Final

Citywide Guidelines for Traffic Calming and Neighborhood Traffic Management

Adopted by the:

Traffic Advisory Committee
July 14, 2005

Prepared by the:

FEHR & PEERS
TRANSPORTATION CONSULTANTS

City of Napa
Public Works Department
Transportation Engineering Division

ACKNOWLEDGEMENT

PROJECT MANAGEMENT TEAM

Public Works Department

- Michael O'Bryon, Public Works Director
- Laurence Pollard, Assistant Public Works Director
- Eduardo Serafin, Senior Traffic Engineer
- Frederick Navarro, Associate Civil Engineer
- Edward Moore, Senior Engineering Aide

STAKEHOLDER TECHNICAL WORKING GROUP

Community Development Department

- Barry Munowitch, Planning Manager
- Deborah Faaborg, Senior Planner
- Jean Hasser, Senior Planner
- Scott Klingbeil, Senior Planner
- Jacqueline Solomon, Development Engineering Manager
- Ernie Cabral, Associate Civil Engineer

Community Resources Department

- Robert Carlsen, Parks Superintendent
- Amy Williams, Management Analyst
- Sherrie Stone, Administrative Assistant
- Ginnie Mosher, Senior Center

Fire Department

- Darren Drake, Fire Marshall/Division Chief

Police Department

- Dan Monez, Police Chief (former)
- Steve Potter, Commander, Patrol/Traffic

Redevelopment Agency/Economic Development Department

- Jennifer LaLiberte, Project Coordinator
- Robin Klingbeil, Management Analyst

Water Division

- Megan Thomas, Associate Civil Engineer

CONSULTANT PROJECT TEAM

Fehr & Peers

- Matthew Ridgway, Principal
- Colin Burgett, Senior Transportation Planner
- Phyllis Chan, Senior Engineering Technician
- Matt Haynes, Transportation Engineer

TABLE OF CONTENTS

I. OVERVIEW 1

1.1 Definition of Traffic Calming 1
1.2 General Plan Policies 1
1.3 Goals and Objectives 2
1.4 Planning Process 4
1.5 Funding Constraints 4
1.6 Implementation Options 5
1.7 Potential Negative Impacts 5

II. POLICY GUIDELINES 6

2.1 When to Consider Traffic Calming Measures 7
Warrants 7
2.2 Protecting Emergency Response Routes 8
2.3 Protecting Arterial and Collector Streets 10
Downtown Pedestrian Zone 10
2.4 Protecting Truck Routes 10
2.5 Protecting Transit Access 11
2.6 Role of Traffic Calming in the Safe Routes to School Program 15
2.7 Importance of Landscaping for Aesthetic Purposes 15
2.8 Selection and Placement of Appropriate Traffic Calming Measures 17
Problem Type 17
Location Type 20
Street Classification, Location and Other Constraints 22
Effectiveness Comparison 25
Placement of Traffic Calming Measures 26

III. PLANNING FOR NEW DEVELOPMENT AND REDEVELOPMENT PROJECTS 28

3.1 Development Review Process 28
3.2 Relevant City Policies 29
3.3 Designing Street Networks 29
Designing for Appropriate Speeds 30
Designing for Local Traffic 32
Pedestrian/Vehicle Conflict Areas 32
Developing a Traffic Calming Plan for New Development 33
3.4 Recommended Development Review Practices 33

IV. SELF-HELP NEIGHBORHOOD PROGRAM FOR TRAFFIC CALMING 36

Step 1: Neighborhood Traffic Calming Request 37
Step 2: Neighborhood Support Petition 37
Step 5: Preliminary Traffic Calming Plan 43
Step 6: Neighborhood Survey and Proposed Funding Mechanism 43
Step 7: Final Traffic Calming Plan 44
Step 8: Optional Effectiveness Assessment 44

V. TOOLBOX OF TRAFFIC CALMING MEASURES 46

5.1 Non-Physical Measures 47
Targeted Speed Enforcement 48
Radar Trailer 48
NASCOP Program 49
Lane Striping 50
Optical Speed Bars 50
Signage 51
Speed Legends 52
Botts Dots and rumble strips 52
High-Visibility Crosswalk 53
Angled Parking 53
5.2 Vertical Measures 54
Speed Cushion 55
Split Devices 56
Speed Table 57
Raised Crosswalk 58
Raised Intersection 59
Textured Pavement 60
5.3 Horizontal Measures 61
Traffic Circle 62
Roundabout 63
Lateral Shift 64
Chicane 65
5.4 Narrowing Measures 66
Neckdown/Bulbout 67
Center Island Narrowing/Pedestrian Refuge 69
5.5 Diversion Measures 70
Full Closure 71
Half Closure 72
Diagonal Diverter 73
Median Barrier 74
Forced-Turn Island 75

VI. BICYCLE-COMPATIBLE MEASURES 76

6.1 Vertical Measures 76
6.2 Non-Physical Measures 76
6.3 Horizontal Measures 77
6.4 Diversion Measures 78

6.5 Other 81
6.6. Summary of Bicycle-Compatible Measures 82
6.7 Measures That Should be Used with Care 82

VII. REFERENCES 84

General Information on Traffic Calming 84
Local Traffic Calming Programs 85
Roundabouts 85

APPENDIX A ..... A

Proposed Policy Guidelines for Livable Residential Local Streets and Connectivity ..... A

APPENDIX B ..... B

Proposed Design Guidelines for Traffic Calming Measures ..... B

APPENDIX C C

Guidelines for Typical Traffic Calming Device Designs C

APPENDIX D ..... D

Policy Guidelines for City of Napa "Bicycle Boulevard" ..... D

List of Figures

FIGURE 1 – PRIMARY RESPONSE ROUTES 9

FIGURE 2 - PEDESTRIAN SAFETY ZONE 12

FIGURE 3 – TRUCK ROUTE MAP 13

FIGURE 4 – TRANSIT MAP 14

FIGURE 5 – SCHOOL LOCATIONS 16

FIGURE 6 – STEPS IN THE NEIGHBORHOOD TRAFFIC CALMING PROCESS 45

List of Tables

TABLE 1 – TRAFFIC CALMING MEASURES AND PROBLEM TYPES 19

TABLE 2 – TRAFFIC CALMING MEASURES AND LOCATION TYPES 21

TABLE 3 – TRAFFIC CALMING MEASURES AND TRAFFIC CONSTRAINTS 23

TABLE 4 – QUANTITATIVE IMPACTS OF TRAFFIC CALMING MEASURES 25

I. OVERVIEW

These policy guidelines provide a framework for the potential selection, funding, application, and design of traffic calming measures in the City of Napa. The development of the City of Napa Traffic Calming Guidelines was pursued by the Public Works Department (PWD) through its Transportation Engineering Division (TED) in fulfillment of the City's General Plan policy *"to protect residential neighborhoods from high-volume and high-speed traffic and its effect"* (Residential Streets, Policy Goal T-4).

1.1 Definition of Traffic Calming

Traffic calming, as defined by the Institute of Traffic Engineers (ITE), is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users. Descriptions of typical traffic calming measures are provided in Chapter 5. Related strategies, such as enforcement and safety education, are also important to reducing the effects of neighborhood motor vehicle traffic though not included as part of this document. The policy guidelines in this document, however, include both traffic calming measures and neighborhood traffic management strategies.

1.2 General Plan Policies

The City's General Plan, *Envision Napa 2020*, Policy Document specifies the following policies and implementation programs related to traffic calming, which this policy guidelines document addresses.

Policy T-4.1 The City shall identify neighborhoods where traffic conditions may indicate the need for traffic calming measures. Conditions will include, but not be limited to, high vehicle operating speeds, high traffic volumes, and/or high accident rates.

Policy T-4.5 The City shall, whenever possible, require private streets to be consistent with public street standards (e.g. for utilities, street lights, sidewalks, street trees, parking) as well as to include traffic calming measures where appropriate.

Program T-4.A The City shall prepare traffic calming standards and other measures to provide increased protection to existing neighborhoods. Responsibility: Public Works Department; Traffic Advisory Committee

Program T-4.B The City shall investigate the feasibility of creating a special assessment district to fund capital improvements for traffic calming. Responsibility: Public Works Department; Finance Department

1.3 Goals and Objectives

City staff frequently receives requests from residents to install traffic calming measures to slow or divert traffic, generally in response to neighbor's concerns or perceptions about speeding or cut-through traffic on particular streets, or as concerns are generated by "in-fill" development.

While such measures may be effective in alleviating one type of problem, consequences of improperly placed measures can result in traffic problems on adjoining streets and reduce the ability of emergency vehicles to maintain adequate response times. Additionally, the City does not currently have abundant funding to plan and install such measures throughout Napa.

This document creates a process for neighborhoods to take the lead in working with City staff to study a particular traffic issue, identify potential solutions, develop neighborhood consensus on desired measures and identify or create a funding source.

The key goals of the Citywide Traffic Calming Policy are to:

- Define a process for neighborhoods to sponsor traffic calming plans and identify funding sources for specific streets, areas or neighborhoods

- Provide guidance for the types of traffic calming measures that may be considered, both as part of the neighborhood process and during the City's review of new development applications

The City's traffic calming program targets residential and collector streets. The main operational objectives include:

- 85th percentile travel speeds (the speed at which 85 percent of vehicles travel at or below on a particular street) within 5 mph of the appropriate speed limit

- Reduced cut-through traffic where existing levels are inappropriate and where the remedy will not create a problem on other streets (consistent with the *Policy Guidelines for Livable Residential Local Streets and Connectivity*, see Appendix A)

- Reduced collisions for motor vehicles and pedestrians

- Adequate access for emergency vehicles

These objectives are met through a combination of parallel strategies, known collectively as the "Three E's":

Education – Information-sharing and awareness raising, targeting drivers, pedestrians, and cyclists about the safest, best ways to share the road.

Engineering – Physical measures constructed to lower speeds, improve safety, or otherwise reduce the impacts of automobiles.

Enforcement – Targeted police enforcement that supports neighborhood goals.

This document focuses on the engineering aspects of traffic calming, though education and enforcement play an important role in any engineering strategy. Education and enforcement are addressed in greater detail through other City programs and departments. This includes a recently initiated program on education, safety, and

awareness called *Street Smarts* and ongoing enforcement activities by the Napa Police Department and Public Works Department.

1.4 Planning Process

These guidelines establish a neighborhood-driven process for initiating a request for traffic calming measures on a particular street or corridor. Residents will take the lead in studying traffic conditions to determine if traffic calming measures are appropriate, developing a traffic calming plan and identifying a funding source for construction and maintenance. Additionally, as part of the development review process, the City of Napa will work with developers to ensure that new development or redevelopment projects are properly designed, in order to avoid the types of problems that frequently result in requests for traffic calming measures.

1.5 Funding Constraints

The City of Napa has limited resources, and none at present, to plan, construct and maintain traffic calming measures. Many neighborhoods are requesting traffic calming projects, and the prioritization process for funds, when they become available, may result in long delays for traffic calming projects. Given this constraint, a key element of the neighborhood-driven process will be the identification of a funding source by the neighborhood to plan, construct and maintain appropriate traffic calming measures. The self-help program empowers neighborhoods to propose and fund improvements to their community. Neighborhoods can form assessment districts to develop their program and fund improvements. The neighborhood assessment district may have the financial responsibility for building and maintaining traffic calming features. As part of this process, City staff can help identify potential strategies, review proposed traffic calming programs developed by the neighborhoods, and serve as a partner on grant applications for supplementary funding of improvements.

Additionally, as part of the City's development review process, the City, through the guidance from the Community Development Department, may work with developers, as appropriate, to identify measures that will reduce the likelihood of traffic problems arising that would require costly traffic calming measures in the future.

1.6 Implementation Options

Guidance for determining whether traffic calming measures are appropriate for a particular location or problem type, and for selecting and placing appropriate measures are provided in Chapter 2. Recommendations for incorporating traffic calming measures into new development projects are provided in Chapter 3. The process for developing traffic calming plans for existing neighborhoods is described in Chapter 4. Detailed descriptions of the "toolbox" of possible traffic calming measures are provided Chapter 5. Chapter 6 reviews the appropriateness of various traffic calming measures for bicyclists. References and other sources for researching traffic calming issues are provided in Chapter 7.

1.7 Potential Negative Impacts

The installation of traffic calming measures can potentially lead to unintended consequences, such as diverting traffic problems to adjoining streets, reducing street connectivity, or impacting bus or transit circulation along designated bus or truck routes. In addition, certain types of traffic calming measures can impact response time for emergency vehicles or cause uncomfortable rides for persons with certain skeletal disabilities. Negative impacts can be avoided through the selection and placement of measures that are appropriate to each type of street. Chapter 2 provides guidance for selecting appropriate measures and avoiding negative impacts.

II. POLICY GUIDELINES

The following section provides criteria for considering whether traffic calming measures are appropriate for a specific location and problem type, and what types of devices may be installed in specific circumstances. The process for neighborhoods to develop and implement a traffic calming plan is described in Chapter 4.

Traffic calming measures are typically divided into five categories:

- Non-physical measures
- Vertical measures
- Horizontal Measures
- Narrowing Measures
- Diversion Measures

Refer to Chapter 5 ("Toolbox of Traffic Calming Measures") for detailed descriptions of each type of traffic calming measure.

2.1 When to Consider Traffic Calming Measures

Traffic calming measures should be considered if initial data collection confirms that a perceived traffic problem meets a defined threshold, or "warrant", indicating that traffic calming measures may be appropriate. Traffic calming may be considered for local streets, residential collector streets, streets in the Downtown Pedestrian Zone, and non-residential minor collector streets. Arterials and major collector streets are not appropriate candidates for traffic calming.

Warrants

The warrants for determining whether traffic calming measures should be considered for a specific location or corridor are listed below for specific problem types:

- **Speeding** – 85th percentile motor vehicle speeds (the speed at which 85 percent of vehicles are traveling at or below) exceed the posted speed limit by more than six miles per hour (mph) on a specified street or corridor. For a 25-mph street, this warrant would be met when the 85th percentile speed is 32 mph or greater.

- **Traffic Volumes** – traffic volumes exceed 2,500 vehicles per day on a local residential street, or 5,000 vehicles per day on a collector street serving primarily residential neighborhoods (consistent with the *Policy Guidelines for Livable Residential Local Streets and Connectivity*, see Appendix A).

- **Pedestrian Volumes** – where pedestrian volumes at a particular street crossing location exceed 40 pedestrians during a one-hour period or 25 pedestrians per hour for a four-hour period and sidewalks or stop-controlled crossings (such as a stop sign or traffic signal) are not provided for the pedestrian's primary path of travel. This warrant is not applicable to downtown streets or arterial streets.

- **Safety** – three or more collisions per year (involving motor vehicles, bicycles or pedestrians) that may be correctable through traffic calming measures are reported over a three-year period at a specific location, such as at an intersection.

If initial data collection indicates that one or more warrants are met, then development of a traffic calming plan may be warranted. Failure to meet at least one warrant suggests that traffic calming is not an appropriate solution for the specified location or corridor. Key considerations in developing a traffic calming plan are described in the following sections.

2.2 Protecting Emergency Response Routes

In order to promote public safety by ensuring unimpeded emergency vehicle access by the Fire and Police Departments, vertical traffic calming measures, such as speed humps, and diversion measures shall not be installed on the Fire Department's Emergency Response Routes. The types of traffic calming measures that may be considered on Emergency Response Routes are listed in Table 3. The map of emergency response routes is displayed on Figure 1. In addition, all horizontal, vertical and diversion measures on all Emergency Response Routes are subject to the review and approval of the fire department.

As a guideline, the Fire Department uses the following performance objectives for the City of Napa:

- Four minutes (240 seconds) or less for travel time for the initial arriving unit and / eight minutes (480 seconds) or less travel time for a full initial assignment. This is evaluated at the 90% fractile. A full response is the ability to deliver a complement of at least 15 initial responders (or 5 emergency units) to structure fire calls in the urbanized areas of a community.

- Ability to handle concurrent calls for service within the eight-minute response time objective for Advanced Life Support and structure fire calls.

