American Association of State Highway and Transportation Officials
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Exploring Transportation Safety Evaluation

December 15, 2021 11AM EST

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

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

Kelly Hardy, AASHTO

Exploring Transportation Safety Evaluation

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This webinar features infrastructure transportation safety evaluation approaches, tools and outcomes employed by state transportation agencies around the United States.

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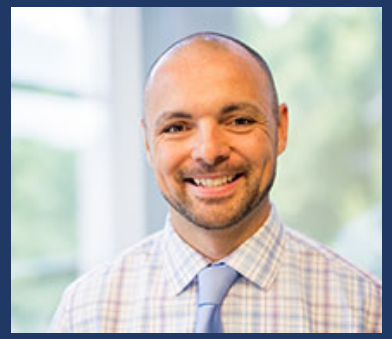

Frank Gross, Ph.D.
VHB, NCHRP 52-08

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Illinois DOT

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North Carolina DOT

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Discussion

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

Practices for Balancing Safety Investments in a Comprehensive Safety Program

NCHRP Synthesis 52-08

Frank Gross
VHB Safety Practice Leader

December 7, 2021

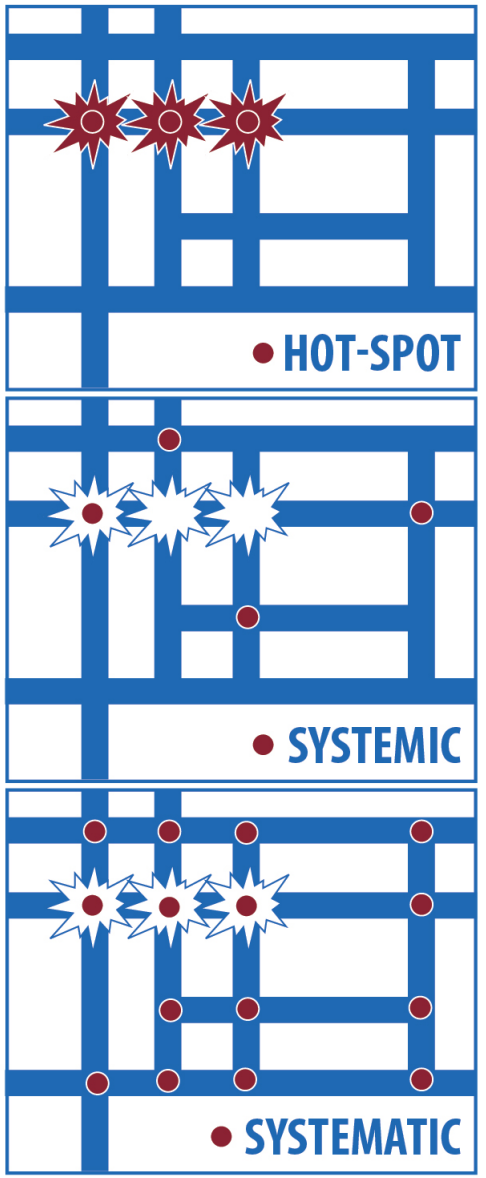
Project Goals

Document current State DOT practices for:

- Identifying HSIP projects
- Prioritizing HSIP projects
- Evaluating HSIP projects

Look for differences in:

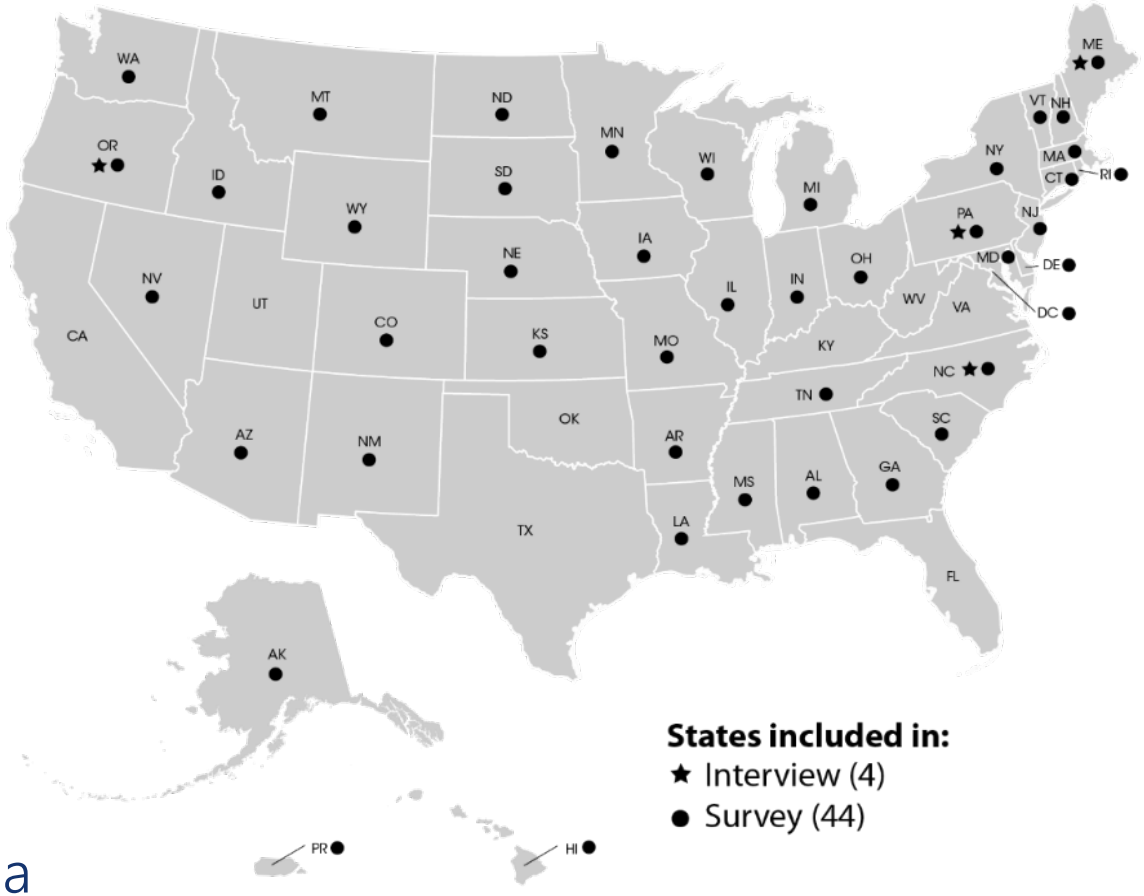
- State vs. local projects
- Spot, systemic, and systematic approaches



Approach

Three primary sources:

1. Literature review
   - 36 State HSIP/Safety Program manuals
   - State HSIP annual reports
   - Federal and State HSIP resources
2. Survey of State safety programs
   - 44 DOTs (85% response rate)
3. In-depth interviews (case examples)
   - Maine, North Carolina, Oregon, Pennsylvania



Project Evaluation Summary

1. State DOT guidance on project evaluations
   - **Ranges**: no reference to detailed procedures
2. Evaluation methods
   - **Simple before-after** is most common for project evaluations
   - Some states use **more reliable methods to develop CMFs**
3. Differences by project type (e.g., spot vs. systemic or State vs. local road)
   - **Most states use same framework/method** for evaluating all projects

Survey Results

Project evaluation methods on State system

Method	Spot	Systemic
Simple before-after	32	23
Empirical or Full Bayes before-after	10	9
Comparison group before-after	5	8
Regression cross-section	1	1
Other	4	6
We don't evaluate	5	9

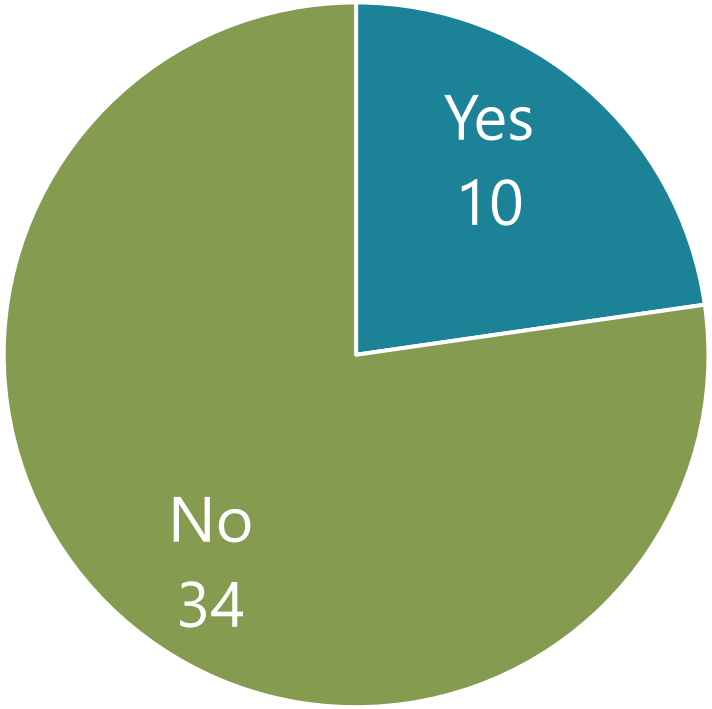
Survey Results

"Other" methods

- Colorado: has not determined a methodology for systemic projects *yet*
- Connecticut: plans to hire consultant to conduct before-after studies
- Illinois: depends on data availability
- Maryland: spot projects evaluated on case-by-case basis
- Massachusetts: EB method when possible; alternative methods as needed; no evaluation of Every Day Counts initiatives and proven countermeasures
- Michigan: performs before-after studies separately for State and local projects
- Ohio: performs before-after studies with traffic volume correction

Survey Results

Different evaluation method on Local system?



Project evaluation methods on Local system

Method	Spot	Systemic
Simple before-after	4	3
Empirical or Full Bayes before-after	2	1
Comparison group before-after	1	1
Regression cross-section	0	0
Other	2	4
We don't evaluate	4	3

Survey Results

"Other" methods

- Maryland: developing program to allocate HSIP funds to locals starting in FY22. No evaluations done yet.
- Michigan: performed analysis of FY 2013 local agency programs to assess program and countermeasure effectiveness. Assessed projects, countermeasures, and program using two techniques: simple before-after and Empirical Bayes before-after.
- New York: currently has Post Implementation Evaluation System. New safety management system scheduled for implementation in Fall 2021 will be able to evaluate State and local road projects.
- Washington: measures systemic projects on a larger scale (often agency wide) in a simple before-after comparison.

Noteworthy Examples, Challenges, and Opportunities

Noteworthy Examples

- Use simple methods for project evaluations
- Use advanced methods for systemic and countermeasure evaluations
- Focus on change in target crashes rather than total crashes for project evaluations
- Share evaluation results
- Develop tools/spreadsheet to facilitate EB analysis
  - NC's spreadsheet tool updates CMFs automatically as new sites are added
  - NY's PIES tool automates process

Noteworthy Examples, Challenges, and Opportunities

Challenges

- May be difficult to identify specific project locations for bundled systemic projects (e.g., if project records indicate “multiple locations” without listing specific sites)

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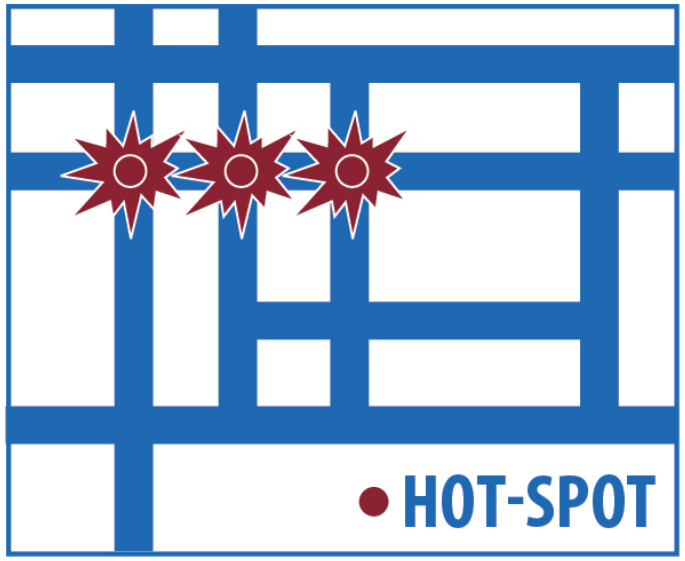
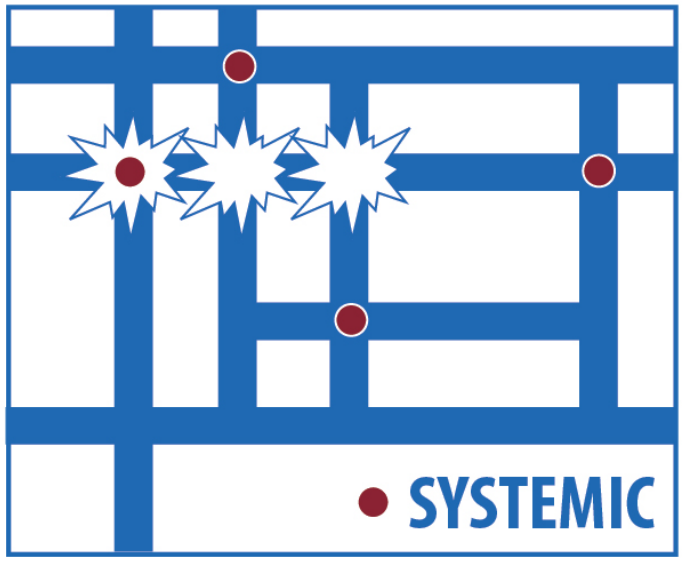
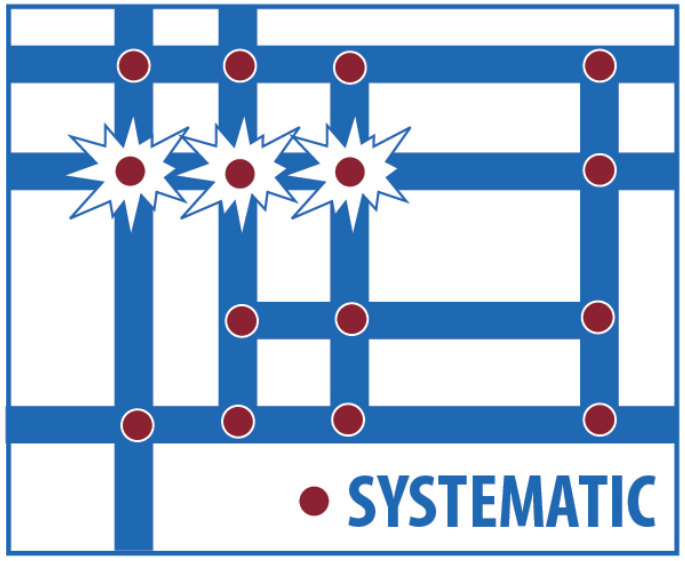
Noteworthy Examples, Challenges, and Opportunities

Challenges

- Time consuming to properly evaluate systemic projects
  - Large number of treated locations
  - Need to confirm associated data (e.g., construction date, locations, crash data)
  - May not be feasible to perform detailed crash analyses for each systemic site



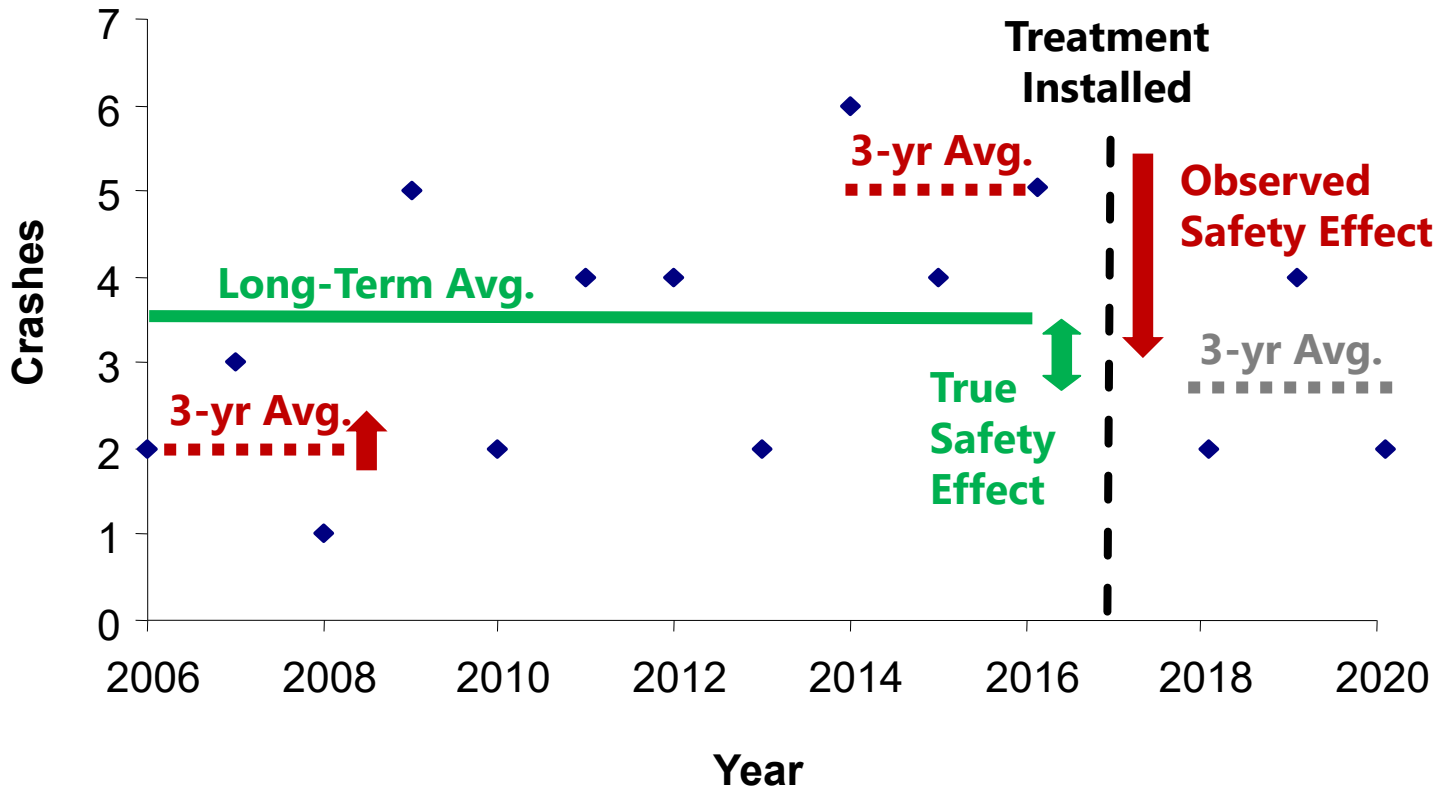




Noteworthy Examples, Challenges, and Opportunities

Challenges

- Regression-to-the-mean
  - Hot-spot: sites selected based on high crashes before implementation
  - Systemic: sites with few or no crashes before implementation



Noteworthy Examples, Challenges, and Opportunities

Opportunities

- **Use more rigorous methods**
  - Account for regression-to-the-mean
- **Develop guidance or training**
  - Document nuances of evaluating systemic improvements
- **Evaluate effectiveness of systemic countermeasures**
  - Determine if effectiveness remains as prevalence increases (i.e., is strategy as effective at sites with lower potential for safety improvement)
- **Share evaluation results**
  - Convince people (internal and external) of potential benefits of systemic
  - Retain (and even increase) safety funding
  - Increase confidence in investments

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Illinois Safety Evaluation

Katherine Beckett, P.E, RSP2 B/I

December 15, 2021

Illinois Department of Transportation

Illinois Safety Evaluation

- Overview
- Data
- Challenges and solutions
- Methodology
- Results
- Communication and use of results
- Future development of evaluation

Overview

- Objectives
  - Understand the effectiveness of individual HSIP project investments, countermeasures and overall program
  - Identify opportunities to improve HSIP allocation to maximize the return on investment
  - Inform future decisions regarding investment location, project type and conditions
  - Use evaluation results to proactively enhance and improve the program

- Develop a tool to evaluate the effectiveness of all HSIP investments
  - After SAFETEA-LU and the shift to reducing fatalities and serious injuries
  - User friendly, versatile, informative
  - Accessible by practitioners and leaders, state and local agencies

Data Summary

- HSIP Applications Data
  - Over $300M in projects
  - 1,037 HSIP Applications + Attachments
  - State and local jurisdiction segments, intersections, corridors
- Contract Data
  - All Contracts Using Safety Funds and programmed after 2004
  - 905 Programmed Contract Numbers
  - Approximately 2600 miles
- Construction Data
  - Contract Plans
  - Contract Pay Items
- Crash Data
  - KAB crash severities
  - 2001 to 2016

Challenges & Solutions

- Expansive range of roadway conditions
- Safety performance functions (SPFs) available for state routes only
- SPF were not calibrated for all of the years
- Data set too large, varied for empirical bayes
- Project data
  - Actual contract may differ from HSIP application in the geographical extent or the scope of work
  - Type of treatment was too general for the purpose of evaluation

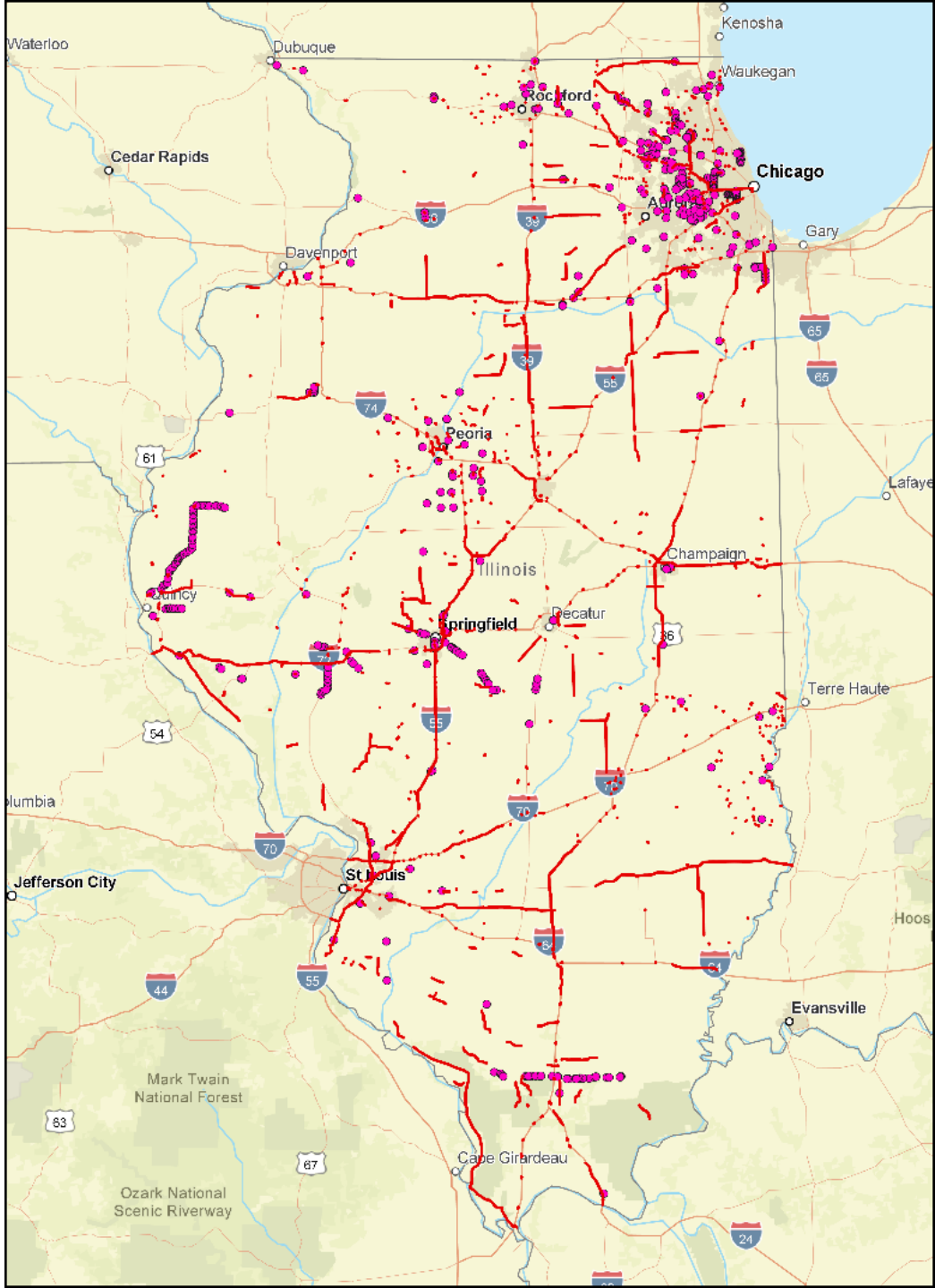
- Evaluation Based on Construction Data
  - Improved location accuracy
  - Treatment based on plans and pay items
- Large data over many years
  - Reduced the effect of regression to the mean

Summary of Contracts Evaluated

	Number of Evaluated Contracts	Total Completion Amount	Total HSIP Funds
Total	370	$314.9M	$227.7M
State HSIP	309 (84%)	$274.9M (87%)	$203M (89%)
Local HSIP	61 (16%)	$40.0M (13%)	$24.7M (11%)
Hotspot	273 (74%)	$238.7M (76%)	$163.8M (72%)
Systemic	97 (26%)	$76.2M (24%)	$63.9M (28%)

Extensive Evaluation

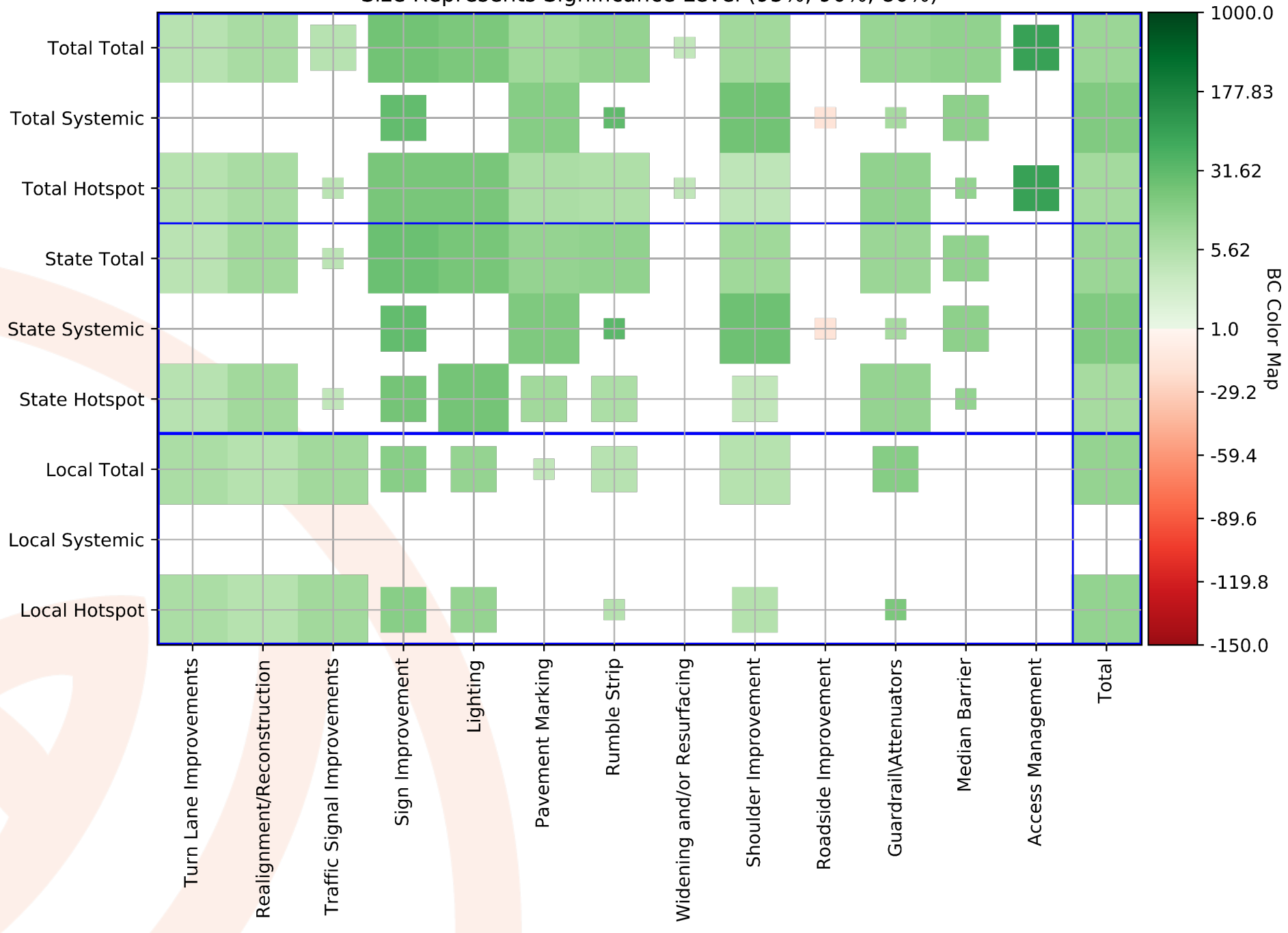
- 370 Contracts
- +2100 Miles
- +500 Intersections
- +86,000 KAB Crashes in Before-Period
- +71,000 KAB Crashes in After-Period
- 2004 Before Contract-Years
- 1892 After Contract-Years

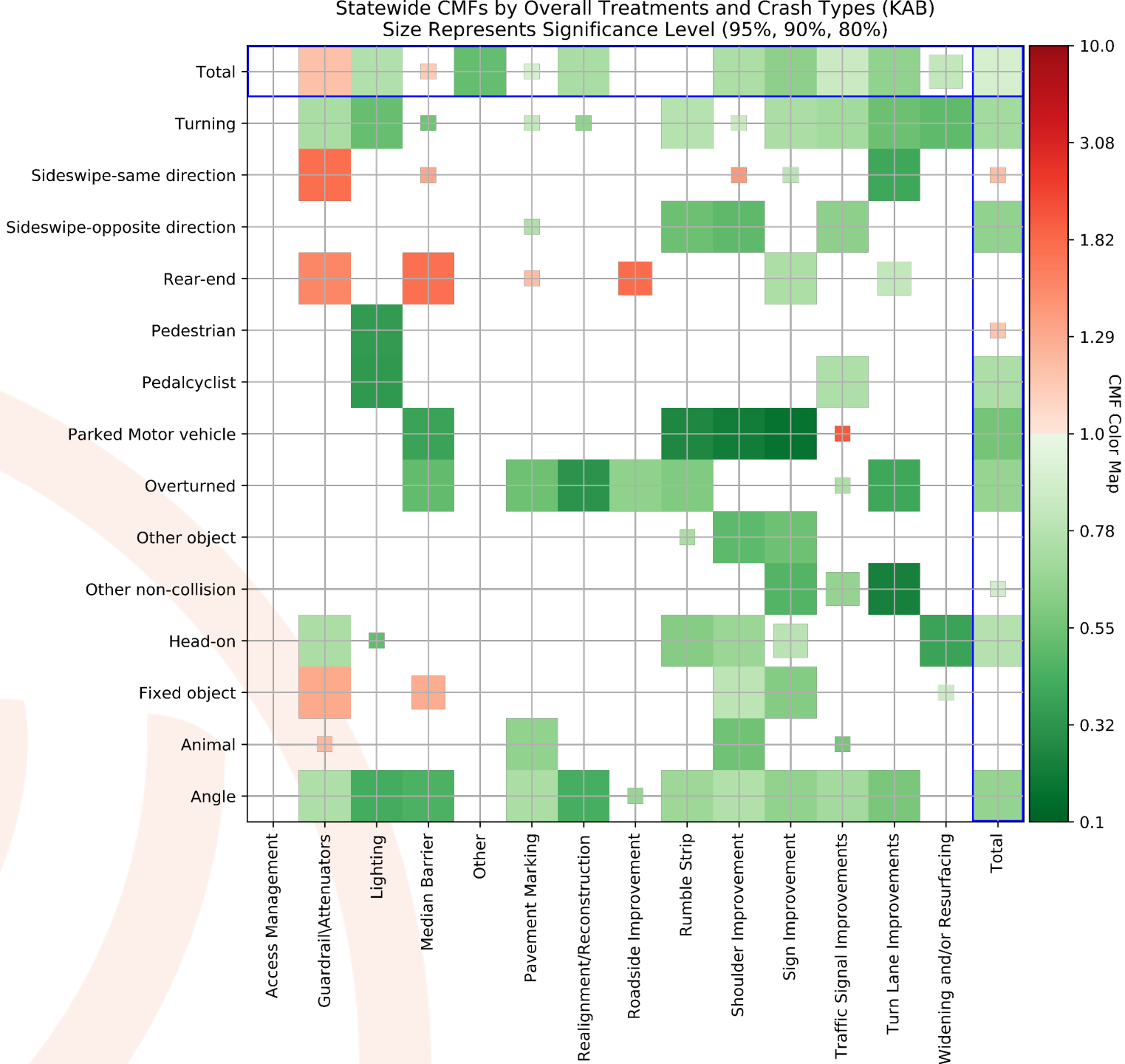


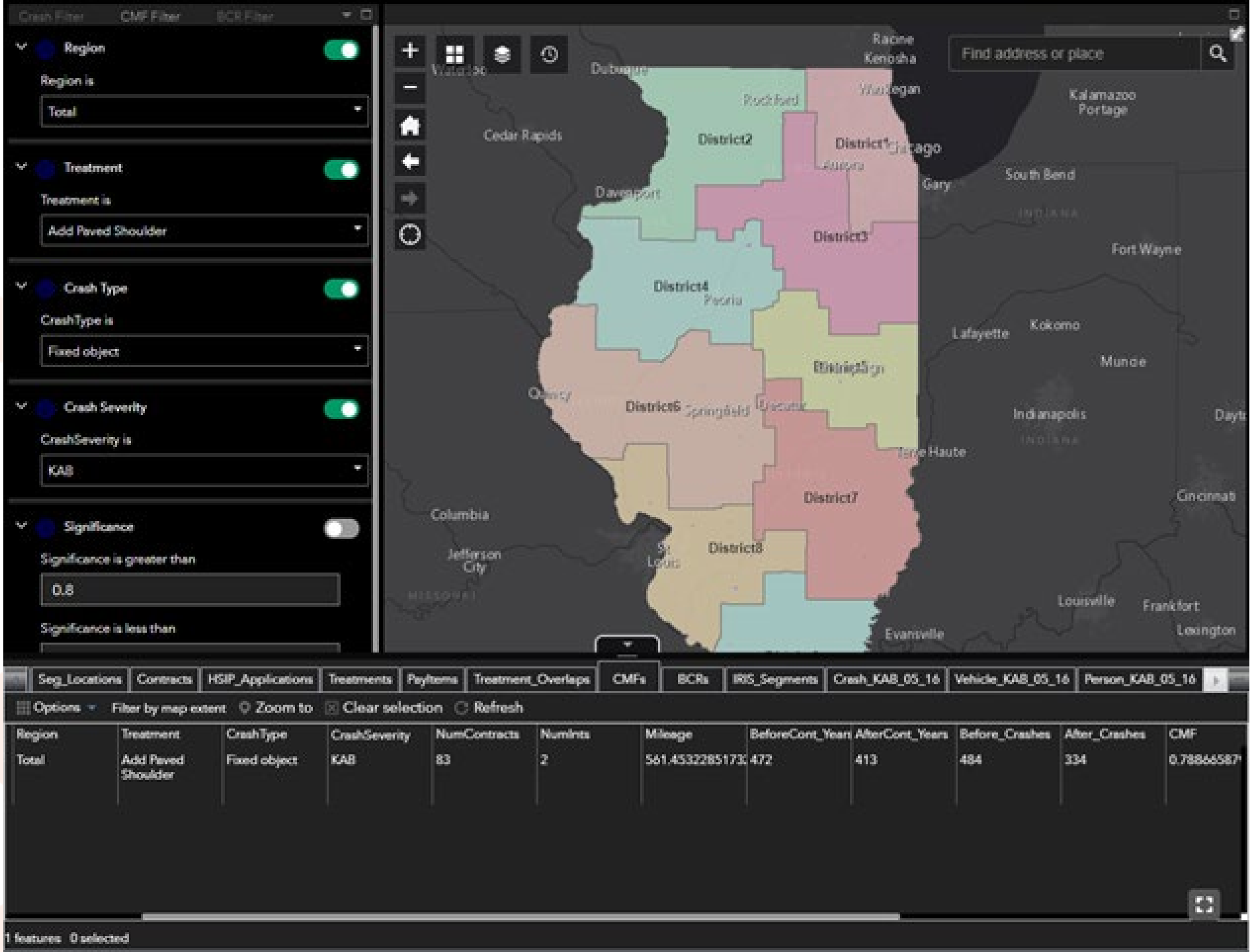
Analysis Methodology

- Benefit-Cost Analysis
  - Total Completion Amounts (2019 Dollars): **$367.96M**
  - Total HSIP Funds (2019 Dollars): **$266.36M (72%)**
  - Total Statewide BC Ratio based on Completion Cost: **9.61**
  - Total Statewide BC Ratio based on HSIP Funds: **13.27**

