Road Safety Audit for Intersection of US 218 and County Road C-57 (West Cedar Wapsi Road) in Black Hawk County, Iowa

Final Report
July 2009

IOWA STATE UNIVERSITY
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ROAD SAFETY AUDIT FOR INTERSECTION OF US 218 AND COUNTY ROAD C-57 (WEST CEDAR WAPSI ROAD) IN BLACK HAWK COUNTY, IOWA

Final Report
July 2009

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The author would like to thank Black Hawk County Engineer's and Sheriff's Offices as well as the Iowa State Patrol for their support and participation in this review and the Iowa Department of Transportation (Iowa DOT) for requesting and participating in this road safety audit and for sponsorship of the effort.

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 the following people:

- Dave Little — Iowa Department of Transportation
- Troy Jerman — Iowa Department of Transportation
- Bob Clark — Iowa Department of Transportation
- Lynn Kloberdanz — Black Hawk County Engineer's Office
- Sgt. Randy Olmstead — Iowa State Patrol
- Chief Deputy Rick Abben — Black Hawk County Sheriff's Office
- Jerry Roche — Federal Highway Administration
- Kevin Korth — Federal Highway Administration
- Jack Latterell — Safety Consultant
- Randy Hunefled — Governor's Traffic Safety Bureau
- Bob Sperry — Safety Liaison, Institute for Transportation (InTrans)
- Tom McDonald — Safety Circuit Rider, Institute for Transportation (InTrans)

EXECUTIVE SUMMARY

Beginning on June 22, 2009, a road safety audit was initiated for the intersection of US 218 and County Road C-57 in Black Hawk County, Iowa. Due to the traffic volumes and the number of conflicting traffic movements on these two roadways, this intersection has developed a crash history that concerns the Iowa Department of Transportation (Iowa DOT), Iowa State Patrol, and local agencies. This intersection is ranked seventh in Iowa for the highest number of at-grade expressway intersection crashes. Considering this, Black Hawk County and the Iowa DOT requested that a road safety audit be conducted to address the safety concerns and recommend possible mitigation strategies.

INTRODUCTION

Beginning on June 22, 2009, a road safety audit was initiated for the intersection of US 218 and County Road C-57 in Black Hawk County, Iowa. Due to the traffic volumes and the number of conflicting traffic movements on these two roadways, this intersection has developed a crash history that concerns the Iowa Department of Transportation (Iowa DOT), Iowa State Patrol, and local agencies. This intersection is ranked seventh in Iowa for the highest number of at-grade expressway intersection crashes. Considering this, Black Hawk County and the Iowa DOT requested that a road safety audit be conducted to address the safety concerns and recommend possible strategies.

In 2005, the Iowa DOT reported the annual average daily traffic on US 218 to be 16,000 vehicles per day, of which 10%–15% were trucks. County Road C-57 carried about 2,400 and 1,250 total vehicles per day east and west, respectively, of the US 218 intersection. Turning movement counts for 2005 indicated that approximately 46% of the 1,200 daily westbound C-57 vehicles turned south at the intersection and approximately 36% turned north. For eastbound C-57 vehicles, about 47% of the 659 vehicles turned south at the intersection. Approximately 370 southbound US 218 vehicles turned east onto C-57, and about 265 northbound US 218 vehicles turned west onto C-57 each day. About 540 northbound vehicles on US 218 turned east onto C-57 daily. The traffic data indicated peak volumes during morning hours of 7:00 to 8:00 a.m. and evening hours of 4:00 to 6:00 p.m. This report includes a complete summary of traffic volume and turning movement data in Appendix A. The Iowa DOT will complete a new traffic count in 2009, and these data should be reviewed for significant changes in the current data.

US 218 was constructed in this area between 1993 and 1995 and consists of a four-lane portland cement concrete (PCC) pavement, with northbound and southbound lanes separated by an 88-foot-wide grass median. However, at the US 218 and C-57 intersection, the median widens to approximately 100 feet. The paved section of US 218 is 25.5 feet wide in each direction and has shoulders constructed of granular material that are 10 feet wide on the outside and 6 feet wide on the inside.

Because of the high volume of turning traffic on US 218, deceleration and acceleration lanes were constructed in 2006. The deceleration lane for northbound to eastbound traffic is a 12-foot-wide hot mix asphalt pavement that is approximately 600 feet long with a 120-foot-long taper. The acceleration lane is a 12-foot-wide hot mix asphalt pavement that is approximately 1,500 feet in length with a 200-foot-long taper. The acceleration lane features several painted arrow pavement markings to guide traffic. US 218 also has left-turn lanes for northbound and southbound traffic with approximately 150 feet of storage. The median crossing is paved at a minimum width of approximately 32 feet. The intersection is illuminated by five standard-design roadway lamps installed and maintained by Black Hawk County. The alignment of US 218 results in an approach angle of about 76 degrees for County Road C-57.

County Road C-57 is a 24-foot-wide, PCC-paved road with approximately 8- to 10-foot-wide granular shoulders. C-57 has an at-grade railroad crossing of the Cedar River Railroad Company (CEDR) approximately 115 feet west of the southbound lanes of US 218. Due to the temporary

loss of a river bridge in Waterloo/Cedar Falls, the number of daily trains has been reduced to approximately two trains per day, but the company may increase that number to four per day in the future.

Images of the intersection are included in Appendix B.

INITIAL MEETING

The initial meeting for the audit took place on the afternoon of June 22, 2009, in the Janesville City Council Chambers. The following audit team members participated in the meeting:

- Dave Little — Iowa DOT
- Troy Jerman — Iowa DOT
- Bob Clark — Iowa DOT
- Lynn Kloberdanz — Black Hawk County Engineer's Office
- Sgt. Randy Olmstead — Iowa State Patrol
- Chief Deputy Rick Abben — Black Hawk County Sheriff's Office
- Jerry Roche — Federal Highway Administration
- Kevin Korth — Federal Highway Administration
- Jack Latterell — Safety Consultant
- Randy Hunefled — Governor's Traffic Safety Bureau
- Bob Sperry — Safety Liaison, Institute for Transportation (InTrans)
- Tom McDonald — Safety Circuit Rider, Institute for Transportation (InTrans)

The multi-disciplinary composition and variation in experience and background of the audit team allowed for fresh ideas to be considered in identifying problems and possible solutions.

Following introductions, Troy Jerman explained the purpose and characteristics of road safety audits and why this intersection was selected for the audit. Bob Clark distributed information listing all the safety improvements that have been implemented at the intersection to date since the intersection was opened to traffic. This information is included in Appendix C.

Tom McDonald then displayed video footage taken on June 9 and 10, 2009, by InTrans staff to illustrate common traffic conflicts at this intersection and to acquaint the team with issues to observe during the field reviews that would be conducted. This video was valuable for observing and commenting on turning movement conflicts during peak traffic periods.

Tom McDonald also distributed copies of a summary of video observations and possible mitigation strategies that was prepared by Josh Hochstein, a graduate student at Iowa State University. This summary is included in Appendix D. In addition, crash data from 2001 through 2008 were distributed, including a collision diagram for the intersection and summaries of pertinent crash information. For the analysis period, these data listed a total of 63 crashes: 1 fatal, 5 major injury, 8 minor injury, 16 possible/unknown injuries, and 33 with property damage

only. The majority of motorists involved in the serious crashes were local area residents. The predominant crash type was right-angle collisions, with 37 (59%). Twenty-one of these occurred on the far side of the intersection and 16 occurred on the near side. It is interesting to note that for the easterly side of the intersection, 8 of 12 near-side right-angle crashes occurred after installation of a right-turn lane in 2006. Twelve other crashes were listed as rear-end collisions. While many of these crashes occurred during morning and evening peak periods, about 16% were recorded during lunch hours. No one could propose a reason for the high number of midday crashes.

The major cause of crashes (41%) was failure to yield right-of way from a stop sign. A review of individual crash reports revealed that almost all of these crashes involved a vehicle traveling on C-57 pulling out from a stop sign into the path of a US 218 vehicle. The second highest major cause (10%) was running a stop sign. Most crash reports noted improper action by at least one driver. Only five animal crashes were recorded during the eight-year period. The manner of collisions was predominantly broadside (54%), followed by rear-end (17%). Ninety percent of the 119 drivers involved in these crashes were judged to be apparently normal by the investigating officers; only one driver was found to be under the influence of alcohol or drugs.

The day of week for crashes was fairly consistent, although the number of Sunday crashes was somewhat higher than expected. For vehicle type involved in crashes, about 50% were passenger cars, 21% pick-ups, 11% vans or mini-vans, and 9% sports utility vehicles. Only about 4% of vehicles involved were tractor-trailer trucks.

Approximately 78% of the intersection crashes occurred in daylight conditions; very few were recorded at night. Weather conditions were clear, cloudy, or partly cloudy for 51 of 63 crashes (81%); snow was noted for three crashes (5%). Road surface conditions were recorded as dry for 47 of 63 crashes (75%); snow or ice was noted for 5 of 63 crashes (8%). Driver age was well-distributed, with about 9% for teenagers ages 15–19 and about 9% over 65 years of age.

Using the latest five years of data, the crash rate for this intersection is 1.23 crashes per million entering vehicles. A complete summary of crash data and the collision diagram are included in Appendix E.

Lynn Kloberdanz stated that most southbound tractor-trailer trucks turning east are traveling to US 63, approximately six miles to the east, and then south to the Waterloo industrial area. Commuter traffic westbound on C-57 turning left, or south, on US 218 is likely traveling to work in Cedar Falls or the west side of Waterloo. Diverting this traffic to alternate routes is not feasible with the area’s existing roadway network.

