ROAD SAFETY AUDIT

GRATIOT AVENUE (M-3): I-375 TO 8 MILE ROAD (M-102)

CITY OF DETROIT, MI

FINAL REPORT

DATE: MARCH 2019

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1 INTRODUCTION

The Michigan Department of Transportation (MDOT) retained WSP to facilitate an Operational/Planned Road Safety Audit (RSA) along the Gratiot (M-3) corridor from I-375 north to Eight Mile Road (M-102) in Detroit, MI in Wayne County. The objective of this study was to conduct a formal safety performance examination of the Gratiot corridor and propose treatments for the safety of all road users with a specific focus on pedestrian, bicycle, and other non-motorized users by an independent, multi-disciplinary team. Consideration was given to ways in which planned and proposed changes along the study corridor might impact safety. RSAs are a proactive approach to addressing the safety of all road users and involve identifying both safety issues and developing potential mitigation measures.

This RSA followed the Federal Highway Administration's (FHWA) eight-step process which is detailed in Figure 1 below.

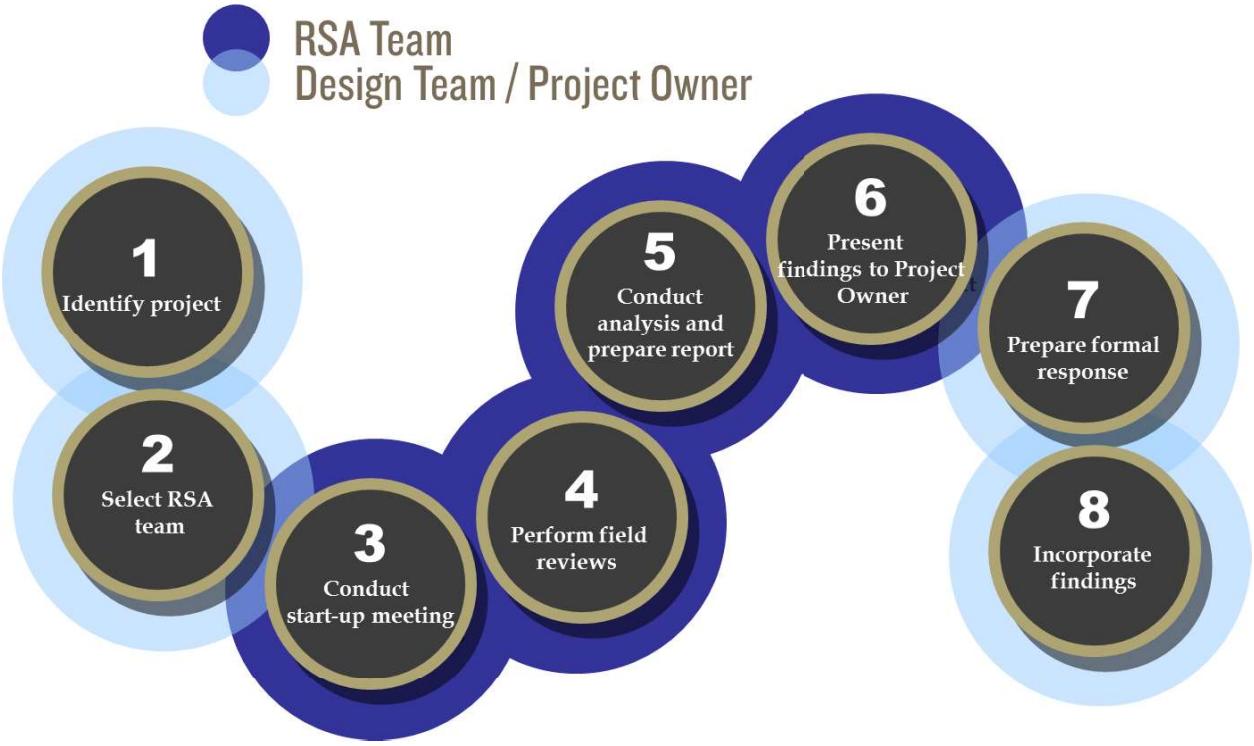

Figure 1 - RSA Eight-Step Process

The objectives of the RSA are to:

- Review road safety within the study area;
- Identify physical and operational issues that may affect road safety, and;
- Develop and evaluate potential countermeasures to reduce the frequency and severity of collisions.

The following sections will detail the RSA process, the methodology for this analysis, and data obtained throughout the study. The report will also present significant findings and safety issues as well as provide recommended mitigation strategies.

1.1 BACKGROUND

This RSA was initiated in response to several factors including upcoming MDOT reconstruction projects at major interchanges along the corridor, significant crash history involving non-motorized users, heavy non-motorized and transit ridership along the corridor and concerns raised by local stakeholders.

Two of the projects planned for the corridor include the reconstruction of the I-375 at Gratiot Avenue Connector and the I-94 interchange with Gratiot Avenue. These projects are at relatively early stages, providing an opportunity to include changes or considerations raised in the RSA to proactively improve safety at these locations. Additional projects lead by the City of Detroit through the Strategic Neighborhood Fund (SNF) are also in the planning stages, particularly encompassing the neighborhoods around the intersection of Gratiot Avenue and Seven Mile Road. Again, this provides an opportunity to support these efforts through proactive review of the corridor to further enhance the eventual project plans. Recommendations from this RSA will be used to help shape future safety funding projects already programmed by MDOT along Gratiot Avenue.

Traffic volumes through the corridor range from approximately 12,700 – 33,100 AADT[1] across a seven-lane cross-section. These volumes fluctuate periodically throughout the year as Gratiot Avenue is often used as a detour route (official and unofficial) when I-94 is closed or experiences heavy congestion. Additionally, the corridor services a significant pedestrian, bicycle, and transit ridership population resulting in a frequent mix of road user types. The wide cross-section and significant volume of motorized and non-motorized users presents a range of issues and opportunities to improve safety along the corridor.

Figure 2 provides the extent of the RSA with some of the major intersections identified for legibility and the two project areas identified.

[1] 2017 Michigan HPMS Shapefile

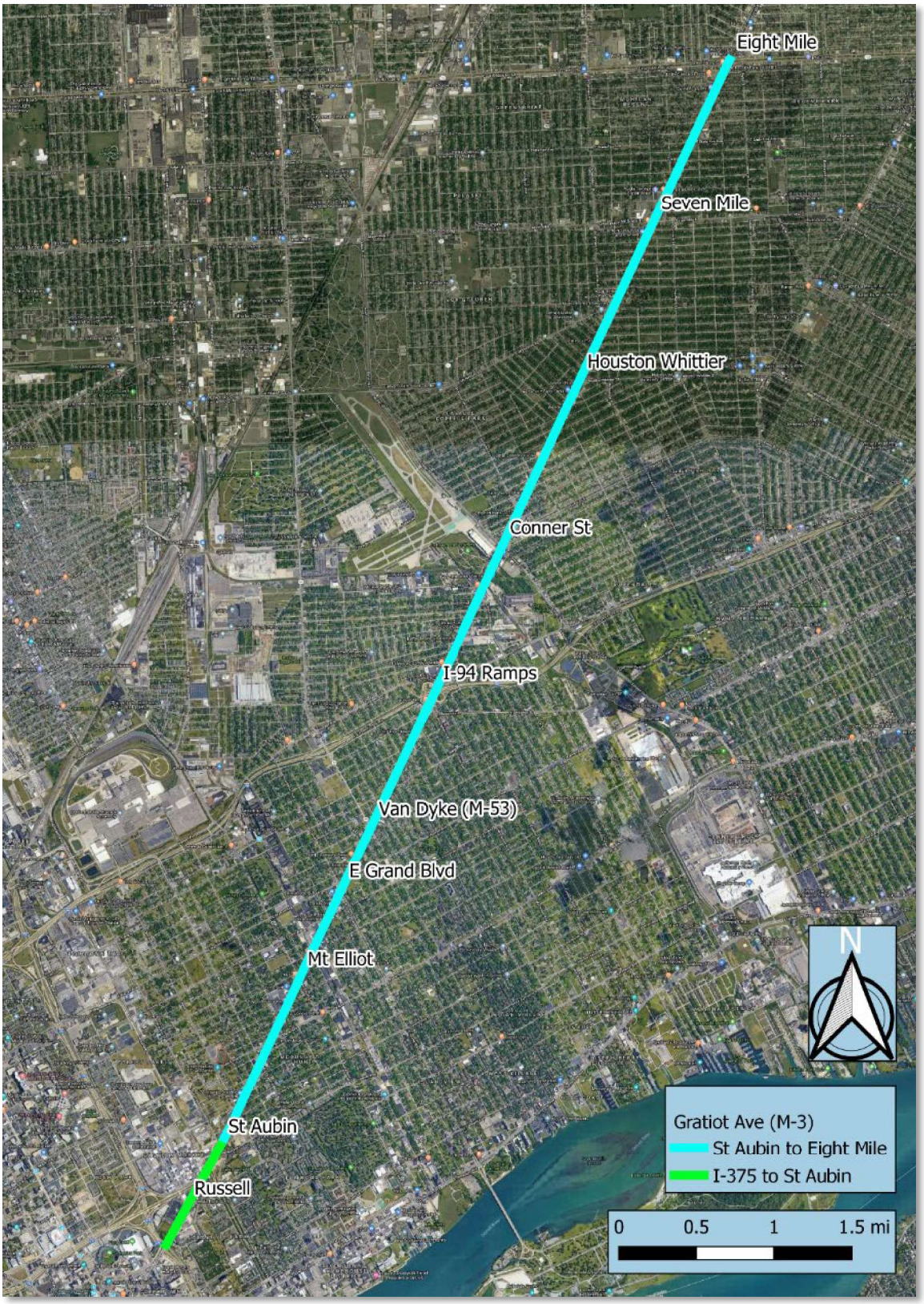

Figure 2 - Road Safety Audit Study Location (Base Map Source: Google Earth)

2 ROAD SAFETY AUDIT

A RSA is a formal safety performance examination of an existing or future road or intersection by an independent multi-disciplinary audit team. RSAs 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.

2.1 ROAD SAFETY AUDIT TEAM

Location:	Gratiot **Avenue (M-3) Corridor between I-375 and Eight Mile Road (M-102)**	
Audit Team Members:	Lauren Warren	WSP
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Project Owner:	Michigan Department of Transportation	
Review Date:	February 12th – 14th, 2019	
Audit Stage:	Operational / Pre-Design	
Start-up Meeting:	February 12th, 2019	
Preliminary Findings Meeting:	February 14th, 2019	
Attended By:	City of Detroit Mayor's Office Dept. of Public Works Dept. of Transportation Health Dept. Planning and Development Dept. Parking Dept. Michigan Department of Transportation Southeast Michigan Council of Governments SMART WSP	

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 roadways remains with the agency with jurisdictional authority. Any implemented recommendations require adherence to all applicable standards and procedures and appropriate engineering judgement.

2.2 ROAD SAFETY AUDIT MATERIALS

The RSA was based on the following data and analysis:

Site Review: Site visits were conducted in 2019 from February 12th though the 14th and included review of both day and night time conditions as well as during precipitation. This time was spent driving the length of the corridor and walking select portions to observe traffic operations, conflicts, and surrounding land uses. This was augmented through comments and concerns received during the kick-off meeting and during the field reviews from stakeholders and road user interactions.

Traffic Counts: Traffic counts were obtained by the project team for the corridor from the 2017 Michigan Highway Pavement Management System (HPMS) shapefile.

Conceptual Design Plans: MDOT provided the audit team with access to the latest conceptual drawings for the I-375/Gratiot Avenue Connector and the I-94 Interchange reconfiguration.

Crash Data: Crash data for the study area was obtained by the project team from Michigan Traffic Crash Facts for 2013 through 2017.

Project Documents Available for RSA:

- Traffic counts along the study corridor
- Project Concepts
  (a) I-375 / Gratiot Connector
  (b) I-94 Interchange Reconfiguration
- Crash UD-10 reports
- Mapped Crash Locations
- Major incidents along I-94 (2014- Oct 2018)
- DDOT Transit Ridership Data (Gratiot Only)
- MDOT Speed Study (10/01/1979)
- MDOT Speed TCO
- MDOT Pedestrian & Bicyclist Safety Risk Assessment Tool
- SEMCOG High Priority Safety Locations Story Map

Identification of Treatment Measures: On the basis of the above tasks, road safety issues and potential contributing factors were identified. Countermeasures were identified to help mitigate the safety issues and possible crash causes, along with the crash reductions that are anticipated to result from their implementation.

All documents were provided to the project team prior to or during the RSA.

2.3 ROAD SAFETY AUDIT PROCESS

A road safety audit framework was applied in both the analysis and presentation of findings. The expected frequency and severity of crashes caused by each safety issue have been identified and rated using the categories shown in Table 1 and Table 2, as defined by the FHWA RSA process. These two risk elements were then combined to obtain a risk assessment shown in the matrix shown in Table 3. Consequently, each safety issue is assessed a ranking between F (highest risk and highest priority) and A (lowest risk and lowest priority). For each safety issue identified, possible mitigation measures have been suggested.

Table 1 - Crash Frequency

Estimated		Frequency Rating
Exposure	**Probability**	
Medium → High	High	***Frequent***
Low → High	Medium → High	***Occasional***
Low → Medium	Low	***Rare***

Table 2 - Crash Severity

Typical Collisions Expected (per audit item)	Expected Collision Severity	Severity Rating
Collisions involving high speeds or heavy vehicles, pedestrians, or bicycles	Probable fatality or incapacitating injury	***High***
Collisions involving medium to high speed; head-on, crossing, or off-road collisions	Moderate to severe injury	***Moderate***
Collisions involving medium to low speeds; left-turn and right-turn collisions	Minor to moderate injury	***Low***
Collisions involving low to medium speeds; rear-end or sideswipe collisions	Property damage only	***Negligible***

Table 3 - Crash Risk Assessment

Frequency Rating	Severity Rating			
	Negligible	***Low***	***Moderate***	***High***
Frequent	**C**	**D**	**E**	**F**
Occasional	**B**	**C**	**D**	**E**
Rare	**A**	**B**	**C**	**D**

Collision Risk Rankings - A: Lowest priority F: Highest priority

3 SITE CHARACTERISTICS

3.1 STUDY LOCATION

Gratiot Avenue is classified as "Principal Arterial" per the National Functional Classification[2] and intersects with several other principal arterial routes and interstates. The corridor serves as a significant northeast/southwest route into and out of the City of Detroit serving both local neighborhood traffic but also servicing commuters from the northern end of the corridor. Gratiot Avenue also serves as the detour route for I-94 when crashes, inclement weather, or other events close local portions of the interstate. The route consists of approximately 8.5 miles of roadway with three lanes in each direction (approx. 11' each) and a relatively narrow (approx. 9' wide) center two-way left turn lane. The outside lane serves as a combination travel/parking lane along the length of the corridor. The corridor is signed at 35 mph for most its length with a short section near the southern end signed at 30mph as it nears downtown Detroit. Additionally, the significant angle Gratiot Avenue makes with the rest of the network grid results in skewing of nearly all intersections along the length of the study area.

Several significant intersections exist within the study area, including intersections with Eight Mile Road, Seven Mile Road, Conner Avenue, Van Dyke (M-53), I-94 interchange, and the I-375 connector. Land use is mixed along the length of the corridor, but transitions from a denser urban area along the southern portion to less dense mixed uses as it moves northward. This include both active and abandoned commercial establishments located sporadically along Gratiot Avenue with neighborhoods of varying densities in the immediate vicinity.

Figure 3 on the following page provides some representative perspectives of the corridor from both the driver's perspective and that of a pedestrian.

3.1.1 SITE OBSERVATIONS

Below is a sampling of the site observations noted by the RSA team during field reviews:

- Continuous pedestrian facilities present (+)
- Continuous lighting of the roadway present (+)
- Bus shelters in good condition (+), located close to roadway
- Signs are not cluttered/over information (+)
- Significant intersection skews
- Heavy non-motorized presence
- Pedestrians traveling in roadway or with traffic
- Cyclists traveling against traffic
- Heavy transit user presence
- Wide pavement cross-section
- Varied maintenance of snow removal
- Flooding of roadway

[2] https://mdotcf.state.mi.us/public/maps_nfc/pdf/NFC14_WAYNE.pdf

Figure 3 - Corridor Characteristics

3.2 ROAD USER CHARACTERISTICS

The most recent traffic volumes for the study area were obtained from the 2017 Michigan HPMS shapefile. The annual average daily traffic volume (AADT) along the corridor ranged from approximately 12,775 to 33,162 vehicles per day. The peak volumes were recorded between the I-94 interchange and Connor St, as shown in Figure 4.

Figure 4 - 2017 HPMS AADT (Base Map Source: Google Earth)

These volumes are expected to increase during localized closures of I-94 when Gratiot Avenue is utilized as a detour. The duration and severity of this impact will vary depending on the specific causes and context surrounding each individual closure. The following provides a summary of the historic record of directional closures of I-94 between 2014 and 2018.

- Number of Full Closures (*Avg Duration*) 1 closure in five years (*59 min.*)
- Number of Westbound AM* Closures (*Avg Duration*) 4 closures in five years (*115 min.*)
- Number of Eastbound PM* Closures (*Avg Duration*) 4 closures in five years (60 *min.*)

**AM 6am – 9am, PM 3:30pm – 6:30pm*

A range of vehicle types and road users were observed along the corridor, including those listed below with some examples provided in Figure 5:

- Semi-trucks and other commercial vehicles;
- Transit buses;
- Passenger vehicles;
- Bicyclists; and,
- Pedestrians.

