ROAD SAFETY AUDIT

ROCHESTER ROAD CORRIDOR

OAKLAND COUNTY

FINAL REPORT

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FINAL REPORT

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Table of Contents

1.0 INTRODUCTION 1
1.1 Project Location 2
2.0 ROAD SAFETY AUDITS 4
2.1 Road Safety Audit Team 4
2.2 Road Safety Audit Materials 5
2.3 RSA Team and Process 5
3.0 CORRIDOR CHARACTERISTICS 8
3.1 Corridor Conditions and Adjacent Land Uses 8
3.2 Traffic Control 9
3.3 Traffic Volumes 9
3.4 Collision Characteristics 10
4.0 ROCHESTER ROAD AND AVON ROAD 11
4.1 Intersection Geometry 11
4.2 Traffic Control 13
4.3 Collision Analysis 15
4.4 Safety Issues and Suggested Mitigation Measures 18
5.0 ROCHESTER ROAD AND HAMLIN ROAD 27
5.1 Intersection Geometry 27
5.2 Traffic Control 29
5.3 Collision Analysis 31
5.4 Safety Issues and Suggested Mitigation Measures 34
6.0 ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH ROAD 38
6.1 Intersection Geometry 38
6.2 Traffic Control 40
6.3 Collision Analysis 42
6.4 Safety Issues and Suggested Mitigation Measures 45
7.0 ROCHESTER ROAD AND AUBURN ROAD 51
7.1 Intersection Geometry 51
7.2 Traffic Control 53
7.3 Collision Analysis 55
7.4 Safety Issues and Suggested Mitigation Measures 58
8.0 ROCHESTER ROAD AND MEIJER DRIVEWAYS 63
8.1 Intersection Geometry 63
8.2 Traffic Control 65
8.3 Collision Analysis 67
8.4 Safety Issues and Suggested Mitigation Measures 71
9.0 ROCHESTER ROAD AND M-59 RAMPS 75
9.1 Intersection Geometry 75
9.2 Traffic Control 76
9.3 Collision Analysis 77
9.4 Safety Issues and Mitigation Measures 81
10.0 SOUTH BOULEVARD AND ROCHESTER ROAD 85
10.1 Intersection Geometry 85
10.2 Traffic Control 86
10.3 Collision Analysis 88
10.4 Safety Issues and Suggested Mitigation Measures 91

APPENDIX A: COLLISION DIAGRAM LEGEND

List of Figures

FIGURE 1-1 RSA 8 STEP PROCESS 1
FIGURE 1-2 STUDY INTERSECTIONS AND CORRIDOR 3
FIGURE 3-1 CURRENT CORRIDOR CONDITIONS 8
FIGURE 3-2 ANNUAL AVERAGE DAILY TRAFFIC COMPARISON 10
FIGURE 4-1 CONDITION DIAGRAM: ROCHESTER ROAD AND AVON ROAD 11
FIGURE 4-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND AVON ROAD 12
FIGURE 4-3 SITE OBSERVATION PHOTOGRAPHS: ROCHESTER ROAD AND AVON ROAD 13
FIGURE 4-4 SIGNALS DIAGRAM: ROCHESTER ROAD AND AVON ROAD 14
FIGURE 4-5 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND AVON ROAD 15
FIGURE 4-6 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND AVON ROAD 16
FIGURE 4-7 COLLISION DIAGRAM: ROCHESTER ROAD AND AVON ROAD 17
FIGURE 4-8 ISSUES DIAGRAM: ROCHESTER ROAD AND AVON ROAD 18
FIGURE 5-1 CONDITION DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD 27
FIGURE 5-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND HAMLIN ROAD 28
FIGURE 5-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD 30
FIGURE 5-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND HAMLIN ROAD 31
FIGURE 5-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND HAMLIN ROAD 32
FIGURE 5-6 COLLISION DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD 33
FIGURE 5-7 ISSUES DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD 34
FIGURE 5-8 MITIGATIONS DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD 37
FIGURE 6-1 CONDITION DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH 38
FIGURE 6-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH 39
FIGURE 6-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH 41
FIGURE 6-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH 42
FIGURE 6-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH 43
FIGURE 6-6 COLLISION DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH 44
FIGURE 6-7 ISSUES DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH 46
FIGURE 6-8 MITIGATIONS DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH 50
FIGURE 7-1 CONDITION DIAGRAM: ROCHESTER ROAD AND AUBURN ROAD 51
FIGURE 7-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND AUBURN ROAD 52
FIGURE 7-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND AUBURN ROAD 54
FIGURE 7-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND AUBURN ROAD 55
FIGURE 7-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND AUBURN ROAD 56
FIGURE 7-6 COLLISION DIAGRAM: ROCHESTER ROAD AND AUBURN ROAD 57
FIGURE 7-7 ISSUES DIAGRAM: ROCHESTER ROADX AND AUBURN ROAD 58
FIGURE 8-1 CONDITION DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS 63
FIGURE 8-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND MEIJER DRIVEWAY (SIGNALIZED) 64
FIGURE 8-3 SITE PHOTOGRAPHS: ROCHESTER ROAD AND MEIJER DRIVEWAYS (UNSIGNALIZED) 65
FIGURE 8-4 SIGNALS DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS 66
FIGURE 8-5 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND MEIJER DRIVEWAYS 67
FIGURE 8-6 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND MEIJER DRIVEWAYS 68
FIGURE 8-7 COLLISION DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS 69
FIGURE 8-8 ISSUES DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS 71
FIGURE 8-9 MITIGATION MEASURES DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS 74

FIGURE 9-1 CONDITION DIAGRAM: ROCHESTER ROAD AND M-59 RAMPS 75
FIGURE 9-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND M-59 RAMPS 76
FIGURE 9-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND M-59 RAMPS 77
FIGURE 9-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND M-59 RAMPS 78
FIGURE 9-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND M-59 RAMPS 79
FIGURE 9-6 COLLISIONS DIAGRAM: ROCHESTER ROAD AND M-59 RAMPS 80
FIGURE 9-7 ISSUES DIAGRAM: ROCHESTER ROAD AND M-59 RAMPS 81
FIGURE 10-1 CONDITIONS DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD 85
FIGURE 10-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND SOUTH BOULEVARD 86
FIGURE 10-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD 87
FIGURE 10-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND SOUTH BOULEVARD 88
FIGURE 10-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND SOUTH BOULEVARD 89
FIGURE 10-6 COLLISION DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD 90
FIGURE 10-7 ISSUES DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD 91
FIGURE 10-8 MITIGATIONS DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD 93

1.0 INTRODUCTION

The Michigan Department of Transportation (MDOT) retained Opus International Consultants Inc. to lead an Operational Stage Road Safety Audit (RSA) on Rochester Road (M-150) corridor in Oakland County. The objectives of this study were to conduct a formal safety performance examination of the study corridor with an independent, multi-disciplinary team. RSA's are a proactive approach to addressing safety of all road users and involve identifying both safety issues and developing mitigation measures.

This RSA followed the eight-step process which is detailed in the recent MDOT Road Safety Audit training course, as shown in **Figure 1-1**.

Figure 1-1 RSA 8 STEP PROCESS

This document is the draft report for the *Rochester Road (M-150) Corridor Road Safety Audit*. The following sections will detail the RSA process, the methodology for this analysis, and data obtained throughout the study. The report will also present all significant findings and safety issues as well as provide recommended mitigation strategies.

1.1 Project Location

This operational stage RSA of Rochester Road (M-150) between Avon Road and South Boulevard is being completed per the request of MDOT and the City of Rochester Hills. The Rochester Road corridor is shown in Figure 1-2. The intersections (from north to south) include:

- Rochester Road & Avon Road
- Rochester Road & Hamlin Road
- Rochester Road & Barclay Road/Wabash Road
- Rochester Road & Auburn Road
- Rochester Road & the Meijer Driveways
- Rochester Road & M-59 Ramps
- Rochester Road & South Boulevard

The study corridor was identified for further review in the recently completed *City of Rochester Hills Major Throughfare Plan.*[1] The specific study intersections were chosen by MDOT and the City of Rochester Hills for safety assessment on the basis of crash history. The City of Rochester Hills Major Throughfare Plan provided the basis for this analysis of the Rochester Road corridor and suggested mitigation measures to existing issues.

The objectives of this report are to:

- Observe traffic operations and safety at intersections;
- Identify physical and operational problems that may affect traffic safety;
- Develop and evaluate potential countermeasures to reduce the frequency and severity of collisions.

[1] The Corrinado Group of Michigan Inc. 2008 *Rochester Hills Master Thoroughfare Plan Update* http://www.rochesterhills.org/city_services/uploads/Master_Thoroughfare_Final_Report.pdf

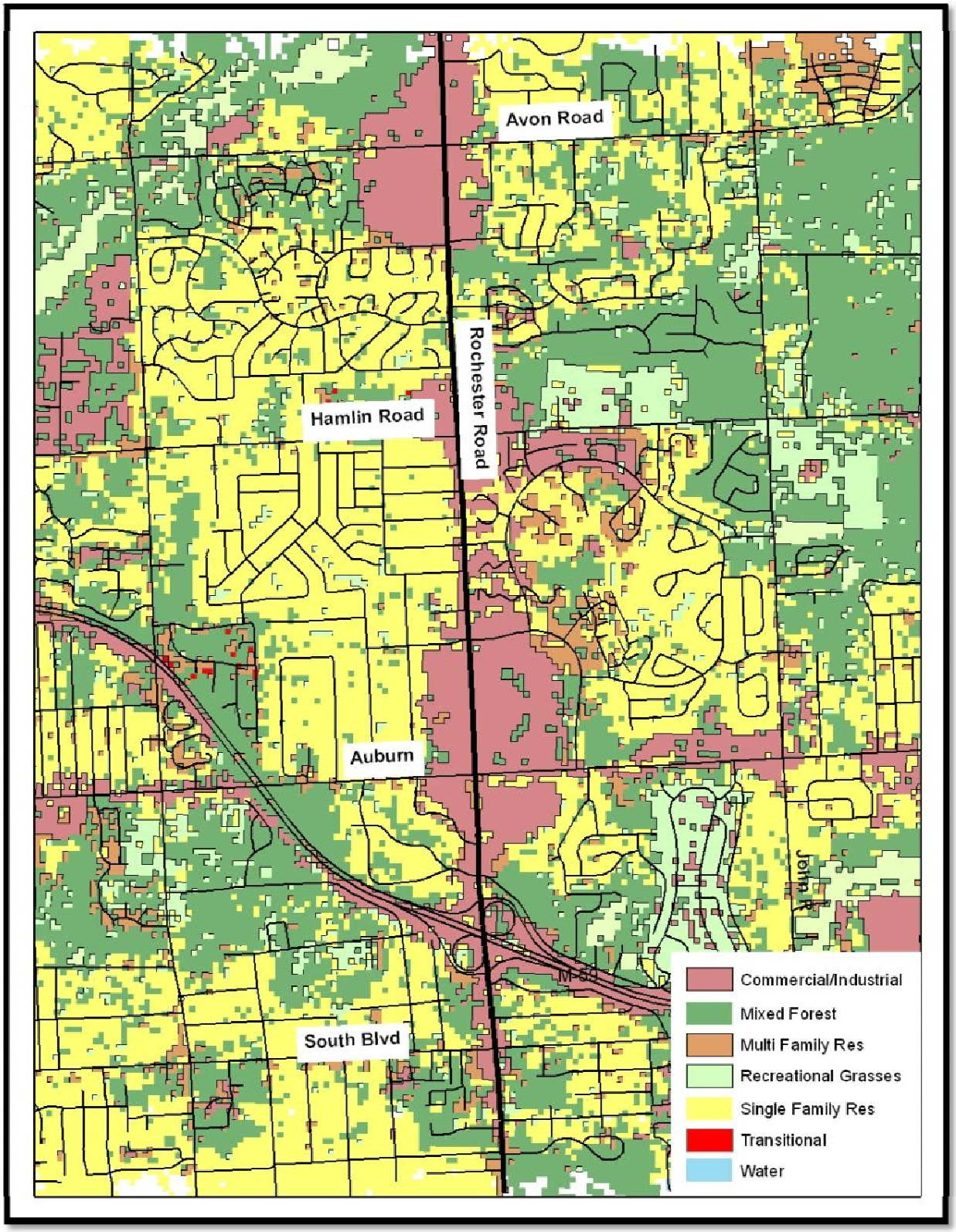


Figure 1-2 STUDY INTERSECTIONS AND CORRIDOR

2.0 ROAD SAFETY AUDITS

2.1 Road Safety Audit Team

A Road Safety Audit (RSA) is a formal safety performance examination of an existing or future road or intersection by an independent audit team. RSA's help promote road safety by identifying safety issues during the planning, design and implementation stages, promoting awareness of safe design practices, integrating multimodal safety concerns, and considering human factors.

Location: Rochester Road (M-150) Corridor from Avon Road to South Boulevard in Rochester Hills and Troy, Michigan

RSA Team Members:

Jeffrey S. Bagdade, PE	Opus International Consultants
Joyce Yassin, EIT	Opus International Consultants
Margaret Myers	Opus International Consultants
Deirdre Thompson, PE	MDOT
Kelby Wallace, PE	MDOT
Kajal Patel, EIT	SEMCOG
Brian Pawlik	SEMCOG

Project Owner: Michigan Department of Transportation

Review Date: April 27-30, 2010

Review Stage: Operational Stage RSA of existing intersections

Start Up Meeting: April 27, 2010

Preliminary Findings Meeting: April 30, 2010

Attended by:
Opus International Consultants
Michigan Department of Transportation
Road Commission of Oakland County (RCOC)
City of Rochester Hills
City of Troy
Southeast Michigan Council of Governments (SEMCOG)
Traffic Improvement Association (TIA)

The RSA team members conducted this audit to the best of their professional abilities within the on-site time available and by referring to provided information. While every attempt has been made to identify significant safety issues, the project owner is reminded that responsibility for the design, construction, and performance of the roadway remains with the agency with jurisdictional authority.

2.2 Road Safety Audit Materials

The safety review was based on the following data and analyses:

Field Review: Site visits were conducted from April 27-29, 2010 to review the corridor and intersection geometry and adjacent land use and to observe traffic operations and conflicts.

Traffic Counts: Peak hour turning movement and average annual daily traffic (AADT) counts were provided by MDOT.

Operational Analysis: An operational analysis was not part of the RSA. MDOT is currently conducting a signal optimization along the study corridor, and SEMCOG is coordinating an access management study in summer 2010.

Review of Collision Data and Analysis of Collision Trends: Electronic crash data was provided by MDOT and SEMCOG; and UD-10 crash reports were obtained using Michigan Office of Highway Safety Planning's michigantrafficcrashfacts.org website for the years of 2006 through 2008.

Identification of Countermeasures: On the basis of the above tasks, intersection safety issues and collision causes were identified. Countermeasures were identified to address the safety issues and collision causes, along with the collision reductions that are anticipated to result from their implementation.

2.3 RSA Team and Process

Site visits were conducted in April 2010, to gain an understanding of the existing conditions and surroundings, observe road user behavior, and to identify existing safety concerns.

An RSA framework was applied in both the audit analysis and presentation of findings. The expected frequency and severity of crashes caused by each safety issue have been identified and rated according to the categories shown in **Table 2-1** and **Table 2-2**. These two risk elements were then combined to obtain a risk assessment on the basis of the matrix shown in **Table 2-3**. Consequently, each safety issue is assessed on the basis of a ranking between A (lowest risk and lowest priority) and F (highest risk and highest priority).

For each safety issue identified, possible mitigation measures have been suggested. The suggestions have focused on measures that can be cost-effectively implemented.

Table 2-1CRASH FREQUENCY

ESTIMATED		EXPECTED CRASH FREQUENCY (per audit item)	FREQUENCY RATING
EXPOSURE	PROBABILITY		
high	high	10 or more crashes per year	*Frequent*
medium	high		
high	medium	1 to 9 crashes per year	*Occasional*
medium	medium		
low	high		
high	low	less than 1 crash per year, but more than 1 crash every 5 years	*Infrequent*
low	medium		
medium	low	less than 1 crash every 5 years	*Rare*
low	**low**		

Table 2-2 SEVERITY RATING

TYPICAL CRASHES EXPECTED (per audit item)	EXPECTED CRASH SEVERITY	SEVERITY RATING
crashes involving high speeds or heavy vehicles, pedestrians, or bicycles	probable fatality or incapacitating injury	*Extreme*
crashes involving medium to high speed; head-on, crossing, or off-road crashes	moderate to severe injury	*High*
crashes involving medium to low speeds; left-turn and right-turn crashes	minor to moderate injury	*Moderate*
crashes involving low to medium speeds; rear-end or sideswipe crashes	property damage only or minor injury	*Low*

Table 2-3 CRASH RISK ASSESSMENT

FREQUENCY RATING	SEVERITY RATING			
	Low	*Moderate*	*High*	*Extreme*
Frequent	C	D	E	F
Occasional	B	C	D	E
Infrequent	A	B	C	D
Rare	A	A	B	C

Crash Risk Ratings:

A: minimal risk level
B: low risk level
C: moderate risk level
D: significant risk level
E: high risk level
F: extreme risk level

3.0 CORRIDOR CHARACTERISTICS

3.1 Corridor Conditions and Adjacent Land Uses

The segment of the Rochester Road corridor which was reviewed as part of this RSA runs north-south through the cities of Rochester Hills and Troy. Along most of the study corridor, Rochester Road is marked as two lanes in each direction with a continuous two-way left-turn lane (TWLTL). Dedicated left-turn lanes are provided on all approaches at each of the study intersections. Condition diagrams of the individual study intersections are provided in the sections associated with the intersections.

The corridor passes through moderately dense commercial land-use areas. Land uses at specific intersections are discussed in the sections associated with the intersections.

Figure 3-1 CURRENT CORRIDOR CONDITIONS

Rochester Road is a state trunkline with the route designation of M-150 and is classified as a principal urban arterial[2]. The intersecting road classifications include other principal urban arterials (M-59), minor arterials (Avon Road, Auburn Road, South Boulevard), local roads (Barclay Circle/Wabash Road, Hamlin) and a private driveway (Meijer Driveway). Governing jurisdictions vary along the corridor and can be found in **Table 3-1**, below.

Table 3-1 ROAD INFORMATION

Road	Classification	Jurisdiction	Speed Limit (mph)
Rochester Road (M-150)	Principal Urban Arterial	MDOT (north of M-59) RCOC (south of M-59)	50
Avon	Minor Arterial	RCOC	40
Hamlin	Local Road	Rochester Hills	45
Barclay/Wabash	Local Road	Rochester Hills	25
Auburn	Minor Arterial	MDOT	40
Meijer Driveways	Driveway	Private	n/a
M-59 Ramps	Principal Urban Arterial	MDOT	25
South Boulevard	Minor Arterial	RCOC	45

3.2 Traffic Control

All of the study intersections are signalized. Several other unsignalized intersections are located between the study sites on Rochester Road. The traffic signals are under the jurisdiction of MDOT and maintained by RCOC. The traffic signals are all part of the FAST-TRAC system and operate utilizing the Sydney Coordinated Adaptive Traffic System (SCATS). Signal timing and displays at each of the study sites are described in the section associated with each intersection. The roadway classification is partially based on the posted speed limit. The speed limits for Rochester Road and all intersecting sites are also found in **Table 3-1**.

3.3 Traffic Volumes

Annual Average Daily Traffic (AADT) counts were provided by MDOT and SEMCOG. **Figure 3-2** summarizes the AADT counts at different points along the corridor.

[2] A Principal Urban Arterial as described by the FHWA Highway Functional Classification Guidelines "serves the major centers of activity of a metropolitan area, have the highest traffic volume corridors, and the longest trip desires; and should carry a high portion of the total urban **travel on a minimum of mileage."**

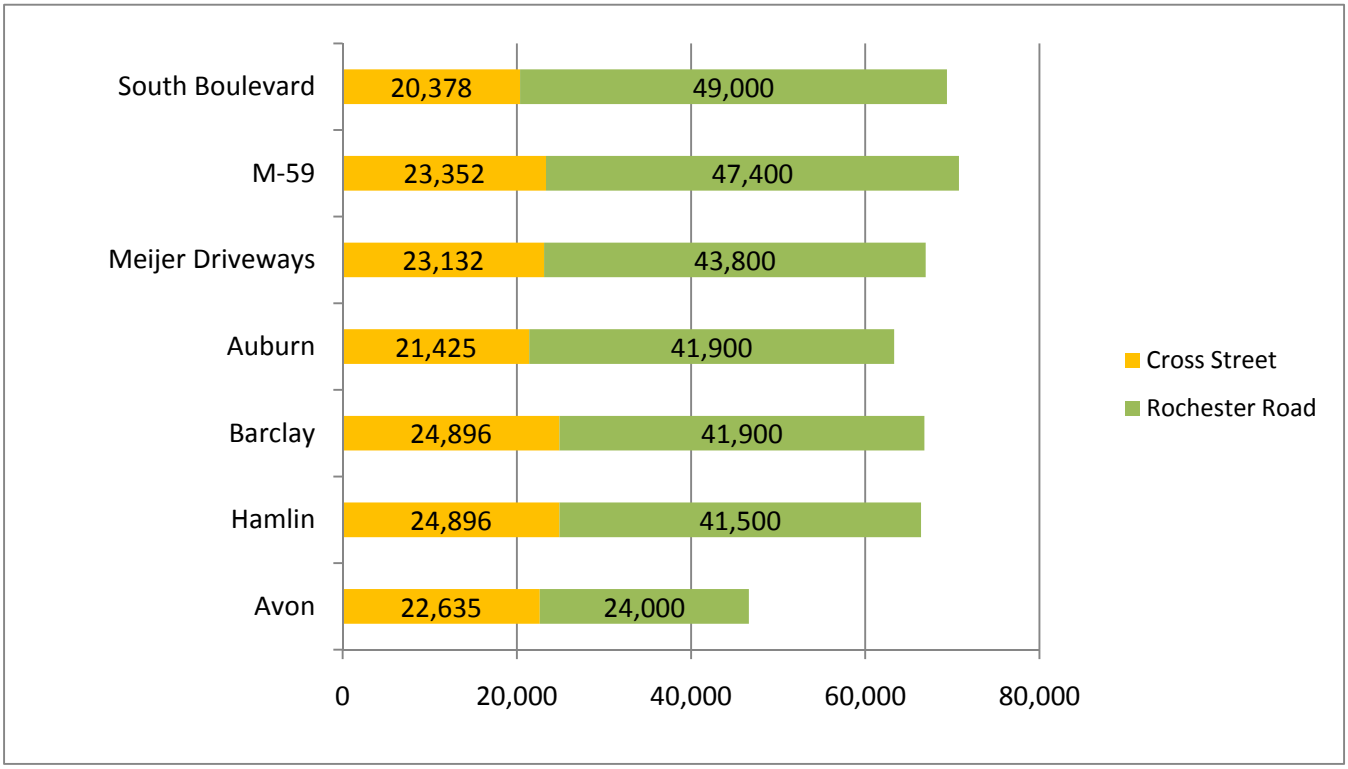


Figure 3-2 ANNUAL AVERAGE DAILY TRAFFIC COMPARISON

3.4 Collision Characteristics

The collision analysis for the study intersections is based on three years (2006-2008) of crash data. The collision frequency and rate for each intersection is summarized in **Table 3-2**. Critical crash rates were provided by SEMCOG.

Table 3-2 INTERSECTION CRASH FREQUENCY AND RATE

Intersection with ROCHESTER ROAD	Average Annual Daily Traffic (vehicles)	Crash Rate (crashes/million entering vehicles)	Crash Frequency (crashes/year)	Injury/Fatal Crash Frequency	Critical Crash Rate
Avon	61,813	2.3	51	6.7	1.4
Hamlin	62,968	1.6	37	6.7	1.4
Barclay/Wabash	Insufficient Data	Insufficient Data	18	13	Insufficient Data
Auburn	63,190	2.2	51	5.3	1.4
Meijer Driveways	Insufficient Data	Insufficient Data	82	16	Insufficient Data
M-59	42,360	2.9	44	9	1.56
South Boulevard	50,515	1.4	25	6	1.51

4.0 ROCHESTER ROAD AND AVON ROAD

4.1 Intersection Geometry

A condition diagram of the intersection is shown in FIGURE 4.1. Site photographs are provided in FIGURE 4.2. The intersection is surrounded by commercial land uses. Currently this intersection operates with one left-turn lane, two through lanes, and one right turn lane on the Rochester Road approaches. The eastbound leg of Avon Road operates with one dedicated left-turn lane, one through-only, and one dedicated right turn lane. The westbound leg of Avon Road has one dedicated left-turn lane, one through only, and one through/right lane.

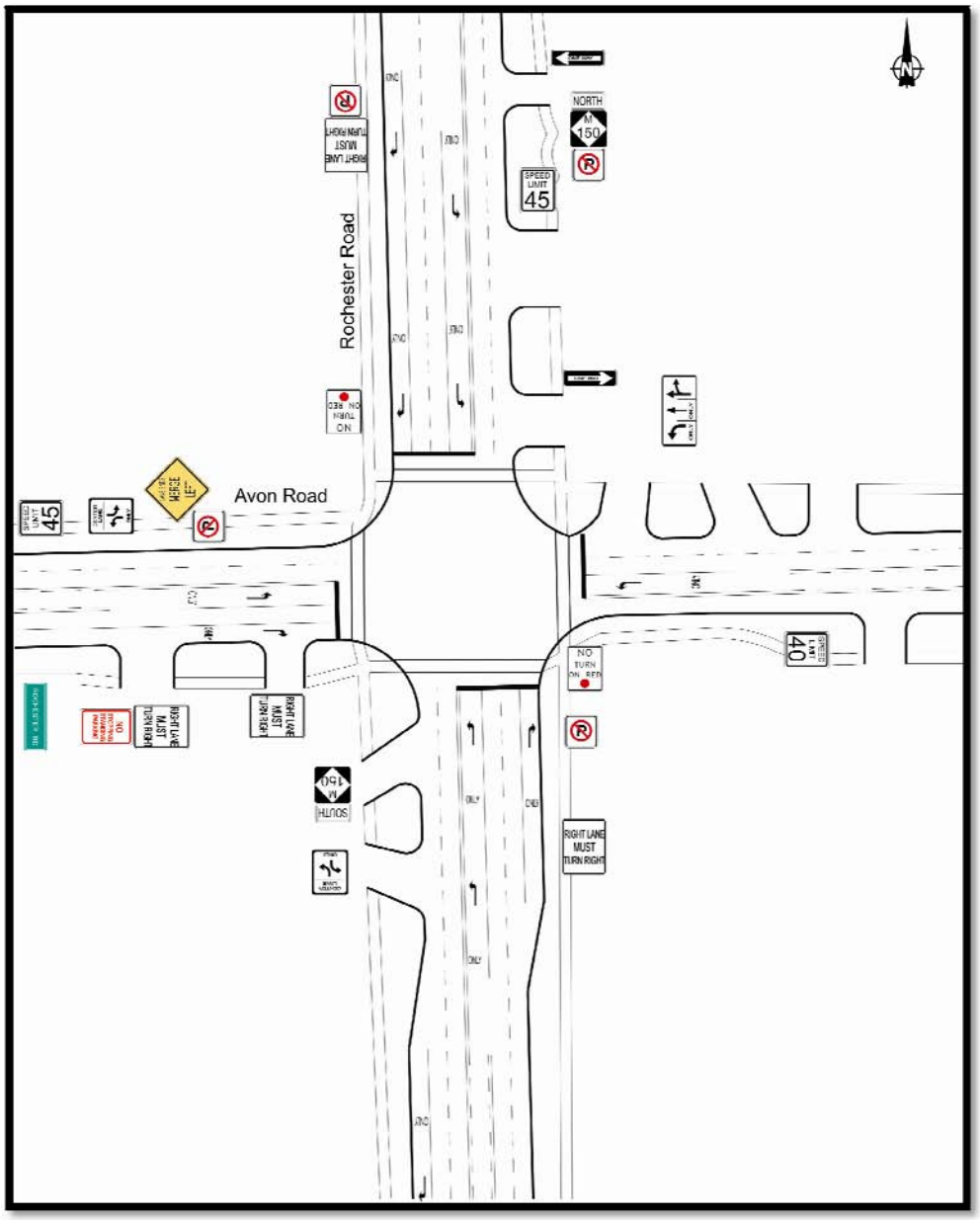


Figure 4-1 CONDITION DIAGRAM: ROCHESTER ROAD AND AVON ROAD

Northbound approach along Rochester Road *Southbound approach along Rochester Road*

Eastbound approach along Avon Road *Westbound approach along Avon Road*

Figure 4-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND AVON ROAD

Site Observations

A. *No truncated domes are provided on two of the four corners.*
B. *Crest vertical curves on both the north and east legs.*
C. *Grass-bare area on the southeast corner as a result of tires jumping the curb during southbound left-turn movements.*

A

B

C

Figure 4-3 SITE OBSERVATION PHOTOGRAPHS: ROCHESTER ROAD AND AVON ROAD

4.2 Traffic Control

The traffic signal display is shown schematically within **Figure 4-4**. Four signal heads are provided on each of the approaches including three overhead span wire signals and one far left post mounted signal. All signal heads have 12 inch lenses. There are no blackplates provided at this intersection. Pedestrian signal heads are provided for all crosswalks. The pedestrian signals are push-button actuated across all legs. The signals at this intersection are fully actuated and operate with leading protected-only left-turn phasing. The signals at this intersection are maintained by MDOT and are part of the FAST-TRAC system.

