Neighborhood Traffic Calming Program Handbook
City of San Leandro
Adopted by City Council July 7, 2003
Engineering and Transportation Department

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1. INTRODUCTION

Traffic calming is the use of engineered solutions to reduce vehicle speeds to an appropriate level and to encourage motorists to utilize appropriate through routes across the city, rather than cut through residential neighborhoods. The Institute of Transportation Engineers defines traffic calming as "the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users".

Purpose of Neighborhood Traffic Calming Program: The purpose of the Neighborhood Traffic Calming Program (NTCP) is to improve livability and quality of life by deploying of a wide array of engineered calming devices. A NTCP provides a more comprehensive and objective approach to traffic calming on local residential and residential collector roadways.

2. PROJECT IMPLEMENTATION

Local residential streets and residential collectors are eligible roadways in the NTCP. Non-residential local roadways and collectors, residential arterials and arterials do not qualify under the NTCP. These street designations are defined in the City's General Plan. The Neighborhood Traffic Calming Program does not provide the mechanism to change the roadway designation in the General Plan; a General Plan Amendment is required.

Local residential streets are low-speed, low-volume roadways that provide for circulation within residential neighborhoods, with direct access to access to abutting land uses. They typically have two travel lanes with parking on both sides.

Collector streets are relatively low-speed, medium-volume roadways that collect and distribute local traffic moving between local and arterial streets. Collector routes provide for circulation between neighborhoods. Average daily traffic volumes are generally less than 10,000 vehicles per day. Residential collectors are those collectors within residential areas, as defined in the General Plan, and typically have two travel lanes with curbside parking.

Arterials serve as the basic network for through traffic in and around San Leandro. They provide connections between the freeways and major destinations in the city and carry cross-town and commercial traffic. Arterial streets generally provide direct access to adjacent land uses, although access may be restricted by medians and dividers. Curb cuts for driveways are limited to essential points and curb parking may be restricted where lane capacity is needed. Arterials may have two, four or six travel lanes. Residential arterials are those that traverse residential neighborhoods.

Due to the difference in functionality between roadways primarily meant to provide access to abutting land uses and roadways meant to carry through traffic, the identified problems and solutions for these roadways differ. Traffic calming devices are appropriate on roadways serving high volumes of through traffic. It is for this reason that non-residential roadway and arterial roadways are not eligible in the NTCP.

NEIGHBORHOOD TRAFFIC CALMING PROCESS

Roadways Types: The classification of roadways that qualify under the NTCP include residential local and residential collector roadways. Residential arterials do not qualify under this process due to the emphasis of residential arterials in the overall roadway network and the need to carry higher volumes of traffic.

Initiation: The first step in initiating a traffic calming measure is for a citizen to contact the Engineering and Transportation Department and describe the problem. Staff will evaluate if simple traffic request procedures may solve the problem such as speeding around a curve being addressed with a painted centerline and signing, etc. If the traffic problem persists, the citizen may complete the Neighborhood Traffic Calming Application for consideration in the NTCP. The Application requires a description of the problem and the signatures of 4 other residents in the neighborhood.

Minimum Criteria: The City receives more requests for traffic calming measures than it has resources. Sometimes, requests for traffic calming measures are received on streets that have very small traffic volumes or on streets that do not have a documented speeding problem. Minimum criteria are used in order to ensure that City staff and financial resources are used efficiently. Spending resources on streets that do not have a significant traffic problem and creating unmet expectations by keeping a long list of projects that may never get built are to be avoided. A candidate roadway in a neighborhood must meet at least one of the following minimum criteria:

> **85th Percentile Speed:** Critical speed is at least **32 miles per hour** for residential local roadways and **34 miles per hour** for residential collectors
>
> **Average Daily Traffic:** The average daily traffic volume is at least **1,000 vehicles** for local roadways and **2,000 vehicles** for residential collectors

Staff will collect this traffic data to determine if the roadway meets at least one of the minimum criterion. If no criteria are met, the roadway will not qualify for the NTCP. If one of the minimum criterion is met, then the neighborhood will be placed on the list of neighborhoods to be prioritized.

Neighborhood Boundary: A neighborhood boundary will be determined by staff for each traffic calming request based on the specific characteristics of each neighborhood. This neighborhood boundary will be used to work with the property owners within this area to determine appropriate traffic calming solutions. Since the traffic pattern of each neighborhood is unique, each neighborhood will be evaluated on a case-by-case basis to determine the boundary of the traffic calming study area. It is important to make the study area small enough so that consensus can be achieved. However, it must be large enough to address the root of the traffic problem.

