# Topic: Speed Limits

## Key Points

- MnDOT procedures for establishing speed limits are based on State Statutes and use established best practice performance measures.
- The national research indicates the majority of drivers select a reasonable and safe maximum speed based on their perception of the roadway environment and that the actual posted speed limit has little influence on the speed drivers choose.
- Research does NOT support the notion that urban roads with lower speed limits are safer – safety on urban roads is more a function of access density than speed limit.
- Research does indicate that safety on rural roads is optimized when prevailing speeds are at or near the 85th percentile and the majority of vehicles are in the 10 mile per hour pace.

**Background**

One of the most challenging issues agency traffic engineers face is responding to local requests to change posted speed limits. Anecdotal evidence suggests that these requests are usually based on two points that seem to be intuitively correct to residents – first, that roadways with lower speed limits are safer and second, that the majority of drivers select their speed based on the posted limit. However, like much of traffic engineering, the facts surrounding this matter appear to be counterintuitive.

Discussions pertaining to speed limits would be enhanced by making sure that all parties understand the process for setting speed limits, the basic premise that underlies the process and the facts based on both local experience and national research.

The basic process for setting speed limits in Minnesota has been in place since the 1930's and is documented in State Statutes (M.S. 169.14, Subdivisions 2, 4 & 5). The law establishes two basic types of speed restrictions: statutory speed limits and established speed zones. Statutory speed limits which are 30 miles per hour in urban areas and 55 miles per hour in rural, apply in areas in which no special hazards exist. The law also recognizes higher statutory limits on expressways and freeways and lower limits on residential roadways if adopted by the road authority. When local authorities believe that the statutory speed limit should be altered in either direction, they may request that the Commissioner of Transportation conduct an engineering and traffic investigation to determine a reasonable and safe speed. The authority to establish speed zones was delegated to the Commissioner as part of the original law so that there would be a high level of consistency across the entire State on all roads with the intention that drivers experiencing similar conditions could expect to find similar speed restrictions.

The process MnDOT has used to conduct the required engineering and traffic investigation is objective and involves measuring a sample of actual vehicle speeds and documenting two particular traffic characteristics on the segment of road in question: the 85th Percentile Speed and the Ten Mile Per Pace. The use of these performance measures is considered to be a best practice and is consistent with the conclusions contained in national research and the guidance in the Minnesota Manual on Uniform Traffic Control Devices. The 85th Percentile Speed is the speed at which 85 percent of drivers are traveling at or below and the Pace is the ten miles per hour that contain the highest fraction of the drivers in the sample.

The use of these performance measures reflects the two basic premises behind the speed law and the speed zoning process:

- The majority of drivers will select a reasonable and safe speed based on their perception of the road environment.
- The more drivers that chose to travel at nearly the same speed, the fewer the number of potential conflicts and the greater the level of safety.

The national research suggests and MnDOT has found that the 85th Percentile Speed approximates what drivers select as a reasonable and safe speed and that where the selected speed limit is in the upper end of the Pace that contains 65 to 75 percent of vehicles, compliance and safety are optimized.

The wisdom and rationale of relying on the users of a segment of roadway to basically select the speed limit is regularly questioned by residents and local authorities. However, the national research and MnDOT's experience is clear and consistent: drivers select reasonable and safe speeds based on their perception of the roadway environment and not based on the speed limit signs posted along the roadway. The most comprehensive national research (Effects of Raising and Lowering Speed Limits on Selected Roadway Sections, FHWA-RD-97-084) looked at 100 sites in 22 states where speed limits were either artificially lowered (59 locations) or raised (41 locations) by 5 to 20 miles per hour. The report concluded that "a review of the before and after speed data at each site revealed that differences in mean speed and 85th percentile speeds were generally less than 2 miles per hour and were not related to amount the posted speed limit was changed". In other words, changing the posted speed limit did not in any of the 100 cases actually change the driver's behavior. Instead they continued to select an operating speed based on their perception of the roadway environment.

