Final Report

Effectiveness of Increased Law Enforcement Surveillance on Work Zone Safety in Mississippi

Study No. 175

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16. Abstract

Increased law enforcement surveillance program is one of the methods currently been implemented by departments of transportation in the United States in an effort to increase safety for both drivers and workers in highway construction zones. Unfortunately, there is a dearth of studies documenting the impact of this type of programs on construction zone's safety. Thus, this study summarizes an effort funded by the Mississippi Department of Transportation to quantitatively document the safety impact of increased law enforcement surveillance on highway construction zones in Mississippi. Both descriptive and inferential statistics were used to determine the safety impact on one construction project. The center of this research project was a construction project located on I-59 in the Jackson (Mississippi) area. The results presented in this paper intend to serve as a sample of the impact of this type of programs. Furthermore, other projects and other departments of transportations might benefit with implementing the analysis presented here as an avenue to quantify the safety impact of increased law enforcement surveillance in construction zones.

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FORWARD

This manual provides a valuable resource for people who analyze the impact of roadway safety programs. Safety analyzes are difficult and often the require data that is not available or require extensive manipulation. This Mississippi Department of Transportation Study No. 175 "Effectiveness of Increased Law Enforcement Surveillance on Work Zone Safety in Mississippi" was conducted by the University of Southern Mississippi in collaboration with MDOT. This document will be of particular interest to individuals who plan and evaluate the benefits of investments in public roadways' safety. Other audiences for this document include policymakers, transportation professionals, and students in related fields.

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EXECUTIVE SUMMARY

This document presents the results of evaluating the safety impact of increased law enforcement surveillance on construction zones through the analysis of a case in Mississippi. The evaluation is based on a nationwide literature review of increased law enforcement surveillance in construction zones; (2) data obtained from the Mississippi Department of Transportation, the Ridgeland Police Department and the Mississippi Highway Patrol; and (3) a statistical analysis of the compiled Mississippi data and the nationwide literature findings.

The results of the statistical analysis indicate the following:

- <u>Analysis 1 - Law Enforcement Presences Vs Number of Citations:</u> The number of citations issued was statistically significantly higher during the period of increased law enforcement presence.
- <u>Analysis 2 - Law Enforcement Over Time Vs Number of Citations:</u> The number of citations issued decreases over time during law enforcement presence.
- <u>Analysis 3- Number of Citations per Week Vs Number of Crashes Per Week:</u> The number of citations issued by the law enforcement agencies does not have a direct correlation with the number of crashes.
- <u>Analysis 4- Distribution of Volume Vs Distribution of Crashes:</u> The higher the traffic volume the higher the number of crashes.
- <u>Analysis 5- Time of The Day Vs Number of Crashes:</u> It was observed that the direct correlation between traffic volume and number of crashes is held constant through the day with exceptions of the lunch period of the normal business days.
- <u>Analysis 6- Law Enforcement Presences Vs Number of Crashes:</u> The presence of law enforcement does not have a statistically significant impact on the number of crashes.

It was found that all agencies that participated in the study consider of paramount importance the safety of drivers and workers in construction zones. It was also found that all agencies were very willing to collaborate in the data consolidation process. However, collecting, archiving and retrieving information was not a main priority for any of these agencies. Additionally, no general guidelines for data structuring was communicated among the agencies. Therefore, it was evident that input into the data gathering process before the data is collected rather than after the fact, could greatly improve the process of assessing the impact of law enforcement surveillance in construction zones or assessing the impact of any other program. By defining the data to be collected, the method for collecting the data, the formatting of the data, the timeframes for collecting the data (before, during and after construction) all the participating agencies would be able to share information and to demonstrate the impact of their performance to the stakeholders.

It is suggested the creation of a data structure that allow agencies to share common data for common purposes and reduce the cost of the data collection efforts and analysis. It is also suggested to evaluate all MDOT safety initiatives to identify the most effective method to increase driver safety.

CHAPTER 1:
BACKGROUND ON LAW ENFORCEMENT SURVEILLANCE IMPACT ON CONSTRUCTION ZONES

1.1. PROBLEM STATEMENT

According to the mission statement of the Mississippi Department of Transportation (MDOT), MDOT is responsible for providing a safe intermodal transportation network [MDOT 2003]. However, in 2001 the National Safety Council ranked Mississippi worst in three categories for motor vehicle safety. In these three categories of motor vehicle safety, Mississippi had the greatest number of traffic deaths (1) per million miles driven, (2) per 10,000 vehicles registered and (3) per 100,000 population." [Breazeale 2001]. These numbers include both traffic deaths in normal highway conditions and work zones. However, work zones are considered more dangerous due to the inherent nature of highway construction. Furthermore, "work zone fatalities are on the rise and are likely to continue climbing as we repair our aging roadways" [Safe Roads 2003]. This is compounded with an all time peek volume of work zones in Mississippi due to the 1987 four-lane highway program and TEA-21 [Young 2001]. The work zone issue is not limited to Mississippi, it is estimated that every year over 1000 people are killed and over 40,000 people are injured nationwide in work zones [Safe Roads 2003].

MDOT through the Traffic Engineering Division is commitment to improve Mississippi highway work zone safety. MDOT has invested for several years valuable resources to implement a series of programs to improve work zone safety. These programs include: "The Buckle up Mississippi Campaign", "The Work Zone Safety Awareness Week", "An Agreement with Mississippi Highway Patrol", "Deployment of Changeable Message Board", "A Partnership with Child Safety Program", "The Drive Smart Program", "Ruble Striping", "Widening Road Strips", "Clear Zone Projects", "Distribution of GPS to Highway Patrol" among many others. Despite MDOT's high commitment and efforts to improve work zone safety, MDOT does not know the impact of each work zone safety program implemented to reduce accidents. In other words, MDOT lacks quantifiable evidence of effectiveness of work zone programs on reducing accidents.

The MDOT Traffic Engineering Division initiative to quantify the effectiveness of the work zone safety programs will provide the decision makers with the much-needed factual information. This factual information will help to make continuous enhancements on these programs, which will lead to work zone safety improvement. These improvements will come by identifying and implementing the most cost effective work zone safety programs. Therefore, improving Mississippi's rank within the National Safety Council regarding highway Work Zone safety.

1.2. OVERVIEW

Among the MDOT work zone safety initiatives, MDOT has established an agreement with Mississippi Highway Patrol. As part of the agreement, MDOT has provided funds to the Mississippi Highway Patrol to increase surveillance in high profile work zones. The objective of this project is to evaluate the safety impact of this increased surveillance. The objective will be achieved by (1) collecting historical and field data from selected Mississippi work zones before, during and after the increased highway patrol surveillance; (2) reviewing nationwide literature of increased highway patrol surveillance in work zones; and (3) analyzing the compiled Mississippi data and the nationwide literature findings.

The data collection in Mississippi work zones will begin by consolidating MDOT and other governmental entities' historical data. The data consolidation will include: (a) characteristics of work zones (such as: locations, safety programs, conditions before, during and after the construction), (b) traffic parameters (such as: volume before, during and after construction), and (c) accident information (such as: location, time, severity, and cause of the accident). The historical data collection will be followed by gathering current and accurate field data. This field data will include: (a) characteristics of work zones (such as: field implementation of safety programs), (b) traffic parameters in the work zones (such as: volume and speed), and (c) accident information in the work zones (such as: location, time, and cause).

Another important component of this study will be a literature review of nationwide work zone highway patrol increased surveillance. This review will focus on identifying the impact of increased highway patrol surveillance in other states. Additionally, nationwide criterion disseminated by: U.S. Department of Transportation's Federal Highway Administration [FHWA 2003], the American Association of State Highway and Transportation Officials [AASHTO 2003], and the American Traffic Safety Services Association [ATSSA 2003] will be considered. All this information will be evaluated for its possible implications on Mississippi work zone safety improvement relating to the increase of highway patrol surveillance.

Finally, the data analysis will begin by establishing correlations between traffic parameters (such as: volume and speed) and accidents in work zones. A second correlation between the increased highway patrol surveillance program and traffic parameters will be established. Using these two correlations (traffic parameters->accidents and increase surveillance->traffic parameters) the impact of increased highway patrol surveillance implemented by MDOT on accident reduction will be identified.

1.3. METHODOLOGY

The proposed methodology for this project is based on the idea of dividing the project into stages. Each stage will have a pre-defined set of goals to be accomplished and will require approval from MDOT Traffic Engineering Division personnel (before proceeding to the next stage). Additionally, to accomplish the proposed goals, close interaction between MDOT and USM personnel will be required. Table 1-1 shows the proposed stages with their corresponding goals.

Table 1-1 Project Proposed Stages with Their Corresponding Goals.

Stages	Goals
Stage 1	▪ Review the latest nationwide literature on increased highway patrol surveillance on work zone safety ▪ Review criterion disseminated by FHWA, AASHTO, ATSSA regarding increased highway patrol surveillance ▪ Establish highway patrol surveillance effectiveness measurement criterion and variables based on the literature review ▪ Report findings to MDOT of the nationwide highway patrol surveillance criterion and variables. ▪ Interact with MDOT personnel from the Traffic Engineering Division (Robert W. Dean, Bob L. Mabry, Jim C. Willis, etc) to approve the specific study parameters (programs, variables, etc)
Stage 2	▪ Interact with MDOT to select highway work zones to be used in this project ▪ Interact with MDOT personnel to obtain access to Mississippi historical data regarding work zones, traffic parameters and accident data. ▪ Compile work zone data (such as: location, safety programs, conditions before and after construction, etc) ▪ Arrange the work zone data into a useful format for the study ▪ Interact with MDOT and seek verification of completeness of the work zone data compiled ▪ Seek approval of MDOT Traffic Engineering Division personnel before proceeding
Stage 3	▪ Compile historical traffic parameter data (such as: volume and speed in the work zone) ▪ Arrangement the traffic parameter data into a useful format for the study ▪ Interact with MDOT and seek verification of completeness of the traffic data compiled. ▪ Seek approval of MDOT Traffic Engineering Division personnel before proceeding
Stage 4	▪ Compile historical accident information (such as: location, time, severity, and cause of the accident) ▪ Arrangement the accident information data into a useful format for the study. ▪ Interact with MDOT and seek verification of completeness of the accident information data compiled ▪ Seek approval of MDOT Traffic Engineering Division personnel before proceeding.
Stage 5	▪ Appraise compiled historical data to determine the additional data that needs to be collected from the field to support the assessment of the increased highway patrol surveillance ▪ Report to MDOT Traffic Engineering Division personnel and seek approval to proceed.

Stages	Goals
Stage 6	▪ Interact with MDOT personnel from the Traffic Engineering Division to prepare field data collection plan ▪ Prepare field data collection plan including variables, sites, dates, measurement procedure, etc. MDOT will gather the field data according to the plan prepared by USM. ▪ Report to MDOT and seek approval to proceed
Stage 7	▪ Collect field data from the selected sample work zones ▪ Interact with MDOT data collection team every 2 weeks to obtain status update ▪ Interact with MDOT Traffic Engineering personnel every 6-8 weeks to provide an update on the field data collected
Stage 8	▪ Compare MDOT historical data with collected field data ▪ Merge MDOT historical data with collected field data ▪ Interact with MDOT personnel to give an update of the merged data
Stage 9	▪ Analyze the historical and field data to identify whether or not there are correlations between traffic parameters (such as: volume and speed) and accidents in the work zones. ▪ Analyze the data to identify whether or not there is correlation between increased highway patrol surveillance and traffic parameters. ▪ Establish links between increased highway patrol surveillance implemented by MDOT on Mississippi Highways and accident reduction. ▪ Compare Mississippi findings with the nationwide findings
Stage 10	▪ Prepare a draft report of the findings ▪ Report to MDOT findings of the data analysis and seek input from the MDOT Traffic Engineering Division
Stage 11	▪ Fine-tune the draft report based on Traffic Engineering Division recommendations ▪ Issue final report ▪ Obtain final approval from the MDOT Traffic Engineering Division
Stage 12	▪ Provide up to 4 presentations to MDOT, FHWA and/or any other federal or state agencies of the Traffic Engineering Division effort on the assessment of increased highway patrol surveillance on Mississippi highway work zones.

1.4. DELIVERABLES

As indicated in the methodology, the project will be divided into stages with pre-defined goals. In addition to the goals, each stage will have tangible deliverables. Table 1-2 presents the deliverables that the MDOT personnel will receive at the completion of each stage.

Table 1-2 Project Proposed Stages With Their Corresponding Deliverables.

Stages	Deliverables
Stage 1	▪ Report “Synopsis of Nationwide Increased Highway Patrol Surveillance Programs”, which will focus on work zone highway patrol surveillance criterion and measurable variables. This report is expected to have between 5 to 9 pages ▪ Presentation of the major highway patrol surveillance criterion and measurable variables. This presentation will have between 6 and 15 slides
Stage 2	▪ Report “Work Zones in Mississippi with Increased Highway Patrol Surveillance”, which will include the work zones locations, conditions before and after the work and safety programs. This report is expected to have between 3 and 8 pages
Stage 3	▪ Report “Traffic Parameters in Mississippi Work Zones with Increased Highway Patrol Surveillance”, which will include the work zones locations, conditions before and after the work and safety programs. This report is expected to have between 3 and 8 pages
Stage 4	▪ Report “Current Status of Accidents in Mississippi Work Zones with Increased Highway Patrol Surveillance”, which will include location, time, severity and cause of the accident. This report is expected to have between 3 and 8 pages.
Stage 5	▪ Report “Appraisal of Mississippi Work Zone Safety Historical Data”, which will be a compilation of the previous three reports. This report will be prepared following guidelines of a conference (to be defined) and will have between 6 and 12 pages. ▪ Presentation of the “Appraisal of the Mississippi Work Zone Safety Historical Data”. This presentation will have between 8 and 16 slides.
Stage 6	▪ Report “Field Data Collection Plan for the Selected Work Zones” which will include variables, sites, dates and measurement procedures for the sites and teams. This report is expected to have between 3 and 8 pages. ▪ Presentation of the “Field Data Collection Plan for the Selected Work Zones”. This presentation will have between 4 and 10 slides.
Stage 7	N/A
Stage 8	▪ Report “Work Zone Historical Vs. Field Data Comparison in Mississippi with Increased Highway Patrol Surveillance” which will include characteristics of work zones, traffic parameters and accident information. This report is expected to have between 5 and 10 pages.
Stage 9	N/A
Stage 10	▪ Report “DRAFT Effectiveness of Increased Highway Patrol Surveillance on Work Zone Safety in Mississippi”, which will include the most relevant finding of the study. This report is expected to have between 10 and 20 pages ▪ Presentation of the “Effectiveness of Increased Highway Patrol Surveillance on Work Zone Safety in Mississippi”. This presentation will have between 12 and 24 slides

Stages	Deliverables
Stage 11	▪ Report “Effectiveness of Increased Highway Patrol Surveillance on Work Zone Safety in Mississippi”, which will include the most relevant finding of the study as well as recommendation from MDOT. This report is expected to have between 10 and 20 pages
Stage 12	▪ Presentations of the “Effectiveness of Increased Highway Patrol Surveillance on Work Zone Safety in Mississippi”. These presentations will be done upon request of federal/state agencies and will have between 12 and 24 slides.

1.5- ANTICIPATED BENEFITS

The assessment of increased highway patrol surveillance on Mississippi Highways will provide both tangible and intangible benefits to MDOT and Mississippi road users (taxpayers). Some of those benefits are as follows:

- Furnish a quantifiable measure of the effectiveness of the program
- Provide evidence regarding improvement of work zone safety to federal agencies requiring such information
- Improve Mississippi’s National Safety Council ranking by reducing the loss of construction workers, motorists, pedestrians, law enforcement officers, firefighters, paramedics, and children
- Enhance public perception of MDOT management through the reduction in work zone accidents in the state of Mississippi
- Provide a framework for assessing other work zone safety programs implemented by MDOT

1.6. URGENCY

As documented in the literature, accidents in work zones are rising. Therefore, It is critical to expedite the assessment of work zone safety programs, especially in Mississippi with an all time peek volume of work zones and the worst safety ranking in the nation.

It is essential that assessment methods be developed to evaluate the effectiveness of the resources invested on work zone safety programs. Therefore, it is imperative that MDOT promptly demonstrate its commitment to highway safety by funding safety programs (as it has been doing) and studies to measure their effectiveness (as the one propose here).

CHAPTER 2: STATE-OF-THE-ART:
LAW ENFORCEMENT SURVEILLANCE IMPACT ON CONSTRUCTION ZONES

2.1. INTRODUCTION TO CONSTRUCTION ZONES

Construction zones are a necessary part of maintaining and upgrading the United State's aging highway system. Although necessary, the construction zones temporarily negatively affect traffic flow causing frustration for the road users. Additionally, the potentially hazardous nature of construction zones increases the likelihood of accidents that impact both road users and construction workers. Furthermore, construction zone's fatalities are on Construction zones are a necessary part of maintaining and upgrading the United States' aging highway system. Although necessary, the construction zones temporarily negatively affect traffic flow causing frustration for the road users. Additionally, the potentially hazardous nature of construction zones increases the likelihood of accidents that affect both road users and construction workers. Furthermore, construction zones' fatalities are on the rise and are likely to continue climbing as departments of transportation continue repairing and upgrading the United States' aging roadways [Safe Roads 2003]. This is particularly compounded in Mississippi due to an all time peak volume of construction zones as well as the 1987 four-lane highway program and TEA-21 [Young, 2001]. The construction zone issue is not limited to Mississippi; it actually affects all the United States. It is estimated that every year over 1000 people are killed and over 40,000 people are injured nationwide in construction zones [Safe Roads, 2003].

This project begins by presenting the characteristics of construction zones and an overview of some of the safety measures used to reduce the potentially hazardous nature of these zones. This is followed by a description of the methodology used in the project. Finally, the results of the meta-analysis regarding the effect of law enforcement in construction zones are presented.

2.2. CHARACTERISTICS OF CONSTRUCTION ZONES

The construction zones could be characterized from different perspectives. This section focus on the characteristics of the construction zones from the safety perspective. The following are safety characteristics that are supported by the current literature:

2.2.1. Construction work zones are necessary, and frustrating to road users:

Unfortunately, work zones are a necessary part of maintaining and upgrading our aging highway system. The combination of more work zones and heavier traffic volumes means work zones are having a greater effect on roadway systems. Between 1982 and 2002 there was a 79% increase of miles of travel but only 3% increase of miles of highway, so there are many more road users traveling on the same road system. Between 1982 and 2002 the rush "hour" increased from 3-4 hours to 6-7 hours per day, causing delays and greatly increasing driver frustration. The American public has cited work zones as second only to poor traffic flow in causing dissatisfaction with the roadway system [FHWA, 2004a].

2.2.2. Construction work zones have a dramatic negative impact on traffic flow:

Work zones account for nearly 24% of non-recurring congestion, and 482 million vehicle hours of road user delay. Since 20% of National Highway System is under construction during the summer, and 7% of National Highway System is under construction during winter, the traffic effect of work zones is seasonal. Departments of transportation have tried to affect the negative impact of work zones by being creative, as shown by the fact that 33% of work zones are active primarily at night [FHWA, 2003].

2.2.3. Construction work zones cause accidents:

The rate of accidents in work zones is 3 to 10 times greater than in areas with no roadwork. Total accident rates during construction increase from 7.5% to 21.4% above rates experienced before construction. Thirty-one percent of projects experience a reduced accident rate during construction, while 24% experience a rate increase of 50% or more [Tsyganov, 2003].

2.2.4. Construction work zones are costly and potentially hazardous to road users:

Accidents involving motorists account for 70% of the total highway work zones accidents. Motorists suffer approximately 700 fatalities, 40,000 injuries, and 52,000 property-damage-only accidents, at a total cost of $6.2 billion/year [Mohan & Gautam, 2002]. Between 1997 and 2001 there was an increase in number of people killed in motor vehicle crashes from 693 to 1079. To understand the potentially hazardous nature of work zones, other facts about work zones have been documented. Eighty-five percent of those killed in work zones are drivers or occupants. Rear-end crashes are the most common kind of work zone crash. In 2001, the majority of fatal work zone crashes for all vehicles occurred on roads with speed limits of 55 miles per hour or greater (57 percent and 70 percent, respectively). That same year, more than 50% of all fatal work zone crashes occurred during the day. In 2001, more than twice as many fatal work zone crashes occurred on weekdays as on weekends; and fatal work zone crashes occurred most often in the summer and the fall [FHWA, 2003].

2.2.5. The driving behavior of road users with respect to lane changing and speed reduction:

The driving behavior of road users with respect to lane changing and speed reduction in the work zone has an effect on accidents and must be understood in the analysis of work zones. Documented driving behavior of road users with respect to lane changing: 40% of drivers change lanes at a distance of 3,000 to 2,000 feet from lane closure; 30% of drivers change lanes at a distance of 2,000 to 1,000 feet from lane closure; 30% of drivers change lanes at a distance of 1,000 to 0 feet from lane closure; 50.7% of drivers change lanes at the first opportunity; 12% of drivers attempt to pass vehicles in the adjacent lane prior to changing lanes; 18% of drivers wait until they actually see construction to change lanes; and under low-volume conditions (less than 1,000 vph), drivers wait even longer to change lanes. Documented driving behavior of road users with respect to speed reduction: 46.5% of drivers indicated that they begin to reduce speed when they see the signs directing them to do so; 21% of drivers indicated that they begin to reduce speed when they actually see construction work; 17.3% of drivers watch the behavior of other drivers for cues; and there is a 16% to 50% speed reduction in work zones with lane closures [Tsyganov, 2003].

2.3. OVERVIEW OF SAFETY MEASURES IN CONSTRUCTION ZONES

Based on the potentially hazardous nature of construction zones, departments of transportation have tried many methods to reduce accidents and fatalities in construction work zones. As an example, the Mississippi Department of Transportation has invested for several years valuable resources to implement a series of programs to improve work zone safety. These programs include: “The Buckle up Mississippi Campaign”, “The Work Zone Safety Awareness Week”, “Deployment of Changeable Message Board”, “A Partnership with Child Safety Program”, “The Drive Smart Program”, “Rumble Striping”, “Widening Road Strips”, “Clear Zone Projects”, "Distribution of GPS to Highway Patrol", and "Increased Law Enforcement Surveillance in Construction Zones" among many others.

Each of these programs has been implemented with the expectation of improving safety conditions in construction zones; and the Mississippi Department of Transportation is very interested in quantifying the benefits of each of these programs. Therefore, this paper is presenting a part of a project focusing on quantifying the impact of the resources used to increase law enforcement surveillance on construction zones grounded on the literature available nationwide on this subject.

2.4. Research Methodology

A descriptive research methodology was followed to summarize the available literature on increased law enforcement surveillance impact on construction zones. As part of the research methodology, a systematic literature review and a meta-analysis were performed. The meta-analysis combined the results from a number of previous studies, in an attempt to summarize the evidence of law enforcement impact on construction zones. The meta-analysis included a qualitative component (pre-determined search criteria) and a quantitative component (integration of numerical information) [CHP, 2005].

The qualitative component (search criteria) of the meta-analysis is challenging for most research projects. Because, it could vary from very general keywords, resulting on an unbearable amount of data to be analyzed or very specialized and precise technical keywords, resulting on very limited data. Additionally, the databases used during the meta-analysis, also play an important role on the results of the search.

A slight variation in the search criteria (keyword and database) could result in differences in the outcome. Therefore, it is important to explicitly state the search criteria used. The keywords used in this project are presented in Table 2-1. These two keywords were used after several preliminary searches with a variety of keywords related to the subject. The databases used in this project were limited to the seven databases presented in Table 2-2. These databases were used based on the studied subject and recommendations from the Mississippi Department of Transportation.

Table 2-1. Keywords/Phrases Used for the Search

Keywords
Work Zone Safety
Highway Patrol

Table 2-2. Databases: Name, URL Location and Information used to Search

Database's Name	URL	Information
Transportation Research Board (TRIS)	http://trisonline.bts.gov/	TRIS Online provides links to full text and to resources for document delivery or access to documents where such information is available. These may include links to publishers, document delivery services, and distributors.
Federal Highway Administration (FHWA)	http://www.fhwa.dot.gov/search.html	FHWA search provides information regarding the outcomes of partnerships with the state and local agencies to meet the nation's transportation needs. The information provided relates to the FHWA work done cooperatively with governmental agencies, industry, and research community partners to research, develop, test, and implement the latest proven technological advancements including intelligent transportation systems.
American Association of State Highway and Transportation Officials (AASHTO)	http://www.transportation.org/publications/search.nsf/SearchAdvanced?openform	AASHTO search provides information regarding: official press releases issued by AASHTO, overview of transportation issues, and updates on federal regulatory action related to transportation issues.
National Highway Traffic Safety Administration (NHTSA)	http://www.nhtsa.dot.gov/nhtsasearch/index.asp	NHTSA site has valuable information and statistics related to the many ways that NHTSA works to reduce deaths, injuries and economic losses resulting from motor vehicle crashes. The site is organized by three major sections: 1- Vehicles and Equipment, 2- Traffic Safety and Vehicle Occupants, and 3- General Information.
Transportation Research Board - Research In Progress (TRB-RiP)	http://rip.trb.org	TRB-RiP database contains over 7,800 current or recently completed transportation research projects. Most of the RiP records are projects funded by Federal and State Departments of Transportation. University transportation research is also included.
The National Work Zone Safety Information Clearinghouse (WZSRD)	http://wzsafety.tamu.edu/searches/research.stm	WZSRD database contains 1686 records of journal articles, research reports, research projects, and other types of publications that are related to work zone safety. Each publication record includes bibliographic information, a summary, and a link to full text if available. Each project record includes a description, sponsor, and contact information.
American Traffic Safety Services Association (ATSSA).	http://www.atssa.com/	ATSSA site contains tools to discover the latest news on technology in the roadway safety community and an electronic clearing house of technical issues that affect road safety.

