Development of Safety Performance Functions for

Network Screening: Roadway Segments and Intersections on Arterials and Collectors

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UPDATED FEBRUARY 2024

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Background

Safety Performance Functions (SPFs) and Crash Modification Factors (CMFs) are integral parts of the Highway Safety Manual (HSM) methods to support data-driven safety analysis. An SPF is a mathematical model that predicts the mean crash frequency for locations with similar characteristics. SPFs serve a number of functions, including the estimation of predicted crashes for a given site. Agencies can use these crash predictions alone or in combination with reported crash history (i.e., the Empirical Bayes method) to identify sites for further diagnosis. SPFs also support the economic analysis and safety evaluation steps in the roadway safety management process. While SPFs are available from a number of sources such as the HSM, CMF Clearinghouse, AASHTOWare Safety Analyst™, and state-specific reports, they are produced using data from specific locations and times. As such, the results may not be nationally applicable in their raw form. MassDOT calibrated the SPFs from the HSM to fit their local data, but the results suggested that state-specific SPFs may be more appropriate than calibrated national SPFs.

In 2017, MassDOT initiated a task to develop and integrate state-specific, planning-level SPFs in their roadway safety management process for network screening (i.e., selecting sites for further analysis from a larger group of sites). The primary data requirements to develop SPFs include quality crash, roadway, and traffic volume data for a large number of sites that represent the facility types of interest. Due to data limitations and data quality issues on interstates and local roads, MassDOT was not able to develop reliable SPFs for these facility types. Further, without an intersection inventory, MassDOT was not able to develop intersection SPFs. As such, the 2017 efforts focused on the development of planning-level segment SPFs for urban and rural arterials and collectors. This first SPF development effort resulted in the first version of "Development of Safety Performance Functions for Rural and Urban Arterials and Collectors" in February 2018.

In 2020, MassDOT updated the SPFs using new and improved data. The updated SPFs were developed using five years of crash data, from 2013 to 2017. However, due to lack of an intersection inventory and remaining data issues and interstate and local roads, the effort was still limited to roadway segments on rural and urban arterials and collectors. This iteration of SPF development was documented in the 2020 version of the "Development of Safety Performance Functions for Rural and Urban Arterials and Collectors".

In 2022, MassDOT followed up with another round of updates for the SPFs. With data availability and quality improvements made since 2020, the scope of this iteration was expanded to include roadways with partial access-control and intersections. While new facility types were added, this effort updated SPFs for existing facility types to ensure consistency among the underlying years of data. This allows comparisons to be made across facility types. Five years of data (2015 through 2019) were used to develop the SPFs. This report documents the development of these updated and additional SPFs and the results.

The following sections are included in this report.

1. **Data**: description of data collection and integration process.
2. **Methodology**: description of the methodology used in SPF development and assessment process.
3. **SPF Results for Roadway Segments**: presentation of planning-level SPFs for roadway segments (arterials and collectors). This section presents the SPFs along with general summary statistics based on the underlying data.
4. **SPF Results for Intersections**: presentation of planning-level SPFs for both stop-controlled and signal-controlled, 3-leg and 4-leg intersections. This section presents the SPFs along with general summary statistics based on the underlying data.

The report also includes brief discussion related to the application of the SPFs in the network screening engine for divided roadways and scenarios where traffic volumes are zero or missing. The last section of the report is an appendix with the full model parameters and associated Cumulative Residual (CURE) Plots to provide interested readers with more detailed information.

While much progress has been made in overall data quality, the inaccurate assignment of crash locations on freeways remains a known issue. Therefore, **no SPFs for freeways were developed** and included in this report. **SPFs for ramp terminals were developed and tested, but they were not included in this report or used for network screening** because of concerns about their reliability.

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Data

The dataset used for developing SPFs under this effort includes roadway segments, intersections, traffic, and crashes. The following sections provide more details on each dataset used for this assignment.

Roadway and Traffic Data

VHB obtained a copy of the March 2022 ALRS extract of the roadway network and segmentation from MassDOT. The data include key identifying variables such as route ID, route system, route number, route direction, city/town, district, MPO/RPA, urban type, urban area, access control type, and functional classification. The data also include key geometric variables: segment length, number of lanes and opposing lanes, and median type. Total number of lanes was calculated by adding the number of opposing lanes (where available) to the number of lanes. Traffic volumes were included in the March 2022 ALRS extract with major improvement in data quality compared to the 2020 SPF updates. Only a very small number of segments in the dataset did not have a valid AADT value (i.e., value is either missing or entered as a default value). For comparison, approximately 60 percent of segments had this issue in the 2020 SPF updates, while only 1.6 percent of segments had this issue in the 2022 SPF updates.

The team performed the following tasks to clean and process the data for SPF development:

1. **Mainline**: keep segments coded as "mainline roadway", remove all others (e.g., tunnel, doubledeck, ramp).
2. **Short segments**: delete segments shorter than 0.05 miles.
3. **Number of lanes**: keep segments with 2, 4, and 6 total lanes.
4. **Median type**: remove segments with missing median type, which is necessary to identify whether a segment is undivided or divided.
5. **Access control**: separate segments with no access control, partial access control, and full access control.
6. **Surface type**: keep segments with paved surface.
7. **Toll road**: remove segments coded as toll road.
8. **Classification**: remove segments with functional class coded as Local and separate those Interstate and Principal Arterial - other freeways and expressways.
9. **AADT**: In some urban areas, default values of AADTs were used so these known default AADT values were flagged and removed together with those segments without AADTs.

10. **Flag data within the city of Boston**: data within the city of Boston is known to have systemic issues related to crash location reporting.
11. **Abnormal AADT values**: a small number of segments appear to have abnormally high AADT values (e.g., 2-lanes segments with 50,000 or 60,000 vehicles per day or 4-lanes segments with over 100,000 vehicles per day).

Intersection and Traffic Data

The team obtained an April 2022 extract of the intersection data, which included intersection point and intersection approach layers. The intersection point layer represents the center point of each intersection and includes key information at intersection level such as basic geometry, type and location, intersection control. The intersection approach layer provides more detailed information regarding each approach such as number of lanes and traffic. The two layers are linked using Intersection ID.

The team performed the following tasks to clean and process the intersection data for SPF development:

1. **Junction type**: remove all intersections except those with junction type coded as RRN (Roadway/Roadway, Not Interchange Related).
2. **Intersection geometry**: delete intersections with unusual configurations and only keep those coded as T-intersection, Y-intersection, Cross-intersection (4 legs), and roundabout.
3. **Traffic control**: keep intersections with 2-way stop, all-way stop, and signalized (with and without ped signal).
4. Determine major and minor approaches:
    a. **Numbers of lanes**: assign the larger number of lanes to the major approach and the smaller one to the minor approach. If numbers of lanes are the same, major and minor approaches are determined by AADTs below.
    b. **Approach AADTs**: assign the larger AADT value to major approach and the smaller value to the minor approach.
5. **Merging intersection point and intersection approach layers**: the key features of intersections are merged using Intersection ID.
6. **Flag data within the city of Boston**: data within the city of Boston is known to have systemic issues related to crash location reporting.
7. **AADT**: In some urban areas, default values of AADTs were used so these known default AADT values were flagged and removed together with those intersection approaches without AADTs.
8. **Abnormal AADT values**: a small number of intersections appear to have abnormally high AADT values (e.g., 2x2-lane stop-controlled intersections with 25,000 or 30,000 vehicles per day).

Crash Data

VHB obtained five years of crash data (2015 through 2019) for analysis. While more recent data were available at the time of this effort, the decision was made to **exclude crash data from the COVID-19 pandemic (2020 through 2021) for the purpose of *SPF development***. As such, SPF development efforts included crash data from 2015 through 2019. The decision was then made to include the **most recent five years of closed crash data at the time of analysis (2017 through 2021) for the purpose of *SPF application***. As such, SPF application (network screening) included crash data from 2017 through 2021.

The dataset included crashes from all regions within Massachusetts, as shown in Figure 1. The first step was to separate intersection and non-intersection crashes. A 125-ft radius (250-ft buffer area) was used to spatially assign crashes to each intersection. The remaining "non-intersection" crashes were assigned to roadway segments. The crashes were then counted and merged to each intersection and segment for analysis. The crashes were counted and grouped into the following categories:

- Total crashes (i.e., all types and severity levels).
- Fatal and Injury crashes (i.e., all types and only severity levels of K, A, B, and C).

Subsets of Data

After cleaning and processing the data, the team further separated the data into smaller subsets, based specific facility types and region for analysis.

Subsets of Roadway Segment Data

The following subsets were created for roadway segment data:

1. 2-lane, undivided, uncontrolled arterials and collectors by area type (urban, rural).
2. 2-lane, undivided, partially controlled arterials and collectors by area type (urban, rural).
3. 4-lane, undivided, uncontrolled arterials and collectors by area type (urban, rural).
4. 4-lane, divided, uncontrolled arterials and collectors by area type (urban, rural).
5. 4-lane, undivided, partially controlled arterials and collectors by area type (urban, rural).
6. 4-lane, divided, partially controlled arterials and collectors by area type (urban, rural).
7. 6-lane, undivided, uncontrolled arterials and collectors by area type.
8. 6-lane, undivided, partially controlled arterials and collectors by area type.
9. 6-lane, divided, uncontrolled arterials and collectors by area type (urban, rural).
10. 6-lane, divided, partially controlled arterials and collectors by area type (urban, rural).

Subsets of Intersection Data

The following subsets were created for intersection data:

1. 2-lane major road, 2-lane minor road, 3-leg, stop-controlled intersection by area type (urban, rural).
2. 4-lane major road, 2-lane minor road, 3-leg, stop-controlled intersection by area type (urban, rural).
3. 2-lane major road, 2-lane minor road, 4-leg, stop-controlled intersection by area type (urban, rural).
4. 4-lane major road, 2-lane minor road, 4-leg, stop-controlled intersection by area type (urban, rural).
5. 2-lane major road, 2-lane minor road, 3-leg, signal-controlled intersection by area type (urban, rural).
6. 4-lane major road, 2-lane minor road, 3-leg, signal-controlled intersection by area type (urban, rural).
7. 2-lane major road, 2-lane minor road, 4-leg, signal-controlled intersection by area type (urban, rural).
8. 4-lane major road, 2-lane minor road, 4-leg, signal-controlled intersection by area type (urban, rural).
9. 4-lane major road, 4-lane minor road, 4-leg, signal-controlled intersection by area type (urban, rural).
10. Roundabout

Subsets by Region

Where sample sizes were large enough, subsets of roadway and intersection data were split further to develop separate SPFs for each region. In some cases, there were too few segments or intersections in each category to develop reliable SPFs and the team handled those as follows:

- If the number of segments or intersections for a category is too small, they were removed from the dataset. For example, there were only 4 roundabouts in the clean dataset, so the team removed them from the analysis.
- If the number of segments for a category is relatively small (e.g., 20 to 30 range), the team combined similar categories into one to increase the sample size for more reliable SPFs. For example, there are too few intersections in Cape Cod, Old Colony, and SE Mass for the rural, 3-leg, 2x2 lane category to develop individual SPFs. As such, the team combined these three regions in one dataset, with the consideration of geographical continuity.