MnDOT has conducted similar research at a variety of locations across Minnesota where local authorities disputed the results of their engineering and traffic investigation. In each of these cases, MnDOT agreed to undertake a research project by temporarily changing the speed limit, offering the local authority the opportunity to apply increased levels of enforcement and then regularly documenting the resulting speed profiles. The agreement with the local authorities was that if driver behavior changed sufficiently such that the new speed profiles supported the lower speed limits, the lower limits would remain in place and if they did not the limits would be raised consistent with the results of the engineering and traffic investigation. In each case the limits were either raised or lowered between 5 and 15 miles per hour and the measured 85th percentile speeds changed between zero and three miles per hour (Table 1).

Table 1 – Results of MnDOT Speed Zoning Studies

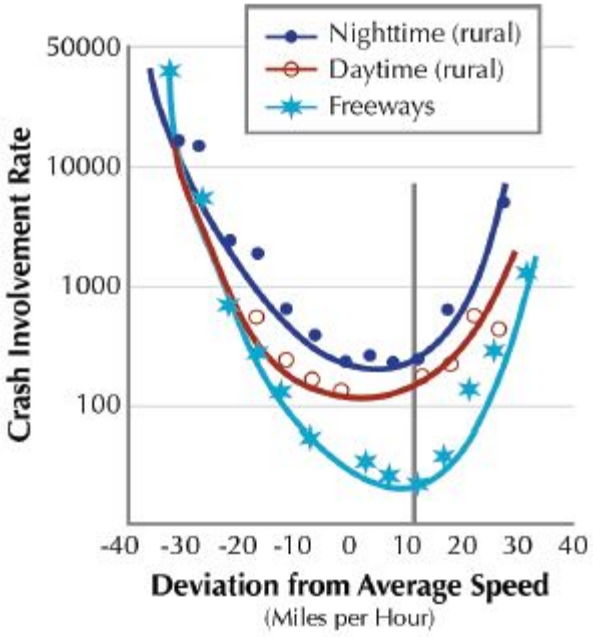
| Speed Zoning Studies | | | | | |
|---|---|---|---|---|---|
| Study Location | Before | After | Sign Change +/- MPH | 85% Before After | Change MPH |
| TH 65 | SPEED LIMIT 40 | SPEED LIMIT 30 | -10 | 34 34 | 0 |
| TH 65 | SPEED LIMIT 50 | SPEED LIMIT 40 | -10 | 44 45 | +1 |
| Anoka CSAH 1 | SPEED LIMIT 45 | SPEED LIMIT 40 | -5 | 48 50 | +2 |
| Anoka CSAH 24 | SPEED LIMIT 30 | SPEED LIMIT 45 | +15 | 49 50 | +1 |
| Anoka CSAH 51 | SPEED LIMIT 40 | SPEED LIMIT 45 | +5 | 45 46 | +1 |
| Hennepin CSAH 4 | SPEED LIMIT 50 | SPEED LIMIT 40 | -10 | 52 51 | -1 |
| Noble Ave | SPEED LIMIT 30 | SPEED LIMIT 35 | +5 | 37 40 | +3 |
| 62nd Ave N | SPEED LIMIT 35 | SPEED LIMIT 30 | -5 | 37 37 | 0 |
| Miss. St | SPEED LIMIT 30 | SPEED LIMIT 35 | +5 | 39 40 | +1 |

*Minnesota Department of Transportation (MnDOT)*

The key conclusion from these experiments is consistent with the national research indicating that changing the posted speed limit did not change driver's behavior. Drivers continued to select what they consider to be a reasonable and safe speed based on their perception of the road environment.

The use of the 85$^{th}$ percentile speed as an approximation of reasonable and safe speeds has also been called into question. Research going back as far as 1964 (Accidents on Main Rural Highways, David Solomon) has demonstrated a relationship between vehicle speed and safety. The results of this research (Figure 1) concluded that crash involvement rates were lowest when vehicle speeds were in a range between the median speed and seven miles per hour above the median. It should be noted that 85$^{th}$ percentile speeds are typically five to seven miles per hour greater than the median.

