Process to Identify High-Priority Corridors for Access Management Near Large Urban Areas in Iowa

Final Report

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ABSTRACT

When access via driveways and minor public roads from arterial and collector roadways to land development is not effectively managed, the result is often increased accident rates, increased congestion, and increased delays for motorists. The most common access management problem in Iowa involves allowing a high density of direct driveway access via private driveways to commercial properties located alongside arterial highways, roads, and streets. Although access management is often thought of as an urban problem, some of the most difficult access management issues occur in areas at and just beyond the urban fringe. Like most other states, Iowa is becoming more urbanized, with large urban centers accounting for more and more employment and inbound commuting from rural hinterlands. This research project is intended to produce a strategy for addressing current and future access management problems on state highway routes located just outside urban areas that serve as major routes for commuting into and out of major employment centers in Iowa.

There were two basic goals for the project: (1) to develop a ranking system for identifying high-priority segments for access management treatments on primary highways outside metro and urban areas and (2) to focus efforts on routes that are major commuting routes at present and in the future. The project focused on four-lane expressways and two-lane arterials most likely to serve extensive commuter traffic. Available spatial and statistical data were used to identify existing and possible future problem corridors with respect to access management. The research team developed a scheme for ranking commuter routes based on their need for attention to access management.

This project was able to produce rankings for corridors based on a variety of factors, including proportion of crashes that appear to be access-related, severity of those crashes, and potential for improvement along corridors. Frequency and loss were found to be highly rank correlated; because of this, these indicators were not used together in developing final priority rankings. Most of the highest ranked routes are on two-lane rural cross sections, but a few are four-lane expressways with at-grade private driveways and public road intersections. The most important conclusion of the ranking system is that many of the poor-performing corridors are located in a single Iowa Department of Transportation district near two urban areas—Des Moines and Ames. A comprehensive approach to managing access along commuting corridors should be developed first in this district since the potential benefits would be highest in that region.

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INTRODUCTION

Overview of Access Management in Iowa

Iowa has completed and received national attention for its program of access management research. Access management is a process that provides or manages access to land development while simultaneously preserving the flow of traffic in the surrounding system in terms of safety, capacity, and speed. Managing access involves the control of spacing, location, and design of driveways, medians/median openings, intersections, traffic signals, and freeway interchanges. The most common access management problem in Iowa involves allowing a high density of direct driveway access via private driveways to commercial properties located alongside arterial highways, roads, and streets (*1*). Access issues are thought to be a contributing factor in over 50 percent of all highway crashes; however, this figure is much higher in built-up urban and suburban areas than in rural areas.

Problem Definition

Iowa's highways play a dual role of serving through traffic and providing direct access to adjacent land and development. When access via driveways and minor public roads from arterial and collector roadways to land development is not effectively managed, the result is often increased accident rates, increased congestion, and increased delays for motorists. Research in Iowa and elsewhere has shown access management to be highly effective in increasing highway safety and improving traffic operations.

Although access management is often thought of as an urban problem, some of the most difficult access management issues occur in areas at and just beyond the urban fringe. Fringe areas are the most rapidly developing areas in Iowa. Like most other states, Iowa is becoming more urbanized, with large urban centers accounting for more and more employment and inbound commuting from rural hinterlands.

In urban fringe areas considerable commuting occurs inbound to employment centers within the suburban areas and urban cores. Two-lane and four-lane arterials that were originally designed to serve long-distance, high-speed travel may also serve growing numbers of commuters and sometimes will also have land development and recreational facilities such as trails and parks in place alongside. Unless access to minor public roads and land development is carefully managed, such highways can lose their effectiveness in terms of serving through travel. They can also become considerably less safe rather quickly.

Project Objectives

This research project is intended to produce a strategy for addressing current and future access management problems on state highway routes located just outside urban areas that serve as major routes for commuting into and out of major employment centers in Iowa. There were two basic goals for the project:

1. Develop a ranking system for identifying high-priority segments for access management treatments on primary highways outside metro and urban areas. Identify routes that could become candidates for corridor management pilot projects.
2. Focus efforts on routes that are major commuting routes at present and in the future.

It was important to the project's sponsor, the Iowa Department of Transportation (Iowa DOT), that the research focus on finding a limited number of four-lane corridors with at-grade intersections ("expressways" in Iowa DOT terminology) that ought to be given high priority for proactive access management attention based on both current safety problems and future growth in traffic and development.

Project Formulation

This research project will assist the Iowa DOT in systematically identifying "commuter corridors" radiating out from urban areas that are the most likely to need attention in terms of access management. Existing as well as likely future indicators of access management issues will be considered. The project is focused on four-lane expressways and two-lane arterials most likely to serve extensive commuter traffic.

This research used available spatial and statistical data to identify existing and possible future problem corridors with respect to access management. The research team developed a scheme for ranking "commuter routes" based on their need for attention to access management. To do this, a number of Iowa DOT, local government, and other data sources were integrated using geographic information systems (GIS) technology. Sources integrated included crash data, Census data, roadway configuration data, and traffic data.

Key Conclusions and Implications

This project was able to produce rankings for corridors based on a variety of factors, including proportion of crashes that appear to be access-related, severity of those crashes, and potential for improvement along corridors. The most important conclusion of the ranking system is that many of the poor-performing corridors are located in a single Iowa DOT district (District 1) near two urban areas—Des Moines and Ames. In fact, over half of the problem corridors identified are in Iowa DOT District 1. A comprehensive approach to managing access along commuting corridors should be developed first in District 1 since the potential benefits would be highest in that region. The second highest concentration of high-ranking corridors is in Iowa DOT District 6—the Cedar Rapids–Iowa City area. There are other high-ranking (problem) corridors spread throughout the state, but they tend to be more isolated in nature.

Key findings of the analysis include the following:

- Frequency and loss are highly rank correlated (as might have been expected since loss is partially a function of crash frequency); because of this, these indicators were not used together in developing final priority rankings.
- Most of the highest ranked routes are on two-lane rural cross sections, but a few are four-lane expressways with at-grade private driveways and public road intersections.

Table 1 indicates routes (including both two-lane and four-lane routes) that are suggested for consideration as corridor management pilot projects based upon the results of the analysis.

Table 1. Potential Corridors for Corridor Management

Corridor ID	Route	Nearby City	Growth Factor	Access Class.	Within 20 Miles of Metro	Driveway Density	No. of Lanes	Direction from City
14	982	Sioux City	3	6 to none	Yes	2.70	2	Southeast
26	20	Dubuque	4	2 to 3	Yes	1.21	4	West
29	52	Dubuque	4	none	Yes	0.71	2	North
34	67	Davenport	3	4 to 3	Yes	6.56	2	Northeast
35	956	Davenport	4	6 to none	Yes	3.41	2	North
37	130	Davenport	3	4 to none	Yes	0.63	2	Northwest
47	13	Cedar Rapids	3	3	Yes	0.29	4	East
49	94	Cedar Rapids	3	none	Yes	3.82	2	Northwest
51	151	Cedar Rapids	3	4 to 6 to 3	Yes	4.51	2	Southwest
59	6	Iowa City	3	6	Yes	3.99	2	Northwest
66	69	Ames	4	3 to none	Yes	0.23	2	South
68	17	Ames	3	6 to none	Yes	0.31	2	West
69	69	Ames	4	none	Yes	8.47	2	North
70	931	Des Moines	6	none	Yes	0.12	2	North
71	65	Des Moines	3	3	Yes	2.84	4	Northeast
72	415	Des Moines	6	3 to 4	Yes	6.12	2 to 4	Northwest
73	6	Des Moines	4	3	Yes	3.51	2	West
74	28	Des Moines	2	4 to none	Yes	2.79	2	South
75	92	Des Moines	5	none	Yes	8.08	2	Southeast
76	65	Des Moines	3	3	Yes	6.54	4	South
77	5	Des Moines	3	3	Yes	2.36	4	Southeast
81	191	Council Bluffs	2	6	Yes	0.35	2	East
82	183	Council Bluffs	9	none	Yes	5.11	2	North
87	275	Council Bluffs	4	none	Yes	0.18	2	Southeast
107	163	Des Moines	3	3	Yes	0.12	4	Southeast
109	52	Dubuque	3	none	Yes	3.05	2	South

Note: Four-lane routes are shaded.

METHODOLOGY AND RESULTS

The research methodology consisted of two distinct activities. The first focused on finding corridors that exhibited signs of having access management problems at present. The second activity involved finding corridors likely to have future access management problems. In Iowa, outside built-up areas, there is a limited number of routes where capacity and operations are current issues. Therefore, the current problem phase of the research focused almost entirely on safety and safety data.

This overview details the methodology used to create a statewide mapping and database system of Iowa's non–access-controlled primary commuting corridors to locate and proactively identify access management problems. The project used ESRI ArcView GIS (geographic information systems) to develop a mapping system of these corridors, corresponding attribute tables of the corridors, databases of crashes related to these corridors, and databases created for analysis of the corridors, their crashes, and their possible problems as related to access management. Data sources included crash databases, Iowa state, county, and city databases, roadway and vehicle databases from the Center for Transportation Research and Education (CTRE) database, and an access ratings database from the Iowa DOT.

The goals of utilizing GIS technologies to create and analyze the chosen Iowa commuter corridors were twofold:

1. Develop an ArcView project illustrating the current access classifications of Iowa's primary road system.
2. Generate an ArcView project portraying the chosen commuter routes of Iowa and the automobile crashes occurring on these corridors.

An innate benefit of using ArcView GIS over traditional statistical or mapping techniques is the ability to integrate data into the maps. This allows for a much "smarter" map; this allows for data analysis to occur within the program, and for results to be displayed graphically in map form.

In general, the following four ranking indicators were used to identify high-priority corridors:

- **Frequency—**This indicator represents the number of crashes that appear to be access related, in particular those that involve turning vehicles. All turning crashes were included, whether they occurred at private driveways or public road intersections.
- **Rate—**This indicator is the frequency of access-related crashes per million vehicle miles traveled (VMT).
- **Loss/severity—**This indicator measures the estimated cost of access-related crashes in dollars, including an estimate of the cost of fatalities, personal injuries, and property damage.
- **Percentage access related—**This indicator represents the percentage of total crashes that appear to be access related.

The distribution of ranking indicators was compiled for all 109 corridors for each of the four indicators. Access-related crash frequency over a three-year period ranged from a high of 529 down to zero; the mean frequency was 60. Access-related crash rates per million VMT ranged from a high of 5.61 down to zero; the mean rate was 1.21. Access-related crash losses for a three-year period ranged from a high of 43.5 million dollars down to zero dollars; the mean loss was just over five million dollars. The percentage of crashes deemed to be related to access ranged from a high of 33.3 percent to a low of zero percent; the mean value for this indicator was 10.6 percent. The 109 corridors being analyzed are located primarily outside built-up urban areas. If similar percentage calculations were conducted inside urban areas, it is very likely that these percentages would be significantly higher.

Corridors with Current Access Management Problems

The process of identifying current problem corridors involved the following nine steps:

1. Mapping Iowa DOT's Access Priority Classifications

The first objective of the GIS work was to create a statewide mapping and database system depicting how the primary road system in Iowa is classified due to each road's assessed access management objectives. CTRE developed the access classifications database from basic information supplied by the Iowa DOT, but a need was seen for it to be presented in a GIS format to integrate mapping and database capabilities. The definitions of the six access classifications are located in Tables 2 and 3.

Table 2. Access Priority Classifications (Metric)

Rating	Description
1	Access points at interchanges only
2	Access points spaced at minimum 800 m
3	Access points spaced at minimum 300 m rural, 200 m urban
4	Access points spaced at minimum 200 m rural, 100 m urban
5	Iowa DOT has minimum access rights acquired
6	Iowa DOT has no access rights acquired

Source: Iowa DOT.

Table 3. Access Priority Classifications (English Conversion)

Rating	Description
1	Access points at interchanges only
2	Access points spaced at minimum 2625 ft
3	Access points spaced at minimum 984 ft rural, 656 ft urban
4	Access points spaced at minimum 656 ft rural, 328 ft urban
5	Iowa DOT has minimum access rights acquired
6	Iowa DOT has no access rights acquired

Source: Iowa DOT.

The process of developing the project was as follows:

- The access priority classifications mapping system began with themes of Iowa counties, Iowa roads, Iowa proposed roads, and Iowa cities. The access classifications road database was then added to the project to overlay these themes.
- City names and road number labels were added to this map to assist in readability.
- The final map, Figure A.1 in Appendix A, can be used to pinpoint Iowa roads that do not have a static access classification and will also be used in data analysis for the commuter route mapping system.

2. Identifying Key Iowa Commuting Corridors

The second objective of the GIS work was to create a statewide mapping and database system depicting Iowa's primary commuting corridors. Similar state, city, and road themes were used, in addition to the creation of a new road theme of Iowa's commuter corridors. The commuter routes study project began in the following manner:

- Using secondary data on Iowa cities, populations, industries, and roads, 21 Iowa towns were chosen as major commuter destination cities. These cities included Spencer, Mason City, Dubuque, Cedar Falls, Waterloo, Fort Dodge, Sioux City, Ames, Marshalltown, Cedar Rapids, Iowa City, Clinton, Davenport, Muscatine, Burlington, Fort Madison, Keokuk, Oskaloosa, Ottumwa, Des Moines, and Council Bluffs. From these 21 cities, 109 road segments radiating from the cities were identified as being non–access-controlled primary commuter routes into these areas. Each of these 109 road segments was issued an identification number for analysis. Table B.1 in Appendix B shows each road segment, its commuter route identification number, its route number, and the city that it is located nearest to.
- This initial designation was later verified using results from a statewide modeling effort that produced maps of estimated current and future commuting flows.
- The commuter route mapping system began with themes of Iowa counties, Iowa roads, Iowa major commuter destination towns, and Iowa roads.
- A commuter route theme was created by selecting each of the 109 commuter route road segments from the Iowa roads theme, and then converting the selections into a new shapefile. A map of the commuter routes chosen is shown below in Figure 1.

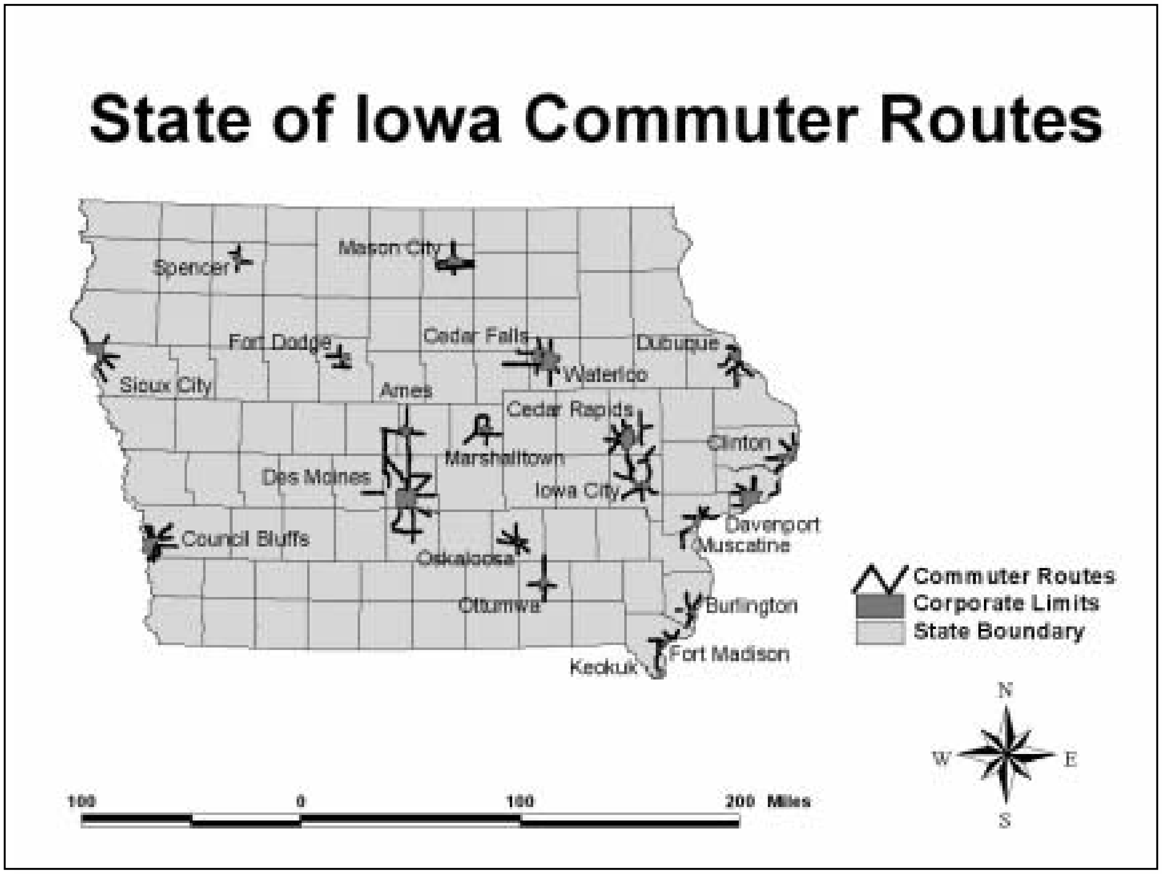

Figure 1. Iowa Commuter Routes

3. Performing Crash Data Analysis

Three years of Iowa crash databases were added to the project to illustrate high crash locations on the commuter routes. (Multiple years were analyzed to control for random variations in crash data and to avoid "regression to the mean" problems that often occur in crash analyses.) The Iowa DOT crash databases from the Accident Location and Analysis System (ALAS) used included the years of 1997, 1998, and 1999, the most recent data available at the time of the work. The process of creating crash databases containing only information pertinent to the commuter routes is detailed below:

- The crashes located on the commuter routes were selected and converted to a new shapefile, commuter route crashes, for easier analysis.
- To analyze access management on these roads, the total commuter route crashes were queried by collision type to locate crashes that involved right- and left-turning maneuvers, then queried by turning action to distinguish between left- and right-turning crashes. The methods used to detect *access-related crashes* are given in Appendix C; Table C.1 in Appendix C describes the fields used for the access-related crash queries. The access-related crashes on the commuter routes are illustrated in map form in Figure 2 below.

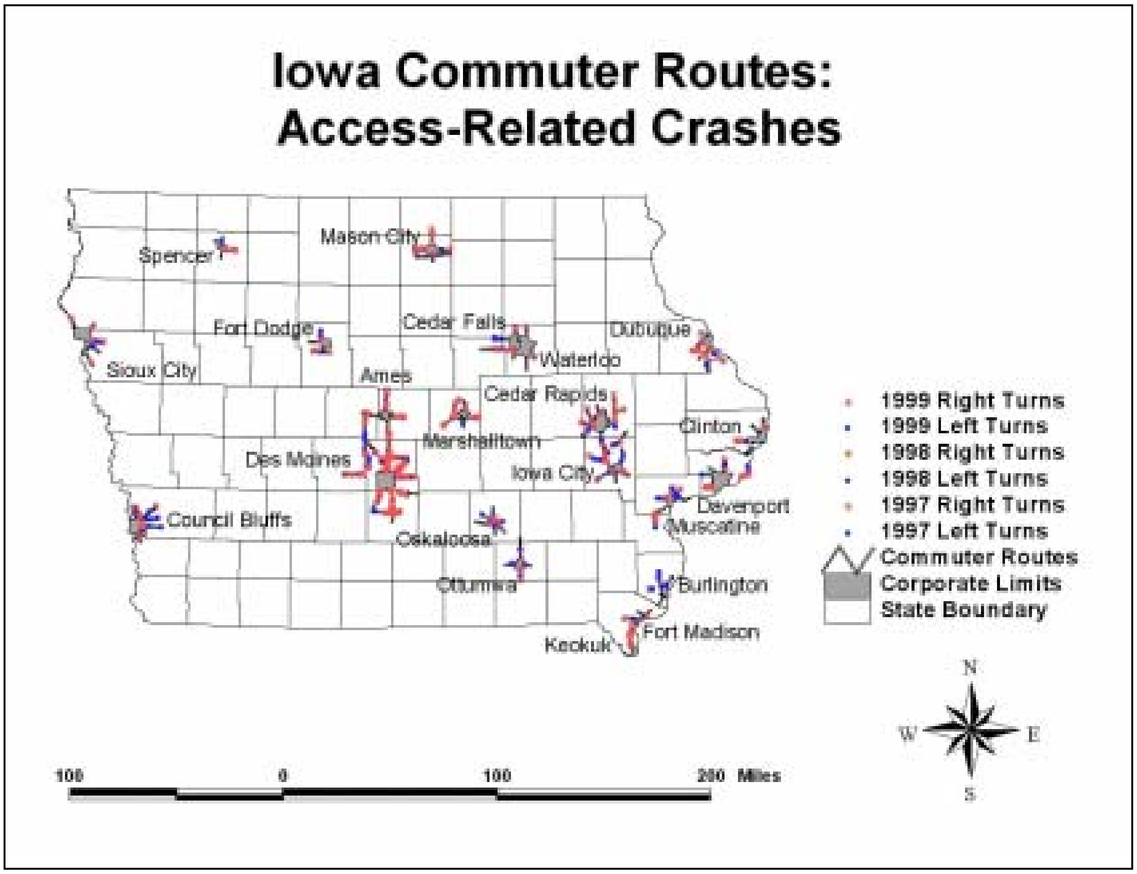

Figure 2. Access-Related Crashes on Iowa Commuter Routes

- The *frequency* of both access-related crashes and total crashes on the commuter routes was calculated; the methodology used for this is given in Appendix D. The resulting frequency findings were ranked in Microsoft Excel. The ranked frequency of overall crashes for each commuter route can be found in Table D.1, and the ranked frequency of access-related crashes for each commuter route can be seen in Table D.2 (both in Appendix D).
- The *vehicle miles traveled* for the commuter routes was calculated from existing data in the project and from other road databases. The methodology used to calculate VMT is given in Appendix D. The summed VMT values for the commuter routes are available in Table D.3 in Appendix D.

