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CITY OF
DELAWARE
OHIO

Traffic Calming Guide
for
Neighborhood Streets

City of Delaware

Public Works Department

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1.0 Introduction and Overview

The City of Delaware has long-standing policy for implementing traffic calming measures with the goal being safer streets and lower vehicular speeds in residential neighborhoods, near schools, and other areas with high numbers of pedestrians and bicyclists. In the past, policy has lumped regulatory measures with non-regulatory measures. Also, some older policy advocates traffic calming measures that have been deemed ineffective over the years or are outdated due to advances in technology. In the past, the use of the term "traffic calming measures" has been overly broad. Therefore, the purpose of this manual is to give City leaders new focus and direction in keeping City streets safer for all modes of travel. This manual replaces the City's existing traffic calming policy and attempts to address the most frequently requested items from the public.

Speeding in residential neighborhoods is often times a concern among City of Delaware residents because of its effect on the livability of our streets and neighborhoods. In response to citizen concerns, the City of Delaware has developed the Neighborhood Traffic Calming Guide to more effectively work with neighborhoods in developing appropriate traffic solutions. The work represents a collaborative effort by the City of Delaware Police Department, Public Works Department, Parking and Safety Committee and Citizens to address speeding concerns on public streets.

The purpose of traffic calming is to address problems associated with neighborhood speeding, though the techniques and traffic calming measures can be extended to higher order major collector and minor arterial routes as well. Cut-thru traffic is often blamed as the source of neighborhood speeding problems, however it has been found that both neighborhood residents as well as motorists travelling through a residential area are equally likely to exceed posted speed limits. Therefore, the focus of this document is to provide guidance in mitigating vehicle speed regardless of origin or destination.

A successful traffic calming program requires involvement and cooperation from the impacted residents, travelling public, and local jurisdiction. Delaware's Traffic Calming Guide employs an approach that incorporates Education, Encouragement, Enforcement, Engineering, and Evaluation in resolving traffic issues.

Public **Education** and **Encouragement** are recommended first steps for residents to help promote traffic calming in their neighborhoods. Motorists are made aware of community concerns and reminded of the importance of safe driving habits. Well informed motorists regarding safety concerns and traffic laws in neighborhoods, are more likely to follow the rules. The implementation of a yard sign campaign is an inexpensive means to remind all motorists of the posted speed limit and risks associated with speeding in a residential neighborhood. Speed feedback display units can be used to promote awareness and reinforce safe driving habits by showing actual travel speeds next to the posted speed limit. The community can also play a role through encouraging motorists to respect the speed

limits within residential areas and to consider alternative routes on higher level roads to help reduce the traffic load on a particular street.

Enforcement typically involves an increased presence of law enforcement to monitor and enforce the speed limits in neighborhoods. Enforcement efforts should be undertaken as much as possible prior to implementation of physical traffic calming devices. Citizens can call the City of Delaware Police Department at (740)203-1111 and report areas where speeding is perceived to be a problem and request enforcement.

There are cases where enhanced public **Education, Encouragement and Enforcement** need to be supplemented with additional measures to address traffic concerns such as continued complaints over excessive speeding, vehicular crashes and pedestrian incidents. In these cases **Engineering Analysis, Design and Follow-up Evaluation** may be initiated to further understand the issue and make recommendations to mitigate the undesirable behavior. In these cases engineering strategies can involve adding non-intrusive signage, pavement marking and geometric roadway features that result in lowered vehicle speeds on affected roads. These physical traffic calming measures are indiscriminate and affect all motorists; therefore, they are used after education, encouragement and enforcement strategies have been exhausted. More intrusive traffic calming measures are available if the volume of traffic must be adjusted, redirected or otherwise changed to address a particular safety concern within a neighborhood such as high crash history or congestion.

An **Evaluation** of traffic calming measures generally follows the installation of traffic calming measures to verify the effectiveness in addressing a particular traffic safety concern. Evaluation may involve community survey, social media feedback, additional speed studies, and traffic counts to determine the impacts a particular measure may have had on motorist behavior. Adjustments to traffic calming measures may be recommended based on the results of the evaluation.

2.0 Program Limitations

Traffic calming is a community-driven effort, however there are limitations as to the effectiveness that calming measures achieve, and those requesting improvements should have realistic expectations as to what those benefits are. Additionally, what may seem like obvious solutions are often not viable in accordance with accepted traffic regulations and codes.

a) As a municipal organization, the City must abide by regulations set forth by our State and Federal government. The Ohio Manual of Uniform Traffic Control Design (OMUTCD) is a governing set of regulations adopted by the State of Ohio, which contains specific regulations regarding the use of public right of way, and specifically concerning pavement markings, signage and the management of traffic. The City of Delaware does not approve of any infrastructure modification or improvement that is not specifically permitted under the regulations of the OMUTCD.

b) For the purposes of this guide, the recommendations are limited to implementation on publically owned local residential and collector streets.
c) There is limited funding available for the construction of permanent traffic calming measures. If it is determined that permanent traffic calming measures are recommended, funding sources must be considered. Section 4.0 addresses recommended strategies for the funding of traffic calming measures in various situations.
d) In some instances, the implementation of certain traffic calming measures can result in unintended consequences such as increased traffic in surrounding streets and neighborhoods, increased vehicle noise and pollution, sign clutter, tree removal, and the reduction or elimination of on-street parking.
e) It has been found that the use of traffic calming measures is minimally effective in reducing vehicle speeds when the measured 85th percentile speeds are determined to be below 30 MPH. (See Appendix C for definition of 85th percentile speed)

3.0 Development of Neighborhood Traffic Calming Plans

The following process is followed when evaluating requests for the installation of proposed traffic calming measures on a neighborhood street.

3.1 Receipt of Initial Traffic Complaint

A request for the installation of traffic calming measures can be initiated by an individual, neighborhood group and/or by City staff. If the request is initiated by a neighborhood group, it is recommended that the neighbors designate a point-of-contact who will act as a liaison between City staff and other neighborhood residents. In any case, the consideration for, and the implementation of traffic calming measures should involve considerable neighborhood consensus building in the community. The neighborhood point-of-contact should submit, on behalf of the neighborhood, a formal written request to the City of Delaware Parking and Safety Committee explaining the concerns and to request traffic calming measures be implemented. Requests can be sent via email or through the City website.

Following initial receipt of a request for traffic calming, Public Works and Police staff will work with the neighborhood point-of-contact to define the specific nature of the complaint as well as the neighborhood study area. The study area may include more streets within a neighborhood than the street associated with the complaint. It is important to include an expanded study area because traffic calming measures installed on one street may have an impact on adjacent streets resulting in the shifting of a problem as opposed to mitigating it.

3.2 Review Eligibility for Neighborhood Traffic Calming

Traffic calming measures are generally most effective in residential areas to manage speeds along residential streets, and where there exists the highest interaction between pedestrians, cyclists, parked vehicles, and pets. Therefore, only streets meeting the following criteria are appropriate candidates for further consideration for implementation of the neighborhood traffic calming measures detailed in this guide.

- ✓ Streets with a posted speed limit of 25 mph
- ✓ Streets classified as a local or neighborhood collector street
- ✓ Streets with an ADT<3500 vehicles per day
- ✓ Street is not a cul-de-sac
- ✓ Streets is not designated as primary emergency response route

3.3 Data Collection & Analysis

The following data is collected by Public Works and Police staff within the study area and used in analyzing the traffic characteristics, driving patterns and motorist behavior of a particular street in question.

