

Boston Region Vision Zero Action Plan

Appendix D: High-Risk (Systemic) Network Methodology



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1 | Introduction

As a supplement to the crash-based (reactive) network screening analysis used to develop the High-Injury Network (HIN), in this systemic analysis a proactive approach was used to identify risk factors commonly associated with fatal and serious injury crashes and to evaluate the road network based on site-specific risk levels. While the HIN targeted locations with a high concentration of historical crashes, the systemic analysis focused on locations with a significant risk of severe crashes, regardless of crash history. **By focusing on where crashes are more likely to occur in the future, this proactive approach enables road owners to prioritize higher-risk locations for preventative safety improvements before a significant number of severe crashes occur.**

The screening and prioritization process of systemic analysis, as described in the Federal Highway Administration's (FHWA) [Systemic Safety User Guide](#), typically consists of six steps:

1. Identify types of crashes, or *focus crash types*, that represent the highest frequency of severe crashes or highest potential of severe crashes on the system.
2. Identify types of facilities on the system, or *focus facility types*, where focus crashes most frequently occur.
3. Identify risk factors that are most correlated with an increased risk of a severe crashes, based on these focus crash and facility types.
4. Identify system elements (i.e., roadway segments, intersections, and curves) that have features associated with each risk factor.
5. Calculate a risk score for each system element based on the presence and weight of applicable risk factors.
6. Prioritize system elements by ranking them from highest to lowest risk scores.

The results of a systemic analysis can support the development of comprehensive safety plans and inform the installation of low-cost proven safety countermeasures to effectively reduce fatalities and serious injuries at scale.¹

¹ FHWA, Systemic Approach to Safety, <https://highways.dot.gov/safety/data-analysis-tools/systemic#:~:text=It%20can%20be%20used%20to,and%20serious%20injuries%20at%20scale>.

The Massachusetts Department of Transportation (MassDOT) first implemented the systemic approach for network screening with a grant received from the United States Department of Transportation (U.S. DOT) in 2020 as part of the competitive Safety Data Initiative (SDI) process. Following FHWA's systemic analysis process, MassDOT identified focus crash types, facility types, and risk factors for each emphasis area outlined in the 2018 [Strategic Highway Safety Plan](#) (SHSP). In 2023, the analysis was updated using crash data from 2017 to 2021. A [Risk-Based Network Screening Tool](#) was developed accordingly in the IMPACT portal, allowing users to visualize the systemic network screening results and filter top-ranked, high-risk sites.

Drawing on findings from the Risk-Based Network Screening Tool, this appendix includes a summary of the systemic analysis results for each key emphasis area identified in the Existing Conditions Report in Appendix B:

- Intersections
- Vulnerable Road Users (VRUs)
- Lane Departure
- Older Drivers
- Large Vehicles
- Speeding

These summaries can help the Boston Region MPO strategically identify and address locations with the greatest potential for severe crashes across the region's network.

Data Sources and Processing

The IMPACT [Risk-Based Network Screening Tool](#) is the primary data source for the systemic analysis result summaries. The tool provides outputs identifying high-risk towns, road segments, and intersections at the MPO level for most of the key emphasis areas based on specific risk factors for each emphasis area. Each emphasis area targets specific focus facility types, so not all segments and intersections are included in the analysis.

In addition, roadway attribute data from MassDOT's [Road Inventory \(2022\)](#) were used to analyze the distribution of roadway segments by risk level across different jurisdictions. Since the systemic analysis for large vehicle-involved crashes had not been updated by MassDOT using the most recent crash data and the speeding-related systemic analysis was completed only at the town level, fatal and serious injury crash data from 2018 to 2022 also were collected from the [MassDOT Data Query and Visualization Tool](#). These crashes were combined with the road inventory data to

determine focus facility types and risk factors and to identify high-risk sites for crashes involving large vehicles and speeding-related crashes.

2 | Key Findings

This section summarizes the key findings of the analysis completed using the MassDOT IMPACT Risk-Based Network Screening Tool and the additional analysis completed for emphasis areas not covered by the tool. For the risk-based network screening, MassDOT prioritized sites by ranking them based on risk scores derived from site-specific risk factors for each emphasis area. Sites ranked in the top 5th percentile were classified as “Primary Risk Sites,” indicating the highest risk for the emphasis area, while sites in the next highest 10th percentile were “Secondary Risk Sites,” representing a moderate risk. All remaining sites were classified as “Not a Risk Site.”

The MassDOT IMPACT Risk-Based Network Screening Tool visualizes primary and secondary risk sites for each emphasis area at both the state and MPO levels. The tool provides the following outputs that correspond to the region’s key emphasis areas identified in the Existing Conditions Report in Appendix B:

- **Intersections:** Focus facility types were split into primary risk sites and secondary risk sites.
- **Vulnerable Road Users:** Focus facility types for both segments and intersections for pedestrians and bicyclists separately were split into primary risk sites and secondary risk sites. For this analysis, the pedestrian and bicyclist risk sites were combined into one VRU layer.
- **Lane Departure:** Focus facility types for segments were split into primary risk sites and secondary risk sites.
- **Older Drivers:** Focus towns were split into primary risk towns and secondary risk towns. This analysis was not done at the segment or intersection level as crashes involving older drivers are not as easily tied to specific roadway attributes. Older driver interventions are primarily behavior based rather than infrastructure based.
- **Speeding:** Focus towns were split into primary risk towns and secondary risk towns. However, a manual systemic analysis of speeding-related crashes was conducted for more detail at the segment level.
- **Large Vehicles:** Since there were no current outputs from the tool regarding crashes involving large vehicles, a manual systemic analysis was completed for this emphasis area.

Key Takeaways

- Traffic volumes, the number of approach lanes, and the type of intersection control are all key risk factors at intersections.
- Of the 314 centerline miles identified as primary risk sites for crashes involving vulnerable road users, 78 percent are under municipal jurisdiction.
- The majority of lane departure crashes occur on two-lane, two-way undivided highways. These roads are the highest-risk sites for fatalities and serious injuries due to lane departures.
- Towns north of the inner core of the region, including Revere, Saugus, Lynn, and Peabody, are most at-risk for crashes involving older drivers.
- Roads under MassDOT jurisdiction have the highest proportion of mileage considered as high-risk for crashes involving large vehicles.
- Narrow medians, wide traveled ways, and high traffic volumes are key risk factors for speeding-related crashes on urban roads without traffic controls.

Key Emphasis Areas

A distinct set of focus facility types and associated risk factors was identified for each emphasis area. Table D-1 lists the focus facility types and risk factors identified for key emphasis areas covered by the MassDOT Risk-Based Network Screening Tool and for the additional “Large Vehicle” and “Speeding” emphasis areas, which were identified through a manual systemic analysis.

As a summary, for emphasis areas with multiple focus facility types, the associated risk factors were combined by category in the table. The full list of risk factors for each focus facility type within each emphasis area is provided in Section 4, along with a summary of sites by jurisdiction and risk category. The full systemic analysis methodology for the “Large Vehicle” and “Speeding” emphasis areas is also included in Section 4.

