An evaluation of the dynamic curve warning system in the Sacramento River Canyon
by Lani Alyson Tribbett

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering
Montana State University


Abstract:
The dynamic curve warning system in the Sacramento River Canyon consists of five dynamic curve warning signs at five different curves. The system has been installed to inform and prepare the drivers of upcoming potentially hazardous curves. The five sites are located on Interstate 5, in Shasta County, California. This report includes the results of the evaluation conducted on the effectiveness of the system.

The individual sign systems include a radar unit to measure speeds of approaching vehicles and a changeable message sign to display the corresponding speeds to the travelers. Four site visits were made to collect data both before and after the installation of the system: one before the installation, and the remaining three at different times after the installation date. Measures of effectiveness included crashes, vehicle speeds, driver behavior (erratic maneuvers), motorist opinion, and maintenance personnel opinion. Statistical analyses were conducted on the speed and erratic maneuver data to show if the observed changes were statistically significant.

Because crash data could only be obtained for the six-month period following the installation date, a thorough crash analysis could not be completed. A brief analysis was done showing slight reductions at two of the five sites, while the other three experienced slight increases. Truck speeds were found to significantly decrease at three of the five sites, while non-truck speeds were found to significantly decrease at two of the five sites. Two of the five sites experienced significant reductions in the percentage of drivers conducting erratic maneuvers. Overall, drivers favored the dynamic curve warning system. Maintenance personnel reported a couple of problems that had either been solved or were being modified at the time this report was written.

Results show the dynamic curve warning system to be most effective at lowering speeds at the curves with the more severe horizontal and vertical curves. Due to the uncertainty of interpretation of the erratic maneuver data, the results of the final evaluation were not influenced by erratic maneuvers. Drivers and maintenance personnel were generally supportive of the system. For a more accurate evaluation, further crash analysis should be conducted after more crash data can be obtained.

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APPROVAL

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Lani Alyson Tribbett

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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# ABSTRACT

The dynamic curve warning system in the Sacramento River Canyon consists of five dynamic curve warning signs at five different curves. The system has been installed to inform and prepare the drivers of upcoming potentially hazardous curves. The five sites are located on Interstate 5, in Shasta County, California. This report includes the results of the evaluation conducted on the effectiveness of the system.

The individual sign systems include a radar unit to measure speeds of approaching vehicles and a changeable message sign to display the corresponding speeds to the travelers. Four site visits were made to collect data both before and after the installation of the system: one before the installation, and the remaining three at different times after the installation date. Measures of effectiveness included crashes, vehicle speeds, driver behavior (erratic maneuvers), motorist opinion, and maintenance personnel opinion. Statistical analyses were conducted on the speed and erratic maneuver data to show if the observed changes were statistically significant.

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Results show the dynamic curve warning system to be most effective at lowering speeds at the curves with the more severe horizontal and vertical curves. Due to the uncertainty of interpretation of the erratic maneuver data, the results of the final evaluation were not influenced by erratic maneuvers. Drivers and maintenance personnel were generally supportive of the system. For a more accurate evaluation, further crash analysis should be conducted after more crash data can be obtained.

# CHAPTER 1

## INTRODUCTION

In 1994, there were approximately 6.5 million motor vehicle crashes in this country, which cost the United States over $150 billion in associated medical and legal expenses, insurance administration costs, lost productivity, and property damage (1). It is generally acknowledged that countermeasures must be developed and implemented by states to reduce the frequency and severity of vehicle crashes. One method of improving conditions at high crash locations involves alerting motorists of approaching hazards or conditions through the use of traffic control devices, including signs, signals, and pavement markings. Different types of signs can be installed, depending on the specific needs of the particular area. General sign types include regulatory, warning, guidance, recreational, and construction or maintenance. Specifically, warning signs are used to inform motorists of hazards to minimize crashes and reduce injuries and crash-related costs. Warning signs are commonly installed as permanent safety improvements, and can be accompanied by regulatory signs.

Because of cost considerations and geographic constraints, such as mountains, canyons, and waterways, some sections of highways are constructed below the design speed. Specifically, some horizontal curves may need to have a radius shorter than can be traversed safely at the operating speed for the rest of the highway. Additionally, heavy trucks may need to travel at lower speeds on long, steep downgrades in order to avoid a runaway situation. Where geometric features, such as curves of short radii and long and steep downgrades, cannot feasibly be eliminated from a highway, appropriate warning signs should be placed in advance of these features to warn the driver of a reduction in appropriate speed.

Types of warning signs vary both in function and effectiveness. Static warning signs are usually installed at locations where an advisory speed differs from the design speed of the proceeding section of the roadway. Unfortunately, drivers can become desensitized to some such common applications. In an attempt to increase effectiveness by catching the attention of motorists, changes can be made to the traditional hardware and placement. For example, to attract drivers and possibly increase their attentiveness, flashing beacons can be added to static signs, or warning signs can be mounted over travel lanes.

Intelligent Transportation System (ITS) advancements provide a number of new possibilities for warning motorists of approaching hazards. For instance, ITS technologies, such as changeable message signs (CMS), have proven to be effective in informing and warning drivers, resulting in reductions in crashes and related costs (2). These signs are used by Departments of Transportation to display dynamic information to drivers. CMS are still relatively new and have had limited use in rural areas. Some CMS can present only one of a few predetermined messages, while others can display any message at any time. CMS are useful in problem areas, such as areas with recurring congestion, adverse weather conditions, and frequent road closures or crashes.

## Background

There are strong correlations between the speed of a vehicle and the probability of the vehicle being involved in a crash. Moreover, speed is also related to the severity of a crash. In 1997, 30% of all fatal crashes in the United States had speed reported as a contributing factor. Crashes in which speed was found to be a contributing factor accounted for 13,000 deaths and 41,000 critical injuries. These figures represent the investigating officer's interpretation of "speeding" or traveling at a "speed too fast for conditions" as *one* of the contributing factors to the crash and should be interpreted with caution (3). However, the numbers clearly suggest that excessive speed is a major safety challenge.

Many traditional solutions exist to mitigate speed-related crashes, such as (1) adjusting the speed limit and increasing enforcement; (2) installing static warning signs in advance of changes in alignment, access, or road surface where high speeds could increase the likelihood of a crash; and (3) reconstructing alignments, cross-sections and clear zones to improve a driver's chances to recover from overdriving the highway (4). These solutions may not always be feasible and speed-related crashes may still exist regardless of the countermeasures put into effect.

There are many types of rural ITS applications that can complement the existing infrastructure to improve the safety and efficiency of the transportation system. Some rural ITS applications can provide information to the driver regarding unsafe traveling speeds, particularly in relation to an upcoming hill or curve. The primary purpose of these ITS applications is to reduce crashes by better informing the drivers of what lies ahead on their route and posting an appropriate advisory travel speed.

## Static Signing

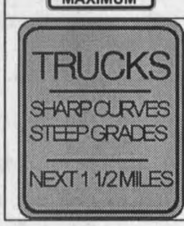
The Manual on Uniform Traffic Control Devices (MUTCD) was created in 1935 in order to regulate the use of traffic control devices with warrants. According to the MUTCD, these warrants are necessary to: "help insure highway safety by providing for the orderly and predictable movement of all traffic, motorized and non-motorized, throughout the national highway transportation system, and to provide such guidance and warnings as are needed to insure the safe and uniformed operation of individual elements of the traffic stream." (5).

Warning signs must meet requirements in the MUTCD concerning application, design, and placement. To ensure that static signs will "(1) fulfill a need; (2) command attention; (3) convey a clear, simple meaning; (4) command respect of road users; and (5) give adequate time for proper response" they should comply with the MUTCD and the Caltrans Traffic Manual for California (5). It is important that signs are only placed where needed to maximize their effectiveness. Unnecessary signs could result in motorists eventually learning to ignore all signs, even the imperative ones.

Static curve warning signs are used when drivers must be notified of a curve where the advisory speed has been lowered in order for drivers to safely complete it. Such static signs can be accompanied by a speed advisory plate to further increase safety conditions. Although currently under revision, the MUTCD only recognizes dynamic curve warning signs, such as CMS, but does not define specific requirements except to state that CMS should meet other warrants concerning design and application (5).

The MUTCD has a designated code for each sign, while the California Department of Transportation (Caltrans) uses a separate set of codes for identifying standard signs. Table 1 shows the different curve warning and speed signs present in the study area, their respective MUTCD symbol, the corresponding Caltrans symbol, a description of the sign, and its standard dimensions. Caltrans also has four signs not included in the MUTCD, as shown in Table 1.

Table 1. Existing Warning Sign Types (5, 6)

| Graphic | MUTCD | Caltrans | Description | Standard Dimensions |
|---|---|---|---|---|
|  | W1-2R | W5 (RT) | Right Curve | 30" X 30" |
|   | W13-1 | W6 (speed) | Speed Advisory Plate | 18" X 18"<br>24" X 24" |
|   | No MUTCD | W4 (RT) | Curve w/ Advisory Speed | 72" X 72" |
|  | W1-4R | W1 (RT) | Reverse Curve | 30" X 30" |
|  | W1-8 | W81 | Chevron Alignment | 18" X 24" |
|   | No MUTCD | W4 (RT) | Curve w/ Advisory Speed | 96" X 96" |
|   | No MUTCD | R48-1 | Speed Limit Plate | |
|   | R2-4 | R6(65) | Speed Limit | 24" X 30" |
|   | No MUTCD | R6-1 | Speed Limit | 24" X 30" |
|   | No MUTCD | No Caltrans Symbol | Trucks: Sharp Curves; Steep Grades | 96" X 96" |

ITS Applications of Dynamic Warning Systems

Intelligent Transportation Systems (ITS) are the advanced technologies and management strategies used to enhance the safety and efficiency of current transportation systems. There are many different applications of ITS, including lateral collision warning devices, automated highway systems, and dynamic speed warning systems, to name a few.

Dynamic speed warning systems can be used to mitigate speed in areas where geometric features may keep drivers from safely maintaining a uniform speed. These warning signs, which may be accompanied by other signs or advisories, can be installed in advance of locations with steep downgrades, areas with weather conditions that can affect safety, construction work zones, and specific curves with high frequencies of crashes. Other states, such as Colorado, Oregon, and Washington, and some European countries have conducted studies and installed similar changeable message sign systems for speed warning and regulation. It should be noted that this area of study is relatively new in the transportation industry and few systems exist that are similar to the dynamic curve warning system installed in the Sacramento River Canyon. The dynamic curve warning system differs from the aforementioned systems because it is the first ITS application to use radar for speed measurement and to sign for a specific curve(s).

In the summer of 1998, a Downhill Truck Speed Warning System was installed in Colorado for commercial vehicles on Interstate 70. The system determines the weight and configuration of commercial vehicles weighing over 40,000 pounds as they pass a weigh-in-motion device. A CMS displays a safe speed for the drivers to travel down the steep grade. According to the evaluation conducted at the University of Colorado at Denver, the Dynamic Truck Speed Warning System has significantly reduced commercial truck speeds through the steep descent from average speeds of 41 mph to 34 mph (7).

The Oregon Department of Transportation has installed a Downhill Warning System for commercial vehicles traveling on I-84 between Pendleton and La Grande, Oregon. This system utilizes existing infrastructure, including a Mainline Preclearance System used for weigh-in-motion purposes and a CMS, both located at the top of Emigrant Hill. The Downhill Warning System integrated these two existing elements to give a warning to trucks, based on the weight and configuration of each truck. When a vehicle is identified and weighed by the preclearance system, messages are posted on the CMS. The first line reads "TRUCK ADVISORY" and the second line reads "CAUTION". The third line reads "XX MPH DOWNHILL" if an accurate weight is obtained for the vehicle. The displayed advisory speed is dependent on the measured weight of the vehicle. If an accurate weight is not obtained by the preclearance system, the third line will read "STEEP DOWNGRADE". The shipping companies utilizing this system can choose to subscribe to the Green Light Mainline Preclearance Program, which would provide personalized messages to the drivers. When a driver from a subscribing company passes through the system area, the second line displays the company name of the specific truck. An evaluation is currently underway, but no results were available for inclusion in this document. A final evaluation report should be completed in July 2000 (8).

The Washington Department of Transportation installed 13 variable speed limit signs along a 40-mile segment of Interstate 90 over Snoqualmie Pass in December 1997. Harsh weather conditions during the winter season can increase the risk of traveling this route through the Cascade Mountains. This ITS system includes loop detectors in three different locations throughout the section and the real-time traffic flows collected will help to determine safe speed limits. The CMS display safe, enforceable speed limits for current weather conditions and display messages to inform drivers of closures or the need for chains. Although the variable speed limit is enforceable, if weather conditions are severe enough to alter the speed limit, the Washington State Patrol agree they will most likely not stop anyone on the side of the roadway. A pre-installation evaluation was completed at the University of Washington through the use of simulation to determine if the traveler information conveyed externally (via the variable speed limit signs) and/or any information received in-vehicle were affecting driver behavior. This study concluded the variable speed limit signs had no statistically significant effect on a vehicle's mean speed over longer segments of the route. It was found, however, there was a statistically significant reduction in vehicle mean speed in sections immediately following a variable speed limit sign. A post-installation evaluation is in the process of being conducted and a December 2000 completion is planned (9).

Several European communities have installed changeable message signs to display variable speed limits. Loop detectors have been positioned to maintain real-time traffic flows in order to measure if the traffic is slowing downstream of the CMS. Automated enforcement is used in many areas to ensure that vehicles are following the set limits. This automated procedure eliminates the confusion that standard enforcement officers might face with a constantly changing speed limit. Although these CMS display dynamic speed information, the main purpose of the application is to maintain an adequate level of service on congested freeways; improving safety is a secondary objective (10).

Europeans also have experimented with in-vehicle speed advisories and speed limiters. With such a system, a roadside beacon is placed at dangerous areas where lower speeds are desired. When an equipped vehicle passes the beacon, a warning is given to the driver and, if appropriate, the vehicle speed is reduced. Initial trials included small test fleets that did not yield sufficient data to statistically verify any safety benefits. Larger trials are currently underway (10).

Speed warning signs also are used in construction or maintenance work zones to display speeds to both motorists and workers. These signs can be attached to a trailer and displayed to inform drivers of their current traveling speeds. The intent is to slow the drivers to reduce the number of vehicle-pedestrian collisions. Although these systems are widely used around the United States, evaluations are currently unavailable.

## Report Purpose and Contents

The dynamic curve warning system installed in the Sacramento River Canyon is an example of a rural ITS application used to enhance safety. The system utilizes changeable message signs (CMS) to display dynamic warnings in advance of sharp horizontal curves and steep downgrades. It is envisioned that this or similar ITS applications can provide other roadside messaging services associated with maintenance, construction, weather, and roadway conditions. Specifically, this report: (1) describes the various evaluation sites and the dynamic speed warning system implemented (Chapter 2); (2) details the evaluation methodology (Chapter 3); (3) documents data analysis results for vehicle crashes, speed measurements, and erratic maneuvers (Chapter 4); (4) summarizes motorist and maintenance personnel opinions (Chapter 5); and (5) provides conclusions and recommendations (Chapter 6).

Interstate 5 between Redding and Dunsmuir, the area known as the Sacramento River Canyon, was selected as the demonstration site for the dynamic curve warning system because of its high traffic volumes, mountainous terrain and the number of crashes specifically related to heavy trucks. In addition to safety costs, crashes involving heavy trucks in this corridor can close the Interstate to travel for several hours. Specific curves were selected for the dynamic curve warning system based on a potential cost-benefit procedure used by Caltrans. The procedure is based on a potential estimation of crash reduction for a five-year period. Table 2 lists the data used for the cost-benefit procedure. Crashes shown in Table 2 occurred between September 1, 1992 and August 31, 1997, and are separated into fatal, injury, and property damage only (PDO) categories.

Table 2. Total Crashes for Proposed Sites (11)

| Site | Total | Fatal | | Injury | | PDO | |
|---|---|---|---|---|---|---|---|
| | | # | % | # | % | # | % |
| Sidehill Viaduct (PM 29.0-29.88 SB only) | 30 | 1 | 3.3 | 13 | 43.3 | 16 | 53.3 |
| O'Brien (PM 31.95-32.17 SB only) | 21 | 0 | 0 | 6 | 28.6 | 15 | 71.4 |
| Salt Creek (PM 36.7-37.3 SB only) | 13 | 0 | 0 | 3 | 23.1 | 10 | 76.9 |
| LaMoine (PM 48.8-49.1 SB only) | 14 | 0 | 0 | 4 | 28.6 | 10 | 71.4 |
| Sims Road (PM 58.1-58.2 NB only) | 9 | 0 | 0 | 5 | 55.6 | 4 | 44.4 |

# CHAPTER 2

# SITE AND SYSTEM DESCRIPTIONS

Five study sites were selected by Caltrans staff, based on a quasi cost-benefit analysis. Each site has unique characteristics that must be considered in the evaluation, as described below.

## General Site and System Descriptions

Caltrans District 2 has installed five dynamic curve warning signs with radar-measured vehicle speed incorporated into the respective changeable warning messages. The five sites, all within Shasta County, include:

1. Sidehill Viaduct, Southbound, Postmile 30.00;
2. O'Brien, Southbound, Postmile 32.30;
3. Salt Creek, Southbound, Postmile 37.53;
4. La Moine, Southbound, Postmile 49.23; and
5. Sims Road, Northbound, Postmile 57.90.

The sight distance for each CMS met or exceeded the manufacturer's specifications. Specifically, for the minimum 18-inch lettering that is being displayed on each CMS, the sign manufacturer specifies a sight distance of 1,000 feet (12). O'Brien is the only site at which the adequacy of the sight distance was questionable, due to existing obstructions. However, the actual sight distance of the CMS at O'Brien was measured to be 1,100 feet. Figure 1 shows the location of each site on Interstate 5.

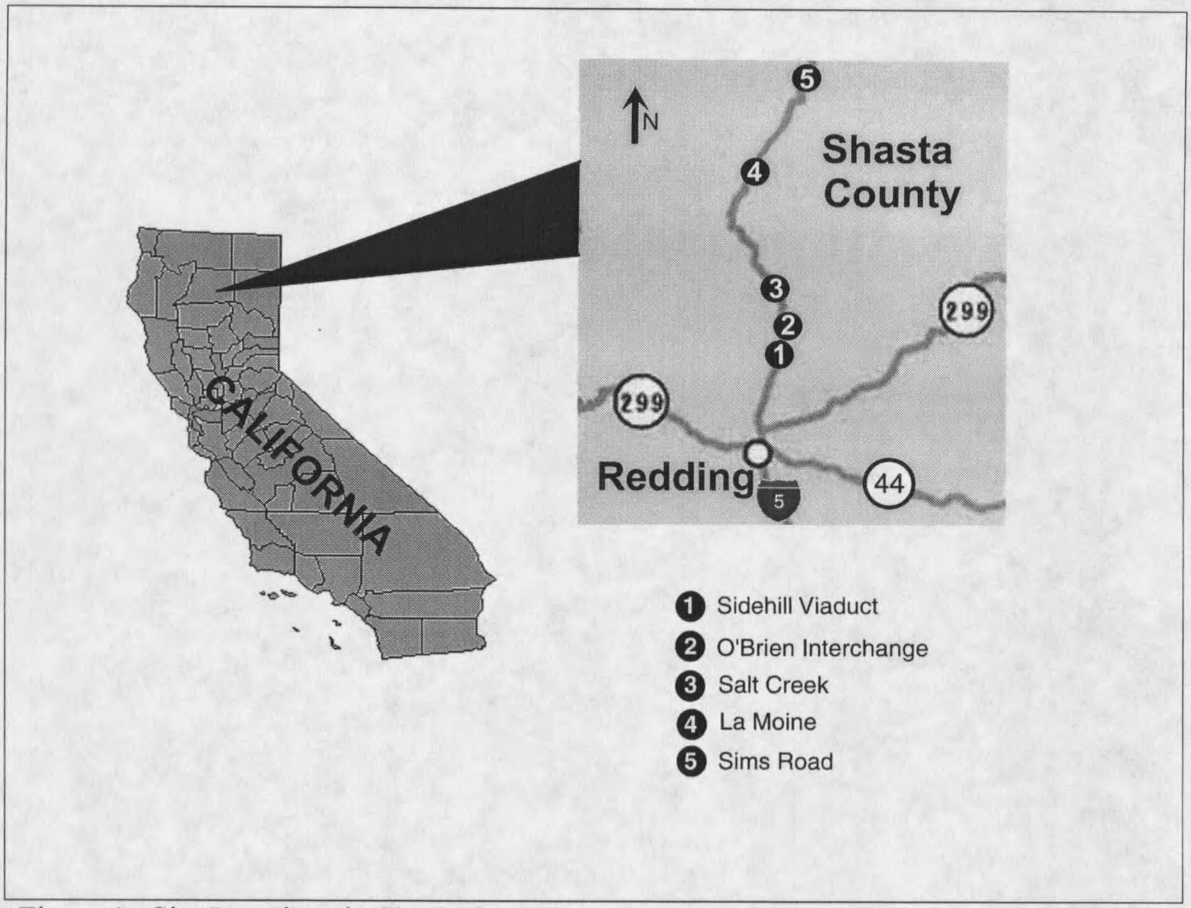


Figure 1. Site Locations in Shasta County

Sidehill Viaduct

Sidehill Viaduct is the southernmost site on Interstate 5. This is the only location where the CMS is on the left-hand side, due to the steep cut slope on the right side of the road. The curve for which this system applies is placed about one-third of the way down a 6% downgrade on a southbound divided section of I-5 (13). Figure 2 shows the Sidehill Viaduct site.

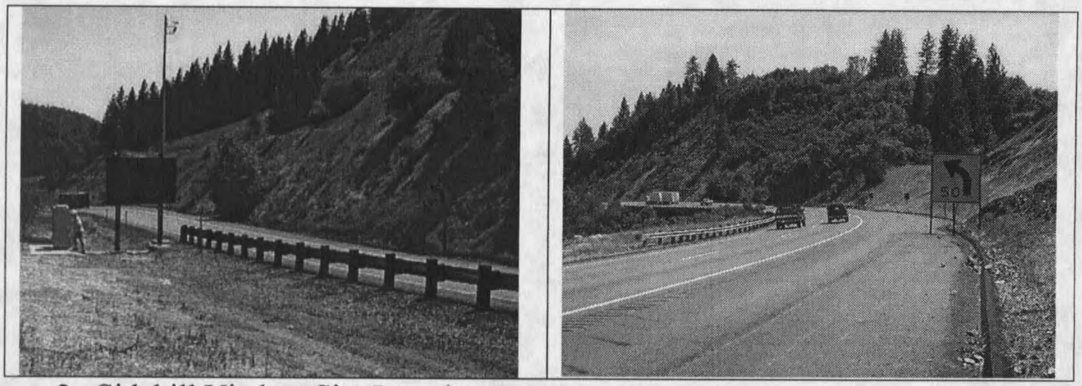



Figure 2. Sidehill Viaduct Site Location

At the time of pre-installation data collection, this area had a speed limit of 55 mph. When the second set of data was collected, the speed limit had been increased to 65 mph for passenger cars; the speed limit for commercial trucks remains at 55mph. The advisory speed for the curve has remained at 50 mph.

O'Brien

The O'Brien site is located facing southbound traffic on Interstate 5. The signed right-hand curve is located preceding a diamond interchange. The photograph in Figure 3 is the O'Brien site.

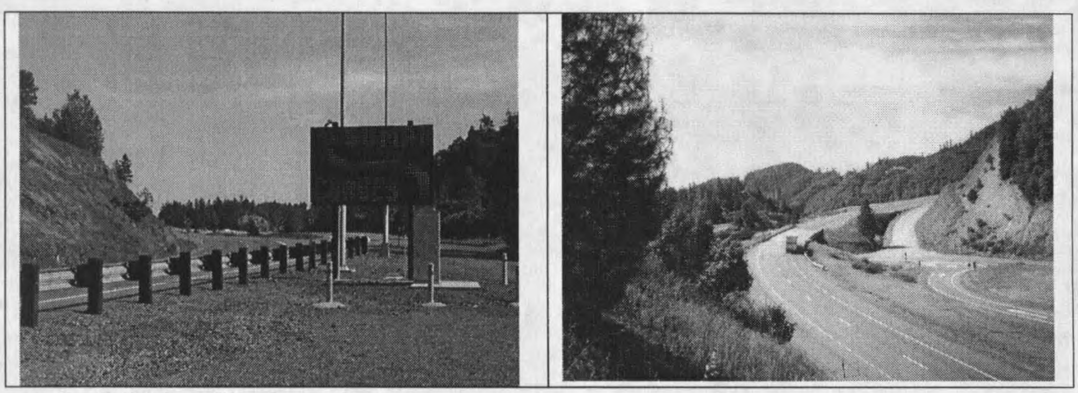


Figure 3. O'Brien Site Location

An advisory speed of 50 mph has been maintained throughout the course of the curves at the O'Brien Interchange. Although this area had a 55 mph speed limit at the time of the first data collection trip, it since has been raised to 65 mph for passenger cars. The truck speed limit remains at 55 mph.

Salt Creek

This site is on Interstate 5 southbound, following the Salt Creek Interchange. Of the two curves proceeding the CMS (shown on the right in Figure 4), the second curve is the principal reason for placing the dynamic curve warning sign in this area. Placing the CMS after the first curve, just prior to the second curve, would not have allowed adequate sight distance for motorists to respond prior to entering the second curve; therefore, the CMS was placed before the first curve. A fairly steep downgrade exists prior to and within the first curve. The second horizontal curve coincides with a vertical curve changing from a grade of –5% to +6% (13). The site location at Salt Creek is shown in Figure 4.

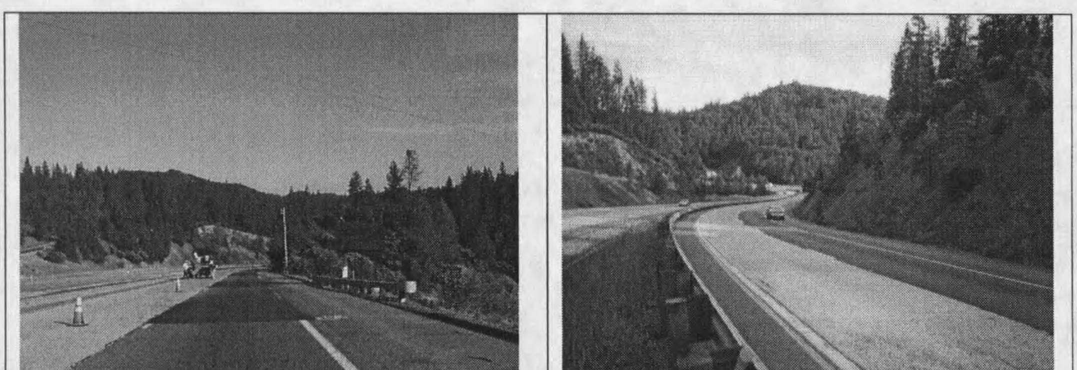


Figure 4. Salt Creek Site Location

At the time of the first site visit, this area had a 55 mph speed limit that has been increased to 65 mph for passenger cars. The speed limit for trucks remains at 55 mph, and the curve advisory speed remains at 50 mph.

La Moine

This dynamic curve warning sign is located on the southbound side of Interstate 5, near the La Moine Interchange. Following the interchange, this site includes an S-Curve (left then right). Although both curves are of concern, data were collected only for the first curve for simplicity and time-saving purposes. Figure 5 depicts the La Moine site and curves.

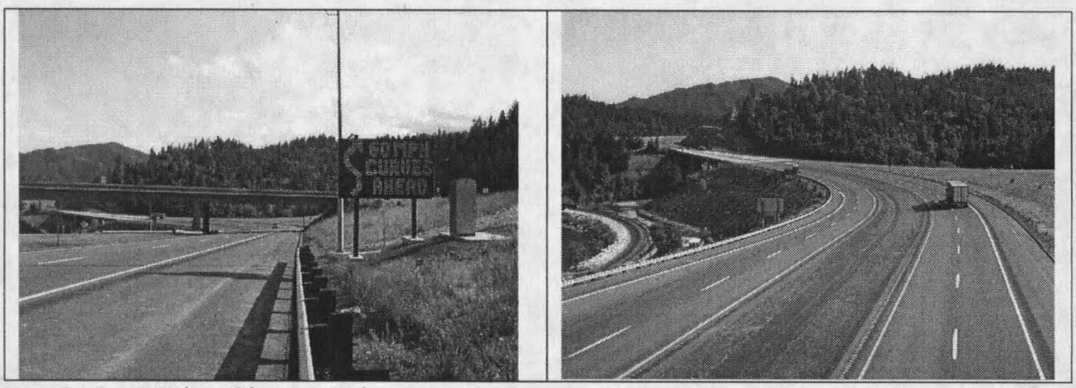



Figure 5. La Moine Site Location

Since the study began, this area has maintained a 65 mph speed limit for passenger cars and 55 mph speed limit for trucks. This is the only curve among the five study sites with an advisory speed of 60 mph.

Sims Road

The site following the Sims Road Interchange is the only northbound study site on Interstate 5. The signed curve is a right hand curve, which is pictured in Figure 6.

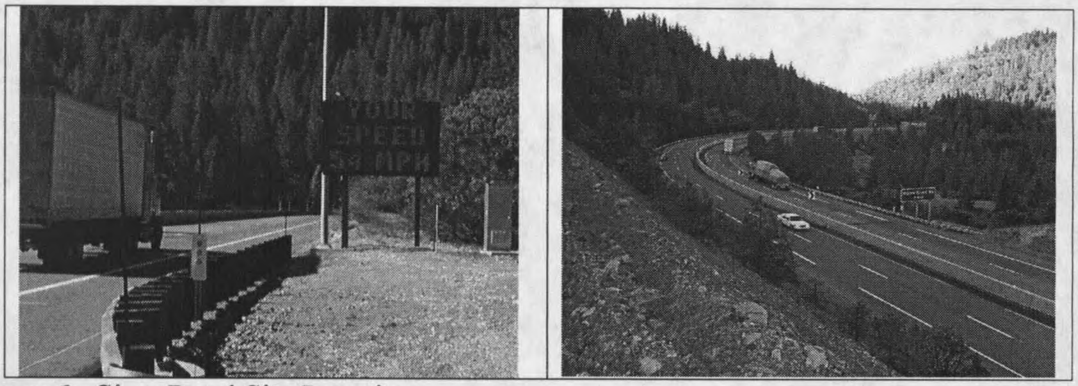



Figure 6. Sims Road Site Location

This area also has maintained a 65 mph speed limit for passenger cars and a 55 mph speed limit for commercial trucks. An advisory speed of 50 mph exists for the curve.

## Geometric Features

Some important existing geometric features are included in Table 3 for each of the five sites. The radius of the curve is used to describe the sharpness of the curve (i.e., the smaller the radius, the sharper the turn).

Table 3. Existing Geometric Features by Site (13)

| Site: NB/SB | CMS (PM) | Curve | Radius (ft) | Length (ft) | Grade (%) | Posted Advisory Speed (mph) |
|---|---|---|---|---|---|---|
| Sidehill Viaduct: SB | 30.00 | Left | 850 | 1007.96 | -6.0 | 50 |
| O'Brien : SB | 32.30 | Right | 850 | 1137.85 | +2.7 to +6.0 | 50 |
| Salt Creek: SB | 37.53 | Right | 1150 | 855.80 | -5.0 | 50 |
| | | Left | 1174 | 1274.92 | -5.0 to +6.0 | 50 |
| La Moine: SB | 49.23 | Left | 1150 | 928.14 | -4.4 to +3.0 | 60 |
| | | Right | 1150 | 1126.50 | +3.9 | 60 |
| Sims Road: NB | 57.90 | Right | 950 | 1023.08 | +1.3 | 50 |

One standard procedure for determination of an advisory speed uses a ball-bank indicator. This test is conducted to determine the maximum speed at which a driver can remain at a moderate level of comfort in a given curve. A ball-bank indicator measures the amount of lateral force on the vehicle. A measurement of 10° by a ball-bank indicator is the typically accepted limit (for speeds over 35 mph), above which riding discomfort is excessive and the likelihood of losing control of a vehicle increases. During the test, a vehicle is driven through the designated curve(s) with the device securely and precisely attached to the dashboard. Calibration is completed to ensure the indicator is at zero when the vehicle is level. As the driver steadily maneuvers the vehicle through the particular curve at a constant speed, an observer watches the ball-bank indicator until it reaches a peak height and records the reading. Drivers generally start at a lower speed and continuously repeat this process in 5 mph increments until a maximum reading of 10° is reached. Once the highest speed that can be traveled without exceeding the 10° maximum has been determined, the process must be repeated two more times to ensure accuracy and consistency. Again, this speed is considered the speed at which a driver can negotiate a curve without experiencing excess lateral force that can cause the driver discomfort and result in possible loss of control (14). Although the ball-bank indicator test is commonly used to determine appropriate advisory speeds, crash history and geometry of the roadway also should be considered.

Ball-bank tests were conducted at each curve at the designated study sites. Although many additional test runs were completed, Table 4 lists the three ball-bank readings used to determine an appropriate advisory speed.

Table 4. Ball-Bank Test Results

| Curve | Test Speed (mph) | Ball-Bank Reading at Safe Speed |
|---|---|---|
| Sidehill Viaduct | 50 | 1) 10 |
| | | 2) 10 |
| | | 3) 10 |
| O'Brien | 55 | 1) 11 |
| | | 2) 10 |
| | | 3) 10 |
| Salt Creek Curve 1 | 60 | 1) 10 |
| | | 2) 9 |
| | | 2) 9 |
| Salt Creek Curve 1 | 60 | 1) 10.5 |
| | | 2) 11 |
| | | 3) 10.5 |
| La Moine Curve 1 | 60 | 1) 12 |
| | | 2) 11 |
| | | 3) 11 |
| La Moine Curve 2 | 60 | 1) 10 |
| | | 2) 10 |
| | | 3) 10.5 |
| Sims Road | 55 | 1) 9 |
| | | 2) 9 |
| | | 3) 9 |

## Average Annual Daily Traffic (AADT) and Composition

Table 5 includes the 1998 average annual daily traffic (AADT) volumes for the appropriate direction of travel at each study site, which is assumed to equal 50% of the total AADT. Two traffic counters in the area measure directional volumes. During the week of January 3, 2000, the northbound traffic passing the Sims Road offramp accounted for 50.4% of the total (leaving 49.6% in the southbound direction) and the northbound traffic at Fawndale accounted for 50.3% (49.7% in the southbound direction) (15). Worth noting is the high percentage of commercial vehicles traveling this route.

Table 5. Average Annual Daily Traffic and Composition by Site (16)

| Site | Directional AADT | %Truck |
|---|---|---|
| Sidehill Viaduct | 9300 | 32.1 |
| O'Brien | 9300 | 34.0 |
| Salt Creek | 8600 | 34.2 |
| La Moine | 7900 | 38.4 |
| Sims Road | 7650 | 37.4 |

## Traffic Control/Warning Signs at the Study Sites

In addition to the CMS, there are other static warning signs located at each site, with the exception of the La Moine site. Table 6 shows the type of static sign, the quantity present, and the location. The sign type is listed by the California sign code (See Table 1 for the corresponding MUTCD codes).

Table 6. Existing Static Signs (6)

| Site | CA Code | Description | Qty. | Side: Left (L) or Right (R) | Date Installed or Replaced (I) or Removed (R) |
|---|---|---|---|---|---|
| Sidehill Viaduct | W5(LT) | Left Curve | 2 | L & R | (R) after 8/97 |
| | W6(50) | Advisory Plate | 2 | L & R | (R) after 8/97 |
| | W4(LT) 60" | Left Curve w/ Advisory Speed | 2 | L & R | (I) 12/93 |
| | W4(LT) 96" | Left Curve w/ Advisory Speed | 1 | R | (I) 11/98 |
| | W81 | Chevron Alignment | 6 | R | (I) 3/97 |
| | | Trucks: Steep Grades and Sharp Curves | 1 | L | (I) 8/98 |
| O'Brien | W1 (LT) | Reverse Curve | 2 | L & R | (I) 6/95 |
| | W6 (50) | Advisory Plate | 2 | L & R | (I) 6/95 |
| | W5 (RT) | Right Curve | 2 | L & R | (I) 6/21/95 |
| | W6 (50) | Advisory Plate | 2 | L & R | (I) 6/21/95 |
| Salt Creek | W5 (RT) | Right Curve | 2 | L & R | (I) prior to 9/93 |
| | W6 (55) | Advisory Plate | 2 | L & R | (I) prior to 9/93 |
| La Moine | None | | | | |
| Sims Road | R 6(65) | Speed Limit | 1 | R | (I) 7/6/97 |
| | R48-1 | Radar Enforced Plate | 1 | R | (I) 10/1/97 |
| | R 6-1 | Speed Limit | 1 | R | (I) 7/6/97 |
| | R48-1 | Radar Enforced Plate | 1 | R | (I) 10/1/97 |
| | W4(RT) | Right Curve w/ Advisory Speed | 1 | R | (I) 7/16/97 |
| | W5(RT) | Right Curve | 1 | R | (R) 7/6/97 |
| | W6(50) | Advisory Plate | 1 | R | (R) 7/6/97 |
| | W81 | Chevron Alignment | 15 | L | (I) 8/28/97 |

## Recent Changes

In order to adequately determine if changes in crashes or driving behavior can be attributed to the dynamic curve warning sign system, it is important to identify any other safety improvements that have been made within the designated stretch of Interstate 5.

The speed limit for trucks and autos with trailers has been 55 mph for all study sites throughout the analysis period. For passenger cars, the speed limit was 65 mph for the La Moine and Sims Road sites throughout the study period. At the other sites, the speed limit for passenger cars was 55 mph during the first data collection trip, but was subsequently increased to 65 mph before the second data collection trip.

The 55 mph speed limit for passenger cars was not changed immediately following the repeal of the national Maximum Speed Limit of 55 mph by Congress in 1995. Since 1995, many states have conducted speed studies and, as a result, many states increased their speed limits on highways and most of the Interstates. A section in the Sacramento River Canyon, including the Sidehill Viaduct, O'Brien, and Salt Creek sites, was one of the last sections on Interstate 5 in California to be evaluated and the speed limit adjusted accordingly (15). In terms of this evaluation, the speed limit for passenger cars was raised to 65 mph between the first and second data collection trips. It should be noted that this change might have had an effect on the differences in speeds collected prior to, and following, the dynamic curve warning sign system installation.

In addition to speed limit changes, minor site changes involving surfacing, separation, and signing have occurred which could confound the results of this study. Table 7 summarizes any improvements documented since 1994, excluding the signing changes noted in Table 6.

Table 7. Summary of Recent Site Changes (6)

| Site | Speed | Surfacing | Separation |
|---|---|---|---|
| Sidehill Viaduct | 55 mph to 65 mph for passenger cars | None | None |
| O'Brien | 55 mph to 65 mph for passenger cars | None | None |
| Salt Creek | 55 mph to 65 mph for passenger cars | 1996 | May 1999 |
| La Moine | None | None | May 1999 |
| Sims Road | None | None | None |

## Dynamic Curve Warning Systems

The dynamic curve warning system includes the following elements at each site: a changeable message sign (CMS), a radar speed-measuring device, two cameras, video detection software for one of the cameras, and control/communications equipment. This report includes the evaluation conducted on the effectiveness of the CMS on driver behavior, and does not include an evaluation of the camera and software functions. The CMS at this location is a 10-foot by 7-foot full matrix light-emitting diode (LED) sign supplied by American Signal Company that allows for 50 columns and 28 rows of lights (12). Each CMS has specific messages and graphics that can be displayed and rotated every three to four seconds. Some of the standard messages are shown in Figure 7.

