CITY OF MADISON HIGH INJURY NETWORK 2017-2019

Evaluation of Crash Frequency with Equivalent Property Damage Only (EPDO)

Prepared by

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1. INTRODUCTION

High Injury Network (HIN) consists of mapping roadway corridors of a network and evaluate the associated number of people killed and severely injured in traffic crashes. Adoption of a HIN is recommended in Vision Zero, which is a strategy aimed at eliminating all traffic fatalities and severe injuries, while increasing safe, healthy, and equitable mobility for all road users.

The City of Madison is in the process of adopting a Vision Zero strategy. Accounting for resources available, a practical and repeatable process to develop and update a HIN was developed for the period of 2017-2019. The period of analysis was specifically selected to address the implementation of Wisconsin's new crash report format (DT4000) in 2017. Also, year 2020 was not included in the analysis since the pandemic has had a significant effect in traffic volume and crash patterns.

The methodology consisted of network segmentation into intersections and segments, crash data collection, and evaluation of crash frequency analysis using the Equivalent Property Damage Only (EPDO) for all crashes and safety focus areas. Figure 1 illustrates an overview of the methodology for the development of the HIN for the City of Madison. The following sections of the methodology describe each step of the process in more detail.

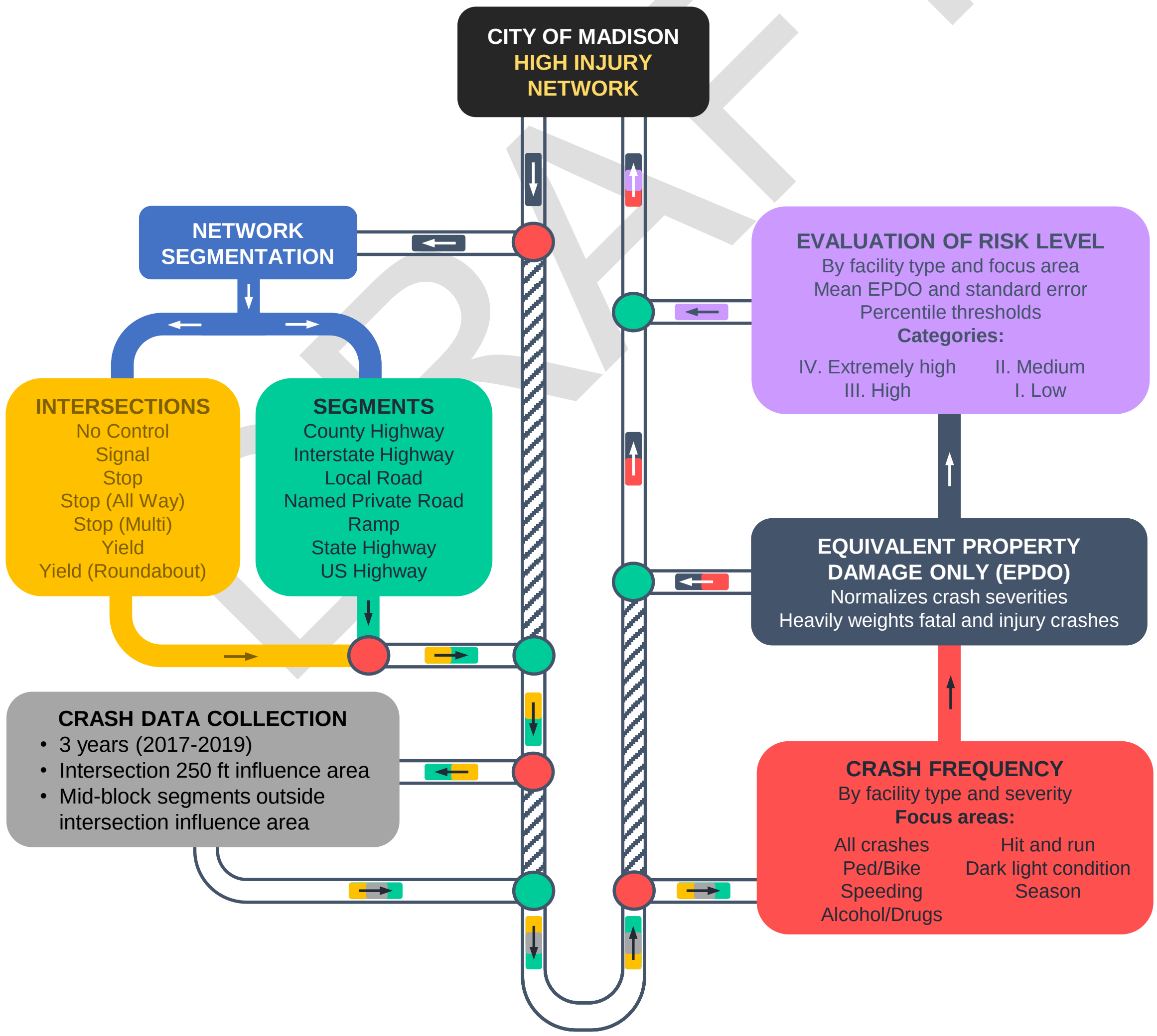


Figure 1. Overview of High Injury Network Development Methodology

2. METHODOLOGY

2.1. Network Segmentation

The City of Madison used existing GIS network layers to divide the network according to the roadway facility. For intersections, a buffer of 250 ft was used to delineate the area of influence of intersections. Segments were designated as continuous mid-block roadway sections outside the 250 ft buffer of intersections. Some assumptions were be made in cases where intersections are closely spaced and have overlapping buffers. Each roadway element was coded and assigned geometric and operational attributes to further categorize the type of intersection and roadway segment. Table 1 provides a summary of the number of intersections and segments evaluated in the study.

Table 1. Summary of Facilities Evaluated

Facility	Classification	Count
Intersections	No Control	1,968
	Signal	311
	Stop	2,102
	Stop (All Way)	84
	Stop (Multi)	10
	Yield	107
	Yield (Roundabout)	8
	All	**4,590**
Segments	County Highway	249
	Interstate Highway	5
	Local Road	8,314
	Named Private Road	40
	Ramp	10
	State Highway	65
	US Highway	172
	All	**8,855**

2.2. Crash Data Collection

With the network divided into intersections and segments, crash data was collected and assigned to each of the roadway facilities in the network. The period of analysis was carefully selected since the new crash report was implemented in 2017 and the pandemic influenced traffic and crashes in 2020. Thus, the period of analysis in this first version of the HIN is of three years (2017-2019), which will be followed by a four-year period (2017-2020) and five-year period (2017-2021), and subsequent periods of analysis will continue using a five-year rolling period (i.e., 2018-2022). Periods of analysis including years 2020 and 2021 will have to account for the effect of the pandemic.

2.3. Crash Frequency

Evaluating safety in terms of crash frequency is one of the simplest forms of safety analysis. Crash frequency is defined as the number of crashes that occur over a period of analysis at a roadway facility. Crash frequency may be evaluated in crashes per year through yearly crash averaging or crashes per entire period of analysis. In this study, crashes during the three-year period (2017-2019) were evaluated without yearly averaging. Also, roadway segments were normalized to crashes per mile during the three-year period. Table 2 provides examples of crash frequency estimates for an intersection and a segment.

