

TECHBRIEF



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Traffic Calming on Main Roads Through Rural Communities

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Introduction

Speed management is a significant challenge for most communities in the United States. This is particularly true for small, rural communities where the main roadway through the town serves a dual role. Outside the town, the roadway provides high-speed travel over long distances; within the built-up area, however, the same roadway accommodates local access, pedestrians of all ages, on-street parking, bicycles, and the many other features unique to the character of a community. This convergence of roadway purposes presents both an enforcement challenge for the community and a potential safety problem for the public.

Addressing the issue through law enforcement alone often leads to temporary compliance at a significant cost. A more permanent way to reinforce the need to reduce speed is to change the look and feel of the road by installing traffic calming treatments that communicate to drivers that the function of the roadway is changing. Traffic calming has been evaluated and used extensively within low-speed urban areas in the United States but less so in rural areas where driver expectations and traffic characteristics are different.

Traffic calming is more common in rural communities in Europe where multiple measures such as colored pavement, physical lane narrowing, signing, and landscaping are often combined.^(1,2) A gateway treatment intended to evoke lower speed on the approach and entrance to the community is usually followed by a series of other measures repeated throughout the community to encourage drivers to maintain appropriate speeds. Speed reductions up to 15 mi/h from rural traffic calming have been

reported in France, Denmark, and the UK, although speed reductions of 5 mi/h were more typical.^(1,3) Total accidents were reduced by 50 percent and injury accidents by 25 percent or more.^(3,4)

This TechBrief summarizes an evaluation of the effects on speed of low-cost, traffic-calming treatments on main rural highways passing through small, rural communities in Iowa. The full report, *Appropriate Traffic Calming Techniques for Small Iowa Communities* (TR-523), is available on Iowa State University's Web site at: <http://www.ctre.iastate.edu/research/detail.cfm?projectId=-226410767>.⁽⁵⁾

Study Methodology

Site Selection

Thirty rural communities (with populations less than 5,000) were identified as potential pilot-study locations through solicitation in a rural community newsletter. Site visits were conducted for each community; 18 met the initial selection criteria, which included the following:

- Through, paved, major county or state highway.
- No traffic calming currently in place or planned.
- No construction, reconstruction, or significant maintenance activities planned along the route during the study period.
- No access control.
- No adverse geometry such as sharp horizontal curves or steep vertical curves where treatments would be placed.

Initial speed studies were conducted in the 18 communities, and 5 were selected as pilot-study locations. These five locations were found to have the most significant speeding problems, as determined by the difference between the posted speed and prevailing travel speed.

Treatment Selection

An extensive list of both traditional traffic-

calming treatments used in the urban areas of the United States and treatments used specifically for major roads in small communities (identified from European and other literature) was compiled. The appropriateness of each treatment for use in built-up areas along main rural roads was determined based on the following criteria:

- Low cost.
- Ability to accommodate farm vehicles and large trucks.
- Compatibility with the rural setting and driver expectations.

Treatments were selected for each study location in cooperation with local agencies.

A request for experimentation was submitted and approved by the Federal Highway Administration (FHWA) for three of the treatments that did not meet current provisions of the *Manual on Uniform Traffic Control Devices*.⁽⁶⁾

Seven different low-cost, traffic-calming treatments were implemented and evaluated in the five communities as shown in table 1. In some communities, a single traffic calming measure was installed, and in others, a combination of measures was implemented and evaluated. Speed limits ranged from 55 mi/h to 60 mi/h outside the community and from 25 mi/h to 35 mi/h inside the community where the treatments were applied.

Unless otherwise noted, treatments were placed from July through August 2006. Any treatment that included pavement markings was repainted in May 2007, just before the 12-month "after" data-collection period.

Data Collection

Speed and volume data were collected by a roadside traffic recorder using pneumatic road tubes placed across the road. Data were collected immediately downstream of each treatment or in the case of road narrowing near the midpoint of the section. For Roland and Union where combinations of treatments were applied, data were also collected 0.5 mi upstream of the first

Table 1. Summary of treatments by Iowa community.