- ✓ Vehicle Speeds to document the 85th percentile speeds
- ✓ Average Daily Traffic (ADT) volumes on all streets within the study area
- ✓ Turning movement counts at pertinent intersections that are within the study area during the peak hours 7AM-9AM, 11AM-1PM and/or 4PM-6PM (if applicable)
- ✓ Pedestrian counts at intersections if study area is near-by or adjacent to a school and/or park
- ✓ Accident history and rate of occurrence
- ✓ Roadway condition/geometrics
- ✓ Percent cut-through traffic

The collected data is reviewed to help identify observable safety issue such as excessive vehicle speeds, or conditions leading to the perception of speeding, and to make a determination as to what traffic calming measure(s) may be effective in addressing the issues. Staff will also identify the potential negative effects associated with the installation of traffic calming measures including impacts on the provision of emergency services, city refuse collection, highway maintenance and snow removal operations. Additional consideration is given to the impact on institutions such as, but not limited to, local schools, hospitals and emergency care facilities.

3.4 Draft Traffic Calming Plan

City staff will develop a Traffic Calming Plan that identifies strategies to help reduce speeding, and that employs the Educate, Encourage, Enforcement, Engineering and Evaluation approach. Traffic Calming measures may include non-intrusive/guidance strategies, more intrusive measures, or a combination of both. Non-intrusive strategies include educational programs, enforcement, signage, pavement markings, construction of islands, bump-outs, chicanes etc., all to influence the motorist behavior in a particular location. The more Intrusive measures generally involve construction of deterrents that limit vehicle direction of travel and access to particular street. Non-intrusive measures are most successful in managing vehicle speed while intrusive measures are implemented to control vehicle volumes. Both have advantages and disadvantages as further described in detail in the information provided in Appendix A and B.

3.5 Public Involvement Process

Following development of a draft traffic calming plan, staff will present the plan before the public and accept public input as to the proposal. City staff will prepare a summary describing the problem and potential solutions and make the information available to all interested parties via a combination of door hangers, mail service and other social media outlets. All interested parties are invited to attend a public discussion of the issue to be held during a regularly scheduled City Parking & Safety Committee meeting. Property owners within the study area, generally defined as those households and businesses fronting the affected segments of the project street(s), will receive additional information regarding the identified problem and potential traffic calming measures being considered. This includes, but not limited to, homeowners, businesses, apartment tenants and area schools. Adjustments to the plan may be considered based on public feedback.

3.6 Legislative Review & Approvals

The City Parking & Safety Committee will make a final recommendation as to the approval or denial of a proposed traffic calming initiative for a particular area. For those plans recommended for approval, the recommendation is taken before full City Council for consideration, and ultimate approval. Because the Neighborhood Traffic Calming policy is for guidance only, City Council may have to consider such things such as public acceptance and project construction and funding responsibilities before any improvements can be implemented.

3.7 Implementation of Traffic Calming Plan

Depending on the extent of the Neighborhood Traffic Calming Plan and the amount of funding available, the traffic calming measures may be implemented in phases and evaluated prior to considering full implementation. Construction of improvements may be by the property owners group, the city, or a combination of both entities. Some improvements can be installed any time of the year such as additional new signage, while others requiring changes to pavement markings, curb and roadway are generally restricted to the April through October construction season.

3.8 Evaluation

A follow-up evaluation will be conducted to ensure that the strategies implemented are effective. The evaluation includes additional traffic counts and speed studies after each set of measures has been implemented. If speeding has not effectively reduced, the City and neighborhood residents will have additional meetings to determine what further measures may be needed.

The City will also be reviewing unintended consequences such as redistribution of vehicle trips to other residential streets, increase in accident rates, or other traffic problems developing as a result of the implementation of the traffic calming plan. Depending on the severity of the unanticipated consequences, the City may modify the plan, reduce the plan, or eliminate it all together.

4.0 Funding Strategies for Construction of Traffic Calming Measures

Available funding for transportation system improvements is limited, and in many cases tied to the availability of outside revenues such as grants, safety program funds or other State sources. The value of traffic calming improvements are generally too low to make good candidate projects for grant programs, yet larger than what can typically be managed in the annual traffic maintenance operations budget at current funding levels. Nevertheless, as the need arises to make traffic calming improvements within the community, it would be helpful to have an established source of funding to allocate toward these efforts. Once a requested improvement has been identified, evaluated and approved for installation through the guidelines established in the Traffic Calming Guide, the cost of the improvement could be added to the next operations budget for funding consideration by council as part of the overall budget approval process. For improvements considered critical in nature addressing a high-risk situation, where prudence demands an immediate response, a recommendation should be made to Council to consider a supplemental appropriation so that the improvement could be made sooner. For low impact improvements, Council could require alternative funding arrangements such as specifying a neighborhood HOA provide some of all of the funding required to make an improvement. In all cases, the City should only fund projects that will have a positive and measurable impact on improving neighborhood safety as it relates to traffic calming.

5.0 Non-Intrusive Traffic Calming Measures

Non-intrusive traffic calming measures are most effective at increasing motorist's awareness of their surroundings, and have been shown to yield a drop in vehicle travel speeds of up to several miles per hour in the correct application. Non-intrusive measures however, generally do not result in a notable drop in traffic volume, though the more physical alterations could discourage a motorist from travel on a treated street. Non-intrusive measures may be most effective when implemented in combination e.g. establishing a neighborhood yard sign "Speed Watch" program concurrent with the introduction of new pavement striping.

The cost of non-intrusive measures vary widely and can range from a few hundred dollars to tens of thousands or more for complex modifications to roadway geometry. Details regarding the approved non-intrusive traffic calming measures utilized within the City of Delaware are found in Appendix A.

A note about the use of Stop signs – The use of Stop signs is not a recognized nor approved means to manage neighborhood speeding though it may seem like an obvious approach to "slow" motorists down. The reality is that unwarranted Stop signs can increase risk and safety concerns in areas where they have been placed, as motorists quickly realize the minimal chance of encountering side street traffic and end up "rolling through" an intersection. The result is a diminished respect for Stop signs. Improper installations have actually been shown to result in an increase in vehicle speed both ahead of and following a Stop sign installation. Appendix E describes the only permitted applications for mulit-way Stop sign applications under very limited conditions.

6.0 Intrusive/Barrier Traffic Calming Measures

Intrusive barriers are most effective in diverting traffic away from any given street regardless of trip origin or destination, by directing motorists toward adjacent streets or alternative routes. These type of traffic calming measures may be helpful in addressing changes to traffic volumes that were not originally anticipated or otherwise previously present. In some cases the volume of traffic on a street exceeds that which can be associated just from the neighborhood. This often presents conflict as residents feel that they have certain rights to the management of the level of traffic using the public right of way fronting their respective properties, in contrast with the permissible use by non-resident motorists on the same street. In general, the implementation of intrusive barriers should be reserved to address safety issues such as high accident rates, continuous congestion, and intersection delay. See Appendix B for specific details of the Intrusive traffic calming measures utilized within the City of Delaware.

