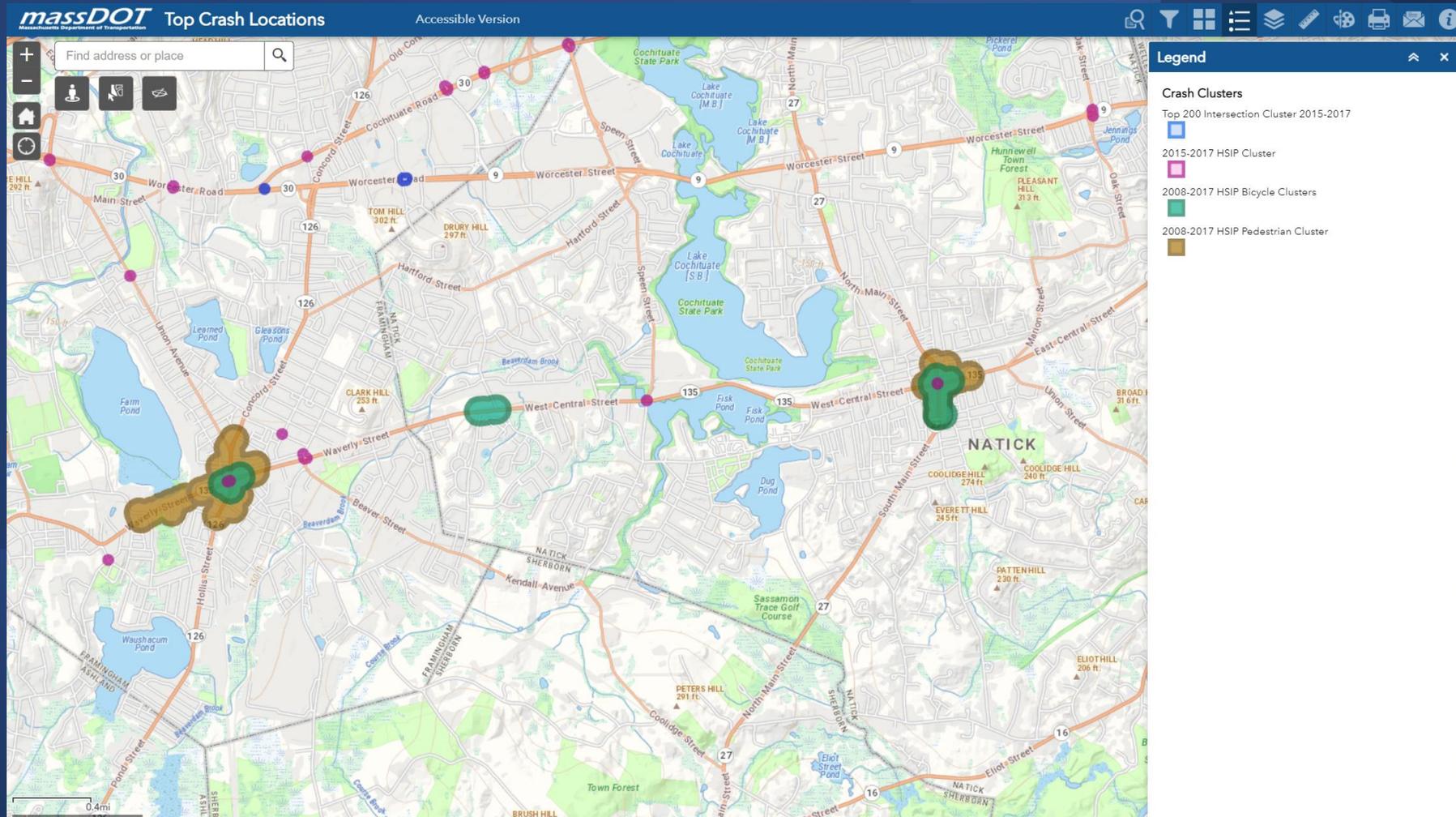


Crash and Systemic-Based Approaches to Safety in MA

MassDOT Traffic and Safety Engineering

Jennifer Inzana & Kirsten Johnson

Existing Hot Spot/Crash-Based Approach



<https://gis.massdot.state.ma.us/topcrashlocations>

New Modules in IMPACT – Safety Analysis Tools

IMPACT Home Welcome, Guest User Log In

IMPACT is designed to encourage public safety initiatives and awareness specific to crash information. Within IMPACT you can engage with crash related data through easy to understand pre-built reports or conduct your own self-driven analysis. Please take the time to explore the various options and find what is right for you.

<h3>Interactive Data Dashboards</h3> <p>IMPACT dashboards tell powerful data stories using maps, charts and tables based on complex analyses. These pre-built dashboards allow for interactive analysis and data exploration specific to a given data theme in a range of categories.</p>	INTERACT
<h3>Data Query and Visualization</h3> <p>Using the Data Query and Visualization tool you can conduct simple to sophisticated data queries to generate subsets of the crash data. This may be done at the crash level, the vehicle level or the person level. Once generated you can then visualize the data in three core ways: on charts, on tables, or spatially on a map. Though noted separately, these elements all work in tandem providing the ability to switch between the visualization methods seamlessly.</p>	EXPLORE
<h3>Data Extraction</h3> <p>Using the data extraction service, you can request publicly available data by municipality and date range in several formats. The standard data report request form should be used when trying to obtain datasets of town-wide crash data for specific years. In addition, a link is provided to MassDOT's Open Data Portal for more large-scale data download capabilities where the entire crash data file may be downloaded for each year.</p>	EXTRACT
<h3>Reports</h3> <p>IMPACT provides a suite of pre-built reports for rapid access to cleanly organized information across a spectrum of categories. Some reports are configurable given desired date ranges and all are downloadable in several formats.</p>	REPORTS
<h3>Crash Tabulation and Charting</h3> <p>IMPACT provides this tool to aggregate selected data in a matrix to display two or more variables. The crosstab provides summary data and can be used to summarize the full crash database as well as subsets of the data, based on the user selected variables.</p>	EXPLORE
<h3>Safety Analysis Tools</h3> <p>IMPACT provides several safety analysis tools focused on network screening and diagnosis. Network screening includes both Spot and Systemic mapping. Diagnosis tools include a Crash Tree Maker and a Site Proportions tool.</p>	EXPLORE

