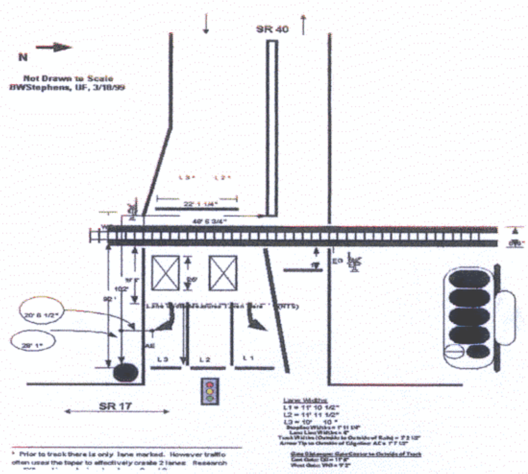
Evaluation of X-Box Pavement Markings At Railroad-Highway Crossings



Final Report

University of Florida
Department of Civil and Coastal Engineering
Gainesville, FL 32611-6580

Evaluation of X-Box Pavement Markings at Railroad-Highway Crossings

Burton W. Stephens
Adjunct Scientist

and

Gary Long, Ph.D., P.E.
Principal Investigator

University of Florida
Department of Civil and Coastal Engineering
P.O. Box 116580
Gainesville, FL 32611-6580

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ABSTRACT

An evaluation was performed of special X-box pavement marking configurations at railroad-highway grade crossings, originally used in several European countries. The intent is to provide motorists with supplemental visual cues about whether sufficient space is available for safe storage of a vehicle beyond the track for a motorist to proceed across. It is intended for application where nearby intersections can cause queues to backup to the track. These conspicuous markings, configured as an "X" in a box, were tested at two Florida locations, one in an urban area and one in a rural area, over a 1½-year period. The rates of cars hazardously stopping on or closely adjacent to the railroad tracks at the crossings were compared under pre- and post-installation conditions. Results at the rural location showed a decline of more than 60% in the stoppage rates over an extended period of time. No significant differences were found between the pre-installation and post-installation tests at the urban location. A control site was utilized near the crossing in the urban location, and it showed no significant differences between the two test periods that were concurrent with the analysis at the treated site. Recommendations are provided for application of these markings at rural highway-railroad grade crossing sites.

Keywords: railroad-highway, grade crossings, pavement markings, X-box

ACNOWLEDGEMENTS

This research has been conducted with assistance from Jackie Miller and Gail Holley of the Office of Traffic Engineering, Florida Department of Transportation (FDOT), who provided guidance, direction and special arrangements for the study. The FDOT specifically provided assistance with publicity related to the meaning and use of the European X markings in the Ft. Lauderdale area, and installed the X markings in a timely manner for the comparative evaluation of the pre- and post-installation phases of the study. The FDOT also secured Federal permission to install and test these experimental pavement markings.

Gratitude is expressed to Professor Ken Courage, University of Florida (UF) for his help in designing and installing a video-data acquisition system capable of withstanding the rigors of time and weather. His guidance and assistance throughout the study is gratefully acknowledged.

Gratitude is also expressed to Peter Moore, a graduate student at UF, who set up and obtained data tapes at the Ft. Lauderdale locations. Thanks are also due to two UF undergraduate students, Alex Bellon and Audrie Liszewski, who worked many hours to covert video images to quantitative data that could be analyzed in this study.

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CHAPTER 1

INTRODUCTION

1.0. Background

Drivers approaching a railroad crossing must make two critical judgments. First is the decision as to whether to stop prior to the tracks. If the decision is made to proceed, then a driver must determine whether there is sufficient space to store the vehicle beyond the tracks. Both of these decisions are made 'on the fly' and they are not necessarily independent of one another.

A new type of pavement marking, first implemented in Europe and referred to as the "European X" marking for lack of a better name, is intended to discourage motorists from stopping on or adjacent to the tracks at railroad grade crossings by providing supplemental information on the amount of space available for storing an additional vehicle on the far side of the track. The basic concept is to place a 25-foot "X" in a box painted on the pavement on the downstream side of the roadway slightly past the track as a warning to motorists that their vehicles will not clear the track unless the entire X is visible before they begin to cross the track. The concept is shown in figure 1-1. The preliminary concept was modified in implementation so that the start of the X box was placed farther from the track than shown in figure 1-1.

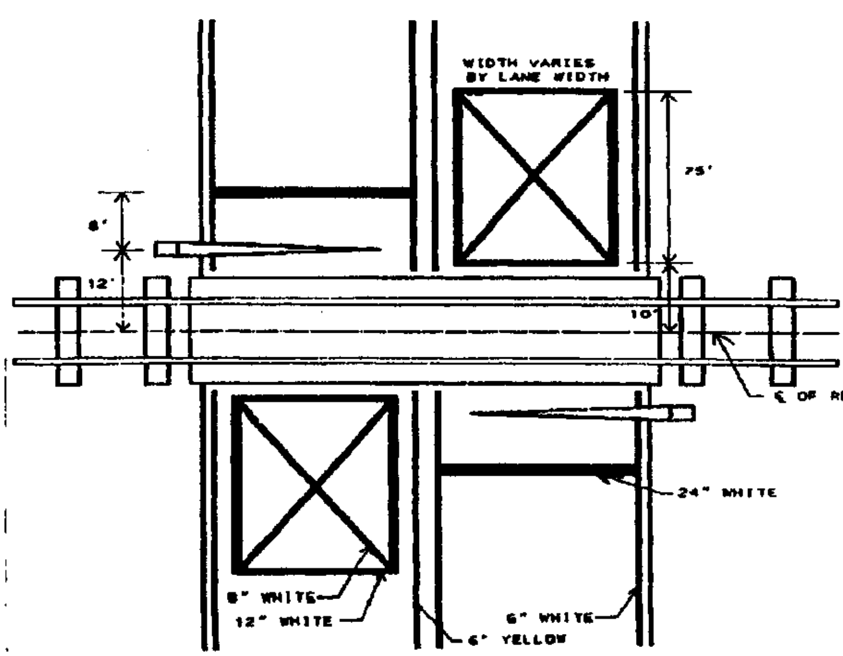

Figure 1.1. Concept Drawing of European X Markings (Florida DOT)

The Florida Department of Transportation (FDOT) was interested in testing whether this innovative pavement marking could help drivers improve the accuracy of their decisions, and hence reduce the frequency of railroad-highway crossing collisions.

Specifically, the European X pavement marking provides a direct visual indication to approaching drivers by literally showing them whether there is sufficient clearance between the tracks and preceding road vehicle for storage of the approaching vehicle. The proposed X design is sufficiently large to encompass most passenger road vehicles. However, its 25-foot length will not encompass all trucks, buses and other large road vehicles. FDOT has proposed that this innovative technique be tested at two crossings that are actively controlled with gates.

Initially, testing of X pavement markings was to take place at urbanized locations where crossings are controlled with automatic gates. The test sites in this study were to be conducted on arterials where approach speeds were expected to be no more than 45 mph. Ft. Lauderdale crossing sites at Sample Road (SR 814), Powerline Road (SR 845) and Prospect Avenue were originally proposed because of the relatively high crash rates. After initial inspection of these sites, FDOT agreed to broaden the search for other candidate test sites because of difficulties with geometries, camera mounting vantages, and other factors at these locations that might possibly affect results. See Appendix A for difficulties in camera mountings and Appendix D for descriptions of candidate sites. Ultimately two nearby sites in Ft. Lauderdale, at Commercial Blvd and Oakland Park Blvd, were chosen due to their similarities. In early meetings with the FDOT, it was agreed to include a site in a rural area where fewer remedial treatments had been evaluated and/or installed. A crossing at Barberville, Florida, adjacent to the intersection at SR 40 and SR 17 was selected as this site.

1.1. Driver Factors

Section 8C-5 of the *Manual on Uniform Traffic Control Devices* (MUTCD) requires that flashing light signals be actuated 20 seconds before the arrival of any train. This provides motorists with ample time to stop no closer than 15 feet from the nearest rail, as required by section 11-701 of the *Uniform Vehicle Code,* if they are far enough from a crossing to have sufficient space to stop. If they are too close to the track when the flashing lights are actuated to have sufficient space to stop comfortably, then they have only a short time to decide to try an emergency stop or to try to cross the track before the gate blocks it. Section 8C-4 of the MUTCD requires that gate arms begin descent not less than 3 seconds after the signal lights begin to operate. While there will be a couple of seconds before the gates descend far enough to block automobiles, it means that motorists have only about 5 seconds from the initial actuation of the signal lights to reach the gates or they will be blocked by the gates. At an approach speed of 45 mph, motorists would be up to about 330 feet from the gates, or 360 feet from the X-box at a single-track crossing, when they need to assess whether sufficient space exists on the far side of the track to store their vehicle.

The European X marking will only be useful if motorists can see it. Many railroad grade crossings are humped where a motorist 360 feet away cannot see, over a track, pavement markings that are located in the vicinity of the where the X-box is to be placed. It only takes a rather small elevation of the track to obscure a motorist's view. If a track is about 1 inch higher than the pavement at the X-box, a motorist whose eyes are at the standard design height of 3.25 feet will be unable to see the close edge of the X-box from 360 feet. If the track is elevated only 3.5 inches, the entire X-box will be obscured at 360 feet. Since many tracks are humped to some extent, candidate study sites had to be chosen with an adequate view[1]. Approaching a crossing at higher speeds can work against a driver's ability to make judgments about available storage space on the far side of a crossing. This study of the X pavement marking was intended to evaluate explicitly the accuracy of drivers' judgments about the availability of storage space, both with and without the X pavement marking.

In addition to driver aggressiveness, vehicle types (related to vehicle length) were to be recorded. Rainfall and fog will reduce the visibility (in particular the contrast of the markings); therefore, an attempt to provide a range of weather conditions was desirable for inclusion in this study, but the size of the study limited the ability to explicitly consider such factors.

It was expected that some drivers might enter the crossing zone when the final vehicle in the forward queue still covered part or all of the X-marking. This was expected to occur when encroaching drivers predicted that leading vehicles would clear the tracks by the time a train arrived. Accordingly, information on the dispersion of the queue at the time of entry into the crossing zone was also to be obtained, although this information was not used in the analysis because the most important issue was whether each vehicle stopped in a hazardous position, both with and without the X marking, rather than a partial analysis of what factors might have contributed to risky decisions.

It was not anticipated that the X-markings would have an adverse effect on traffic operations or safety. However, any unusual traffic control treatment can create some unforeseen and unintentional problems. Accordingly, the study was planned to be terminated should any such problems occur. Fortunately, the intermediate results from data collection did not indicate any safety problems were posed by the presence of the markings.

1.2. Previous Research

Although European X markings have been used in a number of places in Europe, there is a lack of published information on their effectiveness. In the U.S., a laboratory study was conducted in 1988 to see whether people could discern the meaning of such a marking. The study, which consisted primarily of a series of slide identifications, was conducted in a laboratory with 40 test subjects. It was found that the pavement X-marking was not well recognized as might be expected; the size of the marking did not make a difference[2].

Although not an X-type configuration, the Australian Road Research Board conducted a pilot study of conspicuous road markings in 1997. This study employed cross-hatched

[1] A site inspection and/or a review of site plans was employed to determine the actual distances needed for drivers to see the X markings.

[2] Kemper, W.J. Modified Railroad-Highway Grade Crossing Pavement Marking, *Public Roads*. 1988/12. 52(3) pp. 76-81.

markings on the near side of the crossing, as shown in figure 1-2, and yielded few encroachments onto the tracks. Although the study was very short in duration, it did show a significant reduction in the number of encroachments on or adjacent to the tracks, as can be seen in figure 1-3[3].

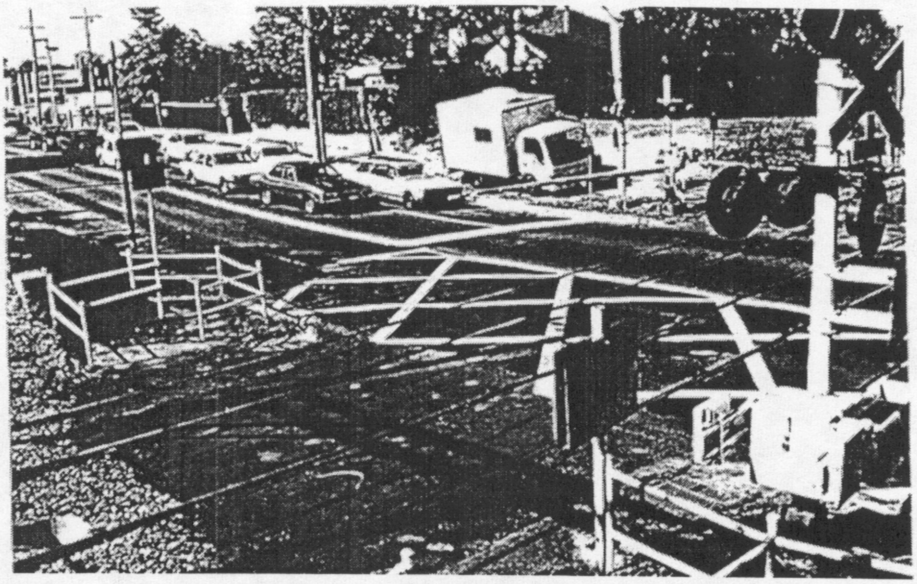

Figure 1-2. Crossing at Middleborough Road, Box Hill, Australia

1.3. Organization of Report

This chapter has provided the background of how the study of European X markings came into being, provided a brief indication of some of the human factors issues associated with the use of such a technique, and indicated that there has been a paucity of information about the effectiveness of this low-cost technique to reduce tragic crashes at highway-railroad crossings.

Chapter 2 presents the evaluation plan for conducting the study, taking into account many of the practical issues associated with setting up field studies of this nature.

Chapter 3 provides the results from installing X-markings at two locations, one in a rural setting, and the other in a high-density urban environment.

Chapter 4 summarizes the results and their implications for implementation.

The Appendices provide substantive information that supplements the chapters on the evaluation plan and the study results.

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[3] Unpublished communication with staff members of the Australian Road Research Board, August 1998.

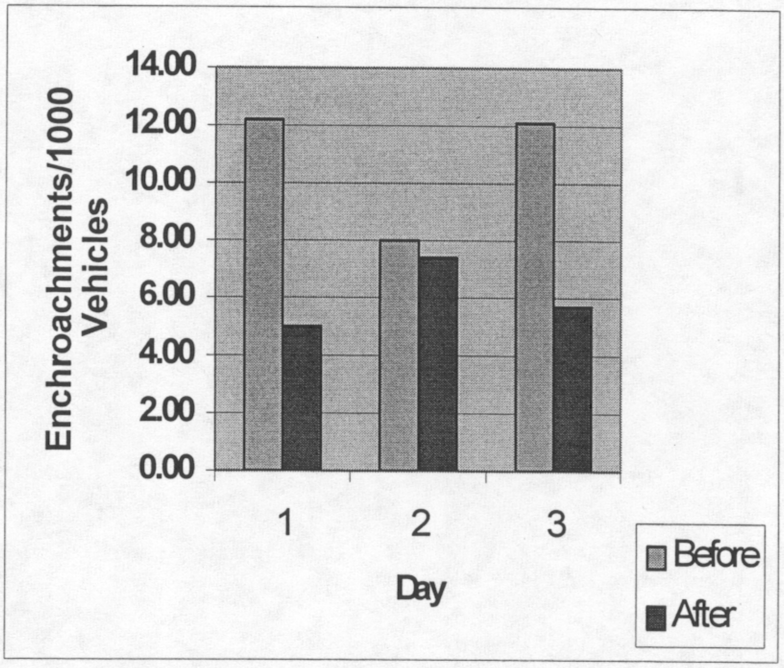


Figure 1-3. Comparison of Encroachments at Box Hill Grade Crossing

CHAPTER 2

EVALUATION PLAN

2.0. Initial Experimental Plan

The initial experimental plan was for three phases of data collection of approximately seven days each, eight hours a day, throughout one-week periods. Videotape data were required for each phase of the experiment at each test and control site. Two phases, a "before" and "after" period, were originally planned for the site at Barberville, Florida. However, an additional pair of study periods was added thus providing four data collection periods for this location. Three phases, representing the "before", "after" and "follow-up" periods were originally planned for the Ft. Lauderdale sites, but this was reduced to two after the two extra data collection periods at Barberville were able to answer the issue about persistence, and the effects in Ft. Lauderdale were not found to be significant.

The evaluation plan was for three sites, one rural test site as shown in figure 2-1, and one urban test site as shown in figure 2-1, both of which involved the installation of the European X marking. The third site was an urban control site which was not treated. There was to be a suitable period in which "before data" could be collected so that direct comparisons of "after data" with similar traffic conditions would allow analysis of the potential safety performance at these locations once the markings had been installed by FDOT maintenance crews. It was attempted to locate two suitable locations for control sites, one rural and one urban, with each in close proximity to the test sites, where data could be collected during the same time periods when before and after data were collected at the treated sites. These controls were intended to determine whether there were changes in the study measures of effectiveness (MOEs) which were not directly attributable to the introduction of the experimental X markings, but instead to systemic changes in traffic characteristics, weather, public safety campaigns, etc., which could contaminate results of a simple "before-after" design. Only one suitable control site was found. If the sites had been selected because of their unusually high numbers of incidents (which was not considered in the selection for this study), this type of experimental design would help make corrections for regression-to-the-mean bias. The basic experimental design therefore is referred to as a before-after design with controls.

In the initial plan, several independent variables and MOEs were suggested for consideration in the evaluation. Ideally, it would be desirable to assess several variables and MOEs to determine the benefits (and possible negative effects) of the European X markings. The following were considered:

1. Independent Variables:
- Driver aggressiveness (measured by speed and speed changes of vehicles approaching and crossing the tracks), categorized by periods when (1) no trains approached and (2) automatic gates were activated.