7.0 Recommended Applications of Traffic Calming Measures

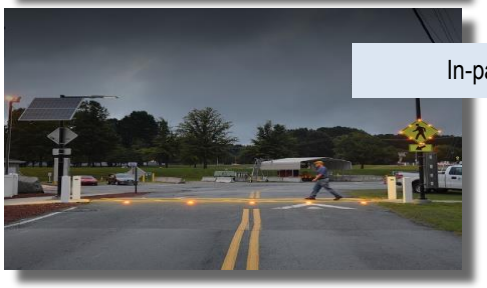
The following table provides recommendations as to the use of certain traffic calming measures on local and collector streets as a function of 85% speed. Not all traffic calming measures are suitable for both local streets and collector roadways. Only those measures indicated with and 'X' are approved for the specified condition.

Recommended Application of Traffic Calming Measures						
Traffic Calming Measure	**Local Street** 85th % Over Posted Limit			**Collector Street** 85th % Over Posted Limit ADT>1500		
	0–5 MPH	**6–10 MPH**	**11+ MPH**	**0–5 MPH**	**6–10 MPH**	**11+ MPH**
Police Enforcement		X	X		X	X
Public Encouragement	X	X	X	X	X	X
Yard Sign Campaign	X	X	X	X	X	X
Enhanced Crosswalks		X	X	X	X	X
Pavement Striping		X	X	X	X	X
Speed Feedback Signs		X	X		X	X
Intersection Bump-outs		X	X		X	X
Curb Bump-outs			X			X
Chicanes			X			X
Median Islands			X			X
Chokers			X			X
Roundabouts			X			X
Speed Bumps			X			
Raised Intersections			X			
Time of Day Restrictions						X
One-Way Streets			X	Generally the application of 'Intrusive' traffic calming measures that restrict the use of a public road planned as a collector servicing local and regional traffic is not recommended		
Diverter Islands			X			
Turn Restrictions			X			

8.0 Non-Compliant Traffic Calming Measures (Not Permitted in Delaware)

Non-compliant crosswalk markings

Non-compliant crosswalk markings



In-pavement lighting

Non-compliant symbols/wording

Appendix A – Non-Intrusive Traffic Calming Measures

Neighborhood Yard Signs

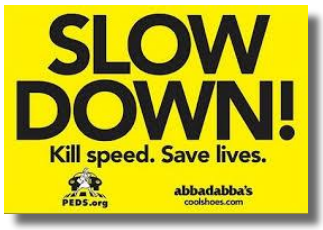
Yard signs are temporary plastic signs in the front yards of community residents, which serve as a vivid reminder to drive 25 mph within neighborhoods. The sign is connected with metal stakes, similar to an advertisement sign or political candidate's sign, and is placed on private property at the discretion of the property owner. These signs may not be installed within the right-of-way of the adjacent street because they are not compliant with the Ohio Manual of Uniform Traffic Control Devices (OMUTCD), which regulates the types and designs of signs installed above or adjacent to all roads within the State of Ohio.

Advantages:

- Can be effective in reducing speeding by community residents. These signs are most effective when a community is supportive and promotes the need for speed reduction through other community educational efforts.
- Inexpensive to manufacture

Disadvantages:

- Impact may be reduced over time unless regularly reinforced. Moving the signs periodically may cause them to be continually noticed.



Dynamic Speed Feedback Signs

On occasion, local communities have sought to resolve their traffic speed issues and traffic diversion issues through the use of artificially reduced speed limits. Section 4511.12 of the Ohio Revised Code (ORC) establishes statutory speed limits and prescribes how those speed limits may be altered when an engineering study determines that they do not fit the road and traffic conditions.

Speed limit signs in and of themselves are rarely effective in reducing travel speeds and they should not be used as a standalone device. Experience has shown that drivers tend to travel at the speed that is most comfortable, based on the surrounding roadway environment. Speed limit signs may be installed to reinforce existing speed limits or to supplement other traffic calming devices. Speed limits set at levels less than those expected by drivers eventually lead to increased disregard of the signed speed limit.

Dynamic speed feedback signs provide a real-time display of a driver's vehicular speed at a particular location where speeding has been documented to be a problem. These signs are used in conjunction with a regulatory speed limit sign to give drivers an immediate confirmation of their actual speed in comparison to the legal speed limit. The dynamic speed feedback signs serve to supplement regular enforcement of speed limits alerting drivers to specific driving behavior. Although residential streets carry the lowest volume of traffic and are subject to the fewest accidents, they are often the subject of the most complaints regarding neighborhood speeding. Residents observe vehicles being driven at speeds perceived as "too fast" and conclude the need for increased local speed enforcement or for the installation of all Way Stop Signs along the route. In many cases, the speeds perceived as excessive by residents while standing in their yards are the same that they operate their vehicles at while driving.

Advantages:

- Studies have shown these signs produce 10-20% reductions in speeding violations, along with an increase in compliance with the posted speed limit.
- Can be cost effective when compared with the construction of physical traffic calming measures to reduce speed.

Disadvantages:

- Expensive initial cost with continuous maintenance and repair costs.
- Impact may be reduced over time unless regularly enforced by local police.

Pavement Striping

Pavement striping means of controlling speed includes measures to effectively narrow the travel lanes to encourage lower speeds, to emphasize pedestrian crossings or to supplement signing regulations (such as existing stop signs). Striping which can be used in traffic calming includes centerlines, edge lines, crosswalks and stop bars. Pavement striping options can vary depending on the type of striping being used; therefore, the application of each type of striping treatment is as follows:

Centerline Striping: Centerline striping is primarily used for residential streets without existing centerlines. In many cases, a centerline stripe can be effective in channeling traffic and thereby reducing speeds. There are also other specialized striping techniques that can be used to draw attention to lane markings, such as the addition of reflective pavement markers where appropriate.

Edge Line Striping: Edge line striping is also effective in residential areas to narrow the lanes and/or provide additional delineation for other uses. Reducing the lane width has the potential for reducing speed by creating a narrower traffic lane. The area between the edge of the road and the lane marking can often be used for parking or as a bike lane, depending on the resulting shoulder width.

Enhanced Crosswalks: At high volume pedestrian crossings, striped crosswalks might be appropriate to channelize pedestrians and notify motorists of pedestrians crossing the street. Crosswalks alone may not provide the desired level of protection or call sufficient attention to a pedestrian to allow them to safely cross the street. Depending on the need, there are a variety of crosswalk options that may be used at intersections to identify the safest place to cross. These includes enhanced diagonal ladder-style striping and possibly the use of textured pavements to increase the visibility by the motorist and encourage slowing down.

Advantages:

- Centerline striping can be effective in reducing sideswipe accidents, as it channelizes traffic in its own lane.
- Centerline striping can be combined with edge lines to create narrower travel lanes, which subsequently help to slow traffic.
- Edge line striping may increase bicycle and pedestrian safety by moving vehicular traffic closer to the centerline providing more shoulder space for bicycles and pedestrians.
- Crosswalks provide a visible pedestrian crossing, increasing pedestrian awareness and safety.

Disadvantages:

- Periodic maintenance of striping.
- Striping can lose its effectiveness in reducing speed over time as regular users of the street become more comfortable with the physical space they have available to operate.
- Crosswalks used without other traffic control devices may lure pedestrians into a false sense of security.
- Appearance of the road with paint striping may cause residents to feel that the road is a higher classification than a local residential street.
- Potential loss of on-street parking in order to provide 10 foot minimum lane width for vehicular traffic which doesn't leave adequate width for an 8 foot wide parking aisle on both sides of the street.