2.5. Impact of Law Enforcement Surveillance Nationwide

There have been a number of studies documenting the relationship between the presence of law enforcement surveillance and traffic speed. In 1999, traffic enforcement reduced 47% of crash fatalities in Tennessee [Traffic Safety Digest, 2004]. In Utah, the presence of law enforcement surveillance reduced the average speed by 9 mph [Saito & Bowie, 2003]. In Minnesota, Uniformed Police Officers reduced motorist speeds 8-10 mph [FHWA, 2004]. In Illinois, the average speeds of the cars inside the work zone were 4.3 – 4.4 mph lower when police were patrolling the work zone compared to the no-police condition. Trucks presented speed reductions of 4.3 – 5.0 mph due to police presence. The percentages of cars and trucks exceeding the speed limit decreased by 14% and 32%, respectively, at a location before the work zone due to police presence [Benkohal, 1992].

Benekohal et al. (1986) evaluated the impact of mobile patrol vehicle enforcement on car and truck speeds through a highway construction zone. They found that the presence of a marked patrol car reduced average car and truck speeds while no reduction occurred in an un-patrolled condition. Additionally, the proportion of cars traveling faster than conditions permitted in the work zone were reduced by 14 percent, and trucks traveling faster by 32 percent, when the patrol car was present. Average car speeds increased immediately after patrols ended. Vaa (1997) found that intensive enforcement (an average of 9 hours of police presence per day) resulted in reductions in vehicle speed that lasted up to 8 weeks [FHWA, 2005].

Although not work zone related, Armour (1986) examined the impact on traffic speeds of parking a marked patrol car along an urban street. The presence of the patrol car was associated with (1) a 2/3 drop in the number of vehicles violating the speed limit; (2) an increase in community awareness of police enforcement in the surrounding area; and (3) a measurable decrease in speed at the site of enforcement. Stuster (1995). The study found significant declines in unobtrusive measures of vehicle speed and speed-related crashes in the special enforcement zones of the experimental communities. In addition, time series analysis found 112 fewer crashes that expected [FHWA, 2005].

2.6. SUMMARY

An important component of this study is the literature review of nationwide work zone highway patrol increased surveillance. This review focused on identifying the impact on safety of increased highway patrol surveillance. Additionally, nationwide criteria disseminated by the U.S. Department of Transportation's Federal Highway Administration [FHWA 2003], the American Association of State Highway and Transportation Officials [AASHTO 2003], and the American Traffic Safety Services Association [ATSSA 2003] were considered. All this information was evaluated for its possible implications on Mississippi work zone safety improvement relating to the increase of highway patrol surveillance.

As documented in the literature, accidents in work zones are rising. Therefore, it is critical to expedite the assessment of work zone safety programs, especially in Mississippi, with its all time peak volume of work zones and the worst safety ranking in the nation.

It is essential that assessment methods be developed to evaluate the effectiveness of the resources invested on work zone safety programs. Therefore, it is imperative that MDOT promptly demonstrate its commitment to highway safety by funding safety programs (as it has been doing) and studies to measure their effectiveness (as the one proposed here).

CHAPTER 3:
AGENCIES AND THEIR DATA TO ASSESS LAW ENFORCEMENT SURVEILLANCE IMPACT ON CONSTRUCTION ZONE SAFETY.

3.1. INTRODUCTION TO CONSTRUCTION ZONES

Maintaining and upgrading the United State's aging highway system requires a number of construction zones at any given time. These construction zones temporarily negatively impact traffic flow and deteriorate safety conditions impacting both road users and construction workers. Construction zone accidents involving motorists account for 70% of the total highway accidents. Motorists suffer approximately 700 fatalities, 40,000 injuries, and 52,000 property-damage-only accidents, at a total cost of $6.2 billion/year [Mohan & Gautam, 2002]. Between 1997 and 2001 there was an increase in number of people killed in motor vehicle crashes from 693 to 1079.

Significant effort has been placed to further understand the potentially hazardous nature of work zones and several facts about work zones have been documented such as 1- Eighty-five percent of those killed in work zones are drivers or occupants, 2- Rear-end crashes are the most common kind of work zone crash, 3- Roads with speed limits of 55 miles per hour or greater account for the majority of fatal work zone crashes in 2001, 4- More than 50% of all fatal work zone crashes occurred during the day in 2001, 5- More than twice as many fatal work zone crashes occurred on weekdays as on weekends; and 6- Fatal work zone crashes occurred most often in the summer and the fall [FHWA, 2003].

Furthermore, construction zone's fatalities are on the rise and are likely to continue climbing across the nation as departments of transportation continue repairing and upgrading the United State's aging roadways [Safe Roads 2003]. This is particularly compounded in Mississippi due to an all time peek volume of construction zones as well as the 1987 four-lane highway program and TEA-21 [Young 2001]

The project was funded by the Mississippi Department of Transportation to determine the safety effectiveness of increased law enforcement surveillance in construction zones in Mississippi. More specifically, this project presents an inter-agency collaboration to provide the data collected to measure the impact of law enforcement in construction zones.

This chapter begins by presenting an overview of the agencies involved. This is followed by a description of data collected and its structure. Finally, the results of the lessons learns are presented.

3.2. OVERVIEW OF AGENCIES INVOLVED IN COLLECTING DATA

Collecting, processing, archiving and retrieving of data/information are a costly, demanding and necessary activity of all organizations. Each organization manages data/information in a different way for a variety of purposes to fulfill their primary responsibility. This primary responsibility is important to understand in requesting the appropriate data from the agencies. Following is a brief description of the responsibilities of the agencies involved in collecting data in work zones with increased law enforcements.

3.2.1 Mississippi Department of Transportation

The Mississippi Department of Transportation is responsible for providing a safe intermodal transportation network that is planned, designed, constructed and maintained in an effective, cost efficient, and environmentally sensitive manner. In order to provide the framework for accomplishing the Mississippi Department of Transportation's (MDOT) mission, a set of seven goals has been developed. These goals are multimodal, comprehensive in scope and interdependent. Table 3-1 shows the goals of MDOT. [MDOT, 2006]

Table 3-1. Mississippi Department of Transportation Goals [MDOT, 2006]

Goal 1: Accessibility and Mobility: Improve Accessibility and Mobility for Mississippi's People, Commerce and Industry.
Goal 2: Safety: Ensure High Standards of Safety in the Transportation System.
Goal 3: Maintenance and Preservation: Maintain and Preserve Mississippi's Transportation System.
Goal 4: Environmental Stewardship: Ensure that Transportation System Development is Sensitive to Human and Natural Environment Concerns.
Goal 5: Economic Development: Provide a Transportation System that Encourages and Supports Mississippi's Economic Development.
Goal 6: Awareness, Education and Cooperative Processes: Create Effective Transportation Partnerships and Cooperative Processes that Enhance Awareness of the Needs and Benefits of an Intermodal System.
Goal 7: Finance: Provide a Sound Financial Basis for the Transportation System

Three offices within MDOT actively participated in this project: 1- District office, 2- Planning Division and 3- Traffic Engineering Division.

Planning Division: provides the Legislature, MDOT and the Federal Highway Administration with information to support program planning and decisions. Table 3-2 shows the planning division fundamental functions to provide support for planning and decisions [MDOT Planning Division, 2006]

Table 3-2. Planning Division Fundamental Functions [MDOT Planning Division, 2006]

Function	Brief Description
The Long Range Statewide Transportation Plan (MLRTP)	Provides the framework for Mississippi's transportation program. This is a 20+ year outlook.
Statewide Transportation Improvement Program (STIP)	Provides a listing of the projects to be accomplished during the next three years.
Traffic Monitoring System for Highways (TMS/H)	Includes the collection and analysis of all traffic data including traffic counts, vehicle classification counts, truck weight surveys, turning movement counts, speed surveys, and occupancy surveys.
Roadway Inventory and Mapping	Provide statistics such as highway dimensions and mileage, structure information, and an extensive array of maps.
A Federal Functional Classification System	Used distinguish highways according to the character of service provided by the facility.
Special Programs and Studies	Administer programs including Urbanized Area support (places larger than 50,000), Federal Aid to all Urban areas (places above 5,000), Transit Planning grants, Transportation Enhancement program, Latin American Trade Study, Environmental Noise studies, Intermodal Connector Improvement Program, Great River Road Transportation Committee, etc.
Specialized Reports and Feasibility Studies	Prepare for decision makers include activities such as the Highway Performance Monitoring System (HPMS), Statistical reports on state, city and county highway finance, and analyses of interchanges and highway improvements.

<u>District 5 Office:</u> is responsible for coordinating, planning, design, construction and maintenance of the intermodal transportation network within the ten counties. The counties include: Hinds, Madison, Rankin, Leake, Scott, Neshoba, Newton, Noxubee, Kemper, and Lauderdale. The project was located in the city of Ridgeland in the Madison county.

<u>Traffic Engineering Division:</u> ensures that safe, efficient traffic control measures are standardized throughout the State Maintained Highway System. It is responsible for the development of programs to add, upgrade or revise existing traffic control devices. This task compels studies to determine and recommend appropriate speed zones as well as the development and distribution of policies for the application of traffic control devices in accordance with established guidelines. The Traffic Engineering Division also directs the in-house manufacture and distribution of MDOT erected signs. Personnel travel statewide to install and maintain signs and signals on assigned sections of state maintained highways. [MDOT Traffic Engineering Division, 2006]

3.2.2. Mississippi Safety Highway Patrol

The Mississippi Highway Safety Patrol was one of the two law enforcement agencies that participated in increase law enforcement presence in the construction project. The Mississippi Highway Safety Patrol, formed in 1938, is charged with the responsibility of enforcing traffic laws on state and federal highways. Mississippi's state troopers must be prepared to assist local law enforcement agencies and to respond to statewide emergencies at the request of the governor. The officers of the patrol exemplify the agency's motto of Courtesy, Service and Safety. The mission of the Mississippi Highway Safety Patrol is to: 1- Encourage and promote the safe operation of vehicles on Mississippi's state and federal highways; 2- Enforce traffic laws and other applicable laws in a fair, impartial and courteous manner; 3- Function as guardians of public safety in a professional capacity; 4- Assist other law enforcement and criminal justice agencies; and 4- Enhance the public esteem for law enforcement by precept and example of each member of the department. [Mississippi Highway Patrol, (2006)]

3.2.3 Ridgeland Police Department

The Ridgeland Police was one of the two law enforcement agencies that participated in increase law enforcement presence in the construction project. Figure 3-1, shows the location of the city of Ridgeland and it interrelation with the capital of the state of Mississippi (Jackson). The location of the city of Ridgeland has a direct impact on the traffic conditions on the area. The mission of the Ridgeland Police Department indicate that they are dedicated to providing the highest police services in order to enhance community safety, protect life and property, and reduce crime and the fear of crime. To do this, the Ridgeland Police Department pledge to develop a partnership with the community, lead a community commitment to resolve problems, improve the safety and quality of life in our city by identifying and resolving public safety concerns. [Ridgeland Police Department, (2006)]

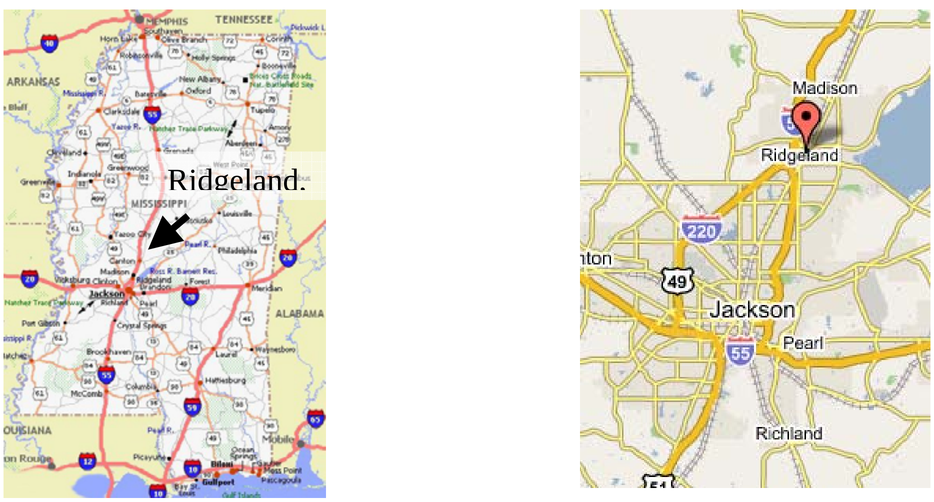


Figure 3-1. Ridgeland Mississippi Location

3.3. Archived Data, Structure And Means Of Retrieval

Upon identifying the agencies, the offices within the agencies and their roles in collecting data, the MDOT leader of this project contacted the agencies and provided a brief description of the project and the research team. The research team followed-up this initial contact by requesting a meeting with the representatives of the agencies to provide an overview of the project and initiate the consolidation of the data that had been collected. During, this initial meeting an informal interview was conducted with the agency representative to explicitly identify the data that the agency had already collected, the structure, and the media in which the data was stored as well as the retrieval means of the agency. Upon agreeing with the agency concerning the data to be retrieved, a mechanism to transfer the data was established. As expected and evidenced below, each agency used a different structure to archive the data. Furthermore, some agencies were able to retrieve the data in electronic form while other agencies were only able to retrieve the data in hard copies. Following are some examples of the data that was obtained for the project.

3.3.1. Planning Division - Mississippi Department of Transportation

In order to fulfill its mission, the MDOT planning division has placed a number of traffic recording devices around the state. This office handled mainly pictorial and numerical information. The planning division archived the information both in hard copies and electronic media. Some of the information received by the research team was in hardcopy and some was received in electronic files. In the cases where the information was made available to the research team in hard copy, further processing was required. The research team entered the information either in a spreadsheet or another program that allowed the processing of the data. One the first pieces of information received by the research team was a series of maps showing geographical information of gathered data. Figure 3-2 shows the map that was provided to the research team that illustrates the location of each the stations. From this map, recording devices in the studied area were selected. Figure 3-3 shows a blowup of Figure 3-2 showing the studied area devices. Traffic information (data) from these devices was then obtained for the study.

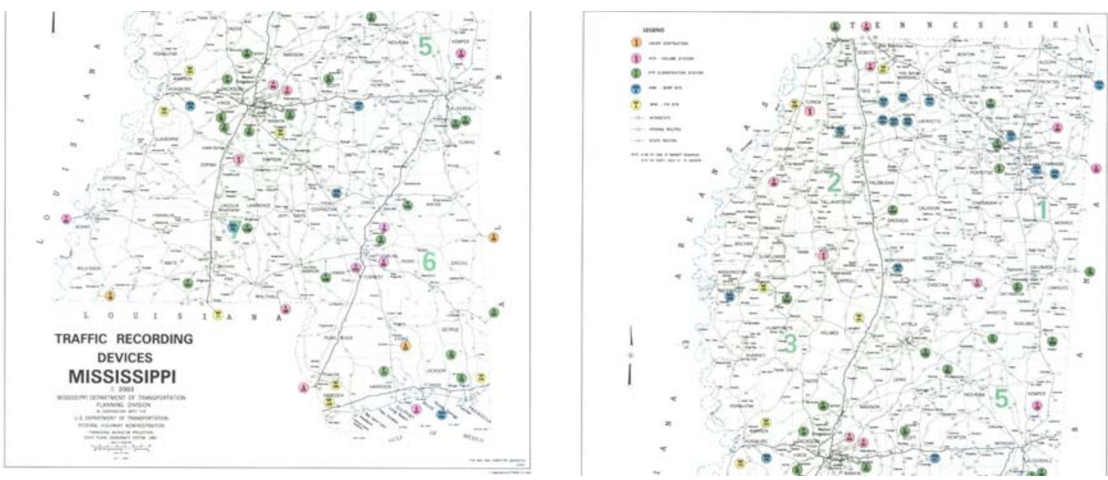


Figure 3-2. Traffic Recording Devices - Mississippi

Figure 3-3. Traffic Recording Devices – In the Studied Area

Although the Planning Division did not have a GIS system to link the data presented in the figures above with their corresponding values, the Planning Division had extensive data regarding the recording devices in the studied area. Several computers files with data from the stations from several years were received by the research team. Figure 3-4 shows a sample of file types (extensions) that were received by the research team. The planning division also provided a detailed description of the data structure of each file type (extension) which is shown in Table 3-3. Figure 3-5 shows a sample of the data contained in the data files.

Figure 3-4. Sample Data Files from the Planning Division

Table 3-3. Data Structure and Content of Each File Type [MDOT 2005]

File Type	Content Description
.dat -	This file contains classification data for a 48 hour period and can be opened with notepad. The file name will consist of 7 digits: the 1st 6 is the location identifier (which we will include a spreadsheet with the location specified) and the last digit is the lane number. Once opened, the file will contain some headers at the top followed by the symbol "{" which is then followed by a column of numbers. The columns represent the vehicle classification type starting with vehicle class 1 for the first column and ending in vehicle class 13 for the last column which is the

13th column. Within the header there will be a start date, start time, end date and end time listed. The rows represent the hourly counts with the first row beginning on the start time and start date with the consecutive rows representing the consecutive hours until reaching the end time of the end date. This file can also be imported into excel for data manipulation now that data formatting has been described.

.txt - This file contains classification data for a 48 hour period and can be opened with notepad. The file name will consist of 7 digits: the 1st 6 is the location identifier (which we will include a spreadsheet with the locations specified) and the last digit is the lane number. Once opened, the file will contain some headers at the top and followed by two tables each one containing counts listed by hour by vehicle classes for a 24 hour period. This file can also be imported into excel for data manipulation now that data formatting has been described.

.prn - The .prn will be composed of six digits. This file contains volume data for a 48 hour period and can be opened with notepad. The file name will consist of six digits which is the location identifier (which we will include a spreadsheet with the location specified). Once opened, the file will contain some headers followed by columns of data. In the first line of the header, the 4th and 5th set of numbers will contain the start date (month / day / year) and start time and the 6th and 7th set of numbers will contain the end date and end time of the count. The table that follows the header contains volume data in 15 minute intervals. The 4th column will contain the ending time of the 15 minute interval with the 5th column containing the corresponding count for the 15 minute interval. The first 15 minutes count is not used since it usually does not contain the full 15 minutes worth of data due to placement of the counter on the road. This file can also be imported into excel for data manipulation now that the data formatting has been described.

1		Start	End
2	Date	111203	111403
3	Time	1030	1045
4			
5	Start	End	15 min-Vol
6	1030	1045	3
7	1085	1100	217
8	1100	1115	242
9	1115	1130	265
10	1130	1145	291
11	1185	1200	270
12	1200	1215	272
13	1215	1230	249
14	1230	1245	261
15	1285	1300	253
16	1300	1315	279

17	1315	1330	240
18	1330	1345	231
19	1385	1400	241
20	1400	1415	257
21	1415	1430	294
22	1430	1445	278
23	1485	1500	260
24	1500	1515	307
25	1515	1530	338
26	1530	1545	319
27	1585	1600	269
28	1600	1615	295
29	1615	1630	253
30	1630	1645	246
31	1685	1700	245
32	1700	1715	241

451264-2003prn

Figure 3-5. Sample data in contained in the data files.

It is important to highlight that the information provided by the Planning Division represented a wide range of timeframe. The data shown in Figures 3-5 represent individual 15 minutes counts on a particular day, in one of the stations in the studied area. Historical statistical information was also available for the stations in the studied area. Figure 3-6 shows the Annual Average Daily Traffic data for two stations in the studied area for a ten year period. Figure 3-7 shows the traffic data during weekdays (Monday thru Friday) for a particular station averaged for each month of the year. Figure 3-8 and 3-9 show the average Saturday and Sunday (respectively) traffic data discriminated by month for a particular station. Figure 3-10 shows the one hour interval for the highest and 10, 20, 30 percentile volume (AADT) of traffic for a particular station in 2003 in the studied area. Figure 3-6 to 3-10 are examples in which the data was received by the research team in printed version and then converted to electronic format for processing.

Station	Location	FC	1993	1994	1995	1996	1997
46	I-55 - Gluckstadt	1	19,061	20,363	21,690	23,246	24,522
54	I-55 - Jackson	11	89,416	92,175	96,470	98,071	100,570
				6.8%	6.5%	7.2%	5.5%
				3.1%	4.7%	1.7%	2.5%

Station	Location	1998	1999	2000	2001	2002	2003
46	I-55 - Gluckstadt	25,287	26,702	26,550	26,649		28,273
54	I-55 - Jackson	104,453	108,110	107,702	108,503	112,122	114,812
		3.1%	5.6%	-0.6%	0.4%		
		3.9%	3.5%	-0.4%	0.7%	3.3%	2.4%

Figure 3-6. Annual Average Daily Traffic for Stations 46 and 54 from 1993 to 2003

Station	Location	June	July	Aug	Sept	Oct	Nov	Dec	**Avg**
54	I-55 - Jackson	126,857	128,740	127,341	125,297	128,781	128,277	121,889	**126,315**
		1.7%	1.5%	-1.1%	-1.6%	2.8%	-0.4%	-5.0%	3.6%

Figure 3-7. Weekdays Average Traffic Discriminated By Months For 2003

Station	Location	Jan	Feb	Mar	April	May	June	July	Aug
54	I-55 - Jackson		93,396		90,122	90,497	94,517	89,276	95,627

Figure 3-8. Saturday Average Traffic Discriminated By Months For 2003

Station	Location	Jan	Feb	Mar	April	May	June	July	Aug
54	I-55 - Jackson		73,299		68,791	70,268	72,894	73,548	73,697

Figure 3-9. Sunday Average Traffic Discriminated By Months For 2003

Station	Location	AADT		The Highest	10th Highest	20th Highest	30th Highest
54	I-55 - Jackson	114,812	Volume	9,995	9,942	9,913	9,876
			Percent	8.7	8.7	8.6	8.6

Figure 3-10. Highest and 10, 20, 30 percentile volume of traffic for a particular station in 2003 in the studied area

The Planning Division also had maps of the studied area with traffic counts. Figure 3-11 shows the AADT (Annual Average Daily Traffic) directly on the roads shown for the studied area. This map presents the estimated values for 2003. Figure 3-12 shows ADT's for individual surface roads within the studied area.

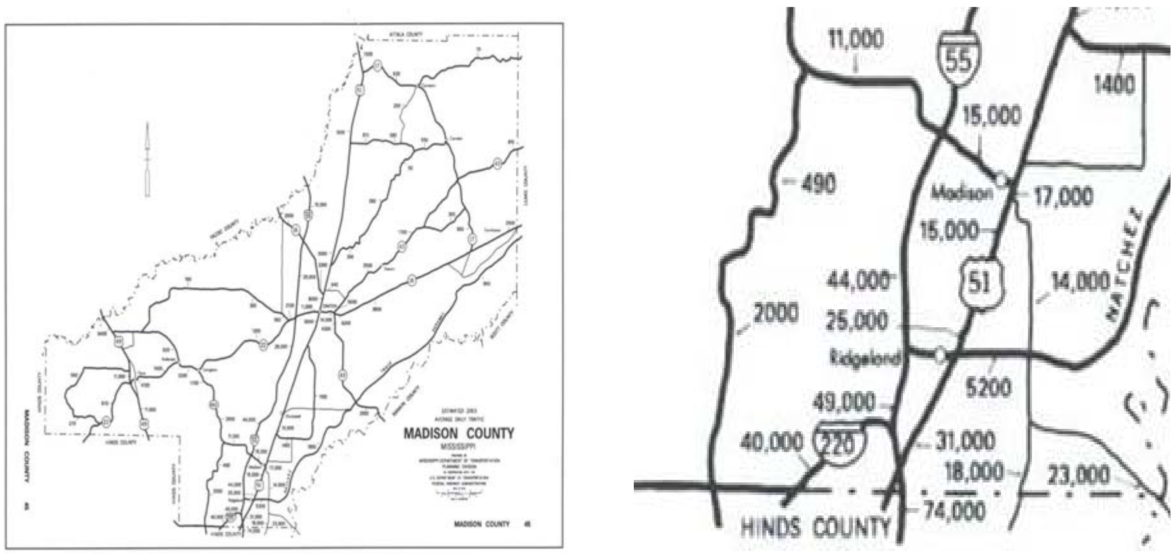


Figure 3-11. Annual Average Daily Traffic – Estimated 2003 – Studied Area

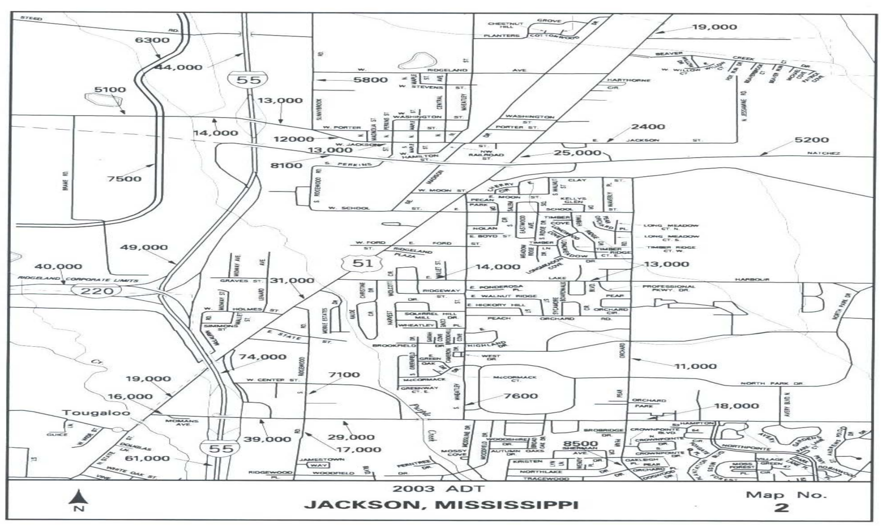


Figure 3-12 Average Daily Traffic for the Surface Roads in the Studied Area in 2003

Prior to the construction, the Planning Division collected and studied in great detail the intersection to be enhanced as part of the construction project. Figure 3-13 shows the existing 24-hours traffic count for an intersection within the studied area. Figure 3-14 shows the existing peak hour traffic counts for an intersection within the studied area. Figure 3-15 and 3-16 shows the A.M. and P.M. (respectively) levels of service for the existing configuration of an intersection within the studied area.