Neighborhood Prioritization: The need to prioritize projects arises when the demand for traffic calming exceeds City resources. This includes staff time to work on the projects, as well as funding. A common approach used by many other cities to efficiently utilize resources, is to prioritize projects so that the neighborhoods with the greater problems are addressed first. Since neighborhood traffic problems involve speeding vehicles or a high volume of vehicles relative to the street type, these criteria are weighted heavier in the ranking. Another factor that is considered in defining the extent of the problem is the average annual reported accidents. Additionally, neighborhoods that have a higher number of pedestrian generators, such as parks, schools and other public facilities, will be impacted greater than those neighborhoods without

pedestrian generators. Due to the high concentration of school-aged pedestrians and localized traffic congestion associated with elementary, middle and high schools, these pedestrian generators are weighted double that of other non-school pedestrian generators. A school can be public or private, but it must have at least 300 students in order to qualify for points. A day care facility does not qualify. This prioritization point system is based on the positive experience of other cities. The maximum number of points possible is 30 points and the points are allocated as follows:

Critical (85th Percentile) Speed

Local Street	**Residential Collector Street**	**Points**
32 mph	34 mph	1
33 mph	35 mph	2
34 mph	36 mph	3
35 mph	37 mph	4
36 mph	38 mph	5
37 mph	39 mph	6
38 mph	40 mph	7
39 mph	41 mph	8
40 mph	42 mph	9
41 mph	43 mph	10 maximum

Average Daily Traffic Volume

Local Street	**Residential Collector**	**Points**
1,000 – 1,100	2,000 – 2,200	1
1,101 – 1,200	2,201 – 2,400	2
1,201 – 1,300	2,401 – 2,600	3
1,301 – 1,400	2,601 – 2,800	4
1,401 – 1,500	2,801 – 3,000	5
1,501 – 1,600	3,001 – 3,200	6
1,601 – 1,700	3,201 – 3,400	7
1,701 – 1,800	3,401 – 3,600	8
1,801 – 1,900	3,601 – 3,800	9
1,901 and above	3,801 and above	10 maximum

Collision History – One point for each collision susceptible to correction by traffic calming over the past 3 years. (5 points maximum)

Pedestrian Generators – One point for each park, recreation facility or other public facility that is a significant pedestrian generator within the neighborhood boundary as determined by the traffic engineer. Elementary, middle and high schools will be weighted double points in the category. (5 points maximum)

Neighborhood Selection: Staff will prioritize eligible neighborhoods annually during the month of October. The application deadline to meet this cycle is September 1. After the neighborhoods have been prioritized, the top neighborhoods will be selected to participate in the NTCP. The number of neighborhoods selected will be based on funding and staffing level each fiscal year.

The neighborhoods that are not selected for the NTCP will be evaluated to determine if they meet all of the criteria for speed humps as indicated in Appendix A. Some neighborhoods that meet all of the speed hump criteria can elect to pursue speed humps only as a traffic calming solution. The number of neighborhoods selected to receive speed humps will be dependent upon the availability of funding and will be selected from the top of the prioritized list.

Acceptable Traffic Calming Measures: The following devices may be considered by the Engineering and Transportation Department for installation as either temporary or permanent calming measures on local access streets and residential collectors. Notably, stop signs as speed controls and calming devices are not considered appropriate. Also note that most calming measures are not traffic control devices as defined by the California Vehicle Code, but rather, are geometric features of the street.

- Speed humps
- Traffic circles
- Chicanes
- Raised Crosswalks and Speed Tables
- Raised Intersections
- Medians and Gateways
- Bulb-outs, Chokers and Curb Extensions
- Re-striping
- In-Pavement Lighted Crosswalks

Chapter 3 of this document contains illustrations of these devices including standard applications, design guidelines and limitations, and the advantages, disadvantages and other special considerations.

First Neighborhood Meeting: All of the residents and property owners within a neighborhood boundary will be invited by the City. The purpose of the first meeting is to listen to the concerns of the neighborhood, discuss the NTCP and process and the advantages and disadvantages of various traffic calming measures. It will be an educational meeting, both for the public to learn about the traffic calming process and its implications and for staff to learn about the concerns of the public. This meeting is purposely held prior to the distribution of the initial ballot so that residents can be educated about the process they will be asked to support. Depending upon the size of the neighborhood, the City may request that the neighborhood identify a neighborhood captain or a neighborhood working group in order to coordinate the future outreach efforts within the neighborhood.

Initiation Ballot Requirement: Since traffic calming measures impact many people in the neighborhood and the measures tend to be costly, it is necessary to determine if there is adequate support for the process before continuing. A ballot will be mailed to each resident. If the resident is not the property owner, a ballot will be mailed to both the property owner and the resident with each receiving an equal vote. A ballot measure requesting initiation of the NTCP must be approved by at least 67% of the ballots returned by the property owners and residents within a neighborhood boundary. A minimum of 50% of the mailed out ballots must be returned. If the minimum number of ballots is not received by the deadline, or if the ballot measure does not achieve 67% approval, the neighborhood will be reprioritized the following year and the next neighborhood on the priority list will be selected for traffic calming evaluation.

Development of Alternative Plans: Based on the outcome of the first neighborhood meeting, staff will develop alternative traffic calming plans to address the problems within the design and operational guidelines of the Transportation Element. The alternative plans will conform to the design standards of the Engineering and Transportation Department, and will be reviewed by the Police Department, the Fire Department and the Public Works Department prior to distribution to the public. The Fire Department must approve the location and design of all traffic calming devices. The alternative plans will also be limited based on available funding.

