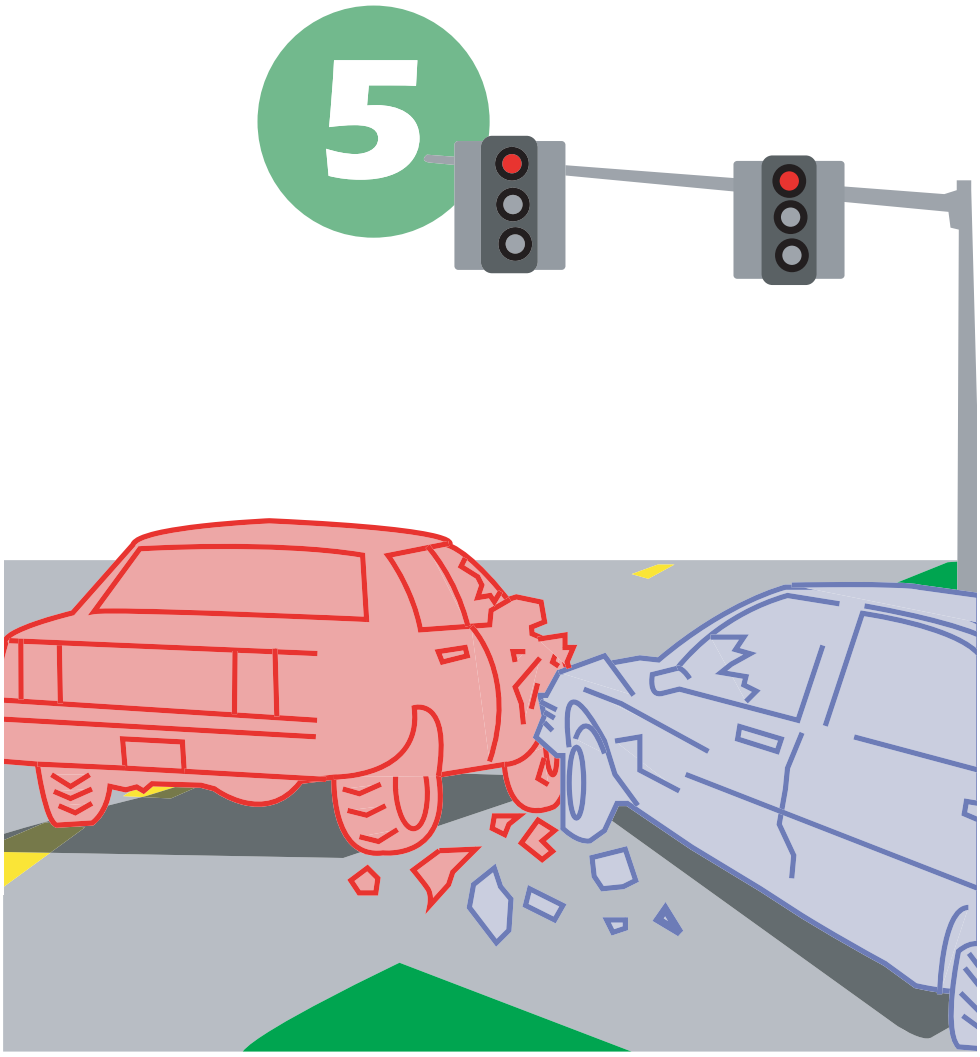
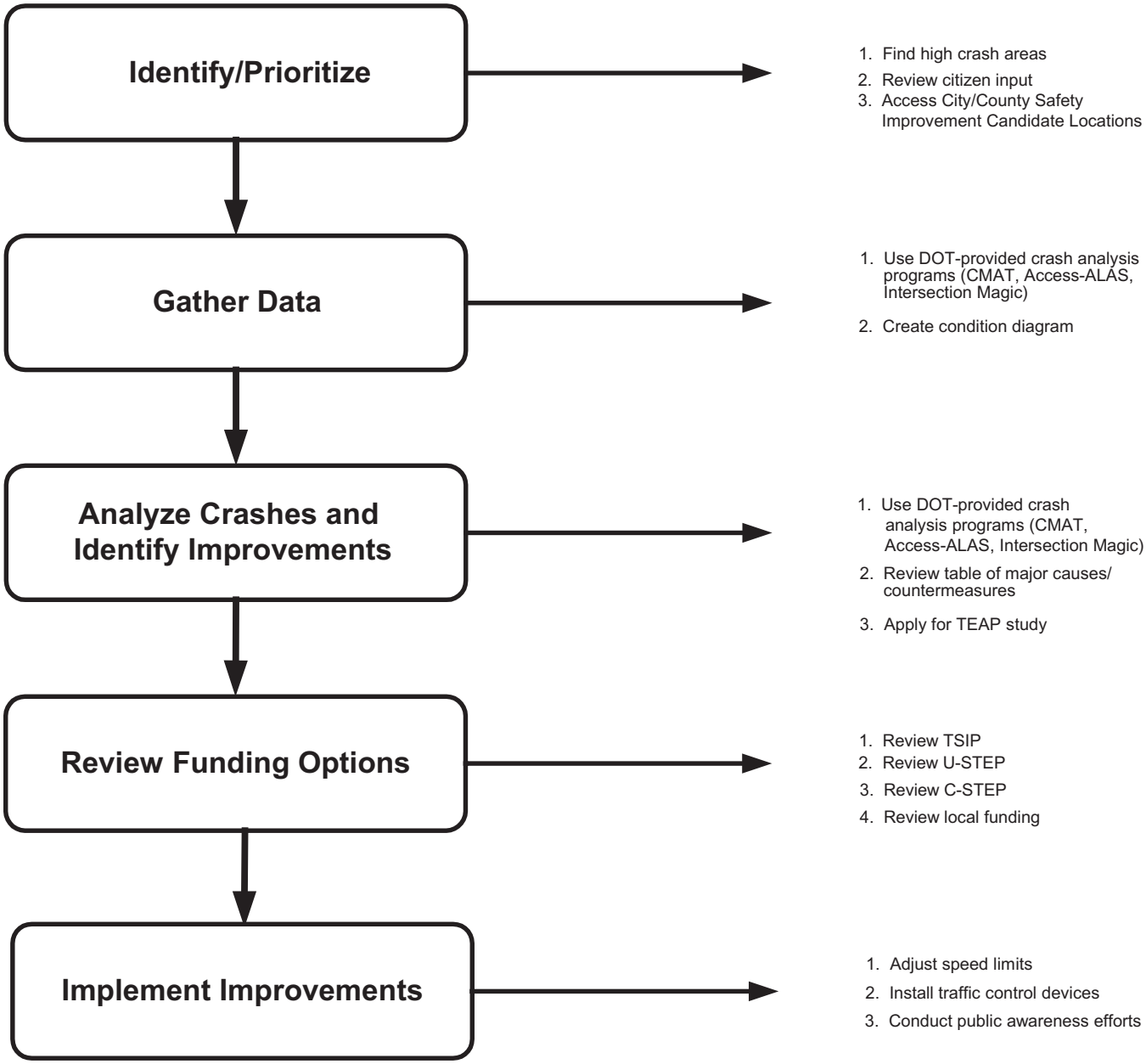
Crash Analysis

