

MDOT Road Safety Audit: Hamilton and Huron St (US-12-BR) from Interstate 94 to Cross St (M-17)

MDOT

November 14 2018
Ypsilanti, MI

Table of contents

Chapter	Pages
1. Introduction	5
1.1. Background	5
1.2. RSA Framework	6
1.3. RSA Details	7
2. Study Corridor Background	8
2.1. Site Description	8
2.2. Corridor Traffic Volumes	10
2.3. RITIS Speed Data	11
2.4. International Road Assessment Program (iRAP) Analysis	13
3. Existing Safety Features	16
4. Historical Crash Analysis	17
4.1. Empirical Bayes Method Evaluation	22
5. Safety Issues and Suggestions	25
5.1. Cross Street from Huron Street to Hamilton Street	26
5.2. Cross Street from Hamilton Street to Washtenaw Avenue	27
5.3. Washtenaw Avenue from Cross Street to Hamilton Street	30
5.4. Hamilton Street from Washtenaw Avenue to Michigan Avenue	35
5.5. Hamilton Street from Michigan Avenue to Harriet Street	37
5.6. Huron Street from Harriet Street to Michigan Avenue	40
5.7. Huron Street from Michigan Avenue to Cross Street	43
5.8. General Observations	45
Appendices	46
Appendix A. RITIS Segment Data	48
A.1. January through April	48
A.2. May through August	49
Appendix B. Crash Data	51
Appendix C. EB-Method Analysis – Total Crashes	53
Appendix D. Safety Issues	55
Appendix E. Suggestions	56
Appendix F. Bike Lane Transition Options	57
F.1. Option A – Install a Bike Lane Transition Ramp	57
F.2. Option B – Utilize an Existing Ramp for Transition	58
Appendix G. Corridor Volume Data	59
Appendix H. iRAP Risk Score Maps	63

Tables

Table 2-1	Average Corridor Volume, 2013-2017.....	10
Table 2-2	iRAP Data Requirements - Motor Vehicle Occupants.....	13
Table 2-3	iRAP Data Requirements - Motorcyclists	13
Table 2-4	iRAP Data Requirements - Pedestrians	14
Table 2-5	iRAP Data Requirements - Bicyclists	14
Table 2-6	iRAP Star Rating Framework	14
Table 4-1	Summary of RSA Study Area Traffic Crash Data (2013-2017)	17
Table 4-2	Summary of EB-Method Intersection Safety Analysis by Corridor (2013-2017)	22
Table 5-1	Safety Issues for Cross Street from Huron Street to Hamilton Street.....	26
Table 5-2	Suggestions for Cross Street from Huron Street to Hamilton Street.....	27
Table 5-3	Safety Issues for Cross Street from College Place to Washtenaw Avenue	29
Table 5-4	Suggestions for Cross Street from College Place to Washtenaw Avenue.....	29
Table 5-5	Safety Issues for Washtenaw Avenue from Cross Street to Hamilton Street	31
Table 5-6	Suggestions for Washtenaw Avenue from Cross Street to Hamilton Street	34
Table 5-7	Safety Issues for Hamilton Street from Washtenaw Avenue to Michigan Avenue.....	35
Table 5-8	Suggestions for Hamilton Street from Washtenaw Avenue to Michigan Avenue.....	36
Table 5-9	Safety Issues for Hamilton Street from Michigan Avenue to Harriet Street	39
Table 5-10	Suggestions for Hamilton Street from Michigan Avenue to Harriet Street	39
Table 5-11	Safety Issues for Huron Street from Harriet Street to Michigan Avenue.....	41
Table 5-12	Suggestions for Huron Street from Harriet Street to Michigan Avenue.....	42
Table 5-13	Safety Issues for Huron Street from Michigan Avenue to Cross Street	44
Table 5-14	Suggestions for Huron Street from Michigan Avenue to Cross Street.....	44

Figures

Figure 1-1	Map of RSA Study Corridor Location in Washtenaw County, Michigan	5
Figure 1-2	The 8-Step RSA Process	6
Figure 1-3	RSA Safety Risk Matrix	6
Figure 2-1	Map of Ypsilanti RSA Study Area	8
Figure 2-2	Ypsilanti RSA Area Intersection Map	9
Figure 2-3	Average Corridor Volumes, 2013-2017	10
Figure 2-4	Huron Street Average Speed by Time of Day	11
Figure 2-5	Cross Street Average Speed by Time of Day	11
Figure 2-6	Washtenaw Avenue Average Speed by Time of Day	12
Figure 2-7	Hamilton Street Average Speed by Time of Day	12
Figure 2-8	iRAP Pedestrian Scores	15
Figure 3-1	View of Bike Lane and Parking along Cross Street	16
Figure 3-2	View of Intersection Bulb-Outs on Huron Street North of Michigan Avenue	16
Figure 4-1	Fatal Crash Location Map	18
Figure 4-2	Pedestrian and Bicycle Crash Location Map	19
Figure 4-3	Fatal and Injury Crash Hot Spot Map	20
Figure 4-4	Total Crash Hot Spot Map	21
Figure 4-5	Cross Street Fatal and Injury EB-Method Analysis	23
Figure 4-6	Washtenaw Avenue Fatal and Injury EB-Method Analysis	23
Figure 4-7	Huron Street Fatal and Injury EB-Method Analysis	24
Figure 4-8	Hamilton Street Fatal and Injury EB-Method Analysis	24
Figure 5-1	Overview of RSA Analysis Sections	25
Figure 5-2	Aerial of Cross Street from Huron Street to Hamilton Street	26
Figure 5-3	Bike Lane Buffer Alternatives	27
Figure 5-4	Aerial of Cross Street from Hamilton Street to College Place	28
Figure 5-5	Aerial of Cross Street from College Place to Washtenaw Avenue	28
Figure 5-6	Cross Street and Washtenaw Avenue Proposed Re-Alignment	29

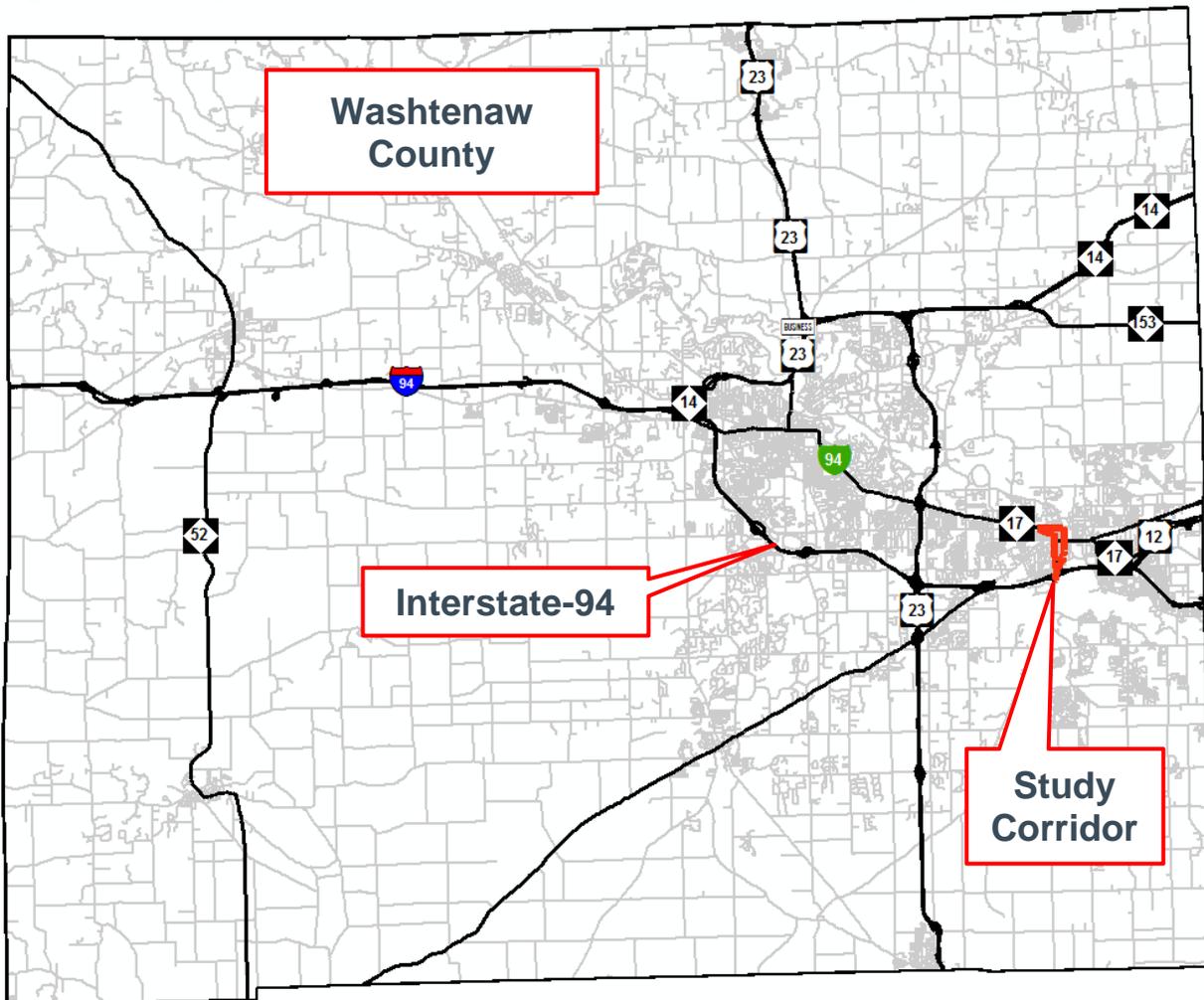
Figure 5-7	Aerial of Washtenaw Avenue from Cross Street to Perrin Street	30
Figure 5-8	Aerial of Washtenaw Avenue from Perrin Street to Hamilton Street	30
Figure 5-9	Washtenaw Avenue Road Diet and Pedestrian Crossing Enhancements	32
Figure 5-10	Driver Feedback Examples	32
Figure 5-11	Washtenaw Avenue and Hamilton Street - Long-Term Alternative #1	33
Figure 5-12	Washtenaw Avenue and Hamilton Street - Long-Term Alternative #2	33
Figure 5-13	Washtenaw Avenue and Hamilton Street - Long-Term Alternative #3	34
Figure 5-14	Aerial of Hamilton Street from	35
Figure 5-15	Turn-Path Marking Example	36
Figure 5-16	Aerial of Hamilton Street from Michigan Street	37
Figure 5-17	Aerial of Hamilton Street from Catherine Street	38
Figure 5-18	Potential Improvements near Ferris Street	39
Figure 5-19	Aerial of Huron Street from Harriet Street	40
Figure 5-20	Aerial of Huron Street from Catherine	41
Figure 5-21	Potential Improvements near Huron Street	42
Figure 5-22	AM Queuing at Michigan Avenue	42
Figure 5-23	Aerial of Huron Street from Michigan Avenue	43
Figure 5-24	Right-Turn Conflict at Michigan Avenue	44
Figure 5-25	Sight Distance and Signal Obstructions	45

1. Introduction

1.1. Background

Both, Hamilton Street and Huron Street (US-12 BR) are state trunklines arranged in a one-way pair to move traffic between Interstate-94 and downtown Ypsilanti in Washtenaw County, Michigan. Huron Street (US-12 BR) operates as one-way northbound between I-94 and M-17 The Cross Street (M-17) corridor operates as one-way westbound and services Eastern Michigan University which is located just north of the study site. Washtenaw Avenue (M-17), operates one-way eastbound, beginning at the intersection of Cross Street and Washtenaw Avenue, and continues east as M-17 until the intersection with Hamilton Street (US-12 BR). **Figure 1** below shows each corridor considered as part of this Road Safety Audit (RSA).

Figure 1-1 Map of RSA Study Corridor Location in Washtenaw County, Michigan



An RSA is a formal safety performance evaluation of an existing or future road or intersection by an independent and multidisciplinary team. RSAs provide MDOT with a proactive and innovative approach to analyze safety issues and collaboratively develop cost-effective solutions. Specifically, RSAs are targeted to identify and address safety issues related to emphasis areas, which include intersections, roadway departure, and non-motorized road users. Significant reductions in fatal and severe injury crashes can be achieved by addressing safety issues related to these emphasis areas and implementing proven safety countermeasures.

1.2. RSA Framework

This RSA was conducted using framework developed as a part of the Federal Highway Administration's (FHWA) Road Safety Audit Guidelines and associated training course. Safety issues specific to the study corridor were identified during the RSA process and a relative risk rating was provided for each. Treatments and countermeasures aimed to address these safety issues were suggested by the RSA team. Finally, a planning-level economic analysis was performed to provide additional guidance as to the potential impacts of implementing the quantifiable suggestions included in this report. **Figure 2** shows the RSA process applied as a part of this evaluation.

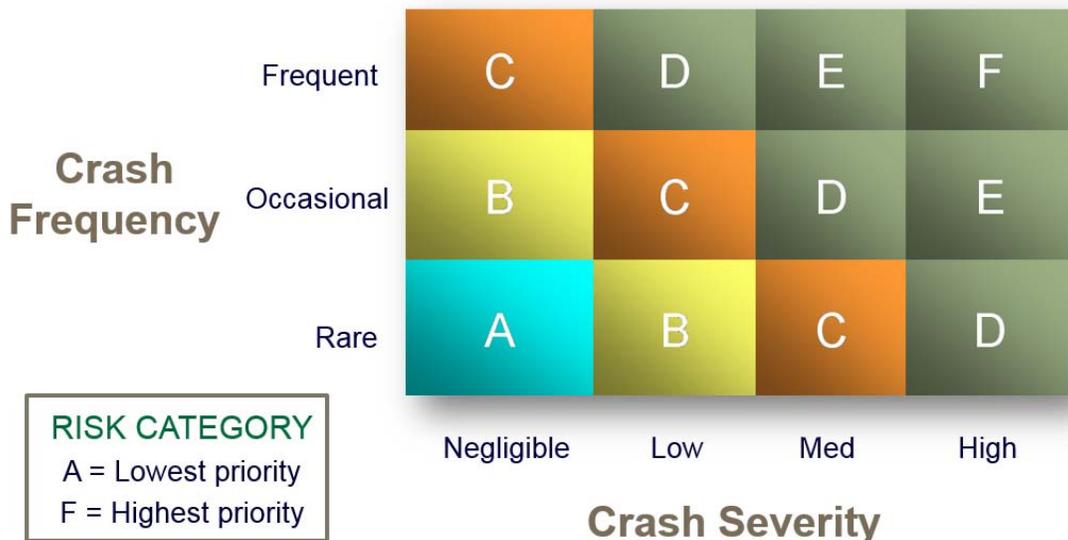
Figure 1-2 The 8-Step RSA Process



1.2.1. RSA Safety Risk Framework

Safety issues identified as a part of this evaluation were assigned a letter grade according to the *RSA Safety Risk Matrix* presented in **Figure 3 below**. These letter grades represent the relative risk and priority of the identified safety issues between **F** (highest risk and highest priority) and **A** (lowest risk and lowest priority). The letter grades included in the *RSA Safety Risk Matrix* are developed based upon the combination of the estimated crash frequency and severity associated with each safety issue.

Figure 1-3 RSA Safety Risk Matrix



1.3. RSA Details

The RSA was facilitated by the Atkins team from September 25 to 27, 2018 and relevant details are provided in **Table 1** below. The RSA included a pre-audit kick-off meeting, field reviews during peak, off-peak, and nighttime conditions, in-office evaluation, and a preliminary findings meeting. The RSA team included members from the Atkins team to facilitate the RSA, along with MDOT staff independent of the study area MDOT region.

Table 1. Road Safety Audit Details

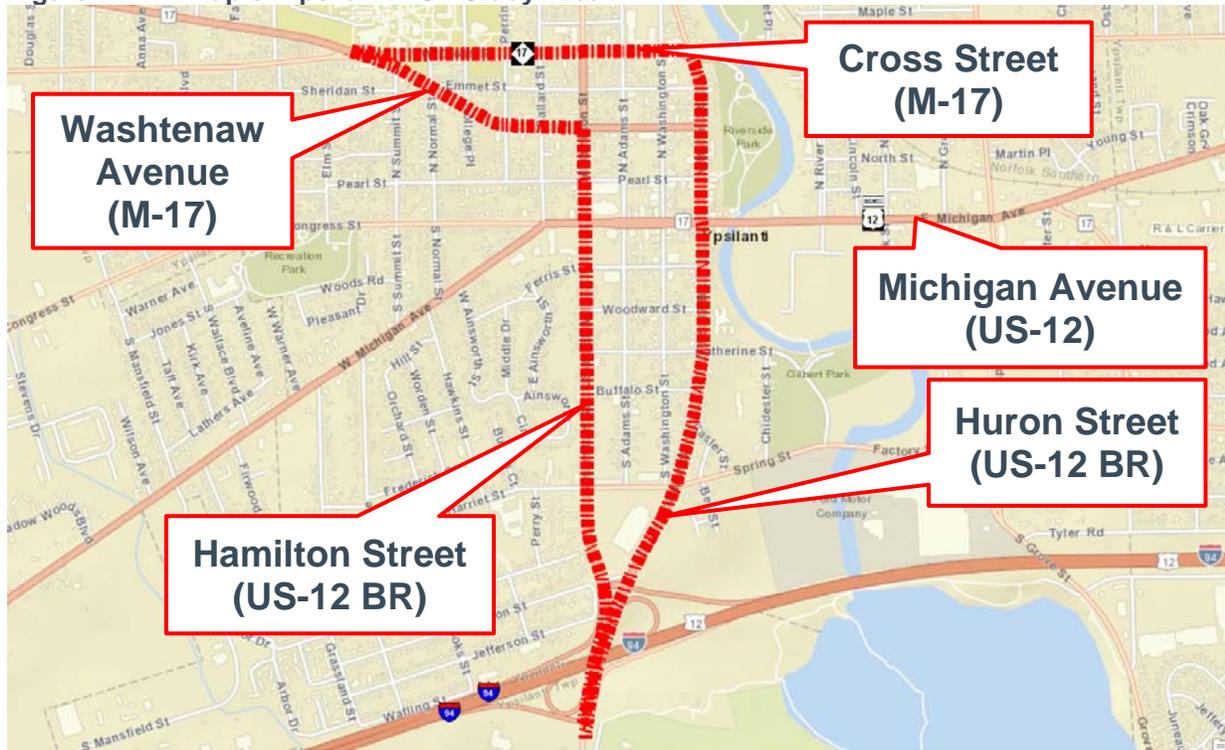
Item	Details
Project Limits	Hamilton and Huron Street (US-12-BR) from Interstate 94 to Cross Street (M-17) and Washtenaw Avenue (M-17)
Project Location	Washtenaw County, Michigan
Project Environment	Urban and Suburban Areas; including downtown Ypsilanti
Project Owner	MDOT
Date of RSA	September 25 – 27, 2018
RSA Stage	Existing Facility
RSA Team Members	The RSA team included the following members: <ul style="list-style-type: none">• Jeffrey Bagdade (Atkins) – RSA Team Lead• Adam McArthur (Atkins) – RSA Secretary• Sterling Frazier – Atkins• Nivas Dammalapati - Atkins• Jason Ealy - MDOT• Mia Silver – MDOT• Tracie Leix – MDOT

2. Study Corridor Background

2.1. Site Description

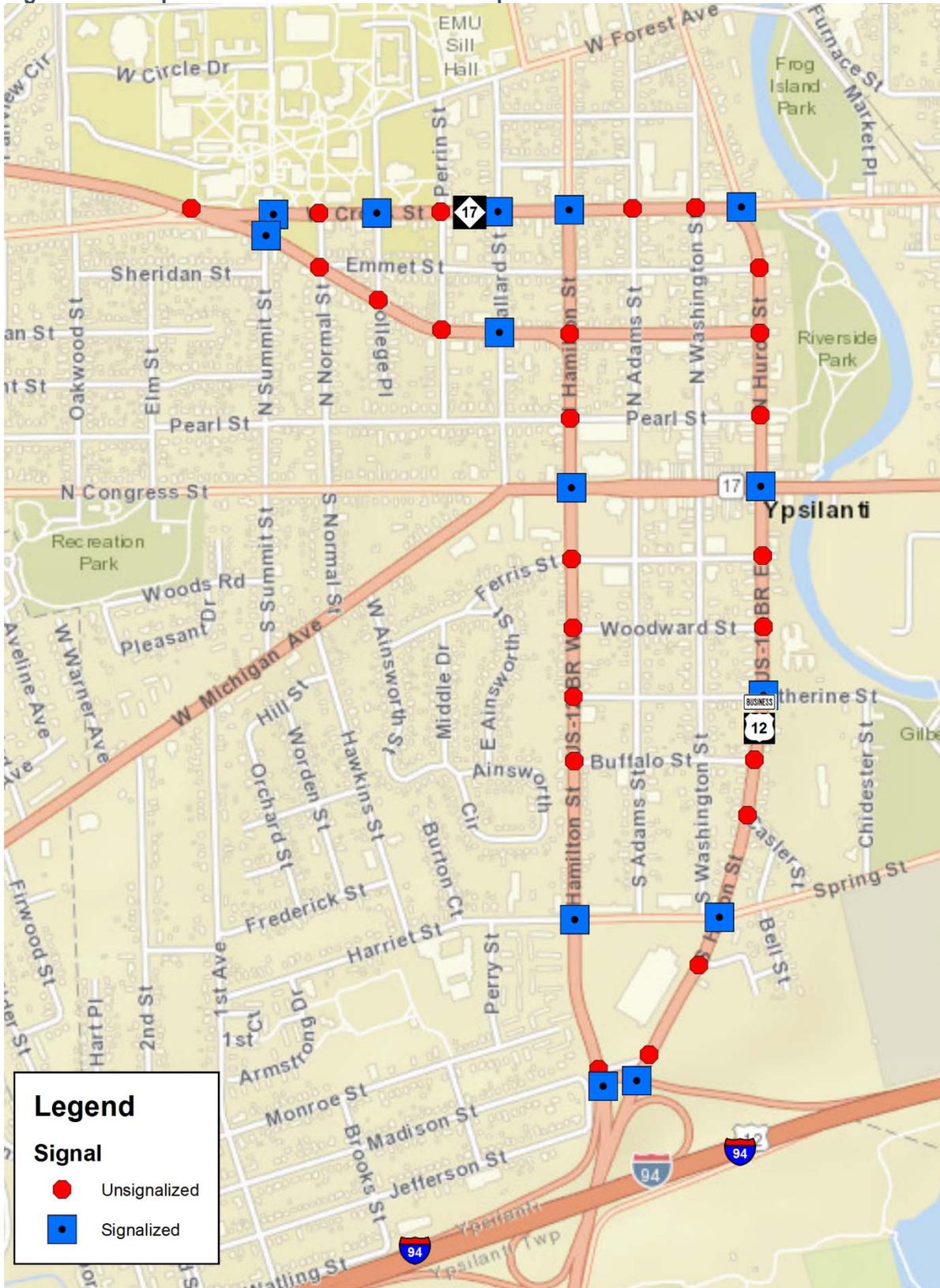
They RSA study area consists of four corridors servicing the vicinity between Interstate-94 and downtown Ypsilanti, spanning approximately 5 miles in length as shown in **Figure 2-1** below. Eastern Michigan University is located just north of Cross Street (M-17), where students use Huron Street and Hamilton Street (US-12 BR) as primarily access to and from Interstate-94. Michigan Avenue (US-12) bisects Hamilton and Huron Street south of the University area and is indicated on the map below. For reference, the intersections with Michigan Avenue were considered as part of this study, while the corridor of Michigan Avenue was not.