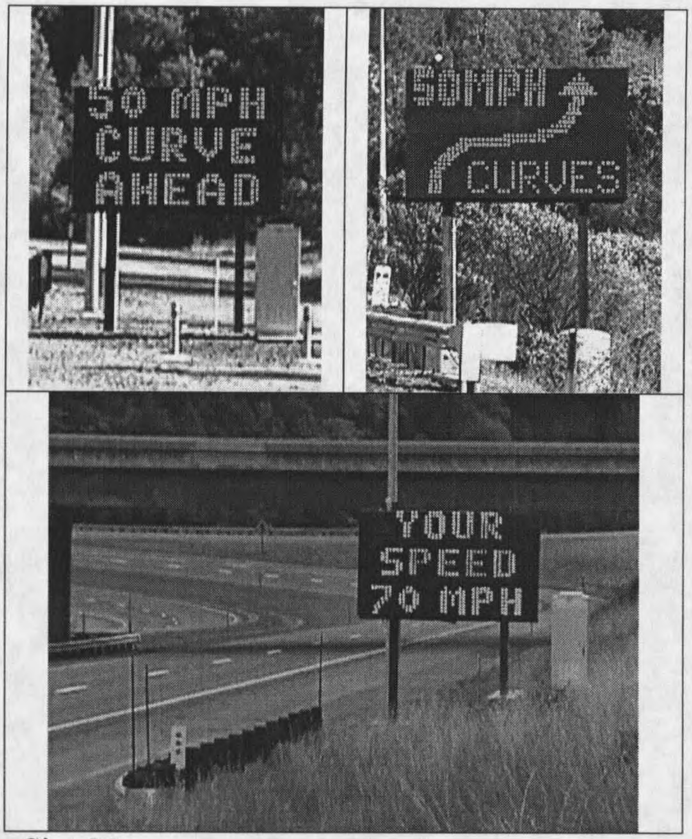



Figure 7. Common Sign Messages

The Decautor Radar Unit measures speeds accurately between 15 mph and 120 mph on vehicles up to 2500 feet away, depending on the size of the vehicle. Smaller passenger cars can be read from approximately 1250 feet; larger commercial vehicles can be recognized at approximately 2500 feet. The radar unit is mounted on top of the CMS; the radar has a cone of detection of 18° and operates at a frequency of 10.525 GHz ± 5 MHz. The speed measured by the radar unit is used by the controller to determine the appropriate message on the CMS (12). The radar unit does not distinguish between direction of travel and, therefore, it may display the speeds of vehicles traveling in the opposite direction. To eliminate confusion resulting from this phenomenon or doubt on the part of the drivers with regard to the accuracy of the dynamic curve warning sign systems, the radar unit should be angled, if possible, so the cone of vision includes only the relevant travel lanes and does not include lanes traveling in the opposite direction. This is an issue only at the Salt Creek, La Moine, and Sims Road sites. Enough space between the two directions of traffic at the Sidehill Viaduct and O'Brien sites that the opposite lane of traffic does not intrude into the cone of vision and, therefore, does not affect the radar readings.

Two fixed-view, closed-circuit television cameras are mounted at each site with one camera pointing in each direction. The camera viewing upstream (facing the traffic approaching the CMS) utilizes the Autoscope Video Vehicle Detection System to detect vehicles and measure their speeds. The video vehicle detection system also is capable of collecting data relating to vehicle headway, vehicle classification, occupancy and volume. The speeds measured by the vehicle detection system are used to provide possible incident warning. If five or more vehicles are traveling at speeds less than 35 mph, a warning message is sent via pager to several key Caltrans personnel. In such an event, the second camera viewing downstream traffic is used for monitoring the roadway, weather, and traffic conditions from the Caltrans District 2 Office in Redding. In the future, these images may be accessible by the public via the Internet (12).

The video elements of each site are controlled by an Adpro controller accessible via telephone line. The systems operate as stand-alone units, but may be controlled and monitored from a personal computer at the Caltrans Redding District Office or a laptop computer at remote locations (12).

Initial costs of the dynamic curve warning system installation are comprised of hardware and construction expenses. The initial costs for the entire system, encompassing all five sites, totaled $565,222. However, this does not mean that a single sign system at each site cost exactly one-fifth of the total cost because there were expenses related to integration between the five individual systems and the setup of the workstation stationed at the District office (12).

The CMS system is designed as a stand-alone system and requires no dedicated staff for its day-to-day operation. As long as the system is in good working condition, power and communication costs are the only operational costs associated with the system. These typically average $60 per month per sign, totaling approximately $300 per month for the entire system (17).

# CHAPTER 3

# METHODOLOGY

According to the *ITS Handbook 2000*, when evaluating ITS applications, there are standard steps to follow in order to demonstrate effectiveness correctly. Measures of effectiveness must be chosen and then site visits must occur during various stages of the evaluation process. Studies must be done before and after the installation of the application to collect both the baseline data and the characteristics after implementation (18).

## Measures of Effectiveness

Crash reductions and the associated cost savings are typically some main measures of effectiveness related to safety improvements (2). Other attributes to observe and analyze for the effectiveness of a particular safety improvement include speeds and erratic maneuvers in this case.

The purpose of the dynamic curve warning sign system is to better inform drivers of their current speeds and display an appropriate advisory speed for the upcoming section of roadway. Crash reductions after system implementation would most directly confirm system effectiveness and as such were considered in this study. Crash reductions could not, however, be proven significant due to the short time duration between system implementation and study completion. For this reason, the average speeds at the sites were examined to determine if there were any statistically significant speed differences (i.e., reductions in crashes) after the dynamic curve warning sign system had been installed.

Maneuvers conducted while a vehicle is in the curve, such as the actuation of brake lights or lane line encroachments, *may* indicate drivers are attempting to complete a curve at an unsafe speed and correcting for their actions. It is important to understand that these maneuvers are not necessarily indicative of emergency reactions but, rather, may have been executed so as to make drivers feel more comfortable as the curve is traveled. The number of these maneuvers at a site, however, may be related to crash frequency; therefore, these measurements were studied to monitor changes at curves equipped with the dynamic curve warning signs.

It was hypothesized that drivers familiar with a route may travel differently than those who are unfamiliar with the area. Therefore, an attempt was made to separate drivers into these two subsets for analysis purposes.

A measure of public opinion was necessary to see how people were responding and adjusting to the dynamic curve warning system. A motorist survey was administered at a truck stop and a rest area to collect reactions and feelings about the systems from both commercial truck operators and passenger car drivers.

Lastly, telephone interviews were conducted with selected Caltrans maintenance personnel to determine how difficult the dynamic curve warning system was to maintain.

## Site Visits

A total of four site visits was completed over the course of the evaluation. The first trip occurred on June 4-6, 1998, approximately nine months prior to the final installation of the dynamic curve warning system, and included the collection of the baseline speed and erratic maneuver data. Shortly after the completion of the dynamic curve warning system installation, the next visit was made on May 18 and 19, 1999 in order to see how drivers were initially reacting to the new sign system. Only four of the five sites were visited at this time, due to construction taking place at the Salt Creek site. Although traffic was moving at the Salt Creek site, the lane closure and construction activities made any data collection invalid. Data measurements at Salt Creek were collected during the remaining two trips. The motorist survey was conducted for the first time during this trip, as well. The third trip was made three months later on August 17-19, 1999 to observe if drivers were becoming desensitized to the advanced sign systems, and to determine if system effectiveness was reduced over time. The final visit was made on January 3 and 4, 2000 to see if there was any further desensitization and if driving behaviors differed under potentially inclement weather conditions. In addition to the data collected at each curve, the second administration of the motorist survey was completed during this fourth trip. The curve data were collected during daylight hours and the survey was administered during both daylight and nighttime hours. The weather for all of the sites for each of the trips was sunny and clear, with the exception of the Sidehill Viaduct and O'Brien sites in January 2000 when it was raining and/or the roadway was wet.

## Data Collection

Data collected at each of the five study sites included (1) crashes, (2) speeds, (3) erratic maneuvers, (4) motorist opinions, and (5) maintenance personnel opinions.

### Crashes

Reductions in crashes are a substantial measure of effectiveness for safety improvements in transportation systems. Costs can be associated with each crash to determine the dollar savings that correspond to the reduction in crashes. Combined with the costs of the system, these values can be converted into a benefit-cost ratio, which is a standard form used to express the effectiveness of a safety improvement (2).

Crash records for the three years prior to CMS installation were gathered and an annual average was calculated. For each curve, the crashes taking place between the CMS location (or planned CMS location) and one-tenth of a mile following the endpoint of the particular curve were examined. Once the pre-installation crashes were compiled, post-installation crash records were gathered for comparison purposes. Due to the short period of time between the installation of the dynamic curve warning sign system and the completion of this evaluation, insufficient data have been collected to determine if any observed reductions in crashes were statistically significant.

### Speeds

According to *Traffic Engineering*, speed data are typically collected using one of four measurement methods, including (1) the use of a speed measuring unit (i.e., radar or laser) to find spot speeds, (2) timing drivers using stopwatches as they cross over a relatively short, pre-measured distance for spot speeds, (3) timing drivers as they pass through a longer section of roadway (also pre-measured) to determine space mean speeds in the area, and (4) timing several test runs through sections of the road, also for space mean speeds (14). For this evaluation, a spot speed was desired. The manual timing method (i.e., alternative (2) above) was chosen over the use of a radar or laser unit for various reasons, as discussed below.

Radar may bias the sample by (1) placing an obstruction near the traveled way, and (2) imitating speed enforcement. When using radar, there is an error associated with the angle between the radar path and the line of traffic. To minimize this error, data collectors would control and read the radar units from parked vehicles in the shoulder (as close to the traveled way as possible to achieve the best measurements). It is commonly accepted that free-flow speed is affected by obstacles within close lateral proximity to the traveled way (19). In terms of bias associated with the imitation of enforcement, drivers with radar detectors may slow their speeds upon receipt of the radar signal. Similarly, when drivers without detectors catch their first glimpse of a parked vehicle with a radar unit, they may reduce their speeds for fear an enforcement official is measuring speeds. Reductions in speed resulting from fear of enforcement would provide an inflated measure of CMS effectiveness.

Because concerns exist with the accuracy of the stopwatch method, a comparison was made between stopwatch-measured and radar-measured speeds. Speeds were measured at the O'Brien and La Moine sites using stop watches while, simultaneously, the same vehicle speeds were measured with a radar unit along the roadside. In all, 42 vehicles were measured. Stopwatch-measured speeds averaged 1.1 mph lower than the speeds measured by radar units (see Appendix A). Assuming (1) a normal distribution, (2) a 99% confidence interval and (3) the radar-measured speed is the accurate speed, the stopwatch-measured speed will have an error of less than 1.5 mph. In actuality, however, the radar-measured speed is likely in error by as much as 0.5 mph due to rounding, because it measures speed to the nearest 1 mph. Although the stopwatch method does contain some error, the researchers believed the stopwatch method to be the best viable option, due to radar's potential for measurement error and its probable influence on speeds, as discussed previously.

In addition to potential data bias, the researchers were concerned about safety risks associated with positioning an obstruction (i.e., the radar collection setup) near the traveled way. The manual speed measurement method allowed data collection personnel to measure speeds from a vantage point well away from traffic. This method was felt to be a safer alternative and it minimized adverse effects on traffic flow compared to radar measurement methods. Road tubes also were considered, but could not accurately track the same vehicle through both measurement sections without significant costs associated with both setup and software development.

One disadvantage of measuring speeds by use of a stopwatch is that this method primarily determines a vehicle's average speed over a given distance. Thus, there is an inability to know if, and at what point, reductions in speed are occurring over the course of the marked distance. According to *Traffic Engineering*, however, the times produced with the stopwatch method can be used to calculate instantaneous spot speeds (14).

Statistical procedures, which took into account such factors as the type of highway, determined that approximately 50 to 100 vehicles at each curve would serve as sufficient sample size for proposed analyses. To ensure random selection and to include all types of vehicles for statistical purposes (e.g., fast vehicles, slow vehicles, commercial trucks, and platoon leaders), every fifth vehicle was chosen for inclusion in the sample (14). The use of fifth vehicle was based on abilities of data collectors to keep up with the rate of data collection. Collecting data on every vehicle was not possible due to the amount of data elements collected and every tenth vehicle would have been too time-consuming. Vehicle selections do not exclude those traveling at encumbered speeds, but due to the low traffic volumes at the designated study sites, all vehicles can be considered to be operating at a free-flow speed. Radios were used to communicate the description of the vehicle to the downstream data collectors in order to track the same vehicle through both speed measurement sections.

During each of the four site visits, vehicle speeds were measured at two locations at each site: just upstream of the CMS location (or planned location) and then at the approximate beginning of the curve. This provided upstream and downstream speed data both before and after the CMS implementation.

The recommended speed measurement section lengths range from 50-300 feet, based on the expected average speed. The advisory speeds of the curves ranged from 50-60 mph and, therefore, a length of 300 feet was utilized for the speed measurement sections (14). Speed section locations were chosen to correspond with (1) the beginning of the curve, and (2) the planned or actual CMS location. Speeds measured in the second section (i.e., at the entrance to the curve) collected during different visits were compared with one another to determine if the dynamic curve warning signs were effectively warning drivers of the curve. In other words, if speeds as vehicles were entering the curve during post-installation trips were slower than speeds measured during the pre-installation trip, it could be inferred that the sign was having a desired effect by reducing speeds. The average changes in speed between the two measurement sections also were analyzed to assess the effectiveness of the dynamic curve warning system.

The first speed measurement section was measured from the CMS location to 300 feet upstream, and the second section was measured from the approximate beginning of the curve to 300 feet upstream. Brightly colored paint was used on the center lane line to mark the beginning and endpoint of each speed section. To observe the vehicles and record the requisite information, data collectors sat between the two points. Because a tire from each vehicle could be followed as it crossed the painted marks, parallax error was negligible (14). Figures 8-12 display diagrams from each site, showing the speed measurement section setup and positioning of the data collectors.

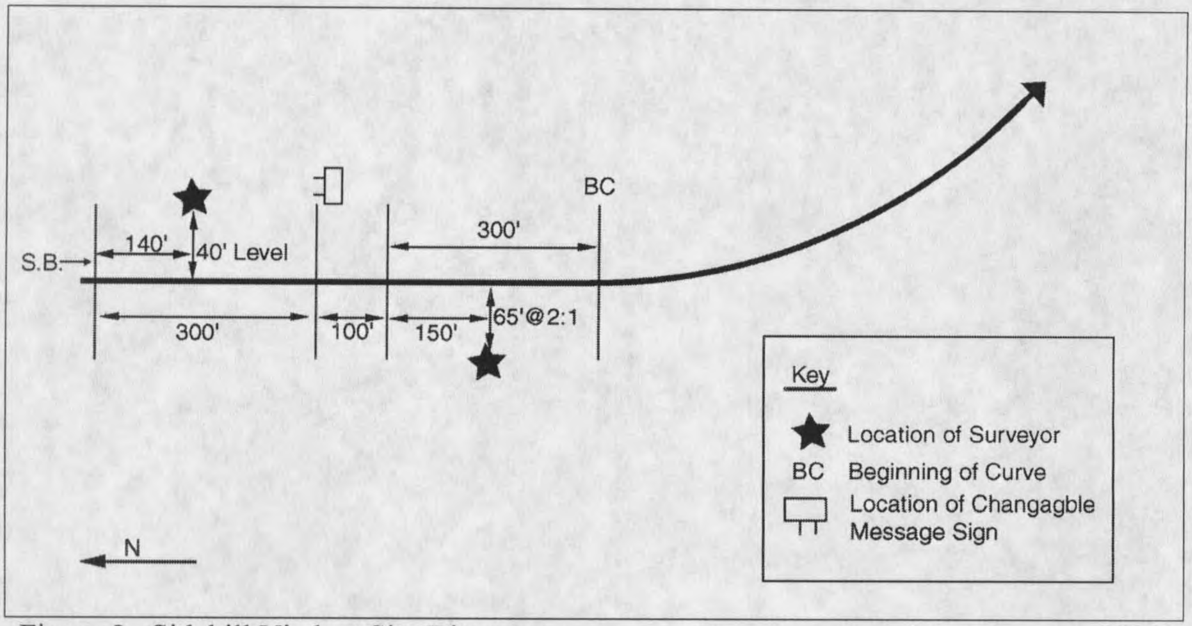



Figure 8. Sidehill Viaduct Site Diagram

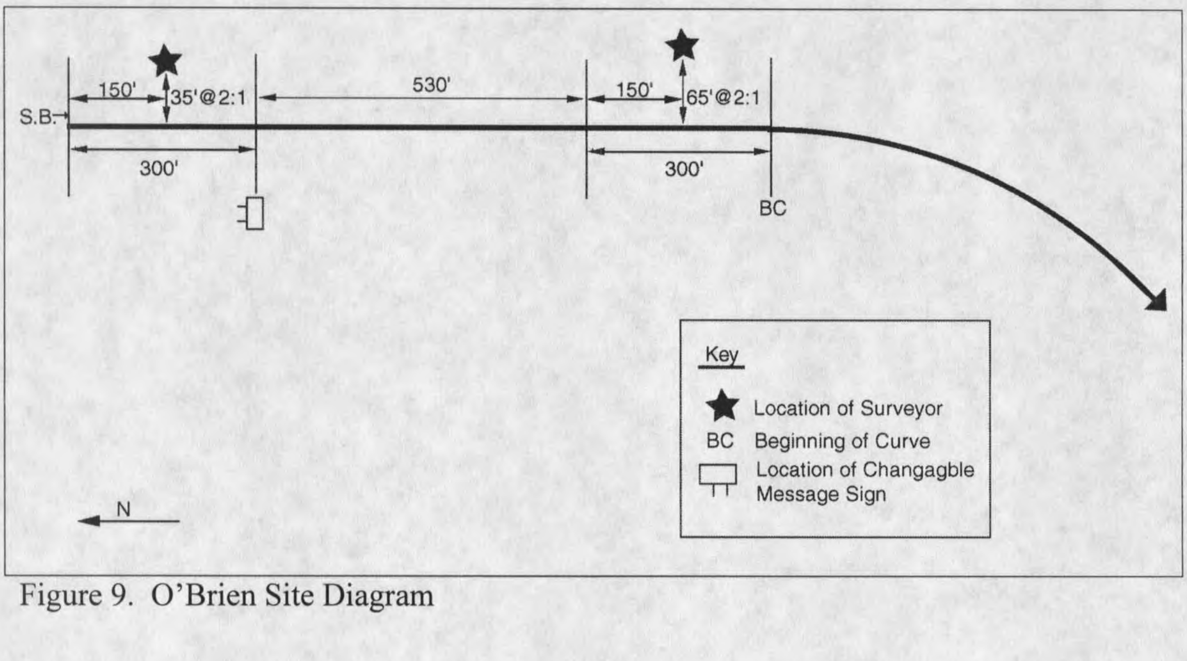



Figure 9. O'Brien Site Diagram

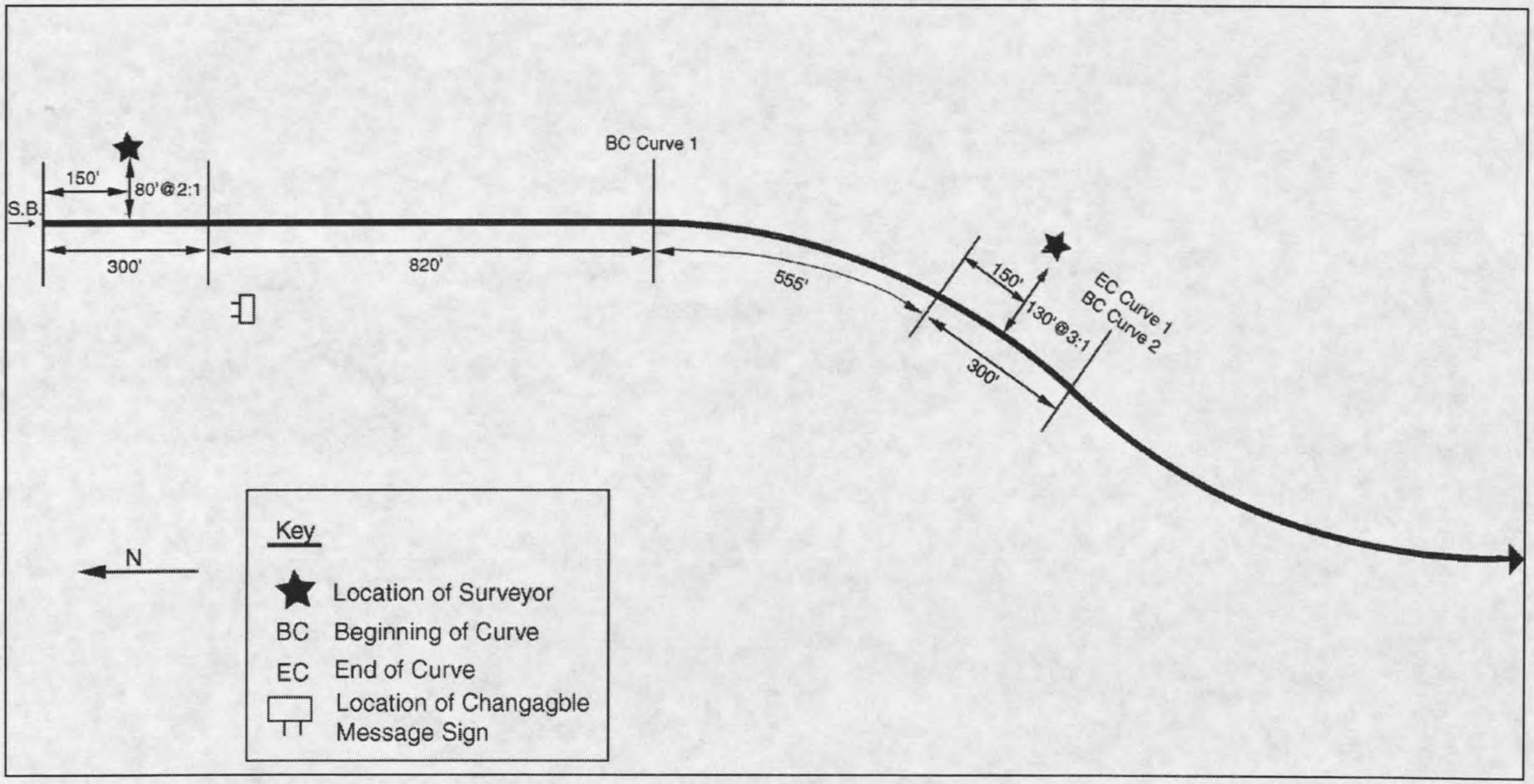



Figure 10. Salt Creek Site Diagram

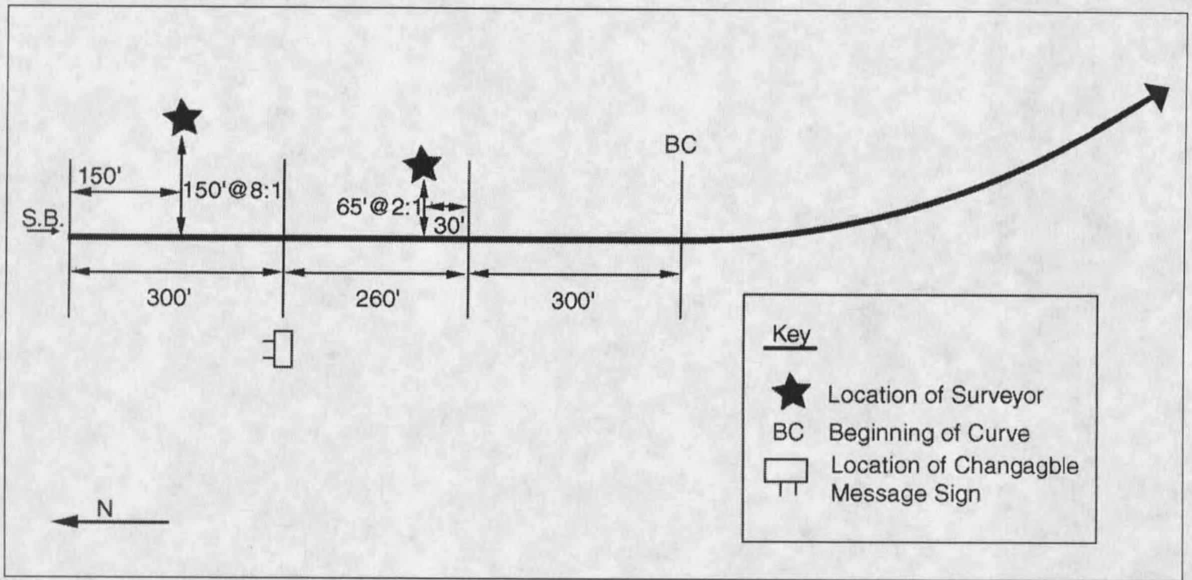



Figure 11. La Moine Site Diagram

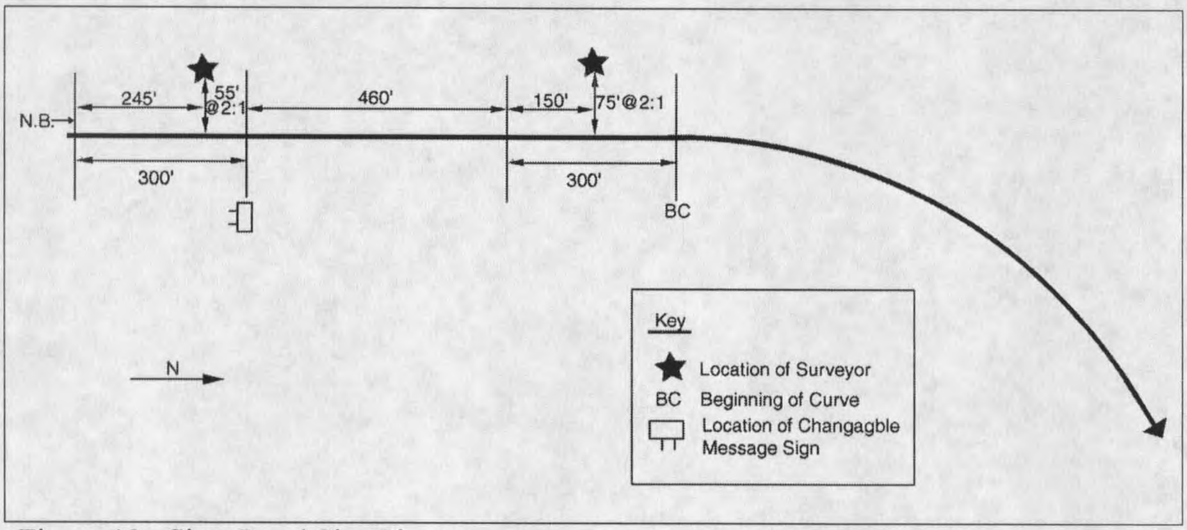



Figure 12. Sims Road Site Diagram

Three people were stationed at each site: two people at the first speed measurement section, and one at the second. One person at the first speed section collected vehicle characteristics (i.e., vehicle type, lane of travel) and measured vehicle times, while the other person communicated which vehicle was chosen to the collector at the second speed section. The person at the second speed measurement section read the time measurement and recorded any movement outside the lane boundaries or braking activity (described below).

## Erratic Maneuvers

Any erratic maneuvers made while traveling the curve, including lane encroachments and brake light actuations, suggest the corresponding drivers *may* be traveling at a speed too fast for safe negotiation of the curve. During each trip, any erratic maneuvers were recorded at each site to determine how drivers handled the curve. The maneuver data were collected on the same vehicles as the speed information, which enabled statistical analyses to be conducted in conjunction with the corresponding speed data.

Lane Line Encroachments. While in the process of traveling a curve, vehicles sometimes leave the lane and/or traveled way. This may or may not indicate a driver is having problems safely completing the curve. However, a lane or traveled way departure could result in a crash if it causes the driver to lose control of the vehicle. If the vehicle leaves the entire traveled way, it could collide with roadside obstacles, or if it crosses the lane boundaries, it could strike another vehicle in an adjacent or opposing lane. Rain, snow, or slippery roads can exacerbate these effects. It is possible the driver may be moving in such a way as to simply flatten out the curve for a smoother drive, change lanes after passing another vehicle, or miss uneven bumps in a lane. In such cases, safety is less apt to be an issue and the maneuvers are less accurately defined as "erratic".

However, the frequency and type of the maneuvers *may* correlate to the frequency of crashes and, therefore, these actions were recorded for analysis.

There are several different ways for a vehicle to leave the lane, which are described below in Figures 13-15. The inside lane maneuver refers to the lane that is on the inside of the curve (i.e., for a left curve, the left lane would be the inside lane). An outside lane maneuver, on the other hand, refers to the lane opposite the curve.

Inside or outside edgeline maneuvers occurred when the vehicle crossed the painted stripe with two wheels from the inside or outside lane and then returned to the travel lane (Figure 13). Records were kept when the vehicle crossed the center laneline to the other lane and then returned to the original lane (Figure 14). If a vehicle was performing a full lane change during the curve, this was classified as a "Lane Change" maneuver (Figure 15).

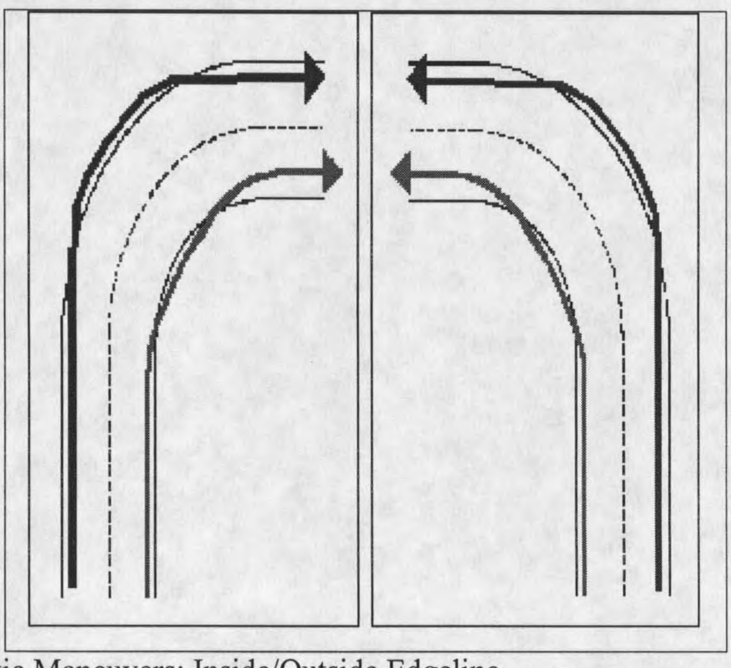


Figure 13. Erratic Maneuvers: Inside/Outside Edgeline

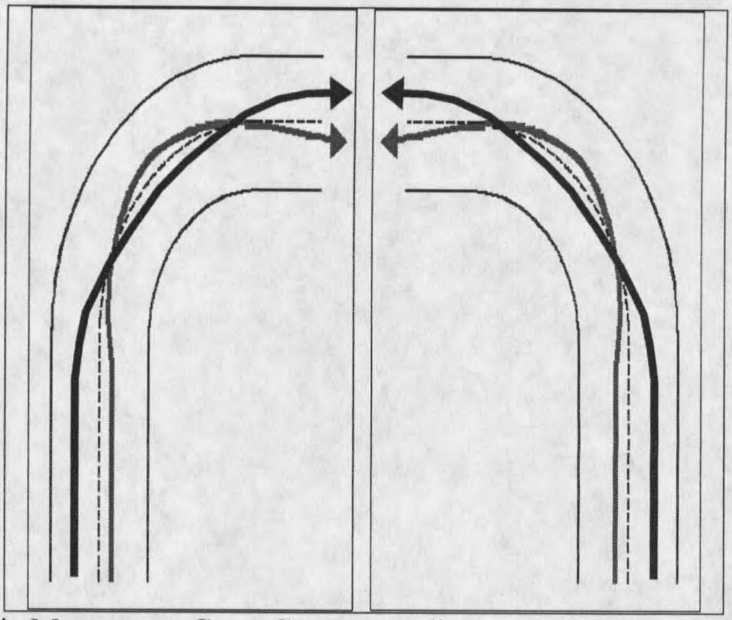


Figure 14. Erratic Maneuvers: Cross Center Laneline

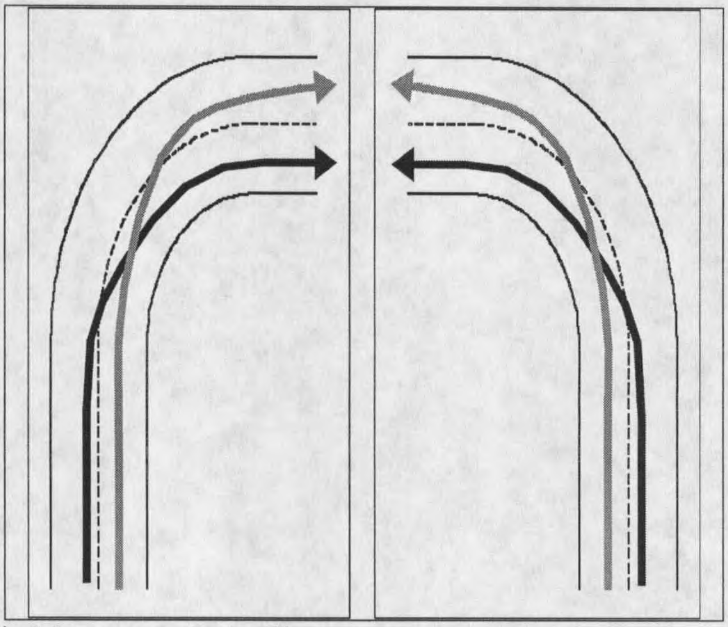


Figure 15. Erratic Maneuvers: Lane Change

<u>Brake Light Actuations.</u> Observing the driver's brake lights is another good way to determine if drivers may be prepared for a particular curve. If brakes are not used

during a curve, the driver apparently felt comfortable completing the curve at the speed he was traveling when he entered the curve. Conversely, if the brake lights are actuated during a curve, this implies a driver *may* have been uncomfortable with the speed he was traveling. Using the brakes in a curve increases the likelihood of losing control of the vehicle, especially if roadway conditions are wet or icy. Brakes are often used by drivers to continually slow themselves when a downgrade or vertical curve is present in the horizontal curve, so this action does not necessarily mean the driver is traveling at an unsafe speed. The only brake light actuations that were recorded were those that occurred while the vehicle was in the curve.

## Motorist Opinions

During the second and fourth site visits, a non-scientific motorist survey was conducted to collect input about the dynamic curve warning system from the driving public. The motorist survey consisted of questions for the public concerning their opinions of the importance, placement, and visibility of the signs. The survey was designed to gather information from commercial vehicle operators, passenger car drivers, and recreational vehicle drivers. A copy of the survey instrument can be found in Appendix B. Furthermore, all results have been broken down by vehicle type, with the exception of the answers to the visibility question, where results were separated by the time of day the survey was administered (day versus night).

A total of 250 surveys per trip was completed during each administration, with the sample split between locations and times as follows: (1) 100 surveys were administered during the daytime at the 76 Travel Center in Redding, south of all sites; (2) 50 surveys were administered at the same truck stop after dark; and (3) 100 surveys were administered during the daytime at the Lakehead Rest Area, south of the La Moine site. The 76 Travel Center was used as a survey location to reach operators of commercial vehicles. Surveys collected at night were at the request of the study sponsor to evaluate the visibility of the CMS during dark conditions. Surveys completed at the Lakehead Rest Area focused on the opinions of passenger car and recreational vehicle drivers. Dates and times of survey administrations are as follows:

- 76 Travel Center on May 20, 1999 from 11:00 AM to 4:00 PM;
- 76 Travel Center on January 6, 2000 from 10:30 AM to 2:30 PM;
- 76 Travel Center on May 20, 1999 from 10:00 PM to 11:30 PM;
- 76 Travel Center on January 6, 2000 from 7:00 PM to 8:30 PM;
- Lakehead Rest Area on May 21, 1999 from 11:00 AM to 2:30 PM; and
- Lakehead Rest Area on January 5, 2000 from 9:30 AM to 12:30 PM.

Surveyors verbalized each question to the participating respondents; every attempt was made to ask survey questions without biasing the responses. Brochures with pictures and additional information were used to help describe the signs, and participants were allowed to keep them if they chose to do so.

Maintenance Personnel Opinions

Telephone interviews were conducted with selected Caltrans personnel to determine any construction and maintenance issues associated with the dynamic curve warning system. Interviews were held prior to the third data collection trip in August

1999, and again in March 2000. Among the interviewed Caltrans District 2 employees were Roy Arnett, Electrical Supervisor for Maintenance Crew; Tim Huckabay, Chief Traffic Operations; Jim Elgin, Transprtation Engineer/Electrical; Chuck Lees, Project Engineer, and Norville Hanke, Maintenance Road Supervisor. An informal method of interviewing was used, but certain key topics were addressed with each individual. Questions included:

- Has any maintenance been required on the dynamic curve warning system since installation?
- If so, who conducted these activities (Caltrans or a vendor)?
- If there were maintenance activities, rate the difficulty/ease of the activities completed by Caltrans or the task of working with vendors.

In addition, any general comments were welcomed and recorded.

## Statistical Analysis

In order to determine if observed changes in vehicle speeds or erratic maneuvers were statistically significant, standard statistical analysis methods were used, as described by Kleinbaum, Kupper, and Muller (20). Statistically significant differences would indicate the dynamic curve warning signs are effective in reducing speeds and/or erratic maneuvers. For each statistical test, a 95% confidence level ($\alpha = 0.05$) was used to determine statistical significance. Throughout the remainder of this document, any reference to a significant difference in the before/after comparisons refers to statistical significance at the $\alpha = 0.05$ level. It was assumed that data collected for trucks could differ immensely from passenger car data; therefore, each vehicle was classified as a truck or non-truck for purposes of analysis. Specifically, the truck category includes commercial vehicles, vehicles towing trailers, and recreational vehicles; the non-truck category includes passenger cars and pickups.

Hypothesis testing is commonly used in statistical analysis to compare the mean or other parameter of one data set to a particular known value. In addition, parameters of two different data sets could be compared with one another to determine if there is a statistically significant difference between the two samples. Speed and erratic maneuver data were compared with the use of different hypothesis tests, including paired t-tests, two-sample t-tests, and two-sample binomial tests. Among other assumptions described for the individual tests below, all three types of tests require that the data be collected randomly (20). As mentioned previously, every fifth vehicle was observed in order to comply with the random sampling requirement. To complete these hypothesis tests, normal approximations were assumed for all data sets.

## Paired t-tests

Paired t-tests are used when two sets of data are not independent (20). For instance, when comparing vehicle speeds found at the two different speed measurement sections, the same vehicle appears in both samples and, therefore, the value of the second speed reading depends on the speed of that vehicle at the first section. A paired t-test was used to confirm or deny the hypothesis that mean vehicle speeds are lower at the beginning of the curve (i.e., vehicles are slowing after seeing the CMS).

The paired t-test is conducted using the equations:

$$S_d = [\Sigma(d_i^2) - ((\Sigma d_i)^2/n)] / (n-1)^{0.5}$$

$$t = d\ bar / (S_d/n^{0.5})$$

Where: $S_d$ = Composite standard deviation value, based on standard deviations of individual samples

$i$ = Increment value for each individual data value

$d_i$ = Difference between values of two samples at i

$n$ = Sample size

dbar = Average of all $d_i$'s

Once the test statistic was found, it was compared with a critical value, which was based on the confidence level ($\alpha = 0.05$) and sample size. If the absolute value of the calculated test statistic was greater than the critical value, it was shown there was a statistically significant difference between the means of the two samples.