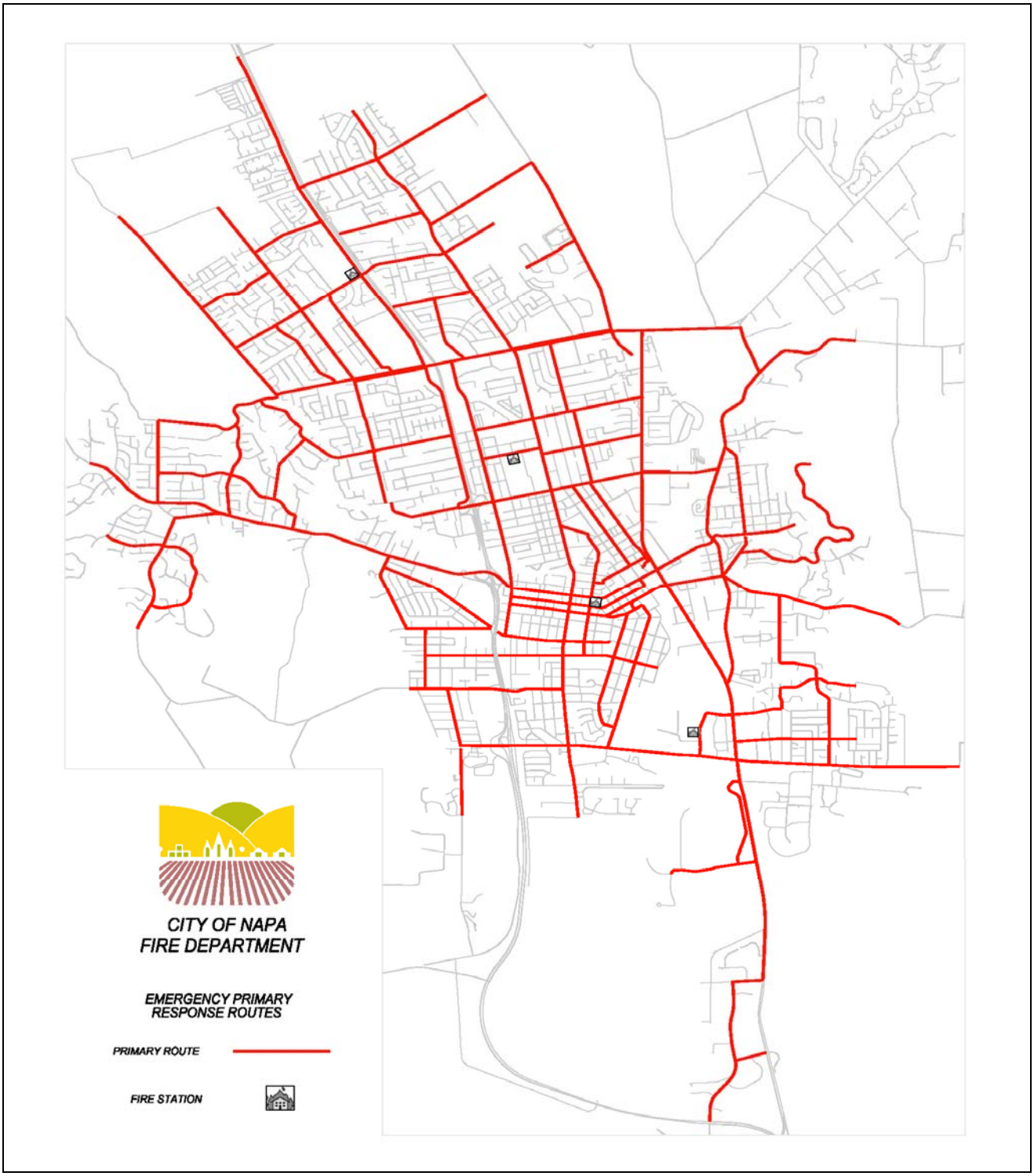


FIGURE 1 – PRIMARY RESPONSE ROUTES

2.3 Protecting Arterial and Collector Streets

The City of Napa's street network consists of arterial, collector and local streets. Many types of physical traffic calming measures are not appropriate for arterial and collector streets since the purpose of those streets is to accommodate traffic flow and reduce the likelihood of traffic diverting to local streets. Table 3 lists the types of measures that are appropriate for each street type.

Enhanced Pedestrian Safety Zone

Given higher pedestrian volumes within downtown Napa, traffic calming measures may be considered on arterial or collector streets within the *Enhanced Pedestrian Safety Zone* in the downtown area, shown on Figure 2. However, because of the comparatively high cost of infill development and real estate in the downtown area, providing traffic calming at certain locations may be economically infeasible. In some cases additional traffic calming may be determined unnecessary due to the pre-existing conditions that may already have a calming effect on traffic. These conditions include the existence of taller buildings and the higher usage of on-street parking, which provide a narrowing effect of the roadway.

The benefit-to-cost-ratio of doing traffic calming in the downtown area should be closely analyzed before recommendations are made. In addition, the Redevelopment Agency should be involved whenever traffic calming features are proposed or considered in the downtown area.

2.4 Protecting Truck Routes

Vertical traffic calming measures should not be installed on designated truck routes within the City of Napa (shown on Figure 3) since these measures may inhibit large truck movement. The types of traffic

calming measures that may be considered on truck routes are listed in Table 3. The truck route map is displayed on Figure 3.

2.5 Protecting Transit Access

Vertical traffic calming measures should not be installed that would impede transit operation along bus routes within the City. Coordination with the NCTPA/VINE should be included during development of any traffic calming plan affecting a bus route. The 2004 VINE transit route map is displayed on Figure 4.

ENHANCED PEDESTRIAN SAFETY ZONE

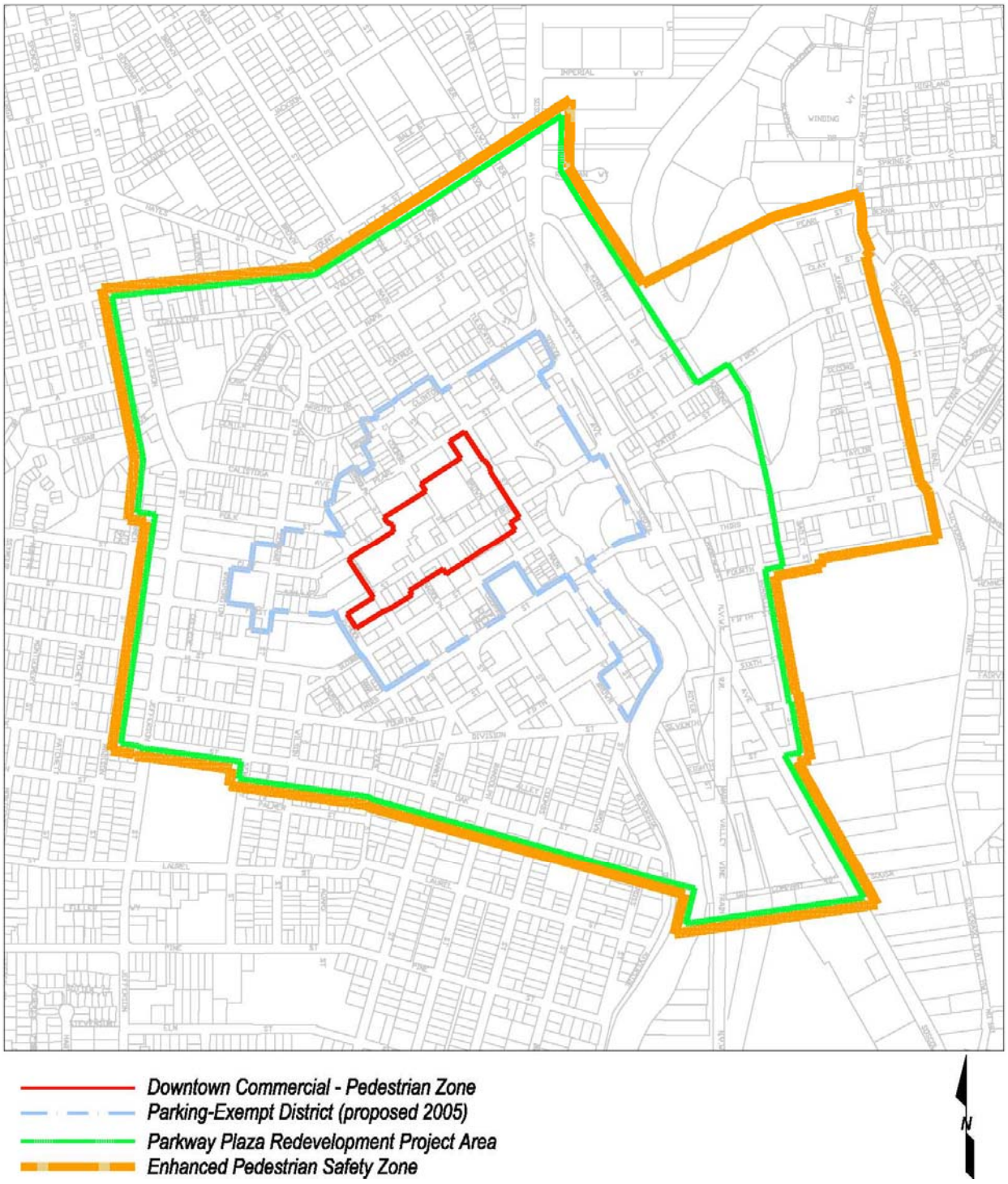


FIGURE 2 - PEDESTRIAN SAFETY ZONE

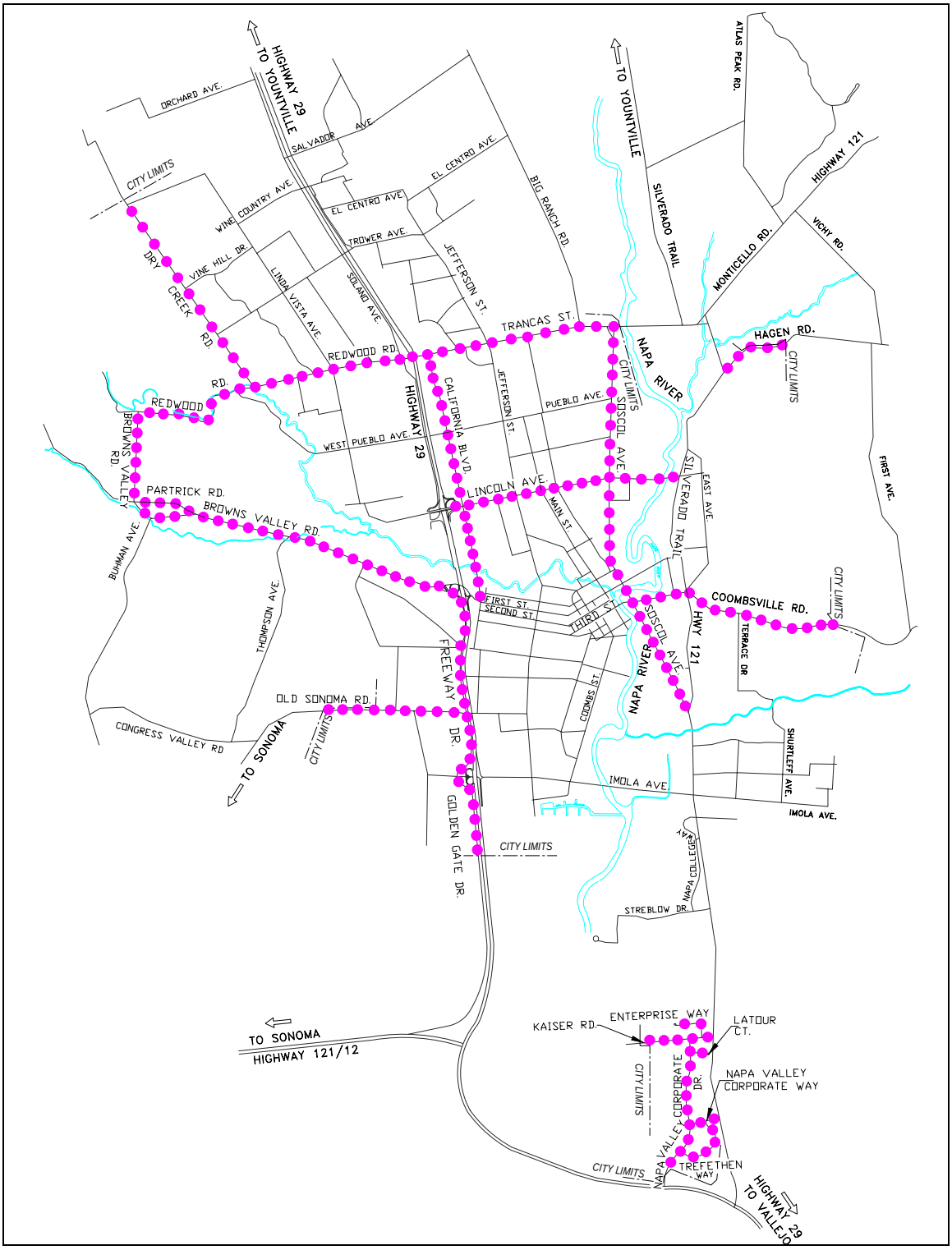


FIGURE 3 – TRUCK ROUTE MAP

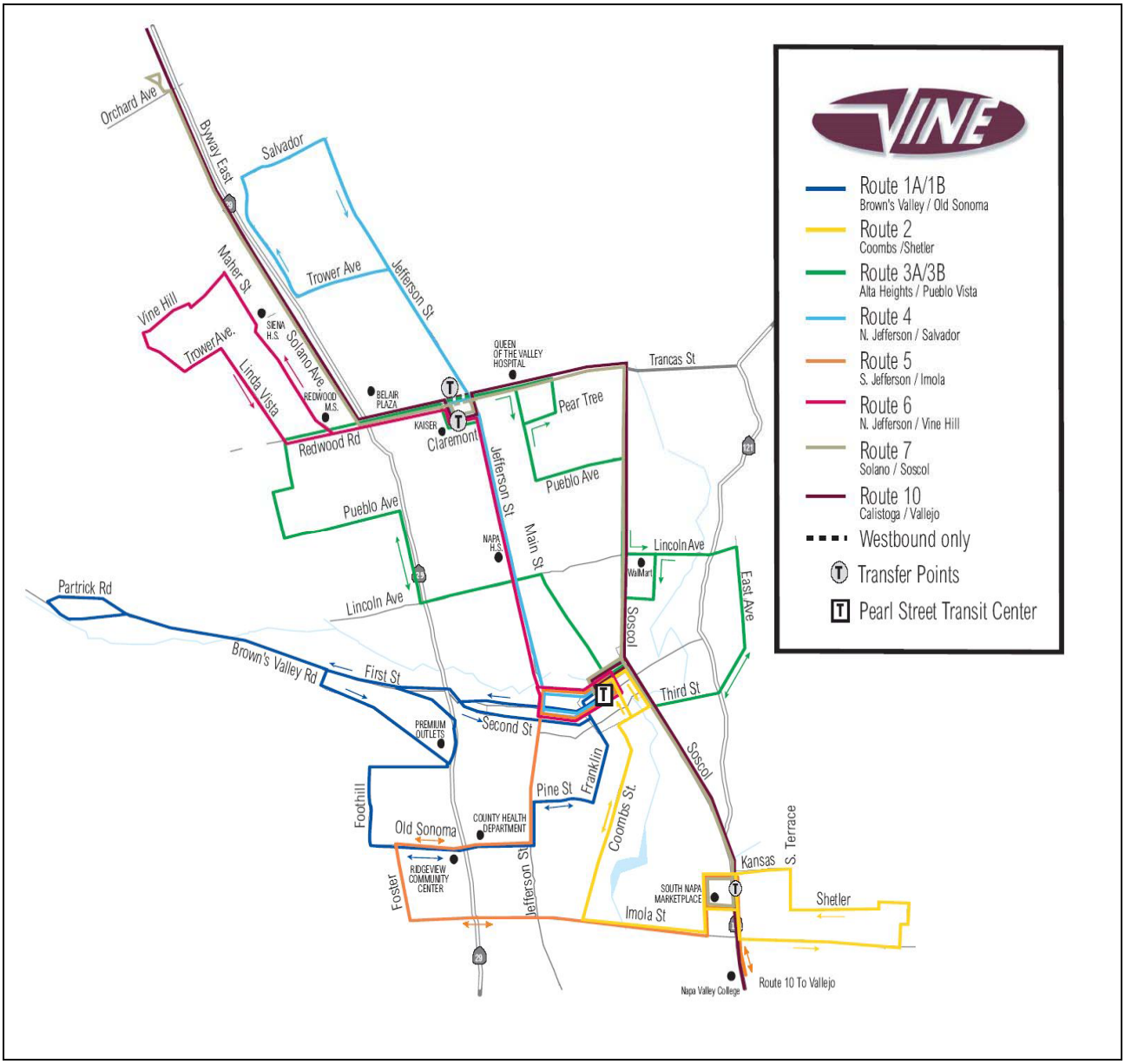


FIGURE 4 – TRANSIT MAP

2.6 Role of Traffic Calming in the Safe Routes to School Program

Many cities have developed "safe routes to school" programs to identify potential concerns for students walking to and from neighborhood schools, including issues related to sidewalks, crosswalks, and drop-off and pick-up zones. Appropriately installed traffic calming devices on roads leading to schools may enhance conditions near a school and complement a "safe routes to school" program. School locations in Napa are shown on Figure 5.