4. Calculating Crash Rates

Using the calculated VMT and crash frequency, crash rates were found and ranked per commuter route for total crashes and for access-related crashes. Methods used to calculate both total crash rates and access-related crash rates for the commuter routes are given in Appendix D. Table D.4 lists the ranked total crash rates for the commuter routes, and Table D.5 lists the ranked access-related crash rates for the commuter routes (both in Appendix D). Figure 3 below illustrates the ranked corridors by access-related crash rates for Iowa's commuter routes.

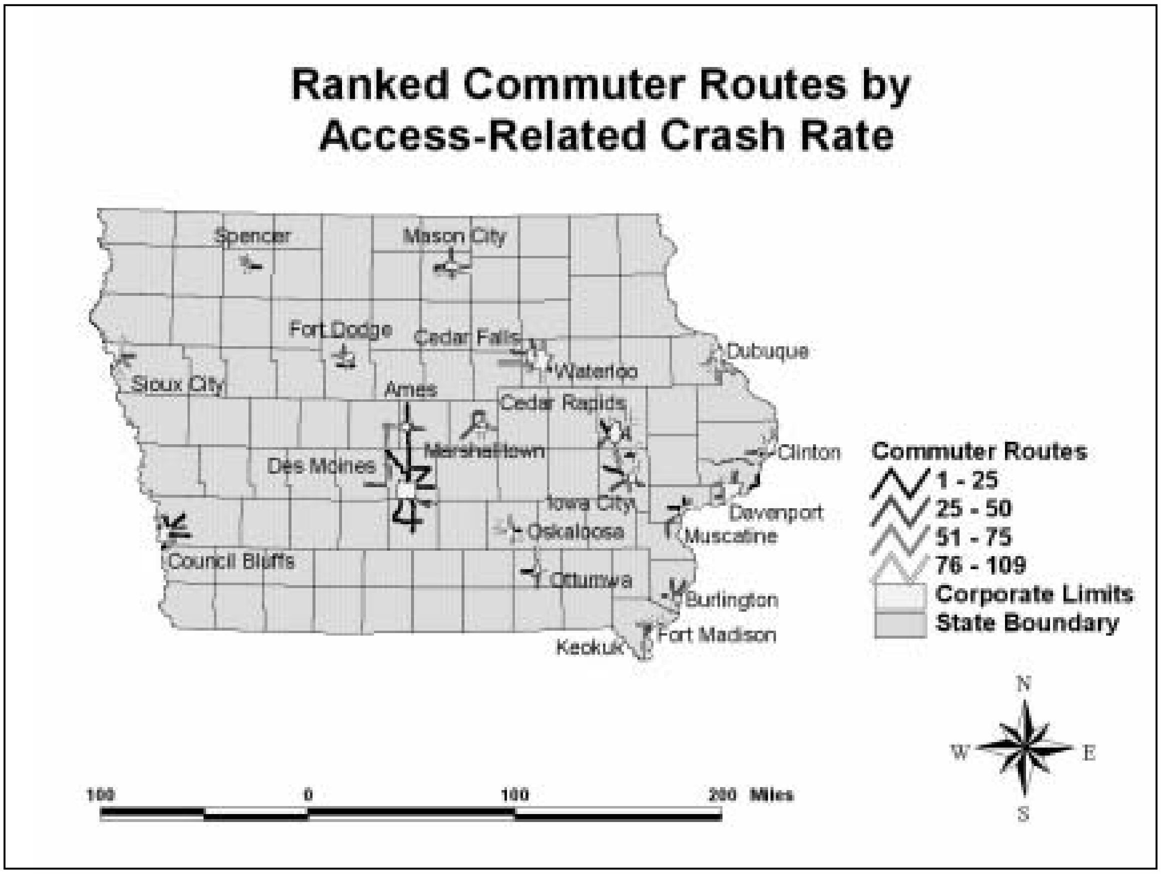

Figure 3. Corridors Ranked by Access-Related Crash Rate

Important total and access-related crash rate analysis points are as follows:

- Twenty-one large Iowa cities were chosen as major commuter destinations. In some cases where there is substantial cross-commuting (e.g., Des Moines and Ames, and Cedar Rapids and Iowa City) continuous routes between cities were analyzed together. Findings from Table D.4 in Appendix D show the following:
  - Out of the 21 cities, the corridors that serve Ames and Des Moines contained 28 percent of the top 25 corridors ranked by total crash rates.
  - The cities with the next-highest percentage are Council Bluffs and Fort Dodge, with each area holding 12 percent of the top 25.
- Comparing the ranked access-related crash rates of the Ames and Des Moines areas to those of other cities shows that they hold an even more dominant percentage of the rankings. Table D.5 in Appendix D shows the following:
  - Ames and Des Moines commuter corridors account for 32 percent of the top 25 corridors ranked by access-related crash rates; these cities also claim 6 of the top 10 corridors.
  - The commuting regions with the next-highest percentage are Council Bluffs and Cedar Rapids, with each area holding 12 percent of the top 25; these cities list only one corridor apiece in the top ten rankings.

5. Ranking Corridors by Iowa DOT District

The commuter corridors were next studied to determine the highest ranking four-lane and two-lane corridors in both total and access-related crash rates for each Iowa DOT district in the state. Because the findings of this study could be used within Iowa DOT districts in their regional planning, it was recognized that tailoring some results of the project toward the districts could be beneficial. The Iowa DOT requested that four-lane corridors be looked at specifically in this regard to ensure that any access management problems on the four-lane corridors were identified. Table E.1 in Appendix E lists each city's commuter routes with their appropriate districts. Table E.2 in Appendix E lists the highest ranking four-lane corridors in total crash rates; Figure E.1 in Appendix E shows these corridors graphically. Table E.3 in Appendix E lists the highest ranking four-lane corridors in access-related crash rates; Figure E.2 in Appendix E depicts these districts and corridors graphically. Some notable findings (see Tables E.2 and E.3 in Appendix E) from the district study include the following:

- The Des Moines area's commuter routes reach into four different Iowa DOT districts: 1, 4, 5, and 6.
- Under total crash rate rankings, there are many corridors radiating from Des Moines that are high-ranking four-lane corridors:
  - District 1: The Des Moines and Ames areas contain five out of the seven top ranking four-lane corridors.
  - District 4: US Highway 6 west of Des Moines is the only qualifying corridor.
  - District 5: US Highway 65 south of Des Moines is the only qualifying corridor.
  - District 6: Iowa Highway 5 southeast of Des Moines is the third highest ranked qualifying corridor; only US Highway 20 west of Dubuque and US Highway 151 southwest Cedar Rapids had higher crash rate rankings.
- Most four-lane corridors that ranked high did so as a result of high total crash rates rather than high access-related crash rates. This indicates that, in general, four-lane corridors in Iowa are better managed in terms of access than two-lane corridors. This is not an unexpected result given the higher access management priority given to four-lane corridors.
- Although the number of four-lane corridors represented by high-ranking access-related crash rates was not large statewide, the corridors in the Des Moines and Ames corridors were notable exceptions.
- In terms of access-related crash rate rankings, both Waterloo and Mason City in Iowa DOT District 2 showed corridors that were also highly ranked under total crash rate. These corridors include US Highway 218 both north and south of Waterloo, and Iowa Highway 122 (formerly US Highway 18) west of Mason City.

6. Calculating Crash Severity

Severity values were estimated for each commuter route crash to determine the monetary loss associated with the crashes. The Iowa DOT ranks severities in crashes by a level of 1, 2, 3, or 4; each level has a corresponding dollar amount that may be applied to determine the estimated loss of the crash. Table F.1 in Appendix F details each level of severity used by the Iowa DOT, a description of the severity, and the dollar amount assigned to each severity. Some crashes may have more than one severity; in this situation, dollar amounts for each severity are added together to estimate the total loss from the crash.

For this study, loss amounts were calculated for both total crashes and access-related crashes on the commuter routes. Each commuter routes' losses from crashes were then summed to find the total loss amounts from total crashes and the total loss amounts from access-related crashes for each commuter route. Table F.2 in Appendix F ranks the summed loss amounts due to total crashes for each commuter route, and Table F.3 in Appendix F ranks the summed loss amounts due to access-related crashes for each commuter route. Table 4 below shows the total crash loss and access-related crash loss amounts for corridors by city. The access-related crash loss amounts are compared to the total crash loss amounts for corridors per cities. The percentages of city access-related crash loss to total access-related crash loss are also shown. Table 5 shows this result broken down by Iowa DOT district rather than by city.

Table 4. Comparison of Access-Related Crash Loss to Total Crash Loss by City

City	Loss from Total Crashes	Loss from Access Crashes	Percentage of Access Crash Loss to Total Crash Loss	Percentage of City Access Crash Loss to Total Access Crash Loss
Des Moines	$14,006,860,000	$3,671,627,500	26.21%	48.45%
Ames	$9,685,508,500	$1,663,237,500	17.17%	21.95%
Muscatine	$845,520,000	$299,205,000	35.39%	3.95%
Cedar Rapids	$2,173,032,500	$270,357,500	12.44%	3.57%
Mason City	$839,165,000	$268,832,500	32.04%	3.55%
Waterloo	$1,017,075,000	$218,575,000	21.49%	2.88%
Davenport	$987,915,000	$201,500,000	20.40%	2.66%
Fort Madison	$1,775,370,000	$192,292,500	10.83%	2.54%
Council Bluffs	$836,187,500	$129,672,500	15.51%	1.71%
Dubuque	$1,575,732,500	$180,640,000	11.46%	2.38%
Iowa City	$890,860,000	$123,510,000	13.86%	1.63%
Fort Dodge	$314,642,500	$60,960,000	19.37%	0.80%
Sioux City	$677,597,500	$56,480,000	8.34%	0.75%
Clinton	$190,980,000	$52,225,000	27.35%	0.69%
Ottumwa	$471,372,500	$51,250,000	10.87%	0.68%
Marshalltown	$1,004,627,500	$42,665,000	4.25%	0.56%
Burlington	$292,122,500	$39,702,500	13.59%	0.52%
Oskaloosa	$580,907,500	$32,267,500	5.55%	0.43%
Spencer	$74,475,000	$23,445,000	31.48%	0.31%
Total	$38,239,951,000	$7,578,445,000	20.00%	100.0%

Table 5. Comparison of Access-Related Crash Loss to Total Crash Loss by District

District	Loss from Total Crashes	Loss from Access Crashes	Percentage of Access Crash Loss to Total Crash Loss	Percentage of District Access Crash Loss to Total Access Crash Loss
1	$19,266,493,500	$4,132,017,500	21.45%	54.52%
5	$9,171,777,500	$1,698,090,000	18.51%	22.41%
6	$5,818,520,000	$828,232,500	14.23%	10.93%
2	$1,856,240,000	$487,407,500	26.26%	6.43%
4	$1,374,847,500	$352,772,500	25.66%	4.65%
3	$752,072,500	$79,925,000	10.63%	1.05%
Total	$38,239,951,000	$7,578,445,000	20.00%	100.00%

Key conclusions from the severity study (Tables F.2–F.5 in Appendix F) are as follows:

- Des Moines and Ames area corridors include 9 out of the top 25 highest ranking single corridors by loss from total crashes (see Table F.2).
- Des Moines and Ames area corridors include 11 out of the top 25 highest ranking single corridors by loss from access-related crashes (see Table F.3), notably more than for their number of corridors in the top 25 for loss from total crashes. This indicates that access management problems on commuting corridors are very much concentrated in central Iowa.
- Compared to the rest of the cities, the Des Moines and Ames areas have the highest amounts of loss from both total crashes and access-related crashes, and the highest percentages of city access crashes to total access crashes, at 48.25 percent and 21.95 percent, respectively (see Table 4 above).
- Muscatine, Mason City, and Spencer have the largest percentages of access crash loss to total crash loss, of 35.39 percent, 32.04 percent, and 31.48 percent, respectively (see Table 4 above).
- Other notable percentages of access crash loss to total crash loss are those of Clinton, Des Moines, Waterloo, and Davenport, at 27.35 percent, 26.21 percent, 21.49 percent, and 20.40 percent, respectively (see Table 4 above).
- District 1 has by far the highest loss amount for both total crashes and access-related crashes of any Iowa DOT district (see Table 5 above).
- Districts 2 and 3 have the highest percentages of access crash loss to total crash loss, of 26.26 percent and 25.66 percent, respectively (see Table 5 above).
- District 1 has by far the largest percentage of district access crash loss to all districts' access crash loss amount, at 54.52 percent (see Table 5 above). District 1's commuting corridors are clearly the most in need of attention with respect to managing access. This is not all that surprising in that District 1 contains Iowa's largest and fastest growing metropolitan area.

In addition to ranking severity, the percentage of access-related crashes to total crashes was calculated and ranked for each commuter route. The ranked percentages of access-related crashes per corridor can be found in Table F.6 in Appendix F. Figure 4 below (see also Figure F.1 in Appendix F) shows these corridors broken down into four classes of ranked corridors.

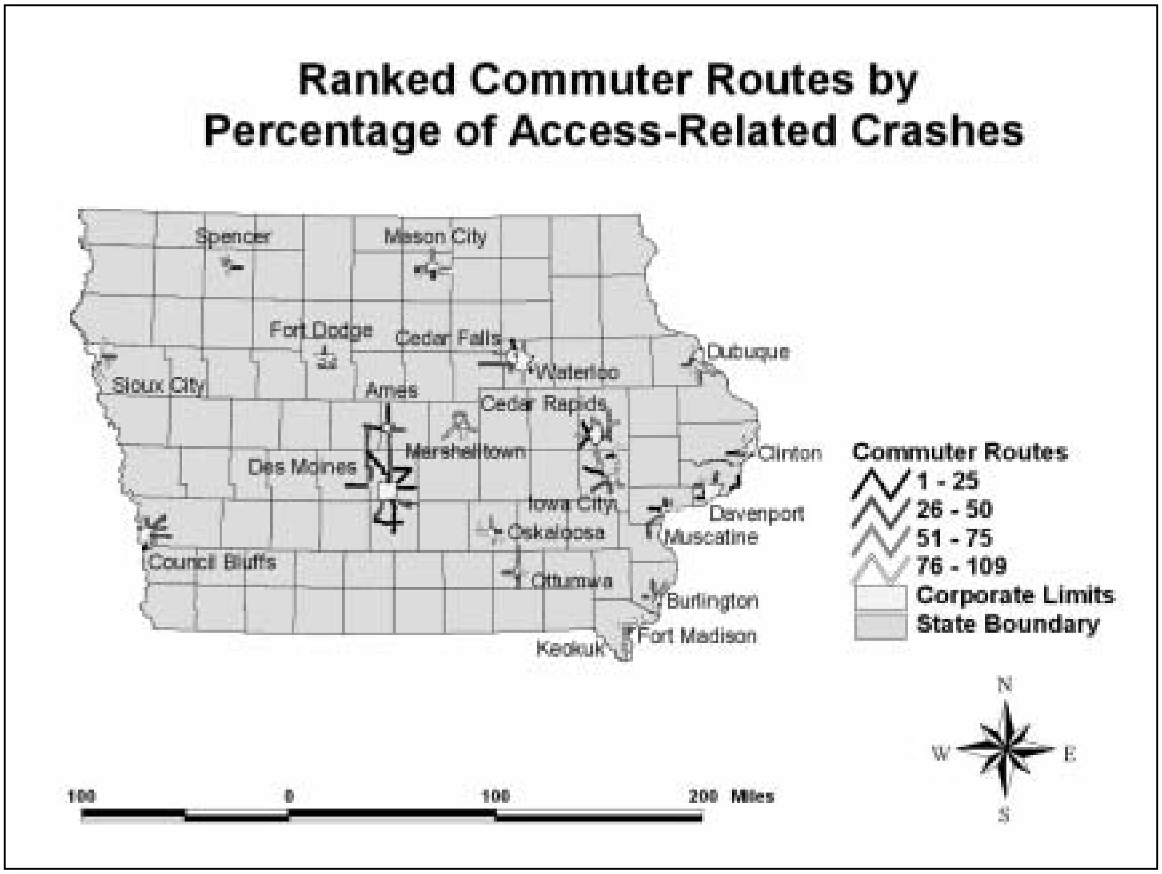

Figure 4. Corridors Ranked by Percentage Access-Related Crashes

Several key analysis points that may be derived from studying the ranked corridors by percentage of access-related crashes in Table F.6 in Appendix F are as follows:

- Out of the top 25 corridors ranked by percentage of access-related crashes, 7 are located near Des Moines.
- Three out of the top 10 ranked corridors, with ranks of third, fifth, and eighth, respectively, are located near Des Moines.
- All 9 Des Moines area commuter corridors are represented in the top 50 corridors ranked by percentage of access-related crashes.
- Two of the top 10 ranked corridors are located near Muscatine; these 2 corridors have ranks of second and sixth, respectively.
- Another 2 of the top 10 ranked corridors are located near Cedar Rapids; these 2 corridors rank fourth and tenth, respectively.

7. Identifying the Best Opportunities for Potential Improvement

To take a more preventive measure toward access-related crashes, the corridors were analyzed to determine whether access-related crashes would decrease from a hypothetical roadway treatment to better manage access. For this, a "potential improvement" factor was created, using, among other data, forecast annual average daily traffic (AADT) growth data generated from the travel demand model. The potential improvement factor development process identified the number of expected future crashes for each corridor, along with the expected number of future crashes for each corridor with roadway treatment to ease access problems. The methodology used to develop the potential improvement factor is given in Appendix G.

The corridors were ranked by their potential improvement; the top 25 ranked corridors are represented in Figure 5 below. Table G.1 in Appendix G ranks the corridors by potential improvement.

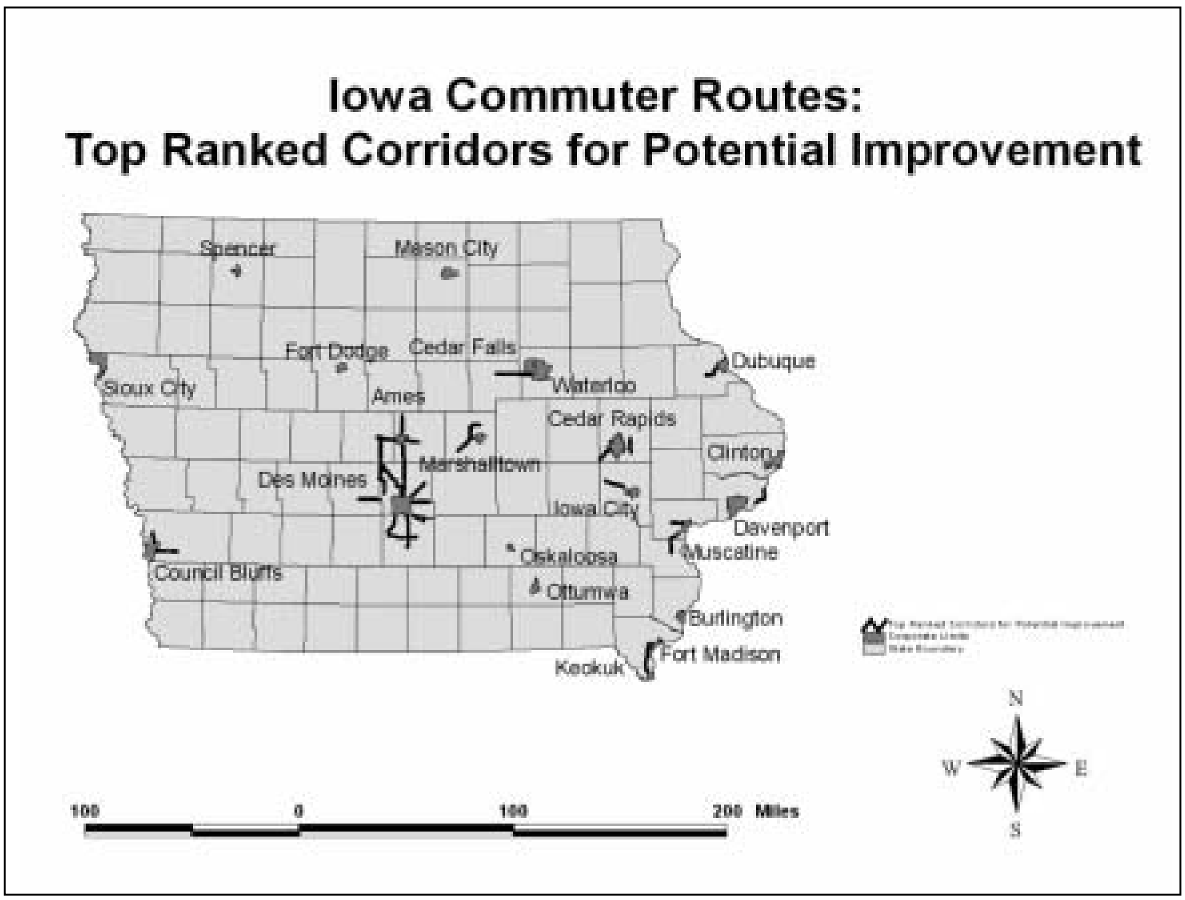

Figure 5. Top 25 Ranked Corridors by Potential for Improvement

Key findings from the potential improvement analysis are as follows:

- The top 25 corridors for potential improvement contain all 8 of the commuter route corridors near Des Moines; this is a strong signal that Des Moines commuter routes could noticeably benefit from road treatments to ease access management problems.
- The top 25 corridors for potential improvement also contain all 5 of the commuter routes near Ames. Other commuter destination cities in Iowa have no more than 2 routes each in the top 25 ranked corridors by potential improvement; from this it is clear that both the Ames and Des Moines areas could both greatly benefit from road treatments aimed at managing access.
- The Ames and Des Moines commuting regions together contain 7 of the top 10 corridors ranked by potential improvement.

