TRAFFIC CALMING GUIDE

FOR

NEIGHBORHOOD STREETS

Virginia Department of Transportation
Traffic Engineering Division
Richmond, Virginia

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TRAFFIC CALMING GUIDE FOR NEIGHBORHOOD STREETS

I. INTRODUCTION & OVERVIEW

The "Traffic Calming Guide for Neighborhood Streets" (hereafter referred to as The Guide) replaces VDOT's previous "Traffic Calming Guide for Local Residential Streets." The Guide provides guidance and procedures for a local community to pursue traffic calming in their neighborhoods on streets maintained by VDOT.

The purpose of traffic calming is to lower vehicle speeds on neighborhood streets without restricting access. Traffic calming measures may also alleviate other issues such as cut-through traffic or through-truck traffic, where motorists or truckers, use neighborhood streets to avoid and bypass other nearby roads. Where there are persistent issues with through-truck traffic the "Through truck Restriction" program provides a process for restricting such traffic, (see http://www.virginiadot.org/programs/is-VDOTCommunityPrograms.asp for more information).

The Guide reflects a restructured process where local residents of the community, the Home Owners Association (HOA) or the Civic Association (CA) initiate a request for traffic calming and study. County or Town staff (where traffic calming is taking place within a town) work with the local community to conduct the traffic calming process, working through the Board of Supervisors or the Town Council, as appropriate. VDOT's involvement focuses on confirming the appropriateness of the community efforts at critical points in the process and coordinating the implementation of the approved plan.

The Guide focuses on *existing* streets. Ideally, new residential developments would implement traffic calming concepts within the initial roadway design such as horizontal alignment shifts, narrower lanes etc. Various traffic calming measures in the Guide may be options as well. The design & review of development plans for new subdivisions should identify and address traffic management concerns and incorporate geometric designs and traffic calming concepts that make streets less desirable for speeding and cut-through traffic.

II. TRAFFIC CALMING –ROLES & PROCESS

Roles of Local Government, Community & VDOT

Local Government: County or Town staff (generally referred to as the Locality in the Guide) work with the local community and through the Board of Supervisors (BOS) or Town Council (where traffic calming is taking place within a town), to guide and implement the traffic calming process and plan development (Steps 1 – 6 in Figure 1).

VDOT: VDOT representatives confirm the eligibility and feasibility of streets proposed for traffic calming and the proposed traffic calming plan and; coordinates

implementation as appropriate (Steps 1, 3, 4, 7 and 8 in Figure 1). In Fairfax, Prince William, and Loudoun Counties, the Northern Virginia District Traffic Engineer's (DTE) office is the primary liaison for traffic calming. For all other areas of the state, the local Resident Engineer/Administrator (RA) is the primary liaison to the community for traffic calming; and coordinates with the DTE's office as appropriate for the various processes.

The Traffic Calming Process

The process for traffic calming is below (see Figure 1) with the details for each step laid out on the subsequent pages.

FIGURE 1 - THE TRAFFIC CALMING PROCESS



Step 1: Initial Contact & Review

To begin a traffic-calming project, local community members contact the BOS or the Town Council. The Locality confirms with VDOT that the street proposed for traffic calming meet the basic eligibility requirements for VDOT's traffic calming program, which are:

1. Street is in the state system of highways owned and maintained by VDOT.
2. Street is within a neighborhood setting where the residences and businesses face the street rather than reverse-frontage (where houses along a street do not face or generally have access to the street). A typical neighborhood street for traffic calming is a secondary road within a subdivision with a high density of residences and a functional classification of "local".
3. Street has a posted speed limit of 25 mph or less. Unposted, residential streets such as within a subdivision generally have a statutory speed limit of 25 mph however; the applicable speed limit must be confirmed with VDOT.

Step 2: Traffic Calming Study Request

After confirming the street meets the basic eligibility requirements for traffic calming, the Home Owners Association (HOA) or Civic Association (CA) gets approval from the Board of Supervisors or the Town Council to pursue traffic calming on the proposed street, conduct an engineering review and pursue a traffic calming study. If there is not an HOA or CA a minimum of 10 residents (or 10% of residents) along the street may secure approval from the BOS. Upon agreement by the Board of Supervisors or the Town Council to pursue traffic calming on the requested street, they proceed to Step 3.

Step 3: Engineering study/review

The Locality conducts an engineering review, speed study and traffic count as follows to determine if the street is suitable for traffic calming and document important related features.

i. An engineering field review determines the suitability of the street for traffic calming considering the extent of horizontal curves and grades and any related sight distance issues, roadway drainage appurtenances, extent and location of road access points etc. that may affect the location, extent and type of traffic calming implemented.
ii. A speed study determines the operating speed (typically via the 85th percentile method). In order to be eligible for further consideration of traffic calming the street must have an operating speed 10 mph or more above the speed limit (e.g. 35 mph or more where the speed limit is 25 mph) in at least one travel direction.
iii. The level of traffic determines the type & extent of traffic calming considered. A traffic count is conducted to determine the average daily traffic (ADT) volume including both travel directions. A traffic count conducted for a period of 48-hours, on a Wednesday and Thursday is the common practice in order to capture the

average daily traffic. Traffic counts on other days of the week are more likely to represent non-typical traffic, particularly weekends.

- Streets with a daily traffic volume between 600 and 4,000 vehicles per day (VPD) are appropriate for consideration of the full range of traffic calming measures in the Guide.
- Streets with less than 600 VPD may be a consideration for some of the lower cost non-intrusive actions such as community education and the Additional $200 Fine Signs. Other non-intrusive options can be quite costly such as community gateways, pavement marking schemes (depending on the type/extent of markings) and speed display signs.
- Where traffic volumes on the study street exceed 4,000 VPD the Additional $200 Fine Signs or Speed Display signs can be used under the specific programs for those signs, outside the traffic calming program (see pp. 16-17). Some of the measures in the Guide can likewise be used on higher volume roads and may be options to pursue outside the traffic calming program as well. These are Corner Extension/Bulbouts, Chokers, Median Islands, On-Street Parking and Road Diets.

VDOT reviews the study results, confirms the appropriateness of the street for traffic calming and notes any items or limitations etc. that should be considered in developing the traffic calming plan.

Step 4: Traffic Calming Plan Development

The Locality, in coordination and consultation with VDOT, next develops a conceptual traffic calming plan following the requirements and considerations laid out in APPENDIX I: Development & Implementation of the Traffic Calming Plan. This section lays out the various considerations for the selection, location, installation, operation and maintenance aspects of the various traffic calming devices.

Agreement must be secured for each affected property owner of a residence or business where the physical location of a proposed traffic calming device or some portion (excluding warning signs posted for a device) lies within the roadway frontage of the property boundary. Note: the affected property owner may agree to the device affecting their property without agreeing with the entire traffic calming plan. Where a particular property owner does not concur with a particular device as it affects their property, other options such as shifting the location or proposing an alternate device should be considered.

Step 5: Community Support / Approval

Prior to soliciting community approval, the Locality identifies the survey area, coordinating with the local community, HOA, CA the District Supervisor's or Town Council and VDOT. The survey area comprises (i) residences and businesses on the street identified for traffic calming and (ii) residences and businesses on other streets

whose sole or primary access is the street identified for traffic calming and who would be considerably inconvenienced if they chose an alternate route.
The proposed traffic calming plan, along with the supporting information below, is presented or provided to the community within the survey area for their review for a sufficient period of time (a minimum of 30 days is suggested). This may be through a public meeting(s) and/or electronic/postal distribution, or some other means or combination thereof that serves to inform the community of the proposal.

Supporting Information:

(i) A map that that indicates the location and approximate footprint of the proposed traffic calming devices along the street and the affected property boundaries.
(ii) A map that indicates the survey area including residences, businesses and the connecting streets.
(iii) Information about the nature and features of the proposed traffic-calming devices such as contained in the Guide.
(iv) The process and procedures that will be used to measure and document community support (e.g. petition, ballot survey etc.).

To measure and document community support the Locality conducts a petition, survey, or other process that ensures the accurate measure and documentation of support.

The measure and documentation of support shall hold to the following:

- Only occupied residences or businesses in the survey area are included/counted in measuring and documenting community support (e.g. signing a petition for traffic calming, cast a ballot/vote etc.).
- Each residence or business address gets a single signature or ballot/vote etc. to indicate agreement or disagreement with the entire plan.
- More than 50% of the occupied residences or businesses in the survey area must support the traffic calming plan in order for the plan to be implemented.

Step 6: County Board of Supervisors or Town Council Endorsement

Upon approval by the community of the proposed plan, the BOS or Town Council endorses the plan by a resolution**.** The resolution should state the following:

(i) The proposed Traffic Calming Plan was properly presented to the community in the affected survey area for their review and consideration
(ii) The plan was subsequently approved by (indicate percentage) of the occupied residences and businesses within the appropriate surveyed area
(iii) The intended source of funding (e.g. 50% secondary highway funds, 50% local funds).

The resolution and traffic calming plan is then conveyed to VDOT along with the following related documentation:

(i) The engineering study/review
(ii) A map depicting the streets and residences identified as part of the survey area
(iii) A description of the method used to measure and document community support (e.g. petition, survey etc.)
(iv) The survey documents and a summary of the survey results including the number of residences and businesses in the survey area and the number/percentage that support the proposed plan.

Step 7: Consideration for Implementation –VDOT

After reviewing and confirming the proposed plan, BOS resolution and survey results, VDOT will consider implementation of the traffic calming plan through VDOT contract forces or the Locality. The implementation of the plan by VDOT forces is dependent on their funding priorities and availability of resources, materials and equipment. Preferably, the Locality will implement the traffic calming plan where such an arrangement is acceptable to VDOT.

Funding

Secondary or locality-provided funds are the primary sources for funding. The Locality should consult with the BOS and the local VDOT residency office to determine use of appropriate funds. Note that streets subject to VDOT's Secondary Street Acceptance Requirements (SSAR) - generally, those subdivision streets where plats and plans were submitted to the local government and VDOT on or after July 1, 2009 - are not eligible for VDOT funds on any portion of the street width that exceeds that specified in Appendix B (1) of VDOT's Road Design Manual. To illustrate, on a subdivision street 36 feet wide where a minimum street width of only 29 feet is required by the SSAR standards VDOT funds for the cost of materials, construction and maintenance may only be applied for 29 feet of the total 36 feet width or 80 ½ % of the total cost. The remaining 19 ½ % of construction and maintenance costs must be funded entirely by the locality.

Step 8: Evaluation -VDOT

Following construction of the traffic calming plan, VDOT will review the installation and the related traffic control devices to ensure that there is no safety, operational, or maintenance issue.

Subsequent to installation (after 3 months is suggested), a follow-up review may be conducted to evaluate the effectiveness of the traffic calming measures in reducing the operating speeds or any safety issues etc. VDOT may wish to disseminate any findings

and recommendations from such reviews through the Board of Supervisors in order to obtain feedback from those involved in the plan development.

Modification of Installed Traffic Calming Devices

Where a safety, maintenance, or operational issue arises following installation of a traffic calming device(s) VDOT or the Locality (where they installed the devices) may adjust, relocate or remove the relevant traffic calming device(s) as necessary to address the issue, with the same funding sources used to install the devices originally. The Locality must confirm the issue and any proposed changes with VDOT prior to their adjusting, relocating or removing a traffic calming device(s).

Where the Locality proposes to adjust, relocate or remove a traffic calming device(s) for other than a safety, operational, or maintenance issue they must use their secondary or local funds, secure (re)approval of the affected residents and likewise confirm the proposed changes with VDOT.

III. TRAFFIC CALMING MEASURES

The traffic calming devices included in The Guide are characterized as Non-Intrusive or Vertical, Horizontal and Narrowing devices and are discussed on the following pages.

1. Non-Intrusive Traffic Calming Devices

Non-intrusive measures include administrative measures such as a public information campaign, posting certain types of signs to promote speed reduction, and utilizing pavement markings to reduce the number of lanes and/or pavement travelway widths. The additional pavement width available through the various reductions can be reallocated for parking lanes, bike lanes, or sidewalks etc.

The Non-intrusive devices offer the advantage that they do not physically constrain vehicle maneuvers and thus are less invasive. This is particularly desirable for streets that serve as major emergency and bus routes. Other desirable aspects of the non-intrusive devices are that they involve standard signs and pavement markings easily recognized by motorists and; can generally be less costly overall than the vertical, horizontal and narrowing measures.

However, some non-intrusive applications are not as effective because they do not physically constrain vehicles to reduce speed.

The following describes the features of the Non-intrusive devices regarding their placement, advantages/disadvantages, effectiveness and costs. The non-intrusive measures included in the Guide are Community Education, Community Gateways, Pavement marking measures, Speed Display Signs and Additional $ 200 Fine signs.

Non-Intrusive Devices -Community Education

Informing and reminding the community of speeding issues and concerns and the importance of driving safely in their neighborhood is an important step. Various resources and literature are available to inform the community on these various issues. The Virginia Department of Motor Vehicles (DMV) has considerable literature and information on all aspects of safety including speeding and aggressive driving, school bus safety, bicyclists, pedestrians, teen drivers, mature drivers etc. which can serve to educate both motorists and pedestrians/bicyclists alike and raise the overall awareness of safety. See DMV's site at https://www.dmv.virginia.gov/safety/#programs/index.asp for this information.

