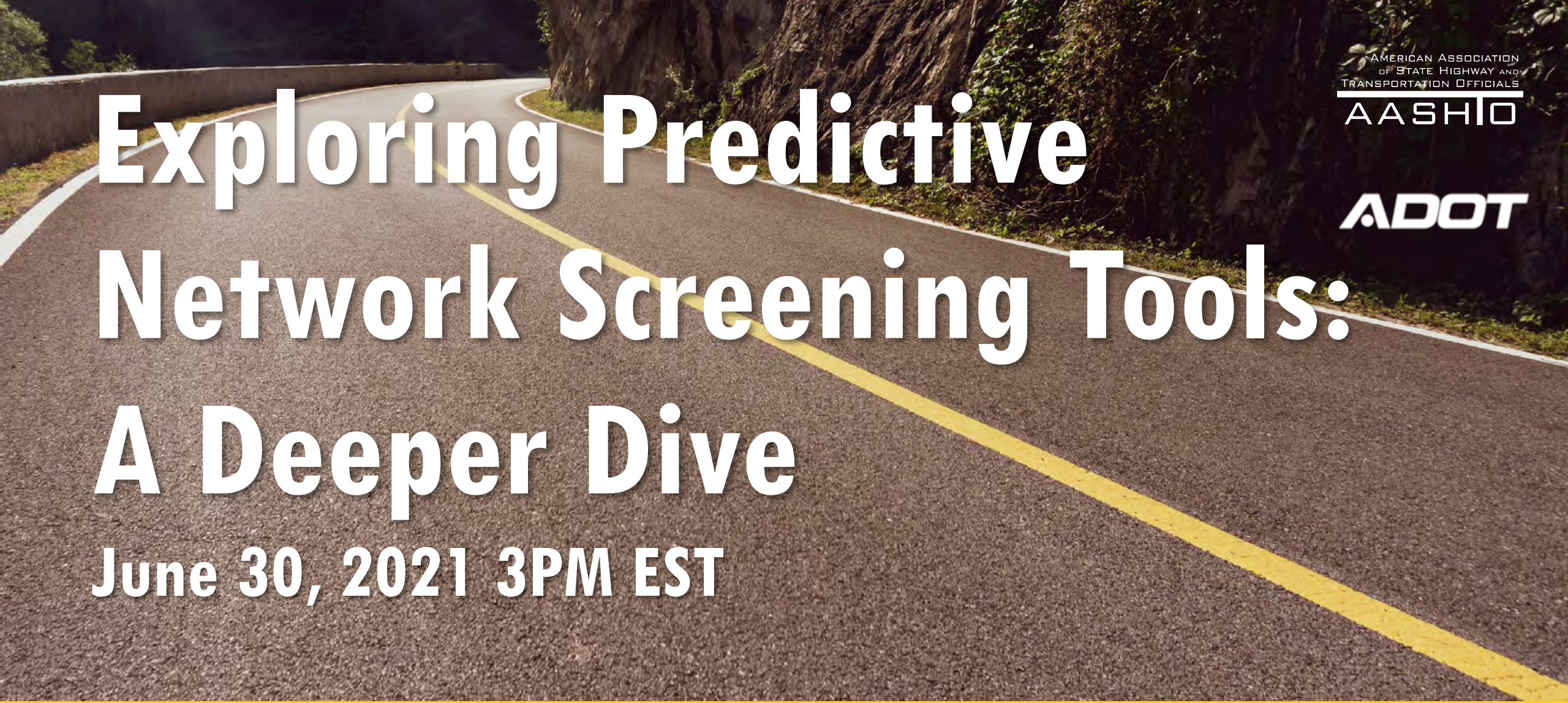


# Exploring Predictive Network Screening Tools: A Deeper Dive

## June 30, 2021 3PM EST


**Stephen Read,** Virginia DOT & AASHTO Highway Safety Manual Steering Committee Chair

**Bonnie Polin,** Massachusetts DOT & AASHTO Highway Safety Manual Steering Committee Co-Chair

**Kerry Wilcoxon & Saroja Devarakonda,** Arizona DOT

# Exploring Predictive Network Screening Tools

American Association of State Highway and Transportation Officials
AASHTO

ADOT

This webinar series features innovative software tools for predictive network screening employed by state transportation agencies around the United States.

Kick-off webinars provided a high-level overview of the tools using a speed-dating format and this webinar provides a more detailed description and demonstration of specific tools.

**Stephen Read,** Virginia DOT & AASHTO Highway Safety Manual Steering Committee Chair

**Bonnie Polin,** Massachusetts DOT & AASHTO Highway Safety Manual Steering Committee Co-Chair

**Kerry Wilcoxon & Saroja Devarakonda,** Arizona DOT

# Exploring Predictive Network Screening Tools




David Swenka, P.E. PTOE
**Colorado DOT – DiExSys**





Alan El-Urfali, P.E. & Javier Ponce, P.E.
**Florida DOT – SAS**





Shanshan Zhao, Ph.D. & Eric Jackson, Ph.D.
**Connecticut DOT – CRSMS**

**Stephen Read,** Virginia DOT & AASHTO HSM Steering Committee Chair
**Bonnie Polin,** Massachusetts DOT & AASHTO Highway Safety Manual Steering Committee Co-Chair
**Kerry Wilcoxon & Saroja Devarakonda,** Arizona DOT

American Association of State Highway and Transportation Officials
AASHTO

ADOT

# Discussion

For additional information go to www.highwaysafetymanual.org or contact Kelly Hardy, P.E. at khardy@aashto.org

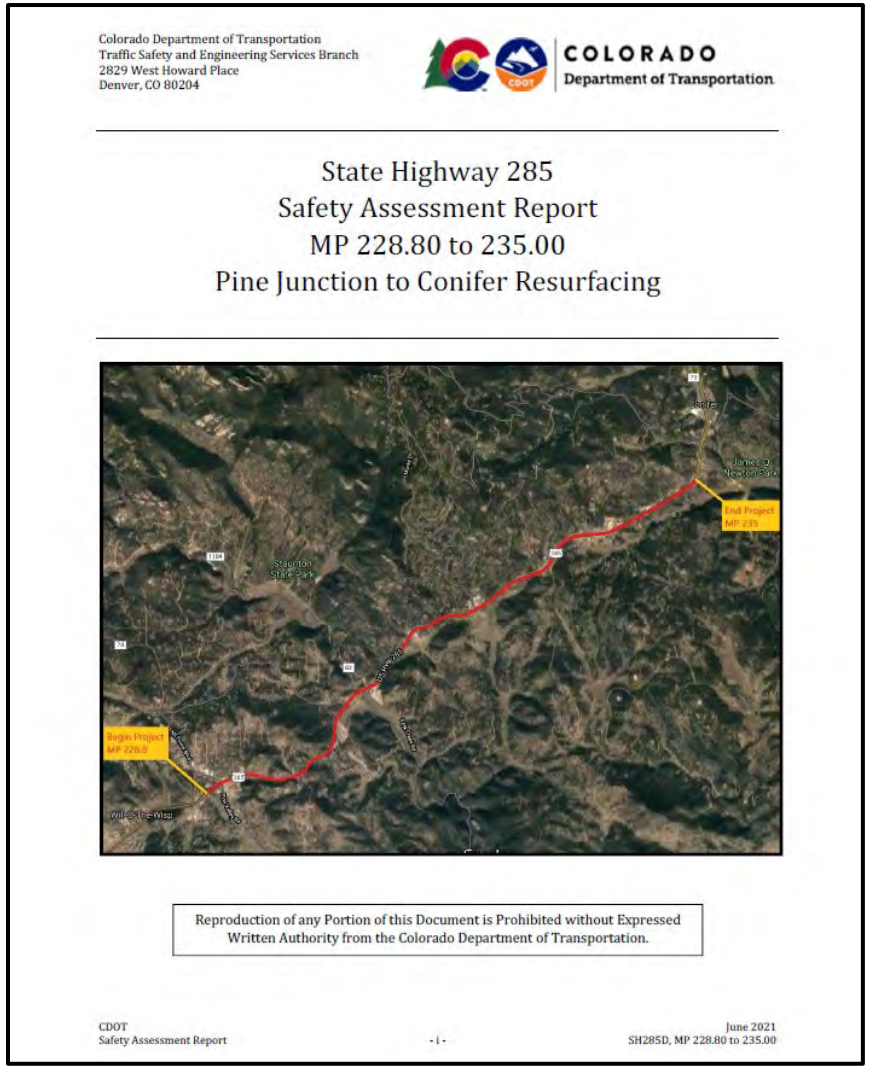

COLORADO
Department of Transportation

# Colorado DOT Network Screening with DiExSys: Vision Zero Suite (VZS) June 30th, 2021

# DiExSys: VZS Program

## Activities Supported:

- Crash Data Requests
- Crash Data Analysis
  - Level of Service of Safety (LOSS)
  - Crash Pattern Recognition and Diagnostics
- Safety Assessment Reports
- Network Screening
- Evaluation of HSIP projects
  - Meets Criteria
  - Benefit Cost Analysis
- Before and After Studies



Colorado Department of Transportation
Traffic Safety and Engineering Services Branch
2829 West Howard Place
Denver, CO 80204

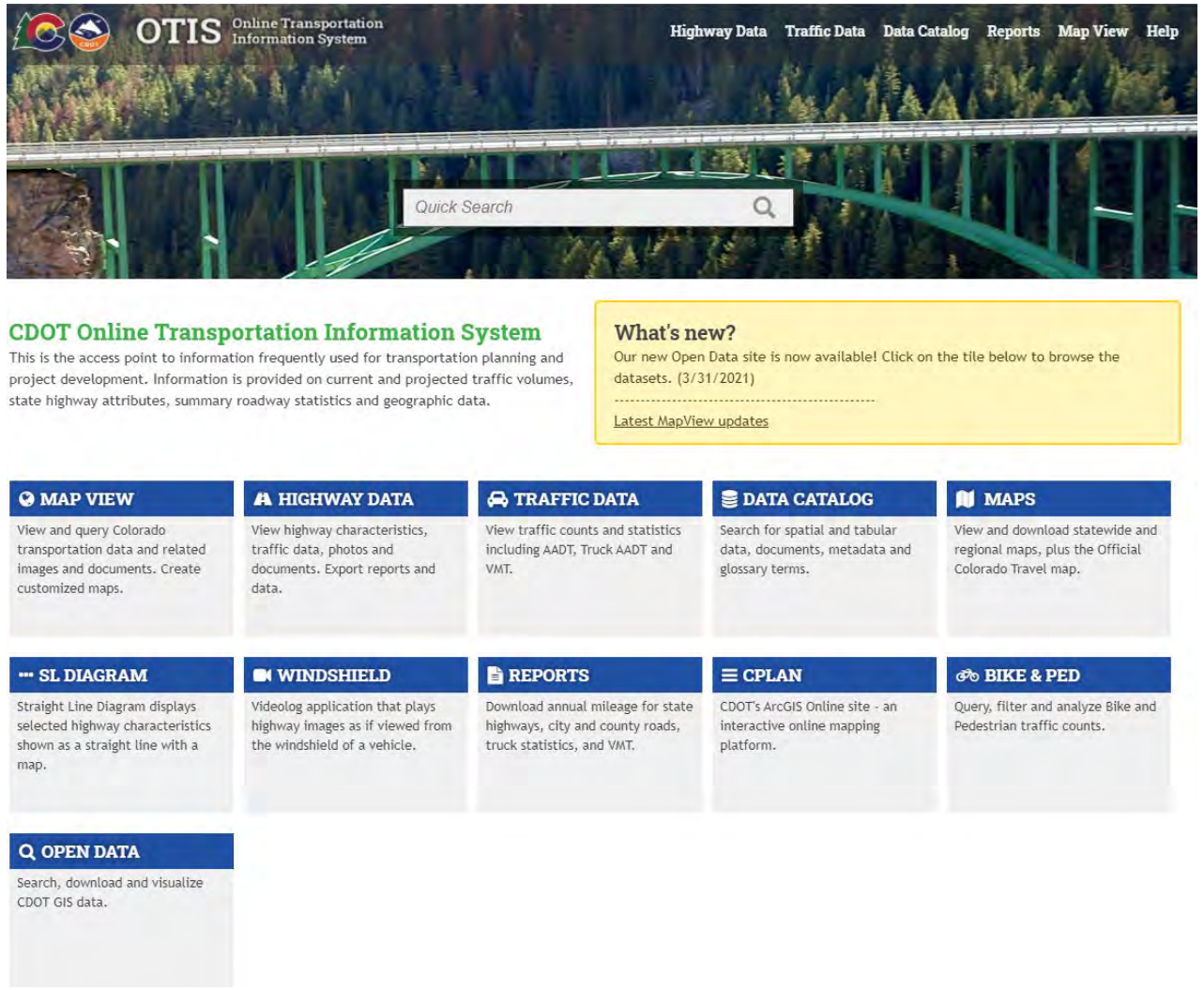
COLORADO
Department of Transportation

State Highway 285
Safety Assessment Report
MP 228.80 to 235.00
Pine Junction to Conifer Resurfacing

# DiExSys: VZS Program

## Data Inputs and Integration:

- Crash Data
- Roadway Data
  - Linear Referencing System
- Safety Performance Functions (SPF)
- Diagnostic Norms
- Crash Reduction Factors
- Crash Costs by Severity