These alternative plans will be presented to the neighborhood residents in a second meeting for public review and comment.

Second Neighborhood Meeting: The purpose of the second neighborhood meeting is to determine the neighborhood's preferred alternative. This will include a review of the alternatives, discussion of the advantages and disadvantages of each alternative and selection of the preferred alternative. It may be necessary to have more than one meeting on this topic in order to develop consensus for a preferred alternative.

Trial Project: Staff may recommend a trial project phase for extremely extensive traffic calming projects to study the effects of diverted traffic and to determine the effectiveness of the traffic calming measures. The trial project period may last from six to nine months.

Diverted traffic is traffic that is diverted off of the roadway treated with traffic calming measures and is placed on a different travel path. The goal is to encourage this diverted traffic onto appropriate roadways, such as collectors and arterials, rather than onto other local residential roadways. However, it is acceptable to see a small increase in traffic (approximately 10% increase of the existing roadway volumes) on other parallel residential roadways.

It is important to note that trial projects tend to not be as effective as permanent installations. Trial projects are much less attractive because they usually consist of pavement markings, cones or rubber in the roadway to mimic the shape of the traffic calming device. There is no new landscaping associated with trial projects. It is important to communicate this to the neighborhood if staff recommends a trial project.

After the trial period, another neighborhood meeting will be held to discuss the effects of the trial project and implementation of permanent measures.

Final Approval Ballot Requirement: Once the permanent project is finalized, another neighborhood ballot measure is required to approve the final plan. A ballot will be mailed to each resident. If the resident is not the property owner, a ballot will be mailed to both the property owner and the resident with each receiving an equal vote. The ballot form will include the locations of the measures, advantages and disadvantages of the Traffic Calming Plan. A positive response from 67% of the returned ballots from the property owners and residents within the neighborhood boundary is required. A minimum of 50% of the mailed out ballots must be returned. 100% of the property owners that are directly impacted by the traffic calming measures being placed adjacent to their property will be required to approve of the Traffic Calming Plan. This includes those residents that are impacted by parking restrictions due to traffic calming devices. If a traffic calming project is considered controversial or has major impacts in traffic circulation, City staff may present it to the Planning Commission for approval.

Implementation: Engineering and Transportation shall implement the final approved plan. Generally, permanent installation of strategies will be included only within the capital improvement budget for the year the plan is implemented. If the Traffic Calming Plan exceeds the budget for the year, it will be phased. The first phase of the Plan will be for the budgeted amount for the first year. The subsequent phases of the Plan will be required to be reprioritized amongst the other neighborhoods the following year. New traffic data will be collected after the implementation of the first phase in order to determine the extent of the resulting traffic problem.

Follow-up Evaluation: Six months or more after full Plan implementation, the Engineering and Transportation staff will conduct data collection to determine whether the problems have been reduced or eliminated. Only data related to the issues need be collected. A brief report will be prepared that can be mailed to all the residents signing the petitions (for and against).

Removal or Appeals: Appeals against continuation of the calming improvements can be made at any time during the process. In order to appeal the use of or remove traffic calming devices, a petition needs to be signed by 67% of the residents within the neighborhood. The appeal will be agendized on the Planning Commission calendar, and the planned neighborhood improvements will be delayed pending the results of the appeal.

Funding: Each year, the Engineering and Transportation Department shall propose a budget in the through the Capital Improvement Program for the Neighborhood Traffic Calming Program. These resources may include consulting assistance or the retention of temporary staff for managing the various projects initiated during the budget year.

3. TOOLBOX OF TRAFFIC CALMING MEASURES

Traffic calming is defined as physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, improve safety for non-motorized street users, and improve neighborhood livability. The following pages describe and illustrate physical traffic calming measures that may be used in the City of San Leandro. For a variety of reasons, not all measures may be acceptable or desirable in all situations. Some measures are not acceptable for use on certain streets that may be primary emergency response routes as determined by the Fire Department. The Fire Department must approve the location and design of all traffic calming devices. The determination of which measures best suit each application will be worked out between the Engineering and Transportation Department, the Fire Department and the residents in the neighborhood. This toolbox is meant to be a flexible inventory of tools that may be updated as new and innovated traffic calming measures are discovered.

There are a few devices that are commonly requested as traffic calming devices but are not allowable under this program. As few examples are as follows:

Stop Signs: Stop signs are traffic control devices, not traffic calming devices. As such, their use is governed by the State that requires certain established criteria (warrants) to be met. Studies have shown that stop signs that do not meet established criteria have a higher violation rates which may increase collisions. Also, these studies show that vehicle speeds after the vehicle has passed through an unwarranted stop controlled intersection are as high, if not higher that without a stop sign, as motorists try to "make up" time lost. The acceleration and deceleration near stop signs generates noise and adversely effects air quality. A stop sign may be requested as part of a routine request for traffic control devices and they will be evaluated based on established criteria.