Dave Little explained that when US 218 was designed, the projected 2012 traffic was 10,400 total average annual daily vehicles, and that traffic volume was easily exceeded several years ago. Traffic volumes seemed to increase significantly with the completion of the Avenue of the Saints corridor. Planning is underway for several significant improvements to this roadway corridor, including a potential interchange at Janesville and possibly at the C-57 site, or adding ramps to the exiting Dunkerton Road overpass. However, accommodating the railroad crossing will undoubtedly complicate an interchange design at C-57. Ultimately, a complete freeway

section might be established for this corridor, but that would be many years in the future. However, some interchanges could be constructed at problem locations as individual improvements at an earlier time. Recently, a public meeting was held to present a proposal to construct a J-turn configuration for the US 218 and C-57 intersection, and the public's reaction was mixed.

FIELD REVIEWS

Daylight Reviews

Two daylight reviews were conducted for this audit; the first was performed during the afternoon peak hour traffic period on June 22, and the second was conducted during the morning peak hour on June 23. All members of the review team participated in the first field review, but the law enforcement representatives were unable to participate on June 23.

Visual observations during these reviews verified conflicts and safety concerns noted during the viewing of the video footage during the initial meeting. Vehicles passing through the intersection on C-57 experienced delays waiting for acceptable gaps in US 218 traffic. Occasionally, westbound C-57 vehicles waiting to cross US 218 blocked left-turning traffic in the median, resulting in a backup of several vehicles with impatient drivers. The trailing vehicle in the queue was often near the inside through lane of northbound US 218. Traffic was also congested when southbound tractor-trailer trucks turning east completely blocked the intersection while waiting for gaps in US 218 traffic. This blockage could result in several minutes of delay during peak traffic periods.

Signing for this intersection appeared in satisfactory condition during the daylight reviews. Stop signs at US 218 for C-57 traffic are enhanced with flashing beacons and auxiliary plaques stating "Cross Traffic Does Not Stop." Stop signs in the median have supplemental plaques stating "Re-check Traffic Before Proceeding" but do not have flashing warning lights. The left-turn acceleration lane is signed with a regulatory sign with the message "Left-Turn Acceleration Lane—1,400 feet" mounted along this lane approximately 50 feet south of the intersection. For turning vehicles, this sign is difficult to see until the turn has been executed. Two parallel warning signs have been installed several hundred feet in advance of the intersection for both northbound and southbound US 218. These four signs display the message "Watch for Cross Traffic" and are enhanced with amber flashing warning lights and 55 mph advisory speed signs. Some team members questioned the appropriateness of the advisory plaques.

Centerline pavement markings and stop bars for the two stop signs within the median crossing have been almost entirely obliterated by traffic. In addition, the yellow edge lines along the right-turn deceleration and left-turn acceleration lanes were badly worn and ineffective. Painted arrow pavement markings in the left-turn acceleration lane were visible during daylight conditions. Pavement markings on US 218 and C-57 away from the intersection appeared in satisfactory condition.

Nighttime Review

A nighttime review was conducted of the site during the evening of June 22. Participants included all members of the audit team except for the law enforcement representatives. Significantly reduced traffic volume resulted in improved operations during nighttime hours. Very few conflicts were noted. Most signing appeared adequate, although sign visibility could be effectively improved with higher grade sheeting. Flashing warning lights were very visible. Pavement markings in the intersection were not visible, but the existing roadway lighting resulted in adequate visibility for traffic during the time of observation.

WRAP-UP MEETING

Following a second daylight field review, a wrap-up meeting was conducted in the Janesville City Council Chambers. The entire audit team participated except for Chief Deputy Abben, who had a conflicting meeting. Mitigation strategies suggested by the audit team should be considered as temporary only, with more effective and permanent measures to be implemented in the future.

To again familiarize team members with traffic congestion and conflicts and potential safety concerns, the video footage was viewed in its entirety and comments were made. As with most high-volume intersections, most problems resulted from turning movements, especially left turns. These turning movements must be addressed to improve the observed operational problems at this intersection. Two movements were particularly problematic: southbound vehicles, especially large commercial vehicles, turning east and westbound vehicles, especially commuting traffic, making left turns to go south. Both movements were especially troublesome during peak hours.

To possibly address the large truck issue, Sgt. Randy Olmstead suggested that a connecting road could be constructed between the Lone Tree interchange, about 3.5 miles south of C-57, to Dunkerton Road, which connects directly to US 63. Large trucks could then be directed to use that route and avoid the C-57 intersection. However, since this would involve new right-of-way, several years would be required for implementation once the proposal was adopted.

The other major conflicting movement in the intersection median is the westbound traffic turning left from C-57 onto southbound US 218. Since the existing left-turn acceleration lane can be accessed without waiting for a gap in southbound US 218 traffic, the only potential conflicts for this movement are eastbound C-57 vehicles and southbound US 218 vehicles making left turns to go east, both of which are fairly low volume. As was explained earlier, a common delay for left-turning C-57 vehicles is waiting for westbound traffic to clear the intersection. This delay could be eliminated by providing a separate left-turn lane in the median for westbound C-57. Additional median paving would be necessary possibly on both sides to achieve adequate width. This extra width would allow for three lanes within the median and a larger radius for left-turning tractor-trailer trucks. The Iowa DOT Office of Design should review the commercial vehicle use of this intersection and design a width with acceptable turning radii. Lane lines should also be milled in to provide lane assignment for vehicles. This relatively low-cost

improvement could significantly benefit the intersection operation. If doubts persist of the feasibility of this option, simulation testing could be undertaken at the University of Iowa.

Another method to reduce conflicts might be to completely close C-57 west of US 218. According to the 2005 traffic data, about 1,240 vehicles use this leg daily, but adequately paved diversions are available. Only about 200 vehicles proceed entirely through the intersection on C-57. Lynn Kloberdanz stated that the CEDR railroad plans to improve the at-grade crossing at the C-57 location in 2009, which will result in approximately a two-week closure of the west leg of C-57. This might be an excellent time to consider some concurrent improvements in the median.

Other options proposed by team members included total closure of the intersection and diversion of traffic elsewhere. Offset T-intersections have worked well in other situations, but again, new right-of-way would most likely be required along with several years for implementation. In addition, conflicts in the median crossing would still exist for the most part.

Replacement of the median stop signs with yield signs was suggested to avoid the unnecessary delay for westbound vehicles in the median turning left to go south. However, it was pointed out the yield signs had been initially installed when safety concerns were first noted at the intersection. These were then replaced with the current stop signs in 1996.

Currently, traffic using the left-turn lanes on US 218 is not controlled at the median crossing. It was suggested that yield signs be installed to provide priority of movement to median traffic. This action may require expanding the storage capacity of the southbound left-turn lane considering the volume of tractor-trailer trucks using this lane during peak periods. Extending the existing northbound left-turn lane was also suggested to provide more deceleration room for turning traffic.

Numerous broadside collisions have occurred on the near side of the intersection following the installation of the right-turn deceleration lane in 2006. A possible contributing cause was noted as “shadowing vehicles,” impacting visibility of oncoming US 218 traffic. This could potentially be addressed by offsetting this turn lane, and this action was suggested for consideration. A supplemental enhancement for westbound C-57 traffic might be the installation of additional roadway lights south of the intersection, with one at the deceleration lane taper and another about 300 feet further south. In addition to enhanced lighting at night, these poles can provide reference points for waiting drivers to judge acceptable gaps in oncoming traffic.

In both the video summary and field observations, it was noted that drivers frequently encounter delay when waiting to merge with northbound US 218 traffic from westbound C-57. This delay could be reduced or eliminated by the addition of a merging lane along northbound US 218 and by the replacement of the existing stop sign with a yield sign. This merging lane would also address shoulder maintenance in this area due to vehicle encroachment. A similar treatment could be considered for eastbound traffic turning south from C-57, although there is less traffic volume for that movement.

Mixed suggestions were made for reducing the speed limit on US 218 through the intersection. Some team members suggested removal of the 55 mph advisory plaques to avoid possible variation in travel speeds by individual vehicles. One suggestion was to establish a regulatory 55 mph speed limit, but it was pointed out that enhanced enforcement would probably be needed to achieve compliance.

Enhancement of pavement markings in the intersection, especially in the median is needed. It was suggested that a double yellow centerline be milled into the pavement and durable pavement markings placed. The same treatment would be recommended for the stop bars and arrows. Other markings such as the edge lines along the acceleration/deceleration lanes should be re-painted annually, or these could be milled in and applied with durable markings at the same time as the median markings described above.

It was suggested that offset left-turn lanes be considered along US 218 to eliminate possible sight restrictions for C-57 traffic in the median. However, offsetting these lanes would further reduce storage space for large commercial vehicles.

The Missouri Department of Transportation is evaluating the benefits of an interactive warning sign for crossing traffic in at-grade expressway intersections. The warning lights on this sign activate when approaching traffic on the higher-speed, mainline roadway reaches a predetermined location from the intersection. The audit team concluded that additional signs such as this may be misunderstood by drivers and may add possible confusion and distraction as well. Pending results of the Missouri evaluation, this device could be re-considered. Signalization of this intersection was mentioned but thought infeasible and possibly counterproductive in such a high-speed isolated location.

Although a few instances of stop sign violations were observed with the video footage and field observations, most driver errors appeared to result from impatience and misjudgment; thus, enhanced law enforcement at this location would probably not be cost effective. However, public information news releases outlining common driver errors, citing current crash statistics, and suggesting driving practices, such as the proper use of the left-turn acceleration lane, might be beneficial.

The position of the cameras would not allow InTrans staff and students to use the video footage to estimate the percentage of left-turning C-57 traffic that properly utilized the existing acceleration lane, although audit team's short-term observations indicated a high recognition and use of this lane by left-turning drivers.