2.7 Importance of Landscaping for Aesthetic Purposes

Traffic calming measures should be appropriately designed to enhance the appearance of streets and neighborhoods in which they are placed. For certain measures, such as traffic circles or roundabouts, appropriate funding will be needed for installing and maintaining landscaping. Neighborhoods may consider forming assessment districts to assume responsibility for maintenance if City funding is unavailable.

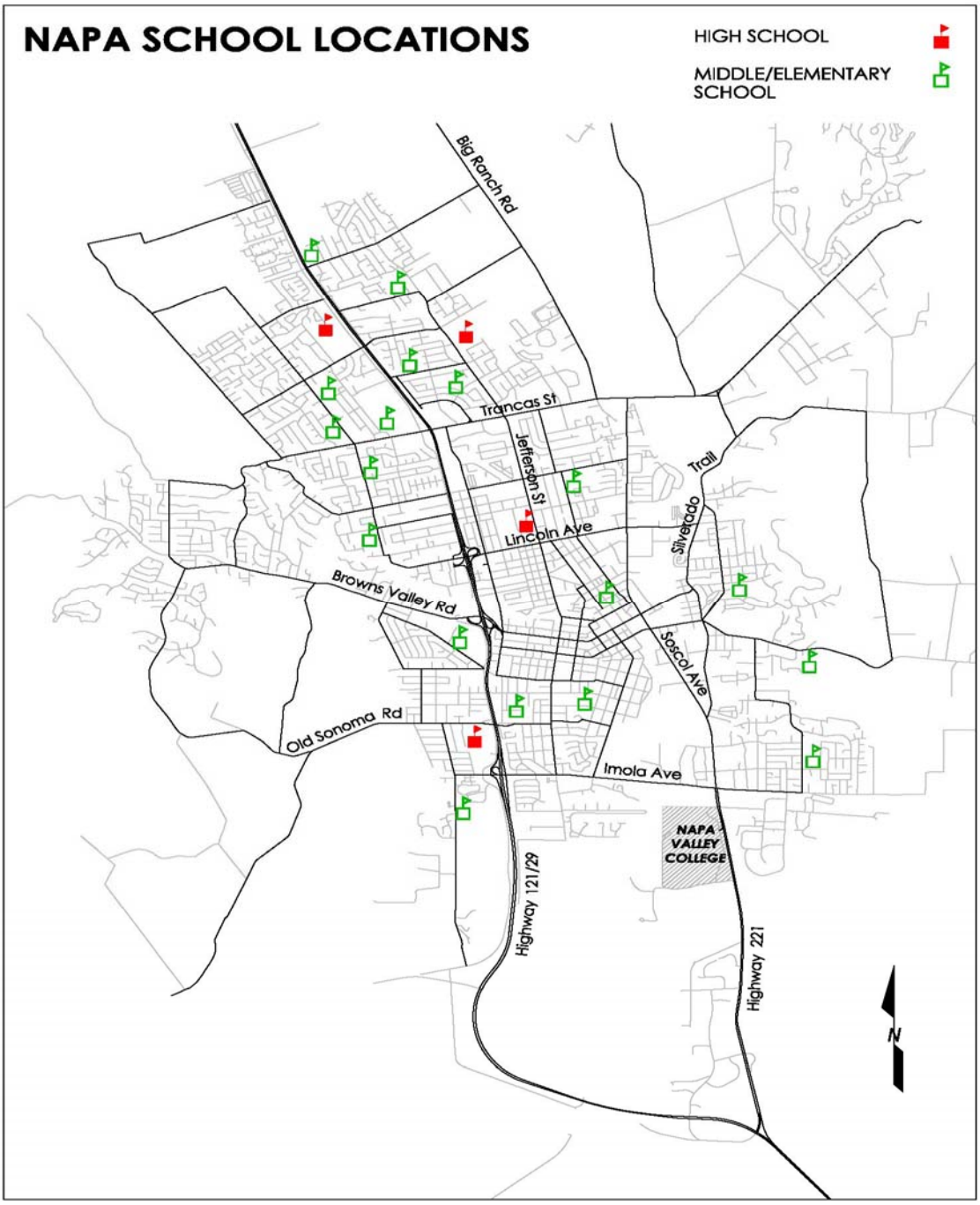


FIGURE 5 – SCHOOL LOCATIONS

2.8 Selection and Placement of Appropriate Traffic Calming Measures

Selecting the most appropriate traffic calming measure requires the narrowing of the toolbox of traffic calming measures to those that will: 1) most closely target the key traffic issue, 2) are appropriate for the type of location concerned, and 3) are compatible with the traffic volumes, geometrics, and adjacent land uses at that location. When the list has been narrowed, devices should be considered that balance effectiveness and likelihood of consensus among affected residents (demonstrated by 80 percent support). Finally, the selected devices need to be placed in a manner that will produce the desired results.

Problem Type

The first task when selecting the most appropriate traffic calming device is to narrow the field of devices to those that address the primary traffic problem. The major types of problems that result in a desire for traffic calming are:

- **Speeding** – motor vehicle speeds are significantly higher than what can be reasonably expected for the type of street
- **Traffic Volumes** – motor vehicle usage levels (all trips or non-local trips only) are significantly higher than what can be reasonably expected for the type of street
- **Vehicle Safety** – motor vehicle collision rates are significantly higher than what can be reasonably expected for the type of street or intersection
- **Pedestrian Safety** – motor vehicles cause an unnecessary risk to pedestrians
- **Noise/Vibration/Air Pollution** – motor vehicles cause excessive levels of these environmental effects

Speed Control Measures

Speed control measures can be used to address any of the major problem types.

Non-Physical Measures – The first solutions to consider should be Non-Physical Measures, such as signs and markings, since these can be most easily removed if unanticipated problems occur.

Vertical Measures – The use of vertical deflection devices, such as speed tables, should be carefully considered especially to limit any potential impact on emergency vehicles or transit access.

Narrowing Measures – The next type of traffic calming measure to consider should be narrowing measures, such as bulbouts or center island medians, which are less obtrusive and more aesthetically appealing than some other devices since they can be combined with landscaping.

Horizontal Measures – Narrowing devices are followed by horizontal deflection devices, such as chicanes and traffic circles, which are more intrusive but also more effective because they force vehicles to navigate horizontally around physical objects. These can also be combined with landscaping.

Diversion Measures

If speed-control measures fail to produce desired results, then diversion measures, such as forced turns, may be considered. Diversion of traffic often conflicts with other City goals aimed at encouraging street connectivity and a dispersion of traffic across multiple streets. These measures are generally appropriate only in special locations, such as in downtown "plaza" areas. Diversion measures should not exceed allowable daily traffic volumes of 2,500 vehicles/day on local residential streets (consistent with the *Policy Guidelines for Livable Residential Local Streets and Connectivity*, see Appendix A).

The appropriateness of each device for specific problem types is summarized in Table 1.

Table 1 – Traffic Calming Measures and Problem Types

Types of Measures		Type of Problem				
		Speeding	Traffic Volume	Vehicle Accidents	Pedestrian Safety	Noise
Non-Restrictive Measures						
	Targeted Speed Enforcement	●	○	◒	◒	◒
	Radar Trailer / NASCOP	●	○	○	○	◒
	Edgeline/Centerline Striping	●	○	○	○	○
	Optical Speed Bars	◒	○	○	○	○
	Speed Limit Signage	●	○	○	○	○
	Speed Legends	●	○	○	○	○
	Truck Restriction Signs	○	◒	○	○	●
	"Cross Traffic Does Not Stop" Signage	○	○	●	◒	○
	Botts Dots/Raised Reflectors	○	○	●	◒	○
	High-Visibility Crosswalks	◒	○	○	●	○
	Angled Parking	●	◒	○	○	○
Vertical Measures						
	Speed Cushions	●	●	◒	◒	×
	Split Devices	●	●	◒	◒	×
	Speed Tables	●	◒	◒	◒	×
	Raised Crosswalks	●	◒	◒	●	×
	Raised Intersections	●	◒	◒	●	×
	Textured Pavement	◒	○	○	◒	×
Horizontal Measures						
	Traffic Circles	●	◒	●	◒	○
	Roundabouts (Single-Lane)	◒	◒	●	○	●
	Lateral Shifts	◒	◒	○	○	○
	Chicanes	●	◒	○	○	○
Narrowing Measures						
	Neckdowns	●	◒	○	●	○
	Two-Lane Chokers	●	◒	○	○	○
	Center Island Narrowings/ Pedestrian Refuges	●	◒	◒	●	○
Diversion Measures						
	Full Closures	●	●	○	○	○
	Half Closures	●	●	○	○	○
	Diagonal Diverters	●	●	○	○	○
	Median Barriers	○	●	◒	○	○
	Forced Turn Islands	○	●	◒	○	○

Key: ● = Strongly Appropriate ◒ = Moderately Appropriate × = Inappropriate/Counterproductive ○ = Indifferent **NA** = Not acceptable due to other concerns

Location Type

The next step is determining the type of measures appropriate for the location type, such as whether the area is residential in character and whether devices would be installed mid-block or at intersections. Certain types of devices are appropriate in residential areas but not in non-residential areas. Additionally, special consideration must be given when considering measures on streets designated as "primary response routes" by the Fire Department.

Table 2 indicates the location(s) where each type of traffic calming measure is applicable.

Table 2 – Traffic Calming Measures and Location Types

Types of Measures	Residential			Non-Residential	
	Midblock	Intersection	Boundary of Area	Midblock	Intersection
Non-Restrictive Measures					
Targeted Speed Enforcement / Radar Trailer	●	●	●	●	●
Edgeline/Centerline Striping	●	×	×	●	×
Optical Speed Bars	●	×	×	●	×
Speed Limit Signage / Speed Legends	●	●	●	●	●
Truck Restriction Signs	×	×	●	×	●
"Cross Traffic Does Not Stop" Signage	×	○	●	×	○
Botts Dots/Raised Reflectors	**On Curves**	×	×	●	×
High-Visibility Crosswalks	●	**Unsignalized Intersections**	**Unsignalized Intersections**	●	**Unsignalized Intersections**
Angled Parking	●	×	×	●	×
Vertical Measures					
Speed Cushions	●	×	×	×	×
Split Devices	●	×	×	×	×
Speed Tables	●	×	×	○	×
Raised Crosswalks	●	○	○	○	×
Raised Intersections	×	●	●	×	●
Textured Pavement	●	●	●	●	●
Horizontal Measures					
Traffic Circles	×	●	○	×	○
Roundabouts (Single-Lane)	×	○	○	×	●
Lateral Shifts / Chicanes	●	×	×	●	×
Narrowing Measures					
Neckdowns	×	●	●	×	●
Two-Lane Chokers	●	×	×	●	×
Center Island Narrowings/ Pedestrian Refuges	●	●	●	●	●
Diversion Measures					
Full Closures	×	●	●	×	×
Half Closures	×	●	●	×	×
Diagonal Diverters	×	●	×	×	×
Median Barriers	×	○	●	×	×
Forced Turn Islands	×	○	●	×	●

Key: × = Seldom or never applicable. ● = Generally applicable.
○ = Not applicable except in some cases.

Street Classification, Location and Other Constraints

The third step in narrowing the field of devices requires finding which devices are compatible with the street classification, traffic volumes, posted speeds, and special roadway users at the proposed location, as indicated in Table 3.

Table 3 – Traffic Calming Measures and Traffic Constraints

Types of Measures		Roadway Classification: Local Streets	Roadway Classification: Residential Collectors or Downtown Pedestrian Zone	Roadway Classification: Non-residential Collectors	Fire Department Primary Response Route or Truck Route	Other Considerations
Non-Restrictive Measures[1]						
	Targeted Speed Enforcement / NASCOP	Yes				(None)
	Radar Trailers					
	Edgeline/Centerline Striping	ADT < 10,000; Speed Limit ≤ 35 mph				(None)
	Optical Speed Bars					
	Signage					
	Speed Legend					
	Center Line or Edge Line Botts Dots					
	High Visibility Crosswalk	School zone only	Yes	Yes	Yes	City Policy Guidelines for Marked Crosswalks
	Angled Parking	ADT < 4,000; Width ≥ 48 feet; Speed Limit ≤ 30 mph				Not recommended with bike lanes
Vertical Measures[1]						
	Speed Humps	No		No	No	Grade ≤ 8%. Special consideration should be given on bus routes.
	Speed Cushions	ADT < 4,000; Speed Limit ≤ 30 mph				
	Split Devices	No	ADT < 4,000; Speed Limit ≤ 30 mph			
	Speed Tables	ADT < 7,500; Speed Limit ≤ 35 mph				
	Raised Crosswalks					
	Raised Intersections	ADT < 7,500; Speed Limit ≤ 35 mph				
	Textured Pavement	Yes	Yes			(None)
Horizontal Measures[1]						
	Traffic Circles	Daily Entering Volume < 7,500; Speed Limit ≤ 35 mph			Must design inscribed radius with appropriate dimensions to accommodate fire trucks	Grade ≤ 10%
	Roundabouts	Daily Entering Volume < 18,000; Speed Limit ≤ 45 mph				Grade ≤ 6%; On bike routes, design with clear bike accommodations
	Lateral Shifts	ADT < 10,000; Speed Limit ≤ 35 mph			Must design with appropriate dimensions to accommodate fire trucks	Grade ≤ 10%
	Chicanes	ADT < 5,000; Speed Limit ≤ 35 mph		No		Grade ≤ 8%
Narrowing Measures[1]						
	Neckdowns/Bulbouts	ADT < 20,000; Speed Limit ≤ 35 mph			Must design with appropriate dimensions to accommodate fire trucks	On bike routes, design with clear bike accommodations
	Two-Lane Chokers	ADT < 20,000; Speed Limit ≤ 35 mph		No		
	Center Island Narrowings/ Pedestrian Refuges	No	ADT < 20,000; Speed Limit ≤ 35 mph			

Note: [1] Traffic calming devices are suitable for existing and new streets.

Table 3 (continued) – Traffic Calming Measures and Traffic Constraints

Types of Measures		Roadway Classification			Fire Department Primary Response Route or Truck Route	Other Considerations
		Local Streets	Residential Collectors or Downtown Pedestrian Zone	Non-residential collectors		
Diversion Measures [2]						
	Full Closures	> 25% Non-Local Traffic	No		No	Maintain access on bus routes
	Half Closures					
	Diagonal Diverters					
	Median Barriers	ADT < 5,000; > 25% Non-Local Traffic				
	Forced Turn Islands					
Combined Measures		Subject to Constraints of Component Measures				
Notes: [2] Only if other measures are deemed unsatisfactory. Not to be used on new streets.						

Effectiveness Comparison

Table 4 summarizes the effectiveness data that has been compiled for each of the traffic calming measures in the toolbox. Note that these data are averages. Actual effectiveness can vary based on site-specific circumstances, such as proximity to major roads and the availability of alternate routes.

Table 4 – Quantitative Impacts of Traffic Calming Measures

Types of Measures	Effectiveness									
	85th Percentile Speeds				Vehicles per Day		Average Annual Collisions			
	Before	After	Change	Percent Change	Change	Percent Change	Before	After	Change	Percent Change
Non-Restrictive Measures	I/D									
Restrictive Measures										
Speed Cushions	I/D				I/D		I/D			
Split Devices	I/D				I/D		I/D			
Speed Tables / Raised Crosswalks	36.7	30.1	-6.6	-18%	-415	-12%	6.71	3.66	-3.05	-45%
Raised Intersections	34.6	34.3	-0.3	-1%	I/D		I/D			
Textured Pavement	I/D				I/D		I/D			
Horizontal Measures										
Traffic Circles	34.2	30.3	-3.9	-11%	-293	-5%	2.19	0.64	-1.55	-71%
Roundabouts (Single-Lane)	Insignificant Speed Effects				Insignificant Volume Effects		Not Recorded			-15% to -33%
Lateral Shifts	I/D				I/D		I/D			
Chicanes	I/D				I/D		I/D			
Narrowing Measures										
Neckdowns / Two-Lane Chokers / Center Island Narrowings/ Pedestrian Refuges	34.9	32.3	-2.6	-7%	-293	-10%	I/D			
Diversion Measures										
Full Closures	I/D	I/D	I/D	I/D	-671	-44%	I/D			
Half Closures	32.3	26.3	-6.0	-19%	-1,611	-42%	I/D			
Diagonal Diverters	29.3	27.9	-1.4	-5%	-501	-35%	I/D			
Median Barriers / Forced Turn Islands	I/D	I/D	I/D	I/D	-1,167	-31%	I/D			

Notes: I/D = Insufficient Data
Source: *Traffic Calming: State of the Practice* (Ewing, 1999)

Placement of Traffic Calming Measures

The last task in laying out a traffic calming plan is to identify the actual locations where devices should be placed. Strategies for locating devices differ depending on whether the major issue is speed-control, volume-control, or safety. The final layout of traffic calming devices should consider the cumulative effects of such measures on emergency vehicle response times.