Figure 2-1 Map of Ypsilanti RSA Study Area



The study area incorporates 38 intersections, including 14 using signal control as shown in **Figure 2-2**. Major intersections located in the study area include: Huron Street at Michigan Avenue, Hamilton Street at Michigan Avenue, Washtenaw Avenue at Cross Street, Huron Street at Harriet Street, and Hamilton Street at Harriet Street.

Figure 2-2 Ypsilanti RSA Area Intersection Map



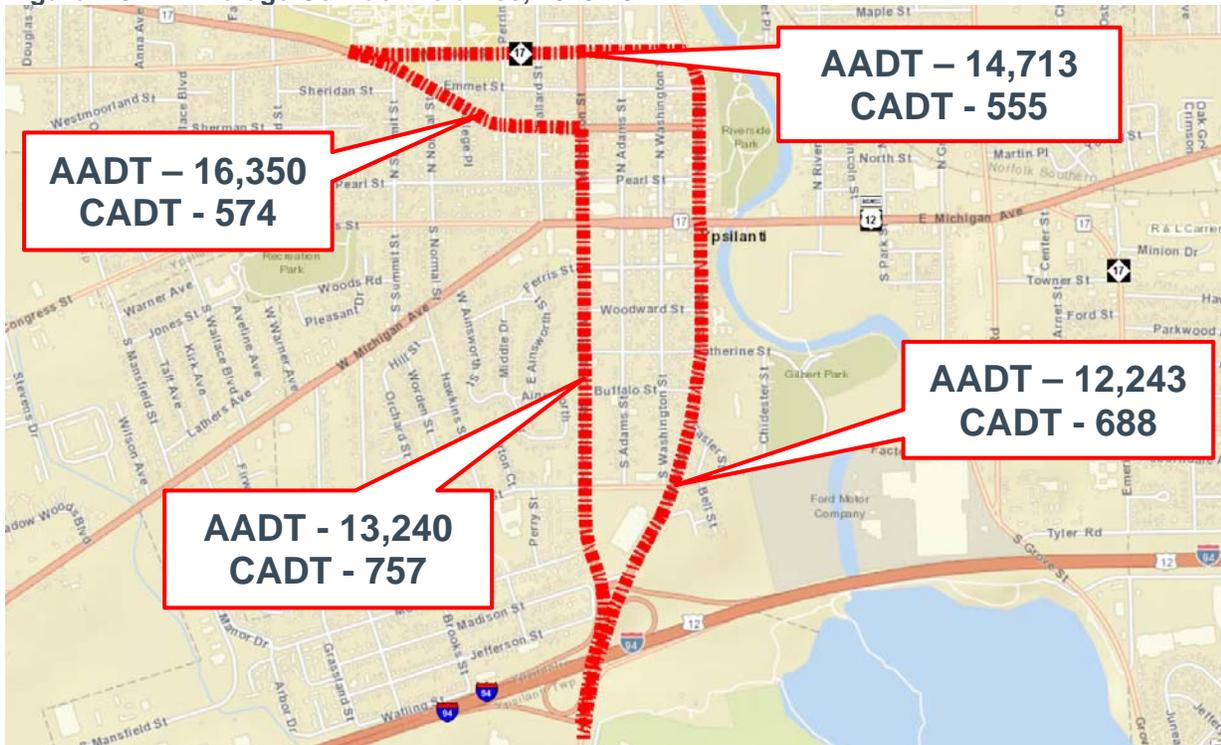
2.2. Corridor Traffic Volumes

Historical annual average daily traffic (AADT) volumes from 2013 to 2017 were collected from the annual MDOT shapefiles specific to each corridor. **Appendix G** provides an average year AADT calculated based on the data collected for each corridor, along with commercial annual average daily traffic (CADT) values as well. **Table 2-1** below provides a summary of the average volumes for each corridor.

Table 2-1 Average Corridor Volume, 2013-2017

Corridor	AADT	CADT
Cross Street	14,713	555
Washtenaw Avenue	16,350	574
Hamilton Street	13,240	757
Huron Street	12,243	688

Figure 2-3 Average Corridor Volumes, 2013-2017



2.3. RITIS Speed Data

The Regional Integrated Transportation Information System (RITIS) *Probe Data Analytics Suite* which is an online based tool utilized by MDOT provides real-time and average speed data using INRIX probe data. For analysis, data was obtained from January to August 2018 and aggregated separately for each corridor: Huron Street, Cross Street, Washtenaw Avenue and Hamilton Street. Two separate periods of time were assessed to determine if winter conditions factored into speed patterns. **Figures 2-4** through **2-7** provide the output by time of day for each corridor.

Figure 2-4 Huron Street Average Speed by Time of Day

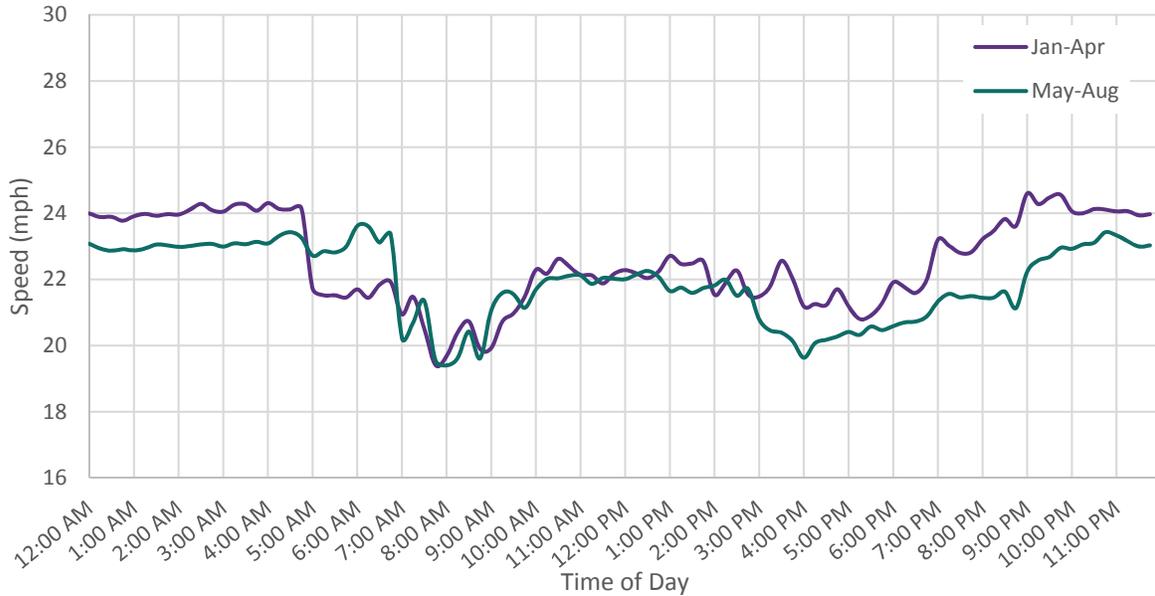


Figure 2-5 Cross Street Average Speed by Time of Day

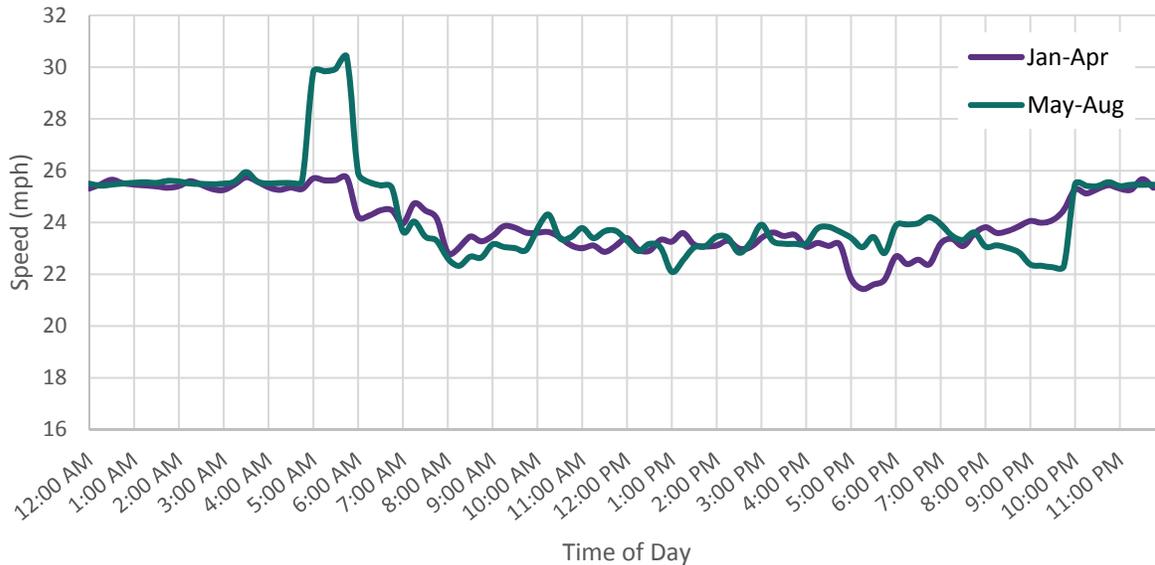


Figure 2-6 Washtenaw Avenue Average Speed by Time of Day

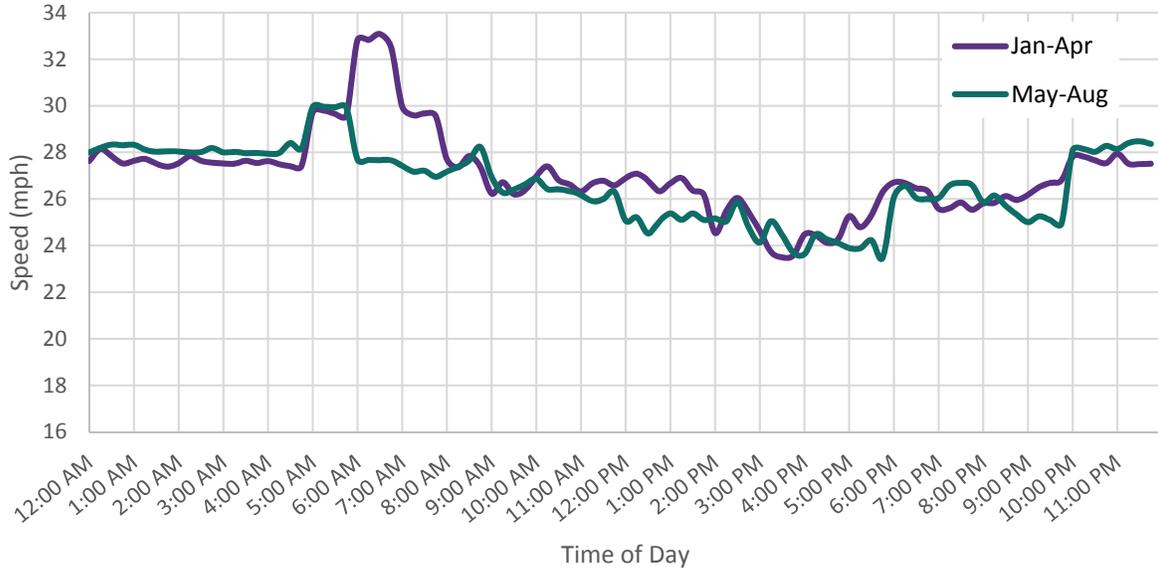
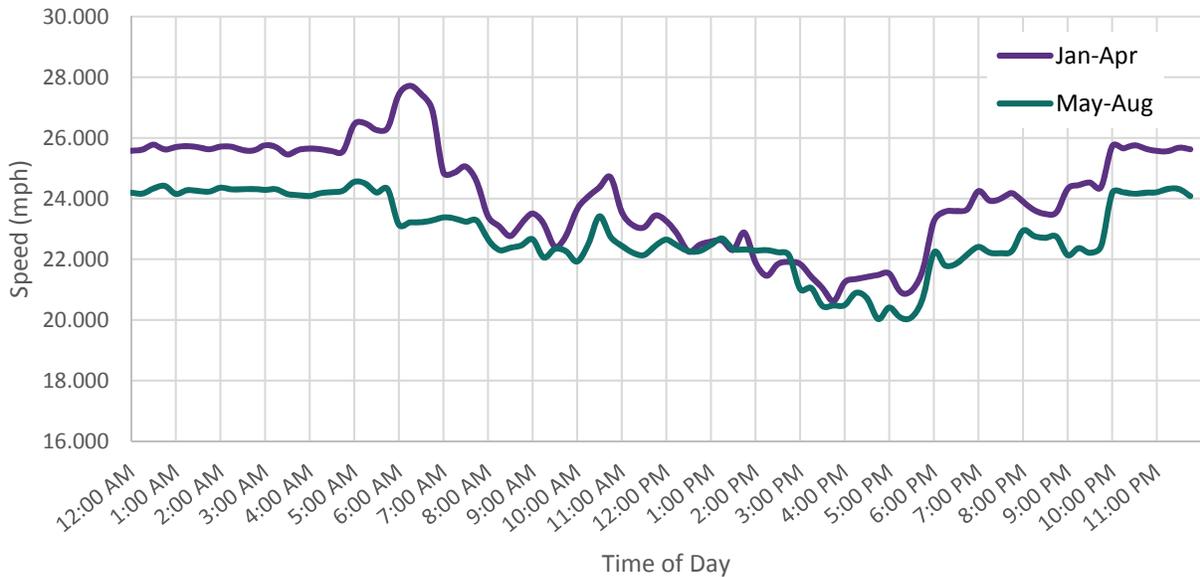


Figure 2-7 Hamilton Street Average Speed by Time of Day



As shown, speeds were greatest during the early AM and late evening for each corridor. Speeds were lowest during the PM peak, where minimum values for each corridor were found. These findings correlate with the congestion observed on the corridor during those times. **Appendix A** provides additional information for each corridor with data provided by each segment as obtained from RITIS.

2.4. International Road Assessment Program (iRAP) Analysis

The iRAP is a worldwide road assessment program (RAP) that offers tools that aid in assessing the amount of risk related to a roadway segment or intersection. The approach is focused on screening roadway networks and quantifying risk based on the presence or absence of traffic control and other roadway design features that are known to impact safety. Using the iRAP provided tool, each roadway section is assigned a risk score and the risk score is then translated into a star rating. The tool is comprised of four risk models based on the type of road user (motor vehicle occupants, motorcycle, pedestrian, or bicyclist). The risk models for vulnerable road users (motorcyclists, pedestrians, and bicyclists) are very effective in identifying safety issues for pedestrians and bicyclists; especially in the absence of statistically significant clusters of crashes.

Data requirements for each road user is outline in **Table 2-2** through **Table 2-5**. The roadway was divided into 100 meter segments and data was collected for every segment, which is then input to the iRAP risk models and analyzed. Data is typically collected from the most recently available satellite imagery of the corridor. The data collected is based on the risk factors associated with key crash types. Each attribute listed below has a weighting based on its relative risk of causing a fatal or serious injury crash involving the corresponding road user. Details iRAP model is publicly available on the iRAP website (www.irap.org). **Table 2-6** outlines the iRAP star rating framework which was utilized in the analysis.

Table 2-2 iRAP Data Requirements - Motor Vehicle Occupants

Intersection	Head-on	Run-off-road
<ul style="list-style-type: none"> • Operating speed • Intersection type • Intersecting road volume • Intersection quality • Minor access density • Channelization • Sight Distance 	<ul style="list-style-type: none"> • Operating speed • Median type • Number of lanes • Lane width • Curvature • Curvature quality • Overtaking demand • Road condition 	<ul style="list-style-type: none"> • Operating speed • Roadside severity – left • Roadside severity – right • Lane width • Paved shoulder • Curvature • Curvature quality • Delineation • Shoulder rumble • Road condition • Skid Resistance • Grade • Sight Distance

Table 2-3 iRAP Data Requirements - Motorcyclists

Intersection	Head-on	Run-off-road
<ul style="list-style-type: none"> • Operating speed • Intersection type • Intersecting road volume • Intersection quality • Minor access density 	<ul style="list-style-type: none"> • Operating speed • Number of lanes • Lane width • Curvature • Curvature quality • Overtaking demand • Road condition 	<ul style="list-style-type: none"> • Operating speed • Lane width • Paved shoulder width • Curvature • Curvature quality • Delineation • Shoulder rumble strips • Road condition • Facilities for motorcycles

Table 2-4 iRAP Data Requirements - Pedestrians

Along	Crossing
<ul style="list-style-type: none"> • Speed • Sidewalk provision – left • Sidewalk provision – right • Side friction • Pedestrian fencing 	<ul style="list-style-type: none"> • Speed • Number of lanes • Median type • Crossing facilities – main road • Crossing facilities – cross street • Crossing facilities quality • Street lighting

Table 2-5 iRAP Data Requirements - Bicyclists

Intersection	Along	Crossing
<ul style="list-style-type: none"> • Operating speed • Intersection type • Intersecting road volume • Intersection quality • Minor access density 	<ul style="list-style-type: none"> • Operating speed • Roadside severity – left • Roadside severity – right • Lane width • Paved shoulder • Curvature • Curve quality • Delineation • Road condition • Facilitates for bikes • Side friction 	<ul style="list-style-type: none"> • Operating speed • Crossing facilities • Number of lanes • Median type • Crossing facilities • Crossing facilities quality

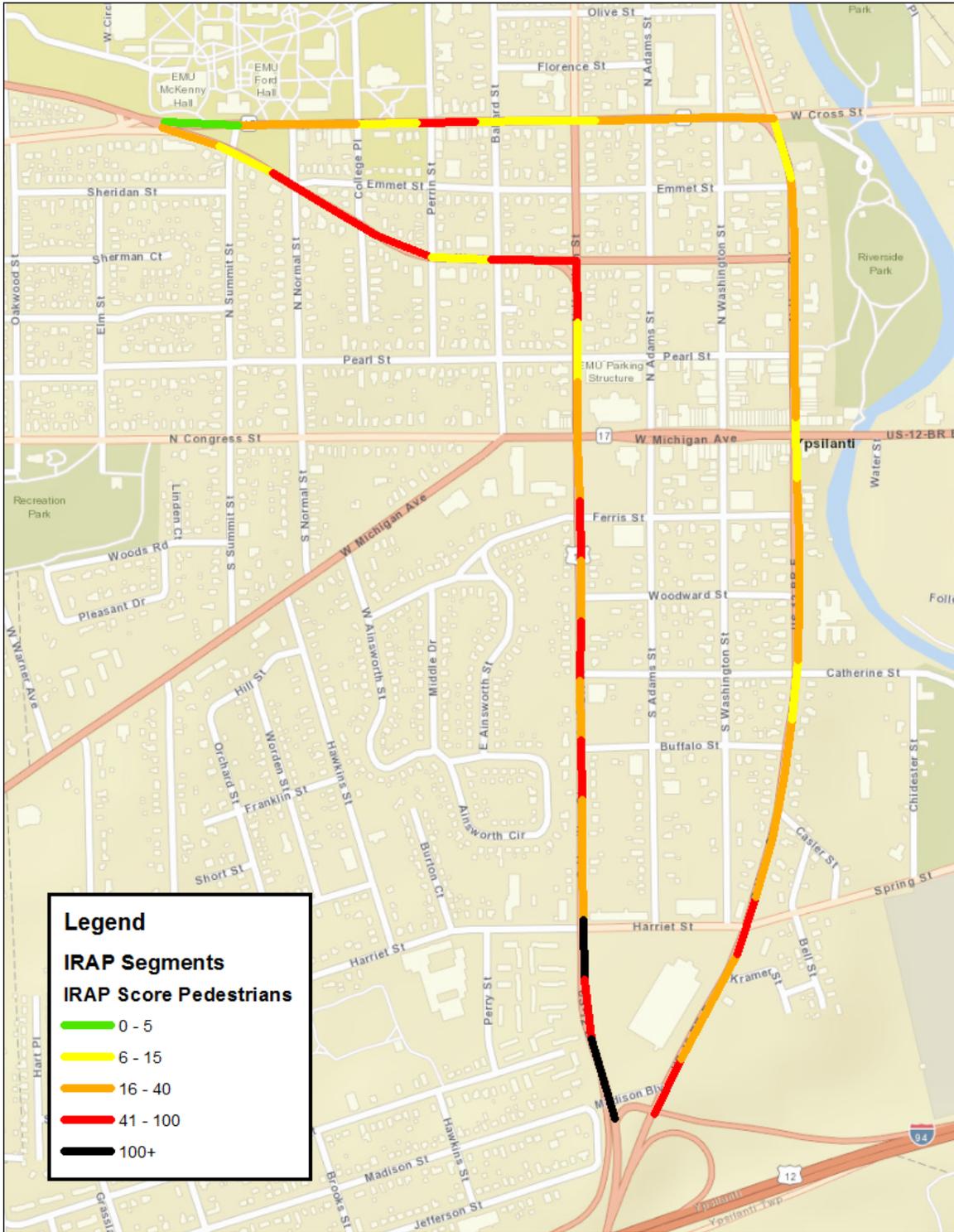
Table 2-6 iRAP Star Rating Framework

Star Rating	Motor Vehicle Occupants	Motorcyclists	Pedestrians	Bicyclists
5	0 to < 2.5	0 to < 2.5	0 to < 5	0 to < 5
4	2.5 to < 5	2.5 to < 5	5 to < 15	5 to < 10
3	5 to < 12.5	5 to < 12.5	15 to < 40	10 to < 30
2	12.5 to < 22.5	12.5 to < 22.5	40 to < 100	30 to < 60
1	22.5 +	22.5+	100+	60+

2.4.1. iRAP Analysis Results

iRAP analyses were conducted for the entire study corridor as outlined in **Figure 2-1** for motor vehicle occupants, motorcyclists, pedestrians and bicyclists. **Figure 2-8**, along with additional figures provided in **Appendix H**, indicate the risk scores obtained from iRAP risk models. **Figure 2-8** provides the pedestrian iRAP scores for each project segment.

