NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar:

Advances in Analysis and Visualization for Safe Streets and Roads for All

June 13, 2025

11:00 AM – 12:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING
RCEP
REGISTERED CONTINUING EDUCATION PROGRAM

AICP Credit Information

1.5 American Institute of Certified Planners Certification Maintenance Credits

You must attend the entire webinar

Log into the American Planning Association website to claim your credits

Contact AICP, not TRB, with questions

Purpose Statement

This webinar will introduce participants to innovative methods used to support Vision Zero and SS4A initiatives. Presenters will demonstrate new and accessible techniques including vehicle heading analysis at intersections, sliding window analysis, and crash tree diagram visualizations.

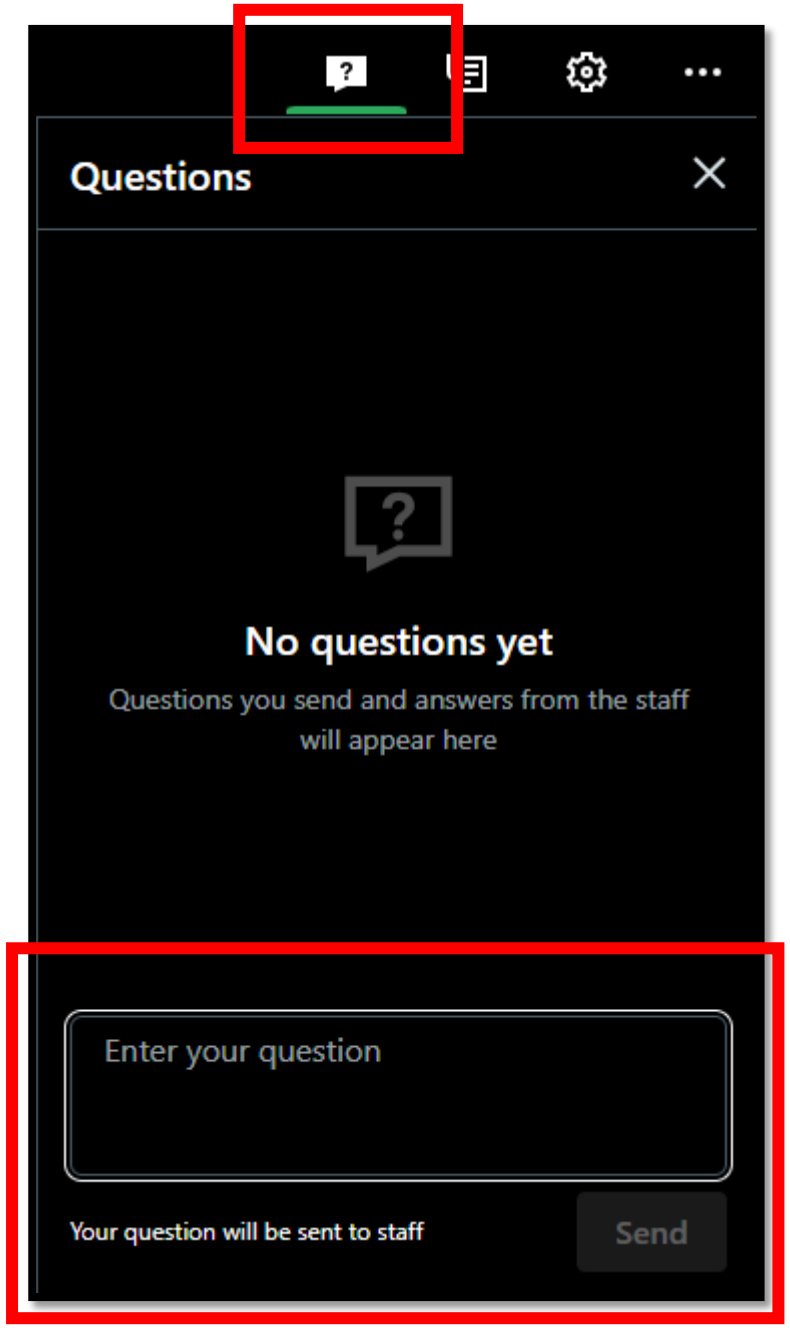
Learning Objectives

At the end of this webinar, participants will be able to:

- Describe new approaches for analyzing and visualizing safety planning data
- Explain how Big Data and AI can be applied to safety planning
- Identify methods to validate and visualize safety analysis results

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

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Nicholas Samuel
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Josh Pilachowski
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TRB Webinar: Advances in Analysis and Visualization for Safe Streets and Roads for All

Leveraging AI and Big Data to Enhance Safety Analysis

June 13, 2025

NCHRP Research Report 1152

Contributors

University of Washington: Yinhai Wang, Shuyi Yin, Mehrdad Nasri, Chenxi Liu, Shucheng Zhang, Joey Cai
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Gates Logic: Janet Gates

National Cooperative Highway Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

Phase 1	Phase 2
• Literature review of AI/ML frameworks • Literature review of big data used in safety analysis • Identification of data needs	• Develop framework and AI/ML models • QA/QC • Pilot projects • User guide on how the data and results can be used

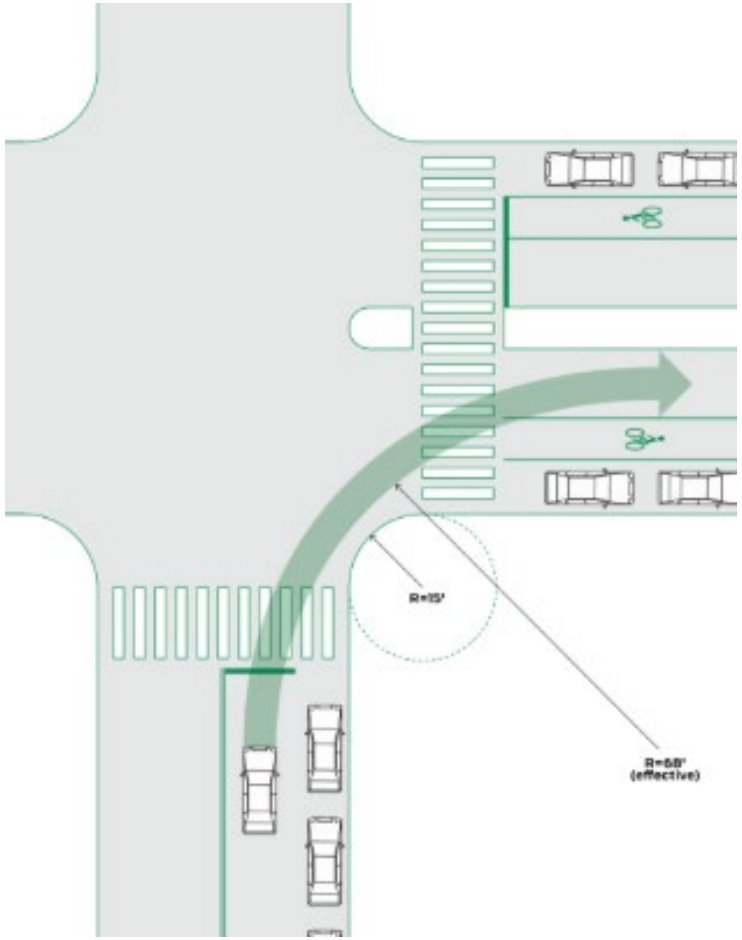
Bellevue Pilot Project

Problem Statement: What is the effect of intersection curb radii on actual vehicle turning radii and vehicle turning speed?

How: Examine how video analytics can be used for more in-depth analysis of road user behaviors.

Goal: Finding the connection between vehicular turning behavior and roadway geometries helps agencies to understand VRU risks better and propose countermeasures.

