

**THE EFFECTIVENESS OF LOW-COST TRAFFIC CALMING APPLICATIONS
APPROPRIATE FOR MAIN STREETS THROUGH RURAL COMMUNITIES**

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ABSTRACT

County and state highways that enter small rural towns commonly become a major roadway through the community. These roadways typically have high speed limits outside of town and then transition to a reduced speed limit through the community. Pass-through drivers that enter at high speeds and continue speeding throughout create unsafe conditions for residents and other drivers. When speeding is a problem, city officials often struggle to find solutions to slow down traffic. The majority of traffic calming studies focus on local and collector streets in large, urban areas. Therefore, city officials have little information about the effectiveness of traffic calming measures that are appropriate for major highways. They may also have few resources to combat a speeding problem. As a result, installing unwarranted stop signs or requesting more law enforcement is commonly viewed as the only remedy. The purpose of this study was to identify economically feasible traffic calming strategies that are appropriate for major roadways, implement these strategies in several rural communities, and analyze their effectiveness by comparing speed data before and one month after implementation.

INTRODUCTION

Many rural communities have developed around highways or major county roads and as a result, the main street through small Iowa communities is often part of a high speed rural highway. Highways and county roads are characterized by high speeds outside the city limits and then transition into a reduced speed section through the rural community. Consequently, drivers passing through the community often enter at high speeds and continue speeding throughout.

In 2004, there were 13,192 traffic fatalities (30%) in the United States which were a result of speed related crashes (1). The total number of crashes in rural areas is often lower than urban areas but is more likely to be severe due to higher vehicle speeds. Furthermore, crashes in rural communities may be more likely to have a severe outcome since many small communities do not have emergency management services and consequently it takes longer for emergency personnel to reach crash victims. A Washington State study evaluated pedestrian-vehicle collisions over a three-year period and determined that the likelihood of a pedestrian dying in a rural collision was more than twice that for a pedestrian struck in an urban area (2). The study noted that the higher risk was most likely due to less rapidly available emergency services.

In addition to a higher accident potential and accident severity, high speeds also have an effect on the quality of life for residents in a community. Some potential impacts of speeding may include:

- An increase in traffic noise and emissions
- Less bicycling, walking, and other forms of street life
- Less community interaction and involvement
- A higher crime rate
- Lower property values

When speeds in rural communities are problematic, traffic calming provides a potential solution. Small communities, however, often do not have the resources to conduct traffic studies to examine possible remedies. Although the Iowa DOT has no jurisdiction unless a state highway is involved, they are often asked for guidance from residents and officials of small towns. Traffic calming has been used extensively in the United States in urban areas and a number of documents and studies are available that provide guidance on the use of different traffic calming devices on residential urban roadways. Most traffic calming techniques, however, have only been evaluated on low-speed roadways, generally local streets and collectors. The effectiveness of traffic calming along major routes that transition from high speed facilities to low speed facilities through rural communities is not well documented. Guidelines on the use of appropriate traffic calming devices are also not readily available. As a result, the community response to high speeds is frequently a request for traffic control, such as stop signs, even when not warranted. The Manual on Uniform Traffic Control Devices (MUTCD) specifically states that stop signs should not be used solely for speed control.

Traffic calming techniques can be used to achieve more than just speed reduction. They can also be used to control traffic volumes, improve transit access, and encourage bicycling and other forms of street life. However, the use of traffic calming is usually considered for local urban streets with pedestrian-vehicle interaction, but a different approach is needed for higher speed roadways since their primary function is carrying traffic. Traffic patterns in small, rural cities are also much different than large, densely populated cities. Traffic volumes are typically lower on main streets of rural communities, and the majority of the traffic is generally through traffic. Rural

traffic calming attempts to balance personal safety and efficient mobility through the area while preserving the route's rural character.

Research objectives

There has been much research on the effectiveness of traffic calming in the United States and other countries around the world. The research has consistently pointed out that traffic calming measures can effectively reduce traffic speeds, traffic volumes, or both. However, many of these studies have taken place in large urban communities such as Seattle, WA, Berkeley, CA, and West Palm Beach, FL. The traffic calming plans in these communities have been widespread and have been expensive to implement and maintain. Low-cost traffic calming solutions appropriate for small rural cities, such as those seen in Iowa, have not been evaluated.

The purpose of this research was to evaluate and provide guidance on the use of different traffic calming techniques that can be used by both engineers and communities to select economically feasible alternatives for conditions typical of Iowa's county roads and other major roads within small rural communities. To accomplish this, the following research objectives were identified:

1. Identify traffic calming strategies that are appropriate in small Iowa communities (population less than 5,000).
2. Test and demonstrate several of the most promising technologies through pilot studies in several communities.
3. Summarize the effectiveness of various applications in reducing speeds through these communities.