Figure 2-8 iRAP Pedestrian Scores



3. Existing Safety Features

MDOT in partnership with the City of Ypsilanti has already implemented several countermeasures to reduce speeds and improve safety on Cross Street with the inclusion of bike lanes and on-street parking, and on Huron Street from Michigan Avenue to Pearl Street with bulb-outs and on-street parking as shown in **Figures 3-1** and **3-2**. In addition, lighting was observed as operational and illuminating throughout the entire RSA study area.

Figure 3-1 View of Bike Lane and Parking along Cross Street



Figure 3-2 View of Intersection Bulb-Outs on Huron Street North of Michigan Avenue



4. Historical Crash Analysis

As a supplement to the findings obtained as part of the RSA process, the Atkins team conducted a comprehensive historical crash analysis. First, a traditional crash data evaluation was completed, which includes the analysis of descriptive statistics for intersections and segments separately to determine crash patterns specific to each facility in the RSA study area. In addition, a state-of-the-art analysis was conducted for intersections using the Empirical Bayes (EB) method outlined in the American Association of State Highway Transportation Official’s (AASHTO) *Highway Safety Manual* (HSM). Data for analysis were collected for the most recent five-year period (2013-2017) from the *Michigan Traffic Crash Facts* (MTCF) website, where a summary of the overall data is provided in **Table 4-1**.

Table 4-1 Summary of RSA Study Area Traffic Crash Data (2013-2017)

Location	Traffic Crashes				Non-Motorized	
	Fatal	Injury	PDO	Total	Ped	Bike
Segments	0	5	36	41	0	0
Intersections	2	150	897	1049	10	8
Corridor Total	2	155	933	1090	10	8

Overall, 1,090 traffic crashes occurred on study segments from 2013 to 2017, with 155 resulting in a non-fatal injury. Fatal and injury crashes were most prevalent on Washtenaw Avenue between Perrin Street and Ballard Street, along Cross Street near Huron Street, and at Harriet Street for both Huron Street and Hamilton Street as shown in the **Figure 4-3** heat map. Total crashes were most apparent near Michigan Avenue and Huron Street, along with Harriet Street at Hamilton Street and Huron Street, and are shown in the **Figure 4-4** heat map. A comprehensive set of crash data is provided by intersection in **Appendix B**.

For reference, two fatal crashes occurred during the analysis period as shown in **Figure 4-2**:

- Washtenaw Avenue and Perrin Street – September 1, 2017 at 9:08 PM – A single motorcycle was speeding, ran off road right and struck a utility pole.
- Hamilton Street and Buffalo Street – June 26, 2014 at 2:14 PM – A single vehicle struck a pedestrian in the middle lane of Hamilton and fled the scene.

Pedestrians and bicyclists were involved in ten and eight crashes, respectively. The specific location of each pedestrian and bicycle crash is shown in **Figure 4-1** on the next page.

Figure 4-1 Fatal Crash Location Map

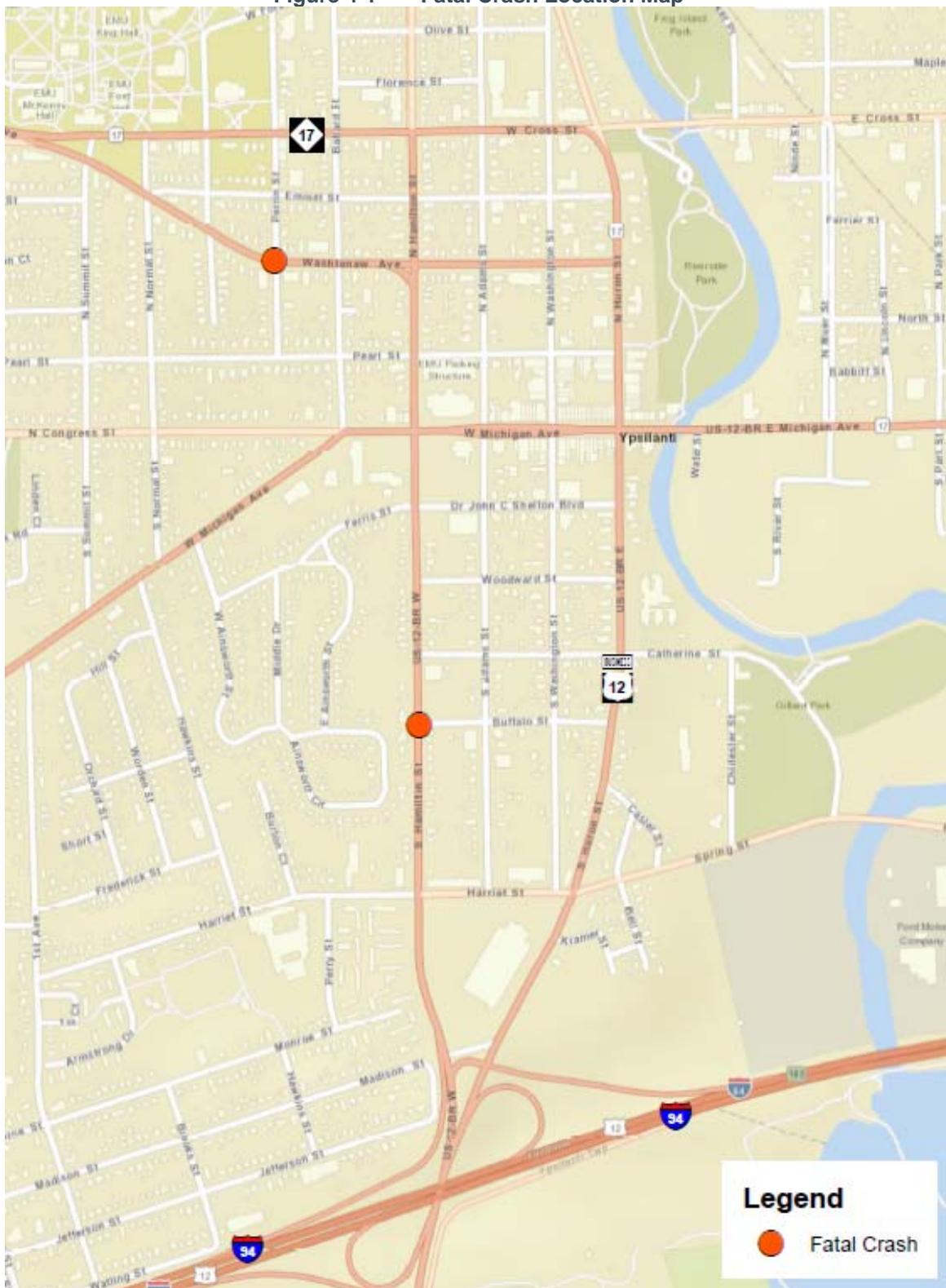


Figure 4-3 Fatal and Injury Crash Hot Spot Map

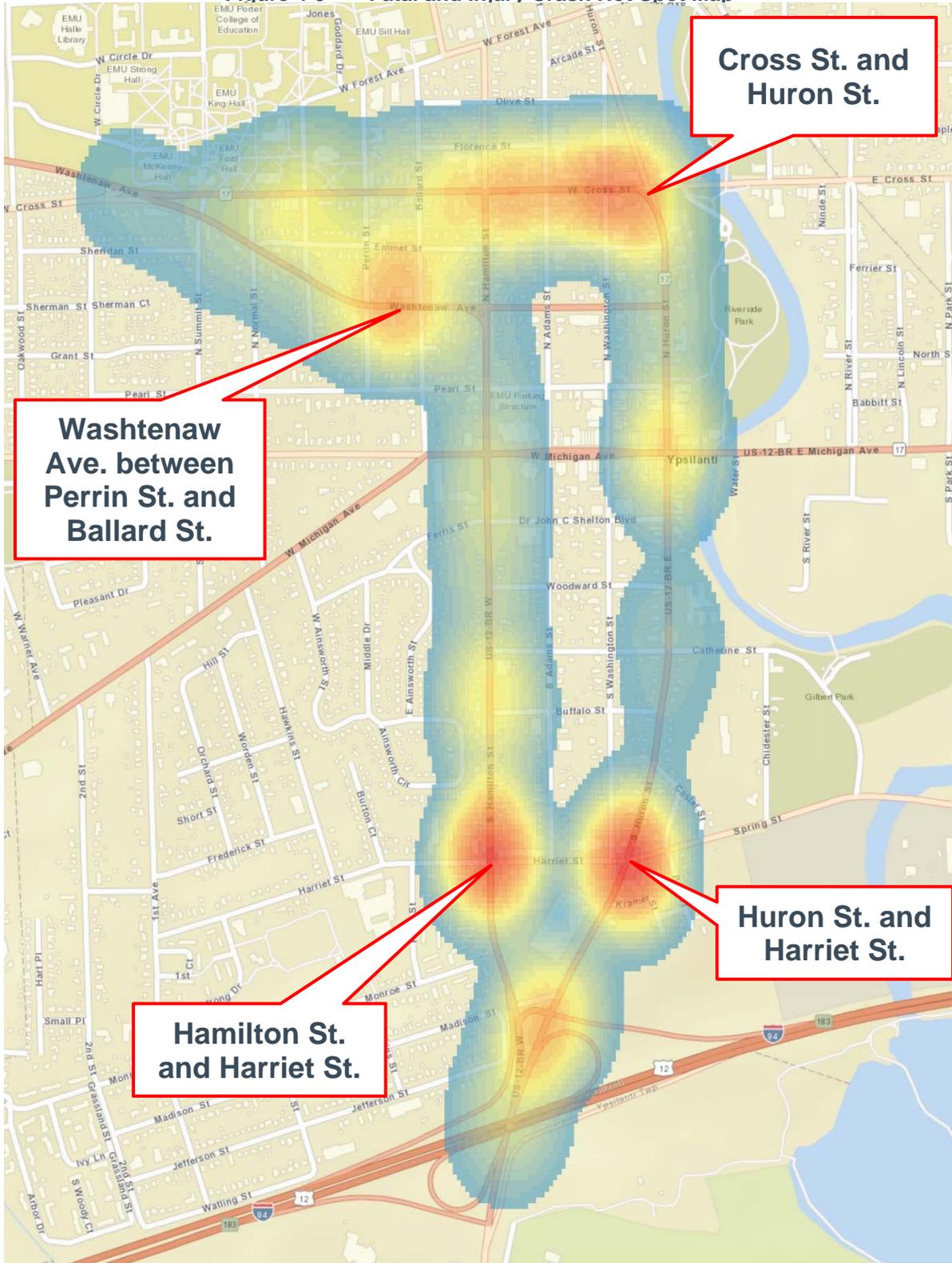
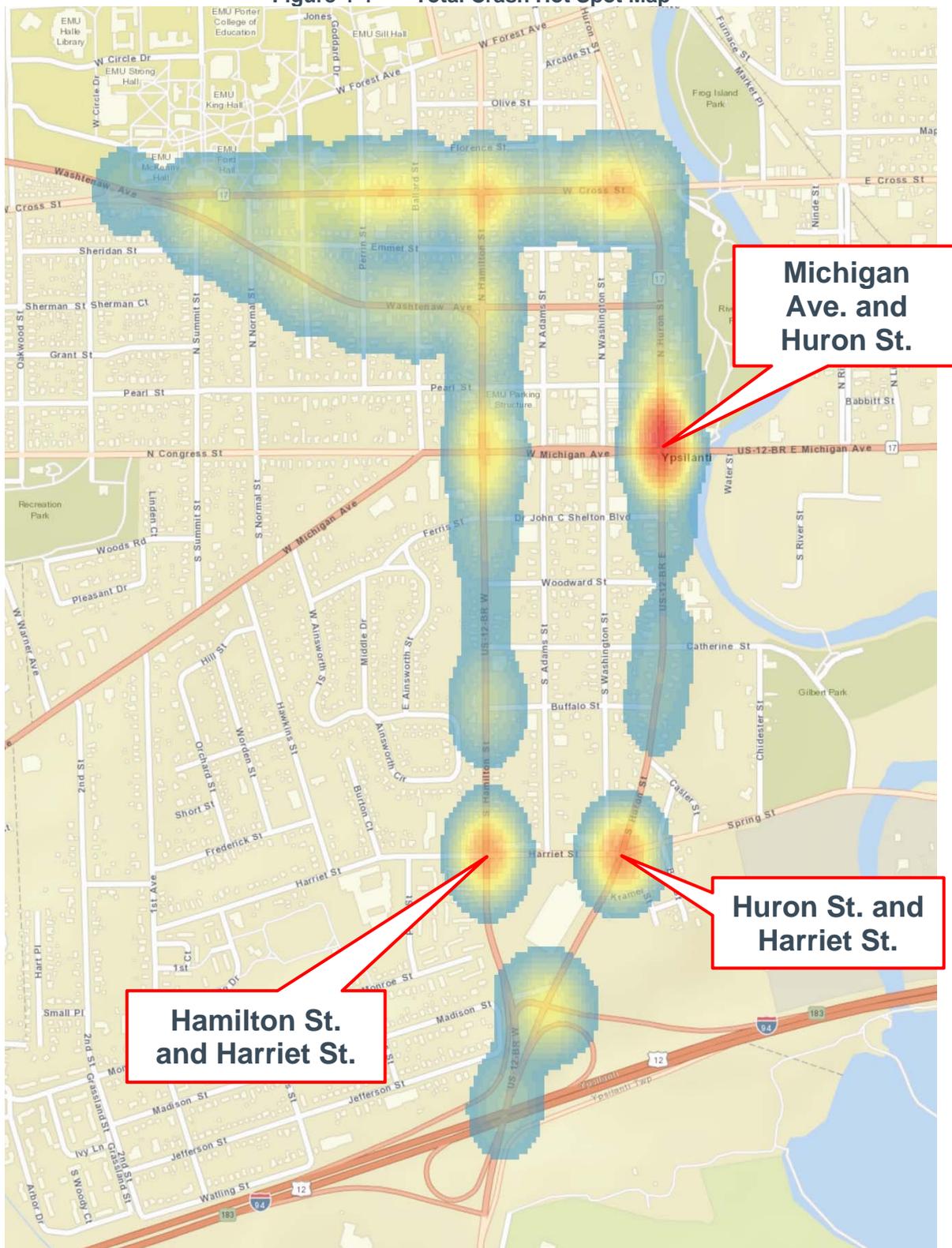


Figure 4-4 Total Crash Hot Spot Map



4.1. Empirical Bayes Method Evaluation

While traditional safety analysis techniques provide an important contextual understanding of existing safety performance, the inherent bias and overdispersion of crash data is present when using these methodologies alone. As such, the American Association of State Highway and Transportation Officials (AASHTO) has developed state-of-the-art Empirical-Bayes (EB) methodology outlined in their 2010 Highway Safety Manual (HSM), which considers the impact of changing traffic volumes, regression-to-the-mean bias, and other factors that potentially affect the frequency of traffic crashes.

The EB-method combines a site's observed crash frequency developed using a statistical model, referred to as a safety performance function, to estimate an expected average yearly crash frequency. Ultimately, the estimated predicted crash frequency is subtracted from the calculated expected crash frequency to determine excess expected crashes, or the number of expected crashes above or below crash frequencies for other similar facilities. For analysis, the *Michigan Urban Trunkline Intersections Safety Performance Functions (SPFs) Development and Support* models were used to calculate the predicted and expected crash numbers for each facility. These models considered the one-way nature of the roadway facilities for each intersection. For reference, HSM methodology is not yet available for one-way segments and therefore was not conducted for segments as part of this project. **Table 4-2** below shows model results aggregated by corridor.

Table 4-2 Summary of EB-Method Intersection Safety Analysis by Corridor (2013-2017)

Corridor	Predicted			Expected			Excess Expected		
	FI	PDO	Total	FI	PDO	Total	FI	PDO	Total
Cross	10.8	52.2	63.0	8.7	49.8	58.5	-2.1	-2.4	-4.5
Washtenaw	8.5	36.8	45.3	3.7	23.2	26.9	-4.8	-13.6	-18.4
Huron	8.9	44.5	53.4	6.3	27.9	34.2	-2.6	-16.7	-19.3
Hamilton	6.4	28.6	35.0	4.9	20.9	25.8	-1.6	-7.7	-9.3

Overall, each corridor exhibits positive safety performance, where the expected number of crashes is lower than the predicted. This finding is exemplified by the negative excess expected numbers shown in **Table 4-2**, where the facilities are operating better than similar peers. For additional context, charts have been prepared to show the predicted and expected fatal and injury crash values for each intersection by corridor and are shown in **Figures 4-5** through **4-8**. The excess expected shown on these charts represents opportunity for improvement, as those intersections with excess expected are operating with poor safety performance in comparison with other similar intersections. In addition, total crash EB-method analysis charts are provided in the **Appendix C** of this report.