Diverters and Street Closures: Diverters and street closures are measures that alter the existing transportation circulation system. In developing a solution for one neighborhood traffic problem, it is important not to shift the problem to another neighborhood. These devices can cause a tremendous amount of traffic diversion over a wide area. As such, their impacts would need to be evaluated in a greater scope than just within a particular neighborhood. The impacts would include the environmental impacts due to changing the transportation circulation system. Many other cities have policies that ban or discourage street closures. For these reasons, diverters and street closures are not recommended for use as traffic calming measures, but rather should be evaluated as part of a larger area-wide study if their use is to be considered.

Rumble Strips: Rumble strips are a series of pavement bumps that create a "rumble" effect as cars drive over them. They are often used to alert drivers as they approach tolls on toll-ways or stop signs on highways in rural isolated areas. Rumble strips are not effective as speed control devices. In addition, due to the noise they generates as vehicles pass over them, their use is inappropriate within neighborhoods.

Children at Play Signs: These signs are commonly requested in neighborhoods, however, they are no longer approved traffic control devices. They have not been found to be effective in improving the safety of children. Residential areas commonly have children and the presence of signs does not change driving behavior in the neighborhood. One of the disadvantages of these signs is that they can create a false sense of security amongst children and their parents which may increase the potential for accidents. If the safety of children is the major concern in a neighborhood, there are more effective tools that can be used to improve safety.

SPEED HUMPS

DESCRIPTION: Speed humps are a gradual rise and fall in the pavement surface, usually with a circular profile, to a maximum height of 3 inches over a distance of 12 to 14 feet in the direction of travel.

APPLICATION: They are usually used in controlling maximum speeds. Typical average speeds within 100 feet of the humps are not higher than 22 mph, and if positioned no further than 600 feet apart, they usually control average speeds to less than 30 mph and eliminate all speeds above 40 mph. They also may reduce traffic volumes by about 10 to 20 percent if there is an alternate travel path. They should be installed at 300 to 600 foot spacing and properly signed with a 15-mph advisory speed. The preferred marking for humps is similar to the "zebra-striped" crosswalk. Speed humps may be appropriate on local residential roadways and residential collectors with traffic volumes less than 4,000 average daily trips.

LIMITATIONS: All speed hump plans must be approved by the Alameda County Fire Department. Typically, speed humps delay emergency response vehicle approximately 10 seconds. Speed humps can not be placed within roadway curves due to sight distance issues and they cannot be installed within 200 feet of an intersection. Additionally, speed humps cannot be installed on grades steeper than 8%. Speed humps are not to be used on non-residential roadways and on roadway with more than 4,000 average daily trips.

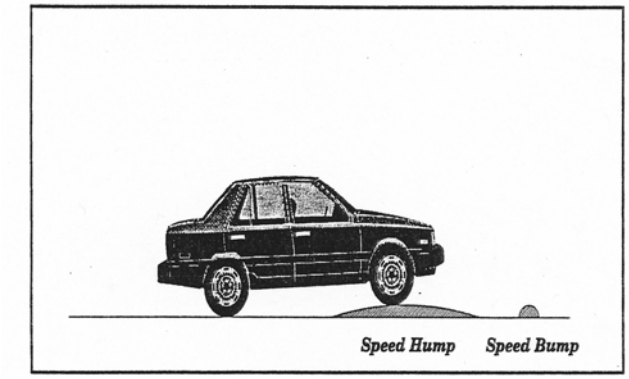
ADVANTAGES:

- Effective in reducing vehicle speeds
- Requires minimum maintenance

DISADVANTAGES:

- Increases emergency response times
- May increase traffic noise in vicinity of hump
- Several humps are required on long blocks in order to be effective

TYPICAL COST: Typical construction costs are $3,500 per hump. Typical annual maintenance cost is $270 per hump.



TRAFFIC CIRCLES

DESCRIPTION: As used for traffic calming purposes, traffic circles are relatively small circular or oval median islands (usually landscaped with raised curbs) placed at the center of intersections of local and/or residential collector streets.

APPLICATION: Their primary purpose is to reduce speeds through an intersection or, if used in a series, reduce speeds for several blocks. They reduce speeds by forcing motorists to negotiate horizontal curves and also by reducing long straight lines of sight on long straight roadways by providing landscaping in the intersection. Traffic circles reduce speeds within 100 to 200 feet of an intersection, and if used between 300 feet and 600 feet apart, can effectively reduce average speeds on a street to below 30 mph, and eliminate all speeds above 40 mph. Circles may reduce traffic volumes based on the traffic circulation and the availability of alternate routes. Depending upon their design, traffic circles can also reduce conflicts at intersections. Caution must be applied when using traffic circle on roadways with more than 6,000 average daily trips.

