CITY OF VALLEJO

TRAFFIC CALMING TOOLBOX

FEHR PEERS

OCTOBER 2020

Table of Contents

NON-PHYSICAL MEASURES

Non-physical measures do not require physical changes to the roadway. They are intended to increase drivers' awareness of surroundings and influence driver behavior without physical devices. Because these devices are not self-enforcing, they have limited effectiveness as stand-alone devices and should supplement physical devices.

SPEED CONTROL – VERTICAL MEASURES

Vertical deflection devices use variations in pavement height and alternative paving materials to physically reduce travel speeds. These devices are designed for travel speeds over the device of approximately 15 to 35 miles per hour (MPH).

SPEED CONTROL – HORIZONTAL MEASURES

Horizontal deflection devices use raised islands and other means to eliminate straight-line paths along roadways and through intersections.

SPEED CONTROL – NARROWING DEVICES

Narrowing devices use raised islands, curb extensions, and other treatments to narrow the travel lane for motorists. They are not as effective as vertical or horizontal devices but can still calm traffic.

VOLUME CONTROL

Diversion devices use raised islands and curb extensions to preclude particular vehicle movements, such as left turn or through movements, usually at an intersection.

Table 1: Applicability and Efficacy of Devices by Traffic-Related Concerns

Types of Measures	Types of Traffic-Related Concerns		
	Speeding	Traffic Volumes	Collisions
Non-Physical Measures			
Targeted Speed Enforcement	◓	○	◓
Speed Trailer	◓	○	◓
Speed Feedback Sign	◓	○	◓
Centerline/Edgeline Lane Striping	◓	○	◓
Signage	◓	◓	◓
Education	◓	◓	◓
Speed Control Vertical			
Speed Lump/Cushion	●	○	◓
Speed Hump	●	○	◓
Speed Table	●	○	◓
Raised Crosswalk	●	○	◓
Raised Intersection	●	○	◓
Speed Control Horizontal			
Traffic Circle	●	◓	●
Roundabout (Single Lane)	◓	◓	●
Median with Horizontal Deflection	◓	◓	●
Lateral Shift	●	◓	●
Chicane	●	◓	●
Slow turn wedges	●	◓	●
Hardened Centerlines/Rubber Speed Bumps	●	◓	●
Speed Control – Narrowing Devices			
Bulb-Outs/Curb extensions	◓	◓	●
Road Diet	◓	◓	◓
Two-Lane Choker	◓	◓	●
Medians without Horizontal Deflection/Pedestrian Refuge Island	◓	◓	◓
Street Trees/Landscape Buffer	◓	○	◓
On-Street Parking	◓	◓	◓
Volume Control Devices			
Full Closure	◓	●	●
Half/Partial Closure	◓	●	●
Diagonal Diverter	◓	●	●
Forced-Turn Island	◓	●	◓
Quiet Streets	●	●	●

● Strongly Appropriate ◓ Moderately Appropriate ○ Inappropriate

Table 2: Applicability of Devices by Location Type

Types of Measures	Local Streets		Collectors*	
	Mid-block	Intersection	Mid-block	Intersection
Non-Physical Measures				
Targeted Speed Enforcement	●	●	●	●
Speed Trailer	●	◓	●	◓
Speed Feedback Sign	●	◓	●	◓
Centerline/Edgeline Lane Striping	◓	X	●	X
Signage	●	●	●	●
Education	●	●	●	●
Speed Control Vertical				
Speed Lump/Cushion	●	X	◓	X
Speed Hump	●	X	◓	X
Speed Table	●	X	◓	X
Raised Crosswalk	◓	◓	◓	◓
Raised Intersection	X	●	X	●
Speed Control Horizontal				
Traffic Circle	X	●	X	●
Roundabout (Single Lane)	X	●	X	●
Median with Horizontal Deflection	●	◓	●	◓
Lateral Shift	●	◓	◓	◓
Chicane	●	X	◓	X
Slow Turn Wedges	X	●	X	●
Hardened Centerlines/Rubber Speed Humps	◓	◓	◓	◓
Speed Control – Narrowing Devices				
Bulb-Outs/Curb Extensions	◓	●	◓	●
Road Diet	●	◓	●	◓
Two-Lane Choker	●	X	●	X
Medians without Horizontal Deflection/Pedestrian Refuge Island	●	●	◓	◓
Street Trees/Landscape Buffer	●	●	●	●
On-Street Parking	●	X	●	X
Volume Control Devices				
Full Closure	X	●	X	X
Half/Partial Closure	◓	●	◓	◓
Diagonal Diverter	X	●	X	X
Forced-turn island	X	●	X	◓
Quiet Streets	●	●	●	●

