in summer. Often, no provision is made for pedestrian pathways in parking lots.

The Cambridge Zoning Ordinance requires that parking lots with five or more spaces be screened with a 5-foot strip of vegetation or a fence that is at least 50% opaque. The ordinance also requires landscaping within the lot. However, many parking lots are not required to comply with these regulations because they are pre-existing facilities.

Owners of pre-existing parking lots can be encouraged to comply with the zoning ordinance by planting trees and other vegetation within and at the perimeter of their parking lots and to create safe pedestrian pathways within large lots.