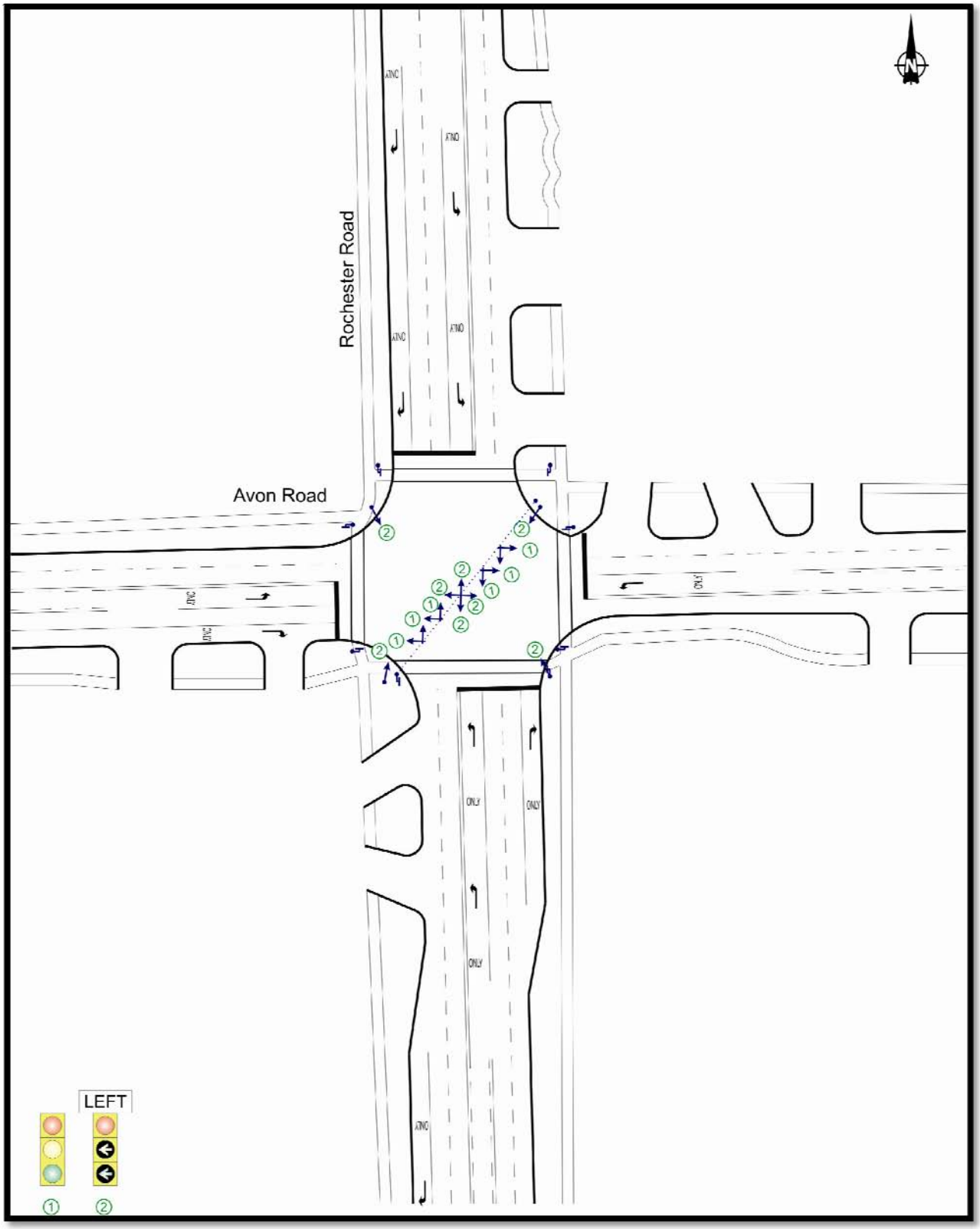


Figure 4-4 SIGNALS DIAGRAM: ROCHESTER ROAD AND AVON ROAD

4.3 Collision Analysis

Between 2006 and 2008, 155 crashes were recorded at or near the intersection. As summarized in **Figure 4-5**, 15 percent of crashes resulted in at least one injury. The remainder of the collisions involved property damage only. No fatalities were reported during the study period.

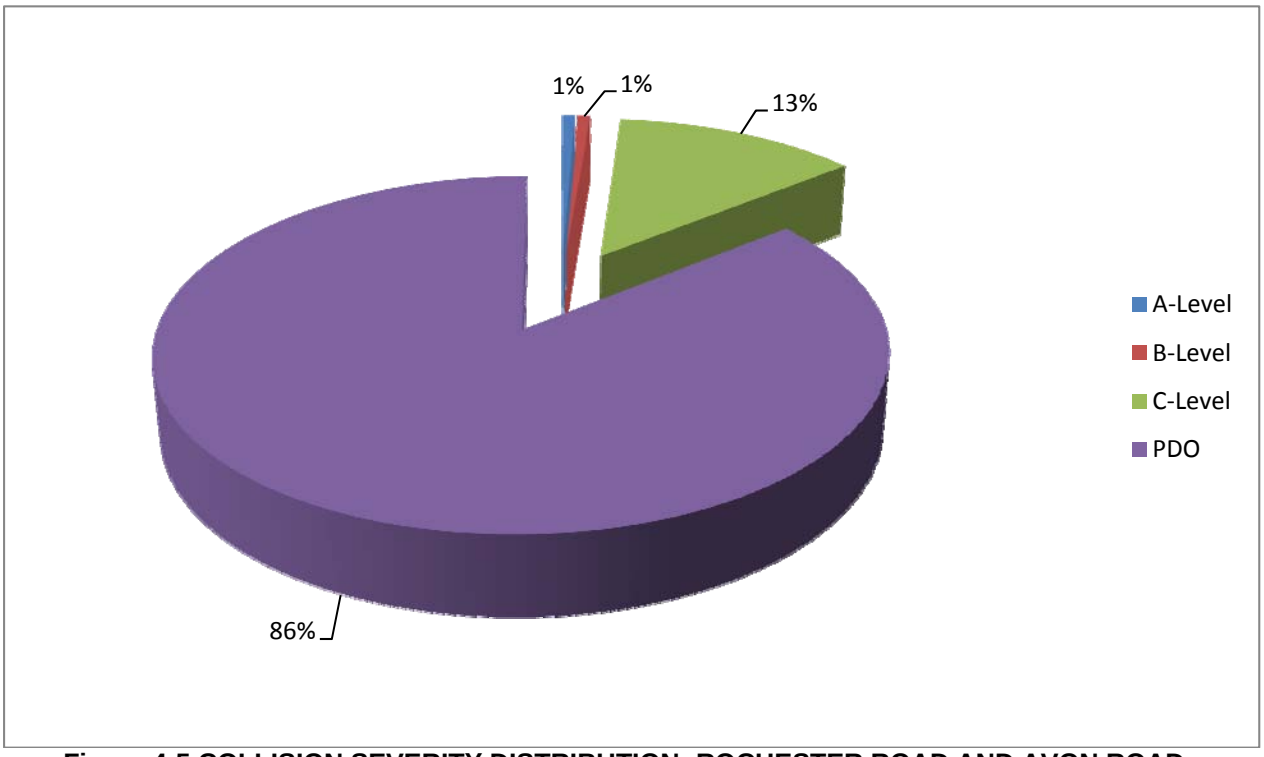


Figure 4-5 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND AVON ROAD

Collision Types

Collision type distribution is summarized in **Figure 4-6**, and a collision diagram of crashes in which UD-10's were available from michigantrafficcrashfacts.org is shown in **Figure 4-7**. A legend of the symbols used on the collision diagrams can be found in Appendix A. The following collision trends were observed:

- Rear-end collisions predominated, accounting for 63 percent of all recorded collisions.
- Angle collisions accounted for 17 percent of the three-year total collisions.

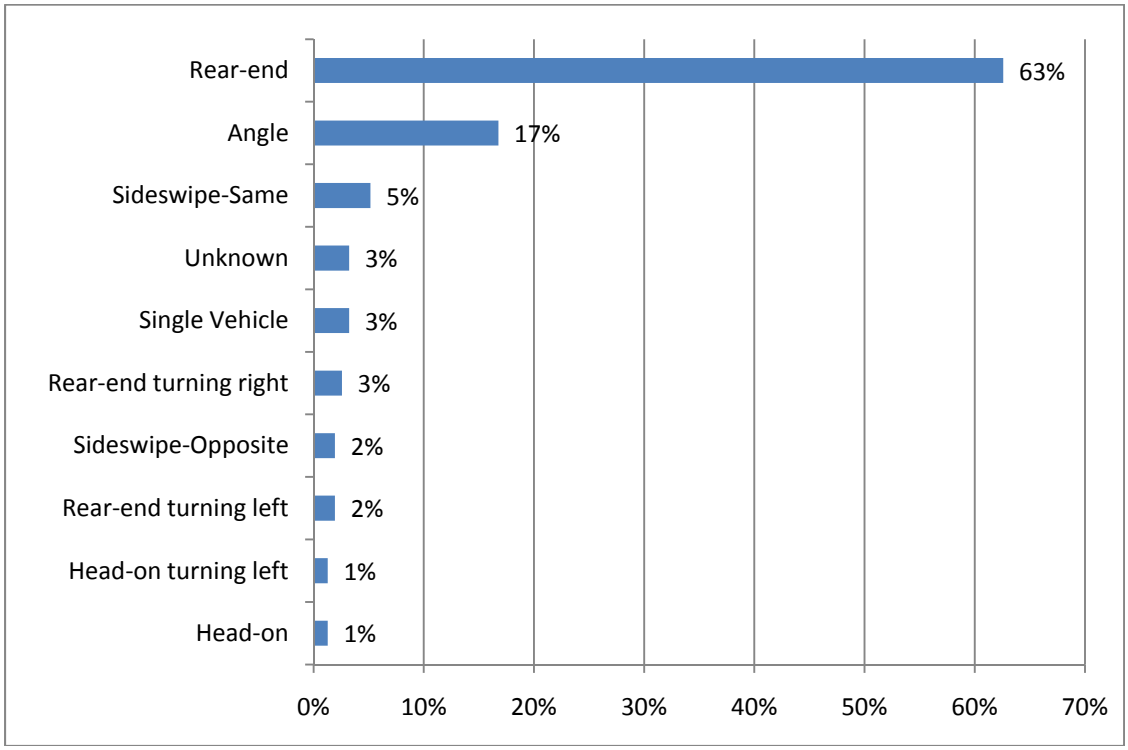


Figure 4-6 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND AVON ROAD

Temporal and Environmental Distribution

Temporal and environmental distributions, located in APPENDIX A, indicated the following trends:

- The highest frequency of collisions occurred during the month of August.
- Hourly distributions show a higher frequency of crashes at 11:00 AM; approximately lunch hour.
- Twenty-three percent of collisions occurred under wet or winter conditions suggesting that road conditions may be a contributing factor to collisions.
- Approximately 81 percent of crashes occurred during daylight or lighted conditions, suggesting that lighting is likely not an issue at this intersection.

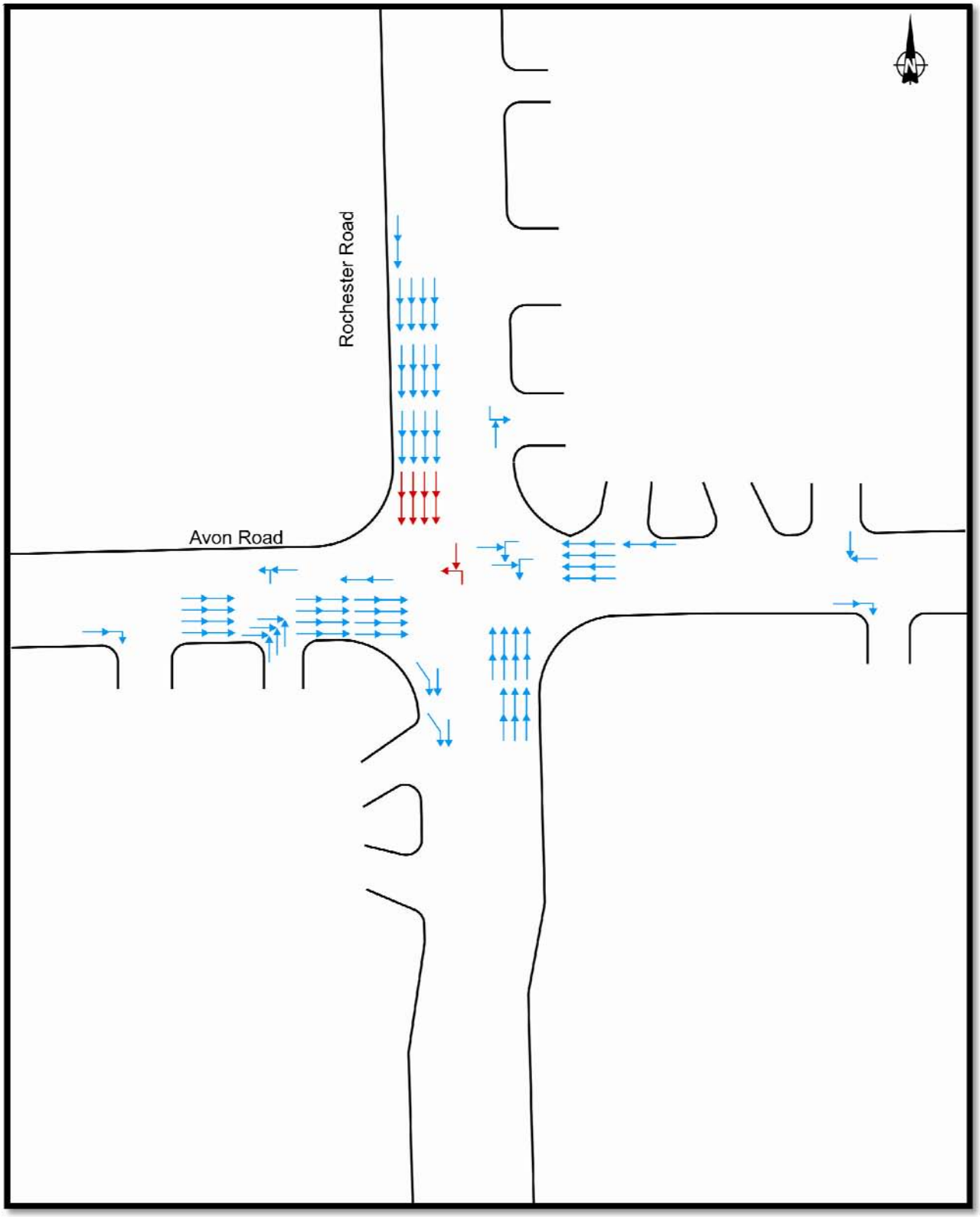


Figure 4-7 COLLISION DIAGRAM: ROCHESTER ROAD AND AVON ROAD

4.4 Safety Issues and Suggested Mitigation Measures

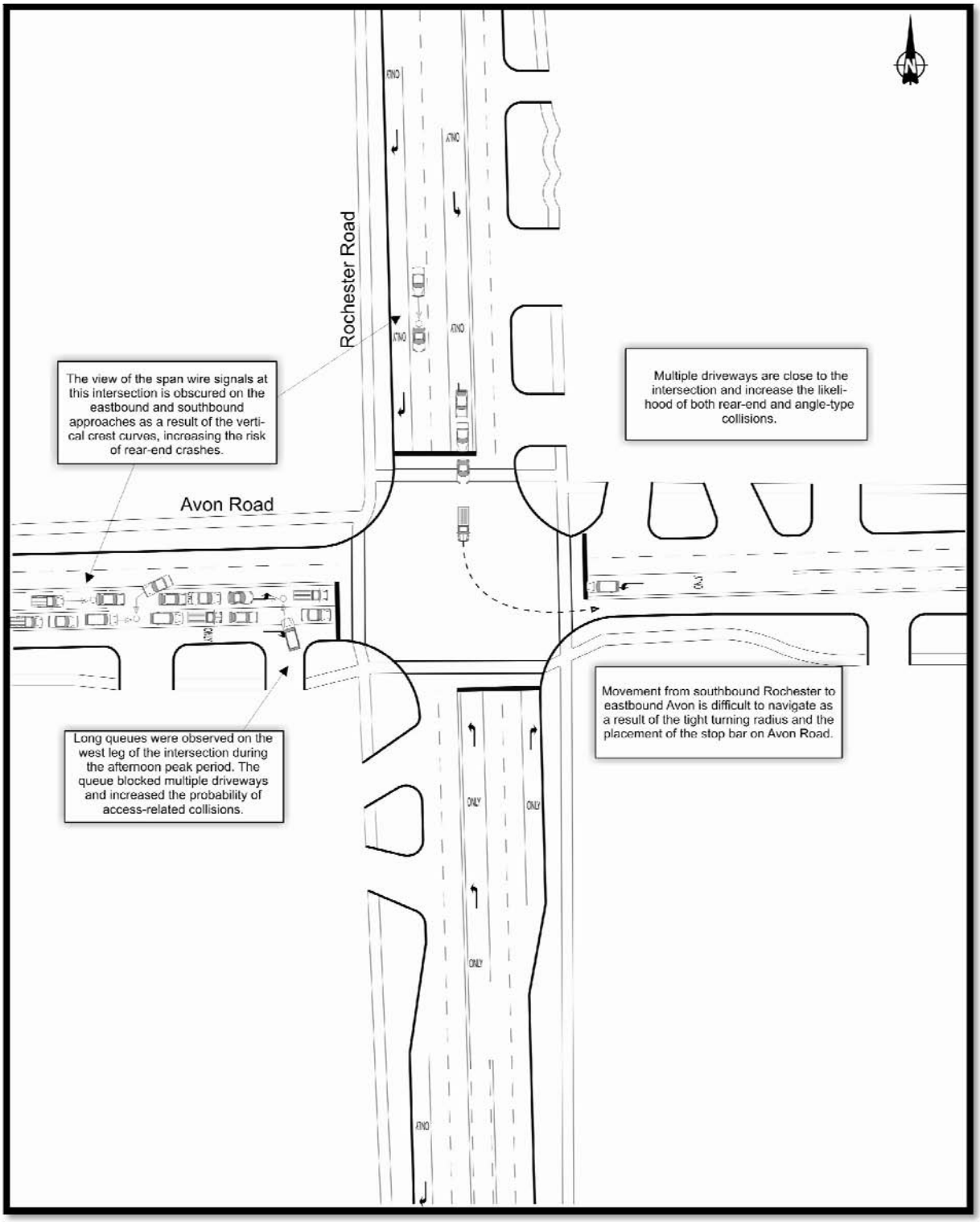


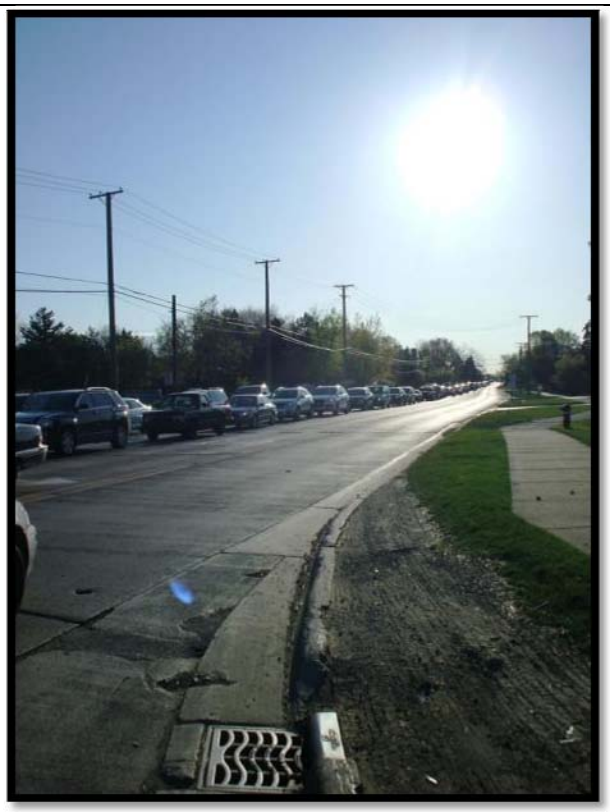
Figure 4-8 ISSUES DIAGRAM: ROCHESTER ROAD AND AVON ROAD

SAFETY ISSUE **(Number and Description)**		**Risk Rating**	**Suggestions**
	Queues	**B**	▪ Review and optimize the signal timing plan.
	Signal Visibility	**C**	▪ Install a high mounted near right signals for the eastbound and southbound approach. ▪ Provide an Advance Warning Flasher for signal on the eastbound and southbound approaches
	Tight Turning Radii	**C**	▪ Stagger the westbound stop bars.
	Access Management	**C**	▪ Directionalize the accesses to Avon and Rochester roads. ▪ Improve cross access ▪ Provide narrow medians on the eastbound approach
	Pedestrian Facilities	**D**	▪ Install truncated domes on sidewalk ramps. ▪ Install pedestrian countdown signals.

Safety Issue 1: Long Queues During the Peak Periods

During the site visit, long queues were observed during both the morning and afternoon peak periods. During the A.M peak period (approximately 8:00 AM), westbound through traffic on Avon Road was found to consist in excess of 30 vehicles waiting in the queue. A long queue was observed in the eastbound through lane on Avon Road between 2:45 and 3:00 PM. This afternoon peak hour is likely a result of a number of local schools releasing around the same time. The long queues may have been worse than normal during the field review due to a detour resulting from construction on Hamlin Road. The long queues made it difficult for drivers to make left-turns out of the driveways both near the intersection as well as outside of the intersection's functional area. Long queues at intersections increase the risk of rear-end collisions and driver frustration, leading to red light running. Queuing may also lead to erratic movements as drivers attempt to merge into over-full lanes increasing the likelihood of sideswipe collisions.

Eastbound approach of Avon Road during the afternoon peak period



Westbound approach of Avon Road during the afternoon peak period

Safety Issue 2: Signal Visibility is obstructed by Crest Vertical Curves

The signal visibility on the eastbound and southbound approaches is obstructed by the crest vertical curves resulting in limited stopping sight distance. As was stated in Issue 1, vehicles were observed queuing on several of the approaches during the field review. Vehicles stopped at the top of the crest vertical curve can block the view of the traffic signal for following vehicles. This issue is further aggravated when a taller vehicle such as a large SUV, truck or commercial van are waiting in the queue. Many of the rear end crashes are likely due to a driver's limited stopping sight distance due to the above listed complicating factors. Given the moderate truck volumes at this intersection, drivers may unwittingly follow taller vehicles into the intersection during the red phase. As a result, the obstructed signal visibility leads to an increased frequency in rear-end collisions and increases the risk for red light running.

Eastbound approach of Avon Road.

Poor signal visibility as a result of the crest vertical curve on the eastbound approach of Avon Road.

Safety Issue 3: Left-turning Vehicles Overtracking due to a Tight Turn Radius

The southbound left-turn from Rochester Road to eastbound Avon Road is tight and drivers were observed having difficulty completing this maneuver. As a result of the tight left-turn radius, tire tracks and broken curbs were observed on the southeast corner of the intersection. It was noted during the site visit that vehicle tires were over-tracking over the curb. This tight turning radius increases the risk of sideswipe-opposing collisions.

Westbound approach on Avon Road during the morning peak period.

Tight turn radius from southbound Rochester Road to eastbound Avon Road.

Safety Issue 4: Access Management

During the afternoon peak hour the eastbound through movement was observed blocking the Avon Road entrances to the Speedway gas station, Genisys Credit Union, and the Sears parking lot. Drivers in the Sears parking lot were observed attempting to both enter and pass through the queue. Drivers attempting making left-turns from the commercial driveways onto Avon Road also face limited intersection sight distance due to the vertical alignment. Driver's view of cross traffic is likely obstructed by the queued vehicles. Drivers who attempt to enter or pass through queues from the commercial driveways on Avon Road increase the risk of causing an angle crash or ancillary rear end crashes.

In addition, drivers attempting to turn into the driveways from Avon Road also run the risk of being involved in left-turn opposing collisions. Drivers making left-turning movements, from the aforementioned driveways, must cross three lanes (one left-turn, one through, and one right-turn lane) of eastbound traffic to enter westbound traffic.

Left –turn movement across traffic from Genisys Credit Union Driveway.

Left-turning movement across traffic from Sears driveway.

Safety Issue 5: Accessibility of the Pedestrian Facilities

The likelihood of visually impaired pedestrians utilizing this intersection is increased by the presence of the Leader Dogs for the Blind school on the northeast corner. This school educates the blind on how to use a leader dog. During the training, many blind pedestrians utilize this intersection to better understand how to use a leader dog when crossing a busy street. As a result, the presence of accessible facilities for use by blind pedestrians is vital at this intersection.

During the field review it was observed that accessible pedestrian signals, sidewalks and ramps had been provided on all approaches. The ramps on the north side of the intersection lacked the presence of a detectable warning surface. Blind pedestrians using a long cane need a detectable warning surface such as truncated domes to find the crossing. Given the increased likelihood of blind pedestrians at this intersection, complete pedestrian facilities are a necessity. Lack of fully accessible pedestrian facilities, increases the risk of a crash involving a blind pedestrian.

Pedestrian crosswalk across the west leg of Avon Road.

Pedestrian crosswalk across the north leg of the intersection of Rochester Road.

Mitigation Measure 1: Review Signal Timing

Review the signal timing plan at this intersection and ensure that the intersection is functioning at an optimal level.

Mitigation Measure 2: *Provide High Mounted Near Right Signals*

Installing high mount (minimum of fifteen-foot bottom height) near right signals on the eastbound and southbound approaches will increase the conspicuity of the traffic signal display. Drivers approaching the intersection and cresting the vertical curve or those behind tall vehicles should be able to see near side signals and react within an appropriate amount of time. Installing high mounted near side signals will likely result in a decrease in rear-end collisions at this intersection.

Mitigation Measure 3: Provide Advance Warning Flasher for Signal

It is also suggested that an advance warning flasher should be considered for the eastbound and southbound approaches of Rochester Road. The advance warning flasher should utilize the message "PREPARE TO STOP WHEN FLASHING." This advance dilemma zone warning device has been found to reduce traffic fatalities and injuries by 39 percent[3]. While some drivers may increase their speeds right when the device starts flashing, the majority of drivers have been found to be more aware of the signal. These devices can be installed either overhead or post mounted. Examples of the two types of mountings are shown below on the following page. Similar installations have been provided within Oakland County on northbound Telegraph (US-24) and 14 Mile Road and on northbound Northwestern Highway (M-10) at Inkster. In both of these cases, vertical curves limit the traffic signal visibility.

Mitigation Measure 4: *Provide Staggered Stop Bars*

Consider staggering the stop bars on the westbound approach of Avon Road. Staggering the stop bars on the westbound approach may reduce the risk of sideswipe-opposing (left-turning vehicles hitting the westbound, front driver's side panel) collisions.

Mitigation Measure 5: *Access Management*

Consider directionalizing the private driveway entrances and creating a right-in/right-out configuration. Limiting the number of possible movements reduces the chance of left-turn angle type collisions. Directionalizing the driveway and limiting movements to right turns in and right turns out would eliminate 12 different conflict points. It is also suggested that as part of the future permitting process that cross access be considered at this location. Cross access will allow drivers to utilize driveways further away from the intersection.

[3] **Bahar et al, *Desktop Reference for Crash Reduction Factors,* Federal Highway Administration, 2007.**

Mitigation Measure 6: Provide a Narrow Median

It is suggested that a narrow median be considered on the west leg of Avon Road and south leg of Rochester Road to limit the number of movements to/from driveways. It is suggested that median be approximately six feet in width. The median will reduce the risk of access related collisions on Avon. It is suggested that cross access be considered to allow drivers alternate access to westbound Avon Road.

Mitigation Measure 7: *Improve Pedestrian Facilities for Vulnerable Pedestrians*

It is suggested that truncated domes be provided on the pedestrian ramps. Ramps with truncated domes are a safety benefit for all pedestrians, specifically for those whom are vision impaired. It is also suggested that the pedestrian signal timings be verified to determine whether enough time is provided for vulnerable pedestrians. It is suggested that an "extended push button control" where vulnerable pedestrians (including the blind) have the option to hold down the push button to trigger extra crossing time. This will likely have a minimum impact on the intersection operations due to the relatively low volume of vulnerable pedestrians. The existing accessible pedestrian signal units likely include that option.

Mitigation Measure 8: *Provide Pedestrian Countdown Signals*

Pedestrians (particularly blind pedestrians) may unintentionally enter the crosswalk with an insufficient amount of clearance time remaining. A pedestrian countdown display may be added to a pedestrian signal head to accurately inform pedestrians of the time remaining in the pedestrian clearance interval, so that they can complete their crossing before conflicting traffic starts up.

Two concerns about countdown signals include pedestrian confusion over the meaning of the countdown display, and the potential for motor vehicle drivers to inappropriately use the countdown display. Recent evaluations of countdown signals[4] indicate that pedestrians have an adequate understanding of the display, and that the displays do not have a negative impact on driver behavior. Guidance on timing the pedestrian countdown display is provided in Section 4E.07 of the 2009 MUTCD.