Figure 4-5 Cross Street Fatal and Injury EB-Method Analysis



Figure 4-6 Washtenaw Avenue Fatal and Injury EB-Method Analysis

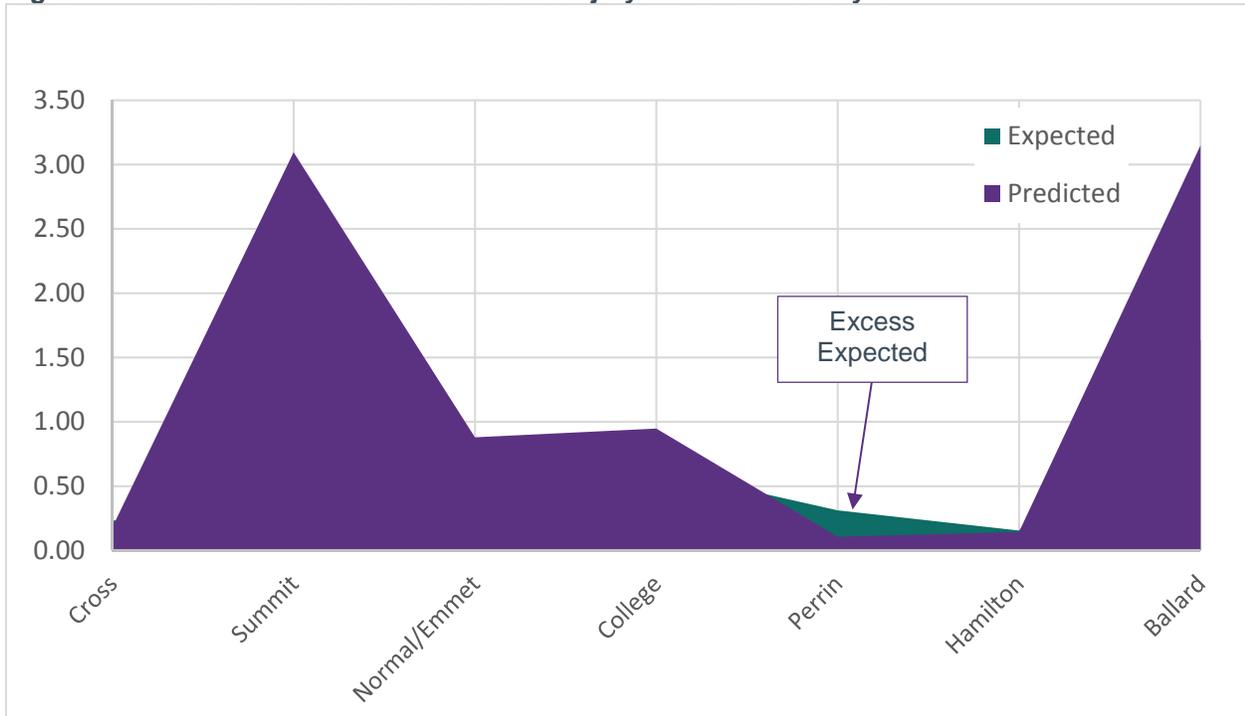


Figure 4-7 Huron Street Fatal and Injury EB-Method Analysis

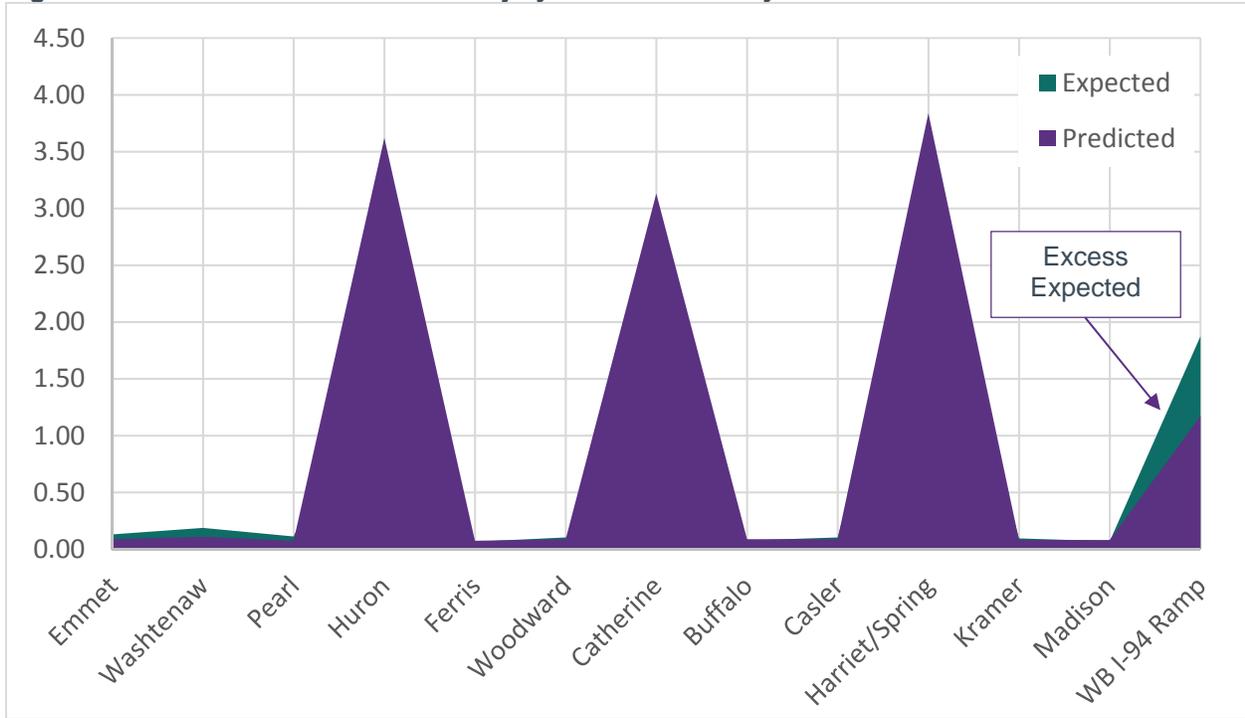
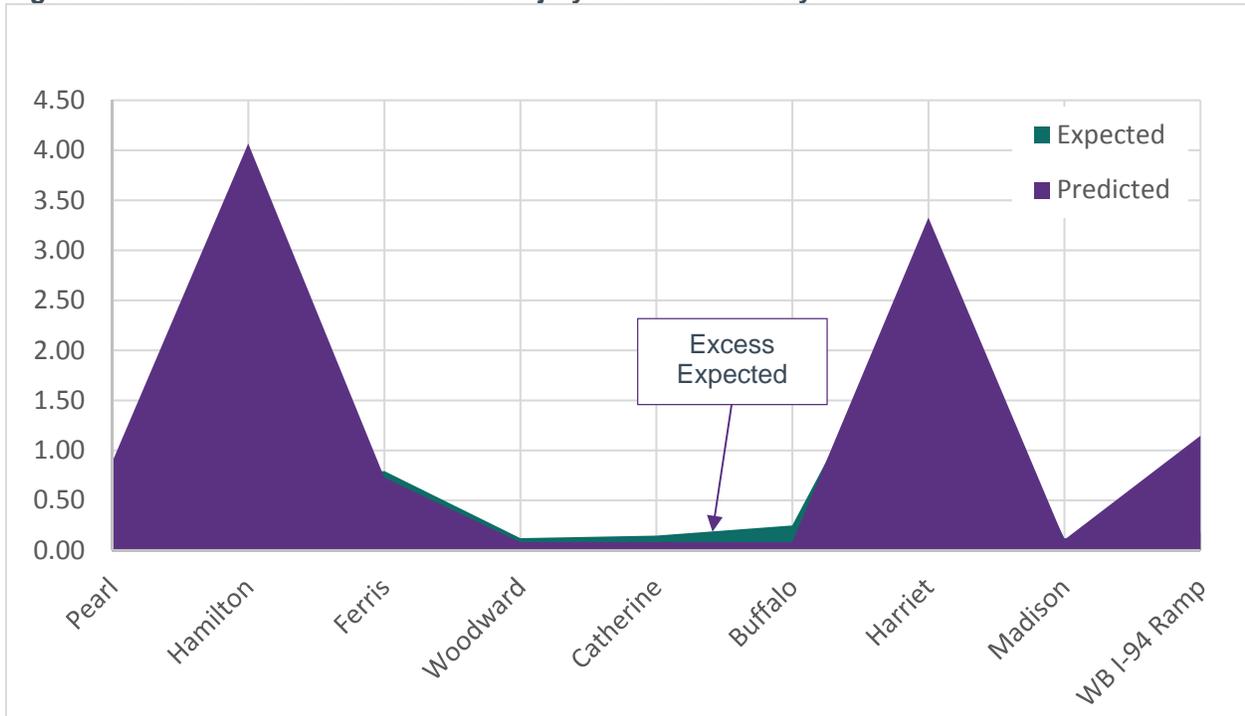
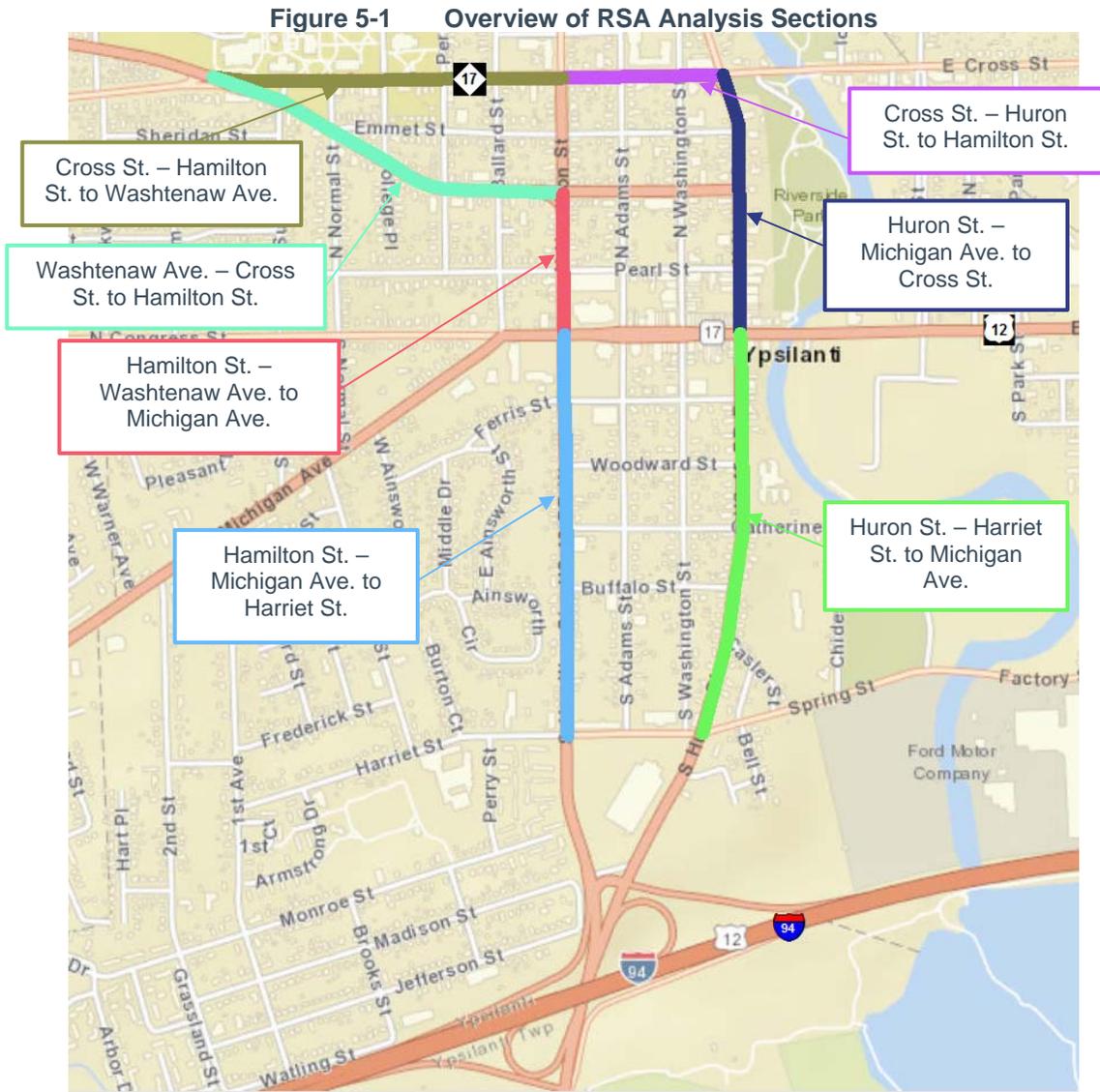


Figure 4-8 Hamilton Street Fatal and Injury EB-Method Analysis



5. Safety Issues and Suggestions

Safety issues specific to each section of the corridor were identified during as part of the RSA team’s field review and crash analysis. A relative risk rating is provided based upon the estimated frequency and severity as specified in the *RSA Safety Risk Framework* outlined in **Section 1.2.1**. A comprehensive list of safety issues is provided in **Appendix D** and a complete list of suggestions is found in **Appendix E**. For reference, the corridor was disaggregated into seven sections for presenting safety issues and their associated suggestions as shown in **Figure 5-1** below.

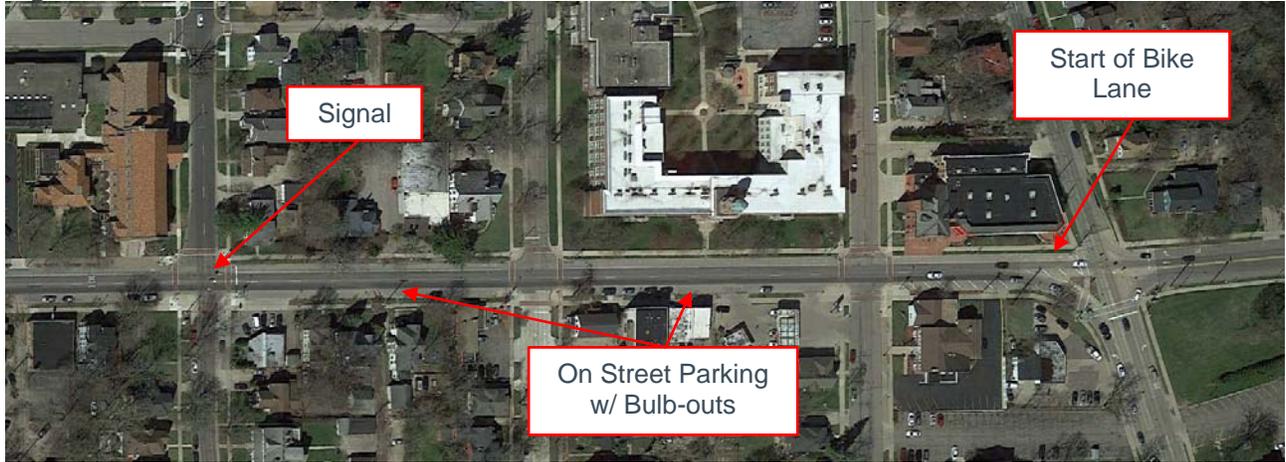


In addition to the sections shown above, the RSA team reviewed the area around I-94. However, due to the frequency of other studies previously completed for this area, the team decided to spend most of their effort in the sections above. More information regarding the I-94 interchange is provided in **Section 5.8**.

5.1. Cross Street from Huron Street to Hamilton Street

Beginning at the most northeast point of the study area, Cross Street is primarily a two-lane one-way cross-section with a single non-buffered bike lane on the north side and on-street parking with bulb-outs on the south side of the roadway (Figure 5-2). A signal is present at the intersection of Cross Street and Hamilton Street.

Figure 5-2 Aerial of Cross Street from Huron Street to Hamilton Street



According to speed data obtained from RITIS, the mean free-flow speeds are consistent with the posted speed limit of 25 MPH. However, drivers entering Cross Street from northbound Huron Street using the free-flow lane were observed speeding and crossing over into the right lane in front of through traffic from the east, which would require a speed study to verify. Also, this resulted in a few conflicts (near misses) for sideswipe-same direction crashes observed during field review. Further review of the crash data found that 27 sideswipe-same crashes occurred here over a five-year period.

In addition, the crosswalks for pedestrians traversing Cross Street at both Adams Street and Washington Street were difficult to see while driving the corridor and were not signed as well. Two bicycle crashes occurred at the intersection with Adams Street as follows:

- Cross Street and Adams Street – February 18, 2013 at 1:54 PM – A single vehicle hit a bicyclist in the south leg crosswalk.
- Cross Street and Adams Street – June 3, 2013 at 4:27 PM – A single vehicle struck a bicyclist in the south leg crosswalk and fled the scene.

Table 5-1 Safety Issues for Cross Street from Huron Street to Hamilton Street

#	Safety Issue	Crash Frequency	Crash Severity	Risk Category
I-1	Delivery vehicles impeding bike and vehicle traffic	Rare	Low	B
I-2	No buffer space for bike lanes	Occasional	Medium	D
I-3	Poor pavement markings for crosswalks, bike lanes and lane lines	Occasional	Medium	D

Figure 5-3 Bike Lane Buffer Alternatives



Providing shared or flexible parking spaces that are designated as loading zones based on time of day would accommodate delivery vehicles supporting businesses along Cross Street. This could be accomplished by using a combination of pavement markings and signage to alert drivers of the restrictions.

For the bicycle lanes, a buffer could be introduced using one of three methods separately or in combination with one another:

- Pavement markings
- Flexible delineators
- Raised curb

Maintenance costs and operations should be considered and discussed before implementation of any proposed alternative.

Finally, to address crosswalk visibility, enhanced pavement markings using wet reflective or other innovative materials could be utilized to enhance delineation and command driver attention to pedestrian crosswalks. These markings could be recessed into the pavement to improve durability related to winter maintenance. In addition, the use of R1-6 or R1-6a In-Street Pedestrian Crossing signs should be considered to increase driver yield compliance at crosswalks and reduce vehicle speeds as shown in recent pedestrian gateway research by MDOT. For reference, these signs shall not be used at signalized locations according to the MMUTCD and are only recommended for the unsignalized crossings at Washington Street and Adams Street as part of this study.

Table 5-2 Suggestions for Cross Street from Huron Street to Hamilton Street

#	Suggestion
S-1	Provide flex spaces for designated loading zones based on time of day.
S-2	Provide buffer lane with optional enhancements
S-3	Provide enhanced transverse pavement markings and/or in-street pedestrian crosswalk signs

5.2. Cross Street from Hamilton Street to Washtenaw Avenue

Continuing from the previously identified section, Cross Street is primarily a two-lane one-way cross-section with a single non-buffered bike lane on the north side and on-street parking with bulb-outs on the south side of the roadway (Figure 5-4). The bike lane is not continuous through the whole section and terminates abruptly at Normal Street as indicated in Figure 5-4. Signals are present at the intersections with Hamilton Street, Ballard Street, College Place and Summit Street.

Figure 5-4 Aerial of Cross Street from Hamilton Street to College Place

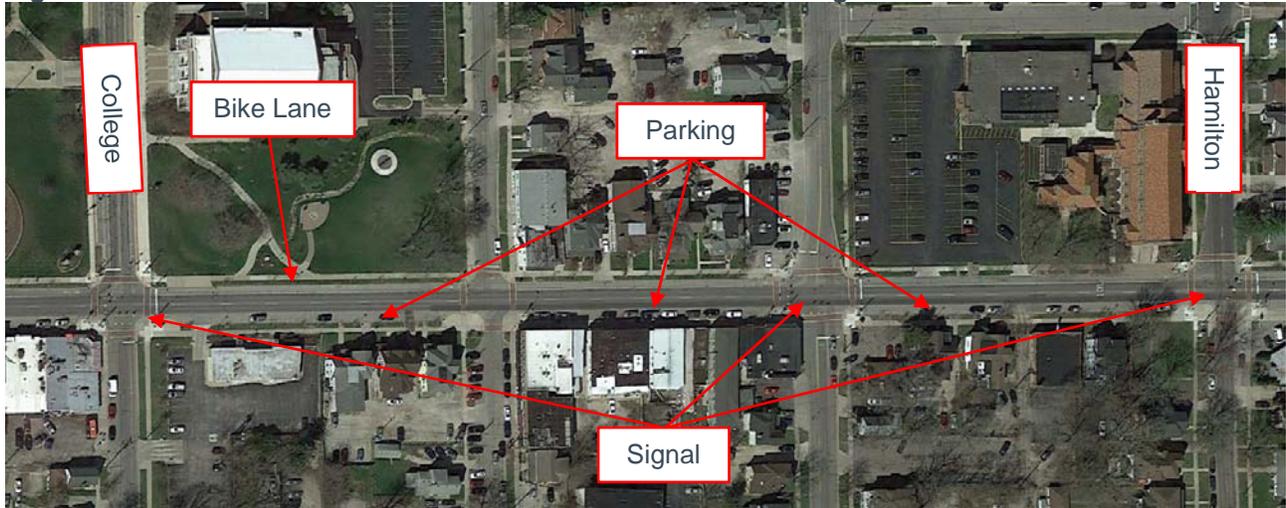


Figure 5-5 Aerial of Cross Street from College Place to Washtenaw Avenue



According to speed data obtained from RITIS, the mean free-flow speeds generally agree with the posted speed limit of 25 MPH, except for the period between 5 AM and 7 AM during the months of May through August where average speed exceeds 30 MPH. Based on five-years of data, 8 of the 19 pedestrian and bicycle crashes in the study area have occurred in this section. Moreover, a single pedestrian crash occurred at the unsignalized intersection with Normal Street as follows:

- Cross Street and Normal Street – November 21, 2017 at 6:08 PM – A single vehicle struck a pedestrian while turning left onto Cross Street from Normal Street.

As such, the unsignalized crosswalks at Normal Street and Perrin Street would benefit from enhanced pavement markings and in-street pedestrian crossing signs like those discussed in **Section 5.1**. In addition, the crossing at Summit Street would benefit from ADA ramp improvements in the northeast and southeast quadrants as indicated in **Figure 5-5**. Finally, the abrupt termination of the bike lane at Normal Street present a concern for bicyclist traversing Cross Street. For better continuity, the use of shared lane markings covered in Section 9C.07 should be implemented or a bicycle lane exit ramp configuration should be utilized to properly transition bicyclists up to the crosswalk. More information regarding potential bicycle lane transition options is included in the **Appendix F**.

Table 5-3 Safety Issues for Cross Street from College Place to Washtenaw Avenue

#	Safety Issue	Crash Frequency	Crash Severity	Risk Category
I-4	Uncontrolled pedestrian crossings	Occasional	Medium	D
I-5	Abrupt termination of bike lane at west end of corridor	Rare	Medium	C
I-6	Lack of ADA ramps	Rare	Medium	C

Table 5-4 Suggestions for Cross Street from College Place to Washtenaw Avenue

#	Suggestion
S-4	Provide enhanced transverse pavement markings and/or in-street pedestrian crosswalk signs
S-5	Implement shared lane markings per the MMUTCD or install a transition ramp
S-6	Install ADA compliant facilities

5.2.1. Long-Term Improvements

Other modifications discussed by the RSA team included closure of the eastbound free-flow right-turn lane from Cross Street west of Washtenaw Avenue for vehicles entering eastbound Washtenaw Avenue. In addition to that closure, a re-alignment of Cross Street to ‘tee’ into Washtenaw Avenue would be necessary. The combination of these modifications would result in a two-lane cross-section for Washtenaw Avenue, effectively reducing the total distance required for pedestrians crossing Washtenaw Avenue.