5



Crash Analysis



INTRODUCTION

Crashes are rare events. A typical intersection experiences less than one crash per million vehicles that navigate the intersection. Crashes occur because of various factors including the driver, vehicle, roadway, and environment. The primary source of crash data is the local law enforcement agencies. Local law enforcement agencies are usually an excellent source for current conditions at a particular crash location.

Crash data are used to help understand why crashes occur, to help identify high-crash locations, to aid in the choice of safety programs or countermeasures, and to assist evaluations of countermeasure effectiveness (Robertson 1994). The main purpose of crash analysis is to improve safety by identifying crash patterns, mitigating crash severity, and reducing the number of crashes by adopting suitable countermeasures.

KEY STEPS TO A CRASH ANALYSIS STUDY

A crash analysis study includes six key steps:

1. Identify the locations that are candidates for improvement.
2. Quantify the main crash trend(s) at a particular location.
3. Determine the source of the problem(s).
4. Evaluate types of improvements to address the crash problem(s).
5. Obtain an expert opinion about safety improvement(s).
6. Obtain funding to implement a safety improvement.

Identify the Locations That Are Candidates for Improvement

The Iowa Department of Transportation (Iowa DOT) Office of Traffic and Safety has developed a website to assistant jurisdictions in identifying locations within their jurisdiction that are candidates for safety improvement. Please refer to **www.dot.state.ia.us/crashanalysis/**.

The first place to navigate on the website is the City or County (as appropriate) Safety Improvement Candidate Locations (SICL) link. See Figure 5.1. An individual can select their jurisdiction from a list of all cities or counties in Iowa having a candidate location. Once a city or county is selected, the intersections, links and nodes with the highest ranking of crashes, crash rates, and crash severity for that jurisdiction are listed.

Crash Analysis Resources - Iowa Department of Transportation Office of Traffic and Safety Page 2 of 2

Safety Improvement Candidate Locations (SICL) (Top 200 List)

Iowa DOT Top 200 Safety Improvement Candidate Locations 1995-1999 (statewide)

City Safety Improvement Candidate Locations 1995-1999 (by city, MicroSoft™ Excel® files)

County Safety Improvement Candidate Locations 1995-1999 (by county, MicroSoft™ Excel® files)

Safety Improvement Candidate Location (SICL) Methodologies

Safety Improvement Candidate Location (SICL) Methodologies

Figure 5.1. Iowa DOT SICL Link Listings

The same website also provides a list of the top 200 Safety Improvement Candidate Locations (SICL) within Iowa as shown above. This link provides the same information as listed above but for the top 200 intersections of concern within the state.

Quantify the Main Safety Concern(s) at a Particular Location

The main safety problem(s) at a given location can be quantified a few ways:

- Refer to the Iowa DOT's lists of safety improvement candidate locations.
- Obtain and use crash data and analysis programs from the Iowa DOT.
- Consult the Iowa Traffic Safety Data Service.
- Calculate the crash rate for an intersection.

Refer to the Iowa DOT's Lists of Safety Improvement Candidate Locations

The Iowa DOT Office of Traffic and Safety's City or County (as appropriate) Safety Improvement Candidate Locations (SICL) listings (**www.dot.state.ia.us/crashanalysis/**) provide each location's statewide rank and crashes by year for a five-year period. Locations that do not meet minimum criteria are not included in the listings. The minimum criteria are at least one fatal crash, four injury crashes, or eight total crashes in the most recent five-year analysis period. The locations are ranked according to a composite of the number of crashes, the severity of the crashes, and the crash rate per traffic volume. SICL listing also provides a breakdown of crashes at each location by crash severity and injury severity.

Obtain and Use Crash Data and Analysis Programs from the Iowa DOT

Free of charge, the Iowa DOT Office of Traffic and Safety will provide statewide crash data, programs to query and print crash data, and training to use their computer programs (see also Appendix D.2). The computer programs are Access-ALAS (accident location and analysis system) and Crash Mapping and Analysis Tool (CMAT). See Figure 5.2. These two programs are available as a set. To find information about obtaining these programs, refer to **www.dot.state.ia.us/crashanalysis/**. The most currently available crash data can be viewed within these programs. Every year the Iowa DOT Office of Traffic and Safety distributes the new crash data to the jurisdictions that have the programs.

Table of Contents

Crash Analysis Tools

Access®-ALAS - Iowa's MicroSoft™ Access®-based Accident Location and Analysis System

Intersection Magic - Vendor-developed collision diagramming software, configured to work with Iowa crash data

SAVER - Iowa's new set of Safety Analysis, Visualization, and Exploration Resources...Anticipated release soon (August 2002?)!

Crash Analysis Tools Training

Access®-ALAS Training - provided free of charge by a training consultant

Intersection Magic - no free training, instead a manual has been written for Iowa's system

SAVER Training - coming soon (August?)!

Data Requests

If you have a data request, please fill out the Data Request Form. Please be advised that data requests are not necessarily answered in the order they are received nor are they necessarily answered directly by the Iowa Department of Transportation, Highway Division, Engineering Bureau, Office of Traffic and Safety. Your request may be forwarded to a more appropriate agency. Finally, please be advised that request complexity directly influences timeliness of response.