City (population)	Treatment	Roadway	AADT (veh/day)	Cross section (all are two-lane)
Union (427)	Transverse pavement markings ¹ with speed feedback sign	D-65 (west edge of City)	830	Asphalt (22.4 ft), unpaved shoulders
	Transverse pavement markings ¹ with speed feedback sign	S-62/SH 215 (from intersection with D-65 to north city limit)	1,680	Concrete (40.0 ft), curb and gutter
	Lane narrowing using painted center island and edge line markings			
	Transverse pavement markings ¹	SH 215 (near south city limit)	1,000	Asphalt (22.4 ft), unpaved shoulders
Roland (1,324)	Converging chevrons ¹ with "25 MPH" pavement legend	E-18 (near east and west city limits)	2,300	Asphalt (22.6 ft), unpaved shoulders
	Lane narrowing using shoulder widening and "25 MPH" pavement legend	E-18 (from intersection with R-77 to east city limit)	2,300	Concrete (36.0 ft), curb and gutter
	"25 MPH" pavement legend	E-18 (from intersection with R-77 to west city limit)	2,300	Asphalt (22.6 ft), unpaved shoulders
Gilbert (987)	Speed table	E-23 (center of community)	1,480	Asphalt (22.0 ft), shoulders
Slater (1,306)	Lane narrowing with center island using tubular markers channelizing markers	R-38 (from intersection with SH 210 to south city limit)	2,060	Concrete (25.8 ft), curb and gutter
	Speed feedback sign	R-38 (near north city limit)	2,870	Asphalt (22.6 ft), unpaved shoulders
	"SLOW" pavement legend	SH 210 (west from intersection with R-38 to west city limit)	2,940	Asphalt (22.5 ft), unpaved shoulders
Dexter (689)	"35 MPH" pavement legend with red background ¹	F-65 (near east and west city limits as well as at curve before west city limit)	1,000	Asphalt (25.4 ft), unpaved shoulders

¹ A request for experimentation was submitted to and approved by FHWA for this treatment.

treatment in order to determine whether speed changes observed were due to the treatments or to normal variation in speeds.

Results in this TechBrief are presented only for vehicles in the direction of travel that actually passed through the treatment. An in-depth discussion on data collected at other locations is presented in the full report.

After final locations were selected, a formal "before" speed study was conducted to establish baseline speeds and volumes. Speeds of all vehicles were collected continuously for at least 48 hours during each deployment. Data collection was planned at 1-, 3-, 6-, 9- and 12-month intervals after installation of the traffic-calming treatments. In several cases, data were not collected for a particular "after" period, mainly due to adverse winter conditions.

Most of the communities do not have any police officers and have no regular traffic enforcement, instead relying mostly on county sheriffs who drive through the community occasionally. Each community was asked to not change or request additional enforcement during the study period and to report any unusual speed enforcement or any other unusual activities. When additional enforcement or any unusual situation coincided with data collection, the data were discarded and recollected the following week. For instance, one community decorated the area around the roadway for Flag Day, and in one community roadway maintenance occurred during a data-collection period. In both cases, data were discarded and recollected. Data were only collected during nonholiday weekdays.

Measure of Effectiveness

Vehicular speed was the primary measure used to evaluate the effectiveness of each treatment. This report presents changes observed in the 85th percentile speed of all vehicles. The 85th percentile speed is the speed at or below which 85 percent of the vehicles are traveling. Each data set had at least 630 vehicle speed samples. In almost all cases, differences were statistically significant at the 95-percent confidence level.

The effects on mean speed and the percent of vehicles exceeding the speed limit by various amounts, along with statistical significance, are presented in the full report but not within this TechBrief. In most cases, only minor reductions in mean speed resulted. The changes in the percentage of vehicles exceeding the speed limit by various amount correlated with the changes in 85th percentile speeds. Overall, the treatments appeared to have a greater effect on drivers traveling at higher speeds.

Results

The effectiveness of each traffic-calming treatment is discussed in the following sections. A brief description and photograph of each treatment is provided, along with a summary of the effects on speed.

Transverse Markings With and Without Speed Feedback Signs

Description

The transverse markings consisted of a series of parallel bars on the inside edges of the travel lane. The spacing between bars decreased approaching the community. The series of markings are intended to create the perception that the vehicle's speed is increasing to trigger driver awareness of the need to slow down. The transverse markings were 12 inches wide (parallel to roadway edge) by 18 inches long (figure 1). The markings were installed at the north, south, and west entrances to the city of Union. Markings were placed in advance of and terminated at the speed limit sign which established the speed within the community. The length of each series and distance between bars varied based upon each speed transition and location within the series.