- Crash Modification Factor development


Statewide BCs by Overall Treatments (KAB)
Size Represents Significance Level (95%, 90%, 80%)
Total Total
Total Systemic
Total Hotspot
State Total
State Systemic
State Hotspot
Local Total
Local Systemic
Local Hotspot
Turn Lane Improvements
Realignment/Reconstruction
Traffic Signal Improvements
Sign Improvement
Lighting
Pavement Marking
Rumble Strip
Widening and/or Resurfacing
Shoulder Improvement
Roadside Improvement
Guardrail\Attenuators
Median Barrier
Access Management
Total
1000.0
177.83
31.62
5.62
1.0
-29.2
-59.4
-89.6
-119.8
-150.0
BC Color Map


Statewide CMFs by Overall Treatments and Crash Types (KAB)
Size Represents Significance Level (95%, 90%, 80%)
Total
Turning
Sideswipe-same direction
Sideswipe-opposite direction
Rear-end
Pedestrian
Pedalcyclist
Parked Motor vehicle
Overturned
Other object
Other non-collision
Head-on
Fixed object
Animal
Angle
Access Management
Guardrail\Attenuators
Lighting
Median Barrier
Other
Pavement Marking
Realignment/Reconstruction
Roadside Improvement
Rumble Strip
Shoulder Improvement
Sign Improvement
Traffic Signal Improvements
Turn Lane Improvements
Widening and/or Resurfacing
Total
CMF Color Map
10.0
3.08
1.82
1.29
1.0
0.78
0.55
0.32
0.1


Crash Filter
CMF Filter
BCR Filter
Region
Region is
Total
Treatment
Treatment is
Add Paved Shoulder
Crash Type
CrashType is
Fixed object
Crash Severity
CrashSeverity is
KAB
Significance
Significance is greater than
0.8
Significance is less than
Find address or place
Racine
Kenosha
Dubuque
Waukegan
Rockford
Kalamazoo
Portage
Cedar Rapids
District2
District1
Chicago
Aurora
Gary
South Bend
Davenport
District3
Fort Wayne
District4
Peoria
Lafayette
Kokomo
Muncie
Quincy
District6
Springfield
Decatur
Indianapolis
Terre Haute
District7
Cincinnati
Columbia
Jefferson City
St Louis
District8
Louisville
Frankfort
Evansville
Lexington
Seg_Locations
Contracts
HSIP_Applications
Treatments
PayItems
Treatment_Overlaps
CMFs
BCRs
IRIS_Segments
Crash_KAB_05_16
Vehicle_KAB_05_16
Person_KAB_05_16
Options
Filter by map extent
Zoom to
Clear selection
Refresh
Region
Treatment
CrashType
CrashSeverity
NumContracts
NumInts
Mileage
BeforeCont_Years
AfterCont_Years
Before_Crashes
After_Crashes
CMF
Total
Add Paved Shoulder
Fixed object
KAB
83
2
561.4532285173
472
413
484
334
0.78866587
1 features 0 selected

Summary

- Outcomes
  - Understand the effectiveness of individual HSIP project investments, countermeasures and overall program
  - Identify opportunities to improve HSIP allocation
  - Outcomes are guiding future investments

- HSIP Investment Evaluation Tool
  - User friendly, versatile, informative
  - Review specific sites or group by attributes
  - Online portal accessible by practitioners and leaders

Future Developments

- HSIP Safety Evaluation
  - Add additional crash data through 2020
  - Add additional construction contracts
  - Updating local SPFs
  - Compare state CMFs to CMF Clearinghouse; update IL Benefit Cost Tool
  - Continue to integrate evaluation output in project programming and development
- Evaluation Highway Safety Program enforcement investments

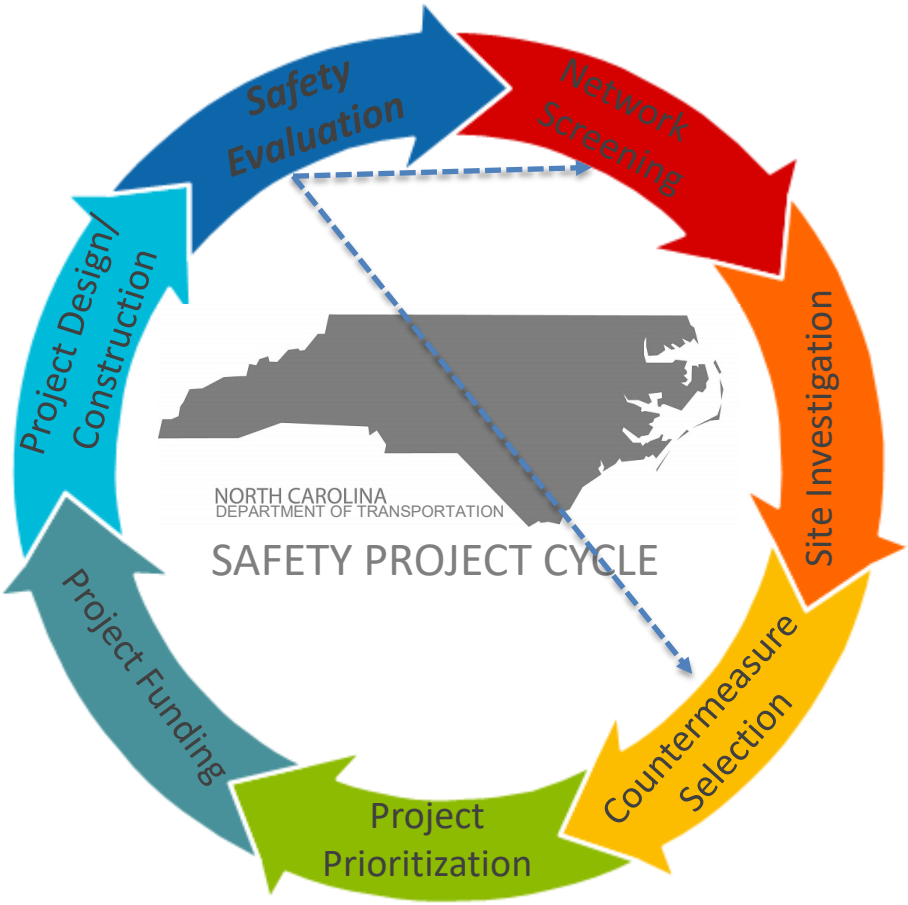
NORTH CAROLINA
Department of Transportation

NCDOT Traffic Safety Unit Safety Evaluations

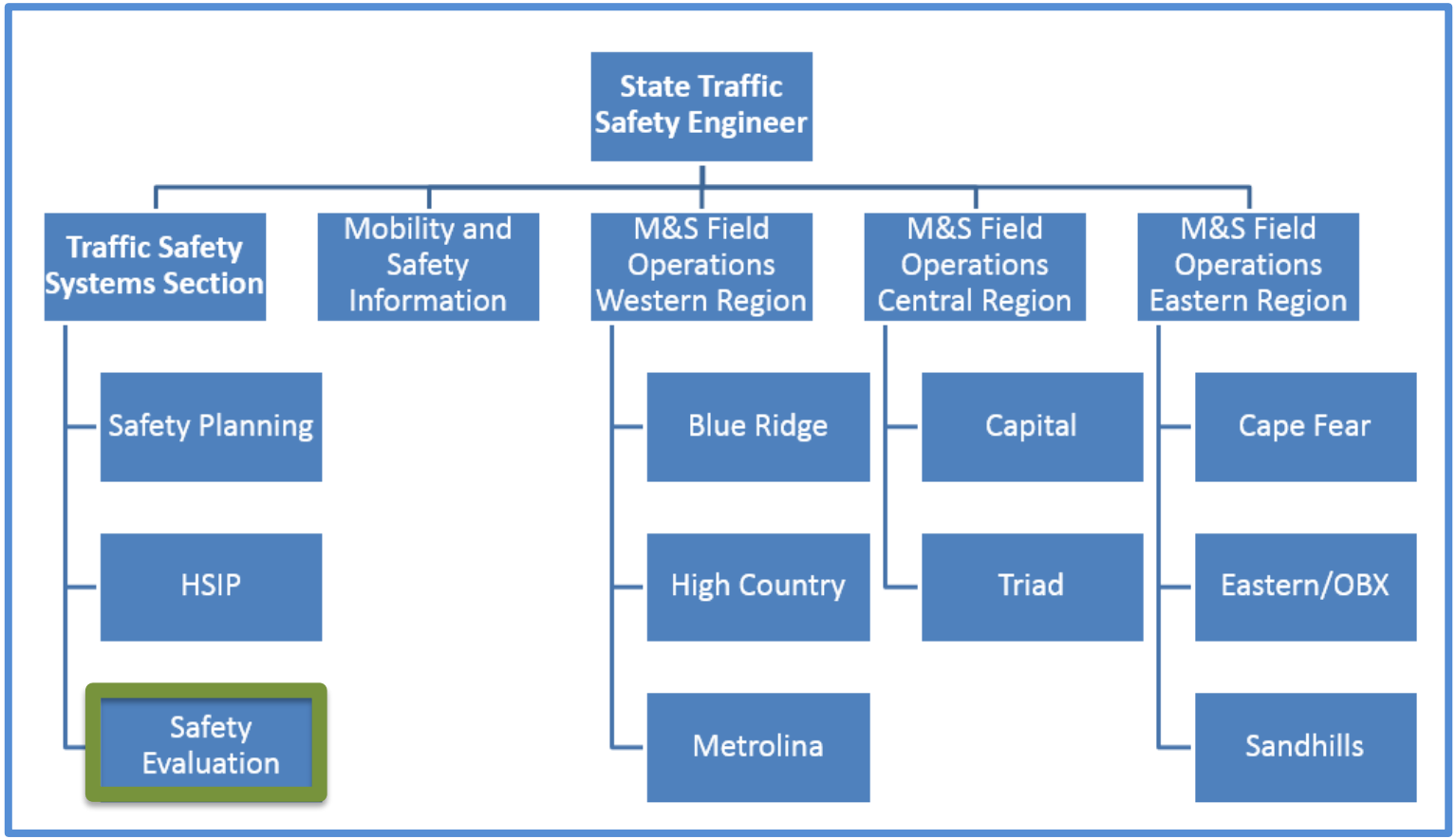
Carrie L. Simpson, PE

December 15, 2021

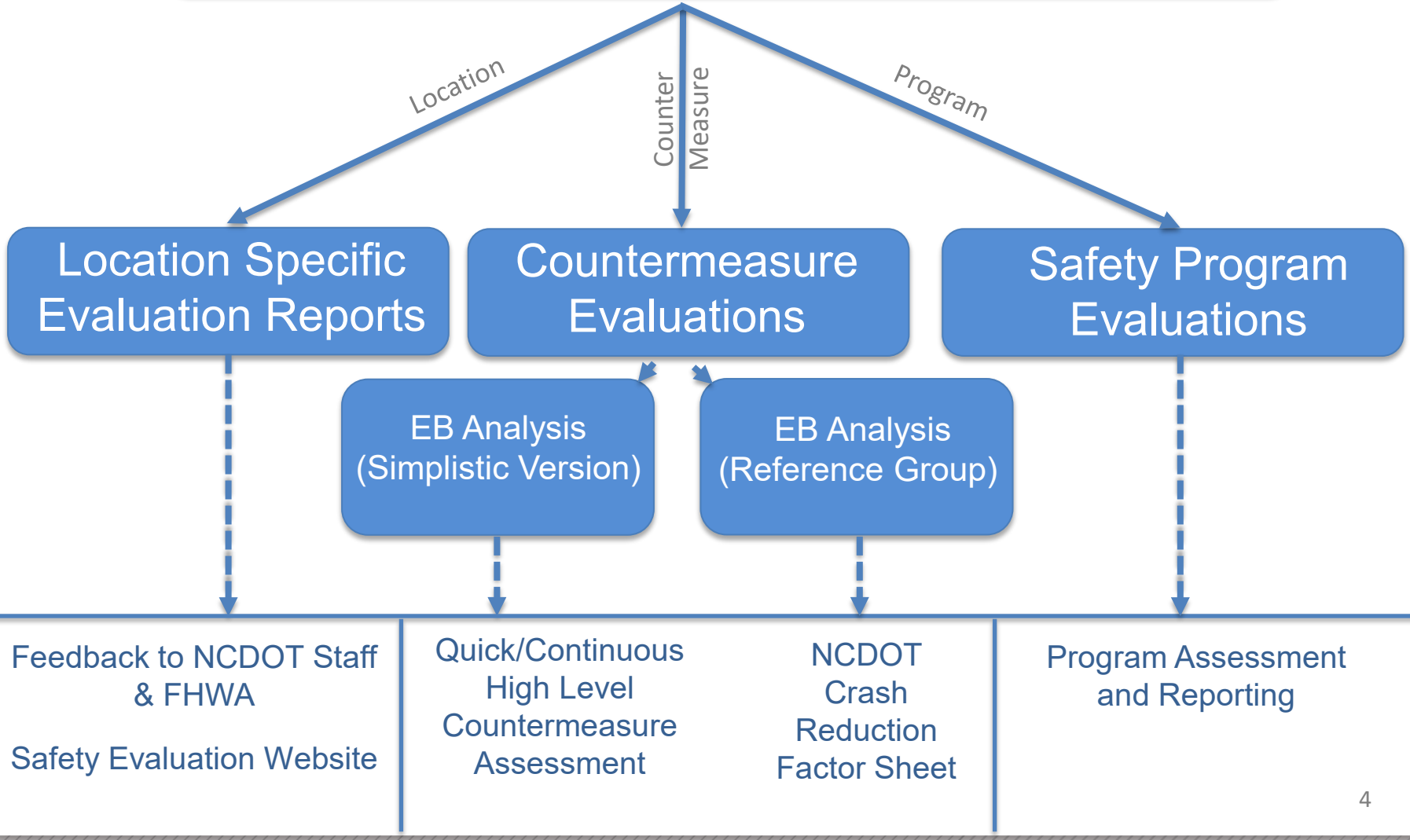
Safety Project Cycle



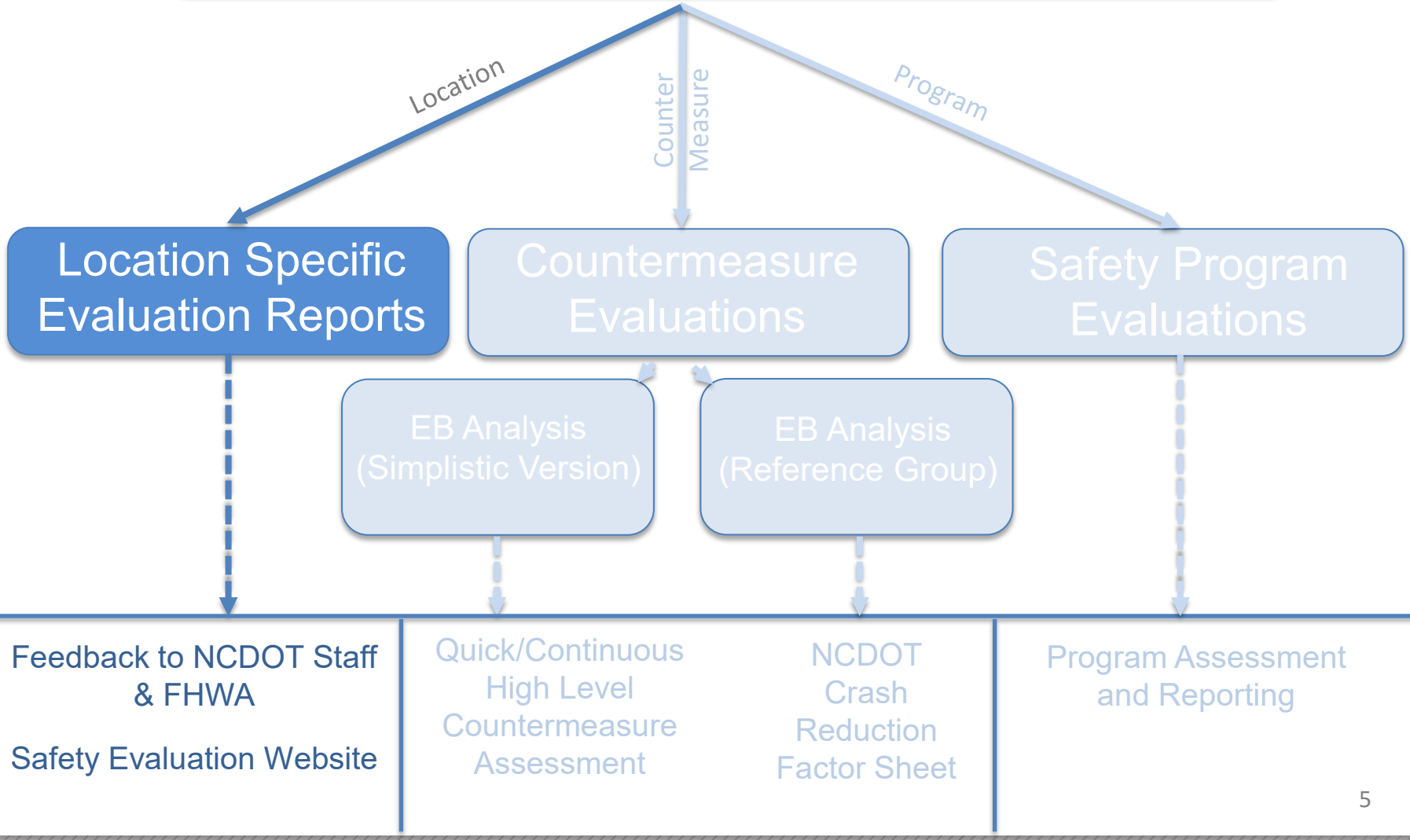
NCDOT Traffic Safety Unit Org Chart



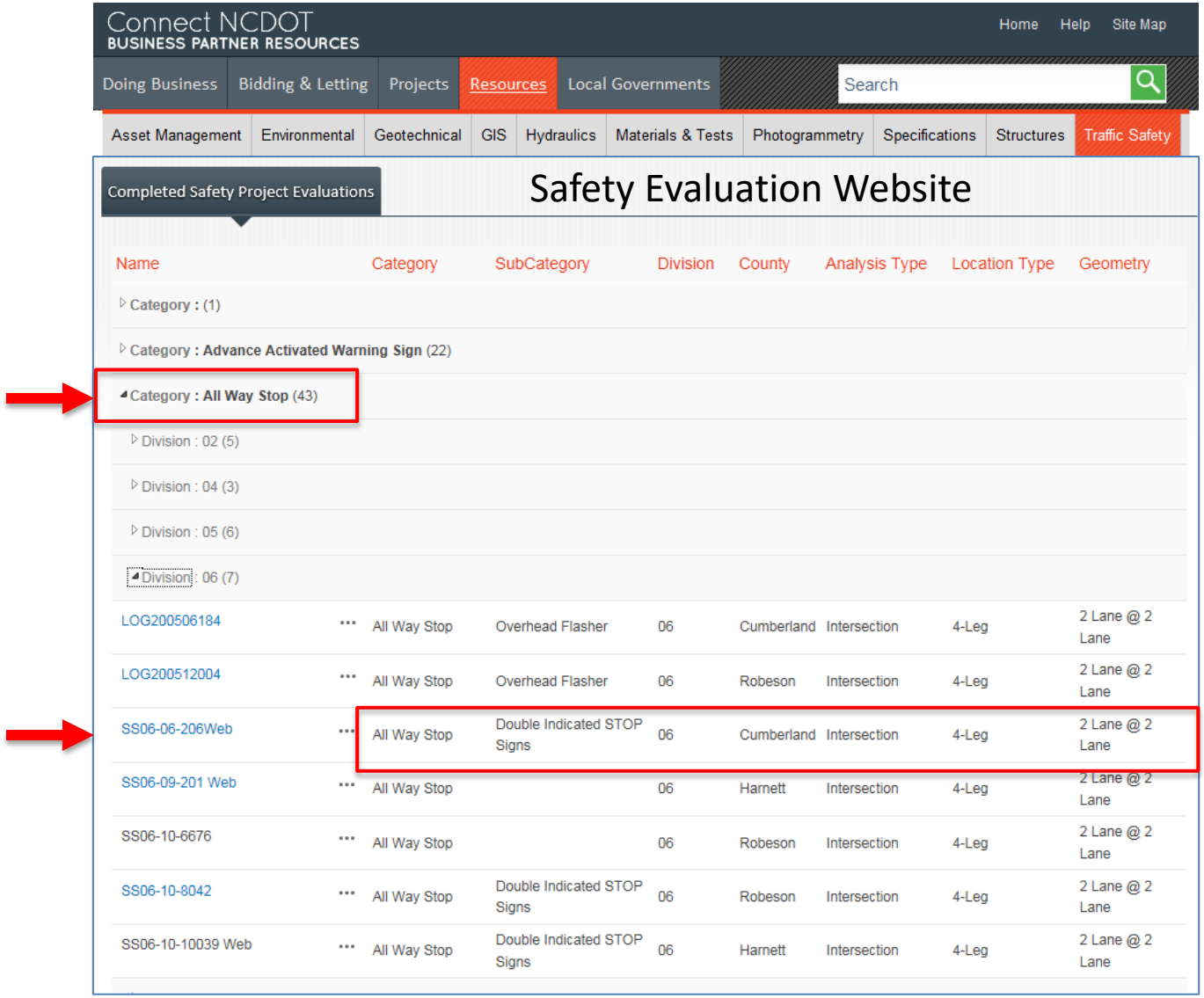
NCDOT Safety Evaluation Process



NCDOT Safety Evaluation Process



Location Specific Safety Evaluations

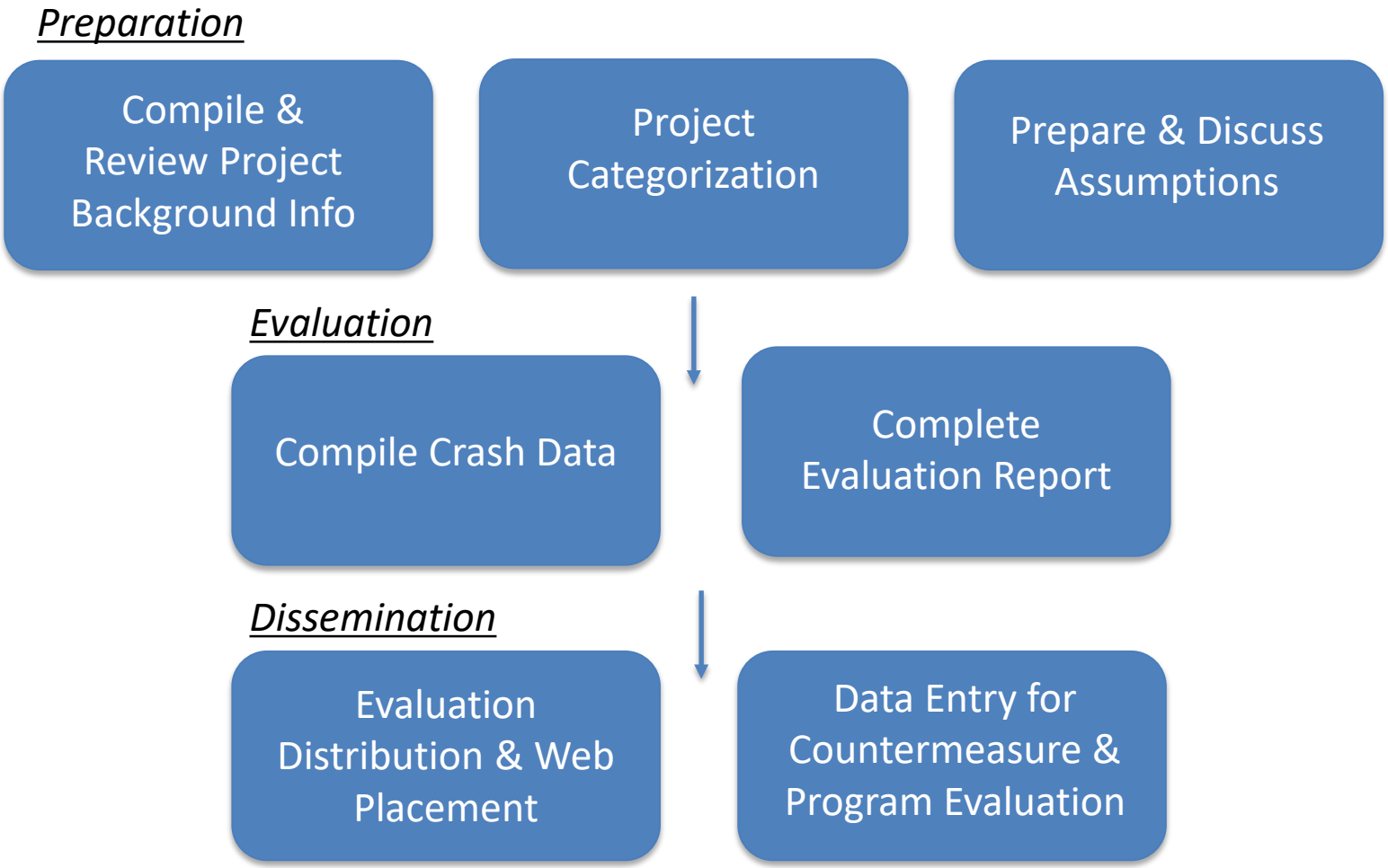


https://connect.ncdot.gov/resources/safety/Pages/Safety-Evaluation.aspx

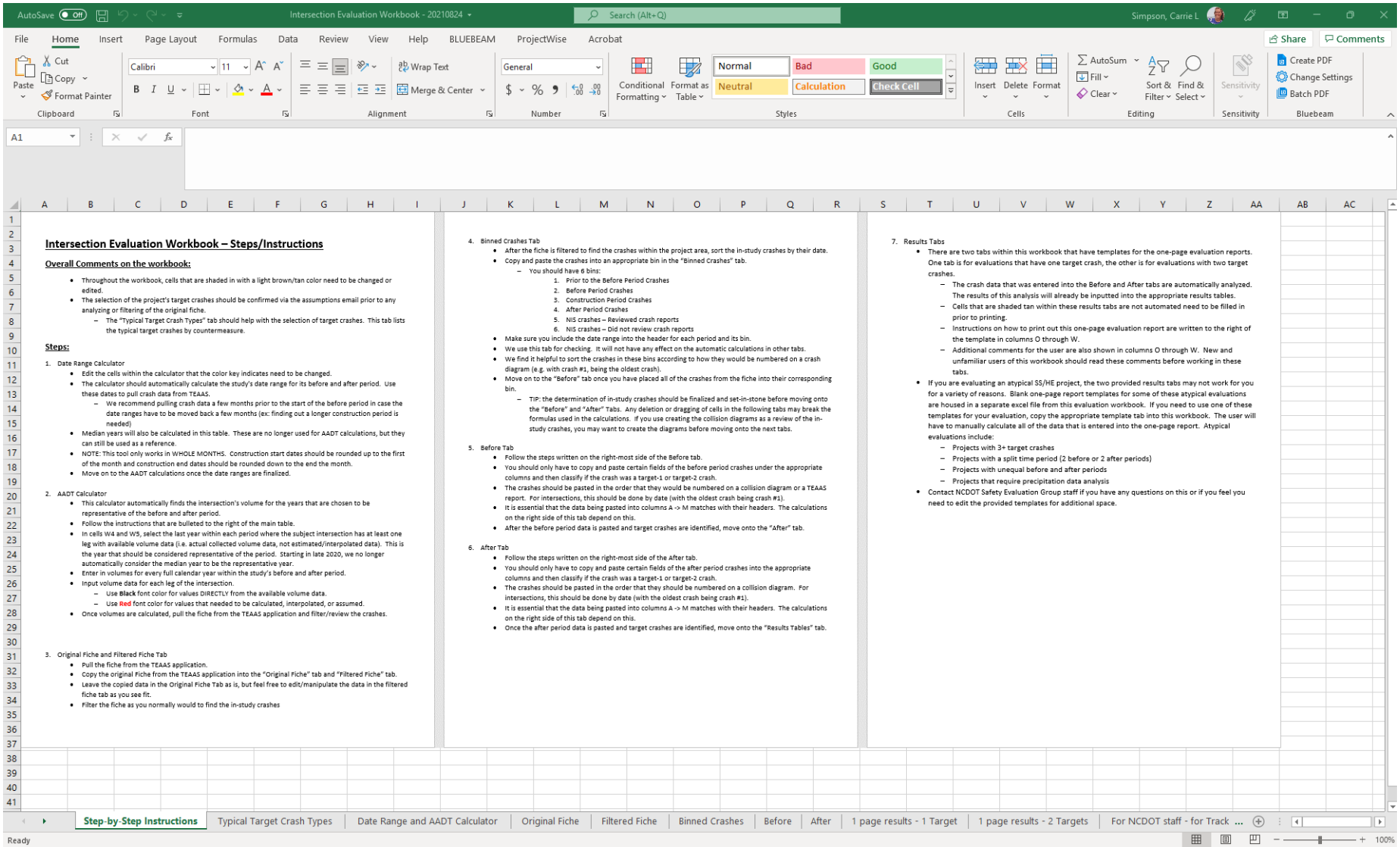
Location Specific Safety Evaluations

Advance Activated Warning Sign
All Way Stop
Bridge Fencing
Bridge Removal/Replacement
Clear Zone Improvements
Closed Loop Signal System
Congestion Detection System
Curve Superelevation Improvements
Curve Wedging and Resurfacing
Deceleration Lane for Ramp
Directional Crossover
Drainage Improvements
Driveway Channelization
Enforcement Programs
Flashing Traffic Signal
Grade Separation
Guardrail
Horizontal Alignment Improvements
Incident Management
Intersection Realignment
Left Turn Lane
Lighting
Median Berm
Median Channelization
Median Guardrail
Merge Lane Modifications
Modify Curb Radius
New Traffic Signal
Offset Left Turn Lane
Pavement Markings
Pedestrian Structure
Railroad Crossing
Remove Access/Intersection
Resurfacing
Right Turn Channelization
Right Turn Lane
Road Diet
Rumble Strips
Shoulder Wedge
Sidewalk
Sight Distance Improvements
Signalized Superstreet
Signing
Speed Tables
Traffic Signal Revisions
Traffic Signal Revisions/Turn Lanes
Two-Way Center Turn Lane
Vehicle Entering When Flashing
Widen Existing Travel Lanes
Widening for Paved Shoulders
Work Zone Evaluations
Other

Location Specific Safety Evaluations



Location Specific Safety Evaluations



Intersection Evaluation Workbook – Steps/Instructions

Overall Comments on the workbook:

- Throughout the workbook, cells that are shaded in with a light brown/tan color need to be changed or edited.
- The selection of the project's target crashes should be confirmed via the assumptions email prior to any analyzing or filtering of the original fiche.
  - The "Typical Target Crash Types" tab should help with the selection of target crashes. This tab lists the typical target crashes by countermeasure.

