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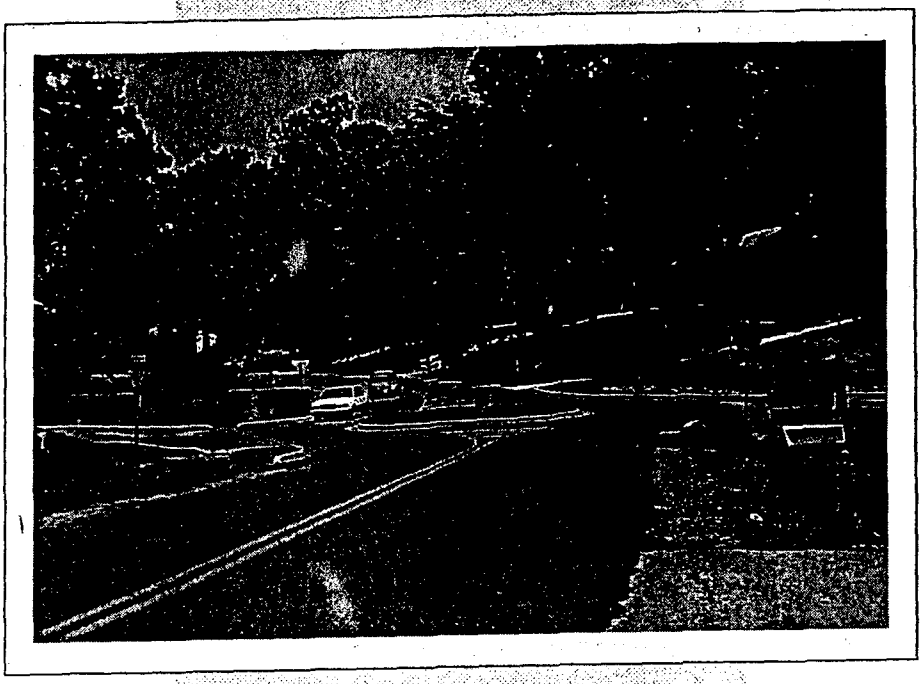
FINAL REPORT

EVALUATION OF THE VIRGINIA DEPARTMENT OF TRANSPORTATION'S RESIDENTIAL TRAFFIC CALMING GUIDE



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This report documents the activities of the pilot program and VDOT's Residential Traffic Calming Committee, which administered the program. Numerous conclusions were drawn by the researchers based on specific experiences during the pilot program. The conclusions ranged from the usefulness of specific elements of the *Guide*, actions that worked well for a particular county, the description of side effects from having the pilot program in place, lessons learned from specific traffic calming projects, and a list of other activities that have occurred under the moniker of traffic calming.

The recommended changes to the *Guide* that were identified during this effort and incorporated in the latest version of the *Guide* are described. An implementation plan outlines a suggested approach to transition from a pilot to a statewide program. The plan emphasizes the *Guide* as a component of a residential traffic management program.

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ABSTRACT

The purpose of this research was to evaluate the Virginia Department of Transportation's (VDOT's) *Residential Traffic Calming Guide.* A 2-year pilot program served as a means to evaluate the *Guide*. The results of the evaluation enabled VDOT to strengthen its *Guide* based, to a large extent, on the lessons learned in the pilot program and to prepare for effective statewide implementation of this customer service–oriented program.

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INTRODUCTION

Two statewide policies have existed since the late 1980s to help neighborhoods address traffic issues: a cut-through traffic policy and a through truck restriction policy. In 1997, based on an extensive literature review, the Virginia Department of Transportation's (VDOT's) Residential Traffic Calming Committee (RTCC) developed a *Residential Traffic Calming Guide*[1] *(*the *Guide)* that provided communities with a third traffic management tool to deal specifically with speeding on local streets. The *Guide* outlines the process for addressing speeding concerns in neighborhoods and identifies the countermeasures that may be considered.

There are many examples of traffic calming programs across the United States and in the world. The RTCC attempted to address potential problems in the *Guide* based on what was learned from others. However, traffic calming programs in some areas have generated complaints and created problems for transportation agencies that are customer service–oriented. Some groups within VDOT view speeding as a subdivision development issue and/or an enforcement problem and are skeptical as to whether it is VDOT's role to become involved in this issue.

Because of the potential controversy that may accompany traffic calming, the *Guide* was implemented initially as a 2-year pilot program (January 1998–December 1999). The purposes of the pilot program were to gain experience with traffic calming and to evaluate the effectiveness of the new guidelines to address speeding on local residential streets on a small scale. A limited number of counties that had previously expressed an interest in traffic calming were participants in the pilot program. At the end of the pilot, the guidelines were to be revised as needed and then implemented statewide. The state traffic engineer requested that the Virginia Transportation Research Council (VTRC) conduct the evaluation of the pilot.

The RTCC, composed of representatives from VTRC and VDOT's resident engineers; district traffic engineers; and traffic engineering, secondary roads, and transportation planning divisions played a key role in VDOT's traffic calming efforts. The RTCC developed the *Guide* and devised the pilot program. As counties and VDOT field staff agreed to participate in the pilot, the VDOT field staff were added to the RTCC. In periodic meetings, the RTCC made

decisions regarding the pilot program, provided status reports of pilot program activities in each county, and exchanged information.

While the RTCC was developing and piloting the *Guide*, Virginia's General Assembly enacted amendments to the *Code of Virginia* that led to VDOT policies on the use of "watch for children" signs and an "additional $200 fine sign" for speeding. These two signs were intended to have an impact similar to that of the *Guide*. Although these signs are not part of the *Guide,* they are connected to the *Guide* as possible alternatives to address speeding concerns.

OVERVIEW OF THE *RESIDENTIAL TRAFFIC CALMING GUIDE*

The purpose of traffic calming is to slow speeders in residential neighborhoods on streets classified as local. Particular collector streets that have many of the characteristics of local residential streets may also qualify for traffic calming measures. Traffic calming focuses on slowing traffic without restricting access, which is more related to cut-through traffic. Traffic calming measures are appropriate for slowing traffic when cut-through traffic is not the problem. A final point is that the traffic calming program is for existing streets. Streets in developing subdivisions should be designed in such a way as to prevent speeding problems. Accordingly, the county should have a subdivision ordinance in place and VDOT should exert its discretionary authority in applying geometric standards to encourage designs that discourage speeding.

A street is eligible for a traffic calming measure if all the following apply:

1. It is a two-lane roadway with a posted speed limit of 25 mph or less.

2. The average speed is at least 5 mph over the posted speed limit, i.e., 30 mph.

3. A petition requesting traffic calming and signed by at least 75 percent of the total occupied households within the petition area must be obtained.

4. The street does not serve as the primary access to commercial or industrial sites.

5. There is a minimum of 12 dwellings fronting the street per 1,000 feet of roadway, including both sides.

The county and VDOT are partners in addressing traffic calming. Accordingly, the process must start with a resolution, with support data, from the county board of supervisors that requests traffic calming measures on a particular street. The plan is then developed, approved, implemented, and evaluated. The support data that must accompany the resolution include those items that would allow VDOT to determine that the street meets the eligibility requirements discussed earlier; namely:

- street functional classification

- average daily traffic volumes
- average speed
- description of petition area (residences on the proposed study street section and on all streets that have major access onto the proposed study street section)
- description of impacted areas (typically includes the surrounding collector or arterial roads)
- petition with signatures (the traffic calming plan should be developed by a group that includes representatives from the petition area, the impacted area, homeowner associations, board of supervisors, local transportation/planning staff, police, fire, rescue, VDOT, and others as appropriate.

The board of supervisors and homeowner associations are responsible for scheduling and facilitating meetings. It is intended that VDOT staff will provide technical support and advise the community of the potential advantages and disadvantages of calming measures.

Traffic calming measures promoted in the *Guide* include:

- community awareness and education
- enforcement
- non-physical devices (low-cost measures that do not physically restrict driver maneuvers, e.g., pavement markings to narrow travel lanes)
- physical devices (measures designed to reduce speed by creating a vertical or horizontal shift in the roadway or travel lanes)
- alternative actions (e.g., network analysis).

The various devices are depicted schematically in Figure 1. Descriptive and placement information and the advantages, disadvantages, and estimated cost are provided for each of the six physical devices shown.

Traffic volumes on the residential street can help determine the appropriate traffic calming measure as follows:

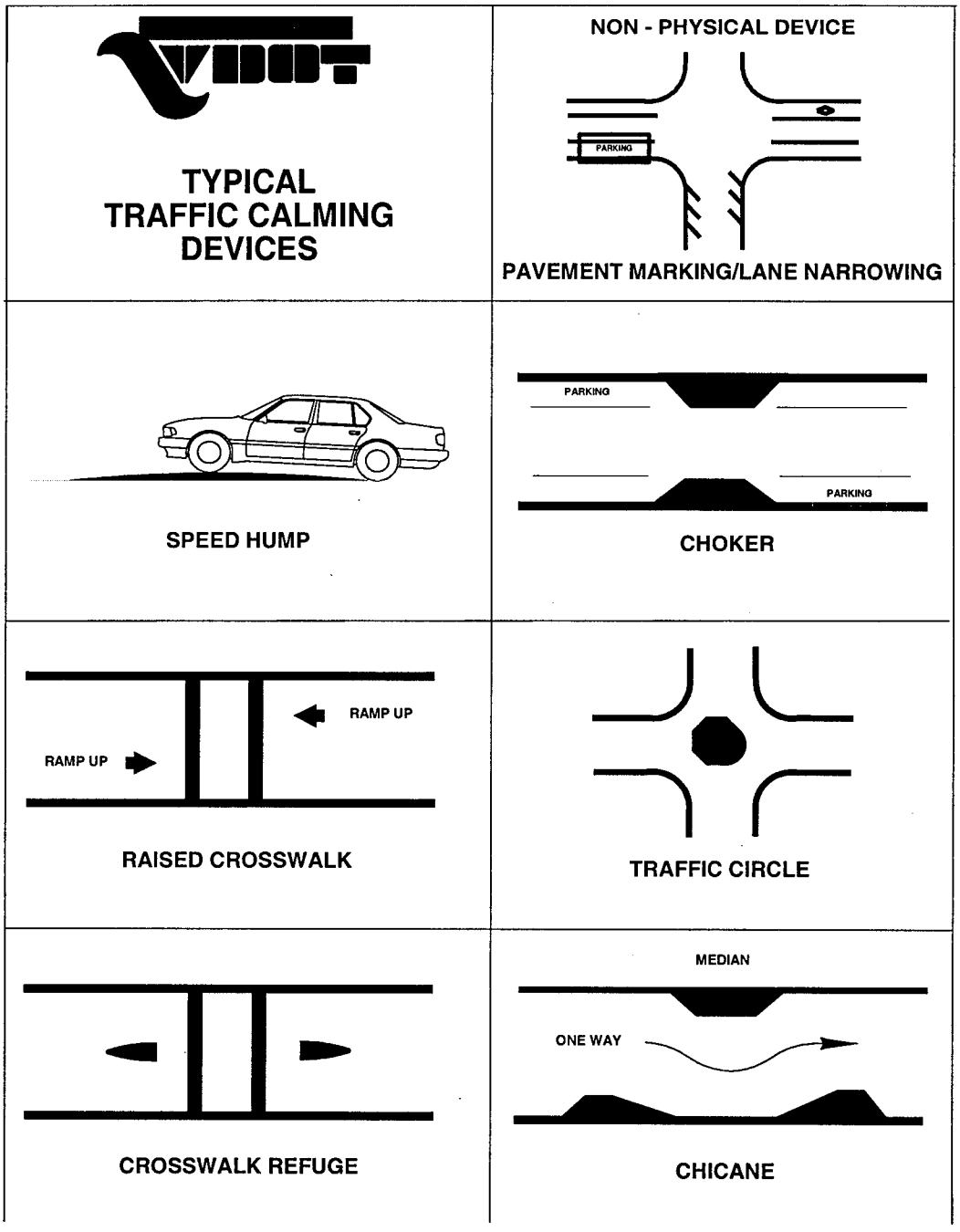


Figure 1. Typical Traffic Calming Devices. From VDOT's *Traffic Calming Guide for Local Residential Streets.*

Fewer than 600 vehicles per day

Education
Enforcement
Non-physical devices

600–4,000 vehicles per day

Education
Enforcement
Non-physical devices
Physical devices

More than 4,000 vehicles per day

Education
Enforcement
Alternative actions only
No traffic calming devices

Traffic calming measures may be funded in several ways:

- 100 percent exclusively county-generated or other funds (no VDOT funding)
- revenue sharing funds with 50 percent exclusively county-generated or other funds and 50 percent VDOT funds.
- secondary road construction funds with a maximum of 2 percent of the county's secondary road construction funds being used with a 3-year limit on its accumulation.

The *Guide* can be practically applied to all counties in Virginia. However, if a particular county believes that minor modifications are necessary to serve the needs of its citizens, modifications may be requested. The request must be agreed upon and approved by the local VDOT representative. An optional point system using accidents, average daily traffic, and speeds as input is provided as a tool for counties to use to prioritize traffic calming projects. An Implementation Guide for Traffic Calming Measures including information on the design and installation of traffic calming measures and typical drawings for seven traffic calming measures are in the appendix. There are 30 pages in the *Guide*.

PURPOSE AND SCOPE

The purpose of this research was to evaluate the *Guide*. The primary means for accomplishing this was by evaluating its application in the pilot program and whether its procedures were accurate and up to date. Since the output or deliverable of the *Guide* is an

implemented traffic calming plan, a secondary objective was to evaluate the implemented traffic calming plans to determine if they were effective in reducing speeds. The results of the evaluation enabled VDOT to strengthen the *Guide* based, to a large extent, on the lessons learned in the pilot program and prepare for effective statewide implementation of this customer service oriented program.

The *Guide* was primarily evaluated based on experiences by each county and VDOT staff applying it in case studies, what worked well and what did not, what caused problems, better ways to perform various aspects of the *Guide*, etc. A second tool was also used to evaluate the *Guide:* a survey of VDOT district traffic engineers and resident engineers. Its purpose was to collect information about traffic calming activities that were not under the auspices of the pilot program in order to assess whether the pilot program as written encompassed all elements of traffic calming in the state. The effectiveness of the implemented traffic calming plans was based on comparing before and after studies to assess the impact on speeds. This study was limited because only those measures selected to be implemented by the pilot county were evaluated.

METHODS

The following tasks were performed:

1. *Inventory of the information needed for the evaluation.* The purpose was to identify the information needed, how it was collected, and the questions to be answered in the evaluation. The measures of performance were determined.

2. *Monitoring of the pilot program during the evaluation process.* The following counties were selected by the RTCC for the pilot program: Albemarle, Chesterfield, Fairfax, Hanover, Loudoun, Prince William, Spotsylvania, and York. The information gathering depended heavily on the cooperation and coordination with the residency and district staff. Quarterly reports, periodic meetings, site visits, and contacts with VDOT staff involved with the pilot program were used for the monitoring. The traffic calming plans and before and after study data were obtained at the RTCC meeting or by mail as a follow up to the exchange at the meeting.

3. *Survey of VDOT and county staff in the pilot program.* A questionnaire survey was distributed by email to VDOT residency and district staff that had a major role in the pilot program (see Appendix A). A similar survey of county staff was conducted. The survey was divided into two parts: the process used by a particular county and VDOT, and each project considered during the pilot for that county. The survey was a follow up to the monitoring of the pilot program and served to fill in gaps where information was not available and on what activities transpired and to provide opinions, ratings, and assessments on selected aspects of the *Guide*.

4. *Survey of other traffic calming tools.* A survey entitled "What's Happening in Traffic Calming in Your Area?" was sent to the nine district traffic engineers and 52 resident

engineers (see Appendix B). The purpose was to collect information about traffic calming activities that were not under the auspices of the pilot program to assess whether the *Guide* as written encompassed all elements of traffic calming in the state. It focused on several measures that relate to reducing speeds but not specifically listed in the *Guide*.

5. *Development of a revised guide and an implementation plan.* The results of the monitoring and surveys of the pilot program were used as input for this task. A ballot consisting of the concerns and issues identified in the pilot program was completed by the RTCC and tabulated by the research team.

The RTCC was a focal point for the activities undertaken in this study. The update on the status of traffic calming activities for each county was a key part of the periodic meetings of the RTCC. The results of Task 3, survey of VDOT and county staff, was presented at a RTCC meeting as a starting point to identify aspects of the *Guide* to revise. The RTCC also went through the *Guide* page by page identifying possible changes. A ballot of potential changes to the *Guide* was produced and completed by the RTCC (Task 5). In a RTCC meeting, the ballot results were discussed and consensus was achieved for the outstanding issues. Subsequent to this meeting, a couple of issues were resolved through an exchange of emails among RTCC members. The survey and ballot were tools that aided the RTCC by identifying issues to consider for revision. The consensus of the RTTC was the driving force in revising the *Guide*.

RESULTS AND DISCUSSION

Inventory of Information

A list of information needed for the evaluation was developed to describe the type of information that would be useful in the monitoring and evaluation of the *Guide*. Table 1 presents the list provided to VDOT staff from the participating pilot program counties. The information was grouped in three parts: pilot program monitoring and information exchange, neighborhood plan, and county process.

Pilot Program Monitoring and Information Exchange

Prince William County

Staff from VDOT's Northern Virginia District and Manassas Residency met with the county's planning staff in January 1998 to implement the program in the county. A general procedure was agreed upon and carried forward to the county's board of supervisors. The procedure was subsequently formalized as the county's "Policy on Traffic Management in Residential Areas,"[2] and approved by the BOS in Resolution No. 98-179 dated March 3, 1998.