Placing Speed-Control Measures

If feasible, traffic calming measures should be spaced in such a way that the following two design speeds are achieved.

- **Slow-Point 85th Percentile Design Speed –** the speed that 85% of vehicles are going less than when they are *crossing* a traffic calming device; the target slow-point speed is defined as 5 mph *below* the posted speed limit

- **Midpoint 85th Percentile Design Speed –** the speed that 85% of vehicles are going less than, when they are *halfway between two* traffic calming devices

The spacing of traffic calming measures directly affects the midpoint speeds: the farther apart they are, the higher the midpoint speed. See the sidebar "Estimating Midpoint Speeds" for more information on setting spacing based on midpoint speeds.

In some cases, the midpoint speed may not be achievable if resources are limited. If this is the case, devices may need to be constructed in stages. A limited number of fundable devices would be constructed first, followed by an evaluation of the results and, if necessary, a second round of construction when additional funding becomes available.

ESTIMATING MIDPOINT SPEEDS

In mathematical terms, the relationship between midpoint speed and spacing of slow points is given by an exponential function:

$$85^{th}_{midpoint} = 85^{th}_{slow\ point} + (85^{th}_{street} - 85^{th}_{slow\ point}) * 0.56 * (1 - e^{-0.004 * spacing})$$

where,

$85^{th}_{midpoint}$ = resulting 85th percentile speed at midpoint after calming;
$85^{th}_{slow\ point}$ = estimated 85th percentile speed at the slow point after treatment;
85^{th}_{street} = 85th percentile speed of street before treatment;
spacing = distance in feet between two devices.

When placing speed-control measures, the above formula should be used to test proposed spacing to determine whether the estimated midpoint speeds would be acceptable.

Placing Volume-Control Measures

Traffic calming devices intended to control traffic volumes, such as partial street closures or diagonal diverters, can be placed either at entrances to a neighborhood or internally to the neighborhood.

Gateway Measures – Volume-control measures placed at entrances or gateways to the neighborhood can be more immediately effective in reducing volumes because non-local traffic is made aware even before entering the neighborhood that passing through is not a desirable option, causing them to choose to take other routes. However, these measures can also cause local traffic to take more circuitous paths than internal measures would.

Internal Measures – When placed internal to a neighborhood, internal measures have a less direct effect on non-local traffic. Attempts by non-local traffic to cross the neighborhood will only be reduced over time as more drivers become that the passing through the neighborhood is not possible. However, internal volume control measures cause less of an inconvenience to local traffic.

Placing Safety Measures

The placement of safety-oriented traffic calming devices is dependent on the particulars of the problem and of the characteristics of the selected traffic calming device. For example, if the problem involves pedestrian safety, then the solution—a raised crosswalk, for example—should be placed at a location where it is likely to be heavily used by pedestrians. Or if a traffic circle is selected as a means of reducing vehicle collisions and the problem is not limited to a particular intersection, then preference should be given to four-way intersections, since T-intersections require special considerations.

III. PLANNING FOR NEW DEVELOPMENT AND REDEVELOPMENT PROJECTS

New neighborhoods and new development in the planning stage can benefit from neighborhood traffic management. Traffic problems can often be anticipated and prevented by reviewing street and lot plans for a neighborhood and prescribing refinements to the plan or identifying traffic calming measures that can be constructed concurrent with street construction.

3.1 Development Review Process

As part of the City's development review process, City staff may consider whether proposed developments would generate impacts that would ultimately trigger the warrants for considering traffic calming measures. This may include impacts within the proposed development site, or off-site impacts (such as traffic that would travel to and from the proposed development).

New development and redevelopment projects may be conditioned to design, build and maintain traffic calming features as part of the development project through the subdivision improvement agreement, development agreement, homeowners' association and other development-related mechanisms. Recommended development review practices are described in Section 3.4.

3.2 Relevant City Policies

A key element of existing City policies include a desire to maintain and enhance street connectivity and neighborhood livability. Policies and guidelines that are relevant to new development and the design of streets include:

- General Plan
- Zoning and Subdivision Ordinances
- Residential Design Guidelines
- Policy Guidelines for Livable Residential Local Streets and Connectivity (see Appendix A)

Additionally, several districts have distinct design standards and guidelines:

- Soscol Corridor / Downtown Riverfront Development & Design Guidelines
- Tannery Bend Development & Design Guidelines
- Downtown Riverfront Urban Design Plan

As a guideline for appropriate levels of traffic on Napa's residential streets, streets with traffic levels of less than 2,500 vehicles per day (vpd) may be considered "livable" residential streets and should not require traffic calming measures based on traffic volumes alone. Streets with volumes of 2,500 to 5,000 vpd may be acceptable as livable residential streets, though issues such as driveway backing maneuvers should be considered along with possible traffic calming measures. For streets with volumes over 5,000 vpd, property access treatments such as loop driveways (thereby avoiding driveway backing maneuvers) or combined driveways (that allow turning around to face forward on egress) may be considered in addition to traffic calming measures.

3.3 Designing Street Networks

Traffic calming measures have traditionally been installed as retrofit measures in existing neighborhoods, in response to a particular traffic

problem or concern. This section provides guidance in designing a street network to reduce the likelihood of future traffic problems arising that would require costly retrofits.

In addition to the recommendations of this section, other factors such as sight distance issues and emergency vehicle access should be considered in the design of street networks. The adopted City standard for street widths, knuckles, and bulbs has taken all these factors into consideration.

Designing for Appropriate Speeds

The following paragraph from *Residential Streets* (ASCE/NAHB/ULI, 1990) provides a useful summary of the task of designing residential streets to minimize speeding problems:

> "The selection of appropriate pavement widths must account for probable peak traffic volume, parking needs and controls, likely vehicle speeds, and limitations imposed by sight distances, climate, terrain, and maintenance requirements. Designers should select the *minimum* width that will reasonably satisfy all realistic needs, thereby minimizing construction and average annual maintenance costs. The tendency of many communities to equate wider streets with better streets and to design traffic and parking lanes as though the street were a 'microfreeway' is a highly questionable practice. Certainly the provision of 11- or 12-foot clear traffic lanes is an open invitation to increased traffic speeds."

Residential Streets goes on to recommend pavement widths for access streets, subcollectors, and collector streets. In addition to wide streets, long, straight, and uninterrupted stretches of residential roadways can also induce drivers to accelerate to unsafe speeds, increasing noise and risk of collisions with pedestrians and other vehicles. The following attributes should be considered when designing residential streets.

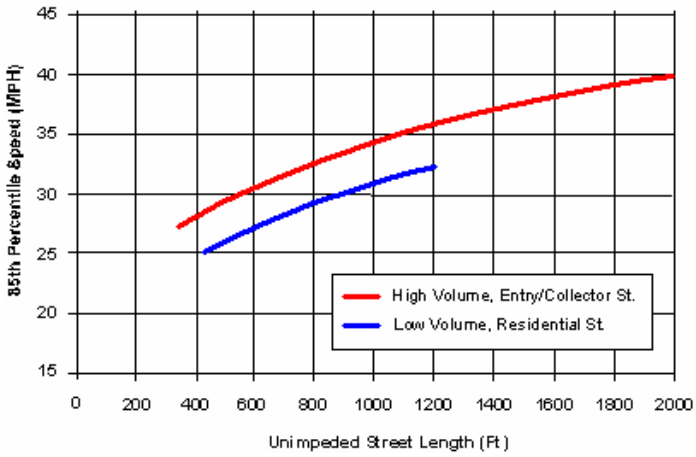
- ***Travel Lane Width –*** Travel lanes are often designed with excessive widths. To minimize drivers' propensity to speed, residential travel lanes on local streets should be designed to be no more than 10 feet wide. If excess width is provided in anticipation of a future need for traffic capacity, then in the

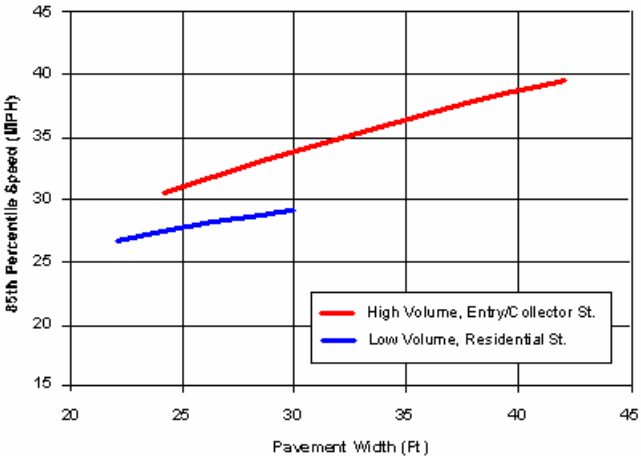
short-term this width could be occupied by appropriately spaced chokers or other traffic calming measures.

- ***Parking Lanes*** – Excessive width is sometimes provided for on-street parking in places where adjacent land uses generate little parking demand, leaving long gaps of unused space adjacent to the travel lane. This can often be the case along residential collector streets with few front-on houses. If parking demand can be accommodated elsewhere, the parking lanes should be eliminated and the street width reduced accordingly.

- ***Block Length*** – Some street networks leave excessively long blocks without interrupting intersections. Drivers that travel a long distance (600 feet or greater) without being required to slow or stop by traffic control or traffic calming devices tend to travel at speeds higher than the limit. To minimize this effect, the street network can be designed such that street blocks are interrupted by streets of sufficient traffic volumes to warrant a traffic control device (e.g. a traffic circle or stop sign) on the street of concern. Shorter block lengths also facilitate pedestrian movement throughout the neighborhood.

Correlation Between Width, Unimpeded Block Length and Speed





Designing for Local Traffic

If designed improperly, some residential collector streets can become cut-through routes, or routes used by non-local motorists as a means of bypassing congested or circuitous arterial roads. In these cases, the residential collector should be modified in one of two ways.

- The collector can be designed with a deviating path so that the overall distance by collector is greater than the distance by arterial.
- The residential roadway network can be designed such that traffic-controlled intersections interrupt the parallel collector route sufficiently that the travel time by collector is greater than the travel time by arterial.

Pedestrian/Vehicle Conflict Areas

Some elements of residential areas, such as schools and parks, have particularly high potential for vehicle and pedestrian conflicts because of the pedestrian activity they generate. The major pedestrian routes to school should be identified and traffic controls should be structured so that the number of crossings at uncontrolled cross-streets is minimized. For both schools and parks, entrances tend to focus on pedestrian street crossings at particular locations. These entrances can be made safer by combining them with roadway intersections, so that the intersection's traffic control can also allocate right-of-way to pedestrians.

If a pedestrian-oriented land use is located in an area where speeding or high traffic volumes are unavoidable, then traffic calming measures should be selected that incorporate pedestrian accommodations. For example, at an intersection, bulbouts or center island narrowing should be given some preference over other measures, such as intersection realignment. Midblock locations can benefit from such treatments as chokers or chicanes.

Developing a Traffic Calming Plan for New Development

When the Community Development Department determines that a proposed development has the potential impact of increasing speeds or cut-through traffic in a neighborhood, a traffic calming plan should be developed to address potential traffic problems related to the project.

- For potential volume-related problems, traffic volume data will only be available in the form of traffic forecasts, and these will typically be limited to the major roads. Some manual traffic volume estimates may be required using land use quantities and trip generation rates for the proposed development.

- For speed-related problems, existing travel speed data will not be available. Consequently, a response to anticipated speeding problems would need to rely on roadway geometry. For example, if a block length is greater than 600 feet, then traffic calming measures could be used to break up the block into segments that are each shorter than 600 feet.

- Anticipated safety problems will likely revolve around land uses that generate pedestrian activity, such as schools, parks, and community centers. The placement of traffic calming devices that include pedestrian crossings should take into consideration the planned locations of walkways, gates, and building entrances for these land uses.

- For some traffic calming measures, particularly those involving modified roadway curbs, significant cost-savings can be achieved by constructing them concurrent with roadway construction. Consequently, when selecting a type of traffic calming measure, some additional preference should be given to measures that take advantage of these cost-savings.

3.4 Recommended Development Review Practices

As part of the City's development review process, City staff may consider the need for traffic calming measures in and adjacent to proposed developments. Regardless of how well a transportation system is planned, there are locations where local agencies may want slower speeds and increased motorist awareness. These locations include intersections, school areas, pedestrian or bicycle facility

interfaces with roadways, etc. For these situations, developers should be required to prepare a traffic management plan for proposed roads or road networks. Guidelines that determine the appropriate traffic calming application on different type roadways should be included in the City's Standard Specifications.

When setting guidelines, the process for reviewing street and lot plans for new developments and prescribing refinements may include the following, at the discretion of the Public Works Department (PWD) and/or the Community Development Department (CDD):

- **Traffic Volumes:** Project average daily traffic (ADT) on adjacent internal roadways surrounding the proposed project. If traffic is projected to be less than 2,500 vpd with the proposed development, street livability may not be affected, and traffic calming measures based on traffic volumes unnecessary. For projected volumes of above 2,500 vpd, traffic calming measures may be considered. In addition, driveway treatments, that do not require vehicles to back out of driveways, such as loop driveways or shared driveways, may also be considered.

- **Traffic Speeds:** Identify potential speeding concerns on new streets and adjacent existing streets. Potential problem areas may include:

    - Where there is a distance of greater than 600 feet between traffic control or traffic calming devices, or as determined by PWD or CDD

    - Where roadway grades may increase the potential for speeding, as determined by PWD or CDD

    - Potential pedestrian/vehicle conflict areas such as nearby schools and parks (Section 3.3)

    - Design speed attributes that encourage speeding, such as travel lane width, parking lanes, and block lengths (Section 3.3)

- **Street Layout:** Street design and layout modifications may be proposed by the City if an area is likely to experience cut-through traffic.

- **Nearby Neighborhoods:** Where traffic calming measures have been implemented in nearby neighborhoods, consideration may be given to their inclusion in new developments, as determined by PWD or CDD.

- **Traffic Calming Plan:** Based on the size and nature of the proposed development, the City will determine if a traffic calming plan is necessary. As described above, a traffic calming plan should be developed when the proposed street layout cannot be modified in such a way that will eliminate all potential traffic problems.

IV. SELF-HELP NEIGHBORHOOD PROGRAM FOR TRAFFIC CALMING

This chapter outlines the process for neighborhoods to request traffic calming solutions. The process for neighborhoods to request traffic calming measures requires that residents play an active role in development of a Traffic Calming Plan for a particular street, area or neighborhood. Key elements of each Traffic Calming Plan will include:

- Identification of traffic issue(s)
- Data documenting existing traffic conditions
- Identification of appropriate measures (see Chapter 2, Policy Guidelines, and Chapter 5, Toolbox of Traffic Calming Measures)
- Consensus among affected residents on the chosen measure(s), demonstrated by 80 percent support of residents and property owners
- Identification of a funding source for design, construction and maintenance of proposed measure(s); funding sources may include formation of a neighborhood assessment district, voluntary contributions, cost share program or identification of other sources, such as grant funding or City funds, if available

The initial steps in developing a Traffic Calming Plan are described on the following pages and shown in Figure 6.

Step 1: Neighborhood Traffic Calming Request

Resident(s) submits a formal written request using the *Neighborhood Traffic Calming Reques*t (see Form TC-1) standard form to the City of Napa to develop a Traffic Calming Plan for a particular street or neighborhood. This request will be forwarded to the Transportation Engineering Division (TED) of the Public Works Department.

TED shall review the request and determine the appropriate boundaries for the study area, which will be the boundaries of an entire neighborhood or an area large enough so that potential traffic cut-through and speeding problems are not moved to adjacent blocks, districts, areas, or neighborhoods. TED shall provide a list of property owners within the defined study area to the resident(s) who filed the formal request. TED shall also direct the resident(s) to the City's web-site link that contains these guidelines.

Step 2: Neighborhood Support Petition

Using the study area determined by TED and the list of property owners, the resident(s) shall be required to generate a signed petition requesting the development of a Traffic Calming Plan. The signed petition must be supported by a minimum of 80 percent of the households in the defined study area. Each household (or housing unit) gets one vote.

TED will provide standard signature forms, which will include name, address, phone number of signatories, and date of signing (see Form TC-2). After completing the signed petition, the resident(s) will submit the completed petition to TED.