Steps:

1. Date Range Calculator
   - Edit the cells within the calculator that the color key indicates need to be changed.
   - The calculator should automatically calculate the study's date range for its before and after period. Use these dates to pull crash data from TEAAS.
     - We recommend pulling crash data a few months prior to the start of the before period in case the date ranges have to be moved back a few months (ex: finding out a longer construction period is needed)
   - Median years will also be calculated in this table. These are no longer used for AADT calculations, but they can still be used as a reference.
   - NOTE: This tool only works in WHOLE MONTHS. Construction start dates should be rounded up to the first of the month and construction end dates should be rounded down to the end the month.
   - Move on to the AADT calculations once the date ranges are finalized.

2. AADT Calculator
   - This calculator automatically finds the intersection's volume for the years that are chosen to be representative of the before and after period.
   - Follow the instructions that are bulleted to the right of the main table.
   - In cells W4 and W5, select the last year within each period where the subject intersection has at least one leg with available volume data (i.e. actual collected volume data, not estimated/interpolated data). This is the year that should be considered representative of the period. Starting in late 2020, we no longer automatically consider the median year to be the representative year.
   - Enter in volumes for every full calendar year within the study's before and after period.
   - Input volume data for each leg of the intersection.
     - Use **Black** font color for values DIRECTLY from the available volume data.
     - Use **Red** font color for values that needed to be calculated, interpolated, or assumed.
   - Once volumes are calculated, pull the fiche from the TEAAS application and filter/review the crashes.

3. Original Fiche and Filtered Fiche Tab
   - Pull the fiche from the TEAAS application.
   - Copy the original Fiche from the TEAAS application into the "Original Fiche" tab and "Filtered Fiche" tab.
   - Leave the copied data in the Original Fiche Tab as is, but feel free to edit/manipulate the data in the filtered fiche tab as you see fit.
   - Filter the fiche as you normally would to find the in-study crashes

4. Binned Crashes Tab
   - After the fiche is filtered to find the crashes within the project area, sort the in-study crashes by their date.
   - Copy and paste the crashes into an appropriate bin in the "Binned Crashes" tab.
     - You should have 6 bins:
       1. Prior to the Before Period Crashes
       2. Before Period Crashes
       3. Construction Period Crashes
       4. After Period Crashes
       5. NIS crashes – Reviewed crash reports
       6. NIS crashes – Did not review crash reports
   - Make sure you include the date range into the header for each period and its bin.
   - We use this tab for checking. It will not have any effect on the automatic calculations in other tabs.
   - We find it helpful to sort the crashes in these bins according to how they would be numbered on a crash diagram (e.g. with crash #1, being the oldest crash).
   - Move on to the "Before" tab once you have placed all of the crashes from the fiche into their corresponding bin.
     - TIP: the determination of in-study crashes should be finalized and set-in-stone before moving onto the "Before" and "After" Tabs. Any deletion or dragging of cells in the following tabs may break the formulas used in the calculations. If you use creating the collision diagrams as a review of the in-study crashes, you may want to create the diagrams before moving onto the next tabs.

5. Before Tab
   - Follow the steps written on the right-most side of the Before tab.
   - You should only have to copy and paste certain fields of the before period crashes under the appropriate columns and then classify if the crash was a target-1 or target-2 crash.
   - The crashes should be pasted in the order that they would be numbered on a collision diagram or a TEAAS report. For intersections, this should be done by date (with the oldest crash being crash #1).
   - It is essential that the data being pasted into columns A -> M matches with their headers. The calculations on the right side of this tab depend on this.
   - After the before period data is pasted and target crashes are identified, move onto the "After" tab.

6. After Tab
   - Follow the steps written on the right-most side of the After tab.
   - You should only have to copy and paste certain fields of the after period crashes into the appropriate columns and then classify if the crash was a target-1 or target-2 crash.
   - The crashes should be pasted in the order that they should be numbered on a collision diagram. For intersections, this should be done by date (with the oldest crash being crash #1).
   - It is essential that the data being pasted into columns A -> M matches with their headers. The calculations on the right side of this tab depend on this.
   - Once the after period data is pasted and target crashes are identified, move onto the "Results Tables" tab.

7. Results Tabs
   - There are two tabs within this workbook that have templates for the one-page evaluation reports. One tab is for evaluations that have one target crash, the other is for evaluations with two target crashes.
     - The crash data that was entered into the Before and After tabs are automatically analyzed. The results of this analysis will already be inputted into the appropriate results tables.
     - Cells that are shaded tan within these results tabs are not automated need to be filled in prior to printing.
     - Instructions on how to print out this one-page evaluation report are written to the right of the template in columns O through W.
     - Additional comments for the user are also shown in columns O through W. New and unfamiliar users of this workbook should read these comments before working in these tabs.
   - If you are evaluating an atypical SS/HE project, the two provided results tabs may not work for you for a variety of reasons. Blank one-page report templates for some of these atypical evaluations are housed in a separate excel file from this evaluation workbook. If you need to use one of these templates for your evaluation, copy the appropriate template tab into this workbook. The user will have to manually calculate all of the data that is entered into the one-page report. Atypical evaluations include:
     - Projects with 3+ target crashes
     - Projects with a split time period (2 before or 2 after periods)
     - Projects with unequal before and after periods
     - Projects that require precipitation data analysis
   - Contact NCDOT Safety Evaluation Group staff if you have any questions on this or if you feel you need to edit the provided templates for additional space.

Location Specific Safety Evaluations

Tables used for Multi-treatment EB analysis and CMF tracking - Please DO NOT edit or change any cells in this section

	Before				After			
Severity	Total	Target-1	Target -2	All - Targets	Total	Target-1	Target -2	All - Targets
K	0	0	0	0	0	0	0	0
A	0	0	0	0	0	0	0	0
B	1	1	0	1	1	0	0	0
C	6	2	2	3	5	1	1	2
O	14	10	1	11	18	3	2	5
Total	21	13	3	15	24	4	3	7
SI	3.47	2.71	5.93	2.97	2.85	2.85	3.47	3.11

2010					2011					2012					2013					2014						
Total Crashes	Frontal Impacts	Rear Ends	Major AADT	Minor AADT	Total Crashes	Frontal Impacts	Rear Ends	Major AADT	Minor AADT	Total Crashes	Frontal Impacts	Rear Ends	Major AADT	Minor AADT	Total Crashes	Frontal Impacts	Rear Ends	Major AADT	Minor AADT	Total Crashes	Frontal Impacts	Rear Ends	Major AADT	Minor AADT	Total Crashes	Fro Imp
5	3	2	11500	1600	3	2	1	11500	1575	3	3	0	11500	1550	9	5	3	11750	1675	4	0	4	12000	1800	8	

Copy and Paste into Countermeasure Evaluation Workbooks

... | Typical Target Crash Types | Date Range and AADT Calculator | Original Fiche | Filtered Fiche | Binned Crashes | Before | After | 1 page results - 1 Target | 1 page results - 2 Targets | For NCDOT staff - for Tracking

Location Specific Safety Evaluations

Location Specific Evaluation Report

Order ID:	41000051484
Project ID:	06-17-48582
Signal ID:	n/a
Location:	SR 1002 (Old Allenton Rd) at SR 2104 (Seventh St Rd)
GPS Coordinates	34.625564, -78.921555
County:	Robeson
City:	East of Lumberton
Division:	6
Countermeasure(s):	Convert from a two-way stop to an all-way stop
Project Cost:	$12,500

	Start Date	End Date	Length
Before Period	9/1/2014	8/31/2017	3y, 0m
Construction Period	9/1/2017	9/30/2017	0y, 1m
After Period	10/1/2017	9/30/2020	3y, 0m

Analysis Criteria:	Treatment data consists of all crashes within 150 feet of the subject intersection
Target Crashes:	Frontal Impact Crashes (left-turn, same roadway; left-turn, different roadway; right-turn, same roadway; right-turn, different roadway; head-on; and angle crashes) in the intersection.

Project Development Comparison

Crashes Per Year by Project Time Period	Project Development	Before Period	After Period
Years	5 years	3 years	3 years
Start Date	7/1/2012	9/1/2014	10/1/2017
End Date	6/30/2017	8/31/2017	9/30/2020
Total	3.40	4.33	1.00
Fatal Injury	0.00	0.00	0.00
Class A Injury	0.20	0.00	0.33
Class B Injury	0.60	1.00	0.00
Class C Injury	1.60	2.00	0.33
Property Damage Only	1.00	1.33	0.33

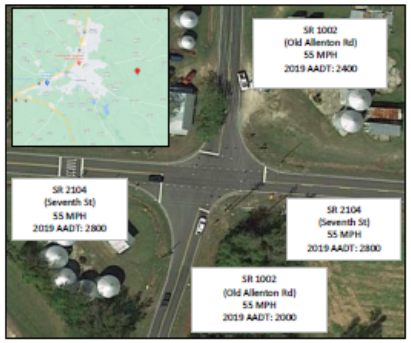
Treatment Information	Before	After	Percent Reduction (-) Percent Increase (+)
Total Crashes	13	3	-76.92%
Total Severity Index	6.12	28.73	100+%
Target Crashes	10	2	-80.00%
Target Crash Severity Index	6.18	42.60	100+%
Volume (2017, 2019)	5,200	5,000	-3.85%

Injury Crash Summary	Before	After	Percent Reduction (-) Percent Increase (+)
Fatal Injury Crashes	0	0	n/a
Class A Injury Crashes	0	1	n/a
Class B Injury Crashes	3	0	-100.00%
Class C Injury Crashes	6	1	-83.33%
Property Damage Only	4	1	-75.00%

Target Injury Crash Summary	Before	After	Percent Reduction (-) Percent Increase (+)
Fatal Injury Crashes	0	0	n/a
Class A Injury Crashes	0	1	n/a
Class B Injury Crashes	2	0	-100.00%
Class C Injury Crashes	5	1	-80.00%
Property Damage Only	3	0	-100.00%

Additional Information	Before	After	Percent Reduction (-) Percent Increase (+)
n/a			n/a
n/a			n/a
n/a			n/a
n/a			n/a

Map/Satellite Views

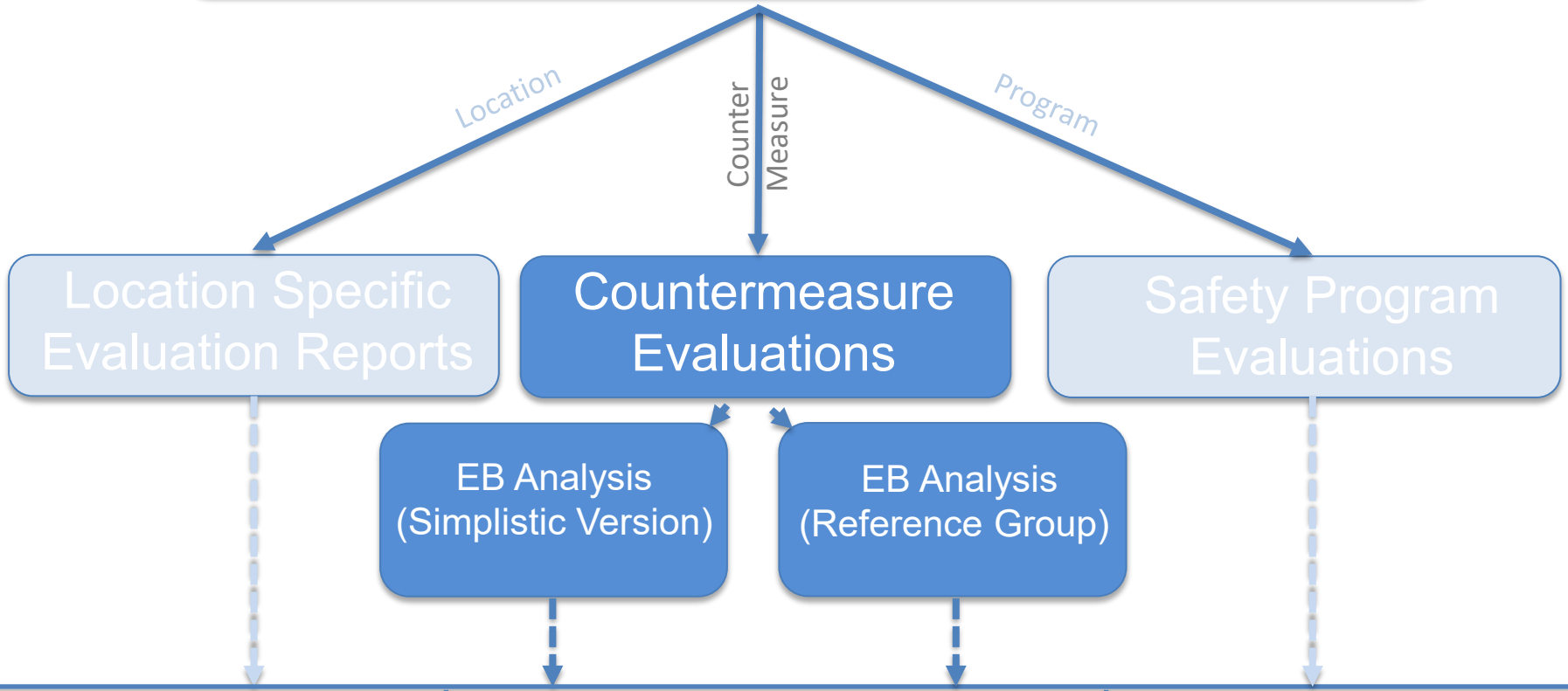


Items for Discussion

The single A-injury crash in the after period involved a vehicle failing to stop at the all way stop. This crash occurred in the first month of the after period after the all way stop was in place. There were no crashes in the last year of the study after period.

The implementation of the countermeasure at this intersection significantly reduced total crashes (-77%) and target crashes (-80%), however, the average severity index significantly increased for both total and target crashes (100+% each). Although the total and target crash severity indices increased after improvements were made, there was a decrease in the frequency of injury total and target crashes from the before to the after period. The severity index is calculated as a weighted average where Fatal and A injury crashes receive the same weight (76.8) and B and C injury crashes receive the same weight (8.4). Even though there was a reduction in B and C injury crashes, the one A Injury crash in the after period made up a higher proportion of total and target crashes in the after period, which led to the increased total and target severity indices.

NCDOT Safety Evaluation Process



Countermeasure Evaluations
CMF Workbook (Intersection - Simplistic)

THIS SPREADSHEET IS A TOOL USED TO FACILITATE THE DEVELOPMENT OF CMFS FOR SPECIFIC PROJECT TYPES FUNDED THROUGH OUR SPOT SAFETY AND HAZARD ELIMINATION PROGRAMS. AS PROJECTS ARE EVALUATED AND ADDED TO THE WEB, IT IS OUR INTENT TO UPDATE THIS SPREADSHEET WITH NEW SITES AND NEW COUNTERMEASURES. WE MAY DECIDE TO USE THE CMFS FOR A PARTICULAR COUNTERMEASURE ONCE WE HAVE ESTABLISHED A LARGE ENOUGH SAMPLE SIZE AND NUMBER OF SITES.

Intersection Countermeasures	Classification on Web	# Sites	EB CMFs Developed						Simple B-A CMFs Developed					
			Total		Frontal Impact		Rear End		Total		Frontal Impact		Rear End	
			CMF	SE	CMF	SE	CMF	SE	CMF	SE	CMF	SE	CMF	SE
Stop Controlled Intersections														
All Way Stop	All Way Stop	32	0.42	0.04	0.36	0.04	0.97	0.19	0.32	0.03	0.24	0.03	0.84	0.21
Intersection Realignment	Intersection Realignment	8	0.49	0.09	0.55	0.13	0.42	0.19	0.41	0.08	0.40	0.10	0.34	0.16
Intersection Signing/Marking Enhancement	Signing	5	0.69	0.15	0.49	0.18	0.24	0.18	0.59	0.14	0.43	0.17	0.16	0.13
Left Turn Lane	Left Turn Lane	11	0.63	0.09	0.93	0.21	0.52	0.11	0.67	0.10	1.11	0.29	0.46	0.10
Median Channelization	Median Channelization	4	0.52	0.16	0.49	0.17	0.46	0.48	0.35	0.12	0.30	0.11	0.45	0.45
Offset Left Turn Lane	Offset Left Turn Lane	3	0.71	0.11	0.50	0.11	0.93	0.23	0.73	0.12	0.50	0.12	0.96	0.26
Sight Distance Improvements	Sight Distance Improvements	3	0.45	0.20	0.55	0.32	0.39	0.26	0.63	0.32	0.88	0.64	0.39	0.27
VEWF	Vehicle Entering When Flashing	16	1.13	0.12	1.39	0.16	1.14	0.28	0.76	0.11	0.86	0.13	0.45	0.16
Signalized Intersections														
Advance Activated Warning Sign	Advance Active Warning Sign	17	0.95	0.08	0.92	0.11	1.04	0.12	0.87	0.07	0.73	0.09	1.02	0.13
New Traffic Signal	New Traffic Signal	23	0.49	0.03	0.44	0.05	0.49	0.04	0.51	0.03	0.40	0.05	0.48	0.04
Traffic Signal Revisions - Left Turn FYA	Traffic Signal Revisions	21	0.80	0.05	0.71	0.06	0.83	0.09	0.91	0.06	0.77	0.07	1.08	0.13
Traffic Signal Revisions - Non-FYA Related	Traffic Signal Revisions	17	0.88	0.06	0.72	0.08	1.06	0.12	0.96	0.07	0.76	0.09	1.26	0.16
Traffic Signal Revisions/Turn Lanes	Traffic Signal Revisions/Turn Lanes	7	0.79	0.07	0.65	0.10	0.89	0.09	0.86	0.08	0.71	0.12	0.92	0.11
Unconventional Intersections														
Directional Crossover	Directional Crossover	13	0.93	0.09	0.39	0.07	1.48	0.20	0.95	0.09	0.42	0.08	1.46	0.22
Roundabout	Roundabout	12	0.57	0.07	0.36	0.07	0.46	0.14	0.50	0.06	0.25	0.05	0.33	0.11
TOTAL		192												

* Includes All Projects Funded With Safety Dollars After 2008

CMF Summary | Data Input | Sums Tab | FORMULAS

Countermeasure Evaluations
CMF Workbook (Intersection - Simplistic)

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	COLOR KEY																*note: only enter in volumes for years with crash data. For clarity, gray-out				
2	User Input (From Project Files)																				
3	Automated Calculations																		B - Yr 1		
4	Project ID	Intersection	County	GPS	Project Cost	Countermeasure Description	Countermeasure Grouping	Major Speed Limit	Minor Speed Limit	Install Year	Before, Yr 1	Before, Yr 2	Before, Yr 3	After, Yr 1	After, Yr 2	After, Yr 3	Intersection Type	Total Crashes	Frontal Impacts	Rear Ends	Major AADT	Minor AADT
37	13-11-215	SR 1510 at SR 1538	Rutherford	35.397670, -81.899940	$40,000	Installation of a four-way stop and insta	All Way Stop	55	55	2013	2010	2011	2012	2014	2015	2016	R2-4ST	1	1	0	3600	1500
38	08-07-204-1	SR 1413 at SR 1406	Hoke	34.98957, -79.10560	$250,000	Modify the grade on the western leg of S	All Way Stop	55	55	2012-2013	2009	2010	2011	2014	2015	2016	R2-4ST	1	0	0	3800	1100
39	07-09-203	SR 1539 at SR 1523	Guilford	34.98957, -79.10560	$154,000	Install dual mounted stop signs and "ST	All Way Stop	35	35	2012	2009	2010	2011	2013	2014	2015	R2-4ST	2	2	0	2200	1200
40	02-12-18731	SR 1760 at SR 1756	Pitt	35.55026,-77.25642	$8,500	Convert existing two-way stop to an all-v	All Way Stop	55	55	2012	2009	2010	2011	2013	2014	2015	R2-4ST	1	1	0	2700	1300
41	07-09-1320	US 70 Bus at SR 1709	Orange	36.060172, -79.065998	$25,000	Widen radii and install 4-way stop	All Way Stop	40	45	2011-2012	2008	2009	2010	2013	2014	2015	R2-4ST	6	6	0	3400	2200
42	08-11-4840	SR 1140 at SR 1144	Lee	35.380792, -79.118590	$18,500	Revise existing overhead actuated flash	All Way Stop	55	50	2012	2010	2011		2013	2014	2015	R2-4ST	2	2	0	3800	1300
43	10-09-202	SR 1003 at SR 1941	Union	34.955469, -80.485285	$35,000	Convert the intersection to a 4-way stop	All Way Stop	45	45	2010	2007	2008	2009	2011	2012	2013	R2-4ST	4	4	0	4600	2100
44	09-07-217	SR 1221 at SR 1002	Rowan	35.521585,-80.532266	$151,000	Improve sight distance at intersection b	All Way Stop	55	45	2010	2007	2008	2009	2011	2012	2013	R2-4ST	9	9	0	4200	3500
45	08-10-4890	SR 1406 at SR 1408	Hoke	34.986796,-79.167277	$31,000	Install center concrete islands on SR 140	All Way Stop	35	55	2010	2007	2008	2009	2011	2012	2013	R2-4ST	3	3	0	4600	3900
46	08-07-201	SR 1001 at SR 1146	Lee	35.434974,-79.166373	$13,000	Convert to All-Way Stop Control	All Way Stop	55	45	2011	2009	2010		2012	2013		R2-4ST	4	1	1	4500	2200
47	04-10-3980	NC 55 at NC 111	Wayne	35.201104, -77.888144	$90,000	Install all-way stop by modifying existin	All Way Stop	55	55	2011	2008	2009	2010	2012	2013	2014	R2-4ST	9	9	0	4300	3100
48	06-10-8042	SR 1752 at SR 1758	Robeson	34.739303,-79.053926	$9,500	Convert Intersection to All-Way Stop Con	All Way Stop	55	55	2011	2009	2010		2012	2013	2014	R2-4ST	8	7	0	3100	990
49	06-10-6676	SR 1529 at SR 1752	Robeson	34.702539,-79.019224	$9,500	Convert Intersection to All-Way Stop Con	All Way Stop	55	55	2010	2007	2008	2009	2011	2012	2013	R2-4ST	5	4	0	4100	3100
50	04-10-6978	NC 33 at NC 42	Edgecombe	35.794934,-77.536604	$60,000	Install an all-way stop with advance sol	All Way Stop	55	55	2010	2008	2009		2011	2012	2013	R2-4ST	6	4	1	3300	1500
51	04-12-17473	NC 96 at SR 1934 (Old Beulah Road	Johnston	35.564715, -78.280736	$97,000	Convert existing intersection to all-way	All Way Stop	55	55	2013	2010	2011	2012	2014	2015	2016	R2-4ST	0	0	0	2300	1900
52	04-12-20572	NC 55 at NC 242	Johnston	35.263332, -78.491946	$65,000	Install an all-way stop with supplement	All Way Stop	55	55	2013	2010	2011	2012	2014	2015	2016	R2-4ST	0	0	0	2800	1400
53	04-12-21408	NC 96 at NC 231	Johnston	35.733302, -78.297344	$75,000	Install an all-way stop, including revisio	All Way Stop	45	55	2013	2010	2011	2012	2014	2015	2016	R2-4ST	3	2	0	2200	1700
54	06-10-10039	SR 1006 at SR 1505	Harnett	35.502720, -78.691507	$9,500	Convert to All-Way Stop with dual mount	All Way Stop	55	55	2011	2008	2009	2010	2012	2013	2014	R2-4ST	3	3	0	2700	1900
55	04-14-27371	SR 1243 (Leggett Rd) at SR 1250 (Sp	Edgecombe	35.963595, -77.755167	$22,500	Convert existing intersection to an all-w	All Way Stop	45	45	2014	2012	2013		2015	2016	2017	R2-4ST	2	1	0	2200	1000
56	W-5011	NC 49 at NC 119	Alamance	36.189376, -79.282102	$497,500	Install all-way stop and channelization;	All Way Stop	55	55	2014	2011	2012	2013	2015	2016	2017	R2-4ST	2	2	0	2400	2500
57	06-13-26081	SR 1945 at SR 1984 / SR 2033	Robeson	34.644264, -78.979035	$11,000	Convert both intersections to All-Way St	All Way Stop	55	55	2014	2011	2012	2013	2015	2016	2017	R2-4ST	1	1	0	6700	2500
58	06-13-26081	SR 1003 at SR 1339	Robeson	34.649085, -79.176484	$11,000	Convert both intersections to All-Way St	All Way Stop	55	55	2014	2011	2012	2013	2015	2016	2017	R2-4ST	6	6	0	3700	2800
59	07-14-918	SR 1700 (Apple Street) at Richmon	Alamance	36.105384, -79.427626	$22,000	Convert to all-way stop operations. Cons	All Way Stop	35	35	2014	2011	2012	2013	2015	2016	2017	U-4ST	1	1	0	3500	1000
60	06-14-30492	NC 72 at SR 1515 (Union Chapel Rd	Robeson	34.706017, -79.152864	$6,500	Convert the intersection to all-way stop	All Way Stop	55	55	2015	2012	2013	2014	2016	2017	2018	R2-4ST	6	5	0	3000	4100
61	06-16-39055	SR 1340 (Prospect Rd) at SR 1515 (S	Robeson	34.703303, -79.196785	$80,000	Install an all-way stop with concrete cha	All Way Stop	55	45	2016	2014	2015		2017	2018		R2-4ST	6	3	1	6300	2150
62	05-15-4144	SR 2724 (Banks Rd) at Chambers R	Wake	35.635326, -78.708736	$150,000	Convert to All-Way Stop with LED stop si	All Way Stop	45	25	2015	2012	2013	2014	2016	2017	2018	U-3ST	0	0	0	4350	1500
63	05-15-5139	NC 96 at SR 1141 (Bruce Garner Rd)	Franklin	36.080596, -78.540121	$25,000	Install All-Way Stop with LED Stop Signs	All Way Stop	55	45	2015	2012	2013	2014	2016	2017	2018	R2-4ST	3	3	0	3800	1150
64	05-13-4973	SR 1518 (Newton Dairy Rd/Stewart	Vance	36.329409, -78.355096	$12,500	Convert to All-Way Stop and Revise Over	All Way Stop	45	45	2015	2012	2013	2014	2016	2017	2018	R2-4ST	3	3	0	2700	1225
65	02-15-35606	SR 1700 (Old Tar Rd) at SR 1133 (M	Pitt	35.528223, -77.384944	$22,500	Install All-Way Stop	All Way Stop	45	35	2015	2012	2013	2014	2016	2017	2018	R2-4ST	3	2	1	10900	3450
66	07-14-212	SR 1710 (Old NC 10) at SR1713 (Mo	Orange	36.031468, -79.021890	$30,010	Installed Standard Flasher – Spot Safety	All Way Stop	45	40	2014			2013	2015	2016	2017	R2-4ST					
67	06-17-48963	NC 11 (General Howe Rd) at NC 87	Columbus	34.376289, -78.277365	$85,000	Convert to all-way stop with overhead re	All Way Stop	55	55	2017		2015	2016	2018	2019		R2-4ST					
68	12-14-402	US 321BUS/NC 155 (Dallas High Sh	Gaston	35.375469, -81.207300	n/a	Convert two-way stop to all-way stop co	All Way Stop	45	45	2017	2014	2015	2016	2018	2019	2020	R2-4ST	4	3	0	2100	3300
69	02-06-204	US 70 at SR 1147	Carteret	34.747649, -76.835677	$130,000	Construct a median island to allow only	Directional Crossover	55	45	2013	2010	2011	2012	2014	2015	2016	R4-3ST	2	1	1	32000	3200
70	04-09-1131	SR 1165 (Forest Hills Rd) at Walgr	Wilson	35.718610,-77.952184	$160,000	Install a median with a mainline direct	Directional Crossover	45	n/a	2013	2010	2011	2012	2014	2015	2016	U-4ST	2	2	0	20000	500
71	09-12-319	SR 4000 (University Parkway) at W	Forsyth	36.13741, -80.27199	$120,000	Install Directional Crossover	Directional Crossover	45	25	2013	2010	2011	2012	2015	2016	2017	U-3ST	6	0	5	18500	6500
72	W-5206C	Int 1: NC 87 at SR 1155 (Cromartie	Bladen	34.625753, -78.651241	$1,210,000	Install limited movement crossovers wit	Directional Crossover	55	45/55	2013	2009	2010	2011	2014	2015	2016	R4-4ST	0	0	0	6600	1100
73	W-5206C	Int 2: NC 87 at NC 87 Bus (Broad St	Bladen	34.641920, -78.675824	-	"	Directional Crossover	55	55	2013	2009	2010	2011	2014	2015	2016	R4-4ST	1	0	1	10000	4300
74	06-11-13090	NC 24/NC 87 (Bragg Blvd) at Barrin	Cumberland	35.07128, -78.92058	$110,000	Construct Directional Crossovers at both	Directional Crossover	45	25	2013	2010	2011	2012	2014	2015	2016	U-4ST	12	3	4	31000	1300
75	06-11-13090	NC 24/NC 87 (Bragg Blvd) at McPhe	Cumberland	35.06994, -78.91684	$110,000	Construct Directional Crossovers at both	Directional Crossover	45	25	2013	2010	2011	2012	2014	2015	2016	U-4ST	4	0	3	31000	700
76	08-11-1536	US 74 at SR 1251 (Murdock St)/SR 1	Scotland	34.807112, -79.544369	$687,721	Installed Directional Crossover	Directional Crossover	55	35	2014	2010	2011	2012	2015	2016	2017	R4-4ST	5	4	0	19000	500
77	W-5010	US 70 at SR 1234 (Ebenezer Church	Wayne	35.443335, -78.103340	$1,381,000	Construct mainline directional crossove	Directional Crossover	55	45	2013	2009	2010	2011	2015	2016	2017	R4-4ST	9	4	0	20500	960
78	W-5203C	NC 24 (Freedom Way) at SR 1744 (H	Onslow	34.716250, -77.207937	$885,000	Construct mainline directional crossovel	Directional Crossover	55	55	2014	2011	2012	2013	2015	2016	2017	R4-4ST	6	1	1	22250	250

CMF Summary | Data Input | Sums Tab | FORMULAS

Countermeasure Evaluations
CMF Workbook (Intersection - Detailed)

Step 1. Enter in the below information for each of the reference sites. Both of the Major and Minor roads of each reference site need an inputted volume for EVERY year within the study's period.

For Example, If your earliest before period year is 2005 and your latest after period year is 2018, then you need volumes for both the major and minor roads for every year within 2005 - 2018

NOTE: This tab is set up to work wth 200 Reference sites. If rows are added in the case of having more than 200 reference sites, the automated formulas in the blue cells to the right will need to be dragged/copied.

NOTE: DO NOT insert in any rows below the red line at the bottom of this tab. The automated formulas will work up until the red line. If more rows are needed, right click and "insert" new rows above the red line

**Combined CMF default is 1, consult HSM for how to calculate a Site's CMF based on its characteristics (LTLs, RTLs, lighting, phasing, etc.)