Reported Crashes YTD

69,461

As of: Tue Aug 31 2021

Reported Fatalities YTD (FARS)

252

As of: Mon Aug 30 2021

Reported Pedestrian Crashes YTD

853

As of: Tue Aug 31 2021

Reported Bicyclist Crashes YTD

588

As of: Tue Aug 31 2021

Reported Crash Severity By Year (CDS)

Year	Fatal	NonFatal	Property Damage Only	Other
2017	~1000	~35000	~100000	~10000
2018	~1000	~35000	~100000	~10000
2019	~1000	~35000	~100000	~10000
2020	~1000	~25000	~70000	~10000
2021	~1000	~20000	~45000	~10000

As of: Tue Aug 31 2021

Reported Ages of Drivers in Crashes YTD

Age Group	Number of Drivers
<16	~1000
16-20	~15000
21-24	~12000
25-34	~25000
35-44	~18000
45-54	~15000
55-64	~15000
65-74	~10000
75-84	~5000
>84	~1000

14,124 drivers with ages unknown
As of: Tue Aug 31 2021

Safety Analysis Tools- Network Screening

- Crash-Based
- Risk-Based

IMPACT Impact Home > Safety Analysis Tools vr 0.3.21

IMPACT Safety Analysis Tools Provides Network Screening and Diagnosis Tools for Statewide and Regional Analysis

Network Screening Crash Based

The crash-based network screening tool is based on excess average crash frequency with an Empirical Bayes (EB) adjustment for five facility types on collectors and arterials: rural two-lane undivided segments, urban four-lane divided segments, urban four-lane undivided segments, urban two-lane undivided segments and urban two-lane divided segments for either all crashes or the fatal and injury crashes only. Segments are ranked from most [more...](#)

[Explore →](#)

Network Screening Risk Based

The risk-based network screening tool is based on risk factors identified for many of the emphasis areas of the Strategic Highway Safety Plan. Sites with the greatest risk, ranked based on risk scores which are generated from the number and types of risk factors present, are then visualized. A variety of statistical methods were used to identify the risk factors for each of the emphasis areas. This would supplement the crash-based network [more...](#)

[Explore →](#)

Crash Tree

The crash tree maker tool allows users to generate crash trees to summarize and analyze crash data. The user can select key data elements, gradually building a tree which shows common characteristics of crashes in the jurisdiction or emphasis area of their choice. This can be done at the crash level, vehicle level or person level.

[Explore →](#)

Test of Proportions

The test of proportions tool provides an automated process to identify overrepresented crash types and other data attributes within a user-defined area, such as a municipality, intersection or a corridor. The module will compare the proportions of crashes by attribute in the subject data to proportions in user-selected comparison groups.

[Explore →](#)

Network Screening Level – Risk Based Approach for SHSP Emphasis Areas

A systemic approach to safety involves widely implemented improvements based on high-risk roadway features correlated with specific severe crash types. The approach helps agencies broaden their traffic safety efforts at little extra cost. [Source: FHWA -<https://safety.fhwa.dot.gov/systemic/index.cfm>]

The systemic approach:

- Does not replace the site analysis approach.
- Is a complementary technique that supplements the site analysis approach.
- Helps agencies to better meet the requirements for the Highway Safety Improvement Program.
- Is best used by evaluating an entire system using a defined set of criteria, which results in an inferred prioritization that indicates some elements of the system are better candidates for safety investment than others.
- Acknowledges that crashes alone are not always sufficient to establish countermeasure prioritization across a system.

Network Screening Level – Risk Based Approach for SHSP Emphasis Areas

✓ Model uses roadway-based and community-based risk factors



Emphasis Areas

based upon average fatalities (2012-2016)

- Lane Departure Crashes [198]
- Impaired Driving [124] ✓
- Occupant Protection [102] ✓
- Speeding and Aggressive Driving [97] ✓
- Intersection Crashes [96]
- Pedestrians [80] ✓
- Older Drivers [74] ✓
- Motorcycle Crashes [49] ✓
- Younger Drivers [41] ✓
- Large Truck-Involved Crashes [34] ✓
- Driver Distraction [30] ✓
- Bicyclists [10] ✓
- Safety of Persons Working on Roadways [2]
- At-Grade Rail Crossings [1]

Selected EAs in order of those with the highest annual fatality average to lowest.

Risk-Based Approach for SHSP Emphasis Areas

Risk model factors for various emphasis areas and road types

Table 1. Binary logit model for bike KAB crashes on principal arterials.

