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# Countermeasures for Pedestrian-Involved Accidents on Interstate-Highways

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# Countermeasures for Pedestrian-Involved Accidents on Interstate-Highways

A thesis submitted in partial fulfillment
of the requirements for honors designation for the degree of
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By

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# PROJECT SUMMARY

Pedestrian access to the Interstate is prohibited, but many pedestrian-involved accidents still occur on the Interstate in the United States. This project is a case study of West Memphis, Arkansas, which has the second highest occurrence of pedestrian-involved accidents on the Interstate in Arkansas. The study site location includes a segment of Interstate I-40 which is at-grade. The surrounding area contains several different land-uses, which is believed to be the primary generator of these accidents. The goal of this project is to determine the primary causes of these accidents and determine potential countermeasures to reduce the crash rate for pedestrian-involved accidents on Interstate 40 and 55 in West Memphis, Arkansas.

Although the Interstate system comprises about one percent of the nation's public road mileage, more than 10 percent of all pedestrian fatalities in the United States over the past five years have occurred on Interstate-Highways, and pedestrian deaths account for 12 percent of all fatalities occurring on Interstate-Highways (Johnson, 1997). The statistics listed above are shocking, especially considering pedestrian access to Interstates is prohibited. Pedestrians on Interstate-Highways present a distinctive traffic safety problem and accounted for 20 percent of all pedestrian fatalities in Arkansas from 1993-2012 (AAA Foundation for Traffic Safety, 2014). Also, pedestrian fatalities accounted for eight percent of all traffic fatalities in Arkansas from 2010-2014 (Arkansas Highway Safety Office, 2017).

The objective of this study is to determine the causes of pedestrian-involved accidents in West Memphis and determine appropriate countermeasures. To better understand the causes of pedestrian-involved accidents, we designed and implemented a mail-back style survey, preformed a site visit, and conducted a matched city analysis. Once countermeasures are identified, they are compared based on Crash Reduction (CR) factors and costs of implementation.

This report is organized as follows. Chapter 1 analyzes crash data for pedestrian-involved accidents on the Interstate in West Memphis. Chapter 2 details the survey and survey findings. Chapter 3 includes an analysis of West Memphis compared to a matched city. Chapter 4 details potential countermeasures. Chapter 5 outlines the countermeasure selection process. Lastly, Chapter 6 includes recommended countermeasures and conclusions.

# CHAPTER 1: CRASH DATA ANALYSIS

The City of West Memphis is located in Crittenden County, Arkansas, and, specifically, experiences a high crash rate for pedestrian-involved accidents on the Interstate. Of all the counties in Arkansas, Crittenden County has had the highest number of pedestrian-involved accidents on the Interstate per 100,000 residents and the second highest number of pedestrian-involved accidents on the Interstate in Arkansas from 2011-2017 (**Table 1**). The majority of these pedestrians can be considered intentional pedestrians. An intentional pedestrian is a person who is a pedestrian by their choice and intentionally crosses or walks along the Interstate as a means of transportation. However, an unintentional pedestrian is a person who becomes a pedestrian by unforeseen circumstances that causes them to need to walk along or cross the Interstate such having car trouble or being involved in an accident.

**TABLE 1: PEDESTRIAN-INVOLVED ACCIDENTS ON THE INTERSTATE BY COUNTY IN ARKANSAS (AMERICAN FACT FINDER, 2010)**

| Counties | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Total | Population (2010) | Crashes per 100,000 Residents |
|---|---|---|---|---|---|---|---|---|---|---|
| **CRITTENDEN** | 4 | 4 | 4 | 2 | 1 | 3 | 5 | **23** | 50,902 | **45.2** |
| **PRAIRIE** | 1 | | 1 | | | 1 | | **3** | 8,715 | **34.4** |
| **ST. FRANCIS** | 1 | | 1 | 1 | 3 | | | **6** | 28,258 | **21.2** |
| **CONWAY** | | | 1 | | 1 | 2 | | **4** | 2,1273 | **18.8** |
| **FRANKLIN** | | 1 | 1 | | | | 1 | **3** | 18,125 | **16.6** |
| **HOT SPRING** | | 2 | 2 | | | | 1 | **5** | 32,923 | **15.2** |
| **PULASKI** | 6 | 10 | 5 | 2 | 11 | 8 | 13 | **55** | 382,748 | **14.4** |
| **MILLER** | | | 2 | | 1 | 2 | 1 | **6** | 43,462 | **13.8** |
| **POINSETT** | | | | | | 2 | 1 | **3** | 24,583 | **12.2** |
| **CRAWFORD** | | 1 | 1 | 1 | 2 | | 2 | **7** | 61,948 | **11.3** |
| **POPE** | | 1 | 3 | | | | 2 | **6** | 61,754 | **9.7** |
| **HEMPSTEAD** | 1 | | | | | 1 | | **2** | 22,609 | **8.8** |
| **WASHINGTON** | 2 | 2 | 2 | 2 | | | 4 | **12** | 203,065 | **5.9** |
| **JEFFERSON** | | | 2 | | | 1 | 1 | **4** | 77,435 | **5.2** |
| **FAULKNER** | 1 | | | 2 | | 1 | 1 | **5** | 113,237 | **4.4** |
| **CLARK** | 1 | | | | | | | **1** | 22,995 | **4.3** |
| **SALINE** | | | 1 | 1 | 2 | | | **4** | 107,118 | **3.7** |
| **BENTON** | | | 1 | 1 | 1 | 1 | 2 | **6** | 221,339 | **2.7** |
| **MISSISSIPPI** | | | | | 1 | | | **1** | 46,480 | **2.2** |
| **CRAIGHEAD** | | | | | | | 1 | **1** | 96,443 | **1.0** |
| **SEBASTIAN** | | | 1 | | | | | **1** | 125,744 | **0.8** |
| **Total** | 17 | 21 | 28 | 12 | 23 | 22 | 35 | 158 | 1,771,156 | 251.9 |

After ranking counties in Arkansas, cities were ranked by the number of pedestrian-involved accidents on the Interstate, and West Memphis was ranked second highest, after Little Rock (**Table 2**). The number of pedestrian-involved accidents on the Interstate is alarmingly high when considering that intentional pedestrian access to the Interstate is already prohibited. The frequency of these occurrences makes it important to determine an effective solution for reducing pedestrian-involved accidents on the Interstate. One possible means is to develop a safer transportation route for pedestrians to cross the Interstate in West Memphis.

**TABLE 2: PEDESTRIAN-INVOLVED ACCIDENTS ON THE INTERSTATE BY CITY IN ARKANSAS**

| Year | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Total |
|---|---|---|---|---|---|---|---|---|
| LITTLE ROCK | 4 | 9 | 4 | 2 | 8 | 5 | 7 | **39** |
| WEST MEMPHIS | 2 | 4 | 3 | | 1 | 1 | 2 | **13** |
| NORTH LITTLE ROCK | 1 | 1 | 1 | | | 3 | 4 | **10** |
| FAYETTEVILLE | | 1 | 2 | 1 | | | 1 | **5** |
| RURAL PULASKI | | | | | 2 | 1 | 2 | **5** |
| SPRINGDALE | | | | 1 | 1 | | 3 | **5** |
| MALVERN | | 1 | 2 | | | | 1 | **4** |
| MARION | 2 | | 1 | | | 1 | | **4** |
| MAYFLOWER | 1 | | | 2 | | 1 | | **4** |
| RURAL CRITTENDEN | | | | | | 1 | 3 | **4** |
| BENTON | | | 1 | 1 | 1 | | | **3** |
| LOWELL | | | 1 | 1 | | | 1 | **3** |
| RURAL MILLER | | | | | 1 | 1 | 1 | **3** |
| RURAL POINSETT | | | | | | 2 | 1 | **3** |
| TEXARKANA | | | 2 | | | 1 | | **3** |
| VAN BUREN | | | | | 2 | | 1 | **3** |
| WEST FORK | 2 | 1 | | | | | | **3** |
| FORREST CITY | 1 | | | | 1 | | | **2** |
| HOPE | 1 | | | | | 1 | | **2** |
| MENIFEE | | | 1 | | | 1 | | **2** |
| OZARK | | 1 | | | | | 1 | **2** |
| POTTSVILLE | | | 1 | | | | 1 | **2** |
| RURAL JEFFERSON | | | | | | 1 | 1 | **2** |
| RUSSELLVILLE | | 1 | | | | | 1 | **2** |
| TURRELL | | | | 2 | | | | **2** |
| WIDENER | | | | | 2 | | | **2** |
| ALEXANDER | 1 | | | | | | | **1** |
| ALMA | | | | 1 | | | | **1** |
| ALTUS | | | 1 | | | | | **1** |
| ATKINS | | | 1 | | | | | **1** |
| BISCOE | 1 | | | | | | | **1** |
| BRYANT | | | | | 1 | | | **1** |
| CONWAY | | | | | | | 1 | **1** |
| DORA | | | 1 | | | | | **1** |
| FORT SMITH | | | 1 | | | | | **1** |
| GURDON (EXIT 63) | 1 | | | | | | | **1** |
| HAZEN | | | 1 | | | | | **1** |
| JONESBORO | | | | | | | 1 | **1** |
| LONDON | | | 1 | | | | | **1** |
| MAUMELLE | | | | | 1 | | | **1** |
| MULBERRY | | 1 | | | | | | **1** |
| PALESTINE | | | | 1 | | | | **1** |
| PLUMERVILLE | | | | | 1 | | | **1** |
| REDFIELD | | | 1 | | | | | **1** |
| ROCKPORT | | 1 | | | | | | **1** |
| ROGERS | | | | | | | 1 | **1** |
| RURAL CONWAY | | | | | | 1 | | **1** |
| RURAL CRAWFORD | | | | | | | 1 | **1** |
| RURAL MISSISSIPPI | | | | | 1 | | | **1** |
| RURAL PRAIRIE | | | | | | 1 | | **1** |
| WHEATLEY | | | 1 | | | | | **1** |
| WHITE HALL | | | 1 | | | | | **1** |
| Total | 17 | 21 | 28 | 12 | 23 | 22 | 35 | 158 |

Upon examining crash data from the Arkansas Annual Crash Database, pedestrians were separated into categories based on their intent (ASP, 2011-2017). **Figure 1** shows that the majority of pedestrian-involved accidents on the Interstate in West Memphis are intentional pedestrians, using the Interstate illegally as a primary means of transportation. Because the Interstate in West Memphis is at-grade and the land use is divided by the Interstate, West Memphis presents a unique layout that generates pedestrian traffic across and along the Interstate. Ingram Boulevard is an overpass that crosses over I-40 and I-55 along the highest concentration of intentional pedestrian-involved accidents (**Figure 2**). The land use division is caused by the division of residential areas from businesses by the Interstate. Pedestrians forgo the safe option of crossing over the Interstate using the overpass because it is more direct (shorter) to cross the Interstate. By opting to cross the Interstate, pedestrians put themselves and others in danger by chancing their involvment in a high-speed pedestrian-vehicle accident.