Similarly, the "Virginia 2017-2021 Strategic Safety Highway Safety Plan" available at http://www.virginiadot.org/info/resources/SHSP/VA_2017_SHSP_Final_complete.pdf provides extensive information on aspects of safety related to speeding and pedestrians in Virginia and strategic efforts to address these issues.
VDOT's "Bicycling and Walking in Virginia" web page at http://www.virginiadot.org/programs/bikeped/default.asp covers the safety and legal aspects of bicyclists and pedestrians in Virginia.

Non-Intrusive Devices -Community Gateways

Figure 1.1 – Community Gateway



Figure 1.2 - Community Gateway



Description

Community Gateway treatments involve the combined use of sign installations, landscaping, textured pavements, name plates, monuments, or other arrangements placed at the entrance to a neighborhood to communicate a sense of neighborhood identity. The installations serve to inform motorists they are entering a community where there is a significant change in the driving environment such as a transition from a rural or urban road a residential street.

Note: Funds for landscaping-related items for a gateway treatment may be limited to a minimal percentage of the construction funds budgeted for a proposed traffic calming plan with the remaining funds required provided by the locality. In addition, the neighborhood association or other community group would be solely responsible for ongoing maintenance of landscaping-related items.

Placement

The gateway is placed at the entrance or “gateway” to the community at a prominent location and should be large enough to attract the attention of motorists and to effectively communicate they are entering the neighborhood or community.

Advantages:

Provides an attractive addition to a community.

Disadvantages

- Generally, requires ongoing maintenance such as painting, renewing and watering the vegetation or possibly repairs. The neighborhood association or other community group would be responsible for maintaining these installations.

Effectiveness

FHWA (Federal Highway Administration “Engineering Countermeasures to Reduce Speeds” –see references) indicates an average reduction in operating speeds of about 2 mph.

Cost

The cost of gateways varies significantly according to the features included and the extent of the construction.

Non-Intrusive Devices -Pavement Markings

Figure 2.1 –Pavement Marking Options

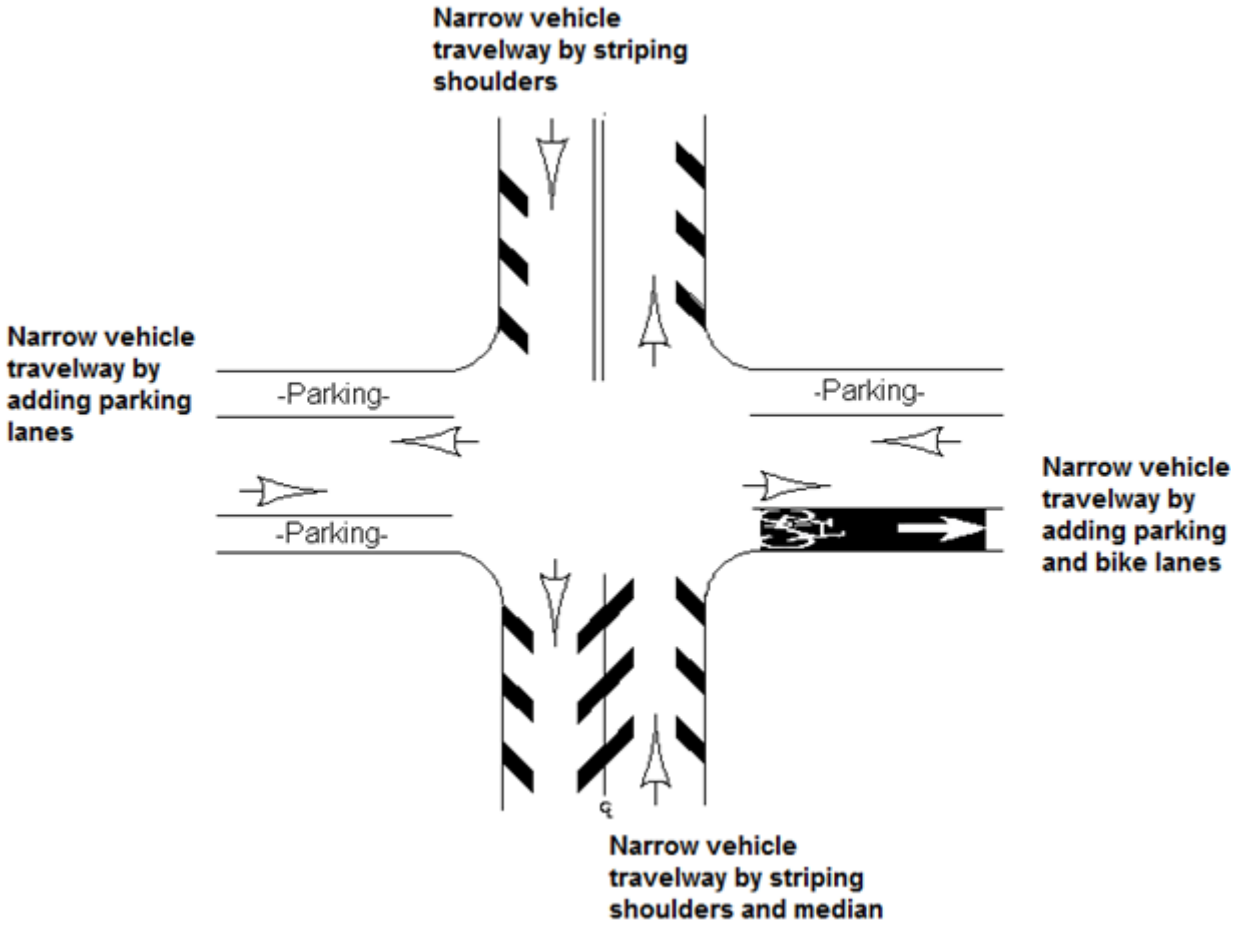


Figure 2.2 –Narrow travelway by re-striping pavement



Figure 2.3 - Narrow travelway by re-striping to add parallel parking lanes



Figure 2.4 – Narrow travelway by re-striping pavement for a bike lane



Description

The **pavement marking** options are used in various ways to narrow the vehicle travel lanes, which tends to make motorists drive slower. These include striping the shoulder and/or centerline to narrow the travel lanes (per north and south legs of intersection in Figure 2.1) or adding parking and/or bicycle lanes (per east and west legs of intersection in Figure 2.1 and depicted in Figure's 2.2 – 2.4). The addition of parking to narrow the travelway (particularly parallel parking) can have a pronounced effect on speed, particularly on a narrow two-way street with parking on both sides where parked vehicles occupy one-half or more of the block. One option when adding parking lanes is to alternate parking along opposite sides of the street which introduces a physical change in the straight vista of a roadway, similar to that of a chicane (discussed further on) to promote reduced speeds.
"Road diets" likewise incorporate markings to narrow and/or eliminate travel lanes although the common application (conversion of a high traffic, undivided four-lane roadway to a three-lane roadway with two through lanes and a center two-way left-turn lane) is not relevant on a typical neighborhood street, the focus of the Guide.

Note: On local streets, bicyclists are considered a normal part of the vehicle mix and do not necessarily require a marked or designated bike lane which is more appropriate on

collector roads and where they connect to a network of bike lanes on streets identified in a local and/or regional Bicycle Plan.

Placement

The desired features (e.g. add bike lanes and/or parking etc.) and available pavement width as well as the allowable minimum travelway widths (see Appendix I –Selection of Measures), dictates the type of pavement striping and its location.

Advantages

- Does not physically restrict driver maneuvers and thus will not impose speed reductions on emergency and transit vehicles
- Involves a standard traffic control device easily recognizable by motorists
- Can be less costly to implement than some of the other devices depending on thee type and extent of application

Disadvantages

Restriping the pavement involves considerably more effort where significant eradication of existing pavement markings is required. Therefore, where this is the case it is recommended that this measure is implemented in conjunction with a re-paving project.

Effectiveness

FHWA suggests a reduction between 1 and 5 mph (a reduction of 2 to 3 mph being the most common) where parallel parking is added to narrow the travelway and a reduction of ½ mph where shoulder markings are used to narrow the travel lane.

Cost

An estimated cost of $5 per linear foot of pavement marking/striping, including eradication of existing markings and maintenance of traffic, is suggested. Special symbols such as bicycle emblem on a bike lane are approximately $300 each.

Non-Intrusive Devices -Pole Mounted Speed Display (PMSD) Sign

Figure 3.1 –Pole Mounted Speed Display Sign



Description

A **Pole Mounted Speed Display (PMSD) Sign** combines the regulatory speed limit sign with a radar speed feedback sign that displays the real-time speed of an approaching vehicle which tends to make motorists reduce their speed.

Placement

Signs are installed only on streets with a single through-travel lane per travel direction (e.g. a two-lane, two-way or one-lane, one-way street). Generally, one sign is placed at the beginning of the street section identified for traffic calming in each travel direction, in order to reinforce the posted speed limit for vehicles entering the section of street designated for traffic calming. At least 200 feet of visibility distance should be allowed approaching the sign and at least 100 feet between any other signs.

Advantages

- These signs can potentially be used as a portable assembly that allows for placement at alternating locations.

- Does not physically restrict driver maneuvers and thus will not impose speed reductions on emergency and transit vehicles.
- Involves a standard traffic control device easily recognizable by motorists.

Disadvantages

Installing these signs may be impacted by the availability of a power source.

Effectiveness

Various sources indicate an average sustained reduction in operating speeds of 5 mph may be achieved.

Cost

An estimated cost of $7,500 per installation is suggested, depending on whether solar or conventional power is used as well as the proximity of the power source.

Non-Intrusive Devices -Additional $200 Fine Signs

FIGURE 4.1 –Additional $200 Fine Sign



Description

The **Additional $200 Fine Signs**, when properly implemented and posted on a residential street, impose a $200 fine for speeding in addition to the typical fine. These signs must follow the requirements of VDOT's policy (see http://www.virginiadot.org/programs/resources/FINAL_POLICY_ADDL_FINE_June_17_1999.pdf) which requires a formal acceptance process including a request by resolution of the local governing body for the signs, verification that there is a speeding problem and that the increased penalty has community support. The full requirements are met for these signs when identified and approved for traffic calming per the Guide.

Placement

These signs are installed in conjunction with the posted speed limit sign and are placed at the beginning of the roadway section in each travel direction where the higher fines will apply. At least 200 feet of visibility distance should be provided approaching the sign and at least 100 feet between any other signs.

Advantages

- Does not physically restrict driver maneuvers and thus will not impose speed reductions on emergency and transit vehicles.
- Involves a standard traffic control device easily recognizable by motorists.

Disadvantages

The effectiveness of these signs in reducing vehicles speeds is unknown.

Effectiveness

The effectiveness of these signs is unknown.

Cost

The estimated cost for installing these signs, which consists of producing and installing the posted speed limit sign and the supplemental "Additional $200 Fine" plaque, is $750 per sign. The minimum estimated cost to install these signs on a street designated for the additional $200 fines is $3,000 (a total of four signs, two per travel direction indicating the beginning and ending of the additional fine street section).

2. Vertical, Horizontal and Narrowing Devices

These are traffic calming devices constructed and installed on the street pavement surface to narrow the travelway or create vertical or horizontal shifts on the roadway. These devices can be particularly effective in slowing vehicles because they physically

constrain vehicles to pass over, through or around physical obstructions on the roadway.

Vertical, Horizontal, and Narrowing devices can also significantly affect emergency response (as well as transit) times; from three to ten seconds per device depending on the type of device and the vehicle traversing it; with the delay compounded by multiple devices.

Although neighborhood streets do not generally serve as primary emergency or transit routes, streets in close proximity to Fire/Rescue services and hospitals etc. or identified by the local Fire & Rescue Chief as having significant usage by their fire and rescue vehicles should use non-intrusive devices and speed lumps to minimize impacts for emergency vehicles. Similarly, streets on major (large bus) transit routes or that experience significant use by such vehicles should consider use of non-intrusive devices and speed lumps.

Some of the vertical, horizontal and narrowing devices such as speed humps can also affect bicyclists, and may introduce additional maintenance costs and considerations, particularly the horizontal, narrowing devices, which can create drainage issues if not appropriately located and constructed.

A disadvantage of the vertical devices is increased noise to nearby residents when vehicles, particularly large trucks pass over the devices particularly speed humps (and speed lumps for passenger vehicles).

Observations also show that the vertical devices generally reduce traffic volumes by an average of 20 percent when installed as part of a series. The horizontal measures generally have little effect on traffic volumes.

The following describes the features of the vertical, horizontal and narrowing devices regarding their placement, advantages/disadvantages, effectiveness and cost. The vertical, horizontal and narrowing devices included in the Guide are Speed Humps, Speed Lumps, Speed Tables, Raised Intersections, Raised Crosswalks, Median Islands, Crosswalk Refuges, Chicanes, Chokers and Curb Extensions.

Vertical Devices –Speed Hump

FIGURE 5.1 –Speed Hump



Description

A **Speed Hump** is a vertical device with a raised parabolic shaped area in the roadway, extending across the road at right angles to the traffic. The raised surface is higher, and occurs over a shorter travel distance than for other vertical devices. Speed humps are the most commonly used traffic calming devices.