REVIEW OF TRAFFIC CALMING MEASURES

More than a dozen traffic calming measures that are applicable to rural, Iowa roadways were reviewed. These measures were selected after giving consideration to the design driver, design vehicle, cost, and impact to the roadway. The design driver was assumed to be an older resident who has little experience with traffic calming devices. The measures had to accommodate large trucks and farm machinery, and they had to be inexpensive to install and maintain. Finally, the measure could not drastically alter the roadway due to the high volumes and high speeds that were present.

Although many of the traffic calming measures had previously only been evaluated in large urban areas, a literature review was conducted to determine the expected effectiveness of each measure. A summary of the effectiveness of the traffic calming measures ultimately used in the study is shown in Table 1.

Table 1: Review of effectiveness

Traffic calming measure	Effectiveness
Converging pavement markings	<ul style="list-style-type: none"> • Reduced average speeds 3-5 mph after 1 week and 2-4 mph after 1 month; reduced 85th percentile speeds 5-7 mph after 1 week and 4-6 mph after 1 month (3)
Surface treatments	<ul style="list-style-type: none"> • Reductions in mean and 85th percentile speeds, no exact reduction reported (4)
Lane narrowing	<ul style="list-style-type: none"> • Speed reduction of 15-20% (5) • Reduction in mean speeds of 3-5 mph (6)
On-pavement speed signing	<ul style="list-style-type: none"> • Previously not analyzed as a traffic calming measure
Speed tables	<ul style="list-style-type: none"> • Reduction in 85th percentile speeds by about 18% (7)
Longitudinal channelizers	<ul style="list-style-type: none"> • Previously not analyzed as a traffic calming measure

PILOT STUDY LOCATIONS

In order to solicit pilot study communities, the project was advertised in the Iowa League of Cities newsletter. The project scope was outlined in the newsletter and rural Iowa communities who met a certain set of criteria and were interested in serving as a pilot study location were asked to contact the study team. Some of the criteria included:

- Population must be 5,000 or less
- Traffic calming devices must not already be in place at any location along the roadway that will affect results (if traffic calming devices are already in place, the community may still be used to compare the town against a similar community without traffic calming)
- Locations cannot have experienced recent construction, reconstruction, or significant maintenance activities nor have construction or reconstruction scheduled
- Roadway must be a major through county or state route
- Roadway must be paved
- Roadway must continue through the community (roadway cannot terminate within or shortly beyond the community)
- Roadway must not be access controlled
- No adverse geometry is present, such as sharp horizontal curves or steep vertical curves at the entrances of the community
- Location in the state –closer locations were preferred, but not required, in order to facilitate data collection

Occasionally, problems with speeding are perceived rather than actual – residents complain of speeding when in fact no evidence exists that a speeding problem is present. Therefore, for each community that responded to the advertisement and met the criteria, the magnitude of each community’s speeding problem was determined. Speed data were collected using pneumatic road tubes at various locations along each community’s main roadway. This preliminary data were analyzed, and the five communities that had the highest degree of speeding were selected as pilot study locations. The five communities were the City of Roland, the City of Union, the City of

Gilbert, the City of Dexter, and the City of Slater. The preliminary data results were discussed with each community's city council, and a traffic calming plan for each was formed.

METHODOLOGY

Speed data were collected before and one month after implementing traffic calming in the five communities. Pneumatic road tubes were used to collect individual vehicle speeds both upstream and downstream of where the traffic calming device was to be placed. The tubes were placed away from businesses or major driveways; this was done to cut down on the number of accelerating or decelerating vehicles that would affect the data. Speeds were then analyzed about 1 month after the device was in place, at the same locations where the 'before' data were gathered. Each site was analyzed for a period of at least 48 hours during the middle of the week. In order to evaluate normal traffic patterns, holidays and unusual events were avoided. A few of the statistics used to measure the effectiveness of each traffic calming strategy included:

- Average speed
- 85th percentile speed, or the speed at which 85% of traffic is traveling at or below
- Percent of vehicles over the speed limit, 5 mph or more over the limit, 10 mph or more over the limit, and 15 mph or more over the limit

RESULTS

The following describes each test site and the traffic calming plan implemented, along with the before and after speed results.

Dexter, IA

Dexter, IA is located about 30 miles west of Des Moines and has a population of 689. City officials were concerned about speeding on their main route, County Highway F65. Residents complained of drivers entering town at high speeds. The posted speed limit is 55 mph outside of town and 35 mph at the center of town, with no transition zones on either end. There is also a '25 mph when flashing' zone near the center of town, which is in effect before and after school. Some sensitive areas near the highway include a school, park, and metal fabrication plant.

