Texas Transportation Institute

Houston East End Safety Study

Final Report
by the

Center for Transportation Safety
Texas Transportation Institute
Texas A&M University System

Prepared
for the

Houston-Galveston Area Council
Metropolitan Planning Organization

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Executive Summary

This study was conducted by the Center for Transportation Safety, a part of the Texas Transportation Institute and the Texas A&M University System. In response to concerns about the traffic, bicycle, and pedestrian safety within the Houston East End (also known as the Eastside), which is bound by the streets of Navigation on the North, Harrisburg on the South, and bisected by Wayside. The Injury Prevention Center of the Texas Children's Hospital identified this area as having a concentration of crashes involving children. The Houston Police Department also identified this area as having a high number of motor vehicle crashes, and the Houston-Galveston Area Council identified this area as being among the top 400 crash hot spots in the region as well as being within the top 10 pedestrian crash hot spots.

Crash investigation reports and street operational data were analyzed in detail along with extensive field studies and observations. Preventable crash patterns were identified and remedial safety improvement countermeasures determined. Estimated improvement costs were related to potential crash reduction benefits and calculations of Safety Improvement Index made for all recommended countermeasures.

The recommended countermeasures of striping and raised pavement marker application on US 90 Alternate mainlane are indicated to hold potential to be highly beneficial and a first priority for funding. The US 90 Alternate intersection safety improvements recommended are also highly cost-effective and should be funded as a second priority. While also cost-beneficial, the recommended safety improvements associated with parking restrictions to improve sight distance at other Stop-controlled intersections within the East End Study Area will be controversial and potentially the most difficult politically to implement. The last recommended safety improvement countermeasure involving re-designed and constructed driveway access in the 6800 Block of Harrisburg is marginally beneficial at the most conservative of cost estimates.

The total initial estimated cost for implementation of all recommended engineering safety improvements within the East End Study Area is approximately $160,000 to reduce annual vehicle collisions by approximately 30 crashes representing an estimated annual cost savings of over $550,000. It must be emphasized that these are preventable crashes susceptible to remediation by engineering countermeasures. The preponderance of crashes (and pedestrian/bicycle conflicts) occurring within the East End are behaviorally influenced by speed, alcohol, parental supervision, etc. Remediation or reduction in the frequency of these crashes is dependent and influenced by both increased and diligent law enforcement and/or continued and increased school and community traffic safety education programs.

Chapter 1 – Introduction

Background

The Houston-Galveston Area Council (H-GAC) in conjunction with the Texas Department of Transportation (TxDOT) and the City of Houston (COH) have sponsored a study on traffic safety in the East End of Houston. They have engaged the Center for Transportation Safety, Texas Transportation Institute (TTI), to conduct the study.

The study is in response to concerns about the traffic, bicycle, and pedestrian safety of the Houston East End (also known as the Eastside), which is bound by the streets of Navigation on the North, Harrisburg on the South, and bisected by Wayside. The Injury Prevention Center of the Texas Children's Hospital has identified this area as having a concentration of crashes involving children. The Houston Police Department has also identified this area as having a high number of motor vehicle crashes. Finally, the Houston-Galveston Area Council has identified this area as being among the top 400 crash hot spots in the region as well as being within the top 10 pedestrian crash hot spots.

Scope of Work

The following Tasks comprise the scope of work for the Houston East End Safety Study.

Task 1: Technical Advisory Task Force Meeting

Within two weeks after study initiation, a meeting with a technical advisory group (selected by H-GAC) would be held. The objective of the meeting would be to solicit assistance and assimilate any and all data relevant to the study scope. This meeting would also affect coordination of efforts, designate a schedule of activities, and delineate any specific agency concerns or issues to the project staff. Analysis methodology would be highlighted and discussed. A schedule of tasks would be delineated from this meeting.

Task 2: Broader Stakeholder Task Force Meeting

Within a month after study initiation, a meeting with a group of Broader Stakeholders (selected by H-GAC) would be scheduled and conducted. The objective of the meeting is to solicit support for the goals of the study and to solicit general assistance from the Stake-holders. The details of the study schedule, as discussed in Task 1, would be presented. Any broader concerns of the Stakeholders will be discussed.

Task 3: Obtain/Analyze Crash Data

With the assistance of the Houston Department of Public Works and Engineering and the Houston Police Department complete crash records will be obtained for the past two years and analyzed in detail. Collision and condition diagrams will be prepared to determine common crash types, locations, and patterns. Crashes will be segregated by those susceptible to correction as opposed to others involving compromising factors (alcohol, speed, etc). Variables of influence to crashes will be summarized for comparative purposes in analysis. A brief report summarizing the methodology and the types of crashes will be prepared and presented to the sponsor.

Task 4: Obtain/Analyze Traffic Operational Data

With the assistance of the Houston Department of Public Works and Engineering, operational data related to vehicular, bicycle, and pedestrian movements will be obtained an analyzed. Areas of congestion, delay, or conflicts will be determined. Origins and destinations of traffic generation and/or attraction will be established if possible. A rough survey (count) of pedestrian and bicycle volumes will be conducted to establish pedestrian and bicycle traffic patterns. A brief report summarizing the methodology and the traffic patterns will be prepared and presented to the sponsor.

Task 5: Obtain/Analyze Land Use and Street Inventory Data

Available land use and street inventory data will be obtained and analyzed. Location, function, and warrant of traffic control devices within the study area will be reviewed for existing performance as related to crash history. Any potential improvements will be

noted as relevant to traffic safety. A brief report summarizing this data will be prepared and presented to the sponsor.

Task 6: Determine Crash Patterns and Casual Relationships

All of the previously discussed data will be assimilated to formulate, as strictly as possible, crash patterns and causative factors. Special focus will be given to pedestrian and bicycle crashes, especially in proximity to schools. Any follow-up investigation to specific crashes will be conducted as necessary. A brief report summarizing the methodology, the crash patterns, and the causal relationships will be prepared and presented to the sponsor.

Task 7: Establish Engineering Countermeasure Improvements

Causal patterns or factors of influence to crashes within the study area will be addressed, where applicable, with engineering countermeasure improvements or alternative improvements. These recommendations will follow accepted and published guidelines unless there are special conditions or circumstances associated with a special crash scenario. A brief report summarizing the methodology and the suggested countermeasures will be prepared and presented to the sponsor.

Task 8: Establish Expected Crash Reduction from Countermeasure

With the assistance of the Texas Department of Transportation and the City of Houston Department of Public Works and Engineering, each of the proposed countermeasures identified in Task 7 will be analyzed with respect to expected crash reductions, by type of crash and by severity level. The basis of these estimates will come from the above mentioned agencies, TTI's own experience, and existing national databases on crash reductions will be prepared and presented to the sponsor.

Task 9: Establish Expected Costs of Countermeasures

With the assistance of the Texas Department of Transportation and the City of Houston Department of Public Works and Engineering, each of the proposed countermeasures identified in Task 7 will be analyzed with respect to costs. Detailed cost estimates will be

provided for each countermeasure. These will include equipment costs, construction costs, and maintenance costs. A brief report summarizing the methodology and the expected costs will be prepared and presented to the sponsor.

Task 10: Prioritize Alternative Improvements by Preliminary Benefit-Cost

For each countermeasure identified in Task 7, a benefit-cost analysis will be conducted. This will allow preliminary benefit-cost ratio calculations for all countermeasures or alternatives to allow funding and implementation prioritization. Advantages and disadvantages of all alternatives will be discussed as they relate to benefit-cost priority. A brief report summarizing the methodology, the expected benefit-costs, and the recommended prioritization will be prepared and presented to the sponsor.

Task 11: Preliminary Final Report

A preliminary final report will be prepared and presented to H-GAC and the sponsor. Five (5) copies will be produced. The report should consolidate all the previous steps and should read as a coherent document, separated into chapters corresponding to the above tasks.

Task 12: Receive Comments from Sponsor and Stakeholders Group

Within three weeks of receiving the preliminary final report, H-GAC, TxDOT, the sponsor, and the other stakeholder agencies will review the preliminary final report and will provide detailed written comments to TTI.

Task 13: Final Report

Within three weeks of receiving the written comments received from H-GAC, TxDOT, the sponsor, and the stakeholders, TTI will provide a final report that summarizes the entire study. Each of the above tasks will be sections of the report. The aim is to produce a document that will serve as a framework for implementing study recommendations as well as a "best practices" prototype for conducting a safety study.

Task 14: Final Meeting with Broader Stakeholders

The final report will be presented at a meeting of the Broader Stakeholders. TTI is expected to make a presentation on the general conclusions and to invite discussion. Twenty (20) copies of the final report will be given to the sponsor, H-GAC, TxDOT, and the Stakeholders.

This preliminary report is produced in satisfaction of Task 11 and is a compilation of work efforts from Tasks 1–10 which will be presented as independent chapters in the remainder of this report.

Chapter 2 - Technical Advisory Task Force Meeting

The Houston East End Safety Study was initiated by signed contract on April 1, 2003. A meeting was held on April 2, 2003 between TTI staff and H-GAC Safety Program staff. Crash data to be furnished by H-GAC was identified and discussed. Task outline for the study was reviewed. Contacts within other advisory agencies were noted and communication protocol established initial field observations were scheduled as well as an advisory Task Force meeting to be held in lieu of a stakeholder meeting as designated in Task 2. This meeting was tentatively scheduled for April 21, 2003 with no formal presentation required. The purpose of this initial meeting was to solicit study inputs for follow-up investigation.

Chapter 3 - Broader Stakeholder Task Force Meeting

A meeting was held at the H-GAC conference room on April 21, 2003 in satisfaction of the Task 2 objective. The following individuals representing their associated agencies in as follows:

1. Ned Levine	H-GAC
2. Alan Clark	H-GAC
3. Dan Raine	H-GAC
4. Thomas Funney	H-GAC
5. Martin Chavez	East End District
6. Susan Hirtz	Texas Children's Hospital
7. Nicole Flannory	City of Houston
8. Leonel Castillo	City of Houston
9. Sylvia Cavazos	City of Houston
10. Elizabeth Andre	City of Houston
11. John Gaynor	TxDOT
12. Stuart Corder	TxDOT
13. John Mounce	TTI
14. Ida van Schalkwyk	TTI
15. Robert Benz	TTI
16. Rene Smith	TTI

Based upon input from this meeting, subsequent field observations were conducted during both daytime and nighttime by TTI staff on May 7, 2003. Observations were made at different locations throughout the Study Area. As an example, the following field observations were noted at Thomas Edison Middle School in the 6900 Block of Avenue I:

Thomas Edison Middle School area. (6901 Avenue I)

- Approximately 3:30 PM students began exiting school. By 3:40 most appear to have left school grounds
- Most students leave via Ave I school entrance
- Single gate from school parking lot for vehicles & pedestrians. Consider closing to vehicles during student exit rush period
- Parked cars along Ave I awaiting student pick-up.
- Several bicycle/push-cart street venders along Ave I and surrounding streets.
- Marked cross walks in area, but many students walk (apparently comfortably, without any concern for traffic) in and out of traffic surrounding school. Appear to stay in street longer than necessary to cross.
- Much mid-block crossing on smaller streets around school (e.g., Avenue I, 70th Street). Less mid-block crossing on nearby major streets (e.g., Sgt Garcia) where students were observed to use cross walk.
- Pedestrian gate from school grounds to mid-block on Sgt Garcia
- Poor sight distance from Ave I at Sgt Garcia intersection (looking south toward north bound one-way traffic on Sgt Garcia.) (near school)

- Re: Sidewalks in immediate vicinity of school:
- Obstructions on Ave I include a fire hydrant and residential property gates open onto sidewalk.
- Sidewalks are generally narrow, some in disrepair.
- On 70th Street between Ave I and H: sidewalk on one side only.
- Check the layout of the major arterials then the sun might create visibility problems in the morning and afternoon along these routes – signal backplates might then aid visibility of the signals.
- Traffic controls along some routes are not consistent – at one intersection you might have a stop and in the next case the cross traffic are stopped. This might cause confusion.
- A speed hump exists on 78th close to the intersection with Navigation. No warning is provided – this maybe a hazard because it is not consistent – there are no other observed traffic calming devices in the area.
- The intersection of Parkview/Harrisburg is a non-typical intersection: intersection area too big and might cause confusion, limit with road markings to improve readability
- Day labor was observed at the northwestern corner of Harrisburg/ 78th
- The person we interviewed at the metro stop observed crashes at the bank – the bank is located on the corner of Harrisburg and 71st
- At the Thomas Edison Middle School: corner clearances are very poor and at the intersection of Garcia and Avenue I the fencing is a corner obstruction that greatly reduces the ability of a driver to observe traffic along Garcia when exiting Avenue
- The area west of Wayside (north of Harrisburg): there seems to be some sort of construction effort in the area
- New walkways and driveways are being installed in the area
- Check the connection between pedestrian related crashes and metrostops
- The intersection of Harrisburg/Latham is staggered – this might increase the likelihood of pedestrian crashes (pedestrians won't know where to cross and the requirements on the driver are also higher) and other crashes.
- The T-junction of Harrisburg and Bryan – there is a park, a swimming pool and other recreational facilities south of Harrisburg – might lead to higher pedestrian exposure rates and likelihood of pedestrian crashes
- There is a metrostop at the intersection of Lockwood/Harrisburg
- The school on Lamar (just off 75th) and south of Harrisburg: roads are very narrow and sidewalks are not maintained well (overgrowth) and obstructed by parked vehicles
- Review metro stop locations in cases where pedestrian crashes coincide (maybe the metro bus organization is willing to discuss the location of their stops with us).

Appendix A provides photo documentation of these field inspections along with associated captions.

Chapter 4 - Obtain/Analyze Crash Data

Data Resources

The following crash record files were obtained from the designated agencies:

1. EMS crash data: 1998-2001. These data were collected by the EMS trauma centers at Herman Memorial Hospital and Ben Taub Hospital and compiled by the Injury Prevention Center at the Texas Children's Hospital and geocoded by H-GAC.
2. DPS crash data: 1998-2000. These data were collected by the Accident Records Bureau of the Department of Public Safety who obtained the data from the police departments of individual jurisdictions according to the DPS reporting criteria. The data were then compiled and geocoded by H-GAC.
3. HPD crash data: December 2001 – January 2003 were collected by the Houston Police Department using the state reporting form (ST 3). The data were compiled and geocoded by TTI.

Data Analysis

Four years of EMS crash data for bicycles and pedestrians were collected from Texas Children's Hospital. The EMS crash data set was pared down to just the East End Study Area, which resulted in 26 crashes. Of those crashes, over 80 percent were pedestrian crashes and males were twice as likely to be involved in a crash as shown in Table 1. All of the bicycle crashes were male, making up almost 20 percent of the total crashes. All the crashes in the study area involve Hispanic children with ages ranging from 2 to 14. Forty-two percent of the crash victims were 0-5 or not of school age, 38 percent were in elementary school, and 19 percent were in middle school (Table 2). Table 3 represents the interpretation of comments to determine which crashes are potentially susceptible to engineering correction. Almost a quarter of the crashes were identified as educational issues for parents or children. Thirty percent of the crashes did not have any comments thus it was not possible to determine if there is an engineering correction possible. Driveway, hit and run, and crashes involving speeding were also removed from the dataset since those require behavioral corrections and are not engineering related. The severity of all crashes could not be determined but most comments just listed abrasions and contusions with no fatalities or severe injury. Total and correctable plots of the Texas Children's Hospital Pedestrian and Bicycle crashes are shown in Figure 1 and Figure 2.

Table 1. Crashes by Vehicle and Sex

Female Pedestrian	7	27%
Male Pedestrian	14	54%
Male Bike	5	19%
Total	26	100%

Table 2. Crashes by Age

0-5	11	42%
6-11	10	38%
12-15	5	19%
Total	26	100%

Table 3. Crashes Potentially Susceptible to Engineering Correction

	Total		Removed Speeding and Hit and Run	
Correctable	10	38%	7	27%
Non-Correctable	16	62%	19	73%
Total	26	100%	26	100%

Figure 1. All Pedestrian and Bicycle Crashes Reported by Texas Children's Hospital

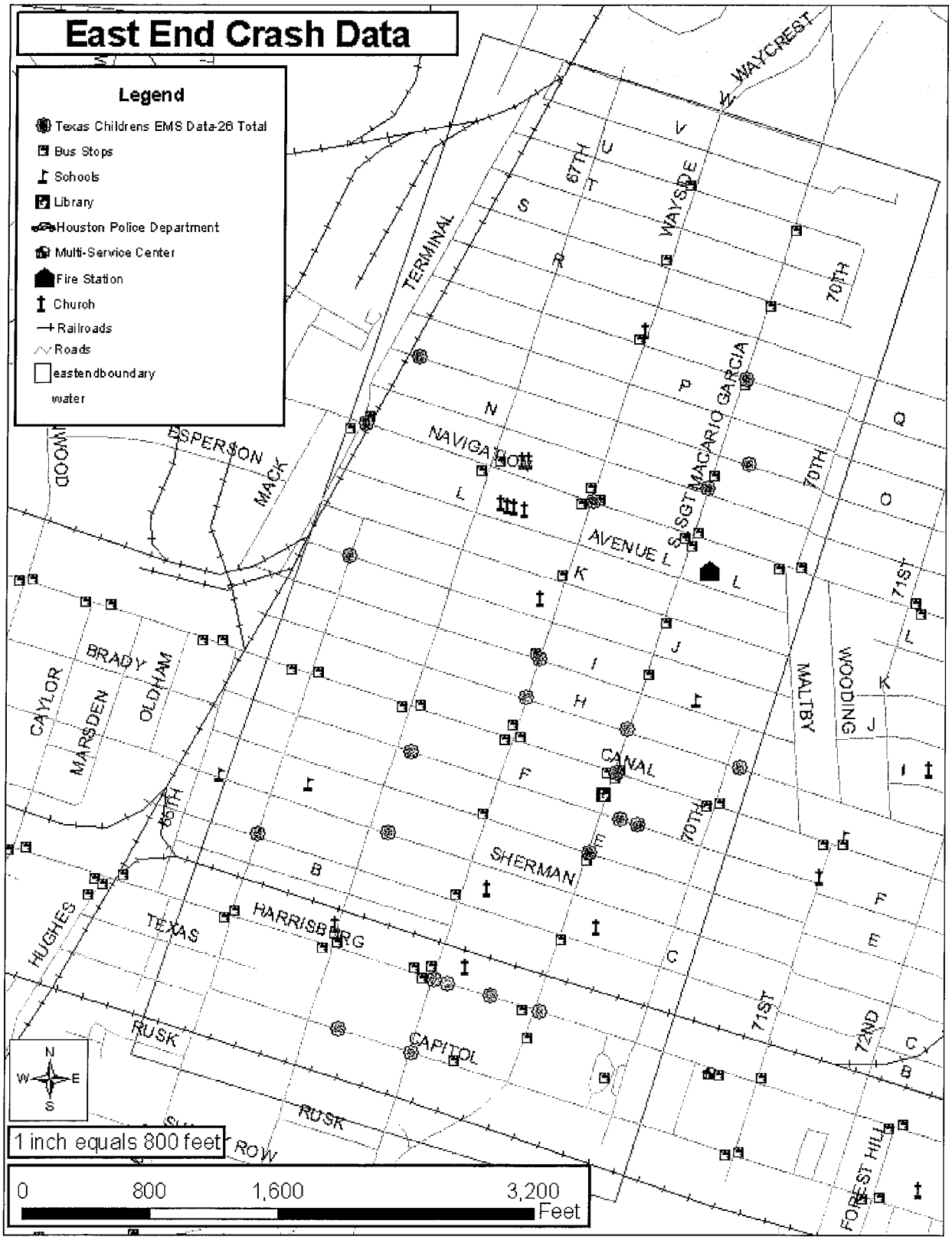
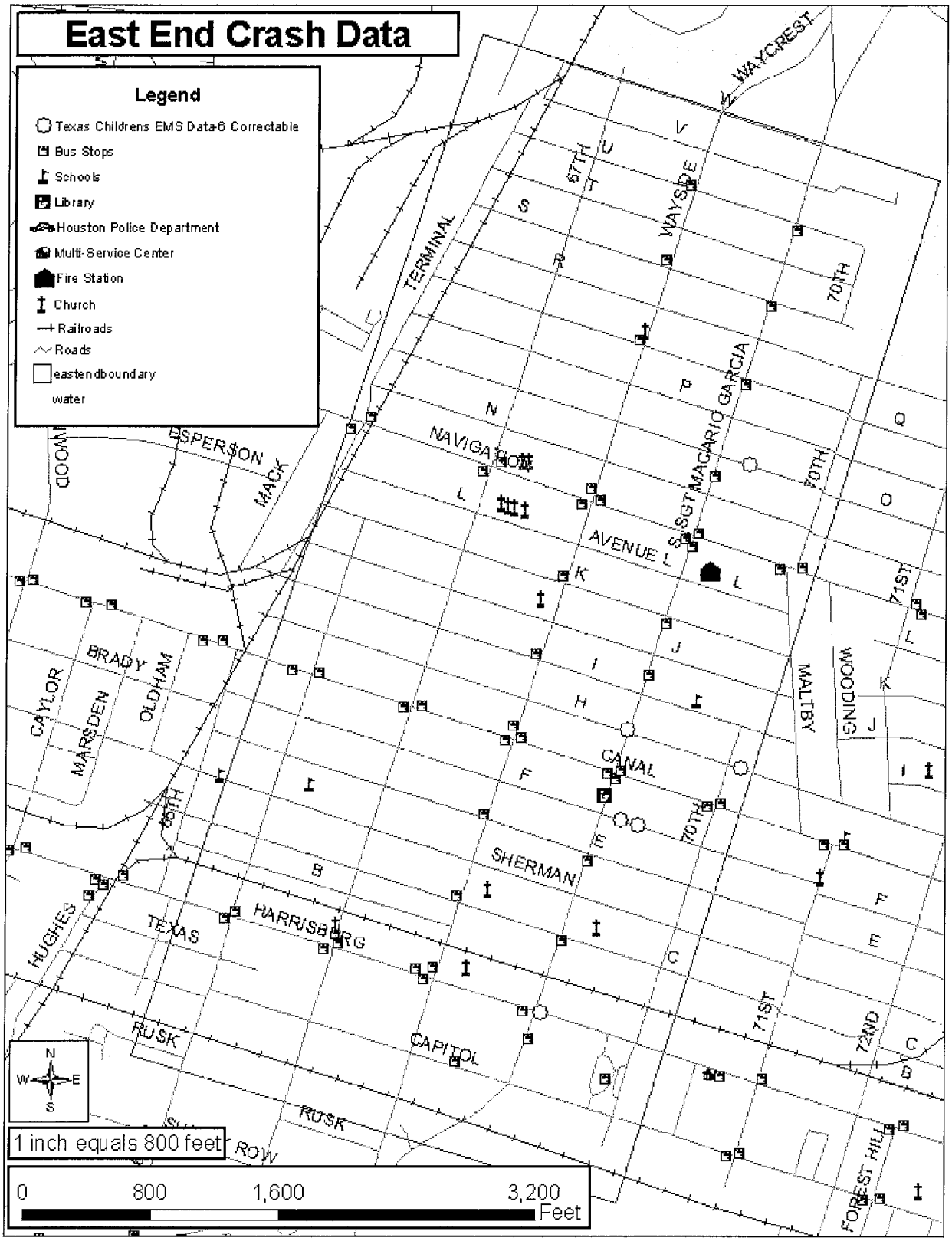


Figure 2. Pedestrian and Bicycle Crashes Reported by Texas Children's [illegible]ital Amenable to Engineering Countermeasures



There were twenty-eight pedestrian crashes and 11 bicycle crashes found in the 1998 to 2000 DPS crash data set. Summary findings were also produced from the 1998 – 2000 DPS crash file to establish trends based on relevant contributory variables. These resulting crash statistics are presented in Tables 4 – 15.

The total number (488) of reportable crashes from the 1998 – 2000 DPS crash data occurring in the Houston East End Study Area is plotted by location in Figure 3. Figure 4 plots only those crashes susceptible to correction by engineering countermeasures; i.e. no alcohol, drugs, excessive speed, or unlicensed driving behavior is a crash identified as susceptible to correction. The total number of crashes, susceptible to correction, is reduced to 98 occurring within the study area.

Working collision and condition diagrams were produced by major street corridor and intersection within the Houston East End Study Area for all complete, hard copy crash data obtained from the City of Houston Police Department (HPD) for the period December, 2001, through January, 2003. These data are also plotted by location as shown in Figure 5. The total number of crashes (231) within the designated time period was reduced as previously discussed to only those crashes susceptible to correction by engineering countermeasures. These crashes (197) are plotted by location in Figure 6. The following major intersections within the study area were focused on:

1. Navigation @ Wayside
2. Navigation @ Sgt. Macario Garcia
3. Wayside @ Canal
4. Canal @ Sgt. Macario Garcia
5. Capitol @ Wayside

Narrative summaries from the HPD hard copy crash data for the major intersections in the study area are given in Appendix B. Likewise, similar narrative crash data summaries for street corridors within the study area are given in Appendix C.

Table 4. Number and Percent of Crashes by Severity (1998-2000)						
	Crash Severity (Most serious injury sustained in crash)					
	Fatal	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	PDO (Non-Injury)	Total
Total	4	12	67	255	150	488
Percent of all Crashes	0.8	2.5	13.7	52.3	30.7	100

Table 5. Casualties by Person Injured (1998-2000)						
	Casualty Severity					
Person injured	Fatality	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	Non-injury	Total
Drivers	1	6	48	258	579	892
Passengers	1	4	32	226	-	263
Pedestrians	1	6	14	12	-	33
Bicyclists	1	0	4	6	-	11
Other	0	0	1	4	-	5
Total Casualties	4	16	99	506	579	1204

Table 6. Crash Severity by First Harmful Event (1998-2000)							
	Crash Severity (Most serious injury sustained in crash)						
First Harmful Event	Fatal	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	PDO (Non-Injury)	Total	Percent of all crashes
Another Motor Vehicle in Transit	2	8	43	221	88	362	74.2
Fixed Object	-	-	3	13	43	59	12.1
Other Non-collision	-	-	-	-	1	1	0.2
Other object	-	-	-	-	2	2	0.4
Overturned	-	-	1	-	-	1	0.2
Parked Car	-	1	4	4	15	24	4.9
Bicyclist	1	-	3	6	-	10	2.0
Pedestrian	1	3	12	9	-	25	5.1
RR Train	-	-	1	2	1	4	0.8
Total	4	12	67	255	150	488	100
Percent of all Crashes	0.8	2.5	13.7	52.3	30.7	100	

Table 7. Crash Severity by Traffic Control and Intersection Relationship (1998-2000)							
		Crash Severity (Most serious injury sustained in crash)					
	Type of Traffic Control	Fatal	Incapacitating Injury	Non-incapacitating Injury	PDO (Non-Injury)	Possible Injury	Total
Intersection	Center stripe or divider	1	-	4	11	17	33
	Flashing red light	-	-	-	1	1	2
	None shown or inoperable	-	-	-	1	1	2
	RR gates or signal	-	-	-		1	1
	Stop & go signal	1	3	24	21	57	106
	Stop sign	1	1	10	14	39	65
	Turn marks	-	-	-	1	-	1
Intersection Total		3	4	38	49	116	210
Intersection Related	Center stripe or divider	-	-	1	3	6	10
	Stop & go signal	-	2	4	13	38	57
	Stop sign	-	-	-	2	6	8
	(blank)	-	-	1	-	-	1
Intersection Related Total		0	2	6	18	50	76
Driveway access	Center stripe or divider	-	-	1	14	27	42
	None shown or inoperable	-	1	-	-	4	5
	Officer, flagman	-	-		1		1
Driveway access Total		0	1	1	15	31	48
Non-intersection	Center stripe or divider	1	4	15	52	47	119
	None shown or inoperable	-	1	5	16	8	30
	RR gates or signal	-	-	1		2	3
	Stop & go signal	-	-	1			1
	(blank)	-	-	-	-	1	1
Non-intersection Total		1	5	22	68	58	154
Grand Total		4	12	67	150	255	488

Table 8. Crash Severity by Vehicle Movement/Manner of Collision (1998-2000)							
	Crash Severity (Most serious injury sustained in crash)						
Vehicle Movement/ Manner of Collision	Fatal	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	PDO (Non-Injury)	Total	Percent of all crashes
1 Vehicle going straight	2	3	21	29	60	115	23.6
1 Vehicle backing	0	1	0	0	0	1	0.2
1 Vehicle turning left	0	0	3	2	0	5	1.0
1 Vehicle turning right	0	0	0	2	2	4	0.8
1 Vehicle, other	0	0	0	1	0	1	0.2
2 Vehicles -approaching at angle	1	3	27	103	40	174	35.7
2 Vehicles - opposite directions	0	0	4	14	14	32	6.6
2 Vehicles -going same direction	1	5	12	104	33	155	31.8
2 Vehicles -other	0	0	0	0	1	1	0.2
Total	4	12	67	255	150	488	100

Table 9. Crash Severity by Light Condition (1998-2000)							
	Crash Severity (Most serious injury sustained in crash)						
Light Condition	Fatal	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	PDO (Non-Injury)	Total	Percent of all crashes
Darkness-Lighted	2	3	28	58	49	140	28.7
Darkness-Not Lighted	0	0	3	7	8	18	3.7
Dawn	0	1	0	3	3	7	1.4
Daylight	2	8	35	183	87	315	64.5
Dusk	0	0	1	4	3	8	1.6
Total	4	12	67	255	150	488	100

Table 10. Crash Severity by Time of Day (1998-2000)							
	Crash Severity (Most serious injury sustained in crash)						
Time of Day	Fatal	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	PDO (Non-Injury)	Total	Percent of all crashes
Midnight-4AM	0	0	8	21	17	46	9.4
4AM-8AM	2	1	4	16	18	41	8.4
8AM-Noon	0	2	4	40	26	72	14.8
Noon-4PM	2	4	12	79	29	126	25.8
4PM-8PM	0	3	21	68	32	124	25.4
8PM-Midnight	0	2	18	31	28	79	16.2
Total	4	12	67	255	150	488	100

Table 11. Crash Severity by Weather Condition (1998-2000)							
	Crash Severity (Most serious injury sustained in crash)						
Weather	Fatal	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	PDO (Non-Injury)	Total	Percent of all crashes
Clear (cloudy)	4	12	64	237	133	450	92.2
Raining	0	0	3	16	16	35	7.2
Fog	0	0	0	1	1	2	0.4
Smoke	0	0	0	1	0	1	0.2
Total	4	12	67	255	150	488	100

Table 12. Number and Percent of Crashes by Severity in which At Least One Driver was Reported as Driving Under the Influence of Alcohol or Drugs (1998-2000)						
	Crash Severity (Most serious injury sustained in crash)					
	Fatal	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	PDO (Non-Injury)	Total
Number of Crashes	4	12	67	255	150	488
Number of DUI Crashes	1	3	8	15	14	41
Percent of all Crashes Reported as DUI	25.0	25.0	11.9	5.9	28.0	8.4
Note: All but 3 of the 'DUI' crashes are alcohol as opposed to drug-related.						

Table 13. Number and Percent of Crashes by Severity in which At Least One Driver was Reported as Driving Over the Speed Limit or at a Speed Unsafe for Conditions (1998-2000)						
	Crash Severity (Most serious injury sustained in crash)					
	Fatal	Incapacitating Injury	Non-incapacitating Injury	Possible Injury	PDO (Non-Injury)	Total
Number of Crashes	4	12	67	255	150	488
Number of Speed-related Crashes	1	2	14	64	34	115
Percent of all Crashes Reported as Speed-related	25.0	16.7	20.9	25.1	22.7	23.6
Note: All but 3 of the Speed-related crashes are 'speed unsafe for conditions' as opposed to 'speed over the limit'						

Table 14. Summary of Pedestrian Causality Crashes (1998-2000)			
	Number		Number
Vehicle Driver Factors Contributing to Crash (1)		**Pedestrian Action**	
Speed Unsafe for Conditions	6	Crossing road at intersection or crosswalk	6
Fail to yield ROW	1	Crossing road NOT at intersection or crosswalk	3
Disregard stop & go signal	2	Getting on/off a vehicle	1
Other factor	1	Working in roadway	1
N/A	24		
		Injured Pedestrians reported committing a violation	8
Vehicle Driver Factors Contributing to Crash (2)		Injured Pedestrian reported drinking	1
Fail to yield ROW to Pedestrians	5		
DWI	1	**Light Condition When Pedestrian Injured**	
Other factor	4	Daylight	20
N/A	25	Darkness - Lighted	11
		Darkness – Not Lighted	2
Injured Pedestrian Age Range = 2-72			
0-5 yrs old	5	**Time of Day When Pedestrian Injured**	
6-12 yrs old	3	Midnight-4AM	2
13-20 yrs old	4	4AM-8AM	1
21-65 yrs old	15	8 AM - Noon	4
>65	5	Noon-4PM	6
Unknown age	1	4PM-8PM	13
		8 PM- Midnight	7

Pedestrian Crashes by Traffic Control and Intersection Relationship

Type of Traffic Control	Driveway access	Intersection	Intersection Related	Non-intersection	Total
Center stripe or divider	1	3	-	5	9
None shown or inoperative	1	-	-	6	7
RR gates or signal	-	-	-	1	1
Stop & go signal	-	2	7	1	10
(blank)	-	-	1	-	1
Total	2	5	8	13	28

Table 15. Summary of Bicyclist Causality Crashes (1998-2000)			
	Number		Number
Vehicle Driver Factors Contributing to Crash (1)			
Speed Unsafe for Conditions	1	Injured Bicyclist reported committing a violation	4
Fail to yield ROW	1	Injured Bicyclist reported drinking	1
Disregard stop sign/light	1		
N/A	8	**Light Condition When Bicyclist Injured**	
		Daylight	10
Vehicle Driver Factors Contributing to Crash (2)		Darkness - Lighted	1
Fail to yield ROW to Bicyclist	1		
DWI	1		
Other factor	1	**Time of Day When Bicyclist Injured**	
N/A	8	Midnight-4AM	0
		4AM-8AM	0
Injured Bicyclist Age Range = 12-49		8 AM - Noon	1
0-5 yrs old	0	Noon-4PM	4
6-12 yrs old	1	4PM-8PM	5
13-20 yrs old	3	8 PM- Midnight	1
21-65 yrs old	7		
>65	0		

Bicycle Crashes by Traffic Control and Intersection Relationship					
Type of Traffic Control	Driveway access	Intersection	Intersection Related	Non-intersection	Total
Center stripe or divider	1	1	-	-	2
None shown or inoperative	-	-	-	1	1
Stop & go signal	-	3	1	-	4
Stop sign	-	2	2	-	4
Total	1	6	3	2	11

Figure 3. All 1998-2000 DPS Reported Crashes

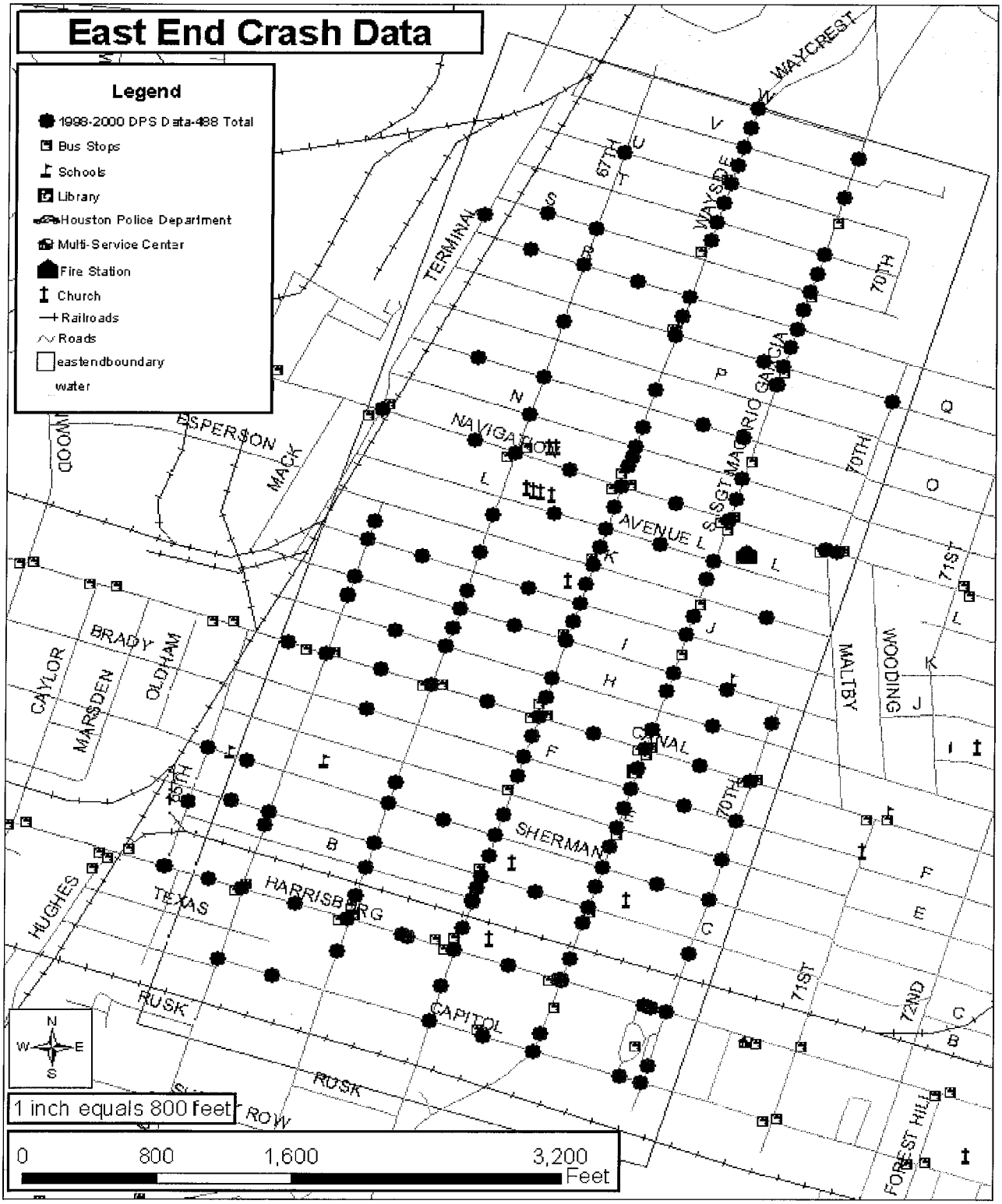


Figure 4. 1998-2000 DPS Reported Crashes Amenable to Engineering Coun[illegible] easures

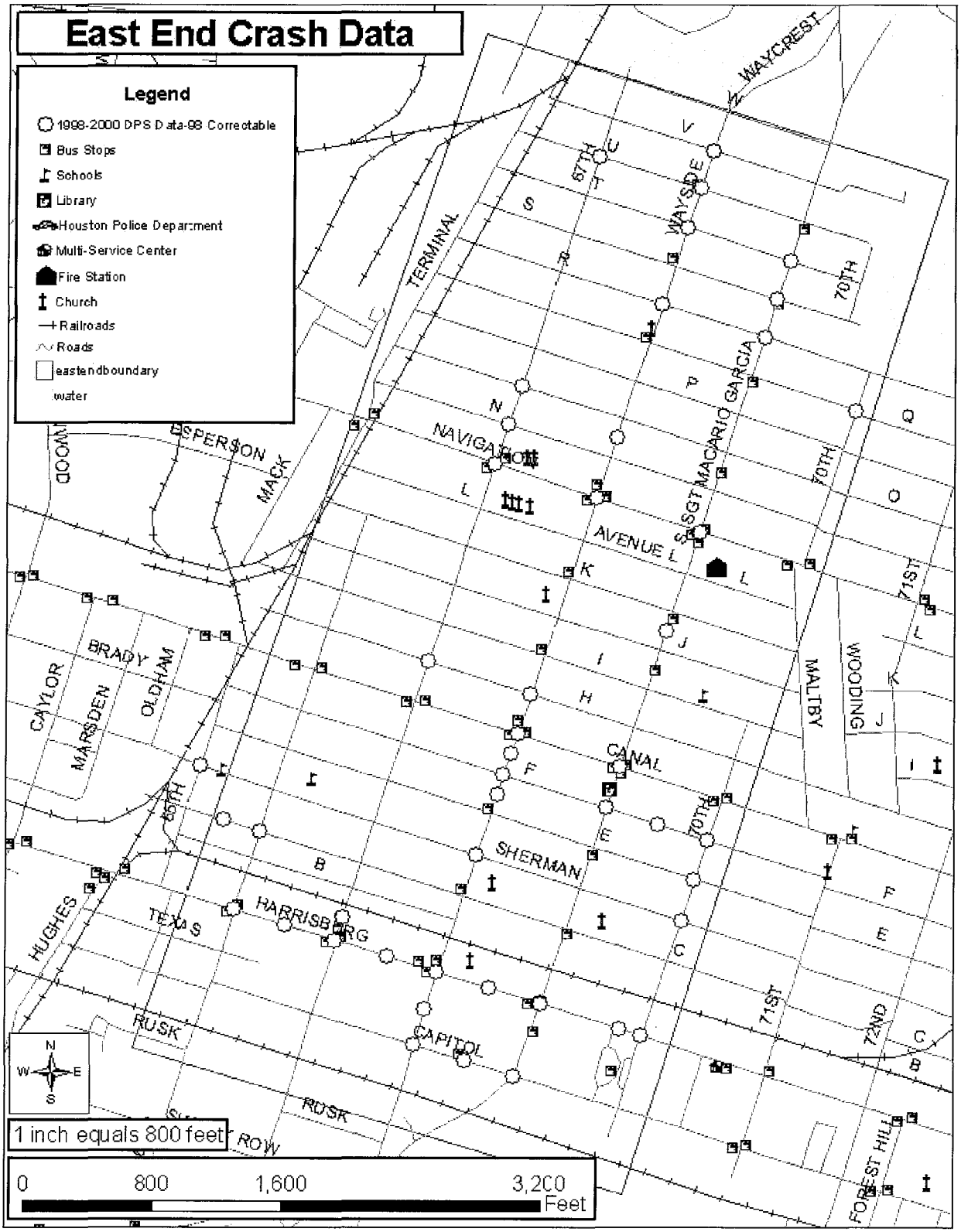


Figure 5. All HPD Reported Crashes

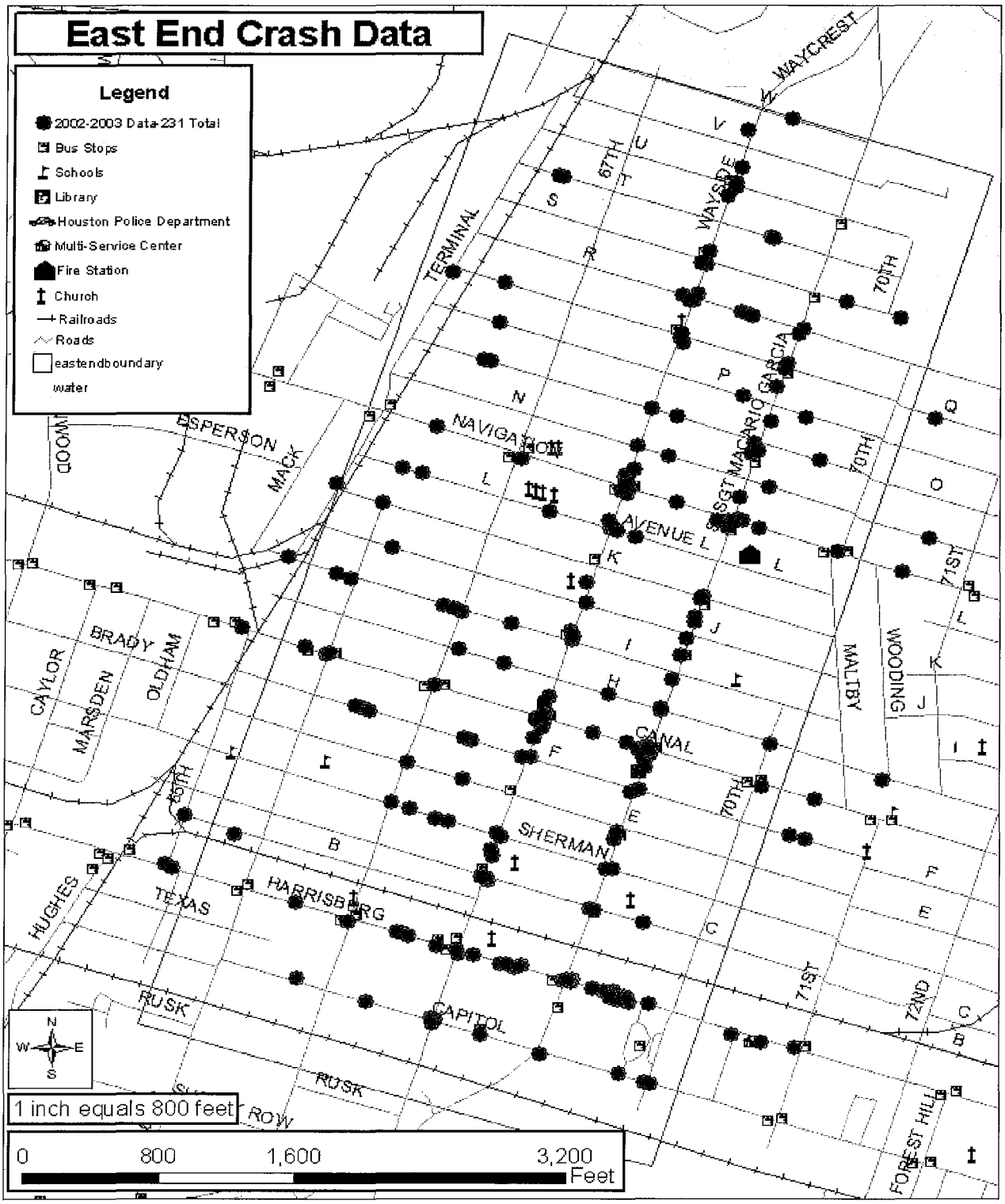
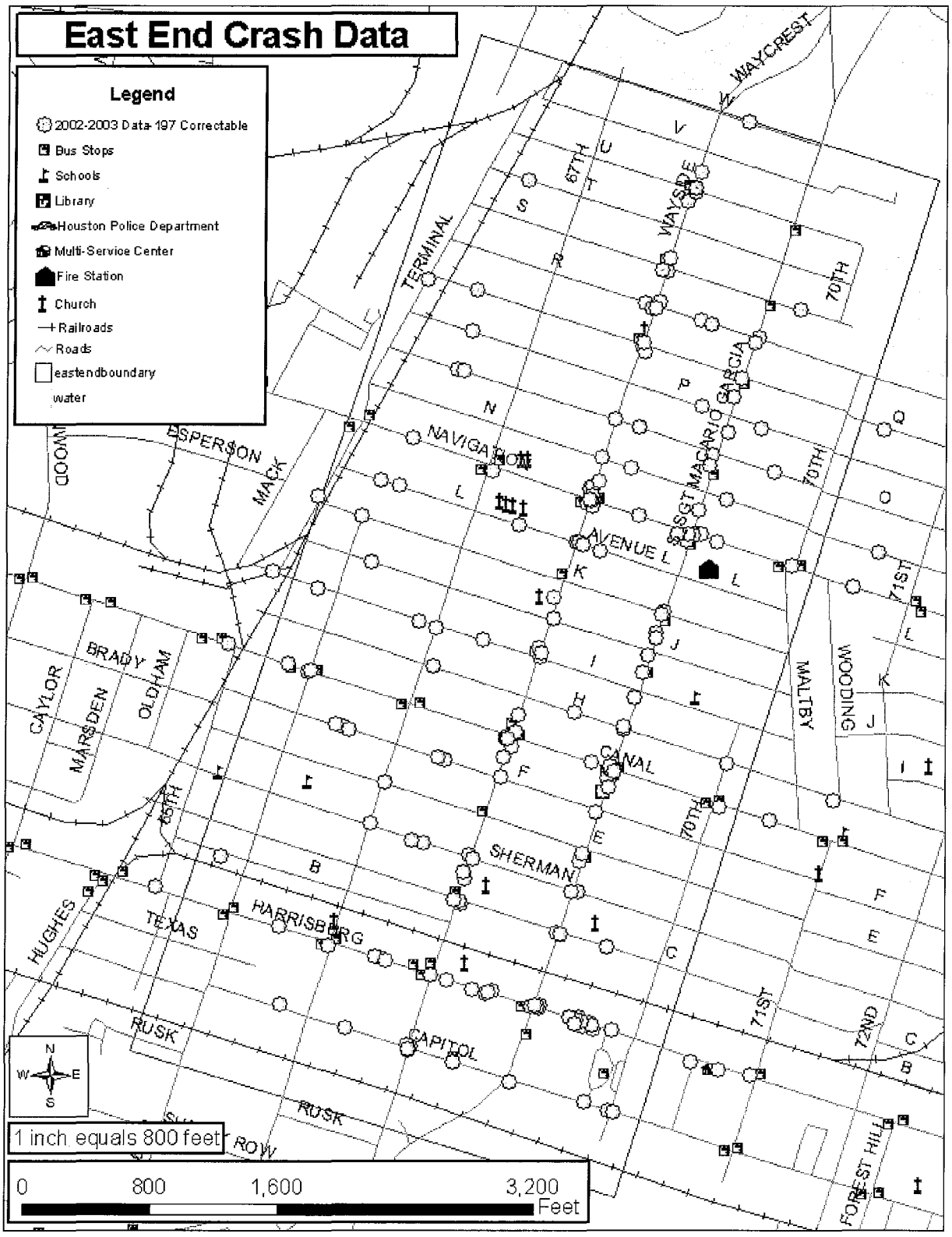


Figure 6. HPD Reported Crashes Amenable to Engineering Counterm res



Chapter 5 - Obtain/Analyze Traffic Operational Data

Data Resources

The following operational data were obtained from the designated agencies:

1. 24-hour Traffic Volume Counts January 2000 from the City of Houston, Department of Public Works and Engineering, Traffic Management & Maintenance Branch (website);
2. 24-hour Count Record 2000 to 2002 data from the Texas Transportation Institute Houston Office were obtained for the study area;
3. 2001 Traffic Map containing the 24-hour urban traffic volumes from Texas Department of Transportation;
4. Origin and Destination data were obtained from H-GAC's modeling group to determine percentage of through traffic;
5. Traffic Signal Inventory and selected signal timings from the City of Houston, Department of Public Works and Engineering; and
6. Traffic Speed Data were collected by the research team to aid in the crash analysis.

Data Analysis

Traffic volume data were collected from the City of Houston's website. An extensive database is available; however, no counts from this data set were within the study area. The Texas Transportation Institute's internal traffic volumes database contained three traffic counts within the study area and is shown in Figure 7. The majority of the traffic counts (27) was from TxDOT and is shown in Figure 8.