Speed feedback signs (figure 2) were also installed within Union. These signs consisted of a static "Your Speed" sign and an electronic display of the approaching vehicle speed measured by radar. These signs were installed for inbound motorists at the north and west city entrances and were placed immediately downstream of the transverse markings as shown in figure 3. Due to purchasing and installation problems,

Figure 1. Experimental transverse markings at entrance to Union.



Figure 2. Speed feedback sign in Union.



the signs did not become operational until just before the 9-month data collection period.

Results

Table 2 shows the change in 85th percentile

speed by location and observation period. For the south entrance (U5) where transverse markings were the only treatment installed, there was little change in prevailing speed. Similar results were found for southbound traffic entering the north side of town (U2) and eastbound traffic entering from the west (U1) prior to the installation of speed feedback signs.

After the feedback signs were installed, speeds dropped an additional 3 mi/h to 6 mi/h at the north and west entrances during the 9- and 12-month analysis periods. Since the signs were only in place for a short period of time, it is not known if the observed speed reductions persisted over the longer term.

Lane Narrowing Using Painted Center Island and Edgeline Markings

Description

Median and shoulder pavement markings shown in figure 4 were used to reduce lane

Figure 3. Treatment and data collection locations in Union.

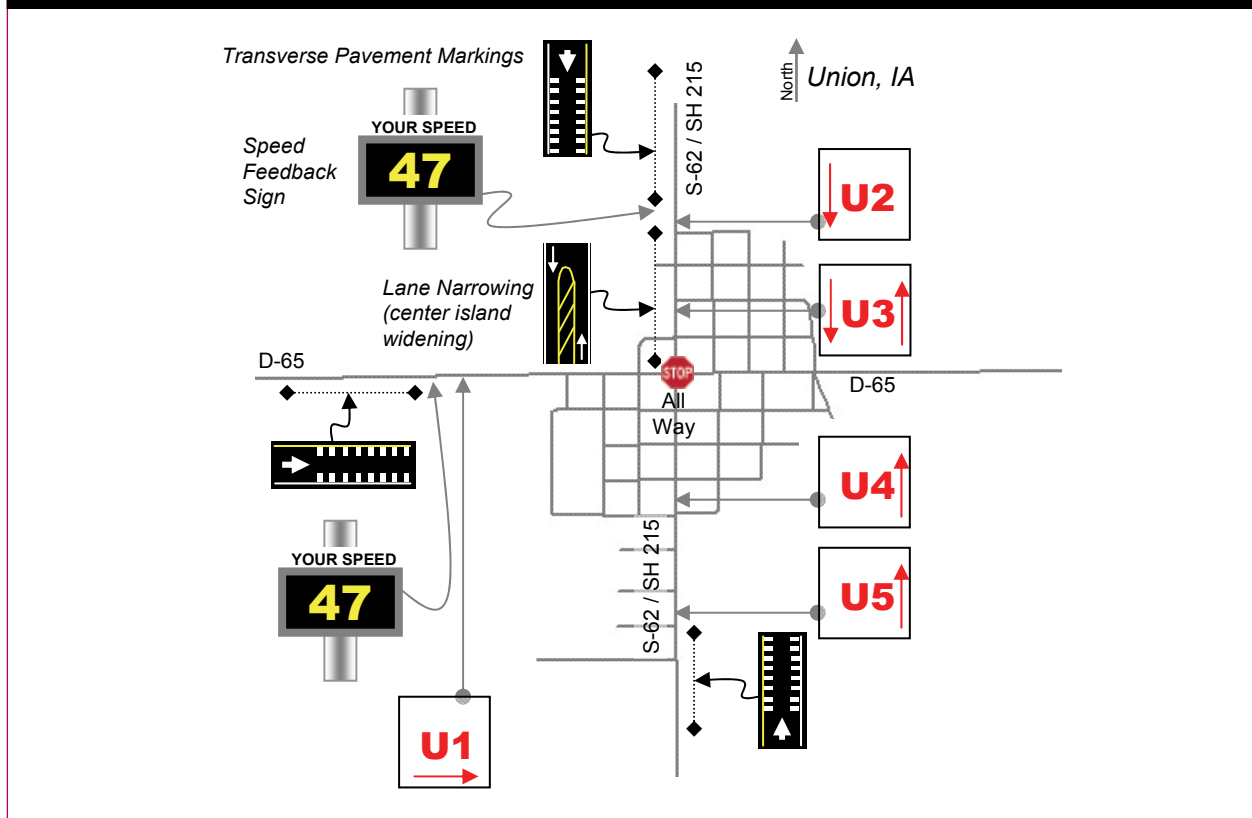


Table 2. Speeds before and after transverse pavement markings with and without speed feedback sign (SFS) at the entrances to Union.