For instance, the crash frequency evaluated for an intersection was **11 crashes over three years** and the crash frequency for a **two-mile** segment was **10 crashes per mile over three years**.

Table 2. Crash Frequency Examples

<table>
<tr><td rowspan="5">Intersection</td><td>Year</td><td>Crashes</td><td>Period</td><td colspan="2">Crash Frequency</td></tr>
<tr><td>2017</td><td>4</td><td>1 year</td><td colspan="2">4 crashes/year</td></tr>
<tr><td>2018</td><td>2</td><td>1 year</td><td colspan="2">2 crashes/year</td></tr>
<tr><td>2019</td><td>3</td><td>1 year</td><td colspan="2">3 crashes/year</td></tr>
<tr><td>2017-2019</td><td>9</td><td>3 years</td><td colspan="2">9 crashes/3-year</td></tr>
<tr><td rowspan="5">Segment</td><td>Year</td><td>Crashes</td><td>Period</td><td>Length</td><td>Crash Frequency</td></tr>
<tr><td>2017</td><td>10</td><td>1 year</td><td>2 miles</td><td>5 crashes per mile/year</td></tr>
<tr><td>2018</td><td>6</td><td>1 year</td><td>2 miles</td><td>3 crashes per mile/year</td></tr>
<tr><td>2019</td><td>4</td><td>1 year</td><td>2 miles</td><td>2 crashes per mile/year</td></tr>
<tr><td>2017-2019</td><td>20</td><td>3 years</td><td>2 miles</td><td>10 crashes per mile/3-year</td></tr>
</table>

Crash frequency estimates were obtained for different focus areas:

- All crashes
- Pedestrians and bicycles
- Speeding
- Hit and run
- Alcohol and drugs
- Dark lighted condition
- Dark unlighted condition
- Summer and fall seasons
- Winter and spring seasons

2.4. Equivalent Property Damage Only (EPDO)

Wisconsin specific crash costs and EPDO weighs were available from the Madison MPO 2012-2016 network screening project. This section of the report provides an overview of the methodology to obtain EPDO estimates.

Wisconsin CODES data was used to estimate jurisdiction specific crash costs by crash type and severity. Crash costs were used to estimate EPDO weights. CODES database provides cost estimates for medical, societal, and quality of life costs by person injured in a crash. Crash and hospital databases were linked to categorize injuries by part of the body, fracture involvement, and threat to life. Cost estimates were also provided for non-hospitalized crash cases using the Bureau of Labor Statistics data. Costs were adjusted for inflation (standard CPI changes).

Persons injured in crash cases were used to estimate crash costs by type and severity. Types of crashes were classified by motor vehicle-pedestrian (Ped), motor vehicle-bicycle (Bike), and motor vehicle (Veh) crashes. Crash severity classification adopted was conventional KABCO scale (K, Fatal; A, Incapacitating; B, Non-incapacitating; C, Possible Injury; and O, Property Damage). Person injured crash costs had to be translated to costs per crash. Each person injured identification number was linked to the corresponding crash report identification number. Since police crash reports are designated by the highest injury severity observed from one of the persons injured in the crash, multiple individuals with different injury severities may be involved in the crash. All persons injured crash costs by injury severity were included in the calculation of the overall crash costs with the designated maximum severity. Person injured severity was also available in terms of Maximum Abbreviated Injury Scale (MAIS) which was used to further evaluate crash costs.

EPDO weights were obtained as a function of crash types and severities. The base property damage cost was $24,322, which corresponds to the motor vehicle property damage crash cost. Table 3 provides a summary of crash costs and EPDO weights by crash type and severity.

Table 3. Crash Costs and EPDO Weights by Crash Type and Severity

Severity		Crash Cost			EPDO Weight		
		Ped	Bike	Veh	Ped	Bike	Veh
K	Fatal	$3,305,922	$3,147,627	$3,782,512	135.9	129.4	155.5
A	Incapacitating	$433,383	$362,759	$389,169	17.8	14.9	16.0
B	Non-Incapacitating	$113,100	$90,303	$107,674	4.7	3.7	4.4
C	Possible Injury	$73,539	$60,060	$56,365	3.0	2.5	2.3
O	Property Damage	$35,692	$49,042	$24,322	1.5	2.0	1.0

Notes: Ped = motor vehicle-pedestrian crashes, Bike = motor vehicle-bicycle crashes, Veh = motor vehicle crashes, KABCO severity scale.

EPDO weights were multiplied to the corresponding observed crash frequencies by crash type and severity of each facility to obtain the overall EPDO according to the different focus areas. Each facility EPDO estimate was evaluated to determine the risk level based on the type of facility.

2.5. Evaluation of Risk Level

Since all facilities safety estimates are based on the EPDO which is a single representation of crash occurrence of different crash severities at a roadway facility, level of risk was evaluated in terms of the mean EPDO and standard error by facility type. Four levels of risk were defined based on percentiles thresholds with reference to the mean values. Figure 2 illustrates the risk level percentile thresholds.

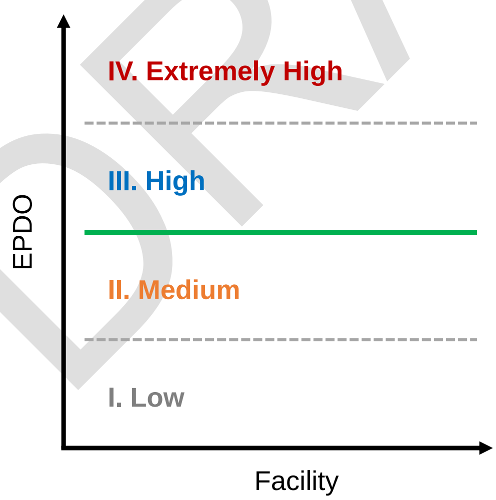


Figure 2. Risk Level Evaluation

Risk level was based on the EPDO data distribution and mean by facility type. For instance, for a signalized intersection, the EPDO of the facility was compared to the mean EPDO of all signalized intersection. The 25th percentile, mean, and 75th percentile were selected as thresholds. Since crash data may not be observed during the period of study at several facilities, the mean is significantly influenced by the number of zeros in the sample. Thus, there is a well define lower bound limit of zero crashes (there cannot be negative number crashes observed). On the other hand, there is not an upper bound limit of the number of crashes that can be observed, so locations can theoretically have unbounded number of observed crashes. With this consideration, the percentile thresholds selected heavily categorize EPDO estimates higher than the mean.

Since the EPDO and risk level are available for each facility, the HIN can be visualized by color coding each roadway facility in a map according to risk levels for intersections and segments to identify facilities, locations, or corridors with high crash injury in the network.

2.6. Example of HIN Development

Figure 3 provides an illustration of the methodology and process to develop the HIN for the City of Madison with crash frequency using the EPDO including segmentation, crash assignment, EPDO calculation, risk level categorization, and visualization of HIN.