- Uncertainty of drivers (measured by smoothness of acceleration/deceleration patterns over the tracks into the X-marked storage area (recorded only when the queue length was less than 50 feet from the X — approximately 2 car-lengths)

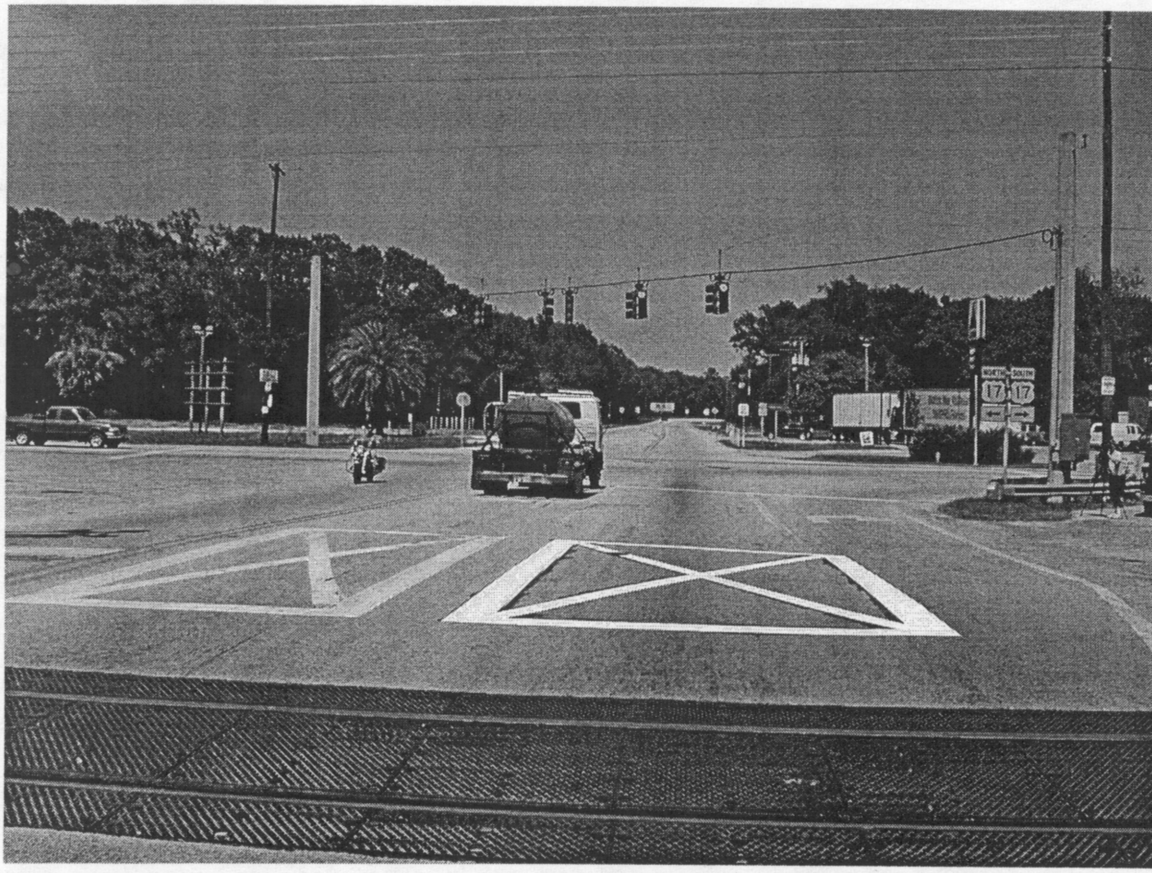


Figure 2-1. Barberville Crossing with European X Markings Installed

2. Measures of Effectiveness (Dependent Variables)

- Number of drivers who cross the track when the X-marking is completely covered, nearly covered (75%), half covered (50%), nearly clear (25%) or completely clear (0%). These counts were to be assessed randomly so not to be influenced by the presence of a train.
- Vehicle control, as measured by erratic maneuver counts (number of brake light actuations, out of lane counts, etc.).
- Attempts to turn the vehicle around (indication of extreme confusion).

2.1. Initial Assessment

As indicated in chapter 1, in conjunction with the FDOT, changes were made in the experimental design to simplify the study and to consider the potential use of the X-markings in both urban and rural settings. Review of test videotapes at Barberville, and then in Ft. Lauderdale, indicated that it would not be possible to accurately discriminate changes in speed or to make inferences about the impacts of the X-markings on aggressive drivers. What were judged to be aggressive drivers and indications of confusion were observed, but not explicitly related to the absence or presence of any particular traffic control device. Although drivers who turn around at crossings have been observed, this behavior did not occur at the selected sites. Accordingly, it was decided that the data would be much more reliable if counts were restricted to drivers who stopped in hazardous zones — on the tracks, and adjacent to the tracks. Furthermore, there were sufficient numbers of such stops during the early trials that it was clear that significant reductions, if they occurred, could be detected during the post-installation periods.

Figure 2-2. Commercial Blvd. Crossing with European X Markings Installed

2.2. Final Evaluation Plan

The final experimental design was to use a single measure of effectiveness (MOE). This involved counts of vehicle stoppages on or adjacent to the tracks relative to the number of vehicles that passed over the crossings — what the Australians referred to as the crossing encroachment rate. All vehicle types were examined, but it was found that the number of stopped vehicles in non-car categories were not sufficient to justify a full-scale assessment.

Accordingly, the selected MOE that allowed comparisons between sites was "car stops/1,000 passing cars."

Obviously, the major independent variable of concern was the absence or presence of the X markings. From previous studies and observations at the three selected sites, it was clear that the middle lanes experienced the most traffic and, from observations, the greatest numbers of stops in the vicinity of the tracks. Of course, the number of lanes determined the number of levels for the lane variable. In addition, it was desired to distinguish between zones of hazard, with the most hazardous zone being on the tracks and the next most hazardous at two adjacent locations, before and after passing over the tracks. In all, four zones were selected — immediately prior to the tracks, on the tracks, immediately after the tracks, and in the X-box. Details on the specification of these variables are presented in chapter 3.

To assess the persistence of the effects of the X marking, two replications of before-after data were collected and analyzed at Barberville.

2.3. Statistical Analysis

A statistical analysis tool known as Analysis of Variance (ANOVA) was selected to perform the primary analyses. An advantage of this tool is that multiple factors can be analyzed together rather than having to try to conduct multitudes of tests on selected pairings of factors while trying to keep all other factors the same. Ideally, the factors of site location, day-of-week, month-of-year, weather, period, half-day, lane and zone would all be analyzed together. However, the number of lanes differed among the sites as well as the length of the zone over the track since the number of tracks also differed. This required separate ANOVA evaluations for each site using only the factors of period, half-day, lane and zone. A disadvantage of ANOVA is that observation periods should all be the same length and factors not involved in the analyses that might affect results, such as weather, day-of-week and month-of-year, need to be balanced among treatments if they are not entered as separate levels of additional independent variables. Therefore, the before and after observations were planned for the same month-of-year, one year apart. The same days of week before and after were planned for data collection. Dry days and wet days on the same days-of-week in the observation samples were planned to be matched between the before and after periods at each site.

2.4. Sampling Plan

Samples were to be collected by videotaping traffic operations over the length of a standard 8-hour videotape. One videotape was to be recorded per day, and each videotape of approximately 8 hours duration was considered to be the day's sample.

The final sampling plan was for four successive days of videotaping both before and after treatment for the Labor Day weekend study at the rural site in Barberville. Seven successive days of videotaping before and after treatment were planned for the Spring study of the Barberville site, six successive days before and after at the Commercial Blvd. site and six successive days before and after at the control site at Oakland Park Blvd.

CHAPTER 3

ANALYSIS OF DATA

3.0. Introduction

The variables of interest related to the effectiveness of the European X markings in reducing potentially hazardous behaviors in the vicinity of railroad crossings were analyzed. The results are presented for two types of crossings, those located in rural areas where few other devices were being used to attempt to prevent drivers from stopping on or adjacent to the tracks, and those in urbanized areas where multiple measures had already been employed in an effort to prevent crashes at highway-railroad grade crossings.

3.1. Measure of Effectiveness

As indicted earlier, only the actions of cars were included in the analysis due to limited samples of other types of vehicles. The measure of effectiveness (the dependent variable) used in this study is car stops/1,000 cars that pass through each of the railroad crossings. It is acknowledged that stoppage patterns may differ among vehicle types. For example, the videotapes showed that school buses consistently stopped prior to the stop line and gate as they approached railroad grade crossings, but other non-cars did not. Although it seems clear that, in general, most vehicles with long wheel-bases would be at greater risk than cars, there were not sufficient numbers of such vehicles to justify analysis associated with differences in stoppage patterns.

The number of stops by cars per 1,000 total vehicles could also have been chosen. It might be argued that it is the best choice since leading vehicles which are not cars can obscure the view of the European X markings by car drivers, so all vehicles should be included in the denominator. It could also be argued that increased traffic densities, regardless of the types of vehicles in the traffic stream, reduce the gaps between vehicles and reduce the spacing at which a pavement marking can be seen. However, it is not expected that this selection would have much affect on the results since most vehicles were cars. Cars were selected for the denominator simply to be the same as the variable in the numerator and to provide some consistency with the study in Australia for comparison.

The use of a calculated rate (car stops/1,000 cars) implies a linear relationship between the variable in the numerator, cars stopping, and the variable in the denominator, 1,000 cars passing. This relationship was not verified. It is convenient to use because it scales stoppages in perspective with a measure of exposure and means that the observation periods do not need to be perfectly identical in duration. Although observation periods were close in duration, they were not all precisely the same. Furthermore, even if the relationship is nonlinear, it should not have any significant effect because observation periods were matched to be similar (same time of year, days of week, times of day and weather conditions) so the traffic volumes were about the same at each site between the observation periods before and after the X markings were installed. The comparisons being made are between conditions at each site over nominally 8-hour periods, where traffic volumes were similar, not between different sites where traffic volumes may differ.

The number of stops per unit of time is an integer since each car either stops or does not stop in each zone. Consequently, the distribution of stops in each zone at each crossing could be expected to be described by a Poisson distribution. When the number of stops is divided by the number of passing cars, the rates from the ratios of stops to passing cars will no longer be integers. Preliminary verification indicated the stoppage rates appeared to be reasonably approximated by a normal distribution.

3.2. Independent Variables

Zones. Stops were recorded within four distinct zones associated with differing levels of risk of being struck by a train should a vehicle be unable to move at the time of a train's arrival. As previously indicated, these zones are as follows: (1) immediately prior to the tracks with the front bumper of the vehicle approximately 5 feet or less from the tracks but not positioned on the tracks, (2) vehicle on the tracks, (3) immediately after the tracks with the vehicle's rear bumper approximately 5 feet or less distance from the tracks with the front portion of the vehicle usually penetrating the area where the X was planned or actually installed, and (4) the rear bumper of the vehicle was within the zone designated by the X box that clearly was beyond the tracks. Although it is nearly certain that if a vehicle were positioned on the tracks at the time of a train arrival that it would be struck, it is not certain that a vehicle stopped in zones immediately before or after the tracks would be struck, but there is a high likelihood that it could be. Rail cars can overhang the outside edge of the rail by about 2.5 feet, so half of Zones 1 and 3 would be within an impact area, but cars stopped in these zones probably can squeeze either backward or forward that much to avoid a crash.

It was expected that the smallest number of stops would occur on the tracks (Zone 2), with a larger number immediately before the tracks (Zone 1) and immediately after the tracks (Zone 3). The area designed for the X marking (Zone 4) would provide storage, and hence should contain the largest number of stopped vehicles. No counts were made between Zone 4 and the stop line at the adjacent signalized intersection nor prior to the stop line or gate on the approach to the railroad crossing. Because the distance between the X markings and the track was 10 feet, it would have been possible for two-wheeled vehicles to not be counted as stopping in one of the four zones, but all other vehicles were either counted as non-stopping or stopping in one of the four zones once they passed the entry gate and were within 5 feet of the nearside train track.

At Barberville, the length of Zone 2 was only the 5-foot distance between the rails because there was only one track. At both Commercial Blvd. and Oakland Park Blvd. in Ft. Lauderdale, Zone 2 was considerably longer since there were two tracks plus separation space between them. The stoppage rate in Zone 2 probably will not be independent of zone length.

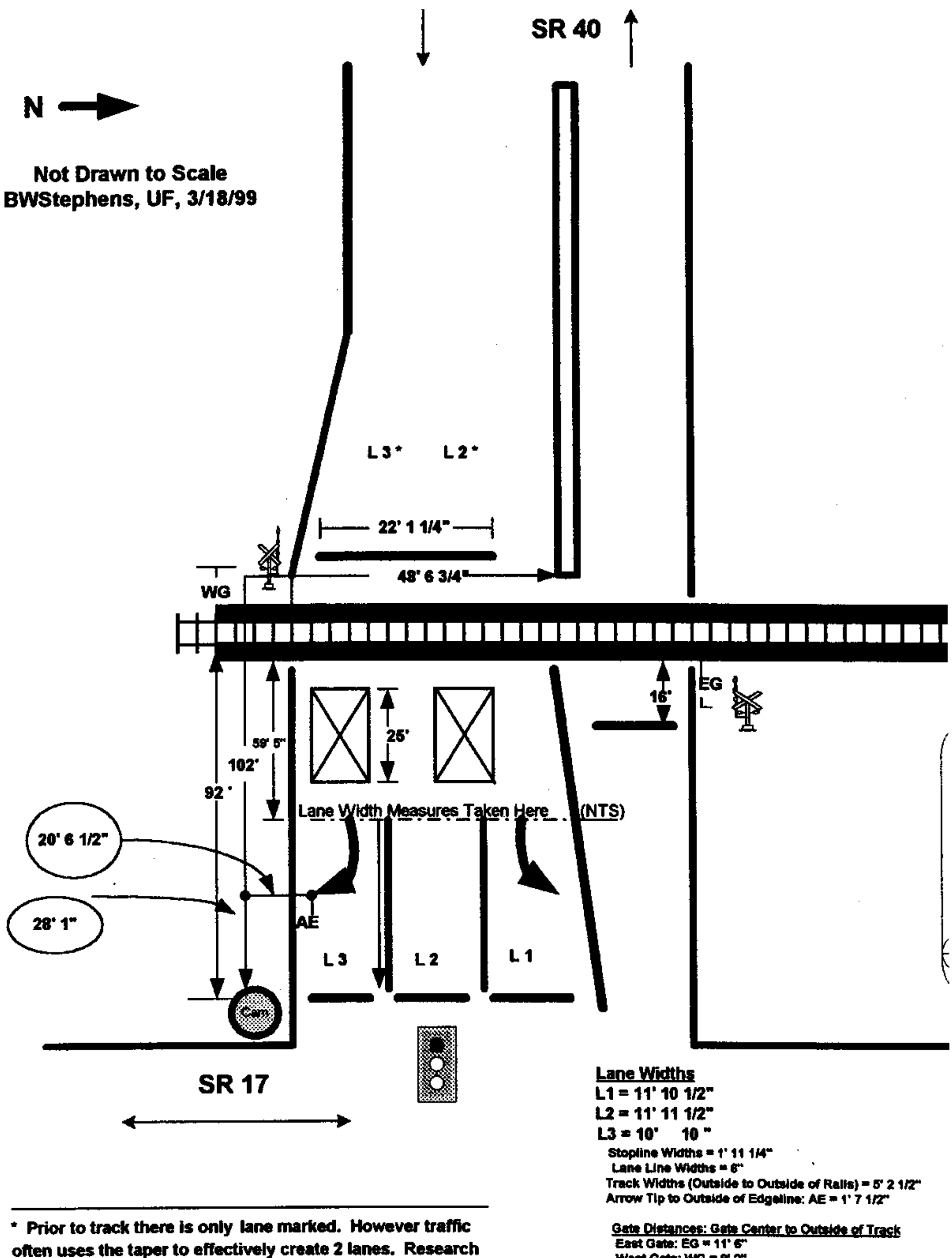
The analyses do not involve stops in Zone 4, the location of the X-box. While originally it seemed like stops in the X-box might be of interest, it is unclear how to interpret the meaning of any significant increase or decrease. The intent of the X-markings is to reduce stops at hazardous locations, so changes in stops in the X-box, a safe location, are irrelevant.

Lanes. Each of the railroad crossings was within 200 feet of adjacent intersections. Because of the different lane volumes and the fact that the constraints on the forward movement of vehicles differ for each of the lanes at these locations, lanes are treated as an independent variable in the study. For the inside lanes, left-turning movements tend to take longer and can lead to unanticipated backups onto the tracks. Right-turning lanes offer the least number of constraints on forward movement and therefore were expected to provide the fewest number of stops on or near the railroad tracks at the crossings.

The crossing at Commercial Blvd. had a total of four lanes. The crossings at Oakland Park Blvd and at Barberville each had three lanes. The Barberville crossing was somewhat unique because the roadway had one lane in the approach direction and started widening to three lanes to add additional lanes for turning left or right at the signalized intersection. This is shown schematically in figure 3-1. The railroad crossing intercepted the transition section where the width was narrowed for three lanes. Consequently, only two X-boxes were painted on the pavement. When queues backed up from the signalized intersection, the lane was identified based on which of the three lanes at the intersection the queue extended from. All three traffic streams across the track were analyzed as three separate lanes even though only two queues at the track usually existed at any time. The differences in number of lanes at Commercial Blvd. and Oakland Park Blvd. complicated the analysis of lane effects between a treated and control site.

Data Collection Periods. Data were collected in Barberville during comparable times-of-day and during the same days-of-week at four intervals over a 19-month period from September 1998 through March 2000. These intervals all involved daylight times-of-day. Two overlapping "before-after" studies were conducted. The first was a study over the Labor Day weekends in 1998 and 1999. In the second study, conducted in the Spring of the year, offset approximately ½-year from the Labor Day study, data were obtained during March and April of 1999 and 2000. This allowed examining four time periods at the same location over the 19-month period to determine whether there were any changes in driver behavior (such as regression in the effectiveness of the X-markings on stopping patterns after the X-box was no longer "new").

Data were not collected at comparable times-of-year at the test and control locations in Ft. Lauderdale. The "before" data were collected in April and May, but due to taking longer than anticipated to get the X-markings installed at this location, the "after" data were not collected until June of the following year. Although times-of-day were the same, starting at 7:30 a.m., it was dark during the earliest portion of the "before" data collection period, but not during the after period. However, the higher volume conditions at the Ft. Lauderdale sites allowed separating each day's observations into two 4-hour



* Prior to track there is only lane marked. However traffic often uses the taper to effectively create 2 lanes. Research on "X" markings designates lanes 2 and 3.

Figure 3-1. Schematic Diagram of Barberville Site with X-Markings Installed

segments, from 7:30 a.m. through 11:30 a.m. (referred to as "morning") and from 11:30 a.m. until 3:30 p.m. (referred to as "afternoon"), for consideration as half-day factors. Obviously, the most comparable data for these locations was for the "afternoon" periods when it was daylight throughout.

Presence of X-Markings. The main effect studied in this research was the effect of the presence of the X-marking. Based on earlier observations and experience overseas, the hypothesis being tested was whether the presence of the X-marking would alter drivers' behaviors such that they would be less likely to stop on or near the railroad tracks.

Matching Before and After Samples. The data collection plan was to collect data on successive days, and schedule videotaping during the same days of the week in the before and after sampling phases. If it rained or was dry on both the Monday before and after, then both sets of data were used. If it was dry on one Monday but wet on the other, neither were used. Short duration rains on dry days were disregarded. The before-and-after samples were thus matched by season-of-year, day-of-week, and wet-or-dry weather conditions. Fog and other weather conditions did not occur.

3.3. Analysis Procedures

Scenarios. Analysis was conducted to determine whether observed differences in stops/1,000 cars associated with the presence of the X-marking and the other variables were reliably different for each of four basic scenarios. The four scenarios provide comparisons of the performance of the X markings at crossings. They are as follows:

- Before treatment in 1998 and after treatment in 1999 during Labor Day weekends at Barberville;
- Before treatment in Spring 1999 and after treatment in Spring 2000 at Barberville;
- Before treatment in late Spring 1999 and after treatment in Summer 2000 at Commerical Blvd in Ft. Lauderdale (test site); and
- Before treatment in late Spring 1999 and after treatment in Summer 2000 at Oakland Park Blvd. in Ft. Lauderdale (control site).

Data Collection and Preparation. The techniques used for processing the videotape images to extract and code the data are presented in Appendix B.

