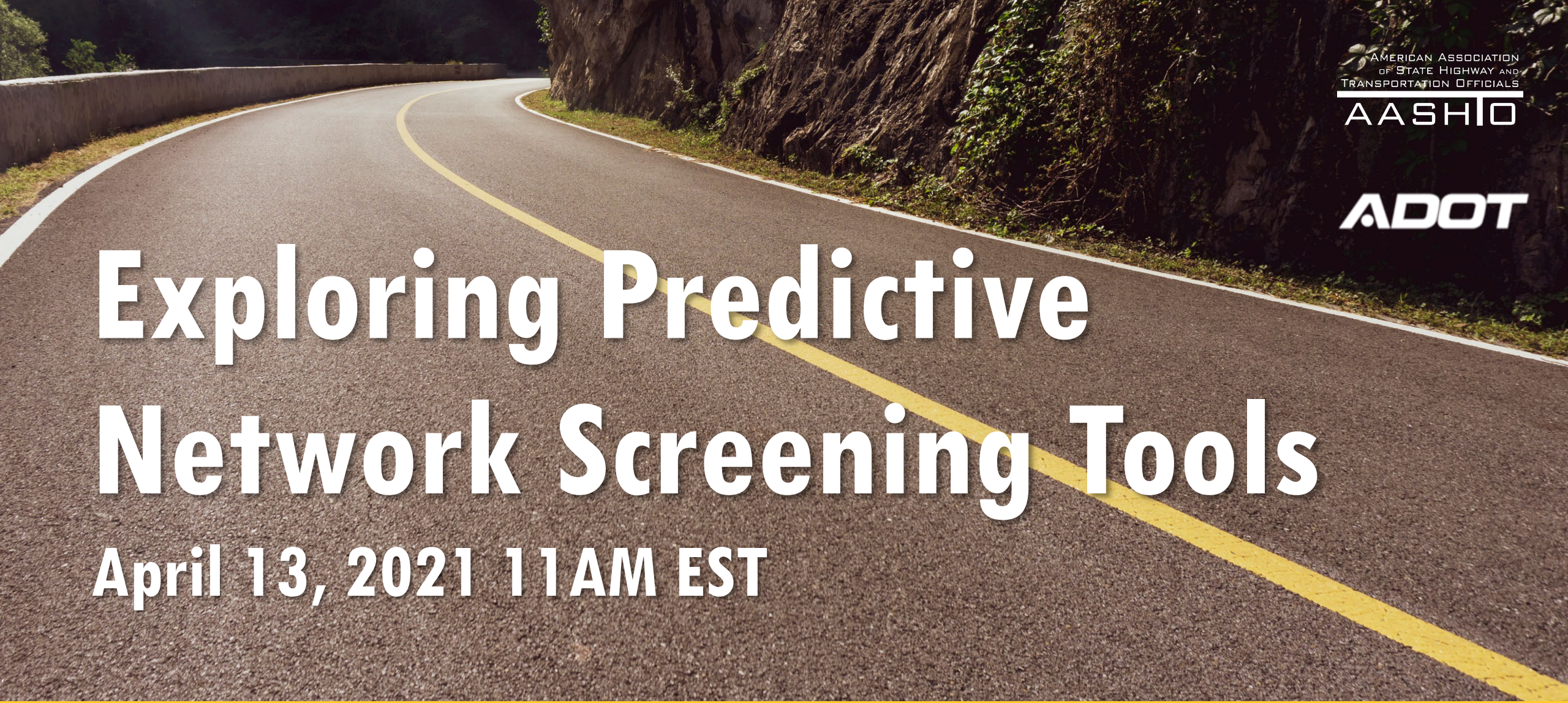


Exploring Predictive Network Screening Tools

April 13, 2021 11AM EST

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

Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT

Exploring Predictive Network Screening Tools

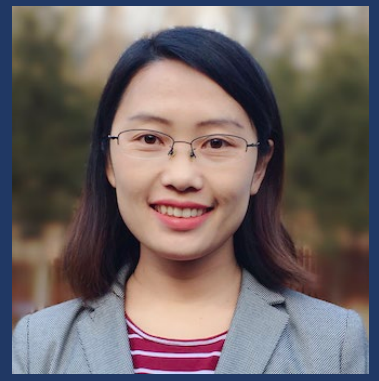
American Association of State Highway and Transportation Officials
AASHTO

ADOT

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

Kick-off webinars provide a high-level overview of the tools using a speed-dating format and subsequent webinars will provide a more detailed description and demonstration.

Stephen Read, Virginia DOT & AASHTO HSM Steering Committee Chair
Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT



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

Alan El-Urfali, P.E.
Florida DOT – SAS

Carla P. Anderson, P.E.
Kansas DOT – SafetyAnalyst

Eric Green, Ph.D. & Mike Vaughn
Kentucky TC – CDAT/RTool

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Exploring Predictive Network Screening Tools (Part 1)

Stephen Read, Virginia DOT & AASHTO HSM Steering Committee Chair

Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT

Joe McCarthy
Wyoming DOT – Safety Portal

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

Samuel Harris, P.E.
Georgia DOT – AASHTOWare Safety Powered by Numetric

Katherine Beckett, P.E., RSP2
Illinois DOT – Safety Tiers

American Association of State Highway and Transportation Officials
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ADOT

"Speed-dating" Part 2
April 16, 1pm ET

Exploring Predictive Network Screening Tools (Part 2)

Stephen Read, Virginia DOT & AASHTO HSM Steering Committee Chair

Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT

American Association of State Highway and Transportation Officials

AASHTO

Network Screening Speed-dating

A quick review of notable agency predictive network screening tools

Connecticut

Agency Overview

Connecticut Department of Transportation (CTDOT) & Connecticut Transportation Safety Research Center (CTSRC) at the University of Connecticut (UConn)

CTDOT Contact:

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

UConn Contact:

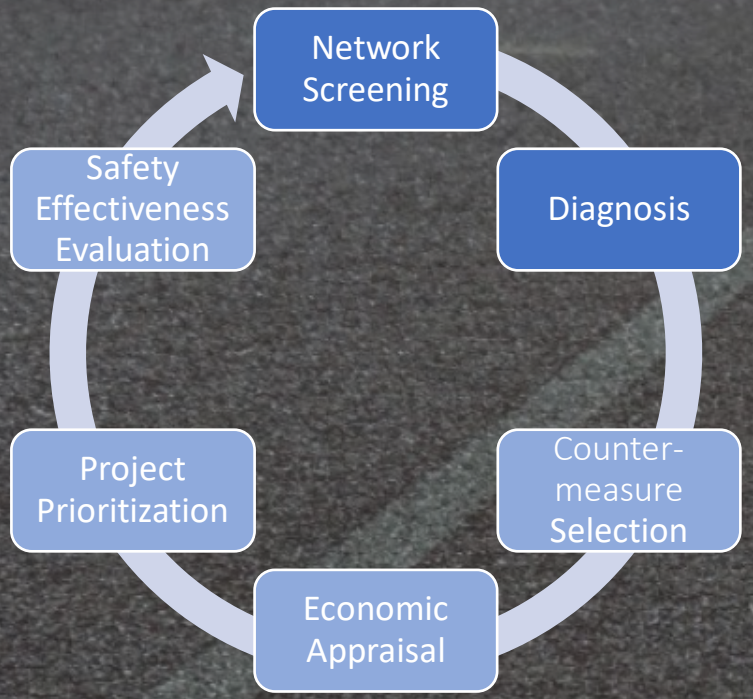
Eric Jackson, Ph.D., Director, eric.d.jackson@uconn.edu