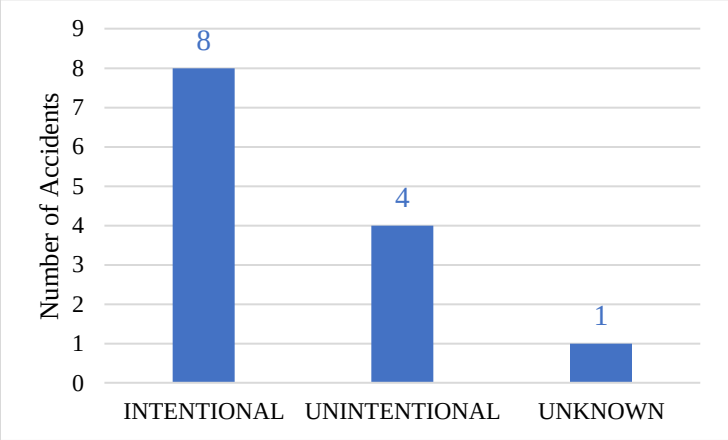


**FIGURE 1. NUMBER OF PEDESTRIAN-INVOLVED ACCIDENTS BY TYPE OF PEDESTRIAN**

**Figure 2** shows the location of West Memphis relative to the State of Arkansas. The callout in the figure provides a detailed depiction of the pedestrian involved accidents along I-40 in West Memphis. The majority of intentional pedestrian-involved accidents occur in a clustered location. This cluster will be defined as the *critical location* for this project and has been determined to be the critical area in the most need of countermeasure implementations. The critical location is measured to be approximately 3,600 feet along I-40 and I-55, extending about 2,000 feet west of Ingram Boulevard and 1,600 feet east of Ingram Boulevard (**Figure 3**). This section was determined to be the critical section because it has the highest concentration of intentional pedestrian-involved accidents along the Interstate in West Memphis, and this section is the region with the greatest land use division along the Interstate in West Memphis which generates pedestrian traffic from one side of the Interstate to the other.

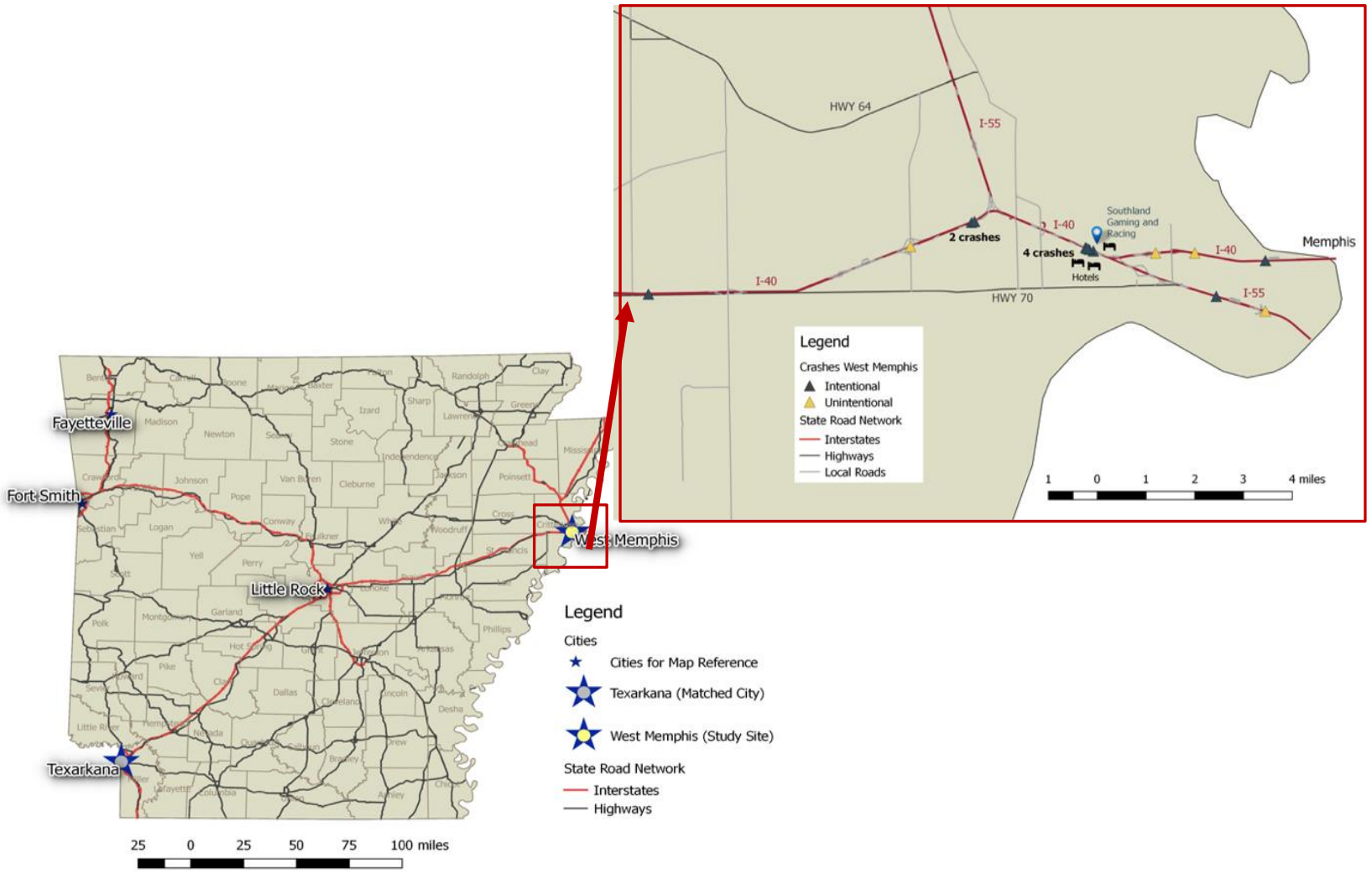


**FIGURE 2: PEDESTRIAN-INVOLVED CRASH LOCATIONS IN WEST MEMPHIS FROM 2011 TO 2017**

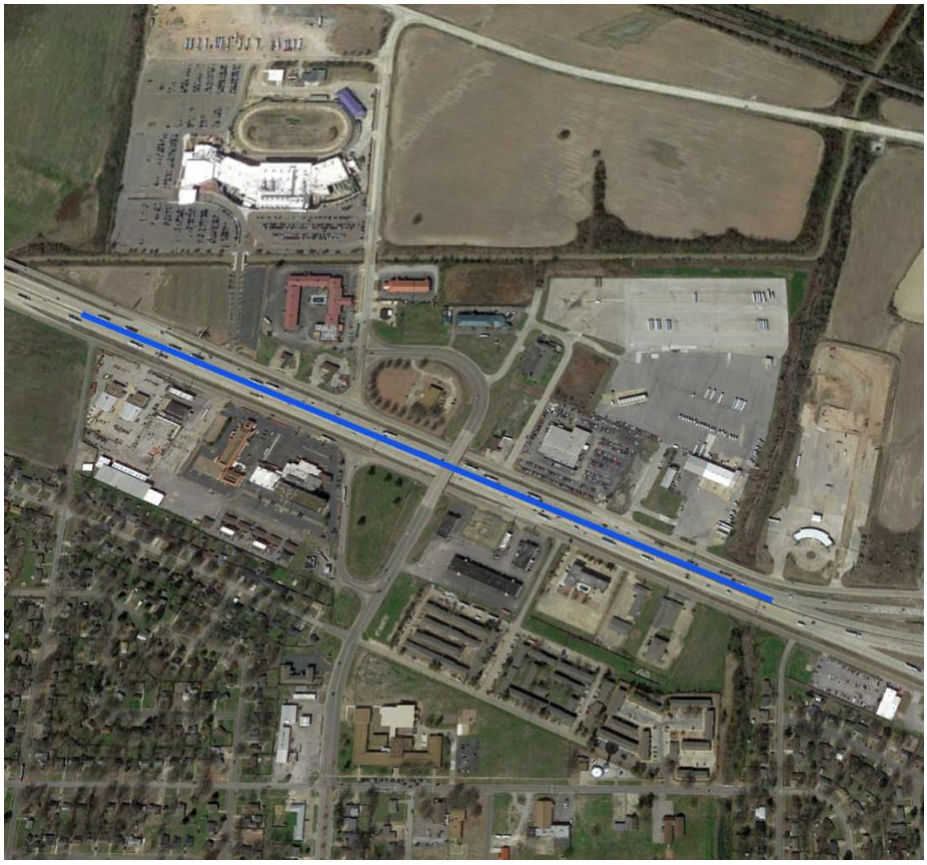

**FIGURE 3: CRITICAL REGION (GOOGLE EARTH (A), 2018)**

The population of West Memphis has been declining since 2011, but this decline has not had a major impact on the amount of pedestrian-involved accidents on the Interstates (**Figure 4**). These accidents have fluctuated heavily since 2011, but the trend shows that the number of accidents is increasing once again. The goal of this study is to determine a countermeasure that can be implemented to prevent this steady increase in pedestrian-involved accidents on the Interstate to protect the population of West Memphis.