Analysis Tools. The primary statistical analysis procedure was the Analysis of Variance (ANOVA). This procedure makes assumptions that the effects are additive and linear, distributions are normal, measures are independent, and the variances are homogeneous. Modest departures from these assumptions will have little influence on the results, but can have greater influence if the ratio of variances (F Ratio) is close to the criteria for acceptance of a hypothesis that no significant difference exists between two sets of data. A rather stringent criterion was adopted for acceptance of the results as valid: the risk of a. Type I error or the alpha criterion = 0.01. That is, the probability of rejecting a hypothesis that is true is 1 time in 100, which is a rather low risk. For this analysis, the computer software SPSS 8.0 for Windows was used[1].

Presentation of Results. Results for each of the four scenarios are presented as follows:

- Factor identification table,
- ANOVA table and description of the outcomes, and
- Table of descriptive statistics and graphs (if appropriate) with implications regarding the use of the X-markings.

Complete data tables are included in Appendix C.

This analysis was then extended to answer the question as to whether the effect of the X-markings are transitory or are likely to persist. Also examined was whether there were general changes in drivers' stopping behavior (at least in the Ft. Lauderdale study area) that are not explained as changes (if any) due to the presence of the X-markings.

3.4. Barberville Labor Day Weekend Study

The first results of the study of the effectiveness of the European X-markings were obtained from the rural site at Barberville. At this site, four eight-hour tapes of video recordings of pre- and post-installation periods were obtained. All of data collected were suitable for inclusion in the analysis. The basic experimental design for this analysis is shown in table 3-1. Note that only lanes 2 and 3 were marked, although the right turning lane 1 allowed vehicles to back onto the tracks.

The value of N gives the number of sets of conditions available for testing each level of each variable. The total number of sets are (4 days) x (2 periods) x (3 lanes) x (4 zones) = 96. When analyzing lane 2, for example, the data for lanes 1 and 3 are irrelevant, resulting in (4 days) x (2 periods) x (1 lane) x (4 zones) = 32.

The results are shown in table 3-2 (note that the word "corrected" used with "model" and "total" is a statistical term referring to an a standard adjustment for the mean and does not refer to mistakes found in the data). Factors having a significance level less than 0.01 are accepted as being significantly different.

These results were reassuring in that all major factors expected to influence stopping behavior were significant at the 0.01 level. From table 3-2, it can be seen that significant differences were found between the evaluation periods ("before" and "after") as well as between the lanes and four zones within the lanes. It can also be seen that there is an interaction between the lanes and zones, which is to say that the stopping patterns differ between the inside and outside lanes.

From the ANOVA table, it can be seen that there was no interaction between the before and after periods with the other main variables. However, there are differences between the stoppage patterns for the critical zones within the lanes. This is illustrated in figures

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[1] Produced by SPSS Inc., Chicago, Illinois

Table 3-1. Factors in Analysis of Barberville Labor Day Study (Days = 4, used to calculate the error term in the ANOVA)

Independent Variable	Levels	Labels	N
Period	1	Before Installation	48
	2	After Installation	48
Lane	1	Lane 1	32
	2	Lane 2	32
	3	Lane 3	32
Zone	1	Prior to tracks	24
	2	On tracks	24
	3	After tracks	24
	4	In X area	24

Table 3-2. ANOVA Table for the Barberville Labor Day Study (Measure of Effectiveness: Stops/1,000 Cars)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Significance
Corrected Model	27389.903	23	1190.865	24.812	.000
Intercept	18645.866	1	18645.866	388.497	.000
PERIOD	865.140	1	865.140	18.026	.000
LANE	11114.658	2	5557.329	115.790	.000
ZONE	9746.773	3	3248.924	67.693	.000
PERIOD x LANE	344.465	2	172.233	3.589	.033
PERIOD x ZONE	261.608	3	87.203	1.817	.152
LANE x ZONE	4870.397	6	811.733	16.913	.000
PERIOD x LANE x ZONE	186.861	6	31.144	.649	.691
Error	3455.633	72	47.995		
Total	49491.402	96			
Corrected Total	30845.536	95			

3-2 and 3-3. When looking at these patterns for the pre- and post-installation conditions, similarities between the patterns can be observed, but the scale is different.

A dramatic reduction in stoppages of cars on or near the tracks occurred after the installation of the X-markings. The differences between stoppage rates within the designated X-area area were not significantly different. (See Appendix C for more

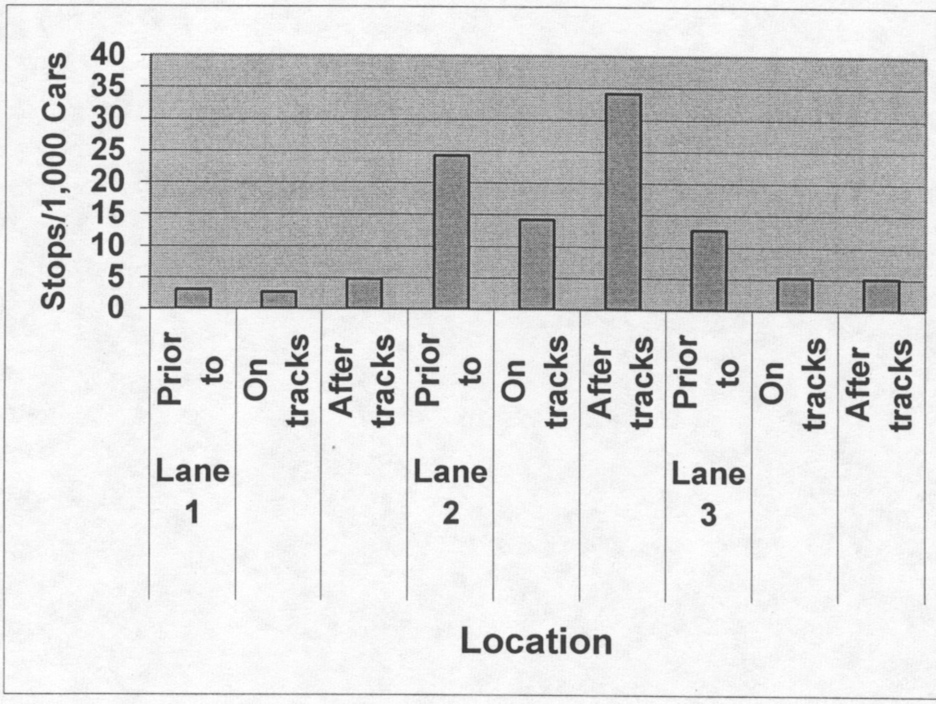

Figure 3-2. Stoppage Patterns for Barberville Labor Day Study Prior to Installation of European X Markings

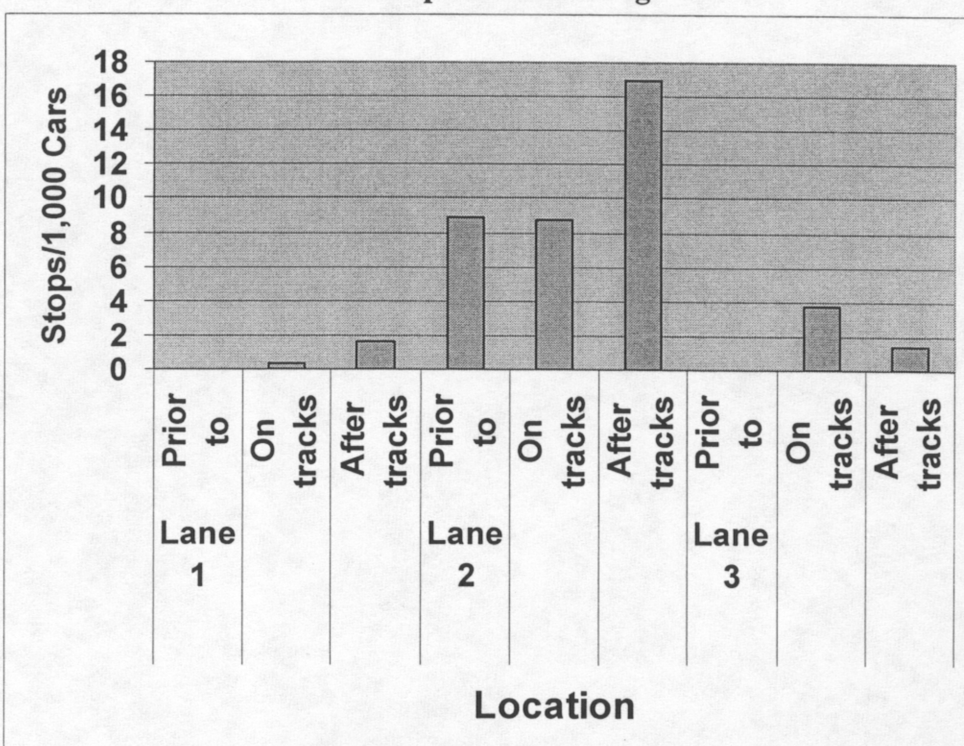

Figure 3-3. Stoppage Patterns for Barberville Labor Day Study After Installation of European X Markings

information.) The percentage changes for each lane and each of the three zones on or near the tracks are shown in figure 3-4.

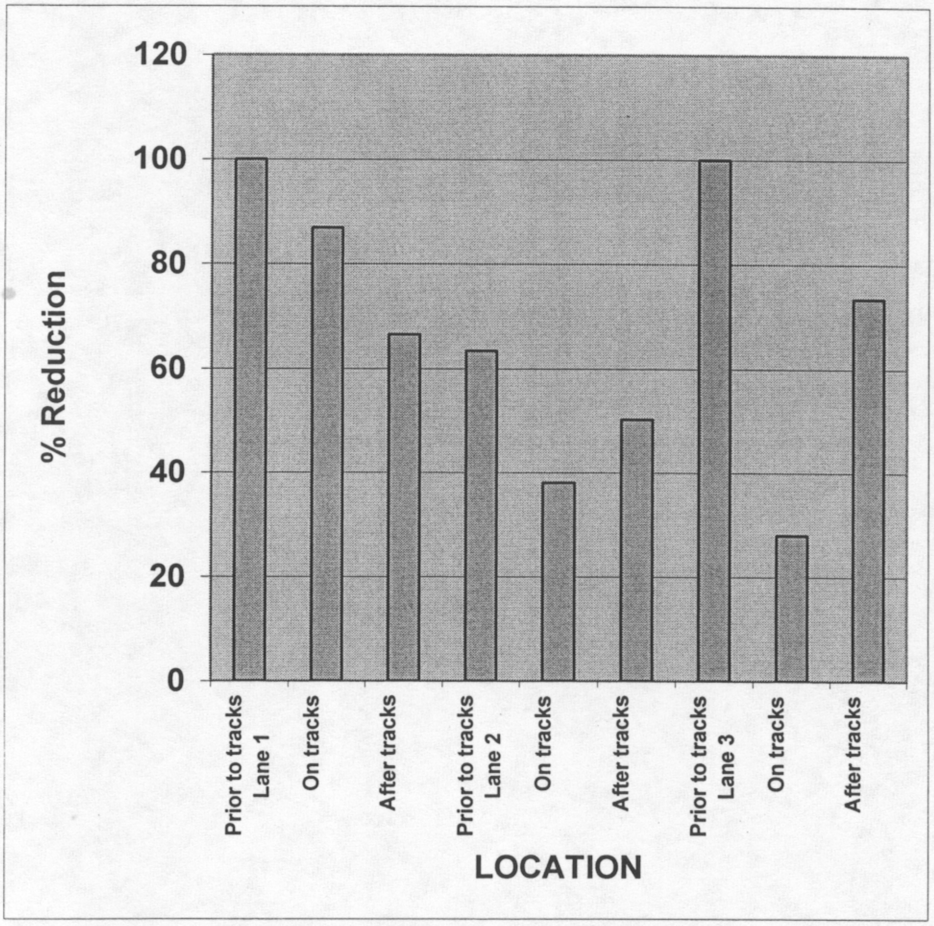

Figure 3-4. Percentage Reductions in Stops/1,000 Cars for Barberville Labor Day Study

3.5. Barberville Spring Study

The plan was for data to be taped for at least six consecutive days in the Spring study at Barberville. In the "before" phase of this study, 8 days of videotape were successfully recorded resulting in more than 60 hours of useful data. However, during the "after" phase, only 5 days totaling about 40 hours of useful data were obtained due to unexplained intermittent camera stoppages (probably from electrical storms), unexplained blank sections of videotape and rain. The basic experimental design for this analysis is shown in table 3-3.

From table 3-4, it can be seen that the evaluation periods ("before" and "after") are significantly different as are the lanes and four zones within the lanes. These results were again reassuring, in that all major factors expected to influence stopping behavior were

Table 3-3. Factors in Analysis of Barberville Spring Study (Days = 5, used to calculate the error term in the ANOVA)

Independent Variable	Levels	Labels	N
Period	1	Before Installation	60
	2	After Installation	60
Lane	1	Lane 1	40
	2	Lane 2	40
	3	Lane 3	40
Zone	1	Prior to tracks	30
	2	On tracks	30
	3	After tracks	30
	4	In X area	30

significant at the 0.01 level. It can also be seen that there are interactions between the "period and the lane" as well as between the "lane and zone."

These interactions called for a closer look at the stoppage profiles. Figures 3-5 and 3-6 show these profiles. As in the previous examination, only the stoppages on or adjacent to the tracks are compared. Again, it is important to be mindful that the scales of these two figures are much different.

Table 3-4. ANOVA Table for the Barberville Spring Study (Measure of Effectiveness: Stops/1,000 Cars)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Significance
Corrected Model	34661.200	23	1507.009	31.702	.000
Intercept	20339.646	1	20339.646	427.870	.000
PERIOD	1195.445	1	1195.445	25.148	.000
LANE	15050.173	2	7525.086	158.300	.000
ZONE	10545.144	3	3515.048	73.943	.000
PERIOD x LANE	2397.434	2	1198.717	25.217	.000
PERIOD x ZONE	198.565	3	66.188	1.392	.250
LANE x ZONE	5044.945	6	840.824	17.688	.000
PERIOD x LANE x ZONE	229.495	6	38.249	.805	.569
Error	4563.549	96	47.537		
Total	59564.395	120			
Corrected Total	39224.748	119			

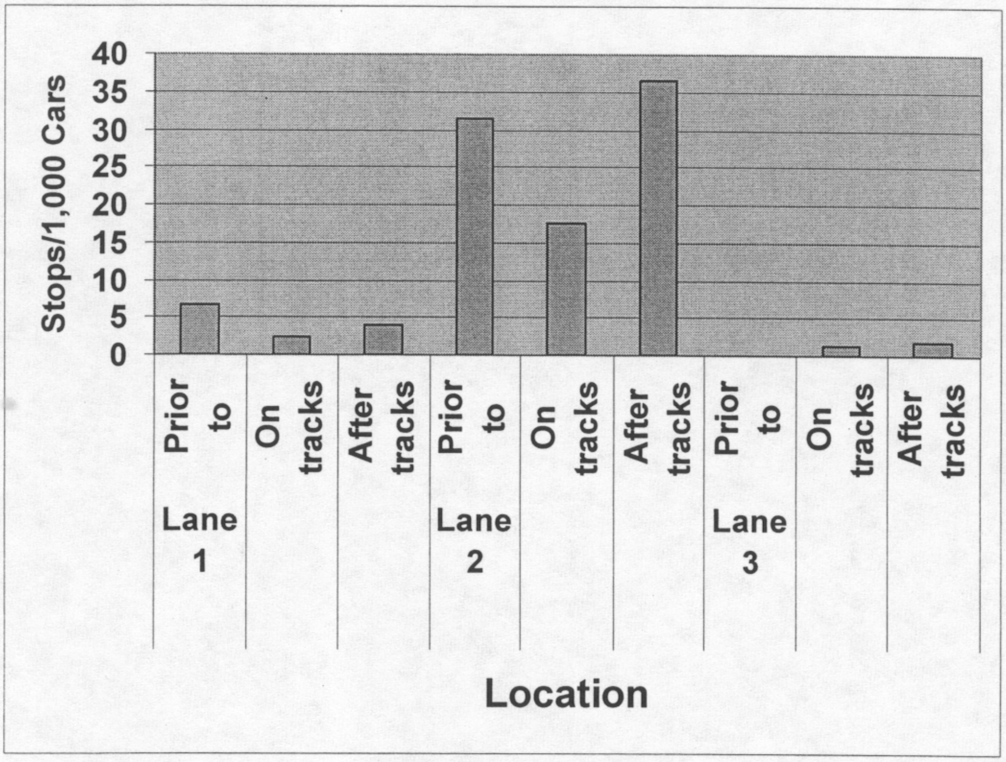

Figure 3-5. Stoppage Patterns for Barberville Spring Study Prior to Installation of European X Markings

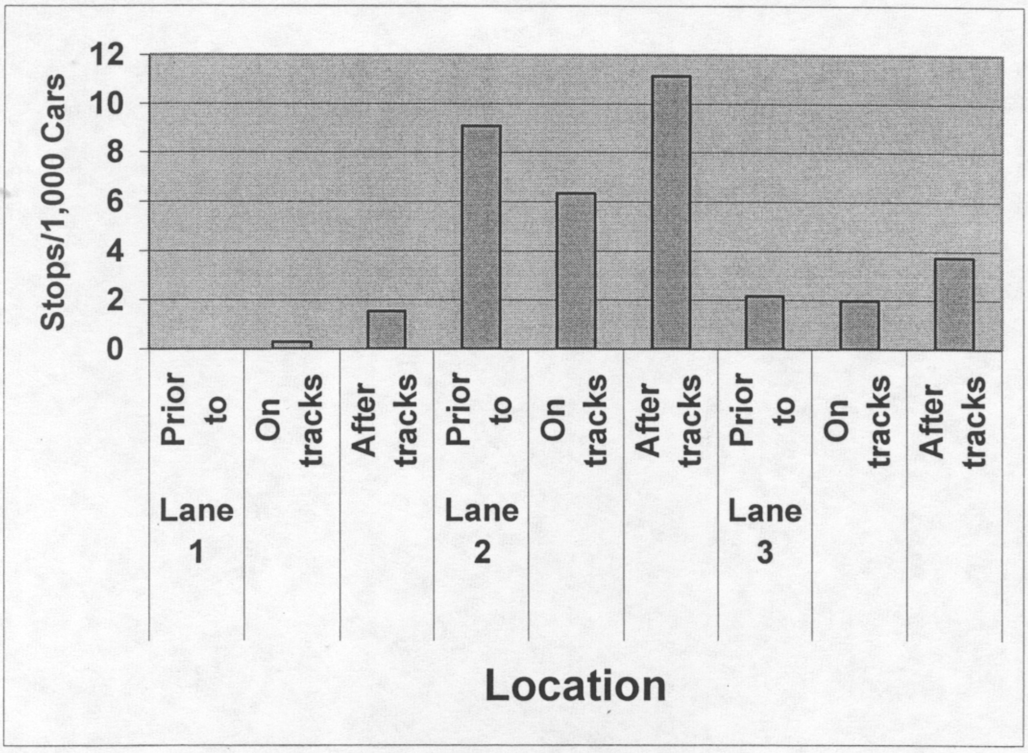

Figure 3-6. Stoppage Patterns for Barberville Spring Study After Installation of European X Markings

As with the Labor Day study, the percentage changes between the stoppage rates for each of the Barberville lanes and the critical zones within the lanes were plotted as shown in figure 3-7. The picture that emerges is not as clean-cut as in the earlier analysis, in that there were increases in the stoppage rates in all zones for lane 3. Notwithstanding this situation, the overall rate still decreases dramatically because the relative stoppage rates are low for lane 3.