Placement

Speed humps are placed at mid-block.

Advantages

Speed Humps are among the most recognizable traffic calming devices, which may promote a quicker response by motorists to reduce their speed.

Disadvantages

- Increases noise to nearby residents as vehicles pass over the device (particularly larger trucks)
- Impedes bicyclists
- Impacts travel times of emergency vehicles and transit (buses)

Effectiveness

FHWA & ITE (Institute of Transportation Engineers “Traffic Engineering Handbook, Sixth Edition”–see references) indicate an average reduction in operating speeds of 5 - 8 mph.

Cost

The estimated cost for a speed hump is approximately $2,000 depending on drainage conditions and materials used.

Vertical Devices –Speed Lump

FIGURE 6.1 –Speed Lump



FIGURE 6.2 –Speed Lump



Description

A **Speed Lump** is a modified Speed Hump where openings are added to accommodate emergency or other large vehicles to utilize the openings without traversing over the raised portion to minimize speed reduction. However, the sizing of the lumps ensures that passenger vehicles cannot likewise avoid traveling over at least one set of lumps.

Placement

Speed lumps are placed at mid-block.

Advantages

- Allows emergency vehicles and buses to traverse the device without reducing speed by utilizing the openings provided for those particular vehicles.
- Produces less noise than speed humps for emergency or other large vehicles.
- Speed lumps are more accommodating for bicyclists than speed humps, as bicyclists can utilize the openings to traverse the device.

Disadvantages

- These devices likewise increase noise to nearby residents for passenger vehicles.
- May encourage passenger vehicles to cross into the opposing lane in an attempt to straddle the humps provided for emergency vehicles. Providing a centerline stripe approaching the speed lump in each travel direction may discourage this.

Effectiveness

ITE & FHWA data indicate an average reduction in operating speeds of 5 - 7 mph.

Cost

The estimated cost for a speed lump is similar to a speed hump; approximately $2,000 depending on drainage conditions and materials used.

Vertical Devices – Speed Table

Figure 7.1 - Speed Table



Figure 7.2 – Speed Table



Description

Speed Tables are similar to speed humps except they incorporate a flat “table” and thus provide an overall gentler transition than the speed hump. The top “flat area’ is sized to accommodate the most typical vehicle wheelbase (usually a passenger car) entirely on the top, but can be extended to accommodate other vehicles if desired.

Placement

Speed tables are placed at mid-block.

Advantages

Provides a more moderate vertical transition for crossing vehicles and therefore motorists experience less discomfort than when driving over speed humps or lumps.

Disadvantages

These devices likewise increase noise to nearby residents as vehicles pass over the device although to a lesser extent than speed humps.

Effectiveness

ITE & FHWA indicate an average reduction in operating speeds of about 6 – 9 mph for tables with the dimensions used in the Guide (22 feet wide in the direction of travel). For longer tables ITE indicates a speed reduction of about 4 mph.

Cost:

The estimated cost for a speed table ranges from $5,000–$15,000 depending on drainage conditions and the materials used.

Vertical Devices – Raised intersections

Figure 8.1 – Raised Intersection



Description

Raised intersections incorporate a speed table concept by encompassing the entire area of the intersection (see Figure 8.1) and thus provide traffic calming on all connecting streets. A larger vehicle typically crosses a raised intersection at a lower speed than a passenger car. A typical delay through a raised intersection for a large commercial vehicle is 2 - 6 seconds.

Placement

By definition, these devices are located at the intersection of two or more streets where the top, flat or “table” area covers the area of the intersection.

Advantages

- Raised intersections can be visually attractive
- Cans serve as a Gateway treatment as well
- Provides traffic calming on all connecting streets at the intersection.
- The typically longer dimensions provide a smoother transition than speed tables so drivers feel less discomfort.

Disadvantages

- Raised intersections have a significantly higher cost.
- The data indicates they have less reduction on vehicle speeds
- These devices likewise increase noise to nearby residents as vehicles cross over.

Effectiveness

FHWA & ITE indicate an average reduction in operating speeds of about 0.3 - 1 mph.

Cost:

The cost for a raised intersection can range from an estimated $25,000 to $70,000 depending on the number and width of the streets at the intersection to be raised.

Vertical Devices –Raised Crosswalk

Figure 9.1 - Raised Crosswalk



Description

A **Raised Crosswalk** is identical to a speed table (see Figure 13 below), except it utilizes the top, flat surface to provide a marked pedestrian crossing.

Placement

A raised crosswalk is located at mid-block (not recommended at intersections) where there is an existing, marked crosswalk or where one is warranted. New crosswalk locations require an engineering study and must be approved by VDOT.

Advantages

- Provides improved visibility and safety for pedestrians.
- Enhances the pedestrian environment at pedestrian crossing.
- Can increase the number of motorists yielding to pedestrians crossing at the raised device

Disadvantages

None noted.

Effectiveness

As their design is identical to speed tables, presumably they have similar speed reductions of 6 – 9 mph.

Cost

The estimated costs for a raised crosswalk is approximately $5,000 - $7,000, depending on drainage conditions and the type of materials used.

Horizontal Devices – Chicane

Figure 12.1 – Chicane (Single lane, One-way travel)



Figure 12.2 – Chicane (Two-way travel)



Figure 12.3 – Chicane (Two-way travel)



Description

Chicanes are adjacent to the curb on alternating sides of the street in sets of three in order to introduce an S-shape travel path on a straight section of street that compels vehicles to slow down in order to negotiate the curved section.

Placement

These devices are at mid-block with a median or other non-traversable barrier to separate travel in each direction through the chicane. Note: With no physical separation between the travel directions drivers tend to cross the centerline to make their travel path as smooth as possible through the chicane, particularly an issue when there is a vehicle approaching in the opposing lane who may be doing the same. This cross-centerline behavior is a potential safety concern and contributes to a general ineffectiveness of the device in terms of speed reduction.

The appropriate applications of chicanes are in Figures 12.1 – 12.3. In Figure 12.1, the travel directions are separated by a raised median and in Figures 12.2 and 12.3 the travel directions are separated in the vicinity of the chicane by a median island.

The spacing and travelway width between the chicanes can vary to promote a greater or lesser vehicle speed reduction. Closer spaced constructions and narrower travelway widths promote a greater reduction in speeds.

Advantages

Provides for adding greenery and thus enhance the attractiveness of the street.

Disadvantages

- Narrows travel-way for bicyclists and creates some loss of parking.
- Presents a fixed object within the travel-way that may be struck by vehicles especially snow plows etc.

Effectiveness

FHWA indicates an average reduction in operating speeds of 3 to 9 mph.

Cost

An estimated cost for asphalt chicanes of $10,000 (for a set of three chicanes) is suggested and $16,000 for a concrete set of three. Drainage issues may be the most significant cost consideration.

Narrowing Devices –Median Island

Figure 10.1 - Median Island



Description

A **Median Island** involves placement of a raised island in the middle of the roadway in order to narrow the vehicle travel lanes.

Placement

This device is generally located at mid-block but can also serve as a gateway treatment when located at the entrance to a community.

Advantages

Provides dual use, as both a narrowing device and a gateway, when placed at the entrance to a community.

Disadvantages

- Narrows travel-way for bicyclists.
- Presents a fixed object within the travel-way that vehicles may strike, especially snow plows, etc.

Effectiveness

FHWA indicates an average reduction in operating speeds of about 4 mph.

Cost

The estimated costs range from $6,000 - $9,000 per island.

Narrowing Devices –Crosswalk Refuge

Figure 11.1 –Crosswalk Refuge



Figure 11.2 - Crosswalk Refuge –Offset "Z"-option



Description

A **Crosswalk Refuge** is similar to a raised median (see previous "raised median" device) but with a cut etc. provided to provide refuge for pedestrians. The optional "**Z**" design utilizes an offset on either side of the median (see Figure 10-2) which points pedestrian to (and thus better observe) oncoming vehicles which improves the safety of crossing. Either design could also incorporate a raised crosswalk.

Placement

A crosswalk refuge is placed at an existing, marked crosswalk or where one is warranted. New crosswalks require an engineering study and must be approved by VDOT. Crosswalk refuges are desirable where vehicle speeds or the required crossing distance do not provide sufficient time for pedestrians to cross the street in a single movement.

Advantages

Provides additional safety in comparison to the standard crosswalk refuge, especially where there is no signal control such as at mid-block and T-intersection locations. In addition to providing a mid-block refuge for pedestrians so that they do not have to traverse the entire street, the "Z"-option crosswalk compels pedestrians to face, and

thus more likely to be aware of approaching traffic before crossing the remaining section of the street, which may improve safety.

Disadvantages

- Narrows travel-way for bicyclists.
- Presents a fixed object within the travel-way that vehicles may strike, especially snow plows, etc.

Effectiveness

Although data specific to a crosswalk refuge was not found, as they are identical to median islands, presumably they would experience similar speed reductions (e.g. 4 mph, see previous).

Cost:

The estimated cost for installing a raised concrete pedestrian refuge island (with landscaping) is about $10,000 to $30,000. The cost is less for an asphalt island or one without landscaping.

Narrowing Devices – Choker

Figure 13.1 – 2-Lane, 2-Way Choker



Figure 13.2 –1-Lane, 1-Way Choker



Description

A **Choker** is constructed at mid-block or as a curb extension to reduce the width of the travelway and serves to accommodate parking downstream of the device.

Placement

Chokers are located at mid-block. When located at an intersection they are considered curb extensions or bulb-outs (discussed on following page).

Advantages

Provides protection for parking which increases safety for pedestrians as well as vehicles when entering and exiting the parking area.

Disadvantages

- Narrows travel-way for bicyclists and creates some loss of parking.
- Presents a fixed object within the travel-way that may be struck by vehicles especially snow plows etc.

Effectiveness

FHWA data indicates an average reduction in operating speeds of 1 - 4 mph.

Cost

An estimated cost per set of chokers of $5,000-$20,000 (including landscaping) is suggested, depending on site conditions and the extent of landscaping.

Narrowing Devices – Curb Extension (bulb-out)

Figure 14.1 –Curb Extension (Neckdown)



Description

Curb extensions, also known as corner extensions or bulb-outs are used where there is on-street parking. They primarily serve to protect parking and enhance the safety of pedestrian crossings at an intersection by narrowing the roadway section, which in turn shortens pedestrian crossing distance and time. They also reduce the speeds of turning vehicles thereby increasing pedestrian visibility. When placed at mid-block they are considered chokers).

Placement

At an intersection, with any number of legs and may be applied on any or all approach legs.

Advantages

Shortens crossing distances for pedestrians, which increases safety and provides parking protection downstream with the goal of decreasing vehicle speeds as well.

Disadvantages

Requires additional considerations for accommodation of bus routes and bicycle lanes.

Effectiveness

FHWA data indicates an increase of vehicle speeds of 1 - 3 mph however; they can reduce the turning speeds of vehicles by 6-8 mph.

Cost

An estimated cost of $2,000 to $20,000 per corner is suggested, depending on design and site conditions where the accommodation of drainage is usually the most significant cost.

IV. COMBINED MEASURES

Combining one or more traffic calming devices can enhance aesthetics and may also produce a greater speed reduction. For example, FHWA indicates that when a speed hump is combined with a choker the average speed reduction is 13 mph (vs. 9 mph for a speed hump or 4 mph for a choker).

See FHWA's "Engineering Countermeasures for Reducing Speeds" at https://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/ for various other combinations that may be considered.

V. TRAFFIC CALMING MEASURES NOT INCLUDED IN THE GUIDE

A number of other measures were considered and were either ruled out as a traffic calming device altogether or not recommended due to cost, ineffectiveness etc. These are: (1) Stop Signs (2) Enforcement (3) devices that restrict traffic (4) Speed Reduction Markings (5) Zigzag pavement markings (6) In-Roadway Warning Lights (7) Roundabouts (8) Traffic Circles.

1. Stop Signs are not intended for use as traffic calming devices. Numerous studies show that unwarranted stop signs actually increase speeding on residential streets,

where motorists tend to proceed through a stop without stopping in an attempt to make up lost time for stops they perceive as unnecessary. Thus, safety for pedestrians, especially for small children is compromised due to their expectation that vehicles will stop as required when in reality they may not.

2. Although systematic enforcement of speed limits is a traditional and effective approach to reduce speeding experience indicates that it is unreasonable to expect that enforcing speed limits on low volume residential streets will be a priority of local enforcement agencies. Therefore, this is not a sustainable measure.

3. Full or half-closures, diagonal diverters and forced turn islands (including forced right-turns) are not desirable speed reduction measures as they restrict traffic. These options are more applicable to restrict Cut-Through traffic and are available under VDOT's Cut-Through Traffic program.

4. Speed reduction markings are transverse markings placed on both edges of the roadway in a pattern of progressively reduced spacing to create the illusion of traveling faster and thus prompting motorists to reduce speed. However, per the MUTCD they are not suitable on long, straight sections of roadway or; areas primarily frequented by local drivers, the typical conditions where traffic calming is most likely to be implemented. Therefore, they are not as effective and so are not included in the Guide as a traffic calming measure.