<u>Two-Sample t-tests</u>

When two data sets are independent, the two-sample t-test can be used. An example is when the comparison is being made between one set of measurements collected during the pre-installation visit and another set gathered after the installation of the dynamic curve warning system. Two sample t-tests are used in this case to confirm or deny the hypothesis that changes in vehicle speeds collected between the pre-installation trip and each of the post-installation trips (i.e., the vehicles were entering the curve at a lower speed after the installation of the CMS) (20). The two-sample t-test also was used to compare the differences in speed (between the CMS and beginning of the curve) of each data collection visit, to monitor driver reaction over time.

The statistical procedure began with testing the variances to determine if they were equal or unequal, using the equation:

$$F = S_1^2 / S_2^2$$

Where: $S_1$ = Standard deviation of first sample

$S_2$ = Standard deviation of second sample

The calculated F value was compared with two critical values, which were based on the confidence level ($\alpha = 0.05$) and the sample size. If the calculated F value was either less than or greater than both critical F values, the variances were shown to be unequal. However, if the calculated F value fell between the two critical values, the variances were shown to be equal. The remainder of the two-sample t-test procedure is dependent on whether or not the variances are equal. If the variances were equal, the formula used for the test statistic is as follows:

$$t = (x\ bar_1 - x\ bar_2) / S((1/n_1)+(1/n_2))\verb|^|0.5$$

Where: $xbar_1$ = Average value of first sample

$xbar_2$ = Average value of second sample

S = Composite standard deviation value, based on standard deviations of individual samples

$n_1$ = Size of first sample

$n_2$ = Size of second sample

If the variances were not equal, the test statistic was found using:

$$t = (\text{x bar}_1 - \text{x bar}_2) / ((S_1^2/n_1)+(S_2^2/n_2))\char`^0.5$$

Once the test statistic was found, it was compared with a critical value. If the absolute value of the calculated test statistic was greater than the critical value, it was shown there was a statistically significant difference between the means of the two samples.

Two-Sample Binomial Tests

When comparing two proportions that are independent, a two-sample binomial test can be used (20). A two-sample binomial test was conducted to confirm or deny the hypothesis that the proportion of drivers executing erratic maneuvers before and after the dynamic curve warning system installation date decreased.

Once it was determined that the two-sample binomial test was to be used, the Z statistic was found using the equation:

$$Z = P_1\text{-}P_2 / ((P(1\text{-}P))((1/n_1)+(1/n_2)))^{0.5}$$

Where: $P_1$ = Proportion of first sample

$P_2$ = Proportion of second sample

$n_1$ = Size of first sample

$n_2$ = Size of second sample

Once the Z statistic was found, it was compared with a critical value, which was based on the confidence level ($\alpha = 0.05$) and sample size. If the absolute value of the calculated test statistic was greater than the critical Z value, it was shown there was a statistically significant difference between the means of the two samples.

Unfamiliar Motorists

Because unfamiliar drivers are less aware of the road geometrics than drivers who frequently travel the route, they may drive with a different level of attentiveness and caution. Familiar drivers may ignore posted advisory speeds, relying on their familiarity with the geometry of the roadway to determine an appropriate travel speed. Thus, the dynamic curve warning system may have different effects on familiar and unfamiliar drivers. In an attempt to categorize drivers on the basis of their familiarity with the roadway, license plates were used as a surrogate measure of a driver's experience with the route. That is, if the license plate was from a different state, the driver was assumed to be an unfamiliar driver. Statistical analysis of these data yielded inconclusive results. After further consideration, it was acknowledged that an out-of-state license plate does not necessarily mean a driver is unfamiliar with the route. Conversely, in-state license plates do not necessarily mean a driver is familiar with the specific segment of roadway being studied. Therefore, these data have been omitted from the evaluation.

# CHAPTER 4

# DATA ANALYSIS AND RESULTS

Data related to vehicle crashes, speeds, and erratic maneuvers were collected and statistically analyzed to determine the effect of the dynamic curve warning system. Results are detailed in this section.

## Crashes

As mentioned previously, reductions in crashes can be a primary measure of effectiveness when evaluating safety improvements. Crashes occurring within the postmile location of the CMS (or planned CMS location) and one-tenth following the end of the curve were observed. The official contract completion date for CMS installation was April 18, 1999; however, the system was operational in mid-March. For purposes of this report, March 15, 1999 was used as the installation date for all five CMS. Three years of crash data before the signs were installed (March 15, 1996 – March 14, 1999) were obtained. The time between the installation of the dynamic curve warning system and the completion of this report was very limited. Moreover, crash records were only accessible for the first six months following installation (March 15 – September 15, 1999). It should be noted that for crashes taking place after July 31, 1999, the records in the database may still be incomplete.

Seasonal variations in traffic and weather conditions can affect the number of crashes occurring at a given location. To account for this variation, crashes that occurred prior to the CMS installation date were separated into a time period equivalent with the post-installation data (i.e., March 15 – September 15 for 1996, 1997, and 1998). The totals were divided by three to reflect annual averages for comparison with the corresponding totals of the post-installation data. Crashes have been categorized by severity, primary collision factor of "speeding", and vehicle type (if a commercial vehicle was involved in the collision). Tables 8-12 list the number of crashes that took place between the March 15, 1996 and September 15, 1999 by site location.

Table 8. Crashes at the Sidehill Viaduct Site (21)

| | Total | Fatal | Injury | PDO | Speed | Trucks |
|---|---|---|---|---|---|---|
| Crashes in 3 Years Prior to Sign Installation Date (3/15/96-3/14/99) | 19 | 1 | 9 | 9 | 12 | 11 |
| Crashes in Equivalent Period Prior to Sign Installation Date (3/15 – 9/14 of 1996, 1997, and 1998) | 11 | 1 | 6 | 4 | 6 | 7 |
| Average Number of Crashes in Equivalent Period Prior to Sign Installation Date (per period) | 3.7 | 0.3 | 2 | 1.3 | 2 | 2.3 |
| Crashes in 6 months After Sign Installation Date (3/15/99-9/14/99) | 4 | 0 | 1 | 3 | 2 | 1 |

Table 9. Crashes at the O'Brien Site (21)

| | Total | Fatal | Injury | PDO | Speed | Trucks |
|---|---|---|---|---|---|---|
| Crashes in 3 Years Prior to Sign Installation Date (3/15/96-3/14/99) | 6 | 0 | 2 | 4 | 3 | 2 |
| Crashes in Equivalent Period Prior to Sign Installation Date (3/15 – 9/14 of 1996, 1997, and 1998) | 1 | 0 | 0 | 1 | 1 | 1 |
| Average Number of Crashes in Equivalent Period Prior to Sign Installation Date (per period) | 0.3 | 0 | 0 | 0.3 | 0.3 | 0.3 |
| Crashes in 6 months After Sign Installation Date (3/15/99-9/14/99) | 2 | 0 | 0 | 2 | 1 | 1 |

Table 10. Crashes at the Salt Creek Site (21)

| | Total | Fatal | Injury | PDO | Speed | Trucks |
|---|---|---|---|---|---|---|
| Crashes in 3 Years Prior to Sign Installation Date (3/15/96-3/14/99) | 7 | 0 | 2 | 5 | 2 | 3 |
| Crashes in Equivalent Period Prior to Sign Installation Date (3/15 – 9/14 of 1996, 1997, and 1998) | 3 | 0 | 1 | 2 | 1 | 2 |
| Average Number of Crashes in Equivalent Period Prior to Sign Installation Date (per period) | 1 | 0 | 0.3 | 0.7 | 0.3 | 0.7 |
| Crashes in 6 months After Sign Installation Date (3/15/99-9/14/99) | 4 | 0 | 2 | 2 | 1 | 0 |

Table 11. Crashes at the La Moine Site (21)

| | Total | Fatal | Injury | PDO | Speed | Trucks |
|---|---|---|---|---|---|---|
| Crashes in 3 Years Prior to Sign Installation Date (3/15/96-3/14/99) | 16 | 0 | 9 | 7 | 7 | 6 |
| Crashes in Equivalent Period Prior to Sign Installation Date (3/15 – 9/14 of 1996, 1997, and 1998) | 5 | 0 | 2 | 3 | 1 | 2 |
| Average Number of Crashes in Equivalent Period Prior to Sign Installation Date (per period) | 1.7 | 0 | 0.7 | 1 | 0.3 | 0.7 |
| Crashes in 6 months After Sign Installation Date (3/15/99-9/14/99) | 0 | 0 | 0 | 0 | 0 | 0 |

Table 12. Crashes at the Sims Road Site (21)

| | Total | Fatal | Injury | PDO | Speed | Trucks |
|---|---|---|---|---|---|---|
| Crashes in 3 Years Prior to Sign Installation Date (3/15/96-3/14/99) | 14 | 0 | 3 | 11 | 6 | 7 |
| Crashes in Equivalent Period Prior to Sign Installation Date (3/15 – 9/14 of 1996, 1997, and 1998) | 8 | 0 | 1 | 7 | 4 | 2 |
| Average Number of Crashes in Equivalent Period Prior to Sign Installation Date (per period) | 2.7 | 0 | 0.3 | 2.3 | 1.3 | 0.7 |
| Crashes in 6 months After Sign Installation Date (3/15/99-9/14/99) | 1 | 0 | 0 | 1 | 1 | 0 |

A valid before-after comparison cannot be made with the limited crash information available to date. As can be seen in Tables 8-12, there have been slight reductions in total crashes at the La Moine and Sims Road sites, but the Sidehill Viaduct, O'Brien, and Salt Creek sites appear to have experienced small increases. Along with a slight decrease in total crashes seen at the La Moine and Sims Road sites, a corresponding decrease in speed-related crashes and crashes involving trucks is evident. Although slight variations in crash frequency or severity may be noted, it is not possible to attribute any observed changes to the presence of the CMS. Until sufficient data are available to establish the statistical significance of any differences in before-after comparisons, any attempts to credit the CMS with observed decreases in crash frequency or severity are unfounded.

## Speed Measurements

Speed measurement data were collected at each of the five sites on four different occasions. To reiterate, one trip was made prior to the dynamic curve warning system installation, while the remaining three took place after the CMS were in place and functioning. The data gathered on the first trip were compared to the data collected on all three of the trips after the CMS were in place. The similarities and differences noted in the analyses will help determine the effectiveness of the dynamic curve warning signs. The collected speed measurement data is included in Appendix C.

Mean Speeds

Speeds were measured and recorded as the vehicles were traveling through the speed measurement section at the beginning of the curve at each site. A mean speed was found for each data collection trip at each site; Figures 16 and 17 graphically depict the mean speeds. The speed data were separated by vehicle type: Figure 16 shows the speed data collected for commercial vehicles, vehicles towing trailers, and recreational vehicles; Figure 17 shows the speed data for passenger cars. The black columns signify the average speeds found at each study site during the trip made prior to the dynamic curve warning system installation. The gray columns are the speeds observed after the sign systems were in place, and correspond specifically to the second, third, and fourth trips from left to right. The white column for each site represents the average of the speed measurements obtained on the second, third and fourth trips (i.e., all the data collected after the dynamic curve warning system was installed). The gray arrow appearing in some of the columns indicates a significant decrease in speed ($\alpha = 0.05$) when these data were compared with the data collected on the first trip (i.e., before the CMS). If no arrow is present, there was either no significant change or there was an increase in mean speed from before to after the installation of the CMS. An increase in speed or no change in speed between the before and after CMS installation data (denoted by no arrow in the corresponding column) suggest the dynamic curve warning sign system may be ineffective at reducing speeds at the specific location.

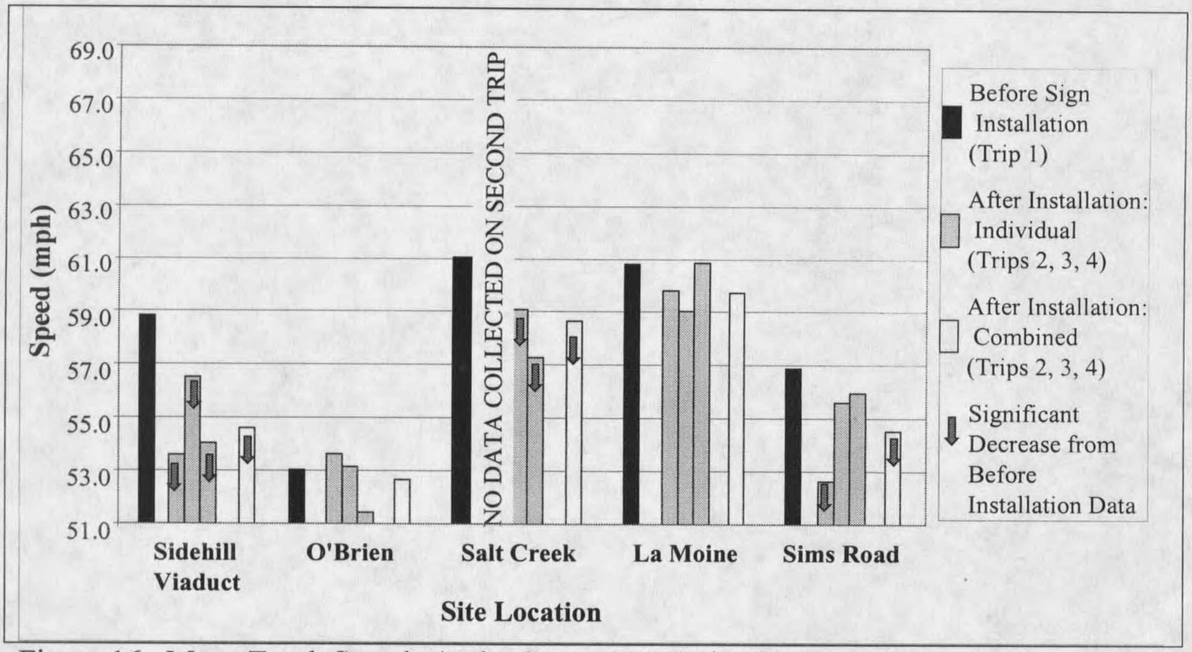



Figure 16. Mean Truck Speeds At the Curve At All Five Sites

As can be noted in Figure 16, there were significant decreases in speed at the curves at the Sidehill Viaduct, Salt Creek, and Sims Road sites. Sidehill Viaduct and Salt Creek both showed significant decreases in all post-installation periods. An examination of roadway characteristics reveals that these two sites are the only curves located on rather steep downgrades (–5.0 to –6.0%). The speeds at the Sims Road site significantly decreased initially (64.1 mph to 61.9 mph), but then continued to rise over time. Overall, mean post-installation truck speed was significantly lower than the corresponding pre-installation speed at Sims Road, but given the increases in speed noted in the data collected on the third and fourth trips, it would appear that desensitization to the CMS is a possibility at this site. The truck speeds collected at the O'Brien and LaMoine sites did not show any significant decreases after the dynamic curve warning system was in place.

During the fourth data collection trip, there were wet weather conditions at the Sidehill Viaduct and O'Brien sites, which could have had some effect on the speed measurements. When roadways are wet, drivers may reduce their travel speeds, thereby affecting the measured speeds at these sites.

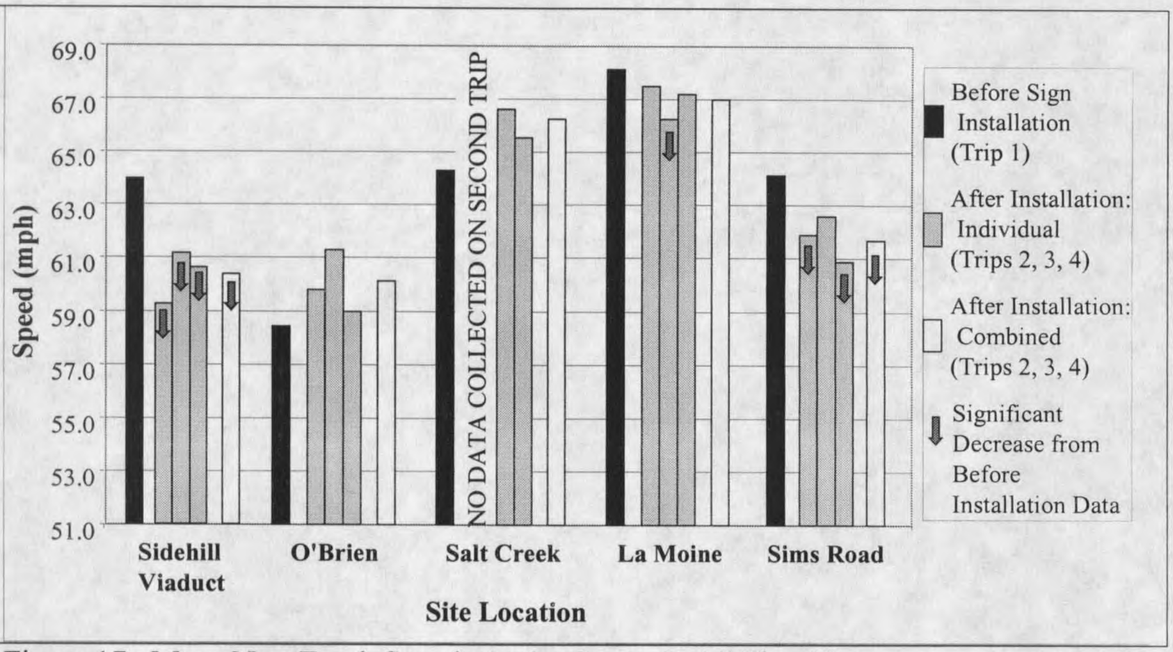



Figure 17. Mean Non-Truck Speeds At the Curve At All Five Sites

The results of the passenger car speed analyses indicate the Sidehill Viaduct and Sims Road sites have experienced significant speed decreases. The speeds collected on all three of the post-installation trips at Sidehill Viaduct showed statistically significant decreases. There was one statistically significant reduction in mean speeds at the La Moine site. The mean speeds of the remaining trips were not significant reductions, and the reduction represented by the combined average of the three post-installation mean speeds was not a statistically significant change. The reductions in mean speed at the La Moine site may or may not have been attributable to the intallation of the CMS.

However, the speed reductions at Sidehill Viaduct and Sims Road provide convincing evidence that the dynamic curve warning sign may be effective at reducing non-truck speeds at these curves.

The data collected for passenger cars at the O'Brien and Salt Creek sites did not show a significant decrease in speeds in the period following the CMS installation. In fact, average speeds at these sites actually increased in the post-installation period. A change in the area that may have influenced the speed results is the increase in the posted speed limit that would have affected the Sidehill Viaduct, O'Brien, and Salt Creek sites. Between the first and second trips, the speed limit for passenger cars was raised from 55 to 65 mph, although the curve advisory speed remained at 50 mph for each curve. It seems reasonable to assume that an increase in the posted speed limit might be reflected in higher mean speeds at the curves, despite the warnings and advisory speeds provided on the CMS. Although this theory would help to explain increases observed at the O'Brien and Salt Creek sites, the data collected at the Sidehill Viaduct are counterintuitive. In fact, the decreases in mean speeds at this site were the most dramatic of any and provided the strongest indication of the CMS's effectiveness at reducing non-truck speeds.

As mentioned previously, weather also could have had some contributing effects on the data. Conditions were clear and dry for the majority of the data collection trips, with the exception of the fourth trip to Sidehill Viaduct and O'Brien where it was raining and/or the roadway was wet. Reductions in speeds at these two sites may have been due, at least in part, to drivers slowing their speeds because of the roadway conditions. Again, however, the discrepancy between the two sites remains unexplained.

Other Speed Considerations

In addition to the speeds recorded at the beginning of the curve, speeds were collected at the CMS location (or planned CMS location before the installation). The differences in speeds observed between the location of the CMS and the beginning of the curve were compared between trips to determine if the degree of driver slowing changed from before to after the CMS installation. Table 13 displays the measured differences in speed. A negative value indicates vehicles are slowing down between the CMS and the curve, while a positive value denotes an increase in speed. Shaded cells denote statistically significant changes between the results found during the pre-installation trip and the remaining post-installation trips.

Table 13. Speed Changes Between the CMS (or Planned CMS Location) and the Curve

| Site | Speed Reduction for Trip #1 (mph) | Speed Reduction for Trip #2 (mph) | Speed Reduction for Trip #3 (mph) | Speed Reduction for Trip #4 (mph) |
|---|---|---|---|---|
| Sidehill Viaduct | -0.9 | 1.1 | 0.7 | 0.4 |
| O'Brien | -2.4 | -2.2 | -2.3 | -1.8 |
| Salt Creek | 1.2 | N/A* | 0.5 | -1.7 |
| La Moine | 1.5 | 2.1 | -0.4 | 0.5 |
| Sims Road | -1.3 | -2.4 | -1.5 | -2.4 |

* No data was collected, due to ongoing construction

Observed increases or decreases in speed between the CMS location and the approximate beginning of the curve are less indicative of the CMS's effectiveness than an overall reduction in speed in the area at the beginning of the curve following the installation of the CMS, as found in the previous section. Decreases in speeds between the two speed measurement sections may indicate drivers are slowing for the curve, but this does not necessarily mean the CMS was more effective in reducing speeds than a static curve warning sign. Increases in speeds between the CMS and the beginning of the curve may indicate drivers have overadjusted their speeds and then sped up to complete the curve. This initial reduction in speed could suggest the CMS was so effective at slowing the driver, they slowed down too much. Because of the possibility of two interpretations, conclusions concerning the effectiveness of the dynamic curve warning signs at reducing speeds in the distance between the CMS and the entrance to the curve are less definitive.

Once again, the speed limit increase for passenger cars (from 55 to 65 mph between the first and second trips) at the Sidehill Viaduct, O'Brien, and Salt Creek sites complicates the interpretation of the findings. In theory, the higher posted speed limit should not have affected this analysis as much as the mean speed analysis in the previous section. If anything, a higher traveling speed as cars approached the CMS should have resulted in a greater decrease in speed as they entered the curve, if they adjusted their speed in response to the CMS advisory. The results reported in Table 13, however, do not support this theory.

Positioning of the speed measurement sections may have influenced the results of the speed reduction analysis. Placement of the first section was intended to measure the speed at the driver's first reaction to the CMS. In retrospect, it might have been more appropriate to have positioned the first speed measurement section farther upstream so as to measure the speed at the driver's first sight of the CMS. It is possible that drivers began their deceleration process before reaching the first speed measurement section, in which case both the initial speed measurement and the overall change in speed would have been underestimated. This would have adversely affected the results of the analysis.

Other analyses of the speed data were conducted. For each vehicle, the speed collected at the CMS location and the speed at the approximate beginning of the curve were compared to determine if there was a statistically significant change in speed between the two speed measurement sections. Secondly, the speeds of the drivers who were observed performing erratic maneuvers during each data collection visit were compared with one another. Results of these additional statistical tests did not affect the final results of the evaluation.

## Erratic Maneuvers

In addition to the speeds at which drivers were traveling, two measures of driver behavior and vehicular movements during the negotiation of the curves were observed and recorded. Specifically, these "erratic" maneuvers included lane encroachments and brake light actuations that occurred while the vehicle was in the curve. As discussed previously, both phenomena could indicate that drivers *may* have been traveling too fast for safe negotiation of the curve and had to react to correct their actions. However, it is possible a driver may have performed an erratic maneuver even though he was able to safely complete the curve. For instance, a driver may swing wide simply to smooth out a curve, but this erratic maneuver also could indicate that a driver was compensating for approaching a curve too fast. Because of the uncertainty in interpreting erratic maneuvers, less emphasis was placed on the results of this analysis. Statistical tests were conducted to determine if the percentage of drivers performing *any* type of erratic maneuver changed significantly between data collection periods. No statistical analyses were conducted on individual types of erratic maneuvers, given the interpretation uncertainties and the limited data available for analysis.

Figures 18-22 include erratic maneuver information recorded at each site during each data collection trip. Although lane encroachment categories are mutually exclusive, it is quite possible for a driver to apply his brakes and cross the boundaries of the travel lane during his negotiation of the curve. Therefore, some drivers are double-counted in the following figures.

Sidehill Viaduct

Figure 18 displays the erratic movements or use of brakes by drivers during data collection at the Sidehill Viaduct site.

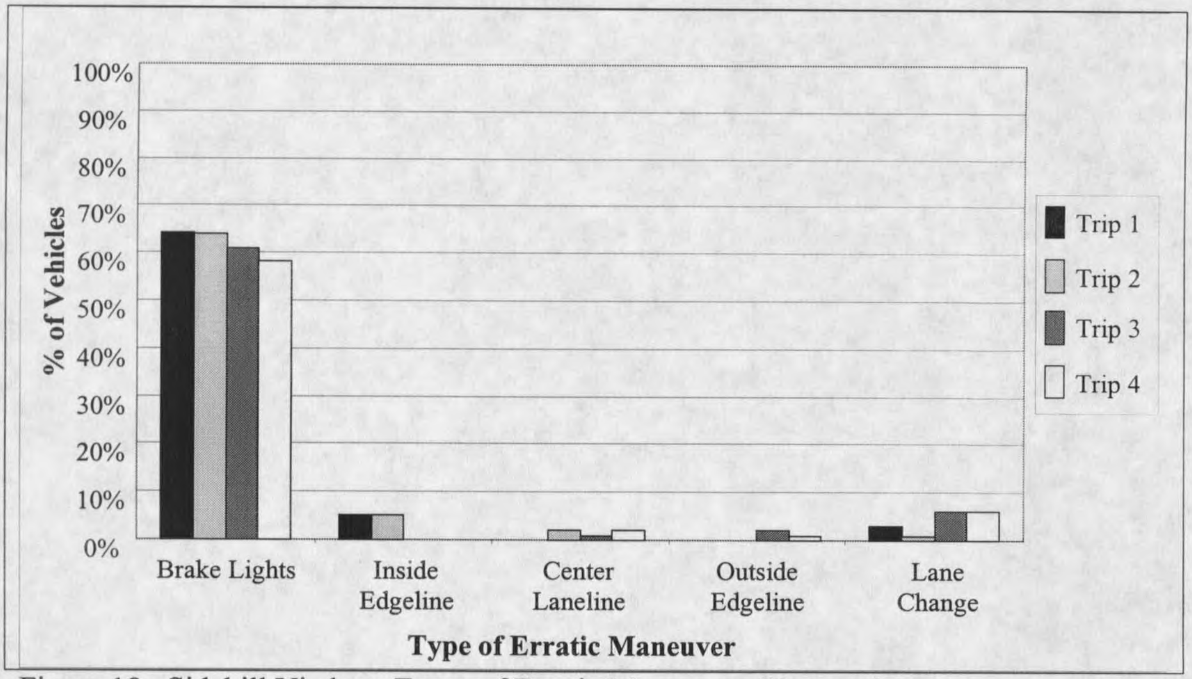



Figure 18. Sidehill Viaduct: Types of Erratic Maneuvers Observed

Lane line encroachments were seldom executed at this site; at most, only 6% of the total vehicles that passed through this curve were observed crossing over their lane boundaries. Brake lights actuations were much more commonly noted, ranging from 58% to 64% of the observed vehicles, depending on the trip. There was a small reduction in the percentage of drivers who utilized their brakes over time. This curve is positioned on a steep downgrade (-6.0%) and, therefore, the application of brakes in the curve could be an instinctive reaction to the slope of the road, alone, or in combination with the curve, more than a perception of excessive speed on the driver's part. Tests to determine statistical significance were only completed on the total number of vehicles performing any maneuver, not on specific maneuvers, as explained previously. There were not any statistically significant changes in the number of combined erratic maneuvers.

O'Brien

The O'Brien site experienced significant reductions in the percentages of drivers performing any type of erratic maneuver between the pre-installation trip and each of the post-installation trips. The types of erratic movements performed at the O'Brien site during each of the data collection trips are shown in Figure 19.

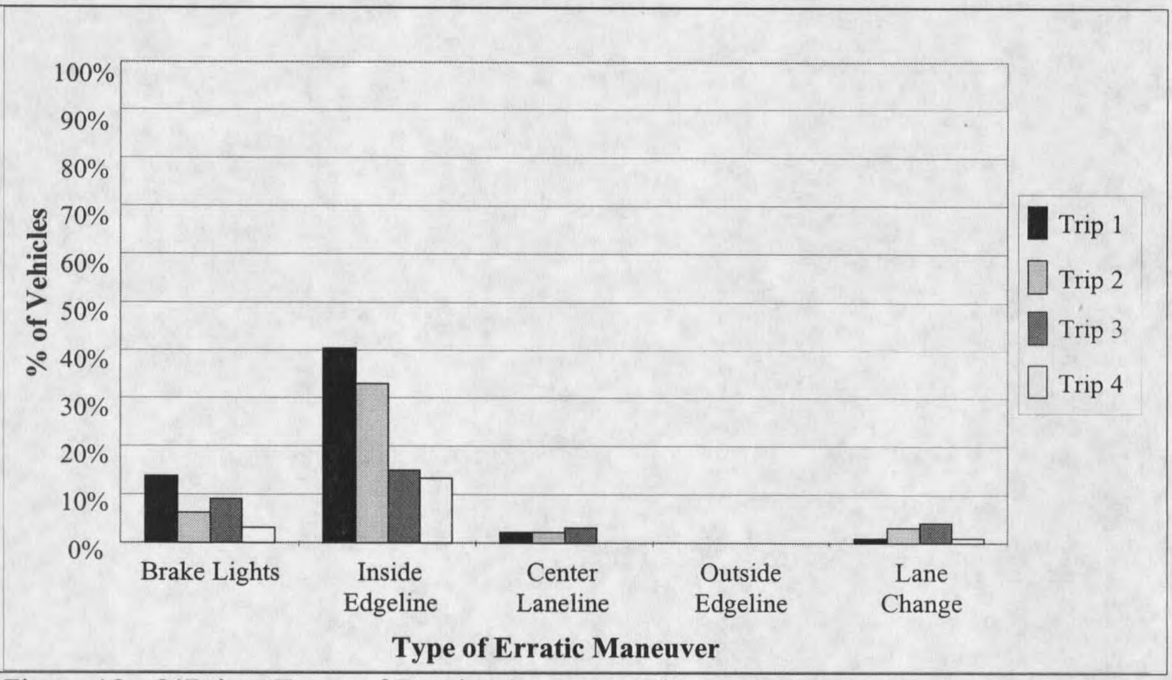



Figure 19. O'Brien: Types of Erratic Maneuvers Observed

At the O'Brien site, the most common erratic maneuver (ranging from 13% to 40% of the observed vehicles) was the inside edgeline movement. This site is one of two right-hand curves, and because most vehicles travel in the driving (right) lane, this maneuver might have been made to smooth the curve to lessen or avoid the need to slow down. As seen in Figure 19, the number of inside edge maneuvers was noticeably reduced over time, although these findings are somewhat counterintuitive to increased speeds at this site that were noted in the speed analysis section. It would seem that drivers traveling at higher speeds would be more likely to apply their brakes or cross outside their lane, but the speed data collected during the first and second trips, in particular, do not support this notion. No explanation for this finding is offered.

Salt Creek

Figure 20 illustrates that less than 10% of the vehicles were observed making any type of lane line encroachment at the Salt Creek site.

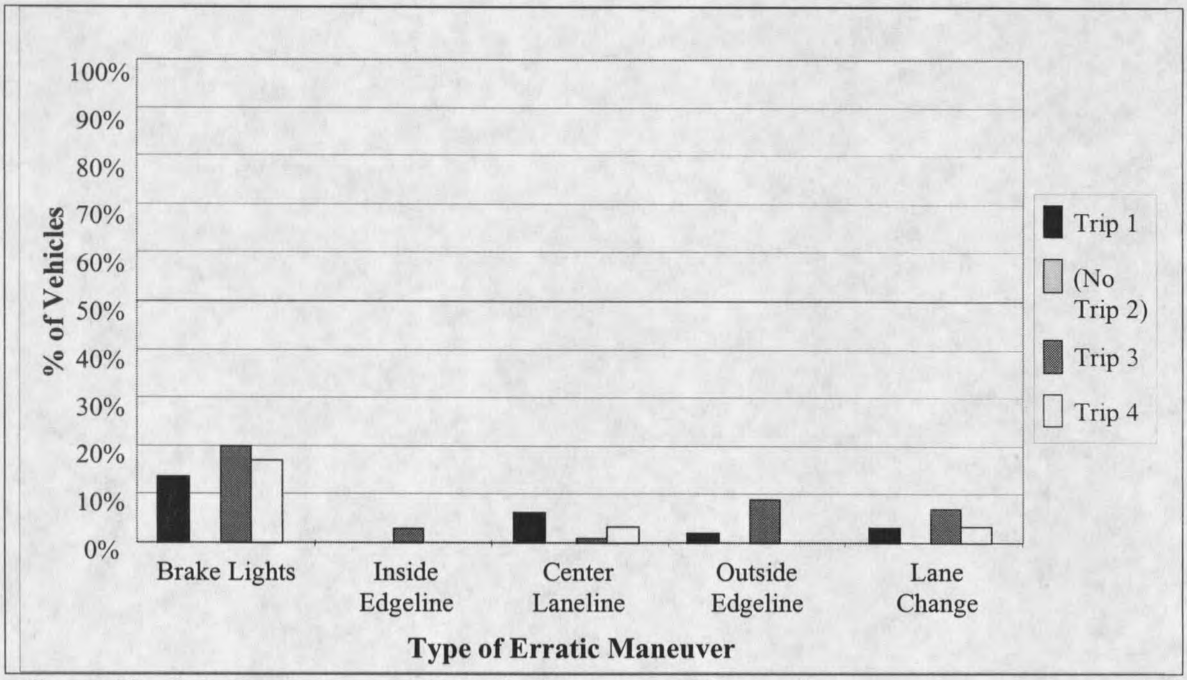



Figure 20. Salt Creek: Types of Erratic Maneuvers Observed

Brakes were used in the Salt Creek curve by 14% to 20% of the drivers in observed vehicles (depending on the data collection trip), which could be partly due to the downgrade and vertical curve in this segment. There are no statistically significant changes or trends in the erratic maneuver data collected at Salt Creek, and there does not appear to be a dominant type of lane line encroachment. Again, it should be noted that no data were collected during Trip 2 because of ongoing construction activities.

La Moine

During each data collection, the majority of drivers observed at the LaMoine site (over 90%) did not perform any lane line encroachments, as can be seen in Figure 21.

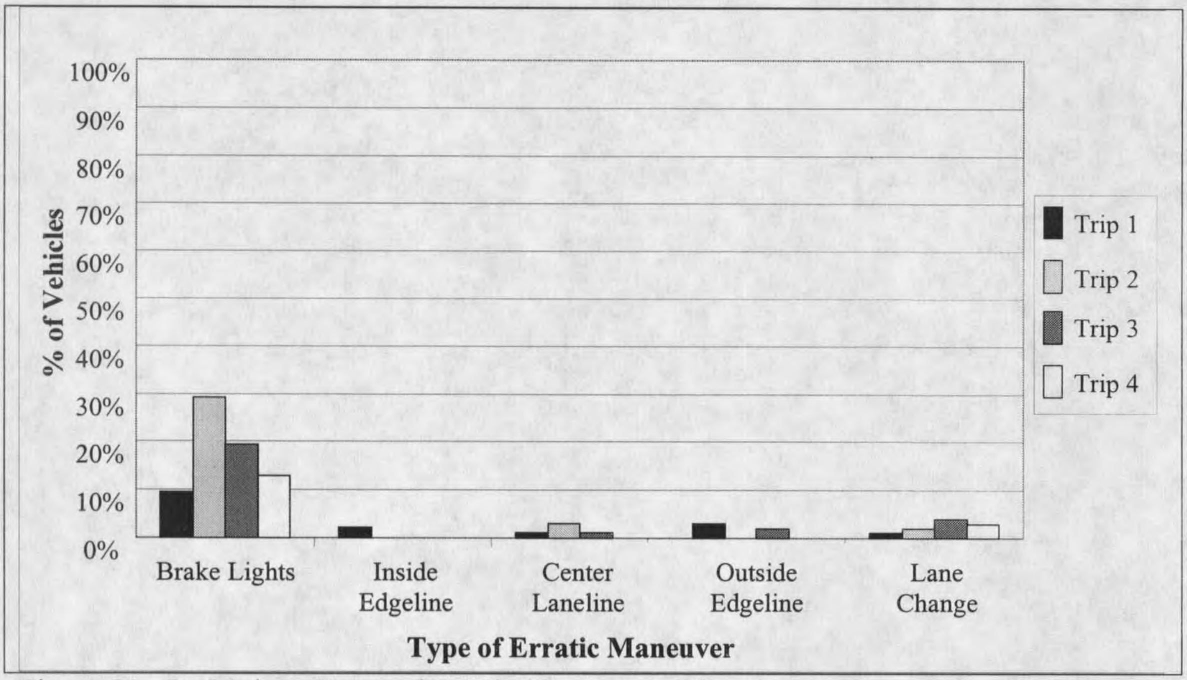



Figure 21. La Moine: Types of Erratic Maneuvers Observed

Compared to all of the study sites besides Sidehill Viaduct, brake light actuations were fairly common in this curve (ranging from 10% to 29%). In theory, drivers traveling at higher speeds are more likely to use their brakes to safely complete a curve. Therefore, there would be a correlation between the mean speed and the number of drivers utilizing their brakes. However, the speed data at the La Moine site do not follow the same trend displayed by the brake light actuation data, which cannot be explained. There were no significant reductions in the erratic maneuver data at the La Moine site.

Sims Road

The Sims Road site experienced a significant decrease in the percentage of drivers performing any type of erratic maneuver. Figure 22 displays the different ways in which vehicles left the lane boundaries at the Sims Road site and the percentage of drivers who used their brakes while traveling the curve.

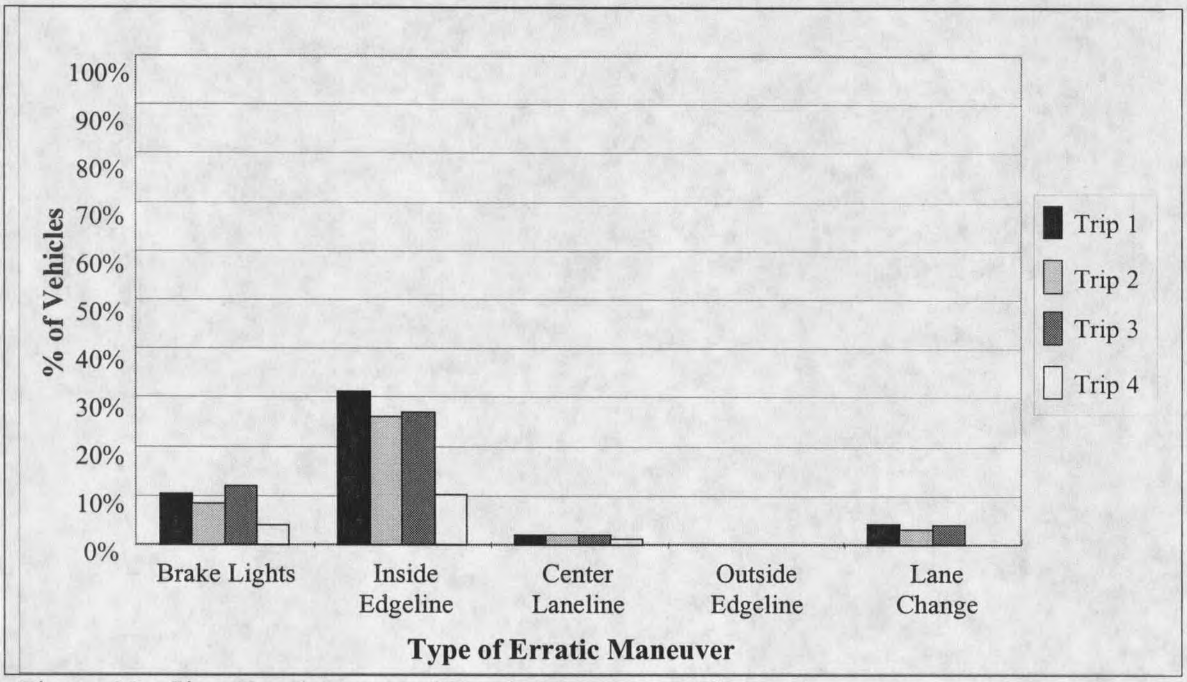



Figure 22. Sims Road: Types of Erratic Maneuvers Observed

The curve at this site experienced a large group of drivers (10% to 30%) who drifted over the inside edge as they traveled the curve. Other than this type of lane line encroachment, most motorists executed this curve without leaving their designated lanes, and only 4% to 12% of the drivers used their brakes around the curve. The percentage of drivers performing each particular type of erratic maneuvers remained relatively constant through the first three data collection trips, but dropped rather noticeably in the fourth trip.