● Generally Applicable ◓ Seldom, except in some cases X Never Applicable

*Due to emergency response concerns

Table 3: Applicability of Devices Street Type

Types of Measures	Street Types	
	Local Streets	Collectors
Non-Physical Measures		
Targeted Speed Enforcement	No limitations with respect to ADT or speed	
Speed Trailer		
Speed Feedback Sign		
Centerline/Edgeline Lane Striping		
Signage		
Education		
Speed Control Vertical		
Speed Lump/Cushion	Speed Limit ≤ 25 MPH; Grade ≤ 8%	
Speed Hump		
Speed Table	Daily Entering Volume <16,000; Speed Limit ≤ 35 MPH	
Raised Crosswalk*		
Raised Intersection		
Speed Control Horizontal		
Traffic Circle	Daily Entering Volume <10,000; Speed Limit ≤ 35 MPH	
Roundabout (Single Lane)	Daily Entering Volume <25,000; Speed Limit ≤ 45 MPH	
Median with Horizontal Deflection	Daily Entering Volume <20,000; Speed Limit ≤ 35 MPH	
Lateral Shift		
Chicane		
Slow Turn Wedges		
Hardened Centerlines/Rubber Speed Bumps		
Speed Control – Narrowing Devices		
Bulb-Outs/Curb Extensions	ADT ≤25,000; Speed Limit ≤ 45 MPH	
Road Diet		
Two-Lane Choker		
Medians without Horizontal Deflection/Pedestrian Refuge Island	Daily Entering Volume <16,000; Speed Limit ≤ 35 MPH	
Street Trees/Landscape Buffer	No limitations with respect to ADT or speed, but sight lines must be preserved	
On-street Parking		
Volume Control Devices		
Full Closure	Proper evaluation should be conducted to determine amount of diverted traffic to alternate routes	
Half/Partial Closure		
Diagonal Diverter		
Forced-Turn Island		
Quiet Streets		

* Not appropriate for streets without curbs, gutters, or sidewalks

Targeted Speed Enforcement

Staff or the police department identifies locations for temporary targeted enforcement, based on observations or public comments.

Advantages

- Proven to enhance safety
- Decreases collisions resulting from speed violations
- Very mobile - can quickly target areas of concern

Disadvantages

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

COST:

No incremental cost; depends on duration

Speed Trailer

Portable speed trailers visually display drivers' real-time speeds compared to the posted speed limit. The number flashes in red if the driver's speed exceeds the limit. This device allows the residents to observe the actual speeds at which vehicles are traveling along their neighborhood street and it makes the driver more aware of their speed to make any speed adjustments in accordance to the speed limit. Speed trailers are not substitutes for permanent action, such as traffic calming measures to address neighborhood speeding.

Advantages

- Relatively low cost
- Does not physically slow emergency vehicles or buses
- Quick implementation
- Provides immediate feedback
- Does not require enforcement personnel to be present
- Can be moved to different locations
- Data can be recorded

Disadvantages

- Effectiveness may be temporary
- Only effective for one direction of travel
- Subject to vandalism

COST:

$8,000-$10,000 per unit

Speed Feedback Sign

Speed feedback signs measure each approaching vehicle's speed. They are typically mounted on or near speed limit signs and are most common in school zones. Real-time speeds are relayed to drivers and flash when driver speeds exceed the posted speed limit.