LIMITATIONS: All traffic calming devices must be approved by the Alameda County Fire Department. Depending upon the design, traffic circles may delay emergency equipment from 6 to 12 seconds. Traffic circles may create conflicts for pedestrians if the vehicle is forced to drive in the path of the pedestrian crosswalk. Vehicles are forced to share the lane with bicyclists since the travel lane is narrow through the intersection. Also, large trucks (i.e., moving trucks) may not be able to negotiate left turns around the traffic circle. It may be necessary for these trucks to turn the wrong way around the circle, which is generally acceptable as long as special consideration is taken by the driver.

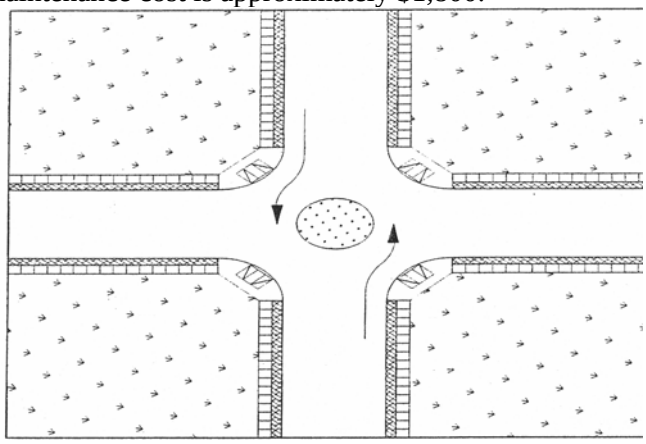
ADVANTAGES:

- Effective in reducing vehicle speeds
- Breaks up sight-line on long straight streets
- Opportunity for enhanced landscaping

DISADVANTAGES:

- May reduce emergency response time
- May impede left turns by large trucks
- May pose conflicts for pedestrians and bicyclists
- May require removal of on-street parking

TYPICAL COST: Typical construction costs range between $20,000 and $30,000. Annual maintenance cost is approximately $1,800.



CHICANES

DESCRIPTION: A serpentine street or chicane is an artificially created, curving, two-way street on a naturally straight road section. The curvilinear alignment requires additional maneuvering and breaks up long straight sight lines for motorists.

APPLICATION: The curves can be created by offset centerline striping, a series of bulb-outs or parking areas installed on alternating sides of the street, or by varying the size or shape of a series of median islands. The length of the curve and the amount of side-to-side offset can be varied to obtain more or less reductions in speed. They may be used at both midblock and at intersections. In addition to the forced speed reduction, a serpentine alignment that is created by landscaped islands gives the appearance that a street may not be a convenient shortcut. Chicanes may reduce traffic volumes depending upon the traffic circulation and the availability of alternate routes. Travel lanes usually need to be narrowed in order to further reduce the ability of drivers to straighten the curves.

LIMITATIONS: If raised islands do not force the lane offsets, many drivers will easily "straighten the curves" by not staying in the proper lane in the transition area, thus reducing the effectiveness of this measure. Any chicane must be designed to permit travel by emergency equipment. Because the designs are so diverse, it is not possible to generally describe the added delays to emergency equipment. Chicanes tend to be ineffective on roadways with more than two lanes due to the tendency to cut a straight path.

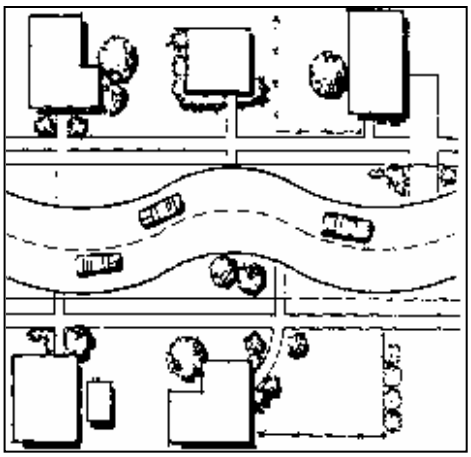
ADVANTAGES:

- Provides for landscape opportunities
- Minimal impact on emergency vehicles

DISADVANTAGES:

- Relatively expensive
- Needs to be combined with narrowing lanes
- May require on-street parking removal

TYPICAL COSTS: Costs are highly dependent upon the design and may range from $15,000 to $30,000. The annual maintenance cost is approximately $250 per block.



RAISED CROSSWALKS OR SPEED TABLES

DESCRIPTION: A raised crosswalk is a flat-topped speed hump built as a pedestrian crossing with a maximum height of 3 inches over a distance of 22 feet in the direction of travel. The central 10-foot section of the table is flat.

APPLICATION: They may be used singly for a raised crosswalk, or in a series of two or more for the purpose of speed reduction; similar to a speed hump. The raised crosswalk should extend all the way to the curb, possibly requiring new storm drainage construction, thus increasing the cost considerably. The design application is similar to a speed hump. This design is appropriate for heavily used crosswalks near schools and recreation facilities. Raised crosswalk and speed tables are fairly effective in reducing vehicle speed similar to that of speed humps. However, due to longer crossing distance, it results in less abrupt speed reduction. If an alternate travel path is available, traffic diversion may occur. Raised crosswalks may be used on local residential and residential collectors with average daily traffic volumes less than 4,000 vehicles.

