



# Research

## Investigating the Effects of Traffic Calming Strategies on Driver Behavior



Minnesota Local Road Research Board



# **Investigating the Effects of Traffic Calming Strategies on Driver Behavior**

## **Final Report**

Prepared by:

*Kathleen A. Harder, Ph.D.*

Program for Interdisciplinary Human Factors Research in Simulation and Transportation  
Department of Mechanical Engineering  
Institute of Technology  
and  
Center for Sustainable Building Research  
College of Architecture and Landscape Architecture  
University of Minnesota

*John C. Carmody, M.Arch.*

Center for Sustainable Building Research  
College of Architecture and Landscape Architecture  
University of Minnesota

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### **Technical Advisory Committee**

Tom Eggum, Director of Public Works, City of St. Paul (Chair)

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Carla Jones, Traffic Engineer, City of Plymouth

Don Theisen, County Highway Engineer, Dakota County

Jim Aamot, Office of Research Services, Mn/DOT

Mark Lober, Office of Environmental Services, Mn/DOT

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# **EXECUTIVE SUMMARY**

## **Introduction**

The objectives of this project were twofold: (1) to investigate whether the results obtained in a *before-and-after* traffic calming experiment conducted on a driving simulator parallel a real world *before-and-after* traffic calming study, and (2) to document whether or not targeted traffic calming strategies result in reduced driving speeds. The two traffic calming experiments reported here are part of a larger traffic calming study conducted by SRF Consulting Group, Inc. (Corkle, Giese, and Marti; 2001). This report gives a detailed account of the two traffic calming experiments that were conducted, in an interleaved manner, in a driving simulator.

## **Experiment #1: Franklin Avenue Traffic Calming Study**

Experiment #1 investigated the effect of traffic calming devices already installed on the stretch of Franklin Avenue running between Chicago Avenue and Hiawatha Avenue in Minneapolis. A parallel *before-and-after* study was conducted on the actual roadway, by Corkle et al. (2001). (Reconstruction of Franklin Avenue in Minneapolis, MN was finalized in Spring 2001.)

## ***Method***

Data are reported for 20 participants (10 females and 10 males-between 18 and 65 years of age), all of whom had a valid driver's license and were reimbursed for their time. Each participant drove in the wrap-around driving simulator located in the University of Minnesota's Human

Factors Research Laboratory. The simulator vehicle had sensors to detect accelerator, brake, and steering inputs, and provided a real-time interface for the driver.

For Experiment #1, there were two road environments:

- 1) "Old" Franklin Avenue (4-lane bi-directional roadway).
- 2) "New" Franklin Avenue (2-lane bi-directional with center turn lane, chokers, and plantings).

Each participant drove in both environments, with the order in which they encountered them counterbalanced-half the participants drove the "Old" Franklin Avenue followed by the "New" Franklin Avenue; the other half drove the "New" Franklin Avenue and then the "Old" Franklin Avenue. [Note: the participants drove the two Franklin Avenue environments *after* driving the first block of trials for Experiment #2, and *before* driving the second block of trials for Experiment #2.] After driving in the simulator, each participant was asked to complete a short questionnaire.

### ***Results and Discussion***

Analysis of the data showed that the average speed in the "New" (and calmed) Franklin Avenue was slower than in the "Old" Franklin Avenue-the average speed was 26.55 mph (42.73 kph) in the "New" Franklin and 28.25 mph (45.46 kph) in the "Old" Franklin (the difference was statistically significant, at the  $p = 0.0254$  level). Further, when looking at the data on a case by case basis, 18 of the 20 participants drove more slowly in the "New" Franklin Avenue. (This, too, was statistically significant, at the  $p < 0.001$  level.) However, the questionnaire data revealed

that only 11 of the 20 participants realized that their speed had been different in the two drives.

The experiment suggests that the traffic calming elements deployed along Franklin Avenue between Chicago and Hiawatha Avenues will produce modest reductions in average traffic speed (of approximately 1.70 mph, 2.73 kph). It should be noted that similar reductions in speed were obtained in the field study conducted by Corkle et al.

## **Experiment #2: Residential Traffic Calming Study**

This experiment examined the individual effects on driver speed of adding median islands, chokers, and plantings in a residential environment. This study was *not a before- and-after* study with real world parallels.

### ***Method***

In Experiment #2, which was run concurrently with Experiment #1, data were collected from 23 participants. There were 12 females and 11 males, all between 18 and 65 years of age, each of whom had a valid driver's license and was reimbursed for their time. Each participant drove in the wrap-around driving simulator located in the University of Minnesota's Human Factors Research Laboratory.