Reference Site's Volume Data

Input Reference Site Major and Minor Approach Volumes below for every calender year that falls within the study

	Major Road	Minor Road	County	GPS Coordinates	Intersection Type	Combined CMF for Site's Features**	1999 Major AADT	1999 Minor AADT	2000 Major AADT	2000 Minor AADT	2001 Major AADT	2001 Minor AADT	2002 Major AADT	2002 Minor AADT	2003 Major AADT	2003 Minor AADT	2004 Major AADT	2004 Minor AADT	2005 Major AADT	2005 Minor AADT	2006 Major AADT	2006 Minor AADT	2007 Major AADT	2007 Minor AADT	2008 Major AADT	2008 Minor AADT	2009 Major AADT	2009 Minor AADT	2010 Major AADT	2010 Minor AADT	2011 Major AADT
Ref Site 1	Example 1	Example 1	County		R2-4ST	0.8	1,310	850	1,340	870	1,370	890	1,400	910	1,450	930	1,500	905	1,400	880	1,300	990	1,300	1,100	1,300	1,035	1,250	970	1,200	905	1,250	
Ref Site 2	Example 2	Example 2	County		R2-4ST	0.8	940	1,240	960	1,270	980	1,340	1,000	1,370	1,100	1,400	1,200	1,375	1,150	1,350	1,100	1,325	1,005	1,300	910	1,250	955	1,200	1,000	1,100	1,100	
Ref Site 3	Example 3	Example 3	County		R2-4ST	0.8	2,050	1,120	2,100	1,140	2,150	1,160	2,200	1,180	2,250	1,200	2,300	1,090	2,550	980	2,800	895	2,750	810	2,700	805	2,650	800	2,600	710	2,800	
Ref Site 4	Example 4	Example 4	County		R2-3ST	1	5,880	4,040	6,010	4,130	6,140	4,220	6,270	4,310	6,400	4,400	6,350	4,350	6,300	4,300	6,500	4,700	6,700	5,100	6,525	4,450	6,350	3,800	6,175	3,700	6,000	
Ref Site 5	Example 5	Example 5	County		R2-3ST	1	5,420	1,480	5,540	1,510	5,660	1,540	5,780	1,570	5,900	1,600	6,350	1,550	6,800	1,500	6,850	1,550	6,900	1,600	7,000	1,550	7,100	1,500	7,200	1,500	7,300	
Ref Site 6	Example 6	Example 6	County		R2-3ST	1	10,560	1,860	10,920	1,920	11,280	1,980	11,640	2,040	12,000	2,100	12,000	2,170	12,000	2,100	12,000	2,030	12,000	1,960	11,500	1,890	11,000	1,700	11,500	1,750	12,000	
Ref Site 7	Example 7	Example 7	County		R2-4ST	1	1,310	770	1,340	790	1,370	810	1,400	830	1,400	840	1,500	850	1,400	805	1,400	760	1,400	785	1,500	810	1,100	790	1,300	770	1,000	
Ref Site 8	Example 8	Example 8	County		R2-4ST	1	2,100	1,125	2,150	1,150	2,200	1,175	2,250	1,200	2,300	1,100	2,300	1,000	2,300	1,000	2,250	1,000	2,200	990	2,500	980	2,800	1,040	2,650	1,100	2,500	
Ref Site 9	Example 9	Example 9	County		R2-4ST	0.8	1,880	860	1,920	880	1,960	900	2,000	920	2,100	875	2,000	830	2,000	840	2,1											
Ref Site 10	Example 10	Example 10	County		R2-3ST	0.8	8,100	690	8,175	705	8,350	720	8,525	735	8,700	750	8,450	745	8,200	740	7,9											
Ref Site 11	Example 11	Example 11	County		R2-3ST	0.8	10,340	480	1,560	490	10,780	500	11,000	510	10,000	490	11,000	470	10,000	510	10,0											
Ref Site 12	Example 12	Example 12	County		R2-3ST	0.8	6,950	2,300	7,100	2,350	7,250	2,400	7,400	2,450	7,200	2,500	7,000	2,550	7,100	2,600	7,3											
Ref Site 13	Example 13	Example 13	County		R2-4ST	0.8	7,030	520	7,120	530	7,210	540	4,300	550	4,400	560	4,100	615	4,300	670	3,9											
Ref Site 14	Example 14	Example 14	County		R2-4ST	0.8	2,200	920	2,250	940	2,300	960	2,350	980	2,400	945	2,850	910	3,300	875	3,3											
Ref Site 15	Example 15	Example 15	County		R2-4ST	0.8	1,980	140	2,020	145	2,060	150	2,100	150	2,400	205	3,000	260	3,000	190	3,6											
Ref Site 16	Example 16	Example 16	County		R2-4ST	0.95	2,150	590	2,200	600	2,250	610	2,300	620	2,600	630	2,900	560	2,800	490	2,7											
Ref Site 17	Example 17	Example 17	County		R2-4ST	0.95	2,065	1,100	2,110	1,125	2,155	1,150	2,200	1,175	2,300	1,200	2,400	1,200	2,250	1,200	2,1											
Ref Site 18	Example 18	Example 18	County		R2-4ST	0.95	3,780	580	3,860	590	3,940	600	4,020	610	4,100	620	4,400	650	4,500	680	4,6											
Ref Site 19	Example 19	Example 19	County		R2-4ST	0.8	4,900	920	5,000	940	5,100	960	5,200	980	6,200	970	6,100	960	6,200	1,080	5,1											
Ref Site 20	Example 20	Example 20	County		R2-4ST	0.8	4,330	2,400	4,420	2,450	4,510	2,500	4,600	2,550	4,100	2,600	4,300	2,700	4,300	2,800	4,4											
Ref Site 21	Example 21	Example 21	County		R2-4ST	0.8	11,280	1,040	11,520	1,060	11,760	1,080	12,000	1,100	12,000	1,050	10,000	1,000	11,000	845	12,0											
Ref Site 22	Example 22	Example 22	County		R2-4ST	0.8	3,780	1,680	3,860	1,720	3,940	1,760	4,020	1,800	4,100	1,800	4,600	1,800	5,100	1,800	4,4											
Ref Site 23	Example 23	Example 23	County		R2-4ST	0.8	2,150	1,610	2,200	1,640	2,250	1,670	2,300	1,700	2,300	1,600	2,300	1,500	2,400	1,450	2,5											
Ref Site 24	Example 24	Example 24	County		R2-4ST	0.8	4,500	2,080	4,600	2,120	4,700	2,160	4,800	2,200	4,800	2,250	4,800	2,300	4,950	2,450	5,1											
Ref Site 25	Example 25	Example 25	County		R2-4ST	0.8	9,400	1,210	9,600	1,240	9,800	1,270	10,000	1,300	9,000	1,330	8,600	1,360	8,200	1,400	8,2											
Ref Site 26	Example 26	Example 26	County		R2-4ST	0.8	6,310	3,220	6,440	3,290	6,570	3,360	6,700	3,430	7,500	3,500	7,100	3,400	6,700	3,300	6,8											
Ref Site 27	Example 27	Example 27	County		R2-3ST	0.8	8,660	3,090	8,840	3,160	9,020	3,230	9,200	3,300	9,200	3,250	9,100	3,200	10,000	3,350	11,0											
Ref Site 28	Example 28	Example 28	County		R2-3ST	0.8	11,280	2,940	11,520	3,020	11,760	3,080	12,000	3,140	11,000	3,200	9,900	3,350	11,000	3,500	11,0											
Ref Site 29	Example 29	Example 29	County		R2-3ST	0.8	7,720	1,510	7,880	1,540	8,040	1,570	8,200	1,600	7,100	1,600	7,000	1,600	8,100	1,550	7,6											
Ref Site 30	Example 30	Example 30	County		R2-4ST	0.8	3,760	880	3,840	900	3,920	920	4,000	940	4,600	970	4,900	1,000	5,300	1,050	5,8											
Ref Site 31	Example 31	Example 31	County		R2-4ST	0.8	3,090	570	3,160	580	3,230	590	3,300	600	3,350	610	3,400	555	3,700	500	4,0											
Ref Site 32	Example 32	Example 32	County		R2-4ST	0.8	3,500	550	3,580	560	3,660	570	3,740	580	3,820	605	3,900	630	4,200	715	4,5											
Ref Site 33	Example 33	Example 33	County		R2-4ST	0.8	4,100	730	4,200	745	4,300	760	4,400	775	4,500	790	4,600	835	4,700	880	4,8											

Set-up - 1st steps | Tool to Calc. Crash Proportions | Formula Values | **Reference Site Volume Entry** | Reference Site Crash Data | Calibration Factor Calculation | Treatment Site Volume Entry

Final, Calculated Crash Modification Factors

EB Method

CMF =	**0.68**
VAR(CMF) =	0.022
SE(CMF) =	**0.15**
Lower 95% Confidence Interval =	*0.39*
Upper 95% Confidence Interval =	*0.97*
Lower 90% Confidence Interval =	*0.44*
Upper 90% Confidence Interval =	*0.92*
Number of Treatment Sites =	10
Total Observed After =	30
Total Expected After =	43.49

Naïve Method

CMF =	**0.56**
VAR(CMF) =	0.017
SE(CMF) =	**0.13**
Lower 95% Confidence Interval =	*0.30*
Upper 95% Confidence Interval =	*0.81*
Lower 90% Confidence Interval =	*0.34*
Upper 90% Confidence Interval =	*0.77*
Number of Treatment Sites =	10
Total Observed After =	30
Total Expected After =	52.75

Countermeasure Evaluations

NCDOT Traffic Safety Unit Programs

Evaluation of Roundabouts on High-Speed Roadways

NCDOT completed a safety study of 13 intersections in North Carolina where a high speed (at least one 55 mph approach) roundabout was installed. A majority of the study locations were converted from a stop-controlled intersection to a roundabout as a safety countermeasure to mitigate frontal impact crashes.

Background

All of the roundabouts included in this study effort were located in rural areas and were converted from minor road stop-controlled intersections. Additionally, all of the roundabouts in the study were single lane and had at least one leg with an approaching speed limit of 55 mph. The included roundabouts had inscribed circle diameters between 100 and 160 feet and had an average major road volume of 6,000 AADT and an average minor road volume of 3,600 AADT.

The Empirical Bayes methodology was utilized to provide a more robust statistical analysis of the data. The purpose of the evaluation is to measure changes in total intersection crashes, fatal and injury crashes, and frontal impact crashes after intersections were converted to roundabouts.

Results

The overall results from all study locations indicate a:

- **41%** Reduction in Total Crashes,
- **79%** Reduction in Fatal and Injury Crashes, and
- **62%** Reduction in Frontal Impact Crashes.

Other key points of the study:

- The results are similar to the crash reductions previously determined in an NCDOT study of 30 intersections converted from two-way stop sign control or from signalization to a roundabout in urban, suburban and rural areas with varying ranges of volumes and approach speeds.
- The reductions in Total Crashes were similar regardless of whether the intersection has three legs or four legs.

Top: Aerial View of a rural roundabout included in the study
Middle: Roundabout located near South Stanly High School in Nor
Bottom: Roundabout located in Clemmons

North Carolina Project Development
Crash Reduction Factor (CRF) Information

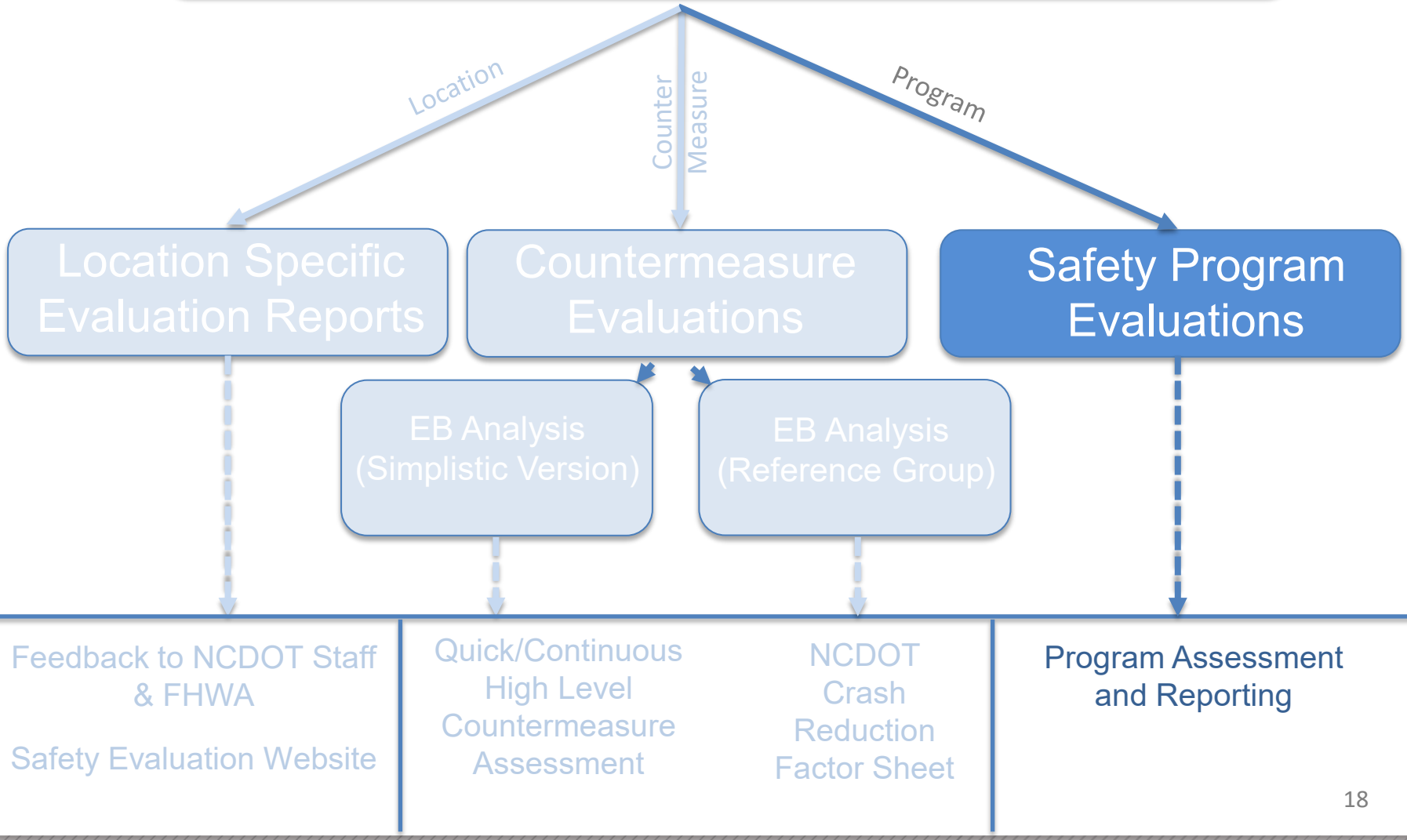
North Carolina Department of Transportation
Traffic Safety Unit

NCDOT Reference Number	Countermeasure Location Type	Countermeasure	CRF Site Specifications	CRF Crash Pattern Affected	CRF
2.1 - One-Lane Roundabout					
2.1.1	Intersection	Two-Way Stop to One-Lane Roundabout	Urban and Suburban	Injury Crashes	78
2.1.2	Intersection	Two-Way Stop to One-Lane Roundabout	Rural, At least one 55 mph approach	Injury Crashes	79

https://connect.ncdot.gov/resources/safety/TrafficSafetyResources/NCDOT%20CRF%20Update.pdf

Countermeasure Evaluations

NCDOT Safety Evaluation Process

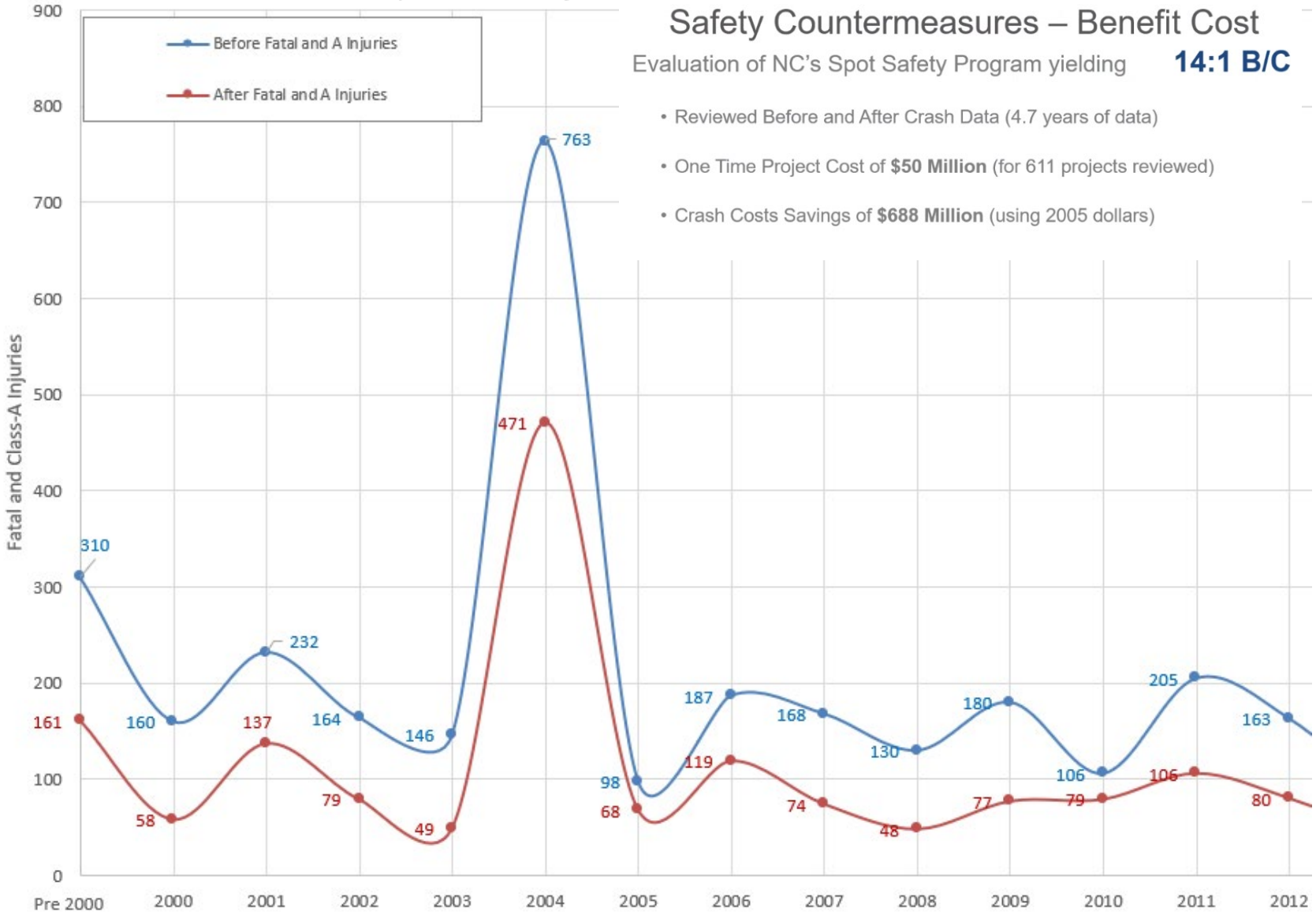


Safety Program Evaluations

	C	E	F	G	I	J	K	L	N	O	P	Q	R	U	X
1	Project Funding Year	Project Completion Date	Project Cost Estimate	TIP #	Treatment Category	Treatment Subcategory	Pedestrian Aspect (I-PED/S-PED)?	Project Improvement Description	County	Location Description	Analysis Type	Location Type	Geometry	Evaluation Report Completion Date	Study Years
11	2014	22-Sep-15	$28,518.00	SS-4903BM	Traffic Signal Revisions	Rest in Red		Adjust signal to rest in red from 11 pm to 6 am which requires additional traffic detection.	New Hanover	US 17 Business (Market Street) at 5th Street (non-system) in Wilmington at the Kenan Fountain.	Intersection	4-Leg	4 Lane @ 4 Lane	4/12/2021	5.25
12	2011	01-Oct-14	$176,000.00	SS-4906BA	Road Diet	Multiple Other Countermeasures		Change lane marking pattern from 4 lanes to an offset left turn lane and one through lane in each direction. Project includes resurfacing	Harnett	SR 1718 (Dunn-Erwin Rd) at Powell Avenue, in the Town of Dunn	Section	Multilane Undivided	3 Lane	2/12/2021	6.08
13	2012	06-Nov-15	$265,000.00	SS-4901AG	Curve Superelevation Improvements			Improve superelevation.	Hertford	SR 1108 (Boone Farm Road) between 500' north and 500' south of SR 1129 (Rea Road)	Section	2 Lane Undivided	2 Lane	5/14/2021	5.00
14	2015	14-Jul-15	$85,000.00	SS-4904DE	Traffic Signal Revisions	Multiple Other Countermeasures		(1) Install advance shoulder-mounted "Be Prepared to Stop" sign and flasher assemblies on both approaches of US 70.	Wayne	(1) US 70 at NC 581 (SIN 04-0279), (2) NC 581 at SR 2075 (Ashe Street) and NC 581 Connector (SIN 04-1279).	Intersection	4-Leg - 2 Intersections	N/A	2/22/2021	5.33
15	2014	11-Aug-16	$860,000.00	W-5601N	Roundabout			Construct a roundabout.	Pitt	SR 1774 (Mills Road) at SR 2241 (Ivy Road).	Intersection	4-Leg	2 Lane @ 2 Lane	2/15/2021	4.25
16	2014	10-Feb-16	$475,000.00	SS-4908AL	Roundabout			Construct a roundabout.	Randolph	US 220 Business at SR 2114 (Providence Church Rd)	intersection	3-Leg	2 Lane @ 2 Lane	2/25/2021	5.25
17	2016	14-Dec-17	$474,600.00	W-5702A	Left Turn Lane	Multiple Other Countermeasures		Construct left turn lanes on US 13 in both directions, splitter islands on side roads with additional stop signs, and channelize parking	Greene	US 13 at SR 1151 (Burrellfield Road) and SR 1202 (Corbett Town Road)	Intersection	4-Leg	2 Lane @ 2 Lane	3/3/2021	3
18	2015	11-Dec-15	$25,000.00	SS-4912BK	Traffic Signal Revisions	Multiple Other Countermeasures	I-PED	1. Convert the NB NC 127 5-section head for left turns to a 4-section Flashing Yellow Arrow. 2. Install backplates with reflective borders for	Catawba	NC 127 @ SR 1314 (3rd Ave. NE)	Intersection	4-Leg	4 Lane @ 2 Lane	4/12/2021	5.00
19	2014	31-Oct-15	$35,000.00	SS-4905CJ	Median Channelization			Install a raised concrete island.	Durham	US 70 at SR 1957 (Peyton Avenue).	Intersection	4-Leg	5 Lane @ 2 Lane	2/16/2021	5.08
20	2015	11-Sep-15	$310,000.00	SS-4908AV	New Traffic Signal	Crosswalk	PED	Install a traffic signal with pedestrian countdown heads and construct a mid-block crossing with a pedestrian refuge island on SR	Moore	SR 1309 (Morganton Rd) at Fire Lane.	Intersection / Sectio	Multiple Intersections	N/A	6/23/2021	5.5
	2013	26-Jan-15	$338,000.00	SS-4913BM	Sidewalk	Crosswalk	PED	Construct sidewalk, install crosswalk and add pedestrian signal heads and phasing to	Rutherford	SR 2241 (Oak St.) from SR 2178 across US 74A to Plaza Drive in Forest City. Length = 0.849	Intersection / Sectio	Multilane Undivided	5 Lane	2/17/2021	6.25

	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ
	Total Before	TOB F	TOB A	TOB B	TOB C	TOB PDO	Target Before	TAB F	TAB A	TAB B	TAB C	TAB PDO	Total After	TOA F	TOA A	TOA B	TOA C	TOA PDO	Target After	TAA F	TAA A	TAA B	TAA C	TAA PDO	ADT Year Before	ADT Before	ADT Year After	ADT After
	73	0	0	3	20	50	61	0	0	2	19	40	31	0	0	2	8	21	20	0	0	1	8	11	2013	16000	2017	14400
	50	0	1	3	11	35	28	0	0	2	9	17	19	0	0	2	5	12	10	0	0	1	5	4	2014	10400	2016	11300
	3	0	0	1	1	1	2	0	0	1	0	1	4	1	0	1	0	2	2	1	0	1	0	0	2015	2700	2019	3700
	116	2	1	7	35	71	27	1	1	6	11	8	94	0	1	4	26	63	20	0	0	2	10	8	2015	22900	2018	23100
	18	1	0	3	5	9	12	1	0	2	4	5	5	0	0	0	1	4	0	0	0	0	0	0	2014	5800	2016	8300
	20	0	0	3	7	10	8	0	0	3	1	4	23	0	0	3	2	18	2	0	0	0	0	2	2015	6400	2019	5600
	4	0	0	0	2	2	3	0	0	0	2	1	4	1	0	0	1	2	1	0	0	0	1	0	2017	7500	2019	7000
	48	1	0	4	10	33	22	1	0	3	5	13	54	0	0	0	10	44	9	0	0	0	2	7	2015	29800	2017	30600
	92	0	0	5	14	73	59	0	0	4	9	46	52	0	0	3	13	36	16	0	0	2	3	11	2015	40000	2017	43500
	10	2	0	2	2	4	8	2	0	2	1	3	11	0	0	3	5	3	4	0	0	2	2	0	2015	18800	2019	22000

Safety Program Evaluations



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PennDOT's Highway Safety Improvement Program Project Evaluations

AASHTO

pennsylvania
DEPARTMENT OF TRANSPORTATION

Today's PennDOT Speaker

Jason Hershock

Manager – Safety Engineering & Risk Management Unit

Pennsylvania Department of Transportation

Highway Safety & Traffic Operations Division

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Today's Presentation

Overview of HSIP Project Evaluation Process

- Data Collection Process
- Tools for Evaluation Process
- Methodology- Systemic & Spot Locations
- Utilizing the Results
- Challenges to the Analysis
- Next Steps and Future Evaluations

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Data Collection

- Review of 424 projects from 2002 to 2017 (over $560 million in HSIP funds)
- Analysis of fatal and serious injury crashes
  - Pull from CDART and PCIT
  - Use Pennsylvania SPFs for base conditions
  - Refer to CMF clearinghouse for expected performance of countermeasures and compare project results
- Video log, RMS, and TIRe
- Funding by MPO, District, and Countermeasure types
- Use PennDOT's MPMS and ECMS systems for project information
  - Contains project locations,
  - Scope of work descriptions,
  - Special provisions,
  - Project plans and drawings,
  - Itemized costs for countermeasures,
  - Project let or Notice to proceed dates, open to traffic dates (OTT)

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Analysis Tools

- No special off-the-shelf tool.
- PennDOT developed our own tools to complete the HSIP project evaluations
- Consultants developed large workbook with multiple spreadsheets with VB coding

Table 2-27. HSIP Funds Spent by Improvement Type (2002-2015)

Improvement Category	2002-2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Alignment	$2,199,882	$184,043	$2,459,193	$1,908,199	$31,017	$11,368,853	$0	$1,507,828	$6,487,081	**$26,146,096**
Auxiliary Lanes	$17,833,761	$1,778,443	$1,160,033	$1,604,365	$795,582	$2,305,619	$23,807,790	$15,711,708	$1,147,829	**$66,145,129**
Barrier	$15,161,211	$0	$898,803	$3,708,005	$1,946,847	$3,831,060	$0	$817,860	$14,733,210	**$41,096,996**
Bridge Deicing System or Overlay	$534,000	$0	$0	$0	$917,432	$0	$0	$0	$0	**$1,451,432**
Bridge Repairs	$0	$0	$0	$364,414	$0	$0	$0	$450,000	$0	**$814,414**
Delineators	$315,000	$0	$0	$219,332	$0	$0	$0	$0	$0	**$534,332**
Drainage	$0	$0	$0	$0	$0	$99,862	$0	$0	$0	**$99,862**
Dynamic Message Signs	$0	$0	$0	$0	$0	$1,832,916	$0	$0	$0	**$1,832,916**
High Friction Surface Treatment	$0	$0	$0	$0	$0	$629,765	$0	$576,596	$5,726,756	**$6,933,117**
Interchange Geometry	$276,000	$0	$0	$1,006,341	$0	$2,160,118	$0	$6,385,913	$3,944,907	**$13,773,278**
Intersection Geometry	$26,811,710	$775,269	$1,843,133	$1,229,227	$502,074	$195,695	$1,347,400	$25,830,863	$4,146,618	**$62,681,989**
Lighting (interchange)	$0	$0	$458,000	$0	$0	$0	$0	$0	$0	**$458,000**
Modify Traffic Signal	$6,342,877	$192,500	$0	$8,327,399	$2,144,481	$11,286,083	$4,383,050	$5,491,479	$2,831,276	**$40,999,146**
New Traffic Signal	$2,761,000	$3,475,514	$7,695,624	$5,594,438	$3,814,499	$6,308,126	$4,957,217	$2,874,900	$1,581,882	**$39,063,199**
Pavement Surface	$0	$3,755,547	$601,293	$0	$1,998,550	$0	$373,438	$2,475,967	$0	**$9,204,794**
Pedestrian and Bicycle	$350,000	$0	$0	$0	$256,494	$0	$3,578,692	$0	$0	**$4,185,186**
Roadside	$1,121,000	$0	$0	$0	$0	$0	$0	$0	$214,652	**$1,335,652**
Roadway - Other	$858,337	$0	$0	$0	$8,941,749	$860,813	$11,336,851	$0	$9,339,124	**$31,336,873**
Roadway Widening - add lane(s)	$20,129,949	$0	$0	$1,865,333	$0	$0	$0	$6,548,424	$0	**$28,543,705**
Roundabout	$0	$0	$0	$0	$0	$0	$0	$0	$872,591	**$872,591**
Rumble Strips	$636,661	$1,197,943	$135,038	$269,370	$252,049	$4,258,456	$830,000	$525,000	$1,701,892	**$9,806,410**
Shoulder Widening	$0	$0	$0	$0	$659,336	$0	$0	$0	$1,385,457	**$2,044,793**
Signing and Pavement Markings	$3,245,973	$829,709	$2,679,967	$106,673	$0	$85,745	$0	$891,220	$4,643,012	**$12,482,299**
Truck Pull-off and Escape Ramps	$0	$0	$0	$0	$1,731,621	$0	$0	$0	$0	**$1,731,621**
Wrong-Way Ramp Treatments	$520,063	$0	$0	$0	$0	$0	$0	$0	$1,256,974	**$1,777,037**
Total	**$99,097,423**	**$12,188,969**	**$17,931,082**	**$26,203,095**	**$23,991,730**	**$45,223,110**	**$50,614,438**	**$70,087,758**	**$60,013,261**	**$405,350,866**

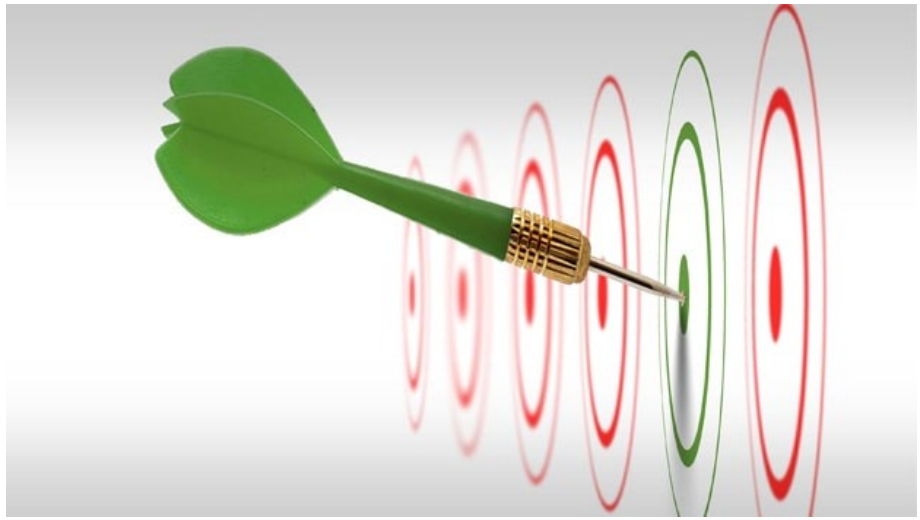
Methodology

- Gather complete list of all HSIP Projects from 2002 up to 2017
- Determine countermeasures used in every project
- Exclude construction by identifying the NTP and OTT dates for every project
- Compare observed data to predicted models if CMFs exist for improvement
- Assess project successes and failures
- Systemic projects assessed network wide, not by site alone
  - Allocated costs proportionally

Proj. ID	HSIP Project ID	PennDOT Description	County	SR	Beg Seg	Beg Off	End Seg	End Off	Length (f	AADT
					0261	0000	0261	2410	2410	11546
78555	78555.000	Intersection Upgrade & Signalization	Lehigh	0100	0220	2092	0220	3402	1310	15096
					0230	0000	0230	1146	1146	13569
48418	48418.000	Intersection Improvement	Montgomery	1001	0060	0000	0060	1537	1537	13508
					0070	0000	0070	2611	2611	12057
				1004	0030	0000	0030	2268	2268	4739
					0040	0001	0040	3826	3825	7974
95391	95391.000	Systematic mitigation on a corridor basis to remove non-compliant rumble strips.	Fayette	0051	0091	0000	0091	3626	3626	7255
	95391.001			1073	0020	0000	0020	1768	1768	5945
	95391.002		Greene	0018	0010	0000	0010	3100	3100	0688
					0020	0000	0020	2905	2905	0688
	95391.003				0120	0000	0120	2920	2920	0688
	95391.004				0300	0000	0300	2880	2880	5084
	95391.005			0019	0360	0000	0360	2890	2890	3073
					0370	0000	0370	2638	2638	3073
					0380	0000	0380	1482	1482	3073
	95391.006			0021	0170	0000	0170	2806	2806	2382
	95391.007			0018	0170	0000	0170	2702	2702	2694
	95391.008				0230	0000	0230	3104	3104	2998
	95391.009				0300	0000	0300	2035	2035	6492
	95391.010				0510	0000	0510	2329	2329	7201

Results

- Many ways to present data analysis
  - Statewide
  - Districts
  - MPOs and RPOs
  - Counties
  - Funds spent on focus areas vs. needs
  - Predicted vs. Observed crashes
  - Benefit Cost Analysis
  - Countermeasure Analysis
  - Systemic vs. Spot Locations
  - Urban vs. Rural
  - Roadway Classifications
  - Exposure to Licensed Drivers



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Statewide HSIP Spending: SHSP Priority Focus Area

SHSP Priority Focus Area	Number of Projects	Number of Sites	HSIP Funds Spent ($M)
Intersection Safety	198	1,176	$302.9
Lane Departures	156	2,660	$148.0
Pedestrians and Bicyclists	4	4	$4.3
Other Priorities	66	140	$107.1
TOTAL	**424**	**3,980**	**$562.3**

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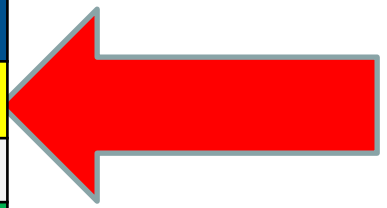
Statewide Crashes – for comparison to spending

Crash Type	5-Year Average (2016-2020)		Percent of Crashes (2016-2020)	
	Fatalities	SSI	Fatalities	SSI
Intersections	**276**	**1,505**	**24%**	**34%**
Signalized	103	575	9%	13%
Lane Departures	**588**	**1,869**	**52%**	**42%**
Single Vehicle Run-Off-Road	491	1,780	43%	40%
Hit Fixed Object	386	1,369	34%	31%
Head On / Opp Dir Side Swipe	153	614	13%	14%
Pedestrians & Bicyclists	**184**	**551**	**16%**	**12%**
Pedestrians	165	457	14%	10%
Bicyclists	19	94	2%	2%