8. Modeling Statewide Commuting Traffic Flows

A significant portion of this research project involved the development of a statewide commuter traffic model. This was accomplished using an ArcView-Tranplan interface that CTRE developed for an earlier project funded by the Federal Highway Administration (FHWA) (*2*). This model has a number of other potential uses for the Iowa DOT but was constructed for this project in order to produce reasonable estimates of future commuting traffic growth or decline on the 109 commuter routes being analyzed. The statewide model has the following attributes:

- 2,940 zones (based on U.S. Census block groups); this is about one zone for every 1,000 persons in Iowa, with about 30 zones per average-sized county in Iowa. The zonal structure is small in metropolitan areas and large in sparsely populated rural areas.
- Trip productions were based on population estimates and forecasts.
- Trip attractions were based on employment estimates and forecasts.
- The model used a 1999 base year and a 2004 forecast year.
- The data source for the productions and attractions was the Geolytics, Inc., CensusCD+Maps Version 3.0 product, which provides Census data and forecasts by Census tract and block group.
- The main focus of the model was on estimating growth and decline in trips, not on accuracy in estimating actual trips.

The model network included all primary (state jurisdiction), and some secondary and municipal roads were needed to fill out the network. Average travel speeds were set at 50 miles per hour on most links in the network, but 30 miles per hour on local roads (connectors) and 65 miles per hour on interstates. Friction factors for the model were borrowed from the Des Moines Area Metropolitan Planning Organization's (DMAMPO) model but were extended to provide for a practical maximum trip length of 100 minutes. Multi-state flows were not modeled and there were no "external" zones, so absolute traffic estimates in the model are likely to be inaccurate in areas near the state borders. An "all-or-nothing assignment" and visual validation were used.

The model was used to produce tabular and graphical estimates of 1999 and 2004 work trip volumes assigned to the primary road network. These were in turn used to calculate a future growth factor for each primary route. As Figures 6 and 7 indicate, commuting activity in Iowa is very concentrated, particularly around Des Moines–Ames (Central Iowa) and Cedar Rapids–Iowa City (East Central Iowa).

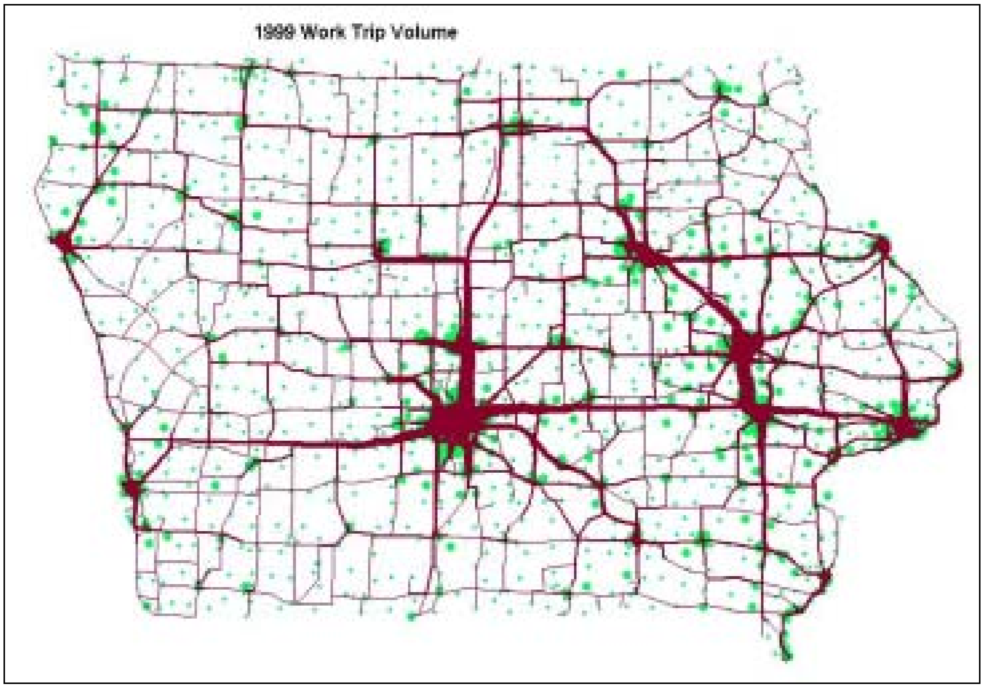

Figure 6. Model Estimated 1999 Iowa Daily Work Trip Volumes

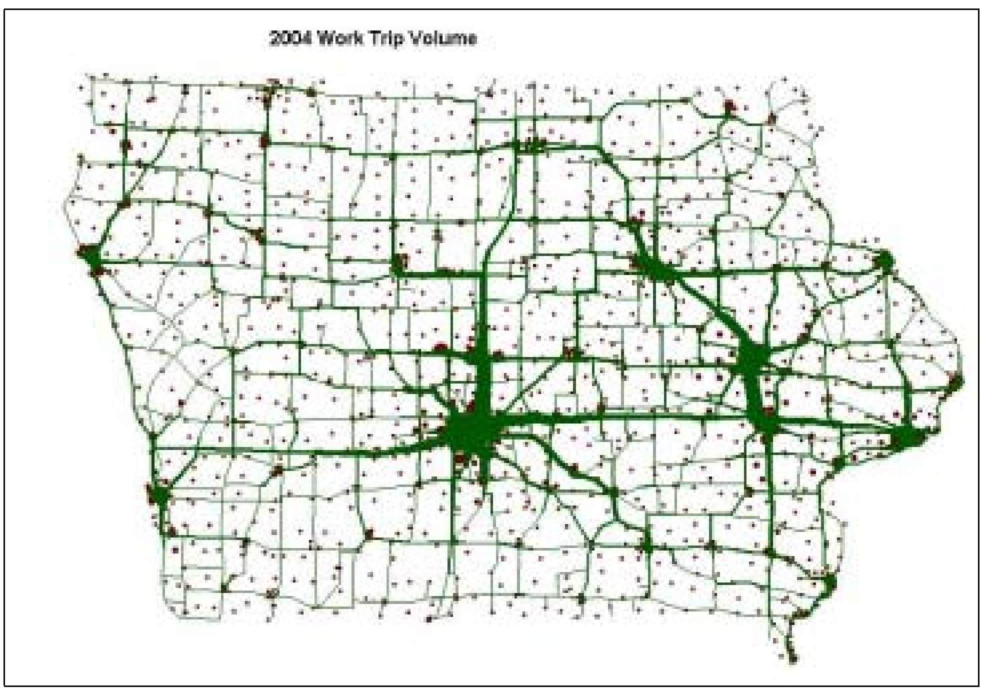

Figure 7. Model Estimated 2004 Iowa Daily Work Trip Volumes

Change is likewise expected to be concentrated (see Figures 8 and 9), although there are other parts of Iowa (e.g., the Davenport, Dubuque, Sioux City, and Waterloo areas) with significant anticipated growth in commuting activity.

Figure 8. Model Estimated 1999–2004 Absolute Change in Iowa Daily Work Trip Volumes

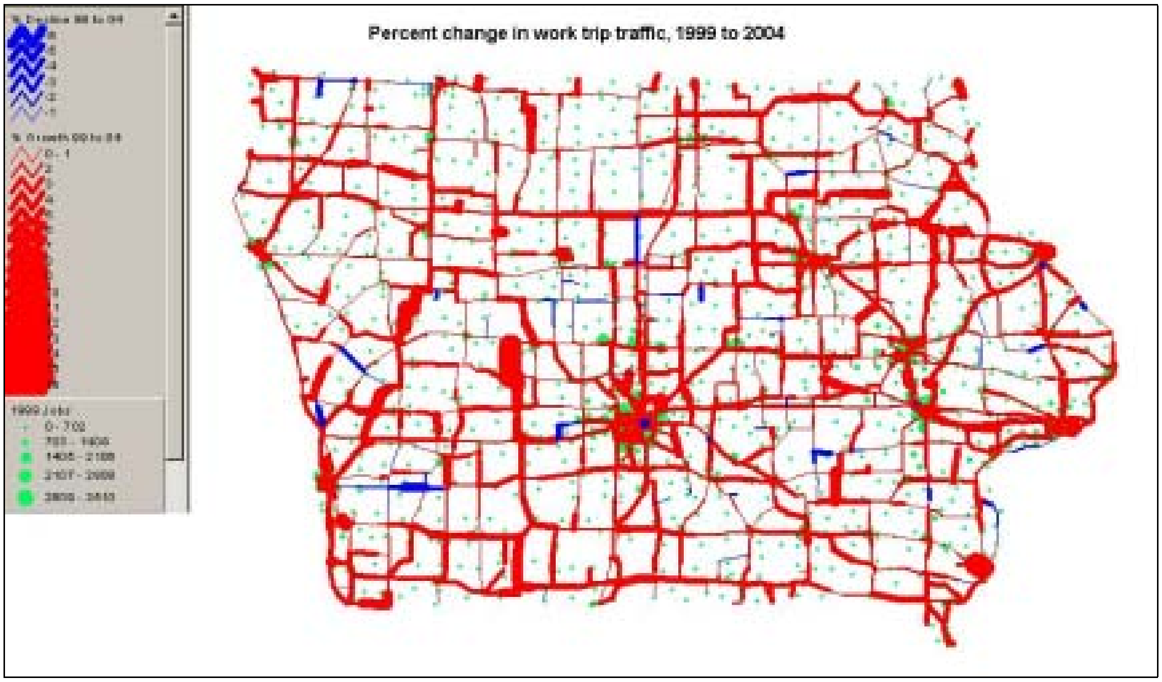

Figure 9. Model Estimated 1999–2004 Percentage Change in Iowa Daily Work Trip Volumes

9. Identifying "Proactive Corridors"

To identify each corridor's possible future problems due to poor access management left untreated, a qualification system to identify "proactive corridors" was designed. A corridors was included in this list if it had high driveway density, a forecast traffic growth factor from the statewide model, any priority access classification of less than 2, and close proximity (within 20 miles) to a metropolitan or large urban area. The full methodology for this process is given in Appendix H. Table 6 below lists the corridors chosen as proactive corridors, in addition to each corridor's qualifying data. Figure 10 below shows these corridors graphically.

Table 6. Proactive Corridors

Comm_ID	Road_Num	City	Growth Factor	Access Classification	Within 20 miles of Metro	Driveway Density	Number of Lanes
82	183	Council Bluffs	9	None	Yes	5.11	2
70	931	Des Moines	6	None	Yes	0.12	2
72	415	Des Moines	6	3 to 4	Yes	6.12	2 to 4
75	92	Des Moines	5	None	Yes	8.08	2
26	20	Dubuque	4	2 to 3	Yes	1.21	4
29	52	Dubuque	4	None	Yes	0.71	2
35	956	Davenport	4	None to 6	Yes	3.41	2
66	69	Ames	4	None to 3	Yes	0.23	2
69	69	Ames	4	None	Yes	8.47	2
73	6	Des Moines	4	3	Yes	3.51	2
87	275	Council Bluffs	4	None	Yes	0.18	2
14	982	Sioux City	3	None to 6	Yes	2.70	2
34	67	Davenport	3	3 to 4	Yes	6.56	2
37	130	Davenport	3	None to 4	Yes	0.63	2
47	13	Cedar Rapids	3	3	Yes	0.29	4
49	94	Cedar Rapids	3	None	Yes	3.82	2
51	151	Cedar Rapids	3	3 to 6	Yes	4.51	2
59	6	Iowa City	3	6	Yes	3.99	2
68	17	Ames	3	None to 6	Yes	0.31	2
71	65	Des Moines	3	3	Yes	2.84	4
76	65	Des Moines	3	3	Yes	6.54	4
77	5	Des Moines	3	3	Yes	2.36	4
107	163	Des Moines	3	3	Yes	0.12	4
109	52	Dubuque	3	None	Yes	3.05	2
74	28	Des Moines	2	None to 4	Yes	2.79	2
81	191	Council Bluffs	2	6	Yes	0.35	2

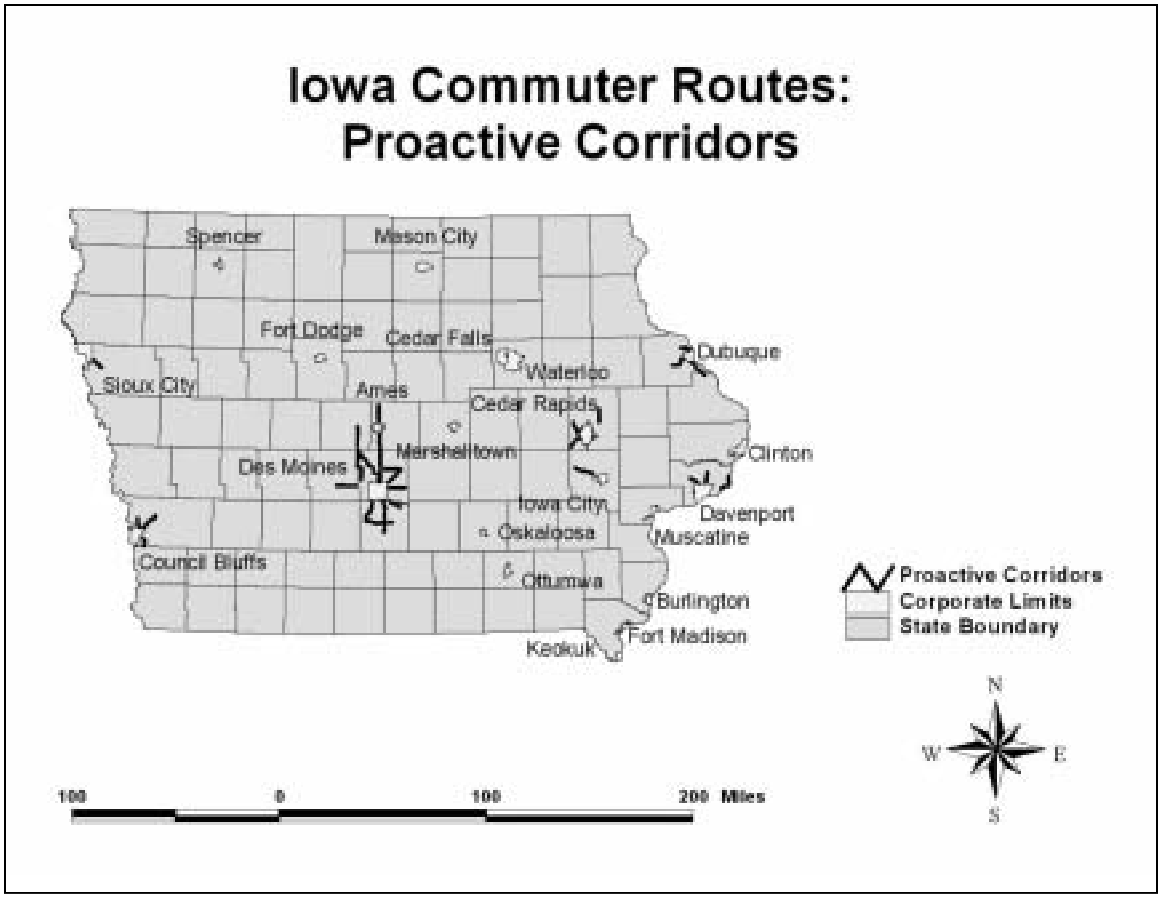

Figure 10. Map of Proactive Corridors

Table 7 below compares each "proactive corridor to its current access-related crash rate ranking to assess the commuter routes that could drastically worsen in terms of access problems in the foreseeable future. Once again, corridors in Central Iowa dominate the list.

Table 7. Access-Related Crash Rates of the Proactive Corridors

Comm_ID	Road_Num	City	Growth Factor	Access Classification	Within 20 miles of Metro	Driveway Density	Number of Lanes
82	183	Council Bluffs	9	None	Yes	5.11	2
70	931	Des Moines	6	None	Yes	0.12	2
72	415	Des Moines	6	3 to 4	Yes	6.12	2 to 4
75	92	Des Moines	5	None	Yes	8.08	2
26	20	Dubuque	4	2 to 3	Yes	1.21	4
29	52	Dubuque	4	None	Yes	0.71	2
35	956	Davenport	4	6 to none	Yes	3.41	2
66	69	Ames	4	3 to none	Yes	0.23	2
69	69	Ames	4	None	Yes	8.47	2
73	6	Des Moines	4	3	Yes	3.51	2
87	275	Council Bluffs	4	None	Yes	0.18	2
14	982	Sioux City	3	6 to none	Yes	2.70	2
34	67	Davenport	3	4 to 3	Yes	6.56	2
37	130	Davenport	3	4 to none	Yes	0.63	2
47	13	Cedar Rapids	3	3	Yes	0.29	4
49	94	Cedar Rapids	3	None	Yes	3.82	2
51	151	Cedar Rapids	3	4 to 6 to 3	Yes	4.51	2
59	6	Iowa City	3	6	Yes	3.99	2
68	17	Ames	3	6 to none	Yes	0.31	2
71	65	Des Moines	3	3	Yes	2.84	4
76	65	Des Moines	3	3	Yes	6.54	4
77	5	Des Moines	3	3	Yes	2.36	4
107	163	Des Moines	3	3	Yes	0.12	4
109	52	Dubuque	3	None	Yes	3.05	2
74	28	Des Moines	2	4 to none	Yes	2.79	2
81	191	Council Bluffs	2	6	Yes	0.35	2

Corridors with Likely Future Access Management Problems

Several key details of the proactive corridor analysis results are as follows:

- There were 26 total corridors that met the qualifications to be proactive corridors; out of these 26 corridors, half were located near either Des Moines or Ames.
- The Davenport, Dubuque, Council Bluffs, and Cedar Rapids areas each contained 3 of the 26 corridors, the next highest concentration of proactive corridors within a region.
- Nine out of the top 10 access-related crash rate ranked corridors were represented within the list of proactive corridors. All 6 of the Ames and Des Moines top 10 access-related crash rate ranked corridors were represented in the proactive corridors list. This indicates that many of today's problem access management corridors will continue to be problems in the future and will in fact worsen.
- Ten out of the 26 proactive corridors currently have a very low ranking for access-related crash rates now. These corridors represent opportunities to get ahead of future problems.
- The Dubuque area contains 3 out of the 10 low-ranked proactive corridors in terms of current access-related crash rates. These corridors are US Highways 20 west, 52 north,

and 52 south. These corridors represent good opportunities to prevent future problems as growth occurs.

- The Davenport area contains another 2 the 10 low-ranked proactive corridors in terms of current access-related crash rates. These corridors are Iowa Highways 130 west and 956 north. Highway 956 is an interesting case, in that it previously was Highway 61 before a new four-lane divided highway was constructed to replace it. The proactive corridor study suggests that although Highway 956 is a two-lane bypassed route, it still carries a significant amount of traffic and could still pose access management problems in the future. Highway 956's driveway density is 3.41; the combination of increased traffic and a high driveway density suggests that its access should be controlled to avoid a large future increase in access-related crash rates.

CONCLUSIONS AND IMPLICATIONS

This research produced rankings for corridors based on a variety of factors, including proportion of crashes that appear to be access-related, severity of those crashes, and potential for improvement along corridors. Most of the highest ranked routes are on two-lane rural cross sections, but a few are four-lane expressways with at-grade private driveways and public road intersections.

The most important conclusion of the ranking system is that many of the poor performing corridors are located in a single Iowa DOT district (District 1) near two urban areas—Des Moines and Ames. A comprehensive approach to managing access along commuting corridors should be developed first in District 1 since the potential benefits would be highest in that region. The second highest concentration of high-ranking corridors is in Iowa DOT District 6—the Cedar Rapids–Iowa City area.

ACKNOWLEDGMENTS

Tom Welch and Larry Heintz of the Iowa DOT provided valuable input on traffic safety matters and Iowa's access management policy related to this project. They were particularly valuable in validating the results of the ranking process. Zach Hans of CTRE provided valuable assistance in combining and using the variety of spatial data used in this project.

Several Iowa State University undergraduate and graduate students in the civil and construction engineering, community and regional planning, and transportation played important roles in this project. Lee Edgar coded the statewide model used to estimate current and forecast future commuting flows. Kyle Kosman and Jamie Luedtke performed the GIS analysis work and created the thematic maps used in presenting the findings.

REFERENCES

1. Maze, T., and D. Plazak. *Access Management Awareness Program: Phase II Report.* Iowa Highway Research Board TR-402. Center for Transportation Research and Education, Iowa State University, Ames, Iowa, Dec. 1997.

3. Anderson, M.D., and R.R. Souleyrette. *FHWA Priority Technology Program: Transportation Planning GIS.* FHWA-PT-96-IA (01). Center for Transportation Research and Education, Iowa State University, Ames, Iowa, Feb. 1997.

APPENDIX A: HIGH-PRIORITY ACCESS CLASSIFICATIONS MAPPING SYSTEM

The access classifications mapping system used for this project was based on the high-priority access classifications shapefile created by the CTRE for the Iowa DOT from Iowa DOT Microsoft Excel spreadsheet files. This ArcView shape file identifies the high-priority corridors in Iowa and their corresponding access classifications. Tables A.1 and A.2 show the six access priority classifications used by the Iowa DOT, for metric and equivalent English measurements.

