

CITY OF REDWOOD CITY POLICY AND GUIDELINES FOR SPEED HUMP USE

INTRODUCTION

Speed humps have been increasingly recognized by engineers as a suitable geometric design technique for controlling traffic speeds under appropriate roadway circumstances. This policy and guideline describes those appropriate roadway circumstances and details of geometric design requirements for speed humps as applicable in the City of Redwood City. They are based on *Guidelines for the Design and Application of Speed Humps* (Institute of Transportation Engineers, March 1993); research and experimentation by the City of Portland, Oregon; the City of Portland's *Traffic Manual, Chapter 7 - Speed Bumps*; experience in the City of Redwood City's own tests and prior applications of speed humps; and interpretations and amplification of details specific to Redwood City.

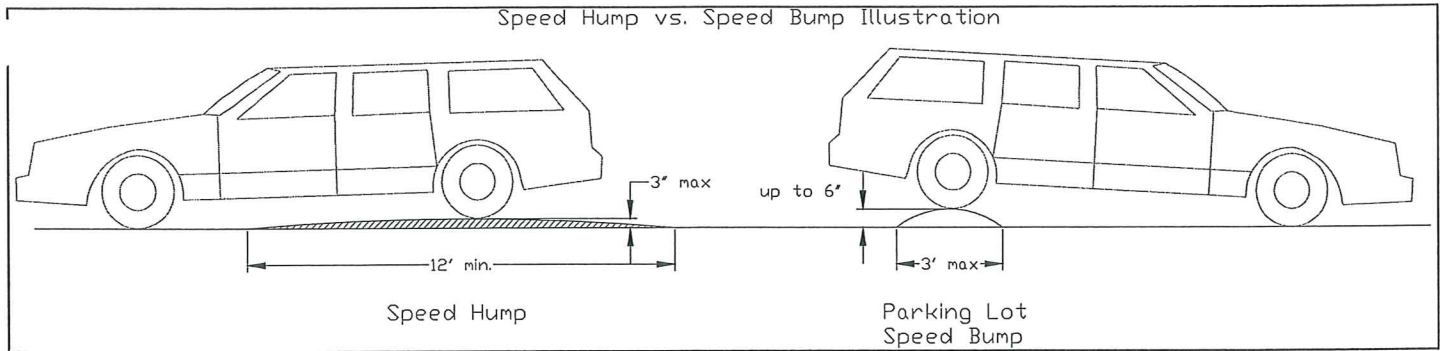
USE OF THIS POLICY AND GUIDELINES

This document is to be used in conjunction with good professional engineering judgment and practice. The guidelines herein do not constitute either final or complete design and evaluation criteria for speed humps and speed hump systems. Local site conditions must be evaluated for all speed hump installations. In addition, specific terrain, roadway, traffic or land use characteristics or other unusual conditions may require case-specific modification of or exception to these guidelines.

DEFINITIONS

A speed hump is a roadway geometric design feature consisting of raised pavement extending transversely across (or partly across) a roadway for the primary purpose of reducing the speed of vehicles traveling thereon. In a speed hump, the raised pavement area normally rises and returns to the prevailing grade of the surrounding pavement over a distance of at least 12 feet in the direction of travel, with a maximum rise of 2.5 to 4 inches. Most speed humps are parabolic in cross-section. Flat-topped sections and elongated forms to 22 feet in the direction of travel are also recognized.

The considerable length in the direction of travel and limited maximum height is what physically distinguishes speed humps from the abrupt speed "bumps" commonly found in private drives and parking lots. Although there are no explicit standards for speed bumps, they generally have heights of 3 to 6 inches or more and lengths in the direction of travel of less than 3 feet. Figure I illustrates the difference between the cross section of a speed hump and an abrupt parking lot speed bump.



From an operational performance perspective, speed humps and abrupt speed bumps have crucially different effects on vehicles and their occupants. Within the range of typical residential street speeds, speed humps cause a gentle vehicle rocking motion that causes mild discomfort to drivers and passengers, with the level of discomfort tending to increase the faster the vehicle passes over the speed humps, which is an effect consistent with the objective of inducing drivers to travel at speeds reasonable for neighborhood streets. Drivers typically choose to cross speed humps at speeds between 15 and 25 miles per hour. Abrupt speed bumps, by contrast, cause significant driver discomfort at typical desirable residential street speeds. In a performance effect, which is completely contrary to the intended purpose of the bumps, driver/passenger discomfort tends to *decrease* the faster a vehicle is driven over an abrupt speed bump, because vehicle suspensions are expressly designed to absorb the jolts of quick passage over abrupt bumps rather than transmitting them to the passenger compartment. As a result, when confronted with an abrupt speed bump, most drivers either cross at extremely low speeds (5 mph or less) or continue at relatively high speeds (30 mph or more).