Table 1. Inventory of Information Needed from VDOT Residency and District Staff for Evaluation of *Guide*

Pilot Program Monitoring and Information Exchange

1. Prepare and present reports at RTCC meetings.
2. Participate in discussions at meetings, by phone and in writing.
3. Inform VTRC staff of schedule for key meetings.

Neighborhood Plan

General

1. Prepare a file of information on each neighborhood. Brief minutes of all meetings are requested. (The following three items may be in this file.)

Support Data

2. Describe the problem, including the support data and other information.

Plan Development

3. Describe how the plan was developed.
4. Describe the plan.

Approval and Implementation

5. Describe the approval and implementation process, including the use of temporary and permanent devices.

Evaluation and Follow-up

6. Describe the results of the after study.
7. Describe the process to obtain feedback from the residents and the results, including satisfaction with the devices, layout, and the process.
8. Describe any changes made to the devices or traffic calming layout.

County Process

General

1. Prepare a file of information on agreements and processes established for each county and VDOT. Brief minutes of all meetings are requested.

Selection Process

2. Describe the process used to select the sites that were eligible for plan development including, as appropriate:
   - how potential neighborhoods/sites were identified and how many,
   - how the list of potential neighborhoods/sites were short-listed and how many (specify reasons for eliminating sites),
   - how the list of eligible neighborhoods/sites were prioritized,
   - how many neighborhoods/sites had plans developed, and
   - how many plans were implemented.

The procedure set forth in the policy was subsequently adopted by several other pilot counties and is referred to in other sections of this report as the Prince William County procedure. An excerpt from the policy is shown in Figure 2. In addition, the county published a *Residential Traffic Management Guide*[3] that provided details on a number of VDOT policies and programs available to address residential traffic problems.

The purpose of this policy is to establish uniform criteria throughout the county for the two year pilot program on the installation of physical traffic calming measures such as speed humps, traffic circles, and other approved measures. Prince William County shall use the following criteria and process to determine whether or not such traffic calming measures would be supported by the Virginia Department of Transportation (VDOT), the community and the Board of County Supervisors.

1. The Board of County Supervisors submits a list of proposed streets to the Department of Public Works for installing physical traffic calming measures.

2. The Department of Public Works collects any necessary data to determine if the proposed locations meet VDOT requirements for installing traffic calming measures. The criteria used for evaluation are as follows:

   a) Average Daily Traffic (ADT) counts should range between 600-4,000 vehicles per day.

   b) The posted speed limit must be 25 mph.

   c) The road should be functionally classified as a local residential street or collector and does not serve as the primary access to commercial or industrial sites.

   d) There should be a minimum of 12 homes per 1,000 ft. of roadway with homes on both sides of the street.

3. The Department of Public Works submits the collected data to VDOT for review.*

4. VDOT evaluates the roads and determines which ones are eligible for physical traffic calming measures. The time for review will be approximately 2-3 weeks. VDOT will send a list of acceptable projects to the Department of Public Works.

5. Each County Supervisor can select one project for the pilot program. The Supervisor informs the citizen that a petition from 75% of the citizens living on the road is required. A petition requesting implementation of traffic calming measures on the residential road is circulated.

6. A resolution is drafted for Board approval that identifies a source of funding as well as a limit of funding, which is not to exceed $15,000. The signed petition representing 75% of the citizens living on the road will be attached to the resolution and sent to VDOT.

7. VDOT and the Department of Public Works will hold joint community meetings to start a plan development process. A committee will be selected comprised of citizens representing all viewpoints of the community as well as representatives from VDOT and the Department of Public Works.

8. The committee will develop a proposed traffic management plan for the road in question. This plan will include which form of traffic calming device(s) would be most appropriate for the road being studied.

9. The traffic management plan developed by the committee will be presented to the community. A two week review process will be allowed in order to receive public comments.

10. Public Works will compile public comments and provide a summary to the affected supervisor.

11. A board item will be drafted for the Board's approval.

12. If the Board approves the resolution, then VDOT will install the agreed upon traffic calming measures. It will take VDOT approximately eight weeks to design the project and three or four months to install the traffic calming measures.

* The county's traffic management guide requires that speed samples also be included in the submittal to VDOT.

Figure 2. Policy on Traffic Management in Residential Areas.[2] Excerpt from Prince William Board of County Supervisors.

The county initially identified approximately 25 communities and 100 roads to evaluate; however, a number of the roads were minor arterials and the county was advised by VDOT to remove them from further consideration. Eligibility data were collected on 49 roads, and speed data were collected on only 20 roads. The results of the speed studies led county staff to conclude that the speeding problem was one based more on perception than reality. The county submitted the eligibility data and a proposal to consider four roads for project implementation. Three of the four received VDOT support, with minor exceptions being granted in two of the cases for average speeds being less than the 30 mph average speed criterion. The fourth road received tentative support pending a reevaluation because of the installation of a multi-way stop intersection and "Through Truck Restriction" signs, neither of which was under the auspices of the pilot program. It was felt that either of these factors could influence citizens' desire to proceed further. VDOT and county staff then met to discuss and reach consensus on the boundaries of the petition and impact areas.

By the end of the pilot period in December 1999, two projects were inactive and two were active. Public hearings were held for both proposed plans and the projects were awaiting completion of the petitions and a county resolution. The anticipated county funds for revenue sharing were depleted, and implementation was not expected until mid-2000. Accordingly, no projects were developed under the auspices of the pilot program.

Chesterfield County

Prior to the implementation of the pilot program, speed humps had been installed by VDOT in a couple of county subdivisions, and Chesterfield County had subsequently developed a list of about 60 subdivisions that were potential candidates for traffic calming projects. These earlier speed humps had proved to be largely unsuccessful in reducing volumes and speed and had been harshly criticized by residents of the neighborhoods. Because of this, and because county staff and the board of supervisors viewed the draft traffic calming guidelines as burdensome and cumbersome, the county was reluctant to enthusiastically embrace VDOT's *Guide* and set out to develop its own procedure for implementing a traffic calming program.

This effort never came to fruition, and the county ultimately implemented a single traffic calming project under the auspices of the pilot program. Using secondary road funds, VDOT installed two 3-inch speed humps on a short section of Larkspur Road with the goal of reducing speeding and traffic volumes (see Figure 3). The procedures in the *Guide* were essentially followed with the exception that the board of supervisor's resolution supporting the project came at the end of the process rather than at the beginning. Instead, county staff initiated the request with VDOT, and the Richmond District Traffic Engineering Section collected the supporting data. The street met the eligibility requirements as there was a documented speeding problem and the average speed on the street was 32.8 mph. VDOT and county staff met and agreed on the petition and impact areas, which were determined to be the same because a single neighborhood surrounded the one short street in question. A petition was signed by more than 75 percent of the neighborhood, and residents on Larkspur Road participated with VDOT, county staff, and fire and rescue personnel in the development plan for the project. Finally, a

Figure 3. Speed Hump on Larkspur Drive

public meeting was held, and the county board of supervisors passed a resolution requesting the humps.

A before and after speed study was undertaken on Larkspur Road by the district traffic engineering section, and a summary of the results is given in Table 2. Total two-way volume was reduced slightly by about 4 percent; however, the reduction in speeds was much more significant. Average speeds were reduced from 33 to 21 mph, or 35 percent, and 85th percentile speeds were reduced from 36 to 23 mph, or 37 percent.

Table 2. Summary of Results from Before and After Studies

County	Location	Measures Implemented	% Change Vehicles/ Day	% Change Avg. Speed	Change B to A (mph)	% Change 85% Speed	Change B to A (mph)
Chesterfield	Larkspur Rd.	2 humps	- 4	- 35	33 to 21	- 37	36 to 23
Spotsylvania	Green Arbor Dr.	2 humps 1 circle	- 12	- 17	29 to 24	- 18	34 to 28
Spotsylvania	Fox Point Rd.	6 humps	- 21	- 15	26 to 22	- 18	33 to 27
Fairfax	Powhatan St. (North end)	4 humps 1 raised crosswalk	- 31	- 23 NB - 11 SB	35 to 27 27 to 24	- 17 NB 0 SB	36 to 30 30 to 30
Fairfax	Powhatan St. (south end)	4 humps 1 raised crosswalk	- 31	- 33 NB - 33 SB	36 to 24 36 to 24	- 23 NB - 23 SB	39 to 30 39 to 30
Fairfax	Fairwood Ln.	2 humps 2 AWSC 1 raised crosswalk	+ 1	- 23 NB - 31 SB	35 to 27 36 to 25	- 14 NB - 23 SB	35 to 30 39 to 30

Little feedback was received from the residents. About a half dozen calls opposing the installation were received by VDOT. Shortly after the installation, however, VDOT received complaints that motorists were riding through the neighborhood at all hours of the night blowing their horns and yelling and that teenagers were speeding across the humps to cause as much noise as possible. No changes were made at the site, and complaints eventually stopped.

The residents along Fairwood Lane in the Providence District also adopted a calming plan and forwarded it to the county board for approval in early September 1999. Five measures were installed: two multi-way stops, two speed humps, and one raised crosswalk.

A before and after speed study on Fairwood Lane was undertaken by the district traffic engineering section, and a summary of the results is given in Table 2. Total two-way volume remained essentially the same, increasing just slightly by 1 percent. Speed reductions were more significant, with the average being reduced 8 to 11 mph, or 23 percent to 31 percent, and the 85th percentile being reduced 5 to 9 mph, or 14 percent to 23 percent.

Fairfax County

On September 8, 1997, the Fairfax County Board of Supervisors directed county staff to work with VDOT on the pilot program and requested that VDOT designate $100,000 in the FY 99 secondary road construction budget to fund recommended projects. A traffic calming engineer was hired by the county to develop and run a calming program. Subsequently, the county adopted the Prince William County procedure (see Figure 2). Ten neighborhoods (one per magisterial district) that met the technical criteria (local residential street, 25 mph posted speed limit, and average speeds ≥5 mph) were identified. Each neighborhood then proceeded to collect the required signatures on the petition and initiated plan development. Ultimately, two projects were implemented in late 1999 within the pilot period.

The residents along Powhatan Street in the Dranesville District adopted a traffic calming plan and forwarded it to the county board of supervisors for approval in late July 1999. Five measures were installed: four speed humps and one raised crosswalk. Before and after speed studies at the north and south ends of Powhatan Street were undertaken by the district traffic engineering section, and a summary of the results is given in Table 2. Total two-way volume reduction was 31 percent at both ends. Average speed reductions ranged from 3 to 12 mph, or 11 to 33 percent. The 85th percentile speed reductions ranged 0 to 9 mph, or 0 to 23 percent.

Spotsylvania County

The county board of supervisors endorsed the pilot program in early 1998. The residency had previously collected data in the Timbers/Camelot subdivision to address cut-through traffic concerns. By the spring, however, the county had lost some of its enthusiasm, apparently because of the magnitude of its responsibilities in the *Guide*. Concerns included the 75 percent requirement for signatures on the petition, the desire for all-way stop control that was not included in the procedures being piloted, and the required county funding.

The county initially selected three subdivisions as possible candidates for the pilot program: Timbers/Camelot, Enchanted Woods, and Chancellor Green. Each had a single spine road carrying between 1,000 and 2,000 vehicles per day (vpd). Speed and volume surveys were conducted by the offices of the district traffic engineer, and average speeds were just shy of 30 mph, with the 85th percentile speed falling between 32 and 35 mph. Although the average speed criterion of ≥5 mph was not met, the residency decided to move forward with the program in all three subdivisions because of the significant volume in the higher speed ranges (35 mph and above).

The Timbers/Camelot Subdivision was the only one of the three where a petition was completed. The process was initiated in late April 1998 when the county sent a letter to the residents that explained the program and circulated the petition. Figure 4 shows the petition.

PETITION TO THE SPOTSYLVANIA COUNTY BOARD OF SUPERVISORS REQUESTING TRAFFIC CALMING DEVICES
IN
THE TIMBERS AND CAMELOT SUBDIVISIONS

Whereas, spreading and cut-through traffic has become a problem along Green Arbor Drive and,
Whereas, the Virginia Department of Transportation has developed and approved the Residential Traffic Calming Guide and,
Whereas, the Traffic Calming Guide was developed to address spending and cut-through problems in residential districts and,
Whereas, the Virginia Department of Transportation has conducted a speed study along Green Arbor Drive, which confirmed that a speeding problem does exist and,
Whereas, the Traffic Calming Guide has been explained by letter to the residents of the affected subdivisions,
The undersigned residents of the Timbers and Camelot Subdivisions hereby request that the Spotsylvania County Board of Supervisors pass a resolution requesting that the Virginia Department of Transportation begin the implementation process for traffic calming measures in the Timbers and Camelot Subdivisions.

NAME OF RESIDENT	ADDRESS

Figure 4. Sample Petition (from Spotsylvania County)

Approximately 79 percent (based on 394 county-verified signatures of the 444 signatures obtained) of the total property owners responded favorably. The Civic Association reported that residents were most interested in all-way stop signs in combination with speed humps and were most concerned with the negative impacts on other streets if measures were installed only on Green Arbor Drive.

On September 8, 1998, the county board of supervisors passed Resolution No. 98-83 that supported implementation of traffic calming measures in the Timbers subdivision. Representatives from the Civic Association agreed to distribute a flyer to all residents explaining the timeframe for installation and that the measures were being installed on a trial basis to obtain feedback on the location and installation of permanent devices. Based on the plan developed, on November 4, VDOT installed two speed humps (between Albany Street and Burlington Drive and between Clarence Drive and Switchback Lane) on Green Arbor Drive and one traffic circle at the intersection of Albany Street and Green Arbor Drive (see Figures 5 and 6). A school bus provided by the county was used to "lay out" the traffic circle in the field, which was installed on a temporary basis using flex posts. This was done to ensure that school buses and other similar large vehicles could safely maneuver around the traffic circle.

Community meetings were held in April and June 1999 and minor changes in signing and pavement markings were made to the installations. Also, header curbing to prevent circle run-around was installed at the Green Arbor/Albany intersection. The neighborhood was generally supportive of the measures and the traffic circle was made permanent with curbing and landscaping (Figure 6). Based on neighborhood recommendations, three additional speed humps were installed on Green Arbor Drive and one was installed on Durham Drive, a parallel street. All costs were funded from the county's secondary road construction funds.

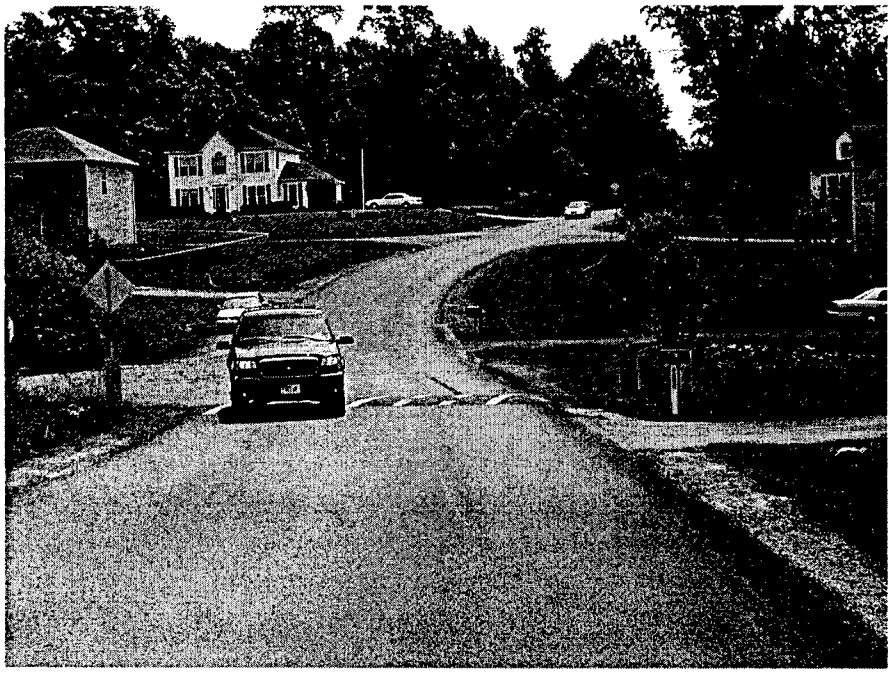


Figure 5. Speed Hump on Green Arbor Drive

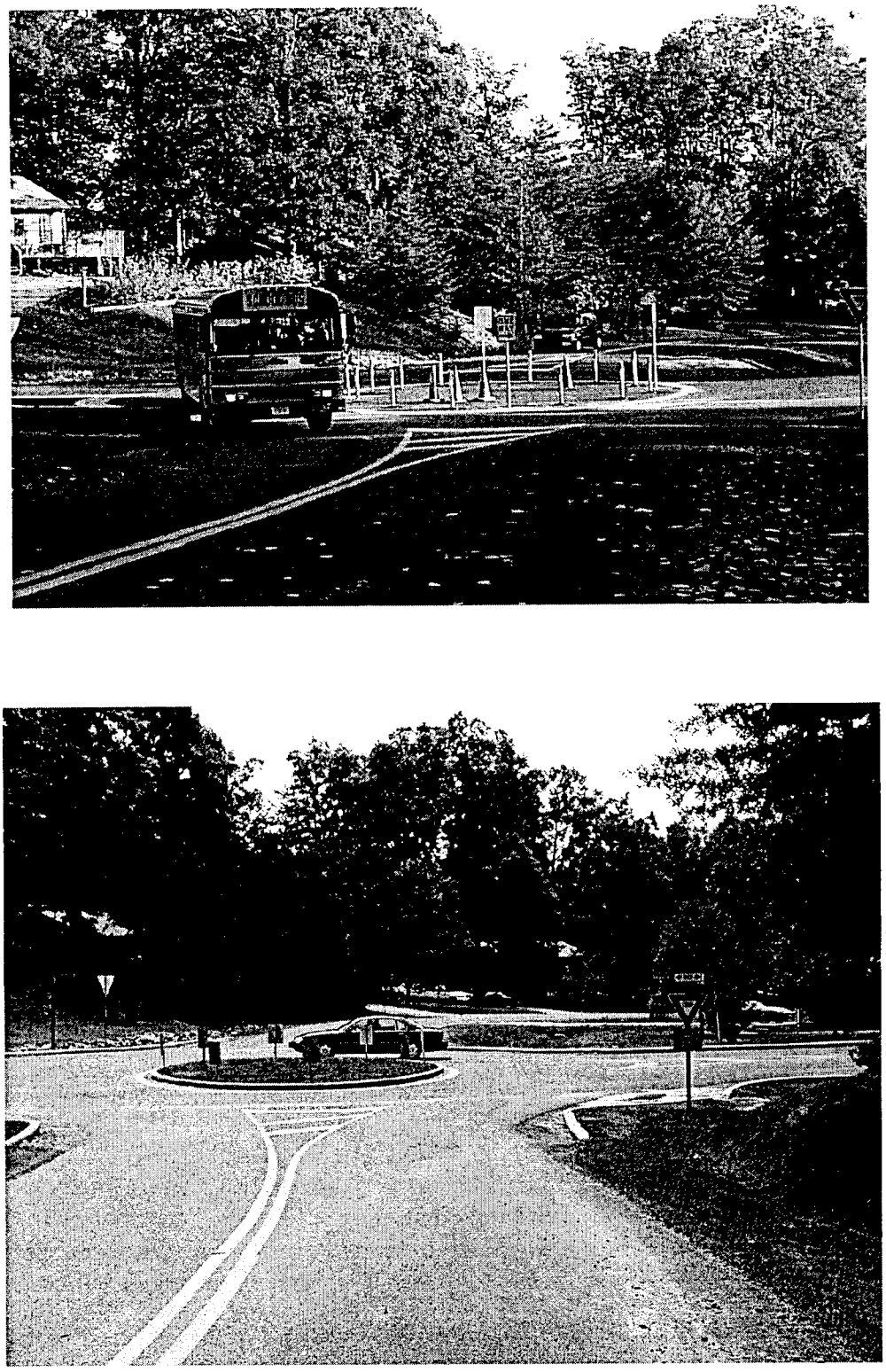


Figure 6. Traffic Circle on Green Arbor Drive. Top, permanent circle; bottom, temporary circle.