Advantages

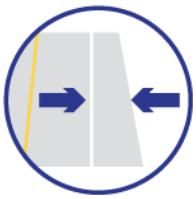
- Real-time speed feedback
- Does not physically slow emergency vehicles or buses
- Permanent installation
- Data can be recorded

Disadvantages

- Effectiveness may be temporary
- May require power source
- Only effective for one direction of travel
- Subject to vandalism

COST:

$7,000-$10,000 per sign



Centerline/ Edgeline Lane Striping

Striping can be used to narrow the travel lanes for vehicles, inducing drivers to lower their speeds.

Advantages

- Inexpensive
- Can be used to create bicycle lanes or delineate on-street parking
- Does not physically slow emergency vehicles

Disadvantages

- Travel speed reductions vary widely by installation and can be minor
- Requires regular maintenance

COST:

$2 per linear foot

Signage

Signs can be used to restrict trucks and/or certain vehicle turn-movements to prevent undesired truck traffic and turning movements. These restriction signs may specify time periods.

Signage can also be used to communicate speed restrictions and/or the presence of bicycle and pedestrian movements.

Advantages

- Reduce truck traffic on certain streets
- Reduce cut-through traffic at specific times of the day
- Does not physically slow emergency vehicles or buses
- Can increase the safety at intersections with prohibited turning movements by reducing conflict points
- Low cost

Disadvantages

- Requires regular maintenance
- Turn restrictions require enforcement during time of restriction to be effective
- May divert a traffic problem to another street

COST:

$200-$700 per sign

Education

A variety of education strategies can be used to educate people on speeding and the safety risks associated with speeding. Changing driver behavior and attitudes will require increased public safety education.

The following strategies can be employed by the City as part of a public safety education campaign:

- Brochure – describe the Traffic Calming Program and process.
- Traffic Safety newsletter (Citywide and/or neighborhood specific) – provide information on volumes, speeds, and speeding fines; describe traffic concerns and recommendations; provide reminders of traffic laws and traffic safety tips for all modes.
- Website – provide a designated page on the City's website to provide information on the Traffic Calming Program and the same information recommended for the newsletter.
- Speed yard signs – Make yard signs available to the public for free at locations around the City. They should be brightly colored and include phrases like, "20 is plenty," "Keep kids safe," "Drive like you/your children live here," and "Slow down."
- Permanent roadside memorial signs at crash locations – install displays (photos, memorials, handmade signs, etc.) to show where pedestrians and bicyclists were injured or killed in a crash.

Advantages

- Relatively inexpensive
- Can be implemented incrementally over time

Disadvantages

- Staff time required to maintain and update these resources

COST:

Varies

Speed Lump/ Cushion

Speed lumps/cushions are rounded raised areas placed across the road with two wheel cut-outs designed to allow large vehicles, such as emergency vehicles and buses, to pass with minimal slowing. The design limits passenger cars and mid-size SUVs from fully passing through the cut-outs and requires travel over the lump. When installed on a street with rolled curbs or no curbs, bollards can be placed at the ends of the speed lump to discourage vehicles from veering outside of the travel lane to avoid the device. Speed lumps/cushions are slightly less than four inches high, typically parabolic in shape, and have a design speed of 15 to 20 MPH. They are usually constructed with a taper on each side to allow unimpeded drainage between the lump and curb.

Advantages

- Effective in reducing speeds
- Does not physically slow emergency vehicles or buses
- Relatively easy for bicyclists to cross

Disadvantages

- Maintenance can be challenging
- Vehicles with a wide wheel base can pass through the lump using the wheel cut-outs
- Increased noise

COST:

$3,000-$5,000

Speed Hump

Speed humps are rounded raised areas placed across the road with no wheel cut-outs for large vehicles and bicycles. They are slightly less than four inches high, typically parabolic in shape, and have a design speed of 15 to 20 MPH.

Advantages

- Effective in reducing speeds

Disadvantages

- Slows down emergency vehicles and buses
- Maintenance can be challenging
- Increased noise
- More difficult for bicyclists to cross

COST:

$2,000-$5,000

Speed Table

Speed tables are flat-topped speed humps approximately 20-25 feet long, which is typically long enough for the entire wheel base of a passenger car to rest on top. The large flat area, plus ramps that are more gently sloped than speed lumps/cushions and speed humps, give speed tables a higher design speed than speed lumps/cushions and speed humps. Speed tables may be more appropriate for streets with higher ambient speeds.