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

Tool Overview

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

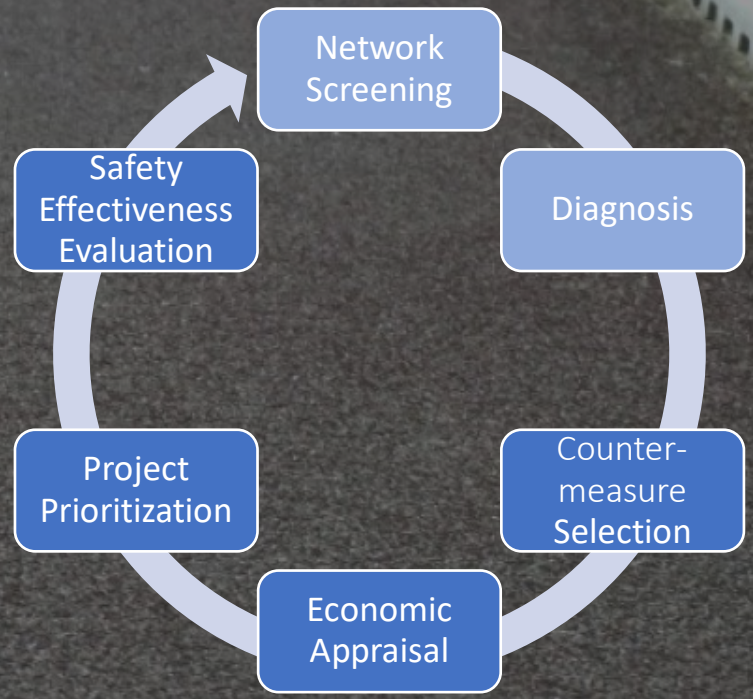
Key Features



- Easier data manipulation with Data Management
- Screening by geographical areas, emphasis areas, crash type and severity, roads, and facility types
- Multiple performance measures and screening methods using EB and sliding window/peak searching
- Visualization of results on maps
- Multiple diagnosis tools with map views, statistical tests, charts and tables, collision diagram, crash tree, and street image viewer

Key Features (Continued)

- Integration of the latest CMF Clearinghouse data
- Create reports, publish, clone, download and save
- Create and compare multiple proposed projects
- Conduct benefit-cost analysis for proposed projects
- Programmatically prioritize projects with limited budgets
- Conduct varied levels of EB before-after analysis for evaluating the effectiveness of projects



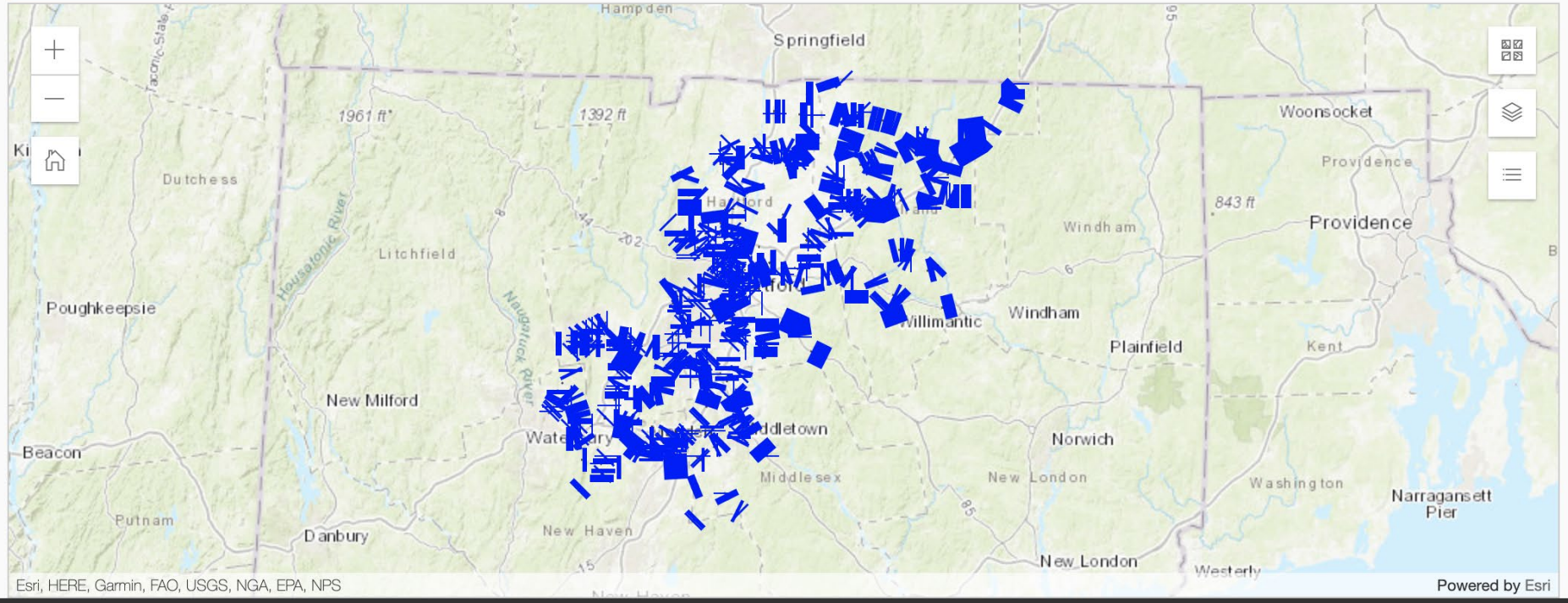
- Dashboard
- Data Management
  - Prepare Data for Analysis Tools
  - Update Network Screening SPFs
  - Update Project Level SPFs
  - Update Crash Comprehensive Cost
  - Update Contributing Factors List
  - Update Countermeasures List
- Safety Analysis
  - Network Screening
  - Diagnosis
  - Countermeasure Selection
  - Economic Appraisal
  - Project Prioritization
  - Safety Effectiveness Evaluation

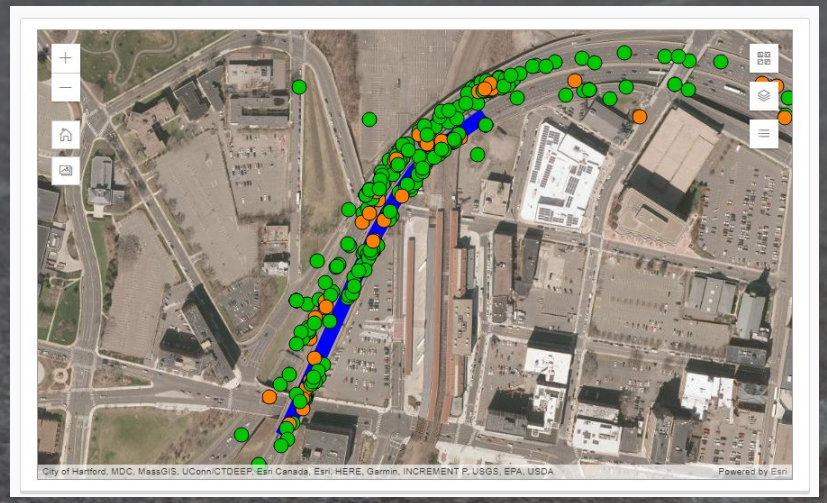
ADD SELECTED SITES TO DIAGNOSIS | EXPORT DATA AS CSV | COPY WFS LINK TO CLIPBOARD