Figure 5.2. Iowa DOT Crash Analysis Tools Information

CMAT is used to view crash locations on a map and select the crashes needed for further analysis. An individual can enter CMAT, zoom to an intersection, select the crashes needed for analysis, and export them to Access-ALAS. The crash data is then queried and printed from Access-ALAS. A step-by-step process is given in Appendix D.2. Once the data are active in Access-ALAS, an individual can find the number of crashes for the predetermined study period.

Consult the Iowa Traffic Safety Data Service

The Center for Transportation Research and Education (CTRE) also offers a service to jurisdictions called the Iowa Traffic Safety Data Service (ITSDS). ITSDS provides timely access to crash analyses and reports from many safety and geographic information systems tools developed by the Iowa DOT and CTRE in recent years. ITSDS facilitates decision-making, effective presentation of information, and education. The ITSDS is not available to all requestors and is not meant to relieve all traffic data users from performing their own analyses. Rather, it fills the large gap between what data users can get for themselves and what can be obtained by experts with the best software and hardware. An example of crash mapping produced by ITSDS is shown in Figure 5.3. For more information, visit the ITSDS website at **www.ctre.iastate.edu/itsds/.**

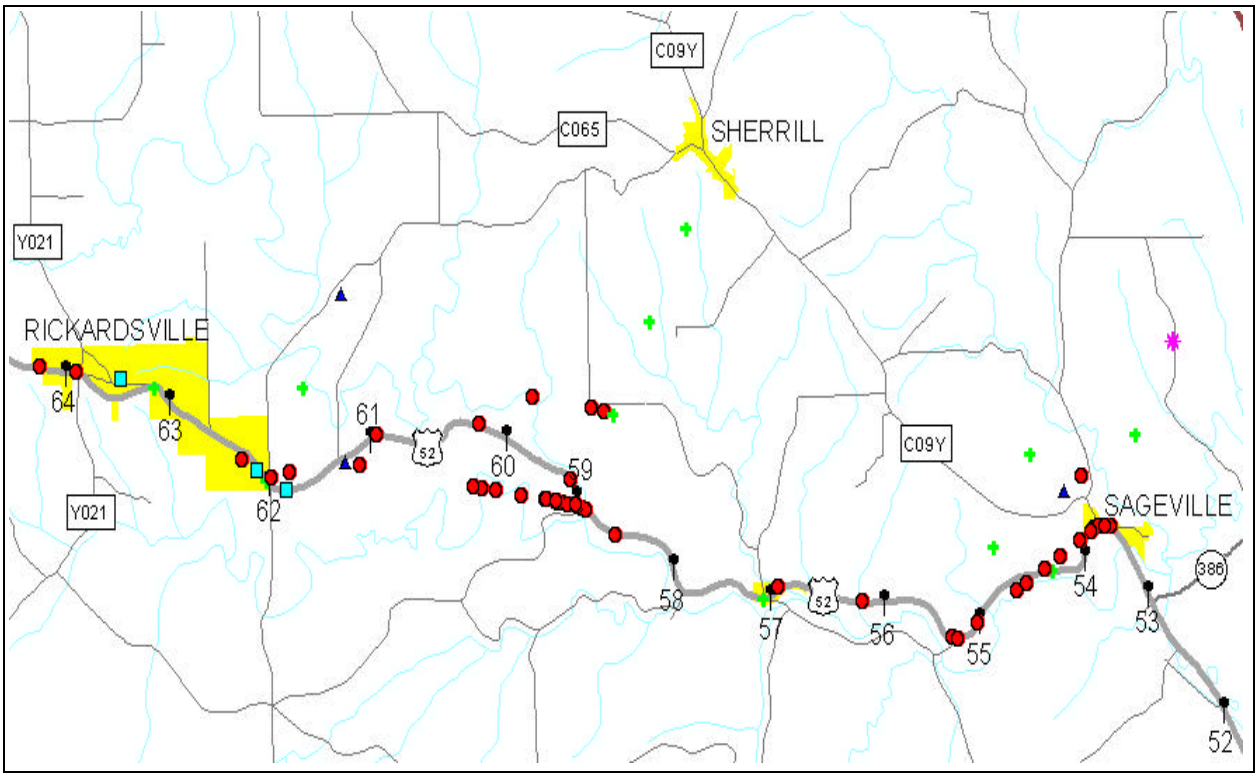


Figure 5.3. Example Crash Mapping Produced by ITSDS

Calculate the Crash Rate for an Intersection

Finally, a jurisdiction can calculate the crash rate for an intersection and compare the rate to statewide averages as shown in Table 5.1 (Iowa DOT 1989).

Table 5.1. Iowa Statewide Average Crash Rates by Daily Entering Volume

	Rural					Municipal				
	1–999 DEV	1,000–2,499 DEV	2,500–4,999 DEV	5,000–9,999 DEV	10,000+ DEV	1–2,499 DEV	2,500–4,999 DEV	5,000–9,999 DEV	10,000–24,999 DEV	25,000+ DEV
Average crash rate per million entering vehicles	2.1	1.2	0.9	0.7	0.7	1.3	1.0	0.7	0.8	1.0

Note: DEV = daily entering volume.

To calculate the crash rate for an intersection, the following data are needed: the number of crashes at the intersection for the time period of the study (found using the computer programs as described above), the number of years in the study, and the annual average daily traffic (AADT) for each leg of the intersection. To develop a crash trend, it is recommended to collect three to five years of crash data.

To obtain the AADT for your intersection, you may have to perform a traffic volume count study as described in Chapter 3 of this handbook. The AADT is sum of the two-way traffic counts for all the intersection's legs, factored to account for the day of the week and the month of the year. In order to calculate the AADT for an intersection, a jurisdiction may conduct pneumatic road tube counts for all legs or 8 hours of intersection volume counts. These counts are typically conducted between 7:00 a.m. and 11:00 a.m. and between 2:00 p.m. to 6:00 p.m. Once a jurisdiction has obtained these volumes, they may contact the Iowa DOT Office of Transportation Data for assistance in using factors to calculate AADT.