Advantages

- Effective in reducing speeds, though not to the extent of speed lumps/cushions and speed humps
- Maintenance is easier than speed lumps/ cushions and speed humps
- Slightly higher design speed compared to speed lumps/cushions and speed humps, thus compatible with collector streets and on grades

Disadvantages

- Increased noise

COST:

$4,000-$8,000

Raised Crosswalk

Raised crosswalks are speed tables striped with crosswalk markings and signage to channelize pedestrian crossings, providing pedestrians with a level street crossing. The raised crosswalk slows traffic and makes pedestrians more visible to approaching motorists.

Advantages

- Effective in reducing speeds, though not to the extent of speed lumps and speed humps
- Maintenance is easier than speed lumps/cushions and speed humps
- Improves safety for both vehicles and pedestrians

Disadvantages

- Increased noise
- Impacts to drainage needs to be considered

COST:

$5,000-$10,000

Raised Intersection

A raised intersection is a speed table for an entire intersection. Construction involves providing ramps on each intersection approach and elevating the entire intersection to the level of the sidewalk. The crosswalks on each approach are also elevated so pedestrians can cross the road at the same level as the sidewalk.

Advantages

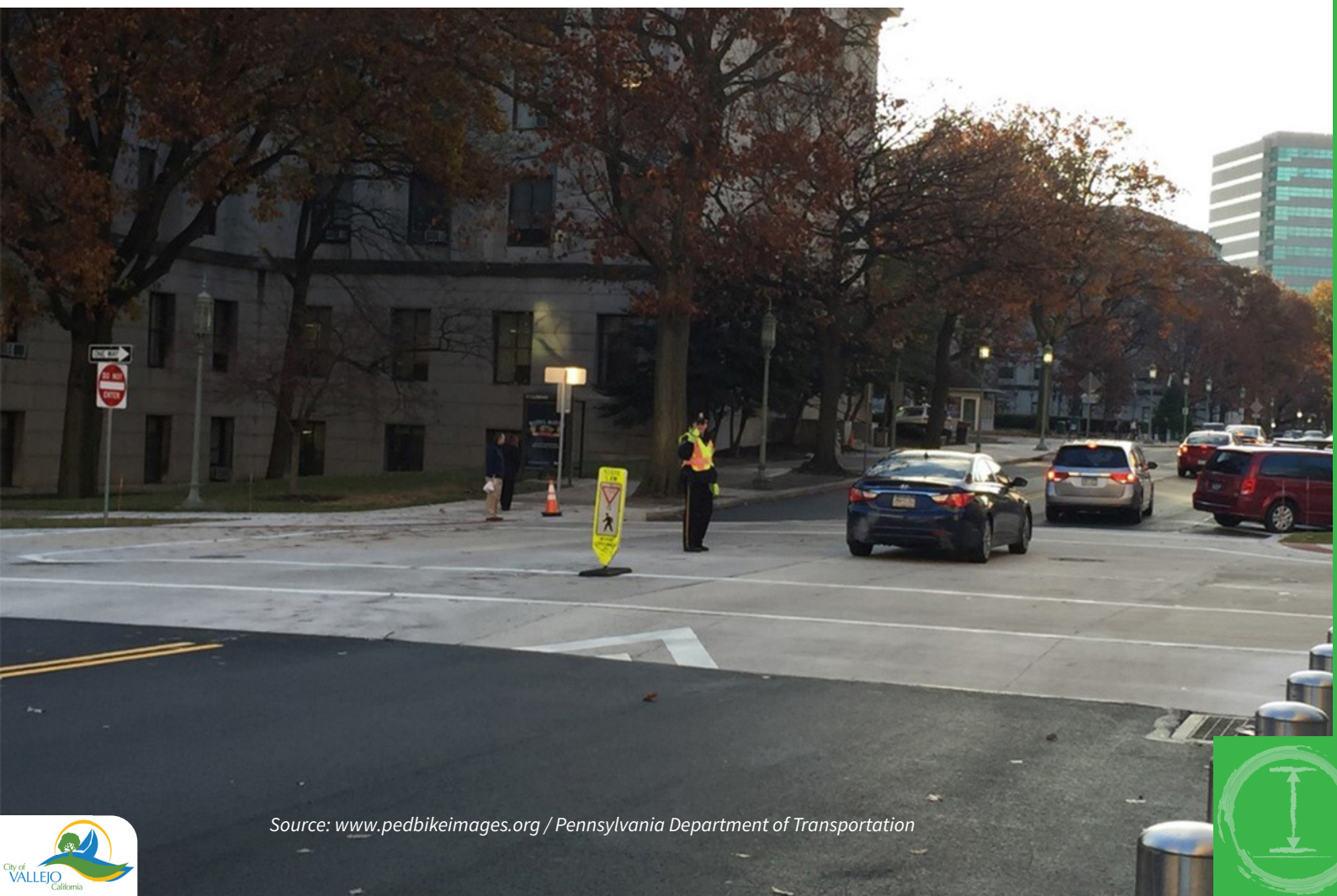
- Effective in reducing speeds, though not to the extent of speed lumps and speed humps
- Enhances pedestrian environment and crossings

