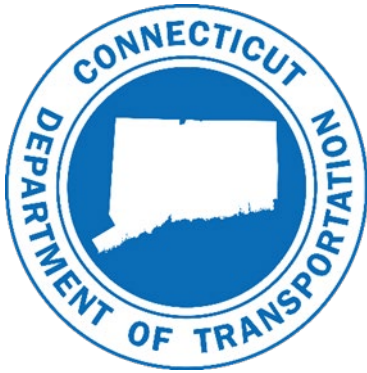


Development of the CT Roadway Safety Management (CRSMS) Tool



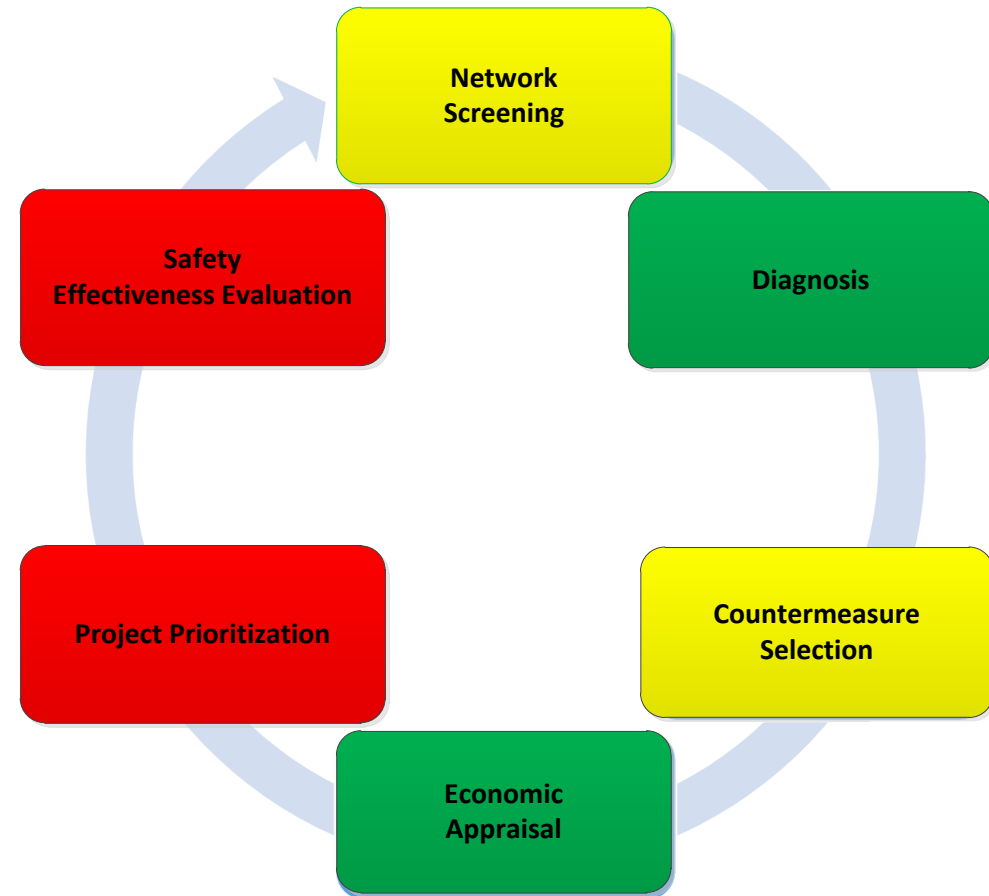
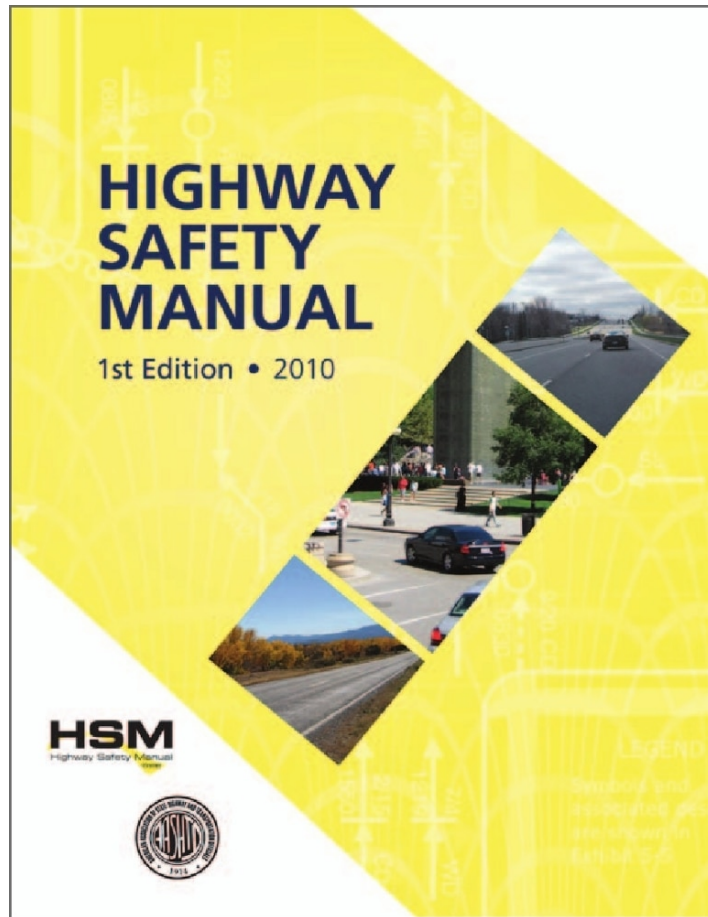
Northeast Transportation Safety Conference