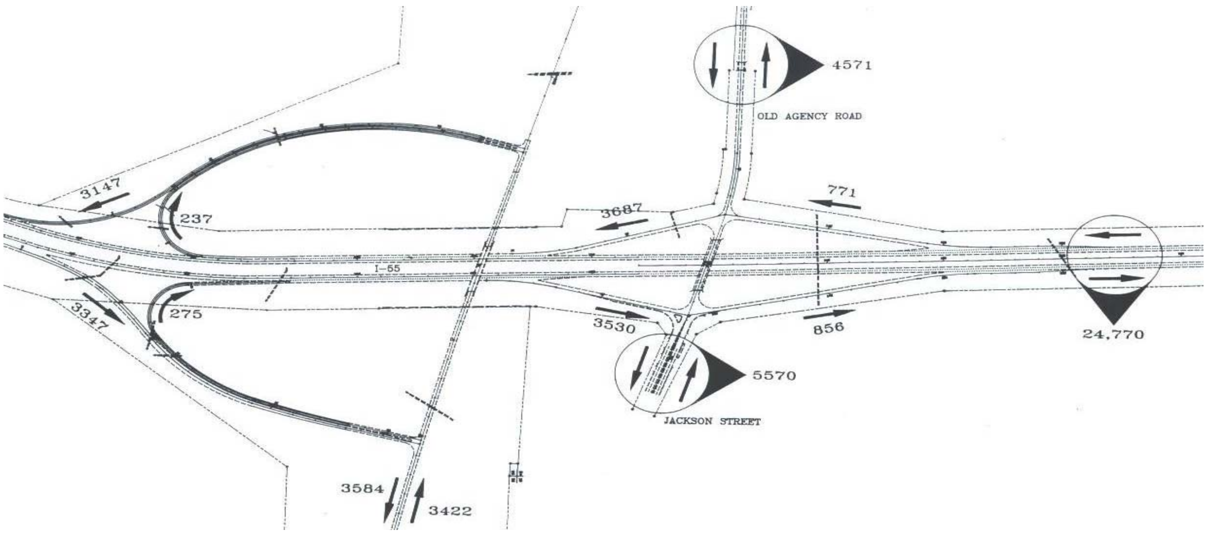


Figure 3-13. Existing 24-Hours Traffic Count for an Intersection within the Studied Area.

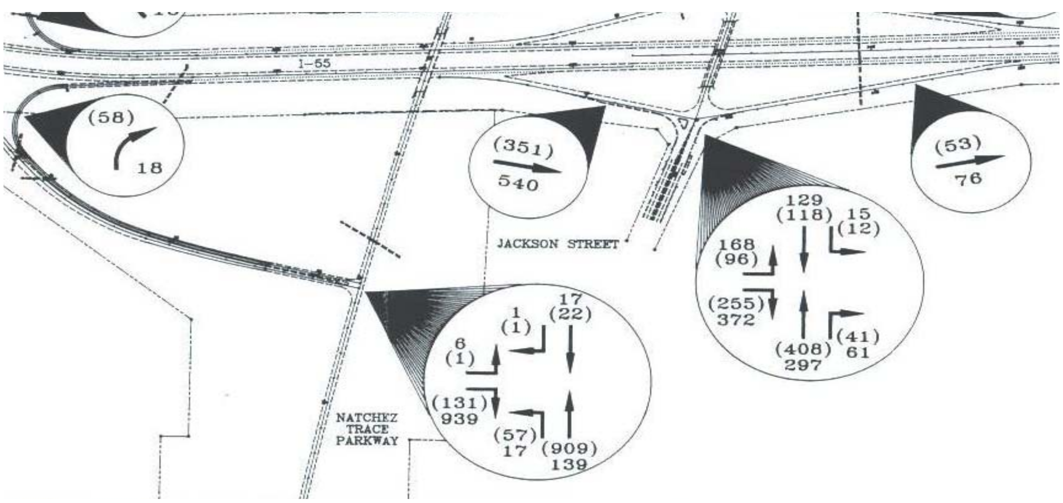


Figure 3- 14. Existing Peak Hour Traffic Count for an Intersection within the Studied Area.

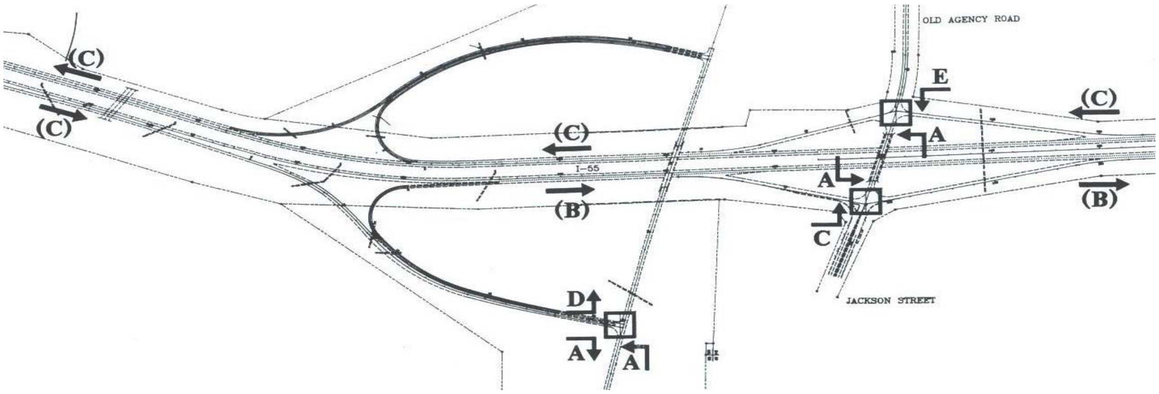


Figure 3-15. A.M. Levels of Service for the Existing Configuration of an Intersection within the Studied Area.

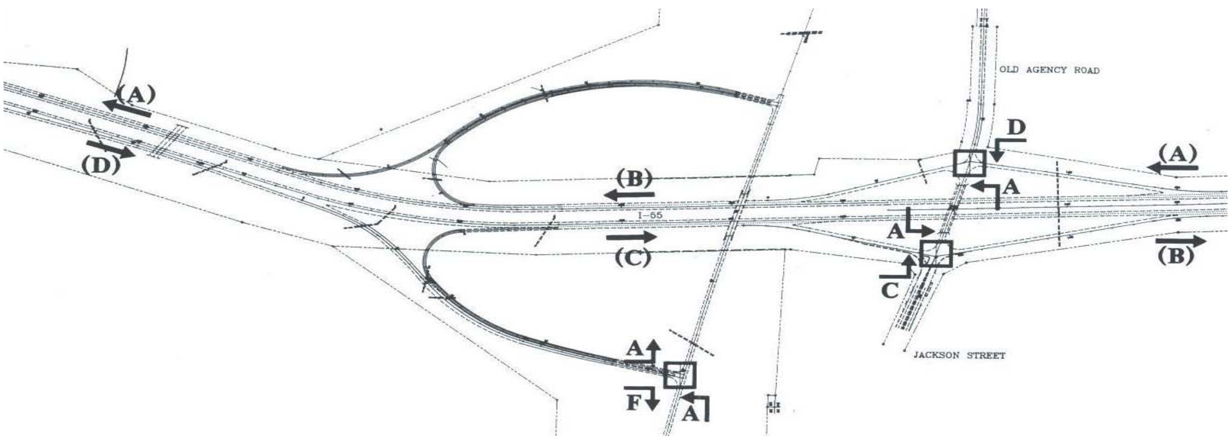


Figure 3-16. P.M. Levels of Service for the Existing Configuration of an Intersection within the Studied Area.

The Planning Division also projected the level of service for the intersections in the event that construction would not take place in the studied area. Figure 3-17 and 3-18 show the No-Build alternative A.M. and P.M. (respectively) levels of service in 2020 for the existing configuration of an intersection within the studied area.

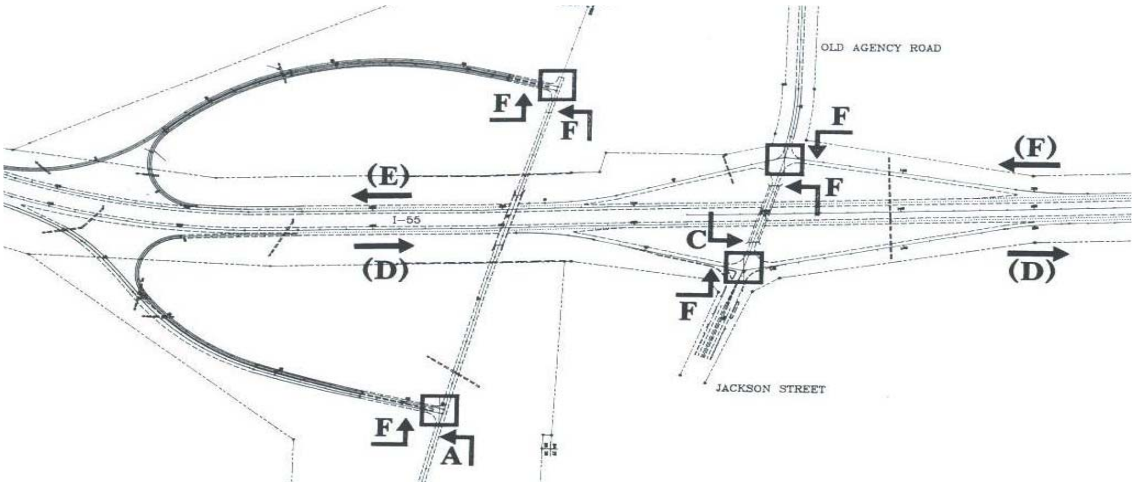


Figure 3-17. P.M. Levels of Service for the No-Build Alternative of an Intersection within the Studied Area in 2020.

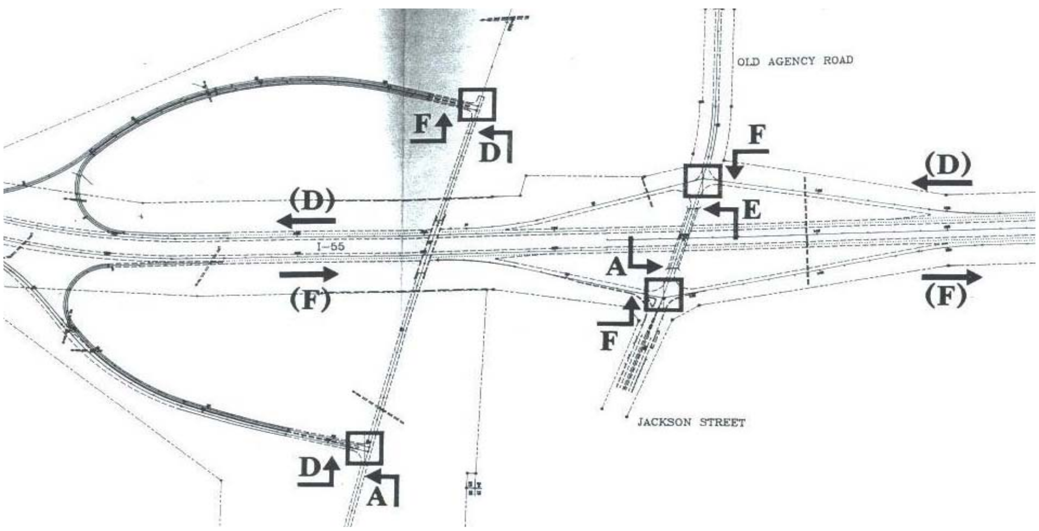


Figure 3-18. A.M. Levels of Service for the No-Build Alternative of an Intersection within the Studied Area in 2020.

Several construction alternatives were analyzed and their corresponding levels of service calculated for the intersections in the studied area. Figure 3-19, Figure 3-20, and Figure 3-21 show levels of service in 2020 for alternative construction configurations of an intersection within the studied area. Based on the analysis of the alternatives the Planning Division recommended a configuration for the construction project. Figure 3-22 shows the recommended configuration with its corresponding traffic volume.

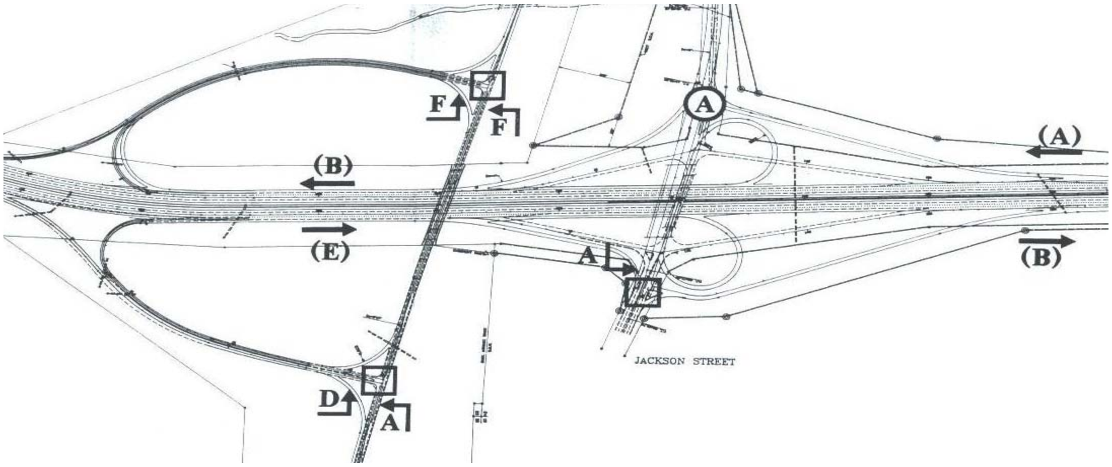


Figure 3-19. P.M. Levels of Service for Alternative B1 and C1of an Intersection within the Studied Area in 2020.

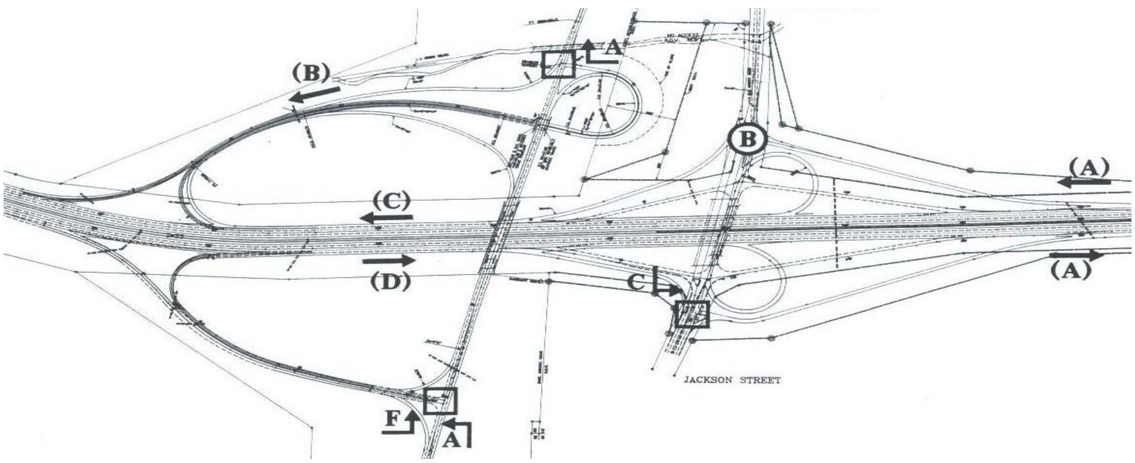


Figure 3-20. A.M. Levels of Service for Alternative B2 and C2of an Intersection within the Studied Area in 2020.

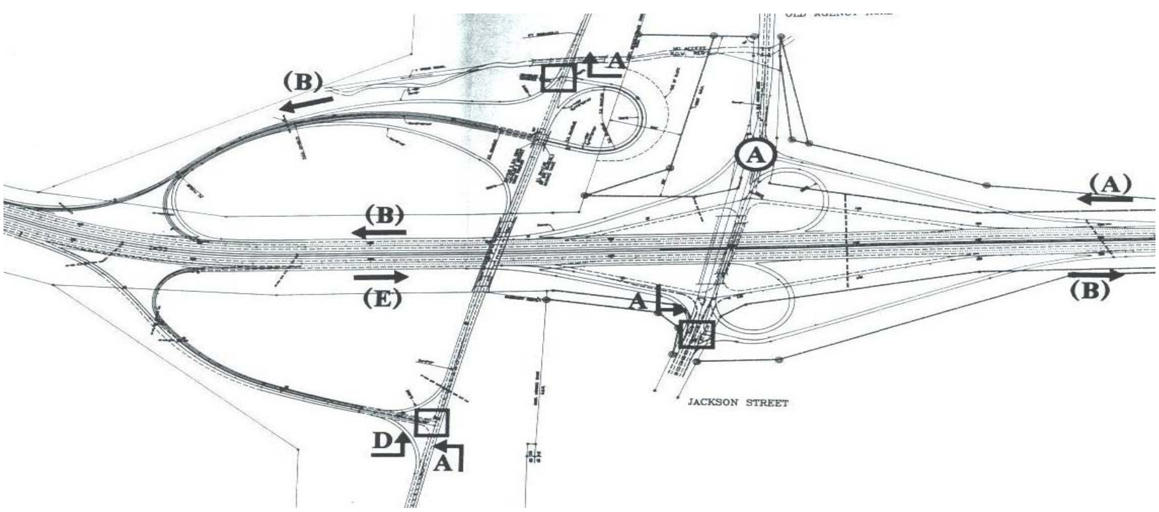


Figure 3-21. P.M. Levels of Service for Alternative B2 and C2of an Intersection within the Studied Area in 2020.

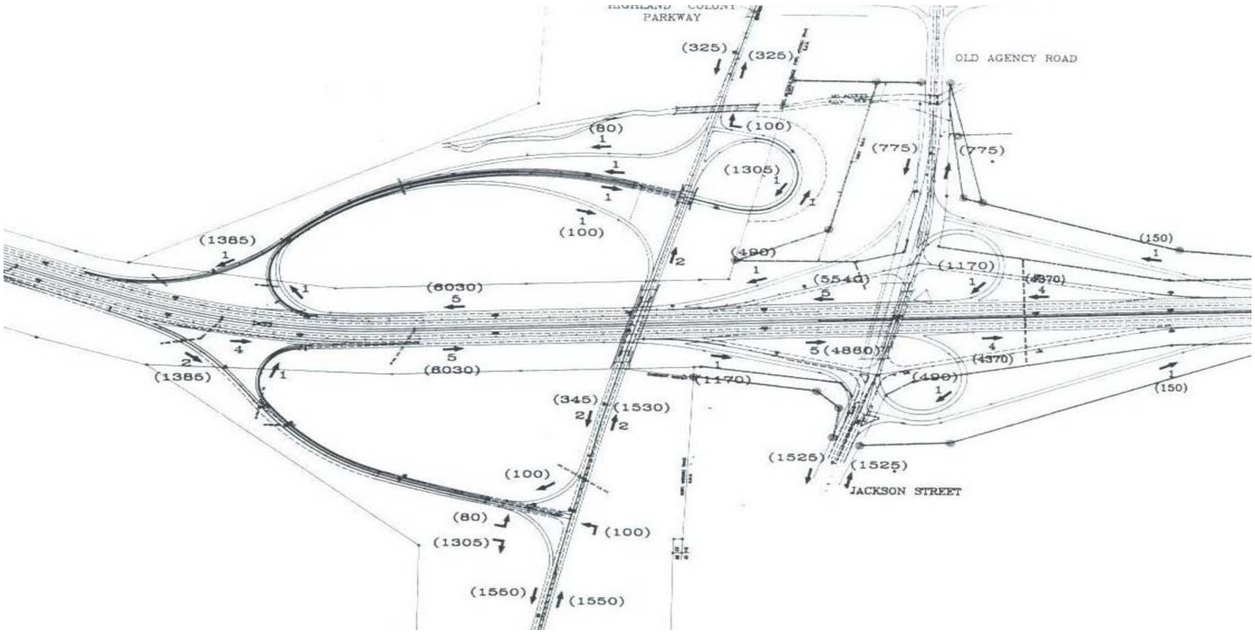


Figure 3-22 Recommended Construction Configuration and Traffic Volume.

It is important to highlight the fact that the Planning Division data was organized and structured in a way that was most suitable for the initial intent of the data. However, very little field standardization was found in the data and consolidation of the data was not a trivial task.

3.3.2. District 5 Office - Mississippi Department of Transportation

In order to fulfill its mission, the MDOT District Office had all the construction documents developed by engineering prior to the construction, as well as all the construction documents generated during the construction process. All the data provided by the District office to the research team was hard copy. Given the diversity of the information handled by this office, there was no common structure in the data archived by this organization. This office handled descriptive, pictorial and numerical information. Information ranged from specific in nature (either by location or day) to very broad. Table 3-4 shows the project overview. Figure 3-23, Figure 3-24 and Figure 3-25 show examples of a construction drawing provided by the District Office. Table 3-5 shows a brief description of the construction sequence of activities

Table 3-4. Project Overview

Project:	I-55 @ Old Agency Rd
Project No.:	IM-055-2(160)
Length of the project:	1.6 miles + 1.3 miles
Approximate Cost:	$20M

Time Frame: 02-16-01 to 08-31-04 (Construction)

Lane Closure: ONLY between 8:30am – 3:30pm (M-F)

ANYTIME (S-S)

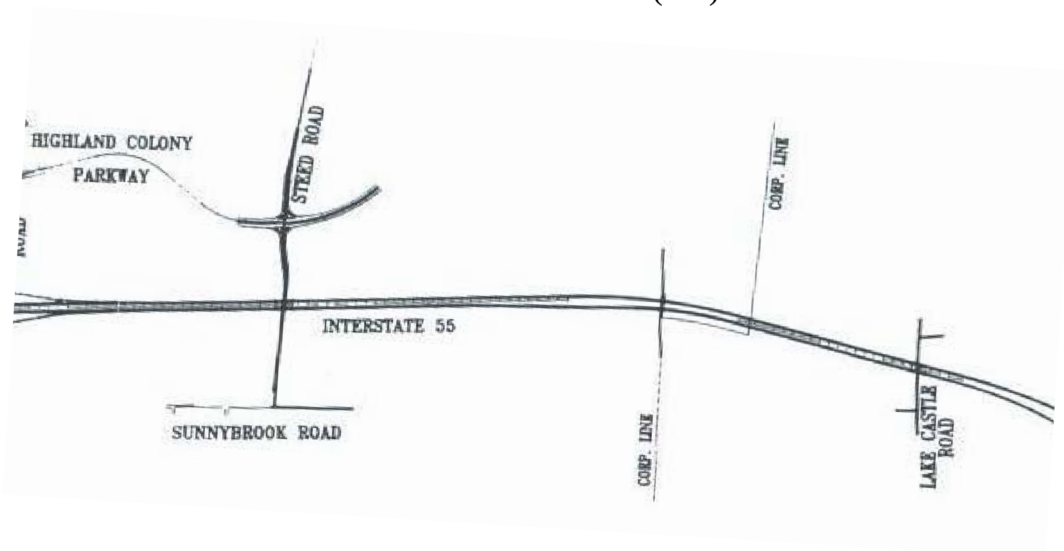


Figure 3-23. Sample of a Construction Drawing

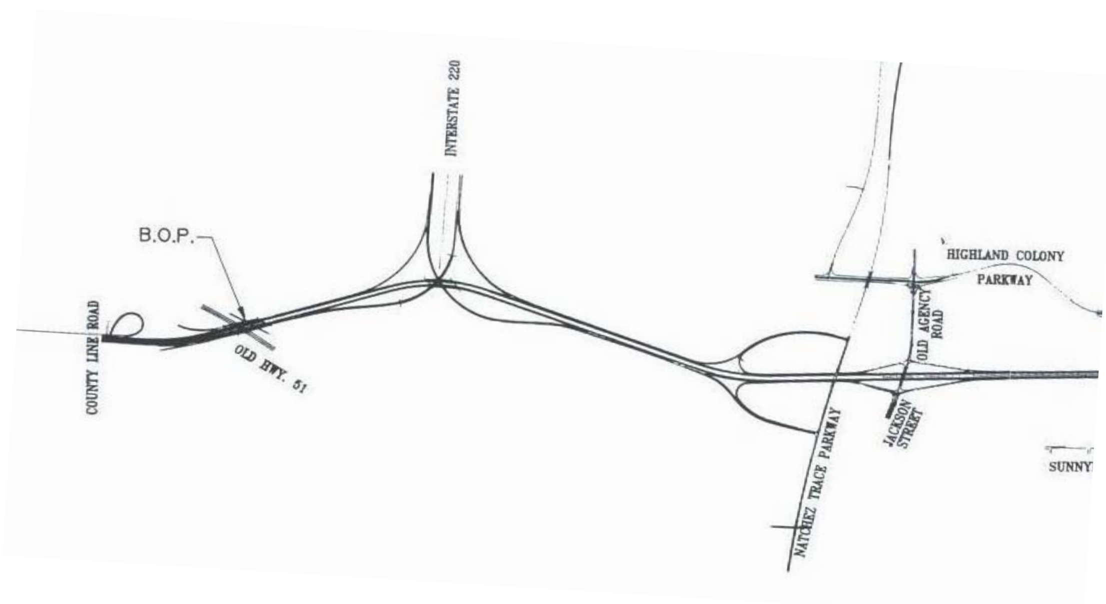


Figure 3-24. Sample of a Construction Drawing

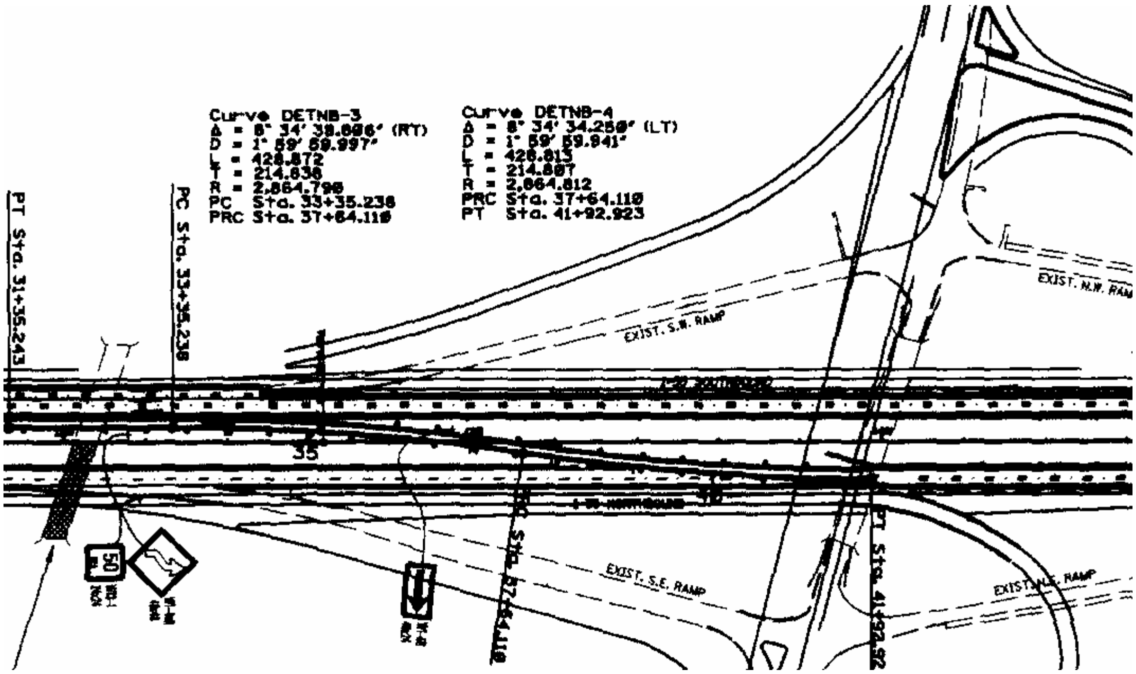


Figure 3-25. Sample of a Construction Drawing

Table 3-5 Brief Description of the Construction Sequence of Activities

Timeframe	Description
02-16-01 - 2-22-01	Placed median barriers southbound
02-23-01 - 03-13-01	Placed median barriers northbound
03-20-01 (NTP)	Closed Natchez Trace Parkway Bridge & West ramps of NTP
10-03-01 - 10-12-01	Placed median barriers southbound to put traffic on newly constructed inside lane (becomes shoulder when complete)
11-01-01 - 11-09-01	Placed median barriers northbound to put traffic to the newly constructed inside lane (becomes shoulder when complete)
12-18-01	Opened new SE ramp @ OAR
12-19-01	Opened new SW ramp @ OAR
06-03-02	Opened new NE and NW ramps @ OAR
07-08-02	Closed NTP East ramps
02-19-03 lanes	Moved northbound traffic to outside 2 to finish leveling Sta 108+00 - E.O.P.
04-01-03	Opened NTP east ramps
04-01-03	Changeable Speed Sign with Radar Slow down

06-04-03 - 06-15-03 Removed median barriers northbound
06-15-03 So far there were only two lanes open
06-15-03 – 08-31-04 Paving, Opening Lane, Landscaping
07-14-03 Switched Northbound traffic back to
inside lanes
(like described previously 11-1-01 - 11-9-01).
11-12-03 Switched Southbound traffic to outside
lanes
11-20-03 Opened NE and NW loops plus Natchez
Trace
Bridge and West ramps of NTP
12-19-03 Opened a new lane Northbound from I-220 - Northeast Ramp
12-19-03 Opened a new lane Southbound from NW Ramp to I-220
03-09-04 Opened all lanes Southbound in final
locations
03-30-04 Opened all lanes Northbound in final
locations.
05-04-04 Began permanent stripe and completed 5-
17-04

3.3.3. Traffic Engineering Division - Mississippi Department of Transportation

In order to fulfill its mission the MDOT Traffic Engineering Division continuously collects safety related information. All the information provided by this office to the research team was in electronic files. Several files were provided to the research team to analyze the safety conditions of the studied area. Although, all the data was electronically stored, there were very limited (if any) common fields. This lack of uniformity in the data stored could be attributed to it diversity.