Figure 5-6 Cross Street and Washtenaw Avenue Proposed Re-Alignment



These modifications would also provide an opportunity to start a road diet on Washtenaw Avenue, where a buffered bicycle lane could replace the entry point for the existing right-turn movement and the cross-section be reduced to two-lanes on Washtenaw Avenue.

5.3. Washtenaw Avenue from Cross Street to Hamilton Street

Washtenaw Avenue starting at Cross Street is primarily a three-lane cross-section with a posted speed of 35 MPH. No bicycle lanes are present, and there are a series of uncontrolled pedestrian crosswalks present along the corridor as shown in **Figures 5-7** and **5-8** below. Speeding was observed during field review along the downhill section associated with the sagging vertical curve and should be reviewed by a speed study.

Figure 5-7 Aerial of Washtenaw Avenue from Cross Street to Perrin Street



Figure 5-8 Aerial of Washtenaw Avenue from Perrin Street to Hamilton Street



Numerous pedestrians were observed crossing mid-block in front of approaching traffic, particularly in the section between Perrin Street and Hamilton Street. Crossing Washtenaw Avenue at Normal Street was also particularly challenging for the RSA team during field review, where a near-miss was also observed. For reference, two non-motorized crashes occurred in this section during the five-year analysis period:

- Washtenaw Avenue west of Ballard Street – February 6, 2013 at 10:54 PM – A single vehicle struck a pedestrian crossing mid-block west of Ballard under poorly lighted conditions.
- Washtenaw Avenue at Normal Street – November 5, 2016 at 12:51 AM – A single vehicle struck a bicycle crossing Washtenaw southbound east of Normal.

In addition, there was evidence of pedestrian’s crossing the free-flow right-turn lane that facilitates movement from Washtenaw Avenue to Hamilton Street. Walking paths were observed bisecting the center of the channelizing island there, which was at the apex of the turn. This informal crossing has a higher risk or crash potential as observed in the iRAP analysis in **Section 2.4.1**, as vehicles may not see pedestrians crossing the lane until they’ve already started their turn at speed. The issue of sight distance also effects pedestrians here, as they don’t immediately see vehicles approaching upstream when crossing.

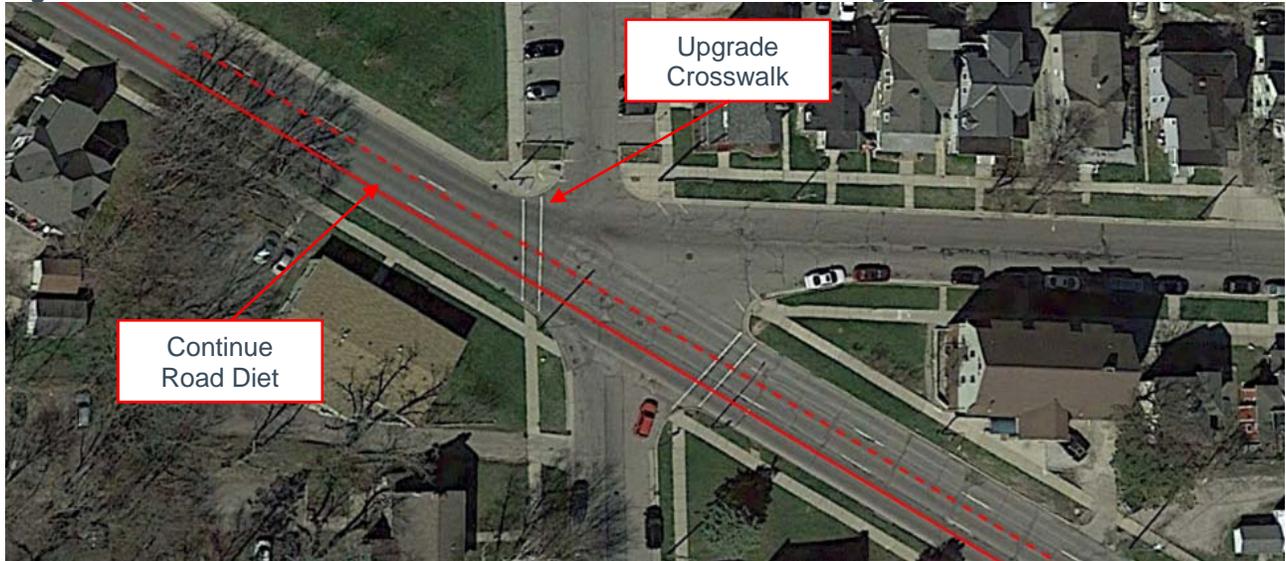
Queuing was also observed during late afternoon and early evening at the Ballard Street traffic signal, where queues extended up to and past Perrin Street with each cycle. Sight distance was an issue here as the queue was not immediately visible when traveling on the downhill section starting at Normal Street. The lack of sight distance coupled with higher vehicle speeds in this section contributes to a greater crash potential. **Table 5-5** summarizes the safety issues observed by the RSA team during this review.

Table 5-5 Safety Issues for Washtenaw Avenue from Cross Street to Hamilton Street

#	Safety Issue	Crash Frequency	Crash Severity	Risk Category
I-7	Uncontrolled pedestrian crossings	Occasional	Medium	D
I-8	High vehicle speeds	Rare	Medium	C
I-9	Horizontal curve present after sagging vertical curve	Rare	Medium	C
I-10	Queuing at Ballard signal in right lane	Occasional	Low	C
I-11	Pedestrians crossing free-flow right at Hamilton Street	Rare	High	D

Continuing the road diet for Washtenaw Avenue as suggested in **Section 5.2.1** would help to address the high-vehicle speed and pedestrian crossing issues noted here. Supplementing the road diet with high-visibility pedestrian crossings would provide clearly designated areas for pedestrians to cross in a safe manner. This could be accomplished using wet reflective pavement markings and advanced and at-crosswalk signage, along with the use of innovative treatments like Rectangular Rapid Flash Beacons (RRFB). In addition, the existing ramp facilities are not ADA compliant and would need to be upgraded as part of any project work in this area. **Figure 5-9** on the next page demonstrates this concept.

Figure 5-9 Washtenaw Avenue Road Diet and Pedestrian Crossing Enhancements



Other countermeasures discussed by the RSA team included the installation of W3-4 “Be Prepared to Stop” sign with a flasher assembly synced with the signal at Ballard. This would serve to alert drivers of a red signal ahead, so they could reduce their speeds and avoid any conflicts with the queuing at that signal. In conjunction or as an alternative, a driver feedback sign (DFS) could also be installed to alert drivers of their speed relative to the speed limit. DFS signs have been shown to achieve a considerable reduction in speed when installed and can operate with solar power for ease of installation. **Figure 5-10** shows examples of these signs along with potential placement for their location.

Figure 5-10 Driver Feedback Examples



5.3.1. Long-Term Improvements

The RSA team developed three potential concepts for the section between Ballard Street and Hamilton Street to address the queuing and pedestrian crossing issues. First, the lowest cost option retains existing geometry but adds a proper pedestrian crossing at the start of the continuous right-turn to Hamilton Street as shown in **Figure 5-11**. This would include the addition of pavement markings, signage, ADA ramps and sidewalk for pedestrians to continue east along Washtenaw Avenue.

The second alternative shown in **Figure 5-12** involves removing the signal from Ballard Street, closing the continuous right-turn lane to Hamilton Street, and modernizing the intersection with Hamilton Street to include a signal and ADA ramps. This configuration would provide a controlled pedestrian crossing and potentially additional right-turn capacity for Washtenaw Avenue, as both lanes would have the option of turning right onto Hamilton Street. In addition, if a two-lane road diet is implemented, vehicles will not have to change lanes to make a right on Hamilton Street. Buses would stay in the left-lane to continue through on Washtenaw Avenue and not be effected by right-turning traffic onto Hamilton Street. One potentially negative impact with adding a signal to Hamilton Street, would be if a second right-turn lane is not allowed. Providing only one right-turn lane could lead to an increased queue since free-flow right turns would be prohibited in this alternative. Also, prior to installation of a signal at Hamilton Street, a signal warrant analysis should be conducted to confirm need for signal.

Finally, the third alternative shown in **Figure 5-13**, would include the same signal modifications as presented with the second, but would retain the continuous free-flow right turn to Hamilton Street. This option would still require a pedestrian crossing which is fully visible to approaching drivers and provides for adequate stopping sight distance.

Figure 5-11 Washtenaw Avenue and Hamilton Street - Long-Term Alternative #1



Figure 5-12 Washtenaw Avenue and Hamilton Street - Long-Term Alternative #2

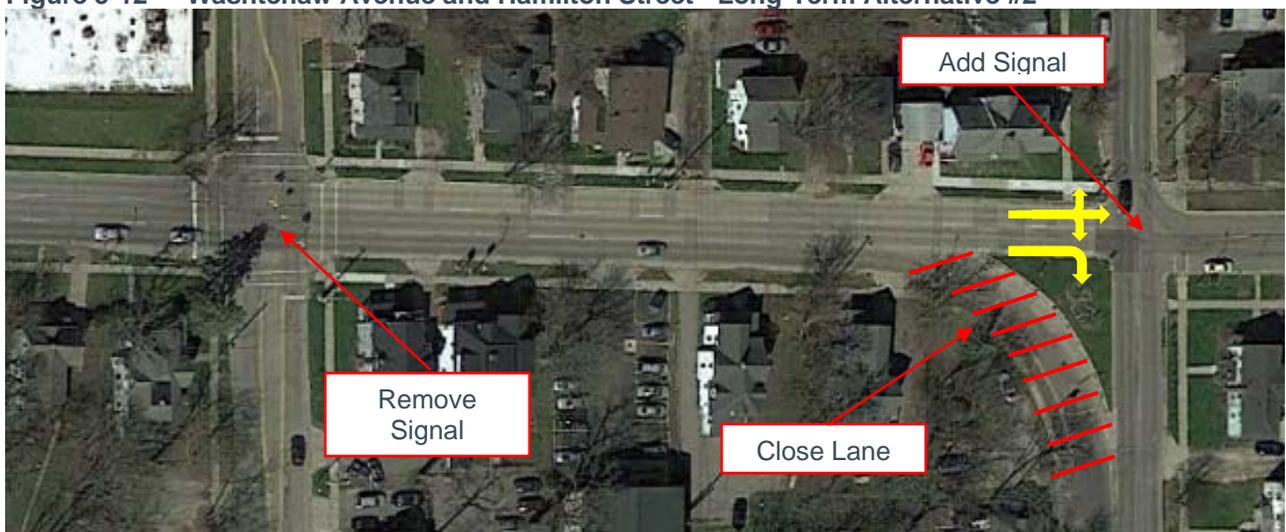


Figure 5-13 Washtenaw Avenue and Hamilton Street - Long-Term Alternative #3



Table 5-6 Suggestions for Washtenaw Avenue from Cross Street to Hamilton Street

#	Suggestion
S-7	Provide enhanced transverse pavement markings and/or in-street pedestrian crosswalk signs
S-8	Implement road diet with buffered bike lane and/or ITS speed warning
S-9	Install W3-4 “Be Prepared to Stop” with flasher interconnected to signal
S-10	Remove signal from Ballard Street; Install signal at Hamilton Street
S-11	Install pedestrian crossing fully visible to approaching vehicles

5.4. Hamilton Street from Washtenaw Avenue to Michigan Avenue

Figure 5-14 Aerial of Hamilton Street from Washtenaw Avenue to Michigan Avenue



Hamilton Street starting at Washtenaw Avenue is primarily a three-lane cross-section one-way in the southbound direction. No bicycle lanes are present, and there is an uncontrolled pedestrian crosswalk at the intersection of Pearl. An AATA transit station is located east of Hamilton Street on Pearl Street, where there is considerable transit bus and pedestrian traffic throughout the day. In addition, a three-story parking structure is in the southeast quadrant of Hamilton Street and Pearl Street, with the Eastern Michigan University School of Business immediately adjacent to the south.

Dual left-turns are provided for the north leg approach at Michigan Avenue, with a shared through and left-turn lane designated in conjunction with an exclusive left-turn bay utilizing approximately 230 feet of storage. A shared through and right-turn lane is provided as well. The stop bar for this approach is set back to accommodate the ADA compliant crossing of the north leg. Pedestrian signals without countdown indicators were present on all approaches at Michigan Avenue.

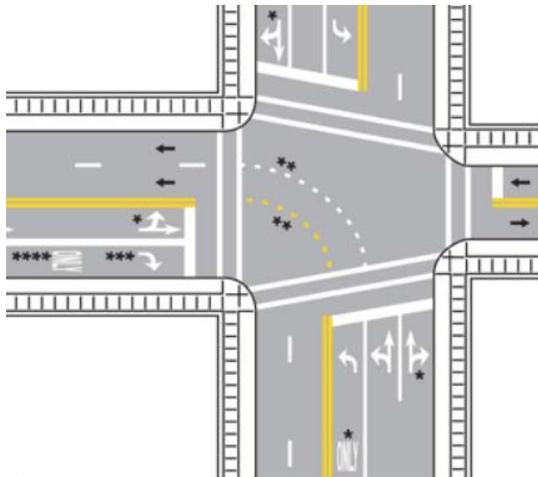
Queuing was observed between 3 and 4 PM at the north leg of Michigan Avenue, which appeared to correspond with class dismissal at the university. Maximal queue lengths were observed to extend back past Pearl Street to the north. Several vehicles appeared to weave from the continuous right-turn lane from Washtenaw Avenue to the left-turn lanes provided at Michigan Avenue. This maneuver was generally conducted at relatively high-speeds and was common during observations.

Vehicles were also observed having difficulty utilizing the dual left-turn lanes at Michigan Avenue, where several positioned in the outside lane were observed to have crossed over to the inside vehicles turning path. This caused the inside vehicle to tighten their turn and drive over the stop bar of left-turning vehicles on the east leg of Michigan Avenue. **Table 5-7** below provides the associated risk with these issues.

Table 5-7 Safety Issues for Hamilton Street from Washtenaw Avenue to Michigan Avenue

#	Safety Issue	Crash Frequency	Crash Severity	Risk Category
I-12	P.M. Queuing at Michigan Avenue	Occasional	Negligible	B
I-13	Weaving	Occasional	Negligible	B
I-14	Left-turn conflicts	Rare	Medium	C

Figure 5-15 Turn-Path Marking Example



To address these issues, the RSA team suggests starting with a signal re-timing to help alleviate queuing problems associated with class dismissal at the university. Separate timing plans may need to be developed to accommodate university related events. A separate study should be conducted to determine if there are any other important peak periods for this and the other study corridors.

Adding a more visible crosswalk at Pearl Street by installing wet reflective pavement markings with improved signage, along with other more innovative treatments such as RRFB should be considered. Additional counts should be conducted to determine actual pedestrian usage prior to installation of advanced treatments here.

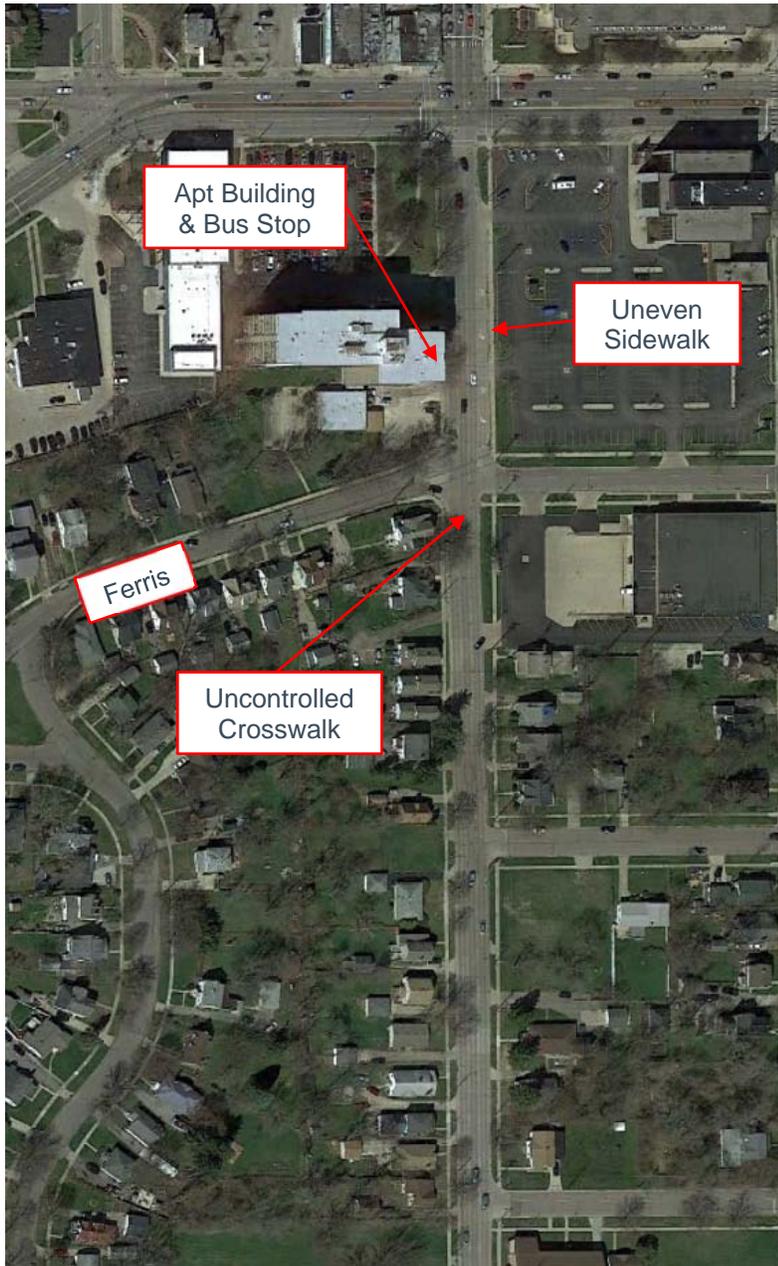
For left-turn conflicts at Michigan Avenue, moving the westbound left-turn lane’s stop bar more upstream would stop those vehicles farther away from the signal and reduce the likelihood of sideswipe-opposite crashes here. In conjunction with stop bar modifications, installing turn-path markings would give drivers a better sense of their intended pathway, helping to reduce lane violations of vehicles making this movement. In addition, using the crosswalk was challenging as a pedestrian as vehicles seemed rather aggressive when attempting the left-turn maneuver there. As such, a leading pedestrian interval should be considered to allow pedestrians to begin crossing the intersection prior to vehicles getting green time.

Table 5-8 Suggestions for Hamilton Street from Washtenaw Avenue to Michigan Avenue

#	Suggestion
S-12	Re-time signals based on recent counts
S-13	Close continuous free-flow lane for better vehicle positioning coming from Washtenaw Avenue
S-14	Stagger the Westbound stop-bar and add turn-path markings

5.5. Hamilton Street from Michigan Avenue to Harriet Street

Figure 5-16 Aerial of Hamilton Street from Michigan Street to Catherine Street



Hamilton Street south of Michigan Avenue is primarily a three-lane cross-section with a posted speed limit of 40 MPH. RITIS data indicates a maximum hourly mean speed of 33.2 MPH for the 6 AM hour. That said, the RSA team observed vehicles traveling well over the speed limit throughout the day while studying the corridor. A speed study should be conducted for verification.

Bicycle lanes are not provided, and there are several unmarked crosswalks throughout the corridor. A ten-story apartment building is present just north of Ferris Street with a recently constructed bus shelter in front along Hamilton Street. Sidewalk was present on both sides of Hamilton Street and did not include ADA compliant ramps at the Ferris crossing. The RSA team also found uneven sidewalk on the east side of Hamilton, adjacent to the urgent care building. Also, in that same area, a 265 foot storage bay is provided for left-turning vehicles from Hamilton Street to Ferris Street. It should also be noted that the iRAP analysis indicated a high amount of risk for pedestrians along Hamilton Street.

One bicycle crash occurred in this section as follows:

- Hamilton Street at Michigan Avenue – September 19, 2016 at 7:04 PM – A single vehicle struck a bicyclist using the south leg crosswalk at Michigan.

Figure 5-17 Aerial of Hamilton Street from Catherine Street to Harriet Street



Like the previous section, a three-lane cross-section is maintained moving south on Hamilton Street from Catherine Street to Harriet Street with a posted speed of 40 MPH.

No bike lane is provided, and sidewalk is present on both sides of Hamilton Street. Numerous residential driveways are present along this section with minimal commercial activity except near Harriet Street where a gas station exists in the northwest quadrant of the intersection.

Three non-motorized crashes occurred within this section where two were pedestrian related and one involved a bicyclist. One pedestrian crash resulted in a fatality and occurred at the intersection with Buffalo Street as follows:

- Hamilton Street at Buffalo Street – June 26, 2014 at 2:14 PM – A single vehicle struck an elderly pedestrian in the center lane of Hamilton and fled the scene.

The other two non-motorized crashes occurred at the intersection with Harriet and did not result in any fatalities as follows:

- Hamilton Street at Harriet Street – July 11, 2017 at 11:45 AM – A single vehicle struck a pedestrian in the south leg crosswalk while making a left-turn onto Hamilton.
- Hamilton Street at Harriet Street – October 6, 2017 at 7:32 PM – A single vehicle struck a bicyclist using the south leg crosswalk while making a right-turn onto Hamilton.

