Road Safety Audit for Marshall County Road E-35 (Main Street) from the ECL of Marshalltown, Iowa, to Zeller Avenue

Final Report
February 2009

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ACKNOWLEDGMENTS

The author would like to thank the Marshall County engineer and staff for requesting and participating in this road safety audit and the Iowa Department of Transportation for sponsorship of the effort. Input from the Marshall County Sheriff's Office was also valuable.

Participation and contribution by the members of the road safety audit team were invaluable in the successful completion of this activity. The audit team included

- Royce Fichtner — Marshall County Engineer
- Steve Thomassen — Marshall County Assistant to the Engineer
- Bob Lentz — AECOM Consultants
- Tim Simodynes — Iowa Department of Transportation
- Bryan Bradley — Iowa Department of Transportation
- Bob Sperry — Center for Transportation Research and Education
- Tom McDonald — Center for Transportation Research and Education

INTRODUCTION

On January 26, 2009, a road safety audit was conducted on a section of County Road E-35 (Main Street) in Marshall County, Iowa, at the request of the county engineer. The following people participated in the audit:

- Royce Fichtner — Marshall County Engineer
- Steve Thomassen — Marshall County Assistant to the Engineer
- Bob Lentz — AECOM Consultants
- Tim Simodynes — Iowa Department of Transportation
- Bryan Bradley — Iowa Department of Transportation
- Bob Sperry — Center for Transportation Research and Education
- Tom McDonald — Center for Transportation Research and Education

This section of roadway is composed of asphaltic concrete. The segment from the limits of Marshall County maintenance to the Wallace Avenue intersection was last resurfaced in 1996, and the segment from Wallace Avenue to Three Bridges Road was last resurfaced in 1987. According to Iowa Department of Transportation's (Iowa DOT's) 2005 estimates, traffic volumes vary from 3,960 vehicles per day from the east corporate limits (ECL) of Marshalltown to Wallace Avenue, with 2,710 vehicles proceeding northerly from that intersection on Wallace Avenue and 1,710 continuing easterly on County Road E-35. This roadway is listed among the Iowa DOT's top 5% of road segments for serious crashes, and a portion of this segment just east of the city limits is also on the Iowa DOT's list of high-crash horizontal curves, released December 2008.

INITIAL MEETING

An initial meeting was conducted in the county engineer's office in Marshalltown, Iowa, beginning at 1:00 p.m. on January 26. Following introductions, Tom McDonald began the meeting by briefly discussing the purpose of the audit and distributing crash data. Several sets of data were made available to all audit team members, including a large-scale map showing crash locations, crash data from 2003–2007 inclusive, crash data from 2008, and, due to the large number of animal crashes, a map showing the approximate location of these crashes. Details regarding the crash data will be discussed later in this report and are provided in Appendix A.

Law enforcement representatives were unable to participate in this meeting. The Marshall County Sheriff's Office was invited to provide information from the perspective of those professionals and the response is included in this report.

FIELD REVIEWS

Daylight Review

Following the initial meeting on January 26, a daylight review of the route was conducted by the audit team beginning about 2:30 p.m. The review began at the ECL of Marshalltown and proceeded easterly.

County Road E-35 (Main Street) at this location is composed of 26 ft wide asphaltic concrete pavement of unknown initial age, although the last major rehabilitation occurred in 1996. The current pavement condition is satisfactory, with signs of routine maintenance. Granular surfaced shoulders are approximately 10 ft wide, and right-of-way width is 100 ft. Foreslopes through this area are quite steep, and the elevation of the roadway is approximately 5–8 ft above the surrounding terrain. This area is in the Iowa River floodplain and has little variation in elevation. During the audit, pavement markings appeared quite worn. However, Marshall County engineer Fichtner indicated that annual replacement was routine, although edge lines were not replaced in 2008. The edge line markings are painted in about 2 ft from the pavement edge, resulting in two 11 ft wide travel lanes.

Two warning signs advising "Watch for Ice on Road" are in place adjacent to a power generating plant just westerly from the beginning of this segment. However, ice conditions on the road from plant operations have occurred very infrequently.

Just easterly from the limits of Marshall County maintenance responsibilities is a horizontal leftward curve with a 36 in. advance curve warning sign in excellent condition. No chevrons are located in this curve. A granular surfaced side road intersection exists on the right side of the road near the beginning of curvature with a long exit taper and apron. In addition, a line of power poles continues from E-35 down the side road to serve a local residence. The side road configuration does not appear to cause confusion for E-35 traffic traversing the horizontal leftward curve. This location serves as a pick-up point for students from Marshalltown, and six to eight vehicles park on the side road waiting for the school bus. This practice does not appear to pose a safety concern.

The existing Iowa River bridge is approximately 580 ft in length and 30 ft in width. W-beam guardrail is in place at all four corners and appears in satisfactory condition, with no evidence of impact damage. A current-design concrete handrail is in place on the bridge.

A high number of animal (deer) crashes have been recorded through this area, but mitigation using deer-proof fence might be impractical due to the location of access points just easterly from the river bridge. However, new designs of deer barriers across access points should be studied for application here. Information about these options is included in Appendix B.

Several hundred feet easterly from the Iowa River is a T-intersection with Vance Avenue, a granular surfaced roadway that approaches E-35 from the left (north). The side road approach

includes a double arrow warning sign. Street name signs are in good condition, with 6 in. lettering.

Just easterly from the Vance Avenue intersection is a horizontal rightward curve with a 36 in. advance warning sign in excellent condition. No chevrons are in place through the curve. Steep foreslopes and a 5–8 ft high roadway grade continue through the area. Near Vance Avenue, some utility poles and trees were noted in the right-of-way along the outside of the horizontal curve. These should be reviewed for clear zone compliance.

Just easterly from Vance Avenue is a minor horizontal alignment change to the right with no advance curve warning signs.

Beyond the horizontal curve is the Vine Avenue intersection, which also approaches E-35 from the left or northerly side only. The granular surfaced side road approach is marked with a double arrow, and street name signs are in good condition, with 6 in. lettering. Just westerly from Vine Avenue, the granular shoulders appear to narrow somewhat.

Side slopes on intersecting roads and access points appear quite steep throughout the floodplain area.

A bridge crossing a minor stream is located just easterly from Vine Avenue, approximately 28 ft in width and shielded with satisfactory-condition w-beam guardrail at all four corners. Three-beam guardrail continues through the bridge as a handrail. No signs of impacts were noted on the guardrail.

A long horizontal rise exits easterly from the bridge, rising from the Iowa River floodplain. The granular shoulder width remains about 10 ft, but the right-of-way narrows at this point.

For drivers approaching the Wallace Avenue intersection, warning is provided by double 48 in. "Stop Ahead" warning signs in excellent condition. Rumble panels have been milled into the asphalt surface, but these have been distorted to the point of ineffectiveness. The existing route sign assembly and destination signs are in excellent condition. At the Wallace Avenue T-configuration intersection, double 36 in. "Stop" signs are in place for eastbound E-35 traffic, with an aging double arrow warning sign in place for that eastbound movement. The right-side "Stop" sign includes a black and yellow plaque advising that "Traffic from the Right Does Not Stop." Southbound Wallace Avenue, County Road T-29, is controlled with a single "Stop" sign with a black and yellow plaque advising that "Oncoming Traffic Does Not Stop." Both plaques were installed in 2006, and all signing in this intersection, including street name signs, appears to be in excellent condition, with the exception of the double arrow warning sign. Painted stop bars are well worn at all stop locations. Northbound (westbound) E-35 traffic approaching this intersection is not controlled.

Southerly (easterly) from Wallace Avenue, E-35 features a horizontal leftward curve with 36 in. advance curve warning signs and small 40 mph advisory speed plaques. The curve is marked with small, widely spaced chevrons. The pavement width in this area is 22 ft, 6 in., with painted

edge lines that result in 11 ft travel lanes. Granular shoulders are approximately 3–4 ft in width. Through the curve area, foreslopes are quite steep and high. Some 2–3 ft wide shoulder paving has been accomplished along the low side of the curve (westerly-bound traffic). A granular surfaced minor roadway intersects with E-35 from the right side in a T-configuration near the middle of the curve. Sight distance to this intersection appears adequate for the low traffic volume.

Easterly from the horizontal curve is the granular surfaced T-intersection with Three Bridges Road from the right. A double arrow warning sign is in place for side road traffic, and street name signs are in excellent condition.

Edge line markings are installed on the pavement edge for the remainder of the reviewed section, and the pavement width is approximately 24 ft. The pavement was last resurfaced in 1987.

Yates Avenue is the next road to interest with E-35 and features granular surfaced approaches on both sides of E-35. Visibility to the intersection for eastbound traffic is poor, and an "intersection ahead" symbol warning sign is in place. Street name signs with 6 in. lettering are installed at this intersection.

A crest vertical curve lies just westerly from the Zeller Avenue intersection, and a destination sign is located west of the hill to better advise eastbound traffic. A large-sized advance street name sign is in place prior to the intersection. County Road E-35 is not paved to the east beyond this intersection. Paved County Road T-37 continues southerly from this point toward Le Grand.

Nighttime Review

The audit team also conducted a review of the route in dark conditions to observe nighttime traffic operations and visibility. The conspicuity of signing was very good as a result of quality maintenance and the use of high-intensity sheeting. Pavement markings were visible for the most part, but they apparently lacked retro-reflective beads, and visibility in more adverse conditions would be hampered. Visibility of the "Stop" signs at the Wallace Avenue intersection was good for eastbound traffic, so installation of flashing red lights on these signs should prove effective.

The visibility of the existing "Stop" sign at the side road near the westerly terminus of the audited section should be reviewed for westbound E-35 traffic. It appears that this sign may be confusing, and adjustment should be considered.

WRAP-UP MEETING

A brief wrap-up meeting was conducted in the Marshall County Engineer's office during the late afternoon on January 26. Observations from the review of the route were discussed, and as-built plans from the 1998 improvement project were examined. County Engineer Fichtner advised that almost all signs on Marshall County local rural roads have Type 3 high-intensity sheeting. Only

a small number still have engineering-grade sheeting. In addition, the team was advised that truck traffic from aggregate sources and an asphalt plant is significant on E-35.

Preliminary findings were then reviewed, and potential mitigation efforts were presented and discussed. Marshall County plans to request funding from the Iowa DOT's Transportation Safety Improvement Program to offset the cost of some of the improvements that have been recommended by the audit team.

Law Enforcement Comments

During the meeting, Deputy Wes Beane from the Marshall County Sheriff's Office, who had been unable to participate in the review, was contacted. Deputy Beane furnished the following information regarding law enforcement issues on this roadway.

Deputy Beane advised that a fatal crash recorded in 2008 possibly occurred when the driver overcorrected from a right-side lane departure, crossed the roadway, and entered the left-side ditch, becoming submerged in flood water. A possible medical condition was suspected of the driver. The pavement surface was dry at the time of the crash.

Some drivers may use E-35 to avoid the heavier traffic conditions and more prevalent enforcement presence on US 30 and/or IA 14 in this area of the state. Some employees of major businesses in Marshalltown may not have valid driver's licenses, making travel on E-35 more attractive than surrounding roads.

Some swerving/evasive action crashes or even some run-off-road crashes may have be influenced by an animal in or near the roadway, but the actual number of these crash types could not be estimated accurately unless noted in the crash report's sequence of events or narrative.

Most of the crashes at the Wallace Avenue intersection are related to impaired or inattentive drivers who fail to heed the "Stop" sign or T-intersection configuration.

Deputy Beane related that he had been surprised by the number of drivers in the 20–29 age bracket who were involved in crashes. Many older drivers use the route, but teenage drivers are also common due to the number of schools located in the immediate area.