Figure 3-8 shows the overall trend in stoppage rates at the Barberville site. Periods 1 and 2 are associated with pre-installation of the European X (September 1998 and Spring 1999). Periods 3 and 4 are post-installation (September 1999 and Spring 2000). Figure 3-8 includes all of the reduced data, including data not included in the prior analysis. Figure 3-9 compares the first and the last periods, suggesting a 68% overall reduction in stops across all lanes and critical zones (corresponding to an overall decrease in 7.75 stopped cars per thousand cars in the critical zones on and adjacent to the tracks).

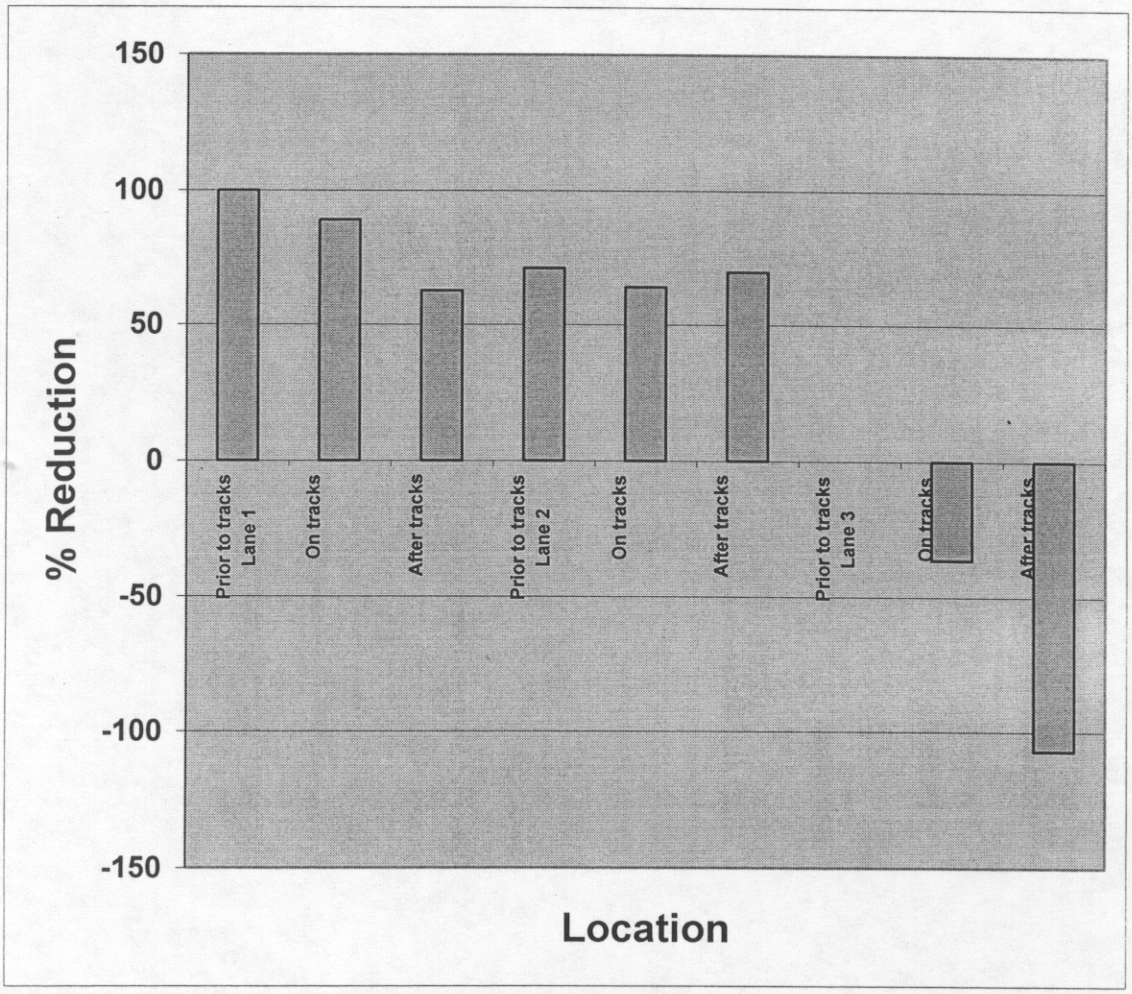

Figure 3-7. Percentage Reduction in Stops/1,000 Cars for Barberville Spring Study

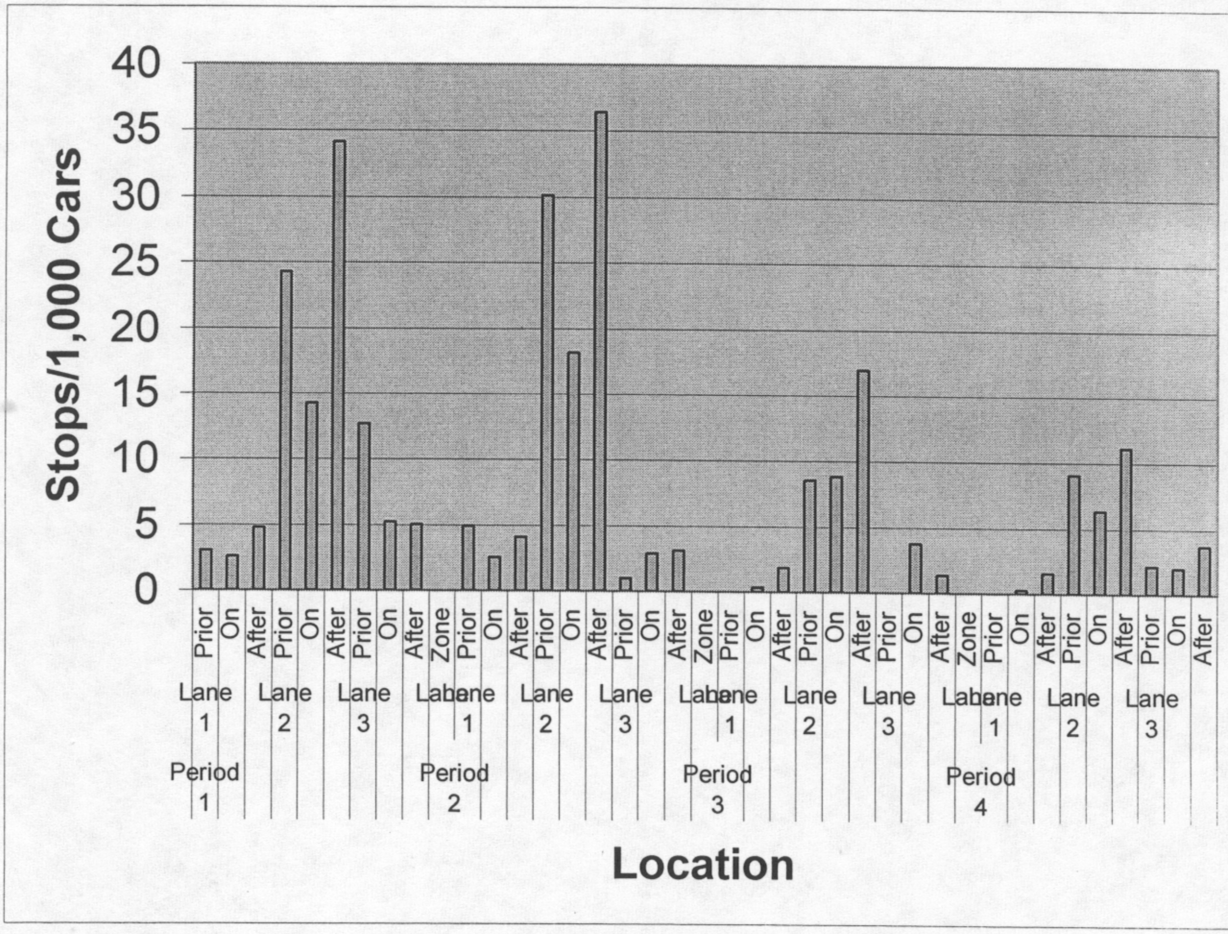

Figure 3-8. Stoppage Rate Over Four Study Periods for Barberville (1½ Year Duration)

3.6. Commercial Blvd Study

The test site at Commercial Blvd in Ft. Lauderdale is an example of a highway-railroad crossing in an urbanized area that has been subjected to a variety of treatments aimed at reducing incidents. In addition to a "DO NOT STOP ON TRACKS" sign, it had blinking lights that were triggered, after a few seconds of delay (in case cars still moving might clear the area), by detectors in the pavement when queues from the intersection traffic signal extended back into the vicinity of where the X-box was located. About one train per hour came through the crossing.

At this site, six eight-hour tapes of video recordings were obtained during both the before and after installation phases of the study. From these tapes, weather conditions and days-of-week allowed five days of data (approximately 40 hours for each phase) to be matched. The basic experimental design for this analysis is shown in table 3-5.

The results, shown in table 3-6, were less assuring than at Barberville. Although the differences between stoppage patterns associated with lanes, the four zones within lanes,

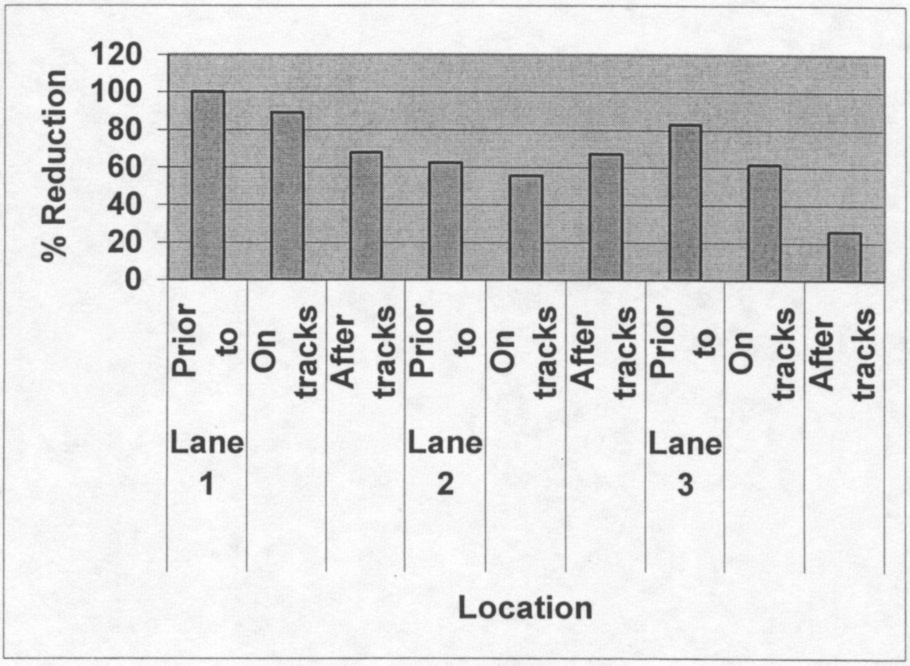

Figure 3-9. Percentage Reductions in Stops/1,000 Cars for Barberville Between First Pre-Installation and Last Post-Installation Periods

and morning and afternoon half-days were significant at the 0.01 level, the differences between the pre-installation and post-installation conditions were clearly not significant. For some reason the stoppage rate was found to be higher during afternoons than during mornings, both before and after the X-marking installation. The stoppage rates in all zones in lane 1 were virtually negligible both before and after the X-marking installation, probably because the left-turn queues did not often extend back to the tracks. The stoppage rates in lane 4 more than doubled from before to after, almost offsetting

Table 3-5. Factors in Analysis of Commercial Blvd Study (Days = 5, used to calculate the error term in the ANOVA)

Independent Variable	Levels	Labels	N
Period	1	Before Installation	160
	2	After Installation	160
Half-Day	1	Morning	160
	2	Afternoon	160
Lane	1	Lane 1	80
	2	Lane 2	80
	3	Lane 3	80
	4	Lane 4	80
Zone	1	Prior to tracks	80
	2	On tracks	80
	3	After tracks	80
	4	In X area	80

Table 3-6. ANOVA Table for the Commercial Blvd Study (Measure of Effectiveness: Stops/1,000 Cars)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Significance
Corrected Model	19570.499	63	310.643	9.317	.000
Intercept	13523.900	1	13523.900	405.604	.000
PERIOD	55.228	1	55.228	1.656	.199
HALF-DAY	254.006	1	254.006	7.618	.006
LANE	4434.584	3	1478.195	44.333	.000
ZONE	7878.429	3	2626.143	78.762	.000
PERIOD * HALF	4.423	1	4.423	.133	.716
PERIOD * LANE	1716.662	3	572.221	17.162	.000
HALF * LANE	214.525	3	71.508	2.145	.095
PERIOD * HALF * LANE	308.420	3	102.807	3.083	.028
PERIOD * ZONE	32.858	3	10.953	.328	.805
HALF * ZONE	66.717	3	22.239	.667	.573
PERIOD * HALF * ZONE	42.142	3	14.047	.421	.738
LANE * ZONE	2947.329	9	327.481	9.822	.000
PERIOD * LANE * ZONE	1265.916	9	140.657	4.219	.000
HALF * LANE * ZONE	93.530	9	10.392	.312	.971
PERIOD * HALF * LANE * ZONE	255.730	9	28.414	.852	.569
Error	8535.713	256	33.343		
Total	41630.111	320			
Corrected Total	28106.211	319			

reductions in the inside lanes. An overall increase of 75% occurred in the stoppage rates in the three hazard zones of lane 4. The cause of these increases is unknown. The stoppage rate in the X-box in lane 4 increased 169%, which was not undesirable, but was unexplained. To see if the large increase in the stoppage rate in the X-box in lane 4 might be offsetting significant reductions in the inside lanes, the ANOVA was performed selecting only the three hazard zones in each lane. Significant differences still were not found between the before and after installation periods.

Further examination of the data suggests that there was a positive effect of the European X markings for the inside lanes, about a 50% reduction in stoppage rates over the three hazard zones in both lanes, with a 41% reduction in stoppages in the X-boxes. It can also be seen in table 3-6 that several interactions are significant. The interaction between the before and after periods with the combination of lanes and zones was significant. There is also a significant interaction between period and lane. Accordingly, these variables were examined more closely for the inside lanes (i.e., lanes 2 and 3, which displayed the most stable improvements between the before and after periods). Figures 3-10 and 3-11 show the patterns of stoppage rates for the inside lanes at the Commercial Blvd crossing for the pre-installation and post-installation conditions, respectively. Although no further statistical analysis was conducted, it can be observed that the patterns are very similar for these two lanes, but show a difference in scale. In figure 3-12, it can be observed that there is consistency in the differences. The results suggest that the X-markings may have a positive effect on critical stoppage rates for the inside lanes, but no improvement on the exterior lanes, and an overall insignificant effect.

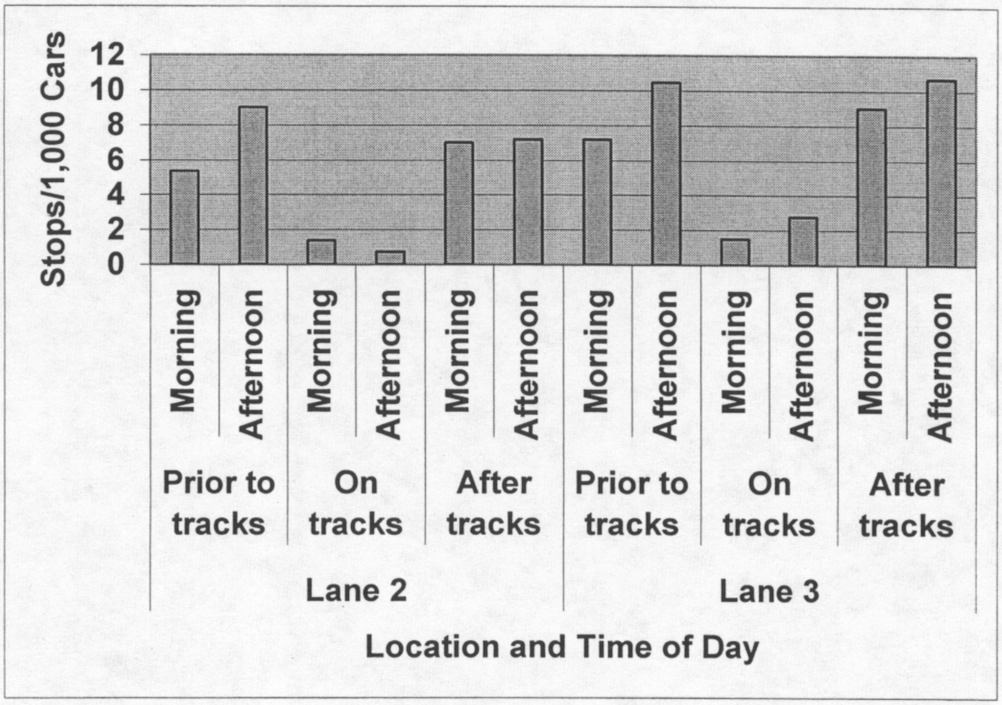

Figure 3-10. Stoppage Patterns for Inside Lanes on Commercial Blvd Before Installation of European X Markings

3.7. Oakland Park Blvd Study

The control site at Oakland Park Blvd in Ft. Lauderdale was selected because many of the conditions were similar to those at Commercial Blvd. It also had about one train per hour because it was crossed by the same track as Commercial Blvd. It is another example of a highway-railroad crossing in an urbanized area that has been subjected to supplementary treatments aimed at reducing incidents. It displayed a blinking light when queues from the intersection traffic signal extended back into the vicinity of the crossing.