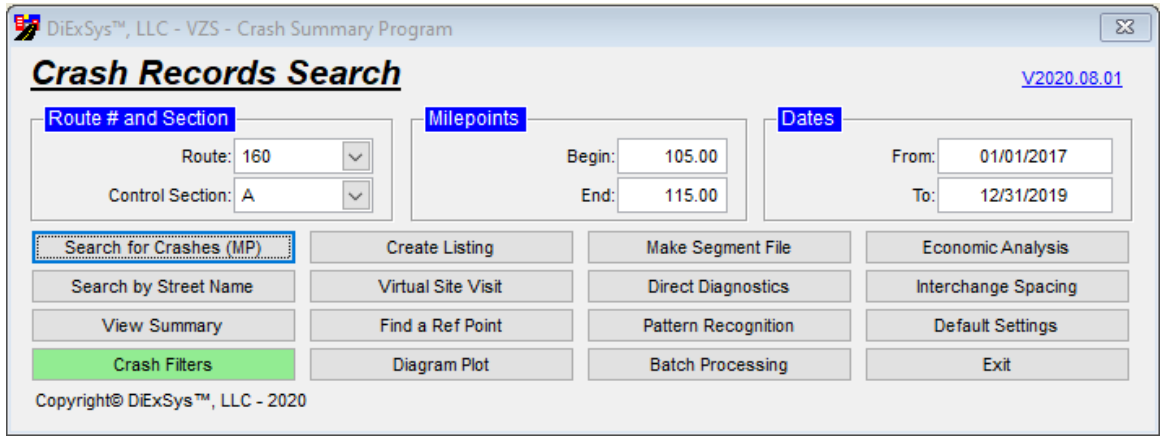


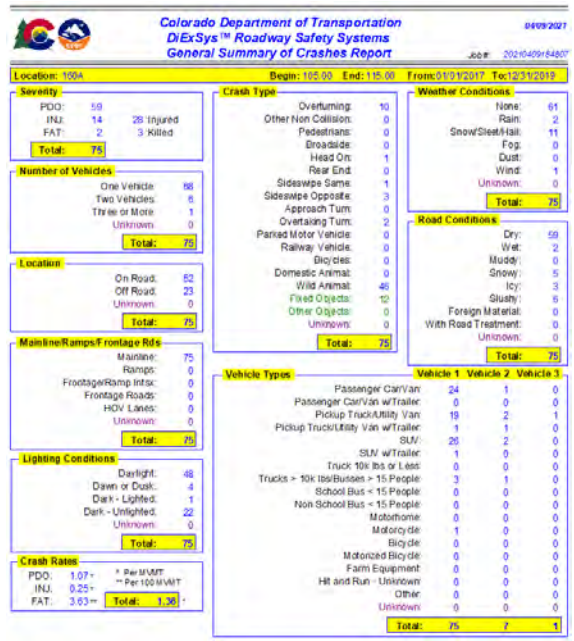
# DiExSys: VZS Program

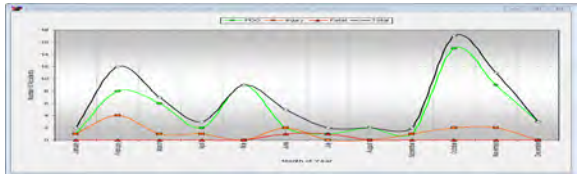
## Crash Query Program Features:

- Search by Linear Referencing System (LRS, Highway/Milepoint)
- Search by crash data location fields (Off System Locations)
- Summaries/Listings
- Graphs/Charts
- Economic Analysis (Benefit Cost)
- Crash Mitigation/Reduction Factors

All customized to agencies crash and roadway data



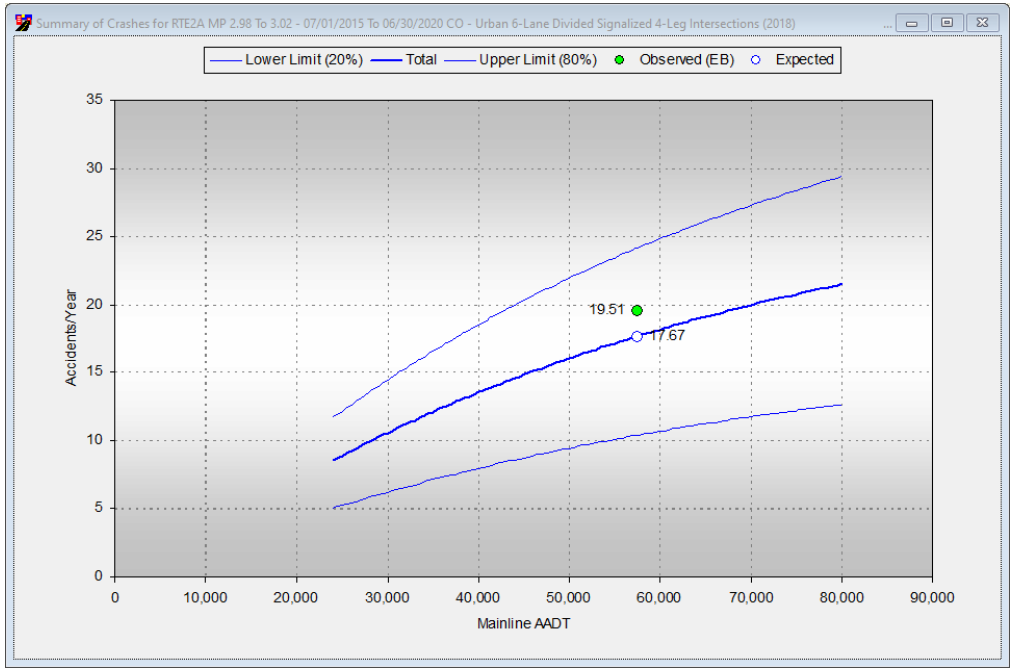



# DiExSys: VZS Program

## Safety Analysis Features:

- SPF Analysis
- Empirical Bayes Corrected
- Diagnostics Norms
- Crash Pattern Analysis




*Colorado Department of Transportation*
*DiExSys™ Roadway Safety Systems*
*Direct Diagnostics (Spot Location) Analysis*

*04/09/2021*

*Job #: 20210409174848*

**Location File:** DIRECT_DIAGNOSTICS_FOR_RTE2A_00298_00302 **Cutoff:** 5 Acc's @ 95%

**Baseline Statistics**

| | Statewide Average | | This Location | | Probability |
|---|---|---|---|---|---|
| CATEGORY | # Crashes | % | # Crashes | % | % |
| Property Damage Only (PDO) | 2,920 | 75.24% | 69 | 70.41% | 16.07% |
| Injury (INJ) | 957 | 24.66% | 29 | 29.59% | 89.27% |
| Fatal (FAT) | 4 | 0.10% | 0 | 0.00% | N/A |
| Persons Injured | 1,356 | | 33 | | |
| Persons Killed | 4 | | 0 | | N/A |
| Single Vehicle Accidents | 154 | 3.97% | 4 | 4.08% | 65.10% |
| Two Vehicle Accidents | 3,257 | 83.92% | 85 | 86.73% | 81.33% |
| Three or More Vehicle Accidents | 470 | 12.11% | 9 | 9.18% | 23.74% |
| Unknown Number of Vehicles | 0 | 0.00% | 0 | 0.00% | N/A |
| On Road | 3,736 | 96.26% | 94 | 95.92% | 50.04% |
| Off Road | 145 | 3.74% | 4 | 4.08% | 69.59% |
| Off Road Left | 67 | 1.73% | 3 | 3.06% | 90.97% |
| Off Road Right | 71 | 1.83% | 1 | 1.02% | 46.28% |
| Off Road at Tee | 4 | 0.10% | 0 | 0.00% | N/A |
| Off Road in Median | 3 | 0.08% | 0 | 0.00% | N/A |
| Unknown Road Location | 0 | 0.00% | 0 | 0.00% | N/A |
| Overturning | 26 | 0.67% | 0 | 0.00% | N/A |
| Other Non Collision | 5 | 0.13% | 0 | 0.00% | N/A |
| Vehicle Cargo or Debris | 5 | 0.13% | 0 | 0.00% | N/A |
| Pedestrian | 51 | 1.31% | 11 | 11.22% | **100.00%** |
| Broadside | 406 | 10.46% | 16 | 16.33% | **97.46%** |
| Head On | 10 | 0.26% | 0 | 0.00% | N/A |
| Rear End | 2,229 | 57.43% | 33 | 33.67% | 0.00% |
| Sideswipe (Same Direction) | 338 | 8.71% | 10 | 10.20% | 76.71% |
| Sideswipe (Opposite Direction) | 10 | 0.26% | 0 | 0.00% | N/A |
| Approach Turn | 613 | 15.79% | 19 | 19.39% | 86.62% |
| Overtaking Turn | 12 | 0.31% | 1 | 1.02% | 96.26% |
| Parked Motor Vehicle | 3 | 0.08% | 1 | 1.02% | 99.73% |
| Railway Vehicle | 0 | 0.00% | 0 | 0.00% | N/A |
| Bicycle or Pedal Cycle | 34 | 0.88% | 3 | 3.06% | 98.89% |

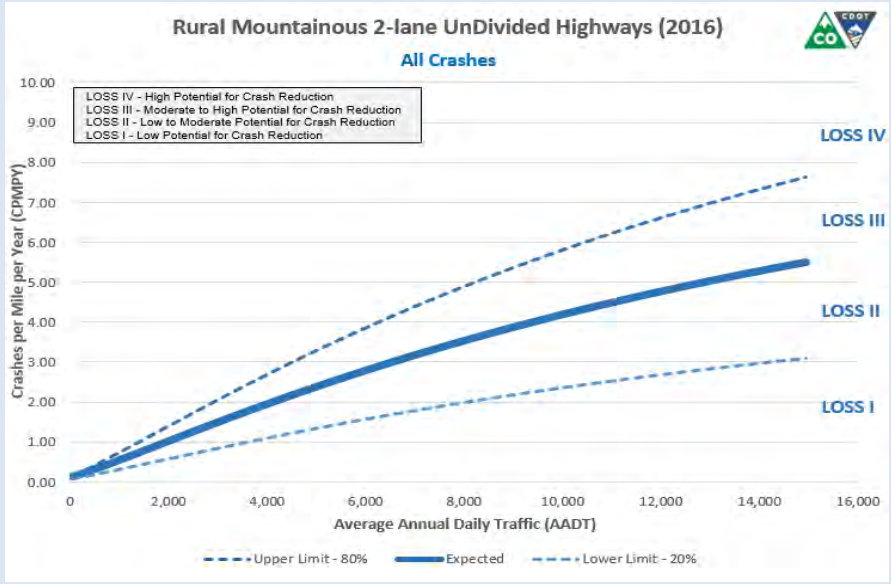
# Safety Performance Functions (SPF)

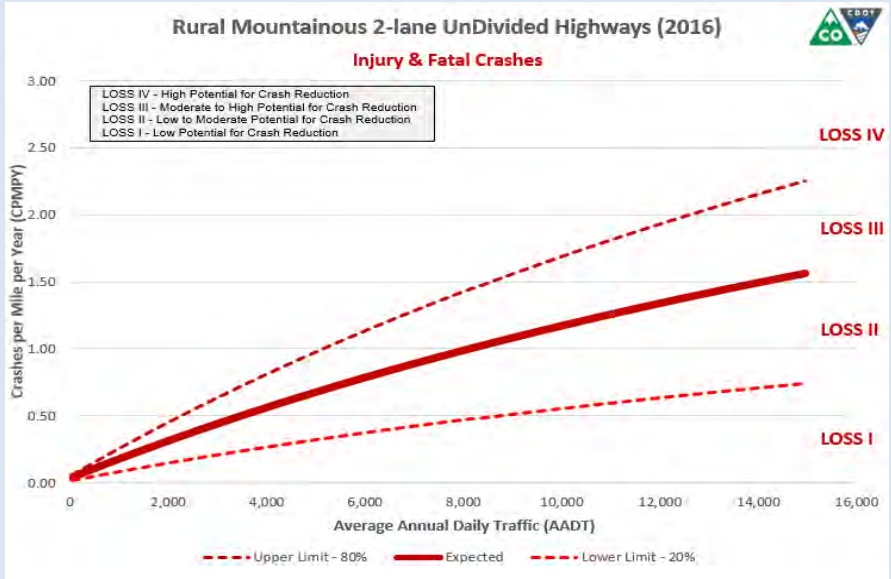
Colorado Specific SPFs created from Colorado Crash Data (5 to 10 years) by facility type (urban/rural terrain, lanes, highway/freeway)

12 segments types
20 intersection types
5 interchange ramp intersections

Each type has an SPF for total crashes (KABCO) and an SPF for injury and fatal crashes (KABC)