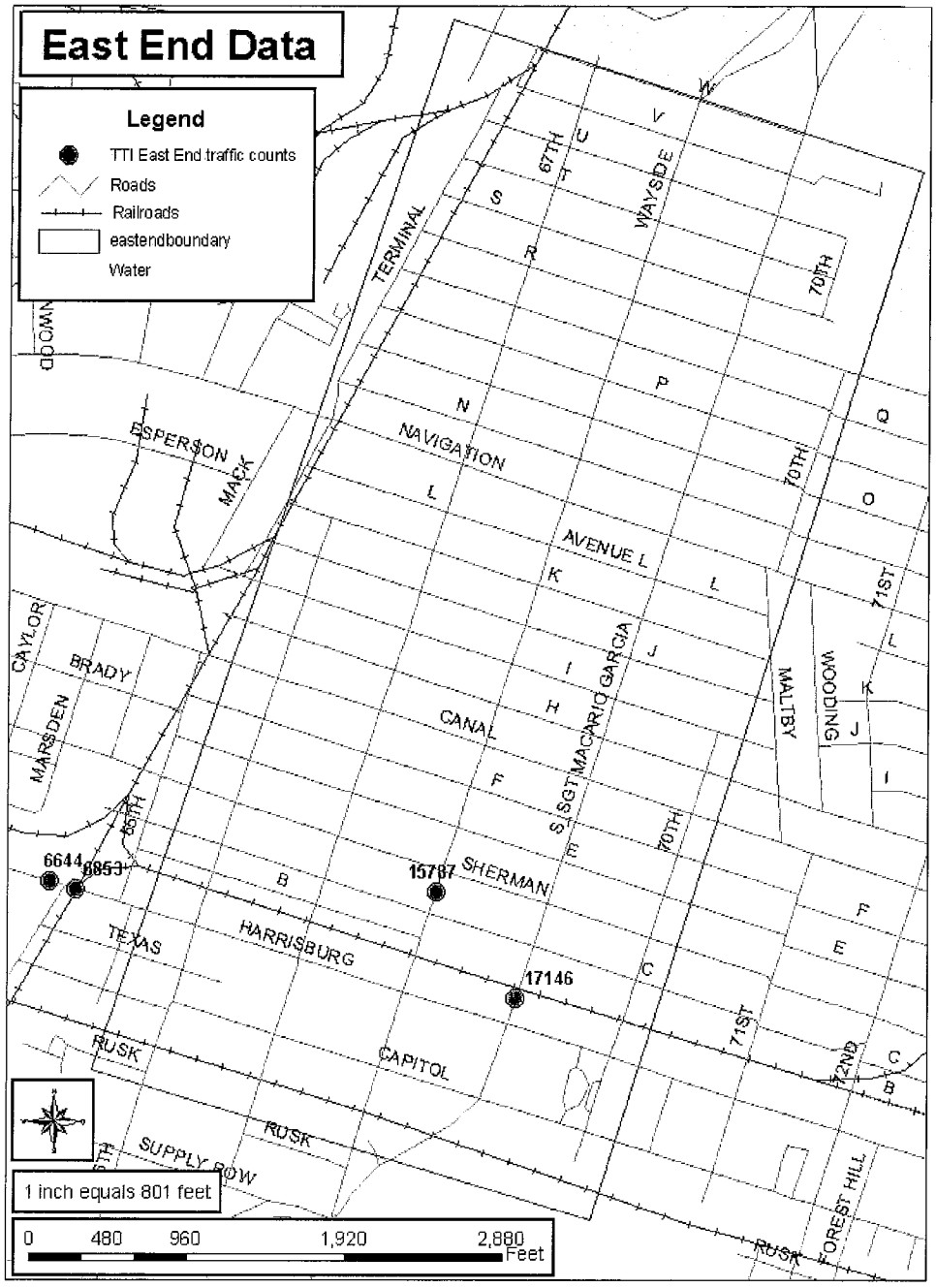


Figure 7. TTI Traffic Counts.

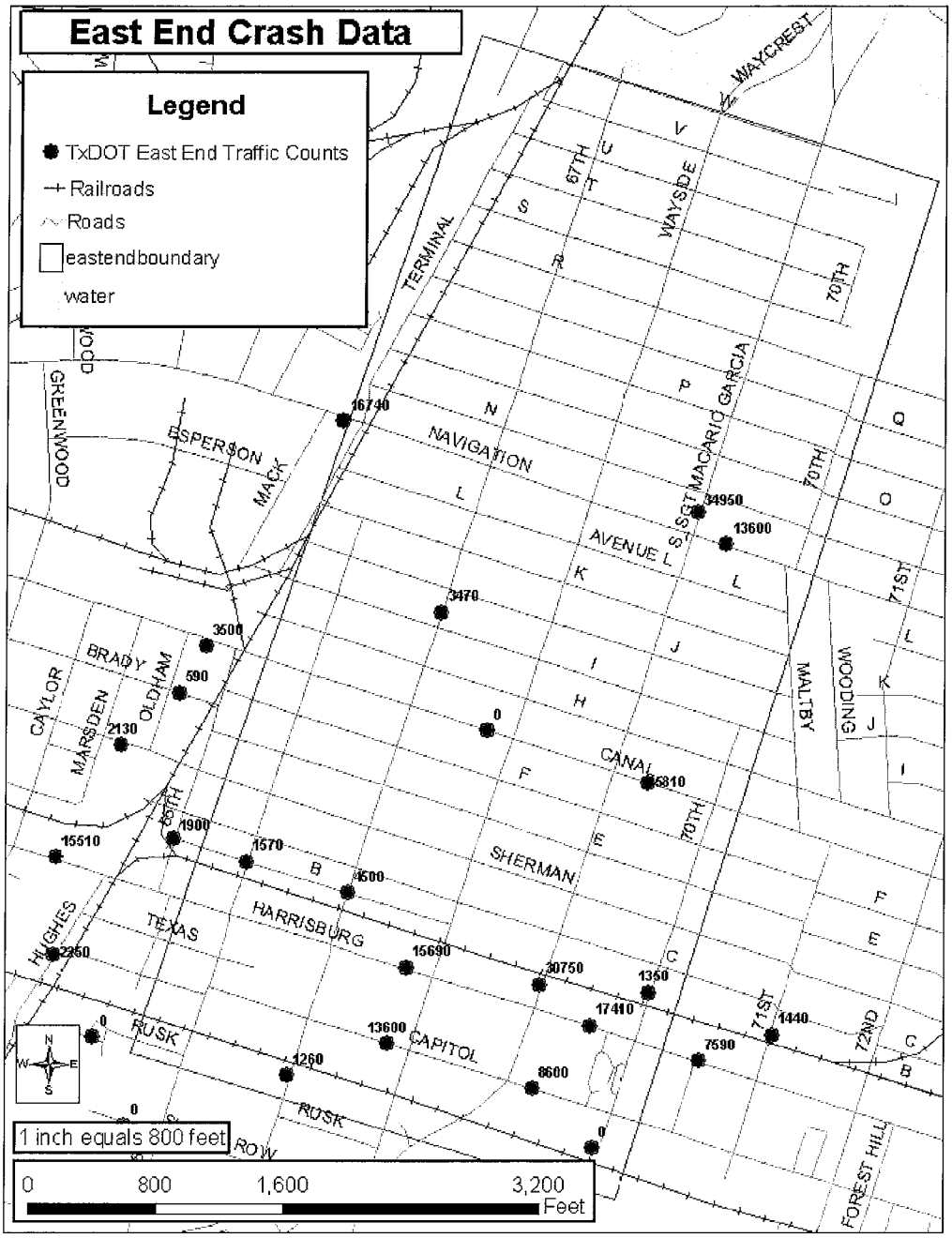


Figure 8. 2001 TxDOT Houston District Coverage Counts.

The traffic volume data sets ranged from electronic to paper copies. All d: ere summarized to 24-hour traffic counts to be utilized for crash frequency calculations. Data were obtained on all major roadways as shown in Figure 9.

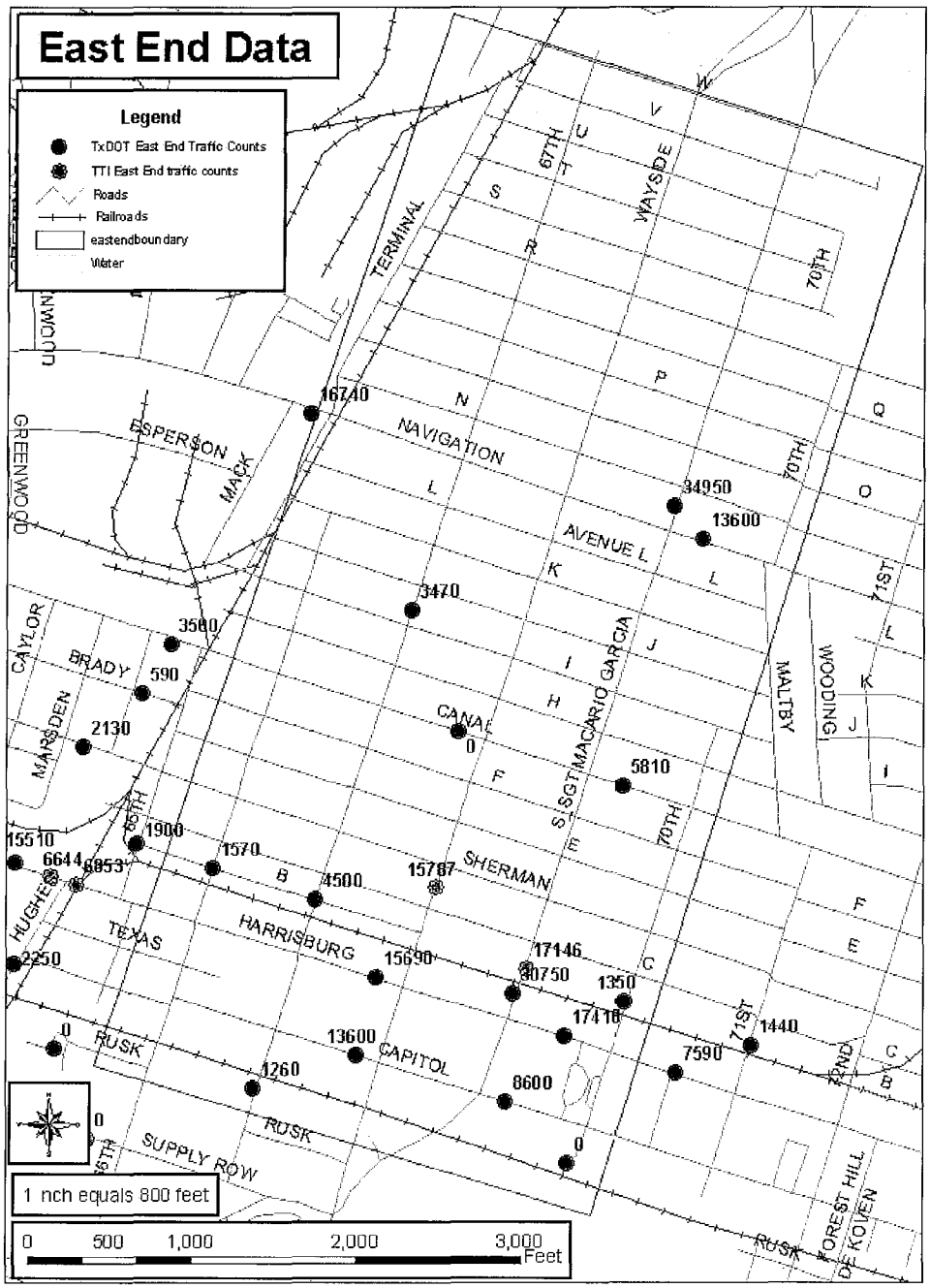


Figure 9. All Applicable Traffic Counts.

A detailed listing of the counts can be found in Appendix D and E. Traffic volumes were checked for consistency and site investigation combined with cursory traffic analysis did not reveal any congestion problems.

Bicycle and pedestrian counts were requested from the City of Houston but none were available. No counts were made based on the low number crashes susceptible to engineering correction and the lack of a crash pattern or grouping.

Origin and destination data were obtained from H-GAC's modeling group to determine the percentage of through traffic. The smallest possible analysis area is based on the Traffic Analysis Zone (TAZ) data bounded on the North by Canal, on the East by Sergeant Macario Garcia, and on the South and West by the railroad tracks. No formal data were provided except an email indicating that the estimated percentage of local traffic to all traffic was 21.8 percent (local traffic defined as a trip with an origin or destination within this boundary: North to Navigation, South to the Missouri-Kansas-Texas (MKT) rail line, East to the Houston Belt and Terminal (HB&T) rail line). An additional piece of useful information was that the percentage of truck traffic to all vehicles was estimated at 9.1 percent. Reports of high truck volume and site inspection confirmed this estimate.

A query of the City of Houston's Traffic Control Device database was used to determine the locations of the traffic signals, stop signs, and other traffic elements in the area. The following list and Figure 10 provides a breakdown of the number and the location of traffic control devices in the study area. Copies of the traffic signal timings for the following intersections were obtained and clearance intervals were verified for compliance. No deficiencies were found. All traffic signals appear to have the proper clearance interval, amber phase, and all red indications.

- Traffic Signals 13
- Four-way Stop Signs 3
- Two-way Stop Signs 61

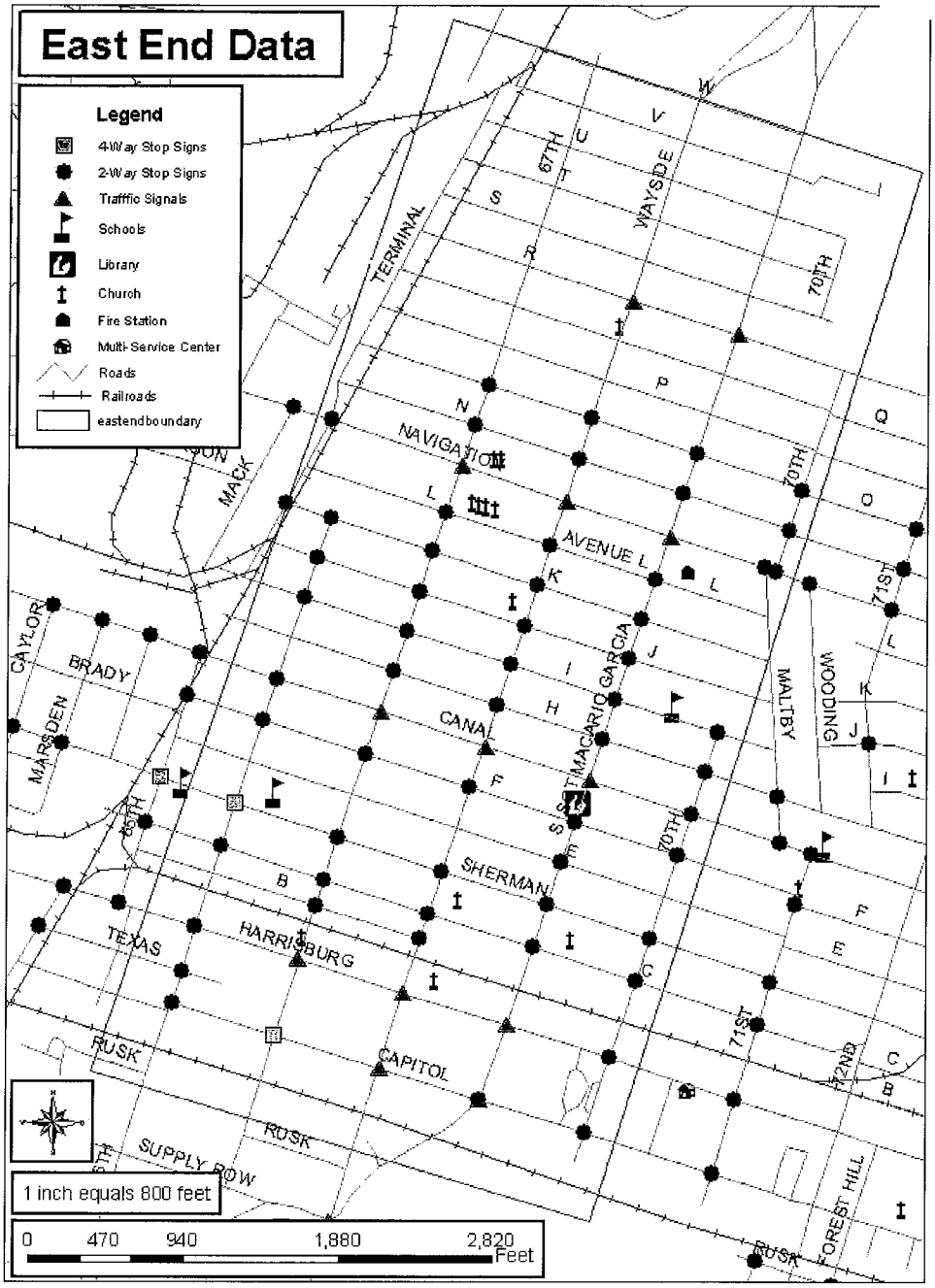


Figure 10. East End Traffic Control Devices.

A spot speed study conducted at selected intersections approaches. These approaches were selected based on the preliminary crash analysis. The following intersections were surveyed:

- Wayside and Navigation,
- Wayside and Canal,
- Wayside and Capitol, and
- Sergeant Macario Garcia and Canal.

Figure 11 shows a map of the location and direction where the speed surveys were conducted. Selected approaches were studied based on the crash data and collision diagrams. Speeds of the lead vehicles or non-influenced vehicles were collected. Most locations were mid-block and care was taken to conceal the laser gun to ensure an unbiased sample. Vehicles approaching a red light were not included in the sample. Table 16 presents a summary of the 85th percentile speeds. Most locations had an 85th percentile speed below the posted speed limit. The raw data, tabulated speed statistics, and graphs were generated for each location and are presented in Appendix F.

Table 16. Summary of Spot Speed Study.

Location #	Street Name	Direction	Speed Limit	85th Percentile Speed
1	Wayside @ Navigation	SB	40	42
2	Navigation @ Wayside	EB	35	34
3	Wayside @ Canal	SB	40	40
4	Canal @ Wayside	EB	30	31
5	Canal @ Sgt. Macario Garcia	EB	30	32
6	Sgt. Macario Garcia @ Canal	NB	40	38
7	Wayside @ Capitol	SB	40	32
8	Capitol @ Wayside	WB	30	30
9	Capitol @ Wayside	EB	30	28

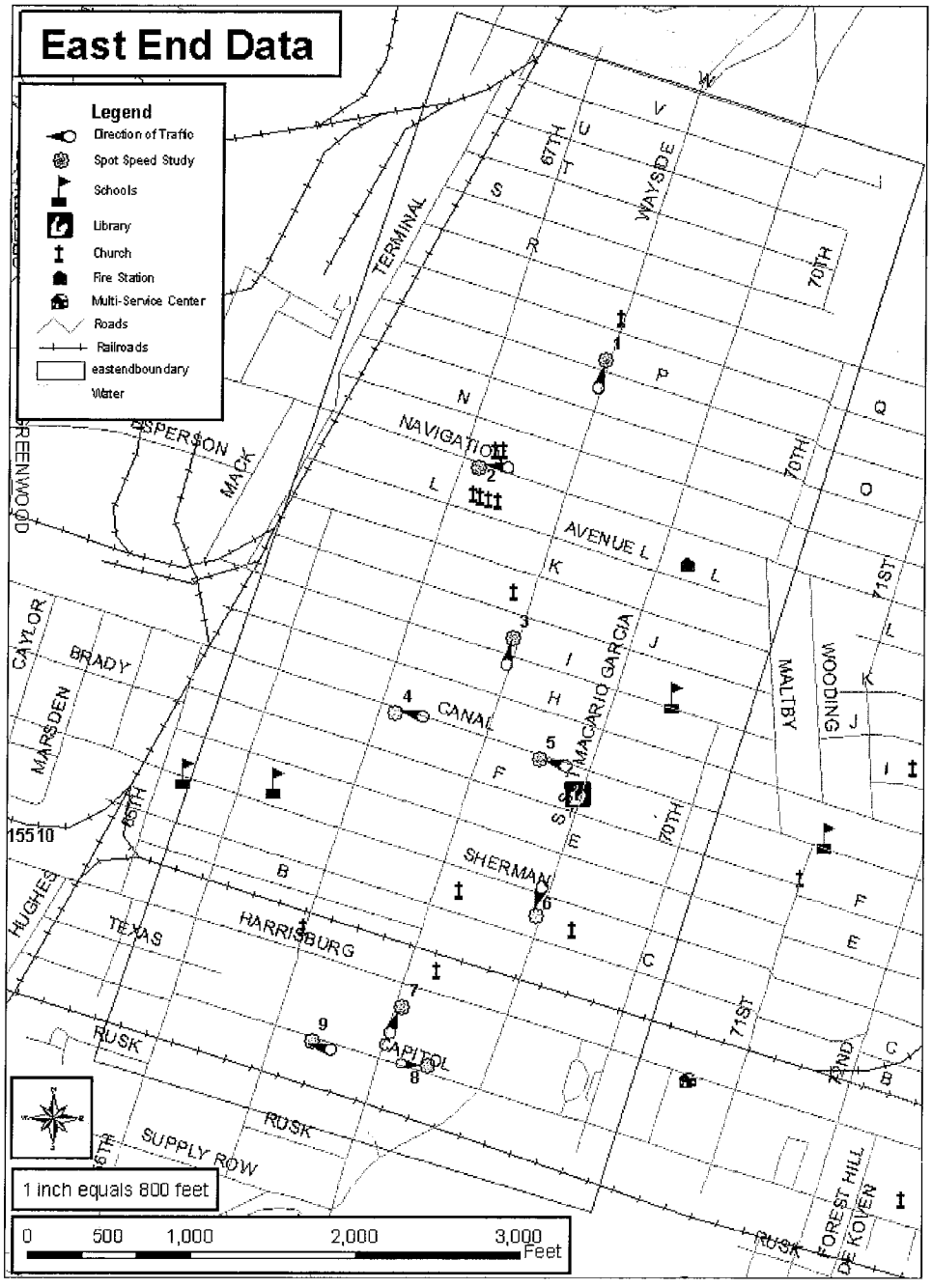


Figure 11. Spot Speed Study Locations.

Preliminary Findings

Based upon the examination of the available traffic data for the East End Study, there appears to be no congestion or delay problems. Simple volume-to-capacity ratios, engineering judgment, and site inspections verified these results. Traffic signal timing clearance intervals were found to be adequate for the posted and operating speeds on the corridors. No deficiencies were found. The lack of bicycle and pedestrian crash clusters did not warrant any bicycle or pedestrian counts. The spot speed study doesn't indicate any speed-related problems in the area.

Chapter 6 - Obtain/Analyze Land Use and Street Inventory Data

Data Resources

The following land use and street inventory data were obtained from the designated agencies:

1. Aerial Photographs (TxDOT)
2. Study Boundary Area (TTI)
3. Parcel and Land Use (H-GAC)
4. Demographics: Population and Vehicle Tenure (H-GAC)
5. Bus Stops (50) and Routes (METRO)
6. HISD Boundaries (HISD) 4 Elementary, 1 Middle, and 1 High School
7. City of Houston Data:
    a. Traffic Signals (13)
    b. Stop Signs (64)
    c. Schools (2)
    d. Parks (2 just outside study area)
    e. Libraries (1)
    f. HPD Stations and Districts (2)
    g. Multi-Service Medical Center (1)
    h. Fire Station (1)
    i. Churches (13)
    j. Railroad
    k. Water Features
    l. Super neighborhoods
    m. Subdivisions
    n. Council Districts (2)
    o. MUD
    p. Zip Codes

Data Analysis

The above data were obtained from the responsible agency and imported into a Geographical Information System (GIS). These layers are shown on the maps in Figures 12 through 14. Aerial photos are used for verification of land use and to confirm inventory information. The road inventory data, traffic counts, and traffic operational data combined with the crash data were used to determine if there were any cause and effect relationships between land use or attractions and crash patterns.

The land use was classified and summarized by like-travel patterns. Table 17 shows the totals for each classification of land use by parcel. In some cases, joined parcels are not aggregated in the database. For example, at one of the school locations the database lists aggregated parcels on one side of the block and individual parcels on the other side, but both are included in the school property.

Table 17. Summarization by Land Use Classification

Classification	No. of Parcels	Area
Short-Term Shopping	1.6%	1.9%
Long-Term Shopping	4.9%	6.6%
Industrial/Warehouse	3.7%	21.7%
Housing	10.5%	6.9%
Single Family Housing	59.3%	28.7%
Children's Activity Area	2.6%	13.4%
Parking	2.6%	1.9%
Vacant Land	11.6%	16.7%
Miscellaneous	3.2%	2.2%

The classifications used in Table 17 are based on like traffic patterns, characteristics, and vehicle type. For instance Short Term Shopping is based land use such as gas stations, convenience stores, fast food, etc.; land uses that have high turnover rates. Long Term Shopping are grocery stores and department stores where patrons are on site for an hour or more. Industrial/warehouse has peaking characteristics in the AM and PM but also has some delivery vehicles throughout the day. The other classifications are similar, again being based on how traffic accesses the parcel, the length of time (dwell time), and vehicle type (passenger cars and trucks, delivery trucks and 18 wheelers, and pedestrians and bicyclists).

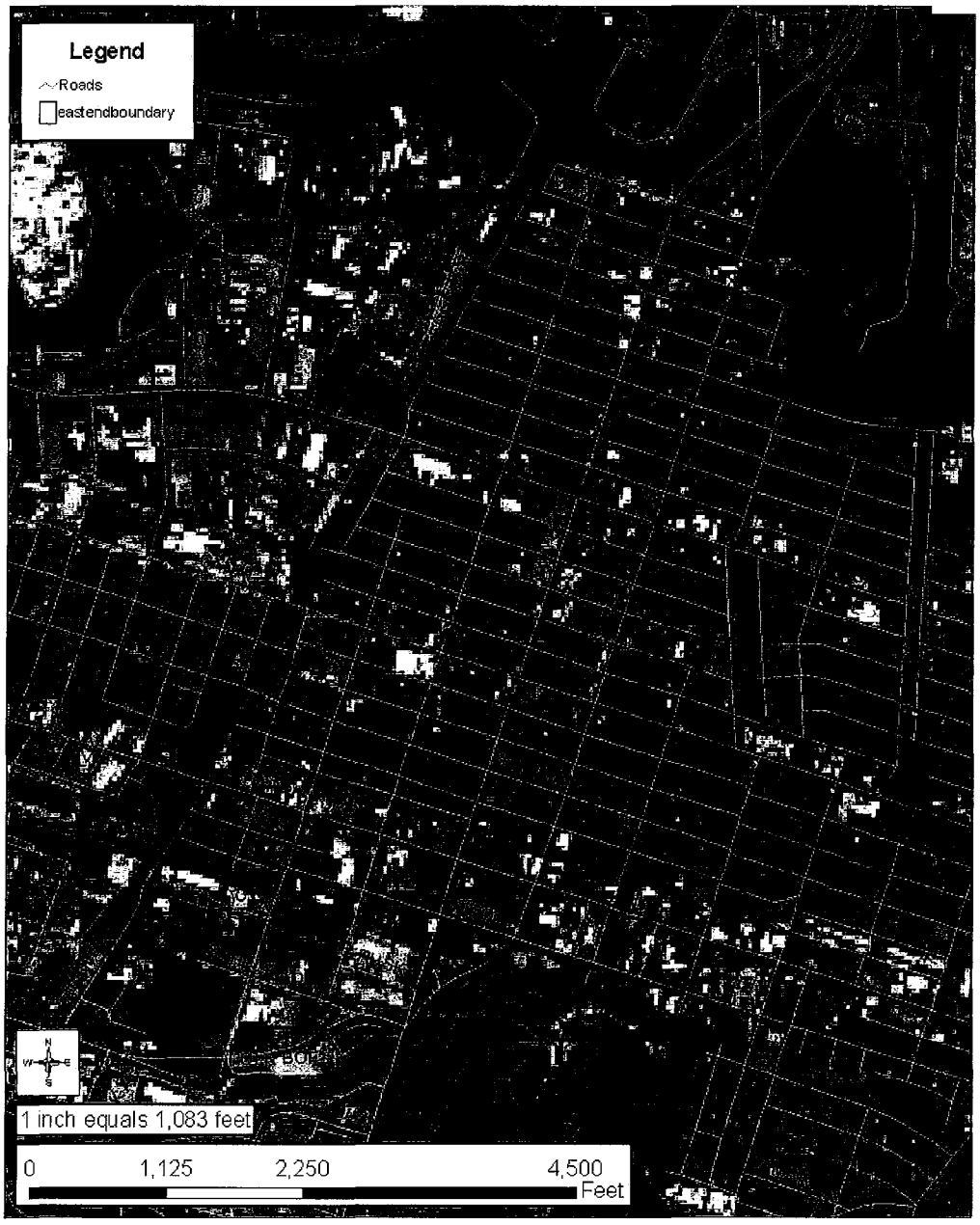


Figure 12. Aerial Photograph Showing Land Use and Area Characteristics.

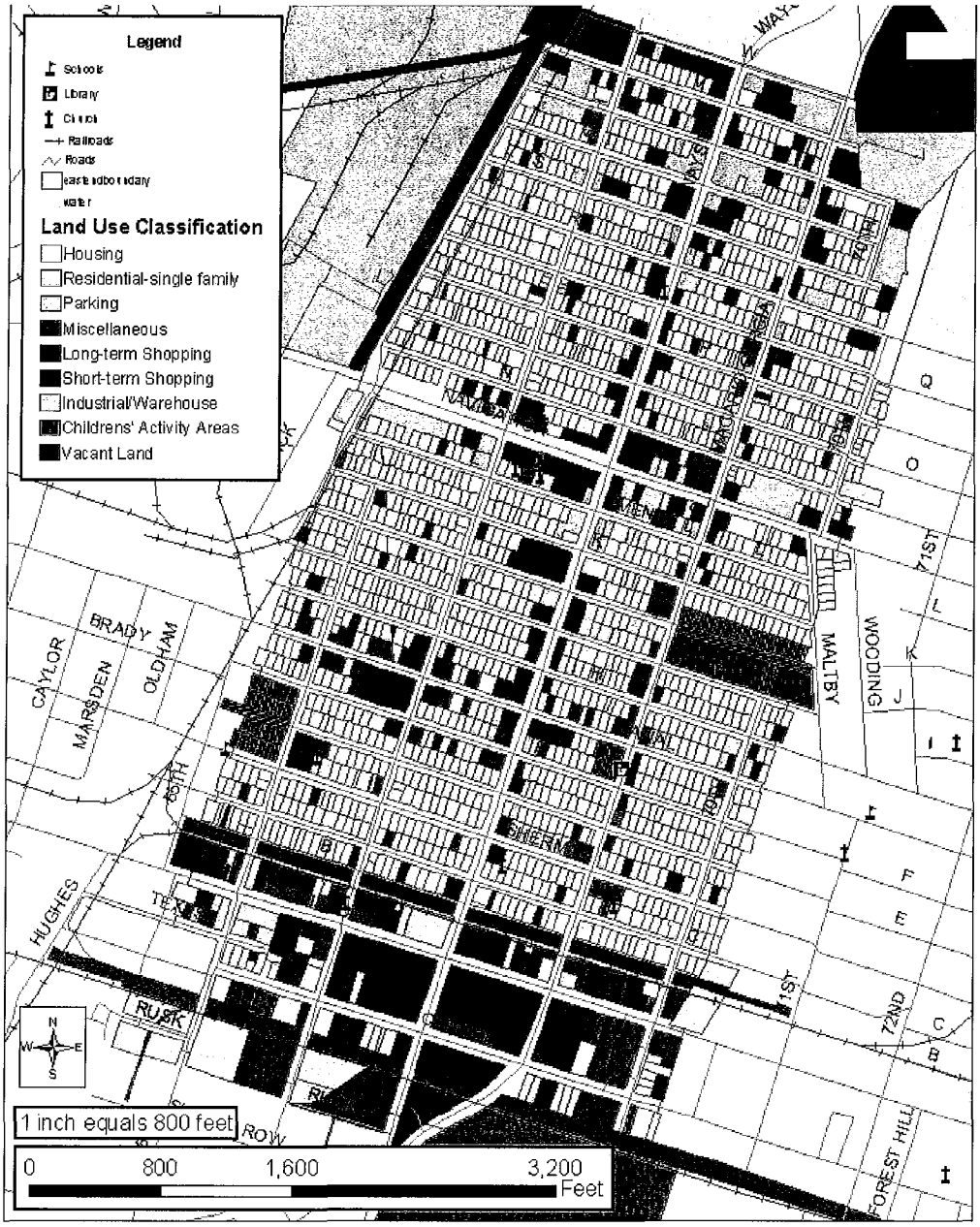


Figure 13. Aggregated East End Land Use Map.

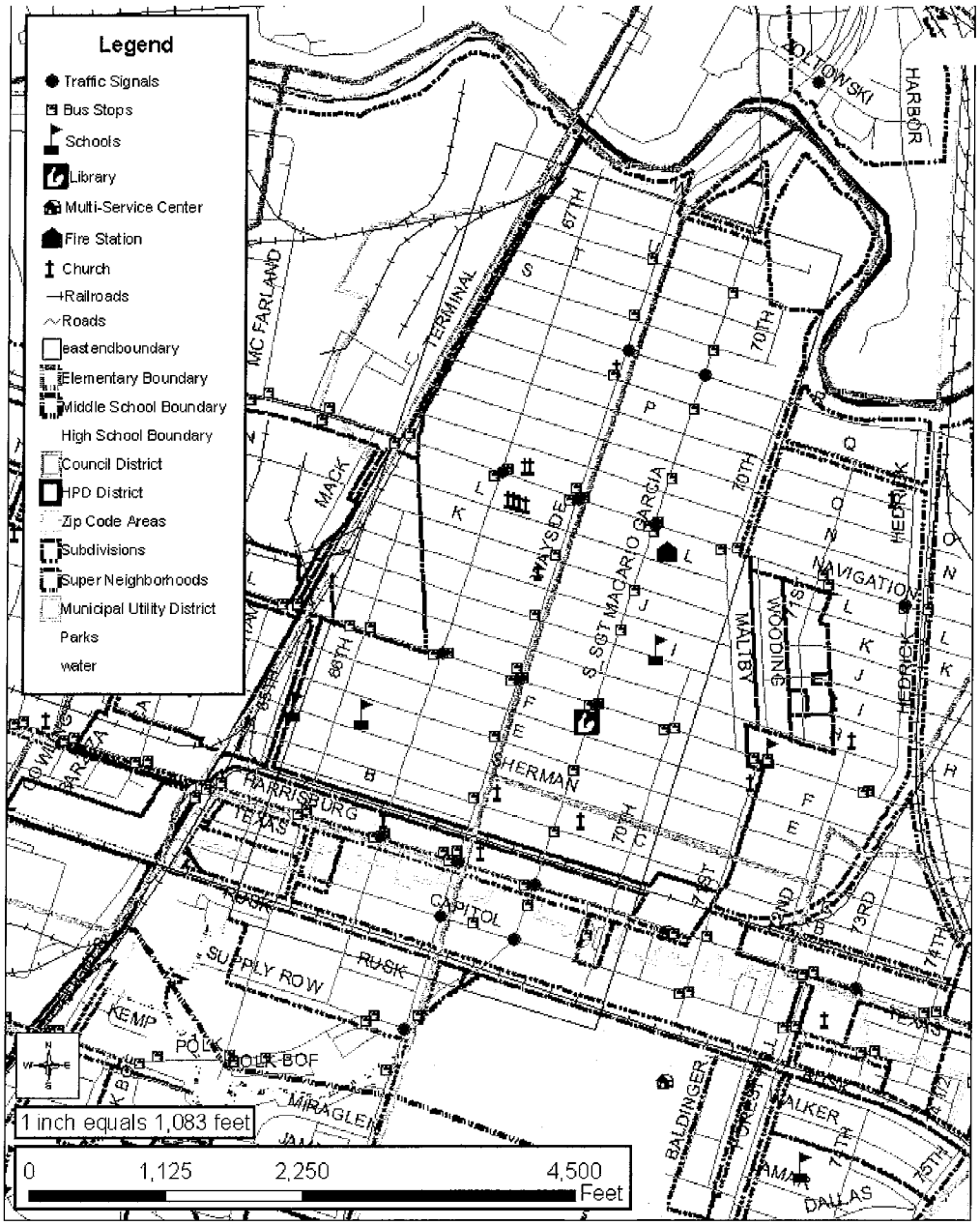


Figure 14. East End Inventory Map.

No patterns could be found with respect to schools, libraries, and other attractions. However, there appears to be a cluster of crashes east of Sergeant Macario Garcia on Harrisburg: six rear ends, three right angle crashes, two sideswipes, and a head-on crash. Land use and access management seem to be contributing factors to these crashes. Short-term and long-term shopping areas tend to have the highest number of crashes, but they also have the highest turnover rate. Land use and access management seem to be problems throughout the area, although no direct correlation can be made. On the streets, the close vicinity of 18-wheel trucks to residential housing could be the cause of many potential conflicts. Too many driveways and poor pavement conditions tend to keep the speeds low on the major streets. Minor streets have lots of parking and therefore speeds are relatively low as well.

While there would appear to be a correlation between bus stops and crashes, as shown by Figure 15, no pattern of casual relationship could be established. Only four bus stop locations have not had a crash. Nine of the 26 EMS bicycle or pedestrian crashes are in the vicinity of the 50 bus stops. Far more crashes from the Department of Public Safety (DPS) data set were in close proximity to a bus stop. From DPS data only seven of the bus stops did not have a crash in close proximity to the bus stop.

A summarization of the demographic data obtained from the 2000 census revealed the following facts:

- Ethnicity (based on 2000 census table PL2 Hispanic or Latino, and not Hispanic or Latino by Race [73])
  - Black 16.7%
  - Hispanic 40.6%
  - White 39.5%
  - Asian 2.3%
  - Other 0.9%
- Median Household Income $22,430
- Auto Availability
  - No Car Available 22.4%
  - One Car Available 44.0%
  - Two Cars Available 21.7%
  - Three Cars Available 8.8%
  - Four Cars Available 2.4%
  - Five Cars Available 0.7%

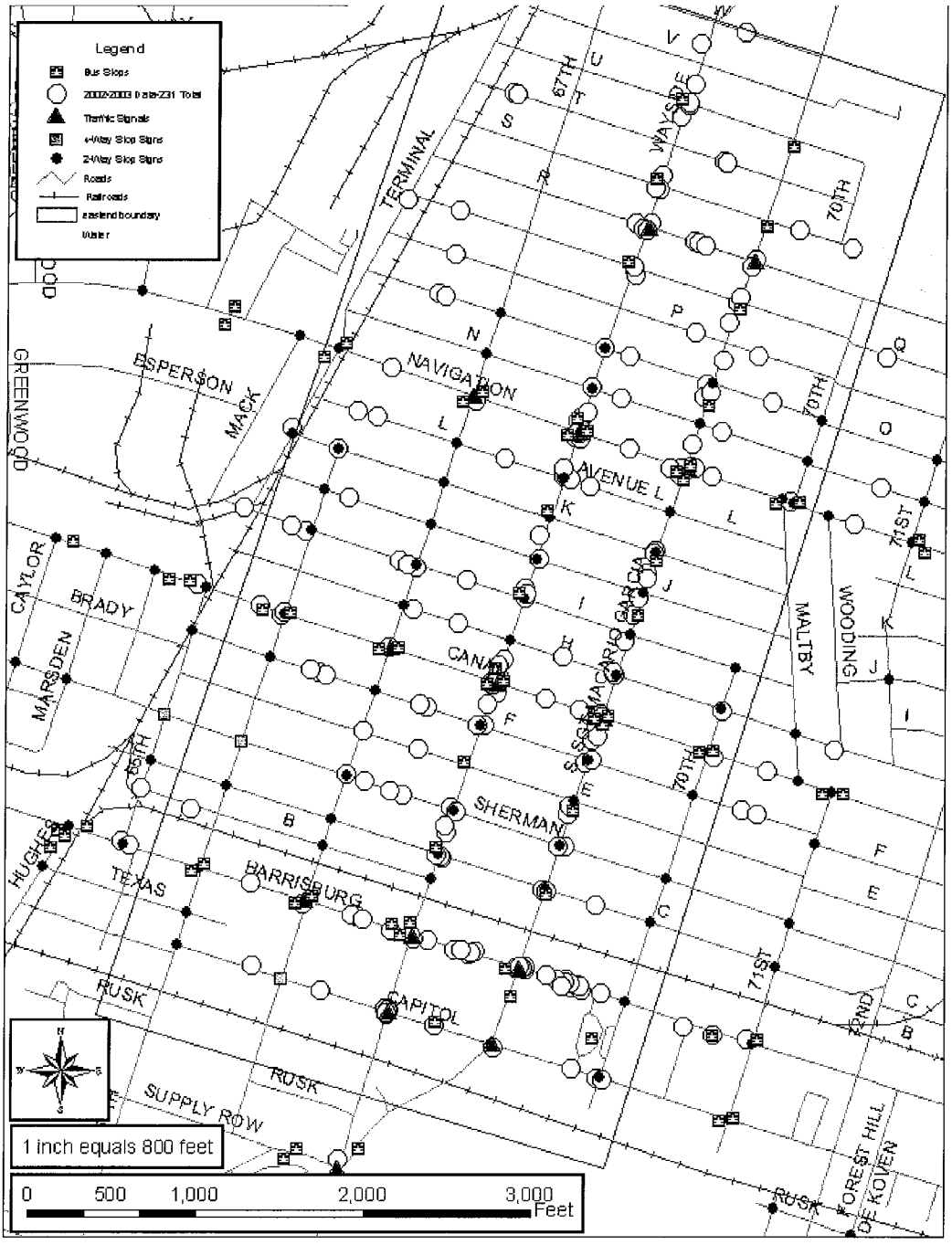


Figure 15. Bus Stop and Crash Data Correlation.

Preliminary Findings

The population in the area is predominately poor with low education levels and is made up of a large immigrant population predominantly from Mexico and Central America. It is possible that these factors may contribute to some of the crashes in the study area and improvements in driver's education could improve safety above-and-beyond the engineering roadway improvements. Non-ideal land use patterns have formed over the years and mixed industrial and residential land use remains. The mix of large trucks near children walking and bicycling, residential housing near industrial warehouses are typically not considered desirable and can pose severe conflicts. Street parking, tight driveways spacing, building set back, and poor sight distance are contributing causes for some of the side street crashes. On the main streets, poor access management practices create unanticipated maneuvers both to access the property and/or avoid other vehicles making those maneuvers.

Site investigation shows that old drainage design, narrow lanes, and bus traffic on Harrisburg could contribute to the crashes on this street. Harrisburg has a large crown, or center of the roadway compared to the gutter, and at each cross street the two crowns for each street intersect, causing a hump on the major arterial. This hump can cause drivers to avoid this lane or change lanes to avoid the hump. This curb lane is typically used by buses, and as a result there are ruts and potholes present.

Chapter 7 - Determine Crash Patterns and Causal Relationships

Data Resources

In addition to the previously discussed crash and operational data collected and analyzed in Tasks 3 – 5, East End intersection collision diagrams and hard copy crash data summaries are incorporated in Appendix E of this report. All of this information will be assessed relative to Table 18, General Countermeasures for Crash Patterns and Their Probable Causes, which is taken from National Cooperative Highway Research Program (NCHRP) Report No. 91 by Zeeger, et al.

Data Analysis

Based upon data assimilation and analyses conducted within Chapters 4 – 6, the following crash patterns identified within the East End Study Area and causal relationships determined to be associated with those crash patterns will be discussed.

Pedestrian/Bicycle Crashes

Pedestrian and Bicycle crashes were specified and located within the East End Study Area from both the EMS and DPS records as previously discussed. Examination of this data indicated no geographic or temporal aggregation of these types of crashes within the East End Study Area. No association can be established with children involved in these types of crashes with routes or access to public schools. No pattern related to bus stop locations has been established; or any significant frequency of conflicts or collisions at intersections or marked crosswalk locations. Assessments of contributing factors given in the TCH medical treatment records indicates lack of parental supervision and knowledge of risk led to the majority of injuries to children involved in pedestrian and bicycle collisions.

Table 18

General Countermeasures for Crash Patterns and Their Probable Causes

CRASH PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Right-angle collisions at Unsignalized intersections	Restricted sight distance	-Remove sight obstructions -Restrict parking near corners -Install stop signs (see MUTCD) -Install warning signs (see MUTCD) -Install/improve street lighting -Reduce speed limit on approaches -Install signals (MUTCD) -Install yield signs (MUTCD) -Channelize intersections
	Large total intersection volume	-Install signals (see MUTCD) -Reroute through traffic
	High approach speed	-Reduce speed limit on approaches -Install rumble strips
Right-angle collisions at Signalized intersections	Poor visibility of signals	-Install advanced warning devices (see MUTCD) -Install 12-in. signal lenses (see MUTCD) -Install overhead signals -Install visors -Install back plates -Improve location of signal heads -Add additional signal heads -Reduce speed limit on approaches
	Inadequate signal timing	-Adjust amber phase -Provide all-red clearance phases -Add multi-dial controller -Install signal actuation -Retime signals -Provide progression through a set of signalized intersections
Rear-end collisions at Unsignalized intersections	Pedestrian crossing	-Install/improve signing or marking of pedestrian crosswalks -Relocate crosswalk
	Driver not aware of intersection	-Install/improve warning signs
	Slippery surface	-Overlay pavement -Provide adequate drainage -Groove pavement -Reduce speed limit on approaches -Provide "SLIPPERY WHEN WET" signs
	Large numbers of turning vehicles	-Create left or right-turn lanes -Prohibit turns and/or increase curb radii

Table 18 (Continued)

General Countermeasures for Crash Patterns and Their Probable Causes

CRASH PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Rear-end collisions at signalized intersections	Poor visibility of signals	-Install/improve advance warning devices -Install overhead signals -Install 12 in. signal lenses (see MUTCD) -Install visors -Install back plates -Relocate signals -Add additional signal heads -Remove obstacles -Reduce speed limits on approaches
	Inadequate signal timing	-Adjust amber phase -Provide progression though a set of signalized intersections
	Pedestrian crossings	-Install/improve signing or marking of pedestrian crosswalks -Provide pedestrian "WALK" phase
	Slippery surface	-Overlay pavement -Provide adequate drainage -Groove pavement -Reduce speed limit on approaches -Provide "SLIPPERY WHEN WET" signs
	Unwarranted signals	-Remove signals (see MUTCD)
	Large turning volumes	-Create left or right-turn lanes -Prohibit turns -Increase curb radii
Pedestrian crashes at intersections	Restricted sight distance	-Remove sight obstructions -Install pedestrian crossings -Install/improve pedestrian crossing signs -Reroute pedestrian paths
	Inadequate protection for pedestrians	-Add pedestrian refuge islands
	Inadequate signals	-Install pedestrian signals (see MUTCD)
	Inadequate signal phasing	-Add pedestrian "WALK" phase -Change timing of pedestrian phase
	School crossing area	-Use school crossing guards
Pedestrian crashes between intersections	Driver has inadequate warning of frequent mid-block crossings	-Prohibit parking -Install warning signs -Lower speed limit -Install pedestrian barriers
	Pedestrians walking on roadway	-Install sidewalks

Table 18 (Continued)

General Countermeasures for Crash Patterns and Their Probable Causes

CRASH PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Pedestrian crashes between intersections	Long distance to nearest walk	-Install pedestrian crosswalk -Install pedestrian actuated signals (see MUTCD)
Pedestrian crashes at driveway crossings	Sidewalk too close to traveled way	-Move sidewalk laterally away from highway
Left-turn collisions at intersections	Large volume of left turns	-Provide left-turn signal phase -Prohibit left turns -Reroute left-turn traffic -Channelize intersection -Install STOP signs (see MUTCD) -Create one-way streets -Provide turning guidelines (if there is a dual left turn lane)
	Restricted sight distance	-Remove obstacles -Install warning signs -Reduce speed limit on approaches
Right-turn collisions at intersections	Short turning radii	-Increase curb radii
Fixed-object collisions	Objects near traveled way	-Remove objects near roadway -Install barrier curbing -Install breakaway feature light poles, signposts, etc. -Protect objects with guardrail
Fixed-object collisions and/or vehicles off roadway	Slippery pavement	-Overlay existing pavement -Provide adequate drainage -Groove existing pavement -Reduce speed limit -Provide "SLIPPERY WHEN WET" signs
	Roadway design inadequate for traffic conditions	-Widen lanes -Relocate islands -Close curb lanes
	Poor delineation	-Install/improve pavement markings -Install roadside delineators -Install advance warning signs (e.g., curves)
Sideswipe collisions between vehicles traveling in opposite directions or head-on collisions	Roadway designs inadequate for traffic conditions	-Install/improve pavement markings -Channelize intersections -Create one-way streets -Remove constructions such as parked vehicles -Install median divider, widen lanes

Table 18 (Continued)

General Countermeasures for Crash Patterns and Their Probable Causes

CRASH PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Collisions between vehicles traveling in same direction such as sideswipe, turning, or lane changing	Roadway design inadequate for traffic conditions	-Widen lanes -Channelize intersections -Provide turning bays -Install advance route or street signs -Install/improve pavement lane lines -Remove parking -Reduce speed limit
Collisions with parked cars or cars being parked	Large number of parking turnovers	-Prohibit parking -Change from angle to parallel parking -Reroute through traffic -Create one-way streets -Create off-street parking -Reduce speed limit
	Roadway design inadequate for present conditions	-Widen lanes -Change from angle to parallel parking -Prohibit parking -Reroute through traffic
Collisions at driveways	Left turning vehicles	-Install median divider -Install two-way left-turn lanes
	Improperly located driveway	-Regulate minimum spacing driveways -Regulate minimum corner clearance -Move driveway to side street -Install curbing to define driveway location -Consolidate adjacent driveways
	Right-turning vehicles	-Provide right-turn lanes -Restrict parking near driveways -Increase the width of the driveway -Widen "through" lanes -Increase curb radii
	Large volume of through traffic	-Move driveway to side street -Construct a local service road -Reroute through traffic
	Large volume of driveway traffic	-Signalize driveway -Provide acceleration and deceleration lanes -Channelize driveway
	Restricted sight distance	-Remove sight obstructions -Restrict parking near driveway -Install/improve street lighting -Reduce speed limit*

In summary, no pattern or causal relationship of pedestrian and bicycle crashes, within the East End Study Area, susceptible to remediation (crash reduction) by engineering safety improvements can be established. Field observations did note several locations where physical countermeasures would be recommended; however, no pattern of crashes can be identified to be directly associated. These suggested safety improvements will be discussed in the Chapter 8 report. Education of both parents and children seems to hold the most potential for influence (reduction) in these types of conflicts.

Primary Arterial Crashes

Alternate US Highway 90 consists of the one way pairs of Wayside and Sgt. Macario Garcia. These roadway facilities are multi-lane with a traffic demand of over 30,000 vehicles per day. Major signalized intersections exist at Navigation, Canal, Harrisburg, and Capitol. For the 1.3 mile section of US 90 Alternate within the East End Study Area, the crash rate was over three (3) times the State and Harris County rate for urban principal arterials (4 or more lanes) over the time period 1998 – 2000. Of the 488 total crashes within the East End Study Area for 1998 – 2000, 343 crashes occurred on Wayside or Sgt. Macario Garcia. Less than one third of these crashes were at major intersections. This data is shown in Table 19. No geographic, temporal, or environmental aggregation of crashes was established in examination.

From analysis of the hard copy crash data (2002) over 20 percent of all crashes occurring on the Wayside/Sgt. Macario Garcia routes within the East End Study Area are sideswipe crashes associated with lane position. These crashes are typically described as "failure to drive in single lane, changed lanes when unsafe, turned improperly, and failure to control speed." Analysis indicates that reinforcement of lane demarcation with improved lane striping and the addition of raised pavement markers (RPM's) holds potential to influence (reduce) this historical pattern of crashes.

In addition, there are numerous Stop-controlled, intersecting side streets onto Wayside/Sgt. Macario Garcia. These at grade intersections exhibit restricted quadrant sight distance due to corner development with minimum setbacks. These visibility restrictions are further exaggerated with no parking restrictions. This creates a situation of a vehicle stopped legally behind the Stop

sign on the minor intersecting street without clear and sufficient visibility of major road vehicles for a safe judgment to enter or cross the major street (Wayside/Sgt. Macario Garcia). The result is a substantial number of right angle collisions due to failure to yield right of way.

Analysis indicates that the institution and enforcement of parking restrictions along Wayside/Sgt. Macario Garcia in proximity to the intersection corners with minor, Stop-controlled streets holds potential to provide safe and required sight distance to influence (reduce) the historical pattern of crashes at these locations.

Major Signalized Intersection Crashes

As stated previously, less than one third of all the crashes which occurred during the period 1998-2000 on US 90 Alternate (Wayside/Sgt. Macario Garcia) were at the major signalized intersections with Canal, Navigation, Capitol and Harrisburg. Calculated crash rates, from the hard copy data, for these major signalized intersections within the East End Study Area are shown in Table 20 except for the Capitol/Wayside intersection, these crash rates are all greater than both the State and Harris County rates as determined for the 1998 – 2000 annual average on urban principal arterials (4 or more lanes) and for intersection/intersection related crashes. Further analysis of the hard copy crash reports indicates two predominate patterns associated with these crashes at these designated major signalized intersections. One, violation of the traffic control signal (ran red light) and, two, improper turn at or within the intersection. Red light running was a causative factor in 20 – 50% of all intersection crashes, while an improper turn, either as wide turn, turn from wrong lane, or as part of an unsafe lane change, and was designated as a causative factor in 25 – 40 % of all intersections crashes. Countermeasures of influence (reduction) to these indicated intersection crashes include increased size of signal faces (8 inch to 12 inch), improved lane line demarcation both in approach as well as with turn definition, and reinforcement of lane assignment for thru and turning movements with signs and/or pavement word/symbol messages. Any or all of these potential remedial measures hold potential for safety improvements (reduced crashes). No other patterns of crashes based on temporal or environmental influence was established.