Initial speed studies indicated high vehicle speeds on the edges of town. Downtown, speeding was not nearly as severe. After reviewing the initial speed studies and consulting with city officials, the traffic calming plan seen in Figure 1 was produced. A surface treatment at both ends of town was selected in order to slow down drivers as they entered the community. The surface treatment consisted of two painted red strips with white lettering. The first strip displayed "35" and the second displayed "MPH". In addition to painting the messages at both ends of town, city officials preferred to have a third location just west of the Ramark Industries, Inc., plant. This was done with the intention of slowing down eastbound traffic before they reached the plant. Therefore, a third location was tested for the eastbound lane only. The surface treatments were selected after confirming that the measures did not violate guidelines of the MUTCD. Figure 2 shows one of the surface treatments after installation.

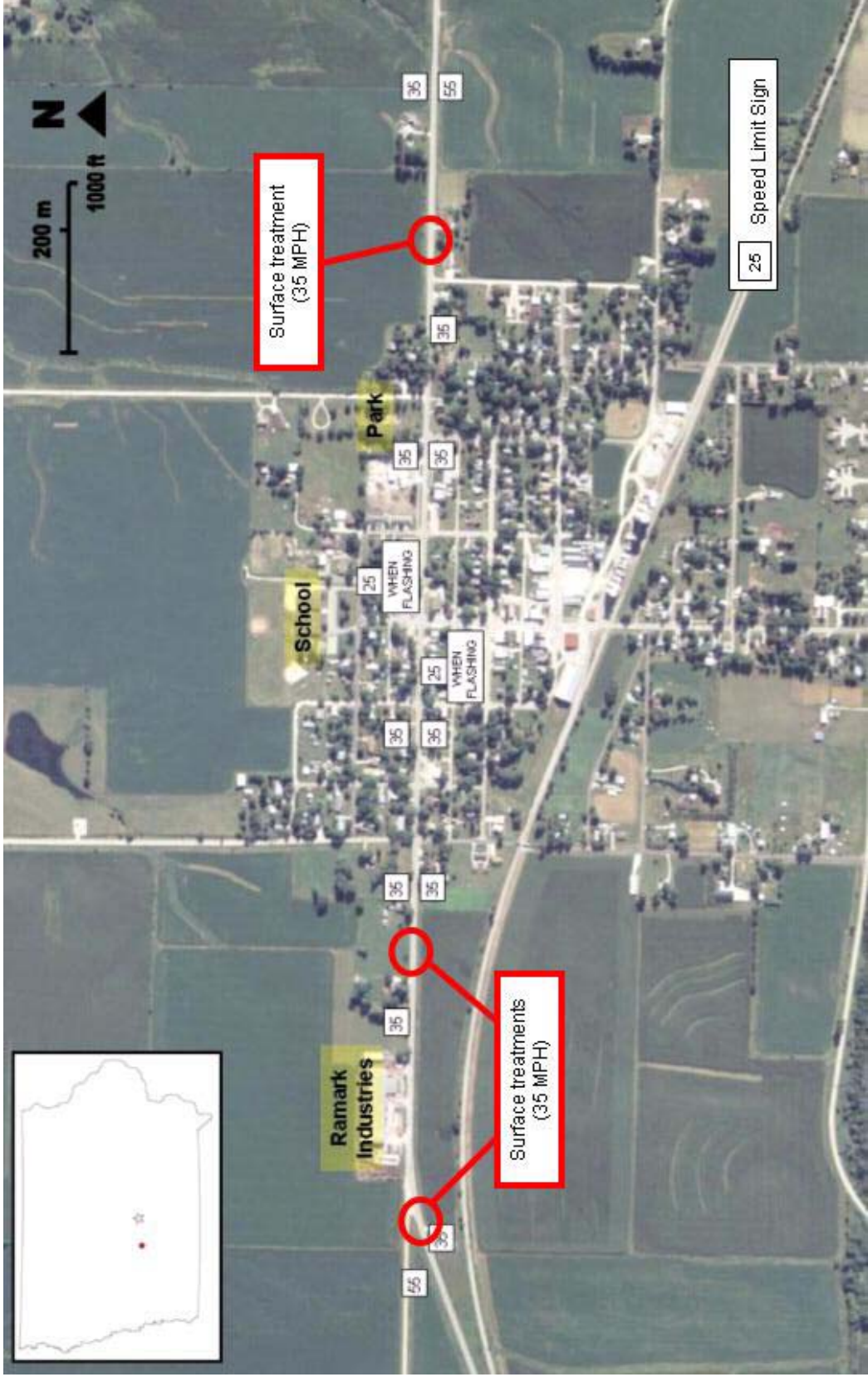


Figure 1: Traffic calming plan for Dexter, IA

Speed results

The western-most surface treatment, which was only in the eastbound lane, reduced speeds for both directions of traffic. This treatment:

- Reduced the average speed from 45 mph to 40 mph (eastbound) and from 50 mph to 44 mph (westbound)
- Reduced the 85th percentile speed from 52 mph to 47 mph (eastbound) and from 57 mph to 52 mph (westbound)
- Reduced the percent of speeds greater than 15 mph over the speed limit from 25% to 8% (eastbound) and from 52% to 21% (westbound)



Figure 2: Dexter, IA, after traffic calming (surface treatment)

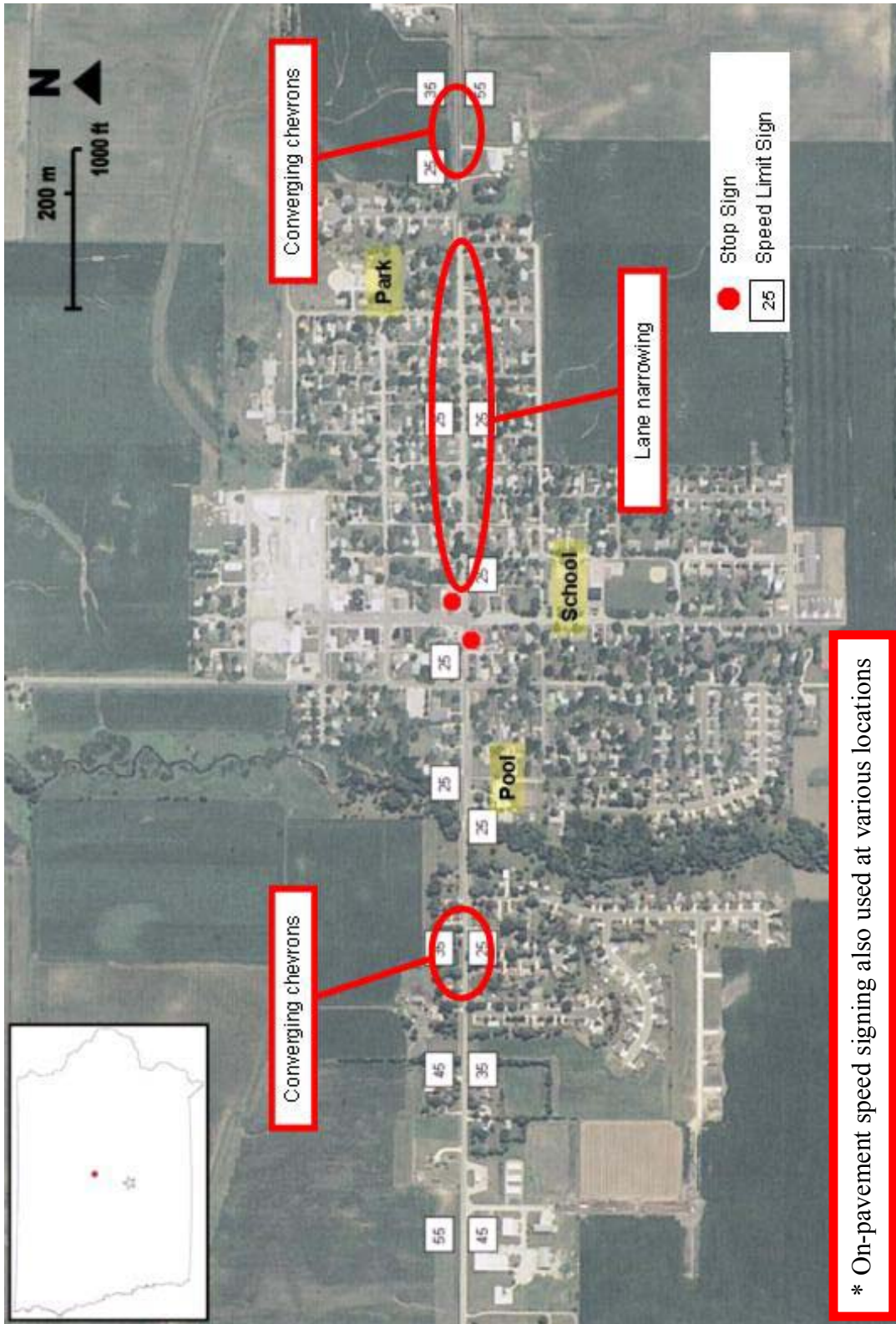
The surface treatment west of town (closest to town) was used across both lanes. For eastbound traffic, this was the second surface treatment crossed. The combination of these two treatments reduced the average speed at this location from 37 mph to 35 mph and reduced the 85th percentile speed from 43 mph to 40 mph. For westbound traffic leaving town, average speeds were reduced from 39 mph to 37 mph and 85th percentile speeds were reduced from 45 mph to 42 mph.