74 total models, more in development



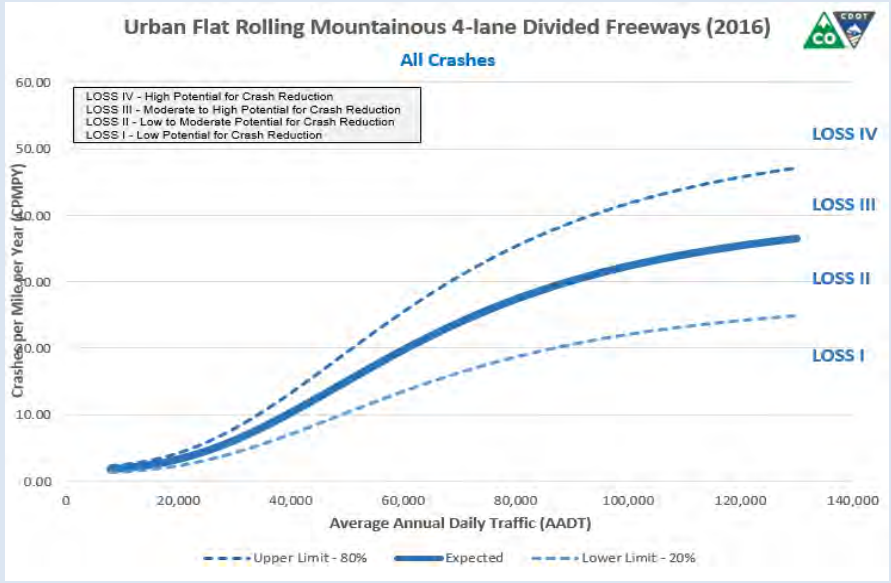
# Level of Service of Safety (LOSS)

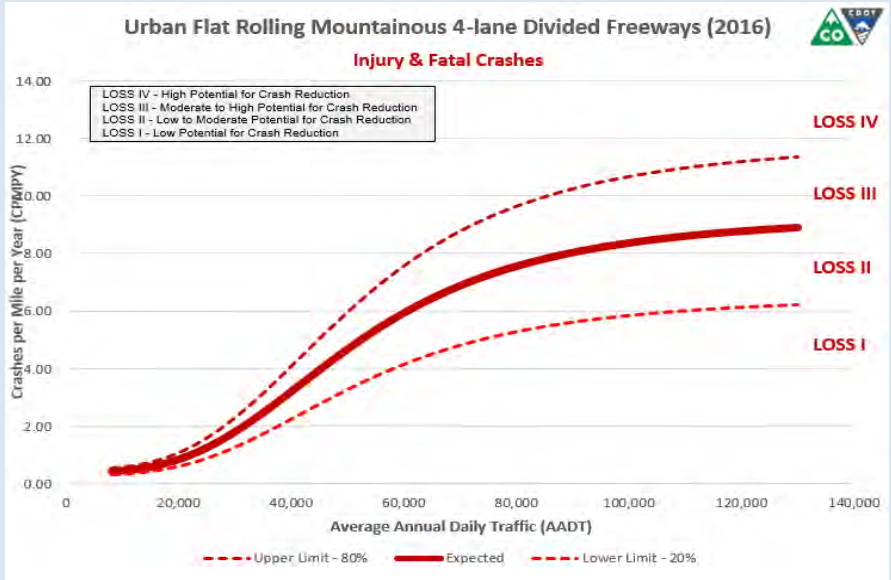
LOSS 1 – Low potential for crash reduction (Below 20th Percentile)

LOSS 2 – Low to moderate potential for crash reduction (20th Percentile to Mean/Expected)

LOSS 3 – Moderate to high potential for crash reduction (Mean/Expected to 80th Percentile)

LOSS 4 – High potential for crash reduction (Above 80th Percentile)

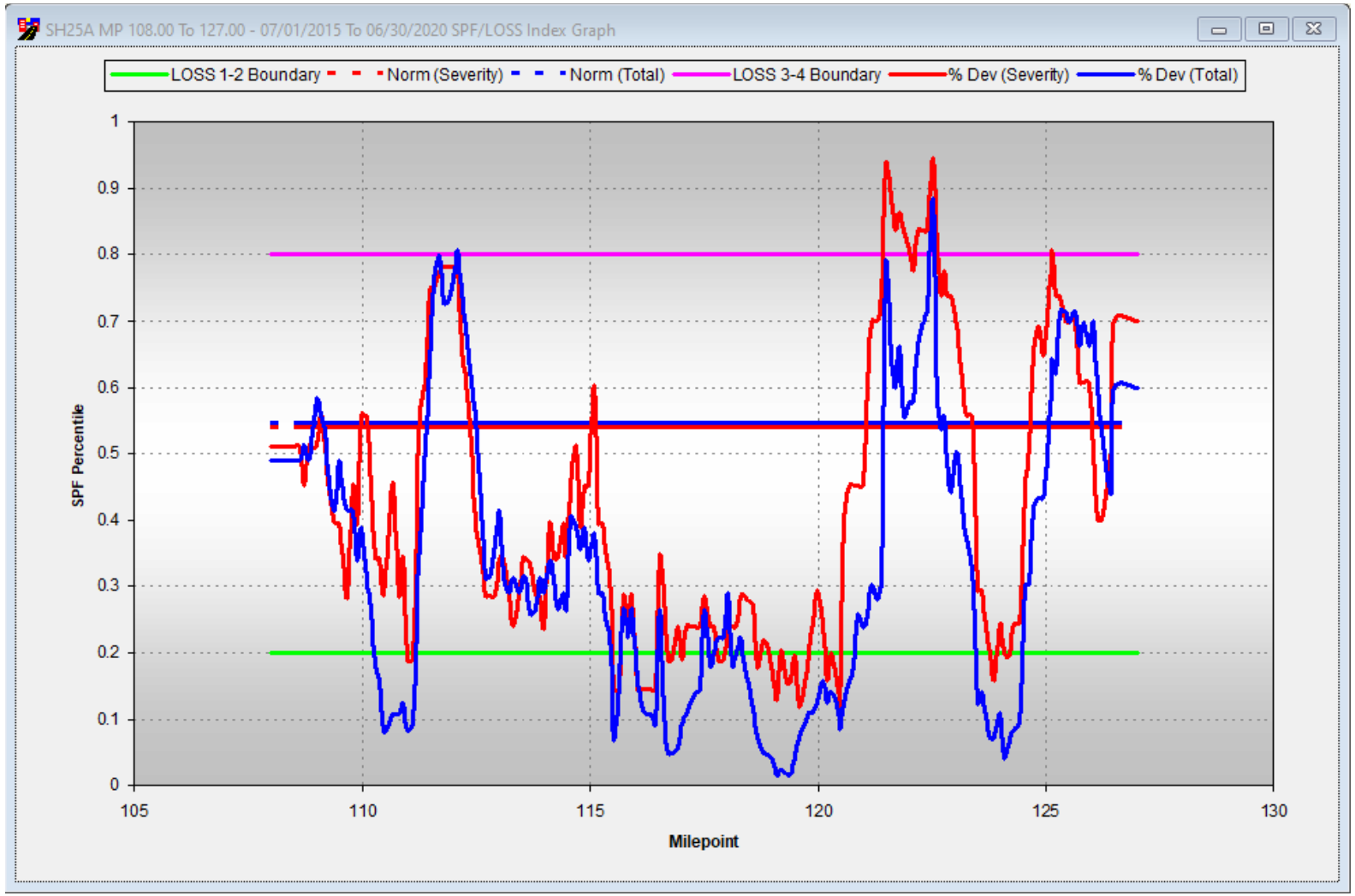


# DiExSys: VZS Program

**Safety Analysis Features Supporting Network Screening:**

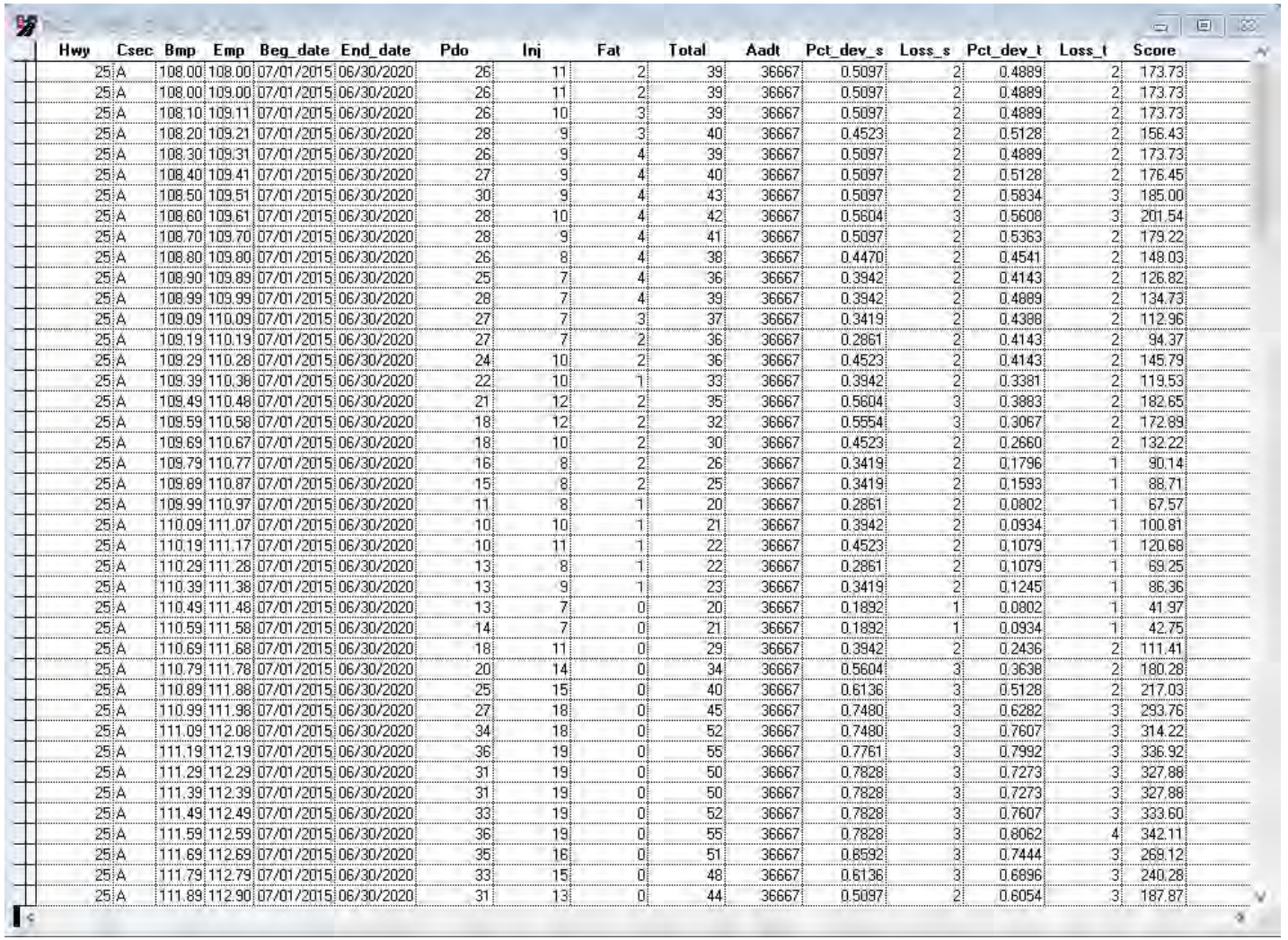
- SPF/LOSS for Freeway/Highway Corridors
- Crash Pattern Analysis for Freeway/Highway Corridors



# DiExSys: VZS Program

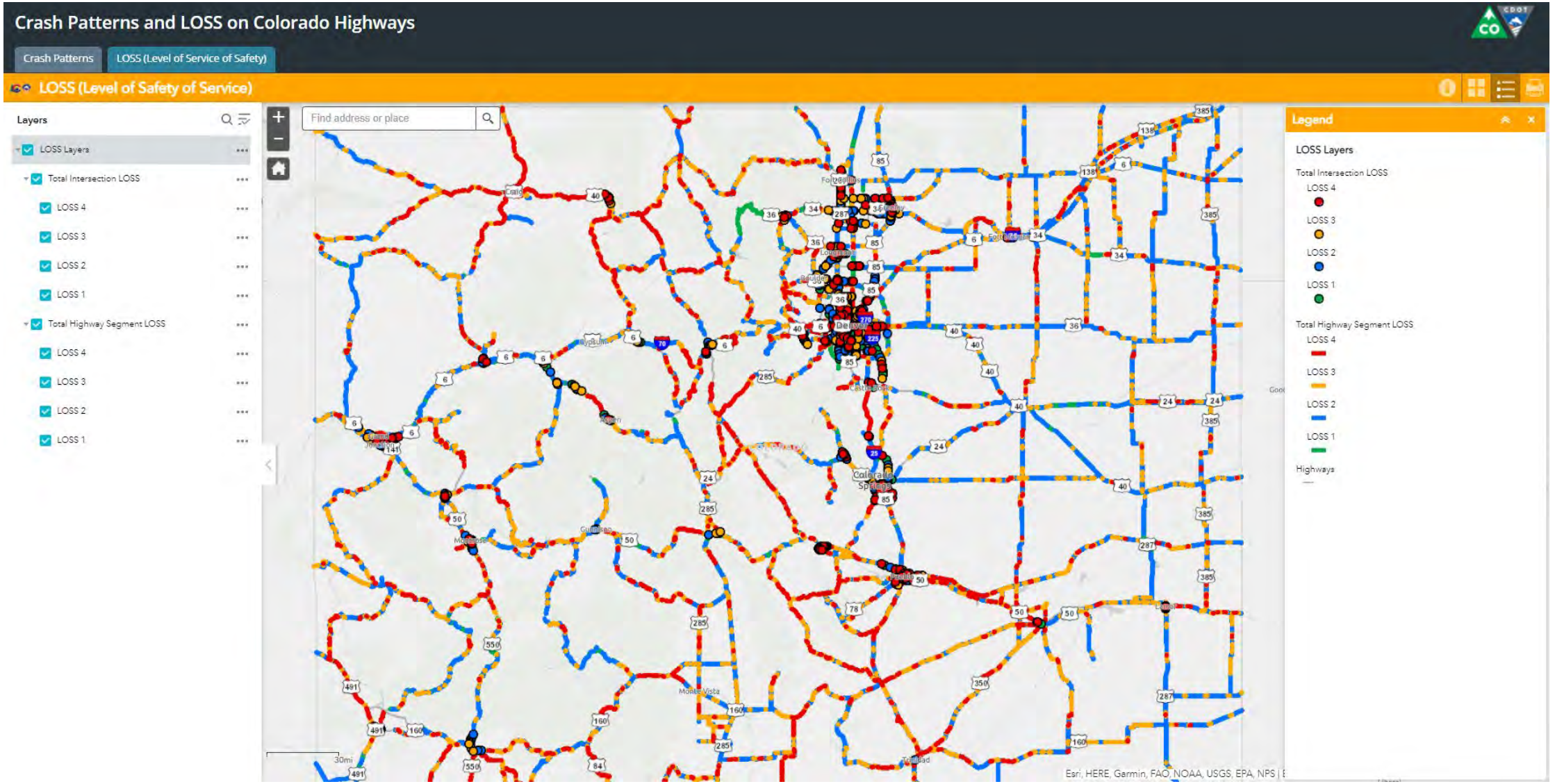
**Safety Analysis Features Supporting Network Screening:**