Table D-1 | Facility Types and Risk Factors Identified for Each Key Emphasis Area

Emphasis Area	Focus Facility Type	Risk Factor Category	
Intersection Angle Crashes	<ul style="list-style-type: none"> All intersections (except roundabouts, other circular intersections, and nonconventional intersections) 	<ul style="list-style-type: none"> Intersection major approach annual average daily traffic (AADT) Intersection minor approach AADT Respective town meets three environmental justice criteria¹ 	<ul style="list-style-type: none"> Number of through lanes on major road Intersection traffic control type Number of intersection approaches
VRU Crashes—Segments	<ul style="list-style-type: none"> Principal arterials Minor arterials Major collectors 	<ul style="list-style-type: none"> Segment length Segment AADT Roadway attributes, including shoulder type, median type, curb presence, sidewalk width, number of lanes, etc. Posted speed limit Segment proximity to destinations, including liquor stores, bike trails, transit, colleges, etc. Segment proximity to hazardous waste Biking and walking potential² 	<ul style="list-style-type: none"> Environmental justice criteria Block group socioeconomic characteristics, including population density, median household income, employee density, etc. Segment proximity to different land use types, including commercial, mixed-use, residential, etc. Percentage of commuters walking, biking, and using transit
VRU Crashes—Intersections	<ul style="list-style-type: none"> All intersections (except roundabouts, other circular intersections, and nonconventional intersections) 	<ul style="list-style-type: none"> Intersection major approach AADT Intersection minor approach AADT Presence of lighting Respective town meets three environmental justice criteria Number of intersection approaches 	<ul style="list-style-type: none"> Number of through lanes on major road Urban type Biking and walking potential² Intersection traffic control type Land use mix Intersection proximity to destinations, including liquor stores and transit stops

Emphasis Area	Focus Facility Type	Risk Factor Category	
Lane Departure Crashes	<ul style="list-style-type: none"> Urban, two-lane, two-way, undivided highways Rural, two-lane, two-way, undivided highways 	<ul style="list-style-type: none"> Segment length Segment AADT Federal functional classification Roadway attributes, including shoulder type and width, curb presence, surface width, etc. 	<ul style="list-style-type: none"> Posted speed limit Number of Alcoholic Beverage Control Commission (ABCC) Licenses within a quarter mile of the segment Presence of horizontal curvatures Terrain type
Older Driver-Involved Crashes	Analysis was performed at town level	<ul style="list-style-type: none"> Proportion of mileage that is Interstate, freeway, or expressway Number of senior care providers and assisted living facilities in town Number of traffic citations, including impaired driving citations and speeding citations per centerline mile in the town 	<ul style="list-style-type: none"> Town-level demographic characteristics, including population aged over 64, percentage of population aged over 64 with self-reported cognitive issues, and proportion of licensed drivers aged over 64
Large Vehicle-Involved Crashes	<ul style="list-style-type: none"> Urban, uncontrolled, principal arterials (other) Urban, uncontrolled, minor arterials 	<ul style="list-style-type: none"> Segment AADT Roadway attributes, including shoulder type, surface width, median width, etc. 	<ul style="list-style-type: none"> Posted speed limit Roadway jurisdiction
Speeding-Related Crashes	<ul style="list-style-type: none"> Urban, uncontrolled, principal, arterials (other) Urban, uncontrolled, minor arterials Urban, uncontrolled, major collectors Urban, uncontrolled, local roads 	<ul style="list-style-type: none"> Segment AADT Roadway attributes, including shoulder width, median width, surface width, curb presence, etc. 	<ul style="list-style-type: none"> Posted speed limit

¹ Environmental justice criteria, determined by Massachusetts Executive Office of Energy and Environmental Affairs (EEA), include the following: 1) Income: The annual median household income is 65 percent or less of the statewide annual median household income; 2) Minority: Minorities make up 40 percent or more of the population; 3) English Isolation: 25 percent or more of households identify as speaking English less than "very well"; 4) Minorities make up 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.

² See MassDOT's [Potential for Everyday Biking \(2022 Update\)](#) and [Potential for Walkable Trips \(2022 Update\)](#).

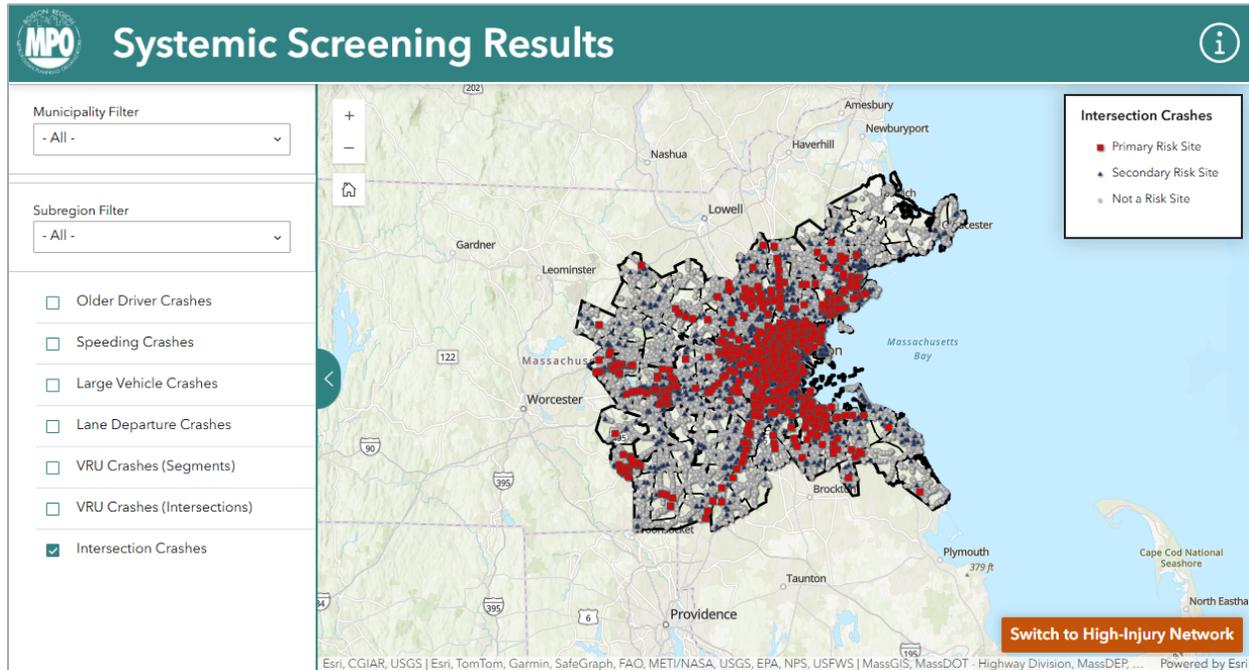
AADT = annual average daily traffic. VRU = vulnerable road user.

Source: [MassDOT Network Screening Risk-Based Methodology Reports](#) and additional systemic analysis performed by Cambridge Systematics.

Online Map of Systemic Network

To better view the systemic network, an [online application](#) was created as seen in Figure D-1. This application allows for comparison between the systemic network and the HIN to identify overlaps and similarities. Each network was developed through a different methodology, so it is not expected that they identify identical locations. Locations that were identified as being on both the systemic network and HIN should be reviewed independently to determine if all fatal and serious injury crashes are tied to systemic issues or if there is a need for supplemental tailored treatments.

Figure D-1 | Online Systemic Network Viewing Application



3 | Next Steps

The HIN, systemic analysis, and existing conditions analysis can be used at the regional, subregional, and municipal levels to identify locations where safety improvements are needed and to plan for projects both reactively and proactively. These resources will support decision-makers as they prioritize safety projects in the Boston region, and they will inform strategies and actions as the *Vision Zero Action Plan* is implemented.

A key next step in the implementation of the *Vision Zero Action Plan* will be the development of subregion safety profiles that describe the common infrastructure, behavioral, operational, and modal safety problems in each subregion. These profiles will combine results from the Existing Conditions Report in Appendix B, the HIN, outreach activities, and more aspects of the plan to provide a holistic view of safety specific to each subregion.

4 Systemic Analysis Methodology

This section outlines the development of focus facility types and associated risk factors for the region's key emphasis areas. A complete list of focus facility types and risk factors identified for each emphasis area is provided. The methodology used for the manual systemic analysis of large vehicle crashes and speeding-related crashes is also discussed.