In Experiment #2, there were two independent variables:

- 1) Curb Treatments (median islands and chokers, median islands only, chokers only, and a control with neither median islands nor chokers).
- 2) Plantings (median islands and chokers with plantings, median islands with plantings, chokers with plantings, and a control with neither median islands nor chokers nor plantings).

The experiment was divided into two sections, with Experiment #1 presented between them, as a buffer. The Curb Treatments were varied within sections (with Latin squares used to randomize their order in a counterbalanced fashion). The Plantings and No Plantings conditions were counterbalanced (across the participants) between the two sections. The Plantings and No Plantings sections were both 4.97 miles (8.00 km) in length, and the participants encountered all the conditions within each section without interruption.

Half of the participants drove with the four No Plantings conditions first. Then, they drove twice on Franklin Avenue--once on the "Old" Franklin Avenue, once on the "New" Franklin Avenue, with the order of these two drives counterbalanced across participants. After completing both Franklin Avenue drives, these participants drove the residential environment with Plantings. The other half of the participants drove with Plantings first, then drove the two Franklin Avenue conditions of Experiment #1, following this by driving with No Plantings. The order of conditions within each section was randomized. After driving in the simulator, each participant completed a short questionnaire.

## ***Results and Discussion***

A two-way analysis of variance of the speed data showed that there were two statistically significant effects:

- For Curb Treatments ( $p < 0.05$ ).
- And for the interaction between Curb Treatments and Plantings ( $p < 0.01$ ).

First, considering Curb Treatments, irrespective of whether there were Plantings or No Plantings, average speed decreased as Curb Treatments were added to the control condition:

- There was a reduction when chokers, but not median islands, were added.
- There was a further reduction when median islands, but not chokers, were added.
- And, there was still a further reduction when both chokers and median islands were added.

The reduction in average speed from the control condition to the condition with all three treatments (median islands and chokers, and Plantings) was approximately 3.3 mph (5.3 kph). When there were No Plantings, this reduction was approximately halved—it was 1.7 mph (2.7 kph).

Second, the interaction between Curb Treatments and Plantings occurred, in part, because the reductions between the control conditions and the conditions with median islands and chokers were different in the presence and absence of Plantings. In addition, the average speeds were lower for the three conditions in which there were Plantings with the Curb Treatments than they were when there were No Plantings with these same three Curb Treatments. And, at the same

time, the average speed was higher for the control condition embedded in the with-Plantings conditions than it was for the control condition embedded in the No-Plantings conditions.

The analysis of the results of Experiment #2 indicates that the participants drove slower when both median islands and chokers were placed on the residential road than they did when there were no Curb Treatments.

The influence of Plantings on speed is complex. When Plantings were combined with Curb Treatments, lower mean speeds were obtained than when the same Curb Treatments were used without Plantings. However, the mean speed in the control condition that was included in the Plantings section of Experiment #2 was faster than the mean speed for the control condition in the No Plantings section of Experiment #2. It may seem strange that there was a difference in mean speeds, since the two control conditions were identical- except for the fact that they occurred in different sections of Experiment #2. It is possible that the difference in mean speeds occurred was a context effect. If Plantings are introduced as calming devices on extensive road segments, they may be effective, but if the "calmed" segments are interspersed with "uncalmed" segments, there may be an increase in speed in the adjacent "uncalmed" segments. The result obtained here suggests that planners should be cautious when adding features intended to calm traffic, since there may be unintended consequences in neighboring road segments in which no calming elements are added.

## **Conclusion**

Taken together, the two experiments reported here show that if median islands, chokers and plantings are deployed, they are likely to produce reductions in traffic speed. Further research is required to discover how specific placement or spacing of the traffic calming elements would affect traffic speeds. Further, results obtained with the driving simulator parallel the direction of results obtained in the real world study of the urban environment of Franklin Avenue in Minneapolis, Minnesota. Nevertheless, the traffic calming elements produced only modest speed reductions in both the real world study and the driving simulator study; whether these reductions are of operational importance remains to be determined. These studies illustrate that the addition of traffic calming elements makes a difference in driver speed, but a systematic research program must be conducted before traffic calming standards are implemented.