- SPF/LOSS for Freeway/Highway Corridors
- Crash Pattern Analysis for Freeway/Highway Corridors
- Create Batch Files

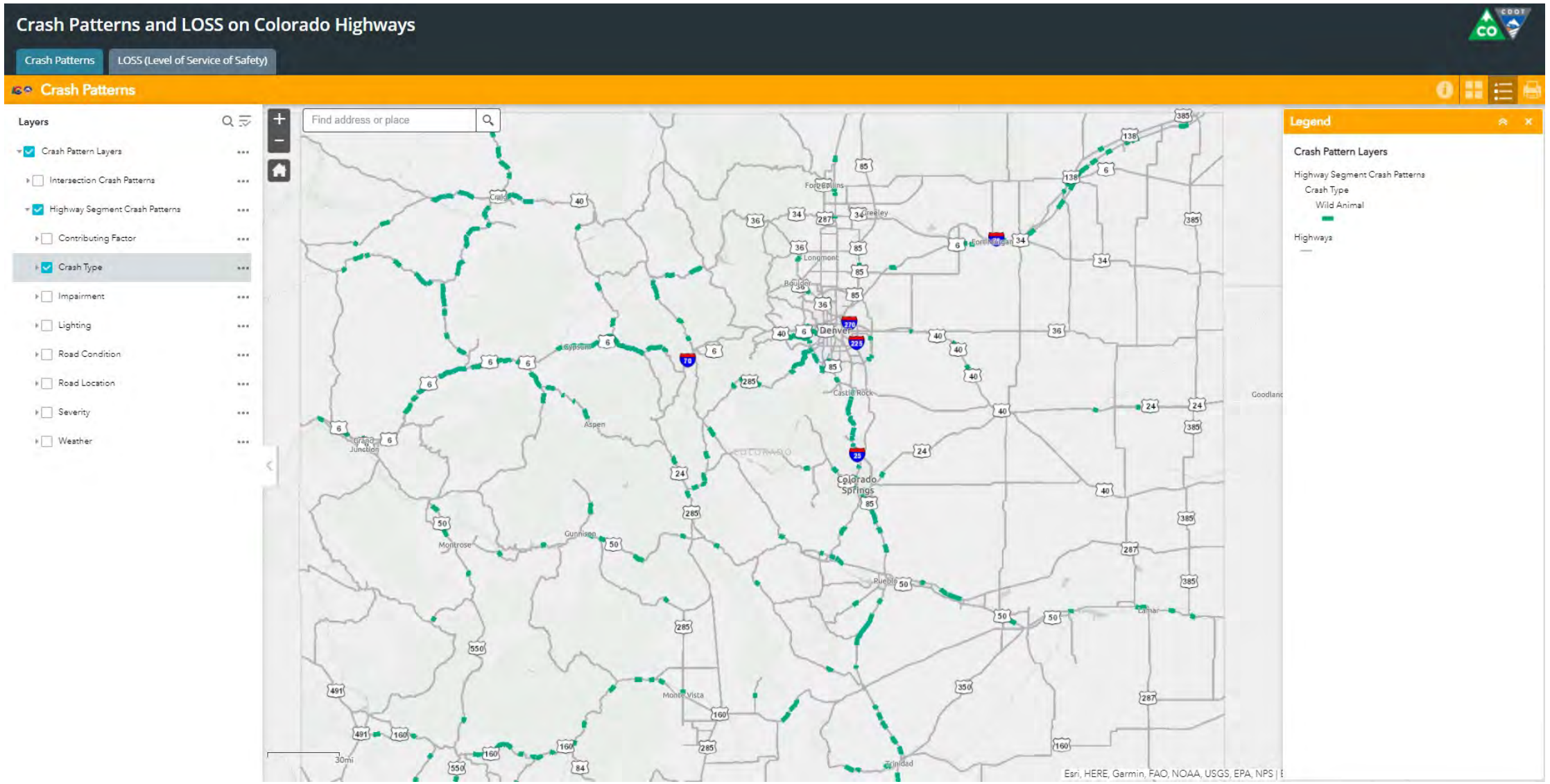


| Hwy | Csec | Bmp | Emp | Beg_date | End_date | Pdo | Inj | Fat | Total | Aadt | Pct_dev_s | Loss_s | Pct_dev_t | Loss_t | Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | A | 108.00 | 108.00 | 07/01/2015 | 06/30/2020 | 26 | 11 | 2 | 39 | 36667 | 0.5097 | 2 | 0.4889 | 2 | 173.73 |
| 25 | A | 108.00 | 109.00 | 07/01/2015 | 06/30/2020 | 26 | 11 | 2 | 39 | 36667 | 0.5097 | 2 | 0.4889 | 2 | 173.73 |
| 25 | A | 108.10 | 109.11 | 07/01/2015 | 06/30/2020 | 26 | 10 | 3 | 39 | 36667 | 0.5097 | 2 | 0.4889 | 2 | 173.73 |
| 25 | A | 108.20 | 109.21 | 07/01/2015 | 06/30/2020 | 28 | 9 | 3 | 40 | 36667 | 0.4523 | 2 | 0.5128 | 2 | 156.43 |
| 25 | A | 108.30 | 109.31 | 07/01/2015 | 06/30/2020 | 26 | 9 | 4 | 39 | 36667 | 0.5097 | 2 | 0.4889 | 2 | 173.73 |
| 25 | A | 108.40 | 109.41 | 07/01/2015 | 06/30/2020 | 27 | 9 | 4 | 40 | 36667 | 0.5097 | 2 | 0.5128 | 2 | 176.45 |
| 25 | A | 108.50 | 109.51 | 07/01/2015 | 06/30/2020 | 30 | 9 | 4 | 43 | 36667 | 0.5097 | 2 | 0.5834 | 3 | 185.00 |
| 25 | A | 108.60 | 109.61 | 07/01/2015 | 06/30/2020 | 28 | 10 | 4 | 42 | 36667 | 0.5604 | 3 | 0.5608 | 3 | 201.54 |
| 25 | A | 108.70 | 109.70 | 07/01/2015 | 06/30/2020 | 28 | 9 | 4 | 41 | 36667 | 0.5097 | 2 | 0.5363 | 2 | 179.22 |
| 25 | A | 108.80 | 109.80 | 07/01/2015 | 06/30/2020 | 26 | 8 | 4 | 38 | 36667 | 0.4470 | 2 | 0.4541 | 2 | 148.03 |
| 25 | A | 108.90 | 109.89 | 07/01/2015 | 06/30/2020 | 25 | 7 | 4 | 36 | 36667 | 0.3942 | 2 | 0.4143 | 2 | 126.82 |
| 25 | A | 108.99 | 109.99 | 07/01/2015 | 06/30/2020 | 28 | 7 | 4 | 39 | 36667 | 0.3942 | 2 | 0.4889 | 2 | 134.73 |
| 25 | A | 109.09 | 110.09 | 07/01/2015 | 06/30/2020 | 27 | 7 | 3 | 37 | 36667 | 0.3419 | 2 | 0.4388 | 2 | 112.96 |
| 25 | A | 109.19 | 110.19 | 07/01/2015 | 06/30/2020 | 27 | 7 | 2 | 36 | 36667 | 0.2861 | 2 | 0.4143 | 2 | 94.37 |
| 25 | A | 109.29 | 110.28 | 07/01/2015 | 06/30/2020 | 24 | 10 | 2 | 36 | 36667 | 0.4523 | 2 | 0.4143 | 2 | 145.79 |
| 25 | A | 109.39 | 110.38 | 07/01/2015 | 06/30/2020 | 22 | 10 | 1 | 33 | 36667 | 0.3942 | 2 | 0.3381 | 2 | 119.53 |
| 25 | A | 109.49 | 110.48 | 07/01/2015 | 06/30/2020 | 21 | 12 | 2 | 35 | 36667 | 0.5604 | 3 | 0.3883 | 2 | 182.65 |
| 25 | A | 109.59 | 110.58 | 07/01/2015 | 06/30/2020 | 18 | 12 | 2 | 32 | 36667 | 0.5554 | 3 | 0.3067 | 2 | 172.89 |
| 25 | A | 109.69 | 110.67 | 07/01/2015 | 06/30/2020 | 18 | 10 | 2 | 30 | 36667 | 0.4523 | 2 | 0.2660 | 2 | 132.22 |
| 25 | A | 109.79 | 110.77 | 07/01/2015 | 06/30/2020 | 16 | 8 | 2 | 26 | 36667 | 0.3419 | 2 | 0.1796 | 1 | 90.14 |
| 25 | A | 109.89 | 110.87 | 07/01/2015 | 06/30/2020 | 15 | 8 | 2 | 25 | 36667 | 0.3419 | 2 | 0.1593 | 1 | 88.71 |
| 25 | A | 109.99 | 110.97 | 07/01/2015 | 06/30/2020 | 11 | 8 | 1 | 20 | 36667 | 0.2861 | 2 | 0.0802 | 1 | 67.57 |
| 25 | A | 110.09 | 111.07 | 07/01/2015 | 06/30/2020 | 10 | 10 | 1 | 21 | 36667 | 0.3942 | 2 | 0.0934 | 1 | 100.81 |
| 25 | A | 110.19 | 111.17 | 07/01/2015 | 06/30/2020 | 10 | 11 | 1 | 22 | 36667 | 0.4523 | 2 | 0.1079 | 1 | 120.68 |
| 25 | A | 110.29 | 111.28 | 07/01/2015 | 06/30/2020 | 13 | 8 | 1 | 22 | 36667 | 0.2861 | 2 | 0.1079 | 1 | 69.25 |
| 25 | A | 110.39 | 111.38 | 07/01/2015 | 06/30/2020 | 13 | 9 | 1 | 23 | 36667 | 0.3419 | 2 | 0.1245 | 1 | 86.36 |
| 25 | A | 110.49 | 111.48 | 07/01/2015 | 06/30/2020 | 13 | 7 | 0 | 20 | 36667 | 0.1892 | 1 | 0.0802 | 1 | 41.97 |
| 25 | A | 110.59 | 111.58 | 07/01/2015 | 06/30/2020 | 14 | 7 | 0 | 21 | 36667 | 0.1892 | 1 | 0.0934 | 1 | 42.75 |
| 25 | A | 110.69 | 111.68 | 07/01/2015 | 06/30/2020 | 18 | 11 | 0 | 29 | 36667 | 0.3942 | 2 | 0.2436 | 2 | 111.41 |
| 25 | A | 110.79 | 111.78 | 07/01/2015 | 06/30/2020 | 20 | 14 | 0 | 34 | 36667 | 0.5604 | 3 | 0.3638 | 2 | 180.28 |
| 25 | A | 110.89 | 111.88 | 07/01/2015 | 06/30/2020 | 25 | 15 | 0 | 40 | 36667 | 0.6136 | 3 | 0.5128 | 2 | 217.03 |
| 25 | A | 110.99 | 111.98 | 07/01/2015 | 06/30/2020 | 27 | 18 | 0 | 45 | 36667 | 0.7480 | 3 | 0.6282 | 3 | 293.76 |
| 25 | A | 111.09 | 112.08 | 07/01/2015 | 06/30/2020 | 34 | 18 | 0 | 52 | 36667 | 0.7480 | 3 | 0.7607 | 3 | 314.22 |
| 25 | A | 111.19 | 112.19 | 07/01/2015 | 06/30/2020 | 36 | 19 | 0 | 55 | 36667 | 0.7761 | 3 | 0.7992 | 3 | 336.92 |
| 25 | A | 111.29 | 112.29 | 07/01/2015 | 06/30/2020 | 31 | 19 | 0 | 50 | 36667 | 0.7828 | 3 | 0.7273 | 3 | 327.88 |
| 25 | A | 111.39 | 112.39 | 07/01/2015 | 06/30/2020 | 31 | 19 | 0 | 50 | 36667 | 0.7828 | 3 | 0.7273 | 3 | 327.88 |
| 25 | A | 111.49 | 112.49 | 07/01/2015 | 06/30/2020 | 33 | 19 | 0 | 52 | 36667 | 0.7828 | 3 | 0.7607 | 3 | 333.60 |
| 25 | A | 111.59 | 112.59 | 07/01/2015 | 06/30/2020 | 36 | 19 | 0 | 55 | 36667 | 0.7828 | 3 | 0.8062 | 4 | 342.11 |
| 25 | A | 111.69 | 112.69 | 07/01/2015 | 06/30/2020 | 35 | 16 | 0 | 51 | 36667 | 0.8592 | 3 | 0.7444 | 3 | 269.12 |
| 25 | A | 111.79 | 112.79 | 07/01/2015 | 06/30/2020 | 33 | 15 | 0 | 48 | 36667 | 0.6136 | 3 | 0.6896 | 3 | 240.28 |
| 25 | A | 111.89 | 112.90 | 07/01/2015 | 06/30/2020 | 31 | 13 | 0 | 44 | 36667 | 0.5097 | 2 | 0.6054 | 3 | 187.87 |

# Colorado Network Screening (LOSS)



# Colorado Network Screening (Crash Patterns)



# DiExSys: VZS Program Costs and Training

**Annual License (Colorado DOT):**

- $60,000/year
- Unlimited users within agency (100+ users @ CDOT)

**Maintenance and Training:**

- $25,000/year
- 2 Training Sessions per year

DiExSys stands for Diagnostic Expert Systems.