Intersection Crashes

The systemic analysis of intersection crashes was performed by MassDOT and focused on multi-vehicle angle crashes, defined as those where the first harmful event was a "collision with a motor vehicle in traffic" and the manner of collision was "angle." All angle crashes that occurred at four-way intersections, T-intersections, Y-intersections, traffic circles, or intersections with five or more legs were considered.

To determine the most common focus facility types where angle crashes have resulted in fatal and serious injuries, MassDOT developed a [crash tree](#) to analyze crash distribution by intersection geometry and traffic control type. All intersections except circular intersections and nonconventional intersections were included as focus facility types. For these selected intersections, risk factors that potentially contribute to an increased risk of severe angle crashes were assessed using various datasets, including intersection inventory data, land use data, and environmental justice data. Eight risk factors were identified:

- Major approach annual average daily traffic (AADT) of 9,000 and above
- Minor approach with AADT of 1,500 and above
- Respective town meets three environmental justice criteria²
- Three or more through lanes on major approach

² Environmental justice criteria, determined by Massachusetts Executive Office of Energy and Environmental Affairs (EEA), include the following: 1) Income: The annual median household income is 65 percent or less of the statewide annual median household income; 2) Minority: Minorities make up 40 percent or more of the population; 3) English Isolation: 25 percent or more of households identify as speaking English less than "very well"; 4) Minorities make up 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.

- Two-way stop-control
- All-way stop-control
- Signalized control
- Four or more intersection legs

MassDOT assigned an equal weight to each risk factor, except for “All-way stop-control,” which was given a weight of 0.75, and “Major Approach AADT,” which received a variable weight ranging from 0 to 1 based on the major approach AADT value. A normalized risk score was then calculated for each intersection, and a percentile rank was generated at the MPO level. Further details on the risk factor identification and facility scoring process can be found in the [Risk Factors for SHSP Emphasis Areas](#) report published by MassDOT. An example application of the scoring process also is provided in Section 5 using a randomly selected intersection in the region to illustrate how MassDOT evaluated site-specific risk levels after identifying focus facility types and risk factors.

Within the region, intersections ranked in the top 5 percent were categorized as “Primary Risk Intersection,” and intersections ranked in the next 10 percent were categorized as “Secondary Risk Intersection.” Table D-2/figure D-2 summarizes the number of intersections by risk category and jurisdiction.

Table D-2 | Intersections by Risk Category and Jurisdiction (Intersection Angle Crashes)

Jurisdiction	Primary Risk Site		Secondary Risk Site		Not a Risk Site		Total
	Number	Percentage	Number	Percentage	Number	Percentage	
MassDOT	325	13%	469	18%	1,778	69%	2,572
Non-MassDOT	870	4%	1,919	9%	15,522	87%	21,311
Total	1,195	5%	2,388	10%	20,300	85%	23,883

Note: Data in the MassDOT IMPACT Network Screening Risk-Based Tool only specify intersection jurisdiction as MassDOT or non-MassDOT. This table includes all intersections (except roundabouts, other circular intersections, and nonconventional intersections).

Source: MassDOT IMPACT Network Screening Risk-Based Tool.

Vulnerable Road User Crashes

Since VRUs are susceptible to serious injuries and fatalities in crashes involving motor vehicles, a systemic analysis was performed by MassDOT for crashes involving pedestrians and bicyclists at both roadway segment and intersection levels.

For serious injury crashes involving pedestrians and bicyclists on roadway segments, the crash distribution by roadway functional classification identified principal arterials, minor arterials, and major collectors as focus facility types. Separate sets of segment-level risk factors were identified for each focus facility type, using a combined dataset of roadway attributes, biking-walking infrastructure, land use types, and socioeconomic considerations at the block group level. Full lists of the identified risk factors for each focus facility type are provided in Table D-3 through Table D-5.

Table D-3| Segment-level Risk Factors for VRU-Involved Crashes on Principal Arterials (Other)

Focus Facility Type	Risk Factor (Pedestrian)	Risk Factor (Bicycle)
Principal Arterials	<ul style="list-style-type: none"> • Natural log of segment length • AADT over 8,000 • Curbs on both sides • Three or more total lanes on the segment • “Medium” or “high” walking potential • Bike trails present within a half mile • Colleges present within a half mile • Transit stops present within a quarter mile • Segment within 100 feet of area zoned as “commercial” • Segment within 100 feet of area zoned as “mixed use commercial” • Segment within 100 feet of area zoned as “mixed use residential” • Segment within 100 feet of area zoned as “residential multifamily” • Total population of the respective block group over 3,000 • Respective block group meets at least one environmental justice criterion¹ • Percentile of low life expectancy in the respective census tract 	<ul style="list-style-type: none"> • Natural log of segment length • AADT over 9,000 • Curbs on both sides • No shoulder present • No median present • Two-way traffic operation • Posted speed limit over 30 mph • “High” biking potential • Bike trails present within a half mile • Alcohol sold within a quarter mile • Respective census tract classified as “Environmentally Disadvantaged” by U.S. DOT • Population density of the respective block group over 8,000 per square mile • Hazardous waste present within a quarter mile • Segment within 100 feet of area zoned as “commercial” • Segment within 100 feet of area zoned as “mixed use other” • Segment within 100 feet of area zoned as “open land” • Percentage of the population aged over 64 in the respective block group

¹ Environmental justice criteria, determined by Massachusetts Executive Office of Energy and Environmental Affairs (EEA), include the following: 1) Income: The annual median household income is 65 percent or less of the statewide annual median household income; 2) Minority: Minorities make up 40 percent or more of the population; 3) English Isolation: 25 percent or more of households identify as speaking English less than “very well;” 4) Minorities make up 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.

AADT = annual average daily traffic. mph = miles per hour. VRU = vulnerable road user.

Source: [MassDOT Network Screening Risk-Based Methodology Reports](#).

Table D-4| Segment-level Risk Factors for VRU-Involved Crashes on Minor Arterials

Focus Facility Type	Risk Factor (Pedestrian)	Risk Factor (Bicycle)
Minor Arterials	<ul style="list-style-type: none"> • Natural log of segment length • AADT over 10,000 • Curbs on both sides • Curbed median present • Two-way traffic operation • Sidewalk width over 10 feet • “High” walking potential • Transit stops present within a quarter mile • Segment within 100 feet of area zoned as “commercial” • Segment within 100 feet of area zoned as “mixed use residential” • Segment within 100 feet of area zoned as “open land” • Segment within 100 feet of area zoned as “residential multifamily” • Median household income of the respective block group under \$100,000 • Percentage of limited English-speaking households in the respective block group over 25 percent • Percentage of Black or African American population in the respective census tract 	<ul style="list-style-type: none"> • Natural log of segment length • AADT over 5,000 • No shoulder present • Sidewalk present • Posted speed limit under 45 mph • Bike trails present within a half mile • Employee density of the respective block group over 5,000 per square mile • Percentage of commuters walking, biking, and using transit over 10 percent • Segment within 100 feet of area zoned as “commercial” • Segment within 100 feet of area zoned as “mixed use other” • Segment within 100 feet of area zoned as “mixed use residential” • Percentage of population aged under 5 in the respective block group

AADT = annual average daily traffic. mph = miles per hour. VRU = vulnerable road user.

Source: [MassDOT Network Screening Risk-Based Methodology Reports](#).