October 28-29, 2019 – Burlington, VT

Agenda

- Project Background
- Changes in Practice
- Highlights of CRSMS Tool
- Screenshots of Select Modules
- Challenges & Lessons Learned
- Next Steps

Highway Safety Manual



Changes in Practice

BEFORE

- Annual Hot Spot Locations
- Manual Query/Diagrams/Charts/Test
- No formal project analysis documentation
- Reactive project planning

AFTER

- Screening any time by geographical area
- Convenient data access & chart/test creation
- Save records of entire project analysis process
- Proactive project planning



Highlights of the CRSMS Tool

- Web-based application & easy access
- Easy data manipulation & homogeneous segmentation
- Screening by geographical areas, emphasis areas, crash types & severity levels, roads, facility types, etc.
- Multiple performance measures & screening methods
- Visualize results on maps
- Multiple diagnosis tools including maps, statistic tests, charts, collision diagrams, crash trees, etc.
- Select & compare countermeasure using CMF Clearinghouse data
- Create reports, share, download & save

Practical Application

- Used by CTDOT to identify locations for improvements
- Used by consultants contracted with CTDOT
- Introduced to CT local transportation agencies
- Open to other state DOTs nationwide
- Over 100 users: CTDOT, COGs, researchers, other DOTs

CRSMS Dashboard



- Dashboard
- Data Management
 - Prepare Data for Analysis Tools
 - Prepare Homogeneous Sites for SPF
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Known Issues

Network Screening: The intersection data contains 100% state-state and 80% post-processed state-local intersections