Source: https://roadsafetyanalytics.com

# Contact Information and Links

David Swenka, PE PTOE
Safety Programs and Analysis
Traffic Safety and Engineering Services
David.Swenka@state.co.us

https://www.codot.gov/safety/traffic-safety/programs-and-analysis
https://cdot.maps.arcgis.com/home/index.html

Thank you!

# CONNECTICUT ROADWAY SAFETY MANAGEMENT SYSTEM (CRSMS)

Presenter

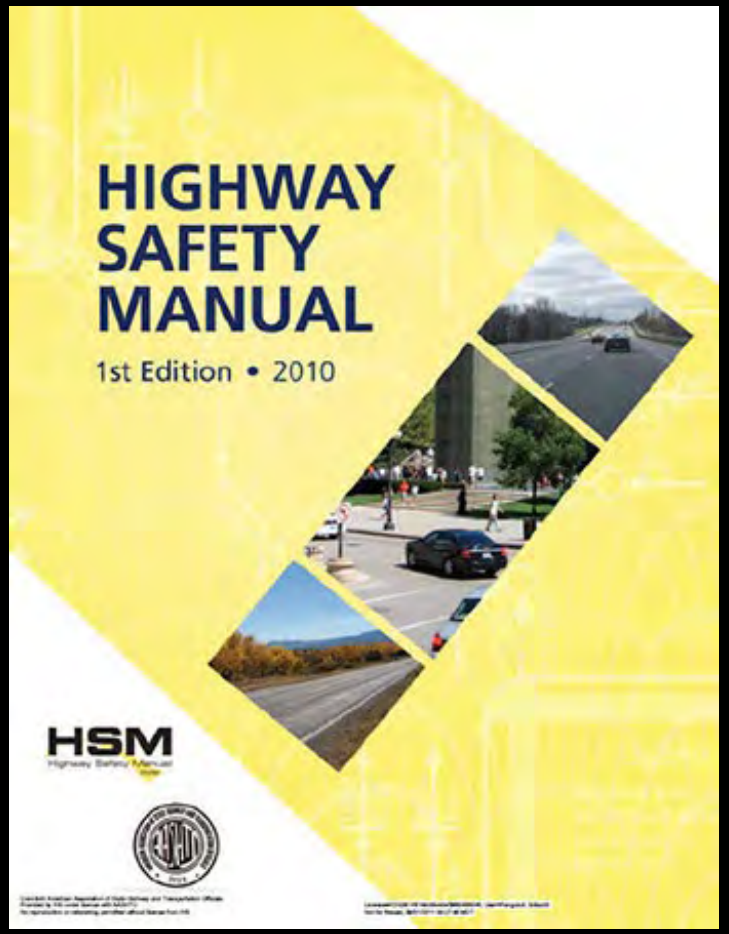
Shanshan Zhao, Ph.D., Research Scientist, Connecticut Transportation Institute, UCONN

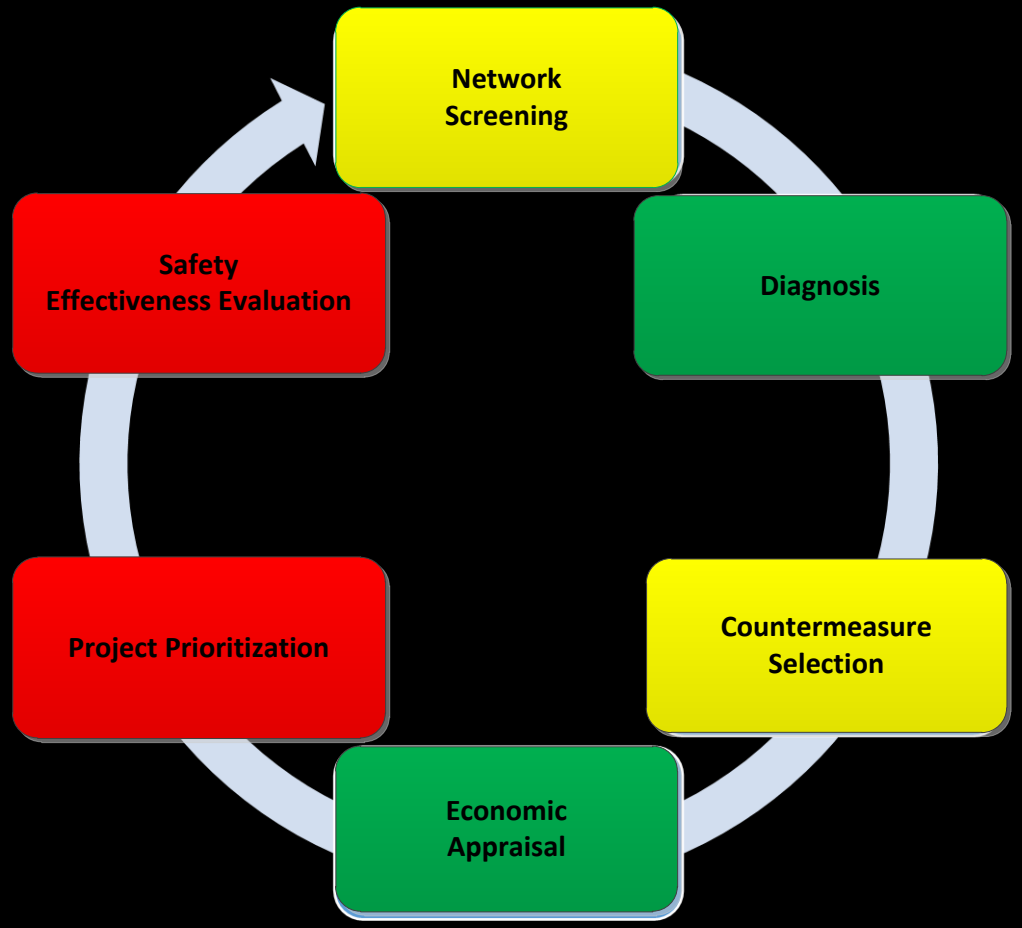
Eric Jackson, Ph.D., Director, Connecticut Transportation Institute, UCONN

# TOOL OVERVIEW

- Connecticut Roadway Safety Management System (CRSMS)
- Developed by CTSRC and VHB
- Web-based and easy access
- Full-implementation of the Highway Safety Manual with maps and visualizations
- Agency use since 2019

# OBJECTIVE


HIGHWAY
SAFETY
MANUAL
1st Edition • 2010
HSM


Network Screening
Diagnosis
Countermeasure Selection
Economic Appraisal
Project Prioritization
Safety Effectiveness Evaluation

# CHANGES TO DECISION MAKING

## BEFORE

- Hot spot list generated annually
- Critical-crash-rate-based measure
- Simple ranking method
- Manual crash query and diagnosis
- Lack documentation of project planning process
- Reactive project planning

## AFTER

- Network screening anytime by any geographical area
- Safety-performance-function-based measures
- Sliding window/peak searching method
- Automatic data query and various diagnosis tools
- Report of the entire project planning lifecycle within the tool
- Proactive project planning

# SNAPSHOT INFO

## Methodology

- State-specific SPFs by 44 facility types
- All public roads DEMO
  - state, local; segment, intersection, ramp
- Eight performance measures provided based on data availability DEMO
  - SPF/EB expected, LOSS, MOM, EPDO, CCR
- Three recommended screening methods DEMO
- Analysis, visualization and reporting

## Training

- On-demand, manual, self-paced video tutorial, forum

# SNAPSHOT INFO (CONT.)

## Cost & Setup Duration

- $10 million, 5-year project in CT with other deliverables
- Free of cost to COGS and local agencies in CT
- Setup with full analysis modules through this pooled fund for interested states https://www.pooledfund.org/Details/Solicitation/1550
- Commitment needed for each partner state
  - Phase I - $90,000 per state for year 1
  - Phase II - $110,000 per state for year 2 and 3; $70,000 per state for year 4 and 5

## Maintenance

- Data update frequency: mostly yearly
- Data update duration: days-weeks
- Documentation (user requirements, system development, Git)

# SNAPSHOT INFO (CONT.)

## Other Key Features

- Easier data manipulation with Data Management Module
- Screening by emphasis areas, crash type and severity DEMO
- Varied diagnosis tools including statistical tests, collision diagram, crash tree DEMO
- Integration of the latest CMF Clearinghouse data
- Reporting in MS Word and Excel DEMO
- Comparing benefits and costs of proposed projects
- Optimizing project plans within limited budgets
- Conducting EB before-after analysis for evaluating the effectiveness of projects

## Features In Progress

- Systemic analysis module
- Complete local intersections

# DEMO

NETWORK SCREENING

# DEMO

DIAGNOSIS

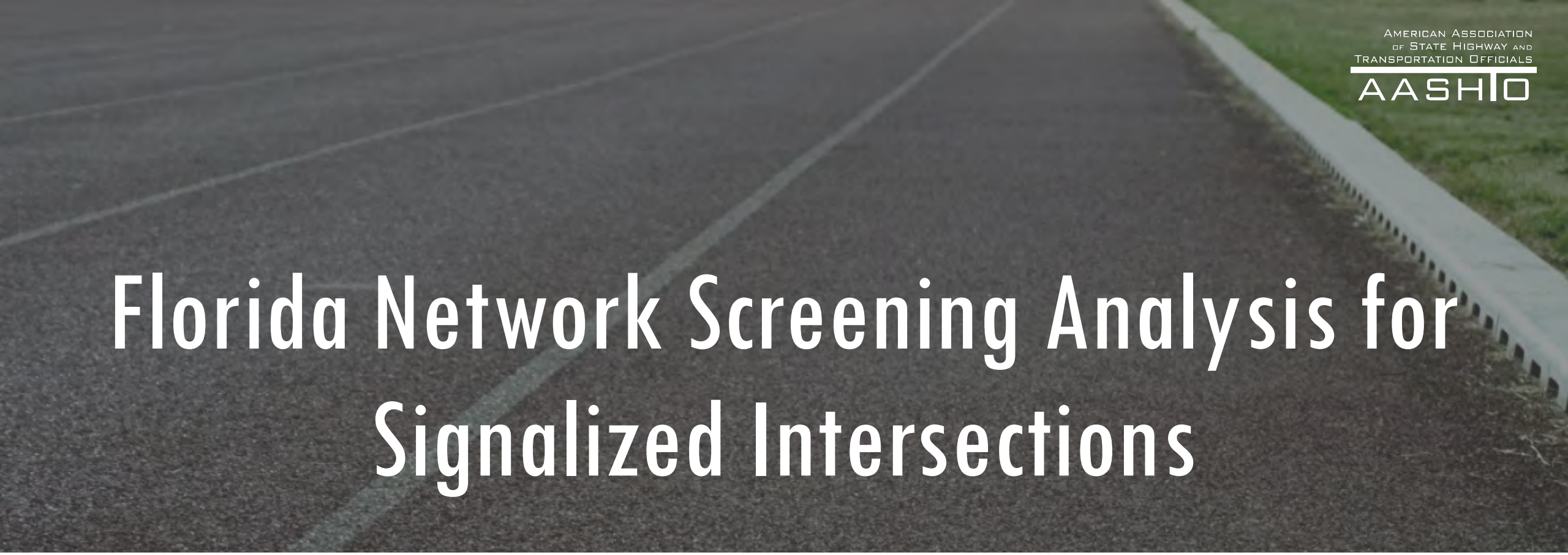
# THANK YOU!