52% of HSIP Spending

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Statewide HSIP Spending: Project Performance

Year	Projects Completed	HSIP Funds Spent (Millions)	Before F+SSI Crashes/ Year	After F+SSI Crashes/ Year	% Change F+SSI Crashes
2002-2007	100	$99.1	601	531	-12%
2008	26	$12.2	259	215	-17%
2009	21	$17.9	31	22	-29%
2010	24	$26.2	130	107	-18%
2011	28	$24.0	85	88	4%
2012	28	$45.2	196	151	-23%
2013	20	$50.6	98	112	14%
2014	32	$70.1	67	68	1%
2015	45	$60.0	271	255	-6%
2016	53	$67.4	326	289	-11%
2017	47	$89.6	432	456	6%
Total	**424**	**$562.4**	**2,436**	**2,295**	**-6%**

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Statewide HSIP Spending: Spot vs Systemic

Type of Projects	HSIP Funds Spent ($M)	Before F+SSI Crashes	After F+SSI Crashes	Cost per F+SSI Reduction ($M)
Spot Improvements	$390.0	469	442	$14.44
Systemic	$172.3	1,967	1,852	$1.50
Total	$562.3	2,436	2,294	$3.96

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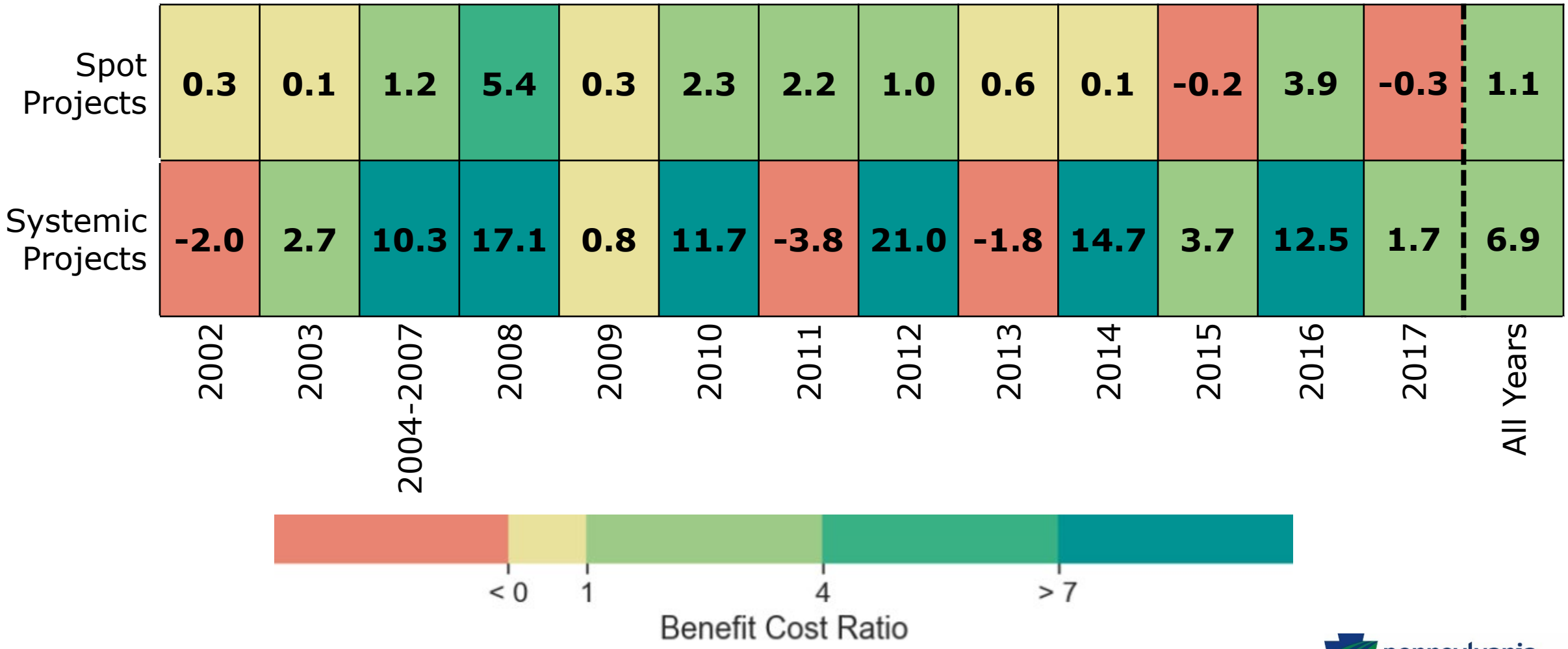
Statewide HSIP: Spot vs. Systemic—Benefit/Cost Ratio



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Statewide HSIP Performance: Functional Classification

Functional Classification	HSIP Funds Spent ($M)	Before F+SSI Crashes	After F+SSI Crashes	F+SSI Crash Change (%)
Rural Minor Collectors	$12.6	82	52	-37%
Rural Major Collectors	$41.0	186	124	-33%
Rural Other Principle Arterials	$91.8	245	189	-23%
Rural Local Roads	$11.6	24	19	-21%
Rural Minor Arterials	$81.7	363	291	-20%
Urban Major Collectors	$25.8	85	78	-8%
Undefined	$3.9	128	122	-5%
Urban Minor Arterials	$82.3	217	208	-4%
Rural Interstate	$20.6	447	434	-3%
Urban Minor Collectors	$0.0	0	0	0%
Urban Other Principle Arterials	$153.5	536	564	5%
Urban Interstate	$13.6	53	57	8%
Urban Other Freeways and Expressways	$20.4	124	145	17%
Urban Local Roads	$3.5	6	11	83%

Statewide HSIP Project Performance: Urban vs Rural

	HSIP Funds Spent ($M)	Before F+SSI Crashes	After F+SSI Crashes	% Change F+SSI Crashes
Urban	$299.1	1,021	1,062	+4%
Rural	$259.3	1,347	1,109	-18%
Not Defined	$3.9	128	123	-4%
Total	**$562.3**	**2,496**	**2,294**	**-8%**

Lesson: Safety improvements on rural roads were much more effective

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Predicted vs. Observed Performance

Improvement Type	Improvement Sub-Type	Before F+I	After F+I	After F+I with CMF
Alignment	-	199	96	123
Auxiliary Lanes	Add Left-Turn Lane	321	233	254
Auxiliary Lanes	Add Right-Turn Lane	92	116	69
Auxiliary Lanes	Extend Existing Left-Turn Lane	316	244	282
Auxiliary Lanes	Other/Unknown	377	332	288
Barrier	Guiderail Replacement with New W-beam	2,575	2,537	2,405
Barrier	High Tension Cable Median Barrier	387	451	226
Barrier	Median - Concrete	509	484	55
Barrier	Median - W-beam	56	97	49
Barrier	New Guiderail at Unprotected Bridge Ends	10	4	8
Barrier	Other	3	9	0
Barrier	Remove Guiderail	1	1	0
Delineators	-	101	120	89
High Friction Surface Treatment	-	447	250	189
Intersection Geometry	-	474	272	350

- CMFs for fatal and injury crashes were used rather than CMFs for total crashes for severity
- For consistency, these results used Fatal and injury crashes

- Used dominant CMF for project analysis
- For analysis of PennDOT's HSIP projects, CMFs applicable to all crash types were selected when possible

Improvement Type	Improvement Sub-Type	Before F+I	After F+I	After F+I with CMF
Lighting (interchange)	-	4	10	3
Modify Traffic Signal	Coordination/Timing	457	463	418
Modify Traffic Signal	Replace Existing Indications	521	483	544
New Traffic Signal	-	401	264	331
Pavement Surface	Resurfacing	222	249	176
Pedestrian and Bicycle	Pedestrian Signal	991	1,064	943
Roadway Widening - add lane(s)	-	181	119	103
Roundabout	-	7	3	6
Rumble Strips	Center Line	1,326	956	866
Rumble Strips	Edge Line	241	233	152
Rumble Strips	Unknown or Both	1,083	922	879
Rumble Strips	Remove Non-Compliant Rumble Strips	6	9	5
Shoulder Widening	-	65	67	23
Signing and Pavement Markings	Curve-Related	1,168	891	1,119
Signing and Pavement Markings	Intersection-Related	431	354	392
Signing and Pavement Markings	Interstate Signs	2,209	1,963	2,193
Signing and Pavement Markings	Other/Unknown	190	244	167
Signing and Pavement Markings	Raised Pavement Markers	4,384	4,151	3,555
Signing and Pavement Markings	With Flashers	23	12	23

Most Effective Safety Countermeasures

Improvement Type	Improvement Sub-Type	Before F+SSI Crashes	After F+SSI Crashes	Project Cost	Cost to Eliminate a F+SSI	Net Benefit	F+SSI B/C Ratio
Rumble Strips	Unknown or Both	116	110	$700,000	$116,667	$46,491,600	66.4
Signing and Pavement Markings	Curve-Related	124	82	$4,373,383	$104,128	$260,637,434	59.6
Modify Traffic Signal	Replace Existing Indications	28	17	$616,787	$56,072	$26,680,853	43.3
Rumble Strips	Center Line	116	86	$4,257,153	$141,905	$154,526,315	36.3
Signing and Pavement Markings	Intersection-Related	48	34	$3,462,916	$247,351	$115,801,524	33.4
Rumble Strips	Edge Line	29	24	$4,816,057	$963,211	$56,582,863	11.8
High Friction Surface Treatment	-	26	19	$6,933,117	$990,445	$47,146,600	6.8
Signing and Pavement Markings	Interstate Signs	184	175	$1,434,906	$159,434	$8,103,725	5.7

Least Effective Safety Countermeasures

Improvement Type	Improvement Sub-Type	Before F+SSI Crashes	After F+SSI Crashes	Project Cost	Cost to Eliminate a F+SSI	Net Benefit	F+SSI B/C Ratio
Signing and Pavement Markings	Raised Pavement Markers	295	306	$2,028,000	-$184,364	-$52,713,043	-26.0
Pedestrian and Bicycle	Pedestrian Signal	51	57	$3,835,186	-$639,198	-$34,203,386	-8.9
Barrier	High Tension Cable Median Barrier	30*	37*	$7,295,629	-$1,042,233	-$57,190,617	-7.8
Auxiliary Lanes	Other/Unknown	15	22	$8,114,334	-$1,159,191	-$25,971,663	-3.2
Modify Traffic Signal	Coordination/Timing	13	23	$6,012,716	-$601,272	-$12,580,345	-2.1
Modify Traffic Signal	Replacement	44	41	$22,503,950	$7,501,317	-$38,948,786	-1.7
Auxiliary Lanes	Add Right-Turn Lane	8	12	$15,715,364	-$3,928,841	-$12,436,493	-0.8

* Values reflects total crashes, and are not isolated to Cross Median crash events

Challenges to Analysis

- Over the last two decades there have been several personnel changes and policy changes
- Project justification for project from years ago
  - How projects qualified for HSIP funds has changed
  - At least 95 projects did not have an apparent safety justification
    - Bridges, bridge de-icing, , and others
- Older projects' data had broad scope
- Older projects did have some changes to segment and offset due to alignment projects
- Some Routes had changed route numbers
- Change in the definition of serious injuries in 2016
- Limited crash data for some years
  - Older projects and newest projects (Only keep 20 years of crash data)

Next Steps

- Update HSIP project analysis annually
- Use analysis data to make changes to the HSIP
- Include more systemic safety projects
- Determine better options for safety projects in urban areas
- Complete more detailed analysis on specific countermeasures
  - Like ATSCs and HTCMBs
- Mandated HSM based project justification for any spot location project
- Expand State's Highway Safety Network Screening to local roads
- Make data sets easier to combine for future analysis
- Create a new HSIP project applications website
  - Current SharePoint site is at critical point/maximum ability

Final Lesson Learned

We also found from 2002 to 2017 there were no reported cases of Grandma getting runover by a reindeer in Pennsylvania

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Questions

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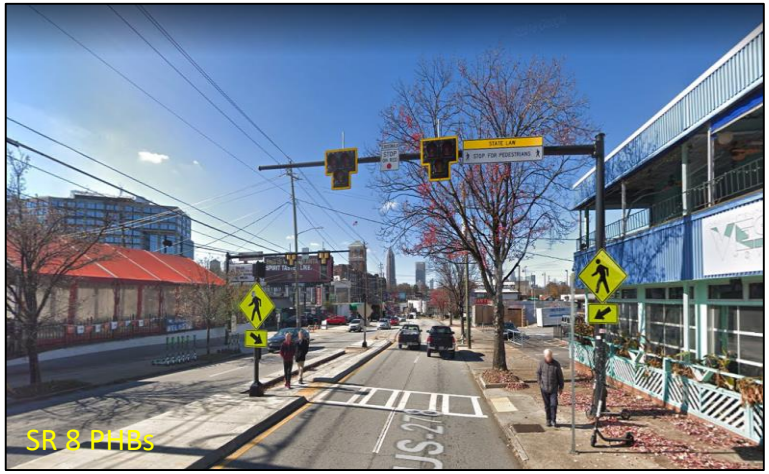
Georgia Department of Transportation

GDOT Safety Engineering Program: Safety Evaluation

Samuel Harris, PE

State Safety Engineering Manager

December 15th, 2021



SR 8 PHBs

SR 138 @ N Moseley Dr, Henry County, GA

Three Takeaways

1. Data Collection
2. Crash Analytics = Numetric
3. Evaluation of Program and Projects

Agency Overview

GDOT

Georgia Department of Transportation

2021 WORLD SERIES CHAMPIONS Braves

Data Collection Process

GDOT
Georgia Department of Transportation

Page ___ of ___

Agency Case Number	Agency NCIC Number	GEORGIA MOTOR VEHICLE CRASH REPORT	County	Date Rec. by GDOT

Estimated Crash Date	Estimated Crash Time	Dispatch Date	Dispatch Time	Arrival Date	Arrival Time	Total Number of Vehicles	Total Number of Injuries	Total Number of Fatalities	Inside City Of

Road of Occurrence _____ At Its Intersection With _____ ☐ Corrected Report

Not At Its Intersection But _____ ☐ Miles ☐ Feet ☐ North ☐ South ☐ East ☐ West Of _____ ☐ Sup To Original

Latitude (Y) (Format) 00.00000 Longitude (X) (Format) -00.00000 ☐ Hit and Run

Unit #	☐Driver ☐Ped ☐Bike	LAST NAME	FIRST	MIDDLE
		Address		
☐ Susp At Fault	City	State	Zip	DOB
Driver's License No.	Class	State	Country	
Insurance Co.	Policy No.	Telephone No.		
Year	Make	Model		
VIN	Vehicle Color			
Tag #	State	County	Year	
Trailer Tag #	State	County	Year	
☐ Same as Driver	Owner's Last Name	First	Middle	
Address				
City	State	Zip		
Removed By:			☐ Request ☐ List	

Alco Test:	Type:	Results:	Drug Test:	Type:	Results:

First Harmful Event:	Most Harmful Event:	Operator/Ped Cond:

Operator Contributing Factors: ____ ____ ____ ____

Vehicle Contributing Factors:	Roadway Contributing Factors:

Direction of Travel:	Vehicle Maneuver:	Non-Motor Maneuver:
Vehicle Class:	Vehicle Type:	Vision Obscured:
Number of Occupants:	Area of Initial Contact:	Damage to Veh:
Traffic-Way Flow:	Road Comp:	Road Character:
Number of Lanes:	Posted Speed:	Work Zone:

Traffic Control: Device Inoperative: ☐ Yes ☐ No

Citation Information:
Citation # _____ O.C.G.A. § _____
Citation # _____ O.C.G.A. § _____
Citation # _____ O.C.G.A. § _____

COMMERCIAL MOTOR VEHICLES ONLY

Carrier Name:

Address	City	State	Zip

U.S. D.O.T. #	No. of Axles	G.V.W.R.

Cargo Body Type	Vehicle Config.	☐ Interstate ☐ Intrastate	Fed. Reportable ☐ Yes ☐ No

C.D.L.?	C.D.L. Suspended?	Vehicle Placarded?	Hazardous Materials?
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

Haz Mat Released? ☐ Yes ☐ No

If YES: Name or four Digit Number from Diamond or Box: _____

One Digit Number from Bottom of Diamond: _____

☐ Ran Off Road ☐ Down Hill Runaway ☐ Cargo Loss or Shift ☐ Separation of Units

GDOT-523 (07/17)

Carrier Name:

Address	City	State	Zip

U.S. D.O.T. #	No. of Axles	G.V.W.R.

Cargo Body Type	Vehicle Config.	☐ Interstate ☐ Intrastate	Fed. Reportable ☐ Yes ☐ No

C.D.L.?	C.D.L. Suspended?	Vehicle Placarded?	Hazardous Materials?
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

Haz Mat Released? ☐ Yes ☐ No

If YES: Name or four Digit Number from Diamond or Box: _____

One Digit Number from Bottom of Diamond: _____

☐ Ran Off Road ☐ Down Hill Runaway ☐ Cargo Loss or Shift ☐ Separation of Units

GEORGIA MOTOR VEHICLE CRASH REPORT OVERLAY

GDOT Georgia Department of Transportation

ALCOHOL AND/OR DRUG TEST GIVEN
1-Yes
2-No
3-Refused

TEST TYPE
1-Blood
2-Breath
3-Urine
4-Other

FIRST / MOST HARMFUL EVENT
Non Collision
1-Overturn
2-Fire/Explosion
3-Immersion
4-Jackknife
5-Other Non-Collision
35-Cargo/Equipment Loss or Shift
Collision With Object Not Fixed
6-Pedestrian
7-Pedalcycle
8-Railway Train/Street Car
9-Animal
10-Parked Motor Vehicle
11-Motor Vehicle in Motion
12-Other Object (Not Fixed)
14-Deer
36-Work Zone/Maintenance Equipment
Collision With Fixed Object
15-Impact Attenuate
16-Bridge Pier/Abutment
17-Bridge Parapet End
18-Bridge Rail
19-Guardrail Face
20-Guardrail End
21-Median Barrier
22-Highway Traffic Sign Post
23-Overhead Sign Support
24-Luminaire Light Support
25-Utility Pole
26-Other Post
27-Culvert
28-Curb
29-Ditch
30-Embankment
31-Fence
32-Mailbox
33-Tree
34-Other-Fixed Object
37-Bridge Overhead Structure
38-Cable Barrier

OPERATOR/PEDESTRIAN CONDITION
1-Not Drinking
2-Unknown
4-U.I. Alcohol
5-U.I. Drugs
6-U.I. Alcohol & Drugs
7-Physical Impairment
8-Suspected Fatigued or Asleep
9-Emotional (depressed, angry, disturbed, etc.)
10-Suspected U.I. (Alcohol and/or Drugs)

OPERATOR CONTRIBUTING FACTORS
1-No Contributing Factors
2-Under the Influence (U.I.)
3-Following Too Close
4-Failed to Yield
5-Exceeding Speed Limit
6-Disregard Stop Sign/Signal
7-Wrong Side of Road
9-Improper Passing
10-Driver Lost Control
11-Changed Lanes Improperly
12-Reaction to Object or Animal
13-Improper Turn
14-Parked Improperly
17-Misjudged Clearance
18-Improper Backing
19-No Signal/Improper Signal
20-Driver Condition
22-Too Fast for Conditions
23-Improper Passing of School Bus
24-Disregard Police - Traffic Control
26-Other
28-Inattentive or Other Distraction (Distracted)
29-Texting (Distracted)
30-Talking on Hands-Free Device (Distracted)
31-Talking on Hand-Held Device (Distracted)
32-Other Activity-Mobile Device (Distracted)
33-Occupant Distraction (Distracted)
34-Other Interior Distraction (Distracted)
35-Other Exterior Distraction (Distracted)
36-Disregard Other Traffic Control
37-Reckless Driving
38-Aggressive Driving
39-Racing
40-Disregard Police - Evasion
41-Not Visible (Object, Person, or Vehicle)
42-Vision Obscured

VEHICLE CONTRIBUTING FACTORS
1-No Contributing Factors
2-Tire Failure
3-Brake Failure
4-Improper or Inoperative Lights/Signals
5-Steering Failure
6-Slick Tires
7-Other
8-Mirrors
9-Power Train
10-Suspension
11-Truck Coupling/Trailer Hitch/Safety Chains
12-Windows/Windshield
13-Wipers

ROADWAY CONTRIBUTING FACTORS
1-No Contributing Factors
2-Shoulder (none, low, soft, high)
3-Ruts, Holes, Bumps
4-Loose Material On Surface
5-Water Standing
6-Work Zone (construction/maintenance/utility)
7-Running Water
8-Other
9-Backup Due to Prior Crash/Secondary Crash
10-Traffic Congestion
11-Road Surface Condition (wet, icy, snow, slush, etc.)
12-Obstruction in Roadway
13-Visual Obstruction(s) - Other Along Roadway
14-Visual Obstruction(s) - Vegetation Along Roadway
15-Insident Response Scene

DIRECTION OF TRAVEL
1-North
2-South
3-East
4-West

VEHICLE MANEUVER
1-Turning Left
2-Turning Right
3-Making U-Turn
4-Stopped
5-Straight
6-Changing Lanes
7-Backing
8-Parked
9-Passing
10-Negotiating a Curve
11-Entering/Leaving Parking
12-Entering/Leaving Driveway
13-PIT
14-Other

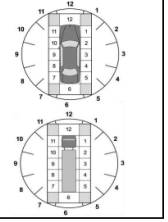
NON-MOTORIST MANEUVER
1-Crossing, Not at Crosswalk
2-Crossing at Crosswalk
3-Moving With Traffic on Roadway
4-Moving Against Traffic on Roadway
5-Pushing or Working on Vehicle
6-Other Working in Roadway
7-Playing in Roadway
8-Standing in Roadway
9-Off Roadway
10-Other
11-Darting Into Traffic
12-Entering/Exiting Bus
13-Entering/Exiting Parked or Standing Vehicle

VEHICLE CLASS
1-Privately Owned
2-Police
3-Fire
4-School
5-Other Govt. Owned
6-Military
7-Commercial Motor Vehicle (CMV)
8-Other
9-Non-Transport Emergency Services Vehicle/HERO
10-Passenger Service Vehicle (Taxi)

VEHICLE TYPE
1-Passenger Car
2-Pickup Truck
3-Truck Tractor (Bobtail)
4-Tractor/Trailer
5-Tractor W/Twin Trailers
6-Logging Truck
7-Logging Tractor/Trailer
8-Single Unit Truck
9-Panel Truck
10-Van
11-Sports Utility Vehicle (SUV)
12-Vehicle With Trailer
13-Bus
14-Truck Towing House Trailer
15-Ambulance
16-Motorized Recreational Vehicle
17-Motorcycle
18-Moded, Scooter, or Minibike
19-Pedalcycle or Bicycle
20-Farm or Construction Equip.
21-All Terrain Vehicle (ATV)
22-Other
23-Golf Cart or Go Cart

VISION OBSCURED BY
1-Not Obscured
2-Headlights
3-Sunlight/Glare
4-Parked/Stopped Vehicle
5-Trees, Bushes
6-Rain, Snow, Ice on Windshield
7-Other

AREA OF INITIAL CONTACT
10-Overturned
13-Top
14-Undercarriage
15-Non-Contact Vehicle
16-Not Applicable - Pedestrian



GDOT-523 Overlay *(07/17)*

DAMAGE TO VEHICLE
1-No Damage
2-Minor Damage
3-Functional Damage
4-Disabling Damage

TRAFFIC-WAY FLOW
1-Two-way Traffic-way With No Physical Separation
2-Two-way Traffic-way With a Physical Separation
3-Two-way Traffic-way With a Physical Barrier
4-One-way Traffic-way
5-Continous Turning Lane

ROAD COMPOSITION
1-Concrete
2-Black Top
3-Tar and Gravel
4-Dirt
5-Gravel
6-Other

ROAD CHARACTER
1-Straight and Level
2-Straight on Grade
3-Straight on Hillcrest
4-Curve and Level
5-Curve on Grade
6-Curve on Hillcrest

WORK ZONE
0-None
1-Construction
2-Maintenance
3-Utility
4-Unknown Type

TRAFFIC CONTROL
0-Gate
1-No Control Present
2-Traffic Signal
3-RR Signal/Sign
4-Warning Sign
5-Stop Sign
6-No Passing Zone
7-Lanes
8-Other
9-Flashing Lights
10-Yield Sign

CARGO BODY TYPE
1-Van (Enc. Box)
2-Auto Carrier or Tow Truck
3-Bus
4-Dump
5-Garbage/Refuse
6-Flatbed
7-Cargo Tanker
8-Concrete Mixer
9-Other
10-Hopper
11-Intermodal Container Chassis
12-Pole-Trailer

VEHICLE CONFIGURATION
1-Bus (Seating for More Than 15 Passengers)
2-Single Unit Truck: 2 Axles
3-Single Unit Truck: 3 or More Axles
4-Truck Trailer
5-Truck Tractor (Bobtail)
6-Tractor Trailer
7-Tractor With Twin Trailers
8-Unknown Heavy Truck (Cannot Classify)
9-Bus/Large Van (seats for 9-15 occupants, including driver)
10-Vehicle 10,000 Pounds or Less Placarded for Hazardous Materials

PAGE 2 ATTRIBUTES (EVENTS)

MANNER OF COLLISION
1-Angle
2-Head On
3-Rear End
4-Sideswipe - Same Direction
5-Sideswipe - Opposite Direction
6-Not a Collision With a Motor Vehicle

LOCATION AT AREA OF IMPACT
1-On Roadway - Non-Intersection
2-On Shoulder
3-Off Roadway
4-Median
5-Entrance/Exit Ramp
6-Gore
7-On Roadway - Roadway Intersection
8-On Roadway - Roundabout
9-On Roadway - Driveway Intersection
10-On Roadway - Railroad Crossing
11-On Roadway - Managed Lane (HOV, HOT, Reversible)
12-On Roadway - Collector Distributor (CD)
13-On Roadway - Bicycle Lane
14-On Roadway - In Crosswalk
15-Off Roadway - Sidewalk
16-Private Property

WEATHER
1-Clear
2-Cloudy
3-Rain
4-Snow
5-Sleet
6-Fog
7-Other
8-Severe Thunderstorm or Tornadic

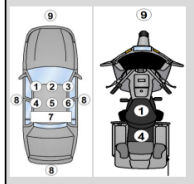
SURFACE CONDITION
1-Dry
2-Wet
3-Snow
4-Ice/Frost
5-Other
6-Mud
7-Sand
8-Slush
9-Oil
10-Water (standing or moving)

LIGHT CONDITION
1-Daylight
2-Dusk
3-Dawn
4-Dark - Lighted
5-Dark - Not Lighted

AGE
00-Up to One Year
01 to 97-Actual Age
98-Ninety-eight years old or Older
99-Unknown

SEX
M-Male F-Female

SEATING POSITION
1-Front Seat - Left Side (Operator)
2-Front Seat - Middle
3-Front Seat - Right Side
4-Rear Seat - Left Side
5-Rear Seat - Middle
6-Rear Seat - Right Side
7-Other Seat - Interior
8-Riding on Vehicle Exterior
9-Non-Motorist - Outside of a Vehicle



SAFETY EQUIPMENT
0-None Used
1-Shoulder Belt Only Used
2-Lap Belt Only Used
3-Lap and Shoulder Belt Used
4-Child Restraint System (Properly Used)
5-Child Restraint System (Improperly Used)
6-Motorcycle Helmet
7-Bicycle Helmet
8-Unknown
9-Booster Seat (Properly Used)
10-Booster Seat (Improperly Used)
11-Non-Motorist Lighting
12-Reflective: Clothing/Backpack/Equipment

EJECTION
1-Not Ejected
2-Trapped
3-Totally Ejected
4-Partially Ejected
5-Not Applicable

EXTRICATION (Equipment Used)
1-Yes
2-No

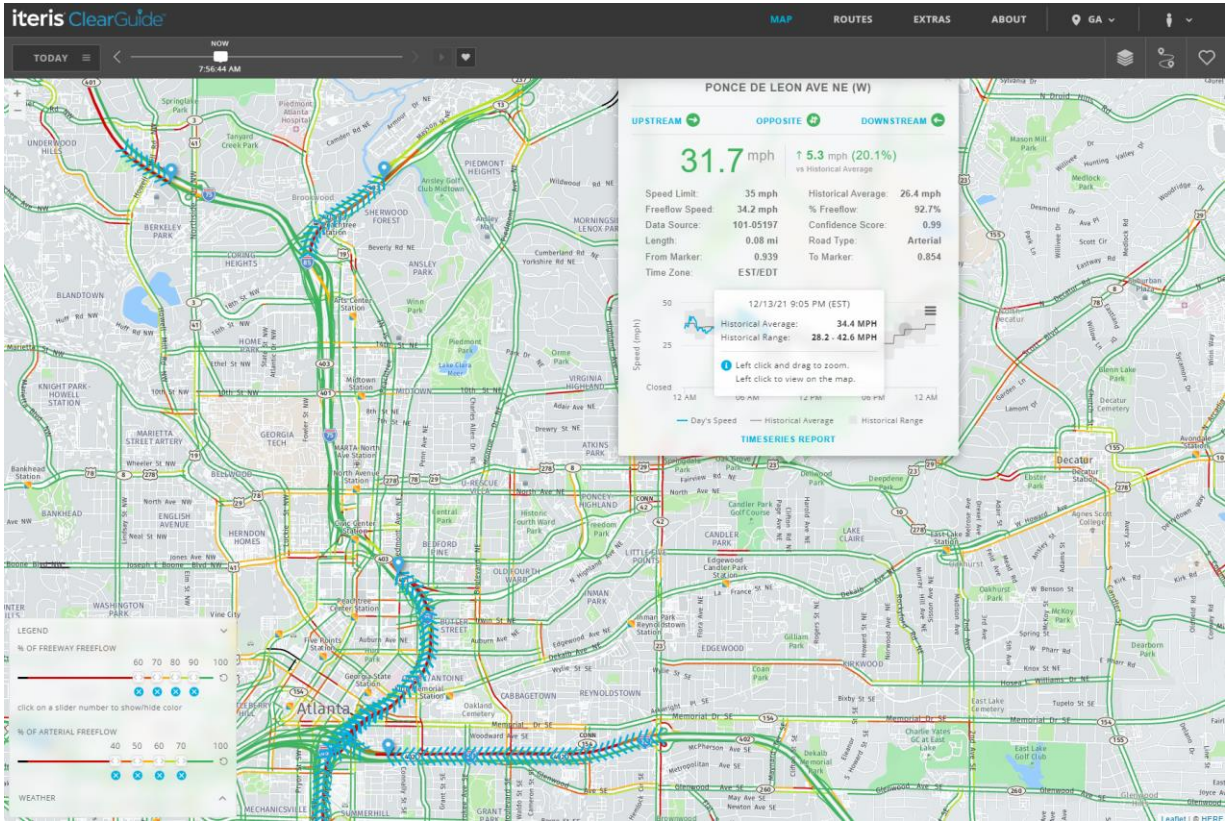
AIR BAG FUNCTION
1-No Air Bag in this Seat
1-Deployed Air Bag
2-Non-Deployed Air Bag
3-Deployed Side
4-Deployed other Directions
5-Deployed Multiple Directions
6-Non-Deployed Front
7-Non-Deployed Side
8-Non-Deployed Other Direction
9-Non-Deployed Multiple Directions
10-Deployed Curtain

INJURY
0-No Apparent Injury (O)
1-Fatal Injury (K)
2-Suspected Serious Injury (A)
3-Suspected Minor or Visible Injury (B)
4-Possible Injury or Complaint (C)