[4] including Botha et al, *Pedestrian Countdown Signals: An Experimental Evaluation* (San Jose State University and City of San Jose Department of Transportation, 2002); Eccles et al, *Evaluation of Pedestrian Countdown Signals in Montgomery County MD* (Compendium of Transportation Research Board Annual Meeting, 2004)

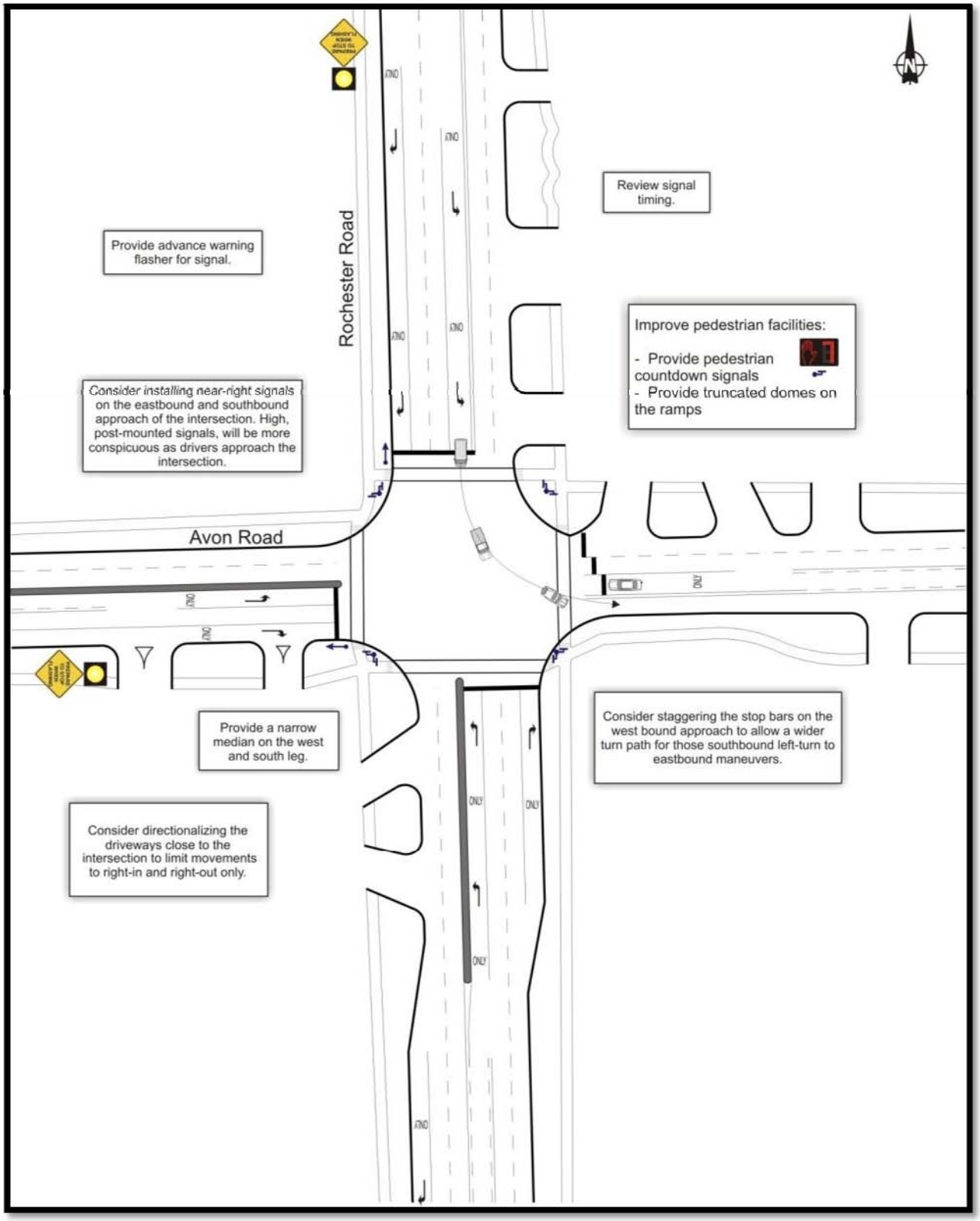


Figure 4-9 MITIGATION DIAGRAM: ROCHESTER ROAD AND AVON ROAD

5.0 ROCHESTER ROAD AND HAMLIN ROAD

5.1 Intersection Geometry

A condition diagram of the intersection is shown in **Figure 5.1**, and site photographs are provided in **Figure 5-2**. The intersection is surrounded by commercial land uses. Currently this intersection operates with one left-turn lane, two through lanes, and one right turn lane on the Rochester Road approaches. The eastbound leg of Hamlin Road operates with one dedicated left-turn lane, one through-only, and one through/right turn lane. The westbound leg of Hamlin Road has one dedicated left-turn lane and two through lanes.

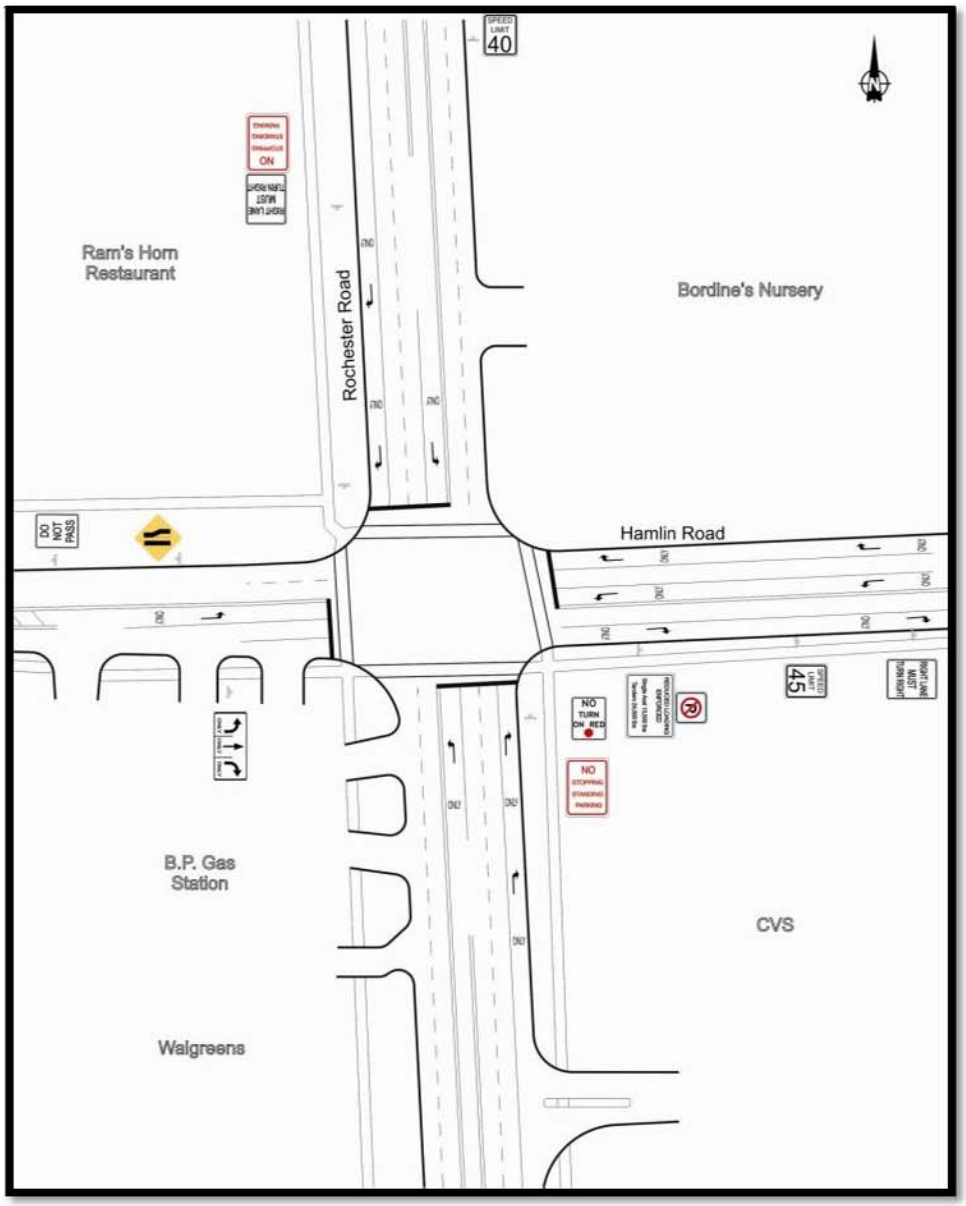
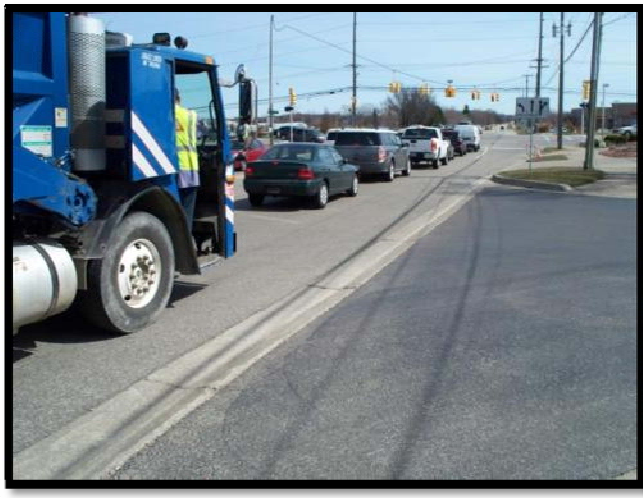


Figure 5-1 CONDITION DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD

Northbound approach along Rochester Road

Southbound approach along Rochester Road



Eastbound approach along Hamlin Road

Westbound approach along Hamlin Road

Figure 5-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND HAMLIN ROAD

Site Observations

A. *Crest vertical curve on the north leg.*
B. *Significant volume of pedestrian and bicycle traffic.*

A

B

5.2 Traffic Control

Signal Displays

The traffic signal display is shown schematically within **Figure 5-3**. Four signal heads are provided on each of the approaches including three overhead span wire signals and one far left post mounted signal. All signal heads have twelve-inch lenses. There are no blackplates provided at this intersection. Pedestrian signal heads are provided for all crosswalks. The pedestrian signals are push-button actuated across all legs.

The signals at this intersection are fully actuated and operate with protected permissive left-turn phasing on all approaches. These signals operate as part of the FAST-TRAC system. The intersection operates with leading protected-only phasing on all approaches.

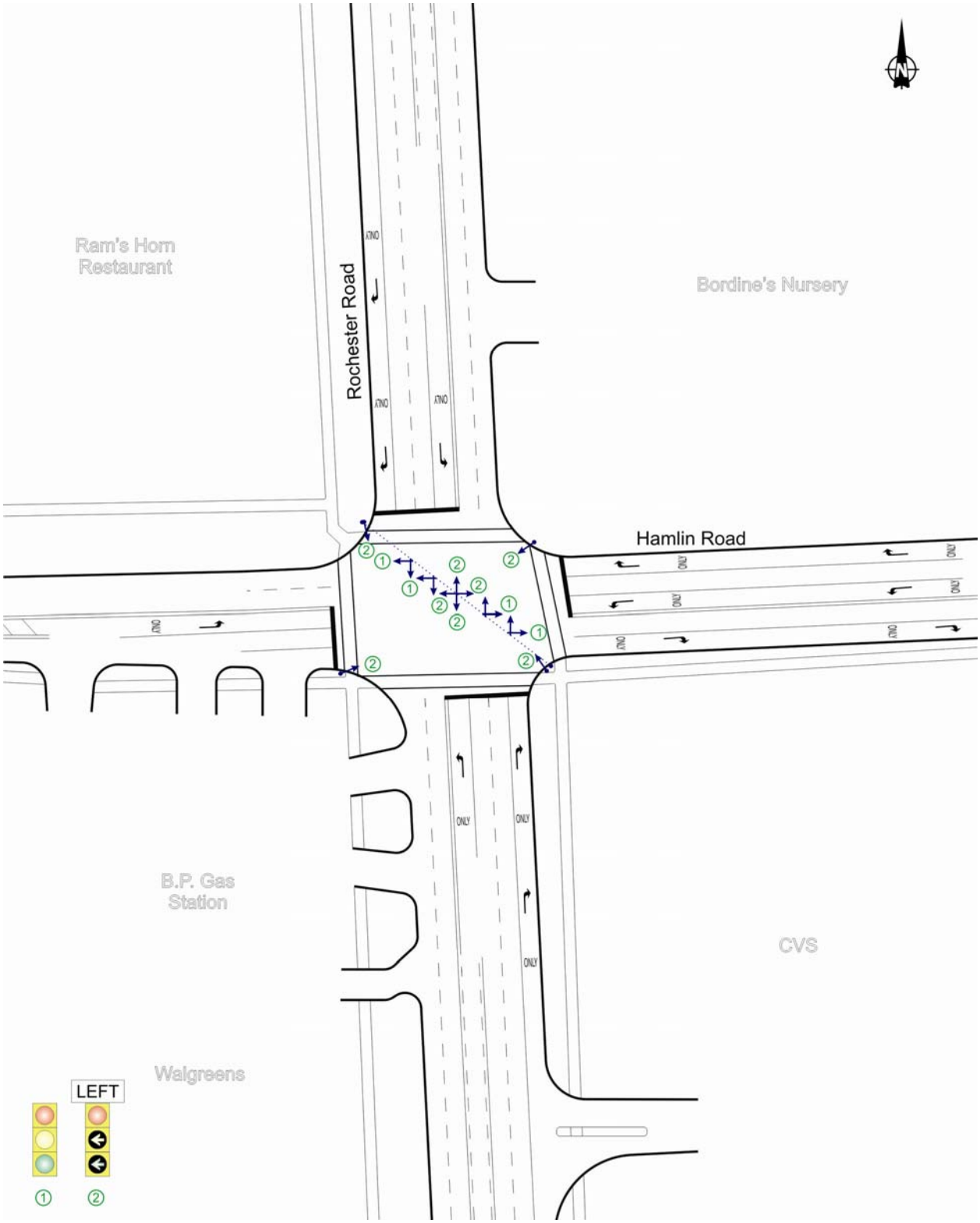


Figure 5-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD

5.3 Collision Analysis

Crash data for the years of 2006 to 2008 were provided by MDOT and using the Office of Highway Safety Planning's website. Over the three years analyzed, 111 collisions were recorded at or near the intersection. As summarized in **Figure 5-4**, 18 percent of collisions resulted in at least one injury. The remainder of the collisions involved property damage only. No fatalities were reported during the study period.

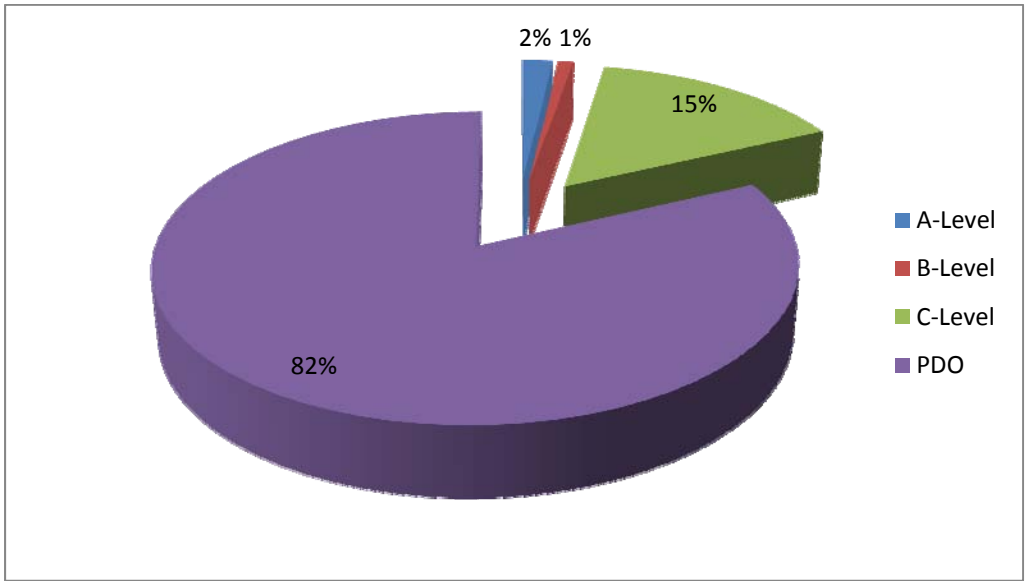


Figure 5-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND HAMLIN ROAD

Collision Types

Collision type distribution is summarized in **Figure 5-5**, and a collision diagram is shown in **Figure 5-6**. The collision diagram illustrates crashes which UD-10 reports were available using michigantrafficcrashfacts.org. The following collision trends were observed:

C. Rear-end collisions predominated, accounting for 62 percent of all recorded collisions.
D. Angle collisions accounted for 11 percent of the three-year total collisions.

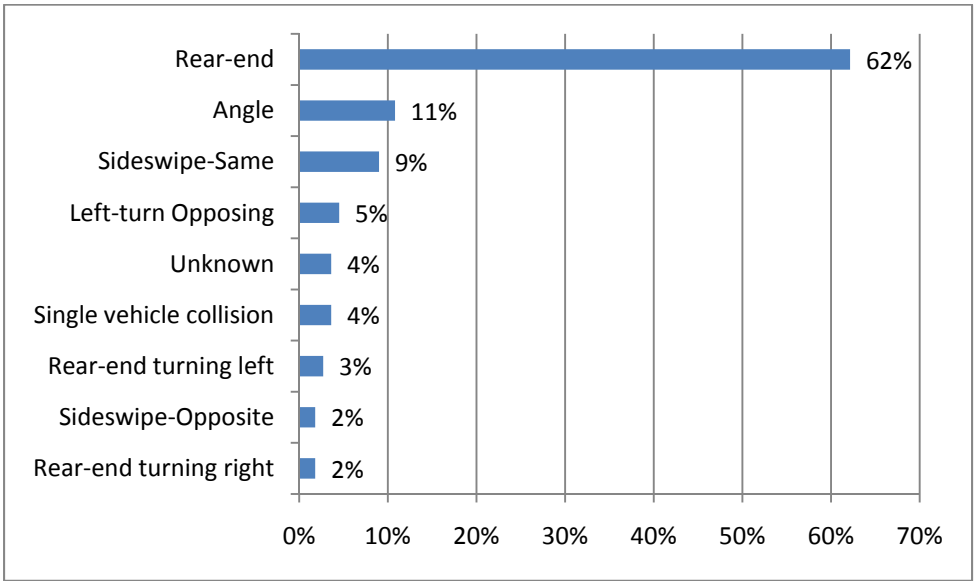


Figure 5-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND HAMLIN ROAD

Temporal and Environmental Distribution

Temporal and environmental distributions are showing in APPENDIX A, indicating the following trends:

- The highest frequency of collisions occurred during the month of December.
- Hourly distributions show a higher frequency of crashes at 5:00 PM; the evening peak hour.
- Twenty-six percent of collisions occurred under wet or winter conditions suggesting that road conditions may be a contributing factor to collisions.
- Approximately 86 percent of crashes occurred during daylight or lighted conditions, suggesting that lighting is likely not an issue at this intersection.

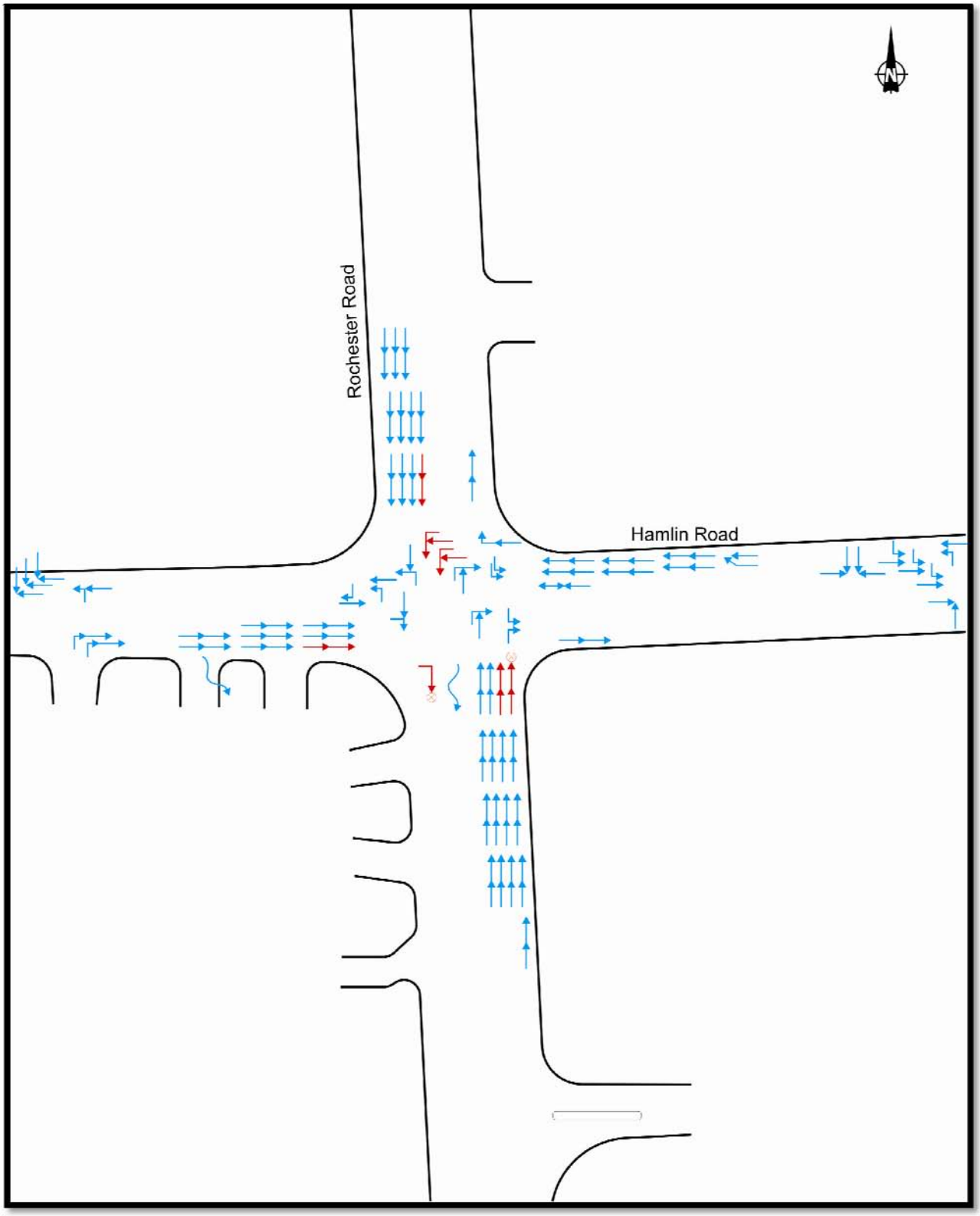


Figure 5-6 COLLISION DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD

5.4 Safety Issues and Suggested Mitigation Measures

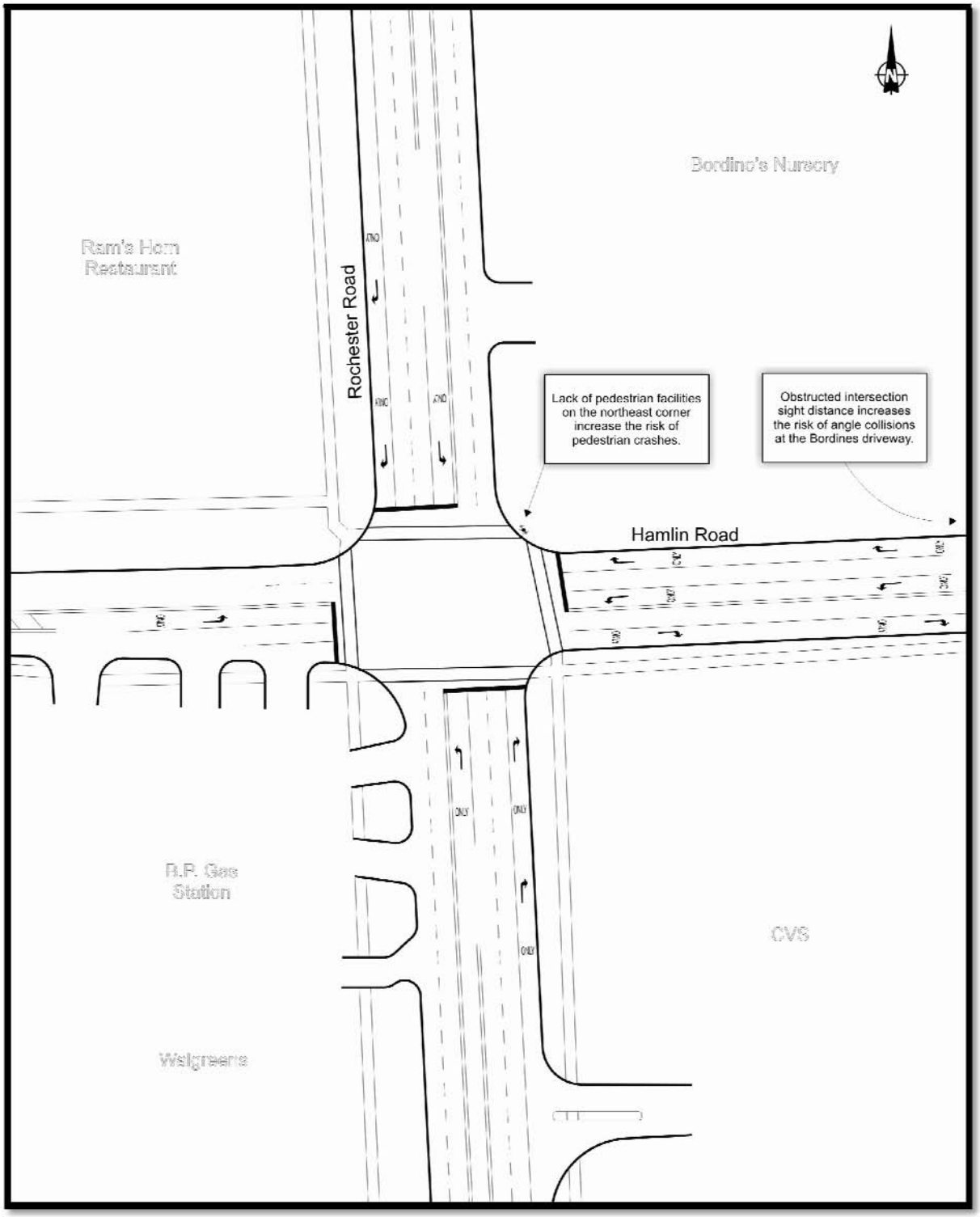


Figure 5-7 ISSUES DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD

SAFETY ISSUE **(Number and Description)**	**Risk Rating**	**Suggestions**
Non-motorized Facilities	D	▪ Update Pedestrian Facilities
Access Management	C	• Improve Intersection Sight Distance at Bordines Driveway on Hamlin

Issue 1: Non-motorized Facilities

During the site visit, a moderate volume of non-motorized road users was observed travelling through the intersection. Several of the pedestrian connections were observed to be incomplete and not in compliance with current ADA standards. The northeast corner of the intersection has no pedestrian ramps or sidewalks. This was due to the fact that a building used to be located on the corner located within the public right-of-way. As a result, pathways and ramps were not provided within that corner even though pedestrian signals and crosswalks are provided. Additionally, several of the pedestrian ramps are quite steep and are not flush with the roadway surface. Collisions involving pedestrians are more likely to occur where pedestrian facilities are limited.

Issue 2: Access Management

The crash data indicated a trend of angle crashes near the Bordine's driveway on the east leg of Hamlin. This was reviewed during the site visit and it was determined that the crashes was likely due to intersection sight distance obstructions at the driveway. Landscaping is present within the sight triangles and the driveway is on a steep vertical grade. As a result, vehicles attempting to make a left-turn out of this driveway have an obstructed view of cross traffic leading drivers to select insufficient gaps.

Mitigation Measure 1: Upgraded Pedestrian Facilities

It is suggested that several upgrades to the existing pedestrian facilities are considered at this intersection. First, it is suggested that ramps and a level landing be provided on the northeast corner. Additionally, it is suggested that the other ramps be reviewed to determine whether they are too steep.

Mitigation Measure 2: Improve Intersection Sight Distance at the Bordine's Driveway on Hamlin

It is suggested that improvements to the intersection sight distance at the Bordine's driveway on Hamlin be considered. This would include removing the large pine tree shown above and replacing it with shorter landscaping. Additionally, raising the grade of the driveway approach should also be considered to improve visibility of cross traffic.

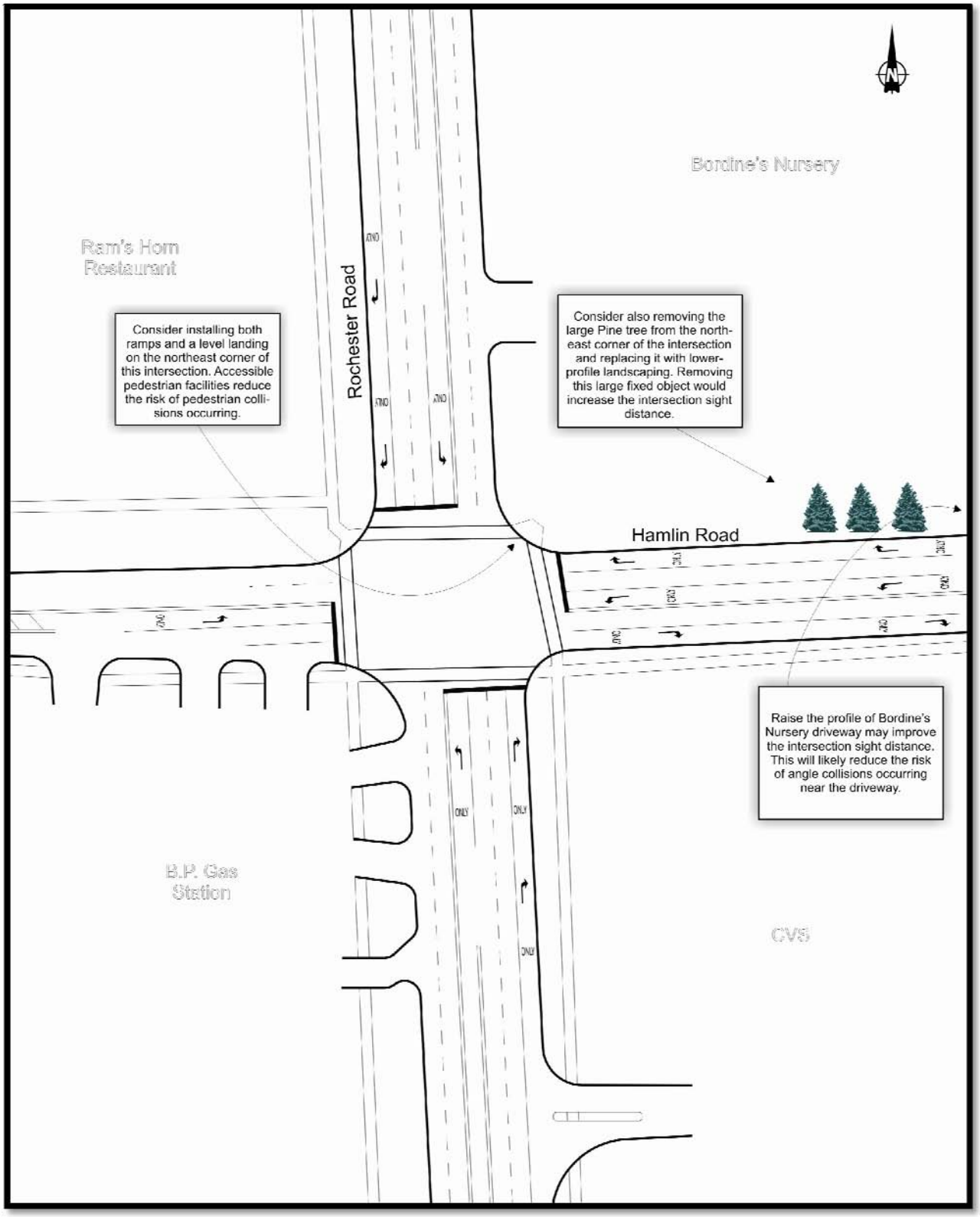


Figure 5-8 MITIGATIONS DIAGRAM: ROCHESTER ROAD AND HAMLIN ROAD

6.0 ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH ROAD

6.1 Intersection Geometry

A condition diagram of the intersection is shown in **Figure 6-1**, and site photographs are provided in **Figure 6-2.** The intersection is surrounded by commercial land uses. Currently, this intersection operates with one left-turn lane, two through lanes, and one right turn lane on the Rochester Road approaches. The eastbound leg of Barclay Circle/Wabash Road operates with one dedicated left-turn lane and one through lane. The westbound leg of Barclay Circle/Wabash Road has one dedicated left-turn lane, one through/left and one dedicated right turn lane.