The higher-than-average number of crashes that had occurred on Mondays could not be explained, but the shift change from 11:00 to 11:30 p.m. for some large employers would account for higher traffic volumes and perhaps higher resultant crashes during nighttime hours.

Focused enforcement efforts have not been applied to this route due to work demands on higher volume roads such as US 30 and IA 14. With reduced numbers of Iowa State Patrol officers in the area, Marshall County law enforcement officers are required to spend more time patrolling the higher traffic volume state-owned roadways.

CRASH DATA

As stated above, detailed sets of crash data were furnished to all audit team members. The data sets had been developed by Danielle Mulholland and others in the Iowa DOT's Office of Traffic and Safety. A full six years of data were provided, with 2003–2007 in one set and 2008 in a separate set.

A review of crash locations indicated that most crashes occurred within the approximately two-mile segment from the ECL of Marshalltown through the Three Bridges Road intersection. The curvilinear alignment of the roadway through this area probably contributes to the incidence of crashes.

A total of 71 crashes occurred during the six-year study period, with 1 fatality, 5 major injuries, 9 minor injuries, 17 possible injuries, and 39 property damage only crashes. A high number of the crashes were animal related, 29 of the 71 total. In 2008 alone, 8 of the 12 crashes were animal related. A total of 11 swerving/evasive action crashes were also recorded, and some of these may have been related to animal encounters. It should be noted that many animal crashes are recorded by officers on an abbreviated crash reporting form or are self-reported by drivers, and many of the common crash report details are often omitted from those reports. A crash location map indicated that most animal-related crashes occurred in the Iowa River floodplain area, with scattered crashes beyond that point. This map is included in Appendix A.

Right- or left-side roadway departure crashes totaled 12, and 7 crashes involved running stop signs. Almost all of the latter occurred at Wallace Avenue. The crash history at this intersection will be discussed below. At least six crashes were noted as speed related.

It is significant that a high number of the recorded crashes involved single vehicles departing the roadway. Roadway departure was involved in the one fatal crash, three of the major injuries, four minor injuries, and one possible injury, as well as numerous property damage only crashes. Crossed centerline was recorded as the major crash cause for two of the major injuries and one minor injury. Narratives from the severe crash reports are included in Appendix A to provide more detailed information.

A high majority of vehicles involved in the crashes on this roadway section were passenger cars, light pick-ups, or sports utility vehicles. Only one large truck was involved in a reported crash during the six-year study period.

When reported, weather conditions were noted as clear, cloudy, or partly cloudy during most crashes. Rain or snow was recorded for only 5 of the 71 crashes.

Pavement surface conditions were dry during most crashes, but ice or snow was noted on the pavement for a total of seven crashes.

A high number of crashes occurred during dark conditions, 18 of the 42 crashes for which light conditions were noted happened at night. Twenty-four crashes were recorded during daylight hours.

The major driver contributing factor, when recorded, was loss of vehicle control. Of the 83 drivers involved in crashes during the six-year study period, 32 were found to be apparently normal, but 7 were found to be under the influence of a substance. However, for 42 drivers the condition was unknown or not reported. The most common age group for drivers involved in the reported crashes was 20–29, with the next highest 40–49. Eleven teenage drivers were involved in crashes during the study period.

Even though pavement surface conditions did not indicate a weather-related concern for this roadway, more crashes were recorded during the months of November through January than during other months. The day of the week on which most crashes occurred was Monday, followed by the weekend days of Saturday and Sunday. The time of day during which most crashes occurred was 4:00 p.m. to 6:00 p.m., with 12 crashes, but a high number of crashes were also recorded during the nighttime hours, with 8 noted between 2:00 a.m. and 4:00 a.m. and 6 noted between midnight and 2:00 a.m.

The collision diagrams in Appendix A indicate a total of nine crashes at the Wallace Avenue intersection, almost all involving eastbound vehicles at the stop location. All of these crashes occurred during dark conditions. Two turning crashes were recorded, but no additional turning crashes occurred after the cross traffic advisory plaques described earlier were installed,.

Complete crash data are included in Appendix A.

SUGGESTIONS AND RECOMMENDATIONS

Based on the observations made during the field reviews, examination of the available data, and discussion among audit team members, the following suggestions and recommendations are offered for consideration as crash mitigation strategies that may be used on this roadway segment. The options listed below are not arranged by priority:

1. Add approximately 3 ft wide paved shoulders from the beginning of the Marshall County maintenance area through the Three Bridges Road intersection. This improvement would allow the travel lane to be painted to a 12 ft width. In addition, mill narrow-width rumble strips near the inside edge of all shoulder widening improvements and consider installing rumble stripes at least through the curve areas.
2. Resurface the roadway through these same limits and specify milled-in all-weather pavement markings, center lines, and edge lines where rumble stripes are not in place.
3. Update selected signing:

    a. Replace the double arrow sign at Wallace Road.
    b. Replace and add additional chevrons along the curve southerly from the Wallace Road intersection.

c. Install chevrons along the first curve at the westerly beginning of the segment and along the first curve east from the Vance Avenue intersection.
d. Study the possibility of removing some of the large paved apron at the first intersection to better direct side-road traffic movements and to allow for installation of more chevrons for the E-35 curve.
e. Consider larger sized fluorescent sheeting for all chevrons.

4. Install portland cement concrete (PC) rumble strip panels for eastbound traffic approaching the Wallace Avenue intersection
5. Add flashing warning lights to the two "Stop" signs for eastbound traffic at Wallace Road. Solar powered units might be more cost-effective than other options at this location. Consider installation of a destination light at this intersection as well.
6. Consider milled-in stop bars at the two locations at the Wallace Road intersection to improve longevity.
7. Flatten the foreslope along the outside of the curve southerly from the Wallace Road intersection to a minimum of a 3 to 1 slope, preferably 4 to 1.
8. Working with the Department of Natural Resources, install "Deer Crossing" warning signs on each side of the Iowa River floodplain area. Study the use of deer barriers through this area, considering newly developed designs of cattle guards at low-volume property access points.
9. Work with the Marshall County Sheriff's Office to address safety concerns on this roadway segment:

    a. Meet periodically to discuss crash causes and mitigation.
    b. Encourage focused enforcement to address common violations such as speeding and driving under the influence.

APPENDIX A. CRASH DATA, 2003–2008

Table A-1. Crash history for the section of E-35 from the ECL of Marshalltown to the Tama County line in Marshall County, Iowa, 2003–2007

		Fatal	Major injury	Minor injury	Possible/ unknown	PDO	Total
2003	Crashes	0	0	0	2	8	10
	Injuries	0	0	0	2/0		2
2004	Crashes	0	2	2	1	11	16
	Injuries	0	2	4	1/0		7
2005	Crashes	0	0	2	0	4	6
	Injuries	0	0	2	0/0		2
2006	Crashes	0	2	2	3	7	14
	Injuries	0	2	2	1/2		7
2007	Crashes	0	1	3	3	6	13
	Injuries	0	2	3	1/0		6
Five-year summary, 2003–2007							
	Crashes	0	5	9	9	36	59
	Injuries	0	6	11	7		24