Figure 3-26 provides the measurements of speed distribution at a particular location. This figures shows the number (and percentage) of vehicles that were traveling at different speeds in the studied area. The traffic engineering division also gathers from various law enforcement agencies information regarding crashes. Table 3-6 shows the components of the crashes report. Table 3-7 shows the possible options within each component. Figure 3-27 shows some sample crash information using the components and their elements showed in Tables 3-6 and 3-7.

DISTRICT	: 5	DAY	: THUR
COUNTY	: HINDS	DATE	: 01/09/03
CITY	: JACKSON	TIME	: 1:32-1:41
ROUTE NO	: I-55	WEATHER	: CLR/DRY
LOCATION	: 0.2 N. BEASLEY	DIRECTION	: NB/ONLY
FILE NAME	: 03250I55C.XLS	POSTED SL	: 60/MPH

UPPER CLASS BOUND.	SPEED RANGE		MID VALUE (MPH)	NUM. of VEHS.	%	CUM. %	VEH-MILES /HOUR	
12.5	8 -	12	10		0.0	0.0	0	12.5
17.5	13 -	17	15		0.0	0.0	0	17.5
22.5	18 -	22	20		0.0	0.0	0	22.5
27.5	23 -	27	25		0.0	0.0	0	27.5
32.5	28 -	32	30		0.0	0.0	0	32.5
37.5	33 -	37	35		0.0	0.0	0	37.5
42.5	38 -	42	40		0.0	0.0	0	42.5
47.5	43 -	47	45		0.0	0.0	0	47.5
52.5	48 -	52	50		0.0	0.0	0	52.5
57.5	53 -	57	55	9	6.4	6.4	495	57.5
62.5	58 -	62	60	27	19.1	25.5	1620	62.5
67.5	63 -	67	65	53	37.6	63.1	3445	67.5
72.5	68 -	72	70	47	33.3	96.5	3290	72.5
77.5	73 -	77	75	3	2.1	98.6	225	77.5
82.5	78 -	82	80	2	1.4	100.0	160	82.5
87.5	83 -	87	85		0.0	100.0	0	87.5
92.5	88 -	92	90		0.0	100.0	0	92.5
	TOTAL			141			9235	

Figure 3-26. Speed Distribution in the Studied Area

Table 3-6. Components of the Crashes Report

County
Weather
Direction
Number of Vehicles
Number of Injuries
Number of Fatalities
Accident
Object Struck
Lighting
Weather
Road
Veh 1 Action
Veh 2 Action

Table 3-7. Options within Components of the Crashes Report

County
- Madison
- Hinds

Weather
- Clear
- Cloudy
- Fog
- High W
- Other
- Raining
- Showing
- Unknown
- Blank

Direction
- North
- South
- East
- West

Number of Vehicles

Number of Injuries

Number of Fatalities

Accident
- Angle
- Animal
- Fixed Obj
- Head On
- Left Turn
- Other In
- Other Obj
- Overturn
- Parrked Veh
- Pedestria
- Ran off
- Rear End
- Right Turn
- Sideswipe
- Unknown

Object Struck
- Abutment
- Animal
- Bicycle
- Center ba
- Curb, catc
- Guard rai
- Other
- Pedestria
- Sign Post
- Trees
- Unknown o
- Utility p
- Blank

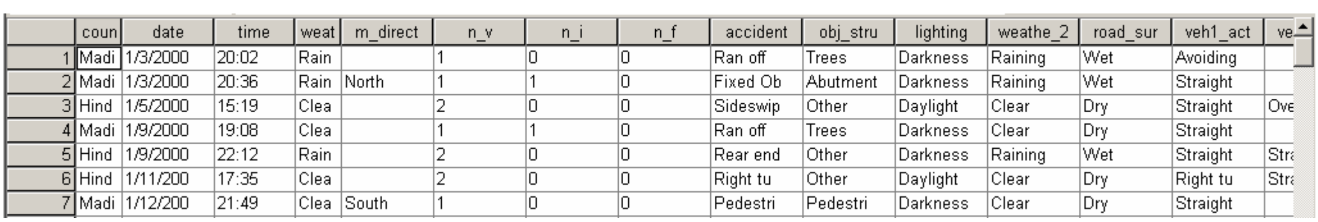
Lighting
- Darkness
- Dawn or
- Daylight
- Unknown

Weather
- Clear
- Cloudy
- d Clear
- d Cloudy
- d Raining
- Fog
- High wind
- I Clear
- I Cloudy
- I Unknown w
- Other
- Raining
- Snowing
- Unknown w
- Blank

Road
- 99
- Dry
- Other
- Snow
- Wet
- (Blank)

Veh 1 Action
- Avoiding
- Backing
- Leav Park
- Left Turn
- Overtakin
- Right Tur
- Slowing I
- Stopped
- Straight
- U turn
- Unknow a
- (Blanks)

Veh 2 Action
- Avoiding
- Backing
- Leav Park
- Left Turn
- Overtakin
- Right Tur
- Slowing I
- Stopped
- Straight
- U turn
- Unknow a
- (Blanks)



	coun	date	time	weat	m_direct	n_v	n_i	n_f	accident	obj_stru	lighting	weathe_2	road_sur	veh1_act	ve
1	Madi	1/3/2000	20:02	Rain		1	0	0	Ran off	Trees	Darkness	Raining	Wet	Avoiding	
2	Madi	1/3/2000	20:36	Rain	North	1	1	0	Fixed Ob	Abutment	Darkness	Raining	Wet	Straight	
3	Hind	1/5/2000	15:19	Clea		2	0	0	Sideswip	Other	Daylight	Clear	Dry	Straight	Ove
4	Madi	1/9/2000	19:08	Clea		1	1	0	Ran off	Trees	Darkness	Clear	Dry	Straight	
5	Hind	1/9/2000	22:12	Rain		2	0	0	Rear end	Other	Darkness	Raining	Wet	Straight	Stra
6	Hind	1/11/200	17:35	Clea		2	0	0	Right tu	Other	Daylight	Clear	Dry	Right tu	Stra
7	Madi	1/12/200	21:49	Clea	South	1	0	0	Pedestri	Pedestri	Darkness	Clear	Dry	Straight	

Figure 3-27. Sample Crash Information with Components and their Elements

3.3.4. Mississippi Safety Highway Patrol

In order to fulfill its mission and its contractual obligation with MDOT, the Mississippi Safety Highway Patrol prepared monthly reports of the law enforcement efforts in the studied area. All of the information provided by this agency to the research team was in hard copy. Additional, the information was only summary of activities (such as the report shown in Figure 28). The detailed information related each event was not accessible to the research team because the retrieval would require hand search of the individual documents. Figure 3-28 shows a portion of a sample activity report prepared by this organization in the studied area.

DPS/MHP Enforcement Program								
Construdtion Traffic Enforcement								
MHP/MDOT								
Project # I-55 North								
January 1, 2003 Through January 31, 2003								
Prepared by: Lt. Donald McCain								
Date			Badge		Hours	Haz	Nonhaz	Mileage
M	D	Year						
1	8	2003	C	37	8	17	4	200
1	8	2003	C	27	8	19	6	300
1	9	2003	C	60	8	10	7	250
1	9	2003	C	42	8	9	1	204
1	10	2003	C	40	8	17	3	200
1	10	2003	C	22	8	6	0	200

Figure 3-28. Sample of the Law Enforcement Report presented by the Mississippi Highway Patrol to MDOT

3.3.5. Ridgeland Police Department

The Ridgeland Police Department also prepared monthly reports of the law enforcement efforts in the studied area. Figure 3-29 shows the Traffic Citations given by the Ridgeland Police Department. All of the information provided by this department was in electronic format and contained all the information generated at the moment of the incident. Each record represents one citation. Additionally, this information was compiled in a report as shown in Figure 3-30.

1	CITATION_DATE	CITATION_NO	LOCATION	OFFICER_ID
2	8/3/2003	083812	I 55	71
3	5/30/2003	080990	I-55-OLD AGENCY	2004110333
4	8/10/2003	083893	I-55N	27
5	8/10/2003	083894	I-55N	27
6	8/10/2003	083895	I-55N	27
7	8/10/2003	083896	I-55N	27
8	6/24/2003	082042	I-55N	2004110464
9	5/7/2003	081738	I-55N	2004110464
10	8/3/2003	083811	55	71

	location	offi_id	off_id_s	offi_nam	offi_n_s	descript
1	I 55	71	20	RON PHILLIPS	18	NO LICENSE TAG
2	I-55-OLD AGENCY	2004110333	3	YOUNG, HOWARD	23	NO PROOF OF INSURANCE
3	I-55N	27	7	REVELL DIXON	15	SPEEDING - 16 - 20 MILES OVER I
4	I-55N	27	7	REVELL DIXON	15	SPEEDING - 16 - 20 MILES OVER I
5	I-55N	27	7	REVELL DIXON	15	NO PROOF OF INSURANCE
6	I-55N	27	7	REVELL DIXON	15	SUSPENDED DRIVERS LICENSE
7	I-55N	2004110464	4	DERRINGTON, DEE	5	NO PROOF OF INSURANCE
8	I-55N	2004110464	4	DERRINGTON, DEE	5	SPEEDING - 16 - 20 MILES OVER I
9	55	71	20	RON PHILLIPS	18	SPEEDING - 10 - 15 MILES OVER I
10	55	71	20	RON PHILLIPS	18	CHILD RESTRAINT LAW
11	55	71	20	RON PHILLIPS	18	IMPROPER EQUIPMENT

Figure 3-29. Sample Traffic Citations given by the Ridgeland Police Department

City Of Ridgeland								
I-55/Old Agency Construction Zone Traffic Enforcement								
				Total	Hazardous			
Date	Time	Officer	Hrs.	Citations	Citations	Warnings	Arrests	Accidents
8/15/2003	0600-1800	Dixon	12	20	15	0	0	0
8/18/2003	0600-1200	Robinson	6	9	5	0	0	0
8/18/2003	1200-1800	McGahey	6	3	1	0	0	1
8/20/2003	0600-1200	Dotson	6	3	2	0	0	0
8/20/2003	1200-1800	Dixon	6	5	2	0	1	0
8/29/2003	0600-1800	Martin	12	4	3	0	1	0
8/29/2003	1800-0000	Grissett	6	8	7	0	0	0
8/30/2003	0000-1200	Neal	12	0	0	5	0	0
8/30/2003	1200-0000	Davis	12	4	4	5	1	0
8/31/2003	0000-1200	Dillard	12	3	2	2	0	0
8/31/2003	1200-0000	Grissett	12	7	7	0	0	0
9/1/2003	0000-0600	Sorrell	6	11	9	0	0	0
9/1/2003	0600-1200	Robinson	6	9	9	0	0	0
9/1/2003	1200-0000	McGahey	12	14	13	3	1	0
Total			**126**	**100**		**15**	**3**	**1**

Figure 3-30. Sample of the Law Enforcement Report presented by the Ridgeland Police Department to MDOT

3.4. LESSONS LEARNED

The safety of drivers and workers in construction zones is of paramount importance for all the agencies that were interviewed. All agencies were very willing to collaborate in the data consolidation process. However, collecting, archiving and retrieving information was not a main priority for any of these agencies. Additionally, no general guidelines for data structuring was communicated among the agencies. Therefore, it is evident that input into the data gathering process before the data is collected rather than after the fact, could greatly improve the process of accessing the impact of law enforcement surveillance in construction zones. By defining the data to be collected, the method for collecting the data, the formatting of the data, the timeframes for collecting the data (before, during and after construction) all the participating agencies would be to share information and to demonstrate the impact of their performance the stakeholders.

Additionally, this collection effort demonstrated that the data was available and the agencies were willing to provide the data to the research team. The research team was able to combine, reform, integrate and analyze the data to produce quantifiable results.

Finally, although each agency participating in this project had a different mission and collected different data, it is possible to create a data structure that allow these agencies to share common data for common purposes and reduce the cost of the data collection efforts.

3.5. SUMMARY

Maintenance and construction programs are arguably one of the most important functions of States DOT (as represented by the percentage of the budget invested). On the other hand during the construction period, there are temporary traffic disruptions, which increase the number of accidents with associated deaths and injuries. Therefore, several states have taken a proactive role in implementing special measures in construction work zones to reduce number of accidents. One of these special measurements is the increase of law enforcement surveillance in construction zones.

This chapter focused on the agencies involved in collecting and storing the data as well as the data used to measure the impact of law enforcement in construction zones. The content of this chapter was them used as the foundation for the statistical analysis.

This work followed a descriptive research methodology to systematically collect data from the several agencies involved in construction projects. The first step in the data collection was for MDOT to contact the agency and provide brief information about the project and research. Then the research met with the agency to discuss the overall purpose of the project and request the required data. Then the agency was responsible for assembling the collected data and sending it to the researchers.

The results presented in this paper demonstrate the importance of inter-agency collaboration. Furthermore, this paper provide an example of data collected, archiving mechanism and retrieval procedures of each agency involved in this project. Therefore, the results could be used as lessons learned and serve as the foundation for similar studies.

CHAPTER 4:
DATA STRUCTURING FOR STATISTICAL ANALYSIS OF:
LAW ENFORCEMENT SURVEILLANCE IMPACT
ON CONSTRUCTION ZONES

4.1. OVERVIEW OF THE AGENCIES AND THEIR COLLECTED DATA

Collecting, processing, archiving and retrieving data/information is a costly, demanding and necessary activity of all agencies. Each agency manages data/information in a different way for a variety of purposes to fulfill their primary responsibility/mission.

The first step in consolidating the data was to identify the agencies with needed data, the offices within the agencies and their responsibility/roles in collecting data. Then, the MDOT leader of this project contacted the agencies and provided a brief description of the project and the research team. The research team followed-up this initial contact by requesting a meeting with the representatives of the agencies to provide an overview of the project and initiate the turn-over of the data that had been collected by the agencies. During, this initial meeting an informal interview was conducted with the agency representative to explicitly identify the data that the agency had already collected, the structure, and the media in which the data was stored as well as the retrieval means of the agency. Upon agreeing with the agency concerning the data to be retrieved, a mechanism to transfer the data was established. As expected and evidenced below, each agency used a different structure to archive the data. Furthermore, some agencies were able to retrieve the data in electronic form while other agencies were only able to retrieve the data in hard copies. The following is a brief description of the data collected by different agencies involved in a road construction zone:

4.1.1. District 5 Office - Mississippi Department of Transportation (MDOT)

The MDOT District Office had all the construction documents developed by engineering prior to the construction as well as all the construction documents generated during the construction process. All the data provided by the District Office to the research team was hard copy. Given the diversity of the information handled by this office, there was no common structure in the data archived. This office handled descriptive, pictorial and numerical information. Information ranged from specific in nature (either by location or day) to very broad. One of the most valuable pieces of information provided by the District 5 office to the research team was the actual construction timeline shown in Table 4-1.

Table 4-1. Construction Timeline Received from District 5

Dates	Activities
02-16-01 - 02-22-01	Placed median barriers southbound
02-23-01 - 03-13-01	Placed median barriers northbound
03-20-01	Closed Natchez Trace Parkway (NTP) Bridge & West ramps of NTP
10-03-01 - 10-12-01	Placed median barriers southbound to put traffic on newly constructed inside lane (becomes shoulder when complete)
11-01-01 - 11-09-01	Placed median barriers northbound to put traffic to the newly constructed inside lane (becomes shoulder when complete)
12-18-01	Opened new SE ramp @ OAR
12-19-01	Opened new SW ramp @ OAR
06-03-02	Opened new NE and NW ramps @ OAR
07-08-02	Closed NTP East ramps
02-19-03	Moved northbound traffic to outside 2 lanes to finish leveling Sta 108+00 - E.O.P.
04-01-03	Opened NTP east ramps
04-01-03	Changeable Speed Sign with Radar Slow down
06-04-03 - 06-15-03	Removed median barriers northbound
06-15-03	So far there were only two lanes open
06-15-03 - 08-31-04	Paving, Opening Lane, Landscaping
07-14-03	Switched Northbound traffic back to inside lanes (like described previously 11-1-01 - 11-9-01).
11-12-03	Switched Southbound traffic to outside lanes
11-20-03	Opened NE and NW loops plus Natchez Trace Bridge and West ramps of NTP
12-19-03	Opened a new lane Northbound from I-220 - Northeast Ramp
12-19-03	Opened a new lane Southbound from NW Ramp to I-220
03-09-04	Opened all lanes Southbound in final locations
03-30-04	Opened all lanes Northbound in final locations.
05-04-04	Began permanent stripe and completed 5-17-04

4.1.2. Planning Division - Mississippi Department of Transportation (MDOT)

The MDOT Planning Division had placed a number of traffic recording devices around the state. The data/information collected from these devices was mainly handled/presented in pictorial and numerical form. The Planning Division archived the information both in hard copies and electronic media. Some of the information received by the research team was in hardcopy and some was received in electronic files. In the cases where the information was made available to the research team in hard copy, further processing was required. The research team entered the information either in a spreadsheet or another program that allowed the processing of the data. One of the most valuable pieces of information provided by the Planning Division to the research team was traffic volume in the studied area. Figure 4-1 shows a sample of traffic volume obtained from the Planning Division.

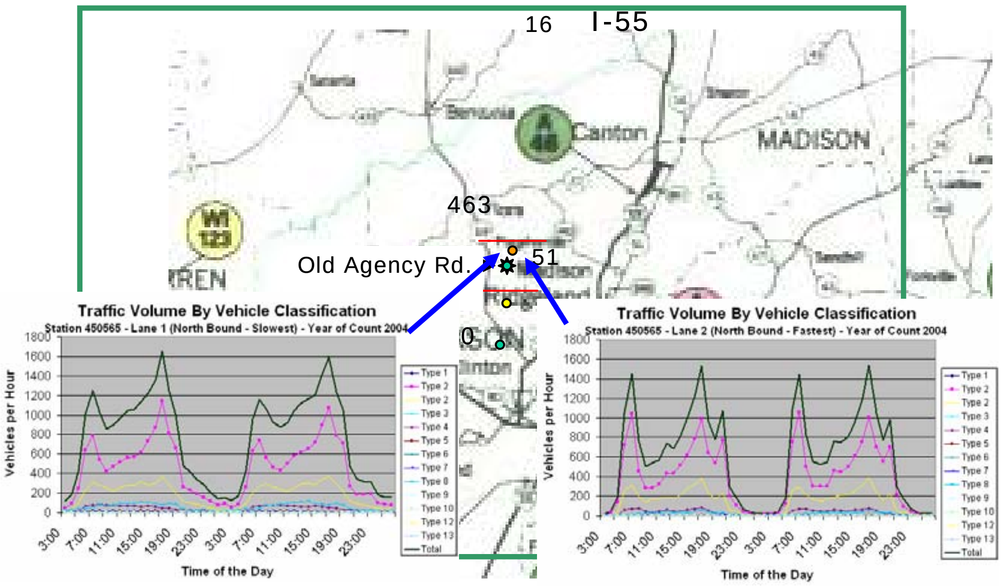


Figure 4-1 – A Sample of the Traffic Volume Data Received from Planning Division

4.1.3. Mississippi Safety Highway Patrol

The Mississippi Safety Highway Patrol as part of a contract with MDOT established through a Memorandum of Understanding, prepared monthly reports of law enforcement efforts in the studied area. All information provided by this agency to the research team was in hard copy. Additionally, the information was only a summary of activities, where each record represented a number of citations. The detailed information related to each event was not accessible to the research team because the retrieval would require a hand search of the individual documents. Figure 4-2 shows an example of the citation provided by this agency.

DPS/MHP ENFORCEMENT PROGRAM

CONSTRUCTION TRAFFIC ENFORCEMENT
MHP/MDOT
Project # I-55 NORTH

MARCH 1, 2003 THROUGH MARCH 31, 2003

PREPARED BY: LT. DONALD McCAIN

DATE	SSN	BADGE	NAME	HOURS	HAZ	NONHAZ	MILEAGE
03/01/03				8	20	4	200
03/01/03				8	12	0	150
03/02/03				8	22	1	200
03/02/03				8	8	1	100
03/03/03				8	15	3	200
03/03/03				8	3	7	200
03/04/03				8	20	1	250
03/04/03				8	14	1	275
03/05/03				8	5	0	150
03/05/03				8	9	12	203

Figure 4-2. A Sample of the Citation Information Received from the Mississippi Highway Patrol

4.1.4. Ridgeland Police Department

The Ridgeland Police Department also prepared monthly reports of the law enforcement efforts in the studied area. All information provided by this department was in electronic format and contained all the information generated at the moment of the incident. The data provided by the Ridgeland Police Department to the research team was citation data in the studied area. Each citation was represented as one record as shown in Figure 4-3.

	A	B	C	D	E	F
1	CITATION_DATE	CITATION_NO	LOCATION	OFFICER_NAME	DESCRIPTION	VIOLATION
2	8/15/2003	084817	1-55 S/B		SPEEDING - 16 - 20 MILES OVER LIMIT	SPD2
3	8/15/2003	084814	1-55 S/B		SPEEDING - 10 - 15 MILES OVER LIMIT	SPD1
4	8/15/2003	083900	I-55N/B		SPEEDING - 10 - 15 MILES OVER LIMIT	SPD1
5	8/15/2003	081226	I 55		WINDOWS, TINTED OR DARKENED, 1ST OFFE	TINT1
6	8/15/2003	080625	I55		SPEEDING - 10 - 15 MILES OVER LIMIT	SPD1
7	8/15/2003	080624	I55 N/B		SPEEDING - 10 - 15 MILES OVER LIMIT	SPD1
8	8/15/2003	084816	I-55 N/B		SPEEDING - 16 - 20 MILES OVER LIMIT	SPD2

Figure 4-3. A Sample of the Citation Information Received from
The Ridgeland Police Department

4.1.5. Traffic Engineering Division – Mississippi Department of Transportation (MDOT)

The MDOT Traffic Engineering Division continuously collects safety related information. All information provided by this office to the research team was in electronic files. Several files were provided to the research team to analyze the safety conditions of the studied area. Although, all the data was electronically stored, given the diversity of the data, few (if any) of the fields were common to all the data stored. Two of the most valuable pieces of information provided by the Traffic Engineering Division to the research team were the crash data in the studied area and the Memorandum of Understanding between the MDOT and the law enforcement agencies. Figure 4-4 and 4-5 show a sample of crash data obtained from the Traffic Engineering Division and a portion of sample Memorandum of Understanding respectively.