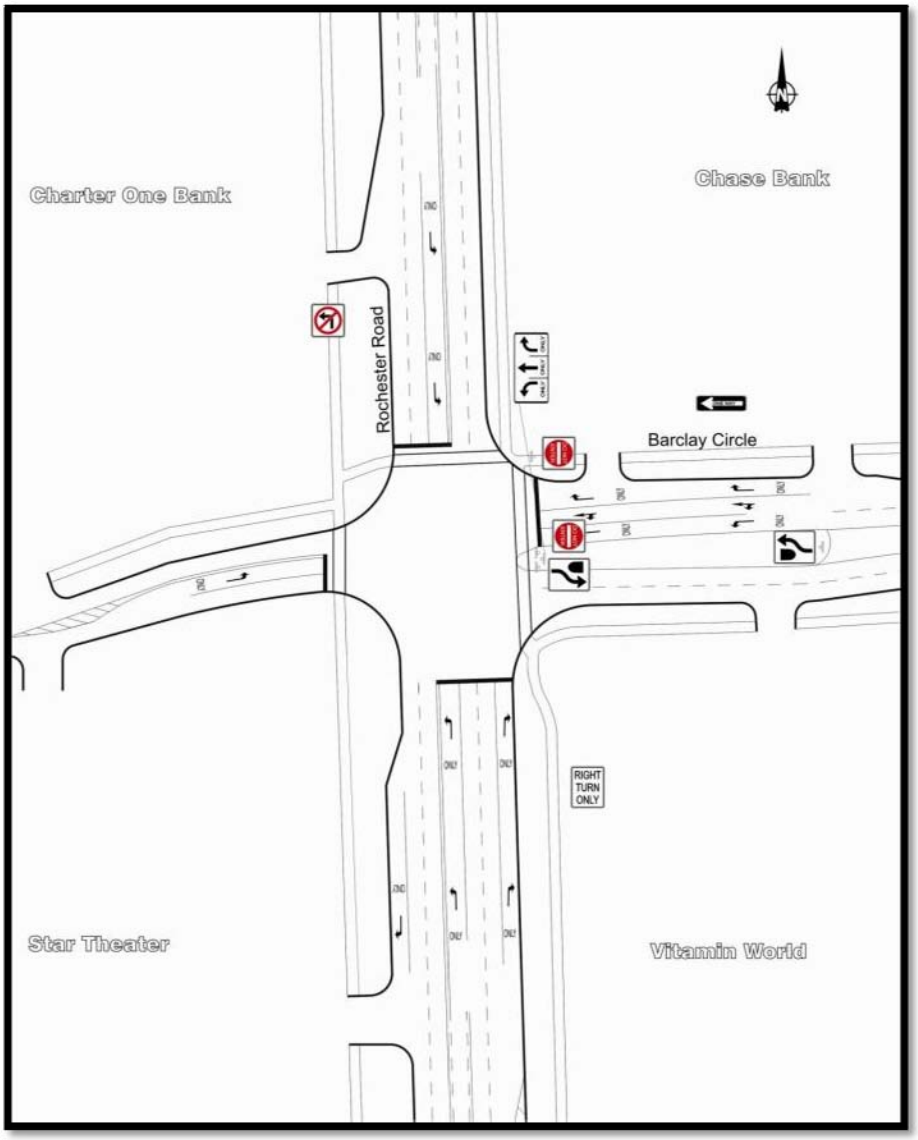


Figure 6-1 CONDITION DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH

Northbound approach along Rochester Road

Southbound approach along Rochester Road

Eastbound approach along Barclay Circle/Wabash Road

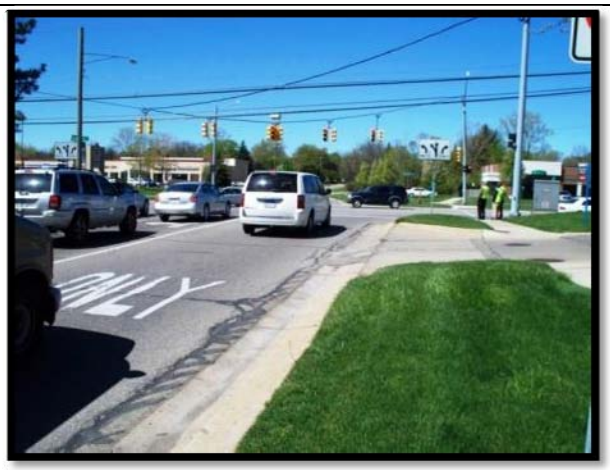
Westbound approach along Barclay Circle/Wabash Road

Figure 6-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH

Site Observations

A. *No crosswalk present across the south leg.*
B. *Signal Display on the westbound approach is not consistent with the lane use*
C. *Turn path markings are present for southbound to eastbound left turns.*
D. *Pedestrian refuge is flush with pavement and has no pedestrian push button.*
E. *Left-turns are made from the "right-out-only" VitaminWorld driveway.*
F. *Pedestrian actuated push buttons are provided for the movements across the north, east, and west legs.*

A



B

D

F

6.2 Traffic Control

The traffic signal display is shown schematically within **Figure 6-3**. Four signal heads are provided on each of the approaches including three overhead span wire signals and one far left post mounted signal. All signal heads have twelve inch lenses. There are no blackplates provided at this intersection.

The signals at this intersection are fully actuated and operate with protected permissive left-turn phasing on all approaches. The signals at this intersection are owned by MDOT and maintained by the Road Commission of Oakland County. These signals function as part of the FAST-TRAC system. Rochester Road has leading protected-only left-turn phases while Barclay/Wabash operates under split phasing. Under certain high demand conditions, southbound Rochester Road will operate with lead/lag protected-only phasing. Pedestrian signal heads and pushbuttons are provided for all crosswalks.

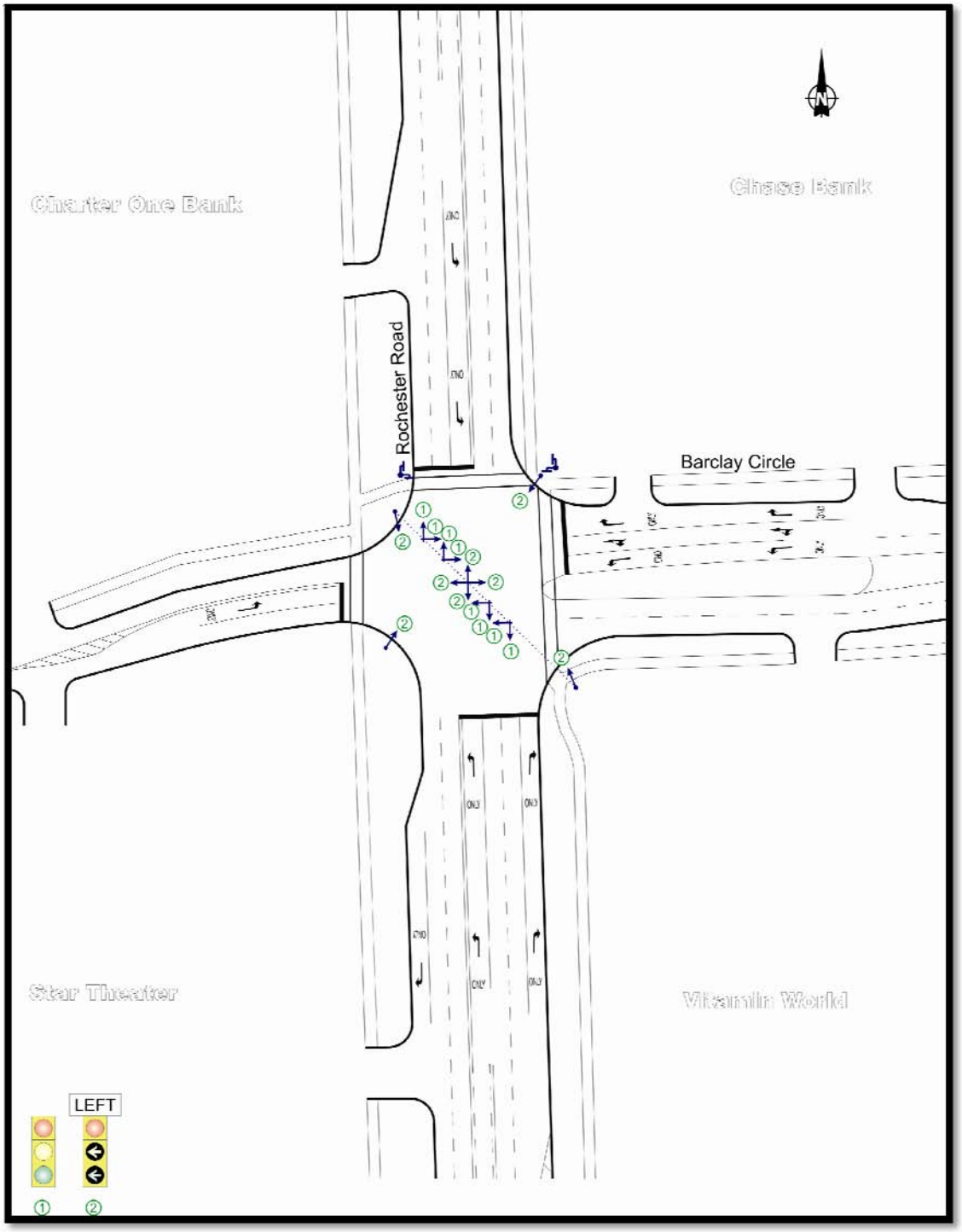


Figure 6-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH

6.3 Collision Analysis

Crash data for the years of 2006 to 2008 were provided by MDOT and using the Office of Highway Safety Planning's website. Over the three years analyzed, 55 collisions were recorded at or near the intersection. As summarized in **Figure 6-4**, 18 percent of collisions resulted in at least one injury. The remainder of the collisions involved property damage only. No fatalities were reported during the study period.

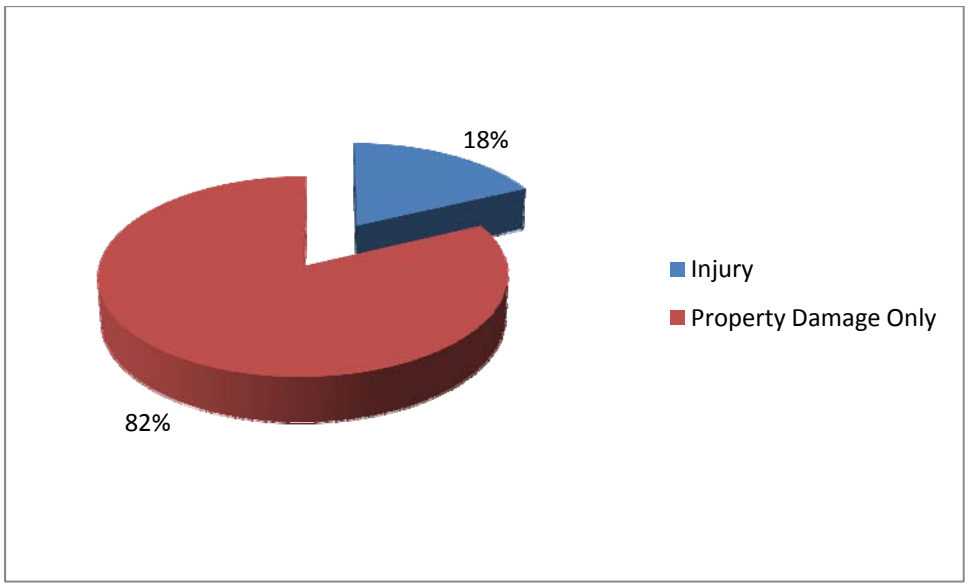


Figure 6-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH

Collision Types

Collision type distribution is summarized in **Figure 6-5**, and a collision diagram is shown in **Figure 6-6**. The collision diagram illustrates crashes which UD-10 reports were available using michigantrafficcrashfacts.org. The following collision trends were observed:

- Rear-end collisions predominated, accounting for 62 percent of all recorded collisions.
- Angle collisions accounted for eleven percent of the three-year total collisions.

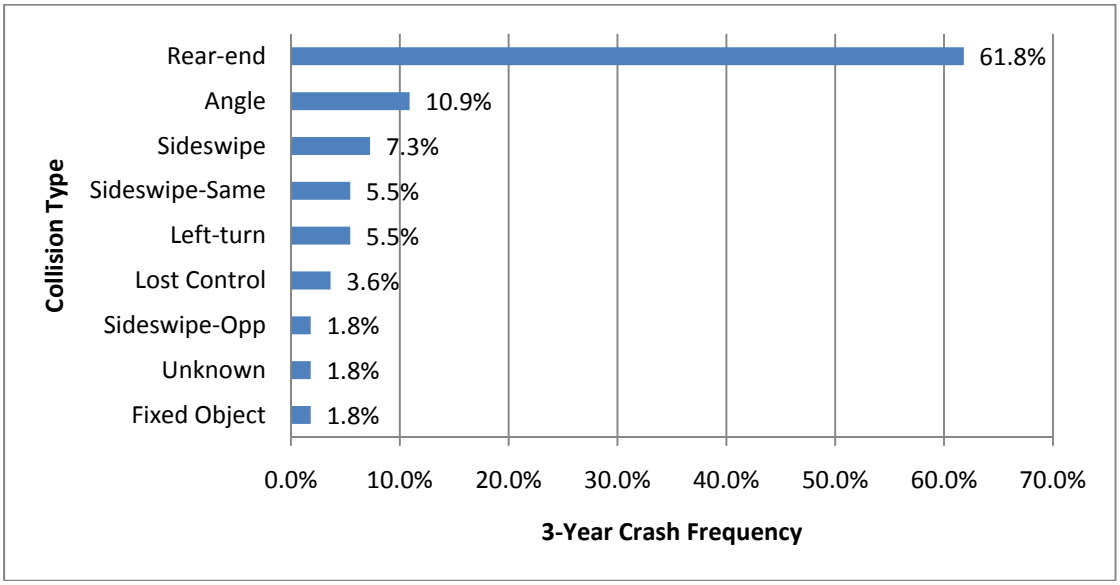


Figure 6-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH

Temporal and Environmental Distribution

Temporal and environmental distributions indicate the following trends:

- The highest frequency of collisions occurred during the months of June and July.
- Hourly distributions show a higher frequency of crashes between 1:00 and 2:00 PM.
- Twenty-six percent of collisions occurred under wet or winter conditions suggesting that road conditions may be a contributing factor to collisions.
- Approximately 71 percent of crashes occurred during daylight or lighted conditions, suggesting that lighting is likely not an issue at this intersection.

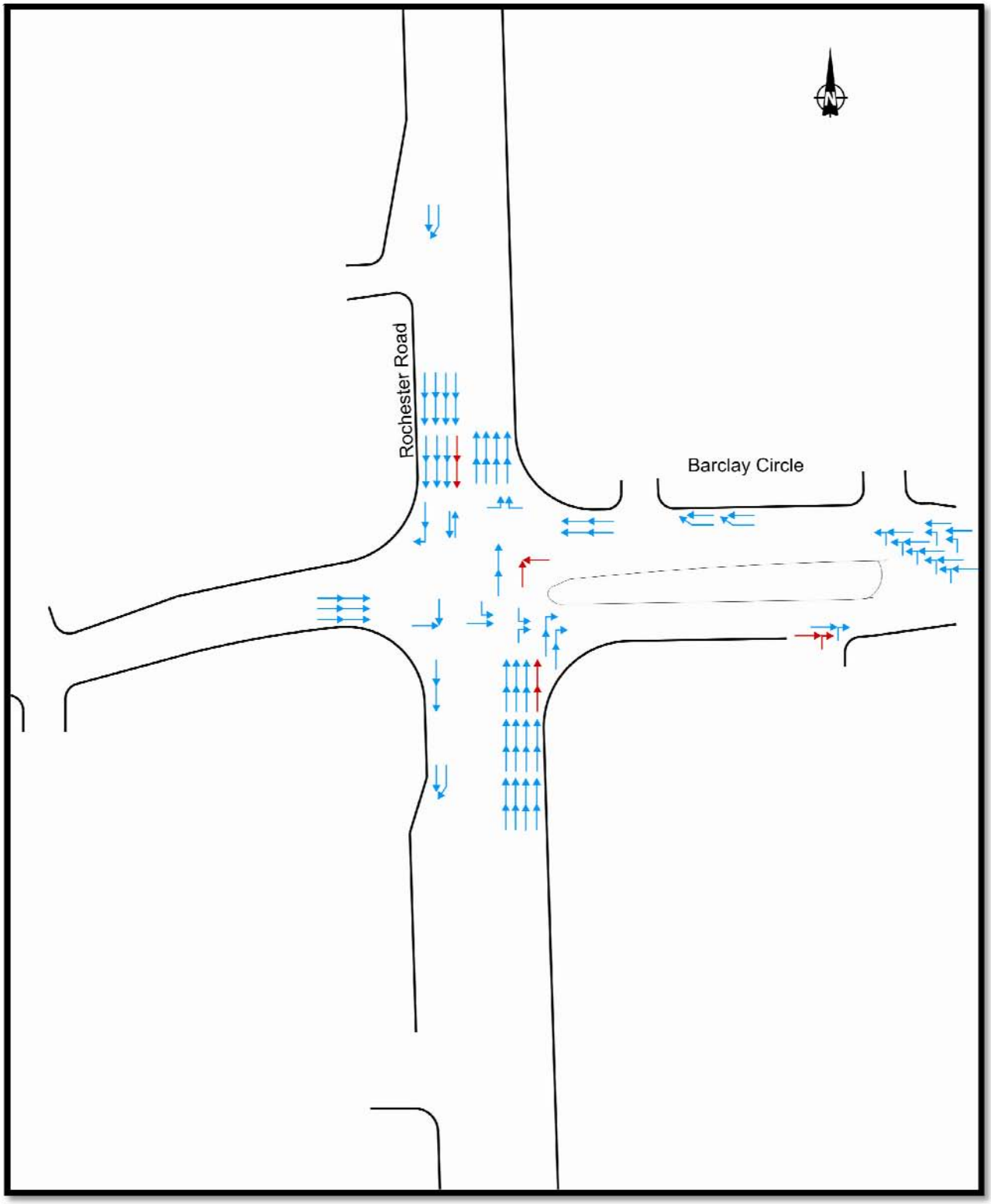


Figure 6-6 COLLISION DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH

6.4 Safety Issues and Suggested Mitigation Measures

SAFETY ISSUE **(Number and Description)**	**Risk Rating**	**Suggestions**
Signal display	**C**	▪ Add a fourth level left-turn arrow signal face for the through/left lane on westbound Barclay.
Offset approaches on Barclay/Wabash	**C**	▪ Realign the eastbound Wabash approach. ▪ If the eastbound Wabash approach is realigned provide protected-permissive left-turn phasing.
Pedestrian facilities	**D**	▪ Provide a crosswalk across the south leg. ▪ Improve pedestrian refuge on the east leg
Access Management on Barclay	**C**	▪ Directionalize driveway ▪ Consolidate driveways ▪ Extend median on Barclay
Signing	**B**	▪ Review signing on east leg median.

Issue 1: Signal Display

The signal displays for westbound Barclay Circle at Rochester Road are not consistent with the current lane use. The signals currently do not display a left-turn arrow for the center through/left lane. This display leads to driver confusion and an underutilized center lane. This display increases the risk for angle crashes.

Issue 2: Offset Approaches on Barclay/Wabash

The Barclay and Wabash approaches to the intersection are not lined up. As a result, split phasing is required for the Barclay/Wabash approaches of the intersection as the opposing left-turning paths to cross. The use of split phasing at this intersection increases driver frustration.

Furthermore, many of the rear end crashes on Rochester Road are the result of the regular queues which are present at this intersection due to the use of split phasing.

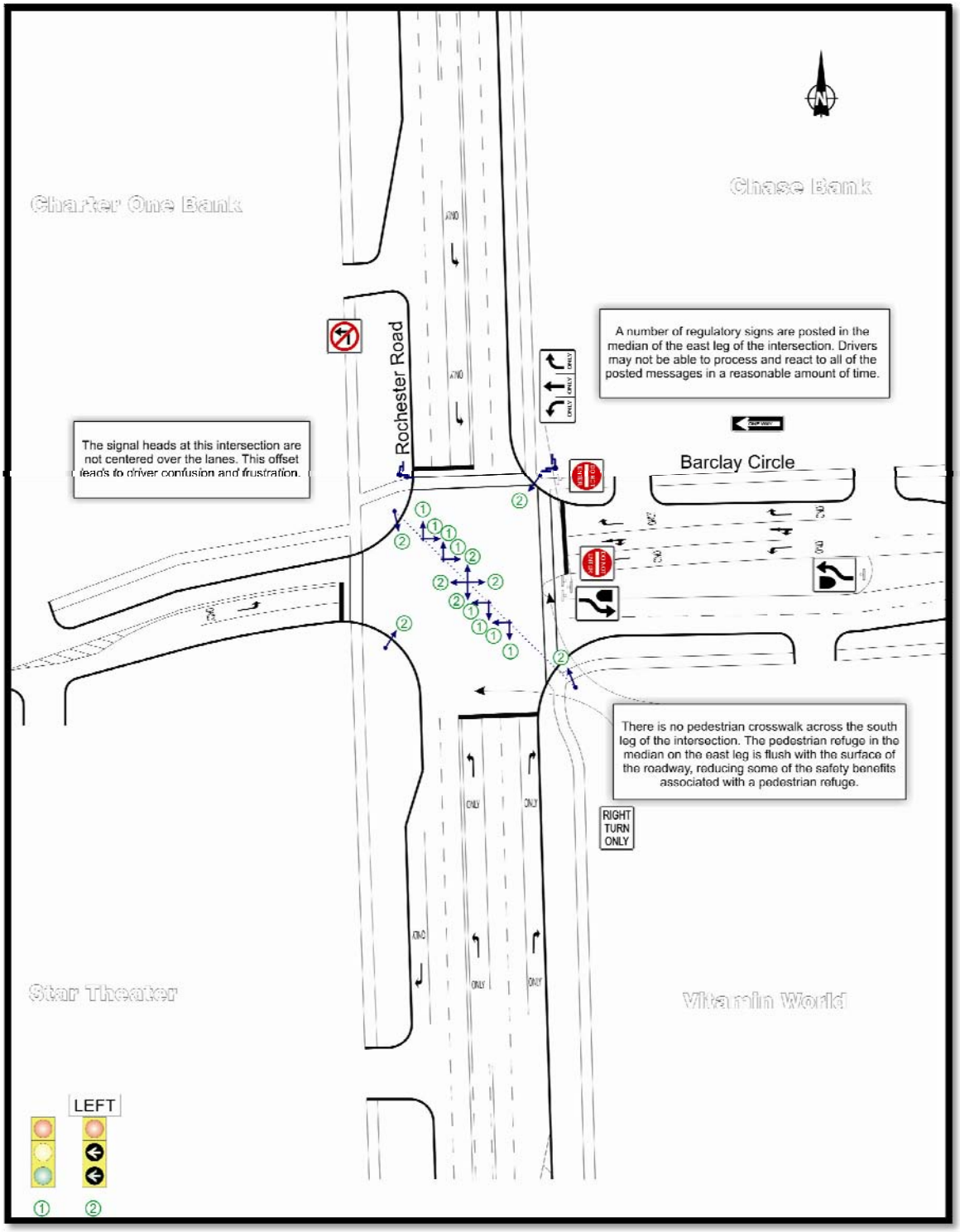


Figure 6-7 ISSUES DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH

Issue 3: Pedestrian Facilities

The pedestrian refuge in the crosswalk across the east leg of the intersection is flush with the surface of the roadway. This may lead visually impaired pedestrians to inadvertently veer into the center of the intersection. Additionally, there is no pushbutton at the refuge for those pedestrians who are unable to cross the entire distance in a single pedestrian phase. As a result, pedestrians run the risk of getting stranded in the median with no way to actuate a WALK signal.

There are also no pedestrian facilities across Rochester Road on south leg of the intersection. Given the pedestrian traffic generators at this intersection, including the Hampton Village Center Shopping Center and condominiums to the east of the intersection, several pedestrians were observed crossing this leg during the site visit.

Issue 4: Access Management on Barclay

A private driveway, providing access to the commercial developments on the southeast corner of the intersection, opens onto Barclay Circle/Wabash Road. The driveway lane use is marked as having through or right turn only lanes. During the site visit, many drivers were observed making left-turn maneuvers from the driveway. Drivers disregard for the pavement markings is likely a leading factor in the number of left-turn opposing collisions recorded on Barclay Circle. Additionally, this driveway is located in close proximity to the driveway which provides access to the Hampton Village shopping center. Several conflicts were observed when drivers attempted to exit both driveways simultaneously on to Barclay.

Issue 4: Signing

The signing in the median of Barclay Circle is crowded and overwhelming. There are likely too many pieces of information for drivers to comprehend within a reasonable amount of time. Too much information increases the risk that a driver will stop short, causing rear end collisions, and to make other erratic merging maneuvers resulting in sideswipe collisions.

Mitigation Measure 1: Signal Display

It is suggested that the signal at this intersection be modernized to revise the westbound signal display. The eastbound signal display should include three overhead signals with the following sections from top to bottom:

- Left Signal – Red Left Arrow; Yellow Left Arrow; Green Left Arrow.
- Center Signal – Circular Red; Circular Yellow; Circular Green; Green Left Arrow.

- Right Signal - Circular Red; Circular Yellow; Circular Green

This revised display will likely reduce angle and left-turn crashes at the intersection as well as improve operations by increasing lane utilization for the center lane. It is also suggested that yellow reflective backplates be added to the signal display as part of the modernization.

Mitigation Measure 2: Install Crosswalk on the South Leg of Rochester Road

Install complete pedestrian facilities across the south leg of the intersection. This should include pedestrian signal heads, push-button actuators, ramps with truncated domes, a crosswalk and connections with the existing pathways.

Mitigation Measure 3: Improve Pedestrian Refuge on the East Leg

Reconstruct the pedestrian refuge on the east leg such that there is an ADA compliant cut through and includes detectable edging. In addition to upgrading the refuge, install a pedestrian pushbutton on the median.

Mitigation Measure 4: Access Management

Short-term Option:

1) Directionalize the private driveway to allow only right-in and right-out movements.

Consider directionalizing the current entrance/exit onto Barclay Circle with a directionalized pork-chop median in the private drive.

Longer-term Option(s):

2) Extend the median past the driveway to prohibit left-turning movements.

Extending the current median on Barclay Circle past the private driveway would prohibit left-turning movements from the driveway and, thus, reduce the risk for left-turn/angle-type collisions.

3) Close the current driveway and re-routed parking lot traffic to the entrance to the east.

There exists an entrance to the Hampton Village shopping center directly to the east of the aforementioned private driveway. The commercial facilities on the southeast corner of the

intersection of Rochester Road and Barclay Circle are not affiliated with those establishments making up the Hampton Village shopping center. Consider suggesting to both parties that parties that the driveways be merged and the current entrance/exit be closed. Closing the current entrance/exit would prohibit any conflicts between the two driveways that may result in left-turn or angle-type collisions.

Mitigation Measure 4: Signing

Review the current signing plan and consider removing any unnecessary signs. Reducing the number of pieces of information that drivers need to process may reduce the number of short stops and erratic movements. Simplifying the singing plan will allow drivers to process and comprehend all information that is necessary, reducing confusion and the likelihood of a collision occurring.

Mitigation Measure 5: Realign Barclay and Wabash

To reduce the need for split phasing at the intersection, it is suggested that the realignment of the eastbound approach of Wabash be considered. It is suggested that the through lane be shifted to the south and the left-turn lane be aligned with the westbound left-turn lane. If this location is to be realigned, protected permissive left-turn phasing should be evaluated. If protected-permissive left-turn phasing is utilized, then the left-turn lanes should be aligned or designed with a positive offset. If a median is installed and negative offset left-turn lanes are provided, then there is a significant risk that crashes will increase at this intersection.