The cost of the initial two speed humps and temporary traffic circle on Green Arbor Drive was approximately $8,000. One hump was 3 inches and one was 4 inches, with the higher one appearing to be more effective in reducing speeds.

A before and after speed study was undertaken on Green Arbor Drive by the district traffic engineering section, and a summary of the results are given in Table 2. Total two-way volume was reduced by about 12 percent. Average speeds were reduced from 29 to 24 mph, or 18 percent, and 85th percentile speeds were reduced from 34 to 28 mph, or 18 percent. Residency personnel concluded that the project was a reasonable application of the traffic calming program. A small contingency of passionate residents, however, ended up pushing their desires through the "county oversight" portions of the program with little supervision, and perhaps little involvement outside of their group. They secured the 75 percent petition; however, there was some argument over its credibility.

A before and after speed study on Fox Point Road was undertaken by the district traffic engineering section, and a summary of the results are given in Table 2. Total two-way volume was reduced by about 21 percent. Average speeds were reduced from 26 to 22 mph, or 15 percent, and 85th percentile speeds were reduced from 33 to 27 mph, or 18 percent. Figure 7 shows a speed hump on Fox Point Road.

Figure 7. Speed Hump on Fox Point Road

Albemarle County

In December 1997, staff from VDOT's Charlottesville Residency and VDOT's Culpeper District Traffic Engineer met with planning and engineering staff from Albemarle County to discuss and initiate the residential traffic calming pilot program. Subsequent to the meeting, the county board of supervisors endorsed the pilot program and a local traffic management pilot program committee was established. Over the course of several meetings in early 1998, the committee agreed to use revenue sharing (50 percent county funds and 50 percent VDOT funds) to fund pilot projects, adopted the Prince William procedure (see Figure 2), and identified four general subdivisions and areas that would be targeted for pilot projects. County staff and police had received speeding and cut-through traffic complaints at these four sites.

A close review of these sites revealed that none of the locations qualified for the traffic calming program under the pilot guidelines. All four locations had posted speed limits of 35 mph, and one location was not a local residential street. Rather than change any of the pilot criteria, which is an allowed option in the *Guide* if the county and VDOT concur, it was decided in this case to maintain these two qualifying criteria. This action effectively ended the pilot program in Albemarle County.

However, the meetings and discussions between the county and VDOT resulted in several "traffic calming" projects being undertaken by VDOT outside the auspices of the pilot program. The posted speed limit was reduced on two residential streets. After repaving or overlaying projects, the lane widths were reduced to 9 feet and centerlines and edge lines were painted with 4-inch markings on several streets. In the latter case, a paved bicycle and pedestrian lane was also added.

Hanover County

A request from Hanover County in the spring of 1998, resulted in its being added to the list of seven counties participating in the pilot program. Three subdivisions were considered in early deliberations; however, a board of supervisor resolution was never submitted to VDOT. The county noted an intention of funding any calming projects strictly with private money. In the spring of 1999, the county identified another subdivision and VDOT staff met with several residents. There was widespread support in the neighborhood, and residents were interested in paying for the improvements themselves. A petition was also circulated to obtain the needed signatures. Based on a VDOT speed study, however, none of the streets being considered for calming had average speeds of 5 mph or greater over the posted speed limit of 25 mph and thus did not qualify for calming under the draft guidelines. By late 1999, VDOT and the county had received a number of additional inquiries; however, no projects were developed under the auspices of the pilot program.

Loudoun County

In early 1998, the board of supervisors adopted a resolution supporting traffic calming and was briefed on the program by VDOT staff. The board adopted the Prince William County procedure (see Figure 2) and began collecting the technical data in two subdivisions that would qualify them for the program. Plans for projects in these two neighborhoods were never developed, and activities under the auspices of the pilot program ceased. In early 1999, the county initiated the process in four neighborhoods; however, again, no projects were developed under the pilot program. It was reported that the $200 additional fine sign and multiway stop signs were considered in several neighborhoods in response to concerns about speeding.

York County

VDOT had previously installed a choker in response to neighborhood concerns about speeding. It had been funded through revenue sharing and was not considered a part of the pilot program. Additional efforts in the subdivision included narrowing of lanes and painted stop bars and crosswalks. The traffic calming program was presented and discussed at a board of supervisor's work session, with emphasis on the fact that it was county driven. No follow up or feedback was ever received from the board of supervisors. Inquiries about traffic calming were received periodically during the pilot period; however, no feedback was ever received once the program brochure was provided. Interest in the program seemed to disappear once the required effort by the county/residents was realized. It was reported that the $200 additional fine sign was being considered in several neighborhoods in response to concerns about speeding.

Summary

A summary table displaying a view of the activities by county is shown in Table 3. Of the eight counties, four did not complete the first activity in the *Guide*. One county stopped before completing the second activity. Three counties completed the procedures provided in the *Guide* and implemented five traffic calming plans. Two counties that did not complete the first activity in the *Guide* were reported to be considering the "additional $200 fine sign." One county included the "Watch for Children" and the "additional $200 fine sign" in their residential traffic management guide.

Survey of VDOT and County Staff

Responses were received from five of the eight VDOT offices (62.5 percent) and six of the eight county offices (75 percent). One county submitted responses from three Board of Supervisor members; these responses were combined with the response from the county staff to generate one response for the county. In addition to supplementing the data obtained in the monitoring process, the key use for this effort was to identify features of the Guide that the RTCC should examine for revisions. Concerns that were identified include the qualifying criteria, adding more traffic calming measures, and time line for conducting the process.

Table 3. Activities Completed by County Programs

Activity	County							
	Albemarle	**Chesterfield**	**Fairfax**	**Hanover**	**Loudoun**	**Prince William**	**Spotsylvania**	**York**
BOS resolution w/support data to VDOT	No problem	✓	✓	No problem	Process started but no follow through	✓	✓	County lost interest when role identified
Traffic calming plan developed		✓	✓			No plans completed within pilot period	✓	
County-VDOT approved plan			2 plans				2 plans	
Plan implemented		2 speed humps	P1: 4 speed humps, 1 raised crosswalk P2: 2 AWS, 2 speed humps, 1 raised crosswalk				P1: 5 speed humps, 1 traffic circle P2: 6 speed humps	
Project evaluated		✓	✓				✓	

Survey of Other Traffic Calming Tools

Since only three of the eight pilot counties installed a traffic calming plan, the RTCC believed that other traffic calming tools might be addressing concerns that were expected to be addressed by the *Guide*. Therefore, a survey was conducted on the use of other traffic calming tools. Responses to the survey were received from seven districts (there were two responses from Northern Virginia) and 20 residencies. In addition, three residencies deferred to the district response. Effectively, therefore, there were 31 responses.

The findings are tabulated in Appendix C and are summarized here:

1. A number of districts and residencies have installed the "$200 Additional Fine" sign, the "Watch for Children" sign, and multi-way stop signs.

2. No respondents have installed pavement markings that narrow the roadway (though this has been done in Albemarle County).

3. All these measures received some positive response for their effectiveness; however, there have been essentially no formal before and after studies undertaken to verify their effectiveness.

4. Other traffic calming measures reported by VDOT include installing "School Bus Stop Ahead" signs, lowering speed limits on secondary roads, installing "Maximum

Safe Speed" signs on curves, chokers, rumble strips, roundabouts, a system of raised crosswalks, and "Through Trucks restricted" signs.

5. Additional traffic calming measures by localities includes the use of radar speed display trailers.

SELECTION OF REVISIONS TO THE *GUIDE*

Based on general information collected about the pilot programs, the findings from the surveys, and discussions with members of the RTCC, a number of potential changes to the *Guide* were suggested to the RTCC by the researchers. These potential changes were sent to the RTCC for balloting. Detailed information on the ballot and the results are contained in Appendix D. The changes that were ultimately recommended through RTTC consensus are provided in the Recommendations section of this report.

The changes suggested by the researchers and the source of these suggestions were as follows:

1. Clarify that the intent is for secondary roads by modifying the title (the RTCC).

2. Clarify in the Introduction that the county has the lead role (the RTCC).

3. Clarify/state more clearly the county's role regarding the design of new subdivisions and calmed streets (the RTCC).

4. Eliminate the requirement of "a minimum of 12 dwellings fronting the street per 1,000 feet of roadway, including both sides" (county survey).

5. Change the speeding criterion: 85th percent speed ≥10 mph over the posted speed (county survey).

6. Add a speeding criterion that 5 percent of the vehicles must be traveling >35 mph (VDOT survey).

7. Make residential streets with posted speed limits >25 mph eligible (county survey).

8. Change the requirements to allow the initial county submittal to include only technical requirement information, with the petition submitted later if the technical requirements are met (county survey).

9. Change the 75 percent requirement for the petition; it is too high (county survey).

10. Change the requirements so that the petition is obtained after the plan has been developed rather than in the beginning (county survey).

11. Emphasize (require?) the need for community meetings to present the proposed traffic calming plan (county survey).

12. Expand the list of physical measures to include a raised median island as a stand-alone measure (county survey).

13. Review both the design details and the costs of the physical measures in the *Guide* for accuracy (VDOT survey).

14. Reduce the number of signs required in the traffic calming plans (VDOT survey).

15. Make the markings and signs consistent with those proposed for the 2000 MUTCD (VDOT survey).

16. Establish a time line for the process (county survey).

17. Rename "traffic calming devices" to "traffic calming measures" (the RTCC).

18. Include the "Watch for Children" Sign program under VDOT's Residential Traffic Management Program (the RTCC).

19. Include the "Additional $200 Fine" Sign Program under VDOT's Residential Traffic Management Program (the RTCC).

STUDY LIMITATIONS

It was envisioned that since the seven pilot counties were chosen because of their interest in traffic calming, there would be many traffic calming plans implemented. However, only three counties developed and implemented a total of five plans. It would have been useful to evaluate the pilot program's activities with full implementation of two or more projects in more counties with different personnel and under different operating environments. Nonetheless, the experience gained was valuable in revising the guidelines.

CONCLUSIONS

- All three funding options in the *Guide* are viable alternatives as all were used or proposed to be used by at least one of the pilot counties.

- The detailed procedure developed by Prince William County for implementing VDOT's program shown in Figure 2 provides a good model for counties considering traffic calming in the future. In fact, several of the pilot counties adopted their procedure.

- As demonstrated by the pilot in Albemarle County where traffic calming projects were implemented outside the scope of the pilot, VDOT's program can provide benefits to residents simply by creating an increased awareness of neighborhood problems that can then lead to the creation of alternative strategies to mitigate the identified problems.

- A documented procedure for justifying and implementing a traffic calming program is vital to success as evidenced by the experience in Chesterfield County.

- In the case of a large county with a number of potential traffic calming projects, e.g., Fairfax County, a traffic calming engineer to manage the required data collection and comprehensive citizen involvement is a valuable, if not necessary, addition to the staff.

- As observed in several of the pilot counties where speeding was considered a problem, speed studies documented actual average speeds of less than 5 mph over the posted speed limit. This suggested that residents simply perceived speeding as a problem.

- Based on the experiences in Prince William and Loudoun counties, the $200 Additional Fine Sign Program is easier to implement than the traffic calming program.

- As informally agreed to by VDOT and Spotsylvania County, a potential county-specific addition to the speeding criterion is a speed study finding that there are a significant number of vehicles traveling in the higher speed ranges, particularly 35 mph and above.

- Several important operational and implementation features of traffic calming measures were demonstrated in the Spotsylvania projects:

  —The effectiveness of a series of physical measures on a given street is reduced if the distance between them is large.

  —The potential negative impacts of traffic and speeding on adjacent streets should be considered when physical measures are contemplated.

  —A school bus or other large vehicle should be used in "laying" out a traffic circle at an intersection.

  —At intersections with traffic circles, the installation of "header" curbs is necessary on streets without curb and gutter to eliminate the tendency of motorists to attempt to maintain their speed by traversing the shoulders as they navigate the circle.

  —If a traffic circle is recommended, a low-cost first step is the installation of temporary devices that can be removed easily if not accepted by residents.

  —Many residents felt the use of the word "hump" on the signing for a traffic hump is not appropriate because of its potential as a target for graffiti artists.

— A 3-inch hump is relatively ineffective, and a 5-inch hump, although clearly reducing speed, can cause significant jarring and potential vehicle damage if not traversed very slowly. A 4-inch hump is effective in achieving the desired speed reduction without the significant negative impact of the 5-inch hump.

- As experienced in Spotsylvania County, it may be better to coordinate with homeowner associations and county staff rather than with a small group of passionate residents while developing the traffic calming plans for the neighborhood. It is important to let the county exercise its "oversight" role in the program and VDOT exercise its technical expert role. All residents need to understand the county's responsibility and accountability in involving all affected homeowners before asking VDOT to install measures.

- As observed in several of the pilot counties, including York County, the excitement over and clamor for neighborhood traffic calming from both the counties and residents subsided significantly when the pilot program was introduced and the extent of the local involvement and funding required was understood.

- The traffic calming process defined in the Guide requires an evaluation of traffic calming plans that are implemented. As documented in the before and after studies conducted to evaluate the six plans implemented in the pilot program, speed humps, traffic circles, and raised crosswalks proved to be effective in decreasing traffic speeds in residential areas. This conclusion is also supported by a number of studies reported in the literature. Finally, this conclusion supports the validity of these three measures being promoted in the Guide as viable measures for a county to consider in developing its traffic calming plan.

- Other measures are being used throughout the state to "calm" traffic. The measures being used the most are the "$200 Additional Fine," "Watch for Children," and multi-way stop signs. Several other measures have minimal usage.

- The "$200 Additional Fine" and "Watch for Children" signs already have their own statewide VDOT programs and therefore do not need to be added to the traffic calming program. VDOT's Northern Virginia District has a multi-way stop sign policy; however, there is disagreement whether multi-way stop signs reduce speed. Accordingly, multi-way stop signs do not need to be added to the program as a traffic calming measure. The use of multi-way stops could be considered as a county-specific modification to the Guide if the appropriate steps are followed. The few other measures being used to "calm" traffic need not be added to the Guide.

RECOMMENDATIONS

Based on the results of the ballot sent to the RTCC and subsequent discussions at a meeting of the RTCC, the following recommendations for revision to the *Guide* were made and adopted by VDOT. The revised *Traffic Calming Guide for Residential Streets*[4] is provided in Appendix E.

1. Clarify that the *Guide* is intended for implementation on secondary roads in subdivisions by revising the title to *Traffic Calming Guide for Local Residential Streets.*

2. Couch and promote all of VDOT's neighborhood programs under a Residential Traffic Management Program (RTMP). Clarify that traffic calming is one of five tools in the RTMP by adding the following as a Preface, which identifies all the tools in the program:

   Since the late 1980s, the Virginia Department of Transportation (VDOT) has concerned itself with neighborhood traffic problems on streets and roadways in the state's operated and maintained highway systems.