Choker Islands

A choker narrows the travel lanes of a road by bringing the existing curbs closer to the centerline of the road. The typical two-lane choker is 20-feet wide (curt-to-curb) at its most narrow point. Chokers should extend toward the centerline beyond any parking lanes. While the typical curb to curb width of a two-lane curb extension is significantly less than most streets, there is sufficient width for vehicles to pass each other. As a result, speed reductions will be modest.

The length of a choker can vary depending on the location of driveways and curbside parking. By bringing the curbs closer together, chokers may also present a favorable location to install a mid-block crosswalk (either raised or level with the roadway) because crossing distances are reduced, motor vehicles speeds are lower, and the combination of design elements will draw greater visual attention to the crossing location.

Chokers can be created by either curb extensions or edge islands. Edge islands are less aesthetic but leave existing drainage channel opens. They also make it possible to provide bicycle bypass lanes on streets without curbside parking. If motor vehicle volumes are large, chokers can be hazardous to bicyclists, who get squeezed by passing motorists. In such cases the bicycle bypass lanes should be considered.

Advantages:

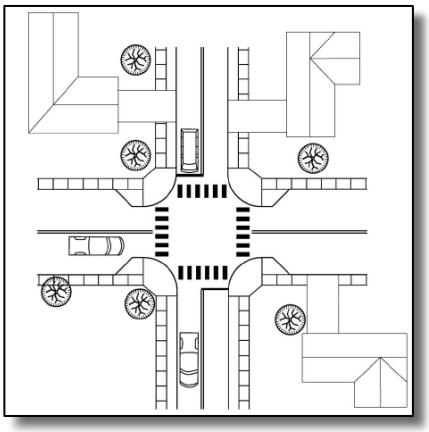
- Reduced speeds in area of choker.
- Minimal impact to driving comfort.
- Where provided, shorter crossing distances for pedestrians.
- Protects adjacent on-street parking spaces.
- Provides landscaping opportunity.
- Can accommodate emergency vehicles.

Disadvantages:

- Only a modest reduction in vehicle speeds can be expected, unless chokers are used in conjunction with other speed reduction measures.
- Loss of some on-street parking spaces.

Corner Bump-Outs

Corner extensions are chokers installed at intersections. Reduced curb radii can reduce speeds on approaches that are not stop controlled and decrease pedestrian crossing distances. Operational analyses should always be performed when corner extensions are constructed to ensure that the intersection will operate acceptably with respect to queues and delays.



Advantages:

- Reduces speeds through the intersection area.
- Shorter crossing distances for pedestrians.
- Provides landscaping opportunity.
- Can accommodate emergency vehicles for through movements.

Disadvantages:

- Loss of on-street parking spaces.
- Potentially high cost, if there are significant utility and drainage impacts.
- Forces bicyclists into travel lanes at intersections.
- Can make right turns by large vehicles more difficult.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Median Islands (Center Island Narrowing)

Center island narrowing is achieved by placing an island in the centerline of the roadway at the entry point to a neighborhood or midblock which narrows the lane width on either side of the island. The visual appearance of the narrowed lanes will encourage drivers to slow down. In addition to slowing traffic, center island narrowing provides opportunities to provide a pedestrian refuge area (if at a pedestrian crossing location), landscaping, or installation of entrance features or gateway signs. To be most effective, the islands should be raised islands. Median treatments often incorporate textured pavements on the island itself, particularly for median islands without raised concrete islands, where textured pavements are essential in helping draw attention to the island.

Advantages:

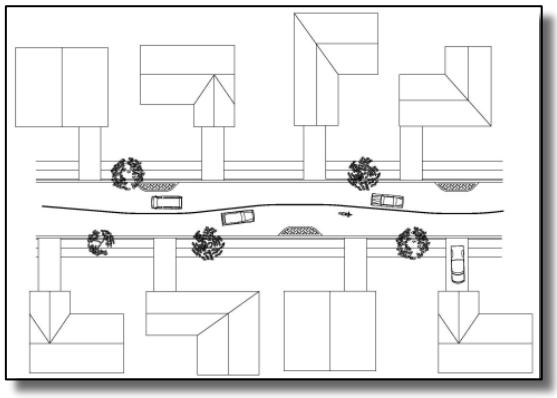
- Reduced speeds.
- Shorter crossing distances for pedestrians.
- If sufficiently wide enough (6-feet minimum), islands can provide a refuge area for pedestrians in the middle of the roadway.
- Provides a visual break in the streetscape and reduces the wide open appearance.
- Provides landscaping opportunity.
- Creates visual cues to drivers at entrance of a residential neighborhood.
- Little impact on emergency vehicles.

Disadvantages:

- Only modest speed reduction can be expected from standalone installations.
- Loss of on-street parking spaces.
- May force bicyclists into travel lanes at lane narrowing points.
- May impact driveways.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Chicanes

Chicanes are a series of curb extensions or narrowing of the roadway that alternate from one side of the street to the other, forming an S-shaped and curvilinear roadway alignment. The purpose of a chicane is to introduce horizontal curvature to the road, breaking up the "runway effect" of wide, straight streets.



Advantages:

- Speed reductions.
- Accommodates large vehicles and has little effect on emergency response times.
- Provides a visual break in the streetscape and reduces the wide open appearance of the street.
- Provides landscaping opportunities.

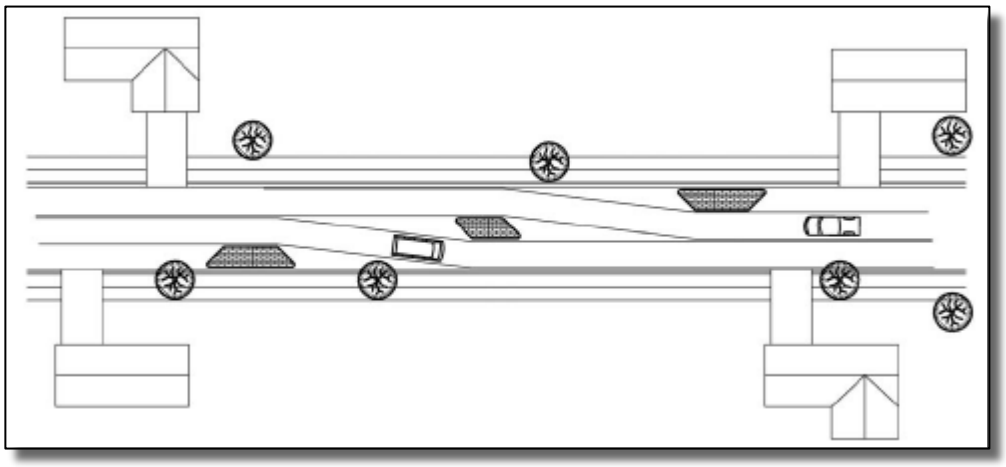
Disadvantages:

- Loss of on-street parking spaces.
- Bicyclists have less space to occupy the road through the narrowed portions.
- Some aggressive/careless drivers may view chicanes as an "obstacle course", leading to sharp cornering, braking and acceleration to negotiate the islands and curb extensions.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Lateral Shifts

A lateral shift is a variation of the typical chicane. It has the same dimensions and details as the typical chicane, but because the roadway alignment shifts only one, has a crossing approximately 5 mph higher than a chicane of the same dimensions.