	A	B	C	D	E	F	G	H	I	J	K	L
1	COUNTY	DATE	TIME	WEATHE	STREET 1	DISTANCE	FEET OR	M DIRECTION	STREET 2	NUM	OF VE NUM	OF IN NUM
2												
3	Madison	1/3/2000	20:02	Rainin	I-55	0			S. TRACE RAMP	1	0	0
4	Madison	1/3/2000	20:36	Rainin	HWY 55	400	Feet	North	105 A EXIT	1	1	0
5	Hinds	1/5/2000	15:19	Clear	I-55	300	Feet		WOODROW WILSON	2	0	0
6	Madison	1/9/2000	19:08	Clear	I-55	0			MILE MARKER 11	1	1	0

	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	OF IN NUM	OF FA ACCIDENT	OBJ STRUC	LIGHTING	WEATHER	ROAD	SURF VEH 1 CONTR	IB	VE	H 2 CONTR	IB	VEH 1	DIR VEH 2 DIR	VEH 1 ACT
2														
3	0	Ran off r	Trees	Darkness	Raining	Wet						South		Avoiding
4	0	Fixed Obj	Abutment	Darkness	Raining	Wet						North		Straight
5	0	Sideswipe	Other	Daylight	Clear	Dry						South	South	Straight
6	0	Ran off r	Trees	Darkness	Clear	Dry	Inattention					South		Straight

Figure 4-4. A Sample of the Crash Data Received from Traffic Engineering Division

MEMORANDUM OF UNDERSTANDING
BETWEEN
MISSISSIPPI TRANSPORTATION COMMISSION
AND
CITY OF RIDGELAND, MISSISSIPPI

This agreement is executed by and between the Mississippi Transportation Commission (the "MTC") and the City of Ridgeland, Mississippi, each of which is a body corporate of the State of Mississippi, effective as of the most recent date of execution hereof:

WITNESSETH:

WHEREAS, the MTC and City of Ridgeland, through its adjunct the Ridgeland Police Department, have identified an area in the City of Ridgeland, Madison County in the State of Mississippi where an increase of motor vehicle crashes resulting in fatalities and injuries has become evident; and

WHEREAS, the area of concern is located on and along Interstate Highway 55 from County Line Road and extending north to the 105 mile-marker which is just south of the Highway 463 exit, specifically in the construction area of the Old Agency Road interchange and including the Old Agency Road and Jackson Street areas located between Highland Colony and Sunnybrook Road; and,

WHEREAS, increasing the visibility of Ridgeland Police Officers in marked patrol cars and generally strengthening the enforcement efforts on this section of Interstate 55 and within the interchange area is likely to result in a decrease in the number of serious motor vehicle accidents thereby increasing the safety of both the traveling public and the workers in the construction area; and,

WHEREAS, it is in the best interest of the traveling public and the construction workers in this area that the City of Ridgeland provide additional enforcement of traffic laws through the issuance of traffic citations and other appropriate measures, with one officer assigned per shift in the aforestated area three days one week from 6 a.m. until 6 p.m. and one officer assigned per shift two days the next week from 6 a.m. until 6 p.m.); and,

WHEREAS, there is a substantial increase in travel over major holiday periods, therefore, it is in the best interest of highway safety that the City of Ridgeland provide 24-hour enforcement over the holiday periods of Labor Day, Thanksgiving and Christmas in 2003 and New Year's and Memorial Day in 2004 for a total of approximately 414 holiday hours; and,

WHEREAS, MTC has no funds available to expend to further these stated goals but the United States of America, through the Federal Highway

Figure 4-5. A Portion of Sample Memorandum of Understanding between MDOT and a Law Enforcement Agency

4.2. THE RESTRUCTURING AND CONSOLIDATION OF THE AVAILABLE DATA FOR THE ANALYSIS

The restructuring and consolidation of the data was driven by the main objective of the project which was to evaluate the safety impact of increased law enforcement surveillance on construction zones. To achieve this main objective, six specific statistical analyses were established aiming to determine if there was any correlation between the studied variables. The six analyses were as follows:

- Analysis 1 - Law Enforcement Presences Vs Number of Citations:
- Analysis 2 - Law Enforcement Over Time Vs Number of Citations:
- Analysis 3- Number of Citations per Week Vs Number of Crashes Per Week
- Analysis 4- Distribution of Volume Vs Distribution of Crashes
- Analysis 5- Time of The Day Vs Number of Crashes
- Analysis 6- Law Enforcement Presences Vs Number of Crashes

Based on the six analyses, the following data was required:

- Date of the Mississippi Highway Patrol Presences over time
- Date of the Ridgeland Police Presences over time
- Number of Citations Issued by the Mississippi Highway Patrol over time
- Number of Citations Issued by the Ridgeland Police Presences over time
- Number of Crashes in the studied area over time
- Hourly Traffic Volume in the studied area over time

- Construction condition over time

Upon comparing the required statistical analysis and the data available from the different agencies, it was recognized that there were five distinctive data sets (as shown in Figure 4-6): 1- Construction Information, 2- Traffic Volume Information, 3-Mississippi Highway Patrol (MHP) Activities, 4- Ridgeland Police (RP) Department Activities, and 5- Crash Information.

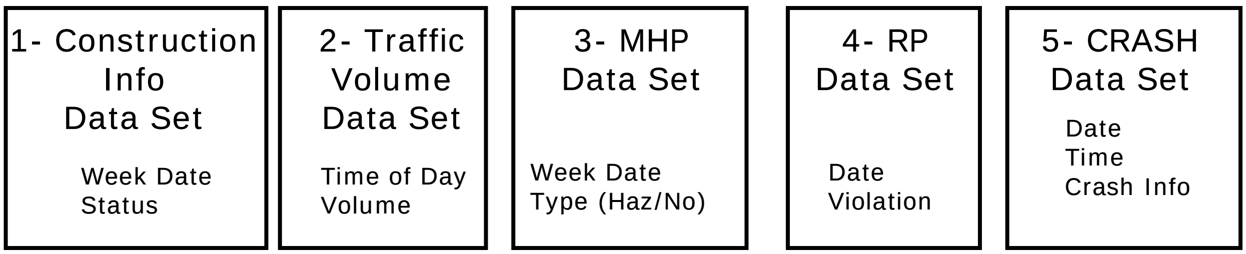


Figure 4-6. Data Sets for Analysis

The following is a brief description of the restructuring of the data from the different agencies involved:

4.2.1. Restructuring District 5 Office - Mississippi Department of Transportation (MDOT) Data

The construction timeline received from District 5 (shown in Table 1) was re-structured to two variables: Week Date and Construction Status. Since both data sets represented categories with intrinsic order, they were both defined as “Ordinal”.

The Week Date variable was assigned a number between 1 and 242. The number 1 was assigned to the week starting of January 2nd of 2000 and the successive numbers were assigned to the subsequent weeks as show in the Figure 4-7. The Construction Status variable received a value between 1 and 3, where 1 was assigned to the “After” construction condition, 2 was assigned to the “During” construction condition, and 3 was assigned to the “Prior” to construction condition as Show in Table 4-2.

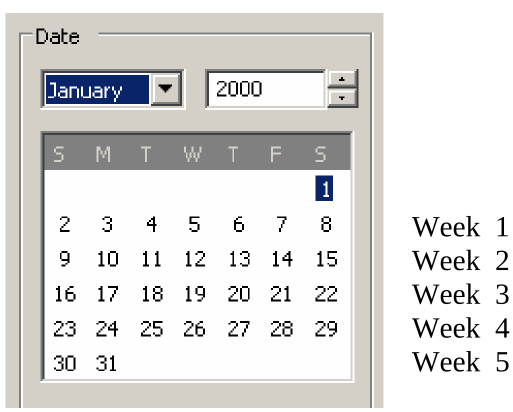


Figure 4-7. Week Date

Table 4-2. Construction Status

Start Date	End Date	Construction Status	Start Week	End Week
--	02/16/01	Prior	--	59
02/17/01	05/17/04	During	60	229
05/18/04	--	After	230	--

4.2.2. Restructuring Planning Division - Mississippi Department of Transportation (MDOT) Data

The traffic volume information received from District 5 (shown in Figure 4-1) was re-structured to two variables: Time of the Day and Volume. The variable Time of the Day was defined as "Ordinal" and since the "Volume" variable represented magnitude it was defined as "Scale".
The Time of the Day variable was assigned a number between 0 and 23 representing a 24 hours clock which begins at midnight (which is 0000 hours). The Volume variable received the number of vehicles per hour that passed the studied area as shown in Figure 4-8.

Tim_Day_2	Cas_Num_2	volume
0	12	290.00
1	10	198.00
2	11	160.00
3	4	155.00
4	13	204.00
5	6	547.00
6	21	1,749.00
7	59	3,552.00
8	33	2,630.00
9	31	1,931.00
10	23	1,926.00
11	45	2,135.00
12	54	2,212.00
13	60	2,236.00
14	33	2,405.00
15	57	2,846.00
16	34	3,188.00
17	59	3,506.00
18	46	2,300.00
19	24	1,685.00
20	17	1,386.00
21	19	1,057.00
22	9	724.00
23	11	453.00

Figure 4-8. Sample Traffic Volume Discriminated by Time of the Day

4.2.3. Restructuring Mississippi Safety Highway Patrol Data

The citation information received from the Mississippi Safety Highway Patrol (shown in Figure 2) was restructured to two variables: Week Date and MHP Type of Citation. The variable Week Date was defined as "Ordinal" as previously described and the variable "MHP Type of Citation" was defined as "Nominal" because the data values represented categories with no intrinsic order. Additionally, each record in the information received from the Mississippi Safety Highway Patrol represented several Hazards and Non-Hazards citations. Therefore, each of the record was restructured to represent individual citations.
The Week Date variable as was assigned a number between 1 and 242 as previously described. The MHP Type of Citation variable received a value between 1 and 3, where 1 was assigned to the "No Applicable" condition, 2 was assigned to the "Hazard" condition, and 3 was assigned to the "Non Hazard" condition.

4.2.4. Restructuring Ridgeland Police Department Data

The citation information received from the Ridgeland Police Department (shown in Figure 3) was restructured to two variables: Week Date and RP Type of Violation. The variable Week Date was defined as "Ordinal" as previously described and the variable RP Type of Violation was defined as "Nominal" because the data values represented categories with no intrinsic order.

The Week Date variable was assigned a number between 1 and 242 as previously described. The RP Type of Violation variable received a value between 1 and 35, where each number represented a type of violation. The number 1 was assigned to “No Applicable”, 2 was assigned to “Allow Unauthorized Pers. To Oper. M/Veh. ”, 3 was assigned to “Careless Driving”, 4 was assigned to “Child Restraint Law”, 5 was assigned to “Disobey Traffic Control Device”, 6 was assigned to “Driving Without Headlights”, 7 was assigned to “Expired Drivers License”, 8 was assigned to “Expired License Tag”, 9 was assigned to “Fail To Exhibit D.L. On Demand”, 10 was assigned to “Following Too Closely”, 11 was assigned to “Improper Equipment”, 12 was assigned to “Improper Lane Usage”, 13 was assigned to “Improper License Tag – Altered”, 14 was assigned to “Littering”, 15 was assigned to “No Drivers License”, 16 was assigned to “No Insurance”, 17 was assigned to “No License Tag”, 18 was assigned to “No Motorcycle Endorsement”, 19 was assigned to “No Proof Of Insurance”, 20 was assigned to “Obstructing Traffic”, 21 was assigned to “Reckless Driving”, 22 was assigned to “Running A Stop Sign”, 23 was assigned to “Seat Belt Violation”, 24 was assigned to “Speeding - 10 - 15 Miles Over Limit”, 25 was assigned to “Speeding - 16 - 20 Miles Over Limit”, 26 was assigned to “Speeding - 21 - 25 Miles Over Limit”, 27 was assigned to “Speeding - 26 - 30 Miles Over Limit”, 28 was assigned to “Speeding - 30+ Miles Over Limit”, 29 was assigned to “Suspended Drivers License”, 30 was assigned to “Suspended Drivers License, Dui”, 31 was assigned to “Tag, Switched”, 32 was assigned to “Tag, Unauthorized Dealer”, 33 was assigned to “Tag, Covered Or Defaced”, 34 was assigned to “Tag, Improperly Mounted”, and 35 was assigned to “Windows, Tinted Or Darken”

4.2.5. Restructuring Traffic Engineering Division - Mississippi Department of Transportation (MDOT) Data

The crash information received from the Traffic Engineering Division (shown in Figure 4) was restructured to three variables: Week Date, Time of the Day and Crash Information. The variables Week Date and Time of the Day were defined as “Ordinal” as previously described and the variable Crash Information was defined as “Nominal” because the data values represented categories with no intrinsic order.

The Week Date variable was assigned a number between 1 and 242 as previously described. The Crash Information variable received a value between 2 and 17, where each number represented the crash information. The number 2 was assigned to “Angle”, 3 was assigned to “Animal”, 4 was assigned to “Fixed Object”, 5 was assigned to “Head on”, 6 was assigned to “Left turn”, 7 was assigned to “Other”, 8 was assigned to “Other Incoming”, 9 was assigned to “Other Object”, 10 was assigned to “Overturn”, 11 was assigned to “Parked Vehicle”, 12 was assigned to “Pedestrian”, 13 was assigned to “Ran off road”, 14 was assigned to “Rear end”, 15 was assigned to “Right turn”, 16 was assigned to “Sideswipe”, and 17 was assigned to “Unknown”.

The Memorandums of Understanding between the MDOT and the law enforcement agencies (shown in Figure 5) was restructured to three variables: Week Date, Permanent Presence of MHP and Permanent Presence of RP. The variables Week Date was defined as “Ordinal” as previously described and the variables Permanent Presence of MHP and Permanent Presence of RP was defined as “Nominal” because the data values represented categories with no intrinsic order.

The Week Date variable was assigned a number between 1 and 242 as previously described. The Permanent Presence of MHP and Permanent Presence of RP variable received a value between 1 and 2, where 1 was assigned to “No” presence, and 2 was assigned to “Yes” regarding presence as shown in Table 4-3.

Table 4-3. Permanent Presence of Law Enforcement per Memorandum of Understanding

Start Date	End Date	MHP	RP	Start Week	End Week
--	01/01/03	No	No		156
01/02/03	08/13/03	Yes	No	157	189
08/14/03	11/10/03	Yes	Yes	190	202
11/11/03	08/13/04	No	Yes	203	241
08/14/04	--	No	No	242	

4.3. Consolidation of all the data

After restructuring the information received from each agency, the next step was to consolidate (or integrate) all of the data sets into one master data file. The variable Week Date was identified as the common field among all the data sets with the exception of the Traffic Volume Information data set. It was also identified that the Time of the Day was a common filed between the Traffic Volume Information data set and the Crash data set. The solid arrows pointing in two directions, in Figure 4-9 shows the common fields among all the data sets. Based on this information, both the Week Date and Time of the Day were used as key fields and the data from all the data sets was copied to each other creating a master data set with the fields shown in Table 4-4. The doted arrows, in Figure 4-9 show the fields that were transferred from one data set to the other to create the fields in Table 4-4. As a result of this consolidation, a total of 7156 records were integrated into the master data set as shown in Table 4-5.

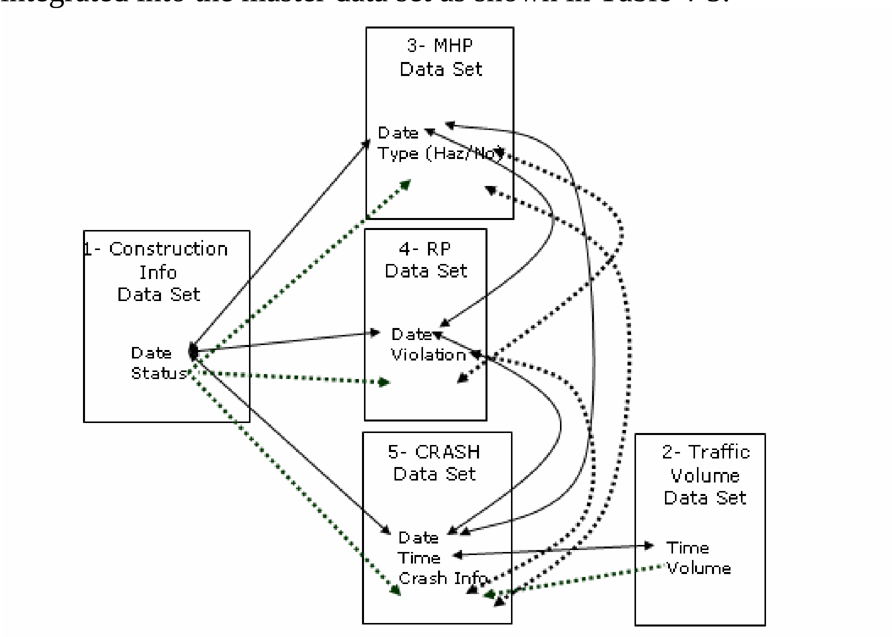


Figure 4-9. Data Set Consolidation

Table 4-4. Date Set Variables, Type of Variables and Value Codes

Variable	Type of Variable	Value Codes
Case #	Nominal	Not Applicable
Crash or Citation?	Nominal	1: Citation 2: Crash
Week Date	Ordinal	Not Applicable (01/02/00=Week1)
Construction Status	Ordinal	1: After 2: During 3: Prior
Time of the Day (Hr)	Ordinal	Not Applicable
Volume (Veh/Hr)	Scale	Not Applicable
Source of the Data	Nominal	1: MDOT 2: MHP 3: RP
MHP Type of Citation	Nominal	1: Not Applicable 2: Hazard 3: Non Hazard
RP Type of Violation	Nominal	1-35
Crash Information	Nominal	1-17
Permanent Presence of MHP	Nominal	1: No 2: Yes
Permanent Presence of RP	Nominal	1: No 2: Yes

Table 4-5. Number of Records Restructured From the Data Sets

Source	Records after Restructuring
Ridgeland Police Department	1944
Mississippi Highway Patrol	4521
MDOT (Crash Data)	691
Total Records in the Master Data Set	7156

4.4. LESSONS LEARNED

It is important to highlight that all agencies were very willing to collaborate in the data consolidation process. However, collecting, archiving and retrieving information was not a main priority for any of these agencies. Additionally, no general guidelines for data structuring was communicated among the agencies. Therefore, it is evident that input into the data gathering process before the data is collected rather than after the fact, could greatly improve the process of accessing the impact of law enforcement surveillance in construction zones. By defining the data to be collected, the method for collecting the data, the formatting of the data, the timeframes for collecting the data (before, during and after construction), all the participating agencies would be able to share information and to demonstrate the impact of their performance to stakeholders. It was also learned that the restructuring of the data was of paramount importance for the consolidation of the data. Identifying the variable types and the possible values for each variable, facilitated the comparison of variables to decide whether or not to use the same variable or to create a new variable for each data set. The identification of common data components among the data set was critical for the consolidation of all data sets. The use of the common data components to transfer data among data sets proved to be an effective way to complete the data sets with information from another data set (another agency)

4.5. SUMMARY

During the construction period, there are temporary traffic disruptions, which increase the number of accidents with associated deaths and injuring thousand of people every year. One of the special measures implemented in construction zones by several departments of transportation around the United States to reduce the number of crashes is the increase of law enforcement surveillance. This chapter focuses on the process implemented to structure the data obtained from multiple agencies to be able to measure the impact of law enforcement in construction zones. The content of this chapter was later used as the foundation for the statistical analysis.

The results presented in this chapter reveal that segmentation of the data and the structure of the data is a major barrier to assess the impact of law enforcement surveillance in construction zones. Due to the willingness of the agencies to collaborate in the data consolidation process, it was possible to restructure and consolidate the data to perform statistical analysis. It is also expected that the restructuring process presented in this chapter could be used by other research teams to perform similar analysis of law enforcement surveillance or others methods implemented around the U.S. to reduce the deaths and injuries in road construction zones.

Chapter 5:
STATISTICAL ANALYSIS OF LAW ENFORCEMENT SURVEILLANCE ON CONSTRUCTION ZONE SAFETY

5.1. INTRODUCTION

Construction zone's fatalities are on the rise and are likely to continue climbing across the nation as departments of transportation continue repairing and upgrading the United States' aging roadways [Safe Roads 2003]. This is particularly compounded in Mississippi due an all time peek volume of construction zones as well as the 1987 four-lane highway program and TEA-21 [Young 2001]. Therefore, it is very important to implement programs such as the law enforcement surveillance that aim to improve the safety records of construction zones. Unfortunately, in many cases these programs are implemented without the proper collection, processing, archiving and analysis of the data to evaluate their impact on safety.

Several agencies contributed to the data collection including District 5 Office of the Mississippi Department of Transportation, Planning Division of the Mississippi Department of Transportation, Mississippi Highway Patrol, Ridgeland Police Department, and Traffic Engineering Division of Mississippi Department of Transportation. Upon receiving the data from the different agencies, the data was restructured and consolidated to server as the foundation for descriptive and inferential statistics which are presented in this paper.

5.2. OVERVIEW OF STATISTICAL ANALYSIS

Statistic analysis pertains to collection, analysis, interpretation, and presentation of data as well as drawing valid conclusions and making reasonable decisions on the basis of such analysis [Wikipedia 2006]. In most research projects the statistical analysis involves three major steps, done in roughly this order: Cleaning and organizing the data for analysis (Data Preparation), Describing the data (Descriptive Statistics), Testing Hypotheses and Models (Inferential Statistics)

5.2.1 Data Preparation

It involves checking or logging the data in; checking the data for accuracy; entering the data into the computer; transforming the data; and developing and documenting a database structure that integrates the various measures.

5.2.2. Descriptive Statistics

They are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with graphical analysis, they form the basis of virtually every quantitative analysis of data. Descriptive statistics are used to present quantitative descriptions in a manageable form. They are used to simply large amounts of data in a sensible way. Descriptive statistics involves the examination across cases of one variable at a time. With descriptive statistics the researchers are simply describing what the data shows. The three major characteristics of a single variable are its distribution, central tendency and dispersion.

2.a. <u>Distribution</u> is a summary of the frequency on individual values for a variable. One of the most common ways to describe a single variable is with a frequency distribution. Graphical forms such as histograms or bar charts are effective tools for depicting frequency distributions. [Trochim 2006]

2.b. Central Tendency of a variable is the estimate of the “center” of a distribution of its values. The three major types of estimates of central tendency of a variable are its mean, median and mode. The mean is the variable’s average value. The median is the score found at the exact middle of a set of variable values. The mode is the most frequently occurring value for the variable. [Trochim 2006]

2.c. Dispersion refers to the spread of the values of the variable around the central tendency. The two most common measures of dispersion of a variable are its range and standard deviation. The range is the highest value of the variable minus the lowest value. The standard deviation is more accurate reflection of dispersion by reducing the effect of outlier values of a variable. [Trochim 2006]

5.2.3. Inferential Statistics:

Focus on trying to reach conclusions that extend beyond the raw data. Inferential statistics are used to make inferences from the descriptive statistics to more general conditions; where the descriptive statistics simply is used to describe what's going on with the data. The inferential statistical “tools” available for use within SPSS are Chi-square, *T* test, Regression, General Linear Model, and Correlation. [SPSS 2006]

3.a. Chi-square test: it is used in situations where you have two categorical variables and want to test their independence.

3.b. *t* test: it is used for comparing mean values of two sets of numbers. The comparison will provide a statistic basis to determine if there is a statistically significant difference between the numbers.

3.c. Regression: it is used to determine the effect of one or more predictor variables on an outcome variable. Regression allows you to make statements about how well independent variables will predict the value of a dependent variable.

3.d. Analysis of Variance (ANOVA): Analysis of variance is used to determine if there are differences between groups on the basis an outcome variable. In SPSS the majority of procedures used for conducting analysis of variance (ANOVA) can be found under the *General Linear Model*. [SPSS 2006]

3.e. Correlation: it is a measure of the relation between two or more variables. Correlation coefficients can range from -1.00 to +1.00. The value of -1.00 represents a perfect negative correlation while a value of +1.00 represents a perfect positive correlation. A value of 0.00 represents a lack of correlation. The most widely-used type of correlation coefficient is *Pearson r* correlation. The Pearson *r* correlation assumes that the two variables are measured on at least interval scales, and it determines the extent to which values of the two variables are "proportional" to each other. The value of correlation or correlation coefficient does not depend on the specific measurement units used. The correlation is high if the data can be “summarized by a straight line. This line is called the regression line or least squares line, because it is determined such that the sum of the squared distances of all the data points from the line is the lowest possible. In order to evaluate the correlation between variables, it is important to know the significance of the correlation. The significance level calculated for each correlation is a primary source of information about the reliability of the correlation. The test of significance is based on the assumption that the distribution of the deviations from the regression line for the dependent variable *y* follows the normal distribution, and that the variability of the residual values is the same for all values of the independent variable *x*. [StatSoft 2006]. Figure 5-1 shows some data samples with it corresponding r values.

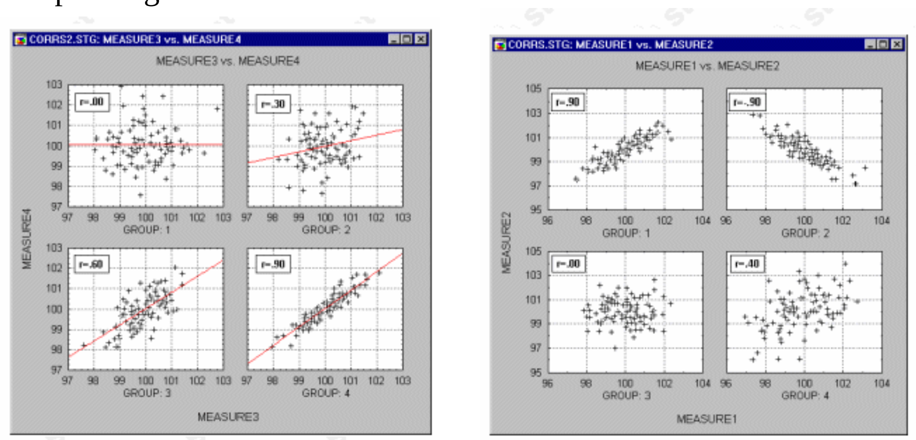


Figure 5-1. Sample data with its corresponding r values.