The major difference between the two roadways studied is that Oakland Park Blvd has three lanes rather than the four at Commercial Blvd. Accordingly, an integrated experimental analysis design that incorporates both data sets from both locations is

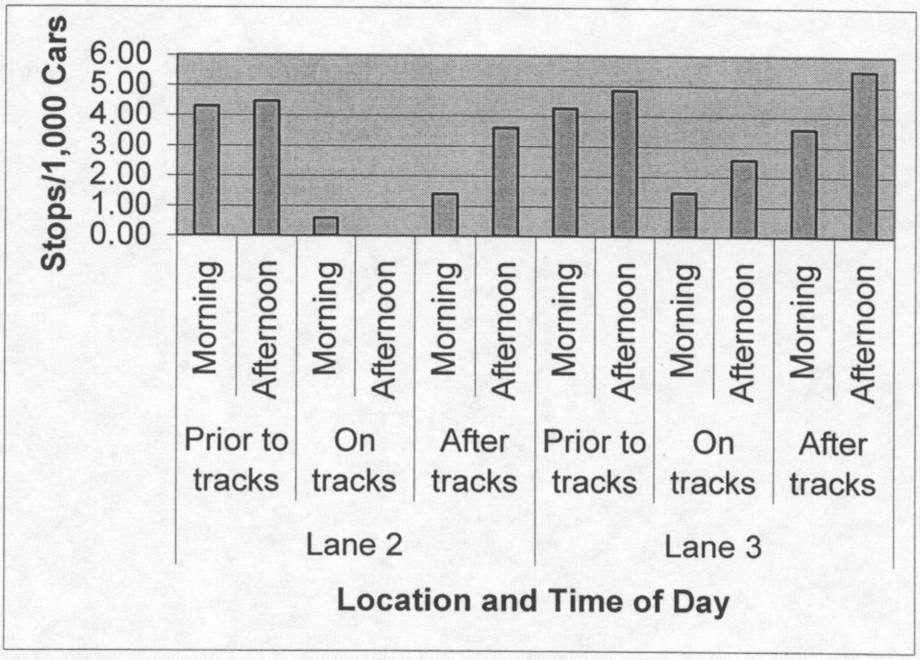

Figure 3-11. Stoppage Rate Patterns for Inside Lanes on Commercial Blvd After Installation of European X Markings

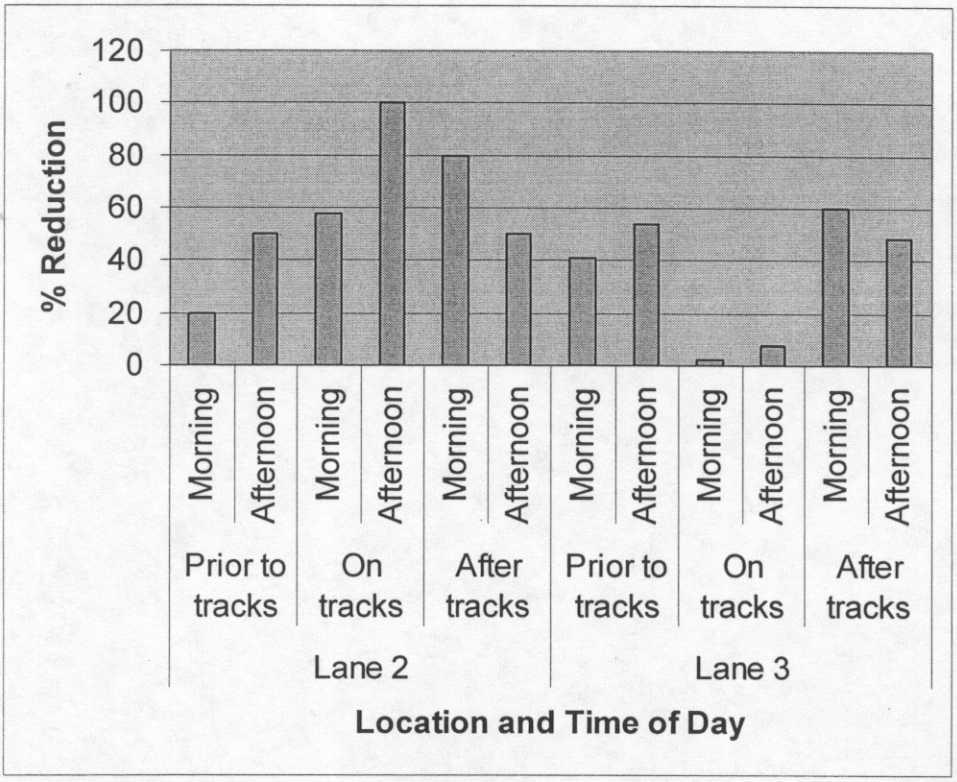

Figure 3-12. Percentage Reductions in Stops/1,000 Cars for Inside Lanes on Commercial Blvd

difficult to achieve. Furthermore, the amount of data reduced from the control location was considerably less than available for the test location. At this site, six 8-hour tapes of video recordings were obtained during both the before and after installation phases of the study. From these tapes, only one day could be matched, although all data was reduced for the six days during the before condition. Accordingly, limited data (one 8-hour day) were used for determining whether there are statistical differences between the two time periods. Two time periods on single days were used to calculate the error term in the ANOVA, but the half-day variable was not included as a separate factor because there was only a single sample of each half-day during the before and after periods. Even without the half-day factor as a separate variable, this data structure only had two samples to compare between the before and after periods. The basic experimental design for this analysis is shown in table 3-7.

Table 3-7. Factors in Analysis of Oakland Park Blvd Study (Days =1 & Half-Days = 2, used to calculate the error term in the ANOVA)

Independent Variable	Levels	Labels	N
Period	1	Before Installation at Test Site	24
	2	After Installation at Test Site	24
Lane	1	Lane 1	16
	2	Lane 2	16
	3	Lane 3	16
Zone	1	Prior to tracks	12
	2	On tracks	12
	3	After tracks	12
	4	In X area	12

Although very little data were available to test whether there were differences between the periods of data collection at the control site, the results shown in table 3-8 were reassuring in that the lane variable, as expected, showed a significant difference. The zone variable approaches significance and probably would have reached the critical level had more data been analyzed. More importantly, the differences between the pre-test and post-test periods are not significant nor are any of the interactions. These results indicate that any effects related to the installation of the X-markings at Commercial Blvd are most likely not attributable to other random variables.

3.8. Summary

The X-markings were successful in significantly reducing stoppages at hazardous locations on or near the track at the rural site in Barberville.

Unfortunately, the statistical analysis of the pre- and post-installation of X-markings does not indicate, overall, that the presence of the X-markings was helpful in significantly reducing stoppages on or near the tracks in the urban setting in Ft. Lauderdale.

Table 3-8. ANOVA Table for the Oak Park Blvd Study (Measure of Effectiveness: Stops/1,000 Cars)

Source	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Level of Significance
Corrected Model	655.867	23	28.516	2.860	.007
Intercept	271.035	1	271.035	27.183	.000
PERIOD	2.960	1	2.960	.297	.591
ZONE	74.939	3	24.980	2.505	.083
LANE	377.116	2	188.558	18.911	.000
PERIOD * ZONE	13.357	3	4.452	.447	.722
PERIOD * LANE	19.008	2	9.504	.953	.400
ZONE * LANE	114.068	6	19.011	1.907	.121
PERIOD * ZONE * LANE	54.419	6	9.070	.910	.505
Error	239.295	24	9.971		
Total	1166.197	48			
Corrected Total	895.162	47			

CHAPTER 4

RESULTS AND RECOMMENDATIONS

The results of this study have to be considered in two parts. First is the application of the European X markings to highway-railroad crossing locations that have relatively few other treatments to help motorists comply with official regulatory signs and markings. The second application of such markings is at locations where other devices and treatments are already in place to help reduce hazardous behavior of motorists at crossings.

The study conducted at a rural location in Barberville, Florida exemplifies the first case. In such a case, the X-marking treatment is likely to be noticed by motorists because it stands out. Here the X-marking provides a conspicuous and dominant cue to motorists that they should avoid stopping on or near the tracks. During periods when warning lights and gates are not activated there are few other indicators as to where the vehicle should stop. When traffic volumes are relatively low, the likelihood that motorists will notice an X-marking is relatively high.

The second study, conducted in Ft. Lauderdale, assessed drivers' responses to the X-markings in a "busy" urban environment. Such a treatment is more likely to blend into the background because of the presence of other crossing-related signs, signals, and markings as well as motorists' heavier information processing loads. This is especially true when traffic volumes are high and trucks and other large vehicles block drivers' forward views of the roadway as they approach a crossing. European X markings in this later context must be thought of as incremental information to be used to increase appropriate crossing behaviors (i.e., not stopping on or near the tracks).

The results of the assessment of the European X markings at the Barberville location provide convincing evidence of a sustained improvement in motorists' behaviors at this crossing. Following installation of the X-markings, an immediate overall reduction of 36% in the stoppage rates was observed on and adjacent to the tracks. The results were even more dramatic for stoppage on the tracks, with a reduction of 42%.

In the second study at Barberville, the results were similar. This reduction, after a 7-month interval between installation of the marking and data collection, yielded a decrease of 39% in the stoppage rate on or near the tracks. During this period, a reduction of 60% in the stoppage rates on the tracks occurred. The benefits of the X-markings are concluded to be lasting rather than diminishing over time.

The test site at Commercial Blvd in Ft. Lauderdale provided less reassuring results. The ANOVA revealed that overall there was not a significant reduction in the car stoppage rates after installation of the X-markings. Likewise, the control site at Oakland Park Blvd showed no significant changes in stoppage rates between the pre- and post- installation periods. However, the inside through-lanes (Lanes 2 and 3) at Commercial Blvd showed a slightly different picture. Although the stoppage rates were not consistent for these locations, there were reductions on and near the tracks after installation of the X-markings. For example, reductions of stoppages on the tracks for lane 2 was 72%, although for lane 3, only 6%. The decreases certainly suggest that no harm was done with the installation of the X-markings in these lanes, but they do not show a consistent improvement in driver responses. The X-markings might have proved more valuable if blinking lights and other supplementary devices did not exist, but testing this was beyond the scope of the study.

Stoppages on or near the tracks were relatively low in both the left and right outside lanes at all sites with or without the X-markings. The right lane at Commercial Blvd and at Barberville during the Labor Day study showed slight counterproductive results. This might have been due to random variation because the stoppage rates on or near the tracks were generally low both before and after the installation of the X-markings. These slight increases were more than offset by decreases in the inside lanes and did not indicate that any harm was caused by the X-markings.

From the studies in Barberville, the results are clear and point to increased safety benefits from applying the X-marking more widely at crossings situated close to rural intersections or other intersections that are uncluttered.

From the studies in Ft. Lauderdale, the results also are clear and suggest that there is little, if any, benefit to be achieved by application of the European X markings in settings where there already exists supplementary signs, signals and/or markings aimed at improving motorists' compliance at crossings, along with heavy traffic volumes and aggressive urban drivers. However, because of the relatively low cost of the X-markings, it may be appropriate to include them in some groupings of measures implemented to reduce stoppage on or near railroad tracks, especially for uncluttered urbanized locations with moderate or low traffic volumes. Use of the European X markings did not result as being harmful at urban crossings.

Part of the reason for lesser effectiveness of the X markings at urban crossings having heavier traffic volumes may be that traffic densities increase with traffic volumes, and as vehicles travel closer together, motorists have shorter views of, and less time to view, the pavement ahead in addition to more distractions competing for their attention. It is also possible that unfamiliarity with the X marking required more time for study by motorists to understand its message, which was not fully available at the urban site. If the X-box was in common use where motorists were readily familiar with its meaning, it might improve in effectiveness because motorists might begin relying on the use of the X marking to determine if sufficient space for their vehicles was available.

The X-box length of 25 feet seemed to perform well even though it is shorter than the length of some vehicles. For placement of the X-box, it is recommended that it be located nominally 10 feet from the farthest rail. This is 5 feet less than the 15-foot buffer usually desired by design standards, but there is 5 more feet in the box than the longest passenger cars. Placing the box further from the track may lead motorists to think that the box does not need to be completely clear for them to have enough space to cross the track.

For the X-markings to be of value in any setting they must be able to be seen by motorists at appropriate distances in advance of a crossing. Humped crossings can obscure visibility of pavement markings located immediately past the track. A track elevated only one inch above the pavement at the X marking can interfere with a motorist's view of the X marking at the position from where it needs to first be seen.

While all of the study sites had flashing lights and gates at the track, there is no reason to suspect that the European X marking would not be similar in effectiveness at passive crossings, or crossings with flashers only, where nearby intersection traffic signals, or other intermittent traffic impediments, create risks of queues backing up towards a track. Over most of every observation period in this study, the flashers and gates were not under actuation by approaching trains, so most of the data collected were under conditions similar to what would exist with other types of railroad crossing warning devices.

If additional installations of European X markings are implemented, it would be judicious to monitor such locations to help develop guidelines for extended applications.

APPENDIX A

VIDEO CAMERA AND RECORDER INSTALLATIONS

The Ft. Lauderdale locations posed greater challenges for setting cameras and other equipment and are used to illustrate the installation procedures. The European X marking was deployed at the Commercial Blvd. railroad grade crossing as a test site, and the Oakland Park Blvd crossing was used as a control site. During the original planning, consideration was given to conducting another "before-after" study at another Broward County crossing; however, a suitable crossing with a workable video camera vantage point could not be found.

Initially, each of these sites was inspected to determine what, if any, facilities were available for mounting a camera and a cabinet to house the video recorder. The two most important considerations for a potential vantage point were the field of view and the availability of 115 volt ac power.

It was attempted to avoid facilities not owned by the Florida DOT or Broward County because of the difficulty in obtaining permission to attach equipment. In addition, the cost of installing an underground electrical service precluded the use of facilities where power was not already available. This limited the options considerably. Field visits confirmed that there were no existing poles meeting the selection criteria at any of the Broward County sites. The installation of wooden poles with electrical service was undesirable for several reasons, including the brief and temporary nature of the study, and the lack of resources to carry out such an installation.

After considering several options, it was decided to use a temporary telescoping pole clamped to an existing sign or attached to a support pole at each site, and to obtain power from the cabinet that served a flashing beacon on each pole. The telescoping pole enabled the camera to be raised to a height of approximately 20 feet above ground. The cabinet for housing the video recorder was mounted on the same pole, immediately above the flasher service cabinet. A photograph of the installation at Commercial Blvd., as originally proposed, is shown in figure A-1.

This figure shows the sign support pole with the camera on the telescoping pole attached temporarily. It also shows the proposed location of the video recorder enclosure above the flasher cabinet, with 115 volt ac power obtained from the flasher cabinet. With a very wide angle lens, an adequate field of view was obtained from this location.

The other location was more difficult because of differences in the flasher pole installation. The telescoping pole was subsequently accommodated at the Oakland Park Blvd site using extended mounting clamps for greater clearance as shown in figure A-2.

The installation of the housing for the video recorder at the Barberville site was similar to the one at the Commercial Blvd location. The video camera, however, was mounted on a high existing pole as shown in figure A-3.

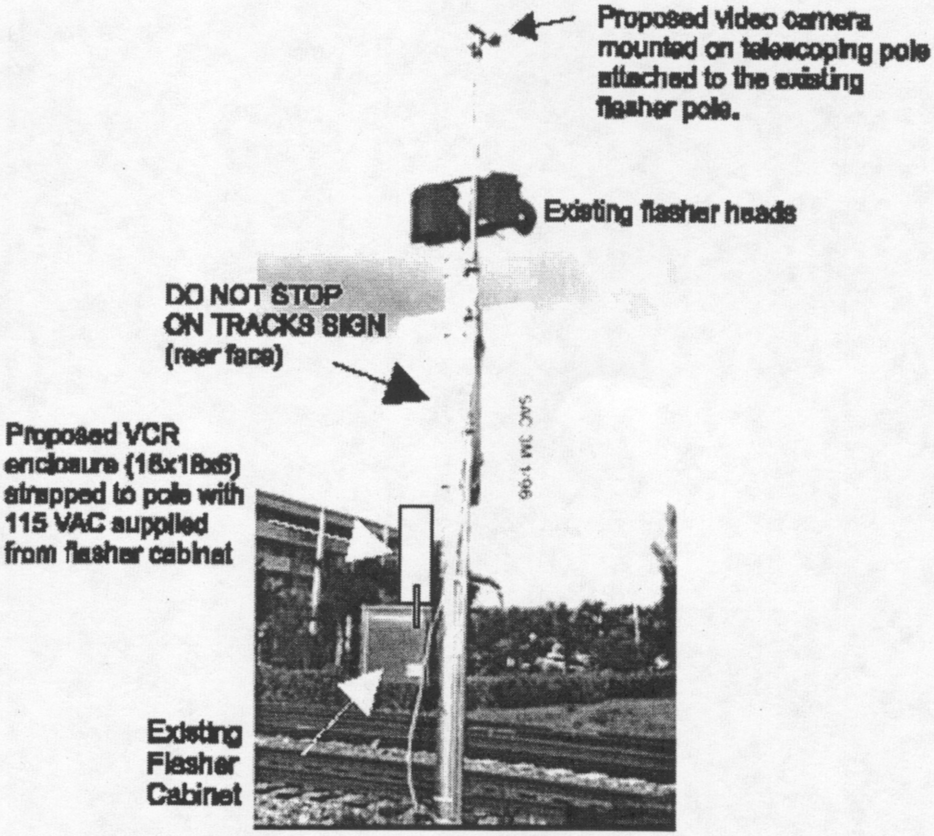

Figure A-1. Installation of Camera and Recorder Box at Commercial Blvd

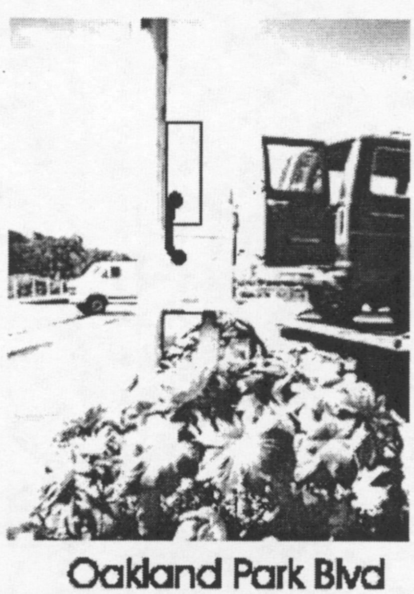

Figure A-2. Installation of Recorder Box at Oakland Park Blvd

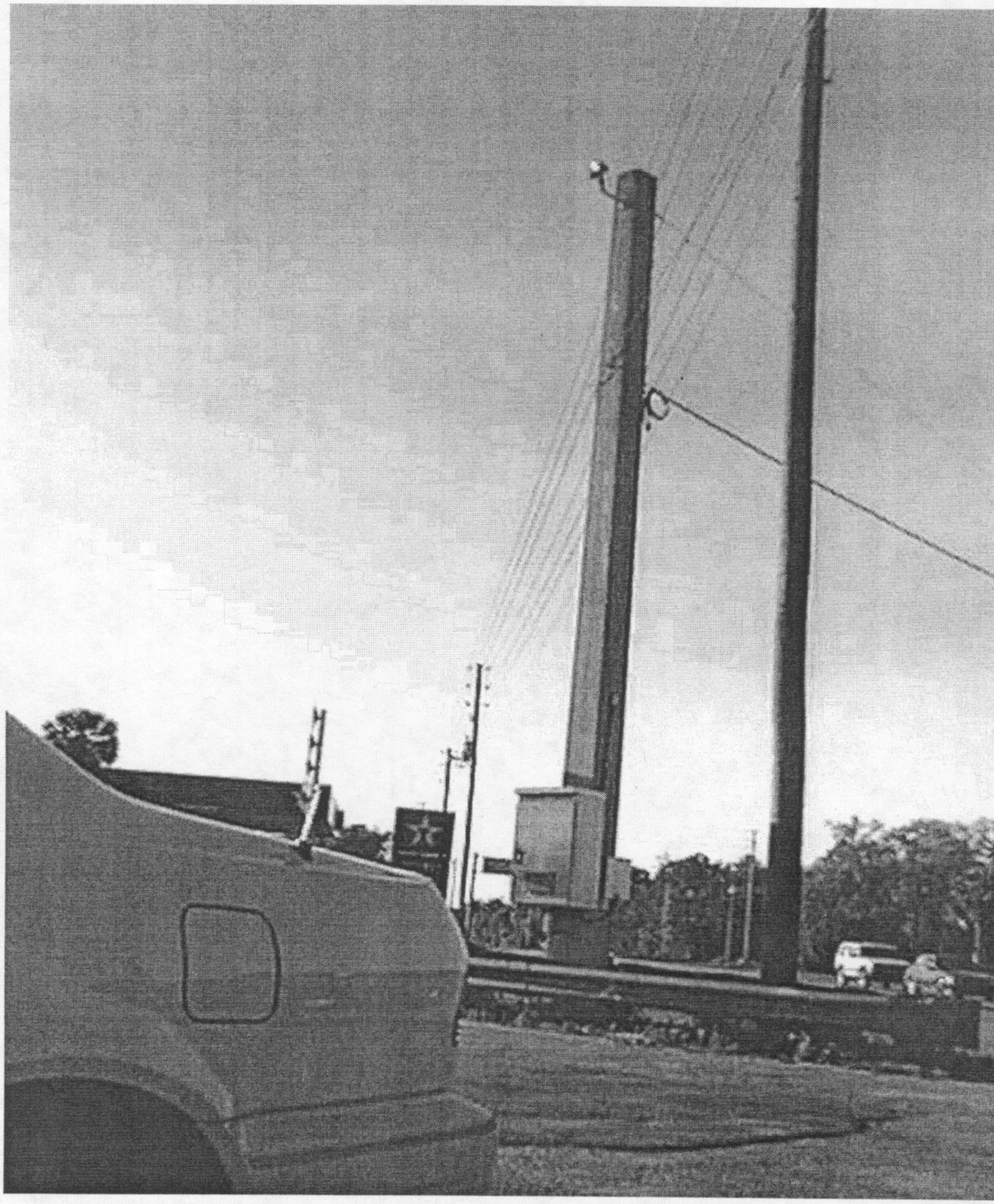

Figure A- 3. Camera Mounted at Barberville Highway-Railroad Crossing

APPENDIX B

ANALYSIS PROCEDURES

B.0. Overview of Analysis Procedures

The analysis procedure consisted of six steps including:

- Continuous recording of events at each of the crossing sites using a video recorder,
- Playing the videotape back in the office and using a voice recognition system to translate the events to codes that corresponded to each stopped vehicle location, vehicle type and passing vehicle,
- Editing the text files generated by the voice recognition system,
- Calculating the frequencies of events including the location of stopped vehicles for all vehicle types,
- Developing arrays of the data by each of the independent variables and the measure of effectiveness employed in the study (stops/1,000 vehicles), and
- Generating statistical tests and performing graphical analysis of the data.