The typical lateral shift separates opposing traffic by means of a center island. Without a center island, some drivers may cross the centerline to minimize the deflection of their travel path. With the center island, drivers cannot veer into the opposing lane as easily, thus improving the safety and effectiveness of the later shift.



Advantages:

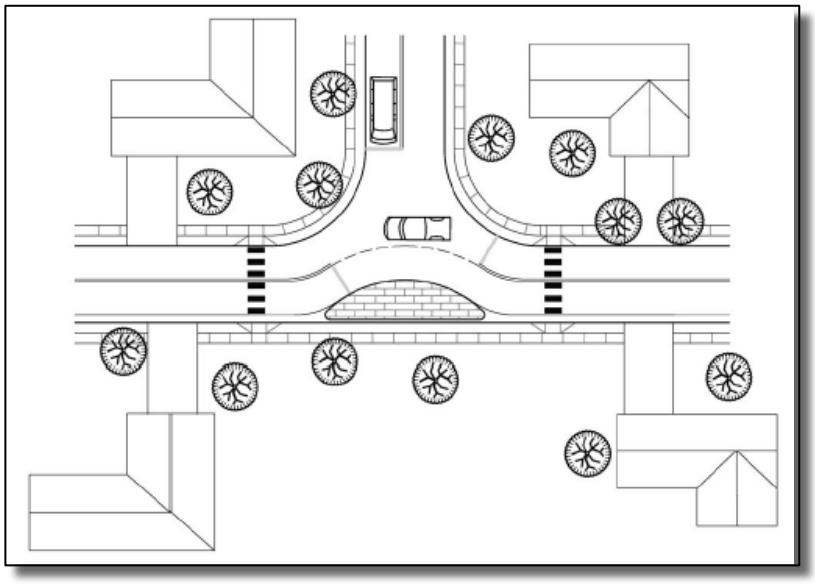
- Feasible method of reducing vehicle speeds on higher classified collector roads.
- Accommodates larger vehicles and has negligible effect on emergency response times.
- Provides visual break in the streetscape and reduces the wide open appearance of the street.
- Lane shifts discourage high speeds by forcing horizontal deflection.
- Provides landscaping opportunities.

Disadvantages:

- Loss of on-street parking spaces.
- Narrows pavement surface requiring consideration for providing space bicycles.
- Curb extensions can become expensive if drainage system adjustments are required.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow remov

Realigned Intersections

Realigned intersections create changes in the horizontal alignment at the approaches to t-intersections. Curbed islands are used to convert the straight approaches of the through street into a curving street within the intersection. Realigned intersections may provide conditions where warrants are met for additional traffic controls (i.e. all-way stop, etc.).



Advantages:

- Reduced speeds.
- Shorter crossing distances for pedestrians.
- Accommodates large vehicles and has negligible effect on emergency response times.
- Reduces straight line of sight and enhances visual breaks in the streetscape.
- Provides landscaping opportunities.

Disadvantages:

- Loss of on-street parking spaces.
- Narrows pavement surface requiring consideration for providing space bicycles.
- Curb extensions can become expensive if drainage system adjustments are required.
- May create congestion and increase delay on the major street during the peak periods.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Roundabouts

Roundabouts are becoming more accepted as an intersection design that can often address capacity and safety issues in a more effective manner than installing a traffic signal or all way stop condition. Depending on the traffic operational issue and size of the intersecting roads, roundabouts can be designed in three general sizes: full roundabouts, mini-roundabouts and neighborhood traffic circles.

Full roundabouts are primarily found on higher functional classification roads such as collectors and arterials. They ae the largest size and are designed to handle higher volumes and speeds. The full roundabout is typically sized to accommodate trucks and buses circulating around the central island and the central island is non-traversable. Full roundabouts generally do not fit within the footprint of residential collector and local roads, therefore, the City of Delaware reserves their use for the larger, higher classified roads and are not installed as a traffic calming measure.

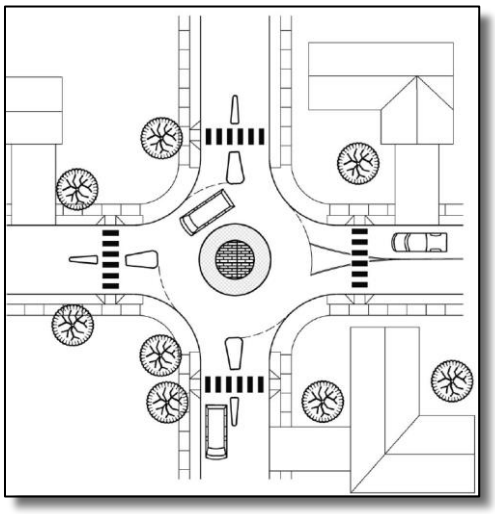
Mini-roundabouts and neighborhood traffic circles are small roundabouts with traversable central islands and are appropriate as a traffic calming measure to solve certain traffic calming issues. While they are similar in design, neighborhood traffic circles are smaller and, therefore, are slightly different in the way vehicles operate through them. The Federal Highway Administration's (FHWA) report Mini-Roundabouts defines the difference between min-rounabouts and neighborhood traffic circles as follows:

> *Mini-roundabouts are distinguished from neighborhood traffic circles primarily by their traversable islands and yield control on approaches, which allows them to function as other roundabouts do. Neighborhood traffic circles are typically built at the intersections of local streets for reasons of traffic calming and/or aesthetics. They typically are operated as two-way stop-controlled intersections and frequently do not include raised neighborhood traffic circles, left-turning vehicles must turn in front of the central island, potentially conflicting with other circulating traffic.*

Mini-roundabouts are typically intended for use on residential streets with operating speeds of 30 mph or less. Mini-roundabouts, with yield cross speeds of 20 mph or less, typically require only minor modification to existing intersections. Depending on the width of the intersection and the diameter of the circular island, large vehicles (emergency vehicles and buses) may not be able to negotiate the turn around the central island. In order to facilitate those vehicles, mini-roundabouts are typically designed to include mountable concrete aprons, and with a fully traversable raised central island, so that large vehicles may be permitted to turn left over the circular island rather than going around it.

Neighborhood traffic circles have many of the same features of a mini-roundabout, except they are installed in smaller intersections and are designed to avoid modification of an existing intersection. In neighborhood traffic circles most vehicles larger than a passenger car must travel over at least a portion of the central island to make a left turn. Therefore, due to their small size, typically neighborhood traffic circles do not raise any portion of the central island and are installed without diverter islands on the approaches.

<u>Advantages</u>:



- Improved safety: a traditional four-legged intersection has 16 potential vehicle/pedestrians conflict points and 16 potential vehicle/vehicle conflict points for a total of 32 conflict points. A mini-roundabout or a neighborhood traffic circle has only 8 potential vehicle/pedestrian conflict points and only 4 potential vehicle/vehicle conflict points for a total of only 12 potential conflict points.
- Reduced speeds.
- Little right-of-way is needed for construction of a mini-roundabout and no right-of-way is required for a neighborhood traffic circle.
- Provides traffic calming and traffic control for two streets simultaneously.
- Lower maintenance cost than traffic signals.
- May reduce cut-through traffic volumes.
- Mini-roundabouts can be implemented at modest cost.