In early May, the Iowa DOT conducted a public meeting to describe a J-turn concept for improving traffic flow through the C-57 intersection. Among the attendees at that meeting was Mr. Keith Borglum, a local businessman and commercial vehicle owner. Mr. Borglum submitted several suggestions and sketches to be considered for improving this intersection. Some of Mr. Borglum's suggestions would require a major investment of funding, such as reconstructing the northbound lanes of US 218 to provide a 900-foot-wide median crossing, but many other improvements were quite similar to those of the audit team. These included extending the

existing deceleration lanes, adding other lanes, and widening the paved area of the median to allow more turning area for large commercial vehicles.

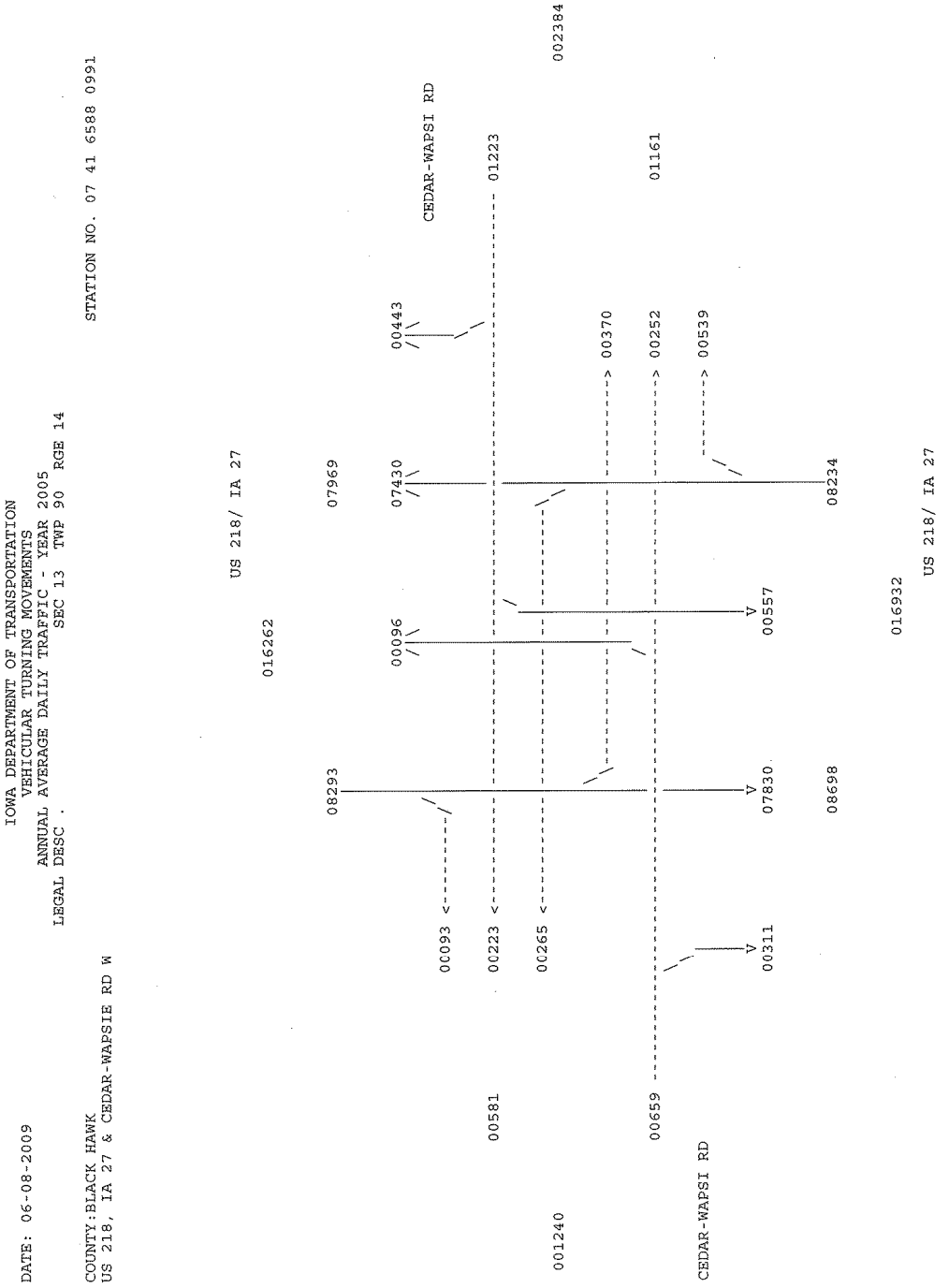
RECOMMENDATIONS

Considering the field review observations, comments from the audit team, and data gathered for the review, the following recommendations for addressing safety and congestion at this intersection are presented for consideration. These improvements are assumed to be short-term in nature until more permanent solutions can be devised and funded.

- To address possible visibility issues for westbound C-57 traffic, reconstruct the existing right-turn lane on northbound US 218 to an offset design. Consider adding two roadway lamps near the taper for this turning lane to enhance nighttime visibility and to provide a distance reference for C-57 vehicles waiting to cross US 218.
- To reduce delay, possible rear-end collisions, and shoulder maintenance, construct a northbound acceleration lane on US 218 for C-57 traffic. Also replace the existing stop sign for this movement with a yield sign.
- The major concern for safety and mobility at this intersection involves westbound C-57 traffic, especially during peak hour periods. Any significant improvement must include addressing this issue. Several options are available with varying levels of effectiveness. As a minimum, pavement markings in the median should be replaced with milled in durable markings and symbols to improve longevity. Another step for consideration would be to establish priority of movement for westbound C-57 traffic by installing yield signs and symbols in the southbound US 218 left-turn lane. The existing length of this lane is 150 feet, and capacity should be reviewed for adequacy to accommodate current commercial vehicle usage. Extension of the lane may be needed.
- The most effective and relatively low-cost improvement to address capacity and traffic movement for westbound C-57 vehicles would be to widen the paved surface of the intersection to permit installing a left-turn storage lane for C-57 traffic and allowing more turning radius for eastbound turning tractor-trailer trucks. Turning lanes at intersections are not uncommon and the existing traffic should easily adapt. Again, milled in and durable pavement markings should be used. A sketch of this option is included in Appendix F.
- Another option to address traffic conflicts in the median would be to construct raised islands in the west intersection of C-57 to restrict traffic movements to right-in and right-out. A raised island in the median could also be used to restrict movements to westbound to southbound left turns and southbound to eastbound left turns, with the latter movement controlled with a yield sign. These innovations would address existing conflicts in the median and eliminate the most problematic crash type—far side right-angle impacts. With this option, westbound traffic on C-57 would likely be diverted north to County Road C-50 and then back to C-57 on old US 218, with about six miles of additional travel. A sketch of this option is included in Appendix F.
- Milled in and durable pavement markings should also be considered for the yellow edge lines along all turn acceleration and deceleration lanes.
- The benefit of adding a southbound acceleration lane for eastbound C-57 traffic turning south onto US 218 should be studied for need.

- If funding can be identified, consider making median improvements to coincide with proposed railroad crossing improvements by the CEDR Company.
- Upgrade existing advance warning signs to high-grade micro-prismatic fluorescent sheeting to improve conspicuity.
- Consider media and public information releases to advise drivers of safety concerns and the crash history of this intersection.

APPENDIX A. TRAFFIC VOLUME AND VEHICLE TURNING MOVEMENTS, 2005



D1530926
COUNTY TOWNSHIP NODE LOCATION YEAR
07 41 6588 0991 2005

TURNING MOVEMENT SYSTEM
TRAFFIC COUNT SUMMARY
ALL VEHICLES

PRINTER ID: TPRT003W PAGE 0001
CITY:
COUNTY: BLACK HAWK

HOUR	******* NORTH LEG ******* US 218/ IA 27				******* EAST LEG ******** CEDAR-WAPSI RD				******* SOUTH LEG ******* US 218/ IA 27				******* WEST LEG ******** CEDAR-WAPSI RD			
	RT	ST	LT	TOTAL	RT	ST	LT	TOTAL	LT	ST	RT	TOTAL	LT	ST	RT	TOTAL
07- 8AM	7	761	34	802	26	11	70	107	10	476	19	505	8	25	42	75
08- 9AM	6	529	20	555	21	18	50	89	9	446	15	470	3	9	25	37
09-10AM	3	515	20	538	23	12	51	86	5	372	24	401	8	15	23	46
11-12PM	9	519	29	557	17	18	24	59	15	405	25	445	6	13	19	38
12-1 PM	6	546	30	582	21	15	35	71	21	442	32	495	6	12	21	39
3- 4PM	5	586	25	616	44	17	28	89	24	695	51	770	8	16	17	41
4- 5PM	8	609	30	647	64	21	34	119	43	810	76	929	11	26	20	57
5- 6PM	11	571	31	613	46	20	38	104	30	753	77	860	7	33	17	57
TOTALS	55	4636	219	4910	262	132	330	724	157	4399	319	4875	57	149	184	390