Table A.1. Access Priority Classifications (Metric)

Rating	Description
1	Access points at interchanges only
2	Access points spaced at minimum 800 m
3	Access points spaced at minimum 300 m rural, 200 m urban
4	Access points spaced at minimum 200 m rural, 100 m urban
5	Iowa DOT has minimum access rights acquired
6	Iowa DOT has no access rights acquired

Source: Iowa DOT.

Table A.2. Access Priority Classifications (English Conversion)

Rating	Description
1	Access points at interchanges only
2	Access points spaced at minimum 2625 ft
3	Access points spaced at minimum 984 ft rural, 656 ft urban
4	Access points spaced at minimum 656 ft rural, 328 ft urban
5	Iowa DOT has minimum access rights acquired
6	Iowa DOT has no access rights acquired

Source: Iowa DOT.

The sources used for this section included ArcView shapefiles from the CTRE geographic information system server. These were put into ArcView GIS as themes to create a map of Iowa and its access classified roads. The shapefiles are listed below:

- Iowa counties shapefile: *st_bord.shp*
- Iowa cities shapefile: *st_corp_old.shp*
- Iowa roads shapefile: *pri_roads00.shp*
- Iowa proposed roads shapefile: *proposed_pri_road00.shp*
- Iowa access classification data table: *access00_locatable.shp*

The resulting map was adequate but not easily read because of the many cities in the Iowa cities shapefile and the large road network depicted in the Iowa roads shapefile. Therefore, labels were placed on each city and along roadways for better legibility when the map is enlarged. The high-priority access classifications map (Figure A.1) is not enlarged for readability; it is kept to the smaller size for the purpose of this report.

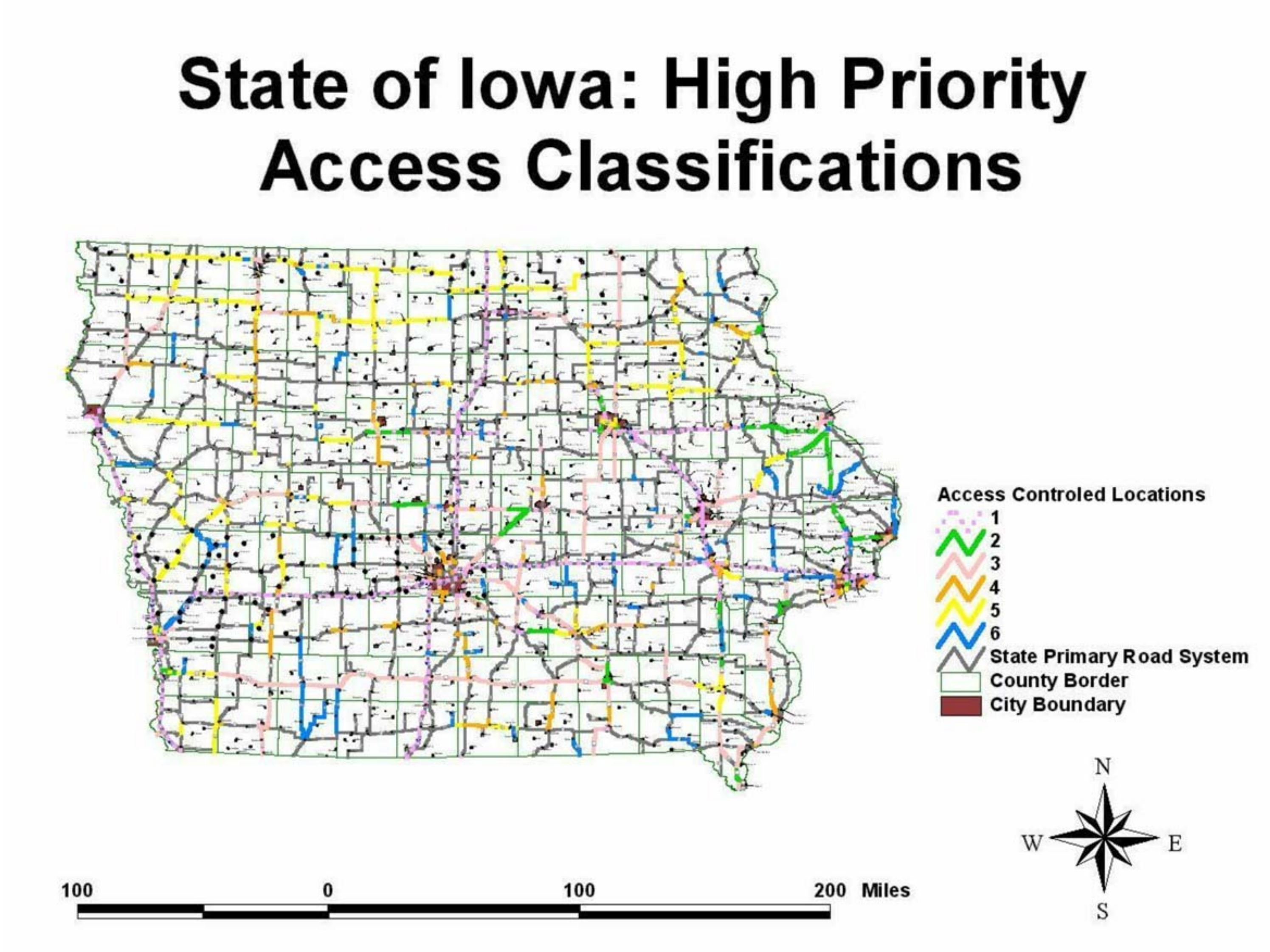

Figure A.1. High-Priority Access Classifications

APPENDIX B: CREATION OF IOWA'S PRIMARY COMMUTER ROUTES

The Iowa commuter routes mapping system created for this project was to be used as a data analysis tool; the ArcView interface would allow for in-depth analysis of the routes, the crashes that occurred on those routes, and implementation of data or maps from the travel demand model and the high-priority access classification map.

The commuter route analysis began with the selection of the commuter routes by identifying major employment centers in Iowa and the routes most commonly used to reach them. After the selection was made, the routes were mapped into ArcView by visually selecting desired road segments from the Iowa roads shapefile. When the selections were complete, they were converted into an ArcView shapefile named *Final_Commuter_Routes.shp*.

Each road segment was assigned a number in the *Final_Commuter_Routes.shp* attribute table. This number, called a commuter route identification number (Comm_ID), is used to assist in future data analysis. Table B.1 lists each commuter route, its commuter route identification number, the major city (core city in the case of all metropolitan areas) that is closest, and the direction it radiates from the city center.

Due to a data processing error, some interstate highway routes were inadvertently included in the study. These include portions of Interstates 29, 35, 80, and 380. By definition, interstates have no direct access points and should have very low numbers and rates for access-related crashes. They remain included in the Table B.1 and can be identified by their road number (Road_Num). Even though not intentionally included, these route segments proved valuable in validating the crash analysis and ranking results in that no interstate route ended up in the rankings at the end of the process.

Table B.1. Iowa Commuter Routes Identification Key

Comm_ID	Road_Num	Direction	City
1	71	N	Spencer
2	18	W	Spencer
3	71	S	Spencer
4	18	E	Spencer
5	65	N	Mason City
6	122	W	Mason City
7	35	N-S	Mason City
8	18	E-W	Mason City
9	65	S	Mason City
10	122	E	Mason City
11	12	N	Sioux City
12	75	NE	Sioux City
13	20	E	Sioux City
14	982	SE	Sioux City
15	29	S	Sioux City
16	169	N	Fort Dodge
17	7	W	Fort Dodge
18	169	S	Fort Dodge
19	20	E-W	Fort Dodge
20	20	W	Waterloo
21	57	W	Waterloo
22	218	N	Waterloo
23	63	N	Waterloo
24	218	SE	Waterloo
25	21	S	Waterloo
26	20	W	Dubuque
27	151	SW	Dubuque
28	61	S	Dubuque
29	52	SE	Dubuque
30	67	N	Clinton
31	136	NW	Clinton
32	30	W	Clinton
33	67	S	Clinton
34	67	N	Davenport
35	956	N	Davenport
36	61	N	Davenport
37	130	NW	Davenport
38	927	W	Davenport
39	61	SW	Davenport
40	22	E	Muscatine
41	61	NE	Muscatine
42	38	N	Muscatine
43	22	W	Muscatine
44	61	S	Muscatine
45	151	S	Cedar Rapids
46	151	E	Cedar Rapids
47	13	N	Cedar Rapids
48	380	N	Cedar Rapids
49	94	NW	Cedar Rapids
50	30	W	Cedar Rapids
51	151	SW	Cedar Rapids
52	965	S	Cedar Rapids
53	380	S	Cedar Rapids
54	382	E-W	Iowa City
55	1	N	Iowa City
56	6	SE	Iowa City
57	218	S	Iowa City
58	1	SW	Iowa City
59	6	NW	Iowa City
60	30	E	Marshalltown
61	14	N	Marshalltown
62	330	SW-NE	Marshalltown
63	30	W	Marshalltown
64	14	S	Marshalltown
65	30	E	Ames
66	69	N	Ames
67	30	W	Ames
68	17	S	Ames
69	69	S	Ames
70	931	E	Des Moines
71	65	NE	Des Moines
72	415	NW	Des Moines
73	6	W	Des Moines
74	28	S	Des Moines
75	92	E-W	Des Moines
76	65	S	Des Moines
77	5	SE	Des Moines
78	92	E	Council Bluffs
79	6	E	Council Bluffs
80	80	NE	Council Bluffs
81	191	NE	Council Bluffs
82	183	N	Council Bluffs
83	988	E-W	Council Bluffs
84	29	N	Council Bluffs
85	370	E-W	Council Bluffs
86	29	S	Council Bluffs
87	275	S	Council Bluffs
88	92	W	Oskaloosa
89	163	NW	Oskaloosa
90	432	NW	Oskaloosa
91	69	N	Oskaloosa
92	92	E	Oskaloosa
93	23	SE	Oskaloosa
94	63	S	Oskaloosa
95	34	W	Ottumwa
96	149	N	Ottumwa
97	34	E	Ottumwa
98	63	S	Ottumwa
99	34	W	Burlington
100	61	N	Burlington
101	99	N	Burlington
102	61	S	Burlington
103	61	N	Fort Madison
104	103	NW	Fort Madison
105	2	W	Fort Madison
106	61	S	Fort Madison
107	163	E	Des Moines
108	58	S	Waterloo
109	52	NW	Dubuque

The base for the commuter routes map was created from shapefiles from the existing CTRE databases, with the exception of the commuter routes shapefile. The quality and components of the base map are important, for other themes will overlay this constant base as the commuter routes are further analyzed. The below shapefiles were used to create the base map:

- Iowa counties shapefile: *st_bord.shp*
- Iowa cities shapefile: *st_corp_old.shp*
- Iowa major commuter destination cities shapefile
- Iowa roads shapefile: *st_road98.shp*

A final shapefile was created for the commuter routes map: *Final_Commuter_Routes.shp*.

When all the components for the base map are added, the resulting map clearly shows Iowa's commuter routes in context with nearby cities and adjoining roads. The commuter routes are shown as a brighter, wider line to both accommodate crash data that was later added and to contrast with noncommuter route roads. Figure B.1 is a map of road segments chosen as commuter routes for the state of Iowa.

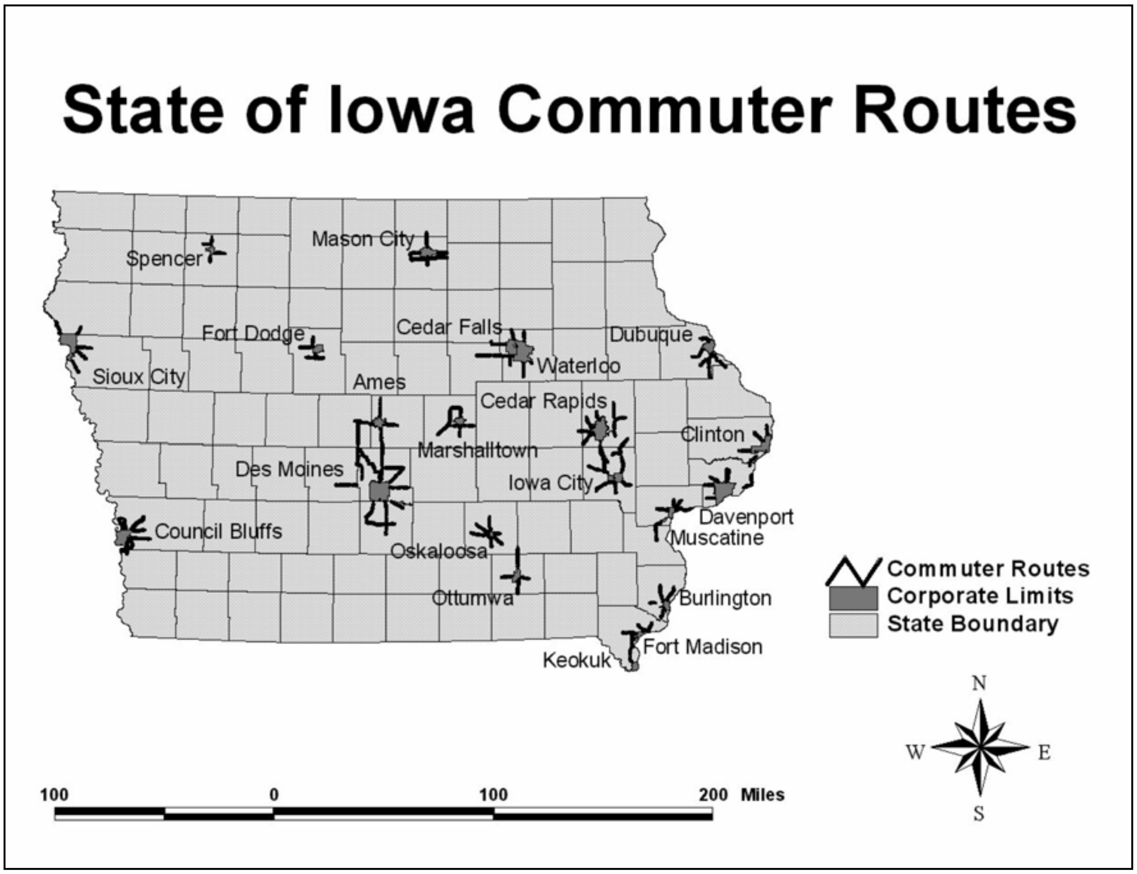

Figure B.1. State of Iowa Commuter Routes

APPENDIX C: INTEGRATING CRASH DATA

Current access management problem locations on the commuter routes were gauged by analyzing access-related automobile crashes on each commuter corridor. Crash data tables for the years 1997, 1998, and 1999 from the CTRE-held ALAS database were added to the commuter route map. Crashes located on the commuter routes were visually selected and converted to a three new shapefiles: commuter route crashes 1997, commuter route crashes 1998, and commuter route crashes 1999. Combined, these shapefiles represented all documented crashes (total crashes) that had occurred on the selected commuter routes for the three years used for analysis.

Access management problems are often indicated by high numbers of crashes involving right- and left-turning vehicles. To measure access management problems on the commuter routes, access-related crashes were queried in ArcView from the total commuter route crashes data tables for 1997, 1998, and 1999. The query was performed under the field “Coll_Type”; five values for this field were used to represent access-related crashes, as illustrated and described in Table C.1.

Table C.1. Access-Related Collision Descriptions

Coll_Type	Description
4	Rear-end/right-turn collision
5	Rear-end/left-turn collision
12	Broadside/right-angle collision
13	Broadside/right-entering collision
14	Broadside/left-entering collision

The queried access-related commuter route crashes were converted to three new shapefiles to represent access-related crashes for 1997, 1998, and 1999. Following this, each of those three data tables was queried to distinguish left-turning crashes from right-turning crashes. Six new shapefiles were then created as a result of the turning crashes query; the created shapefiles included one left-turning crash shapefile (containing Coll_Type fields of 5 and 14) and one right-turning crash shapefile (containing Coll_Type fields of 4, 12, and 13) for each of the three years of study.

Locations of frequent access crashes became apparent on the commuter routes map once the six new access-related turning crash shapefiles were added to the commuter routes map. Figure C.1 shows the turning crashes for the commuter routes, and points to some potential access management problems on those corridors. The map indicates that many commuter routes, but not all, have access management problems. Generally, left-turning crashes predominate.

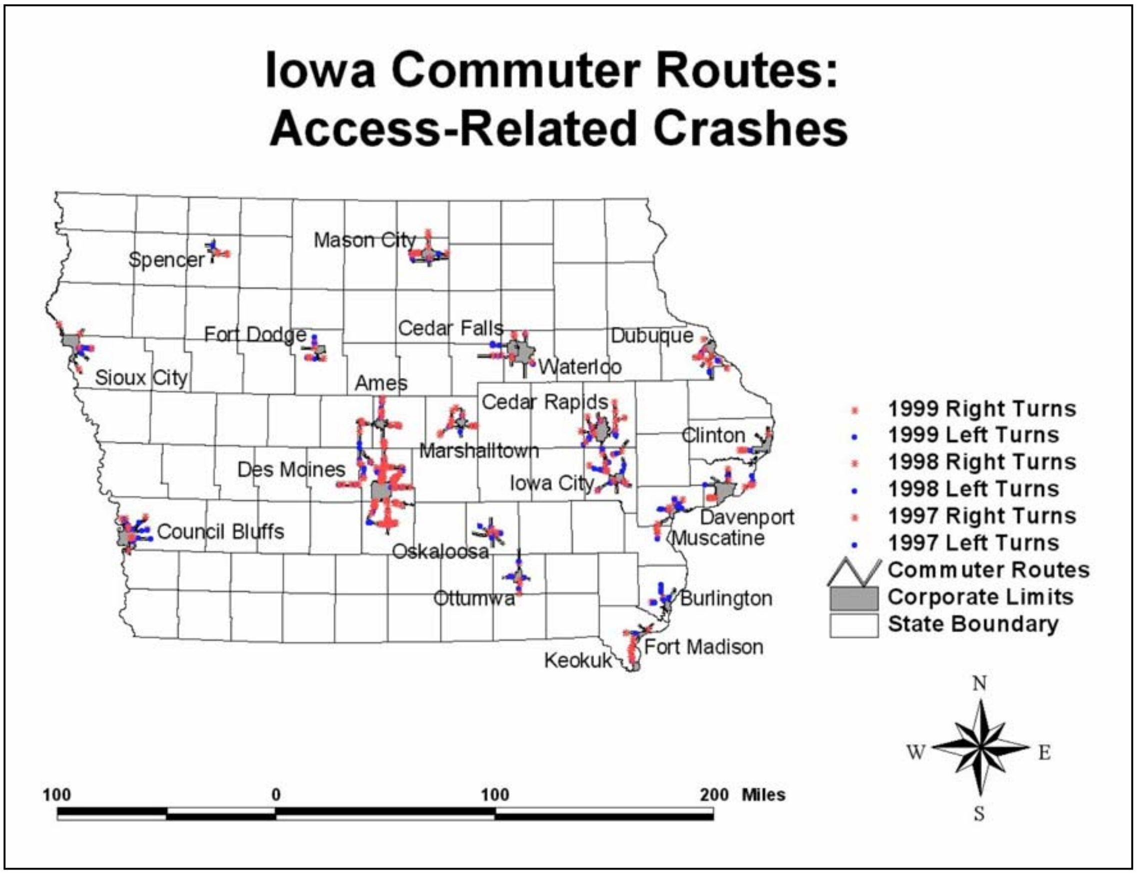

Figure C.1. Access-Related Turning Crashes for 1997, 1998, and 1999

The shapefiles used from the CTRE database for this section are as follows:

- 1997 crash data shapefile: 97crash.shp
- 1998 crash data shapefile: 98crash.shp
- 1999 crash data shapefile: zs1999.shp/za1999.shp

The crash data queried in this section were used for analysis later in the study. The shapefiles created during this section were used for mapping purposes, as well as for calculation of crash rates, frequency, loss values, and the percent of access crashes to total crashes on each commuter corridor. The crash shapefiles created in this section are as follows:

- Commuter route crashes 1997: *1997comrte cra.shp*
- Commuter route crashes 1998: *1998comrte cra.shp*
- Commuter route crashes 1999: *1999comrte cra.shp*
- Access-related commuter route crashes 1997: *1997comrte access cra.shp*
- Access-related commuter route crashes 1998: *1998comrte access cra.shp*
- Access-related commuter route crashes 1999: *1999comrte access cra.shp*
- Right-turn crashes 1997: *1997_rightturns.shp*
- Left-turn crashes 1997: *1997_leftturns.shp*

- Right-turn crashes 1998: *1998_rightturns.shp*
- Left-turn crashes 1998: *1998_leftturns.shp*
- Right-turn crashes 1999: *1999_righturns.shp*
- Left-turns crashes 1999: *1999_leftturns.shp*

APPENDIX D: CALCULATING CRASH FREQUENCY, VEHICLE MILES TRAVELED, AND CRASH RATES

Crash Frequency

The frequency of crashes on each commuter route was determined for both access-related crashes and total commuter route crashes. The analysis was performed in ArcView by spatially joining the desired crash tables (all three years of either total crash tables or access-related crash tables) to the commuter routes attribute table, and then creating a summary table on the commuter route identification number field. This resulted in a field for each commuter route that summed up all crashes that occurred on those routes. To better understand the impact of crash frequency for both access-related and total crashes, each type of crash frequency was ranked in Microsoft Excel to generate a table of ranked corridors by crash frequency. Table D.1 is the resulting table for total crash frequency, and Table D.2 is the resulting ranked table for access-related crash frequency on the commuter routes.

The ranking tables in this study are formatted in the same manner as Table D.1. The first column is the commuter route identification number; this allows for orderly identification of any route desired. The second column contains the field under analysis (in Table D.1, total crash frequency). The third column specifies how each commuter route ranks among all the commuter routes based on its value in the analysis field. The fourth column displays the percentile ranking of each route based on the analysis field.