VRU = Vulnerable Road User



Source: NACTO corner radii

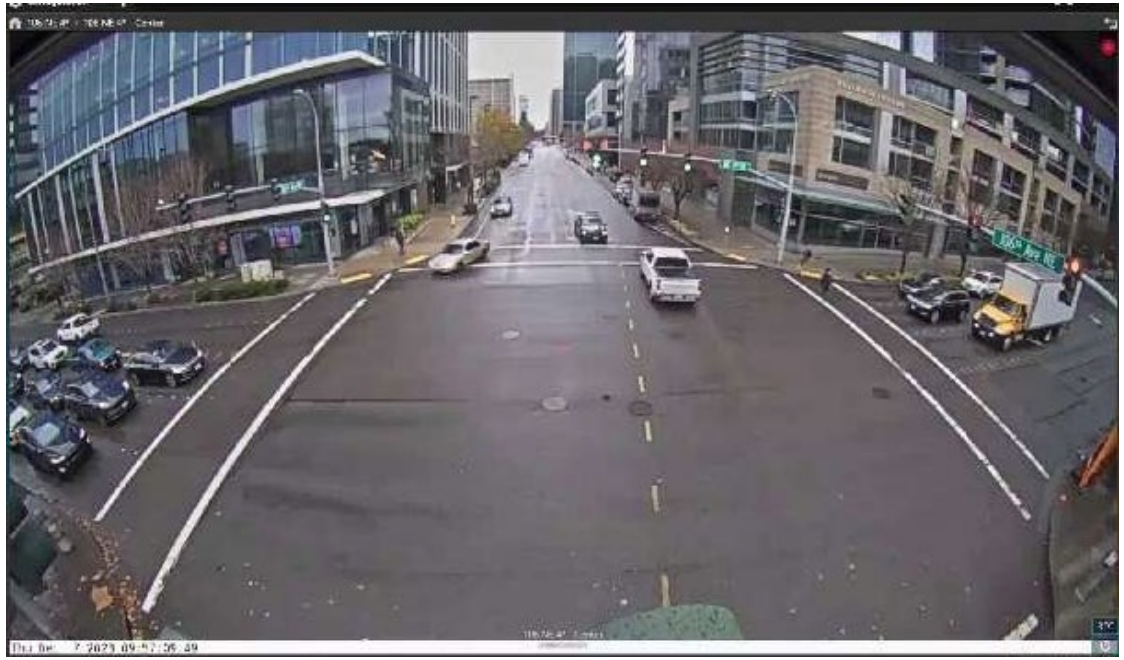
Pilot Overview

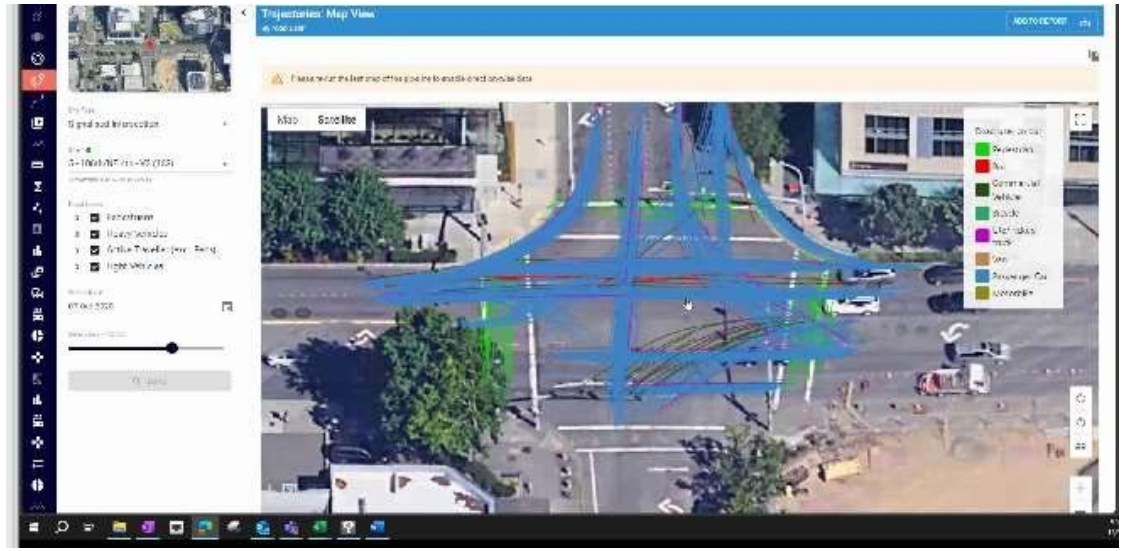
Significance: urban area, data-rich (AMAG, INRIX), Vulnerable Road Users