   1. *The **Restricting Through Trucks on Secondary Highways Policy**, which was adopted in September 1988, states in part that "the Commonwealth Transportation Board, in response to a formal request by a local governing body, may prohibit or restrict the use by through trucks of any part of a secondary highway."*

   2. *The **Control of Residential Cut-Through Traffic Policy**, adopted in March 1989 and most recently revised in 1996, says in part that "VDOT will recognize the problems associated with residential cut-through traffic and implement appropriate measures wherever possible."*

   3. *Pursuant to a 1997 General Assembly amendment to the Code of Virginia regarding the installation and maintenance of "signs alerting motorists that children may be at play nearby," VDOT implemented procedures effective July 1, 1997, that allows counties to request **"Watch for Children"** signs.*

   4. *Pursuant to a 1999 General Assembly amendment to the Code of Virginia regarding the "maximum speed limits in certain residence districts, penalty," VDOT implemented procedures on June 17, 1999, that allow local governing bodies to request signs on local residential streets, collector streets, and minor arterials with a posted speed limit of 35 mph or less advising motorists of a maximum punishment of **$200 for exceeding the speed limit.***

   5. *The **Traffic Calming Guide for Local Residential Streets**, which was adopted in June 2001, provides communities with a traffic management tool dealing specifically with speeding, with the goal being to slow speeders in residential neighborhoods on streets classified as local.*

   *These five traffic management tools have been combined under the Department's **Residential Traffic Management Program**. Neighborhoods, through their local governing bodies, are encouraged to choose one or more of these tools to resolve traffic problems on their local streets and highways. For more information, contact*

the local office of VDOT or the Department's Traffic Engineering Division at the address below.

3. Clarify the *Guide* so that the focus is on traffic calming rather than on the other tools described in the Preface by revising the first paragraph of the Introduction as follows:

   In mid 2001, VDOT implemented the Traffic Calming Guide for Local Residential Streets that provides communities with a traffic management tool dealing specifically with speeding. The guide is based on the premise that the county and VDOT are partners in addressing a speeding problem. For purposes of this guide, the goal of traffic calming is to slow speeders in residential neighborhoods on streets classified as local. The focus is on subdivision streets. Certain collector streets that have many of the characteristics of local residential streets may also qualify for traffic calming measures.

4. Change the second paragraph of the Introduction to read as follows:

   It is important to note that traffic calming efforts generally slow traffic without restricting access. Traffic calming measures are appropriate for slowing traffic when cut-through traffic is not the problem; that is, neighborhoods typically do not qualify for the cut-through traffic program when the majority of the traffic and speeding problems are generated from within the neighborhood.

5. Clarify that the county has the lead role by adding a sentence in the third paragraph of the Introduction. In addition, clarify who the VDOT representative is by revising the last sentence in the paragraph. Accordingly, this paragraph should read as follows:

   The county will initiate and take the lead role in coordinating the traffic calming process and VDOT staff will provide technical support. The county and VDOT will determine who is responsible for a particular task where the responsible agency is not specified. For traffic calming, VDOT is represented by the local resident engineer, except in Fairfax, Prince William, and Loudoun Counties where it is the district traffic engineer.

6. Clarify the expectations for a participating county with regard to designing for "calmed" streets by rewriting and replacing the fourth paragraph of the Introduction with the following:

   Although this guide is intended for existing streets only, there is concern about preventing traffic problems from developing on new subdivision streets. In its process for reviewing subdivision development plans, participating counties should identify and address potential traffic calming as well as other traffic management concerns that may result from a new development. The review process should ensure that the developer of a new subdivision places emphasis on and address the need to design street geometric concepts that make streets less desirable for speeding and cut-through traffic. In the subdivision design review process, VDOT should also

exert its discretionary authority in applying geometric standards to discourage speeding and cut-through traffic. The county should consider planning, enforcement, and transportation together in a comprehensive approach to managing residential traffic.

Ideally, potential traffic calming concerns in new developments should be addressed with roadway design geometry changes, especially roadway width (narrowing) and road curvature. In lieu of or in addition to these geometric changes, traffic calming measures that generally serve to narrow the travel way include pavement markings delineating parking, shoulder, or bike lanes, traffic circles or roundabouts, chokers, crosswalk refuges, and short medians. The county or subdivision developers should consult with VDOT prior to submitting a plan specifying traffic calming measures on newly developed streets.

7. Place a greater emphasis on involving the neighborhood and other important participants early in the pilot program. Revise the Residential Traffic Calming Process outlined and discussed in the second section of the *Guide* by adding a new first step called "Initial Community Meeting." In addition to modifying Figure 1 in the *Guide* to reflect this new step, add the following paragraph to describe it:

   The County and VDOT may employ a number of methods to publicize the traffic-calming program and, more generally, residential traffic management tools. VDOT, in cooperation with County staff, is available for an initial community meeting. All-inclusive participation (community leaders and residents, local politicians, law enforcement, fire and emergency personnel, and county and VDOT staff) is essential for proper problem solving. Presentations made at the meeting should enhance the community's understanding about the traffic calming process, including the amount of community involvement required and the advantages and disadvantages of traffic calming. The meeting is an opportunity for the County and VDOT to learn more about the concerns of the community as well as to help the community assess its traffic concerns. County staff arranges the meeting and determines its size and scope. At this initial meeting, all participants can work together to develop a plan for continuous involvement by and communication with the community during the traffic calming process.

8. Forward data supporting the eligibility of the street to qualify for traffic calming to VDOT in order to establish eligibility prior to undertaking the significant effort of obtaining the 75 percent petition. Accordingly, revise the first sentence under the heading "Petition for traffic calming" to read:

   Once the proposed street meets the above technical criteria, a petition requesting traffic calming and signed by at least 75 percent of the total occupied households within the petition area must be obtained.

9. In addition to the crosswalk refuge, add a raised median island as a stand-alone measure. Add a schematic of a raised median island to Figure 2 in the *Guide,* develop

a design detail sheet and add it to the Appendix, and add the following to the fifth section:

F. *Raised Median Island*

Description: a raised median in the middle of the roadway.

Placement: should accommodate normal turning radii near intersections where applicable; placed in the middle of the roadway with proper warning signing and delineation.

Advantages: reduces speeds, shortens pedestrian crossing time and distance.

Disadvantages: drainage problems, maintenance costs, expensive.

Estimated cost: $5,000-$15,000 per island.

10. Review the design details and the costs of the physical measures in the *Guide* for accuracy and revise them accordingly.

11. Establish a procedure whereby all markings and signs are reviewed by the RTCC to ensure consistency with the 2000 edition of the *Manual on Uniform Traffic Control Devices* (MUTCD).

12. Since the term "devices" has a specific connotation in the MUTCD that can have legal ramifications, change all references in the *Guide* to traffic calming *devices* to traffic calming *measures*.

13. Delete Appendix A of the *Guide,* which included examples of neighborhood traffic programs, and include only the "Implementation Guide for Traffic Calming Measures" as the Appendix.

IMPLEMENTATION PLAN

In June 2001, VDOT's Executive Team approved the *Traffic Calming Guide for Local Residential Streets* with the changes recommended for statewide implementation. The RTCC was charged with developing an implementation plan or statewide rollout for the *Guide.* The RTCC chose to use this opportunity to introduce the Residential Traffic Management Program (RTMP), which included, in addition to the Traffic Calming for Local Residential Streets Program, the Through Truck Restriction Program, the Control of Residential Cut-Through Traffic Program, the Watch for Children Sign Program, and the Additional $200 Fine Sign Program.

In addition to a media campaign that included a redesign of a videotape and brochure that were used for the traffic calming pilot program, several Microsoft PowerPoint presentations and accompanying text files were developed by one of the authors (Arnold). These presentations included (1) an Overview of the Residential Traffic Management Program with an intended audience of VDOT management and staff, county boards of supervisors and staff, community groups and others; (2) a detailed presentation on the RTMP, an in-house "training" tool addressing all the procedures and guides on each of the five elements in the RTMP; (3) What Is Traffic Calming?, which includes background information that describes traffic calming, its objectives, measures, pros and cons, benefits, concerns, etc., that may be useful at the initial community meeting during plan development. In addition, the *Guide* contains a Reference section that points readers to sources of further information on traffic calming (see Appendix E).

After training is completed for VDOT staff, the VDOT field offices are to present information to the county officials and staff followed by a statewide media campaign. It is anticipated that the VDOT training will begin in 2002.

The State Traffic Engineer also requested that VTRC develop guidelines for the implementation of multi-way stop signs should a county opt for a specific modification to the *Guide*. A draft of the guidelines has been developed by one of the authors (Cottrell).

REFERENCES

1. Virginia Department of Transportation. 1997. *Residential Traffic Calming Guide.* Richmond.

2. Prince William Board of County Supervisors. March 3, 1998. *Policy on Traffic Management in Residential Areas.* Res. No. 98-179. Prince William County.

3. Prince William County. 1998. *Residential Traffic Management Guide.* Prince William County.

4. Virginia Department of Transportation. 2001. *Traffic Calming Guide for Local Residential Streets.* Richmond.

APPENDIX A

QUESTIONS FOR VDOT STAFF IN THE PILOT COUNTIES

The Research Council has undertaken a formal evaluation of the Residential Traffic Calming Guide and its 2-year Pilot Program. Both the process in the Guide and the effectiveness of any devices or measures implemented are being analyzed. As the Resident Engineer or District staff in one of the pilot counties, it would be appreciated if you would complete the following survey.

Name: _____ Phone Number: _____
Residency/District: _____ Pilot County: _____

Part 1. Residential Traffic Calming Pilot Process

1. Did VDOT and the county staff establish any agreements that clarified or modified the Residential Traffic Calming Guide? ___ yes ___ no

   If yes, attach information on agreements and processes established .

2. What method of funding was selected? ___ 100% county generated funds ___ revenue sharing funds ___ secondary road construction funds

3. How far through the process did you proceed? Check all that apply.
   ___ Board Resolution with Support Data Requirements
   ___ Plan Development
   ___ County and VDOT Approval
   ___ Implementation
   ___ Evaluation

4. To the extent that you proceeded through the process, did you follow the process as outlined? ___ yes ___ no

   If no, what did you do differently and why? (Do not repeat exceptions noted in question 1.)

5. What is your assessment of the process, including positives and negatives of the process, and suggested changes?

6. Do you agree with the need for the following support data?

	Yes	No
Street functional class	___	___
Average daily traffic volumes	___	___
Average speeds	___	___
Description of petition area	___	___
Description of impacted areas	___	___
Petition with signatures	___	___
Board Resolution	___	___

7. Who obtained the support data?

	County	VDOT	Other	Who?
Street functional class	___	___	___	_____
Average daily traffic volumes	___	___	___	_____
Average speeds	___	___	___	_____
Description of petition area	___	___	___	_____
Description of impacted areas	___	___	___	_____
Petition with signatures	___	___	___	_____

8. Please rate how important you think each of the following criteria is in deciding if a street qualifies for the traffic calming program.

	Very Important	Important	Not Important	Not Sure
Local residential street	_____	_____	_____	_____
Two-lane street	_____	_____	_____	_____
Not primary access to a commercial site	_____	_____	_____	_____
Minimum of 12 dwellings per 1,000 ft	_____	_____	_____	_____
Posted speed limit of 25 mph or less	_____	_____	_____	_____
Average speed of 30 mph or more	_____	_____	_____	_____
Petition of support from 75% of occupied households	_____	_____	_____	_____
Board Resolution	_____	_____	_____	_____

9. Comments on qualifying criteria (include suggested changes or other criteria)

10. Please state your opinion of the six physical devices and the non-physical measures listed in the guide.

	Favor	Oppose	Undecided
Pavement markings/lane narrowing	____	____	____
Speed Hump	____	____	____
Choker	____	____	____
Raised Crosswalk	____	____	____
Traffic Circle	____	____	____
Crosswalk Refuge	____	____	____
Chicane	____	____	____
Community Awareness and Education	____	____	____
Enforcement	____	____	____

11. Comments on the measures and devices (include suggested changes or other measures) :

12. How were potential neighborhoods/streets identified and how many were identified?

13. How was the list of qualifying streets prioritized and how many streets were listed? Qualifying streets are those that have met all of the support data requirements.

14. How many neighborhoods/streets began plan development? ___

15. How many neighborhoods/streets have developed a plan? ___ Please describe why plans were not completed.

16. How many plans were implemented? ___

Part 2. Traffic Calming Projects

If a project was implemented under the pilot program, please proceed; otherwise, please return the survey. Please complete the following for each project. Make copies as needed.

Location: _____

17. The plan development process was: ____ effective ____ ineffective ____ don't know.

18. The amount of effort involved in plan development was: _____ excessive ____ adequate ____ too little. (Attach meeting minutes or a brief description of the meetings.)

19. Comments on the plan development process.

20. The following measures implemented or the devices installed as a result of this effort were:

	Successful	Unsuccessful	Undecided
_____	____	____	____
_____	____	____	____
_____	____	____	____
_____	____	____	____
_____	____	____	____
_____	____	____	____

21. Please send a copy of the plan (include the installation date), plan revisions, before-after studies, and other useful information including community feedback and how it was obtained.

22. Specific comments on the implemented measures and installed devices:

23. Other comments about the traffic calming project:

THANK YOU.

Please return the completed questionnaire survey and attachments by March 23, 2000 to:

Ben Cottrell
Virginia Transportation Research Council
530 Edgemont Road
Charlottesville, VA 22903-2454 (804) 293-1932 FAX (804) 293-1990

APPENDIX B

WHAT'S HAPPENING IN TRAFFIC CALMING IN YOUR AREA?

The Research Council has undertaken an evaluation of VDOT's 2-year Pilot Program of its proposed *Residential Traffic Calming Guide*, which ended on December 31, 1999. For purposes of the guide, traffic calming measures and devices are intended to mitigate speeding problems, not cut-through problems. As a part of that evaluation, we are soliciting information on current traffic calming activities throughout the state. Please complete the following survey and return it to us by **Friday, March 3**. It is important to note that we do not need information on traffic calming activities that are a part of the Pilot Program. Thank you for your help.

NAME: _____

Residency/District: _____

1. Have there been any traffic calming activities initiated by either VDOT or local jurisdictions in your area (including the installation of $200 additional fine for speeding signs, multi-way stop signs, Watch for Children signs, or pavement markings and devices intended to narrow the travel way).

   _____ No (please return the survey)

   _____ Yes (please continue)

$200 Additional Fine for Speeding Sign

2. Do you have any experiences with VDOT's Policy and Procedures entitled "Installation of Signs Advising of Maximum Penalty for Exceeding Posted Maximum Speed Limit in Certain Residence Districts"?

   _____ No (go to Question 7) _____ Yes (continue to Question 3)

3. Have you installed any signs under this program?

   _____ No _____ Yes (approximately how many signs and involved subdivisions?)

   _____

   _____

4. Do you feel they have had any effect on the speeds?

_____ No (please explain) _____ Yes (please explain)

_____
_____
_____

5. Have you conducted or do you anticipate conducting before and after studies of the speeds at the installation?

_____ No _____ Yes (please attach results or indicate when available)

6. Are you aware of any localities in your area that use these signs for traffic calming?

_____ No _____ Yes (please describe)

_____
_____
_____

Pavement Markings

7. Do you have any experiences with "narrowing" the travel way through the use of centerline, edgeline, or other pavement markings?

_____ No (go to Question 11) _____ Yes (please describe or attach documentation)

_____
_____
_____
_____

8. Do you feel they have had any effect on the speeds?

_____ No (please explain) _____ Yes (please explain)

_____
_____
_____

9. Have you conducted or do you anticipate conducting before and after studies of the speeds at the installation?

_____ No _____ Yes (please attach results or indicate when available)

10. Are you aware of any localities in your area that use these types of pavement markings for traffic calming?

_____ No _____ Yes (please describe)

_____
_____
_____

Multi-way Stop Signs

11. Do you have any experiences with the use of multi-way stop signs as a traffic calming device?

_____ No (go to Question 16) _____ Yes (continue to Question 12)

12. Have you installed any multi-way stop signs as a traffic calming device?

_____ No _____ Yes (approximately how many intersections and involved subdivisions?)

_____
_____

13. Do you feel they have had any effect on the speeds?

_____ No (please explain) _____ Yes (please explain)

_____
_____
_____

14. Have you conducted or do you anticipate conducting before and after studies of the speeds at the installation?

_____ No _____ Yes (please attach results or indicate when available)

15. Are you aware of any localities in your area that use multi-way stop signs for traffic calming?

_____ No _____ Yes (please describe)

_____
_____
_____

Watch for Children Signs

16. Do you have any experiences with the use of "Watch for Children" signs as a traffic calming device?

_____ No (go to Question 21) _____ Yes (continue to Question 17)

17. Have you installed any "Watch for Children" signs as a traffic calming device?

_____ No _____ Yes (approximately how many signs and involved subdivisions?)

_____

_____

18. Do you feel they have had any effect on the speeds?

_____ No (please explain) _____ Yes (please explain)

_____

_____

_____

19. Have you conducted or do you anticipate conducting before and after studies of the speeds at the installation?

_____ No _____ Yes (please attach results or indicate when available)

20. Are you aware of any localities in your area that use "Watch for Children" signs for traffic calming?

_____ No _____ Yes (please describe)

_____

_____

_____

Other Measures or Devices

21. Do you have any experiences with any other traffic calming measures or devices?

_____ No _____ Yes (please describe or attach documentation)

22. Are you aware of the use of any other traffic calming measures or devices by localities in your area?

_____ No _____ Yes (please describe)

THANK YOU FOR YOUR TIME!