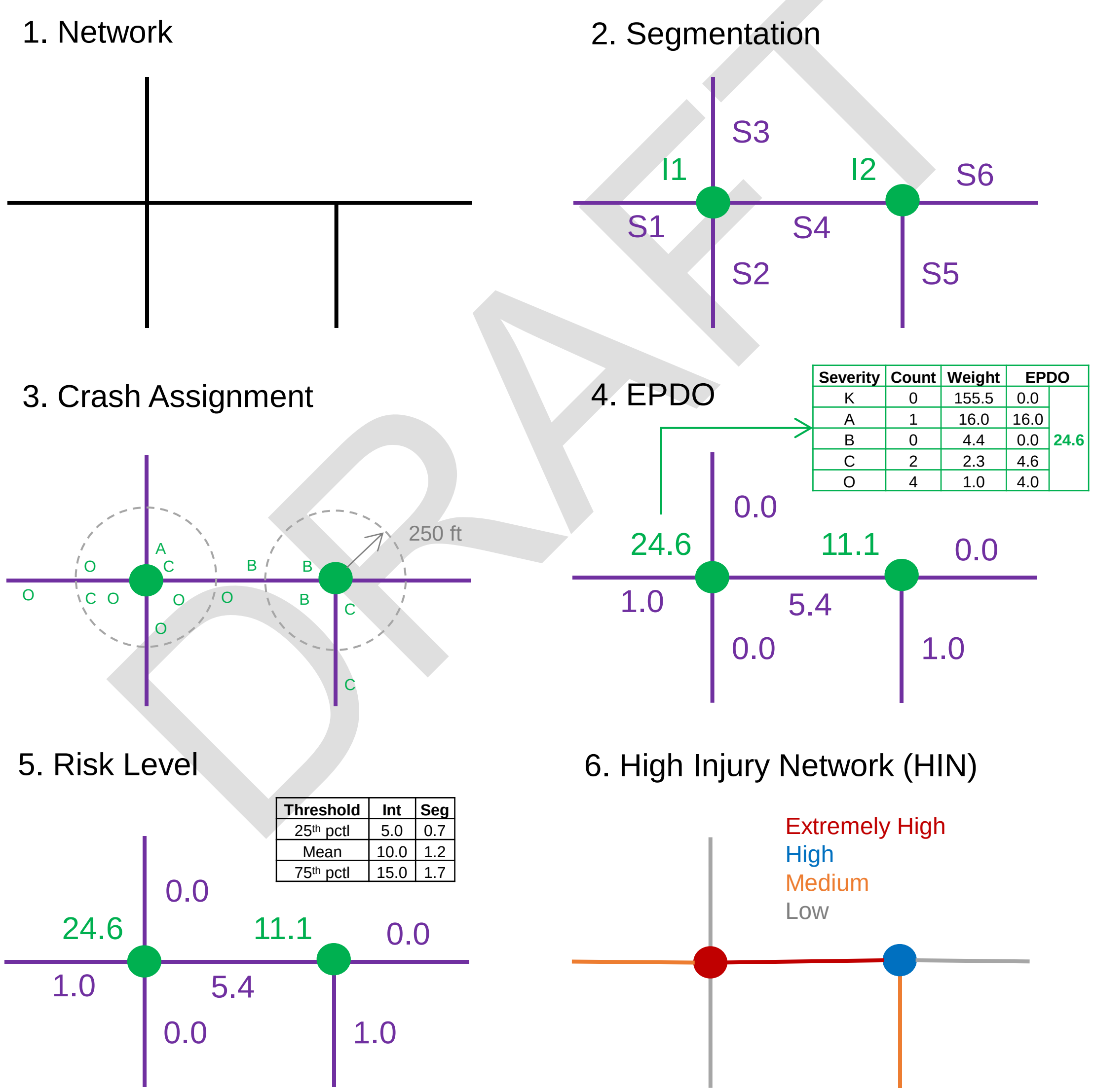
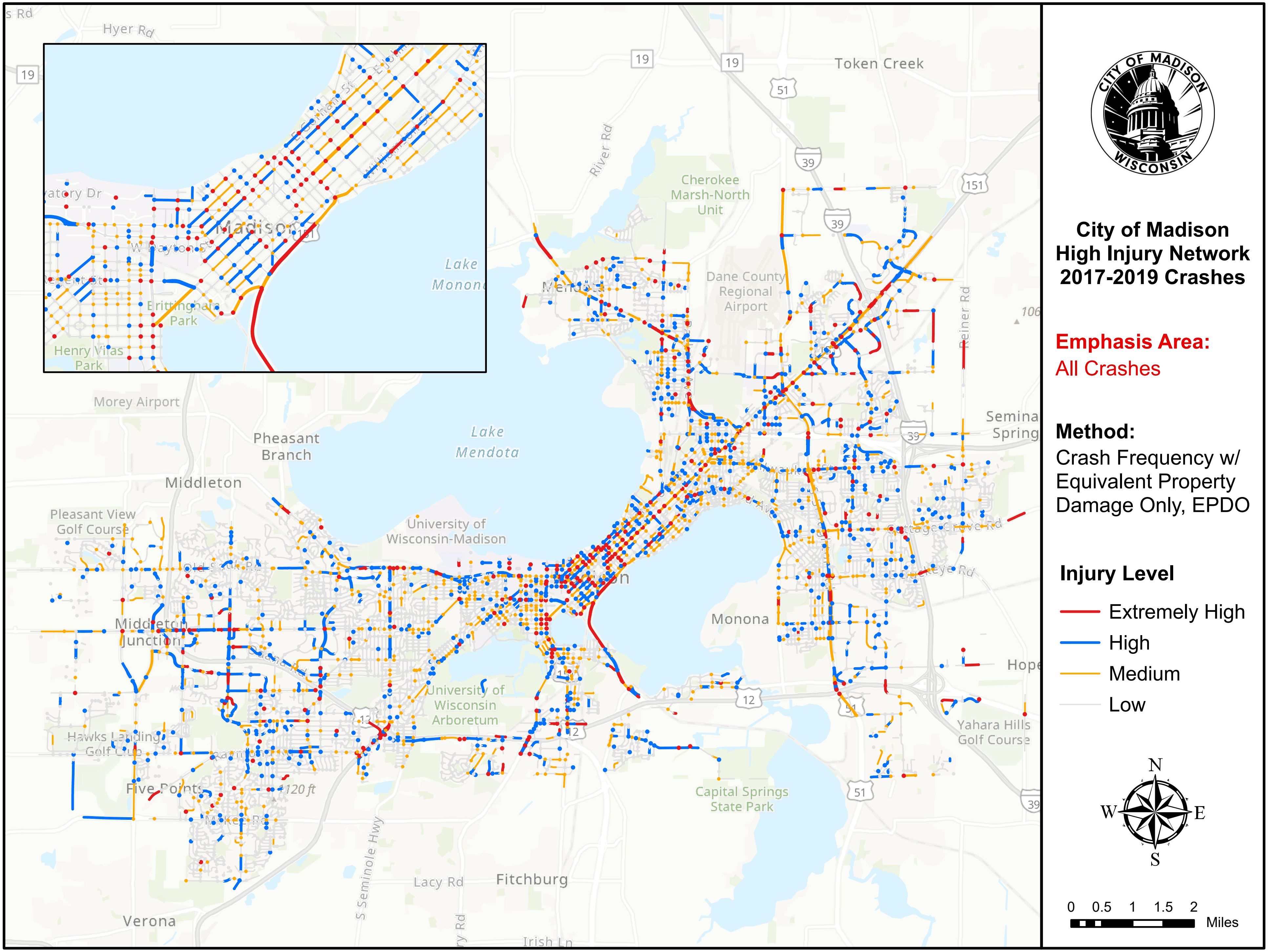