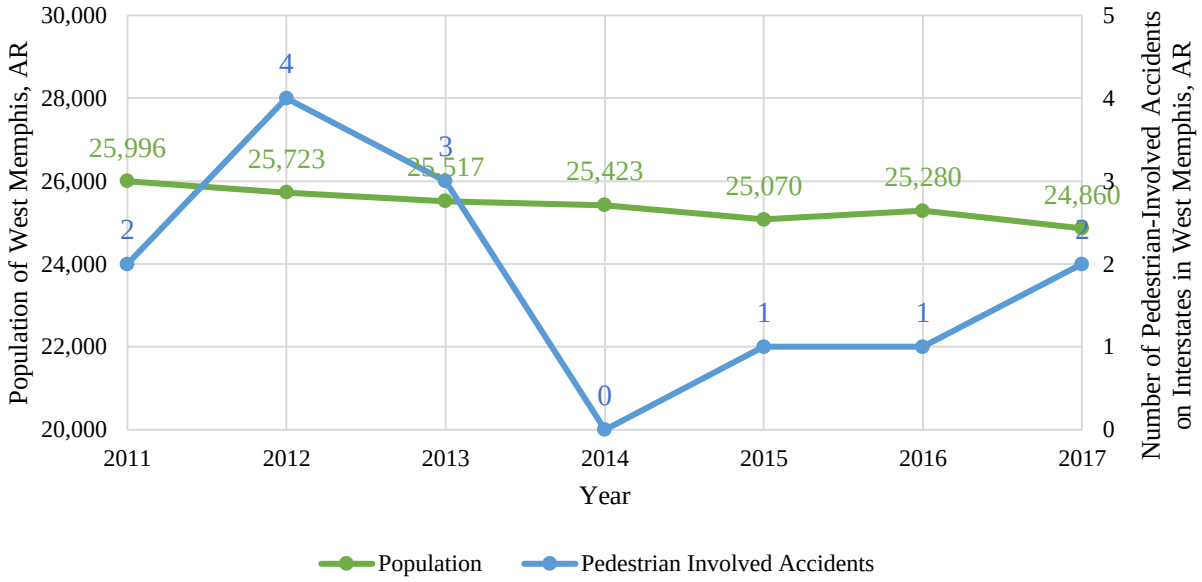


**FIGURE 4: PEDESTRIAN-INVOLVED ACCIDENTS IN WEST MEMPHIS COMPARED TO POPULATION COUNT**

**Figure 5** illustrates the relationship of the occurrence of pedestrian-involved accidents on the Interstate in West Memphis relative to population. The crash rate ranges from a minimum of 0.00 crashes per 10,000 residents in 2014 to a maximum of 1.56 crashes per 10,000 residents in 2012. Since 2014, there has been a steady increase in the number of pedestrian involved accidents each year.

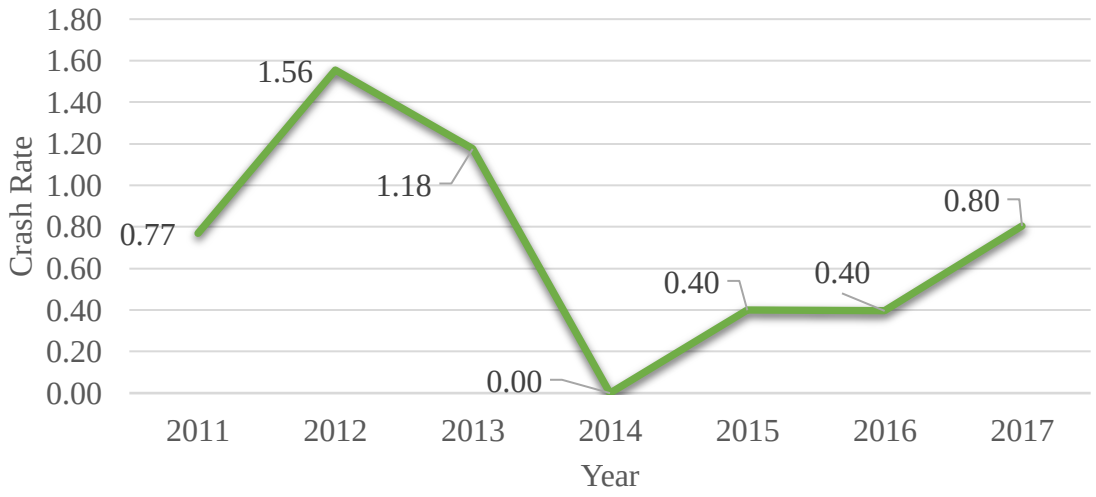


**FIGURE 5: CRASH RATE OF PEDESTRIAN-INVOLVED ACCIDENTS IN WEST MEMPHIS PER 10,000 RESIDENTS**

The age distribution is disproportionate to the population of West Memphis and the pedestrians involved in Interstate crashes (**Figure 6**). This difference in age distribution indicates that people aged 15-24, 25-34, and 55-64 are potentially more likely to be involved in pedestrian-vehicle accidents on the Interstate. Although the age distribution is disproportionate, the distribution of race is proportional (**Figure 7**). Therefore, age seems to be a larger predictor of pedestrian crossing activity in West Memphis than race.

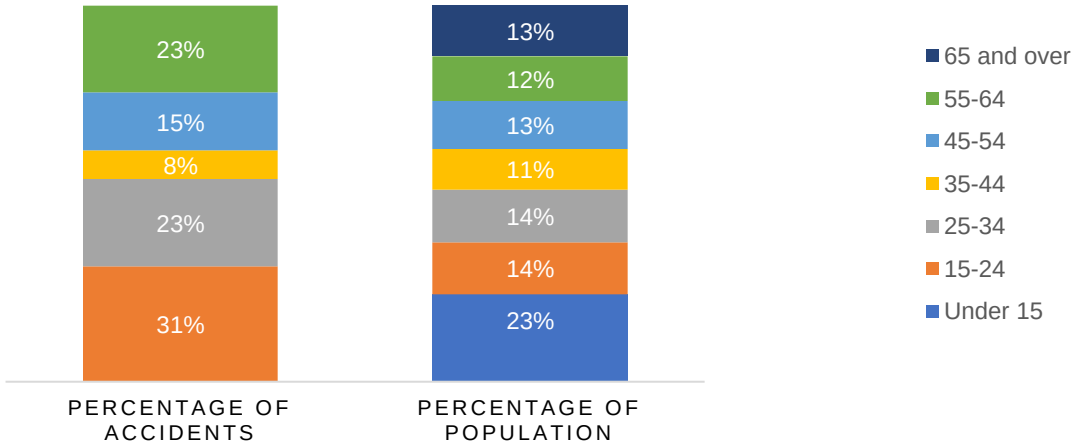


**FIGURE 7: PEDESTRIANS INVOLVED IN INTERSTATE CRASHES BY AGE RELATIVE TO WEST MEMPHIS POPULATION**

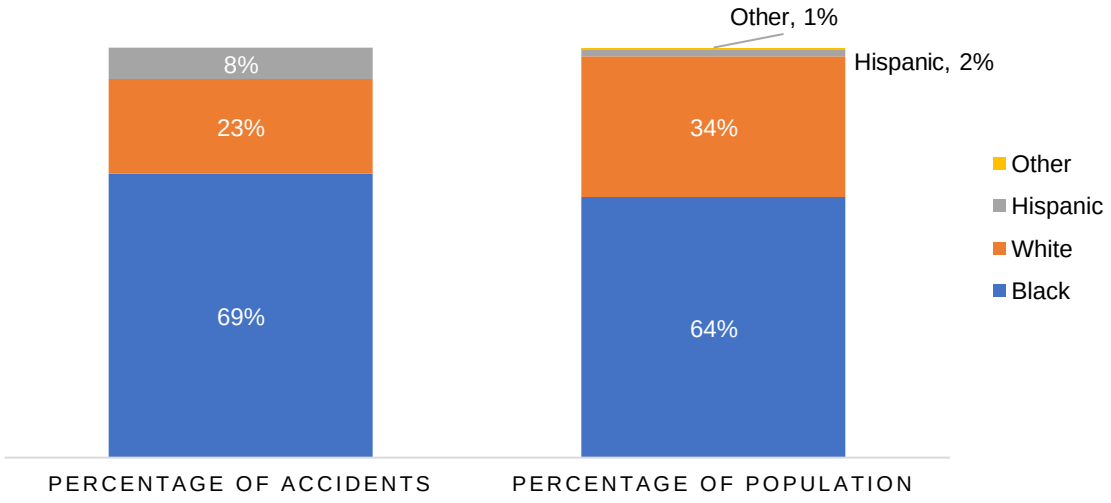


**FIGURE 6: PEDESTRIANS INVOLVED IN INTERSTATE CRASHES BY RACE/ETHNICITY RELATIVE TO WEST MEMPHIS POPULATION**

The majority of pedestrian-involved accidents, as seen in **Figures 8** and **9**, occur on Wednesdays after dark. One explanation for the majority of these accidents occurring at night is that visibility is decreased for the driver and the pedestrian, making it more difficult for pedestrians to judge vehicle distance accurately or drivers to react in time to avoid a pedestrian. These accidents also primarily occur in dry conditions (**Figure 10**). Most of the accidents that occurred under icy conditions involved unintentional pedestrians who got out of their car after an accident on the Interstate caused by the icing on the road. This supports the conclusion that the majority of these accidents are not due to extreme weather conditions like snow or ice.

Accidents that occur at increased speeds are also more likely to have increase severity. The Interstate, thus, is credited with having more fatal and incapacitating injury crashes (**Figure 11**) because Interstates are high-speed roadways. Because these pedestrian-involved accidents are occurring on the Interstate, most of the accidents are fatal. Only 16% of these crashes involved a possible injury or property damage only, and none of the crashes involved a non-incapacitating injury. Because these accidents are more serious, it increases the importance of determining and implementing an effective solution quickly.

**Figures 12 and 13** represent the driver's condition and alcohol involvement in the pedestrian-vehicle accidents on the Interstate in West Memphis. Because alcohol is rarely a factor in these accidents and drivers most commonly appeared normal, it can be concluded that pedestrians are primarily at fault for these accidents. Pedestrians often run across the Interstate at night and cause an accident. These accidents are often fatal, and the age of the pedestrian can indicate if they are more likely to be involved in these accidents.