Motivation: relate turning behavior to roadway geometries so that VRU risks are understood better and countermeasures selected.

Data needed: turning trajectory and speeds at intersections, intersection geometries

Data sources: AMAG (vehicle trajectory and speeds), research team (intersection geometries)



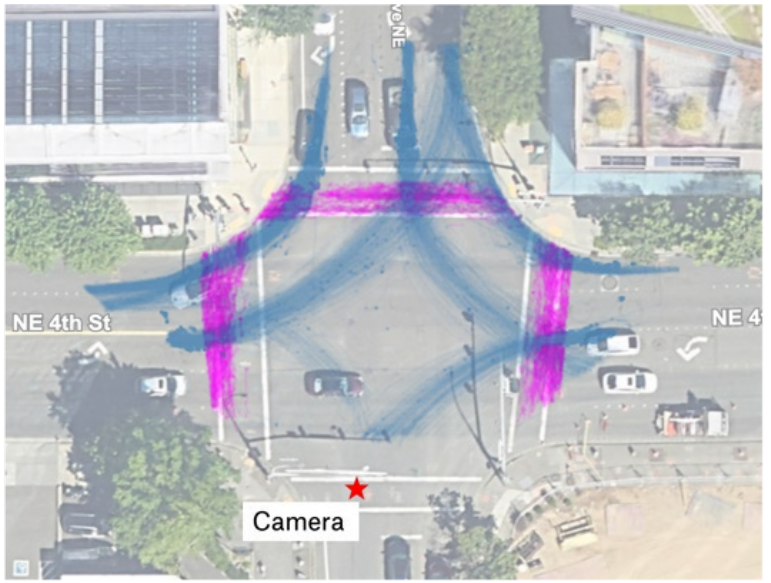


Source: City of Bellevue Traffic Camera, AMAG SMART platform

Data Preparation

Site & Data

- 106th Avenue NE & NE 4th St
  - 18,000 entering vehicles per day
- Complete view of two right-turn pockets + four left-turn movements
  - SB-R has one departure lane and two receiving lanes
  - WB-R has movements from a shared R/T lane into a single lane
- 24 days x 14 hour/day frame-by-frame object detection and tracking