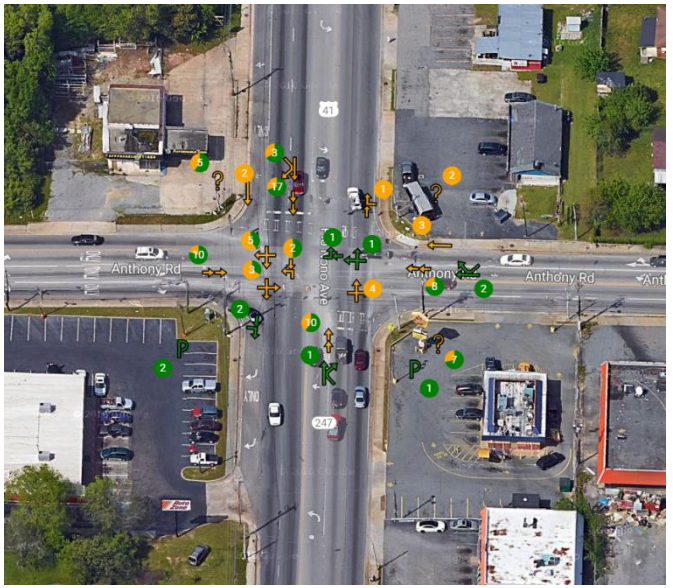
TAKEN FOR TREATMENT
1-Yes
2-No

GDOT-523 Overlay *(07/17)*

GDOT
Georgia Department of Transportation

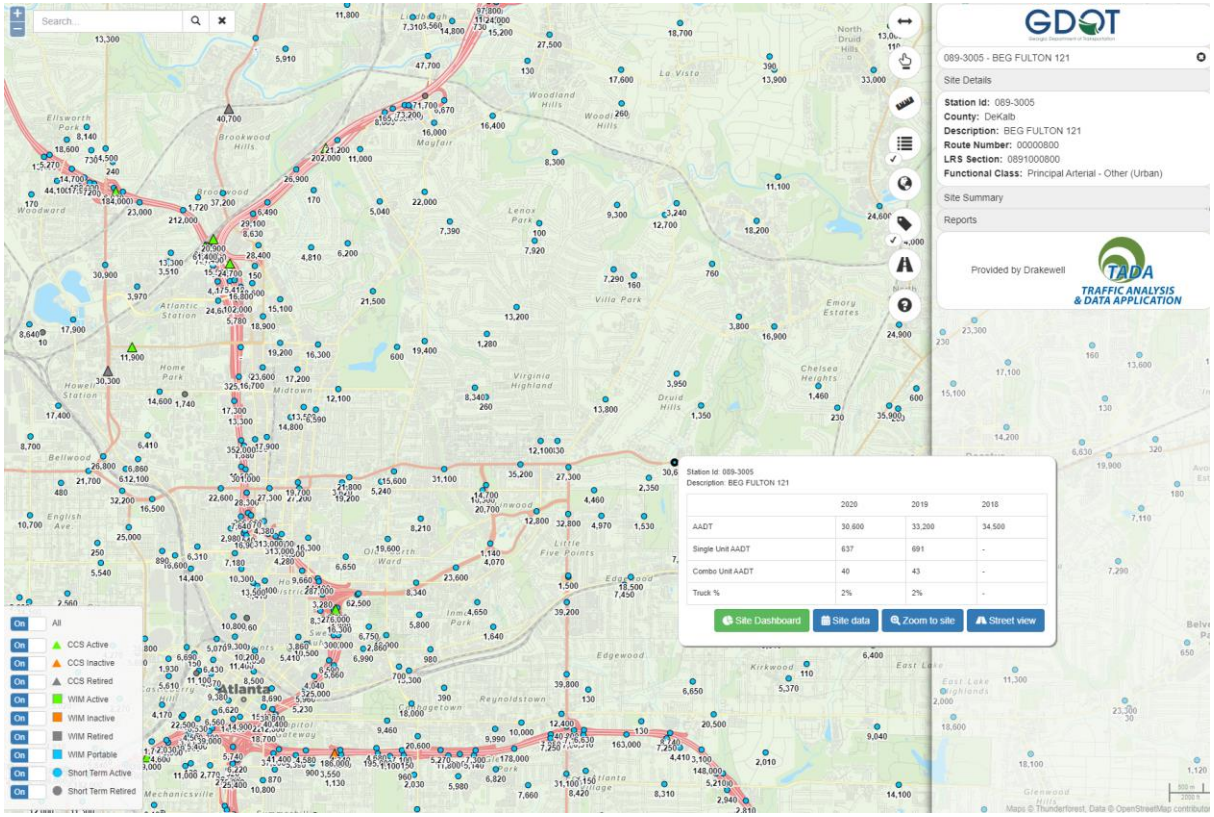


Probe Speed Data



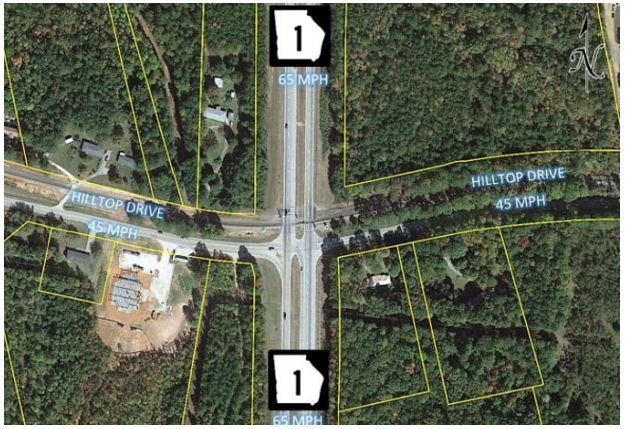
Collison Diagrams

ATSPM
Automated Traffic Signal Performance Measures



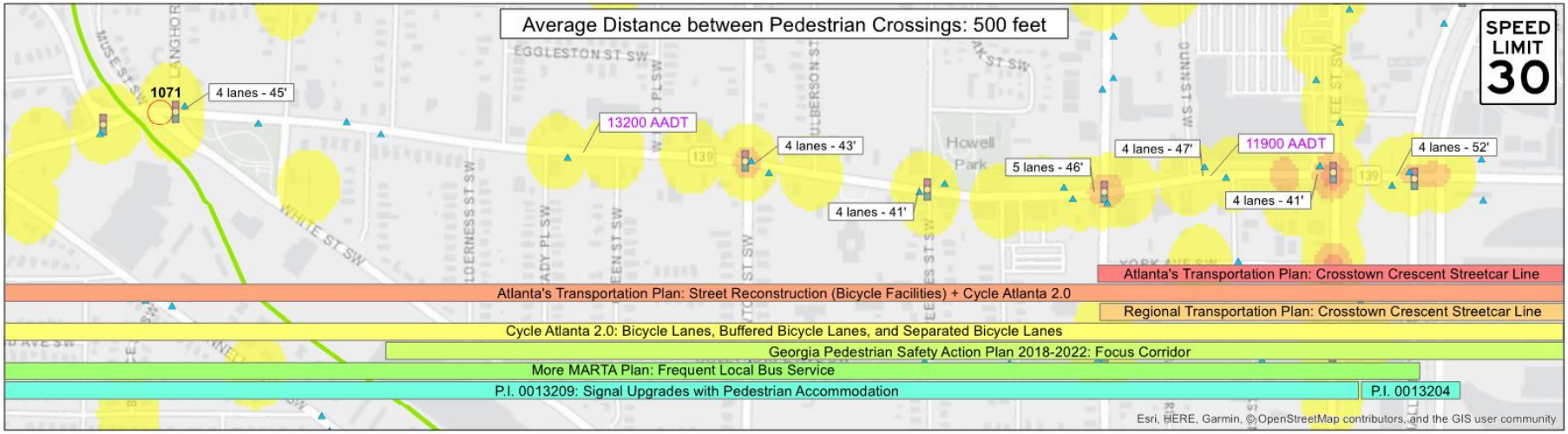
Volume Database

Project Database



Right-of-Way

SR 139 / Ralph D. Abernathy Blvd from the Atlanta BeltLine Westside Trail to SR 154 / W. Whitehall St



Pedestrian and Cyclist Crash Summary 2014-2018:
- 46 Pedestrian Crashes
- 3 Bicycle Crashes
- 34 Injury Crashes
- 2 Fatal Crashes
- 43 Crashes per Mile

Plans Including Corridor:
- Atlanta's Transportation Plan (Bicycle, Transit, Streetscaping)
- Atlanta Regional Transportation Plan (Transit)
- Cycle Atlanta 2.0
- Georgia Pedestrian Safety Action Plan
- More MARTA Plan

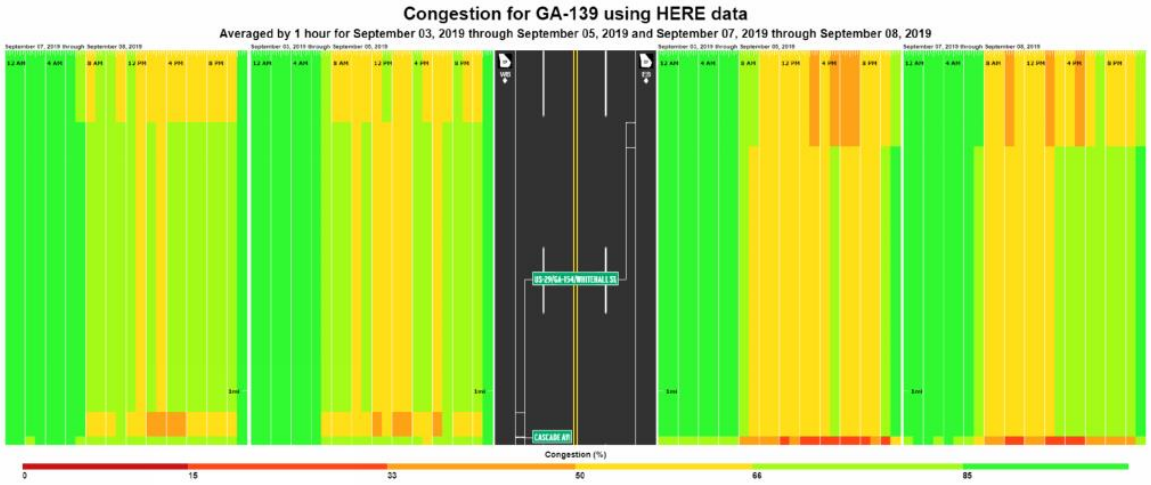
GDOT Projects in Corridor:
- 0013204 SR 3 Conn; SR 14; SR 139 & SR 154 @ 10 Locs in Fulton County Signal Upgrades
- 0013209 I-20 @ 1 Loc & SR 139 @ 8 Locs in Fulton County Signal Upgrades (under construction)

Miles 0 0.025 0.05 0.1 0.15 0.2

Transit Stops
PHB
Pedestrian Flasher
Traffic Signal
Intersection Projects
DRI
BeltLine

Ped/Bike Crash Density as % of Max

0
0.1 - 25
25.1 - 50
50.1 - 75
75.1 - 100



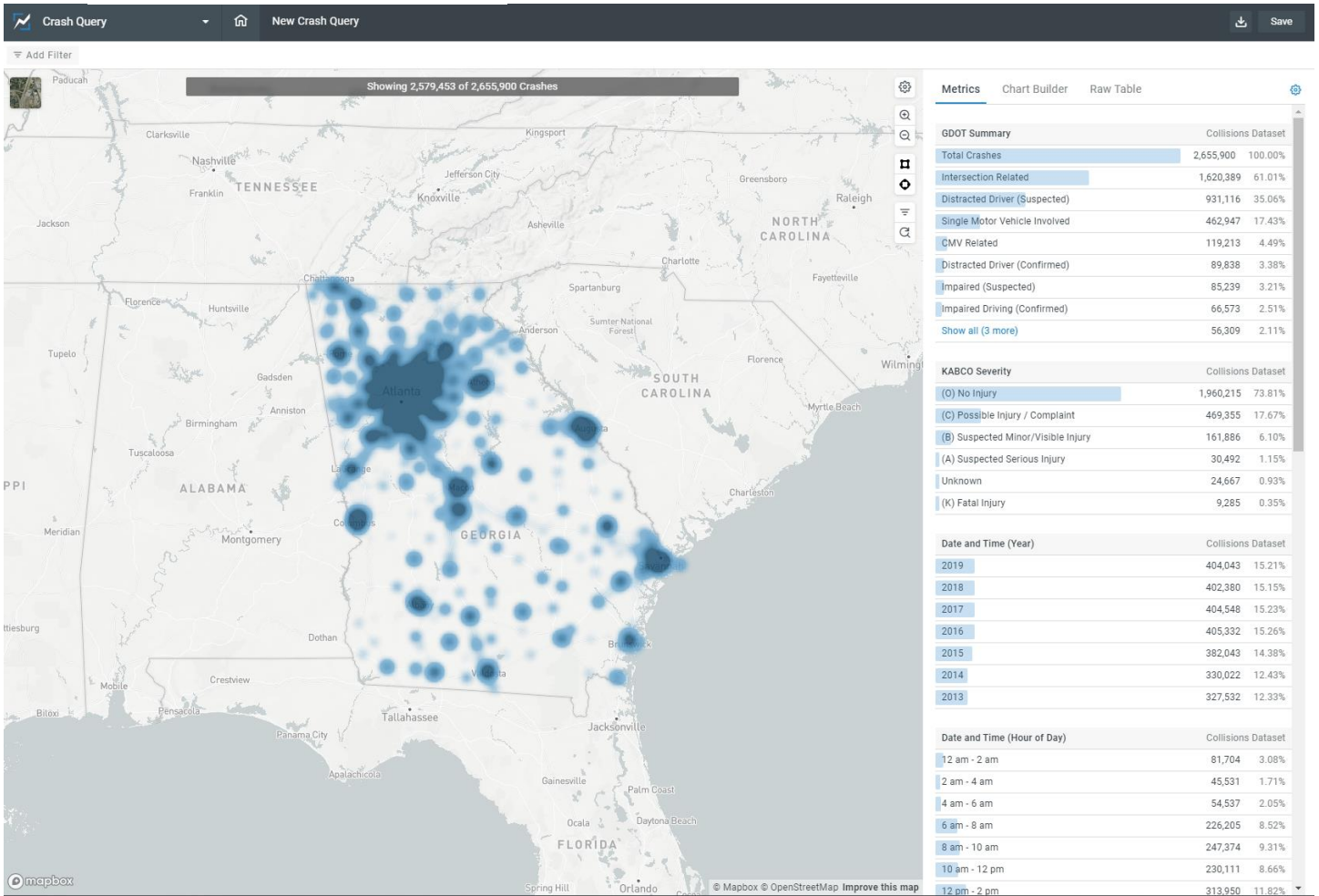
Georgia Department of Transportation

Sa
AASHTOWare
Safety™
AASHTO
numetric

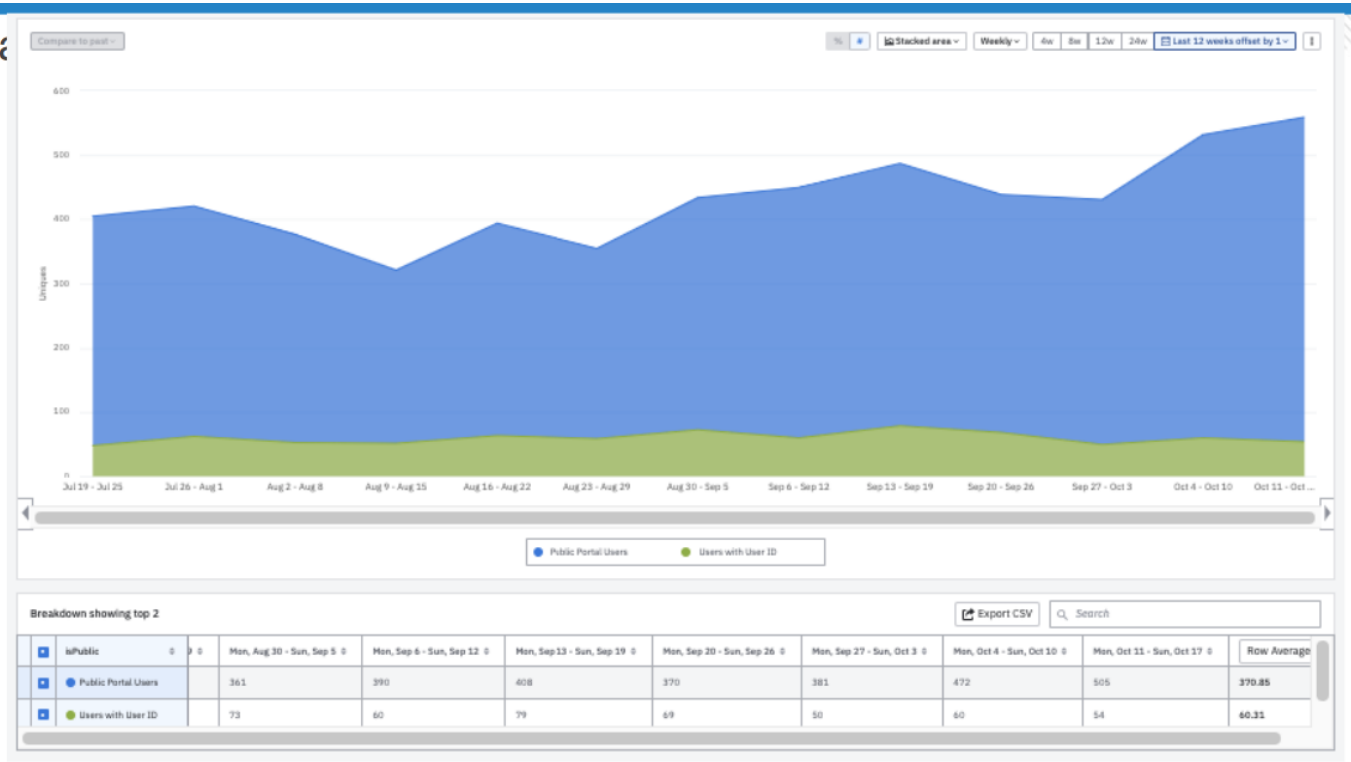
Tool Overview

numetric™

AASHTOWare Safety™



- User Sta

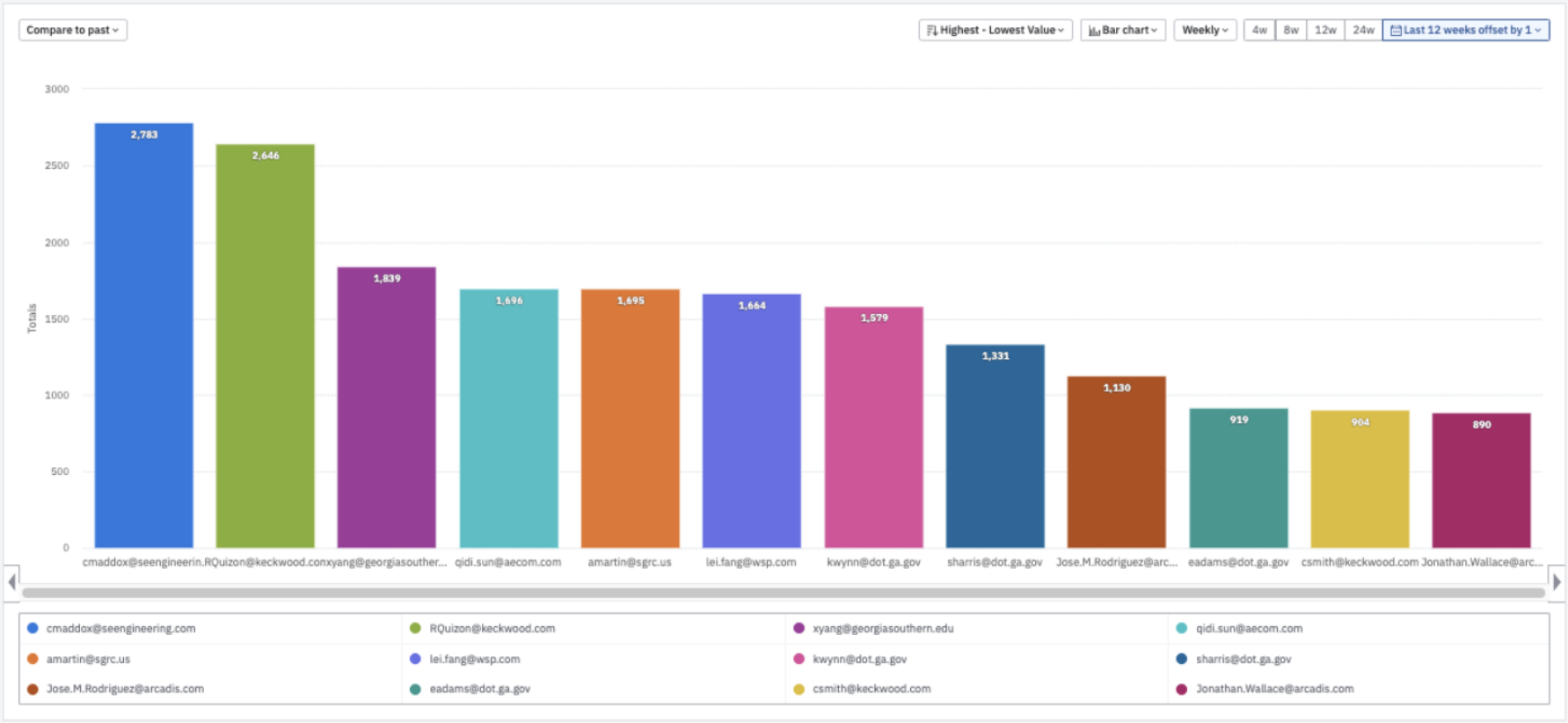


- Public Portal Dashboard Users (Blue): Last week = 505 (381= two weeks ago)
- Numetric User with login (Green): Last week = 54 (50 = two weeks ago)

numetric

https://gdot.numetric.net/crash-data#/

- # User Stats: Top 12 Users



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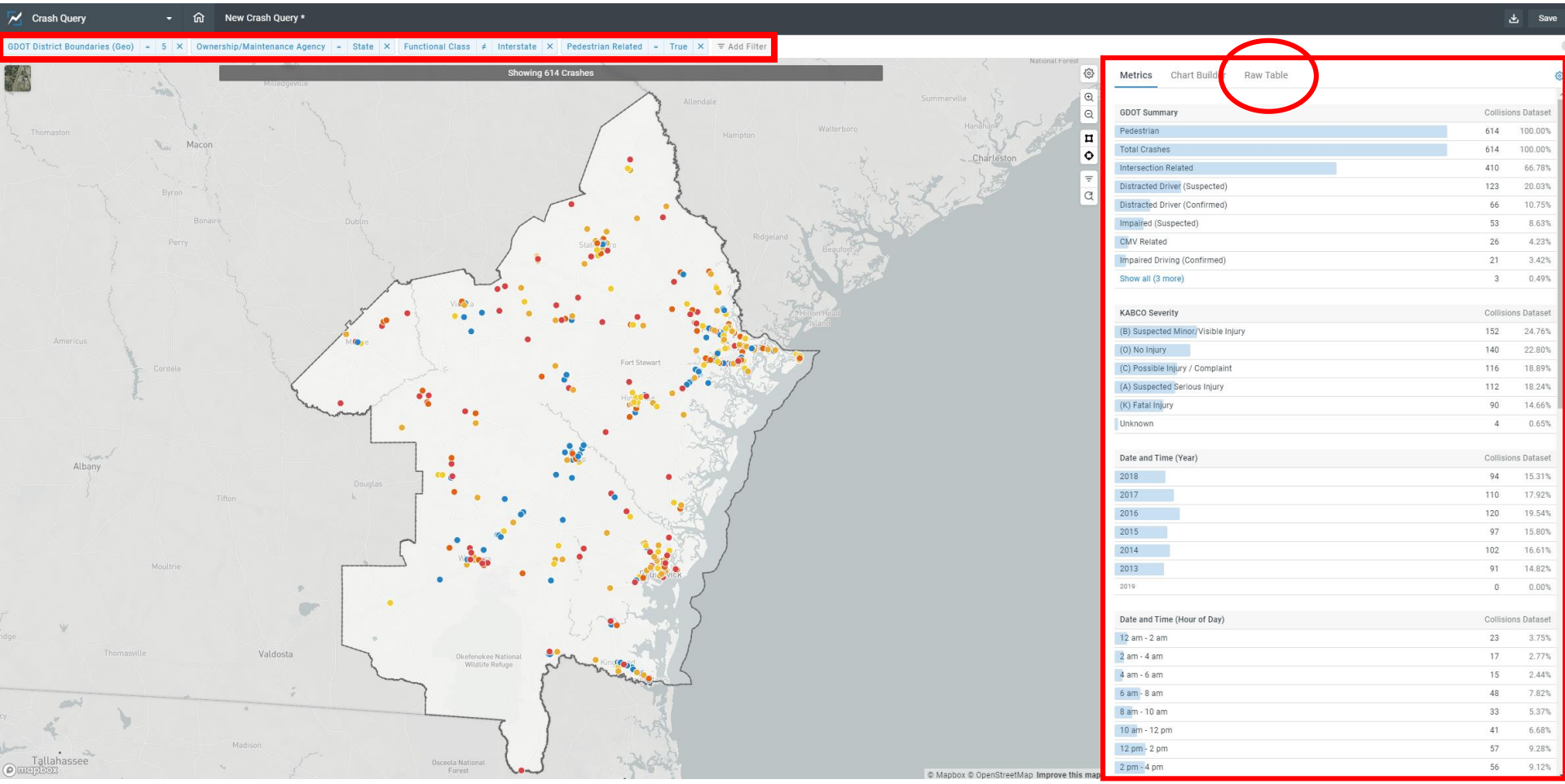
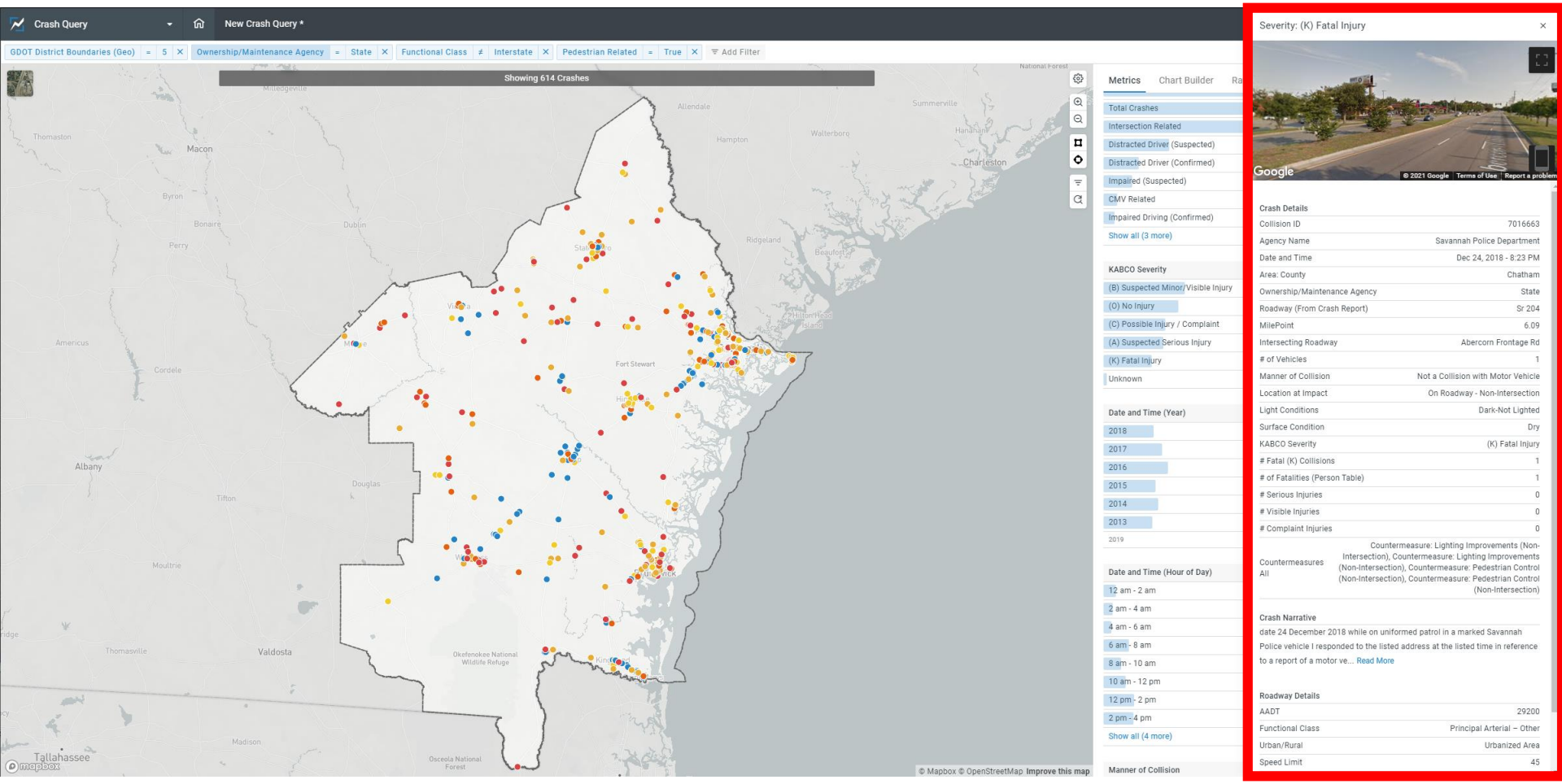
Georgia Department of Transportation



GDOT
Georgia Department of Transportation



Severity: (K) Fatal Injury

Crash Details

Collision ID	7016663
Agency Name	Savannah Police Department
Date and Time	Dec 24, 2018 - 8:23 PM
Area: County	Chatham
Ownership/Maintenance Agency	State
Roadway (From Crash Report)	Sr 204
MilePoint	6.09
Intersecting Roadway	Abercorn Frontage Rd
# of Vehicles	1
Manner of Collision	Not a Collision with Motor Vehicle
Location at Impact	On Roadway - Non-Intersection
Light Conditions	Dark-Not Lighted
Surface Condition	Dry
KABCO Severity	(K) Fatal Injury
# Fatal (K) Collisions	1
# of Fatalities (Person Table)	1
# Serious Injuries	0
# Visible Injuries	0
# Complaint Injuries	0
Countermeasures All	Countermeasure: Lighting Improvements (Non-Intersection), Countermeasure: Lighting Improvements (Non-Intersection), Countermeasure: Pedestrian Control (Non-Intersection), Countermeasure: Pedestrian Control (Non-Intersection)

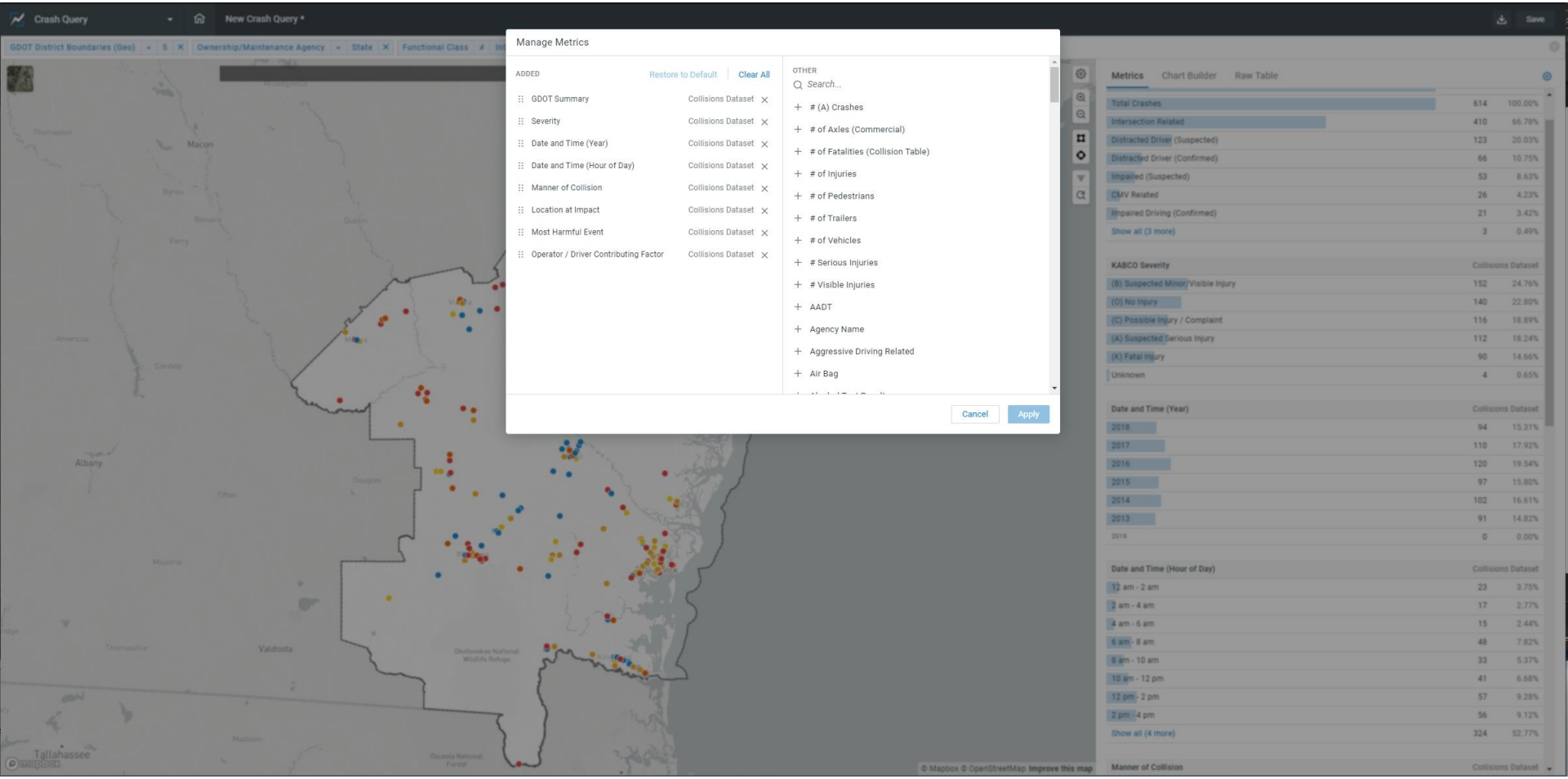
Crash Narrative

date 24 December 2018 while on uniformed patrol in a marked Savannah Police vehicle I responded to the listed address at the listed time in reference to a report of a motor ve... Read More