5.3. Statistical Software

A statistical package is a computer application that is specialized for statistical analysis. It enables the research teams to obtain the results of standard statistical procedures and statistical significance tests, without requiring low-level numerical computations or programming. In addition to provide the results of standard statistical procedures, statistical packages provide facilities for data management [Wikipedia 2006]. There several commercially available statistical packages in the market, the following is a brief description of some of the packages available:

1. AM Software: it has been developed by the American Institutes for Research. This software is used primarily for the analysis of data from educational surveys (such as the National Assessment of Educational Progress). It is used for a stratified unequal-probability (weighted) cluster or multistage samples. Additional, information can be found at http://am.air.org/legal.asp
2. Bascula: it has been developed by Statistics Netherlands. It computes adjustment weights using auxiliary variables. It incorporates various weighting techniques. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/bascula.html
3. CENVAR: it has been developed by the U.S. Bureau of the Census (International Programs Center). This software designs range from simple random samples of elements to more complex stratified, multistage cluster designs. Additional, information can be found at http://www.census.gov/ipc/www/imps/cv.htm

4. CLUSTERS: it has been developed by Professor Vijay K VERMA of the ESRC Research Centre at the University of Essex. The program computes sampling errors taking into account the actual sample design.
5. Epi Info: it has been developed by the Centers for Disease Control and World Health Organization. This software uses stratified sampling, with or without clustering; multistage samples; unequal-probability samples. Additional, information can be found at http://www.cdc.gov/EpiInfo/
6. Generalized Estimation System (GES): it has been developed is by Statistics Canada. The focus of this software is on calibration estimation using generalized regression (GREG) estimator theory. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/genest.html
7. IVEware: it has been developed by the University of Michigan. The authors are T.E. Raghunathan, Michael Elliott and colleagues. This software is used for complex designs with stratification and clustering. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/iveware.html
8. PCCARP: it has been developed by the Iowa State University Statistical Laboratory. This software is used for multistage stratified samples. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/pccarp.html
9. R survey package: it has been developed is by R Project (the R Foundation). The authors are Thomas Lumley from the Department of Biostatistics at the University of Washington. This software is used for incorporating stratification, clustering, and possibly multistage sampling. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/r.html
10. SAS/STAT: it is been developed by the SAS Institute Inc. This software can be used for a complex multistage sample design that includes stratification, clustering, replication, and unequal probabilities of selection. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/sas.html
11. Stata: it has been developed by StataCorp. This software can be used for stratified designs, cluster sampling, and variance estimation. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/stata.html
12. SUNDANN: it has been developed by the Research Triangle Institute. This software's multiple design options allow users to analyze data from stratified, cluster sample, or multistage sample designs. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/sudaan.html
13. VPLX: it has been developed by the U.S. Bureau of the Census. The author is Dr. Robert Fay. This software is used for Stratified and clustered designs. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/vplx.html
14. WesVar: it has been developed by Westat, Inc. This software uses variance estimates based on replicate weights, either generated within the program or user-provided. Additional, information can be found at http://www.hcp.med.harvard.edu/statistics/survey-soft/wesvarpc.html
15. SPSS: it has been developed by SPSS. This software is used for both design and estimation. It accommodates stratification, clustering, and multistage sampling. Additional, information can be found at http://www.spss.com/spss/

The statistical package used for the statistical analysis in this project was SPSS. The version of SPSS used 13.0 for Windows. The primary reason for using this software was that it met the needs of the project was the statistical software most commonly used at the University of Southern Mississippi. The following section provides a description of SPSS.

5.4. SPSS DESCRIPTION

SPSS for Windows is a statistical and data management package for analysts and researchers. SPSS for Windows provides a broad range of capabilities for the entire analytical process. SPSS Inc. is a leading worldwide provider of predictive analytics software. They have been in business for more than 37 years, and have more than 120,000 customers (academic institutions, healthcare providers, market research companies and government agencies) [SPSS 2006].

Government agencies use SPSS predictive analytics software to detect fraud, non-compliance with laws or regulations, and to protect public safety and provide homeland security. Educational institutions use predictive analytics to manage resources by predicting demand for programs. Non-profit organizations use these technologies to anticipate program demand and raise funds. Scientific and healthcare organizations carry out lifesaving research, improve patient outcomes, and manage their business operations effectively, through the use of predictive analytics. . [SPSS 2006]

Predictive analytics includes both the analysis of past, present, and projected future outcomes using advanced analytics, and decision optimization for determining which action will drive the optimal outcome. The recommended action is then delivered to the systems or people that can effectively implement it. [SPSS 2006]

5.5. DESCRIPTIVE STATISTICAL ANALYSIS

The statistical analysis began by analyzing traffic trends and characteristics of the studied area. The Mississippi Department of Transportation, the Ridgeland Police Department and the Mississippi Highway Patrol provided to the research team a wealth of data to perform the analysis. The studied area is shown with a green star in all the figures below. The construction project was located on I-59 at the Old Agency road area. The red lines in all the figures below represent the main area that was affected with the construction project as well as the main limits of the traffic and crash data collection efforts. However, as anticipated additional data was collected beyond the main area of influence (between the red lines) of the construction due to the fact that limited number of collection stations were located in the main affected area. The analysis of the studied area has been organized as follows:

- a- Annual Daily Traffic Growth
- b- Traffic Volume Variance
- c- Hourly Distribution of the Traffic Volume and Vehicle Classification
- d- Volume Hourly Peaks
- e- Number of Citations – Ridgeland Police Department and Mississippi Highway Patrol
- f- Number of Crashes

<u>a- Annual Average Daily Traffic Growth</u>

In the last 12 years, the studied area experienced a constant grow in annual average daily traffic years as show in Figure 1. The “blue arrows” in Figure 5-2, show the locations of measurement stations (A46 and A54) north and south of the Old Agency work zone. As shown in Figure 5-1, the studied area has increased in annual average daily traffic approximately 3% to 4% per year from 1992 to 2004.

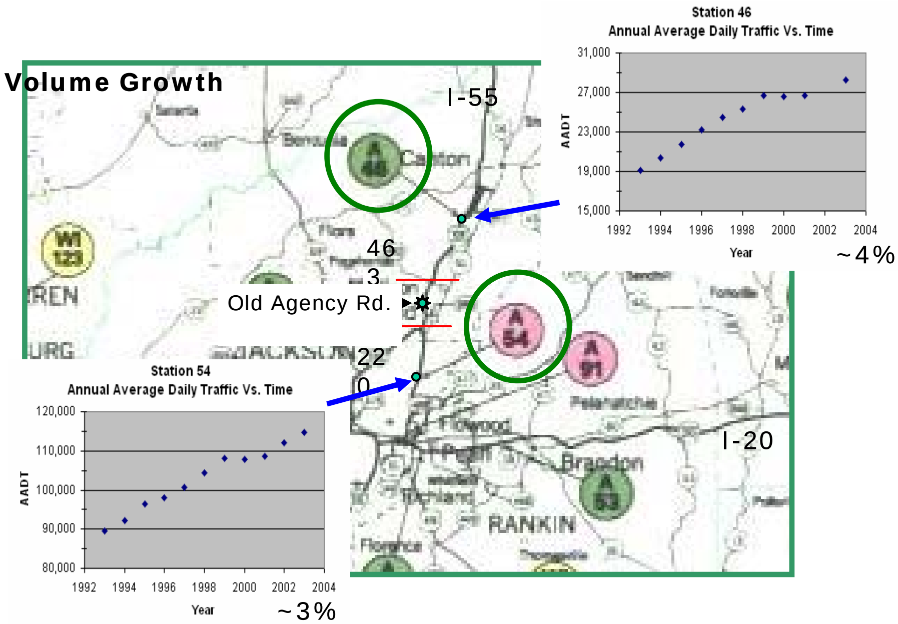


Figure 5-2. Traffic Volume Yearly Increase

<u>b- Traffic Volume Variance</u>

The trend of the traffic volume variance in the studied area is shown in Figure 5-3. Figure 5-3, shows the average daily traffic for each month in 2003 from Station 54, which is south of the Old Agency construction work zone. In top right portion of the figure, it can be observed that during the year there was no significant difference in the daily traffic ranging between 111,585 and 117,872 vehicles per day. The calculations resulted in a daily average traffic volume of 114,812 vehicles per day. In the top left portion of the same figure, it can be observed that the average weekday traffic is also very constant during the year with an average of 126,315 vehicles per day which is approximately 10% higher than the average daily traffic. However, both the Saturday and Sunday average of 92,843 and 72,197 vehicles per day respectively are significantly lower (-19% and -38% respectively) than the average daily traffic.

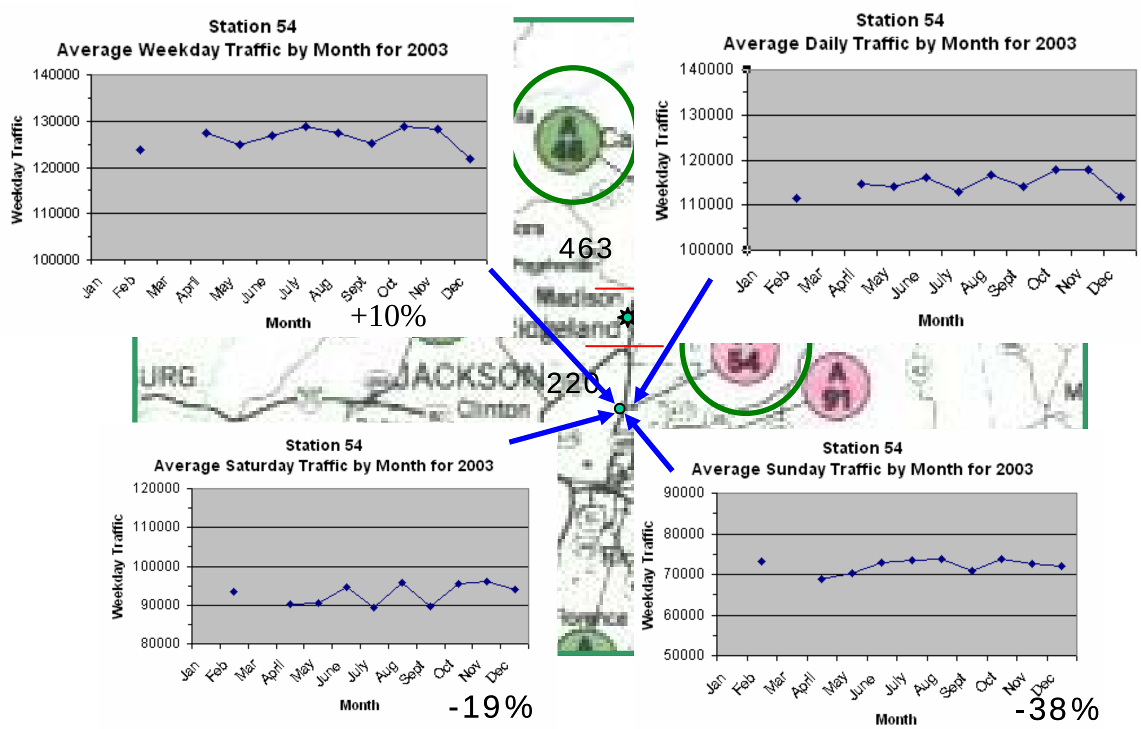


Figure 5-3. Traffic Volume Variance

<u>c- Hourly Distribution of the Traffic Volume and Vehicle Classification</u>

Most vehicle in the studied area were (according to FHWA Vehicle Classification) type 2 (Passenger Cars). Figures 5-4 through 5-7 shows a two days collection sample of the Traffic Volume by Vehicle Classification for north and sound bound in locations north and sound of the construction. The figures illustrate the traffic demand in the studied area. It worth noting that the traffic demand was at least 600 vehicles per hour per lane in non-rush hours with peek reaching up to 2500 vehicles per hour per lane.

Figure 5-4, shows the “Traffic Volume By Vehicle Classification” for north bound lanes 1, 2, and 3 south of the Old Agency construction work zone. Similarly, Figure 5-5 shows the “Traffic Volume By Vehicle Classification” for south bound lanes 1, 2, and 3 south of the Old Agency construction work zone.

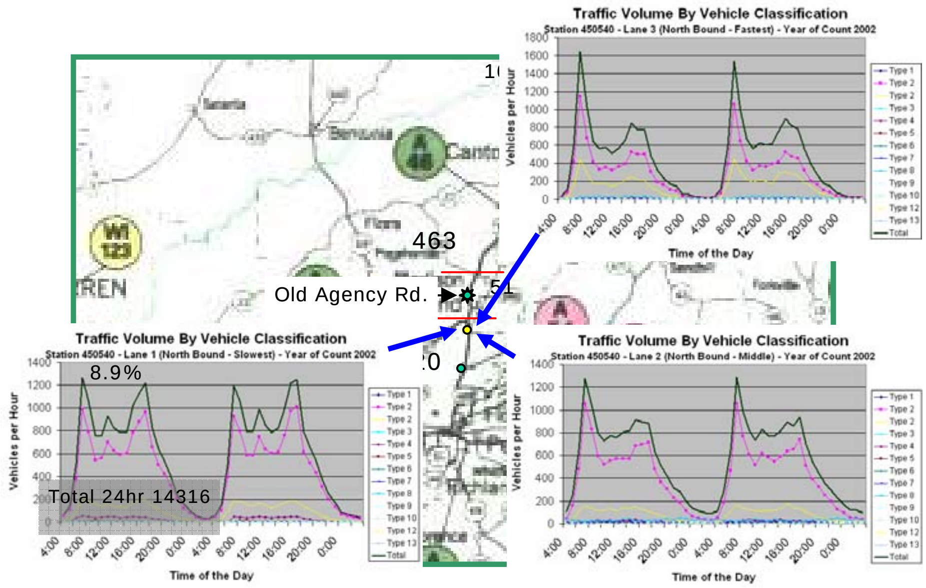


Figure 5-4. Traffic Volume Discriminated by Vehicle Classification
North Bound South of the Construction Zone

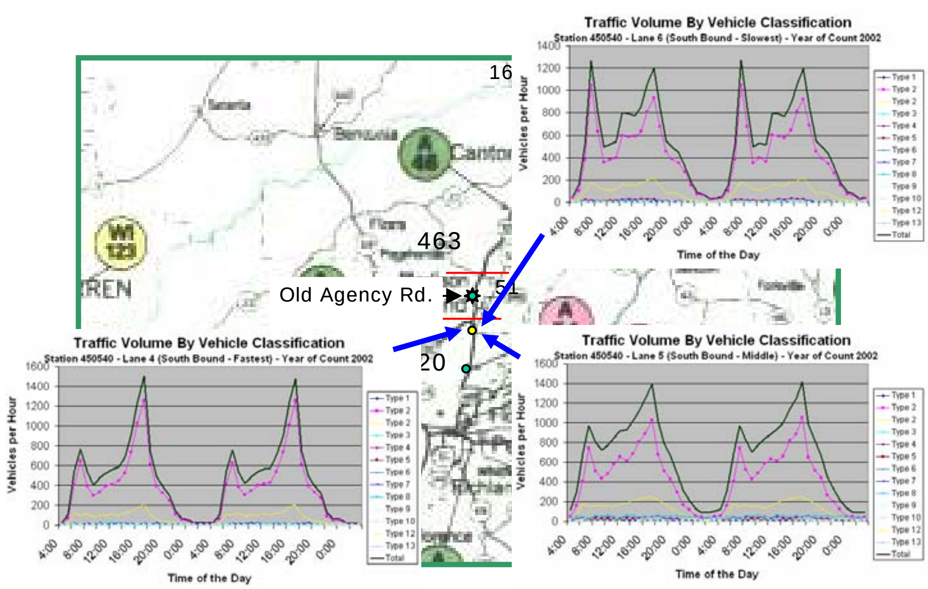


Figure 5-5. Traffic Volume Discriminated by Vehicle Classification
South Bound South of the Construction Zone

Figure 5-6, shows the “Traffic Volume By Vehicle Classification” for north bound lanes 1, and 2, north of the Old Agency construction work zone. Similarly, Figure 5-7 shows the “Traffic Volume By Vehicle Classification” for south bound lanes 1, and 2 north of the Old Agency construction work zone.

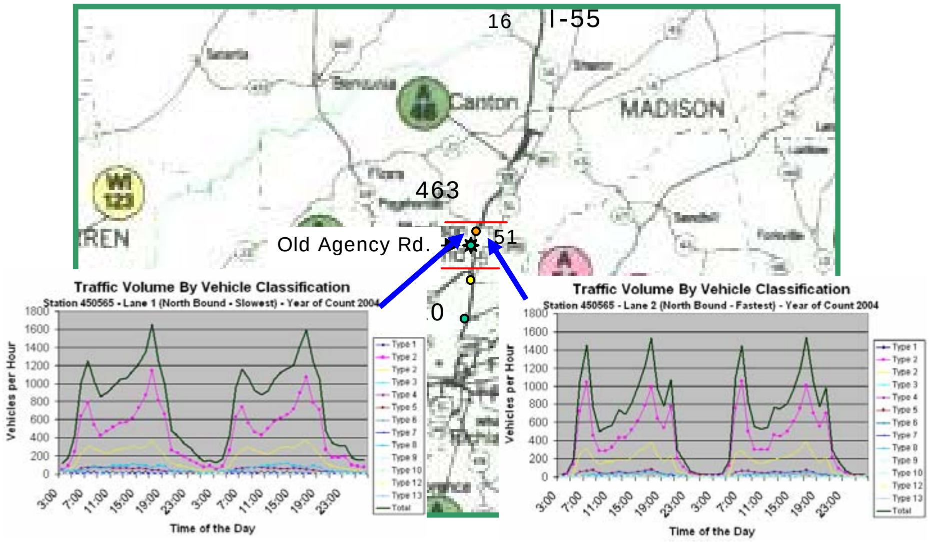


Figure 5-6. Traffic Volume Discriminated by Vehicle Classification
North Bound North of the Construction Zone

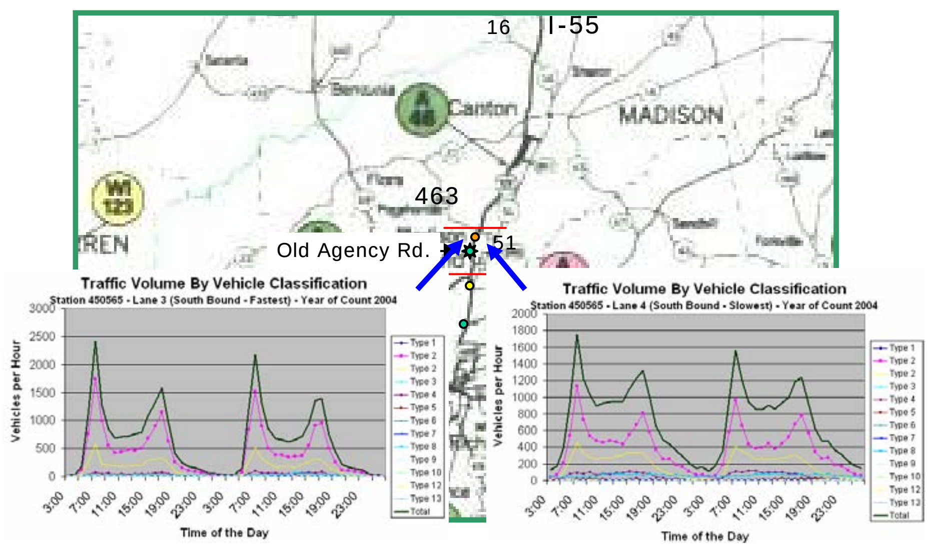


Figure 5-7. Traffic Volume Discriminated by Vehicle Classification
South Bound North of the Construction Zone

Additionally, the traffic volume was categorized in non-commercial, commercial light, and commercial heavy. In the south and north proximities of the studied area, the percentage of non-commercial vehicles were 91% and 83% respectively. Figure 5-8, shows the distribution of the average daily traffic with the categories in the proximities and significantly north of the studies area.

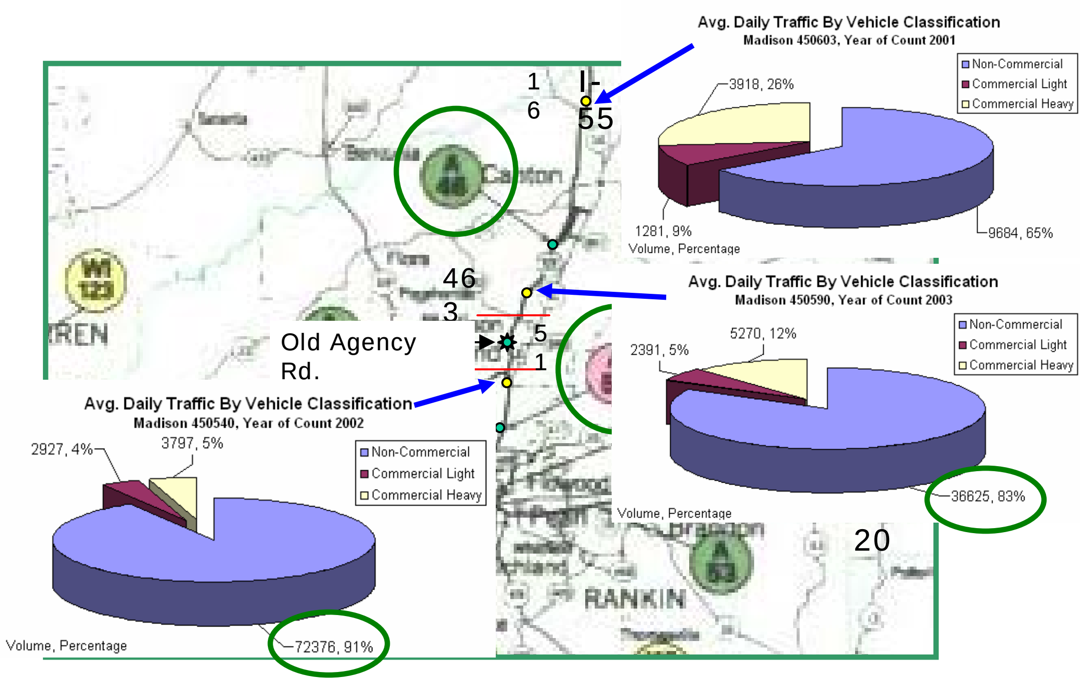


Figure 5-8. Average Daily Traffic by Vehicle Classification

d- Volume Hourly Peaks

The studied area traffic volume was characterized by having the 50th highest hourly traffic volume counts with more than 8.5% percent of the AADT in the year 2003. Figure 5-9 shows for Station 54 (south of the studied area) the relationship between the 50th highest hourly traffic volume counts and the percentage of the AADT.

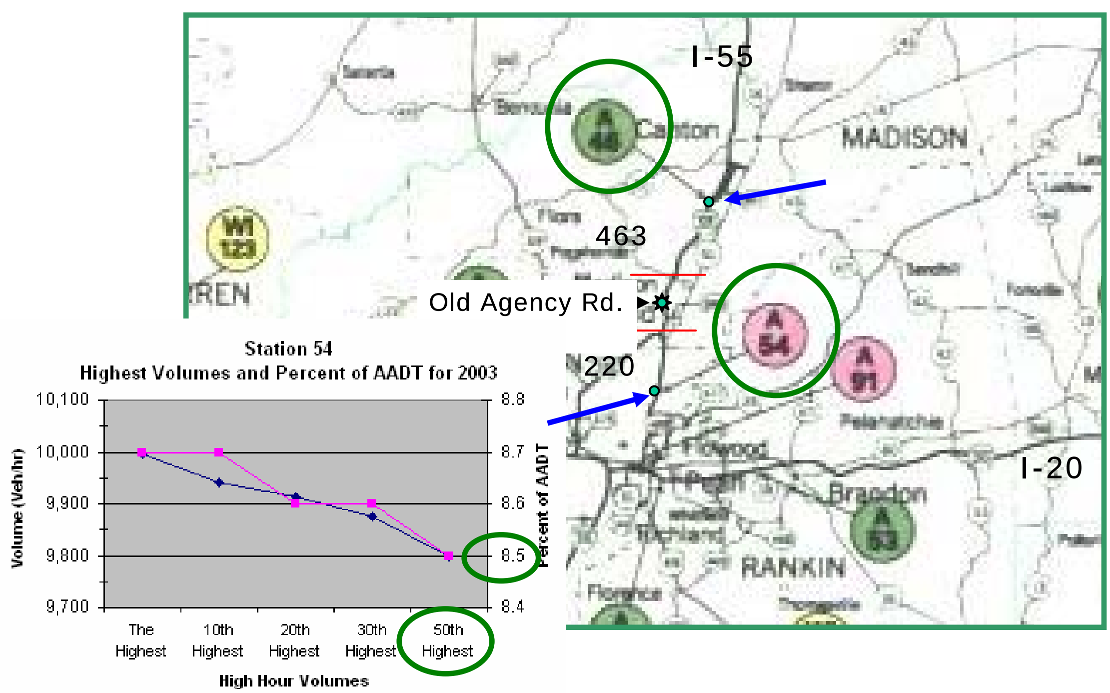


Figure 5-9. Highest Volumes as Percentage of AADT

e- <u>Number of Citations – Ridgeland Police Department and Mississippi Highway Patrol</u>
The Ridgeland Police Department (RPD) and the Mississippi Highway Patrol (MHP) contributed with the increased surveillance in the studied area. The number of citations from RPD and MHP varied significantly from week to week but over time the number of citations had a tendency to lower. Figure 5-10 shows the number of citations issued by the MHP in the studied area from January 8, 2003 till June 25, 2003. Figure 5-11, shows the number of citations issued by the Ridgeland Police Department per week in the studied area from August 15,2003 till June 11, 2004.