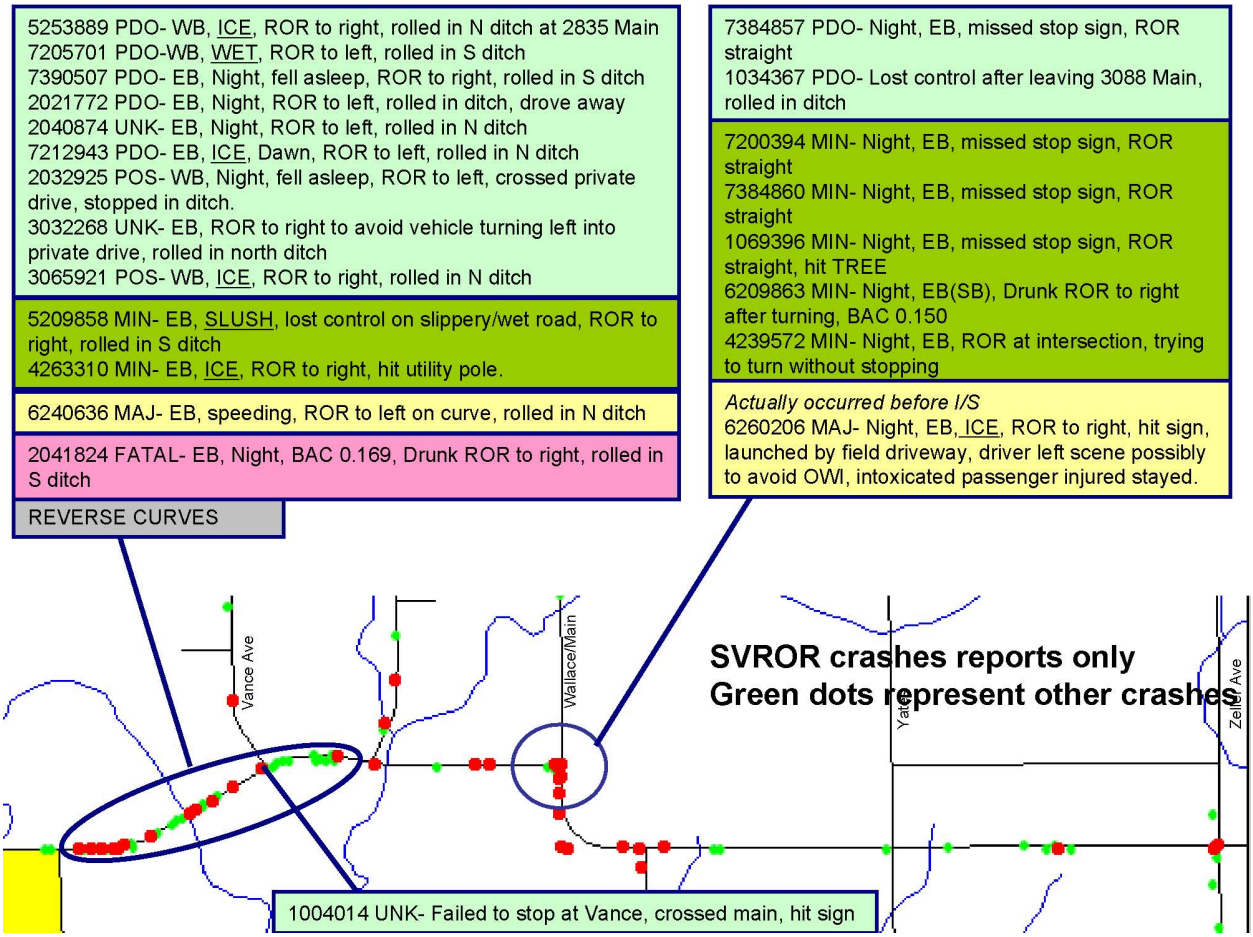


Figure A-1. Single-vehicle run-off-road crashes, 2003–2008

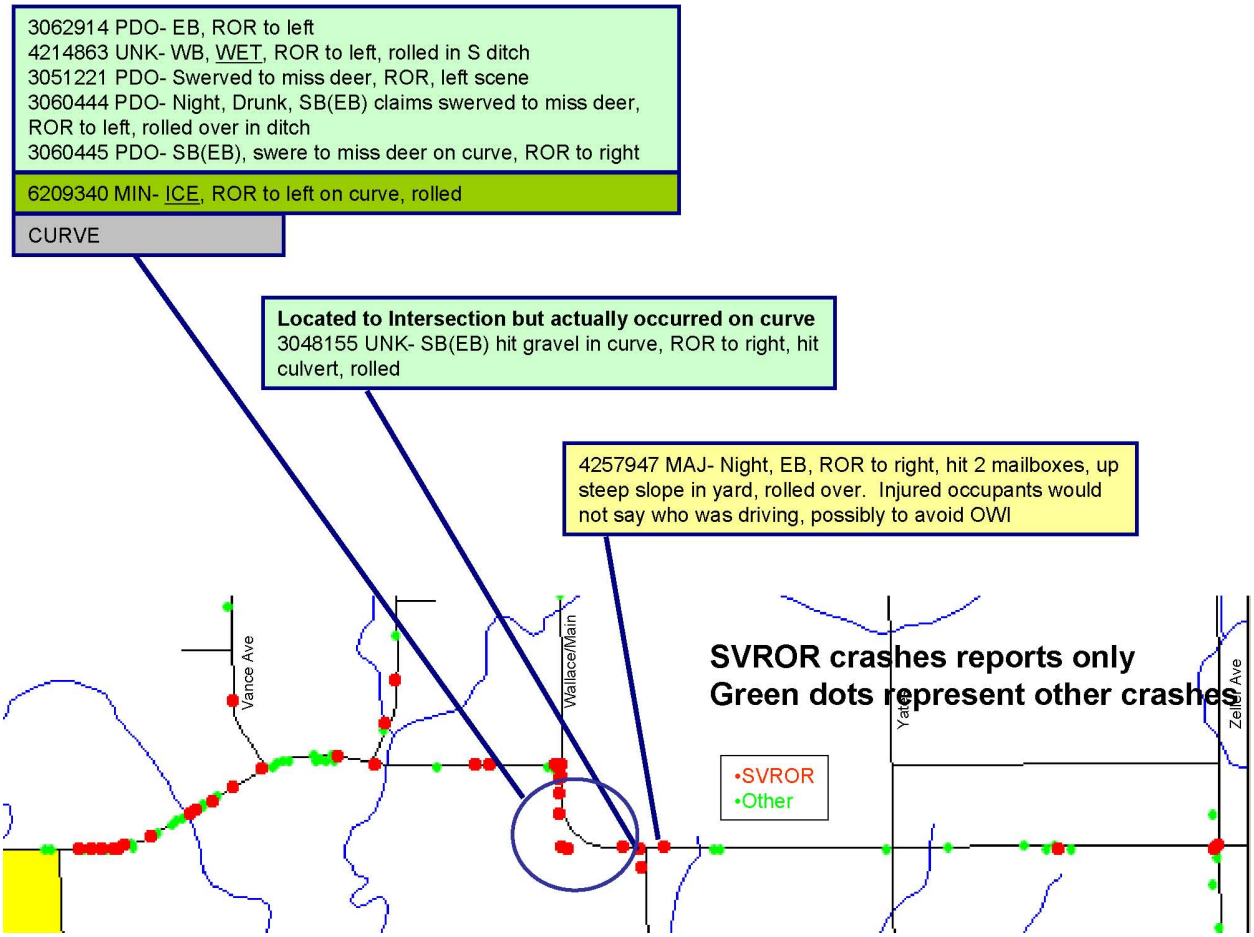


Figure A-1. Single-vehicle run-off-road crashes, 2003–2008 (continued)