Table D.1. Rankings of Commuter Routes: Total Crash Frequency

COMM_ID	Frequency	Rank	Percentile
76	529	1	100%
69	480	2	99%
72	293	3	98%
71	274	4	97%
68	191	5	96%
75	183	6	95%
106	161	7	94%
107	152	8	94%
53	129	9	93%
26	109	10	91%
62	109	10	91%
48	104	12	90%
55	102	13	89%
45	98	14	88%
34	97	15	86%
59	97	15	86%
13	92	17	85%
65	87	18	84%
66	85	19	83%
6	81	20	82%
78	74	21	81%
20	73	22	81%
60	72	23	80%
36	70	24	79%
44	67	25	77%
67	67	25	77%
64	66	27	75%
74	66	27	75%
5	65	29	73%
100	65	29	73%
82	61	31	72%
98	60	32	71%
58	58	33	70%
57	56	34	69%
73	56	34	69%
15	53	36	66%
22	53	36	66%
43	53	36	66%
7	52	39	64%
10	52	39	64%
19	51	41	62%
27	51	41	62%
41	49	43	61%
28	47	44	59%
29	47	44	59%
99	46	46	58%
21	45	47	56%
77	45	47	56%
23	43	49	56%
63	42	50	55%
17	41	51	54%
51	40	52	52%
97	40	52	52%
4	39	54	46%
16	39	54	46%
39	39	54	46%
40	39	54	46%
79	39	54	46%
95	39	54	46%
109	37	60	45%
83	36	61	44%
102	36	61	44%
32	35	63	42%
52	35	63	42%
50	34	65	40%
88	34	65	40%
96	32	67	39%
18	31	68	35%
49	31	68	35%
56	31	68	35%
93	31	68	35%
46	30	72	34%
12	29	73	31%
101	29	73	31%
103	29	73	31%
47	28	76	28%
81	28	76	28%
91	28	76	28%
105	28	76	28%
94	26	80	27%
31	25	81	26%
9	24	82	23%
30	24	82	23%
70	24	82	23%
61	23	85	22%
14	21	86	21%
87	20	87	20%
89	19	88	19%
11	18	89	19%
2	15	90	14%
42	15	90	14%
54	15	90	14%
84	15	90	14%
92	15	90	14%
1	14	95	10%
35	14	95	10%
37	14	95	10%
108	14	95	10%
86	12	99	9%
33	11	100	7%
90	11	100	7%
3	10	102	6%
24	10	102	6%
38	7	104	5%
85	6	105	4%
25	4	106	2%
104	4	106	2%
8	1	108	1%
80	0	109	0%

Table D.2. Rankings of Commuter Routes: Access-Related Crash Frequency

COMM_ID	Frequency	Rank	Percentile
76	116	1	100%
71	81	2	99%
69	79	3	98%
72	61	4	97%
107	36	5	96%
75	34	6	95%
68	21	7	94%
59	18	8	94%
34	17	9	93%
43	16	10	91%
66	16	10	91%
73	15	12	89%
106	15	12	89%
45	14	14	88%
6	12	15	85%
26	12	15	85%
67	12	15	85%
7	11	18	80%
13	11	18	80%
51	11	18	80%
62	11	18	80%
65	11	18	80%
78	11	18	80%
22	10	24	76%
44	10	24	76%
74	10	24	76%
100	10	24	76%
20	9	28	74%
82	9	28	74%
4	8	30	69%
19	8	30	69%
32	8	30	69%
39	8	30	69%
57	8	30	69%
58	8	30	69%
49	7	36	66%
77	7	36	66%
98	7	36	66%
48	6	39	64%
95	6	39	64%
5	5	41	58%
16	5	41	58%
53	5	41	58%
60	5	41	58%
70	5	41	58%
99	5	41	58%
9	4	47	49%
21	4	47	49%
23	4	47	49%
28	4	47	49%
29	4	47	49%
41	4	47	49%
42	4	47	49%
79	4	47	49%
81	4	47	49%
92	4	47	49%
50	3	57	45%
54	3	57	45%
55	3	57	45%
56	3	57	45%
10	2	61	30%
17	2	61	30%
24	2	61	30%
27	2	61	30%
35	2	61	30%
36	2	61	30%
46	2	61	30%
47	2	61	30%
52	2	61	30%
61	2	61	30%
83	2	61	30%
85	2	61	30%
87	2	61	30%
91	2	61	30%
94	2	61	30%
96	2	61	30%
101	2	61	30%
2	1	78	15%
11	1	78	15%
12	1	78	15%
14	1	78	15%
15	1	78	15%
30	1	78	15%
38	1	78	15%
40	1	78	15%
64	1	78	15%
88	1	78	15%
89	1	78	15%
97	1	78	15%
103	1	78	15%
105	1	78	15%
108	1	78	15%
109	1	78	15%
1	0	94	0%
3	0	94	0%
8	0	94	0%
18	0	94	0%
25	0	94	0%
31	0	94	0%
33	0	94	0%
37	0	94	0%
63	0	94	0%
80	0	94	0%
84	0	94	0%
86	0	94	0%
90	0	94	0%
93	0	94	0%
102	0	94	0%
104	0	94	0%

Vehicle Miles Traveled

A calculation to determine the vehicle miles traveled for each commuter corridor was performed; VMT was calculated in ArcView within the commuter routes table. Other data tables had to be joined to the commuter routes table in order to have all the fields necessary to the calculation in the same table. The calculation used for VMT is as follows:

VMT = AADT * length of roadway * time period
where AADT = annual average daily traffic
and time period = three years (1997–1999)

The necessary fields for the VMT calculation were obtained from the CTRE database. The AADT for the commuter routes were found in *traffic.dbf*; these were added to the commuter routes attribute table by first linking the two tables together, then selecting all data in the commuter routes attribute table to find data for the same road segments in *traffic.dbf*. Then, the selected corresponding data in *traffic.dbf* was exported to create a traffic table containing data only for the commuter routes. This resulting table was then joined to the commuter routes attributes table. The roadway length was found in *direction_lane.dbf*; the table was joined to the commuter routes attribute table in the same manner as the *traffic.dbf* table.

The VMT calculation was made in the commuter routes attribute table by creating a new field, then populating it with the VMT formula, pointing to the AADT and lane lengths fields for those values, and entering in three years as a static number. The resulting VMT was only for the road segments that made up each commuter route; VMT then had to be summarized on the commuter route identification number field to find the sum of all VMT for each commuter route. VMT summarized for the commuter routes is given in Table D.3.

Table D.3. Summarized Vehicle Miles Traveled

COMM_ID	VMT	Road_Num	City
1	23,873,632	71	Spencer
2	9,864,089	18	Spencer
3	9,350,939	71	Spencer
4	23,407,848	18	Spencer
5	43,870,629	65	Mason City
6	55,415,103	122	Mason City
7	65,226,709	35	Mason City
8	74,287,638	18	Mason City
9	26,520,246	65	Mason City
10	24,278,888	122	Mason City
11	12,124,159	12	Sioux City
12	48,279,101	75	Sioux City
13	85,067,484	20	Sioux City
14	11,297,489	982	Sioux City
15	104,374,202	29	Sioux City
16	29,152,405	169	Fort Dodge
17	22,061,633	7	Fort Dodge
18	15,270,651	169	Fort Dodge
19	22,894,918	20	Fort Dodge
20	101,254,863	20	Waterloo
21	33,912,850	57	Waterloo
22	62,938,409	218	Waterloo
23	41,265,513	63	Waterloo
24	8,569,033	218	Waterloo
25	17,030,482	21	Waterloo
26	13,1137,966	20	Dubuque
27	58,335,350	151	Dubuque
28	52,884,558	61	Dubuque
29	44,388,243	52	Dubuque
30	11,678,286	67	Clinton
31	10,431,694	136	Clinton
32	50,403,036	30	Clinton
33	26,289,560	67	Clinton
34	87,279,733	67	Davenport
35	17,464,418	956	Davenport
36	123,947,512	61	Davenport
37	13,115,548	130	Davenport
38	18,843,767	927	Davenport
39	49,248,505	61	Davenport
40	30,187,663	22	Muscatine
41	38,568,309	61	Muscatine
42	20,706,450	38	Muscatine
43	42,448,398	22	Muscatine
44	64,349,373	61	Muscatine
45	85,095,099	151	Cedar Rapids
46	56,473,092	151	Cedar Rapids
47	53,110,457	13	Cedar Rapids
48	138,533,981	380	Cedar Rapids
49	16,341,417	94	Cedar Rapids
50	80,000,589	30	Cedar Rapids
51	68,211,389	151	Cedar Rapids
52	32,357,273	965	Cedar Rapids
53	457,235,541	380	Cedar Rapids
54	13,501,373	382	Iowa City
55	101,433,706	1	Iowa City
56	24,237,760	6	Iowa City
57	73,391,380	218	Iowa City
58	61,253,537	1	Iowa City
59	42,618,694	6	Iowa City
60	53,221,493	30	Marshalltown
61	23,355,341	14	Marshalltown
62	92,023,689	330	Marshalltown
63	48,606,847	30	Marshalltown
64	19,703,771	14	Marshalltown
65	78,306,991	30	Ames
66	51,544,851	69	Ames
67	119,877,099	30	Ames
68	277,159,373	17	Ames
69	199,573,032	69	Ames
70	19,576,444	931	Des Moines
71	81,249,339	65	Des Moines
72	128,973,865	415	Des Moines
73	101,425,364	6	Des Moines
74	53,762,553	28	Des Moines
75	89,016,294	92	Des Moines
76	229,055,937	65	Des Moines
77	54,969,664	5	Des Moines
78	57,837,040	92	Council Bluffs
79	21,591,025	6	Council Bluffs
80	156,542,844	80	Council Bluffs
81	19,351,430	191	Council Bluffs
82	20,031,667	183	Council Bluffs
83	17,038,586	988	Council Bluffs
84	101,915,486	29	Council Bluffs
85	8,767,645	370	Council Bluffs
86	135,482,554	29	Council Bluffs
87	18,504,011	275	Council Bluffs
88	30,283,497	92	Oskaloosa
89	62,810,474	163	Oskaloosa
90	1,962,316	432	Oskaloosa
91	23,238,086	69	Oskaloosa
92	15,501,805	92	Oskaloosa
93	17,383,408	23	Oskaloosa
94	34,134,336	63	Oskaloosa
95	28,765,589	34	Ottumwa
96	42,223,035	149	Ottumwa
97	30,367,416	34	Ottumwa
98	43,120,443	63	Ottumwa
99	32,645,848	34	Burlington
100	60,051,994	61	Burlington
101	13,710,461	99	Burlington
102	54,176,228	61	Burlington
103	44,023,383	61	Fort Madison
104	7,960,092	103	Fort Madison
105	18,773,404	2	Fort Madison
106	135,757,064	61	Fort Madison
107	85,993,539	163	Des Moines
108	17,725,981	58	Waterloo
109	74,481,354	52	Dubuque

Crash Rates

The crash frequency and summed VMT figures calculated above were also used in calculations to determine total and access-related crash rates for the commuter routes. Crash rates were calculated in ArcView by programming a new field in the commuter route attribute table with the crash rate calculation after all necessary fields had been joined to it. The calculation used to determine crash rates is as follows:

$$\frac{\text{frequency} * 1{,}000{,}000}{\text{VMT}} = \text{total crash rate}$$

Note: To calculate access-related crash rate, replace the total crash frequency figure with that for access-related crash frequency.

Once the commuter routes had crash rates assigned to them, they were again ranked in Microsoft Excel by both total crash rate and by access-related crash rate. The ranking tables made it possible to both view the corridors that had the highest rankings of total and access-related crash rates, and compare the ranked total crash rate corridors to the ranked access-related crash rate corridors. Table D.4 shows the rankings of the corridors based on total crash rates, and Table D.5 shows the rankings of the corridors based on access-related crash rates. Figure D.1 displays the locations of the corridors ranked by access-related crash rate.

Table D.4. Rankings of Commuter Routes: Total Crash Rates

COMM_ID	Crash Rate	Rank	Percentile	COMM_ID	Crash Rate	Rank	Percentile
90	5.6056	1	100%	13	1.0815	56	49%
71	3.3723	2	99%	87	1.0808	57	48%
64	3.3496	3	98%	3	1.0694	58	47%
82	3.0452	4	97%	37	1.0674	59	46%
69	2.4051	5	96%	29	1.0588	60	45%
31	2.3965	6	95%	23	1.0420	61	44%
76	2.3095	7	94%	44	1.0412	62	44%
59	2.2760	8	94%	55	1.0056	63	43%
72	2.2718	9	93%	61	0.9848	64	42%
19	2.2276	10	92%	92	0.9676	65	41%
10	2.1418	11	91%	58	0.9469	66	40%
101	2.1152	12	90%	9	0.9050	67	39%
83	2.1129	13	89%	28	0.8887	68	38%
75	2.0558	14	88%	27	0.8743	69	37%
30	2.0551	15	87%	63	0.8641	70	36%
18	2.0300	16	86%	22	0.8421	71	35%
49	1.8970	17	85%	26	0.8312	72	34%
14	1.8588	18	84%	77	0.8186	73	33%
17	1.8584	19	83%	35	0.8016	74	32%
79	1.8063	20	82%	7	0.7972	75	31%
93	1.7833	21	81%	39	0.7919	76	31%
107	1.7676	22	81%	108	0.7898	77	30%
4	1.6661	23	80%	57	0.7630	78	29%
66	1.6490	24	79%	94	0.7617	79	28%
2	1.5207	25	78%	96	0.7579	80	27%
105	1.4915	26	77%	48	0.7507	81	26%
11	1.4846	27	76%	42	0.7244	82	25%
5	1.4816	28	75%	20	0.7210	83	24%
6	1.4617	29	74%	32	0.6944	84	23%
81	1.4469	30	73%	68	0.6891	85	22%
99	1.4091	31	72%	85	0.6843	86	21%
98	1.3915	32	71%	102	0.6645	87	20%
95	1.3558	33	70%	103	0.6587	88	19%
60	1.3528	34	69%	12	0.6007	89	19%
16	1.3378	35	69%	1	0.5864	90	17%
21	1.3269	36	68%	51	0.5864	90	17%
97	1.3172	37	67%	36	0.5648	92	16%
40	1.2919	38	66%	67	0.5589	93	15%
78	1.2795	39	65%	73	0.5521	94	14%
56	1.2790	40	64%	46	0.5312	95	13%
41	1.2705	41	63%	47	0.5272	96	12%
43	1.2486	42	62%	15	0.5078	97	11%
74	1.2276	43	61%	104	0.5025	98	10%
70	1.2260	44	60%	109	0.4968	99	9%
91	1.2049	45	59%	50	0.4250	100	8%
106	1.1859	46	58%	33	0.4184	101	7%
62	1.1845	47	57%	38	0.3715	102	6%
24	1.1670	48	56%	89	0.3025	103	6%
45	1.1517	49	56%	53	0.2821	104	5%
88	1.1227	50	55%	25	0.2349	105	4%
34	1.1114	51	54%	84	0.1472	106	3%
54	1.1110	52	52%	86	0.0886	107	2%
65	1.1110	52	52%	8	0.0135	108	1%
100	1.0824	54	51%	80	0.0000	109	0%
52	1.0817	55	50%				

Table D.5. Rankings of Commuter Routes: Access-Related Crash Rate

COMM_ID	Crash Rate	Rank	Percentile
71	0.9969	1	100%
76	0.5064	2	99%
72	0.4730	3	98%
82	0.4493	4	97%
49	0.4284	5	96%
59	0.4223	6	95%
107	0.4186	7	94%
69	0.3958	8	94%
75	0.3820	9	93%
43	0.3769	10	92%
19	0.3494	11	91%
4	0.3418	12	90%
66	0.3104	13	89%
92	0.2580	14	88%
70	0.2554	15	87%
24	0.2334	16	86%
85	0.2281	17	85%
54	0.2222	18	84%
6	0.2165	19	83%
95	0.2086	20	82%
81	0.2067	21	81%
34	0.1948	22	81%
42	0.1932	23	80%
78	0.1902	24	79%
74	0.1860	25	78%
79	0.1853	26	77%
16	0.1715	27	76%
7	0.1686	28	75%
100	0.1665	29	74%
45	0.1645	30	73%
39	0.1624	31	72%
98	0.1623	32	71%
51	0.1613	33	70%
22	0.1589	34	69%
32	0.1587	35	69%
44	0.1554	36	68%
99	0.1532	37	67%
9	0.1508	38	66%
73	0.1479	39	65%
101	0.1459	40	64%
65	0.1405	41	63%
58	0.1306	42	62%
13	0.1293	43	61%
77	0.1273	44	60%
56	0.1238	45	59%
62	0.1195	46	58%
21	0.1179	47	57%
83	0.1174	48	56%
35	0.1145	49	56%
5	0.1140	50	55%
106	0.1105	51	54%
57	0.1090	52	53%
87	0.1081	53	52%
41	0.1037	54	51%
2	0.1014	55	50%

COMM_ID	Crash Rate	Rank	Percentile
67	0.1001	56	49%
23	0.0969	57	48%
60	0.0939	58	47%
26	0.0915	59	46%
17	0.0907	60	45%
29	0.0901	61	44%
20	0.0889	62	44%
14	0.0885	63	43%
91	0.0861	64	42%
30	0.0856	65	40%
61	0.0856	65	40%
11	0.0825	67	39%
10	0.0824	68	38%
68	0.0758	69	37%
28	0.0756	70	36%
52	0.0618	71	35%
94	0.0586	72	34%
108	0.0564	73	33%
105	0.0533	74	32%
38	0.0531	75	31%
64	0.0508	76	31%
96	0.0474	77	30%
48	0.0433	78	29%
47	0.0377	79	28%
50	0.0375	80	27%
46	0.0354	81	26%
27	0.0343	82	25%
40	0.0331	83	24%
88	0.0330	84	23%
97	0.0329	85	22%
55	0.0296	86	21%
103	0.0227	87	20%
12	0.0207	88	19%
36	0.0161	89	19%
89	0.0159	90	18%
109	0.0134	91	17%
53	0.0109	92	16%
15	0.0096	93	15%
1	0.0000	94	0%
3	0.0000	94	0%
8	0.0000	94	0%
18	0.0000	94	0%
25	0.0000	94	0%
31	0.0000	94	0%
33	0.0000	94	0%
37	0.0000	94	0%
63	0.0000	94	0%
80	0.0000	94	0%
84	0.0000	94	0%
86	0.0000	94	0%
90	0.0000	94	0%
93	0.0000	94	0%
102	0.0000	94	0%
104	0.0000	94	0%

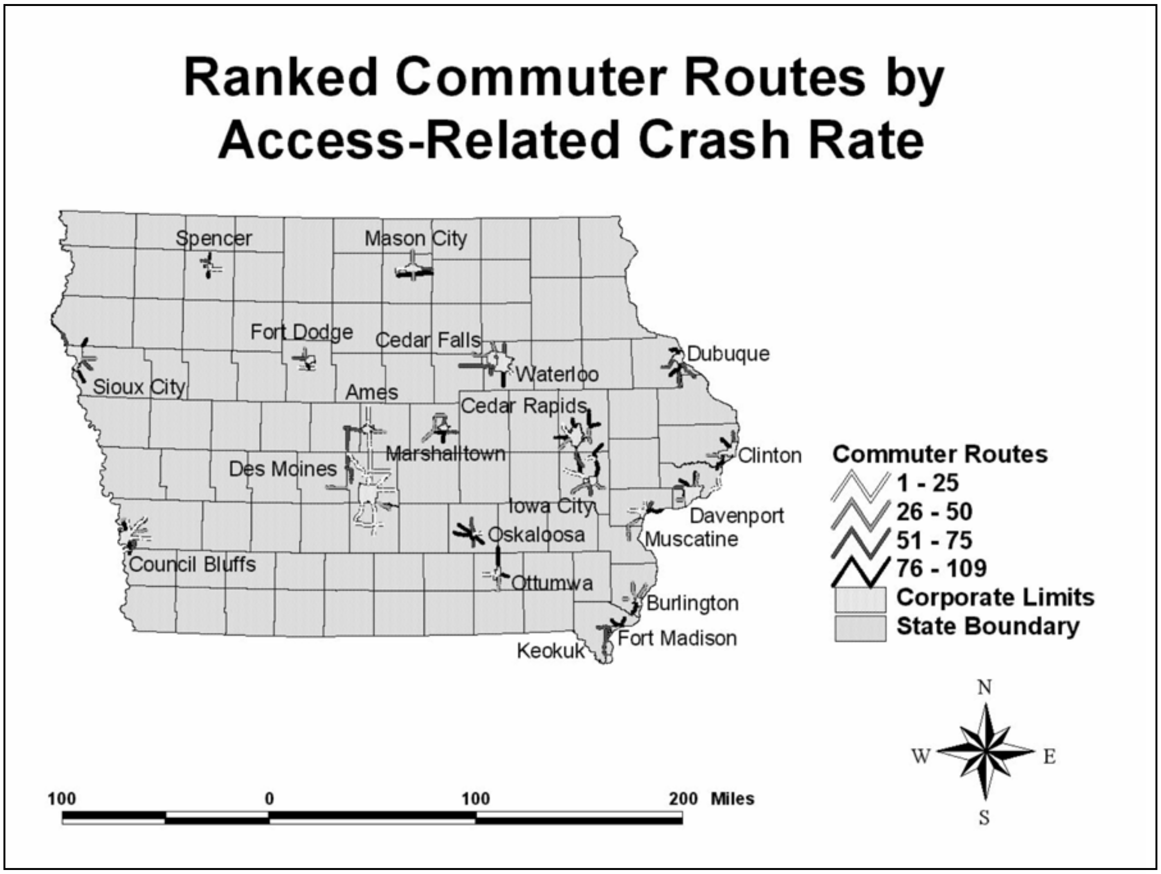

Figure D.1. Corridors Ranked by Access-Related Crash Rate

The data tables from the CTRE database used in this section are as follows:

- *Traffic.dbf*
- *Direction_lane.dbf*

The two data tables from the CTRE database were used to create new tables with the same information, only for the commuter routes. The new data tables were in turn used to create new analysis data for the commuter routes. The data tables created in this section are as follows:

- Lane lengths for commuter routes database: *laneleng_comrte.dbf*
- AADT for commuter routes database: *sumaadt.dbf*
- VMT for commuter routes database: *total_vmt.dbf*
- Ranked crash frequency for commuter routes database: *rankfreq.dbf*
- Ranked access crash frequency for commuter routes database: *rankaccfreq.dbf*
- Ranked commuter routes total crash rates database: *rankrate.dbf*
- Ranked commuter routes access related crash rates database: *rankaccrate.dbf*

APPENDIX E: IDENTIFYING HIGHEST RANKED COMMUTER ROUTE CORRIDORS BY CRASH RATE FOR EACH IOWA DOT DISTRICT

Once the commuter routes were ranked by both total and access-related crash rates, a need was seen to locate the highest ranked four-lane corridors in each Iowa DOT district in Iowa. If each district knew which areas suffered the highest total and access-related crash rates, perhaps the district, coordinated with the state, could focus on reducing the rates in the high-ranking areas.