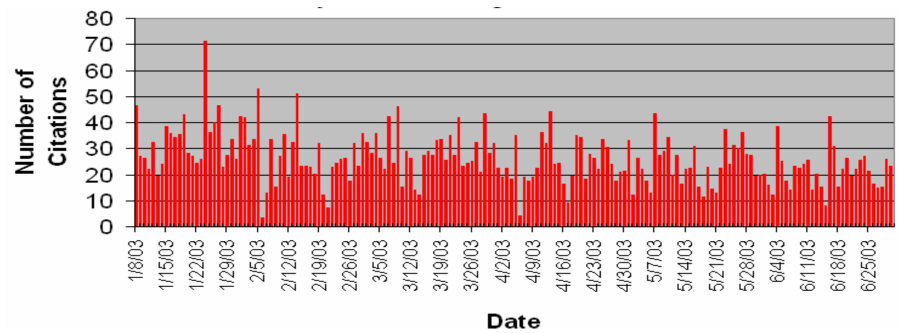


Figure 5-10. Number of Citations issued by
the Mississippi Highway Patrol (MHP) in the studied area

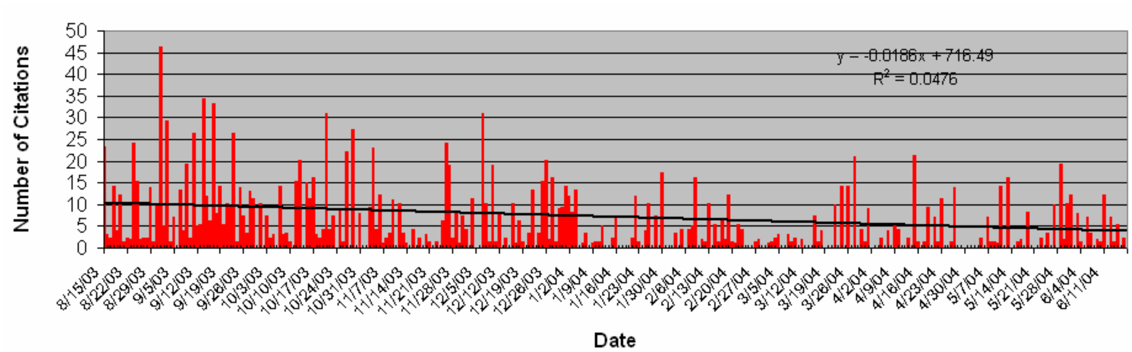


Figure 5-11. Number of Citations issued by
the Ridgeland Police Department (RPD) in the studied area

f- <u>Number of Crashes</u>
There were between 0 and 4 reported crashed per month on I-55 in the studied area. Figure 5-12, shows the number of reported crash from January 2000 till December 2003

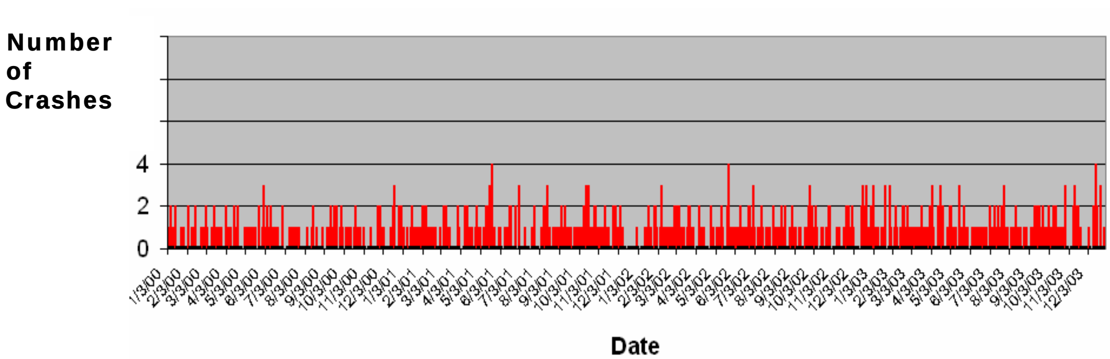


Figure 5-12. Reported Crashes on I-55 in the Studied Area

5.6. INFERENTIAL STATISTIC

Based on the main objective of the project (evaluate the safety impact of increased law enforcement surveillance on construction zones), the available data and the results from the descriptive statistics. Six specific statistical analyses were established aiming to determine if there was any correlation between the studied variables. The six analyses were as follows:

- Analysis 1 - Law Enforcement Presences Vs Number of Citations:
- Analysis 2 - Law Enforcement Over Time Vs Number of Citations:
- Analysis 3- Number of Citations per Week Vs Number of Crashes Per Week
- Analysis 4- Distribution of Volume Vs Distribution of Crashes
- Analysis 5- Time of The Day Vs Number of Crashes
- Analysis 6- Law Enforcement Presences Vs Number of Crashes

5.6.1. Analysis 1 - Law Enforcement Presences Vs Number of Citations

This analysis focused on how much the presence of law enforcement (either MHP or RPD) impacted the number of citations issued in the studied area. The analysis was based on the data obtained from MHP, RPD and MDOT. Figure 5-13, shows a linear chart plotting number of citations (count) vs. time (week date) in the studied area during the time that law enforcement was present on the studied area. This chart was created in SPSS using the sequence of steps shown in Figure 5-14.

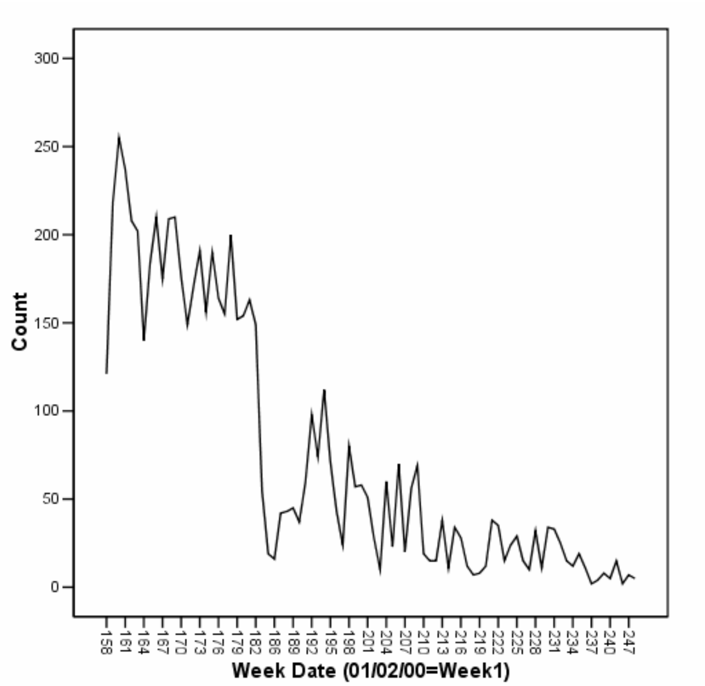


Figure 5-13. Number of Citations Overtime during Law Enforcement Presence in the Studied Area

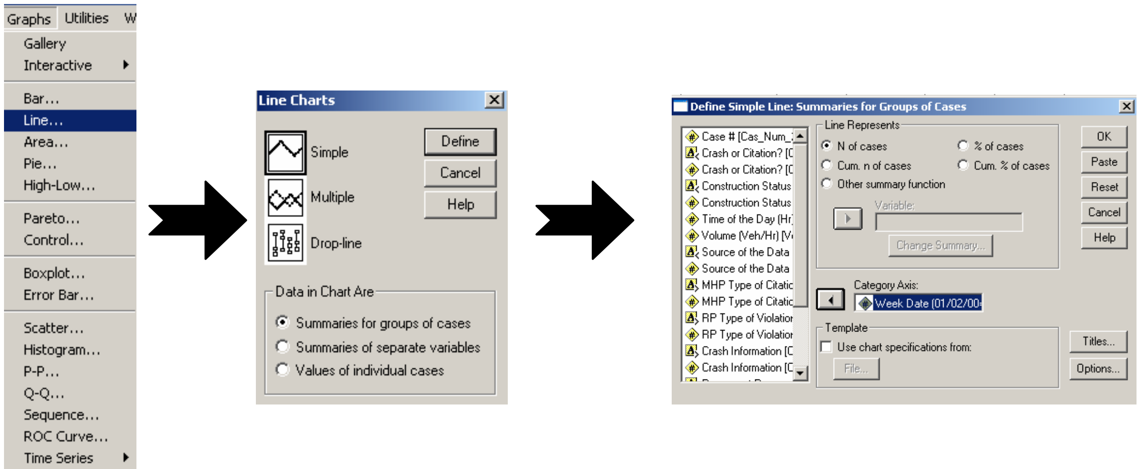


Figure 5-14. SPPS Screen Shoots of Chart Steps

In order to measure the impact of law enforcement on the number of citations, data prior to the presence of law enforcement present was also collected, plotted and analyzed. Figure 5-15, shows a linear chart plotting number of citations (count) vs. time (week date) in the studied area from January 2000 till the last day of law enforcement presence in the studied area. This chart was created in SPSS using the sequence of steps shown in Figure 5-14.

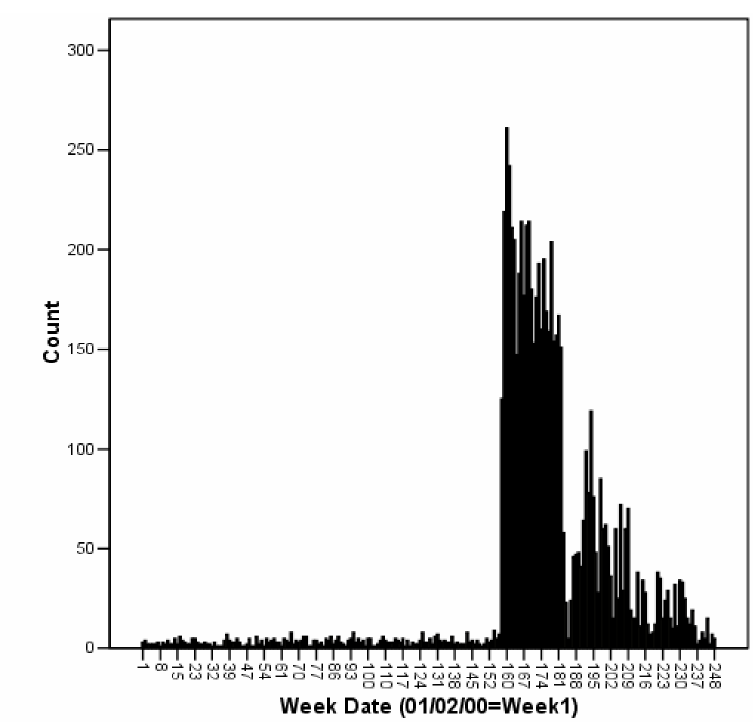


Figure 5-15. Number of Citations Overtime in the Studied Area

A t-test was performed to measure the correlation between number of citation issued and the presence of law enforcement. The variables included in the analysis were: Week Date, Number of Citation and Law Enforcement presence as show in Figure 5-16. This analysis was performed in SPSS using the sequence of steps shown in Figure 5-17.

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure
1	Wee_Dat_2	Numeric	11	0	Week Date (01/02/00=Week	None	None	11	Right	Ordinal
2	Cas_Num_	Numeric	8	2		None	None	9	Right	Scale
3	Num_Case	Numeric	7	0	Number of Cases	None	None	7	Right	Scale
4	Law_Enf	Numeric	8	0	Permanent Law Enforcement	{0, No Perman	None	8	Right	Nominal
5										
6										
7										

Figure 5-16. Variable used in the Analysis

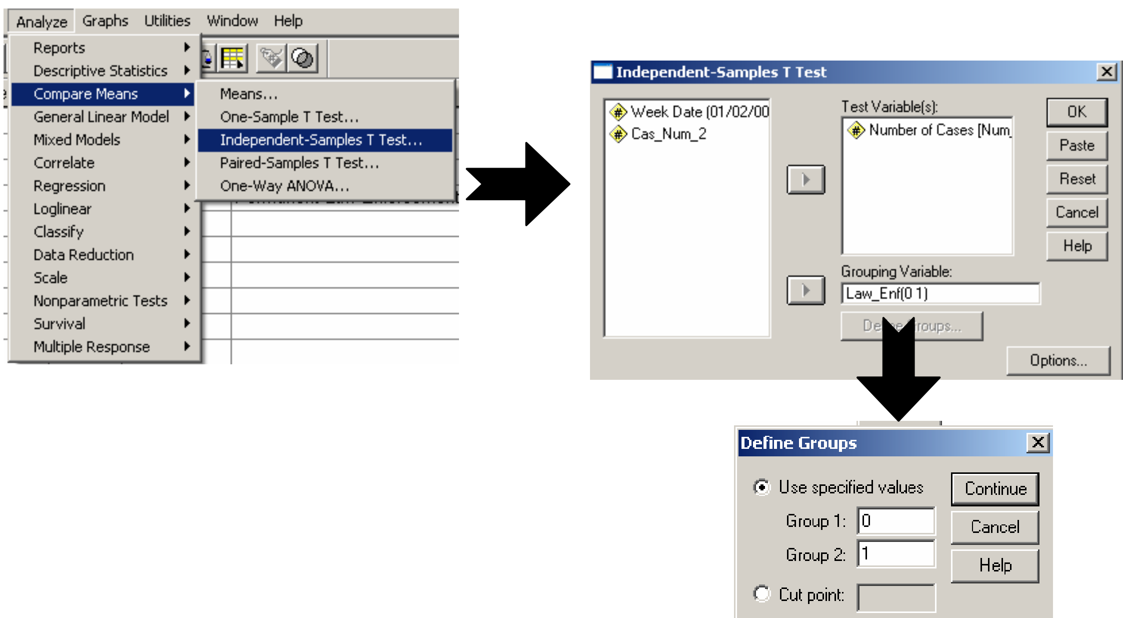


Figure 5-17. SPPS Screen Shoots of Analysis Steps

Table 5-1 shows a summary of the data analyzed. As shown in Table 5-1, there was data for 148 weeks of no permanent law enforcement presence and 84 weeks of law enforcement (either MHP or RP) permanent presence. The analysis of the data indicated that there was an average of 3.45 citations per week issued during the non permanent law enforcement period and 79.11 average citations per week issued during the law enforcement permanent presence. The standard deviation regarding number of citation issues were 2.015 and 74.919 respectively and the standard error mean were .166 and 8.174 respectively.

Table 5-1. Summary of Data Analyzed Number of Citations

	Permanent Law Enforcement	N	Mean	Std. Deviation	Std. Error Mean
Number of Cases	No Permanent Law Enforcement	148	3.45	2.015	.166
	Either MHP or RP Permanent	84	79.11	74.919	8.174

The t-test shown in Table 5-2 showed a significance level below 0.1% that the compared groups/conditions (No Permanent Law Enforcement Vs. Permanent Law Enforcement) were different. As stated by Glenberg, values of test statistics that occur with a relative frequency (Sig.) of less than 5% are in the rejection region [Glenberg 1996]. The rejection region means that the null hypothesis (no difference between groups/conditions) can be rejected, thus there is a difference between groups/conditions. Therefore, with a significance level of less than 0.1%, the null hypothesis (which is that there is no difference between the groups/conditions) is rejected. This less than 0.1% means that only in less than 1/1000 cases in which the true means (number of citations) were the same; the sample will show results as extreme as the one observed here. Thus, it can was concluded that there is statistically significant difference in the number of citations between the period with no permanent law enforcement and the period with permanent law enforcement in the studied area.

Table 5-2. t-test Law Enforcement Presence Vs. Number of Citations

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Number of Cases	Equal variances assumed	434.407	.000	-12.297	230	.000	-75.654	6.152	-87.776	-63.533
	Equal variances not assumed			-9.253	83.068	.000	-75.654	8.176	-91.916	-59.393

5.6.2 Analysis 2 - Law Enforcement Over Time Vs Number of Citations

This analysis focused on determining the effect of the number of weeks that the law enforcement agencies (MHP and RP) stayed the in the studied area on the number of citations issued per week. Figure 5-18 shows the number of citations issues per week the area. The square 1 corresponds to one of the law enforcement agencies and the area in the square 2 corresponds to the other law enforcement agency.

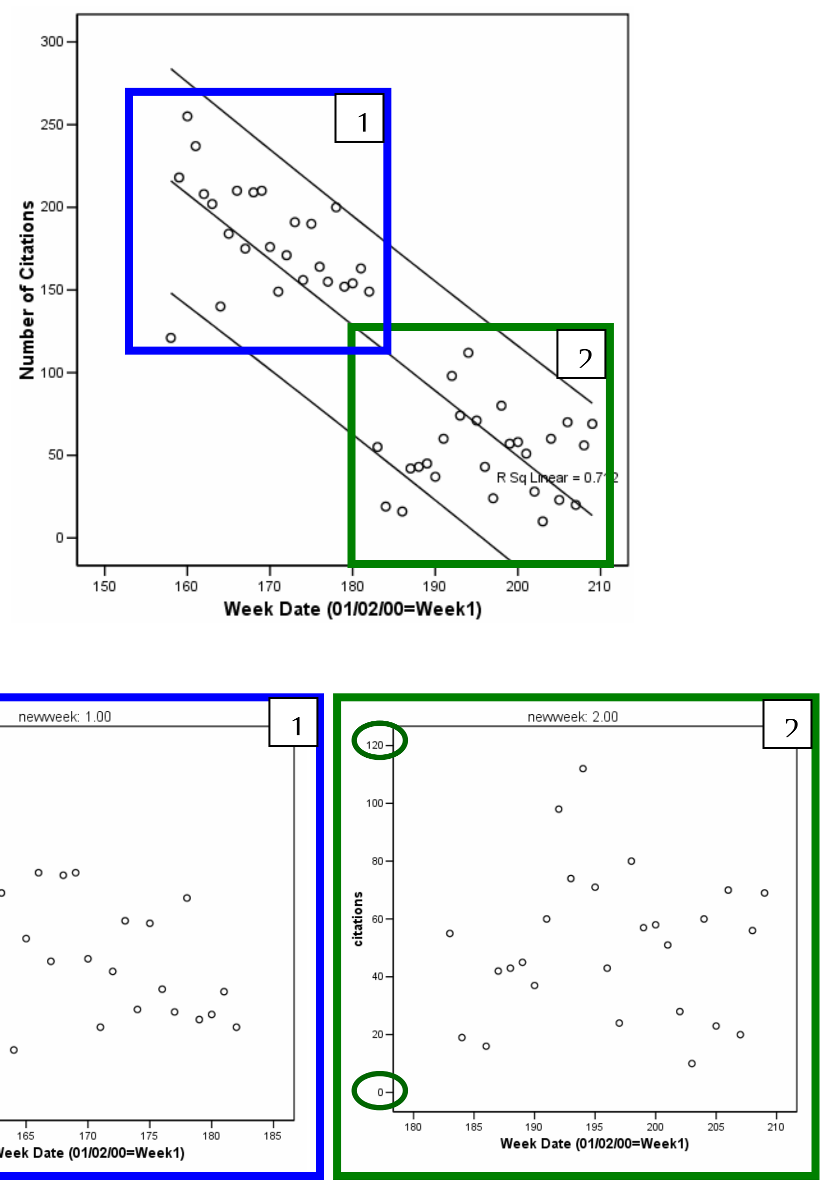


Figure 5-18. Number of Citations Issued in the Studied over time

A Bivariate Correlations was performed between number of citations over time to computes Pearson's correlation coefficient with its significance levels. As previously described, Pearson's correlation coefficient is a measure of linear association. The variables included in the analysis were: Week Date and Number of Citations. This analysis was performed in SPSS using the sequence of steps show in Figure 5-19.

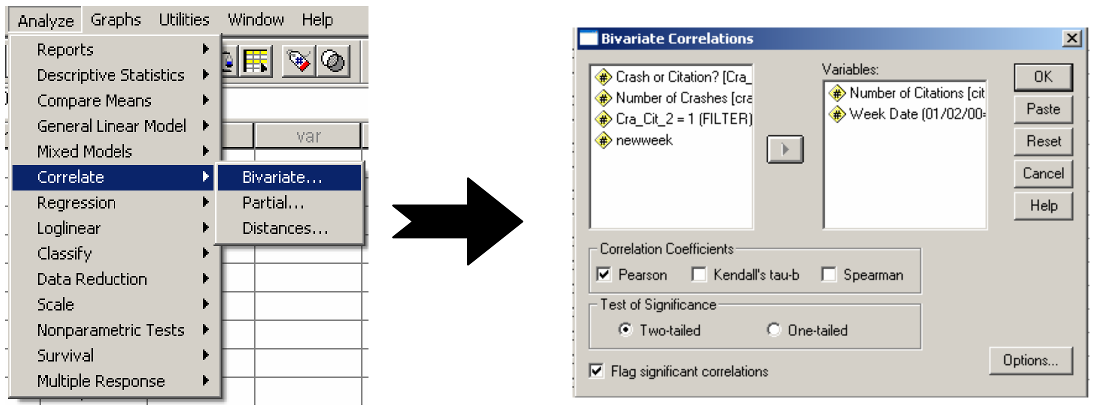


Figure 5-19. SPPS Screen Shoots of Analysis Steps

The correlation analysis shown in Table 5-3 showed a significance of less than 0.01% that the compared variables (number of citation and week date) were related with a pearson correlation factor of -.844 which indicates that the longer that a law enforcement agency is in the studied area the lower the number of citations issued.

Table 5-3. Correlation of Citations Over Time

Correlations

		Number of Citations	Week Date (01/02/00=Week1)
Number of Citations	Pearson Correlation	1	-.844**
	Sig. (2-tailed)	.	.000
	N	51	51
Week Date (01/02/00=Week1)	Pearson Correlation	-.844**	1
	Sig. (2-tailed)	.000	.
	N	51	51

**. Correlation is significant at the 0.01 level (2-tailed).

In addition to the overall bivariate correlation, a bivariate correlation was performed for each law enforcement agency (MHP and RP). The correlation analysis shown in Table 5-4 showed a significance of 0.02% that the compared variables (number of citation and week date) were related with a pearson correlation factor of -.449 which indicates that the longer that this law enforcement agency was in the studied area the lower the number of citations issued. The correlation analysis shown in Table 5-5 showed that there is not a strong pearson correlation factor between the number of weeks that this second law enforcement agency was in the studied area and the number of citations issued. It is worth noting that this different in correlation between the two law enforcement agency could be attributed to many factors not linked to the enforcement agency such as: number of hours, days of operation, sequence of law enforcement agencies in the studied area, just to mention a few of the possible factors that were not considered in this research project.

Table 5-4. Correlation of Citations Over Time

newweek = 1.00

Correlations[a]

		citations	Week Date (01/02/00= Week1)
citations	Pearson Correlation	1	-.449*
	Sig. (2-tailed)	.	.024
	N	25	25
Week Date (01/02/00=Week1)	Pearson Correlation	-.449*	1
	Sig. (2-tailed)	.024	.
	N	25	25

*. Correlation is significant at the 0.05 level (2-tailed).

a. newweek = 1.00

Table 5-5. Correlation of Citations Over Time

newweek = 2.00

Correlations[a]

		citations	Week Date (01/02/00= Week1)
citations	Pearson Correlation	1	.026
	Sig. (2-tailed)	.	.901
	N	26	26
Week Date (01/02/00=Week1)	Pearson Correlation	.026	1
	Sig. (2-tailed)	.901	.
	N	26	26

a. newweek = 2.00

5.6.3. Analysis 3- Number of Citations per Week Vs Number of Crashes Per Week

This analysis focused on determining the effect of the number citations per week on the number of crashes per week on the studied area. Figure 5-20 shows graphs that plots the number of citations issues per week vs. number of crashes.

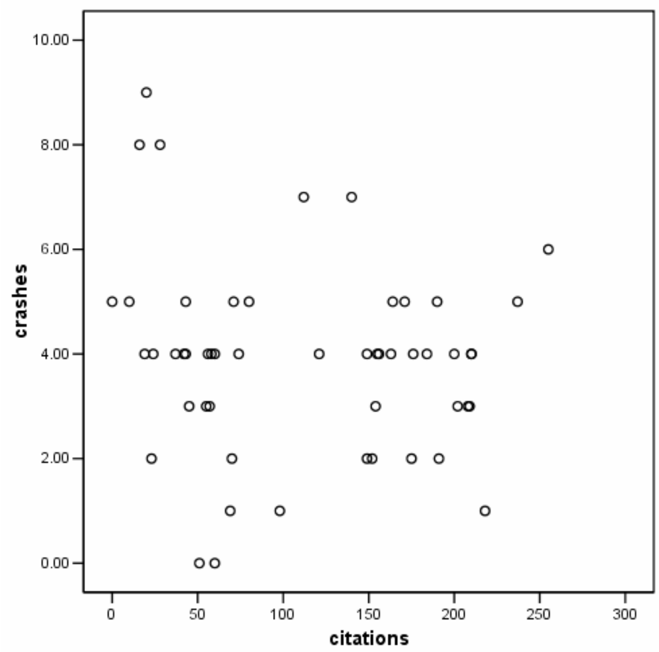


Figure 5-20. Number of Crash Vs Number of Citations in the Studied Overtime

A Bivariate Correlations was performed between number of citations per week and the number of crashes per week to computes Pearson's correlation coefficient with its significance levels. This analysis was performed in SPSS using the sequence of steps show in Figure 5-21.

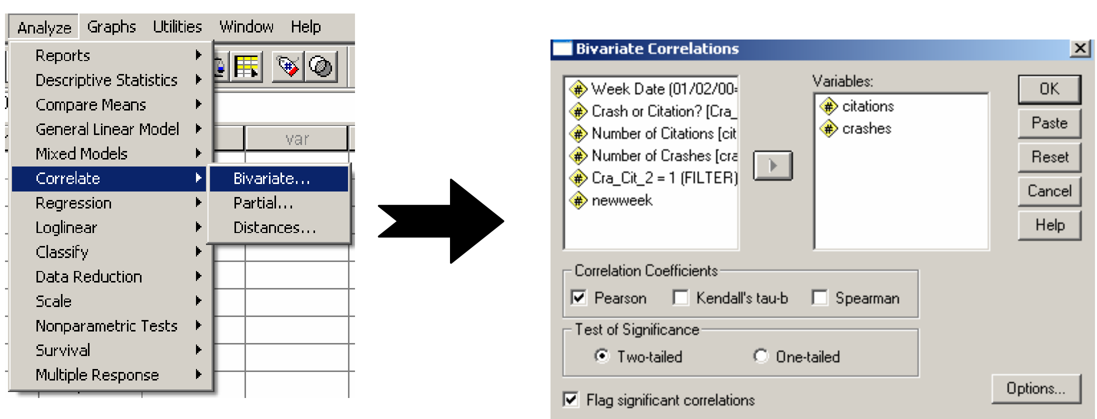


Figure 5-21. SPPS Screen Shoots of Analysis Steps

The correlation analysis shown in Table 5-6 showed that there is not a strong pearson correlation factor between the number citations issued by the law enforcement agencies and the number of crashes in the studied area

Table 5-6. Correlation of Citations Overtime

Correlations

		citations	crashes
citations	Pearson Correlation	1	-.125
	Sig. (2-tailed)	.	.379
	N	101	52
crashes	Pearson Correlation	-.125	1
	Sig. (2-tailed)	.379	.
	N	52	52

5.6.4 Analysis 4- Distribution of Volume Vs Distribution of Crashes

This analysis focused on determining the effect of the traffic volume on the number of crashes in the studied area. The crashes reported in the studied area during the period of the studied were grouped by the time of the day that they occurred and then compared against the average hourly volume for that particular time of the day. Figure 5-22 shows the number of crashes compared to the traffic volume at the moment of the crash.