STATION DISPLAYED
PF4 QUARTER HOUR PF5 CLASS PF7 BKWD PF8 FWD PF15 MAIN MENU PF21 SCREEN PRINT CLEAR EXIT

D1530927
COUNTY TOWNSHIP NODE LOCATION YEAR
07 41 6588 0991 2005

TURNING MOVEMENT SYSTEM
TRAFFIC COUNT SUMMARY
SINGLE UNIT TRUCKS

PRINTER ID: TPRT003W PAGE 0001
CITY:
COUNTY: BLACK HAWK

HOUR	******* NORTH LEG US 218/ IA 27			*******	******* EAST LEG CEDAR-WAPSI RD			********	******* SOUTH LEG US 218/ IA 27			*******	******* WEST LEG CEDAR-WAPSI RD			********
	RT	ST	LT	TOTAL	RT	ST	LT	TOTAL	LT	ST	RT	TOTAL	LT	ST	RT	TOTAL
7- 8AM	0	13	3	16	0	0	2	2	1	14	1	16	0	4	2	6
8- 9AM	1	16	1	18	0	1	0	1	1	37	1	39	0	0	0	0
9-10AM	0	17	1	18	4	1	0	5	1	23	0	24	0	1	2	3
11-12PM	1	22	1	24	0	2	1	3	1	21	1	23	0	0	0	0
12- 1PM	0	22	0	22	3	0	2	5	2	22	0	24	0	1	1	2
3- 4PM	0	20	1	21	2	2	0	4	0	15	0	15	0	0	2	2
4- 5PM	0	12	1	13	0	0	1	1	1	10	2	13	0	0	0	0
5- 6PM	0	5	0	5	0	1	1	2	1	7	0	8	0	1	1	2
TOTALS	2	127	8	137	9	7	7	23	8	149	5	162	0	7	8	15

STATION DISPLAYED
PF4 QUARTER HOUR PF5 CLASS PF7 BKWD PF8 FWD PF15 MAIN MENU PF21 SCREEN PRINT CLEAR EXIT

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TURNING MOVEMENT SYSTEM
TRAFFIC COUNT SUMMARY
COMBINATION TRUCKS

PRINTER ID: TPRT003W PAGE 0001
CITY:
COUNTY: BLACK HAWK

HOUR	NORTH LEG US 218/ IA 27				EAST LEG CEDAR-WAPSI RD				SOUTH LEG US 218/ IA 27				WEST LEG CEDAR-WAPSI RD			
	RT	ST	LT	TOTAL	RT	ST	LT	TOTAL	LT	ST	RT	TOTAL	LT	ST	RT	TOTAL
7- 8AM	0	42	2	44	2	1	5	8	0	44	0	44	2	1	1	4
8- 9AM	0	57	0	57	1	0	1	2	1	50	2	53	0	1	0	1
9-10AM	0	62	0	62	3	2	1	6	0	40	2	42	1	0	1	2
11-12PM	1	65	8	74	2	1	1	4	0	53	5	58	0	1	0	1
12- 1PM	0	81	6	87	0	1	3	4	0	54	2	56	0	0	0	0
3- 4PM	1	100	4	105	1	0	0	1	0	39	0	39	0	1	0	1
4- 5PM	0	80	1	81	5	0	0	5	1	59	0	60	1	0	0	1
5- 6PM	0	73	0	73	7	1	0	8	1	45	0	46	0	0	0	0
TOTALS	2	560	21	583	21	6	11	38	3	384	11	398	4	4	2	10

STATION DISPLAYED
PF4 QUARTER HOUR PF5 CLASS PF7 BKWD PF8 FWD PF15 MAIN MENU PF21 SCREEN PRINT CLEAR EXIT

APPENDIX B. IMAGES OF US 218 AND C-57 INTERSECTION

Figure B.1. Satellite view of US 218 and C-57 intersection (photo courtesy of Google Maps)

Figure B.2. Closer view of US 218 and C-57 intersection (photo courtesy of Google Maps)

Figure B.3. Advance warning sign for intersection of C-57 and northbound US 218

Figure B.4. Right-turn deceleration lane on northbound US 218

Figure B.5. Looking northwest to US 218 intersection with C-57 (photo courtesy of Google Maps)

Figure B.6. Looking west onto C-57 from US 218 intersection with C-57 (photo courtesy of Google Maps)

Figure B.7. US 218/C-57 intersection looking southwest

Figure B.8. Approaching US 218 intersection with C-57 on southbound US 218 (photo courtesy of Google Maps)

Figure B.9. Looking across US 218 intersection with C-57 onto east leg of C-57 (photo courtesy of Google Maps)

Figure B.10. Looking at west leg of C-57 from US 218 and C-57 intersection (photo courtesy of Google Maps)

Figure B.11. Left-turn acceleration lane on southbound US 218

APPENDIX C. HISTORIC SAFETY IMPROVEMENTS, 1993–2008

US 218/IA 27 & Black Hawk County C-57 expressway intersection safety improvements.

- During 1993, red flashing beacons were installed above the "Stop" signs that are in place in the raised pork chop islands on each side of the intersection.
- During 1996, the "Yield" signs that were in place in the median crossover were replaced with "Stop" signs.
- During 1996, the Iowa DOT started painting a Double Yellow Centerline and Stop Bar pavement markings in the median crossover.
- During 2001, "Cross Traffic Does Not Stop" signs were installed below the "Stop" signs on each side of the intersection.
- In July 2001, four "Watch For Cross Traffic" and supplemental "1000 Ft" warning sign installations, with red flags, were installed along northbound and southbound US 218/IA 27 in advance of the intersection.
- During late 2003 and/or early 2004, the Iowa DOT Waverly maintenance equipment operators implemented sign changes to clean up the longitudinal spacing and sequence of signing, along northbound and southbound US 218/IA 27 in advance of the intersection.
- During 2005, Black Hawk County installed "Cedar-Wapsi Road / ¼ Mile" advance street name signs along northbound and southbound US 218/IA 27 in advance of the intersection.
- During 2006, "Recheck Cross Traffic Before Proceeding" signs were installed below the "Stop" signs in the median crossover.
- During 2006, the Iowa DOT relocated the stop bar pavement markings in the median crossovers and started installing them approximately 4' from the near edge of the left turn lanes.
- During 2006, the Iowa DOT installed a northbound right turn lane and a southbound median side acceleration lane along US 218/IA 27.
- Prior to 01/25/07, the Iowa DOT replaced all four of the "Watch For Cross Traffic" and supplemental "1000 Ft" signs with new diamond grade fluorescent yellow warning signs.
- During 2007, the Iowa DOT installed an "Acceleration Lane Next 1400 Feet" sign and installed delineators, with dual yellow reflectors, spaced at 100' on center along the median side acceleration lane.
- During 2007, the Iowa DOT replaced the black on silver "Cross Traffic Does Not Stop" signs with four new diamond grade fluorescent yellow "Cross Traffic Does Not Stop" signs. These signs are in place below the "Stop" signs on each side of the intersection.
- During September 2008, straight arrow pavement markings were installed near the beginning of the southbound median acceleration lane in an effort to encourage motorists to use the acceleration lane.
- On 11/24/08, the Iowa DOT installed four solar powered amber flashing beacons and four supplemental "55 MPH" advisory speed plate signs with each of the existing "Watch For Cross Traffic" signs that are in place along northbound and southbound US 218/IA 27 in advance of C-57.

APPENDIX D. OBSERVATIONS FROM INTERSECTION SURVEILLANCE

IOWA STATE UNIVERSITY
Institute for Transportation

DATE: 6-17-2009

TO: US-218 & C-57 Road Safety Audit Team, Tom Welch
FROM: Joshua Hochstein

SUBJECT: Observations from 6-9-2009 Intersection Surveillance at US-218 & C-57

US-218 & C-57 (W. Cedar Wapsi Road) Video Surveillance Summary

Background:

On Tuesday June 9, 2009, InTrans staff monitored traffic operations at the intersection of US-218 & C-57 (W. Cedar Wapsi Road) in Black Hawk County, IA from 7:00 AM until 6:00 PM. This intersection is between Waterloo and Janesville on the Avenue of the Saints Corridor. US-218 is a four-lane divided expressway with a 65 mph speed limit while C-57 is a two-lane undivided paved county road. The intersection is two-way stop-controlled with the stop control on C-57 and in the median. In 2005, 18,400 vehicles entered the intersection on a daily basis with 16,500 entering from US-218 (equal distribution from North and South) and 1,900 entering from C-57 (1,200 entering from the East leg). There were approximately 13% trucks entering from US-218 and 8% trucks entering from C-57 at that time.

Between 2001 and 2008 this intersection experienced 55 total vehicle collisions (6.88 per year) with 1 fatal, 27 injury, and 27 PDO. Of these collisions, 37 (67%) were right-angle with 21 far-side and 16 near-side. Of these 37 right-angle collisions, 27 involved minor road vehicles entering the intersection from the east leg. 12 intersection collisions (22%) were rear-end with 6 occurring on the mainline and 6 on the minor road. 47 of the 55 collisions (85%) occurred between the hours of monitoring (7 AM – 6 PM) with 30 occurring between the hours of 7-8 AM, 11 AM – Noon, and 4-6 PM. 47 (85%) occurred during daylight and 6 (11%) occurred in darkness. 46 (84%) occurred under dry surface conditions, 4 (7%) with a wet surface, and 3 (5%) with an icy surface. A collision diagram is included in Figure 1 at the end of this document.

Intersection Site Condition Observations:

Nighttime collisions do not seem to be a particular problem and intersection lighting is present via 6 luminaires. The C-57 approaches have rumble strips, raised pork chop islands for right-turn channelization, and 2 stop signs (one to the right of the through/left lane in the island and one to the right of the right-turn lane). Both of these stop signs have "Cross Traffic Does Not Stop" warning signs mounted beneath with one-

way signs mounted above. The stop sign mounted in the raised island includes a single red flashing beacon on top of the stop sign as well. The median is stop controlled with "Recheck Cross Traffic Before Proceeding" warning signs mounted beneath for both directions of travel. There is not a red flasher above these median stop signs. The median centerline and all stop bars at the intersection are almost completely worn off. The median is wide enough to store 1 large truck. In addition, there is an active railroad crossing over the west leg of C-57 at the intersection. There are "Railroad Crossing" signs and flashers in place, but no gates.