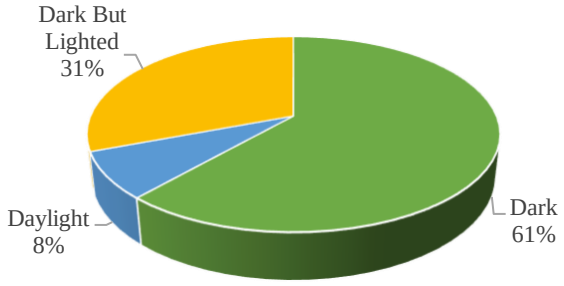


**FIGURE 9: LIGHTING CONDITIONS**

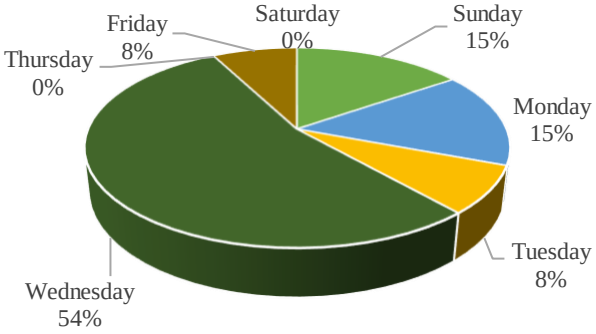


**FIGURE 8: DAY OF THE WEEK**

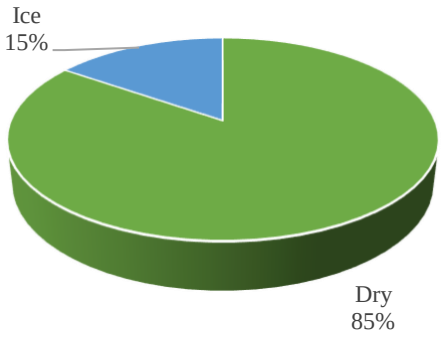


**FIGURE 10: ATMOSPHERIC CONDITIONS**

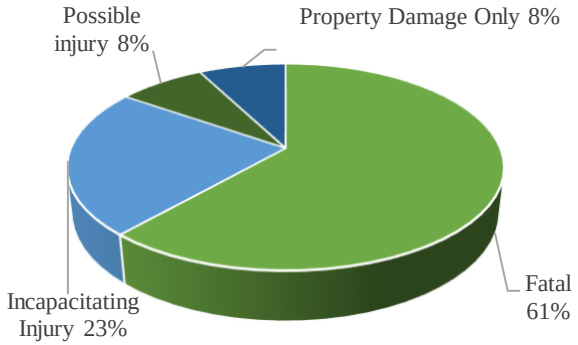


**FIGURE 11: CRASH SEVERITY**

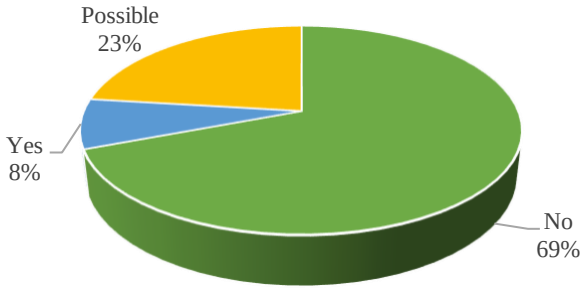


**FIGURE 12: ALCOHOL INVOLVEMENT**

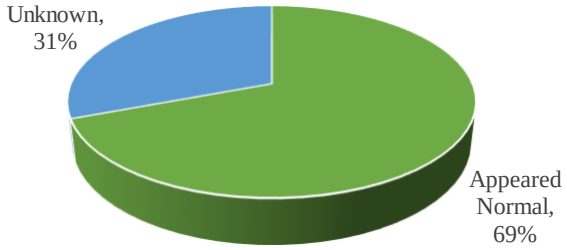


**FIGURE 13: DRIVER'S CONDITION**

# CHAPTER 2: SURVEY OF STUDY AREA

As part of the study of West Memphis, a site survey was conducted to gauge public perception of pedestrian and other travel decisions near the study site. Since this research involved human subjects via survey respondents, an IRB protocol was developed an approved. The approved protocol number is 1801093390 (University of Arkansas Internal Review Board, 2018). The survey was administered as a mail-back survey using pre-addressed, postage paid postcards. The postcards were distributed at five local hotels. In total, 100 surveys were distributed. The survey distribution team consisted of a graduate and two undergraduate students. Surveys were distributed on June 1, 2018 between 1:00 PM and 3:00 PM, and the postcards were returned from June 2-September 14.

## ANECDOTAL OBSERVATIONS IN WEST MEMPHIS

During survey distribution, the research team conversed with several hotel staff and guests. This informal interview process resulted in informative anecdotal evidence about the causes of pedestrian involved accidents at the study site. The follow summarize some of the insightful responses:

- A hotel clerk stated, "They just don't know. I have friends that cross the Interstate just to go to Dollar General."
- A local police officer stated that usually when pedestrians cross the Interstate in West Memphis they are running from law enforcement.

While the anecdotal observations shed some light on the issues of land use leading to pedestrian crossing demand, not all observations coincided with reality. For example, only one of the pedestrian-involved accidents in the crash data listed the pedestrian's reasoning for crossing the Interstate to be due to running from the police.

## SURVEY RESPONSE DATA

The responses were then compiled in a dataset and analyzed to be considered in the countermeasure selection process. The response rate of the survey was 15 percent (15 surveys). The most surveys (9 surveys) were collected from the Ramada by Wyndham hotel. Of the respondents to the survey, 67 percent were female and 33 percent were male. Overall, 47 percent were in the twenty-six to thirty-five age range, 27 percent were sixty-six and up, 13 percent were thirty-six to forty-five, and 13 percent were forty-six to fifty-five. A sample of the postcard survey can be found in **Appendix A.1 and A.2**.

As shown in **Figures 14 and 15** the survey revealed that 27 percent of respondents were unaware that it was illegal to walk along or cross the Interstate, and 20 percent of respondents would be willing to walk along or cross the Interstate as a means of transportation. These numbers are concerning, and the lack of awareness of the illegal nature of walking along or crossing the Interstate contributes to the high frequency of pedestrian-involved accidents on the Interstate in West Memphis.

**Figure 16** illustrates that the majority (40 percent) of respondents would prefer to drive to the casino, and 27 percent of respondents would prefer to walk to the casino. Of the respondents that listed driving as their first preference for transportation to the casino, only three listed a second

preference. Two of the participants' second preferences were to ride a shuttle to/from the casino. The other participant opted to walk along an updated and safer Ingram Boulevard Overpass. Every participant that ranked walking as their first preference for transportation listed taking a shuttle as their second preference. Of the three participants that ranked taking a shuttle as their first preference, two listed driving as their second preference and one did not list another preference. The average price that participants were willing to pay for a shuttle service was $4.30.

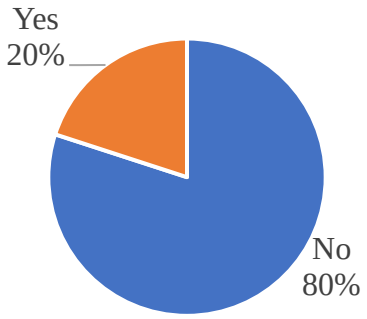


**FIGURE 14: PERCENTAGE OF RESPONDENTS THAT WOULD CONSIDER WALKING ALONG OR CROSSING THE INTERSTATE**

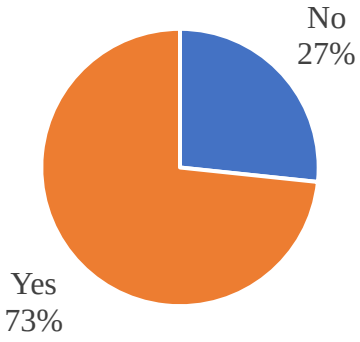


**FIGURE 15: PERCENTAGE OF RESPONDENTS THAT ARE AWARE IT IS ILLEGAL TO WALK ALONG OR CROSS THE INTERSTATE**

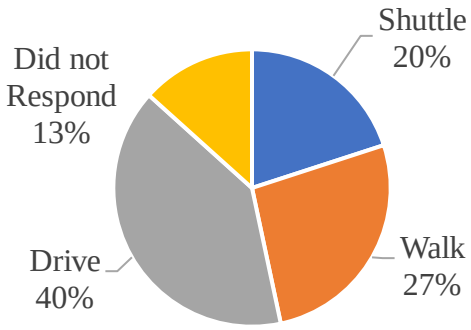


**FIGURE 16: FIRST PREFERENCE FOR FUTURE TRANSPORTATION**

# CHAPTER 3: MATCHED CITY ANALYSIS

To select potential countermeasures for West Memphis, a site comparison was conducted to analyze similarities and differences in crash rates similar sites in Arkansas. In this study, this is referred to as a matched city analysis. A list of potential matched cities in Arkansas was compiled based on demographics and Interstate geometry. This section details the methods to find a comparison city and to analyze the crashes in the matched city.

## METHOD TO FIND MATCHED CITY

First, the following demographics of each city were collected: population, median age, sex, race, occupied housing units, median household income, individuals below poverty level, and education level. These demographics were obtained from American Fact Finder (American Fact Finder, 2010). To compare demographic characteristics, a multi-criteria comparison metric was used (**Eq. 1**). The multi-criteria metric, MCM, sums the differences across multiple demographic characteristics while normalizing the difference in ranges and values of each demographic characteristic (i.e. by using percent difference).

$$MCM_C = \sum_{i=1}^{N} \frac{|X_i - X_W|}{X_W} \times 100\% \qquad \textbf{Eq. 1}$$

Where
$MCM_C$ = the multi-criteria metric for city c
$X_i$ = demographic characteristic i for city c
$X_W$ = demographic characteristic i for West Memphis

Second, once the cities were ranked based on demographics using the MCM metric, the geometric layout of the major Interstates in each city of the highest ranked cities (highest MCM) were examined using Google Earth. Cities with similar Interstate land-use geometries and configurations were noted. A table summarizing the ranking based on MCM and geometry can be found in **Appendix B**. Based on the rankings outlined in **Appendix B**, Texarkana was selected as the matched city for site comparison and crash rate comparison of pedestrian-involved accidents on the Interstate. An analysis comparing crash statistics and site characteristics was conducted in order to examine possible causes of high occurrences of pedestrian-involved accidents in West Memphis. If Texarkana were to have a lower crash rate, it would indicate that there could be underlying factors causing the increased pedestrian-involved accidents on the Interstates in West Memphis besides demographics, land use division, and geometric design.

## DIFFERENCES IN CRASH STATISTICS

Texarkana has a much lower crash rate for pedestrian-involved accidents on the Interstate than West Memphis for 2011-2017 even though it is also an at-grade Interstate that runs through the middle of the city. A total of three accidents occurred in Texarkana over the seven-year analysis period, but thirteen occurred in West Memphis (**Figure 17**). The number of pedestrian-involved accidents on the Interstate in Texarkana were found to always be equal to or less than the amount that occurred in West Memphis. Population was considered in this analysis and the accidents

were compared per 10,000 people to allow for even comparison between the two cities (**Figure 18**).

Because Texarkana has a higher population than West Memphis, the crash rate difference is more alarming than initially considered. Because the crash rate is so much higher in West Memphis than Texarkana, the site differences between the two cities were considered in determining potential countermeasures for pedestrian-involved accidents on the Interstate in West Memphis. Because Texarkana is similar to West Memphis, it is possible that a countermeasure that prohibits or discourages access to the Interstate exists in Texarkana that does not in West Memphis.