Figure 3. Illustration of Development of HIN

3. RESULTS

The results of the study include the City of Madison HIN maps by focus areas. The HIN maps are provided for the following focus areas:

- All crashes
- Pedestrians and bicycles
- Speeding
- Hit and run
- Alcohol and drugs
- Dark lighted condition
- Dark unlighted condition
- Summer and fall seasons
- Winter and spring seasons


City of Madison
High Injury Network
2017-2019 Crashes
Emphasis Area:
All Crashes
Method:
Crash Frequency w/ Equivalent Property Damage Only, EPDO
Injury Level
Extremely High
High
Medium
Low
N
W
E
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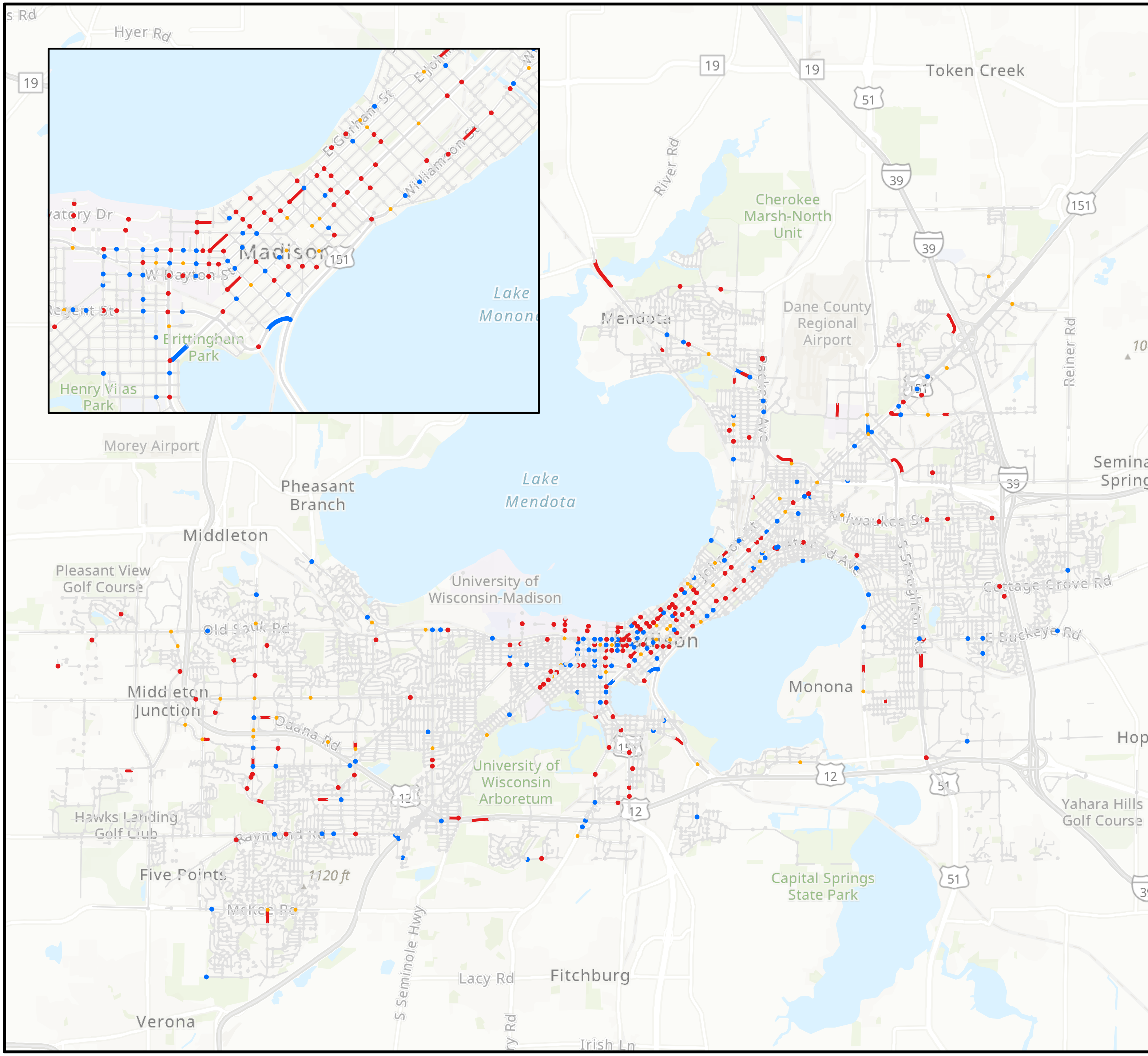
0 0.5 1 1.5 2
Miles
CITY OF MADISON WISCONSIN
Token Creek
Cherokee Marsh-North Unit
Dane County Regional Airport
Lake Mendota
Pheasant Branch
Middleton
Morey Airport
Pleasant View Golf Course
University of Wisconsin-Madison
Middleton Junction
Monona
Hawks Landing Golf Club
Five Points
University of Wisconsin Arboretum
Capital Springs State Park
Yahara Hills Golf Course
Fitchburg
Verona
Lacy Rd
Irish Ln
S Seminole Hwy
Hyer Rd
River Rd
Reiner Rd
Henry Vilas Park
Erittingham Park
Lake Monona
Madison



City of Madison High Injury Network 2017-2019 Crashes

Emphasis Area:

Pedestrians and Bicycles

Method:

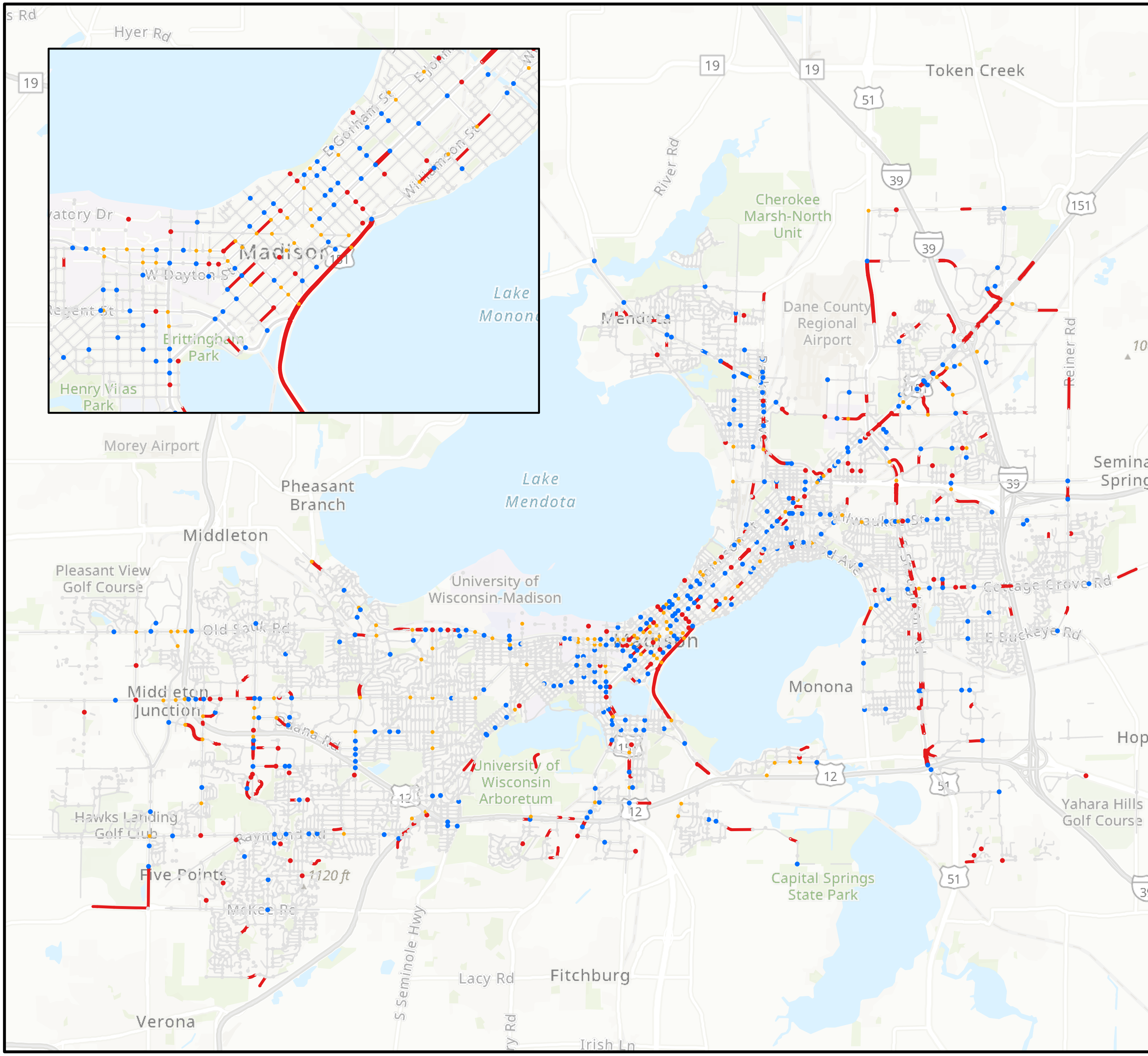
Crash Frequency w/ Equivalent Property Damage Only, EPDO

Injury Level

- Extremely High
- High
- Medium
- Low

N
W E
S

0 0.5 1 1.5 2 Miles



City of Madison High Injury Network 2017-2019 Crashes

Emphasis Area:
Speeding

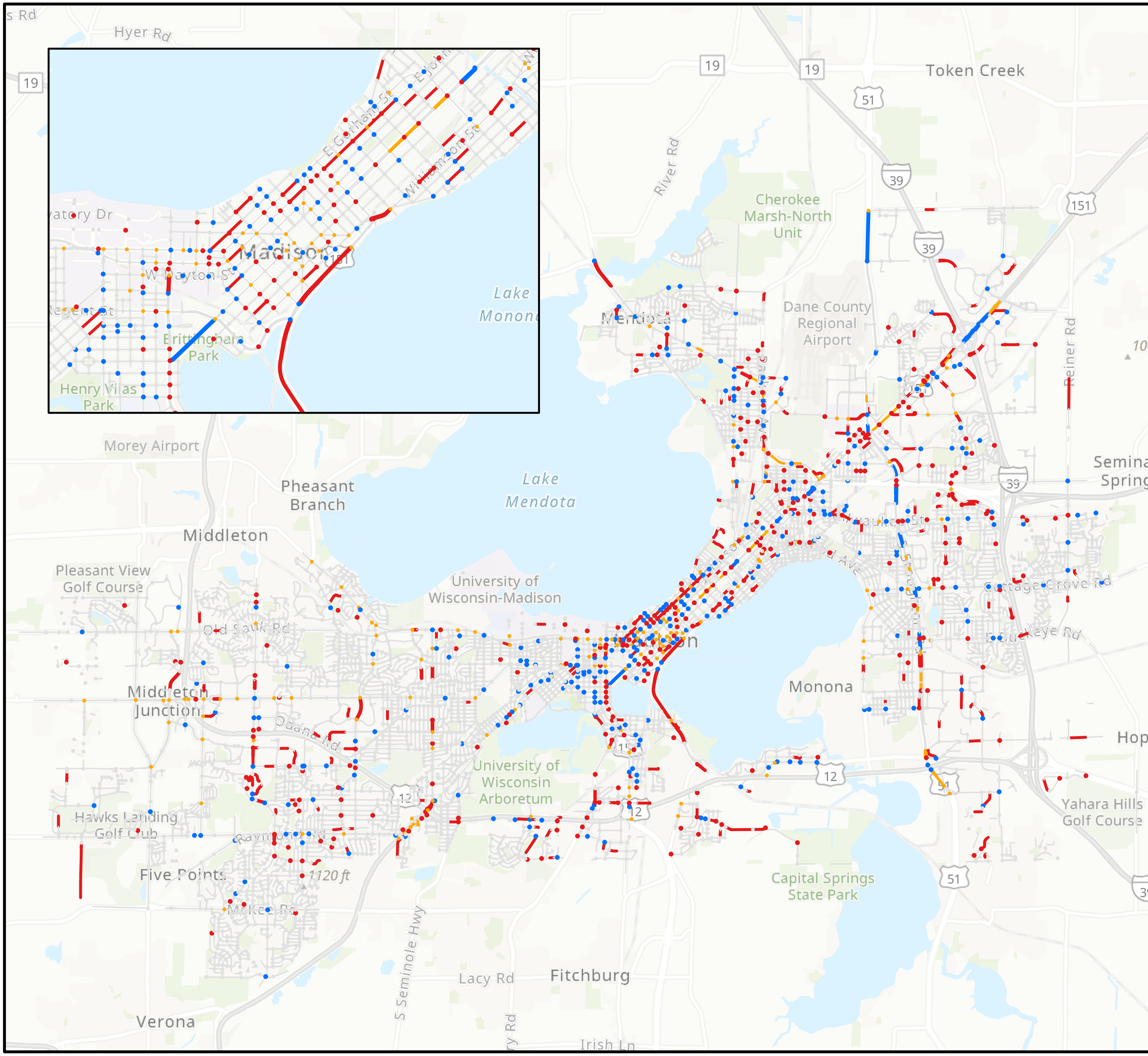
Method:
Crash Frequency w/ Equivalent Property Damage Only, EPDO