Figure 1 – Average Speed vs. Crash Involvement (Solomon's Curve)




Other research has investigated the notion of changing drivers' speeds by changing their perception of the road environment. A study in Connecticut (Designing Roads that Guide Drivers to Choose Safer Speeds, Connecticut Transportation Institute, 2009) documented the effect on mean speeds along roads in urban areas associated with land development patterns (Figure 2), road features (Figure 3) and on-street parking (Figure 4). The results indicate that the more drivers perceive a road to be urban, the lower a mean speed they select. Small building setbacks, the addition of curb & gutter and sidewalks and the presence of on-street parking reduced mean travel speeds by nine, seven and thirteen miles per hour, respectively. These results clearly support the theory that drivers in fact use visual cues from the road environment to select what they consider to be a reasonable and safe operating speed.

Figure 2 - Comparison of Mean Speed by Building Setback


Mean speed = 33.2 mph
ADT = 5500 veh/day
No parking

Mean speed = 20 mph
ADT = 6900 veh/day
Heavy Parking

*Source: "Designing Roads That Guide Drivers to Choose Safer Speeds", Iran, J. & Garrick, N., Connecticut Transportation Institute, 2009*

Figure 3 – Comparison of Mean Speed by Presence of Curb & Gutter and Sidewalk


*Designing Roads That Guide Drivers to Choose Safety Speeds, Iran, J. & Garrick, N., Connecticut Transportation Institute, 2009*

Figure 4 – Comparison of Mean Speed by Presence of On-Street Parking

Mean speed = 42.3 mph
ADT = 3800 veh/day
Setback = large

Mean speed = 32.6 mph
ADT = 7800 veh/day
Setback = small

*Source: "Designing Roads That Guide Drivers to Choose Safer Speeds", Iran, J. & Garrick, N., Connecticut Transportation Institute, 2009*

A second study focused on changing driver perceptions (Traffic Calming on Main Roads through Rural Communities, FHWA-HRT-08-067) documented the effects of using innovative pavement markings and other low-cost strategies to alter vehicle speeds. The results of this effort (Table 2) indicate that the use of pavement markings by themselves failed to change driver behavior in any consistent and meaningful way. The addition of a vertical element (speed table) had a modest effect, a 4 to 5 mile per hour reduction. However, in Minnesota vertical elements (speed tables, bumps and humps) should only be used on purely local streets (no public transit or primary emergency service routes and cannot be used on any state aided route). The most effective device was the dynamic speed feedback sign, which resulted in speed reductions up to 7 miles per hour in the speed transitions at urban boundaries. It should be noted that subsequent work in Minnesota with the dynamic speed feedback sign has found consistent speed reductions when applied in rural/urban transitions, work zones and school areas but not when the device was used in an effort to call attention to a statutory rural or urban speed limit. These results indicate that pavement markings by themselves have not proven to be sufficient to change drivers perceptions of the road environment and dynamic devices have proven to be moderately effective, but only in speed transition areas.

Table 2 – Summary of Effectiveness of Traffic Calming Treatments

| Summary of Impacts and Costs of Rural Traffic Calming Treatments | | | | |
|---|---|---|---|---|
| Treatment | Change in 85th Percentile Speed (mph) | 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 |

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

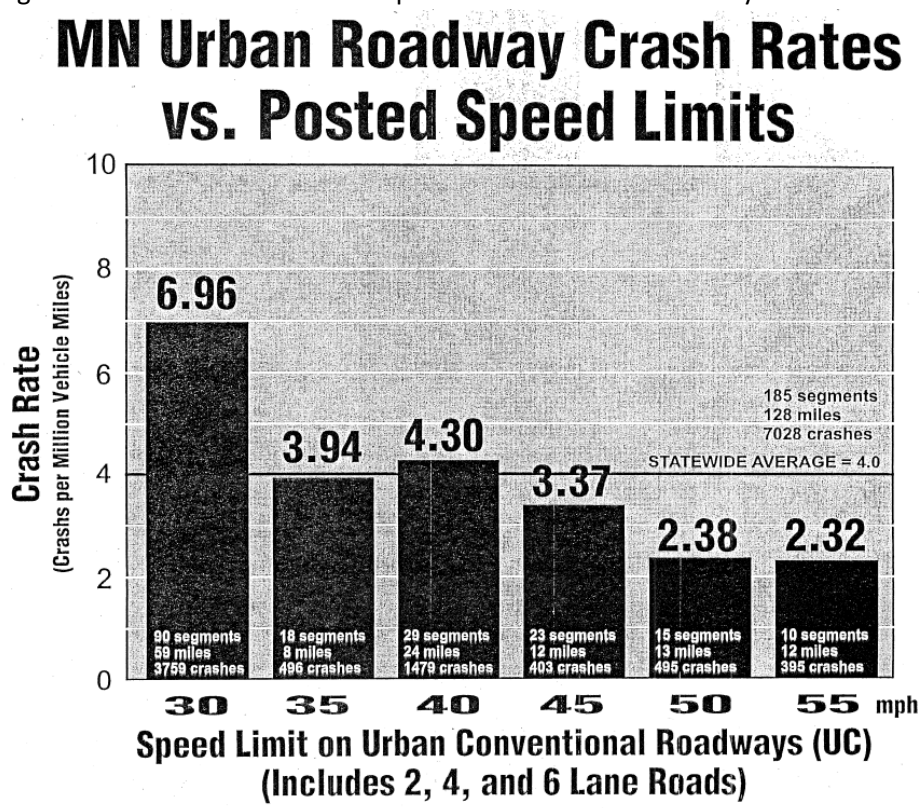
$ = under $2,500
$$ =$2,500 to $5,000
$$$ = $5,000 to $12,000