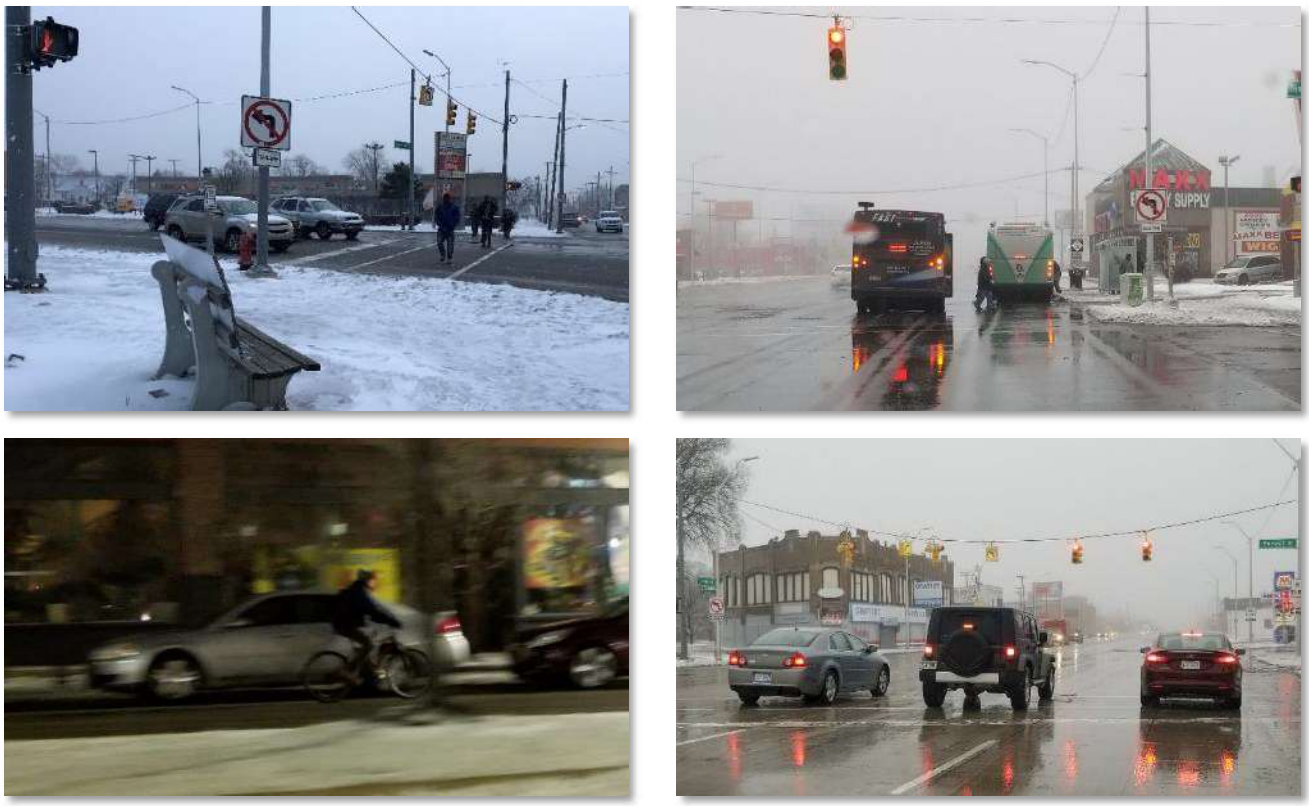


Figure 5 - Example Road Users

3.3 CRASH ANALYSIS

While road users of all types were kept in mind for this RSA, the primary focus was pedestrian and bicycle road users. A crash analysis was conducted for the study area for crashes of all types with an emphasis on non-motorized crashes. Figure 6 shows a mapping of crashes involving a non-motorized road user along the corridor. Crashes of this type were particularly concentrated near the I-94 interchange, Conner Street, and the corridor from Seven Mile Road to Eight Mile Road.

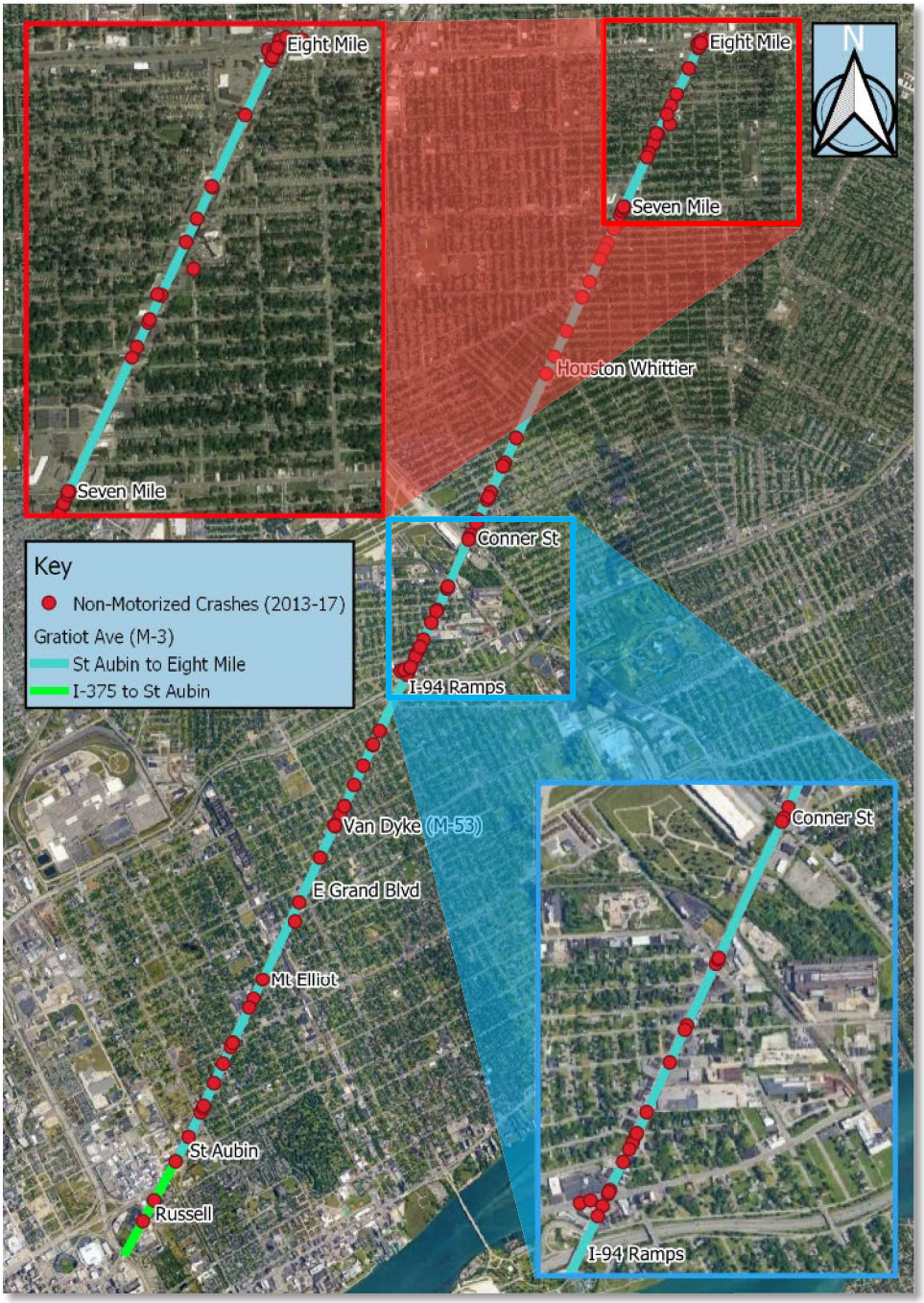


Figure 6 - RSA Study Area (Aerial Source: Google Earth)

The most recent five years of crash data (2013-2017) was obtained from MichiganTrafficCrashFacts.org (MTCF) for the study area. During the five-year period, approximately 2,899 crashes were reported along the corridor with 855 (30%) resulting in a fatality or injury. Figure 7 shows the portion of all crashes by severity and Figure 8 provides the portion of non-motorized crashes by severity. As shown in Figure 8, more than half (23 of 41) of the reported fatalities involved a pedestrian or bicyclist and nearly thirty percent (21 of 68) of serious injury crashes involved a non-motorized road user.

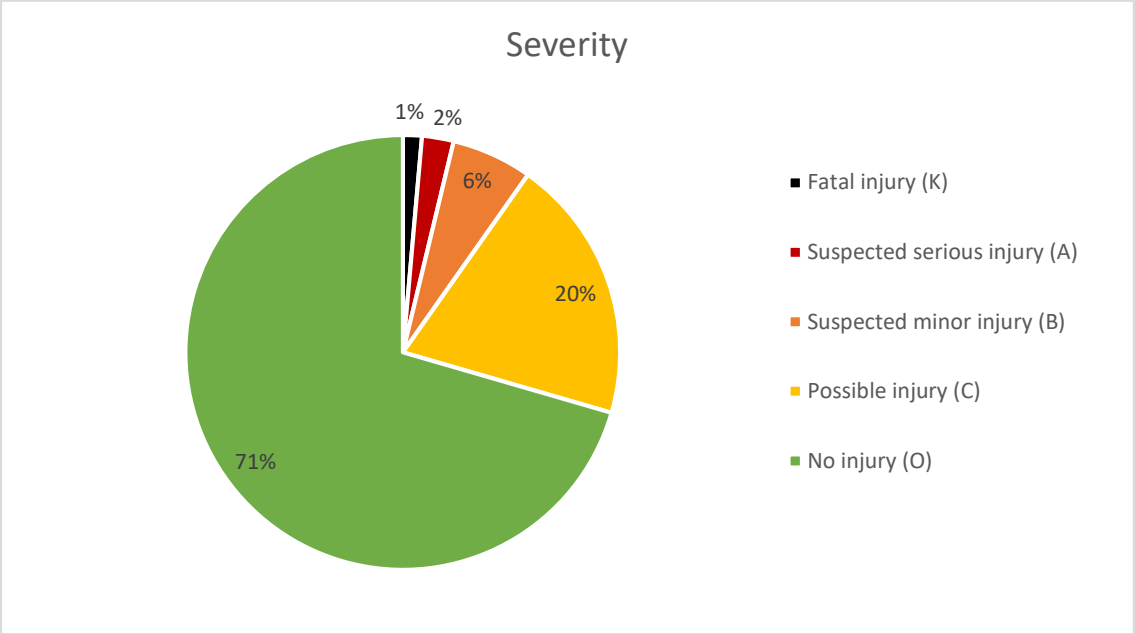


Figure 7 - Overall Crash Severity (2013-17)

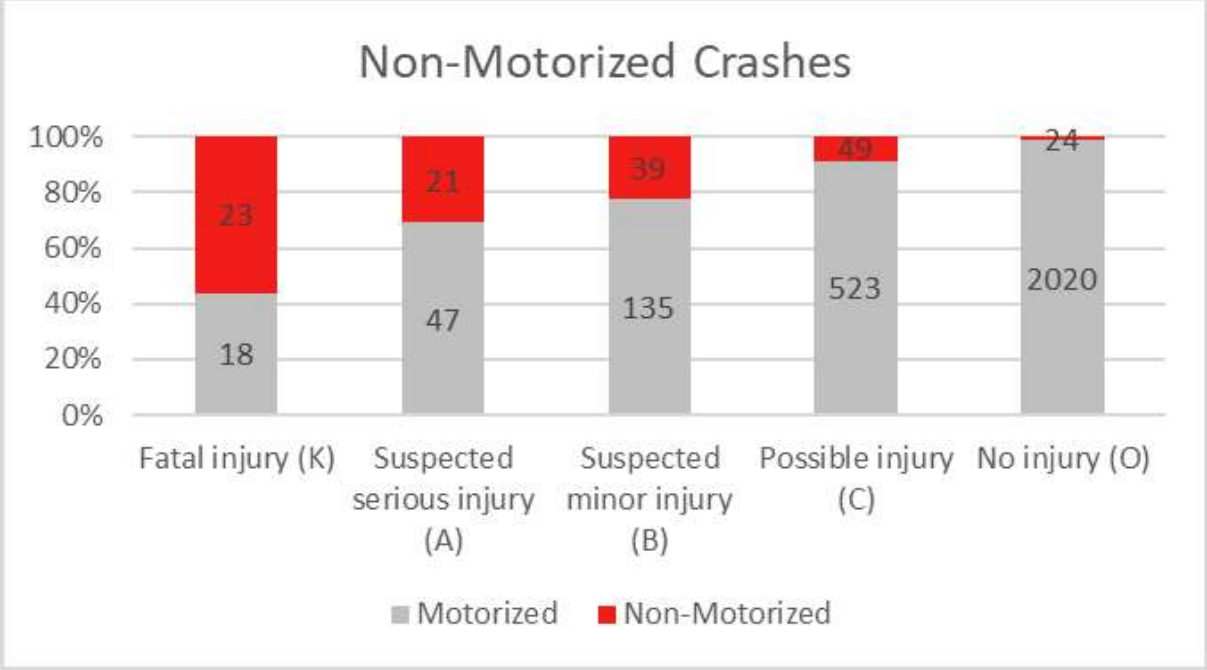


Figure 8 - Portion of Non-Motorized Involved Crashes by Severity (2013-17)

3.3.1 CRASH CHARACTERISTICS

In addition to the spatial distribution of crashes, UD-10s were reviewed for the fatal (K) and serious injury (A) severity crashes involving pedestrians or bicyclists. This information helped to ascertain some of the contributing factors for these types of crashes and the narratives reported by responding law enforcement. The following represent common instances reported for fatal and serious injury crashes involving non-motorized road users.

- Driver hit and run/no insurance;
- Driving too fast for conditions / Speeding;
- Pedestrian walking against the crossing signal;
- Pedestrian crossing not at a crosswalk; and,
- Pedestrian walking in the travel lanes

The UD-10s for the remaining fatal and serious injury crashes (not involving a non-motorized user) were also reviewed to assess any apparent trends. Attributing factors included speeding, improper lane maneuvers (turns, lane changes, etc.), not stopping in an assured clear distance, driving impaired, and hit and run crashes, making it more difficult to glean information from the UD-10 summaries. Hit and ran crashes also impacted pedestrian and bicyclists, limiting the information available in officer narratives. When considering all fatal and serious injury crashes, approximately one third were flagged as "hit-and-run".

Figure 9 provides the overall distribution of crashes by type for fatal and serious injuries (KA). As shown, the top three known crash types resulting in a fatality or serious injury are single motor vehicle (38%), angle (21%), and head-on (8%). Other / unknown crashes could include pedestrian and bicycle involved road users or crash configurations that did not fit neatly into the provided options. When considering crashes of all severity levels, rear end (31%), angle (20%), and sideswipe same (19%) are the three most reported types. When considering only non-motorized involved crashes the predominant type reported by responding officers is single motor vehicle (69%) followed by other / unknown (19%), and angle (1%).

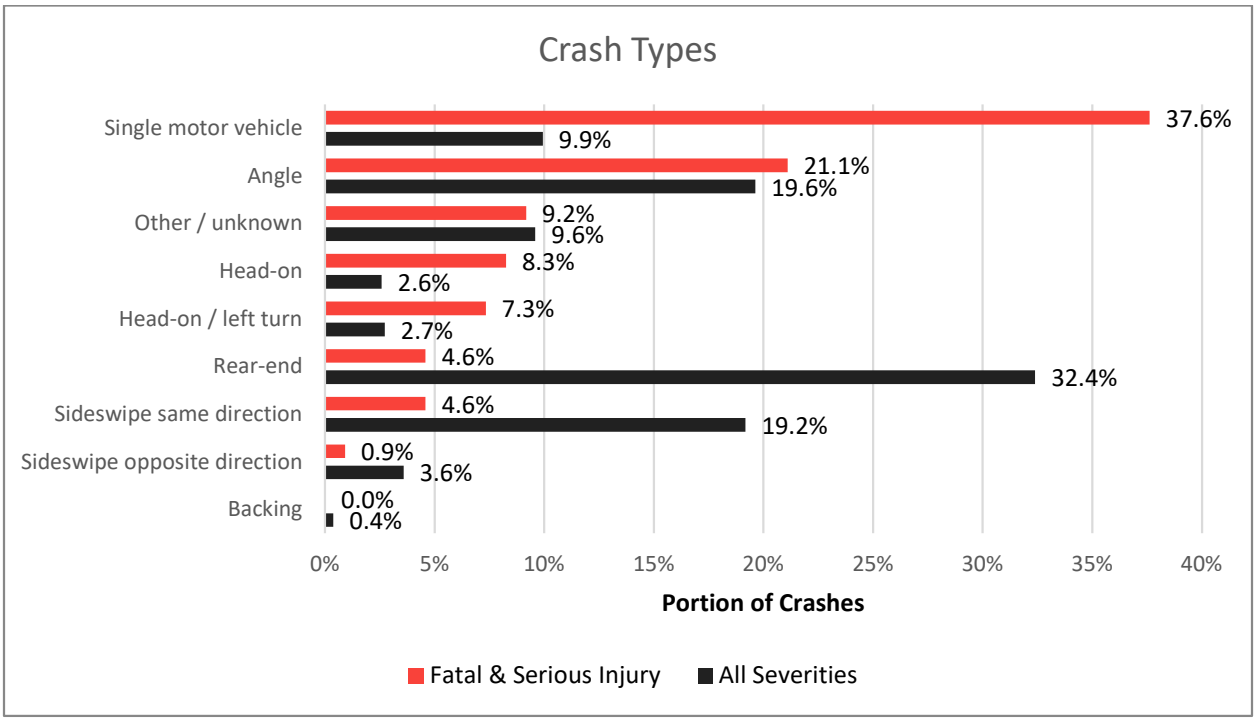


Figure 9 - Distribution of Crashes by Type (2013-17)

3.3.2 TEMPORAL TRENDS

The following provides a high-level summary of the various temporal trends for crashes of all severities. The various categories (crashes of all severities, fatal and serious injury crashes, and crashes of all severities involving a non-motorized road user) tend to follow similar trends.