Table 5-9 Safety Issues for Hamilton Street from Michigan Avenue to Harriet Street

#	Safety Issue	Crash Frequency	Crash Severity	Risk Category
I-15	Mid-block pedestrian crossings	Occasional	Negligible	B
I-16	Vehicle speeding	Occasional	Negligible	B
I-17	Lack of ADA compliant ramps	Rare	Medium	C

Figure 5-18 Potential Improvements near Ferris Street



The RSA team recommends implementation of a road diet consisting of a buffered bike lane and two vehicle travel lanes. For a lower cost alternative, this could be implemented using pavement markings only. For added safety benefit, bollards or a raised curb could be used to protect the bike lane. Moreover, the road diet would also help to reduce vehicle speeds and limit weaving maneuvers associated with the existing three-lane cross-section. Finally, pedestrians would have a shorter distance to cross Hamilton Street.

Near Ferris Street, the RSA team recommends installing a marked crosswalk with ADA compliant ramps and appropriate signage. If the posted speed is reduced, consider installing in-street yield to pedestrian signs for additional safety benefit. Currently, there is a concrete splitter island in the west leg of the intersection with Ferris Street. Consider removing or modifying this island to allow ADA-compliant access

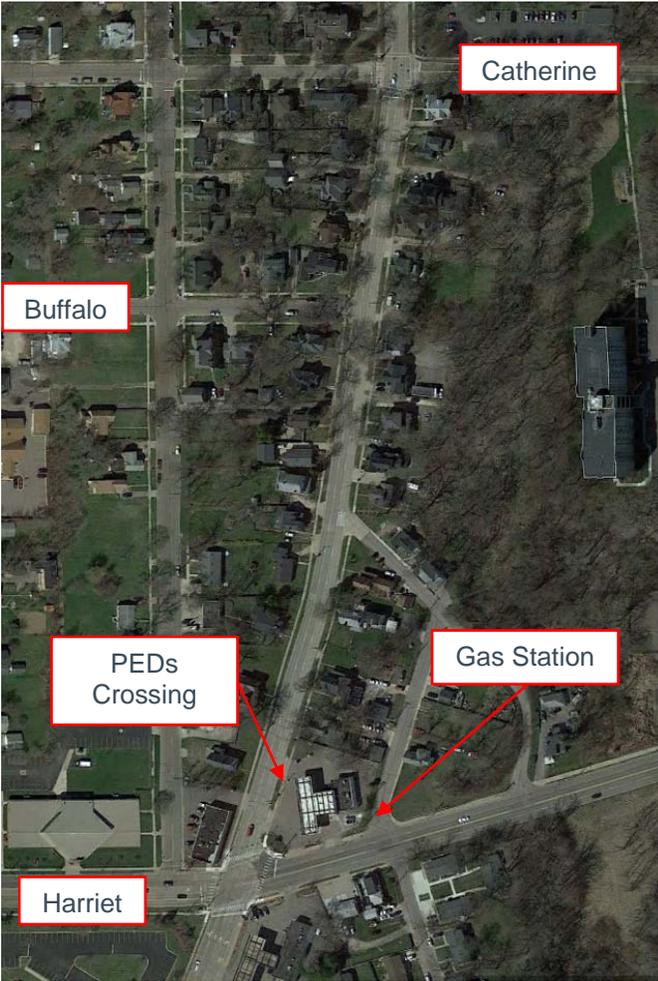
between the two western quadrants. In addition, installing a pedestrian crosswalk at either Buffalo Street or Catherine Street should be considered along with ADA compliant ramps. This would require curb modification for crosswalks spanning Hamilton Street. A study should be conducted at Catherine Street as well to determine the feasibility of a signal for controlled pedestrian and vehicular movements.

Table 5-10 Suggestions for Hamilton Street from Michigan Avenue to Harriet Street

#	Suggestion
S-15	Provide enhanced transverse pavement markings and/or in-street pedestrian crosswalk signs
S-16	Implement road diet with buffered bike lane and/or ITS speed warning
S-17	Install ADA compliant facilities where appropriate
S-18	Study feasibility of signal installation at Catherine Street

5.6. Huron Street from Harriet Street to Michigan Avenue

Figure 5-19 Aerial of Huron Street from Harriet Street to Catherine Street



Huron Street from Harriet Street to Catherine Street is primarily a three-lane cross-section one-way northbound with a posted speed limit of 40 MPH. No bike lane is provided, and sidewalk is present on both sides of Huron Street throughout the length of this segment.

Like Hamilton Street, this segment of Huron Street is primarily residential with numerous driveways throughout. A gas station exists in the northeast quadrant of the intersection with Harriet Street, where several driveways facilitate access. During the RSA field review, pedestrians were observed crossing from the most northern gas station driveway to an alley behind party store bisecting Huron Street and Washington Street.

A single pedestrian crash occurred in this section as follows:

- Huron Street at Harriet Street – April 22, 2016 at 12:05 AM – A single vehicle hit a pedestrian who was crossing east of the intersection outside of the crosswalk.

Figure 5-20 Aerial of Huron Street from Catherine Street to Michigan Avenue



Huron Street from Catherine Street to Michigan Avenue is primarily a one-way northbound roadway with a three-lane cross-section. Speed limits range from 30 to 40 MPH, where 40 MPH exists from Catherine Street to Ferris Street, and 30 MPH is enforced from Ferris Street to Michigan Avenue. At Ferris Street, Huron Street is reduced to a two-lane cross-section that continues north to Michigan Avenue, where a 260 foot left-turn bay is provided along with a through and shared through-right. The lane reduction is facilitated by pavement markings and signage only. No bike lane is provided, and sidewalk is present on both sides of Huron Street throughout the length of this segment.

A mixture of residential and commercial access exists along this section of Huron Street, where an assisted living facility is present between Catherine Street and Woodward Street. In addition, City Hall is in the southeast corner of Huron Street and Michigan Avenue.

No pedestrian or bicycle crashes occurred in this section during the last five years.

Table 5-11 Safety Issues for Huron Street from Harriet Street to Michigan Avenue

#	Safety Issue	Crash Frequency	Crash Severity	Risk Category
I-18	Mid-block pedestrian crossings	Rare	Medium	C
I-19	Speeding	Occasional	Low	C
I-20	A.M. Queuing at Michigan Ave	Occasional	Negligible	B

Like Hamilton Street, marked pedestrian facilities for crossing Huron Street were not available at unsignalized crossings. The RSA recommends the installation of crossings at either Woodward Street or Ferris Street to provide safer mid-block crossings in this area. For the pedestrians crossing north of Harriet, the installation of an R9-3bP “Use Crosswalk” sign may help increase compliance as shown in **Figure 5-21** on the next page. Moreover, a road diet should be considered starting at Harriet Street for the duration of the corridor. Due to width restrictions along the corridor, the RSA team believes only a buffered bike lane or parking lane could be provided and not both.

Figure 5-21 Potential Improvements near Huron Street and Harriet Street



This would allow for design above minimum standards and would prevent conflicts between parked vehicles and bicyclist. The road diet would also have a calming effect on traffic, reducing speeds of vehicles as they approach downtown and reducing the required distance for pedestrians crossing Huron Street. A capacity analysis should be performed to determine the feasibility of a lane diet, with attention placed on the intersection with Michigan Avenue. Additional lanes may be required here to facilitate left and right turning vehicles during peak periods.

Finally, to address the morning queue issue at Michigan Avenue, a review should be conducted of signal timing along the corridor to provide better coordination between the Michigan Avenue and Catherine Street signals. Based on field observations, the RSA team believes more green time could be allocated to Huron Street as Michigan Avenue did not appear to backup and cleared with each cycle. Also, as discussed with Hamilton Street, different timing plans may be needed to accommodate university peak periods based on a proper analysis.



Figure 5-22 AM Queuing at Michigan Avenue

Table 5-12 Suggestions for Huron Street from Harriet Street to Michigan Avenue

#	Suggestion
S-19	Provide pedestrian crossings with enhanced pavement markings and signage
S-20	Implement road diet with buffered bike lane or on-street parking
S-21	Conduct signal timing study

5.7. Huron Street from Michigan Avenue to Cross Street

Figure 5-23 Aerial of Huron Street from Michigan Avenue to Cross Street



Huron Street from Michigan Avenue to Cross Street begins as a one-way northbound roadway, that starts with a two-lane cross-section that expands to three lanes after Pearl Street. Bulb-outs with on-street parking are present in the section from Michigan Avenue to Pearl Street, with a marked pedestrian crosswalk provided at the intersection with Pearl Street. Speed limits range from 30 to 35 MPH, where 30 MPH exists concurrent with the on-street parking between Michigan Avenue and Pearl Street, and increases to 35 MPH with the cross-section change after the intersection with Pearl Street.

Surrounding land use consists of mostly commercial facilities with some residential driveways intermittedly. A bus station is located one block west of Huron Street on Pearl Street, the Ypsilanti Historical Museum is located east of Huron Street near Emmet Street and the Riverside Arts Center is east of Huron Street near Pearl Street.

One pedestrian crash occurred at Cross Street as follows:

- Huron Street at Cross Street – January 9, 2017 at 7:14 AM – A single vehicle turning right from Cross onto Huron struck a pedestrian traveling westbound in the crosswalk.

During field review, several vehicles appeared to have difficulty completing the right-turn from Michigan Avenue to Huron Street due to a tight turning radius. This issue was compounded when two vehicles were making a right at the same time in each of the turning lanes. In those circumstances, the inside vehicle would encroach on the the curb, sometimes breaching the pedestrian ramp area there. Moreover, buses and other commercial vehicles appeared to utilize both turning lanes to complete the turning movement which was related to the tight turning radius.

The RSA team felt the transition area north of Pearl Street had the potential for causing safety conflicts when driving the corridor, as the center lane of the three lane section can be accessed by vehicles in either of the two lanes in the two lane section. Also, Pearl Street was under construction and blocked during the review period and unable to be assessed. Since this intersection was an area of concern for local stakeholders, it should be studied separately under normal operating conditions for pedestrian safety due to the proximity to the bus station.

Finally, when reviewing the intersection with Cross Street, the pedestrian signal was found to confuse drivers leading to reduced compliance with the left-turn signal. Vehicles were observed driving through a solid red after waiting for a substantial period of time without any cross traffic. Some vehicles treated the signal as a yield with minimal stop time. When presented with a green signal, vehicles appeared to use the left-turn lane from Huron Street to Cross Street at relative high speeds, where one RSA team member was nearly sideswiped on Cross Street after a vehicle came through the left-turn lane.

Table 5-13 Safety Issues for Huron Street from Michigan Avenue to Cross Street

#	Safety Issue	Crash Frequency	Crash Severity	Risk Category
I-21	Two-Lane to Three-Lane transition after Pearl Street	Rare	Negligible	A
I-22	Pedestrian and vehicle signal confusion at Cross Street	Rare	Medium	C
I-23	Right-turn conflicts at Michigan Avenue	Rare	Medium	C

Figure 5-24 Right-Turn Conflict at Michigan Avenue



Adding turn-path markings for the dual right-turn lanes at Michigan Avenue would help guide vehicles to the proper receiving lane while completing the turn. As shown in **Figure 5-24**, the white vehicle is encroaching on the path of the approaching black truck. In the video associated with this photo, the white vehicle completes the turn to the outside lane while using the inside lane for most of the maneuver.

For the lane shift after Pearl Street, the RSA team recommends continuing the road diet with parking along the corridor as a long-term solution. This would maintain the two-lane alignment and prevent any conflicting lane

changes among vehicles transitioning to the three-lane section. In the near term, adding lane path markings would help direct drivers to the appropriate receiving lane during the transition.

Finally, for the signal issues at Cross Street, a signal study should be conducted to review phasing requirements and to assess the current operations at the intersection in more detail. This study should also seek to evaluate pedestrian usage and determine if the current pushbutton operation is appropriate. To reduce sideswipe-same crashes related to vehicles exiting the left-turn onto Cross Street, extending solid pavement markings or introducing a raised median to prevent the lane-change maneuver are recommended.

Table 5-14 Suggestions for Huron Street from Michigan Avenue to Cross Street

#	Suggestion
S-22	Implement road diet or install lane-path markings
S-23	Conduct operations and timing study
S-24	Install turn-path markings and consider leading pedestrian interval

5.8. General Observations

Figure 5-25 Sight Distance and Signal Obstructions



General issues observed along the corridor included several instances of vegetation limited sight distance of vehicles entering the corridor. In addition, there was also one case of a tree obscuring the traffic signal at Hamilton Street and Harriet Street. Examples of these findings are shown in **Figure 5-25**.

During the nighttime review, the RSA team observed the corridor following a rain event and found that drainage was a significant issue throughout the study area. While the event was strong, the catch basins should undergo cleaning and a drainage review should be conducted as part of any future projects in this area.

Finally, the RSA team reviewed the I-94 interchange area and found evidence of pedestrian activity in the center median that divides Huron Street and Hamilton Street here. Informal walking paths were present and lead to both signals serving the I-94 westbound off ramp (one at Huron Street and Hamilton Street, respectively). As such, we recommend installation of pedestrian facilities to accommodate this activity. Previous studies indicate a separate bridge would help pedestrians traverse this in the safest manner and would not disturb the existing bridge structure.

Appendices





Appendix A. RITIS Segment Data

A.1. January through April

Description	TMC	Average Speed by Hour of Day (MPH)																							
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Huron from I-94 WB Exit to S of Michigan	108+09423	27.2	27.0	27.1	27.2	27.2	27.4	25.4	22.7	22.0	23.9	25.6	25.4	24.8	25.6	24.9	24.0	23.8	24.9	26.6	27.4	28.4	27.1	26.9	
Cross from Hamilton to Normal	108+07504	25.1	25.0	25.2	25.2	25.0	25.8	24.5	24.4	24.8	25.5	24.8	23.8	23.3	23.9	23.4	23.8	24.4	23.8	23.6	22.9	23.4	24.7	25.3	25.2
Cross from Normal to Mansfield	108+07503	24.4	24.3	24.3	24.4	24.2	22.4	22.4	23.7	23.3	22.2	22.8	22.1	21.1	22.5	21.9	22.8	22.4	21.8	22.4	22.5	23.5	23.9	24.4	24.4
Washtenaw from Normal to Hamilton	108-09348	29.3	29.2	29.3	29.2	29.1	33.2	33.0	29.5	29.0	28.0	29.0	28.6	29.0	28.9	28.0	27.2	27.4	28.2	29.0	28.8	29.0	29.0	29.3	29.3
Hamilton from Michigan to S of Harriet	108-09422	29.9	29.8	29.9	29.8	29.9	32.4	33.2	30.9	29.2	29.4	29.8	29.2	28.4	28.6	27.9	26.3	26.3	27.0	28.8	30.0	29.5	30.4	30.2	30.0
Hamilton from Washtenaw to Pearl	108-09352	25.0	25.0	25.1	24.9	24.9	27.5	26.6	24.6	23.2	23.4	24.7	23.5	22.4	23.0	22.1	21.3	22.0	22.6	24.0	24.2	24.0	24.1	25.0	25.1
Huron from Pearl to Cross, Cross from Huron to Hamilton	108+09348	24.1	23.9	24.1	24.1	24.1	24.0	23.7	25.3	24.9	24.8	24.6	24.1	22.9	23.3	24.4	24.4	23.9	23.0	22.9	23.6	24.1	24.4	24.3	24.1
Huron from Michigan and Pearl	108+09352	16.1	16.1	16.1	16.0	16.1	14.5	12.7	13.4	13.3	12.7	13.3	13.5	13.4	13.0	13.7	14.6	14.4	13.7	14.5	13.8	12.9	14.1	16.1	16.3
Huron from Pearl to Washtenaw	108+07505	24.3	24.1	24.1	24.0	24.1	24.6	24.9	24.8	24.8	25.1	24.7	24.3	24.3	24.6	24.2	24.3	24.5	24.4	24.2	25.2	25.0	25.7	24.6	24.4
Huron from I-94 Overpass to WB I-94 Exit Ramp	108P09422	29.8	30.3	30.5	30.8	30.4	30.0	28.1	27.5	27.7	28.2	29.5	29.4	29.6	29.0	28.6	27.8	26.0	26.7	27.8	28.8	29.4	30.1	30.0	29.9
Washtenaw from Mansfield to Normal	108-07504	28.3	28.2	28.0	28.1	27.9	30.6	28.7	25.8	25.3	25.9	26.3	25.4	25.3	25.7	24.4	24.1	23.8	22.7	23.4	25.5	26.2	25.7	27.5	28.1
Washtenaw to Hamilton Right-Turn	108-07505	26.2	26.1	26.1	26.0	26.0	30.0	29.9	28.3	27.2	25.7	25.6	25.7	25.4	25.5	24.7	23.5	23.4	23.8	24.9	24.2	24.5	24.4	26.1	26.3

A.2. May through August

Description	TMC	Average Speed by Hour of Day (MPH)																							
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Huron from I-94 WB Exit to S of Michigan	108+09423	25.2	25.1	25.1	25.1	25.2	26.0	23.7	21.8	21.1	22.6	24.0	23.2	23.2	23.4	23.4	22.7	22.4	22.6	23.4	25.0	25.5	25.5	25.2	25.1
Cross from Hamilton to Normal	108+07504	26.0	26.1	26.1	26.2	26.0	24.9	25.0	23.7	23.8	24.8	25.2	24.5	24.0	23.6	24.5	24.5	25.1	25.2	26.6	26.3	25.0	24.1	25.9	26.1
Cross from Normal to Mansfield	108+07503	26.1	26.1	26.1	26.2	26.0	22.3	23.4	23.0	22.9	24.1	25.2	23.7	24.0	23.6	24.1	24.4	24.1	25.1	25.0	24.7	24.8	24.9	26.0	26.2
Washtenaw from Normal to Hamilton	108-09348	30.2	30.0	30.0	30.1	30.1	31.9	29.8	29.8	29.4	28.2	28.4	28.1	28.0	28.1	28.2	27.2	27.2	26.7	28.3	28.6	29.0	28.6	30.1	30.1
Hamilton from Michigan to S of Harriet	108-09422	28.9	29.0	29.0	28.9	29.0	30.1	29.4	29.4	29.4	28.8	28.2	27.8	27.8	27.8	27.5	26.2	25.8	25.8	27.2	28.4	29.2	29.5	29.1	28.9
Hamilton from Washtenaw to Pearl	108-09352	23.2	23.1	23.2	23.1	23.0	25.0	24.2	23.1	22.5	23.4	23.4	23.1	23.1	23.1	22.1	20.3	21.6	21.0	23.2	24.6	24.1	21.7	23.2	23.2
Huron from Pearl to Cross, Cross from Huron to Hamilton	108+09348	25.0	25.1	25.0	25.1	25.0	28.1	25.1	24.2	24.3	24.4	24.4	25.3	24.2	23.4	24.2	24.6	25.1	24.0	24.1	25.1	25.0	25.0	24.9	25.0
Huron from Michigan and Pearl	108+09352	17.1	17.1	17.0	17.3	17.2	18.2	19.5	16.2	15.6	15.3	15.3	14.9	14.6	15.0	14.8	14.9	15.0	15.3	15.4	15.0	14.1	16.4	17.1	17.1
Huron from Pearl to Washtenaw	108+07505	24.1	24.1	24.0	24.0	24.0	23.5	23.8	23.6	24.1	24.1	24.1	24.6	24.5	23.9	23.9	23.8	24.2	23.6	23.9	24.5	24.6	23.8	24.3	24.3
Huron from I-94 Overpass to WB I-94 Exit Ramp	108P09422	30.9	31.0	31.2	31.2	31.4	29.0	28.9	29.1	28.1	30.1	29.7	30.0	29.5	29.7	29.6	28.0	27.5	27.9	28.6	28.9	28.7	29.6	30.8	30.8
Washtenaw from Mansfield to Normal	108-07504	25.1	25.0	25.1	25.1	25.0	30.3	23.6	22.1	20.8	21.4	23.3	23.1	22.5	22.4	21.1	21.4	21.1	20.6	21.4	22.0	21.3	19.7	24.6	25.0
Washtenaw to Hamilton Right-Turn	108-07505	26.3	26.1	26.0	26.1	26.1	28.3	25.6	25.2	25.3	25.2	24.3	24.0	24.5	24.4	23.9	23.4	23.5	22.8	24.1	23.5	24.2	24.4	25.8	26.2