Application Updates

May 29, 2019, 18:00

- Multiple:** (Enhancement) Added clustered "Actions" buttons to module grids and pinned to the right for better user experience
- Network Screening:** (New Feature) Show notifications to users on the network screening results page if the underlying engine or data gets updated
- Network Screening:** (New Feature) Added "Facility Type" with other additional data fields to the network screening result grid
- Network Screening:** (Enhancement) Improved the styling of the ESRI popup in the network screening results
- Network Screening:** (Enhancement) Dynamically reorder the performance measures in the network screening results grid based on robustness
- Diagnosis:** (New Feature) Added an instruction tab to Collision Diagram
- Diagnosis:** (New Feature) Added bicycle, pedestrian, and animal symbols to Collision Diagram
- Diagnosis:** (New Feature) Allow switching to different colors for the callout bubble in Collision Diagram
- Diagnosis:** (New Feature) Allow remove and restore crash groups in Collision Diagram
- Diagnosis:** (Enhancement) Improved the drawing tools in the Collision Diagram to allow adding text, point, line, or polygon
- Diagnosis:** (Enhancement) Allow editing and updating features in the drawing tools in the Collision Diagram
- Diagnosis:** (Enhancement) Added dimension information to the print templates in Collision Diagram
- Diagnosis:** (Enhancement) Allow adding sites directly to diagnosis from the filtering panel without navigating to the map
- Diagnosis:** (Enhancement) Improved the process of adding intersections to ad-hoc diagnosis reports
- Diagnosis:** (Bugfix) Texts do not preserve changes in the preview in Collision Diagram
- Data Management:** (New Feature) Admins can keep countermeasures up-to-date with the CMFClearinghouse with one click
- Countermeasure Selection:** (New Feature) Added the Countermeasure Selection Module (try it!)

CRSMS Modules



Network Screening ⓘ

Start a New Scenario ⓘ

Name Description (optional) START

Scenario Id	Name	Created By ▼	Scenario Status	Last Updated ↓	Actions
	<input type="text"/>	<input type="text" value="shan"/>	<input type="text"/>		
> 9928	DGHHKL	shanshan.h.zhao@uconn.edu	Incomplete	May 29, 2019, 12:	
> 9892	Danbury sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	
> 9891	Meriden sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	
> 9890	West Hartford sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	
> 9889	New Britain sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	
> 9888	Norwalk sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	
> 9887	Waterbury sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	
> 9886	Stamford sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	
> 9885	Hartford sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	
> 9884	New Haven sign int	shanshan.h.zhao@uconn.edu	Complete	Apr 12, 2019, 15:3	

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Network Screening

ESTABLISH FOCUS

Emphasis Areas (optional) ⓘ

- DUI Related
- Aggressive Driving Related
- Young Driver Involved
- Motorcycle Involved
- Qualifying Commercial Vehicle Involved
- Adverse Weather Involved
- Wet Road Surface Involved
- Pedestrian Involved
- Bicycle Involved

IDENTIFY NETWORK

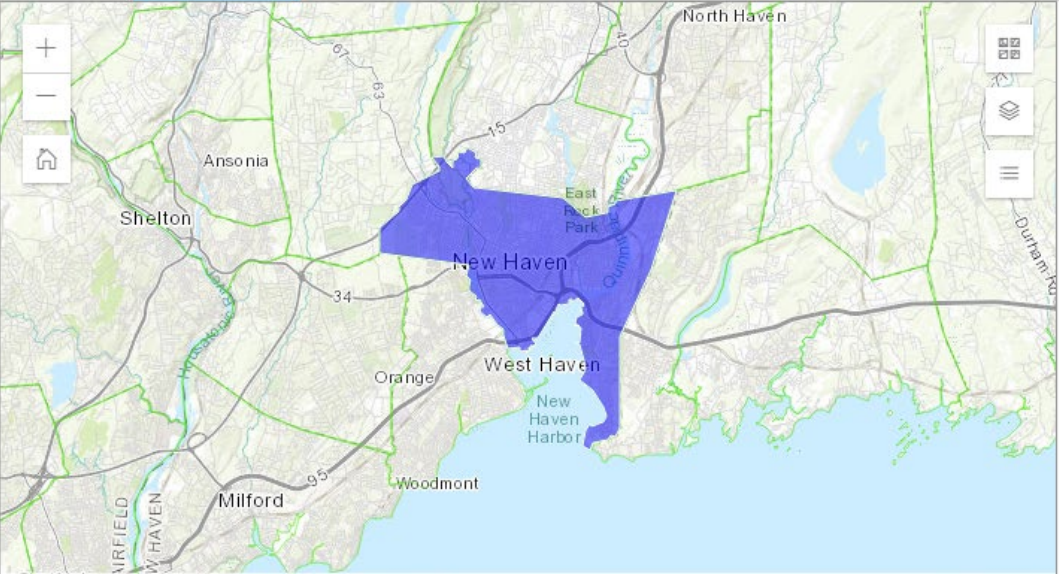
Network Area of Interest

Year Range from 2014 to 2016

Facilities

- All Sites
- > Ramp Segments
- > State Roadway Segments
- > Town Roadway Segments