<u>Disadvantages</u>:

- Emergency response times may be affected if designed for too low a speed.
- May require additional street lighting.
- Potential loss of on-street parking spaces on intersection approaches.
- The raised island of a mini-roundabout can force bicycles and cars closer together increasing the possibility of conflicts.
- May require curb ramps to be relocated further back along the approaches to the mini-roundabout or neighborhood traffic circle.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Speed Bumps

Speed humps are elongated mounds installed across the pavement. Individual designs my vary slightly, but typically they are approximately 3-4 inches high, parabolic in shape and between 12 and 14 feet in length. The profile of a 3 inch high speed hump is gentle enough to provide a comfortable ride when traversed at a speed of approximately 20-25 mph. At high speeds, it becomes more uncomfortable for motorists to driver over the speed humps. To reduce speeds over a longer distance, a number of speed humps can be installed. ITE's *Guidelines for the Design and Application of Speed Humps and Speed Tables* recommends a spacing of 260-feet to 500-feet for the series of speed humps to be effective.

The guidelines further recommend that "The first speed hump in a series is normally located in a position where it cannot be approached at high speed from either direction. To achieve this objective, it is typically installed within 200 feet or less of a small-radius curve or stop sign, if installed on a street with significant downgrade, at the top of a hill".

Advantages:

- Speed reduction for vehicles without increasing accident rates.
- Less need for additional enforcement.
- Possible reduction in cut-through traffic.
- Provides visual reinforcement to discourage speeding.
- Durable and long life span.

Disadvantages:

- Emergency response time may be affected. Approximate delay between 3 and 5 seconds per hump for fire trucks and up to 10 seconds for ambulance with patient.
- Degraded physical driving comfort for auto and truck users.
- Potential increased noise due to vehicle braking and accelerating and the vibration of loose items in truck beds or trailers.
- May impede bicyclists due to the changes in vertical grades.
- Requires a sufficiently long stretch of road to install a series of devices.
- May divert traffic to other streets.
- May result in some motorists speeding up between speed humps.
- Requires additional signage and pavement markings.
- Motorcycles may bypass the speed humps via drainage gutters without slowing.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Note: The City does not currently permit the use of speed bumps on collector streets or primary emergency response routes.

Speed Table/Raised Crosswalk

Speed tables or raised crosswalks are similar in nature to speed humps. They span the full width of the street like speed humps and contain a level area on top of the hump like speed cushions, often marked with a crosswalk. Typically, they are longer than both speed humps (typically 22 feet long) and have a longer flat section in the middle of the devices.

When a speed table is designated as a crosswalk through the use of striping or pavers, it is known as a raised crosswalk. While a 3-inch height is preferable, raised crosswalks can be higher than a speed hump, to ensure that they are level with the adjacent sidewalk/curb. If mid-block pedestrian crossings are an issue, the use of a raised mid-block crosswalk may be an appropriate treatment to lower vehicle travel speeds where pedestrians enter the street. It should be noted that mid-block pedestrian crossings should only be considered per the guidelines established in the City's "Crosswalk Installation & Enhancement Guide".

Advantages:

- Speed reduction for vehicles without increasing accident rates.
- Little need for additional enforcement.
- Possible reduction in cut-through traffic.
- Provides visual reinforcement to discourage speeding.
- Raised crosswalks improve pedestrian safety.
- Relatively low implementation cost.

Disadvantages:

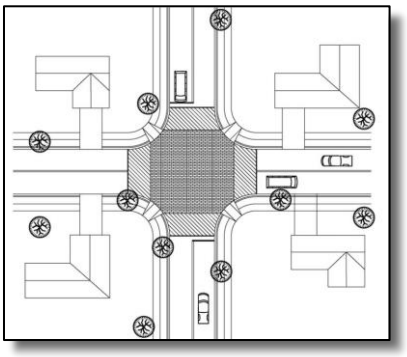
- Emergency response time may be affected. Approximate delay between 3 and 5 seconds per hump for fire trucks and up to 10 seconds for ambulance with patient.
- Degraded physical driving comfort for auto and truck users.
- Potential increased noise due to vehicle braking and accelerating and the vibration.
- May impede bicyclists due to vertical grades.
- May divert traffic to other streets.
- Requires additional signage and pavement markings.
- Motorcycles may bypass the speed humps via drainage gutters without slowing.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Note: The City does not currently permit the use of speed tables on collector streets or primary emergency response routes.

Raised Intersections

A raised intersection is similar to a raised crosswalk, except that the raised section covers an entire intersection, including crosswalks. Approach ramps are provided on all street approaches, resulting in calming of traffic on both intersecting streets. Raised intersections are especially applicable in dense urban areas, where installation of speed humps would result in a larger loss of on-street parking than that of the installation of a raised intersection. A typical installation would be at a signal controlled or all-way stop controlled intersection with large volumes of pedestrians. Raised intersections reinforce the stop condition, or in the case of signalized intersections, the need to slow down and watch for pedestrians.

<u>Advantages</u>:



- Supports speed and accident reduction.
- Reduced need for enforcement.
- Possible reduction in cut-through traffic.
- Visual reinforcement to discourage speeding.
- Minimizes impact to on street parking.
- Raised crosswalks improve pedestrian safety.

<u>Disadvantages</u>:

- Emergency response time may be affected. Approximate delay between 3 and 5 seconds per hump for fire trucks and up to 10 seconds for ambulance with patient.
- May divert traffic to nearby streets.
- Generally requires a major, costly redesign of storm drainage systems.
- Increased difficulty for turning large vehicles.
- Degraded physical driving comfort.
- Requires additional signage and pavement markings.
- Can require major utility relocations.
- High design and construction costs.
- Potential increased noise due to vehicle braking and accelerating and the vibration of loose items in truck beds or trailers.
- Obstruction to distracted motorist.
- Impede snow removal.

Note: The City does not currently permit the use of raised islands speed bumps on collector streets or primary emergency response routes.

Appendix B – Intrusive Traffic Calming Measures

Partial Closures

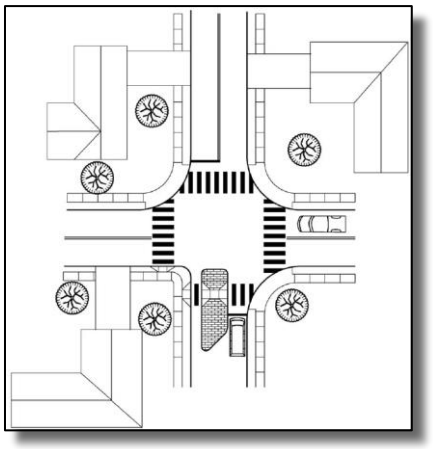
Partial closures are barriers that block travel in one direction for a short distance on otherwise two-way streets. They are also sometimes call partial closures or one-way closures. When two partial closures are placed across from one another at an intersection, the result is a semi-diverter that blocks through movement on a cross street. In some cases, a path can be built behind the measure to accommodate bicycle and pedestrian traffic and separate them from vehicular traffic.

<u>Advantages</u>:

- Reduces volumes and cut-through traffic.
- More effective than signing.
- Interrupts straight street sight lines for motorists and narrows the pavement width through the closure island, which may reduce speed in the open direction.
- Reduces crossing distances for pedestrians.
- Provides landscaping opportunity.