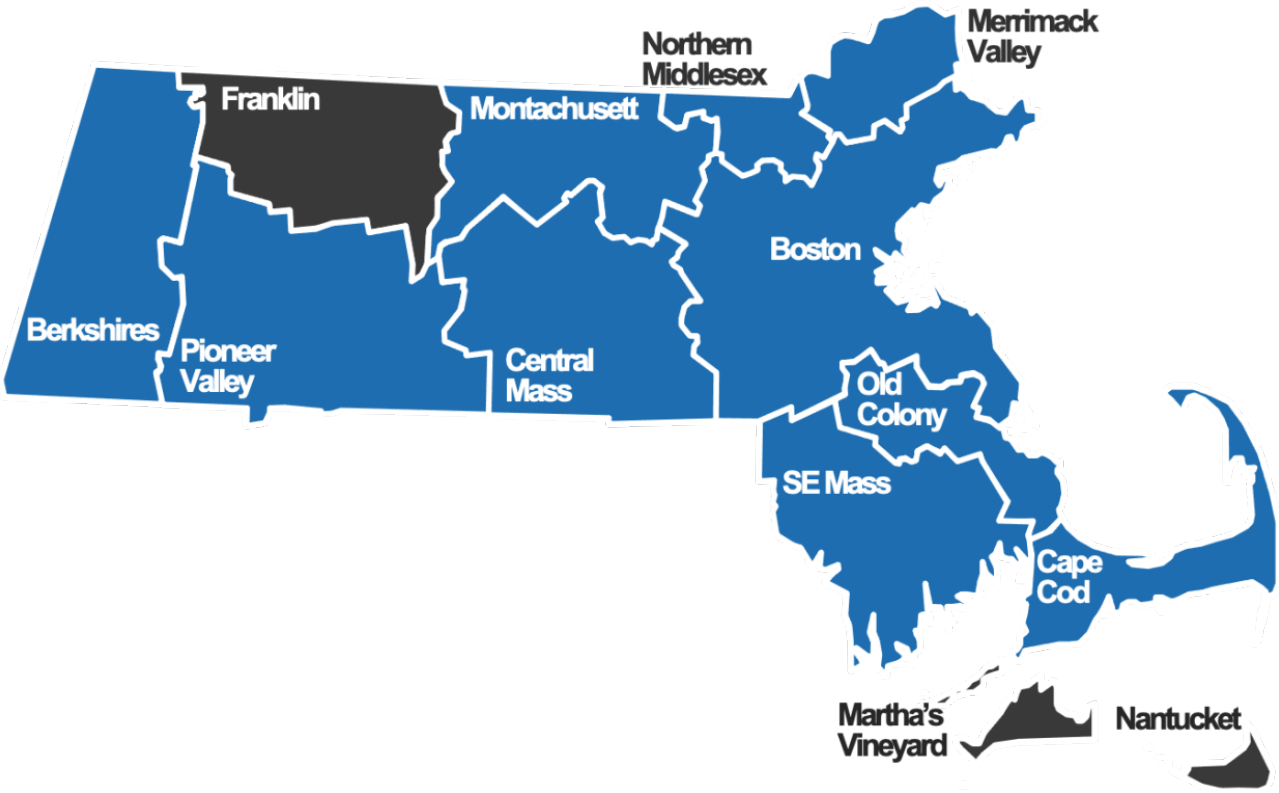

Figure 1 - MPOs in Massachusetts used for Regions

Summary of SPF Development

Table 1 through Table 5 present the summaries of data breakdowns and SPF development for roadway segments and intersections.

Table 1 Summary of SPF Development for 2-lane Roadways

Facility Type/Region	Urban	Rural	Notes
2-lane, Undivided, Uncontrolled			
Berkshire	Yes	Yes	
Boston	Yes	Yes	
Cape Cod	Yes	Yes	
Central Mass	Yes	Yes	
Franklin	Yes	Yes	
Martha's Vineyard	Yes	Yes	
Merrimack Valley	Yes	Yes	Combined with N Middlesex
Montachusett	Yes	Yes	
N Middlesex	Yes	Yes	Combined with Merrimack Valley
Nantucket	Yes	Yes	
Old Colony	Yes	Yes	Combined with SE Mass
Pioneer Valley	Yes	Yes	
SE Mass	Yes	Yes	Combined with Old Colony
2-lane, Undivided, partially controlled			
All regions	Yes	Yes	

Table 2 Summary of SPF Development for 4-lane Roadways

Facility Type/Region	Urban	Rural	Notes
4-lane, undivided, uncontrolled			
All regions	No	No	
4-lane, divided, uncontrolled			
All regions	Yes	No	Only 10 rural segments in the clean dataset
4-lane, undivided, partially controlled			
All regions	Yes	No	No urban data
4-lane, divided, partially controlled			
All regions	No	Yes	
Berkshire	Yes	No	Combined with Pioneer Valley for urban data
Boston	Yes	No	
Cape Cod	Yes	No	Combined with SE Mass for urban data
Central Mass	Yes	No	
Franklin	No	No	No urban data
Martha's Vineyard	No	No	No urban data
Merrimack Valley	Yes	No	Combined with Montachusett and N Middlesex for urban data
Montachusett	Yes	No	Combined with Montachusett and N Middlesex for urban data
N Middlesex	Yes	No	Combined with Merrimack Valley and Montachusett for urban data
Nantucket	No	No	No urban data
Old Colony	No	No	No urban data
Pioneer Valley	Yes	No	Combined with Berkshire for urban data
SE Mass	Yes	No	Combined with Cape Cod for urban data

Table 3 Summary of SPF Development for 6-lane Roadways

Facility Type/Region	Urban	Rural	Notes
6-lane, undivided, uncontrolled			
All regions	No	No	Only 2 segments in the clean dataset
6-lane, divided, uncontrolled			
All regions	Yes	No	No rural data
6-lane, undivided, partially controlled			
All regions	No	No	Only 3 segments in the clean dataset
6-lane, divided, partially controlled			
All regions	Yes	No	No rural data

Table 4 Summary of SPF Development for Stop-controlled Intersections

Facility Type/Region	Urban	Rural	Notes
2x2, 3-legs			
Berkshire	Yes	Yes	Combined Berkshire, Franklin, and Pioneer Valley for rural data
Boston	Yes	Yes	Combined Boston Region, Central Mass, Merrimack Valley, Montachusett, and N. Middlesex for rural data
Cape Cod	Yes	Yes	Combined Cape Cod, Old Colony, and SE Mass for rural data
Central Mass	Yes	Yes	Combined Boston Region, Central Mass, Merrimack Valley, Montachusett, and N. Middlesex for rural data
Franklin	Yes	Yes	Combined Berkshire, Franklin, and Pioneer Valley for rural data
Martha's Vineyard	Yes	Yes	Combined both urban and rural data in Martha's Vineyard and Nantucket
Merrimack Valley	Yes	Yes	Combined Boston Region, Central Mass, Merrimack Valley, Montachusett, and N. Middlesex for rural data
Montachusett	Yes	Yes	Combined Boston Region, Central Mass, Merrimack Valley, Montachusett, and N. Middlesex for rural data
N Middlesex	Yes	Yes	Combined Boston Region, Central Mass, Merrimack Valley, Montachusett, and N. Middlesex for rural data
Nantucket	Yes	Yes	Combined both urban and rural data in Martha's Vineyard and Nantucket
Old Colony	Yes	Yes	Combined Cape Cod, Old Colony, and SE Mass for rural data
Pioneer Valley	Yes	Yes	Combined Berkshire, Franklin, and Pioneer Valley for rural data
SE Mass	Yes	Yes	Combined Cape Cod, Old Colony, and SE Mass for rural data
2x2, 4-legs			
All regions	No	Yes	Combined all regions for rural data
Berkshire	Yes	No	Combined Berkshire, Franklin, and Pioneer Valley for urban data
Boston	Yes	No	
Cape Cod	Yes	No	
Central Mass	Yes	No	
Franklin	Yes	No	Combined Berkshire, Franklin, and Pioneer Valley for urban data
Martha's Vineyard	No	No	Not enough data
Merrimack Valley	Yes	No	
Montachusett	Yes	No	
N Middlesex	Yes	No	
Nantucket	No	No	Not enough data
Old Colony	Yes	No	
Pioneer Valley	Yes	No	Combined Berkshire, Franklin, and Pioneer Valley for urban data
SE Mass	Yes	No	
4x2, 3-legs			
All regions	Yes	No	No rural data
4x2, 4-legs			
All regions	Yes	No	Only 1 rural intersection in the clean dataset

Table 5 Summary of SPF Development for Signal-controlled Intersections

Facility Type/Region	Urban	Rural	Notes
2x2, 3-legs			
All regions	Yes	No	No rural data
2x2, 4-legs			
All regions	Yes	No	No rural data
4x2, 3-legs			
All regions	Yes	No	No rural data
4x2, 4-legs			
All regions	Yes	No	No rural data
4x4, 4-legs			
All regions	Yes	No	No rural data

3

Methodology

This section describes the methodology used to develop the SPFs for use in network screening of arterial and collector segments and intersections in Massachusetts. Negative Binomial regression modeling was applied, which is consistent with the state of research in developing SPFs. The focus crashes include SPFs for total crashes and fatal and injury crashes (KABC on the KABCO scale). For roadway segments, bidirectional traffic volume (AADT), segment length, and number of years were initially considered in the model to account for exposure. For intersections, bidirectional traffic volumes (AADT) on the major road and minor road or the total intersection AADT, and number of years were used. Other factors were considered and included to account for differences across roadway functional classes and among regions. Model coefficients were estimated using R and the glm.nb function from MASS package. In addition to the key measures of model fit such as the Modified R-squared and the standard errors of parameters, the team reviewed the correlation matrix and Cumulative Residual (CURE) Plots to guide the model development process.

VHB considered and tested several functional forms for developing the SPFs. Initial tests showed that specifying AADT directly in the model to account for exposure led to severe over-prediction in the roadway segment models, where the models consistently over predict the number of crashes in comparison to the observed crashes. After further research and testing, the team identified that specifying vehicle-miles, instead of number of vehicles (i.e., AADT) resulted in much more reliable crash prediction. In the end, the SPFs developed for roadway segments under this effort have the following general functional form:

$$Crashes/year = vehmiles^{\beta_1} * exp(\beta_0 + C_1 * X_1 + \cdots + C_n * X_n)$$

Where:

- vehmiles is the measure of exposure calculated from the average daily traffic associated with the roadway segment and the segment length (vehmiles=[AADT]*[SegLength]).
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- X_i is a vector of other independent variables (e.g., indicators for AADT ranges and region).
- β_i and C_i are parameters estimated from data in the SPF development process.

The SPFs developed for intersections under this effort have the following general functional form:

$$Crashes/year = exp(\beta_1 * AADT_{maj} + \beta_2 * AADT_x + \cdots + C_i * X_i)$$

Or

$$Crashes/year = exp(\beta_1 * \text{totAADT} + \cdots + C_n * X_n)$$

Where:

- $AADT_{maj}$ = annual average daily traffic (vehicles per day) for the major road.
- $AADT_x$ = annual average daily traffic (vehicles per day) for the minor road/cross street.
- totAADT = total annual average daily traffic (vehicles per day) for the intersection (=$AADT_{maj}$ + $AADT_x$).
- X_i is a vector of other independent variables (e.g., indicators for AADT ranges and region).
- β_i and C_i are parameters estimated from data in the SPF development process.

4

SPF Results for Roadway Segments

This section presents the SPFs for roadway segments by facility type and region. Below are the SPFs developed for each category presented in Table 1 through Table 3. Only the equations and key information readers would need to apply them are presented in this section. The full model parameters and CURE plots for model assessment are included in the Appendix for interested readers to find more detailed information.