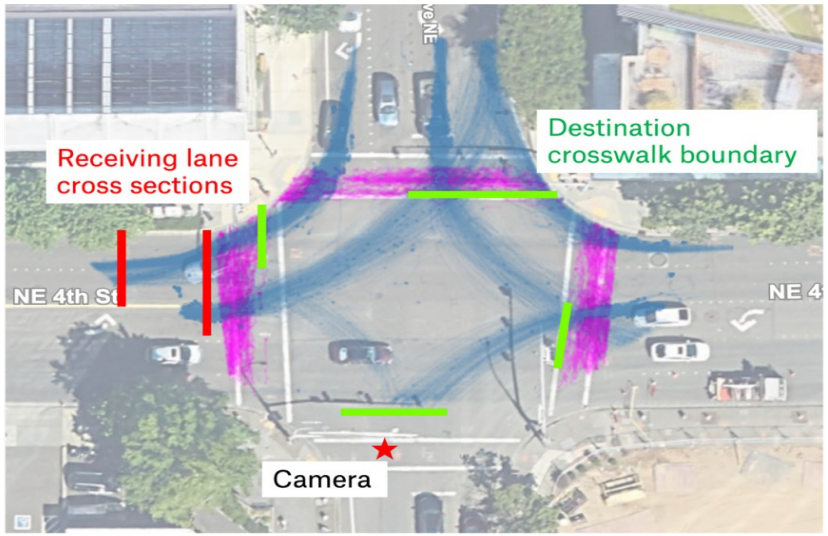


Source: City of Bellevue Traffic Camera, NCHRP Project 17-100

Bellevue Pilot Model Inference

Data processing and feature engineering

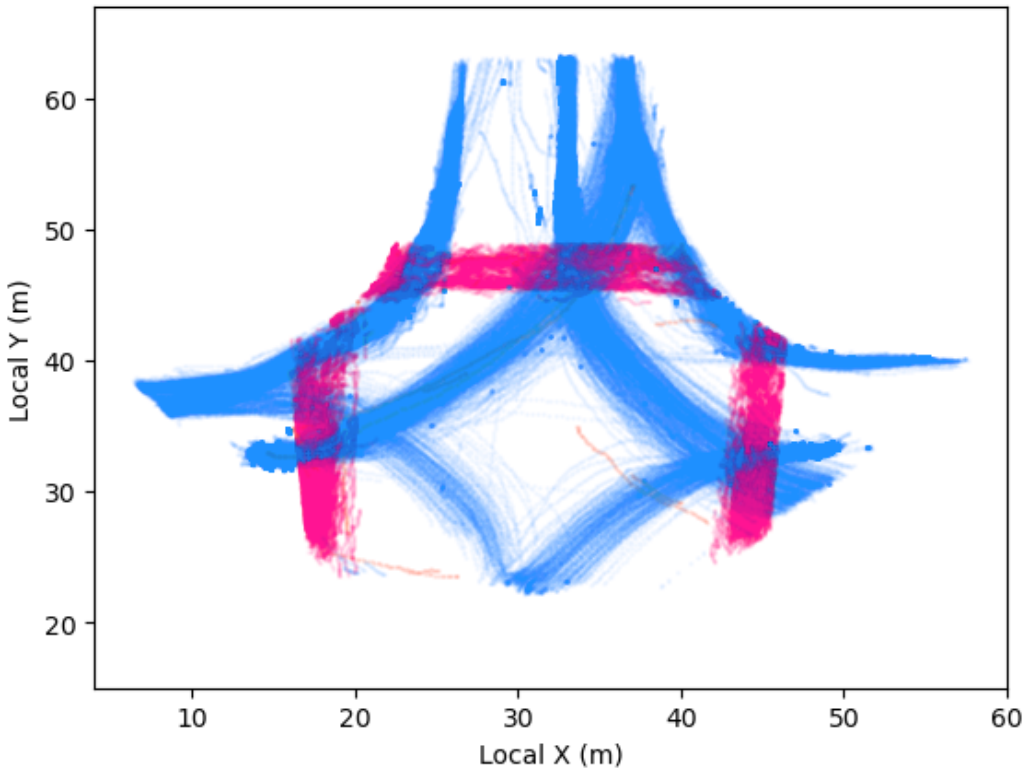
- Stopped (Impeded) vs. Unstopped (Unimpeded)
  - unimpeded trajectories are more informative for turning radii calculation
- Vehicle Heading at Crosswalk
  - important measure of risk to active users when vehicles enter crosswalk of the receiving lane/approaches and the "cone of vision"