Public Works Department
Transportation Engineering Division

Form TC-1 Neighborhood Traffic Calming Request

The purpose of this form is to enable residents of the City of Napa to request the initiation of a traffic study to determine if a traffic calming plan should be developed for a particular street or streets within a neighborhood. The form must be filled out in its entirety and returned to the Transportation Engineering Division (TED) staff.

Name:_____ Organization (if applicable)_____

Date:_____ Daytime Tel. _____ Evening Tel. _____

Mailing Address _____ City _____ Zip_____

E-mail _____

Location: Please describe the street or location of concern, as well as the limits of your neighborhood (street name and cross street or other information). Feel free to provide a sketch of any concerns on the backside of this sheet.

Street name _____

(between _____ and _____)

Description of Problem: please circle the number below that you feel appropriately describes perceived traffic problems on the street.

	Not a Problem		→ → →		Serious Problem
Motorist courtesy toward pedestrians	1	2	3	4	5
Traffic safety for children and elderly	1	2	3	4	5
Volume of motor vehicles	1	2	3	4	5
Speeding	1	2	3	4	5
Motorists obey stop signs	1	2	3	4	5
On-street parking available	1	2	3	4	5
Pedestrians can cross streets easily	1	2	3	4	5
Traffic noise	1	2	3	4	5
Visibility of pedestrians	1	2	3	4	5
Quality of pedestrian experience	1	2	3	4	5
Other (list):	1	2	3	4	5
1. _____	1	2	3	4	5
2. _____	1	2	3	4	5
3. _____	1	2	3	4	5

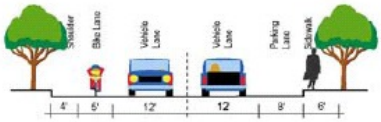
Description of Study Segment: Please describe the elements present on the street with in the proposed study area.

Please circle or write in your responses: **Posted Speed Limit** _____

Roadway Type	Commercial		Residential		Combination			
Total No. of Vehicle Lanes	One	Two	Three	Four	Five+			
Block Length (feet)	200-300	301-400	401-500	501-800	Over 800			
On-Street Parking	None	One side	Both sides					
Parking Usage	Light	Moderate	Heavy					
Walkway / Sidewalk	None	One side	Both	Intermittent	Shoulder space next to street			
Type of Walkway	Grass	Soil	Gravel	Concrete	Asphalt			
Walkway Width (feet)	_____							
Striping (Circle one or more)	Centerline		Shoulder stripe		Bike lanes	None		
Marked Crosswalk(s):	Yes	No						
Vehicles per Hour	0-30	31-60	61-120	120-240	240-480	480+		
Perceived Vehicle Speed (MPH)	15-20	20-25	25-30	30-35	35-40	45-50	55-60	60+

Please draw a typical street section below. Indicate dimensions in feet for each element that you draw.

Draw your street here



Sample Elements

Adapted from Dan Burden's Streets and Sidewalks, People and Cars, the Citizens' Guide to Traffic Calming, April 2000, and Parisi Associates, City of Lafayette Traffic Calming Guidebook, March 2003.

Suggested Improvement: Please describe the type of measures that would be appropriate to address this problem. (Refer to the City of Napa Traffic Calming Guidelines for a listing of appropriate measures).

_____

_____

_____

Public Works Department
Transportation Engineering Division

Form TC-2 Neighborhood Support Petition

Neighborhood Support: The City of Napa Transportation Engineering Division (TED) has received a formal request to develop a traffic calming plan for this neighborhood. Using the study area determined by TED staff, the resident(s) shall be required to complete this signed petition requesting the development of a Traffic Calming Plan.

A minimum of 80 percent of the households within the study area determined by TED must sign the neighborhood support form, indicating support for a study of the traffic issues described on the accompanying *Form TC-1: Neighborhood Traffic Calming Request*. Each household (or housing unit) gets one vote.

By providing the information below, you indicate support for initiation of a traffic calming plan in your neighborhood (as described on the accompanying Form TC-1).

Signature	Date	Printed Name	Address	Phone

Step 3: Traffic Audit and Warrants

Upon TED's receipt of the completed neighborhood petition, TED shall evaluate the petition and determine the preliminary data necessary to be collected to evaluate the problem; this may include traffic counts, radar speed counts and origin/destination license plate observations (see TC-3).

Because of budgetary constraints, funding for the above data collection and surveys is anticipated to be extremely limited. TED will use limited available funds, if any, to conduct the necessary surveys for neighborhoods on a first-come-first-served basis. To bypass funding constraints, the resident(s) may choose to raise private funds to sponsor the conduct of the needed surveys. TED may engage a traffic-engineering consultant to conduct the surveys and will manage the project on behalf of the residents/neighborhood.

TED will review the data collected and determine whether development of a traffic calming plan is warranted (see Section 2.1 for listing of warrants). The completed warrants will be evaluated for compliance with the policy guidelines discussed in Chapter 2 for emergency vehicle response, truck routes, bus routes, among other things.

TED will present the signed neighborhood petition, results from the surveys and data collection, and the completed warrants for traffic calming to the Traffic Advisory Committee (TAC).

TAC will be asked to provide guidance on securing funds for the continuing work on the development of the Traffic Calming Plan for the neighborhood. If the traffic calming warrants are met <u>and</u> the TAC or the neighborhood identifies adequate funds, the following steps are pursued for the development of the Neighborhood Traffic Calming Plan. Using the identified funds, TED may engage a traffic-engineering consultant to conduct the neighborhood outreach and develop the plan. TED will manage the project and the consultant on behalf of the residents and the neighborhood.

Public Works Department
Transportation Engineering Division

Form TC-3 Traffic Audit of Study Area

Date:_____

Street (s): _____

Limits of study area (determined by TED staff):

_____

_____

1. TRAFFIC VOLUMES

   Traffic volumes should be based on mid-week traffic counts for a 24-hour period.

   _____vehicles per day (if available from City)

   _____vehicles per AM peak hour (between 7 am and 9 am)

   _____vehicles per PM peak hour (between 4 pm and 6 pm)

2. TRAVEL SPEEDS

   85th percentile speed is the average speed at which 85 percent of drivers travel below on a particular roadway segment. Attach sheets summarizing the dates, times and locations these speeds were recorded.

   _____Posted Speed Limit

   _____85th Percentile Speed (indicate multiple locations if applicable)

3. COLLISION HISTORY

   Collision data (provided by City)

   ___ More than 5 collisions in a 3-year period

   ___ 2 to 4 collisions in a 3-year period

   ___ 1 to 3 collisions in a 3-year period

   ___ No reported collisions in a 3-year period

4. ADDITIONAL DATA (TED staff will determine additional data necessary to be collected by residents. Attach pages summarizing this data.)

Step 4: Community Open House

Under the facilitation of a traffic engineering consultant, residents will participate in a Community Open House to discuss the traffic issues being evaluated, data collected, proposed traffic calming measures and method(s) of funding the design, construction and maintenance of proposed measures. Funding measures may include the formation of a neighborhood assessment district, voluntary contributions, cost share program, grant funding or City funds, if available. All residents and property owners within the study area should be notified in writing of the date, time and location of the community open house.

Neighborhood residents will help in organizing the open house, inviting attendees, and arranging a meeting time and location. TED staff will provide a mailing list to residents and a room for hosting the meeting. TED staff will be available to attend the meeting as observers. The consultant will provide meeting minutes or summary to the neighborhood residents.

Step 5: Preliminary Traffic Calming Plan

Working interactively with the residents, the consultant will prepare a preliminary Traffic Calming Plan that summarizes the proposed traffic calming features, implementation strategy, and preliminary order-of-magnitude cost estimates (refer to Chapter 5, Traffic Calming Toolbox). TED will review the preliminary plan when submitted to the City.

Step 6: Neighborhood Survey and Proposed Funding Mechanism

The consultant will survey affected residents within the study area to determine the level of support for the Traffic Calming Plan <u>and</u> the proposed funding mechanism. Using the study area determined by TED, the resident(s) will be required to generate a signed petition indicating support for the Traffic Calming Plan that must be supported by a <u>minimum of 80 percent of the households</u> in the defined study area. The consultant will prepare a summary package for review by TED and presentation to the TAC.

Step 7: Final Traffic Calming Plan

Upon confirmation of neighborhood support for the proposed features and identification of a secure funding source for implementation and long-term maintenance, the consultant will proceed with the development of the final plans for the proposed features. The consultant will flesh out the details of the proposed funding program for the construction and long-term maintenance of the traffic calming features to be implemented.

Step 8: Optional Effectiveness Assessment

Following installation of the traffic calming features and depending on available funding, the consultant may conduct an effectiveness assessment, gathering the same data conducted during the initial Traffic Audit to evaluate "before" and "after" conditions related to the implementation of the Neighborhood Traffic Calming Plan. Fine-tuning of the traffic calming features could be done to ensure effectiveness.

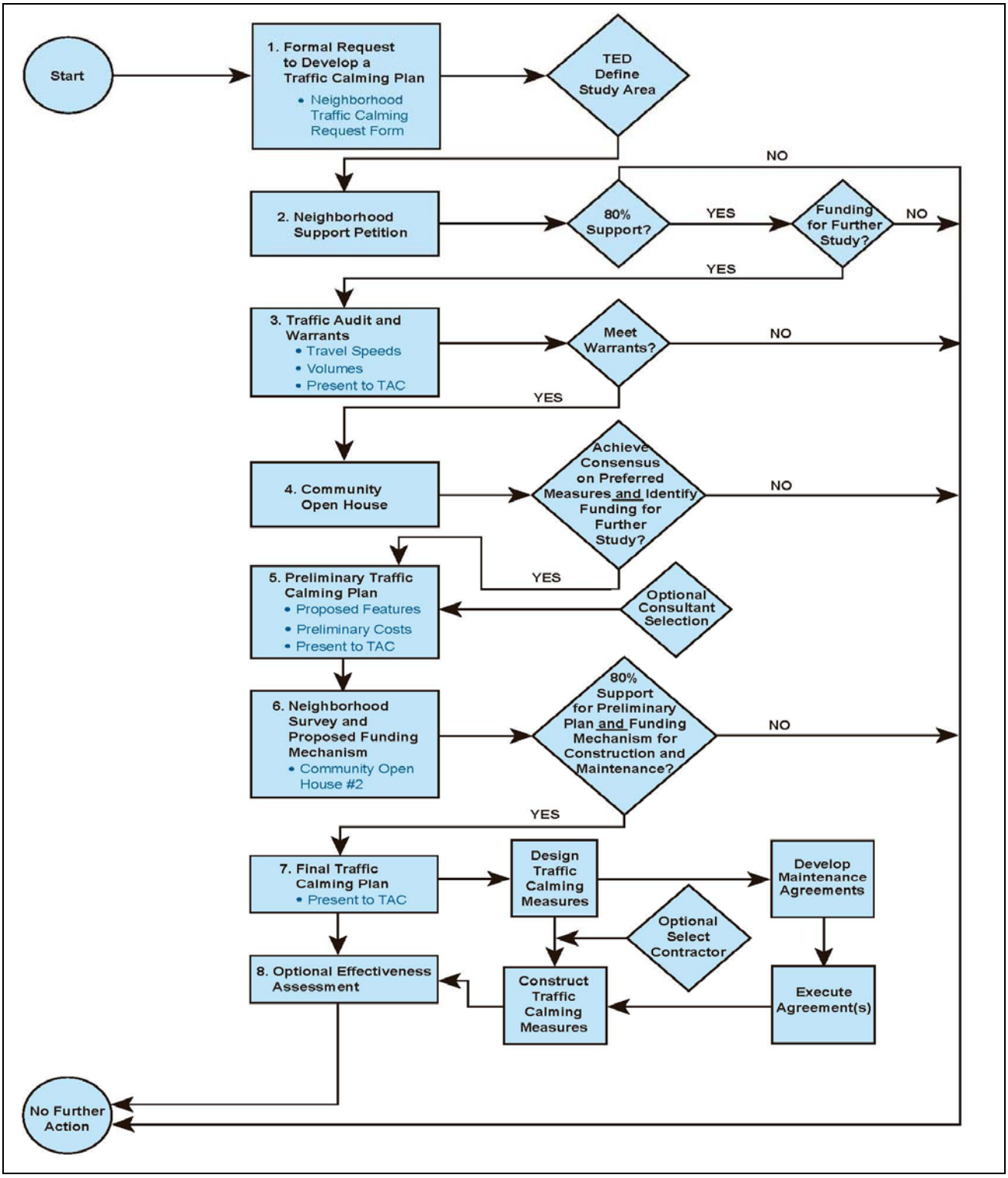


FIGURE 6 – STEPS IN THE NEIGHBORHOOD TRAFFIC CALMING PROCESS

V. TOOLBOX OF TRAFFIC CALMING MEASURES

The following traffic calming measures constitute the standard "toolbox" of devices available to citizens and City staff when developing traffic calming programs. The devices are divided into the following types:

- Non-Physical Measures
- Vertical Deflection Devices
- Horizontal Deflection Devices
- Narrowing Measures
- Diversion Measures

For each physical traffic calming measure or device in the toolbox, a data sheet is provided including a description, photograph, overhead schematic, and list of advantages and disadvantages of the measure. Descriptions of the non-physical measures are also included.

The toolbox reflects what's possible, doable, or potentially available should sufficient funding be found for implementation and long-term maintenance.

5.1 Non-Physical Measures

Non-physical measures include any measures that do not require the construction of physical modifications to the roadway. This category includes signing and striping modifications, as well as temporary use of certain enforcement strategies.

- **Targeted Speed Enforcement**
- **Radar Trailers**
- **NASCOP Program**
- **Lane Striping**
- **Optical Bars**
- **Signage**
- **Speed Legend**
- **Centerline or Edgeline Botts Dots**
- **High-Visibility Crosswalk**
- **Angled Parking**

TARGETED SPEED ENFORCEMENT

The TCC identifies locations for temporary targeted enforcement enhancements, based on personal observations and survey comments. A request is then submitted to the Police Department for the desired enforcement. Because of limited citywide resources, the targeted enforcement will not be continued indefinitely. Targeted enforcement may also be used in conjunction with new traffic calming devices to help drivers become aware of the new restrictions.

Advantages

- Inexpensive if used temporarily
- Does not require time for design
- Does not slow trucks, buses, and emergency vehicles
- Effective in reducing speeds in a short time frame

Disadvantages

- Expensive to maintain an increased level of enforcement
- Effectiveness may be temporary

RADAR TRAILER

A radar trailer is a device that measures each approaching vehicle's speed and displays it next to the legal speed limit in clear view of the driver, reminding speeding drivers to slow to the speed limit. They can be easily placed on a street for a limited amount of time then relocated to another street, allowing a single device to be effective in many locations. Many jurisdictions receive funding for radar trailers from the California Office of Traffic Safety (OTS).

Advantages

- Inexpensive if used temporarily
- Does not require time for design
- Does not slow emergency vehicles
- Effective in reducing speeds in the short-run

Disadvantages

- Effectiveness may be temporary
- Aesthetics
- Only effective on one lane of traffic
- Subject to vandalism

NASCOP PROGRAM

The City of San Jose implemented a mobile photo radar enforcement program known as the Neighborhood Automated Speed Compliance Program (NASCOP), to complement traditional police enforcement. Data taken during the City's pilot program indicated a noticeable speed reduction, with 85th percentile speeds reduced by 3 mph, and positive public response. The program currently deploys 3 photo radar vans on approximately 200 neighborhood street segments. Vehicles exceeding enforced speed thresholds trigger cameras that capture high-resolution digital images of license plates and drivers' faces, and violation notices are mailed to registered vehicle owners. OTS funding may be available for the capital costs associated with the purchase of photo radar vans.

Advantages

- Allows for speed enforcement with minimal staffing
- Enforcement is mobile and can be moved to different locations as needed
- Does not require pursuit of speed vehicles in neighborhoods

Disadvantages

- Privacy concerns
- Vehicle owners may receive citations when they are not driving

LANE STRIPING

Lane striping can be used to create formal bicycle lanes, parking lanes, or simple edge lines. As a traffic calming measure, they are used to narrow the travel lanes for vehicles, to encourage drivers to lower their speeds. The effectiveness of this measure for speed reduction is still subject to more conclusive research.