Speeds were also reduced at the east edge of town, but by a smaller amount. The surface treatment caused average speed reductions of 0 mph and 1 mph for eastbound and westbound vehicles, respectively. Furthermore, 85th percentile speeds were reduced 1 mph for both directions.

Roland, IA

Roland, IA is located about 45 miles north of Des Moines and has a population of 1,324. City officials believed that speeding was occurring on County Highway E18, their main route through town. Highway E18 is a two-lane roadway that runs east/west and has an average daily traffic (ADT) of about 2,400. The posted speed limit is 55 mph outside of town and 25 mph downtown. There is also a 4-way stop controlled intersection at the center of town. Some sensitive areas near the highway include a school, park, and swimming pool.

Initial speed studies indicated speeding problems downtown and east of the 4-way stop. After reviewing the initial speed studies and consulting with city officials, the traffic calming plan seen in Figure 3 was produced. Converging chevron markings were selected to be used just west of downtown in order to slow down eastbound traffic before they reach downtown. The chevrons are spaced at decreasing intervals to make the driver feel as if he or she is speeding up. The same style of markings was also selected to be used on the east edge of town to slow down westbound traffic entering town. Furthermore, lane narrowing was chosen due to the high speeds just east of the 4-way stop and also due to the varying lane widths through town. The original lanes were wider from the 4-way stop to the east edge of town (18 ft.) than at other locations along the highway (11 ft.). Shoulders were painted on the wider section of roadway, decreasing the lane width from 18 ft. to 11 ft. Lane narrowing can make drivers feel more constrained, which can lead to slower speeds. The speed limit was also painted on the roadway at various locations as an added reminder to drivers. The traffic calming measures did not violate guidelines of the MUTCD. Figure 4 shows the traffic calming measures after installation.



* On-pavement speed signing also used at various locations

Figure 3: Traffic calming plan for Roland, IA

Speed results

The converging chevrons had very little effect on speeds. At the west entrance of town, the converging chevrons had no effect on the average speed and increased the 85th percentile speed by 1 mph. At the east entrance of town, the chevrons caused reductions of 1 mph for both the average speed and 85th percentile speed.

Downtown, the combination of traffic calming measures caused different results depending on the lane. For eastbound traffic, the combination of lane narrowing and pavement speed signing caused an average speed reduction of 2 mph and an 85th percentile speed reduction of 3 mph. For westbound traffic, the combination of converging chevrons, lane narrowing, and pavement speed signing caused a 3 mph *increase* in both average speed and 85th percentile speed.

Overall, these traffic calming measures had very little effect on reducing speeds.

Slater, IA

Slater, IA is located about 20 miles north of Des Moines and has a population of 1,306. Two routes through town were analyzed – State Highway 210 and County Highway R38. Highway 210 is a two-lane roadway that runs east/west and County Highway R38 is a two-lane roadway that runs north/south. Both highways have an ADT of about 3,000. A four-way stop controlled intersection is located where the two roadways meet. Highway R38 also has a second four-way stop controlled intersection near a school on the north side of town.

Initial speed studies indicated a speeding problem on both routes. On the east end of town, there is a small transition zone, followed by a four-way stop. Therefore, traffic calming was not considered for this side of town. After reviewing the initial speed data and consulting with city officials, the traffic calming plan seen in Figure 5 was produced. Longitudinal channelizers were selected to slow down northbound traffic entering town from the south. These devices are typically used for directing traffic and previously had not been studied as a traffic calming device. For eastbound and westbound traffic on Highway 210, a surface treatment was preferred. The surface treatment was designed to be a painted “SLOW” message in white lettering on the pavement. The traffic calming measures were selected after confirming that the measures did not violate guidelines of the MUTCD. Figure 6 shows the site after traffic calming was implemented.



Figure 4: Roland, IA, after traffic calming (pavement speed signing, lane narrowing, converging chevrons)