Table D-5 | Segment-level Risk Factors for VRU-Involved Crashes on Major Collectors

Focus Facility Type	Risk Factor (Pedestrian)	Risk Factor (Bicycle)
Major Collectors	<ul style="list-style-type: none"> • Natural log of segment length • Posted speed limit over 25 mph • AADT over 3,000 • Sidewalk width over 5 feet • Alcohol sold within a quarter mile • Respective block group has less than 25 transit stops per square mile • Percentage of “English Isolated” population in the respective block group • Traffic proximity over 300 as calculated by the Climate and Economic Justice Screening Tool (CEJST) • Segment within 100 feet of area zoned as “commercial” • Segment within 100 feet of area zoned as “recreation” • Segment within 100 feet of area zoned as “open land” • Segment within 100 feet of area zoned as “residential other” 	<ul style="list-style-type: none"> • Natural log of segment length • AADT over 4,000 • Sidewalk width over 5 feet • Median present • “Medium” or “high” biking potential • Bike trails present within a half mile • Transit stops present within a quarter mile • Alcohol sold within a quarter mile • Hazardous waste present within a quarter mile • Segment within 100 feet of area zoned as “commercial” • Segment within 100 feet of area zoned as “agriculture” • Segment within 100 feet of area zoned as “open land” • Segment within 100 feet of area zoned as “water” • Percentage of Black or African American population in the respective census tract over 3 percent • Percentage of low-income population in the respective block group

AADT = annual average daily traffic. mph = miles per hour. VRU = vulnerable road user.

Source: [MassDOT Network Screening Risk-Based Methodology Reports](#).

Considering the quality of available data and the potential impact of each risk factor on pedestrian and bicyclist crashes, a weighted sum of the identified risk factors was calculated for each segment within its respective focus facility type and normalized at the MPO level. A corresponding percentile rank was then computed. Similar to the analysis performed for multi-vehicle angle crashes in intersections, segments were categorized into three risk levels based on their percentile ranks. The systemic analysis process for the pedestrian crashes and bicyclist crashes is documented in detail in the [Risk Factors for SHSP Emphasis Areas: Pedestrian Crashes](#) and [Risk Factors for SHSP Emphasis Areas: Bicycle Crashes](#) reports.

To determine the overall segment risk categories for VRU crashes, segment risk levels derived from pedestrian and bicyclist systemic analyses were combined by selecting the higher of the two.

Within the Boston region, 10 percent of selected focus facilities (measured by centerline miles) were identified as primary risk sites; 78 percent of those miles (246 out of 314 miles) were under municipal jurisdiction. Table D-6 summarizes the number of VRU crash sites by risk category and jurisdiction.

Table D-6| Centerline Miles by Risk Category and Jurisdiction (VRU Crashes)

Jurisdiction	Primary Risk Site		Secondary Risk Site		Not a Risk Site		Total
	Number	Percentage	Number	Percentage	Number	Percentage	
Municipality	245.6	10%	371.5	15%	1,827.2	75%	2,444.3
MassDOT	54.3	8%	64.4	9%	575.9	83%	694.6
DCR	14.1	11%	36.0	27%	84.1	63%	134.2
Other ¹	0.0	0%	1.9	33%	3.8	67%	5.7
Total	314.3	10%	473.8	14%	2,491.0	76%	3,278.8

¹ The jurisdiction category “Other” includes the Massachusetts Port Authority, State Park or Forest, State Institutional, Federal Park or Forest, County Institutional, U.S. Air Force, U.S. Army Corps of Engineers, Federal Institutional, Private, and U.S. Army.

Note: This table only includes the identified focus facility types (principal arterials, minor arterials, and major collectors).

DCR = Department of Conservation and Recreation. VRU = vulnerable road user.

Source: MassDOT IMPACT Network Screening Risk-Based Tool and MassDOT Road Inventory 2022.

For intersection-related pedestrian and bicyclist crashes, all intersections (except roundabouts, other circular intersections, and nonconventional intersections) were considered as focus facility types. Risk factors were identified based on intersection-level attributes and community-based characteristics, with a complete list provided in Table D-7.

Table D-7| Intersection-level Risk Factors for VRU-Involved Crashes

Focus Facility Type	Risk Factor (Pedestrian)	Risk Factor (Bicycle)
All intersections (except roundabouts, other circular intersections, and nonconventional intersections)	<ul style="list-style-type: none"> Major approach AADT between 3,000 and 5,999 Major approach AADT between 6,000 and 11,999 Major approach AADT 12,000 and above Minor approach AADT 1,000 and above Three or more through lanes on major approach Respective town meets three environmental justice criteria¹ Alcohol sold within a quarter mile Transit stops present within a quarter mile Four-leg intersection Signalized control Intersection located in urban areas Proportion of impervious land Land use mix Proportion of institutional land use 	<ul style="list-style-type: none"> Major approach AADT between 5,000 and 9,999 Major approach AADT between 10,000 and 14,999 Major approach AADT above 15,000 Minor approach AADT above 1,500 Three or more lanes on minor approach Lighting present Respective town meets three environmental justice criteria Transit stops present within a quarter mile Number of liquor stores within a quarter mile Four-leg intersection Signalized control Yield control Biking potential Intersection located in urban areas Land use mix

¹ Environmental justice criteria, determined by Massachusetts Executive Office of Energy and Environmental Affairs (EEA), include the following: 1) Income: The annual median household income is 65 percent or less of the statewide annual median household income; 2) Minority: Minorities make up 40 percent or more of the population; 3) English Isolation: 25 percent or more of households identify as speaking English less than “very well;” 4) Minorities make up 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.

AADT = annual average daily traffic. VRU = vulnerable road user.

Source: [MassDOT Network Screening Risk-Based Methodology Reports](#).

Based on the weighted sum of these risk factors for each intersection and the corresponding percentile ranks within the Boston Region MPO, Table D-8 shows that 7 percent of intersections were classified as “Primary Risk Sites.” Notably, intersections under MassDOT jurisdiction have a higher proportion of primary and secondary risk sites (31 percent) compared to those under non-MassDOT jurisdiction (18 percent).

Table D-8 | Intersections by Risk Category and Jurisdiction (VRU Crashes)

Jurisdiction	Primary Risk Site		Secondary Risk Site		Not a Risk Site		Total
	Number	Percentage	Number	Percentage	Number	Percentage	
MassDOT	347	13%	461	18%	1,764	69%	2,572
Non-MassDOT	1,253	6%	2,472	12%	17,586	83%	21,311
Total	1,600	7%	2,933	12%	19,350	81%	23,883

Note: Data in the MassDOT IMPACT Network Screening Risk-Based Tool only specify intersection jurisdiction as MassDOT or non-MassDOT.

This table includes all intersections (except roundabouts, other circular intersections, and non-conventional intersections).

Source: MassDOT IMPACT Network Screening Risk-Based Tool.

For a more complete understanding of pedestrian and bicyclist safety issues and which areas to focus VRU safety improvements, the high-risk locations identified through systemic analysis can be layered with historically high-crash frequency locations from the [MassDOT Crash-based Network Screening Analysis](#), as discussed in the 2023 Massachusetts Vulnerable Road User Safety Assessment. Using this combined approach, MassDOT identified the top 5 percent of towns considered high risk based on each town's pedestrian and bicyclist crash history and coverage of top risk sites. Notably, 13 of the 17 identified high-risk towns are within the Boston region:

- Cambridge
- Boston
- Somerville
- Brookline
- Waltham
- Chelsea
- Lynn
- Everett
- Medford
- Quincy
- Malden
- Revere
- Newton

The Boston Region MPO should prioritize targeted systemic safety improvements in these high-risk towns to proactively reduce the risk of future severe crashes.

Lane Departure Crashes

Lane departure crashes have been a leading cause of fatal and serious injury crashes both statewide and within the Boston region. The systemic analysis performed by MassDOT for lane departure crashes included all crashes in which the first harmful event involved a collision with a fixed object, running off the road, or crossing the centerline or median.