Location and analysis period	Sample size (veh)	Posted speed (mi/h)	85th percentile (mi/h)	Change in 85th percentile speed from "before" period (mi/h)
U2 SB Before	1,870	30	41	
1-month	1,785	30	41	0
3-month	1,794	30	40	-1
9-month (+SFS)	1,737	30	35	-6
12-month (+SFS)	1,693	30	34	-7
U5 NB Before	886	25	46	
1-month	783	25	45	-1
3-month	943	25	45	-1
9-month	908	25	44	-2
12-month	871	25	45	-1
U1 EB Before	893	25	53	
1-month	659	25	51	-2
3-month	684	25	52	-1
9-month (+SFS)	749	25	49	-4
12-month (+SFS)	666	25	50	-3

widths for a section of S-62/SH 215 within Union. The existing two-lane roadway was 40 ft wide from curb to curb with parallel parking allowed on one side. A 10-ft-wide painted center island was used to reduce the existing lane widths from roughly 16 to 11 ft in each direction. A solid 6-inch channelizing line was painted to separate the

travel lane from an 8 ft parking lane. Drivers were expected to slow down due to feeling constrained by narrower lanes.

Results

Table 3 summarizes speed data collected mid-way through the narrowed section (U3), as shown in figure 3. Results are presented for both

Figure 4. Painted center island and edgeline used to narrow lane.



directions of traffic, as both were exposed to the lane narrowing. No other traffic-calming measures were in place at this location.

No consistent changes in 85th percentile speed were observed for either direction. In some cases, vehicle speeds decreased; in other cases, vehicle speeds increased. The variability in speeds suggests that the treatment was not effective and that other factors may have influenced speeds. Speed data collected at a point upstream of the north section where vehicles were not influenced by any of the traffic-calming treatments exhibited an overall upward speed trend. This suggests the observed increases in speed were due in part to general time trends.

Even though the roadway was reduced from 16 ft to 11 ft lanes in each direction, the lanes may have still been too wide to affect driver behavior. A more drastic reduction in lane width (e.g., 9 ft lanes) or a physical barrier (e.g., raised curb) may be necessary to produce the desired effect since there are no consequences for driving over the pavement markings.

Converging Chevrons with “25 MPH” Pavement Marking Legend

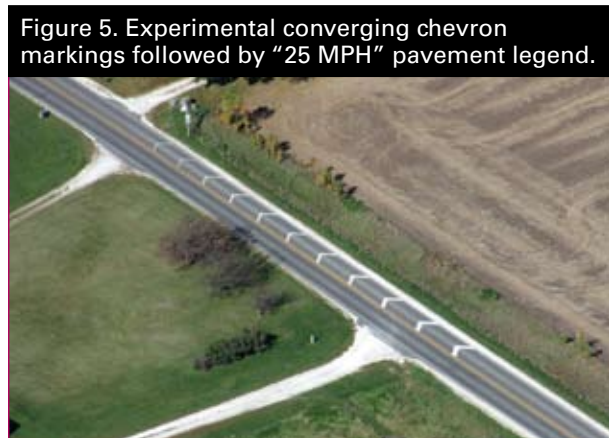
Description

A series of converging chevron markings shown in figure 5 were installed on County Road E-18 on both entrances to Roland. The markings

began 221 ft in advance of and terminated at the speed limit sign which established the speed within the community. The distance between chevrons gradually decreased from 25 ft to 18 ft, and the width of the markings decreased from 36 inches to 6 inches in the direction of travel, giving the perception of increasing speed. The pavement marking legend “25 MPH” was installed at the end of each chevron series to reinforce the posted speed.