Variable	Odds Ratio	Standard error	z-value	P> z	95% Confidence Interval	
3 or more travel lanes, both directions	0.92	0.07	-1.11	0.27	0.79	1.07
Presence of median	0.52	0.05	-6.82	<0.01	0.43	0.63
AADT over 15,000	1.30	0.08	4.12	<0.01	1.15	1.48
Segment length (miles)	4.45	0.64	10.41	<0.01	3.36	5.90
Transit stop presence (rail and/or bus) on road segment	1.83	0.13	8.73	<0.01	1.60	2.09
Median household income	1.87	0.23	5.14	<0.01	1.47	2.38
Proportion of commuters that walk, bicycle, or take transit	2.60	0.39	6.40	<0.01	1.94	3.49
Proportion of households without a motor vehicle	2.07	0.30	5.00	<0.01	1.56	2.75
Proportion of employment in the accommodation, food services, or retail trades	1.67	0.18	4.63	<0.01	1.34	2.07
Employment density	3.39	0.52	7.91	<0.01	2.50	4.58
Population density	5.57	0.96	9.98	<0.01	3.98	7.81
No shoulder wider than 4 feet on either side of the road segment	1.49	0.13	4.71	<0.01	1.26	1.75
Constant	0.0005	0.0001	-50.2	<0.01	0.0004	0.0007

Table 38. Town-level risk factors for suspected alcohol impaired driving crashes.

Town Risk Factors for Impaired Driving Crashes	Scoring
Population Density (Residents per Square Mile)	Linear from 0.5 at 1,500 to 1.0 at max (19,586.9); 0 if less than 1,500
ABCC Licenses per 1,000 Residents	1.0 if 4 or less; 0 if greater than 4
Annual OUI Offender Program Enrollments per 1,000 Residents	1.0 if greater than 1; 0 if 1 or fewer
Annual OUI Citations per 1,000 Residents	Linear from 0.5 at 4 to 1.0 at 10 and greater; 0 if less than 4
Annual Traffic Citations per 1,000 Residents	Linear from 0.5 at 50 to 1.0 at 500 and greater; 0 if less than 50

Table 39. Segment-level risk factors for suspected alcohol impaired driving crashes.

Segment Risk Factors for Impaired Driving Crashes	Scoring
Normalized Lane Departure Risk Score	Range from 0 to 1
Normalized Pedestrian Risk Score	Range from 0 to 1
AADT [vehicles per day]	Linear from 0.5 at 1,999 to 1.0 at 500; 0 otherwise
Roadway Jurisdiction	1.0 if MassDOT; 0 otherwise
Access Control	1.0 if full control; 0.5 if partial control; 0 if no control
Right Shoulder Width	1.0 if 1 to 2 feet; 0 otherwise
Presence of Curbing	1.0 if no curbing present; 0 otherwise

Risk-Based Network Screening in IMPACT Demo

The image shows a laptop displaying the IMPACT web application interface. The interface is divided into several sections:

- Top Navigation:** Mass.gov logo and navigation links: LIVING, WORKING, LEARNING, VISITING & EXPLORING, YOUR GOVERNMENT.
- IMPACT Header:** Impact Home > Safety Analysis Tools > Network Screening Risk Based.
- Map Theme:** Statewide Ranking - Lane Departure (2013 - 2017).
- Map:** A map of Massachusetts showing risk-based lane departure data. A legend on the right indicates:
 - Systemic Risk Factor Lane Departure State Ranking
 - Systemic Risk Factor Lane Departure State Ranking
 - Primary Risk Site
 - Secondary Risk Site
 - Other
- Text Content:**

The Network Screening - Systemic Risk Based tool can be used to access and visualize the top risk sites for each of the Strategic Highway Safety Plan emphasis areas based on specific risk factors developed for each emphasis area. The top risk sites are available statewide as well as top risks within each MPO/RPA. Each emphasis area is focused on certain road types so not all roadway segments are included.

Details on the specific risk factors and how they were developed for each emphasis area can be found in the MassDOT Network Screening Risk Based Methodology Reports. Details on the queries used to identify crashes for each emphasis area can be found on the IMPACT Emphasis Area Definitions webpage.

To start, select the top:

 1. Emphasis Area
 2. Ranking Type (R)

Emphasis Area

Lane Departure

Ranking Type

Statewide Ranking

To further explore the:

 1. Filter/Find specific
 2. View Statistics or
 3. Export/Print the
- Map Theme:** MPO/RPA Ranking - Lane Departure (2013 - 2017) > GREAT BARRINGTON.
- Map:** A detailed map of the Great Barrington area showing risk-based lane departure data. A legend on the right indicates:
 - Other
 - Secondary Risk Site
 - Primary Risk Site
- Statistical Category:**