GUIDELINES FOR SPEED HUMP USE

Engineering Study

Speed humps should only be installed where the engineering study concludes that:

- Speed conditions to which speed humps respond appropriately exist;
- Judicious use of other guide, warning or regulatory control devices has been considered;
- A reasonable level of enforcement has not solved or appears unlikely to solve the problem, or that a necessary level of enforcement is unlikely to be made available; and
- Key design guidelines, as outlined herein for location, placement, configuration details and related street and traffic conditions, can be reasonably conformed-to at the site under consideration.

Street Classification And Use

Speed humps can only be installed on those roadway facilities functionally classified as “local” streets in the Redwood City General Plan.. Table 1 lists the street segments streets classified as “collector” streets or higher classes of streets in the General Plan’s functional classification hierarchy. Street segments on Table I are **not eligible** to be considered as candidates for speed hump application.

TABLE 1: STREETS INELIGIBLE FOR SPEED HUMPS

Primary Arterial Streets

| Roadway | From | To |
|------------------------|-----------------------|-----------------------|
| El Camino Real (SR 82) | N. City Limit | S. City Limit |
| Middlefield Road | Main Street | S. City Limit |
| Broadway | El Camino Real | Woodside Road |
| Veterans Boulevard | U.S. 101 | Woodside Road |
| Industrial Way | N. City Limit | Whipple Avenue |
| Edgewood Road | I-280 | Alameda de las Pulgas |
| Whipple Avenue | El Camino Real | U.S. 101 |
| Farm Hill Boulevard | I-280 | Jefferson Avenue |
| Jefferson Avenue | Farm Hill Boulevard | Veterans Boulevard |
| Woodside Road | Alameda de las Pulgas | U.S. 101 |
| Marine Parkway | U.S. 101 | Bridge |
| Redwood Shores Parkway | U.S. 101 | Bridge |
| Seaport Boulevard | U.S. 101 | East Terminus |
| Main Street | El Camino Real | Veterans Boulevard |
| Winslow Street | Whipple Avenue | Brewster Avenue |

Major Collector Streets

| Roadway | From | To |
|-----------------------|------------------|------------------------|
| Alameda de las Pulgas | N. City Limit | Woodside Road |
| Hudson Street | Jefferson Avenue | Woodside Road |
| Florence | Bay Road | Marsh Road |
| Bay Road | Fifth Avenue | Florence |
| Broadway | Woodside Road | Fifth Avenue |
| Blomquist | Whipple Avenue | Seaport Boulevard |
| Twin Dolphin Drive | Marine Parkway | Redwood Shores Parkway |
| Whipple Avenue | El Camino Real | Alameda de las Pulgas |
| Marine Parkway | Bridge | Shearwater |
| Middlefield Road | Marshall Street | Winslow Street |
| Marshall | Broadway E. | Broadway W. |

Minor Collector Streets

| Roadway | From | To |
|------------------|------------------|------------------------|
| Jefferson Avenue | Farm Hill Blvd. | West Terminus |
| Massachusetts | Woodside Road | Alameda de las Pulgas |
| Oak | El Camino Real | Valota Road |
| Roosevelt | El Camino Real | Alameda de las Pulgas |
| Brewster Avenue | El Camino Real | Alameda de las Pulgas |
| Hopkins Avenue | Broadway | Alameda de las Pulgas |
| Broadway | El Camino Real | Hopkins Avenue |
| Fifth Avenue | Middlefield Road | Broadway |
| Maple | Veterans Blvd. | East Terminus |
| Canyon | Edgewood | Jefferson Avenue |
| Valota Road | Jefferson Avenue | Woodside Road |
| Hudson Street | Whipple Avenue | Jefferson Street |
| Broadway | Hopkins | Main Street |
| Bay Road | Woodside Road | Fifth Avenue |
| Bridge | Marine Parkway | Redwood Shores Parkway |
| Shell | Marine Parkway | Redwood Shores Parkway |
| Shearwater | Marine Parkway | Redwood Shores Parkway |
| Marshall | Middlefield | Main Street |

Street Width And Number Of Lanes

Speed humps should be used only on streets with no more than two travel lanes and only on streets where pavement width is no greater than 40 feet.