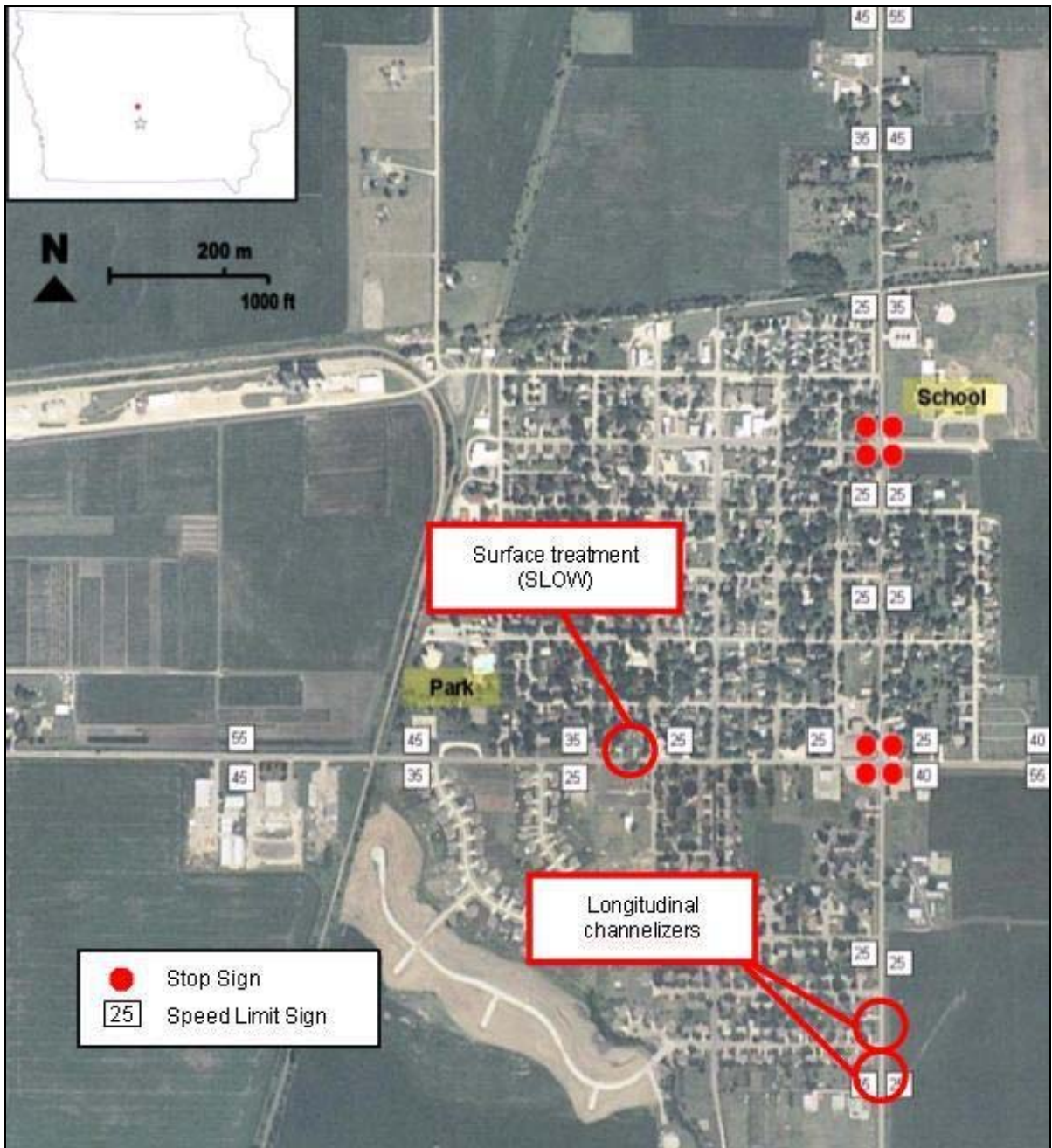


Figure 5: Traffic calming plan for Slater, IA

Speed results

The surface treatment on the west side of town caused no change in the eastbound average speed or 85th percentile speed. For westbound traffic, speeds increased 1 mph for both the average speed and the 85th percentile speed.

The longitudinal channelizers at the south end of town were much more effective in reducing speeds. The channelizers:

- Reduced the average speed from 33 mph to 28 mph (northbound) and from 38 mph to 33 mph (southbound)
- Reduced the 85th percentile speed from 41 mph to 34 mph (northbound) and from 46 mph to 39 mph (southbound)
- Reduced the percentage of vehicles traveling more than 15 mph over the speed limit from 17% to 2% (northbound) and from 45% to 10% (southbound)



Figure 6: Slater, IA, after traffic calming (surface treatment, longitudinal channelizers)

Union, IA

Union, IA is located about 60 miles northeast of Des Moines and has a population of 427. City officials noted that speeding was occurring on two main routes through town, County Highway D65 and County Highway S62/State Highway 215. Highway D65 is a two-lane roadway that runs east/west through the middle of town and has an ADT of about 2,000. County Highway S62 (ADT~1,000) is a two-lane roadway that runs from the center of town to the south, and State Highway 215 (ADT~1,600) runs from the center of town to the north. There is a two-way stop controlled intersection located where the two roadways meet, with stop signs on Highways 215 and S62. Residents complained of high speeds on the north, south, and west edges of town. On the east edge of town, railroad tracks that cross Highway D65 help to significantly slow drivers that are entering town from the east. Therefore, this edge of town was not analyzed in the study. Some sensitive areas near the highways include a middle school, swimming pool, and golf course.