Roadway Details

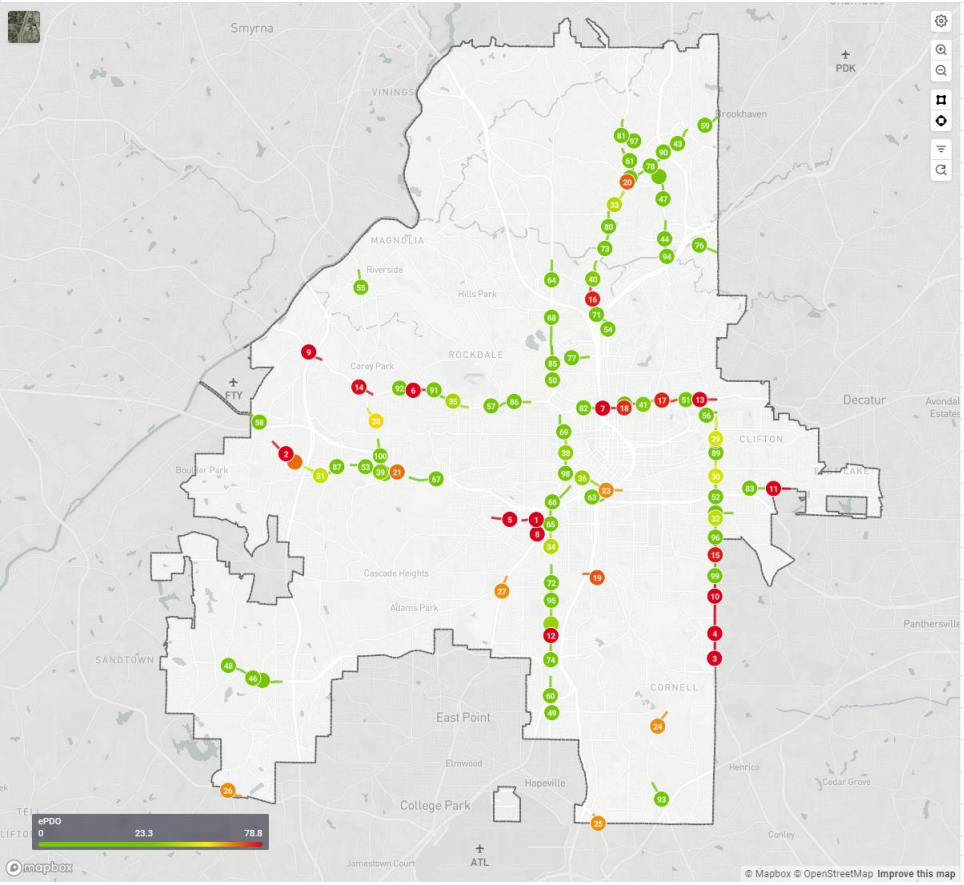
AADT	29200
Functional Class	Principal Arterial – Other
Urban/Rural	Urbanized Area
Speed Limit	45

GDOT
Georgia Department of Transportation



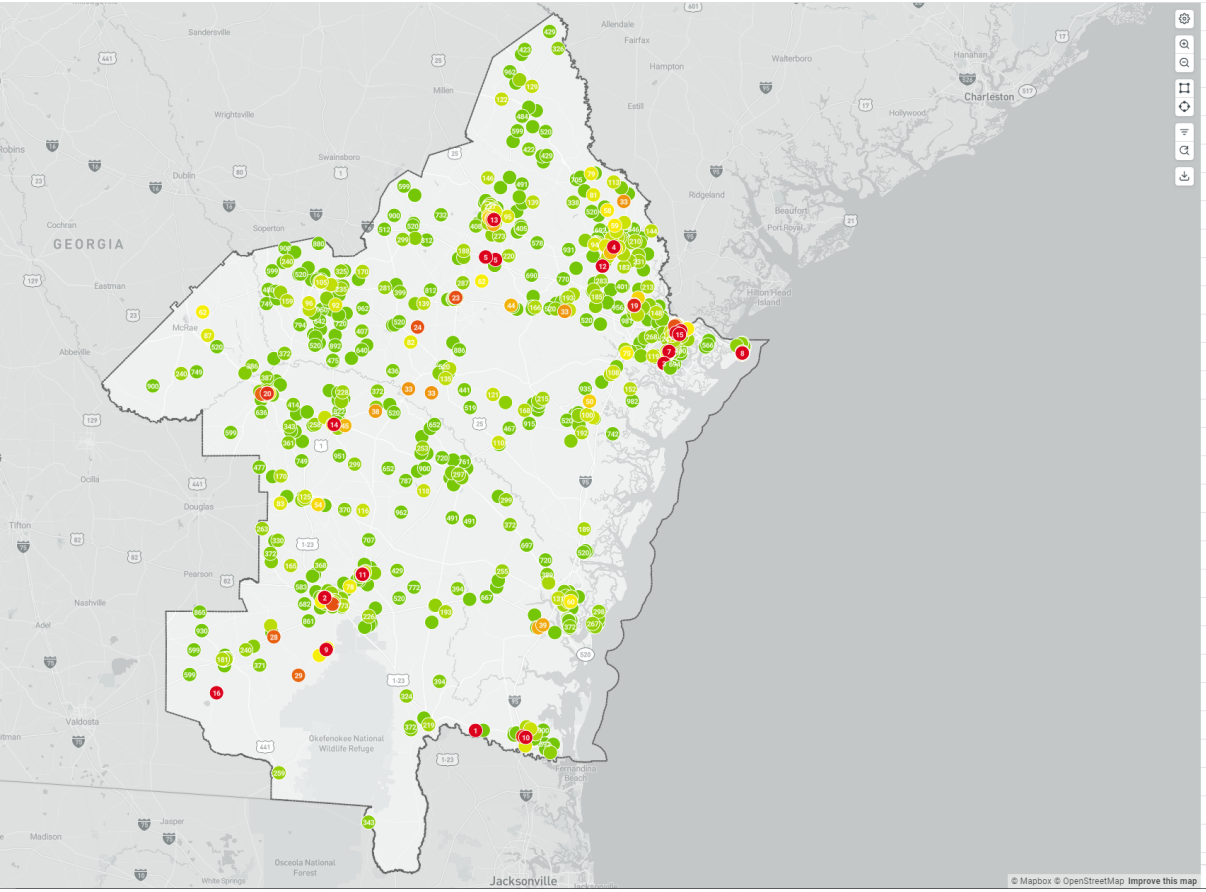
Sliding Window Analysis | New Sliding Window Analysis* | Save

Ownership/Maintenance Agency = State | Functional Class ≠ Interstate | GDOT City Boundaries (Geo) = Atlanta | Pedestrian Related = True | Add Filter



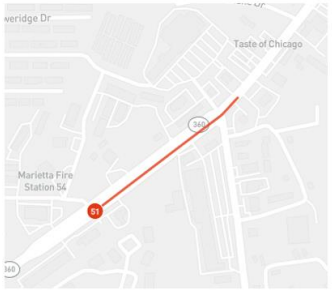
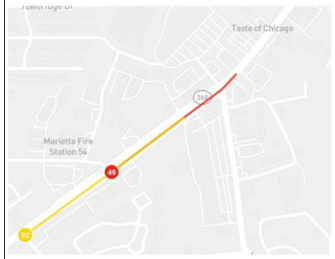
Rank	Route / MP	Crashes	Fatal Crashes	Crash Rate	ePDO
1	1211013900I / 9.3 - 9.6	27	2	2880.3	150.1
2	1211013900I / 15.2 - 15.5	15	2	1110.0	148.4
3	1211004200I / 0.6 - 0.9	3	2	94.4	125.1
4	1211004200I / 1.4 - 1.7	2	2	24.8	124.4
5	1211013900I / 9.9 - 10.2	10	1	1683.2	99.7
6	1211000800I / 3.5 - 3.8	8	1	1252.9	96.6
7	1211000800I / 7.6 - 7.9	28	0	1368.7	89.4
8	1211001400I / 23.5 - 23.8	4	1	381.6	81.6
9	1211000800I / 1 - 1.3	6	1	706.3	80.6
10	1211004200I / 1.9 - 2.2	4	1	193.5	79.3
11	0891015400I / 1.2 - 1.5	3	1	606.6	78.7
12	1211000300I / 4.5 - 4.8	3	1	100.6	78.7
13	1211000800I / 9.7 - 10	6	1	294.3	78.3
14	1211000800I / 2.3 - 2.6	7	1	1441.7	77.4
15	1211004200I / 2.8 - 3.1	3	1	165.3	75.8
16	1211000900I / 2.5 - 2.8	19	0	2530.4	75.1
17	1211000800I / 8.9 - 9.2	13	1	644.8	74.5
18	1211000800I / 8.1 - 8.4	9	1	569.4	73.4
19	1211005400I / 6 - 6.3	4	1	739.5	68.8
20	1211000900I / 5.1 - 5.4	19	0	1851.0	67.6
21	1211013900I / 12.6 - 12.9	4	1	573.2	66.0
22	1211013900I / 14.9 - 15.2	4	1	282.6	66.0
23	1211015400I / 34 - 34.3	3	1	211.6	62.5
24	1211005400I / 2.2 - 2.5	2	1	76.8	62.4
25	1211000300I / -0.1 - 0.2	1	1	11.2	62.2
26	1211000600I / 7.5 - 7.8	1	1	13.3	62.2

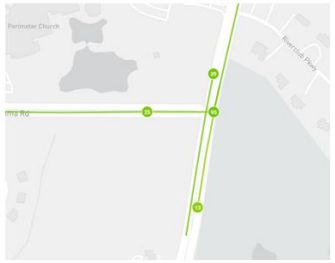
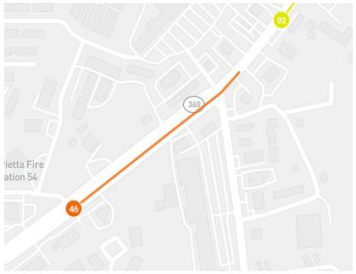
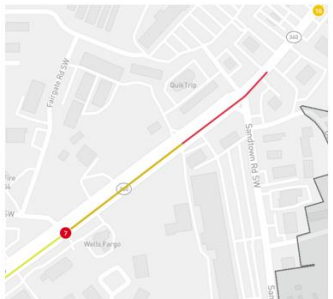
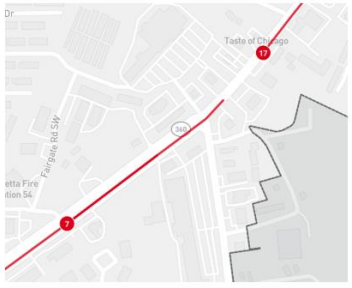
Hide/Show Columns



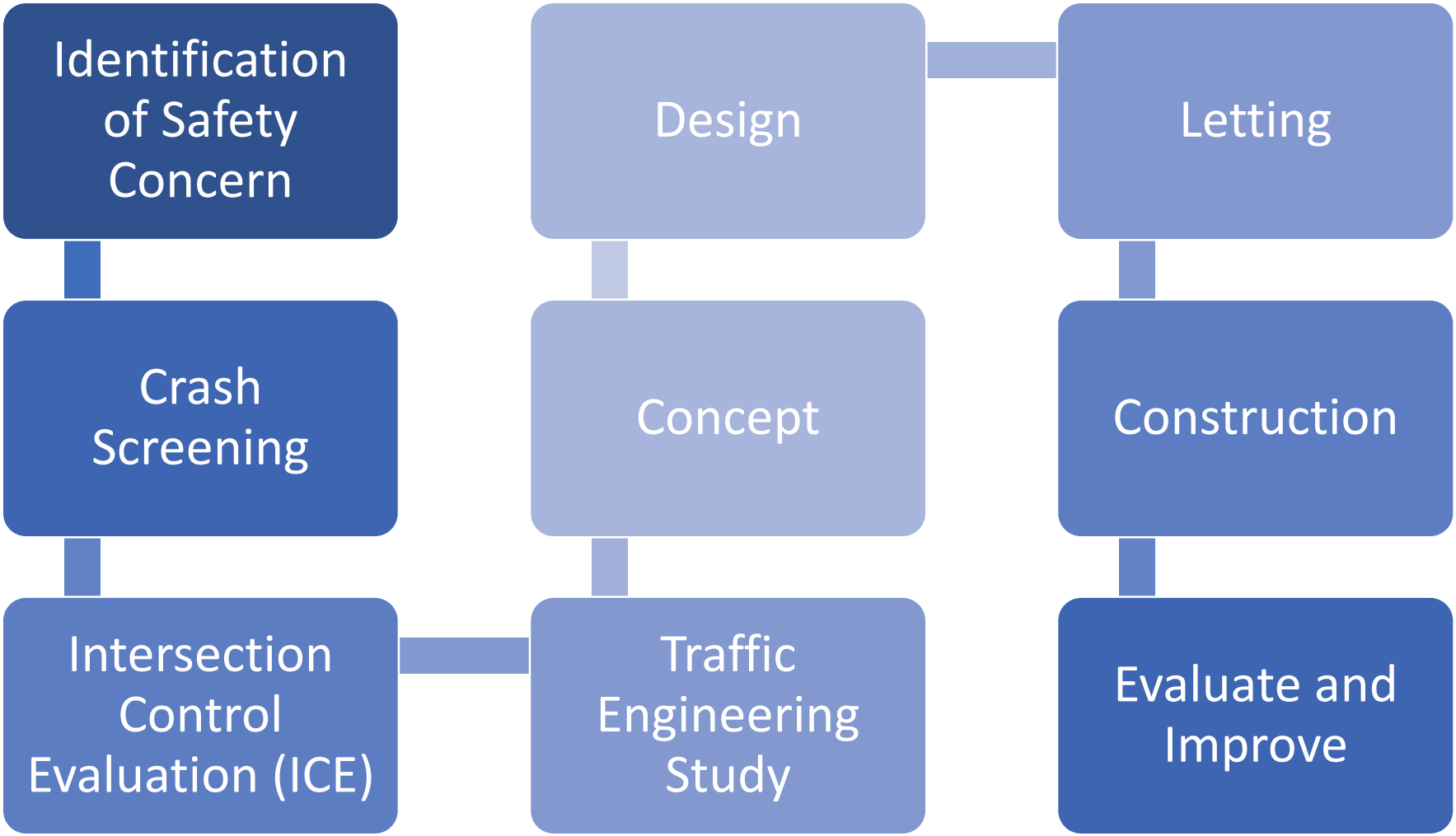
Rank	Intersection	Crashes	Fatal Crashes	Crash Rate	ePDO
1 / 63	0392005100I, State Route 40 E...	5	1	32.6	462.9
2 / 93	2992014700D, 2992014700I, L...	4	0	23.6	11.2
3 / 96	0513115307I, 0513159407I, 0...	21	0	23.4	98.5
4 / 103	1032017900I, Little McCall Ro...	29	0	22.1	135.5
5 / 127	0312025900I, Aden Lanier Roa...	1	0	19.6	1.0
5 / 127	0312022100I, 0312058400I	1	0	19.6	1.0
7 / 147	0513114807I, Atwood Street (...	56	1	19.6	589.5
8 / 151	0513080509I, 0513086909I, B...	24	0	18.7	87.2
9 / 200	2992047300I, 2992091900I, S...	2	0	15.7	2.0
10 / 212	0393071101I, East King Avenu...	122	0	15.2	294.7
11 / 218	2291003800I, 2293060001I, Hi...	41	0	15.0	82.4
12 / 226	1032015700I, 1032017900I	46	0	14.6	480.1
13 / 232	03110067BYD, 03110067BYI, 0...	611	1	14.3	2,077.1
14 / 243	0013058501I, South Main Stre...	31	0	14.0	103.0
15 / 264	0513063607I, 0513089007I, 0...	21	0	13.5	129.5
16 / 291	0651018700I, 0652004000I	1	0	13.0	1.0
17 / 349	0513064507I, 0513090907I	82	0	12.6	292.8
18 / 353	0513089007I, Wheaton Street ...	29	0	12.5	150.3
19 / 368	0513056503D, 0513057403D, ...	393	0	12.2	950.4
20 / 382	16110135SOI, Northeast Railro...	22	0	11.9	143.3
21 / 391	0393052201I, Boone Avenue (...	34	0	11.7	44.8
22 / 402	0513057303D, 0513057303I, 0...	102	0	11.6	227.8
23 / 425	1093068803I, South Duval Stre...	49	0	11.2	126.2
24 / 429	Brunel Street (2993073805I), R...	7	0	11.2	17.8
24 / 429	2672023200I, 2672047300I	2	0	11.2	2.0
26 / 441	0513150507I, 0513177907I	178	0	11.2	357.8
27 / 460	2293060001I, Ware Street (22...	20	0	11.0	184.6
28 / 469	2992047200I, Valdosta Highw...	8	0	10.8	11.6
29 / 478	2992000200I, 2992000300I, 2...	4	0	10.8	4.0

Hide/Show Columns

State Crash Rank	State ePDO Rank	District Crash Rate Rank	District ePDO Rank
NR	NR	NR	NR
NR		NR	

County Crash Rank	County ePDO Rank	City Crash Rank	City ePDO Rank
NR	NR		
			

Data-Driven Safety Analysis


Identification of Safety Concern
Crash Screening
Intersection Control Evaluation (ICE)
Traffic Engineering Study
Concept
Design
Letting
Construction
Evaluate and Improve

SPORTS, A8 INSIDE, A9

MES-GEORGIAN

BER 26, 2021 • $2 CARROLL COUNTY'S TRUSTED INFORMATION LEADER SINCE 1871

Study: I-20 second most dangerous U.S. highway

BY TAYLOR JACKSON
THE TIMES-GEORGIAN

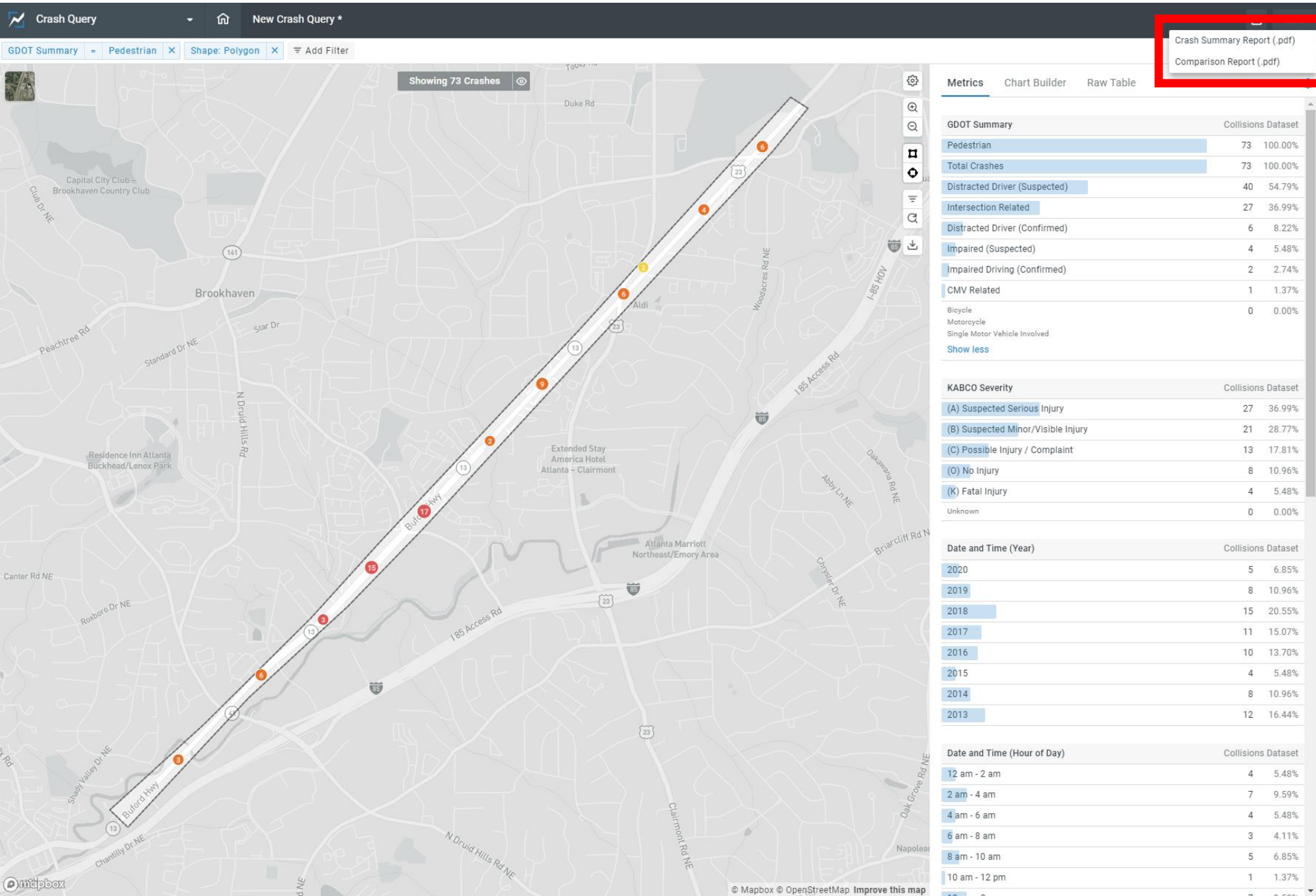
The U.S. Department of Transportation's National Highway Traffic Safety Administration found I-20 to be the second most dangerous highway in the United States.

According to 2019 data, I-20 has the second-highest rate of fatalities per mile with 208 fatalities (13.52 fatalities per 100 miles).

Danielle Marchell, licensed insurance agent and spokesperson for the Zebra (an Austin, Texas-based insurance comparison site), told the Times-Georgian on Tuesday that an estimated 20,160 people died in motor vehicle crashes in the first half of 2021, which is 18.4% more than last year (the largest number of projected fatalities in that time period since 2006).

"The U.S. Department of Transportation's National Highway Traffic Safety Administration has not fully released [numbers for] 2020 and 2021 yet, but there are estimates that 2021 is on track to be one of the deadliest years ever on the road," said Marchell.

SEE HIGHWAY/PAGE A5


Crash Query
New Crash Query *
GDOT Summary = Pedestrian
Shape: Polygon
Add Filter
Crash Summary Report (.pdf)
Comparison Report (.pdf)
Showing 73 Crashes
Metrics
Chart Builder
Raw Table
GDOT Summary
Collisions Dataset
Pedestrian 73 100.00%
Total Crashes 73 100.00%
Distracted Driver (Suspected) 40 54.79%
Intersection Related 27 36.99%
Distracted Driver (Confirmed) 6 8.22%
Impaired (Suspected) 4 5.48%
Impaired Driving (Confirmed) 2 2.74%
CMV Related 1 1.37%
Bicycle 0 0.00%
Motorcycle
Single Motor Vehicle Involved
Show less
KABCO Severity
Collisions Dataset
(A) Suspected Serious Injury 27 36.99%
(B) Suspected Minor/Visible Injury 21 28.77%
(C) Possible Injury / Complaint 13 17.81%
(O) No Injury 8 10.96%
(K) Fatal Injury 4 5.48%
Unknown 0 0.00%
Date and Time (Year)
Collisions Dataset
2020 5 6.85%
2019 8 10.96%
2018 15 20.55%
2017 11 15.07%
2016 10 13.70%
2015 4 5.48%
2014 8 10.96%
2013 12 16.44%
Date and Time (Hour of Day)
Collisions Dataset
12 am - 2 am 4 5.48%
2 am - 4 am 7 9.59%
4 am - 6 am 4 5.48%
6 am - 8 am 3 4.11%
8 am - 10 am 5 6.85%
10 am - 12 pm 1 1.37%
Brookhaven
Buford Hwy
I-85 Access Rd
I-85 HOV
Peachtree Rd
Duke Rd
Aldi
Extended Stay America Hotel Atlanta – Clairmont
Atlanta Marriott Northeast/Emory Area
Residence Inn Atlanta Buckhead/Lenox Park
Capital City Club – Brookhaven Country Club
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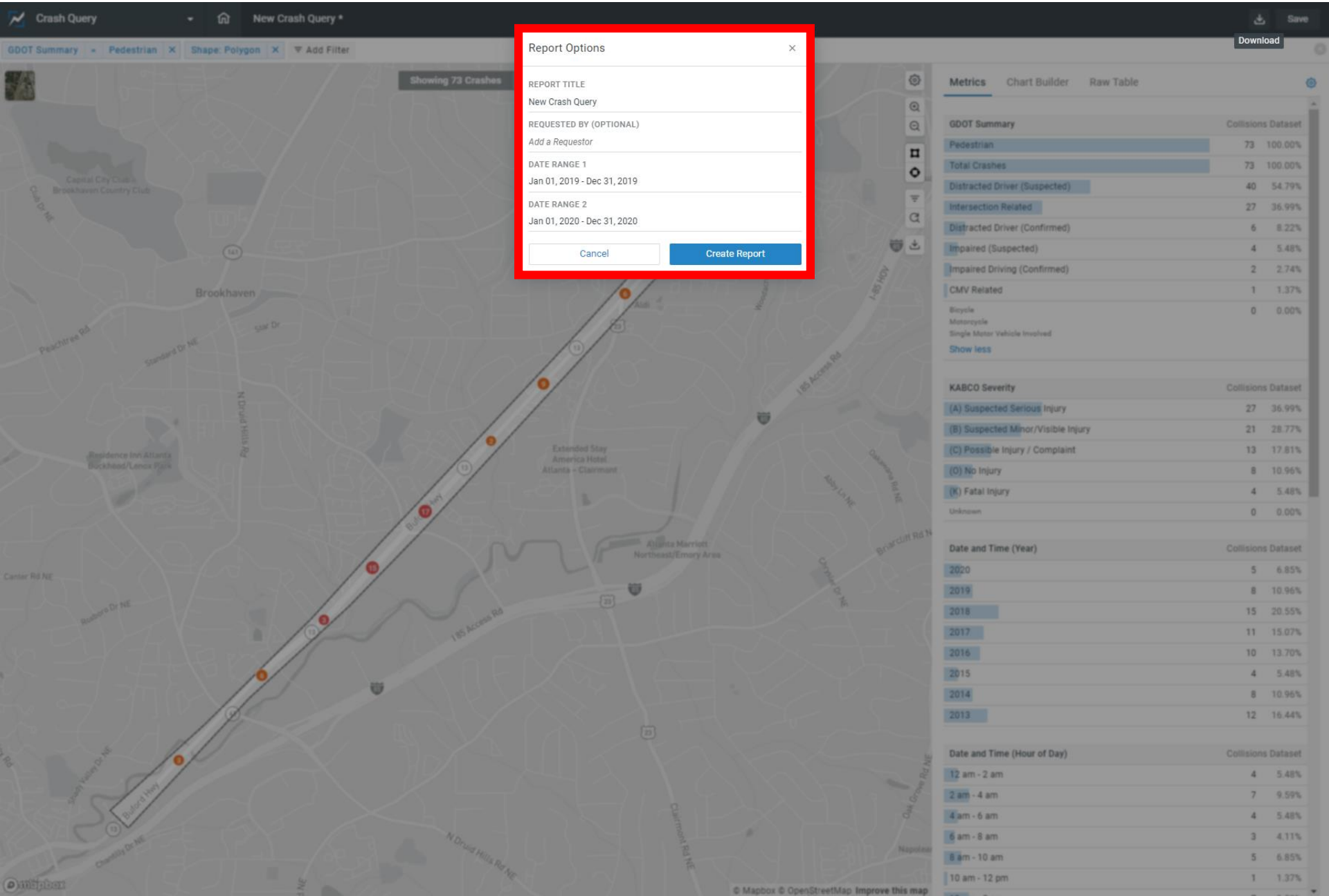
Crash Query
New Crash Query *
Save
Download
GDOT Summary
Pedestrian
Shape: Polygon
Add Filter
Showing 73 Crashes
Report Options
REPORT TITLE
New Crash Query
REQUESTED BY (OPTIONAL)
Add a Requestor
DATE RANGE 1
Jan 01, 2019 - Dec 31, 2019
DATE RANGE 2
Jan 01, 2020 - Dec 31, 2020
Cancel
Create Report
Metrics
Chart Builder
Raw Table
GDOT Summary
Collisions Dataset
Pedestrian 73 100.00%
Total Crashes 73 100.00%
Distracted Driver (Suspected) 40 54.79%
Intersection Related 27 36.99%
Distracted Driver (Confirmed) 6 8.22%
Impaired (Suspected) 4 5.48%
Impaired Driving (Confirmed) 2 2.74%
CMV Related 1 1.37%
Bicycle
Motorcycle
Single Motor Vehicle Involved 0 0.00%
Show less
KABCO Severity
Collisions Dataset
(A) Suspected Serious Injury 27 36.99%
(B) Suspected Minor/Visible Injury 21 28.77%
(C) Possible Injury / Complaint 13 17.81%
(O) No Injury 8 10.96%
(K) Fatal Injury 4 5.48%
Unknown 0 0.00%
Date and Time (Year)
Collisions Dataset
2020 5 6.85%
2019 8 10.96%
2018 15 20.55%
2017 11 15.07%
2016 10 13.70%
2015 4 5.48%
2014 8 10.96%
2013 12 16.44%
Date and Time (Hour of Day)
Collisions Dataset
12 am - 2 am 4 5.48%
2 am - 4 am 7 9.59%
4 am - 6 am 4 5.48%
6 am - 8 am 3 4.11%
8 am - 10 am 5 6.85%
10 am - 12 pm 1 1.37%
Brookhaven
Peachtree Rd
Standard Dr NE
N Druid Hills Rd
I 85 Access Rd
Buford Hwy
Clairmont Rd NE
Briarcliff Rd NE
Oak Grove Rd NE
Chantilly Dr NE
Canter Rd NE
Roxboro Dr NE
Extended Stay America Hotel Atlanta - Clairmont
Atlanta Marriott Northeast/Emory Area
Residence Inn Atlanta Buckhead/Lenox Park
Capital City Club Brookhaven Country Club
Club Dr NE
Star Dr
Abby Ln NE
Chrysler Dr NE
Napoleon
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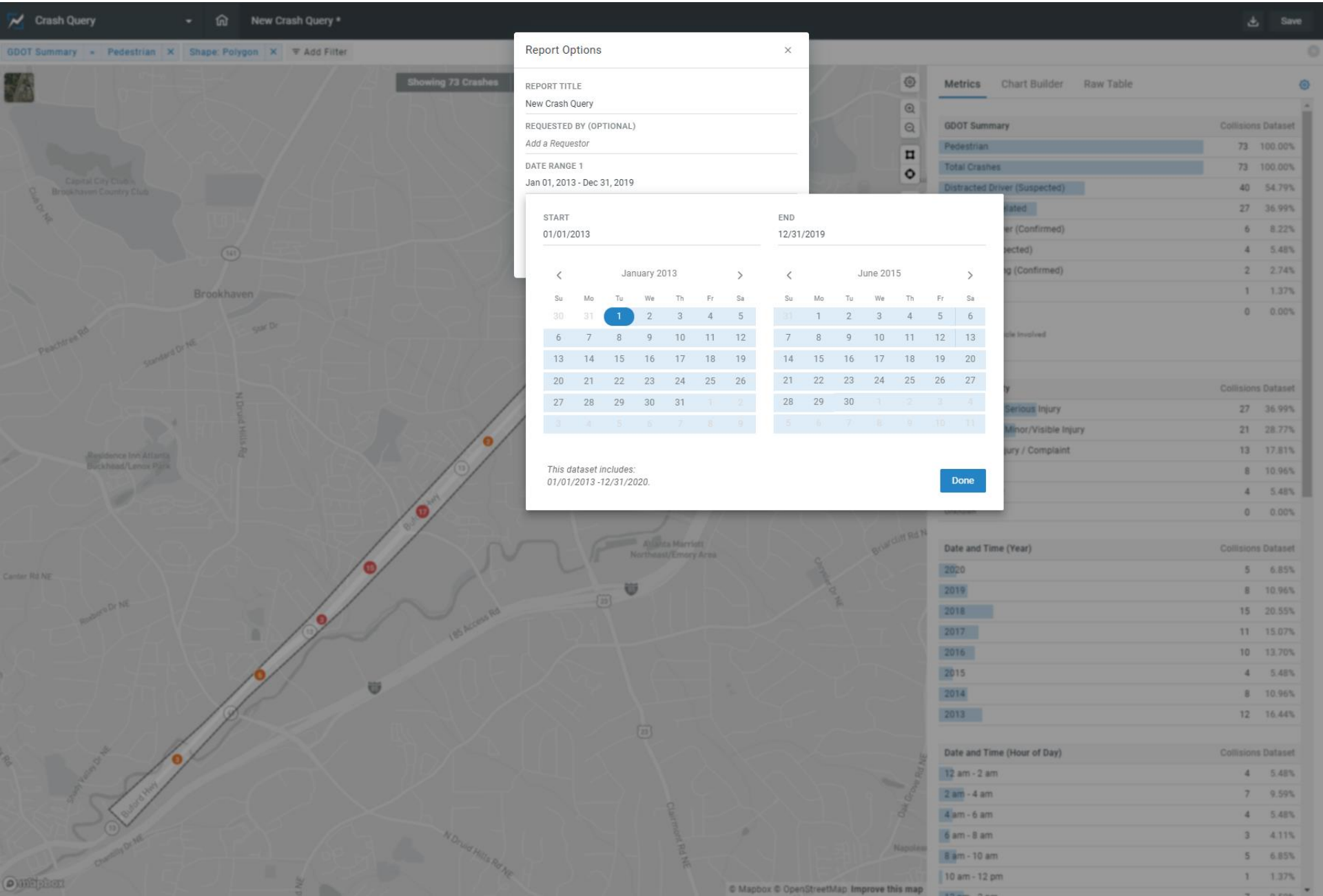
Crash Query
New Crash Query *
Save
GDOT Summary
Pedestrian
Shape: Polygon
Add Filter
Showing 73 Crashes
Report Options
REPORT TITLE
New Crash Query
REQUESTED BY (OPTIONAL)
Add a Requestor
DATE RANGE 1
Jan 01, 2013 - Dec 31, 2019
START
01/01/2013
END
12/31/2019
January 2013
June 2015
Su Mo Tu We Th Fr Sa
This dataset includes:
01/01/2013 -12/31/2020.
Done
Metrics
Chart Builder
Raw Table
GDOT Summary
Collisions Dataset
Pedestrian 73 100.00%
Total Crashes 73 100.00%
Distracted Driver (Suspected) 40 54.79%
Serious Injury 27 36.99%
Minor/Visible Injury 21 28.77%
Date and Time (Year)
2020 5 6.85%
2019 8 10.96%
2018 15 20.55%
2017 11 15.07%
2016 10 13.70%
2015 4 5.48%
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2013 12 16.44%
Date and Time (Hour of Day)
12 am - 2 am 4 5.48%
2 am - 4 am 7 9.59%
4 am - 6 am 4 5.48%
6 am - 8 am 3 4.11%
8 am - 10 am 5 6.85%
10 am - 12 pm 1 1.37%
Brookhaven
Buford Hwy
I 85 Access Rd
N Druid Hills Rd
Peachtree Rd
Mapbox © OpenStreetMap Improve this map