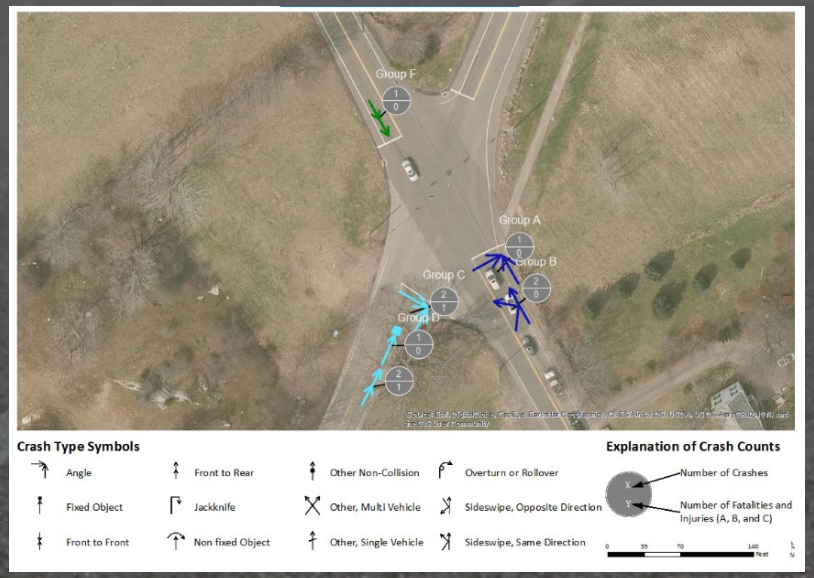
Results | Summary | Chart

							Excess Expected Using SPF		
Site Id	Primary District	Primary Town	Road Name 1	Road Name 2	Start Milepost	End Milepost	Ranking	Score	R
1163	1	Hartford	I-84		61.88	62.04	1	464.15386	1
4464	1	Hartford	I-84		61.63	61.88	1	464.15386	1
3193	1	Hartford	I-84		62.04	62.17	3	415.69946	3
3416	1	Hartford	I-84		61.22	61.36	4	221.38668	7
1387	1	Hartford	I-84		60.93	61.22	4	221.38668	7

EXPAND GRID







Highlights

Crashes	Top 2 Crash Types		Crash Severity				
416	Front to Rear	Sideswipe, Same Direction	K	A	B	C	O
	231	123	0	0	28	57	331

Emphasis Areas

Motorcycles	DUI Related	Aggressive Driving Related	Distracted Driving Related	Young Driver
3	8	238	16	175

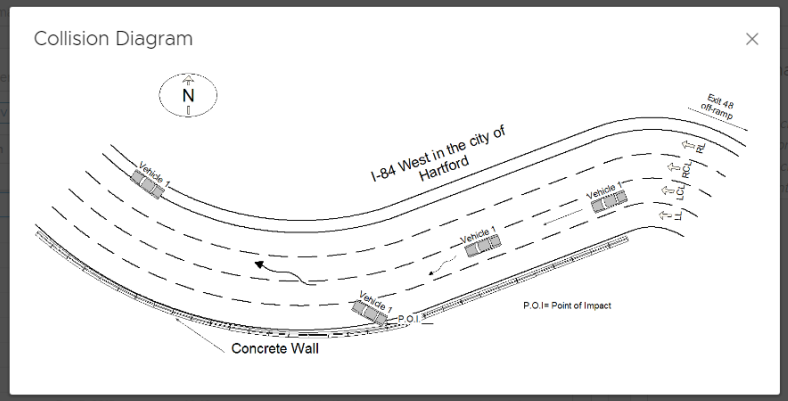
Adverse Weather Conditions	Wet Road Surface	Roadway Departure	Qualifying Commercial Vehicle
47	64	47	31

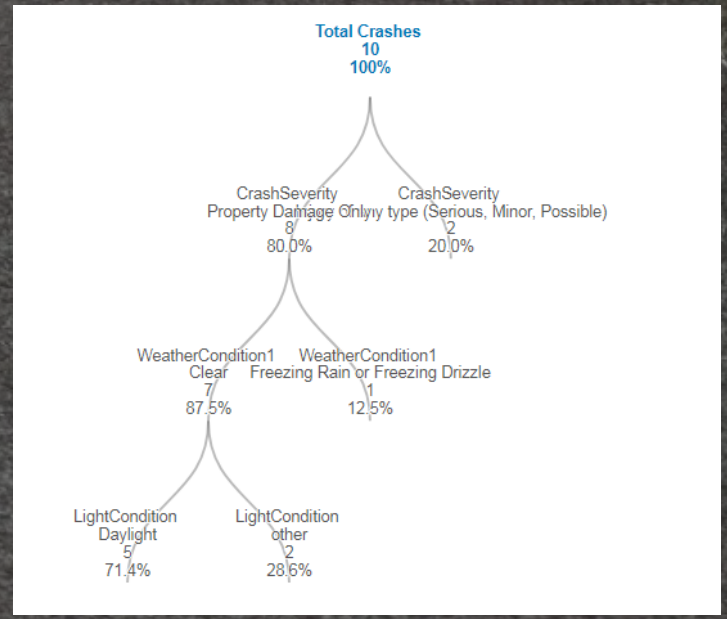
Pre-Defined Reports

All pre-defined report data shows counts by number of crashes.

Crash Information
- Crash Severity
- Crash Type

Vehicle Information
- Vehicle Action
- Vehicle Body Type

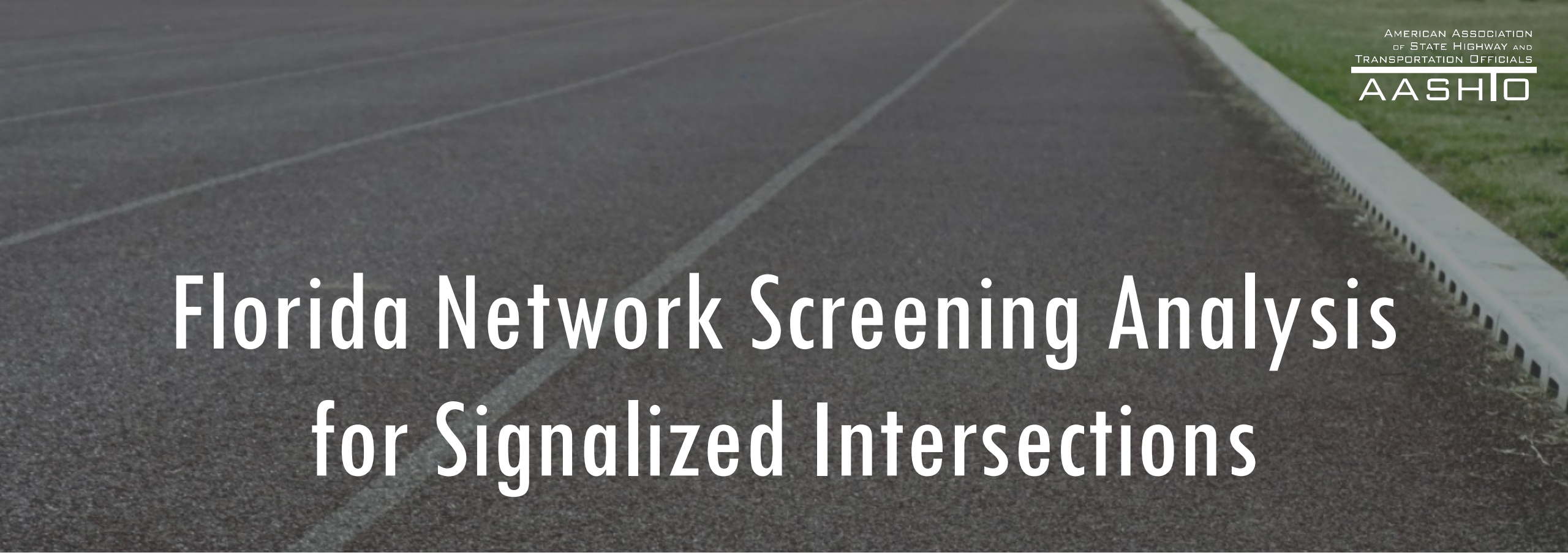




Conclusions

- Used by CTDOT, COGs, and consultants for decision-making
- Replace old SLOSSS list (which uses critical crash rate)
- Use more reliable measures and methods
- Integrate maps and visualizations
- Provide more flexibility, repeatability, and shareability while require less expertise
- High initial setup costs but transferable to other states with less

Register: crsms.uconn.edu
Pooled fund: https://www.pooledfund.org/Details/Solicitation/1550



Florida Network Screening Analysis for Signalized Intersections

Alan El-Urfali, P.E.