Along northbound and southbound US-218, there are two "Watch For Cross Traffic" signs on each approach (one mounted in the median and the other on the shoulder) with amber flashing beacons and 55 mph advisory speed plates. There is a right-turn lane on northbound US-218 and left-turn storage lanes (150 feet) on both northbound and southbound US-218. There is also a left-turn median acceleration lane in place for minor road traffic traveling westbound to southbound. There are fading arrows marked on the pavement within this lane as well as an "Acceleration Lane Next 1400 Feet" sign facing traffic on southbound US-218.

Video Surveillance Observations:

Video intersection surveillance was conducted on June 9, 2009. In the AM period we had sunny conditions and clear skies. In the PM, we had cloudy/overcast conditions. Three cameras were set up at the intersection. 2 were black and white video cameras recording to VHS tape mounted approximately 40 feet in the air on the southeast corner of the intersection. One focused on the west leg of C-57 and the median while the other focused on the east leg of C-57, the median, and the US-218 lanes to the north. The third was a color digital video camera mounted on a tripod in the northeast corner of the intersection focused on the median.

In general, the intersection operated safely. There was one near rear-end collision on US-218 in which a westbound vehicle on C-57 rolled through the near-side stop sign and turned left directly into the southbound US-218 lanes without stopping in the median or using the median acceleration lane. A southbound vehicle on US-218 was forced to slam on their brakes and successfully avoided a collision. Other events and driver behavior witnessed included:

1) median lockups due to large trucks turning left off US-218 through the median,
2) left-turning trucks exiting US-218 taking their front ends off the pavement in the median so their rear-ends wouldn't block the median,
3) turn behind behavior/median centerline violations/side-by-side queuing in the median as vehicles snuck into the left-turn median acceleration lane behind or around another vehicle already in the median,
4) a westbound vehicle on C-57 began to enter the intersection, then reversed back to the stop sign as a north to westbound left-turn truck towing a boat entered the median,
5) a truck which parked for a few minutes in the northbound right-turn lane on US-218,

6) a mini-van which parked for a few minutes in the northbound left-turn lane on US-218,
7) mainline weaving around vehicles turning right onto US-218,
8) right-turn vehicles queued up behind a through/left-turning semi on the C-57 approaches would drive off the pavement to slip past the trailer and into the right-turn lane,
9) gap anticipation by minor road traffic trying to judge a gap while slowly rolling toward the stop signs (either on the near-side or in the median),
10) up to 4 vehicles going the same direction queued up within the median at one time,
11) missed gaps as minor road traffic seemed to have difficulty determining what lanes US-218 traffic was in or due to late separation of traffic (i.e., short right-turn and left-turn deceleration lanes on US-218) and no trust in turn signals, and
12) lots of truck traffic with "Oversize Load" posted on the vehicle.

A DVD accompanying this report will be available which shows examples of these events. If necessary, the video surveillance recording could also be used to do further studies such as counting traffic, estimating peak hour flow rates, truck percentages, vehicle stop delay (on minor road as well as in median), measuring time gaps accepted versus those which were denied, counting the number of occurrences of side-by-side queuing, vehicles which did not stop in the median, etc.

Suggested Intersection Solutions:

After watching the US-218 & C-57 intersection operate, my support of a J-Turn Intersection at this location is waning. There is a high percentage of minor road traffic crossing or turning left who would be redirected via a J-turn and there are relatively few gaps to merge into, especially during peak hours (a larger gap is needed to turn right and merge from stop than to cross over the near-side lanes). For a J-turn to work, there would have to be adequate right-turn acceleration lanes, U-turn deceleration lanes, and a large area provided for weaving, OR a direct crossing path from the minor road into a right-turn median acceleration/creeper lane to direct traffic upstream to the U-turn location. In addition, it would be extremely difficult for trucks to find adequate gaps in US-218 traffic as they U-turn across US-218 using loons/bulb-outs. It would be more likely for them to find gaps if full left-hand U-turn jughandles (similar to the one shown in Figure 2) were provided so that trucks could first cross the expressway lanes and then finish their U-turn maneuver while completely out of the way of through traffic.

It seems that the most pressing issue is vehicle positioning within the median. Large semi trailers turning left off US-218 tend to clog/block the median. Passenger vehicle queues can also have this same effect. If vehicles yield in the left-turn lane prior to entering the median, they can block sight lines for vehicles already in the median attempting to cross over or merge into the far-side lanes. In addition, vehicle queues in the median can make it difficult to enter the left-turn acceleration lane and make it extremely difficult for large trucks to turn left through the median from the minor road. Furthermore, the left-turn storage lanes are short requiring deceleration to occur on the

mainline which could lead to large speed differentials and rear-end collisions. Tapered offset left-turn lanes (similar to those illustrated in Figure 3) with Yield signs/bars at their end may be one possible solution to help set up better vehicle positions within the median and keep large trucks from blocking the median off to other traffic. Another possible median treatment would be to provide median channelization islands as shown in Figures 4 & 5. These islands help to make the median stop signs more visible by placing them more in the minor road driver's line-of-sight and they allow the median driver to position themselves closer to the through lanes, thus reducing the distance to cross. These two concepts (offset lefts and median channelization) could be combined in a single design which creates more orderly median vehicle positions and operations. Another potential treatment includes keeping the median centerline and stop bars more visible by painting the lines more often. This may help relieve some of the median centerline violations and lead to improved vehicle positioning. Additional signage/marking could also be provided to help make minor road traffic more aware of the left-turn median acceleration lane's presence and positively guide minor road traffic into that lane.

Shadowing (sight-line obstructions by other traffic) was reported to be an issue in many near-side right-angle collisions. This shadowing could be occurring in two ways: 1) vehicles in the right-turn deceleration lane could be obstructing sight-lines to through traffic on northbound US-218 or 2) through/left-turning vehicles stopped on the minor road at the stop sign could be obstructing vision for traffic turning right from that same approach. Right-turning traffic also currently has to crank their necks around to see oncoming traffic due to the angle the pork chop channelization island creates. These issues could be improved by constructing offset right-turn deceleration lanes and right-turn acceleration lanes. Offset right and left-turn lanes would also help to filter US-218 traffic more in advance of the intersection; thereby allowing minor road traffic to be more confident in trusting approaching vehicle actions when selecting gaps. Right-turn acceleration lanes would reduce speed differentials on the mainline and allow right-turn traffic to merge using their rear-view mirrors rather than judging gaps at a poor angle of visibility. Another possible solution (rather than right-turn acceleration lanes) would be to redesign the pork chop channelization to position the right-turner at a better visibility angle, thereby reducing shadowing and skew.

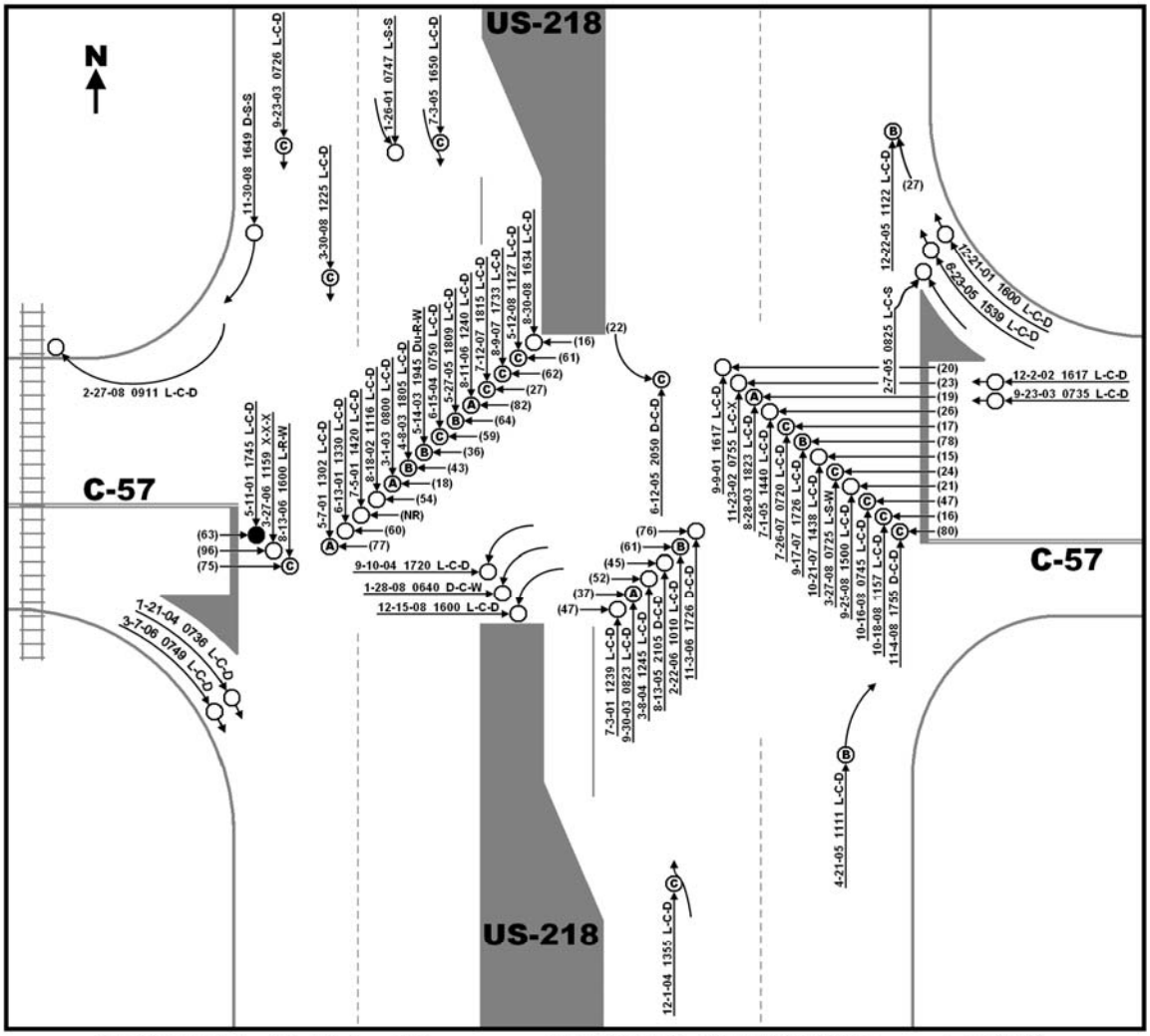

FIGURE 1: Collision Diagram at US-218 & C-57 (2001 through 2008)