5. Zigzag pavement markings involve lines painted on the pavement in a zig-zag pattern (see Figure 16.1) that serve to raise driver's awareness of an approaching crossing with pedestrians and bicyclists and to promote a reduction of vehicle speeds. Although they have a modest cost and appear to be effective in producing a sustained reduction in vehicles speeds they have not been incorporated into the MUTCD and are considered experimental in nature. The U.S. Federal Highway Administration approved their use on an experimental basis in Virginia. A one-year study found both heightened awareness of the crossing by approaching motorists and a sustained speed reduction however, the extent to which speeds reduced is not clear. See report at http://www.virginiadot.org/vtrc/main/online_reports/pdf/11-r9.pdf for further details. It is also not clear if these markings would be effective on neighborhood streets where speeds are lower and are primarily frequented by local drivers

6. In-Roadway Warning Lights involve beacons placed in the roadway surface at a marked crosswalk that flash (either automatically or manually) when a pedestrian is crossing the street and is within the crosswalk to provide additional warning to motorists. Although these devices increase driver awareness of pedestrians when device is operating properly however, when this is not the case they create a false sense of security for pedestrians and approaching motorists as well. Additionally, the devices are costly to install and maintain, have a high failure rate, and pose potential liability issues if not maintained.

7. Although roundabouts have many well-known benefits they are not generally considered traffic calming devices per se -the cost and extent of effort to implement a roundabout (including mini-roundabouts) does not generally fit within the intended scope and budget for traffic calming on a neighborhood street. However, where appropriate a roundabout can be sought outside the traffic calming program.

8. Traffic Circles were not included in the Guide due to VDOT's past experiences with motorists improperly negotiating the circle (such as driving counter-clockwise rather than clockwise around the circle) to get to their street quicker etc. Additionally, experience also indicates traffic circles increased confusion for motorists when encountering a roundabout as to how to properly negotiate the device.

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APPENDIX

DEVELOPMENT & IMPLEMENTATION OF THE TRAFFIC CALMING PLAN

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The following Sections (I, II and III) guide the selection, location/placement, installation, operation and maintenance concerns for traffic calming devices.

I. Considerations for Development of Traffic Calming Plan

The following guides initial considerations for developing the traffic calming plan.

1. **Consider appropriateness of existing traffic control devices** (signs and pavement markings) on the existing street that may affect the need for, as well as the type and location of the traffic calming devices. A lack of appropriate traffic control devices, particularly those that reinforce proper vehicle speeds such as speed limit signs and advisory speed warning signs etc. may be a contributing factor in creating undesirable conditions such as speeding, cut-through traffic etc. The speed limit should be posted at the beginning of the street section identified for traffic calming in each travel direction to notify motorists entering the street of the regulatory speed limit.

2. **Consider all service providers and users of the street** as follows.

    i. Emergency vehicles (fire, ambulance and police) –Emergency vehicle operations are a concern primarily on major emergency routes, which is typically not the case for streets intended for traffic calming in the Guide. On streets where accommodating emergency operations is a concern, response times can significantly increase for fire and ambulance vehicles due to certain vertical, horizontal and narrowing devices, from 3 - 10 seconds per device depending on the type of traffic calming device and the vehicle traversing it, with the delay compounded by multiple devices. The vertical devices are particularly problematic (other than speed lumps) as well as the horizontal measures that require a vehicle to deflect such as a chicane. Narrowing measures, where they have sufficient width for emergency vehicles have minimal impact. The local fire department is generally the first responder to an emergency medical situation therefore delays to a fire vehicle as well as the safety of the occupants is a primary concern. The local Fire & Rescue Chief as well as ambulance operators (such as hospitals) should be consulted to identify streets that serve as major emergency routes and that may be adversely impacted for use by fire or rescue vehicles. The local Fire & Rescue Chief should also be consulted on the dimensions of the emergency vehicles they use to ensure they are accommodated in the proposed plan (e.g., speed lumps can be designed to accommodate specific vehicle widths). Police departments generally approve of traffic calming measures because they slow vehicle speeds without routine enforcement. However, because the typical police vehicle is a passenger vehicle they are still susceptible to reduced speeds, particularly at the vertical devices but also at horizontal devices that deflect (such as a chicane). In an emergency police can bypass some traffic calming measures (such as narrowing measures where they can take the whole travelway). Due to the potential

impacts of traffic calming on police, it is recommended to include the police department in planning and implementation of the traffic calming plan.

Overall, for streets identified as emergency routes or where emergency vehicle traffic is a major concern traffic calming applications can omit the use of vertical devices and horizontal devices that require deflection (chicane) and rely on non-intrusive devices or the various narrowing measures.

ii. Transit (large buses) **-** Transit operations pertaining to large buses are a concern primarily on major transit routes, which is typically not the case for streets intended for traffic calming in the Guide. On streets where accommodating transit (i.e. large buses) operations is a concern, the vertical devices are particularly problematic (other than speed lumps) and horizontal measures that require a vehicle to deflect such as a chicane due to the resulting effects on passenger discomfort. To address these issues where they are a concern the plan may omit vertical devices as well as horizontal devices that require deflection (chicane), relying on non-intrusive devices or the various narrowing measures, as these do not pose any particular issues for large buses.

iii. Maintenance vehicles (waste or snow removal etc.) Accommodating certain maintenance activities such as snowplow operations is a concern primarily on major snow emergency routes, which is typically not the case for streets intended for traffic calming in the Guide. However, where such operations are a concern, snow removal equipment can potentially damage certain traffic calming measures and vice-versa. This can be alleviated in various ways such as by properly marking traffic calming devices for operators, using rubber tipped plows, installing gently sloped vertical measures or simply raising the plows at vertical measures. Alternatively, to avoid the issues altogether the plan may consider only the non-intrusive measures or the horizontal and narrowing devices and omitting any vertical measures. Waste removal vehicles are not affected by the various measures since they travel at slow speeds during trash pickup operations.

iv. Bicyclists –Accommodating bicyclists is a primary concern on streets identified as part of a bicycle network and that have significant bicycle traffic. This is generally not the case on the streets intended for traffic calming in the Guide, where there is little bicycle traffic or low vehicle traffic therefore conflicts are infrequent enough so that specific accommodation of bicyclists is not required as the bicyclist can safely take the (entire) travel lane. Where it is a concern, certain traffic calming devices can create safety issues for bicyclists. The horizontal (i.e. chicane) or narrowing devices can force a bicyclist to share a reduced travelway width with a motor vehicle. This can be addressed by providing (1) a bypass lane for a bicyclist (separated from the main travel lane by a curb extension) or (2) shared lane markings (also known as a sharrow) and "bike may use full lane" signage. Vertical measures

are generally acceptable for a bicyclist however; a speed hump located on a steep hill (downgrade) may cause a bicyclist to lose control where they are traveling at high speeds (20 – 25 mph). A speed lump in lieu of a speed hump can address this situation and is more suitable to accommodate bicyclists overall, as they can utilize the spaces in the device to avoid the vertical deflection. Otherwise, a bicyclist can safely traverse a 3-4 inch height speed hump at speeds of 15 mph or less.

3. **Implement measures on an area-wide basis** - Ideally traffic calming should take an area-wide approach to ensure that problems do not simply shift to adjacent local streets and parallel roadways. Implement traffic calming in stages where funding is not initially available for the entire plan.

4. **Involve and educate the community and decision-makers** - Inform community and decision-makers of the purpose of traffic calming, the relevant issues in the traffic calming process, the nature of the various alternatives including their effectiveness and associated costs. Additionally, informing the community on the nature of the various traffic calming measures may enhance their overall effectiveness. The following link provides information on traffic calming and a video of various calming measures in operation. http://www.virginiadot.org/programs/faq-traffic-calming.asp.

II. Selection, Spacing, Location, Installation, Operation and Maintenance Considerations of various traffic calming devices

The following discusses various aspects pertaining to the selection, location, installation, operation, and maintenance aspects of the vertical, horizontal, narrowing, and non-intrusive devices respectively, in the Guide.

The appropriateness of a device depends on certain street features such as traffic and pavement width etc. **FIGURE A – Subdivision street characteristics pertaining to traffic calming devices** (following) is used for selecting a device considering the travelway width requirements vs. traffic, the location of the device along the street (mid-block or intersection), and some other VDOT requirements.

This is followed by information that is more specific on the spacing / location of devices relative to other devices, signs and street features etc. as well as various installation, operational and maintenance considerations.

FIGURE A – Subdivision street characteristics pertaining to traffic calming devices [1]

Type of Measure	Action	Street Characteristics [1]	Minimum travelway width / lane width [2]	Other Considerations
NON-INTRUSIVE MEASURES - Pavement Markings				
Two-lane, Two-way street	Utilize pavement markings to narrow travelway width by striping pavement or by adding parking lanes or bike lanes. [3]	ADT < 401 vpd	18 feet / 9 feet	Indicates minimum width of striped travelway, physical pavement width is typically wider. For parking lane use additional minimum striped width of 7 feet and 5 feet for Bike lane.
		400 < ADT < 1501 vpd	20 feet / 10 feet	
		1500 < ADT < 2001 vpd	22 feet / 11 feet	
		ADT > 2000 vpd OR: mixed-use area with truck traffic > 5%	24 feet (may use 22 feet where no crash pattern indicates wider pavement should be considered)	
One-lane, One-way street		travelway width = lane width for 1/2 of ADT (e.g. for ADT < 201 vpd, travelway width = 9 feet)		
NON-INTRUSIVE MEASURES -Signs [4]				
Speed Display Sign	Install signs where speed limit signs would ordinarliy (and appropriately) be installed to indicate the posted speed limit.	Street has a single thru-lane per direction	No minimum street width requirements	Confirm the appropriate location of speed limit signs with VDOT.
Additional $ 200 Fine Sign		May not be used on streets functionally classified as arterials.		
VERTICAL MEASURES				
Speed Hump	Install at mid-block	no steep downgrades for bicyclists	No minimum street width requirements	Consider locations of manholes and drain inlets. Do not install adjacent to driveways or other entrances.
Speed Lump	Install as alternative to speed humps to accommodate emergency vehicles or bicyclists	Street experiences more frequent use by emergency vehicles and/or bicyclists		
Speed Table	Install at mid-block			
Raised Crosswalk [5]	Install at mid-block, not at intersection.	Existing marked crosswalk or where one is approved by VDOT.		Engineering study and VDOT approval required for location of crosswalks.
Raised Intersection	install at intersection.	intersection typically has crosswalks at all legs		typically affects drainage structures serving intersection and utilities
HORIZONTAL MEASURES				
Chicane	Install physical measures at shoulder on alternating sides of the street at mid-block, on streets with a single lane of traffic in one travel direction.	Street has with a single lane of traffic in one direction; 1-lane, 1-way street or 2-lane, 2-way streets where travel directions are separated by either a median or a physical barrier in the vicinity of the chicane.	Minimum travelway width / lane width through device: ADT < 401 vpd use: 18 feet / 9 feet 400 < ADT < 1501 use: 20 feet / 10 feet 1500 < ADT < 2001 vpd use: 22 feet / 11 feet ADT > 2000 vpd use: 24 feet / 12 feet (may use 22 feet / 11 feet where no crash pattern indicates wider pavement should be considered). * For one-lane, one-way street travelway width = lane width corresponding to 1/2 of ADT. OPTION -CHOKER ONLY: may use 15 feet travelway width through device for "give way to opposing vehicle" operation with no pavement centerline markings used in this case. Similarly, may use 7.5 feet width for one-way street.	proximity of driveways or other entrances, manholes and drain inlets.
NARROWING MEASURES				
Choker	Install at mid-block along shoulder on one or both sides of street to narrow travelway.	Pavement width can accommodate device and minimum travelway requirements.		proximity of driveways or other entrances, manholes and drain inlets.
Curb Extension (bulb-out) [6]	install at intersection, on one or both sides as appropriate to facilitate corresponding on-street parking and enhance safety of pedestrian crossings.	Street has on-street parking (or is planned), no exclusive right-turn lanes, low volume of right-turning trucks or buses onto narrow cross-streets.		Volume of right-turning trucks and buses and width of cross streets
Raised Median Island	Install in median area of travelway, at intersection or mid-block.	Pavement width can accommodate device and minimum travelway requirements.		proximity of driveways or other entrances, manholes and drain inlets.
Crosswalk Refuge [5]	Install in median area of travelway, at intersection or mid-block.	Existing marked crosswalk or where one is approved by VDOT.		Engineering study and VDOT approval required for location of crosswalks.

(1) For purposes of this chart, unless indicated otherwise streets are considered to be residential or mixed-use with a speed limit of 25 mph or less, ADT 4,000 vpd or less and % trucks are 5% or less.

(2) Per AASHTO Green Book Table 5-5 for local roads and streets (travelway widths are exclusive of curb and gutter).

(3) On local streets, bicyclists are considered a normal part of the vehicle mix and do not require a marked or designated bike lane. Designated bike lanes typically established on collector roads that are part of a designated bike route or bike plan.

(4) These signs are governed by separate VDOT policies however, implementation within the traffic calming process per the Guide encompasses those policy requirements unless otherwise noted.

(5) New crosswalks or modifications to an existing crosswalk are goverened by VDOT's Traffic Engineering Instructional & Informational Memorandum IIM-TE-384.0 titled "Pedestrian Crossing Accommodations at Unsignalized Locations".