LIMITATIONS: All traffic calming plans must be approved by the Alameda County Fire Department. Typically, raised crosswalks may delay emergency vehicles up to 10 seconds. In order to be effective in reducing vehicle speeds, it should be used in conjunction with other traffic calming devices. Raised crosswalk may not be used on non-residential roadways and on roadways with more than 4,000 average daily trips.

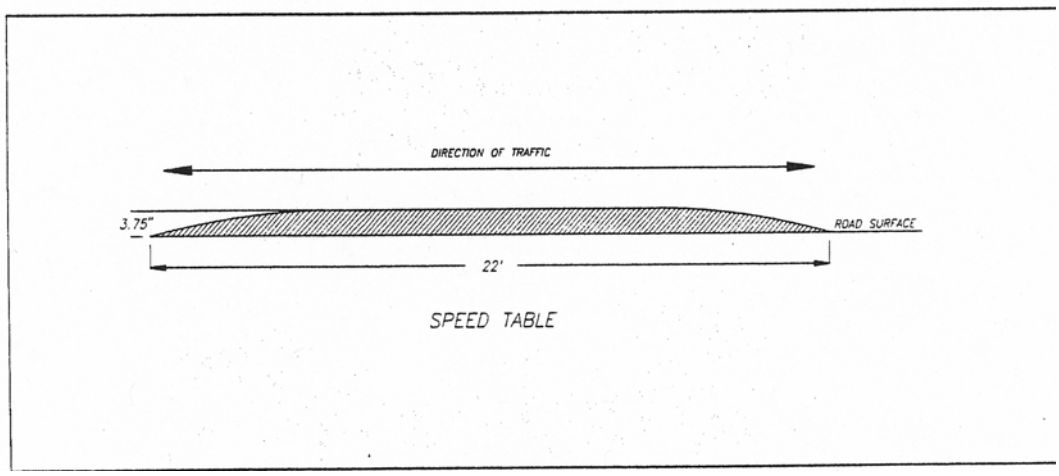
ADVANTAGES:

- Effective in reducing vehicle speeds
- Enhances pedestrian visibility in the crosswalk
- Clearly designates crosswalks

DISADVANTAGES:

- Increases emergency response times
- May increase vehicle noise in the vicinity of the raised crosswalk or speed table
- May require extensive signing

TYPICAL COSTS: Typical costs range between $4000 and $10,000, depending upon drainage issues. Annual maintenance cost is approximately $250.



RAISED INTERSECTIONS

DESCRIPTION: A raised intersection is a raised section of roadway at an intersection where the pavement is elevated to be flush with the top of curbing and the approaches are ramped like speed humps.

APPLICATION: This technique has been used extensively in Europe. Raised intersections control speeds in similar fashion to raised crosswalks. They are much more expensive, but they can be used on both local streets and residential arterials and in commercial areas. In the U.S., they have more often been used as enhancements for pedestrian safety and aesthetics in shopping areas, rather than for neighborhood traffic management. The raised intersection may be given a special pavement treatment. The ramp is 10 to 12 feet along the path of the vehicle. Raising the intersection to 3 inches, results in a gentle grade of only 2.1% which can be easily negotiated by emergency equipment.

LIMITATIONS: Raised intersections slow emergency equipment from 3 to 9 seconds, depending upon the height of the intersection. Raised intersections are relatively expensive, especially if changes in drainage, manholes or other utilities are required, and if decorative pavement treatments are used. Due to the lack of curb separation at the corners of the intersection, some motorists may tend to cut corners. Therefore, a design feature such as bollards may be necessary to keep motorists from driving onto the sidewalk.

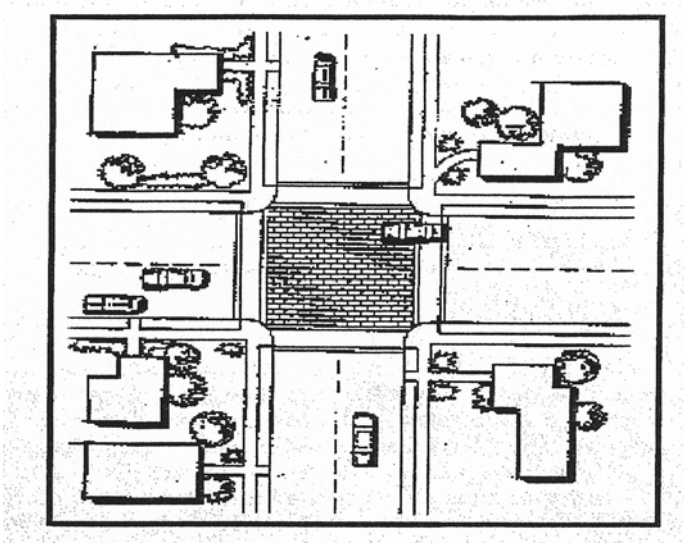
ADVANTAGES:

- Effective in reducing vehicle speeds
- Opportunity for attractive pavement treatments
- Improved pedestrian safety at intersections

DISADVANTAGES:

- May reduce emergency vehicle response times
- May require bollards to define corners of the intersection
- Relatively expensive

TYPICAL COSTS: Costs range from $25,000 to $150,000, depending upon the specific design and size of the intersection and drainage issues. Annual maintenance cost is $1,000.