Table E.1 is a directory that lists each district and the cities whose commuter routes lie in that district. Des Moines is in a noticeable position in this table. The city's home county, Polk County, lies in District 1 and is bordered by District 4 to the west and District 5 to the south. Des Moines's commuter routes stretch into these districts; therefore, Des Moines's commuter routes are located in three different Iowa DOT districts.

Table E.1. Iowa DOT District Commuter Corridor Locations by City

District	Location of Destination Cities' Commuter Routes
1	Ames Des Moines Fort Dodge Marshalltown
2	Mason City Waterloo Cedar Falls
3	Sioux City Spencer
4	Council Bluffs Des Moines
5	Burlington Fort Madison Keokuk Muscatine Oskaloosa Ottumwa Des Moines
6	Cedar Rapids Clinton Davenport Dubuque Iowa City

Table E.2 lists the highest ranked four-lane commuter corridors in total crash rates for each Iowa DOT district. Following the table is Figure E.1, a map indicating the locations of these corridors in relation to their respective district.

Table E.2. Highest Ranked Four-Lane Corridors per Iowa DOT District: Total Crash Rate

District	Comm_ID	Road_Num	City	Ranking
1	71	65	Des Moines	4
	68	141	Des Moines	5
	107	163	Des Moines	7
	62	330	Marshalltown	14
	67	30	Ames	17
	65	30	Ames	22
	19	20	Fort Dodge	38
2	20	20	Waterloo	13
	6	122	Mason City	26
	22	218	Waterloo	27
	7	35	Mason City	31
3	13	20	Sioux City	34
4	73	6	Des Moines	9
5	76	65	Des Moines	3
	77	5	Des Moines	21
6	26	20	Dubuque	11
	45	151	Cedar Rapids	15
	39	61	Davenport	27
	28	61	Dubuque	29
	57	218	Iowa City	30
	53	380	Cedar Rapids	32
	32	30	Clinton	36
	48	380	Cedar Rapids	39

Note: In this table, the interstate routes inadvertently included in the analysis (Road_Num 35 and Road_Num 380) are included to show how their ranking results compare to other routes. They are among the lowest ranked routes in the statewide rankings and for each Iowa DOT district.

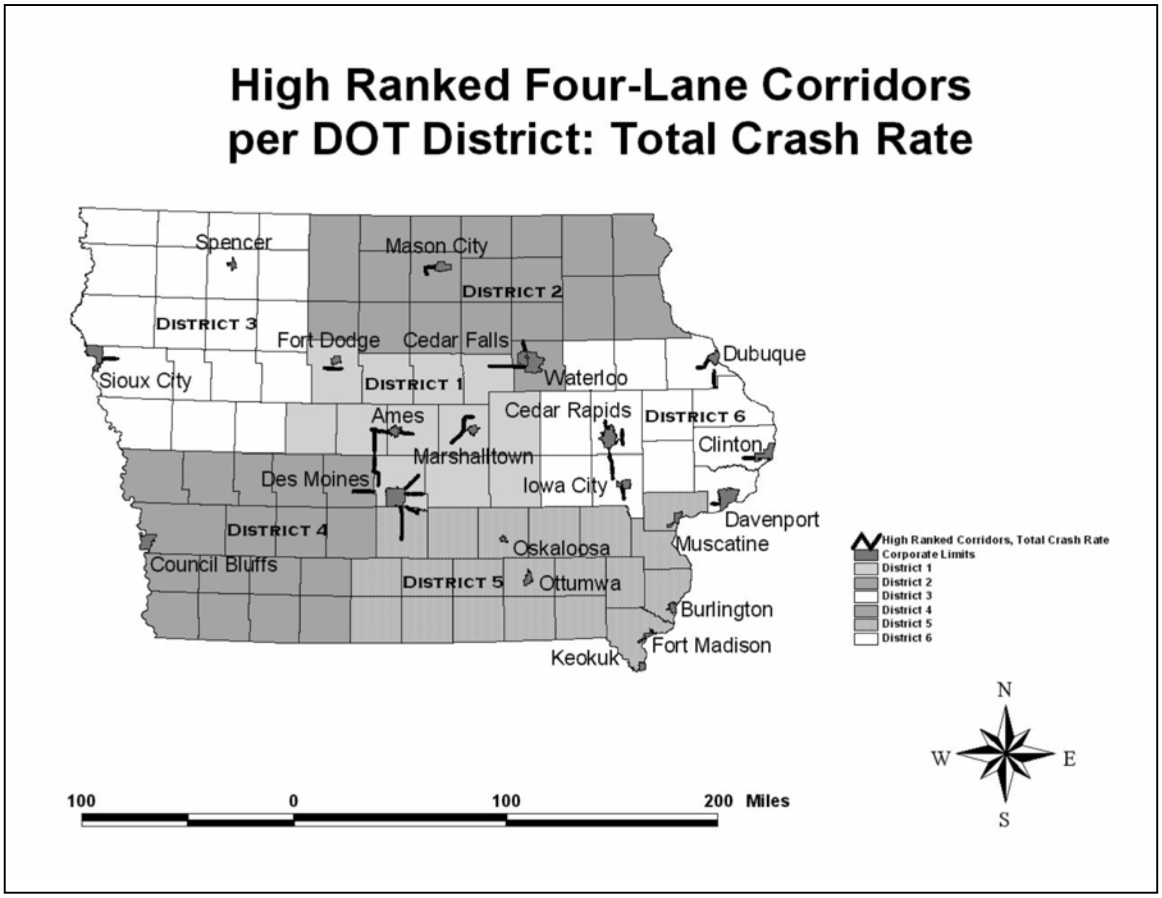

Figure E.1. Highest Ranked Four-Lane Corridors per Iowa DOT District: Total Crash Rate

Table E.3 lists the highest ranked four-lane commuter corridors in access-related crash rates for each Iowa DOT district. Following the table is Figure E.2, a map indicating the locations of these corridors.

Table E.3. Highest Ranked Four-Lane Corridors per Iowa DOT District: Access-Related Crash Rate

District	Comm_ID	Road_Num	City	Ranking
1	71	65	Des Moines	1
	72	415	Des Moines	3
	107	163	Des Moines	7
	19	20	Fort Dodge	11
	65	30	Ames	41
2	24	218	Waterloo	16
	6	122	Mason City	19
	7	35	Mason City	28
	22	218	Waterloo	34
3	13	20	Sioux City	43
4	73	6	Des Moines	39
5	76	65	Des Moines	2
6	45	151	Cedar Rapids	30
	39	61	Davenport	31
	32	30	Clinton	35

Note: In this table, the interstate routes inadvertently included in the analysis (only Road_Num 35 here) are included to show how their ranking results compare to other routes. They are among the lowest ranked routes in the statewide rankings and for each Iowa DOT district.

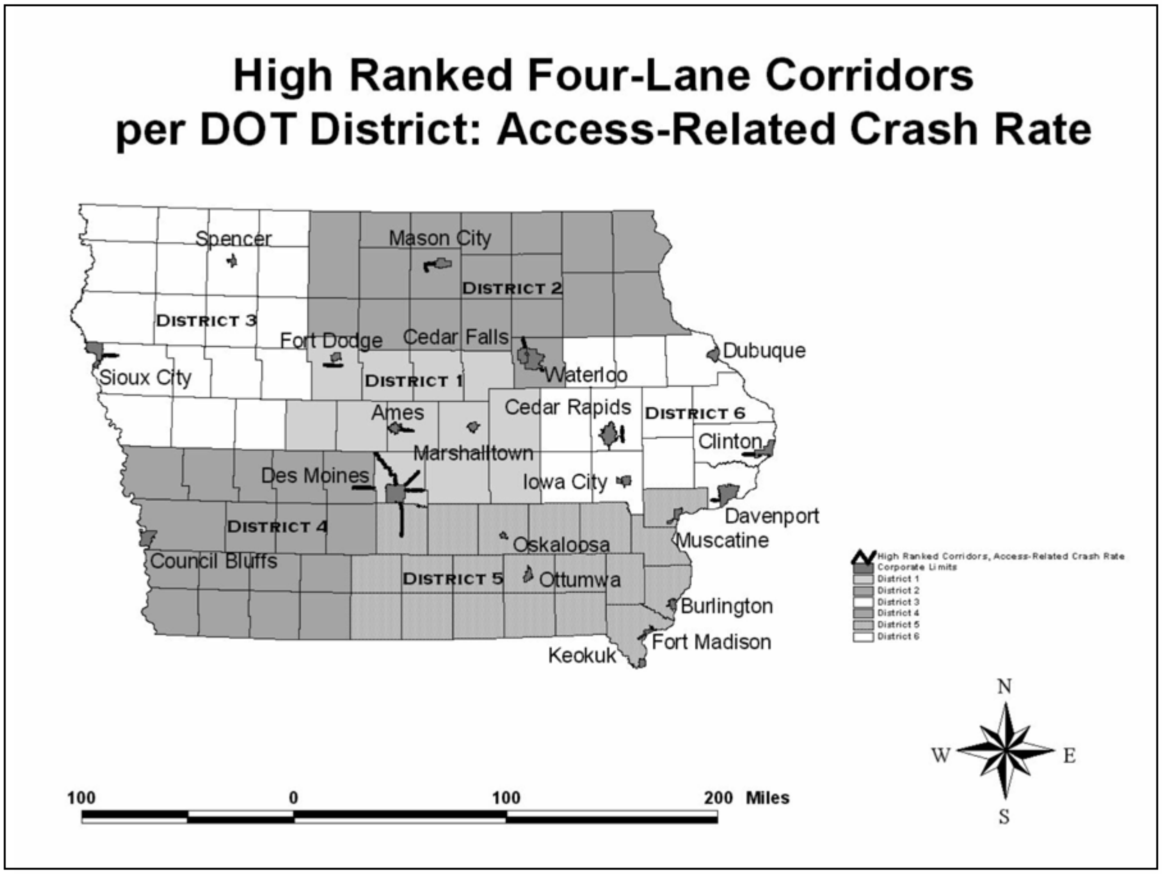

Figure E.2. Highest Ranked Four-Lane Corridors per Iowa DOT District: Access-Related Crash Rate

New ArcView shapefiles were created for both high-ranking corridors in total crash rate and access-related crash rate. These shapefiles are as follows:

- High-ranking corridors in total crash rate: *highrank_district4lanes.shp*
- High-ranking corridors in access-related crash rate: *highrankdist4-lane_acccra.shp*

APPENDIX F: ASSESSING SEVERITY OF CRASHES

Severity was another factor used for analysis of the commuter corridor routes to illustrate how much crashes cost for each commuter route. Each crash in the CTRE database was assigned a severity ranking of 1 to 4, which has a corresponding level of severity and dollar amount to approximate the cost of the crash. Table F.1 describes each level of severity and its assigned dollar amount. The dollar amounts had to be manually entered for each crash into the crash databases for this project to estimate the cost of each route's crashes. Additionally, each entry in the crash databases represented one crash; some crashes may have more than one injury or other severity. Therefore, tables of additional severities had to be linked, exported, and joined to the appropriate crash year data table.

Table F.1. Description of Loss Values Assigned to Severity Rankings

Severity Ranking	Level of Severity	Dollar Amount
1	Fatal	$1,000,000
2	Major injury	$150,000
3	Minor injury	$10,000
4	Possible injury or property damage	$2,500 each

Source: Office of Traffic and Safety, Iowa DOT.

To fully illustrate the cost of negligent access management on commuter routes, severity was calculated and summed for the commuter routes for both total crashes and access-related crashes. The commuter routes were then ranked by loss amounts for both total and access-related crashes. Table F.2 is the ranked table of the routes' loss amounts for total crashes, and Table F.3 is the ranked table of the routes' loss amounts for access-related crashes.

Table F.2. Rankings of Commuter Routes: Loss from Total Crashes

COMM_ID	Loss	Rank	Percentile
69	$43,520,000	1	100%
76	$42,317,500	2	99%
71	$26,437,500	3	98%
72	$26,265,000	4	97%
75	$23,512,500	5	96%
68	$19,067,500	6	95%
106	$14,617,500	7	94%
107	$14,565,000	8	94%
6	$11,840,000	9	93%
53	$11,642,500	10	92%
26	$11,310,000	11	91%
66	$10,447,500	12	90%
20	$8,752,500	13	89%
44	$8,607,500	14	88%
62	$8,350,000	15	87%
13	$8,125,000	16	86%
45	$8,037,500	17	85%
59	$7,690,000	18	84%
48	$7,612,500	19	83%
43	$7,135,000	20	82%
34	$6,855,000	21	81%
60	$6,745,000	22	81%
55	$6,352,500	23	80%
65	$6,190,000	24	79%
36	$6,177,500	25	78%
5	$5,970,000	26	77%
57	$5,905,000	27	76%
73	$5,855,000	28	75%
15	$5,830,000	29	74%
74	$5,697,500	30	73%
16	$5,672,500	31	72%
7	$5,412,500	32	71%
41	$5,342,500	33	70%
10	$5,107,500	34	69%
78	$5,045,000	35	69%
67	$5,027,000	36	68%
98	$4,935,000	37	67%
22	$4,837,500	38	66%
63	$4,575,000	39	65%
100	$4,550,000	40	64%
27	$4,427,500	41	63%
17	$4,415,000	42	62%
97	$4,367,500	43	61%
58	$4,315,000	44	60%
40	$4,270,000	45	59%
21	$3,870,000	46	58%
79	$3,837,500	47	57%
32	$3,795,000	48	56%
82	$3,792,500	49	56%
89	$3,757,500	50	55%
83	$3,690,000	51	54%
51	$3,610,000	52	53%
103	$3,580,000	53	52%
91	$3,572,500	54	51%
87	$3,500,000	55	50%
14	$3,365,000	56	49%
39	$3,145,000	57	48%
19	$3,117,500	58	47%
28	$3,067,500	59	46%
23	$3,005,000	60	45%
109	$2,967,500	61	44%
30	$2,965,000	62	44%
95	$2,837,500	63	43%
9	$2,817,500	64	42%
96	$2,652,500	65	41%
77	$2,622,500	66	40%
12	$2,597,500	67	39%
4	$2,585,000	68	38%
64	$2,572,500	69	37%
52	$2,555,000	70	36%
35	$2,547,500	71	35%
99	$2,507,500	72	34%
29	$2,505,000	73	33%
56	$2,480,000	74	32%
50	$2,357,500	75	31%
47	$2,305,000	76	31%
46	$2,297,500	77	30%
93	$2,282,500	78	29%
81	$2,180,000	79	28%
102	$2,082,500	80	27%
88	$1,920,000	81	26%
49	$1,882,500	82	25%
92	$1,872,500	83	24%
70	$1,850,000	84	23%
94	$1,735,000	85	22%
42	$1,435,000	86	21%
31	$1,417,500	87	20%
11	$1,322,500	88	19%
101	$1,307,500	89	19%
84	$1,142,500	90	17%
105	$1,142,500	90	17%
61	$1,115,000	92	16%
38	$1,060,000	93	15%
37	$975,000	94	14%
18	$897,500	95	13%
2	$885,000	96	12%
54	$880,000	97	11%
86	$870,000	98	10%
1	$850,000	99	9%
24	$830,000	100	8%
108	$722,500	101	7%
90	$540,000	102	6%
3	$520,000	103	6%
33	$402,500	104	5%
25	$190,000	105	3%
104	$190,000	105	3%
85	$60,000	107	2%
8	$10,000	108	1%
80	$0	109	0%

Table F.3. Rankings of Commuter Routes: Loss from Access-Related Crashes

COMM_ID	Loss	Rank	Percentile
76	$10,397,500	1	100%
71	$8,667,500	2	99%
69	$7,277,500	3	98%
72	$6,510,000	4	97%
6	$5,382,500	5	96%
107	$4,622,500	6	95%
43	$3,727,500	7	94%
44	$3,245,000	8	94%
68	$2,787,500	9	93%
66	$2,580,000	10	92%
73	$2,425,000	11	91%
16	$2,320,000	12	90%
75	$2,070,000	13	89%
20	$1,937,500	14	88%
45	$1,875,000	15	87%
32	$1,795,000	16	86%
34	$1,750,000	17	85%
106	$1,735,000	18	84%
65	$1,690,000	19	83%
67	$1,582,500	20	82%
26	$1,565,000	21	81%
74	$1,552,500	22	81%
59	$1,477,500	23	80%
22	$1,245,000	24	79%
4	$1,227,500	25	78%
35	$1,152,500	26	77%
51	$1,142,500	27	76%
7	$1,127,500	28	75%
58	$1,085,000	29	74%
39	$1,077,500	30	73%
10	$1,010,000	31	72%
100	$977,500	32	71%
13	$967,500	33	70%
82	$957,500	34	69%
49	$922,500	35	69%
78	$835,000	36	68%
57	$795,000	37	67%
5	$755,000	38	66%
19	$660,000	39	65%
77	$652,500	40	64%
98	$647,500	41	63%
48	$635,000	42	62%
81	$632,500	43	61%
99	$625,000	44	60%
79	$622,500	45	59%
41	$602,500	46	58%
42	$600,000	47	57%
62	$542,500	48	56%
70	$492,500	49	56%
9	$470,000	50	55%
23	$460,000	51	54%
92	$402,000	52	53%
95	$342,500	53	52%
21	$325,000	54	51%
28	$320,000	55	50%
55	$312,500	56	49%
87	$310,000	57	48%
94	$305,000	58	47%
52	$302,500	59	46%
12	$300,000	60	43%
27	$300,000	60	43%
83	$300,000	60	43%
96	$300,000	60	43%
60	$202,500	64	42%
53	$200,000	65	41%
56	$182,500	66	40%
29	$180,000	67	37%
47	$180,000	67	37%
54	$180,000	67	37%
50	$170,000	70	35%
61	$170,000	70	35%
24	$162,500	72	33%
46	$162,500	72	33%
11	$160,000	74	28%
14	$160,000	74	28%
36	$160,000	74	28%
91	$160,000	74	28%
108	$160,000	74	28%
109	$160,000	74	28%
89	$152,500	80	26%
103	$152,500	80	26%
2	$150,000	82	20%
15	$150,000	82	20%
38	$150,000	82	20%
40	$150,000	82	20%
64	$150,000	82	20%
97	$150,000	82	20%
101	$30,000	88	19%
17	$20,000	89	18%
85	$20,000	89	18%
30	$10,000	91	15%
88	$10,000	91	15%
105	$10,000	91	15%
1	$0	94	0%
3	$0	94	0%
8	$0	94	0%
18	$0	94	0%
25	$0	94	0%
31	$0	94	0%
33	$0	94	0%
37	$0	94	0%
63	$0	94	0%
80	$0	94	0%
84	$0	94	0%
86	$0	94	0%
90	$0	94	0%
93	$0	94	0%
102	$0	94	0%
104	$0	94	0%

In further assessing the severity of crashes on Iowa’s commuter routes, the loss amounts of total crashes and access-related crashes were separately totaled for each city and Iowa DOT district. A comparison of total crash loss to access-related crash loss for each destination city is shown in Table F.4. This table is sorted by losses from access-related crashes. A similar comparison between Iowa DOT districts is shown in Table F.5.