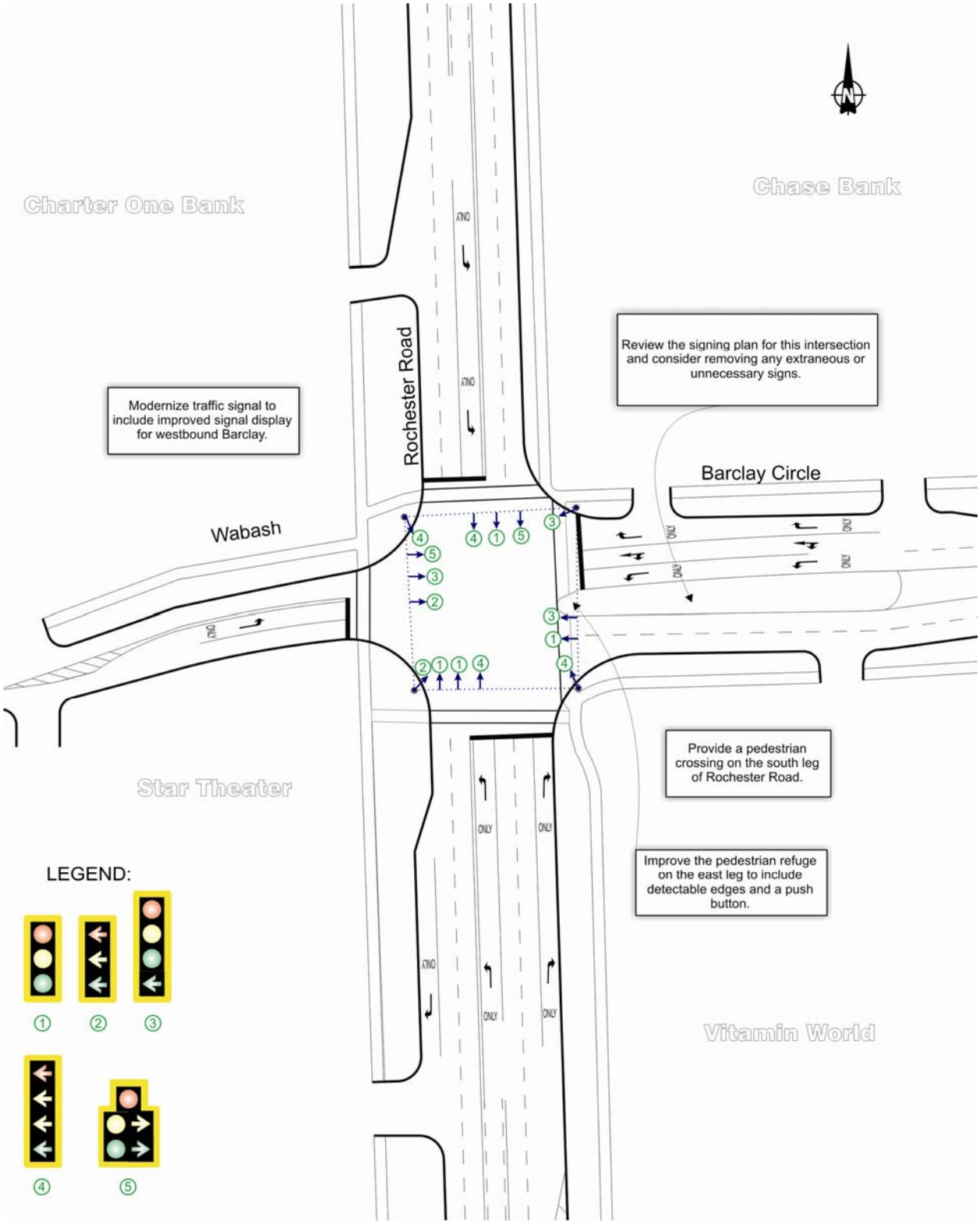


Figure 6-8 MITIGATIONS DIAGRAM: ROCHESTER ROAD AND BARCLAY CIRCLE/WABASH

7.0 ROCHESTER ROAD AND AUBURN ROAD

7.1 Intersection Geometry

A condition diagram of the intersection is shown in **Figure 7-1**, and site photographs are provided in

Figure 7-2. The intersection is surrounded by commercial land uses. Currently this intersection operates with one left-turn lane, two through lanes, and one right turn lane on the Rochester Road approaches. The eastbound leg of Auburn Road operates with one dedicated left-turn lane, one through lane and one dedicated right turn lane. The westbound leg of Auburn Road has one dedicated left-turn lane, two through lanes and one dedicated right turn lane.

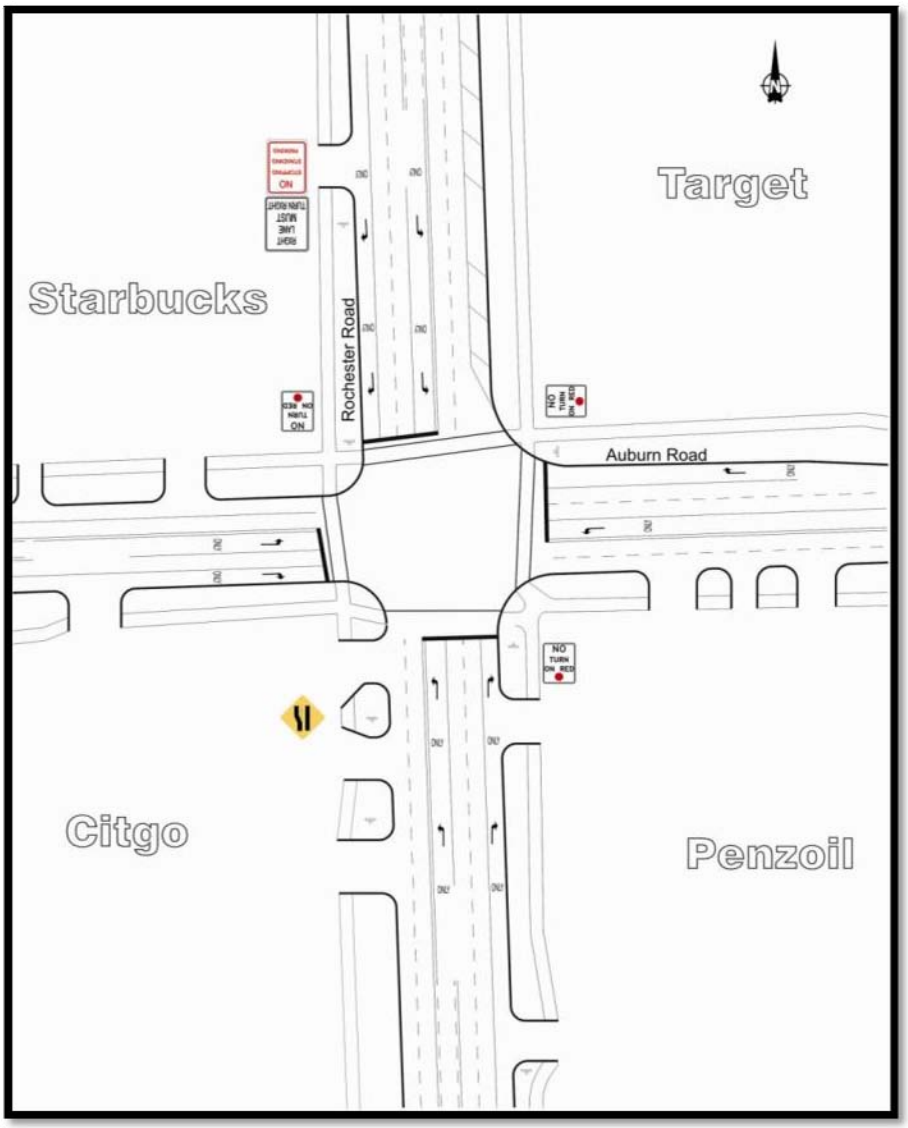


Figure 7-1 CONDITION DIAGRAM: ROCHESTER ROAD AND AUBURN ROAD

Northbound approach along Rochester Road

Southbound approach along Rochester Road

Eastbound approach along Auburn Road

Westbound approach along Auburn Road

Figure 7-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND AUBURN ROAD

Site Observations

- *Some rutting is present.*
- *There is limited access management in this area.*
- *Red light running was observed on Rochester Road*

A

B

7.2 Traffic Control

The traffic signal display is shown schematically within **Figure 7-1**. Four signal heads are provided on each of the approaches including three overhead span wire signals and one far left post mounted signal. All signal heads have 12 inch lenses. There are no blackplates provided at this intersection. Left turns operate with leading protected-only phasing. Pedestrian signal heads are provided for all crosswalks. The pedestrian signals are push-button actuated across all legs.

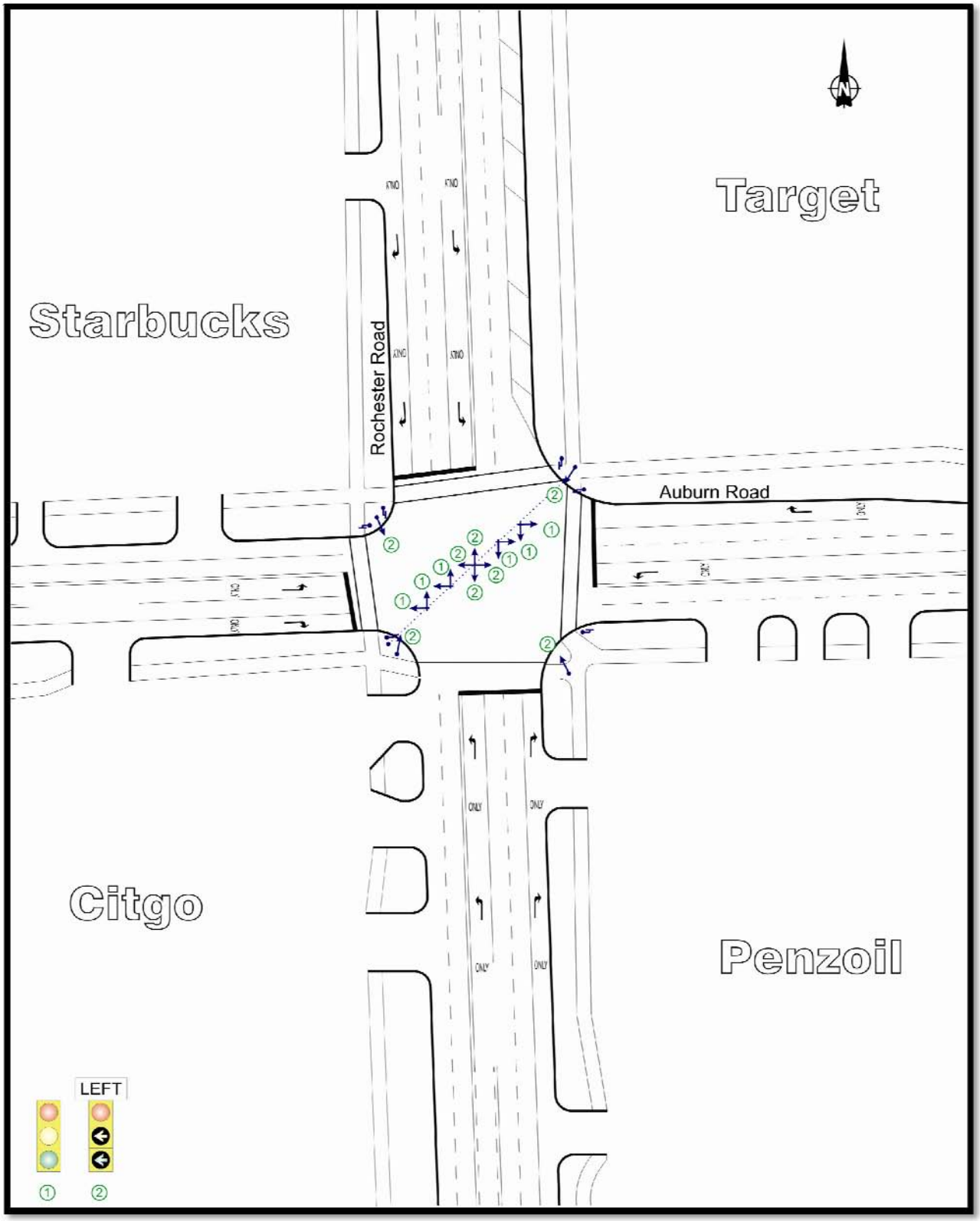


Figure 7-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND AUBURN ROAD

7.3 Collision Analysis

Crash data for the years of 2006 to 2008 were provided by MDOT and using the Office of Highway Safety Planning's website. Over the three years analyzed, 154 collisions were recorded at or near the intersection. As summarized in **Figure 7-4**, 10 percent of collisions resulted in at least one injury. The remainder of the collisions involved property damage only. No fatalities were reported during the study period.

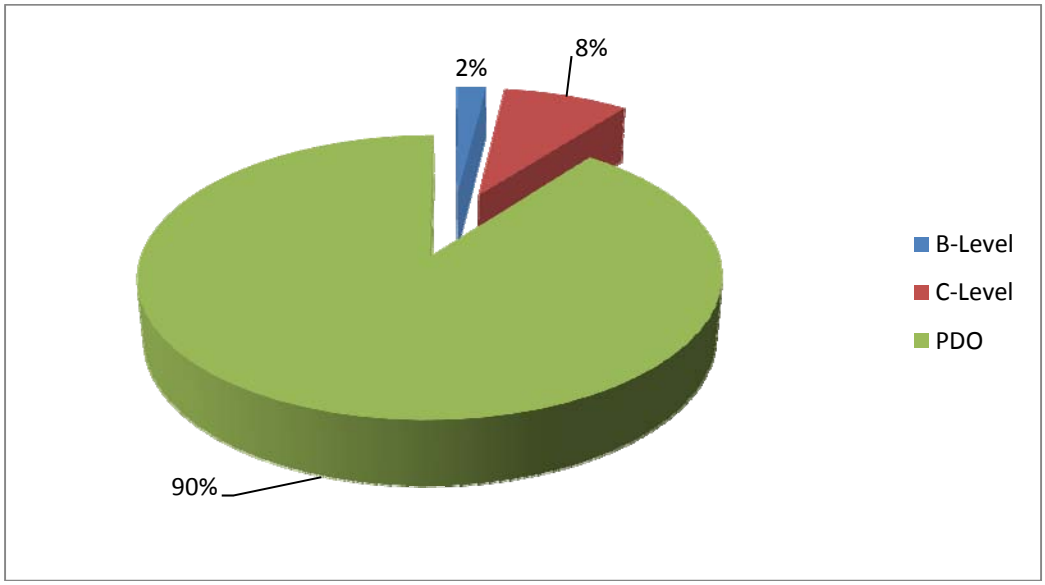


Figure 7-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND AUBURN ROAD

Collision Types

Collision type distribution is summarized in **Figure 7-5**, and a collision diagram is shown in **Figure 7-6**. The collision diagram illustrates crashes which UD-10 reports were available using michigantrafficcrashfacts.org. The following collision trends were observed:

- Rear-end collisions predominated, accounting for 48 percent of all recorded collisions.
- Angle collisions accounted for 29 percent of the three-year total collisions.

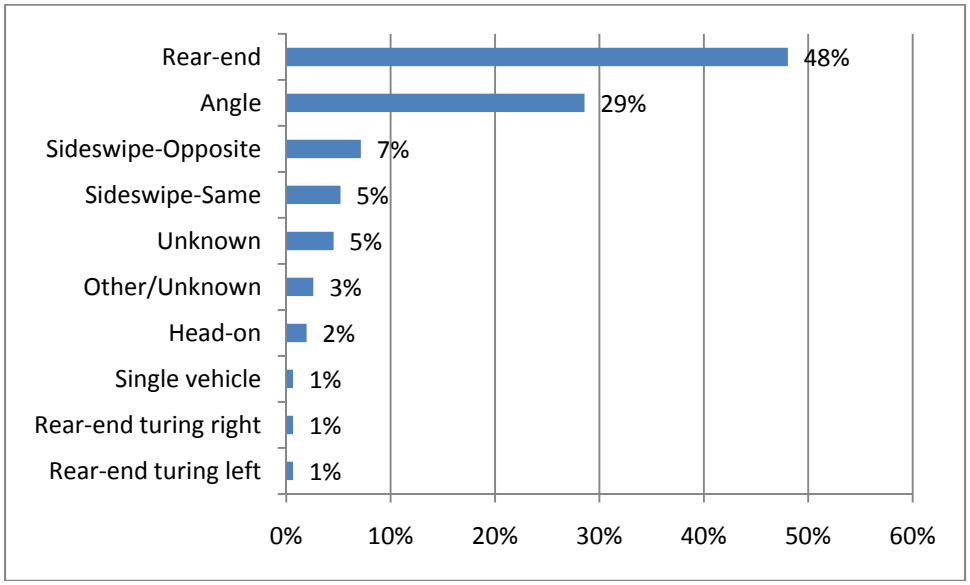


Figure 7-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND AUBURN ROAD

Temporal and Environmental Distribution

Temporal and environmental distributions indicate the following trends:

- The highest frequency of collisions occurred during the month of December.
- Hourly distributions show a higher frequency of crashes between 2:00 and 3:00 PM, approximately when schools release.
- Thirty-one percent of collisions occurred under wet or winter conditions suggesting that road conditions may be a contributing factor to collisions.
- Approximately 80 percent of crashes occurred during daylight or lighted conditions, suggesting that lighting is likely not an issue at this intersection.

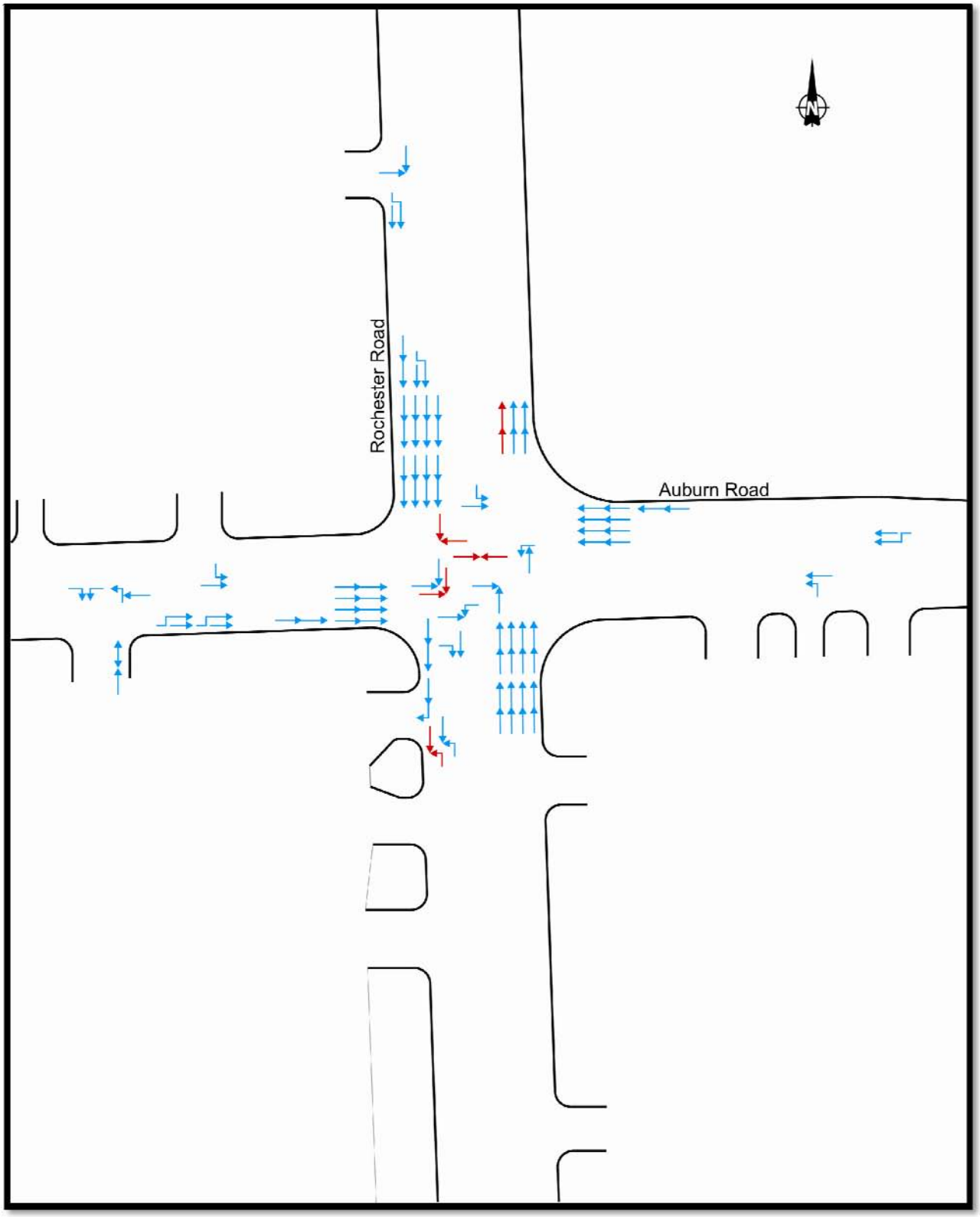


Figure 7-6 COLLISION DIAGRAM: ROCHESTER ROAD AND AUBURN ROAD

7.4 Safety Issues and Suggested Mitigation Measures

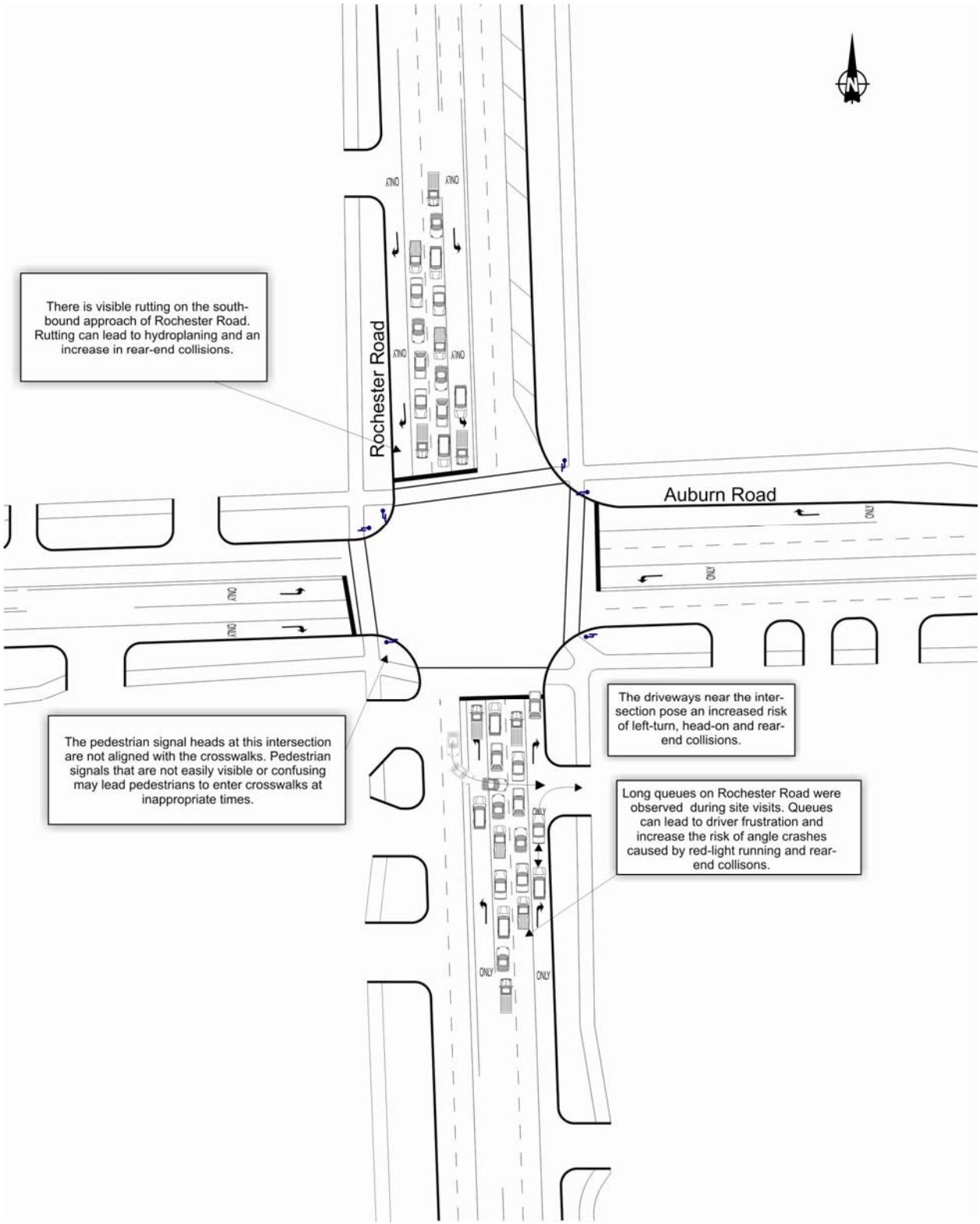


Figure 7-7 ISSUES DIAGRAM: ROCHESTER ROADX AND AUBURN ROAD

SAFETY ISSUE **(Number and Description)**	**Risk Rating**	**Suggestions**
Queues	**C**	▪ Review the signal timing plan for this intersection.
Pedestrian Facilities	**D**	▪ Align pedestrian signal with crosswalk ▪ Relocate the drainage grate in front of the crosswalk.
Access management	**D**	▪ Driveway consolidation ▪ Access restrictions ▪ Narrow median
Rutting	**B**	▪ Install a high friction pavement.
Red-light running	**D**	▪ Upgrade/modernize signal to include: • Backplates with yellow reflective borders • Near right signal displays

Issue 1: Queues

During the site visit, long queues were noted on both approaches of Rochester Road during the evening peak hour. Waiting in queues leads driver frustration increasing the risk of both red-light running and rear end collisions.

Issue 2: Pedestrian Facilities

At the intersection of Rochester Road and Auburn Road, the pedestrian signals are not aligned with the crosswalks. Confusion on behalf of the pedestrian due to offset pedestrian signal heads may lead pedestrians to venture into the crosswalk at inappropriate times. Additionally, there is a drainage grate in the crosswalk on the north leg of the intersection. This may pose a serious problem for those pedestrians using walkers or in wheelchairs.

Issue 3: Access Management

A number of driveways to private commercial establishments are present near this intersection. As a result of the periodic queuing, driveway entrances are often blocked, leading to driver frustration and choosing inappropriate gaps in the traffic flow. During the site visit, drivers were observed attempting to cut through queues to make left turns or to enter right turn lanes. Cutting

through these backups may lead to angle-type collisions as a result of drivers not being able to see oncoming traffic beyond the queue.

Issue 4: Rutting

Moderate rutting is present on Rochester Road at the intersection with Auburn Road. Rutting often results in hydroplaning and loss of control under wet or icy conditions. This is justified as a contributing factor as Thirty-one percent of the crashes occurred in wet or icy conditions.

Issue 5: Red-light Running

Based on the crash data analysis and the site visit observations, it appears that red-light running is a problem at this intersection. Red-light running often results in more severe angle-type collisions. This issue may come as a result of other issues. Drivers who have been waiting in queues, in combination with long wait times caused by the presence of protected-only left-turn phasing with single left-turn lanes, may run a red light out of aggravation and frustration.

Mitigation Measure 1: Queues

Review the signal timing plan to ensure that the intersection is performing optimally during peak hours.

Mitigation Measure 2: Pedestrian Facilities

Remove and relocate the drainage grate located in the crosswalk on the north leg of the intersection. Relocate the pedestrian signal heads to be centered on the crosswalk. Aligning the pedestrian signals with the crosswalks will help to prevent confusion on the part of the pedestrian and may reduce the potential for pedestrian collisions at this intersection.

Mitigation Measure 3: Access Management

Consider directionalizing the private driveway entrances and creating a right-in/right-out configuration. Limiting the number of possible movements reduces the chance of left-turn angle type collisions. Directionalizing the driveway and limiting movements to right turns in and right turns out would eliminated 12 different conflict points. It is also suggested that as part of the future permitting process that cross access be considered at this location. Cross access will allow drivers to utilize driveways further away from the intersection.

Mitigation Measure 4: Provide a Narrow Median

It is suggested that a narrow median be considered on the south leg of Rochester Road to limit the number of movements to/from driveways. The median should be located between Auburn Road and just north of the Meijer Driveway signal. It is suggested that median be minimum of six feet in width. The median will reduce the risk of access related collisions on Rochester Road. It is suggested that cross access be considered to allow drivers alternate access to Rochester Road.

Mitigation Measure 5: Rutting

Consider resurfacing the existing pavement at this intersection to eliminate the pavement rutting. Additionally, consider installing a high friction treatment at this intersection to prevent hydroplaning and sliding during unfavorable weather conditions. The reduced potential for hydroplaning at this intersection may decrease the number of rear end and other crashes which occur at this intersection due to poor weather conditions. Additionally, resurfacing and a high friction treatment may result in a reduction in angle-type collisions occurring at the intersection due to drivers losing control.

Mitigation Measure 6: Red-light running

To target the red light running at this intersection, it is suggested that the signal be modernized. The signal modernization should include several strategies which are targeted at preventing red light running including:

- *Backplates* – It is suggested that backplates with yellow reflective sheeting be added to t he signals. Backplates enhance both the conspicuity and visibility of the traffic signals. It is suggested that mast arms be considered at this location in order to address wind loading issues related to the backplates.
- *Supplemental* Signal Heads – It is suggested that both near right be provided and that far left supplemental signal heads not be removed during a signal modernization. These additional signals will supplement and reinforce the overhead signal heads by increasing overall driver awareness.

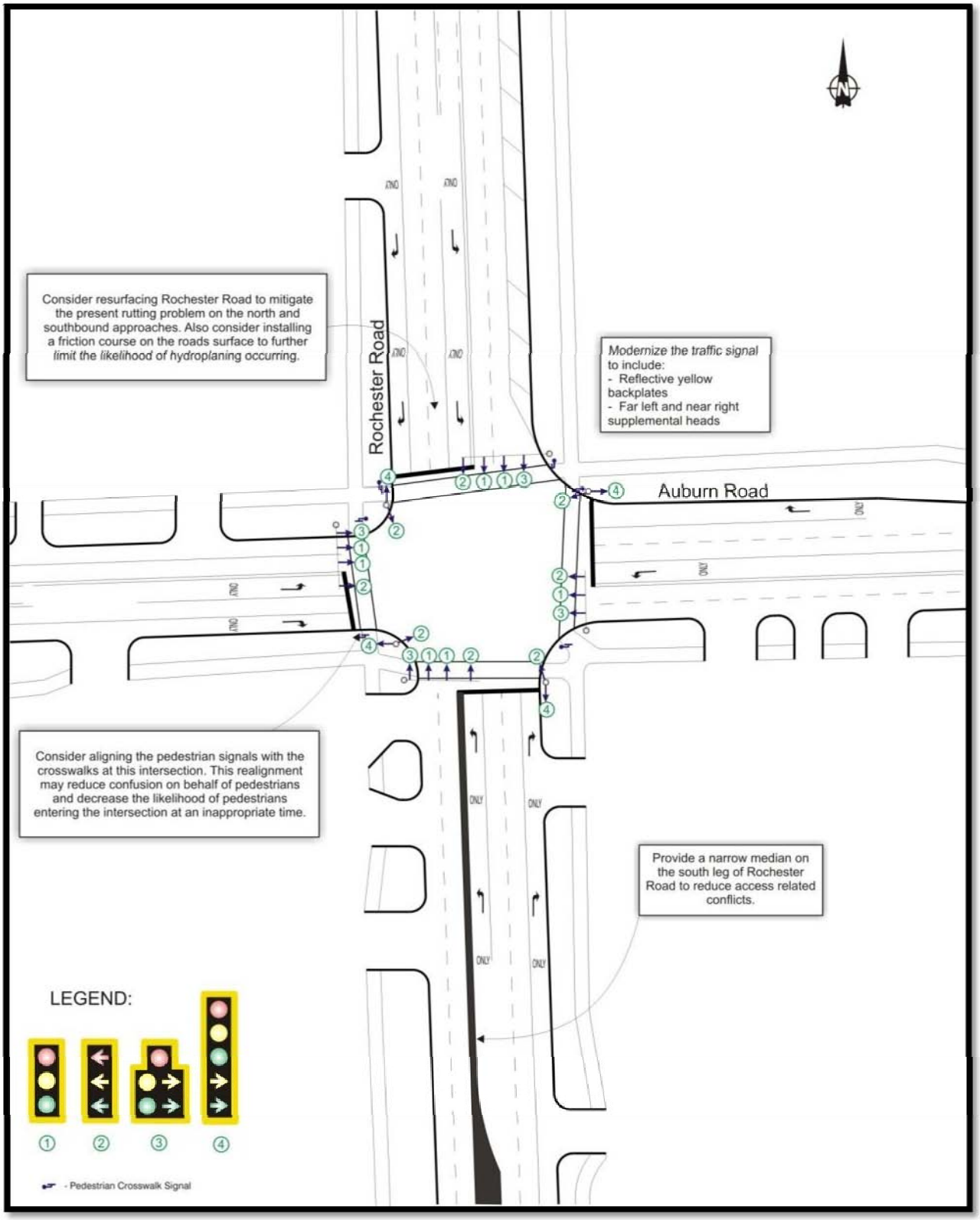


Figure 7-6 MITIGATIONS DIAGRAM: ROCHESTER ROAD AND AUBURN ROAD

8.0 ROCHESTER ROAD AND MEIJER DRIVEWAYS

8.1 Intersection Geometry

A condition diagram of the intersection is shown in **Figure 8-1**, and site photographs are provided in **Figure 8-2**. The intersection is surrounded by commercial land uses. Currently, south Meijer driveway which also provides access to Lowes is signalized while the north driveway unsignalized.