Similar to the O'Brien site, the high number of inside edge encroachments at the Sims Road site (which is also a right hand curve) could be attributed to drivers using the shoulder to give themselves more room around the curve. Although a breakdown by vehicle type was not selected for inclusion in this document, it was of interest that truck drivers were responsible for a majority of the inside edge maneuvers (60% at O'Brien and 70% at Sims Road).

# CHAPTER 5

# MOTORIST AND MAINTENANCE PERSONNEL OPINIONS

In addition to the quantified data described previously, qualified data related to motorist and maintenance personnel opinions of the dynamic curve warning system were sought.

## Motorist Opinions

Motorist opinions were solicited via survey. Response percentages for the questions pertaining to the dynamic curve warning sign are provided in Figures 23-33. Examining the travel trends of the survey respondents concerning vehicle type, trip purpose, and frequency of travel through this section of Interstate 5, responses were found to be similar between the two different survey administrations. Out of the different vehicle types represented at each survey location, it was noted that the vast majority of drivers who participated in the survey at the 76 Travel Center were commercial vehicle operators (99% in the daylight and 98% after dusk), whereas the majority of survey participants at the Lakehead Rest Area were passenger car (79%) or recreational vehicle (14%) drivers. Without exception, all of the truck drivers surveyed were traveling strictly for business purposes, while 77% of the passenger car drivers and 97% of the recreational vehicle operators were traveling for pleasure purposes. When asked about the frequency of driving the particular segment of Interstate 5 where the signs are located, approximately 12% of the truck drivers stated they travel it less than once a month, while

75% of the passenger car drivers and 97% of the recreational vehicle users made the same claim. First time visitors to the area are included in this category, as well. It can be inferred from these figures that the truck drivers are more familiar with the route than their non-truck counterparts.

Commercial Vehicles

During the first survey administration in May 1999, 153 commercial vehicle drivers were surveyed, while 162 participated in the second survey administration in January 2000. Figure 23 shows the response distribution when commercial vehicle drivers were asked if they thought the speed information given on the new dynamic curve warning signs was useful. As can be seen in Figure 23, the vast majority of survey participants who were operating trucks believed the signs were helpful during both survey administrations (73% and 70% for second and fourth visits, respectively).

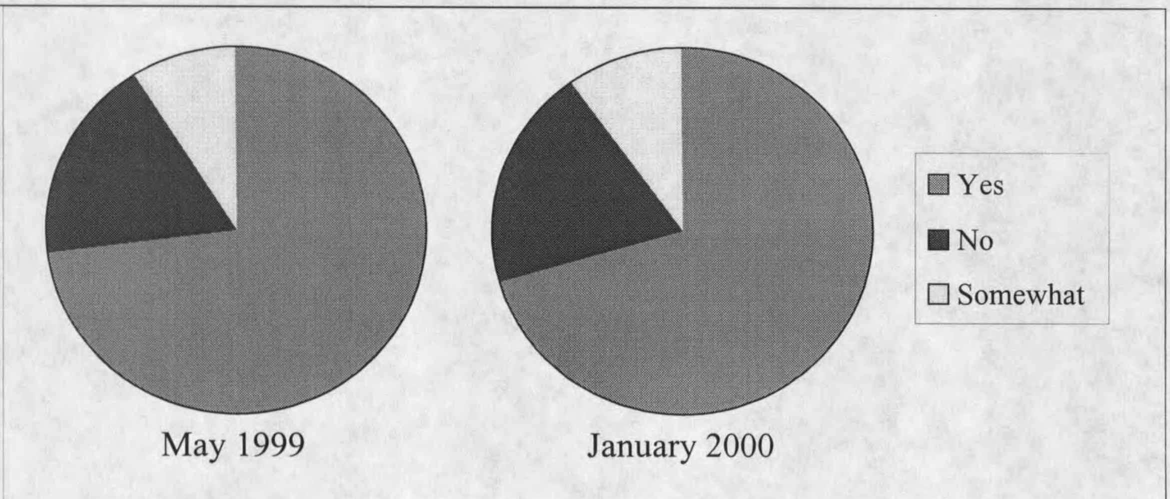



Figure 23. Commercial Vehicle Operators' Responses to "Do you think this speed information was useful to you in driving safely through the curve?"

Figure 24 displays the answers given when truck-driving respondents were asked if they personally responded or adjusted their travel speed through the curve, as advised by the sign. These results may differ from the previous question because some drivers said they thought the signs gave useful information, but felt they were already driving slowly enough that they didn't have to adjust their speeds, or felt they knew their current speed was safe for the particular curve due to experience driving in the area. It is possible that the number of those claiming to respond is inflated because people tend to over-report their personal behaviors. Interestingly, however, the proportion of truck drivers who reportedly responded to the curve warning sign (76% and 69%) is roughly equivalent to the proportion who felt the information provided on the sign was useful (Figure 23).

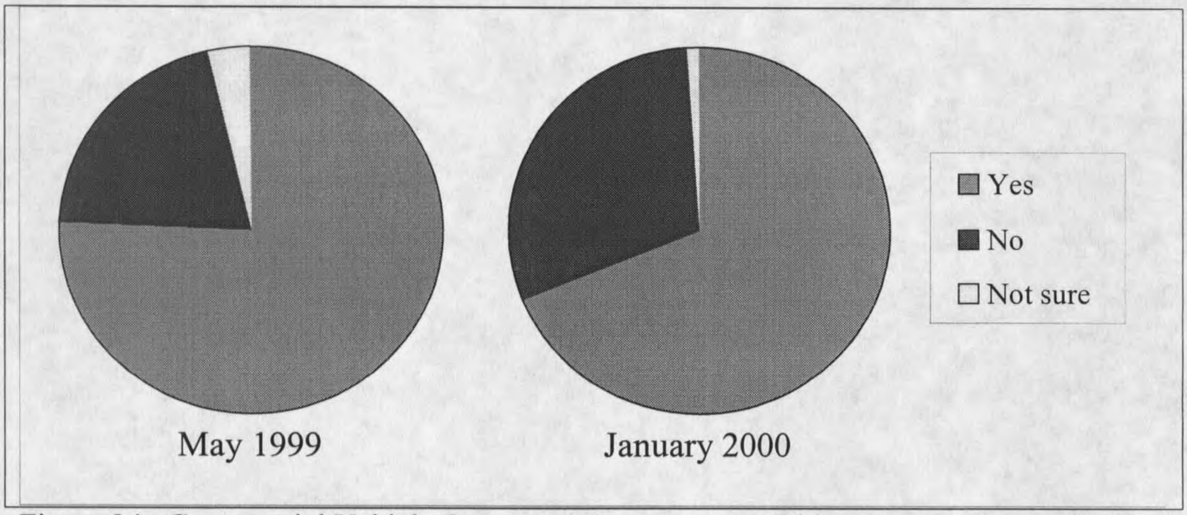



Figure 24. Commercial Vehicle Operators' Responses to "Did you respond and adjust your travel speed through the curve as advised?"

When asked if the positions of the warning signs were adequate, most of the truck drivers (79% and 84%) felt they were positioned well. Comments were made about the

O'Brien CMS location, noting that by the time drivers complete the previous curve, there may not be enough time for them to read more than one or two messages on the sign. Drivers familiar with the area also felt the CMS at the Salt Creek site was difficult to respond to because they knew they would subsequently have to adjust their speed to make the upgrade in the second curve. All of the respondents who didn't think the position was suitable felt the CMS was too close to the curve. Figure 25 shows the proportions of responses to this question made by the commercial vehicle operators during each survey administration.

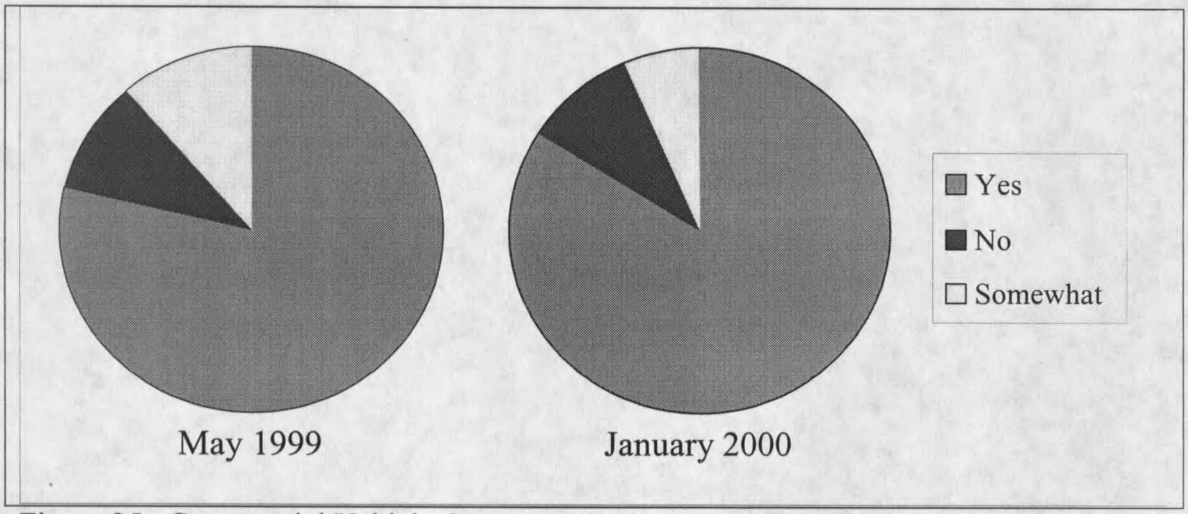



Figure 25. Commercial Vehicle Operators' Responses to "Was the location of the changeable speed warning sign adequate for you to respond?"

Passenger Cars

Survey participants driving passenger cars may have different opinions of the dynamic curve warning system than the commercial vehicle operators due to different traveling habits, such as the purpose of their trips and frequency of travel through the study area. Vehicle size also may affect the driver's ability to slow for each curve upon warning, which may affect opinions about the positioning of the CMS. The location of the survey administration was south of the La Moine site, which meant for those seeing the dynamic curve warning system for the first time, the only CMS seen at the time of the survey was at the La Moine site. For these reasons, the survey answers received from passenger car drivers have been separated from those of the truck drivers (as are the results of recreational vehicle operators reported in the next section).

Eighty-nine passenger car drivers were surveyed in May 1999; 77 passenger car drivers responded in January 2000. Figure 26 shows the responses from passenger car drivers when asked if they thought the information on the CMS was useful. As can be seen, 78% and 85% of the respondents (during the second and fourth site visits, respectively) said they did believe the information was useful. When compared with the results of the truck drivers, the number of passenger car drivers who thought the information was useful is notably higher.

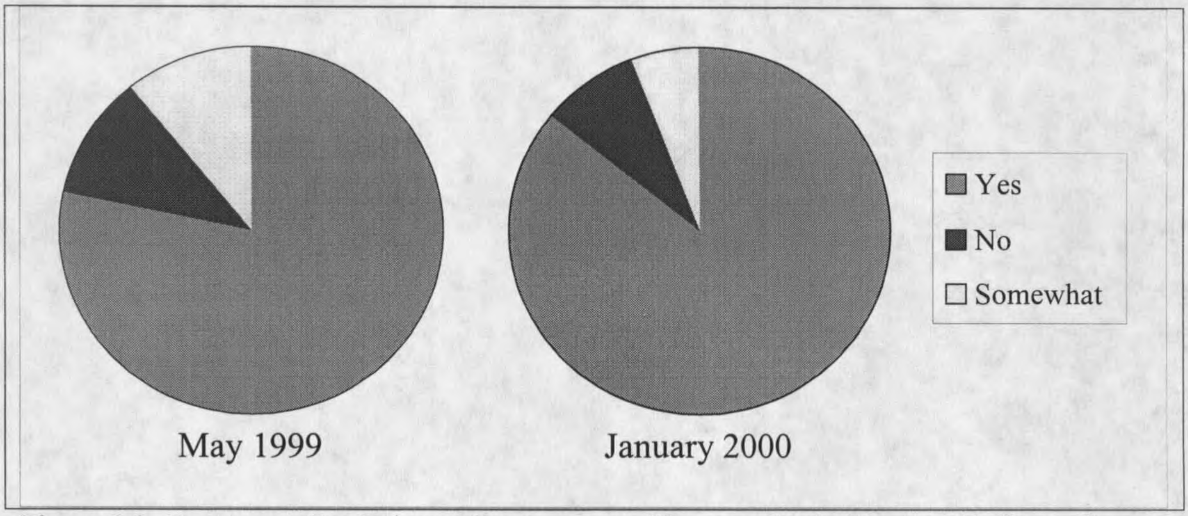



Figure 26. Passenger Car Drivers' Responses to "Do you think this speed information was useful to you in driving safely through the curve?"

The responses of passenger car drivers to the question concerning whether they each, personally, responded to the CMS message are displayed in Figure 27. A smaller percentage of the passenger car drivers adjusted their speed in response to the CMS (60% and 69%), compared to the corresponding percentage who felt the advisory information was useful.

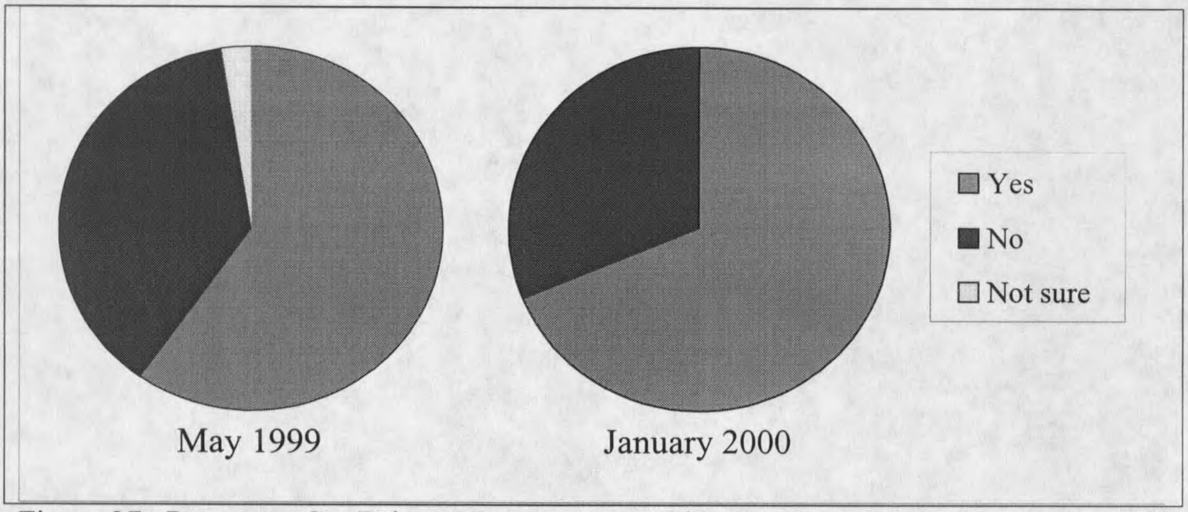



Figure 27. Passenger Car Drivers' Responses to "Did you respond and adjust your travel speed through the curve as advised?"

As some drivers were interviewed, they added that they did not have to slow down because they were already driving at a speed lower than the advisory. This response was categorized as "No" because of the wording of the question, although it is acknowledged that this does, to some extent, underestimate the effectiveness of the CMS at changing driver behavior (i.e., reducing speed). In addition, the numbers may conversely be inflated due to the tendency to over-report personal behavior.

Figure 28 illustrates the distribution of responses of those driving passenger cars to the CMS position question. Approximately 84% and 90% of the passenger car drivers thought the positioning of the CMS at the La Moine site was adequate. Twelve of the 13 people who thought the positioning was inadequate added that the CMS was too close to the curve.

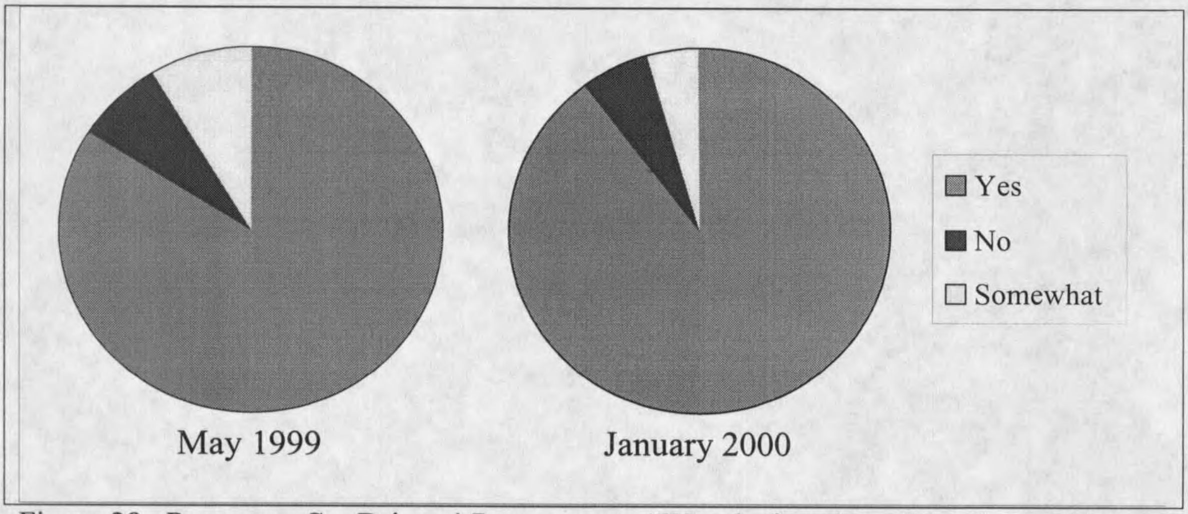



Figure 28. Passenger Car Drivers' Responses to "Was the location of the changeable speed warning sign adequate for you to respond?"

Recreational Vehicles

The survey responses for drivers of recreational vehicles were separated from the rest of the data. Drivers of vehicles traveling for pleasure purposes might have different opinions of the dynamic curve warning system than those traveling for business. Because 97% of the surveyed recreational vehicle drivers stated they traveled this segment of Interstate 5 less than once a month, this was quite possibly the first time some of these drivers had seen the dynamic curve warning system.

The sample sizes of recreational vehicle drivers are small compared to the other vehicle types: only 11 participated in May 1999 and 20 participated in January 2000. Results of this analysis, therefore, should be interpreted with caution. As can be seen in

Figure 29, most surveyed recreational vehicle drivers (100% and 87% for the second and fourth visits, respectively) believed the speed information given on the CMS was useful.

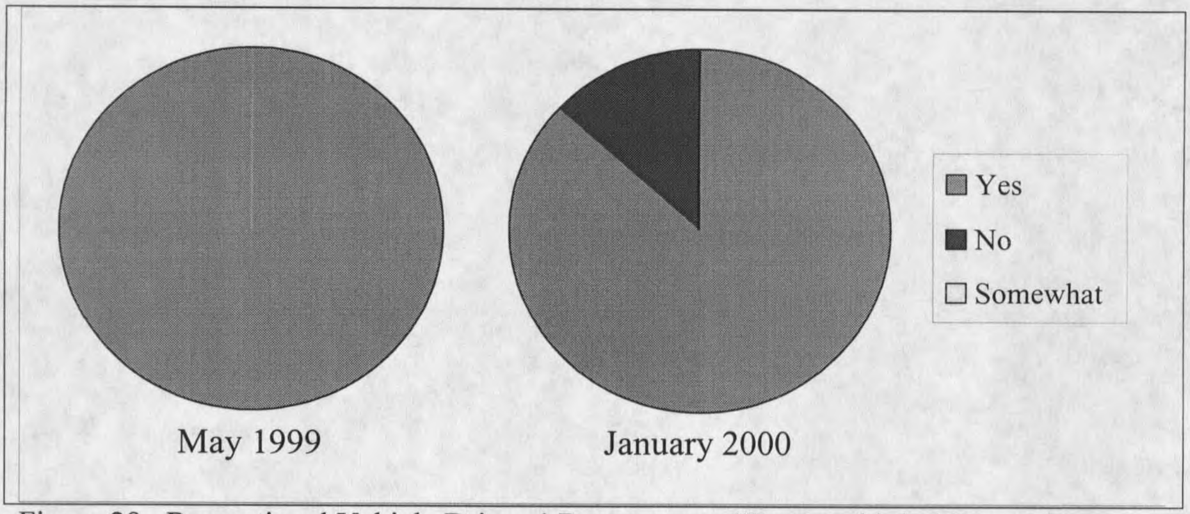



Figure 29. Recreational Vehicle Drivers' Responses to "Do you think this speed information was useful to you in driving safely through the curve?"

Although the percentage of recreational vehicle drivers who reportedly responded to the CMS was high for the first survey administration (89%), half of the respondents said they did not adjust their speed during the second wave of the survey. As noted earlier, this high percentage of persons who did not respond to the CMS could be a reflection of drivers already traveling at speeds lower than the CMS advisory speed by the time the warning was received. Again, these self-reported numbers may be inflated.

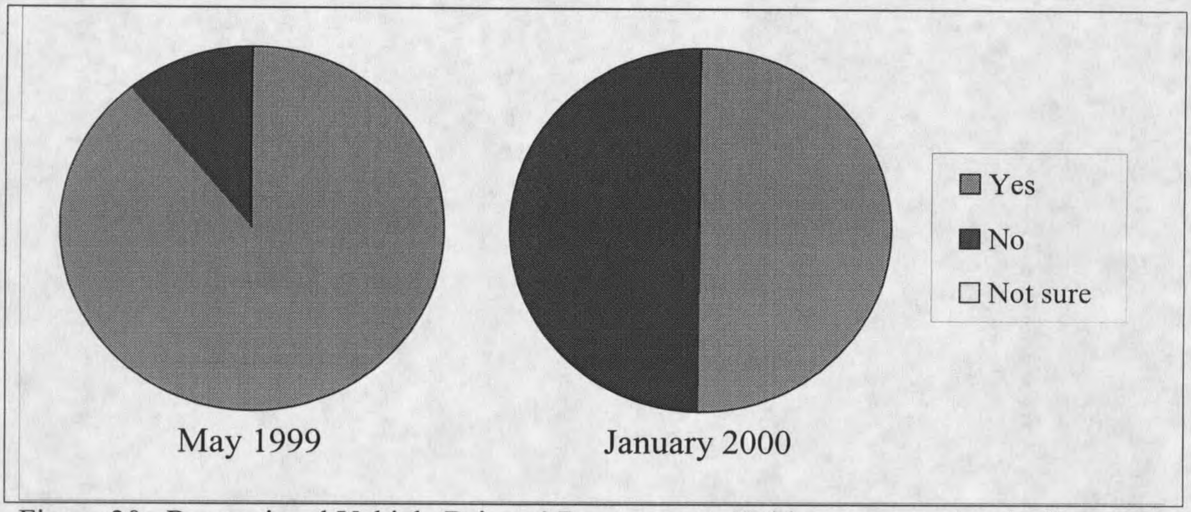



Figure 30. Recreational Vehicle Drivers' Responses to "Did you respond and adjust your travel speed through the curve as advised?"

All of the recreational vehicle drivers surveyed during the second site visit stated the positioning of the sign was adequate, while only 67% of the drivers responded the same way during the fourth visit, as can be see in Figure 31. The extremely small sample sizes make interpretation of any differences in response percentages problematic.

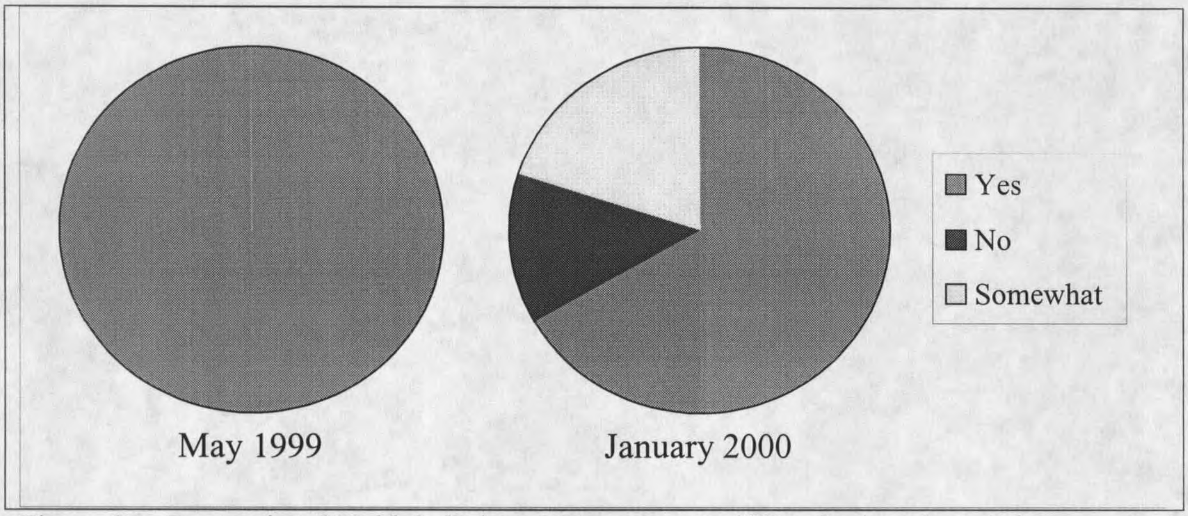



Figure 31. Recreational Vehicle Drivers' Responses to "Was the location of the changeable speed warning sign adequate for you to respond?"

All Vehicles

The question related to the visibility of the sign has been broken down by survey time (i.e., day or night), as opposed to vehicle type, as shown in Figures 32 and 33. The vast majority of the respondents felt the visibility of the CMS in terms of the brightness of the lights was adequate (98% and 99%). The few who didn't think the visibility of the CMS was adequate either thought the lights were too bright or didn't comment.

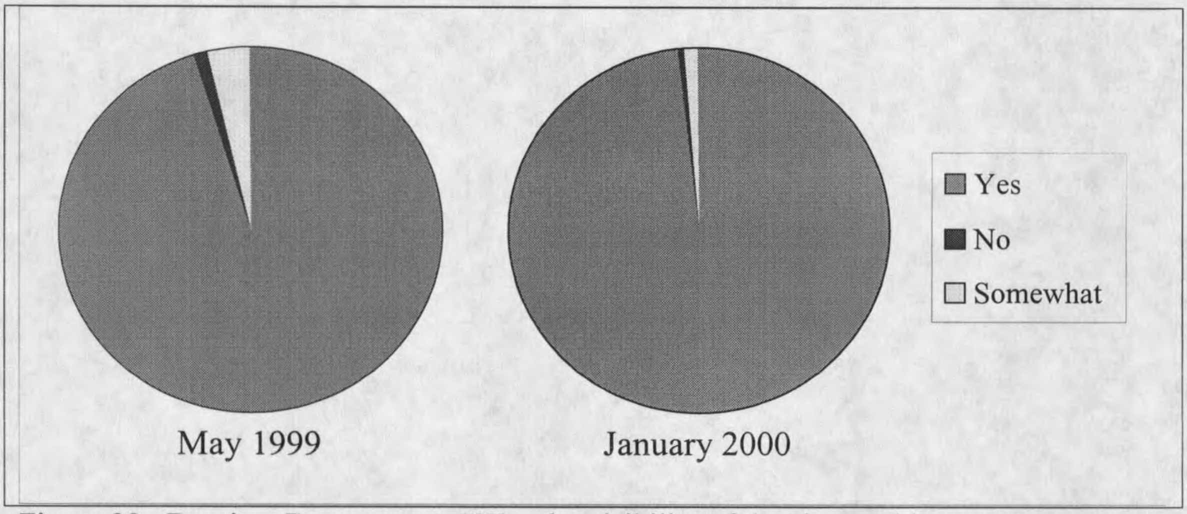



Figure 32. Daytime Responses to "Was the visibility of the changeable message speed warning sign adequate for you to respond?"

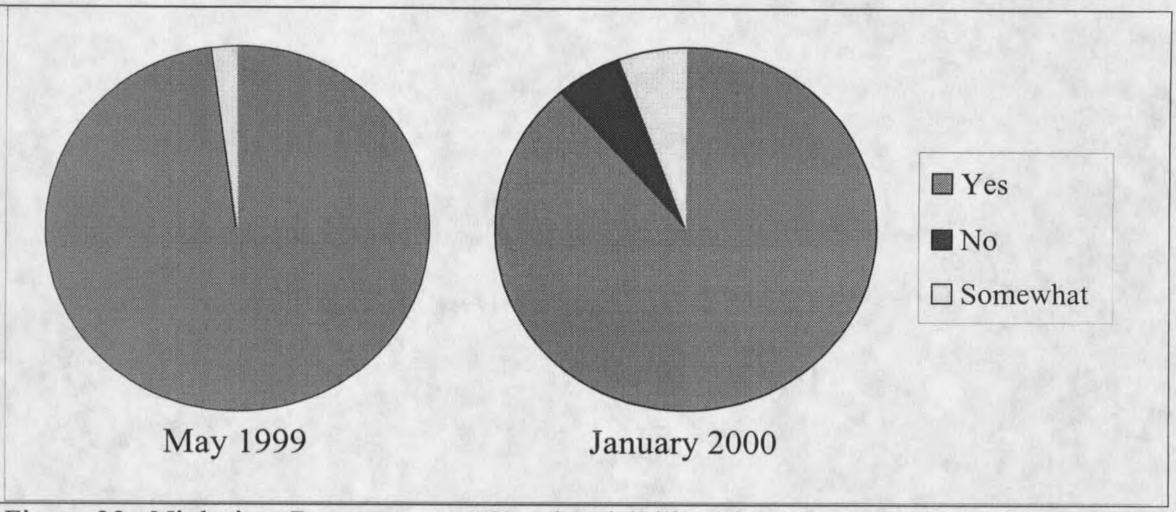



Figure 33. Nighttime Responses to "Was the visibility of the changeable message speed warning sign adequate for you to respond?"

## Maintenance Personnel Opinions

Two initial problems were identified from interviews with Caltrans maintenance personnel. First, the radar units chosen for the system are incapable of distinguishing between north- and southbound directions of traffic. The Sidehill Viaduct and O'Brien sites are divided and separated by enough space that this is not an issue; at the Salt Creek, La Moine, and Sims Road sites, this limitation results in an inaccurate reading and message being displayed to drivers. The positioning and the angle of the radar units have been adjusted, but the cones of vision cannot be changed enough to exclude the traffic in the opposite lanes. For future installations, a different radar unit model that can distinguish between the different directions of travel will be used (17).

Second, the paging system is intended to page authorized Caltrans personnel when five *consecutive* vehicles pass the CMS at speeds of 35 mph or less. At the time of the preparation of this report, there were some errors in the software and the system was notifying the employees when *any* five vehicles were approaching the CMS traveling 35 mph or slower, whether or not the vehicles were consecutive. Work is currently underway to improve this flaw in the pager system (22). In addition, a final comment was made by maintenance personnel that a laptop computer was needed so the CMS could be controlled from the field (23). Aside from these initial problems, there have been no other documented maintenance or operational difficulties with the dynamic curve warning system.

# CHAPTER 6

# CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the results of an evaluation of the effectiveness of the CMS portion of the dynamic curve warning system in the Sacramento River Canyon. Measures of effectiveness (MOEs) used in the analysis include (1) crashes, (2) speeds, (3) driver behavior, and (4) motorist and maintenance personnel opinions. The results indicated the dynamic curve warning signs may be an effective safety improvement at some locations, although data collected at other sites did not demonstrate significant differences in MOEs following the installation of the CMS. Four trips were made to determine changes in the measures of effectiveness: one before the CMS installation; one shortly after the installation to measure initial changes; one approximately four months after the installation to see if there was any desensitization to the system; and the last trip made nine months after the installation during the winter season to observe any changes corresponding to potentially inclement weather conditions.

Due to the lack of sufficient crash data following the installation date of the dynamic curve warning system, a meaningful before-after analysis could not be made at the time of this report. Slight reductions in crashes were noted in the available data obtained for the La Moine and Sims Road sites, while there were small increases in the frequency of crashes at the Sidehill Viaduct, O'Brien, and Salt Creek curves. Because of the extremely small set of post-installation crash data, it is impossible to attribute any observed differences to the installation of the dynamic curve warning system. Even the observed increases or decreases in crashes should be interpreted with caution due to the inherent instability of traffic crash data.

Speed data were collected at the approximate beginning of each designated curve, using a manual stopwatch method at all of the sites during each of the four site visits. Data were analyzed by vehicle type. Decreases in truck speeds (including commercial vehicles, recreational vehicles, and vehicles towing trailers) were found to be statistically significant ($\alpha = 0.05$) at the Sidehill Viaduct and Salt Creek sites, which are the only curves located in steep downgrades (-5.0% to –6.0%). The Sims Road site experienced a significant reduction in truck speeds immediately following the installation of the CMS, but the speed data collected at this site on subsequent visits indicate the mean speeds rose steadily thereafter. There were no significant decreases in truck speeds at the O'Brien and La Moine sites. Passenger car speeds were found to significantly decrease at the Sidehill Viaduct and Sims Road sites, while the O'Brien, Salt Creek, and La Moine sites did not experience any statistically significant decreases in speeds.

Speeds measured and recorded at the CMS location (or planned CMS location), speed changes between the CMS and the beginning of the curve, and speeds of drivers performing erratic maneuvers were analyzed also, although the results showed no significant trends.

Erratic maneuvers were monitored in an attempt to measure possible effects of the dynamic curve warning system on driving behavior, including lane line encroachments and brake applications in the curve. Erratic maneuvers *may* indicate drivers were traveling at unsafe speeds as they entered the curve. Statistical analyses were completed only on the total number of erratic maneuvers performed at each site. Ambiguity of the interpretation of this MOE and insufficient sample sizes prevented further analysis of individual maneuvers. Statistically significant decreases in the number of vehicles performing erratic maneuvers at the O'Brien site were found when comparisons were made with the data collected on the first trip and each of the post-installation trips. A significant reduction was found in the number of vehicles performing erratic maneuvers at the Sims Road site between the first and fourth trips.

Overall, the public was supportive of the dynamic curve warning sign applications in the Sacramento River Canyon. The same survey was given on two different occasions: one shortly after the installation date, and another approximately nine months after the installation date. Responses from each trip were very similar and have been combined for comparison purposes in this conclusion. Amongst the survey respondents, the majority of drivers felt the speed information given on the CMS was useful (72%, 82%, and 92% for commercial vehicle, passenger car, and recreational vehicle drivers, respectively. Passenger car and recreational vehicle drivers reportedly responded less often to the advisory speed provided on the CMS (i.e., reduced their speeds to comply with the advisory) (64% of surveyed drivers of passenger cars and recreational vehicles, respectively) than did their truck driving counterparts (72%). While some commercial vehicle operators didn't think they, personally, needed the information provided on the signs, they still believed it would be useful for drivers who didn't frequent this route as often as they do. The reactions of the majority of survey participants were positive in terms of sign placement and visibility (83% and 96%, respectively).

Some of the Caltrans maintenance personnel were interviewed to see if there were any problems in the field with the dynamic curve warning system. Initial problems with the setup of the sign systems included having to adjust the direction of radar units to maximize accurate readings (i.e., to prevent the units from reading the oncoming traffic speeds), and needing to correct the operation of the paging system. The problem with the radar unit installation cannot be solved with the current system, so a new radar unit has been chosen for future applications of the dynamic curve warning system. At the time this report was written, the software with the paging system was still being modified. There have not been any other maintenance or operational problems reported by Caltrans personnel. Expenses associated with power and communication are the only sources of operational costs involved with the system.

In addition to the MOEs described previously, there may be other less quantifiable effects of the signs, such as increasing driver awareness at the specific curve locations. Although the signs may not be significantly influencing driver speeds or behavior, this relatively new and different form of warning may catch the attention of drivers better than conventional signs and, therefore, drivers may enter the curve with an increased awareness of potential hazards. Unfortunately, there is no feasible way to measure such effects of the CMS except by observing changes in behavior, as was attempted here.

The CMS does appear to be effective in lowering vehicle speed in areas of steep downgrades and level terrain. There was little evidence to suggest the CMS significantly reduced speeds at curves in upgrades. A clearer picture of the potential effectiveness of this system may be provided by an analysis of vehicle crashes in the Sacramento River Canyon, but considerably more time will be needed to accumulate sufficient crash data for a meaningful statistical analysis.

Recommendations include the conduction of further crash analysis. As explained previously, crashes are typically a primary measure of effectiveness for safety improvements, but without sufficient data, a valid before-after comparison cannot be made.

The use of a different radar unit model will be important in the success of future installations of the dynamic curve warning system. When the radar unit reads speeds of other vehicles, the CMS displays messages that appear to be untrue and the dynamic curve warning system loses its credibility. The new radar unit will distinguish between different directions of traffic and, therefore, will appear to be more accurate.

Selection of the dynamic curve warning system at appropriate sites is key to a successful implementation. From this study, it was found that the CMS at sites with or immediately following steep downgrades or level terrain were the most effective at lowering speeds. In addition, a sharper curve (i.e., shorter radius) appeared to contribute to the effectiveness of the CMS. When analyzing vehicle speeds, truck speeds were found to significantly decrease more than passenger car speeds, therefore areas with high commercial vehicle traffic volumes would be ideal for implementation of a dynamic curve warning system.