2-lanes Undivided Roadways (No Access Control)

Urban, Undivided, Uncontrolled 2-lanes (Berkshire)

Table 6 presents the key statistics of the final dataset used for developing SPFs for urban, undivided 2-lane roadways in Berkshire.

Table 6 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Berkshire

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	1463	0.13	0.11	0.05	1.24
AADT (veh/day)	1463	4942	3655	257	14933
Total crashes (5 years)	1463	1.43	2.99	0	58
Fatal & Injury crashes (5 years)	1463	0.32	0.79	0	14

The following SPFs predict crashes for urban, undivided, uncontrolled, 2-lane roadway segments in Berkshire.

$$Total = [vehmiles]^{0.726} * \exp(-5.814)$$

$$FI = [vehmiles]^{0.719} * exp(-0.314 * [aadt2kto5k] - 0.372 * [aadt5kto7.5k] - 7.107)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2kto5k= indicator for AADT range (1 if 2000 < AADT ≤ 5000; 0 otherwise).
- aadt5kto7.5k= indicator for AADT range (1 if 5000 < AADT ≤ 7500; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Boston Region)

Table 7 presents the key statistics of the final dataset used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in Boston region.

Table 7 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Boston Region

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	18298	0.11	0.08	0.05	1.14
AADT (veh/day)	18298	6925	4925	186	23903
Total crashes (5 years)	18298	1.72	3.81	0	96
Fatal & Injury crashes (5 years)	18298	0.41	1.03	0	22

The following SPFs predict crashes for urban, undivided, uncontrolled 2-lane roadway segments in Boston Region.

$$Total = [vehmiles]^{0.922} * \exp\,(0.708 * [aadt2kless] - 0.285 * [aadt4.5kto8k] - 0.245 * [aadt8kto12k] - 0.37 * [aadt12kto15k] - 0.298 * [aadt17.5kplus] - 6.955)$$

$$FI = [vehmiles]^{1.033} * exp(1.103 * [aadt2kless] + 0.294 * [aadt2kto5k] + 0.141 * [aadt15kt18k] - 0.119 * [aadt18kplus] - 9.224)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2kless= indicator for AADT range (1 if AADT < 2000; 0 otherwise).
- aadt4.5kto8k= indicator for AADT range (1 if 4500 ≤AADT < 8000; 0 otherwise).
- aadt8kto12k = indicator for AADT range (1 if 8000 ≤AADT < 12000; 0 otherwise).
- aadt12kto15k = indicator for AADT range (1 if 12000 ≤AADT < 15000; 0 otherwise).
- aadt17.5kplus = indicator for AADT range (1 if AADT ≥ 17500; 0 otherwise).
- aadt2kto5k= indicator for AADT range (1 if 2000 ≤AADT < 5000; 0 otherwise).
- aadt15kto18k= indicator for AADT range (1 if 15000 ≤AADT < 18000; 0 otherwise).
- aadt18kplus = indicator for AADT range (1 if AADT ≥ 18000; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Cape Cod)

Table 8 presents the key statistics of the final dataset used for developing SPFs for urban, undivided 2-lane roadways in Cape Cod.

Table 8 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Cape Cod

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	4243	0.11	0.08	0.05	1.18
AADT (veh/day)	4243	4606	3798	96	24008
Total crashes (5 years)	4243	1.22	3.19	0	57
Fatal & Injury crashes (5 years)	4243	0.33	0.93	0	14

The following SPFs predict crashes for urban, undivided, uncontrolled, 2-lane roadway segments in Cape Cod.

$$Total = [vehmiles]^{0.861} * exp(-0.726 * [aadt2.5kless] - 1.092 * [aadt2.5kto5k] - 0.767 * [aadt5kto11k] - 0.956 * [aadt20kplus] - 5.942)$$

$$FI = [vehmiles]^{0.913} * \exp(-0.495 * [aadt2kto11k] + 0.776 * [aadt16kto19k] - 7.994)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2.5kless= indicator for AADT range (1 if AADT ≤ 2500; 0 otherwise).
- aadt2.5kto5k= indicator for AADT range (1 if 2500 < AADT < 5000; 0 otherwise).
- aadt5kto11k= indicator for AADT range (1 if 5000 ≤AADT < 11000; 0 otherwise).
- aadt20kplus= indicator for AADT range (1 if AADT > 20000; 0 otherwise).
- aadt2kto11k= indicator for AADT range (1 if 2000 < AADT < 11000; 0 otherwise).
- aadt16kto19k= indicator for AADT range (1 if 16000 < AADT < 19000; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Central Mass)

Table 9 presents the key statistics of the final dataset used for developing SPFs for urban, undivided 2-lane roadways in Central Mass.

Table 9 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Central Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	4566	0.14	0.12	0.05	1.46
AADT (veh/day)	4566	5495	3646	147	19728
Total crashes (5 years)	4566	2.11	5.46	0	203
Fatal & Injury crashes (5 years)	4566	0.49	1.26	0	39

The following SPFs predict crashes for urban, undivided, uncontrolled, 2-lane roadway segments in Central Mass.

$$Total = [vehmiles]^{0.907} * \exp\left(-0.276 * [aadt2kto7k] + 0.226 * [aadt11kplus] - 6.716\right)$$

$$FI = [vehmiles]^{1.059} * exp(-0.322 * [aadt2kto8k] - 9.139)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2kto7k = indicator for AADT range (1 if 2000<AADT≤7000; 0 otherwise).
- aadt11kplus = indicator for AADT range (1 if AADT≥11000; 0 otherwise).
- aadt2kto8k = indicator for AADT range (1 if 2000<AADT<8000; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Franklin)

Table 10 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in Franklin.

Table 10 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Franklin

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	690	0.13	0.10	0.05	0.95
AADT (veh/day)	690	3892	2736	290	13050
Total crashes (5 years)	690	1.05	2.26	0	21
Fatal & Injury crashes (5 years)	690	0.24	0.70	0	6

The following SPFs predict crashes for urban, undivided, uncontrolled 2-lane segments in Franklin.

$$Total = [vehmiles]^{-0.637} * exp(-0.429 * [aadt4kless] - 5.263)$$

$$FI = [vehmiles]^{1.16} * exp(-0.836 * [aadt7.2kto10k] - 10.175)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt4kless = indicator for AADT range (1 if AADT < 4000; 0 otherwise).
- aadt7.2kto10k = indicator for AADT range (1 if 7200 ≤AADT < 10000; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Martha's Vineyard)

Table 11 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in Martha's Vineyard.

Table 11 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Martha's Vineyard

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	189	0.13	0.14	0.05	1.36
AADT (veh/day)	189	4776	2653	868	8522
Total crashes (5 years)	189	0.93	1.94	0	17
Fatal & Injury crashes (5 years)	189	0.37	1.11	0	11

The following SPFs predict crashes for urban, undivided 2-lane roadway segments in Martha's Vineyard:

$$Total = [vehmiles]^{0.542} * exp(-0.958 * [aadt3kto6.5k] - 4.76)$$

$$FI = [vehmiles]^{0.576} * exp(-1.673 * [aadt3kto6.5k] - 5.778)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt3kto6.5k = indicator for AADT range (1 if 3000 ≤ AADT < 6500; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Merrimack Valley)

Table 12 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in Merrimack Valley.

Table 12 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Merrimack Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	2508	0.12	0.09	0.05	1.12
AADT (veh/day)	2508	5836	4588	45	24998
Total crashes (5 years)	2508	1.83	4.35	0	61
Fatal & Injury crashes (5 years)	2508	0.40	1.07	0	21

The following SPFs predict crashes for urban, undivided, uncontrolled 2-lane roadway segments in Merrimack Valley.

$$Total = [vehmiles]^{0.815} * exp(-0.23 * [aadt10kless] + 0.752 * [aadt21kplus] - 6.095)$$

$$FI = [vehmiles]^{1.025} * exp(-0.243 * [aadt4kto14k] - 8.99)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt10kless = indicator for AADT range (1 if AADT < 10000; 0 otherwise).
- aadt21kplus = indicator for AADT range (1 if AADT > 21000; 0 otherwise).
- aadt4kto14k = indicator for AADT range (1 if 4000 < AADT < 14000; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Montachusett)

Table 13 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in Montachusett.

Table 13 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Montachusett

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	2721	0.15	0.14	0.05	1.71
AADT (veh/day)	2721	4870	3615	329	20142
Total crashes (5 years)	2721	2.18	6.23	0	117
Fatal & Injury crashes (5 years)	2721	0.50	1.29	0	24

The following SPFs predict crashes for urban, undivided, uncontrolled, 2-lane roadway segments in Montachusett.

$$Total = [vehmiles]^{0.808} * exp(0.459 * [aadt2.5kless] + 0.448 * [aadt6kto13k] + 1.562 * [aadt13kplus] - 6.473)$$

$$FI = [vehmiles]^{0.917} * exp(-0.365 * [aadt3kto6k] + 0.866 * [aadt13kplus] - 8.247)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2.5kless = indicator for AADT range (1 if AADT < 2500; 0 otherwise).
- aadt6kto13k = indicator for AADT range (1 if 6000 < AADT < 13000; 0 otherwise).
- aadt3kto6k = indicator for AADT range (1 if 3000 < AADT ≤ 6000; 0 otherwise).
- aadt13kplus = indicator for AADT range (1 if AADT ≥ 13000; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (N. Middlesex)

Table 14 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in N. Middlesex.

Table 14 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in N. Middlesex

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	2378	0.12	0.08	0.05	0.75
AADT (veh/day)	2378	6192	3945	468	24852
Total crashes (5 years)	2378	2.33	5.09	0	104
Fatal & Injury crashes (5 years)	2378	0.53	1.19	0	11

The following SPFs predict crashes for urban, undivided, uncontrolled 2-lane roadway segments in N. Middlesex.

$$Total = [vehmiles]^{0.899} * exp(-0.459 * [aadt2kto4k] - 0.695 * [aadt4kto7k] - 0.296 * [aadt7kto10k] - 6.344)$$

$$FI = [vehmiles]^{1.013} * exp(-0.53 * [aadt4kto7.2k] - 0.23 * [aadt7.2kto10k] - 8.712)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2kto4k = indicator for AADT range (1 if 2000 ≤ AADT < 4000; 0 otherwise).
- aadt4kto7k = indicator for AADT range (1 if 4000 ≤ AADT < 7000; 0 otherwise).
- aadt7kto10k = indicator for AADT range (1 if 7000 ≤ AADT < 10000; 0 otherwise).
- aadt4kto7.2k = indicator for AADT range (1 if 4000 ≤ AADT < 7200; 0 otherwise).
- aadt7.2kto10k = indicator for AADT range (1 if 7200 ≤ AADT < 10000; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Nantucket)

Table 15 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in Nantucket.

Table 15 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Nantucket

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	115	0.12	0.07	0.05	0.46
AADT (veh/day)	115	6676	4177	111	12156
Total crashes (5 years)	115	0.75	1.78	0	12
Fatal & Injury crashes (5 years)	115	0.16	0.47	0	3

The following SPFs predict crashes for urban, undivided, uncontrolled 2-lane roadway segments in Nantucket.

$$Total = [vehmiles]^{0.639} * exp(-6.064)$$

$$FI = [vehmiles]^{0.667} * exp(-7.809)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

Urban, Undivided, Uncontrolled 2-lanes (Old Colony)

Table 16 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in Old Colony.