Table 19

East End Crash Rate Comparison

Urban Principal Arterials (4 or more lanes)

Year	Total Texas State Crashes	Total Harris County Crashes	Total East End Crashes*	Texas State Crash Rate	Harris County Crash Rate	East End Crash Rate
1998	**40,441**	**4816**	**111**	**248 per 100 MVM**	**274 per 100 MVM**	**935 per 100 MVM**
1999	**41,677**	**6617**	**127**	**234 per 100 MVM**	**234 per 100 MVM**	**1029 per 100 MVM**
2000	**40,265**	**6637**	**105**	**218 per 100 MVM**	**232 per 100 MVM**	**712 per 100 MVM**
Three Year Average	**40,794**	**6025**	**115**	**233 per 100 MVM**	**247 per 100 MVM**	**880 per 100 MVM**
*US 90 Alternate from Avenue W to Rusk						

Table 20

East End Crash Rate Comparison

Urban Principal Arterials (4 or more lanes)

Intersection/Intersection Related Crashes

	Total Crashes per 100 Million Vehicle Miles (MVM)
State of Texas	**133.77***
Harris County	**125.24***
Canal @ Wayside	**142.44****
Canal @ Sgt. Macario Garcia	**175.80****
Capitol @Wayside	**103.06****
Navigation @ Wayside	**161.86****
Navigation @ Sgt. Macario Garcia	**143.60****

* Three Year Average (1998-2000)

**December, 2001 thru January, 2003

Collector Street Crashes

A total of 145 crashes occurred in 1998 – 2000 on all streets other than US 90 Alternate (Wayside/Sgt. Macario Garcia). This represents only approximately 30 percent of the total (488) crashes in the East End Study Area, for the stated three years. These crashes were, for the most part, randomly occurring with no outstanding aggregation based on location, time, or environment. However, a few selected causal associations were note worthy.

First, analysis indicated several crashes occurring again at cross street, Stop-controlled intersections with restricted visibility due to parking in proximity to the intersection or, in some cases, private property obscurements (vegetation, fence, etc). Focused and enforced restrictive ordinances could possibly reduce the number of selected right angle, right-of-way obviated crashes which have occurred historically at certain locations.

Second, proliferations of turning crashes are exhibited along strip commercial development on Harrisburg East of Capitol. Numerous and uncontrolled driveways into these businesses seem to be contributing factor to a cluster of crashes at this location. A study should be undertaken to more safely and efficiently provide access to this development with consolidated, well designed, and controlled driveway access. Access improvement and management at this location along Harrisburg could potentially influence (reduce) those crashes which have historically occurred due to turning conflicts at this site.

Chapter 8 - Establish Engineering Countermeasure Improvements

Data Resources

From the determined crash patterns and causal relationships specified in Chapter 7, associated alternative countermeasures will be established by work code and definition as per guidelines utilized by the Texas Department of Transportation (TxDOT) for safety improvements instituted under the Federal Hazard Elimination and Safety Program (HES). A complete listing, by category, of these work codes, description and definition of each, directed preventable crash, and related crash reduction factor is given in Appendix H.

Data Analysis

Based on the crash patterns and causal relationships established in Chapter 7, the following safety countermeasure improvements are recommended and discussed.

Major Arterials

A predominant crash pattern established on US 90 Alternate (Wayside/Sgt. Macario Garcia) is sideswipe crashes related to proper and safe maintenance of lane position, i.e., a vehicle attempting a mid-block lane change sideswipes an adjacent vehicle. It is recommended that lane lines be re-striped along each 1.3 mile one-way roadway and improved with the addition of raised pavement markers (RPM's). These safety improvements should be instituted in compliance with current and applicable Texas Department of Transportation (TxDOT) specifications. This would encompass TxDOT safety improvement Work Code 401, Install Pavement Markings, and Work Code 406, Install Raised Reflective Pavement Markers. At the major signalized intersections along US 90 Alternate; i.e. Canal @ Wayside, Canal @ Sgt. Macario Garcia, Capitol @ Wayside, Navigation @ Wayside, and Navigation @ Sgt. Macario Garcia, crash patterns associated with intersection turning movements and violation of signal control (red light running) were established. It is recommended that turning movements at these major signalized intersections are reinforced with striped or re-striped radial skip lines,

commonly referred to as cat tracks or chicken scratches. In addition, consideration should be given to redundant communication of turning movements within these intersections with advance arrow directives either from signs or pavement markings. It is also recommended that the signals at all of the US 90 Alternate major intersections within the East End Study Area be upgraded from 8 inch to 12 inch diameter lens face to be more conspicuous to approaching vehicles as signal indications change. These improvements would be categorized by TxDOT as safety improvement Work Code 108, Improve Traffic Signals, and Work Code 401, Install Pavement Markings.

Minor Arterials and Collector Streets

A pattern of turning movement crashes associated with driveway access to commercial businesses was established within the 6800 block of Harrisburg. It is recommended that these egress and ingress movements be evaluated to allow a more safe and efficient access accommodation with fewer and improved driveway locations. This countermeasure would be generally defined under TxDOT safety improvement Work Code 219, Install Curb Control of Access.

At the Stop-controlled, side street intersections along 67th street, it is recommended that parking be prohibited by restrictive markings and/or regulatory signs for a sufficient distance to allow safe and appropriate sight distance for ingress movements. This distance should be based upon the posted speed limit along 67th street. This improvement would be categorized as safety improvements Work Code 117, Eliminate Parking.

Numerous, right angle crashes also occurred at random, Stop-controlled intersections from collector side streets with minor arterials; i.e. Harrisburg, Canal, Navigation, Capitol. Observations indicated selected locations had restricted sight distance due to parking, vegetation, and/or private property development. Consideration should be given to either enactment and/or enforcement of such ordinances to allow sufficient sight distance along the thru street for safe access accommodation. There is no direct TxDOT safety improvement work code to describe this countermeasure.

Bicycle/Pedestrian Facilities

As previously discussed, no pattern of aggregation of pedestrian and/or bicycle crashes could be established such to allow a recommendation for any independent engineering countermeasures. Pedestrian counts taken at the intersection of Canal @ St. Macario Garcia and at a mid-block school crosswalk location in proximity did not show sufficient pedestrian hourly movements to meet the minimum warranting criteria of the Texas Manual on Uniform Traffic Control Devices (MUTCD) for consideration of a pedestrian signal. Although not associated with a demonstrative pattern of pedestrian/bicycle conflicts, field observations indicated other recommended safety improvements (countermeasures).

First, sidewalks on many collector streets, specifically Avenue I, are narrow and in disrepair at many locations. On 70th Street, between Avenue I and Avenue H, a sidewalk exists on only one side of the street. Because of narrow right-of-ways in which sidewalks exist, residential property gates, left open, block sidewalk traversal. There exist many locations of sidewalk discontinuity and poor maintenance. The narrow sidewalks force bicycle vendors into the streets creating conflicts with thru vehicles.

Second, many cross-walks have worn and faint markings with compromised nighttime reflectivity. These should be inspected and re-striped more often to insure safe and adequate visibility.

Other Recommended Countermeasures

Pavement surface on Harrisburg was compromised at several locations with potholes, bumps/humps, and severe rutting and cracking in the outside lane of travel. Lane widths on Harrisburg are narrow, and while no direct correlation with crashes can be established, these indicated pavement surface discontinuities may have contributed to selected sideswipe crashes.

Chapter 9 - Establish Expected Crash Reductions from Countermeasure

Data Resources

For each designated engineering improvement countermeasure, an assigned value for expected reduction in selected frequency and types of crashes will be utilized to allow calculation of benefits. These crash or crash reduction factors have been established historically through research studies and State Department's of Transportation experience. Values used by the Texas Department of Transportation (TxDOT) in Safety Improvement Index (SII) calculations are shown in Appendix I by individual work code. A national survey of comparative crash reduction factors was conducted by the Texas Transportation Institute in 1995. These survey results are given in Appendix J.

Data Analysis

The Texas Department of Transportation (TxDOT) utilizes a methodology for assessing the potential benefits of implementing various types of safety improvement countermeasures to affect a reduction in vehicular crashes of a specified pattern or description. These crashes are defined as those that are "preventable" or "correctable" and did not occur due to driver behavioral actions or inactions. This eliminates all crashes that involve alcohol or unsafe speed influence. Crash reduction factors, based on research and/or agency experience, are applied for commensurate countermeasures to allow calculation of expected safety benefits in terms of reduction in historical crashes. Crash reduction and associated safety benefits expressed as cost of crashes are applied based on severity category. These categories are given as follows:

K – Fatality
A – Incapacitating Injury
B – Non-Incapacitating Injury
C – Possible Injury
PDO – Property Damage Only

The National Safety Council (NSC) has calculated comprehensive costs for 2002 of the various severity classifications. These costs are shown as follows:

K (Fatality)	$3,470,000
A (Incapacitating Injury)	$172,000
B (Non-Incapacitating Injury)	$44,000
C (Possible Injury)	$21,000
PDO (Property Damage Only)	$2,000

These severity classifications and NSC comprehensive crash costs will be used to calculate annual safety benefits estimated from expected crash reductions resulting from the implementation of safety improvement countermeasures recommended in Chapter 8 from crash patterns and causal relationships determined in Chapter 7.

Major Arterial

The following annual preventable crashes on US 90 Alternate (Wayside/Sgt. Macario Garcia) are recommended to be addressed with lane line improvements.

K – 0	Preventable Crashes
A – 2	Preventable Crashes
B – 2	Preventable Crashes
C – 3	Preventable Crashes
PDO – 14	Preventable Crashes
Total – 21	Preventable Crashes

The TxDOT Safety Work Codes for Install Striping (401) and Raised Pavement Marking Addition (406) give potential crash reduction factors of 20 and 25 percent respectively. While crash reduction factors applied in conjunction are not necessarily additive, a 30 percent crash reduction would be conservative and reasonable. Applied to the previous annual preventable

crashes, the resulting reduction in crashes and associated annual safety benefits would be as follows:

K – 0.0 ($3,470,000) = 0
A – 0.6 ($172,000) = $103,200
B – 0.6 ($44,000) = $26,400
C – 0.9 ($21,000) = $18,900
PDO – 4.2 ($2,000) = $8,400
Total – 6.3 = $156,500

Major Signalized Intersections

The following annual preventable crashes occurring at the major signalized intersections of US 90 Alternate (Wayside/Sgt. Macario Garcia) with Capitol, Harrisburg, Navigation, and Canal are recommended to be addressed with signal and pavement marking improvements.

K – 0 Preventable Crashes
A – 2 Preventable Crashes
B – 2 Preventable Crashes
C – 16 Preventable Crashes
PDO – 14 Preventable Crashes
Total – 34 Preventable Crashes

The TxDOT Safety Work Codes for Signal Lens Improvement (108) and Turn Stripe Addition (401) give potential crash reduction factors of 22 and 20 percent respectively. A 25 percent crash reduction would be conservative and reasonable. Applied to the previously specified annual preventable crashes, the resulting reduction in crashes and associated annual safety benefits would be as follows:

K – 0.0 ($3,470,000) = $0

A – 0.5 ($172,000) = $86,000

B – 0.5 ($44,000) = $22,000

C – 4.0 ($21,000) = $84,000

PDO – 3.5 ($2,000) = $7,000

Total – 8.5 = $199,000

Driveway Access Control

The following annual preventable crashes on Harrisburg Avenue are recommended to be addressed through improved driveway access control within the 6800 Block.

K – 0	Preventable Crashes
A – 0	Preventable Crashes
B – 0	Preventable Crashes
C – 3	Preventable Crashes
PDO – 7	Preventable Crashes
Total – 10	Preventable Crashes

Minor Stop-Controlled Intersections

The TxDOT Safety Work Code for Driveway Access Control (219) indicates a potential crash reduction factor of 10 percent as conservative and reasonable. Applied to the previously designated annual preventable crashes, the resulting reduction in crashes and associated annual safety benefits is given as follows:

K – 0.0 ($3,470,000) = $0

A – 0.0 ($172,000) = $0

B – 0.0 ($44,000) = $0

C – 0.3 ($21,000) = $6300

PDO – 0.7 ($2,000) = $1400
Total – 1.0 =$7700

The following annual preventable crashes occurring on all other collector/local streets within the East End Study Area at Stop-controlled intersections which are recommended to be addressed by parking restrictions and/or ordinances regulating sight distance obstructions on private property are as follows:

K – 0	Preventable Crashes
A – 0	Preventable Crashes
B – 4	Preventable Crashes
C – 24	Preventable Crashes
PDO – 28	Preventable Crashes
Total – 56	Preventable Crashes

The TxDOT Safety Work Code for Restrict Parking (117) gives a potential crash reduction factor of 32 percent. A factor of 25 percent would seem more conservative and reasonable. Applied to the previously listed annual preventable crashes, the resulting reduction in crashes and associated annual safety benefits is calculated as follows:

K – 0.0 ($3,470,000) = $0
A – 0.0 ($172,000) = $0
B – 1.0 ($44,000) = $44,000
C – 6.0 ($21,000) = $126,000
PDO – 7.0 ($2,000) = $14,000
Total – 14.00 = $184,000

In summary, it is estimated that a total of approximately 30 annual crashes occurring within the East End Study Area representing an annual cost of over $550,000 may be prevented by the implementation of the described safety improvement countermeasures. As can be seen, severity

and costs of crashes within the East End Study Area are relatively low due to lower speeds and conditions which exist on streets of a more local and collector nature.

Again, other specific countermeasure improvements as discussed in Chapter 8 hold potential to improve overall safety within the East End Study Area. However, these recommended remedial actions could not be correlated with a known historical crash pattern to allow an estimate of potential reduction.

Chapter 10 - Establish Expected Costs of Countermeasures

Data Resources

Cost data for the recommended safety improvement countermeasures was obtained from Texas Department of Transportation (TxDOT) project bid prices submitted for contract lettings in recent months. This information was accessed from the TxDOT web site:
http://www.dot.state.tx.us.instdot\geodist\hov\cserve\uidprice\solol.htm
The remainder of this Task Report delineates specific cost items associated with the previously described engineering countermeasures.

Cost of Countermeasures

The recommended lane striping and raised pavement marking improvement for US 90 Alternate (Wayside and Sgt. Macario Garcia) were calculated based on four (4) lanes on each street with three (3) longitudinal lane line applications required. Sgt. Macario Garcia (SMG) has a 40 foot street cross-section with Wayside 66 feet wide North of Canal and 51 feet wide South of Canal. In the wider cross-sections on Wayside, an edge line is needed for edge of travelway definition with the possible introduction of a marked bike lane in the outside pavement area. There are twenty three (23) intersections with minor streets along the US 90 Alternate route over 1.3 miles in the East End Study Area.

Table 21 provides a summary of the cost calculations for the proposed major arterial safety improvements. The total cost is estimated to be approximately $8,000 with a service life of 2 – 3 years. Major intersection improvements recommended consisted of signal head lens enlargement (8 inch to 12 inch) and striping/pavement marking enhancements. Table 22 indicates the estimated costs for signal equipment change over. It is the understanding of the research staff that signal upgrades on US 90 Alternate have been programmed, however, not to date implemented.

Table 23 gives estimated costs for major intersection striping and pavement marking improvements per intersection approach. Table 24 provides a summary of all approach costs by major intersection the service life for these proposed improvements is 2 – 3 years.

The estimated cost to implement parking restrictions within the East End Study Area is based upon installing three (3) regulatory signs per block for 81 blocks. Costs are estimated for an approximate one (1) square foot of sign blank with pole assembly. Table 25 summarizes these estimated costs for parking restriction sign implementation. No costs are projected for enforcement of ordinances. Expected service life for these signs is 5 – 6 years discounting vandalism.

It is not possible to strictly estimate countermeasure costs to address the need for improved access control within the 6800 Block of Harrisburg Avenue. A study needs to be undertaken to determine the impacts of driveway closures and/or consolidation to more safely accommodate both ingress and egress maneuvers to street adjacent commercial development. This assessment and associated implemented improvements could cost from $50,000 - $100,000.

The estimated total initial cost for implementation of all recommended engineering countermeasures to affect improvements to street safety (crash reduction) within the East End Study Area is approximately $160,000. This compares to an estimated annual cost savings in reduction in crashes of approximately $550,000. Service lives of engineering safety improvement countermeasures follow guidelines given by TxDOT for the Hazard Elimination and Safety (HES) Program and are shown in Appendix K.

Table 21

Estimated Cost * of Striping/RPM

Application on US 90 Alternate

Major Arterial	Skip Lines	Edge Lines	Total Length (FT)	Less Int. (FT)	# of 10' Stripes Every 50 Feet	Striping Length (FT)	Striping Prep ($)	RPM Prep ($)	Striping Cost ($)	RPM Cost ($)	Totals Cost ($)
SMG	**3**	**---**	**6890**	**920**	**358.2**	**3582**	**$813.26**	**$35.82**	**$496.29**	**$1127.19**	**$2472.55**
Wayside	**3**	**---**	**6770**	**920**	**351**	**3510**	**$796.91**	**$35.10**	**$486.31**	**$1104.53**	**$2422.85**
	---	**2**	**4224**	**680**	**---**	**7088**	**$1609.26**	**---**	**$715.89**	**---**	**$2325.15**
	---	**1**	**2546**	**240**	**---**	**2306**	**$523.55**	**---**	**$232.91**	**---**	**$756.46**
Total	---	---	---	---	709.2	16486	$3742.98	$70.92	$1931.39	$2231.72	$7977.01

***Source: TxDOT Project Bid Prices, 2003**

Table 22

Estimated Cost * of Major Intersections

Signal Head Improvements

Intersection	3 Section Signal	4 Section Signal	Total Signal Sections	Sections ($)	Backplates ($)	LED ($)	Total
SMG @ Capital	**7**	**---**	**21**	**$2769.27**	**$396.90**	**$2830.66**	**$5996.83**
SMG @ Harrisburg	**7**	**1**	**25**	**$3296.75**	**$461.09**	**$3378.97**	**$7136.81**
SMG @ Canal	**7**	**---**	**21**	**$2769.27**	**$396.90**	**$2830.66**	**$5996.83**
SMG @ Navigation	**7**	**1**	**25**	**$3296.75**	**$461.09**	**$3378.97**	**$7136.81**
Wayside @Capital	**7**	**---**	**21**	**$2769.27**	**$396.90**	**$2830.66**	**$5996.83**
Wayside @ Harrisburg	**7**	**1**	**25**	**$3296.75**	**$461.09**	**$3378.97**	**$7136.81**
Wayside @ Canal	**7**	**---**	**21**	**$2769.27**	**$369.90**	**$2830.97**	**$5996.83**
Wayside @ Navigation	**7**	**1**	**25**	**$3296.75**	**$461.09**	**$3378.97**	**$7136.81**
Total	56	4	184	$24,264.08	$3431.96	$24,838.52	$52,534.56

***Source: TxDOT Project Bid Prices, 2003**

Table 23

Estimated Cost * of Major Intersection

Striping/Pavement Marking Improvements per Approach

Side Street	Arrows	Cat Tracks	Solid Striping 100' out from Intersection	Skip Striping 100' out from Intersection	Stripe Prep ($)	Cost Arrow ($)	Arrow Prep ($)	Cost Solid Paint ($)	Skip Prep ($)	Cost Skip Paint ($)	Total ($)
40 Foot Wide Intersection	**4**	**---**	**200**	**40**	**$95.56**	**$179.08**	**$45.41**	**$20.20**	**45.408**	**5.542**	**$391.20**
60 Foot Wide Intersection	**5**	**---**	**300**	**40**	**$119.45**	**$223.85**	**$68.11**	**$30.30**	**68.112**	**5.542**	**$515.37**
Main Street		---	---	---	---	---	---	---	---	---	---
SMG	**4**	**100**	---	---	**$95.56**	**$179.08**	---	---	**$22.77**	**$13.86**	**$311.27**
Wayside	**4**	**100**	---	---	**$95.56**	**$179.08**	---	---	**$22.77**	**$13.86**	**$311.27**
Total	17	200	---	---	$406.13	$761.09	---	---	$159.06	$38.794	$1365.07

***Source: TxDOT Project Bid Prices, 2003**

Table 24
Summary of Estimated Costs * for Striping/Marking Improvements by Major Intersection

Intersection	Cost per Intersection ($)
Wayside @ Navigation	**$826.63**
Wayside @ Canal	**$702.46**
Wayside @ Harrisburg	**$826.63**
Wayside @ Capital	**$702.46**
SMG @ Navigation	**$826.63**
SMG @ Canal	**$702.46**
SMG @ Harrisburg	**$826.63**
SMG @ Capital	**$702.46**
Total	$6116.38

***Source: TxDOT Project Bid Prices, 2003**

Table 25
Estimated Costs * for Installation Of Parking Restriction Signs

Cost Per Sign	**$189.27**
# of Blocks	**81**
Signs per Block	**3**
Total	$45,992.61

***Source: TxDOT Project Bid Prices, 2003**

Chapter 11 - Prioritize Improvements by Preliminary Benefit-Cost

Data Resources

The following resource documents were utilized for benefit-cost calculations to establish funding priorities for the previously designated safety improvement countermeasures to be considered for implementation within the East End Study Area:

1. McFarland, William F, et al "Benefit-Cost Analysis for Evaluating Safety Improvement Projects," Texas Transportation Institute, Unpublished report 1484, 2001
2. Griffin, Lindsay I. "Procedures for Evaluating Highway Safety Projects," Federal Highway Administration, Report FHWA-RD-08-033, U.S. Department of Transportation, 1997
3. Texas Department of Transportation, "Chapter 2 – Hazard Elimination Program – Safety Improvement Index," Traffic Operations Manual, 1999

Safety Improvement Index (SII) Analysis

As part of the Federal Hazard Elimination and Safety (HES) Program, The Texas Department of Transportation (TxDOT) has developed and utilizes a formula which assesses the attributes of a safety improvement project and converts it to an index/ratio by which each project can be ranked or prioritized in order of importance. This formula is called the Safety Improvement Index (SII). In its most basic form, it is a benefit-cost ratio that computes the ratio of potential reduction in crash costs to the cost of constructing improvements. This formulated value is weighted heavily on the percentage of expected reduction in prior improvement crashes. Thus an SII greater than or equal to 1.0 is considered to be cost effective, but the ratio is not designed to measure the effectiveness of individual projects, rather, it is a method by which many projects can be compared using the same set of criteria. By way of this comparison, a prioritization list of improvement projects is formed.

With this prioritized list, the projects are funded beginning with the most important project, and each subsequent safety improvement project is then funded individually and sequentially.
The Safety Improvement Index formula is defined as follows:

$$S = \frac{R(C_f F + C_i I + C_p P)}{Y} - M, \qquad Q = \left(\frac{\frac{A_a - A_b}{A_b}}{L} \right) S \tag{11-1}$$

$$B = \frac{S + 1/2Q}{1.08} + \sum_{i=2}^{L} \left[\frac{(S + 1/2Q) + (i-1)Q}{(1.08)^1} \right], \text{ L = Project Service Life} \tag{11-2}$$

$$SII = \frac{B}{C}, \text{ B = Present Worth of Project Benefits over Service Life} \tag{11-3}$$

C = Initial Cost of Project

Where:

S = annual savings in crash cost (equal to crash cost savings per year less annual maintenance costs)

R = percentage reduction factor

F = number of fatal and/or incapacitating injury crashes

C_i = cost of fatal and/or incapacitating injury crash

I = number of non-incapacitating and/or possible injury crashes

C_p = cost of PDO crashes

Y = number of years of crash data

M = change in annual maintenance costs for the proposed project relative to the existing situation

Q = annual change in crash cost savings

A_a = projected average annual ADT at the end of the project service life

A_b = average annual ADT during the year before the project is implemented

The SII formula is the best tool to evaluate the benefit-cost worth and relative priority of the previously discussed and recommended safety improvement countermeasures for the East End Study Area. Table 26 indicates the data input for SII calculations by safety improvement project.

Table 27 gives the priority ranking of safety improvement projects recommended for the East End Study Area by calculated Safety Improvement Index (SII). As can be seen, both the mainlane and intersection improvements on US 90 Alternate are highly cost effective, as well as the Stop-controlled, minor street intersection recommendations. The recommended countermeasures associated with driveway access control for the 6800 Block of Harrisburg Avenue is marginally cost beneficial and well below the SII ranking of the other projects. The cost estimate related to the study and improvements to driveway access at this location is also questionable.

Table 26

Safety Improvement Project Input Data for TTI

Safety Improvement Project	# A+K Crashes	# B+C Crashes	# PDO Crashes	Years of Crash Data	Initial Cost of Project ($1000)	Main Cost of Project ($1000)	Project Service Life	ADT Before Project (1000)	ADT After Project (1000)	Crash Reduction Factor	Present Worth of Project ($1000)
US 90 Alternate Main Lanes Striping/RPM	**2**	**3**	**14**	**1**	**8**	**0**	**3**	**30**	**31.2**	**.30**	**466.7**
US 90 Alternate Intersections Signal/Striping	**2**	**18**	**14**	**1**	**60**	**12**	**10**	**40**	**42**	**.25**	**1641.6**
Stop-controlled Intersections Parking Restrictions	**0**	**28**	**28**	**1**	**46**	**4**	**6**	**5**	**5.25**	**.25**	**714.9**
6800 Harrisburg Driveway Access Controls	**0**	**3**	**7**	**1**	**50**	**5**	**10**	**18**	**18.9**	**.10**	**50.83**

Table 27
Safety Improvement Index
Priority Rankings

Recommended Safety Improvement	Safety Improvement Index (SII)
US 90 Alternate Mainlanes Striping/RPM	**58.34**
US 90 Alternate Intersections Signals/Striping	**27.53**
Stop-controlled Intersections Parking Restrictions	**15.54**
6800 Harrisburg Driveway Access Controls	**1.02**

Chapter 12 – Conclusions/Recommendations

From Chapter 11, utilizing the Safety Improvement Index (SII) as a measure of cost-effectiveness, the recommended countermeasures of striping and raised pavement marker application on US 90 Alternate mainlanes are indicated to hold potential to be highly beneficial and a first priority for funding. The US 90 Alternate intersection safety improvements recommended are also highly cost-effective and should be funded as a second priority. While also cost-beneficial, the recommended safety improvements associated with parking restrictions to improve sight distance at other Stop-controlled intersections within the East End Study Area will be controversial and potentially the most difficult politically to implement. The last recommended safety improvement countermeasure involving re-designed and constructed driveway access in the 6800 Block of Harrisburg is marginally beneficial at the most conservative of cost estimates.

A meeting was held on October 28, 2003 between TTI staff and representatives from H-GAC, TxDOT, and the City of Houston to discuss these study conclusions and recommendations. The total initial estimated cost for implementation of all recommended engineering safety improvements within the East End Study Area is approximately $160,000 to reduce annual vehicle collisions by approximately 30 crashes representing an estimated annual cost savings of over $550,000. Again, it should be emphasized that these are preventable crashes susceptible to remediation by engineering countermeasures. The preponderance of crashes (and pedestrian/bicycle conflicts) occurring within the East End are behaviorally influenced by speed, alcohol, parental supervision, etc. Remediation or reduction in the frequency of these crashes is dependent and influenced by both increased and diligent law enforcement and/or continued and increased school and community traffic safety education programs.

Other observed and recognized minor safety improvements which could not be related to a specific pattern of crashes were discussed with City of Houston staff. These improvements involved mostly maintenance of existing traffic control devices; i.e., selected crosswalks, and may have or will be addressed through existing programs and/or projects.

Appendices

Appendix A

Area Near Mario Gallegos Elementary School (74th & Harrisburg)

Gallegos Elementary School

Crosswalk at 74th

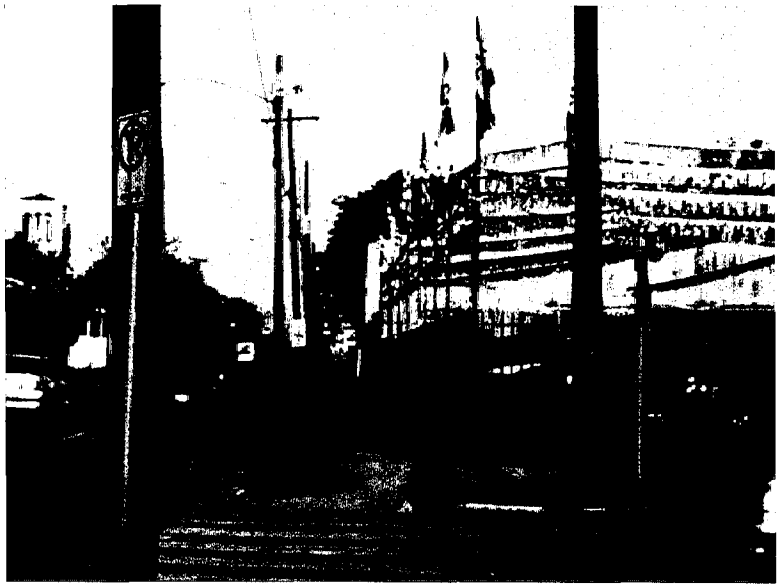
Speed limit zoned 20 or 30 mph
at all schools observed

Sidewalks often, but not always, provided.

Limited pedestrian width and setback (on Harrisburg)

Potholes, rutting, narrow lane widths typical on Harrisburg. May contribute to side-swipe crashes.

Metro stop just off corner. Pedestrians observed crossing here rather than intersection (74th & Harrisburg)

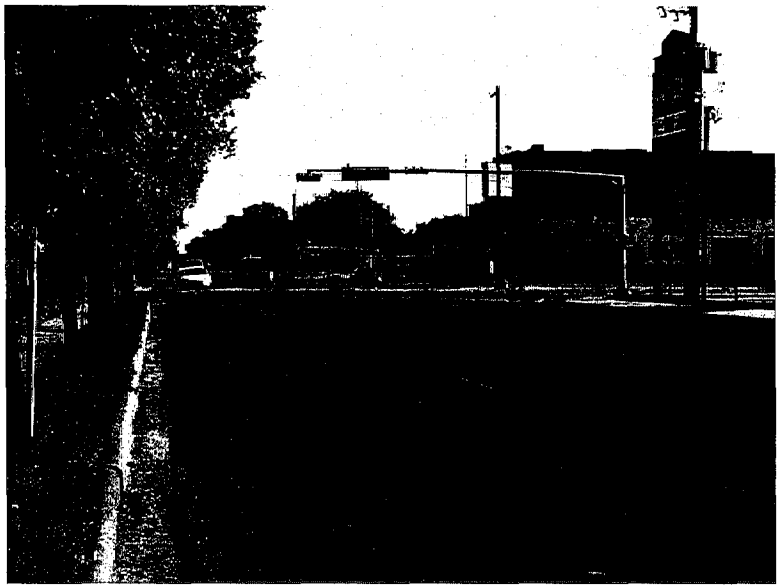


Numerous large trucks (presumably servicing industrial land use areas). Tight radius corners at most intersections may be problem for these vehicles, but also slows entry speed, potentially aiding pedestrian movement.

Near Edna M Carillo Elementary School: Pedestrian gate provided (presumably to provide access to school from residential area behind school).

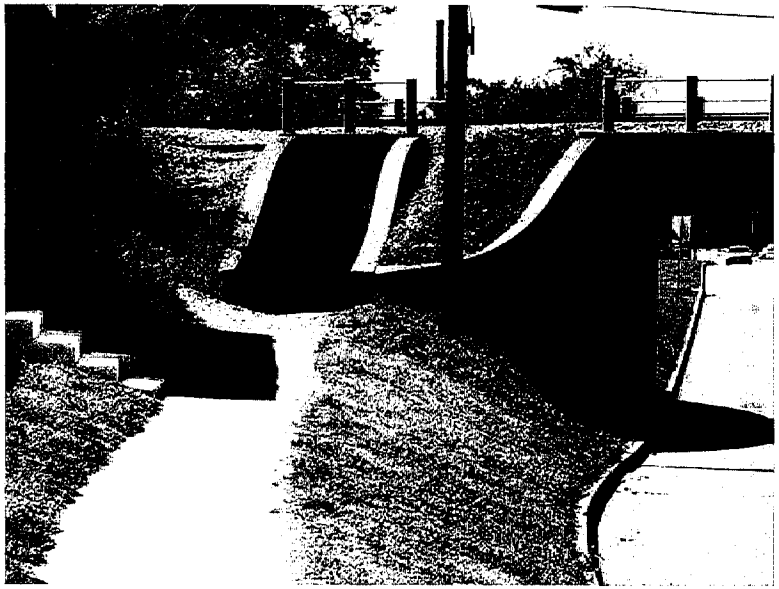
Harrisburg/Wayside/Garcia extension to South

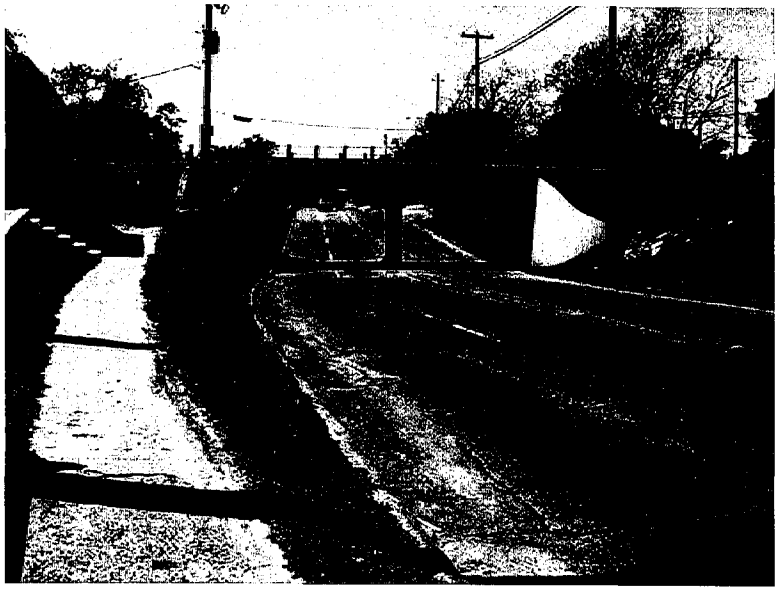
Wayside mid-block cross walk. Note heavy vehicles.



Signal at Harrisburg. Faint/faded lane markings.

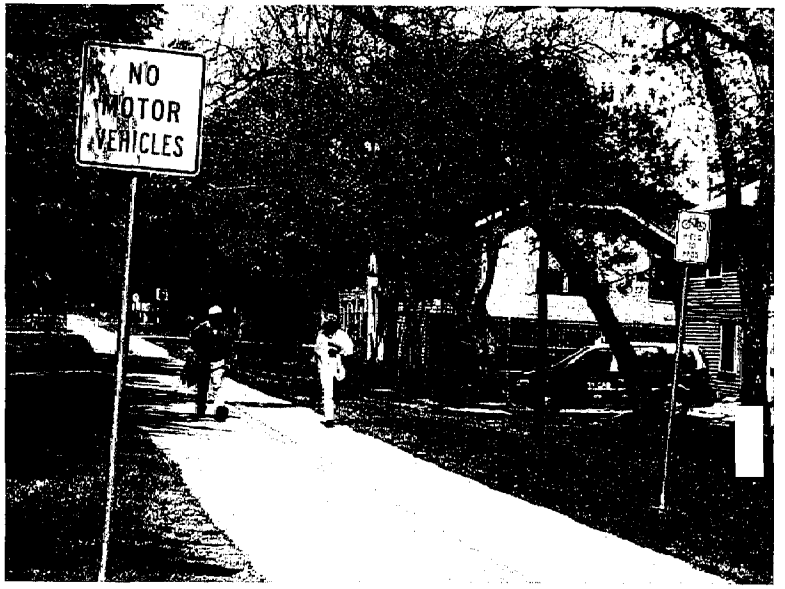
Vegetation obscures some signs – here, a speed limit sign preceding a crosswalk





Southern extension of Wayside/Garcia. Effective separation between pedestrian and vehicle traffic.

Crosswalk indicating pedestrian/bicycle facility intersection with Wayside



Pedestrian/bicycle facility signing

Students exiting Thomas Edison Middle School

Some students use crosswalks & sidewalks – many do not.

Sidewalks in area often in disrepair

Pedestrian gate from school grounds to mid-block on Sgt Garcia

Student use of crosswalks appears more frequent on major streets (e.g., Sgt. Garcia).

Open residential property gates on Ave I obstruct pedestrian use of sidewalks

Bicycle and push cart vendors common around school and elsewhere in area

Potentially hazardous sign placement

Pedestrian signal head obscured by pole from some angles

Appendix B

Appendix B

Major Intersection Crash Summaries

Crash Data – Hard Copy (11/01 – 2/03)

Numbers in parentheses represent factor codes from accident reports [ex: (15)]

Demographics include all parties included in accidents (not the surname of vehicle)

FSGI are those who fail to stop and give insurance (hit and runs)

Intersection 1:

Navigation/Wayside

10 Total Noted Crashes
- All Intersection/intersection related
- Demographics: White=10;Hispanic=6;other=2
  Male=15;Female=3
- FSGI=2
- All auto crashes
- times: 6 day/4 night
- 5 (15, 16) ran red light
  - one incident on wet road surface
- 2 (4) changed lanes when unsafe
- 1 (22) failed to control speed-rear end
- 1 (64) turned improperly-wide right
- 1 (65) turned improperly-wrong lane

Intersection 2:

Navigation/ S_Sgt Macario Garcia

6 Total Noted Crashes
- All Intersection/intersection related
- Demographics: White=6;Hispanic=5
  Male=8;Female=3
- FSGI=1
- 5 auto/1 cyclist
- times: 4 day/2 night
- 3 (65) turned improperly-wrong lane
- 1 (15) ran red light
- 1 (20) driver inattention

1 cyclist involved
1 (22) failed to control speed-rear end

Intersection 3:
Canal/Wayside

11 Total Noted Crashes
All Intersection/intersection related
Demographics: White=19;Hispanic=4
Male=22;Female=1
FSGI=2
All auto crashes
Times: 7 day/4 night
4 (15) ran red light
1 night/rain/wet road surface
2 (65) turned improperly-wrong lane
2 (74) signal lights not working; conflicting statements
1 night/rain/wet road surface
1 (23) failed to drive in a single lane
night/rain/wet road surface
1 (37) failed to yield row-turning left
night/clear/wet road surface
1 unknown

Intersection 4:
Canal/S_Sgt Macario Garcia

12 Total Noted Crashes
All Intersection/intersection related
Demographics: White=15;Hispanic=9
Male=14;Female=10
FSGI=1
11 auto/1 cyclist crashes
Times: 10 day/2 night
4 (15) ran red light
2 (22) failed to control speed
1 rain/wet road surface
2 (4) changed lane when unsafe
1 night
1 (65) turned improperly-wrong lane
1 (74) cyclist failed to yield row
2 unknowns
1 night

Intersection 5:
Capitol/Wayside

6 Total Noted Crashes

All Intersection/intersection related

Demographics: White=4;Hispanic=7;Black=2

Male=8;Female=5

FSGI=1

All auto crashes

Times: all are daytimes

5 (15, 16) ran red light

2 rain/wet road surface

1 rain

1 unknown

rain/wet road surface

Appendix C

Appendix C

Street Corridor Crash Summaries
Crash Data – Hard Copy (11/01 – 2/03)

Numbers in parentheses represent factor codes from accident reports [ex: (15)]
Demographics include all parties included in accidents (not the surname of vehicle)
FSGI are those who fail to stop and give insurance (hit and runs)
Sideswipes: (sd)=same direction; (od)=opposite direction

Ave B
- 1 noted crash
  - Corridor related-parked car
  - 6500 blk
  - Demographics: 1 white male
  - Daytime
  - (3) backed without safety; angled

Ave B/65th
- 1 noted crash
  - Intersection related-fixed object
  - FSGI
  - Daytime

Ave C
- 1 noted crash
  - Corridor related-auto crash
  - 6900 blk
  - Demographics: 1 white male
  - FSGI
  - Daytime
  - (3) backed without safety; angled

Ave C/Wayside
- 3 noted crashes
  - Intersection related-auto crashes
  - Demographics: White=3;Hispanic=3;Male=5;Female=1
  - 3 daytimes
  - 2 (35) failed to yield row-stop sign;1 sideswipe (sd) /1 angled
    - 1 rain/wet road
  - 1 (35,66) failed to yield row-stop sign, turned when unsafe; angled

Ace C/S_Sgt Macario Garcia
- 2 noted crashes
  - Intersection related-auto crashes

Demographics: 2 Hispanic males
2 FSGI
2 nights
2 (35) failed to yield row-stop sign; angled
1 rain/wet road

Ave E

1 noted crash
Corridor related-auto crash
6700 blk
Demographics: White=2; Male=1;Female=1
Daytime
(49) improper start from parked; angled

Ave E/Cesar Chavez (67^{th})

1 noted crash
Intersection related-auto crash
Demographics: Hispanic=1; Black=1; Males=2
Daytime
(35) failed to yield row-stop sign; angled

Ave E/S_Sgt Macario Garcia

2 noted crashes
Intersection related-auto crashes
Demographics: White=4;Male=3;Female=1
1 day/1 night
1 (23) failed to drive in single lane; sideswipe (sd)
1 wet road
1 (4) changed lane when unsafe; sideswipe (sd)

Ave F

6 noted crashes
Corridor related-1 auto, 1 pedestrian, 4 parked cars
6600, 6700, 7000 blk
Demographics: White=2; Hispanic=3; Male=5; Female=1
2 FSGI
4 days/2 nights
3 (3) backed without safety; angled
2 (23) failed to drive in single lane; 2 rear ends
1 (20) driver inattentive; pedestrian

Ave F/Wayside

2 noted crashes
Intersection related-1 auto, 1 pedestrian crash
Demographics: White=1; Hispanic=1; Black=2; Males=4
Daytime
1(35) failed to yield row-stop sign; angled

1 unknown; pedestrian

Ave F/S_Sgt Macario Garcia
2 noted crashes
Intersection related-1 auto, 1 cyclist
Demographics: Hispanic=3; Black=1; Male=2; Female=2
Daytime
1 (20,23) driver inattentive, failed to drive in single lane; sideswipe (sd)
1 unknown; cyclist

Ave H
1 noted crash
Corridor related- parked car
Demographics: 1 White male
Daytime
(23) failed to drive in single lane-sideswipe (sd)

Ave H/67th
1 noted crash
Intersection related-parked car
Demographics: 2 Hispanic males
Night
(23) failed to drive in single lane; sideswipes (sd)

Ave H/70th
1 noted crash
Intersection related-auto crash
Demographics: 2 white females
Night
(35) failed to yield row-stop sign; angled
1 wet road

Ave H/Wooding
1 noted crash
Intersection related-fixed object
Demographics: Hispanic Male
Daytime
(16,22) disregard stop sign or light/failed to control speed

Ave H/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: White=2; Hispanic=2;Males=4
1 FSGI
1 day/1night

1 (35) failed to yield row-stop sign; angled
1 (64) turned improperly -wide right; angled

Ave I

2 noted crashes

Corridor related-parked cars
6500, 6700 blk
Demographics: 1 Hispanic Male
1 FSGI
1 day/1 night
1 (22) failed to control speed; head-on
1 (23) failed to drive in single lane; head-on

Ave I/66th

2 noted crashes

Intersection related-parked cars
Demographics: 1 Hispanic Male
2 FSGI
1 day/1 night
1 (3) backed without safety; angled
1 unknown; angled

Ave I/Cesar Chavez (67th)

2 noted crashes

Intersection related-1 parked car, 1 auto crash
Demographics: Hispanic=2; Black=1; Male=2; Female=1
1 day/1 night
1 (35) failed to yield row-stop sign; angled
1 rain/wet road
1 (3) backed without safety; angled

Ave I/Wayside

2 noted crashes

Intersection related-auto crashes
Demographics: White=2; Hispanic=2; Male=3; Female=1
Daytimes
1 (65) turned improperly –wrong lane; sideswipe (sd)/ angled
1 (4) changed lane when unsafe; sideswipe (sd)

Ave I/S_Sgt Macario Garcia

1 noted crash

Intersection related-auto crash
Demographics: 1 White Male
1 FSGI
Night
(4) changed lane when unsafe; sideswipe (sd)

1 rain/wet road

Ave J

1 noted crash

Corridor related- parked car
Demographics: 2 White males
1 FSGI
Night
(22,23) failed to control speed/failed to drive in single lane; sideswipe (sd)

Ave J/Wayside

1 noted crash

Intersection related-auto crash
Demographics: 2 Hispanic Males
Daytime
(65) turned improperly –wrong lane; angled

Ave J/S_Sgt Macario Garcia

1 noted crash

Intersection related-auto crash
Demographics: Hispanic=2; Male=1; Female=1
Daytime
(65) turned improperly –wrong lane; sideswipe (sd)

Ave K

1 noted crash

Corridor related-auto crash
Demographics: 2 Hispanic Males
Night
(3) backed without safety; angled

Ave K/S_Sgt Macario Garcia

2 noted crashes

Intersection related-auto crashes
Demographics: White=2; Hispanic=2; Male=1; Female=3
1 day/1 night
1 (35) failed to yield row-stop sign; angled
1 (4) changed lane when unsafe; sideswipe (sd)

Ave L

3 noted crashes

Corridor related-parked cars
6600, 6700 blk
Demographics: 1 Hispanic Male; 1 White Female
1 FSGI
1 day/2 nights

1 (23) failed to drive in single lane; sideswipe (od)/ head-on
1 rain/wet roads
1 (22) failed to control speed; sideswipe (sd)
1 rain/wet roads
1 (3) backed without safety; angled

Ave L/Wayside

3 noted crashes

Intersection related-auto crashes
Demographics: White=2; Hispanic=4; Male=2; Female=4
1 FSGI
1 day/2 nights
1 (3,20) backed without safety/ driver inattentive; angled
1 (16) disregard for stop sign or light; angled
1 (3) backed without safety; rear-end

Ave N

3 noted crashes

Corridor related-1 auto, 1 parked car, 1 fixed object
6800-7000 blk
Demographics: White=2; Hispanic=2; Male=3; Female=1
2 days/1 night
1 (26) failed to pass to left safely; angled
1 (20,22) driver inattentive/ failed to control speed; head-on
parked car
1 (23) failed to drive in single lane

Ave N/Wayside

1 noted crash

Intersection related-auto crash
Demographics: Hispanic=2; Male=1; Female=1
1 FSGI
Daytime
(16) disregard for stop sign or signal; angled

Ave O

4 noted crashes

Corridor related-1 pedestrian, 3 parked cars
6600, 6800-6900 blk
Demographics: White=1; Hispanic=1; Male=2
3 FSGI
1 day/3 nights
1 (23) failed to drive in single lane
pedestrian accident
1 (3) backed without safety; angled

2 (22) failed to control speed; 2 rear-ends

Ave O/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: 4 Hispanic Males
1 day/1 night
1 (35) failed to yield row-stop sign; angled
1 (20,23) driver inattentive/ failed to drive in single lane; sideswipe (sd)

Ave O/Wayside
1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Males
Night
(4) changed lane when unsafe; sideswipe (sd)

Ave P
3 noted crashes
Corridor related-parked cars
6600, 6800-6900 blk
3 FSGI
3 days
2 (22) failed to control speed; 1 sideswiped (sd)
1 (3) backed without safety; angled

Ave P/71st
1 noted crash
Intersection related-fixed object
Demographics: 1 White Male
Night
(22) failed to control speed

Ave Q
2 noted crashes
Corridor related-1 parked car, 1 pedestrian
6642, 7000 blk
Demographics: 1 White Female; 1 Hispanic Male
1 FSGI
2 nights
1 (3) backed without safety; rear-end
1 (23) failed to drive in single lane
pedestrian accident

Ave Q/Wayside

3 noted crashes
Intersection related-2 auto, 1 fixed object
Demographics: White=3; Hispanic=2; Male=3; Female=2
3 days
1 (35,48) failed to yield row-stop sign/impaired visibility; angled
1 (20,22) driver inattentive/failed to control speed
fixed object
1 (35) failed to yield row-stop sign; angled
wet road

Ave Q/S_Sgt Macario Garcia
1 noted crash
Intersection related-auto crash
Demographics: 1 White Female
1 FSGI
Night
(35) failed to yield row-stop sign; angled

Ave R
4 noted crashes
Corridor related-2 auto, 1 parked car
6790, 6800 blk
Demographics: White=2; Hispanic=2: Male=4;
3 FSGI
2 day/1 night
2 (22) failed to control speed; 2 rear-ends
1 parked car
1 (74) unable to determine; head-on
1 (3) backed without safety; angled

Ave R/Wayside
3 noted crashes
Intersection related-auto crashes
Demographics: White=3; Hispanic=2; Black=1; Male=4; Female=2
1 day/2 nights
1 (65) turned improperly -wrong lane; sideswipe (sd)
1 (37) failed to yield row-turning left; angled
1 (15) disregard stop and go signal; angled

Ave R/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: White=3; Hispanic=1; Male=2; Female=2
2 days
1 (16) disregard stop sign or light; angled

rain/wet road
1 (22) failed to control speed; rear-end

Ave S
1 noted crash
Corridor related-auto crash
6900 blk
Demographics: 1 Black Male; 1 Hispanic Female
Daytime
(3) backed without safety; rear-end

Ave S/Wayside
2 noted crashes
Intersection related-auto crashes
Demographics: White=1; Hispanic=3; Male=2; Female=2
2 days
1 (37) failed to yield row-turning left; angled
rain/wet road
1 (55, 74) parked in traffic lane/ mechanical failure; angled

Ave T
4 noted crashes
Corridor related-3 parked cars, 1 flying object
6600, 6800 blk
Demographics: 1 Hispanic Male
3 FSGI
2 days/2 nights
1 (22) failed to control speed; rear-end
1 unknown; rear-end
1 (74) other factors; sideswipe
1 (74) flying basketball

Ave U/Wayside
2 noted crashes
Intersection related-auto crashes
Demographics: White=1; Hispanic=1; Black=2; Male=1; Female=3
2 days
1 (65) turned improperly –wrong lane; angled
rain/wet road
1 (4) changed lane when unsafe; sideswipe (sd)

Ave U
1 noted crash
Corridor related-auto crash
6800 blk
Demographics: 2 Black Males

Daytime
(34) failed to yield row-private drive; angled

Capitol
4 noted crashes
Corridor related-1 fixed object, 1 pedestrian, 2 auto crashes
6600-6900 blk
Demographics: White=2; Hispanic=2; Black=2; Male=5; Female=1
1 FSGI
2 days/2 nights
1 (20,23) driver inattentive/failed to drive in single lane
fixed object
1 (28,65) failed to signal or gave wrong signal/turned improperly-wrong lane; sideswipe (sd)
1 (65) turned improperly -wrong lane; sideswipe (sd)
1 (59) pedestrian failed to yield row to vehicle

Capitol/70th
3 noted crashes
Intersection related-auto crashes
Demographics: White=3; Hispanic=2: Male=2: Female=3
3 days
1 (66) turned when unsafe; angled
wet road
1 (29) failed to stop at proper place; angled
1 (57) passed in no passing zone; angled

Canal
5 noted crashes
Corridor related-2 parked cars, 3 auto crashes
6500, 6800, 7000 blk
Demographics: White=6; Hispanic=2; Male=4; Female=4
1 FSGI
2 days/3 nights
1 (20) driver inattentive; rear-end
4 (22) failed to control speed; rear-ends
2 rain/wet road

Canal/66th
2 noted crashes
Intersection related-auto crashes
Demographics: 2 Hispanic Females; 1 White Male
1 FSGI
1 day/1 night
1 (35,74) failed to yield row-stop sign/failed to yield row to vehicle on

the right; angled
1 (35) failed to yield row-stop sign; angled

Harrisburg
Corridor Related
6600-6700 blk
3 noted crashes-1 fixed object, 2 auto crashes
Demographics: White=2; Hispanic=2; Male=3; Female=1
1 FSGI
2 days/1 night
2 (4) changed lanes when unsafe; sideswipes (sd)
1 (22) failed to control speed
fixed object
6800 blk
5 noted crashes-auto crashes
Demographics: White=7; Hispanic=4; Male=6; Female=5
3 days/2 nights
1 (4) changed lanes when unsafe; sideswipe (sd)
rain/wet road
1 (3) backed without safety; rear-end
2 (22) failed to control speed;
angled -rain/wet road
rear-end
1 (34) failed to yield row-private drive; angled

6900 blk
11 noted crashes-auto crashes
Demographics: White=10; Hispanic=9; Male=11; Female=8
5 FSGI
6 days/5 nights
4 (22) failed to control speed; rear-ends
2 rain/wet roads
2 (37) failed to yield row-turning left; angled
1 (22,27) failed to control speed/failed to pass to right safely; angled
1 (33) failed to yield row-open intersection; angled
1 (65) turned improperly -wrong lane; angled
rain/wet road
1 (23) failed to drive in single lane; sideswipe (sd)
1 (29) failed to stop at proper place; angled
7000 blk
3 noted crashes-1 pedestrian, 2 auto crashes
Demographics: White=3; Hispanic=4; Male=5; Female=2
3 days
2 (22) failed to control speed;
angled-1 motorcycle
rear-end

1 (59) pedestrian failed to yield row to vehicle
rain/wet road

Harrisburg/Cesar Chavez(67th)
1 noted crash
Intersection related-auto crash
Demographics: White=2; Male=1; Female=1
Daytime
(22) failed to control speed; rear-end

Harrisburg/S_Sgt Macario Garcia
4 noted crashes
Intersection related-auto crashes
Demographics: White=7; Male=4; Female=3
1 FSGI
1 day/3 nights
2 (22) failed to control speed; rear-ends
2 (15) disregard stop and go signal; angled

Harrisburg/Wayside
1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Males
Night
Unknown factors; angled

Harrisburg/65th
1 noted crash
Intersection related-auto crash
Demographics: 3 White Males
Daytime
(35) failed to yield row-stop sign; angled

Navigation
4 noted crashes
Corridor related-3 auto, 1 parked car
6600, 6800, 7000 blk
Demographics: White=3; Hispanic=4; Male=4; Female=3
1 FSGI
3 days/1 night
1 (23) failed to drive in single lane; sideswipe (sd)
1 (4) changed lanes when unsafe; angled
1 (22) failed to control speed; rear-end
1 (55) parked in traffic lane; sideswipe (sd)
parked car

Navigation/Maltby

1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Males
Daytime
(35) failed to yield row-stop sign; angled

Navigation/Cesar Chavez(67th)
1 noted crash
Intersection related-auto crash
Demographics: 2 White Females; 1 Black Male
Night
(37) failed to yield row-turning left; angled
rain/wet road

S_Sgt Macario Garcia
8 noted crashes
Corridor related-1 cyclist, 7 auto crashes
600, 900-1000, 1300, 1500-1600 blk
Demographics: White=7; Hispanic=7; Male=8; Female=6
3 FSGI
5 days/3 nights
2 (23) failed to drive in single lane; sideswipe (sd)
1 (22,44) failed to control speed/followed too closely; rear-end
1 (22) failed to control speed; rear-end
2 (4) changed lanes when unsafe; sideswipe (sd)
1 (16) disregard stop sign or light; angled
1 (34) failed to yield row-private drive
cyclist accident-muddy road

Sherman
3 noted crashes
Corridor related-1 fixed object, 2 parked car
6700 blk
Demographics: 1 Hispanic Male
2 FSGI
2 days/1night
1 (23) failed to drive in single lane
fixed object-wet road
1 (22) failed to control speed; sideswipe (sd)
parked car
1 unknown factor; sideswipe (sd)

Sherman/Cesar Chavez(67th)
1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Females

Night
(35,20) failed to yield row-stop sign/driver inattentive; angled

Sherman/Wayside
2 noted crashes
Intersection related-auto crashes
Demographics: Hispanic=2; Black=1; Male=2; Female=1
1 FSGI
1 day/1 night
1 (16) diregard stop sign or light; angled
rain/wet road
1 (65) turned improperly –wrong lane; angled

Sherman/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: White=2; Hispanic=2; Males=4
2 days
1 (3) backed without safety; rear-end
1 (20,23) driver inattentive/failed to drive in single lane; sideswipe (sd)

Terminal
1 noted crash
Corridor related-parked car
1100 blk
Demographics: 1 White Female
Daytime
(3) backed without safety; angled
rain/wet road

Terminal/Ave Q
1 noted crash
Intersection related-fixed object
Demographics: 1 White Male
Daytime
(22) failed to control speed

Wayside
12 noted crashes
Corridor related-10 auto crashes, 2 fixed objects
300, 600-700, 900-1000, 1200-1300, 1900-2200 blk
Demographics: White=9; Hispanic=10; Black=2; Asian=1;
Male=17; Female=5
4 FSGI
10 days/2 nights

3 (22) failed to control speed; rear-ends
1 wet road
1 rain/ wet road
4 (4) changed lanes when unsafe; angled/sideswipes (sd)
1 (34) failed to yield row-private drive; angled
1 (22,23) failed to control speed/failed to drive in single lane
fixed object
1 (16) disregard stop sign or light; angled
1 (71) wrong way-one way road; angled
1 (22,43) failed to control speed/fleeing or evading police
fixed object

Wayside/Polk
1 noted crash
Intersection related-auto crash
Demographics: 1 Hispanic Female, 1 Black Male
Daytime
(20,22) driver inattentive/failed to control speed; rear-end/angled

Appendix D

Table D-1. Traffic Volume Data from Texas Transportation Institute.