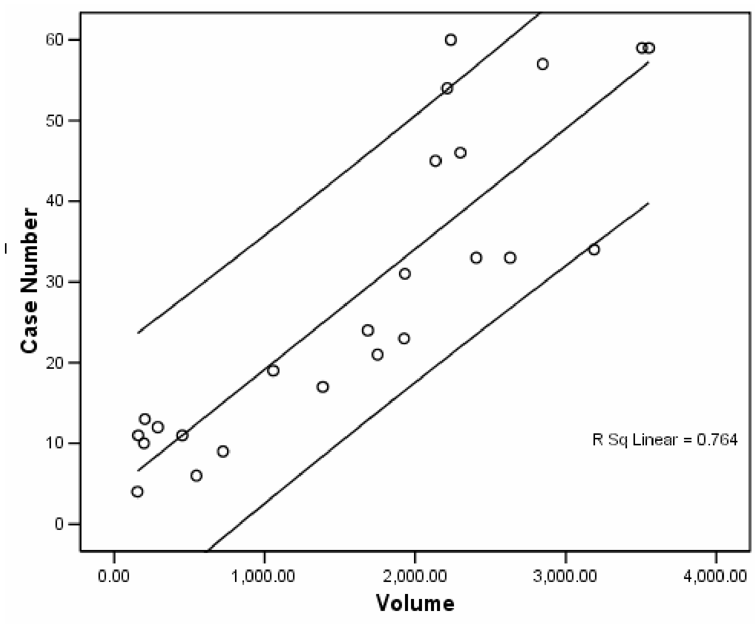


Figure 5-22. Number of Crashes Vs Traffic Volume

A Bivariate Correlations was performed between number of crashes and traffic volume to computes Pearson's correlation coefficient with its significance levels. This analysis was performed in SPSS using the sequence of steps show in Figure 5-23.

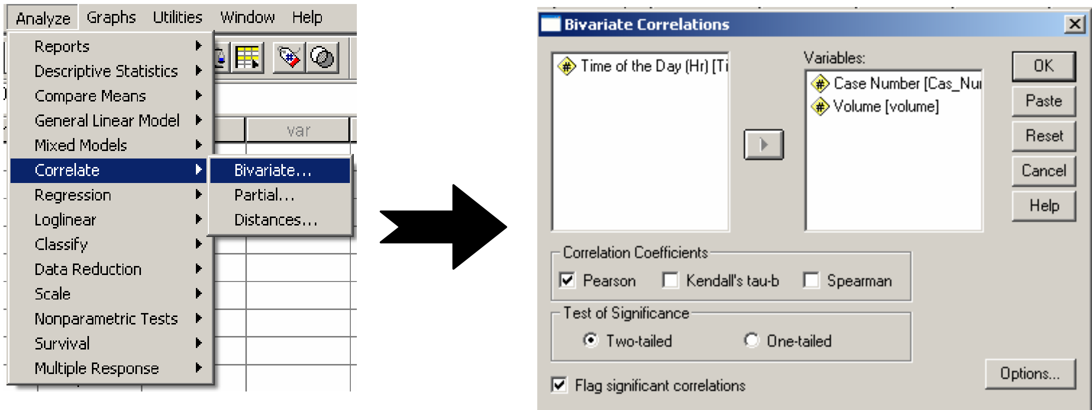


Figure 5-23. SPPS Screen Shoots of Analysis Steps

The correlation analysis shown in Table 5-7 showed a significance of less than 0.01% that the compared variables (number of crashes and traffic volume) were related with a Pearson correlation factor of .874 which indicates that the higher the traffic volume higher the number of crashes in the studied area

Table 5-7. Correlation of Number of Crashes (Cases) Vs. Traffic Volume

Correlations

		Case Number	Volume
Case Number	Pearson Correlation	1	.874**
	Sig. (2-tailed)	.	.000
	N	24	24
Volume	Pearson Correlation	.874**	1
	Sig. (2-tailed)	.000	.
	N	24	24

**. Correlation is significant at the 0.01 level (2-tailed).

5.6.5. Analysis 5- Time of the Day Vs Number of Crashes

This analysis focused on identifying the variation of traffic volume over the time of the day and it implication on the number of crashes. The previous analysis established that a there was a direct correlation between traffic volume and number of crashes in the studied area. By plotting the traffic volume and number of crashes, it was observed that this direct correlation held constant through the day with exceptions of the period following the lunch hour until the end of the normal business day as show in Figure 5-24.

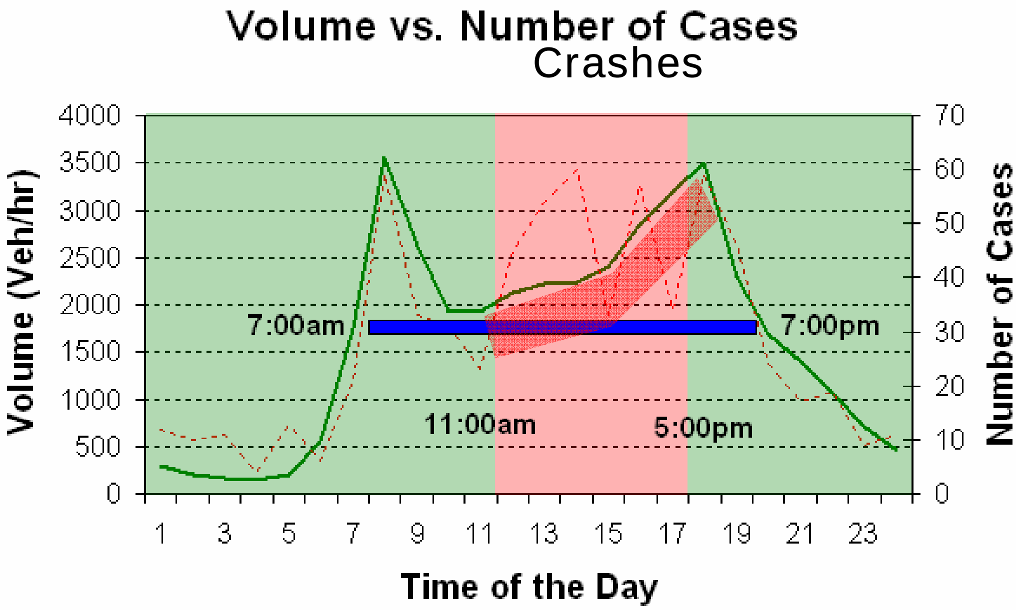


Figure 5-24. Time of the Day Vs. Traffic Volume and Number of Crashes

5.6.6. Analysis 6- Law Enforcement Presences Vs Number of Crashes

A t-test was performed to measure the correlation between number of crashes and the presence of law enforcement. The variables included in the analysis were: Week Date, Number of crashes and Law Enforcement presence as show in Figure 5-25. This analysis was performed in SPSS using the sequence of steps shown in Figure 5-26.

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure
1	Wee_Dat_2	Nume	11	0	Week Date (01/02/00=Week1)	None	None	11	Right	Ordinal
2	Cra_Cit_2	Numeric	1	0	Crash or Citation?	{1, Citation}...	None	9	Right	Nominal
3	Per_MHP_	Numeric	1	0	Permanent Presence of MHP	{1, No}...	None	9	Right	Nominal
4	Per_RP_2	Numeric	1	0	Permanent Presence of RP	{1, No}...	None	8	Right	Nominal
5	Con_Sta_2	Numeric	1	0	Construction Status	{1, After}...	None	9	Right	Ordinal
6	Number_of_	Numeric	7	0	Number of Crashes	None	None	28	Right	Scale
7	Presence	Numeric	8	2	Law Enforcement Permanent Presence	{1.00, No}...	None	10	Right	Scale
8	filter_$	Numeric	1	0	Cra_Cit_2 = 2 (FILTER)	{0, Not Selecte	None	10	Right	Scale
9										

Figure 5-25. Variable used in the Analysis

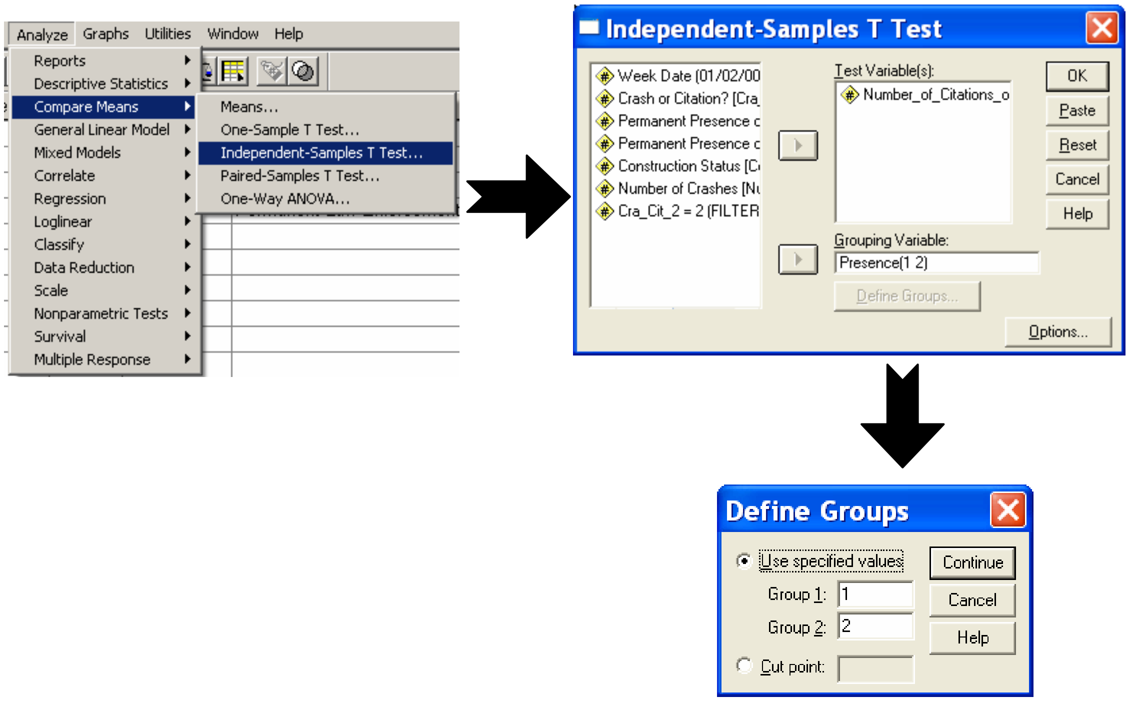


Figure 5-26. SPPS Screen Shoots of Analysis Steps

An assumption that was made during the analysis was that any date without crash information was considered to have 0 crashes. Table 5-8 shows a summary of the data analyzed. As shown in Table 5-8, there was crash data for 155 weeks of no permanent law enforcement presence and 53 weeks of law enforcement (either MHP or RP) permanent presence. The analysis of the data indicated that there was an average of 3.11 crashes per week during the non permanent law enforcement presence period and an average of 3.94 crashes per week during the law enforcement permanent presence period. The standard deviations regarding number of crashes were 1.905 and 1.895 respectively and the standard error mean were .153 and .260 respectively.

Table 5-8 Summary of Data Analyzed Number of Citations

Group Statistics

	Law Enforcement Permanent Presence	N	Mean	Std. Deviation	Std. Error Mean
Number of Crashes	No	155	3.11	1.905	.153
	Yes	53	3.94	1.895	.260

The t-test shown in Table 5-9 showed a significance level of .347 which it is above 5%. As stated by Glenberg, values of test statistics that occur with a relative frequency (Sig.) of less than 5% are in the rejection region [Glenberg 1996]. The rejection region means that the null hypothesis (no difference between groups/conditions) can be rejected, thus there is a difference between groups/conditions. Therefore, with a significance level of .347 which is more than 0.05, the null hypothesis (which is that there is no difference between the groups/conditions) is not rejected.

Thus, it can was concluded that there is no statistically significant difference in the number of crashes between the period with no permanent law enforcement and the period with permanent law enforcement in the studied area.

Table 5-9. t-test Law Enforcement Presence Vs. Number of Citations

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Number of Crashes	Equal variances assumed	.888	.347	-2.753	206	.006	-.834	.303	-1.431	-.237
	Equal variances not assumed			-2.760	90.496	.007	-.834	.302	-1.434	-.234

5.7. LESSONS LEARNED

It is worth noting that this first project from the Mississippi Department of Transportation to quantitatively document the safety impact of increased law enforcement surveillance on highway construction was a success. It provided quantitative evidences of the program effectiveness. It also helps develop a sample process to evaluate other programs in the future and identify the data required for those evaluations. Some of the data required for similar evaluations include: timeframe of the intervention (in this case the law enforcement presence in the studied area), number of citations issued by law enforcement agencies over time, number of crashes in the studied area over time and hourly traffic volume in the studied area over time. It was also evident (based on the statistical analysis) that the most useful inferential statistical analysis for the intended analysis were the t-test and bivariate correlation. Furthermore, histograms, line charts, and scatter plots seems to be the most practical type of chart to present the gathered data.

5.8. SUMMARY

One of the special measures implemented, in construction zones by several departments of transportation around the United States, to reduce the number of crashes is the increase of law enforcement surveillance. This chapter focuses on the descriptive and inferential statistical analysis to quantify the impact of law enforcement in construction zones.

The results presented in this chapter indicate that the permanent presence of law enforcement agencies in the studied area significantly increased the number of citations issued. This number of citations is reduced as law enforcement agencies stay in the studied area over time. It was also determined that there was not a direct correlation between the number of citations issued and the number of crashes. The number of crashes however was directly related to the traffic volume in the studied area.

It is also expected that the results and process presented in this paper could be used by other research teams to perform similar analysis of law enforcement surveillance or others methods implemented around the U.S. to reduce the deaths and injuries in road construction zones.

CHAPTER 6: SUMMARY LAW ENFORCEMENT SURVEILLANCE IMPACT ON CONSTRUCTION ZONE SAFETY

6.1. INTRODUCTION TO THE PROJECT OBJECTIVE AND APPROACH

The objective of this project was to evaluate the safety impact of increased law enforcement surveillance on construction zones. The objective was achieved by (1) reviewing nationwide literature of increased law enforcement surveillance in construction zones; (2) collecting historical and field data from selected Mississippi construction zones before, during and after the increased law enforcement surveillance; and (3) analyzing the compiled Mississippi data and the nationwide literature findings.

The review of the available literature on increased law enforcement surveillance impact on construction zones was accomplished following a descriptive research methodology. As part of the research methodology, a systematic literature review and a meta-analysis were performed. The meta-analysis combined the results from a number of previous studies, in an attempt to summarize the evidence of law enforcement impact on construction zones. The meta-analysis included a qualitative component (pre-determined search criteria) and a quantitative component (integration of numerical information) [CHP, 2005].

The collection of the historical and field data followed also a descriptive research methodology to systematically collect data from the several agencies involved in construction projects. The first step in the data collection was for MDOT to contact the agency and provide brief information about the project and research. Then the researchers met with the agency to discuss the overall purpose of the project and request the required data. Then the agency was responsible for assembling the collected data and sending it to the researchers.

The analysis of the collected data followed a quasi-experimental methodology, because the groups were not randomly selected. More specifically, the nonequivalent groups design was implemented because it allowed the comparison of pretest (no law enforcement-) and posttest (law enforcement) for a treated group. [Trochim, W. 2006]

Following is a summary of findings and lessons learned regarding the evaluation of law enforcement impact in construction zones.

6.2. NATIONWIDE IMPACT LITERATURE OF LAW ENFORCEMENT SURVEILLANCE

Even though a comprehensive study of the law enforcement impact in construction zones was not found, one study was found that documented the reduction of crash fatalities and several studies were found that documented the relationship between the presence of law enforcement surveillance and traffic speed. The study that documented crash fatality indicated that in 1999, traffic enforcement reduced 47% of crash fatalities in Tennessee [Traffic Safety Digest, 2004].

The studies that documented traffic speed reduction ranged from 4.3 mph to 10 mph. In Utah, the presence of law enforcement surveillance reduced the average speed by 9 mph [Saito & Bowie, 2003]. In Minnesota, Uniformed Police Officers reduced motorist speeds 8-10 mph [FHWA, 2004]. In Illinois, the average speeds of the cars inside the work zone were 4.3 – 4.4 mph lower when police were patrolling the work zone compared to the no-police condition. Trucks presented speed reductions of 4.3 – 5.0 mph due to police presence. The percentages of cars and trucks exceeding the speed limit decreased by 14% and 32%, respectively, at a location before the work zone due to police presence [Benkohal, 1992]. Benekohal et al. (1986) found that the presence of a marked patrol car reduced average car and truck speeds while no reduction occurred in an un-patrolled condition. Additionally, the proportion of cars traveling faster than conditions permitted in the work zone were reduced by 14 percent, and trucks traveling faster by 32 percent, when the patrol car was present.

Vaa (1997) found that intensive enforcement (an average of 9 hours of police presence per day) resulted in reductions in vehicle speed that lasted up to 8 weeks [FHWA, 2005].

6.3. AGENCIES, THE DATA AND DATA RESTRUCTURING AND CONSOLIDATION

Collecting, processing, archiving and retrieving of data/information is a costly, demanding and necessary activity of all agencies involved in transportation. It was found that each agency managed data/information in a different way for a variety of purposes to fulfill their primary responsibility. Therefore, it was important to understand these responsibilities to request the appropriate data from the agencies.

It was found that all agencies that were interviewed as part of this study considered of paramount importance the safety of drivers and workers in construction zones. It was also found that all agencies were very willing to collaborate in the data consolidation process. However, collecting, archiving and retrieving information was not a main priority for any of these agencies. Additionally, no general guidelines for data structuring was communicated among the agencies. Therefore, it was evident that input into the data gathering process before the data is collected rather than after the fact, could greatly improve the process of accessing the impact of law enforcement surveillance in construction zones or assessing the impact of any other program. By defining the data to be collected, the method for collecting the data, the formatting of the data, the timeframes for collecting the data (before, during and after construction) all the participating agencies would be able to share information and to demonstrate the impact of their performance to the stakeholders. Furthermore, it is suggested that the creation of a data structure that allow these agencies to share common data for common purposes and reduce the cost of the data collection efforts would be very beneficial.

Additionally the collection effort performed during this study, demonstrated that by combining, reformatting, integrating and analyzing the data from multiple agencies it is possible to produce valuable quantitative analysis.

The restructuring and consolidation of the data was driven by the main objective of the project which was to evaluate the safety impact of increased law enforcement surveillance on construction zones. To achieve this main objective, six specific statistical analyses were established aiming to determine if there was any correlation between the studied variables. The six analyses were as follows:

- Analysis 1 - Law Enforcement Presences Vs Number of Citations:
- Analysis 2 - Law Enforcement Over Time Vs Number of Citations:
- Analysis 3- Number of Citations per Week Vs Number of Crashes Per Week
- Analysis 4- Distribution of Volume Vs Distribution of Crashes
- Analysis 5- Time of The Day Vs Number of Crashes
- Analysis 6- Law Enforcement Presences Vs Number of Crashes

Based on the six analyses, the following data was required:

- Date of the Mississippi Highway Patrol Presences over time
- Date of the Ridgeland Police Presences over time
- Number of Citations Issued by the Mississippi Highway Patrol over time
- Number of Citations Issued by the Ridgeland Police Presences over time
- Number of Crashes in the studied area over time
- Hourly Traffic Volume in the studied area over time
- Construction condition over time

Upon comparing the required statistical analysis and the data available from the different agencies, it was recognized that there were five distinctive data sets (as shown in Figure 6.1): 1- Construction Information, 2- Traffic Volume Information, 3-Mississippi Highway Patrol (MHP) Activities, 4- Ridgeland Police (RP) Department Activities, and 5- Crash Information.

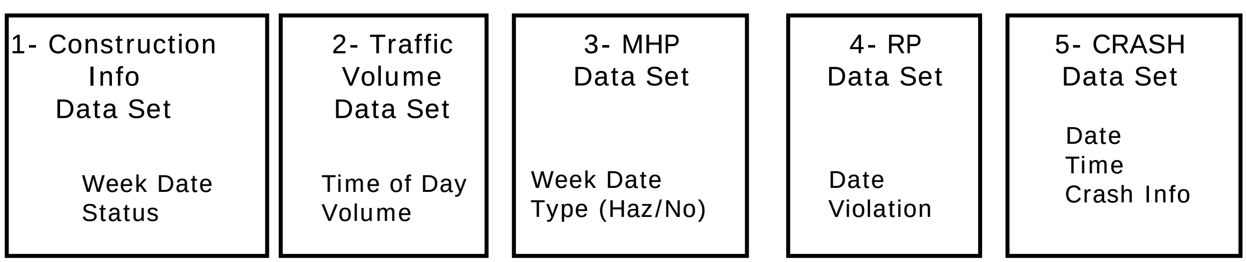


Figure 6.1. Data Sets for Analysis

6.4. Impact of Law Enforcement Surveillance in Mississippi

The results of the statistical analysis were as follows:

Analysis 1 - Law Enforcement Presences Vs Number of Citations

This analysis focused on how much the presence of law enforcement (either MHP or RPD) impacted the number of citations issued in the studied area. The analysis was based on the data obtained from MHP, RPD and MDOT.

Based on analysis it was concluded that there is statistically significant difference in the number of citations between the period with no permanent law enforcement and the period with permanent law enforcement in the studied area. The number of citations was significantly higher with permanent presence of

Analysis 2 - Law Enforcement Over Time Vs Number of Citations

This analysis focused on determining the effect of the number of weeks that the law enforcement agencies (MHP and RP) stayed the in the studied area on the number of citations issued per week.

A correlation was performed for each law enforcement agency (MHP and RP). The correlation analysis indicates that the longer that this law enforcement agency was in the studied area the lower the number of citations issued.

Analysis 3- Number of Citations per Week Vs Number of Crashes Per Week

This analysis focused on determining the effect of the number citations per week on the number of crashes per week on the studied area.

The correlation analysis showed that there is not a strong correlation factor between the number citations issued by the law enforcement agencies and the number of crashes in the studied area

Analysis 4- Distribution of Volume Vs Distribution of Crashes

This analysis focused on determining the effect of the traffic volume on the number of crashes in the studied area.

The correlation analysis showed that the higher the traffic volume the higher the number of crashes in the studied area.

Analysis 5- Time of The Day Vs Number of Crashes

This analysis focused on identifying the variation of traffic volume over the time of the day and it implication on the number of crashes.

By plotting the traffic volume and number of crashes, it was observed that this direct correlation held constant through the day with exceptions of the period following the lunch hour until the end of the normal business day as show in Figure 6.2.

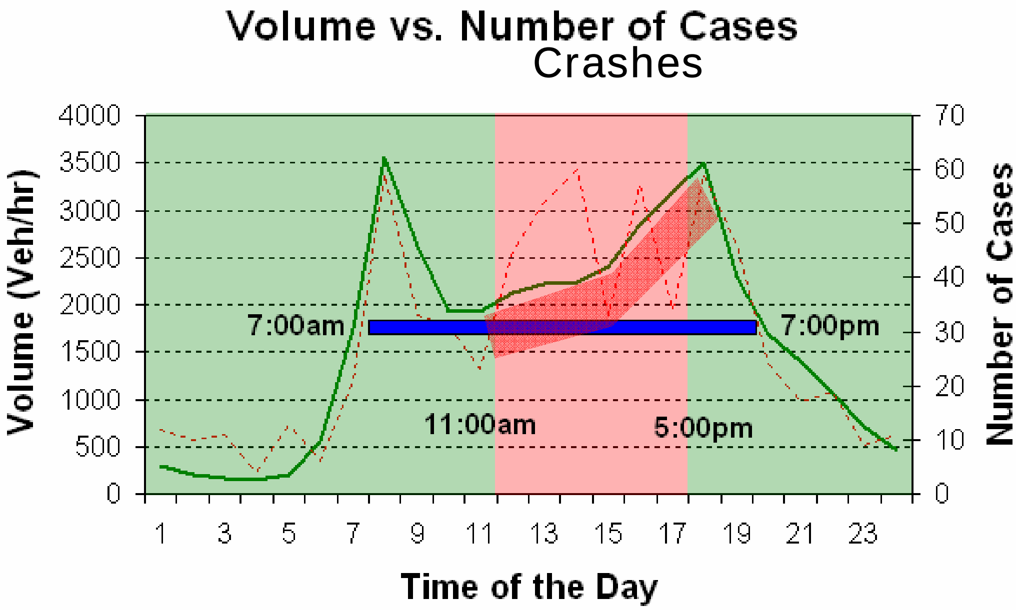


Figure 6.2. Time of the Day Vs. Traffic Volume and Number of Crashes

<u>Analysis 6- Law Enforcement Presences Vs Number of Crashes</u>

A t-test was performed to measure the correlation between number of crashes and the presence of law enforcement. The variables included in the analysis were: Week Date, Number of crashes and Law Enforcement presence.

Thus, it can was concluded that there is no statistically significant difference in the number of crashes between the period with no permanent law enforcement and the period with permanent law enforcement in the studied area.

References

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