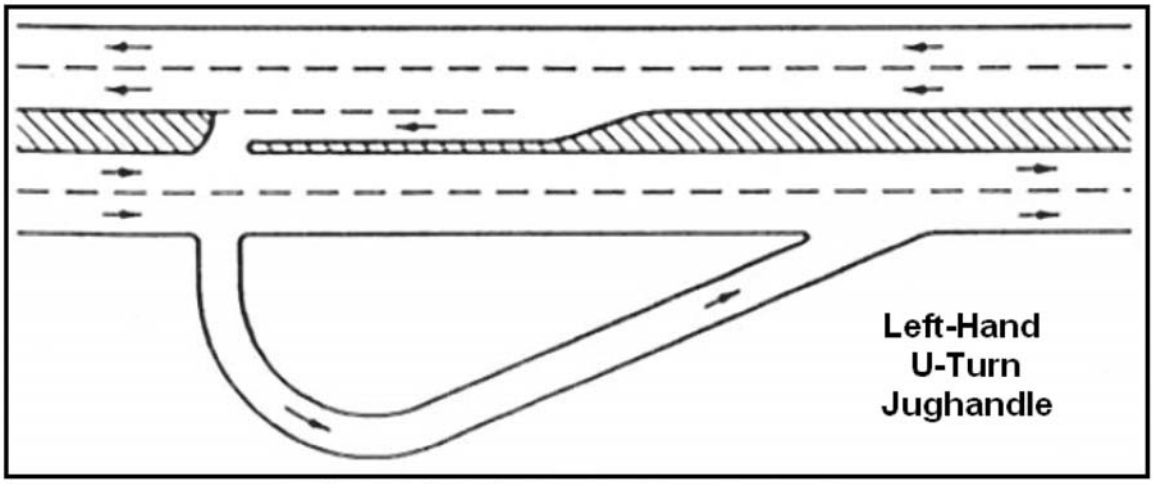

FIGURE 2: Left-Hand U-Turn Jughandle

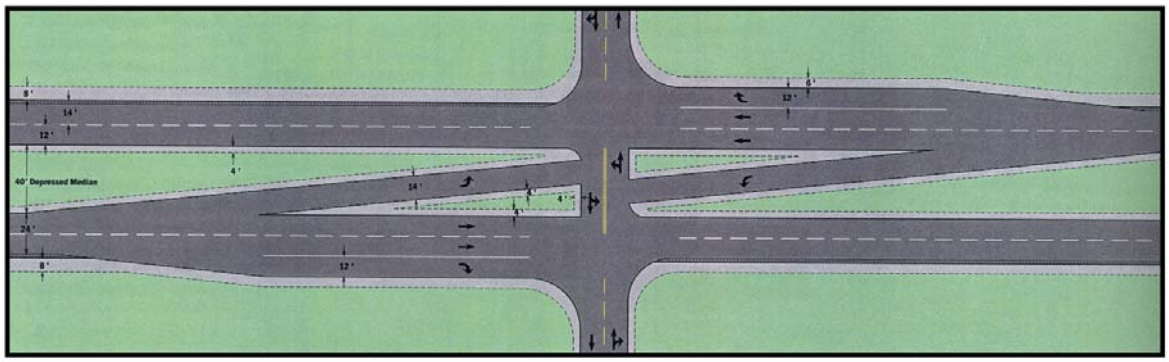

FIGURE 3: Tapered Offset Left-Turn Lanes

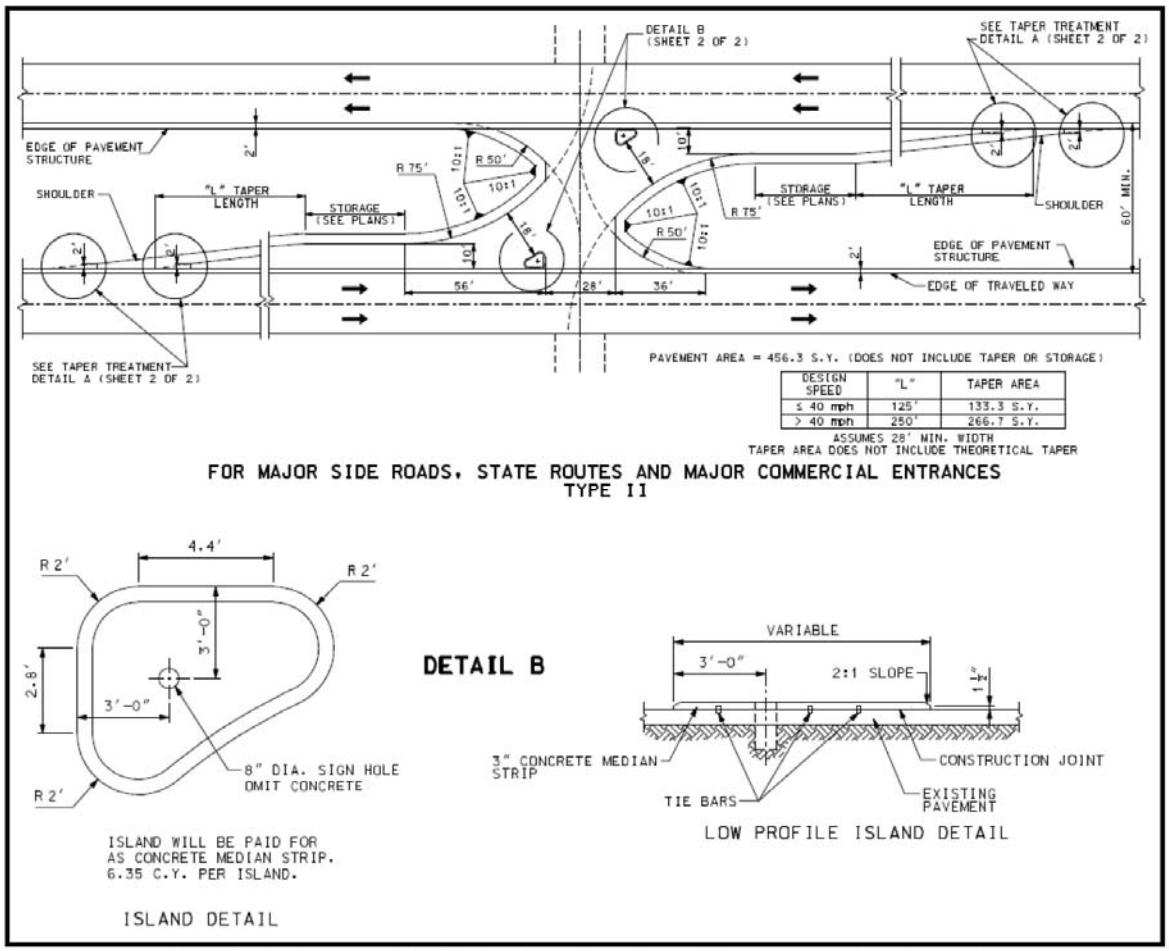

FIGURE 4: MoDOT Plan for Median Channelization Islands

FIGURE 5: Pictures of MoDOT Median Channelization Islands with Delineators

APPENDIX E. CRASH DATA, 2001–2008

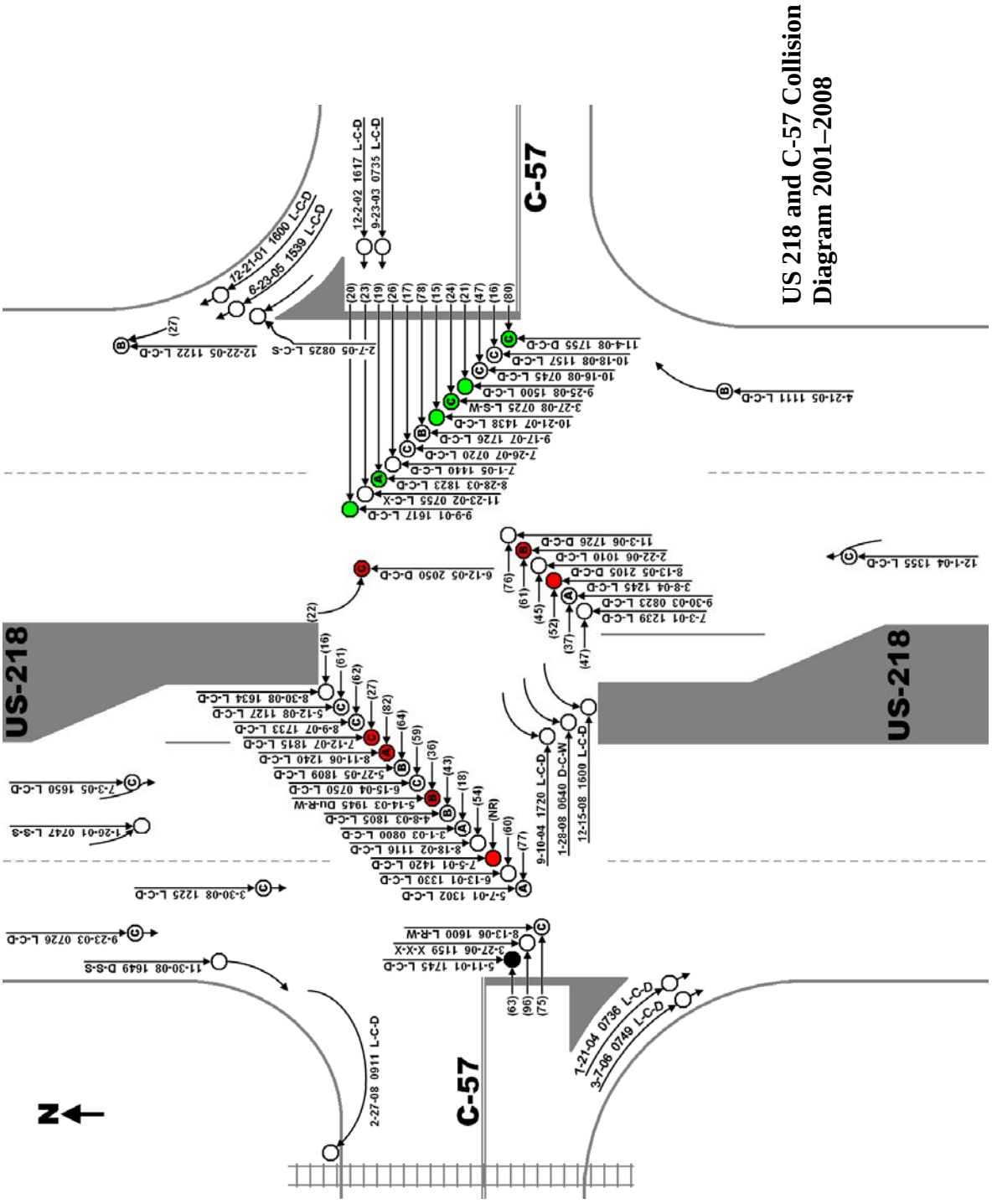

Figure E.1. Collision diagram for 2001 to 2008

The following disclaimer applies to Tables E.1. through E.14: The information contained in this report was derived from the April 2, 2009, Iowa Department of Transportation crash database. The 2008 data are considered unedited, incomplete, and preliminary. If errors or odd cases are found, please communicate the case number or send a printed crash report to Michael Pawlovich, Iowa DOT, Office of Traffic and Safety, (Michael.Pawlovich@dot.iowa.gov, 515.239.1428). Since the database is actively being updated, edited, and reviewed, some of the fatality totals may differ from the Fatality Analysis Reporting System (FARS). If fatal crash/fatality errors or odd cases are found, please contact Scott Falb, Iowa DOT, Office of Driver Services, (Scott.Falb@dot.iowa.gov, 515.237.3154).

Table E.1. Crashes by major cause

Year	Major Cause																	Total
	Animal	Crossed centerline	Driving too fast for conditions	Followed too close	FTYROW: From parked position	FTYROW: From stop sign	FTYROW: Making left turn	FTYROW: Other	Inattentive/distracted by: Use of phone or other device	Made improper turn	No improper action	Other improper action	Vision obstructed	Ran off road-straight	Ran Stop Sign	Swerving/Evasive Action	Unknown	
2001						4					1					2		**7**
2002	2				1	1						1						**5**
2003	1			1		5												**7**
2004	1					2	1	1	1		1							**7**
2005			1	1		5						1		1				**9**
2006	1					1						1			2	1	1	**7**
2007		1	1			3									2	1		**8**
2008		1	1			5				1	1	1	1		1			**12**
2009															1			**1**
Total	**5**	**2**	**3**	**2**	**1**	**26**	**1**	**1**	**1**	**1**	**3**	**4**	**1**	**1**	**6**	**4**	**1**	**63**

Table E.2. Crashes by manner of collision

Year	Manner of Collision							Total
	Angle - oncoming left turn	Broadside	Non-collision	Rear-end	Sideswipe - same direction	Sideswipe - opposite direction	Not Reported/ Unknown	
2001		4			2		1	**7**
2002		2		1			2	**5**
2003		5	1	1				**7**
2004	1	2	1	3				**7**
2005		5		2	2			**9**
2006		4		1			2	**7**
2007		5	2		1			**8**
2008		7	1	2		2		**12**
2009				1				**1**
Total	**1**	**34**	**5**	**11**	**5**	**2**	**5**	**63**

Table E.3. Crashes by hour of day

Year	Hour of Day																							Total
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
2001								1					1	1	1		2	1							**7**
2002								1				1					1		1				1		**5**
2003								1	2										2	1	1				**7**
2004	1							3					1	1				1							**7**
2005									1			2			1	1	1		1		1	1			**9**
2006								1			1	1	1				1	1			1				**7**
2007								1	1						1	1		2	2						**8**
2008							1	2		1		2	1			1	3	1							**12**
2009																		1							**1**
Total	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**10**	**4**	**1**	**1**	**6**	**4**	**2**	**3**	**3**	**8**	**7**	**6**	**1**	**3**	**1**	**1**	**0**	**63**

Table E.4. Crashes by day of week