**Contact**

Joseph Ouellette, State Safety Engineer, CTDOT joseph.ouellette@ct.gov

Eric Jackson, Ph.D., Director, UCONN, eric.d.jackson@uconn.edu

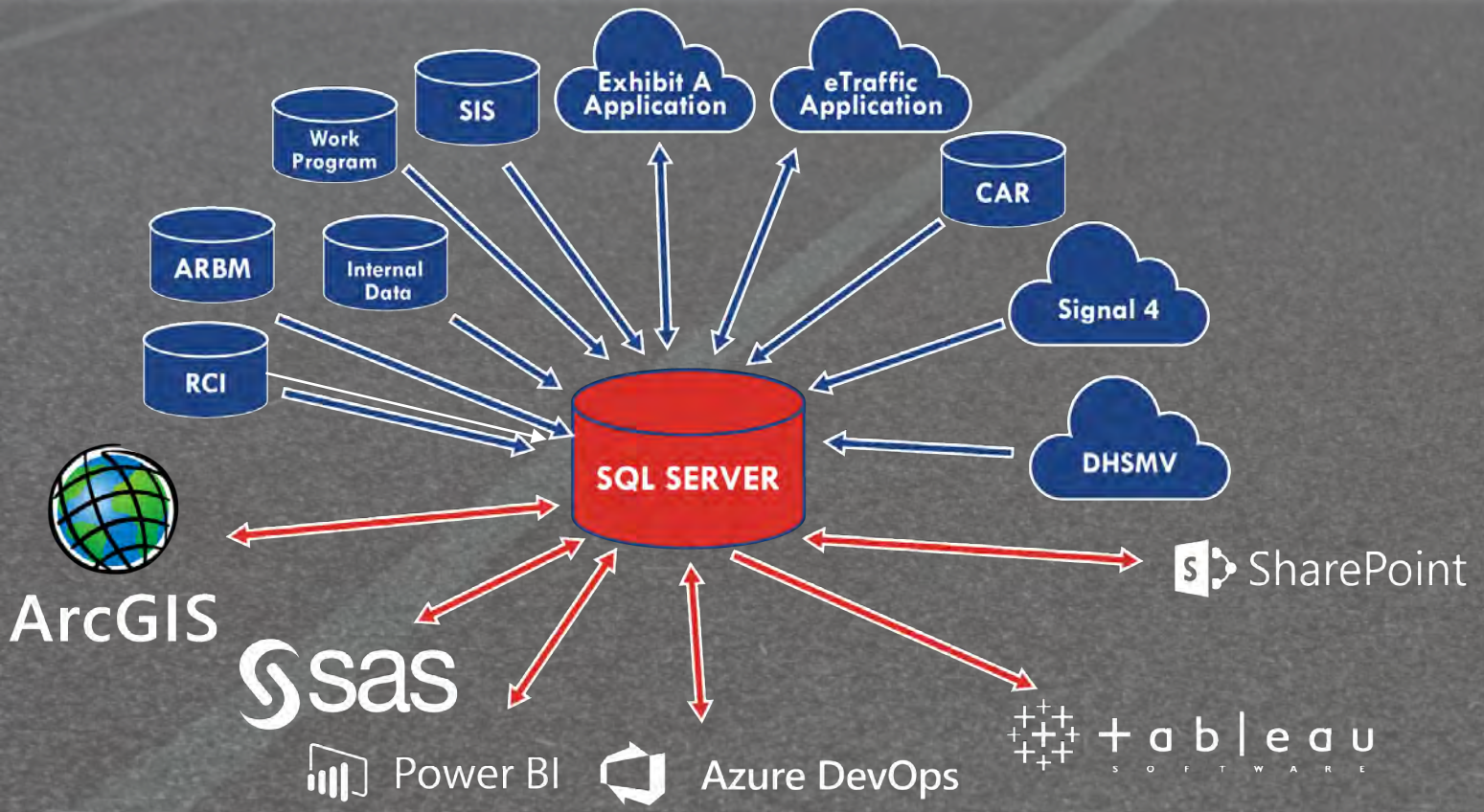
Shanshan Zhao, Ph.D., Research Scientist, UCONN, shanshan.h.zhao@uconn.edu



# Florida Network Screening Analysis for Signalized Intersections

Alan El-Urfali, P.E.
Javier Ponce, P.E.

# STRIDES 2 Zero Program Data Warehouse




**CARS**

- Crash Analysis Reporting System

**DHSMV**

- Department of Highway Safety and Motor Vehicles

**Signal 4**

- Signal Four Analytics Crash Database

**RCI**

- Roadway Characteristics Inventory

**ARBM**

- All Roadway Base Map

**SIS**

- Strategic Intermodal System

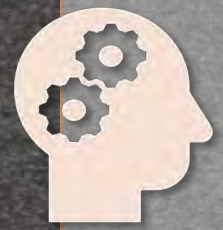
# SAFE STRIDES 2 Zero Program

American Association of State Highway and Transportation Officials
AASHTO

- Address Florida Transportation Plan goals – efficient and reliable mobility of people and freight; safety of residents and visitors
- Leverage department data, roadway characteristics, and crash data to screen roadway sites for improving safety and mobility
- Use predictive analytics for business decisions on roadway and operational improvement projects
- Track and document the return on investment

**SAFE**

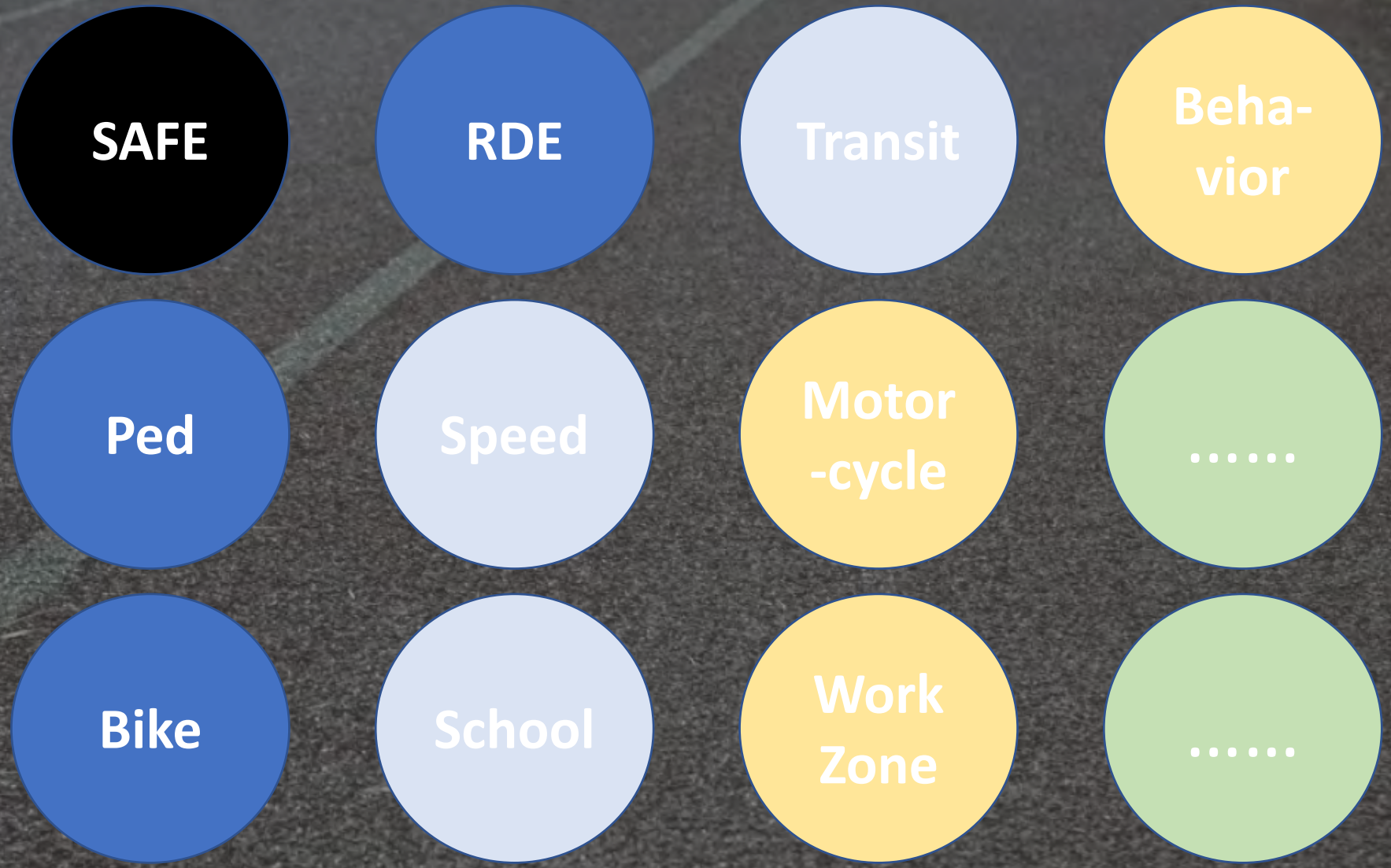
- System Analysis and Forecast Evaluation



**STRIDES 2 Zero**

- State Traffic Roadway and Intersection Data Evaluation System 2020

# STRIDES 2 Zero Programs



# SAFE Program

- SAFE: A subprogram under STRIDES 2 Zero
- Provide network screening tool to identify roadway sites for safety improvements
  - Follow strictly the network screening guidelines in HSM
  - Focus on state highway system
  - Phase I: Signalized intersections
  - Phase II: Roadway segments and unsignalized intersections
- Enhance highway network screening practices in Florida
  - Previous prioritization method: Hot-spot analysis
  - SAFE: Quantitative evaluation with Florida-specific crash predictive models and analytical tools

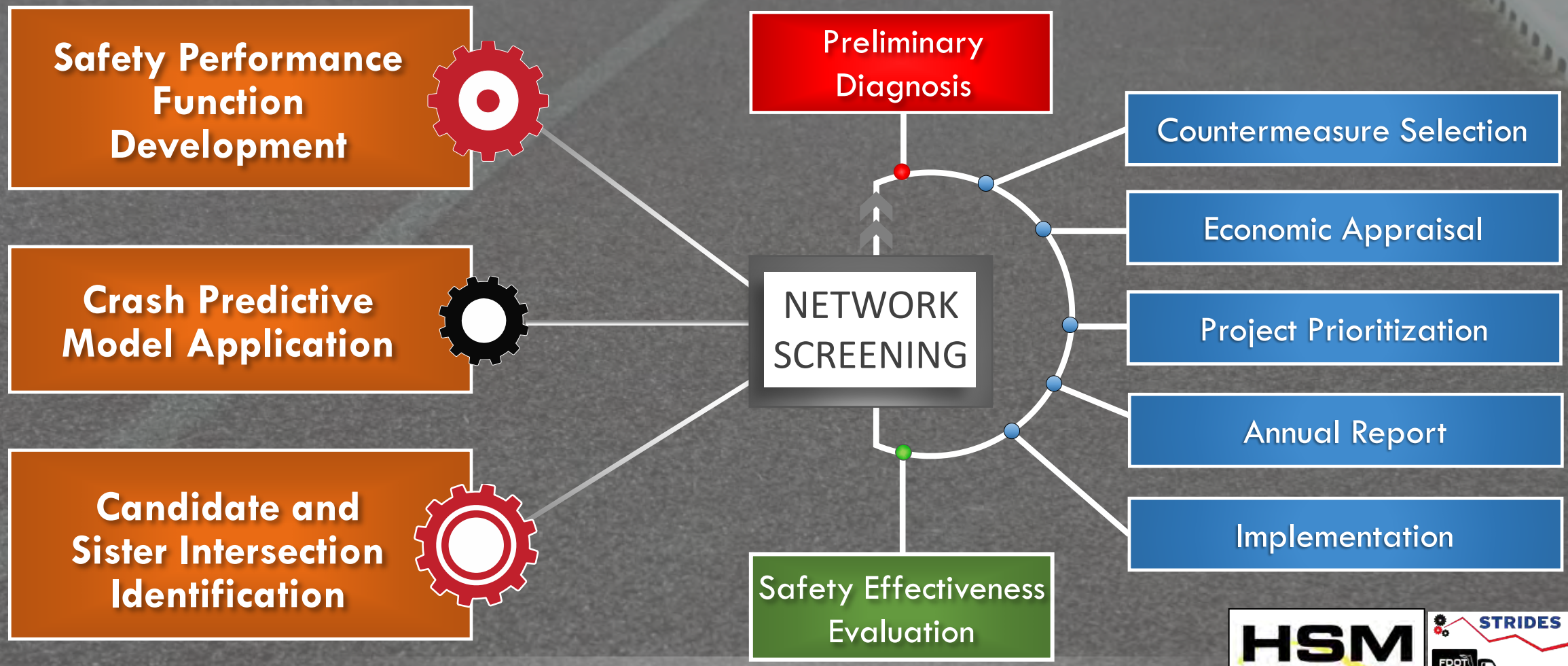
# FDOT Network Screening Tool (SAFE)

- FDOT homegrown tools to implement HSM Part B Roadway Safety Management Process
- SAS-based code and SAS tools (JMP Pro)
- ETL process for assembling roadway and crash data from multiple data sets
- SPFs calculated with SAS code automatically
- Network screening utilizing excess expected average crash frequency with EB adjustment (most reliable)