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# REFERENCES


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# APPENDICES

# APPENDIX A:

## Experimental Data for Stopwatch Versus Radar Collection

Table 14. Experimental Data for Stopwatch Versus Radar Collection
Weather Conditions: Sunny, Warm

MEASURED SPEEDS: O'BRIEN (6/6/97)

| # | Radar (mph) | Stop Watch (s) | Stop Watch (mph) | error | abs error |
|---|---|---|---|---|---|
| 1 | 58 | 3.65 | 56.04 | -1.96 | 1.96 |
| 2 | 57 | 3.7 | 55.28 | -1.72 | 1.72 |
| 3 | 55 | 3.84 | 53.27 | -1.73 | 1.73 |
| 4 | 53 | 4.01 | 51.01 | -1.99 | 1.99 |
| 5 | 56 | 3.77 | 54.26 | -1.74 | 1.74 |
| 6 | 52 | 4.03 | 50.76 | -1.24 | 1.24 |
| 7 | 56 | 3.72 | 54.99 | -1.01 | 1.01 |
| 8 | 72 | 2.96 | 69.10 | -2.90 | 2.90 |
| 9 | 67 | 3.06 | 66.84 | -0.16 | 0.16 |
| 10 | 54 | 3.86 | 52.99 | -1.01 | 1.01 |
| 11 | 52 | 3.95 | 51.78 | -0.22 | 0.22 |
| 12 | 53 | 3.78 | 54.11 | 1.11 | 1.11 |
| 13 | 60 | 3.47 | 58.95 | -1.05 | 1.05 |
| 14 | 44 | 4.65 | 43.99 | -0.01 | 0.01 |
| 15 | 59 | 3.52 | 58.11 | -0.89 | 0.89 |
| 16 | 52 | 3.99 | 51.26 | -0.74 | 0.74 |
| 17 | 57 | 3.62 | 56.50 | -0.50 | 0.50 |
| 18 | 69 | 2.95 | 69.34 | 0.34 | 0.34 |
| 19 | 56 | 3.56 | 57.46 | 1.46 | 1.46 |
| 20 | 64 | 3.2 | 63.92 | -0.08 | 0.08 |
| 21 | 50 | 4.15 | 49.29 | -0.71 | 0.71 |
| 22 | 61 | 3.48 | 58.78 | -2.22 | 2.22 |
| 23 | 54 | 3.79 | 53.97 | -0.03 | 0.03 |
| 24 | 54 | 3.47 | 58.95 | 4.95 | 4.95 |

MEASURED SPEEDS: LA MOINE (6/5/97)

| # | Radar (mph) | Stop Watch (s) | Stop Watch (mph) | error | abs error |
|---|---|---|---|---|---|
| 1 | 62 | 3.445 | 59.37 | -2.63 | 2.63 |
| 2 | 67 | 3.203 | 63.86 | -3.14 | 3.14 |
| 3 | 63 | 3.388 | 60.37 | -2.63 | 2.63 |
| 4 | 61 | 3.44 | 59.46 | -1.54 | 1.54 |
| 5 | 62 | 3.394 | 60.27 | -1.73 | 1.73 |
| 6 | 66 | 3.158 | 64.77 | -1.23 | 1.23 |
| 7 | 74 | 2.806 | 72.90 | -1.10 | 1.10 |
| 8 | 57 | 3.666 | 55.80 | -1.20 | 1.20 |
| 9 | 66 | 3.199 | 63.94 | -2.06 | 2.06 |
| 10 | 71 | 2.944 | 69.48 | -1.52 | 1.52 |
| 11 | 55 | 3.775 | 54.18 | -0.82 | 0.82 |
| 12 | 57 | 3.613 | 56.61 | -0.39 | 0.39 |
| 13 | 71 | 2.999 | 68.20 | -2.80 | 2.80 |
| 14 | 59 | 3.615 | 56.58 | -2.42 | 2.42 |
| 15 | 58 | 3.63 | 56.35 | -1.65 | 1.65 |
| 16 | 65 | 3.273 | 62.49 | -2.51 | 2.51 |
| 17 | 56 | 3.728 | 54.87 | -1.13 | 1.13 |
| 18 | 65 | 3.2 | 63.92 | -1.08 | 1.08 |

| | |
|---|---|
| Average | -1.09 |
| Standard Deviation | 1.41 |
| Maximum Positive | 4.95 |
| Maximum Negative | -3.14 |
| Average Absolute Error | 1.46 |
| Maximum Absolute Error | 4.95 |
| Minimum Absolute Error | 0.01 |

| | | |
|---|---|---|
| Sample Size, n | 42 | |
| 95% confidence interval | -1.51 | -0.66 |
| 99% confidence interval | -1.65 | -0.53 |

APPENDIX B:

Motorist Survey Instrument

# California Department of Transportation Sacramento River Canyon Advanced Curve Warning Motorist Survey

Date: ____________________ Weather: ________________________

Time: ____________________ Interviewer: ________________________

1. What type of vehicle are you driving today?
   ____ Car/Pick-up/Van ____ Commercial Truck ____ RV

2. What is the purpose of your trip on I – 5 today?
   ____ Work ____ Pleasure ____ Other

3. How often have you driven this section of I – 5?
   ____ <1/Month ____ 1-3/Month ____ >3/Month

4. Did you notice the Changeable Message Sign (CMS) displaying your vehicle speed?
   ____ Yes ____ No ____ Not sure

   If yes, do you think this speed information was useful to you in driving safely through the curve?
   ____ Yes ____ No ____ Somewhat

5. Did you respond and adjust your travel speed through the curve as advised?
   ____ Yes ____ No ____ Not sure

6. Was the location of the changeable speed warning sign adequate for you to respond?
   ____ Yes ____ No ____ Somewhat

   If no, what was your difficulty with the sign location?
   ____ Too close to curve ____ Too far from curve

7. Was the visibility of the changeable message speed warning sign adequate for you to respond?
   ____ Yes ____ No ____ Somewhat

   If no, what was your difficulty with the sign visibility?
   ____ Too bright ____ Too dim

8. ______ Age ______ Sex

9. Driver comments, if offered

# APPENDIX C:

## Speed Measurement Collection

Table 15. Sidehill Viaduct: Data Collected During Trip 1

| | | |
|---|---|---|
| Location: | SIDE HILL VIADUCT | |
| Date: | 6/6/98 | (Trip 1) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| | | State | | Vehicle Lane | | | | Brake Lights | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Trap 1 | Trap 2 | In Curve | Inside | Center | Outside | Lane | Trap 1 | Trap 2 | Reduction |
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Edge | Laneline | Edge | Change | mph | mph | mph |
| 1 | C | X | | X | | 3.21 | 3 | | | | | | 63.721 | 68.182 | -4.460 |
| 2 | C | | X | X | | 2.81 | 3.68 | X | | | | | 72.792 | 55.583 | 17.209 |
| 3 | C | | X | X | | 2.886 | 2.99 | X | | | | | 70.875 | 68.410 | 2.465 |
| 4 | T | | X | X | | 3.632 | 3.63 | X | | | | | 56.318 | 56.349 | -0.031 |
| 5 | C | X | | X | | 3.343 | 3.31 | X | | | | | 61.186 | 61.796 | -0.610 |
| 6 | T | | X | X | | 3.543 | 3.52 | X | | | | | 57.732 | 58.110 | -0.377 |
| 7 | C | X | | X | | 3.577 | 3.43 | X | | | | | 57.184 | 59.634 | -2.451 |
| 8 | T | X | | X | | 3.258 | 3.3 | X | X | | | | 62.783 | 61.983 | 0.799 |
| 9 | C | X | | X | | 3.097 | 2.96 | | | | | | 66.046 | 69.103 | -3.057 |
| 10 | C | X | | X | | 3.531 | 3.59 | | | | | | 57.928 | 56.976 | 0.952 |
| 11 | T | | X | X | | 3.429 | 3.42 | X | | | | | 59.652 | 59.809 | -0.157 |
| 12 | C | | X | X | | 2.983 | 2.85 | X | | | | | 68.570 | 71.770 | -3.200 |
| 13 | C | | | X | | 3.097 | 3.34 | | | | | | 66.046 | 61.241 | 4.805 |
| 14 | T | | X | X | | 3.228 | 3.35 | X | X | | | | 63.366 | 61.058 | 2.308 |
| 15 | C | | X | X | | 2.665 | 2.92 | X | | | | | 76.753 | 70.050 | 6.703 |
| 16 | C | | | | X | 3.406 | 3.63 | X | | | | | 60.054 | 56.349 | 3.706 |
| 17 | C | X | | | X | 3.403 | 3.61 | X | | | | | 60.107 | 56.661 | 3.447 |
| 18 | T | | | X | | 3.544 | 3.55 | X | | | | | 57.716 | 57.618 | 0.098 |
| 19 | T | X | | X | | 3.388 | 3.36 | X | | | | | 60.374 | 60.877 | -0.503 |
| 20 | C | | X | X | | 2.911 | 3.11 | X | | | | | 70.266 | 65.770 | 4.496 |
| 21 | T | X | | X | | 3.5 | 3.57 | X | | | | | 58.442 | 57.296 | 1.146 |
| 22 | UH | | X | X | | 3.563 | 3.29 | | | | | | 57.408 | 62.172 | -4.764 |
| 23 | T | | X | X | | 3.94 | 3.93 | X | | | | | 51.915 | 52.047 | -0.132 |
| 24 | UH | | | X | | 3.29 | 3.2 | X | | | | | 62.172 | 63.920 | -1.749 |
| 25 | T | X | | X | | 3.41 | 3.63 | X | | | | X | 59.984 | 56.349 | 3.635 |
| 26 | C | | X | X | | 3.153 | 3.34 | X | | | | | 64.873 | 61.241 | 3.632 |
| 27 | C | X | | X | | 3.232 | 3.16 | X | | | | | 63.288 | 64.730 | -1.442 |
| 28 | C | X | | X | | 3.573 | 3.37 | | | | | | 57.248 | 60.696 | -3.448 |
| 29 | C | | X | X | | 2.752 | 3.13 | X | | | | X | 74.326 | 65.350 | 8.976 |
| 30 | C | X | | X | | 2.904 | 2.99 | X | | | | | 70.436 | 68.410 | 2.026 |
| 31 | C | X | | X | | 3.181 | 3.04 | | | | | | 64.302 | 67.285 | -2.982 |
| 32 | C | | X | X | | 3.86 | 3.83 | X | X | | | | 52.991 | 53.406 | -0.415 |
| 33 | C | | X | X | | 2.993 | 3.4 | X | | | | | 68.341 | 60.160 | 8.181 |
| 34 | PU W/B | X | | X | | 3.483 | 3.66 | X | | | | | 58.727 | 55.887 | 2.840 |
| 35 | T | | X | X | | 3.481 | 3.76 | X | | | | | 58.761 | 54.400 | 4.360 |
| 36 | C | X | | X | | 3.363 | 3.31 | | | | | | 60.822 | 61.796 | -0.974 |
| 37 | T | | | X | | 3.199 | 3.06 | X | | | | | 63.940 | 66.845 | -2.904 |
| 38 | C | X | | X | | 3.33 | 3.55 | X | | | | | 61.425 | 57.618 | 3.807 |
| 39 | C | X | | | X | 3.171 | 3.11 | X | | | | | 64.505 | 65.770 | -1.265 |
| 40 | C | X | | X | | 2.611 | 2.53 | | | | | | 78.340 | 80.848 | -2.508 |
| 41 | C | X | | X | | 2.948 | 2.96 | | | | | | 69.384 | 69.103 | 0.281 |
| 42 | C | X | | X | | 3.572 | 3.66 | | | | | | 57.264 | 55.887 | 1.377 |
| 43 | T | | X | X | | 4.191 | 4.05 | X | | | | | 48.806 | 50.505 | -1.699 |
| 44 | C | X | | X | | 2.512 | 3.52 | | | | | | 81.427 | 58.110 | 23.318 |
| 45 | C | X | | X | | 3.632 | 3.62 | | | | | | 56.318 | 56.504 | -0.187 |
| 46 | C | | X | X | | 3.434 | 3.51 | | | | | | 59.565 | 58.275 | 1.290 |
| 47 | C | X | | | X | 2.853 | 3.13 | | | | | | 71.695 | 65.350 | 6.345 |
| 48 | C | X | | X | | 3.344 | 3.66 | | | | | | 61.168 | 55.887 | 5.281 |
| 49 | C | | X | | X | 3.05 | 3.25 | X | | | | | 67.064 | 62.937 | 4.127 |
| 50 | C | | X | X | | 2.839 | 2.95 | X | | | | | 72.048 | 69.337 | 2.711 |
| 51 | T | | X | X | | 3.86 | 3.63 | X | | | | | 52.991 | 56.349 | -3.358 |
| 52 | T | X | | X | | 3.38 | 3.69 | X | | | | | 60.516 | 55.432 | 5.084 |
| 53 | C | X | | X | | 3.009 | 2.94 | X | | | | | 67.978 | 69.573 | -1.595 |
| 54 | C | | X | X | | 3.163 | 3.31 | | | | | | 64.668 | 61.796 | 2.872 |
| 55 | C | | X | | X | 3.085 | 2.94 | X | | | | | 66.303 | 69.573 | -3.270 |
| 56 | C | X | | X | | 3.387 | 3.2 | | | | | | 60.391 | 63.920 | -3.529 |
| 57 | C | | X | X | | 3.11 | 3.24 | | | | | X | 65.770 | 63.131 | 2.639 |
| 58 | C | | X | X | | 3.366 | 3.26 | | X | | | | 60.768 | 62.744 | -1.976 |
| 59 | C | | X | X | | 3.054 | 3.18 | | | | | | 66.976 | 64.322 | 2.654 |
| 60 | C | X | | X | | 3.05 | 3.11 | X | | | | | 67.064 | 65.770 | 1.294 |
| 61 | C | X | | X | | 3.491 | 3.37 | | | | | | 58.592 | 60.696 | -2.104 |
| 62 | C | | X | | X | 3.336 | 3.27 | | | | | | 61.315 | 62.552 | -1.238 |
| 63 | MH | X | | X | | 3.314 | 3.28 | | | | | | 61.722 | 62.361 | -0.640 |
| 64 | C | X | | X | | 2.994 | 3.31 | | | | | | 68.318 | 61.796 | 6.522 |
| 65 | T | X | | X | | 3.11 | 3.33 | X | | | | | 65.770 | 61.425 | 4.345 |
| 66 | C | | X | X | | 3.102 | 2.95 | X | | | | | 65.940 | 69.337 | -3.398 |

Table 16. O'Brien: Data Collected During Trip 1

| | | |
|---|---|---|
| Location: | O'BRIEN | |
| Date: | 6/6/98 | (Trip 1) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | Reduction mph |
| 1 | T | | | X | | 3.793 | 3.99 | | | | | | 53.927 | 51.265 | 2.663 |
| 2 | C | | | X | | 3.917 | 3.95 | | | | | | 52.220 | 51.784 | 0.436 |
| 3 | C | | | X | | 3.482 | 3.95 | | | | | | 58.744 | 51.784 | 6.960 |
| 4 | T | | X | X | | 3.823 | 3.85 | | | | | | 53.504 | 53.129 | 0.375 |
| 5 | C | X | | X | | 3.763 | 3.64 | | | | | | 54.357 | 56.194 | -1.837 |
| 6 | C | X | | X | | 3.886 | 4.36 | | | | | | 52.637 | 46.914 | 5.722 |
| 7 | C | | | X | | 3.406 | 3.35 | X | X | | | | 60.054 | 61.058 | -1.004 |
| 8 | C | | | X | | 3.088 | 3.5 | | | | | X BC | 66.239 | 58.442 | 7.797 |
| 9 | C | | X | X | | 3.493 | 3.57 | | | | | | 58.559 | 57.296 | 1.263 |
| 10 | C | X | | X | | 3.175 | 3.59 | | | | | | 64.424 | 56.976 | 7.447 |
| 11 | C | X | | X | | 3.554 | 3.31 | | X | | | | 57.554 | 61.796 | -4.243 |
| 12 | C | X | | X | | 3.164 | 3.06 | | | | | X BC | 64.648 | 66.845 | -2.197 |
| 13 | C | X | | X | | 3.437 | 3.3 | | | | | | 59.513 | 61.983 | -2.471 |
| 14 | C | X | | X | | 3.745 | 3.51 | X | | | | X BC | 54.618 | 58.275 | -3.657 |
| 15 | C | | | X | | 3.471 | 3.76 | | | | | | 58.930 | 54.400 | 4.529 |
| 16 | PU W/T | X | | X | | 4.147 | 4.41 | | X | | | | 49.324 | 46.382 | 2.942 |
| 17 | C | | X | X | | 3.276 | 3.5 | | | X | | | 62.438 | 58.442 | 3.996 |
| 18 | C | X | | X | | 3.509 | 3.59 | | X | | | | 58.292 | 56.976 | 1.315 |
| 19 | C | X | | X | | 3.159 | 3.7 | | X | | | | 64.750 | 55.283 | 9.468 |
| 20 | T | | X | X | | 3.597 | 4.17 | | X | | | | 56.866 | 49.052 | 7.814 |
| 21 | C | X | | X | | 3.701 | 3.73 | | | | | | 55.268 | 54.838 | 0.430 |
| 22 | C | | X | X | | 3.853 | 4.19 | | | | | | 53.087 | 48.818 | 4.270 |
| 23 | T | | X | X | | 3.779 | 3.97 | | X | | | | 54.127 | 51.523 | 2.604 |
| 24 | C | X | | X | | 3.421 | 3.45 | | X | | | | 59.791 | 59.289 | 0.503 |
| 25 | C | | X | X | | 3.595 | 3.85 | | | | | | 56.897 | 53.129 | 3.769 |
| 26 | T | | X | X | | 4.119 | 4.51 | | X | | | | 49.659 | 45.354 | 4.305 |
| 27 | C | | X | X | | 3.643 | 3.88 | | | | | | 56.148 | 52.718 | 3.430 |
| 28 | T | | | X | | 3.251 | 3.42 | | | | | | 62.918 | 59.809 | 3.109 |
| 29 | C | | X | X | | 3.431 | 3.3 | | | | | | 59.617 | 61.983 | -2.367 |
| 30 | T | X | | X | | 4.198 | 4.81 | | | | | | 48.725 | 42.525 | 6.199 |
| 31 | T | X | | X | | 3.814 | 3.8 | | | | | | 53.630 | 53.828 | -0.198 |
| 32 | C | | X | X | | 3.681 | 3.7 | | X | | | | 55.568 | 55.283 | 0.285 |
| 33 | C | | X | X | | 3.769 | 3.7 | | X | | | | 54.270 | 55.283 | -1.012 |
| 34 | T | | X | X | | 3.98 | 4.33 | | X | | | | 51.393 | 47.239 | 4.154 |
| 35 | MH | | X | X | | 3.468 | 3.66 | | X | | | | 58.981 | 55.887 | 3.094 |
| 36 | C | X | | X | | 3.298 | 3.11 | | | | | | 62.021 | 65.770 | -3.749 |
| 37 | T | X | | X | | 3.374 | 3.25 | | | | | | 60.624 | 62.937 | -2.313 |
| 38 | C | X | | X | | 3.395 | 3.54 | | | | | | 60.249 | 57.781 | 2.468 |
| 39 | T | | X | X | | 3.687 | 3.85 | | X | | | | 55.477 | 53.129 | 2.349 |
| 40 | C | X | | X | | 3.241 | 3.5 | | | | | | 63.112 | 58.442 | 4.670 |
| 41 | C | | X | X | | 3.513 | 3.44 | X | X | | | | 58.225 | 59.461 | -1.236 |
| 42 | C | | X | X | | 3.38 | 3.28 | | | | | | 60.516 | 62.361 | -1.845 |
| 43 | C | | X | X | | 3.175 | 3.56 | | X | | | | 64.424 | 57.457 | 6.967 |
| 44 | C | | X | X | | 3.437 | 3.4 | | | | | | 59.513 | 60.160 | -0.648 |
| 45 | SUB W/T | | | X | | 3.865 | 4.05 | | | | | | 52.922 | 50.505 | 2.417 |
| 46 | T | | X | X | | 3.58 | 3.54 | | X | | | | 57.136 | 57.781 | -0.646 |
| 47 | T | | X | X | | 3.515 | 3.7 | | X | | | | 58.192 | 55.283 | 2.910 |
| 48 | T | | X | X | | 3.441 | 3.45 | | X | | | | 59.444 | 59.289 | 0.155 |
| 49 | C | | X | X | | 3.357 | 3.63 | | X | | | | 60.931 | 56.349 | 4.582 |
| 50 | C | X | | X | | 3.612 | 3.6 | | | | | | 56.629 | 56.818 | -0.189 |
| 51 | T | | X | X | | 3.575 | 3.92 | | X | | | | 57.216 | 52.180 | 5.036 |
| 52 | C | X | | X | | 3.509 | 3.64 | X | | | | | 58.292 | 56.194 | 2.098 |
| 53 | C | X | | X | | 3.403 | 3.36 | | | | | | 60.107 | 60.877 | -0.769 |
| 54 | C | X | | X | | 3.615 | 3.63 | | | | | | 56.582 | 56.349 | 0.234 |
| 55 | C | | X | | X | 2.646 | 2.88 | | X | | | X | 77.304 | 71.023 | 6.281 |
| 56 | T | | X | X | | 3.867 | 4.49 | | X | | | | 52.895 | 45.556 | 7.339 |
| 57 | C | | X | X | | 3.781 | 3.53 | X | | | | | 54.098 | 57.945 | -3.847 |
| 58 | T | | X | X | | 3.319 | 3.63 | | X | | | | 61.629 | 56.349 | 5.280 |
| 59 | T | | X | X | | 3.373 | 4.37 | | | | | | 60.642 | 46.807 | 13.835 |
| 60 | T | | X | X | | 3.608 | 3.76 | X | X | | | | 56.692 | 54.400 | 2.292 |
| 61 | C | | X | X | | 3.384 | 3.45 | | | | | | 60.445 | 59.289 | 1.156 |
| 62 | C | | X | X | | 2.96 | 3.37 | | | | | | 69.103 | 60.696 | 8.407 |
| 63 | C | | X | X | | 3.101 | 3.27 | | X | | | | 65.961 | 62.552 | 3.409 |
| 64 | C | X | | X | | 2.884 | 3.11 | | | | | | 70.924 | 65.770 | 5.154 |
| 65 | MH | X | | X | | 3.593 | 4.03 | X | X | | | | 56.929 | 50.756 | 6.173 |
| 66 | C | X | | | X | 2.42 | 2.81 | | | X | | | 84.523 | 72.792 | 11.731 |

# Table 17. Salt Creek: Data Collected During Trip 1

| | | | |
|---|---|---|---|
| Location: | SALT CREEK | | |
| Date: | 6/5/98 | (Trip 1) | |
| Speed Trap 1 Distance (FT): | | | 300 |
| Speed Trap 2 Distance (FT): | | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | In Curve (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | Reduction mph |
| 1 | C | | | | X | 3.165 | 2.95 | | | | | | 64.627 | 69.337 | -4.710 |
| 2 | C | | | X | | 3.301 | 3.11 | | | | | | 61.965 | 65.770 | -3.806 |
| 3 | C | | | X | | 3.843 | 3.76 | | | | | | 53.225 | 54.400 | -1.175 |
| 4 | C | | | X | | 3.248 | 3.24 | | | | | | 62.976 | 63.131 | -0.155 |
| 5 | C | | | X | | 3.261 | 3.38 | | | | | | 62.725 | 60.516 | 2.208 |
| 6 | T | | | X | | 3.344 | 3.31 | | | | | | 61.168 | 61.796 | -0.628 |
| 7 | C | | | | X | 2.872 | 3.32 | | | | | | 71.221 | 61.610 | 9.610 |
| 8 | T | | | X | | 3.805 | 3.42 | | | | | | 53.757 | 59.809 | -6.052 |
| 9 | C | | | | X | 3.119 | 3.22 | | | X | | | 65.580 | 63.523 | 2.057 |
| 10 | C | | | X | | 3.675 | 3.5 | | | | | | 55.659 | 58.442 | -2.783 |
| 11 | PU W/T | | X | X | | 3.992 | 3.76 | | | | | | 51.239 | 54.400 | -3.162 |
| 12 | RV | | | | X | 3.779 | 3.75 | | | | X | | 54.127 | 54.545 | -0.419 |
| 13 | C | | | X | | 3.593 | 3.34 | | | | | | 56.929 | 61.241 | -4.312 |
| 14 | C | | | | X | 2.71 | 2.66 | | | | | | 75.478 | 76.897 | -1.419 |
| 15 | C | | | X | | 3.006 | 3.05 | X | | | | | 68.046 | 67.064 | 0.982 |
| 16 | T | | | X | | 3.778 | 3.51 | X | | | | | 54.141 | 58.275 | -4.134 |
| 17 | T | | | X | | 3.878 | 3.59 | X | | | | | 52.745 | 56.976 | -4.231 |
| 18 | C | | | X | | 3.494 | 3.45 | | | | | | 58.542 | 59.289 | -0.747 |
| 19 | C | | | | X | 3.546 | 3.29 | | | | | | 57.683 | 62.172 | -4.488 |
| 20 | C | X | | X | | 3.332 | 3.31 | | X BC | | | | 61.388 | 61.796 | -0.408 |
| 21 | C | X | | X | | 3.743 | 3.71 | | | | | | 54.647 | 55.134 | -0.486 |
| 22 | C | | | | X | 2.923 | 3 | | | | | | 69.978 | 68.182 | 1.796 |
| 23 | C | | X | | X | 2.896 | 3.19 | | | | | | 70.630 | 64.121 | 6.510 |
| 24 | T | | X | X | | 3.589 | 3.32 | | | | | | 56.992 | 61.610 | -4.618 |
| 25 | T | | | X | | 3.51 | 3.3 | | | X | | | 58.275 | 61.983 | -3.708 |
| 26 | C | | | X | | 3.607 | 3.51 | | | | | | 56.708 | 58.275 | -1.567 |
| 27 | C | X | | | X | 3.023 | 3.13 | | | | | | 67.663 | 65.350 | 2.313 |
| 28 | C | | | | X | 3.503 | 3.59 | | | | | | 58.392 | 56.976 | 1.415 |
| 29 | C | | | X | | 3.435 | 3.4 | | | | | | 59.547 | 60.160 | -0.613 |
| 30 | C | | | X | | 3.167 | 3.13 | | | | | | 64.587 | 65.350 | -0.763 |
| 31 | C | | | X | | 3.275 | 3.61 | | | | | | 62.457 | 56.661 | 5.796 |
| 32 | T | | X | X | | 3.453 | 3.18 | X | | | | | 59.237 | 64.322 | -5.085 |
| 33 | T | | | | X | 3.26 | 3.06 | | | | X BC | | 62.744 | 66.845 | -4.101 |
| 34 | T | | | | X | 3.225 | 3.24 | | | X | | | 63.425 | 63.131 | 0.294 |
| 35 | T | | | X | | 3.164 | 2.9 | | | X BC | | | 64.648 | 70.533 | -5.885 |
| 36 | C | | | X | | 2.64 | 2.81 | | | | | | 77.479 | 72.792 | 4.687 |
| 37 | C | | | X | | 3.942 | 3.77 | | X BC | | | | 51.889 | 54.256 | -2.367 |
| 38 | T | | | X | | 3.462 | 3.36 | | | | | | 59.083 | 60.877 | -1.794 |
| 39 | C | | | X | | 2.858 | 2.92 | | | | | X | 71.569 | 70.050 | 1.520 |
| 40 | C | | | | X | 3.166 | 2.84 | | | | | | 64.607 | 72.023 | -7.416 |
| 41 | C | | | | X | 2.846 | 2.92 | | | | X BC | | 71.871 | 70.050 | 1.821 |
| 42 | C | | | | X | 3.029 | 2.79 | X | | | | X | 67.529 | 73.314 | -5.785 |
| 43 | T | | | X | | 3.459 | 3.16 | X | | | | | 59.134 | 64.730 | -5.595 |
| 44 | C | | | X | | 2.856 | 2.85 | | | | | | 71.620 | 71.770 | -0.151 |
| 45 | T | | | X | | 3.943 | 3.52 | X | | | | | 51.876 | 58.110 | -6.234 |
| 46 | C | | X | | X | 2.905 | 3.45 | | | | | | 70.412 | 59.289 | 11.123 |
| 47 | C | | | | X | 3.209 | 3.15 | | | | | | 63.741 | 64.935 | -1.194 |
| 48 | PU W/T | | | | X | 3.423 | 3.23 | | | | | X | 59.756 | 63.327 | -3.571 |
| 49 | C | | | X | | 3.804 | 3.59 | | | | | | 53.771 | 56.976 | -3.205 |
| 50 | C | | | X | | 3.091 | 3.27 | X | | | | | 66.175 | 62.552 | 3.622 |
| 51 | T | | | X | | 3.177 | 3.35 | X | | | | | 64.383 | 61.058 | 3.325 |
| 52 | MH | | | X | | 3.658 | 3.63 | | X BC | | | | 55.917 | 56.349 | -0.431 |
| 53 | C | | | | X | 3.058 | 3.06 | | | | | | 66.889 | 66.845 | 0.044 |
| 54 | T | | | X | | 3.472 | 3.66 | | X BC | | | | 58.913 | 55.887 | 3.026 |
| 55 | C | | | | X | 3.137 | 3.4 | | | | | | 65.204 | 60.160 | 5.044 |
| 56 | C | | | X | | 3.61 | 3.56 | | X BC | X | | | 56.661 | 57.457 | -0.796 |
| 57 | C | | | X | | 2.919 | 2.88 | | | | | | 70.074 | 71.023 | -0.949 |
| 58 | C | | | | X | 3.108 | 3.01 | | | | | | 65.813 | 67.955 | -2.143 |
| 59 | C | | | | X | 3.031 | 3.05 | | | | | | 67.484 | 67.064 | 0.420 |
| 60 | C | | | X | | 3.714 | 3.59 | | | | | | 55.074 | 56.976 | -1.902 |
| 61 | C | | | X | | 3.306 | 3.27 | | | | | | 61.871 | 62.552 | -0.681 |
| 62 | C | | | | X | 2.899 | 2.95 | | | | | | 70.557 | 69.337 | 1.220 |
| 63 | C | | | X | | 2.877 | 2.84 | | | | | | 71.097 | 72.023 | -0.926 |
| 64 | C | | | X | | 3.152 | 2.97 | | | | | | 64.894 | 68.871 | -3.977 |
| 65 | C | | | X | | 3.741 | 3.63 | | | | | | 54.677 | 56.349 | -1.672 |
| 66 | C | | | | X | 3.329 | 3.34 | | | | | | 61.444 | 61.241 | 0.202 |

Table 18. La Moine: Data Collected During Trip 1

| | | | |
|---|---|---|---|
| Location: | LA MOINE | | |
| Date: | 6/5/98 | (Trip 1) | |
| Speed Trap 1 Distance (FT): | | | 300 |
| Speed Trap 2 Distance (FT): | | | 300 |

| | | | | | | | | Brake Lights | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | In Curve | Inside | Center | Outside | Lane | Trap 1 | Trap 2 | Reduction |
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Edge | Laneline | Edge | Change | mph | mph | mph |
| 1 | T | | | X | | 3.538 | 3.49 | | | | | | 57.814 | 58.609 | -0.795 |
| 2 | C | | | X | | 3.146 | 3.09 | | | | | | 65.018 | 66.196 | -1.178 |
| 3 | C | | | X | | 3.134 | 3.04 | | | | | | 65.267 | 67.285 | -2.018 |
| 4 | C | | | | X | 3.168 | 3.08 | | | | | | 64.566 | 66.411 | -1.845 |
| 5 | T | | | X | | 3.169 | 3.01 | X | | | | | 64.546 | 67.955 | -3.410 |
| 6 | C | | | X | | 3.211 | 3.25 | | | | | | 63.701 | 62.937 | 0.764 |
| 7 | T | | X | X | | 3.437 | 3.38 | X BC | | | | | 59.513 | 60.516 | -1.004 |
| 8 | C | | | X | | 3.117 | 3.14 | | | | | | 65.623 | 65.142 | 0.481 |
| 9 | C | | | X | | 2.851 | 2.59 | | | | | X | 71.745 | 78.975 | -7.230 |
| 10 | C | | | X | | 3.293 | 3.31 | | | | | | 62.115 | 61.796 | 0.319 |
| 11 | T | | | X | | 3.228 | 3.2 | | | | | | 63.366 | 63.920 | -0.554 |
| 12 | C | | | | X | 2.828 | 3.07 | | | | | | 72.329 | 66.627 | 5.701 |
| 13 | C | | | X | | 2.925 | 2.95 | | | | | | 69.930 | 69.337 | 0.593 |
| 14 | C | | | X | | 2.845 | 2.96 | | | | | | 71.896 | 69.103 | 2.793 |
| 15 | C | X | | X | | 3.12 | 2.99 | | | | | | 65.559 | 68.410 | -2.850 |
| 16 | T | | | X | | 3.27 | 3.16 | | | | X | | 62.552 | 64.730 | -2.177 |
| 17 | C | | | X | | 3.08 | 2.95 | | | | | | 66.411 | 69.337 | -2.927 |
| 18 | C | | | X | | 3.209 | 3.03 | | | | | | 63.741 | 67.507 | -3.766 |
| 19 | C | | | X | | 2.86 | 2.77 | | | | | | 71.519 | 73.843 | -2.324 |
| 20 | C | | | X | | 3.163 | 3.08 | | | | | | 64.668 | 66.411 | -1.743 |
| 21 | PU W/C | | | X | | 3.194 | 3.16 | | | | | | 64.041 | 64.730 | -0.689 |
| 22 | T | | | X | | 3.365 | 2.94 | | | | | | 60.786 | 69.573 | -8.787 |
| 23 | C | | | | X | 2.899 | 2.9 | X BC | | | | | 70.557 | 70.533 | 0.024 |
| 24 | C | | | X | | 3.114 | 2.94 | | | | | | 65.686 | 69.573 | -3.888 |
| 25 | VAN W/C | | | X | | 3.231 | 3.19 | | | | | | 63.307 | 64.121 | -0.814 |
| 26 | T | | | X | | 3.571 | 3.49 | | | | | | 57.280 | 58.609 | -1.329 |
| 27 | T | | | | X | 3.231 | 3.63 | | | | | | 63.307 | 56.349 | 6.959 |
| 28 | C | | | X | | 2.909 | 2.87 | | | | | | 70.315 | 71.270 | -0.955 |
| 29 | C | | | | X | 2.866 | 2.72 | | | | | | 71.370 | 75.201 | -3.831 |
| 30 | C | | | | X | 2.433 | 2.38 | X | | | | | 84.071 | 85.943 | -1.872 |
| 31 | C | | | | X | 2.856 | 2.74 | | | | X BC | | 71.620 | 74.652 | -3.032 |
| 32 | T | | | X | | 3.09 | 3.04 | X | X | | | | 66.196 | 67.285 | -1.089 |
| 33 | C | | | | X | 2.768 | 2.88 | | | | | | 73.896 | 71.023 | 2.874 |
| 34 | PU W/C | | X | X | | 3.29 | 3.25 | | | | | | 62.172 | 62.937 | -0.765 |
| 35 | T | | | X | | 3.714 | 3.66 | | | | | | 55.074 | 55.887 | -0.813 |
| 36 | C | | | X | | 3.169 | 3.22 | | | | | | 64.546 | 63.523 | 1.022 |
| 37 | PU W/T | | | | X | 3.31 | 5.28 | | | | | | 61.796 | 38.740 | 23.057 |
| 38 | T | | | X | | 3.72 | 3.6 | X | | | | | 54.985 | 56.818 | -1.833 |
| 39 | C | | | | X | 2.97 | 2.81 | | | | | | 68.871 | 72.792 | -3.921 |
| 40 | C | | | | X | 2.877 | 2.76 | | | | | | 71.097 | 74.111 | -3.014 |
| 41 | T | | | X | | 3.113 | 3.13 | | | | | | 65.707 | 65.350 | 0.357 |
| 42 | C | | | X | | 3.097 | 3.31 | | | | | | 66.046 | 61.796 | 4.250 |
| 43 | C | | | | X | 2.96 | 2.84 | | | | | | 69.103 | 72.023 | -2.920 |
| 44 | C | | | X | | 3.023 | 2.87 | | | | | | 67.663 | 71.270 | -3.607 |
| 45 | C | | | | X | 2.797 | 2.56 | | | | | | 73.130 | 79.901 | -6.770 |
| 46 | T | | | X | | 3.156 | 2.79 | X | X | | | | 64.812 | 73.314 | -8.502 |
| 47 | C | | | X | | 3.419 | 3.35 | | | X | | | 59.826 | 61.058 | -1.232 |
| 48 | PU W/C | | | X | | 3.711 | 3.59 | | | | | | 55.119 | 56.976 | -1.858 |
| 49 | C | | | X | | 3.013 | 3 | | | | | | 67.888 | 68.182 | -0.294 |
| 50 | C | | | X | | 3.435 | 3.32 | | | | | | 59.547 | 61.610 | -2.063 |
| 51 | T | | | X | | 3.961 | 3.68 | | | | | | 51.640 | 55.583 | -3.943 |
| 52 | C | | | X | | 3.327 | 3.11 | | | | | | 61.480 | 65.770 | -4.290 |
| 53 | C | | | X | | 3.748 | 3.46 | | | | | | 54.575 | 59.117 | -4.543 |
| 54 | C | | | | X | 2.783 | 2.72 | | | | | | 73.498 | 75.201 | -1.702 |
| 55 | C | | | | X | 3.093 | 2.87 | | | | | | 66.132 | 71.270 | -5.138 |
| 56 | C | | | X | | 3.5 | 3.56 | | | | | | 58.442 | 57.457 | 0.985 |
| 57 | T | | | X | | 3.531 | 3.65 | | | | | | 57.928 | 56.040 | 1.889 |
| 58 | C | | | | X | 2.78 | 2.71 | | | | | | 73.578 | 75.478 | -1.901 |
| 59 | T | | | X | | 3.598 | 3.45 | | | | | | 56.850 | 59.289 | -2.439 |
| 60 | C | | | | X | 2.954 | 2.83 | | | | | | 69.244 | 72.278 | -3.034 |
| 61 | C | X | | X | | 3.252 | 3.22 | | | | | | 62.898 | 63.523 | -0.625 |
| 62 | C | | | X | | 3.35 | 3.25 | | | | | | 61.058 | 62.937 | -1.879 |
| 63 | C | | | X | | 3.066 | 3.09 | | | | | | 66.714 | 66.196 | 0.518 |
| 64 | C | | | X | | 3.502 | 3.4 | | X BC | | | | 58.408 | 60.160 | -1.752 |
| 65 | T | | | X | | 3.531 | 3.46 | | | | | | 57.928 | 59.117 | -1.189 |
| 66 | C | | | X | | 3.371 | 3.3 | | | | | | 60.678 | 61.983 | -1.305 |