(6) Per VDOT's Road Design Manual, Appendix B(2), Section B(2)-3 use only at an intersection on street having on-street parking. Not suitable at intersections with exclusive right-turn lanes or at intersections with a high volume of right-turning trucks or buses

Vertical, Horizontal and Narrowing Devices

Location

Speed Humps, speed lumps, speed tables, chicanes, chokers, and median islands are generally located at mid-block with a minimum distance of 200 feet from an intersection. **Raised Intersections** are by definition, installed at an intersection.

Curb Extensions (corner extensions or bulb-outs), per VDOT's Road Design Manual, Appendix B(2), Section B(2)-3: only used at intersections where there is on-street parking and are not applicable to intersections with exclusive right-turn lanes adjacent to the curb, or intersections with a high volume of right-turning trucks or buses turning into narrow cross streets.

Raised Crosswalks are located at mid-block, at an existing marked crosswalk or where one is approved by VDOT. **Crosswalk Refuges** are located at mid-block or at an intersection, likewise at an existing marked crosswalk or where one is approved by VDOT. New crosswalks or modifications to an existing crosswalk or any other pedestrian-related accommodations are governed by VDOT's Traffic Engineering IIM-TE-384.0 titled "Pedestrian Crossing Accommodations at Unsignalized Locations" available at http://www.virginiadot.org/business/resources/IIM/TE-384_Ped_Xing_Accommodations_Unsignalized_Locs.pdf.

Spacing

The spacing of vertical, horizontal and narrowing devices should not exceed a distance of 500 feet between subsequent devices. As noted in VDOT's Roadway Design Manual; studies indicate that operating speeds are 30 mph or less when the tangent sections were no longer than 500 feet. Long tangent sections can be segmented by conditions that require a complete stop such as a T intersection or by conditions that require reduced speeds such as a traffic calming device. Therefore, this 500 feet spacing minimizes the need to place additional, redundant devices at an increased cost.

Where a closer spacing of traffic calming devices is desired the distance between devices should not be less than 200 feet so that motorists approaching the device at 25-30 mph may appropriately perceive and respond to the device and/or any warning signs posted for the device (see section on traffic control devices pertaining to devices below).

Placement

The placement of vertical, horizontal and narrowing devices should not interfere with existing driveways or entrances, roadway drainage and drainage structures, drainage inlets; etc. or obstruct access to other utilities (e.g. franchise utilities such as gas, power, telephone, water hydrants etc.). Therefore, these devices should be placed at least:

- 5 feet from any driveway, entrance or curb cut on a local street (additional clearance may be required for curb cuts utilized by trucks
- 15 feet from a fire hydrant, either side
- 2 feet from a manhole or utility cover on approach or 6 feet after

Location & Placement of Non-Intrusive Measures

Pavement Markings

The conceptual drawing for pavement markings indicates various items pertaining to their placement and location etc.

Speed Display signs

These signs are only installed on streets with a single through-travel lane per direction (e.g. two-lane, two-way or one-lane, one-way streets etc.), in conjunction with the speed limit (R2-1) sign and where a speed limit sign would normally be installed to indicate the regulatory speed limit. Confirm sign locations with VDOT. Generally, speed display signs would be installed at the beginning of a street section identified for traffic calming, one in each travel direction in order to reinforce the posted speed limit for vehicles entering the street with interim signs as appropriate to reinforce notification of the regulatory speed limit.

See VDOT's TE-374.1 Memorandum, which lays out the requirements for the operation, size, specifications etc. for the speed display signs at: http://www.virginiadot.org/business/resources/traffic_engineering/memos/TE-374_1_Pole_Mounted_Speed_Display_Signs.pdf.

Additional $ 200 Fine Signs

These signs are also installed in conjunction with the speed limit (R2-1) sign. The sign must be posted at the beginning of the section of street in each travel direction that has been designated for higher fines. Also, a sign must be posted in each travel direction where the section of street designated for higher fines ends. Additional, interim signs may be placed as appropriate to further indicate the posted speed limit.

Gateway Treatments

The location of gateway treatments should consider the clear zone requirements in VDOT's Road Design Manual; Appendix B(1), Section B(1)-5, Part A for any structures or landscaping, including fences, stone or brick mailbox posts, columns or walls that do not meet breakaway requirements. For curb and gutter streets with parking lanes, the clear zone is accommodated within the parking lane.

Traffic Control Devices applicable to traffic calming devices

Ensure that all related regulatory signs (e.g. speed limit signs), warning signs and pavement markings pertaining to the street and the specific devices are installed.

Regulatory and warning signs as well as pavement markings generally recommended or required for the various devices are shown on the conceptual drawings. However, additional signs or markings may be required depending on local conditions.

Vertical, Horizontal and Narrowing devices

Advisory speeds, where posted at a particular device, should generally indicate 15 mph - the recommended maximum speed for vehicles while traveling through or over vertical, horizontal and narrowing devices. The goal for vehicle speeds traveling between these devices is 25-30 mph or less therefore, 200 feet of sight distance is recommended per Section 2C.05 of the 2009 MUTCD for vehicles approaching the vertical, horizontal and narrowing devices. This provides sufficient distance for a vehicle approaching at 25-30 mph to perceive the device and/or any warning signs posted for the device and reduce speed to 15 mph when passing over or through the device.

Non-intrusive devices -Signs

For the non-intrusive sign measures (Speed Display Signs and Additional $ 200 Fine Signs) no specific additional regulatory or warning signage is identified however, other signs or markings may be required depending on local conditions.

Size of Signs

See the 2009 MUTCD Section's 2B.03 and 2C.04 for regulatory and warning sign sizes, respectively. Single-lane conventional (low speed) roads are typical of the residential streets covered in the Guide.

Visibility of Measures

Measures should be clearly visible day and night. Reflectors, buttons, highly reflective paint, or illumination should be used as appropriate. Landscaping (now or at maturity), or other features should not obstruct sight distances.

Maintenance

Long-term maintenance needs should be anticipated and accommodated in the design of the various devices as much as possible.

Minimum Design Vehicle

The minimum design vehicle for new subdivision streets is a single unit truck (AASHTO SU-30) therefore the traffic calming plan would consider accommodating this vehicle in the traffic calming plan.

Parking

On-street parking should not obstruct sight lines to installed devices for drivers, cyclists or pedestrians. Add additional “No Parking” zones where needed.

Streetscape and Landscape

Any streetscapes or landscaping installed as part of traffic calming measures (such as for gateway treatments, median islands, chicanes, chokers or curb extensions) should consider the requirements in VDOT’s Road Design Manual; Appendix B(1), Section B(1)-5, Part E.

Landscaping that encroaches onto the right of way can obscure pedestrians or vehicles entering the roadway from residences or side streets. The RDM specifies various constraints for the location, height etc. of landscaping to ensure that the appropriate unobstructed view is maintained to protect the safety of pedestrians, bicyclist, and motorists.

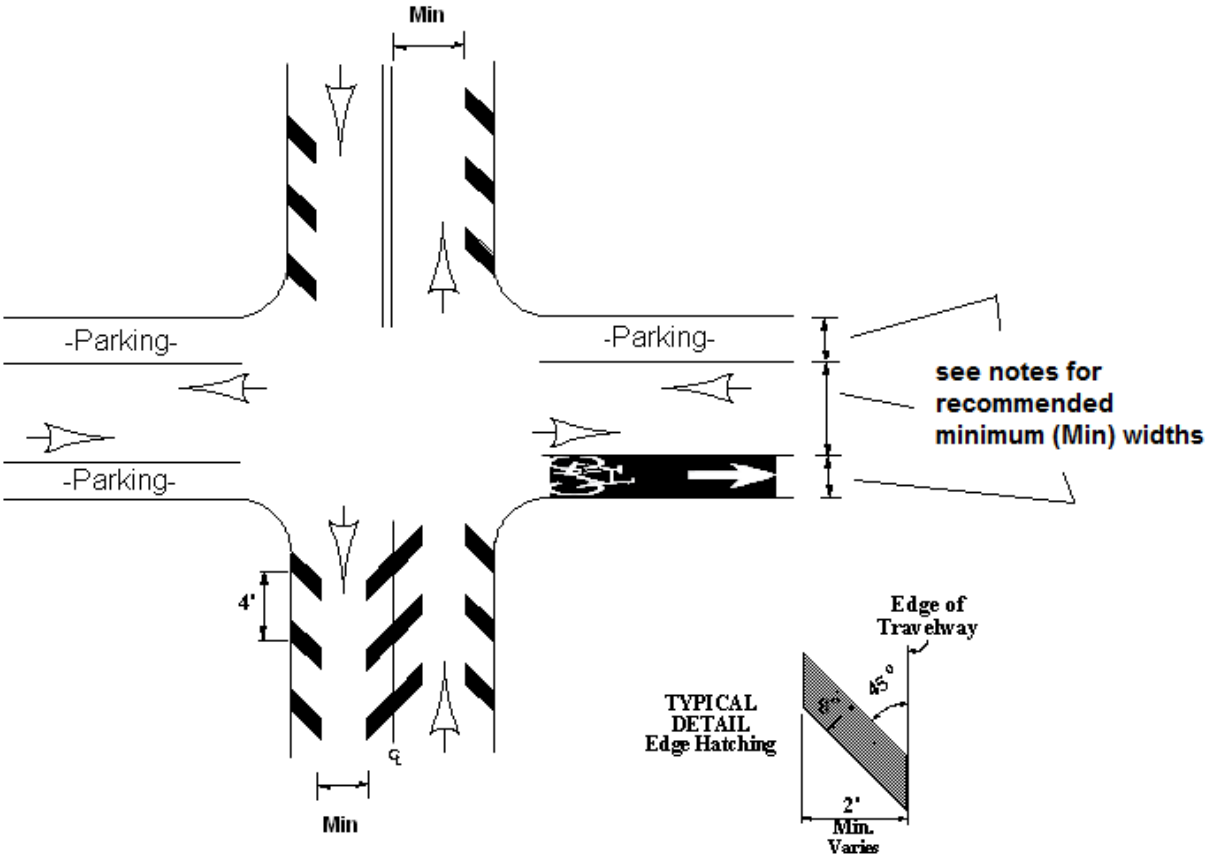
Funds for landscaping may be limited to a minimal percentage of the construction funds budgeted for a proposed traffic calming plan. VDOT is not responsible for maintaining any landscaping.

III. Conceptual Drawings of Traffic Calming Measures

The following conceptual drawings illustrate details and requirements for the traffic calming installations included in the Guide, based on recommendations from industry literature and other sources and considering VDOT’s design, maintenance etc. requirements. The designer/installer should confirm that their installations meet all current VDOT requirements that apply per VDOT’s Roadway Design Manual, Road and Bridge Standards and Road and Bridge Specifications. Signs and pavement markings should be in agreement with the latest version of the Manual of Uniform Traffic Control Devices (MUTCD) and the Virginia Supplement to the MUTCD (VaSupMUTCD).

FIGURE A-1

PAVEMENT MARKING OPTIONS



NOTES:

1. For appropriate application and minimum (**Min**) travelway and parking lane and bike lane widths see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. Each intersection leg indicates a different option for narrowing the travelway
    a. North leg -divided facility; narrow travelway by hatching shoulder area
    b. South leg -un-divided facility; narrow travelway by hatching shoulder area and roadway centerline
    c. East legs – narrow travelway by adding a parking lane and bike lane
    d. West leg – narrow travelway by adding parking lanes
3. See Part 3 of the MUTCD (Section 2B.17 in the 2009 version) for requirements, options and other considerations for pavement markings.
4. As per the 2009 MUTCD Section 3B.24 Cross-Hatching should be a minimum of 8” in width for speed limits of 45 mph or less.

FIGURE A-2

POLE MOUNTED SPEED DISPLAY (PMSD) SIGN



NOTES:

1. For appropriate application, see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. Sign mounted on the same pole and directly below, the speed limit (R2-1) sign as shown above.
3. The changeable display shall be programmed to go blank/no display when an approaching vehicle exceeds the posted speed limit by 20 mph or more.
4. The changeable display shall be programmed to display two dashes when the system is not operating.
5. Other than the speed display, the PMSD sign shall not incorporate animation, flashing, or any dynamic elements.
6. For full requirements on the operation, installation, size, specifications and maintenance aspects of these signs refer to TED Memorandum 374.1 “Pole Mounted Speed Display Signs: Requirements” at http://www.virginiadot.org/business/resources/traffic_engineering/memos/TE-374_1_Pole_Mounted_Speed_Display_Signs.pdf or; the Virginia Supplement to the MUTCD.