Results

As shown in table 4, the 85th percentile speed decreased up to 4 mi/h, while 1 mi/h was more typical for the various analysis periods. Although the chevron markings were somewhat effective in reducing vehicle speeds, prevailing speeds were still 7 mi/h to 9 mi/h above the posted speed limit 12 months after implementation.



Location and analysis period	Sample size (veh)	Posted speed (mi/h)	85th percentile (mi/h)	Change in 85th percentile speed from “before” period (mi/h)	
U3 NB Before	1,870	30	41		
1-month	1,785	30	41		+1
3-month	1,794	30	40	-3	
9-month	1,737	30	35		+1
12-month	1,693	30	34		0
U3 SB Before	893	25	53		
1-month	659	25	51		0
3-month	684	25	52		+4
9-month	749	25	49	-1	
12-month	666	25	50		+1

Table 4. Speeds before and after installing converging chevron markings and “25 MPH” pavement legend.

Location	Analysis period	Sample size (veh)	Posted speed (mi/h)	85th percentile (mi/h)	Change in 85th percentile speed from “before” period (mi/h)
West entrance	Before	4,216	25	35	
	1-month	4,135	25	34	-1
	3-month	3,812	25	32	-3
	9-month	3,958	25	35	0
	12-month	3,945	25	34	-1
East entrance	Before	2,397	25	36	
	1-month	2,426	25	35	-1
	3-month	3,413	25	35	-1
	9-month	2,196	25	34	-2
	12-month	1,778	25	32	-4

Lane Narrowing Using Shoulder Widening with “25 MPH” Legend

Description

A wide edgeline and cross-hatch markings, as illustrated in figure 6, were used to create a shoulder on both sides of the roadway and reduce lane widths for a section of E-18 within Roland. The existing two-lane roadway was 36 ft wide from curb to curb. The painted shoulders reduced the lane width to 10.5 ft in both directions. The narrow lane was intended to make drivers travel

slower due to feeling constrained. White pavement marking legends indicating “25 MPH” were placed at regularly spaced intervals within the narrowed section to remind drivers of the speed limit.

Results

Data were collected at the midpoint of the narrowed section. As shown in table 5, the lane narrowing and speed limit markings were not effective in reducing vehicle speeds. There were no consistent changes in the 85th



percentile speed by analysis period or direction of travel with both increases and decreases recorded. In most analysis periods, there was no change in traffic speed compared to speeds measured before the lane narrowing. No data were collected 6 months after the change due to adverse winter weather.

Even though the eastern section of E-18 was reduced from a 36 ft cross-section to 10 ft lanes, the lanes may have still been too wide to affect driver behavior. A more drastic reduction in lane width (e.g., 9 ft lanes) or a physical barrier (e.g., raised curb) may be necessary to produce the desired effect since there are no consequences for driving on pavement markings.

Speed Table

Description

A speed table (figures 7 and 8) was installed on County Road E-23 within the center of Gilbert. The two-lane asphalt roadway has grass shoulders, no curb, and a 25 mi/h posted speed limit. The speed table was 3 inches high and 22 ft in the direction of travel, including 6 ft ramps at both ends. The asphalt speed table was designed to be traversed at 30 mi/h to accommodate heavy trucks and farm vehicles.

Results

The speed table was very effective in reducing speeds. As shown in table 6, 85th percentile

speeds were reduced at the hump location by 4 mi/h to 5 mi/h over all “after” periods to within a few miles per hour of the 25 mi/h posted speed limit. Approximately 200 ft downstream of the speed table, speeds were still 4 mi/h

Figure 7. Aerial view of speed table in Gilbert.



Figure 8. Driver view of speed table in Gilbert.



Table 5. Speeds before and after lane narrowing using shoulder markings combined with “25 MPH” pavement legend.

Direction of traffic	Analysis period	Sample size (veh)	Posted speed (mi/h)	85th percentile (mi/h)	Change in 85th percentile speed from “before” period (mi/h)	
Outbound	Before	2,884	25	34		
	1-month	2,708	25	34		0
	3-month	2,324	25	34		0
	9-month	2,489	25	33	-1	
	12-month	2,727	25	34		0
Inbound	Before	2,864	25	31		
	1-month	2,681	25	29	-2	
	3-month	2,361	25	31		0
	9-month	2,562	25	31		0
	12-month	2,835	25	32		+1

Table 6. Speeds before and after installing speed table.