As shown in Figure 10, more than a half of all reported crashes occurred between 3PM and Midnight (50% of all severity, 66% of KA, and 62% of non-motorized). When tracking crashes by day of week, there is a slight increase in the number of reported crashes on the weekend, as shown in Figure 11. When considering the distribution of crashes by month, the three categories diverge slightly with crashes of all severities holding relatively steady across the year. This is likely due in part to the higher number of property damage only crashes. Fatal and serious injury crashes and non-motorized crashes track each other more closely and experience a greater prevalence during the warmer months or months without as much precipitation, as shown in Figure 12. This is likely due in part to the tendency for higher speeds in the summer months and greater non-motorized use in more hospitable weather.

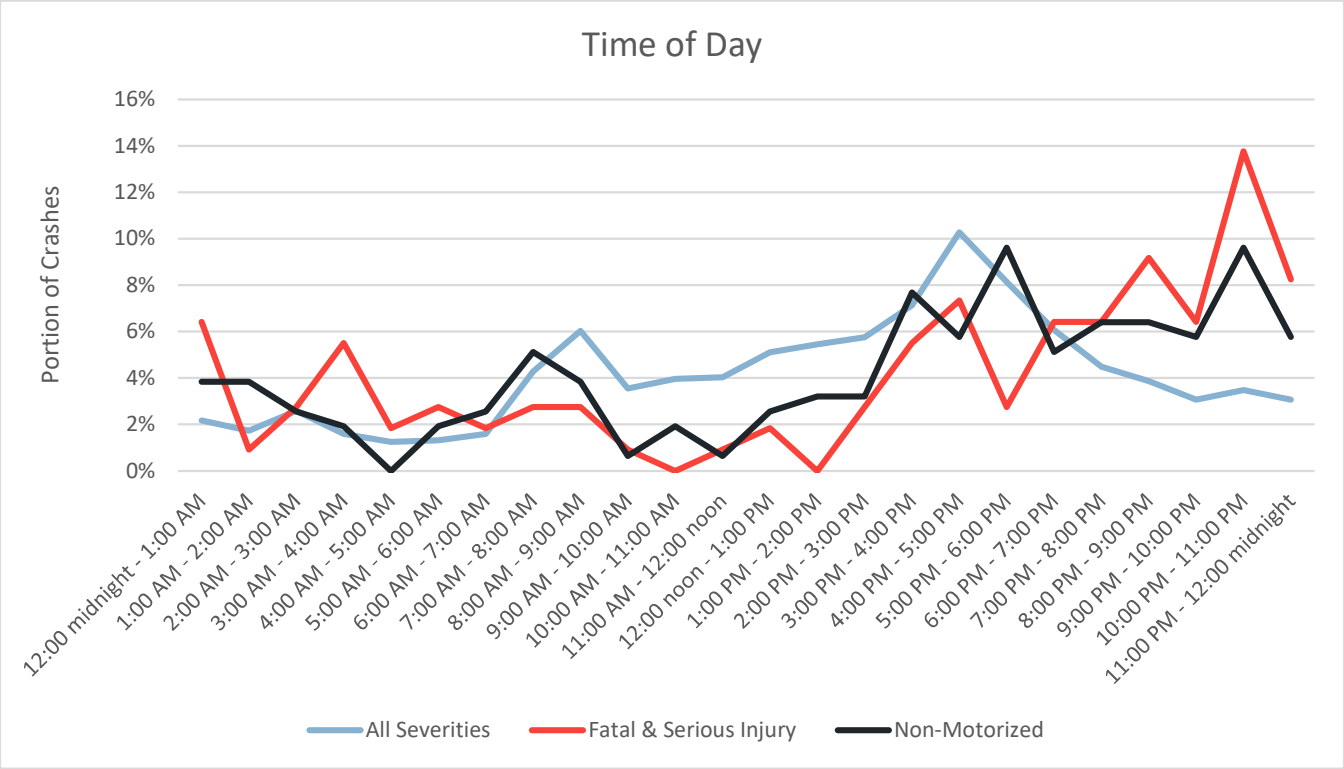


Figure 10 - Crash Distribution by Hour of Day (2013-17)

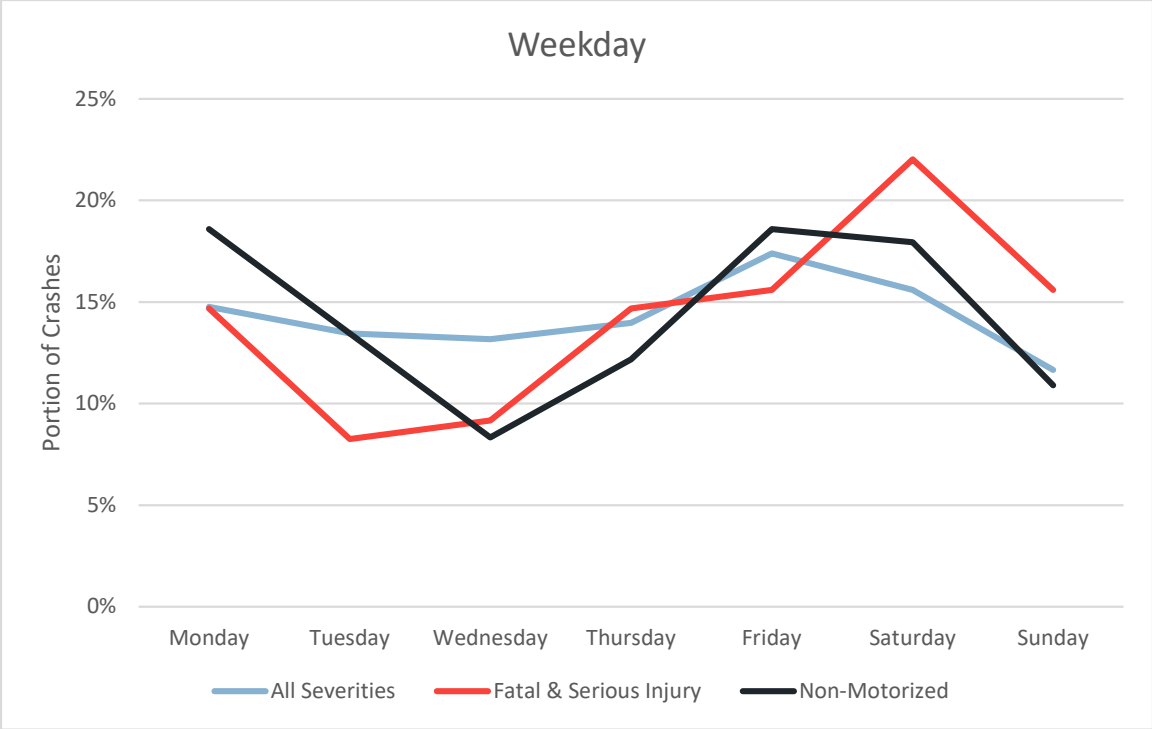


Figure 11 - Crash Distribution by Day of Week (2013-17)

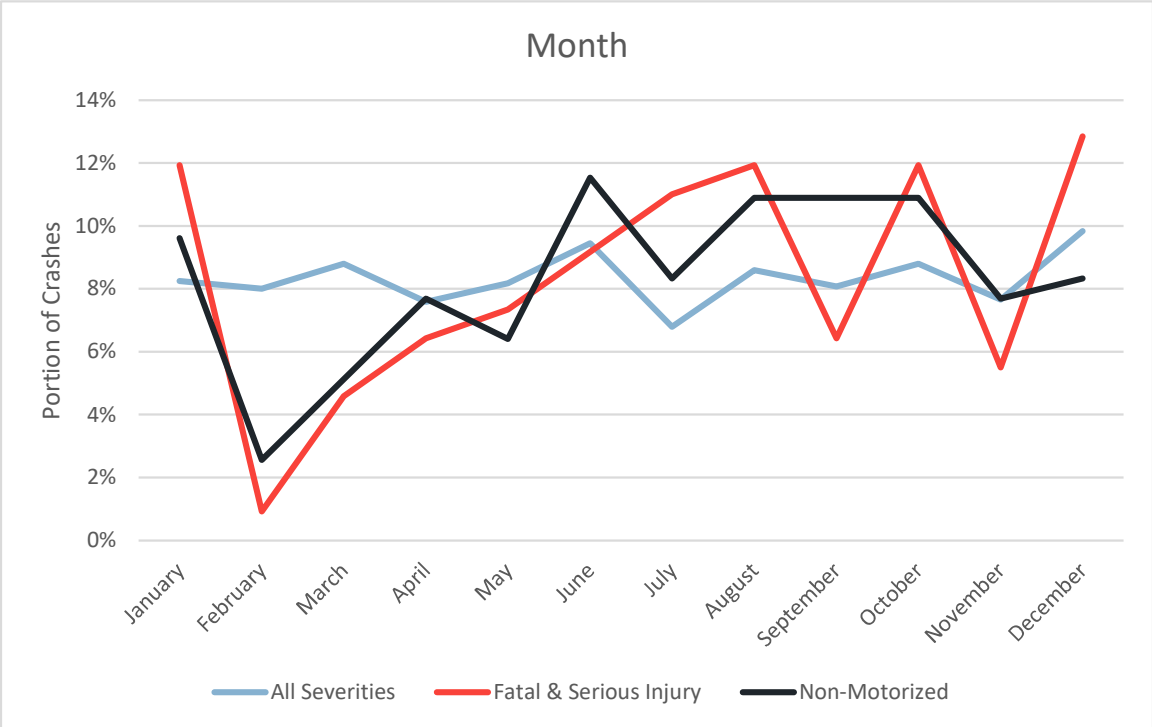


Figure 12 - Crash Distribution by Month of Year (2013-17)

3.3.3 ENVIRONMENTAL CONDITIONS

While environmental conditions are more difficult to account for they are important to consider as mitigating steps can still be taken to try to reduce their impacts on drivers. Figure 13 provides the distribution of crashes by the lighting condition present at the time of the crash, as reported by the responding officer. For crashes of all severities, over ninety percent occurred under daylight or lit conditions. The distribution for the fatal and serious injury crashes and non-motorized crashes is more heavily weighted toward dark light conditions. Based on historic crash data, 40% of all crashes occurred during non-daylight conditions, with 20% under lit conditions and 17.5% under darkness. Lighting has exited along the corridor since 2009 and prior but was upgraded to the current LED utility between 2015 and 2017.

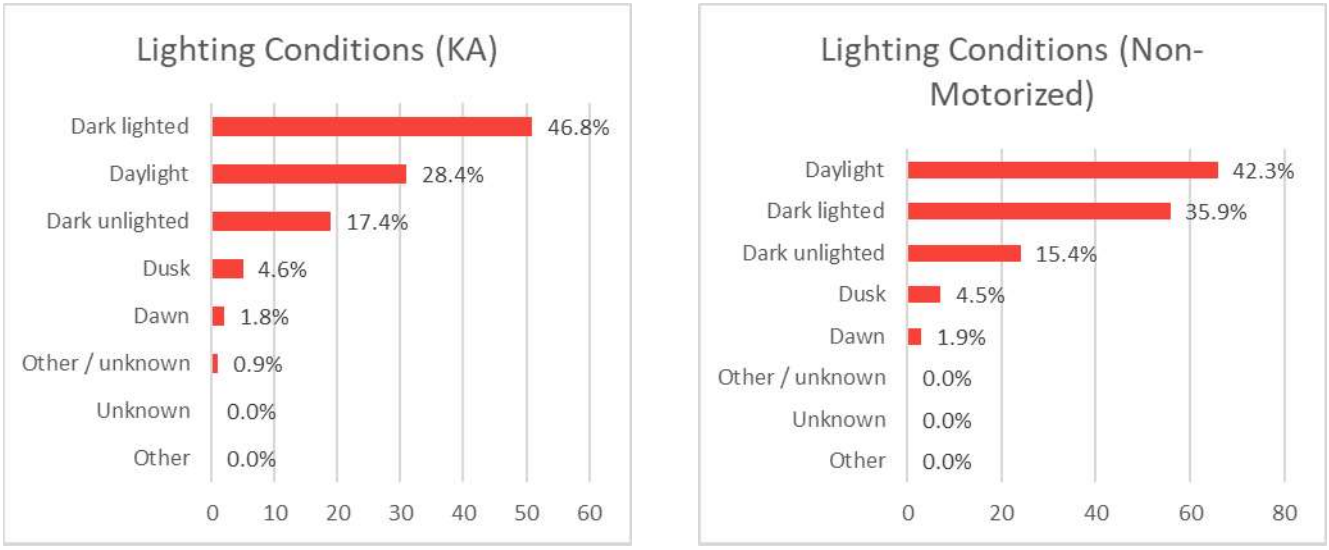


Figure 13 - Crash Distribution by Lighting Condition (2013-17)

When reviewing the distribution of crashes based on the surface condition of the road at the time the crash occurred, no strong trend emerges or significant differences between the categories, as shown in Figure 14.

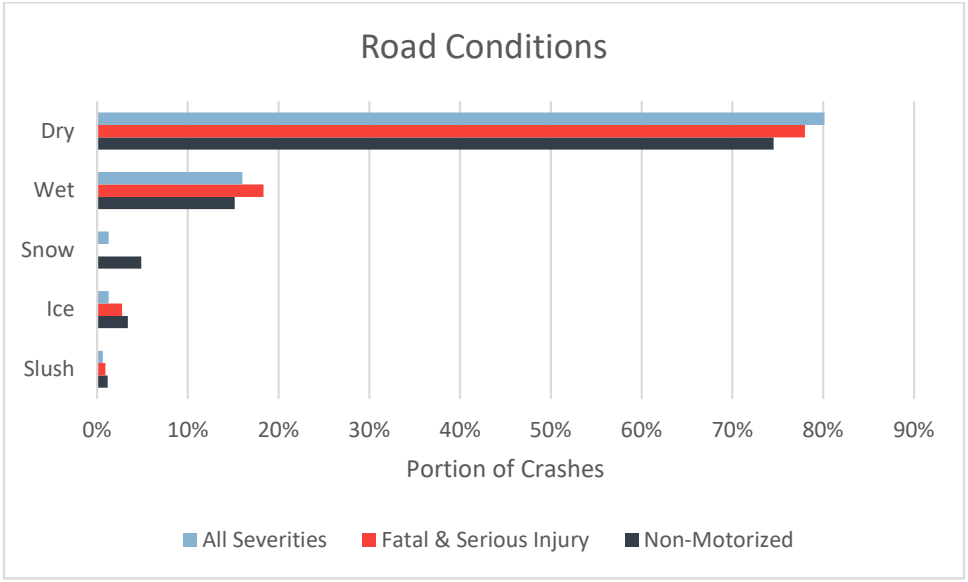
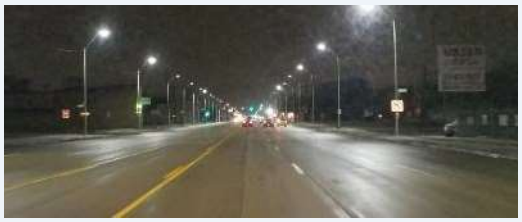


Figure 14 - Crash Distribution by Road Condition (2013-17)

4 EXISTING SAFETY MEASURES

The measures and characteristics in the following table have been identified as having a positive impact on safety along the corridor and highlight the Project Owner's existing focus on safety and maintenance.

Existing Safety Measures	Photo
Signal Spacing & Progression *Existing traffic signals along the corridor are coordinated to provide for smooth progression and platooning along the corridor with timing plans designed to provide for changes in directional traffic. This helps to smooth operations and provide opportunities for gaps and other positive operational benefits.*	
Covered Bus Shelters *Given the significant non-motorized and transit rider presence along the corridor, provision of covered bus stops provides riders with a waiting area relatively protected from the elements.*	
LED Lighting Coverage *LED lighting has been recently installed along the corridor providing better illumination for the roadway itself. This helps to improve the visibility of pavement markings, signs, vehicles, and other obstructions in the roadway, assisting drivers under dark conditions.*	
Continuous Sidewalk Facilities *Continuous sidewalks have been provided along the length of the corridor, including ADA ramps and pedestrian countdown timers.[3] These features assist pedestrians and non-motorized users and provide them with a dedicated space to traverse the corridor.*	
Sign Condition *While the age of signs along the corridor varied widely, they were generally in good condition. This helps to provide drivers with clear messaging and good retro-reflectivity.*	

[3] Due to snow and ice present during the field review, the RSA team was unable to ascertain the extent of these features. Locations not currently meeting ADA and other requirements should be brought up to the current standard as soon as is reasonably feasible.

5 SAFETY CONCERNS AND SUGGESTIONS

The following sections detail the safety concerns identified during the RSA, along with targeted treatment recommendations. Five safety concerns have been identified with specific issues detailed under each category. The safety concerns, risk ratings, and suggestions are summarized below.