Injury Level

- Extremely High
- High
- Medium
- Low

N S W E

0 0.5 1 1.5 2 Miles



City of Madison
High Injury Network
2017-2019 Crashes

Emphasis Area:
Hit and Run

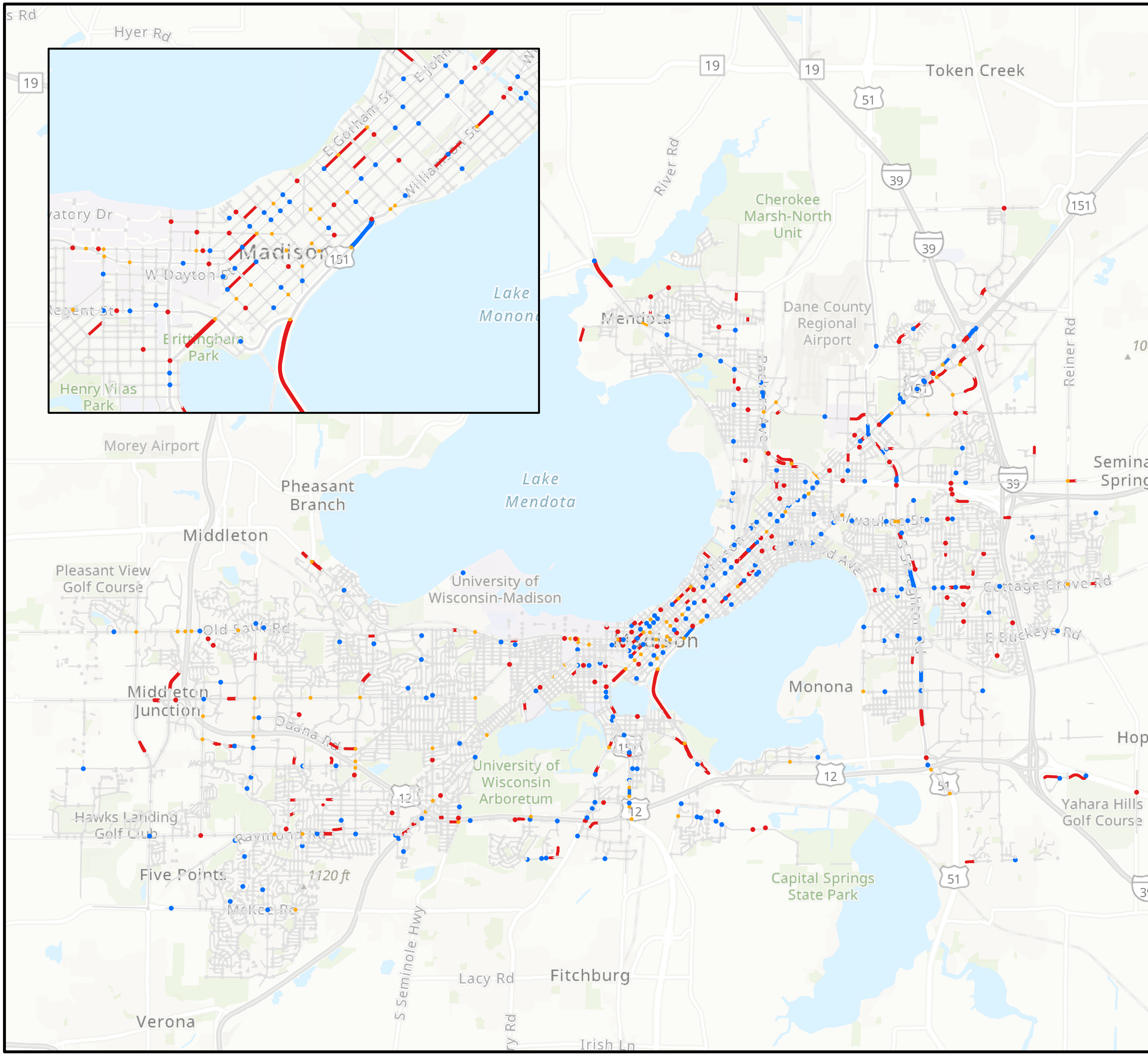
Method:
Crash Frequency w/ Equivalent Property Damage Only, EPDO

Injury Level

- Extremely High
- High
- Medium
- Low

N
W E
S

0 0.5 1 1.5 2 Miles



City of Madison High Injury Network 2017-2019 Crashes

Emphasis Area:
Alcohol and Drugs

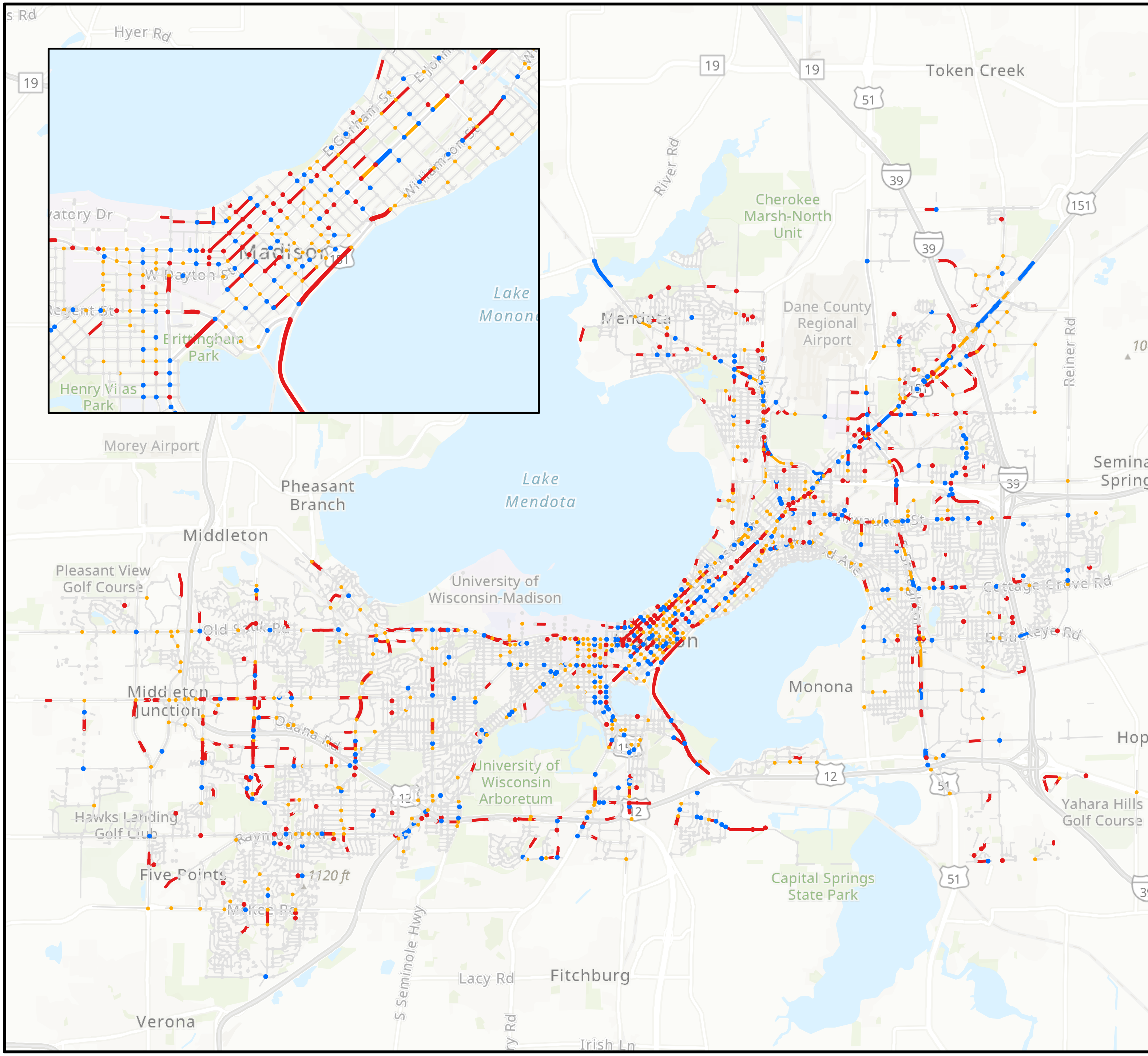
Method:
Crash Frequency w/ Equivalent Property Damage Only, EPDO