## **INTRODUCTION**

The objectives of this project were twofold: (1) to investigate whether or not the results obtained in a before-and-after traffic calming experiment, conducted on a driving simulator, parallel a real world before-and-after traffic calming study conducted by SRF Consulting Group, Inc., and (2) to explore whether or not targeted traffic calming strategies result in reduced driving speeds. The two traffic calming experiments reported here are part of a larger traffic calming project conducted by SRF Consulting Group, Inc. (Corkle, Giese, and Marti, 2001). This report gives a detailed account of the two experiments conducted in a driving simulator. The two experiments, which were interleaved, investigated the effects of various traffic calming strategies (lane manipulations, chokers, median islands, and plantings) on driving speed.



# **EXPERIMENT #1: FRANKLIN AVENUE TRAFFIC CALMING STUDY**

The first experiment presented here investigated the effect of traffic calming devices that were actually installed on the stretch of Franklin Avenue running between Chicago and Hiawatha Avenues in Minneapolis. In addition to the simulation experiment, SRF Consulting Group, Inc conducted a before and after study on the actual roadway. (Reconstruction of Franklin Avenue in Minneapolis, Minnesota was finalized in Spring- 2001.) Comparing the results of the experiment reported here with the Corkle et al. (2001) study allows for validation of the driving simulator.

## **Method**

### ***Participants***

Initially, 24 participants took part in both experiments. However, because there were simulator data collection problems for four of the participants in Experiment #1, the data reported here were obtained from 20 participants. They were between 18 and 65 years of age. There were 10 females and 10 males. Each participant had a valid driver's license at the time of the experiment. Each participant was reimbursed \$10 for his or her time.

## *Driving Simulator*

Each participant drove in the wrap-around driving simulator located in the University of Minnesota's Human Factors Research Laboratory. The simulator vehicle was a full-body 1990 Acura Integra RS. This vehicle was enclosed in a spherical wood and steel dome that was 12.5-ft (3.81-m) high at its apex, and had a 15.5-ft (4.73-m) internal diameter. The vehicle, which had sensors to detect accelerator, brake, and steering inputs, provided a real-time interface for the driver. A torque motor was applied to the steering column to provide force feedback to the steering wheel. The speedometer was functional, and powered by a small motor controlled by the main simulator computer.

The virtual environment through which the participants drove was generated with an SGI Onyx computer (Reality Engine 2). The programming was conducted on MultiGen- Paradigm Vega and SGI Performer APIs. The main simulator computer was a PC, running Linux, which processed all vehicular sensors and controllers. The vehicular hardware interfaced the main simulator computer by means of a National Instruments AT-MIO-16E-10 data card. Information from this computer was transmitted to and from the Onyx via TCP/IP. The Onyx calculated the vehicle dynamics and generated the visual scenario.

A Proxima 9250+ projector, operating at a resolution of 1240 X 768, was used to create the visual scene inside the simulator. A virtual roadway was projected onto the midsection of a curved seamless 24 ft (7.32 m) x 8 ft (2.44 m) screen positioned in front of the simulator vehicle. The projector provided a 52-deg. forward field of view.

Engine noise and road noise were generated by the Onyx and fed through a Cerwin- Vega satellite and subwoofer system, mounted in the trunk of the vehicle, and two Aura bass shakers mounted under the front seats. A separate stereo receiver (Sony #STR-D365, Tokyo) powered this supplemental system.

## *Experimental Design*

For this experiment, there were two road environments:

- 1) "Old" Franklin Avenue (4-lane bi-directional roadway).
- 2) "New" Franklin Avenue (2-lane bi-directional with center turn lane, chokers, and plantings).

The experimental design was a within-subjects design; each participant drove in both environments. The order in which they encountered the environments was counterbalanced across the participants: so, half the participants drove the "Old" Franklin Avenue first and then the "New" Franklin Avenue; while the other half drove the "New" Franklin Avenue first and then the "Old" Franklin Avenue.

It should be noted that the participants drove the two Franklin Avenue environments investigated in this experiment after driving the first block of trials for Experiment #2, and before driving the second block of trials for Experiment #2. The complete order of presentation of conditions in this experiment (along with the order of presentation for the condition in Experiment #2) is presented in Appendix A.

## *Procedure*

First, each participant had a training drive in the simulator vehicle, in order to become familiar with driving on simulated roadways. He or she was instructed to drive as they normally would on real roads. Next, the participant drove a block of trials for Experiment #2. Then, he or she drove twice on the stretch of Franklin Avenue starting at Chicago Avenue and ending just before Hiawatha Avenue in Minneapolis. One drive was with the "Old" Franklin Avenue, the other with the "New" Franklin Avenue. The order of these two drives was counterbalanced across the participants. The two Franklin Avenue drives were separated by a short pause of approximately one minute. After completing the second Franklin Avenue drive, the participant drove a second block of trials for Experiment #2.