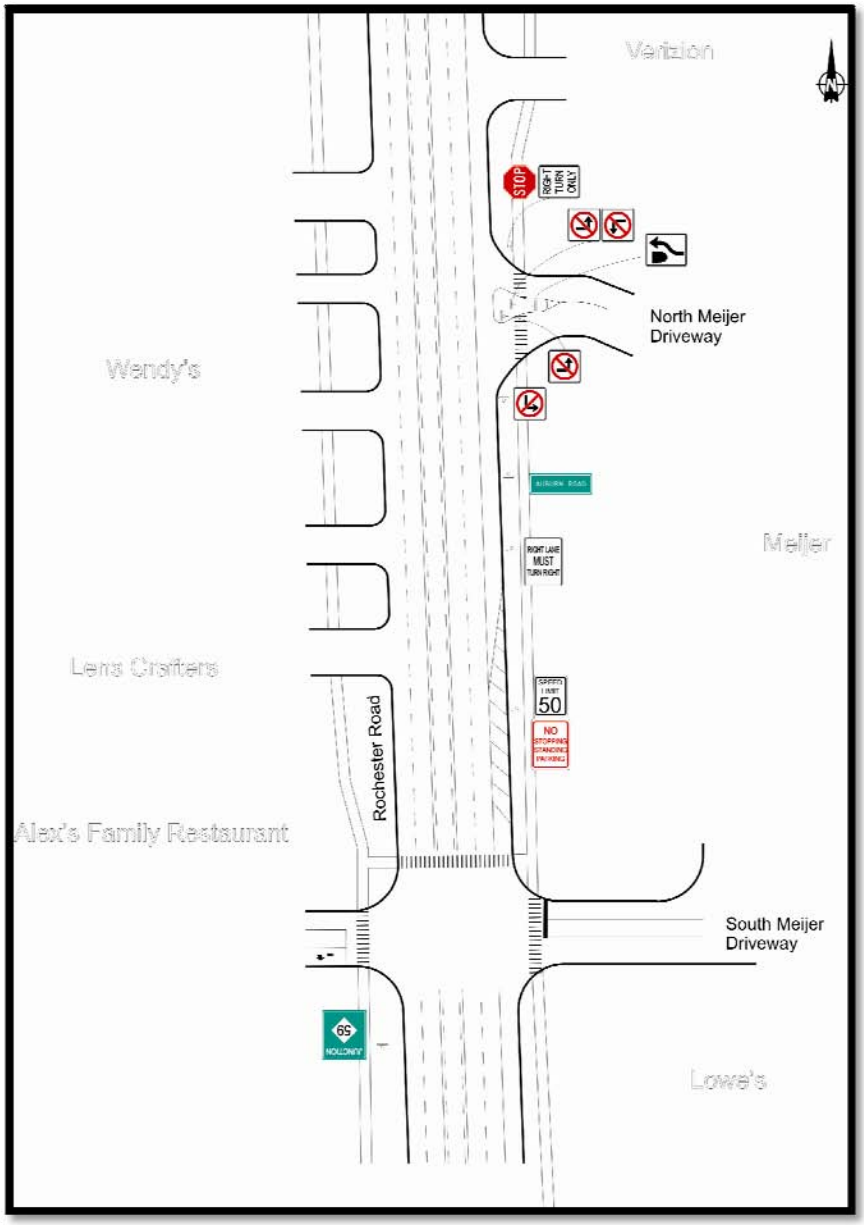
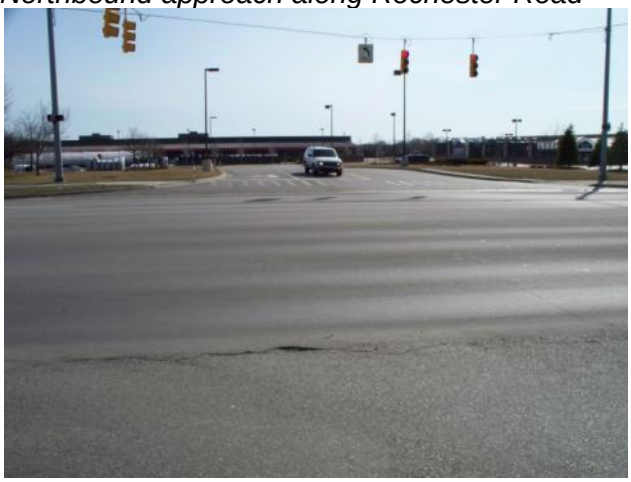


Figure 8-1 CONDITION DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS

Northbound approach along Rochester Road

Southbound approach along Rochester Road



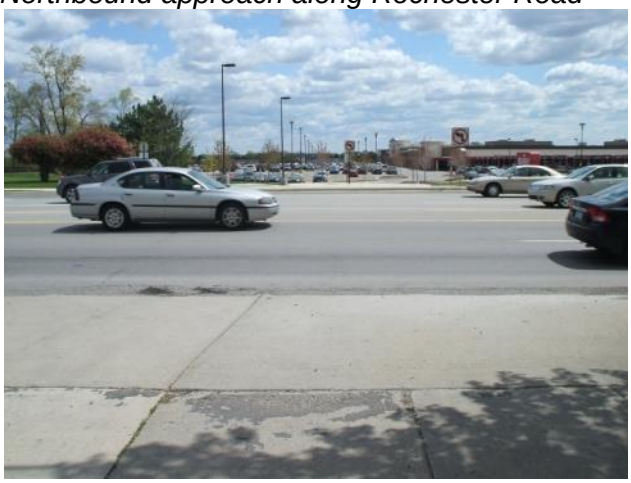
Looking Eastbound
Meijer Driveway (Signalized)

Westbound approach at the
Meijer Driveway (Signalized)

Figure 8-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND MEIJER DRIVEWAY (SIGNALIZED)

Northbound approach along Rochester Road

Southbound approach along Rochester Road



Looking Eastbound
Meijer Driveway (Unsignalized)

Westbound approach at the
Meijer Driveway (Unsignalized)

Figure 8-3 SITE PHOTOGRAPHS: ROCHESTER ROAD AND MEIJER DRIVEWAYS (UNSIGNALIZED)

Site Observations

- *Right-turn lane for Auburn Road extents past driveways.*
- *Limited access management in this area on the west side of Rochester Road.*
- *Left-turns are made where prohibited.*

8.2 Traffic Control

The traffic signal display for the southern Meijer driveway is shown schematically within **Figure 8-4**. Two signal heads are provided on each of the approaches including two overhead span wire signals. All signal heads have twelve-inch lenses. There are no blackplates provided at this intersection. Pedestrian signal heads are provided for the crosswalk. The pedestrian signals are

timed with the signal. The northern Meijer driveway is also shown schematically within **Figure 8-4**. This driveway is unsignalized and operates with a right-in-right-out splitter island.

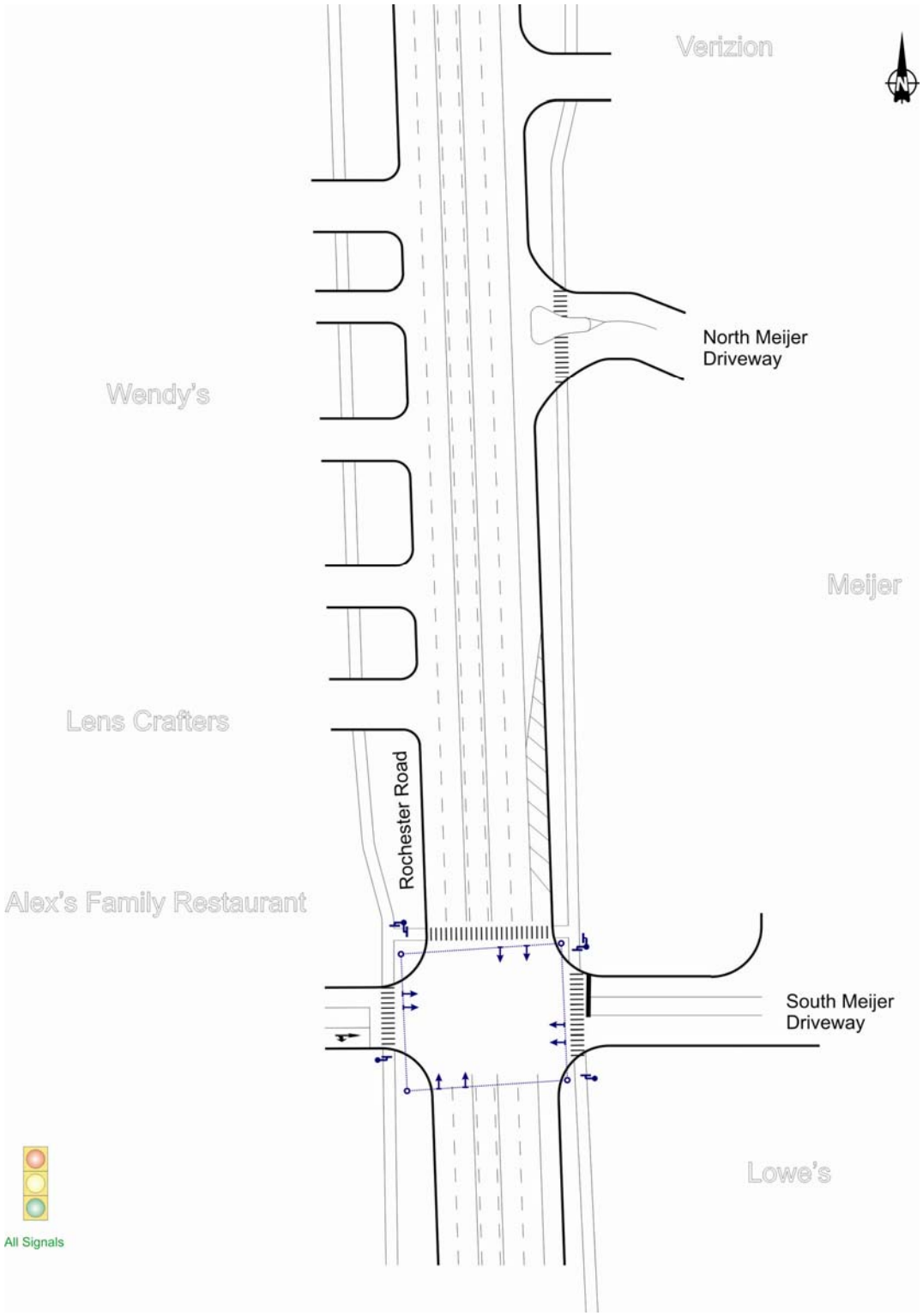


Figure 8-4 SIGNALS DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS

8.3 Collision Analysis

Crash data for the years of 2006 to 2008 were provided by MDOT and the Office of Highway Safety Planning's website. Over the three years analyzed, 154 collisions were recorded at or near the intersection. As summarized in **Figure 8-5**, 10 percent of the collisions resulted in at least one injury. The remainder of the collisions involved property damage only. No fatalities were reported during the study period.

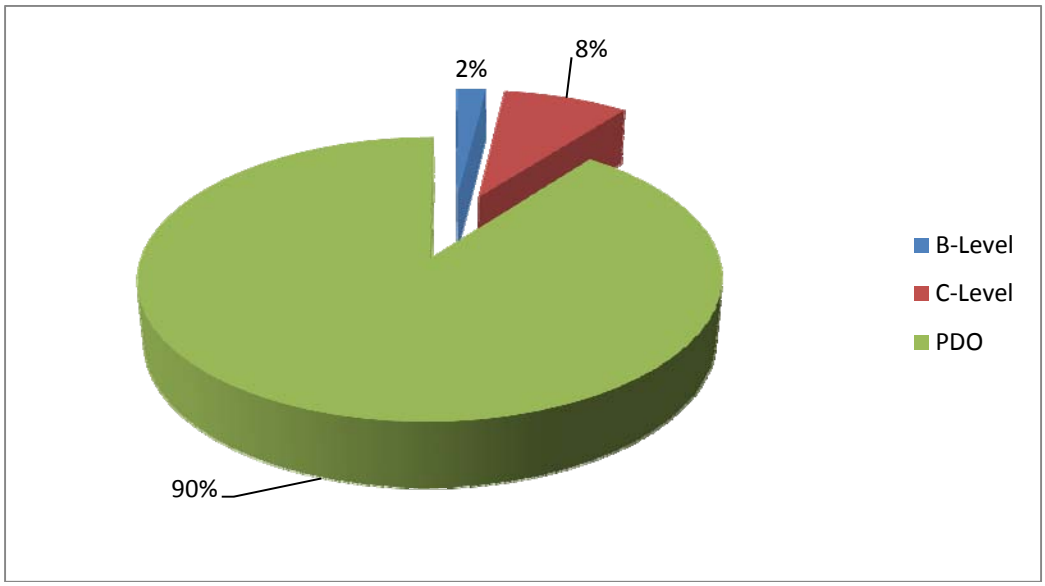


Figure 8-5 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND MEIJER DRIVEWAYS

Collision Types

Collision type distribution is summarized in **Figure 8-6**, and a collision diagram is shown in **Figure 8-7**. The collision diagram illustrates crashes in which UD-10's were available from michigantrafficcrashfacts.org. The following collision trends were observed:

- Rear-end collisions predominated, accounting for 48 percent of all recorded collisions.
- Angle collisions accounted for 29 percent of the three-year total collisions.

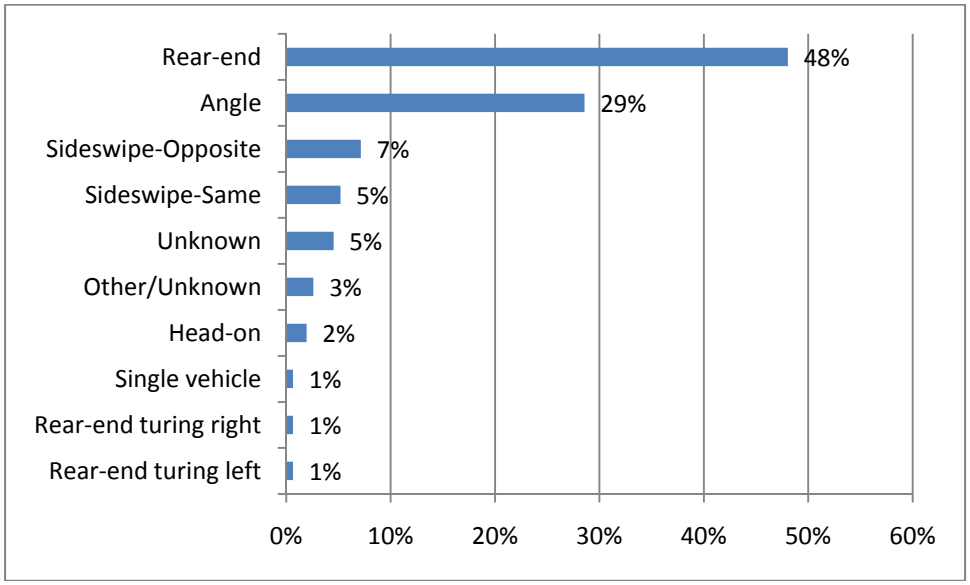


Figure 8-6 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND MEIJER DRIVEWAYS

Temporal and Environmental Distribution

Temporal and environmental distributions indicate the following trends:

- The highest frequency of collisions occurred during the month of December.
- Hourly distributions show a higher frequency of crashes between 2:00 and 3:00 pm, approximately when schools release.
- Thirty-one percent of collisions occurred under wet or winter conditions suggesting that road conditions may be a contributing factor to collisions.
- Approximately 80 percent of crashes occurred during daylight or lighted conditions, suggesting that lighting is likely not an issue at this intersection.

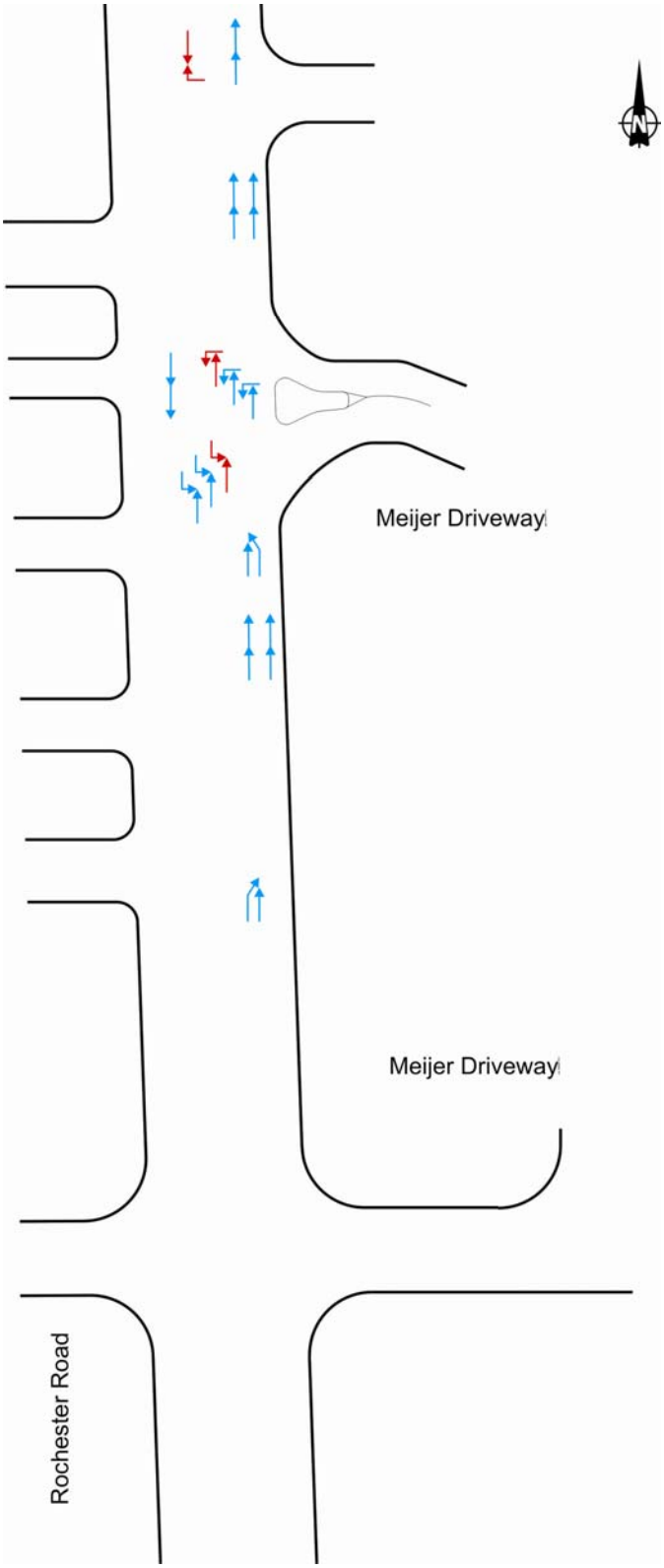


Figure 8-7 COLLISION DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS

8.4 Safety Issues and Suggested Mitigation Measures

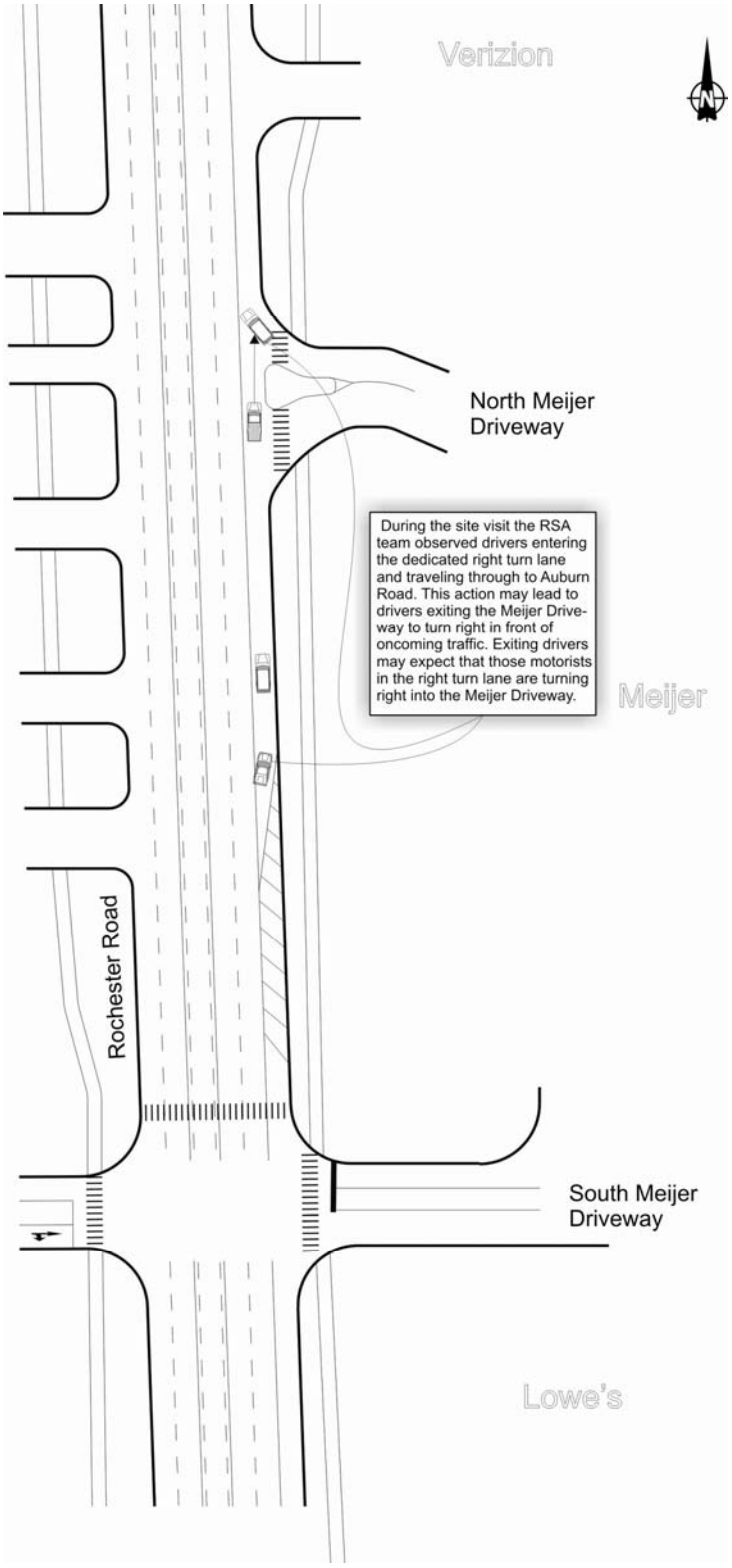


Figure 8-8 ISSUES DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS

SAFETY ISSUE **(Number and Description)**	**Risk Rating**	**SUGGESTIONS**
Lane Use	B	▪ Extend the current splitter island into the right-turn lane on Rochester Road (short-term)
Access Management	C	▪ Provide a narrow median on Rochester Road, which was discussed in the previous section. ▪ Pursue cross access with the business owners on the west side of Rochester Road.

Issue 1: Lane Use

The dedicated right turn lane for the intersection of Auburn Road and Rochester Road extends beyond the northern entrance to the Meijer parking lot. During the evening peak hour, this right turn lane may queue past the entrance leading drivers to attempt to pass through the queue. During the site visit, drivers who ultimately made a right turn at Auburn Road were viewed entering the dedicated right turn lane at the beginning of the lane, and driving through to the intersection. This creates a safety issue for those drivers in the Meijer driveway who may be expecting the drivers in the right turn lane to turn right into the Meijer parking lot and enter the lane in front of a motorist who intends to turn at the intersection.

Issue 2: Access Management

A number of driveways to private commercial establishments are present on the west side of Rochester Road within this segment. As a result of the periodic queuing, driveway entrances are often blocked, leading to driver frustration and choosing inappropriate gaps in the traffic flow. During the site visit, drivers were observed attempting to cut through queues to make left turns or to enter right turn lanes. Cutting through these backups may lead to angle-type collisions as a result of drivers not being able to see oncoming traffic beyond the queue.

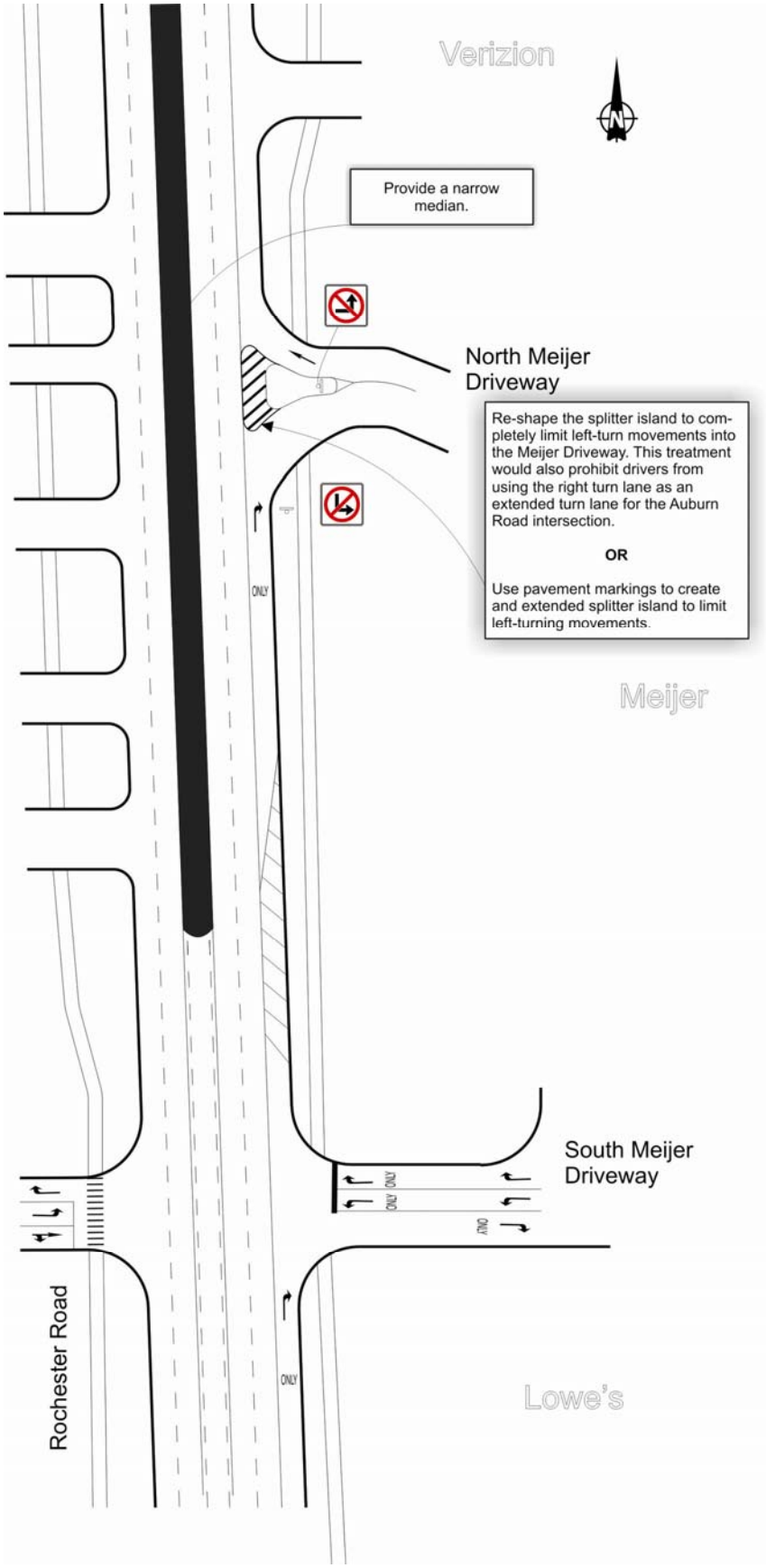

Verizion
Provide a narrow median.
North Meijer Driveway
Re-shape the splitter island to completely limit left-turn movements into the Meijer Driveway. This treatment would also prohibit drivers from using the right turn lane as an extended turn lane for the Auburn Road intersection.
OR
Use pavement markings to create and extended splitter island to limit left-turning movements.
Meijer
South Meijer Driveway
Rochester Road
Lowe's

Figure 8-9 MITIGATION MEASURES DIAGRAM: ROCHESTER ROAD AND MEIJER DRIVEWAYS

Mitigation Measure 1: Lane Use

1) Provide a cross-hatch median using pavement markings to extend the splitter island at the north Meijer driveway. This will prohibit drivers from entering the right turn lane at the beginning of the lane and driving through to Auburn Road.
2) If option 1 is successful, it is suggested that extending the splitter island median out into the right turn lane at the north Meijer driveway be considered as a more permanent solution.