Injury Level

- Extremely High
- High
- Medium
- Low

N W E S

0 0.5 1 1.5 2 Miles



City of Madison High Injury Network 2017-2019 Crashes

Emphasis Area:
Dark Lighted

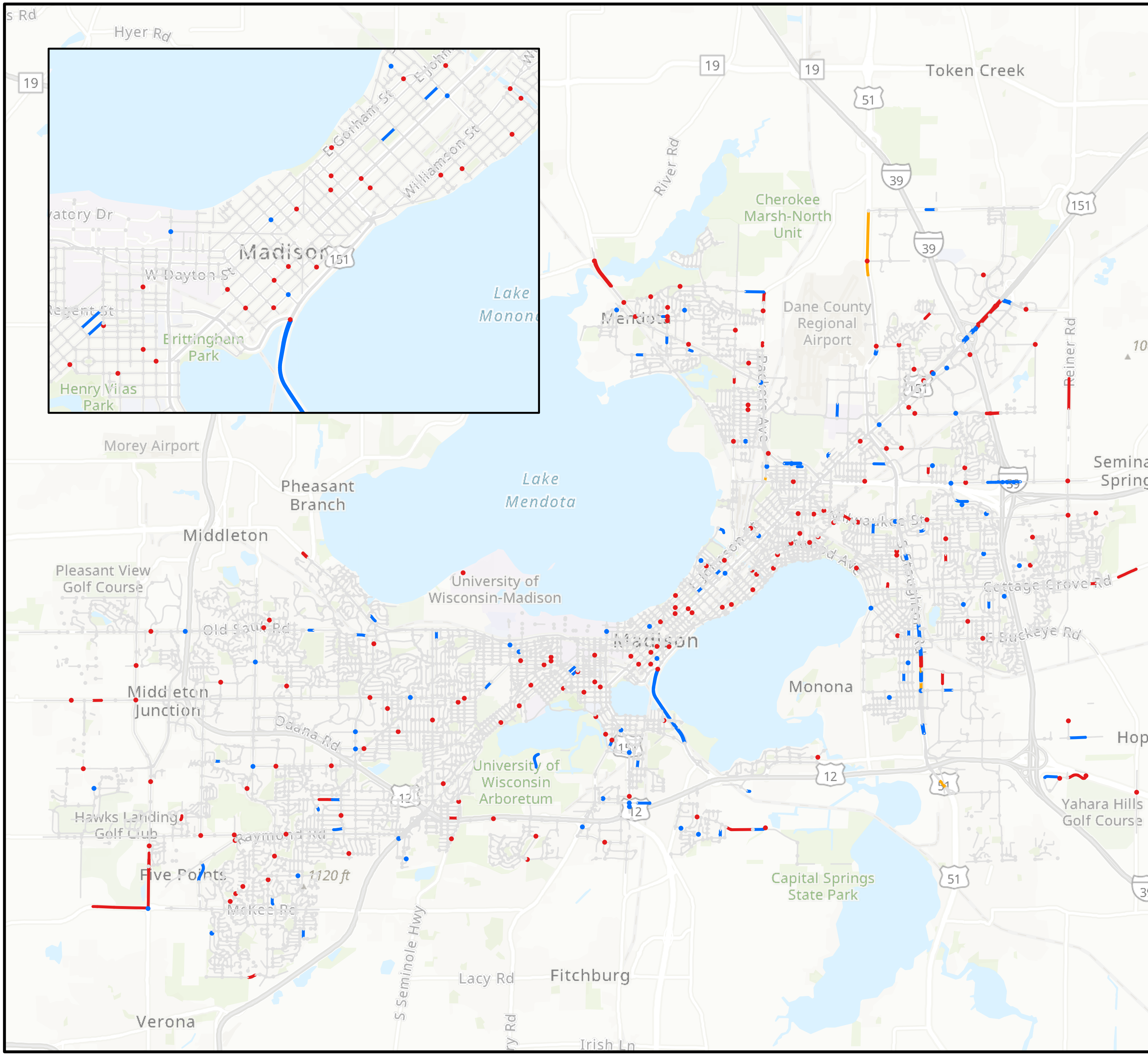
Method:
Crash Frequency w/ Equivalent Property Damage Only, EPDO