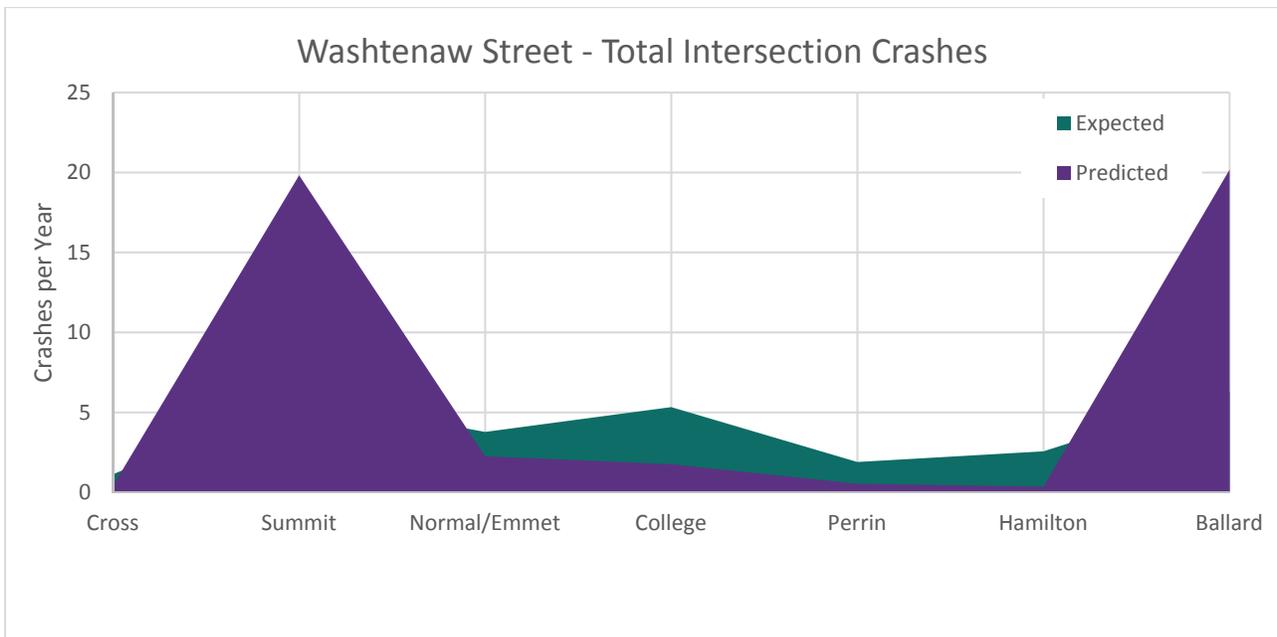
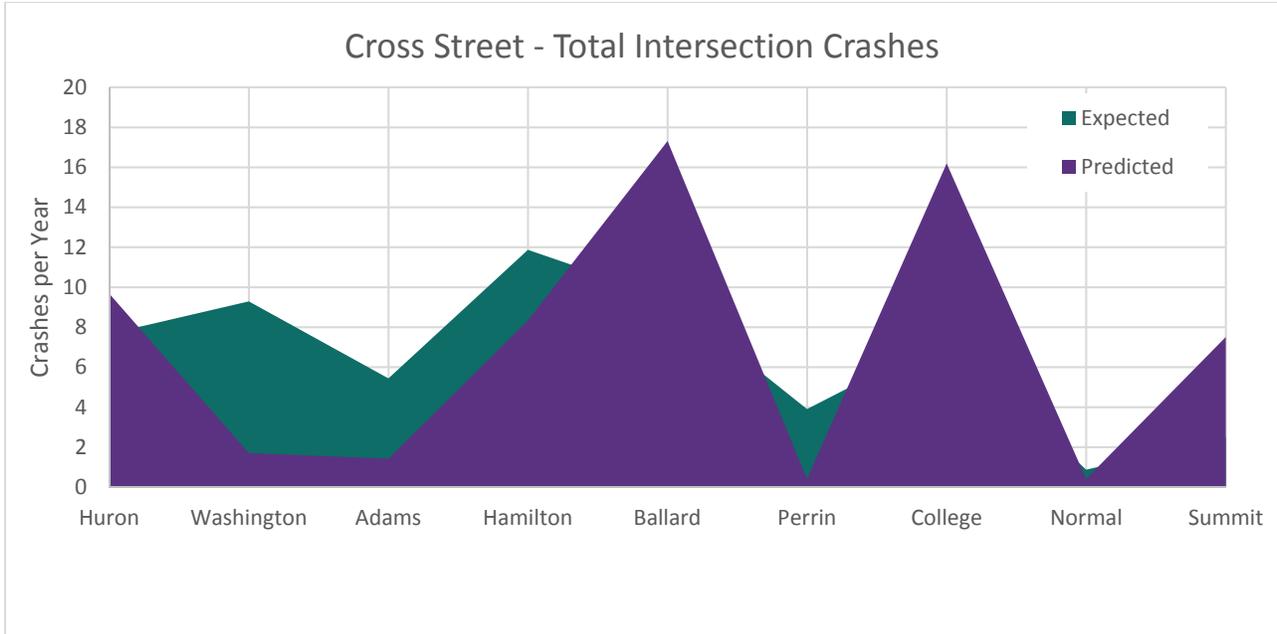


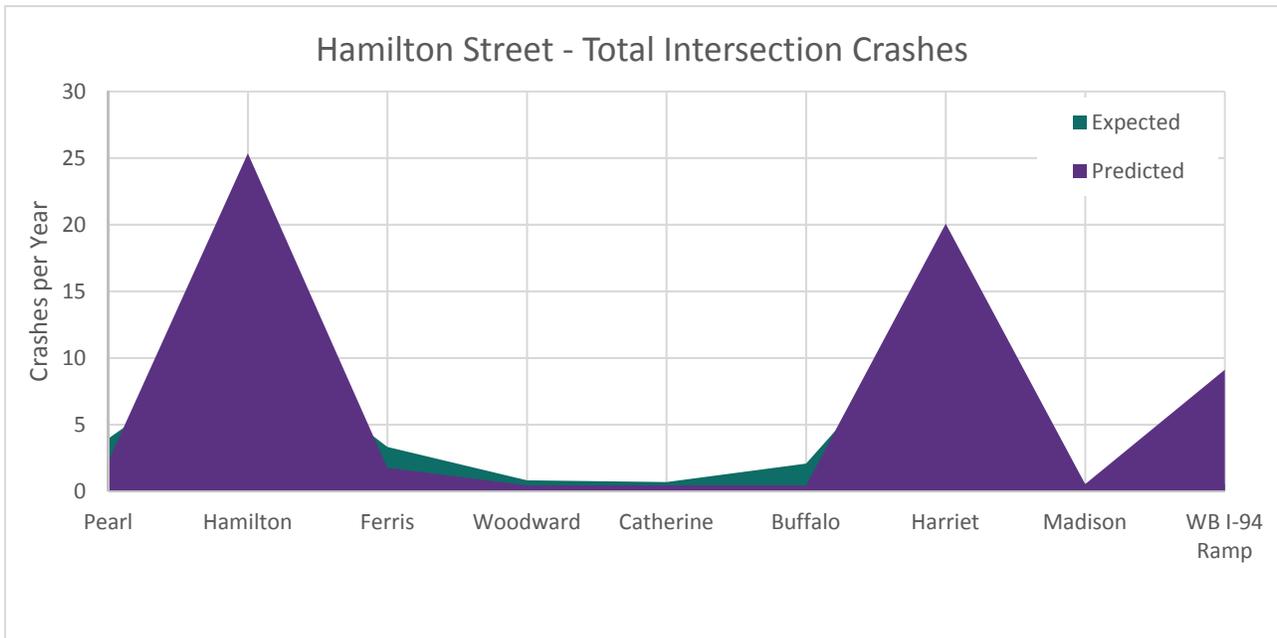
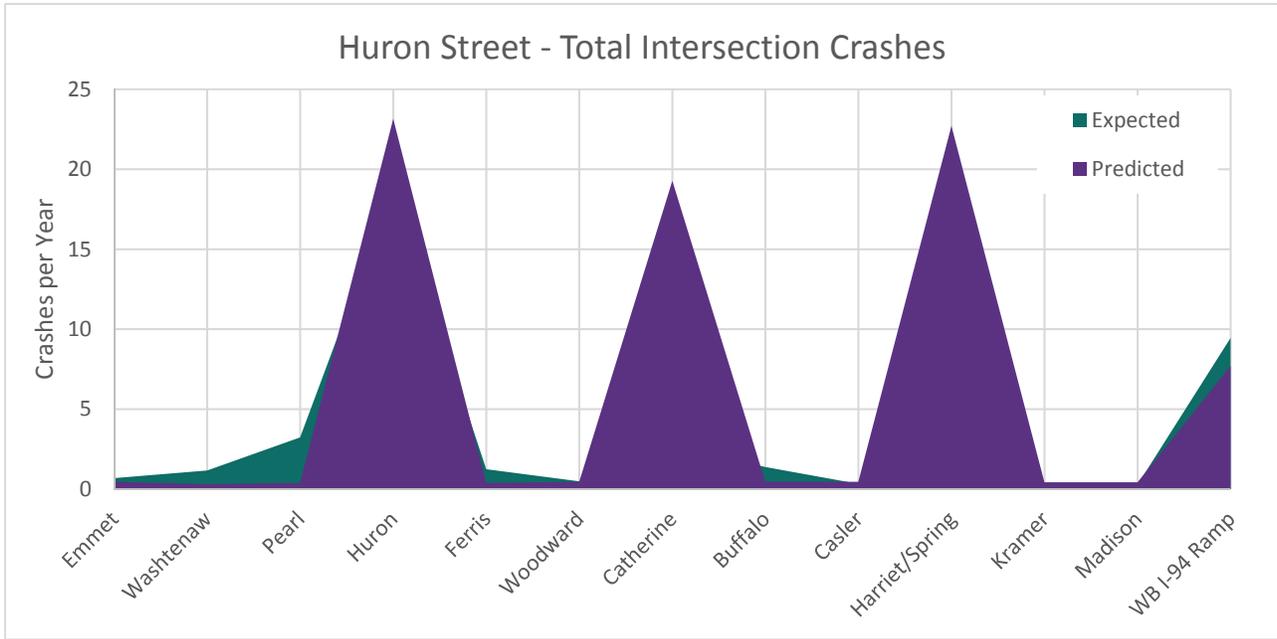
Appendix B. Crash Data

Corridor	Intersection	Observed Annual Crashes			Predicted Annual Crashes			Expected Annual Crashes		
		F & I	PDO	Total	F & I	PDO	Total	F & I	PDO	Total
Cross	Huron	1.4	6.2	7.6	1.60	8.07	9.67	1.42	6.24	7.67
Cross	Washington	1.8	8.8	10.6	0.68	1.02	1.70	1.68	7.61	9.29
Cross	Adams	1.4	5	6.4	0.72	0.70	1.42	1.33	4.11	5.44
Cross	Hamilton	1.6	10.4	12	1.31	7.04	8.35	1.56	10.31	11.87
Cross	Ballard	1.2	8.2	9.4	2.74	14.58	17.32	1.24	8.23	9.47
Cross	Perrin	0.4	9.2	9.6	0.08	0.33	0.41	0.12	3.78	3.90
Cross	College	1	6.4	7.4	2.59	13.60	16.19	1.04	6.44	7.48
Cross	Normal	0.4	1.4	1.8	0.08	0.33	0.41	0.12	0.75	0.87
Cross	Summit	0	2.2	2.2	0.97	6.54	7.51	0.17	2.32	2.50
Washtenaw	Cross	0.4	2.4	2.8	0.18	0.23	0.41	0.23	0.90	1.13
Washtenaw	Summit	0.2	5.6	5.8	3.09	16.73	19.82	0.27	5.65	5.92
Washtenaw	Normal/Emmet	0.4	3.6	4	0.88	1.37	2.25	0.44	3.34	3.78
Washtenaw	College	0.6	5.6	6.2	0.95	0.80	1.75	0.63	4.70	5.33
Washtenaw	Perrin	1.4	3	4.4	0.11	0.42	0.53	0.31	1.58	1.89
Washtenaw	Hamilton	0.2	8	8.2	0.14	0.20	0.35	0.15	2.40	2.56
Washtenaw	Ballard	1.6	4.6	6.2	3.15	17.03	20.18	1.64	4.66	6.29
Huron	Emmet	0.4	0.8	1.2	0.09	0.37	0.46	0.13	0.55	0.68
Huron	Washtenaw	0.6	3	3.6	0.11	0.20	0.31	0.19	0.97	1.15
Huron	Pearl	0.4	7.8	8.2	0.07	0.31	0.38	0.11	3.12	3.23
Michigan	Huron	1.8	17	18.8	3.62	19.54	23.16	1.84	17.01	18.85
Huron	Ferris	0	2.6	2.6	0.07	0.31	0.38	0.07	1.17	1.24
Huron	Woodward	0.2	0.4	0.6	0.09	0.37	0.46	0.10	0.38	0.48
Huron	Catherine	0.4	2.2	2.6	3.13	16.15	19.28	0.46	2.27	2.73
Huron	Buffalo	0	2.6	2.6	0.09	0.37	0.46	0.08	1.30	1.37
Huron	Casler	0.2	0	0.2	0.09	0.37	0.46	0.10	0.21	0.32
Huron	Harriet/Spring	3	9.8	12.8	3.84	18.87	22.70	3.02	9.84	12.85
Huron	Kramer	0.2	0.2	0.4	0.08	0.34	0.42	0.10	0.29	0.38
Huron	Madison	0	0	0	0.08	0.34	0.42	0.07	0.21	0.28
Huron	WB I-94 Ramp	2	7.6	9.6	1.17	6.52	7.70	1.87	7.57	9.44
Hamilton	Pearl	0.4	3.8	4.2	0.88	1.38	2.27	0.44	3.51	3.96
Michigan	Hamilton	0.6	10.6	11.2	4.07	21.29	25.35	0.66	10.64	11.30
Hamilton	Ferris	0.8	2.8	3.6	0.73	1.03	1.76	0.79	2.53	3.32
Hamilton	Woodward	0.4	1.2	1.6	0.08	0.35	0.43	0.12	0.69	0.82

Corridor	Intersection	Observed Annual Crashes			Predicted Annual Crashes			Expected Annual Crashes		
		F & I	PDO	Total	F & I	PDO	Total	F & I	PDO	Total
Hamilton	Catherine	0.6	0.8	1.4	0.08	0.35	0.43	0.15	0.53	0.68
Hamilton	Buffalo	1.4	4	5.4	0.08	0.35	0.43	0.25	1.82	2.07
Hamilton	Harriet	2.8	11	13.8	3.33	16.74	20.07	2.81	11.03	13.84
Hamilton	Madison	0.2	0.4	0.6	0.11	0.42	0.53	0.12	0.41	0.53
Hamilton	WB I-94 Ramp	0	0.2	0.2	1.15	7.97	9.12	0.18	0.38	0.56

Appendix C. EB-Method Analysis – Total Crashes





Appendix D. Safety Issues

#	Safety Issue	Crash Frequency	Crash Severity	Risk Category
I-1	Delivery vehicles impeding bike and vehicle traffic	Rare	Low	B
I-2	No buffer space for bike lanes	Occasional	Medium	D
I-3	Poor pavement markings for crosswalks, bike lanes and lane lines	Occasional	Medium	D
I-4	Uncontrolled pedestrian crossings	Occasional	Medium	D
I-5	Abrupt termination of bike lane at west end of corridor	Rare	Medium	C
I-6	Lack of ADA ramps	Rare	Medium	C
I-7	Uncontrolled pedestrian crossings	Occasional	Medium	D
I-8	High vehicle speeds	Rare	Medium	C
I-9	Horizontal curve present after sagging vertical curve	Rare	Medium	C
I-10	Queuing at Ballard Street signal in right lane	Occasional	Low	C
I-11	Pedestrians crossing free-flow right at Hamilton Street	Rare	High	D
I-12	P.M. Queuing at Michigan Avenue	Occasional	Negligible	B
I-13	Weaving	Occasional	Negligible	B
I-14	Left-turn conflicts	Rare	Medium	C
I-15	Mid-block pedestrian crossings	Occasional	Negligible	B
I-16	Vehicle speeding	Occasional	Negligible	B
I-17	Lack of ADA compliant ramps	Rare	Medium	C
I-18	Mid-block pedestrian crossings	Rare	Medium	C
I-19	Speeding	Occasional	Low	C
I-20	A.M. Queuing at Michigan Avenue	Occasional	Negligible	B
I-21	Two-Lane to Three-Lane transition after Pearl Street	Rare	Negligible	A
I-22	Pedestrian and vehicle signal confusion at Cross Street	Rare	Medium	C
I-23	Right-turn conflicts at Michigan Avenue	Rare	Medium	C

Appendix E. Suggestions

#	Suggestion
S-1	Provide flex spaces for designated loading zones based on time of day.
S-2	Provide buffer lane with optional enhancements
S-3	Provide enhanced transverse pavement markings and/or in-street pedestrian crosswalk signs
S-4	Provide enhanced transverse pavement markings and/or in-street pedestrian crosswalk signs
S-5	Implement shared lane markings per the MMUTCD or install a transition ramp
S-6	Install ADA compliant facilities
S-7	Provide enhanced transverse pavement markings and/or in-street pedestrian crosswalk signs
S-8	Implement road diet with buffered bike lane and/or ITS speed warning
S-9	Install W3-4 "Be Prepared to Stop" with flasher interconnected to signal
S-10	Remove signal from Ballard Street; Install signal at Hamilton Street
S-11	Install pedestrian crossing fully visible to approaching vehicles
S-12	Re-time signals based on recent counts
S-13	Close continuous free-flow lane for better vehicle positioning coming from Washtenaw Avenue
S-14	Stagger the Westbound stop-bar and add turn-path markings
S-15	Provide enhanced transverse pavement markings and/or in-street pedestrian crosswalk signs
S-16	Implement road diet with buffered bike lane and/or ITS speed warning
S-17	Install ADA compliant facilities where appropriate
S-18	Study feasibility of signal installation at Catherine Street
S-19	Provide pedestrian crossings with enhanced pavement markings and signage
S-20	Implement road diet with buffered bike lane or on-street parking
S-21	Conduct signal timing study
S-22	Implement road diet or install lane-path markings
S-23	Conduct operations and timing study
S-24	Install turn-path markings and consider leading pedestrian interval

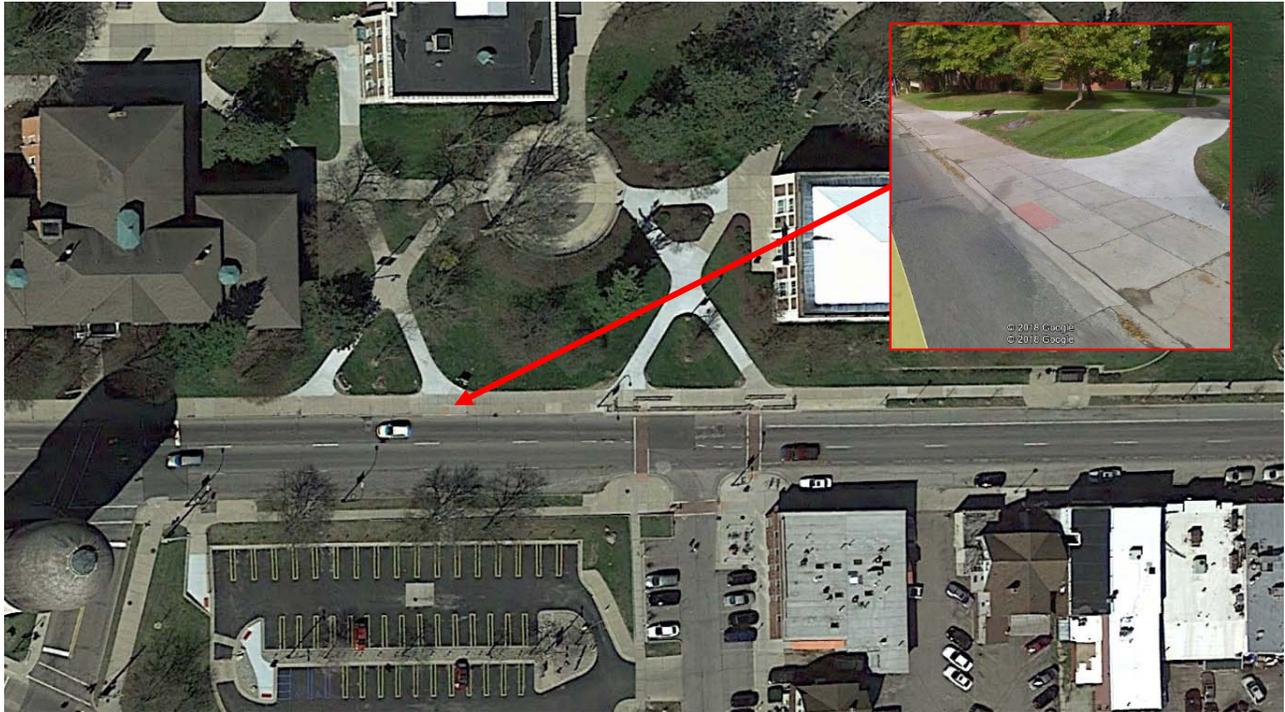
Appendix F. Bike Lane Transition Options

F.1. Option A – Install a Bike Lane Transition Ramp



Installing a bike lane transition ramp like the one pictured to the left would terminate the bike lane just west of the water tower and allow bicyclists to transition onto the sidewalk and into the Eastern Michigan University campus.