Hardfile #	Location Description	Keymap	Start Date	Days1	Days2	Weekday	Saturday	Sunday
3957	Navigation EB -- West of Engleke	494-N	11/11/2002	T		4443	0	0
3958	Commerce WB -- near Roberts	494-N	11/11/2002	T		490	0	0
3959	Sampson SB -- South of Rusk	494-S	11/11/2002	T		4883	0	0
3999	York NB -- South of Rusk	494-S	1/24/2003	SU	M	3250	2213	1352
3960	Lockwood SB -- South of Harrisburg	494-T	11/11/2002	T		9764	0	0
4000	Harrisburg WB -- West of 65th	494-U	1/24/2003	SU	M	6644	6988	5277
0	Telephone	494-X				0	0	0
3963	Lawndale EB -- West of Collier	494-X	11/13/2002	HFSU		2682	2527	1821
0	Griggs	534-K				0	0	0
0	Long	534-K				0	0	0
0	Lawndale near Griggs	535-A				0	0	0
0	Lawndale near San Antonio	535-A				0	0	0
0	Broadway near Galveston Rd.	535-F				0	0	0
0	Howard near Galveston Rd.	535-R				0	0	0
3956	Navigation WB -- East of Engleke	494-N	11/11/2002	T		4618	0	0
3981	Commerce EB -- near Roberts	494-N	12/13/2002	SU	MT	753	508	327
3982	Lockwood NB -- South of RR	494-T	12/13/2002	SU	MT	8407	6515	4829
3961	Harrisburg EB -- West of 65th	494-U	11/11/2002	T		6853	0	0
3984	Wayside SB -- North of Ave C	494-V	12/13/2002	SU	MT	15787	15976	12756
3266	Wayside NB -- South of I-10 East	495-E	9/22/1998	WHFSU		19743	16970	13698
3265	Wayside SB -- North of I-10 East	495-E	9/22/1998	WHFSU		13530	10024	8094
3983	Sgt Macario Garcia NB -- North of Harrisburg	494-V	2/13/2002	SU	MT	17146	16702	13995

Table D-2. Traffic Volume Data from TxDOT.

Sta Loc	Func Class	Posted96	Posted2001	Flag	County
HP5280	1	7740	7590	1	HAR
HP6270	1	6890	5810	1	HAR
HP5137	1	3890	3470	1	HAR
U2246	0	2010	2130	1	HAR
U2243	1	13810	16740	1	HAR
U2244	1	5640	3500	1	HAR
U2317	1	6880	0	0	HAR
U2245	0	450	590	1	HAR
U2312	0	1100	1900	1	HAR
U2313	0	1880	1570	1	HAR
U2314	1	4380	4500	1	HAR
U2315	1	14990	15690	1	HAR
U2319	1	12870	13600	1	HAR
U2247	1	15610	15510	1	HAR
U2248	1	2190	2250	1	HAR
U2249A	0	400	0	0	HAR
U2311	0	1120	1260	1	HAR
U2350	0	16940	0	0	HAR
U2318	1	34840	34950	1	HAR
U2319	1	12870	13600	1	HAR
U2331	0	1800	1350	1	HAR
U2316	1	29630	30750	1	HAR
U2332	1	15520	17410	1	HAR
U2333	1	9050	8600	1	HAR
U2330	0	1200	1440	1	HAR
U2333A	0	310	0	0	HAR
U2309	1	33880	35370	1	HAR

Appendix E

Table E-1. City of Houston Devices.

Major St	Minor St	Intersection	Dev ID	St Control	Inst Date	Dir1	Year
65th	Ave C	65th & Ave C	1	Ave C	9/10/92		1992
65th	Ave F	65th & Ave F	1	Ave F	9/19/80	WB	1980
65th	Canal	65th & Canal	1	65th	7/10/57		1957
65th	Harrisburg	65th & Harrisburg	1	65th	10/23/53		1953
65th	Sherman	65th & Sherman	1	4 way stop	10/23/00		2000
66th	Ave C	66th & Ave C	1	Ave C	6/3/55		1955
66th	Ave F	66th & Ave F	1	Ave F	5/2/60		1960
66th	Ave I	66th & Ave I	1	Ave I	3/21/85		1985
66th	Ave J	66th & Ave J	1	Ave J	3/13/85		1985
66th	Ave K	66th & Ave K	1	66th	9/28/98	NB	1998
66th	Canal	66th & Canal	1	66th	3/5/51		1951
66th	Capitol	66th & Capitol	1	Capitol	2/16/66	WB	1966
66th	Harrisburg	66th & Harrisburg	1	66th	4/2/51		1951
66th	Sherman	66th & Sherman	1	4 way stop	10/6/97		1997
66th	Texas	66th & Texas	1	Texas	2/16/66		1966
67th	Ave F	67th & Ave F	1	Ave F	10/9/59		1959
67th	Ave H	67th & Ave H	1	Ave H	10/9/59		1959
69th	Capitol	69th & Capitol	1	S. 69th	12/19/62	NB	1962
70th	Ave C	70th & Ave C	1	Ave C	4/27/51		1951
70th	Ave F	70th & Ave F	1	Ave F	2/21/68		1968
70th	Ave H	70th & Ave H	1	70th	7/17/61		1961
70th	Ave I	70th & Ave I	1	70th	12/14/92	NB	1992
70th	Ave N	70th & Ave N	1	Ave N	4/13/93		1993
70th	Ave O	70th & Ave O	1	Ave O	9/15/60		1960
70th	Canal	70th & Canal	1	70th	8/1/55		1955
70th	Capitol	70th & Capitol	1	70th	9/29/47		1947
70th	Harrisburg	70th & Harrisburg	1	70th	10/23/53		1953
70th	Navigation	70th & Navigation	1	70th	10/9/47		1947
70th	Sherman	70th & Sherman	1	70th	9/14/49		1949
71st	Ave C	71st & Ave C	1	Ave C	8/5/87		1987
71st	Ave F	71st & Ave F	1	Ave F	4/4/75		1975
71st	Ave J	71st & Ave J	1	Ave J	3/24/70		1970
71st	Ave N	71st & Ave N	1	Ave N	4/15/58		1958
71st	Ave O	71st & Ave O	1	Ave O	8/2/82		1982
71st	Canal	71st & Canal	1	71st	10/23/53		1953
71st	Capitol	71st & Capitol	1	71st	4/14/72	SB	1972
71st	Harrisburg	71st & Harrisburg	1	71st	10/23/53		1953
71st	Navigation	71st & Navigation	1	71st	10/23/53		1953
71st	Sherman	71st & Sherman	1	Sherman	3/21/58		1958
Ave B	67th	Ave B & 67th	1	Ave B	12/21/99		1999
Ave B	Wayside	Ave B & Wayside	1	Ave B	1/25/65	EB	1965
Ave B	Wayside	Ave B & Wayside	1	Ave B	2/3/94		1994
Ave C	67th	Ave C & 67th	1	Ave C	12/21/99		1999
Ave C	S_Sgt Mac	Ave C & S_Sgt Macario Garcia	1	Ave C	6/27/81		1981
Ave C	Wayside	Ave C & Wayside	1	Ave C	7/23/57		1957
Ave E	S_Sgt Mac	Ave E & S_Sgt Macario Garcia	1	Ave B (ty)	2/3/94		1994
Ave F	S_Sgt Mac	Ave F & S_Sgt Macario Garcia	1	Ave F	6/27/81		1981
Ave F	Wayside	Ave F & Wayside	1	Ave F	7/23/57		1957
Ave H	S_Sgt Mac	Ave H & S_Sgt Macario Garcia	1	Ave H	6/27/81		1981
Ave H	Maltby	Ave H & Maltby	1	Ave H	8/19/76		1976
Ave H	Maltby	Ave H & Maltby	1	Ave H	8/19/76		1976
Ave H	Wayside	Ave H & Wayside	1	Ave H	7/23/57		1957
Ave I	67th	Ave I & 67th	1	Ave I	12/21/99		1999
Ave I	S_Sgt Mac	Ave I & S_Sgt Macario Garcia	1	Ave I	6/27/81		1981

Table E-1. City of Houston Devices (continued).

Ave I	Wayside	Ave I & Wayside	1	Ave I	7/23/57		1957
Ave J	67th	Ave J & 67th	1	Ave J	12/11/99		1999
Ave J	S_Sgt Mac	Ave J & S_Sgt Macario Garcia	1	Ave J	7/8/85	WB	1985
Ave J	S_Sgt Mac	Ave J & S_Sgt Macario Garcia	1	Ave J	6/27/81		1981
Ave J	S_Sgt Mac	Ave J & S_Sgt Macario Garcia	1	Ave J	7/8/85	WB	1985
Ave J	Wayside	Ave J & Wayside	1	Ave J	7/22/57		1957
Ave K	67th	Ave K & 67th	1	Ave K	12/21/99		1999
Ave K	S_Sgt Mac	Ave K & S_Sgt Macario Garcia	1	Ave K	6/27/81		1981
Ave K	Terminal	Ave K & Terminal	1	Ave K	9/20/01	WB	2001
Ave K	Terminal	Ave K & Terminal	1	Ave K	9/20/01	WB	2001
Ave K	Wayside	Ave K & Wayside	1	Ave K	7/22/57		1957
Ave L	67th	Ave L & 67th	1	Ave L	12/21/99		1999
Ave L	S_Sgt Mac	Ave L & S_Sgt Macario Garcia	1	Ave L	6/27/81		1981
Ave L	Wayside	Ave L & Wayside	1	Ave L	7/22/57		1957
Ave N	67th	Ave N & 67th	1	Ave N	12/21/99		1999
Ave N	S_Sgt Mac	Ave N & S_Sgt Macario Garcia	1	Ave N	6/27/81		1981
Ave N	Wayside	Ave N & Wayside	1	Ave N	7/22/57		1957
Ave O	67th	Ave O & 67th	1	Ave O	12/21/99		1999
Ave O	S_Sgt Mac	Ave O & S_Sgt Macario Garcia	1	Ave O	6/27/81		1981
Ave O	Wayside	Ave O & Wayside	1	Ave O	7/22/57		1957
Baldinger	Rusk	Baldinger & Rusk	1	Baldinger	9/7/93		1993
Canal	Maltby	Canal & Maltby	1	Maltby	7/10/57		1957
Canal	Maltby	Canal & Maltby	1	Maltby	7/10/57		1957
Canal	Marsden	Canal & Marsden	1	Marsden	7/10/57		1957
Canal	Oldham	Canal & Oldham	1	Oldham	7/10/57		1957
Capitol	67th	Capitol & 67th	1	4 way stop	12/15/55		1955
Capitol	67th	Capitol & 67th	1	Capitol	12/21/99		1999
67th	Sherman	67th & Sherman	1	Sherman	12/21/99		1999
Harrisburg	Hughes	Harrisburg & Hughes	1	Hughes	10/23/53		1953
Hughes	Texas	Hughes & Texas	1	Texas	9/26/56		1956
S_Sgt Mac	Sherman	S_Sgt Macario Garcia & Sherman	1	Sherman	6/27/81		1981
Mack	Navigation	Mack & Navigation	1	Mack	6/8/59		1959
Maltby	Navigation	Maltby & Navigation	1	Maltby	1/14/54		1954
Maltby	Navigation	Maltby & Navigation	1	Maltby	1/14/54		1954
Marsden	Sherman	Marsden & Sherman	1	Marsden	6/22/53		1953
Navigation	Wooding	Navigation & Wooding	1	Wooding	10/23/53		1953
Navigation	Terminal	Navigation N SR & Terminal	1	Terminal	5/17/71	NB	1971
Navigation	Terminal	Navigation S SR & Terminal	1	Terminal	5/17/71		1971
Sherman	Wayside	Sherman & Wayside	1	Sherman	7/5/49		1949
67th	Harrisburg	67th & Harrisburg	3	All appro	7/1/54		1954
Ave R	S_Sgt Mac	Ave R & S_Sgt Macario Garcia	3	All appro	5/23/56		1956
Canal	S_Sgt Mac	Canal & S_Sgt Macario Garcia	3	All appro	5/3/56		1956
Canal	S_Sgt Mac	Canal & S_Sgt Macario Garcia	3	All appro	5/30/56		1956
Canal	Wayside	Canal & Wayside	3	All appro	7/1/54		1954
Capitol	S_Sgt Mac	Capitol & S_Sgt Macario Garcia	3	All appro	2/26/58		1958
Capitol	S_Sgt Mac	Capitol & S_Sgt Macario Garcia	3	All appro	2/26/58		1958
Capitol	Wayside	Capitol & Wayside	3	All appro	7/1/54		1954
Harrisburg	S_Sgt Mac	Harrisburg & S_Sgt Macario Garcia	3	All appro	7/1/54		1954
Harrisburg	S_Sgt Mac	Harrisburg & S_Sgt Macario Garcia	3	All appro	7/1/54		1954
Harrisburg	Wayside	Harrisburg & Wayside	3	All appro	7/1/54		1954
S_Sgt Mac	Navigation	S_Sgt Macario Garcia & Navigation	3	All appro	7/1/54		1954
S_Sgt Mac	Navigation	S_Sgt Macario Garcia & Navigation	3	All appro	7/1/54		1954
S_Sgt Mac	Polk Ways	S_Sgt Mac Garcia & Polk Wayside	3	All appro	5/30/60		1960
Navigation	Wayside	Navigation & Wayside	3	All appro	7/1/54		1954

Appendix F

Data for Site 1

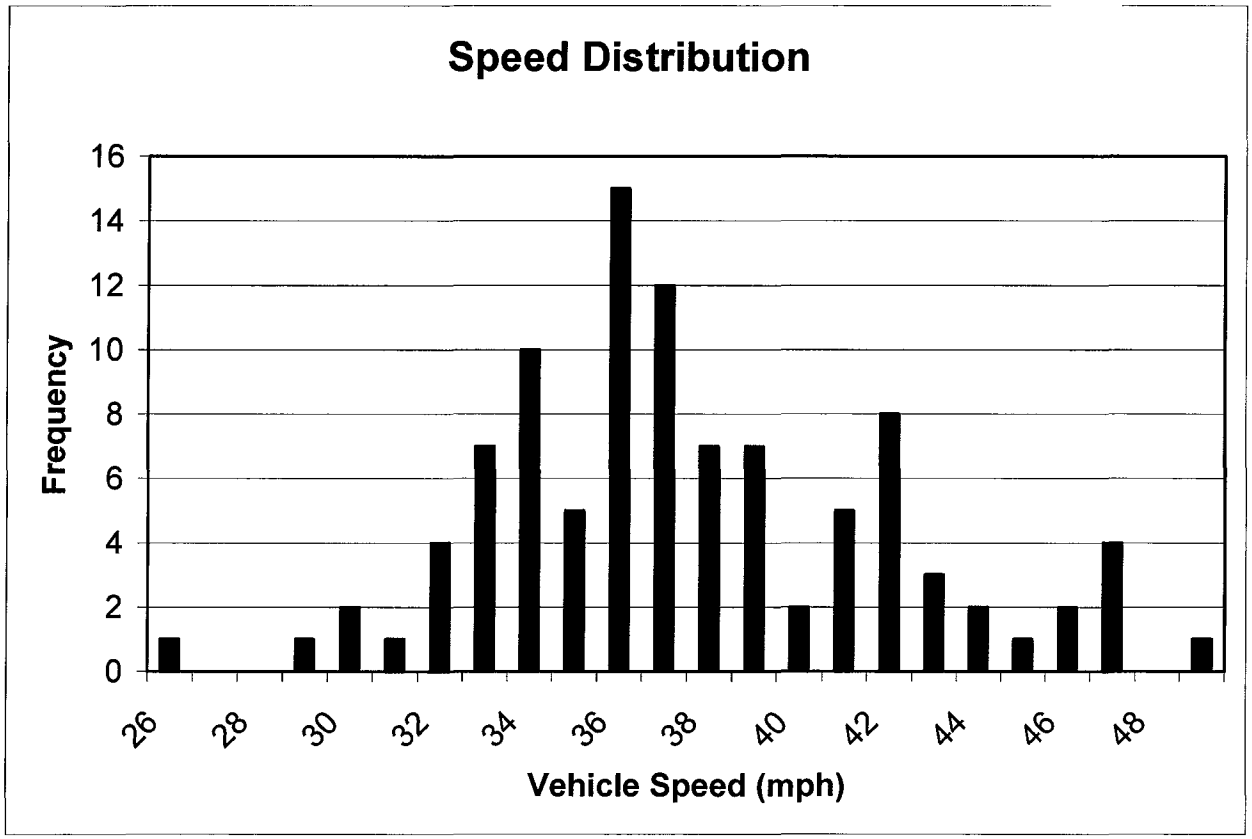
Site Street(s):	Wayside and Navigation, looking SB				
Date:	7/10/03	Lowest Speed:	26	15th Percentile:	33
Start Time:	9:40 AM	Highest Speed:	49	50th Percentile:	36
End Time:	10:25 AM	Average Speed:	37.55	85th Percentile:	42
Direction(s):	SB	Median Speed:	37	95th Percentile:	46
Posted Speed Limit:	40	Modal Speed:	36		
Violation Percent:	26%	Standard Deviation:	4.42		
Number of Lanes:	4	10 mph Pace Speed:	34 to 43		
Types of Vehicles:	cars, trucks	% in Pace Speed:	74%		
Weather Conditions:	clear	% Under Pace Speed:	16%		
Vehicles Observed:	100	% Over Pace Speed:	10%		
Observations:	speed limit sign knocked down at Ave R @ Wayside a year ago, says local				

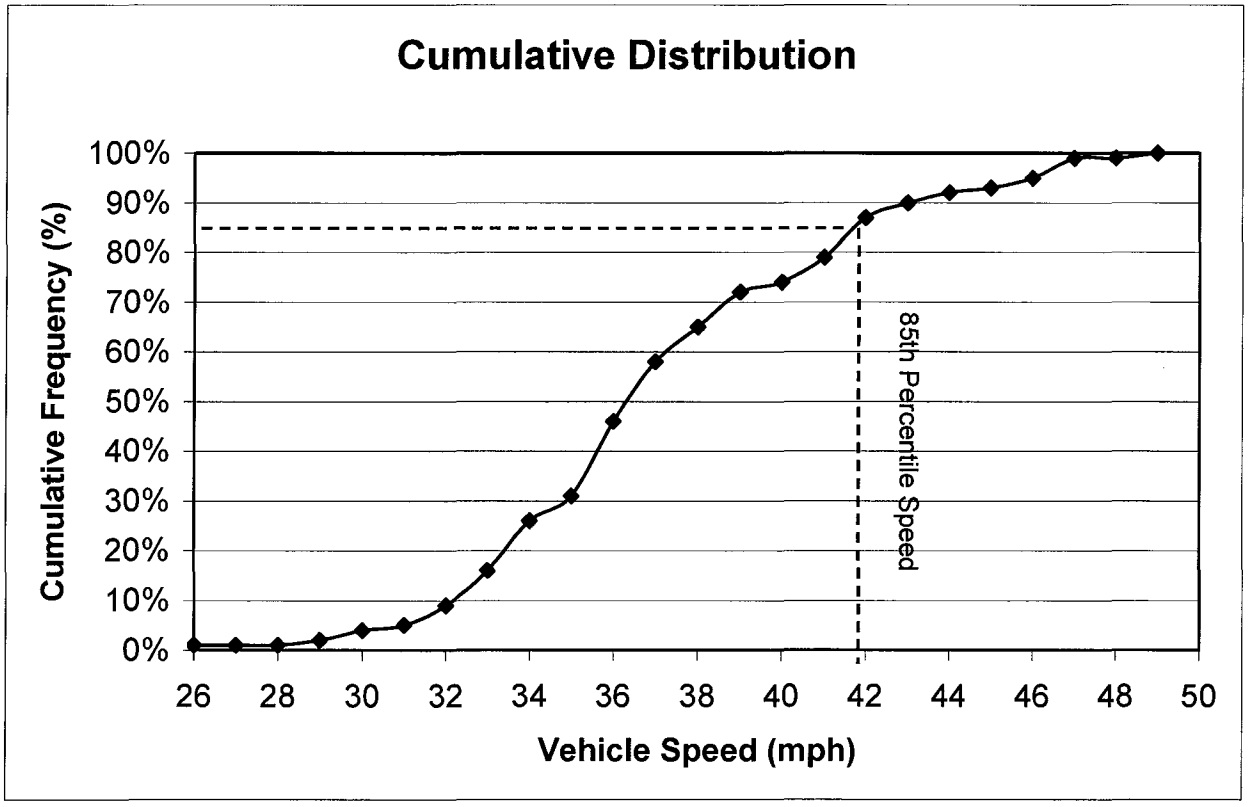
Speeds Recorded:

26	33	35	36	38	41	44
29	34	36	37	38	41	44
30	34	36	37	38	41	45
30	34	36	37	38	41	46
31	34	36	37	38	42	46
32	34	36	37	39	42	47
32	34	36	37	39	42	47
32	34	36	37	39	42	47
32	34	36	37	39	42	47
33	34	36	37	39	42	49
33	34	36	37	39	42	
33	35	36	37	39	42	
33	35	36	37	40	43	
33	35	36	38	40	43	
33	35	36	38	41	43	

Data Analysis:

speed	frequency	% of Speeds	Cumul. %
26	1	1%	1%
27	0	0%	1%
28	0	0%	1%
29	1	1%	2%
30	2	2%	4%
31	1	1%	5%
32	4	4%	9%
33	7	7%	16%
34	10	10%	26%
35	5	5%	31%
36	15	15%	46%
37	12	12%	58%
38	7	7%	65%
39	7	7%	72%
40	2	2%	74%
41	5	5%	79%
42	8	8%	87%
43	3	3%	90%
44	2	2%	92%
45	1	1%	93%
46	2	2%	95%
47	4	4%	99%
48	0	0%	99%
49	1	1%	100%


Speed Distribution
Frequency
16
14
12
10
8
6
4
2
0
26
28
30
32
34
36
38
40
42
44
46
48
Vehicle Speed (mph)


Cumulative Distribution
Cumulative Frequency (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
26
28
30
32
34
36
38
40
42
44
46
48
50
85th Percentile Speed
Vehicle Speed (mph)

Data for Site 2

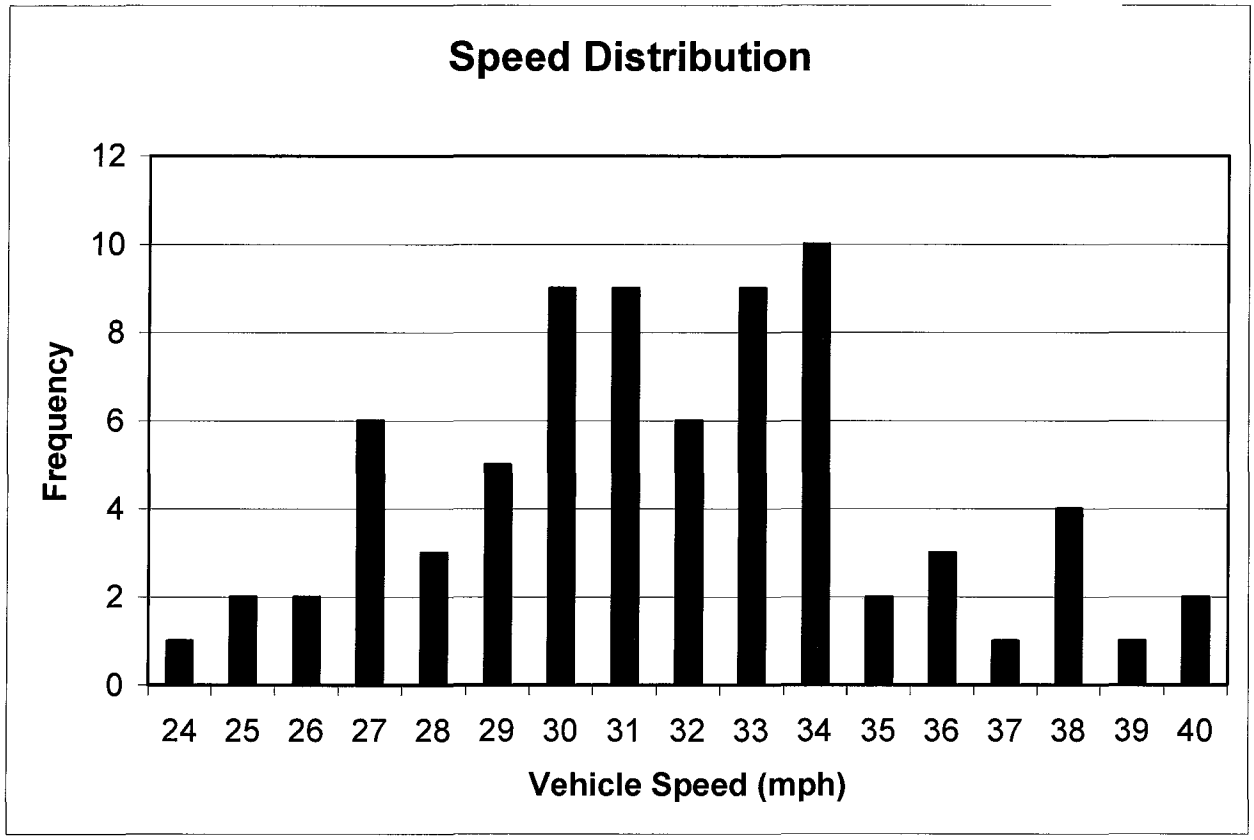
Site Street(s):	Wayside and Navigation, looking EB				
Date:	7/10/03	Lowest Speed:	24	15th Percentile:	27
Start Time:	10:45 AM	Highest Speed:	40	50th Percentile:	31
End Time:	11:45 AM	Average Speed:	31.75	85th Percentile:	34
Direction(s):	EB	Median Speed:	32	95th Percentile:	38
Posted Speed Limit:	35	Modal Speed:	34		
Violation Percent:	15%	Standard Deviation:	3.64		
Number of Lanes:	2 EB, 2 WB	10 mph Pace Speed:	27 to 36		
Types of Vehicles:	cars, trucks	% in Pace Speed:	82.7%		
Weather Conditions:	cloudy, dry	% Under Pace Speed:	6.7%		
Vehicles Observed:	75	% Over Pace Speed:	10.7%		
Observations:	very short light timing on Navigation (12 sec); no chance to really speed				

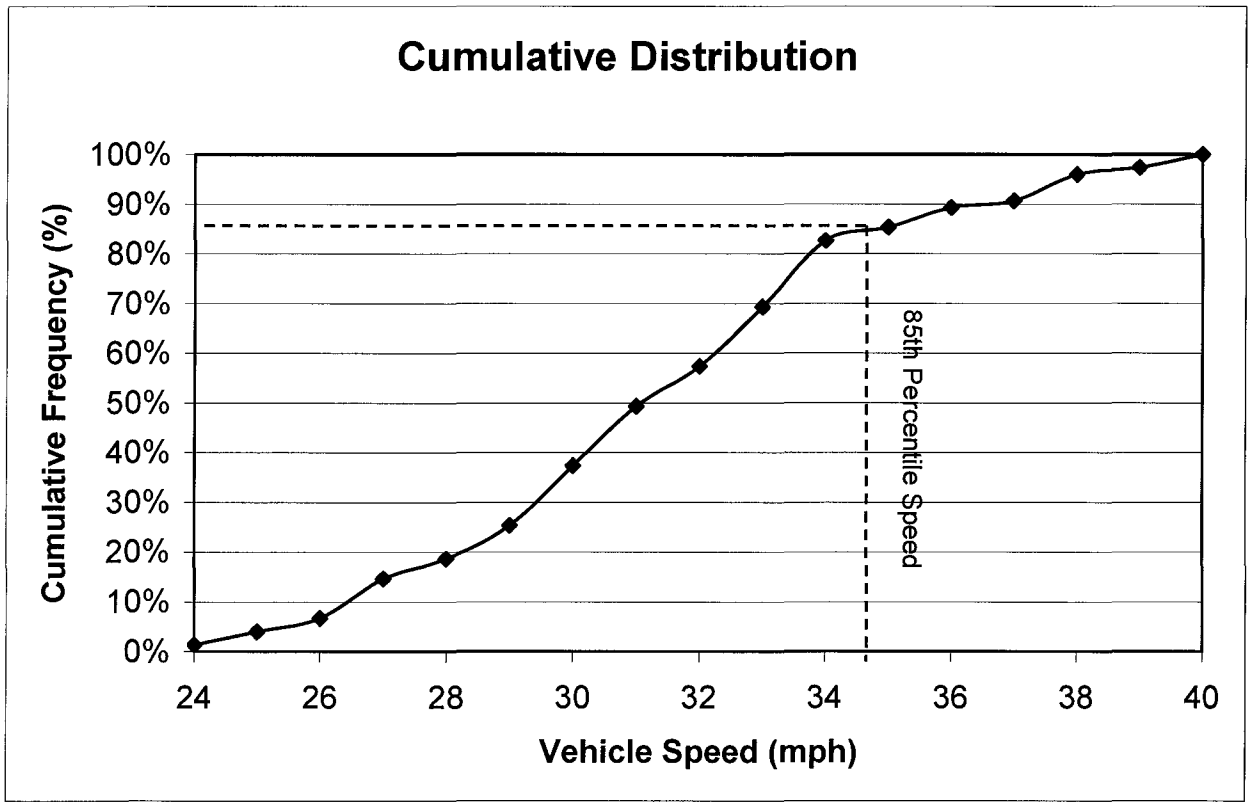
Speeds Recorded:

24	29	31	33	34
25	29	31	33	34
25	29	31	33	35
26	29	31	33	35
26	30	31	33	36
27	30	31	33	36
27	30	31	33	36
27	30	32	34	37
27	30	32	34	38
27	30	32	34	38
27	30	32	34	38
28	30	32	34	38
28	30	32	34	39
28	31	33	34	40
29	31	33	34	40

Data Analysis:

speed	frequency	% of Speeds	Cumulative %
24	1	1%	1%
25	2	3%	4%
26	2	3%	7%
27	6	8%	15%
28	3	4%	19%
29	5	7%	25%
30	9	12%	37%
31	9	12%	49%
32	6	8%	57%
33	9	12%	69%
34	10	13%	83%
35	2	3%	85%
36	3	4%	89%
37	1	1%	91%
38	4	5%	96%
39	1	1%	97%
40	2	3%	100%


Speed Distribution
Frequency
0
2
4
6
8
10
12
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Vehicle Speed (mph)


Cumulative Distribution
Cumulative Frequency (%)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
24 26 28 30 32 34 36 38 40
Vehicle Speed (mph)
85th Percentile Speed

Data for Site 3

Site Street(s):	Wayside and Canal, looking SB				
Date:	7/11/03	Lowest Speed:	26	15th Percentile:	31
Start Time:	9:45 AM	Highest Speed:	50	50th Percentile:	35
End Time:	10:20 AM	Average Speed:	35.98	85th Percentile:	40
Direction(s):	SB	Median Speed:	35.5	95th Percentile:	42
Posted Speed Limit:	40	Modal Speed:	34		
Violation Percent:	16%	Standard Deviation:	4.15		
Number of Lanes:	4	10 mph Pace Speed:	33 to 42		
Types of Vehicles:	cars, trucks	% in Pace Speed:	75%		
Weather Conditions:	clear	% Under Pace Speed:	21%		
Vehicles Observed:	100	% Over Pace Speed:	4%		

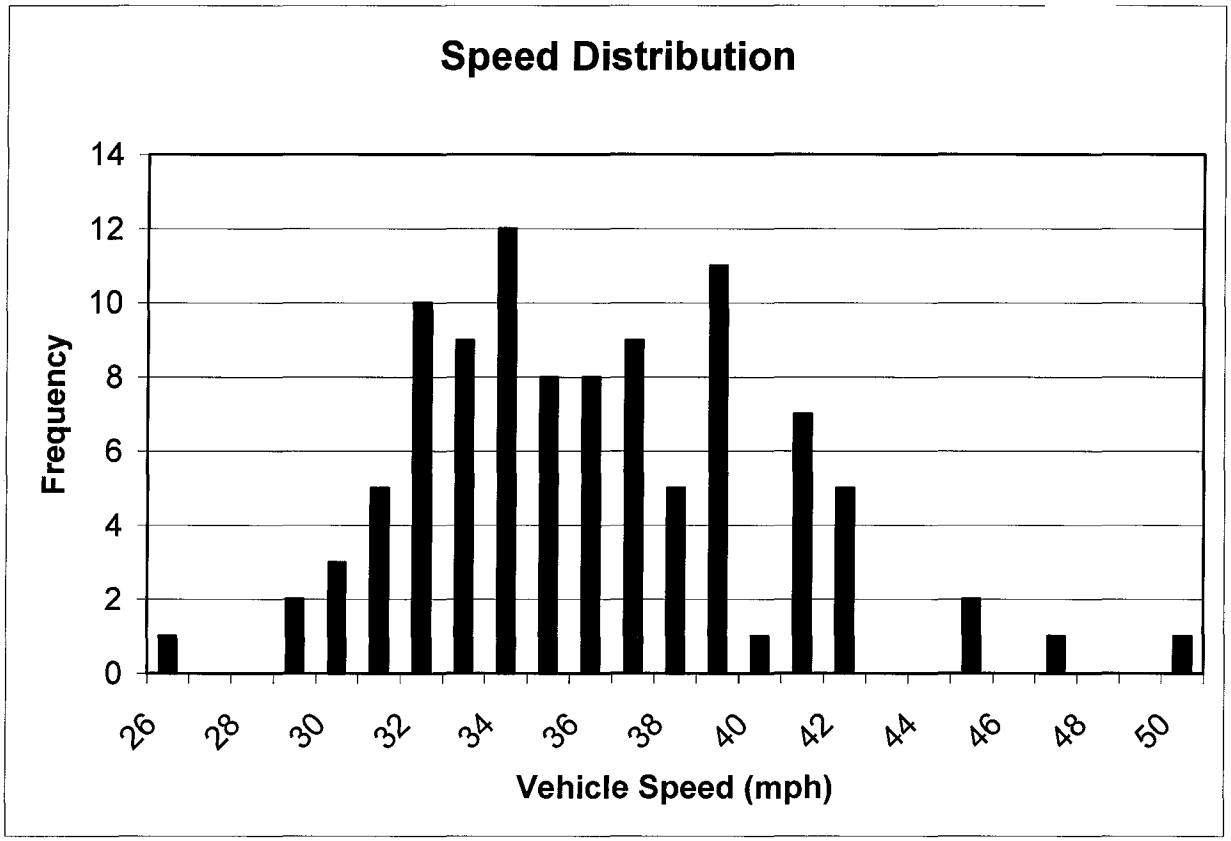
Observations:

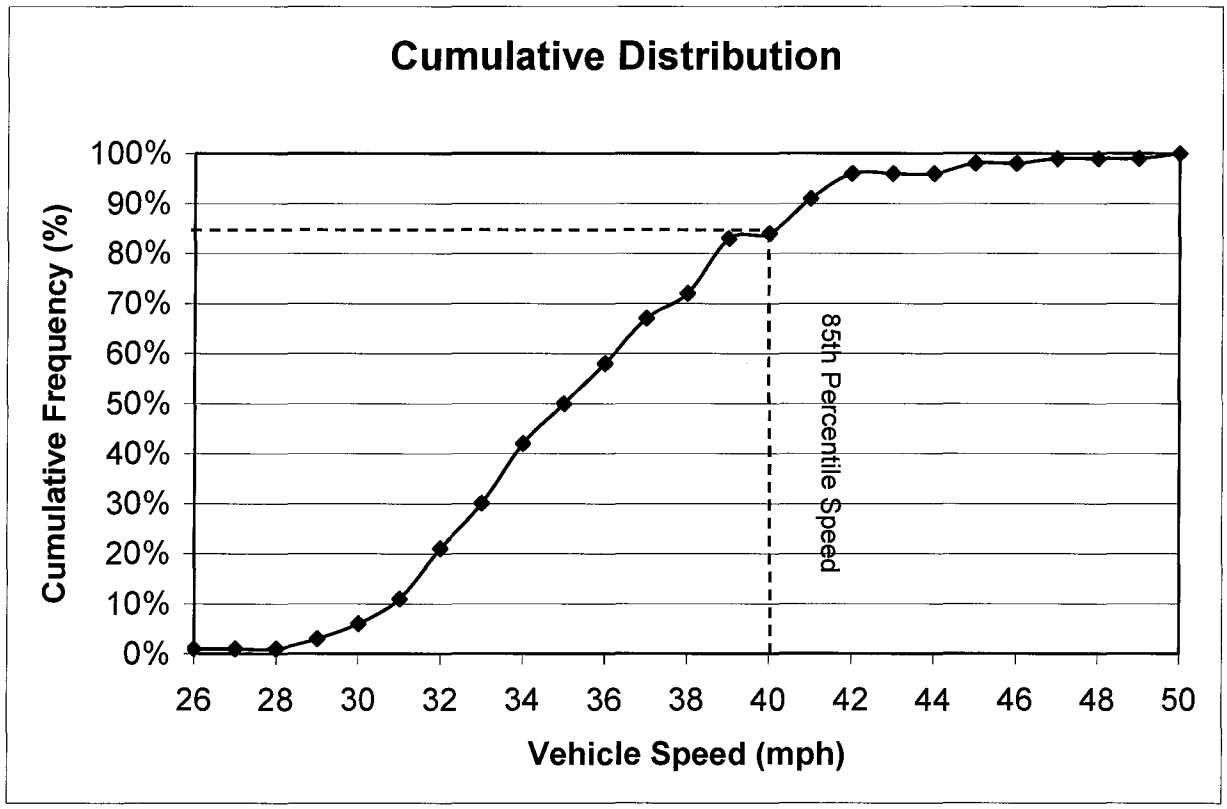
Speeds Recorded:

26	32	34	35	37	39	41
29	32	34	35	37	39	42
29	32	34	35	37	39	42
30	32	34	35	37	39	42
30	32	34	35	37	39	42
30	32	34	36	37	39	42
31	33	34	36	37	39	45
31	33	34	36	38	39	45
31	33	34	36	38	40	47
31	33	34	36	38	41	50
31	33	34	36	38	41	
32	33	34	36	38	41	
32	33	35	36	39	41	
32	33	35	37	39	41	
32	33	35	37	39	41	

Data Analysis:

speed	frequency	% of Speeds	Cumul. %
26	1	1%	1%
27	0	0%	1%
28	0	0%	1%
29	2	2%	3%
30	3	3%	6%
31	5	5%	11%
32	10	10%	21%
33	9	9%	30%
34	12	12%	42%
35	8	8%	50%
36	8	8%	58%
37	9	9%	67%
38	5	5%	72%
39	11	11%	83%
40	1	1%	84%
41	7	7%	91%
42	5	5%	96%
43	0	0%	96%
44	0	0%	96%
45	2	2%	98%
46	0	0%	98%
47	1	1%	99%
48	0	0%	99%
49	0	0%	99%
50	1	1%	100%


Speed Distribution
Frequency
0
2
4
6
8
10
12
14
26
28
30
32
34
36
38
40
42
44
46
48
50
Vehicle Speed (mph)


Cumulative Distribution
Cumulative Frequency (%)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
85th Percentile Speed
26
28
30
32
34
36
38
40
42
44
46
48
50
Vehicle Speed (mph)

Data for Site 4

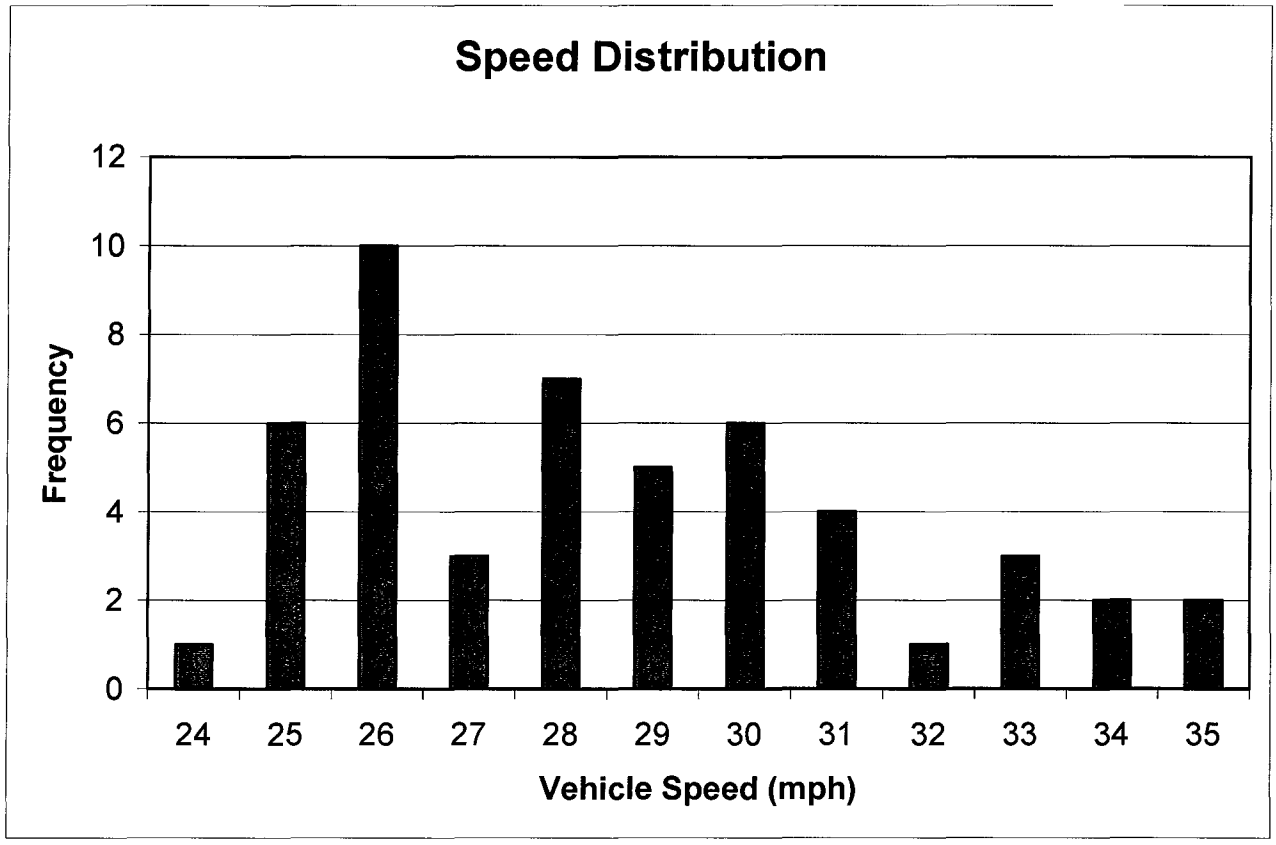
Site Street(s):	Wayside and Canal, looking EB				
Data Collector(s):	LW & H.A.	Lowest Speed:	24	15th Percentile:	25
Date:	7/11/03	Highest Speed:	35	50th Percentile:	28
Start Time:	10:30 AM	Average Speed:	28.58	85th Percentile:	31
End Time:	11:30 AM	Median Speed:	28	95th Percentile:	34
Direction(s):	EB	Modal Speed:	26	Violation Percent:	24%
Posted Speed Limit:	30	Standard Deviation:	2.94		
Number of Lanes:	2 EB, 2 WB	10 mph Pace Speed:	25 to 34		
Types of Vehicles:	cars, trucks	% in Pace Speed:	94%		
Weather Conditions:	clear	% Under Pace Speed:	2%		
Vehicles Observed:	50	% Over Pace Speed:	4%		
Observations:	parking in Rt lane on EB side; lots of driveways and access management issues				

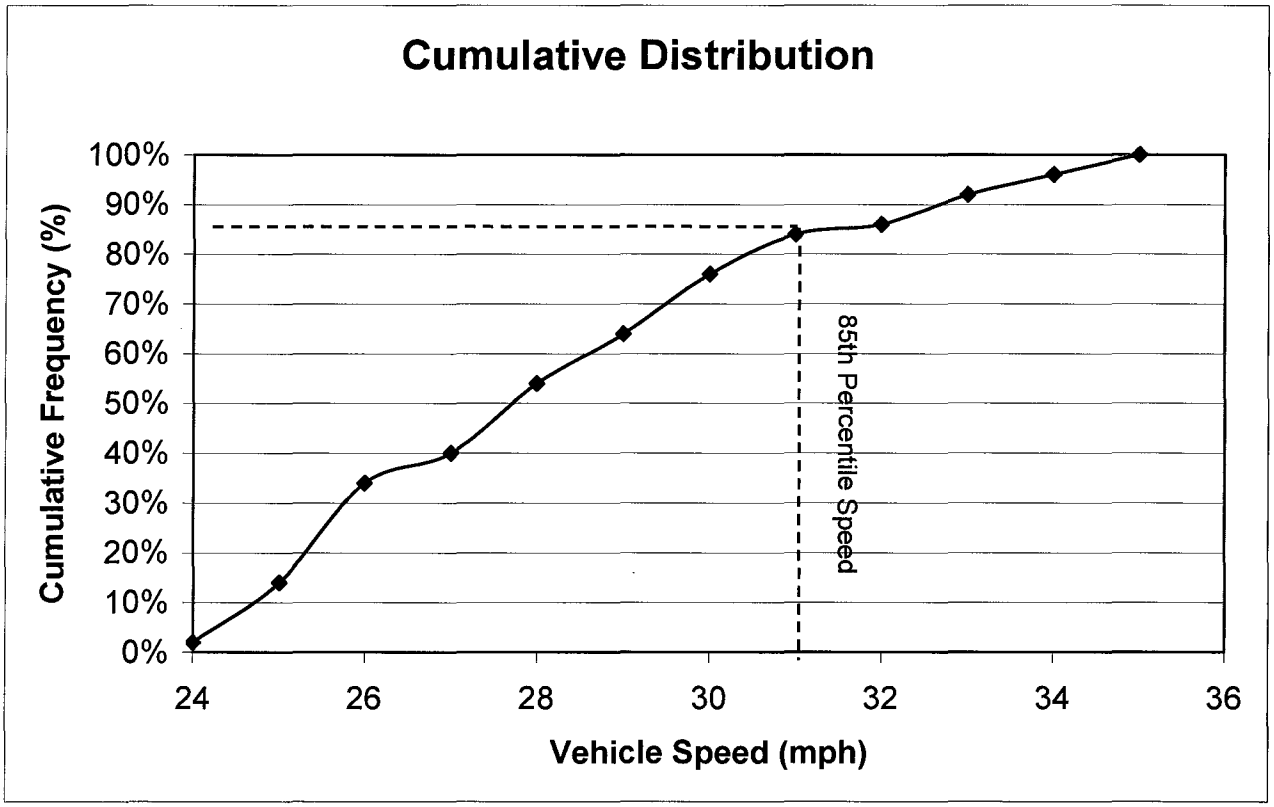
Speeds Recorded:

24	26	29	33
25	26	29	34
25	27	30	34
25	27	30	35
25	27	30	35
25	28	30	
25	28	30	
26	28	30	
26	28	31	
26	28	31	
26	28	31	
26	28	31	
26	29	32	
26	29	33	
26	29	33	