Table F.4. Comparison of Total Crash Loss to Access-Related Crash Loss per City

City	Loss from Total Crashes	Loss from Access-Related Crashes	Percentage of Access Crash Loss to Total Crash Loss	Percentage of City Access Crash Loss to Total Access Crash Loss
Des Moines	$14,006,860,000	$3,671,627,500	26.21%	48.45%
Ames	$9,685,508,500	$1,663,237,500	17.17%	21.95%
Muscatine	$845,520,000	$299,205,000	35.39%	3.95%
Cedar Rapids	$2,173,032,500	$270,357,500	12.44%	3.57%
Mason City	$839,165,000	$268,832,500	32.04%	3.55%
Waterloo	$1,017,075,000	$218,575,000	21.49%	2.88%
Davenport	$987,915,000	$201,500,000	20.40%	2.66%
Fort Madison	$1,775,370,000	$192,292,500	10.83%	2.54%
Council Bluffs	$836,187,500	$129,672,500	15.51%	1.71%
Dubuque	$1,575,732,500	$180,640,000	11.46%	2.38%
Iowa City	$890,860,000	$123,510,000	13.86%	1.63%
Fort Dodge	$314,642,500	$60,960,000	19.37%	0.80%
Sioux City	$677,597,500	$56,480,000	8.34%	0.75%
Clinton	$190,980,000	$52,225,000	27.35%	0.69%
Ottumwa	$471,372,500	$51,250,000	10.87%	0.68%
Marshalltown	$1,004,627,500	$42,665,000	4.25%	0.56%
Burlington	$292,122,500	$39,702,500	13.59%	0.52%
Oskaloosa	$580,907,500	$32,267,500	5.55%	0.43%
Spencer	$74,475,000	$23,445,000	31.48%	0.31%
Total	$38,239,951,000	$7,578,445,000	—	—

Table F.5. Comparison of Total Crash Loss to Access-Related Crash Loss per Iowa DOT District

District	Loss from Total Crashes	Loss from Access-Related Crashes	Percentage of Access Crash Loss to Total Crash Loss	Percentage of District Access Crash Loss to Total Access Crash Loss
1	$19,266,493,500	$4,132,017,500	21.45%	54.52%
5	$9,171,777,500	$1,698,090,000	18.51%	22.41%
6	$5,818,520,000	$828,232,500	14.23%	10.93%
2	$1,856,240,000	$487,407,500	26.26%	6.43%
4	$1,374,847,500	$352,772,500	25.66%	4.65%
3	$752,072,500	$79,925,000	10.63%	1.05%
Total	$38,239,951,000	$7,578,445,000	—	—

In addition to ranking severity, the percentage of access-related crashes to total crashes was calculated and ranked for each commuter route. Table F.6 lists the rankings of percentage of access-related crashes to total crashes for each commuter route. Figure F.1 illustrates the ranked corridors by dividing them into four classes of ranked corridors, grouping the corridors that are top 1–25 ranked, 26–50 ranked, 51–75 ranked, and 76–109 ranked.

Table F.6. Rankings of Commuter Routes: Percentage of Access-Related Crashes to Total Crashes

COMM_ID	Percentage of Access Crashes to Total Crashes	Rank	Percentile
85	33.33%	1	100%
43	30.19%	2	99%
71	29.56%	3	98%
51	27.50%	4	97%
73	26.79%	5	96%
42	26.67%	6	94%
92	26.67%	6	94%
107	23.68%	8	93%
32	22.86%	9	93%
49	22.58%	10	92%
76	21.93%	11	91%
7	21.15%	12	90%
70	20.83%	13	89%
72	20.82%	14	88%
4	20.51%	15	86%
39	20.51%	15	86%
24	20.00%	17	84%
54	20.00%	17	84%
22	18.87%	19	83%
66	18.82%	20	82%
75	18.58%	21	81%
59	18.56%	22	80%
67	17.91%	23	79%
34	17.53%	24	79%
9	16.67%	25	78%
69	16.46%	26	77%
19	15.69%	27	76%
77	15.56%	28	75%
95	15.38%	29	73%
100	15.38%	29	73%
74	15.15%	31	72%
44	14.93%	32	71%
78	14.86%	33	70%
6	14.81%	34	69%
82	14.75%	35	68%
35	14.29%	36	64%
38	14.29%	36	64%
45	14.29%	36	64%
57	14.29%	36	64%
81	14.29%	36	64%
58	13.79%	41	63%
16	12.82%	42	62%
65	12.64%	43	61%
20	12.33%	44	60%
13	11.96%	45	59%
98	11.67%	46	58%
26	11.01%	47	57%
68	10.99%	48	56%
99	10.87%	49	55%
79	10.26%	50	54%
62	10.09%	51	53%
87	10.00%	52	52%
56	9.68%	53	51%
106	9.32%	54	50%
23	9.30%	55	50%
21	8.89%	56	49%
50	8.82%	57	48%
61	8.70%	58	47%
28	8.51%	59	45%
29	8.51%	59	45%
41	8.16%	61	44%
5	7.69%	62	42%
94	7.69%	62	42%
47	7.14%	64	39%
91	7.14%	64	39%
108	7.14%	64	39%
60	6.94%	67	38%
101	6.90%	68	37%
2	6.67%	69	36%
46	6.67%	69	36%
96	6.25%	71	35%
48	5.77%	72	34%
52	5.71%	73	33%
11	5.56%	74	31%
83	5.56%	74	31%
89	5.26%	76	30%
17	4.88%	77	29%
14	4.76%	78	28%
30	4.17%	79	27%
27	3.92%	80	26%
53	3.88%	81	25%
10	3.85%	82	24%
105	3.57%	83	23%
12	3.45%	84	21%
103	3.45%	84	21%
55	2.94%	86	20%
88	2.94%	86	20%
36	2.86%	88	19%
109	2.70%	89	18%
40	2.56%	90	17%
97	2.50%	91	16%
15	1.89%	92	15%
64	1.52%	93	14%
1	0.00%	94	0%
3	0.00%	94	0%
8	0.00%	94	0%
18	0.00%	94	0%
25	0.00%	94	0%
31	0.00%	94	0%
33	0.00%	94	0%
37	0.00%	94	0%
63	0.00%	94	0%
80	0.00%	94	0%
84	0.00%	94	0%
86	0.00%	94	0%
90	0.00%	94	0%
93	0.00%	94	0%
102	0.00%	94	0%
104	0.00%	94	0%

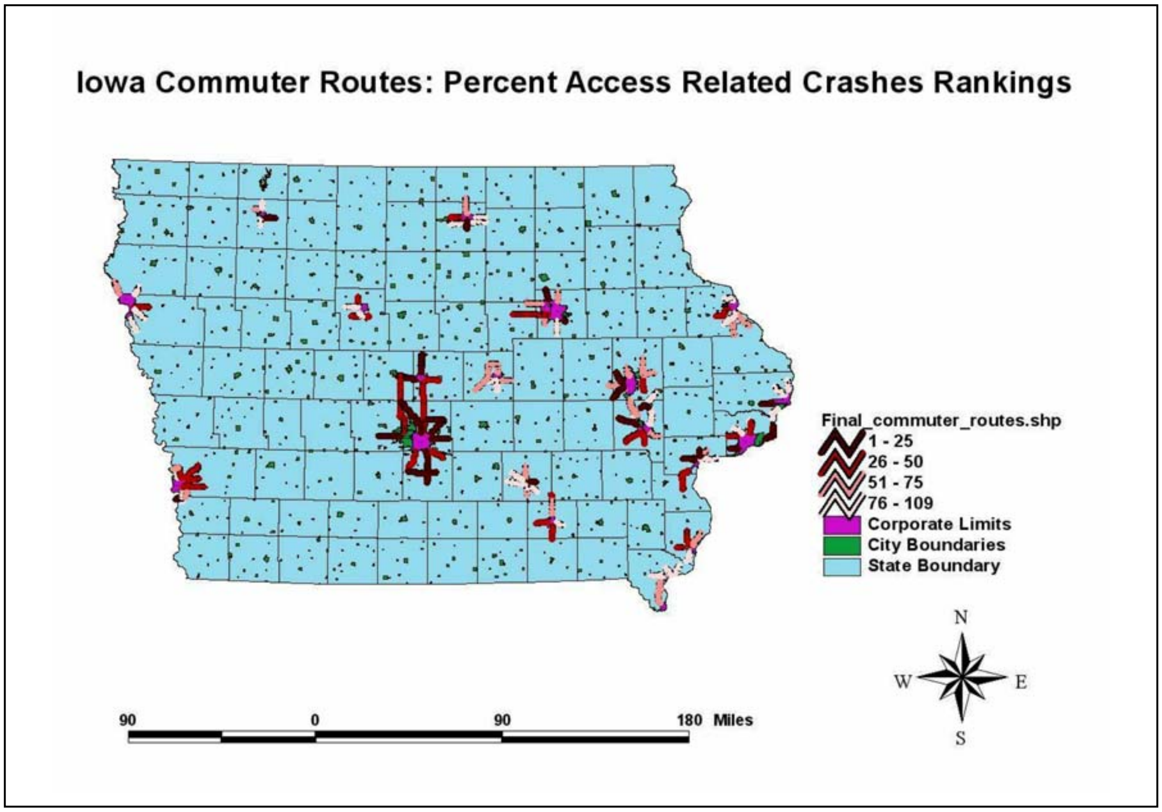

Figure F.1. Ranked Corridors by Percentage Access-Related Crashes

The data tables (ZC records) containing additional severity information were found on the CTRE database.

The data tables that were created during this section include the following:

- Commuter route C records:
    - o *Crec97comrte.dbf*
    - o *Crecacc97.dbf*
- Ranked severity of total commuter route crashes: *rankloss.dbf*
- Ranked severity of access-related commuter route crashes: *rankaccloss.dbf*
- Ranked percentage of access-related crashes: *RankPercAcc.dbf*
- Commuter route data analysis table (loss, frequency, VMT, crash rates, percentage of crashes that are access related) database: *totalcomrtedata.dbf*

APPENDIX G: CALCULATING THE POTENTIAL IMPROVEMENT OF CORRIDORS

Until this point, the commuter corridors that may currently have access management problems have been only identified. To help gauge the worth of improving each corridor through access management treatments, a calculation was developed to describe how the occurrence of access-related crashes would change if the roadway were improved. This calculation for potential improvement was performed as follows:

- Assume the access-related crash rate will stay the same if no changes to the roadway are made.
- Assume that a variable (50% was used for this study) of access-related crashes could be avoided by improving access control.
- Use the percentage AADT growth rate forecast in the travel demand model to create a "VMT factor," using a variable (20 years was used for this study) as a time period. Example: If annual growth rate is 2%,
    - 20-year VMT factor = $(1.02)^{20}$ = 1.48
    - Average VMT factor = 1 + (1.48 – 1)/2 = 1.24
- Compute the number of expected access-related crashes during the time period (20 years) if there were no road treatment. Example:
    - Number of expected access-related crashes = time period * VMT factor * access crash rate * VMT
    - 20 * 1.24 * 5 * 36 = 4,464 crashes
- Multiply the expected number of access-related crashes with no treatment by 50% to calculate the expected number of access-related crashes with road treatment.
- The corridors were then ranked by potential improvement, or the reduced cost of access-related crashes with road treatment; this can be found in Table G.1. A map of the top 25 ranking potential improvement corridors, broken down by turning crashes, can be found in Figure G.1.

Table G.1. Rankings of Commuter Routes: Potential Improvement

COMM_ID	Potential Improvement	Rank	Percentile
72	$145,573	1	100%
69	$123,682	2	99%
76	$92,916	3	98%
71	$85,059	4	97%
68	$25,515	5	96%
75	$23,956	6	95%
107	$19,440	7	94%
106	$17,596	8	94%
73	$15,180	9	93%
34	$12,087	10	92%
26	$11,088	11	91%
66	$7,120	12	90%
20	$6,966	13	89%
62	$6,776	14	88%
45	$6,760	15	87%
59	$5,740	16	86%
67	$5,184	17	85%
51	$5,148	18	84%
43	$5,005	19	83%
74	$4,725	20	82%
77	$4,662	21	81%
65	$4,356	22	81%
78	$3,690	23	80%
44	$3,478	24	79%
82	$3,276	25	78%
6	$3,256	26	77%
22	$3,080	27	75%
39	$3,080	27	75%
28	$2,992	29	74%
57	$2,808	30	73%
7	$2,754	31	72%
53	$2,745	32	71%
29	$2,728	33	70%
13	$2,680	34	69%
98	$2,394	35	69%
32	$2,088	36	68%
100	$2,013	37	67%
19	$1,911	38	66%
48	$1,890	39	65%
95	$1,870	40	64%
55	$1,680	41	63%
50	$1,650	42	62%
58	$1,298	43	61%
5	$1,265	44	60%
49	$1,240	45	59%
60	$1,170	46	58%
54	$1,022	47	57%
36	$990	48	56%
70	$984	49	56%
81	$957	50	55%
52	$896	51	54%
4	$864	52	52%
47	$864	52	52%
89	$693	54	51%
21	$648	55	50%
23	$630	56	48%
27	$630	56	48%
96	$615	58	47%
46	$585	59	46%
103	$583	60	45%
9	$570	61	44%
16	$555	62	44%
79	$525	63	43%
41	$495	64	42%
83	$486	65	41%
87	$483	66	40%
92	$465	67	38%
94	$465	67	38%
91	$435	69	37%
99	$418	70	36%
88	$360	71	35%
56	$336	72	34%
42	$333	73	33%
35	$330	74	31%
105	$330	74	31%
109	$324	76	31%
17	$315	77	29%
61	$315	77	29%
15	$272	79	28%
101	$247	80	27%
12	$242	81	26%
14	$207	82	25%
97	$198	83	23%
108	$198	83	23%
30	$153	85	22%
64	$115	86	21%
40	$112	87	20%
85	$110	88	19%
10	$90	89	19%
38	$77	90	18%
11	$75	91	17%
2	$72	92	16%
24	$52	93	15%
1	$0	94	0%
3	$0	94	0%
8	$0	94	0%
18	$0	94	0%
25	$0	94	0%
31	$0	94	0%
33	$0	94	0%
37	$0	94	0%
63	$0	94	0%
80	$0	94	0%
84	$0	94	0%
86	$0	94	0%
90	$0	94	0%
93	$0	94	0%
102	$0	94	0%
104	$0	94	0%

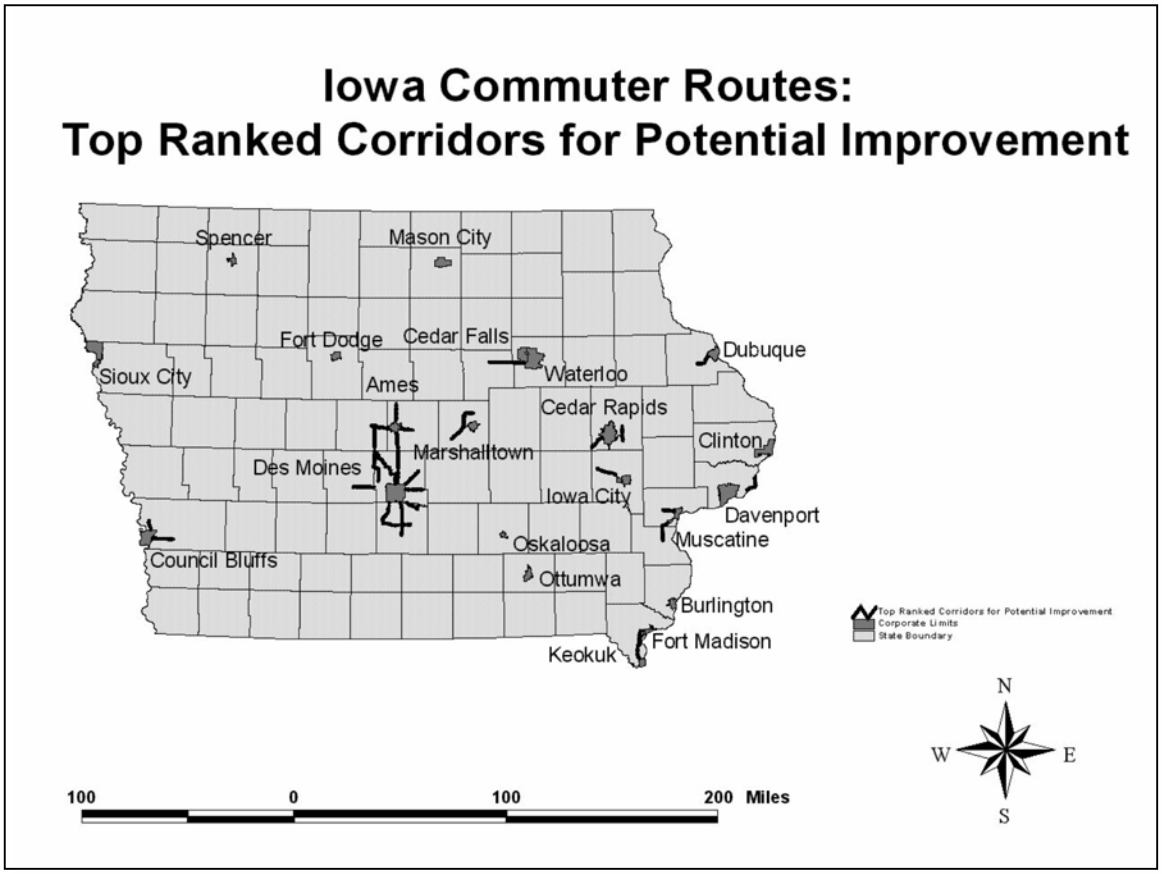

Figure G.1. Potential Improvement Corridors

A main source of data used in this section was the travel demand model (forecast AADT growth) designed for this project.

Data tables created during this section include the following:

- Ranked forecast AADT growth of commuter routes database: *Growth_Rankings.dbf*
- Potential improvement corridors database: *sumpotimp.dbf*
- Top 25 ranked potential improvement corridor shapefiles (broken into turning crashes by year):
    - *1997_rightturns_top25rankedpotimp.shp*
    - *1997_leftturns_top25rankedpotimp.shp*
    - *1998_rightturns_top25rankedpotimp.shp*
    - *1998_leftturns_top25rankedpotimp.shp*
    - *1999_rightturns_top25rankedpotimp.shp*
    - *1999_leftturns_top25rankedpotimp.shp*
- Ranked potential improvement corridors database: *potimprankings.dbf*

APPENDIX H: IDENTIFYING FUTURE ACCESS MANAGEMENT PROBLEMS PROACTIVELY

Identifying and commuter corridors that could have future access management problems can lead to the prevention of access-related crashes. Identification criteria were developed to determine which corridors could have access management problems in the future, as described below:

- First, from the travel demand model (see Appendix B), corridors with high forecast growth in AADT were selected.
- The corridor list was narrowed by location, and included if they were located within 20 miles of a metropolitan area in Iowa.
- Using the Access Classifications mapping system, these corridor list was then narrowed to those that had access classifications of 3, 4, 5 or 6; in effect, this excluded controlled access and mostly controlled access corridors.
- Finally, the corridor list was further narrowed by driveway density. Driveway density was calculated in the following manner:
    - Driveway counts for the remaining corridors were found in the CTRE database, as private and business entrances. The data table was linked, exported, and joined to the commuter routes attribute table.
    - The lane-length data table for the commuter routes was joined to the commuter routes attribute table.
    - Driveway density was calculated in the commuter routes attribute table as
        - $\frac{\text{private + business entrances}}{\text{lane length for each corridor}}$

The commuter corridors that met all the above requirements were considered to be “proactive corridors,” corridors that point to possibly having future access management problems if they do not currently. Table H.1 lists all the proactive corridors, along with their qualifying attributes. Figure H.1 is a map showing the locations of the proactive corridors, created by querying the proactive corridors by commuter route identification number in ArcView.

Table H.1. Proactive Corridors

Comm_ID	Road_Num	City	Growth Factor	Access Classification	Within 20 Miles of Metro	Driveway Density	Number of Lanes
82	183	Council Bluffs	9	None	Yes	5.11	2
70	931	Des Moines	6	None	Yes	0.12	2
72	415	Des Moines	6	3 to 4	Yes	6.12	2 to 4
75	92	Des Moines	5	None	Yes	8.08	2
26	20	Dubuque	4	2 to 3	Yes	1.21	4
29	52	Dubuque	4	None	Yes	0.71	2
35	956	Davenport	4	None to 6	Yes	3.41	2
66	69	Ames	4	None to 3	Yes	0.23	2
69	69	Ames	4	None	Yes	8.47	2
73	6	Des Moines	4	3	Yes	3.51	2
87	275	Council Bluffs	4	None	Yes	0.18	2
14	982	Sioux City	3	None to 3	Yes	2.70	2
34	67	Davenport	3	3 to 4	Yes	6.56	2
37	130	Davenport	3	None to 4	Yes	0.63	2
47	13	Cedar Rapids	3	3	Yes	0.29	4
49	94	Cedar Rapids	3	None	Yes	3.82	2
51	151	Cedar Rapids	3	3 to 6	Yes	4.51	2
59	6	Iowa City	3	6	Yes	3.99	2
68	17	Ames	3	None to 6	Yes	0.31	2
71	65	Des Moines	3	3	Yes	2.84	4
76	65	Des Moines	3	3	Yes	6.54	4
77	5	Des Moines	3	3	Yes	2.36	4
107	163	Des Moines	3	3	Yes	0.12	4
109	52	Dubuque	3	None	Yes	3.05	2
74	28	Des Moines	2	None to 4	Yes	2.79	2
81	191	Council Bluffs	2	6	Yes	0.35	2

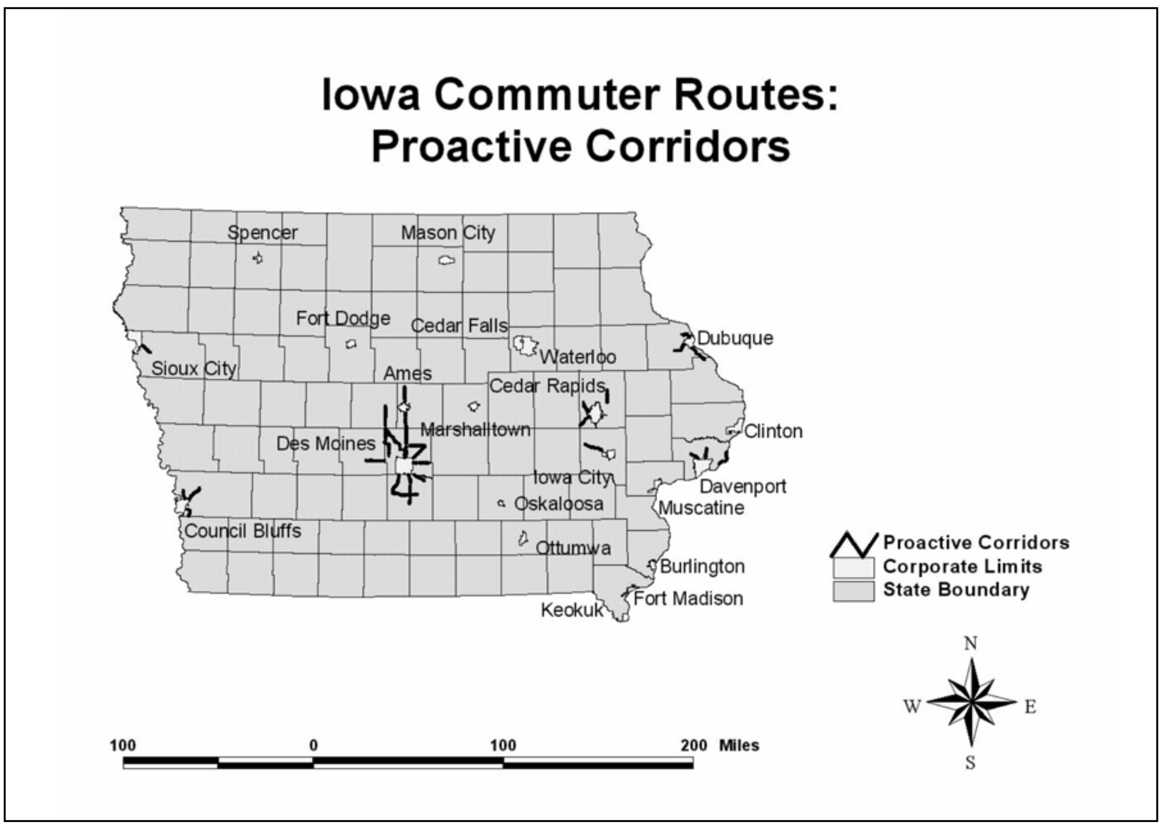

Figure H.1. Locations of Proactive Corridors

Comparing the current access-related crash rates of the proactive corridors can help data analysts determine how drastically the routes could worsen in the future. If a corridor already has a high access-related crash rate and it is not improved, it will most likely still have a high rate in the future. However, if a route that currently has a low access-related crash ranking is listed as a proactive corridor, it could be a warning signal of increasingly large future problems related to access along that corridor. Table H.2 shows the current access-related crash rates of the proactive corridors.