Table 16 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Old Colony

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	3253	0.13	0.10	0.05	1.19
AADT (veh/day)	3253	6532	4359	189	23821
Total crashes (5 years)	3253	2.54	4.94	0	104
Fatal & Injury crashes (5 years)	3253	0.77	1.59	0	25

The following SPFs predict crashes for urban, undivided, uncontrolled 2-lane roadway segments in Old Colony.

$$Total = [vehmiles]^{0.924} * exp(0.256 * [aadt2.5kless] - 0.237 * [aadt3kto8k] - 6.762)$$

$$FI = [vehmiles]^{0.953} * exp(0.26 * [aadt3kless] - 0.236 * [aadt3kto8k] - 8.157)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2.5kless = indicator for AADT range (1 if AADT < 2500; 0 otherwise).
- aadt3kless = indicator for AADT range (1 if AADT < 3000; 0 otherwise).
- aadt3kto8k = indicator for AADT range (1 if 3000 ≤ AADT < 8000; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (Pioneer Valley)

Table 17 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in Pioneer Valley.

Table 17 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in Pioneer Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	5315	0.13	0.11	0.05	1.36
AADT (veh/day)	5315	5386	3425	181	18851
Total crashes (5 years)	5315	2.20	4.90	0	78
Fatal & Injury crashes (5 years)	5315	0.58	1.38	0	23

The following SPFs predict crashes for urban, undivided, uncontrolled 2-lane roadway segments in Pioneer Valley.

$$Total = [vehmiles]^{0.834} * exp(-0.462 * [aadt2kto11.5k] - 5.803)$$

$$FI = [vehmiles]^{0.915} * exp(0.539 * [aadt2kless] + 0.278 * [aadt12.5kplus] - 8.106)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2kto11.5k = indicator for AADT range (1 if 2000 ≤ AADT < 11500; 0 otherwise).
- aadt2kless = indicator for AADT range (1 if AADT ≤ 2000; 0 otherwise).
- aadt12.5kplus = indicator for AADT range (1 if AADT > 12500; 0 otherwise).

Urban, Undivided, Uncontrolled 2-lanes (SE Mass)

Table 18 presents the key statistics of the final data set used for developing SPFs for urban, undivided, uncontrolled 2-lane roadways in SE Mass.

Table 18 Summary of Urban, Undivided, Uncontrolled 2-lane Roadway Segments in SE Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	4945	0.13	0.12	0.05	1.37
AADT (veh/day)	4945	5487	3701	50	22465
Total crashes (5 years)	4945	2.24	4.71	0	107
Fatal & Injury crashes (5 years)	4945	0.59	1.37	0	27

The following SPFs predict crashes for urban, undivided, uncontrolled 2-lane roadway segments in SE Mass.

$$Total = [vehmiles]^{0.777} * exp(-0.279 * [aadt2.5kto8k] + 0.23 * [aadt14kplus] - 5.707)$$

$$FI = [vehmiles]^{0.998} * exp(0.476 * [aadt2kless] - 0.136 * [aadt2.5kto7.5k] + 0.191 * [aadt12kplus] - 8.664)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2.5kto8k = indicator for AADT range (1 if 2500 ≤ AADT ≤ 8000; 0 otherwise).
- aadt14kplus = indicator for AADT range (1 if AADT ≥ 14000; 0 otherwise).
- aadt2kless = indicator for AADT range (1 if AADT < 2000; 0 otherwise).
- aadt2.5kto7.5k = indicator for AADT range (1 if 2500 ≤ AADT < 7500; 0 otherwise).
- aadt12kplus = indicator for AADT range (1 if AADT ≥ 12000; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Berkshire)

Table 19 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Berkshire.

Table 19 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments in Berkshire

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	1542	0.24	0.23	0.05	2.07
AADT (veh/day)	1542	2085	2128	70	13454
Total crashes (5 years)	1542	0.48	1.09	0	9
Fatal & Injury crashes (5 years)	1542	0.12	0.40	0	5

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadways segments in Berkshire:

$$Total = [vehmiles]^{0.894} * exp(-0.784 * [aadt5kplus] - 7.613)$$

$$FI = [vehmiles]^{0.771} * exp(-0.36 * [aadt5kplus] - 8.288)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt5kplus= indicator for AADT range (1 if AADT > 5000; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Boston Region)

Table 20 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Boston Region.

Table 20 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments in Boston Region

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	122	0.18	0.13	0.05	0.66
AADT (veh/day)	122	4108	4501	376	14371
Total crashes (5 years)	122	2.47	4.33	0	23
Fatal & Injury crashes (5 years)	122	0.60	1.12	0	7

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Boston Region:

$$Total = [vehmiles]^{0.473} * exp(0.793 * [aadt10kplus] - 3.968)$$

$$FI = [vehmiles]^{0.379} * exp(0.79 * [aadt10kplus] - 4.752)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt10kplus= indicator for AADT range (1 if AADT ≥ 10000; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Cape Cod)

Table 21 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Cape Cod.

Table 21 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments in Cape Cod

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	115	0.20	0.19	0.05	1.00
AADT (veh/day)	115	1582	1192	323	5437
Total crashes (5 years)	115	0.42	1.89	0	19
Fatal & Injury crashes (5 years)	115	0.05	0.22	0	1

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Cape Cod:

$$Total = [vehmiles]^{0.723} * exp(-1.086 * [aadt1kto3k] - 5.942)$$

$$FI = [vehmiles]^{0.398} * exp(-6.712)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt1kto3k = indicator for AADT range (1 if 1000 ≤ AADT < 3000; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Central Mass)

Table 22 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Central Mass.

Table 22 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments in Central Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	799	0.26	0.23	0.05	1.67
AADT (veh/day)	799	2495	1502	277	7240
Total crashes (5 years)	799	1.01	1.71	0	17
Fatal & Injury crashes (5 years)	799	0.29	0.64	0	4

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Central Mass:

$$Total = [vehmiles]^{0.92} * exp(-0.218 * [aadt2.5kto5k] - 7.364)$$

$$FI = [vehmiles]^{0.933} * exp(0.335 * [aadt2.5kless] - 8.946)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2.5kto5k = indicator for AADT range (1 if 2500 ≤ AADT < 5000; 0 otherwise).
- aadt2.5kless = indicator for AADT range (1 if AADT < 2500; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Franklin)

Table 23 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Franklin.

Table 23 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments in Franklin

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	1472	0.25	0.24	0.05	2.09
AADT (veh/day)	1472	1932	2281	41	13050
Total crashes (5 years)	1472	0.47	1.28	0	24
Fatal & Injury crashes (5 years)	1472	0.12	0.44	0	7

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Franklin:

$$Total = [vehmiles]^{0.847} * exp(-0.387 * [aadt2kto5k] - 0.485 * [aadt8kplus] - 7.23)$$

$$FI = [vehmiles]^{0.807} * exp(-8.457)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt2kto5k = indicator for AADT range (1 if 2000 ≤ AADT < 5000; 0 otherwise).
- aadt8kplus= indicator for AADT range (1 if AADT ≥ 8000; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Martha's Vineyard)

Table 24 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Martha's Vineyard.

Table 24 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments Martha's Vineyard

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	200	0.15	0.10	0.05	0.70
AADT (veh/day)	200	2891	2741	491	7402
Total crashes (5 years)	200	0.84	1.42	0	10
Fatal & Injury crashes (5 years)	200	0.26	0.63	0	6

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Martha's Vineyard:

$$Total = [vehmiles]^{0.738} * exp(-6.136)$$

$$FI = [vehmiles]^{0.674} * exp(-6.918)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

Rural, Undivided, Uncontrolled 2-lanes (Merrimack Valley & N. Middlesex)

Table 25 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Merrimack Valley and N. Middlesex.

Table 25 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments Merrimack Valley and N. Middlesex

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	66	0.19	0.15	0.05	0.94
AADT (veh/day)	66	3112	1559	572	6034
Total crashes (5 years)	66	0.89	1.29	0	5
Fatal & Injury crashes (5 years)	66	0.15	0.47	0	2

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Merrimack Valley and N. Middlesex:

$$Total = [vehmiles]^{0.602} * exp(0.717 * [n.middlesex] - 5.668)$$

$$FI = [vehmiles]^{1.35} * exp(1.46 * [n.middlesex] - 12.56)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- n.middlesex = indicator for MassDOT region (1 if roadway segment in n.middlesex; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Montachusett)

Table 26 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Montachusett.

Table 26 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments Montachusett

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	664	0.27	0.25	0.05	1.96
AADT (veh/day)	664	1887	1643	110	6947
Total crashes (5 years)	664	0.75	1.38	0	9
Fatal & Injury crashes (5 years)	664	0.22	0.55	0	4

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Montachusett:

$$Total = [vehmiles]^{0.955} * exp(-0.396 * [aadt1.5kplus] - 7.421)$$

$$FI = [vehmiles]^{0.902} * exp(-0.535 * [aadt3.5kplus] - 8.48)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt1.5kplus= indicator for AADT range (1 if AADT ≥ 1500; 0 otherwise).
- aadt3.5kplus= indicator for AADT range (1 if AADT ≥ 3500; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Nantucket)

Table 27 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadway segments in Nantucket.

Table 27 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments Nantucket

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	107	0.17	0.12	0.05	0.59
AADT (veh/day)	107	3754	3748	491	12156
Total crashes (5 years)	107	0.46	0.97	0	5
Fatal & Injury crashes (5 years)	107	0.12	0.36	0	2

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Nantucket:

$$Total = [vehmiles]^{0.634} * exp(-6.365)$$

$$FI = [vehmiles]^{0.707} * exp(-8.236)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

Rural, Undivided, Uncontrolled 2-lanes (Old Colony and SE Mass)

Table 28 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Old Colony and SE Mass.

Table 28 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments Old Colony and SE Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	143	0.23	0.19	0.05	0.97
AADT (veh/day)	143	2355	1842	491	9000
Total crashes (5 years)	143	1.31	2.08	0	13
Fatal & Injury crashes (5 years)	143	0.36	0.80	0	4

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Old Colony and SE Mass:

$$Total = [vehmiles]^{0.94} * exp(-0.679 * [se\_mass] - 1.387 * [aadt2kplus] - 5.959)$$

$$FI = [vehmiles]^{0.883} * exp(-0.748 * [se\_mass] - 1.238 * [aadt2kplus] - 6.89)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- se_mass = indicator for MassDOT region (1 if roadway segment in SE Mass; 0 otherwise).
- aadt2kplus = indicator for AADT range (1 if AADT ≥ 2000; 0 otherwise).

Rural, Undivided, Uncontrolled 2-lanes (Pioneer Valley)

Table 29 presents the key statistics of the final data set used for developing SPFs for rural, undivided, uncontrolled 2-lane roadways in Pioneer Valley.

Table 29 Summary of Rural, Undivided, Uncontrolled 2-lane Roadway Segments Pioneer Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	1506	0.27	0.25	0.05	2.16
AADT (veh/day)	1506	1952	1904	41	9729
Total crashes (5 years)	1506	0.63	1.37	0	15
Fatal & Injury crashes (5 years)	1506	0.18	0.52	0	5

The following SPFs predict crashes for rural, undivided, uncontrolled 2-lane roadway segments in Pioneer Valley:

$$Total = [vehmiles]^{0.973} * exp(0.304 * [aadt1.2kless] - 0.292 * [aadt3.5kplus] - 7.957)$$

$$FI = [vehmiles]^{0.958} * exp(0.446 * [aadt0.8kless] - 0.437 * [aadt3.5kplus] - 9.073)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt1.2kless = indicator for AADT range (1 if AADT < 1200; 0 otherwise).
- aadt3.5kplus= indicator for AADT range (1 if AADT ≥ 3500; 0 otherwise).
- aadt0.8kless = indicator for AADT range (1 if AADT < 800; 0 otherwise).