Data Analysis:

speed	frequency	% of Speeds	Cumul. %
24	1	2%	2%
25	6	12%	14%
26	10	20%	34%
27	3	6%	40%
28	7	14%	54%
29	5	10%	64%
30	6	12%	76%
31	4	8%	84%
32	1	2%	86%
33	3	6%	92%
34	2	4%	96%
35	2	4%	100%


Speed Distribution
Frequency
12
10
8
6
4
2
0
24
25
26
27
28
29
30
31
32
33
34
35
Vehicle Speed (mph)


Cumulative Distribution
Cumulative Frequency (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
24
26
28
30
32
34
36
Vehicle Speed (mph)
85th Percentile Speed

Data for Site 5

Site Street(s):	Canal and Sgt. Marcario Garcia, looking EB				
Date:	7/11/03	Lowest Speed:	24	15th Percentile:	25
Start Time:	12:15 PM	Highest Speed:	37	50th Percentile:	28
End Time:	1:15 PM	Average Speed:	28.92	85th Percentile:	32
Direction(s):	EB	Median Speed:	29	95th Percentile:	35
Posted Speed Limit:	30	Modal Speed:	27		
Violation Percent:	26%	Standard Deviation:	3.11		
Number of Lanes:	2 EB, 2 WB	10 mph Pace Speed:	24 to 33		
Types of Vehicles:	cars, trucks	% in Pace Speed:	92%		
Weather Conditions:	clear	% Under Pace Speed:	0%		
Vehicles Observed:	50	% Over Pace Speed:	8%		

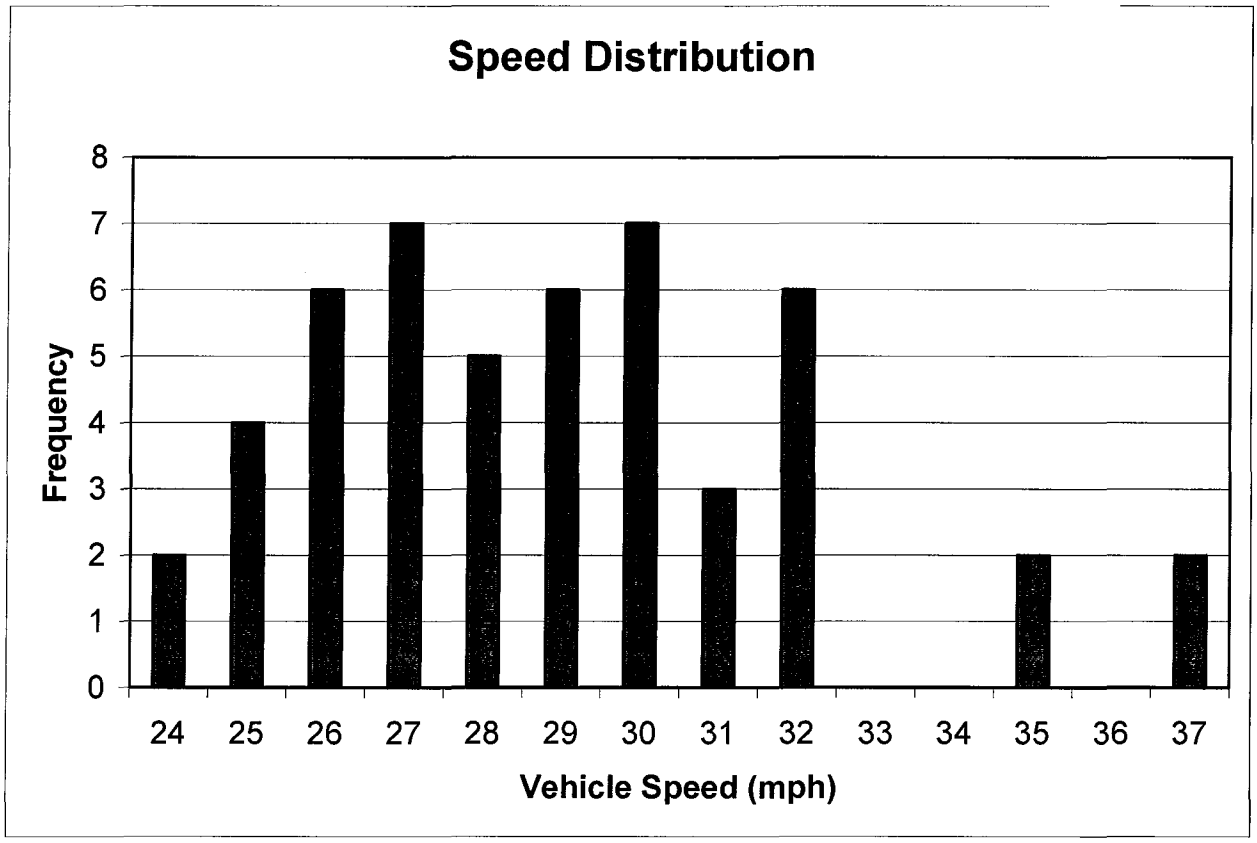
Observations:

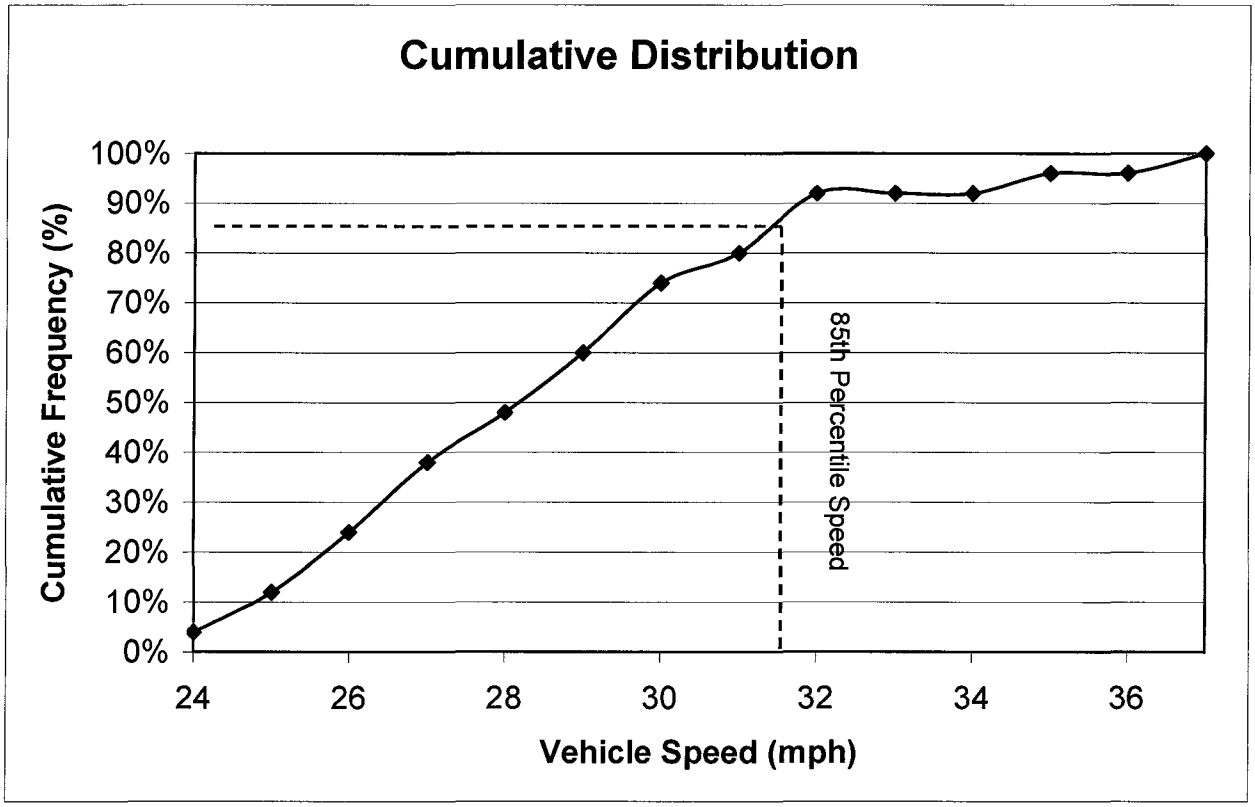
Speeds Recorded:

24	27	30	32
24	27	30	35
25	27	30	35
25	27	30	37
25	28	30	37
25	28	30	
26	28	30	
26	28	31	
26	28	31	
26	29	31	
26	29	32	
26	29	32	
27	29	32	
27	29	32	
27	29	32	

Data Analysis:

speed	frequency	% of Speeds	Cumul. %
24	2	4%	4%
25	4	8%	12%
26	6	12%	24%
27	7	14%	38%
28	5	10%	48%
29	6	12%	60%
30	7	14%	74%
31	3	6%	80%
32	6	12%	92%
33	0	0%	92%
34	0	0%	92%
35	2	4%	96%
36	0	0%	96%
37	2	4%	100%


Speed Distribution
Frequency
0
1
2
3
4
5
6
7
8
24
25
26
27
28
29
30
31
32
33
34
35
36
37
Vehicle Speed (mph)


Cumulative Distribution
Cumulative Frequency (%)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
24
26
28
30
32
34
36
85th Percentile Speed
Vehicle Speed (mph)

Data for Site 6

Site Street(s):	Canal and Sgt. Marcario Garcia, looking NB				
Date:	7/11/03	Lowest Speed:	28	15th Percentile:	30
Start Time:	1:15 PM	Highest Speed:	42	50th Percentile:	34
End Time:	2:00 PM	Average Speed:	34.20	85th Percentile:	38
Direction(s):	NB	Median Speed:	34	95th Percentile:	40
Posted Speed Limit:	40	Modal Speed:	32		
Violation Percent:	4%	Standard Deviation:	3.47		
Number of Lanes:	4	10 mph Pace Speed:	29 to 38		
Types of Vehicles:	cars, trucks	% in Pace Speed:	85%		
Weather Conditions:	clear	% Under Pace Speed:	1%		
Vehicles Observed:	100	% Over Pace Speed:	14%		

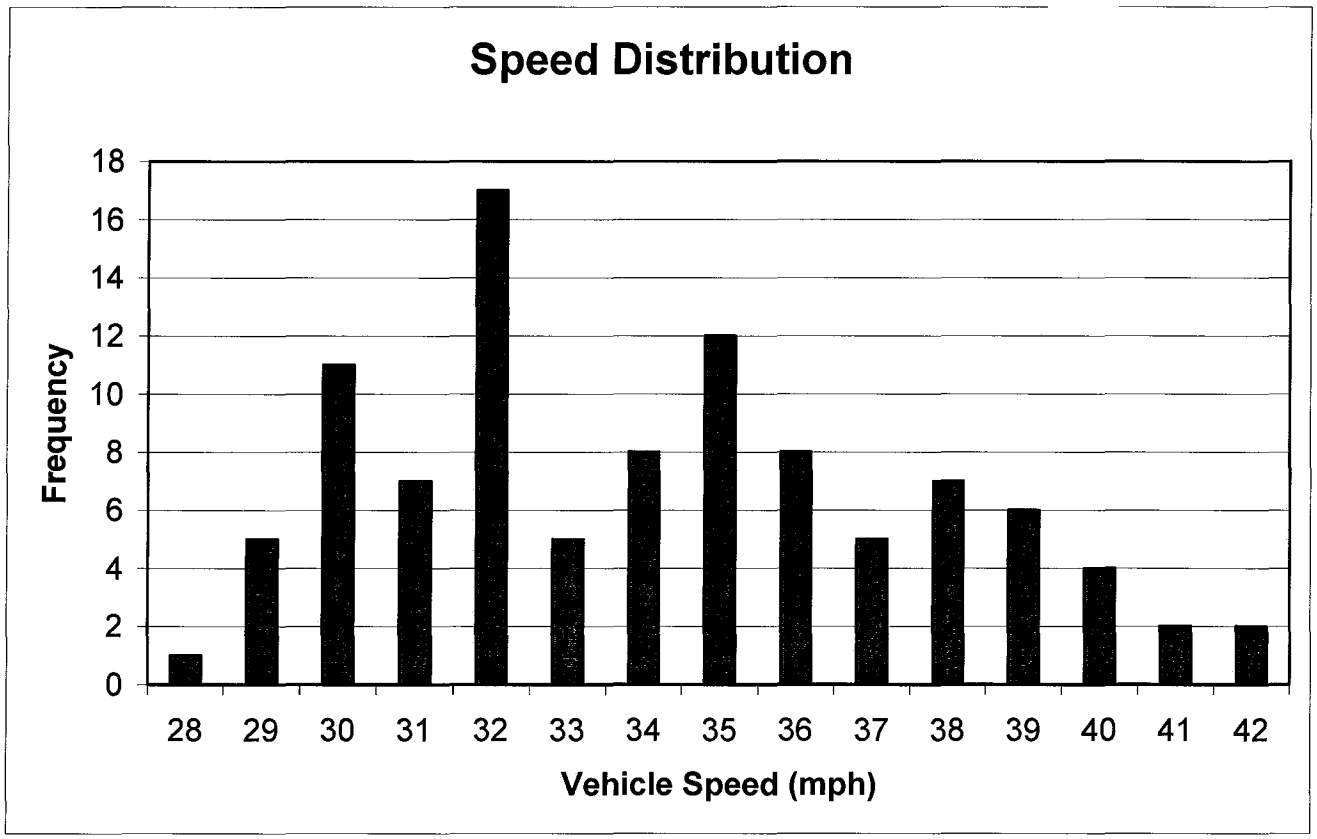
Observations:

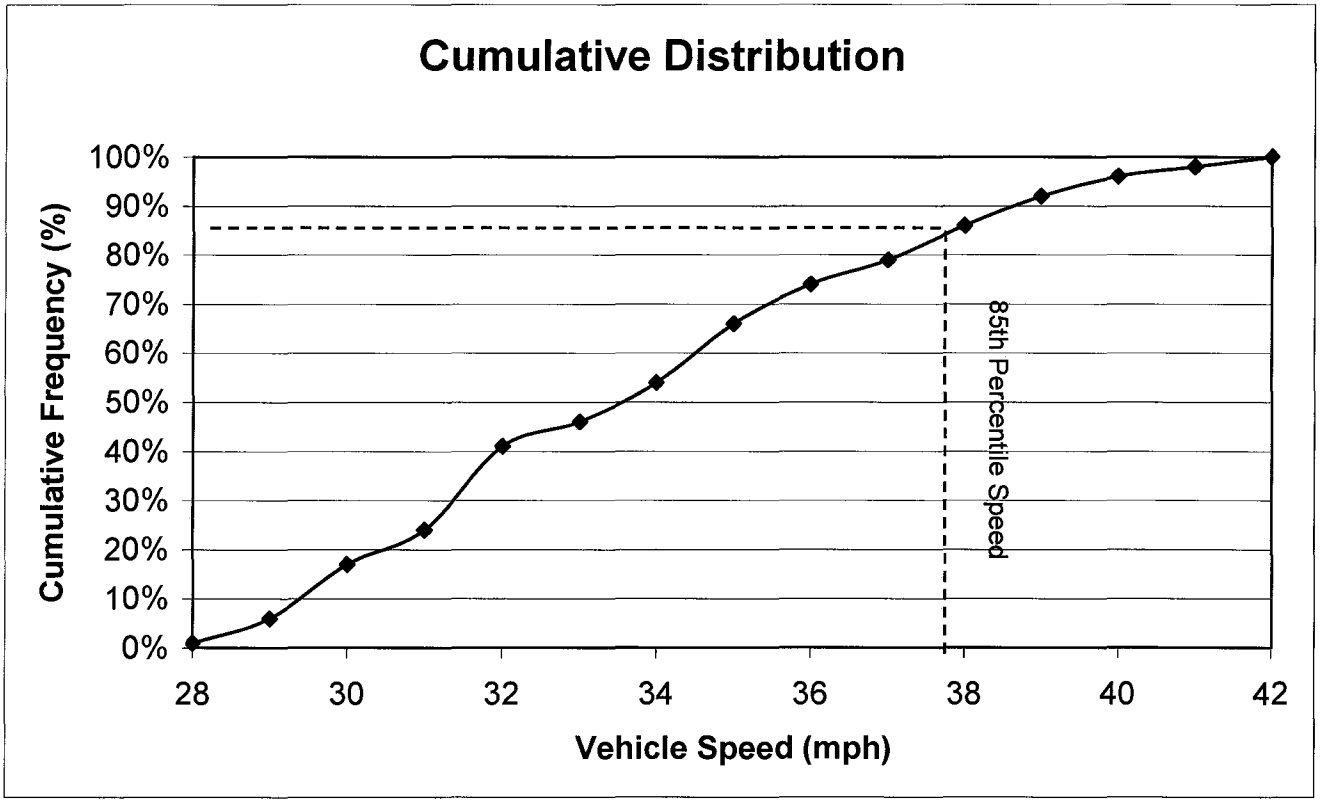
Speeds Recorded:

28	30	32	33	35	37	39
29	30	32	34	35	37	39
29	31	32	34	35	37	40
29	31	32	34	35	37	40
29	31	32	34	35	38	40
29	31	32	34	35	38	40
30	31	32	34	36	38	41
30	31	32	34	36	38	41
30	31	32	34	36	38	42
30	32	32	35	36	38	42
30	32	32	35	36	38	
30	32	33	35	36	39	
30	32	33	35	36	39	
30	32	33	35	36	39	
30	32	33	35	37	39	

Data Analysis:

speed	frequency	% of Speeds	Cumul. %
28	1	1%	1%
29	5	5%	6%
30	11	11%	17%
31	7	7%	24%
32	17	17%	41%
33	5	5%	46%
34	8	8%	54%
35	12	12%	66%
36	8	8%	74%
37	5	5%	79%
38	7	7%	86%
39	6	6%	92%
40	4	4%	96%
41	2	2%	98%
42	2	2%	100%


Speed Distribution
Frequency
0
2
4
6
8
10
12
14
16
18
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
Vehicle Speed (mph)


Cumulative Distribution
Cumulative Frequency (%)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
28
30
32
34
36
38
40
42
85th Percentile Speed
Vehicle Speed (mph)

Data for Site 7

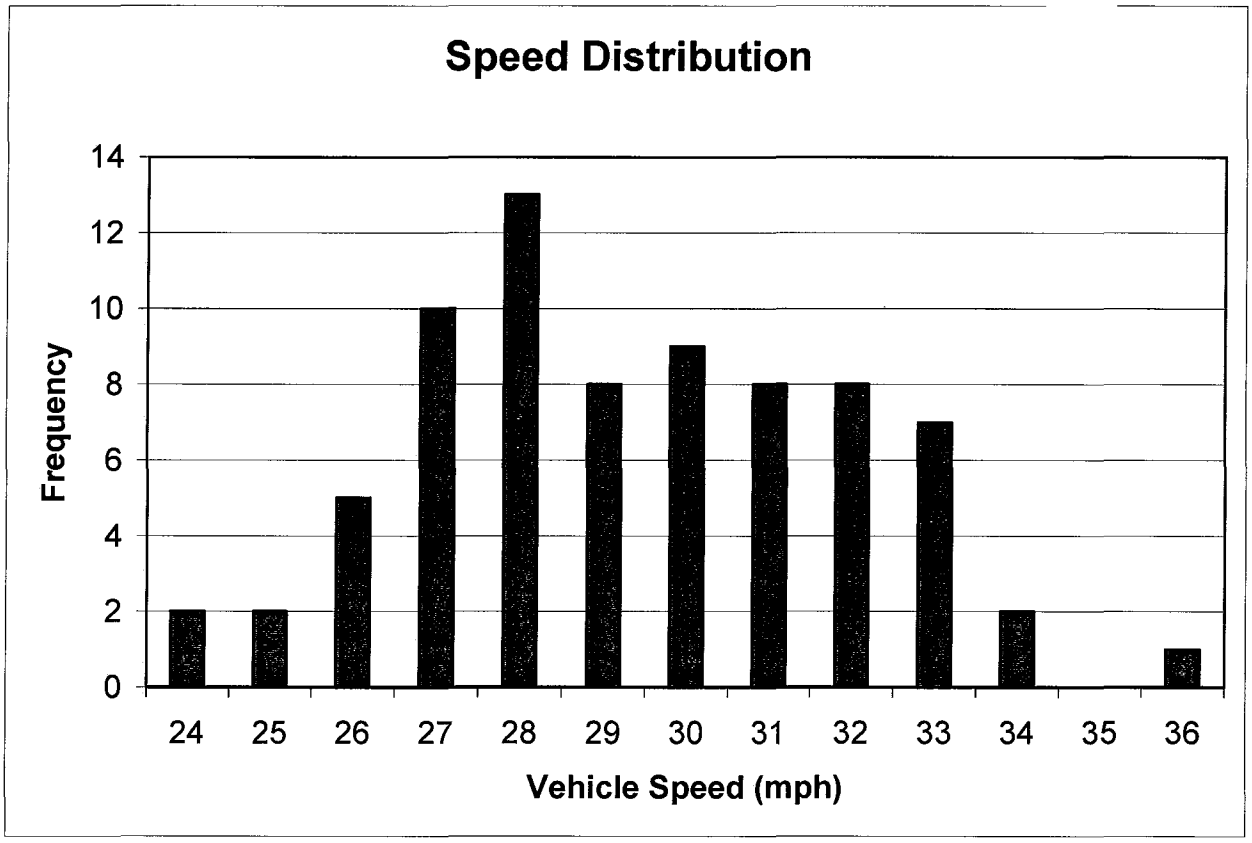
Site Street(s):	Wayside and Capitol, looking SB				
Date:	7/14/03	Lowest Speed:	24	15th Percentile:	27
Start Time:	10:00 AM	Highest Speed:	36	50th Percentile:	29
End Time:	10:35 AM	Average Speed:	29.37	85th Percentile:	32
Direction(s):	SB	Median Speed:	29	95th Percentile:	33
Posted Speed Limit:	40	Modal Speed:	28		
Violation Percent:	0%	Standard Deviation:	2.58		
Number of Lanes:	4	10 mph Pace Speed:	25 to 34		
Types of Vehicles:	cars, trucks	% in Pace Speed:	96%		
Weather Conditions:	clear	% Under Pace Speed:	3%		
Vehicles Observed:	75	% Over Pace Speed:	1%		
Observations:	flattened ped sign by shopping center; lots of peds crossing Wayside; signal timing at Wayside@Harrisburg prevents high speeds at Capitol intersection				

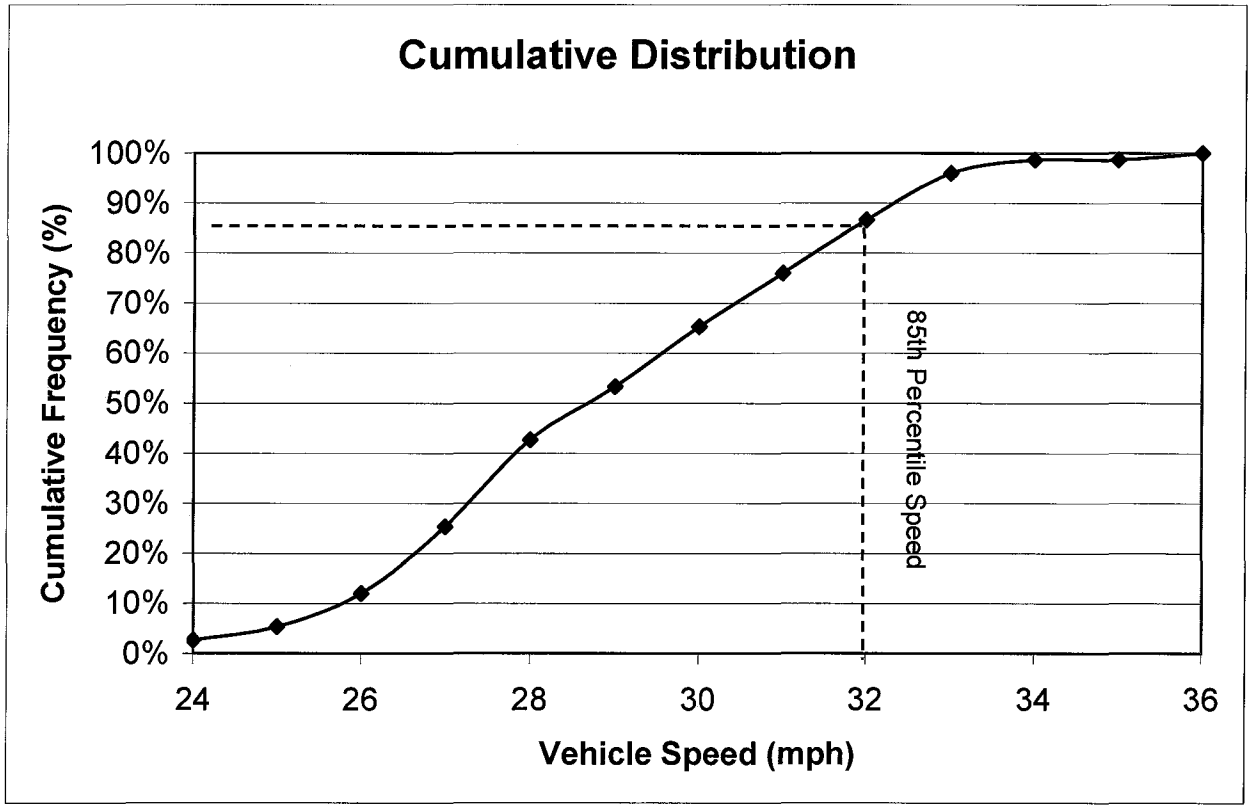
Speeds Recorded:

24	27	28	30	32
24	27	28	30	32
25	27	29	30	32
25	27	29	30	32
26	28	29	31	32
26	28	29	31	33
26	28	29	31	33
26	28	29	31	33
26	28	29	31	33
27	28	29	31	33
27	28	30	31	33
27	28	30	31	33
27	28	30	32	34
27	28	30	32	34
27	28	30	32	36

Data Analysis:

speed	frequency	% of Speeds	Cumul. %
24	2	3%	3%
25	2	3%	5%
26	5	7%	12%
27	10	13%	25%
28	13	17%	43%
29	8	11%	53%
30	9	12%	65%
31	8	11%	76%
32	8	11%	87%
33	7	9%	96%
34	2	3%	99%
35	0	0%	99%
36	1	1%	100%


Speed Distribution
Frequency
14
12
10
8
6
4
2
0
24
25
26
27
28
29
30
31
32
33
34
35
36
Vehicle Speed (mph)


Cumulative Distribution
Cumulative Frequency (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
24
26
28
30
32
34
36
Vehicle Speed (mph)
85th Percentile Speed

Data for Site 8

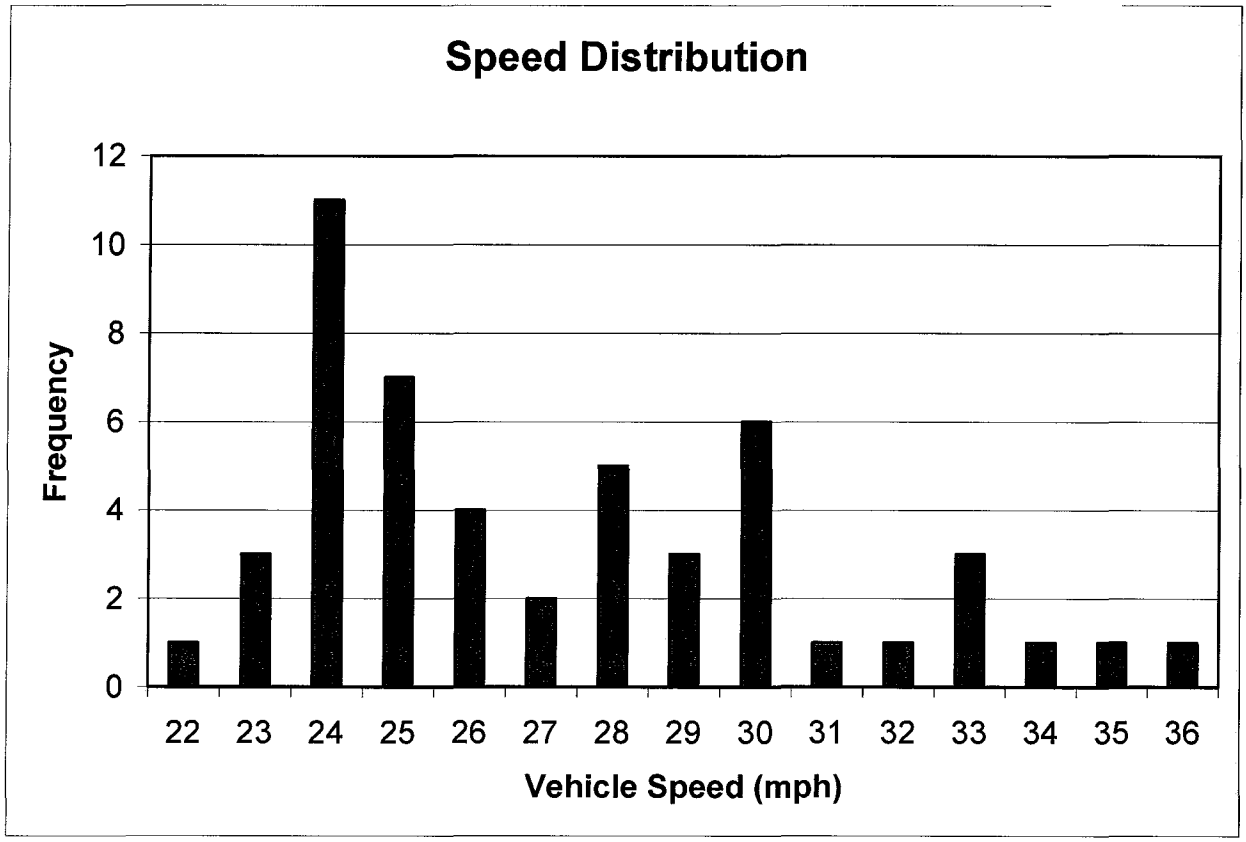
Site Street(s):	Capitol and Wayside, looking WB				
Date:	7/14/03	Lowest Speed:	22	15th Percentile:	23
Start Time:	10:40 AM	Highest Speed:	36	50th Percentile:	26
End Time:	11:25 AM	Average Speed:	27.24	85th Percentile:	30
Direction(s):	WB	Median Speed:	26	95th Percentile:	33
Posted Speed Limit:	30	Modal Speed:	24		
Violation Percent:	16%	Standard Deviation:	3.54		
Number of Lanes:	2 EB, 2 WB	10 mph Pace Speed:	24 to 33		
Types of Vehicles:	cars, buses	% in Pace Speed:	86%		
Weather Conditions:	clear	% Under Pace Speed:	8%		
Vehicles Observed:	50	% Over Pace Speed:	6%		
Observations:	not much traffic; lots of left turns into bank before the intersection				

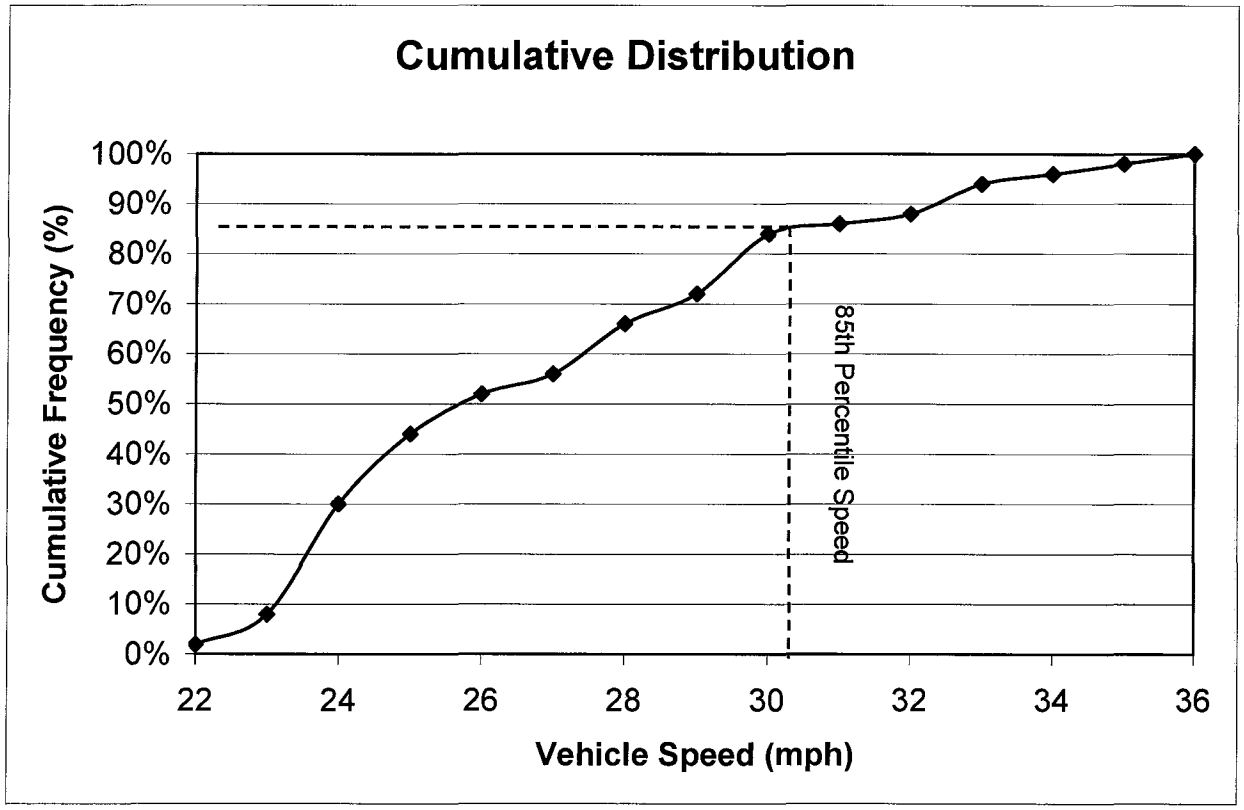
Speeds Recorded:

22	25	28	33
23	25	28	33
23	25	28	34
23	25	29	35
24	25	29	36
24	25	29	
24	25	30	
24	26	30	
24	26	30	
24	26	30	
24	26	30	
24	27	30	
24	27	31	
24	28	32	
24	28	33	

Data Analysis:

speed	frequency	% of Speeds	Cumul. %
22	1	2%	2%
23	3	6%	8%
24	11	22%	30%
25	7	14%	44%
26	4	8%	52%
27	2	4%	56%
28	5	10%	66%
29	3	6%	72%
30	6	12%	84%
31	1	2%	86%
32	1	2%	88%
33	3	6%	94%
34	1	2%	96%
35	1	2%	98%
36	1	2%	100%


Speed Distribution
Frequency
0
2
4
6
8
10
12
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
Vehicle Speed (mph)


Cumulative Distribution
Cumulative Frequency (%)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
85th Percentile Speed
22
24
26
28
30
32
34
36
Vehicle Speed (mph)

Data for Site 9

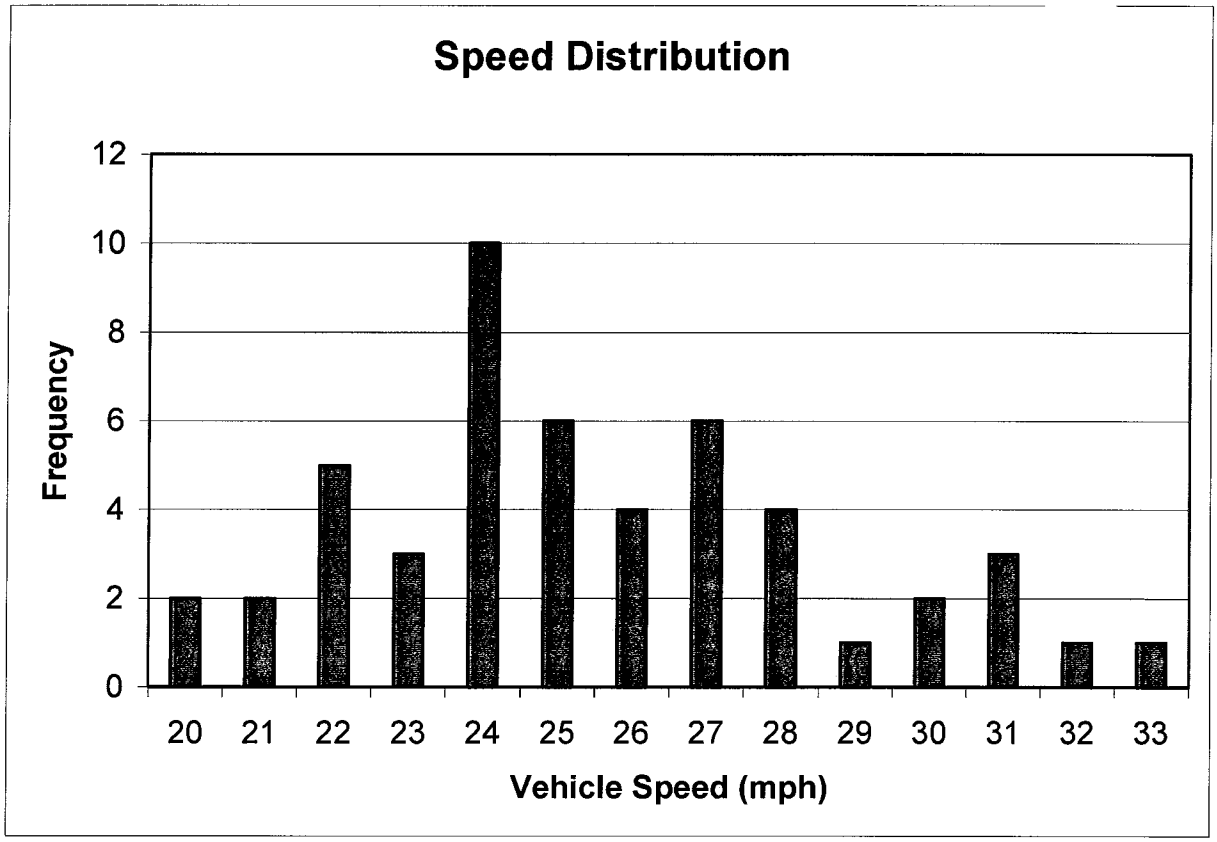
Site Street(s):	Capitol and Wayside, looking EB				
Date:	7/14/03	Lowest Speed:	20	15th Percentile:	22
Start Time:	11:30 AM	Highest Speed:	33	50th Percentile:	25
End Time:	12:20 PM	Average Speed:	25.52	85th Percentile:	28
Direction(s):	EB	Median Speed:	25	95th Percentile:	31
Posted Speed Limit:	30	Modal Speed:	24		
Violation Percent:	10%	Standard Deviation:	3.15		
Number of Lanes:	2 EB, 2 WB	10 mph Pace Speed:	22 to 31		
Types of Vehicles:	cars	% in Pace Speed:	88%		
Weather Conditions:	clear	% Under Pace Speed:	8%		
Vehicles Observed:	50	% Over Pace Speed:	4%		
Observations:	no white lane markings; 2 hr parking in R-lane on EB side; most turn into driveways before intersection; many slow to yield to WB cars turning left onto Wayside				

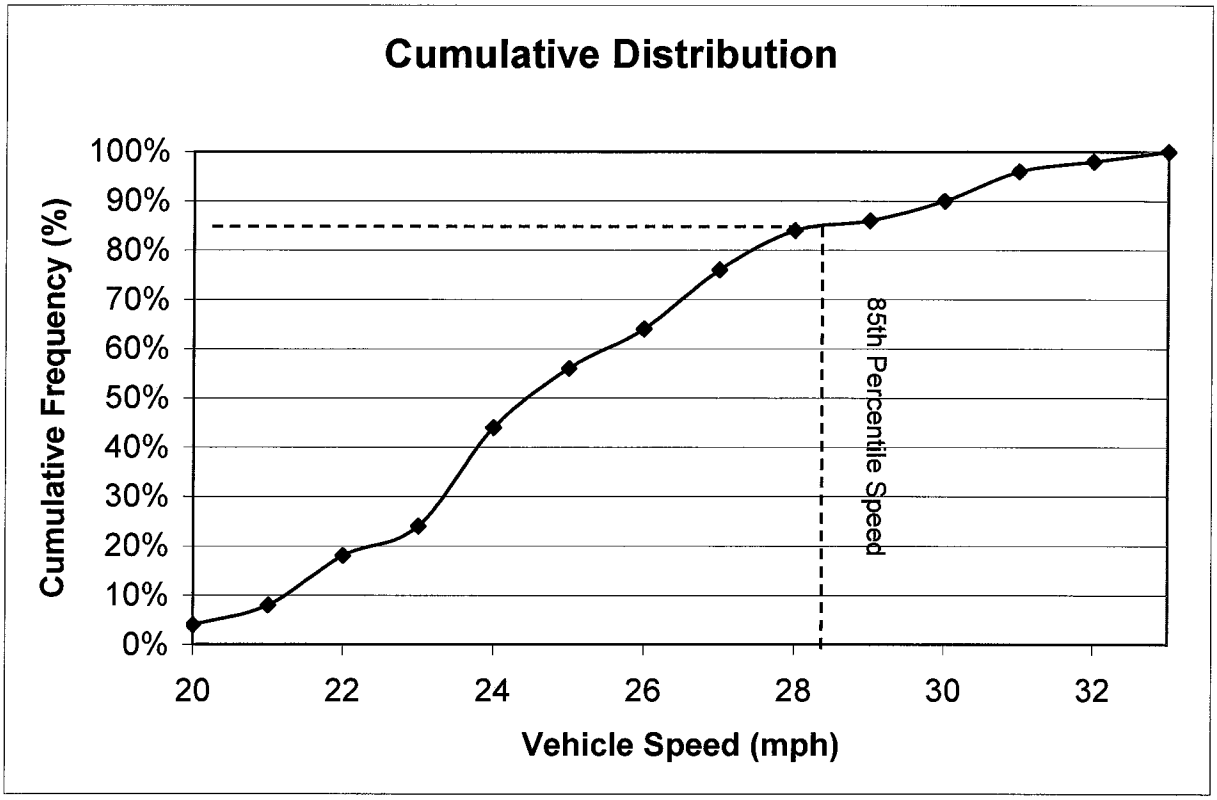
Speeds Recorded:

20	24	26	31
20	24	26	31
21	24	27	31
21	24	27	32
22	24	27	33
22	24	27	
22	24	27	
22	25	27	
22	25	28	
23	25	28	
23	25	28	
23	25	28	
24	25	29	
24	26	30	
24	26	30	

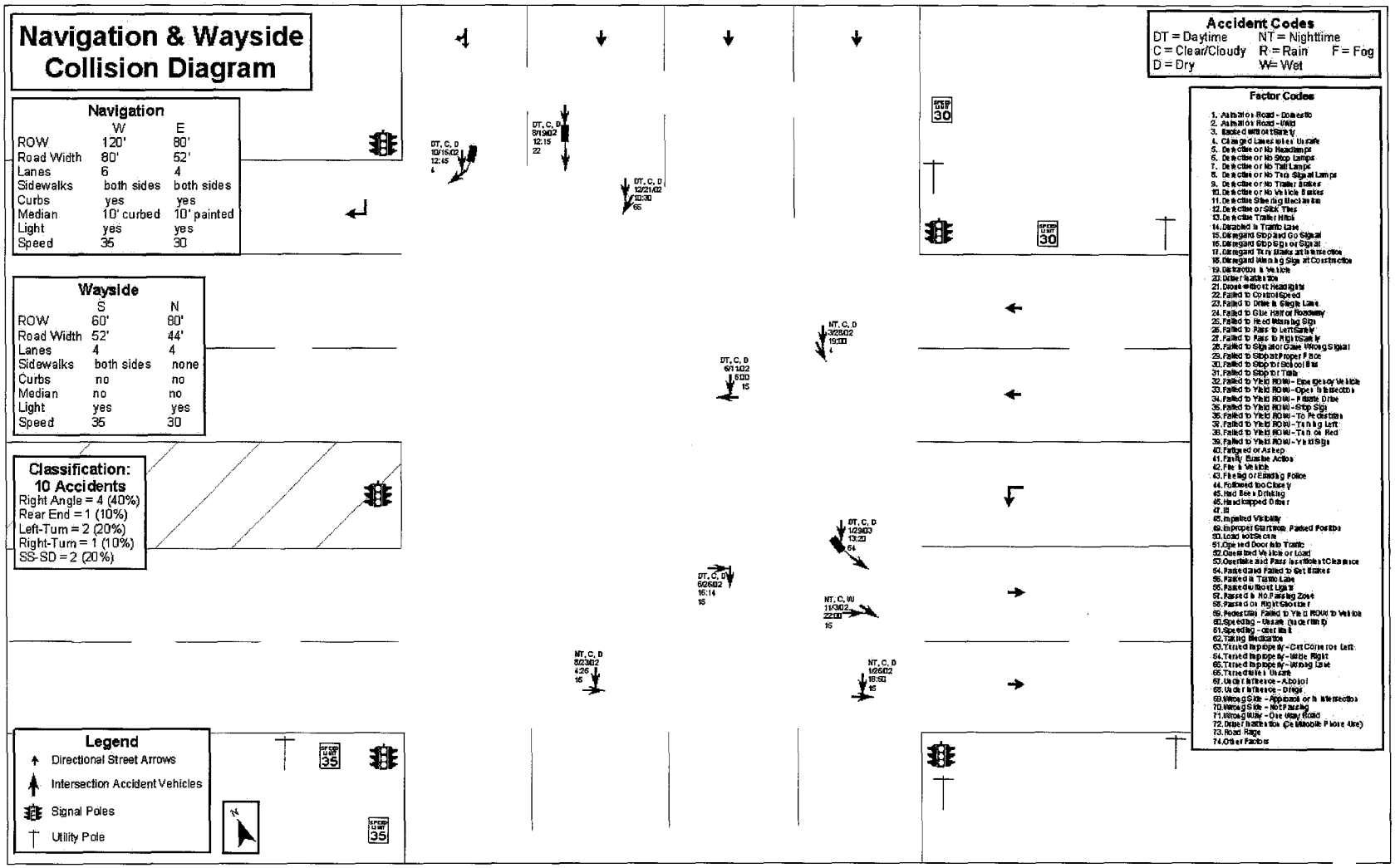
Data Analysis:

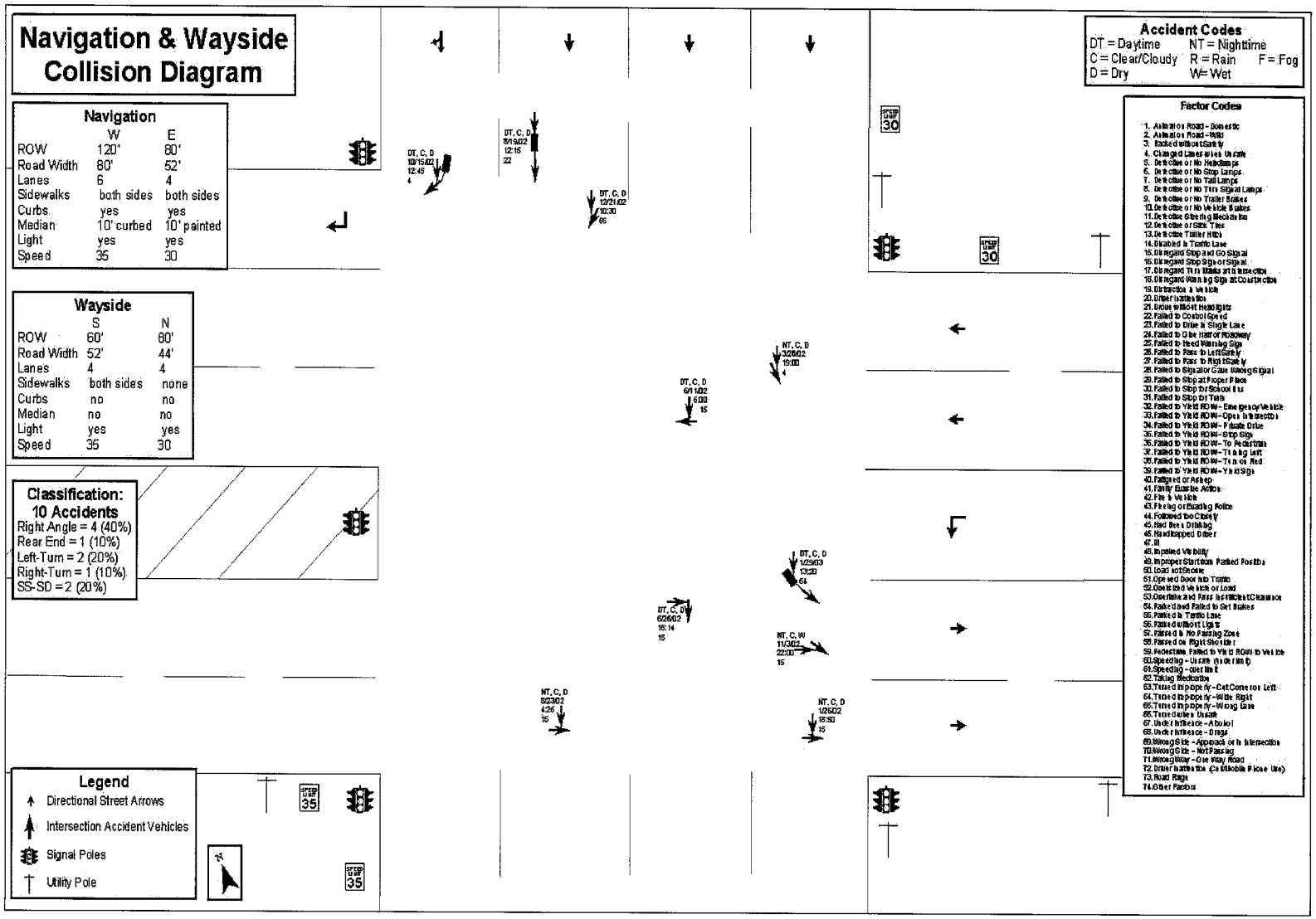
speed	frequency	% of Speeds	Cumul. %
20	2	4%	4%
21	2	4%	8%
22	5	10%	18%
23	3	6%	24%
24	10	20%	44%
25	6	12%	56%
26	4	8%	64%
27	6	12%	76%
28	4	8%	84%
29	1	2%	86%
30	2	4%	90%
31	3	6%	96%
32	1	2%	98%
33	1	2%	100%

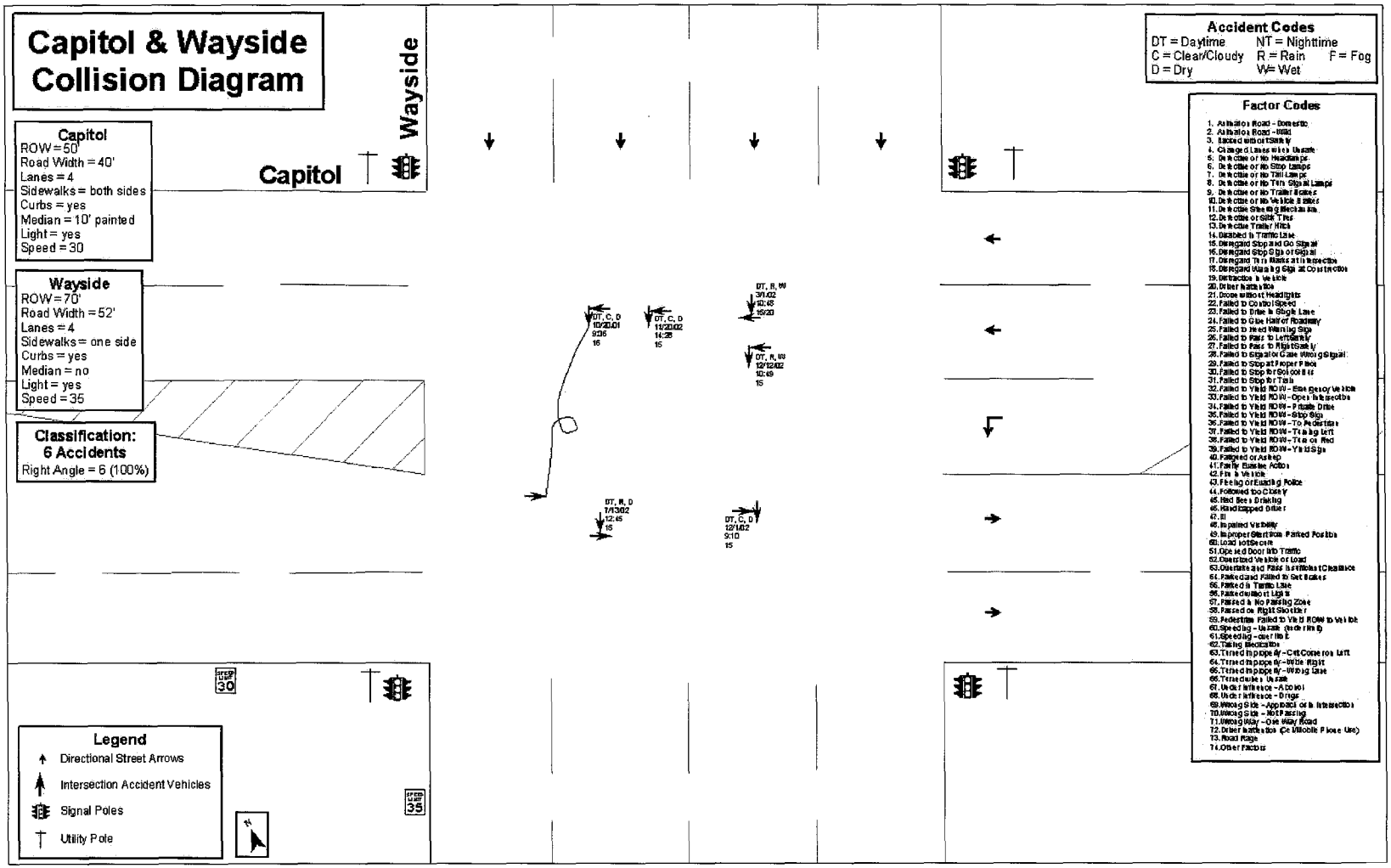

Speed Distribution
Frequency
0
2
4
6
8
10
12
20
21
22
23
24
25
26
27
28
29
30
31
32
33
Vehicle Speed (mph)