Pavement Characteristics

Overall pavement on streets considered for speed humps should have good surface and drainage qualities. Where major resurfacing/reconstruction of a street is planned for the near future, speed hump installation should be deferred and incorporated in the resurfacing process.

Street Grades

Speed humps should not be employed on streets with grades exceeding 5 percent approaching the speed hump site. When installed on streets with sustained downgrades, special care should be taken to ensure that vehicles will not approach a speed hump at excessive speeds.

Horizontal And Vertical Alignment

Speed humps should not be placed within severe horizontal or vertical curves that might result in substantial lateral or vertical forces on a vehicle traversing the speed hump. Speed humps should be avoided within horizontal curves of less than 300 feet centerline radius and on vertical curves with less than the minimum safe stopping sight distance. At mid-block locations on typical residential streets, the stopping sight distance requirement is usually at least 200 feet, the nominal stopping sight distance for vehicles traveling at 30 mph. If possible, speed humps should be located on tangent sections rather than curve sections.

Sight Distance

Speed humps should generally be installed only where the minimum safe stopping sight distance (as defined in AASHTO's *A Policy On Geometric Design Of Streets*) can be provided. For mid-block locations on typical residential streets, a minimum safe stopping sight distance allowance would normally be at least 200 feet, nominal stopping sight distance for vehicles traveling at 30 mph. Depending on the character of the intersection and the control devices employed, sight distance requirements might be less for speed humps located within the influence area of intersections. Speed humps could be placed as close as 60 feet from the intersection where the primary approach is STOP controlled, and where there are clear sight triangles from the cross street, and speeds of traffic approaching the speed hump from the cross street are necessarily slow. Where the approach from the humped street is uncontrolled, or there is substantial prevalence of high speed turns from the cross street, or there is significant obstruction of the sight triangles from the cross street, then minimum separation of the speed hump from the intersection should tend toward the 200 foot limit.

Traffic Speeds

Speed humps should only be used on streets where traffic speeds are intended to be low. Speed humps should not be installed on streets where the posted speed limit is considerably greater than speeds at which most motorists feel comfortable in traversing the speed humps. Speed humps should generally be installed only on streets where the posted or prima facie speed limit is 30 mph or less. Where speed problems occur on streets with higher speed limits (such as streets posted for 35 mph experiencing 45-50 mph traffic), employment of focused enforcement and combinations of other types of control measures should be considered instead of speed humps.

When speed humps are installed to address speeding concerns, studies should be performed to confirm the magnitude of the speeding problem to ensure that the installation of speed humps can be expected to appreciably address that problem. As justification for speed humps on streets intended for low speed, numbers of vehicles exceeding speed limits, percentage of all vehicles exceeding speed limits, 85th percentile speed and speed of fastest vehicles may all be considered in evaluating whether there is a speed problem which speed humps should be used to counter and in allocating available community resources among sites experiencing problems. In Redwood City, specific criteria are as follows: Eighty-fifth percentile speed exceeds 33 mph or 66 percent the traffic exceeds the posted speed limit (normally 25 mph) or the average speed of vehicles in the top 15 percentile is 40 mph or greater.

Traffic Volumes

Speed humps should be installed only on streets classified as "local" streets. Such streets typically serve an average daily traffic volume of 3000 vehicles or less. Requests are occasionally received to install speed humps on streets classified as "local" but serving traffic volume indicative of a higher functional classification of street (nominally, above 3000 ADT). When considering such situations, the City must make a conscious policy decision. Is the street *really* a "local" street that is simply impacted by too much and too fast traffic? Then speed humps may be an appropriate response. Or is the street really fulfilling a necessary and appropriate collector function in the City's circulation network - in essence, is its designation as "local" a misclassification? In this latter case, the level of control speed humps exert is probably too restrictive and speed humps should not be used; the City might even consider upgrading the functional classification of the street in its next general plan review.

In allocation of community resources to implement speed humps, subject to the above consideration of nominal ceiling volume indicating service of more than "local" street function, streets with the highest volume and largest numbers of vehicles exceeding speed limits would tend to receive priority over streets with lower volumes and number of vehicles exceeding speed limits. However, no minimum volume threshold shall preclude speed humps being used in cases where low volume streets experience very high proportions of high speed incursions.

Traffic Safety

When installed for the purpose of addressing documented or anticipated vehicle or pedestrian accidents, the causes of those accidents should be susceptible to correction by speed control.