Figure A-3

$200 ADDITIONAL FINE SIGN



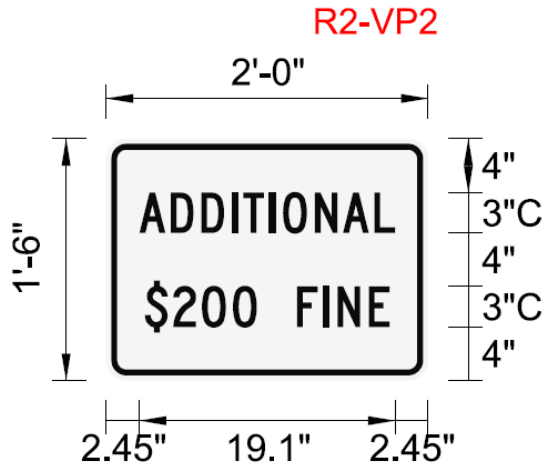
NOTES:

1. For appropriate application, see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. Per the 2009 MUTCD Section 2B.17:
    i. The supplemental sign panel indicating that an “Additional $200 Fine” applies shall be posted below the regulatory R2-1 speed limit sign panel as shown above.
    ii. The “Additional $200 Fine” sign assembly shall be installed at the beginning of the zone in each travel direction where higher fines have been designated.
    iii. A sign indicating “End Higher Fines Zone” shall be installed at the end of the zone in each travel direction where higher fines have been designated.
3. Additional signs may be placed at interim locations between the beginning and ending of the designated higher fines zone to further reinforce the posted speed limit and the additional fines.
4. Sign should be located at least 100 feet should from any other signs.

Figure A-3.1

$200 ADDITIONAL FINE SIGN DETAIL

SIGN DETAIL



SIGN NUMBER	name
WIDTH x HGHT.	2'-0" x 1'-6"
BORDER WIDTH	0.44"
BORDER INSET	0.38"
PANEL RADIUS	1.13" plus 0.38"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Black/White
LEGEND/BORDER	TYPE: Reflective
	COLOR: Black/Black

SYMBOL	ROT	X	Y	WID	HT

Dimensions are In Inches,tenths

Letter locations are panel edge to lower left corner

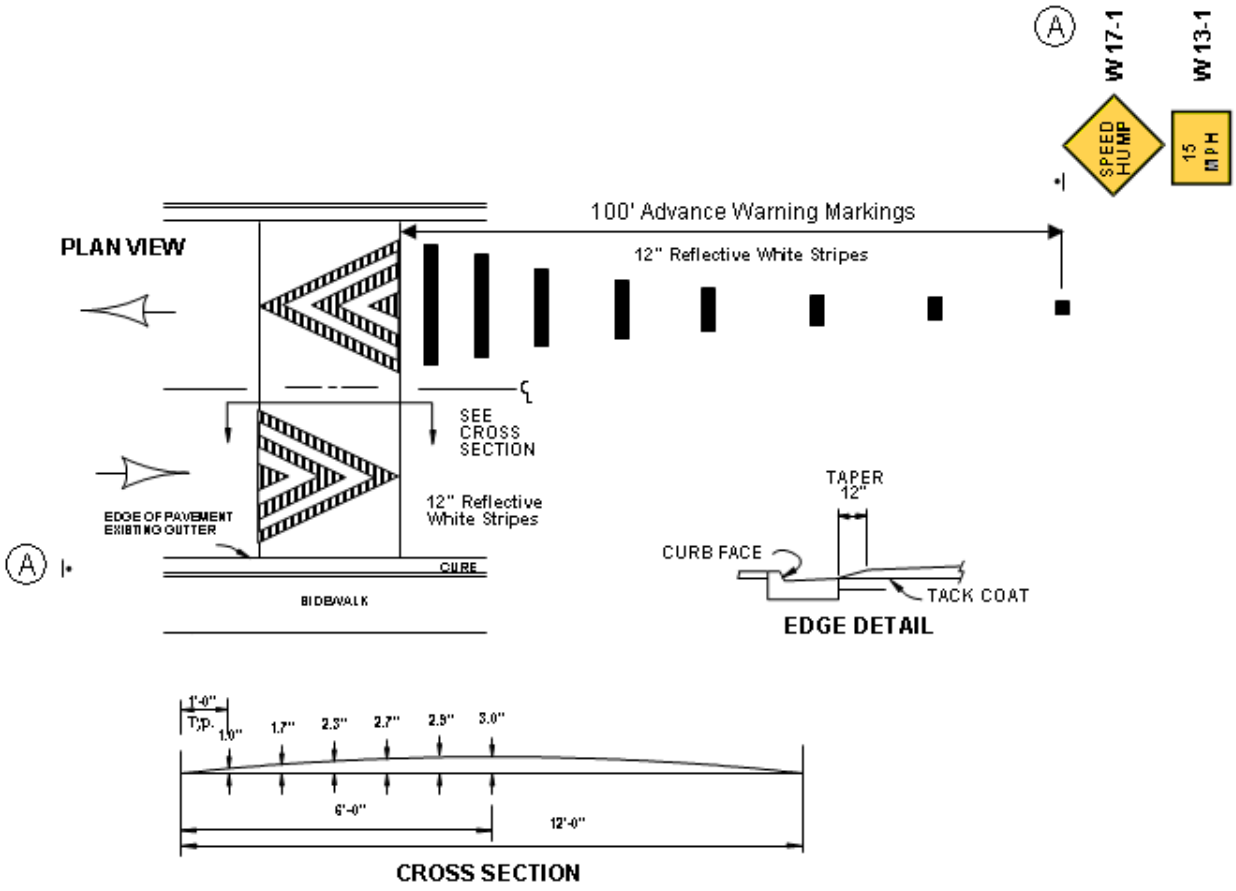
LETTER POSITIONS (X)																					LENGTH	SERIES/SIZE
A	D	D	I	T	I	O	N	A	L													C 2000
2.5	4.8	7.1	9.4	10.2	12.2	13.2	15.6	17.7	20												19.1	3
$	2	0	0		F	I	N	E														C 2000
2.9	5	7.1	9.5	11.2	14.2	16.2	17.3	19.6													18.2	3

NOTES:

1. The size requirements for the “Additional $200 Fine” signs are as shown above and as further indicated in the future version of the Virginia Standard Highway Signs book.

Figure A-4

SPEED HUMP

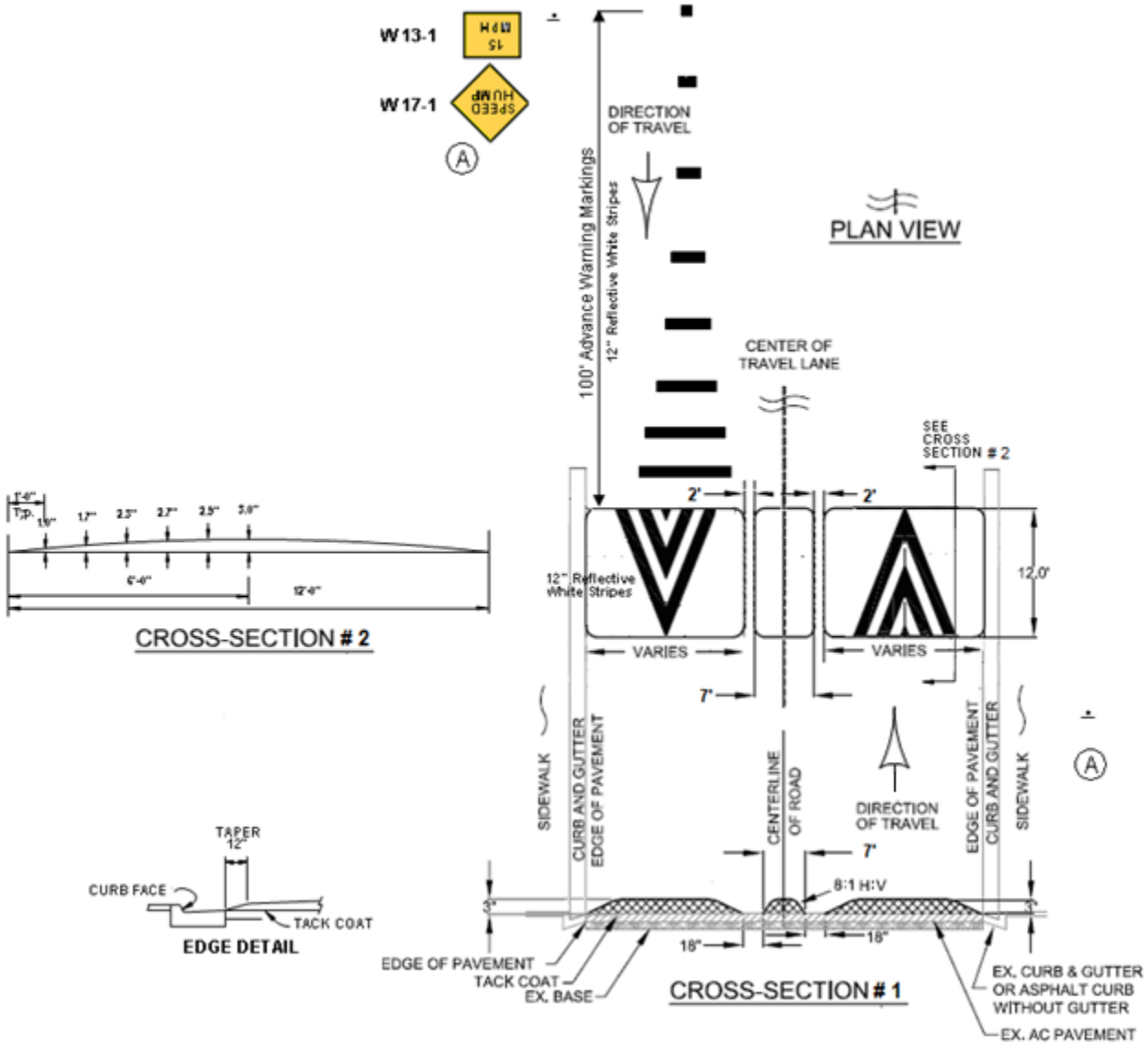


NOTES:

1. For appropriate application, see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. Per the 2009 MUTCD:
   i. Section 3B.25 –speed hump markings are not required but if used they must comply per options in Section 3B.25.
   ii. Section 3B.26 –the 100' advance warning pavement markings are optional but if used they must comply with the dimensions and spacing per Section 3B.26.
   iii. Section 2C.29 -advance warning sign (W17-1) is optional but if used, should include the advisory speed plaque (W13-1) and; sign may use "Speed Bump" instead of "Speed Hump."
3. Leave gutter pan open to facilitate drainage.

Figure A-5

SPEED LUMP

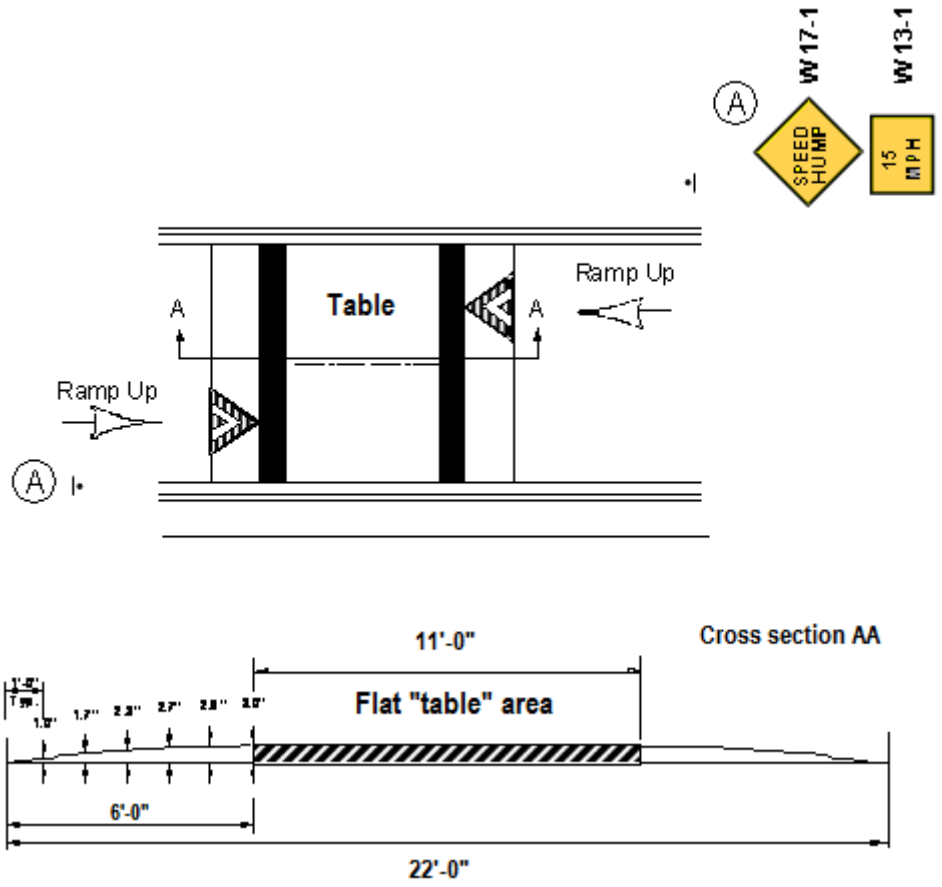


NOTES:

1. All notes for speed hump in Figure A-2 apply in addition to the following.
2. Cross-section #2 is identical to speed hump cross section with a transition for vehicles over the device of 3 inches per 6 feet.
3. Width of center lump is 7 feet with 2 feet of spacing between adjacent lumps to accommodate trucks, school buses, transit buses and other larger vehicles with an 8-foot width and ensure that passenger vehicles (typical width of 7 feet) cannot avoid traveling over at least one set of lumps. However, the width of the center lump can vary based on dimensions of local emergency vehicles to be accommodated.
4. Striping to delineate the street centerline is recommended to discourage vehicles from crossing into the opposing lane in order to straddle the humps provided for emergency vehicles.