<u>Disadvantages</u>:

- Restricts residents' access by increasing their travel path and time for some movements.
- Emergency vehicles may have increased response times.
- Traffic is diverted to other streets and potentially to other neighborhoods.
- Potential for wrong-way travel.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

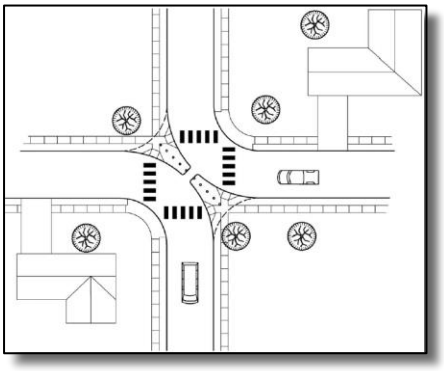


Diagonal Diverters

Diagonal diverters are barriers placed diagonally across an intersection blocking the through movement. They are also called full diverters and diagonal road closures. Diagonal diverters can have an at-grade pass through that allows bicycles and pedestrians to navigate along the original street alignment. The islands should be signed or landscaped with vertical elements to draw motorists' attention, so that they see the measure on their approach.

Advantages:

- Reduces volumes and cut-through traffic.
- More effective than signing.
- Interrupts sight lines for motorists with potential for a reduction in speed approaching and through the diversion curve.
- Provides a landscaping opportunity.



Disadvantages:

- May increase travel distance and time for residents of the street for certain trip patterns.
- Emergency vehicles may have increased response times.
- Traffic is diverted to other streets and potentially to other neighborhoods.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Intersection Barriers

Intersection barriers are raised islands located along the centerline of a street and continuing through an intersection to block the through movement at a cross street. They also prevent cars on the cross street from turning left at the intersection. Intersection barriers are also referred to as intersection diverters or, occasionally, as island diverters. Intersection barriers differ from center islands in that they are intended to force or prevent a turning movement rather than narrow the road like a center island.

Advantages:

- Reduces volumes and cut-through traffic.
- More effective than signing.
- Interrupts straight street sight lines for motorists.
- Eliminates left turn and angle crashes at intersections.

Disadvantages:

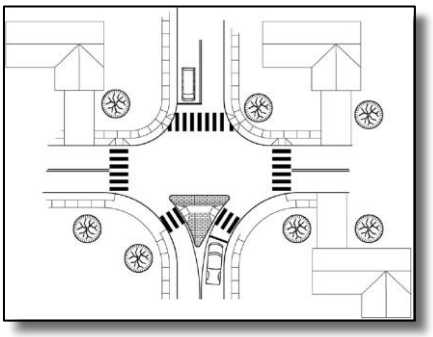
- May increase travel distance and time for residents of the street.
- Emergency vehicles may have increased response times.
- Traffic is diverted to other streets and potentially to other neighborhoods.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

Forced Turn Islands/Restrictions

Forced turn islands are raised islands on approaches to an intersection that force a vehicle to turn right at an intersection and block through movements. They are sometimes called forced turn channelization, pork chops or right turn islands.

Advantages:

- Reduces volumes and cut-through traffic.
- More effective than signing.
- Interrupts sight lines for motorists.



Disadvantages:

- May increase travel distance and time for residents of the street.
- Emergency vehicles may have increased response times.
- Traffic is diverted to other streets and potentially to other neighborhoods.
- Obstruction to distracted motorist.
- Impact roadway drainage.
- Impede snow removal.

One-Way Streets

Making a street one-way involves limiting the direction of travel on a street to one direction only through regulation and signing. In many communities, an individual street carries a much larger traffic burden than other streets within the same community. Sometimes a larger traffic volumes on these streets is due to the design of the street layout within the subdivision, or in some cases, it is the result of a particular route being used by traffic attempting to avoid congestion on the surrounding highway system. When these situations occur, often the simplest and easiest solution is to distribute the additional traffic burden to other streets. This can be achieved in some cases by designating the high volume street as a one-way street and then designating a parallel street one-way in the opposite direction.

One-way streets may be used on any classification of street (local, collector or arterial) where traffic engineering studies indicate that operational improvements can be achieved by the implementation of a one-way street system. For use on local roads, as a traffic calming solution, the use of a one-way system is appropriate when the traffic volume on the single street exceeds the highest traffic volumes on any other street within the subdivision by 100% or more and the street is not intentionally designed to serve as the collector road for the subdivision. It is also important for the traffic volumes on the high volume street to be generally balanced in both directions and the geometric design features on the high volume street and the parallel street to be approximately the same. When such conditions exist, community streets may be a candidate for a one-way street system.

It should be noted that some streets within subdivisions are intended to be higher volume collector streets for the community and are thus wider than the standard subdivision street. Generally, these streets also have a limited number of properties with direct driveway access. In subdivisions with this type of higher volume collector street, using a one-way street system to divert traffic to a parallel street, which is narrower and provides driveway access to many more properties, would not be appropriate.

Advantages:

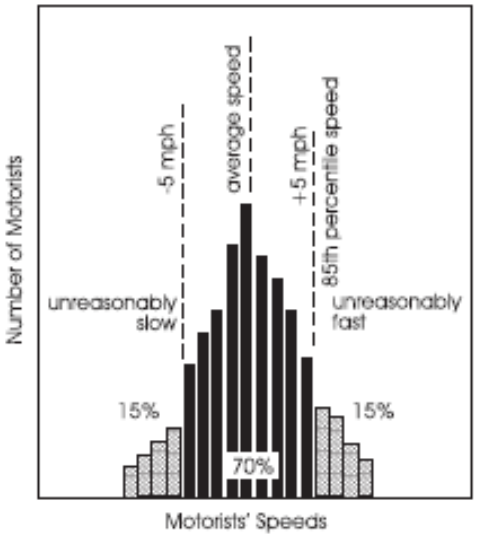
- One-way streets can reduce the traffic volumes on the higher volume street by 40% to 60%
- One-way streets may discourage cut-through traffic from using subdivision streets to avoid congestion on the adjacent roadway network.
- If supported by the community, a one-way street system is fairly easy to implement.
- A one-way street system is a low cost solution to traffic problems arising from cut-through traffic and high traffic volumes.

Disadvantages:

- A one-way street system will shift some volume on traffic (to be estimated by an engineering study) to a parallel street, increasing, in some cases significantly, the traffic volumes on that second street.
- Residents on the parallel street may not be willing to share the reduction of the traffic burden on the higher volume street.
- Traffic speeds may increase as traffic volumes decrease on the higher volumes street and motorists no longer need to contend with opposing traffic.
- Increased circulation and travel time will be required for residents with homes along the one-way streets to access their properties.

Appendix C – 85th Percentile Speed

Determination of 85th Percentile Speeds: By definition, the 85% speed is the speed at which 85 percent of all motorists are travelling at or below, or the speed that separates the bottom 85% of vehicle speeds from the top 15%. The 85th percentile speed statistic is of particular interest in planning because the 85th percentile speed is often located at the upper end of a range of speeds that includes the majority of motorists who select "safe and proper speeds".