Mitigation Measure 2: Narrow Median

It is suggested that a narrow median be considered on the south leg of Rochester Road to limit the number of movements to/from driveways. The median should be located between Auburn Road and just north of the Meijer Driveway signal. It is suggested that median be minimum of six feet in width. The median will reduce the risk of access related collisions on the west side of Rochester Road. It is suggested that cross access be pursued with the business owners to allow drivers alternate access to Rochester Road.

9.0 ROCHESTER ROAD AND M-59 RAMPS

9.1 Intersection Geometry

A condition diagram of the intersection is shown in **Figure 9-1**, and site photographs are provided in **Figure 9-2**. This site is a service interchange between two state trunklines, M-150 (Rochester Road) and the M-59 freeway. The interchange is a partial cloverleaf design. During the site visits, the interchange was under construction as part of the M-59 reconstruction.

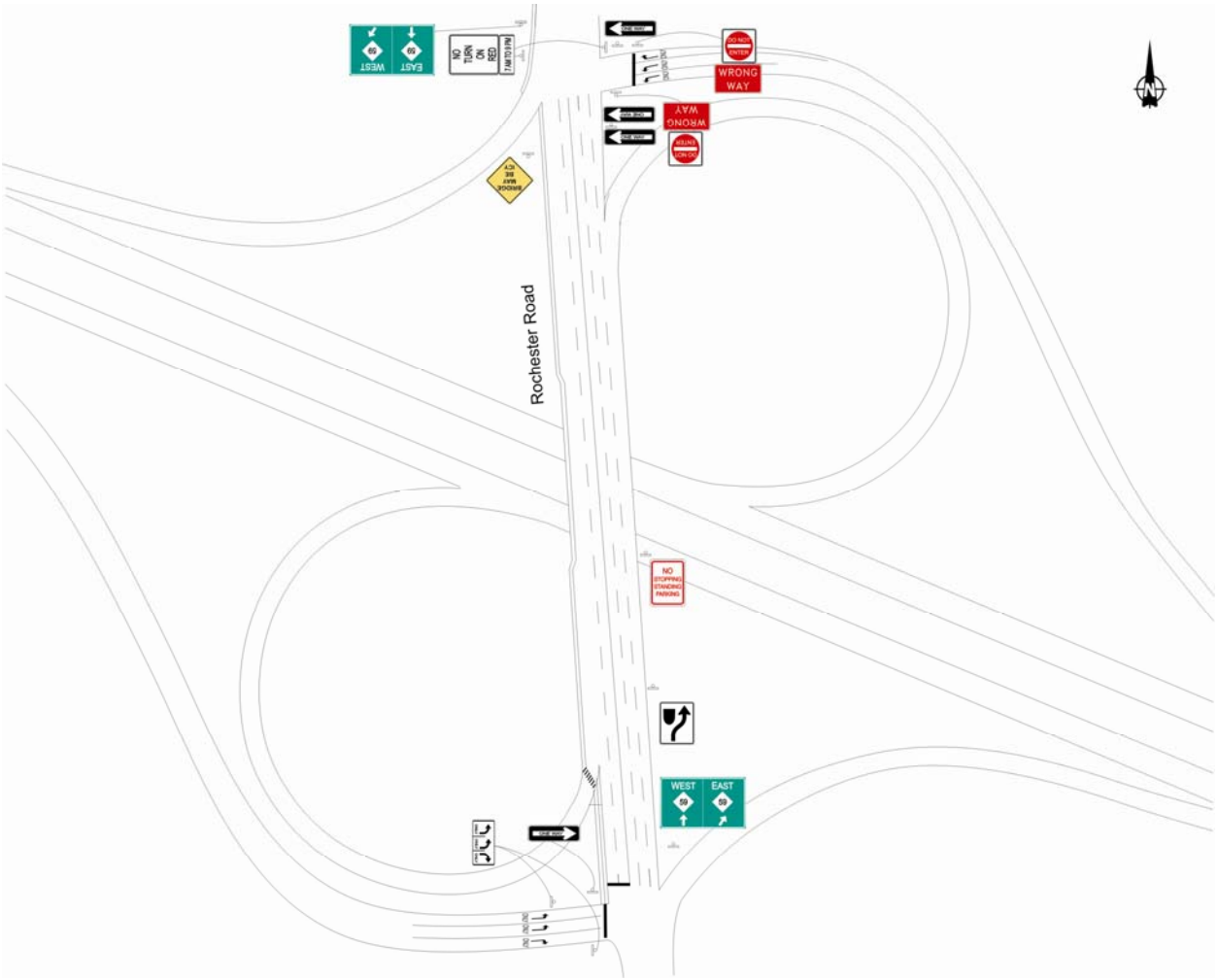


Figure 9-1 CONDITION DIAGRAM: ROCHESTER ROAD AND M-59 RAMPS

Eastbound M-59 exit ramp *Eastbound M-59 entrance ramp*

Westbound M-59 entrance ramp *Westbound M-59 exit ramp*

Figure 9-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND M-59 RAMPS

Site Observations

- *Limited signal visibility as a result of the crest vertical curve on the bridge.*
- *Some limited visibility of freeway guide signs due to being blocked by other signs.*
- *Evidence of pedestrian and bicycles being present and an absence of sidewalks.*

9.2 Traffic Control

Traffic signals are provided at each of the ramp terminals. The traffic signals were in the process of undergoing modernization as part of the M-59 reconstruction project. The traffic

signals will be converted from a diagonal span to a box span. There are no pedestrian signals at this intersection.

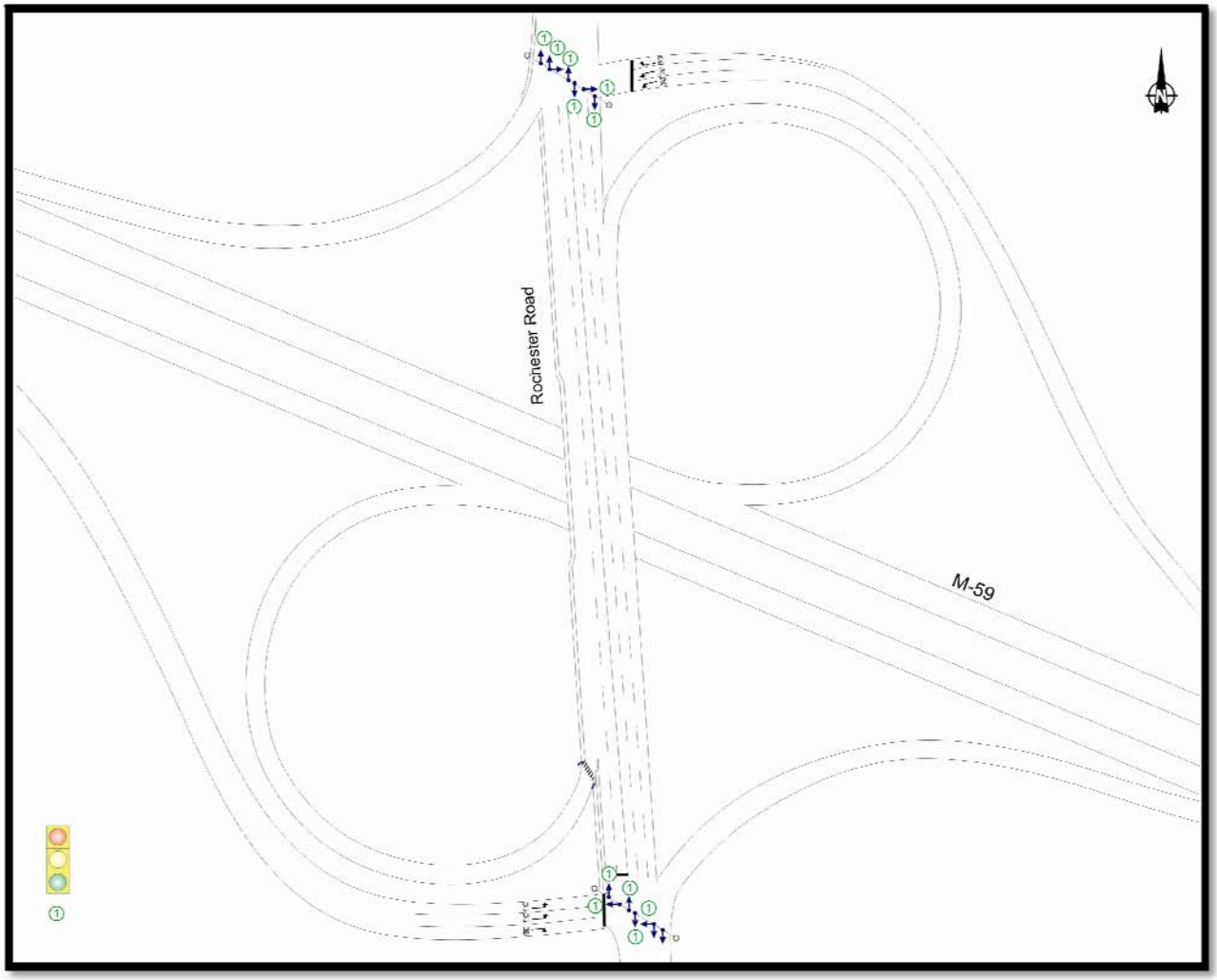


Figure 9-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND M-59 RAMPS

9.3 Collision Analysis

Crash data for the years of 2006 to 2008 were provided by MDOT and the Office of Highway Safety Planning's website. Over the three years analyzed, 154 collisions were recorded at or near the intersection. As summarized in **Figure 9-4**, 10% of collisions resulted in at least one injury. The remainder of the collisions involved property damage only. No fatalities were reported during the study period.

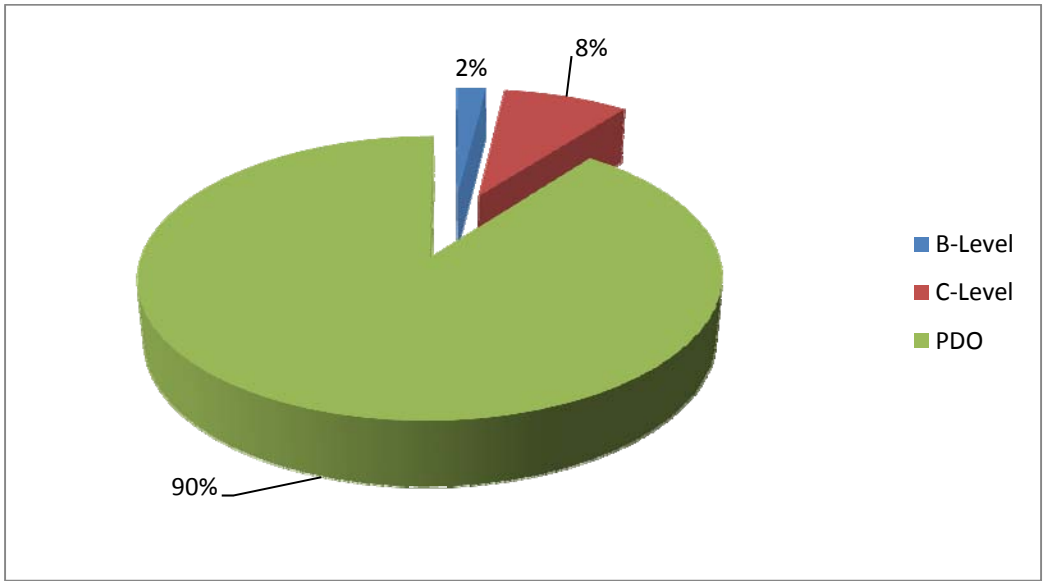


Figure 9-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND M-59 RAMPS

Collision Types

Collision type distribution is summarized in **Figure 9-5**. A collision diagram is provided in **Figure 9-6**. The collision diagram illustrates crashes which UD-10 reports were available using michigantrafficcrashfacts.org. The following collision trends were observed:

Source : michigantrafficcashfacts.org

- Rear-end collisions predominated, accounting for 48 percent of all recorded collisions.
- Angle collisions accounted for 29 percent of the 3-year total collisions.
- According to michigantrafficcrashfacts.org, three pedestrian crashes occurred between 2004 and 2008 within the limits of the interchange (right).

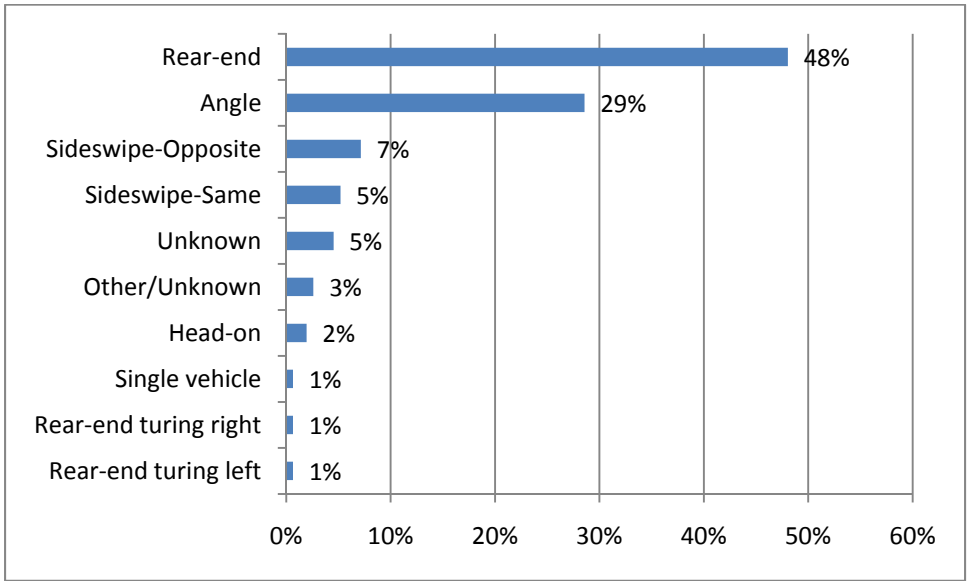


Figure 9-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND M-59 RAMPS

Temporal and Environmental Distribution

Temporal and environmental distributions indicate the following trends:

- The highest frequency of collisions occurred during the month of December.
- Hourly distributions show a higher frequency of crashes between 2:00 and 3:00 PM, approximately when schools release.
- Thirty-one percent of collisions occurred under wet or winter conditions suggesting that road conditions may be a contributing factor to collisions.
- Approximately 80 percent of crashes occurred during daylight or lighted conditions, suggesting that lighting is likely not an issue at this intersection.

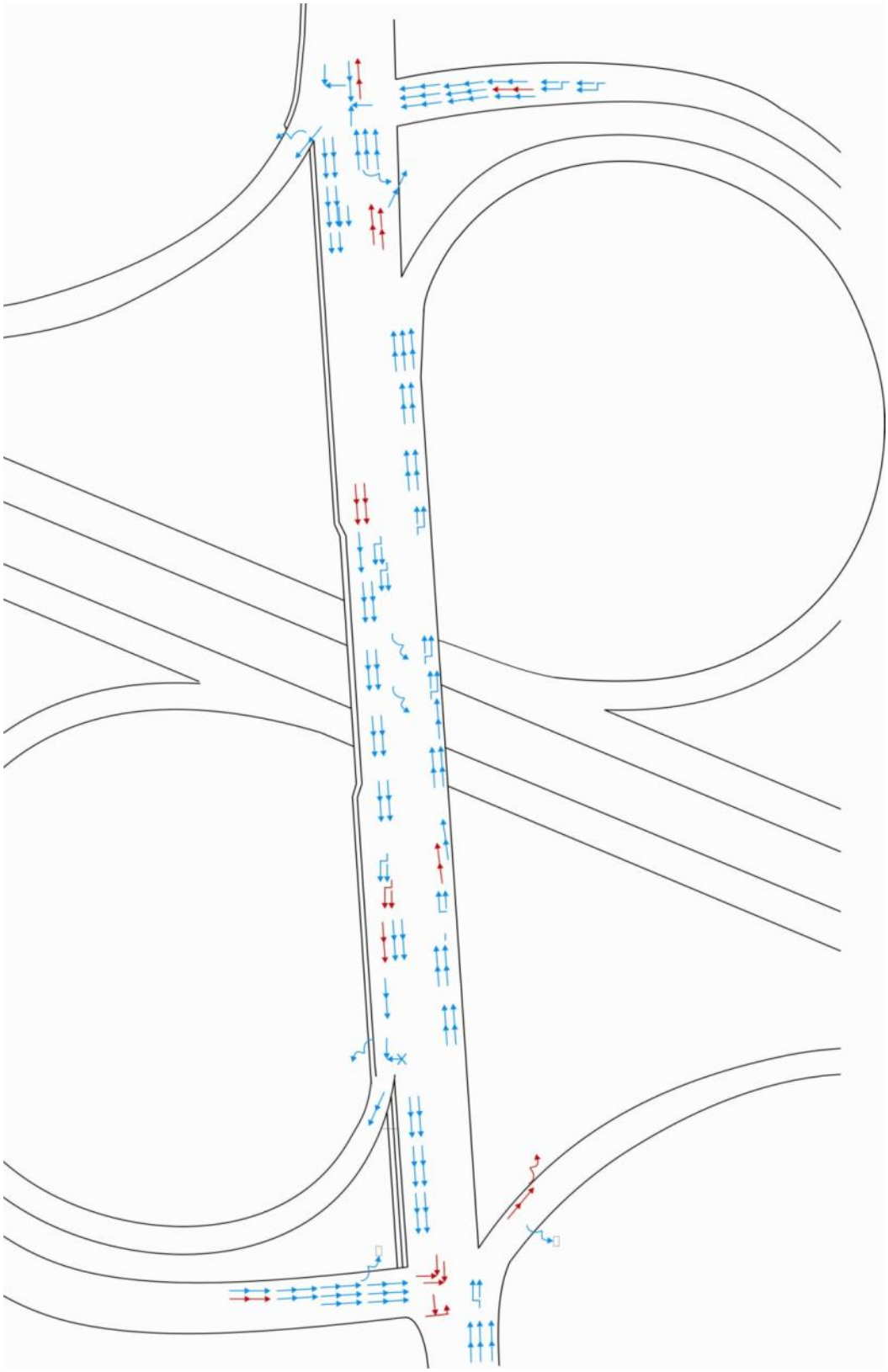


Figure 9-6 COLLISIONS DIAGRAM: ROCHESTER ROAD AND M-59 RAMPS

9.4 Safety Issues and Mitigation Measures

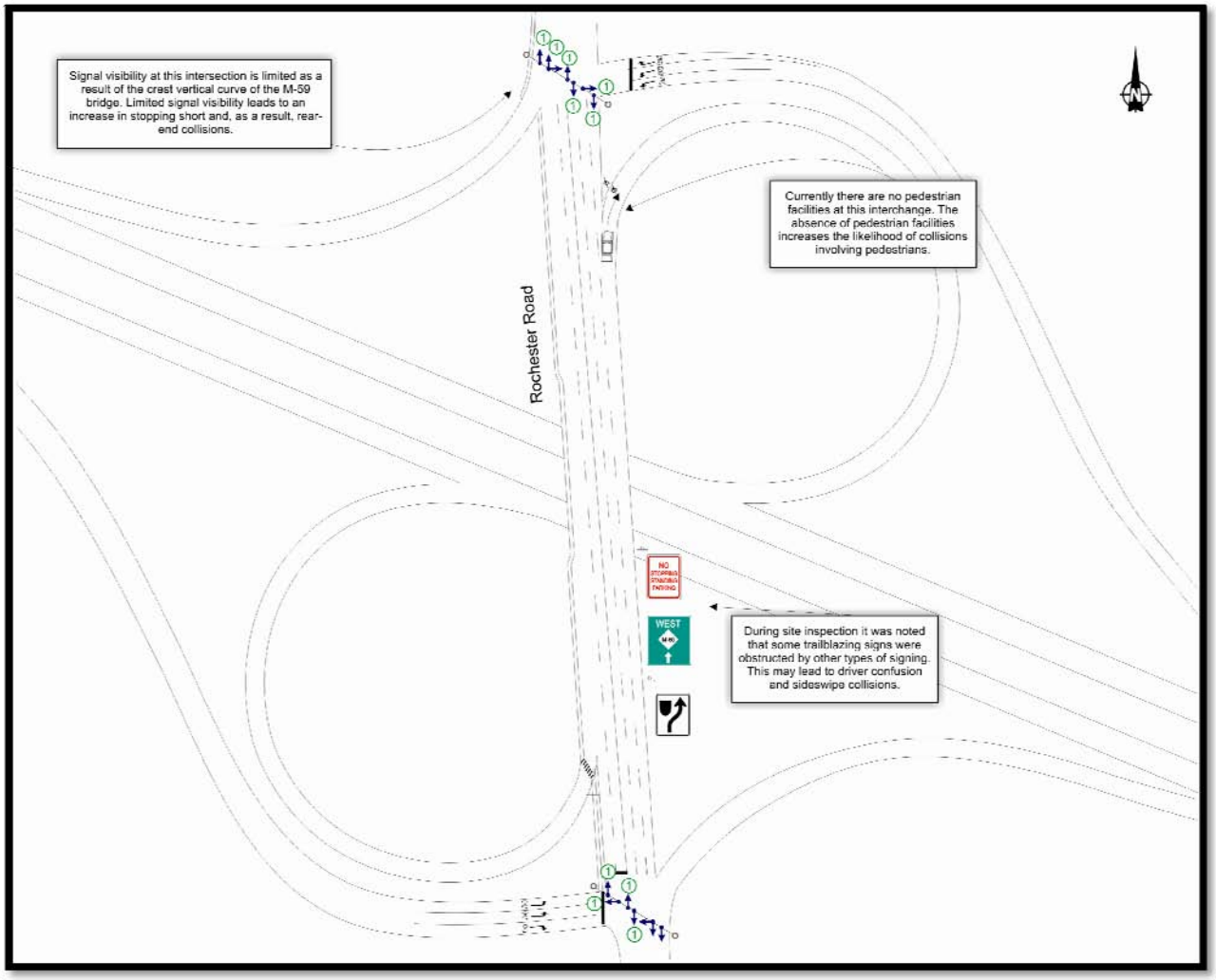


Figure 9-7 ISSUES DIAGRAM: ROCHESTER ROAD AND M-59 RAMPS

SAFETY ISSUE **(Number and Description)**	**Risk Rating**	**SUGGESTIONS**
Signal Visibility	C	▪ High mounted near right signals
Signing	B	▪ Revise signing to eliminate the blocked guide signs. ▪ Overhead freeway guide signs
Pedestrian Facilities	D	▪ Provide sidewalks through the interchange, (long term) ▪ Provide pedestrian actuated rectangular rapid flashing beacons at crosswalks across the free flow ramps. ▪ Review the loop ram design (long term)

Issue 1: Signal Visibility

The visibility of the ramp terminal traffic signals is limited for drivers on Rochester Road as they proceed over the bridge. This is due to the vertical crest curve of the bridge. The modernization of the signals from a diagonal span to a box span is expected to further complicate this issue as the signals will be located even further down the horizon for approaching drivers. The limited signal visibility may lead to an increased risk for rear-end and angle collisions.

Issue 2: Signing

Several of the freeway guide signs on Rochester Road at the interchange are blocked by other signing. Limited visibility of guide signing within an interchange signing can result in driver confusion, leading to weaving, and other erratic movements.

Issue 3: Non-Motorized Facilities

Currently, there are no non-motorized facilities within the interchange. During the site visit, numerous pedestrians were observed walking through the interchange on Rochester Road. Additionally, evidence of pedestrian use such as worn paths on both sides of Rochester Road indicated that this is likely a key link for pedestrians. Additionally, non-motorized pathways networks are located on both sides of the interchange and terminate as a pedestrian enters the functional area of the interchange. Three pedestrian crashes occurred within the interchange between 2004 and 2008. Risk for a pedestrian crash in this area is increased by the presence of continuous flow loop ramps as well as by the high speeds of vehicles traveling through the interchange. A lack of non-motorized facilities through the interchange increases the risk that additional serious pedestrian collisions will occur.

Mitigation Measure 1: Signal visibility

Provide high mounted near right signals at the following locations:

- South Ramp Terminal – southbound Rochester Road
- North Ram Terminal – northbound Rochester Road

The near right signals will increase visibility for drivers as they proceed through the crest vertical curve. The signals will be located higher up on the horizon and drivers they will increase perception reaction time.

Mitigation Measure 2: Signing

It is suggested that the signing plan for the interchange on Rochester Road be reviewed. To improve visibility of the signing, it is suggested that the guide signs which are currently blocked by other regulatory and warning signs be placed overhead. Overhead signing increases the conspicuity and visibility and reduces confusion for unfamiliar drivers.

Mitigation Measure 3: Pedestrian facilities

It is suggested that the pedestrian facilities be extended through the interchange. To extend the pedestrian facilities will require the sidewalks be provided on both sides of Rochester Road. This may require that the freeway bridge be upgraded to accommodate sidewalks. Additionally, the terminals for the free-flow ramps may need to be revised to provide pedestrian facilities. This is likely a longer term solution. That being said, it will likely significantly reduce the risk of further pedestrian crashes through this high speed facility. If pedestrian facilities are provided across the free flow ramps, it is suggested that pedestrian actuated rectangular rapid flashing beacons (RRFB's) be installed on the left side of each crosswalk. RRFB's have been found to be an effective strategy in alerting drivers of pedestrians at unsignalized crossings.

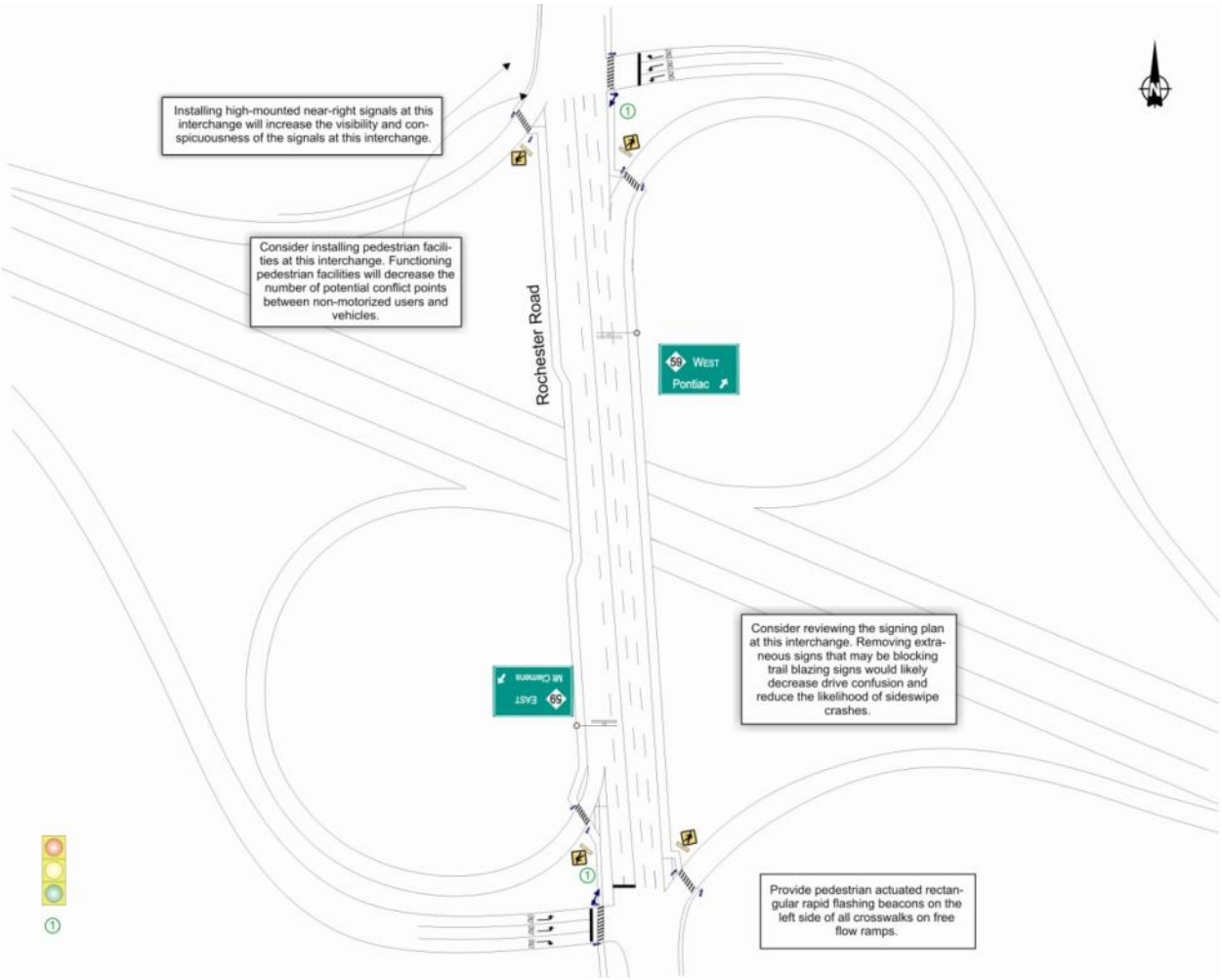


Figure 9-8 MITIGATION MEASURES: ROCHESTER ROAD AND M-59 RAMPS

10.0 SOUTH BOULEVARD AND ROCHESTER ROAD

10.1 Intersection Geometry

A condition diagram of the intersection is shown in FIGURE 10.1, and site photographs are provided in FIGURE 10.2. The intersection has some residential land uses on the northeast corner but is otherwise surrounded by commercial developments. Currently, Rochester Road operates with one left-turn lane, one through lane, and one though/right turn lane in the southbound direction. The northbound approach of Rochester Road operates with one left turn lane, two through lanes and one right-turn lane. South Boulevard operates with one left-turn lane, one through lane, and one right-turn lane on both approaches.