Location	Analysis period	Sample size (veh)	Posted speed (mi/h)	85th percentile (mi/h)	Change in 85th percentile speed from "before" period (mi/h)	
200 ft downstream	Before	2,257	25	34		
	1-month	2,199	25	30	-4	
	3-month	2,763	25	30	-4	
	9-month	3,885	25	30	-4	
	12-month	3,886	25	30	-4	
15 ft downstream	Before	3,685	25	32		
	1-month	3,355	25	27	-5	
	3-month	3,413	25	28	-4	
	9-month	3,982	25	27	-5	
	12-month	3,279	25	27	-5	

lower than baseline speeds and within 5 mi/h of the posted speed.

Lane Narrowing with Center Island Using Tubular Markers

Description

Tubular markers shown in figure 9 were used to create two center islands along the southern section of R-39 in Slater. At this location, the roadway is 26 ft wide from curb to curb. Center islands were formed by placing two rows of 36-inch-tall yellow tubular channelizing markers to reduce lane widths to 11 ft in each direction. The tubular markers were spaced 4 ft apart in the taper and 8 ft elsewhere. A 25 mi/h speed limit sign was placed on a mountable sign support at both ends of each island. The first island was located at the southern entrance to Slater, just after the first posted 25 mi/h speed limit sign. The second island was located approximately one block north of the first island.

Although the treatment was designed to accommodate agricultural equipment and maintenance vehicles such as snowplows, the markers were damaged during winter operations and were removed for 6 weeks. The markers were reinstalled as soon as no more snow events were expected.

Results

Table 7 shows the speed data collected midway

between the two center islands. The data indicate the islands using tubular channelizing markers reduced vehicle speeds; 85th percentile speeds decreased by up to 3 mi/h when the tubular markers were in place and increased up to 4 mi/h when the tubular markers were removed. Similar speed changes were also observed for inbound traffic just downstream of the second island. Even with the speed drop, 85th percentile speeds were still 10 mi/h to 15 mi/h above the posted speed limit.

Speed Feedback Signs

Description

A speed feedback sign pictured in figure 10 was

Figure 9. Tubular channelizing markers used for center island to narrow lanes.



Table 7. Speeds before and after lane narrowing using center islands with tubular markers for traffic entering (NB) and leaving (SB) Slater.

Dir	Analysis period	Sample size (veh)	Posted speed (mi/h)	85th percentile (mi/h)	Change in 85th percentile speed from "before" period (mi/h)	
NB	Before	2,669	25	40		
	1-month	2,453	25	38	-2	
	6-month	2,234	25	39	-1	
	9-month/markers removed	1,808	25	44		+4
	9-month/markers replaced	1,549	25	37	-3	
	12-month	2,207	25	40		0
SB	Before	2,806	25	45		
	1-month	2,657	25	42	-3	
	6-month	2,387	25	42	-3	
	9-month/markers removed	1,665	25	45		0
	9-month/markers replaced	1,402	25	42	-3	
	12-month	2,172	25	43	-2	

installed on County Road R-38 for inbound traffic at the north entrance to Slater. This section of R-38 is adjacent to an elementary school, has a 25 mi/h posted speed limit, and has a rural cross-section with steep shoulders and open ditch drainage.

The sign display varied based upon vehicle speeds measured via radar. The sign remained blank (black) when no traffic was present or when the approaching vehicle speed was less than or equal to 25 mi/h (or greater than 75 mi/h). Between 26 mi/h and 29 mi/h, the sign displayed the text "Your Speed" along with the measure vehicle speed, as shown in figure 10. For vehicles approaching between 30 mi/h and 75 mi/h, the message "Slow Down 25" was displayed. No other traffic-calming treatments were in place at this location.

Due to sign purchasing and installation problems, the speed feedback sign was not installed at the same time as the other traffic-calming treatments in the study. Once the sign was in place, it experienced numerous electrical failures, and the analysis was limited to only one "after" period.

Results

The speed feedback sign, when operational, was very effective. Speeds measured just down-

stream of the sign decreased from 37 mi/h to 30 mi/h 3 months after the sign was operational. It is not known if the 7 mi/h speed reduction can be sustained over time.

"SLOW" Pavement Legend

Description

Pavement marking legends indicating "SLOW" (as shown in figure 11) were used at two locations along the western section of SH 210 in Slater. The first pavement legend was placed just inside the

Figure 10. Speed feedback sign in Slater.