The Iowa DOT provides the AADT for some legs of intersections at www.mmsp.dot.state.ia.us/ trans_data/traffic/aadtpdf.html. A jurisdiction can enter this website, click on their city or county and an AADT map will appear. It is on this map that a jurisdiction may find the AADTs that are needed to calculate the crash rate.

When using AADT to calculate crash rates, use the following equation (Iowa DOT 1989):

$$Ri = \frac{2 * C * 1{,}000{,}000}{\sum \text{AADTs} * Y * 365}, \tag{5.1}$$

where Ri = crash rate per million entering vehicles, C = number of crashes, and Y = number of years analyzed. For example, at the intersection of 4th Street and Main Street, a total of fifteen crashes occurred in five years. The two-way AADTs for the legs of the intersection were 4,000, 4,000, 1,000, and 1,000.

The sum of these AADTs equals 10,000 vehicles. The crash rate per million entering vehicles is as follows:

$$Ri = \frac{2 * 15 \text{ crashes} * 1{,}000{,}000}{10{,}000 \text{ vehicles} * 5 \text{ years} * 365 \text{ days}} = 1.64 \text{ crashes per million entering vehicles.}$$

The calculation shows that there were 1.64 crashes for every million vehicles that entered the intersection of 4th Street and Main Street during the given five year period. The statewide average crash rate for this type of intersection is 0.8 crashes per million entering vehicles. That indicates the crash rate at this intersection is approximately twice as high as the statewide average and the intersection should be considered for further analysis. A crash may be higher than the state average but not significantly different.

Determine the Source of the Problem(s)

The source of the problem may be identified in different ways, including using Access-ALAS and Intersection Magic software programs and completing a crash analysis observation report.

Access-ALAS provides a major crash cause summary, a day/time and accident rate summary, a surface and light condition summary, and details for all crashes. See Appendix D.2 or go to www.dot.state.ia.us/crashanalysis/ for more information.

Also, free of charge, the Iowa DOT will provide another program—Intersection Magic—for crash analysis purposes. To find detailed information about obtaining this program, go to www.dot.state.ia.us/crashanalysis/. Intersection Magic is a Microsoft Windows based PC application for crash analysis. Intersection Magic is a node-based application that generates collision diagrams. Starting in the year 2000, crash data were recorded by real coordinates. Because of this, at this point in time, Intersection Magic cannot analyze data more current than 1999. Intersection Magic requires intersection node numbers locate crashes. The intersection node numbers may be obtained within the CMAT program. Use the crash data selection process described in Appendix D.3 to select the node numbers and then use Intersection Magic to create a collision diagram. See Figure 5.10.

A jurisdiction may also fill out a crash analysis field observation report (a form is provided in Appendix D.1; FHWA 1991). The report includes a checklist relating to physical and operational characteristics. A jurisdiction may wish to fill out the observation form and then compare the results to those from the crash analysis programs. This may highlight consistencies between the conditions of the particular location and the type of major causes of the crashes.

Evaluate Types of Improvements to Address the Crash Problem(s)

Once a safety concern is identified, a jurisdiction can begin to evaluate possible countermeasures. Table 5.2 provides a list of possible countermeasures for safety concerns relating to pedestrians, speed, and sight distance (Ogden 1996, SEMCOG 1998, NCHRP 2000). Additional information is provided in Appendix D.4 (FHWA 1991).

Table 5.2. Major Safety Concern Causes and Countermeasures

Major Cause	Possible Countermeasures
Ran traffic signal	Remove signal sight obstructions Post "Signal Ahead" warning signs Install/replace signal visors and back plates Add signal back plates Install advance flasher signs Install (additional) 12-inch signal lenses Upgrade signalization Review warrants/consider removing signal Synchronize adjacent signals
Ran stop sign	Remove sign sight obstructions Install larger signs Install "Stop"/"Yield Ahead" signs Construct rumble strips in pavement Review warrants/consider removing sign Replace "Stop" with "Yield" sign, if feasible Place flashing beacons overhead or on "Stop" sign Place red flags on "Stop" sign Place "Stop" signs on both sides of road
Failed to yield right-of-way to pedestrian	Add stop bars/crosswalks Post "Ped Xing"/"Advance Xing" signs Place advance pavement messages Add/improve lighting Post "School Xing"/"Advance Xing" signs Use crossing guards near schools Reroute pedestrians to safer crossing Signalize pedestrian crossing Install barrier curbing Add pedestrian refuge islands Post "No Right Turn on Red" sign, if at intersection
Exceeded speed limit	Post/reduce speed limit Increase traffic/speed enforcement Install traffic-calming measures: refer to www.ite.org Install larger signs Install flashing beacons on signs
Turned improperly	Prohibit turns Signalize intersection Reduce speed limit Install raised median Install left turn bays Widen approaches to handle turn lanes Improve signing and pavement markings
Vision was obscured	Eliminate parking Remove obstructions from sight triangles Close/relocate driveways near intersections Signalize intersection Install intersection warning signs

Obtain an Expert Opinion about Safety Improvements

Jurisdictions in Iowa may receive an expert opinion about a safety improvement by applying for a Traffic Engineering Assistance Program (TEAP) study through the Iowa DOT. The intent of this program is to

offer traffic engineering assistance to local governments for improvements in traffic safety and operations including high crash locations, confusing intersections, school pedestrian routes, railroad crossings, and truck routes.

Obtaining Funding to Implement a Safety Improvement

The Iowa DOT offers three funding programs to assist jurisdictions with safety improvements. The programs are the Traffic Safety Improvement Program (TSIP), the Urban-State Traffic Engineering Program (U-STEP), and the County-State Traffic Engineering Program (C-STEP). These programs are described below. Additional detailed information about the current status of the funding can be found in the Iowa DOT Funding Guide at www.dot.state.ia.us/fundguid.htm.

Traffic Safety Improvement Program

The intent of the TSIP program is to offer funding for traffic safety improvements or studies on public roads under county, city, or state jurisdiction. Funding per project cannot exceed $500,000. TSIP provides Traffic Safety Funds (TSF) on an annual basis to projects with the greatest safety benefit/project cost ratio.

Urban-State Traffic Engineering Program

The intent of the U-STEP program is to offer construction funding to solve traffic operation and safety problems on primary roads in Iowa cities. Funding per project cannot exceed $200,000 for spot improvements and $400,000 for linear improvements. Linear improvements are those that span for two or more intersections. The city must engineer and administer the project, and the project costs are split, 45% city and 55% state.