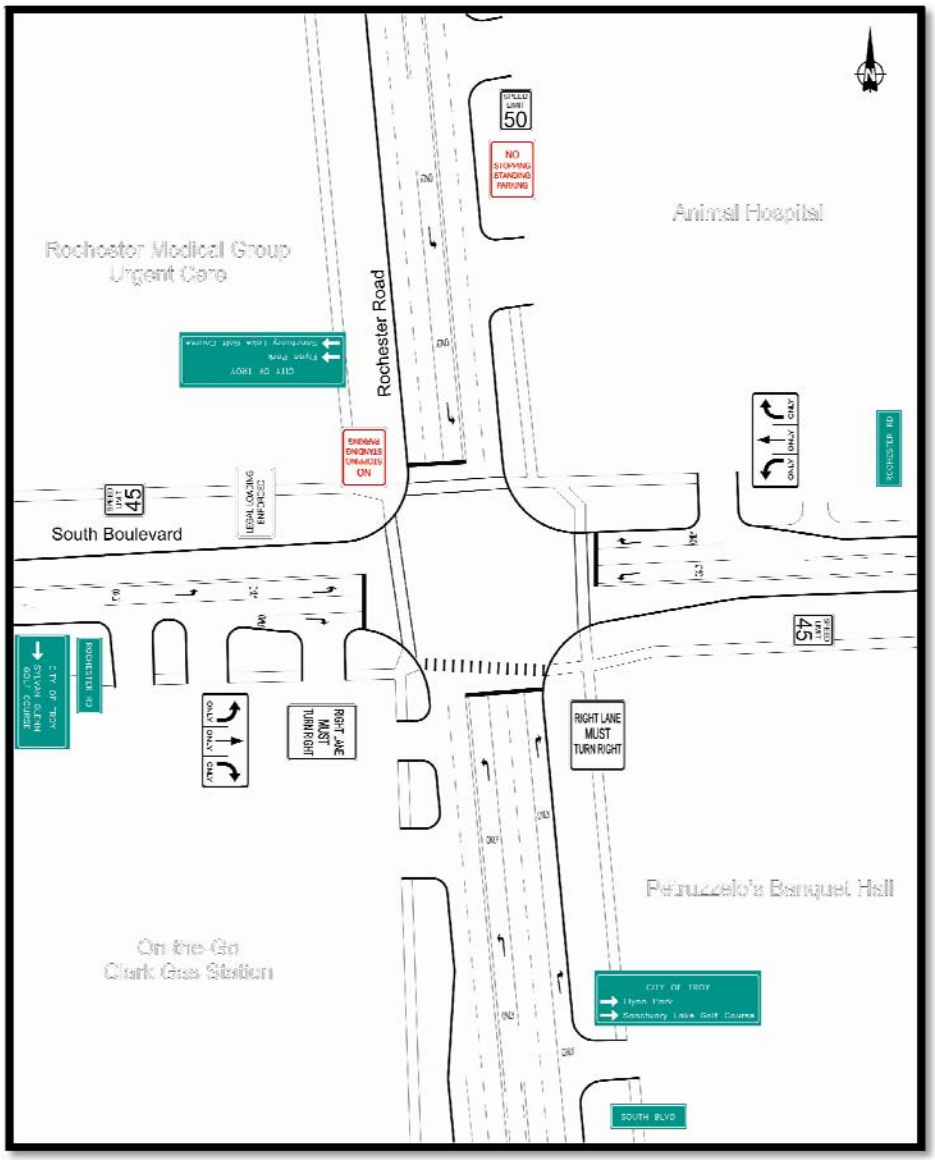


Figure 10-1 CONDITIONS DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD

Eastbound South Boulevard

Westbound South Boulevard

Northbound Rochester Road

Southbound Rochester Road

Figure 10-2 SITE PHOTOGRAPHS: ROCHESTER ROAD AND SOUTH BOULEVARD

Site Observations

- *Close proximity to the M-59/M-150 interchange.*
- *Some worn pavement markings.*

10.2 Traffic Control

The traffic signal display is shown schematically within **Figure 10-3**. Four signal heads are provided on each of the approaches including three overhead span wire signals and one far left post mounted signal. All signal heads have twelve- inch lenses. There are no blackplates provided at this intersection. The signal operates with lagging permissive-protected left-turn phasing on all approaches. Pedestrian signal heads are provided for all crosswalks. The pedestrian signals are push-button actuated across all legs.

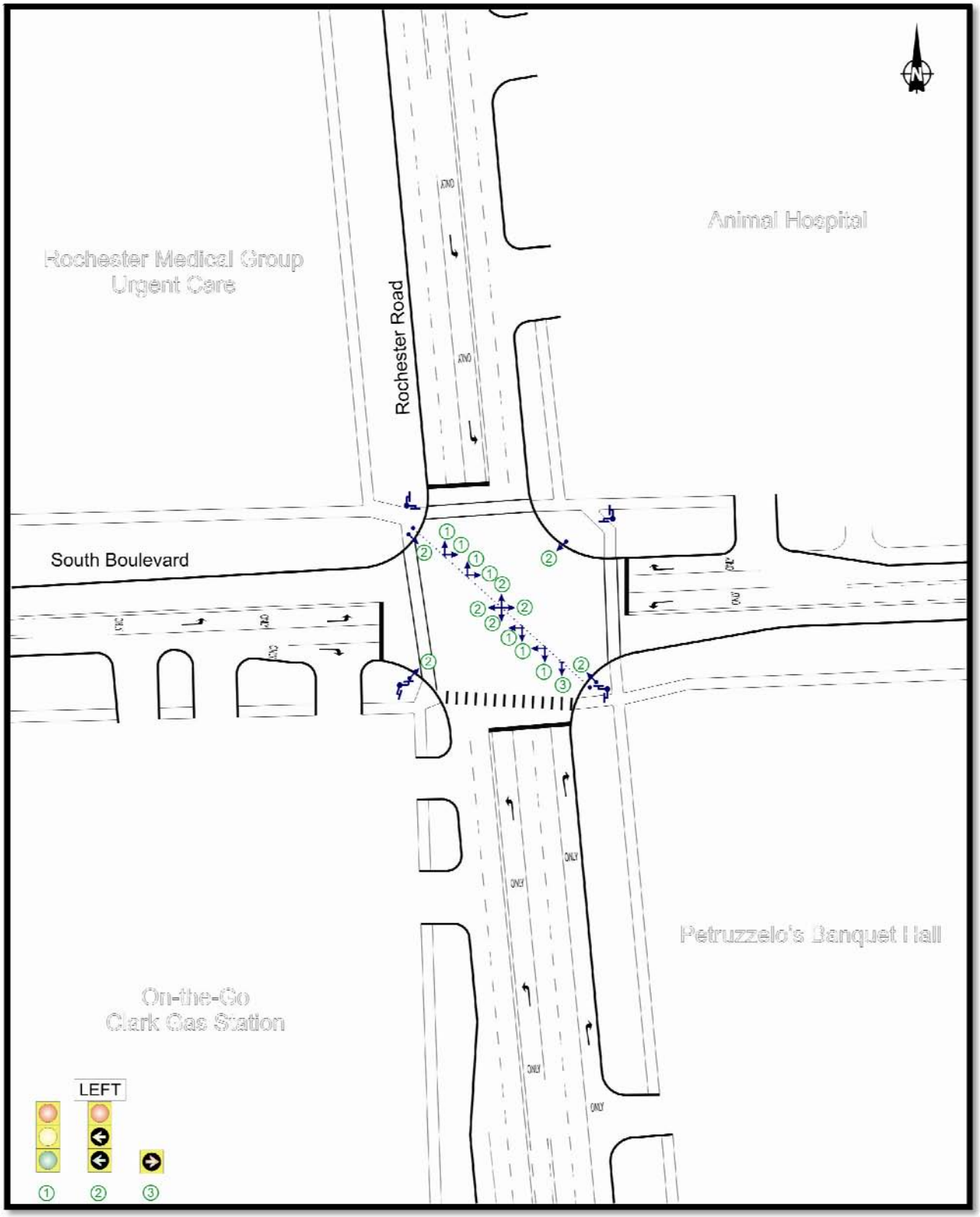


Figure 10-3 SIGNALS DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD

10.3 Collision Analysis

Crash data for the years of 2006 to 2008 were provided by MDOT and using the Office of Highway Safety Planning's website. Over the three years analyzed, 76 collisions were recorded at or near the intersection. As summarized in
Figure 10-4, 24% of the collisions resulted in at least one injury. The remainder of the collisions involved property damage only. No fatalities were reported during the study period.

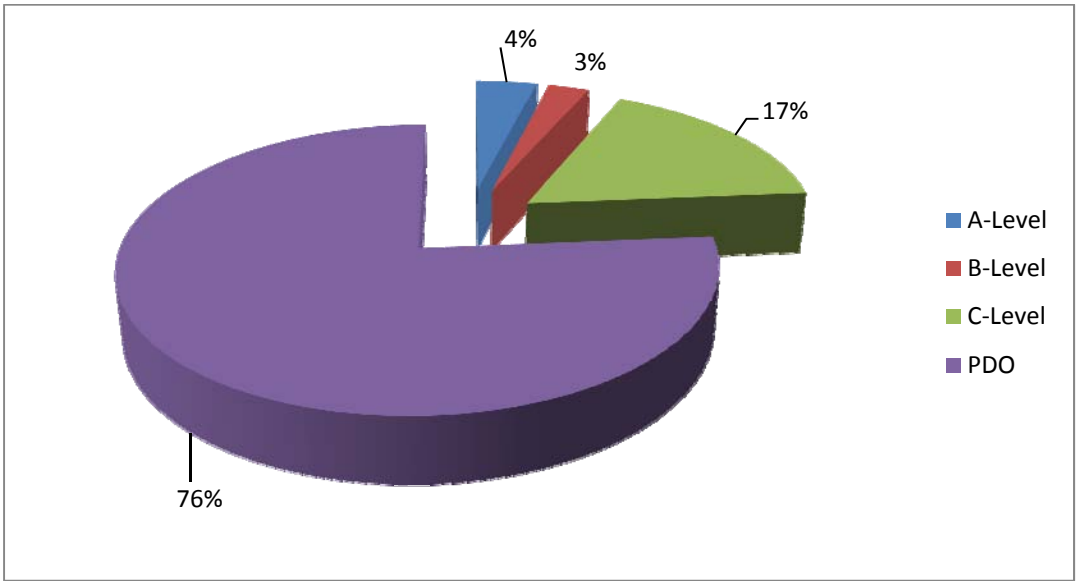


Figure 10-4 COLLISION SEVERITY DISTRIBUTION: ROCHESTER ROAD AND SOUTH BOULEVARD

Collision Types

Collision type distribution is summarized in **Figure 10-5**, and a collision diagram is shown in **Figure 10-6**. The collision diagram illustrates crashes which UD-10's were available on michigantrafficcrashfacts.org. The following collision trends were observed:

- Rear-end collisions predominated, accounting for 49 percent of all recorded collisions.
- And head-on left turn crashes accounted for 21 percent of the 3-year total collisions.

Temporal and Environmental Distribution

Temporal and environmental distributions indicate the following trends:

- The highest frequency of collisions occurred during the month of December.
- Hourly distributions show a higher frequency of crashes between 4:00 and 6:00 PM.
- Twenty-five percent of collisions occurred under wet or winter conditions suggesting that road conditions may be a contributing factor to collisions.

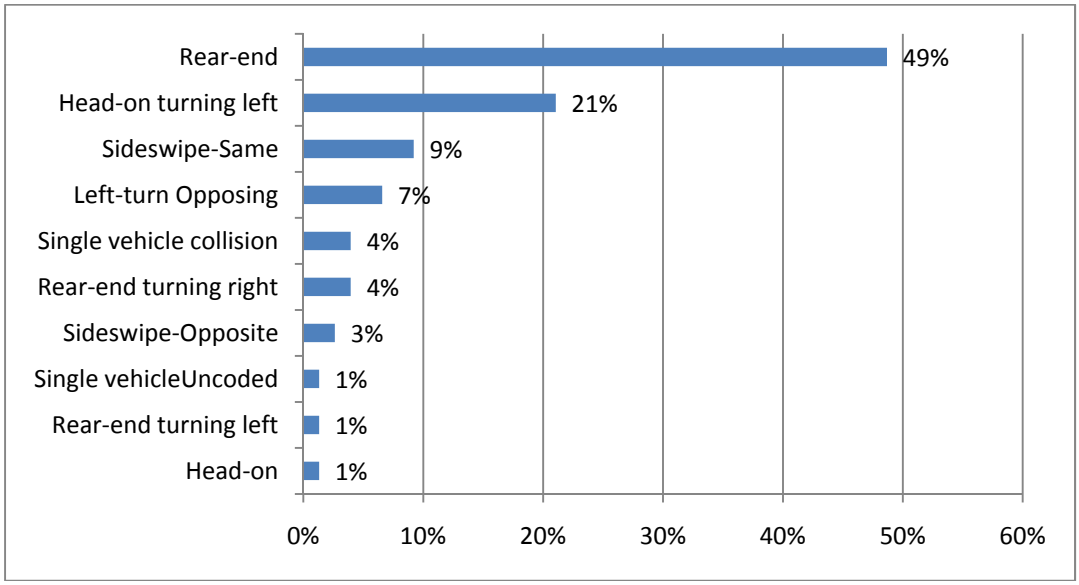


Figure 10-5 COLLISION TYPE DISTRIBUTION: ROCHESTER ROAD AND SOUTH BOULEVARD

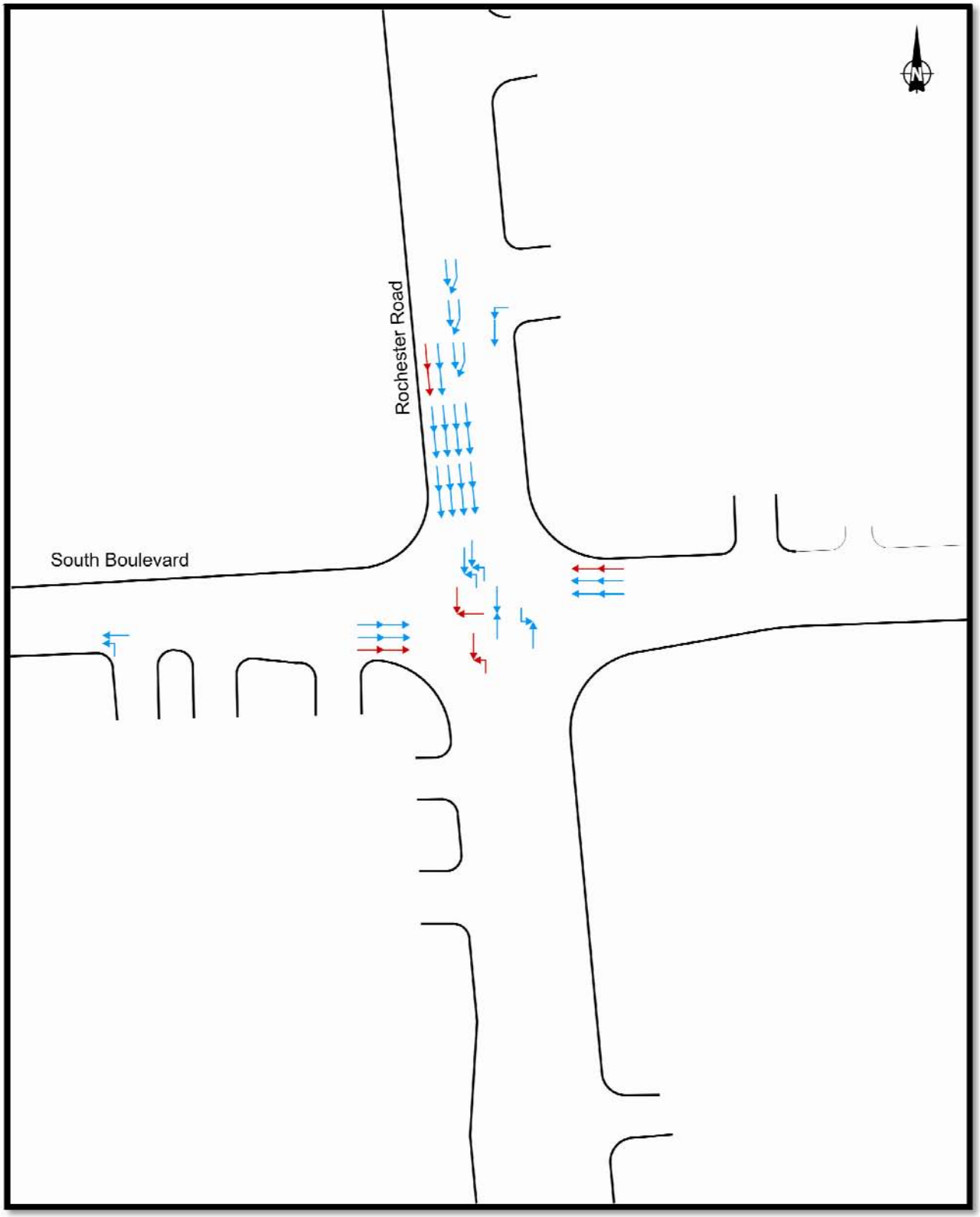


Figure 10-6 COLLISION DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD

10.4 Safety Issues and Suggested Mitigation Measures

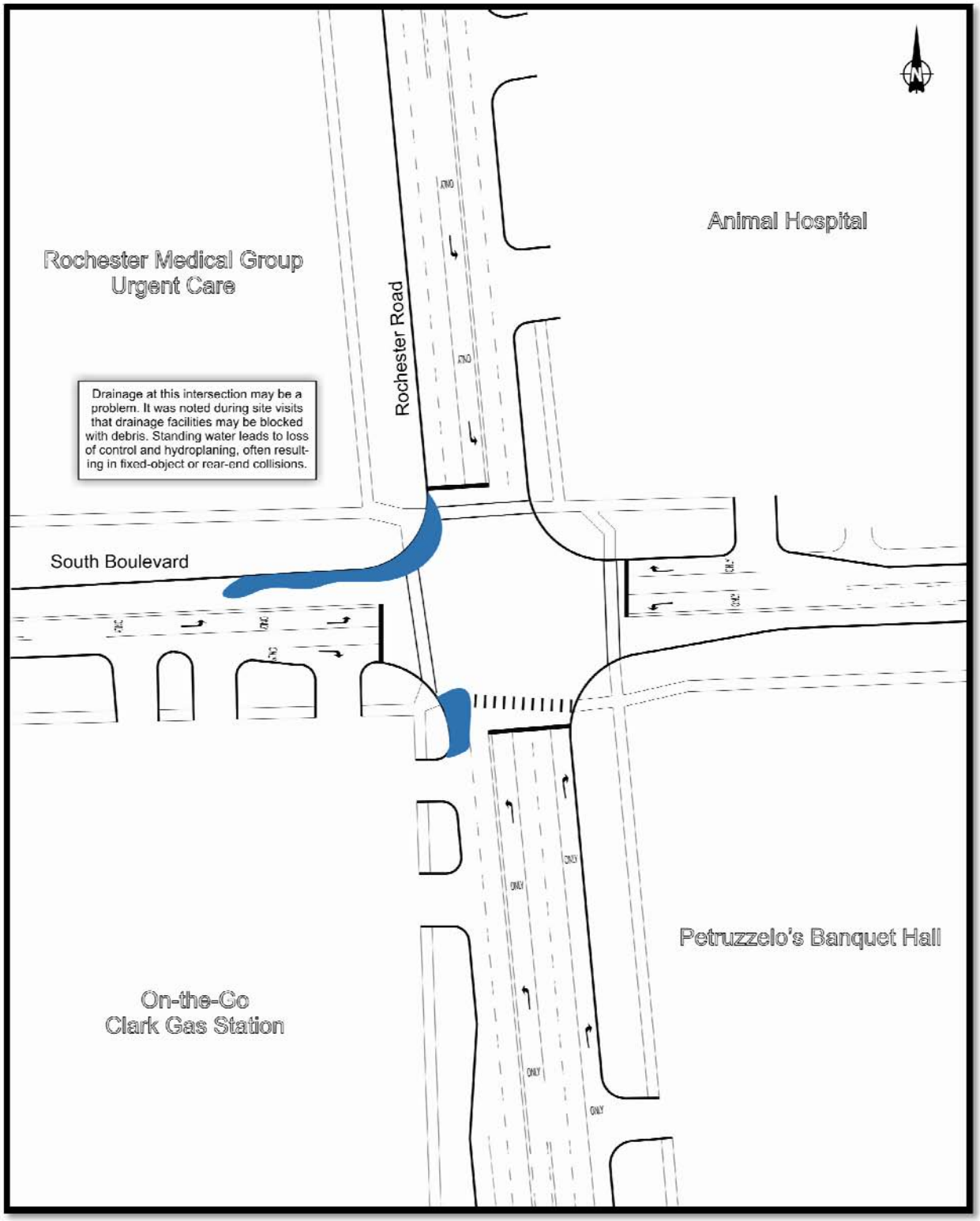


Figure 10-7 ISSUES DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD

Issue 1: Wet Weather Conditions

Based on the crash data analysis, this intersection has a drainage issue. During the site visit the RSA team noted drainage grates that appeared to be obstructed with debris. While on site, the RSA team viewed the intersection under moderate rain conditions and confirmed that the intersection was not draining well, resulting in hydroplaning and reduced stopping capacity. Poor drainage of an intersection leads to hydroplaning, loss of control, and an increase in rear-end collisions.

Mitigation Measure 1: Wet Weather Conditions

It is suggested that the drainage be reviewed around the intersection. Once the intakes and the drainage structures are cleaned out, if the intersection continues to have standing water after rain storms, it is suggested that the intersection be repaved.

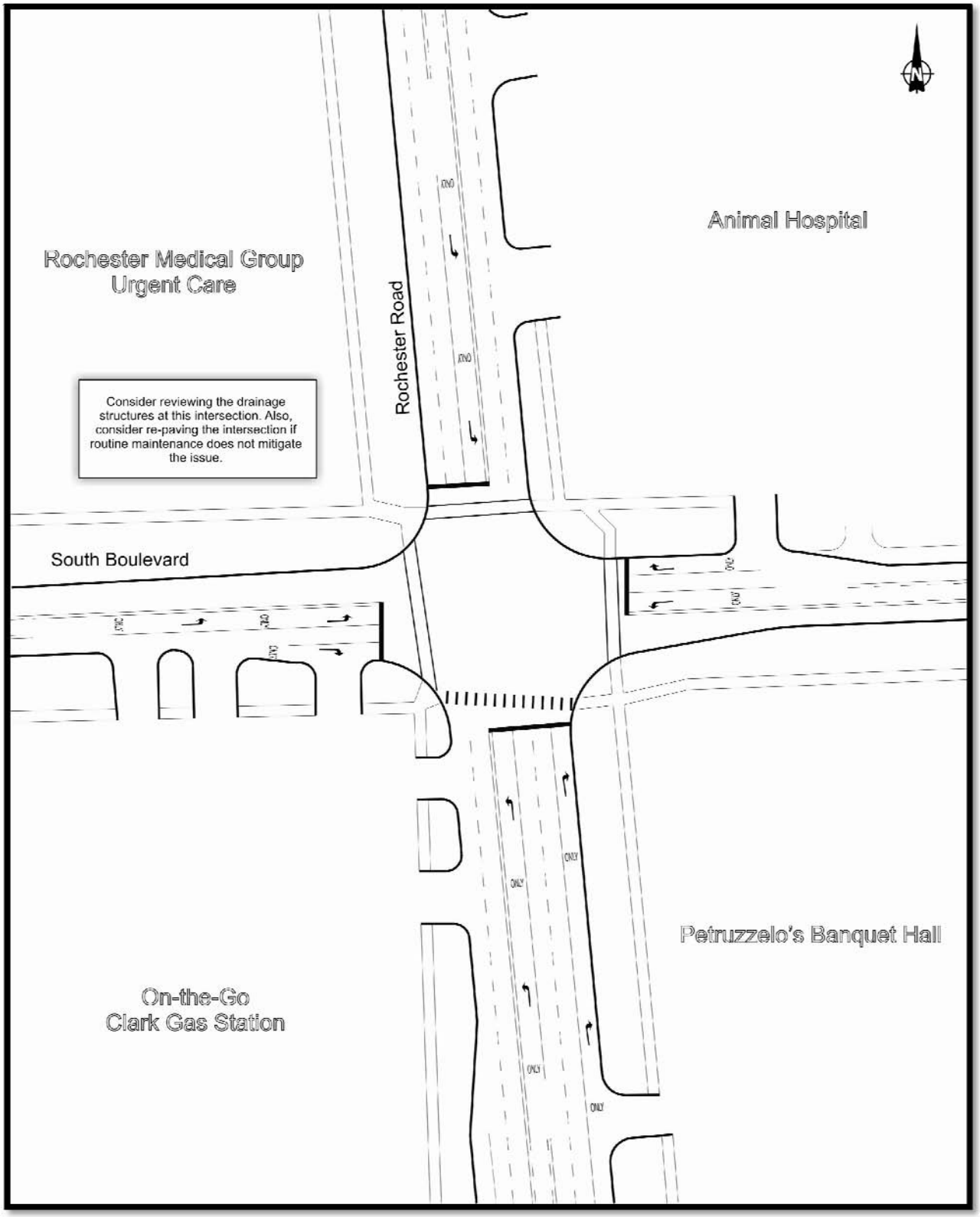


Figure 10-8 MITIGATIONS DIAGRAM: ROCHESTER ROAD AND SOUTH BOULEVARD

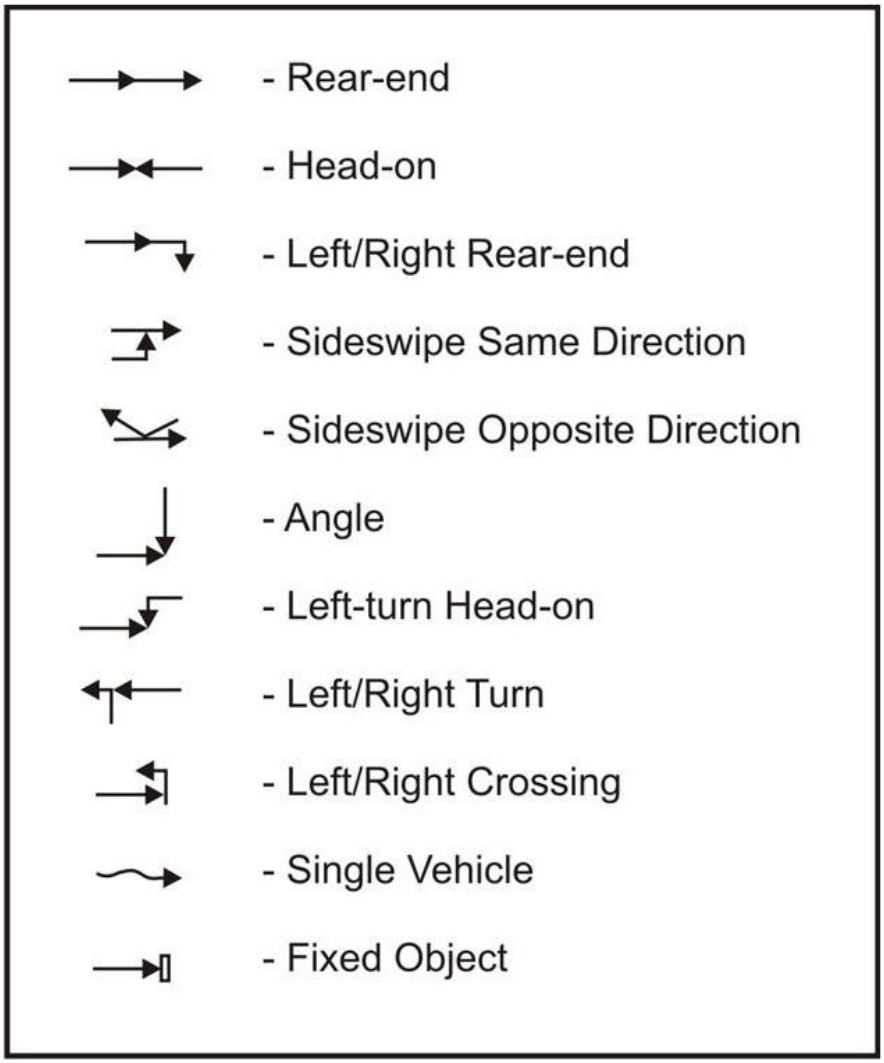
11.0 Summary

Intersection	Safety Issue	Short Term Mitigations	Long Term Mitigations
Avon Road	1. Long queues during peak period 2. Signal visibility is blocked by crest vertical curves 3. Southbound left-turning vehicles over-tracking due to tight turn radius 4. Access management 5. Accessibility of pedestrian facilities	• Review and optimize signal timing plan • Install high mounted near right signals on the eastbound and southbound approaches • Provide an advance warning flasher on the eastbound and southbound approaches • Stagger the westbound stop bars • Install truncated domes on sidewalk ramps • Install pedestrian countdown signals	• Directionalize accesses to Rochester and Avon Roads • Improve cross access • Provide narrow medians on the eastbound and northbound approaches.
Hamlin Road	1. Incomplete non-motorized facilities 2. Access management	• Provide sidewalk on the northeast corner • Improve intersection sight distance at the Bordines access to Hamlin	
Barclay / Wabash	1. Signal Display 2. Pedestrian Facilities 3. Access management on Barclay 4. Signing	• Add a fourth level arrow for the through/left lane on westbound Barclay. • Provide a crosswalk across the south leg of the intersection. • Improve pedestrian refuge on east leg • Review signing on east leg	• Directionalize driveway access to Barclay • Consolidate driveway access to Barclay • Extend median on Barclay
Auburn Road	1. Queues 2. Pedestrian facilities 3. Access management 4. Rutting 5. Red-light running	• Review signal timing plan for intersection • Align pedestrian signals with crosswalks • Relicate drainage grate adjacent to crosswalk • Modernize signal to include backplates with reflective borders and near right signal displays.	• Driveway consolidation • Access restrictions • Narrow medians on south and west legs of intersection. • Install high friction pavement

Intersection	Safety Issue	Short Term Mitigations	Long Term Mitigations
Meijer Driveways	1. Lane Use 2. Access management	• Extend splitter island into right-turn lane on Rochester Road	• Provide narrow median on Rochester Road • Driveway consolidation • Cross access
M-59 Interchange	1. Signal visibility 2. Signing 3. Pedestrian facilities	• High mounted near right signals • Revise guide signing to eliminate blocked signs • Overhead guide signing	• Provide sidewalks through interchange • Review loop ramp design • If pedestrian facilities are installed, provide rectangular rapid flashing beacons at crosswalks across free flow ramps
South Boulevard	1. Wet weather conditions	• Clear out drainage intakes	• Repave intersection

APPENDIX A

COLLISION DIAGRAM SYMBOLS


- Rear-end
- Head-on
- Left/Right Rear-end
- Sideswipe Same Direction
- Sideswipe Opposite Direction
- Angle
- Left-turn Head-on
- Left/Right Turn
- Left/Right Crossing
- Single Vehicle
- Fixed Object