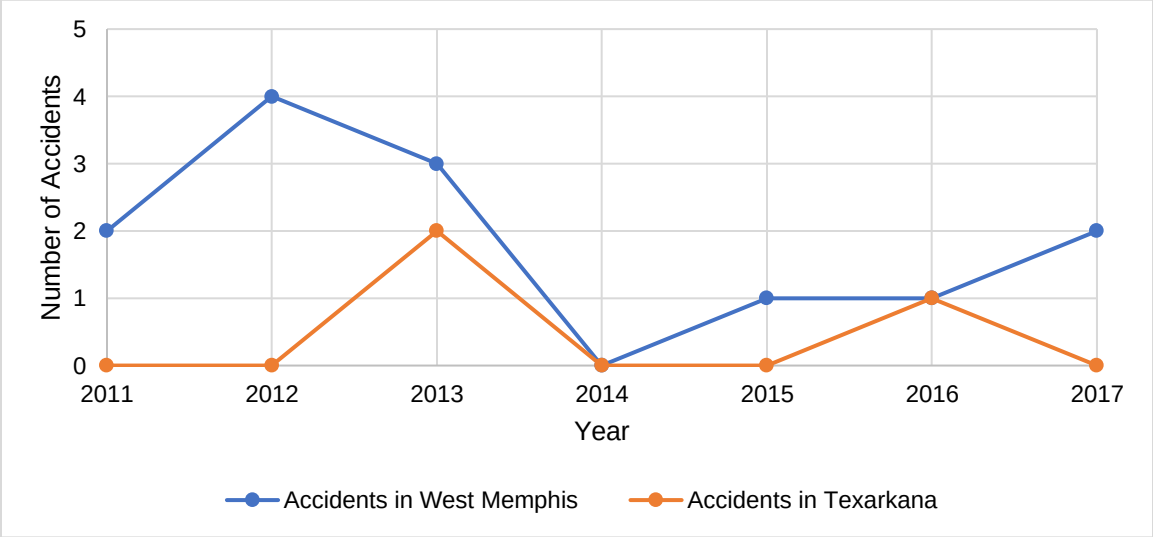


**FIGURE 17: PEDESTRIAN-INVOLVED ACCIDENTS ON THE INTERSTATE IN TEXARKANA AND WEST MEMPHIS**

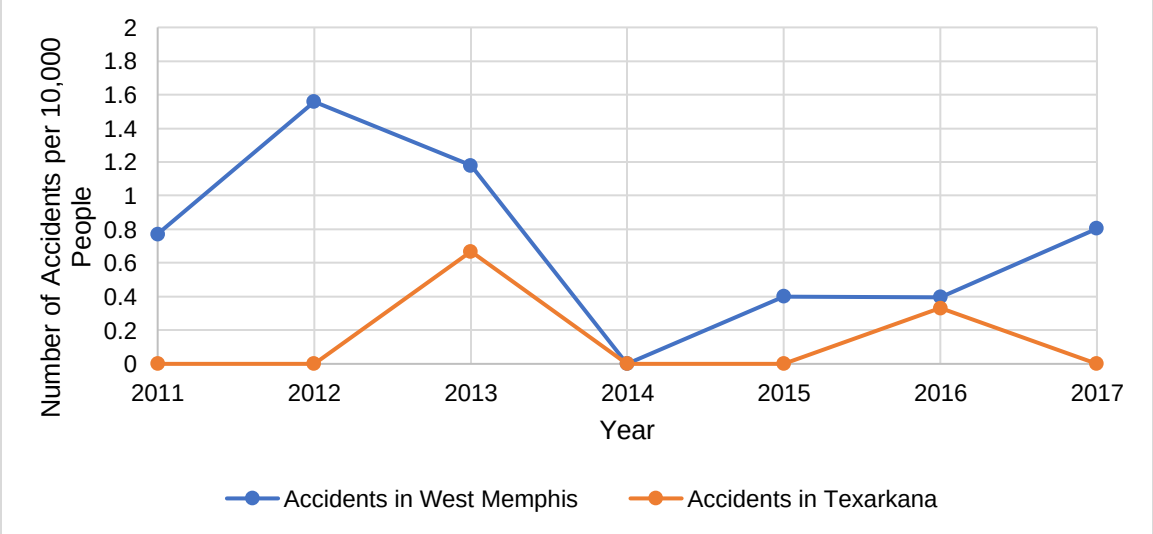


**FIGURE 18: PEDESTRIAN-INVOLVED ACCIDENTS ON THE INTERSTATE PER 10,000 PEOPLE IN TEXARKANA AND WEST MEMPHIS**

## DIFFERENCES IN SITE INFRASTRUCTURE AND CONDITIONS

The key differences between Texarkana and West Memphis, besides a greater land use division in West Memphis, were determined to be the existence of public transportation and better lighting along the Interstate in Texarkana.

### *PUBLIC TRANSPORTATION*

According to Texarkana Urban Transit District, Texarkana has a fully functioning public transportation system operating Monday through Saturday from 5:30 A.M.-6:20 P.M (Texarkana Urban Transit District, 2018). The accessibility of public transportation allows for a safe alternative to walking as a means of primary transportation. Public transportation can decrease the amount of pedestrian-involved accidents by decreasing the frequency of pedestrian-vehicle interaction.

According to Memphis Local News, funds for public transit in West Memphis diminished in 2012. Since the funds were diminished, public transit was able to continue through sparing funds, thus, decreasing service and quality. Once service declined, public transit usage declined with a difference of 280,386 customers in 2009 to 76,000 customers in 2017 (Local Memphis, 2015). Because of the termination of funds and the decline of service, public transportation in West Memphis has been discontinued as of March 31, 2018.

### *LIGHTING*

There is sufficient lighting in Texarkana that can be noticed by large 360° lights (**Figure 19**) along the Interstate that are positioned closer together than those in West Memphis (**Figure 20**). This could be a potential reason for decreased pedestrian-involved accidents along the Interstate in Texarkana and should be considered as a viable potential countermeasure. Comparatively, there is minimal lighting along the Interstate in West Memphis. Lack of lighting can cause an increased risk for all accidents in an area, especially pedestrian-involved accidents due to low visibility. Even though pedestrians cannot legally cross or walk along Interstates, lighting can help prevent pedestrian-involved accidents on the Interstate, especially when the pedestrian in an unintentional pedestrian.

**FIGURE 19: LIGHTING ALONG THE INTERSTATE IN TEXARKANA (GOOGLE EARTH, 2017)**


**FIGURE 20: LIGHTING ALONG THE INTERSTATE IN WEST MEMPHIS (GOOGLE EARTH (B), 2018)**

# CHAPTER 4: POTENTIAL COUNTERMEASURES

Engineering modifications can be classified into three categories: separation of pedestrians from vehicles by time or space, increasing visibility of pedestrians, and reduction of vehicle speeds (Retting et al, 2003). Because the Interstate is generally closed to pedestrians, countermeasures such as roadway and crossing design improvements, specialized enforcement, or traffic calming are impractical (AAA Foundation for Traffic Safety, 2014). Several articles were compiled and analyzed to determine potential countermeasures for pedestrian-involved accidents on the Interstate in West Memphis.

Countermeasures applicable to West Memphis and discussed in this section are divided into two types: site improvements and deterrent methods. Site improvements add physical infrastructure to the site and include fencing, lighting, signage, and sidewalks to the overpass. Deterrent methods would prevent crashes by changing the demand for travel or the mode of travel.

## SITE IMPROVEMENTS

### *PEDESTRIAN BARRIERS AND FENCES*

**Overview** Pedestrian fencing is recommended as a countermeasure for pedestrian-vehicle crashes (Retting et al, 2003). Upon surveying state representatives from the National Association of Governors Highway Safety Representatives (NAGHSR), Johnson received several responses advocating for fencing in open areas to prevent pedestrian entry to the Interstate, fining pedestrians for entering the Interstate intentionally, and providing a good network of pedestrian facilities (Johnson, 1997). Reducing intentional pedestrian access to the Interstate is a vital step in reducing the frequency of pedestrian-involved accidents on the Interstate in West Memphis. Because the Interstate in West Memphis is at-grade, pedestrians are tempted to run across the Interstate, despite its unsafe and illegal nature, because it is a shorter route to their destination. If there were a barrier preventing pedestrians from being able to get to the other side of the Interstate, they would no longer be tempted to cross.

Several studies indicate that pedestrian-vehicle crashes at midblock crossings are similar to that of pedestrians crossing the Interstate because it is illegal and unexpected for the driver (Retting et al, 2003). The main issue with implementing fencing along the Interstate is that adding fencing adds a fixed object to the Interstate system and can, thus, increase the crash rate of other types of accidents on the Interstate. It would not be ethical to trade one crash rate for another. However, by simply making the median barrier on the Interstate taller, a barrier for pedestrians can be constructed without adding another fixed object to the Interstate System. Glare Screens are commonly used in traffic management during periods of construction on the Interstate (**Figure 21)**. A glare screen would, in effect, extend the median concrete barrier upwards would prevent pedestrians from being able to get across the Interstate and reduce pedestrian use of the Interstate as a method of transportation, creating a safer environment for drivers and pedestrians without compromising the safety on the Interstate.

**FIGURE 21: EXAMPLE OF GLARE SCREENS (TRANSPO INDUSTRIES, 2018)**

**Crash Reduction Potential** For the purpose of this research, the crash reduction factor for installing animal fencing will be used because it is the most similar crash reduction factor for pedestrian-involved accidents on the Interstate currently available. These accidents can be considered similar because intentional pedestrians, like animals, run into the Interstate to cross the road when the driver is traveling at high speeds and is not expecting to stop. A heightened median barrier, like animal fencing, will prohibit pedestrian access to the Interstate and prevent these types of accidents from occurring.

The crash reduction factor for installing animal fencing for all animal-vehicle accidents on all roadway types averages 92 percent (Agent et al, 1996).

**Cost** If glare screens were used for barriers on top of the concrete median barrier of the Interstate in West Memphis, it is estimated that material cost would be $15 per linear foot (U.S. Department of Transportation Federal Highway Administration(b), 2017). The critical length is estimated to be 3,600 feet. Therefore, the estimated material cost for installing glare screens as pedestrian barriers along the median of the Interstate is $54,000.