State Traffic Services Program Engineer

TARGET ZERO
FATALITIES & SERIOUS INJURIES

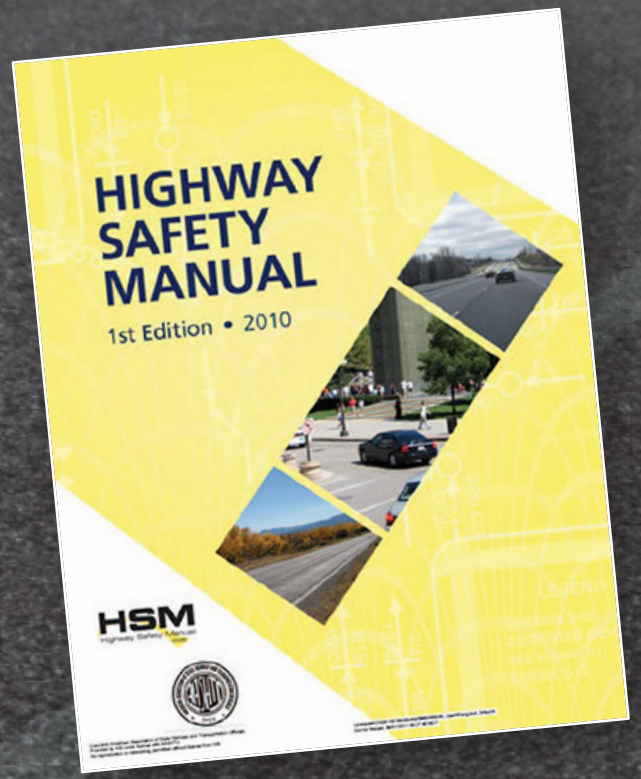
AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO

Florida Network Screening Tool Evolution

- Historically, FDOT used AASHTOWare Safety Analyst
- 2019 FDOT developed System Analysis & Forecast Evaluation (**SAFE**) Tool
- 2020 FDOT published first network screening report with 154 candidate intersections
- 2021 FDOT published second network screening report with 161 candidate intersections
- 2021 FDOT Acquired SPF Tool for visualization and dynamic reporting

FDOT

FDOT Network Screening Tool (SAFE)



- FDOT homegrown tools to implement HSM Part B Roadway Safety Management Process
- SAS-based code and SAS tools (Jump Pro)
- ETL process for assembling roadway and crash data from multiple data sets
- SPFs calculated with SAS code automatically
- Focuses on Fatal and Severe Injury Crashes
- Performance Measure: Excess Expected Crashes with EB adjustment (most reliable)

Note: ETL is for Extract, Transform, and Load

SAFE Data Structure

- Currently, screening signalized intersections on state highway system
- Group intersections by number of legs and roadway context classification
- Expanding analysis to cover roadway mid-block crosswalks

Context Classification

C1 – Natural C2 – Rural C2T – Rural town C3R – Suburban Residential
C3C – Suburban Commercial C4 – Urban General C5 – Urban Center C6 – Urban Core

FDOT Intersection Groups

Group 1: C1-C2T 4-leg signalized
Group 2: C1-C3C 3-leg signalized
Group 3: C4-C6 3-leg signalized
Group 4: C3C 4-leg signalized
Group 5: C3R 4-leg signalized
Group 6: C4 4-leg signalized
Group 7: C5-C6 4-leg signalized