Disadvantages

- Relatively expensive
- Increased noise
- Impacts to drainage need to be considered

COST:

$50,000-$100,000



Source: www.pedbikeimages.org / Pennsylvania Department of Transportation

Traffic Circle

Traffic circles are raised islands, placed in intersections, around which traffic circulates. Stop signs or yield signs can be used as traffic controls at the approaches of the traffic circle. Traffic circles prevent drivers from speeding through intersections by impeding the straight-line path and forcing drivers to slow down to yield. Depending on the size of the intersection and circle, trucks may be permitted to turn left in front of the circle, and the City can use mountable curbs if turn radii are a concern for emergency vehicles and/or trucks.

Advantages

- Very effective in moderating speeds and improving safety
- Can have positive aesthetic value

Disadvantages

- Can be difficult for emergency vehicles or large trucks to travel around if not designed properly
- Must be designed so that the circulating traffic does not encroach on crosswalks
- Potential loss of on-street parking

COST:

$15,000-$50,000

Roundabout (Single-Lane)

Roundabouts require traffic to circulate counterclockwise around a center island. Unlike traffic circles, roundabouts are used on higher volume streets to allocate right-of-way among competing movements. Roundabouts have raised splitter islands to channel approaching traffic to the right, and do not have stop signs. They are often found on collector streets and are a substitute for traffic signals. Due to the large amount of required right-of-way and construction costs, roundabouts may be more appropriate for new developments or redevelopment areas.

Advantages

- Enhanced safety compared to a traffic signal or stop sign
- Minimizes queuing at approaches to the intersection
- Less expensive to operate than traffic signals
- Can have positive aesthetic value
- Shorter pedestrian crossing distance

Disadvantages

- May require major reconstruction of an existing intersection
- Loss of on-street parking
- Continuous flow of traffic limits opportunity for pedestrians to cross (compared to signalized intersections with designated pedestrian crossing time)
- May present additional obstacles to visually impaired pedestrians

COST:

$100,000-$500,000

Median with Horizontal Deflection

Medians are narrow, raised islands placed in the middle of the roadway around which traffic circulates. A median with horizontal deflection extends into the travel lane to eliminate the straight-line path and force drivers to slow down to navigate.

Advantages

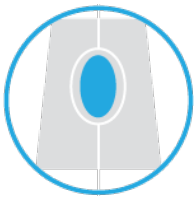
- Effective in moderating speeds and improving safety
- Can have positive aesthetic value
- Can provide two-stage pedestrian crossing opportunities

Disadvantages

- Can increase potential for fixed object collisions
- Potential loss of on-street parking

COST:

$35,000-$55,000



Lateral Shift

A lateral shift uses midblock islands or striping to realign travel lanes laterally to eliminate the straight-line path.