COMPARISON REPORT

New Crash Query

Created on December 13, 2021
Created by Samuel Harris
Data extents: January 1, 2013 to December 31, 2020

Applied Filters

GDOT Summary = Pedestrian | Shape: Polygon

Time Ranges

1	**January 1, 2013 - December 31, 2018** (2191 days) K: 4 (6.7%) A: 20 (33.3%) B: 19 (31.7%) C: 11 (18.3%) O: 6 (10.0%)	60 Crashes
2	**January 1, 2019 - December 31, 2020** (731 days) K: 0 (0.0%) A: 7 (53.8%) B: 2 (15.4%) C: 2 (15.4%) O: 2 (15.4%)	13 Crashes

K = (K) Fatal Injury, A = (A) Suspected Serious Injury, B = (B) Suspected Minor/Visible Injury, C = (C) Possible Injury / Complaint, O = (O) No Injury

Change Overview (annualized)

▲ 0 (5%)	▼ -1 (100%)	▼ $7.8M (47%)
Serious Crashes	Fatal Crashes	Crash Cost

Crash Counts & Cost (annualized)	1	2	+ / -	1	2	+ / -
(K) Fatal Injury	0.7	0	-0.7	$7M	$0	-$7M
(A) Suspected Serious Injury	3.3	3.5	+0.2	$7.6M	$8M	+$388.2K
(B) Suspected Minor/Visible Injury	3.2	1	-2.2	$1.6M	$501.7K	-$1.1M
(C) Possible Injury / Complaint	1.8	1	-0.8	$201.8K	$110.1K	-$91.6K
(O) No Injury	1	1	+0	$24K	$24K	+$21.5

Top Differentiators	1	2	+ / -
Operator / Driver Contributing Factor: (None)	8.3%	84.6%	+76.3%
Operator / Driver Contributing Factor: No Contributing Factors	76.7%	7.7%	-69%
Operator / Driver Contributing Factor: Other	30%	0%	-30%
KABCO Severity: (A) Suspected Serious Injury	33.3%	53.8%	+20.5%
Location at Impact (Crash Level) : On Roadway - In Crosswalk	3.3%	23.1%	+19.7%

GDOT Summary	1	2	+ / -
Pedestrian	100%	100%	0%
Total Crashes	100%	100%	0%
Distracted Driver (Suspected)	53.3%	61.5%	+8.2%
Intersection Related	36.7%	38.5%	+1.8%
Bicycle	0%	0%	0%

Date and Time (Hour of Day)	1	2	+ / -
12 am - 2 am	6.7%	0%	-6.7%
2 am - 4 am	10%	7.7%	-2.3%
4 am - 6 am	6.7%	0%	-6.7%
6 am - 8 am	5%	0%	-5%
8 am - 10 am	5%	15.4%	+10.4%
10 am - 12 pm	1.7%	0%	-1.7%
12 pm - 2 pm	11.7%	0%	-11.7%
2 pm - 4 pm	3.3%	0%	-3.3%
4 pm - 6 pm	5%	7.7%	+2.7%
6 pm - 8 pm	21.7%	30.8%	+9.1%
8 pm - 10 pm	18.3%	15.4%	-2.9%
10 pm - 12 am	5%	23.1%	+18.1%

Manner of Collision	1	2	+ / -
Not a Collision with Motor Vehicle	95%	84.6%	-10.4%
Angle (Other)	0%	7.7%	+7.7%
Head On	3.3%	7.7%	+4.4%
(None)	0%	0%	0%
Left Angle Crash	0%	0%	0%
Rear End	1.7%	0%	-1.7%
Right Angle Crash	0%	0%	0%
Sideswipe-Opposite Direction	0%	0%	0%
Sideswipe-Same Direction	0%	0%	0%

Location at Impact (Crash Level)	1	2	+ / -
On Roadway - Non-Intersection	48.3%	53.8%	+5.5%
On Roadway - In Crosswalk	3.3%	23.1%	+19.7%
On Roadway - Roadway Intersection	35%	23.1%	-11.9%
(None)	1.7%	0%	-1.7%
Entrance/Exit Ramp	0%	0%	0%
Gore	0%	0%	0%
Median	0%	0%	0%
Off Roadway	1.7%	0%	-1.7%
Off Roadway - Sidewalk	0%	0%	0%
On Roadway - Bicycle Lane	0%	0%	0%
On Roadway - Collector Distributor (CD)	0%	0%	0%
On Roadway - Driveway Intersection	0%	0%	0%
On Roadway - Managed Lane (HOV, HOT, Reversible)	0%	0%	0%
On Roadway - Railroad Crossing	0%	0%	0%

Georgia Department of Transportation

Memorandum

Subject: Memorial Drive Road Diet Before and After Crash and Speed Analysis

Date: November 12, 2021

To: Sam Harris, PE
State Safety Engineering Manager, GDOT

From: Carly Queen
Sustainable Transportation Specialist, AECOM

The Georgia Department of Transportation (GDOT) Safety Office requested that AECOM perform a before and after analysis of crash data and vehicular speeds for the SR 154 / Memorial Drive corridor from Pearl St to SR 155 / Candler Rd to better understand the impacts of PI M005724, the resurfacing and road diet project completed in the first half of 2019. This memo provides a summary of the analysis findings and results including:

- Statistically significant reductions in quarterly crash totals and rates (crashes/AADT) were observed
  - Crashes were reduced by 39% (36% for injury crashes)
  - Crash rates (crashes/AADT) were reduced by 45% (38% for injury crash rates)
- Hourly vehicle speeds and average delay in the corridor were similar before and after the project

Before and After Road Diet Crash Analysis

The number of crashes in each quarter for 2-year periods before (Q3 2016 to Q2 2018) and after (Q3 2019 to Q2 2021) project construction are shown in Table 1. Quarterly crashes were reduced from an average of 125 before the project to an average of 76 after, representing a 39% reduction overall and 197 fewer crashes per year. The key for the linear color scale used in the Before and After quarterly crash total columns, based on a green to yellow to red scale with a midpoint (yellow) defined as the minimum quarterly crashes during the before period, is shown at the bottom of the table. The same colors are applied to the Ratio and Change columns using a scale of 0 (green) to 1 (yellow) to 2 (red) and -130 (green) to 0 (yellow) to 130 (red), respectively. A paired t-test was performed for the before and after crash data, which confirmed a statistically significant reduction in crashes (at the 1% significance level) after the road diet was implemented.

Table 1 - Before and After Quarterly Crash Data for SR 154

Quarter	Before	Quarter	After	Ratio	Change
Q3 2016	124	Q3 2019	100	0.81	-24
Q4 2016	118	Q4 2019	90	0.76	-28
Q1 2017	135	Q1 2020	90	0.67	-45
Q2 2017	148	Q2 2020	18	0.12	-130
Q3 2017	127	Q3 2020	55	0.43	-72
Q4 2017	128	Q4 2020	79	0.62	-49
Q1 2018	110	Q1 2021	79	0.72	-31
Q2 2018	111	Q2 2021	97	0.87	-14
Key	220	110	0		

The before and after quarterly crash counts are also shown in Figure 1.

Review of Historical Project Performance

- **R-Cut (16:1 AVG B/C)**
  - Our analysis showed an 89% reduction in both property damage only and injury/fatal crashes among vehicles crossing through or turning left from the side street.

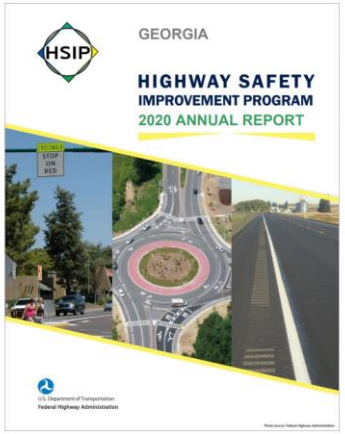
- **Roundabout (12:1 AVG B/C)**
  - The Naïve method analysis identified an average 57% reduction in PDO crashes and 80% reduction in injury/fatal crashes at the intersections. The analysis also showed a 64% reduction in crashes for all manner of collisions.
  - **New Roundabout Design Guide**

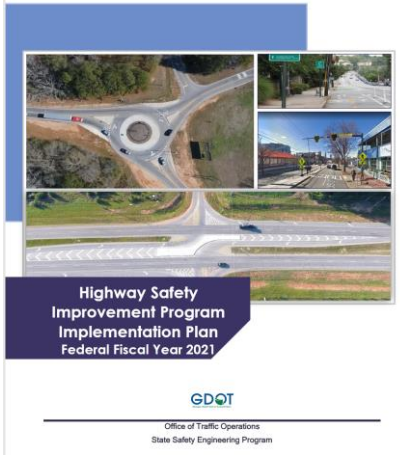
- **Cable Barrier**
  - The crash rate analysis identified a 35% reduction of injury and fatal crashes and a 72% increase in PDO crashes.

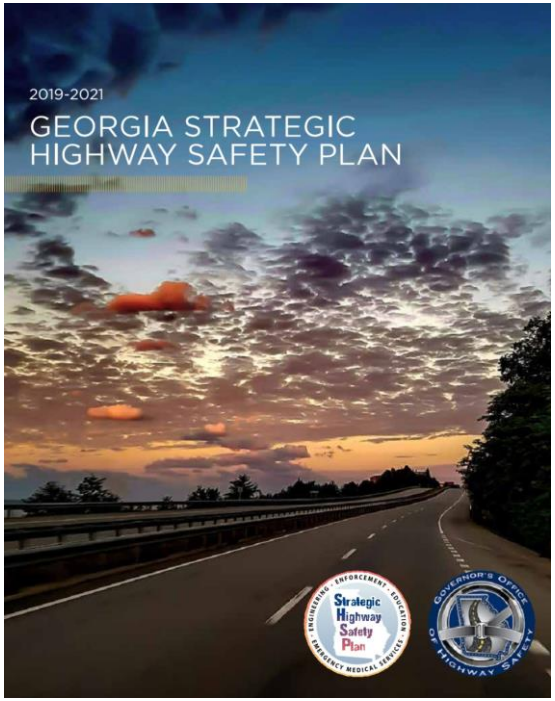
- **Rumble Strips (100:1 AVG B/C)**
  - The crash rate analysis identified an average of 48% decrease in injury/fatal crashes per year on the roadway.
  - **New Policy update**

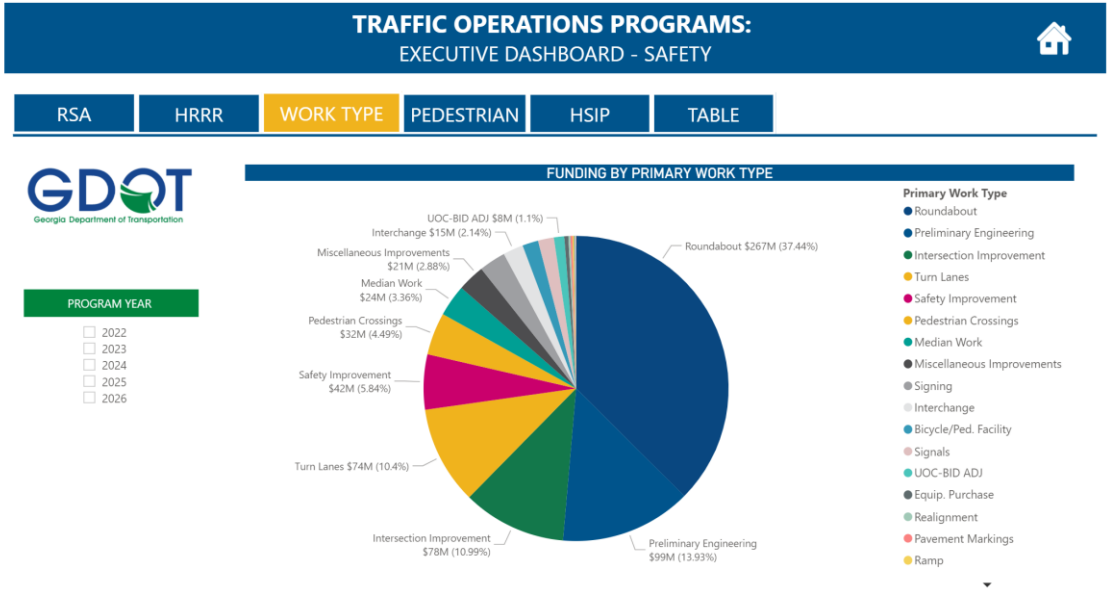
- **Pedestrian Hybrid Beacon**
  - In analyzing the mid-block pedestrian crashes, an 86% decrease in injury/fatal mid-block pedestrian crashes occurred. In analyzing all pedestrian crashes (at mid-block and at intersections) along the corridor where the project was constructed, a 46% decrease in all injury/fatal pedestrian crashes occurred.

Reporting and Plans









Challenges and Next Steps for Future Evaluation

- Challenges
  - Data quality
  - Resource management with Big Data
  - Buy-in, finding champions
- Next Steps
  - Update comparison template for all users
  - Intersection rankings
  - Predictive Analysis and SPFs
  - Work Zone Analysis?

Three Takeaways

1. Data Collection
2. Crash Analytics = Numetric
3. Evaluation of Program and Projects

Questions?

Samuel Harris, PE

State Safety Engineering Manager

sharris@dot.ga.gov

404.635.2881

Washington State DOT

WSDOT

Safety Effectiveness Evaluation Process

Kelvin Daratha, PE, PTOE
HQ Traffic Operations

Background

Goal: Evaluate how effective safety $ spent for hot spot projects

Technique for evaluating safety: Empirical Bayes (for B/A studies)

- Results in CMFs
- RTM
- Traffic Volume Changes

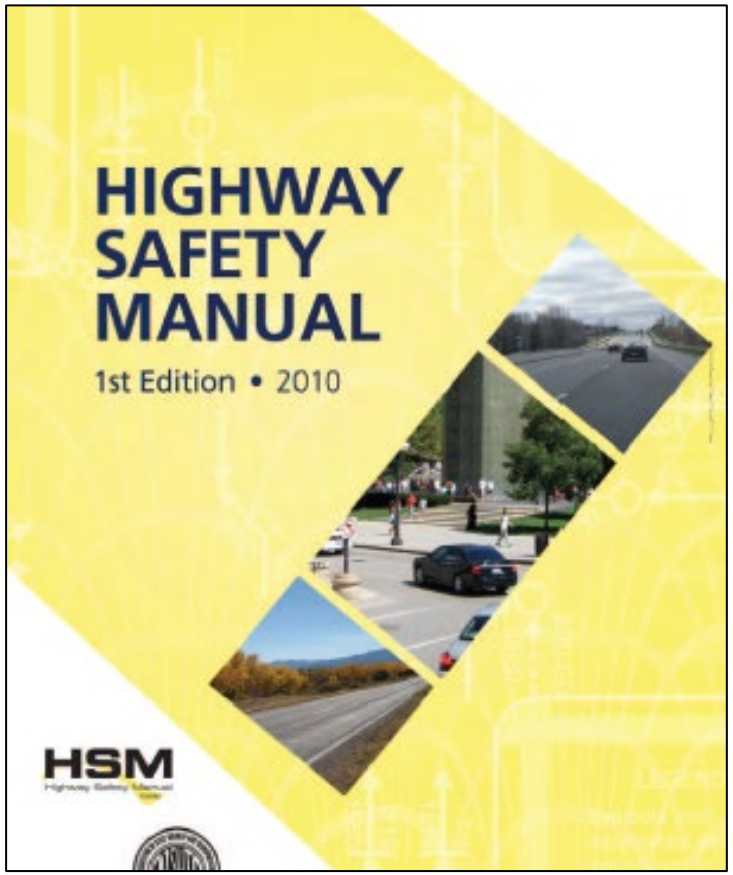
Why Local CMFs?

- **Evaluate effectiveness of safety $**
- WA specific driving behavior and conditions
- Assists in choosing a national level CMF when there are many CMFs
- Contribute to national literature
  - Not all countermeasures have a CMF defined
    - Road types, crash types, # lanes, etc
  - Strengthen Existing CMFs

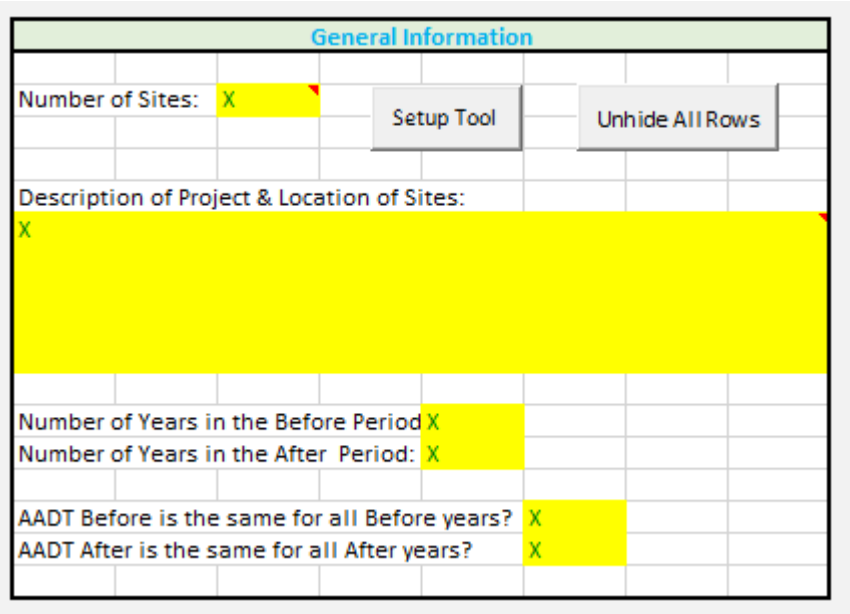
Better Data = Better Decisions

CMF Formation Tool

- WSDOT created a Microsoft Excel template to calculate the CMF
  - Methodology from HSM Chapter 9
  - Supports between 1-1,000 sites
  - Supports up to 10 yrs B & 5 yrs A
  - SPFs as Reference Group
  - Adjustment Factors (HSM Part C CMFs) to adjust for SPF baseline conditions
  - Calibration Factors



CMF Formation Tool



General Information

Number of Sites: X

Setup Tool

Unhide All Rows

Description of Project & Location of Sites:

X

Number of Years in the Before Period X

Number of Years in the After Period: X

AADT Before is the same for all Before years? X

AADT After is the same for all After years? X

*Screenshots of tool are from different studies. Used strictly to observe tool, not specific numbers.

Site Information

1	2	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	4a	4b	4c	4d	4e
		AADT (veh/day) - Before										AADT (veh/day) - After				
Site No.	Site length in miles. (L)	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y1	Y2	Y3	Y4	Y5
1	0.029	2,293	2,293	2,293	-	-	-	-	-	-	-	2,293	2,293	2,293	-	-
2	0.021	2,293	2,293	2,293	-	-	-	-	-	-	-	2,293	2,293	2,293	-	-
3	0.045	624	624	624	-	-	-	-	-	-	-	693	693	693	-	-
4	0.122	1,886	1,886	1,886	-	-	-	-	-	-	-	1,886	1,886	1,886	-	-
5	0.158	1,217	1,217	1,217	-	-	-	-	-	-	-	1,217	1,217	1,217	-	-

CMF Formation Tool

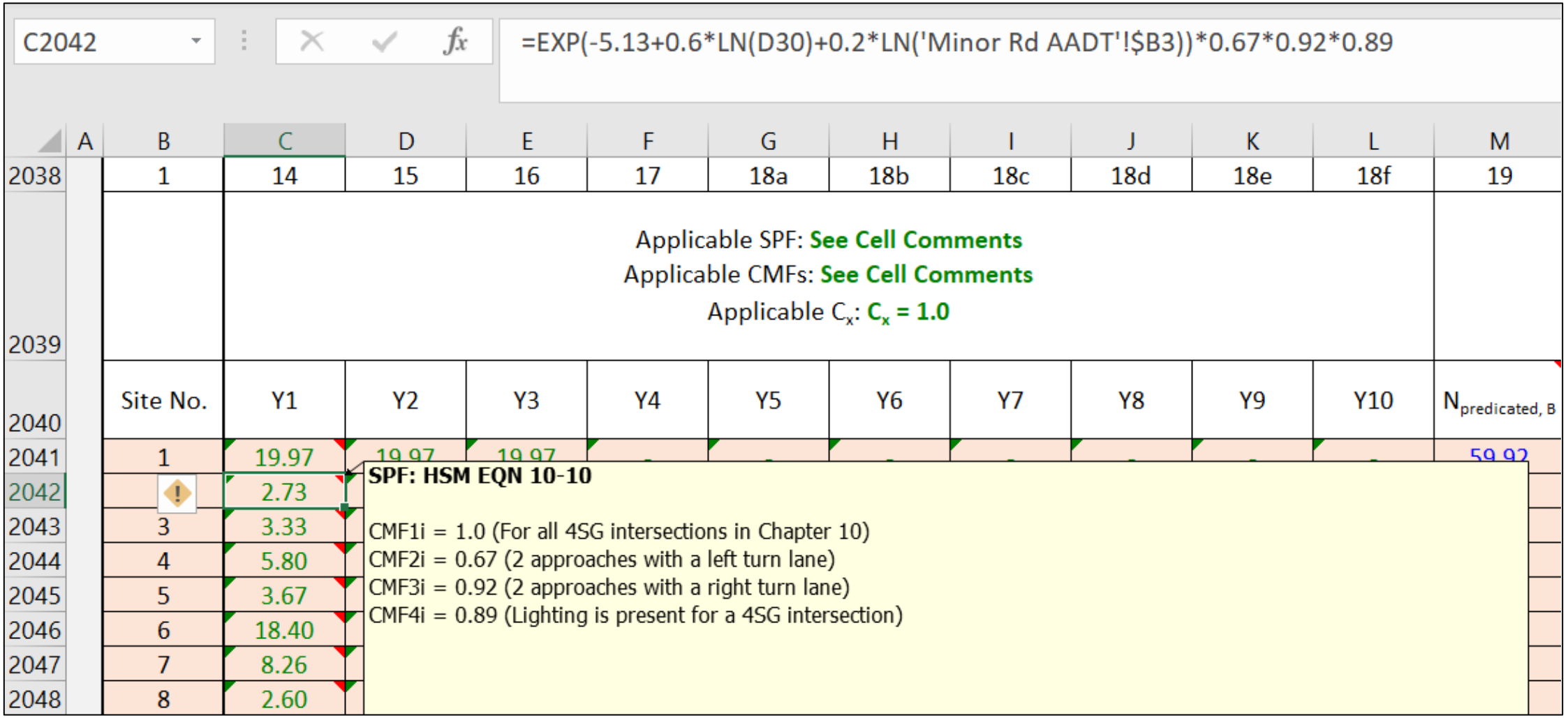
SPF, CMF (Adjustment Factors), k vary by site
-cell comments indicate formulas/methods used

Observed Crashes																	
1	5	6	7	8	9a	9b	9c	9d	9e	9f	10	11	12a	12b	12c	12d	13
	Observed before total crash frequency by year											Observed after total crash frequency by year					
Site No.	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	$N_{observed, B}$	Y1	Y2	Y3	Y4	Y5	$N_{observed, A}$
1	0	1	2	-	-	-	-	-	-	-	3	0	0	0	-	-	0
2	0	0	1	-	-	-	-	-	-	-	1	1	0	0	-	-	1

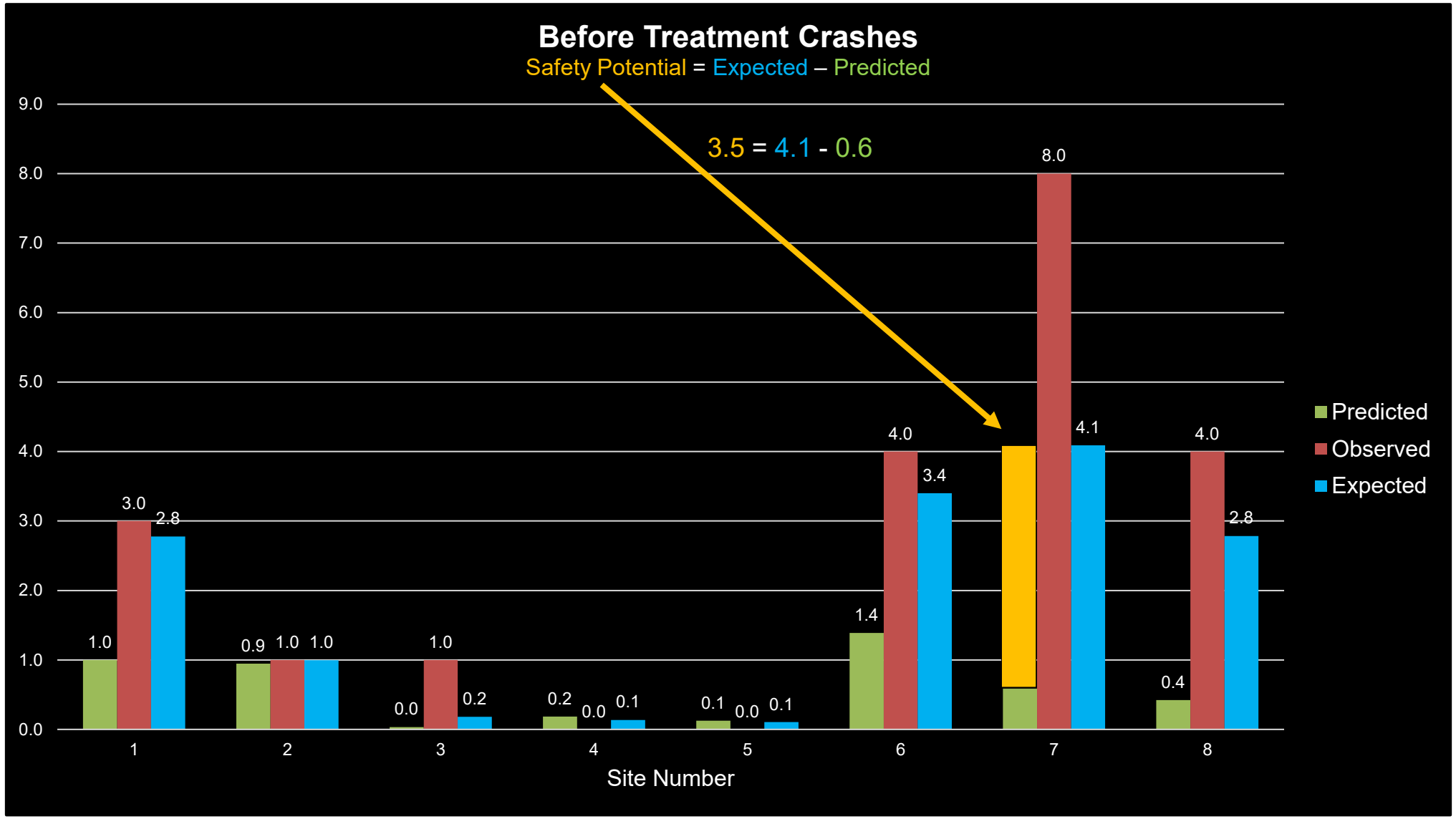
	$N_{predicted, Before}$											$N_{expected, Before}$		
1	14	15	16	17	18a	18b	18c	18d	18e	18f	19	20	21	22
	Applicable SPF: **See Cell Comments** Applicable CMFs: **See Cell Comments** Applicable C_x: **C_x = 1.0**											Applicable k: **See Cell Comments**		
Site No.	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	$N_{predicted, B}$	k	w	$N_{expected, B}$
1	19.97	19.97	19.97	-	-	-	-	-	-	-	59.92	0.28	0.06	31.70
2	2.73	2.73	2.73	-	-	-	-	-	-	-	8.20	0.11	0.53	8.11

	$N_{predicted, After}$						$N_{expected, A, no\ treatment}$		Site Output		
23	24a	24b	24c	24d	25	26	27	28	29	30
Applicable SPF (If No Treatment): **Same as Before Period, unless cell comments indicate otherwise.** Applicable CMFs: **Same as Before Period, unless cell comments indicate otherwise.** Applicable C_x: **C_x = 1.0**										
Y1	Y2	Y3	Y4	Y5	$N_{predicted, A}$	r	$N_{expected, A, no\ treatment}$	OR	Safety effectiveness	Var ($N_{expected, A}$)
20.50	20.50	20.50	-	-	61.50	1.03	32.54	0.55	45%	31.496
2.78	2.78	2.78	-	-	8.35	1.02	8.25	0.24	76%	3.982

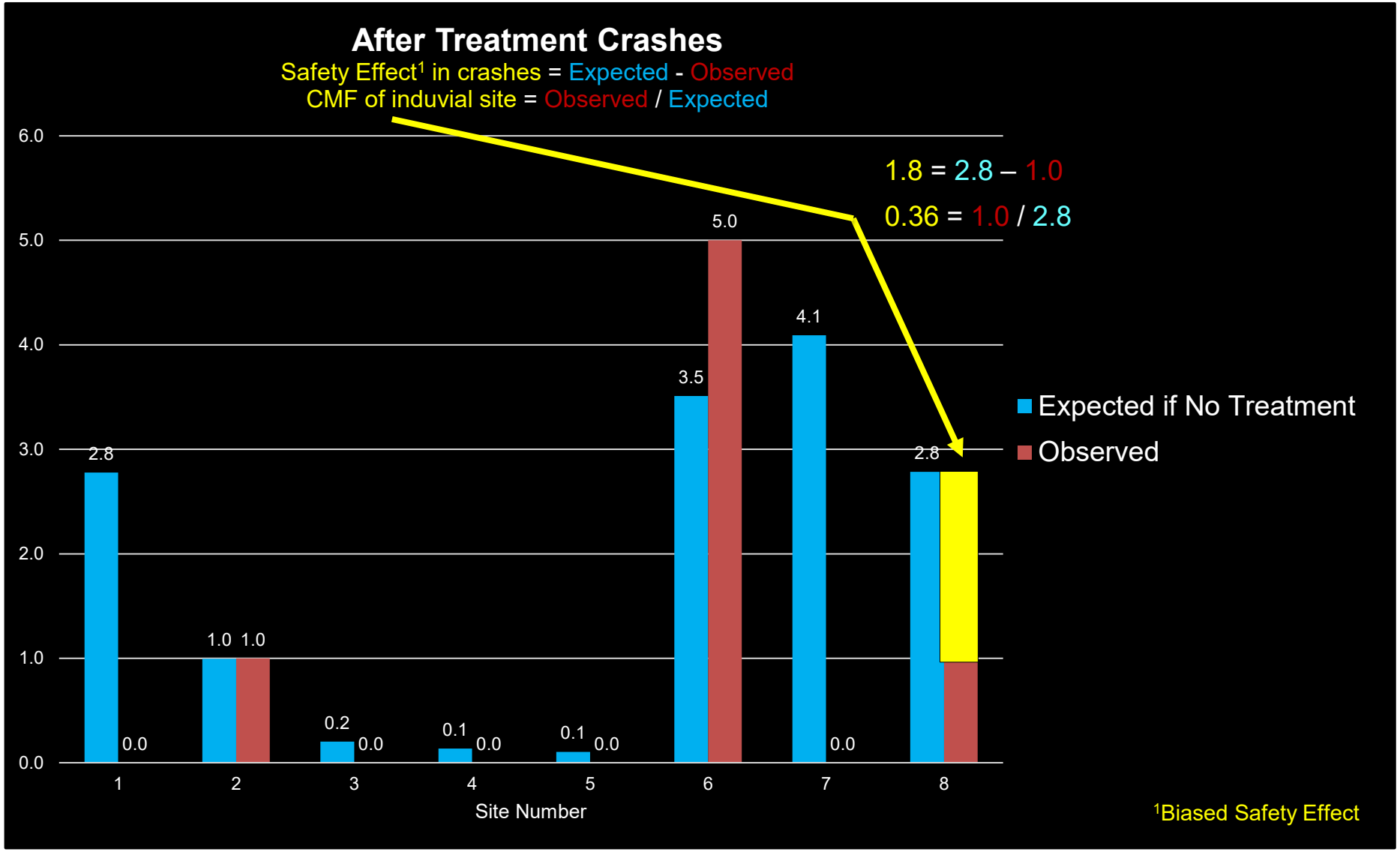
CMF Formation Tool – predicted crashes cell comments



CMF Formation Tool



CMF Formation Tool



CMF Formation Tool

Results			
Step 8: Site Combined Crash Modification Factor (CMF) - Biased			
CMF (Biased) =	0.757		
Step 9: Site Combined Crash Modification Factor (CMF) - Unbiased			
CMF =	**0.751**		
Step 10: Site Combined Safety Effectiveness - Unbiased			
Safety Effectiveness =	24.9%	reduction in crashes on average	
Step 11 & 12: Variance of Unbiased CMF & Standard Error of Unbiased CMF			
Variance (CMF) =	0.012	SE(CMF) =	0.109
Step 13 & 14: Statistical Significance			
Confidence Interval:	CMF Lower-Bound of CI:	CMF Upper-Bound of CI:	Statistically Significant:
50% CI	0.675	0.827	**yes**
80% CI	0.622	0.880	**yes**
90% CI	0.572	0.930	**yes**
95% CI	0.538	0.964	**yes**
99% CI	0.471	1.031	**no**

Outcomes

- Evaluated 7 countermeasures
- Affects decision making for future projects
- Plan to continue development of CMFs
  - Increase sample size over time
  - Report to CMF Clearinghouse?
- Challenges
  - Obtaining minor road counts
  - Time Consuming

Questions/Feedback

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