County-State Traffic Engineering Program

The intent of the C-STEP program is to offer construction funding to solve traffic operation and safety problems on primary roads outside incorporated cities. The county must engineer and administer the project. Funding cannot exceed $200,000 for spot improvements (those limited to one location). Construction costs are split, 45% county and 55% state. Funding breakdowns for linear improvements are described in the Iowa DOT funding guide at www.dot.state.ia.us/fundguid.htm.

EXAMPLE CRASH ANALYSIS STUDY

The city of Carroll needed a crash analysis conducted at a high-volume intersection (US 30 and Grant Road) that had numerous vehicular crashes in the recent past (see Figure 5.4). The city decided to analyze the crash data for a five-year period.

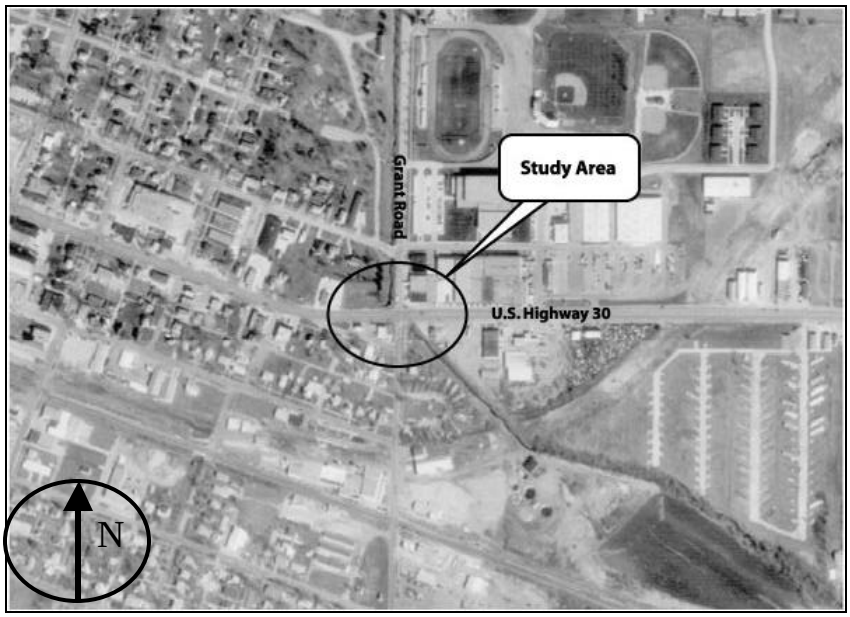


Figure 5.4. Example Crash Analysis Intersection (US 30 and Grant Road, Carroll, IA)

Carroll opened the Access-ALAS program and selected Carroll County from the database. They then located the intersection of US 30 and Grant Road within the CMAT program and selected the crashes at the subject intersection. The data were then exported to Access-ALAS.

Once the data were in Access-ALAS, they could be broken down and specified into three summaries: (1) major cause summary, (2) day/time and accident rate summary, and (3) surface and light condition summary. A listing of all crashes was also available. The city printed out the three Access-ALAS data summaries as shown in Figures 5.5, 5.6, and 5.7.

Instructions for this entire process are given in Appendix D.2.

Major Cause Summary

Accident Summary

Fatal Accidents	1
Injury Accidents	17
Property Damage Only	49
Total	67

Injury Summary

Fatal	1
Major	1
Minor	9
Possible	20

Property Damage Total $194,251

Major Causes of Accidents

Animal in Roadway		Drag Racing	
None Apparent	10	Improper Turn	1
Ran Traffic Signal	2	Improper Lane Change	
Ran Stop Sign	1	Following Too Close	6
Passed Stopped School Bus		No Signal or Improper Signal	
Passing Where Prohibited		Disregarded Railroad Signal	
Passing Interfered With Other Vehicle		Disregarded Warning Signal	1
Left of Center, Not Passing		Reckless Driving	
FTYROW at Uncontrolled Intersection		Improper Braking	
FTYROW From Stop Sign		Illegal or Improper Parking	
FTYROW From Yield Sign	1	Failure to Have Control	5
FTYROW Making Left Turn	30	Headlights Not On	
FTYROW From Driveway		Inattentive or Distracted	1
FTYROW From Parked Position		Driver Confused	
FTYROW To Pedestrian		Vision Obscured	
FTYROW Other	2	Oversized Vehicle	
Wrong Way on One-Way Road		Overloaded With Passengers or Cargo	
Speed Too Fast for Conditions		Inexperienced Driver	1
Exceeding Speed Limit		Other	2
		Unknown	4

Figure 5.5. Example Major Cause Summary (Access-ALAS)

Day/Time and Accident Rate Summary

Accidents by Time Of Day and Day of Week *

Weekday	0:00	2:00	4:00	6:00	8:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	24:00	Total
Unknown														0
Sunday											1			1
Monday						1				4	1	1		7
Tuesday						1			3	1	2			7
Wednesday						1	2	3	3		1	2		12
Thursday		1				5		1	3	5				15
Friday					1	2	1	2	2	1			1	10
Saturday					1		2	3	2	2	2	1	1	14
All Days		1			2	10	5	9	13	13	7	4	2	66

* (Accidents with no time recorded are not included.)

Figure 5.6. Example Day/Time and Accident Rate Summary (Access-ALAS)

Surface and Light Condition Summary

Surface Conditions

14 Wet
3 Snow
3 Icy
46 Dry
1 Unknown

Light Condition :

52 Daylight
2 Dusk
13 Darkness (Roadway Lighted)

Night to Day Ratio
(3 x #Night / #Day)
0.87 **To 1**

Figure 5.7. Example Surface and Light Condition Summary (Access-ALAS)

As illustrated in Figure 5.5, there were 67 intersection-related vehicular in the five-year period of the study. Failure to yield to the right-of-way while making a left turn accounts for 30 of the vehicular crashes at the intersection.

The data may also be exported to Microsoft Excel (not provided by the Iowa DOT) for further analysis (see Figures 5.8–5.10). The annual number of crashes is shown in Figure 5.10.