Advantages

- Can moderate speeds
- Can have positive aesthetic value

Disadvantages

- Can increase potential for fixed object collisions
- Drivers can bypass the lateral shift in the absence of islands
- Potential loss of on-street parking

COST:

$10,000-$50,000

Chicane

A chicane is a variation of a lateral shift. It includes a series of alternating mid-block curb extensions or islands that narrow the street and require drivers to navigate a curved path, thus reducing vehicle speeds.

Advantages

- Can moderate speeds
- Can have positive aesthetic value

Disadvantages

- Can increase potential for fixed object collisions
- Potential loss of on-street parking

COST:

$20,000-$60,000

Slow Turn Wedges

Slow turn wedges use markings and flexible plastic posts to buffer pedestrians from traffic and shrink the area where they could get hit by a car.

Advantages

- Effective in reducing speeds and conflicts with pedestrians/bicyclists
- Discourage drivers from cutting corners and encourages following the proper path when making left turns
- Low cost

Disadvantages

- Limited to one-way streets
- Less durable

COST:

$500-$3,000

Hardened Centerlines/ Rubber Speed Bumps

Hardened centerlines are bollards that prevent left-turners from crossing the centerlines when making a turn. Pedestrian islands can also accomplish the same if they are placed strategically, with the added benefit of being more durable and providing a pedestrian refuge. Rubber speed bumps are often used in conjunction with hardened centerlines and placed in an intersection. There are a variety of design configurations.

Advantages

- Effective in reducing speeds and conflicts with pedestrians/bicyclists
- Discourages drivers from cutting corners and encourages following the proper path when making left turns
- Low cost

Disadvantages

- Less durable

COST:

$500-$2,000

Bulb Outs/Curb Extensions

Bulb-outs and curb extensions extend the sidewalk into the parking lane to narrow the roadway at intersections. Their effectiveness in calming traffic is limited by the absence of vertical or horizontal deflection but can still be beneficial. Bulb-outs decrease the curb radii, thus reducing turning vehicle speeds. Bulb-outs can also make intersections more pedestrian friendly by shortening the crossing distance.

Advantages

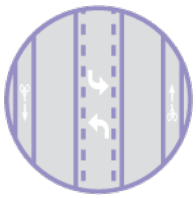
- Reduces vehicle turning speeds
- Reduces traffic volumes if alternative routes are available
- Can increase pedestrian safety by reducing pedestrian crossing distance and exposure to vehicles
- Through and left-turn movements can be easily navigated by large vehicles
- Creates protected on-street parking bays

Disadvantages

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

COST:

$80,000-$130,000



Road Diet

A road diet reduces the number and/or width of travel lanes to allocate space for other facilities such as bike lanes, sidewalks, buffer zones, and/or on-street parking. A road diet can create the perception of a narrow lane width, thus reducing travel speeds.

Advantages

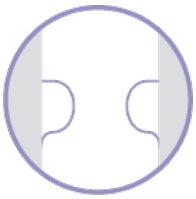
- Reduces vehicle speeds
- Reduces volumes if alternative routes are available
- Increases space for bike lanes, sidewalks, buffer zones, and/or on-street parking
- Can be done as part of resurfacing project

Disadvantages

- Effectiveness is limited by the absence of vertical or horizontal deflection

COST:

$50,000-$500,000



Two-Lane Choker (Mid-Block Curb Extension)

Chokers are curb extensions at midblock that narrow the street. They leave the street cross section with two lanes that are narrower than the normal cross section. Their effectiveness in calming traffic is limited by the absence of vertical or horizontal deflection, but can still be beneficial.

Advantages

- Reduces vehicle speeds
- Reduces traffic volumes if alternative routes are available
- Can be easily navigated by emergency vehicles and buses
- Can have positive aesthetic value

Disadvantages

- Effectiveness is limited by the absence of vertical or horizontal deflection
- May require bicyclists to briefly merge with vehicular traffic
- Loss of on-street parking
- Potential buildup of debris in gutter

COST:

$40,000 - $80,000

Medians without Horizontal Deflection/Ped Refuge Island

Medians are narrow, raised islands placed in the middle of the roadway around which traffic circulates. Medians without horizontal deflection do not extend into the travel lane, maintaining the straight-line path for drivers. While they are not as effective as medians with horizontal deflection, they can still reduce speeds by creating the perception of a narrow lane width. Medians without horizontal deflection can also be used as pedestrian refuge islands, increasing pedestrian safety, and adding potential aesthetic benefits.