Advantages

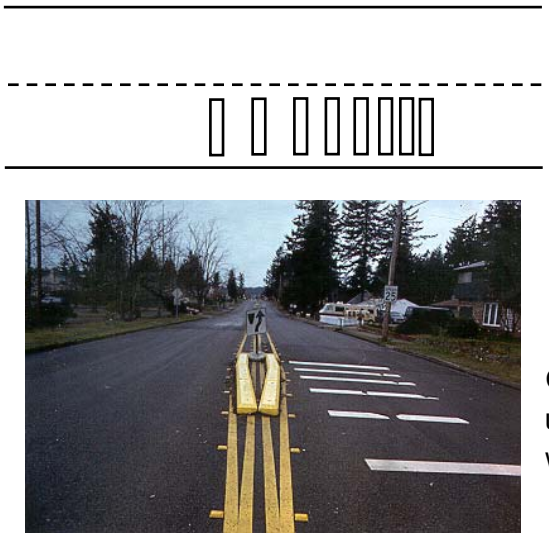
- Inexpensive
- Can be used to create bicycle lanes or delineate on-street parking
- Does not require time for design
- Does not slow emergency vehicles

Disadvantages

- Has not been shown to significantly reduce travel speeds
- Increases regular maintenance

OPTICAL SPEED BARS

Optical speed bars are a series of pavement markings spaced at decreasing distances. They have typically been used in construction areas to provide drivers with the impression of increased speed and approaches to railroads and crosswalks or stops. Provides an added benefit when used with other vertical speed control measures.



Optical Speed Bars used in conjunction with split speed lump.

Advantages

- Inexpensive
- Reduction in 85th % percentile speed
- Does not slow bus and emergency vehicles
- Does not require time for design

Disadvantages

- Effectiveness diminishes after repeated use
- Aesthetics

SIGNAGE

Signage that can be used as a traffic calming measure include:

- Speed Limit Signs;
- Truck Restriction Signs; and

- "Cross Traffic Does Not Stop" Signs.

Note that speed limit signs, to be eligible for radar enforcement, must be set using an appropriate engineering and speed study. As noted on the following page, the installation of stop signs is not considered an appropriate traffic calming installation.

Advantages

- Inexpensive
- Does not require time for design
- Turn restrictions can reduce cut-through traffic
- Does not significantly slow emergency vehicles

Disadvantages

- Speed limit signs are ineffective if unaccompanied by increased police enforcement
- If speed limit is set unreasonably low, drivers are more likely to exceed it

Stop signs are not considered a traffic calming device. It is common for residents in many communities to request the installation of stop signs at specific locations to slow travel speeds or discourage cut-through traffic. City of Napa policies support the following policies from the Caltrans Traffic Manual:

- Stop signs should not be used for speed control
- Care should be taken not to install too many signs. A conservative use of regulatory and warning signs is recommended as these signs, if used to excess, tend to lose their effectiveness
- Signs should be used when warranted by facts and field studies

SPEED LEGENDS

Speed legends are numerals painted on the roadway indicating the current speed limit in miles per hour. They are usually placed near speed limit signposts. Speed legends can be useful in reinforcing a reduction in speed limit between one segment of a roadway and another segment. They may also be placed at major entry points into a residential area.

Advantages

- Inexpensive
- Helps reinforce a change in speed limit
- Does not require time for design
- Does not slow emergency vehicles

Disadvantages

- Has not been shown to significantly reduce travel speeds

BOTTS DOTS AND RUMBLE STRIPS

Botts dots and raised reflectors, or "raised pavement markers," are small bumps lining the centerline or edgeline of a roadway. They are often used on curves where vehicles have a tendency to deviate outside of the proper lane, risking collision. Raised reflectors improve the nighttime visibility of the roadway edges.

Advantages

- Inexpensive
- Does not slow trucks, buses, and emergency vehicles
- Can help keep drivers in the appropriate travel lane on curves and under low-visibility conditions

Disadvantages

- Noise caused by rumble strips

Botts dots can be arranged into a rectangular array across the roadway, creating a *rumble strip*, which causes a rumbling sensation to drivers as they cross. These can reduce travel speeds but also increase roadway noise considerably. Consequently, rumble strips are only placed in very low density areas because of the noise factor.

HIGH-VISIBILITY CROSSWALK

High-visibility crosswalks use special marking patterns and raised reflectors to increase the visibility of a crosswalk at night. A "triple-four" marking pattern is created by painting two rows of four-foot wide rectangles, separated by four feet of unpainted space across the roadway. Raised reflectors are placed at the approach edges of these rectangles. The unpainted space along the center of the crosswalk allows wheelchairs and foot traffic to cross in the rain without sliding problems across the paint.

Advantages

- Increase visibility under low-visibility conditions
- Focus crossing pedestrians at a single location

Disadvantages

- May give pedestrians a false sense of security, causing them to pay less attention to traffic
- Require more maintenance than normal crosswalks

ANGLED PARKING

Angled parking reorients on-street parking spaces to a 45-degree angle, increasing the number of parking spaces and reducing the width of the roadway available for travel lanes. Angled parking is also easier for vehicles to maneuver into and out of than parallel parking. Consequently, it works well in locations with high parking demand, such as multi-family residences, and high turnover rates, such as commercial and mixed-use areas.

Advantages

- Reduces speeds by narrowing the travel lanes;
- Increases the number of parking spaces
- Makes parking maneuvers easier and takes less time than with parallel parking
- Favored by businesses and multi-family residences

Disadvantages

- Precludes the use of bike lanes (unless roadway is wider than 58 feet)
- Ineffective on streets with frequent driveways
- May be incompatible with one-way streets approaching a two-way segment

5.2 Vertical Measures

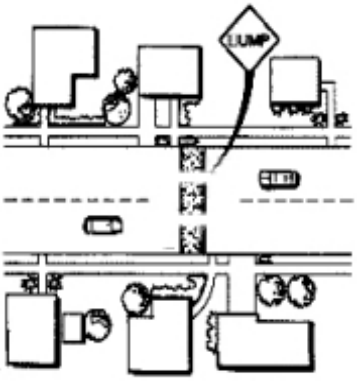
Vertical deflection devices use variations in pavement height and alternative paving materials to cause drivers discomfort at high travel speeds. Vertical deflection devices include:

- **Speed Cushions**
- **Split Devices**
- **Speed Tables**
- **Raised Crosswalks**
- **Raised Intersections**
- **Textured Pavement**

Speed bumps, dips, or similar devices are not part of the Traffic Calming Toolbox in Napa and are prohibited without written approval of the Fire Chief or his/her designee as per Napa Municipal Code Chapter 15.28.030 Section 902.2.2.8. The Traffic Advisory Committee has established as policy: Vertical traffic calming measures, such as speed bumps and humps, shall not be implemented on the Fire Department's Emergency Primary Response Routes to promote public safety by ensuring unimpeded emergency vehicle access by the Fire and Police Departments. This rationale extends to all local streets where emergency access to residences and businesses needs to be preserved as well. **All vertical measures on all public streets are subject to the approval of the Fire Department.**

SPEED CUSHION

Speed cushions are a variation of the speed hump that is constructed out of durable recycled rubber. These prefabricated devices consistently have a uniform shape unlike AC humps. The devices can be constructed without or with tapers or inlaid markings. The installation of speed cushions should be carefully considered in order to avoid impacts to emergency vehicles and bus routes.



Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-14%**
Source: City of Portland, Rubber Speed Bumps Research.		

Advantages

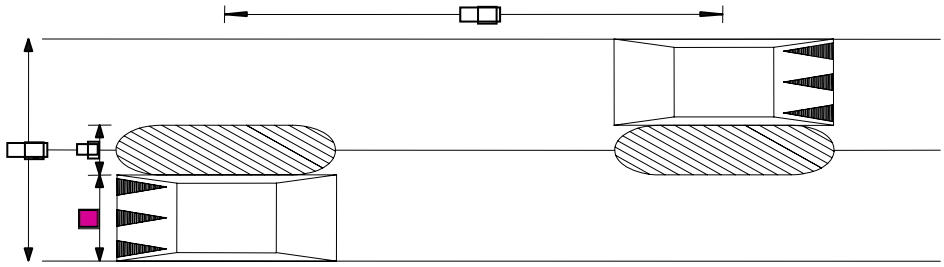
- Provides a softer ride than asphalt humps
- Can be used as a temporary device during a testing phase
- Reduces impacts to emergency vehicles with wheel well cut-outs
- Easily accommodates street resurfacing

Disadvantages

- Increase noise and air pollution
- Aesthetics

SPLIT DEVICES

Split Devices are a variation of the speed lump. Each approach of the speed lump is split in two with approximately 28-50 feet separating the lumps. The approach island at each lump discourages drivers from maneuvering around the lumps while the distance between the two lumps is adequate for emergency response vehicles to maneuver around without traversing.



Advantages

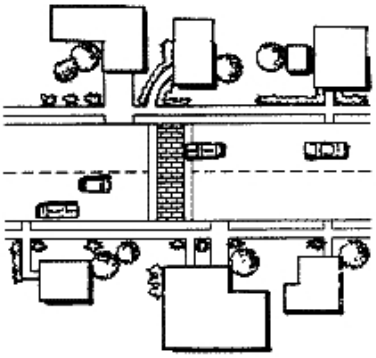
- Effective at reducing speeds;
- Less of an impedance on emergency response vehicles as compared to speed hump

Disadvantages

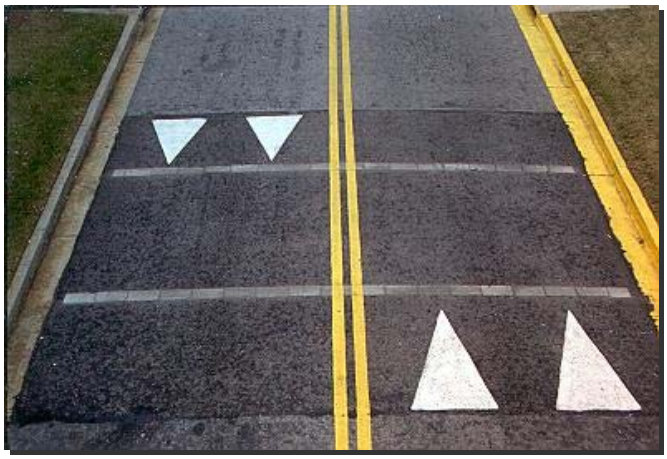
- Aesthetics
- May require the removal of on-street parking within the limits of the device.

SPEED TABLE

Speed tables are flat-topped speed humps often constructed with a brick or other textured materials on the flat section. Speed tables are typically long enough for the entire wheelbase of a passenger car to rest on top. Their long flat fields, plus ramps that are sometimes more gently sloped than speed humps, give speed tables higher design speeds than humps. The brick or other textured materials improve the appearance of speed tables, draw attention to them, and may enhance safety and speed reduction.



Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-18%**
Volume Impacts	**Reduction in Vehicles per Day**	**-12%**
Safety Impacts	**Reduction in Average Annual Number of Collisions**	**-45%**
Source: Traffic Calming: State of the Practice, 2000.		



Advantages

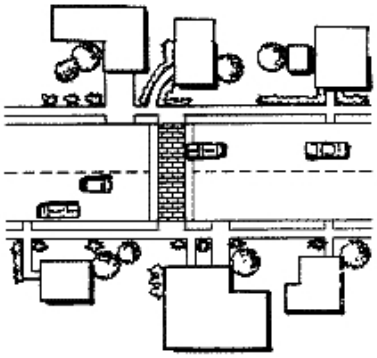
- Smoother on large vehicles (such as fire trucks) than speed humps
- Effective in reducing speeds, though not to the extent of speed humps

Disadvantages

- Aesthetics, if no textured materials are used
- Textured materials, if used, can be expensive
- Causes a "rough ride"

RAISED CROSSWALK

Raised Crosswalks are speed tables outfitted with crosswalk markings and signage to channelize pedestrian crossings, providing pedestrians with a level street crossing. Also, by raising the level of the crossing, pedestrians are more visible to approaching motorists.



Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-18%**
Volume Impacts	**Reduction in Vehicles per Day**	**-12%**
Safety Impacts	**Reduction in Average Annual Number of Collisions**	**-45%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

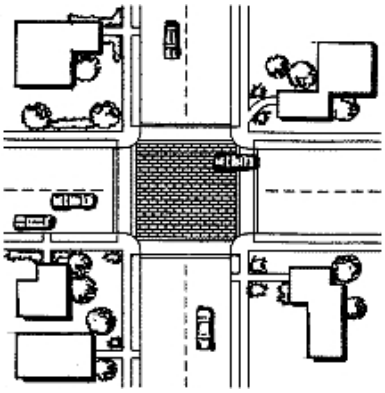
- Improve safety for both vehicles and pedestrians
- If designed well, can have positive aesthetic value
- Effective in reducing speeds, though not to the extent of speed humps

Disadvantages

- Textured materials, if used, can be expensive
- Impact to drainage needs to be considered
- Increased noise to adjacent residences

RAISED INTERSECTION

Raised intersections are flat raised areas covering entire intersections, with ramps on all approaches and often with brick or other textured materials on the flat section. They usually rise to sidewalk level, or slightly below to provide a "lip" for the visually impaired. By modifying the level of the intersection, the crosswalks are more readily perceived by motorists to be pedestrian territory. They are particularly useful in dense urban areas, where the loss of on-street parking associated with other traffic calming measures is considered unacceptable.



Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-1%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

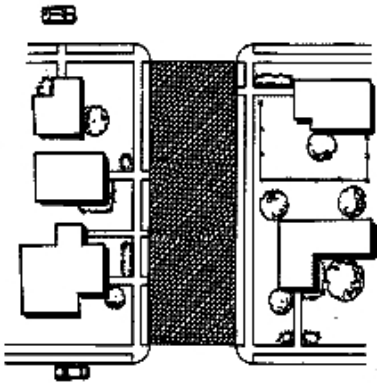
- Improves safety for both pedestrians and automobiles
- If designed well, can have positive aesthetic value
- Can calm two streets at once

Disadvantages

- Less effective in reducing vehicle speeds than speed humps and speed tables
- Expensive, varying by materials used

TEXTURED PAVEMENT

Textured colored pavement includes the use of stamped pavement (asphalt) or alternate paving materials to create an uneven surface for vehicles to traverse. They may be used to emphasize either an intersection or a pedestrian crossing.



Advantages

- Can reduce vehicle speeds over an extended length
- If designed well, can have positive aesthetic value
- Placed at an intersection, it can calm two streets at once

Disadvantages

- Expensive, varying by materials used
- If used on a crosswalk, can make crossing difficult for wheelchair users or the visually impaired
- Increased noise

5.3 Horizontal Measures

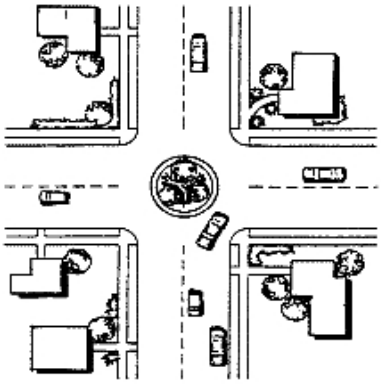
Horizontal deflection devices use raised islands and curb extensions to eliminate straight-line paths along roadways and through intersections. The horizontal deflection devices in the toolbox include:

- **Traffic Circles**
- **Roundabouts**
- **Lateral Shifts**
- **Chicanes**

All horizontal measures on all public streets are subject to the approval of the Fire Department.

TRAFFIC CIRCLE

Usually found in local residential neighborhoods, traffic circles are raised islands, placed in intersections, around which traffic circulates. They are usually circular in shape and landscaped in their center islands, though not always. Traffic controls at the approaches vary by location. Circles prevent drivers from speeding through intersections by impeding the straight-through movement and forcing drivers to slow down to yield. Drivers must first turn to the right, then to the left as they pass the circle, and then back to the right again after clearing the circle.



Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-11%**
Volume Impacts	**Reduction in Vehicles per Day**	**-5%**
Safety Impacts	**Reduction in Average Annual Number of Collisions**	**-71%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

- If designed well, can have positive aesthetic value
- Very effective in moderating speeds and improving safety

Disadvantages

- Difficult for large vehicles (such as fire trucks) to circumnavigate
- Must be designed so that the circulating lane does not encroach on crosswalks
- Potential loss of on-street parking
- Landscaping must be maintained, either by City or by residents

ROUNDABOUT

Like traffic circles, roundabouts require traffic to circulate counterclockwise around a center island. But unlike circles, roundabouts are used on higher volume streets to allocate rights-of-way among competing movements. They are found primarily on arterial and collector streets, often substituting for traffic signals or all-way STOP signs. They are larger than neighborhood traffic circles and typically have raised splitter islands to channel approaching traffic to the right.