Please return the completed survey by March 3, 2000, to:

Gene Arnold
Virginia Transportation Research Council
530 Edgemont Road
Charlottesville, VA 22903
FAX 804/293-1990
Email: garnold@vdot.state.va.us

APPENDIX C

RESULTS OF THE "WHAT'S HAPPENING IN TRAFFIC CALMING IN YOUR AREA?" SURVEY (9 District Traffic Engineers and 52 Resident Engineers)

Measure and Response	No. Affirmative Responses from Districts	No. Affirmative Responses from Residencies
$200 Fine Sign		
Experiences with?	6	7
Installation of?	5	7
Effectiveness of?	2	4
B/A studies available?	1	0
Locality use?	1	3
Multi-Way Stop Sign		
Experiences with?	6	4
Installation of?	2	1
Effectiveness of?	2	2
B/A studies available?	1	0
Locality use?	2	3
Watch for Children Sign		
Experiences with?	5	8
Installation of?	5	8
Effectiveness of?	0	2
B/A studies available?	0	0
Locality use?	2	3
Pavement Markings That Narrow Roadway		
Experiences with?	4	3
Installation of?	0	0
Effectiveness of?	4	2
B/A studies available?	3	1
Locality use?	1	0
VDOT Experience with Any Other TC Measures Install School Bus Stop Ahead sign (some HI yellow green) Lower speed limits on secondary roads Sign curves with maximum safe speed signs Choker Rumble strips Speed humps Roundabouts System of raised crosswalks (with warning signs and pavement markings) Through-truck restriction	1	6
Local Experience with Any Other TC Measures Radar speed display trailers Speed humps/bumps Traffic circle (Blacksburg removed)	1	4

APPENDIX D

RESULTS OF BALLOTING FOR POTENTIAL CHANGES TO THE TRAFFIC CALMING GUIDE

1. Clarify that the intent is for secondary roads by modifying the title to "Residential Traffic Calming Guide for Secondary Roads in Subdivisions." (Note this is slightly different than that discussed at our meeting.)

   [14] Agree [1] Disagree

   Comments:

   AGR 1) However, drop "in Subdivision"; are all secondary highways in subdivision?

   DIS 1) While clarifying the intent in the title could be very helpful, the suggested change is not. The Guide specifies local residential streets (and certain collectors) that qualify for traffic calming. I would not think that the proposal intends to change this. If I recall correctly, secondary roads also include minor arterials. Additionally, traffic calming problems could occur and qualify outside of subdivisions. Perhaps the title could be: RTC Guide for Local Residential Streets.

2. Clarify that the county has the lead role in the introduction by adding as the first sentence in paragraph 3 of the Introduction "The County will initiate and take the lead role in coordinating the traffic calming process and VDOT staff will provide technical support."

   [15] Agree [ ] Disagree

   Comments:

   AGR 1) Emphasizing the lead role for the County is helpful. However, close County/VDOT coordination every step of the way is very beneficial. We do not want to end up with some "reverse" problem, i.e. the County proceeds without involving us and we only learn about problems when something is blowing up. (I called it "reverse' problem, because this is something VDOT has been blamed to do.)

3. Clarify and state more clearly the expectations for a participating county with regard to designing for "calmed" streets by rewriting and replacing the existing paragraph 4.

   [10] Agree [5] Disagree

   Comments:

   DIS 1) Traffic Calming is implemented after residents identify concerns. What is a concern to one resident may not be of concern to others. Therefore at subdivision design review stage it is impossible to know if traffic calming will even be a concern. Hence, it will be difficult

to require a developer to implement such measures for a problem that may or may not exist. In addition, legislation exists for determining how a BOS can allocate secondary road funds. This note appears to restrict that authority over and above current code. I agree with our intent here... but believe this issue is different than say bringing a private road into the state system.

DIS 2) VDOT cannot enforce the 2nd sentence since the county controls secondary road funding. The resolution requirement has questionable value. Although the intent is understood and supported, the tone of this paragraph may be viewed as offensive to the county. I would depend on cooperation to achieve the intended goal and suggest deleting the 2nd sentence.

DIS 3) I do not believe that we can force this resolution on the counties. I also think that the counties can spend their secondary funds as they wish and I'm not sure we can deny them access to this program after the date of the guide. The rest of the language is OK. I believe the issue needs to be addressed through the Subdivision Street Requirements and not through this program.

DIS 4) Chris Winstead summarized real well in his response what the problems are with the above suggestion, i.e., the Board controls the secondary funds and also it may be hard to prove in the land development process that there will be a problem. Even if problems are expected, the future residents of the road may or may not see conditions as problematic. The Committee has been struggling with this subject, and it is a difficult one. On one hand, VDOT and the Counties should make every effort to not "build" future traffic calming problems. On the other hand, I do not believe that it would be reasonable or realistic for VDOT to draw a hard line and refuse traffic calming on new subdivision streets. I also would like to remind the Committee of earlier discussions where I brought up the need to deal with traffic calming plans for new subdivisions differently than for existing ones. Based on the Guide, that is addressing ONLY retrofit conditions, the current traffic calming plans are retrofit plans. Obviously retrofitting is a very constricted process. When dealing with a new, not-yet-built subdivision, there are much more opportunities to avoid or minimize problems than just doing the retrofit measures. Again, I would like to suggest the formation of a group that, in addition to RTC Committee members, includes Planning and Land Development staff from VDOT and also County representation. The purpose of the group would be to develop guidelines for how to avoid traffic calming for new subdivisions, or how to do traffic calming if it cannot be avoided.

AGR 1) Sentence two change "will not be" to "are not intended to be."

AGR 2) Disagree on footnote; The county adopts a six-year plan along with VDOT and VDOT develops a budget based on the priority list and both the county and VDOT adopt such budget; if the RE does not agree to the use of funds as requested by the county the Commissioner has final say; therefore, if the Commissioner/VDOT does not want to use secondary roads funds for this purpose, then we can make that decision.

AGR 3) [Had some revisions for the Secondary Roads Division to see.]

3. Eliminate the requirement of "a minimum of 12 dwellings fronting the street per 1,000 feet of roadway, including both sides."

[8] Agree [7] Disagree

Comments:

DIS 1) I don't remember this being discussed.

DIS 2) A dwelling density requirement is needed.

DIS 3) I still feel there should be some definition that measures the density along the street rather than it be what you stated or something else. The VA Code gives a good definition of "residence district" but I'm not saying to use it. *"Residence district" means the territory contiguous to a highway, not comprising a business district, where seventy-five percent or more of the property abutting such highway, on either side of the highway, for a distance of 300 feet or more along the highway consists of land improved for dwelling purposes, or is occupied by dwellings, or consists of land or buildings in use for business purposes.*

DIS 4) This criterion is helpful in reducing unreasonable requests. If the County strongly supports traffic calming for a street that does not meet criteria, they can ask for a County specific modification. For previous requests for County specific modification, we have been responding with considering exceptions on a case by case basis (instead of over-all modification), which has been working well.

AGR 1) Would not want traffic calming on reverse frontage streets.

AGR 2) However, the counties "may" delete this requirement if they choose.

4. The definition of the speeding problem as having an *average* speed of 5 mph over the posted speed limit is being questioned. The traditional traffic engineering threshold of 10 mph over the *85th percentile* speed may be better. On the other hand, an *average* speed is more understandable to the average citizen. Also, in order to address the safety concern of a few excessive speeders, a finding that 5% of the vehicles are traveling greater than 35 mph (or some variation) may also qualify a street for calming. This would most likely be considered as a second potential qualifying criterion. Check the criteria that you prefer (choose either the average OR 85th criteria and whether you want the second qualifying criterion):

[9] *Average speed* of 5 mph over the posted speed limit

[6] *85th percentile speed* is 10 mph over the posted speed limit

[5] Add as another qualifying criterion that "5% of the vehicles are traveling over 35 mph" or note your recommended variation below.

Comments:

Avg. Speed of 5 1) County could/should establish another criteria if they think necessary.

Avg. speed of 5 2) Suggest making the 2nd choices a local option to the average speed criteria if the county's experience is that most streets will qualify under the Avg. speed criteria.

Avg. speed of 5 3) The general public do not understand 85th percentile speeds.

Avg. speed of 5 4) The "average speed" expression has been working very well with the communities. This was a request/suggestion by our PR team long time ago.
Several communities who have desperately wanted traffic calming (and were supported and funded by their BOS) did not even meet this (average speed 5 mph over) criterion with their speed, and (based on more detailed speed study) most of them were approved on a case-by-case basis.

85th 1) I think it should be added to increase flexibility, should be an "or" not an "and" say minimum 5%!!??!! Is 5% too low?

5. Residential streets with posted speed limits greater than 25 mph should be eligible.

[2] Agree [13] Disagree

Comments:

DIS 1) Speed should be reduced if needed.

DIS 2) There is provision in the guide for "exceptions," and I think this issue should be handled as a local option change decision with VDOT.

DIS 3) This program is intended for "residential traffic" and in my opinion that is the local functional roads posted at 25 mph.

DIS 4) The County can ask for exception.

6. Due to the significant effort involved with obtaining the petition, the county's first submittal to VDOT should require only the "technical" support data, i.e., street functional classification, average daily traffic volumes, average speed, description of petition area, and description of impacted areas. Then, pending VDOT concurrence that the proposed calming meets these technical requirements, the petition should be obtained and submitted. Prince William County adopted this approach and some others have followed.

[13] Agree [2] Disagree

Comments: None

7. The 75% requirement for the petition is too high.

   [1] Agree [14] Disagree

   Comments/What should the percentage be:

   DIS 1) Strongly believe 75% is proper; simple majority insufficient to show problem enough in community's eye to warrant extreme mitigation measures; too many pitfalls with lesser amount of citizen participation.

   DIS 2) Leave at 75%.

   DIS 3) Community needs strong involvement & support.

   DIS 4) 75% is not too high . . . it's been with us since the beginning and I believe hasn't been challenged until recently.

   AGR 1) 60%.

8. The petition should be obtained *after* the plan has been developed rather than *in the beginning* in order for the residents to know exactly what calming measures are being planned. On the other hand, VDOT would like to have the neighborhood show of support before any time is spent developing the plan.

   [3] Agree [11] Disagree

   Comments:

   NO VOTE 1) Perhaps 51% to get it going and 75% to implement; have heard many people complain they didn't want to sign a petition for something that they disagree with later; one of the devices may be unacceptable to them or where it is placed!

   DIS 1) No; a public forum is only way; petitions on specific plans would come back with a hundred opinions and no clear direction; local and VDOT staff will become jaded and it simply will not work.

   DIS 2) Petition-plan-meeting.

   DIS 3) Petition without the petition early a lot of effort may be wasted on developing the plan when there is minimal support of traffic calming.

   DIS 4) Up front support is necessary.

   DIS 5) Petition could include potential devices that are of interest to the residents that initiated the process.

DIS 6) I believe the number of requests may get out of hand unless we get the petition first.

DIS 7) If I understand this question right, I strongly disagree. All-inclusive involvement from the beginning is essential for successful plan development, because it provides opportunities for being heard, for education and for working on options together.

AGR 1) Neighborhood show of support could be found by a letter from the civic association indicating the desire to pursue traffic calming as well as the desire to obtain the petition and therefore requesting the plan be developed.

9. There should be greater emphasis, and a requirement, on the fact that community meetings be held to present the proposed traffic calming plan.

[13] Agree [1] Disagree

Comments:

NO VOTE 1) Would need to know more where this concern is coming from; If an all-inclusive plan development process took place, as it should, this should not be a problem. Assessing community support can be then left up to the BOS member.

DIS 1) We can emphasize and encourage community meetings, especially to present the final proposed traffic calming plan, but I do not think we can require them. It is a county program after all as we have clearly pointed out earlier.

AGR 1) Cannot fall into what happened in Spotsylvania to C.

AGR 2) This approach is preferred for the issue of question 9; perhaps more emphasis is needed to inform all residents of the final plan and obtain feedback on the plan before installation.

10. The list of physical devices should be expanded to include a raised median island as a stand-alone measure, not just as a part of the crosswalk refuge.

[11] Agree [4] Disagree

Comments:

DIS 1) No strong feelings here.

DIS 2) Edit title; was under impression that NO device is a stand alone measure; bits and pieces of each could be developed into the communities' plans.

AGR 1) If we can find a design for this.

11. Both the design details and the costs of the physical devices in the Guide should be reviewed for accuracy.

[14] Agree [1] Disagree

Comments:

DIS 1) Hasn't this already been done?

AGR 1) Review cost.

AGR 2) The physical measures are not "designs," they're only typical, ideas.

AGR 3) I thought that this was going to be an obvious part of the evaluation of the Pilot.

12. The number of signs required in the traffic calming plans should be reduced.

[9] Agree [5] Disagree

Comments:

NO VOTE 1) Each location should be signed appropriately based on an engineering study of the unique factors that each area may have as we do any signing plan. (The signs in the sketches came from our research of the best practices.)

DIS 1) Think we need more experience to determine changes in signing.

DIS 2) There may be cases where there are too many signs shown, but I think a lot of this is optional; I don't think we can say across the board that signs should be reduced.

AGR 1) Let's just say *use engineering judgment.*

AGR 2) Less is better, label "optional" if need be; plans were meant to be typical.

AGR 3) I believe that the number of signs should be the minimum that standards allow. (I've received complaints about too many signs already.) We can always supplement as needed.

AGR 4) Again, this should be part of the evaluation of the Pilot. Still, I have to add that the Guide does leave flexibility for adjustments by the engineer, and this has been used in developing the plans. However, looking at the signing components of the measures would be helpful to try to minimize intrusiveness, but of course not at the expense of safety.

13. The markings and signs should be consistent with those proposed for the 2001 MUTCD.

[15] Agree [ ] Disagree

Comments:

AGR 1) Responses to 13 & 14 may conflict; not sure of what is proposed in 2001 MUTCD.

14. The Guide should establish a time line for the process. On the other hand, there are many local variations and such a time line would likely not be practical.

[4] Agree [10] Disagree

Comments:

DIS 1) Each locality should establish their own time line; a typical may be helpful.

DIS 2) At best, we could suggest a time line, or particularly a "typical" time for each element. I'm not sure this would even be valid, or even possible to pull together from the information we have.

DIS 3) The Guide should only suggest a time line and not dictate one.

DIS 4) With the Counties having the lead, this should be left up to them. Of course, if for some reason we cannot meet their timeline, we should work with them. It appears that so far the Counties have been much slower than what we could do.

AGR 1) Instead a Local government/VDOT timeline should be established.

AGR 2) Have one in PW County developed by them; wide range of timeframes for each step in process, seems to help citizens and Supervisor follow; may need some modifying itself; we could always say the County can develop a flow chart with a timeline if desired, but VDOT must review and comment on it before it is adopted.

AGR 3) Establish a general timeline that could be modified by local needs.

15. Traffic calming *devices* should be renamed traffic calming *measures*. Some jurisdictions have experienced legal problems with physical traffic calming devices being ruled as illegal because they are not in the MUTCD. By using measures instead of devices, this will avoid the misclassification of these measures being traffic control devices.

[15] Agree [ ] Disagree

Comments:

AGR 1) Seems a minor point (I'm indifferent).

AGR 2) Ask the attorneys.

16. Two recently adopted statewide policies that relate to speed reduction in neighborhoods should be included under the umbrella of VDOT's management program, though not specifically in the Residential Traffic Calming Guide.

a. "Watch for Children" Signs

[13] Agree [2] Disagree

Comments:

DIS 1) This sign would most likely be interpreted by kids that it's OK to hangout, play catch, roller skate or skateboard in the roadway.

AGR 1) We need to be honest, open, and fair.

b. "Additional $200 Fine" Signs

[15] Agree [ ] Disagree

Comments:

AGR 1) We need to be honest, open, and fair.

APPENDIX E

TRAFFIC CALMING GUIDE FOR LOCAL RESIDENTIAL STREETS

Traffic Engineering Division
Virginia Department of Transportation
Richmond, Virginia

June 2001

PREFACE

Since the late 1980s, the Virginia Department of Transportation (VDOT) has concerned itself with neighborhood traffic problems on streets and roadways in the state's operated and maintained highway systems.

1. The **Restricting Through Trucks on Secondary Highways Policy**, which was adopted in September 1988, states in part that "the Commonwealth Transportation Board, in response to a formal request by a local governing body, may prohibit or restrict the use by through trucks of any part of a secondary highway".

2. The **Control of Residential Cut-Through Traffic Policy**, adopted in March 1989 and most recently revised in 1996, says in part that "VDOT will recognize the problems associated with residential cut-through traffic and implement appropriate measures wherever possible."

3. Pursuant to a 1997 General Assembly amendment to the Code of Virginia regarding the installation and maintenance of "signs alerting motorists that children may be at play nearby", VDOT implemented procedures effective July 1, 1997, that allows counties to request **"Watch for Children"** signs.

4. Pursuant to a 1999 General Assembly amendment to the Code of Virginia regarding the "maximum speed limits in certain residence districts, penalty", VDOT implemented procedures on June 17, 1999, that allows local governing bodies to request signs on local residential streets, collector streets, and minor arterials with a posted speed limit of 35 mph or less advising motorists of a maximum punishment of **$200 for exceeding the speed limit**.

5. The ***Traffic Calming Guide for Local Residential Streets***, which was adopted in June 2001, provides communities with a traffic management tool dealing specifically with speeding, with the goal being to slow speeders in residential neighborhoods on streets classified as local.

These five traffic management tools have been combined under the Department's **Residential Traffic Management Program**. Neighborhoods, through their local governing bodies, are encouraged to choose one or more of these tools to resolve traffic problems on their local streets and highways. For more information contact the local office of VDOT or the Department's Traffic Engineering Division at the address below.

Traffic Engineering Division
Virginia Department of Transportation
1401 East Broad Street
Richmond, Virginia 23219
(804) 786-2966

TABLE OF CONTENTS

TRAFFIC CALMING GUIDE FOR LOCAL RESIDENTIAL STREETS

I. INTRODUCTION

In mid 2001, VDOT implemented the Traffic Calming Guide for Local Residential Streets that provides communities with a traffic management tool dealing specifically with speeding. The guide is based on the premise that the county and VDOT are partners in addressing a speeding problem. For purposes of this guide, the goal of traffic calming is to slow speeders in residential neighborhoods on streets classified as local. The focus is on subdivision streets. Certain collector streets that have many of the characteristics of local residential streets may also qualify for traffic calming measures.