Note: ETL is for Extract, Transform, and Load

# SAFE Methodology

## FDOT Highway Safety Management Process




American Association of State Highway and Transportation Officials
AASHTO

HSM Highway Safety Manual

STRIDES 2 Zero
(SAFE) System Analysis & Forecast Evaluation

# Safety Performance Function Development

- Florida jurisdiction-specific safety performance functions (SPF) for intersection network screening analysis
  - Calculated annually and used for network screening analysis
  - No SPF calibration required
- Procedures for SPF development
  - Determine intersection groups
  - Collect intersection geometric and crash data
  - SPF regression analysis
  - SPF model verification

# FDOT Context Classification

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- Describe the general characteristics of the land use, development patterns, and roadway connectivity along a roadway
- Provide cues as to the types of uses and user groups that will likely utilize the roadway
- Replace the “urban”, “suburban” and “rural” classification used in previous crash predictive models

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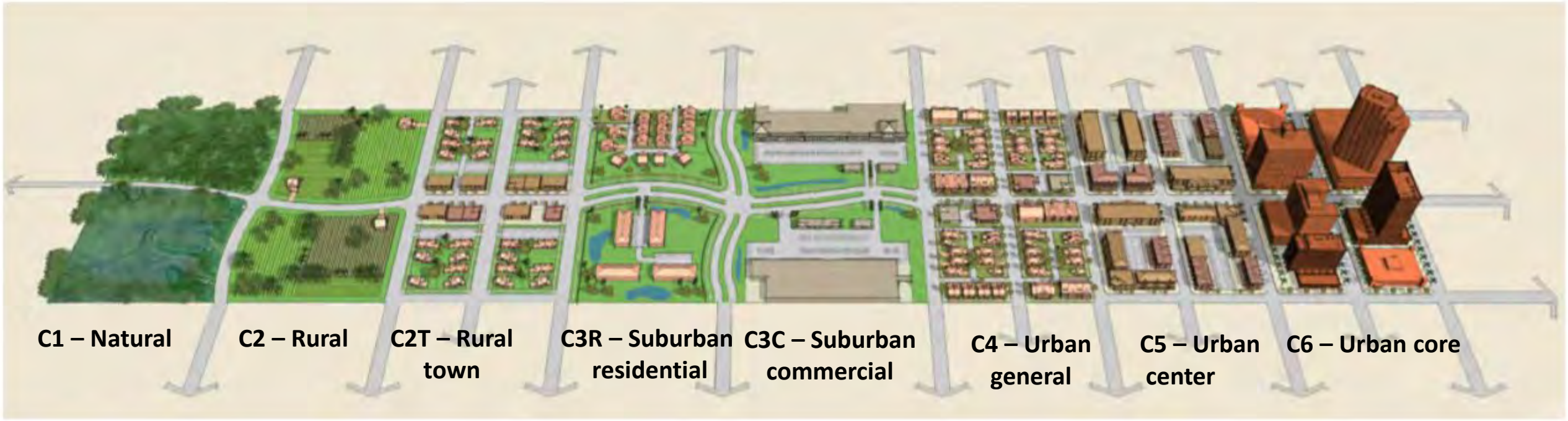


# Intersection Classification

- Criteria for intersection classification
  - Context classification
    - C1 to C6 based on land use category
  - Intersection traffic control mode
    - Signalized intersections only
  - Number of legs
    - 3-leg and 4-leg intersection

**Intersection Groups for SPF Development**

| Number of Legs | Context Classification |
|---|---|
| 3-leg | C1/C2/C2T/C3R/C3C |
| | C4/C5/C6 |
| 4-leg | C1/C2/C2T |
| | C3C |
| | C3R |
| | C4 |
| | C5/C6 |

# Intersection and Crash Data Collection

- Intersection geometric and traffic control data
  - FDOT Traffic Signal Maintenance and Compensation Agreement (TSMCA) Exhibit A
  - FDOT intersection database
  - FDOT Roadway Characteristics Inventory (RCI) database
- Intersection crash data
  - 2017-2019 crash data from FDOT Crash Analysis Reporting System (CARS)
  - Only fatal (K) and serious injury (A) crashes
  - Crashes within 250 feet buffer from intersections as intersection crashes

# SPF Regression Analysis and Verification

- SPF regression analysis with SAS
  - Negative binomial distribution
- SPF verification
  - Goodness-of-fit evaluation with cumulative residual (CURE) plot

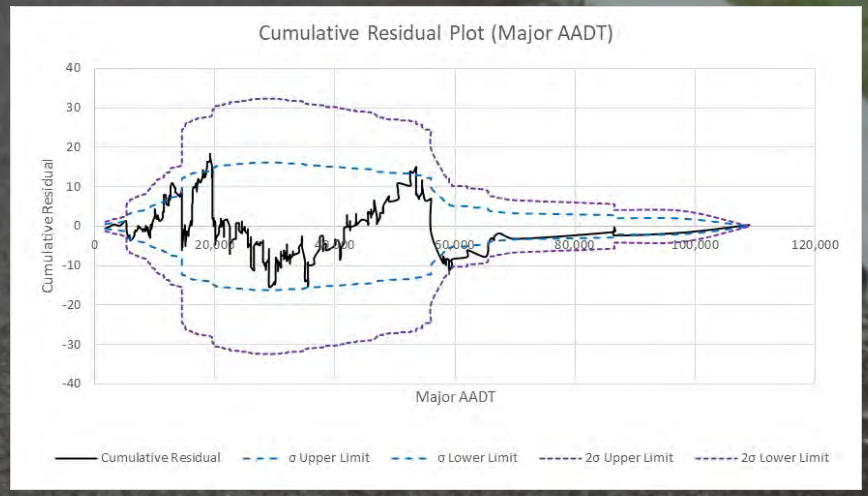
$$N_{predicted} = \exp(\alpha + \beta_1 \ln(AADT_{major}) + \beta_2 \ln(AADT_{minor}))$$

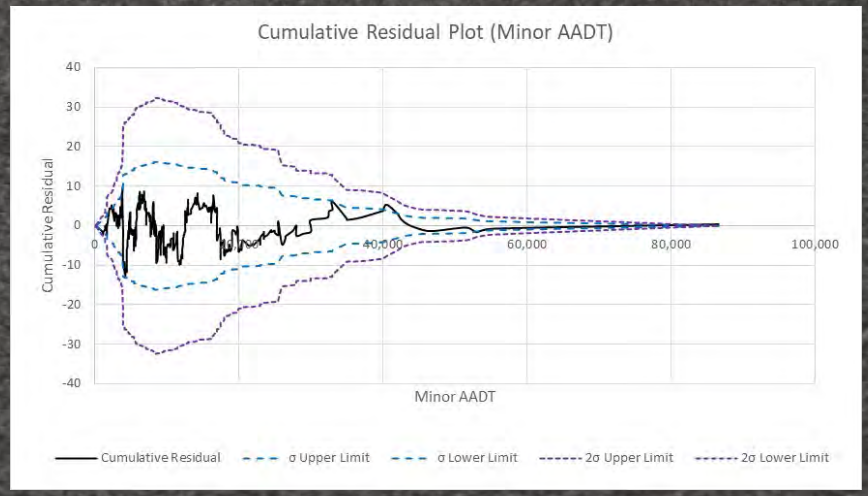
**Where,**

$N_{predicted}$ **= predicted crashes for intersection**

$AADT_{major}$ **= major road AADT**

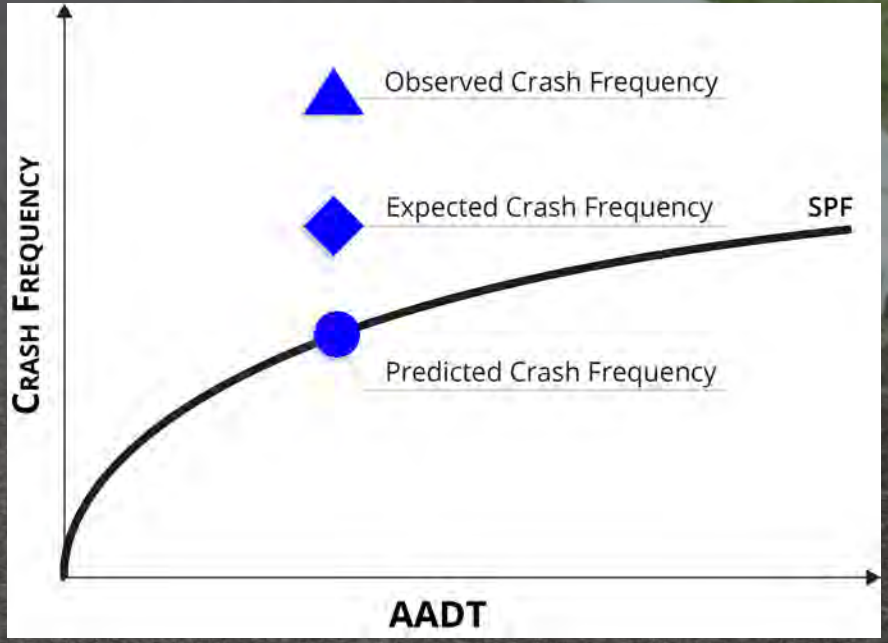
$AADT_{minor}$ **= minor road AADT**



# Crash Predictive Model Application

- Estimate predicted crashes with Florida-specific SPFs
- Determine expected crashes with Empirical Bayesian (EB) method
- Calculate excess expected crashes by subtracting predicted crashes from expected crashes
  - Will be used for selecting candidate intersections
- All analysis with SAS code




$$w = \frac{1}{1 + k \times \sum_{all\ study\ years} N_{predicted}}$$

$$N_{expected} = w \times N_{predicted} + (1 - w) \times N_{observed}$$

$$N_{excess} = N_{expected} - N_{predicted}$$

# Candidate Intersections

- Select candidate intersections based on excess expected crash frequency
- Identify low-cost safety countermeasures for candidates
  - Collect intersection safety features to determine the applicable safety countermeasure(s) for candidates
- Apply crash modification factors (CMF) to calculate crash reduction for safety improvements
- Calculate benefit/cost ratio for intersection improvements

$$\frac{B}{C}Raio = \frac{All\ reduction\ on\ crash\ costs}{Cost\ for\ countermeasure(s)}$$

# Countermeasures for Intersections

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| Countermeasure | Countermeasure Description | | CMF Value | Source |
|---|---|---|---|---|
| **Backplates** | Add 3-inch yellow retroreflective sheeting to signal backplates | | 0.850 | CMF Clearinghouse (CMF ID 1410) |
| **Crosswalk** | Install high-visibility crosswalk | | 0.810 | CMF Clearinghouse (CMF ID 4124) |
| **Lighting** | Provide intersection illumination | | 0.920 | CMF Clearinghouse (CMF ID 5421) |
| **FYA** | Install flashing yellow arrow (FYA) | Permissive only to protected/permissive | 0.654 | CMF Clearinghouse (CMF ID 7683) |
| | | Protected/permissive | 0.880 | CMF Clearinghouse (CMF ID 9667) |
| **LT Offset** | Improve left-turn lane (LT) offset to create positive offset | | 0.662 | CMF Clearinghouse (CMF ID 6095) |
| **LT Lane** | Provide a left-turn (LT) lane | Rural 3-leg intersection | 0.850 | Highway Safety Manual (Chapter 14) |
| | | Urban 3-leg intersection | 0.930 | |
| | | Rural 4-leg intersection | 0.820 | |
| | | Urban 4-leg intersection | 0.900 | |
| **RT Lane** | Provide a right-turn (RT) lane | | 0.960 | Highway Safety Manual (Chapter 14) |
| **LPI** | Implement a leading pedestrian interval (LPI) | | 0.870 | CMF Clearinghouse (CMF ID 9916) |
| **DSWF** | Install dynamic signal warning flashers (DSWF) | | 0.820 | CMF Clearinghouse (CMF ID 4201) |

FDOT

# Candidate and Sister Intersections

- Candidate intersections
  - Intersection with below average safety performance
  - Prioritized for safety improvements
  - Calculate crash reduction and B/C ratio for proposed safety improvements
- Sister intersections
  - Have similar intersection characteristics with candidate but above average safety performance
    - Top 5 sister intersections selected for each candidate
  - Collect safety features for sister intersections
    - Provide additional clues on possible safety improvements for candidate intersection
- SAS code to identify  candidate and sister intersections automatically

# FDOT Network Screening Reporting

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO

Thursday, February 18, 2021

## FLORIDA DEPARTMENT OF TRANSPORTATION

### Traffic Engineering and Operations Office

### System Analysis and Forecast Evaluation (SAFE) Candidates

### Fatal and Severe Crashes at Signalized Intersections 2017-2019

----------District 4----------

*Sorted by Context Classification and Estimated BCR*

| RDWYID | Mile Post | Days Between Expected KA Crashes | Proposed Countermeasure | | | | | | | | | Days Between Expected KA Crashes After Treatment | Expected Savings of Treatment(s) | Months to Reduce One KA Crash | BCR | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Backplates | Crosswalk | Lighting | FYA | LT Offset | LT Lane | RT Lane | LPI | DSWF | | | | | |
| **Four-leg Intersections in Suburban Commercial (C3C)** | | | | | | | | | | | | | | | | |
| *86100000* | *19.529* | *127* | | ✓ | | | ✓ | | ✓ | ✓ | | *295* | *$9,845,231* | *7* | *84.54* | |
| 93030000 | 6.984 | 142 | ✓ | ✓ | | | ✓ | | ✓ | ✓ | | 389 | $9,757,515 | 7 | 82.38 | |
| 87002000 | 8.756 | 249 | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | | 815 | $6,088,479 | 12 | 39.63 | |
| **Four-leg Intersections in Suburban Residential (C3R)** | | | | | | | | | | | | | | | | |
| *86006000* | *0.688* | *194* | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | *679* | *$7,982,210* | *9* | *57.62* | |
| 93016000 | 4.138 | 274 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | 942 | $5,616,148 | 13 | 49.10 | ICE analysis recommended |
| *93030000* | *6.400* | *236* | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | *1081* | *$7,192,126* | *10* | *46.27* | *ICE analysis recommended* |
| 86006000 | 1.571 | 216 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | 949 | $7,782,172 | 9 | 45.75 | ICE analysis recommended |
| **Four-leg Intersections in Urban General (C4)** | | | | | | | | | | | | | | | | |
| 86039000 | 0.000 | 109 | | | | | ✓ | | ✓ | ✓ | | 206 | $10,691,287 | 8 | 95.53 | |
| 86014000 | 3.219 | 169 | ✓ | | | | ✓ | | | ✓ | | 318 | $6,912,527 | 12 | 84.72 | |
| *86090000* | *5.337* | *205* | ✓ | | | | ✓ | | ✓ | ✓ | | *402* | *$5,941,582* | *14* | *61.09* | |
| 86014000 | 1.998 | 194 | | ✓ | | | ✓ | | ✓ | ✓ | | 471 | $7,514,030 | 11 | 56.88 | |
| *86090000* | *6.855* | *236* | ✓ | ✓ | | | ✓ | | ✓ | ✓ | | *525* | *$5,812,499* | *14* | *53.47* | |
| 86100000 | 2.573 | 240 | | | | | ✓ | | ✓ | ✓ | | 452 | $4,865,604 | 17 | 43.48 | |

Note: Candidates in italic for duplicates with 2020 candidate list.