Most of the steps were automated, but the voice coding and editing steps were rather manually intensive. Each of these steps is described in greater detail in the following sections. (See figure B-1 for a diagram of the flow of information in the analysis process.)

B.1. Recording of Events

Once the camera and video recorder were in place, the task of recording was very straightforward. According to a schedule that allowed for comparable time periods and days-of-week, tapes were marked and inserted into the video recorder at the beginning of the day of data collection. The recorders used operated on 115 volt ac and cut off at the end of recording of the 8-hour tapes that were used. Starting times varied by as much as one or two hours at the Barberville site. At the Ft. Lauderdale site, taping began at approximately 7:30 a.m. on each day of data collection and was concluded at approximately 3:30 p.m.

During data collection, rain and wind were encountered, but no electrical outages. Rain drops caused minor distortions for brief periods on some of the recorded images but these data were not used in the analysis. There was also some intermittent operation on one of the tapes from unknown causes and this tape was also not used in the analysis.

Several camera lens types were used to determine the best field of view and clarity of the images. Had dynamic information such as vehicle speed or acceleration or deceleration been required, the lens focal length and quality would have been important.
Data were recorded with a narrow-angle lens during the first three data collection periods at Barberville and during all periods in Ft. Lauderdale. A wide-angle lens was used for the final data collection period at Barberville. All camera lenses used were acceptable

because all that was needed was to count passing vehicles and to determine where stoppages occurred. The narrower angle lenses were able to cover all of the fields of view that were needed and provided a little better clarity, so they performed best. An example of a video frame taken with a narrow-angle lens is shown in figure B-2.

B.2. Translating Video Images into Coded Events

The processing of the videotape required the analyst to look at the moving scene recorded on the videotape and to verbally indicate what type of vehicle that passed through the crossing area, by lane and vehicle type. If the vehicle stopped in one of four designed areas the zone would be coded accordingly. Reference lines and marks were drawn on the video display monitor to assist the identification of vehicle positions.

Vehicle types were coded and used in the preliminary analysis. These included vehicle types such as trucks, vehicles with following trailers, vehicles with following boats, recreational vehicles, buses, school buses, motorcycles, and other configurations that were labeled as "special" (unusual situations such as a bicyclist hauling a cart).

Other details were also recorded as events by the analyst, although this information was not used directly in the European X evaluation study. These events included the onset of gates descending ("warning"), a train entering a crossing ("train"), gates ascending ("warning off"), the onset of a queue in a lane ("queue"), and the dispersion of the queue ("dispersed").

After the video data were coded, it was categorized and analyzed to determine the frequency of hazardous events associated with crossing behavior. This procedure required lane counts and the classification of all vehicles that halted at locations near or in the path of an oncoming train.

The specific technique used to translate vehicle crossing behavior required the use of a videotape playback machine with a counter, a timer, and a personal computer with a voice recognition program, Dragon System's *Naturally Speaking Preferred.* The analyst started a videotape, noted the playback counter, set a 15-minute timer, and then recited events occurring on the tape for the next 15-minute segment. Coding involved simply providing numerical information followed by the word "comma" (followed by an occasional "new line" in the language of the voice recognition system), and as indicated above, other information (e.g., truck, bus, school (for school bus), trailer (for vehicle and recreational trailer combination) or special (for any unusual vehicle type). This coding required speaking into a microphone and saving the data at the end of each 15-minute segment.

Counts of vehicles that halted within the designated zones were coded by reciting a 2-digit number where the first digit indicates the lane number (numbered sequentially from

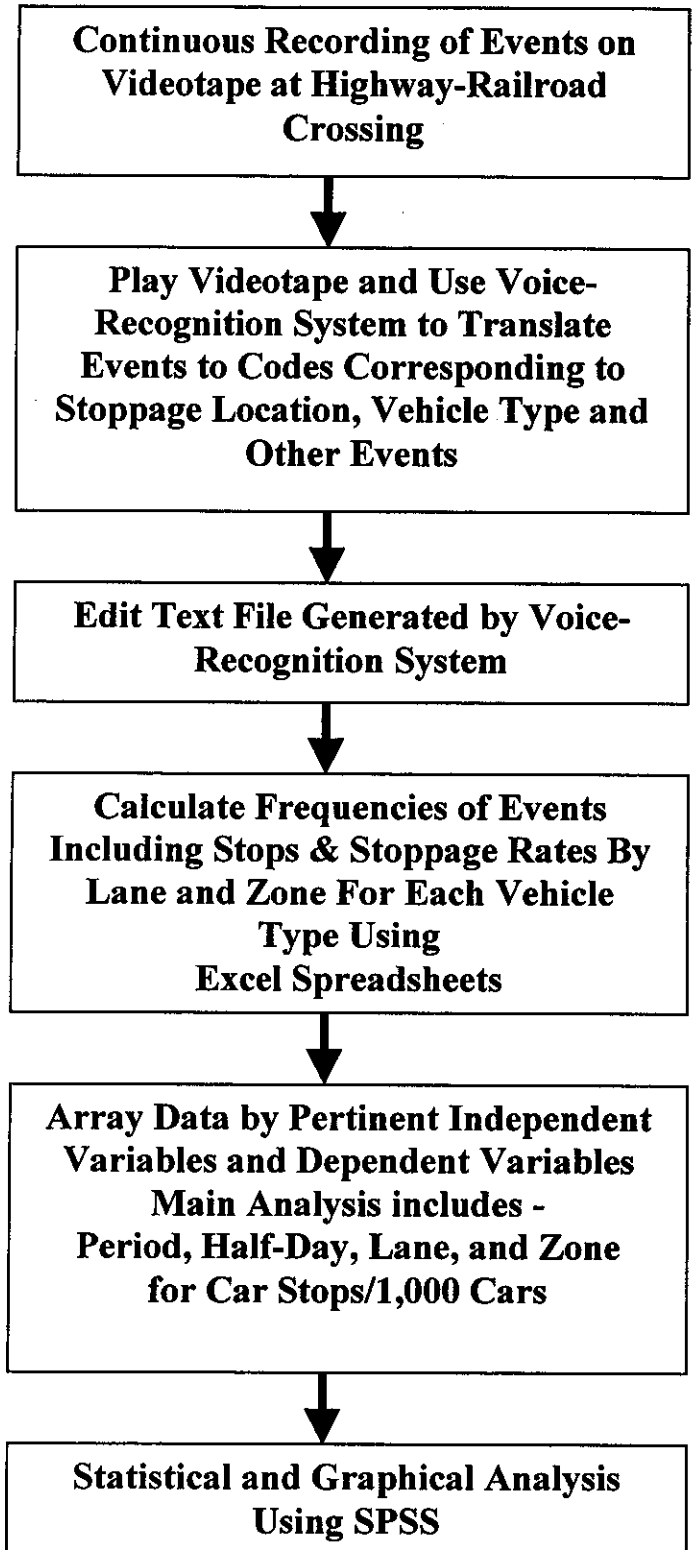

Figure B-1. Data Acquisition and Analysis Process

Figure B-2. Camera View of Barberville Highway-Railroad Crossing

left-turn lane to right-turn lane), and the second digit indicated the stopping zone (numbered in travel sequence) as shown in table B-1.

Table B-1. Event Location Codes

		Vehicle Lane			
Vehicle Action	**Zone**	**Lane 1**	**Lane 2**	**Lane 3**	**Lane 4**
Halts Within 5 ft Prior to Track	**1**	**11**	**21**	**31**	**41**
Halts over Track	**2**	**12**	**22**	**32**	**42**
Halts Within 5 ft Past Tracks	**3**	**13**	**23**	**33**	**43**
Halts Within X-Area	**4**	**14**	**24**	**34**	**44**

Counts of vehicles that did not halt within the designated areas were simply coded by a single digit, 1,2,3, or 4 corresponding to the lane. If the vehicle was a non-passenger car (e.g., truck, bus, school bus, vehicle pulling trailer, etc.) then the vehicle type was also designated. Figure B-3 illustrates the data recording sequence.

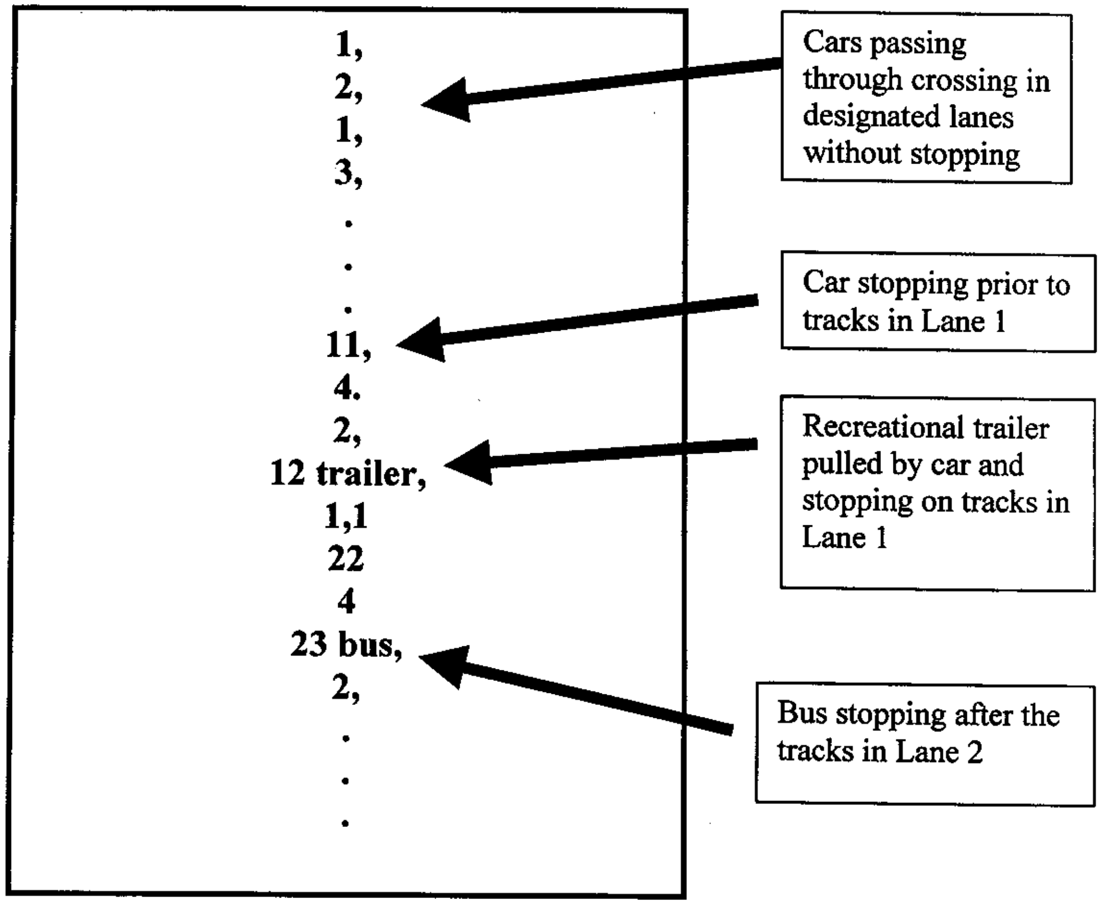

Figure B-3. Example of Coding

Special attention was given to conditions where trains passed or where queuing at the signal could constrain the actions of drivers approaching or crossing the tracks. These conditions were coded to indicate the onset of the warning light at the crossing (the analyst would say, "warning") and the train arrived at the crossing (the analyst would say, "train"). For instances where there were hazardous incidents that occurred within a time period, a note was made for a subsequent more precise assessment of the consequences of hazardous maneuvers. Likewise, for instances where queuing was evident, the analyst would say, "queue," and when the queue began to disperse, the analyst would say, "dispersed." See figure B-4 for examples.[1]

In the data stream, commas separate the sequential data items. They were entered when the analyst said, "comma". At the end of each 15-minute segment, the analyst then converted the data items into summaries and identified the specific data segment (discussed later), using the form shown in figure B-5.

[1] After a non-numeric entry, the analyst would precede the next number with the word "numerical," such as "numerical three." The word "numerical" was a command to change the data mode of the voice recognition software, and since it was not data, it was not entered into the data stream.

BUL01

(0-15 min)

3,2 trailer, 1,2, queue 2,24, 2,23, dispersed 2,1, 2,2 truck, 1,queue 2,21 truck, dispersed 2,2 truck, 2,2,2 truck, 2,queue 2,24 truck, 22, dispersed 2, 2,2,1, 1, 2, 1, 2, 1,2,2,2, queue 2, 24, 2,23, 21, dispersed 2,2,2, 2 truck, queue 2,24 truck, 21 truck, dispersed 2,2 truck, 2,2,2,2, 3, 2,1, 3 truck,3, 1,1,2,2 trailer,1 truck, queue 2,24 trailer, 21, dispersed 2,2,1,2,2,1,2,1,1,1 trailer,2 trailer, 1,2,2,queue 2,24, 23, dispersed 2,2,1,2 truck, queue 2,23 truck, dispersed 2, ...

Figure B-4. Excerpt of Text File Generated By Voice Recognition System

These entries provided the basic data for the evaluation study. After the data were transferred to the analysis sheets, the matrices were subsequently subjected to preliminary analysis.

The three data collection sites differ in their geometrics. Accordingly, the coding differed somewhat for each location. The test site on Commercial Blvd. in Ft. Lauderdale had four lanes, the control site on Oakland Park Blvd. had only three lanes, and the crossing location at Barberville had one skewed approach lane prior to the crossing and three lanes past the track (a left-turn lane, a through lane, and a right-turn lane). At the Barberville site, the approach lane widened to a width of two lanes at the track (illustrated earlier in figure 3-1), which were referred to as lanes 2 and 3. Standard nomenclature was used elsewhere.

B.3. Text Files Editing

The most manual labor-intensive task in analysis of the data was the review of text files generated by analysts using the voice recognition system. These "comma delimited" files ideally would look like the segment shown in figure B-4.

However, the analyst often introduced extra spaces, mispronounced a word or the voice recognition software would covert a numerical representation into a verbal counterpart (e.g., "4" might be interpreted as "four", "for" or "fore"). This required the conversion of these text files to another format that could be easily edited. Word For Windows was used for this purpose, and global edits were performed.

The process of manually coding the data from the videotapes and editing the results to rectify errors required about 2 hours of labor for each hour of videotape for the best coder, and about 3 to 3.5 hours per tape for the least efficient coder. The voice recognition system seemed to distinguish the speech of some voices better than others.

*Segment/ No. Vehicles	Event Type	Lane 1 (Left Turn)	Lane 2 (Through)	Lane 3 (Through)	Lane 4 (Right Turn)
1	**Lane Volume**				
Total Volume:	Stops Closer Than 5 ft. From Track				
No. SU Trucks:	Stops Over Track				
No. School Buses:	Stops Beyond Track Within 5 ft. of Rail				
No. Other Vehicles:	Stops in Area Designated for "X"				
****Comments**					
2	**Lane Volume**				
Volume:	Stops Closer Than 5 ft. From Track				
No. SU Trucks:	Stops Over Track				
No. School Buses:	Stops Beyond Track Within 5 ft. of Rail				
No. Other Vehicles:	Stops in Area Designated for "X"				
****Comments:**					
3	**Lane Volume**				
Volume:	Stops Closer Than 5 ft. From Track				
No. SU Trucks:	Stops Over Track				
No. School Buses:	Stops Beyond Track Within 5 ft. of Rail				
No. Other Vehicles:	Stops in Area Designated for "X"				
****Comments:**					
4	**Lane Volume**				
Volume:	Stops Closer Than 5 ft. From Track				
No. SU Trucks:	Stops Over Track				
No. School Buses:	Stops Beyond Track Within 5 ft. of Rail				
No. Other Vehicles:	Stops in Area Designated for "X"				
****Comments:**					

*15 minute segments **Note hazardous maneuvers during train passings or resulting from queuing during 15 minute segments

EUROPEAN X-MARKING DATA ANALYSIS SHEET

Crossing Location: ____

Tape No./Counter No. ______________/______________

DATE OF ANALYSIS: ______________ **ANALYST'S NAME:**______________

Figure B-5. Videotape Summary Form

B.4. Frequency Calculations

The conversion of comma-delimited text files into numerical format was accomplished with the use of Microsoft Excel spreadsheets. This required two steps: (1) translation of text files to Excel data using Excel's comma-delimited option for reading data, and (2) the creation and use of templates to convert the data to frequencies and useful measures.