Figure 11. "SLOW" pavement legend in Slater.



western community entrance. At this location, there was a park and a crosswalk that children used to cross to and from school and the park. The second was placed about 1,500 ft downstream of the first location.

Results

The "SLOW" markings were not effective in reducing speeds. As shown in table 8, the 85th percentile speed actually increased for traffic entering Slater just downstream of the first pavement legend. There was little or no reduction in vehicle speed just downstream of the second "SLOW" marking. Data were not collected for the 12-month data collection interval because the road was resurfaced after the 9-month data collection period.

Entrance Treatment Using "35 MPH" Legend with Red Background

Description

Speed limit markings (figure 12) modeled after European entrance treatments using colored pavement were used at the east and west community entrances to Dexter. The treatment was also placed west of the community on a curve just before a steel fabrication plant, as requested by the community. Community members were concerned about the combination of large trucks backing out of the plant and high-speed vehicles approaching the plant after negotiating a horizontal curve. A large red rectangle (9.5 ft by 12 ft) was used to frame the on-pavement "35 MPH" speed limit markings. An 8 inch edgeline was also painted along the treatments to enhance visibility.

Results

As shown in table 9, the treatment was very effective in reducing the speed of traffic entering the community. Speeds downstream of the curve on the western edge of Dexter and at the western entrance decreased from 4 mi/h to 9 mi/h during most analysis periods. The speed reductions at the eastern entrance to Dexter were not as dramatic. This may be due in part to the prevailing speed in the baseline period at the east entrance, which was already lower than the west entrance to the community.

Table 8. Speeds before and after installing "SLOW" pavement legend.

Location	Analysis period	Sample size (veh)	Posted speed (mi/h)	85th percentile (mi/h)	Change in 85th percentile speed from "before" period (mi/h)	
First legend	Before	2,812	25	41		
	1-month	2,888	25	44		+3
	6-month	2,901	25	42		+1
	9-month	2,570	25	42		+1
Second legend	Before	3,503	25	34		
	1-month	3,294	25	34		0
	6-month	2,886	25	32	-2	
	9-month	3,084	25	33	-1	

Summary of Effectiveness

Table 10 summarizes speed impact, cost, and maintenance requirements for the various traffic-calming treatments evaluated in this study. The effectiveness of the treatments in reducing speeds varied widely.

The most effective treatments were the speed feedback signs, speed table, median island using tubular markers, and speed limit markings with red background. The converging chevrons and transverse pavement markings were somewhat effective with speed reductions generally less than 3 mi/h. Lane narrowing using pavement markings to create a center island, lane narrowing using shoulder markings in combination with on-pavement speed limit markings, and on-pavement "SLOW" markings were either not effective or were only marginally effective.

Lessons Learned

The following lessons were learned during the course of the study and may be helpful to small communities considering traffic calming on main rural roads:

- Design vehicles should be considered when determining the type of traffic-calming treatment

to implement. For example, farm vehicles and heavy truck traffic are common in many rural communities and must be accommodated.

- Maintenance can be an issue with many traffic-calming treatments. For example, the tubular channelizing markers used in this study to create a center island were effective in reducing speeds, but the tubular markers were frequently struck by vehicles and required frequent maintenance. The speed feedback signs provide a different example in that, to be effective, agencies must establish the capability to troubleshoot and maintain these signs within a reasonable response time.

- Cost effectiveness is always a factor in selecting traffic-calming treatments. While speed feedback signs were effective in all situations, their higher cost make them most appropriate for areas where it is critical that drivers slow down, such as near schools, playgrounds, or community pools.

- Durable pavement marking materials (such as thermoplastic, tape, epoxy, or other paint alternatives) should be considered when the markings extend within wheel paths.

Figure 12. Speed limit markings with experimental red background in Dexter.



Table 9. Speeds before and after “35 MPH” pavement legend with red background markings.