Network Area of Interest



Area of Interest

BOUNDARY TYPE ▾ Towns

BOUNDARY NAME ▾

Item
⋮ New Haven
1 items

RESET

MassGIS | Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS Powered by Esri

Diagnosis – Geolocation

CRSMS

Connecticut Roadway Safety Management System - CRSMS

Select Date Range From 01/01/2015 To 03/22/2018 (The default is the Network Screening data range if sites come from Network Screening)

Diagnosis Summary | Crash Data | Summary Statistics | Test of Proportions | Collision Diagram | Crash Tree | Review Supporting Documentation | View Site Condition

Map

Check to include in the final report | Export the map

1. Allow users to select Diagnosis year range; allow selecting to the most available crash data from the db
2. Put it on the top to allow users change it while they are on other pages
3. Give warnings if the selected date range is too small to result in with robust conclusions

2. Basic zoom and pan mapping functionality
3. 2nd version: add other layers including traffic, roadway geometry. The option of a roadway geometry table is discussed - may require the same efforts as plotting the data to the map

Diagnosis – Crash Summaries

CRSMS

crsms-app.grove.ad.uconn.edu/safety-analysis/diagnosis

Connecticut Roadway Safety Management System - CRSMS

Select Date Range From To (The default is the Network Screening data range if sites come from Network Screening)

Map **Diagnosis Summary** Crash Data **Summary Statistics** Test of Proportions Collision Diagram Crash Tree Review Supporting Documentation View Site Condition

Check to include in the final report Check to include in the final report

Month and Date of Crashes

	2015		2016		2017		2018	
	Crashes	% of All Crashes	Crashes	% of All Crashes	Crashes	% of All Crashes	Crashes	% of All Crashes
Jan	8,935	8.0%	9,110	7.8%	10,387	9.2%	329	79.7%
Feb	9,630	8.7%	9,400	8.1%	8,576	7.6%	84	20.3%
Mar	9,559	8.6%	8,636	7.4%	8,963	8.0%		
Apr	7,681	6.9%	9,297	8.0%	8,387	7.4%		
May	9,120	8.2%	9,697	8.3%	9,589	8.5%		
Jun	9,152	8.2%	10,023	8.6%	9,908	8.8%		
Jul	9,304	8.4%	9,659	8.3%	9,159	8.1%		
Aug	8,829	7.9%	9,517	8.2%	9,089	8.1%		
Sep	9,213	8.3%	9,283	8.0%	9,127	8.1%		
Oct	10,033	9.0%	10,577	9.1%	10,322	9.2%		
Nov	9,599	8.6%	10,247	8.8%	9,851	8.7%		
Dec	10,145	9.1%	10,775	9.3%	9,243	8.2%		
Total	111,200	100.0%	116,221	100.0%	112,601	100.0%	413	100.0%

Check to include in the final report

Time and Day of the Week

	Hour of Crash Time											Crashes	% of All Crashes			
	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM			11 AM		
Sunday																
Monday																
Tuesday																
Wednesday																
Thursday																
Friday																
Saturday																
Saturday																
Grand Total																

Hour of Crash Time	Crashes	% of All Crashes
12 AM	5,669	1.67%
1 AM	4,928	1.45%
2 AM	4,373	1.28%
3 AM	2,777	0.82%
4 AM	2,594	0.76%
5 AM	3,917	1.15%
6 AM	8,054	2.37%
7 AM	16,205	4.76%
8 AM	19,583	5.75%
9 AM	16,092	4.73%
10 AM	16,062	4.72%
11 AM	18,127	5.32%
12 PM	21,418	6.29%
1 PM	21,433	6.30%
2 PM	24,098	7.08%
3 PM	28,021	8.23%
4 PM	28,863	8.48%
5 PM	29,244	8.59%
6 PM	19,627	5.77%

Check to include in the final report

Hints same types of crashes certain time of a day

Please summarize your findings from this tab in this space

1. The graphs and table types will be predefined and not allow modification for Version 1
 2. In future versions, enhance by allowing modifications (e.g., range of the axis)

USER MANUAL CONTACT

This web site is exempt from discovery or admission under 23 U.S.C. 409.