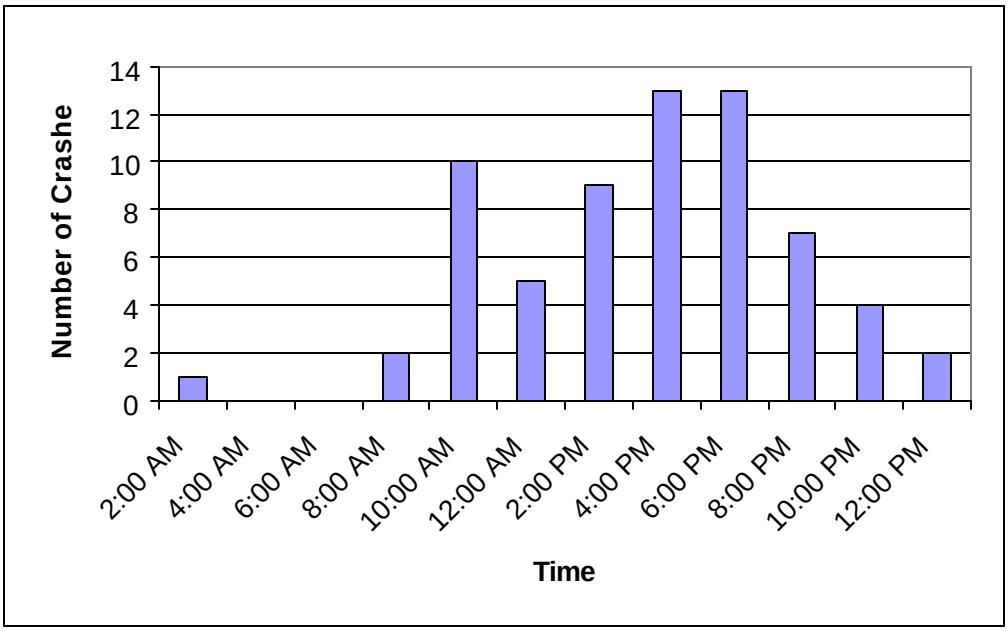


Figure 5.8. Example Crash Count by Time of Day (Microsoft Excel)

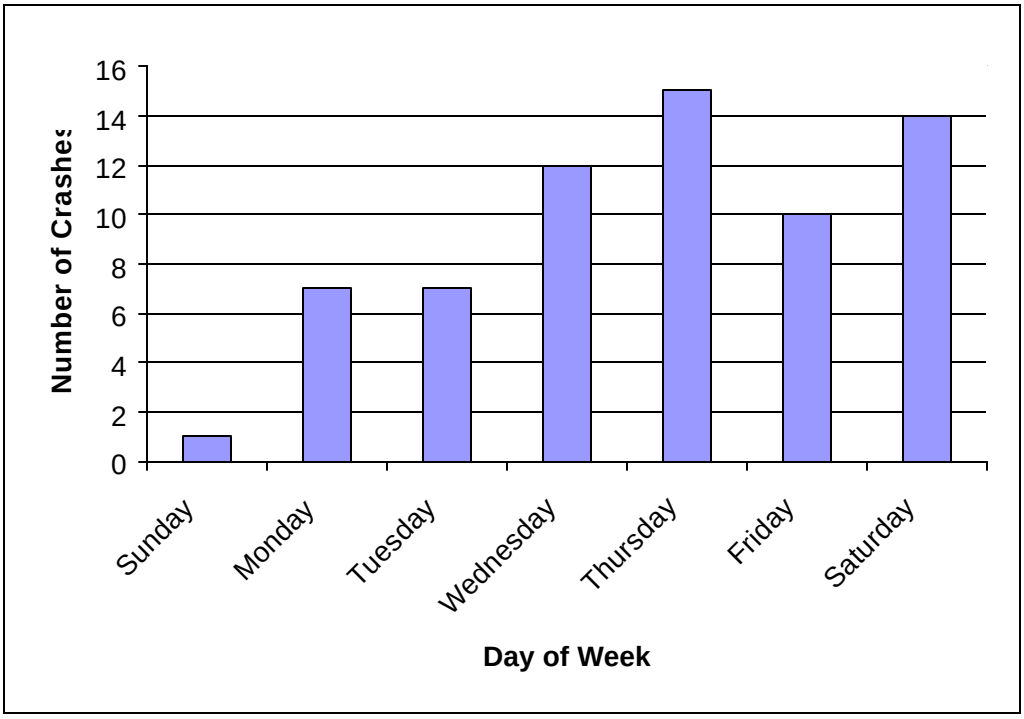


Figure 5.9. Example Crash Count by Day of Week (Microsoft Excel)