2-lanes Undivided Roadways (Partial Access Control)

Urban, Undivided, Partially Controlled 2-lanes (All Regions)

Table 30 presents the key statistics of the final dataset used for developing SPFs for urban, undivided, partially controlled 2-lane roadways (all regions).

Table 30 Summary of Urban, Undivided, Partially Controlled 2-lane Roadway Segments (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	69	0.25	0.32	0.05	1.95
AADT (veh/day)	69	10784	7186	660	26269
Total crashes (5 years)	69	2.83	4.60	0	27
Fatal & Injury crashes (5 years)	69	0.78	1.63	0	8

The following SPFs predict crashes for urban, undivided, partially controlled 2-lane roadway segments.

$$Total = [vehmiles]^{0.653} * exp(-5.589)$$

$$FI = [vehmiles]^{0.8} * exp(-8.04)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

Rural, Undivided, Partially Controlled 2-lanes (All Regions)

Table 31 presents the key statistics of the final dataset used for developing SPFs for rural, undivided, partially controlled 2-lane roadways (all regions).

Table 31 Summary of Rural, Undivided, Partially Controlled 2-lane Roadway Segments (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	41	0.35	0.48	0.05	2.91
AADT (veh/day)	41	7116	1441	3696	10194
Total crashes (5 years)	41	1.10	1.76	0	6
Fatal & Injury crashes (5 years)	41	0.32	0.79	0	3

The following SPFs predict crashes for rural, undivided, partially controlled 2-lane segments.

$$Total = [vehmiles]^{0.704} * exp(-6.92)$$

$$FI = [vehmiles]^{0.473} * exp(-6.324)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

4-lane Divided Roadways (No Access Control)

Urban, Divided, Uncontrolled 4-lanes (All regions)

Table 32 presents the key statistics of the final dataset used for developing SPFs for urban, divided, uncontrolled 4-lane roadways (all regions).

Table 32 Summary of Urban, Divided, Uncontrolled 4-lane Roadway Segments (All regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	1724	0.11	0.08	0.05	1.28
AADT (veh/day)	1724	18721	10840	969	56561
Total crashes (5 years)	1724	3.01	5.26	0	34
Fatal & Injury crashes (5 years)	1724	0.75	1.59	0	15

The following SPFs predict crashes for urban, divided, uncontrolled 4-lane segments (all regions).

$$Total = [vehmiles]^{0.402} * exp(-3.343 + 0.275 * [SEMass] - 0.389 * [aadt13k20k] - 0.6 * [aadt30kplus])$$

$$FI = [vehmiles]^{0.485} * exp(-5.380 + 0.4 * [SEMass] - 0.333 * [aadt13k20k] - 0.628 * [aadt30kplus])$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- SEMass = indicator for SE Mass region (1 if in SE Mass, 0 otherwise)
- aadt13k20k = indicator for AADT range (1 if 13000 < AADT < 20000; 0 otherwise).
- aadt30kplus = indicator for AADT range (1 if AADT > 30000; 0 otherwise).

4-lane Undivided Roadways (Partial Access Control)

Urban, Undivided, Partially Controlled 4-lanes (All Regions)

Table 33 presents the key statistics of the final dataset used for developing SPFs for urban, undivided partially controlled 4-lane roadway (all regions).

Table 33 Summary of Rural, Undivided, Partially Controlled 4-lane Roadway Segments (All regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	47	0.11	0.05	0.05	0.24
AADT (veh/day)	47	21632	11456	994	51906
Total crashes (5 years)	47	3.30	4.19	0	14
Fatal & Injury crashes (5 years)	47	0.68	1.11	0	4

The following SPFs predict crashes for urban, undivided, partially controlled 4-lane segments.

$$Total = [vehmiles]^{0.372} * exp(-3.263)$$

$$FI = [vehmiles]^{0.542} * exp(-6.136)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

4-lanes Divided Roadways (Partial Access Control)

Urban, Divided, Partially Controlled 4-lanes (Berkshire and Pioneer Valley)

Table 34 presents the key statistics of the final data set used for developing SPFs for urban, divided partially controlled 4-lane roadways in Berkshire and Pioneer Valley.

Table 34 Summary of Urban, Divided, Partially Controlled 4-lane Roadway Segments in Berkshire and Pioneer Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	135	0.14	0.10	0.05	0.65
AADT (veh/day)	135	16638	5156	6518	24707
Total crashes (5 years)	135	3.64	9.04	0	78
Fatal & Injury crashes (5 years)	135	0.90	2.32	0	17

The following SPFs predict crashes for urban, divided, partially controlled 4-lane segments in Berkshire and Pioneer Valley:

$$Total = [vehmiles]^{0.921} * \exp\left(2.088 * [pioneer\_valley\,] - 1.171 * [aadt19kplus] - 8.855\right)$$

$$FI = [vehmiles]^{0.979} * exp(2.425 * [pioneer\_valley\,] - 1.166 * [aadt17kplus] - 10.814)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- pioneer_valley = indicator for MassDOT region (1 if roadway segment in Pioneer Valley; 0 otherwise).
- aadt17kplus = indicator for AADT range (1 if AADT > 17000; 0 otherwise).
- aadt19kplus = indicator for AADT range (1 if AADT > 19000; 0 otherwise).

Urban, Divided, Partially Controlled 4-lanes (Boston Region)

Table 35 presents the key statistics of the final data set used for developing SPFs for urban, divided, partially controlled 4-lane roadways in Boston Region.

Table 35 Summary of Urban, Divided, Partially Controlled 4-lane Roadway Segments in Boston Region

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	528	0.14	0.12	0.05	1.07
AADT (veh/day)	528	40290	11658	10198	69999
Total crashes (5 years)	528	5.05	9.90	0	107
Fatal & Injury crashes (5 years)	528	1.14	2.44	0	24

The following SPFs predict crashes for urban, divided, partially controlled 4-lane segments in Boston Region:

$$Total = [vehmiles]^{0.543} * \exp(-0.819 * [aadt20kto44k] - 4.332)$$

$$FI = [vehmiles]^{0.658} * exp(-0.609 * [aadt20kto44k] - 6.881)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt20kto44k= indicator for AADT range (1 if 20000 ≤ AADT < 44000; 0 otherwise).

Urban, Divided, Partially Controlled 4-lanes (Cape Cod and SE Mass)

Table 36 presents the key statistics of the final data set used for developing SPFs for urban, divided, partially controlled 4-lane roadways in Cape Cod and SE Mass.

Table 36 Summary of Urban, Divided, Partially Controlled 4-lane Roadway Segments Cape Cod and SE Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	77	0.17	0.10	0.05	0.48
AADT (veh/day)	77	24189	8013	13942	35709
Total crashes (5 years)	77	2.23	2.82	0	17
Fatal & Injury crashes (5 years)	77	0.65	1.09	0	4

The following SPFs predict crashes for urban, divided, partially controlled 4-lane roadway segments in Cape Cod and SE Mass:

$$Total = [vehmiles]^{0.775} * \exp(-0.503 * [se\_mass] - 0.657 * [aadt19kplus] - 6.614)$$

$$FI = [vehmiles]^{0.71} * exp(-7.858)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- se_mass = indicator for MassDOT region (1 if roadway segment in SE Mass; 0 otherwise).
- aadt19kplus = indicator for AADT range (1 if AADT ≥ 19000; 0 otherwise).

Urban, Divided, Partially Controlled 4-lanes (Central Mass)

Table 37 presents the key statistics of the final data set used for developing SPFs for urban, divided, partially controlled 4-lane roadways in Central Mass.

Table 37 Summary of Urban, Divided, Partially Controlled 4-lane Roadway Segments in Central Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	103	0.18	0.13	0.05	0.77
AADT (veh/day)	103	31708	9908	15913	51906
Total crashes (5 years)	103	6.19	9.86	0	51
Fatal & Injury crashes (5 years)	103	0.92	1.63	0	8

The following SPFs predict crashes for urban, divided, partially controlled 4-lane roadway segments in Central Mass:

$$Total = [vehmiles]^{1.331} * \exp\left(-0.97 * [aadt20kto25k] - 1.229 * [aadt37.5kto41k] - 10.786\right)$$

$$FI = [vehmiles]^{1.479} * exp(-0.967 * [aadt37.5kto41k] - 14.279)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).
- aadt20kto25k= indicator for AADT range (1 if 20000 ≤ AADT < 25000; 0 otherwise).
- aadt37.5kto41k= indicator for AADT range (1 if 37500 ≤ AADT < 41000; 0 otherwise).

Urban, Divided, Partially Controlled 4-lanes (Merrimack Valley, Montachusett and N. Middlesex)

Table 38 presents the key statistics of the final data set used for developing SPFs for urban, divided, partially controlled 4-lane roadways in Merrimack Valley, Montachusett and N. Middlesex.

Table 38 Summary of Urban, Divided, Partially Controlled 4-lane Roadway Segments in Merrimack Valley, Montachusett and N. Middlesex

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	69	0.19	0.17	0.05	0.76
AADT (veh/day)	69	20287	15182	6029	53282
Total crashes (5 years)	69	2.06	3.53	0	21
Fatal & Injury crashes (5 years)	69	0.59	1.12	0	4

The following SPFs predict crashes for urban, divided, partially controlled 4-lane in Merrimack Valley, Montachusett and N. Middlesex:

$$Total = [vehmiles]^{0.428} * \exp(-4.363)$$

$$FI = [vehmiles]^{0.473} * exp(-5.983)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

Rural, Divided, Partially Controlled 4-lanes (All regions)

Table 39 presents the key statistics of the final dataset used for developing SPFs for rural, divided partially controlled 4-lane roadway (all regions).

Table 39 Summary of Rural, Divided, Partially Controlled 4-lane Roadway Segments (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	18	0.17	0.10	0.06	0.46
AADT (veh/day)	18	8442	328	7999	8859
Total crashes (5 years)	18	0.17	0.51	0	2
Fatal & Injury crashes (5 years)	18	0.06	0.24	0	1

The following SPFs predict crashes for rural, divided, partially controlled 4-lane segments (all regions).

$$Total = [vehmiles]^{3.503} * exp(-29.494)$$

$$FI = 0.21 * Total$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

For this category, number of FI crashes was too small for developing an SPF. Therefore, the number of FI crashes is calculated as a proportion of the total crashes estimated by the total crash SPF. This proportion was determined by the number of FI crashes divided by the total crashes on 4-lane, divided, partially controlled roadways.

6-lanes Divided Roadways

Urban, Divided, Uncontrolled 6-lanes (All Regions)

Table 40 presents the key statistics of the final data set used for developing SPFs for urban, divided uncontrolled 6-lane roadways (all regions).

Table 40 Summary of Urban, Divided, Uncontrolled 6-lane Roadway Segments (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	37	0.09	0.04	0.05	0.24
AADT (veh/day)	37	22554	13226	7718	57306
Total crashes (5 years)	37	3.97	8.25	0	38
Fatal & Injury crashes (5 years)	37	0.70	1.63	0	6

The following SPFs predict crashes for urban, divided uncontrolled 6-lane roadway segments:

$$Total = [vehmiles]^{1.548} * \exp(-12.016)$$

$$FI = [vehmiles]^{1.156} * exp(-10.742)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

Urban, Divided, Partially Controlled 6-lanes (All Regions)

Table 41 presents the key statistics of the final data set used for developing SPFs for urban, divided partially controlled 6-lane roadways (all regions).