Initial speed studies indicated speeding problems on both State Highway 215 and County Highway S62, as well as County Highway D65 on the west side of town. After reviewing the initial speed studies and consulting with city officials, the traffic calming plan seen in Figure 7 was produced. Converging transverse bars were selected to be used at the entrances to the town on the north, south, and west. Like the converging chevrons, the converging bars are spaced at decreasing intervals in order to psychologically slow the driver down. Along State Highway 215 downtown, which originally had lane widths of about 20 feet, lanes were narrowed to about 11 feet. A left turn lane was also added for southbound traffic on Highway 215 as part of the lane narrowing. Figure 8 shows the traffic calming measures after installation.

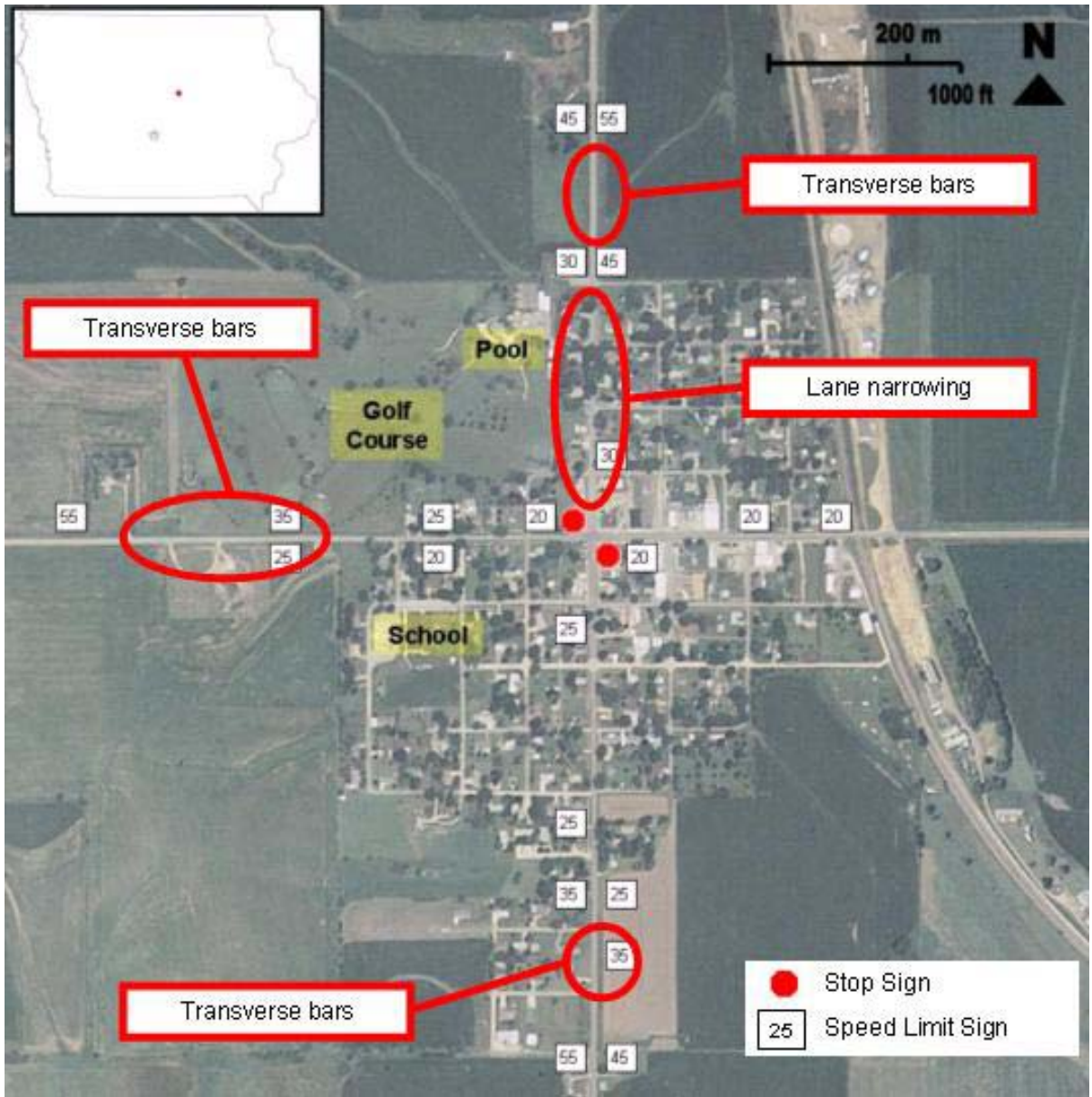


Figure 7: Traffic calming plan for Union, IA

Speed results

The transverse bars were installed at three of the town's four entrances. Afterward, there was very little change in speeds at all three locations. This treatment:

- Caused no change in average speed and a 1 mph increase in 85th percentile speed at the west entrance
- Increased the average speed 1 mph and caused no change in 85th percentile speed at the north entrance
- Reduced both the average speed and 85th percentile speed by 1 mph at the south entrance

The lane narrowing led to a slight increase in speeds. For southbound traffic, the average speed increased 1 mph and the 85th percentile speed was unchanged. For northbound traffic, both the average speed and the 85th percentile speed increased 2 mph.