Table H.2. Access-Related Crash Rates of the Proactive Corridors

Comm_ID	Road_Num	City	Current Access-Related Crash Rate Rank
82	183	Council Bluffs	4
70	931	Des Moines	15
72	415	Des Moines	3
75	92	Des Moines	9
26	20	Dubuque	59
29	52	Dubuque	61
35	956	Davenport	49
66	69	Ames	13
69	69	Ames	8
73	6	Des Moines	39
87	275	Council Bluffs	53
14	982	Sioux City	63
34	67	Davenport	22
37	130	Davenport	94
47	13	Cedar Rapids	47
49	94	Cedar Rapids	5
51	151	Cedar Rapids	33
59	6	Iowa City	6
68	17	Ames	69
71	65	Des Moines	1
76	65	Des Moines	2
77	5	Des Moines	44
107	163	Des Moines	7
109	52	Dubuque	91
74	28	Des Moines	25
81	191	Council Bluffs	21

The sources used in this section were either found in the CTRE database or were derived earlier. They include

- Travel demand model, AADT growth: *Corridor_Growth.dbf*
- Driveway density data: *Road_inv.dbf*
- Access priority classification maps

The theme created in this section was a shapefile of the proactive corridors, along with a database containing the proactive corridors with their qualifying attributes:

- *Proactive_Corridors.shp*
- *Proactive_Corridors.xls*

APPENDIX I: BUILDING A TRAVEL DEMAND MODEL TO SUPPORT STATEWIDE ACCESS MANAGEMENT CORRIDOR PLANNING

Building a fully calibrated and validated statewide passenger demand model is well beyond the scope of this project. However, it was thought that a model could be built that would indicate the potential for traffic growth along corridors of interest. The basic simplifying assumption was that traffic growth on Iowa roads will be proportional to growth in population and employment in and around major Iowa cities. The model was built using three of the four steps of the conventional travel demand modeling process: trip generation by zone, trip distribution by gravity model, and traffic assignment to shortest travel path assuming free-flow speeds. Model data were assembled and processed in GIS. Previously written CTRE software allowed the GIS data to be used in Tranplan, which executed the three modeling steps.

To provide for sufficient detail, Census block groups were used to define the zonal structure. Boundaries of Census block groups were stored in an ArcView GIS layer named *TAZ.shp*. Centroids, or the geographic centers of each zone, were stored in *Centroids.shp.* See Figure I.1 below for an illustration of the 2,939 traffic analysis zones (TAZs) in the state of Iowa, each representing the geography where about 1,000 persons live.

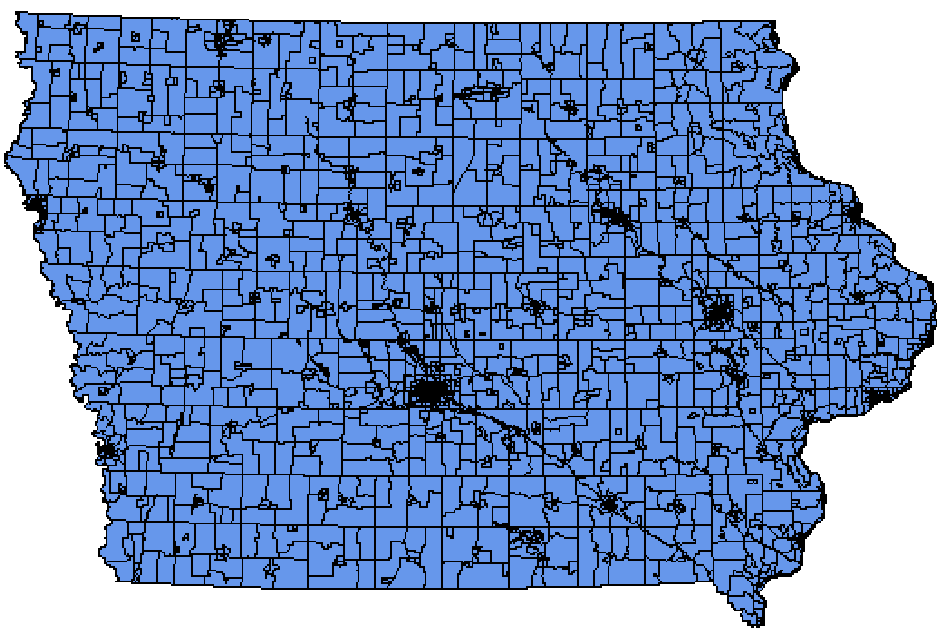

Figure I.1. Iowa's Traffic Analysis Zones (Block Groups)

The model network, *Network.shp*, was derived from a combination of Iowa DOT primary roads ([1] interstates, [2] U.S. highways, [3] state highways), and selected municipal and secondary roads where needed (where the state highway system is sparse and where population and employment are dense, chiefly within proximity of urban areas). "Centroid connectors," or generalized representations of local roads, were then manually added to connect each TAZ centroid to proximate segment endpoints of *Network.shp*. See depiction of the network in Figure I.2.

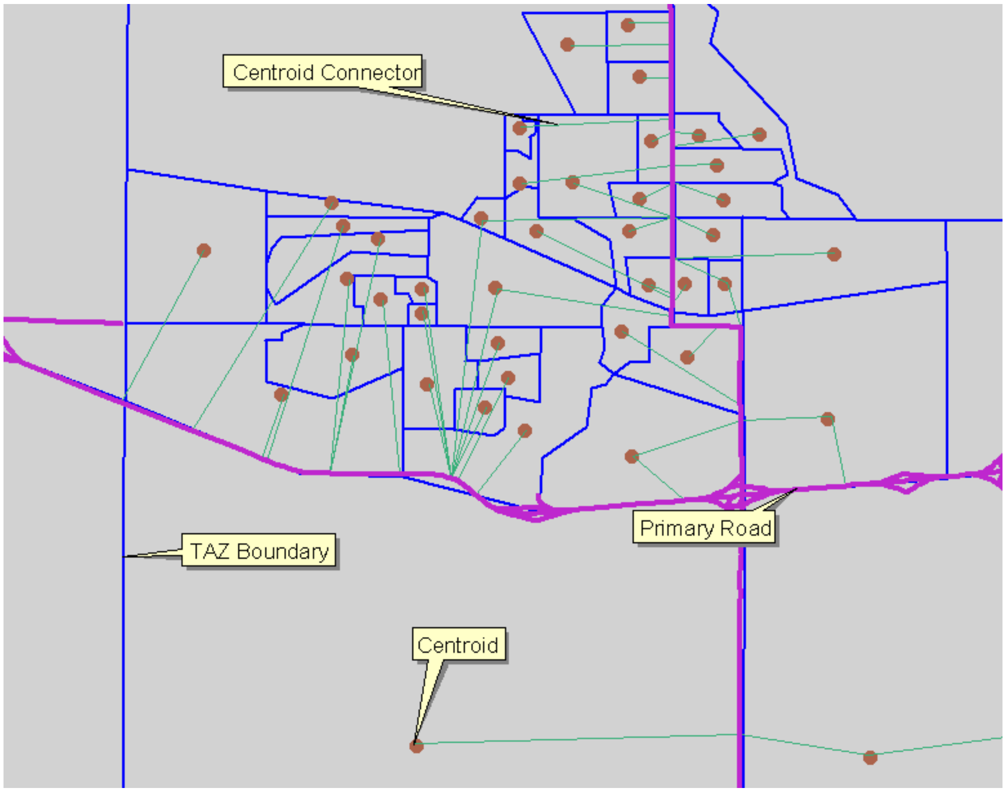

Figure I.2. Section of Statewide Commuting Model for Ames

The resulting network had many segment breaks (places where road attributes change) that are not required by Tranplan and in fact are not desired as they increase processing time, maintenance, and storage requirements. Therefore, network segments were combined between intersections (resulting in only one segment being required between each intersection). To accomplish this combining of segments, ArcInfo's unsplit command was used (see Figure I.3). This required converting the ArcView data into ArcInfo format, and subsequent reconversion of the "unsplit" network. ArcInfo AMLs/scripts (see code in Figures I.4 and I.5) were written specifically to facilitate this unsplitting process.

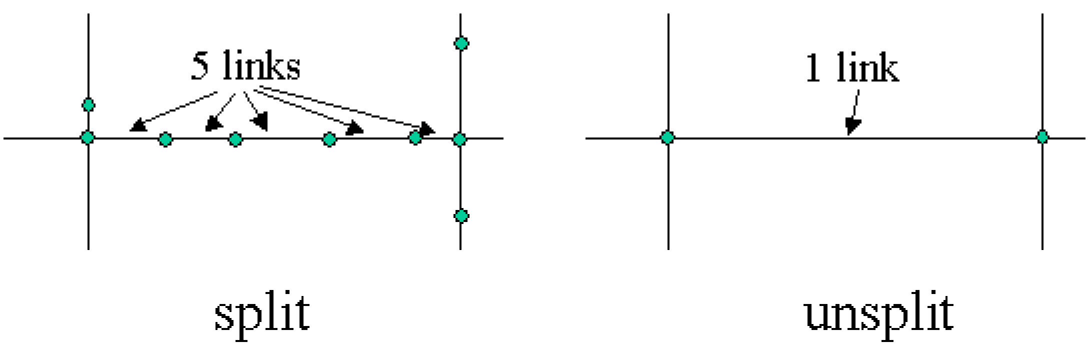

Figure I.3. Network Segments Unsplit Using ArcInfo

```
/*******************************/
/* Pipat Reungsang July 2, 2001 */
/* GIS Facility, 218 Durham ISU */
/*******************************/
&echo &on
&args shape
&if [ exist cov_split -cover] &then kill cov_split all
shapearc %shape% cov_split
regionclass cov_split cov_split line
build cov_split line
&if [ exist cov_unsplit -cover] &then kill cov_unsplit all
copy cov_split cov_unsplit
ae
disp 9999
ec cov_unsplit
de arc node errors
nodecolor dangle 2
nodecolor pseudo 3
draw
ef arc
sel all
unsplit none
q
y
y
build cov_unsplit line
&echo &off
&ty **********************************************
&ty * This program will create coverages named  *
&ty * cov_split and cov_unsplit. please make sure *
&ty * that you have these coverages before you  *
&ty * run ArcView program         Pipat *
&ty **********************************************
&return
```

Figure I.4. ArcInfo Script REG.AML

```
'******************************************************************
'*
*
'* If "View1", "Table1", and/or "Table2" exist in the project, *
'* this section deletes the listed documents. *
'*
*
'******************************************************************
   alist = { "View1","Table1","Table2"}
'** Creates list of document names to delete
   for each i in 1..alist.count
'** FOR LOOP...for each item in list...counts from 1 to "number of items in list"
   aDoc = av.GetProject.FindDoc(alist.get(i-1))
'** Finds the document in the project
   if (aDoc <> nil) then
'** IF document exists,
   av.GetProject.RemoveDoc(aDoc)
'** THEN delete
   end
   end
'******************************************************************
'*
*
'* Creates the view, adds the themes, and adds the tables to the project. *
'* Also sets some parameters (i.e., theme visibility). *
'*
*
'******************************************************************
   aView = View.Make
'** Makes a new view
   aSrcName = SrcName.Make("C:\temp\test\cov_split line")
   aTheme1 = Theme.Make (aSrcName)
'** Makes a new theme from "above"
   aView.AddTheme (aTheme1)
'** Adds theme to view
   aTheme1.setVisible(true)
'** Sets theme as visible
   aTheme1.setActive(true)
'** Sets theme as active
   aSrcName = SrcName.Make("C:\temp\test\cov_unsplit line")
   aTheme2 = Theme.Make (aSrcName)
   aView.AddTheme (aTheme2)
   'aTheme2.setVisible(true)
   aVtab1 = aTheme1.getFtab
'** Get the database (FTab) for first theme
   aVtab2 = aTheme2.getFtab
'** Get the database (FTab) for second theme
   aTable1 = Table.Make (aVTab1)
'** Makes the table (what you see) for first theme
   aTable1.getwin.open
'** Opens window for first table
   aTable2 = Table.Make (aVTab2)
```

```
'** Makes the table (what you see) for first theme
   aTable2.getwin.open
'** Opens window for second table
   aView.GetWin.Open
'** Opens window for the new view
'*******************************************************************
'*
*
'*   *
'*   *
'*
*
'*******************************************************************
   aField2 = aVTab2.FindField("Cov_unsplit#")
'** Finds "Cov_unsplit#" in second table
   aVTab1.SetEditable(true)
'** Sets first table as editable
   sum_Field_1 = Field.Make ("total_product", #FIELD_DOUBLE , 25, 5)
'** Makes a new field called "product"...#FIELD_DOUBLE allows double percision (decimal places),
25 is the total number of characters, 5 is the number of decimal places.
   sum_Field_2 = Field.Make ("auto_product", #FIELD_DOUBLE , 25, 5)
   tt_Field = Field.Make ("travel_time", #FIELD_DOUBLE, 25, 5)
   aVTab1.AddFields ({sum_Field_1,sum_Field_2,tt_Field})
'** Adds new field to first table
   aVTab1.Calculate("[Length] * [Aadt]", sum_Field_1)
'** Populates new field
   aVTab1.Calculate("[Length] * [Automobile]",sum_Field_2)
   aVTab1.Calculate("[Length] / [Limitmph] / 1609.344",tt_Field)
   aVTab1.Refresh
   aVTab1.SetEditable(false)
'** Stops editing first table
   aadt_Field = aVTab2.FindField("Aadt")
'** Find "Aadt" field in second table
   auto_Field = aVTab2.FindField("Automobile")
   speed_Field = aVTab2.FindField ("Limitmph")
   length_field = aVTab2.FindField("Length")
'** Find "Length" field in second table
   aVTab2.SetEditable(true)
'** Makes second tabel editable
   for each rec in aVtab2
'** Goes through each record in the second table
   s = aVTab2.ReturnValueString(aField2,rec)
'** Returns the value in the "Cov_unsplit#" field
   l = aVTab2.ReturnValueString(length_field,rec)
'** Returns the length
   theQuery = "[Cov_unsplit#] = " + s
'** String used to query table
   theBitmap = aVTab2.GetSelection
'** Creates bitmap to assigned queried records to
   aVTab2.Query(theQuery, theBitmap, #VTAB_SELTYPE_NEW)
'** Performs query...#VTAB_SELTYPE_NEW means first unselects all records before querying table
   aVTab2.UpdateSelection
   aTheme1.SelectByTheme (aTheme2, #FTAB_RELTYPE_ISCOMPLETELYWITHIN , 0, #VTAB_SELTYPE_NEW )
'** Selects lines in first theme that are the same as selected records in second theme
   aTotal = 0
'** Initalize variable for total [Length]*[Aadt] of selected records
   bTotal = 0
   cTotal = 0
   for each aRec in aVTab1.GetSelection
'** Goes through each selected record in first table
   n = aVTab1.ReturnValueString(sum_Field_1,aRec)
'** Returns the record's [Length]*[Aadt] value
   o = aVTab1.ReturnValueString(sum_Field_2,aRec)
   p = aVTab1.ReturnValueString(tt_Field,aRec)
   aTotal = aTotal + n.asNumber
'** Keeps running total of [Length]*[Aadt]
   bTotal = bTotal + o.asNumber
   cTotal = cTotal + p.asNumber
   end
   result = aTotal / l.Asnumber
'** Divides the (sum of [Length]*[Aadt]) by segment length
   result_1 = bTotal / l.Asnumber
   result_2 = l.Asnumber / cTotal / 1609.344
   aVTab2.Calculate(result.asstring, aadt_Field)
'** Populates weighted value
   aVTab2.Calculate(result_1.asstring, auto_Field)
   aVTab2.Calculate(result_2.asstring, speed_Field)
   aVTab2.Refresh
   end
   aVTab2.SetEditable(false)
'** Stops editing second table
   aTable2.getwin.maximize
'** Maximizes window for second table
   aTable2.getwin.open
```

Figure I.5. ArcInfo Script MAIN.AVE

The next stage in model development was the creation of nodes, or intersections, required by Tranplan. This was accomplished using ArcView and Excel.

The next step was to associate free-flow speed and length to each network link. This was done by displaying Iowa DOT GIS layers of various road types behind the network and manually choosing network elements in various speed classes. For example, interstates were highlighted in the background, allowing model links corresponding to interstate roads to be selected. Selected network links were then assigned a free-flow speed of 65 mph, etc. ArcView was used to calculate the length of the network links.

Once network and TAZ features were completed in ArcView, CTRE's ArcView-Tranplan Interface software was used to build the model in Tranplan format. Trip generation tables (work trip productions and attractions) were developed from CensusCD+Maps block group data on population and jobs, assuming one trip daily from home zone to work zone and one trip daily from work zone to home zone. Each job in the database was therefore considered to generate two work trip "attractions" and each TAZ was assumed to have two work trip "productions" for each person living in the TAZ. Trip tables were prepared using 1999 and 2004 CensusCD+Maps estimates.

Trip Distribution was accomplished in Tranplan using a gravity model. Friction factors for trips under 45 minutes were borrowed from the DMAMPO model (work trip purpose). For trips over 45 minutes in length, friction factors were estimated. These estimates were modified in subsequent model runs to reproduce national average trip length frequencies. Trip attractions were held constant.

Traffic assignment was performed using the all-or-nothing or free assignment method in Tranplan. For each link in the model network, 1999 and 2004 estimates of work trip flows were computed (see Figure I.6). The ratio of 2004 to 1999 trips was then calculated as a growth factor. Flows and growth rates on links making up various access management corridors throughout the state were then calculated as an important input to the prioritization process.

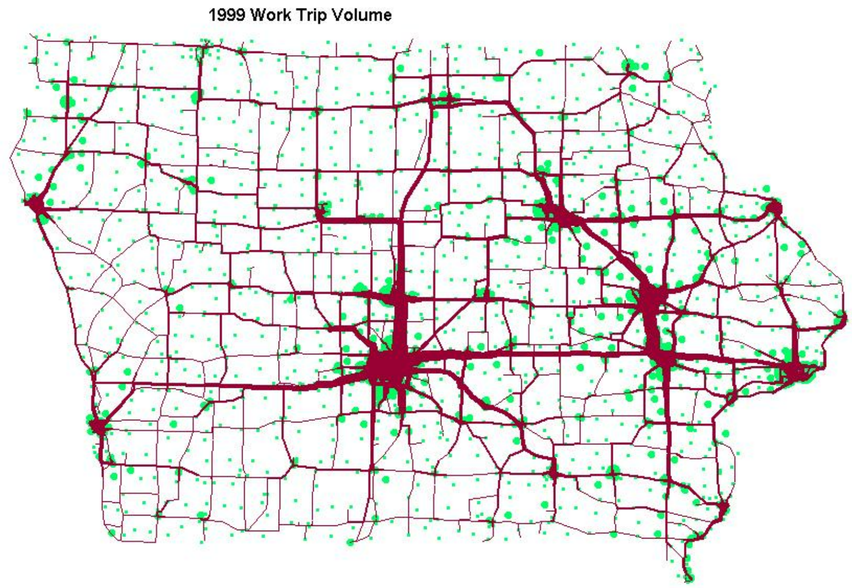

Figure I.6. Estimated Work Trip Flow (1999)