After driving in the simulator, each participant was asked to complete a short questionnaire pertaining to the experience of driving the virtual roadways.

## Results

### *Driving Performance Data*

The mean speeds (and the standard deviations around the means) at which the participants drove in the "old" and "new" Franklin Avenue environments are shown in Table 1.

**Table 1. Mean Speed (with standard deviation) when Participants Drove on the "Old" and the "New" Franklin Avenue.**

Environment	Mean Speed	Standard Deviation
"Old" Franklin Avenue	28.25 mph (45.46 kmh)	3.90 mph (6.28 kmh)
"New" Franklin Avenue	26.55 mph (42.73 kmh)	3.04 mph (4.89 kmh)

When a paired-sample *t*-test was performed on these data, it revealed that the difference between these means was statistically significant-the average speed was significantly slower in the "New" Franklin Avenue condition ( $t = 2.425$ , with 19 *df*,  $p = 0.0254$ ). Closer inspection of the data reveals that just two participants drove "New" Franklin Avenue faster than "Old" Franklin Avenue. One participant in particular, whose data are included in this analysis, drove "New" Franklin Avenue 9.4 mph (15.05 kmh) faster than

**"Old" Franklin Avenue.** Eighteen of the 20 participants drove more slowly on the "New" Franklin Avenue-this was also statistically significant (sign test,  $p < .001$ ).

In order to compare the simulation findings with the real world findings of Corkle et al., average speeds were calculated at two intersections along the Franklin Avenue route: (i.) Elliot Avenue and (ii.) 11th Avenue. The average speeds obtained at these intersections with the driving simulator are presented in Table 2.

**Table 2. Average Intersection Speeds (in Driving Simulator) for Two Test Sites on Franklin Avenue**

	"Old" Elliot Avenue	"New" Elliot Avenue	"Old" 11th Avenue	"New" 11th Avenue
Mean Speed	31.2 mph (50.2 kph)	29.3 mph (47.1 kph)	33.5 mph (53.9 kph)	30.6 mph (49.2 kph)
Standard Deviation	4.3 mph (6.9 kph)	5.0 mph (8.0 kph)	5.3 mph (5.3 kph)	4.5 mph (7.2 kph)

Table 2 shows that speeds at the "New" Elliot Avenue intersection decreased by 1.9 mph (3.1 kph) relative to the "Old" Elliot Avenue intersection. And average speeds at the "New" 11th Avenue intersection were 2.9 mph (4.7 kph) lower than average speeds on the "Old" 11th Avenue.

### ***Questionnaire Data***

Questionnaire data are included for the 20 participants for whom we obtained driving simulator data. When participants were asked "Did you drive at the same speed when you were driving past the buildings on the city street?" 9 participants responded that "yes" they did drive at the same speed and 11 responded that "no" they did not drive the same speed.

A variety of answers were given in response to the question "If you didn't drive at the same speed, what made your speed change?" These responses included:

- "The buildings made me slow down."
- "Speed lights; different buildings around with different colors making me slow down to look at them."
- "Cars parked on side of street; cars in left-turn lane."

- "Being cautious in city and residential areas."
- "I was more likely to drive a little faster on the street without intermittent curbs. I believe the curbs did have an impact psychologically which hindered me slightly (hindered my speed)."

It is interesting to note that the last of these five comments directly referred to the traffic calming elements introduced in the "New" Franklin Avenue. Another comment ". . . cars in left turn lane" referred to another change. It should be noted that the other three comments referred to elements that were constant in the "Old" and "New" Franklin Avenue.