Figure B-6 shows a snapshot of a small portion of such a translated data file. These cells, which could then be counted (using Excel's "Countif" command), and these frequencies could be used to calculate rates, joint probabilities, etc. For example, the number of vehicles in a particular lane that arrived between queues, the arrival rates of school buses or the stopping location of vehicles with boats, trailers, etc., could be calculated.

dispersed 2	3	2	1	1
1	3	3	2	1
3	2	1	1 truck	2 truck
1	1	2	queue 2	1
1	3 boat	3 boat	queue 3	22 boat
2	queue 2	2	1	23
1	dispersed 2	2	3	2
2	24	2	21	dispersed 2
2 motorcycle	1	2	2	queue 2
1	1	2	1	2 motorcycle
1	2	2	queue 2	2
34 truck	dispersed 3	2	1	1 motorcycle
2	2	3	2	1
2	21	dispersed 2	2	1
queue 3	34	1	2 boat	queue 2
21	dispersed 2	2	3	2
22	2	21	3	queue 3
dispersed 2	1	2	2	queue 2
1	1	1	3	2
2	2	1	2	1
2	21	dispersed 2	2	2
queue 1	11	queue 2	23	dispersed 2
23	2	22	2	21
21	dispersed 2	2	1	3
11 RV	dispersed 1	2 motorcycle	2 motorcycle	2
1	3	2	1	2

Figure B-6. Excerpt of Excel Spreadsheet Showing Conversion of Text Data

It was anticipated that stoppage patterns for all vehicle types and combinations would be calculated. However, stable rates could not be obtained for vehicles other than cars.

Consequently, the analyses focused on stoppage patterns for cars. The sample sizes of other vehicle types were just too small.

Summary statistics were then calculated for each data block. These blocks consisted of full days for the data collected at Barberville, and were broken into morning and afternoon blocks for the Ft. Lauderdale grade crossings which had higher traffic volumes. To develop these summary statistics, templates were prepared for each of the three sites. The templates were used to automatically calculate summary values for the data contained in each of the spreadsheets. Figures B-7, B-8 and B-9 present excerpts from sample spreadsheets. These excerpts provide only a small portion of the spreadsheets, and are shown here only to illustrate the analysis process. Figure B-7 shows frequency tables for stopped passenger cars by lane and zone, and volumes of non-passenger vehicles by lane. Figure B-8 shows the passage of cars by lane, thus providing the major share of the lane volumes. Figure B-9 shows rate calculations that extract stoppage information in combination with lane volumes, which permits calculation of stoppage rates of cars (Stops/1,000 Cars) by lane and zone.

B.5. Development of Data Arrays For Analysis

This step in the evaluation process is one in which the data from each day (or half-day) from each of the sites for pre-and post-installation phases is collated to allow subsequent statistical analysis. This is effectively a grouping of tables as illustrated in table B-2. It should be noted that table B-2 is the smallest of all of the arrays because it has only two effectiveness measures (morning data and afternoon data from only one day) for each of the variables of interest (lanes and zones). A complete set of these tables is presented in Appendix C.

Such tables provide at a glance the magnitude and the variation of the stoppage rates for each lane and zone within lane. They also provide the values to be entered into the statistical procedures to be subsequently applied.

B.6. Statistical and Graphic Procedures

It is essential to determine whether the results obtained are due to chance or due to impacts from the major variables of interest. One of the most powerful procedures that can be used for this is the Analysis of Variance (ANOVA). The ANOVA allows evaluating several levels of each variable as well as several variables simultaneously and is more powerful than alternative techniques such as the statistical t-test. The assumptions underlying the ANOVA are well established. There are many textbooks and automated procedures that simplify the processing of data such as that developed in this project.

The specific software used for this project is known as SPSS and has been available for more than a decade. The SPSS software presents results in tabular form such as shown in table B-3. No attempt will be made here to explain the ANOVA procedures, but a couple of points are worth mention for persons not acquainted with this procedure. First, the F-ratio is the mean sum of squares for each of the variables listed under source divided by

Stopped Passenger Cars	N	Subtotals	Non-Passenger Cars	N
Zone 11 - Prior to Tracks	2		Truck in Lane 1	9
Zone 12 - On Tracks	5		Truck in Lane 2	15
Zone 13 - After Tracks	2		Truck in Lane 3	4
Zone 14 - In X Area	10		Total	28
Total		19	Pickup Hauling Boat Lane 1	0
Zone 21 - Prior to Tracks	48		Pickup Hauling Boat Lane 2	2
Zone 22 - On Tracks	41		Pickup Hauling Boat Lane 3	5
Zone 23 - After Tracks	54		Total	7
Zone 24 - In X Area	89		RV Hauling Car Lane 1	1
Total		232	RV Hauling Car Lane 2	3
Zone 31 - Prior to Tracks	0		RV Hauling Car Lane 3	0
Zone 32 - On Tracks	1		Total	4
Zone 33 - After Tracks	0		Motorcycle in Lane 1	7
Zone 34 - In X Area	3		Motorcycle in Lane 2	15
Total		4	Motorcycle in Lane 3	2
Stopped Trailers			Total	24
Zone 11 - Prior to Tracks	0		Trailer in Lane 1	9
Zone 12 - On Tracks	0		Trailer in Lane 2	26
Zone 13 - After Tracks	0		Trailer in Lane 3	5
Zone 14 - In X Area	0		Total	40
Total		0	Special in Lane 1	2
Zone 21 - Prior to Tracks	0		Special in Lane 2	2
Zone 22 - On Tracks	0		Special in Lane 3	2
Zone 23 - After Tracks	1		Total	6
Zone 24 - In X Area	3		RV with Trailer in Lane 1	0
Total		4	RV with Trailer in Lane 2	1
Zone 31 - Prior to Tracks	0		RV with Trailer in Lane 3	0
Zone 32 - On Tracks	0		Total	1
Zone 33 - After Tracks	0		School Bus in Lane 1	0
Zone 34 - In X Area	0		School Bus in Lane 2	0
Total		0	School Bus in Lane 3	0
Stopped Boats			Total	0
Zone 11 - Prior to Tracks	0		Bus in Lane 1	0
Zone 12 - On Tracks	0		Bus in Lane 2	0
Zone 13 - After Tracks	0		Bus in Lane 3	0
Zone 14 - In X Area	0		Total	0

Figure B-7. Excerpt from a Sample Spreadsheet Used to Calculate Frequencies

Passenger Cars	Count (Non-stopped)
Lane 1	457
Lane 2	1059
Lane 3	119
Total	1635

Figure B-8. Non-Stopped Car Volumes

Lane and Zone	Stops/1000 Cars
Zone 11 - Prior to Tracks	4.20
Zone 12 - On Tracks	10.50
Zone 13 – After Tracks	4.20
Zone 14 - In X Area	21.01
All Lane 1	39.916
Zone 21 - Prior to Tracks	37.18
Zone 22 - On Tracks	31.76
Zone 23 – After Tracks	41.83
Zone 24 - In X Area	68.94
All Lane 2	179.706
Zone 31 - Prior to Tracks	0.00
Zone 32 - On Tracks	8.13
Zone 33 – After Tracks	0.00
Zone 34 - In X Area	24.39
All Lane 3	32.520

Figure B-9. Excerpt from a Sample Spreadsheet Used to Calculate Stoppage Rates

Table B-2.
Stoppage Rates at Oakland Park Blvd. After Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	6/13/00 Morning	6/13/00 Afternoon	Average	S.D.
Zone 11 - Prior to Tracks	0.00	0.31	0.16	0.22
Zone 12 - On Tracks	0.30	0.31	0.31	0.00
Zone 13 - After Tracks	0.00	0.62	0.31	0.44
Zone 14 - In X Area	1.52	0.31	0.92	0.86
All Lane 1	1.826	1.55	1.69	0.19
Zone 21 - Prior to Tracks	1.15	0.78	0.96	0.26
Zone 22 - On Tracks	0.00	0	0.00	0.00
Zone 23 - After Tracks	0.76	0	0.38	0.54
Zone 24 - In X Area	3.44	0	1.72	2.43
All Lane 2	5.35	0.78	3.06	3.23
Zone 31 - Prior to Tracks	6.23	7.14	6.68	0.65
Zone 32 - On Tracks	1.64	4.65	3.14	2.13
Zone 33 - After Tracks	2.95	4.34	3.64	0.98
Zone 34 - In X Area	6.55	8.07	7.31	1.07
All Lane 3	17.376	24.20	20.78	4.83

Table B-3. Example of ANOVA Table from Analysis of Barberville Data

Source	Sum of Squares	df	Mean Square	F Ratio	Significance
Corrected Model	27389.903	23	1190.865	24.812	.000
Intercept	18645.866	1	18645.866	388.497	.000
PERIOD	865.140	1	865.140	18.026	.000
LANE	11114.658	2	5557.329	115.790	.000
ZONE	9746.773	3	3248.924	67.693	.000
PERIOD * LANE	344.465	2	172.233	3.589	.033
PERIOD * * ZONE	261.608	3	87.203	1.817	.152
LANE * ZONE	4870.397	6	811.733	16.913	.000
PERIOD * LANE * ZONE	186.861	6	31.144	.649	.691
Error	3455.633	72	47.995		
Total	49491.402	96			
Corrected Total	30845.536	95			

the error term. Second, the column titled Significance is a value to correspond to the likelihood that the result could have been due to chance. Thus, a value of 0.000 indicates that the probability of the result obtained being due to chance is less than 0.0005 and is almost certainly attributable to the variable being evaluated. In this example, it can be inferred that "Period" (the pre- and post-installation periods) yielded different results. Upon examining the means, the post-installation values were smaller, meaning that the X-marking resulted in significantly fewer numbers of stops on or near the railroad tracks.

The SPSS package also provides nested means and graphic capabilities that allow probing more deeply into the data. This facility was used to attempt to understand why the European X markings were successful at Barberville, but not at Commercial Blvd. This feature is illustrated in figure B-10.

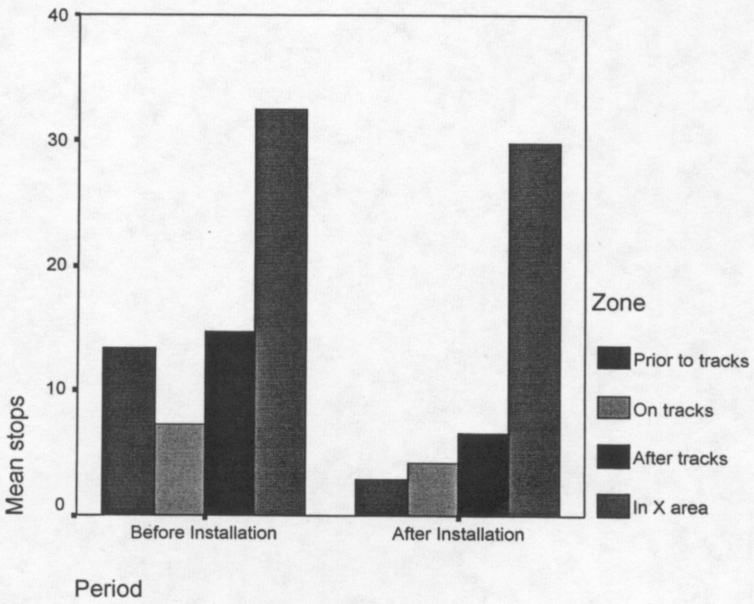

Figure B-10. Example of Graphical Analysis

APPENDIX C

DATA SUMMARIES FROM TEST AND CONTROL SITES

Table C-1. Barberville Labor Day 1998 Stoppage Rates Before Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	9/4/98	9/5/98	9/6/98	9/7/98	Average	S.D.
Zone 11 - Prior to Tracks	1.70	0.00	0.00	10.34	3.01	4.95
Zone 12 - On Tracks	3.41	1.80	0.00	5.17	2.59	2.21
Zone 13 - After Tracks	3.41	3.60	1.82	10.34	4.79	3.78
Zone 14 - In X Area	8.52	9.01	3.65	20.67	10.46	7.22
All Lane 1	17.04	14.41	5.47	46.51	20.86	17.80
Zone 21 - Prior to Tracks	19.87	25.19	29.74	22.25	24.26	4.25
Zone 22 - On Tracks	18.97	9.80	17.10	11.13	14.25	4.47
Zone 23 - After Tracks	26.20	33.59	36.43	40.33	34.14	5.97
Zone 24 - In X Area	66.36	65.33	62.07	76.81	67.64	6.38
All Lane 2	131.40	133.91	145.34	150.53	140.29	9.13
Zone 31 - Prior to Tracks	0.00	16.81	0.00	33.90	12.68	16.22
Zone 32 - On Tracks	6.54	0.00	14.29	0.00	5.21	6.79
Zone 33 - After Tracks	13.07	0.00	7.14	0.00	5.05	6.32
Zone 34 - In X Area	19.61	25.21	7.14	33.90	21.46	11.21
All Lane 3	39.22	42.02	28.57	67.80	44.40	16.64

Table C-2. Barberville Labor Day 1999 Stoppage Rates After Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	9/3/99	9/4/99	9/5/99	9/6/99	Average	S.D.
Zone 11 - Prior to Tracks	0.00	0.00	0.00	0.00	0.00	0.00
Zone 12 - On Tracks	1.36	0.00	0.00	0.00	0.34	0.68
Zone 13 - After Tracks	1.36	2.42	0.00	3.65	1.86	1.55
Zone 14 - In X Area	8.16	4.84	10.53	3.65	6.80	3.14
All Lane 1	10.88	7.26	10.53	7.30	8.99	1.98
Zone 21 - Prior to Tracks	4.98	8.19	13.10	7.85	8.53	3.37
Zone 22 - On Tracks	9.96	3.07	13.10	9.16	8.82	4.20
Zone 23 - After Tracks	13.28	17.40	17.47	19.63	16.95	2.65
Zone 24 - In X Area	60.05	56.76	44.25	71.24	58.08	11.11
All Lane 2	88.27	85.42	87.92	107.89	92.37	10.42
Zone 31 - Prior to Tracks	0.00	0.00	0.00	0.00	0.00	0.00
Zone 32 - On Tracks	5.38	9.62	0.00	0.00	3.75	4.66
Zone 33 - After Tracks	5.38	0.00	0.00	0.00	1.35	2.69
Zone 34 - In X Area	21.51	38.46	0.00	35.09	23.77	17.46
All Lane 3	32.26	48.08	0.00	35.09	28.86	20.43

Table C-3. Barberville Spring 1999 Stoppage Rates Before Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	3/13/1999	3/14/1999	3/21/1999	3/22/1999	3/23/1999	3/26/1999	4/2/1999	5/30/1999	Average	S.D.
Zone 11 - Prior to Tracks	3.68	6.87	3.29	19.74	0.00	3.29	2.42	0.00	4.91	6.38
Zone 12 - On Tracks	9.21	0.00	3.29	0.00	0.00	6.59	1.21	0.00	2.54	3.57
Zone 13 - After Tracks	5.52	6.87	1.65	6.58	0.00	4.94	2.42	4.74	4.09	2.47
Zone 14 - In X Area	18.42	13.75	8.24	6.58	0.00	4.94	12.09	4.74	8.60	5.87
All Lane 1	36.83	27.49	16.47	32.90	0.00	19.77	18.14	9.48	20.13	12.14
Zone 21 - Prior to Tracks	37.06	26.14	25.99	41.15	27.14	32.23	30.15	21.33	30.15	6.47
Zone 22 - On Tracks	31.47	8.71	20.64	8.23	19.00	16.57	22.18	18.67	18.18	7.47
Zone 23 - After Tracks	40.56	28.32	35.17	41.15	37.99	34.99	35.84	37.33	36.42	4.01
Zone 24 - In X Area	70.44	60.40	70.64	64.38	65.55	69.46	69.21	38.15	63.53	10.85
All Lane 2	179.53	123.58	152.45	154.91	149.68	153.25	157.38	115.48	148.28	20.12
Zone 31 - Prior to Tracks	0.00	0.00	0.00	0.00	0.00	7.94	0.00	0.00	0.99	2.81
Zone 32 - On Tracks	7.30	0.00	0.00	0.00	0.00	15.87	0.00	0.00	2.90	5.83
Zone 33 - After Tracks	0.00	0.00	9.01	0.00	0.00	15.87	0.00	0.00	3.11	6.04
Zone 34 - In X Area	21.90	19.61	0.00	27.78	11.11	23.81	45.00	0.00	18.65	14.97
All Lane 3	29.20	19.61	9.01	27.78	11.11	63.49	45.00	0.00	25.65	20.72

Table C-4. Barberville Spring 2000 Stoppage Rates After Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	3/16/00	3/19/00	3/20/00	3/26/00	3/31/00	Average	S.D.
Zone 11 - Prior to Tracks	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zone 12 - On Tracks	0.00	0.00	0.00	1.38	0.00	0.28	0.62
Zone 13 - After Tracks	0.00	3.06	1.87	2.76	0.00	1.54	1.47
Zone 14 - In X Area	6.18	10.70	7.49	5.52	6.06	7.19	2.09
All Lane 1	6.18	13.76	9.36	9.66	6.06	9.00	3.15
Zone 21 - Prior to Tracks	11.11	10.82	6.35	12.39	4.76	9.09	3.32
Zone 22 - On Tracks	9.09	5.82	5.08	9.30	2.38	6.33	2.91
Zone 23 - After Tracks	11.11	14.14	16.50	13.94	0.00	11.14	6.51
Zone 24 - In X Area	55.16	48.78	61.30	62.75	31.10	51.82	12.84
All Lane 2	86.47	79.56	89.22	98.38	38.24	78.37	23.43
Zone 31 - Prior to Tracks	0.00	5.81	0.00	4.98	0.00	2.16	2.97
Zone 32 - On Tracks	0.00	0.00	0.00	9.95	0.00	1.99	4.45
Zone 33 - After Tracks	0.00	5.81	7.87	4.98	0.00	3.73	3.57
Zone 34 - In X Area	32.47	52.33	15.75	14.93	0.00	23.10	19.98
All Lane 3	32.47	63.95	23.62	34.83	0.00	30.97	23.01

Table C-5. Commercial Blvd 1999 Stoppage Rates Before Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	4/6/99 1st Half	4/6/99 2nd Half	4/8/99 1st Half	4/8/99 2nd Half	4/29/99 1st Half	4/29/99 2nd Half	4/30/99 1st Half	4/30/99 2nd Half	5/19/99 1st Half	5/19/99 2nd Half	5/25/99 1st Half	5/25/99 2nd Half	Average	S.D.
Zone 11 - Prior to Tracks	0.43	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.30	0.16	0.28
Zone 12 - On Tracks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.05	0.17
Zone 13 - After Tracks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.02	0.09
Zone 14 - In X Area	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.06	0.14
All Lane 1	0.87	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	1.50	0.30	0.51
Zone 21 - Prior to Tracks	8.42	9.55	2.68	3.81	5.46	11.52	3.38	10.19	6.86	9.98	6.54	3.77	6.85	3.05
Zone 22 - On Tracks	2.53	0.87	0.00	0.00	2.73	0.89	0.00	1.85	1.72	0.00	1.63	0.94	1.10	1.00
Zone 23 - After Tracks	10.94	7.81	1.79	0.95	14.57	11.52	4.23	10.19	3.43	5.44	4.90	13.21	7.42	4.59
Zone 24 - In X Area	28.62	39.06	6.26	8.57	33.70	32.80	23.67	31.48	22.30	37.21	27.78	32.08	26.96	10.36
All Lane 2	50.51	57.29	10.73	13.33	56.47	56.74	31.28	53.70	34.31	52.63	40.85	50.00	42.32	16.57
Zone 31 - Prior to Tracks	5.00	10.12	1.84	2.47	10.31	17.80	9.72	10.77	9.00	11.18	11.02	12.88	9.34	4.44
Zone 32 - On Tracks	0.83	2.64	0.00	0.49	3.75	4.66	1.69	2.69	1.23	3.44	2.04	2.76	2.19	1.40
Zone 33 - After Tracks	12.50	15.85	2.76	2.96	13.13	13.14	8.03	9.43	8.59	12.04	9.80	12.88	10.09	4.05
Zone 34 - In X Area	26.25	36.97	5.53	6.41	34.22	35.59	27.90	30.97	24.55	33.55	30.61	32.20	27.06	10.52
All Lane 3	44.58	65.58	10.14	12.33	61.42	71.19	47.34	53.86	43.37	60.22	53.47	60.72	48.68	19.39
Zone 41 - Prior to Tracks	16.33	0.00	5.68	2.75	2.34	18.52	0.00	0.00	0.00	20.62	93.75	15.71	14.64	26.19
Zone 42 - On Tracks	4.08	0.00	2.58	2.06	2.34	0.00	0.00	0.00	0.00	10.31	62.50	0.00	6.99	17.73
Zone 43 - After Tracks	12.24	0.00	6.71	4.12	4.68	0.00	0.00	0.00	0.00	10.31	31.25	15.71	7.09	9.35
Zone 44 - In X Area	20.41	11.49	11.36	8.93	11.71	18.52	0.00	0.00	0.00	10.31	62.50	26.18	15.12	17.04
All Lane 4	53.06	11.49	26.34	17.87	21.08	37.04	0.00	0.00	0.00	51.55	250.00	57.59	43.83	68.22