Table 41 Summary of Urban, Divided, Partially Controlled 6-lane Roadway Segments (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Segment length (miles)	126	0.11	0.06	0.05	0.42
AADT (veh/day)	126	48084	24290	15826	98826
Total crashes (5 years)	126	6.97	10.59	0	53
Fatal & Injury crashes (5 years)	126	2.15	3.50	0	18

The following SPFs predict crashes for urban, divided partially controlled 6-lane roadway segments:

$$Total = [vehmiles]^{0.676} * exp(-5.391)$$

$$FI = [vehmiles]^{0.705} * exp(-6.811)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- SegLength = length of road segment (miles).

5

SPF Results for Intersections

This section presents the SPFs for intersections by facility type and region. Below are the SPFs developed for each category presented in Table 4 and Table 5. Only the equations and key information readers would need to apply them are presented in this section. The full model parameters and CURE plots for model assessment are included in the Appendix for interested readers to find more detailed information.

2x2-lanes 3-legs Intersections (Stop-Controlled)

Urban, Stop-Controlled, 2x2 lanes, 3-legs (Berkshire)

Table 42 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Berkshire.

Table 42 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Berkshire

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	98	5151	3920.59	302	22434
Minor Road AADT (veh/day)	98	1404	1331	297	11865
Total crashes (5 years)	98	1.72	2.78	0	17
Fatal & Injury crashes (5 years)	98	0.40	0.85	0	6

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersection in Berkshire with AADTs.

$$Total = [maj\_aadt]^{0.573} * [x\_aadt]^{0.546} * exp(-9.872)$$

$$FI = [maj\_aadt]^{0.806} * [x\_aadt]^{0.684} * exp(-14.395)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.

Urban, Stop-Controlled, 2x2 lanes, 3-legs (Boston Region)

Table 43 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Boston Region.

Table 43 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Boston Region

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	4083	6149	4132.58	210	23818
Minor Road AADT (veh/day)	4083	1550	1201	112	10018
Total crashes (5 years)	4083	2.91	4.43	0	60
Fatal & Injury crashes (5 years)	4083	0.71	1.26	0	13

The following SPFs predict crashes for urban, 2x2 lanes, 3-leg, stop-controlled intersections in Boston Region.

$$Total = [maj\_aadt]^{0.477} * [x\_aadt]^{0.473} * exp(0.412 * [aadt3kless] + 0.22 * [aadt5kto7k] + 0.269 * [aadt10kplus] - 8.243)$$

$$FI = [maj\_aadt]^{0.47} * [x\_aadt]^{0.53} * exp(0.456 * [aadt3kless] + 0.224 * [aadt10kplus] - 9.955)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- aadt3kless = indicator for AADT range (1 if AADT < 3000; 0 otherwise).
- aadt5kto7k = indicator for AADT range (1 if 5000 ≤AADT < 7000; 0 otherwise).
- aadt10kplus = indicator for AADT range (1 if AADT > 10000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 3-legs (Cape Cod)

Table 44 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Cape Cod.

Table 44 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Cape Cod

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	533	5305	3635.27	207	15667
Minor Road AADT (veh/day)	533	1362	910	206	7931
Total crashes (5 years)	533	2.16	3.95	0	35
Fatal & Injury crashes (5 years)	533	0.58	1.17	0	7

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in Cape Cod.

$$Total = [maj\_aadt]^{0.867} * [x\_aadt]^{0.342} * \exp(-0.409 * [totaadt5kto12k] - 10.569)$$

$$FI = [maj\_aadt]^{0.81} * [x\_aadt]^{0.482} * \exp(-0.477 * [totaadt5kto12k] - 12.352)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- totaadt5kto12k = indicator for Total AADT range (1 if Total 5000 ≤AADT < 12000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 3-legs (Central Mass)

Table 45 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Central Mass.

Table 45 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Central Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	854	5007	3406.70	112	17392
Minor Road AADT (veh/day)	854	1175	1218	112	8808
Total crashes (5 years)	854	2.85	4.39	0	46
Fatal & Injury crashes (5 years)	854	0.60	1.16	0	9

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in Central Mass.

$$Total = [maj\_aadt]^{0.638} * [x\_aadt]^{0.248} * exp(-0.358 * [totaadt5kto7k] - 7.583)$$

$$FI = [maj\_aadt]^{1.093} * [x\_aadt]^{0.239} * exp(0.782 * [totaadt5kless] + 0.445 * [totaadt6kto15k] - 13.501)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- totaadt5kto7k = indicator for Total AADT range (1 if 5000 ≤Total AADT < 7000; 0 otherwise).
- totaadt5kless = indicator for Total AADT range (1 if Total AADT < 5000; 0 otherwise).
- totaadt6kto15k = indicator for Total AADT range (1 if 6000 ≤ Total AADT ≤ 15000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 3-legs (Franklin)

Table 46 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Franklin.

Table 46 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Franklin

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	112	3832	2558.35	117	15635
Minor Road AADT (veh/day)	112	1318	876	217	4852
Total crashes (5 years)	112	1.71	2.09	0	12
Fatal & Injury crashes (5 years)	112	0.45	0.97	0	6

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in Franklin.

$$Total = [tot\_aadt]^{0.44} * exp(-4.798)$$

$$FI = [tot\_aadt]^{0.175} * exp(-3.89)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- vehmiles = vehicle-miles travelled for the segment (vehmiles=[AADT]*[SegLength].
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

Urban, Stop-Controlled, 2x2 lanes, 3-leg (Merrimack Valley)

Table 47 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Merrimack Valley.

Table 47 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Berkshire in Merrimack Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	323	5443	3270.31	83	16020
Minor Road AADT (veh/day)	323	1529	992	83	5839
Total crashes (5 years)	323	3.50	4.98	0	28
Fatal & Injury crashes (5 years)	323	0.72	1.34	0	9

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in Merrimack Valley.

$$Total = [tot\_aadt]^{1.017} * exp(-9.361)$$

$$FI = [tot\_aadt]^{1.146} * exp(-12.098)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

Urban, Stop-Controlled, 2x2 lanes, 3-leg (Montachusett)

Table 48 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Montachusett.

Table 48 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Montachusett

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	357	4371	3021.75	213	15696
Minor Road AADT (veh/day)	357	1507	1212	350	8319
Total crashes (5 years)	357	3.02	4.54	0	45
Fatal & Injury crashes (5 years)	357	0.61	1.03	0	6

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in Montachusett.

$$Total = [maj\_aadt]^{0.712} * [x\_aadt]^{0.311} * exp(-8.716)$$

$$FI = [maj\_aadt]^{0.725} * [x\_aadt]^{0.264} * exp(-10.059)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.

Urban, Stop-Controlled, 2x2 lanes, 3-leg (N. Middlesex)

Table 49 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in N. Middlesex.

Table 49 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in N. Middlesex

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	330	5534	3006.67	218	15539
Minor Road AADT (veh/day)	330	1751	1452	420	10001
Total crashes (5 years)	330	3.76	6.06	0	42
Fatal & Injury crashes (5 years)	330	0.95	1.66	0	9

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in N. Middlesex.

$$Total = [maj\_aadt]^{0.451} * [x\_aadt]^{0.842} * exp(-10.442)$$

$$FI = [maj\_aadt]^{0.546} * [x\_aadt]^{0.801} * exp(-12.319)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.

Urban, Stop-Controlled, 2x2 lanes, 3-leg (Old Colony)

Table 50 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Old Colony.

Table 50 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Old Colony

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	348	5691	3254.21	390	15908
Minor Road AADT (veh/day)	348	1748	1308	217	9139
Total crashes (5 years)	348	3.61	4.87	0	35
Fatal & Injury crashes (5 years)	348	1.32	2.25	0	15

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in Old Colony.

$$Total = [maj\_aadt]^{0.579} * [x\_aadt]^{0.318} * exp(-0.645 * [totaadt2.5kto12k] - 7.163)$$

$$FI = [maj\_aadt]^{0.789} * [x\_aadt]^{0.287} * exp(-0.646 * [totaadt2.5kto12k] - 9.777)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- totaadt2.5kto12k = indicator for Total AADT range (1 if 2500 ≤ AADT ≤ 12000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 3-leg (Pioneer Valley)

Table 51 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in Pioneer Valley.

Table 51 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in Pioneer Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	936	7632	4970.27	407	23813
Minor Road AADT (veh/day)	936	1353	1339	202	8825
Total crashes (5 years)	936	3.84	4.70	0	38
Fatal & Injury crashes (5 years)	936	1.20	1.83	0	18

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in Pioneer Valley.

$$Total = [maj\_aadt]^{0.288} * [x\_aadt]^{0.312} * exp(-0.242 * [totaadt2.5kto6k] - 0.328 * [totaadt16kplus] - 4.998)$$

$$FI = [maj\_aadt]^{0.642} * [x\_aadt]^{0.321} * exp(-9.392)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- totaadt2.5kto6 k = indicator for Total AADT range (1 if 2500 < AADT < 6000; 0 otherwise).
- totaadt16kplus = indicator for Total AADT range (1 if AADT > 16000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 3-leg (SE Mass)

Table 52 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, stop-controlled intersections in SE Mass.

Table 52 Summary of Urban, 3-leg, Stop-Controlled 2x2 lane Intersection in SE Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	351	6088	3650.93	1473	18286
Minor Road AADT (veh/day)	351	1570	1095	350	6131
Total crashes (5 years)	351	3.44	4.70	0	33
Fatal & Injury crashes (5 years)	351	0.96	1.65	0	12

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, stop-controlled intersections in in SE Mass.

$$Total = [tot\_aadt]^{0.705} * exp(-6.648)$$

$$FI = [tot\_aadt]^{0.673} * exp(-7.645)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

Urban and Rural, Stop-Controlled, 2x2 lanes, 3-leg (Martha's Vineyard and Nantucket)

Table 53 presents the key statistics of the final dataset used for developing SPFs for 2x2 lane, 3-leg stop controlled intersections in both urban and rural areas in Martha's Vineyard and Nantucket.

Table 53 Summary of Urban and Rural, 3-leg, Stop-Controlled 2x2 lane Intersection in Martha's Vineyard and Nantucket

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	46	4953	3879.27	550	14488
Minor Road AADT (veh/day)	46	1186	1090	350	5761
Total crashes (5 years)	46	2.17	3.55	0	19
Fatal & Injury crashes (5 years)	46	0.41	0.75	0	3

The following SPFs predict crashes for both urban and rural, 2x2 lanes, 3-leg, stop-controlled intersections in Martha's Vineyard & Nantucket.

$$Total = [tot\_aadt]^{0.768} * exp(-7.474)$$

$$FI = [tot\_aadt]^{0.595} * exp(-7.613)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

Rural, Stop-Controlled, 2x2 lanes, 3-legs (Berkshire, Franklin and Pioneer Valley)

Table 54 presents the key statistics of the final dataset used for developing SPFs for rural, 2x2 lane, 3-leg, stop-controlled intersections in Berkshire, Franklin and Pioneer Valley.

Table 54 Summary of Rural, 3-leg, Stop-Controlled 2x2 lane Intersection in Berkshire, Franklin and Pioneer Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	226	1087	923.39	404	6538
Minor Road AADT (veh/day)	226	464	410	95	3382
Total crashes (5 years)	226	0.84	1.94	0	20
Fatal & Injury crashes (5 years)	226	0.20	0.58	0	5

The following SPFs predict crashes for rural, 2x2 lane, 3-leg, stop-controlled intersections in Berkshire, Franklin and Pioneer Valley.

$$Total = [tot\_aadt]^{0.861} * exp(0.406 * [pioneer\ valley] - 8.387)$$

$$FI = [tot\_aadt]^{1.136} * exp(-11.607)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- pioneer_valley = indicator for MassDOT region (1 if roadway segment in Pioneer Valley; 0 otherwise).