#	Safety Concern	Risk Rating	Suggestions
1	Non-Motorized Facilities	F	— Median Refuge Crossing Locations — Curb Bump-Outs — High Visibility Crosswalks — Bike Lanes — Extend Curb Line into Road — Sidewalk Lighting — Relocate Bus Shelters — Winter Sidewalk Maintenance
2	Non-Motorized Compliance	F	— Median Refuge Crossing Locations — Pedestrian Countdown Timers — Update Pedestrian Clearance Intervals — Always Run Pedestrian Phase — Non-Motorized Education Campaign
3	Intersection Operations & Geometrics	D / E	— Consolidate Access Points — Standardize Unique Intersection Configurations — Review Channelized Right Turns
4	Roadway Geometrics	D	— Consider Alternate Cross Sections — Extend I-94 Lane Shift Transition — Access Management — Drainage Inspection & Maintenance
5	Signs	B	— Update Signing — Clarify Left Turn Restrictions — Delineate Parking

5.1 SAFETY CONCERNS AND TREATMENT OPTIONS

The following sections provide detail regarding the concerns identified under each grouping, as well as several potential treatments which cover a range of time frames and levels of investment.

5.1.1 NON-MOTORIZED FACILITIES

SAFETY CONCERNS

Non-motorized road users represent a significant portion of traffic along Gratiot Avenue, including pedestrians, bicyclists, and those traveling to/from provided transit services. This was reflected in observations made by the RSA team during the field review, comments and concerns raised by several stakeholders, and in the historic crash data. As discussed in the crash analysis provided in Section 3.3, pedestrian and bicyclist involved crashes account for a disproportionate amount of fatal and serious injury crashes. While there are several positive aspects of the corridor to provide facilities for non-motorized users, the following items represent a summary of the concerns identified by the project team.

Sidewalk Maintenance

The maintenance of sidewalks along the corridor varied significantly depending on the active status of the adjacent businesses. With the amount of ice and snow present along stretches of the corridor, many pedestrians were observed walking in the travel lanes of the roadway as those had been plowed, providing a clearer walking area. Where active, local businesses did work to keep their portions of the sidewalk clear, but the number of inactive establishments resulted in significant portions of the sidewalk network remaining covered in ice and snow, as shown in Figure 15. Inadvertently encouraging pedestrians to walk in the roadway itself increases the potential for non-motorized collisions.

Figure 15 - Comparison of Observed Sidewalk Maintenance

Distance between Crossings

Steps have been taken to provide ADA compliant crossings at signalized intersections along the corridor. Many of these include push buttons and pedestrian countdown timers to provide pedestrians and bicyclists with a clear indication of remaining crossing time. There are instances of non-motorized trip generators along the corridor (residential areas, gas stations, grocery/convenience stores, etc.) that are not located near the signalized intersections, resulting in high crossing demand at unmarked locations. A review of signalized crossing locations shows that of the approximately thirty signalized crossings along the corridor, half are more than a quarter mile apart. This includes distances between crossings of four tenths of a mile or more in areas with a significant portion of non-motorized crashes (roughly from Seymour Rd to Eight Mile). The large distance between crossings contributes to a significant number of non-motorized crossings at uncontrolled locations where drivers may not be anticipating vulnerable road users, increasing the potential for crashes.

Length of Crossings

The width of pavement along Gratiot Avenue, combined with the skew the corridor makes with intersecting roadways, results in a significant distance pedestrians and bicyclists are required to cross, as illustrated in Figure 16. In most locations, this distance is approximately 110’ from curb to curb; compared to a perpendicular crossing, the skew adds approximately 15’ of crossing distance. The greater crossing distances require pedestrians to be in the roadway for longer periods of time and may make it difficult to complete the crossing in the allotted timeframe, especially for pedestrians with slower than average walking speeds.

Figure 16 - Example Crosswalk Distance (7 Mile Road & Gratiot Avenue)

Bus stop Offsets

During conversations with stakeholders at the kick-off meeting as well as interaction with transit users at bus shelters, it was noted that several bus shelters had been struck in the past by errant vehicles. Transit riders noted that they did not necessarily feel safe with the shelter being so close to the road, but utilize the shelter as it provided some level of protection from the weather elements.

Figure 17 - Bus Offset Examples

Lack of Bicycle Facilities

Bicycle use along the corridor was noted by stakeholders and during the field review. No dedicated bicycle facilities are provided along Gratiot Avenue, despite several intersecting bicycle facilities being present along the corridor. These intersection facilities range from “bike friendly” designated roadways (Conner Street) to physically separated multi-use trails (the Dequindre Cut). The current lack of dedicated facilities reduces the level of awareness for drivers that they may need to share the road, and is a disconnect between the many generators along the corridor with the intersecting bicyclist and non-motorized facilities.

Based on the traffic volumes along the corridor, reported and observed levels of non-motorized and transit activity, and the history of severe pedestrian and bicycle involved crashes, the RSA team felt the potential for crashes related to pedestrian facilities was frequent and severe, resulting in a risk rating of F.

Crash Frequency	Crash Severity
	High
Frequent	**F**
Expected Crash Types	*Pedestrian & Bicycle Involved*

POTENTIAL TREATMENTS

MEDIAN REFUGE CROSSINGS

COST: MODERATE - HIGH

Median refuge crossings could provide significant benefits for non-motorized road users along the corridor. They could be used to provide marked crossings at midblock locations and could range from relatively low investment installations to higher cost, higher visibility crossings. Additionally, at locations where left turns are prohibited at the existing signalized intersection crossings, median refuge island could be installed to provide a protected refuge area on Gratiot Avenue.[4] Provision of midblock crossings would help alert the driver to the potential presence of non-motorized traffic crossing Gratiot Avenue and would provide those non-motorized uses with a protected refuge island to divide the wide crossing distance into two shorter lengths. Figure 18 provides some examples of the range of potential levels of investment for median refuge crossings. Variations would be required to accommodate mid-block or intersection crossings, but the basic elements are similar.

[4] With the provision of a sufficiently designed refuge island the pedestrian clearance phase can be timed to provide crossing time in two phases, allowing the pedestrian to rest in the refuge until the next walk signal.

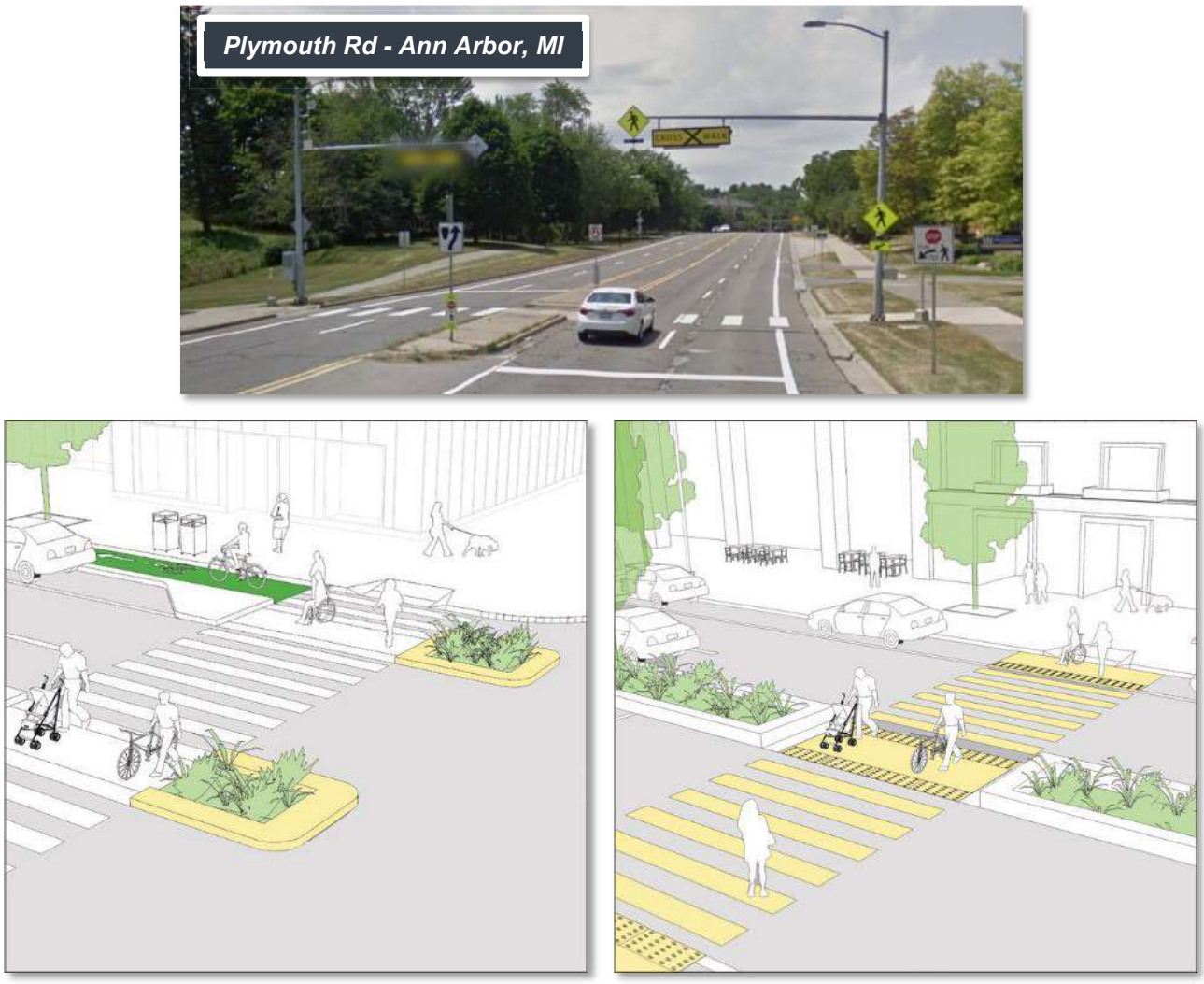


Figure 18 - Example Median Refuge Crossing Installations (Sources: Google Earth & FHWA)

CURB BUMP-OUTS

COST: LOW - MODERATE

Curb bump-outs may go by several different names, including knock-outs and bulb-outs among others. All instances rely on the use of short sections of curb line extended out into the roadway, typically at an intersection, to help reduce the amount of open pavement non-motorized users need to cross. The effect is to reduce the length of time a non-motorized user is crossing travel lanes reducing their exposure and potential crash risk. If used in conjunction with dedicated parking, bump-outs could be utilized at mid-block crossings as well. Some examples are provided in Figure 19 and Figure 20. As shown, curb bump outs could be trialed on a temporary basis to determine their effects on the corridor and operations before installing more permanent installations. While the example images show bulb-outs installed on local streets with smaller cross sections, the principal remains the same in reducing the crossing distance along Gratiot Avenue. Careful consideration must be given to their implementation if / when installed alongside other treatments. For example, bike lanes are installed between parking and the curb, additional curb cuts may prove beneficial to keep the curb bump-outs from becoming an obstacle to the bike lane.

Figure 19 - Temporary Bulb-Out Example (Source: 8th St S, Seattle, WA)

Figure 20 - Example Bulb-Out Installation + Buffered Bike Lane (Source: 9 Mile Rd, Ferndale, MI)

HIGH VISIBILTY CROSSWALKS

COST: LOW

Current crosswalks along the corridor consist of the typical pavement marking with two parallel stripes outline the crosswalk area. Consideration should be given to utilizing more visible pavement markings or related low cost treatments to increase the visibility of the crosswalk itself. An example crosswalk of this type is the continental or "ladder" pavement marking as shown in Figure 21. This would better alert drivers to the presence of the crossing, whether at an intersection or mid-block. The level of effort associated with any improvements to crosswalk visibility and any associated components will impact the level of funding required.

Figure 21 - High Visibility Crosswalk Installation (Source: NACTO)

BIKE LANES

COST: LOW - MODERATE

Consideration should be given to the provision of bike lanes or some other dedicated bicycle facility along the corridor. This will ultimately depend on the travel speeds along the corridor but should be considered as it can provide bicyclists with a dedicated space to traverse the corridor and opportunities to connect existing intersecting bicycle facilities. In this way, bicycle facilities along the full corridor could be incrementally implemented. Additionally, these facilities could range from bicycle lanes delineated with pavement markings up to a physically separated bicycle lane.

It is recommended that any bike lane installation be carefully considered. It is important to make sure any new facilities provide connection to other existing facilities or are part of a coordinated, phase in approach to a wider bicycle friendly network. This is intended to help minimize or prevent the existence of, "bike lanes to nowhere" which could leave unknowing bicyclist on stressful or uncomfortable routes.

EXTEND CURB LINE INTO ROAD

COST: MODERATE

Given the wide cross-sectional pavement area along Gratiot Avenue, the potential exists to widen the sidewalk space on either side of the road without necessarily eliminating parking or other amenities (other lanes would need to be removed or narrowed to accommodate). This would potentially provide several benefits. It would increase available furniture space along the sidewalk, providing pedestrians with more walking room and potentially easier maintenance activities. It would also increase the potential distance between motorized vehicles and pedestrians, increasing the buffer distance and reducing the potential for a lane departure crash to result in a pedestrian strike. The extended curb line would also help to reduce the distance pedestrians would be required to traverse when crossing Gratiot Avenue, reducing potential exposure to motorized vehicles. Space making options for this type of treatment could include linear parks or green infrastructure.

SIDEWALK LIGHTING

COST: MODERATE

While there is good lighting coverage for the roadway along the length of the corridor, there is relatively little lighting for the sidewalk itself. The roadway lighting is angled well for the road, but as a result doesn't provide much illumination for pedestrians and other users on the sidewalk. Working with local businesses, neighborhood groups, and the City, additional lighting may improve conditions along the sidewalk, encouraging pedestrians and other non-motorized users to utilize it rather than walking in the roadway.

RELOCATE BUS SHELTERS

COST: LOW - MODERATE

Bus shelters are currently located near the curb line of the roadway. It was noted during consultation that these shelters have been hit on several occasions by vehicle departing the roadway and that transit authorities have limited their installations as a result. Where possible, and potentially in conjunction with business and property owners, consideration should be given to moving the shelters to the back side of the sidewalk. This would increase the buffer distance between the travel lanes and the shelter, reducing the potential for strikes by errant vehicles.

A related option is the inclusion of bus bays. If the curb line is extended into the road as discussed previously, the wider sidewalk area could provide space to offer room for bus bays. This would allow buses to pull out of the traffic stream, minimizing disruptions for other vehicles.

Relocating bus shelters to the back side of the sidewalk would provide the opportunity to improve amenities in several ways. Depending on available space, larger shelters could be installed at the more heavily utilized bus stops, providing more cover and seating areas. Transit riders were observed sheltering in nearby businesses and running, sometimes across Gratiot, to catch buses as shelters were already full. Additionally, combined efforts with local neighborhoods and organizations could be leveraged to plant trees and other space making amenities. These would provide additional shade, improving the comfort of the shelters. This is important to provide a safe sufficient shelter for transit riders to wait, rather than sheltering elsewhere and making potentially risky maneuvers to catch their buses. It must be noted that these options would typically require relocation of the shelter away from the curb, as installation of larger / additional fixed objects along the curb line is generally discouraged.

WINTER SIDEWALK MAINTENANCE

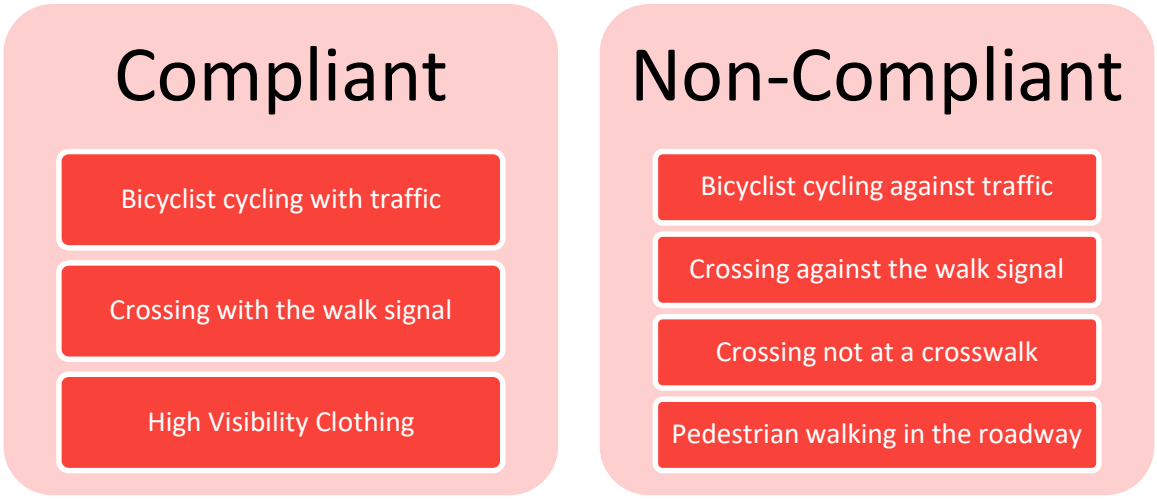
COST: LOW - MODERATE

The City of Detroit has an ordinance requiring property owners to maintain sidewalks in front of their properties by keeping them clear of snow and ice. This is difficult to enforce along the corridor given the number of vacant properties. Alternative methods should be considered to maintain stretches of sidewalk during the winter months. Clear sidewalks reduce the potential for pedestrians to walk in the roadway. In some instances, community groups have volunteered to maintain these locations for the good of the community. Another option is the help of local philanthropic groups, such as the Downtown Detroit Partnership to help orchestrate efforts to improve the corridor.