# Table 19. Sims Road: Data Collected During Trip 1

| Location: | Sims Road | | |
|---|---|---|---|
| Date: | 6/4/98 | (Trip 1) | |
| Speed Trap 1 Distance (FT): | | | 300 |
| Speed Trap 2 Distance (FT): | | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | Reduction mph |
| 1 | C | | X | X | | 3.259 | 3.27 | | X | | | | 66.651 | 59.216 | 7.435 |
| 2 | T | | X | X | | 3.42 | 4.03 | | | | | | 63.513 | 48.049 | 15.465 |
| 3 | C | | X | X | | 3.745 | 3.07 | | | | | | 58.002 | 63.074 | -5.072 |
| 4 | C | | | X | | 3.089 | 2.84 | | | | | | 70.319 | 68.182 | 2.137 |
| 5 | C | X | | X | | 2.763 | 2.72 | | X | | | | 78.616 | 71.190 | 7.426 |
| 6 | C | | X | | X | 3.666 | 3.41 | | | | | | 59.251 | 56.785 | 2.467 |
| 7 | C | | X | | X | 3.106 | 3.17 | | | | | | 69.934 | 61.084 | 8.850 |
| 8 | C | X | | X | | 3.031 | 2.73 | | X | | | | 71.665 | 70.929 | 0.736 |
| 9 | T | | | X | | 3.163 | 3.43 | | X | | | | 68.674 | 56.454 | 12.220 |
| 10 | T | | X | X | | 3.69 | 3.41 | | X | | | | 58.866 | 56.785 | 2.081 |
| 11 | C | X | | | X | 3.22 | 3.03 | | | | | X | 67.458 | 63.906 | 3.552 |
| 12 | C | X | | X | | 3.066 | 3.06 | | | | | | 70.847 | 63.280 | 7.567 |
| 13 | C | | | X | | 3.313 | 3.16 | | X | | | | 65.565 | 61.277 | 4.287 |
| 14 | T | | X | X | | 3.531 | 3.17 | X | X | | | | 61.517 | 61.084 | 0.433 |
| 15 | T | | X | X | | 3.633 | 3.19 | | X | | | | 59.790 | 60.701 | -0.911 |
| 16 | C | | X | X | | 3.406 | 3.05 | | X | | | | 63.774 | 63.487 | 0.287 |
| 17 | T | | X | X | | 3.67 | 3.24 | | | | | | 59.187 | 59.764 | -0.577 |
| 18 | T | | X | X | | 3.921 | 4.05 | | X | | | | 55.398 | 47.811 | 7.587 |
| 19 | C | | | | X | 3.23 | 2.88 | | | | | | 67.250 | 67.235 | 0.015 |
| 20 | T | | | X | | 3.61 | 3.51 | | X | | | | 60.171 | 55.167 | 5.004 |
| 21 | T | | X | X | | 3.764 | 3.45 | | X | | | | 57.709 | 56.126 | 1.582 |
| 22 | C | | X | | X | 3.021 | 2.64 | | | | | X | 71.902 | 73.347 | -1.445 |
| 23 | C | | X | | X | 3.3 | 2.8 | | | | | | 65.823 | 69.156 | -3.333 |
| 24 | T | | X | X | | 3.719 | 3.44 | | X | | | | 58.407 | 56.290 | 2.117 |
| 25 | C | | | X | | 3.354 | 3.04 | | X | | | | 64.763 | 63.696 | 1.067 |
| 26 | C | | | X | | 3.361 | 2.79 | | | | | X BC | 64.628 | 69.404 | -4.775 |
| 27 | C | | X | | X | 3.696 | 2.74 | | | | | | 58.771 | 70.670 | -11.900 |
| 28 | T | | | X | | 3.94 | 3.32 | | X BC | | | | 55.131 | 58.324 | -3.193 |
| 29 | C | | X | | X | 3.071 | 2.77 | | | | | | 70.731 | 69.905 | 0.827 |
| 30 | T | | X | X | | 4.082 | 3.59 | | X | | | | 53.213 | 53.938 | -0.725 |
| 31 | C | X | | X | | 3.945 | 3.8 | | | | | | 55.061 | 50.957 | 4.104 |
| 32 | T | | | X | | 3.535 | 3.37 | X | X | | | | 61.447 | 57.459 | 3.988 |
| 33 | MH | | X | X | | 3.818 | 3.33 | | X | | | | 56.893 | 58.149 | -1.256 |
| 34 | C | | | X | | 3.457 | 2.95 | | X | | | | 62.834 | 65.639 | -2.806 |
| 35 | T | | X | X | | 3.576 | 3.19 | | X BC | | | | 60.743 | 60.701 | 0.042 |
| 36 | T | | | X | | 3.568 | 3.22 | | X | | | | 60.879 | 60.136 | 0.743 |
| 37 | C | | | X | | 3.413 | 3.06 | | X BC | | | | 63.644 | 63.280 | 0.364 |
| 38 | T | | X | X | | 3.697 | 3.22 | X | X BC | | | | 58.755 | 60.136 | -1.381 |
| 39 | T | | X | X | | 4.009 | 3.57 | | X | | | | 54.182 | 54.240 | -0.058 |
| 40 | C | | | X | | 3.405 | 2.93 | | X BC | | | | 63.793 | 66.087 | -2.294 |
| 41 | C | | | X | | 3.699 | 3.34 | | | | | | 58.723 | 57.975 | 0.748 |
| 42 | C | | | | X | 3.157 | 2.73 | X | | X | | | 68.805 | 70.929 | -2.125 |
| 43 | T | | | X | | 4.222 | 3.76 | | | | | | 51.449 | 51.499 | -0.050 |
| 44 | C | X | | X | | 3.771 | 3.57 | | | | | | 57.602 | 54.240 | 3.362 |
| 45 | T | | X | X | | 3.612 | 3.06 | | | | | | 60.137 | 63.280 | -3.143 |
| 46 | T | | X | X | | 3.734 | 3.22 | | X BC | | | | 58.172 | 60.136 | -1.963 |
| 47 | T | X | | X | | 3.543 | 3.34 | X | | | | | 61.308 | 57.975 | 3.334 |
| 48 | T | | X | X | | 4.052 | 3.45 | | X | | | | 53.607 | 56.126 | -2.519 |
| 49 | T | | | X | | 4.185 | 3.74 | | | | | | 51.903 | 51.774 | 0.129 |
| 50 | PU W/T | | | X | | 3.232 | 3.13 | | X | | | | 67.208 | 61.865 | 5.343 |
| 51 | T | | | X | | 3.5 | 3.05 | X | X | | | | 62.062 | 63.487 | -1.426 |
| 52 | T | | | X | | 3.91 | 3.63 | | | | | | 55.554 | 53.343 | 2.211 |
| 53 | T | | | X | | 4.147 | 3.75 | | | | | | 52.379 | 51.636 | 0.743 |
| 54 | C | | | | X | 3.571 | 3.12 | X | | | | | 60.828 | 62.063 | -1.235 |
| 55 | C | | | X | | 3.19 | 2.88 | | | | | | 68.093 | 67.235 | 0.858 |
| 56 | C | | X | | X | 3.09 | 2.94 | | | | | | 70.296 | 65.863 | 4.434 |
| 57 | C | | X | | X | 3.542 | 2.91 | | | | | | 61.326 | 66.542 | -5.216 |
| 58 | C | | | X | | 4.024 | 3.41 | | | | | | 53.980 | 56.785 | -2.805 |
| 59 | T | | | X | | 3.734 | 3.52 | | | | | | 58.172 | 55.010 | 3.162 |
| 60 | C | | | X | | 3.217 | 3.06 | | | | | | 67.521 | 63.280 | 4.241 |
| 61 | C | | | X | | 3.248 | 2.91 | | | | | | 66.877 | 66.542 | 0.335 |
| 62 | C | | | | X | 3.277 | 2.8 | | | | | | 66.285 | 69.156 | -2.871 |
| 63 | T | | | X | | 3.826 | 3.23 | | X | | | | 56.774 | 59.949 | -3.176 |
| 64 | T | | | X | | 3.769 | 3.4 | | | | | | 57.632 | 56.952 | 0.680 |
| 65 | C | | | | X | 3.169 | 3.03 | | | | | X | 68.544 | 63.906 | 4.638 |
| 66 | C | | X | X | | 3.4 | 2.99 | | X | | | | 63.887 | 64.761 | -0.874 |

# Table 20. Sidehill Viaduct: Data Collected During Trip 2

| | | |
|---|---|---|
| Location: | SIDE HILL VIADUCT | |
| Date: | 5/19/99 | (Trip 2) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| Veh ID | Vehicle Type | State In | State Out | Vehicle Lane Drive Ln (x) | Vehicle Lane Pass Ln (x) | Trap 1 Time | Trap 2 Time | Brake Lights In Curve (x) for yes | Encroachment Inside Edge | Encroachment Center Laneline | Encroachment Outside Edge | Encroachment Lane Change | Speed Trap 1 mph | Speed Trap 2 mph | Speed Reduction mph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | T | | | X | | 4.31 | 3.98 | X | | X | | | 47.458 | 51.393 | -3.935 |
| 2 | C | X | | | X | 2.85 | 2.97 | | | | | | 71.770 | 68.871 | 2.900 |
| 3 | C | X | | X | | 3.85 | 3.74 | X | | | | X | 53.129 | 54.691 | -1.563 |
| 4 | C | X | | X | | 4.37 | 3.97 | | | | | | 46.807 | 51.523 | -4.716 |
| 5 | T | | X | X | | 4.1 | 3.95 | X | | | | | 49.889 | 51.784 | -1.895 |
| 6 | C | | X | | X | 3.22 | 3.87 | | | | | | 63.523 | 52.854 | 10.669 |
| 7 | C | X | | | X | 3 | 3.39 | X | | | | | 68.182 | 60.338 | 7.844 |
| 8 | T | | X | X | | 4.16 | 3.87 | X | | | | | 49.170 | 52.854 | -3.685 |
| 9 | T | | X | X | | 3.78 | 3.49 | X | | | | | 54.113 | 58.609 | -4.496 |
| 10 | RV | X | | X | | 4 | 3.51 | X | | | | | 51.136 | 58.275 | -7.139 |
| 11 | T | | X | X | | 3.91 | 3.63 | X | X | | | | 52.313 | 56.349 | -4.035 |
| 12 | T | | | X | | 3.81 | 3.55 | | | | | | 53.686 | 57.618 | -3.932 |
| 13 | C | X | | X | | 3.69 | 3.27 | X | | | | | 55.432 | 62.552 | -7.120 |
| 14 | C,RV | X | | X | | 3.44 | 3.42 | | | | | | 59.461 | 59.809 | -0.348 |
| 15 | C | | X | | X | 2.82 | 3.09 | | | | | | 72.534 | 66.196 | 6.338 |
| 16 | C | X | | X | | 4.13 | 3.45 | | | | | | 49.527 | 59.289 | -9.762 |
| 17 | T | | X | X | | 4.56 | 4.04 | X | | | | | 44.856 | 50.630 | -5.774 |
| 18 | C | | X | X | | 4.19 | 3.98 | X | | | | | 48.818 | 51.393 | -2.576 |
| 19 | C | | X | | X | 2.93 | 3.19 | X | | | | | 69.811 | 64.121 | 5.690 |
| 20 | C | X | | X | | 3.68 | 3.44 | | | | | | 55.583 | 59.461 | -3.878 |
| 21 | C | X | | | X | 3.38 | 3.22 | X | | | | | 60.516 | 63.523 | -3.007 |
| 22 | C | X | | | X | 2.88 | 3.25 | | | | | | 71.023 | 62.937 | 8.086 |
| 23 | C | | X | X | | 4.22 | 4.08 | | | | | | 48.470 | 50.134 | -1.663 |
| 24 | C | X | | X | | 3.19 | 2.77 | | | | | | 64.121 | 73.843 | -9.722 |
| 25 | C | X | | X | | 3.63 | 3.15 | | | | | | 56.349 | 64.935 | -8.586 |
| 26 | C | X | | | X | 3.25 | 3.41 | X | | | | | 62.937 | 59.984 | 2.953 |
| 27 | C | | X | X | | 4.44 | 3.95 | X | | | | | 46.069 | 51.784 | -5.715 |
| 28 | C | | X | X | | 3.96 | 3.72 | | | | | | 51.653 | 54.985 | -3.332 |
| 29 | C | X | | X | | 3.78 | 4.14 | | | | | | 54.113 | 49.407 | 4.705 |
| 30 | C,RV | X | | X | | 4.62 | 4.16 | X | X | | | | 44.274 | 49.170 | -4.896 |
| 31 | C | X | | | X | 3.22 | 3.31 | X | | | | | 63.523 | 61.796 | 1.727 |
| 32 | T | | X | X | | 5.03 | 4.48 | | X | | | | 40.665 | 45.657 | -4.992 |
| 33 | C | X | | X | | 3.94 | 3.93 | X | | | | | 51.915 | 52.047 | -0.132 |
| 34 | C | X | | X | | 3.34 | 3.43 | X | | | | | 61.241 | 59.634 | 1.607 |
| 35 | T | X | | X | | 4.66 | 3.86 | X | | | | | 43.894 | 52.991 | -9.097 |
| 36 | C | X | | X | | 3.03 | 3.18 | | | | | | 67.507 | 64.322 | 3.184 |
| 37 | C | X | | X | | 3.41 | 3.16 | X | | | | | 59.984 | 64.730 | -4.746 |
| 38 | C | X | | X | | 3.35 | 3.27 | X | | | | | 61.058 | 62.552 | -1.494 |
| 39 | C | | X | | X | 3.62 | 3.73 | X | | | | | 56.504 | 54.838 | 1.666 |
| 40 | C | X | | X | | 4 | 3 | X | | | | | 51.136 | 68.182 | -17.045 |
| 41 | T | | X | X | | 4.13 | 3.74 | X | | | | | 49.527 | 54.691 | -5.165 |
| 42 | C | | X | X | | 3.88 | 3.67 | X | | | | | 52.718 | 55.734 | -3.017 |
| 43 | C | | | X | | 3.15 | 2.81 | | X | | | | 64.935 | 72.792 | -7.857 |
| 44 | C | | X | X | | 3.75 | 3.47 | X | | | | | 54.545 | 58.947 | -4.401 |
| 45 | C | X | | X | | 3.59 | 3.46 | X | | | | | 56.976 | 59.117 | -2.141 |
| 46 | C | | | X | | 3.31 | 3.48 | | | | | | 61.796 | 58.777 | 3.019 |
| 47 | T | X | | | X | 3.53 | 3.41 | | | | | | 57.945 | 59.984 | -2.039 |
| 48 | T | | X | X | | 3.97 | 3.77 | X | | | | | 51.523 | 54.256 | -2.733 |
| 49 | C | X | | | X | 3 | 3.18 | X | | | | | 68.182 | 64.322 | 3.859 |
| 50 | T | | X | | X | 3.72 | 3.7 | X | | | | | 54.985 | 55.283 | -0.297 |
| 51 | C | X | | | X | 3.25 | 3.36 | X | | | | | 62.937 | 60.877 | 2.060 |
| 52 | T | | | X | | 3.91 | 3.84 | X | | | | | 52.313 | 53.267 | -0.954 |
| 53 | C | | X | | X | 3.09 | 3.27 | X | | | | | 66.196 | 62.552 | 3.644 |
| 54 | T | X | | X | | 4.21 | 4.09 | X | | | | | 48.586 | 50.011 | -1.425 |
| 55 | T | X | | X | | 4.62 | 4.13 | | | | | | 44.274 | 49.527 | -5.253 |
| 56 | C | | X | X | | 4 | 3.66 | | | | | | 51.136 | 55.887 | -4.750 |
| 57 | T | | | | X | 3.75 | 3.81 | X | | | | | 54.545 | 53.686 | 0.859 |
| 58 | C | X | | | X | 3.19 | 3.4 | X | | | | | 64.121 | 60.160 | 3.960 |
| 59 | C | X | | X | | 4.22 | 4.06 | | | | | | 48.470 | 50.381 | -1.910 |
| 60 | C | X | | X | | 3.66 | 3.21 | | | | | | 55.887 | 63.721 | -7.835 |
| 61 | T | X | | X | | 3.75 | 3.38 | X | | | | | 54.545 | 60.516 | -5.971 |
| 62 | T | | X | X | | 4.13 | 4.26 | | | | | | 49.527 | 48.015 | 1.511 |
| 63 | C | X | | | X | 3.03 | 3.37 | X | | | | | 67.507 | 60.696 | 6.811 |
| 64 | C | X | | X | | 3.59 | 3.33 | | | | | | 56.976 | 61.425 | -4.449 |
| 65 | T | | X | X | | 4.25 | 4.09 | X | X | | | | 48.128 | 50.011 | -1.883 |
| 66 | C | X | | X | | 3.57 | 3.79 | | | | | | 57.296 | 53.970 | 3.326 |

# Table 21. O'Brien: Data Collected During Trip 2

| | | | | | |
|---|---|---|---|---|---|
| Location: | O'BRIEN | | | | |
| Date: | 5/19/99 | (Trip 2) | | | |
| Speed Trap 1 Distance (FT): | | | 300 | | |
| Speed Trap 2 Distance (FT): | | | 300 | | |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | Reduction mph |
| 1 | C | | X | X | | 3.35 | 3.41 | | | | | | 61.058 | 59.984 | 1.074 |
| 2 | C | | | X | | 3.35 | 3.84 | | | | | | 61.058 | 53.267 | 7.791 |
| 3 | C | | | X | | 3.25 | 3.26 | | | | | | 62.937 | 62.744 | 0.193 |
| 4 | C | | X | X | | 3.63 | 3.42 | | | | | | 56.349 | 59.809 | -3.460 |
| 5 | T | | X | X | | 3.44 | 3.86 | | X | | | | 59.461 | 52.991 | 6.470 |
| 6 | C | | X | X | | 3.38 | 3.4 | | X | | | | 60.516 | 60.160 | 0.356 |
| 7 | C | X | | X | | 3.16 | 3.23 | | | | | | 64.730 | 63.327 | 1.403 |
| 8 | C | X | | | X | 3.84 | 3.82 | | | | | | 53.267 | 53.546 | -0.279 |
| 9 | T | | | X | | 3.56 | 4.02 | | | | | | 57.457 | 50.882 | 6.575 |
| 10 | T | | | X | | 3.38 | 3.95 | | X | | | | 60.516 | 51.784 | 8.733 |
| 11 | C | | X | X | | 3.03 | 3.34 | | | | | | 67.507 | 61.241 | 6.266 |
| 12 | C | | X | X | | 2.66 | 2.81 | | | X | | | 76.897 | 72.792 | 4.105 |
| 13 | C | | | | X | 2.91 | 3.29 | | | X | | | 70.291 | 62.172 | 8.119 |
| 14 | T | | | X | | 3.41 | 4.01 | | | | | | 59.984 | 51.009 | 8.975 |
| 15 | T | | | X | | 3.35 | 3.34 | | X | | | | 61.058 | 61.241 | -0.183 |
| 16 | T | | | X | | 3.37 | 3.64 | | | | | | 60.696 | 56.194 | 4.502 |
| 17 | C | | | X | | 3.78 | 4.05 | | | | | | 54.113 | 50.505 | 3.608 |
| 18 | C | X | | X | | 3 | 3.13 | | | | | | 68.182 | 65.350 | 2.832 |
| 19 | C | | X | X | | 2.66 | 3.05 | | X | | | | 76.897 | 67.064 | 9.833 |
| 20 | C | | X | | X | 3.28 | 3.21 | | | | | | 62.361 | 63.721 | -1.360 |
| 21 | T | | X | X | | 3.38 | 3.81 | | X | | | | 60.516 | 53.686 | 6.830 |
| 22 | C | | X | X | | 3.65 | 3.86 | | | | | | 56.040 | 52.991 | 3.049 |
| 23 | T | | | X | | 3.9 | 3.77 | | X | | | | 52.448 | 54.256 | -1.809 |
| 24 | C | | X | X | | 3.06 | 3.27 | | | | | | 66.845 | 62.552 | 4.293 |
| 25 | T | | | X | | 4.28 | 4.45 | | X | | | | 47.791 | 45.965 | 1.826 |
| 26 | C | | | X | | 3.34 | 3.41 | | X | | | | 61.241 | 59.984 | 1.257 |
| 27 | C | | | | X | 2.78 | 2.82 | | | | | | 73.578 | 72.534 | 1.044 |
| 28 | C | X | | | X | 3.28 | 3.3 | | | | | | 62.361 | 61.983 | 0.378 |
| 29 | RV | | X | | X | 3.78 | 3.77 | | | | | | 54.113 | 54.256 | -0.144 |
| 30 | UHAUL | | | X | | 3.79 | 3.85 | | X | | | | 53.970 | 53.129 | 0.841 |
| 31 | T | | | X | | 3.53 | 3.41 | | X | | | | 57.945 | 59.984 | -2.039 |
| 32 | C | | X | X | | 3.16 | 3.59 | | X | | | | 64.730 | 56.976 | 7.753 |
| 33 | T | | | X | | 3.47 | 3.55 | | X | | | | 58.947 | 57.618 | 1.328 |
| 34 | C | | | X | | 3.1 | 3.2 | | | | | | 65.982 | 63.920 | 2.062 |
| 35 | C | | X | X | | 4.12 | 4.38 | | | | | | 49.647 | 46.700 | 2.947 |
| 36 | C | X | | | X | 3.03 | 2.93 | | | | | | 67.507 | 69.811 | -2.304 |
| 37 | C | | X | X | | 3.88 | 4.01 | | X | | | | 52.718 | 51.009 | 1.709 |
| 38 | C | | X | X | | 3.1 | 3.3 | | X | | | | 65.982 | 61.983 | 3.999 |
| 39 | C | X | | X | | 3.19 | 3.29 | | | | | | 64.121 | 62.172 | 1.949 |
| 40 | T | | | X | | 3.6 | 3.34 | X | | | | | 56.818 | 61.241 | -4.423 |
| 41 | T | | X | X | | 3.72 | 4.26 | X | X | | | | 54.985 | 48.015 | 6.970 |
| 42 | C | X | | X | | 3.34 | 4.01 | | X | | | | 61.241 | 51.009 | 10.232 |
| 43 | C | X | | X | | 3.16 | 3.13 | | | | | | 64.730 | 65.350 | -0.620 |
| 44 | C | X | | X | | 3.94 | 3.86 | | | | | | 51.915 | 52.991 | -1.076 |
| 45 | T | | X | X | | 3.07 | 3.42 | | X | | | | 66.627 | 59.809 | 6.819 |
| 46 | T | | X | X | | 4.16 | 4.63 | X | X | | | | 49.170 | 44.178 | 4.991 |
| 47 | T | | X | X | | 3.41 | 3.73 | | | | | | 59.984 | 54.838 | 5.146 |
| 48 | C | | X | X | | 3.5 | 3.83 | | X | | | | 58.442 | 53.406 | 5.035 |
| 49 | T | | X | X | | 3.66 | 3.94 | | X | | | | 55.887 | 51.915 | 3.972 |
| 50 | T | X | | X | | 3.51 | 3.65 | | | | | | 58.275 | 56.040 | 2.235 |
| 51 | T | | X | X | | 4.25 | 4.4 | | | | | | 48.128 | 46.488 | 1.641 |
| 52 | C | X | | | X | 3.22 | 3.45 | | | | | X | 63.523 | 59.289 | 4.235 |
| 53 | C | | X | X | | 3.57 | 3.64 | | X | | | | 57.296 | 56.194 | 1.102 |
| 54 | C | | X | X | | 3.69 | 3.84 | | | | | | 55.432 | 53.267 | 2.165 |
| 55 | T | | | X | | 3.81 | 4.66 | X | X | | | | 53.686 | 43.894 | 9.793 |
| 56 | T | | | X | | 3.39 | 3.33 | | X | | | | 60.338 | 61.425 | -1.087 |
| 57 | T | X | | X | | 3.56 | 3.34 | | X | | | | 57.457 | 61.241 | -3.785 |
| 58 | T | | | X | | 3.32 | 3.55 | | | | | | 61.610 | 57.618 | 3.992 |
| 59 | C | | | X | | 3.4 | 3.55 | | | | | | 60.160 | 57.618 | 2.542 |
| 60 | C | X | | X | | 3.66 | 3.53 | | | | | | 55.887 | 57.945 | -2.058 |
| 61 | C | | X | X | | 3.53 | 3.61 | | | | | | 57.945 | 56.661 | 1.284 |
| 62 | C | X | | | X | 3.34 | 3.31 | | | | | X | 61.241 | 61.796 | -0.555 |
| 63 | C | X | | X | | 3.5 | 3.66 | | | | | | 58.442 | 55.887 | 2.555 |
| 64 | C | X | | | X | 2.97 | 3.06 | X | | | | | 68.871 | 66.845 | 2.026 |
| 65 | C, TRAILER | | X | X | | 3.85 | 3.95 | | | | | | 53.129 | 51.784 | 1.345 |
| 66 | T | | X | X | | 3.57 | 3.56 | | X | | | | 57.296 | 57.457 | -0.161 |

# Table 22. La Moine Data Collected During Trip 2

| | | |
|---|---|---|
| Location: | La Moine | |
| Date: | 5/19/99 | (Trip 2) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | | Encroachment | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | Reduction mph |
| 1 | T | | | X | | 3.62 | 3.41 | X | | | | | 56.504 | 59.984 | -3.480 |
| 2 | T | X | | X | | 3.47 | 3.21 | | | | | | 58.947 | 63.721 | -4.775 |
| 3 | T | | X | X | | 3.28 | 3.31 | X | | | | | 62.361 | 61.796 | 0.565 |
| 4 | C | | X | X | | 3.65 | 3.55 | | | | | | 56.040 | 57.618 | -1.579 |
| 5 | C | | X | X | | 3.03 | 2.81 | X | | | | | 67.507 | 72.792 | -5.285 |
| 6 | C | | | | X | 3.03 | 2.96 | | | | | | 67.507 | 69.103 | -1.596 |
| 7 | T | | X | X | | 3.9 | 3.53 | | | | | | 52.448 | 57.945 | -5.497 |
| 8 | C | X | | X | | 3.59 | 3.52 | | | | | | 56.976 | 58.110 | -1.133 |
| 9 | C | X | | | X | 3.22 | 3.25 | | | | | | 63.523 | 62.937 | 0.586 |
| 10 | C | | X | | X | 2.78 | 2.76 | X | | | | | 73.578 | 74.111 | -0.533 |
| 11 | T | | | X | | 3.53 | 3.43 | | | | | | 57.945 | 59.634 | -1.689 |
| 12 | T | | | X | | 3.28 | 3.04 | X | | | | | 62.361 | 67.285 | -4.923 |
| 13 | C | X | | | X | 2.93 | 2.84 | | | | | | 69.811 | 72.023 | -2.212 |
| 14 | C | | X | | X | 3.18 | 3.34 | X | | | | | 64.322 | 61.241 | 3.081 |
| 15 | T | | X | X | | 3.87 | 3.61 | | | | | | 52.854 | 56.661 | -3.807 |
| 16 | C | | X | X | | 3.44 | 3.27 | X | | | | | 59.461 | 62.552 | -3.091 |
| 17 | C | | | X | | 3.13 | 3.14 | | | | | | 65.350 | 65.142 | 0.208 |
| 18 | T | | X | | X | 3.5 | 3.31 | X | | | | | 58.442 | 61.796 | -3.355 |
| 19 | T | X | | X | | 4.03 | 3.8 | | | | | | 50.756 | 53.828 | -3.072 |
| 20 | C | | X | | X | 2.78 | 2.95 | X | | | | | 73.578 | 69.337 | 4.240 |
| 21 | C | | X | X | | 3 | 3.12 | | | | | | 68.182 | 65.559 | 2.622 |
| 22 | T | | X | X | | 3.25 | 3.1 | | | X | | | 62.937 | 65.982 | -3.045 |
| 23 | C | | X | X | | 3.22 | 3.08 | X | | | | | 63.523 | 66.411 | -2.887 |
| 24 | C | | | | X | 2.69 | 2.57 | | | | | | 76.039 | 79.590 | -3.550 |
| 25 | C | X | | X | | 3.25 | 3.33 | | | | | | 62.937 | 61.425 | 1.512 |
| 26 | T | | X | X | | 3.62 | 3.51 | X | | | | | 56.504 | 58.275 | -1.771 |
| 27 | T | | X | X | | 3.41 | 3.06 | | | | | X | 59.984 | 66.845 | -6.861 |
| 28 | C | X | | | X | 3.31 | 2.76 | X | | | | | 61.796 | 74.111 | -12.314 |
| 29 | T | | X | X | | 3.25 | 3.31 | | | | | | 62.937 | 61.796 | 1.141 |
| 30 | C | | X | X | | 3 | 2.9 | | | | | | 68.182 | 70.533 | -2.351 |
| 31 | C | | X | X | | 3.03 | 3.09 | | | | | | 67.507 | 66.196 | 1.311 |
| 32 | T | | | X | | 3.34 | 3.14 | X | | | | | 61.241 | 65.142 | -3.901 |
| 33 | C | X | | X | | 2.87 | 2.94 | | | | | | 71.270 | 69.573 | 1.697 |
| 34 | C | | X | | X | 2.75 | 2.6 | X | | | | | 74.380 | 78.671 | -4.291 |
| 35 | C | X | | X | | 3.3 | 3.27 | | | | | | 61.983 | 62.552 | -0.569 |
| 36 | T | | X | X | | 3.56 | 3.38 | | | | | | 57.457 | 60.516 | -3.060 |
| 37 | T | | X | X | | 3.91 | 3.73 | | | | | | 52.313 | 54.838 | -2.525 |
| 38 | C | X | | X | | 3.16 | 3.16 | | | | | | 64.730 | 64.730 | 0.000 |
| 39 | C | | X | X | | 3.25 | 3.05 | X | | | | | 62.937 | 67.064 | -4.127 |
| 40 | T | | X | X | | 3.47 | 3.55 | X | | | | | 58.947 | 57.618 | 1.328 |
| 41 | C | X | | X | | 3.56 | 3.4 | | | | | X | 57.457 | 60.160 | -2.704 |
| 42 | T | | X | X | | 3.9 | 3.72 | X | | | | | 52.448 | 54.985 | -2.538 |
| 43 | C | | | X | | 3.22 | 3.3 | | | | | | 63.523 | 61.983 | 1.540 |
| 44 | T | | X | X | | 3.66 | 3.45 | | | | | | 55.887 | 59.289 | -3.402 |
| 45 | C | | X | | X | 2.97 | 2.98 | | | | | | 68.871 | 68.639 | 0.231 |
| 46 | C | | X | X | | 3.16 | 3.16 | | | | | | 64.730 | 64.730 | 0.000 |
| 47 | C | X | | X | | 3.18 | 3.02 | | | | | | 64.322 | 67.730 | -3.408 |
| 48 | T | | X | X | | 3.31 | 3.18 | | | | | | 61.796 | 64.322 | -2.526 |
| 49 | C,RV | | X | X | | 3.25 | 3.16 | | | | | | 62.937 | 64.730 | -1.793 |
| 50 | C,RV | X | | X | | 3.53 | 3.47 | | | | | | 57.945 | 58.947 | -1.002 |
| 51 | T | | X | X | | 3.5 | 3.56 | X | | | | | 58.442 | 57.457 | 0.985 |
| 52 | T | X | | X | | 3.44 | 3.2 | X | | | | | 59.461 | 63.920 | -4.460 |
| 53 | C | | X | X | | 3.15 | 3.06 | X | | | | | 64.935 | 66.845 | -1.910 |
| 54 | C | | X | X | | 3.25 | 3.16 | | | | | | 62.937 | 64.730 | -1.793 |
| 55 | C | | X | | X | 2.88 | 2.81 | | | | | | 71.023 | 72.792 | -1.769 |
| 56 | T | | | X | | 3.97 | 3.47 | | | | | | 51.523 | 58.947 | -7.424 |
| 57 | C | | X | X | | 3.16 | 2.91 | | | | | | 64.730 | 70.291 | -5.561 |
| 58 | T | | X | X | | 3.63 | 3.45 | | | | | | 56.349 | 59.289 | -2.940 |
| 59 | C | X | | X | | 3.38 | 3.27 | | | | | | 60.516 | 62.552 | -2.036 |
| 60 | C,RV | | X | X | | 4.47 | 4.07 | | | | | | 45.760 | 50.257 | -4.497 |
| 61 | C | | X | X | | 3.47 | 3.21 | | | | | | 58.947 | 63.721 | -4.775 |
| 62 | T | | X | X | | 3.44 | 3.31 | | | | | | 59.461 | 61.796 | -2.335 |
| 63 | C | | X | X | | 3.13 | 3.1 | | | | | | 65.350 | 65.982 | -0.632 |
| 64 | C | | | | X | 2.97 | 2.94 | | | | | | 68.871 | 69.573 | -0.703 |
| 65 | C | | X | X | | 2.81 | 2.81 | | | | | | 72.792 | 72.792 | 0.000 |
| 66 | C | | X | X | | 3.12 | 3.14 | X | | | | | 65.559 | 65.142 | 0.418 |

Table 23. Sims Road: Data Collected During Trip 2

| | | |
|---|---|---|
| Location: | Sims Road | |
| Date: | 5/18/99 | (Trip 2) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | Reduction mph |
| 1 | T | | | X | | 3.56 | 3.73 | | | | | | 57.457 | 54.838 | 2.619 |
| 2 | T | | | X | | 3.5 | 3.41 | | | | | | 58.442 | 59.984 | -1.542 |
| 3 | C | X | | X | | 3 | 2.96 | | | | | | 68.182 | 69.103 | -0.921 |
| 4 | C | X | | X | | 3.93 | 3.7 | | X | | | | 52.047 | 55.283 | -3.235 |
| 5 | T | | | X | | 3.65 | 3.57 | X | | | | | 56.040 | 57.296 | -1.256 |
| 6 | C | X | | X | | 3.31 | 3.41 | | | | | | 61.796 | 59.984 | 1.812 |
| 7 | T | | X | X | | 5.31 | 5.16 | | X | | | | 38.521 | 39.641 | -1.120 |
| 8 | T | X | | X | | 4.03 | 4.22 | | X | | | | 50.756 | 48.470 | 2.285 |
| 9 | C | | X | X | | 3.1 | 3.41 | | | | | X | 65.982 | 59.984 | 5.998 |
| 10 | C | | X | | X | 3.06 | 3.84 | | X | | | | 66.845 | 53.267 | 13.578 |
| 11 | C | X | | X | | 3.69 | 4.1 | | | | | | 55.432 | 49.889 | 5.543 |
| 12 | C | X | | X | | 3.25 | 3.3 | | | | | | 62.937 | 61.983 | 0.954 |
| 13 | RV | X | | X | | 4 | 4.05 | | X | | | | 51.136 | 50.505 | 0.631 |
| 14 | T | | X | | X | 3.82 | 4.26 | | X | | | | 53.546 | 48.015 | 5.531 |
| 15 | C | X | | X | | 3.44 | 3.95 | | X | | | | 59.461 | 51.784 | 7.677 |
| 16 | C | X | | X | | 3.28 | 3.29 | | | | | | 62.361 | 62.172 | 0.190 |
| 17 | RV | X | | X | | 3.81 | 3.89 | | X | | | | 53.686 | 52.582 | 1.104 |
| 18 | T | | X | X | | 3.94 | 4.09 | | | | | | 51.915 | 50.011 | 1.904 |
| 19 | T | | X | X | | 3.47 | 3.52 | | | | | | 58.947 | 58.110 | 0.837 |
| 20 | C | | X | | X | 3.16 | 3.31 | | | | | | 64.730 | 61.796 | 2.933 |
| 21 | C | X | | | X | 3.49 | 3.02 | | | | | | 58.609 | 67.730 | -9.121 |
| 22 | C,TRAILER | | X | | X | 3.38 | 3.95 | | | X | | | 60.516 | 51.784 | 8.733 |
| 23 | C | X | | | X | 3.09 | 3.16 | | | | | | 66.196 | 64.730 | 1.466 |
| 24 | C | X | | | X | 2.59 | 2.61 | | | | | | 78.975 | 78.370 | 0.605 |
| 25 | C,TRAILER | X | | X | | 3.41 | 3.27 | | X | | | | 59.984 | 62.552 | -2.568 |
| 26 | T | | X | X | | 3.41 | 3.77 | | X | | | | 59.984 | 54.256 | 5.728 |
| 27 | C | X | | X | | 3.56 | 3.63 | | | | | | 57.457 | 56.349 | 1.108 |
| 28 | T | | X | X | | 3.19 | 3.66 | | X | | | | 64.121 | 55.887 | 8.234 |
| 29 | T | | X | X | | 3.91 | 3.84 | | | | | | 52.313 | 53.267 | -0.954 |
| 30 | T | X | | X | | 4.12 | 3.9 | X | X | | | | 49.647 | 52.448 | -2.801 |
| 31 | C | X | | | X | 3.06 | 3.02 | | | | | | 66.845 | 67.730 | -0.885 |
| 32 | C | X | | | X | 3.06 | 3.01 | | | | | | 66.845 | 67.955 | -1.110 |
| 33 | C | | X | X | | 3.1 | 3.6 | X | X | | | | 65.982 | 56.818 | 9.164 |
| 34 | C | | X | | X | 2.87 | 3.09 | | | | | | 71.270 | 66.196 | 5.074 |
| 35 | C | | X | | X | 2.75 | 2.93 | | | | | | 74.380 | 69.811 | 4.569 |
| 36 | C | X | | X | | 3.78 | 3.8 | | | | | | 54.113 | 53.828 | 0.285 |
| 37 | T | X | | X | | 3.43 | 3.77 | X | | | | | 59.634 | 54.256 | 5.378 |
| 38 | T | | X | X | | 3.53 | 3.99 | | X | | | | 57.945 | 51.265 | 6.680 |
| 39 | C | | X | | X | 2.93 | 3.57 | | | | | | 69.811 | 57.296 | 12.515 |
| 40 | C | X | | X | | 3.6 | 3.48 | | | | | | 56.818 | 58.777 | -1.959 |
| 41 | T | | X | X | | 3.78 | 3.66 | | | | | | 54.113 | 55.887 | -1.774 |
| 42 | T | | X | X | | 3.78 | 3.95 | | | | | | 54.113 | 51.784 | 2.329 |
| 43 | C | X | | | X | 3.13 | 4.03 | | | | | X | 65.350 | 50.756 | 14.594 |
| 44 | C | X | | X | | 3.16 | 3.1 | | | | | | 64.730 | 65.982 | -1.253 |
| 45 | C | | X | X | | 3.22 | 3.45 | | | | | | 63.523 | 59.289 | 4.235 |
| 46 | C | X | | X | | 3.34 | 3.58 | | X | | | | 61.241 | 57.136 | 4.106 |
| 47 | C | X | | | X | 3.1 | 3.04 | | | X | | | 65.982 | 67.285 | -1.302 |
| 48 | T | | X | X | | 3.47 | 3.7 | | | | | | 58.947 | 55.283 | 3.664 |
| 49 | T | | X | X | | 3.91 | 4.15 | | | | | | 52.313 | 49.288 | 3.025 |
| 50 | C | | X | X | | 3.28 | 3.31 | | | | | | 62.361 | 61.796 | 0.565 |
| 51 | C | X | | | X | 2.88 | 2.95 | | | | | | 71.023 | 69.337 | 1.685 |
| 52 | C | X | | | X | 3.13 | 3.2 | | | | | | 65.350 | 63.920 | 1.430 |
| 53 | C | X | | | X | 3.37 | 3.59 | | | | | | 60.696 | 56.976 | 3.720 |
| 54 | T | | X | X | | 3.87 | 4.13 | | | | | | 52.854 | 49.527 | 3.327 |
| 55 | T | | X | X | | 3.41 | 3.7 | X | | | | | 59.984 | 55.283 | 4.701 |
| 56 | T | X | | X | | 4.22 | 4.52 | | | | | | 48.470 | 45.253 | 3.217 |
| 57 | C | X | | | X | 3.03 | 2.99 | | | | | | 67.507 | 68.410 | -0.903 |
| 58 | C,TRAILER | | X | X | | 3.84 | 3.48 | X | | | | | 53.267 | 58.777 | -5.510 |
| 59 | C | X | | X | | 3.47 | 3.17 | | | | | | 58.947 | 64.525 | -5.579 |
| 60 | C | | X | X | | 3.44 | 3.7 | | | | | | 59.461 | 55.283 | 4.178 |
| 61 | C | | X | X | | 3.22 | 3.3 | | | | | | 63.523 | 61.983 | 1.540 |
| 62 | C | X | | | X | 3.56 | 3.59 | | | | | | 57.457 | 56.976 | 0.480 |
| 63 | T | | X | X | | 3.85 | 4.05 | | | | | | 53.129 | 50.505 | 2.624 |
| 64 | C | X | | | X | 2.81 | 2.91 | | | | | | 72.792 | 70.291 | 2.501 |
| 65 | T | | X | X | | 4.03 | 4.28 | | | | | | 50.756 | 47.791 | 2.965 |
| 66 | C | | X | | X | 3.13 | 3.31 | | | | | | 65.350 | 61.796 | 3.554 |