*Traffic Calming on Main Roads Through Rural Communities, FHWA-HRT-08-067, Krammes, R., 2009*

**Lowering Urban Speed Limits**

Most requests from local authorities to lower speed limits in urban areas appear to be based on an intuitive sense that slower speeds are implicitly associated with greater safety. While it is true that urban roadways have fewer severe crashes than rural roadways, a review of the crash data for urban areas indicates that roads with a 30 mile per hour limit have the highest total crash involvement rate and that the rate diminishes with increasing speed limit (Figure 5). The research that produced this chart (Statistical Relationship Between Vehicular Crashes and Highway Access, MN/RC-1998-27) found that the density of access had a greater effect on crash involvement rates than the posted speed limit and that the highest levels of access were found on roadways with lower speed limits. This data suggests that safety on urban roadways is more a function of access density than the posted speed limit.

Figure 5 – Crash Rate vs. Posted Speed Limit on Urban Roadways



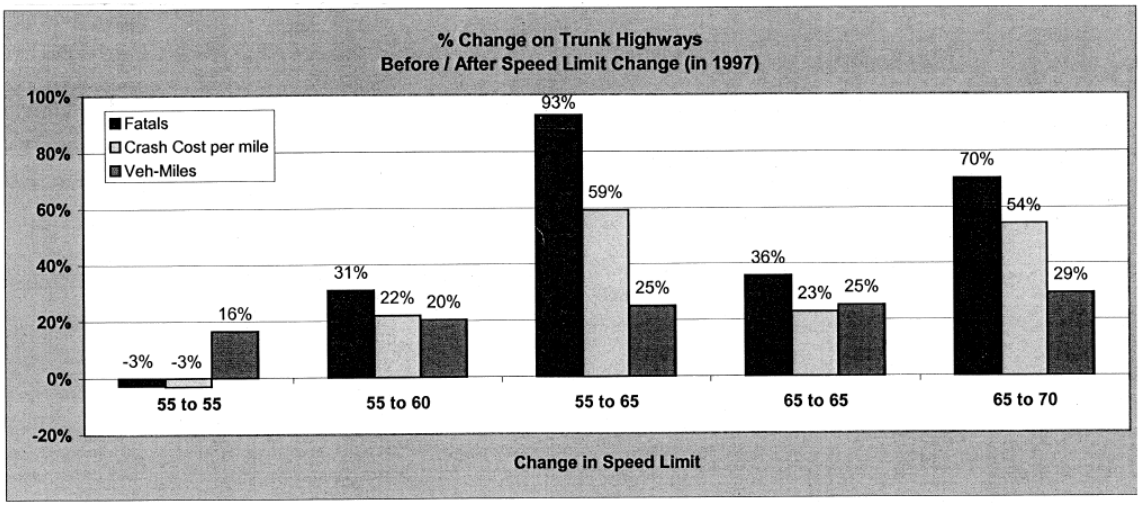

The key conclusion is that in urban areas, there is no information in either the national research or using Minnesota data that supports the theory that lower speed limits are somehow associated with greater safety. The single exception to this statement involves the severity of crashes involving pedestrians – that data is conclusive. Pedestrian involved crashes at 40 miles per hour are fatal 90% of the time whereas crashes at 30 miles per hour are fatal 45% of the time.