*LIGHTING IMPROVEMENTS*

**Overview** Increasing lighting can increase driver and pedestrian visibility at night, when 92 percent of pedestrian-vehicle accidents occur on the Interstate in West Memphis. Protection of pedestrians who do end up on the Interstate is necessary. Unintentional pedestrians should be protected from high speed vehicles when stranded on the Interstate, and lighting can protect those pedestrians by increasing driver visibility allowing drivers to react to pedestrians in time to "move over". Approximately 23 percent of drivers reported that they couldn't see the pedestrian until it was too late. The high level of pedestrian-involved accidents on the Interstate at night in West Memphis indicates that better lighting could reduce the amount of pedestrian-vehicle accidents on the Interstate in this area.

West Memphis currently has lighting installed along the Interstate. However, this lighting could be improved by replacing the current lighting with brighter lights at a higher frequency along the Interstate. When the lighting facilities in West Memphis were compared to those in Texarkana, lighting in Texarkana seemed to be more effective than that in West Memphis (**Figure 19**). Lighting is recognized for reducing the crash rate of all accidents, not just pedestrian-involved accidents. Therefore, updating lighting along the Interstate in West Memphis could have a dual benefit by reducing vehicle-vehicle and vehicle-pedestrian accidents due to increased visibility.

**Crash Reduction Potential** Improving lighting along the freeway has been determined to have a crash reduction factor for roadway segment crashes of 25 percent (Gan et al, 2005).

**Cost** Installing new lights along the Interstate has a highly variable cost. However, lighting is a key component that is effective at reducing all types of crashes on urban Interstates, and was a key differential element noticed when comparing West Memphis to Texarkana.

### *PEDESTRIAN SIGNAGE*

**Overview** It is believed that many pedestrians in West Memphis are unaware of the law restricting pedestrian and bicycle access to Interstates. This belief stems from conversations at the site survey and data from the postcard survey that was distributed. Signage could reduce the amount of Interstate crossings in West Memphis by increasing awareness to the illegal nature of Interstate crossing. Posting signs (**Figure 22**) facing the frontage road and at onramps visible for pedestrians rather than drivers could create awareness to the issue and reduce the frequency of pedestrian crossings of the Interstate.

**Crash Reduction Potential** Pedestrian signing is credited with having a crash reduction of 15 percent for all severities of pedestrian-involved accidents (Gan et al, 2005).

**Cost** PEDSAFE estimates that the average cost of each sign is $300 (Zegeer (a), 2013).
If signs were placed 200 ft apart on each side of the Interstate, as recommended in the "Traffic Sign Design, Placement, and Application Guidelines", in the critical region, defined in the "Background" section, the project would require approximately 36 signs. The resulting estimated cost for materials for pedestrian signing in this project is approximately $10,800.


**FIGURE 22: NO PEDESTRIAN SIGNAGE (U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION (A), 2017)**

### *DRIVER SIGNAGE*

**Overview** Four states post signs on Interstates to warn drivers of sections where pedestrian crossing happen frequently including Texas, California, Arizona, and Rhode Island (Johnson, 1997). Posting signage directed towards vehicles stating that pedestrians are prohibited on the Interstate could create the false pretense to drivers that pedestrians are not on the Interstate, possibly diminishing the cautiousness of drivers. Warning signs could be used in the West Memphis Area to warn drivers of increased pedestrian traffic on the Interstate to encourage drivers to be cautious of pedestrians along the Interstate. Driver awareness reduces crash

frequency. **Figure 23** depicts an example of a potential sign that could warn drivers of pedestrian traffic in an unexpected area. This sign is not an approved sign, and it serves only as an example.

**Crash Reduction Potential** Installing advanced warning signs for positive guidance in urban areas has a crash reduction factor of 18 percent for crashes that strike animals and all crash severities (Gan et al, 2005).

**Cost** PEDSAFE estimates that on average each sign costs $300 (Zegeer (a), 2013). If two signs were posted in each direction along I-40 and I-55 before the critical zone, the estimated material cost for this project would be $1,200.


**FIGURE 23: EXAMPLE OF DRIVER SIGNAGE (THE LAW OFFICES OF BRIAN BRANDT, 2016)**

### *OVERPASS IMPROVEMENTS*

**Overview** While conducting a site survey in West Memphis, numerous pedestrians were spotted using Ingram Boulevard to cross over the Interstate safely, and these pedestrians should have safe facilities to do so. This overpass, however, does not currently have suitable pedestrian facilities for safe pedestrian transportation (**Figure 24**). The overpass has wide shoulders and lighting, but it does not have a sidewalk to separate pedestrian traffic from vehicle traffic. The installation of a raised sidewalk would reduce the likelihood of a pedestrian-vehicle accidents and provide a safer environment for pedestrians in West Memphis. To add a sidewalk to Ingram Blvd., a lane would need to be removed from Ingram Blvd. This could affect vehicle traffic and cause vehicles to slow down also contributing to a saver environment for pedestrians. A study will need to be conducted to ensure that reducing a lane on Ingram Blvd. would not have a significant negative impact on vehicle traffic. The highest concentration of pedestrian-involved accidents on the Interstate in West Memphis is near the Ingram Boulevard overpass. By preventing pedestrians from crossing the Interstate, the alternative, walking along Ingram Boulevard, would be encouraged and increase pedestrian traffic along the overpass. It is important that the alternative to crossing the Interstate is deemed safe for pedestrian access so that pedestrian-involved accidents are not simply shifted off of the Interstate and onto the

overpass. “Walkways should be part of every new and renovated road facility and every effort should be made to retrofit streets that currently do not have sidewalks” (Zegeer (b), 2013).

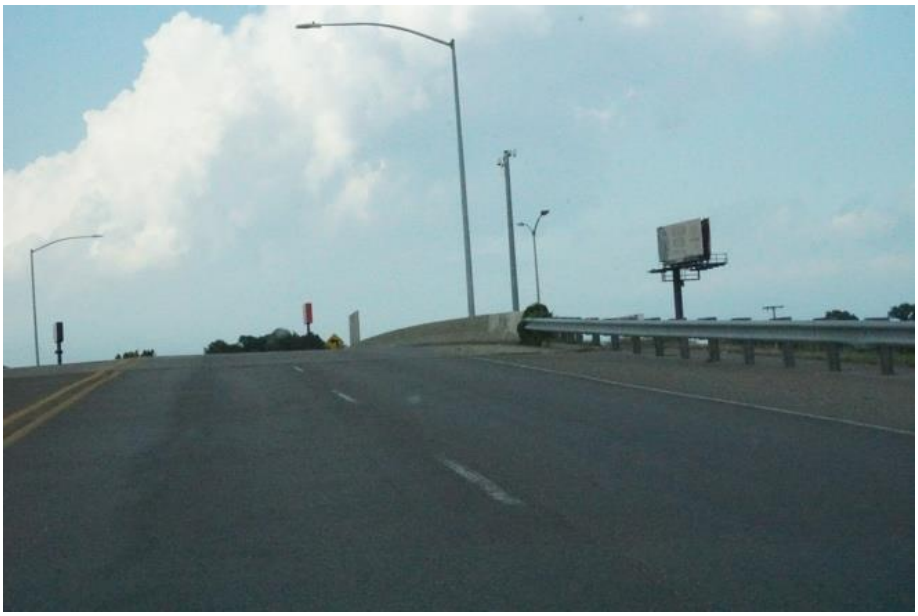

**FIGURE 24: WEST MEMPHIS OVERPASS**

**Crash Reduction Potential** Having an overpass at an uncontrolled pedestrian crossing is listed to reduce all severities of pedestrian-involved accidents by 13 percent (Federal Highway Administration, 2014). Also, installing sidewalks along city streets is listed for reducing pedestrian-vehicle crashes for pedestrians walking along the shoulder by 72 percent, as averaged from the crash reduction factors measured in Alaska, Arizona, Kentucky, Missouri, and Oklahoma (Florida Department of Transportation, 2005). The overall crash reduction factor for improving the pedestrian overpass in this project is estimated to be 75.64 percent by **Equation 2**.

$CR=CR_1+(1-CR_1)CR_2$ **Eq. 2**
$CR=0.72+(1-0.72)(0.13)$
$CR=0.72+(0.28)(0.13)$
$CR=0.72+0.0364$
$CR=0.7564$

**Cost** PEDSAFE estimates that the average material cost of a raised is approximately $150 per linear foot (Zegeer (a), 2013). If sidewalks were installed along the Ingram Boulevard overpass, it is estimated that the total necessary sidewalk length would be 1,650 feet, and this path would require one marked crossing to connect the new sidewalk to the existing sidewalk on Ingram Boulevard. The estimated path for the purpose of cost estimation in this study stretches from the Waffle House entrance on Ingram Boulevard, on the south side of I-55, to the opposite side of the street from the existing sidewalk on Ingram Boulevard on the north side of I-55. The average cost, according to PEDSAFE for a striped crosswalk is $8.51 per linear foot, not including instillation costs, and it is estimated that this would require 35 feet of striping (Zegeer (a), 2013). The total estimated cost for overpass improvements, including crosswalk striping, is $250,000.

## DETERRENT METHODS

### *PUBLIC TRANSPORTATION IMPLEMENTATION*

**Overview** Public transportation is a great way to reduce the frequency of pedestrian-vehicle interaction and, thus, reduce the amount of these accidents. West Memphis provided public transportation until this year, but the Memphis Area Transit Authority (MATA) did not have any stops on the north side of the Interstate. This left for the need of transportation to the other side of I-40 and I-55 and did not help reduce the number of pedestrian crossings over or across the Interstate. The main route that provided transportation throughout the city of West Memphis, seen in green **Figure 25** below was terminated this year due to lack of funding. "The last day of service for Route 77-West Memphis, Route 98-West Memphis Express, and West Memphis MATAplus [was] Saturday, March 31" (Local Memphis, 2018).


**FIGURE 25: MAP OF TRANSIT IN WEST MEMPHIS (MATA)**

**Crash Reduction Potential** There is a lack of data that supports a reduction factor for the effectiveness of providing public transportation at reducing pedestrian-involved accidents.

**Cost** If funding could be renewed to MATA and a new route providing service to the north side of West Memphis, a reduction of pedestrian-involved accidents could potentially be observed because it would reduce the frequency of pedestrian-vehicle interaction. The base fare for route 77 was $1.75 (MATA). The survey that was administered in this research project indicates that

people would be willing to pay up to $4.30 for a shuttle service from local hotels to Southland Park Gaming and Racing. From this survey, it can be inferred that the public transportation route could charge a higher fare for providing transportation to and from the casino and local hotels.