Diagnosis – Collision Diagram

CRSMS

crsms-app.grove.ad.uconn.edu/safety-analysis/diagnosis

Connecticut Roadway Safety Management System - CRSMS

Select Date Range From 01/01/2015 To 03/22/2018 (The default is the Network Screening data range if sites come from Network Screening)

Map Diagnosis Summary Crash Data Summary Statistics Test of Proportions **Collision Diagram** Crash Tree Review Supporting Documentation View Site Condition

Check to include in the final report Export

TOTAL ACCIDENTS = 21
TOTAL INJURIES = 11

CRASH DIAGRAM

ROUTE 69 (WINDMILL AVENUE)
PEACEDALE STREET
MAPLE AVENUE

RT. 69 FROM MILE 29.65 TO 29.85
ACCIDENT RECORDS FROM
JAN. 2008 TO DEC. 2010

LEGEND

X	Y	X = NO. OF ACCIDENTS	Y = NO. OF INJURIES
—	—	BACKING	
↗	—	ANGLE	
—	—	REAR-END	
↶	—	TURNING-OPP. DIRECTION	
↷	—	TURNING-SAME DIRECTION	
—	—	FIXED OBJECT	
—	—	SIDESWIPE-SAME DIRECTION	

Hints clustered at a location same types of crashes
certain time of a day

Please summarize your findings from this tab in this space

Diagnosis – Site Conditions

CRSMS

Connecticut Roadway Safety Management System - CRSMS

Select Date Range From To (The default is the Network Screening data range if sites come from Network Screening)

Map **Diagnosis Summary** Crash Data Summary Statistics Test of Proportions Collision Diagram Crash Tree Review Supporting Documentation View Site Condition

Check to include in the final report

Check to include in the final report

Hints clustered at a location same types of crashes
certain time of a day

Please summarize your findings from this tab in this space

74 COMMON-1920x1080: 2016 CT-Route 1 North - Front

Left-Click for Zoom Blue Box
Right-Click for Window Menu

Checkpoints - 2016 CT-Route 1 North

Miles	Kilometers	Description
-0.019	-0.030	<Photologging Begins> Run Code 6A80V248>
Greenwich	0.000	Begin DS 1 @ New York State-Line[90]
0.020	0.032	Northbound-Byram Road(South) [70]
0.020	0.032	Northbound-Byram Road(North) [70]
0.040	0.064	Northbound-Connector From Byram Road North
0.250	0.402	Western Junior Highway [90]

Control - 2016 CT-Route 1 North

Views: Front, Pavement

Selected Segments: 2016 CT-Route 1 North, 2016 CT-Route 1 South

0.050 km, -0.030 km, 0.030 km

HELP PREVIOUS NEXT SEARCH

OPTIONS HELP NEW EXIT Homepage

Depending on access to different APIs, this component could use one or more from the below:

1. CTDOT Digital Highway
2. Google Streeview
3. Bing BirdEye
4. Mapillary

Countermeasure Selection

< COUNTERMEASURE SELECTION

SR-530 and WETHERSFIELD AV in Hartford

OPEN DIAGNOSIS REPORT IN NEW TAB

SAVE COUNTERMEASURE SELECTION

COMPLETED

Countermeasures Diagnosis Summary Roadway Characteristics Selection Summary

Press 'Enter' to search keywords...