Advantages

- Reduces vehicle speeds
- Reduces traffic volumes if alternative routes are available
- Can increase pedestrian safety
- Can have positive aesthetic value

Disadvantages

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

COST:

$35,000-$75,000

Street Trees/ Landscape Buffer

Street trees and landscape buffers can help reduce vehicle speeds and collisions. Streets lined with trees or landscape center medians can create the perception of a narrow lane width, thus reducing travel speeds.

Advantages

- Effective in reducing speeds and collisions
- Relatively low cost
- Environmental benefits such as reduced flooding, absorbing carbon emissions and producing oxygen, and roadway cooling effect
- Can provide positive aesthetic value and placemaking

Disadvantages

- Requires maintenance

COST:

Varies by scope

On-Street Parking

On-street parking is street parking adjacent to a travel lane. Drivers looking for parking will slow down along the corridor. For drivers not looking for parking, on-street parking can create the perception of a narrow lane width, thus reducing travel speeds.

Advantages

- Reduces vehicle speeds
- Increase in on-street parking
- Can provide protection for pedestrians from moving vehicles
- Low cost

Disadvantages

- Effect on vehicle speeds is limited by the absence of vertical or horizontal deflection
- May interfere with bicyclists

COST:

Varies by marking and signage

Full Closure

Full street closures are barriers places across a street to close the street completely to through traffic, usually leaving only sidewalks and bicycle facilities 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. Emergency vehicles can be accommodated via removable bollards or similar devices.

Advantages

- Very effective in reducing cut-through traffic volumes
- Maintains pedestrian and bicycle connectivity
- Can be designed to maintain access for emergency vehicles

Disadvantages

- Creates circuitous routes for local residents
- Diverts traffic to another street
- Delays emergency vehicles

COST:

$50,000-$500,000

Half/Partial Closure

Half/partial closures are barriers that block travel in one direction for a short distance on otherwise two-way streets. They are the most common volume control measure after full closures. Half/partial closures are often used in sets to make travel through neighborhoods circuitous rather than direct.

Advantages

- Effective in reducing traffic volumes if alternative routes are available
- Maintains pedestrian and bicycle connectivity
- Can direct vehicle travel on a desired route
- Can be designed to maintain access for emergency vehicles

Disadvantages

- Creates circuitous routes for local residents
- Drivers can bypass the barrier
- Can delas emergency vehicles

COST:

$70,000-$200,000

Diagonal Diverter

Diagonal diverters place barriers, similar to those used for full or partial street closures, diagonally across an intersection, blocking through movement. Like half closures, diagonal diverters are usually staggered to create circuitous routes through neighborhoods.

Advantages

- Effective in reducing traffic volumes if alternative routes are available
- Maintains pedestrian and bicycle connectivity
- Can direct vehicle travel on a desired route

Disadvantages

- Creates circuitous routes for local residents
- Drivers can bypass the barrier
- Delays emergency vehicles
- May require reconstruction of corner curbs

COST:

$20,000-$85,000

Forced-Turn Island

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

Advantages

- Can improve safety at an intersection by prohibiting critical turning movements
- Reduces traffic volumes if alternative routes are available
- Can direct vehicle travel on a desired route

Disadvantages

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

COST:

$15,000-$40,000

Quiet Streets

Quiet Streets are residential streets that have been designed to limit through traffic and provide more and safer space for pedestrian and bicycle activity. Full or half closures can also be employed as part of a Quiet Street conversion.

Advantages

- Effective in reducing traffic volumes
- Creates a safer pedestrian and bicycle environment
- Provides more space for pedestrian and bicycle activity

Disadvantages

- Creates circuitous routes for local residents
- Drivers can bypass barrier if used
- Can delays emergency vehicles
- Not ideal for collectors or streets that serve transit, large vehicles, or emergency service corridors

COST:

$2,500-$300,000