Table C-6. Commercial Blvd 2000 Stoppage Rates After Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	6/13/00 1st Half	6/13/00 2nd Half	6/15/00 1st Half	6/15/00 2nd Half	6/22/00 1st Half	6/22/00 2nd Half	6/23/00 1st Half	6/23/00 2nd Half	6/27/00 1st Half	6/27/00 2nd Half	Average	S.D.
Zone 11 - Prior to Tracks	0.00	0.65	0.86	0.80	1.05	0.43	1.08	0.46	0.42	0.00	0.57	0.39
Zone 12 - On Tracks	0.46	0.22	0.43	0.00	0.00	0.00	0.00	0.93	0.42	0.42	0.29	0.30
Zone 13 - After Tracks	0.46	0.22	0.00	0.00	0.00	0.00	0.00	0.93	0.00	0.42	0.20	0.31
Zone 14 - In X Area	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.46	0.42	0.00	0.13	0.21
All Lane 1	0.91	1.08	1.30	1.21	1.05	0.43	1.09	2.78	1.27	0.84	1.19	0.61
Zone 21 - Prior to Tracks	6.34	10.74	8.62	6.08	1.73	1.79	1.79	1.97	3.09	1.77	4.39	3.33
Zone 22 - On Tracks	0.00	0.00	1.92	0.00	0.00	0.00	0.00	0.00	1.03	0.00	0.30	0.66
Zone 23 - After Tracks	1.06	1.61	2.87	0.00	0.00	3.58	0.00	3.94	3.09	8.85	2.50	2.70
Zone 24 - In X Area	13.74	16.11	17.24	13.37	8.64	3.58	12.52	3.94	23.69	10.62	12.34	6.09
All Lane 2	21.14	28.46	30.65	19.44	10.36	8.94	14.31	9.84	30.90	21.24	19.53	8.53
Zone 31 - Prior to Tracks	5.30	8.33	9.86	7.30	0.00	0.65	2.01	1.27	4.12	6.76	4.56	3.48
Zone 32 - On Tracks	0.00	0.25	0.00	0.52	2.00	1.96	3.02	3.82	2.29	6.28	2.01	2.00
Zone 33 - After Tracks	2.89	3.43	5.17	4.69	0.00	1.96	3.02	6.37	6.86	11.11	4.55	3.09
Zone 34 - In X Area	14.46	20.83	26.77	21.91	8.98	13.07	16.08	15.29	23.80	25.12	18.63	5.87
All Lane 3	22.66	32.84	41.80	34.43	10.98	17.65	24.12	26.75	37.07	49.28	29.76	11.55
Zone 41 - Prior to Tracks	16.50	23.05	7.92	0.00	0.00	9.00	0.00	9.86	3.62	17.64	8.76	8.18
Zone 42 - On Tracks	4.34	5.93	0.00	0.00	0.00	4.50	0.00	5.63	8.14	8.33	3.69	3.43
Zone 43 - After Tracks	6.51	8.56	2.64	0.00	0.00	7.00	0.00	15.49	20.81	34.30	9.53	11.12
Zone 44 - In X Area	29.09	38.63	15.83	12.05	0.00	33.52	0.00	35.21	41.16	43.61	24.91	16.63
All Lane 4	56.45	76.16	26.39	12.05	0.00	54.03	0.00	66.20	73.72	103.87	46.89	35.54

Table C-7. Oakland Park Blvd 1999 Stoppage Rates Before Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	4/6/99 1st Half	4/6/99 2nd Half	4/8/99 1st Half	4/8/99 2nd Half	4/29/99 1st Half	4/29/99 2nd Half	4/30/99 1st Half	4/30/99 2nd Half	5/19/99 1st Half	5/19/99 2nd Half	5/25/99 1st Half	5/25/99 2nd Half	Average	S.D.
Zone 11 - Prior to Tracks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zone 12 - On Tracks	0.00	0.00	0.30	1.99	0.32	0.89	0.32	1.85	0.00	0.62	0.00	0.33	0.55	0.70
Zone 13 - After Tracks	0.00	0.00	0.89	0.33	0.64	0.59	0.32	0.00	0.00	0.31	0.00	0.00	0.26	0.31
Zone 14 - In X Area	0.00	0.00	0.89	0.99	0.64	0.30	0.32	1.24	0.00	0.62	0.00	0.67	0.47	0.43
All Lane 1	0.00	0.00	2.07	3.32	1.60	1.78	0.96	3.09	0.00	1.56	0.00	1.00	1.28	1.18
Zone 21 - Prior to Tracks	0.00	0.00	3.92	1.31	2.26	1.22	0.79	0.42	0.79	0.42	0.86	1.71	1.14	1.10
Zone 22 - On Tracks	0.00	0.00	5.88	1.31	1.51	0.81	1.97	0.42	0.40	0.42	0.43	1.71	1.24	1.61
Zone 23 - After Tracks	3.21	0.00	4.90	1.31	2.26	2.44	1.97	0.42	0.40	0.42	0.86	0.00	1.52	1.50
Zone 24 - In X Area	0.00	0.00	8.83	2.61	7.15	3.65	2.76	0.83	2.78	2.54	1.29	3.84	3.02	2.67
All Lane 2	3.21	0.00	23.54	6.53	13.18	8.12	7.50	2.08	4.36	3.82	3.43	7.26	6.92	6.26
Zone 31 - Prior to Tracks	12.35	0.00	16.38	8.90	11.23	7.05	8.90	6.75	8.16	8.75	10.10	6.02	8.72	3.94
Zone 32 - On Tracks	4.94	0.00	13.58	7.79	12.55	7.05	9.85	3.71	7.18	4.20	3.70	4.61	6.60	3.93
Zone 33 - After Tracks	9.88	0.00	14.38	6.68	8.92	8.98	9.54	5.06	5.55	3.15	1.01	2.83	6.33	4.21
Zone 34 - In X Area	9.88	22.73	22.77	12.98	17.50	12.50	14.30	10.12	12.08	8.75	8.75	8.86	13.44	5.07
All Lane 3	37.04	22.73	67.12	36.35	50.20	35.59	42.59	25.63	32.97	24.84	23.56	22.32	35.08	13.36

Table C-8. Oakland Park Blvd 2000 Stoppage Rates After Installation of European X Markings (Stops/1,000 Cars)

Lane and Zone	6/13/00 1st Half	6/13/00 2nd Half	Average	S.D.
Zone 11 - Prior to Tracks	0.00	0.31	0.16	0.22
Zone 12 - On Tracks	0.30	0.31	0.31	0.00
Zone 13 - After Tracks	0.00	0.62	0.31	0.44
Zone 14 - In X Area	1.52	0.31	0.92	0.86
All Lane 1	1.83	1.55	1.69	0.19
Zone 21 - Prior to Tracks	1.15	0.78	0.96	0.26
Zone 22 - On Tracks	0.00	0	0.00	0.00
Zone 23 - After Tracks	0.76	0	0.38	0.54
Zone 24 - In X Area	3.44	0	1.72	2.43
All Lane 2	5.35	0.78	3.06	3.23
Zone 31 - Prior to Tracks	6.23	7.14	6.68	0.65
Zone 32 - On Tracks	1.64	4.65	3.14	2.13
Zone 33 - After Tracks	2.95	4.34	3.64	0.98
Zone 34 - In X Area	6.55	8.07	7.31	1.07
All Lane 3	17.37	24.20	20.78	4.83

Table C-9. Barberville Labor Day Block-Summary Statistics (Stops/1,000 Cars)

Period	Lane	Zone	Mean	N	Std. Deviation
Before Installation	Lane 1	Prior to tracks	3.0100	4	4.9519
		On tracks	2.5950	4	2.2106
		After tracks	4.7925	4	3.7835
		In X area	10.4625	4	7.2223
		Total	5.2150	16	5.4493
	Lane 2	Prior to tracks	24.2625	4	4.2508
		On tracks	14.2500	4	4.4698
		After tracks	34.1375	4	5.9695
		In X area	65.3500	4	2.3821
		Total	34.5000	16	20.1742
	Lane 3	Prior to tracks	12.6775	4	16.2164
		On tracks	5.2075	4	6.7947
		After tracks	5.0525	4	6.3165
		In X area	21.4650	4	11.2146
		Total	11.1006	16	11.9702
	Total	Prior to tracks	13.3167	12	12.8716
		On tracks	7.3508	12	6.8247
		After tracks	14.6608	12	15.2128
		In X area	32.4258	12	25.7557
		Total	16.9385	48	18.6676
After Installation	Lane 1	Prior to tracks	.0000	4	.0000
		On tracks	.3400	4	.6800
		After tracks	1.6075	4	1.7294
		In X area	7.7075	4	2.3495
		Total	2.4137	16	3.4845
	Lane 2	Prior to tracks	8.8575	4	3.3452
		On tracks	8.8225	4	4.1951
		After tracks	16.9450	4	2.6536
		In X area	58.0750	4	11.1067
		Total	23.1750	16	21.8309
	Lane 3	Prior to tracks	.0000	4	.0000
		On tracks	3.7500	4	4.6633
		After tracks	1.3450	4	2.6900
		In X area	23.7650	4	17.4553

		Total	7.2150	16	12.8859
	Total	Prior to tracks	2.9525	12	4.6980
		On tracks	4.3042	12	4.9098
		After tracks	6.6325	12	7.9202
		In X area	29.8492	12	24.4885
		Total	10.9346	48	17.0118
Total	Lane 1	Prior to tracks	1.5050	8	3.6191
		On tracks	1.4675	8	1.9353
		After tracks	3.2000	8	3.2117
		In X area	9.0850	8	5.1855
		Total	3.8144	32	4.7189
	Lane 2	Prior to tracks	16.5600	8	8.9635
		On tracks	11.5363	8	4.9519
		After tracks	25.5413	8	10.1362
		In X area	61.7125	8	8.3918
		Total	28.8375	32	21.4625
	Lane 3	Prior to tracks	6.3387	8	12.5945
		On tracks	4.4787	8	5.4510
		After tracks	3.1988	8	4.9120
		In X area	22.6150	8	13.6379
		Total	9.1578	32	12.3924
	Total	Prior to tracks	8.1346	24	10.8543
		On tracks	5.8275	24	6.0188
		After tracks	10.6467	24	12.5499
		In X area	31.1375	24	24.6129
		Total	13.9366	96	18.0192

Table C-10. Barberville Spring Block-Summary Statistics (Stops/1,000 Cars)

Period	Lane	Zone	Mean	N	Std. Deviation
Before Installation	Lane 1	Prior to tracks	6.7160	5	7.6764
		On tracks	2.5000	5	4.0124
		After tracks	4.1220	5	3.1073
		In X area	9.3980	5	7.0346
		Total	5.6840	20	5.9553
	Lane 2	Prior to tracks	31.4960	5	7.1087
		On tracks	17.6100	5	9.6230
		After tracks	36.6380	5	5.2181
		In X area	66.2825	5	4.3316
		Total	38.0066	20	19.2703
	Lane 3	Prior to tracks	.0000	5	.0000
		On tracks	1.4600	5	3.2647
		After tracks	1.8020	5	4.0294
		In X area	16.0800	5	10.7992
		Total	4.8355	20	8.6638
	Total	Prior to tracks	12.7373	15	15.0944
		On tracks	7.1900	15	9.6157
		After tracks	14.1873	15	16.9161
		In X area	30.5868	15	27.2652
		Total	16.1754	60	19.9409
After Installation	Lane 1	Prior to tracks	.0000	5	.0000
		On tracks	.2760	5	.6172
		After tracks	1.5380	5	1.4706
		In X area	7.1900	5	2.0914
		Total	2.2510	20	3.2202
	Lane 2	Prior to tracks	9.0860	5	3.3249
		On tracks	6.3340	5	2.9096
		After tracks	11.1380	5	6.5129
		In X area	51.8160	5	12.8353
		Total	19.5935	20	20.3738
	Lane 3	Prior to tracks	2.1580	5	2.9695
		On tracks	1.9900	5	4.4498
		After tracks	3.7320	5	3.5656
		In X area	23.0960	5	19.9786

		Total	7.7440	20	13.2632
	Total	Prior to tracks	3.7480	15	4.6663
		On tracks	2.8667	15	3.8923
		After tracks	5.4693	15	5.8689
		In X area	27.3673	15	22.9729
		Total	9.8628	60	15.7138
Total	Lane 1	Prior to tracks	3.3580	10	6.2224
		On tracks	1.3880	10	2.9493
		After tracks	2.8300	10	2.6659
		In X area	8.2940	10	5.0291
		Total	3.9675	40	5.0351
	Lane 2	Prior to tracks	20.2910	10	12.9180
		On tracks	11.9720	10	8.9576
		After tracks	23.8880	10	14.5457
		In X area	59.0492	10	11.8192
		Total	28.8001	40	21.6811
	Lane 3	Prior to tracks	1.0790	10	2.2831
		On tracks	1.7250	10	3.6899
		After tracks	2.7670	10	3.7284
		In X area	19.5880	10	15.5853
		Total	6.2898	40	11.1552
	Total	Prior to tracks	8.2427	30	11.8913
		On tracks	5.0283	30	7.5355
		After tracks	9.8283	30	13.2071
		In X area	28.9771	30	24.8261
		Total	13.0191	120	18.1554

APPENDIX D

CANDIDATE RAILROAD CROSSING SITES FOR EUROPEAN X CROSSING STUDY

Candidate Railroad Crossing Sites for European X Crossing Study

REF # -Crossing Location[1] (Crossing Number)	Nearest Intersection Characteristics	Road Geometrics/ Crossing Characteristics	Matching Site?	ADT	AC Available	Comments
D4-1 -Sample Rd.,SR 834 (628168-G)	➢ WB traffic approaches Andrews Ave. ➢ Signal <500 ft., appears to be fixed timing, no pre-emption ➢ EB signal ~ 1,200 ft.	➢ WB - 3 through lanes, 2 LT lanes and 1 RT lane for adj. shopping ct. ➢ Slight grade at crossing ➢ Construction activity between crossing and Andrews Ave.	No	53,000	NLT June '98	➢ High accident location 1997 Priority Index - #2) ➢ Have sketch ➢ Marginal site for B-A evaluation
D4-2 - Commercial Blvd., SR 870 (628186-E)	➢ WB traffic approaches I-95 ➢ Signal <200 ft.,with pre-emption; ➢ EB approaches signal > 500 ft. from crossing ➢ DO NOT STOP ON TRACKS sign	➢ EB - 3 through lanes, 1 RT lane onto I-95 ➢ Track at ~90° angle	Yes (D4-5)	63,000	Utility pole with AC close by (Camera mount on pole would provide ~35° FOV	➢ Good candidate location for B-A evaluation (with control site) ➢ Blinking lights at location
D4-3 - Stirling Road, SR 848 (628-274P)	➢ WB traffic approaches 29th Ave. ➢ Signal <500 ft. with no pre-emption ➢ one active track, one dead track thru intersection	➢ WB - 3 lanes and LT lane ➢ Slight grade at tracks	No	39,300	?	➢ Peak queues long enough to cross the CSX tracks ➢ Needs signal timing changes ➢ Track repairs needed ➢ Noted backups on tracks Not a good candidate

[1] All sites are located in FDOT District 4, Broward County

REF # -Crossing Location[2] (Crossing Number)	Nearest Intersection Characteristics	Road/Crossing Geometrics	Matching Site?	ADT	AC Available	Comments
D4-4 - Pembroke Road, SR 824 (628-282G)	➢ WB traffic approaches I-95 ➢ Signal <200 ft. with pre-emption, ➢ DO NOT STOP ON TRACKS sign	EB - 3 through lanes, 2 LT and 1 RT onto I-95	?	47,000	?	Possible candidate
D4-5 - Oakland Park Blvd. SR 816 (628-191B)	Signal <500 ft. at I-95 Blinking light (all the time)	➢ EB - I-95, 3 lanes in each direction ➢ 2 tracks	Yes (D4-2)	53,500	?	➢ Possible resurfacing ➢ Monitoring of signal state possible ➢ Possible Site
D4-6 - Cypress Creek Road	No signal pre-emption	➢ EB- 4 lanes, 2 LT lanes, 1 RT lane ➢ Driveway in WB direction	?	40,800	Poles for camera mounting	Accessible loops in both directions
D4-7 - Broward Blvd.	➢ Signal ~ 350 ft. with no pre-emption ➢ Single flashing signal (activated by train) for EB traffic when vehicles in zone between tracks and signal	➢ EB - 3 lanes, WB - 3 lanes with driveway for buses ➢ 2 tracks	No	36,200	Possible at parking garage	➢ High accident location ➢ In downtown Ft. Lauderdale ➢ Bridge on tracks to South (18 min recycle time) ➢ Backups in a.m.
D4-8 - Hillsboro Blvd. (Deerfield, FL)	➢ ➢ DO NOT STOP ON TRACKS sign	➢ Single track (double track planned)	?	50,000	Yes	➢ Amtrack Passenger Train station within 600 ft. ➢ Good access to parking Not a good candidate

[2] All sites are located in FDOT District 4, Broward County

REF # -Crossing Location[3] (Crossing Number)	Nearest Intersection Characteristics	Road/Crossing Geometrics	Matching Site?	ADT	AC Available	Comments
D4-9 - Powerline Road, SR 845	➢ Signal <200 ft. with pre-emption ➢ Located at Prospect Ave.	➢ Staggered 3 lane (acute angle of crossing)	No	27,700	NA	➢ Lane to be added in near future ➢ Not a candidate
D4-10 - Palmetto	➢ Signal ~ 200 ft from I-95. ➢ DO NOT STOP ON TRACKS sign	➢ EB - 3 lanes, 2 LT lanes, 1 RT lane	Yes	47,000	?	Not a candidate site
D4-11 - McNabb Road	➢ Signal < 200 ft. with pre-emption	➢ Quad gates to be installed & evaluated ➢ Crossover possible ➢ Driveway within 100 ft. ➢ 44 sec warning	No	Unk	?	➢ Prompted by whistle-ban ➢ Not a real candidate. See video tape FMI

[3] All sites are located in FDOT District 4, Broward County