Functional Class: 276 segments

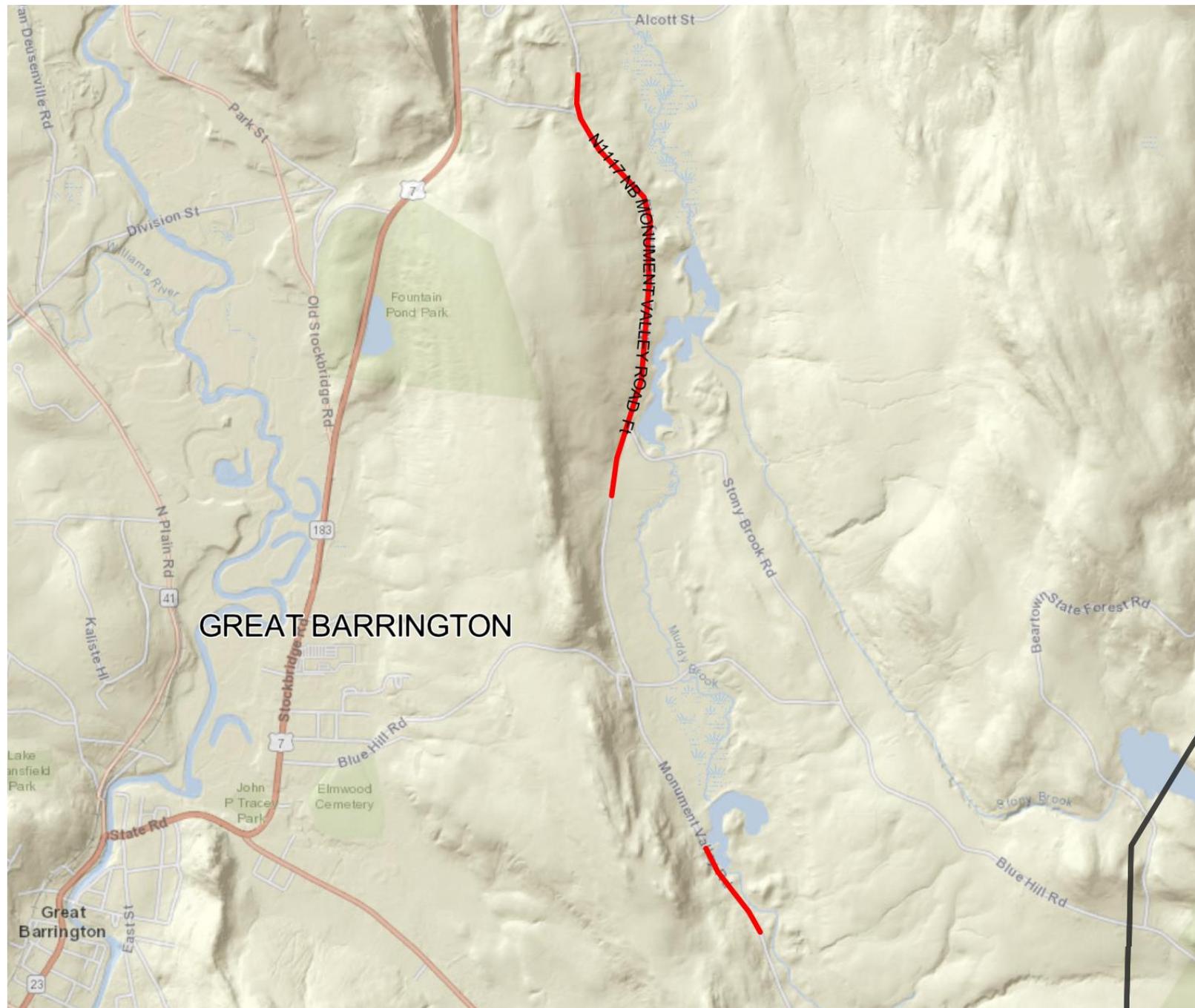
Legend: Other (grey), Secondary Risk Site (blue), Primary Risk Site (red)

Functional Class	Secondary Risk Site	Primary Risk Site
Local	91	0
Urban Collector or Rural Minor Collector	0	32
Urban Minor Arterial or Rural Major Collector	0	105
Urban Principal or Rural Minor Arterial	19	0
Urban or Rural Principal Arterial	40	0
- Data Table:**

Highlight	Ranking	Category	Total Pk.	Rowcount	AADT	MPO/RPA	Functional Class	Facility Type	Route ID	Street Name	Jurisdiction	City/Town
<input type="checkbox"/>	99.405224	Primary Risk Site	5,000,000	42,500,000	1,125	Berkshire	Urban collector or rural minor c...	Mainline roadway		MONUMENT VALLEY ROAD	City or Town accepted road	GREAT BARR
<input type="checkbox"/>	99.405224	Primary Risk Site	5,000,000	42,500,000	1,152	Berkshire	Urban collector or rural minor c...	Mainline roadway		MONUMENT VALLEY ROAD	City or Town accepted road	GREAT BARR
<input type="checkbox"/>	99.405224	Primary Risk Site	5,000,000	42,500,000	1,196	Berkshire	Urban collector or rural minor c...	Mainline roadway		MONUMENT VALLEY ROAD	City or Town accepted road	GREAT BARR
<input type="checkbox"/>	99.405224	Primary Risk Site	5,000,000	42,500,000	1,202	Berkshire	Urban collector or rural minor c...	Mainline roadway		MONUMENT VALLEY ROAD	City or Town accepted road	GREAT BARR
<input type="checkbox"/>	99.405224	Primary Risk Site	5,000,000	42,500,000	1,203	Berkshire	Urban collector or rural minor c...	Mainline roadway		MONUMENT VALLEY ROAD	City or Town accepted road	GREAT BARR
<input type="checkbox"/>	99.405224	Primary Risk Site	5,000,000	42,800,000	1,206	Berkshire	Urban collector or rural minor c...	Mainline roadway		MONUMENT VALLEY ROAD	City or Town accepted road	GREAT BARR