Rural, Stop-Controlled, 2x2 lanes, 3-legs (Boston Region, Central Mass, Montachusett, Merrimack Valley & N. Middlesex)

Table 55 presents the key statistics of the final dataset used for developing SPFs for rural, 2x2 lane, 3-leg, stop-controlled intersections in Boston Region, Central Mass, Montachusett, Merrimack Valley and N. Middlesex

Table 55 Summary of Rural, 3-leg, Stop-Controlled 2x2 lane Intersection in Boston Region, Central Mass, Montachusett, Merrimack Valley and N. Middlesex

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	199	1900	2061.86	435	14583
Minor Road AADT (veh/day)	199	590	604	350	5216
Total crashes (5 years)	199	1.28	2.09	0	15
Fatal & Injury crashes (5 years)	199	0.35	0.85	0	5

The following SPFs predict crashes for rural, 2x2 lane, 3-leg, stop-controlled intersections in Boston Region, Central Mass, Montachusett, Merrimack Valley and N. Middlesex.

$$Total = [tot\_aadt]^{0.884} * exp(-8.227)$$

$$FI = [tot\_aadt]^{0.816} * exp(-8.969)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

Rural, Stop-Controlled, 2x2 lanes, 3-legs (Cape Cod, Old Colony, and SE Mass)

Table 56 presents the key statistics of the final dataset used for developing SPFs for rural, 2x2 lane, 3-leg, stop-controlled intersections in Cape Cod, Old Colony, and SE Mass.

Table 56 Summary of Rural, 3-leg, Stop-Controlled 2x2 lane Intersection in Cape Cod, Old Colony, and SE Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	57	1525	1030.95	550	3895
Minor Road AADT (veh/day)	57	470	258	228	1252
Total crashes (5 years)	57	1.23	2.13	0	13
Fatal & Injury crashes (5 years)	57	0.26	0.55	0	2

The following SPFs predict crashes for rural, 2x2 lane, 3-leg, stop-controlled intersections in Cape Cod, Old Colony, and SE Mass.

$$Total = [tot\_aadt]^{1.133} * exp(-10.035)$$

$$FI = [tot\_aadt]^{0.869} * exp(-9.52)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

2x2-lanes 4-leg Intersections (Stop-Controlled)

Urban, Stop-Controlled, 2x2 lanes, 4-legs (Berkshire, Franklin & Pioneer Valley)

Table 57 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lane, 4-leg, stop-controlled intersections in Berkshire, Franklin and Pioneer Valley.

Table 57 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersections in Berkshire, Franklin and Pioneer Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	314	6657	4883.51	774	22860
Minor Road AADT (veh/day)	314	1513	1235	328	10033
Total crashes (5 years)	314	7.59	7.00	0	38
Fatal & Injury crashes (5 years)	314	2.71	3.12	0	16

The following SPFs predict crashes for urban, 2x2 lane, 4-leg, stop-controlled intersections in Berkshire, Franklin and Pioneer Valley.

$$Total = [maj\_aadt]^{0.383} * [x\_aadt]^{0.305} * exp(0.735 * [berkshire] + 0.884 * [pioneer\_valley\ ] + 0.337 * [totaadt4kto10k] - 6.026)$$

$$FI = [maj\_aadt]^{0.421} * [x\_aadt]^{0.266} * exp(0.499 * [berkshire] + 0.755 * [pioneer\_valley\ ] - 6.84)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- berkshire = indicator for MassDOT region (1 if roadway segment in Berkshire; 0 otherwise).
- totaadt4kto10k = indicator for Total AADT range (1 if 4000 ≤ AADT < 10000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 4-legs (Boston Region)

Table 58 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lanes, 4-leg, stop-controlled intersections in Boston Region.

Table 58 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersections in Boston Region

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	1351	6404	4082.23	782	21800
Minor Road AADT (veh/day)	1351	1519	944	350	9184
Total crashes (5 years)	1351	5.66	6.90	0	50
Fatal & Injury crashes (5 years)	1351	1.45	2.20	0	14

The following SPFs predict crashes for urban, 2x2 lanes, 4-leg, stop-controlled intersections in Boston Region:

$$Total = [maj\_aadt]^{0.4} * [x\_aadt]^{0.634} * exp(0.297 * [totaadt3kto4k] + 0.233 * [totaadt7kto13k] - 8.091)$$

$$FI == [maj\_aadt]^{0.398} * [x\_aadt]^{0.582} * exp(0.341 * [totaadt3kto4k] + 0.282 * [totaadt6.5kto12.5k] - 9.08)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- Totaadt3kto4k = indicator for AADT range (1 if 3000 ≤ AADT < 4000; 0 otherwise).
- Totaadt7kto13k = indicator for AADT range (1 if 7000 ≤ AADT < 13000; 0 otherwise).
- Totaadt6.5kto12.5k= indicator for AADT range (1 if 6500 ≤ AADT < 12500; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 4-legs (Cape Cod)

Table 59 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lanes, 4-leg, stop-controlled intersections in Cape Cod.

Table 59 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersections in Cape Cod

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	213	4656	3026.07	1112	13837
Minor Road AADT (veh/day)	213	1478	875	227	6610
Total crashes (5 years)	213	3.64	5.21	0	29
Fatal & Injury crashes (5 years)	213	0.98	1.74	0	9

The following SPFs predict crashes for urban, 2x2 lanes, 4-leg, stop-controlled intersections in Cape Cod:

$$Total = [maj\_aadt]^{0.59} * [x\_aadt]^{1.002} * exp(-12.659)$$

$$FI = [maj\_aadt]^{0.432} * [x\_aadt]^{1.458} * exp(-16.004)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.

Urban, Stop-Controlled, 2x2 lanes, 4-leg (Central Mass)

Table 60 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lane, 4-leg, stop-controlled intersections in Central Mass.

Table 60 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersection in Central Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	236	5506	3722.29	746	17392
Minor Road AADT (veh/day)	236	1032	829	346	5293
Total crashes (5 years)	236	7.87	9.68	0	73
Fatal & Injury crashes (5 years)	236	1.95	2.59	0	16

The following SPFs predict crashes for urban, 2x2 lane, 4-leg, stop-controlled intersections in Central Mass with AADTs:

$$Total = [maj\_aadt]^{0.327} * [x\_aadt]^{0.295} * exp(-0.28 * [totaadt2.5kto7.5k] - 4.196)$$

$$FI = [tot\_aadt]^{0.403} * exp(-0.492 * [totaadt2.5kto6k] - 4.265)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- totaadt2.5kto7.5k = indicator for AADT range (1 if 2500 ≤ AADT < 7500; 0 otherwise).
- totaadt2.5kto6k = indicator for AADT range (1 if 2500 ≤ AADT < 6000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 4-legs (Merrimack Valley)

Table 61 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lane, 4-leg, stop-controlled intersections in Merrimack Valley.

Table 61 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersection in Merrimack Valley

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	210	6007	3622.57	1367	16020
Minor Road AADT (veh/day)	210	1616	1077	66	6900
Total crashes (5 years)	210	7.75	7.93	0	37
Fatal & Injury crashes (5 years)	210	2.15	2.51	0	13

The following SPFs predict crashes for urban, 2x2 lanes, 4-leg, stop-controlled intersections in Merrimack Valley:

$$Total = [maj\_aadt]^{0.529} * [x\_aadt]^{0.475} * exp(0.439 * [totaadt6kto9k] - 7.755)$$

$$FI = [maj\_aadt]^{0.406} * [x\_aadt]^{0.406} * exp(0.539 * [totaadt6kto9k] - 7.488)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- totaadt6kto9k = indicator for AADT range (1 if 6000 ≤ AADT < 9000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 4-leg (Montachusett)

Table 62 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lane, 4-leg, stop-controlled intersections in Montachusett.

Table 62 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersection in Montachusett

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	159	4365	3311.60	748	14193
Minor Road AADT (veh/day)	159	1393	887	427	6137
Total crashes (5 years)	159	5.72	7.15	0	44
Fatal & Injury crashes (5 years)	159	1.52	2.31	0	15

The following SPFs predict crashes for urban, 2x2 lane, 4-leg, stop-controlled intersections in Montachusett:

$$Total = [maj\_aadt]^{0.366} * [x\_aadt]^{0.859} * exp(-9.103)$$

$$FI = [tot\_aadt]^{0.708} * exp(-7.284)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

Urban, Stop-Controlled, 2x2 lanes, 4-legs (N. Middlesex)

Table 63 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lane, 4-leg, stop-controlled intersections in N. Middlesex.

Table 63 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersection in N. Middlesex

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	184	5871	2998.93	1195	18159
Minor Road AADT (veh/day)	184	1792	1072	752	5696
Total crashes (5 years)	184	9.38	11.32	0	72
Fatal & Injury crashes (5 years)	184	2.04	2.79	0	18

The following SPFs predict crashes for urban, 2x2 lane, 4-leg, stop-controlled intersections in N. Middlesex with AADTs:

$$Total = [maj\_aadt]^{0.648} * [x\_aadt]^{0.637} * exp(-0.378 * [totaadt6kto9k] - 9.637)$$

$$FI = [maj\_aadt]^{0.635} * [x\_aadt]^{0.6} * exp(-0.529 * [totaadt6kto9k] - 10.734)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- totaadt6kto9k = indicator for AADT range (1 if 6000 ≤ AADT < 9000; 0 otherwise).

Urban, Stop-Controlled, 2x2 lanes, 4-legs (Old Colony)

Table 64 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lane, 4-leg, stop-controlled intersections in Old Colony.

Table 64 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersection in Old Colony

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	160	5569	3611.71	760	18435
Minor Road AADT (veh/day)	160	1551	864	212	5276
Total crashes (5 years)	160	9.46	13.21	0	68
Fatal & Injury crashes (5 years)	160	4.04	6.40	0	36

The following SPFs predict crashes for urban, 2x2 lane, 4-leg, stop-controlled intersections in Old Colony:

$$Total = [tot\_aadt]^{0.912} * exp(-7.446)$$

$$FI = [tot\_aadt]^{0.987} * exp(-8.967)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

Urban, Stop-Controlled, 2x2 lanes, 4-legs (SE Mass)

Table 65 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lane, 4-leg, stop-controlled intersections in SE Mass.

Table 65 Summary of Urban, 4-leg, 2x2 lane Stop-Controlled Intersection in SE Mass

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	166	5644	2469.46	1668	18072
Minor Road AADT (veh/day)	166	1643	1109	686	6108
Total crashes (5 years)	166	8.40	8.69	0	45
Fatal & Injury crashes (5 years)	166	2.51	3.32	0	19

The following SPFs predict crashes for urban, 2x2 lane, 4-leg, stop-controlled intersections in SE Mass:

$$Total = [tot\_aadt]^{0.989} * exp(-8.273)$$

$$FI = [tot\_aadt]^{1.059} * exp(-10.102)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

Rural, Stop-Controlled, 2x2 lanes, 4-leg (All Regions)

Table 66 presents the key statistics of the final data set used for developing SPFs for rural, 2x2 lane, 4-leg, stop-controlled intersections (all regions).