MEDIANS AND GATEWAYS

DESCRIPTION: A median is a raised island in the center of the roadway with one-way traffic on each side. A gateway consists of an architectural or roadway feature on each side and/or in the center of a roadway used primarily to indicate to drivers that they are entering a special area. In the case of traffic calming, it is usually a residential neighborhood or commercial district.

APPLICATION: Medians are used on wide streets to narrow each direction of travel and to interrupt sight lines down the center of long straight streets. Hence, medians are more effective when properly landscaped. Neighborhood gateways can include a median island to identify entry into a neighborhood. If the gateway were narrow, it would reduce speeds at that point and could reduce through traffic. The most effective gateways include vertical elements such as trees or columns. Gateways may be formed by curb bulb-outs, fences, poles, signs, artwork, and other features that can be combined with each other. Medians may be extended for longer stretches through intersections to preclude left turns. Medians may be effective in reducing speeds through sweeping curves by discouraging motorists from cutting the corner and crossing over the centerline. Medians can also reduce the occurrence of head-on collisions by separating two-directional traffic. Medians can be used in conjunction with crosswalks, with the median serving as a pedestrian refuge. Speed reduction depends on the amount of horizontal deflection and the width of the travel lanes. Traffic diversion is expected to be minimal.

LIMITATIONS: Long medians may adversely impact emergency vehicle access and operations. Medians may also disrupt driveway access. To accommodate a median, it may be necessary to remove on-street parking and/or narrow travel lanes. Since medians tend to narrow travel lanes, it may force bicyclists and motor vehicles to share the same space. If this is being considered on a major bikeway, design consideration should be made to accommodate the bicyclist, however this usually negates the effectiveness of reducing vehicle speeds.

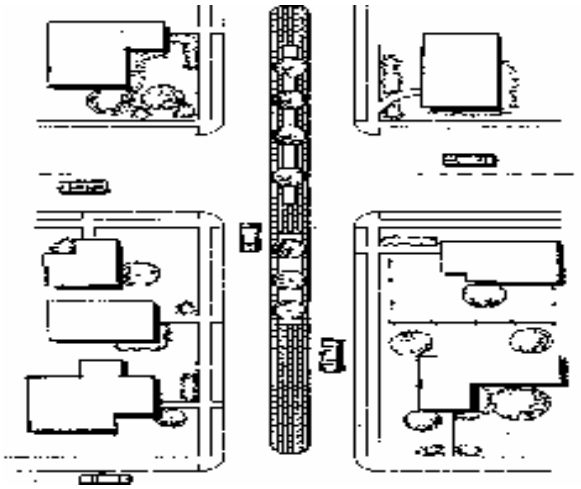
ADVANTAGES:

- May be slightly effective in reducing vehicle speed
- May provide an opportunity for enhanced landscaping or decorative hardscaping
- Can be used to control access and turning movements

DISADVANTAGES:

- May reduce emergency vehicle access
- May require on-street parking removal
- May disrupt driveway access

TYPICAL COSTS: Costs range greatly depending upon the length and design of the median. A typical 40-foot median may cost $25,000 for construction and annual maintenance cost is $100.



BULB-OUTS, CHOKERS AND CURB EXTENSIONS

DESCRIPTION: Bulb-outs, curb bulbs, chokers, curb extensions and neckdowns are synonymous for an extension of the curb into the formerly paved street area, typically for the width of a parallel parking space. A low-cost design does not literally extend the curb line; rather a gap remains between the former curb line and the new islands to maintain gutter flow.

ADVANTAGES: Bulb-outs may be installed at intersections or mid-block, on one or both sides of the street. They usually do not impede or redirect traffic flow; rather they reduce the width of the traveled way to the minimum required for two-way traffic. They may be used for numerous purposes including:

- Reducing curb radii at intersections to slow turning traffic
- Enhancing pedestrian safety and visibility at pedestrian crossings
- Providing extra space for landscaping and sidewalk amenities
- Possibly reducing speeds by creating a sense of narrowness
- Creating a neighborhood gateway feature

Bulb-outs on one side of the street coupled with an offset centerline can be used to create serpentines and chicanes. In addition, bulb-outs can be combined with small medians between them to further restrict the driver's path, and to slow the speed of turning traffic, especially at intersections that are angled greater than 90^{o}.

LIMITATIONS: The low-cost version of the curb bulb may be less expensive to construct, but may be more expensive to maintain due to debris accumulating between the original curb line and the new island. The narrowed travel way may present challenges to bicyclists by forcing bicyclists and motorists to share the same space. Design consideration should be made for bicyclists on bicycle routes. Minimum corner radii requirements for small trucks and emergency vehicles may reduce the effectiveness of this option in slowing vehicles and shortening the pedestrian crossing distance. Overall effects on vehicle speeds can be fairly modest.