5.1.2 NON-MOTORIZED COMPLIANCE

SAFETY CONCERNS

While the physical facilities provided for non-motorized road users play a significant role in influencing pedestrian and bicyclist safety, another significant component is the behavior of non-motorized users. Several behaviors, ranging from positive safety conscious activities to potentially risky maneuvers were observed by the RSA team. Examples of both compliant and non-complaint behavior observed during the field review are included below.



Non-compliant behavior typically puts pedestrians or bicyclists in areas of the road where drivers are less likely to expect them, less able to see them, or have less opportunity to react to their presence. These factors contribute to an increase in the potential for crashes involving these vulnerable road users.

Based on the traffic volumes along the corridor, reported and observed levels of non-motorized and transit activity, and the history of severe pedestrian and bicycle involved crashes, the RSA team felt the potential for crashes related to pedestrian facilities was frequent and severe, resulting in a risk rating of F.

Crash Frequency	**Crash Severity**
	High
Frequent	**F**
Expected Crash Types	*Pedestrian & Bicycle Involved*

POTENTIAL TREATMENTS

MEDIAN REFUGE CROSSINGS

COST: MODERATE - HIGH

As a significant number of pedestrians were observed crossing at locations without a marked or signalized crosswalk, mid-block crossings with refuge islands may help to improve compliance. Some compliance related issues arise in part due to a disconnect between travel demand and available facilities. A review of the corridor should be conducted to identify high traffic crossing locations which could benefit from a mid-block crossing. In many locations a non-motorized traveler would be required to add a half-mile or more to their trip to travel to the nearest signalized intersection to cross Gratiot Avenue. Provision of a mid-block crossing would shorten these trips and provide a marked crossing where the need is greatest.

The specific type and level of installation will likely vary along the corridor depending on the specific needs of the local road users and site specific conditions. Example of median refuge crossings were provided in Section 5.1.1.

PEDESTRIAN COUNTDOWN TIMERS

COST: MODERATE

Pedestrian countdown timers are already provided at several signalized locations along the corridor. These timers provide non-motorized users with a better understanding of the remaining time available to cross. Consideration should be given to providing these at any locations where they are not already provided, and signalization of future intersections along the corridor may also benefit from their inclusion. An example installation from the study corridor is provided in Figure 22.

Figure 22 - Pedestrian Push Button and Countdown Timer (7 Mile & Gratiot)

UPDATE PEDESTRIAN CLEARANCE INTERVAL

COST: LOW

The existing pedestrian clearance intervals for the signalized intersections along the corridor appear to meet the minimum requirements. Consideration should be given to retiming or updating the clearance intervals to current standard and in some cases, extending them to better accommodate local road users. An example of this includes the intersection of Gratiot Avenue at Van Dyke (M-53) where a senior living center is located at the intersection. Pedestrians requiring additional time to cross would benefit from an extended clearance interval.

A related recommendation is the use of leading pedestrian intervals. These would provide pedestrians with a walk signal in advance of parallel vehicular traffic when the pedestrian push button is activated. This gives pedestrian time to get into the crosswalk ahead of turning vehicles, making them more visible before vehicles begin to make the turn.

ALWAYS RUN PEDESTRIAN PHASES

COST: LOW

Based on the field observations, many signalized intersections require a pedestrian to use the push button to call the pedestrian walk phase each cycle. During the field review the RSA team observed high crossing volumes on all legs at intersections such as 7 Mile Road, however did not observe any pedestrians activating the signal using the push buttons. Consideration should be given to removal of the pedestrian push buttons and retiming of the traffic signal so that the walk phase is automatically provided each time, particularly at high volume crossing locations. Accounting for pedestrian traffic automatically could potentially provide reliable crossing signals with sufficient crossing time and encourage the pedestrian to be more compliant. In addition, the signal progression along the corridor could benefit from the planned crossing time rather than the frequent extension of time due to push button actuation.

NON-MOTORIZED EDUCATION CAMPAIGN

COST: LOW

Based on observations made during the field review and feedback received from stakeholders, road users may benefit from an education campaign to remind users of the correct behavior in various situations. This could include walking against traffic as a pedestrian, biking with traffic when cycling, the importance of walking at a crosswalk with the signal, and the benefits of higher visibility clothing, especially at night. A campaign could take many different forms depending on need and resources, but some examples include pamphlets, social media efforts targeting local neighborhoods/groups, or even utilizing traffic signal boxes as a location for posting approved material, as shown in Figure 23.

Figure 23 - Traffic Signal Cabinet w/Crossing Information (Source: http://trafficsafetyteam.org)

5.1.3 INTERSECTION OPERATIONS & GEOMETRY

SAFETY CONCERNS

As previously mentioned, Gratiot Avenue travels to the northeast at a significant angle compared to the surrounding grid of streets. This results in unique intersection configurations along the corridor, intersections skews which affect crossing distances and sight distances, and complicated access points in the vicinity of intersections. These issues increase the potential for intersection related crashes as well as non-motorized involvement.

One example which encompasses several of these issues is the intersection of Gratiot Avenue with Harper Road and Cadillac Road, as shown in Figure 24. Several minor approaches intersect near the main intersection, while various driveways serving local establishments further complicate operations for both motorized and non-motorized users. While this location serves as one of the more extreme examples along the corridor, these issues were not unique to this location. Additional strain on drivers and other road users increases the potential for errant maneuvers and crashes, potentially resulting in severe injuries as exhibited by the types of crashes typically seen at intersections and historically reported along the corridor.

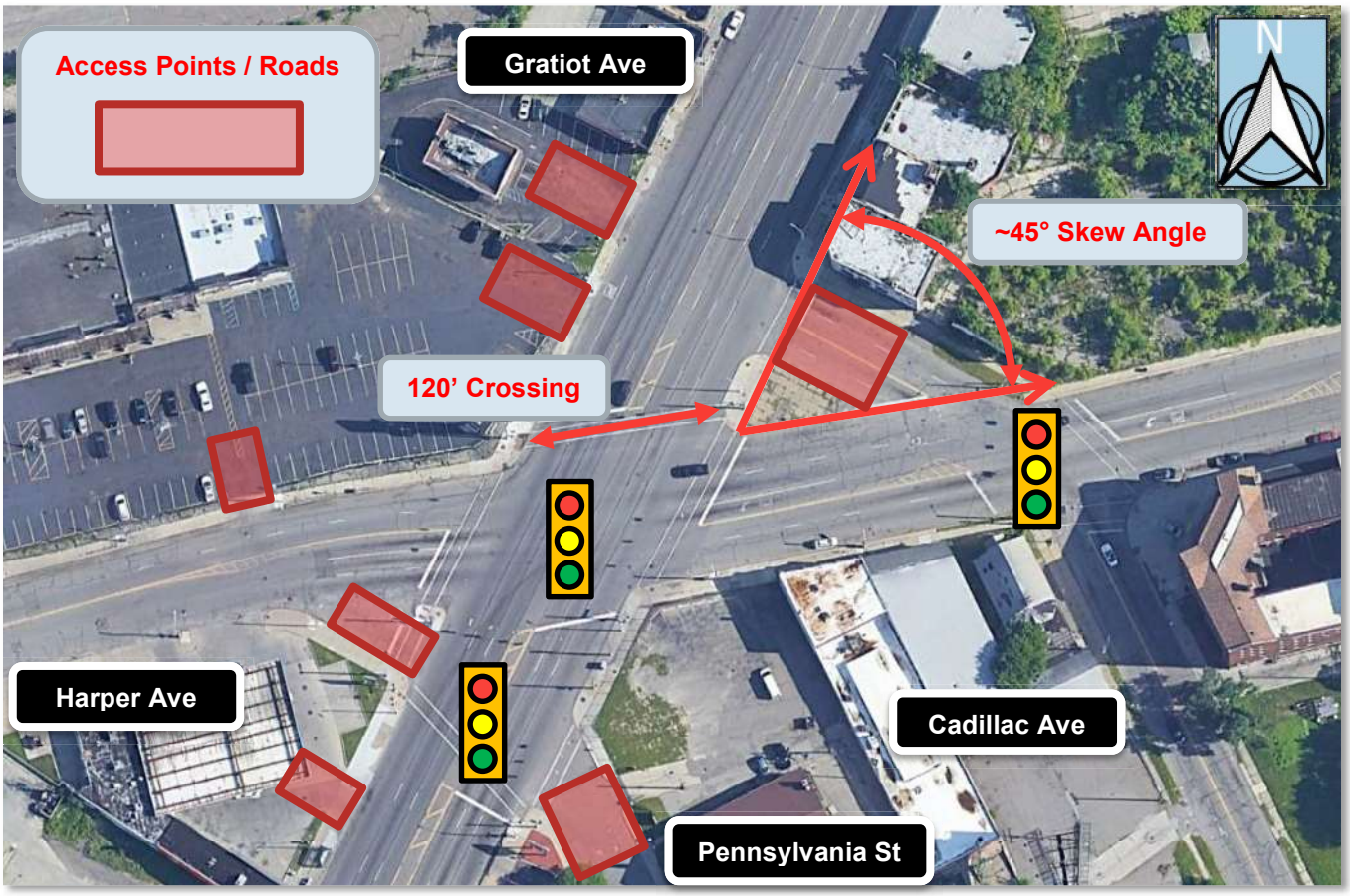


Figure 24 - Intersection of Gratiot, Harper, and Cadillac

In addition to the geometric concerns identified at intersections along the corridor, operational concerns were identified. Specifically, at the intersection reviewed in the preceding figure, conflicting permissive turn arrows were observed (westbound left turn traffic from Harper Road potentially conflicting with eastbound right turn traffic from Pennsylvania). This issue is illustrated in Figure 25 showing the conflicting movements. Use of the green right turn arrow for eastbound traffic from Pennsylvania suggests to drivers that it is a protected movement when the permissive "green ball" for westbound left turns from Gratiot are occurring at the same time.

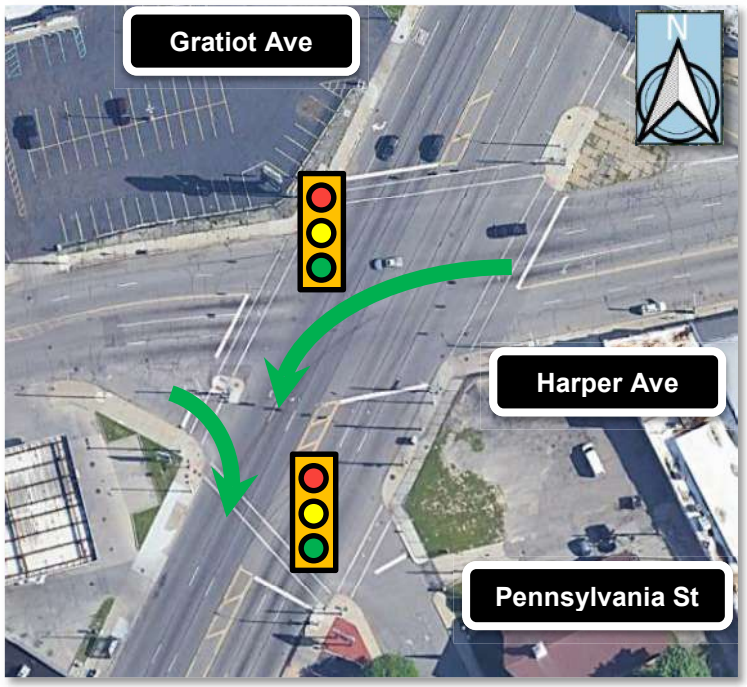


Figure 25 - Permissive Movements w/ Green Right Turn Arrow

Other operational issues included an apparent power failure (Gratiot Ave & Filbert / Findlay) and a signal operating in flash mode (Gratiot Ave & Lappin). These issues may have been due in part to the recent snowfall events, but persisted for at least the three days the field review was in progress.

Based on the traffic volumes along the corridor (motorized and non-motorized), the intersection configurations observed along the length of the corridor, and the history of non-motorized involved, angle, sideswipe, and left turn head on crashes, the RSA team felt the potential for crashes related to intersection operations and geometrics was frequent and low to moderate in nature, resulting in a risk rating of a D to E.

Crash Frequency	Crash Severity	
	Low	***Moderate***
Frequent	**D**	**E**
Expected Crash Types	*Non-motorized, Angle, Left Turn-Head On*	

POTENTIAL TREATMENTS

CONSOLIDATE ACCESS POINTS

COST: HIGH

It may be beneficial to work with local establishments and residents to explore the closure of some access points located in the functional area of the intersection. This could include commercial driveways or short minor roadway segments, such as those identified in Figure 24. This would require cooperation and discussions with local business owners and the provision of alternate access points in the cases where they aren't already available. This could include closure of smaller side streets that intersection Gratiot in the functional area of larger intersections. Reducing the number of access points in the functional area of the intersection helps to reduce the number of conflict points and simplifies maneuvers in the immediate vicinity of the intersection.

REVIEW CHANNELIZED RIGHT TURNS

COST: MODERATE

Given the angle of Gratiot Avenue as it heads northeast out of the downtown area, sight distance for drivers making right turns at intersections with acute angles was noted as a concern. Some locations already provide a channelized right turn lane which pulls the driver away from the intersections somewhat and provides a dedicated space to watch for conflicting traffic before completing their maneuver. A general review of existing facilities may provide insight regarding potential improvements to existing channelized right turns or other locations which might benefit from their implementation.

5.1.4 ROADWAY GEOMETRY

SAFETY CONCERNS

Geometric issues and concerns along the corridor were raised by stakeholders and observed by the RSA team during the field review. While many of these issues impact pedestrians and other non-motorized users, this section focuses on the impacts to vehicular traffic.

Speeding was identified as an issue along the length of the corridor by both stakeholders and the RSA team due to the relation of the roadway's geometry to driver behavior. Part of this can be attributed to drivers simply traveling too fast for conditions, but another factor is the cross section of Gratiot Avenue. Drivers tend to travel at speeds they feel comfortable maintaining based on the roadway geometry and the surrounding environment. Gratiot Avenue is currently seven lanes wide traveling through a relatively low density area for most of the length of the study corridor. This gives drivers the impression of a highspeed roadway as opposed to the lower speed urban arterial it is intended to be. Compounding the number of lanes in the cross sections is the presence of relatively wide travel lanes and a wide combination travel/parking lane located along the curbside. Conversely, the center left turn lane was relatively narrow with turning vehicles regularly left partially in the through lanes. Figure 26 provides an example of the cross-section taken during the field review along with approximate lane measurements for a typical section along the corridor.

Figure 26 - Typical Gratiot Cross Section (Graphic Created via Streetmix.net)[5]

Another concern raised by both stakeholders and the RSA team along the corridor included instances of flooding, particularly near intersections and along the parking lane. Flooding and ponding could contribute toward conditions leading to hydroplaning, black ice or general slippery conditions, and overtime damage to the roadway. Flooding along the curbside could also serve to push pedestrians and bicyclists further into the through lanes to avoid standing water and ice.

[5] Parking areas long Gratiot Ave are not currently striped but were included in the graphic to differentiate the space from the travel lanes.

The I-94 interchange was also identified by the RSA as an area of review. On the newly constructed overpass, the cross-section is altered to accommodate stacked left turn lanes and no outside parking lane. The current transition distance between the typical Gratiot cross-section and the area across the bridge is relatively short, causing the lanes to shift abruptly. This may be contributing to sideswipes or rear ends in the vicinity of the interchange.

Based on the traffic volumes along the corridor and reported and observed levels of vehicular crashes, the RSA team felt the potential for crashes related to the corridor's roadway geometrics was frequent and but lower in severity, resulting in a risk rating of D.

Crash Frequency	Crash Severity
	Low
Frequent	**D**

Expected Crash Types	*Lane Departure, Sideswipe, Rear End, Head On*

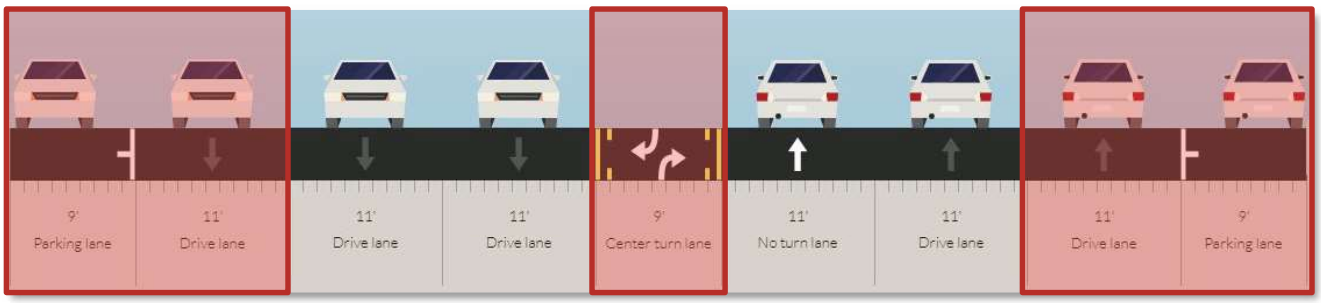
POTENTIAL TREATMENTS

ALTERNATE CROSS SECTIONS

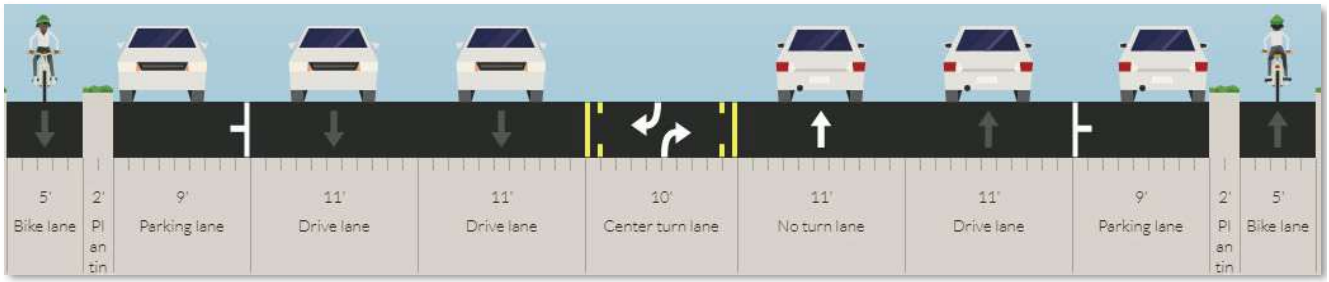
COST: LOW - HIGH

The current cross section of Gratiot Avenue currently contributes to several of the issues and concerns raised by stakeholders and identified by the RSA team. As noted in Figure 26, the typical pavement cross-section along Gratiot is approximately 94' in width. This includes three through lanes, a center left turn lane, and parking provided on both sides of the roadway. Current traffic volumes don't necessarily warrant the number of lanes and the relatively large pavement area tends to encourage higher speeds and increases crossing distances for all users. A wide range of opportunities exist to alter the cross section along Gratiot Avenue including making lanes consistent widths and reducing overall laneage. By reducing the cross-section, travel speeds may reduce, other modes of travel could be better accommodated, and the general feel of the corridor would be brought more in line with the low speed urban arterial Gratiot Avenue is intended to be in this area.