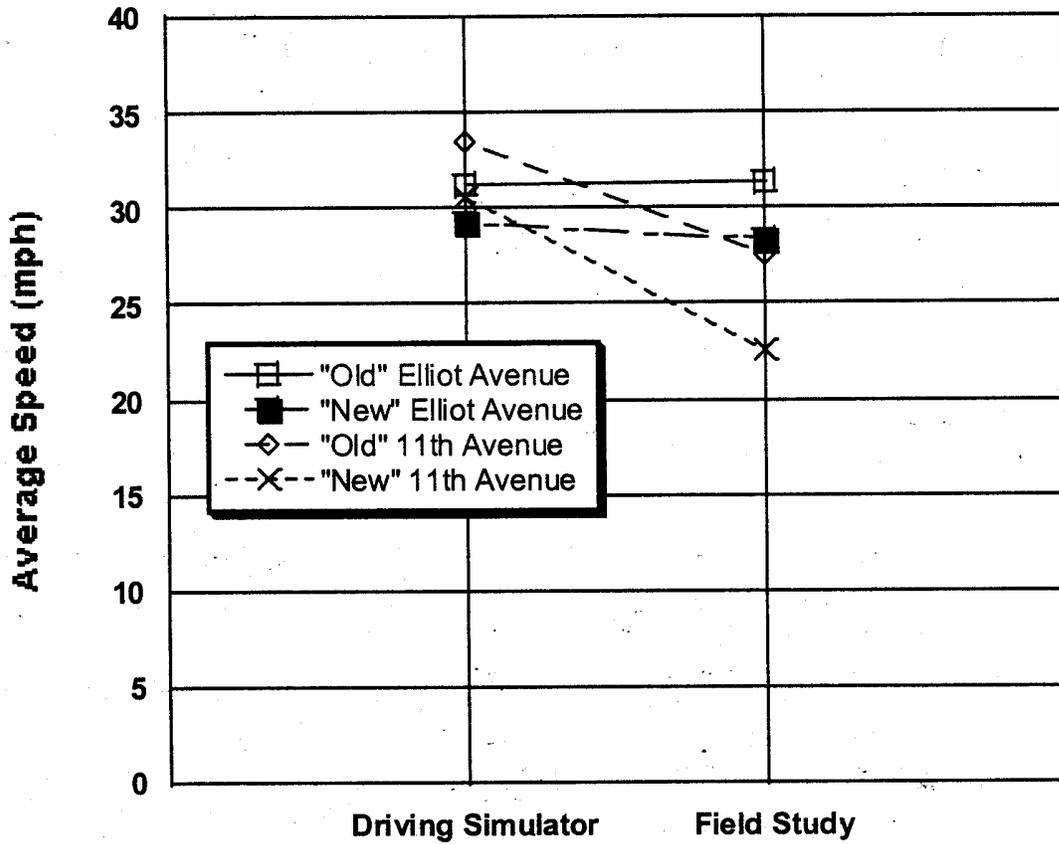
## **Discussion**

The results indicate that the traffic calming elements implemented along Franklin Avenue from Chicago to Hiawatha Avenues produced a statistically significant reduction in the average speed of the traffic, though this reduction was relatively small-it was only 1.70 mph (2.73 kmh). It should be noted, however, that when the outlying participant's data were removed from the analysis the average speed of traffic on the "New" Franklin Avenue was 2.29 mph (3.67 kph) less than the average speed on the "Old" Franklin Avenue.

It is interesting to note that the direction of the results obtained with the driving simulator parallels results obtained along the same stretch of roadway in the real world (Corkle et al., 2001). Figure 1 shows the average speeds obtained in the driving simulator and the field study. For both intersections there were reductions in speed in the "New" *calmed* sections in both the driving simulator experiment and field study. However, in this study, as well as in all prior comparisons of simulator driving and real world driving ( e.g., Walter Wierwille's work on driving simulator validation in the early 1980s, and the validation work by Peter Grant in the early 1990s on the Iowa Driving Simulator), the relationship between performance in the driving simulator and the real world is complex. Figure 1 reveals that there is not a one-to-one relationship between driving in the simulator and driving in the real world. At the Elliot Avenue intersection, there is only a small reduction in the speeds obtained in the real world versus the speeds obtained in the driving simulator; whereas, at the 11th Avenue intersection, the reduction

in speed is somewhat larger in the real world than in the driving simulator. However, the trends in the driving simulator and the real world are the same at both intersections.

Figure 1. Average Speed at Two Intersections: Driving Simulator vs. Field Study







## **EXPERIMENT #2: RESIDENTIAL TRAFFIC CALMING STUDY**

This experiment investigated the influence of individual traffic calming elements on driver speed. It was *not* a *before-and-after* study with real world parallels. While Experiment #1 investigated the effects of applying several traffic calming elements simultaneously to a section of Franklin Avenue (an urban environment), this experiment examined the particular effects on driver speed of adding median islands, chokers, and plantings to a residential environment.

### **Method**

This experiment was run concurrently with Experiment #1 (the Franklin Avenue Traffic Calming Study) described in the previous section of this report. Only the differences between the two studies are mentioned here.