### *EDUCATIONAL PROGRAMS AND INCREASED LAW ENFORCEMENT*

**Overview** One critical element in preventing pedestrians from crossing and walking along the Interstate is to discourage the illegal activity. Many people are unaware that what they are doing is illegal, especially because they rarely face consequences if they make it across the Interstate safely. Public education programs can increase awareness of the dangers of crossing the Interstate and its illegal nature. Also, making the population aware of the law will increase compliance with the law. Johnson also suggested educational campaigns targeting at-risk demographic groups and fining pedestrians who intentionally enter the Interstate (Johnson, 1997).

Public education programs are not only for increasing awareness of the issue and the law, but they also can provide useful tips for drivers in case of emergency. Preparing drivers for becoming unintentional pedestrians in the event of an emergency and teaching them safe precautions to use is another key element involved with education programs. Education programs can go as far as distributing safety vests, road flares, and safety pamphlets or they can simply broadcast on local radio stations that it is illegal to cross or walk along the Interstate and provide safety tips if a driver were ever stranded on the Interstate. According to the Arkansas Highway Safety Office, a pedestrian and bicycle safety educational and awareness program was to be developed in 2017 (Arkansas Highway Safety Office, 2017). This program could extend to West Memphis to help prevent these accidents from continuing to occur.

**Crash Reduction Potential** Law enforcement can help reduce the amount of pedestrian-involved accidents on the Interstate by fining pedestrians for crossing the Interstate. The most similar proven countermeasure with a proven crash reduction factor is for increasing law enforcement related to motorist yielding in marked crosswalks combined with a public education campaign, and it has a proven crash reduction factor of 23 percent for the reduction of pedestrian involved accidents (Federal Highway Administration, 2014). It is believed that the reduction factor for increasing law enforcement developing educational programs for pedestrian-involved accidents on the Interstate in West Memphis, Arkansas would be similar to that for motorist yielding in marked crosswalks. More research is needed for determination of a crash reduction factor for education programs and law enforcement increase for pedestrian-involved accidents on Interstates.

**Cost** The cost for these programs is highly variable because the implementing agency can choose to implement a wide variety of program types. Other states such as Connecticut, California, Mississippi, and Texas offer educational and awareness programs by establishing September as Pedestrian Safety Month, funding and distributing safety equipment, television and radio broadcasts to bring awareness, offering education programs through their state department of transportation, and developing safety campaign materials (Retting et al, 2016). “Delaware provides overtime law enforcement officers to preform outreach and enforcement in high crash areas” (Retting et al, 2016).

# CHAPTER 5: COUNTERMEASURE SELECTION PROCESS

Each of the countermeasures identified in Chapter 3, are compared based on crash reduction potential (crash reduction factor) and cost. The following measures were used for comparison:

1. **Cost to reduction factor (CTR):** A countermeasure cost-to-reduction factor (CTR) was calculated by dividing the estimated cost of the countermeasure by the crash reduction factor.
2. **Estimated Crashes Prevented (ECP):** The number of estimated crashes that would be prevented by the countermeasure if it had been implemented in 2010 (i.e. prior to the 2011-2017 study period) was estimated by taking the product of the crash reduction factor and the number of pedestrian-involved crashes that occurred on the Interstate in West Memphis in from 2011-2017.
3. **Estimated Fatalities Prevented (EFP):** The number of estimated fatalities that would have been prevented by the countermeasure for 2011-2017 was estimated by the same process as estimated crashes prevented, but instead taking the product of the crash reduction factor and the number of fatalities in pedestrian-involved accidents on the Interstate in West Memphis from 2011-2017.
4. **Cost of Preventable Life (CPL):** For each calculation, the total estimated cost of life is $9.4 million (Thompson, 2015). Therefore, the estimated total preventable cost of life is the product of the estimated cost of life and the number of fatalities that could have been prevented by that countermeasure.

**Table 3** shows driver signage would be the most cost-effective solution. However, driver signage cannot solve this issue alone because it is important to prevent pedestrians from entering the Interstate and prevent drivers from being solely responsible for preventing these accidents from occurring. It is important to note that barriers and fencing are recognized for being the most effective solution for reducing the frequency of pedestrian-involved accidents on the Interstate followed by overpass improvements. Different combinations of countermeasures were tested (**Table 4**), to determine what combinations of countermeasures would be the most effective. Compound countermeasure crash reduction factors calculated as shown in the example for Overpass Improvements.

The current crash rate for pedestrian-involved accidents on the Interstate in West Memphis has been calculated to be 250.74 pedestrian-involved accidents per million entering vehicles (RMEV), and by implementing all of the countermeasures listed above, it is predicted that this crash rate could be reduced to 1.97 pedestrian-involved accidents per million entering vehicles on the Interstate in West Memphis. Based on the data and survey of West Memphis, it is believed that barriers are an important inclusion in the countermeasure implementation project. The Interstate has such an ease of access to pedestrians and runs throughout a central part of the city. Thus, it creates temptations for pedestrians to cross, not realizing the danger. Without blocking off access to the Interstate to pedestrians, it is highly likely that pedestrians will continue to use the Interstate as a means of transportation regardless of other countermeasure implementations. Public Transportation has not been included in the calculation of total countermeasure effectiveness because determination of a crash reduction factor for changes to

public transportation routes and their effectiveness was not possible due to limited research and data.

**TABLE 3: INDIVIDUAL COUNTERMEASURE COMPARISON**

| Counter-measure [Ref. #] | Barriers and Fencing [1] | Increased Lighting [2] | Pedestrian Signage [3] | Driver Signage [4] | Overpass Improvements [5] | Public Transport [6] | Education and Increased Law Enforcement [7] |
|---|---|---|---|---|---|---|---|
| **CRF (%)** | 92.0 | 25.0 | 15.0 | 18.0 | 75.6 | Unknown | 23.0 |
| **Estimated Cost ($)** | 54,000 | Highly Variable | 10,800 | 1,200 | Highly Variable | Highly Variable | Highly Variable |
| **CTR ($/%)** | 587.0 | N/A | 720.0 | 66.7 | N/A | N/A | N/A |
| **ECP** | 12.0 | 3.3 | 2.0 | 2.3 | 9.8 | N/A | 3.0 |
| **EFP** | 8.3 | 2.3 | 1.4 | 1.6 | 6.8 | N/A | 2.1 |
| **CPL (Million $)** | 77.8 | 21.2 | 12.7 | 15.2 | 64.0 | N/A | 19.5 |

**TABLE 4: COMBINED COUNTERMEASURE COMPARISON METRICS**

| Countermeasure | All | [1], [5] | [1], [5], [2] | [1], [2], [3], [4], [5] | [1], [2], [3], [4], [7] | [1], [2], [3], [5], [7] | [1], [2], [4], [5], [7] | [1], [3], [4], [5], [7] | [2], [3], [4], [5], [7] |
|---|---|---|---|---|---|---|---|---|---|
| **CRF (%)** | 99.2 | 98.1 | 98.5 | 99.0 | 96.8 | 99.0 | 99.1 | 99.0 | 90.2 |
| **Estimated Cost ($)** | Highly Variable | Highly Variable | Highly Variable | Highly Variable | Highly Variable | Highly Variable | Highly Variable | Highly Variable | Highly Variable |
| **CTR ($/%)** | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| **ECP** | 12.9 | 12.8 | 12.8 | 12.9 | 12.6 | 12.9 | 12.9 | 12.9 | 11.7 |
| **EFP** | 8.9 | 8.8 | 8.9 | 8.9 | 8.7 | 8.9 | 8.9 | 8.9 | 8.1 |
| **CPL (Million $)** | 83.9 | 83.0 | 83.4 | 83.7 | 81.9 | 83.8 | 83.8 | 83.7 | 76.3 |

Countermeasures were ranked by their crash reduction factors and their cost to reduction ratio in order to assist in the countermeasure selection process (**Table 5**). It is important to note that all of the data included in the tables above are estimates and should be recalculated with more accurate cost estimates from bid sheets in the West Memphis Area to result in more accurate recommendations.

**TABLE 5: RANKING OF COUNTERMEASURES BY CRASH REDUCTION FACTOR AND CTR**

| **By Crash Reduction Factor:** | **By Cost to Reduction (CTR) Ratio:** |
|---|---|
| 1. All Countermeasures | 1. Driver Signage |
| 2. All Except Pedestrian Signage | 2. Barriers/Fencing |
| 3. All Except Driver Signage | 3. Pedestrian Signage |
| 4. All Except Education and Increased Law Enforcement | 4. Overpass Improvements |
| 5. All Except Lighting Improvements | *5. All Countermeasures* |
| 6. Overpass Improvements, Barriers/Fencing, and Lighting Improvements | *6. All Except Pedestrian Signage* |
| 7. Overpass Improvements and Barrier/Fencing | *7. All Except Driver Signage* |
| 8. All Except Overpass Improvements | *8. All Except Education and Increased Law Enforcement* |
| 9. Barriers/Fencing | *9. All Except Lighting Improvements* |
| 10. All Except Barriers/Fencing | *10. Overpass Improvements, Barriers/Fencing, and Lighting Improvements* |
| 11. Overpass Improvements | *11. Overpass Improvements and Barrier/Fencing* |
| 12. Increased Lighting | *12. All Except Overpass Improvements* |
| 13. Education and Increased Law Enforcement | *13. Increased Lighting* |
| 14. Driver Signage | *14. Education and Increased Law Enforcement* |
| 15. Pedestrian Signage | *15. Public Transportation* |
| *16. Public Transportation* | *16. All Except Barriers/Fencing* |

**Italicized text indicates that the cost of the countermeasure was highly variable or undetermined.*

# CHAPTER 6: RECOMMENDATIONS AND CONCLUSIONS

As concluded from this study, the single most effective countermeasure is installing barriers or fencing, and the single most cost-effective solution is driver signage. For countermeasure combinations, the most effective countermeasures would be a combination of all the countermeasures, and the most cost effective was unable to be determined due to lacking data for the estimated cost of increased lighting, overpass improvements, public transportation, and public educational programs with increased law enforcement. Without better cost estimates, the determination of the best countermeasure or countermeasure combination to implement is unable to be accurately determined. However, it can be determined that barriers/fencing and overpass improvements are key elements in reducing the frequency of pedestrian-involved accidents on the Interstate in West Memphis.