Gilbert, IA

Gilbert, IA is located about 40 miles north of Des Moines and has a population of 987. County Highway E23 is a two-lane roadway with an ADT of about 1,600 and runs east/west through the middle of the community.

The posted speed limit is 55 mph outside of town and 25 mph at the center of town, with transition zones on each end of town. There is also a four-way stop controlled intersection at the center of town. The town has plans for a new middle school near Highway E23, and two other schools are already near the route. Furthermore, there are two parks nearby that generate additional pedestrian traffic.

Initial speed studies indicated high speeds downtown and on the east end of town. Near the west edge of town, a rough set of railroad tracks that cross Highway E23 helped to slow drivers. Therefore, traffic calming was not considered in this area. Also, the city was considering installing a four-way stop controlled intersection on the east side of town and adjusting the speed zones east of the intersection. As a result, the east end of town was not considered for traffic calming. Instead, traffic calming was focused downtown. After reviewing the initial speed studies and consulting with city officials, the traffic calming plan seen in Figure 9 was produced. A speed table with a design speed of 30 mph was selected to be placed near the center of town. A speed table is similar to a speed hump, but its trapezoidal shape allows for less vehicle disruption. It is therefore generally preferred by residents over a speed hump. The Iowa DOT does not have formal guidelines for design of speed tables, so the Delaware DOT guidelines for speed tables were used with approval from the Iowa DOT. Speed table pavement markings were those approved by the MUTCD. Figure 10 shows the site after installation of the speed table.



Figure 8: Union, IA, after traffic calming (lane narrowing, transverse bars)



Figure 9: Traffic calming plan for Gilbert, IA

Speed results

The speed table was effective in reducing speeds. Upstream of the speed table:

- Average speeds were reduced from 30 mph to 26 mph (eastbound) and from 28 mph to 26 mph (westbound)
- 85th percentile speeds were reduced from 35 mph to 30 mph (eastbound) and from 34 mph to 31 mph (westbound)
- The percentage of vehicles exceeding the speed limit were reduced from 93% to 65% (eastbound) and from 79% to 62% (westbound)



Figure 10: Gilbert, IA, after traffic calming (speed table)

Speeds were also reduced downstream of the speed table, where:

- Average speeds were reduced from 26 mph to 23 mph (eastbound) and from 30 mph to 26 mph (westbound)
- 85th percentile speeds were reduced from 32 mph to 28 mph (eastbound) and from 34 mph to 30 mph (westbound)
- The percentage of vehicles exceeding the speed limit were reduced from 64% to 32% (eastbound) and from 90% to 64% (westbound)

CONCLUSION

Since its origination in Europe in the mid-1900s, traffic calming has been recognized as an effective approach to reduce vehicle speeds and increase the quality of life of residents. However, its effectiveness and appropriateness on major roadways in small, rural communities has not been evaluated in great detail. Furthermore, some traffic calming strategies may be too expensive to implement and maintain, especially for small communities with limited resources. This project examined the effectiveness of six low-cost strategies that a small community can use to slow down traffic on their main street. Some of the measures were very successful, and some of the measures had almost no impact on speeds. Although these devices were evaluated in several rural communities, their effectiveness may differ depending on the community and if the measures are used in combination with other measures. Overall, the study produced the following results:

- The converging pavement markings had very little effect on reduced speeds in Roland and Union (about 1 mph).
- The surface treatments used in Dexter reduced speeds up to 5 mph, but the surface treatments used in Slater caused a slight increase in speeds (about 1 mph).
- The lane narrowing in Roland caused a 2 mph reduction for one direction of traffic, but a 3 mph increase in the other direction. In Union, the lane narrowing resulted in increases of 1-2 mph.
- The on-pavement speed signing was used in combination with other measures, but appeared to have very little impact on reducing speeds.
- The speed table in Gilbert resulted in a 2-4 mph reduction in average speeds. The 85th percentile speeds were reduced 3-5 mph.
- The longitudinal channelizers in Slater resulted in a 5 mph reduction in average speeds and a 7 mph reduction in 85th percentile speeds.

The psychological traffic calming measures (converging markings and lane narrowing) had the least effectiveness, while the physical measures (speed table and longitudinal channelizers) had much more success in reducing speeds.

ACKNOWLEDGEMENTS

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