### ***Participants***

There were 24 participants, but, because of driving simulator data collection problems for Experiment #2, the data were only valid for 23 participants. There were 12 females and 11 males all of whom were between 18 and 65 years of age. Each had a valid driver's license at the time of the experiment. Participants were reimbursed \$10 for the time they spent in both experiments.

## *Apparatus*

The wrap-around driving simulator used for this experiment is described in the Method section of Experiment #1 (the Franklin Avenue Traffic Calming Study).

## *Experimental Design*

This experiment explored two independent variables:

1) Curb Treatments (median islands and chokers, median islands only, chokers only, and a control condition with neither median islands nor chokers).

2) Plantings (median islands and chokers with plantings, median islands with plantings, chokers with plantings, and a control condition with neither median islands nor chokers nor plantings).

The experiment was divided into two sections, with Experiment #1 presented between them, as a buffer. The Curb Treatments were varied within the sections, with Latin squares used to randomize their order in a counterbalanced fashion. The Plantings conditions were varied between sections, with their order counterbalanced across the participants. The complete order of presentation of conditions in this experiment (along with the order of presentation for the conditions in Experiment #1) is presented in Appendix A.

## *Procedure*

As mentioned in the procedure section for Experiment #1, each participant began with a training drive in the simulator vehicle in order to become familiar with driving on simulated roadways. Next, the participant drove one of the two sections of Experiment #2. Half of the participants drove the four No Plantings conditions first. Then, he or she drove twice on Franklin Avenue--Once on "Old" Franklin Avenue, and once on "New" Franklin Avenue, with the order of these two drives counterbalanced across the participants. After completing the second Franklin Avenue drive, these participants drove the Plantings conditions.

The other half of the participants drove the Plantings conditions first, then drove the two Franklin Avenue conditions of Experiment #1, and followed this by driving the No Plantings conditions. The order of conditions within each section was randomized and participants were randomly assigned to their order of conditions. Each section of Experiment #2 was 4.97 miles (8.00 km) and the conditions within each section were presented without interruption. There was a short break between each section.

After driving in the simulator, each participant was asked to complete a short questionnaire pertaining to the experience of driving the virtual roadways.

## Results

### *Driving Performance Data*

A two-way analysis of variance (ANOVA) was conducted to determine the effects of Curb Treatments and Plantings. The results of this ANOVA are shown in Table 3.

**Table 3. Summary Table for Two-Way ANOVA Performed on the Speed Data Obtained in Experiment #2**

Source	Degrees of freedom	Sum of squares	Error c term used	Variance estimate	F-value	P-value
Curb Treatments	3	432.104	(1)	144.035	3.329	<b>&lt;0.05</b> (3, 66)
Plantings	1	8.266	(2)	8.266	0.055	– (1 & 22)
CT x P	3	69.189	(3)	23.063	24.483	<b>&lt;0.01</b> (3,66)
Subjects	22	18,135.489				
(1) CT x Subjects	66	2,855.771		43.269		
(2) P x Subjects	22	3,332.859		151.494		
(3) CT x P x Subjects	66	62.186		0.942		
<b>Total</b>	<b>183</b>	<b>24,895.864</b>				

Table 3 shows that there was a statistically significant main effect for Curb Treatments ( $p < .05$ ). In addition, there was a statistically significant interaction between Curb Treatments and Plantings ( $p < 0.01$ ). Both the interaction and the main effect are shown in Figure 2.