Table 24. Sidehill Viaduct: Data Collected During Trip 3

| | | | |
|---|---|---|---|
| Location: | SIDE HILL VIADUCT | | |
| Date: | 8/19/99 | (Trip 3) | |
| Speed Trap 1 Distance (FT): | | | 300 |
| Speed Trap 2 Distance (FT): | | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | mph |
| 1 | T | | | X | | 3.43 | 3.69 | X | | | | | 59.634 | 55.432 | 4.202 |
| 2 | T | | | X | | 3.75 | 3.54 | | | | | | 54.545 | 57.781 | -3.236 |
| 3 | C | X | | | X | 3.16 | 3.28 | X | | | | | 64.730 | 62.361 | 2.368 |
| 4 | C | X | | | X | 3.38 | 3.43 | X | | | | | 60.516 | 59.634 | 0.882 |
| 5 | C | | X | X | | 3.72 | 3.34 | X | | | | | 54.985 | 61.241 | -6.256 |
| 6 | C | X | | X | | 3.75 | 3.3 | | | | | X | 54.545 | 61.983 | -7.438 |
| 7 | C | | | X | | 3.68 | 3.57 | X | | | | X | 55.583 | 57.296 | -1.713 |
| 8 | T | | | X | | 3.75 | 3.57 | X | | | | | 54.545 | 57.296 | -2.750 |
| 9 | C | X | | X | | 3.84 | 3.66 | X | | | | | 53.267 | 55.887 | -2.620 |
| 10 | C | | X | | X | 3.1 | 3.44 | | | | | | 65.982 | 59.461 | 6.522 |
| 11 | C | X | | | X | 3.04 | 3.36 | | | | | | 67.285 | 60.877 | 6.408 |
| 12 | C | X | | | X | 2.94 | 3.25 | | | | | | 69.573 | 62.937 | 6.636 |
| 13 | C | | X | | X | 3 | 3.55 | X | | | | | 68.182 | 57.618 | 10.563 |
| 14 | C | X | | | X | 3 | 3.31 | X | | | | | 68.182 | 61.796 | 6.386 |
| 15 | C | X | | | X | 2.91 | 2.93 | X | | | | | 70.291 | 69.811 | 0.480 |
| 16 | RV | X | | X | | 3.81 | 3.63 | | | | | | 53.686 | 56.349 | -2.662 |
| 17 | C | | X | | X | 3.54 | 3.42 | X | | | | | 57.781 | 59.809 | -2.027 |
| 18 | C | X | | | X | 3.21 | 3.44 | | | | | | 63.721 | 59.461 | 4.260 |
| 19 | C | | X | | X | 3.43 | 3.93 | | | | | | 59.634 | 52.047 | 7.587 |
| 20 | C | X | | X | | 3.78 | 3.37 | X | | | | | 54.113 | 60.696 | -6.583 |
| 21 | C | | X | X | | 3.54 | 3.54 | X | | | | | 57.781 | 57.781 | 0.000 |
| 22 | C | X | | | X | 2.91 | 3.02 | X | | | | X | 70.291 | 67.730 | 2.560 |
| 23 | C | | X | X | | 3.25 | 2.95 | X | | | | | 62.937 | 69.337 | -6.400 |
| 24 | T | | | X | | 4 | 3.55 | X | | | | | 51.136 | 57.618 | -6.482 |
| 25 | T | | | X | | 3.85 | 3.69 | X | | | | | 53.129 | 55.432 | -2.304 |
| 26 | T | | | X | | 4.06 | 3.68 | | | | | | 50.381 | 55.583 | -5.202 |
| 27 | C | | X | X | | 3.44 | 3.34 | | | | | | 59.461 | 61.241 | -1.780 |
| 28 | T | | | X | | 3.97 | 3.47 | X | | | | | 51.523 | 58.947 | -7.424 |
| 29 | C | X | | | X | 3.09 | 3.38 | | | | | | 66.196 | 60.516 | 5.680 |
| 30 | C | | | | X | 2.75 | 3.22 | X | | | | | 74.380 | 63.523 | 10.857 |
| 31 | C | X | | X | | 3.81 | 3.68 | X | | | | | 53.686 | 55.583 | -1.897 |
| 32 | RV | | | X | | 3.78 | 3.48 | | | | | | 54.113 | 58.777 | -4.665 |
| 33 | C | | | X | | 3.31 | 3.19 | | | | | X | 61.796 | 64.121 | -2.325 |
| 34 | RV | | | X | | 4.4 | 3.84 | X | | | | | 46.488 | 53.267 | -6.779 |
| 35 | T | | | X | | 3.69 | 3.41 | | | | | | 55.432 | 59.984 | -4.552 |
| 36 | RV | | X | X | | 3.78 | 3.61 | X | | | | | 54.113 | 56.661 | -2.548 |
| 37 | C | X | | | X | 3 | 3.68 | X | | | | | 68.182 | 55.583 | 12.599 |
| 38 | C | | X | | X | 2.78 | 3.03 | X | | | | | 73.578 | 67.507 | 6.071 |
| 39 | C | | X | | X | 3.4 | 3.27 | X | | | | | 60.160 | 62.552 | -2.392 |
| 40 | C | | | X | | 3.28 | 2.94 | X | | | | | 62.361 | 69.573 | -7.212 |
| 41 | C | | | X | | 4.22 | 3.92 | X | | | | | 48.470 | 52.180 | -3.709 |
| 42 | C | X | | | X | 3.16 | 3.4 | | | | | | 64.730 | 60.160 | 4.569 |
| 43 | C | | | X | | 3.5 | 3.15 | X | | | | | 58.442 | 64.935 | -6.494 |
| 44 | C | X | | | X | 3.21 | 3.68 | | | | | | 63.721 | 55.583 | 8.138 |
| 45 | C | X | | X | | 3.75 | 3.38 | | | | | | 54.545 | 60.516 | -5.971 |
| 46 | C | | X | | X | 3.16 | 3.54 | | | | | | 64.730 | 57.781 | 6.948 |
| 47 | C | | X | X | | 3.6 | 3.52 | X | | | | | 56.818 | 58.110 | -1.291 |
| 48 | C | | | | X | 2.81 | 3.22 | | | | | | 72.792 | 63.523 | 9.269 |
| 49 | C | | | X | | 3 | 3.49 | X | | | | | 68.182 | 58.609 | 9.573 |
| 50 | RV | X | | | X | 3.29 | 3.74 | X | | | | | 62.172 | 54.691 | 7.481 |
| 51 | RV | | | X | | 4.63 | 4.16 | X | | | | | 44.178 | 49.170 | -4.991 |
| 52 | C | X | | X | | 3.44 | 2.99 | X | | | | | 59.461 | 68.410 | -8.949 |
| 53 | T | | | X | | 3.78 | 3.59 | | | | | | 54.113 | 56.976 | -2.864 |
| 54 | C | | X | X | | 3.31 | 3.04 | X | | | | | 61.796 | 67.285 | -5.488 |
| 55 | C | X | | X | | 2.97 | 2.7 | X | | | | X | 68.871 | 75.758 | -6.887 |
| 56 | T | | | X | | 4.29 | 4.09 | X | | | | | 47.680 | 50.011 | -2.332 |
| 57 | C | X | | X | | 3.34 | 3.09 | | | | | | 61.241 | 66.196 | -4.955 |
| 58 | C | | X | X | | 4.37 | 3.99 | | | | | | 46.807 | 51.265 | -4.458 |
| 59 | C | X | | X | | 3.84 | 3.66 | | | | | | 53.267 | 55.887 | -2.620 |
| 60 | C | | X | | X | 3.34 | 3.27 | | | | | | 61.241 | 62.552 | -1.311 |
| 61 | C | X | | X | | 3.64 | 3.23 | X | | | | | 56.194 | 63.327 | -7.133 |
| 62 | C | | | X | | 3.72 | 3.41 | | | | | | 54.985 | 59.984 | -4.999 |
| 63 | T | | | X | | 3.63 | 3.31 | X | | | | | 56.349 | 61.796 | -5.448 |
| 64 | C | | | | X | 2.87 | 3.11 | | | | | | 71.270 | 65.770 | 5.500 |
| 65 | T | | | X | | 4.22 | 3.68 | X | | | | | 48.470 | 55.583 | -7.113 |
| 66 | C | X | | X | | 3.4 | 3.23 | X | | | | X | 60.160 | 63.327 | -3.166 |

## Table 25. O'Brien: Data Collected During Trip 3

| | | |
|---|---|---|
| Location: | O'BRIEN | |
| Date: | 8/19/99 | (Trip 3) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | Reduction mph |
| 1 | T | | | | X | 3.5 | 3.54 | | | | | | 58.442 | 57.781 | 0.660 |
| 2 | C | | | X | | 4.91 | 5.11 | | | | | | 41.659 | 40.028 | 1.630 |
| 3 | C | X | | X | | 3.19 | 3.23 | | | | | | 64.121 | 63.327 | 0.794 |
| 4 | T | | | X | | 3.91 | 4.31 | | X | | | | 52.313 | 47.458 | 4.855 |
| 5 | C | X | | X | | 3.34 | 3.59 | | X | | | | 61.241 | 56.976 | 4.265 |
| 6 | C | X | | X | | 3.44 | 3.41 | | | | | | 59.461 | 59.984 | -0.523 |
| 7 | C | X | | X | | 3.31 | 3.32 | | | | | | 61.796 | 61.610 | 0.186 |
| 8 | C | X | | X | | 3.09 | 3.14 | | | | | | 66.196 | 65.142 | 1.054 |
| 9 | T | | | X | | 3.97 | 4.34 | | X | | | | 51.523 | 47.130 | 4.392 |
| 10 | C | | | X | | 3.13 | 3.2 | | | | | | 65.350 | 63.920 | 1.430 |
| 11 | T | | | X | | 3.35 | 3.49 | | | | | | 61.058 | 58.609 | 2.449 |
| 12 | T | | | X | | 3.66 | 4.52 | | X | | | | 55.887 | 45.253 | 10.633 |
| 13 | C | | X | X | | 3.37 | 3.82 | | | | | | 60.696 | 53.546 | 7.150 |
| 14 | C | X | | X | | 3.31 | 3.23 | | | | | | 61.796 | 63.327 | -1.531 |
| 15 | C | | X | X | | 3.72 | 3.81 | | X | | | | 54.985 | 53.686 | 1.299 |
| 16 | C | | | X | | 4.09 | 4.05 | | | | | | 50.011 | 50.505 | -0.494 |
| 17 | T | | | X | | 3.34 | 3.99 | | X | | | | 61.241 | 51.265 | 9.977 |
| 18 | C | | X | X | | 3.18 | 3.51 | | | | | | 64.322 | 58.275 | 6.047 |
| 19 | C | X | | X | | 3.78 | 3.55 | | | | | | 54.113 | 57.618 | -3.506 |
| 20 | C | X | | | X | 3.28 | 3.61 | | | | | | 62.361 | 56.661 | 5.701 |
| 21 | C | X | | X | | 3.44 | 3.34 | | X | | | | 59.461 | 61.241 | -1.780 |
| 22 | C | | | X | | 3.97 | 3.56 | | | | | | 51.523 | 57.457 | -5.934 |
| 23 | C | | X | X | | 3.4 | 3.31 | | | | | | 60.160 | 61.796 | -1.636 |
| 24 | T | | | X | | 3.56 | 3.88 | | | | | | 57.457 | 52.718 | 4.739 |
| 25 | C | | X | X | | 3.4 | 3.38 | | | | | | 60.160 | 60.516 | -0.356 |
| 26 | C | | | X | | 2.75 | 2.84 | X | | | | | 74.380 | 72.023 | 2.357 |
| 27 | C | | X | | X | 3.03 | 3.2 | | | | | | 67.507 | 63.920 | 3.586 |
| 28 | C | X | | | X | 2.37 | 2.67 | | | | | | 86.306 | 76.609 | 9.697 |
| 29 | C | | X | | X | 3.31 | 3.81 | | X | | | | 61.796 | 53.686 | 8.110 |
| 30 | C | | | X | | 3.31 | 3.33 | | | | | | 61.796 | 61.425 | 0.371 |
| 31 | C | | | | X | 2.9 | 3.16 | | | | | X | 70.533 | 64.730 | 5.803 |
| 32 | C | X | | X | | 3.84 | 4.27 | | | | | | 53.267 | 47.903 | 5.364 |
| 33 | C | | X | | X | 2.94 | 3.56 | | | | | | 69.573 | 57.457 | 12.117 |
| 34 | C | | | | X | 3.09 | 3.02 | | | | | | 66.196 | 67.730 | -1.534 |
| 35 | C | | | | X | 2.69 | 2.99 | | | | | | 76.039 | 68.410 | 7.629 |
| 36 | C | X | | | X | 3.03 | 2.88 | | | X | | | 67.507 | 71.023 | -3.516 |
| 37 | RV | X | | X | | 3.59 | 4.38 | | | | | | 56.976 | 46.700 | 10.277 |
| 38 | C | | | X | | 3 | 2.94 | | | | | | 68.182 | 69.573 | -1.391 |
| 39 | C | | X | | X | 3.12 | 3.14 | | X | | | | 65.559 | 65.142 | 0.418 |
| 40 | C | X | | X | | 3.47 | 3.39 | | | | | | 58.947 | 60.338 | -1.391 |
| 41 | C | X | | X | | 3.34 | 3.22 | | | | | | 61.241 | 63.523 | -2.282 |
| 42 | C | X | | | X | 2.81 | 2.91 | | | | | | 72.792 | 70.291 | 2.501 |
| 43 | C | | | X | | 3.25 | 3.32 | | | | | | 62.937 | 61.610 | 1.327 |
| 44 | T | | | X | | 3.63 | 3.73 | | X | | | | 56.349 | 54.838 | 1.511 |
| 45 | T | | | X | | 2.07 | 4.42 | | | | | | 98.814 | 46.277 | 52.537 |
| 46 | C | | X | X | | 4.4 | 4.08 | | | | | | 46.488 | 50.134 | -3.646 |
| 47 | C | | X | X | | 3.35 | 3.45 | | | X | | | 61.058 | 59.289 | 1.770 |
| 48 | C | X | | X | | 3.44 | 3.57 | | | | | | 59.461 | 57.296 | 2.165 |
| 49 | C | X | | X | | 3.31 | 3.31 | | | | | | 61.796 | 61.796 | 0.000 |
| 50 | C | X | | | X | 2.59 | 3.01 | X | | | | | 78.975 | 67.955 | 11.020 |
| 51 | C | X | | X | | 3.93 | 3.7 | | | | | | 52.047 | 55.283 | -3.235 |
| 52 | C | X | | X | | 3.75 | 3.45 | | | | | | 54.545 | 59.289 | -4.743 |
| 53 | C | | X | X | | 3.06 | 3.05 | | | | | | 66.845 | 67.064 | -0.219 |
| 54 | C | | X | X | | 2.81 | 2.76 | X | | | | | 72.792 | 74.111 | -1.319 |
| 55 | C | | X | X | | 3.72 | 3.88 | X | | | | | 54.985 | 52.718 | 2.267 |
| 56 | C | X | | | X | 3.19 | 3.29 | | | X | | | 64.121 | 62.172 | 1.949 |
| 57 | C | X | | | X | 3.18 | 3.38 | | | | | | 64.322 | 60.516 | 3.806 |
| 58 | C | | | X | | 3.25 | 3.64 | | | | | | 62.937 | 56.194 | 6.743 |
| 59 | C | | X | X | | 3.35 | 3.5 | | X | | | | 61.058 | 58.442 | 2.617 |
| 60 | C | X | | X | | 3.91 | 3.81 | | X | | | | 52.313 | 53.686 | -1.373 |
| 61 | C | | X | X | | 4 | 3.86 | | | | | | 51.136 | 52.991 | -1.855 |
| 62 | C | | X | | X | 3.03 | 3.22 | X | | | | | 67.507 | 63.523 | 3.983 |
| 63 | T | | | X | | 3.6 | 3.7 | | X | | | | 56.818 | 55.283 | 1.536 |
| 64 | C | X | | X | | 3.4 | 3.38 | | | | | | 60.160 | 60.516 | -0.356 |
| 65 | RV | | X | X | | 3.28 | 3.27 | | | | | | 62.361 | 62.552 | -0.191 |
| 66 | C | X | | | X | 2.75 | 2.93 | | | | | | 74.380 | 69.811 | 4.569 |

# Table 26. Salt Creek: Data Collected During Trip 3

| | | |
|---|---|---|
| Location: | SALT CREEK | |
| Date: | 8/18/99 | (Trip 3) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | mph |
| 1 | RV | | | X | | 5.03 | 4.46 | | | | | | 40.665 | 45.862 | -5.197 |
| 2 | C | | | | X | 2.72 | 2.8 | | X | | | | 75.201 | 73.052 | 2.149 |
| 3 | T | | | X | | 4.25 | 3.64 | X | X | | | | 48.128 | 56.194 | -8.065 |
| 4 | T | | | X | | 3.94 | 3.41 | X | | | X | | 51.915 | 59.984 | -8.069 |
| 5 | C | X | | | X | 2.9 | 3.22 | | | | | | 70.533 | 63.523 | 7.009 |
| 6 | RV | | X | X | | 3.56 | 3.45 | | | | | | 57.457 | 59.289 | -1.832 |
| 7 | C | | | | X | 2.85 | 2.89 | X | | | | | 71.770 | 70.777 | 0.993 |
| 8 | RV | | | X | | 3.78 | 3.75 | X | | | | | 54.113 | 54.545 | -0.433 |
| 9 | C | | | X | | 3.31 | 3.34 | | | | | | 61.796 | 61.241 | 0.555 |
| 10 | C | X | | X | | 3.28 | 3.38 | | | | | | 62.361 | 60.516 | 1.845 |
| 11 | C | | X | | X | 3 | 3.26 | | | | | | 68.182 | 62.744 | 5.438 |
| 12 | C | | | X | | 3.47 | 3.38 | | | | | | 58.947 | 60.516 | -1.570 |
| 13 | C | X | | X | | 3.47 | 3.12 | X | | | | | 58.947 | 65.559 | -6.613 |
| 14 | C | | | | X | 3 | 2.96 | | | | | | 68.182 | 69.103 | -0.921 |
| 15 | T | | | X | | 4.04 | 3.68 | | | | | | 50.630 | 55.583 | -4.953 |
| 16 | T | | | X | | 3.79 | 3.37 | | | | | | 53.970 | 60.696 | -6.726 |
| 17 | T | | | X | | 2.91 | 3.13 | | | | | | 70.291 | 65.350 | 4.941 |
| 18 | C | | X | X | | 3.03 | 3.06 | | | | | | 67.507 | 66.845 | 0.662 |
| 19 | T | | | X | | 4.12 | 3.28 | | | | X | | 49.647 | 62.361 | -12.714 |
| 20 | C | X | | | X | 2.35 | 2.91 | | | | X | | 87.041 | 70.291 | 16.750 |
| 21 | T | | | X | | 3.28 | 3.37 | | | | | | 62.361 | 60.696 | 1.665 |
| 22 | C | | X | | X | 2.62 | 2.01 | | | | | | 78.071 | 101.764 | -23.693 |
| 23 | C | X | | | X | 3.06 | 3.08 | | | | | | 66.845 | 66.411 | 0.434 |
| 24 | C | | | | X | 3.1 | 2.98 | | | | | | 65.982 | 68.639 | -2.657 |
| 25 | T | | | X | | 3.47 | 3.01 | | | | X | | 58.947 | 67.955 | -9.008 |
| 26 | T | | | X | | 3.82 | 3.41 | | | | X | | 53.546 | 59.984 | -6.438 |
| 27 | C | | X | | X | 3.03 | 3.2 | | | | | | 67.507 | 63.920 | 3.586 |
| 28 | C | X | | X | | 3.59 | 2.91 | | | | | | 56.976 | 70.291 | -13.314 |
| 29 | C | | | | X | 2.81 | 3.02 | X | | | | | 72.792 | 67.730 | 5.062 |
| 30 | C | X | | | X | 2.78 | 2.7 | X | | | | | 73.578 | 75.758 | -2.180 |
| 31 | C | X | | X | | 3.16 | 3.15 | | | | | | 64.730 | 64.935 | -0.205 |
| 32 | RV | X | | | X | 3.09 | 3.04 | | | | | | 66.196 | 67.285 | -1.089 |
| 33 | T | | X | X | | 3.16 | 3.18 | | | | | | 64.730 | 64.322 | 0.407 |
| 34 | C | X | | | X | 2.72 | 3.01 | X | | | | | 75.201 | 67.955 | 7.245 |
| 35 | T | | | X | | 3.97 | 3.68 | | | | | | 51.523 | 55.583 | -4.060 |
| 36 | T | | | X | | 3.56 | 3.64 | | | | X | | 57.457 | 56.194 | 1.263 |
| 37 | C | X | | X | | 3.19 | 3.15 | | | | | | 64.121 | 64.935 | -0.814 |
| 38 | C | X | | X | | 3.28 | 3.35 | | | | | | 62.361 | 61.058 | 1.303 |
| 39 | C | | | | X | 2.81 | 3.06 | | | | | | 72.792 | 66.845 | 5.947 |
| 40 | C | X | | | X | 2.28 | 2.74 | X | | | | | 89.713 | 74.652 | 15.061 |
| 41 | C | | | X | | 2.97 | 3.12 | | | | | | 68.871 | 65.559 | 3.311 |
| 42 | T | | | X | | 4.06 | 3.36 | X | | | | | 50.381 | 60.877 | -10.496 |
| 43 | C | X | | | X | 3.03 | 3.14 | | | | | | 67.507 | 65.142 | 2.365 |
| 44 | C | | X | X | | 2.91 | 3.13 | X | | | | | 70.291 | 65.350 | 4.941 |
| 45 | C | X | | X | | 3.69 | 3.32 | | | | | | 55.432 | 61.610 | -6.178 |
| 46 | C | X | | | X | 3.06 | 3.05 | | | | | | 66.845 | 67.064 | -0.219 |
| 47 | T | | | X | | 3.69 | 3.39 | | | | X | | 55.432 | 60.338 | -4.906 |
| 48 | C | | X | | X | 2.69 | 3.89 | | | | | X | 76.039 | 52.582 | 23.457 |
| 49 | C | X | | | X | 3.03 | 2.86 | | | | | | 67.507 | 71.519 | -4.013 |
| 50 | C | | X | X | | 3.12 | 3.38 | | | | | | 65.559 | 60.516 | 5.043 |
| 51 | T | | | X | | 3.56 | 3.38 | | | | | | 57.457 | 60.516 | -3.060 |
| 52 | C | | | | X | 2.65 | 3.14 | | | X | | | 77.187 | 65.142 | 12.045 |
| 53 | C | X | | | X | 2.81 | 3.13 | | | | | | 72.792 | 65.350 | 7.442 |
| 54 | C | X | | X | | 3.28 | 3.27 | | | | | | 62.361 | 62.552 | -0.191 |
| 55 | T | | | X | | 3.81 | 3.64 | | | | | | 53.686 | 56.194 | -2.507 |
| 56 | C | | | | X | 3.03 | 3.18 | | | | | | 67.507 | 64.322 | 3.184 |
| 57 | C | | X | X | | 3.16 | 2.86 | | | | | | 64.730 | 71.519 | -6.790 |
| 58 | C | | X | X | | 3.87 | 3.92 | X | | | | | 52.854 | 52.180 | 0.674 |
| 59 | C | X | | | X | 2.53 | 2.5 | X | | | | | 80.848 | 81.818 | -0.970 |
| 60 | C | | | X | | 3.16 | 3.08 | X | | | | | 64.730 | 66.411 | -1.681 |
| 61 | C | | X | X | | 2.78 | 2.99 | | | | | X | 73.578 | 68.410 | 5.168 |
| 62 | C | X | | X | | 3.04 | 3 | | | | | | 67.285 | 68.182 | -0.897 |
| 63 | C | X | | X | | 3.25 | 3.27 | | | | | | 62.937 | 62.552 | 0.385 |
| 64 | C | | X | | X | 2.66 | 2.66 | X | | | | | 76.897 | 76.897 | 0.000 |
| 65 | C | | | X | | 3.16 | 3.35 | | | | | | 64.730 | 61.058 | 3.671 |
| 66 | C | | X | X | | 3.15 | 3.35 | X | | | | | 64.935 | 61.058 | 3.877 |

Table 27. La Moine: Data Collected During Trip 3

| | | |
|---|---|---|
| Location: | LA MOINE | |
| Date: | 8/19/99 | (Trip 3) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | Reduction mph |
| 1 | T | | | X | | 3.44 | 3.44 | | | | | | 59.461 | 59.461 | 0.000 |
| 2 | RV | | | X | | 3.22 | 3.29 | X | | | | | 63.523 | 62.172 | 1.352 |
| 3 | C | | X | | X | 3.03 | 2.92 | | | | | | 67.507 | 70.050 | -2.543 |
| 4 | C | | | | X | 2.91 | 2.84 | | | | | | 70.291 | 72.023 | -1.733 |
| 5 | C | | X | | X | 2.97 | 2.98 | | | | | | 68.871 | 68.639 | 0.231 |
| 6 | C | X | | | X | 2.85 | 3.15 | | | | X | | 71.770 | 64.935 | 6.835 |
| 7 | T | | | X | | 3.43 | 3.38 | | | | | | 59.634 | 60.516 | -0.882 |
| 8 | C | X | | | X | 3.59 | 3.27 | | | | | | 56.976 | 62.552 | -5.576 |
| 9 | C | X | | X | | 3.07 | 3.22 | | | | | | 66.627 | 63.523 | 3.104 |
| 10 | T | | | X | | 3.69 | 3.57 | X | | | | | 55.432 | 57.296 | -1.863 |
| 11 | T | | | X | | 3.5 | 3.4 | | | | | | 58.442 | 60.160 | -1.719 |
| 12 | C | X | | X | | 3.12 | 3.11 | | | | | | 65.559 | 65.770 | -0.211 |
| 13 | C | | X | X | | 3.59 | 3.37 | | | | | | 56.976 | 60.696 | -3.720 |
| 14 | T | | | X | | 2.93 | 3.32 | X | | | | | 69.811 | 61.610 | 8.201 |
| 15 | C | | X | X | | 3.1 | 3.02 | | | | | X | 65.982 | 67.730 | -1.748 |
| 16 | C | | X | X | | 3.12 | 3.12 | | | | | | 65.559 | 65.559 | 0.000 |
| 17 | C | X | | | X | 3.25 | 3.2 | | | | | | 62.937 | 63.920 | -0.983 |
| 18 | C | | | X | | 3.13 | 3.17 | | | | | | 65.350 | 64.525 | 0.825 |
| 19 | C | | | X | | 2.81 | 3.76 | | | | | | 72.792 | 54.400 | 18.392 |
| 20 | C | | X | X | | 2.88 | 2.88 | | | | | | 71.023 | 71.023 | 0.000 |
| 21 | C | X | | | X | 2.65 | 2.65 | | | | | | 77.187 | 77.187 | 0.000 |
| 22 | T | | | X | | 3.47 | 3.52 | | | | | | 58.947 | 58.110 | 0.837 |
| 23 | T | | | X | | 4 | 3.8 | X | | | | | 51.136 | 53.828 | -2.691 |
| 24 | T | | | X | | 3.47 | 3.31 | | | | | | 58.947 | 61.796 | -2.849 |
| 25 | C | X | | X | | 3.29 | 3.29 | | | | | | 62.172 | 62.172 | 0.000 |
| 26 | T | | | | X | 3.06 | 3.07 | | | | | | 66.845 | 66.627 | 0.218 |
| 27 | T | | | X | | 3.53 | 3.41 | | | | | | 57.945 | 59.984 | -2.039 |
| 28 | C | X | | X | | 2.94 | 2.77 | X | | | | X | 69.573 | 73.843 | -4.270 |
| 29 | T | | | X | | 3.53 | 3.48 | | | | | | 57.945 | 58.777 | -0.833 |
| 30 | C | | | X | | 3.06 | 3.04 | | | | | | 66.845 | 67.285 | -0.440 |
| 31 | T | | | X | | 3.6 | 3.48 | X | | | | | 56.818 | 58.777 | -1.959 |
| 32 | C | X | | X | | 2.97 | 3.06 | | | | | | 68.871 | 66.845 | 2.026 |
| 33 | T | | | X | | 3.68 | 3.56 | X | | | | | 55.583 | 57.457 | -1.874 |
| 34 | C | | X | X | | 3.03 | 3.05 | | | | | | 67.507 | 67.064 | 0.443 |
| 35 | C | X | | X | | 3.16 | 3.01 | | | | | | 64.730 | 67.955 | -3.226 |
| 36 | C | X | | | X | 2.87 | 3.16 | | | | | | 71.270 | 64.730 | 6.541 |
| 37 | C | | X | X | | 3.18 | 3.15 | | | | | | 64.322 | 64.935 | -0.613 |
| 38 | C | | | | X | 2.85 | 2.73 | | | | | | 71.770 | 74.925 | -3.155 |
| 39 | T | | | X | | 3.34 | 3.45 | | | | | | 61.241 | 59.289 | 1.953 |
| 40 | C | | X | X | | 2.82 | 2.84 | | | | | | 72.534 | 72.023 | 0.511 |
| 41 | T | | | X | | 3.63 | 3.63 | | | | | | 56.349 | 56.349 | 0.000 |
| 42 | C | | X | X | | 3.19 | 3.4 | | | | | | 64.121 | 60.160 | 3.960 |
| 43 | C | | | X | | 3.03 | 3.2 | | | | | | 67.507 | 63.920 | 3.586 |
| 44 | C | | X | X | | 3.03 | 2.93 | | | | | | 67.507 | 69.811 | -2.304 |
| 45 | T | | | X | | 3.72 | 3.51 | X | | | | | 54.985 | 58.275 | -3.290 |
| 46 | C | | X | | X | 2.81 | 2.84 | | | | | | 72.792 | 72.023 | 0.769 |
| 47 | T | | | X | | 3.59 | 3.95 | X | | | | | 56.976 | 51.784 | 5.193 |
| 48 | C | | X | | X | 3.12 | 3.02 | | | | | | 65.559 | 67.730 | -2.171 |
| 49 | C | X | | X | | 3.6 | 3.58 | | | | | | 56.818 | 57.136 | -0.317 |
| 50 | C | X | | | X | 3.15 | 3.19 | | | | | | 64.935 | 64.121 | 0.814 |
| 51 | C | | X | | X | 2.91 | 3.12 | | | | | | 70.291 | 65.559 | 4.731 |
| 52 | T | | | X | | 3.44 | 3.41 | | | | | | 59.461 | 59.984 | -0.523 |
| 53 | RV | | | X | | 3.43 | 3.47 | | | | | | 59.634 | 58.947 | 0.687 |
| 54 | T | | | X | | 3.63 | 3.72 | | | | | | 56.349 | 54.985 | 1.363 |
| 55 | T | | | X | | 3.62 | 3.62 | X | | | | | 56.504 | 56.504 | 0.000 |
| 56 | C | | X | X | | 3 | 2.9 | X | | | | | 68.182 | 70.533 | -2.351 |
| 57 | C | | | X | | 3.34 | 3.23 | | | | | | 61.241 | 63.327 | -2.086 |
| 58 | C | | | X | | 3.31 | 3.02 | | | | | X | 61.796 | 67.730 | -5.934 |
| 59 | C | X | | X | | 3.68 | 3.72 | | | | | | 55.583 | 54.985 | 0.598 |
| 60 | C | | X | X | | 3.16 | 3.39 | | | | | | 64.730 | 60.338 | 4.392 |
| 61 | T | | | X | | 3.31 | 3.37 | | | | | | 61.796 | 60.696 | 1.100 |
| 62 | RV | | | X | | 3.53 | 3.38 | | | | | | 57.945 | 60.516 | -2.572 |
| 63 | T | | | X | | 3.22 | 3.61 | | | | | | 63.523 | 56.661 | 6.863 |
| 64 | C | | X | X | | 3 | 3.03 | | | | | | 68.182 | 67.507 | 0.675 |
| 65 | C | | X | X | | 3.28 | 3.34 | | | | | | 62.361 | 61.241 | 1.120 |
| 66 | T | | | X | | 3.31 | 3.21 | | | | | | 61.796 | 63.721 | -1.925 |

# Table 28. Sims Road: Data Collected During Trip 3

| | | |
|---|---|---|
| Location: | SIMS ROAD | |
| Date: | 8/17/99 | (Trip 3) |
| Speed Trap 1 Distance (FT): | | 300 |
| Speed Trap 2 Distance (FT): | | 300 |

| | | State | | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights In Curve | Encroachment | | | | Speed | | Speed Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Vehicle Type | In | Out | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Inside Edge | Center Laneline | Outside Edge | Lane Change | Trap 1 mph | Trap 2 mph | mph |
| 1 | T | | | X | | 3.5 | 3.45 | | X | | | | 58.442 | 59.289 | -0.847 |
| 2 | C | | X | X | | 3.1 | 3.28 | | | | | | 65.982 | 62.361 | 3.621 |
| 3 | T | | | X | | 3.56 | 3.65 | | | | | | 57.457 | 56.040 | 1.417 |
| 4 | T | | | X | | 3.5 | 3.29 | | | | | | 58.442 | 62.172 | -3.730 |
| 5 | C | X | | X | | 3.87 | 3.91 | | X | | | | 52.854 | 52.313 | 0.541 |
| 6 | C | X | | | X | 3.25 | 3.29 | | | | | | 62.937 | 62.172 | 0.765 |
| 7 | RV | | | X | | 3.71 | 3.75 | | X | | | | 55.134 | 54.545 | 0.588 |
| 8 | C | | | X | | 3.21 | 3.13 | | | | | | 63.721 | 65.350 | -1.629 |
| 9 | C | | X | X | | 3.25 | 2.95 | | X | | | | 62.937 | 69.337 | -6.400 |
| 10 | C | | X | | X | 3.53 | 3.55 | | | | | | 57.945 | 57.618 | 0.326 |
| 11 | C | | | X | | 3 | 2.97 | | | | | | 68.182 | 68.871 | -0.689 |
| 12 | C | X | | X | | 3.53 | 3.76 | | | | | | 57.945 | 54.400 | 3.545 |
| 13 | RV | | X | X | | 3.9 | 3.88 | | X | | | | 52.448 | 52.718 | -0.270 |
| 14 | T | | | X | | 3.72 | 3.74 | | | | | | 54.985 | 54.691 | 0.294 |
| 15 | C | X | | X | | 3.28 | 3.31 | | X | | | | 62.361 | 61.796 | 0.565 |
| 16 | T | | | X | | 3.34 | 3.3 | | X | | | | 61.241 | 61.983 | -0.742 |
| 17 | C | | X | X | | 3.37 | 3.74 | | | | | | 60.696 | 54.691 | 6.005 |
| 18 | T | | | X | | 4.1 | 4 | | X | | | | 49.889 | 51.136 | -1.247 |
| 19 | T | | | X | | 4.15 | 4.11 | | | | | | 49.288 | 49.768 | -0.480 |
| 20 | C | X | | X | | 3.31 | 3.34 | | | | | | 61.796 | 61.241 | 0.555 |
| 21 | T | | | X | | 2.97 | 3.24 | | | | | | 68.871 | 63.131 | 5.739 |
| 22 | T | | | X | | 4 | 4 | | X | | | | 51.136 | 51.136 | 0.000 |
| 23 | C | | X | | X | 2.81 | 2.89 | X | | | | | 72.792 | 70.777 | 2.015 |
| 24 | C | X | | X | | 3.19 | 3.39 | | | | | | 64.121 | 60.338 | 3.783 |
| 25 | T | | | | X | 3.38 | 3.58 | | | | | | 60.516 | 57.136 | 3.381 |
| 26 | T | | | X | | 3.59 | 3.74 | X | X | | | | 56.976 | 54.691 | 2.285 |
| 27 | C | X | | X | | 4.03 | 3.77 | | | | | | 50.756 | 54.256 | -3.500 |
| 28 | C | | X | | X | 3.43 | 3.25 | | | | | | 59.634 | 62.937 | -3.303 |
| 29 | C | | X | X | | 3.84 | 3.88 | | | | | | 53.267 | 52.718 | 0.549 |
| 30 | C | | X | | X | 3.22 | 3.31 | | | | | | 63.523 | 61.796 | 1.727 |
| 31 | C | X | | X | | 3.06 | 3.27 | | X | | | | 66.845 | 62.552 | 4.293 |
| 32 | T | | | X | | 3.62 | 3.81 | X | X | | | | 56.504 | 53.686 | 2.818 |
| 33 | T | | | X | | 4 | 4.05 | | | | | | 51.136 | 50.505 | 0.631 |
| 34 | T | | | X | | 3.53 | 3.38 | | | | | | 57.945 | 60.516 | -2.572 |
| 35 | C | | X | | X | 2.88 | 2.93 | | | | | | 71.023 | 69.811 | 1.212 |
| 36 | C | | | | X | 3.09 | 2.94 | | | | | | 66.196 | 69.573 | -3.377 |
| 37 | C | | | | X | 2.59 | 2.83 | | | | | | 78.975 | 72.278 | 6.698 |
| 38 | T | | | X | | 4.22 | 4.61 | | | | | | 48.470 | 44.370 | 4.101 |
| 39 | C | X | | | X | 3.16 | 3.43 | | X | | | | 64.730 | 59.634 | 5.095 |
| 40 | C | X | | | X | 3 | 2.88 | | | | | | 68.182 | 71.023 | -2.841 |
| 41 | C | | X | X | | 3.28 | 3.18 | | | | | | 62.361 | 64.322 | -1.961 |
| 42 | C | X | | X | | 3.13 | 3.09 | | X | | | | 65.350 | 66.196 | -0.846 |
| 43 | C | X | | X | | 3.43 | 3.26 | | | | | | 59.634 | 62.744 | -3.110 |
| 44 | C | X | | X | | 3.09 | 3.17 | | | | | | 66.196 | 64.525 | 1.671 |
| 45 | C | X | | | X | 3.03 | 3.4 | | | | | | 67.507 | 60.160 | 7.346 |
| 46 | C | | X | | X | 3.56 | 3.55 | | | | | | 57.457 | 57.618 | -0.162 |
| 47 | C | | X | X | | 3.44 | 3.47 | | | | | | 59.461 | 58.947 | 0.514 |
| 48 | RV | | X | X | | 3.75 | 3.87 | | X | | | | 54.545 | 52.854 | 1.691 |
| 49 | T | | | X | | 3.4 | 3.34 | | X | | | | 60.160 | 61.241 | -1.081 |
| 50 | C | | | | X | 3.13 | 3.26 | | | | | | 65.350 | 62.744 | 2.606 |
| 51 | T | | | X | | 3.5 | 3.53 | | | | | | 58.442 | 57.945 | 0.497 |
| 52 | C | X | | | X | 3.06 | 2.96 | | | | | X | 66.845 | 69.103 | -2.258 |
| 53 | T | | | X | | 3.47 | 3.37 | | | | | | 58.947 | 60.696 | -1.749 |
| 54 | T | | | X | | 3.53 | 3.66 | | X | | | | 57.945 | 55.887 | 2.058 |
| 55 | C | X | | | X | 3.44 | 3.58 | | | | | | 59.461 | 57.136 | 2.325 |
| 56 | C | X | | | X | 3.09 | 3.18 | | | | | | 66.196 | 64.322 | 1.873 |
| 57 | C | X | | | X | 2.69 | 2.94 | | | | | | 76.039 | 69.573 | 6.466 |
| 58 | C | X | | X | | 3 | 3 | | X | | | | 68.182 | 68.182 | 0.000 |
| 59 | T | | | X | | 3.62 | 3.78 | | X | | | | 56.504 | 54.113 | 2.392 |
| 60 | T | | | X | | 3.62 | 3.85 | X | X | | | | 56.504 | 53.129 | 3.376 |
| 61 | T | | | X | | 3.6 | 4.24 | | X | | | | 56.818 | 48.242 | 8.576 |
| 62 | C | | X | X | | 2.88 | 3.02 | X | | | | | 71.023 | 67.730 | 3.292 |
| 63 | T | | | X | | 3.56 | 3.73 | X | | | | | 57.457 | 54.838 | 2.619 |
| 64 | T | X | | X | | 3.91 | 3.97 | | | | | | 52.313 | 51.523 | 0.791 |
| 65 | C | X | | | X | 3 | 2.9 | | | | | X | 68.182 | 70.533 | -2.351 |
| 66 | C | X | | | X | 3.19 | 3.33 | | | | | X | 64.121 | 61.425 | 2.696 |