Year	Day of Week							Total
	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	
2001	1	1	1		1	3		**7**
2002	2	1	1				1	**5**
2003			3	2	1		1	**7**
2004		2	1	2	1	1		**7**
2005	2	1			3	2	1	**9**
2006	2	1	1	1		2		**7**
2007	1	1			3	2	1	**8**
2008	2	3	1	1	3		2	**12**
2009						1		**1**
Total	**10**	**10**	**8**	**6**	**12**	**11**	**6**	**63**

Table E.5. Crashes by month

Year	Month												Total
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	
2001	1				2		2		1			1	**7**
2002					1			1			1	2	**5**
2003			1	1	1			2	2				**7**
2004			1		1	1	2		1			1	**7**
2005		1		1	1	2	2	1				1	**9**
2006		2	2					2			1		**7**
2007		1	1				2	1	1	1		1	**8**
2008	1	1	2		1			1	1	2	2	1	**12**
2009		1											**1**
Total	**2**	**6**	**7**	**2**	**7**	**3**	**8**	**8**	**6**	**3**	**4**	**7**	**63**

Table E.6. Crashes by severity and day of week

Crash Severity	Day of Week							Total
	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	
Fatal						1		**1**
Major Injury		1	1		1	1	1	**5**
Minor Injury		1	1	2	2	2		**8**
Possible/Unknown	4	1	3	1	5		2	**16**
PDO	6	7	3	3	4	7	3	**33**
Total	**10**	**10**	**8**	**6**	**12**	**11**	**6**	**63**

Table E.7. Crashes by severity and hour of day

Crash Severity	Hour of Day																							Total
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Fatal																		1							1
Major Injury									2				1	1					1						5
Minor Injury											1	2						1	3	1					8
Possible/ Unknown								5	1			2	1	1			2	2	1		1				16
PDO	1						1	5	1	1		2	2		3	3	6	3	1		2	1	1		33
Total	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**10**	**4**	**1**	**1**	**6**	**4**	**2**	**3**	**3**	**8**	**7**	**6**	**1**	**3**	**1**	**1**	**0**	**63**

Table E.8. Crashes by road surface condition

Road Surface Conditions							
Year	Dry	Ice	Wet	Snow	Unknown	Not Reported	Total
2001	6			1			**7**
2002	2					3	**5**
2003	5		1		1		**7**
2004	6					1	**7**
2005	8			1			**9**
2006	4		1		1	1	**7**
2007	6	2					**8**
2008	9	1	2				**12**
2009	1						**1**
Total	**47**	**3**	**4**	**2**	**2**	**5**	**63**

Table E.9. Crashes by light condition

Year	Light Conditions					Total
	Dark - roadway lighted	Dark - roadway not lighted	Daylight	Dusk	Unknown/Not Reported	
2001			7			**7**
2002			3		2	**5**
2003			5	1	1	**7**
2004			6		1	**7**
2005	1	1	7			**9**
2006	1		4		2	**7**
2007		1	7			**8**
2008	3		9			**12**
2009			1			**1**
Total	**5**	**2**	**49**	**1**	**6**	**63**

Table E.10. Crashes by weather conditions

Year	Weather Conditions								Total
	Blowing sand/soil/dirt/snow	Clear	Cloudy	Snow	Partly cloudy	Rain	Not Reported	Unknown	
2001		5		1	1				**7**
2002		2			1		2		**5**
2003		3	1		1	1		1	**7**
2004		3			3		1		**7**
2005		5			4				**9**
2006		3	1			1	1	1	**7**
2007	1	7							**8**
2008		7	3	2					**12**
2009		1							**1**
Total	**1**	**36**	**5**	**3**	**10**	**2**	**4**	**2**	**63**

Table E.11. Crashes by driver condition

Year	Driver Condition					Total
	Apparently normal	Emotional (e.g., depressed/angry/ disturbed)	Under the influence of alcohol/drugs/ medications	Other (explain in narrative)	Not Reported/ Unknown	
2001	13				1	**14**
2002	6				2	**8**
2003	12			1	1	**14**
2004	11				2	**13**
2005	17		1			**18**
2006	10				3	**13**
2007	13	1				**14**
2008	23					**23**
2009	2					**2**
Total	**107**	**1**	**1**	**1**	**9**	**119**