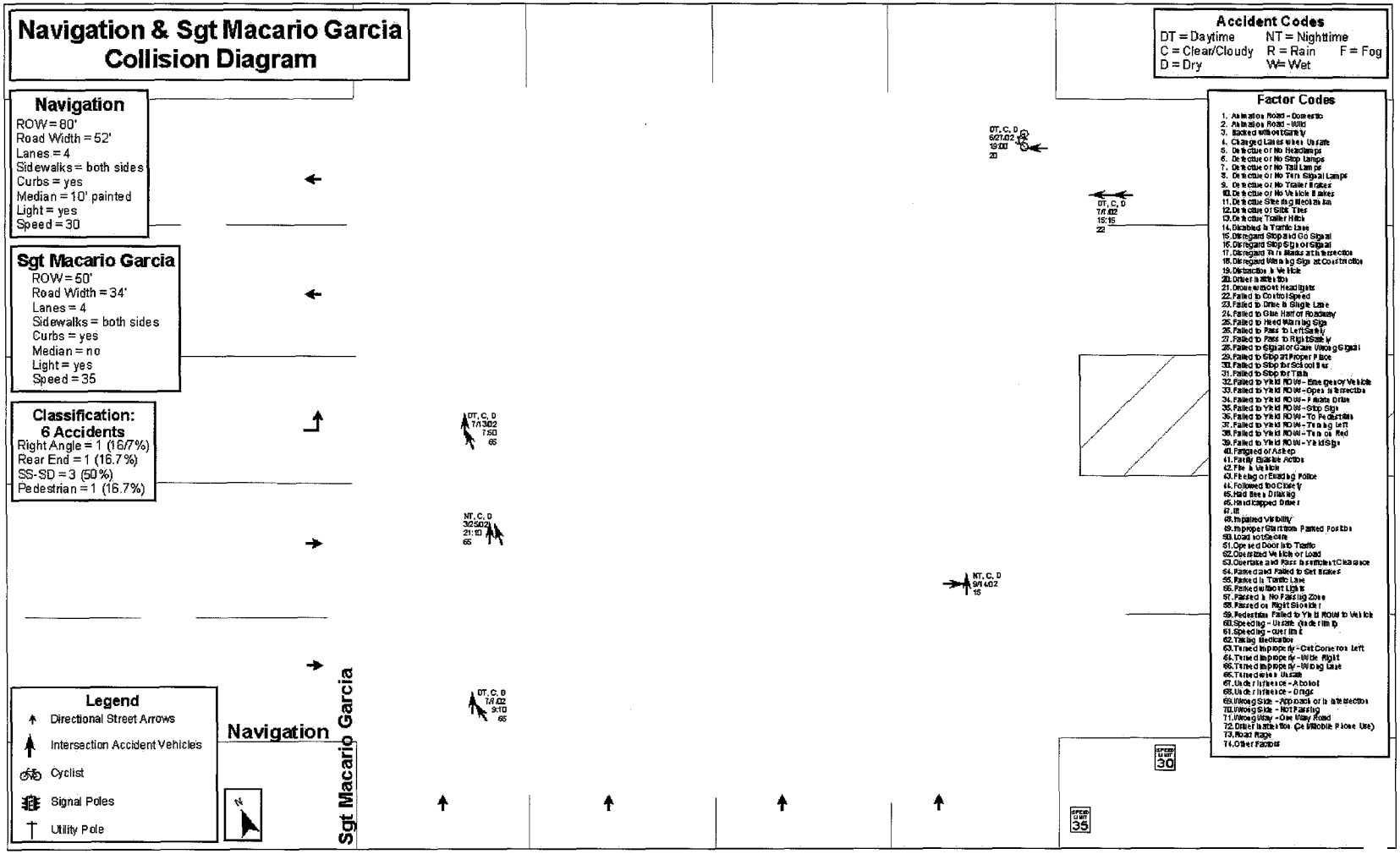

Cumulative Distribution
Cumulative Frequency (%)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
20
22
24
26
28
30
32
85th Percentile Speed
Vehicle Speed (mph)

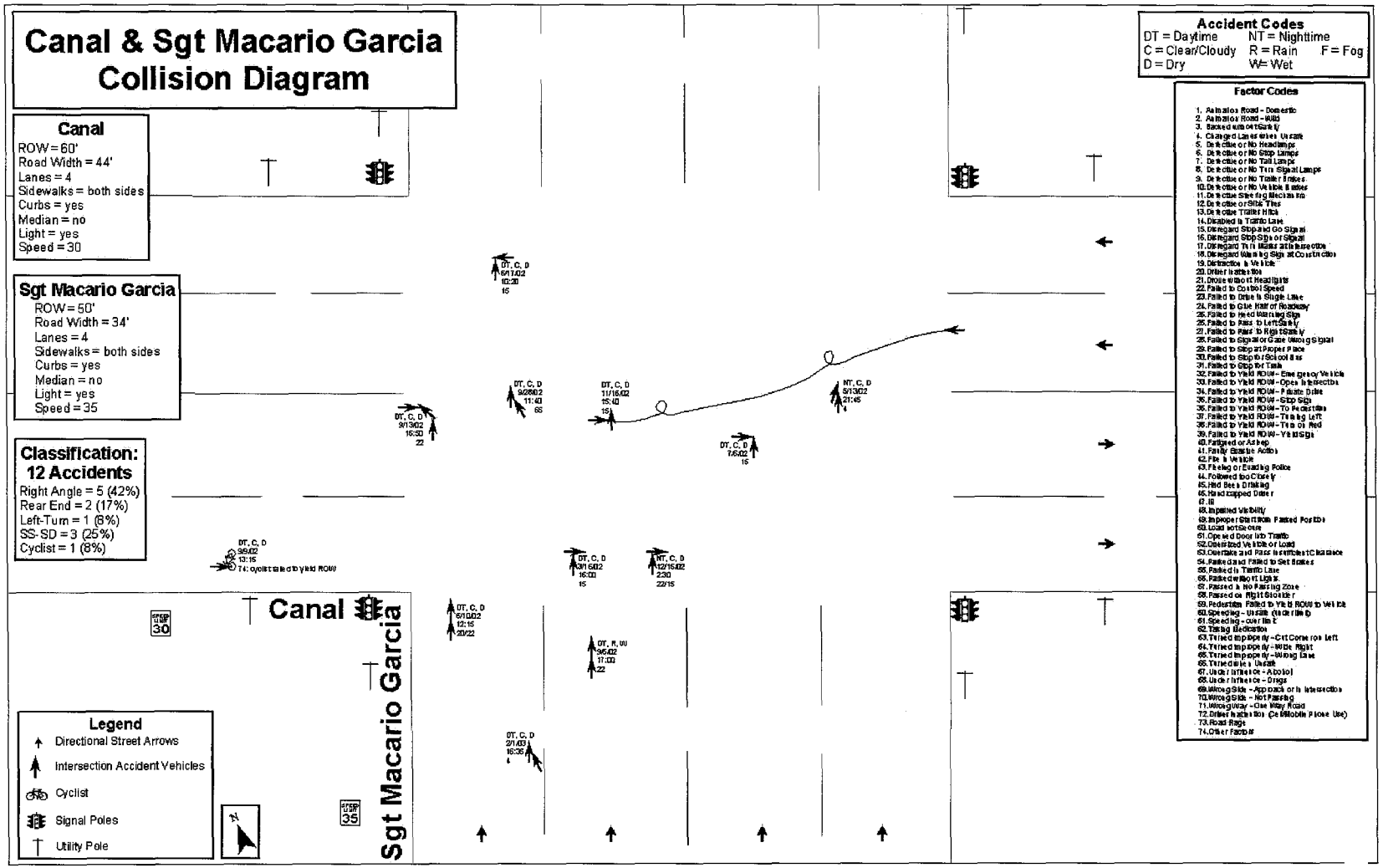
Appendix G


Navigation & Wayside Collision Diagram
Navigation
W E
ROW 120' 80'
Road Width 80' 52'
Lanes 6 4
Sidewalks both sides both sides
Curbs yes yes
Median 10' curbed 10' painted
Light yes yes
Speed 35 30
Wayside
S N
ROW 60' 80'
Road Width 52' 44'
Lanes 4 4
Sidewalks both sides none
Curbs no no
Median no no
Light yes yes
Speed 35 30
Classification:
10 Accidents
Right Angle = 4 (40%)
Rear End = 1 (10%)
Left-Turn = 2 (20%)
Right-Turn = 1 (10%)
SS-SD = 2 (20%)
Legend
Directional Street Arrows
Intersection Accident Vehicles
Signal Poles
Utility Pole
Accident Codes
DT = Daytime NT = Nighttime
C = Clear/Cloudy R = Rain F = Fog
D = Dry W = Wet
Factor Codes
1. Animal on Road - Domestic
2. Animal on Road - Wild
3. Backed Unsafely
4. Changed Lanes when Unsafe
5. Defective or No Headlamps
6. Defective or No Stop Lamps
7. Defective or No Tail Lamps
8. Defective or No Turn Signal Lamps
9. Defective or No Trailer Brakes
10. Defective or No Vehicle Brakes
11. Defective Steering Mechanism
12. Defective or Slick Tires
13. Defective Trailer Hitch
14. Disabled in Traffic Lane
15. Disregard Stop and Go Signal
16. Disregard Stop Sign or Signal
17. Disregard Turn Marks at Intersection
18. Disregard Warning Sign at Construction
19. Distraction in Vehicle
20. Driver Inattention
21. Drove without Headlights
22. Failed to Control Speed
23. Failed to Drive in Single Lane
24. Failed to Give Half of Roadway
25. Failed to Heed Warning Sign
26. Failed to Keep to Left Safely
27. Failed to Keep to Right Safely
28. Failed to Signal or Gave Wrong Signal
29. Failed to Stop at Proper Place
30. Failed to Stop for School Bus
31. Failed to Stop for Train
32. Failed to Yield ROW - Emergency Vehicle
33. Failed to Yield ROW - Open Intersection
34. Failed to Yield ROW - Private Drive
35. Failed to Yield ROW - Stop Sign
36. Failed to Yield ROW - To Pedestrian
37. Failed to Yield ROW - Turning Left
38. Failed to Yield ROW - Turn on Red
39. Failed to Yield ROW - Yield Sign
40. Fatigued or Asleep
41. Fault/ Evasive Action
42. Fire in Vehicle
43. Fleeing or Eluding Police
44. Followed too Closely
45. Had Been Drinking
46. Handicapped Driver
47. Ill
48. Impaired Visibility
49. Improper Start from Parked Position
50. Loud Noise Cars
51. Opened Door into Traffic
52. Overload Vehicle or Load
53. Overtake and Pass Insufficient Clearance
54. Raced and Failed to Get Brakes
55. Passed in Turning Lane
56. Raced without Lights
57. Passed in No Passing Zone
58. Passed on Right Shoulder
59. Pedestrian Failed to Yield ROW to Vehicle
60. Speeding - Unsafe (Under Limit)
61. Speeding - Over Limit
62. Taking Medication
63. Turned Improperly - Cut Corner on Left
64. Turned Improperly - Wide Right
65. Turned Improperly - Wrong Lane
66. Turned into Unsafe
67. Under Influence - Alcohol
68. Under Influence - Drugs
69. Wrong Side - Approach or in Intersection
70. Wrong Side - Not Passing
71. Wrong Way - One Way Road
72. Other Inattention (Cellphone Phone Use)
73. Road Rage
74. Other Factors


Navigation & Wayside Collision Diagram
Navigation
W E
ROW 120' 80'
Road Width 80' 52'
Lanes 6 4
Sidewalks both sides both sides
Curbs yes yes
Median 10' curbed 10' painted
Light yes yes
Speed 35 30
Wayside
S N
ROW 60' 80'
Road Width 52' 44'
Lanes 4 4
Sidewalks both sides none
Curbs no no
Median no no
Light yes yes
Speed 35 30
Classification: 10 Accidents
Right Angle = 4 (40%)
Rear End = 1 (10%)
Left-Turn = 2 (20%)
Right-Turn = 1 (10%)
SS-SD = 2 (20%)
Legend
Directional Street Arrows
Intersection Accident Vehicles
Signal Poles
Utility Pole
Accident Codes
DT = Daytime NT = Nighttime
C = Clear/Cloudy R = Rain F = Fog
D = Dry W= Wet
Factor Codes
1. Animal on Road - Domestic
2. Animal on Road - Wild
3. Backed Vehicle not Safely
4. Changed Lanes when Unsafe
5. Defective or No Headlamps
6. Defective or No Stop Lamps
7. Defective or No Tail Lamps
8. Defective or No Turn Signal Lamps
9. Defective or No Trailer Brakes
10. Defective or No Vehicle Brakes
11. Defective Steering Mechanism
12. Defective or Slick Tires
13. Defective Trailer Hitch
14. Disabled in Traffic Lane
15. Disregard Stop and Go Signal
16. Disregard Stop Sign or Signal
17. Disregard Turn Marks at Intersection
18. Disregard Warning Sign at Construction
19. Distraction in Vehicle
20. Other Inattention
21. Drove Without Headlights
22. Failed to Control Speed
23. Failed to Drive in Single Lane
24. Failed to Give Half of Roadway
25. Failed to Heed Warning Sign
26. Failed to Pass to Left Safely
27. Failed to Pass to Right Safely
28. Failed to Signal or Gave Wrong Signal
29. Failed to Stop at Proper Place
30. Failed to Stop for School Bus
31. Failed to Stop for Train
32. Failed to Yield ROW - Emergency Vehicle
33. Failed to Yield ROW - Open Intersection
34. Failed to Yield ROW - Private Drive
35. Failed to Yield ROW - Stop Sign
36. Failed to Yield ROW - To Pedestrian
37. Failed to Yield ROW - Turning Left
38. Failed to Yield ROW - Turn on Red
39. Failed to Yield ROW - Yield Sign
40. Fatigued or Asleep
41. Family Disorder Action
42. Fire in Vehicle
43. Fleeing or Evading Police
44. Followed too Closely
45. Had Been Drinking
46. Handicapped Driver
47. Ill
48. Impaired Visibility
49. Improper Start from Parked Position
50. Load not Secure
51. Opened Door into Traffic
52. Overload Vehicle or Load
53. Overtaken and Passed by Vehicle Otherwise
54. Parked Improperly/Failed to Set Brakes
55. Parked in Traffic Lane
56. Parked without Lights
57. Parked in No Passing Zone
58. Passed on Right Shoulder
59. Pedestrian Failed to Yield ROW to Vehicle
60. Speeding - Unsafe (Under Limit)
61. Speeding - Over Limit
62. Talking Pedestrian
63. Turned Improperly - Cut Corner on Left
64. Turned Improperly - Wide Right
65. Turned Improperly - Wrong Lane
66. Turned Unsafely
67. Under Influence - Alcohol
68. Under Influence - Drugs
69. Wrong Side - Approach or in Intersection
70. Wrong Side - Not Passing
71. Wrong Way - One Way Road
72. Driver Inattention (Cellphone Related)
73. Road Rage
74. Other Factors
DT, C, D 10/15/02 12:45 4
DT, C, D 8/19/02 12:15 22
DT, C, D 12/21/02 10:30 65
NT, C, D 3/28/02 19:00 4
DT, C, D 6/1/02 6:00 15
DT, C, D 1/29/03 13:20 64
DT, C, D 6/26/02 16:14 15
NT, C, W 11/3/02 22:00 15
NT, C, D 3/23/02 4:26 15
NT, C, D 1/26/02 18:50 15
STOP 30
STOP 35


Capitol & Wayside Collision Diagram
Wayside
Capitol
Capitol
ROW = 50'
Road Width = 40'
Lanes = 4
Sidewalks = both sides
Curbs = yes
Median = 10' painted
Light = yes
Speed = 30
Wayside
ROW = 70'
Road Width = 52'
Lanes = 4
Sidewalks = one side
Curbs = yes
Median = no
Light = yes
Speed = 35
Classification:
6 Accidents
Right Angle = 6 (100%)
Accident Codes
DT = Daytime
NT = Nighttime
C = Clear/Cloudy
R = Rain
F = Fog
D = Dry
W = Wet
Factor Codes
1. Animal in Road - Domestic
2. Animal in Road - Wild
3. Backed into or Starting
4. Changed Lanes when Unsafe
5. Defective or No Headlamps
6. Defective or No Stop Lamps
7. Defective or No Tail Lamps
8. Defective or No Turn Signal Lamps
9. Defective or No Trailer Brakes
10. Defective or No Vehicle Brakes
11. Defective Steering Mechanism
12. Defective or Slick Tires
13. Defective Trailer Hitch
14. Disabled in Traffic Lane
15. Disregard Stop and Go Signal
16. Disregard Stop Sign or Signal
17. Disregard Turn Marks at Intersection
18. Disregard Warning Sign at Construction
19. Distraction in Vehicle
20. Driver Inattention
21. Drove without Headlights
22. Failed to Control Speed
23. Failed to Drive in Single Lane
24. Failed to Give Half of Roadway
25. Failed to Heed Warning Sign
26. Failed to Keep to Left Safely
27. Failed to Keep to Right Safely
28. Failed to Signal or Gave Wrong Signal
29. Failed to Stop at Proper Place
30. Failed to Stop for School Bus
31. Failed to Stop for Train
32. Failed to Yield ROW - Emergency Vehicle
33. Failed to Yield ROW - Open Intersection
34. Failed to Yield ROW - Private Drive
35. Failed to Yield ROW - Stop Sign
36. Failed to Yield ROW - To Pedestrian
37. Failed to Yield ROW - Turning left
38. Failed to Yield ROW - Turn on Red
39. Failed to Yield ROW - Yield Sign
40. Fatigued or Asleep
41. Family Emotion Action
42. Fire in Vehicle
43. Fleeing or Evading Police
44. Following too Closely
45. Had Been Drinking
46. Handicapped Driver
47. Ill
48. Impaired Visibility
49. Improper Start from Parked Position
50. Load not Secure
51. Opened Door into Traffic
52. Oversized Vehicle or Load
53. Overtake and Pass Insufficient Clearance
54. Parked and Failed to Set Brakes
55. Parked in Traffic Lane
56. Parked without Lights
57. Passed in No Passing Zone
58. Passed on Right Shoulder
59. Pedestrian Failed to Yield ROW to Vehicle
60. Speeding - Unsafe (under limit)
61. Speeding - over limit
62. Taking Medication
63. Turned Improperly - Cut Corner on Left
64. Turned Improperly - Wide Right
65. Turned Improperly - Wrong Lane
66. Turned under Unsafe
67. Under Influence - Alcohol
68. Under Influence - Drugs
69. Wrong Side - Approach or in Intersection
70. Wrong Side - Not Passing
71. Wrong Way - One Way Road
72. Other Inattention (Or Middle Picture Use)
73. Road Rage
74. Other Factors
Legend
Directional Street Arrows
Intersection Accident Vehicles
Signal Poles
Utility Pole
SPEED LIMIT 30
SPEED LIMIT 35
DT, C, D 10/2001 9:06 16
DT, C, D 11/2002 14:28 15
DT, R, W 3/1402 10:45 16/20
DT, R, W 12/12402 10:49 15
DT, R, D 7/1302 12:45 16
DT, C, D 12/1402 9:10 15


Navigation & Sgt Macario Garcia
Collision Diagram
Navigation
ROW = 80'
Road Width = 52'
Lanes = 4
Sidewalks = both sides
Curbs = yes
Median = 10' painted
Light = yes
Speed = 30
Sgt Macario Garcia
ROW = 50'
Road Width = 34'
Lanes = 4
Sidewalks = both sides
Curbs = yes
Median = no
Light = yes
Speed = 35
Classification:
6 Accidents
Right Angle = 1 (16/7%)
Rear End = 1 (16.7%)
SS-SD = 3 (50%)
Pedestrian = 1 (16.7%)
Legend
Directional Street Arrows
Intersection Accident Vehicles
Cyclist
Signal Poles
Utility Pole
Navigation
Sgt Macario Garcia
Accident Codes
DT = Daytime
NT = Nighttime
C = Clear/Cloudy
R = Rain
F = Fog
D = Dry
W = Wet
Factor Codes
1. Animal on Road - Domestic
2. Animal on Road - Wild
3. Backed without Safety
4. Changed Lanes when Unsafe
5. Defective or No Headlamps
6. Defective or No Stop Lamps
7. Defective or No Tail Lamps
8. Defective or No Turn Signal Lamps
9. Defective or No Trailer Brakes
10. Defective or No Vehicle Brakes
11. Defective Steering Mechanism
12. Defective or Slick Tires
13. Defective Trailer Hitch
14. Disabled in Traffic Lane
15. Disregard Stopped Go Signal
16. Disregard Stop Sign or Signal
17. Disregard Turn Marker at Intersection
18. Disregard Warning Sign at Construction
19. Distraction in Vehicle
20. Driver Inattention
21. Drove without Headlights
22. Failed to Control Speed
23. Failed to Drive in Single Lane
24. Failed to Give Half of Roadway
25. Failed to Heed Warning Sign
26. Failed to Pass to Left Safely
27. Failed to Pass to Right Safely
28. Failed to Signal or Gave Wrong Signal
29. Failed to Stop at Proper Place
30. Failed to Stop for School Bus
31. Failed to Stop for Train
32. Failed to Yield ROW - Emergency Vehicle
33. Failed to Yield ROW - Open Intersection
34. Failed to Yield ROW - Private Drive
35. Failed to Yield ROW - Stop Sign
36. Failed to Yield ROW - To Pedestrian
37. Failed to Yield ROW - Turning left
38. Failed to Yield ROW - Turn on Red
39. Failed to Yield ROW - Yield Sign
40. Fatigued or Asleep
41. Faulty Evasive Action
42. Fire in Vehicle
43. Fleeing or Evading Police
44. Followed too Closely
45. Had been Drinking
46. Handicapped Driver
47. Ill
48. Impaired Visibility
49. Improper Starting from Parked Position
50. Load not Secure
51. Opened Door into Traffic
52. Oversized Vehicle or Load
53. Overtaken and Passed in Unsafe Clearance
54. Parked on Failed to Set Brakes
55. Parked in Traffic Lane
56. Parked without Lights
57. Passed in No Passing Zone
58. Passed on Right Shoulder
59. Pedestrian Failed to Yield ROW to Vehicle
60. Speeding - Unsafe (Under Limit)
61. Speeding - Over Limit
62. Taking Medication
63. Turned Improperly - Cut Corner on Left
64. Turned Improperly - Wide Right
65. Turned Improperly - Wrong Lane
66. Turned Wide Unsafe
67. Under Influence - Alcohol
68. Under Influence - Drugs
69. Wrong Side - Approach or in Intersection
70. Wrong Side - Not Passing
71. Wrong Way - One Way Road
72. Other Inattention (ex Mobile Phone Use)
73. Road Rage
74. Other Factors
DT, C, D
NT, C, D
30
35


Canal & Sgt Macario Garcia
Collision Diagram
Canal
ROW = 60'
Road Width = 44'
Lanes = 4
Sidewalks = both sides
Curbs = yes
Median = no
Light = yes
Speed = 30
Sgt Macario Garcia
ROW = 50'
Road Width = 34'
Lanes = 4
Sidewalks = both sides
Curbs = yes
Median = no
Light = yes
Speed = 35
Classification:
12 Accidents
Right Angle = 5 (42%)
Rear End = 2 (17%)
Left-Turn = 1 (8%)
SS-SD = 3 (25%)
Cyclist = 1 (8%)
Accident Codes
DT = Daytime
NT = Nighttime
C = Clear/Cloudy
R = Rain
F = Fog
D = Dry
W= Wet
Factor Codes
1. Animal on Road - Domestic
2. Animal on Road - Wild
3. Backed unsafely
4. Changed Lanes when Unsafe
5. Defective or No Headlamps
6. Defective or No Stop Lamps
7. Defective or No Tail Lamps
8. Defective or No Turn Signal Lamps
9. Defective or No Trailer Brakes
10. Defective or No Vehicle Brakes
11. Defective Steering Mechanism
12. Defective or Slick Tires
13. Defective Trailer Hitch
14. Disabled in Traffic Lane
15. Disregard Stopped Go Signal
16. Disregard Stop Sign or Signal
17. Disregard Turn Marker at Intersection
18. Disregard Warning Sign at Construction
19. Distraction in Vehicle
20. Driver Inattention
21. Drove without Headlights
22. Failed to Control Speed
23. Failed to Drive in Single Lane
24. Failed to Obey Rule of Roadway
25. Failed to Heed Warning Sign
26. Failed to Pass to Left Safely
27. Failed to Pass to Right Safely
28. Failed to Signal or Gave Wrong Signal
29. Failed to Stop at Proper Place
30. Failed to Stop for School Bus
31. Failed to Stop for Train
32. Failed to Yield ROW - Emergency Vehicle
33. Failed to Yield ROW - Open Intersection
34. Failed to Yield ROW - Private Drive
35. Failed to Yield ROW - Stop Sign
36. Failed to Yield ROW - To Pedestrian
37. Failed to Yield ROW - Turning Left
38. Failed to Yield ROW - Turn on Red
39. Failed to Yield ROW - Yield Sign
40. Fatigued or Asleep
41. Faulty Evasive Action
42. Fire in Vehicle
43. Fleeing or Eluding Police
44. Followed too Closely
45. Had Been Drinking
46. Handicapped Driver
47. Ill
48. Impaired Visibility
49. Improper Start from Parked Position
50. Load or Use Error
51. Opened Door into Traffic
52. Oversized Vehicle or Load
53. Overtake and Pass in Unsafe Clearance
54. Parked and Failed to Set Brakes
55. Parked in Traffic Lane
56. Parked without Lights
57. Passed in No Passing Zone
58. Passed on Right Shoulder
59. Pedestrian Failed to Yield ROW to Vehicle
60. Speeding - Unsafe (Under limit)
61. Speeding - over limit
62. Taking Medication
63. Turned Improperly - Cut Corner on Left
64. Turned Improperly - Wide Right
65. Turned Improperly - Wrong Lane
66. Turned Unsafe
67. Under Influence - Alcohol
68. Under Influence - Drugs
69. Wrong Side - Approach or in Intersection
70. Wrong Side - Not Passing
71. Wrong Way - One Way Road
72. Driver Inattention (Cellphone Phone Use)
73. Road Rage
74. Other Factor
Canal
Sgt Macario Garcia
Legend
Directional Street Arrows
Intersection Accident Vehicles
Cyclist
Signal Poles
Utility Pole
N

East End Crash Data – 2 Year Hard Copies
2002-2003

Numbers in parentheses represent factor codes from accident reports [ex: (15)]
Demographics include all parties included in accidents (not the surname of vehicle)
FSGI are those who fail to stop and give insurance (hit and runs)
Injury Severities include all drivers and passengers.
SSSD=Sideswipe Same Direction

The following intersections are high frequency accident sites.

Navigation/Wayside

Classifications: 10 accidents in diagram
- Right Angle = 4 (40%)
- Rear End = 1 (10%)
- Left Turn = 2 (20%)
- Right Turn = 1 (10%)
- SSSD = 2 (20%)

10 Total Noted Crashes
- All Intersection/intersection related
- demographics: White=10;Hispanic=6;other=2
  Male=15;Female=3
- FSGI=2
- all auto crashes
- times: 6 day/4 night
- 5 (15, 16) ran red light
  - one incident on wet road surface
- 2 (4) changed lanes when unsafe
- 1 (22) failed to control speed-rear end
- 1 (64) turned improperly-wide right
- 1 (65) turned improperly-wrong lane
- Injury Severities:
  - 16 non-injured
  - 1 possible injury to passenger
  - 6 possible injuries to drivers

Navigation/ S_Sgt Macario Garcia

Classifications: 6 accidents in diagram
- Right Angle = 1 (16.7%)
- Rear End = 1 (16.7%)
- SSSD = 3 (50%)

Pedestrian = 1 (16.7%)

6 Total Noted Crashes

All Intersection/intersection related

Demographics: White=6;Hispanic=5

Male=8;Female=3

FSGI=1

5 auto/1 cyclist

times: 4 day/2 night

3 (65) turned improperly-wrong lane

1 (15) ran red light

1 (20) driver inattention

1 cyclist involved

1 (22) failed to control speed-rear end

Injury Severities:

16 non-injured

1 possible injury to cyclist

1 possible injury to driver

4 possible injuries to passengers

1 non-incapacitating passenger

1 incapacitating injury to driver

Canal/Wayside

Classifications: 11 accidents in diagram

Right Angle = 6 (55%)

Rear End = 1 (9%)

Left Turn = 1 (9%)

SSSD = 3 (27%)

11 Total Noted Crashes

All Intersection/intersection related

Demographics: White=19;Hispanic=4

Male=22;Female=1

FSGI=2

All auto crashes

Times: 7 day/4 night

4 (15) ran red light

1 night/rain/wet road surface

2 (65) turned improperly-wrong lane

2 (74) signal lights not working; conflicting statements

1 night/rain/wet road surface

1 (23) failed to drive in a single lane

night/rain/wet road surface

1 (37) failed to yield row-turning left

night/clear/wet road surface

1 unknown

Injury Severities:

31 non-injured

5 possible injuries to drivers
3 possible injuries to passengers

Canal/S_Sgt Macario Garcia

Classifications:12 accidents in diagram
Right Angle = 5 (42%)
Rear End = 2 (17%)
Left Turn = 1 (8%)
SSSD = 3 (25%)
Cyclist = 1 (8%)
12 Total Noted Crashes
All Intersection/intersection related
Demographics: White=15;Hispanic=9
Male=14;Female=10
FSGI=1
11 auto/1 cyclist crashes
Times: 10 day/2 night
4 (15) ran red light
2 (22) failed to control speed
1 rain/wet road surface
2 (4) changed lane when unsafe
1 night
1 (65) turned improperly-wrong lane
1 (74) cyclist failed to yield row
2 unknowns
1 night

Injury Severities:
34 non-injured
5 possible injuries to passengers
2 possible injuries to drivers
2 non-incapacitating drivers

Capitol/Wayside

Classifications: 6 accidents in diagram
Right Angles = 6 (100%)
6 Total Noted Crashes
All Intersection/intersection related
Demographics: White=4;Hispanic=7;Black=2
Male=8;Female=5
FSGI=1
All auto crashes
Times: all are daytimes

5 (15, 16) ran red light
    2 rain/wet road surface
    1 rain
1 unknown
    rain/wet road surface
Injury Severities:
    10 non-injured
    5 possible injuries to driver
    1 possible injury to passenger
    1 non-incapacitating injury to driver

Crash Data – 2 Year Hard Copies
2002-2003

Numbers in parentheses represent factor codes from accident reports [ex: (15)]
Demographics include all parties included in accidents (not the surname of vehicle)
FSGI are those who fail to stop and give insurance (hit and runs)
Sideswipes: (sd)=same direction; (od)=opposite direction
The following are corridor and intersection data.
Injury Severities include all drivers and passengers

Ave B

1 noted crash

Corridor related-parked car
6500 blk
Demographics: 1 white male
Daytime
(3) backed without safety; angled

Ave B/65th

1 noted crash

Intersection related-fixed object
FSGI
Daytime

Ave C

1 noted crash

Corridor related-auto crash
6900 blk
Demographics: 1 white male
FSGI
Daytime
(3) backed without safety; angled

Ave C/Wayside

3 noted crashes

Intersection related-auto crashes
Demographics: White=3;Hispanic=3;Male=5;Female=1
3 daytimes
2 (35) failed to yield row-stop sign;1 sideswipe (sd) /1 angled
1 rain/wet road
1 (35,66) failed to yield row-stop sign, turned when unsafe; angled

Ace C/S_Sgt Macario Garcia

2 noted crashes
Intersection related-auto crashes
Demographics:2 Hispanic males
2 FSGI
2 nights
2 (35) failed to yield row-stop sign; angled
1 rain/wet road

Ave E
1 noted crash
Corridor related-auto crash
6700 blk
Demographics: White=2; Male=1;Female=1
Daytime
(49) improper start from parked; angled

Ave E/Cesar Chavez(67th)
1 noted crash
Intersection related-auto crash
Demographics: Hispanic=1; Black=1; Males=2
Daytime
(35) failed to yield row-stop sign; angled

Ave E/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: White=4;Male=3;Female=1
1 day/1 night
1 (23) failed to drive in single lane; sideswipe (sd)
1 wet road
1 (4) changed lane when unsafe; sideswipe (sd)

Ave F
6 noted crashes
Corridor related-1 auto, 1 pedestrian, 4 parked cars
6600, 6700, 7000 blk
Demographics: White=2; Hispanic=3; Male=5; Female=1
2 FSGI
4 days/2 nights
3 (3) backed without safety; angled
2 (23) failed to drive in single lane; 2 rear ends
1 (20) driver inattentive; pedestrian

Ave F/Wayside
2 noted crashes
Intersection related-1 auto, 1 pedestrian crash
Demographics: White=1; Hispanic=1; Black=2; Males=4

Daytime
1(35) failed to yield row-stop sign; angled
1 unknown; pedestrian

Ave F/S_Sgt Macario Garcia
2 noted crashes
Intersection related-1 auto, 1 cyclist
Demographics: Hispanic=3; Black=1; Male=2; Female=2
Daytime
1 (20,23) driver inattentive, failed to drive in single lane; sideswipe (sd)
1 unknown; cyclist

Ave H
1 noted crash
Corridor related- parked car
Demographics: 1 White male
Daytime
(23) failed to drive in single lane-sideswipe (sd)

Ave H/67th
1 noted crash
Intersection related-parked car
Demograhics: 2 Hispanic males
Night
(23) failed to drive in single lane; sideswipes (sd)

Ave H/70th
1 noted crash
Intersection related-auto crash
Demographics: 2 white females
Night
(35) failed to yield row-stop sign; angled
1 wet road

Ave H/Wooding
1 noted crash
Intersection related-fixed object
Demographics: Hispanic Male
Daytime
(16,22) disregard stop sign or light/failed to control speed

Ave H/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: White=2; Hispanic=2;Males=4
1 FSGI
1 day/1night
1 (35) failed to yield row-stop sign; angled

1 (64) turned improperly -wide right; angled

Ave I

2 noted crashes

Corridor related-parked cars
6500, 6700 blk
Demographics: 1 Hispanic Male
1 FSGI
1 day/1 night
1 (22) failed to control speed; head-on
1 (23) failed to drive in single lane; head-on

Ave I/66th

2 noted crashes

Intersection related-parked cars
Demographics: 1 Hispanic Male
2 FSGI
1 day/1 night
1 (3) backed without safety; angled
1 unknown; angled

Ave I/Cesar Chavez (67th)

2 noted crashes

Intersection related-1 parked car, 1 auto crash
Demographics: Hispanic=2; Black=1; Male=2; Female=1
1 day/1 night
1 (35) failed to yield row-stop sign; angled
1 rain/wet road
1 (3) backed without safety; angled

Ave I/Wayside

2 noted crashes

Intersection related-auto crashes
Demographics: White=2; Hispanic=2; Male=3; Female=1
Daytimes
1 (65) turned improperly –wrong lane; sideswipe (sd)/ angled
1 (4) changed lane when unsafe; sideswipe (sd)

Ave I/S_Sgt Macario Garcia

1 noted crash

Intersection related-auto crash
Demographics: 1 White Male
1 FSGI
Night
(4) changed lane when unsafe; sideswipe (sd)
1 rain/wet road

Ave J

1 noted crash
Corridor related- parked car
Demographics: 2 White males
1 FSGI
Night
(22,23) failed to control speed/failed to drive in single lane; sideswipe (sd)

Ave J/Wayside
1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Males
Daytime
(65) turned improperly –wrong lane; angled

Ave J/S_Sgt Macario Garcia
1 noted crash
Intersection related-auto crash
Demographics: Hispanic=2; Male=1; Female=1
Daytime
(65) turned improperly –wrong lane; sideswipe (sd)

Ave K
1 noted crash
Corridor related-auto crash
Demographics: 2 Hispanic Males
Night
(3) backed without safety; angled

Ave K/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: White=2; Hispanic=2; Male=1; Female=3
1 day/1 night
1 (35) failed to yield row-stop sign; angled
1 (4) changed lane when unsafe; sideswipe (sd)

Ave L
3 noted crashes
Corridor related-parked cars
6600, 6700 blk
Demographics: 1 Hispanic Male; 1 White Female
1 FSGI
1 day/2 nights
1 (23) failed to drive in single lane; sideswipe (od)/ head-on
1 rain/wet roads
1 (22) failed to control speed; sideswipe (sd)
1 rain/wet roads

1 (3) backed without safety; angled

Ave L/Wayside

3 noted crashes

Intersection related-auto crashes
Demographics: White=2; Hispanic=4; Male=2; Female=4
1 FSGI
1 day/2 nights
1 (3,20) backed without safety/ driver inattentive; angled
1 (16) disregard for stop sign or light; angled
1 (3) backed without safety; rear-end

Ave N

3 noted crashes

Corridor related-1 auto, 1 parked car, 1 fixed object
6800-7000 blk
Demographics: White=2; Hispanic=2; Male=3; Female=1
2 days/1 night
1 (26) failed to pass to left safely; angled
1 (20,22) driver inattentive/ failed to control speed; head-on
parked car
1 (23) failed to drive in single lane

Ave N/Wayside

1 noted crash

Intersection related-auto crash
Demographics: Hispanic=2; Male=1; Female=1
1 FSGI
Daytime
(16) disregard for stop sign or signal; angled

Ave O

4 noted crashes

Corridor related-1 pedestrian, 3 parked cars
6600, 6800-6900 blk
Demographics: White=1; Hispanic=1; Male=2
3 FSGI
1 day/3 nights
1 (23) failed to drive in single lane
pedestrian accident
1 (3) backed without safety; angled
2 (22) failed to control speed; 2 rear-ends

Ave O/S_Sgt Macario Garcia

2 noted crashes

Intersection related-auto crashes
Demographics: 4 Hispanic Males
1 day/1 night
1 (35) failed to yield row-stop sign; angled
1 (20,23) driver inattentive/ failed to drive in single lane; sideswipe (sd)

Ave O/Wayside
1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Males
Night
(4) changed lane when unsafe; sideswipe (sd)

Ave P
3 noted crashes
Corridor related-parked cars
6600, 6800-6900 blk
3 FSGI
3 days
2 (22) failed to control speed; 1 sideswiped (sd)
1 (3) backed without safety; angled

Ave P/71st
1 noted crash
Intersection related-fixed object
Demographics: 1 White Male
Night
(22) failed to control speed

Ave Q
2 noted crashes
Corridor related-1 parked car, 1 pedestrian
6642, 7000 blk
Demographics: 1 White Female; 1 Hispanic Male
1 FSGI
2 nights
1 (3) backed without safety; rear-end
1 (23) failed to drive in single lane
pedestrian accident

Ave Q/Wayside
3 noted crashes
Intersection related-2 auto, 1 fixed object
Demographics: White=3; Hispanic=2; Male=3; Female=2
3 days
1 (35,48) failed to yield row-stop sign/impaired visibility; angled

1 (20,22) driver inattentive/failed to control speed
fixed object
1 (35) failed to yield row-stop sign; angled
wet road

Ave Q/S_Sgt Macario Garcia
1 noted crash
Intersection related-auto crash
Demographics: 1 White Female
1 FSGI
Night
(35) failed to yield row-stop sign; angled

Ave R
4 noted crashes
Corridor related-2 auto, 1 parked car
6790, 6800 blk
Demographics: White=2; Hispanic=2: Male=4;
3 FSGI
2 day/1 night
2 (22) failed to control speed; 2 rear-ends
1 parked car
1 (74) unable to determine; head-on
1 (3) backed without safety; angled

Ave R/Wayside
3 noted crashes
Intersection related-auto crashes
Demographics: White=3; Hispanic=2; Black=1; Male=4; Female=2
1 day/2 nights
1 (65) turned improperly -wrong lane; sideswipe (sd)
1 (37) failed to yield row-turning left; angled
1 (15) disregard stop and go signal; angled

Ave R/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: White=3; Hispanic=1; Male=2; Female=2
2 days
1 (16) disregard stop sign or light; angled
rain/wet road
1 (22) failed to control speed; rear-end

Ave S
1 noted crash

Corridor related-auto crash
6900 blk
Demographics: 1 Black Male; 1 Hispanic Female
Daytime
(3) backed without safety; rear-end

Ave S/Wayside

2 noted crashes

Intersection related-auto crashes
Demographics: White=1; Hispanic=3; Male=2; Female=2
2 days
1 (37) failed to yield row-turning left; angled
rain/wet road
1 (55, 74) parked in traffic lane/ mechanical failure; angled

Ave T

4 noted crashes

Corridor related-3 parked cars, 1 flying object
6600, 6800 blk
Demographics: 1 Hispanic Male
3 FSGI
2 days/2 nights
1 (22) failed to control speed; rear-end
1 unknown; rear-end
1 (74) other factors; sideswipe
1 (74) flying basketball

Ave U/Wayside

2 noted crashes

Intersection related-auto crashes
Demographics: White=1; Hispanic=1; Black=2; Male=1; Female=3
2 days
1 (65) turned improperly –wrong lane; angled
rain/wet road
1 (4) changed lane when unsafe; sideswipe (sd)

Ave U

1 noted crash

Corridor related-auto crash
6800 blk
Demographics: 2 Black Males
Daytime
(34) failed to yield row-private drive; angled

Capitol

4 noted crashes

Corridor related-1 fixed object, 1 pedestrian, 2 auto crashes
6600-6900 blk
Demographics: White=2; Hispanic=2; Black=2; Male=5; Female=1
1 FSGI
2 days/2 nights
1 (20,23) driver inattentive/failed to drive in single lane
fixed object
1 (28,65) failed to signal or gave wrong signal/turned improperly-wrong lane; sideswipe (sd)
1 (65) turned improperly -wrong lane; sideswipe (sd)
1 (59) pedestrian failed to yield row to vehicle

Capitol/70th

3 noted crashes
Intersection related-auto crashes
Demographics: White=3; Hispanic=2: Male=2: Female=3
3 days
1 (66) turned when unsafe; angled
wet road
1 (29) failed to stop at proper place; angled
1 (57) passed in no passing zone; angled

Canal

5 noted crashes
Corridor related-2 parked cars, 3 auto crashes
6500, 6800, 7000 blk
Demographics: White=6; Hispanic=2; Male=4; Female=4
1 FSGI
2 days/3 nights
1 (20) driver inattentive; rear-end
4 (22) failed to control speed; rear-ends
2 rain/wet road

Canal/66th

2 noted crashes
Intersection related-auto crashes
Demographics: 2 Hispanic Females; 1 White Male
1 FSGI
1 day/1 night
1 (35,74) failed to yield row-stop sign/failed to yield row to vehicle on the right; angled
1 (35) failed to yield row-stop sign; angled

Harrisburg

Corridor Related

6600-6700 blk

3 noted crashes-1 fixed object, 2 auto crashes
Demographics: White=2; Hispanic=2; Male=3; Female=1
1 FSGI
2 days/1 night
2 (4) changed lanes when unsafe; sideswipes (sd)
1 (22) failed to control speed
fixed object

6800 blk

5 noted crashes-auto crashes
Demographics: White=7; Hispanic=4; Male=6; Female=5
3 days/2 nights
1 (4) changed lanes when unsafe; sideswipe (sd)
rain/wet road
1 (3) backed without safety; rear-end
2 (22) failed to control speed;
angled -rain/wet road
rear-end
1 (34) failed to yield row-private drive; angled

6900 blk

11 noted crashes-auto crashes
Demographics: White=10; Hispanic=9; Male=11; Female=8
5 FSGI
6 days/5 nights
4 (22) failed to control speed; rear-ends
2 rain/wet roads
2 (37) failed to yield row-turning left; angled
1 (22,27) failed to control speed/failed to pass to right safely; angled
1 (33) failed to yield row-open intersection; angled
1 (65) turned improperly -wrong lane; angled
rain/wet road
1 (23) failed to drive in single lane; sideswipe (sd)
1 (29) failed to stop at proper place; angled
Injury Severities for 6800 & 6900 Harrisburg:
31 non-injured;
5 possible injuries to passengers;
3 possible injuries to drivers;
1 fatality due to alcohol influence (not included in study)(driver hit tree)

7000 blk

3 noted crashes-1 pedestrian, 2 auto crashes
Demographics: White=3; Hispanic=4; Male=5; Female=2
3 days
2 (22) failed to control speed;
angled-1 motorcycle

rear-end
1 (59) pedestrian failed to yield row to vehicle
rain/wet road

Harrisburg/Cesar Chavez(67th)
1 noted crash
Intersection related-auto crash
Demographics: White=2; Male=1; Female=1
Daytime
(22) failed to control speed; rear-end

Harrisburg/S_Sgt Macario Garcia
4 noted crashes
Intersection related-auto crashes
Demographics: White=7; Male=4; Female=3
1 FSGI
1 day/3 nights
2 (22) failed to control speed; rear-ends
2 (15) disregard stop and go signal; angled

Harrisburg/Wayside
1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Males
Night
Unknown factors; angled

Harrisburg/65th
1 noted crash
Intersection related-auto crash
Demographics: 3 White Males
Daytime
(35) failed to yield row-stop sign; angled

Navigation
4 noted crashes
Corridor related-3 auto, 1 parked car
6600, 6800, 7000 blk
Demographics: White=3; Hispanic=4; Male=4; Female=3
1 FSGI
3 days/1 night
1 (23) failed to drive in single lane; sideswipe (sd)
1 (4) changed lanes when unsafe; angled
1 (22) failed to control speed; rear-end
1 (55) parked in traffic lane; sideswipe (sd)
parked car

Navigation/Maltby

1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Males
Daytime
(35) failed to yield row-stop sign; angled

Navigation/Cesar Chavez(67th)
1 noted crash
Intersection related-auto crash
Demographics: 2 White Females; 1 Black Male
Night
(37) failed to yield row-turning left; angled
rain/wet road

S_Sgt Macario Garcia
8 noted crashes
Corridor related-1 cyclist, 7 auto crashes
600, 900-1000, 1300, 1500-1600 blk
Demographics: White=7; Hispanic=7; Male=8; Female=6
3 FSGI
5 days/3 nights
2 (23) failed to drive in single lane; sideswipe (sd)
1 (22,44) failed to control speed/followed too closely; rear-end
1 (22) failed to control speed; rear-end
2 (4) changed lanes when unsafe; sideswipe (sd)
1 (16) disregard stop sign or light; angled
1 (34) failed to yield row-private drive
cyclist accident-muddy road

Sherman
3 noted crashes
Corridor related-1 fixed object, 2 parked car
6700 blk
Demographics: 1 Hispanic Male
2 FSGI
2 days/1night
1 (23) failed to drive in single lane
fixed object-wet road
1 (22) failed to control speed; sideswipe (sd)
parked car
1 unknown factor; sideswipe (sd)

Sherman/Cesar Chavez(67th)
1 noted crash
Intersection related-auto crash
Demographics: 2 Hispanic Females

Night
(35,20) failed to yield row-stop sign/driver inattentive; angled

Sherman/Wayside
2 noted crashes
Intersection related-auto crashes
Demographics: Hispanic=2; Black=1; Male=2; Female=1
1 FSGI
1 day/1 night
1 (16) diregard stop sign or light; angled
rain/wet road
1 (65) turned improperly –wrong lane; angled

Sherman/S_Sgt Macario Garcia
2 noted crashes
Intersection related-auto crashes
Demographics: White=2; Hispanic=2; Males=4
2 days
1 (3) backed without safety; rear-end
1 (20,23) driver inattentive/failed to drive in single lane; sideswipe (sd)

Terminal
1 noted crash
Corridor related-parked car
1100 blk
Demographics: 1 White Female
Daytime
(3) backed without safety; angled
rain/wet road

Terminal/Ave Q
1 noted crash
Intersection related-fixed object
Demographics: 1 White Male
Daytime
(22) failed to control speed

Wayside
12 noted crashes
Corridor related-10 auto crashes, 2 fixed objects
300, 600-700, 900-1000, 1200-1300, 1900-2200 blk
Demographics: White=9; Hispanic=10; Black=2; Asian=1;
Male=17; Female=5
4 FSGI
10 days/2 nights
3 (22) failed to control speed; rear-ends

1 wet road
1 rain/ wet road
4 (4) changed lanes when unsafe; angled/sideswipes (sd)
1 (34) failed to yield row-private drive; angled
1 (22,23) failed to control speed/failed to drive in single lane
fixed object
1 (16) disregard stop sign or light; angled
1 (71) wrong way-one way road; angled
1 (22,43) failed to control speed/fleeing or evading police
fixed object

Wayside/Polk
1 noted crash
Intersection related-auto crash
Demographics: 1 Hispanic Female, 1 Black Male
Daytime
(20,22) driver inattentive/failed to control speed; rear-end/angled

Appendix H

Hazard Elimination Program (HES)

Work Codes

CODE	ITEM
100	SIGNING AND SIGNALS
200	ROADSIDE OBSTACLES AND BARRIERS
300	RESURFACING AND ROADWAY LIGHTING
400	PAVEMENT MARKINGS
500	ROADWAY WORK

Signing and Signals

Work Code	Description	Definition	Reduction Factor %	Preventable Accident
101	**INSTALL WARNING/GUIDE SIGNS**	Provide advance signing for unusual or unexpected roadway features where no signing existed previously.	20	(Vehicle Movements/Manner of Collision = 20-22 or 30) OR (Roadway Related = 2 or 3)
102	Install STOP Signs	Provide STOP signs where none existed previously.	20	Intersection Related = 1 or 2
103	Install Advance Warning Signals	Provide flasher units, where none existed previously in advance of the identified problem area.	To be defined.	Will be determined from supplied diagram
104	Improve Advance Warning Signals	Bring existing flasher units into conformance with current design standards. Refer to W.C. 106 for modernization of intersection flashing beacons.	To be defined.	Will be determined from supplied diagram
105	Install Intersection Flashing Beacon	Provide a flashing beacon at an intersection where a beacon did not exit previously.	50	Intersection Related = 1 or 2
106	Modernize Intersection Flashing Beacon	Improve an existing flashing beacon, located at an intersection, to current design standards. Refer to W.C. 104 for non-intersection flashing beacon.	10	Intersection Related = 1or 2
107	Install Traffic Signal	Provide a traffic signal where none existed previously.	28	[(Intersection Related = 1 or 2) AND (Vehicle Movements/Manner of Collision = 10-39)] OR (First Harmful Event = 1 or 5)