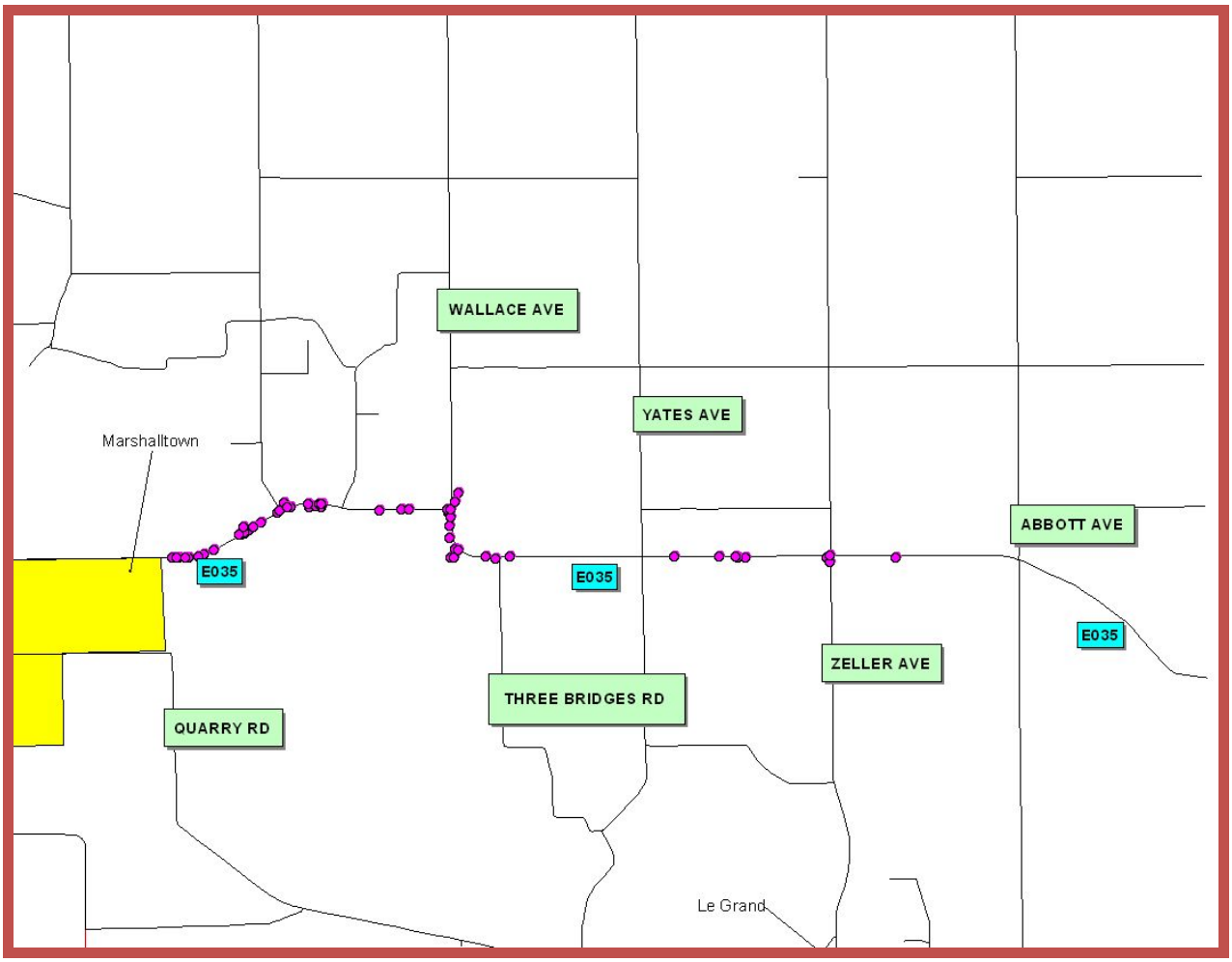


Figure A-2. All crashes on E-35 Marshall County, 2003-2007

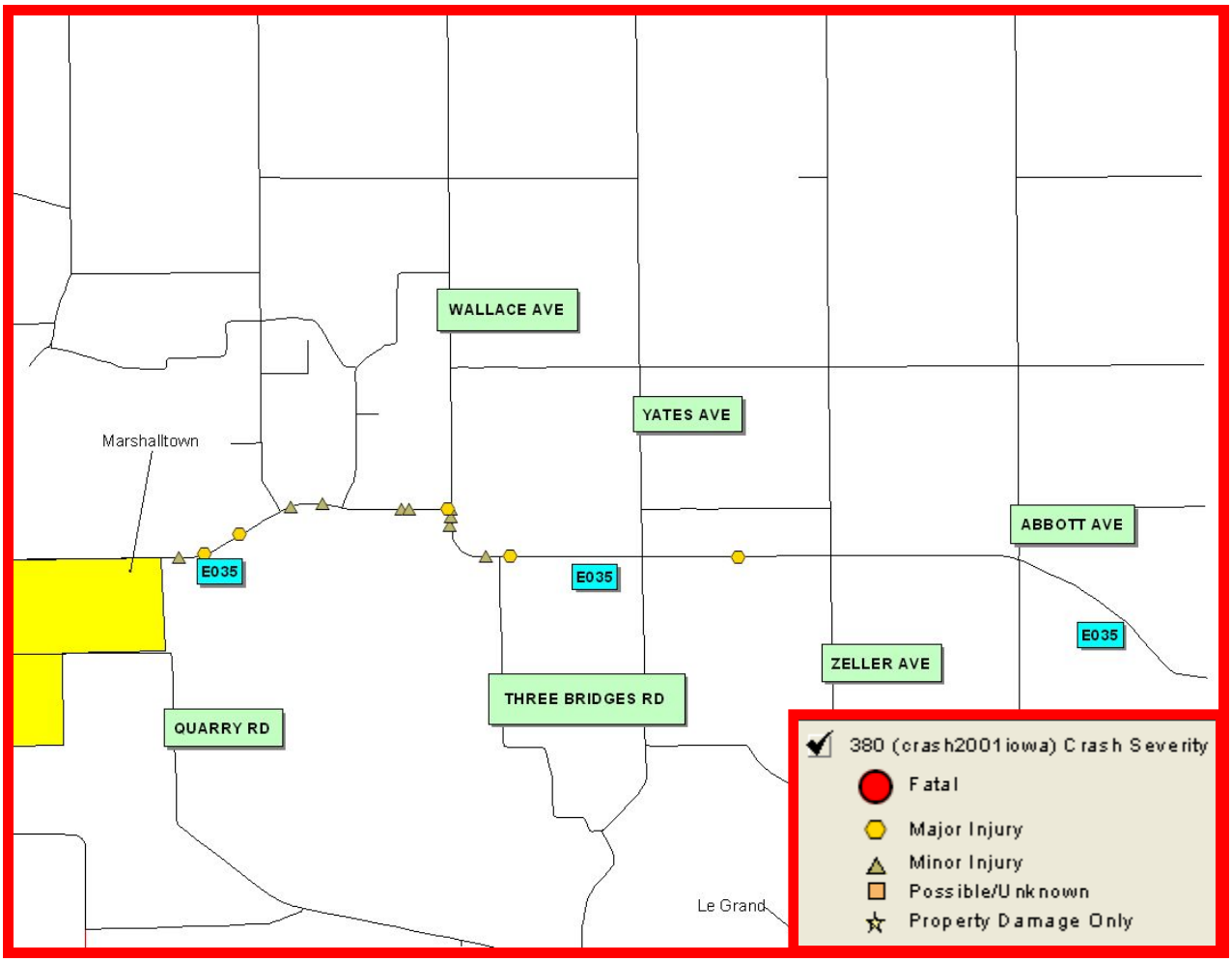


Figure A-3. All crashes by crash severity on E-35 Marshall County, 2003-2007

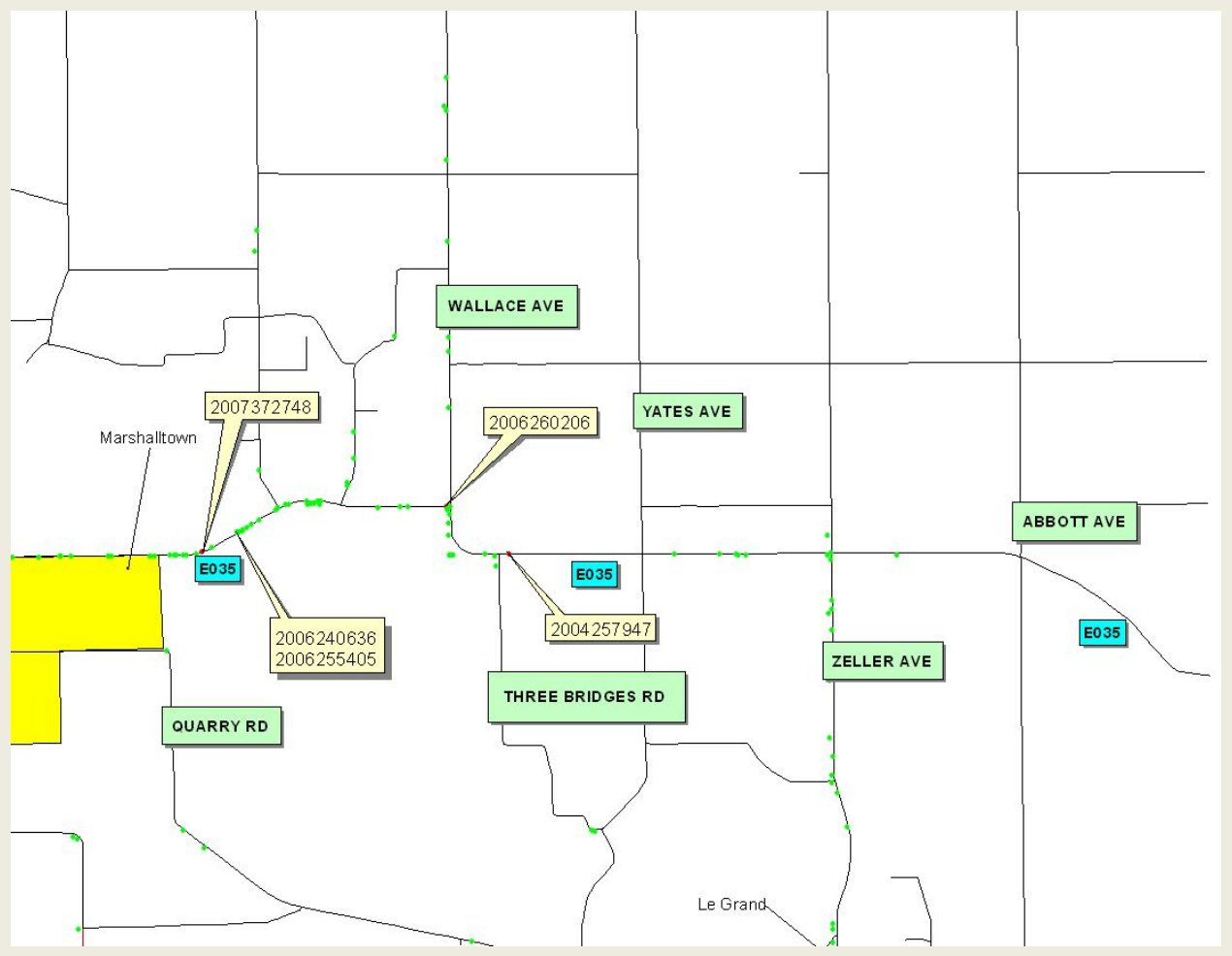
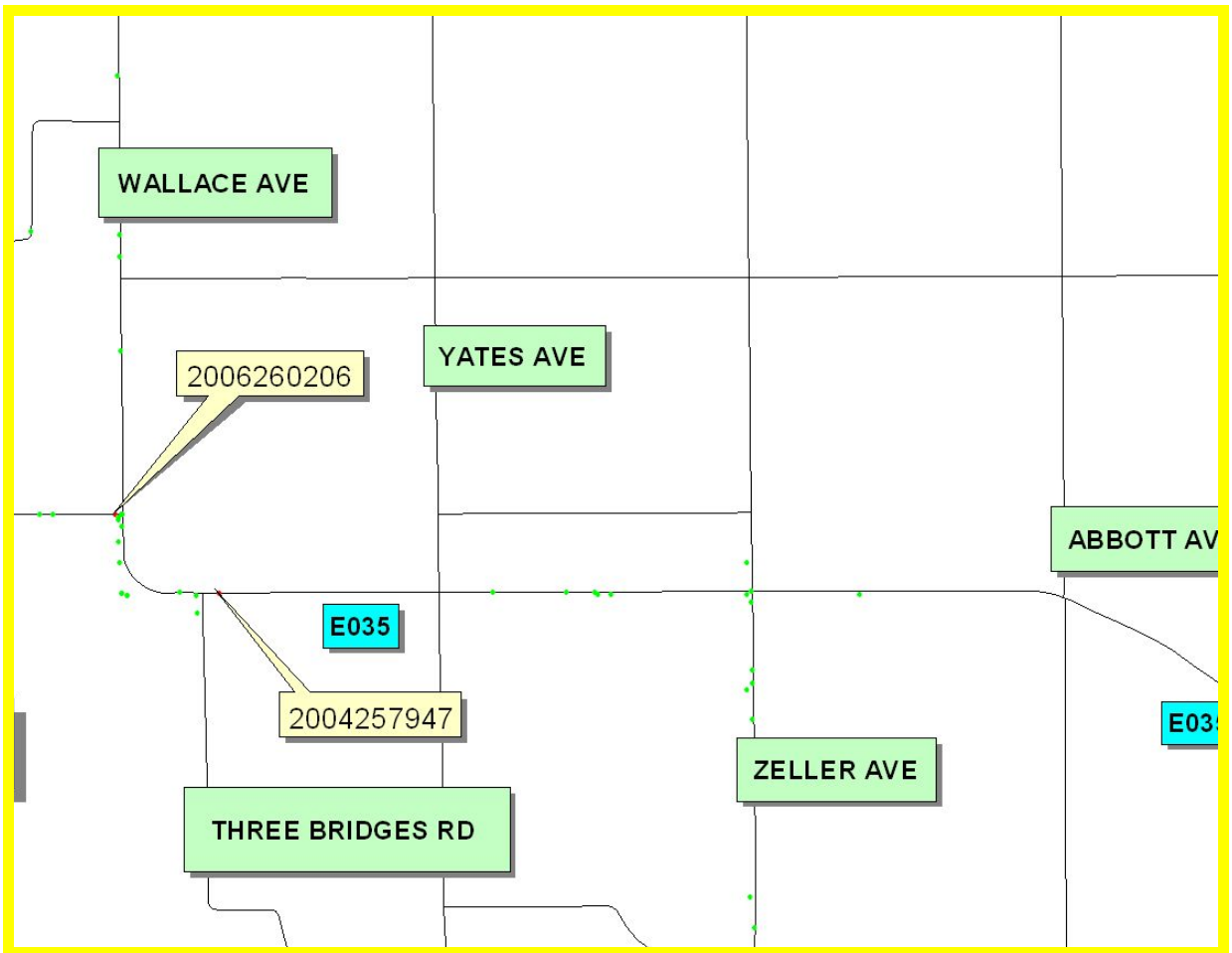


Figure A-4. Fatal and major injury crashes on E-35 Marshall County, 2003-2007



NARRATIVE
(Describe what happened (refer to vehicle by number)

VEHICLE 01 WAS EASTBOUND ON EAST MAIN STREET ROAD WHEN IT GRADUALLY LEFT THE PAVED PORTION OF THE ROAD AND CONTINUED EAST IN THE DITCH CROSSING THE DRIVEWAY AT 3124 E MAIN ST RD. VEHICLE 01 STRUCK TWO MAILBOXES AND CONTINUED EAST THROUGH THE YARD TURNING SOUTHERLY IN THE YARD UP A SLOPE. VEHICLE 01 THEN ROLLED AT LEAST FOUR TIMES. INJURED SUBJECTS LOCATED ON SCENE WERE ENTIRELY UNCOOPERATIVE AND DENIED KNOWING WHO WAS DRIVING. VEHICLE 01 CAME TO REST APPROXIMATELY 314'6" SOUTHEAST FROM WHERE IT LEFT THE IMPROVED PORTION OF THE ROAD.

Figure A-5. Crash narrative for case number 2004257947

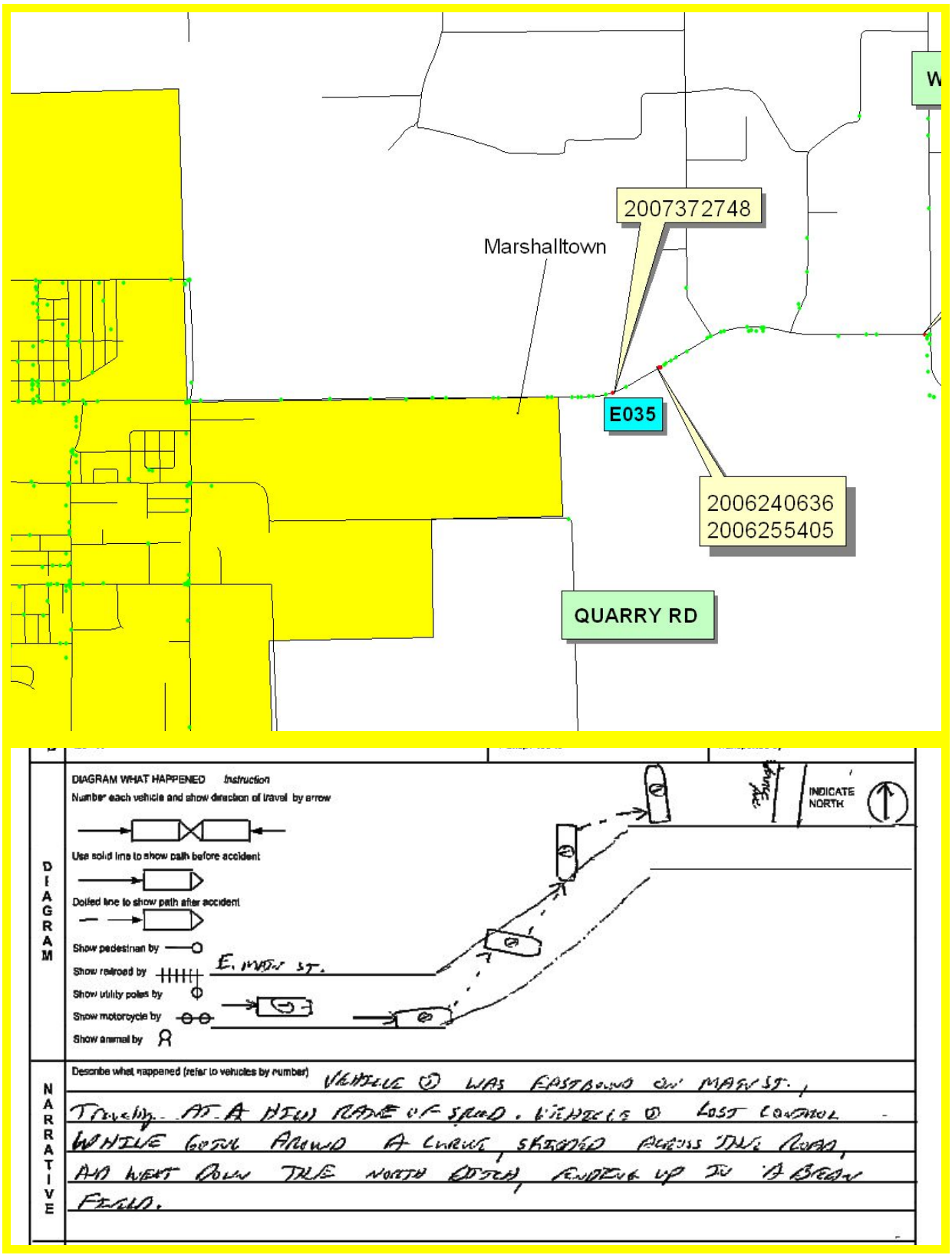
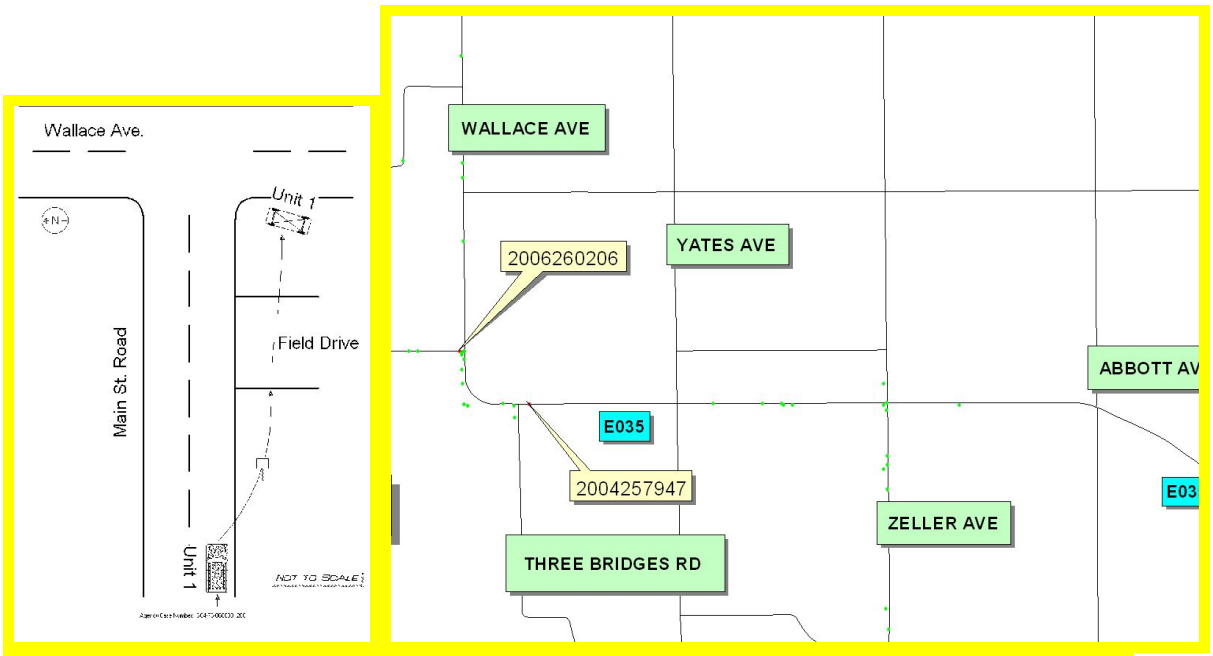