Risk Based Approach- Rural Lane Departure

Primary Lane Departure Risk



Network Screening Level- Combination

Bike and Pedestrian Related
Risk and Hot Spots

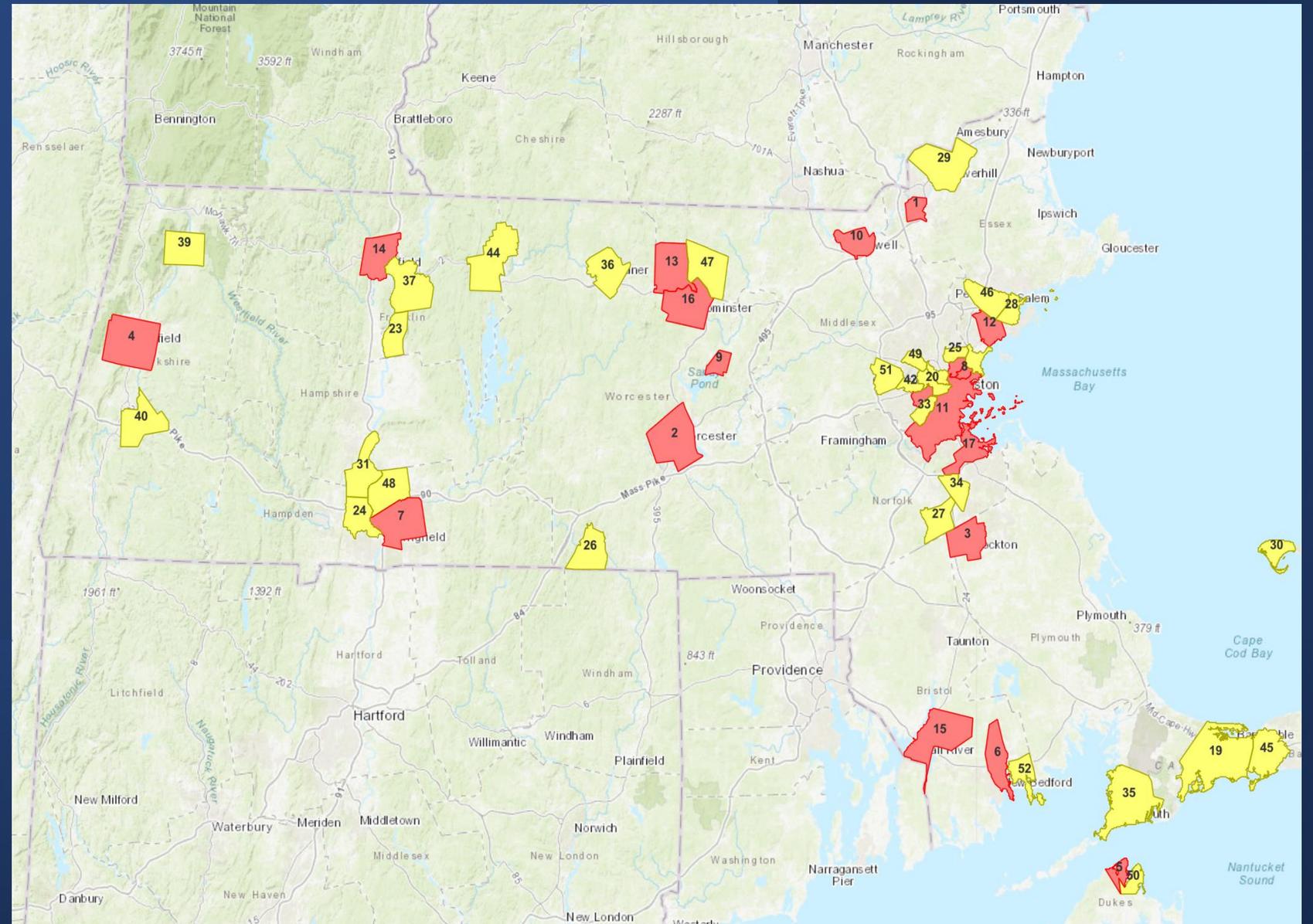
Town Ranking



Top 5%



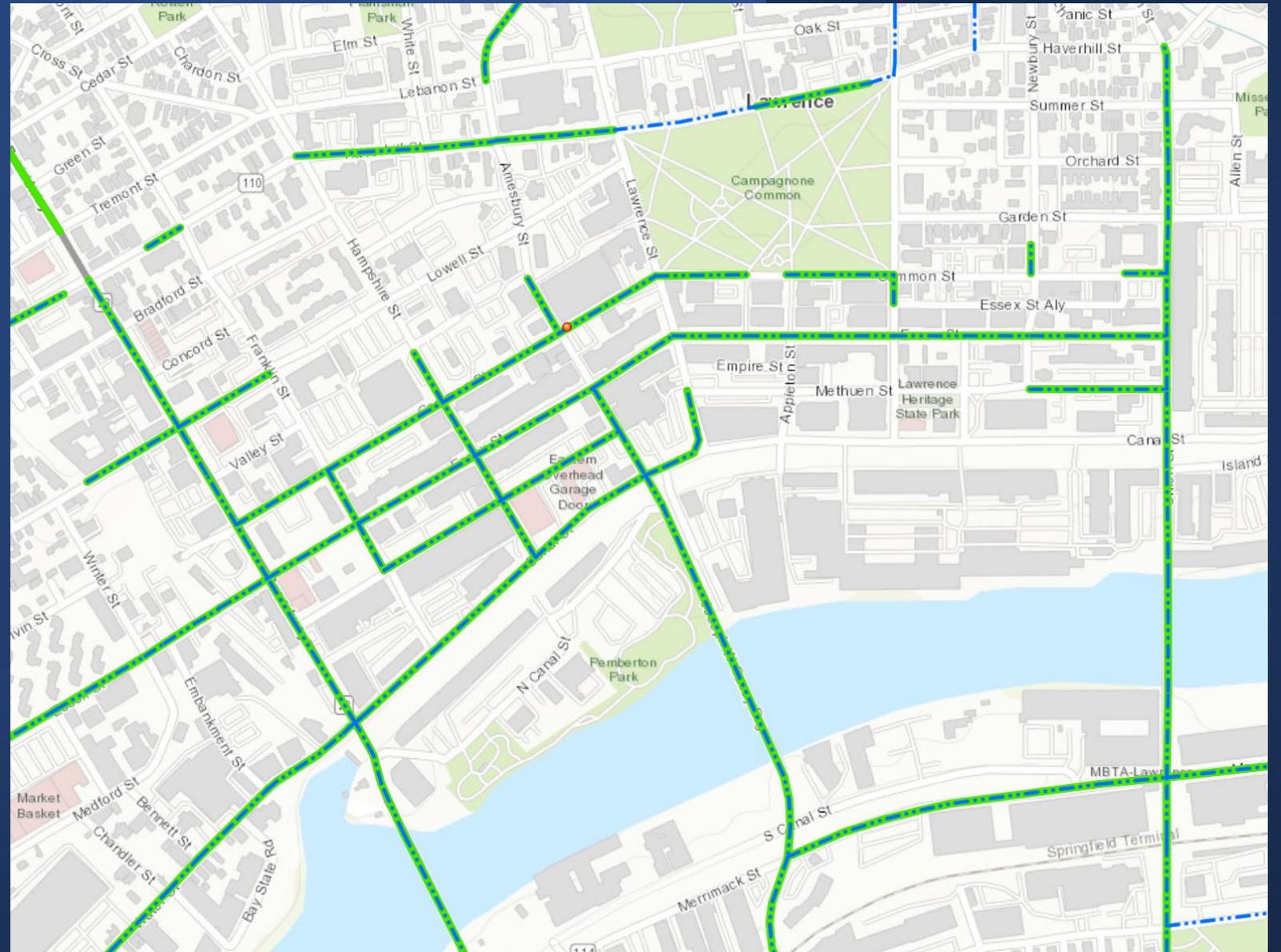
Next 10%



Network Screening Level- Combination

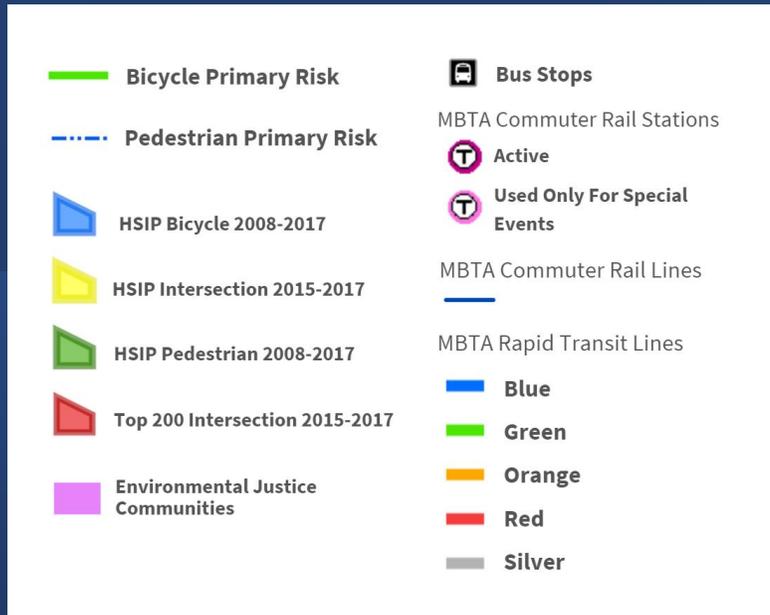