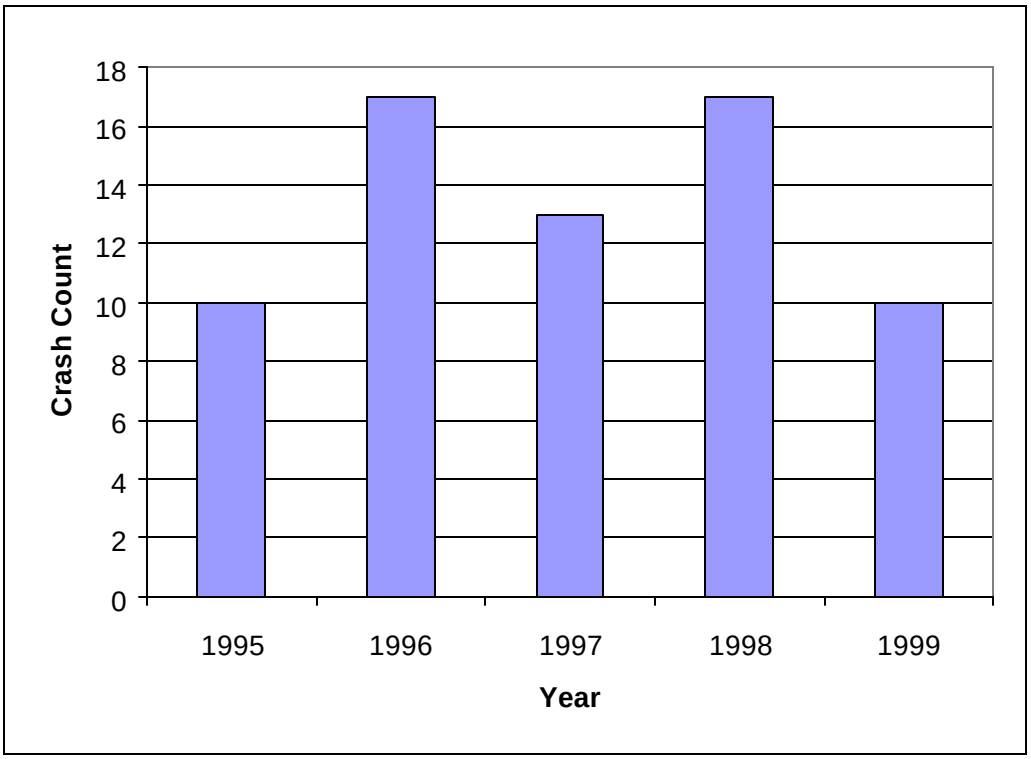


Figure 5.10. Example Crash Count by Year (Microsoft Excel)

The Access-ALAS analysis shows that most crashes occurred in the daylight under dry conditions. The major cause of crashes at the intersection of US 30 and Grant Road was failing to yield to the right-of-way left turning. Half of the crashes occurred on the days of Wednesday, Thursday, and Friday between 4:00 p.m. and 6:00 p.m.

In order to better visualize the types of crashes within the intersection, the city needed a collision diagram. Collision diagrams may be constructed within the program Intersection Magic. The node number for the intersection is needed to run Intersection Magic. CMAT can be used to obtain the node number. The node number is used in Intersection Magic to obtain a collision diagram of all crashes at the intersection of US 30 and Grant Road during the five-year time period. See Figure 5.11. Instructions for this process are provided in Appendix D.3.

The intersection of US 30 and Grant Road was ranked 21st on the Iowa DOT's list of statewide candidate locations for safety improvements. At the time period of the study, the intersection has a leading left-turn phase for eastbound to northbound traffic. From the Access-ALAS queries, left-turn crashes on the US 30 approaches may be identified as the predominate crash type. Vehicles making left turns from US 30

onto Grant Road may have limited sight distance. Some of the possible countermeasures to reduce these types of crashes are as follows:

- Split-phase the signal operation for the US 30 movements.
- Construct left-turn bays with or without raised medians.
- Re-time the traffic signal.

Information on contracting for a crash analysis study, including a project work order using the city of Carroll example, is provided near the end of this chapter.

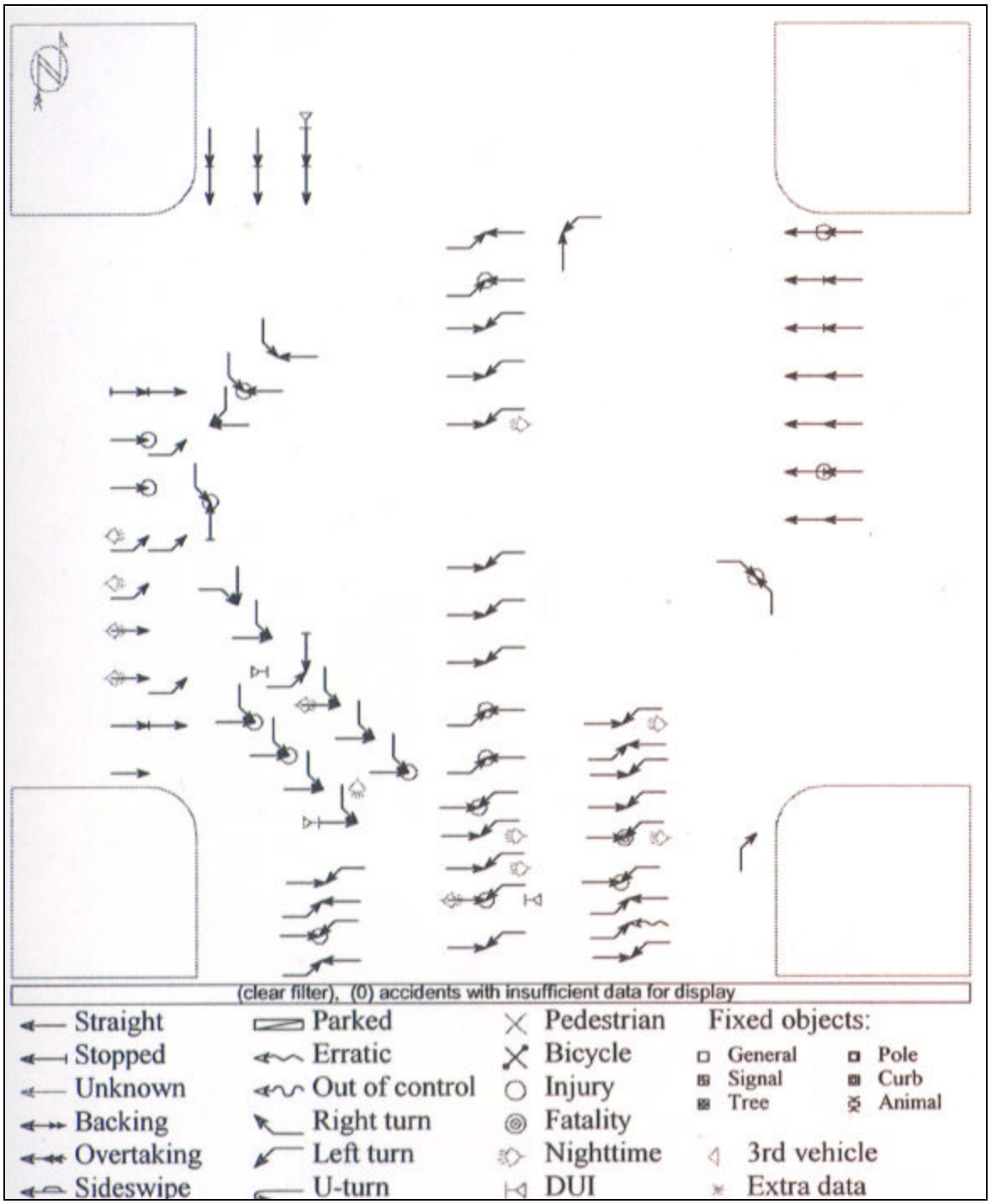


Figure 5.11. US 30 and Grant Road Collision Diagram (Carroll, IA) (Intersection Magic)