108	Improve Traffic Signals	Modernize existing intersection signals to current design standards. Refer to W.C. 106 for modernization of intersection flashing beacons.	22	[(Intersection Related = 1 or 2) AND (Vehicle Movements/Manner of Collision = 10-39)] OR (First Harmful Event = 1 or 5)
109	Add Left Turn Signal Phase	Provide a left turn signal phase at an existing signalized intersection with existing left turn lanes. Affected intersection approaches must be specified.	25	Vehicle Movements/Manner of Collision = 34 or 36
110	Install Pedestrian Signal	Provide a pedestrian signal at an existing signalized location where no pedestrian phase exists, but pedestrian crosswalks existing. Refer to W.C. 403 for installation of pedestrian crosswalks.	15	First Harmful Event – 1
111	Interconnect Signals	Provide a communication link between two or more adjacent signals in a corridor. Specify all signalized intersections to be included in the interconnection.	10	All
112	Overheight Warning System	Install electronic devices to detect overheight loads.	65	Object Struck = 43
113	Install Delineators	Install post mounted delineators to provide guidance.	30	(Roadway Related = 2 or 3) AND (Light Condition = 3 or 4)
114	Install School Zones	Place school zones to include signing and /or pavement marking where none existed previously. Refer to W.C. 403 for pedestrian crosswalk markings.	20	All
115	Eliminate Parking with Milepoints	Completely remove existing parking on one side of the roadway in the direction of the milepoints.	32	(First Harmful Event = 1 or 4 OR (Vehicle Movements/Manner of Collision = 40-44 OR [(Vehicle Movements/Manner of Collision = 10) AND ((Direction of Travel 1=1 or 5) AND (Direction of Travel 2 = 2,3 or 4))] OR [(Vehicle Movements/Manner of Collision = 10) AND ((Direction of Travel 1=2,3,or 4) AND (Direction of Travel 2=1or 5))}
116	Eliminate Parking Opposite Milepoints	Completely remove existing parking on one side of the roadway in the direction of the milepoints.	32	(First Harmful Event = 1 or 4 OR (Vehicle Movements/Manner of Collision = 40-44 OR [(Vehicle Movements/Manner of Collision = 10) AND ((Direction of Travel 1=1 or 5) AND (Direction of Travel 2 =

				6, 7 or 8))] O.. ..hicle Movements/Manner of Collision = 10) AND ((Direction of Travel 1= 6, 7 or 8) AND (Direction of Travel 2=1or 5))}
117	Eliminate Parking	Completely remove existing parking on the roadway.	32	(First Harmful Event = 1 or 4) OR (Vehicle Movements/Manner of Collision = 40-44 or 10)
118	Replace Flashing Beacon with a Traffic Signal	Replace an existing flashing beacon at an intersection with a traffic signal.	25	[(Intersection Related = 1 or 2) AND (Vehicle Movements/Manner of Collision = 10-39)} OR (First Harmful Event = 1 or 5
119	Install Overhead Guide Signs	Install overhead advance signing for unusual or unexpected roadway features where no signing existed previously.	20	Vehicle Movement/Manner of Collision = 20-29
121	Convert 2-way STOP Signs to 4-way STOP Signs	Provide 4-way STOP signs where 2-way STOP signs existed previously.	15	Intersection/Intersection Related = 1 or 2
122	Install Advanced Warning Signals (Intersection – Existing Signal, Flashing Beacon to STOP Signs)	Provide flasher units for in advance of an intersection where none previously existed.	10	Intersection Related = 1 or 2
123	Install Advanced Warning Signals (Curve)	Provide flasher units for in advance of an intersection where none previously existed.	10	(Roadway Related = 2 or 3) OR (Vehicle Movement/Manner of Collision = 20-24 or 30)
124	Install Advanced Warning Signals and Signs (Intersection – Existing Beacon or STOP Signs)	Provide flasher units and signs in advance of an intersection where none previously existed.	15	Intersection Related = 1 or 2
125	Install Advanced Warning Signals	Provide flasher units and signs in advance of a curve where none previously existed.	15	(Roadway Related = 2 or 3) OR (Vehicle Movement/Manner of Collision = 20-24 or 30)
126	Install Advanced Warning Signals and/or Signs (Intersection – Uncontrolled, No Existing Advance Warning)	Provide flasher units and /or signs in advance of an uncontrolled intersection where none previously existed.	20	Intersection Related = 1 or 2
127	Install Advanced Warning Signals (Intersection – Existing Warning Signs)	Provide flasher units in advance of an intersection where none previously existed. Advance warning signs already exist.	10	Intersection Related = 1 or 2

128	Install Advanced Warning Signals (Curve - Existing Warning Signals)	Provide signs in advance of an intersection where none previously existed. Advance warning signals already exist.	5	Intersection Related = 1 or 2
129	Install Advanced Warning Signals (Curve – Existing Warning Signs)	Provide flasher units in advance of a curve where none previously existed. Advance warning signs already exist.	10	(Roadway Related = 2 or 3) OR (Vehicle Movement/Manner of Collision = 20-24 or 30)
130	Install Advanced Warning Signs (Curve – Existing Warning Signals)	Provide signs in advance of a curve where none previously existed. Advance warning signals already exist.	5	(Roadway Related = 2 or 3) OR (Vehicle Movement/Manner of Collision = 20-24 or 30)
131	Improve Pedestrian Signals	Bring existing pedestrian signal units into conformance with current standards.	10	Intersection Related = 1 or 2

Roadside Obstacles and Barriers

Work Code	Description	Definition	Reduction Factor %	Preventable Accident
201	**INSTALL MEDIAN BARRIER**	Construct a metal or concrete median barrier where none existed previously.	65	(Vehicle Movements/Manner of Collision = 30) OR [(Point of Impact = 04, 05, or 63) AND (Object Struck + 01, 03, 20-23, 29-30, 32-36, 39-40, 42, 56, 60, 62, or 63)]
202	Convert Median Barrier	Remove an existing metal median barrier system and install a concrete median barrier.	40	[(Point of Impact = 04, 05, 12, 16 or 63) AND (Object Struck = 23, 39, 56, 62, or 63)] OR (Vehicle Movements/Manner of Collision = 30)
203	Install Raised Median	Install a roadway divider using barrier curb.	25	(Part of Roadway No. 1 Involved = 1) AND (Vehicle Movements/Manner of Collision = 10, 14. 20-22, 24, 26, 28-30, 34 OR 38)
204	Flatten Side Slope	Provide an embankment side slope of 6:1 or flatter.	46	Roadway Related = 3
205	Modernize Bridge Rail and Approach Guardrail	Improve existing substandard bridge rail and approach guardrail to current design standards. Post spacing, end treatment and length of need should be considered. For length of need, if the existing length is less than 20% of the current design length, use W.C.	15	(Object Struck = 23, 39-41 or 56) OR (Bridge Detail = 2 or 3)
207	Install Protection	Provide guardrail or concrete traffic barrier where none existed previously. Refer to W.C. 206 for improving existing guardrail and W.C. 208 for the installation of protection at bridge ends.	30	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)

208	Install Protection at Bridge Ends	Provide guardrail, concrete traffic barrier or other protective system at bridge ends where no protection existed previously. Refer to W.C. 207 for installation of new guardrail and W.C. 206 for improving existing guardrail.	50	(Roadway Re... = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)
209	Safety Treat Fixed Objects	Remove, relocate of safety treat all fixed objects within the project limits, to include both point and continuous objects. Refer to W.C. 210, 211, 212, 213, 214, 215, 216, 217, or 218 if the project includes only one type of fixed object. Guardrail should be coded separately.	55	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)
210	Safety Treat Sign Support	Replace existing sign supports with breakaway supports. Refer to W.C. 217 for the installation of attenuation systems.	45	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)
211	Safety Treat Luminaire Supports	Replace existing luminaire supports with breakaway supports.	35	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)
212	Safety Treat Drainage Structures	Provide safety end treatments to crossroad and/or parallel drainage structures.	60	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)
213	Widen Drainage Structures to Clear Zone	Widen existing structures to provide the desirable clear zone.	30	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)
214	Remove Signal Supports	Redesign signals to remove the existing supports from the median.	10	(Point of Impact = 04, 05, 12 16 or 63) AND (Object Struck = 20-26, 29-36, 40-42, 56-57, 60, 62 or 63)
215	Remove Trees (4:1 or 3:1 w/recovery)	Remove trees from the clear zone. Consideration is given to the embankment slope rate and the clear recovery area gained after removal.	10	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)
216	Remove Trees (6:1)	Remove trees from the clear zone. Consideration is given to the embankment slope rate and the clear recovery area gained after removal.	50	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42)
217	Install Impact Attenuation System	Provide any of a variety of impact attenuators where none existed previously	60	(Object Struck = 20, 30, 40 or 42)
218	Widen Bridge	Provide additional width across an existing structure, either by rehabilitation or replacement. Specify existing bridge width, existing approach roadway width and roadway type (2 lane, 4 lane undivided, etc.)	55	(Bridge Number is not blank) OR (Bridge Detail in not blank) OR (Vehicle Movements/Manner of Collision = 20, 21 or 30) OR (Roadway Related = 2 or 3)

219	Install Curb-Control of Access	Installation of curb for an urban low speed design highway where no previous curb existed and the accident history indicates a control of access problem.	10	[(Intersection Related = 3 or 4) AND (Vehicle Movements/Manner of Collision = 10-19, 20-29, 33-39, 40-44,)] OR (Roadway Related = 2 or 3) IR (Object Struck = 20, 22-23, 26, 29-36) OR (First Harmful Event = 1 or 4)
220	Relocate Luminaire Supports From Median	Relocate luminaire supports from median (usually narrow) and place between outside curb and R.O.W. Refer to Work Code 211 for safety treating luminaire supports.	To be defined.	(Roadway Related = 2 or 3) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)
221	Remove or Modify Barrier Curb	Remove or make traversable the barrier curb in front of existing guardrail or concrete traffic barrier.	30	(Object Struck = 21, 23, 39, 41 or 56) OR (Vehicle Movement/Manner of Collision = 30)

Resurfacing and Roadway Lighting

Work Code	Description	Definition	Reduction Factor %	Preventable Accident
301	**RESURFACING WITH MILEPOINTS**	Provide a new roadway surface to increase pavement skid numbers on the lane(s) in the direction of travel of the milepoints.	42	(Surface Condition = 2) AND ((Direction of Travel 1=1) OR (Direction of Travel 2 = 1))
302	Resurfacing opposite Milepoints	Provide a new roadway surface to increase payment skid numbers on the lane(s) in the direction of travel opposite the milepoints.	42	(Surface Condition = 2) AND ((Direction of Travel 1=5) OR (Direction of Travel 2 = 5))
303	Resurfacing	Provide a new roadway surface to increase pavement skid numbers on all the lanes.	42	Surface Condition = 2
304	Safety Lighting	Provide roadway lighting, either partial or continuous, where either none existed previously or major improvements are being made. Refer to W.C. 305 for intersection lighting.	25	Light Condition = 3 or 4
305	Safety Lighting at Intersection	Install lighting at an inte	75	Light Condition = 3 or 4

Pavement Markings

Work Code	Description	Definition	Reduction Factor %	Preventable Accident
401	**INSTALL PAVEMENT MARKINGS**	Place complete pavement markings, excluding crosswalks, in accordance with the TMUTCD where either no markings or nonstandard markings exist. Refer to W.C. 402 for edge marking, W.C. 403 for pedestrian crosswalks, W.C. 404 for centerline striping.	20	(Road Related = 2 or 3) OR (Vehicle Movements/Manner of Collision = 21 or 30) OR (First Harmful Event = 3)

402	Install Edge Marking	Place edge lines where none existed previously.	25	Roadway Rel..... 2 or 3
403	Install Pedestrian Crosswalk	Place pedestrian crosswalk markings where none existed previously. Refer to W.C. 114 for school zones, and W.C. 110 for pedestrian signal.	10	First Harmful Event = 1
404	Install Center line Striping	Provide centerline striping where either no markings or nonstandard markings existed previously. Refer to W.C. 401 for complete pavement markings.	65	Vehicle Movements/Manner of Collision = 30
405	Install Traffic Buttons	Placed raised nonreflectorized traffic buttons for improved visibility in daylight wet surface conditions. Buttons will be installed where no buttons existed previously. Refer to W.C. 406 for installation of traffic buttons.	30	[(Surface Condition = 2) AND (Light Condition = 1)] OR (Vehicle Movements/Manner of Collision = 21 or 30)
406	Install Raised Reflective Pavement Markers	Place raised reflective pavement markers for improved visibility at night and in wet surface conditions. Markers will be installed where non-existed previously. Refer to W.C. 405 for installation of traffic buttons.	25	(Surface Condition = 2) or (Light Condition = 3 or 4)
407	Install Sidewalks		20	First Harmful Event = 1 or 5
408	Install Bike Lane		20	First Harmful Event = 5

Roadway Work

Work Code	Description	Definition	Reduction Factor %	Preventable Accident
501	Modernize Facility to Design Standards	Provide modernization to all features within the Right-of –Way to achieve current desirable standards. This includes work such as widening the travelway, widening the shoulders, constructing shoulders, flattening the side slopes, and treating roadside obstacles.	15	All
502	Widen Lane(s)	Provide additional width to the lanes(s). Refer to W.C. 517 if adding a through lane.	30	(Roadway Related = 2 or 3) OR (Vehicle Movements/Manner of Collision = 12, 21, 23, 30 or 33)
503	Widen Paved Shoulder	Extend the existing paved shoulder to achieve desirable shoulder width. Refer to W.C. 504 for constructing a paved shoulder.	12	(Roadway Related = 2 or 3) OR (First Harmful Event = 4)

504	Construct Paved Shoulders	Provide paved shoulders to desirable width where no shoulders existed previously. Refer to W.C. 503 for widening paved shoulders.	15	(Roadway Related = 2 or 3) OR (Vehicle Movements/Manner of Collision = 20, 23-24 or 30) OR (First Harmful Event = 4)
505	Improve Vertical	Reconstruct the roadway to improve sight distance.	50	(Roadway Related = 2 or 3) OR (Vehicle Movements/Manner of Collision = 20-24, 30, 32 or 34)
506	Improve Horizontal Alignment	Flatten existing curves. Refer to W.C. 507 for providing superelevation, and W.C. 508 for intersection realignment.	50	(Roadway Related = 2 or 3) OR (Vehicle Movements/Manner of Collision = 20-24, 30)
507	Increase Superelevation	Provide increased superelevation on an existing curve.	65	(Roadway Related = 2 or 3) OR (Vehicle Movements/Manner of Collision = 30)
508	Realign Intersection	Improve an existing intersection by partial or complete relocation of the roadway(s). Refer to W.C. 509 for channelization, and W.C. 506 for improving horizontal alignments.	To be defined.	Will be determined from supplied diagram
509	Channelization	Install islands and/or pavement markings to control or prohibit vehicular movements. A sketch of the proposed channelization should be provided. Refer to W.C. 508 for intersection realignment.	To be defined.	Will be determined from supplied diagram
510	Construct Turn Arounds	Provide turnarounds at an intersection where none existed previously.	40	(Intersection Related = 1 or 2) AND (Vehicle Movements/Manner of Collision = 12, 14, 18. 20, 22, 24, 26, 28, 29, or 34)
511	Add Acceleration/Deceleration Lanes	Construct acceleration and/or deceleration lanes where none existed previously.	10	[Outside 2 Lanes (Main)] AND [Vehicle Movements/Manner of Collision = 20 or 21]
512	Entrance Ramp Modification	Reconstruct existing ramps to conform with current desirable standards.	30	[(Part of Roadway Involved = 2) AND (Vehicle Movements/Manner of Collision = 20)] OR [All Accidents on Outside 2 Main Lanes from 1/10 Mile Before Connection to 2/10 Mile After Connection]

513	Exit Ramp Modification	Reconstruct existing ramps to conform with current desirable standards.	20	{(Part of Roadway Involved = 2 or 4) AND (Roadway Related = 2 or 3)] OR [(Part of Roadway Involved = 2 or 4) AND (Vehicle Movements/Manner of Collision = 10-39)]
514	Grade Separation	Construct vertical separation of intersecting roadways.	80	All
515	Construct Interchange	Construct vertical separation of intersecting roadways to include interconnecting ramps.	55	All
516	Close Crossover	Permanently close an existing crossover.	95	(Part of Roadway Involved = 1) AND (Vehicle Movements/Manner of Collision = 10, 14, 20-22, 24, 26, 28-30, 34 or 38)
517	Add Through Lane	Provide an additional travel lane.	28	Vehicle Movements/Manner of Collision = 20-24, 26-27, 29-30
518	Install Continuous Turn Lane	Provide a continuous two-way left turn lane where none existed previously.	40	Vehicle Movements/Manner of Collision = 20-24, 26-27, 29-30, 34 or 38
519	Add Left Turn Lane	Provide an exclusive left turn lane where none existed previously. The affected intersection approaches must be specified.	25	Vehicle Movements/Manner of Collision = 20-24, 26-27, 29-30, 34 or 38
520	Lengthen Left Turn Lane	Provide an exclusive left turn lane where none existed previously. The affected intersection approaches must be specified.	40	Vehicle Movements/Manner of Collision = 20-22
521	Add Right Turn Lane	Provide an exclusive left turn lane where none existed previously. The affected intersection approaches must be specified.	25	Vehicle Movements/Manner of Collision = 20-23, 25-27, 33 or 36.
522	Lengthen Right Turn Lane	Provide an exclusive left turn lane where none existed previously. The affected intersection approaches must be specified.	40	Vehicle Movements/Manner of Collision = 20-22
523	Construct Pedestrian Over/Under Pass	Construct a pedestrian crossover where none existed previously.	95	First Harmful Event = 1
524	Increase Turning Radius	Provide an increased turning radius at an existing intersection.	10	[(Vehicle No. 1 Type = 2-3, 5-8) AND (First Harmful Event = 7)] OR [(Vehicle No. 2 Type = 2-3, 5-8) AND (First Harmful Event = 7)] OR (Vehicle Movements/Manner of Collision = 13, 20-21, 30 or 33)

525	Covert to One Way Frontage Roads	Convert two-way frontage roads to one-way operation.	25	
526	Increase Vertical Clearance (Lower Grade)	Increase vertical clearance of a roadway underneath an overhead obstacle by lowering the roadway grade.	50	Object Struck = 43
527	Increase Vertical Clearance (Remove Structure)	Remove an overhead structure in order to increase vertical clearance.	95	Object Struck = 43
528	Construct Median Crossover	Provide crossovers in the median where none previously existed.	20	(Part of Roadway Involved = 1) AND (Vehicle Movement/Manner of Collision = 10, 14, 20-22, 24, 26, 28, 29, 34 or 38)
529	Remove Raised Median/Concrete Island	Permanently remove raised median/concrete island	35	Object Struck = 21 or 36
531	Install Jiggle Bar Tiles as a Shoulder Treatment.	Install jiggle bar tiles on the shoulder as a shoulder texturing treatment.	25	(Roadway Related = 2 or 3) OR (Vehicle Movement/Manner of Collision = 30)
532	Texturize Shoulders (rolled in or milled in)	Install milled-in or rolled-in rumble strips along the shoulder.	25	(Roadway Related = 2 or 3) OR (Vehicle Movement = 30)

Appendix I

Summary of Accident Reduction Factors Used in Other States

Table 1. Summary of Accident Reduction Factors for Signing and Signals (Work Codes 101 - 118).

Work Code 101					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Install Warning/Guide Signs	Provide advance signing for unusual or unexpected roadway features where no signing existed previously.	20	Same: Rearend, S-Swipe, #1 Straight - #2 Stopped ; Opposite: Both straight ; Off Rdwy		
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
guidance	15_{AL}, 15_{MO}[3f], 15_{ID} 15_{WA}[9w], 15_{KY}				
install warning signs and delineators	22_{CA}				
advisory speed	36_{MT}[1i], 36_{MT}[1s], 36_{MT}[2] 36_{WA}[9h], 38_{WA}[9r]				
channelization signing	14_{AZ}[7]	-100_{AZ}	-2_{AZ}	-7_{AZ}	27_{AZ}[7]
chevron signing	71_{MT}[1g], 30_{MT}[1h], 50_{MT}[2], 35_{FL}[3d] 35_{WA}[9y]				
cross road/side road signing	33_{AZ}[7], 27_{WA}[9z]	100_{AZ}	56_{AZ}[7]	59_{AZ}[7]	15_{AZ}
icy pavement	-15_{AZ}	67_{AZ}[7]	-24_{AZ}	-13_{AZ}	-17_{AZ}
install diagrammatic exit signs		25_{WA}[9c]	25_{WA}[9c]		25_{WA}[9c]
install stop ahead sign	47_{CA}, 47_{MT}[1h], 47_{WA}[9h], 15_{NY}[11]			80_{WA}[9i]	
install stop ahead sign - rural	47_{WA}[9m]			96_{WA}[9m], 80_{WA}[9f]	45_{WA}[9f]
install yield sign	59_{CA}, 46_{FL}[3b], -37_{AZ} 59_{WA}[9i], 23_{NY}[12]	0_{AZ}	25_{AZ}	25_{AZ}, 80_{WA}[9i]	-89_{AZ}
install yield sign - urban	59_{WA}[9m]			80_{WA}[9f]	60_{WA}[9f]
install/improve other signs (Arrow signs)	34_{NY}[11]				
installation/upgrade traffic signs	37_{NY}[6d]				
intersection directional or warning sign	41_{FL}[3b], 14_{WA}[9p]	47_{FL}[3b]	47_{FL}[3b]		26_{FL}[3b]
interstate signing	7_{AZ}	8_{AZ}	10_{AZ}	10_{AZ}	25_{AZ}[7]
narrow bridge signing	47_{AZ}[7]	0_{AZ}	86_{AZ}[7]	86_{AZ}[7]	13_{AZ}
regulatory - lane use signs	30_{MO}[3i]				
regulatory - other than intersections	25_{AL}, 50_{ID}, 25_{KY}				
regulatory - yield from no control	59_{MO}[5s]				
roadside directional (where to turn)	14_{FL}[3e]				
signing - all	52_{MT}				
signing - dark acc.	76_{MT}				
slippery when wet signing	7_{AZ}, 14_{WA}[9e,14], 36_{WA}[9e,10]	-81_{AZ}	10_{AZ}	6_{AZ}	8_{AZ}
traffic signs	22_{NY}				
upgrade signing	15_{AL}, 15_{ID}, 15_{KY}				
variable message	10_{AL}, 10_{ID}, 10_{KY}	10_{WA}[9c]	10_{WA}[9c]		10_{WA}[9c]
warning - animal warning	10_{AZ}	-15_{AZ}, 5_{WA}[9n]	8_{AZ}, 5_{WA}[9n]	6_{AZ}	13_{AZ}[7], 5_{WA}[9n]
warning - curve warning/guide sign	20_{MT}[1i], 20_{MT}[1e], 18_{MT}[1f] 35_{MT}[1i], 23_{MT}[13], 20_{MT}[1d]				
warning - curve w/speed plate	30_{MT}[1h], 20_{MT}[1s], 22_{MT}[1k] 45_{MT}[1i], 29_{MT}[2], 20_{WA}[9h]				
warning - curves	30_{AL}, 30_{MO}[3d,6], 30_{ID}, 75_{FL}[3b] 43_{FL}[3e], 22_{WA}[9m], 30_{KY}	100_{FL}[3e]	50_{FL}[3e]	41_{WA}[9m]	75_{FL}[3e]
warning - curves - new	14_{AZ}[7]	55_{AZ}[7]	20_{AZ}[7]	24_{AZ}[7]	3_{AZ}
warning - curves - upgraded	21_{AZ}[7]	6_{AZ}	23_{AZ}[7]	22_{AZ}[7]	21_{AZ}[7]
warning - install/improve	35_{CA}[6]				
warning - intersection - T intersection (rural)	61_{WA}[9m]			43_{WA}[9m]	
warning - intersections	39_{WA}[9i]			59_{WA}[9f]	
warning - intersections - rural	40_{AL}, 40_{MO}[3d], 40_{ID} 40_{MT}[1h], 37_{WA}[9m], 40_{KY}			19_{WA}[9m]	
warning - intersections - urban	30_{AL}, 30_{MO}[3d], 30_{ID} 51_{WA}[9g], 30_{WA}[9a,14], 30_{KY}			29_{WA}[9m]	
warning - sections - rural	20_{AL}, 20_{MO}[3d], 20_{ID}, 20_{KY}				
warning - sections - urban	15_{AL}, 15_{MO}[3d], 15_{ID}, 15_{KY}				
warning - watch for falling rocks	13_{AZ}[7]	0_{AZ}	13_{AZ}[7]	12_{AZ}	14_{AZ}[7]
warning - curves - advance	57_{WA}[9m], 75_{WA}[9i]			71_{WA}[9m]	23_{WA}[9m]

Work Code 102				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factor
Install Stop Signs	Provide stop signs where none existed previously.	20	Intersection Related	

Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
stop sign - install	20_{MT}[a], 68_{WA}[a], 19_{AT}[f]	0_{AT}	20_{AT}	20_{AT}	18_{AT}
stop signs - install/improve	68_{CT}				
stop signs - replacement of standard w/large	19_{MT}[g]				
four-way stop/all-way stop	63_{MT}[a], 70_{MT}[a], 73_{MT}[a], 19_{MT}[a] 75_{MT}[a], 33_{MT}[g], 73_{MT}[a], 20_{PI}[a]	67_{FI}[a]	67_{FI}[a]		
install minor leg stop control	48_{PD}, 36_{PI}[a], 48_{WA}[a], 1_{PT}[f]	8_{FI}[a]	8_{FI}[a]	71_{WA}[a]	
install minor leg stop control - rural	65_{WA}[a]			83_{WA}[a], 80_{WA}[a]	65_{WA}[a]
install minor leg stop control - urban	48_{WA}[a]			71_{WA}[a], 73_{WA}[a]	50_{WA}[a,g]
regulatory - four-way stop from two-way stop	47_{MO}[a], 47_{WA}[a]				
regulatory - intersections	50_{AL}, 50_{PI}, 50_{FT}				
regulatory - two-way stop from yield control	48_{MO}[a], 48_{WA}[a]				

Work Code 103				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factor
Install Advance Warning Signals	Provide flasher units, where none existed previously in advance of the identified problem area.	*	Will be determined from supplied diagram	

Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
warning/flashing - intersections/curves - advance	30_{MT}[a], 30_{MT}[a], 20_{MT}[a], 25_{MT}[f]				
warning/flashing - install	25_{WA}[a]				
warning signal - install/improve	$42\text{-}56_{CI}$				
warning/flashing - curves	30_{AL}, 30_{PI}, 33_{FT}				
warning/flashing - intersections - advance	20_{AL}, 24_{PI}, 33_{WA}[a], 24_{WA}[a], 25_{FT}				

Work Code 104				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factor
Improve Advance Warning Signals	Bring existing flasher units into conformance with current design standards.	*	Will be determined from supplied diagram	

Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
warning signal - install/improve	$42\text{-}56_{CI}$				

Work Code 105				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factor
Install Intersection Flashing Beacon	Provide a flashing beacon at an intersection where a beacon did not exist previously.	50	Intersection Related	

Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
warning/flashing - intersections	$42\text{-}56_{WA}$[a]			30_{WA}[a,g,i], 30_{WA}[a,g,i], 15_{WA}[a,g,i] 75_{WA}[a], 25_{WA}[a,g,i]	30_{WA}[a,g,i] 25_{WA}[a,g,i]
install - new flashing red/yellow signal	26_{MT}				
warning/flashing - intersections - 3-leg red-yellow	50_{MT}[a], 50_{MT}[a], 40_{MT}[a], 34_{MT}[a], 22_{MT}[a] 39_{PI}[a], 39_{WA}[a]			7_{WA}[a]	56_{WA}[a]
warning/flashing - intersections - 4-leg red-yellow	50_{MT}[a], 50_{MT}[a], 40_{MT}[a], 15_{MT}[a], 22_{MT}[a] 50_{PI}[a], 34_{MT}[a], 66_{WA}[a], 36_{WA}[a]			15_{WA}[a]	50_{WA}[a]
warning/flashing - intersections - 4-way red	65_{AL}, 64_{PI}, 65_{MT}[a], 75_{MT}[a], 70_{MT}[a] 50_{WA}[a], 65_{FT}			43_{WA}[a]	55_{WA}[a]
warning/flashing - intersections - red/yellow	30_{AL}, 30_{PI}, 39_{FT}				

Table 1. Summary of Accident Reduction Factors for Signing and Signals (Work Codes 101 - 118) - Continued.

Work Code 106					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Modernize Intersection Flashing Beacon	Improve an existing flashing beacon, located at an intersection, to current design standards.	10	Intersection Related		
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO

Work Code 107					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Install Traffic Signal	Provide a traffic signal where none existed previously.	28	Intersection Related ; Collisions at Angle, Same, or Opposite ; Collision w/Pedestrian or Pedalcyclist		
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
install - new	20_{AL}, 29_{CA}, 31_{ID}, -17_{AZ}, 20_{KY}	-14_{AZ}	-20_{AZ}	-20_{AZ}	-15_{AZ}
install - new at channelizated intersection	42_{FL}		42_{FL}		43_{FL}
install - new at non-channelizated intersection	20_{FL}				21_{FL}
install - new from two-way stop	28_{MO}[3v], 28_{WA}[9hh]			43_{MO}[3v], 43_{WA}[9hh]	
install - new red/yellow/green signal	32_{NY}				
install - new signal and geometric revamp	21_{AZ}	57_{AZ}	28_{AZ}	30_{AZ}	13_{AZ}
install - overhead signals	31_{WA}[9f], 25_{WA}[9t], 31_{WA}[9m], 47_{WA}[9v]			30_{WA}[9f], 35_{WA}[9t], 35_{WA}[9m]	30_{WA}[9f]
intersection - 4-legged without channelization	18_{MT}[1b], 24_{MT}[1c], 32_{MT}[1e], 27_{MT}[1f] 15_{MT}[1m], 23_{MT}[3]	49_{MT}[1b], 14_{M} 31_{MT}[3]	32_{MT}[1b], 16_{MT}[1e] 24_{MT}[3]		
traffic signals/devices	27_{NY}, 23_{MT}[1b]				

Work Code 108					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Improve Traffic Signals	Modernize existing intersection signals to current design standards.	22	Intersection Related ; Collisions at Angle, Same, or Opposite ; Collision w/Pedestrian or Pedalcyclist		
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
12-inch lens	10_{AL}, 10_{MO}[3f], 10_{ID}, 10_{WA}[9m], 10_{KY}				
add multi-dial controller	31_{WA}[9f], 25_{WA}[9t], 31_{WA}[9m], 47_{WA}[9v]			30_{WA}[9f], 35_{WA}[9t], 35_{WA}[9m]	30_{WA}[9f]
improve location of signal heads	31_{WA}[9f], 25_{WA}[9t], 31_{WA}[9m], 47_{WA}[9v]			30_{WA}[9f], 35_{WA}[9t], 35_{WA}[9m]	30_{WA}[9f]
install - additional signal heads	31_{WA}[9f], 25_{WA}[9t], 31_{WA}[9m], 47_{WA}[9v]			30_{WA}[9f], 35_{WA}[9t], 35_{WA}[9m]	30_{WA}[9f]
install - back plates	31_{WA}[9f], 25_{WA}[9t], 31_{WA}[9m], 47_{WA}[9v]			30_{WA}[9f], 35_{WA}[9t], 35_{WA}[9m]	30_{WA}[9f]
install - visors	31_{WA}[9f], 25_{WA}[9t], 31_{WA}[9m], 47_{WA}[9v]			30_{WA}[9f], 35_{WA}[9t], 35_{WA}[9m]	30_{WA}[9f]
modernize, modify, or upgrade	20_{AL}, 25_{CA}, 21_{NY}, 26_{ID}, 22_{MT}[1d], 20_{KY}				
modify both signal and channelization	52_{FL}		71_{FL}		43_{FL}
modify signal at channelization intersection	27_{FL}[3h]				
modify signal at non-channelization intersection	27_{FL}[3h]				
pretimed to actuated	20_{AL}, 27_{NY}, 20_{ID}, 20_{KY}				
revamped signal	9_{AZ}	0_{AZ}	3_{AZ}	3_{AZ}	13_{AZ}
revamped signal and geometric revamp	40_{AZ}	50_{AZ}	33_{AZ}	34_{AZ}	43_{AZ}
signal phasing - improve timing	10_{AL}, 10_{ID}, 10_{KY}				
signal phasing - increase clearance interval	30_{AL}, 30_{ID}, 30_{KY}				
upgrade pedestal mounted to mast arm mount pretimed - existing LTL	44_{MO}[3v]			25_{MO}[3v]	
upgrade pedestal mounted to mast arm mount pretimed - LTL added	84_{MO}[3v]			87_{MO}[3v]	
upgrade pedestal mounted to mast arm mount pretimed - no LT lane	51_{MO}[3v], 51_{WA}[9hh], 44_{WA}[9hh], 84_{WA}[9hh]			52_{MO}[3v], 52_{WA}[9hh], 87_{WA}[9hh], 25_{WA}[9hh]	
upgrading - red/yellow/green signal[13]	29_{NY}				

Table 1. Summary of Accident Reduction Factors for Signing and Signals (Work Codes 100 - 118) - Continued.

Work Code 113				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Install Delineators	Install post mounted delineators to provide guidance	30	Off Rdwy on or beyond shoulder ; Darkness lighted or not lighted	

Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Install Delineators	30_{CA}, 40_{MO}, 13_{WA}[9s] 30_{WA}[9s], 11_{AZ}	47_{WA}[9s], 8_{AZ}	20_{WA}[9s], 19_{AZ}[7]	18_{AZ}[7]	4_{AZ}
Delineation of Bridge Ends	40_{MT}[1c], 27_{MT}[1c], 53_{MT}[1c], 39_{MT}[2]				
Delineation of Curves	30_{NY}, 30_{WA}[9c], 22_{WA}[9c], 2_{WA}[9m]				
Delineation of Horizontal Curves	30_{MT}[1c], 30_{MT}[1b], 30_{MT}[3]				
Delineation of Shoulders	9_{NC}				
Delineation of Tangent Sections	30_{MT}[1b], 23_{MT}[1c], 22_{MT}[3]				
Improve marking, signing, and delineation on narrow bridge				5_{WA}[9f]	15_{WA}[9f]
Install Delineation At Bridge Approaches		10_{WA}[9s], 5_{WA}[9c]	10_{WA}[9s], 5_{WA}[9c]		5_{WA}[9s], 5_{WA}[9f]
Install Delineation At Bridge or Underpass	50_{WA}[9f], 47_{WA}[9c21], 53_{WA}[9c22]		8_{WA}[9c21]	62_{WA}[9c22]	89_{WA}[9c22]
Install Delineators – Bridge Underpass	50_{CA}			16_{WA}[9m], 41_{WA}[9c]	
Install Guide Posts on Curve	30_{FL}[3c], 25_{WA}[9m]	25_{FL}[3c]	25_{FL}[3c]	25_{WA}[9f]	25_{FL}[3c], 25_{WA}[9f]
Install Post Mounted Delineators on Horizontal Curve	25_{MD}				
Install Warning Signs and Delineation on Curve	22_{WA}[9m]			41_{WA}[9m]	
Intersection Delineation	10_{FL}[3d]				
Post Delineators	20_{AL}, 20_{ID}				
Post-Mounted Delineation	20_{MT}[1b], 13_{MT}[1c], 25_{MT}[1c] 16_{MT}[1c], 30_{MT}[1d], 25_{MT}[2]	46_{MT}[1c], 23_{MT}[1c] 35_{MT}[2]	20_{MT}[1c], 38_{MT}[1c] 29_{MT}[2]		

Work Code 114					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Install School Zones	Place school zones to include signing and/or pavement markings where none existed previously	20	All		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Install School Zone – Signing and/or Striping	20_{MT}[1d]				

Work Code 115					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Eliminate Parking with Milepoints	Completely remove existing parking on one side of the roadway in the direction of the milepoints	32			
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Nothing Found					

Table 1. Summary of Accident Reduction Factors for Signing and Signals (Work Codes 101 - 118) - Continued.

Work Code 116					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Eliminate Parking Opposite Milepoints	Completely remove existing parking on one side of the roadway in the direction opposite the milepoints.	32			
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
Nothing Found					

Work Code 117					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Eliminate Parking	Completely remove existing parking on the roadway.	32			
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
Change From Angle to Parallel Parking	59_{WA}^{9m}, 28_{WA}^{9h}, 38_{WA}^{9m}, 25_{WA}^{9g}	87_{WA}^{9g}	38_{WA}^{9g}	$30_{WA}^{9f,10}$, 30_{WA}^{9h}	40_{WA}^{9f}
Prohibit Parking	32_{WA}^{9i}, 32_{WA}^{9i}, 90_{WA}^{9g}			$5_{WA}^{9f,16}$, 3_{WA}^{9i}	30_{WA}^{9f}
Prohibit Parking Near Corners	32_{WA}^{9i}, 32_{WA}^{9h}			$5_{WA}^{9f,16}$, 3_{WA}^{9h}	$30_{WA}^{9f,16}$
Restrict Parking Near Driveway	32_{WA}^{9i}			$5_{WA}^{9f,16}$, 3_{WA}^{9i}	30_{WA}^{9f}

Work Code 118					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Replace Flashing Beacon with a Traffic Signal	Replace an existing flashing beacon at an intersection with a traffic signal.	25			
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
Nothing Found					

Miscellaneous 100					
	All	Fatal	Injury	Fatal/injury	PDO
prohibit right-turn on red	25_{WA}^{9p}				
remove signal supports form median	10_{MT}^{1d}				
remove unwarranted signal	100_{AZ}	0_{AZ}	100_{AZ}	100_{AZ}	100_{AZ}
signal phasing - right turn on red phase	5_{WA}^{9r}	30_{WA}^{9r}	3_{WA}^{9r}		
warning/flashing - RR crossing	80_{AL}, 50_{CA}, 80_{WA}^{9i}, 80_{KY}	54_{WA}^{9i}	23_{WA}^{9i}		
warning/flashing - RR crossing - flashing lights replace signs	94_{WA}^{9g}	99_{WA}^{9g}	93_{WA}^{9g}		
Prohibit Left Turns	90_{WA}^{9g}				

Table 2. Summary of Accident Reduction Factors for Roadside Obstacles and Barriers (Work Codes 201 - 221).

Work Code 201					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Install Median Barrier	Construct a metal or concrete median barrier where none existed previously.	65	Head-to -Head collisions, vehicle striking object		
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
double sided on wider median		85_{FL}[3e]	5_{FL}[3e]		
guardrail - 1 to 12 ft. median		75_{MO}[3e], 75_{WA}[9e]	2_{MO}[3e], 2_{WA}[9e]		-28_{MO}[3e], -28_{WA}[9e]
guardrail - 13 to 30 ft. median		85_{MO}[3e], 85_{WA}[9e]	5_{MO}[3e], 5_{WA}[9e]		-30_{MO}[3e], -30_{WA}[9e]
guardrail - 31 to 60 ft. median		85_{MO}[3e], 85_{WA}[9e]	5_{MO}[3e], 5_{WA}[9e]		-30_{MO}[3e], -30_{WA}[9e]
install	36_{CA}, 19_{NY}				
install barrier in median on roadway >2 lanes	-53_{WA}[9e]			-61_{WA}[9e]	
install beam barrier in median on roadway >2 lanes	-20_{WA}[9e], -20_{WA}[9h]	15_{WA}[9e]	-30_{WA}[9e]	-22_{WA}[9h]	-10_{WA}[9e]
install cable barrier in median on roadway >2 lanes	-31_{WA}[9e], -33_{WA}[9h]	36_{WA}[9e]	-20_{WA}[9e]	43_{WA}[9e]	-40_{WA}[9e]
install concrete mb	65_{FL}[3f], 60_{WA}[9f]	45_{FL}, 90_{MO}[3e]	61_{FL}[3b], 10_{MO}5[a]	60_{WA}[9f]	-10_{MO}[3e]
install concrete mb - 1 to 12 ft. median		90_{WA}[9e]	10_{WA}[9e]		-10_{WA}[9e]
install concrete mb - 13 to 30 ft. median		85_{WA}[9e]	5_{WA}[9e]		-25_{WA}[9e]
install concrete mb replacing barrels		50_{WA}[9e]	50_{WA}[9e]		-50_{WA}[9e]
install concrete mb with end treatment		60_{WA}[9e]	40_{WA}[9e]		-150_{WA}[9e]
median barriers	0_{AL}, 0_{MT}[1h], 26_{MT}[1e],	60_{AL}, 38_{ID}, 30_{MT}[1h],	10_{AL}, 38_{ID}, 17_{MT}[1e],		
	3_{MT}[1h], 65_{MT}[1d], 31_{MT}[3]	48_{MT}[1e], 91_{MT}[1h], 56_{MT}	6_{MT}[1h], 11_{MT}[3]		
new/upgraded	36_{AZ}[7], 20_{NY}, 5_{WA}[9e, 4]	60_{AZ}, 38_{WA}[9e]	26_{AZ}[7], 10_{WA}[9e]	28_{AZ}[7]	39_{AZ}[7]
Install Concrete Barrier To Prevent Left Turns		90_{WA}[9e]	10_{WA}[9e]	60_{WA}[9f]	60_{WA}[9f], -10_{WA}[9e]
Install Median Barrier	36_{CA}, 40_{WA}[9e]				

Work Code 202					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Convert Median Barrier	Remove an existing metal median barrier system and install a concrete median barrier.	40	Head-to-Head collisions		
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
new/upgraded	36_{AZ}[7], 20_{NY}, 5_{WA}[9e, 4] Run-off Road: 35_{AZ}[7]	60_{AZ}, 38_{WA}[9e]	26_{AZ}[7], 10_{WA}[9e]	28_{AZ}[7]	39_{AZ}[7]
upgrade to concrete mb	44_{FL}[3f]	60_{FL}[3e]	60_{FL}[3e]	60_{FL}[3e]	
convert to median barrier (remove w-beam plc. barrier)	40_{MT}[1d]				

Work Code 203					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Install Raised Median	Install a roadway divider using barrier curb	25			
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
Install Painted or Raised Median	8_{CA}, 10_{MO}, 25_{MT}[1d], 10_{WA}[9e]			10_{WA}[9f,16]	10_{WA}[9f,16]
Install Painted or Raised Median To Prevent Left Turns	10_{WA}[9e]	90_{WA}[9e]	10_{WA}[9e]	10_{WA}[9f,16]	10_{WA}[9f,16]

Work Code 204					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Flatten Side Slope	Provide an embankment side slope of 6:1 or flatter.	46	Off roadway beyond shoulder		
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
flatten side slope	15_{AL}, 46_{CA}, -4_{AZ}, 16_{FL}[3f], 34_{ID}, 15_{M} 35_{MT}[1f], 46_{MT}[1d], 32_{MT}[2], 47_{NY} Run-off road: 10_{AZ}	30_{AZ}, 20_{WA}[3c]	-15_{AZ}, 20_{WA}[3c]	-12_{AZ}	2_{AZ}, 20_{WA}[3c]
flatten sideslope - from 2:1 to 4:1	Run-off road: 7_{MO}[4.3e], 7_{WA}[9e,10]				
flatten sideslope - from 2:1 to 6:1	Run-off road: 15_{MO}[4.3e], 15_{WA}[9e,10]				
flatten sideslope - from 3:1 to 4:1	Run-off road: 6_{MO}[4.3e], 6_{WA}[9e,10]				
flatten sideslope - from 3:1 to 6:1	Run-off road: 14_{MO}[4.3e], 14_{WA}[9e,10]				

Table 2. Summary of Accident Reduction Factors for Roadside Obstacles and Barriers (Work Codes 201 - 221) - Continued.

Work Code 205				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Modernize Bridgerail and Approach Guardrail	Improve existing substandard bridgerail and approach guardrail to current design standards. Post spacing, end treatment and length of need should be considered.	15		

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
install or upgrade culvert & bridge railing	20_{NY} Collision w/bridge or culvert: 38_{NY}	61_{WA}[9x]	45_{WA}[9x]		-61_{WA}[9x]
modernize bridgersil & approach guardrail	15_{MT}[14]				
modernize rail to design standard/upgrade	5_{CA}, 25_{AZ}[7], 5_{FL}[3g] Run-off Road: 42_{AZ}[7]	-100_{AZ}	50_{AZ}[7]	41_{AZ}[7]	14_{AZ}

Work Code 206				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Improve Guardrail to Design Standards	Bring existing substandard guardrail into conformance with current design standard.	7		

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
end treatments	0_{FL}[3d]	55_{FL}[3x]	25_{FL}[3x]		
replacement or upgrading deficient guardrail	9_{NY}, Run-off Road 34_{NY} Collision w/guardrail 30_{NY} Collision w/fixed object: 16_{NY}				
road edge guardrail install/improve	1_{NY}				
treat guardrail ends as texas turn down		55_{WA}[9x]	25_{WA}[9x]		-15_{WA}[9x]
upgrade/extended	5_{AZ}[7], 5_{CA}, 7_{MT}[14], Run-off Road: 26_{AZ}	9_{AZ}	13_{AZ}[7]	13_{AZ}[7]	16_{AZ}

Work Code 207					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Install Protection	Provide guardrail or concrete traffic barrier where none existed previously.	30			

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
at roadside obstacles	4_{FL}[3x]	38_{FL}[3x]	16_{FL}[3x]		
concrete	39_{MT}[1x]	55_{ID}	35_{ID}	60_{WA}[9f]	
inside curves	30_{MT}[1x], 30_{MT}[1i], 24_{MT}[1j], 28_{MT}[1]				
install	30_{CA}, 9_{AL}, 19_{AZ}[7], 36_{MT}[1x], 13_{MT}[1h] 11_{MT}[1x], 30_{MT}[1f], 23_{MT}[2], 10_{NY}[7] Run-off Road: -18_{NY}[6], 30_{AZ}[7] Collision w/guardrail: -51_{NY} Collision w/fixed object: 4_{NY}[6]	34_{MT}[1x], 59_{MT}[1h], 67_{MT}[1] 48_{MT}[2], 55_{AL}, 47_{AZ}[5]	32_{MT}[1x], 15_{MT}[1h], -4_{MT}[1x] 15_{MT}[2], 35_{AL}, 12_{AZ}	15_{AZ}[7]	21_{AZ}[7]
install along ditch				25_{MO}[3x], 36_{WA}[9x]	-19_{MO}[3x], -19_{WA}[3x]
install along embankment	13_{WA}[9x], 30_{WA}[9x]	47_{WA}[9x], 59_{WA}[9x]	47_{WA}[9x], 15_{WA}[9x]	42_{MO}[3x]	-47_{MO}[3x], -47_{WA}[3x]
install at fixed objects (bridge ends, piers, steel posts)	50_{WA}[9x], 61_{WA}[9x], 50_{WA}[9x]	90_{WA}[9x]	45_{WA}[9x]		-110_{WA}[9x]
install at fixed objects (rocks/steel post)				31_{MO}[3x], 31_{WA}[9x]	-45_{MO}[3x], -45_{WA}[3x]
install at obstacles	20_{FL}[3j], 42_{WA}[9f], 21_{WA}[9x], 12_{WA}[9m]	20_{WA}[9x]	18_{WA}[9x]	45_{WA}[9f], 21_{WA}[9m]	25_{WA}[9x]
install at trees		65_{MO}[3x], 65_{WA}[3x]	51_{MO}[3x], 51_{WA}[3x]		-90_{MO}[3x], -50_{WA}[3x]
install at wood utility pole		-40_{WA}[3x]	37_{WA}[9x]		-31_{WA}[9x]
install breakaway cable terminal		90_{WA}[9x], 75_{WA}[9x]	60_{WA}[9x], 40_{WA}[3x]		-180_{WA}[9x], -40_{WA}[9x], -15_{WA}[3x]
metal		55_{ID}	35_{ID}		
outside curves	55_{MT}[1h], 69_{MT}[1i], 59_{MT}[1g], 63_{MT}[2]				
removal or protection of fixed object in gore	4c				
remove w/o other improvements	-19_{NY}[6] Collision with ditch/cut/bank: -360_{NY}				
road edge gr install/improve	11_{NY}				
shield rock cuts		90_{WA}[9x]	60_{WA}[9x]		-60_{WA}[9x]
steep embankments	50_{FL}[3x]	47_{FL}[3x]	42_{FL}[3x]	47_{FL}[3x]	
steep embankments w/ curve	50_{FL}[3x]				

Work Code 208					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Install Protection at Bridge Ends	Provide guardrail, concrete traffic barrier or other protective system at bridge ends where no protection existed previously.	50			
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
bridge end guardrail	50_{CA}, 50_{FL}[3e], 60_{FL}[3e], 56_{MT}[1e], 50_{MT}[1e] 40_{MT}[1f], 25_{MT}[1g], 50_{MI}[1d], 44_{MT}[3]	90_{FL}[3e], 90_{MT}[1e], 90_{MO}[5] 90_{WA}[9e]	45_{FL}[3e], 45_{MT}[1e], 45_{MO}[5b], 45_{WA}[9e]		-100_{MO}[5b], -110_{WA}[9e]
guardrail transition to bridge end		75_{WA}[9e], 55_{WA}[9b]	50_{WA}[9e], 20_{WA}[9b]		-170_{WA}[9e], -75_{WA}[8e], -50_{WA}[9b]
install bridge approach rail connections				50_{WA}[9f]	35_{WA}[9f]

Work Code 209					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Safety Treat Fixed Objects	Remove, relocate or safety treat, all fixed objects within the project limits, to include both point and continuous objects.	55			
Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
breakaway utility poles	0_{AL}, 0_{ID}	40_{AL}, 40_{ID}	30_{AL}, 30_{ID}		
modify non-breakaway object within 30 ft.	25_{CA}				
relocate fixed objects	0_{AL}, 0_{ID}, 60_{MI}[8b], 20-75_{MI}[8c], 85_{MI}[8], 85_{FL}[3], 60_{WA}[9m], 80_{WA}[9g], 64_{WA}[9g] Collision w/fixed object: 60_{FL}[3b]	40_{AL}, 40_{ID}, 40_{MO}[8c], 40_{MO}[5d]	15_{AL}, 15_{ID}, 15_{MI}[8d], 15_{MO}[5d]		
relocate utility pole offset from road - from 2 to 6 ft.	Collision w/fixed object: 50_{MO}[5e], 50_{WA}[9i]				
relocate utility pole offset from road - from 3 to 8 ft.	Collision w/fixed object: 46_{MO}[5e], 46_{WA}[9i]				
relocate utility pole offset from road - from 5 to 10 ft.	Collision w/fixed object: 36_{MO}[5e], 36_{WA}[9i]				
relocate/remove fixed objects	85-95_{CA}				
remove fixed objects	0_{AL}, 20_{ID}, 75_{MI}[8c], 80_{MI}[8d], 20_{FL}[3e]	50_{AL}, 50_{ID}, 50_{MI}[8e], 50_{MI}[8f], 50_{MO}[5e], 60_{FL}[3e]	15_{AL}, 15_{ID}, 15_{MI}[8e], 20_{MI}[8f], 15_{MO}[5d], 20_{FL}[3e]		
remove obstacle/vegetation	60_{AZ}[7], Run-off Road: 77_{AZ}[7]	0_{AZ}	59_{AZ}[7]	58_{AZ}[7]	64_{AZ}[7]
remove obstacles from cut slopes		35_{WA}[9c]	15_{WA}[9c]		-30_{WA}[9c]
remove obstacles from existing steep slope		14_{WA}[9c]	10_{WA}[9c]		-18_{WA}[9c]
remove obstacles from gentle steep slope		75_{WA}[9c]	23_{WA}[9c]		-40_{WA}[9c]
remove utility poles		35_{WA}[9c]	-2_{WA}[9c]		0_{WA}[9c]
remove, relocate or safety treat objects within clear zon	Fixed object: 55_{MT}[14]				
roadside clear zone recov. dist. - add 5 ft.	Fixed object: 13_{MO}[4,5e], 13_{WA}[9k,10] Run-off Road: 13_{MO}[4,5e], 13_{WA}[9k,11]				
roadside clear zone recov. dist. - add 8 ft.	Fixed object: 21_{MO}[4,5e], 21_{WA}[9k,10] Run-off Road: 21_{MO}[4,5e], 21_{WA}[9k,11]				
roadside clear zone recov. dist. - add 10 ft.	Fixed object: 25_{MO}[4,5e], 25_{WA}[9k,10] Run-off Road: 25_{MO}[4,5e], 35_{WA}[9k,11]				
roadside clear zone recov. dist. - add 15 ft.	Fixed object: 35_{MO}[4,5e], 35_{WA}[9k,10] Run-off Road: 35_{MO}[4,5e], 35_{WA}[9k,11]				

Work Code 210					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Safety Treat Sign Support	Replace existing sign supports with breakaway supports.	45			
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
breakaway signs	0_{AL}, 0_{ID}, 35_{WA}[9j]	60_{AL}, 60_{ID}, 75_{WA}[9e] 50_{WA}[9i]	30_{AL}, 30_{ID}, 75_{WA}[9e] 50_{WA}[9i]		-70_{WA}[9e], -15_{WA}[9i]
breakaway signs or light supports	15_{MT}[1e], 35_{MT}[1f], -14_{MT}[1e], 23_{MT} 35_{MT}[14], 14_{MT}[2], 35_{WA}[9h]	100_{MT}[1b]	44_{MT}[1b], -13_{MT}[1e], 15_{MT}[2]	50_{WA}[9f]	0_{WA}[9f]
breakaway small signs		70_{WA}[9e]	25_{WA}[9e]		-12_{WA}[9e]
convert obstacle to breakaway	35_{FL}[3b]				
safety-treat sign supports	25_{CA}, 25_{WA}[9e]				

Table 2. Summary of Accident Reduction Factors for Roadside Obstacles and Barriers (Work Codes 201 - 221) - Continued.