Lawrence, MA

-  Bicycle Primary Risk
-  Pedestrian Primary Risk



Network Screening Level-Combination

Lawrence, MA



Network Screening Level- Combination

Speeding, Bike, and Pedestrian
Related Risk and Hot Spots

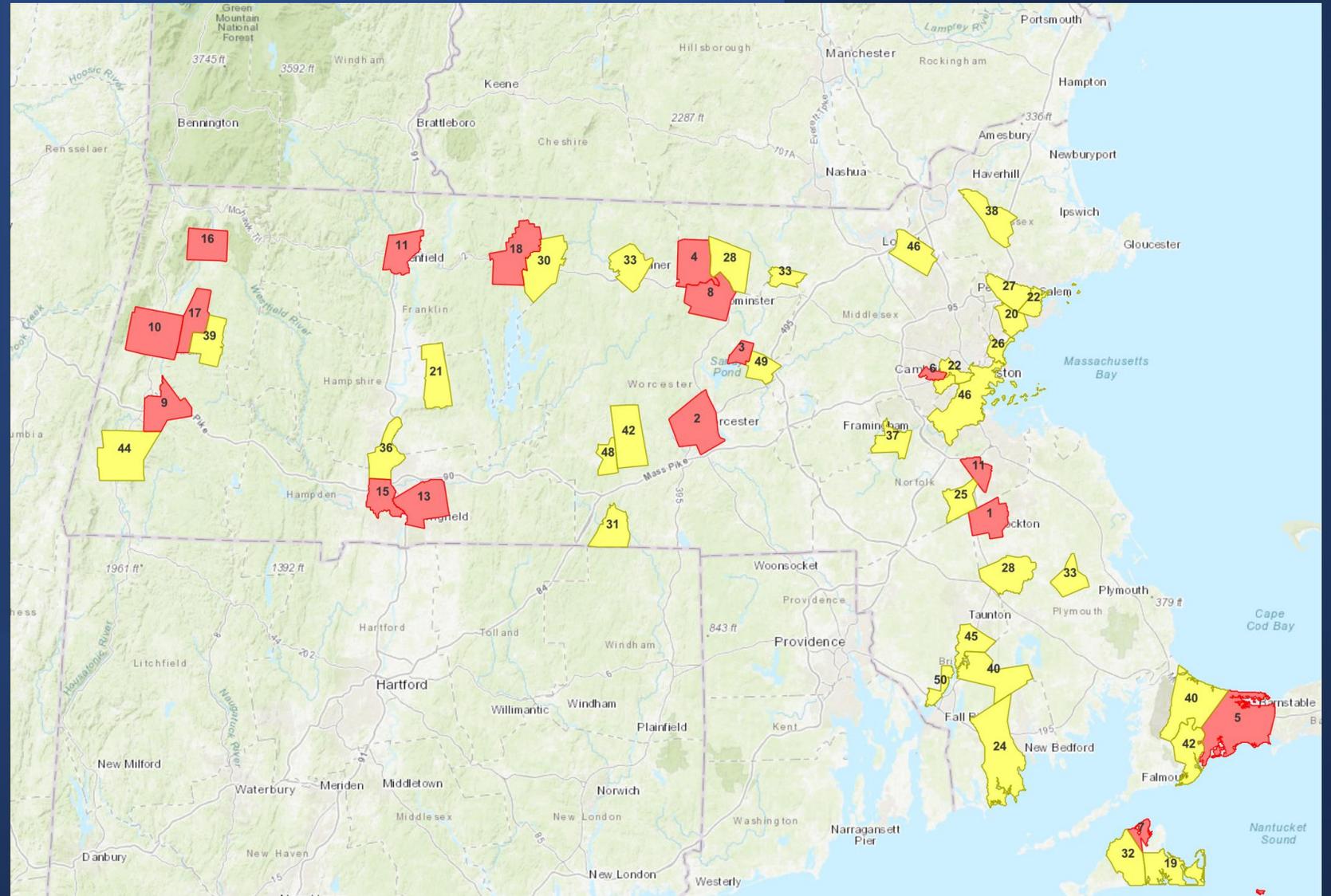
Town Ranking



Top 5%



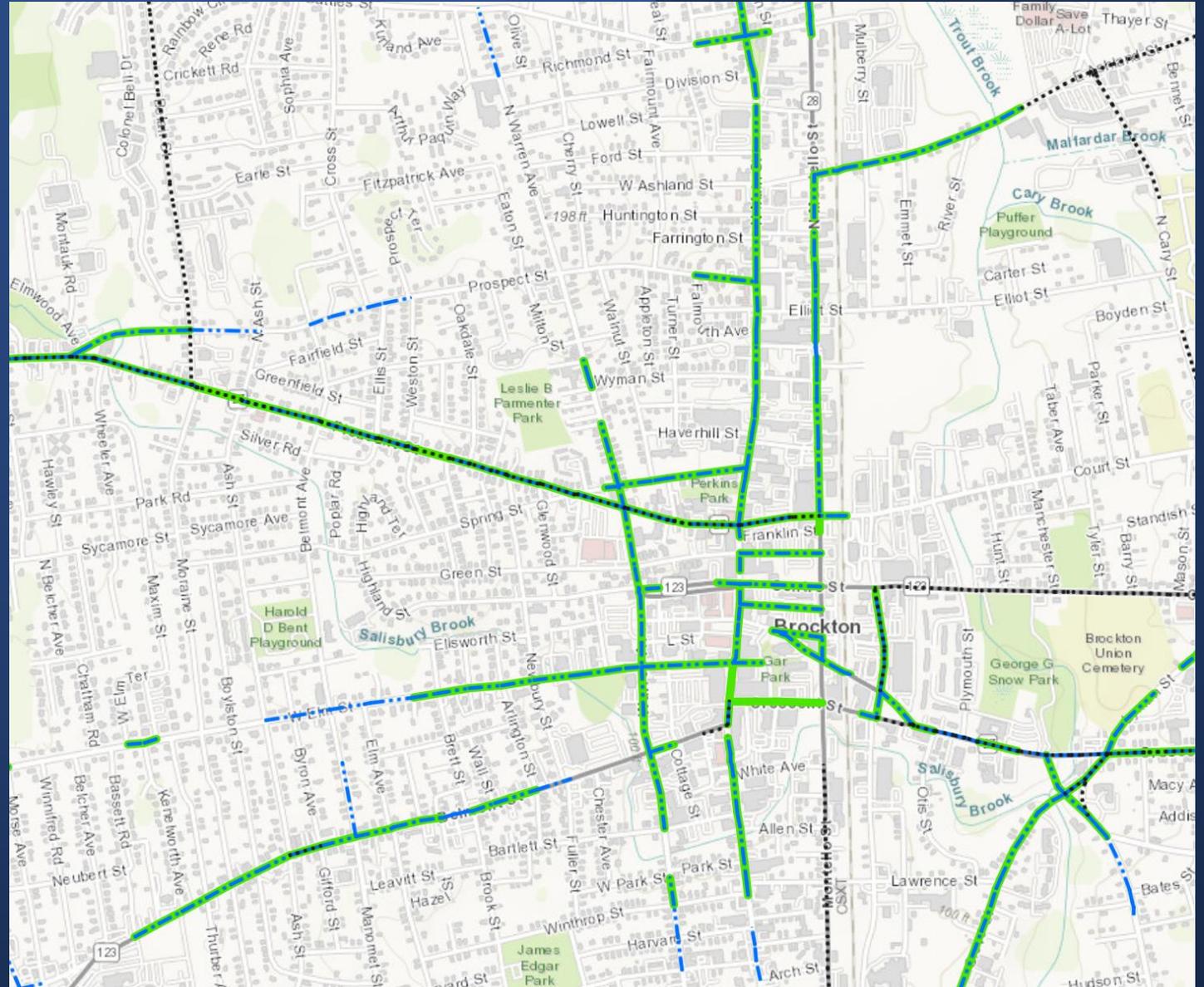
Next 10%