Proposed speed hump locations must be evaluated in the field to determine that such installations will not introduce increased accident potential for the subject street.

Vehicle Mix

Speed humps should not normally be installed on streets that carry significant volumes of long wheel-base vehicles unless there is a reasonable alternative route for those vehicles. (Typically, heavy or long-wheelbase vehicles constituting up to 5 percent of all traffic is considered normal; the heavy vehicle component would have to be well above five (5) percent of all traffic to be considered "significant" enough to refuse hump installation in a situation where speed humps would otherwise seem desirable or necessary). Special consideration of reasonableness of effects on heavy vehicles is also indicated in the anomalous situation where a significant generator of long wheel-base vehicle traffic is located with access and egress only from streets classified "local".

Bicyclists, motorcyclists, low-riders and operators of other types of special vehicles often consider speed humps annoying. However, nothing in the experience with speed humps to date indicates the speed humps constitute any type of unusual hazard or obstruction for these types of vehicles. Hence, possible presence of the vehicle types is **not** reason to deny approval of speed humps in circumstances where they would otherwise appear desirable or needed.

Emergency Vehicle Access

Speed humps should not be installed on streets that are defined or used as primary emergency vehicle access routes. Primary emergency vehicle routes are comprised of two types of streets:

1. Routes used by emergency vehicles to cross large parts of the community or on paths logically used to service large numbers of potential destinations. Routes of this type are generally on the City's designated circulation system of streets of collector level and higher. Hence, they are normally already ineligible for speed humps based on their functional classification.
2. Streets of generally local service character which happen to serve as the immediate egress route from an emergency vehicle dispatch point or immediate access route to a regular destination for emergency vehicles (such as where a fire station or a hospital emergency room access is located on a street classified "local"). Such circumstances will negate the eligibility of streets which would otherwise be eligible for speed humps.

The City has a duty to maintain a street system which reasonably allows for timely emergency service response. However, on local streets the City also has other compelling duties which may to some degree conflict with maintaining the streets in a manner to optimize emergency service response. Those duties include attempting to maintain local residential streets in a manner which will induce traffic behavior consistent with areas where child pedestrians in the street may be expected or to maintain the streets in a manner which induces traffic behavior assuring residents the quiet enjoyment of their homes secure from traffic impacts. On local residential streets which are **not** on primary emergency response routes, what is reasonable accommodation for timely emergency service response may be quite different from what is reasonable on the primary routes. In those circumstances, hump placement which causes minor potential increases

to emergency service response time affecting small numbers of properties would be acceptable. In fact, Portland's experimentation shows that all types of emergency vehicles including 85-foot aerial ladder trucks can safely cross 3 inch by 14 foot speed humps at speeds of at least 20 miles per hour, that rescue vehicles could tolerate speeds to 30 mph and that normal automobiles (such as police cars and battalion chief cars) could tolerate considerably faster speeds. The ability of fire vehicles to tolerate hump-crossing speeds of 20 mph is crucial since it implies a zero impact on response time; fire vehicles rarely if ever achieve speeds of 20 mph on the types of local access streets where speed humps would normally be employed.

The City will normally seek to identify and implement measures which offset the effects of neighborhood traffic management on emergency response and to avoid implementations where the cumulative effect of neighborhood traffic controls dramatically alters the actual delivery of emergency response.

Transit Routes

Speed humps generally should not be installed along streets with established conventional bus transit routes with normal service frequency. School transit, shuttle vans, para-transit vehicles and similar services and "tripper" routes of conventional transit are not included in this consideration because they can reasonably be expected to operate in the neighborhood environment at speeds where speed humps would not pose problems. In addition, many of these vehicles are not exceptionally long wheelbase vehicles. If speed humps are installed on conventional bus transit routes, or streets which serve a confluence of school transit routes, they should not have a height greater than 3 inches.

Citizen Support

Where speed humps are considered at citizen request, and the other factors described in these guidelines are complied with, a petition requesting humps signed by representatives of 60 percent of the properties in the primary impact zone of the speed humps shall be considered sufficient indication of community support for the City to act on the request (impact zone to be defined by the City staff on a case by case basis)

DESIGN AND CONSTRUCTION CONSIDERATIONS

Dimensions And Cross Sections

Figure II shows the profile of the parabolic speed hump to be employed in Redwood City. The 3 inch maximum height by 14 foot length profile is the desired profile with an acceptable construction variation tolerance of .25 inch (giving a hump range from 2.75 to 3.25 inch in maximum height). Speed humps in this height range are expected to cause crossing speeds of 20 to 25 mph.