Work Code 211				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Safety Treat Luminaire Supports	Replace existing luminaire supports with breakaway supports.	35		

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
breakaway signs or light supports	15_{MT}[1], 35_{MT}[15], -14_{MT}[11], 23_{MT} 35_{MT}[14], 14_{MT}[2], 35_{WA}[16]	100_{MT}[16]	44_{MT}[15], -13_{MT}[11], 15_{MT}[2]	30_{WA}[16]	0_{WA}[16]
convert obstacle to breakaway	35_{FL}[26]				
safety-treat luminaire supports	25_{CA}				

Work Code 212				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Safety Treat Drainage Structures	Provide safety end treatments to crossroad and/or parallel drainage structures.	60		

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
modernize to design standards	30_{CA}				
safety treat crossroad/parallel	60_{MT}[14]				
safety-treat concrete headdwalls	30_{CA}, 30_{WA}[8]				

Work Code 213				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Widen Drainage Structures to Clear Zone	Widen existing structures to provide the desirable clear zone.	30		

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
drainage structure extensions	36_{AZ}[7]	18_{AZ}	34_{AZ}[7]	33_{AZ}[7]	38_{AZ}[7]
widen drainage structure to clear zone	30_{MT}[14]				

Work Code 214				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Remove Signal Supports	Redesign signals to remove the existing supports from the median.	10		

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
Nothing Found					

Work Code 215				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Remove Trees (4:1 or 3:1 w/recovery)	Remove trees from the clear zone. Consideration is given to the embankment slope rate and the clear recovery area gained after removal.	10		

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
remove trees	30_{MT}[2]	100_{WA}[36], 65_{WA}[36]	100_{WA}[36], 25_{WA}[36]		50_{WA}[36], 5_{WA}[36]
remove trees - 4:1 or 3:1 recovery zone	10_{MT}[14]				

Work Code 216				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors
Remove Trees (6:1)	Remove trees from the clear zone. Consideration is given to the embankment slope rate and the clear recovery area gained after removal.	50		

Related Countermeasures					
	All	Fatal	Injury	Fatal/injury	PDO
remove trees	30_{MT}[2]	100_{WA}[36], 65_{WA}[36]	100_{WA}[36], 25_{WA}[36]		50_{WA}[36], 5_{WA}[36]
remove trees - 6:1 recovery zone	50_{MT}[14]				

Table 2. Summary of Accident Reduction Factors for Roadside Obstacles and Barriers (Work Codes 201 - 221) - Continued.

Work Code 217					
Description	**Definition**	**Reduction Factor**	**Preventable Accident**	**Best Match Reduction Factors**	
Install Impact Attenuation System	Provide any of a variety of impact attenuators where none existed previously.	60			
Related Countermeasures					
	All	**Fatal**	**Injury**	**Fatal/injury**	**PDO**
install energy attenuators at bridge or underpass	14_{WA}[34]	75_{WA}[3c]	60_{WA}[3c]	22_{WA}[34]	-300_{WA}[3c]
impact attenuation system	0_{ALL}, 80_{CAL}, 41_{AZ}[7], 60_{MT}[14] 4_{MT}[6b], 80_{FL}[3c], 80_{WA}[3c] Run-off Road: 45_{AZ}[7]	75_{ALL}, -100_{AZ}, 32_{ID} 70_{FL}[3c], 100_{WA}[3c]	50_{ALL}, 55_{AZ}[7], 33_{ID} 9_{FL}[3], 44_{WA}[3c]	50_{AZ}[7], 50_{WA}[3c]	36_{AZ}[7], 20_{FL}[3c], 20_{WA}[3c]
install sand-filled cell		75_{WA}[3c]	60_{WA}[3c]		-300_{WA}[3c]
install steel barrels		75_{WA}[3c]	60_{WA}[3c]		-300_{WA}[3c]
install water-filled crash cushion		75_{WA}[3c]	60_{WA}[3c]		-300_{WA}[3c]

Work Code 218					
Description	**Definition**	**Reduction Factor**	**Preventable Accident**	**Best Match Reduction Factors**	
Widen Bridge	Provide additional width across an existing structure, either by rehabilitation or replacement.	55			
Related Countermeasures					
	All	**Fatal**	**Injury**	**Fatal/injury**	**PDO**
Nothing Found					

Work Code 219					
Description	**Definition**	**Reduction Factor**	**Preventable Accident**	**Best Match Reduction Factors**	
Install Curb - Control of Access	Installation of a curb for an urban low speed design highway where no previous curb existed and the accident history indicates a control of access problem.	10			
Related Countermeasures					
	All	**Fatal**	**Injury**	**Fatal/injury**	**PDO**
Nothing Found					

Work Code 220					
Description	**Definition**	**Reduction Factor**	**Preventable Accident**	**Best Match Reduction Factors**	
Relocate Luminaire Supports From Median	Relocate luminaire supports from median (usually narrow) and place between outside curb and R.O.W.	*			
Related Countermeasures					
	All	**Fatal**	**Injury**	**Fatal/injury**	**PDO**
Nothing Found					

Work Code 221					
Description	**Definition**	**Reduction Factor**	**Preventable Accident**	**Best Match Reduction Factors**	
Remove or Modify Barrier Curb	Remove or make traversable the barrier curb in front of existing guardrail or concrete traffic barrier.	30			
Related Countermeasures					
	All	**Fatal**	**Injury**	**Fatal/injury**	**PDO**
Nothing Found					

Miscellaneous 200					
	All	**Fatal**	**Injury**	**Fatal/injury**	**PDO**
install guardrail and shrubs in gaps between bridges		90_{WA}[3c]	60_{WA}[3c]		-100_{WA}[3c], -50_{WA}[3c]
install median and shoulder pier protection		90_{WA}[3c]	60_{WA}[3c]		-100_{WA}[3c], -300_{WA}[3c]
install protection at twin-bridge median opening	50_{CA}, 50_{WA}[3c]				
retro-fit curbs with barrier		75_{WA}[3c]	75_{WA}[3c]		50_{WA}[3c]
gore improvements	30_{MT}				
install/improve median barrier near gore area	17_{MT}				56_{MT}
protection of fixed objects/improve guidance	34_{MT}				
removal or protection of fixed objects	7_{MT}[6]				
clear gore area		75_{WA}[3c], 50_{WA}[3c]	50_{WA}[3c], 50_{WA}[3c]		25_{WA}[3c], 0_{WA}[3c]

Table 3. Resurfacing and Roadway Lighting (Work Codes 303/05).

Work Code 303					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Resurfacing	Provide a new roadway surface to increase pavement skid numbers on all the lanes.	42	wet surface conditions		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
add asphalt seal coat	21_{CA}, 21_{WA}[9h] Wet: 42_{CA}, 42_{WA}[9h]				
deslicking road at intersection (Dense friction course mixture)	Wet: 71_{WA}[9ss]				
groove - longitudinal	21_{NY} Wet: 53_{NY}				
groove - parallel to centerline	Wet: 75_{MO}[3a], 75_{WA}[9r]				
groove - shoulder	18_{AZ}	15_{AZ}	18_{AZ}	18_{AZ}	27_{AZ}
groove to prevent hydroplaning	21_{CA} Wet: 42_{CA}				
install ACP overlay	21_{CA}, 21_{WA}[9h]				
overlay	9_{AZ}, 42_{WA}[9l], 21_{WA}[9h], 12_{WA}[9m] Wet: 39_{AZ}, 42_{WA}[9l], 75_{WA}[9o], 51_{WA}[9m]	2_{AZ}, 20_{WA}[9h] Wet: 61_{AZ}	4_{AZ}, 18_{WA}[9h] Wet: 25_{AZ}	4_{AZ}, 46_{WA}[9l], 21_{WA}[9m] Wet: 27_{AZ}	13_{AZ}, 26_{WA}[9o] Wet: 43_{AZ}
resurface curve w/ skid resistant overlay & improve superelevation	Wet: 51_{MO}[3o]				
resurfacing	20_{AL}, 21_{CA}, 20_{KY}, 20_{ID}, 42_{FL}[3b] Wet: 40_{AL}, 40_{KY}, 42_{CA}, 40_{ID}, 28_{FL}	46_{FL}[3b]	46_{FL}[3b]		
resurfacing and superelevation	28_{NY} Wet: 51_{NY}				
resurfacing w/ open-graded mix	75_{NY} Wet: 91_{NY}				
resurfacing w/ skid resistant pavement	8_{NY} Wet: 35_{NY}				
resurfacing w/ Verglimit	31_{NY}				
saw concrete	20_{WA}[9e,11]				
skid resistance - deslicking	20_{AL}, 20_{CA}, 20_{ID}, 13_{MO}[3b,3o], 20_{FL}[3b], 20_{KY} Wet: 40_{AL}, 40_{ID}, 55_{NU}[3b,3o], 22_{FL}, 40_{KY}	15_{FL}[3b]	15_{FL}[3b]		
skid resistance - pavement grooving	15_{AL}, 22_{NY}, 15_{ID}, 1_{FL}[3c], 15_{KY} Wet: 55_{AL}, 55_{ID}, 55_{KY}	12_{FL}[3c]			9_{FL}[3c]
skid resistance - seal coat	Wet: 19_{ID}				
skid treatment w/ overlay	13_{NY}[6l], 19_{MT}[1b], 17_{MT}[1b], 20_{MT}[1e], 29_{MT}[1p], 25_{MT}[1f], 20_{MT}[1o], 20_{MT}[1c], 42_{MT}[1i], 24_{MT}[2] Wet: 40_{NY}[6l], 41_{MT}[1p]	30_{MT}[1b], 5_{MT}[1c], 17_{MT}[1]	27_{MT}[1b], 16_{MT}[1c], 21_{MT}[1]		
treat pavement with resin/bauxite	40_{WA}[9e]				

Table 3. Resurfacing and Roadway Lighting (Work Codes 301-05) - Continued.

Work Code 304					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Safety Lighting	Provide roadway lighting, either partial or continuous, where either none existed previously or major improvements are being made.	25	light conditions - darkness		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
bridge	50_{CA} Night: 50_{WA}[9l]				
bridge approaches	28_{WA}[9e] Night: 50_{MO}[5r], 50_{FL}[3b], 50_{WA}[9e]				
bridge underpass	10_{CA} Night: 10_{MO}[5r], 10_{FL}[3b], 10_{WA}[3e]				
crosswalks	50_{WA}[9h]				
general	25_{AL}, 25_{CA}, 25_{ID}, 19_{AZ}, 25_{KY} Night: 50_{AL}, 50_{ID}, 30_{AZ}, 50_{KY}	0_{AZ} Night: 100_{AZ}	8_{AZ} Night: 35_{AZ}	8_{AZ} Night: 42_{AZ}	23_{AZ} Night: 23_{AZ}
interchanges	25_{AL}, $25I_{D}$, 25_{KY} Night: 50_{AL}, 30_{ID}, 50_{KY}				
RR crossings	30_{AL}, 30_{ID}, 25_{KY} Night: 60_{AL}, 60_{ID}, 60_{FL}[3b], 60_{WA}[9l], 60_{KY}	41_{WA}[9i]	16_{WA}[9i]	15_{WA}[9f]	20_{WA}[9f]

Work Code 305					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Safety Lighting at Intersection	Install lighting at an intersection where either none existed previously or major improvements are proposed.	75	light conditions - darkness		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
intersections	25_{AL}, 25_{ID}, 25_{KY} Night: 55_{AL}, 55_{ID}, 55_{KY}				
intersections - 3-leg	Night: 69_{MO}[5r], 69_{WA}[9aa]				
intersections - 4-leg, 2-lane	Night: 53_{MO}[5r], 53_{WA}[9aa]				
intersections - 4-leg, 4-lane	Night: 62_{MO}[5r], 62_{WA}[9aa]				
intersections - improve	50_{CA} Night: 50_{FL}[3b]				
intersections - new	75_{CA} Night: 55_{MT}[1h], 9_{MT}[1b], 86_{MT}[1l], 75_{MT}[1i], 80_{MT}[1i], 55_{MT}[1h], 9_{MT}[1b], 86_{MT}[1l], 75_{MT}[1i], 80_{MT}[1i]	73_{MT}[1b]	9_{MT}[1b]		

Table 4 - Pavement Markings (Work Codes 401 -406).

Work Code 401					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Instal Pavement Markings	Place complete pavement markings, excluding crosswalks, in accordance with the TMUTCD where either no markings or nonstandard markings exist.	20	off roadway, OR ss/sam or opp. dir. going straight, OR col. w/ train.		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Striping	2_{MT}[1j] ROR: 25_{MT}				
Add striping on 22 Foot Pavement	36_{MT}[1q], 37_{MT}[1a], 37_{MT}[2]				
Add Pavement Markings at Railroad Crossings	10_{MO}, 10_{ID}, 27_{WA}[9oo]			20_{WA}[9oo]	21_{WA}[9oo]
Channelization Pavement Markings	0_{AZ} SS/Sam: 25_{AZ}	100_{AZ} SS/Sam: 0_{AZ}	-4_{AZ} SS/Sam: 0_{AZ}	-2_{AZ} SS/Sam: 0_{AZ}	1_{AZ} SS/Sam: 33_{AZ}
General Pavement Markings	70_{FL}, 26_{MT}[1d] SS: 61_{FL} ROR: 75_{FL}		67_{FL}		71_{FL}
Install Signing and Striping Combination	24_{WA}[9s]	27_{WA}[9s]	26_{WA}[9s]		
Install/Improve Pavement Markings	20_{CA}				
Land Use/Pavement Arrows	30_{AL}, 30_{ID}				
Pavement Markings	48_{AZ}[7], 9_{NY}, 13_{NY}[4h] ROR: 22_{AZ} Train: 56_{AZ}[7]	-100$_{AZ}$ ROR: 0_{AZ} Train: -100$_{AZ}$	43_{AZ}[7] ROR: 8_{AZ} Train: 50_{AZ}[7]	42_{AZ}[7] ROR: 8_{AZ} Train: 43_{AZ}[7]	51_{AZ} ROR: 30_{AZ} Train: 52_{AZ}[7]
Thermoplastic Pavement Markings	14_{NY}				
Thermoplastic Pavement Markings	56_{NY}				
Thermoplastic Pavement Markings, Spot Locations	22_{NY}[4i]				
Transverse Striping	15_{AL}, 15_{ID}				

Work Code 402					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Install Edge Marking	Place edge lines where none existed previously.	25	off roadway		
Relatec Countermeasures					
	AL	Fatal	Injury	Fatal/Injury	PDO
Add Centerline + Edgeline	12_{MT}[1q], 4_{MT}[1a], 8_{MT}[1]				
Add Edgeline	15_{AL}, 15_{ID}, 11_{MO},15_{MT}[1b], 16_{MT}[1q], 25_{MT}[1c], 19_{MT}[2], 2_{WA}[9f], 25_{WA}[9h], 14_{WA}[9m], 11_{WA}[9BB10], 30_{AZ}[7] ROR: 11_{MO}, 25_{WA}[9f], 11_{WA}[9BB10], 30_{AZ}	-100$_{AZ}$ ROR: 0_{AZ}	63_{AZ}[7] ROR: 60_{AZ}	15_{NC}, 52_{AZ} ROR: 56_{AZ}	8_{MO}, 15_{AZ} ROR: 10_{AZ}
Install Painted Line Only On Tangent Sections	40_{WA}[9r]				
Install Painted Line Only On Winding Sections	28_{WA}[9r]				
Install/Improve Edge Marking	25_{CA}, 40_{MO}, 13_{WA}[9f], 30_{WA}[9n]	47_{WA}[9s]	20_{WA}[9s]		
Painted Median Edge Lines	11_{FL}[5e]			17_{FL}[5e]	
Road Edge Restriping	40_{NY}				
Road Edge Restriping -- Collection with Fixed Objects	40_{NY}				
Right edge lines	...[1h]				

Table 4 - Pavement Markings (Work Codes 401 -406) - Continued.

Work Code 403					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Install Pedestrian Crosswalk	Place pedestrain crosswalk markings where none existed previously.	10	coll. w/ pedestrian		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
install crosswalk	25_{MT}[1d], 60CA				

Work Code 404					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Install Centerline Striping	Provide centerline striping where either no markings or nonstandard markings existed previously.	65	two vehicles going straight, opp. dir.		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Add Centerline	30_{AL}, 65_{CA}, 30_{ID}, 30_{MO}, 60_{FL}[3e], 65_{MT}[1d], 5_{NY}[6g], 65_{WA}[9h], 30_{WA}[9w]				5_{FL}[3e]
Add Centerline + Edgeline	12_{MT}[1q], 4_{MT}[1s], 8_{MT}[2]				
Add No Passing Stripe	40_{AL}, 65_{FL}[3b], 40_{ID}, 40_{MO}, 65_{MT}[1i], 40_{MT}[1h], 53_{MT}[2], 66_{NY}[6d]				
Center Double Yellow	5_{MO}, 5_{WA}[9u]				
Continuous Left-Turn Lane	32_{ID}				
Install Centerline on Winding Sections	28_{WA}[9c]				
Install Centerline Striping @ Crests on Vertical Curve	64_{WA}[9m]				

Table 4 - Pavement Markings (Work Codes 401 -406) - Continued.

Work Code 405					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Install Traffic Buttons	Place raised nonreflectorized traffic buttons for improved visibility in daylight wet surface conditions. Buttons will be installed were no buttons existed previously.	30	wet and daylight cond. OR ss/sam or opp. dir. going straight.		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Raised Pavement Markings	11_{AZ}, 5_{AL}, 5_{m}, SS/Sam: 13_{AZ}[7] SS/Sam and Head-on: 12_{AZ}	16_{AZ}, SS/Sam: 100_{AZ} SS/Sam and Head-on: 40AZ	11_{AZ}, SS/Sam: 6_{AZ} SS/Sam and Head-on: $+15_{AZ}$	12_{AZ}, SS/Sam: 7_{AZ} SS/Sam and Head-on: -4_{AZ}	11_{AZ}, SS/Sam: 14_{AZ}[7] SS/Sam and Head-on: 38_{AZ}

Work Code 406					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Install Raised Reflective Pavement Markers	Place raised reflective pavement markers for improved visibility at night and in wet surface conditions. Markers will be installed where none existed previously.	25	wet cond. OR dark light cond.		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Install Reflectorized Traffic Buttons	25_{CA}, 25_{WA}[98], 5_{WA}[98]				
Install Reflectorized/Raised Pavement Markings	20_{CA}, 20_{WA}[98] Wet: 31_{MO}, 31_{WA}[98]			5_{WA}[98]	5_{WA}[98]
Reflectorized Guide Markings	30_{FL}[31]				

Table 5 - Roadway Work (Work Codes 501-525).

Work Code 501					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Modernize Facility to Design Standards	Provide modernization to all features within the Right-of-Way to achieve current desirable standards(includes work such as widening the travelway, widening the shoulders, constructing shoulders, flattening the side slopes, and treating roadside obstacles)	15	all		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
widen travelway, widen shoulder, construct shoulder, flatten slopes, and treat roadside obstacles	15_{MT}[1d]				

Work Code 502					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Widen Lanes	Provide additional width to the lane(s).	30	off roadway		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
lane	56_{AZ} ROR: 49_{AZ}	58_{AZ} ROR: 100_{AZ}	57_{AZ} ROR: 35_{AZ}	57_{AZ} ROR: 41_{AZ}	54_{AZ} ROR: 54_{AZ}
lane - add 1 foot to both lanes	ROR: 12_{MO}, 12_{WA}[9c,10]				
lane - add 2 feet to both lanes	ROR: 23_{MO}, 23_{WA}[9c,10]				
lane - urban midblock	28_{WA}[9h], 38_{WA}[9m], 25_{WA}[9g]	87_{WA}[9g]	38_{WA}[9g]	30_{WA}[9f,10], 30_{WA}[9h]	40_{WA}[9f]
lane/shoulder widening	20_{AL}, 20_{ID}, 20_{KY}				
pavement widening	32_{MT}[1a], 25_{MT}[1b], 5_{MT}[1c], 53_{MT}[1p], 30_{MT}[1d], 32_{MT}[2f]	87_{MT}[1b], 81_{MT}[1c]	38_{MT}[1b], -9_{MT}[1c], 14_{MT}[3]		
pavement widening w/ no lanes added	42_{NY}				
travelway	28_{CA}, 28_{FL}[3c]				
travelway - from 10 feet	42_{NY}				

Table 5 - Roadway Work (Work Codes 501-525) - Continued.

Work Code 503					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Widen Paved Shoulder	Extend the existing paved shoulder to achieve desirable shoulder width.	12	off roadway OR coll. w/ parked car		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
lane/shoulder widening	20_{AL}, 20_{ID}, 20_{KY}				
shoulder	5_{CA}, 17_{NY}[4f], 12_{MT}[1d], 17_{FL}[3e], 57_{AZ}, ROR: 60_{AZ}	12_{FL}[3c], 48_{AZ}, ROR: 25_{AZ}	12_{FL}[3c], 59_{AZ} ROR: 57_{AZ}	58_{AZ} ROR: 54_{AZ}	20_{FL}[3c], 57_{AZ} ROR: 65_{AZ}
shoulder - add 2 feet to both sides	ROR: 13_{MO}, 13_{WA}[9k,10]				
shoulder - add 4 feet (bike lane)	15_{FL}				
shoulder - add 4 feet to both sides	ROR: 25_{MO}, 25_{WA}[9k,10]				
shoulder - add 6 feet to both sides	ROR: 35_{MO}, 35_{WA}[9k,10]				
shoulder - add 8 feet to both sides	ROR: 43_{MO}, 43_{WA}[9k,10]				
shoulder - increase to full width (12ft.)	Parking: 15_{MI}[8a], 10_{MI}[8d], 20_{MI}[8h], 4-33_{MI}[8c], 17_{MI}[8f], 20_{MI}[8e]				
shoulder - urban midblock - parked cars/being parked	5_{WA}[9h], -2_{WA}[9m], 29_{WA}[9g]	49_{WA}[9g], 21_{WA}[9i]	20_{WA}[9g], 11_{WA}[9i]	5_{WA}[9f], 7_{WA}[9m]	0_{WA}[9f]
shoulder - widen to 28' road width	16_{WA}[9e]	69_{WA}[9e]	30_{WA}[9e]		
shoulder - widen to 32' road width	35_{WA}[9e]	53_{WA}[9e]	17_{WA}[9e]		44_{WA}[9e]
shoulder - widen to 40' road width	29_{WA}[9e]	29_{WA}[9e]	29_{WA}[9e]		31_{WA}[9e]

Work Code 504					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Construct Paved Shoulders	Provide paved shoulders to desirable width where no shoulders existed previously.	15	off roadway OR coll. w/ parked car		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
shoulder	20_{AL}, 20_{KY}, 20ID				
stabilize shoulder	28_{CA}[6]				

Work Code 505					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Improve Vertical Aligment	Reconstruct the roadway to improve sight distance.	50	off roadway		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
change vertical alignment	45_{AL}, [4], 45_{ID}, 45_{KY}				
change hor. and vert. alignment	50_{AL}, 20_{NY}[5a], 21_{NY}[4b], 63_{ID}, 50_{MO}[3d], 50_{MT}[1b], -8_{MT}[1c], 21_{MT}[1b], 50_{MT}[1i], 50_{MT}[1d], 36_{MT}[2], 30_{FL}, 48_{AZ}, 50_{KY} ROR: 66_{AZ}	11_{MT}[1c], 69_{MT}[1b], 40_{MT}[1], 33_{AZ} ROR: 33_{AZ}	-1_{MT}[1c], 32_{MT}[1b], 16_{MT}[2], 56_{AZ} ROR: 71_{AZ}	55_{AZ} ROR: 69_{AZ}	37_{FL}, 42_{AZ} ROR: 62_{AZ}
change hor. and/or vert. alignment	40_{AL}				
improve vertical curve	45_{MO}[3d]				
improve sight distance	30_{AL}, 32_{ID}, 26_{NT}[1a], 33_{MT}[1c], 31_{MT}[1b], 30_{MT}[2], 7_{AZ}, 30_{KY}	57_{MT}[1a], 100_{MT}[1c], 36_{MT}[1b], 64_{MT}[2], 0_{AZ}	20_{MT}[1a], 29_{MT}[1c], 38_{MT}[1b], 29_{MT}[2], 6_{AZ}	5_{AZ}	8_{AZ}

Work Code 506					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Improve Horizontal Aligment	Flatten existing curves	50	off roadway		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
change horizontal alignment	30_{AL}, 61_{NY}, 30_{ID}, 30_{MT}[1b], 37_{MT}[1c], 34_{MT}[2], 30_{KY} ROR: 91_{NY}	26_{MT}[1c]	29_{MT}[1c]		
change hor. and vert. alignment	50_{AL}, 20_{NY}[5a], 21_{NY}[4b], 63_{ID}, 50_{MO}[3d], 50_{MT}[1b], -8_{MT}[1c], 21_{MT}[1b], 50_{MT}[1i], 50_{MT}[1d], 36_{MT}[2], 30_{FL}, 48_{AZ}, 50_{KY} ROR: 66_{AZ}	11_{MT}[1c], 69_{MT}[1b], 40_{MT}[2], 33_{AZ} ROR: 33_{AZ}	-1_{MT}[1c], 32_{MT}[1b], 16_{MT}[2], 56_{AZ} ROR: 71_{AZ}	55_{AZ} ROR: 69_{AZ}	37_{FL}, 42_{AZ} ROR: 62_{AZ}
change hor. and/or vert. alignment	40_{AL}				
curve reconstruction	50_{AL}, 42_{CA}, 50_{ID}, 50_{MT}[1b], 53_{FL}, 50_{KY}				
reduce sharpness of curve for hor. curve - from 10 to 5 degrees	45_{MO}[3a], 45_{WA}[5d1]				
reduce sharpness of curve for hor. curve - from 15 to 5 degrees	63_{MO}[3a], 63_{WA}[5d1]				
reduce sharpness of curve for hor. curve - from 20 to 10 degrees	48_{MO}[3a], 48_{WA}[5d1]				

Work Code 507					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Increase Superelevation	Provide increased superelevation on an existing curve.	63	off roadway OR two veh. going straight opp. dir.		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
correct/improve superelevation	40_{AL}, 65_{CA}, 40_{ID}, 40_{MT}[1b], 50_{MT}[1i], 42_{MT}[1p], 65_{MT}[1d], 49_{MT}[2], 50_{PA}[3b], 40_{KY} Head-on: 20_{MI}[4a], 20_{MI}[4d], 40_{NY}[4h], 5-10_{MI}[4c], 50_{NJ}[4b]				
improve superelevation & resurface curve w skid-resistant overlay	Head-on: 86_{MO}[3a]				

Work Code 508				
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors
Realign Intersection	Improve an existing intersection by partial or complete relocation of the roadway(s).	*	determined by diagram	

Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
improve sight distances at urban intersections	30_{WA}[37]				
remove sight obstructions	85_{WA}[36]	54_{WA}[31]	23_{WA}[31]		
improve sight distances at intersections	35_{WA}[sec.9], 29_{WA}[sec.10], 35_{WA}[sec.18], 31_{NY}[6k]			31_{WA}[sec.9], 29_{WA}[sec.10], 27_{WA}[sec.19]	37_{WA}[sec.9], 29_{WA}[sec.10], 38_{WA}[sec.19]
improve sight distances at intersection on rural, 4-lane, divided hwy.	47_{WA}[sec.9]				60_{WA}[sec.9]
improve intersection approach angle	35_{MO}[5q]				

Work Code 509					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Channelization	Install islands and/or pavement markings to control or prohibit vehicular movements. A sketch of the proposed channelization should be provided.	*	determined by diagram		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Add Signal and Channelization	25_{FL}		30_{FL}		22_{FL}
Add Turn Bay	22_{FL}[3t]	40_{FL}[3t]	22_{FL}[3t]		22_{FL}[3t]
Channelization -- General Intersection	40_{ID}, 24_{NY}, 23_{WA}[9s]	29_{WA}[9s], 47_{WA}[5i]	65_{WA}[5f], 25_{WA}[9i]		
Modify Both Signal and Channelization	52_{FL}		71_{FL}		43_{FL}
Modify Channelization and Add Signal	27_{FL}		23_{FL}		29_{FL}
Modify Channelization at Non-Signalized Intersection	36_{FL}		47_{FL}		30_{FL}
Modify Channelization at Signalized Intersection					
Modify Signal and Add Channelization	28_{FL}				27_{FL}
Other Channelization	27_{NY}				

Work Code 510					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Construct Turn Arounds	Provide turn-arounds at an intersection where none existed previously.	40	intersection		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
construct turn-arounds	40_{CA}				

Work Code 511					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Add Acceleration/Deceleration Lanes	Construct acceleration and/or deceleration lanes where none existed previously.	10	outside 2 lanes (main) AND rear end/sam or ss/sam		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Add Acceleration/Deceleration Lanes	10_{MT}[1d]				
Provide Acceleration Lanes	10_{WA}[9c]			50_{WA}[9f,23]	50_{WA}[9f]
Provide Deceleration Lanes	10_{WA}[9c]			40_{WA}[9f,23]	40_{WA}[9f]
acceleration/decleration lane	10_{AL}, 10_{CA}, 10_{KY}, 10_{ID}, 10_{MO}, 17_{FL}		23_{FL}		

Work Code 512					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Entrance Ramp Modification	Reconstruct existing ramps to conform with current desirable standards.	30	rear-end/sam OR all acc. on outside main lanes from 1/10 mile before connection to 2/10 mile after connection.		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Ramp Modification	25_{AL}, 25_{KY}, 25_{ID}				
Modify entrance ramp	30_{CA}				

Work Code 513					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Exit Ramp Modification	Reconstruct existing ramps to conform with current desirable standards.	20	frontage road or exit ramp AND off roadway		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Ramp Modification	25_{AL}, 25_{KY}, 25_{ID}				
Modify exit ramp	20_{CA}				

Work Code 514					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Grade Separation	Construct vertical separation of intersecting roadways.	80	all		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Construct Grade Separation				60_{WA}[9f]	60_{WA}[9f]

Work Code 515					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Construct Interchange	Construct vertical separtion of intersecting roadways to include interconnecting ramps.	55	all		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
construct interchange	50_{AL}, 55_{CA}, 50_{ID}, 55_{FL}[3k], 50_{KY}	30_{FL}[3c]	30_{FL}[3c]		30_{FL}[3c]
reconstruct interchange	40_{AL}, 40_{CA}, 40_{ID}, 40_{KY}				

Work Code 516					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Close Crossover	Permanently close an existing crossover.	95	main lane involved		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
close median openings	30_{ID}, 30_{AL}, 30_{KY}, 80_{FL}[3a]				

Work Code 517					
Description	Definition	Reductior Factor	Preventable Accident	Best Match Reducten Factors	
Add Through Lane	Provide an additional travel lane.	28	two vehicles going same dir. and opp. dir. going straight.		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Add Climbing Lane	14_{WA}[9c]				
Add Lane Without New Median				-20_{WA}[9d]	17_{WA}[9th], 17_{WA}[9j]
Add Passing Lane	30_{WA}[9p]				
Add Through Lane	28_{MT}[1d]				
lane addition	25_{AZ}[7], 20_{NV}	39_{AZ}[7]	23_{AZ}[7]	23_{AZ}[7]	27_{AZ}[7]
lane added without median	20_{NY}, 7_{MT}[1a], 35_{MT}[1c], 7_{MT}[1b], 20_{MT}[2]	74_{MT}[1c], 31_{MT}[1b], 52_{MT}[2]	30_{MT}[1c], 11_{MT}[1b], 20_{MT}[2]		

Work Code 518					
Description	Definition	Reductior Factor	Preventable Accident	Best Match Reductor Factors	
Install Continuous Turn Lane	Provide a continuous two-lane left turn lane where none existed previously.	40			
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Channelization -- Continuous Lef.-Turn Lane	30_{AL}, 30_{ID}, 30_{MT}[1b], 33_{MT}, 40_{MT}[14] 34_{MT}[2], 30_{WA}[9p], 23_{WA}[9a]				
left-turn lane - two-way LT lane	30_{AL}, 30_{KY}, 32_{ID}				

Work Code 519					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reduction Factors	
Add Left Turn Lane	Provide an exclusive left turn lane where none existed previously. The affected intersection approaches must be specified.	25			
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Add 2nd Left Turn Lane in the Same Direction as Existing Left-Turn Lane	36_{FL}		28_{FL}		42_{FL}
Add Left Turn				80_{WA} [9f,24] 55_{WA} [9f,16]	20_{WA} [9f,24] 5_{WA} [9f,16]
Add Left Turn -- T Intersection	79_{FL} [3e]	80_{FL} [3e]	80_{FL} [3e]	80_{WA} [9f,14] 60_{WA} [9f,16]	80_{FL} [3e] 80_{WA} [9f,14], 50_{WA} [9f,16]
Add Left Turn -- Y Intersection		5_{FL} [3e]	5_{FL} [3e]	5_{WA} [9f,16]	5_{FL} [3e], 35_{WA} [9f,10]
Add Left Turn With Existing Left-Turn Phase	35_{WA} [9bk]				
Add Left Turn With No Left-Turn Phase	15_{WA} [9bk]				
Add Turn Lane and Signal	36_{CA}				
Add Turning Lane	30_{CA}				
Add Left-Turn Lane w/ Physical Separation	0_{NY}, 65_{WA} [9j]				
Two-Way Left-Turn Lane -- Four Lanes to Five Lanes	28_{MO}			42_{MO}	
Two-Way Left-Turn Lane -- Two Lanes to Three Lanes	32_{MO}			59_{MO}	
Install Left-Turn Lane -- Protected Lane With Curb or Raised Bars	67_{WA} [9aa]				62_{WA} [9aa]
Install Left-Turn Lane Without Signal	19_{WA} [9f], 25_{WA} [9b], 19_{WA} [9m,23]			80_{WA} [9f], 80_{WA} [9f,26] 80_{WA} [9m,23]	20_{WA} [9f,26]
Install Left-Turn Lane Without Signal - Painted Line	32_{WA} [9aa]				
Install Left-Turn Lane Without Signal At T-Intersection	19_{WA} [9m,18]			80_{WA} [9f,25], 5_{WA} [9f,18] 79_{WA} [9m,23], 5_{WA} [9m,18]	80_{WA} [9f,25], 35_{WA} [9f,18] 79_{WA} [9m,25], * 15_{WA} [9m,18]
Install Two-Way Left-Turn Lanes	35_{WA} [9f], 25_{WA} [5b], 30_{WA} [9c]				
Install Two-Way Left-Turn Lanes On Two-Lane Highway	32_{WA} [9c], 28_{WA} [9j]			59_{WA} [9j], 32_{WA} [9j]	
New Left Turn Channelization At Signalized Intersection With Left Turn Phase	36_{FL} [3b]				
New Left Turn Channelization At Signalized Intersection Without Left Turn Phase	15_{FL} [3b]		34_{FL}		
New Left Turn Channelized Intersection	19_{FL}				24_{FL}
New Signal, Left-Turn Lane Protected/Permitted Left Turn Phase	58_{WA} [9bb]			61_{WA} [9bb]	
left-turn lane - without signal	25_{AL}, 25_{KY}, 25_{IL}				
left-turn lane - with signal	30_{AL}, 30_{KY}, 30_{IL}				
turn lane - with signal	36_{CA}				
turn lane	25_{CA}, 6_{AZ}	100_{AZ}	-1_{AZ}	3_{AZ}	9_{AZ}
left turn lane - with signal (physical)	39_{NY}				
left turn lane - with signal (painted)	16_{NY}				
left and right turn lanes with signals	25_{NY}				

Work Code 520					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Lengthen Left Turn Lane	Provide addititonal length to an existing exclusive left turn lane. Affected intersection approached must be specified.	40			
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Increase Storage Lane	15_{FL}[3e]				
Length Left-Turn Lane	40_{MT}[1d]				

Work Code 521					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Add Right Turn Lane	Provide an exclusive right turn lane where none existed previously. Affected intersection approaches must be specified.	25			
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Add Right Turn	61_{FL}		49_{FL}	40_{WA}[9f,23]	67_{FL}, 10_{WA}[9f,23]
Add Right-Turn Lane	25_{MT}[1d]				
Add Right-Turn Lane w/ Painted Separation	31_{NY}, 27_{WA}[9d]				
Add Right-Turn Lane w/ Physical Separation	0_{NY}				
left and right turn lanes with signals	25_{NY}				

Work Code 522					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Lengthen Right Turn Lane	Provide additional length to an existing exclusive right turn lane. Affected intersection approaches must be specified.	40			
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Increase Storage Lane	15_{FL}[3e]				
Length Right-Turn Lane	40_{MT}[1d]				

Table 5 - Roadway Work (Work Codes 501-525) - Continued.

Work Code 523					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Construct Pedestrian Over/Under Pass	Construct a pedestrian crossover where none existed previously.	95	coll. w/ pedestrian		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Construct pedestrian over/under pass	95_{MT}[14]				
Construct pedestrain crossover	95_{CA}, 95_{KY}, 95_{AL}, 95_{ID}, 95_{WA}[9h]				

Work Code 524					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Increase Turning Radius	Provide an increased turning radius at an existing intersection.	10	passenger cars and trucks w/ trailers or other truck combinations AND coll. w/ fixed object.		
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Increase Curb Radii				25_{WA}[9f]	25_{WA}[9f]
increase intersection turn radii	15_{AL}, 15_{ID}, 10_{MT}[1d], 15_{KY} Fixed object: 15MI8a, 10MI8d, 15MI8h, 15MI8e	25_{FL}[3c]	25_{FL}[3c]	25_{WA}[9f]	25_{FL}[3c], 25_{WA}[9f]

Work Code 525					
Description	Definition	Reduction Factor	Preventable Accident	Best Match Reducton Factors	
Convert to One Way Frontage Roads	Convert two-way frontage roads to one-way operation.	25			
Related Countermeasures					
	All	Fatal	Injury	Fatal/Injury	PDO
Construct a Local Service Road	40_{WA}[9e]				
Construct Frontage Road	40_{WA}[9e]				
construct frontage road	40_{AL}, 40_{CA}, 40_{ID}, 40_{KY}, 40_{WA}[9c]				

1 - Data sources for Montana reduction factors
- 1a - Kentucky Study
- 1b - FHWA-1977
- 1c - Eff. of Safety Impr.
- 1d - FHWA Report 1986
- 1e - California - 1
- 1f - California - 2
- 1g - Montana Studies
- 1h - Kentucky Study Rec.
- 1i - California
- 1j - Alabama
- 1k - Calif. Minor Impr.
- 1l - Calif. Spcl. Study
- 1m - California - 3
- 1n - Michigan
- 1o - Missouri
- 1p - Pennsylvania
- 1q - FHWA-1982
- 1r - Mississippi

2 - For the Montana report, when multiple sources were used to determine certain reduction factors, an average value was computed for that specific case

3 - Florida sources
- 3a - NCHRP162
- 3b - Missouri
- 3c - Washington
- 3d - Oklahoma
- 3e - Kansas
- 3f - Texas
- 3g - Arkansas
- 3h - New Jersey
- 3i - Montana
- 3j - New York

4 - Conditions for use: 2-lane highway, ADT 100-10,000; Lanes 8-12 feet wide; shoulders 0-12 feet wide. (From Missouri report)

5 - Missouri references
- 5a - J. Lee, et. al., "Measure the Effectiveness of Highway Safety Projects and to Improve Forecasts of Accident Reduction in Kansas," University of Kansas, Transportation Center, February 1981.
- 5b - J. Barbaresso, et. al., "Selection Process for Local Highway Safety Projects," Transportation Research Record 847,

Transportation Research Board, 1982, pp. 24-29.
5c - C. Zegeer, et. al., "Safety Cost-Effectiveness of Incremental Changes in Cross-Section Design - Informational Guide," Federal Highway Administration Report No. FHWA/RD-87/094, December 1987.
5d - T. Creasely, and K. Agent, "Development of Accident Reduction Factors," University of Kentucky, Report No. UKTRP-85-6, March 1985.
5e - C. Zegeer and M. Cynecki, "Selection of Cost-Effective Countermeasures for Utility Pole Accidents - User's Manual," Federal Highway Administration, Report No. FHWA-IP-86-9, December 1986.
5f - "Accident Identification & Surveillance Documentation Manual," University of Alabama, TSM Reprot No. 112-88, Sept. 1988.
5g - "Selecting and Making Highway Safety Improvements: A Self-Instructional Text", Institute of Transportation Engineers, TTC 440, 1977.
5h - J. Lovell and E. Hauer, "The Safety Effect of Conversion to All-Way Stop Control," Transportation Research Record 1068, Transportation Research Board, 1986, pp. 103-107.
5i - J. Laughland, et. al., Methods for Evaluating Highway Safety Improvements," National Cooperative Highway Research Program Report 162, Transportation Research Board, 1975.
5j - "Accident Reduction Factors - State of Kanas HES Project Evaluations," Kansas Department of Transportation, Bureau of Traffic Engineering, June 1990.
5k - B. Benioff and T. Rorabaugh, "A Study of Clearance Intervals, Flashing Operation, and Left-Turn Phasing as Traffic Signals," Federal Highway Administration, Report Number FHWA-RD-78-46, May 1980.
5l - J. Graham and J. Glennon, "Manual on Identification, Analysis and Correction of High Accident Locations," Missouri State Highway Commission, November 1975.
5m - J. A. Wattleworth, et. al., "Accident Reduction Factors for Use in Calculationg Benefit/Cost - Florida Manual of Indentification, Analysis, and Correction of High Accident Locations," University of Florida, November 1988.
5n - "Designing Safer Roads - Practices for Resurfacing, Restoration, and Rehabilitation," Special Report 214, Transportation Research Board, 1987, pp. 256-264.
5o - "Accident Reduction Factors," New York State Department of Transportation, Traffic and Safety Division, January 1989.
5p - "A Study of Motor Vehicle traffic Accidents at Bridges on the Colorado State Highway System," Colorado State Department of Highways, Planning and Research Division, June 1973.
5q - J. McCoy, "Safety Improvement Economic Analysis," Ipwa Department of Transportation, Memo Reference Number 590, December 20, 1985.
5r - "Evaluation of Minor Improvements (Parts 1-6)," California Department of Public Works, Division of Highways, Traffic Department, May 1967.
5s - T. Tamburri and R. Smith, "The Safety Index: A Method of Evaluating and Rating Safety Benefits," Highway Research Rec 332, Highway Research Board, 1970, pp. 28-43.

5 - From New York report: Insufficient number of locations for factor calculation or no statistically significant change in accident rate. If a factor is present the source for the factor is shown in remarks.

6a - Refer to Improvement Code 2721

6b - NYS DOTS PIES

6c - Refer to Improvement Codes 605 & 702
6d - Calif. Transp. Agency, Dept. of Public Works, Div. of Highways, Evaluation of Minor Improvements (Before and after studies of projects in California, tabulated statistics included.)
6e - Traffic Safety Center, Midwest Research Inst. Manual on Identification, Analysis, and Correction of High-Accident Locations, FHWA/DOT 1976. (Studies in cooperation with Missouri Div. of Highway Safety.)
6f - Calif. Dept. of Transp. Accident Rates vs. Shoulder Width, CALTRANS 1977. (Before and after studies of projects in Calif. with tabulated statistics included.) Also noted as 2 lane roads only.
6g - Tamburri, Thomas N., "Accident Reduction Factors for Highway Safety Projects" State of Calif. Transp. Agency, Dept. of Publ Works Div. of Highways, 1969. (Before and after studies of 500 projects in California.)
6h - FHWA/DOT, Evaluation of the Highway-Related Safety Program Standards. 1977 (Compilation of safety project evaluations reported by states.)
6i - See Code 262.
6j - Strate, Harry E., "An Evaluation of Federal Highway Safety Program Effectiveness," FHWA 1978 (Compilation of safety projec evaluations reported by states)
6k - Dale, C. W., "Cost Effectiveness of Safety Improvement Programs," FHWA/DOT 1973. (Project studies in ref 6h listed above.)
6l - Open-graded mix most effective.
7 - Represent statistically significant rate reductions from Arizona report.
8 - Michigan references
8a - Recommended by K. Kunde, P.E., S.P.U., October, 1986. based on review of following references:
8b - Identification, analysis, correction of high accident locations - Missouri State Highway Commission
8c - Highway Safety Design - University of Wisconsin - Madison
8d - Road Commission for Oakland County
8e - UKTRP - 85-6 (March 1985) - University of Kentucky
8f - Estimated Florida Accident Reduction Table, 1987
8h - TSM Report 112-88 (Sept. 1988) - University of Alabama
8i - Accident Reduction Factors for Benefit/Cost - University of Florida
8j - Design Standards for RRR Products - Indiana D.O.T. (January 1991)
9 - Washington references
9a - "Safety Improvement Program for Toll Roads," UKTRP Report 548, July 1980 (J. G. Pigman, K. R. Agent, J. D. Crabtree).
9b - "Assessment of Techniques for Cost-Effectiveness for Highway Accident Countermeasures," Texas Transportation Institute; Report No. FHWA-RD-79-53, January 1979 (McFarland, et al.).
9c - "Interstate Safety Improvement Program," Division Of Research, KYDOT, Report No.517, March 1979 (J. G. Pigman, K. Agent, C. V. Zegeer).
9d - "The 1981 Annual Report, Pennsylvania Highway Safety Improvement Program," Pennsylvania Department of Transportation, September 1981.
9e - "Predicting Accident Reduction Factors for Safety Improvements in the State of Kansas," Kansas University, Transportation Center, August 1981 (Mulinazz, Lee).

9f - "Informational Guide for Highway Safety Improvements," the Washington Traffic Safety Commission and the Federal Highway Administration, Olympia, Washington, 1978.
9g - "Evaluation of Highway Safety Program Standards within the Purview of the FHWA," United States Department of Transportation (USDOT) FHWA, REport No. DOT-FH 11-9129, March, 1977 (Jorgenson).
9h - "California Traffic Manual," California Department of Transportation, 1978.
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9p - "Analysis of Highway Accidents, Pedestrian Behavior and Bicycle Program Implementation," Transportation Research Record 847, Transportation Research Board, Washington, DC., 1982.
9q - "Highway Safety Improvements: An Evaluation of Title II Countermeasures in the State of Texas," Traffic Accident Research and Evaluation Program, Texas Transportation Institute, September, 1979 (Sparks, Flowers).
9r - "Evaluation of Criteria for Safety Improvement on the Highway," Roy Jorgenson and Associates; Westat Research Analysts, Inc., US Department of Commerce, October 1966.
9s - "Selection of Cost-Effective Countermeasures for Utility Pole Accidents - User's Manual," Federal Highway Administration, Report No. FHWA/CA/TE-87/01, January 1987 (C. Zegeer and M. Cynecki).
9t - "Selecting and Making Highway Safety Improvements: A Self-Instructional Text," Institute of Transportation Engineers, TTC 44C 1977.
9u - "The Safety Effects of Conversion to All-Way Stop Control," Transportation Research Record 1068, Transportation Research Board, 1986, pp. 103-107 (J. Lovell and E. Hauer).
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9z - "A Study of Clearance Intervals, Flashing Operation, and Left-Turn Phasing as Traffic Signals," Federal Highway Administration, Report No. FHWA-RD-78-46, May 1980 (B. Benoiff and T. Rorabaugh).

9aa - "Evaluation of Minor Improvements (Parts 1-6)," California Department of Public Works, Division of Highways, Traffic Dept May 1967.

9bb - "Accident Reduction Factors - State of Kanas HES Project Evaluations," Kansas Department of Transportation, Bureau of Traffic Engineering, June 1990.

9cc - "Overhead Yellow-Red Flashing Beacons," California Department of Transportation, Division of Traffic Engineering, Report No. FHWA/CA/TE/-87/01, January 1987 (J. Hammer, and E. Tye).

9dd - "Designing Safer Roads - Practices for Resurfacing, Restoration, and Rehabilitation." Special Report 214, Transportation Research Board, 1987, pp 256-264.

9ee - "Highway Safety Evaluation System," FHWA Office of Highway Safety, 1982.

9ff - "A Study of Motor Vehicle Traffic Accidents at Bridges on the Colorado State Highway System," Colorado State Department of Highways, Planning and Research Division, June 1973.

9gg - "The Pavement Marking Demonstration Program - One State's View," Proceedings ASCE Specialty Conference, Implementing Highway Safety Improvements, pp. 149-164, March 1980 (R. Hatton)

9hh - "Safety Benefits from the Categorical Safety Programs," Transportation Engineering, March, 1978 (Thomas A. Hall)

10 - Conditions for these factors were taken from two-lane rural roadway. (Washington)

11 - Reduction factors updated using 1992 Low Cost Accident Counter Measure Evaluations. (New York)

12 - The average reduction factor for curve warning arrow includes reduction factor for warning/guide sign. (Montana)

13 - The average reduction factor for 4-way stop includes reduction factor for install stop sign. (Montana)

14 - Conditions for these factors were taken from two-lane urban roadway. (Washington)

15 - Includes larger lenses, more/better placed heads, phase adjustment, and general signal upgrades. (New York)

16 - Conditions for these factors were taken from multi-lane urban roadway. (Washington)

17 - Conditions for these factors were taken from multi-lane rural roadway. (Washington)

18 - Conditions for these factors were taken from rural roadway. (Washington)

19 - Reduction factors were given in %/ft. (Michigan)

20 - The average reduction factor for pavement widening includes reduction factors for widen paved shoulder and construction paved shoulder (where no shoulder exist). (Montana)

21 - Conditions for these factors were taken from 2 lane roadway. (Washington)

22 - Conditions for these factors were taken from multi-lane roadway. (Washington)

23 - Conditions for these factors were taken from rural & urban multilane roadway. (Washington)

NOTE: Negative factors represent increases in these types of accidents.

Appendix J

Intersection and Traffic Control HES Service Lives

Project	Projected Service Life (Years)
Construct Turning Lanes (includes two-way continuous turn lanes)	10
Provide Traffic Channelizations	10
Improve Sight Distance	10
Install Traffic Signs	6
Install Pavements Markings	3
Install Delineators	3
Install Illumination	15
Upgrade or Install Traffic Signals	10
Install Flashing Beacons	10

Structures HES Service Lives

Project	Projected Service Life (Years)
Widen or Modify Bridge for Safety	20
Replace Bridge for Safety	30
Construct New Bridge for Safety	30
Replace or Improve Minor Structure for Safety	20
Upgrade Bridge Rail	10
Construct Overpass or Interchange	30

Roadway and Roadside HES Service Lives

Project	Projected Service Life (Years)
Widen Traveled – Way (no lanes added)	20
Add Lane (s) to Traveled – Way	20
Construct Median for Traffic Separation	20
Widen or Improve Shoulder	20
Realign Roadway (except at railroads)	10
Overlay for Skid Treatment	10
Groove Pavement for Skid Treatment	10
Install Breakaway Sign Supports	10
Install Guardrail End Treatments	10
Upgrade Guardrails	10
Upgrade Median Barrier	15
Install New Median Barrier	15
Install Impact Attenuators	10
Flatten or Regrade SideSlopes	20
Install Bridge Approach Guardrail Transitions	10
Remove Obstacles	20
Safety Treat Drainage Structures	20

Note: The projected service lives for various HES projects povided in this appendix were adapted from the FHWA "1993 Annual Report on Highway Safety Improvement Programs."