Network Screening Level- Combination

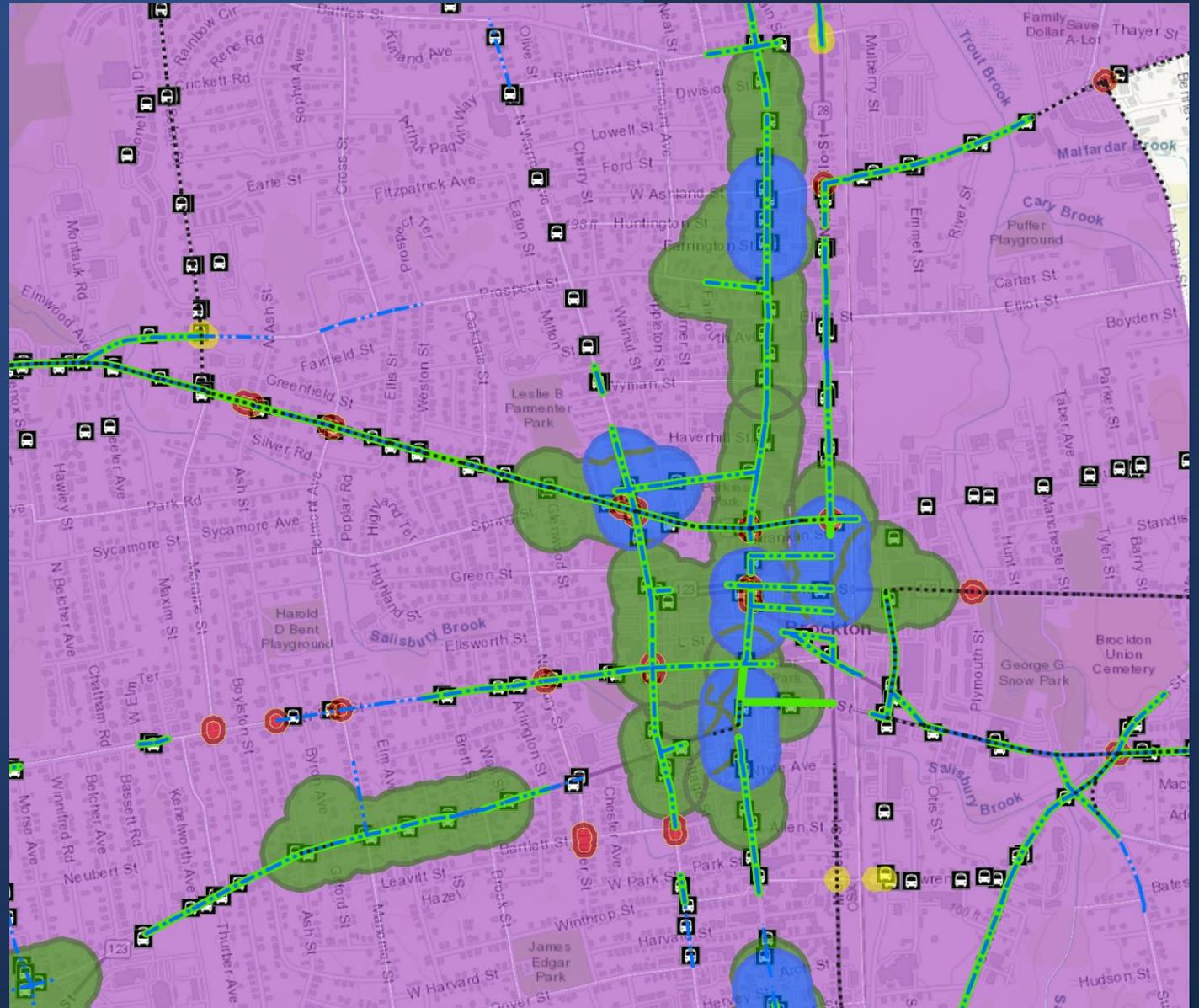
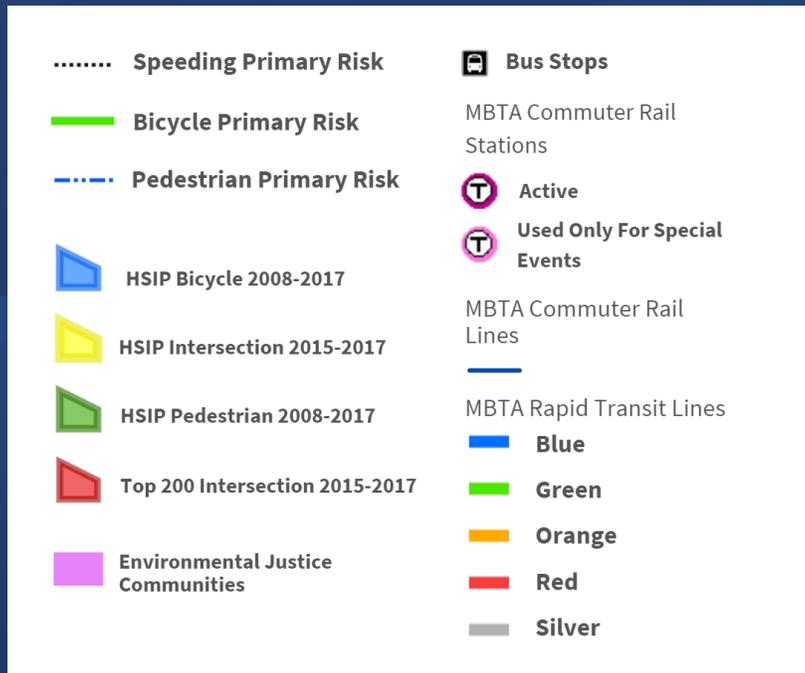
Brockton, MA

- Speeding Primary Risk
- Bicycle Primary Risk
- - - - Pedestrian Primary Risk



Network Screening Level-Combination

Brockton, MA



Plans Using the Systemic Approach

We hope to use the systemic approach to:

- **Bundle projects**
- **Implement low-cost countermeasures**
- **Develop media campaigns**
- **Advertise infrastructure**

Future Data Sources:

- **Bike/Pedestrian counts**
- **2018 Crash Data**
- **Travel vs regulatory speed**

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Thank you

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