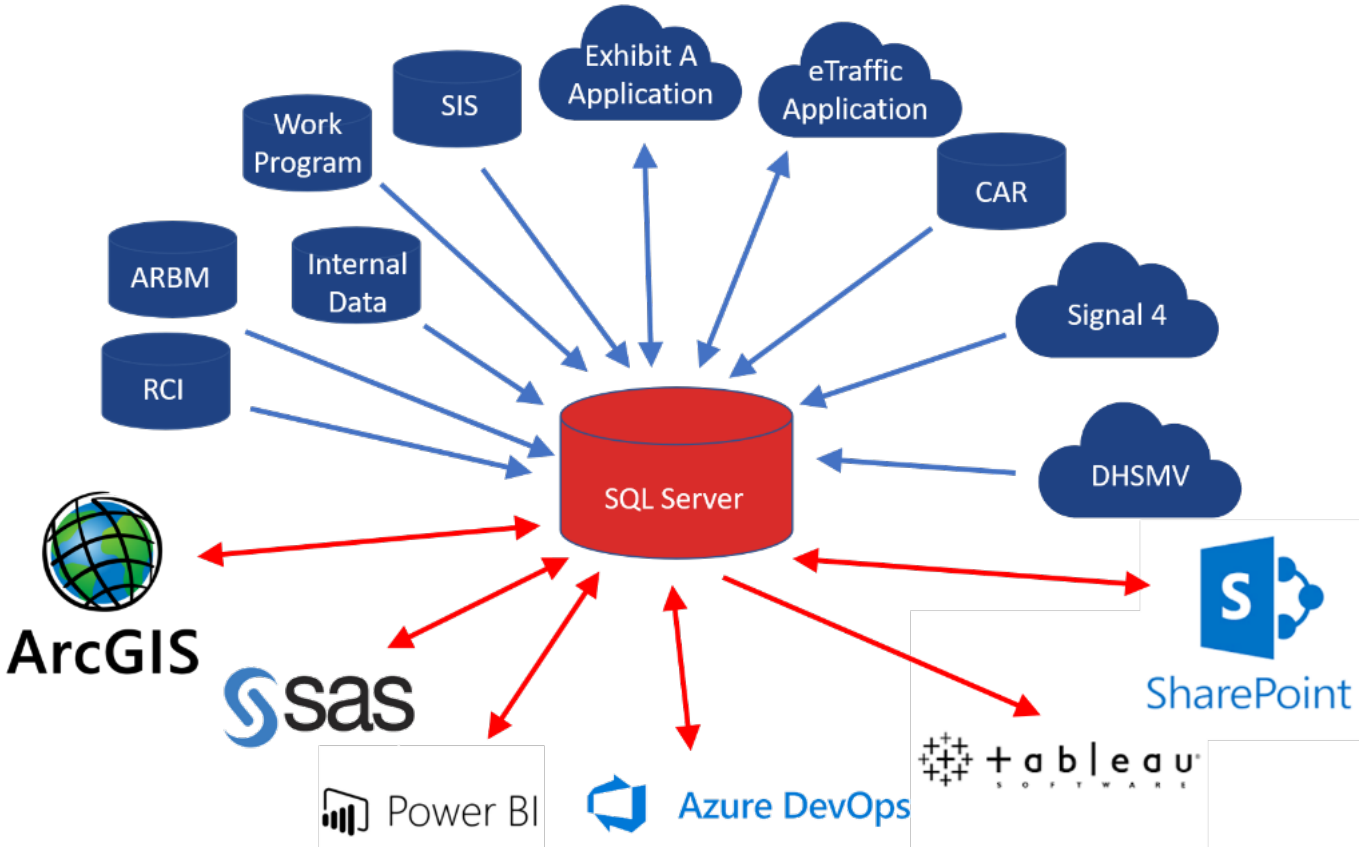
STRIDES 2 Zero

(SAFE) System Analysis & Forecast Evaluation

American Association of State Highway and Transportation Officials

AASHTO

Florida Data Warehouse

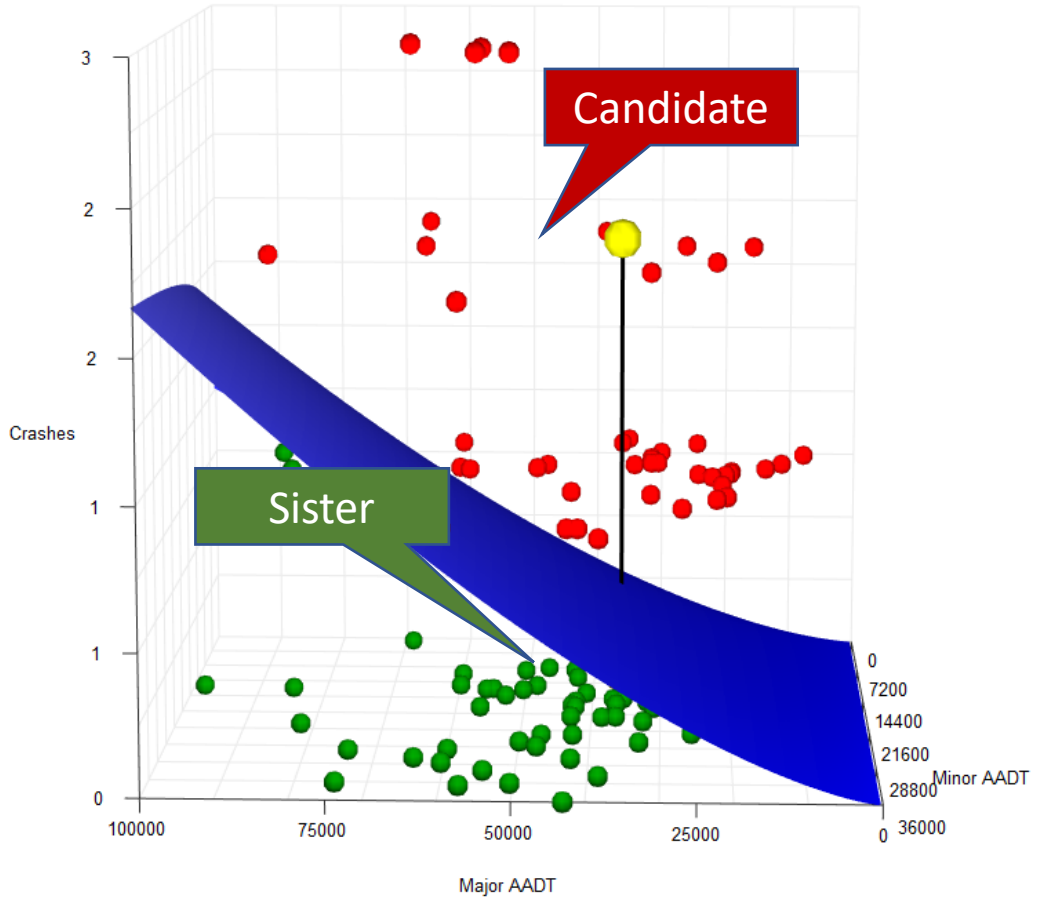


CARS	Crash Analysis Reporting System
DHSMV	Department of Highway Safety and Motor Vehicle
Signal 4	Signal Four Analytics Crash Database
RCI	Roadway Characteristics Inventory
ARBM	All Roadway Base Map
SIS	Strategic Intermodal System

FDOT

TARGET ZERO
FATALITIES & SERIOUS INJURIES

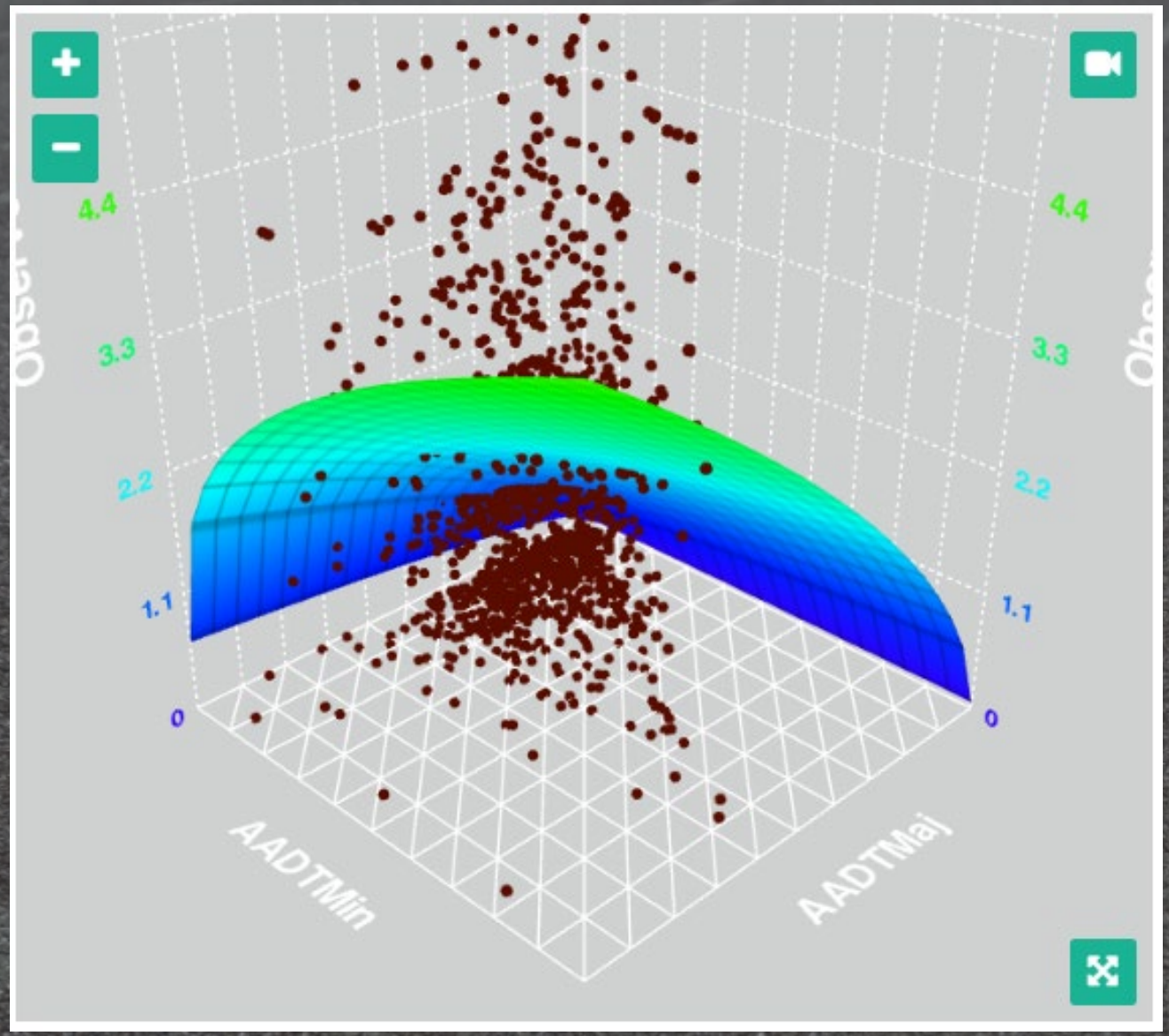
AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO



Safety Performance Functions

- State-specific SPFs developed with Florida AADT (Major/Minor) and KA Crashes
- Unique algorithm to identify Candidate and Sister Intersections
- AI machine learning of missing safety countermeasures

FDOT



FDOT SPF Tool

- FDOT acquired service for SAFE visualization and dynamic reporting
- Unlimited FDOT user access
- Districts use SPF Tool for candidate prioritization, field review, diagnostics and countermeasure selection

Countermeasures for Intersections

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 Network Screening Reporting

FLORIDA DEPARTMENT OF TRANSPORTATION

Traffic Engineering and Operations Office

System Analysis and Forecast Evaluation (SAFE) Candidates

Fatal and Severe Crashes at 4-Leg Signalized Intersections 2016-2018

----------District 2----------

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	Months to Reduce One KA Crash	Estimated BCR	Comments
			Backplates	Special Emphasis Crosswalk	Lighting	Advance Street Name Sign	Mast arm					
Suburban Commercial (C3C)												
72160000	3.63	248	✓	✓		✓		367	$732,750	25	45.45	Close to an interstate, consideration for ICE project
26005000	7.84	271	✓	✓		✓	✓	413	$713,444	26	9.25	
26090000	13.65	176	✓			✓	✓	217	$603,855	31	8.44	
72220000	7.11	256	✓			✓	✓	315	$416,351	45	5.82	
Urban General (C4)												
26050000	3.96	264	✓			✓		316	$428,018	53	40.63	
29002000	2.63	405	✓	✓		✓		597	$550,594	41	34.15	
26010000	15.21	214	✓			✓	✓	264	$609,592	37	8.52	
Urban Center (C5) or Urban Core (C6)												
26070000	20.35	319	✓			✓		381	$418,476	64	39.72	