It is important to note that traffic calming efforts generally slow traffic without restricting access. Traffic calming measures are appropriate for slowing traffic when cut-through traffic is not the problem; that is, neighborhoods typically do not qualify for the cut-through traffic program when the majority of the traffic and speeding problems are generated from within the neighborhood.

The county will initiate and take the lead role in coordinating the traffic calming process and VDOT staff will provide technical support. The county and VDOT will determine who is responsible for a particular task where the responsible agency is not specified. For traffic calming, VDOT is represented by the local resident engineer, except in Fairfax, Prince William, and Loudoun Counties where it is the district traffic engineer.

Although this guide is intended for existing streets only, there is concern about preventing traffic problems from developing on new subdivision streets. In its process for reviewing subdivision development plans, participating counties should identify and address potential traffic calming as well as other traffic management concerns that may result from a new development. The review process should ensure that the developer of a new subdivision place emphasis on and address the need to design street geometric concepts that make streets less desirable for speeding and cut-through traffic. In the subdivision design review process, VDOT should also exert its discretionary authority in applying geometric standards to discourage speeding and cut-through traffic. The county should consider planning, enforcement, and transportation together in a comprehensive approach to managing residential traffic.

Ideally, potential traffic calming concerns in new developments should be addressed with roadway design geometry changes, especially roadway width (narrowing) and road curvature. In lieu of or in addition to these geometric changes, traffic calming measures that generally serve to narrow the travel way include pavement markings delineating parking, shoulder, or bike lanes, traffic circles or roundabouts, chokers, crosswalk refuges, and short medians. The county or subdivision developers should consult with VDOT prior to submitting a plan specifying traffic calming measures on newly developed streets

II. THE RESIDENTIAL TRAFFIC CALMING PROCESS

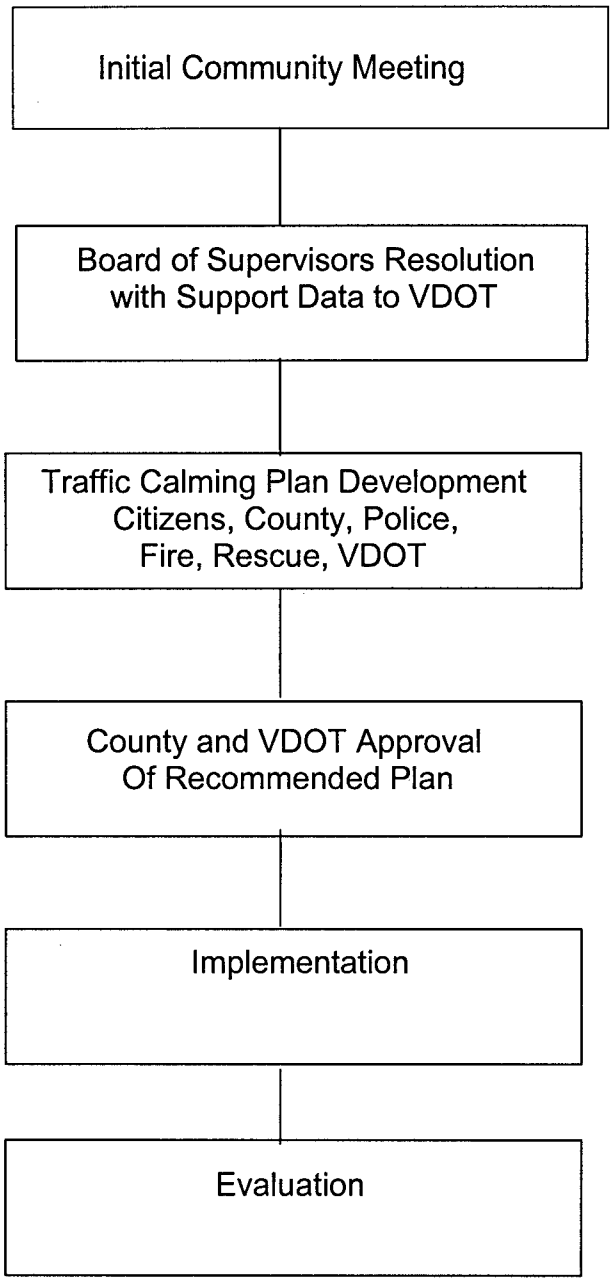


Figure 1. The Residential Traffic Calming Process

A. Initial Community Meeting

The County and VDOT may employ a number of methods to publicize the traffic-calming program, and more generally, residential traffic management tools. VDOT, in cooperation with County staff, is available for an initial community

meeting. All-inclusive participation (community leaders and residents, local politicians, law enforcement, fire, and emergency personnel, and county and VDOT staff) is essential for proper problem solving. Presentations made at the meeting should enhance the community's understanding about the traffic calming process, including the amount of community involvement required and the advantages and disadvantages of traffic calming. The meeting is an opportunity for the County and VDOT to learn more about the concerns of the community as well as to help the community assess its traffic concerns. County staff arranges the meeting and determines its size and scope. At this initial meeting, all participants can work together to develop a plan for continuous involvement by and communication with the community during the traffic calming process.

B. Board Resolution with Support Data Requirements

The Board of Supervisors initiates the traffic calming process by forwarding to VDOT a resolution that requests the initiation of a traffic calming project along with the following information:

- Street functional classification
- Average daily traffic volumes
- Average speed
- Description of petition area
- Description of impacted areas
- Petition with signatures

The support data provided by the county should verify that the following requirements are met:

1. Eligible Streets: Local residential streets are eligible for traffic calming provided the posted speed limit does not exceed 25 mph. A local residential street provides direct access to abutting residences and serves only to provide mobility within the neighborhood. Traffic on these streets is expected to be entering or exiting from the residences.

Certain residential collector streets, although classified as collector roads, have the characteristics of local residential streets. Collector streets may be considered for traffic calming measures if they meet the following conditions:

- 25 mph posted speed limit
- Two-lane roadway
- Not a primary access to commercial or industrial sites
- Minimum of 12 dwellings fronting the street per 1,000 feet of roadway, including both sides

Eligible streets are functionally classified as a local or collector street by VDOT.

2. Documented speeding problem: The average speed is at least 5 mph over the speed limit. Accordingly, the average speed should be at least 30 mph to qualify.

3. Petition for traffic calming: Once the proposed street meets the above technical criteria, a petition requesting traffic calming and signed by at least 75 percent of the total occupied households within the petition area must be obtained. The petition area includes residences on the proposed street section, and residences on all streets that have major access onto the proposed study street section. The county, in cooperation with VDOT, will define the petition area and provide a petition form. The impacted area typically includes the surrounding collector or arterial roads but should be defined by the county in cooperation with VDOT. The county will verify that the petition is valid.

The resolution and appropriate attachments should be sent to VDOT.

C. Plan Development

The traffic calming plan should be developed by a group that includes representatives from the petition area, impacted area, homeowner associations, the board of supervisors, local transportation/planning staff, police, fire, rescue, VDOT, and others as appropriate.

Because the impact of traffic calming measures will extend beyond the petition area, it is important to involve representatives from the larger, impacted area.

The Board of Supervisors and homeowner associations are responsible for scheduling and facilitating meetings. VDOT staff will provide technical support and advise the community of the potential advantages and disadvantages of calming measures. Educating participants about residential traffic management and traffic calming is key to a successful program.

The proposed plan shall be presented to residents at a public meeting, or through some other method such as a petition, to inform and measure support for the plan. This will allow the Board of Supervisors to assess whether community support exists for the proposed measures.

D. Approval and Implementation

The final plan, and method of implementation must be jointly approved by the Board of Supervisors and VDOT. The final plan must identify the source of funding for implementation.

E. Evaluation

A follow-up evaluation should be performed to ensure that the traffic calming measures are effective. The Board of Supervisors in cooperation with VDOT will determine the method to disseminate the findings and recommendations to those involved in the plan development and obtain feedback as appropriate.

If the county decides to remove the traffic calming measures, then funding for removal should be from the same funding sources as implementation. If an unforeseen safety problem develops, VDOT may decide to remove the traffic calming measures.

III. TRAFFIC CALMING MEASURES

Community awareness and education is an important first step. The residents should be made aware of the speeding concerns and should be reminded of the importance of driving safely in their neighborhood. VDOT staff is available to speak to homeowner associations about traffic calming measures and to help raise community awareness about advantages, disadvantages, costs, and funding options.

Enforcement is traditionally the primary means of addressing speeding problems. Local police officers monitor and enforce the posted speed limit. Enforcement efforts should be undertaken as much as possible prior to implementation of traffic calming measures.

Non-physical measures are low-cost measures that do not physically restrict driver maneuvers, such as pavement markings to narrow travel lanes. (See Figure 2.)

Physical measures are designed to reduce speed by creating a vertical or horizontal shift in the roadway or travel lanes. (See Figure 2 and Section V.)

Alternative actions should be considered when traffic volumes on the study street exceed 4,000 vehicles per day. A network analysis is suggested to thoroughly examine the road network in the area and identify potential improvements on major routes that may provide relief to the "study" street.

IV. TRAFFIC VOLUMES AND TRAFFIC CALMING MEASURES

Traffic volumes on the residential street will determine the appropriate traffic calming measures as follows:

- **Fewer than 600 vehicles per day**
  - education
  - enforcement
  - non-physical measures
- **600- 4,000 vehicles per day**
  - education
  - enforcement
  - non-physical measures
  - physical measures
- **More than 4,000 vehicles per day**
  - education
  - enforcement
  - alternative actions only
  - no traffic calming measures

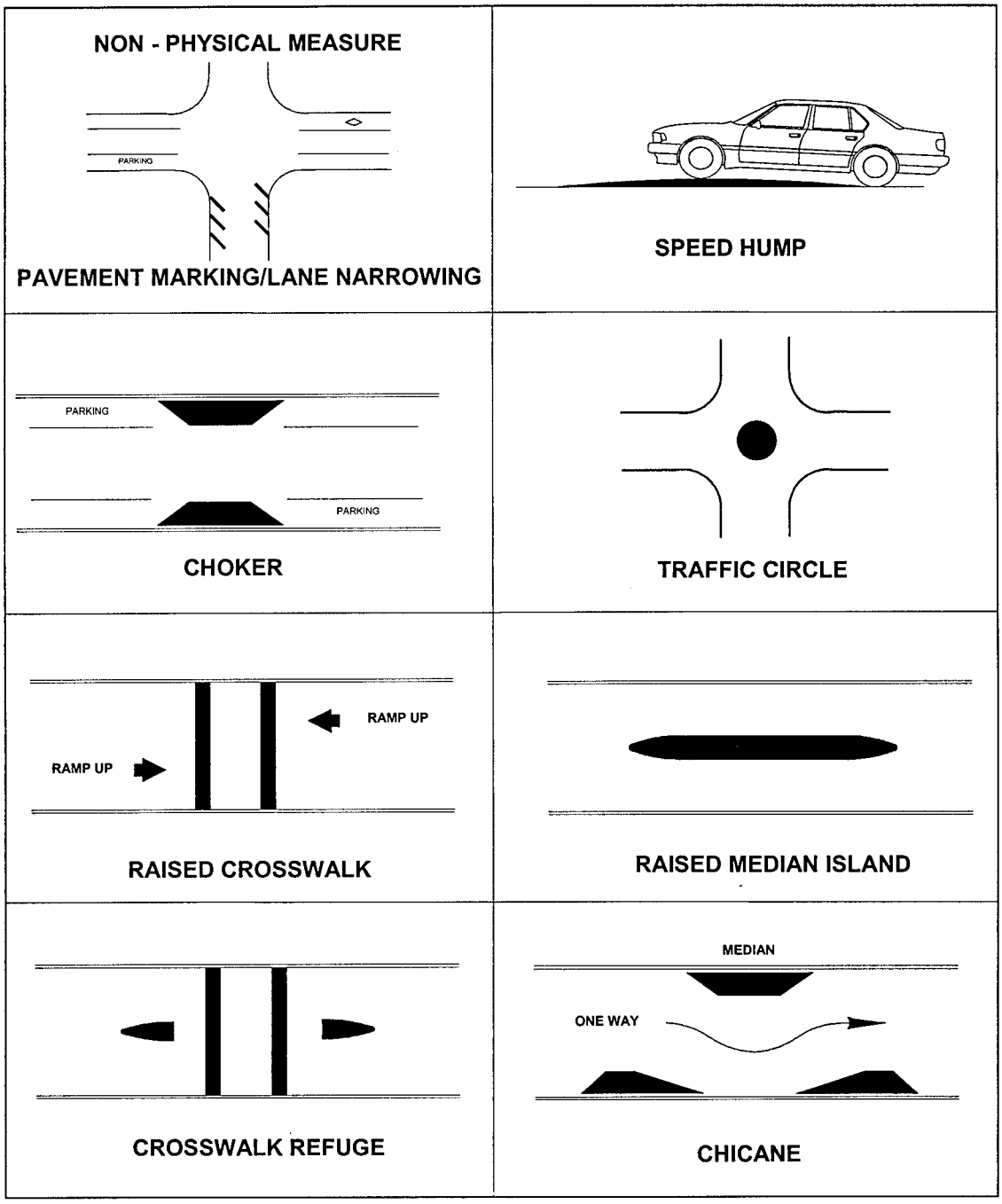


Figure 2. Typical Physical and Non-Physical Traffic Calming Measures

V. PHYSICAL MEASURES FOR TRAFFIC CALMING

The following measures have been effective in slowing traffic in neighborhoods. To ensure minimum delay in emergency response time, the installation of speed humps and raised crosswalks is discouraged on major emergency routes. Costs are provided only as rough estimates; actual construction costs will depend on the number of measures constructed, related signing and pavement markings, and the extent of aesthetic provisions. The estimated costs are derived from Institute of Transportation Engineering's *Traffic Calming State of the Practice* and revised based on VDOT's experience with some of the measures. Physical measures are shown in Figure 2. More details are provided in the Implementation Guide for Traffic Calming Measures" in the Appendix.

A. Speed Hump

Description: a raised hump in the roadway with a parabolic top, extending across the road at right angles to the traffic.

Placement: spacing should be about 500 feet, clearly visible for 200 feet, and placed at least 200 feet from intersections; should include warning signs.

Advantages: reduces speeds.

Disadvantages: increases emergency response times and slows emergency vehicles and buses, potential drainage problems, increases noise, increases maintenance costs.

Estimated cost: $2,000-$3,000 per speed hump.

B. Choker

Description: a physical constriction built at the curb side of the roadway to reduce the width of the travel lane.

Placement: normal turning radii should be accommodated; should include advance warning signs and delineation.

Advantages: reduces speeds, provides parking protection, shortens pedestrian crossing distance.

Disadvantages: potential drainage problems, maintenance costs.

Estimated cost: $7,000-$10,000 per pair.

C. Raised Crosswalk

Description: a raised hump in the roadway with a 10-foot flat top, extending across the road at right angles to the direction of traffic flow.

Placement: where significant number of pedestrians cross the roadway; should include advance warning signs.

Advantages: reduces speeds, provides improved visibility and safety for pedestrians.

Disadvantages: increases emergency response times and slows emergency vehicles and buses, potential drainage problems, increases noise, increases maintenance costs.

Estimated cost: $2,500-$8,000 per raised crosswalk. The higher estimate includes the construction of two curb ramps.

D. Traffic Circle

Description: elevated area in the middle of the intersection that provides circular, counterclockwise traffic flow.

Placement: street grades approaching the intersection should not exceed 10 percent and entrances should be a minimum of 100 feet away on all approaches.

Advantages: reduces speeds, reduces left-turn accidents, can be visually attractive.

Disadvantages: placement of circle may reduce parking spaces and require additional right of way.

Estimated cost: $3,500-$15,000 per circle.

E. Crosswalk Refuge

Description: a raised median in the middle of the roadway with a cut provided for the crosswalk.

Placement: where a significant number of pedestrians cross the roadway.

Advantages: reduces speeds, provides refuge for pedestrians crossing roadway.

Disadvantages: increases maintenance costs.

Estimated cost: $5,000-$15,000 per crosswalk refuge.

F. Raised Median Island

Description: a raised median in the middle of the roadway.

Placement: should accommodate normal turning radii near intersections where applicable; placed in the middle of the roadway with proper warning signing and delineation.

Advantages: reduces speeds, shortens pedestrian crossing time and distance.

Disadvantages: drainage problems, maintenance costs, expensive.

Estimated cost: $5,000-$15,000 per island.

G. Chicane

Description: alternating constrictions built curbside to create a bend in a formerly straight street, forcing vehicles to negotiate the narrowed street in a snake-like fashion.

Placement: should accommodate normal turning radii; sets are to be placed 400-600 feet apart; should include advance warning signing and delineation; used only on roadways divided with a median.

Advantages: reduces speeds, shortens pedestrian crossing time and distance.

Disadvantages: limited to divided roadways, potential drainage problems, maintenance costs.

Estimated cost: $5,000-$15,000 per set.

VI. OPTIONS FOR COUNTIES

A. County-Specific Modifications

The *Traffic Calming Guide for Local Residential Streets* is applicable to all counties. However, if a particular county believes that minor modifications are necessary to serve the needs of its citizens, modifications may be requested. The request should be addressed to VDOT.