CONTRACTING FOR A CRASH ANALYSIS STUDY

Information Gathering

Before a jurisdiction contacts an engineering consulting firm to perform a crash analysis study, a variety of information may need to be collected. Any information may aid the consulting firm in adequately completing the study. The following is a list of possible information that an engineering consulting firm may request:

- issue at hand
- crash history
- traffic volumes
- sight distances
- right-of-way information
- roadway geometry
- roadway classifications
- posted speed limits in and around study area
- preliminary speed studies
- citizen input
- location map
- appropriate contact persons
- any other relevant information

The following project work order may assist local governments in contracting to an engineering firm. The example project work order contains information from the city of Carroll example (a blank form is provided in Appendix E).

Project Work Order: Crash Analysis Study

Referenced Agreement

This work order is part of an agreement between Smith Consulting and the city of Carroll for municipal engineering services.

Project Location Description

This work involves conducting a crash analysis study at the intersection of Highway US 30 and Grant Road. A map depicting the location is attached.

Obligation of the City/County

The city shall provide the following items to the consultant: historic traffic volumes, current traffic volumes, posted speed limits, available sight distances, crash history, roadway geometry, roadway classification, and a list of important contacts.

Scope of Consultant Services

This work includes gathering and analyzing crash data. Crash mitigation recommendations will also be required, if needed.

Schedule

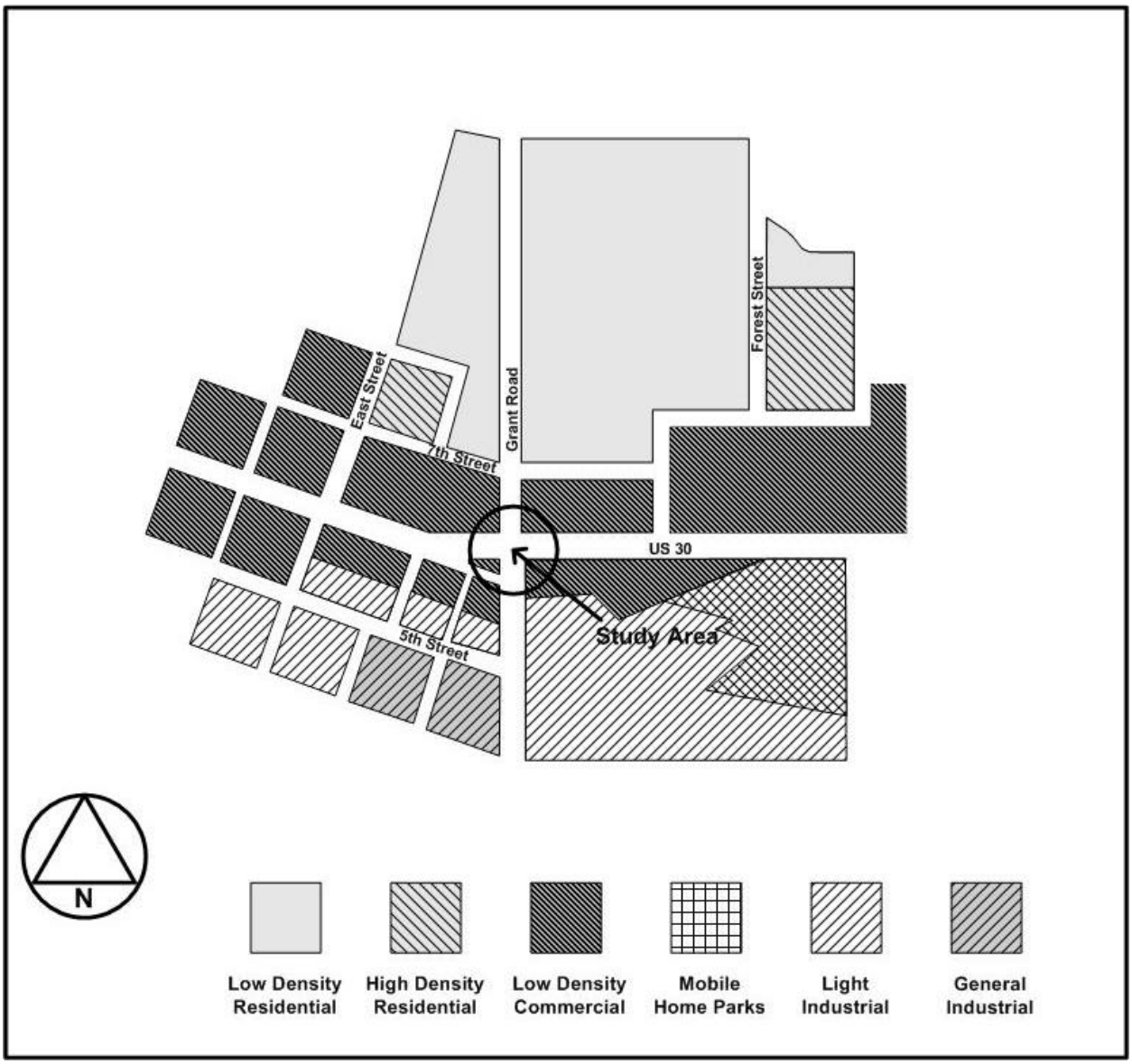
Field meeting date:	_____
Estimated date of preliminary deliverable:	_____
Estimated date of final deliverable:	_____

Compensation

Labor cost	$
Direct expenses	$
Subcontractor cost	$ _____
Overhead	$ _____
Maximum payable	$

Authorization

City of Carroll	Smith Consulting
City/County	Contractor
_____	_____
City/County Administrator	Project Manager's Name/Title
_____	_____
Signature	Signature
_____	_____
Date	Date


Forest Street
Grant Road
East Street
7th Street
US 30
Study Area
5th Street
N
Low Density Residential
High Density Residential
Low Density Commercial
Mobile Home Parks
Light Industrial
General Industrial

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