West Memphis, Arkansas has the second highest occurrences of pedestrian-involved accidents on the Interstate in Arkansas, occurring on Interstate 55 and Interstate 40. These accidents primarily consist of intentional pedestrians who run across the Interstate at night. The pedestrians are more likely to cross and be involved in an accident based upon their age, and the driver is most commonly not distracted, under normal conditions. Also, pedestrian-involved accidents on the Interstate in West Memphis rarely involve alcohol impairments. It is believed that most of these pedestrians are unaware that is illegal to walk along or cross the Interstate, and this leads to increased pedestrian traffic from one side of the Interstate to the other due to the land use division of the on grade Interstates in West Memphis. Lighting is also a key element in these accidents because most of the accidents occur at night and lighting is one key difference in West Memphis and Texarkana. There is a demand for a shuttle service from Southland Park Gaming and Racing, resulting from the survey responses. Also, it is believed that unless something blocks pedestrians from accessing the Interstate pedestrians will use the Interstate as a means of transportation.

In order to combat this issue, barriers/fencing are considered to be the most effective potential countermeasure. Ingram Boulevard needs to be upgraded to provide better pedestrian facilities because it is the primary route of transportation for pedestrians from one side of the Interstate to the other in West Memphis, and it lacks sidewalks and sufficient lighting. Other possible countermeasures that could be implemented along with barriers and overpass improvements are lighting improvements, pedestrian signage, driver signage, public transportation reimplementation, and public education and increased law enforcement. As more countermeasures are implemented in this project, the effectiveness at reducing pedestrian-involved accidents on the Interstate in West Memphis will also increase.

The crash reduction factors used in this study are the most similar proven crash reduction factors found in the current body of literature. More detailed and project specific costs for each potential countermeasure were not evaluated in this study. For these reasons, a conclusive recommendation for a countermeasure is not made in this study. Rather, a ranking of feasible countermeasures that are suggested by the literature for similar settings is included. More research is needed to analyze the crash reduction factors for implementable countermeasures for pedestrian-involved accidents on the Interstate. Considering that pedestrians are not allowed on the Interstate, there are few to no studies developing countermeasures for Interstate pedestrian

involved accidents. Recommended future studies of West Memphis include analyzing pedestrian activity patterns (origin, destination, demographics, mode choice, etc.) near the study site. Specifically, it would be valuable to collect and compare traffic and pedestrian counts during racing season compared to non-racing season in the vicinity of the study area and specifically along Ingram Blvd., to determine if the underlying factor of pedestrian demand for the Interstate crossing is due to the Casino activity. Additionally, a survey to gather more community feedback would help gauge the usage potential of proposed countermeasures like the improvements to the Ingram Blvd. overpass. Lastly, if countermeasures were to be implemented at the study site, it would add value to the body of literature on crash reduction factors to estimate crash reduction factors for pedestrian-involved accidents on Interstates. These studies would enhance this project by providing more accurate data for the countermeasure selection process.

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# APPENDIX A.1 (SURVEY QUESTIONS)

What is your age?

- ☐ 18-25
- ☐ 26-35
- ☐ 36-45
- ☐ 46-55
- ☐ 56-65
- ☐ 66-75
- ☐ 75-Up

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer not to respond

Are you staying at this hotel as part of a trip to the casino?

- ☐ Yes; the night after attending the casino.
- ☐ Yes; the night before attending the casino.
- ☐ Yes; both.
- ☐ No; I will not be going to the casino as part of my trip to West Memphis.

How do you plan to get to the casino today?

- ☐ Drive
- ☐ Walk (Do you plan to walk along the Imperial Road overpass? Y / N )
- ☐ Ride a Bus
- ☐ Taxi
- ☐ Uber, Lyft, or other ride share

How do you plan to get home from the casino today?

- ☐ Drive
- ☐ Walk (Do you plan to walk along the Ingram Blvd overpass? Y / N )
- ☐ Ride a Bus
- ☐ Taxi
- ☐ Uber, Lyft, or other ride share

Would you ever consider walking across the interstate to get to the casino or return home?

- ☐ Yes
- ☐ No

Are you aware that it is illegal to walk along or cross an interstate-highway?

- ☐ Yes
- ☐ No

If the following were to exist in the future, rank your preferred way to get to or from the casino. Rank the items from 1-3 with 1 being your most preferred.

- _ Walking along Ingram Blvd. upgraded with better lighting and sidewalks for a more pedestrian friendly environment.
- _ Riding a shuttle between your hotel and the casino. (How much would you be willing to pay? $_____)
- _ My current method.

# APPENDIX A.2 (SAMPLE POSTCARD)

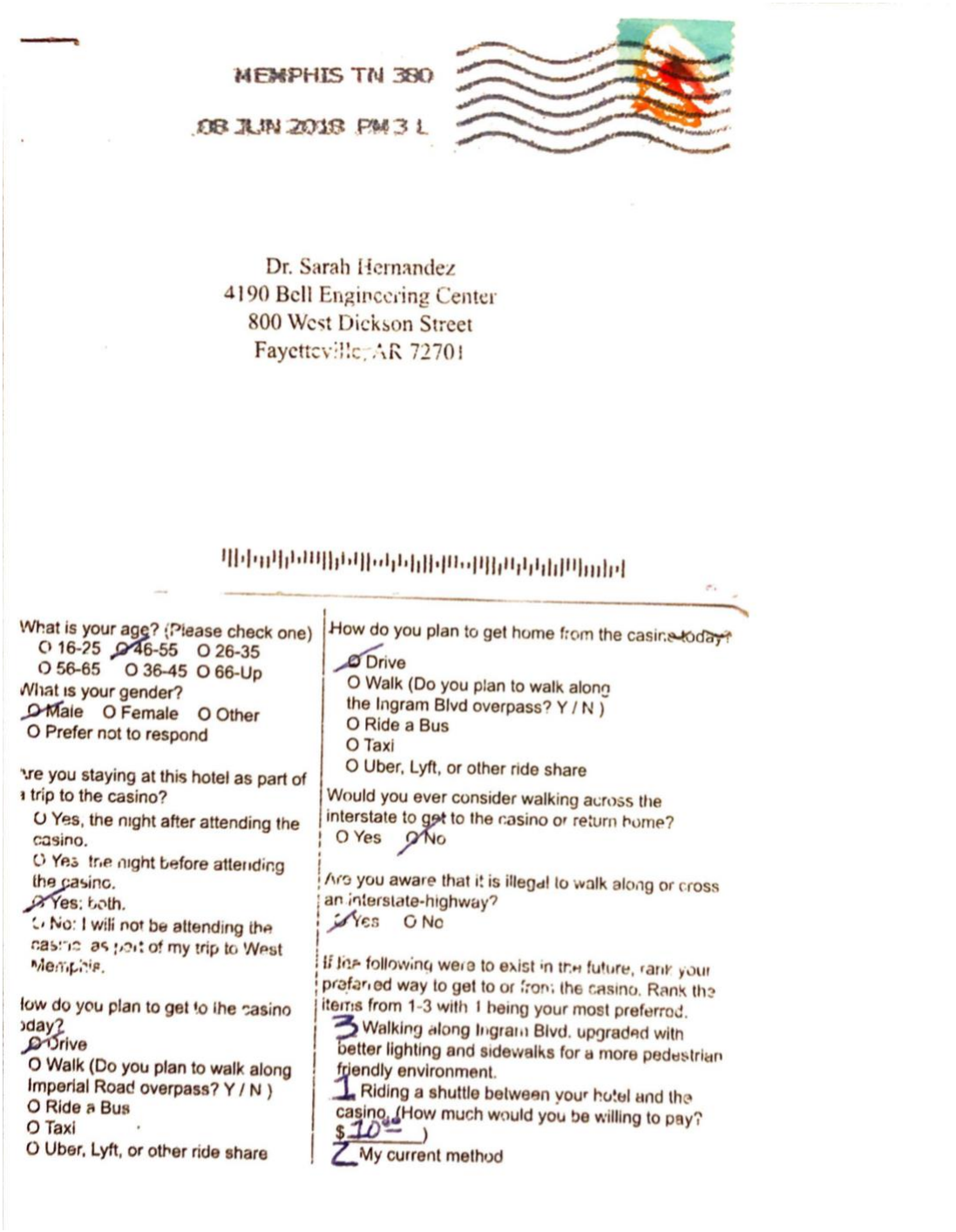


**FIGURE 26: SAMPLE POSTCARD**

# APPENDIX B (RANKING OF POTENTIAL MATCHED CITIES)

**TABLE 6: RANKING OF ARKANSAS CITIES BASED ON DEMOGRAPHICS FOR SITE COMPARISON (DADS, 2010)**

| City | Sum of Differences | Description |
|---|---|---|
| **West Memphis** | 0.00% | |
| **Pine Bluff** | 291.07% | Does not have a similar layout. |
| **Camden** | 312.94% | Does not have a similar layout. |
| **Blytheville** | 439.98% | Has a similar layout, but does not have a similar scale. Slightly land use divided. |
| **Magnolia** | 583.25% | Does not have a similar layout. |
| **Arkadelphia** | 596.66% | Does not have a similar layout. |
| **Texarkana** | 602.54% | I30 has similar layout and land use division. |
| **El Dorado** | 622.06% | Does not have a similar layout. |
| **Forrest City** | 634.23% | Does not have a similar layout. |
| **Malvern** | 677.57% | Does not have a similar layout. |
| **Paragould** | 715.75% | Does not have a similar layout. |
| **Mountain Home** | 782.31% | Does not have a similar layout. |
| **Harrison** | 816.24% | Does not have a similar layout. |
| **Marion** | 824.45% | Has a similar layout, but does not have a similar scale. Slightly land use divided. |
| **Searcy** | 885.94% | Does not have a similar layout. |
| **Benton** | 967.85% | I30 has similar layout and land use division. |
| **Maumelle** | 1077.18% | Does not have a similar layout. |
| **Sherwood** | 1077.77% | Does not have a similar layout. |
| **Cabot** | 1100.48% | Does not have a similar layout. |
| **Hot Springs** | 1199.54% | Does not have a similar layout. |
| **Bryant** | 1268.45% | I30 has similar layout and land use division. |
| **Jacksonville** | 1388.07% | Does not have a similar layout. |
| **Russellville** | 1785.43% | Does not have a similar layout. |
| **Batesville** | 1899.13% | Does not have a similar layout. |
| **Hope** | 2452.17% | I30 has similar layout, but does not have a similar land use division. |
| **Van Buren** | 2707.94% | Does not have a similar layout. |
| **Bentonville** | 2929.62% | Does not have a similar layout. |
| **Siloam Springs** | 4563.58% | Does not have a similar layout. |