Figure III shows details of hump taper at gutter lines. The gutter taper is specifically intended to maintain gutter drainage flows and not affect the downstroke of bicycle pedals on the tapered section.

Traffic Control

Speed humps will be accompanied by standard W 37 warning signs facing each direction of traffic placed generally adjacent to each hump (or slightly in advance if dictated by roadside features) and by standard W 37 advance warning signs placed in each approach direction at least 200 feet in advance of the first hump in a series (or a solo hump). The advance warning signs may be accompanied by a supplementary plate, either W 71 indicating length of section for a series of speed humps or W 34A indicating distance to a solo hump. A supplementary advisory speed plate (W 6) may be provided on the adjacent warning signs. Sign locations and supplementary plates will be as directed by the Transportation Manager. Figure III also illustrates details of hump warning and advance warning signs and supplementary plates.

The speed humps shall be marked with 12 inch reflective white stripes set parallel to the centerline tangent on 6-foot centers with the center-most stripes offset by 3 feet on centers from the centerline. The word message BUMP in eight (8) foot white reflective letters shall be placed fifty (50) feet in advance on each approach to each hump. Figure III provides further specification to these marking details.

Spacing And Location

Location and spacing of speed humps will be determined on a case by case basis by the City's Transportation Manager. In all except very unusual cases, speed humps intended to operate in series would be located no closer than 200 feet apart and no farther than 750 feet apart. Where unaffected by compounding locational factors, they would normally be located at least 275 feet apart and no farther than 550 feet apart within a single block. On short blocks (less than 500 feet in length), a single hump per block would be typical. Spacing and number of speed humps will vary substantially depending on absence or presence and type of control at intersections at the limits of and within the segment where speed humps are to be employed.

The first hump from either direction in a series should, if practical, be located in a position where it is least likely to be approached at very high speed. Possible placements to achieve this objective include putting the first hump in a system close to (but not less than) minimum safe stopping sight distance from an intersection, preferably a controlled one, close to minimum safe stopping sight distance of a small radius curve or at the top of a hill (rather than the middle or the bottom) where a lengthy downgrade is involved. Where solo speed humps are employed, a placement objective is to minimize the likelihood of a very high speed approach from either direction, usually leading to placement roughly at mid-block.

Maximum and minimum spacing criteria may be relaxed somewhat to conform to particular site conditions.

Installation Angle

Speed humps should be installed at a right angle to the centerline tangent of the roadway.

Utilities

Speed humps will not be located over utility manholes, gate valves, pull-boxes, access vaults or ventilation gratings or located immediately adjacent to fire hydrants.

Drainage And Roadway Edge Treatment

The specific hump cross-sections presented above provide edge treatment designed to maintain existing gutter flows. In ideal circumstances, speed humps would be located close downgrade from existing drainage inlets and locations immediately upgrade from inlets would be avoided. However, because the edge tapers are designed to maintain gutter flows, this consideration is subordinated to other locational criterion.

Speed humps should not be installed in the immediate vicinity of features designed for surface cross-drainage (dips) or where surface cross run-off flow is a known problem.

If speed humps are installed on roadways without vertical curb defining the edge of the traveled way, it may be necessary to consider measures to discourage drivers from attempting radical hump avoidance maneuvers outside the traveled way. Countermeasures include placement of the speed humps at points where existing roadside features like trees or utility poles are adjacent to the hump or placing bollards or delineators adjacent to the traveled way at the hump.

Coordination With Street Geometry And Adjacent Features

Speed humps will not be installed where on-site assessment of roadway geometrics finds that the proposed location constitutes a critical point in the roadway system, e.g., a severe combination of horizontal, vertical curvature and/or street cross-slope and/or complicating abutting use conditions or street features.

Intersections And Driveways

Speed humps should not be installed within an intersection or driveway. On approaches to intersections controlled by traffic signals, safe stopping distance separation should be maintained so that motorists preoccupied with hump crossing will still have time to perceive and react to changes in the signal indication.

Parking

Each hump installation will be evaluated individually for site specific considerations involving on-street parking. While speed humps should not normally be cause for on-street parking restrictions, such measures could be contemplated where parked vehicles seriously diminish the effectiveness of warning signing and markings or seriously compromise drainage flows at the speed humps.