**Figure 2. Mean Speed (mph) With and Without Plantings Plotted as a Function of Curb Treatments.**

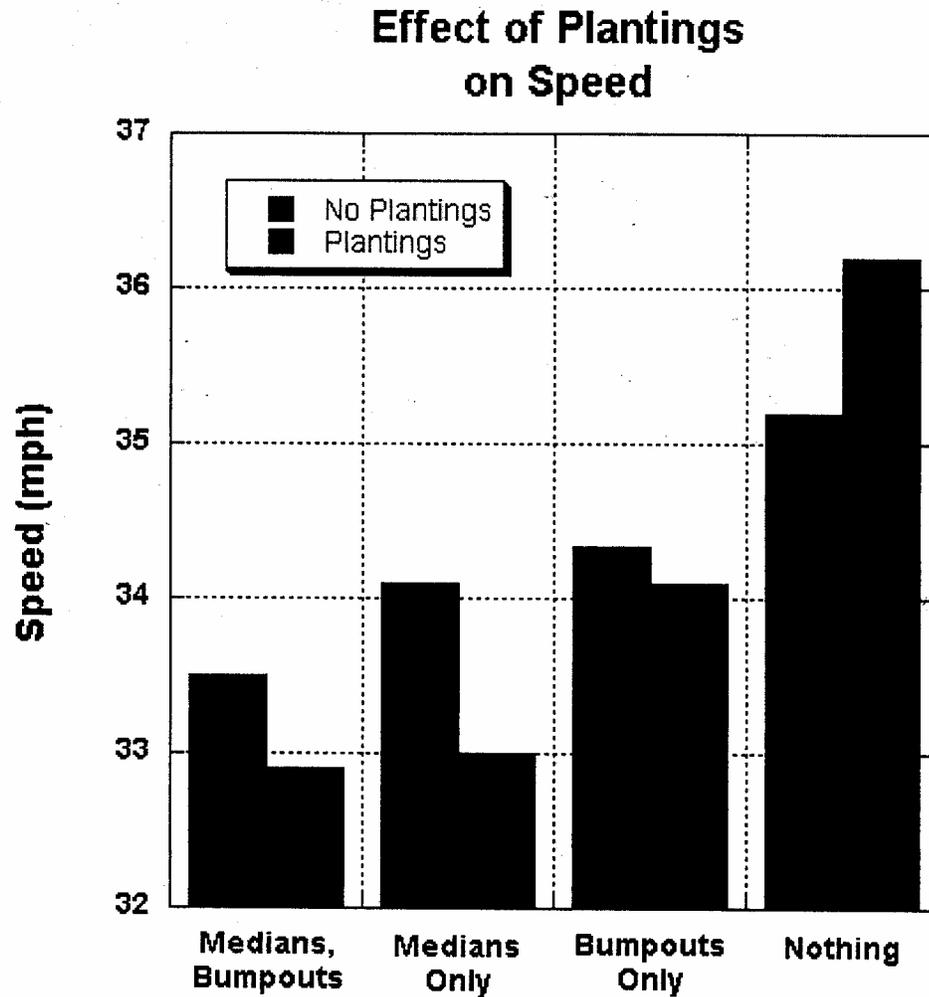


Figure 2 reveals that, irrespective of whether there were plantings or not, the average speed decreased from the control conditions with no Curb Treatments. There was:

- A reduction when chokers only (referred to as bumpouts in the figure) were present,

- A further reduction when median islands only were present,
- A still further reduction when both chokers and median islands were present.

The reduction in average speed from the control condition and the condition with both median islands and chokers with Plantings was approximately 3.3 mph (5.3 kmh). When there were no Plantings this reduction was approximately halved-the reduction was from 1.7 mph (2.7 kmh). The Curb Treatments-Plantings interaction occurred in part because the speed reductions between the control conditions and the conditions with median islands and chokers were different in the presence and absence of Plantings. In addition, the average speeds were lower for the three conditions in which there were Plantings with the Curb Treatments than there were for these same three Curb Treatments without Plantings; while the average speeds were higher for the control condition run in the with Plantings section of the experiment.

### ***Questionnaire Data***

When asked "Did you drive at the same speed when you were driving past the houses in the suburban development?" 10 participants responded that "yes" they did drive at the same speed and 13 responded that "no" they did not drive the same speed.

Typical examples of responses given to the question "If you didn't drive at the same speed, what made your speed change?" included:

- "Protruding boulevards, large trees, curves, and islands with signs caused me to slow down. Straightaways without these caused me to speed up."
- "Narrowness of street, median, sign on median (red especially), proximity maybe of trees."

Unlike Experiment #1, all the responses given here related to the traffic calming elements, added to the residential environment.

## Discussion

The analysis indicates that the participants drove more slowly when both median islands and chokers were placed on the residential road than they did when there were no Curb Treatments.

The influence of Plantings on speed is complex. When Plantings were combined with Curb Treatments there were lower mean speeds than when the same Curb Treatments were used without Plantings. However, it should be noted that the mean speed in the control condition that was included in the Plantings section of Experiment #2 was faster than the mean speed for the control condition in the No Plantings section of Experiment #2.

At first, it may seem strange that this difference in mean speed occurred, since the two control conditions were identical-except for the fact that they occurred in different sections of Experiment #2. A possible explanation for the difference in mean speed is that it occurred as a result of the context within which the otherwise-similar control conditions were experienced by the participants. Specifically, when Plantings are introduced as calming devices on extensive road segments, they may be effective, but if the "calmed" segments are interspersed with "uncalmed" segments, there may be an increase in speed on the "uncalmed" segments. The result obtained here suggests that planners should be cautious when adding features intended to calm traffic, and that they should try to determine whether there are likely to be unintended consequences on driving -speed in neighboring road segments in which no traffic calming elements are added.