**Raising Rural Speed Limits**

Beginning in 1974, a statutory speed limit of 55 miles per hour applied to rural roads in Minnesota (prior to 1974, the basic rural speed limit was 60 miles per hour daytime and 50 miles per hour nighttime). It was acknowledged that this speed limit was not close to the 85$^{th}$ percentile speed on most roads (the typical 85$^{th}$ percentile speed on two lane roads is closer to 65 miles per hour) but the safety performance of Minnesota's rural roads was very good – the fifth lowest fatality rate in the country. MnDOT participated in raising speed limits along rural and urban, multi-lane divided roadways in 1997 and approximately 61% of rural two-lane state highways in 2012. In each case the initiative appears to have been politically driven and based on three assumptions; that the travel times for residents of Greater Minnesota would decrease, the roads could reasonably and safely accommodate the higher speeds and no harm will result. Subsequent analysis proves that the first assumption regarding travel times is likely always true, however, the travel time differences are modest – 50 seconds for a 10 mile trip and four minutes for a 50 mile trip. The second assumption may be true on some roadways and the third may not be true in any case. An analysis completed by MnDOT following the 1997 speed limit increase along multi-lane roads found that in all cases, higher speed limits were associated with increases in fatal crashes that were substantially greater than what would be expected based on the increase in vehicle-miles traveled

(Figure 6). It should be noted that this data is not considered to be proof that higher rural speed limits cause severe crashes to increase because the original analysis was limited and did not account for factors such as, at the time traffic fatalities were increasing across the State and actual operating speeds only changed marginally. The ongoing update of the District Safety Plans will provide additional insight about the safety characteristics associated with 55 versus 60 mile per hour rural speed limits.

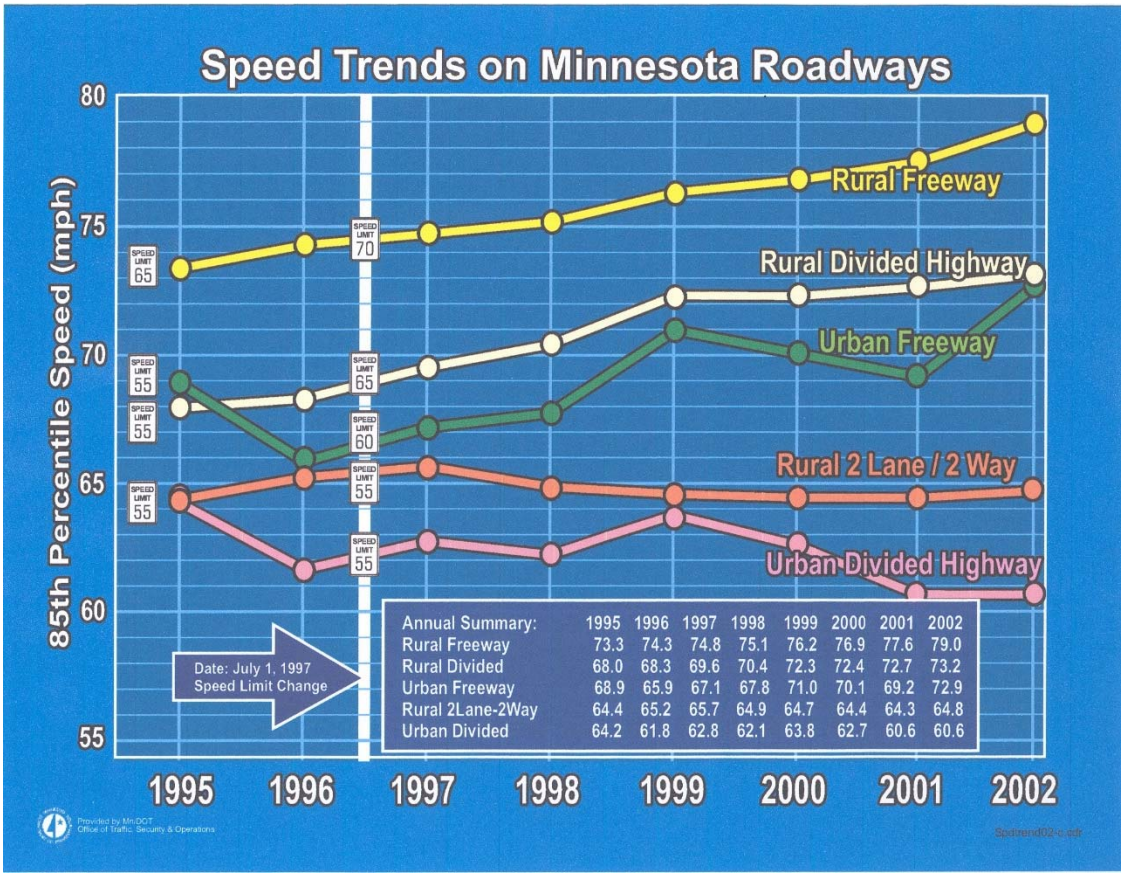
Figure 6 – Fatal Crashes and VMT Following 1997 Speed Limit Change