MassDOT identified urban and rural two-lane, two-way, undivided highways as focus facility types for lane departure crashes. Due to limited AADT data for many local roads, these two facility types were further divided into four categories based on the availability of AADT information. Separate sets of risk factors were then identified for each facility category using roadway attribute data and operational data at the segment level, along with town-level data on Alcoholic Beverage Control Commission (ABCC) licenses. Table D-9 and Table D-10 present the complete sets of risk factors for urban and rural, two-lane, undivided roadway segments.

Table D-9 | Risk Factors for Lane Departure Crashes on Urban, Two-Lane, Undivided Roads

Focus Facility Type	Risk Factor (Roads with Known AADT)	Risk Factor (Roads with Unknown AADT)
Urban, Two-Lane, Undivided Roads	<ul style="list-style-type: none"> Natural log of AADT Federal functional class is principal arterial (other) or minor arterial Federal functional class is major collector or minor collector Average shoulder width of 4 feet or less Surface width of 23 feet or more 1 or fewer ABCC licenses within a quarter mile of the segment MPO is Middlesex or Pioneer MPO is Old Colony or Southeast MPO is Cape Cod or Montachusett Horizontal curvature present ranging from 3.5 degrees to 13.9 degrees 	<ul style="list-style-type: none"> No curb present Curb present on one side of roadway At least one ABCC license within a quarter mile of the segment Surface width 22 feet or less MPO is not Cape Cod MPO is Southeast Horizontal curvature present ranging from 3.5 degrees to 13.9 degrees

AADT = annual average daily traffic. ABCC = Alcoholic Beverage Control Commission. MPO = metropolitan planning organization.

Source: [MassDOT Network Screening Risk-Based Methodology Reports](#).

Table D-10| Risk Factors for Lane Departure Crashes on Rural, Two-Lane, Undivided Roads

Focus Facility Type	Risk Factor (Roads with Known AADT)	Risk Factor (Roads with Unknown AADT)
Rural, Two-Lane, Undivided Roads	<ul style="list-style-type: none"> Natural log of AADT AADT over 4,000 Rolling or Mountainous terrain type MPO is Old Colony Right Shoulder Type is Stable—Unruttable compacted subgrade Posted Speed Limit of 50 mph Horizontal curvature present ranging from 3.5 degrees to 13.9 degrees 	<ul style="list-style-type: none"> MPO is Nantucket Mountainous terrain type Horizontal curvature present ranging from 3.5 degrees to 13.9 degrees

AADT = annual average daily traffic. mph = miles per hour. MPO = metropolitan planning organization.

Source: [MassDOT Network Screening Risk-Based Methodology Reports](#).

Based on the identified risk factors, normalized risk scores and percentile ranks were calculated for each segment within the region. Table D-11 summarizes the distribution of roadway segments by risk site category and jurisdiction.

Table D-11 | Centerline Miles by Risk Category and Jurisdiction (Lane Departure Crashes)

Jurisdiction	Primary Risk Site		Secondary Risk Site		Not a Risk Site		Total
	Number	Percentage	Number	Percentage	Number	Percentage	
Municipality	492.7	6%	922.5	12%	6,469.4	82%	7,884.7
MassDOT	36.6	14%	77.5	30%	142.9	56%	257.0
DCR	13.6	21%	16.7	25%	35.3	54%	65.6
Other ¹	1.1	0%	38.4	6%	558.6	93%	598.1
Total	544.0	6%	1,055.1	12%	7,206.3	82%	8,805.4

¹ The jurisdiction category “Other” includes the Massachusetts Port Authority, State Park or Forest, State Institutional, Federal Park or Forest, County Institutional, U.S. Air Force, U.S. Army Corps of Engineers, Federal Institutional, Private, and U.S. Army.

DCR = Department of Conservation and Recreation.

Note: This table only includes the identified focus facility types (urban two-lane, two-way undivided highways and rural two-lane, two-way undivided highways).

Source: MassDOT IMPACT Network Screening Risk-Based Tool and MassDOT Road Inventory 2022.

Older Driver-Involved Crashes

Due to the prevalence of fatal and serious injury crashes involving older drivers in various facility types, MassDOT performed the systemic analysis at the town-level to prioritize communities for education campaigns and safety initiatives focused on older road users. The analysis identified eight town-level risk factors applicable to the region:

- Proportion of mileage that is Interstate, freeway, or expressway
- Absence of senior care providers in town
- More than 0.5 annual impaired driving citations per centerline mile in the town
- More than 3 annual speeding citations per mile in the town
- Natural log of persons aged 65 or older in the town
- Less than 3 assisted living facilities in the town
- Percentage of persons aged 65 or older with self-reported cognitive issues
- Proportion of licensed drivers aged 65 or older

MassDOT assigned a risk score between 0 and 1 to each risk factor, and ranked towns at the MPO level using the normalized combined risk scores and percentile ranks.

In the Boston Region MPO area, the systemic analysis identified five primary risk towns, representing 10 percent of the region's population and 6 percent of its roadway mileage. Additionally, 10 secondary risk towns were identified, accounting for an additional 12 percent of the population and 11 percent of roadway mileage. Detailed information on these towns is provided in Table D-12 (Primary Risk Towns) and Table D-13 (Secondary Risk Towns), with towns listed in descending order based on their percentile ranks within the region.

Table D-12 | Primary Risk Towns (Older Driver Crashes)

Town	Population	Centerline Mileage by Jurisdiction									Older Driver KA Crashes per 100,000 Population
		Municipality		MassDOT		DCR		Other		Total	
Lynn	101,253	159.8	91%	3.0	2%	3.3	2%	9.3	5%	175.4	30
Revere	62,186	86.1	78%	15.2	14%	7.2	7%	1.9	2%	110.3	26
Somerville	81,045	93.2	83%	7.1	6%	2.0	2%	10.7	9%	112.9	7
Peabody	54,481	173.6	90%	13.6	7%	0	0%	4.8	2%	192.0	28
Saugus	28,619	94.2	82%	8.2	7%	2.7	2%	10.3	9%	115.3	56

Note: This table includes Interstates and other fully access-controlled roadways.

DCR = Department of Conservation and Recreation. KA = crashes involving a fatality or serious injury.

Source: MassDOT IMPACT Network Screening Risk-Based Tool and MassDOT Road Inventory 2022.

Table D-13 | Secondary Risk Towns (Older Driver Crashes)

Town	Population	Centerline Mileage by Jurisdiction									Older Driver KA Crashes Per 100,000 Population
		Municipality		MassDOT		DCR		Other		Total	
Salem	44,480	90.8	90%	4.7	5%	0.0	0%	5.8	6%	101.3	9
Stoneham	23,244	64.6	79%	4.8	6%	5.7	7%	6.6	8%	81.7	30
Weymouth	57,437	151.6	81%	15.6	8%	0.0	0%	19.1	10%	186.3	44
Waltham ¹	65,218	117.6	70%	6.9	4%	0.3	0%	42.2	25%	167.0	127
Brookline	63,191	93.5	87%	3.0	3%	2.6	2%	8.4	8%	107.5	8
Wilmington	23,349	102.9	77%	12.6	9%	0.0	0%	18.8	14%	134.3	39
Watertown	35,329	73.1	92%	1.1	1%	3.1	4%	1.8	2%	79.0	17
Milton	28,630	99.7	80%	9.5	8%	9.6	8%	5.9	5%	124.8	24
Norwood	31,611	104.4	89%	9.2	8%	0.0	0%	3.5	3%	117.1	28
Randolph	34,984	99.8	84%	8.7	7%	0.0	0%	9.6	8%	118.1	51

¹ As identified in Appendix B, the City of Waltham likely has inaccurately coded fatal and serious injury crash data. Despite this leading to potentially misleading analyses, Waltham was kept in this table to ensure consistency with the results of MassDOT's approach to older driver systemic screening.

Note: This table includes Interstates and other fully access-controlled roadways.

DCR = Department of Conservation and Recreation. KA = crashes involving a fatality or serious injury.