Street Lighting

There is no requirement to provide special nighttime illumination of speed humps. However, where street lighting exists on streets being considered for speed humps, the speed humps will

be placed to take advantage of the available lighting unless other compelling location and spacing criteria make placement in the best illuminated areas unfeasible or impractical.

Construction Methods and Materials

Prior to hump construction, construct a wooden template/screed to the dimensions shown on the plans. Prior to placing AC, a tack coat, asphaltic emulsion SS-1 per Section 94 of the Caltrans Specifications shall be applied to all horizontal and vertical surfaces. Sweep clean the pavement of all soil and debris immediately prior to application of the tack coat. Apply the tack coat to existing pavement at a rate of 0.05 to 0.10 gallons per square yard of surface covered or as directed by the Engineer. Spread and compact asphalt concrete in accordance with Section 39 of the California Standard Specifications (1995) and the following requirements. Hand lay the asphalt concrete using the template/screed allowing for compaction (typically about 1/2 inch maximum). Asphalt concrete shall conform to section 39 of the California Standard Specifications and shall be 3/8 inch maximum fine graded. Construct the hump to the dimensions specified on Figures III and IV with a dimensional tolerance of ± 0.25 inch. Compaction of AC shall be equivalent to an 8 ton static roller. Apply the asphaltic emulsion SS-1 to all newly placed AC surfaces as a seal coat. Some communities require that the AC be placed in two lifts. Experience indicates that adequate conformance to design tolerance can be achieved in a single lift through use of the template/screed and reasonable diligence of workmanship and inspection. If the two lift method is used, separate templates should be constructed and used for each lift.

This policy and guideline was prepared by and for the City of Redwood City Community Development Services – Engineering and Construction in 1997.

ATTACHMENT N

REDWOOD CITY SPEED HUMP POLICY SUMMARY

Definitions

Speed hump: A raised pavement area for speed control purposes conforming to explicit engineering specifications for maximum height, profile and minimum length (in direction of vehicle travel). *Speed bump:* A raised pavement area for speed control purposes *not* conforming to recognized engineering specifications for *speed humps*; generally, more abrupt (higher and/or shorter) than *speed humps*.

Eligibility Conditions

| <u>Eligible For Humps</u> | <u>Ineligible/Questionable For Humps</u> |
|--|---|
| Persistent speed problem: 85 th %ile speed 33 mph or greater or 66% of all vehicles exceed 25 mph or average of top 15 %ile speeds observed is 40 mph or greater. | Speeds unremarkable: Criteria opposite not met. |
| Local access street. | Arterial or collector street. |
| Two-lane street. | Street with more than two lanes. |
| Street less than 40 feet wide. | Street wider than 40 feet. |
| Pavement quality satisfactory. | Pavement needs resurfacing/reconstruction. |
| Grades less than 5 percent in area of hump. | Grades greater than 5 percent or sustained downgrade present. |
| Straight and level or mild horizontal and/or vertical curves. | Horizontal curves of less than 300 foot centerline radius or vertical curves with less than safe stopping sight distance. |
| Streets posted 30 mph or less. | Streets posted 35 mph or more. |
| Low volume streets (generally below 3000 ADT). | Moderate to high volume streets (generally more than 3000 ADT). |
| Streets used by a relatively normal percentage of long wheelbased vehicles (trucks). | Streets used by an abnormally high percentage of long wheelbased vehicles. |
| Streets used occasionally by emergency vehicles operating at low to moderate speeds. | Streets used as primary emergency vehicle circulation routes. |
| Streets not used for frequent, regularly-scheduled public transit routes. Use by school transit, paratransit and infrequent conventional transit tripper service is acceptable.. | Regular frequently served conventional transit routes. |

Design And Construction Considerations

Maximum height: 3 inches, *Minimum length:* 14 feet. See profile detail on Figure III.

Signs and markings: See details per Figure IV.

Spacing: 200 feet to 750 feet; 275 to 550 feet desirable.

Location: 60 feet minimum from intersections; 200 foot sight distance desirable for isolated mid-block locations.

Drainage: Maintain gutter flows.

Illumination: Locate to take advantage of existing street lighting where feasible.

Appearance: Locate to minimize visibility of signs and markings from closest homes.

Avoid the following:

- Locations within intersections
- Locations at driveways
- Locations over utility manholes, gate valves, pull boxes, access vaults or ventilation gratings
- Locations at fire hydrants
- Locations immediately upgrade from drainage inlets.
- Locations at or adjacent to surface cross drains.