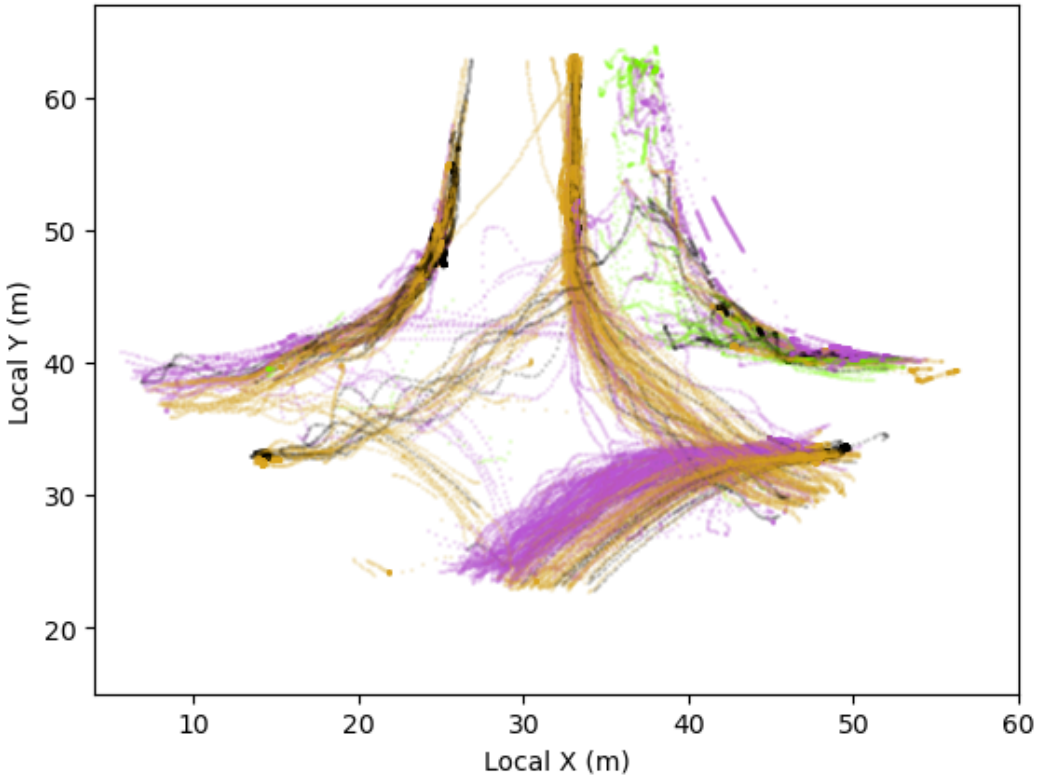
Source: NCHRP 17-100

Bellevue Pilot Results

Type of road user variable



Passenger car + Vulnerable Road User

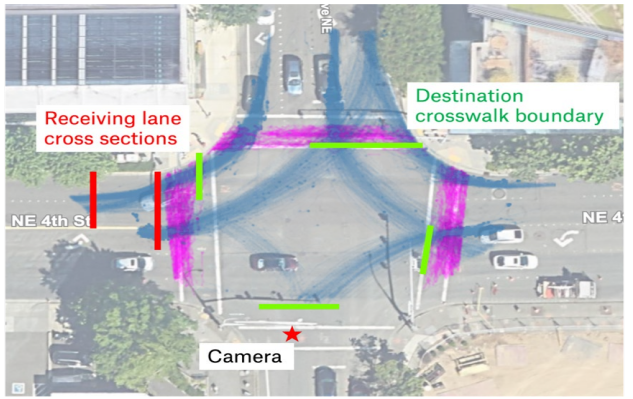


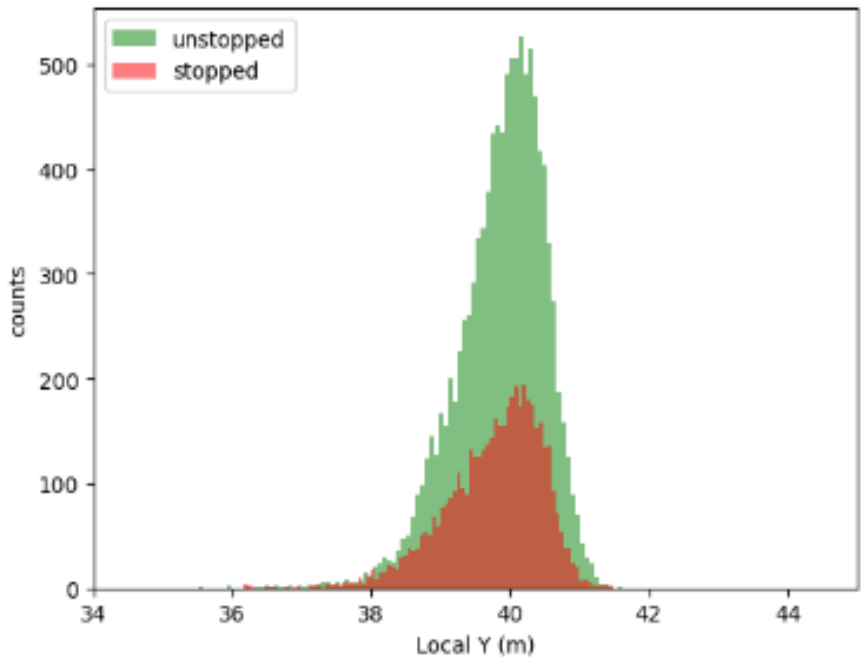