Source: MassDOT IMPACT Network Screening Risk-Based Tool and MassDOT Road Inventory 2022.

The five primary risk towns in Table D-12 were identified mainly due to a combination of a greater older population (more than 5,600) and a significant proportion (over 6 percent) of older adults with self-reported cognitive issues. To address the elevated crash risk in these areas, potential countermeasures, including improved roadway signage and overall visibility, and targeted education programs on safe driving practices for older adults, should be considered.

Large Vehicle-Involved Crashes

In the MassDOT risk-based network screening, crashes involving large vehicles were defined as crashes involving a single-unit or larger truck or a bus. While relatively infrequent, crashes involving large vehicles tend to result in more severe outcomes compared to those involving passenger vehicles. Therefore, these types of crashes were identified as a focus crash type in the systemic analysis performed by MassDOT in 2017. However, this specific analysis has not been updated to incorporate more recent crash data, and its results have not been integrated into the IMPACT Risk-Based Network Screening Tool. Given that crashes involving large vehicles are still considered an emphasis area for the Boston Region MPO, **the previous systemic analysis was updated using a similar approach based on crash data from 2018 to 2022.**

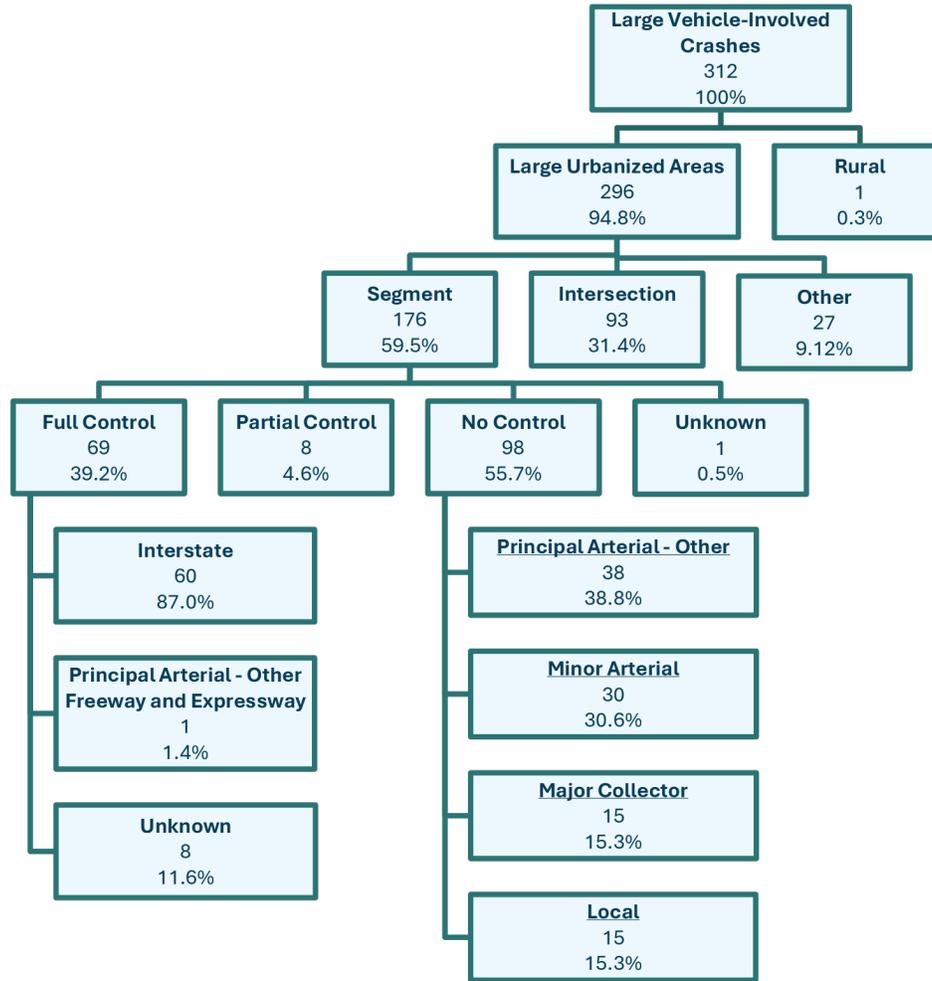
Focus Facility Types

Between 2018 and 2022, 312 of 4,770 (6.5 percent) fatal and serious injury crashes in the region involved large vehicles. Since most of these crashes occurred on roadway segments (60 percent), the analysis focused on segment-level crashes to identify focus facility types, and a crash tree was developed accordingly.

Figure D-2 shows the distribution of fatal and serious injury crashes involving large vehicles on roadway segments by access control type and functional classification. Although segments with full access control, such as Interstates and other expressways or freeways, account for a significant share of large vehicle crashes (39 percent), they were not included as potential focus facility types. This analysis focused on local roads to more effectively address the areas where interventions are most needed and can have the greatest impact on reducing fatal and serious injury crashes.

After the exclusion of Interstates and other expressways and freeways, urban, uncontrolled, principal arterials (other) and urban, uncontrolled, minor arterials were identified as focus facility types, as they accounted for the highest proportion of crashes involving large vehicles among the remaining facility types (underscored in Figure D-2).

Figure D-2| Crash Tree for Large Vehicle-Involved Segment Crashes



Note: This chart includes fatal and serious injury crashes along Interstates and other fully access-controlled roadways.

Source: MassDOT IMPACT Crash Tree Builder.

Risk Factor Identification

Following the selection of focus facility types, the overrepresentation approach was used to determine potential risk factors. The following data were examined: the 2018 to 2022 crash data obtained from the MassDOT IMPACT tool, 2022 road inventory data, factors related to crash characteristics, roadway attributes, and involved vehicles and persons recorded in the crash dataset.

For each focus segment type, an attribute was considered a risk factor if the proportion of fatal and serious injury crashes involving large vehicles with that attribute was statistically higher than the

proportion of centerline miles with the same attribute within that facility type. Statistical significance was determined by constructing 90 percent confidence intervals around the proportion.

For urban, uncontrolled, principal arterials, no statistically significant risk factor was identified relevant to crashes involving large vehicles. However, a slight overrepresentation of crashes was observed on segments with the following characteristics: AADT above 20,000, left-side curb only, MassDOT jurisdiction, four travel lanes, right shoulder width between 4 and 12 feet, right sidewalk width between 9 and 12 feet, speed limits of 40 miles per hour (mph) or above, and traveled way width less than 25 feet. While these factors did not reach statistical significance in this analysis, the observed overrepresentation suggests that there are potential correlations with crashes involving large vehicles. Thus, these factors should still be considered in future screening efforts.

For urban, uncontrolled, minor arterials, Table D-14 presents the risk factors identified for crashes involving large vehicles, along with the percentages of crashes and roadway mileages to help prioritize higher-risk facility elements for safety improvements.

Table D-14 | Risk Factors for Large Vehicle Crashes on Urban Uncontrolled Minor Arterials

Risk Factor	Risk Factor Criteria	Large Vehicle Fatal and Serious Injury Crashes		Urban Uncontrolled Minor Arterials	
		Crash Number	Crash Percentage	Centerline Miles	Mileage Percentage
AADT	20,000–30,000	5	17%	43.2	3%
Curb	Right side only	6	20%	91.8	7%
Jurisdiction	MassDOT	7	23%	119.6	9%
Road Surface Width	> 30 feet	15	50%	437.7	34%
Right Shoulder Type	No Shoulder	23	77%	750.5	58%
Right Sidewalk Width	4–9 feet	17	57%	481.6	37%

Note: This table only includes fatal and serious injury crashes along urban uncontrolled minor arterials.

AADT = annual average daily traffic.

Source: MassDOT IMPACT Data Query and Visualization Tool and MassDOT Road Inventory 2022.