B. Point System for Prioritizing Projects (Optional)

The point system in Table 1 is provided as an option for counties to use in prioritizing projects eligible for physical measures. The point system is based on speeds, volumes, and accident history. VDOT will work with the locality to help develop a county-specific method of prioritization.

Table 1. Optional Point System for Prioritizing Projects

Speed Related Accidents		**Traffic Volume**		**Speeds**	
Accidents / Year	Points	Average Daily Traffic	Points	Average Speed	Points
1	1.0	600-1,000	0.5	30-34	1.0
2	2.0	1,001-3,000	1.0	35-39	2.0
3+	3.0	3,001+	1.5	40+	3.0

VII. FUNDING

Traffic calming measures may be funded using one of the following:

- 100 percent exclusively county-generated or other funds (no VDOT funding).
- Revenue sharing funds with 50 percent exclusively county-generated or other funds and 50 percent VDOT funds.
- Secondary road construction funds; a maximum of 2 percent of the county's secondary road construction funds can be used with a three-year limit on its accumulation.

Maintenance will be funded through the county's VDOT secondary road maintenance funds. Implementation and maintenance of optional landscaping will be provided by the community

REFERENCES

For further information on traffic calming, see the following sources.

1. Federal Highway Administration. *Manual on Uniform Traffic Control Devices For Streets and Highways (MUTCD)*, Washington, D.C., 1988. (The Millennium Edition of the Manual, which is scheduled for release in 2001, will replace the 1988 version. For information, see the following web page: http://mutcd.fhwa.dot.gov/kno-proposed2000.htm.

2. Institute of Transportation Engineers and Federal Highway Administration. *Traffic Calming: State of the Practice*, Washington, D.C., August 1999. (Available for downloading at http://www.ite.org/traffic/tcstate.htm#tcsop .)

3. Institute of Transportation Engineers. *Traffic Engineering Handbook*, Fifth Edition, Chapter 9, "Traffic Calming Applications", Washington, D.C., 1999.

4. Institute of Transportation Engineers. *Transportation Planning Handbook*, Second Edition, Chapter 17, "Traffic Calming", Washington, D.C., 1999.

5. Institute of Transportation Engineers. *Guidelines for the Design and Application of Speed Humps*, A Recommended Practice, Washington, D.C., 1997.

6. Pat Noyes & Associates. *Traffic Calming Primer*, Boulder, CO, 1998.

7. South Western Regional Planning Agency. *Traffic Calming Toolbox, Traffic Calming: Devices, Applications, & Program Management*, Norwalk, CT, June 1998.

8. Texas Transportation Institute. *Handbook of Speed Management Techniques*, Research Report 1770-2, College Station, TX, September 1998.

9. Virginia Transportation Research Council. *An Operating Guide for the Control of Residential Cut-Through Traffic*, B. H. Cottrell, Jr., Charlottesville, VA, 1990. (Appendix contains "Guidelines for Use of Speed Humps".)

10. Washington State Department of Transportation, *A Guidebook for Residential Traffic Management*, Olympia, WA, 1994.

Traffic Calming Internet Web Sites

1. The Institute of Transportation Engineers has a comprehensive Internet web site at: http://www.ite.org/traffic/index.htm.

   The site (which contains the downloadable Reference #4 above) includes an overview of traffic calming and calming measures, a searchable library of references including a topical index (many of which are downloadable), a listing of other traffic calming web sites, and downloadable seminar materials (PowerPoint presentation).

1. The City of Portland has an excellent internet web site describing its traffic calming program at:

http://www.trans.ci.portland.or.us/Traffic_Management/trafficcalming/

APPENDIX

IMPLEMENTATION GUIDE FOR TRAFFIC CALMING MEASURES

CHAPTER I
INTRODUCTION

The purpose of residential traffic management is to address traffic problems in residential neighborhoods. Traffic calming is intended to reduce speeds without restricting access. This "Implementation Guide for Traffic Calming Measures" will:

- Explain the difference between traffic control devices and traffic calming measures
- Give lessons learned in the planning process
- List things to consider before and during measure installation
- Show typical design standards and specifications

Traffic control devices are frequently confused with traffic calming measures. Traffic control devices are signs, signals, and markings that are designed to regulate, warn, guide, and inform. Traffic calming measures are usually physical measures in the roadway used to slow traffic. Although a traffic control device and a traffic calming measure could share the goal of slowing motorists, the purpose of a traffic control device is to attempt to communicate, while the traffic calming measure is a part of the design of the street or intersection. A traffic control device may, however, supplement a traffic calming measure.

CHAPTER II
DO'S OF TRAFFIC CALMING

1. **Quantify the problem.** Identify the real problem(s). Speed, volume and noise are frequent complaints, but often the real problem on a street is just one of these.

   Undertake traffic counts, speed studies, and accident data analyses.

   Remember that you are hearing mostly from people who are dissatisfied. There are other aspects to the situation that you are not likely hearing about.

2. **Involve the community.** Do not develop or implement a plan without the community's involvement. No matter how technically sound a plan might be, it will not work as well if the community is not involved.

3. **Educate decision makers.** Avoid uninformed (often political or emotional) decisions.

4. **Look at the arterial network first.** No one uses a short-cut unless there's a reason to. The reason is often congestion on nearby arterials.

5. **Favor self-enforcing measures.** "Self-enforcing" measures maintain a 24-hour presence and are effective without police enforcement.

6. **Consult with all services.** Police, fire, ambulance, transit, sanitation services, and snow plow operators should be involved from the beginning.

7. **Sign and delineate.** Install appropriate warning signs, and delineate the traffic calming measures.

8. **Implement measures on an areawide basis.** Avoid creating more problems or relocating a problem. Always consider the impacts on adjacent local streets and arterial roads. Identify groups of measures to be implemented in stages if funding for the entire transportation management plan cannot be secured at once.

9. **Monitor and follow-up.** Report back to the community as to the success of traffic calming measures. This helps to justify additional expenditures and enhances the credibility of the traffic management program.

   Implement measures as demonstrations if decided by consensus.

10. **Remember that everybody drives differently.** Some people will drive around or over some calming measures. Some people don't understand traffic circles, no matter how well they are signed.

    Some people resist change.

11. **Expect problems.** Some problems (such as regional traffic issues) cannot be addressed by a neighborhood wide plan.

    Some problems cannot be resolved at a reasonable cost. For example, it may simply be too expensive to acquire property to widen an intersection or a road.

    Refer other problems to the appropriate agency, such as the planning department, the police, etc.

CHAPTER III
DESIGN AND INSTALLATION

A. Key Points with Design

1. Some designers appear to focus solely on traffic calming measures rather than using traditional traffic management and traffic calming measures in combination.
2. Speed humps are an effective means of speed reduction but are often opposed by bus operators and emergency services. In some situations, it should be possible to achieve a sufficiently effective scheme without the need for vertical deflections.
3. While speed humps slow traffic, they can attract criticism because of the inconvenience, discomfort, and vehicle damage.
4. Narrowing travel lanes can be very effective, particularly when the two-way traffic volume is high. Lanes need adequate signing and marking.
5. If systematic monitoring takes place, it will be easier to decide which measures are appropriate for different circumstances.

B. Design Aspects of Residential Traffic Calming Measures

1. **Visibility.** Measures should be clearly visible day and night. Reflectors, buttons, highly reflective paint, or illumination should be used as appropriate to ensure visibility. Additionally, traffic calming measures should not be placed where drivers do not have adequate stopping sight distance for the operating speed of the road.

2. **Signing.** Advance signs should warn motorists of upcoming traffic calming measures and, to the extent possible, guide the motorists' response to such measures.

3. **Streetscape.** Traffic calming measures should blend naturally with the streetscape and enhance the appearance and feel of the street. They should alert drivers that they are in or entering a residential place.

4. **Design vehicles.** Traffic calming measures should be designed to accommodate emergency service and other large vehicles at an acceptable speed.

5. **Maintenance.** Long-term maintenance needs should be anticipated in the design process and minimized to the extent possible. Some jurisdictions contract with the neighborhood to maintain plantings or simply eliminate landscaping in the absence of a willingness on the part of residents to participate.

6. **Parking.** On-street parking in residential areas creates a sense of activity; some jurisdictions encourage on-street parking for this reason. However, in some instances, on-street parking also creates sight line restrictions, which may be unsafe for drivers who are speeding.

7. **Speed control.** Traffic calming measures should be located and designed to limit speeds in residential areas.

C. Do's of the Design Process

1. Consider installing temporary traffic calming measures and monitor them for a period of time before installing the permanent measures.

2. Have an organized program including public involvement with plans and policies approved and supported by the local government.

3. Involve the local service agencies, including fire, police, and emergency medical service personnel from the beginning.

4. Consult with fire department and EMS personnel to develop the design, particularly with speed humps and traffic circles. Set up traffic circles with cones and have the fire trucks and other emergency vehicles drive around them. This will help determine what radius is best for the types of emergency vehicles found in different areas. The same process can be used in the design of speed humps.

5. Review traffic patterns in the neighborhood as a whole. Avoid solving the problem on one neighborhood street by shifting the traffic to another neighborhood street.

6. Make certain that all signing and channelization are in accordance with the *Manual on Uniform Traffic Control Devices* (MUTCD), the Supplement to the MUTCD, and the American Association of State Highway and Transportation Officials (AASHTO) *Policy on Geometric Design of Highways and Streets*.

7. Check sight distances for vehicles, pedestrians, and bicyclists. Sight distance is to meet the requirements of the AASHTO *Policy on Geometric Design of Highways and Streets*.

8. Check sight distances by visiting the site before and after installation. Do parked cars obstruct sight distances? Does landscaping (now or after it grows) or other features obstruct sight distance?

9. Review the on-street parking. Will parked cars block access of emergency vehicles through or around the proposed neighborhood traffic calming measures? Add additional no parking zones where needed.

10. Review the site for utility conflicts. Is there a fire hydrant? Does it need to be moved? Are there utilities in the way?

11. Check the storm water drainage. Will the storm drain system need to be moved or revised? Can the runoff get through or around the measure?

12. When installing traffic calming measures on streets without curbs, supplemental features (e.g., bollards, delineators) may be necessary to keep vehicles within the traveled way.

13. Traffic calming measures may need to be adjusted on streets with grades of greater than 10 percent.

14. Traffic calming measures should be installed on curving, winding roads with limited sight distance only if reduced speed limits and adequate warning signs are used in conjunction with the measures.

15. Traffic calming measures should be away from driveways.

D. Checklist for the Installation of Residential Traffic Calming Measures

As a minimum, the following items should be reviewed by the design professional for each residential traffic calming measure installation:

Geometrics

- Turning radius
- Horizontal and vertical alignment
- Super elevation
- Major geometric features such as sidewalks, curbs, etc.
- Roadway width
- Sight distances

Safety

- Channelization
- Illumination
- Signing
- Clear zone (the total roadside border area starting at the edge of the travel way available for safe use by errant vehicles)
- Crosswalk locations

Utilities

- Water and sewer
- Franchise utilities (such as gas, power, telephone, etc.)
- Storm drainage
- Location of hydrants

Design Vehicles

- Local emergency vehicle characteristics
- Minimum design vehicle - bus, single-unit truck, or passenger car
- Public transit and school bus stops and routes
- Bicycles and wheelchairs

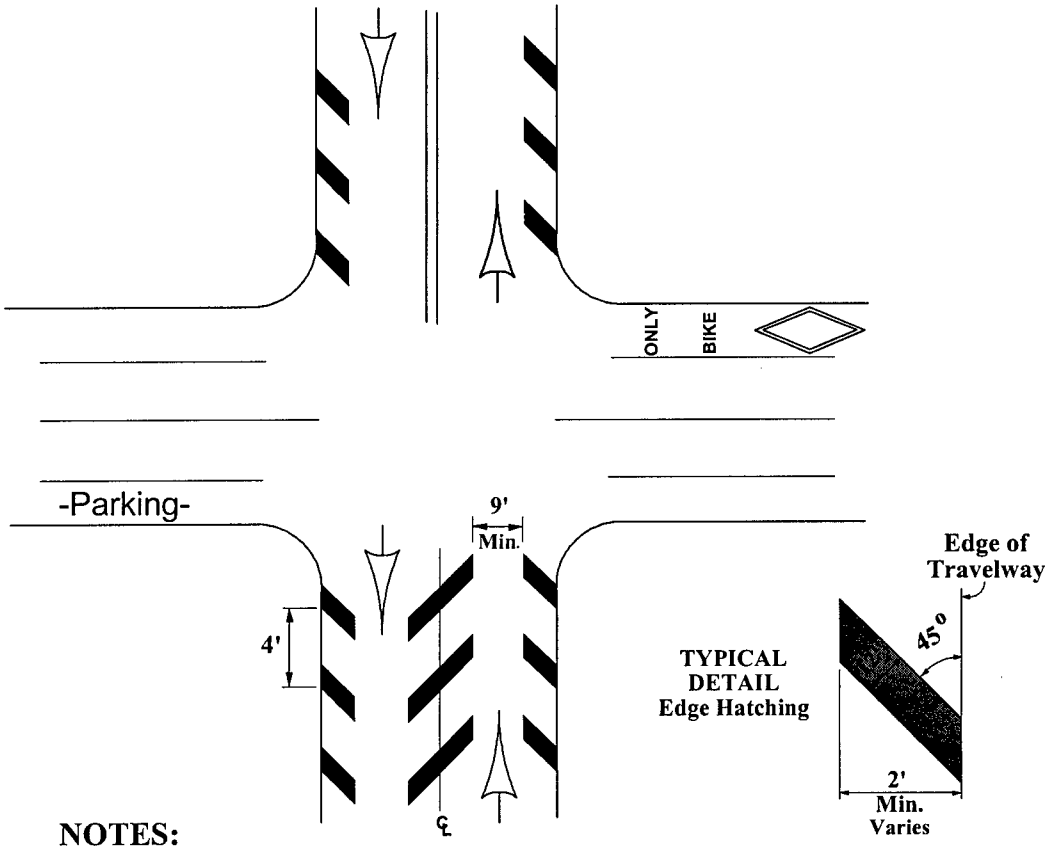
Other

- Landscaping
- Pedestrians and bicycles
- Access for the mobility impaired
- Parking
- Mail delivery routes
- Emergency access

CHAPTER IV
RESIDENTIAL TRAFFIC CALMING MEASURES

TRAFFIC CALMING MEASURE

Figure A-1. NON-PHYSICAL MEASURE
PAVEMENT MARKING / LANE NARROWING



NOTES:

1) Markings shall be in accordance with the MUTCD, VDOT's Road and Bridge Standards and Specification, and Road Design Manual, Sec A5.

2) Narrowing Design Options:
   a) Hatching
   b) Parking Lanes
   c) Bike Lanes

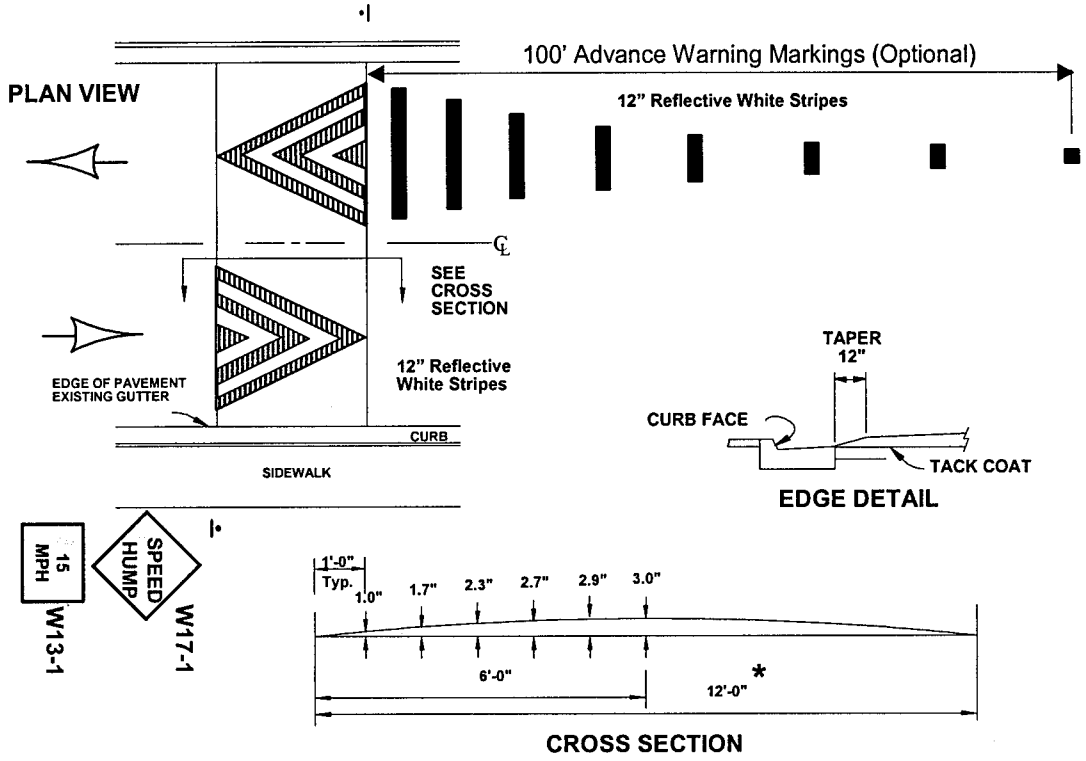
3) The amount of hatching as well as widths, lengths and spacing to be determined by the Engineer. Centerline hatching optional.

4) Travel lanes not to be less than 9' in width.

5) Engineer to modify design to accommodate field conditions while conforming to AASHTO publications and acceptable engineering practices.

TRAFFIC CALMING MEASURE

Figure A-2. SPEED HUMP



NOTES:

1) Signs and Markings shall be in accordance with the MUTCD & ITE practices.