FLORIDA DEPARTMENT OF TRANSPORTATION

Traffic Engineering and Operations Office

System Analysis and Forecast Evaluation (SAFE)

Sister 4-Leg 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	09030000	0.00	161	5	36004000	7.20	534	1
				1	16110000	5.82	1,527	2
				7	10030001	0.00	538	3
				4	93310000	18.25	1,597	4
				7	14050000	11.63	831	5
1	09030000	7.40	241	5	75040000	8.38	2,280	1
				2	72220000	9.15	2,251	2
				7	10340000	11.39	2,273	3
				5	75020000	12.29	2,221	4
				5	79040000	9.28	2,362	5
1	13010000	1.73	177	5	92030000	2.62	900	1
				3	57050000	13.97	2,196	2
				4	94010000	13.34	2,213	3
				7	15150000	17.98	2,138	4
				4	94010000	12.25	923	5
1	13010000	4.26	46	6	87133000	0.00	1,980	1
				6	87133000	0.55	822	2
				4	86065000	10.63	1,991	3
				1	12070000	3.83	823	4
				1	17010000	17.13	1,957	5
1	13020000	2.75	250	1	12040000	1.98	921	1
				2	78070000	14.27	2,858	2
				7	10120000	5.04	920	3
				4	89091000	0.96	2,879	4
				4	93090000	7.74	914	5
1	13030000	4.79	330	5	36030000	17.02	1,965	1
				2	26020000	20.07	1,773	2
				1	16070000	4.75	939	3
				1	16070000	4.99	939	4
				5	36001000	8.42	2,079	5

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 KA 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 with 2-D/3-D interactive graphics (SPFTool)
  - Provides deeper-dive investigation into contributing factors for selecting most appropriate countermeasures

FDOT Network Screening Cost

- FDOT in-house resources
  - Initial setup, identifying data sources, and developing SAS
- 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

Image from SPFTool website: http://spftool.com

Question?

Alan El-Urfali, P.E.

State Traffic Services Program Engineer

Email: Alan.El-Urfali@dot.state.fl.us

Tel: (850) 410-5416

American Association of State Highway and Transportation Officials

AASHTO

Network Screening Speed-dating

A quick review of notable agency predictive network screening tools

Kentucky

Agency Overview

- Kentucky Transportation Cabinet
  - Mike Vaughn - mike.vaughn@ky.gov
- Kentucky Transportation Center/UK
  - Eric Green – eric.green@uky.edu

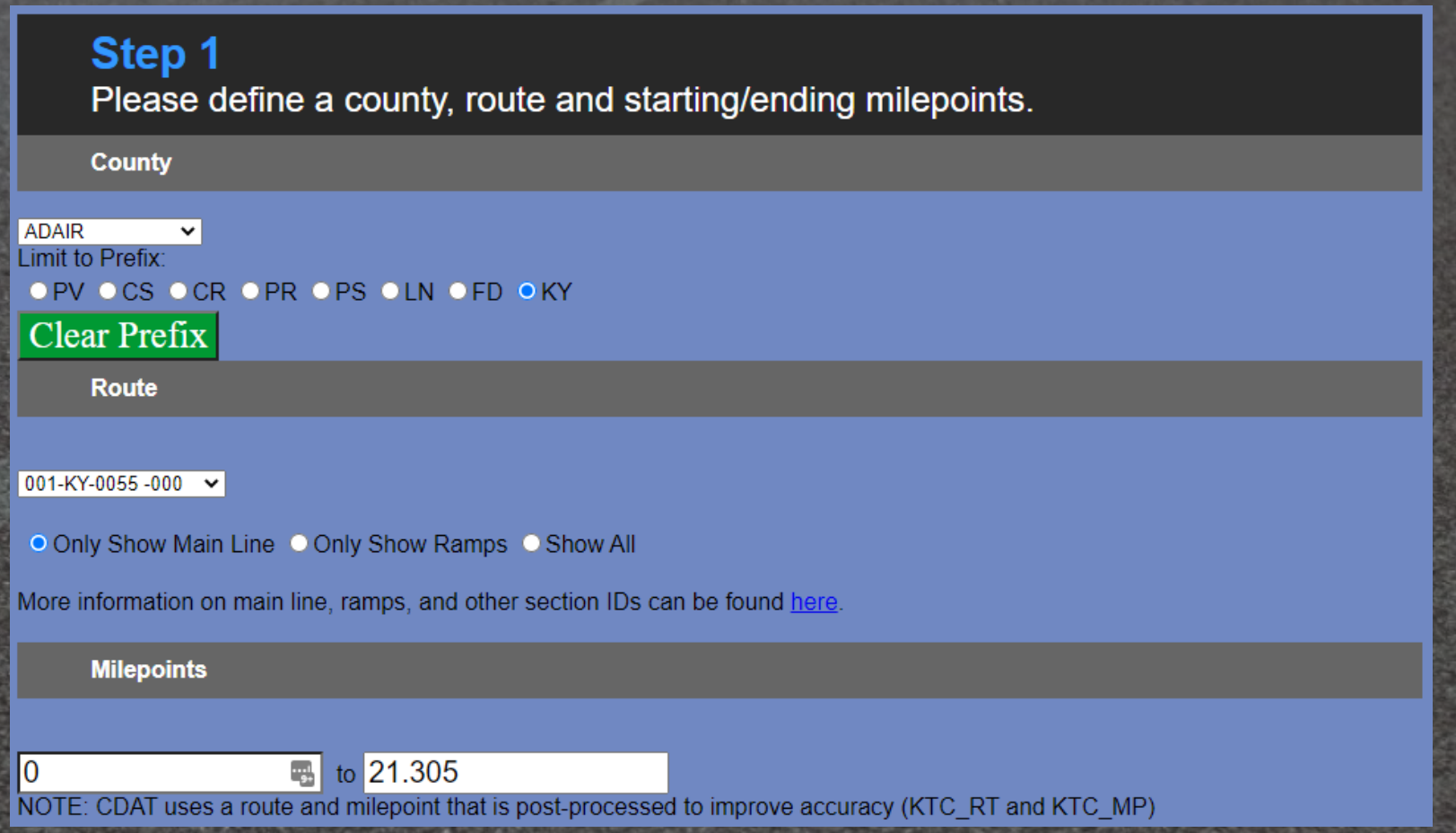
Tool Overview

- Crash Data ~~Access~~ Analysis Tool CDAT, KTC/KYTC
- 1 year in beta, 1 year in production
- Web app (ASPX with VB.Net code-behind)
- CDAT integrates crash and roadway data and then users can query a segment or intersection to obtain a safety score as compared to other segments or intersections employing techniques from the *Highway Safety Manual*.