CLEAR ALL

traffic

signal

Type key word

Show Only Selected CMFs

Countermeasure \updownarrow	CMF ID \updownarrow	Source \updownarrow	Category \updownarrow	Subcategory \updownarrow	CMF \updownarrow	CMF Std Error \updownarrow	CRF % \updownarrow	CRF Std Error \updownarrow	Crash Type \updownarrow
<input type="checkbox"/> Add 3-inch yellow retroreflective sheeting to signal backplates	<input checked="" type="checkbox"/> 1410	Clearinghouse	Intersection traffic control	Traffic control visibility	0.85		15		All
<input type="checkbox"/> Add additional signal and upgrade to 12-inch lenses	2 CMF(s)	Clearinghouse	Intersection traffic control	Traffic control visibility	0.69 to 0.83		17 to 31		All
<input type="checkbox"/> Add all-red clearance interval	2 CMF(s)	Clearinghouse	Intersection traffic control	Signal phasing or timing	0.7 to 0.85		15 to 30		All, Angle
<input checked="" type="checkbox"/> Add all-red clearance interval (from 0 to 1 second)	<input checked="" type="checkbox"/> 1351	Clearinghouse	Intersection traffic control	Signal phasing or timing	1		0		Angle
<input type="checkbox"/> Add exclusive pedestrian phasing	5 CMF(s)	Clearinghouse	Intersection traffic control	Signal phasing or timing	0.65 to 0.97		3 to 35		Vehicle/pedestrian, ...
<input type="checkbox"/> Add signal (additional primary head)	7 CMF(s)	Clearinghouse	Intersection traffic control	Traffic control visibility	0.5799 to 0.9		10 to 42		All, Rear end, Angle
<input type="checkbox"/> Adjust All-Red Clearance Interval	2 CMF(s)	Clearinghouse	Intersection traffic control	Signal phasing or timing	0.6 to 0.8		20 to 40		Angle, Head on, Side...
<input type="checkbox"/> Change difference between actual and ITE-recommended red clearance interv...	3 CMF(s)	Clearinghouse	Intersection traffic control	Signal phasing or timing	0 to 0		0 to 0		All, Rear end, Angle
<input type="checkbox"/> Change difference between actual and ITE-recommended yellow change interv...	3 CMF(s)	Clearinghouse	Intersection traffic control	Signal phasing or timing	0 to 0		0 to 0		All, Rear end, Angle
<input type="checkbox"/> Change from 5-section "doghouse" protected/permisive left turn to flashing y...	4 CMF(s)	Clearinghouse	Intersection traffic control	Signal phasing or timing	0.747 to 0.934		6.6 to 25.3		All, Left turn
<input type="checkbox"/> Change from permisive only to flashing yellow arrow permisive only	4 CMF(s)	Clearinghouse	Intersection traffic control	Signal phasing or timing	0.3489 to 0.892		10.8 to 65.09...		All, Left turn
<input type="checkbox"/> Change from permisive only to flashing yellow arrow protected/permisive left...	4 CMF(s)	Clearinghouse	Intersection traffic control	Signal phasing or timing	0.5919 to 0.935		6.5 to 40.79...		All, Left turn
<input checked="" type="checkbox"/> Change from permisive to protected	<input checked="" type="checkbox"/> 4653	Clearinghouse	Intersection traffic control	Signal phasing or timing	0.94		6		All

Rows: 961 of 8110 Selected: 4

Economic Appraisal



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Economic Appraisal

For an explanation on the Economic Appraisal process, see: [USER MANUAL - USING MODULE 4 - ECONOMIC APP...](#)

Diagnosis ID	Name	Crash Date Range	Created By	Status	Last Updated ↓	Actions
2817	Test CM Mark Complete	Jan 1, 2016 - Dec 31, 2018	seth.kenbeek@uconn.edu	Complete	Oct 8, 2019, 16:09	
2831	I-84 between 61.880 and 62.040	Jan 1, 2016 - Dec 31, 2018	shanshan.h.zhao@uconn.edu	Incomplete	Sep 27, 2019, 14:10	
2837	CT-80 AND CT-103 IN NEW HAVEN	Jan 1, 2016 - Dec 31, 2018	shanshan.h.zhao@uconn.edu	Incomplete		

Economic Appraisal



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< ECONOMIC APPRAISAL

I-84 between 61.880 and 62.040

[OPEN COUNTERMEASURE SELECTION](#) [MARK COMPLETE](#) [DOWNLOAD](#) [SAVE](#)