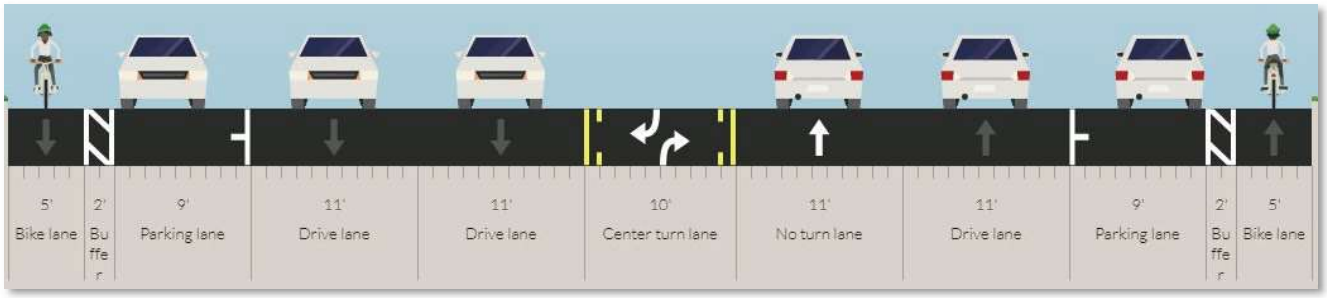
Existing traffic volumes show that Gratiot Avenue could be reduced from three travel lanes in each direction to two while maintaining an acceptable level of service. An additional capacity analysis should be undertaken by the Owner prior to making any reduction in laneage and travel time reliability along the corridor should be established. In addition, the consideration of Gratiot Avenue and its interaction with I-94 should be evaluated. It should be noted, that I-94 reconstruction aims at bringing the freeway up to current standards and adding additional capacity which both can aid in the reduction of crashes closing I-94 and reducing the need for Gratiot Avenue to serve as a detour route. Additional adjustments to lane widths could further add to this "surplus" pavement area. Utilizing this new space, a range of options could be employed as needed along the corridor, with several examples provided in Figure 27.



Protected Bike Lanes



Buffered Bike Lanes



Buffered Bike Lane + Planters / Bioswales

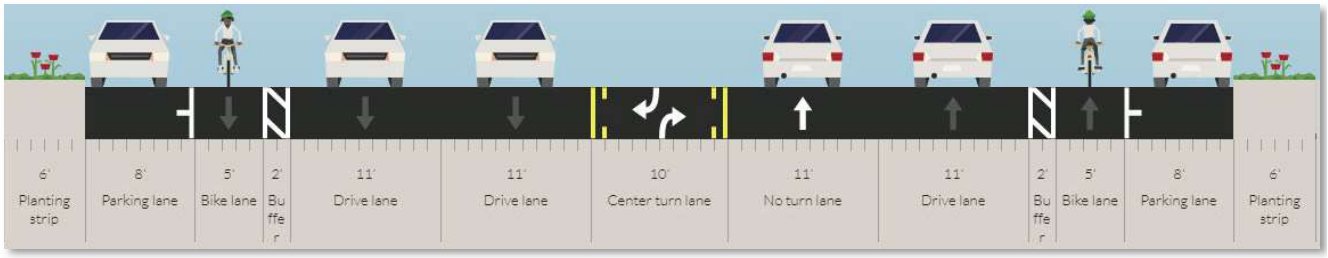


Figure 27 - Alternate Cross Sections

SMOOTH I-94 LANE SHIFT TRANSITION

COST: LOW

The I-94 interchange ramps are in the early stages of planning for reconstruction in the coming years. The RSA team is not aware of specific plans for the bridge and surface streets in the immediate vicinity, however consideration should be given to extending and smoothing the transition in cross-sections when transitioning from the typical Gratiot Avenue cross-section to that used on the interchange bridge. This can be done in the relatively short term with revisions to the current pavement marking layout and should help to reduce sudden lane shifts and related crashes in this area.

ACCESS MANAGEMENT

COST: MODERATE

As previously mentioned, the skew Gratiot Avenue makes with the surrounding road network results in a significant number of non-standard intersections, mostly un-signalized. Additionally, the local neighborhoods have thinned over the previous decades, resulting in a higher portion of neighborhood streets with relatively few homes located on them. While some neighborhoods are returning, it may be beneficial to consider closing some of the smaller roadways along Gratiot to consolidate conflict points. Additionally, where possible it would be beneficial to work with local businesses to consolidate their access driveways where possible for the same reason.

DRAINAGE INSPECTION & MAINTENANCE

COST: LOW - MODERATE

Drainage structures along the corridor should be inspected and evaluated to determine potential degradation of the system and planned for correction. The relative involvement of this treatment will depend on the condition of the drainage system generally.

Consideration could be given, in conjunction with any narrowing of the cross-section, to implementing alternate drainage treatments, such as bioswales along the roadside. These serve as natural detention pods, collecting runoff and slowing its entrance into the manmade drainage system, reducing the impact of sudden rainstorms and heavy precipitation. They can also be used to help improve water quality and be used as an opportunity for space making in conjunction with the local neighborhoods and communities. Figure 28 provides an example of one such installation.

Figure 28 - Example of a Bioswale (Source: NACTO)

5.1.5 SIGNS

SAFETY CONCERNS

Generally, signs along the corridor are in fair to good condition, despite having a wide age range. There were some sign related concerns identified by the project team during the field review, however. These concerns are primarily focused on clarity of messaging around driver navigation and movement restrictions.

Sign visibility and placement was one of the related concerns raised by the RSA team. Given the wide cross-section along Gratiot Avenue, signs located on either side of the roadway are less obvious when driving in the center lanes. Additionally, due in part to the skew, signage for left turn restrictions were frequently placed on the right side of the road, as illustrated in Figure 29. This reduced the potential for drivers to see the signs, as drivers making a left turn are typically looking straight ahead or to the left along their intended route.

Figure 29 - Left Turn Restriction Posted on Right Side of Gratiot

Additionally, left turn restriction signage at intersections, given the skew and multiple interacting roads at some locations, can lead to driver confusion. The RSA team on several occasions had difficulty determining which signs applied to which approaches and where turning maneuvers were allowed or prohibited.

Lastly, it was noted that there was no advanced guidance signage for the I-94 interchange. There appeared to be foundations in place, potentially for gantry signs filling this need, but overhead and advanced signage is currently absent. Existing I-94 guidance signs are located at the ramps and relatively close to the local buildings, potentially obscuring their visibility, as shown in Figure 30.

Figure 30 - I-94 Interchange Signage

Based on the traffic volumes long the corridor and the level of historically related crashes, the RSA team felt the potential for crashes related to the sign related concerns was relatively rare and with a lower severity, resulting in a risk rating of B.

Crash Frequency	Crash Severity
	Low
Rare	**B**
Expected Crash Types	*All*

POTENTIAL TREATMENTS

UPDATE SIGNING

COST: LOW - MODERATE

While sign condition along the corridor was relatively good, a signing review may prove beneficial. The placement and orientation of signs could be adjusted to improve visibility. This could include placement along the roadside, as well as additional overhead signing, particularly for left turn restrictions. Additionally, some signs may benefit from being increased in size, such as the school crossing signs, turn restrictions, and other regulatory signage. The increased size would help drivers perceive and understand the messaging more readily from the center lanes.

CLARIFY LEFT TURN RESTRICTIONS

COST: LOW

Given the somewhat complex nature of some intersections along the corridor, it is important to ensure that turn restrictions and other regulatory signage are clearly marked and directed toward the intended audience. Confirming and correcting sign orientation, utilizing overhead signage, and standardizing movement restrictions along the corridor could improve driver compliance and expectations.

DELINEATE PARKING

COST: LOW

While the southern section of the corridor near the downtown area has established parking zones, the northern portion (from St Aubin northward) is not currently zoned. While the outer lane is a wide combination through/parking lane for the full extent, some areas are specifically signed as “Parking Permitted” or “No stopping/Standing”, while other areas provide no signage. Drivers were observed passing in the parking portion of the outer lane or driving in it for some length of time. To clarify acceptable uses it may be beneficial to standardize parking signage along the corridor and utilize a uniform signing approach (i.e. permitted unless otherwise noted vs prohibited unless otherwise noted).

Additionally, it may help to calm and organize traffic if some combination of pavement markings were utilized to delineate the parking area. This could simply be an “edgeline” pavement marking or periodic parking symbol pavement markings located along the length of the parking lane. The impacts of such a change must be reviewed to determine any potential impacts on funding for Gratiot Avenue, as it would likely impact maintenance and operations funding and how the funds are allocated between MDOT and the City of Detroit.

5.1.6 OTHER CONCERNS

I-94 INTERCHANGE PEDESTRIAN CROSSINGS

During the field review it was noted that the recently reconstructed bridge over I-94 and the adjacent intersections were missing some components. These may be planned for completion for the upcoming ramp reconfiguration, but some marked crosswalks were missing as shown in

Figure 31. Given the relatively low cost / low effort, these crosswalks could be installed as soon as weather permits, rather than waiting for the interchange reconstruction. Marked crossings provide additional information to drivers of the potential presence of pedestrians and clearly delineate the intended crossing for non-motorized traffic.

Figure 31 - I-94 Interchange Missing Pedestrian Crosswalk

DEQUINDRE CUT NON-MOTORIZED CROSSING AT I-375 CONNECTOR

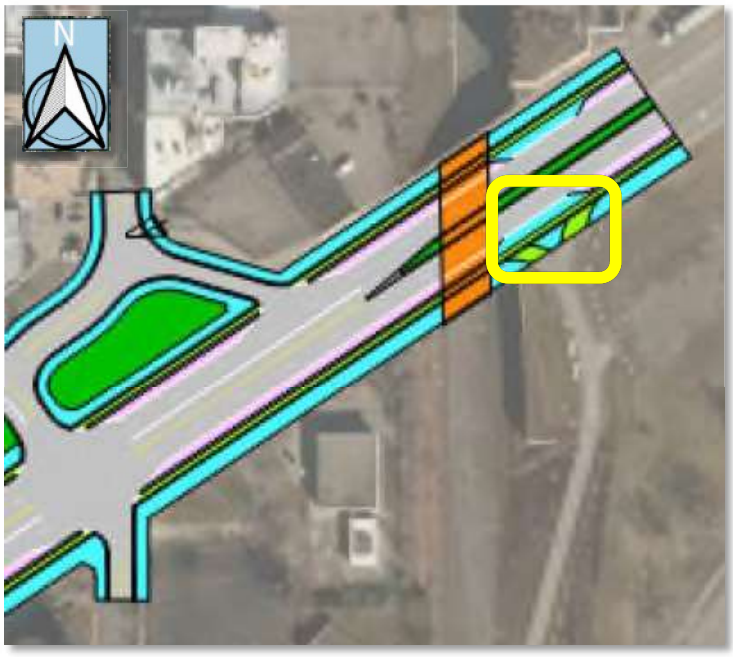


Figure 32 - I-375 Connector Concept

Conceptual plans for the revised I-375 Connector includes a portion of Gratiot Avenue which crosses over the Dequindre Cut. The proposed concept shows curb cuts connecting to an existing ramp which provides access between northbound Gratiot Avenue and the Dequindre Cut. Consideration should be given to providing a crossing point for non-motorized traffic at this connection, as current conditions would require non-motorized users to head north or south along Gratiot Avenue before reaching a marked crossing.

Figure 32 provides an excerpt of the I-375 Connector concept provided to the RSA team. The current curb cuts connecting Gratiot to the Dequindre Cut have been highlighted, illustrating the lack of a planned crossing.

SPEED LIMIT SIGN CONSISTENCY

Based on the traffic control order (TCO) provided to the RSA team, the posted speed limit along Gratiot Avenue is 30mph from Randolph Street to St Aubin and 35mph from St Aubin to Eight Mile (M-102). During the field review a 30mph sign was noted traveling northbound between Joseph Campau Street and McDougall Street within the 35mph zone, as shown in Figure 33. While the difference is not significant, the incorrect signage may create confusion for drivers and should be corrected.

Figure 33 - 30 MPH Speed Limit in 35 MPH Posted Zone

LIGHTING

Relatively new LED lighting is present along the length of the corridor which helps to illuminate the roadway, At least one section of lighting was noted as being out during the night field review north of Gunston St (east side roadway), as shown in Figure 34. The roadway in this section is particularly dark as there were no active businesses along the side of the road where the lighting was out. MDOT maintenance should resolve the issue at their earliest opportunity.

Figure 34 - Dark LED Lighting

WORN PAVEMENT MARKINGS

Portions of pavement markings were noted as being worn or difficult to see, particularly during the night field review. This was due in part to the wet road conditions as well as the pavement marking's proximity to the longitudinal joint which may have helped to accelerate deterioration. A review of pavement markings may be beneficial to identify short term fixes to help improve lane keeping and other navigational activities along the corridor. High traffic areas may benefit from more durable retroreflective pavement markings, helping to improving their visibility and longevity.

BUS OPERATIONS

Transit vehicles are a frequent presence along the corridor with both DDOT and SMART servicing stops along the length of the study area. Some stops are shared by both service providers, resulting in the potential for several buses to utilize the same stop at the same time or immediately following each other. At least one instance was observed where one bus was letting off passengers at the bus shelter while a second bus stopped in the middle lane to allow passengers to disembark, as shown in Figure 35. This increases risk for passengers getting on or off the bus and should be avoided where possible. It may be beneficial to provide reminders to transit drivers of these types or issues, or work with them to develop alternatives to areas with unique concerns or issues. Given their role and frequent observations, they are likely aware of other issues not readily apparent to the RSA team that may be driving this behavior.

Figure 35 - Bus Observations

5.1.7 TREATMENT INVESTMENT RANGE & APPLICABILITY

Table 4 provides a general estimate of the level of investment required for each of the recommended treatments. Details cost estimates will require more specific scope definitions for each treatment based on available resources and labor and will vary.

Table 4 - Treatment Matrix

Treatment	Expected Level of Investment	Applicable To				
		Non-Motorized Facilities	Non-Motorized Compliance	Intersection Operations & Geometry	Roadway Geometry	Signs
Median Refuge Crossings	**Moderate – High**	✓	✓	✓	✓	
Curb Bump-Outs	**Low – Moderate**	✓	✓	✓	✓	
High Visibility Crosswalks	**Low**	✓				
Bike Lanes	**Low – Moderate**	✓	✓		✓	
Extend Curb Line into Road	**Moderate**	✓		✓	✓	
Sidewalk Lighting	**Moderate**	✓				
Relocate Bus Shelters	**Low – Moderate**	✓	✓			
Winter Sidewalk Maintenance	**Low – Moderate**	✓	✓			
Pedestrian Countdown Timers	**Moderate**	✓	✓	✓		
Update Pedestrian Clearance Interval	**Low**	✓	✓	✓		
Always run Pedestrian Phases	**Low**	✓	✓			
Non-Motorized Education Campaign	**Low**		✓			
Consolidate Access Points	**High**	✓		✓	✓	
Review Channelized Right Turns	**Moderate**			✓		
Alternate Cross Sections	**Low – High**	✓	✓	✓	✓	✓
Smooth I-94 Lane Shift Transition	**Low**				✓	
Access Management	**Moderate**	✓	✓	✓	✓	
Drainage Inspection & Maintenance	**Low – Moderate**			✓	✓	
Update Signing	**Low – Moderate**					✓
Clarify Left Turn Restrictions	**Low**					✓
Delineate Parking	**Low**				✓	✓

6 HIGHWAY SAFETY MANUAL ANALYSIS

The Highway Safety Manual (HSM) introduces a science-based technical approach to incorporating safety into traditional roadway planning and safety analyses. The first edition of the HSM (2010) provides the best factual information and tools in a useful form to facilitate roadway planning, design, operations, and maintenance decisions based on precise consideration of their safety consequences. The primary focus of the HSM is the introduction and development of analytical tools for predicting the impact of transportation project and program decisions on road safety.