Figure A-6. Crash narrative for case number 2006240636



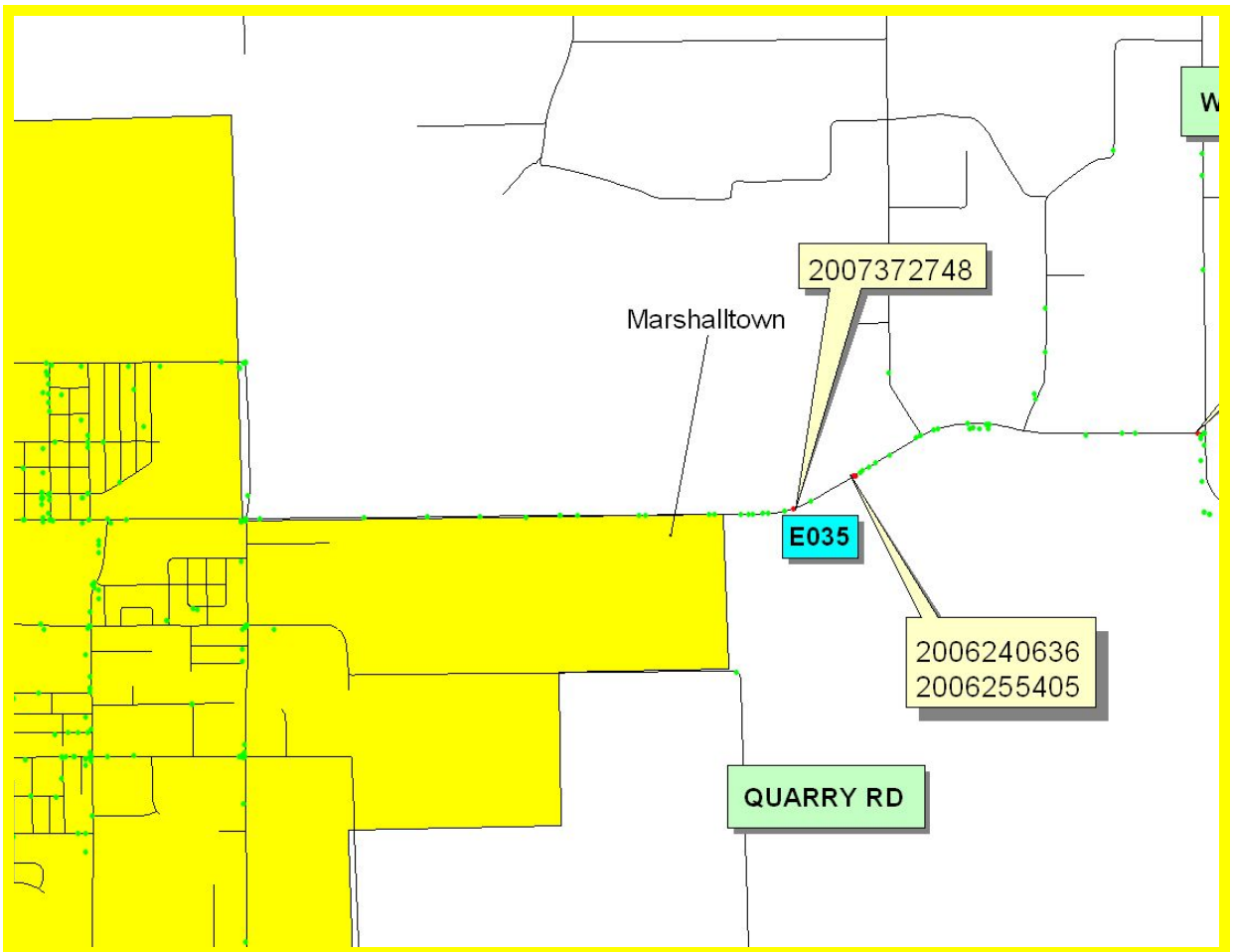
NARRATIVE
(Describe what happened (refer to vehicle by number)

VEHICLE 1 WAS EASTBOUND ON MAIN ST. ROAD, JUST WEST OF WALLACE AVE. VEHICLE 1 WENT INTO THE SOUTH DITCH, STRIKING SIGN AND THEN STRUCK FIELD DRIVE. VEHICLE 1 WENT AIRBORNE AND STRUCK DITCH. VEHICLE 1 CAME TO REST ON ITS TOP IN THE DITCH.

WITNESS STATED THAT THE VEHICLE LOST CONTROL AND WENT INTO THE DITCH.

WILL CITE DRIVER WITH FAILURE TO MAINTAIN CONTROL AND FAILURE TO HAVE A VALID LICENSE WHEN OWI TEST RESULTS ARE KNOWN.

Figure A-7. Crash narrative for case number 2006260206



NARRATIVE
(Describe what happened (refer to vehicle by number)

ON 04-10-07, I WAS DISPATCHED TO A 2 VEHICLE ACCIDENT IN THE 2900 MILE OF E. MAIN ST. RD. FROM THE EVIDENCE COLLECTED AND WITNESS STATEMENTS AT THIS TIME IT IS BELIEVED VEHICLE #2 CROSSED THE CENTERLINE INTO THE PATH OF VEHICLE #1. VEHICLE #1 ATTEMPTED TO TAKE ACTION TO AVOID THE IMPACT, BUT IMPACT DID HAPPEN.

BOTH DRIVERS WERE TRANSPORTED TO THE MARSHALLTOWN MEDICAL AND SURGICAL CENTER WHERE THEY WERE TREATED. THE DRIVER OF VEHICLE #2 WAS THEN TRANSPORTED TO THE U OF I HOSPITAL FOR FURTHER TREATMENT.

I WAS UNABLE TO TALK WITH EITHER DRIVER AT THE ER.

I DID MAKE CONTACT WITH BOTH INSURANCE COMPANIES TO VERIFY BOTH VEHICLES WERE COVERED IN ACCORDANCE WITH IOWA CODE.

Figure A-8. Crash narrative for case number 2007372748

Table A-2. Crashes by vehicle type

Vehicle	Total
Four-tire light truck (pick-up/panel)	15
Not Reported	18
Passenger car	26
Sport utility vehicle	7
Tractor/semi-trailer	1
Unknown	1
Van or mini-van	2
Grand Total	70

Table A-3. Crashes by vehicle action

Vehicle Action	Total
Legally parked	1
Movement essentially straight	31
Not reported	2
Overtaking/passing	2
Slowing/stopping	2
Turning left	5
Turning right	4
Unknown	21
Grand Total	68