Thursday, February 18, 2021

FLORIDA DEPARTMENT OF TRANSPORTATION

Traffic Engineering and Operations Office

System Analysis and Forecast Evaluation (SAFE)

### Sister Signalized Intersections

----------Ranked by District----------

| Candidate Intersection | | | | Sister Intersections | | | | |
|---|---|---|---|---|---|---|---|---|
| District | RDWYID | Mile Post | Days Between One Expected KA Crashes | District | RDWYID | Mile Post | Days Between One Expected KA Crashes | Top Comparable Intersections with Similar Conditions |
| 1 | 13010000 | 3.768 | 156 | 4 | 93180000 | 0.947 | 541 | 1 |
| | | | | 4 | 86190000 | 4.512 | 1,795 | 2 |
| | | | | 4 | 93120000 | 8.228 | 1,788 | 3 |
| | | | | 1 | 13050000 | 2.682 | 1,814 | 4 |
| | | | | 7 | 15070000 | 2.048 | 825 | 5 |
| 1 | 13010000 | 4.254 | 63 | 4 | 86015000 | 3.307 | 815 | 1 |
| | | | | 7 | 15070000 | 1.780 | 809 | 2 |
| | | | | 1 | 17070000 | 1.805 | 1,756 | 3 |
| | | | | 1 | 16300000 | 0.256 | 1,772 | 4 |
| | | | | 7 | 15070000 | 2.794 | 802 | 5 |
| 1 | 13010000 | 5.283 | 105 | 4 | 86120000 | 0.998 | 3,146 | 1 |
| | | | | 6 | 87002000 | 0.747 | 540 | 2 |
| | | | | 4 | 86200000 | 0.000 | 921 | 3 |
| | | | | 3 | 48020000 | 15.154 | 3,149 | 4 |
| | | | | 6 | 87133000 | 0.549 | 919 | 5 |
| 1 | 13010000 | 6.077 | 110 | 4 | 93010000 | 12.894 | 3,584 | 1 |
| | | | | 4 | 89010000 | 7.063 | 3,563 | 2 |
| | | | | 4 | 93020000 | 1.124 | 1,057 | 3 |
| | | | | 4 | 93090000 | 3.619 | 1,049 | 4 |
| | | | | 6 | 87026000 | 1.521 | 3,558 | 5 |
| 1 | 13020000 | 2.745 | 237 | 7 | 15010000 | 10.495 | 869 | 1 |
| | | | | 7 | 15010000 | 10.495 | 869 | 2 |
| | | | | 2 | 26005000 | 3.142 | 1,881 | 3 |
| | | | | 4 | 93210000 | 5.395 | 1,887 | 4 |
| | | | | 7 | 15070000 | 4.652 | 1,893 | 5 |
| 1 | 13020000 | 4.560 | 221 | 3 | 48010000 | 12.203 | 2,293 | 1 |
| | | | | 3 | 48010000 | 12.823 | 896 | 2 |
| | | | | 5 | 70010000 | 16.912 | 2,294 | 3 |
| | | | | 3 | 57040000 | 15.665 | 898 | 4 |
| | | | | 7 | 15230000 | 2.051 | 894 | 5 |

# FDOT SAFE Intersection Report

American Association of State Highway and Transportation Officials
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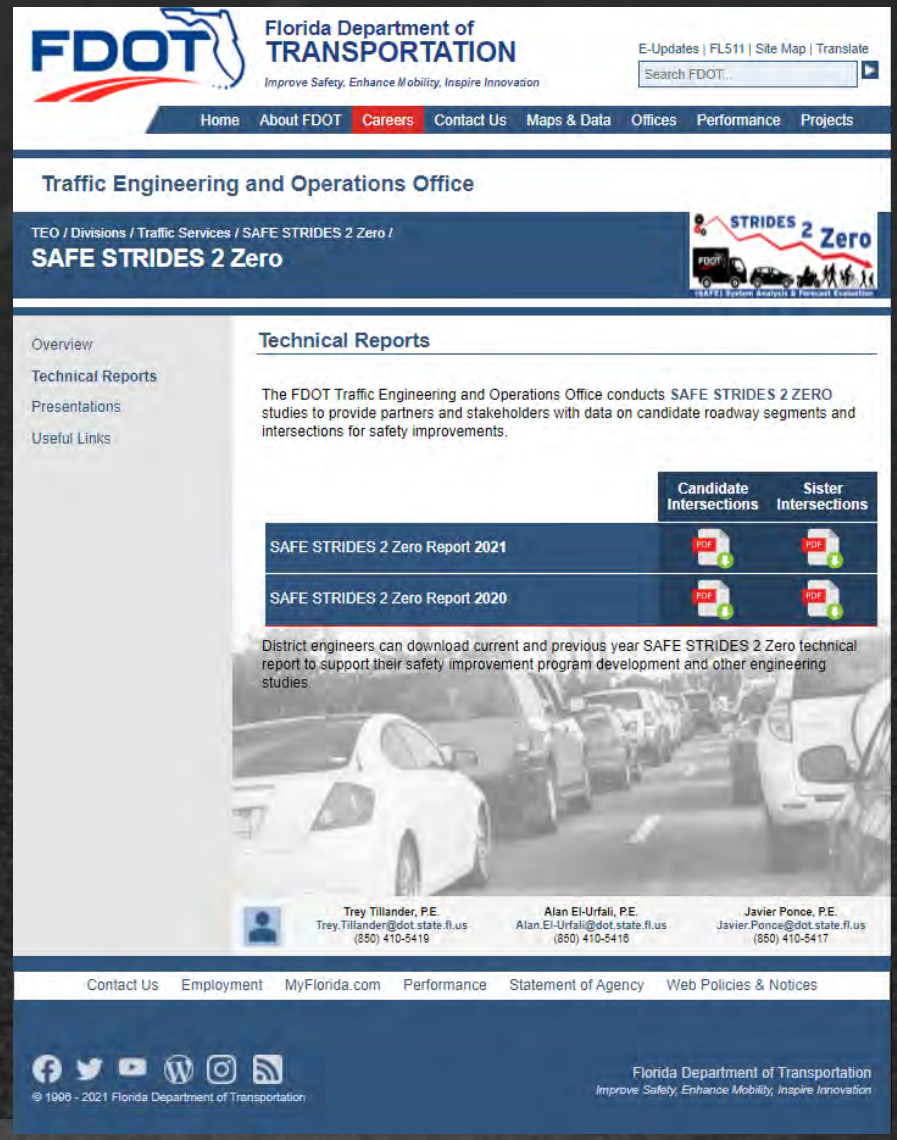


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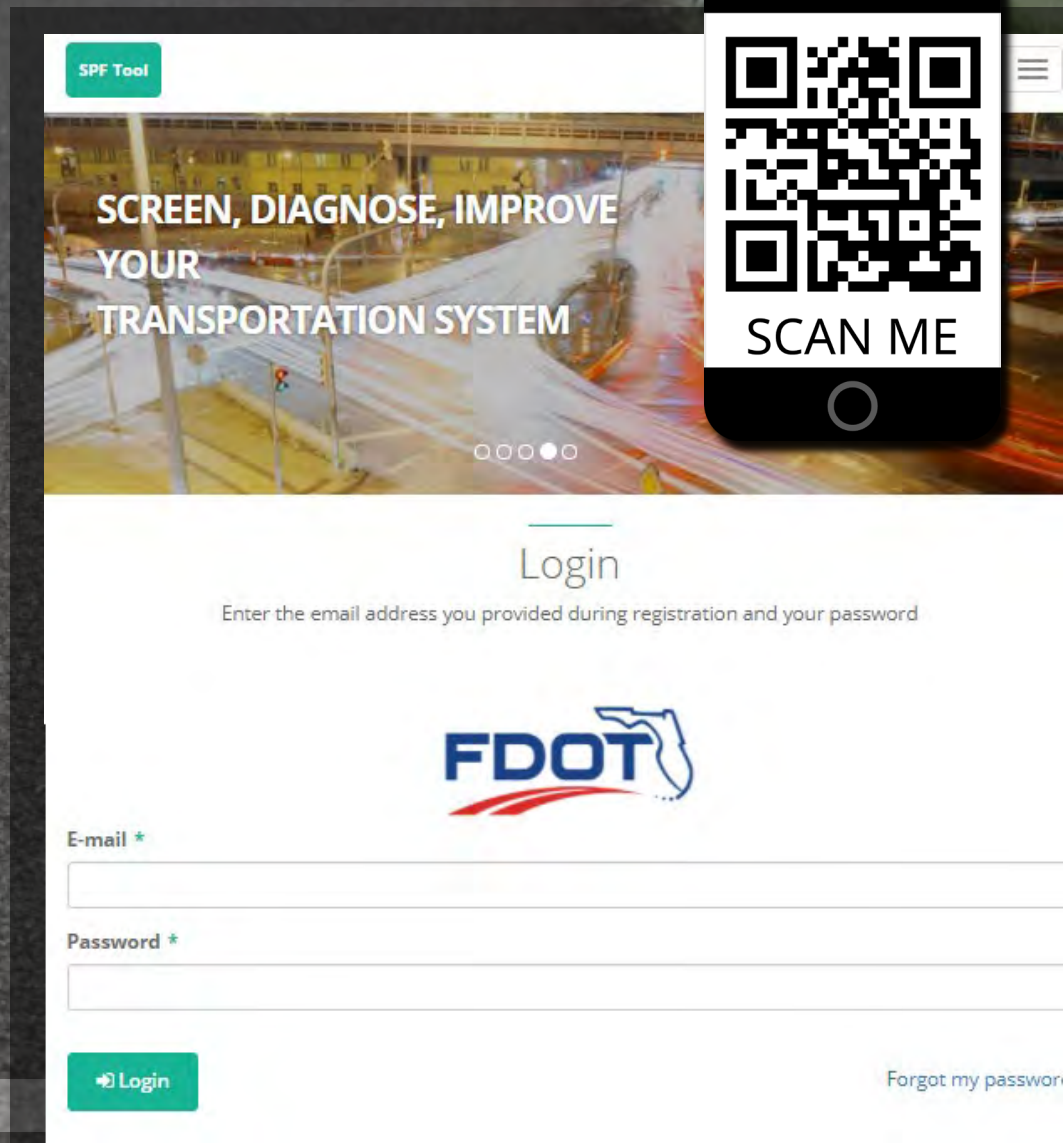
# FDOT SPF Tool

- FDOT acquired service for SAFE program visualization and dynamic reporting
- Customized for SAFE program with additional functions for candidate and sister intersections
- Visualize 3-D graphics and evaluating safety performance interactively



# Main Features for FDOT Network Screening

- State-specific safety performance functions
  - Group intersections by context classification and number of legs
  - SPFs calculated annually utilizing three-year rolling average roadway AADTs and crash data
- Select candidates based on potential safety prioritized by excess expected crashes with EB adjustment
- FDOT unique method for candidate and sister intersections comparison
- Visualize analysis results with 2-D/3-D interactive graphics

# FDOT Network Screening Cost

- FDOT in-house resources
  - Initial setup, identifying data sources, and developing SAS code
- FDOT acquired services (SPFTool) Cloud-based ($25,000 per year)
- SPFTool Customization $20,000 first year
- Projected maintenance cost (Data QC and Validation) $15,000 per year

# FDOT Next Steps

- Roadway segments
  - Groups
  - Segmentation Historical/Sliding window
- Unsignalized intersections
  - Groups

# Questions?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