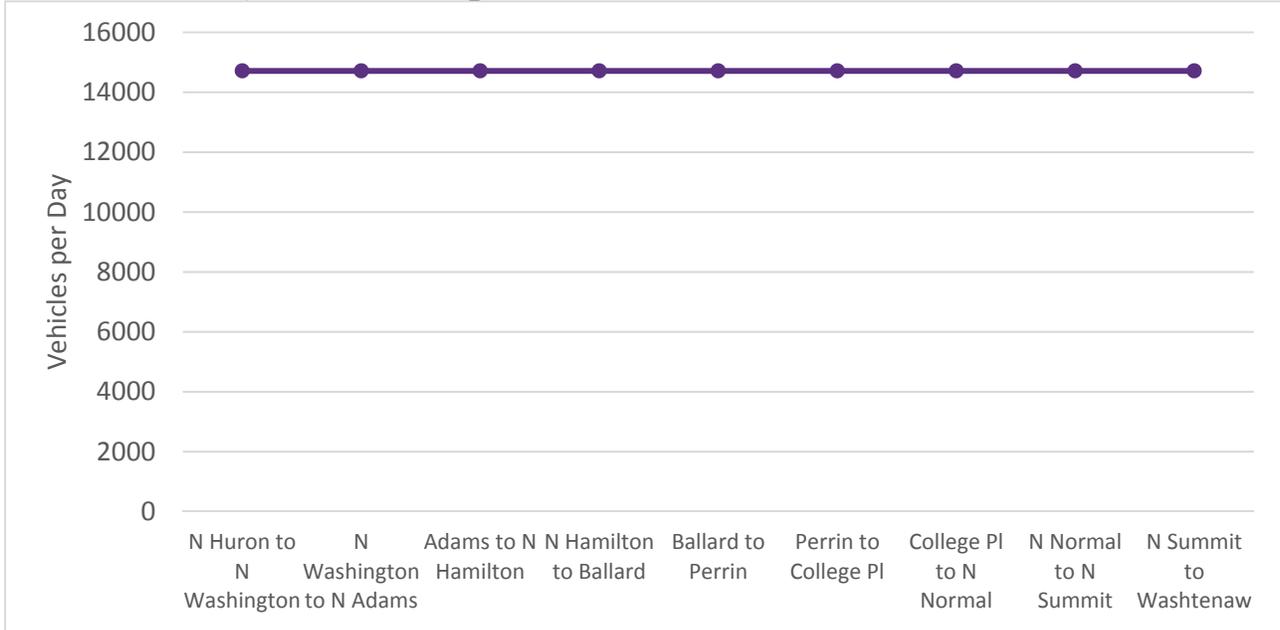
F.2. Option B – Utilize an Existing Ramp for Transition



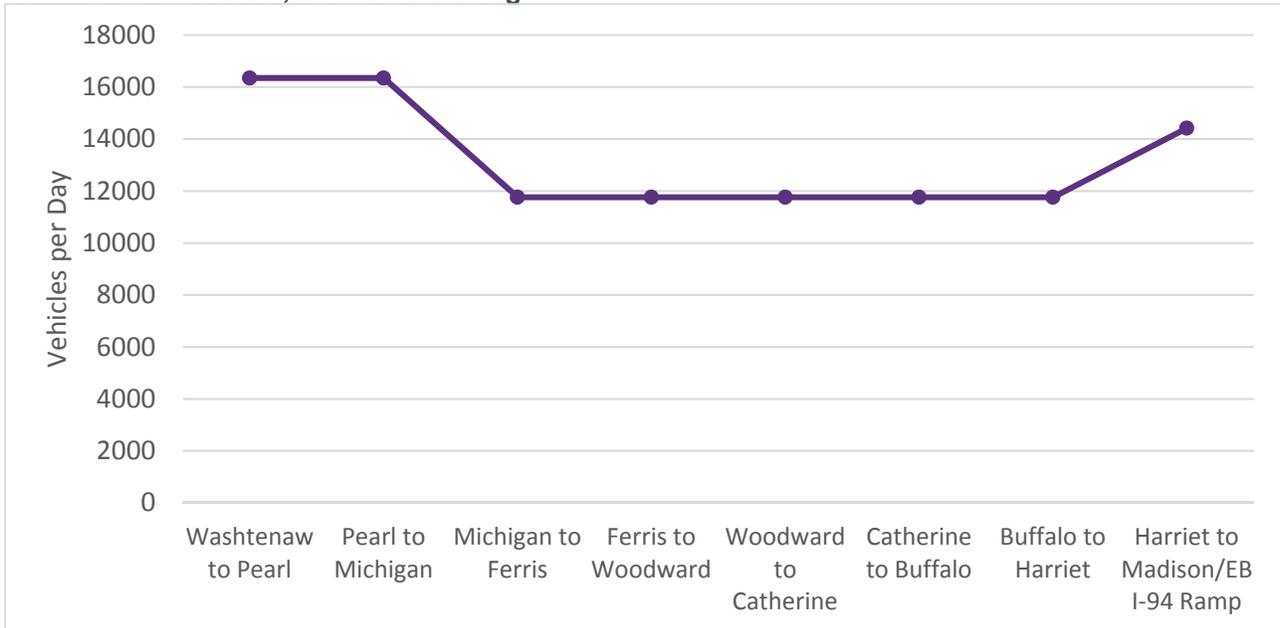
This option would utilize an existing ramp just west of the existing termination point to allow bicyclist to transition onto the sidewalk and into campus.

Appendix G. Corridor Volume Data

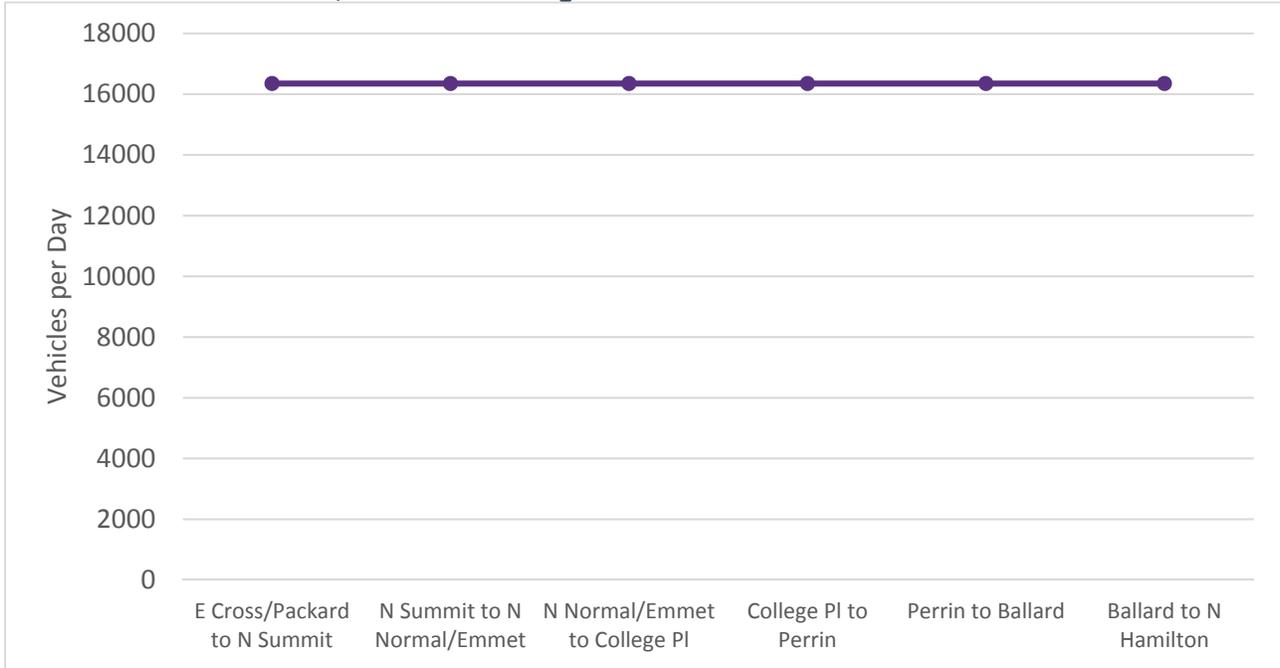
Cross Street AADT, 2013-2017 Average



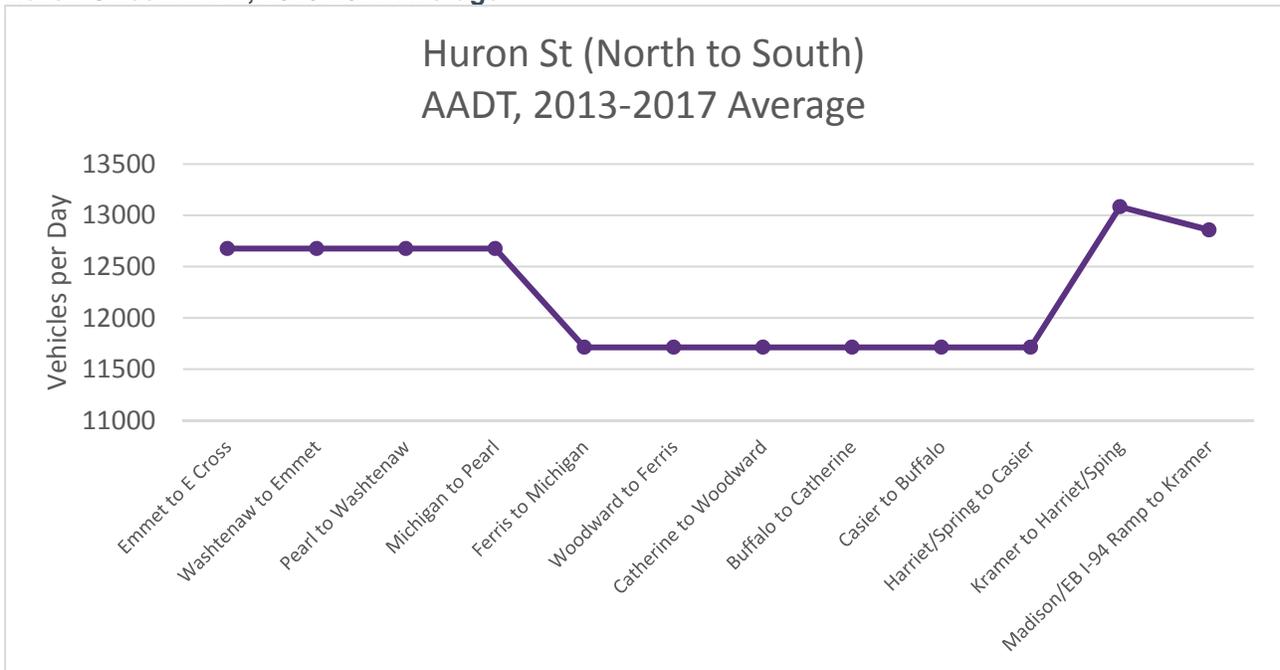
Hamilton Street AADT, 2013-2017 Average



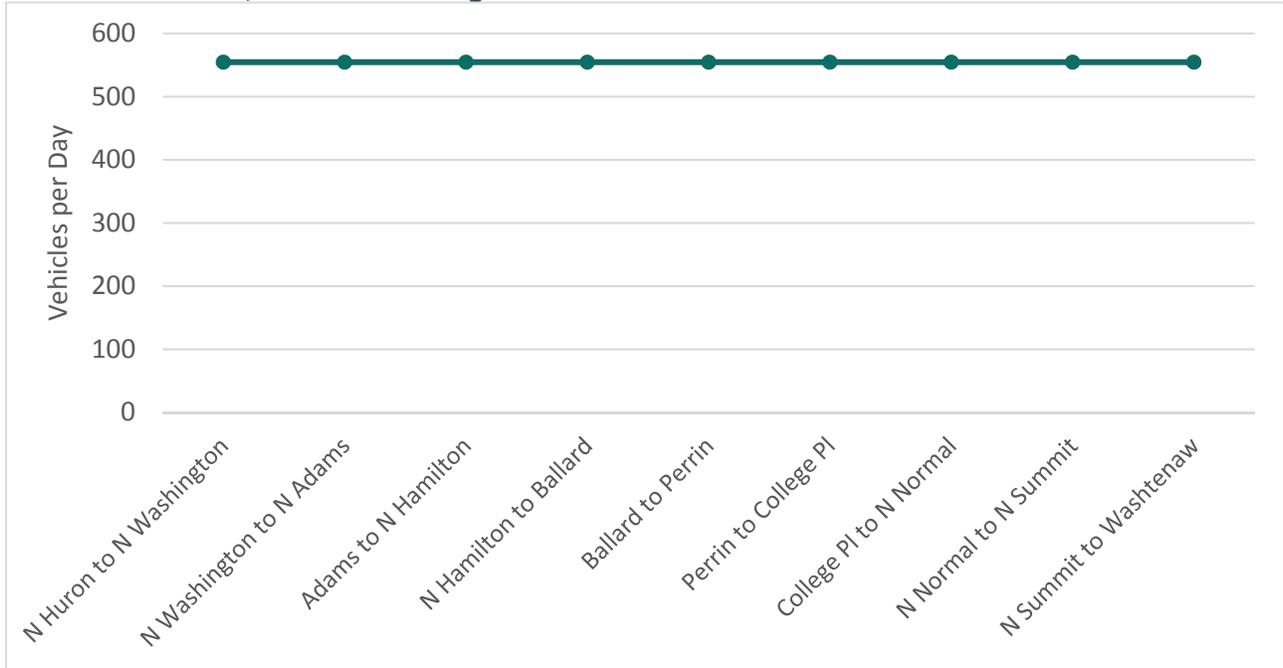
Washtenaw Avenue AADT, 2013-2017 Average



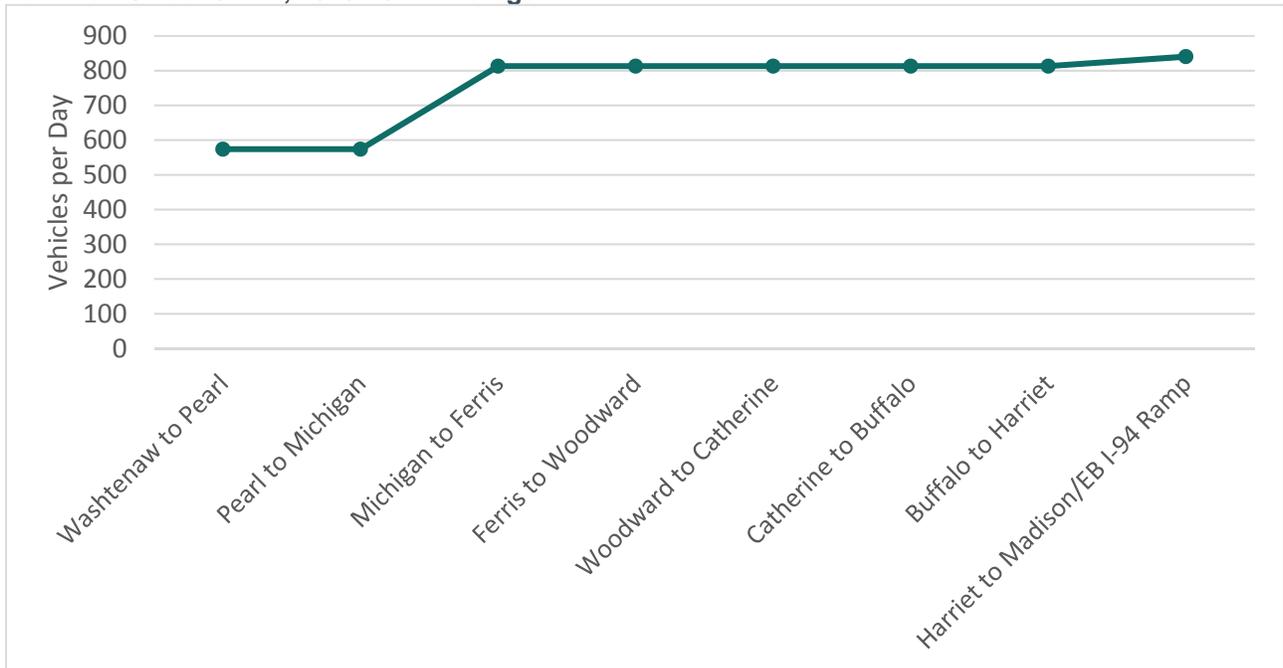
Huron Street AADT, 2013-2017 Average



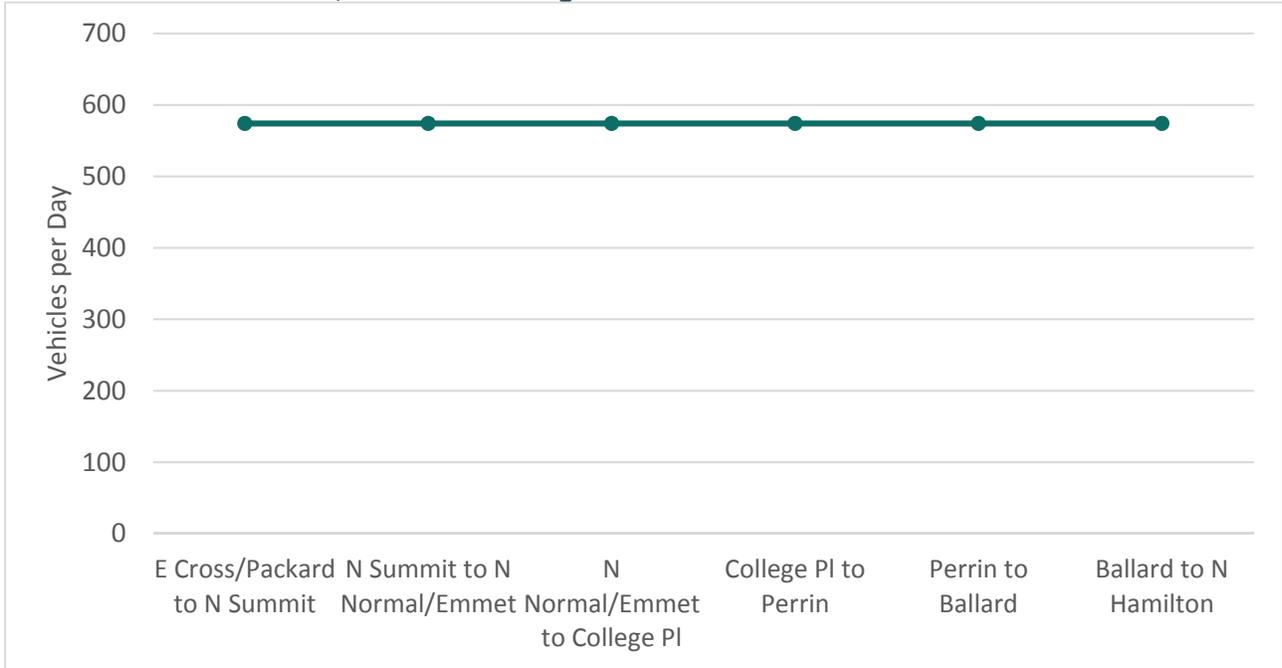
Cross Street CADT, 2013-2017 Average



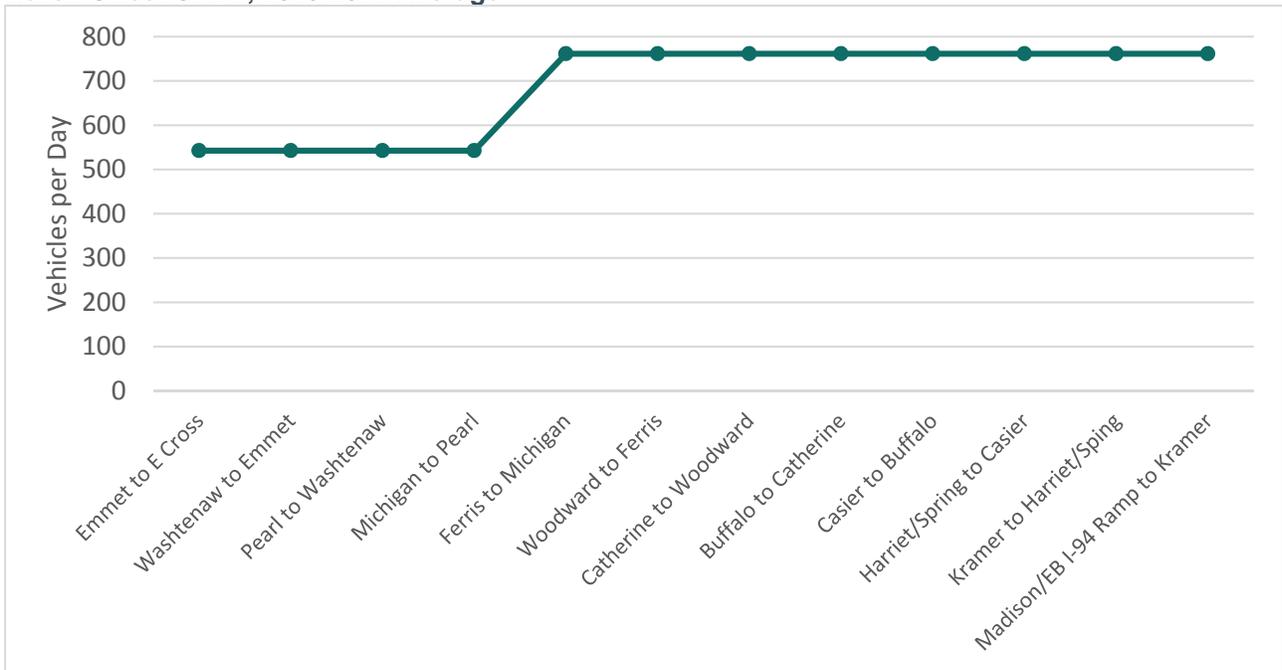
Hamilton Street CADT, 2013-2017 Average



Washtenaw Avenue CADT, 2013-2017 Average



Huron Street CADT, 2013-2017 Average



Appendix H. iRAP Risk Score Maps