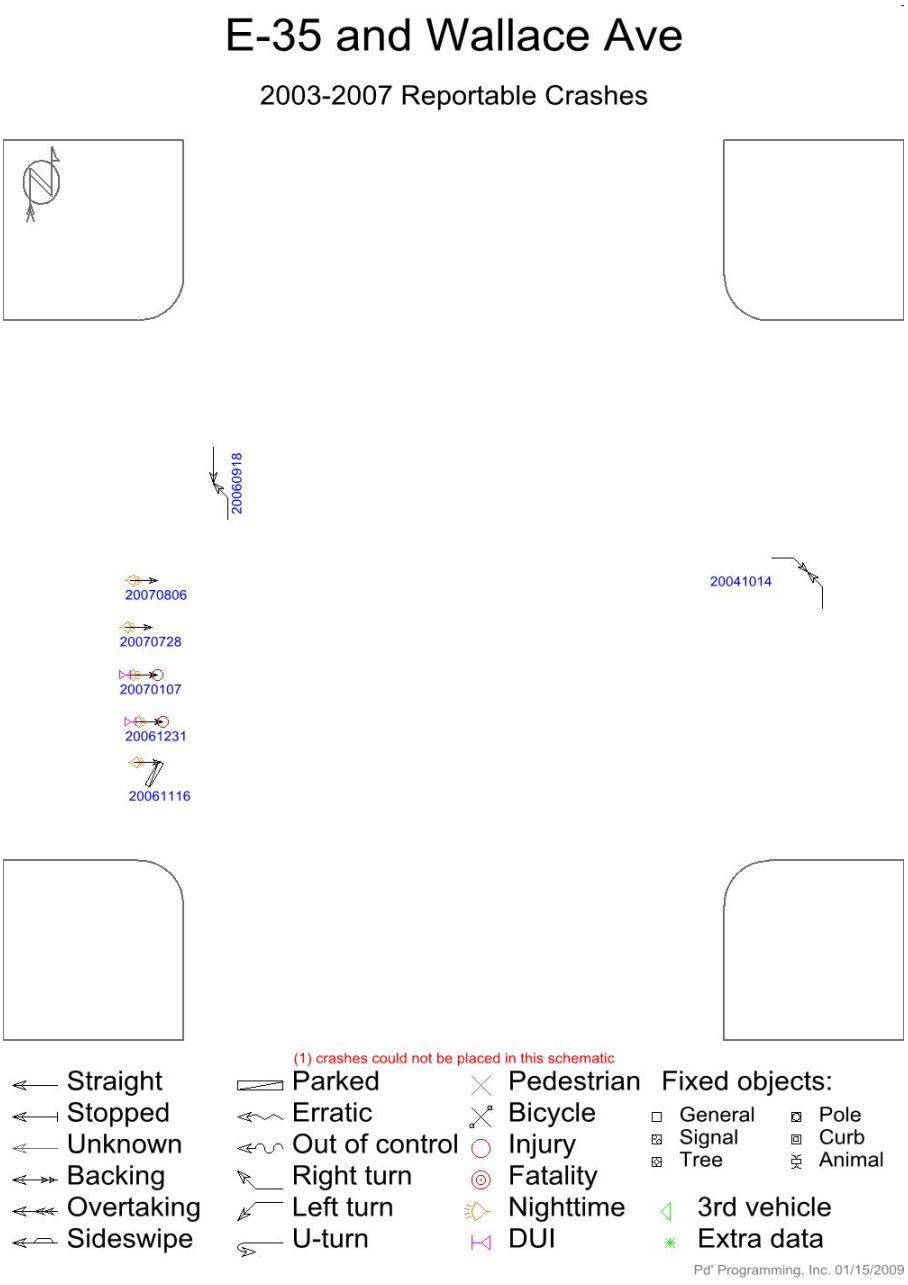


Figure A-9. Collision diagram for E-35 and Wallace Avenue

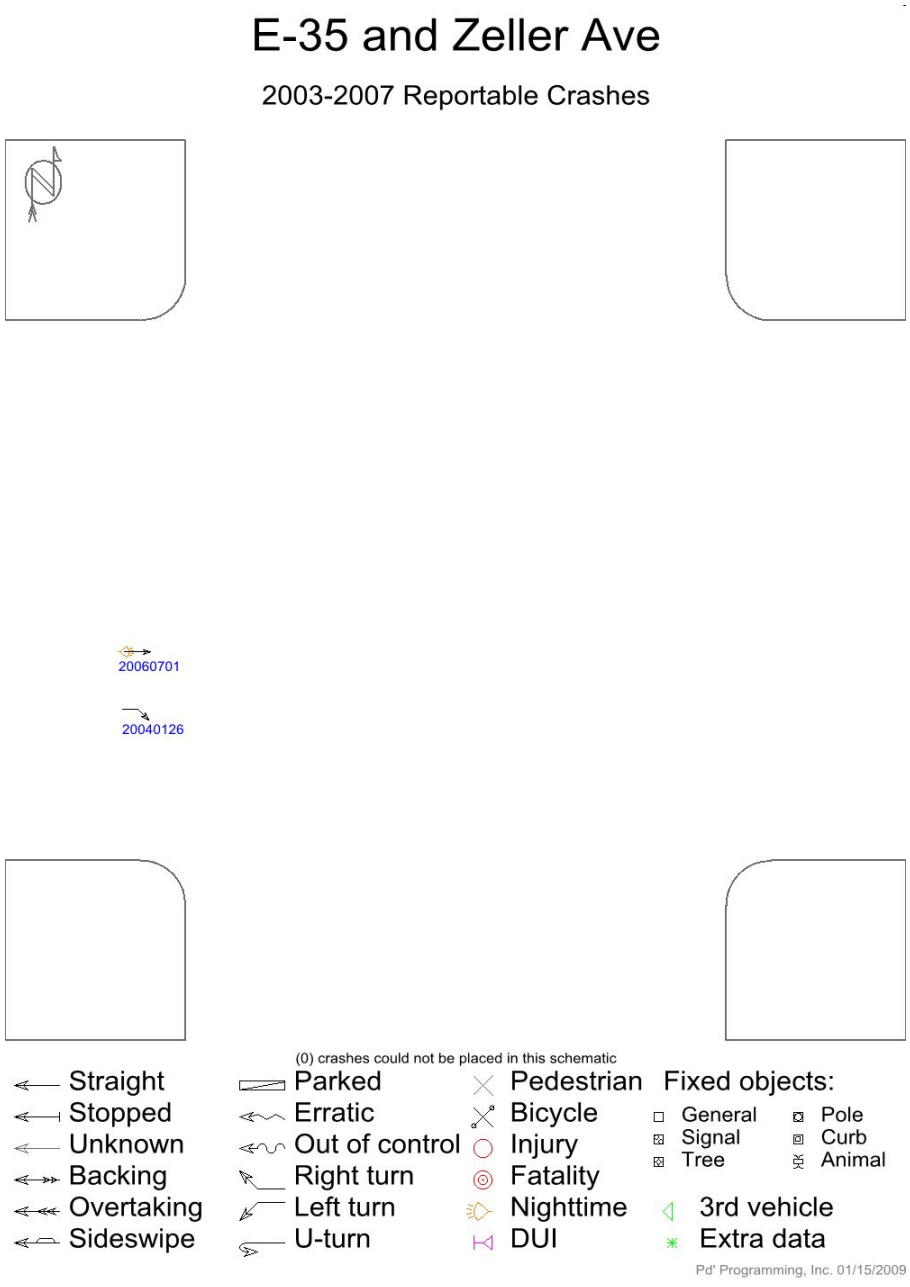


Figure A-10. Collision diagram for E-35 and Zeller Avenue

Table A-4. Crashes by day of week, 2003–2007

Day of Week	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Sunday	10		2	2	1	5	6		2	3	1		6
Monday	14		1	3	3	7	7		1	3	3		12
Tuesday	5		1			4	2		2				5
Wednesday	9			2		7	2			2			8
Thursday	7				2	5	1					1	7
Friday	3			1		2	1			1			3
Saturday	11		1	1	3	6	5		1	2	1	1	7
Totals[1]:	59		5	9	9	36	24		6	11	5	2	48

[1] The values in this table represent crashes and injuries that occurred on one of these days. Unless an error exists in the data, the totals represented here will most likely sum to the total frequency of crashes.

Table A-5. Crashes by driver age, 2003–2007

Driver Condition	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Apparently normal	20			4	5	11	9			4	5		20
Physical impairment													
Emotional (e.g. depressed/angry/disturbed)													
Illness													
Asleep/fainted/fatigued/etc.	1					1							1
Under the influence of alcohol/drugs/medications	7		3	2	1	1	7		3	3	1		2
Other (explain in narrative)	1		1				2		1	1			1
Unknown	29		1	3	2	23	7		2	3		2	25
Not Reported	2				2								
Totals[1]:	60		5	9	10	36	25		6	11	6	2	49

[1] The values in this table represent crashes and injuries that occurred on one of these days. Unless an error exists in the data, the totals represented here will most likely sum to the total frequency of crashes.

Table A-6. Crashes by driver condition, 2003–2007

Driver Age	Crashes						Injuries						Unknown
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Uninjured	
0-13													
14													
15-17	2				1	1	1				1	2	
18-20	11			1	2	8	3			1	2	11	
21-23	6			3		3	3			3		7	
24-26	5		1	1	2	1	5		1	2		1	1
27-29	7		1	2	2	2	5		1	2	1	5	1
30-32	4		1	1		2	2		1	1		3	
33-35	5					5						6	
36-38	3					3						4	
39-41	4			1		3	1			1		5	
42-44	4		2		1	1	5		4		1	2	
45-47	3				2	1	2				1	1	
48-50	1					1						2	
51-53	4				1	3	1				1	4	
54-56	2					2						2	
57-59													
60-62	2					2						5	
63-65													
66-68	2					2						2	
69-71													
72-74												1	
75-77	1					1						1	
78-80													
81-83													
84-86													
87-89													
90-92													
93-95													
96-98+													
Unknown	3		1	1	1		4		1	2		2	1
Totals	69		6	10	12	41	32		8	12	7	66	3

[1] The values in this table represent crashes and injuries that involved a driver experiencing one of these driver conditions. One crash might have multiple Driver Conditions because multiple drivers might experience different Driver Conditions. Therefore, the totals represented here will most likely not sum to the total frequency of crashes.

Table A-7. Crashes by driver contributing circumstances, 2003–2007

Driver Contributing Circumstances [1]	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Ran traffic signal													
Ran stop sign	6			1	3	2	4			1	2	1	5
Exceeded authorized speed	2		1			1	1		1				1
Driving too fast for conditions	3			2	1		3			2	1		2
Made improper turn													
Traveling wrong way or on wrong side of road													
Crossed centerline	3		2	1			5		3	2			1
Lost Control	14		2	2	3	7	8		2	3	2	1	8
Followed too close	1					1							2
Swerved to avoid: vehicle/object/non-motorist/or animal in roadway	1					1							3
Over correcting/over steering													
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner													
FTYROW: From stop sign													
FTYROW: From yield sign													
FTYROW: Making left turn													
FTYROW: Making right turn on red signal													
FTYROW: From driveway													
FTYROW: From parked position													
FTYROW: To pedestrian													
FTYROW: At uncontrolled intersection													
FTYROW: Other (explain in narrative)													
Inattentive/distracted by: Passenger													
Inattentive/distracted by: Use of phone or other device													
Inattentive/distracted by: Fallen object													
Inattentive/distracted by: Fatigued/asleep	1					1							1
Other (explain in narrative): Vision obstructed	1					1							2
Other (explain in narrative): Other improper action	2					2							5
Other (explain in narrative): No improper action	10			1	3	6	4			1	2	1	16
Unknown	8		1	3	2	2	5		2	3			2
Not Reported	18					18							18
Totals[1]:	70		6	10	12	42	30		8	12	7	3	66

[1] The values in this table represent crashes and injuries that involved one of these driver contributing circumstances. One crash might have multiple Driver Contributing Circumstances because multiple drivers might experience different Driver Contributing Circumstances and each driver can experience multiple Driver Contributing Circumstances. Therefore, the totals represented here will most likely not sum to the total frequency of crashes.

Table A-8. Crashes by light conditions, 2003–2007

Light Conditions	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Daylight	20		2	3	4	11	11		3	4	4		20
Dusk													
Dawn	2			1		1	1			1			2
Dark - roadway lighted	1				1		1					1	1
Dark - roadway not lighted	14		3	5	2	4	11		3	6	1	1	5
Dark - unknown roadway lighting													
Unknown	20					20							20
Not Reported	2				2								
Totals[1]:	59		5	9	9	36	24		6	11	5	2	48

[1] The values in this table represent crashes and injuries that involved one of these light conditions. Unless an error exists in the data, the totals represented here will most likely sum to the total frequency of crashes.

Table A-9. Crashes by major cause, 2003–2007

Major Cause	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Animal	21				2	19							19
Ran Traffic Signal													
Ran Stop Sign	6			1	3	2	4			1	2	1	5
Crossed centerline	3		2	1			5		3	2			1
FTYROW: At uncontrolled intersection													
FTYROW: Making right turn on red signal													
FTYROW: From stop sign													
FTYROW: From yield sign													
FTYROW: Making left turn													
FTYROW: From driveway													
FTYROW: From parked position													
FTYROW: To pedestrian													
FTYROW: Other (explain in narrative)													
Traveling wrong way or on wrong side of road													
Driving too fast for conditions	3			2	1		3			2	1		2
Exceeded authorized speed	2		1			1	1		1				1
Made improper turn													
Improper Lane Change													
Followed too close	1					1							2
Disregarded RR Signal													
Disregarded Warning Sign													
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner													
Improper Backing													
Illegally Parked/Unattended													
Swerving/Evasive Action	9			1	1	7	2			1		1	10
Over correcting/over steering	1				1		1				1		
Downhill runaway													
Equipment failure													
Separation of units													
Ran off road - right	6		2	1	1	2	5		2	2	1		3
Ran off road - straight													
Ran off road - left	6			3		3	3			3			3
Lost Control													
Inattentive/distracted by: Passenger													
Inattentive/distracted by: Use of phone or other device													
Inattentive/distracted by: Fallen object													
Inattentive/distracted by: Fatigued/asleep													
Other (explain in narrative): Vision obstructed													
Oversized Load/Vehicle													
Cargo/equipment loss or shift													
Other (explain in narrative): Other improper action	1					1							2
Unknown													
Other (explain in narrative): No improper action													
None indicated													
Totals[1]:	59		5	9	9	36	24		6	11	5	2	48

[1] The values in this table represent crashes and injuries that involved one of these major causes. These values are derived from a combination of crash report data fields. Unless an error exists in the data, the totals represented here will most likely sum to the total frequency of crashes.