Advantages

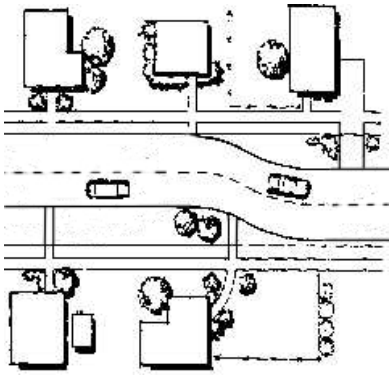
- Moderates traffic speed on an arterial
- Aesthetics
- Enhanced safety compared to a traffic signal
- Minimizes queuing at approaches to the intersection
- Less expensive to operate than traffic signals

Disadvantages

- May require major reconstruction of an existing intersection
- Loss of on-street parking
- Increases pedestrian distance from one crosswalk to the next
- Requires more right-of-way than a signalized intersection

LATERAL SHIFT

Lateral shifts are curb extensions on otherwise straight streets that cause travel lanes to bend one way and then bend back the other way to the original direction of travel. Lateral shifts, with just the right degree of deflection, are one of the few measures that have been used on collectors or even arterials, where high traffic volumes and high posted speeds preclude more abrupt measures.



Advantages

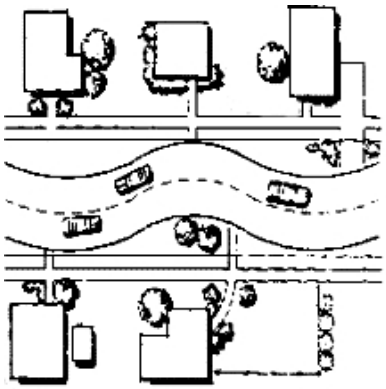
- Can accommodate higher traffic volumes than many other traffic calming measures
- Easily negotiable by large vehicles (such as fire trucks)

Disadvantages

- Not as effective reducing speeds as other traffic calming measures
- Potential loss of on-street parking
- Must be designed carefully to discourage drivers from deviating out of the appropriate lane

CHICANE

Chicanes are curb extensions that alternate from one side of the street to the other, forming S-shaped curves. Chicanes can also be created by alternating on-street parking, either diagonal or parallel, between one side of the road and the other. Each parking bay can be created either by restriping the roadway or by installing raised, landscaping islands at each end, creating a protected parking area.



Advantages

- Discourages high speeds by forcing horizontal deflection
- Easily negotiable by large vehicles (such as fire trucks) except under heavy traffic conditions

Disadvantages

- Must be designed carefully to discourage drivers from deviating out of the appropriate lane
- Curb realignment and landscaping can be costly, especially if there are drainage issues
- Potential loss of on-street parking

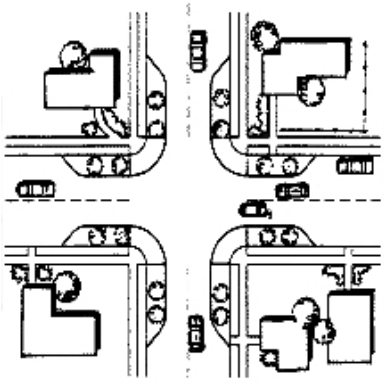
5.4 Narrowing Measures

Narrowing devices use raised islands and curb extensions to narrow the travel lane for motorists. The narrowing devices in the toolbox include.

- **Neckdowns/Bulbouts**
- **Two-Lane Chokers**
- **Center Island Narrowings/Pedestrian Refuge**

All narrowing measures on all public streets are subject to the approval of the Fire Department.

NECKDOWN/BULBOUT



Neckdowns and bulbouts are curb extensions at intersections that reduce roadway width curb to curb. Bulbouts are simple raised curbs at an intersection that narrow the travel lane but do not provide additional pedestrian space. Neckdowns actually "pedestrianize" intersections by shortening crossing distances for pedestrians and drawing attention to pedestrians via raised peninsulas. Both measures tighten curb radii at the corner, shortening the pedestrian crossing distance and reducing the speeds of turning vehicles. Both of these effects increase pedestrian comfort and safety at the intersection.

Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-7%**
Volume Impacts	**Reduction in Vehicles per Day**	**-10%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

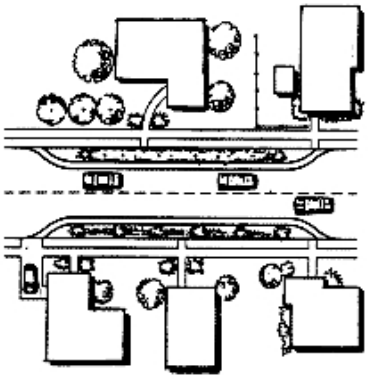
- Improves pedestrian circulation and space
- Through and left-turn movements are easily negotiable by large vehicles
- Creates protected on-street parking bays
- Reduces speeds (especially right-turning vehicles) and traffic volumes

Disadvantages

- Effectiveness is limited by the absence of vertical or horizontal deflection
- May slow right-turning emergency vehicles
- Potential loss of on-street parking
- May require bicyclists to briefly merge with vehicular traffic

TWO-LANE CHOKER

Chokers are curb extensions at midblock that narrow a street by widening the sidewalk or planting strip. If marked as crosswalks, they are also called safe crosses. Chokers leave the street cross section with two lanes that are narrower than the normal cross section.



Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-7%**
Volume Impacts	**Reduction in Vehicles per Day**	**-10%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

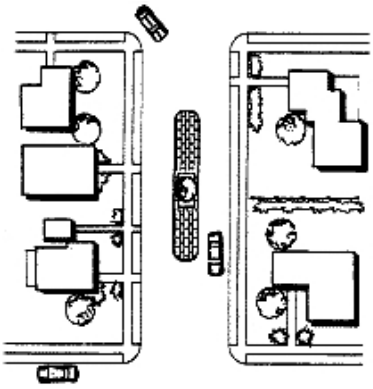
- Easily negotiable by large vehicles (such as fire trucks)
- If designed well, can have positive aesthetic value
- Reduces both speeds and volumes

Disadvantages

- Effect on vehicle speeds is limited by the absence of any vertical or horizontal deflection
- May require bicyclists to briefly merge with vehicular traffic
- Potential loss of on-street parking

CENTER ISLAND NARROWING/PEDESTRIAN REFUGE

Center island narrowings are raised islands located along the centerline of a street that narrow the travel lanes at that location. They are often landscaped to provide visual amenity. Placed at the entrance to a neighborhood, and often combined with textured pavement, they are often called "gateways". Fitted with a gap to allow pedestrians to walk through at a crosswalk, they are often called "pedestrian refuges".



Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-7%**
Volume Impacts	**Reduction in Vehicles per Day**	**-10%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

- Increases pedestrian safety
- If designed well, can have positive aesthetic value
- Reduces traffic volumes

Disadvantages

- Effect on vehicle speeds is limited by the absence of any vertical or horizontal deflection
- Potential loss of on-street parking

5.5 Diversion Measures

Diversion devices use raised islands and curb extensions to preclude particular vehicle movements, such as left-turn or through movements, usually at an intersection. These devices can only be considered after Level I devices have been attempted and failed to resolve the traffic problem. Diversion measures shall not be implemented on the Fire Department's Emergency Primary Response Routes. The effects of these measures need to be consistent with the maximum diversion volumes allowed in the City's *Policy Guideline for Livable Residential Local Streets and Connectivity* (see Appendix A). In addition an emergency response analysis shall be performed to determine the effects of the proposed diversion measure on Fire Department response times.

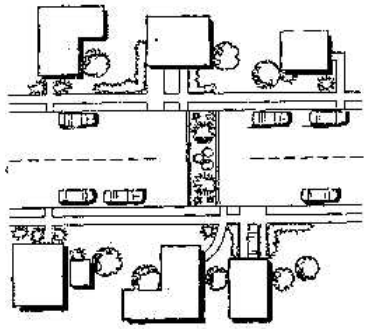
The diversion devices in the toolbox include:

- **Full Closures**
- **Half Closures**
- **Diagonal Diverters**
- **Median Barriers**
- **Forced Turn Islands**

All diversion measures on all public streets are subject to the approval of the Fire Department.

FULL CLOSURE

Full street closures are barriers placed across a street to close the street completely to through traffic, usually leaving only sidewalks or bicycle paths open. The barriers may consist of landscaped islands, walls, gates, side-by-side bollards, or any other obstructions that leave an opening smaller than the width of a passenger car.



Measured Impacts		
Volume Impacts	**Reduction in Vehicles per Day**	**-44%**
Source: Traffic Calming: State of the Practice, 2000.		

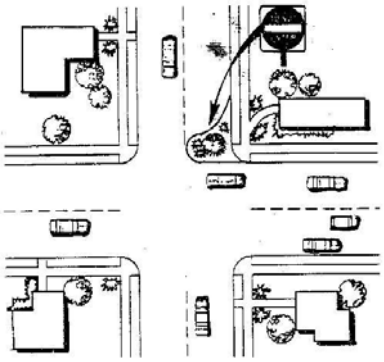
Advantages

- Able to maintain pedestrian and bicycle access
- Very effective in reducing traffic volumes

Disadvantages

- Requires legal procedures for public street closures
- Causes circuitous routes for local residents and emergency services
- May be expensive
- May limit access to businesses

HALF CLOSURE



Half street closures are barriers that block travel in one direction for a short distance on otherwise two-way streets. Half closures are the most common volume control measure after full street closures. Half closures are often used in sets to make travel through neighborhoods with gridded streets circuitous rather than direct. That is, half closures are not lined up along a border, which would preclude through movement, but instead are staggered, which leaves through movement possible but less attractive than alternative routes.

Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-19%**
Volume Impacts	**Reduction in Vehicles per Day**	**-42%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

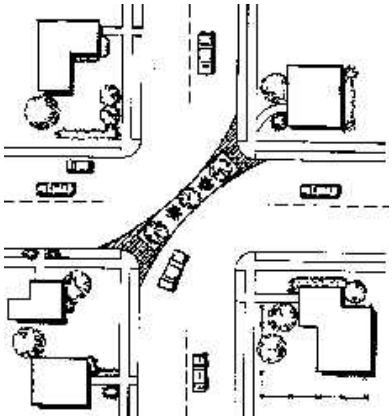
- Able to maintain two-way bicycle access
- Effective in reducing traffic volumes

Disadvantages

- Causes circuitous routes for local residents and emergency services
- May limit access to businesses
- Drivers can circumvent the barrier

DIAGONAL DIVERTER

Diagonal diverters are barriers placed diagonally across an intersection, blocking through movement. Like half closures, diagonal diverters are usually staggered to create circuitous routes through neighborhoods.



Measured Impacts		
Speed Impacts	**Reduction in 85th Percentile Speeds between Slow Points**	**-4%**
Volume Impacts	**Reduction in Vehicles per Day**	**-35%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

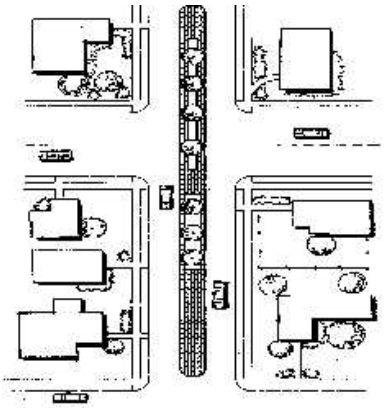
- Does not require a closure per se, only a redirection of existing streets
- Able to maintain full pedestrian and bicycle access
- Reduces traffic volumes

Disadvantages

- Causes circuitous routes for local residents and emergency services
- May be expensive
- May require reconstruction of corner curbs

MEDIAN BARRIER

Median barriers are raised islands that are located along the centerline of a street and continue through an intersection so as to block through movement at a cross street.



Measured Impacts		
Volume Impacts	**Reduction in Vehicles per Day**	**-31%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

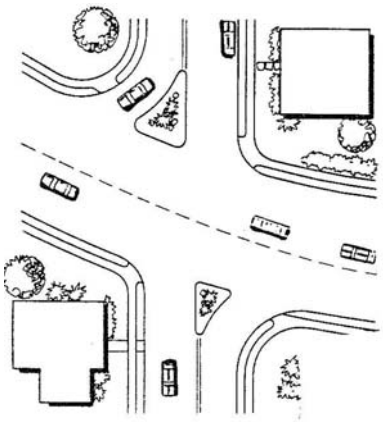
- Can improve safety at an intersection of a local street and a major street by prohibiting dangerous turning movements
- Can reduce traffic volumes on a cut-through route that crosses a major street

Disadvantages

- Requires available street width on the major street
- Limits turns to and from the side street for local residents and emergency services

FORCED-TURN ISLAND

Forced turn islands are raised islands that block certain movements on approaches to an intersection.



Measured Impacts		
Volume Impacts	**Reduction in Vehicles per Day**	**-31%**
Source: Traffic Calming: State of the Practice, 2000.		

Advantages

- Can improve safety at an intersection of a local street and a major street by prohibiting dangerous turning movements
- Reduces traffic volumes

Disadvantages

- If designed improperly, drivers can maneuver around the island to make an illegal movement
- May simply divert a traffic problem to a different street

VI. BICYCLE-COMPATIBLE MEASURES[1]

Special attention should be taken when designing traffic calming measures on City of Napa roadways with designated Class 2 or Class 3 bicycle facilities.

The information for this section is taken from *Traffic Calming Do's and Don'ts to Encourage Bicycling* by M. DiRobertis and A. Wachtel. It has been modified to conform with the needs, policies and guidelines of the City of Napa.

The following section discusses some of the traffic calming measures presented in Chapter 5 and their compatibility with bicycling.

6.1 Vertical Measures

Speed Tables - Speed tables should be located far enough from intersections that turning cyclists are no longer leaning when they encounter the table. Maintenance should ensure that raveling of the hump's edge does not produce irregularities, gaps, or debris that could impede or endanger bicyclists.

Raised Intersections - As with speed tables, the approach and exit gradients should be gentle, and the surface should be smooth but not slippery.

6.2 Non-Physical Measures

Lane Narrowing - Narrower lanes may tend to reduce vehicle speeds. Such modifications can be viewed either as the roadway being restriped to accommodate bicycles, or as bicycle lanes being used as a means to calm traffic. However, narrowing lanes so that bicycles and motor vehicles are forced to share a lane less than 14 feet wide is not bicycle compatible and should not be considered.

---

[1] M. DiRobertis, A. Wachtel, "Traffic Calming Do's and Don'ts to Encourage Bicycling", Institute of Traffic Engineers 66th Annual Meeting 1996 Compendium of Technical Papers, pp. 498

6.3 Horizontal Measures

Traffic Circles - Small traffic circles, also called mini-roundabouts or speed control islands, have been used with great success in Seattle's Neighborhood Traffic Control Program, where they are installed at the request of citizens. Located at the center of an intersection in place of STOP signs or traffic lights, traffic circles both narrow the roadway and force motorists to change direction. They may also produce the visual impression of a dead-end street, at least to strangers.

The bicyclist's objection to all these means of narrowing the roadway is the same. Unless the narrowing is substantial and frequent, any reduction in vehicle speed is usually small. At the same time, the narrow lanes tend to squeeze motorists and bicyclists together. To avoid this conflict, the roadway should remain wide enough for lane-sharing—about 12 feet or wider, depending on traffic volume; otherwise additional traffic calming techniques should be used along with the narrowing, or a cyclist bypass should be provided if geometry permits.

Of all the roadway-narrowing measures, small traffic circles seem to be the most comfortable for bicyclists. This may be because they inherently combine several traffic-calming techniques; because they do not create a competition for the remaining space; or because they are often used on roadways that already carry relatively little traffic. In addition, the elimination of STOP signs that they make possible is highly beneficial to bicyclists. They are not, however, free of controversy. Some bicyclists object to the complication and confusion of turning and crossing movements, the decreased clearance between bicyclists and cross traffic, and the danger of left-turning motorists who shortcut the circle clockwise to avoid traveling counterclockwise three quarters of the way around it. In addition, bicyclists would be better served by stopping the side street traffic in order to give travel on the street in question the right-of-way. This is especially true if the side street has significant traffic volumes. Traffic circles used in conjunction with two-way STOP sign controls should, therefore, be considered.

A well-designed traffic circle employs a small size and sharp deflection at entry to force entering traffic to slow drastically and to continue slowly around the circle. A small triangular island at the entry can force a right turn, eliminating shortcuts, and also provides a pedestrian refuge.

6.4 Diversion Measures

Road Closures/Traffic Barriers/Cul-de-Sacs - As used here, "road closure" refers to closing a road at a single point, either at an intersection (creating a cul-de-sac) or midblock (creating two cul-de-sacs). The closure is usually accomplished by installing a barrier, whose design can vary from an asphalt berm to a set of posts or bollards to a sculptured and landscaped island to a full cul-de-sac with curb and gutter. These designs differ in cost, appearance, and ease of maintenance but not in basic functionality.