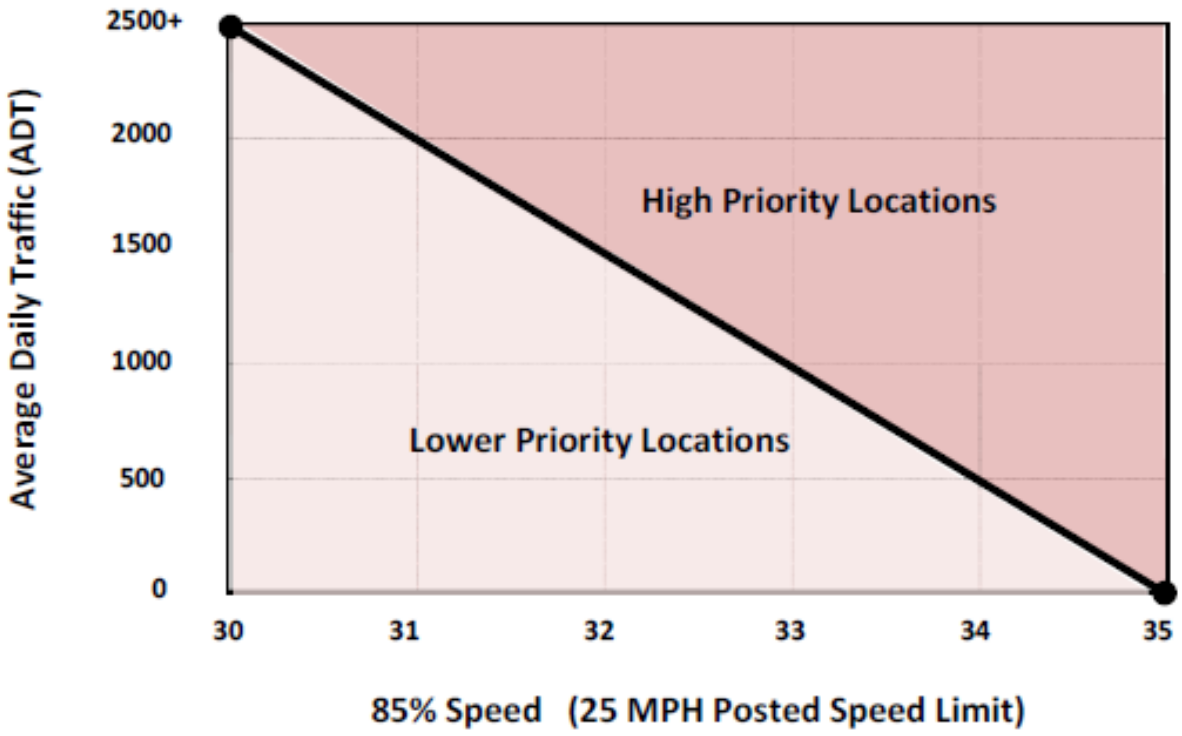


Typical distribution of driver speed

The most widely accepted method by state and local agencies is to set the speed limit at the nearest 5 mph increment to the 85th percentile speed. For instance, if the 85th percentile speed were measured at 27 mph, then the speed limit on the road would typically be set at 25 mph.

Studies have shown that crash rates are lowest around the 85th percentile speed. Drivers traveling significantly faster or slower than this speed are at greater risk of being in an accident. It is not high speeds alone that relate to crash risk, it is the variation of speed within the traffic stream. Other considerations such as accidents and real dangers not perceivable by drivers may suggest a need for a lower speed limit. Since speed limits are generally set using the 85th percentile speed, it is expected that 15 percent of the vehicles will exceed the speed limit on a regular basis.

Appendix D – Criteria for Installation of Dynamic Speed Feedback Signs



- 85th Percentile Speed shall be greater than 30 MPH on a street with posted speed limit of 25 MPH.
- Limited to one (1) set of DSFS units per street and locations to be determined by City.
- Street within a School Zone that contains school flashers and where the 85th percentile speed is greater than 5 mph over the school zone posted speed limit during restricted hours. The signs would only be permitted to be active while the school zone flashers are in operation.
- Streets where crash data suggests that frequent and reoccurring accidents can be clearly linked to excessive vehicle speed may be considered.
- City may periodically re-evaluate the vehicle speeds on streets with DSFS to determine if the presence of the units remains effective; and may relocate the unit to an alternate location to improve efficacy.
- All recommended installations are subject to the availability of funding.

Appendix E – Multi-Way Stop Sign Policy

Multi-way stop signs are intersection controls established for certain operating conditions. As with speed limits, drivers must recognize the need for the controls or they will eventually begin to ignore the control that they deem unnecessary. In the case of stop signs, that would mean disregarding the sign and potentially posing a risk to another motorist or pedestrian. Studies on the use of stop signs as a standalone, non-construction, traffic calming solution for speed control, indicate that drivers will actually exceed speed limits between signs to make up for lost time if they feel that the stop signs serve no other purpose than to slow traffic down.

Where Multi-way Stop Control can be Useful

The OMUTCD states "Multi-way stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multi-way stops includes pedestrians, bicyclists and all road users expecting other road users to stop. Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal."

Criteria for Warranted Multi-Way Stop Control

Section 2B.07 of the OMUTCD gives criteria for a multiway stop sign installation. The following is from the OMUTCD:

The decision to install multiway stop control should be based on an engineering study.

The following criteria should be considered in the engineering study for a multiway STOP sign installation:

a. Where traffic control signals are justified, the multiway stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.
b. Five or more reported crashes in a 12-month period that are susceptible to correction by a multiway stop installation. Such crashes include right-turn and left-turn collisions as well as right-angle collisions.
c. Minimum volumes:
    1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day, and
    2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but
    3. If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the above values.

d. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.

Option:

Other criteria that may be considered in an engineering study include:

a. The need to control left-turn conflicts;
b. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;
c. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to safely negotiate the intersection unless conflicting cross traffic is also required to stop; and
d. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multiway stop control would improve traffic operational characteristics of the intersection.

Location Evaluation Procedures and Considerations

On occasion, local communities have sought to resolve their traffic speed and traffic diversion issues through the use of multi-way stop signs. Numerous studies conducted by transportation agencies and universities have consistently shown the use of this method as standalone, non-constructive solution for traffic calming are counterproductive. Based on past research and the resulting national and state policies, the City of Delaware will not create safety hazards along City maintained roads by installing unwarranted multi-way stop signs as a standalone traffic calming solution unless the following policy requirements are met per Resolution No. 03-79:

a. Request for additional stop sign be presented to the City in writing from the neighborhood group or appointed representative.
b. A signed petition be presented demonstrating neighborhood support for additional stop signs by at least 75% of property owner with property fronting the affected streets for a distance of at least five-hundred feet in all directions of the intersection.
c. The intersection being considered is located on streets defined as residential, low-volume local streets with a traffic county of less than 2000 vehicles per day.
d. A current speed study indicates the recorded 85^{th} percentile speed be at least 5 mph in excess of the posted speed limit.
e. A thorough evaluation of the intersection by the Public Works Director/City Engineer, Fire Chief, Police Chief, and City Attorney find no specific reason to prohibit the installation of the additional stop sign.
f. That the City retains the ability to remove the additional stop sign if any unforeseen negative impacts to traffic or public safety result from the installation.
g. Favorable recommendation of the requested stop sign by the Parking and Safety Committee and approval by City Council, or by approval of City Council by a vote of at least five members in favor of the requested installation if not being favorably recommended by the Parking and Safety Committee.

Advantages:

- Provide orderly traffic flow.
- Reduce the severity and frequency of right angle and left turn crashes.
- Relatively inexpensive and quick to implement.

Disadvantages:

- Potential for increased speeds between controlled intersections.
- Some other types of crashes could increase.
- Increases delay to all legs of the intersection.
- Works best with only single lane approaches.
- Total intersection capacity is limited.
- Can interrupt the progressive flow of traffic on a route causing increased delay and stopping.