**Effect of Law Enforcement on Vehicle Speeds**

Efforts to influence drivers' choices of a reasonable and safe operating speed is a shared responsibility. Road authorities need to consider how to provide drivers with a consistent message with a road environment matching the posted speed limit and law enforcement needs to reinforce the message as to a maximum safe operating speed. The short term effects of applying enforcement at a particular location are well documented demonstrating that the presence of an officer is highly effective at a specific time and place. However, the "halo" effect of spot enforcement has been estimated to be in the range of one hour and one mile. The effect of saturation enforcement campaigns may extend to several months. MnDOT speed trend data (Figure 7) collected at sampling sites around the State indicate that there is only a very limited effect of enforcement across rural systems. The 85$^{th}$ percentile speeds on rural roads are in the range of eight to ten miles per hour over the posted limits and anecdotal information suggests that this is the threshold where enforcement focuses their efforts. It appears to be true that over time the maximum operating speed along rural roads approaches the speed where enforcement begins to hand out tickets.

Figure 7 – Speed Trends on Minnesota Roadways




**Wrap-Up**

Key points to remember:

- The procedures for establishing speed restrictions along roadways in Minnesota are based on State Statutes, which assigns responsibility to the Commissioner of Transportation.
- There are two types of speed restrictions in Minnesota: statutory limits in rural and urban areas where no special hazards exist and speed zones that are based on the outcome of engineering and traffic investigations.
- The performance measures used in the engineering and traffic investigations used to support the selection of speed limits include the 85$^{th}$ percentile speed and the ten mile per hour pace – both are considered to be best practices in the national research.
- The basic premise behind Minnesota's approach to establishing speed zones is that the majority of drivers will select a reasonable and safe maximum speed based on their perception of the road environment. This approach is consistent with the national research which also concludes that the majority of drivers will not obey a posted limit that is artificially set at a speed inconsistent with the road environment.
- A common opinion held by many residents and locally elected officials is that safety on urban roadways is a function of speed limit with roads with lower posted speed limits having a better safety performance. The available research suggests that this is NOT true and instead that the

safety performance of urban roadways appears to be related to access density and not speed limit.

- Research indicates that safety on rural roads is optimized when the prevailing speeds and posted speed limits are at or near the 85$^{th}$ percentile speed.
- Law enforcement should be a partner in any discussion of changing speed limits. However, there is no evidence in the national literature suggesting any lasting effects on driver behavior associated with short-term spot enforcement.
- If discussions with local authorities fail to reach an agreement on the issue of changing a speed limit, it appears that MnDOT's historic approach of making a temporary adjustment followed by regular monitoring and a return to the previous limit if driver behavior does not change is an effective method for settling disputes.

**References**

MnDOT, *Methods for Setting Posted Speed Limits*. 2012 [Transportation Research Synthesis 1204]

FHWA, *Procedures for Setting Advisory Speeds on Curves.* [FHWA-SA-11-22]

FWHA, *Effects of Raising and Lowering Speed Limits on Selected Roadway Sections.* 1997 [FHWA-RD-9 7-084]

MnDOT, *Statistical Relationship between Vehicular Crashes and Highway Access, MN/RC-1998-27*