FIGURE A-6

SPEED TABLE

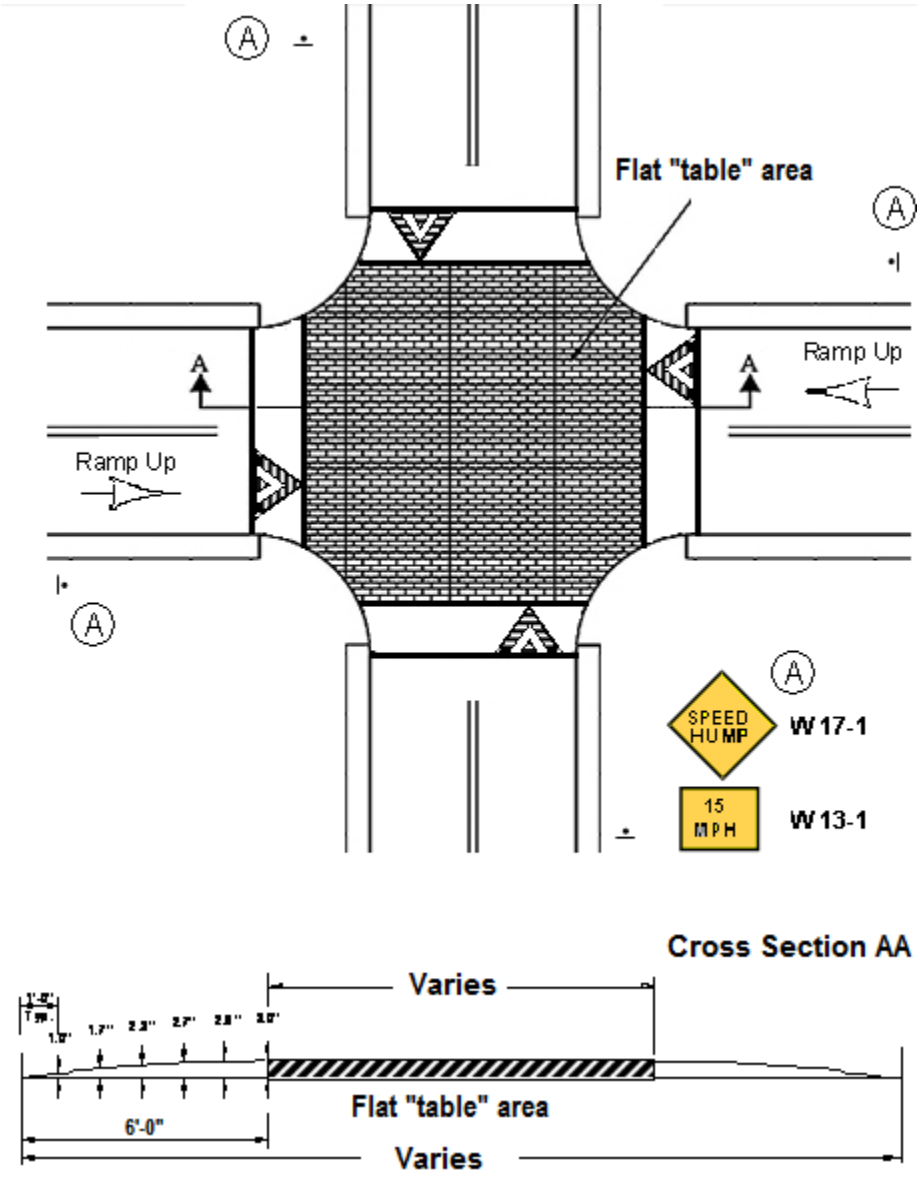


NOTES:

1. For appropriate application, see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. The flat “table” area length of 11 feet accommodates a typical passenger car wheelbase entirely on the top, but if extended may accommodate other vehicle wheelbases if desired. A length of 20 feet accommodates a typical single unit truck (AASHTO SU-30).
3. Per the 2009 MUTCD:
   i. Section 3B.25 –speed hump (table) markings are not required but if used they must comply with options per Section 3B.25.
   ii. Section 2C.29 - warning sign W17-1 is optional but if used, should include the advisory speed plaque (W13-1) and; the sign may use “Speed Bump” instead of “Speed Hump.”
4. Leave gutter pan open to facilitate drainage.
5. A 12” wide, 1” depth grind around the perimeter of the device is recommended in order to allow the surface course to be keyed into the pavement for a more durable application, particularly for snow plowing.

FIGURE A-7

RAISED INTERSECTION

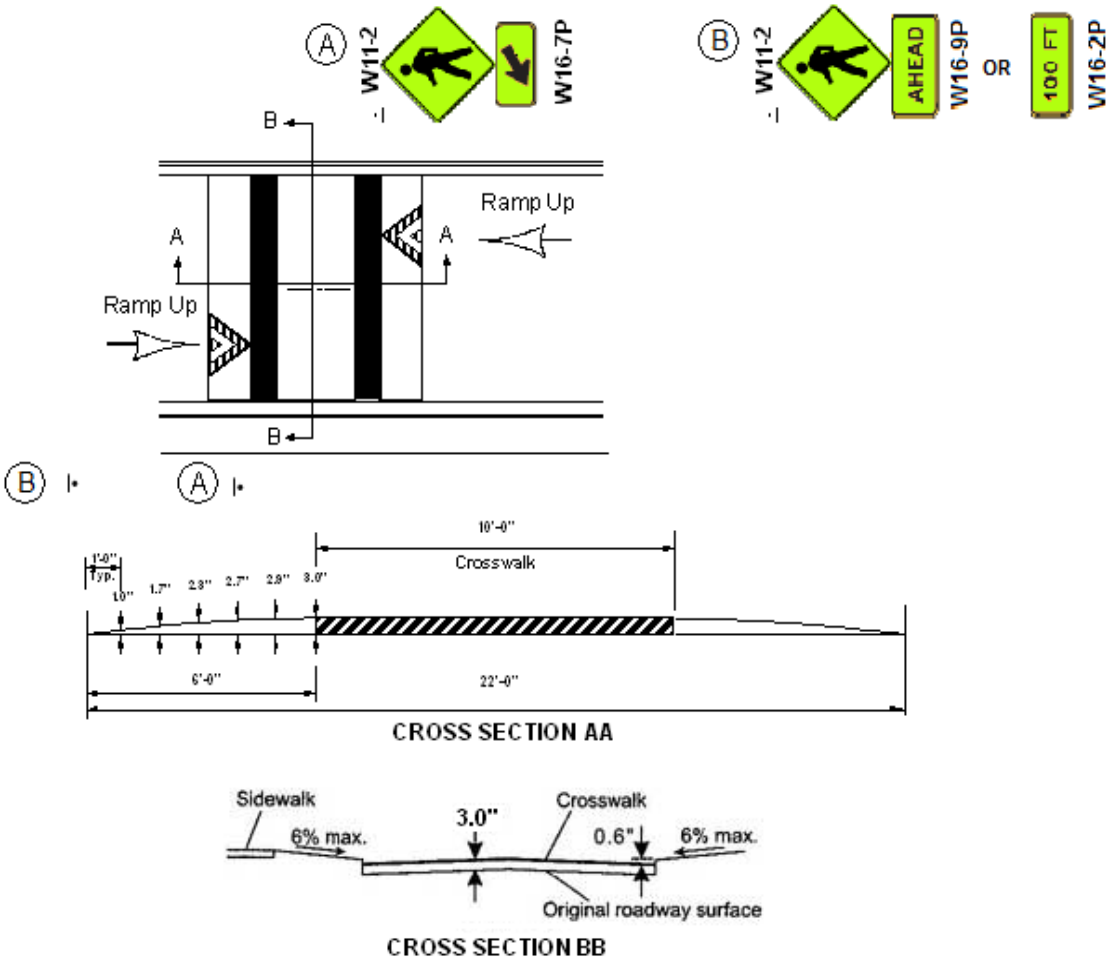


NOTES:

1. For appropriate application, see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. The flat “table” area length varies based on width of intersection.
3. Per the 2009 MUTCD:
    i. Section 3B.25 –speed hump (table) markings are not required but if used they must comply with options per Section 3B.25.
    ii. Section 2C.29 - warning sign W17-1 is optional but if used, should include the advisory speed plaque (W13-1) and; the sign may use “Speed Bump” instead of “Speed Hump.”

FIGURE A-8

RAISED CROSSWALK

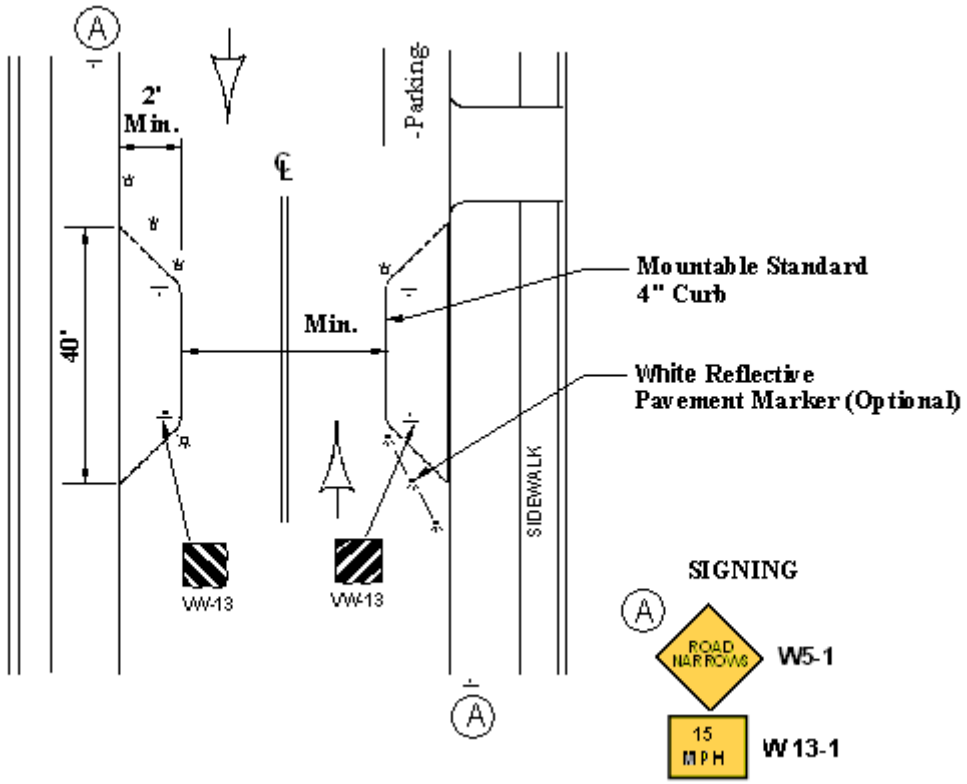


NOTES:

1. For appropriate application, see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. VDOT's Traffic Engineering Instructional & Informational Memorandum IIM-TE-384.0 titled "Pedestrian Crossing Accommodations at Unsignalized Locations" governs new crosswalks or modifications to an existing crosswalk or other pedestrian-related accommodations.
3. Per the 2009 MUTCD and the VaSupMUTCD:
   i. Section 3B.25 –speed hump (table) markings are not required but if used they must comply with options per Section 3B.25.
   ii. Section 2C.50 -the W11-2 may be used in advance of a crosswalk and if used; shall include supplementary plaque W16-9p or W16-2P. If used at the location of a crossing point, the W11-2 should include the supplemental W16-7P plaque.
   iii. Section 2C.50 -The W11-2 sign must be fluorescent yellow-green with black legend and border.
4. A 12" wide, 1" depth grind around the perimeter of the device is recommended in order to allow the surface course to be keyed into the pavement for a more durable application, particularly for snow plowing.
5. Leave gutter pan open to facilitate drainage.

FIGURE A-9

CHOKER

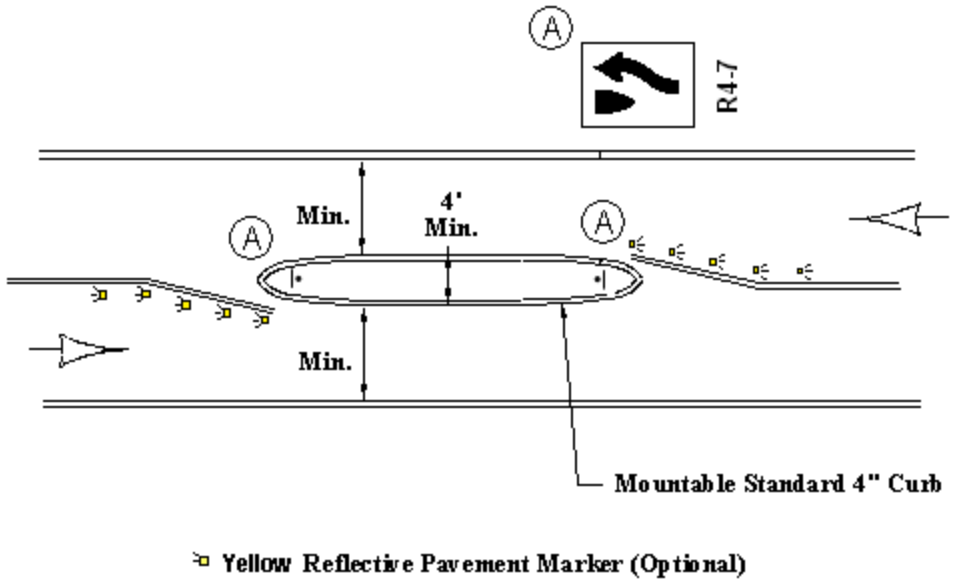


NOTES:

1. For appropriate application and minimum (**Min**) travelway width see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. May be placed along one or both sides of the road where sufficient pavement width.
3. Do not stripe centerline where (**Min**) travelway width of 15 feet is used for “give way to opposing vehicle” operation as described in FIGURE A.
4. Per the 2009 MUTCD Section 2C.19 -Advisory warning sign W5-1 is optional according to the following (If used may also include the advisory speed plaque W 13-1):
    i. Where the (**Min**) travel way width allows two-way travel without requiring vehicles to use the adjacent lane or to give way to opposing traffic.
    ii. On low-volume roadways where the speed limit is 30 mph or less.
5. May be combined with a speed hump, speed lump or speed table (see Figure A-4, A-5 and A-6).
6. Leave gutter pan open to facilitate drainage.