Location	Analysis period	Sample size (veh)	Posted speed (mi/h)	85th percentile (mi/h)	Change in 85th percentile speed from “before” period (mi/h)	
Before curve	Before	2,190	35	52		
	1-month	2,150	35	47	-5	
	3-month	2,022	35	47	-5	
	9-month	4,033	35	43	-9	
	12-month	2,031	35	51		-1
West entrance	Before	2,369	35	45		
	1-month	2,256	35	40	-5	
	3-month	2,119	35	41	-4	
	9-month	4,027	35	37	-8	
	12-month	3,168	35	41	-4	
East entrance	Before	4,254	35	40		
	1-month	3,998	35	38	-2	
	3-month	2,900	35	39	-1	
	9-month	4,087	35	40		0
	12-month	4,031	35	39	-1	

Standard paint products wear quickly and without frequent reapplication can reduce the effectiveness of the message.

- Community buy-in is important. In several cases, although community leadership was on-board, the community was opposed to the treatment, even when it was proven to be effective.
- Lane narrowing using just pavement markings to create a center island or shoulder was not effective. The lane narrowing treatment that used tubular markers to create a center island was more effective, suggesting that lane narrowing is most likely to be effective when drivers are presented with a physical object that causes deflection.
- Small communities may not be familiar with traffic calming and may need additional education.

Other Considerations

In visiting a large number of small communities to select pilot study locations, the research team observed a number of practices that could affect the successful outcome of main road traffic

calming. These and other implementation issues are noted as follows:

- Small communities often do not have a traffic engineer and appear to be addressing perceived speeding problems by lowering the speed limit, believing wrongly that this will change driver behavior. While lower travel speeds may be desirable, reducing the speed limit is not likely to have much effect.
- Speed limits which are not consistent with the area characteristics and roadway function lead to disregard for posted speeds and create animosity toward law enforcement. The recently released USLIMITS Web-based speed zone advisor could be a useful tool in setting appropriate speed limits in rural communities.⁽⁷⁾
- Speed limits in the transition zone between the rural and built-up area in small communities were often improperly set, extending well passed the edge of the community into rural agricultural areas where there was no reason for reduced speeds. In other cases, the speed reductions were abrupt without appropriate speed reduction warning signs.
- The maximum speed reduction observed

Table 10. Summary of impacts and costs of rural traffic calming treatments.

Treatment	Change in 85th percentile speed (mi/h)	Cost	Maintenance	Application
Transverse pavement markings ¹	-2 to 0	\$	Regular painting	community entrance
Transverse pavement markings ¹ with speed feedback signs	-7 to -3	\$\$\$	Regular painting	community entrance
Lane narrowing using painted center island and edge marking	-3 to +4	\$	Regular painting	entrance or within community
Converging chevrons ¹ and "25 MPH" pavement markings	-4 to 0	\$	Regular painting	community entrance
Lane narrowing using shoulder markings and "25 MPH" pavement legend	-2 to 4	\$	Regular painting	entrance or within community
Speed table	-5 to -4	\$\$	Regular painting	within community
Lane narrowing with center island using tubular markers	-3 to 0	\$\$\$	Tubes often struck needing replacement	within community
Speed feedback sign (3-months after only)	-7	\$\$\$	Troubleshooting electronics	entrance or within community
"SLOW" pavement legend	-2 to 3	\$	Regular painting	entrance or within community
"35 MPH" pavement legend with red background ¹	-9 to 0	\$	Background faded quickly; accelerated repainting cycle	entrance or within community

\$ = under \$2,500

\$\$ = \$2,500 to \$5,000

\$\$\$ = \$5,000 to \$12,000

¹ Experimental approval required per Section 1A.10 of MUTCD.

in this study was 9 mi/h. Physical measures such as roundabouts and curbed center islands may be needed to achieve the speed environment that rural communities often desire.

- Large areas of pavement markings, such as the speed limit markings with colored background, may become slippery when wet. Communities planning to use such treatments should ensure adequate skid resistance is provided. High friction surface material should be considered.

- Speed tables are only appropriate when the posted speed limit is 30 mi/h or less and approach speeds are less than 40 mi/h. Speed tables are not recommended for use on routes with significant (more than 5 percent) truck and bus traffic. Because emergency response times may increase, emergency service

providers should be consulted before installing speed tables.

- STOP signs should not be used for traffic calming.
- The chevron markings, transverse markings, and red background for pavement legend evaluated in this study are not standard devices and require experimental approval in accordance with section 1A.10 of the MUTCD.

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Key Words—Traffic calming, speed management, transverse markings, chevron markings, speed feedback signs, lane narrowing, tubular channelizing markers, pavement legend, rural roads.

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