Road segments that have the characteristics noted above are considered to be at higher-risk for crashes involving large vehicles. Roads that meet multiple risk factors would be considered to be *most* at-risk for these crashes.

Risk Site Summary

For each focus segment type, risk factors were combined and weighted equally. A risk score was calculated for each segment based on the total number of applicable risk factors present. This risk score was then normalized by the maximum possible risk score for that facility type to allow for consistent prioritization across different facility types. Using the normalized risk scores, percentile ranks also were computed for each segment at the MPO level. Segments ranked in the top 5 percent were identified as a “Primary Risk Site,” and those in the next 10 percent were identified as a “Secondary Risk Site.”

Table D-15 summarizes the centerline miles of urban, uncontrolled, minor arterials by risk site category and jurisdiction for large vehicle crashes. Although only 120 miles of the facility type within the region are managed by MassDOT, these roads have the highest proportion (24 percent) of mileage considered as high risk for fatal and serious injury crashes involving large vehicles, compared to 8 percent for DCR-owned roads and 14 percent for municipally owned roads. Location and risk assessment information of each individual segment within the identified focus facility types is available through the online data dashboard; available at <https://bostonmpo.org/visionzero>.

Table D-15 | Centerline Miles by Risk Site Categories and Jurisdictions (Large Vehicle Crashes)

Jurisdiction	Centerline Miles by Large-Vehicle-Crash-Risk-Site Categories (miles/percentages)						
	Primary Risk Site		Secondary Risk Site		Not a Risk Site		Total
Municipality	45.8	4%	115.2	10%	960.0	86%	1,121.0
MassDOT	17.6	15%	10.9	9%	91.1	76%	119.6
DCR	1.3	2%	3.4	6%	50.4	92%	55.0
Other ¹	0.2	4%	0.7	13%	4.5	83%	5.5
Total	64.9	5%	130.2	10%	1,106.0	85%	1,301.1

¹ The jurisdiction category “Other” includes the Massachusetts Port Authority, State Park or Forest, State Institutional, Federal Park or Forest, County Institutional, U.S. Air Force, U.S. Army Corps of Engineers, Federal Institutional, Private, and U.S. Army.

Note: This table only includes the identified focus facility types (urban uncontrolled minor arterials).

DCR = Department of Conservation and Recreation.

Source: MassDOT IMPACT Data Query and Visualization Tool and MassDOT Road Inventory 2022.

Speeding-Related Crashes

Given the substantial increase in speeding-related fatal and serious injury crashes across both the Commonwealth and the Boston region during the past five years, addressing speeding-related

issues remains a critical priority. While MassDOT updated its systemic analysis for speeding crashes with recent crash data, the analysis was limited to the town-level due to the lack of reliable operational speed data at individual sites.

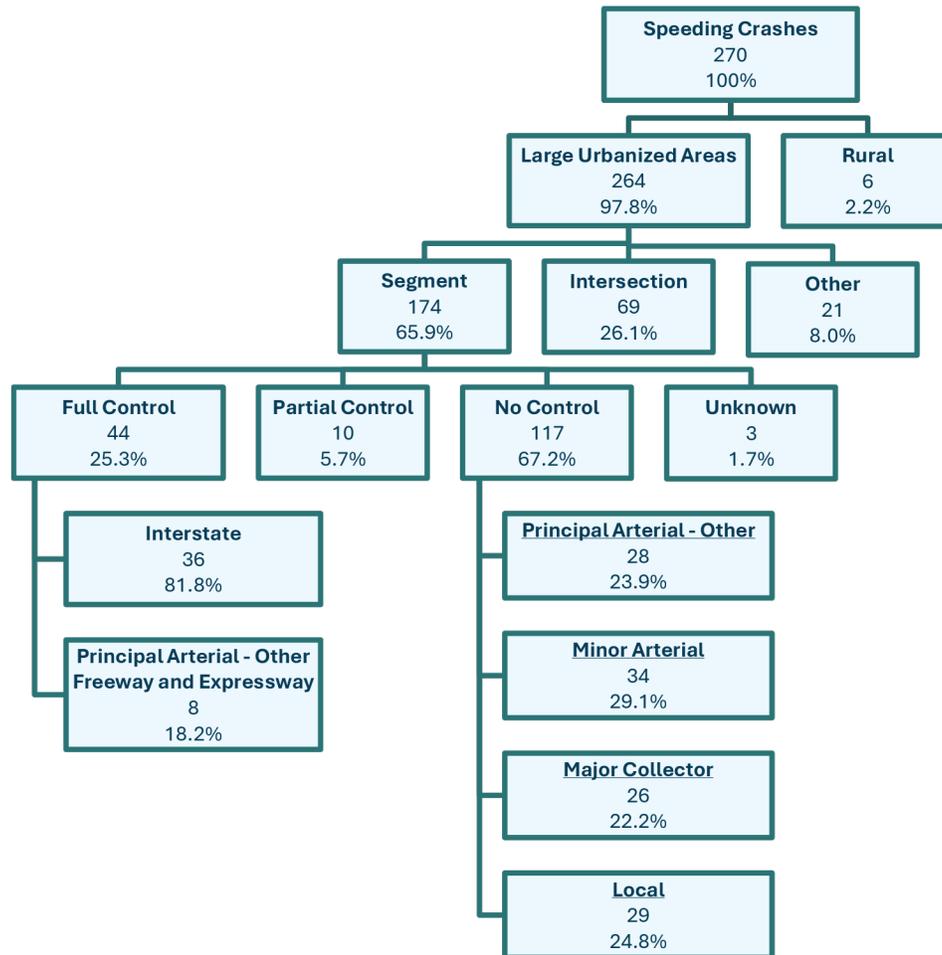
Recognizing that even in the absence of operational speed data, the site-level systemic analysis still offers the advantage of identifying location-specific risk factors and enabling a more efficient prioritization of safety improvements based on detailed risk assessment, **a separate site-level systemic analysis was performed for speeding crashes within the Boston region.** Crash data from 2018 to 2022 were obtained from the MassDOT IMPACT tool; and consistent with MassDOT's definition, any crash in which the "Driver Contributing Circumstances" field indicated "Exceeded authorized speed limit" was considered as a speeding-related crash.

Focus Facility Types

Within the Boston region, a total of 270 fatal and serious injury crashes related to speeding occurred between 2018 and 2022. Similar to the pattern observed in crashes involving large vehicles, 66 percent of speeding-related crashes occurred on roadway segments versus intersections. Given this high concentration of crashes on urban segments, a crash tree was developed to help identify the focus facility types for speeding-related crashes at the segment level.

As indicated in Figure D-1, roadways with no access control accounted for the highest share of speeding-related fatal and serious injury crashes (67 percent), followed by roadways with full access control (25 percent). To prioritize segments where municipal-level safety interventions can be most effective, Interstates and other expressways or freeways were excluded from the analysis. Based on crash frequency, urban, uncontrolled, principal arterials (other), minor arterials, major collectors, and local roads were identified as focus facility types, each representing a significant portion of speeding-related fatal and serious injury crashes.

Figure D-3 | Crash Tree for Speeding-Related Segment Crashes



Note: This chart includes fatal and serious injury crashes along Interstates and other fully access-controlled roadways.

Source: MassDOT IMPACT Crash Tree Builder.

Risk Factor Identification

To identify risk factors associated with a higher risk of severe speeding-related crashes on the selected focus facilities, factors related to crash circumstances, roadway attributes, and details of involved vehicles and persons were analyzed separately for each facility type using the overrepresentation method described in the *Large Vehicle-Involved Crashes* section. Table D-16 through Table D-19 summarize the identified risk factors for speeding-related crashes on urban, uncontrolled, principal arterials (other), minor arterials, major collectors, and local roads.