FIGURE A-10

MEDIAN ISLAND

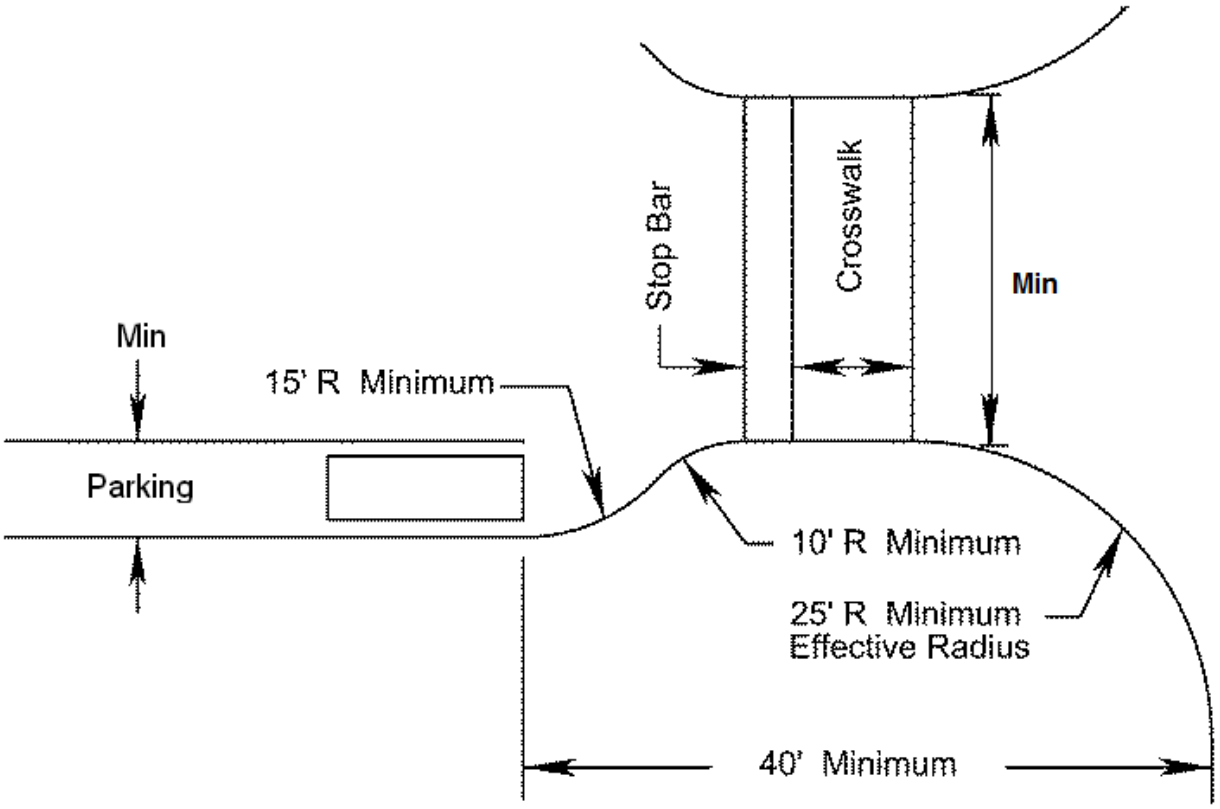


NOTES:

1. For appropriate application and minimum (**Min**) travelway width see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. Approaches to the intersection should not exceed 6 percent and entrances should be a minimum of 75-100 feet away.
3. The transition of the approach curb and any accompanying raised pavement markers shall be in conformance to the design or operating speed of the roadway, whichever is greater.
4. Per the 2009 MUTCD Section 2B.32 - the R4-7 signs are recommended at locations where it is not readily apparent that traffic is required to keep to the right.

FIGURE A-11

CURB EXTENSION (NECKDOWN)

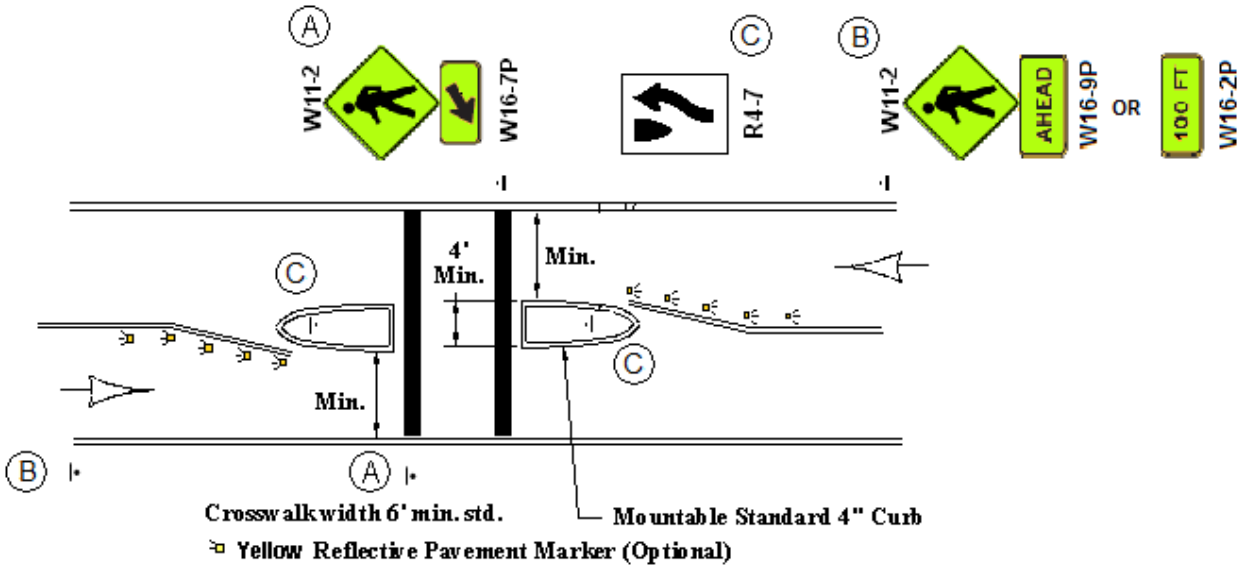


NOTES:

1. For appropriate application and minimum (**Min**) travelway width see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. Per VDOT's Road Design Manual, Appendix B(2), Section B(2)-3:
    a. Use only at an intersection on street having on-street parking
    b. Not suitable at intersections with exclusive right-turn lanes adjacent to the curb, or intersections with a high volume of right-turning trucks or buses turning into narrow cross streets.
3. VDOT's Traffic Engineering Instructional & Informational Memorandum IIM-TE-384.0 titled "Pedestrian Crossing Accommodations at Unsignalized Locations" governs new crosswalks or modifications to an existing crosswalk or any other pedestrian-related accommodations.

FIGURE A-12

CROSSWALK REFUGE

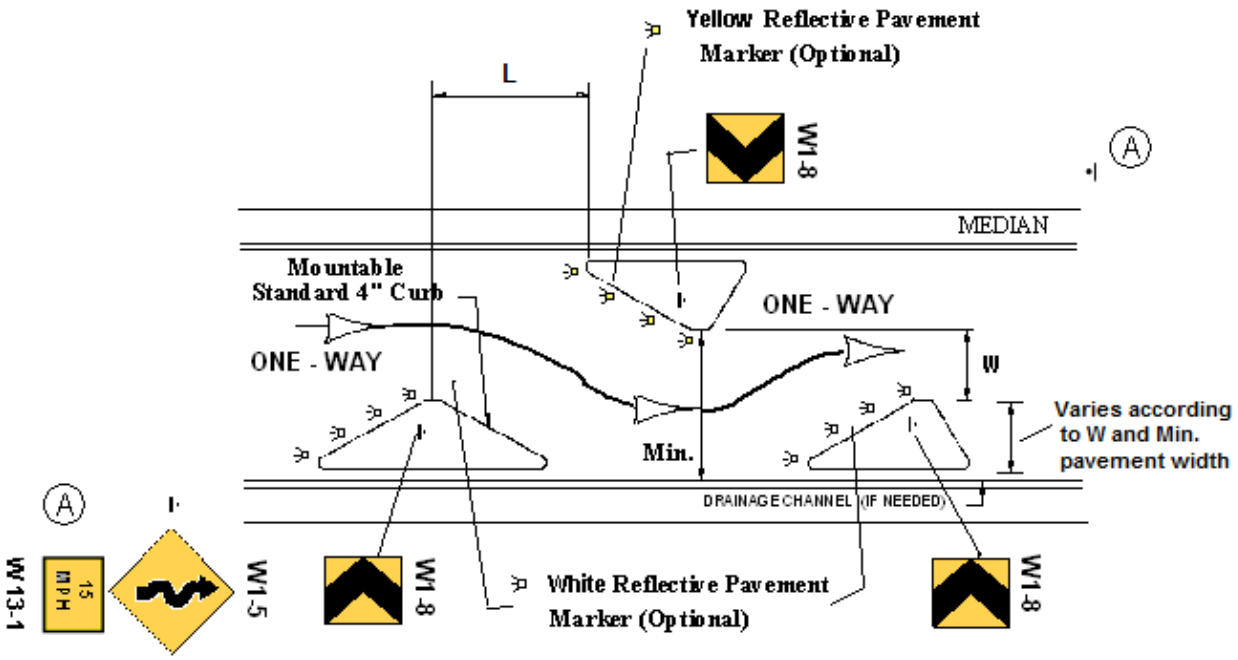


NOTES:

1. For appropriate application and minimum (**Min**) travelway widths see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. VDOT's Traffic Engineering Instructional & Informational Memorandum IIM-TE-384.0 titled "Pedestrian Crossing Accommodations at Unsignalized Locations" governs new crosswalks or modifications to an existing crosswalk or any other pedestrian-related accommodations.
3. May also incorporate a raised crosswalk (see Figure A-7).
4. Leave gutter pan open to facilitate drainage.
5. Per the 2009 MUTCD and the VaSupMUTCD:
    i. Section 2B.32 recommends R4-7 signs at locations where it is not readily apparent that traffic is required to keep to the right.
    ii. Section 2C.50 -the W11-2 may be used in advance of a crosswalk and if used; shall include supplementary plaques W16-9p or W16-2P. If used at the location of a crossing point, the W11-2 should include the supplemental W16-7P plaque.
    iii. Section 2C.50 -The W11-2 sign must be fluorescent yellow-green with black legend and border.

FIGURE A-13

CHICANE



NOTES:

1. For appropriate application and minimum (**Min**) travelway widths see FIGURE A – Subdivision street characteristics pertaining to the selection of traffic calming devices in this document.
2. See chart below for the required maximum "Stagger Length" (L) for various travelway widths (**Min**) and Free View width 'W' to achieve the indicated passenger car speed through the chicane.

Maximum Stagger Length 'L' to achieve indicated Passenger Car Speed				
Lane width (feet)	Free view width 'W' (feet)	Stagger length 'L' (feet) vs. vehicle speed		
		15 mph	20 mph	25 mph
10	+3.5	20	30	45
	0	30	43	60
	-3.5	40	53	-
11	+3.5	-	-	40
	0	30	40	55
	-3.5	36	50	-
12	+3.5	-	-	35
	0	-	37	47
	-3.5	-	45	58

3. See chart below for the maximum “Stagger Length” (L) for various travelway widths (Min) to accommodate a single unit truck (AASHTO SU-30) for a free view width ‘W’ = 0.0 feet.

Minimum stagger length 'L' (feet) for SU-30 Truck free width view 'W' = 0.0 feet			
Travelway width (feet)	**10**	**11**	**12**
Stagger Length 'L' (feet)	40.0	34.0	29.0

4. The transition of the approach curb and any accompanying raised pavement markers shall be in conformance to the design or operating speed of the roadway, whichever is greater.
5. Per the 2009 MUTCD Section 2C.07 -W1-5 signs are required where advisory speeds are 10 mph or more below the speed limit. W1-8 signs are required where advisory speeds are 15 mph or more below the speed limit and recommended where advisory speeds are 5 mph or 10 mph below the speed limit.