For this analysis, the HSM Analysis spreadsheet provided and maintained by MDOT was utilized, which allows the predicted number of crashes to be proportionally increased or decreased based on conditions in Michigan. The Urban/Suburban Intersection model was used for this analysis. Crash Modification Factors (CMF) were applied as necessary for the base conditions and proposed alternatives. The current version of the HSM methodology does not include Safety Performance Functions (SPFs) applicable to Gratiot Ave's current geometry. As such, the Urban / Suburban model was not utilized for the segments and a simpler examination of CMF's for the various applicable segment recommendations is provided.

Additionally, the current iteration of the HSM is not conducive to targeting the impacts of recommendations on specific crash types. As such, the HSM does not currently lend itself well to investigating non-motorized crashes specifically.

6.1 BASE CONDITIONS

An HSM analysis was completed by the audit team along the length of the corridor to evaluate existing conditions. Some basic information is provided here to serve as a summary of inputs.

6.1.1 URBAN / SUBURBAN SEGMENTS

As mentioned previously, the current HSM does not provide SPFs applicable to the majority of segments along Gratiot Ave. While an HSM analysis of the study area segments was not feasible, the following provides some of the more common traits and characteristics identified for these segments which would be impacted by the segment based recommendations

Cross-Section	3 Travel Lanes in Each Direction / Center Two Way Left Turn Lane / Parking Lane
Lane Width	11' travel lanes / 9' Two Way Left Turn Lane / 20' outer travel + parking lane
Shoulder Width	Not Present
Median	Not Present
On-Street Parking	Present
Segment Lighting	Present
Bike Lane	Not Present

6.1.2 URBAN / SUBURBAN INTERSECTIONS

Intersections falling under this analysis category are located along Gratiot Ave and include all signalized locations within the study area. The following provides some of the more common traits and characteristics identified at these intersections. This provide a summary of "typical" characteristics. Individual intersection characteristics will vary.

Intersection Type	4-Leg Signal Controlled
Major / Minor Road Approaches	Two-Way
Major Approach Lanes (Both Directions)	6 Lanes
Minor Approach Lanes (Both Directions)	2 Lanes
Major Road Median	Not Present
Major Approach Left Turn Lane	Present
Right Turn on Red	Permitted
Intersection Lighting	Present

6.2 POTENTIAL IMPACTS OF TREATMENTS

Due to existing limitations in the HSM methodology and the recommendations identified to address concerns in the study area, not all suggested treatments could be evaluated. There are countermeasures proven to address the identified safety concerns, however crash modification factors applicable to the HSM methodology for these treatments do not currently exist. Where possible, these have been evaluated at a simplified level to provide some indication of potential crash reductions.

Some example treatments were evaluated for segments along the corridor, these included a reduction in the number of access points, the addition of a painted bike lane, and the installation of median pedestrian crossing refuges. Their approximate areas are illustrated in Figure 36.

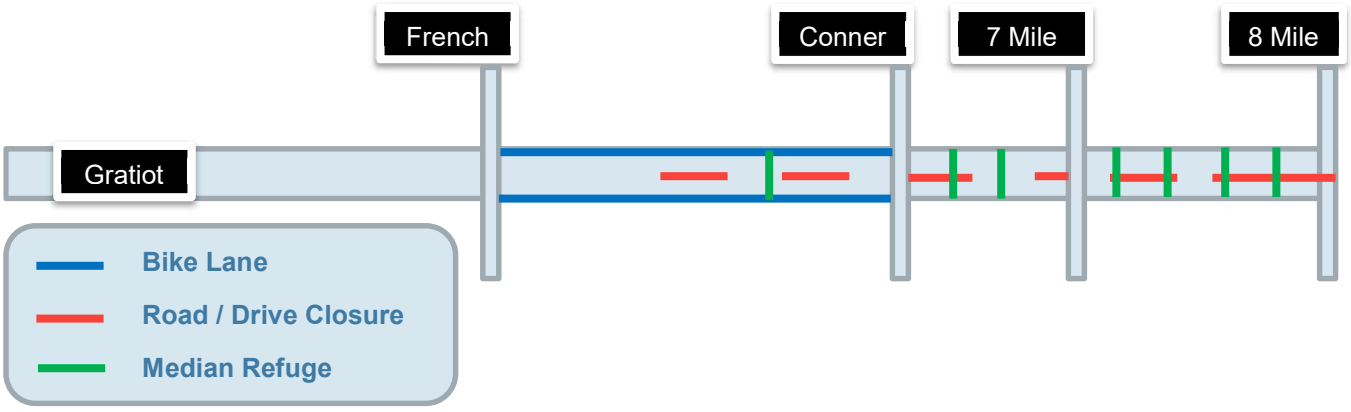


Figure 36 - Example Treatments (Not to Scale)

Based on high level cost estimates, each of the following treatments resulted in a benefit-cost ratio greater than 1.0. Given the high level, approximate nature of these estimates, any potential projects should be assessed using all appropriate MDOT and other regulatory guidelines before programming and implementation to confirm and correct this information. Table 5 provide a high-level summary of the treatments illustrated in Figure 36.

Table 5 - Example Treatment Benefit-Cost Ratios

Treatment	Impacted Crashes		Expected Reduction in Crashes					Benefit[6]	Cost	Ratio
	Severity	Type	K	A	B	C	O			
Bike Lanes[7]	A, B, C	Bicycle Involved	-	1	1	1	-	$100,500	$77,000	1.3
Road / Drive Closures[8]	A, B, C	All	-	2	9	26	-	$1,051,100	$94,500	11.1
Median Refuge Crossing[9]	All	All	2	2	5	15	72	$4,865,500	$210,000	23.2

The corridor's signalized intersections were modeled in the MDOT HSM spreadsheet. Given current limitations, few treatments were applicable to the HSM methodology. As such, the example treatment selected for this exercise is the closure of driveways / roads in the functional area of an intersection. This treatment was applied at the following intersections with Gratiot Avenue:

- Forest Ave;
- Van Dyke (M-53);
- Harper Ave;
- Conner St; and,
- Seven Mile Rd.

As mentioned previously, any implementation of this or any other recommendation should be preceded by a detailed analysis of applicable locations and performance indicators. Based on the HSM results for both the existing and proposed treatment areas, this recommendation could potentially result in a reduction in expected crashes of approximately 1.5 crashes per year as summarized in Table 6.

Table 6 - Comparison of HSM Highest Expected Average Crashes for Example Intersections

Intersection	Major AADT / Minor AADT	Average Crashes	
		Existing	w/Treatment
Gratiot (M-3) @ Conner	37,300 / 14,450	15.36	14.86
Gratiot (M-3) @ 7 Mile Rd	24,850 / 18,250	10.16	9.78
Gratiot (M-3) @ French	35,200 / 5,350	8.25	8.25
Gratiot (M-3) @ Harper	30,250 / 6,850	6.96	6.66
Gratiot (M-3) @ Van Dyke	23,300 / 9,150	6.17	5.88
Total		46.9	45.43

[6] Based on 2017 National Safety Council Crash Cost Estimates (https://injuryfacts.nsc.org/all-injuries/costs/guide-to-calculating-costs/data-details/)

[7] http://www.cmfclearinghouse.org/detail.cfm?facid=4102

[8] http://www.cmfclearinghouse.org/detail.cfm?facid=177

[9] http://www.cmfclearinghouse.org/detail.cfm?facid=8800

7 SUMMARY

The Michigan Department of Transportation retained WSP to facilitate an Operational & Planning stage Road Safety Audit (RSA) along the Gratiot (M-3) corridor between I-375 and Eight Mile Road (M-102). This RSA study area encompassed two planned projects along the corridor including the reconstruction of the I-375 at Gratiot Avenue Connector and the I-94 interchange with Gratiot Avenue. The RSA was initiated primarily to review concerns associated with the significant number of pedestrian and bicyclist involved fatalities, but considered all modes of travel. The audit team was engaged to review the corridor, major intersections and proposed plans within the two project areas to help identify opportunities to improve safety.

Gratiot Avenue is an urban principal arterial and serves as a major route heading to the northeast from downtown Detroit. Gratiot Avenue is often used as a detour route (official and unofficial) when I-94 is closed or experiences heavy congestion. Additionally, the corridor services a significant pedestrian, bicycle, and transit ridership population resulting in a frequent mix of road user types. The frontage along the roadway is primarily commercial in nature with residential neighborhoods of varying density in the immediate vicinity. Some high-level observations made during the field review included:

- Significant pedestrian and bicyclist involved crashes
- Significant pavement width along Gratiot Avenue (7 lanes across plus parking)
- Speeding
- Distance between signalized crossings
- Roadway lighting present
- Sidewalk lighting intermittent

Crash data from 2013 through 2017 for the study area was obtained from Michigan Traffic Crash Facts and reviewed to identify any historic trends. During this period, more than forty fatalities were reported, of which more than half involved a pedestrian or bicyclist. Some safety concerns raised during discussions with stakeholders and identified by the audit team included:

- Pedestrian or bicyclist involved crashes
- Strikes from vehicles departing the roadway
- Speeding vehicles
- Condition or availability of pedestrian facilities contributing to crashes

Based on the review of available crash and traffic volumes data, day and night field observations, and discussions with local stakeholders, the following safety concerns and suggestions were identified, covering a range of cost and implementation timeframes.

#	Safety Concern	Risk Rating	Suggestions
1	Pedestrian Facilities	F	— Median Refuge Crossing Locations — Curb Bump-Outs — High Visibility Crosswalks — Bike Lanes — Extend Curb Line into Road — Sidewalk Lighting — Relocate Bus Shelters — Winter Sidewalk Maintenance
2	Non-Motorized Compliance	F	— Median Refuge Crossing Locations — Pedestrian Countdown Timers — Update Pedestrian Clearance Intervals — Always Run Pedestrian Phase — Non-Motorized Education Campaign
3	Intersection Operations & Geometrics	D / E	— Consolidate Access Points — Standardize Unique Intersection Configurations — Review Channelized Right Turns
4	Roadway Geometrics	D	— Consider Alternate Cross Sections — Extend I-94 Lane Shift Transition — Access Management — Drainage Inspection & Maintenance
5	Signs	B	— Update Signing — Clarify Left Turn Restrictions — Delineate Parking

This was supported through a preliminary Highway Safety Manual analysis conducted using the Michigan Department of Transportation maintained spreadsheet tool. This analysis only included reduction estimates for treatment recommendations with crash modification factors available and applicable to the HSM methodology. Other treatments are still expected to have a positive impact on crashes along the study corridor and provide safety benefits to the general area. Due to limits in the availability of safety performance functions, only applicable intersection related treatments were evaluated with the example slate of treatments showing a predicted reduction of 1.5 crashes per year for the example locations.

The recommended treatments have been shown to provide safety benefits and contribute to improved compliance and behavior. These countermeasures should be considered for incorporation into future projects as feasible and appropriate. Coordination amongst the many vested stakeholders along the corridor provides an opportunity to work together toward improving safety for all users along Gratiot Avenue.

APPENDIX

A MEETING ATTENDANCE

KICK-OFF MEETING ATTENDANCE – NOVEMBER 26TH, 2018

Gratiot (M-3) Non-Motorized Safety Audit – Kick-off Meeting

Feb. 12th, 2019
9:00AM

Name	Organization
Lauren Watson	WSP
Joyce Tessin	WSP
Patrick Eldridge	WSP
Caitlin Mercan	COD-DPW
Erika Linenfelser	COD - PDD
Gustavo Seccatos	CoD - DPW
Ken Kucel	" - Mayors' office
Jenya Abramovich	SEMCOG
Carissa McQuiston	MDOT Safety
MA SILVER	MDOT
KEITH HUTCHINGS	MPO
Nathan Schilling	MDOT GRTSC
Jason Boelell	MDOT STOC
Alex Hill	Detroit Health Dept.
Duc Duong	COD - TED
Chisara Brown	COD PDD

+ Plus 1/2

APPENDIX

PRELIMINARY FINDINGS MEETING ATTENDANCE – NOVEMBER 29TH, 2018

Gratiot (M-3) Non-Motorized Safety Audit – Preliminary Findings

Feb. 14th, 2019
1:00PM

Name	Organization
Lauren Warren	WSP
Sonya Tessin	WSP
Patrick Eldridge	WSP
Nathen Schilling	MDOT GRTSC
JOSH CAREY	MDOT
Ken Kucel	Detroit
KEVIN HOBSON	SMART
BONNIE YU	MDOT DETROIT TSC
James Canty	Municipal Parking
Dayo Akinyemi	City of Detroit DPW
Duc Duong	COD - DPW/TED
Caitlin Murton	COD-DPW
Gustavo Serratos	COD - DPW
HEIDI SPANGLER	MDOT - SAFETY
Carissa McQuiston	MDOT - Safety
Jenya Abramovich	SEMCOG
Alex Hill	Detroit Health Dept.
ROSEMARY EDWARDS	MDOT - T&S - GEOMETRICS
Jason Bodell	MDOT - ITS - STOC

B HIGHWAY SAFETY MANUAL ANALYSIS

B-1 INPUT VALUES

Table 7 - Existing Urban & Suburban Intersection Conditions

	Intersection Information																			Observed Crash Frequency $N_{observed}$ (crashes/year)					
#	Major Roadway	Minor Roadway	Intersection Type	Major Road Flow Type	Minor Road Flow Type	Major AADT	Minor AADT	Major Road Median Presence	Minor Road Median Presence	Total Major Road Through Lanes (Both Directions)	Total Minor Road Through Lanes (Both Directions)	Major Road Speed Limit	Right Turn on Red Status	Lighting Presence	Major Street Left Turn Lane on all approaches	Additional CMF - 1	Additional CMF - 2	Additional CMF - 3	Additional CMF - Numeric	Multiple-Vehicle F-I Observed Crashes	Single-Vehicle F-I Observed Crashes	Multiple-Vehicle PDO Observed Crashes	Single-Vehicle PDO Observed Crashes	*Total Expected Crashes (crashes/year)*	Excess Expected Crashes (crashes/year) Nobserved - Nexpected
1	Gratiot (M-3)	Antietam	3SG	Two-Way	Two-Way	16,800	4,500	Present	Present	6	2	30	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.000	0.200	1.400	0.200	1.154	0.646
2	Gratiot (M-3)	Russell	4SG	Two-Way	Two-Way	17,700	8,500	Present	Not Present	6	2	30	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.800	0.000	3.400	0.400	3.009	1.591
3	Gratiot (M-3)	Jay	4SG	Two-Way	Two-Way	22,900	1,100	Present	Not Present	6	2	30	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.400	1.600	0.000	1.890	0.310
4	Gratiot (M-3)	I-75 On-Ramp	3SG	Two-Way	Two-Way	26,200	16,300	Present	Present	6	6	30	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.200	1.400	0.000	2.125	-0.325
5	Gratiot (M-3)	Adelaide / Vernor Hwy	4SG	Two-Way	Two-Way	35,400	8,500	Present	Not Present	6	2	30	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.200	6.000	0.000	5.873	1.327
6	Gratiot (M-3)	St Aubin	4SG	Two-Way	Two-Way	28,200	3,700	Not Present	Present	6	2	30	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.400	6.000	0.000	4.553	2.847
7	Gratiot (M-3)	Chene	4SG	Two-Way	Two-Way	24,300	4,750	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.400	5.800	0.400	5.679	2.321
8	Gratiot (M-3)	McDougall	4SG	Two-Way	Two-Way	21,050	1,100	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.600	0.200	1.200	0.200	2.418	-0.218
9	Gratiot (M-3)	Mack	4SG	Two-Way	Two-Way	21,900	7,700	Present	Not Present	6	2	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.400	4.600	0.400	4.187	2.613
10	Gratiot (M-3)	Mt Elliott	4SG	Two-Way	Two-Way	23,350	6,100	Not Present	Not Present	6	4	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	2.800	0.600	4.600	0.000	5.627	2.373
11	Gratiot (M-3)	Forest	4SG	Two-Way	One-Way	24,800	3,800	Present	Not Present	6	2	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.000	4.800	0.000	3.915	2.285
12	Gratiot (M-3)	Grand Blvd	4SG	Two-Way	Two-Way	25,800	3,200	Present	Present	6	4	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.000	1.600	0.200	2.263	0.537
13	Gratiot (M-3)	Warren	4SG	Two-Way	One-Way	24,500	4,100	Present	Not Present	6	2	35	Prohibited	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.200	3.400	0.000	3.370	1.230
14	Gratiot (M-3)	Van Dyke	4SG	Two-Way	Two-Way	23,300	9,150	Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	3.200	1.200	8.000	0.200	6.170	6.430
15	Gratiot (M-3)	Burns	4SG	Two-Way	Two-Way	24,800	450	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.000	1.200	0.400	2.376	0.624
16	Gratiot (M-3)	McClellan	4SG	Two-Way	Two-Way	26,000	4,100	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.400	0.000	8.600	0.200	7.718	5.482
17	Gratiot (M-3)	I-94 Eastbound	3SG	Two-Way	Two-Way	36,300	11,600	Not Present	Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.000	0.200	9.400	0.200	8.360	5.440
18	Gratiot (M-3)	I-94 Westbound	3SG	Two-Way	Two-Way	34,600	11,600	Not Present	Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.200	1.600	0.000	2.856	-0.856
19	Gratiot (M-3)	Harper	4SG	Two-Way	Two-Way	30,250	6,850	Present	Not Present	6	4	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.000	0.200	7.600	0.400	6.963	5.237
20	Gratiot (M-3)	Marcus	4SG	Two-Way	Two-Way	34,300	499	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.800	0.200	2.600	1.000	3.412	1.188
21	Gratiot (M-3)	French	4SG	Two-Way	Two-Way	35,200	5,350	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	2.400	0.400	7.600	0.000	8.250	2.150