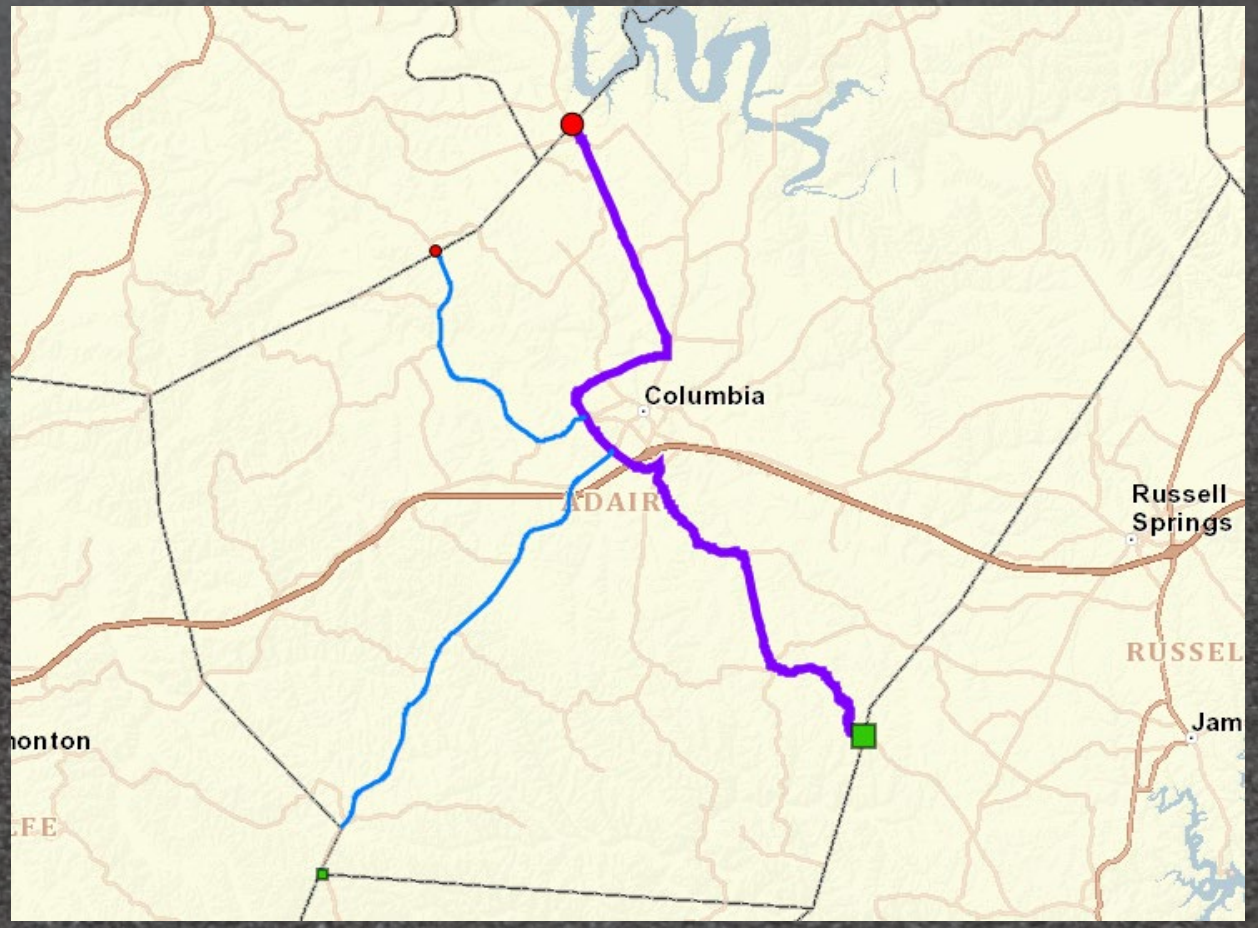
Key Features

- Main features of the tool
  - Mapping interface can be used to query and to display crashes.
  - Charts and graphs provide a better understanding of the crash types and can be compared to other, similar roads.
  - Pre-loaded with current state-based SPFs for a variety of crash types and severities.
  - Users can use CDAT to prioritize projects or evaluate highway improvements.
  - Helps promote the importance of roadway homogeneity.

Query Tool


Step 1
Please define a county, route and starting/ending milepoints.
County
ADAIR
Limit to Prefix:
PV CS CR PR PS LN FD KY
Clear Prefix
Route
001-KY-0055 -000
Only Show Main Line
Only Show Ramps
Show All
More information on main line, ramps, and other section IDs can be found here.
Milepoints
0
to
21.305
NOTE: CDAT uses a route and milepoint that is post-processed to improve accuracy (KTC_RT and KTC_MP)

Map Used to Select Segment



Filter by Crash Type

Filters

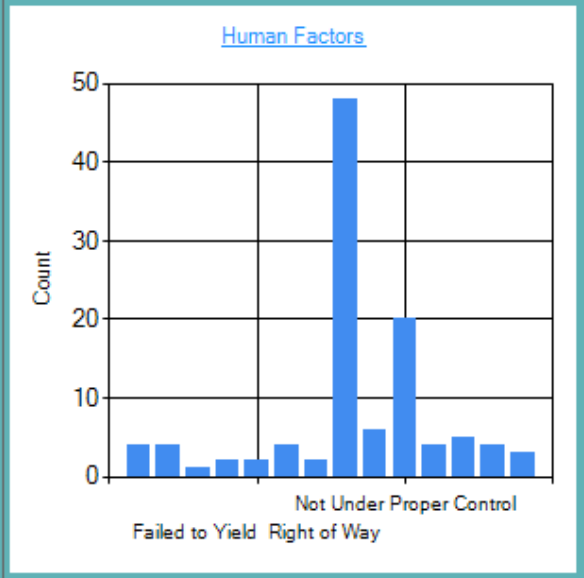
Check any boxes below to limit the results to only include the crash types selected (checking more than one will limit results to be of both crash types)

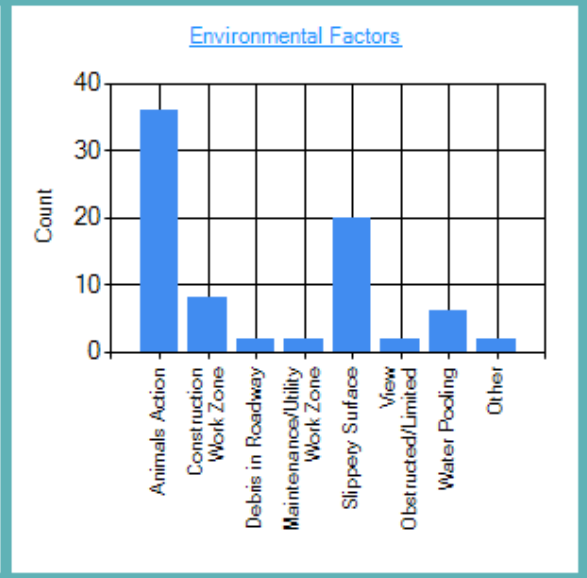
- ☐ Motorcycle
- ☐ Commercial Vehicle
- ☐ Lane Departure
- ☐ Run Off the Road
- ☐ Young Driver
- ☐ Mature Driver
- ☐ Pedestrian Involved
- ☐ Bicyclist Involved
- ☐ Distracted Driving
- ☐ Aggressive Driving
- ☐ Impaired Driving
- ☐ Unrestrained
- ☐ Hit and Run

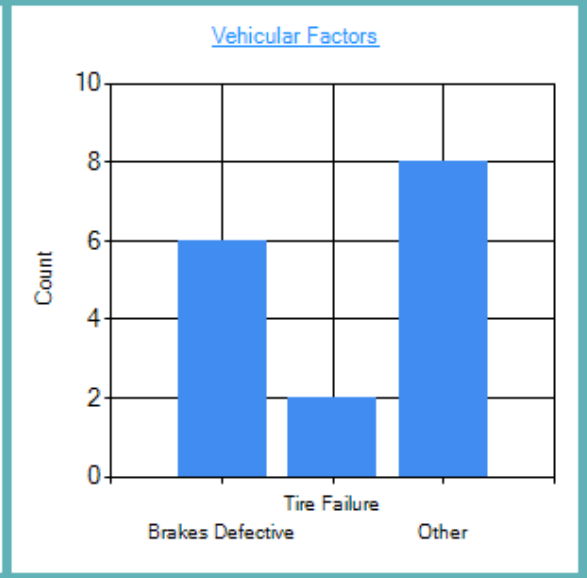
Crash type definitions and intersection descriptions

Review Crash Types

General | Factors | Units and Time | Road and Weather | Emphasis Areas 1 | Emphasis Areas 2 | Emphasis Areas 3







***Contributing Factor codes of 99 (none detected) are excluded**

Note: You can click a graph title for more information.