Table A-10. Crashes by manner of crash, 2003–2007

Manner of Crash/Collision	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Non-collision	38		4	8	4	22	18		4	10	3	1	24
Head-on	2		1		1		3		2		1		1
Rear-end	3					3							7
Angle - oncoming left turn	1					1							2
Broadside	1				1		1					1	1
Sideswipe - same direction	1					1							2
Sideswipe - opposite direction	2			1	1		2			1	1		2
Unknown	9					9							9
Not Reported	2				2								
Totals[1]:	59		5	9	9	36	24		6	11	5	2	48

[1] The values in this table represent crashes and injuries that involved one of these manners of crashes/collisions. Unless an error exists in the data, the totals represented here will most likely sum to the total frequency of crashes.

Table A-11. Crashes by month, 2003–2007

Month	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
January	8			1		7	1			1			9
February	1			1			1			1			
March	5			2		3	2			2			4
April	2		1			1	2		2				1
May	3		1			2	2		1	1			4
June	4					4							4
July	5			2	2	1	4			2	1	1	3
August	1				1		1				1		
September	4		1		1	2	2		1		1		3
October	5			1	1	3	2			1	1		5
November	8		1		3	4	3		1	1		1	6
December	13		1	2	1	9	4		1	2	1		9
Not Reported													
Totals[1]:	59		5	9	9	36	24		6	11	5	2	48

[1] The values in this table represent crashes and injuries that occurred in one of these months. Unless an error exists in the data, the totals represented here will most likely sum to the total frequency of crashes.

Table A-12. Crashes by surface conditions, 2003–2007

Surface Conditions	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Dry	24		4	4	5	11	16		5	6	3	2	20
Wet	4			1	1	2	2			1	1		2
Ice	6		1	3		2	4		1	3			3
Snow	1					1							1
Slush	1			1			1			1			
Sand/mud/dirt/oil/gravel	1				1		1				1		1
Water (standing/moving)													
Other (explain in narrative)													
Unknown	19					19							20
Not Reported	3				2	1							1
Totals[1]:	59		5	9	9	36	24		6	11	5	2	48

[1] The values in this table represent crashes and injuries that involved one of these surface conditions. Unless an error exists in the data, the totals represented here will most likely sum to the total frequency of crashes.

Table A-13. Crashes by weather conditions, 2003–2007

Weather Conditions	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Clear	19		2	3	5	9	11		2	4	5		15
Partly cloudy	8		1	1	2	4	5		2	1		2	8
Cloudy	5		1	2		2	4		1	3			3
Fog/smoke	1			1			1			1			1
Mist													
Rain	2			2			2			2			
Sleet/hail/freezing rain													
Snow	3		1			2	1		1				2
Severe winds													
Blowing sand/soil/dirt/snow													
Other (explain in narrative)													
Unknown	19					19							19
Not Reported	2				2								
Totals[1]:	59		5	9	9	36	24		6	11	5	2	48

[1] The values in this table represent crashes and injuries that involved one of these weather conditions. One crash might have multiple Weather Conditions. Therefore, the totals represented here may not sum to the total frequency of crashes.

Table A-14. Crashes by time of day and day of week, 2003–2007

Time of day	Day of week							Grand total
	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	
00:00-01:59		2			1		1	4
02:00-03:59	1	3		1	1		1	7
04:00-05:59	2	1						3
06:00-07:59		1		3			2	6
08:00-09:59	1	1		2	1			5
10:00-11:59		1	1	1				3
12:00-13:59	1	1				1		3
14:00-15:59	1		1		1			3
16:00-17:59	2	2	1		1	2	3	11
18:00-19:59		1	1	1			2	5
20:00-21:59	1	1	1	1	2			6
22:00-23:59	1						2	3
Grand total	10	14	5	9	7	3	11	59