Table E.12. Crashes by driver age

Year	Driver Age																				Total
	15	16	17	18	19	20	21-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	70-74	75-79	80-84	95-98	Unknown	
2001			1		1	1	1	3	1		1	1	1		1		1			1	14
2002					1		1		1	1	2		2								8
2003				1	1	1	1	1	1	3	1	3		1							14
2004					1		1	2	1	1	1		4	1		1					13
2005							4	2	1	1	2	4	1		3						18
2006					1				1		3	1	1	1	1		2	1	1		13
2007	1		1				2	4	1			1	1	1	1		1				14
2008		2				1	5	2	2	3	1	2	1	1	2			1			23
2009													1			1					2
Total	1	2	2	1	5	3	15	14	9	9	11	12	12	5	8	2	4	2	1	1	119

Table E.13. Crashes by driver contributing circumstances

Year	Driver Contributing Circumstances																	Total
	Crossed centerline	Inattentive/ distracted by: Use of phone or other device	Swerved to avoid: vehicle-object-non-motorist-or animal in roadway	FTYROW: From parked position	FTYROW: From stop sign	FTYROW: Making left turn	FTYROW: Other	Driving too fast for conditions	Lost Control	Made improper turn	Traveling wrong way or on wrong side of road	No improper action	Other improper action	Vision obstructed	Ran stop sign	Followed too close	Not Reported/ Unknown	
2001					4				1			7	1				1	14
2002			1	1	1							1	1				3	8
2003					5							5	1	1		1	1	14
2004		1			2	1	1					6					2	13
2005					5			1				9	2			1		18
2006					1							5	2		2		3	13
2007	1				3			1	1			6			2			14
2008					5			1		1	1	11	1	1	1		1	23
2009												1			1			2
Total	1	1	1	1	26	1	1	3	2	1	1	51	8	2	6	2	11	119

Table E.14. Crashes by vehicle type

Year	Vehicle Type									Total
	Four-tire light truck (pick-up/panel)	Motor home/recreational vehicle	Motorcycle	Passenger car	Single-unit truck (2-axle/6-tire)	Sport utility vehicle	Tractor/semi-trailer	Van or mini-van	Not Reported/ Unknown	
2001	7			5				1	1	**14**
2002	1			4		2		1		**8**
2003	3			7				3	1	**14**
2004	3		2	7				1		**13**
2005	4			7		2	2	3		**18**
2006	1			7		3		1	1	**13**
2007	1	1	1	8		2		1		**14**
2008	3			13	1	2	2	2		**23**
2009				1				1		**2**
Total	**23**	**1**	**3**	**59**	**1**	**11**	**4**	**14**	**3**	**119**

APPENDIX F. SKETCHES OF IMPROVEMENT OPTIONS

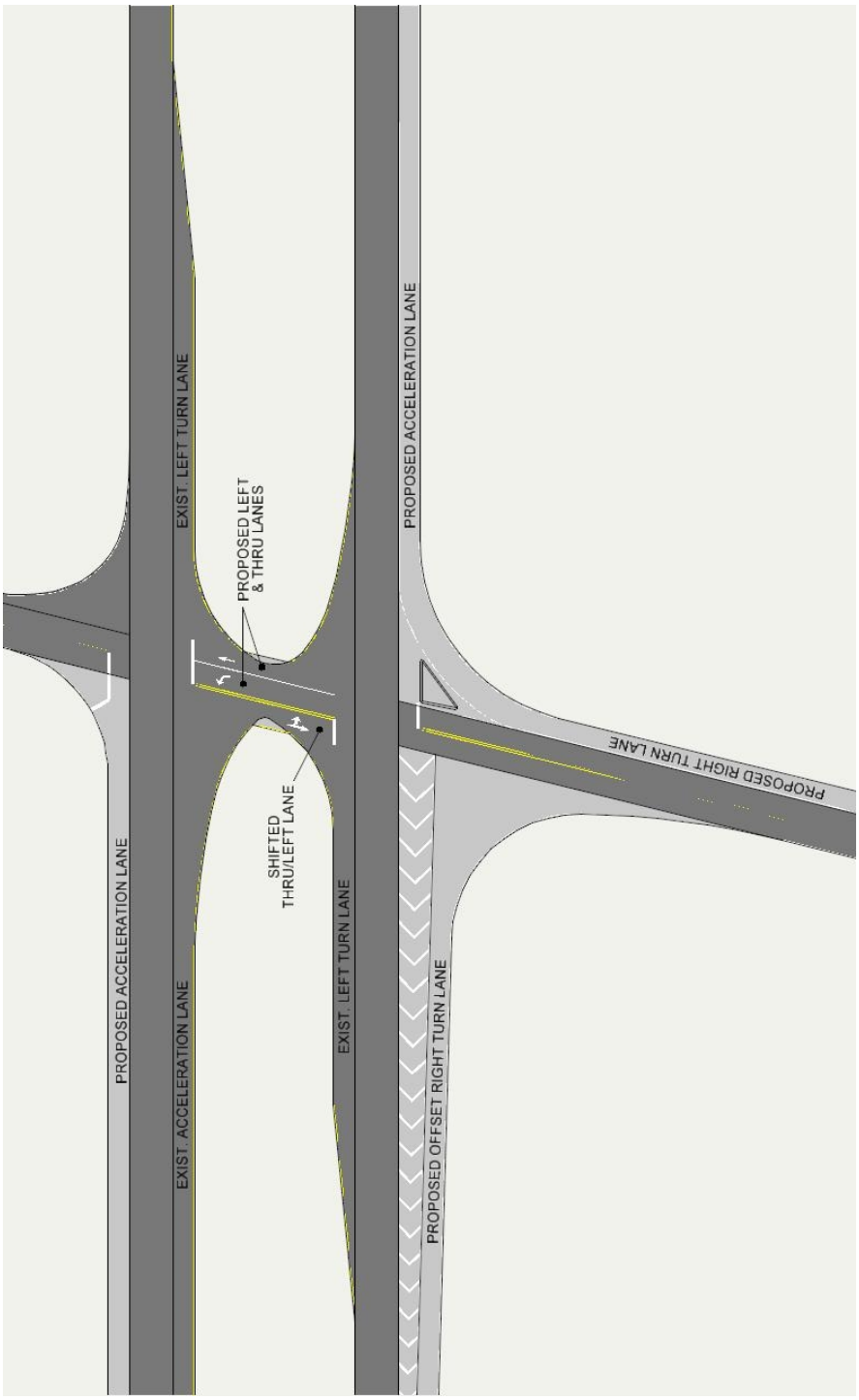

Figure F.1. Median turn-lane option with proposed offset right-turn and acceleration lanes

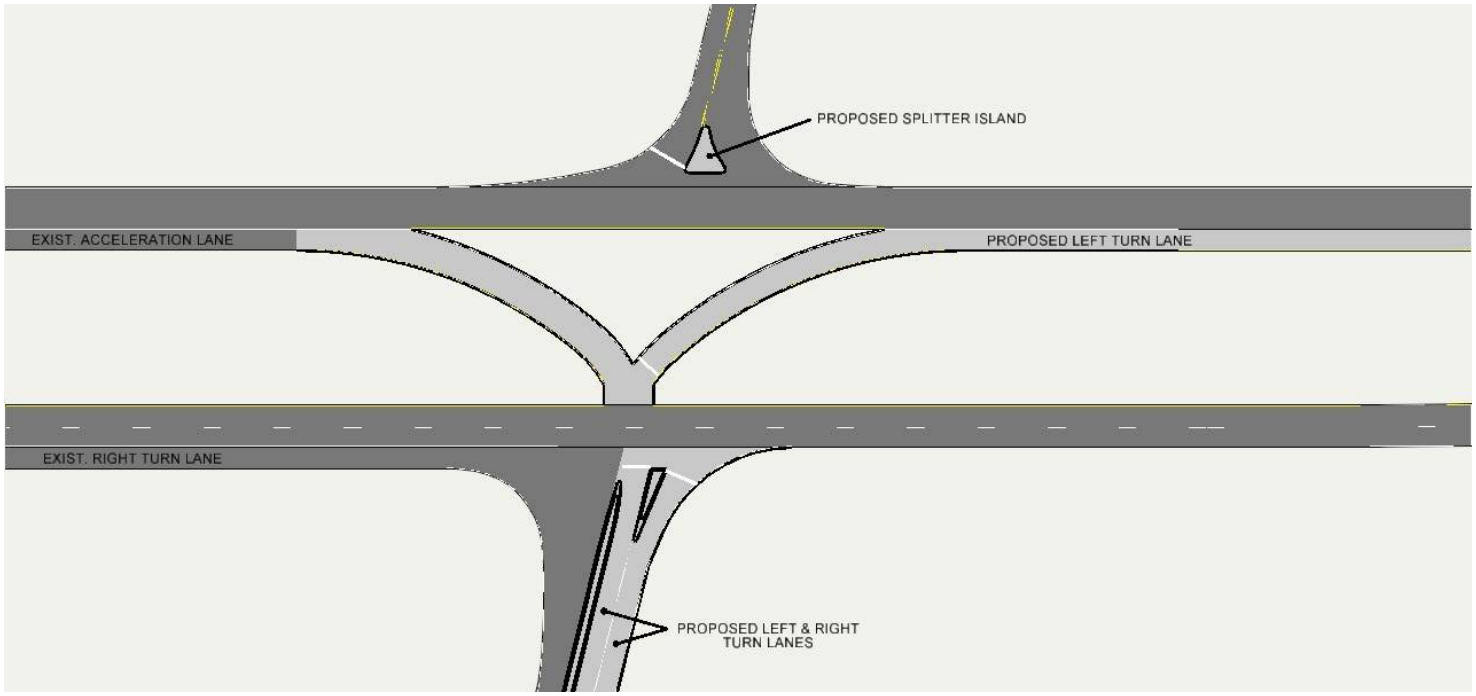

Figure F.2. Right-in/right-out option with proposed turn lanes and a splitter island