2) Advance signing at each location is optional when part of an area wide scheme.

3) Cross-section shows approximate elevation for 3" (maximum) speed hump.

4) Design Options:
   a) 22' section (See Raised Crosswalk for cross-section.)

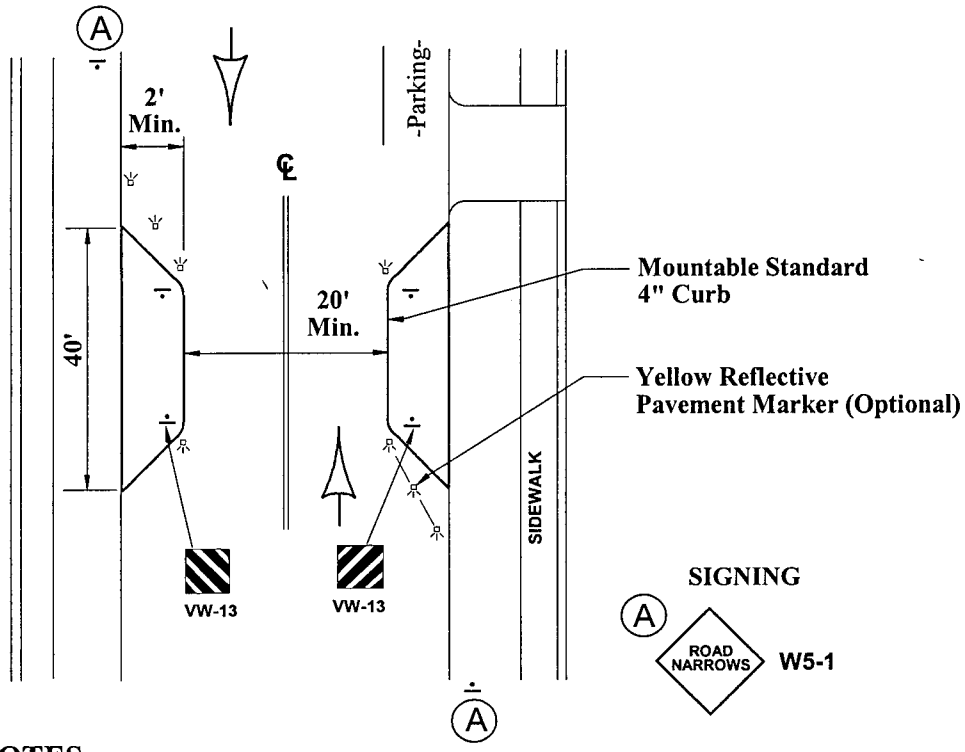
5) Speed Humps shall not be placed over manholes, watergates, junction chambers, etc.

6) Speed Humps must be placed at locations approved by Engineer.

7) Engineer to modify design and location to accommodate field conditions (ex. drainage) while conforming to VDOT's Road and Bridge Standards and Specification manuals, AASHTO publications and acceptable engineering practices.

TRAFFIC CALMING MEASURE

Figure A-3. CHOKER



NOTES:

1) Signs and Markings shall be in accordance with the MUTCD.

2) Advance signing at each location is optional when part of an area wide scheme.

3) Landscaping designs, if any, to be determined by the community and approved by the Engineer. Sight distance shall not be impacted by landscaping. Fixed objects shall not be placed in any portion of the measures that are within the clear zone.

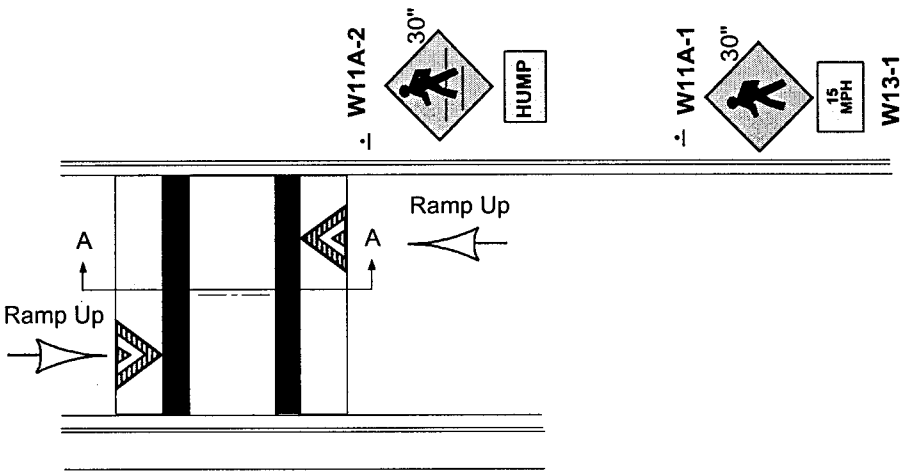
4) The transition of the approach curb, and accompanying raised pavement markers, shall be in conformance to the design speed.

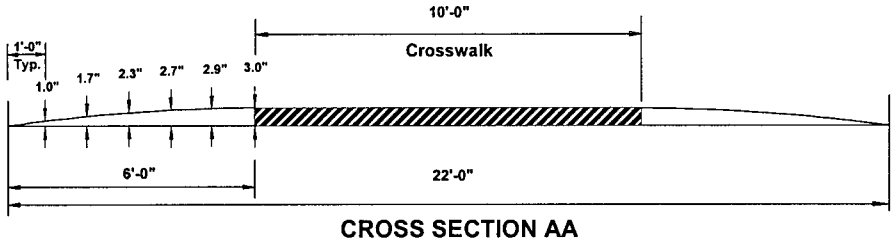
5) Design Options:
   a) Intersection or Mid-block
   b) One-side or Two-side
   c) Combined with Raised Crosswalk

6) Engineer to modify design and location to accommodate field conditions (ex. drainage) while conforming to VDOT's Road and Bridge Standards and Specification manuals, AASHTO publications and acceptable engineering practices.

TRAFFIC CALMING MEASURE

Figure A-4. RAISED CROSSWALK





CROSS SECTION AA

NOTES:

1) Signs and Markings shall be in accordance with the MUTCD.

2) Advance signing at each location is optional when part of an area wide scheme.

3) Cross-section shows approximate elevation for 3" (maximum) raised crosswalk.

4) Design Options: can be combined with choker.

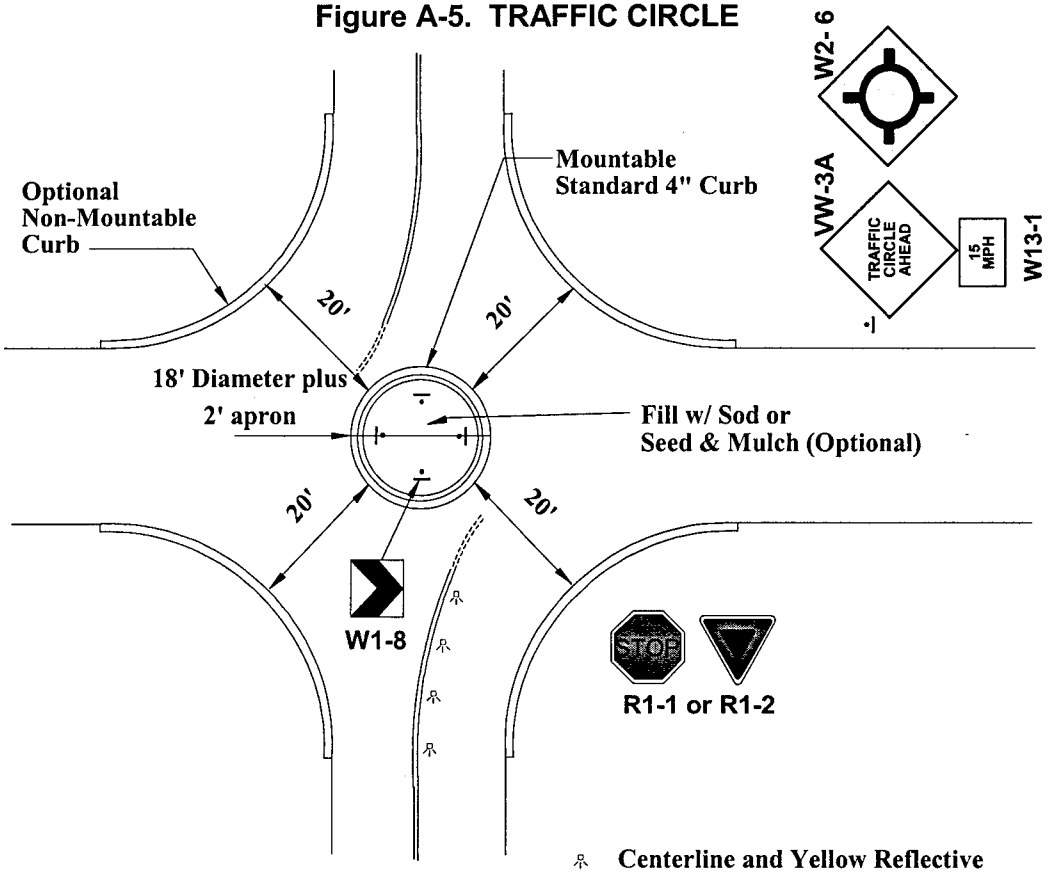
5) Raised Crosswalks should be located mid-block (edge of ramp at least 20' from intersection) and shall not be placed over manholes, watergates, junction chambers, etc.

6) Raised Crosswalk material and placement to be approved by Engineer.

7) Engineer to modify design to accommodate field conditions (ex. drainage and curb cuts) while conforming to VDOT's Road and Bridge Standards and Specification manuals, AASHTO publications and acceptable engineering practices.

TRAFFIC CALMING MEASURE

Figure A-5. TRAFFIC CIRCLE



NOTES:

1) Signs and Markings shall be in accordance with the MUTCD.

2) Advance signing at each location is optional when part of an area wide scheme.

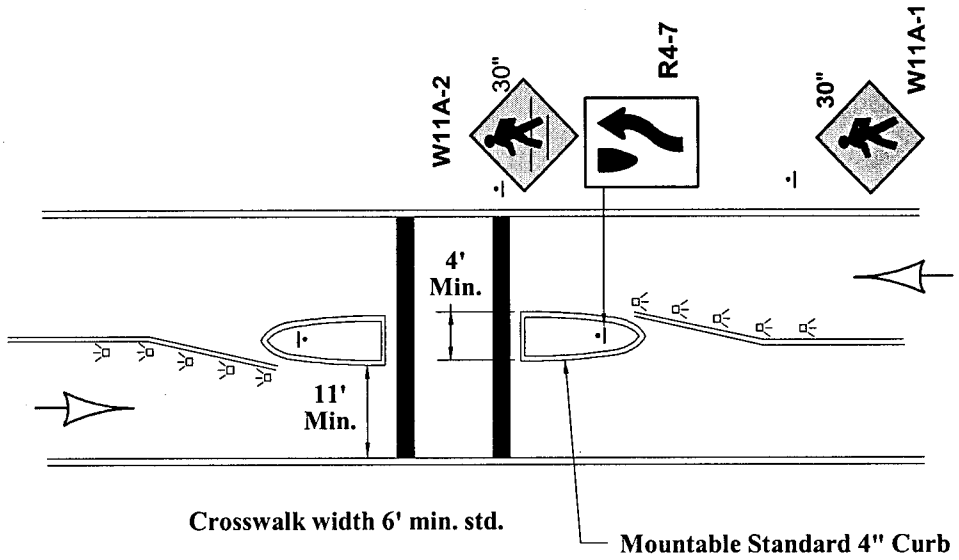
3) Landscaping designs, if any, to be determined by the community and approved by the Engineer. Sight distance shall not be impacted by landscaping. Fixed objects shall not be placed in any portion of the measures that are within the clear zone.

4) Use of Stop or Yield Sign as determined by the Engineer.

5) Engineer to modify design to accommodate field conditions (ex. drainage) and available ROW while conforming to VDOT's Road and Bridge Standards and Specification manuals, AASHTO publications and acceptable engineering practices.

TRAFFIC CALMING MEASURE

Figure A-6. CROSSWALK REFUGE



Yellow Reflective Pavement Marker (Optional)

NOTES:

1) Signs and Markings shall be in accordance with the MUTCD.

2) Advance signing at each location is optional when part of an area wide scheme.

3) Landscaping designs, if any, to be determined by the community and approved by the Engineer. Sight distance shall not be impacted by landscaping. Fixed objects shall not be placed in any portion of the measures that are within the clear zone.

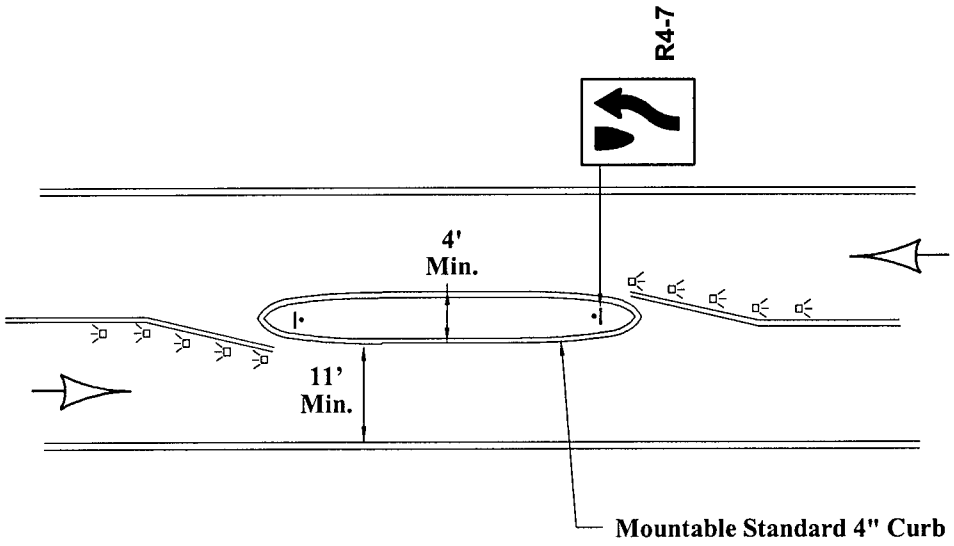
4) Design Options:
   a) Intersection or Mid-block.
   b) Combined with Raised Crosswalk.

5) The transition of the approach curb, and accompanying raised pavement markers shall be in conformance to the design speed.

6) Engineer to modify design and location to accommodate field conditions (ex. drainage) while conforming to VDOT's Road and Bridge Standards and Specification manuals, AASHTO publications and acceptable engineering practices.

TRAFFIC CALMING MEASURE

Figure A-7. RAISED MEDIAN ISLAND



Yellow Reflective Pavement Marker (Optional)

NOTES:

1) Signs and Markings shall be in accordance with the MUTCD.

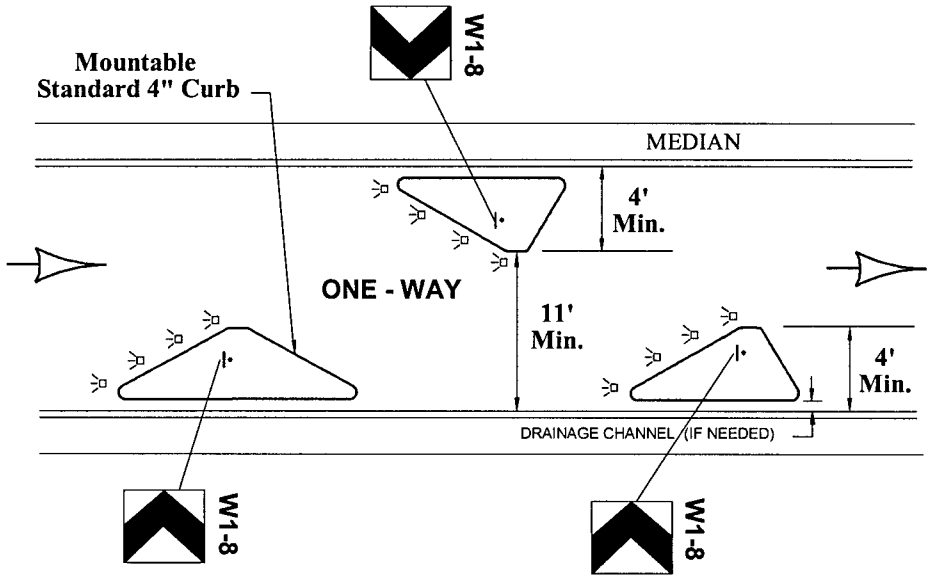
2) Landscaping designs, if any, to be determined by the community and approved by the Engineer. Sight distance shall not be impacted by landscaping. Fixed objects shall not be placed in any portion of the measures that are within the clear zone.

3) The transition of the approach curb, and accompanying raised pavement markers, shall be in conformance to the design speed.

4) Engineer to modify design and location to accommodate field conditions (ex. Island length and drainage) while conforming to VDOT's Road and Bridge Standards and Specification manuals, AASHTO publications and acceptable engineering practices.

TRAFFIC CALMING MEASURE

Figure A-8. CHICANE



Yellow Reflective Pavement Marker (Optional)

NOTES:

1) Signs and Markings shall be in accordance with the MUTCD.

2) Advance signing at each location is optional when part of an area wide scheme.

3) Landscaping designs, if any, to be determined by the community and approved by the Engineer. Sight distance shall not be impacted by landscaping. Fixed objects shall not be placed in any portion of the measures that are within the clear zone.

4) The transition of the approach curb, and accompanying raised pavement markers, shall be in conformance to the design speed.

5) Engineer to modify design and location to accommodate field conditions (ex.drainage) while conforming to VDOT's Road and Bridge Standards and Specification manuals, AASHTO publications and acceptable engineering practices.