This study confirms that in general median islands and chokers impact driver speeds. In a future study it would be valuable to discover how specific placement or spacing of the traffic calming elements would affect traffic speeds.



## CONCLUSION

Taken together, the two Experiments reported here show that, if median islands, chokers and plantings are deployed, they are likely to produce measurable reductions in traffic speed. Further research is required to discover how the specific placement or spacing of the traffic calming elements would affect traffic speeds. Further, the results obtained with the driving simulator parallel the direction of results obtained in the real world study of the urban environment of Franklin Avenue.

It should be noted that of the two experiments presented here, just one has a *before-and-after* real world parallel. While the results of the *before-and-after* simulator study parallel the results of the real world study, conducted by SRF Consulting Group, Inc., it would be useful to run additional simulator studies concurrently with real world studies. This would provide more information and would improve our understanding of the relationship between real world driving and simulator driving.

Further, the issue of what denotes operationally important (or meaningful) speed reduction merits consideration. The results obtained in these studies indicate only modest reductions in speed after the installation of traffic calming elements. These speed reductions are statistically significant. However, it remains to be seen whether the real, but small, speed reductions are operationally important in the real world of roadway design or in terms of the public's perception. More research is needed to explore what "effective" means in traffic calming efforts. A systematic research program must be conducted before traffic calming standards are implemented.



## REFERENCES

Corkle, J., Giese, J.L., and Marti, M.M. (2001). *Investigating the Effectiveness of Traffic Calming Strategies on Driver Behavior, Traffic Flow, and Speed*. Report Number: 2002-02, Minnesota Local Road Research Board, Mn/DOT Office of Research Services, St. Paul, MN.



## **APPENDIX A**

### **Presentation Order of Experimental Conditions**

## Appendix A

The order of presentation of the conditions that were tested in Experiments #1 and #2 are shown in Table A-1

Table A-1  
Presentation Order of Experimental Conditions

Subject												
1	G	H	I	D	Break	New	Old	Break	B	C	D	A
2	D	B	C	A	Break	Old	New	Break	G	I	D	H
3	H	D	G	I	Break	New	Old	Break	C	A	B	D
4	A	B	C	D	Break	Old	New	Break	I	H	G	D
5	I	G	D	H	Break	New	Old	Break	A	C	D	B
6	B	D	A	C	Break	Old	New	Break	H	D	I	G
7	D	I	H	G	Break	New	Old	Break	C	B	A	D
8	C	A	D	B	Break	Old	New	Break	D	G	H	I
9	G	H	D	I	Break	New	Old	Break	B	D	C	A
10	D	C	B	A	Break	Old	New	Break	G	D	H	I
11	H	I	G	D	Break	New	Old	Break	D	A	B	C
12	A	B	D	C	Break	Old	New	Break	D	I	G	H
13	I	D	H	G	Break	Old	New	Break	A	D	B	C
14	B	C	A	D	Break	New	Old	Break	H	G	I	J
15	D	G	I	H	Break	Old	New	Break	D	C	A	B
16	C	D	B	A	Break	New	Old	Break	I	H	D	G
17	G	I	H	D	Break	Old	New	Break	B	A	C	D
18	D	A	C	B	Break	New	Old	Break	G	D	I	H
19	I	D	G	H	Break	Old	New	Break	C	B	D	A
20	A	C	B	D	Break	New	Old	Break	D	H	G	I
21	H	G	D	I	Break	Old	New	Break	A	D	C	B
22	C	D	A	B	Break	New	Old	Break	H	I	D	G
23	D	H	I	G	Break	Old	New	Break	D	B	A	C
24	B	A	D	C	Break	New	Old	Break	I	G	H	D

Key:

A—No Plantings; With Median Islands; With Chokers

B—No Plantings; With Median Islands; Without Chokers

C—No Plantings; Without Median Islands; With Chokers

D—No Plantings; Without Median Islands; Without Chokers

New—“New” Franklin Avenue

Old—“Old” Franklin Avenue

G—With Plantings; on Median Islands; and on Chokers

H—With Plantings; on Median Islands; but Without Chokers

I—With Plantings; Without Median Islands; Plantings on Chokers

D—No Plantings; Without Median Islands; Without Chokers