Traffic barriers are sometimes called diverters, since when traffic is blocked from one street it does not usually disappear, but is instead diverted to another nearby street. This paper uses the term "barrier" for a device that blocks movement completely, and reserves "diverter" for a device that restricts some movements, usually the through movement, but allows other traffic to continue. Many California cities have installed traffic barriers, notably Berkeley and Palo Alto, to prevent commute traffic from cutting through neighborhoods. Barriers are the most extreme traffic calming measure, and are, of course, highly successful in reducing traffic volume and speed near the installation point. Barriers also tend to be highly controversial and are unpopular with some citizens since they restrict access for residents and visitors as well as outsiders.

Barriers can create two kinds of problems for bicyclists:

- They often eliminate bicycle access as well as motorized vehicle access. This is primarily a matter of barrier design. If the barriers are constructed with bicyclists in mind, they can continue to allow unrestricted bicycle access.
- Because motorists look in directions where they expect to see other motorists, they fail to anticipate bicyclists who suddenly enter an intersection across or through a barrier. This problem is primarily a matter of barrier placement. It can be avoided with proper placement and with notification to either bicyclists or motorists that they must yield.

In order to prevent these potential problems as well as potential neighborhood opposition, exceptional attention must be paid to the selection of a location for barriers as well as the details of the design and placement.

Barrier Design - Every barrier should have a gap or opening to allow bicycle passage. To allow for trailers and adult tricycles, the gap should provide a clear width of at least 5 feet (California Highway Design

Manual, Topic 1003.1), although as little as 4 feet can be workable. The practical maximum is 5 feet 6 inches, set by the width of an automobile. On a two-way street this clear width should be provided for each direction of bicycle travel, either by two separate approximately 5-foot openings or a single approximately 10-foot opening in the center, divided by a concrete block or a 4-inch diameter, 4-foot high locking barrier post. The single opening has the advantage that it can allow passage of emergency vehicles.

The barrier itself should be liberally identified, as appropriate, with single white or yellow reflectors, diagonal reflector arrays, edge reflectors, and reflective tape or paint. The upper half of posts should be wrapped diagonally with parallel stripes of orange and white reflective tape for maximum visibility day and night, and a 2-by-10-foot envelope should be painted on the pavement around the post.

Plantings on landscaped barriers or closures should not obstruct sight lines, and should minimize the shedding of leaves, seeds, fruit, or nuts onto the roadway.

Barrier Placement - The relevant principle is that on the far side of a barrier, bicyclists should not immediately encounter cross traffic at intersections or driveways. This means that full barriers should not be placed directly at intersections, but set back at least 50 feet from any cross street or business driveway. (Fifty feet is a reasonable stopping distance, including reaction time, for a bicyclist traveling at 15 mph.) With some designs and at some locations, it may be necessary to prohibit on-street parking or to trim foliage to provide adequate sight lines. This placement also ensures that bicyclists who are leaning to turn onto a street with a barrier have a chance to return to an upright position by the time they encounter the barrier, and therefore to pass through the barrier safely.

Half Closures - A half-closure is defined as a road closure at a single point but across only half its width. This is almost always done at the street entrance, allowing traffic to exit but blocking it from entering and creating a de facto one-way street for one block (except for traffic that originates within the block). Where the half closure includes a bypass for bicycles to enter, the result resembles a contraflow bike lane without that design's inherent disadvantages.

The same design considerations for bicycles apply to half closures as to full closures, although a half-width barrier needs only one opening. The preferred location at a street entrance is satisfactory, since there is no conflict with cross traffic on the far side of the barrier.

Half closures have the advantage of greater flexibility in placement than full closures. Although they can be physically violated by motorists fairly easily, the rate of violation would probably still be relatively low, since motorists must consciously decide, for example, to enter a one-way opening. By the same token, they offer easy passage to emergency vehicles.

Diagonal Diverters - A diagonal diverter is a barrier placed diagonally across the full width of an intersection, creating two L-shaped streets touching but not connected at the corners. Diagonal diverters also used in Berkeley, California; Eugene, Oregon; and Seattle, Washington.

Diverters may be less objectionable to motorists than barriers, but they can be unsatisfactory to through bicyclists, who (depending on the diverter geometry and bicyclist maneuver) may be exposed to unsuspecting cross traffic on both sides of the diverter. Since they function only in intersections, there is no flexibility in diverter placement. The design should therefore provide an opening that is both wide enough for passage and long enough in the direction of travel to create a refuge: 6 feet for a bicycle, or 10 feet for a bicycle plus trailer. This length can most easily be provided if the diverter is constructed as a tapered island or as a permanent landscaped closure, although it can also be created by a double row of bollards.

Since the purpose of the diagonal diverter is to track most of the traffic into a forced right- or left-turn, it is suggested that bicycles allowed through the diverter be required to yield to on-coming traffic on the other side, either motor vehicle or bicycle.

Truncated Diagonal Diverters - As used in Seattle, one end of the diagonal diverter does not extend fully to the corner, permitting right turns as well as left turns on one of the four streets, while continuing to prevent all through movements. It would be possible to vary the design even further to widen this gap, permitting left turns as well as right turns on the intersecting street, or to provide gaps at both ends, creating a kind of diagonal median barrier. These may need to be used in conjunction with STOP signs to assign right-of-way to certain movements.

Median Barriers - Median barriers are currently used in virtually every city on major arterials, where they separate opposing directions of traffic and prevent left turns to and from minor streets. For traffic management purposes, short median barriers can also be placed at intersections to prevent through movements. These barriers differ from the median islands discussed above under "Roadway Narrowing". Median islands are placed along the traffic-calmed street to narrow it, while median barriers are placed perpendicular to it along the centerline of the cross street to prevent traffic from entering or continuing. (A single barrier can

serve both purposes on intersecting streets.) The usual median barrier permits right turns and prevents left turns, but design modifications can add one or two of the four possible left turns according to need. To accommodate bicyclists, the barrier must have a bicycle bypass (or two, depending on design). If it crosses a busy uncontrolled intersection, it is best designed as an island that includes a bicycle refuge.

Forced Turns - Traffic can be forced to turn right rather than continue straight by a pork-chop shaped island, similar to the familiar type used for free right-turns, but extending further to the left to block through travel. It is easy to incorporate a bicyclist bypass around or through the island. With some geometries it might be possible to force left turns as well_- for instance, offset intersections, turns from one-way streets, and turns from the right arm of a T intersection.

Unlike diagonal diverters and median barriers, this method leaves the interior of the intersection clear. The right-hand curb radius may need to be increased to accommodate the forced turn, and large trucks may not be able to negotiate it.

6.5 Other

Irregular or Textured Surfaces - Brickwork or pavers of various colors, shapes and patterns can be used to set off a crosswalk, the entrance to a pedestrian area, or the entire area itself. The warning is primarily visual, although motorists may notice mild noise or vibration. For bicycle safety, the surface should be free of steps, longitudinal or diagonal grooves, or other irregularities that could cause a fall, should not be slippery or become so when wet, and should not be so rough that it causes an uncomfortable ride. These concerns are not a problem with some common designs. Any proposed use of such textured pavements should be done in consultation with the area bicyclists.

Reduced Corner Radii - Reduced corner radii can slow the speed of turning traffic. They are most likely to be useful on a bicycle priority street in combination with other measures that operate midblock. But they can also be useful in making junctions with on- and off-ramps safer for bicyclists. The elimination or redesign of right-turn channelization pork chop islands would also slow turning traffic if the curb radii were also reduced.

6.6. Summary of Bicycle-Compatible Measures

Assuming that the design guidelines just described are observed, the most bicycle-compatible traffic calming measures are the following:

- Narrower lanes may tend to reduce vehicle speeds. However, narrowing lanes so that bicycles and motor vehicles are forced to share a lane less than 14 feet wide is not bicycle compatible and should not be considered.
- Speed tables, and raised intersections can produce small but consistent speed and volume reductions, but only in their immediate vicinity.
- Traffic circles are moderately effective in reducing both speed and volume.
- Forced turn channelization can be highly effective if existing geometry permits it to be used, and is less coercive than road closures. It is a good substitute for diagonal diverters.
- Median barriers, like half closures and forced turns, prevent through vehicular movements but can be configured to permit other movements. If there is significant uncontrolled cross traffic, the median can include a bicycle refuge.
- Textured surfaces have little effect by themselves, and would be most useful as a visual cue to reinforce more restrictive design features.
- Reduced corner radii slow traffic and, therefore, improve safety at intersection

The above considerations need to be balanced with the needs of motorists, pedestrians, service vehicles, and emergency response vehicles, while respecting the rights of residents and businesses.

6.7 Measures That Should be Used with Care

The following measures are not recommended on Napa roadways that are designated as Class 2 or Class 3 bicycle facilities unless designed appropriately to addresss bicycle sfaety needs:

- **Lateral Shift -** Tend to cause erratic movements by motorists and increased travel distances for bicyclists.
- **Chicanes -** Tend to force motorists and bicyclists into a narrow space, and thus are appropriate only where traffic volumes are

very low (<1,000 vpd).

- **Rumble Strips -** Pavement indentations that warn motorists also cause a very uncomfortable ride for bicyclists, which can lead to steering difficulties, loss of control, and falls.

The following measures can be effective and must be designed so as not to adversely impact bicyclists.

- **Neckdowns/Bulbouts** - these narrow the roadway usually to two narrow lanes. This results in less room for motorists and bicyclists to share, but benefits pedestrians by reducing crossing width and increasing visibility. They are acceptable as long as 14 feet of travel lane width remains for bikes and cars to share.
- **Center Island Narrowing/Pedestrian Refuge** - are used to provide a refuge for pedestrians and/or reduce roadway width. By continuing a median through an intersection, they also restrict access to a street. By retaining adequate curb lane width (14 feet minimum) and providing curb cuts, they can be made compatible with bicycling.

VII. REFERENCES

To find out more about traffic calming and neighborhood traffic management, please see the documents and web sites listed below:

General Information on Traffic Calming

- Burden, Dan. (1999). *Street Design Guidelines for Healthy Neighborhoods*. Sacramento, CA: Local Government Commission.
- County Surveyors Society. (1994). *Traffic Calming in Practice.* London: Landor Publishing.
- Ewing, R. (1999). *Traffic Calming: State of the Practice*. Washington, DC: Institute of Transportation Engineers/Federal Highway Administration.
- Fehr & Peers. (1999). Traffic Calming .Org (Web Site: *http://www.trafficcalming.org*). Lafayette, CA: Fehr & Peers
- ITE (2002). *Traffic Calming…for Communities (Web Site: http://www.ite.org/traffic/index.html).* Washington, DC: Institute of Transportation Engineers.
- Hass-Klau, C. et al. (1992). *Civilised Streets: A Guide to Traffic Calming.* Brighton, U.K.: Environment & Transport Planning.
- Hehrstedt, L. et al. (1993). *An Improved Traffic Environment: A Catalogue of Ideas.* Copenhagen, Denmark: Danish Road Directorate.
- Litman, T. (2001). Online TDM Encyclopedia (Web Site: http://www.vtpi.org/tdm/). Victoria, BC: Victoria Transport Policy Institute.
- Smith, D. T. Jr. and D. Appleyard. (1980). *State of the Art: Residential Traffic Management*. Washington, DC: Federal Highway Administration.

- TAC. (1998). *Canadian Guide to Neighbourhood Traffic Calming.* Ottawa, Canada: Transportation Association of Canada.

- Tolley, R. (1990). *Traffic in Residential Areas.* Brefi, U.K.: Brefi Press.

Local Traffic Calming Programs

- City of Sacramento. (2002b). Neighborhood Traffic Management Program (Web Site: *http://pw.sacto.org/traffic/ntmp.html*). Sacramento, CA: City of Sacramento, Department of Public Works.

- City of Austin (2002). Neighborhood Traffic Management Program (Web Site: *http://www.ci.austin.tx.us/roadworks/tc.htm*). Austin, TX: City of Austin Department of Public Works and Transportation.

- City of Portland (2002). Portland Traffic Calming Program (Web Site: http://www.trans.ci.portland.or.us/trafficcalming/default.htm). Portland, OR: City of Portland Neighborhood Traffic Management.

- City of Seattle (2002). Neighborhood Traffic Control Program (Web Site: http://www.seattle.gov/transportation/ntcphome.htm). Seattle, WA: Seattle Transportation.

- Ewing, R. (2000). *Delaware Traffic Calming Design Manual*. Wilmington, DE: Delaware Department of Transportation.

Roundabouts

- Robinson, B. W. et al (2000). *Roundabouts: An Informational Guide*. Washington, DC: Federal Highway Administration.

- Wallwork, M. (2002). Modern Roundabouts (Web Site: *http://www.roundabouts.net*). Orange Park, FL: Alternate Street Design, P.A.

Appendix A

Policy Guidelines for Livable Local Residential Streets and Connectivity

The City of Napa Public Works Department (PWD) receives numerous requests and inquiries from local citizens and residents who wish to have their neighborhood streets not to connect to the public street system because of the perception of and concern for speeding and excessive vehicular traffic volumes on neighborhood streets. This policy guideline statement provides a frame of reference for the Traffic Advisory Committee (TAC) in its advisory role to the City Council, the Planning Commission, and City staff when the TAC discusses the need for street connectivity through neighborhoods, both old and new. These policy guidelines are not "standards" to be applied strictly; rather they are guidelines to help address the quality-of-life issue raised by unwanted traffic impacts.

The policy guidelines document in this appendix was adopted by the Traffic Advisory Committee (TAC) on September 8, 2005. Based on the input from the TAC, the policy guidelines have been transmitted to the Planning Commission for implementation in relation to proposed private development review. Public Works Department (PWD) staff now also use these policy guidelines to respond to requests and inquiries from local citizens and residents who wish to have their neighborhood streets not to connect to the public street system because of their perception of and concern for speeding and excessive vehicular traffic volumes on local residential streets.

Appendix B

Proposed Design Guidelines for Traffic Calming Measures

The proposed design guidelines for traffic calming measures in this appendix come from the ***Delaware Traffic Calming Design Manual***. [2] The City of Napa Public Works Department has received official permission from the Delaware State Department of Transportation to use Chapters IV and V of said manual for the City's policy document.

Chapter IV provides guidelines for the geometric design of traffic calming features, while Chapter V focuses on signing and marking of such measures. All references to other chapters in the Delaware manual should be ignored. Similarly, all references to the State Department should be ignored as well.

Designers, architects, and engineers should also refer to the California Department of Transportation (Caltrans) design manuals, the *Manual on Uniform Traffic Control Devices* (MUTCD) and the *MUTCD California Supplement* when designing streets and related traffic control in conjunction with traffic calming measures.

[2] Delaware Register of Regulations, Vol. 4, Issue 3, Friday, September 1, 2000

Appendix C

Guidelines for Typical Traffic Calming Device Designs

Engineering design drawings for typical traffic calming measures are displayed in this section. Because every situation is potentially different, variations may be appropriate in certain cases. Refer to Appendix B for more guidance in the design of traffic calming measures. As part of the update of the City's street standards by the Community Development, Public Works, and Fire Departments, new standard drawings may need to be developed for consistency.

Triple 4 Crosswalk C-1

Traffic Circle C-2

Chicane C-3

Bulbout (Midblock treatment) C-4

Bulbout (Intersection treatment) C-5

Center Island Narrowings C-6

Choker C-7

Half Closure C-8

Diagonal Diverter C-9

Median Barrier C-10

Forced Turn Island C-11

Warning Signs C-12

Appendix D

Policy Guidelines for City of Napa "Bicycle Boulevard"

The City of Napa Public Works Department (PWD) developed the attached *Policy Guidelines: City of Napa "Bicycle Boulevard"* to supplement the Caltrans Highway Design Manual, AASHTO guidebooks, and the Manual on Uniform Traffic Control Devices (MUTCD)/California Supplement engineering design standards. These guidelines were approved by the Bicycle & Trails Subcommittee on March 23, 2005. On May 12, 1005, the Traffic Advisory Committee adopted the *PWD Policy Guidelines* to guide innovative and creative bike facility planning in the City.

The "Bicycle Boulevard" concept offers a creative and innovative solution that has been used in other California communities, such as Berkeley, Davis, and Palo Alto, and has been tailored to fit Napa's local needs and constraints. "Bicycle Boulevards" are appropriate candidates for traffic calming to transform an ordinary local residential street into a "bikeway expressway" that accommodates local motor traffic while deterring through motor traffic. The planning, design, implementation, and maintenance of traffic calming features on the City of Napa "Bicycle Boulevards" shall be guided by the Public Works Department's *"Citywide Guidelines for Traffic Calming and Neighborhood Traffic Management."* The pursuit of traffic calming on "Bicycle Boulevards" shall be subject to the availability of dedicated funding sources and the commitment of staff resources by the City Administration.