	Intersection Information																			Observed Crash Frequency $N_{observed}$ (crashes/year)					
#	Major Roadway	Minor Roadway	Intersection Type	Major Road Flow Type	Minor Road Flow Type	Major AADT	Minor AADT	Major Road Median Presence	Minor Road Median Presence	Total Major Road Through Lanes (Both Directions)	Total Minor Road Through Lanes (Both Directions)	Major Road Speed Limit	Right Turn on Red Status	Lighting Presence	Major Street Left Turn Lane on all approaches	Additional CMF - 1	Additional CMF - 2	Additional CMF - 3	Additional CMF - Numeric	Multiple-Vehicle F-I Observed Crashes	Single-Vehicle F-I Observed Crashes	Multiple-Vehicle PDO Observed Crashes	Single-Vehicle PDO Observed Crashes	*Total Expected Crashes (crashes/year)*	Excess Expected Crashes (crashes/year)
22	Gratiot (M-3)	Conner	4SG	Two-Way	Two-Way	37,300	14,450	Not Present	Not Present	6	4	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	8.400	0.400	13.200	0.400	15.364	7.036
23	Gratiot (M-3)	Outer Dr	4SG	Two-Way	Two-Way	36,700	6,050	Present	Present	6	4	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.800	0.200	3.600	0.200	4.164	1.636
24	Gratiot (M-3)	Gunston	3SG	Two-Way	Two-Way	29,400	8,700	Not Present	Present	6	3	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	2.400	0.800	6.000	0.200	5.326	4.074
25	Gratiot (M-3)	Findlay / Filbert	4SG	Two-Way	Two-Way	24,300	700	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.400	1.200	0.200	2.557	0.643
26	Gratiot (M-3)	Houston Whittier	3SG	Two-Way	Two-Way	24,650	4,500	Present	Not Present	6	3	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	2.200	0.400	2.200	0.200	2.754	2.246
27	Gratiot (M-3)	Hickory / Hazelridge	4SG	Two-Way	Two-Way	24,800	499	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.000	0.600	0.000	2.060	-1.260
28	Gratiot (M-3)	McNichols / Seymour	4SG	Two-Way	Two-Way	24,950	6,000	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.600	0.400	4.000	0.600	5.159	1.441
29	Gratiot (M-3)	Linnhurts	4SG	Two-Way	Two-Way	25,300	499	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.400	2.000	0.000	2.650	0.750
30	Gratiot (M-3)	7 Mile Rd	4SG	Two-Way	Two-Way	24,850	18,250	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	3.600	0.400	10.600	0.800	10.162	5.238
31	Gratiot (M-3)	Lappin	4SG	Two-Way	Two-Way	24,400	499	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.000	3.200	0.200	2.841	0.759
32	Gratiot (M-3)	State Fair	4SG	Two-Way	Two-Way	24,400	5,100	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.000	0.200	6.200	0.400	6.515	4.285
33	Gratiot (M-3)	8 Mile Rd	4SG	Two-Way	Two-Way	28,800	33,400	Present	Present	6	8	35	Prohibited	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.400	2.600	13.600	0.200	9.367	11.433

Table 8 - Treatment Urban & Suburban Intersection Conditions

	Intersection Information																			Observed Crash Frequency $N_{observed}$ (crashes/year)					
#	Major Roadway	Minor Roadway	Intersection Type	Major Road Flow Type	Minor Road Flow Type	Major AADT	Minor AADT	Major Road Median Presence	Minor Road Median Presence	Total Major Road Through Lanes (Both Directions)	Total Minor Road Through Lanes (Both Directions)	Major Road Speed Limit	Right Turn on Red Status	Lighting Presence	Major Street Left Turn Lane on all approaches	Additional CMF - 1	Additional CMF - 2	Additional CMF - 3	Additional CMF - Numeric	Multiple-Vehicle F-I Observed	Single-Vehicle F-I Observed Crashes	Multiple-Vehicle PDO Observed	Single-Vehicle PDO Observed	*Total Expected Crashes (crashes/year)*	Excess Expected Crashes (crashes/year) Nobserved - Nexpected
1	Gratiot (M-3)	Antietam	3SG	Two-Way	Two-Way	16,800	4,500	Present	Present	6	2	30	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.000	0.200	1.400	0.200	1.154	0.646
2	Gratiot (M-3)	Russell	4SG	Two-Way	Two-Way	17,700	8,500	Present	Not Present	6	2	30	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.800	0.000	3.400	0.400	3.009	1.591
3	Gratiot (M-3)	Jay	4SG	Two-Way	Two-Way	22,900	1,100	Present	Not Present	6	2	30	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.400	1.600	0.000	1.890	0.310
4	Gratiot (M-3)	I-75 On-Ramp	3SG	Two-Way	Two-Way	26,200	16,300	Present	Present	6	6	30	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.200	1.400	0.000	2.125	-0.325
5	Gratiot (M-3)	Adelaide / Vernor Hwy	4SG	Two-Way	Two-Way	35,400	8,500	Present	Not Present	6	2	30	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.200	6.000	0.000	5.873	1.327
6	Gratiot (M-3)	St Aubin	4SG	Two-Way	Two-Way	28,200	3,700	Not Present	Present	6	2	30	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.400	6.000	0.000	4.553	2.847
7	Gratiot (M-3)	Chene	4SG	Two-Way	Two-Way	24,300	4,750	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.400	5.800	0.400	5.679	2.321
8	Gratiot (M-3)	McDougall	4SG	Two-Way	Two-Way	21,050	1,100	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.600	0.200	1.200	0.200	2.418	-0.218
9	Gratiot (M-3)	Mack	4SG	Two-Way	Two-Way	21,900	7,700	Present	Not Present	6	2	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.400	4.600	0.400	4.187	2.613
10	Gratiot (M-3)	Mt Elliott	4SG	Two-Way	Two-Way	23,350	6,100	Not Present	Not Present	6	4	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	2.800	0.600	4.600	0.000	5.627	2.373
11	Gratiot (M-3)	Forest	4SG	Two-Way	One-Way	24,800	3,800	Present	Not Present	6	2	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.000	4.800	0.000	3.725	2.475
12	Gratiot (M-3)	Grand Blvd	4SG	Two-Way	Two-Way	25,800	3,200	Present	Present	6	4	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.000	1.600	0.200	2.263	0.537
13	Gratiot (M-3)	Warren	4SG	Two-Way	One-Way	24,500	4,100	Present	Not Present	6	2	35	Prohibited	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.200	3.400	0.000	3.370	1.230
14	Gratiot (M-3)	Van Dyke	4SG	Two-Way	Two-Way	23,300	9,150	Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	3.200	1.200	8.000	0.200	5.883	6.717
15	Gratiot (M-3)	Burns	4SG	Two-Way	Two-Way	24,800	450	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.000	1.200	0.400	2.376	0.624
16	Gratiot (M-3)	McClellan	4SG	Two-Way	Two-Way	26,000	4,100	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.400	0.000	8.600	0.200	7.718	5.482
17	Gratiot (M-3)	I-94 Eastbound	3SG	Two-Way	Two-Way	36,300	11,600	Not Present	Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.000	0.200	9.400	0.200	8.360	5.440
18	Gratiot (M-3)	I-94 Westbound	3SG	Two-Way	Two-Way	34,600	11,600	Not Present	Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.200	1.600	0.000	2.856	-0.856
19	Gratiot (M-3)	Harper	4SG	Two-Way	Two-Way	30,250	6,850	Present	Not Present	6	4	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.000	0.200	7.600	0.400	6.657	5.543
20	Gratiot (M-3)	Marcus	4SG	Two-Way	Two-Way	34,300	499	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.800	0.200	2.600	1.000	3.412	1.188
21	Gratiot (M-3)	French	4SG	Two-Way	Two-Way	35,200	5,350	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	2.400	0.400	7.600	0.000	8.250	2.150
22	Gratiot (M-3)	Conner	4SG	Two-Way	Two-Way	37,300	14,450	Not Present	Not Present	6	4	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	8.400	0.400	13.200	0.400	14.863	7.537
23	Gratiot (M-3)	Outer Dr	4SG	Two-Way	Two-Way	36,700	6,050	Present	Present	6	4	35	Permitted	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.800	0.200	3.600	0.200	4.164	1.636
24	Gratiot (M-3)	Gunston	3SG	Two-Way	Two-Way	29,400	8,700	Not Present	Present	6	3	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	2.400	0.800	6.000	0.200	5.326	4.074
25	Gratiot (M-3)	Findlay / Filbert	4SG	Two-Way	Two-Way	24,300	700	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.400	0.400	1.200	0.200	2.557	0.643

	Intersection Information																			Observed Crash Frequency $N_{observed}$ (crashes/year)					
#	Major Roadway	Minor Roadway	Intersection Type	Major Road Flow Type	Minor Road Flow Type	Major AADT	Minor AADT	Major Road Median Presence	Minor Road Median Presence	Total Major Road Through Lanes (Both Directions)	Total Minor Road Through Lanes (Both Directions)	Major Road Speed Limit	Right Turn on Red Status	Lighting Presence	Major Street Left Turn Lane on all approaches	Additional CMF - 1	Additional CMF - 2	Additional CMF - 3	Additional CMF - Numeric	Multiple-Vehicle F-I Observed	Single-Vehicle F-I Observed Crashes	Multiple-Vehicle PDO Observed	Single-Vehicle PDO Observed	*Total Expected Crashes (crashes/year)*	Excess Expected Crashes (crashes/year)
26	Gratiot (M-3)	Houston Whittier	3SG	Two-Way	Two-Way	24,650	4,500	Present	Not Present	6	3	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	2.200	0.400	2.200	0.200	2.754	2.246
27	Gratiot (M-3)	Hickory / Hazelridge	4SG	Two-Way	Two-Way	24,800	499	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.000	0.600	0.000	2.060	-1.260
28	Gratiot (M-3)	McNichols / Seymour	4SG	Two-Way	Two-Way	24,950	6,000	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.600	0.400	4.000	0.600	5.159	1.441
29	Gratiot (M-3)	Linnhurts	4SG	Two-Way	Two-Way	25,300	499	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	1.000	0.400	2.000	0.000	2.650	0.750
30	Gratiot (M-3)	7 Mile Rd	4SG	Two-Way	Two-Way	24,850	18,250	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	3.600	0.400	10.600	0.800	9.783	5.617
31	Gratiot (M-3)	Lappin	4SG	Two-Way	Two-Way	24,400	499	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	0.200	0.000	3.200	0.200	2.841	0.759
32	Gratiot (M-3)	State Fair	4SG	Two-Way	Two-Way	24,400	5,100	Not Present	Not Present	6	2	35	Permitted	Present	Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.000	0.200	6.200	0.400	6.515	4.285
33	Gratiot (M-3)	8 Mile Rd	4SG	Two-Way	Two-Way	28,800	33,400	Present	Present	6	8	35	Prohibited	Present	Not Present	N/A (1.000)	N/A (1.000)	N/A (1.000)	1.000	4.400	2.600	13.600	0.200	9.367	11.433

B-2 ANALYSIS RESULTS

Table 9 - Existing Urban & Suburban Intersection Results

#	Major Roadway	Minor Roadway	Excess Expected Crashes (crashes/year) Nobserved - Nexpected	Predicted All Crash types and severities	Predicted All Crash types F-I	Predicted All Crash types PDO
1	Gratiot (M-3)	Antietam	0.646	1.021	0.244	0.777
2	Gratiot (M-3)	Russell	1.591	2.527	0.651	1.876
3	Gratiot (M-3)	Jay	0.310	1.889	0.519	1.370
4	Gratiot (M-3)	I-75 On-Ramp	-0.325	2.373	0.520	1.853
5	Gratiot (M-3)	Adelaide / Vernor Hwy	1.327	4.828	1.174	3.654
6	Gratiot (M-3)	St Aubin	2.847	3.211	0.824	2.387
7	Gratiot (M-3)	Chene	2.321	4.548	1.170	3.378
8	Gratiot (M-3)	McDougall	-0.218	2.713	0.750	1.963
9	Gratiot (M-3)	Mack	2.613	3.308	0.841	2.467
10	Gratiot (M-3)	Mt Elliott	2.373	4.812	1.229	3.583
11	Gratiot (M-3)	Forest	2.285	2.928	0.732	2.195
12	Gratiot (M-3)	Grand Blvd	0.537	2.256	0.587	1.669
13	Gratiot (M-3)	Warren	1.230	2.924	0.731	2.193
14	Gratiot (M-3)	Van Dyke	6.430	3.659	0.919	2.740
15	Gratiot (M-3)	Burns	0.624	2.477	0.700	1.776
16	Gratiot (M-3)	McClellan	5.482	4.661	1.199	3.462
17	Gratiot (M-3)	I-94 Eastbound	5.440	3.891	0.840	3.051
18	Gratiot (M-3)	I-94 Westbound	-0.856	3.722	0.806	2.915
19	Gratiot (M-3)	Harper	5.237	4.456	1.108	3.348
20	Gratiot (M-3)	Marcus	1.188	3.422	0.937	2.485
21	Gratiot (M-3)	French	2.150	6.612	1.640	4.972
22	Gratiot (M-3)	Conner	7.036	9.355	2.215	7.140
23	Gratiot (M-3)	Outer Dr	1.636	3.706	0.911	2.795
24	Gratiot (M-3)	Gunston	4.074	3.070	0.682	2.388
25	Gratiot (M-3)	Findlay / Filbert	0.643	2.739	0.762	1.977
26	Gratiot (M-3)	Houston Whittier	2.246	2.230	0.516	1.714
27	Gratiot (M-3)	Hickory / Hazelridge	-1.260	2.547	0.717	1.830
28	Gratiot (M-3)	McNichols / Seymour	1.441	4.948	1.257	3.690
29	Gratiot (M-3)	Linnhurts	0.750	2.593	0.729	1.865
30	Gratiot (M-3)	7 Mile Rd	5.238	6.495	1.576	4.919
31	Gratiot (M-3)	Lappin	0.759	2.509	0.707	1.802
32	Gratiot (M-3)	State Fair	4.285	4.649	1.192	3.457
33	Gratiot (M-3)	8 Mile Rd	11.433	4.158	0.971	3.187

Table 10 - Treatment Urban & Suburban Intersection Results.

#	Major Roadway	Minor Roadway	Excess Expected Crashes (crashes/year) Nobserved - Nexpected	Predicted All Crash types and severities	Predicted All Crash types F-I	Predicted All Crash types PDO
1	Gratiot (M-3)	Antietam	0.646	1.021	0.244	0.777
2	Gratiot (M-3)	Russell	1.591	2.527	0.651	1.876
3	Gratiot (M-3)	Jay	0.310	1.889	0.519	1.370
4	Gratiot (M-3)	I-75 On-Ramp	-0.325	2.373	0.520	1.853
5	Gratiot (M-3)	Adelaide / Vernor Hwy	1.327	4.828	1.174	3.654
6	Gratiot (M-3)	St Aubin	2.847	3.211	0.824	2.387
7	Gratiot (M-3)	Chene	2.321	4.548	1.170	3.378
8	Gratiot (M-3)	McDougall	-0.218	2.713	0.750	1.963
9	Gratiot (M-3)	Mack	2.613	3.308	0.841	2.467
10	Gratiot (M-3)	Mt Elliott	2.373	4.812	1.229	3.583
11	Gratiot (M-3)	Forest	2.475	2.723	0.681	2.042
12	Gratiot (M-3)	Grand Blvd	0.537	2.256	0.587	1.669
13	Gratiot (M-3)	Warren	1.230	2.924	0.731	2.193
14	Gratiot (M-3)	Van Dyke	6.717	3.403	0.855	2.548
15	Gratiot (M-3)	Burns	0.624	2.477	0.700	1.776
16	Gratiot (M-3)	McClellan	5.482	4.661	1.199	3.462
17	Gratiot (M-3)	I-94 Eastbound	5.440	3.891	0.840	3.051
18	Gratiot (M-3)	I-94 Westbound	-0.856	3.722	0.806	2.915
19	Gratiot (M-3)	Harper	5.543	4.144	1.031	3.114
20	Gratiot (M-3)	Marcus	1.188	3.422	0.937	2.485
21	Gratiot (M-3)	French	2.150	6.612	1.640	4.972
22	Gratiot (M-3)	Conner	7.537	8.700	2.060	6.641
23	Gratiot (M-3)	Outer Dr	1.636	3.706	0.911	2.795
24	Gratiot (M-3)	Gunston	4.074	3.070	0.682	2.388
25	Gratiot (M-3)	Findlay / Filbert	0.643	2.739	0.762	1.977
26	Gratiot (M-3)	Houston Whittier	2.246	2.230	0.516	1.714
27	Gratiot (M-3)	Hickory / Hazelridge	-1.260	2.547	0.717	1.830
28	Gratiot (M-3)	McNichols / Seymour	1.441	4.948	1.257	3.690
29	Gratiot (M-3)	Linnhurts	0.750	2.593	0.729	1.865
30	Gratiot (M-3)	7 Mile Rd	5.617	6.040	1.466	4.575
31	Gratiot (M-3)	Lappin	0.759	2.509	0.707	1.802
32	Gratiot (M-3)	State Fair	4.285	4.649	1.192	3.457
33	Gratiot (M-3)	8 Mile Rd	11.433	4.158	0.971	3.187