State-Specific SPFs

Step 3
Safety Performance Functions.

Please select an SPF for the segment

- ○ No Recommended SPF
- ◉ Rural Two-Lane
- ○ Urban Two-Lane
- ○ Rural Multi-Lane Divided
- ○ Rural Multi-Lane Undivided
- ○ Urban Multi-Lane Divided
- ○ Urban Multi-Lane Undivided
- ○ Rural Interstate and Parkway
- ○ Urban Interstate and Parkway

Choose a severity type for the SPF (this should match your severity filter from Step 2)

- ◉ KABCO
- ○ KAB
- ○ CO

SPF Information

Number of Crashes:	101
Theta:	1.532

Theta defaults to 100 if no model is selected
Model form: SPF = e^a*AADT^b*Length

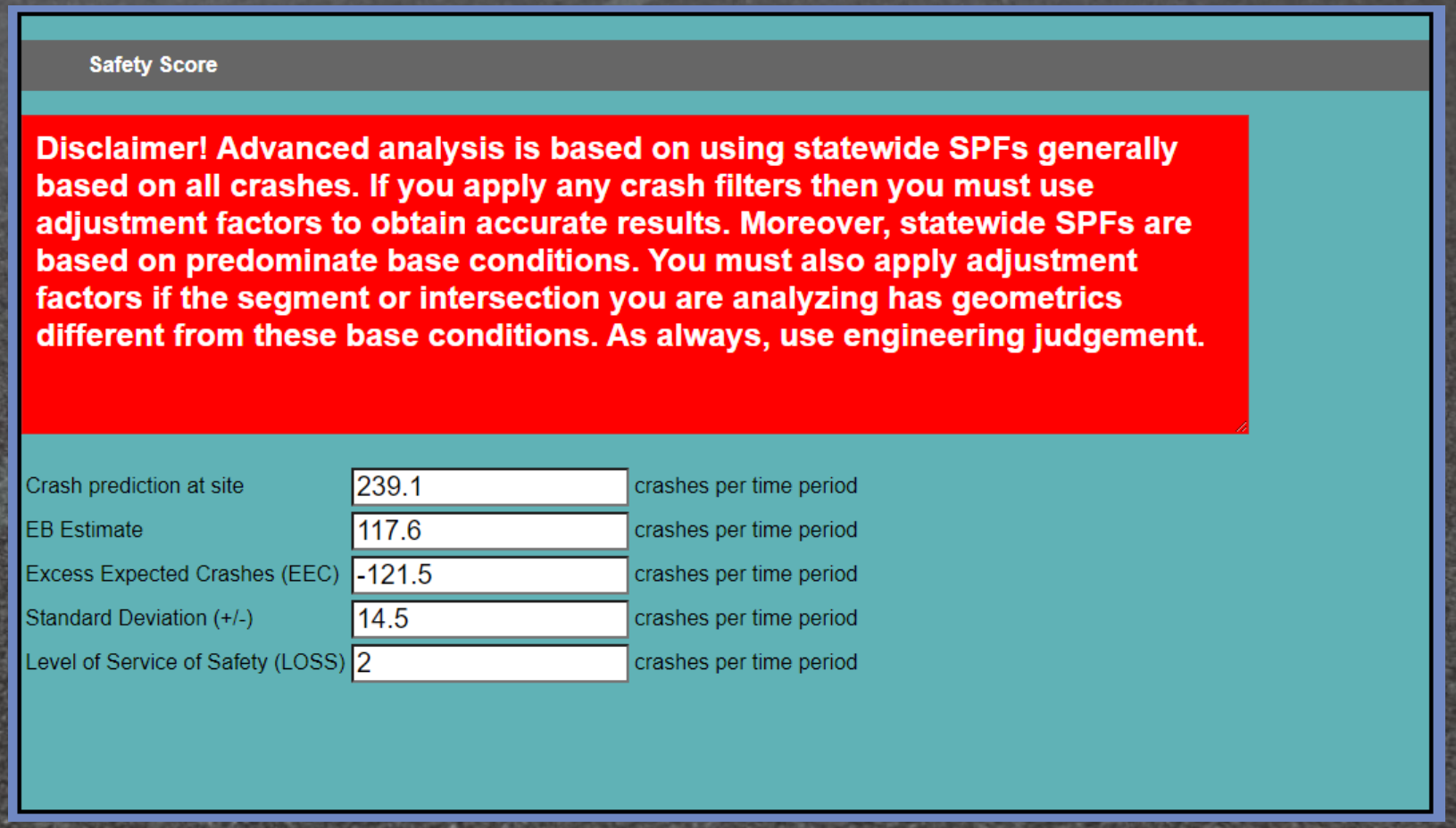
Length:	21.305
AADT:	3594.5
a	-4.492
b	0.844

AADT is 100 if there is no count for a segment
Any values that are changed will be shown in orange. Values will be shown in red if non-numeric values are entered.

Adjustment Factors (optionally add notes)

1	
1	
1	
1	
1	

Safety Score



Conclusions

- Why was the tool ~~selected~~ developed?
  - To provide better access to crash data and help all transportation professionals in KY have a better understanding of safety performance across the state.
- What are the benefits of the tool?
  - Easy and consistent access to crash data and methodologies.
- How has the tool impacted decision-making?
  - Helps a variety of Divisions understand where there are safety improvement opportunities as they develop projects (Planning & Design) and administer annual programs (Maintenance & Operations)

Additional Tool Overview

- SPF-R - KTC/KYTC
- 5 years
- R script (soon to be a web tool)
- SPF-R is a Safety Performance Function development tool that runs within R and Rstudio although a web version of the tool is under development.
- *https://github.com/irkgreen/SPF-R*

Key Features

- Main features of the tool
  - An SPF can be developed from a CSV of segments or intersections.
  - A variety of model forms can be used with examples provided.
  - SPF-R can perform SPF development as well as network screening on the same dataset.
  - CURE plots and other metrics are provided to improve model development.

Thank You!

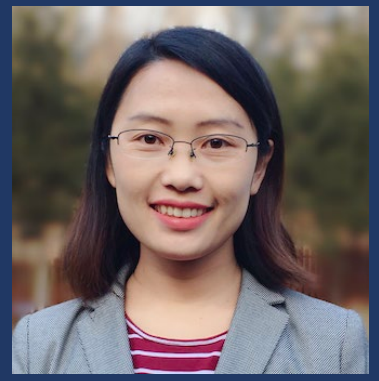
- Kentucky Transportation Cabinet
  - Mike Vaughn - mike.vaughn@ky.gov
- Kentucky Transportation Center/UK
  - Eric Green – eric.green@uky.edu

Discussion

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

Stephen Read, Virginia DOT & AASHTO HSM Steering Committee Chair

Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT



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

Alan El-Urfali, P.E.
Florida DOT – SAS

Carla P. Anderson, P.E.
Kansas DOT – SafetyAnalyst

Eric Green, Ph.D. & Mike Vaughn
Kentucky TC – CDAT/RTool

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ADOT

Exploring Predictive Network Screening Tools (Part 1)

Stephen Read, Virginia DOT & AASHTO HSM Steering Committee Chair

Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT

Joe McCarthy
Wyoming DOT – Safety Portal

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

Samuel Harris, P.E.
Georgia DOT – AASHTOWare Safety Powered by Numetric

Katherine Beckett, P.E., RSP2
Illinois DOT – Safety Tiers

American Association of State Highway and Transportation Officials
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ADOT

"Speed-dating" Part 2
April 16, 1pm ET

Exploring Predictive Network Screening Tools (Part 2)

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