Solution Summary Solution 1 ✕ Solution 2 ✕ + Add Solution

Show Columns KABCO KABC KA

Solution... ↓↑	Selected Countermeasure(s)	Observed Crashes... ↓↑	Expected Crashes w/o Solution ... ↓↑	Expected Crashes Reduced w/ Solution... ↓↑	Present Value of
Solution 1	Add lane lines on multilane road Install chevron signs on horizont	105	105	85	\$22,898,536
Solution 2	Illumination Implement shoulder widening in	210	210	170	\$42,651,014

Put summary here...

Economic Appraisal



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< ECONOMIC APPRAISAL

I-84 between 61.880 and 62.040

OPEN COUNTERMEASURE SELECTION

MARK COMPLETE

DOWNLOAD

SAVE

Solution Summary Solution 1 Solution 2 + Add Solution

ADD OR REMOVE COUNTERMEASURE(S)

RENAME SOLUTION

Discount Rate (%) 3
Annual Traffic Growth Factor (%) 5

Countermeasure 1: Illumination

Comment e.g. X=6, Y=8
Service Life (years) * 10

CMF ID	Crash Types	Crash Severities	CMF Value
565	All	K (fatal)	0.31

Countermeasure 2: Implement shoulder widening in conjunction with shoulder rumble strip installation on freeways

Comment e.g. X=6, Y=8

MORE

Present Value Benefits (KABCO)
\$42,651,014

Present Value Costs
\$1,700,000

Benefit/Cost Ratio (KABCO)
25.09

Project Prioritization



< PROJECT PRIORITIZATION

(Example) Project prioritization report for a few state road sites within town of Hartford

Project Funding Source _____ Prioritize By Budget Limit \$

No sites or projects are in this profile. Start adding sites and projects to the profile by checking the list below.

Include In Analysis	Must Report In Results	Economic Appraisal ID	Economic Appraisal Name	Proposed Revisions	Assessment Date	KABCO Reduced	KABC Reduced	KA Reduced	Costs	Benefits	Net Present Value	B/C Ratio
<input type="checkbox"/>	<input type="checkbox"/>	19	I-91 exit 1 to exit 2	Install shoulder rumble strip	09/01/2019	xx	xx	xx	xx	xx	xx	xx
<input type="checkbox"/>	<input type="checkbox"/>	19	I-91 exit 1 to exit 2	Widen shoulder width	09/01/2019	xx	xx	xx	xx	xx	xx	xx
<input type="checkbox"/>	<input type="checkbox"/>	245	Multiple sites for installing rumble strips	Install shoulder rumble strip	08/15/2019	xx	xx	xx	xx	xx	xx	xx
<input type="checkbox"/>	<input type="checkbox"/>	12	Intersection xx	Convert to signal control	07/10/2019	xx	xx	xx	xx	xx	xx	xx
Total						xx	xx	xx	xx	xx	xx	xx

Run Optimization

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Challenges/Lessons Learned

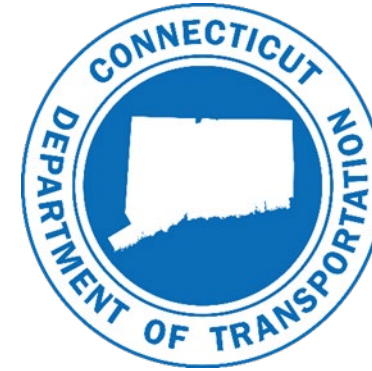
- Lacking certain safety data could delay robust analysis
- Collaborate with relevant data stewards
- Develop plans to collect missing data that meet multiple needs (not just safety)
- Regular collaboration & communication between client & development team
- Have back-ups for personnel - overlapping expertise is desirable
- Prioritize & balance bug fixes, enhancements & new developments

Next Steps

- Deliver Remaining Modules
- Additional Training and Workshops
- Integration with Other Data-Driven Projects at CTDOT (e.g., data linkage)
- Work with other States to promote Roadway Safety nationwide

For More Information

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