Table 66 Summary of Rural, 4-leg, 2x2 lane Stop-Controlled Intersection (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	99	1620	1548.78	409	8154
Minor Road AADT (veh/day)	99	564	445	206	2849
Total crashes (5 years)	99	2.11	3.80	0	23
Fatal & Injury crashes (5 years)	99	0.59	1.13	0	5

The following SPFs predict crashes for rural, 4-leg, 2x2 lane stop-controlled intersections in all regions:

$$Total = [maj\_aadt]^{0.608} * [x\_aadt]^{0.915} * exp(-11.241)$$

$$FI = [maj\_aadt]^{0.766} * [x\_aadt]^{0.643} * exp(-11.909)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.

4x2-lane, 3-leg Intersections (Stop-controlled)

Urban, Stop-controlled, 4x2 lanes, 3-legs (All Regions)

Table 67 presents the key statistics of the final data set used for developing SPFs for urban, 4x2 lane, 3-leg, stop-controlled intersections (all regions).

Table 67 Summary of Urban, 3-leg, 4x2 lane Stop-controlled Intersections (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	218	21730	14988.24	1247	60759
Minor Road AADT (veh/day)	218	1245	987	103	7394
Total crashes (5 years)	218	7.42	6.49	0	30
Fatal & Injury crashes (5 years)	218	2.06	2.51	0	18

The following SPFs predict crashes for urban, 4x2 lane, 3-leg, stop-controlled intersections for all regions:

$$Total = [maj\_aadt]^{0.235} * [x\_aadt]^{0.396} * exp(-4.962)$$

$$FI = [maj\_aadt]^{0.024} * [x\_aadt]^{0.649} * exp(-5.707)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

4x2-lanes 4-leg Intersections (Stop-controlled)

Urban, Stop-controlled, 4x2 lanes, 4-legs (All Regions)

Table 68 presents the key statistics of the final data set used for developing SPFs for urban, 4x2 lane, 4-leg, stop-controlled intersections (all regions).

Table 68 Summary of Urban, 4-leg, 4x2 lane Stop-controlled Intersections (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	35	17049	7767.14	2376	39728
Minor Road AADT (veh/day)	35	1099	298	898	2239
Total crashes (5 years)	35	8.60	7.17	0	29
Fatal & Injury crashes (5 years)	35	2.57	2.91	0	12

The following SPFs predict crashes for urban, 4x2 lane, 4-leg, stop-controlled intersections in all regions:

$$Total = [maj\_aadt]^{0.436} * [x\_aadt]^{1.007} * exp(-10.704)$$

$$FI = [tot\_aadt]^{0.862} * exp(-9.101)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

2x2-lanes 3-leg Intersections (Signalized)

Urban, Signalized, 2x2 lanes, 3-legs (All Regions)

Table 69 presents the key statistics of the final dataset used for developing SPFs for urban, 2x2 lane, 3-leg, signalized intersections (all regions).

Table 69 Summary of Urban, 3-leg, 2x2 lane Signalized Intersection (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	166	11052	5156.25	2221	26763
Minor Road AADT (veh/day)	166	3527	3170	226	14596
Total crashes (5 years)	166	10.89	8.91	0	48
Fatal & Injury crashes (5 years)	166	2.80	2.61	0	12

The following SPFs predict crashes for urban, 2x2 lane, 3-leg, signalized intersections in all regions.

$$Total = [maj\_aadt]^{0.228} * [x\_aadt]^{0.276} * exp(-0.446 * [boston\_region] - 3.236)$$

$$FI = [maj\_aadt]^{0.296} * [x\_aadt]^{0.314} * exp(-0.379 * [boston\_region] - 5.57)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).
- boston_region = indicator for MassDOT region (1 if roadway segment in Boston region; 0 otherwise).

2x2-lanes 4-leg Intersections (Signalized)

Urban, Signalized, 2x2 lanes, 4-legs (All regions)

Table 70 presents the key statistics of the final data set used for developing SPFs for urban, 2x2 lane, 4-leg, signalized intersections (all regions).

Table 70 Summary of Urban, 4-leg, 2x2 lane Signalized Intersections (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	602	9483	4688	1093	25933
Minor Road AADT (veh/day)	602	3781	2398	209	14855
Total crashes (5 years)	602	17.38	11.52	0	58
Fatal & Injury crashes (5 years)	602	5.00	4.39	0	30

The following SPFs predict crashes for urban, 2x2 lanes, 4-leg, signalized intersections in all regions:

$$Total = [maj\_aadt]^{0.197} * [x\_aadt]^{0.186} * exp(-0.427 * [boston\_region] - 0.124 * [totaadt11kto16k] - 1.768)$$

$$FI = [maj\_aadt]^{0.197} * [x\_aadt]^{0.161} * exp(-0.617 * [boston\_region] - 0.216 * [totaadt11kto16k] - 2.693)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- maj_aadt = Annual average daily traffic (vehicles per day) on major street.
- x_aadt = Annual average daily traffic (vehicles per day) on cross street.
- tot_aadt = total traffic for intersection (=maj_AADT + x_AADT).
- boston_region = indicator for Boston region (1 if roadway segment in Boston Region; 0 otherwise).
- totaadt11kto16k = indicator for Total AADT range (1 if 11000 ≤ AADT < 16000; 0 otherwise).

4x2-lanes 3-leg Intersections (Signalized)

Urban, Signalized, 4x2 lanes, 3-leg (All Regions)

Table 71 presents the key statistics of the final data set used for developing SPFs for urban, 4x2 lane, 3-leg, signalized intersections (all regions).

Table 71 Summary of Urban, 3-leg, 4x2 lane Signalized Intersections (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	53	13749	6613.42	1247	26231
Minor Road AADT (veh/day)	53	2663	2375	674	9457
Total crashes (5 years)	53	14.94	11.70	0	51
Fatal & Injury crashes (5 years)	53	4.38	3.83	0	17

The following SPFs predict crashes for urban, 4x2 lane, 3-leg, signalized intersections in all regions:

$$Total = [maj\_aadt]^{0.252} * [x\_aadt]^{0.164} * exp(-2.53)$$

$$FI = [tot\_aadt]^{0.492} * exp(-4.883)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

4x2-lanes 4-leg Intersections (Signalized)

Urban, Signalized, 4x2 lanes, 4-leg (All Regions)

Table 72 presents the key statistics of the final data set used for developing SPFs for urban, 4x2 lane, 4-leg, signalized intersections (all regions).

Table 72 Summary of Urban, 4-leg, Signalized 4x2 lane Intersections (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	143	23180	13267.00	4460	59098
Minor Road AADT (veh/day)	143	4174	4092	544	22771
Total crashes (5 years)	143	25.86	20.55	0	114
Fatal & Injury crashes (5 years)	143	7.65	6.98	0	43

The following SPFs predict crashes for urban, 4x2 lane, 4-leg, signalized intersections in all regions:

$$Total = [maj\_aadt]^{0.292} * [x\_aadt]^{0.169} * exp(-2.615)$$

$$FI = [maj\_aadt]^{0.285} * [x\_aadt]^{0.298} * exp(-4.808)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- maj_aadt = indicator for major street AADT.
- x_aadt = indicator for cross street AADT.

4x4-lane, 4-leg Intersections (Signalized)

Urban, Signalized, 4x4 lanes, 4-legs (All Regions)

Table 73 presents the key statistics of the final data set used for developing SPFs for urban, 4x4 lanes, 4-leg, signalized intersections (all regions).

Table 73 Summary of Urban, 4-leg, 4x4 lane Signalized Intersections (All Regions)

Description	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Major Road AADT (veh/day)	16	28404	16151.97	8581	60759
Minor Road AADT (veh/day)	16	13190	9145	1154	34643
Total crashes (5 years)	16	36.88	30.33	4	113
Fatal & Injury crashes (5 years)	16	9.94	8.68	1	35

The following SPFs predict crashes for urban, 4x4 lane, 4-leg, signalized intersections in all regions:

$$Total = [tot\_aadt]^{0.678} * exp(-5.197)$$

$$FI = [tot\_aadt]^{0.794} * exp(-7.748)$$

Where:

- Total = predicted number of total crashes per year.
- FI = predicted number of fatal and injury crashes per year.
- AADT = annual average daily traffic (vehicles per day).
- tot_aadt = indicator for Total AADT (Major Road AADT plus Minor Road AADT).

6

SPF Deployment and Network Screening Results

Network screening followed the Empirical Bayes procedure presented in MassDOT's Network Screening Guide. A decision was made to use the most recent five years of complete crash data (2017 to 2021) for network screening. While the SPFs were developed using data from 2015 to 2019, it is common practice to implement the SPFs in future years, beyond those used to develop the SPFs. It is reasonable to apply SPFs in future years without calibration as long as no drastic changes to the underlying datasets have taken place. Over time, it is appropriate to calibrate or redevelop SPFs to account for more widespread changes in the crash data, roadway network, vehicle fleet, and other factors that can affect safety.

Predicted crashes for total and FI crashes were calculated for each roadway segment or intersection. The predicted crashes for each facility type were compared to the observed crashes to determine if the SPFs needed to be calibrated to the more recent years. In this process, the research team found that the differences between the predicted and observed crashes for roadway segments were minimal for all facility types. Therefore, it was not necessary to calibrate the segment SPFs to the most recent years. This also indicates that the SPFs performed well on the dataset used for network screening (2017-2021). For intersections, however, there was less consistency across facility types. While the predicted and observed crashes were well aligned for some facility types, the team found the differences for others were substantial enough to deem calibration necessary. The calibration was performed for each intersection facility type and each year. The total number of initial predicted crashes for each facility type in a year was compared to the corresponding total number of observed crashes to calculate a calibration factor for that facility type and year. That calibration factor was then applied to all intersections within that facility type to adjust the predicted crashes. The intersection network screening was performed based on these calibrated predicted crashes.

As stated in previous sections, segment SPFs were developed using bidirectional crash counts and traffic volumes, including for divided roadway segments. However, the network screening engine runs directionally for divided roadway segments, so the number of crashes predicted by the SPFs are divided by two in the screening engine to obtain the prediction for each direction individually. Additionally, the screening engine uses an average default AADT for any network screening segment/window where the AADT is zero or missing. The default is based on the average AADT for the facility type. Table 74 summarizes the average AADT values for each facility type. These average AADTs were calculated using a weighted average from the screening segments.

The Empirical Bayes method was then used to calculate expected crash frequency – the statistically weighted average between the observed and predicted crashes on the segment or at the intersection (in five years, 2017-2021). Excess total and FI crashes were then

calculated as the difference between expected and predicted crashes. Finally, the segments or intersections are ranked and displayed by excess crashes. The display highlights the top 5 percent then the next 10 percent of segments or intersections as ranked by excess total crashes and excess FI crashes. These displays are provided for both statewide rankings and MPO rankings. As such, users can identify if a segment falls within those categories in either the entire State or within its MPO.

Table 74 Average AADT by Facility Type (used to substitute zero or missing AADT)

Facility Type	Average AADT
Rural 2-lane undivided partially-controlled	7,516
Urban 2-lane undivided partially-controlled	10,469
Rural 4-lane divided partially-controlled	17,463
Urban 4-lane divided partially-controlled	34,837
Urban 6-lane divided partially-controlled	63,076
Urban 4-lane divided uncontrolled	29,098
Urban 2-lane undivided uncontrolled	5,752
Rural 2-lane undivided uncontrolled	1,971
Urban 4-lane divided uncontrolled	20,384
Urban 4-lane divided partially controlled	18,319