Injury Level

- Extremely High
- High
- Medium
- Low

N W E S

0 0.5 1 1.5 2 Miles



City of Madison High Injury Network 2017-2019 Crashes

Emphasis Area:
Dark Unlighted

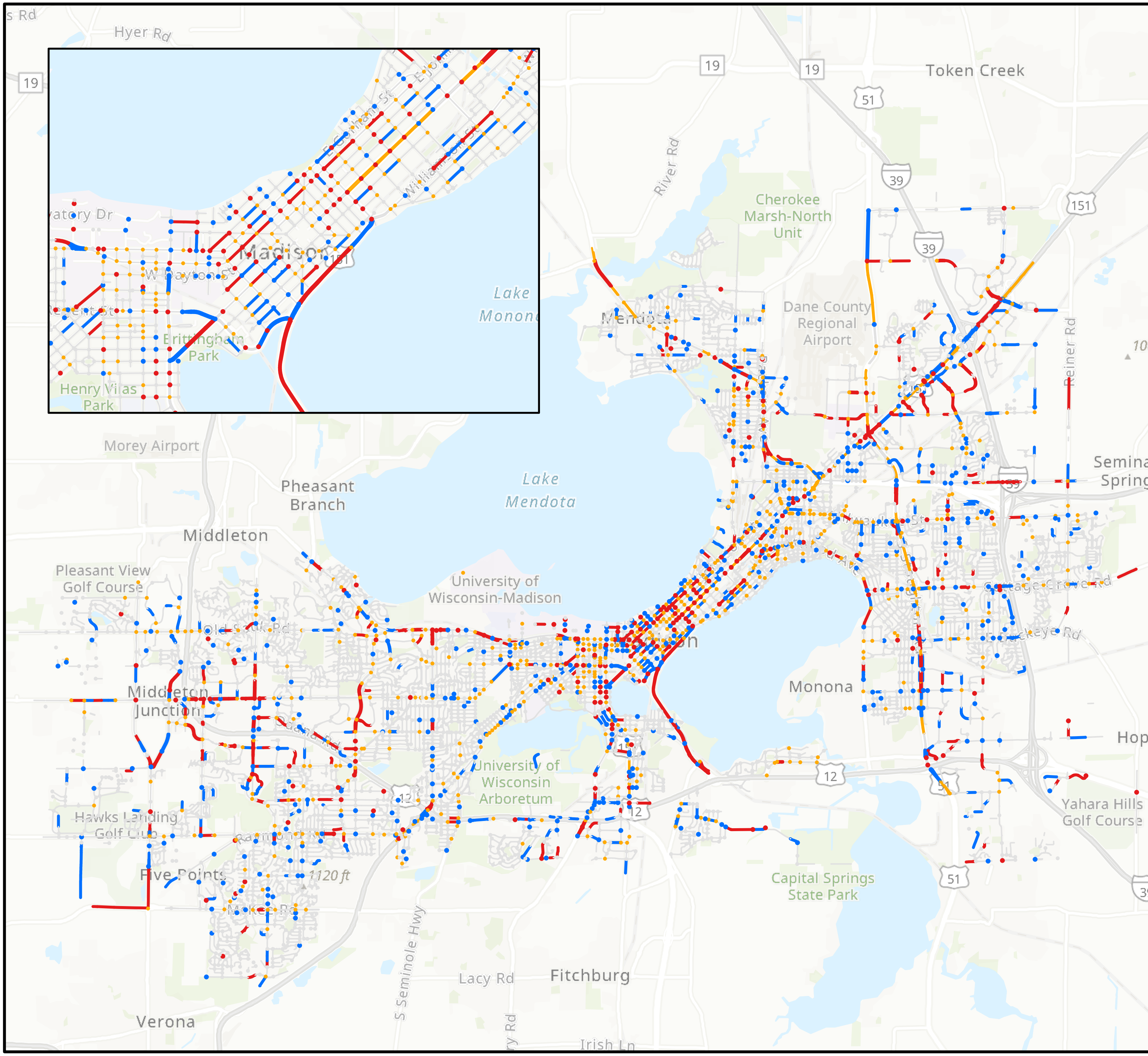
Method:
Crash Frequency w/ Equivalent Property Damage Only, EPDO

Injury Level

- Extremely High
- High
- Medium
- Low

N
W E
S

0 0.5 1 1.5 2 Miles



City of Madison High Injury Network 2017-2019 Crashes

Emphasis Area:
Summer and Fall

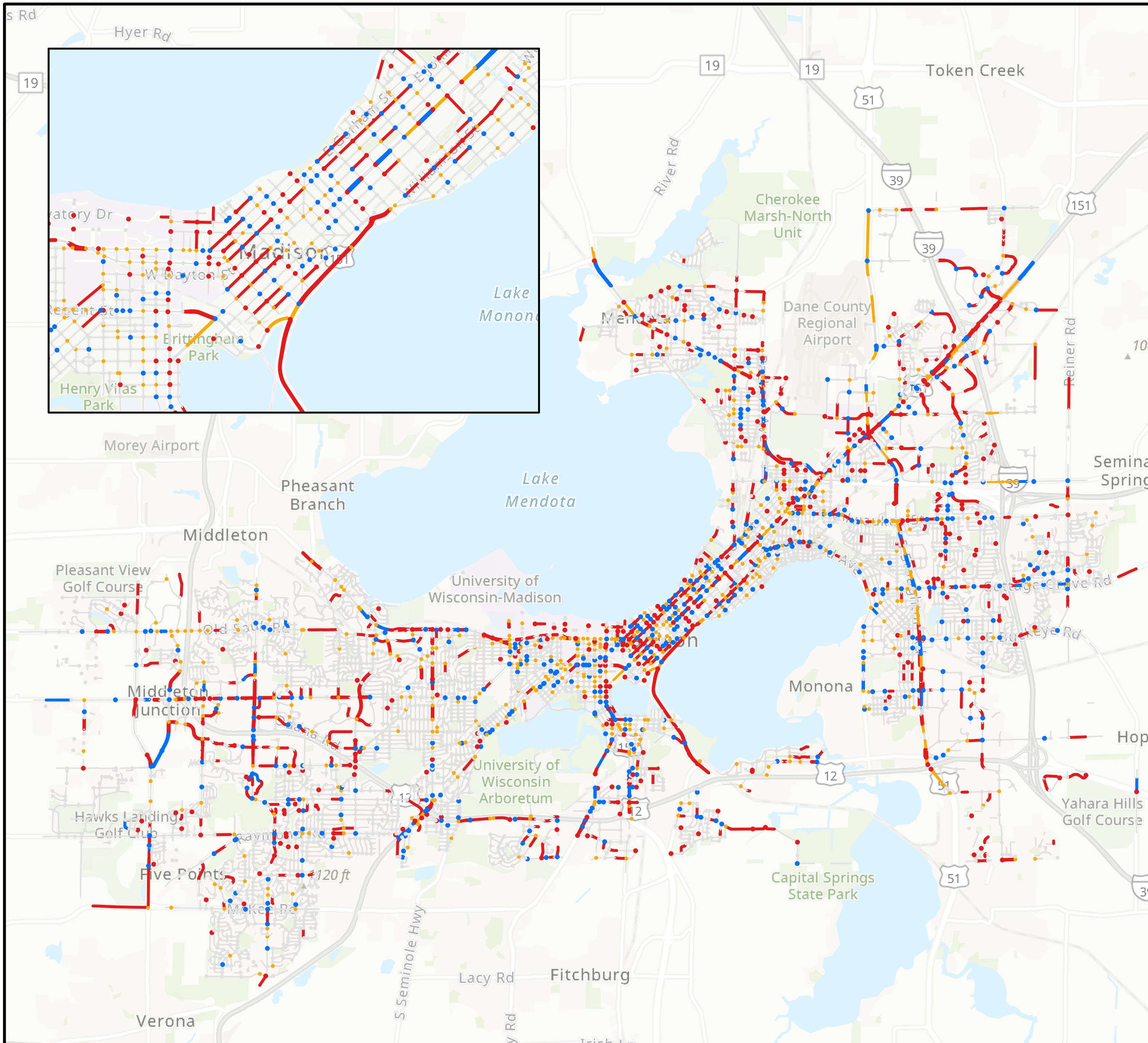
Method:
Crash Frequency w/ Equivalent Property Damage Only, EPDO

Injury Level

- Extremely High
- High
- Medium
- Low

N
W E
S

0 0.5 1 1.5 2 Miles



City of Madison High Injury Network 2017-2019 Crashes

Emphasis Area:
Winter and Spring

Method:
Crash Frequency w/ Equivalent Property Damage Only, EPDO

Injury Level

- Extremely High
- High
- Medium
- Low

N
W E
S

0 0.5 1 1.5 2 Miles