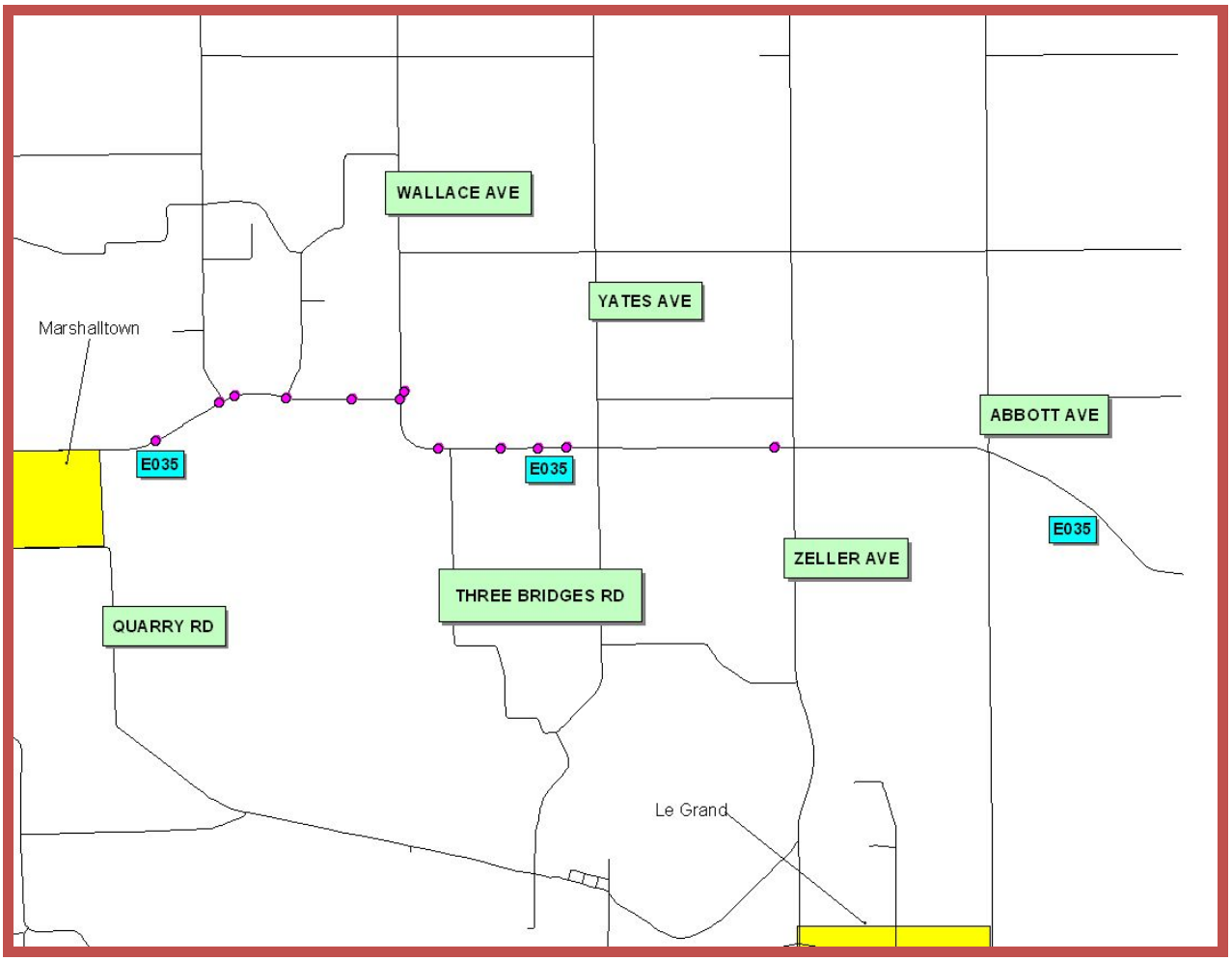


Figure A-11. All crashes on E-35 Marshall County, 2008

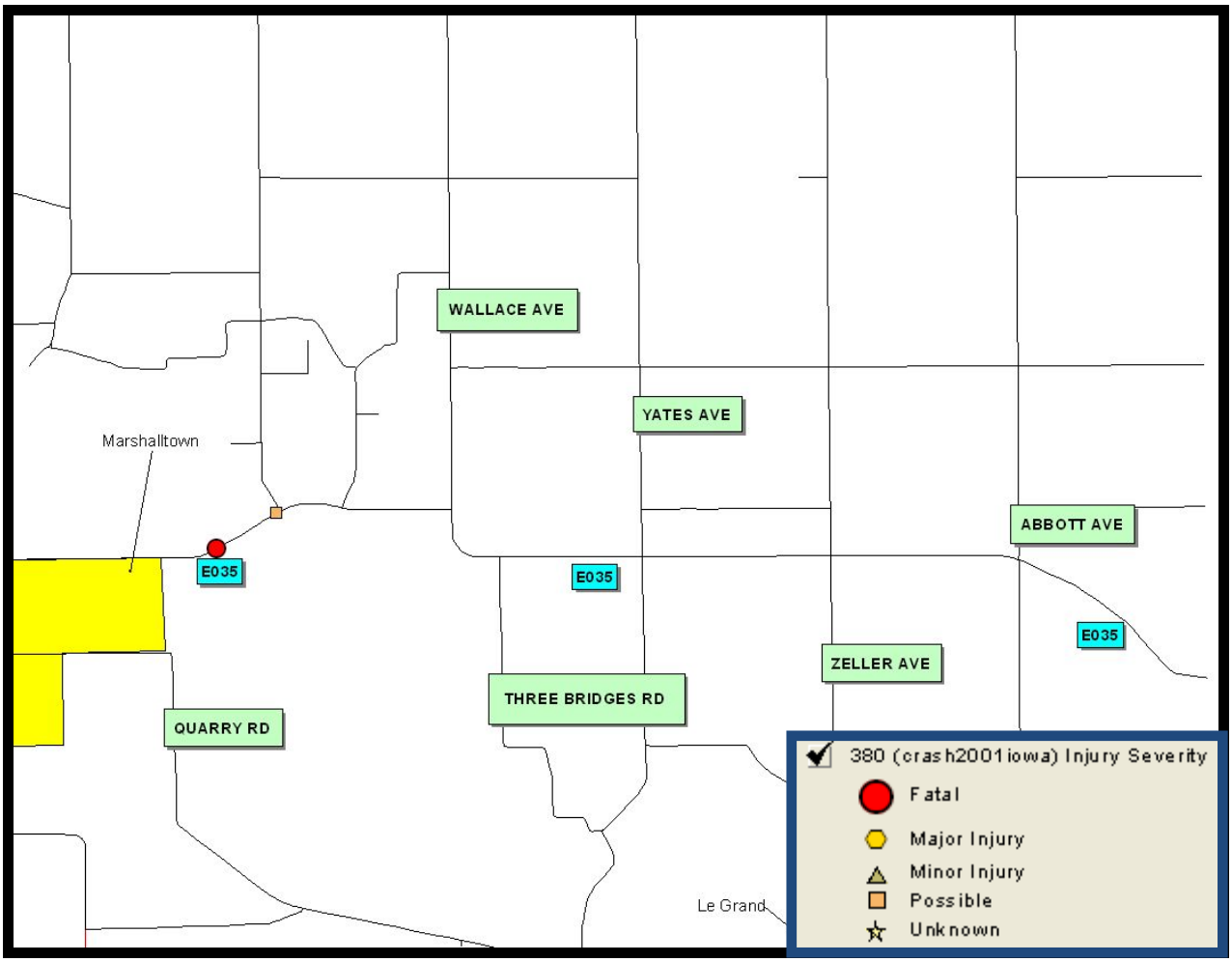
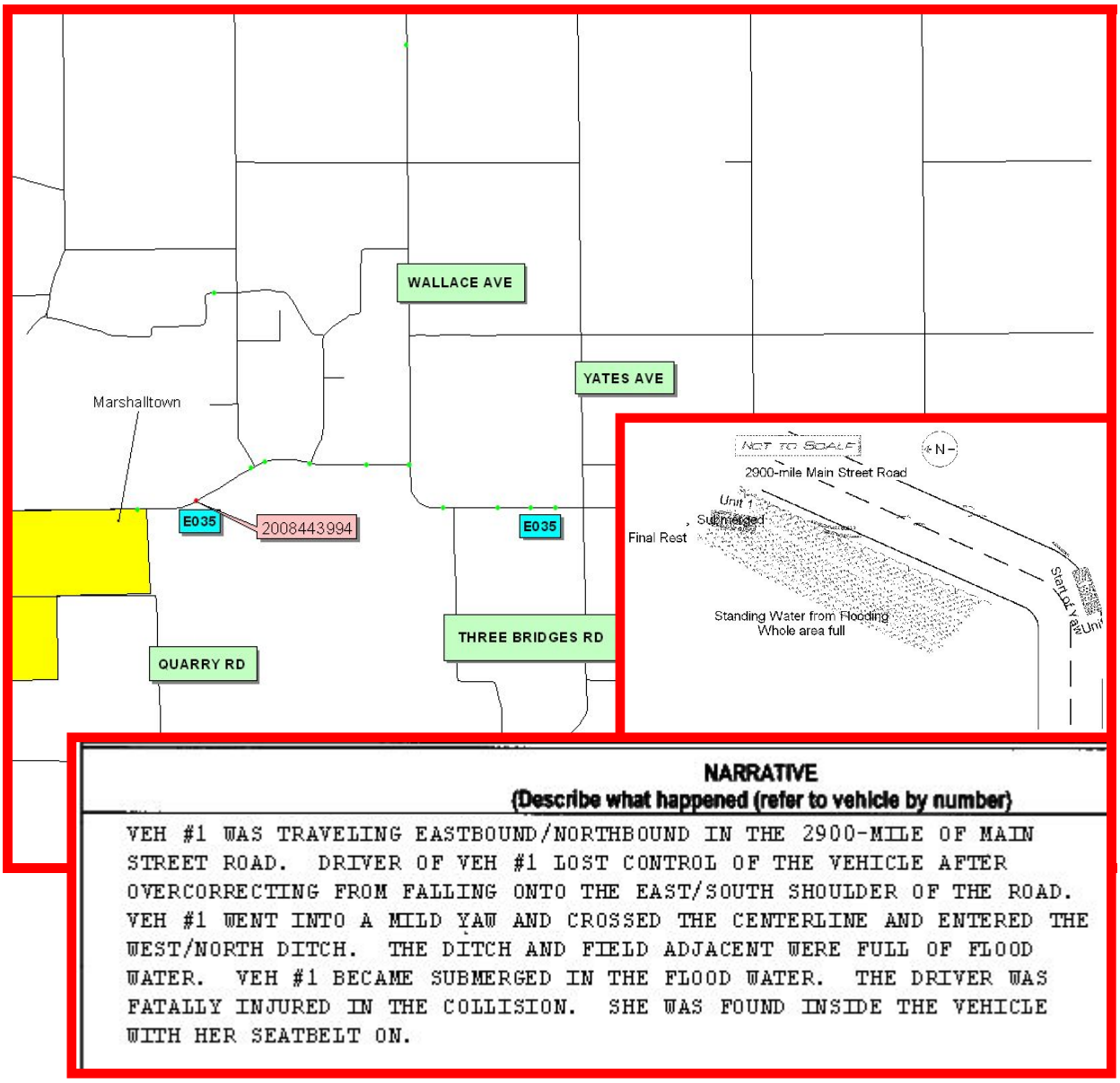


Figure A-12. All crashes on E-35 Marshall County by injury severity, 2008



NARRATIVE
(Describe what happened (refer to vehicle by number)

VEH #1 WAS TRAVELING EASTBOUND/NORTHBOUND IN THE 2900-MILE OF MAIN STREET ROAD. DRIVER OF VEH #1 LOST CONTROL OF THE VEHICLE AFTER OVERCORRECTING FROM FALLING ONTO THE EAST/SOUTH SHOULDER OF THE ROAD. VEH #1 WENT INTO A MILD YAW AND CROSSED THE CENTERLINE AND ENTERED THE WEST/NORTH DITCH. THE DITCH AND FIELD ADJACENT WERE FULL OF FLOOD WATER. VEH #1 BECAME SUBMERGED IN THE FLOOD WATER. THE DRIVER WAS FATALLY INJURED IN THE COLLISION. SHE WAS FOUND INSIDE THE VEHICLE WITH HER SEATBELT ON.

Figure A-13. Crash narrative for case number 2008443994, 2008 crash

Table A-15. Crashes by major cause, 2008

Major Cause	Crashes						Injuries						Uninjured
	Total	Fatal	Major	Minor	Possible	PDO	Total	Fatalities	Major	Minor	Possible	Unknown	
Animal	8				7	1							1
Ran Traffic Signal													
Ran Stop Sign	1					1							
Crossed centerline													
FTYROW: At uncontrolled intersection													
FTYROW: Making right turn on red signal													
FTYROW: From stop sign													
FTYROW: From yield sign													
FTYROW: Making left turn													
FTYROW: From driveway													
FTYROW: From parked position													
FTYROW: To pedestrian													
FTYROW: Other (explain in narrative)													
Traveling wrong way or on wrong side of road													
Driving too fast for conditions	1					1							1
Exceeded authorized speed													
Made improper turn													
Improper Lane Change													
Followed too close													
Disregarded RR Signal													
Disregarded Warning Sign													
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner													
Improper Backing													
Illegally Parked/Unattended													
Swerving/Evasive Action	2	1			1		2	1			1		1
Over correcting/over steering													
Downhill runaway													
Equipment failure													
Separation of units													
Ran off road - right													
Ran off road - straight													
Ran off road - left													
Lost Control													
Inattentive/distracted by: Passenger													
Inattentive/distracted by: Use of phone or other device													
Inattentive/distracted by: Fallen object													
Inattentive/distracted by: Fatigued/asleep													
Other (explain in narrative): Vision obstructed													
Oversized Load/Vehicle													
Cargo/equipment loss or shift													
Other (explain in narrative): Other improper action													
Unknown													
Other (explain in narrative): No improper action													
None indicated													
Totals[1]:	12	1			8	3	2	1			1		3

[1] The values in this table represent crashes and injuries that involved one of these major causes. These values are derived from a combination of crash report data fields. Unless an error exists in the data, the totals represented here will most likely sum to the total frequency of crashes.

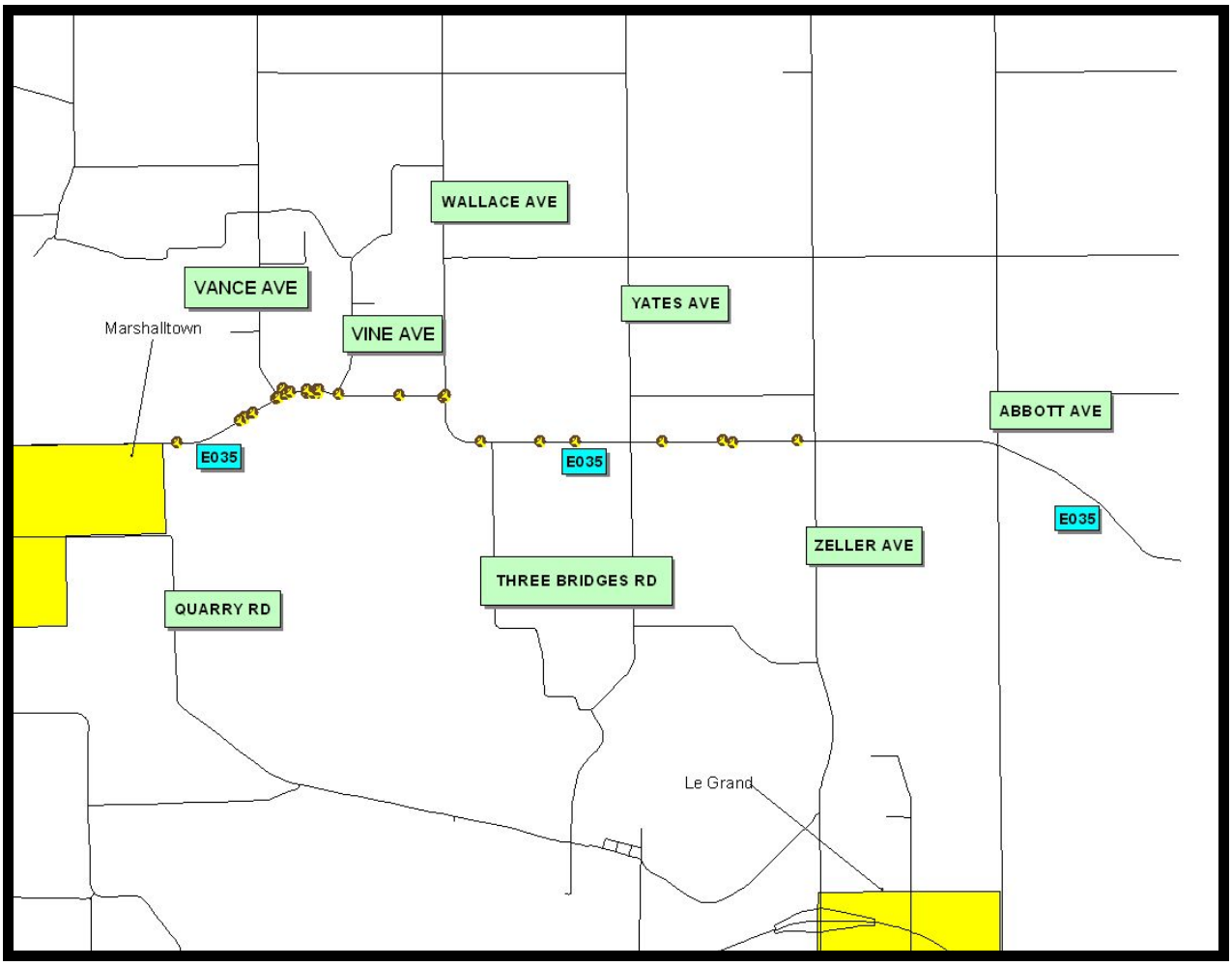


Figure A-14. Animal-related crashes, 2003–2008

APPENDIX B. DEER BARRIER OPTIONS

Figure B-1. Deer fencing

Figure B-2. Cattle gate across access road

APPENDIX C. IMAGES FROM FIELD REVIEWS

Figure C-1. Eastbound E-35 near beginning of review area

Figure C-2. Small bridge eastbound E-35 just east of Vine Avenue intersection

Figure C-3. E-35 eastbound at Wallace Avenue intersection

Figure C-4. Stop sign for eastbound E-35 at Wallace Avenue intersection

Figure C-5. Eastbound E-35 just south of Wallace Avenue intersection

Figure C-6. E-35 Eastbound at Zeller Avenue intersection

Figure C-7. Granular side road intersection with Yates Avenue, looking southerly

Figure C-8. Night view of E-35 showing painted pavement markings

Figure C-9. Painted pavement markings at night on E-35

Figure C-10. Painted pavement markings and sign at night

Figure C-11. Painted pavement markings and traffic control devices at night