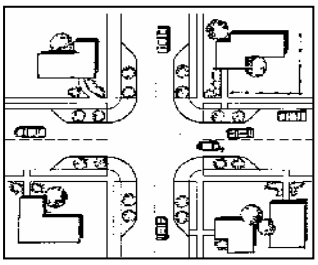
ADVANTAGES:

- May enhance pedestrian safety
- May provide the opportunity for decorative hardscaping or landscaping
- May reduce vehicle speeds slightly

DISADVANTAGES:

- May need to consider design impacts on bicyclists and emergency vehicles
- May require removal of on-street parking

TYPICAL COSTS: Costs typically range from $20,000 to $50,000 per pair of bulbs, depending upon design and extent of landscaping and/or hardscaping and drainage. Annual maintenance cost is $375 each intersection.



IN-PAVEMENT LIGHTED CROSSWALKS

DESCRIPTION: A recent development in pedestrian warning devices is the in-pavement lights along the crosswalk. This can be coupled with pedestrian crossing signs with flashing lights simulating the in-pavement lights. Studies show that a greater proportion of drivers yield the right-of-way to pedestrians in these specially-equipped crosswalks. The lights can be activated either by the pedestrian, or passively through detection. The lights are an application of aircraft runway landing lights embedded in the pavement and are very bright, even in direct sunlight.

APPLICATION: This device can be used to enhance pedestrian safety at a crossing location with a high number of pedestrians, such as in front of a school or in a commercial district. These devices may be coupled with bulb-outs, medians and other devices for even greater pedestrian crossing notification.

LIMITATIONS: There are no long term studies of whether drivers become used to these lights and revert to more typical behavior of not yielding to pedestrians in crosswalks. The City will be evaluating the recently installed in-pavement lighted crosswalks to determine their long term effectiveness. These devices shall not be installed in locations already controlled by other traffic control devices, such as at stop signs or traffic signals. Caution should be used when determining if the use of in-pavement lighted crosswalks are an appropriate application. In general, the Federal Highway Administration guidelines (2002) regarding the use of crosswalks at uncontrolled locations should be considered.

ADVANTAGES:

- Effective in enhancing pedestrian visibility

DISADVANTAGES:

- Additional studies are needed to determine long term effects
- May not be appropriate under certain circumstances

TYPICAL COSTS: Typical costs range from $35,000 to $50,000. Annual maintenance cost is $1000.

PICTURE TO BE INSERTED

TEXTURED INTERSECTIONS AND CROSSWALKS

DESCRIPTION: Crosswalks or intersections can be textured by means of special pavers or decorative concrete.

APPLICATION: In commercial districts, there may be an integrated design concept that includes special pavement for intersections and crosswalks. Such treatment calls attention to a junction or crosswalk. The intention may be to alert the driver that the area being traversed has some special identity, such as where pedestrian traffic is frequent or that requires special attention.

LIMITATIONS: There may be reductions in speed. Generally, special textured pavement has a minimal effect on traffic flow and should be used primarily as an enhancement of the more effective calming devices on collectors and arterials.

ADVANTAGES:

- May enhance driver attention
- May enhance the streetscape

DISADVANTAGES:

- May not be effective in reducing vehicle speeds
- May increase noise as vehicles traverse the textured surface

TYPICAL COSTS: Costs range from $10,000 to $25,000, depending upon the surface treatment. Annual maintenance cost is $250.

RESTRIPING

DESCRIPTION: Streets can be restriped in various ways to alter driver behavior. The striping can include yellow centerlines, edge/shoulder striping or bike lane striping, restriping lanes to have narrower widths or reducing the total number of lanes.

APPLICATION: On wide roadways, it may be desirable to narrow the travel lanes. For example, 12-foot travel lanes can be narrowed to 10-foot travel lanes using striping. If appropriate, bicycle lanes can be added to a street resulting in reductions in width of other travel lanes. Narrower lanes may give drivers the impression of a narrower street with less room for maneuvering, thereby potentially reducing speeds. Impacts to emergency vehicles would be minimal.

LIMITATIONS: The lack of physical limitations results in substantially less impact on driver behavior than other physical measures. Use of striping to achieve traffic calming can be considered a passive measure, since drivers are not physically forced to change their behavior. Enforcement may be required to produce effective results.

ADVANTAGES:

- May have slight impact on reducing vehicle speeds
- Minimal impact on emergency vehicles
- May provide facilities for bicyclists

DISADVANTAGES:

- May require enforcement
- May require additional maintenance of striping

TYPICAL COSTS: Construction and maintenance costs range from $1.00 to $1.30 per linear foot of striping.

REFERENCES

Neighborhood Traffic Calming Program, City of Palo Alto, 2001

Neighborhood Traffic Calming Program, City of Livermore, 2002

Traffic Calming, State of the Practice, Institute of Transportation Engineers, 1999

Traffic Calming Primer, Pat Noyes and Associates, 1998

Traffic Calming Toolbox, City of Berkeley, 2000