Table 29. Sidehill Viaduct: Data Collected During Trip 4

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location:** | SIDEHILL VIADUCT | | | | | | | | | | | | |
| **Date:** | 1/4/00 | (Trip 4) | | | | | | | | | | | |
| **Speed Trap 1 Distance (FT):** | | | 300 | | | | | | | | | | |
| **Speed Trap 2 Distance (FT):** | | | 300 | | | | | | | | | | |
| | | | | | | **Brake Lights** | | **Encroachment** | | | **Speed** | | **Speed** |
| | **veh type** | **Vehicle Lane** | | **Trap 1** | **Trap 2** | **In Curve** | **Inside** | **Center** | **Outside** | **Lane** | **Trap 1** | **Trap 2** | **Reduction** |
| Veh ID | Track Trail | Drive Ln (x) | Pass Ln (x) | Time | Time | **(x) for yes** | **Edge** | **Laneline** | **Edge** | **Change** | **mph** | **mph** | **mph** |
| **1** | T | X | | 3.75 | 3.49 | X | | | | | 54.545 | 58.609 | -4.064 |
| **2** | C | | X | 2.91 | 3.12 | | | | | | 70.291 | 65.559 | 4.731 |
| **3** | C + Trailer | X | | 3.31 | 3.22 | X | | | | | 61.796 | 63.523 | -1.727 |
| **4** | C | | X | 3.13 | 3.7 | X | | | | | 65.350 | 55.283 | 10.067 |
| **5** | T | X | | 4.37 | 4.41 | X | | | | | 46.807 | 46.382 | 0.425 |
| **6** | C | | X | 2.87 | 3.4 | | | | | | 71.270 | 60.160 | 11.110 |
| **7** | C | X | | 3.66 | 3.58 | X | | | | | 55.887 | 57.136 | -1.249 |
| **8** | C | | X | 3.22 | 3.29 | X | | | | | 63.523 | 62.172 | 1.352 |
| **9** | T | X | | 4.22 | 4 | X | | | | | 48.470 | 51.136 | -2.666 |
| **10** | T | X | | 3.96 | 3.74 | X | | | | | 51.653 | 54.691 | -3.038 |
| **11** | C | X | | 3.41 | 3.37 | | | | | | 59.984 | 60.696 | -0.712 |
| **12** | C | X | | 3.5 | 3.3 | X | | | | | 58.442 | 61.983 | -3.542 |
| **13** | T | X | | 3.75 | 3.61 | X | | | | | 54.545 | 56.661 | -2.115 |
| **14** | C | | X | 3.22 | 3.36 | X | | | | | 63.523 | 60.877 | 2.647 |
| **15** | RV | X | | 4.34 | 4.1 | | | | | | 47.130 | 49.889 | -2.759 |
| **16** | C | X | | 3.15 | 3.22 | | | | | | 64.935 | 63.523 | 1.412 |
| **17** | C | | X | 2.65 | 3.36 | X | | | | | 77.187 | 60.877 | 16.310 |
| **18** | C | X | | 3.38 | 2.98 | | | | | | 60.516 | 68.639 | -8.123 |
| **19** | T | X | | 4.22 | 3.89 | X | | | | | 48.470 | 52.582 | -4.112 |
| **20** | C | X | | 3.38 | 3.12 | X | | | | X | 60.516 | 65.559 | -5.043 |
| **21** | C | X | | 3.22 | 3.41 | X | | | | | 63.523 | 59.984 | 3.539 |
| **22** | C | X | | 3.44 | 3.29 | | | X | | | 59.461 | 62.172 | -2.711 |
| **23** | T | X | | 3.63 | 3.4 | X | | | | | 56.349 | 60.160 | -3.812 |
| **24** | C | | X | 3.78 | 4.26 | X | | | | | 54.113 | 48.015 | 6.097 |
| **25** | C | X | | 4.18 | 3.73 | | | | | | 48.934 | 54.838 | -5.904 |
| **26** | T | X | | 4.13 | 3.93 | X | | | | | 49.527 | 52.047 | -2.520 |
| **27** | T | X | | 4.28 | 3.96 | | | | | | 47.791 | 51.653 | -3.862 |
| **28** | C | | X | 3.09 | 3.29 | X | | | | | 66.196 | 62.172 | 4.024 |
| **29** | C | | X | 3.34 | 3.37 | | | | | | 61.241 | 60.696 | 0.545 |
| **30** | C | X | | 4.6 | 4.12 | X | | | | | 44.466 | 49.647 | -5.181 |
| **31** | T | X | | 3.82 | 3.33 | | | | | | 53.546 | 61.425 | -7.879 |
| **32** | Uhaul | X | | 4.75 | 4.52 | X | | | | | 43.062 | 45.253 | -2.191 |
| **33** | C | X | | 3.34 | 3.01 | X | | X | | | 61.241 | 67.955 | -6.714 |
| **34** | C | X | | 3.28 | 3.61 | X | | | | | 62.361 | 56.661 | 5.701 |
| **35** | C | X | | 3.53 | 3.32 | | | | | | 57.945 | 61.610 | -3.665 |
| **36** | T | X | | 4.69 | 4.32 | X | | | | | 43.613 | 47.348 | -3.735 |
| **37** | T | X | | 4.44 | 3.98 | | | | | | 46.069 | 51.393 | -5.325 |
| **38** | C | X | | 3.5 | 3.2 | | | | | X | 58.442 | 63.920 | -5.479 |
| **39** | C | X | | 3.44 | 3.3 | | | | | | 59.461 | 61.983 | -2.523 |
| **40** | RV | X | | 3.84 | 3.66 | X | | | | | 53.267 | 55.887 | -2.620 |
| **41** | C | X | | 3.75 | 3.69 | | | | | | 54.545 | 55.432 | -0.887 |
| **42** | RV | X | | 4 | 3.71 | | | | | | 51.136 | 55.134 | -3.997 |
| **43** | C | X | | 3.57 | 3.34 | | | | | | 57.296 | 61.241 | -3.946 |
| **44** | C | | X | 2.91 | 3.28 | | | | | | 70.291 | 62.361 | 7.929 |
| **45** | C | X | | 4.31 | 3.85 | X | | | | | 47.458 | 53.129 | -5.670 |
| **46** | C | | X | 3.19 | 3.79 | X | | | | | 64.121 | 53.970 | 10.151 |
| **47** | C | | X | 2.85 | 3.21 | X | | | | | 71.770 | 63.721 | 8.049 |
| **48** | T | X | | 4.63 | 4.32 | X | | | | | 44.178 | 47.348 | -3.170 |
| **49** | T | X | | 4.13 | 3.98 | | | | | | 49.527 | 51.393 | -1.867 |
| **50** | C | X | | 3.28 | 3.17 | | | | | | 62.361 | 64.525 | -2.164 |
| **51** | C | X | | 3.28 | 3.02 | | | | | X | 62.361 | 67.730 | -5.369 |
| **52** | C | X | | 3.41 | 3.24 | X | | | | | 59.984 | 63.131 | -3.147 |
| **53** | C | X | | 3.75 | 3.49 | X | | | | | 54.545 | 58.609 | -4.064 |
| **54** | T | | X | 3.1 | 3.65 | X | | | | | 65.982 | 56.040 | 9.943 |
| **55** | C | X | | 3.38 | 3.09 | | | | | X | 60.516 | 66.196 | -5.680 |
| **56** | C | | X | 2.72 | 3.03 | X | | | | | 75.201 | 67.507 | 7.694 |
| **57** | T | X | | 4.43 | 4.01 | X | | | | | 46.173 | 51.009 | -4.836 |
| **58** | C | | X | 3.22 | 3.96 | X | | | | | 63.523 | 51.653 | 11.871 |
| **59** | T | X | | 3.82 | 3.62 | | | | | | 53.546 | 56.504 | -2.958 |
| **60** | C | X | | 3.44 | 3.2 | | | | | | 59.461 | 63.920 | -4.460 |
| **61** | C | | X | 3.18 | 3.5 | | | | | | 64.322 | 58.442 | 5.881 |
| **62** | T | X | | 4.22 | 3.91 | | | | | | 48.470 | 52.313 | -3.843 |
| **63** | T | X | | 3.9 | 3.7 | | | | | | 52.448 | 55.283 | -2.835 |
| **64** | T | X | | 3.81 | 3.38 | X | | | | | 53.686 | 60.516 | -6.830 |
| **65** | C | X | | 3.91 | 3.48 | X | | | | | 52.313 | 58.777 | -6.464 |
| **66** | C | X | | 3.66 | 3.16 | | | | | | 55.887 | 64.730 | -8.843 |

Table 30. O'Brien: Data Collected During Trip 4

| | | | |
|---|---|---|---|
| Location: | O'BRIEN | | |
| Date: | 1/4/00 | (Trip 4) | |
| Speed Trap 1 Distance (FT): | | | 300 |
| Speed Trap 2 Distance (FT): | | | 300 |

| | veh type | Vehicle Lane | | Trap 1 | Trap 2 | Brake Lights in Curve | Inside | Encroachment Center | Outside | Lane | Speed Trap 1 | Trap 2 | Speed Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Track Trail | Drive Ln (x) | Pass Ln (x) | Time | Time | (x) for yes | Edge | Laneline | Edge | Change | mph | mph | mph |
| 1 | T | X | | 4.12 | 4.09 | | | | | | 49.647 | 50.011 | -0.364 |
| 2 | T | X | | 3.76 | 3.86 | | X | | | | 54.400 | 52.991 | 1.409 |
| 3 | C | | X | 2.5 | 3.31 | X | | | | | 81.818 | 61.796 | 20.022 |
| 4 | C | X | | 3.47 | 3.36 | | X | | | | 58.947 | 60.877 | -1.930 |
| 5 | C | X | | 3.37 | 3.29 | | | | | | 60.696 | 62.172 | -1.476 |
| 6 | T | X | | 3.91 | 4.33 | | | | | | 52.313 | 47.239 | 5.074 |
| 7 | C | X | | 4.06 | 4.36 | | | | | | 50.381 | 46.914 | 3.467 |
| 8 | T | X | | 3.6 | 3.59 | | | | | | 56.818 | 56.976 | -0.158 |
| 9 | T | X | | 3.84 | 4.22 | | | | | | 53.267 | 48.470 | 4.797 |
| 10 | C | X | | 3.41 | 3.44 | | | | | | 59.984 | 59.461 | 0.523 |
| 11 | T | X | | 3.75 | 3.95 | | X | | | | 54.545 | 51.784 | 2.762 |
| 12 | C | | X | 3.32 | 3.62 | | | | | | 61.610 | 56.504 | 5.106 |
| 13 | C | X | | 3.28 | 3.27 | | | | | | 62.361 | 62.552 | -0.191 |
| 14 | C | | X | 3.25 | 3.09 | | | | | | 62.937 | 66.196 | -3.259 |
| 15 | C | | X | 3.12 | 3.2 | | | | | | 65.559 | 63.920 | 1.639 |
| 16 | T | | X | 3.38 | 3.74 | | | | | | 60.516 | 54.691 | 5.825 |
| 17 | C | X | | 3.97 | 3.94 | | | | | | 51.523 | 51.915 | -0.392 |
| 18 | T | X | | 4 | 3.81 | | | | | | 51.136 | 53.686 | -2.550 |
| 19 | T | X | | 3.84 | 3.93 | | | | | | 53.267 | 52.047 | 1.220 |
| 20 | T | X | | 3.84 | 3.95 | | | | | | 53.267 | 51.784 | 1.483 |
| 21 | T | | X | 3.38 | 3.8 | | | | | X | 60.516 | 53.828 | 6.689 |
| 22 | T | X | | 3.59 | 3.63 | | | | | | 56.976 | 56.349 | 0.628 |
| 23 | C | X | | 3.94 | 3.69 | | | | | | 51.915 | 55.432 | -3.517 |
| 24 | C | X | | 3.47 | 3.49 | | | | | | 58.947 | 58.609 | 0.338 |
| 25 | RV | X | | 4.66 | 4.38 | | | | | | 43.894 | 46.700 | -2.806 |
| 26 | C | | X | 2.91 | 3.39 | | | | | | 70.291 | 60.338 | 9.953 |
| 27 | C + Trailer | X | | 3.62 | 3.59 | | | | | | 56.504 | 56.976 | -0.472 |
| 28 | C | X | | 3.35 | 3.55 | | | | | | 61.058 | 57.618 | 3.440 |
| 29 | T | X | | 3.69 | 3.92 | | X | | | | 55.432 | 52.180 | 3.252 |
| 30 | C | | X | 3.09 | 3.15 | | | | | | 66.196 | 64.935 | 1.261 |
| 31 | C | | X | 3.06 | 3.31 | X | | | | | 66.845 | 61.796 | 5.049 |
| 32 | C | X | | 3.65 | 3.97 | | | | | | 56.040 | 51.523 | 4.517 |
| 33 | C | X | | 3.87 | 3.66 | | | | | | 52.854 | 55.887 | -3.033 |
| 34 | C | | X | 3.38 | 3.34 | | | | | | 60.516 | 61.241 | -0.725 |
| 35 | C | | X | 3.21 | 3.65 | | | | | | 63.721 | 56.040 | 7.681 |
| 36 | C | X | | 3.37 | 3.19 | | | | | | 60.696 | 64.121 | -3.425 |
| 37 | C | | X | 2.94 | 3.12 | | | | | | 69.573 | 65.559 | 4.014 |
| 38 | T | X | | 3.75 | 3.99 | | X | | | | 54.545 | 51.265 | 3.281 |
| 39 | C | X | | 3.93 | 4.04 | | | | | | 52.047 | 50.630 | 1.417 |
| 40 | C | | X | 3.4 | 3.41 | | | | | | 60.160 | 59.984 | 0.176 |
| 41 | T | X | | 3.75 | 3.81 | | X | | | | 54.545 | 53.686 | 0.859 |
| 42 | T | X | | 3.63 | 3.81 | | | | | | 56.349 | 53.686 | 2.662 |
| 43 | T | X | | 3.53 | 3.68 | | | | | | 57.945 | 55.583 | 2.362 |
| 44 | C | X | | 3.81 | 3.56 | | | | | | 53.686 | 57.457 | -3.770 |
| 45 | C | | X | 3.16 | 3.36 | | | | | | 64.730 | 60.877 | 3.853 |
| 46 | T | X | | 3.79 | 4.25 | | | | | | 53.970 | 48.128 | 5.841 |
| 47 | C | X | | 3.41 | 3.37 | | | | | | 59.984 | 60.696 | -0.712 |
| 48 | C | X | | 3.47 | 3.55 | | | | | | 58.947 | 57.618 | 1.328 |
| 49 | C + Trailer | X | | 4.12 | 4.43 | | X | | | | 49.647 | 46.173 | 3.474 |
| 50 | C | X | | 3.59 | 3.45 | | | | | | 56.976 | 59.289 | -2.312 |
| 51 | C | X | | 3.5 | 3.54 | | | | | | 58.442 | 57.781 | 0.660 |
| 52 | C | X | | 3.43 | 3.2 | | | | | | 59.634 | 63.920 | -4.286 |
| 53 | C | X | | 4.59 | 4.34 | | | | | | 44.563 | 47.130 | -2.567 |
| 54 | C + Trailer | X | | 3.84 | 4.09 | | X | | | | 53.267 | 50.011 | 3.256 |
| 55 | C | X | | 3.41 | 3.42 | | | | | | 59.984 | 59.809 | 0.175 |
| 56 | C | X | | 3.59 | 3.62 | | | | | | 56.976 | 56.504 | 0.472 |
| 57 | T | X | | 4.18 | 4.16 | | X | | | | 48.934 | 49.170 | -0.235 |
| 58 | C | X | | 3.5 | 3.51 | | | | | | 58.442 | 58.275 | 0.167 |
| 59 | C | X | | 3.72 | 3.54 | | | | | | 54.985 | 57.781 | -2.796 |
| 60 | C | X | | 3.16 | 3.13 | | | | | | 64.730 | 65.350 | -0.620 |
| 61 | C | | X | 3.53 | 3.28 | X | | | | | 57.945 | 62.361 | -4.417 |
| 62 | C | | X | 2.78 | 3.07 | | | | | | 73.578 | 66.627 | 6.950 |
| 63 | C | X | | 3.31 | 3.24 | | | | | | 61.796 | 63.131 | -1.335 |
| 64 | T | X | | 4.04 | 4.05 | | X | | | | 50.630 | 50.505 | 0.125 |
| 65 | C + Trailer | X | | 4.06 | 3.07 | | | | | | 50.381 | 66.627 | -16.247 |
| 66 | T | X | | 4.19 | 4.62 | | | | | | 48.818 | 44.274 | 4.544 |

Table 31. Salt Creek: Data Collected During Trip 4

| | | |
|---|---|---|
| **Location:** | SALT CREEK | |
| **Date:** | 1/3/00 | (Trip 4) |
| **Speed Trap 1 Distance (FT):** | | 300 |
| **Speed Trap 2 Distance (FT):** | | 300 |

| | **veh type** | **Vehicle Lane** | | **Trap 1** | **Trap 2** | **Brake Lights** | **Encroachment** | | | | **Speed** | | **Speed** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veh ID | Track Trail | Drive Ln (x) | Pass Ln (x) | Time | Time | **In Curve (x) for yes** | **Inside Edge** | **Center Laneline** | **Outside Edge** | **Lane Change** | **Trap 1 mph** | **Trap 2 mph** | **Reduction mph** |
| **1** | T | X | | 2.94 | 3.04 | | | | | | 69.573 | 67.285 | 2.289 |
| **2** | C + Trailer | X | | 2.84 | 3.22 | | | | | | 72.023 | 63.523 | 8.500 |
| **3** | C | | X | 2.72 | 2.74 | | | X | | | 75.201 | 74.652 | 0.549 |
| **4** | T | X | | 3.53 | 3.59 | | | | | | 57.945 | 56.976 | 0.968 |
| **5** | T | X | | 3.97 | 3.79 | | | | | | 51.523 | 53.970 | -2.447 |
| **6** | C | X | | 3.13 | 3.39 | | | | | | 65.350 | 60.338 | 5.012 |
| **7** | C | X | | 2.78 | 3 | | | | | | 73.578 | 68.182 | 5.396 |
| **8** | C | X | | 3.29 | 3.34 | | | | | | 62.172 | 61.241 | 0.931 |
| **9** | T | X | | 3.41 | 3.49 | | | | | | 59.984 | 58.609 | 1.375 |
| **10** | C | X | | 3.28 | 3.73 | | | | | | 62.361 | 54.838 | 7.523 |
| **11** | C + Trailer | X | | 3.38 | 3.29 | | | | | | 60.516 | 62.172 | -1.655 |
| **12** | C | X | | 3.09 | 2.86 | | | | | | 66.196 | 71.519 | -5.323 |
| **13** | C | | X | 2.6 | 3.3 | | | | | | 78.671 | 61.983 | 16.688 |
| **14** | C | X | | 3 | 2.76 | X | | | | | 68.182 | 74.111 | -5.929 |
| **15** | C | X | | 2.72 | 3.75 | | | | | | 75.201 | 54.545 | 20.655 |
| **16** | RV | X | | 3.35 | 3.05 | | | | | | 61.058 | 67.064 | -6.006 |
| **17** | C | | X | 3.18 | 2.97 | | | | | | 64.322 | 68.871 | -4.548 |
| **18** | C | X | | 3.25 | 3.2 | | | X | | | 62.937 | 63.920 | -0.983 |
| **19** | T | X | | 3.28 | 3.48 | | | | | | 62.361 | 58.777 | 3.584 |
| **20** | C | X | | 3.13 | 3.2 | X | | | | | 65.350 | 63.920 | 1.430 |
| **21** | RV | X | | 3.65 | 3.56 | | | | | | 56.040 | 57.457 | -1.417 |
| **22** | T | X | | 3.59 | 4.11 | X | | | | | 56.976 | 49.768 | 7.209 |
| **23** | C | | X | 2.97 | 2.95 | X | | | | | 68.871 | 69.337 | -0.467 |
| **24** | T | X | | 3.38 | 3.45 | | | | | | 60.516 | 59.289 | 1.228 |
| **25** | C | X | | 3.22 | 3.09 | | | | | | 63.523 | 66.196 | -2.673 |
| **26** | C | X | | 3.21 | 3.38 | | | | | | 63.721 | 60.516 | 3.205 |
| **27** | C + Trailer | X | | 3.84 | 3.71 | X | | | | | 53.267 | 55.134 | -1.867 |
| **28** | C | | X | 2.78 | 2.93 | | | | | | 73.578 | 69.811 | 3.767 |
| **29** | T | X | | 3.53 | 3.68 | X | | | | | 57.945 | 55.583 | 2.362 |
| **30** | RV | X | | 3.84 | 3.98 | | | | | | 53.267 | 51.393 | 1.874 |
| **31** | C | X | | 3.03 | 3.05 | | | | | | 67.507 | 67.064 | 0.443 |
| **32** | C | | X | 2.62 | 2.6 | | | | | | 78.071 | 78.671 | -0.601 |
| **33** | C | X | | 3.4 | 3.29 | | | | | | 60.160 | 62.172 | -2.011 |
| **34** | C | | X | 2.5 | 2.92 | | | | | | 81.818 | 70.050 | 11.768 |
| **35** | C | X | | 2.91 | 3.09 | | | | | | 70.291 | 66.196 | 4.095 |
| **36** | T | X | | 3.53 | 4.01 | | | | | | 57.945 | 51.009 | 6.936 |
| **37** | C | X | | 3.59 | 3.53 | | | | | | 56.976 | 57.945 | -0.968 |
| **38** | C | X | | 3.19 | 2.91 | | | | | | 64.121 | 70.291 | -6.170 |
| **39** | C | X | | 4.15 | 3.88 | X | | | | | 49.288 | 52.718 | -3.430 |
| **40** | T | X | | 4.5 | 4.41 | X | | | | | 45.455 | 46.382 | -0.928 |
| **41** | C | X | | 3.34 | 3.24 | X | | | | | 61.241 | 63.131 | -1.890 |
| **42** | C | | X | 2.68 | 3.09 | | | | | | 76.323 | 66.196 | 10.127 |
| **43** | C | | X | 2.94 | 3.09 | | | | | | 69.573 | 66.196 | 3.377 |
| **44** | C | X | | 3.16 | 3.08 | | | | | | 64.730 | 66.411 | -1.681 |
| **45** | C | X | | 3.03 | 2.95 | | | | | | 67.507 | 69.337 | -1.831 |
| **46** | C | | X | 2.84 | 3.2 | | | | | | 72.023 | 63.920 | 8.103 |
| **47** | C | | X | 2.81 | 2.91 | | | | | | 72.792 | 70.291 | 2.501 |
| **48** | C | X | | 3.31 | 3.31 | | | | | | 61.796 | 61.796 | 0.000 |
| **49** | T | X | | 3.44 | 3.66 | | | | | | 59.461 | 55.887 | 3.574 |
| **50** | C | | X | 2.94 | 2.7 | X | | | | | 69.573 | 75.758 | -6.184 |
| **51** | C | X | | 3.06 | 3.06 | | | | | | 66.845 | 66.845 | 0.000 |
| **52** | T | X | | 3.25 | 3.34 | | | | | | 62.937 | 61.241 | 1.696 |
| **53** | C | X | | 2.91 | 2.96 | | | | | | 70.291 | 69.103 | 1.187 |
| **54** | C | X | | 3.25 | 3.27 | | | | | X | 62.937 | 62.552 | 0.385 |
| **55** | C | X | | 2.97 | 3.04 | | | | | X | 68.871 | 67.285 | 1.586 |
| **56** | C | X | | 2.94 | 3.1 | | | | | | 69.573 | 65.982 | 3.591 |
| **57** | C | X | | 3.25 | 3.41 | | | | | | 62.937 | 59.984 | 2.953 |
| **58** | C | X | | 3.09 | 3.12 | | | | | | 66.196 | 65.559 | 0.636 |
| **59** | C | X | | 3.44 | 3.49 | | | | | | 59.461 | 58.609 | 0.852 |

Table 32. La Moine: Data Collected During Trip 4

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location:** | LA MOINE | | | | | | | | | | | | |
| **Date:** | 1/3/00 | (Trip 4) | | | | | | | | | | | |
| **Speed Trap 1 Distance (FT):** | | | 300 | | | | | | | | | | |
| **Speed Trap 2 Distance (FT):** | | | 300 | | | | | | | | | | |
| | | | | | | **Brake Lights** | | **Encroachment** | | | **Speed** | | **Speed** |
| | **veh type** | **Vehicle Lane** | | **Trap 1** | **Trap 2** | **In Curve** | **Inside** | **Center** | **Outside** | **Lane** | **Trap 1** | **Trap 2** | **Reduction** |
| Veh ID | Track Trail | Drive Ln (x) | Pass Ln (x) | Time | Time | **(x) for yes** | **Edge** | **Laneline** | **Edge** | **Change** | **mph** | **mph** | **mph** |
| **1** | C | X | | 2.63 | 2.6 | | | | | | 77.774 | 78.671 | -0.897 |
| **2** | C | X | | 3.56 | 3.8 | | | | | | 57.457 | 53.828 | 3.629 |
| **3** | C | X | | 3.44 | 3.5 | | | | | | 59.461 | 58.442 | 1.019 |
| **4** | C | X | | 3.15 | 3.06 | | | | | | 64.935 | 66.845 | -1.910 |
| **5** | RV | | X | 3.19 | 3.07 | | | | | | 64.121 | 66.627 | -2.506 |
| **6** | C | X | | 3.72 | 3.65 | | | | | | 54.985 | 56.040 | -1.055 |
| **7** | C | X | | 2.78 | 2.9 | | | | | | 73.578 | 70.533 | 3.045 |
| **8** | C | X | | 3.38 | 3.3 | | | | | | 60.516 | 61.983 | -1.467 |
| **9** | C | X | | 3.03 | 3.19 | | | | | | 67.507 | 64.121 | 3.386 |
| **10** | C | X | | 3.69 | 3.09 | | | | | | 55.432 | 66.196 | -10.764 |
| **11** | C | | X | 3 | 3 | | | | | | 68.182 | 68.182 | 0.000 |
| **12** | C | | X | 2.72 | 2.8 | | | | | | 75.201 | 73.052 | 2.149 |
| **13** | T | | X | 3.31 | 3.13 | | | | | | 61.796 | 65.350 | -3.554 |
| **14** | C | X | | 3.37 | 3.09 | | | | | | 60.696 | 66.196 | -5.500 |
| **15** | C | | X | 3.47 | 3.24 | | | | | | 58.947 | 63.131 | -4.184 |
| **16** | RV | X | | 3.1 | 3 | X | | | | | 65.982 | 68.182 | -2.199 |
| **17** | C | | X | 2.97 | 2.96 | | | | | X | 68.871 | 69.103 | -0.233 |
| **18** | C | X | | 3.19 | 3.08 | | | | | | 64.121 | 66.411 | -2.290 |
| **19** | C | X | | 3.09 | 3.24 | | | | | | 66.196 | 63.131 | 3.065 |
| **20** | T | X | | 3.66 | 3.45 | | | | | | 55.887 | 59.289 | -3.402 |
| **21** | C | X | | 3.16 | 3.07 | | | | | | 64.730 | 66.627 | -1.898 |
| **22** | C | X | | 3.25 | 3.21 | | | | | | 62.937 | 63.721 | -0.784 |
| **23** | C | X | | 3.25 | 3.41 | | | | | | 62.937 | 59.984 | 2.953 |
| **24** | C | X | | 3.46 | 3.4 | | | | | | 59.117 | 60.160 | -1.043 |
| **25** | C + Tr | X | | 3.66 | 3.77 | | | | | | 55.887 | 54.256 | 1.631 |
| **26** | C | | X | 2.97 | 2.89 | | | | | | 68.871 | 70.777 | -1.906 |
| **27** | T | X | | 3.63 | 3.42 | | | | | | 56.349 | 59.809 | -3.460 |
| **28** | C | X | | 3.12 | 3.16 | | | | | | 65.559 | 64.730 | 0.830 |
| **29** | RV | X | | 3.07 | 3.26 | X | | | | | 66.627 | 62.744 | 3.883 |
| **30** | C | X | | 3.19 | 3.22 | | | | | | 64.121 | 63.523 | 0.597 |
| **31** | C | X | | 3.12 | 2.93 | | | | | | 65.559 | 69.811 | -4.251 |
| **32** | C + Tr | X | | 3.87 | 3.75 | | | | | | 52.854 | 54.545 | -1.691 |
| **33** | C | X | | 3.18 | 3 | | | | | | 64.322 | 68.182 | -3.859 |
| **34** | C | X | | 3.22 | 3.52 | X | | | | | 63.523 | 58.110 | 5.414 |
| **35** | C | X | | 3.18 | 3.4 | | | | | | 64.322 | 60.160 | 4.162 |
| **36** | RV | X | | 3.59 | 3.57 | | | | | | 56.976 | 57.296 | -0.319 |
| **37** | C | | X | 3.82 | 2.81 | | | | | | 53.546 | 72.792 | -19.246 |
| **38** | C | | X | 2.81 | 2.74 | | | | | | 72.792 | 74.652 | -1.860 |
| **39** | C | | X | 3.09 | 3.04 | | | | | | 66.196 | 67.285 | -1.089 |
| **40** | C | X | | 3.16 | 3.16 | | | | | | 64.730 | 64.730 | 0.000 |
| **41** | C | | X | 2.75 | 2.8 | X | | | | | 74.380 | 73.052 | 1.328 |
| **42** | C | | X | 3.06 | 3.31 | | | | | | 66.845 | 61.796 | 5.049 |
| **43** | RV | X | | 3.68 | 3.49 | | | | | | 55.583 | 58.609 | -3.026 |
| **44** | C | X | | 3.5 | 3.49 | | | | | | 58.442 | 58.609 | -0.167 |
| **45** | C | | X | 3.15 | 3.17 | | | | | | 64.935 | 64.525 | 0.410 |
| **46** | T | X | | 3.5 | 3.27 | | | | | | 58.442 | 62.552 | -4.111 |
| **47** | C | | X | 2.85 | 2.73 | | | | | | 71.770 | 74.925 | -3.155 |
| **48** | C + Tr | X | | 3.47 | 3.38 | | | | | | 58.947 | 60.516 | -1.570 |
| **49** | C | X | | 3.69 | 3.53 | | | | | | 55.432 | 57.945 | -2.513 |
| **50** | C | X | | 3.44 | 3.46 | | | | | | 59.461 | 59.117 | 0.344 |
| **51** | C | | X | 2.81 | 2.73 | | | | | | 72.792 | 74.925 | -2.133 |
| **52** | C + Tr | X | | 3.53 | 3.39 | | | | | | 57.945 | 60.338 | -2.393 |
| **53** | T | X | | 3.25 | 3.32 | X | | | | | 62.937 | 61.610 | 1.327 |
| **54** | C | | X | 2.88 | 2.87 | | | | | | 71.023 | 71.270 | -0.247 |
| **55** | C | X | | 2.87 | 2.98 | | | | | | 71.270 | 68.639 | 2.631 |
| **56** | Uhaul | X | | 3.22 | 3.02 | | | | | X | 63.523 | 67.730 | -4.207 |
| **57** | C | | X | 3.19 | 3.23 | | | | | | 64.121 | 63.327 | 0.794 |
| **58** | C | | X | 2.96 | 2.88 | X | | | | | 69.103 | 71.023 | -1.920 |
| **59** | C | X | | 3.13 | 3.26 | | | | | | 65.350 | 62.744 | 2.606 |
| **60** | C | X | | 3.16 | 3.1 | X | | | | | 64.730 | 65.982 | -1.253 |
| **61** | C | | X | 2.84 | 2.73 | | | | | | 72.023 | 74.925 | -2.902 |
| **62** | C | X | | 3.46 | 2.99 | | | | | | 59.117 | 68.410 | -9.293 |
| **63** | C | X | | 3.09 | 2.98 | | | | | | 66.196 | 68.639 | -2.443 |
| **64** | C | X | | 3.59 | 3.64 | | | | | | 56.976 | 56.194 | 0.783 |
| **65** | C | | X | 2.56 | 2.66 | | | | | | 79.901 | 76.897 | 3.004 |
| **66** | C | X | | 2.96 | 3.05 | | | | | | 69.103 | 67.064 | 2.039 |

Table 33. Sims Road: Data Collected During Trip 4

| | | |
|---|---|---|
| **Location:** | SIMS ROAD | |
| **Date:** | 1/3/00 | (Trip 4) |
| **Speed Trap 1 Distance (FT):** | | 300 |
| **Speed Trap 2 Distance (FT):** | | 300 |

| Veh ID | veh type Track Trail | Vehicle Lane Drive Ln (x) | Pass Ln (x) | Trap 1 Time | Trap 2 Time | Brake Lights In Curve (x) for yes | Encroachment Inside Edge | Center Laneline | Outside Edge | Lane Change | Speed Trap 1 mph | Trap 2 mph | Speed Reduction mph |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | C | X | | 3.56 | 3.56 | | | | | | 57.457 | 57.457 | 0.000 |
| **2** | C | | X | 2.57 | 3.14 | X | | | | | 79.590 | 65.142 | 14.448 |
| **3** | T | X | | 3.91 | 4.06 | | | | | | 52.313 | 50.381 | 1.933 |
| **4** | C | X | | 3.38 | 3.41 | | | | | | 60.516 | 59.984 | 0.532 |
| **5** | C | X | | 3.63 | 3.59 | | | | | | 56.349 | 56.976 | -0.628 |
| **6** | C | | X | 3.03 | 3.58 | | | | | | 67.507 | 57.136 | 10.371 |
| **7** | C | X | | 3.12 | 3 | | | | | | 65.559 | 68.182 | -2.622 |
| **8** | C | | X | 3.25 | 3.32 | | | | | | 62.937 | 61.610 | 1.327 |
| **9** | T | X | | 3.75 | 3.7 | | | | | | 54.545 | 55.283 | -0.737 |
| **10** | C | X | | 2.9 | 2.98 | | | | | | 70.533 | 68.639 | 1.894 |
| **11** | T | X | | 3.38 | 3.38 | | | | | | 60.516 | 60.516 | 0.000 |
| **12** | C | X | | 2.94 | 3.13 | | X | | | | 69.573 | 65.350 | 4.223 |
| **13** | C | X | | 2.78 | 3 | | | | | | 73.578 | 68.182 | 5.396 |
| **14** | T | X | | 3.78 | 3.85 | | | | | | 54.113 | 53.129 | 0.984 |
| **15** | C | | X | 3.06 | 3.34 | | | | | | 66.845 | 61.241 | 5.604 |
| **16** | C | | X | 3.03 | 3.47 | | | | | | 67.507 | 58.947 | 8.560 |
| **17** | C | X | | 4.41 | 4.58 | | | | | | 46.382 | 44.661 | 1.722 |
| **18** | C | X | | 3.13 | 3.34 | | | | | | 65.350 | 61.241 | 4.109 |
| **19** | T | X | | 3.57 | 3.65 | | | | | | 57.296 | 56.040 | 1.256 |
| **20** | C | | X | 3.41 | 3.44 | | | | | | 59.984 | 59.461 | 0.523 |
| **21** | C | | X | 3.47 | 3.5 | | | | | | 58.947 | 58.442 | 0.505 |
| **22** | C + Trailer | X | | 3.88 | 3.96 | | | | | | 52.718 | 51.653 | 1.065 |
| **23** | C | X | | 4.22 | 4.7 | | | | | | 48.470 | 43.520 | 4.950 |
| **24** | C | | X | 2.81 | 2.84 | | | | | | 72.792 | 72.023 | 0.769 |
| **25** | C | X | | 3.1 | 3.28 | | | | | | 65.982 | 62.361 | 3.621 |
| **26** | C | | X | 2.88 | 3.19 | | | | | | 71.023 | 64.121 | 6.902 |
| **27** | T | X | | 4.62 | 4.27 | | | | | | 44.274 | 47.903 | -3.629 |
| **28** | T | X | | 3.81 | 3.78 | X | | | | | 53.686 | 54.113 | -0.426 |
| **29** | C | | X | 2.97 | 3.23 | | | | | | 68.871 | 63.327 | 5.544 |
| **30** | C | X | | 3.06 | 3.42 | | | | | | 66.845 | 59.809 | 7.036 |
| **31** | C | X | | 3.38 | 3.22 | | | | | | 60.516 | 63.523 | -3.007 |
| **32** | T | X | | 3.66 | 3.66 | | | | | | 55.887 | 55.887 | 0.000 |
| **33** | C | | X | 3.34 | 3.67 | | | | | | 61.241 | 55.734 | 5.507 |
| **34** | C | | X | 3.1 | 3.2 | | | | | | 65.982 | 63.920 | 2.062 |
| **35** | C | X | | 3.41 | 3.34 | | X | | | | 59.984 | 61.241 | -1.257 |
| **36** | C | X | | 3.18 | 3.44 | X | | | | | 64.322 | 59.461 | 4.862 |
| **37** | C | X | | 3.35 | 3.55 | | X | | | | 61.058 | 57.618 | 3.440 |
| **38** | C | | X | 3.41 | 3.44 | | | | | | 59.984 | 59.461 | 0.523 |
| **39** | C | X | | 3.84 | 4.07 | | | | | | 53.267 | 50.257 | 3.010 |
| **40** | C | X | | 3.35 | 3.34 | | | | | | 61.058 | 61.241 | -0.183 |
| **41** | C | X | | 3.16 | 3.12 | | | | | | 64.730 | 65.559 | -0.830 |
| **42** | C | X | | 3.15 | 3.24 | | | | | | 64.935 | 63.131 | 1.804 |
| **43** | T | X | | 3.47 | 3.59 | | | | | | 58.947 | 56.976 | 1.970 |
| **44** | T | X | | 3.34 | 3.41 | | | | | | 61.241 | 59.984 | 1.257 |
| **45** | C | X | | 3.12 | 3.25 | | | | | | 65.559 | 62.937 | 2.622 |
| **46** | C | X | | 3.35 | 3.45 | | | | | | 61.058 | 59.289 | 1.770 |
| **47** | C | X | | 2.94 | 3.34 | | | | | | 69.573 | 61.241 | 8.332 |
| **48** | C | X | | 3.19 | 3.4 | | | | | | 64.121 | 60.160 | 3.960 |
| **49** | C | X | | 3.25 | 3.24 | | | | | | 62.937 | 63.131 | -0.194 |
| **50** | C | X | | 3.25 | 3.37 | | | | | | 62.937 | 60.696 | 2.241 |
| **51** | C | X | | 3.79 | 3.97 | | | | | | 53.970 | 51.523 | 2.447 |
| **52** | C | X | | 3.13 | 3.49 | | | | | | 65.350 | 58.609 | 6.741 |
| **53** | T | X | | 3.31 | 3.42 | | X | | | | 61.796 | 59.809 | 1.988 |
| **54** | C | X | | 3.47 | 4.08 | | | | | | 58.947 | 50.134 | 8.813 |
| **55** | C | | X | 2.91 | 2.96 | | | | | | 70.291 | 69.103 | 1.187 |
| **56** | C | X | | 3.22 | 3.3 | | | | | | 63.523 | 61.983 | 1.540 |
| **57** | T | X | | 3.72 | 3.79 | | | | | | 54.985 | 53.970 | 1.016 |
| **58** | T | X | | 3.19 | 3.38 | | X | | | | 64.121 | 60.516 | 3.604 |
| **59** | C | | X | 2.75 | 2.89 | | | | | | 74.380 | 70.777 | 3.603 |
| **60** | C | X | | 3.68 | 3.59 | | | | | | 55.583 | 56.976 | -1.393 |
| **61** | C | X | | 3.25 | 3.41 | | | | | | 62.937 | 59.984 | 2.953 |
| **62** | C | X | | 3.44 | 3.71 | | | | | | 59.461 | 55.134 | 4.327 |
| **63** | C | | X | 3.22 | 3.09 | | | | | | 63.523 | 66.196 | -2.673 |
| **64** | T | X | | 3.75 | 3.56 | | | | | | 54.545 | 57.457 | -2.911 |
| **65** | C | X | | 4.22 | 3.84 | | | | | | 48.470 | 53.267 | -4.797 |
| **66** | C | | X | 3.09 | 3.12 | | | | | | 66.196 | 65.559 | 0.636 |