For urban, uncontrolled, principal arterials, results suggest that speeding-related crashes were significantly more prevalent on segments with narrow medians (less than 5 feet wide) and wide

traveled ways (more than 30 feet wide). Since wider travel lanes can create a false sense of safety at higher speeds and narrow medians often provide insufficient separation between opposing traffic, this combination can increase both the chance of speeding and the severity of resulting crashes. Additionally, high traffic volumes (above 20,000 AADT) were also found to be associated with an elevated risk of speeding-related crashes. This may be due to the increased potential for conflicts and more frequent aggressive driving behavior in high-volume traffic.

Table D-16 | Risk Factors for Speeding Crashes on Urban Uncontrolled Principal Arterials (Other)

Risk Factor	Risk Factor Criteria	Speeding-Related Fatal and Serious Injury Crashes		Urban Uncontrolled Principal Arterials (Other)	
		Crash Number	Crash Percentage	Centerline Miles	Mileage Percentage
AADT	>20,000	73	56%	256.3	36%
Median Width	1 – 5 feet	19	15%	49.2	7%
Road Surface Width	> 30 feet	44	34%	175.5	25%
Number of Opposing Lanes	2	23	18%	81.0	11%
Speed Limit	30–35 mph	87	67%	410.8	58%

Note: This table only includes fatal and serious injury crashes along urban uncontrolled principal arterials (Other).

AADT = annual average daily traffic. mph = miles per hour.

Source: MassDOT IMPACT Data Query and Visualization Tool and MassDOT Road Inventory 2022.

Table D-17 | Risk Factors for Speeding Crashes on Urban Uncontrolled Minor Arterials

Risk Factor	Risk Factor Criteria	Speeding-Related Fatal and Serious Injury Crashes		Urban Uncontrolled Minor Arterials	
		Crash Number	Crash Percentage	Centerline Miles	Mileage Percentage
AADT	20,000 - 30,000	17	11%	43.2	3%
Curb	Right side only	20	13%	91.8	7%
Right Shoulder Width	4–9 feet	11	7%	33.4	3%
Right Sidewalk Width	9 - 12 feet	14	9%	61.1	5%

Note: This table only includes fatal and serious injury crashes along Urban Uncontrolled Minor Arterials.

AADT = annual average daily traffic.

Source: MassDOT IMPACT Data Query and Visualization Tool and MassDOT Road Inventory 2022.

Table D-18 | Risk Factors for Speeding Crashes on Urban Uncontrolled Major Collectors

Risk Factor	Risk Factor Criteria	Speeding-Related Fatal and Serious Injury Crashes		Urban Uncontrolled Major Collectors	
		Crash Number	Crash Percentage	Centerline Miles	Mileage Percentage
Curb	Left side only	12	11%	56.6	5%
Right Shoulder Width	1 – 4 feet	75	69%	666.6	56%

Note: This table only includes fatal and serious injury crashes along Urban Uncontrolled Major Collectors. AADT = annual average daily traffic.

Source: MassDOT IMPACT Data Query and Visualization Tool and MassDOT Road Inventory 2022.

Table D-19 | Risk Factors for Speeding Crashes on Urban Uncontrolled Local Roads

Risk Factor	Risk Factor Criteria	Speeding-Related Fatal and Serious Injury Crashes		Urban Uncontrolled Local Roads	
		Crash Number	Crash Percentage	Centerline Miles	Mileage Percentage
Median Width	11 – 20 feet	3	2%	7.7	0.1%
Road Surface Width	> 30 feet	23	18%	750.3	10%
Number of Opposing Lanes	2	3	2%	8.1	0.1%
Terrain	Level terrain	106	83%	5,736.4	78%

Note: This table only includes fatal and serious injury crashes along urban, uncontrolled, local roads.

Source: MassDOT IMPACT Data Query and Visualization Tool and MassDOT Road Inventory 2022.

Risk Site Summary

Using the selected risk factors, each segment within the identified focus facility types was assigned a normalized risk score, and a corresponding percentile rank at the regional level. Based on these rankings, segments were categorized as primary risk sites, secondary risk sites, or sites with no identified risk.

Table D-20 provides a detailed distribution of centerline miles by risk site categories across jurisdictions. Among all focus facilities, roadways under the local jurisdiction had the highest proportion of segments classified as “Primary Risk Sites” (5 percent) compared to other jurisdictions. Location and risk assessment information of each individual segment within the

identified focus facility types can be viewed in the online data dashboard; available at <https://bostonmpo.org/visionzero>.

Table D-20| Centerline Miles by Risk Site Categories and Jurisdictions (Speeding Crashes)

Jurisdiction	Centerline Miles by Speeding-Crash-Risk-Site Categories (miles/percentages)						
	Primary Risk Site		Secondary Risk Site		Not a Risk Site		Total
Municipality	472.7	5%	942.8	10%	7,765.9	85%	9,181.4
MassDOT	41.1	11%	49.2	14%	272.7	75%	362.9
DCR	13.4	12%	17.9	16%	81.3	72%	112.5
Other ¹	3.0	0.3%	50.4	5%	892.6	94%	946.0
Total	530.1	5%	1,060.3	10%	9,012.5	85%	10,602.9

¹ The jurisdiction category “Other” includes the Massachusetts Port Authority, State Park or Forest, State Institutional, Federal Park or Forest, County Institutional, U.S. Air Force, U.S. Army Corps of Engineers, Federal Institutional, Private, and U.S. Army.

Note: This table only includes the identified focus facility types (urban uncontrolled principal arterials, minor arterials, major collectors, and local roads).

DCR = Department of Conservation and Recreation.

Source: MassDOT IMPACT Data Query and Visualization Tool and MassDOT Road Inventory 2022.

5 | Example of Site Scoring Process

This section provides an example of the scoring process on a randomly selected intersection in the region to explain the scoring methodology used by MassDOT for the “Intersections” emphasis area. The example site is a two-way, stop-controlled, cross-intersection located at Everett Avenue (major approach) and Arlington Street (minor approach) in the Town of Chelsea.

For the “Intersections” emphasis area, all intersections (except roundabouts, other circular intersections, and nonconventional intersections) were considered focus facilities. The associated risk factors and their assigned weights are listed in Table D-21 . A risk score was calculated for each risk factor based on whether the intersection meets the risk factor criteria and the according weight.

For the selected intersection, the relevant attributes corresponding to each risk factor are detailed in Table D-21 , along with the calculated individual risk scores. By summing these individual risk scores, a total risk score of 4.9 was computed for the intersection site. To allow for comparison across different types of focus facilities, the total risk score was further normalized by the maximum possible risk score a site can achieve within each focus facility type. For this emphasis area, the maximum possible total risk score is 6. Thus, the normalized risk score for the selected intersection site is 0.82.

Table D-21 | Calculation Example of Normalized Risk Score

Risk Factor	Weight	Intersection Attribute	Risk Score
Major Approach AADT	Variable from 0 to 1 based on the range of major approach AADT	20,326	0.9
Minor approach AADT 1,500 and above	1	3,437	1
Respective town meets three environmental justice criteria	1	Respective town meets the “Minority”, “Income”, and “English Isolation” criteria	1
Three or more through lanes on major approach	1	Maximum number of through lanes on major approach is 2	0
Two-way stop-control	1	Two-way stop-control	1
All-way stop-control	0.75	Not all-way stop-control	0
Signalized control	1	Not signalized-control	0
Four or more intersection legs	1	Four intersection legs	1
Total Risk Score			4.9
Normalized Risk Score = Total Risk Score / Maximum Possible Risk Score			0.82

AADT = annual average daily traffic.

Source: [MassDOT Network Screening Risk-Based Methodology Reports](#) and MassDOT IMPACT Network Screening Risk-Based Tool.