Motorbike, pickup truck, commercial vehicle, bus, van

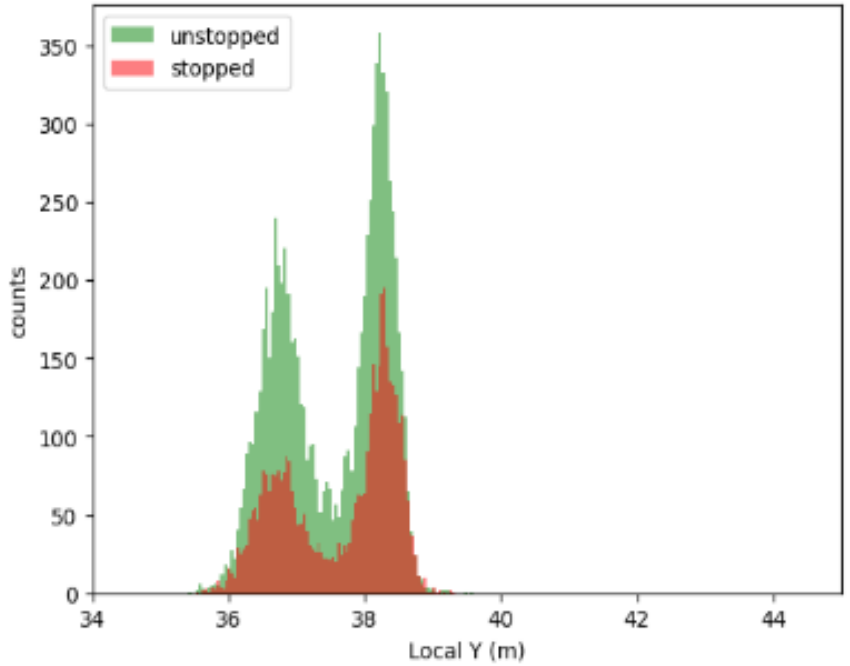
Source: NCHRP 17-100

Bellevue Pilot Results

Receiving lane positions





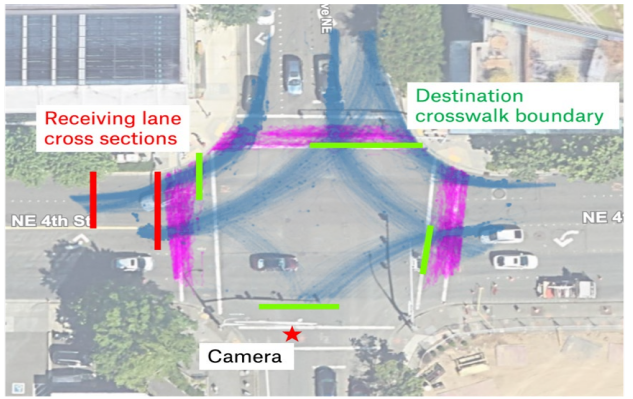


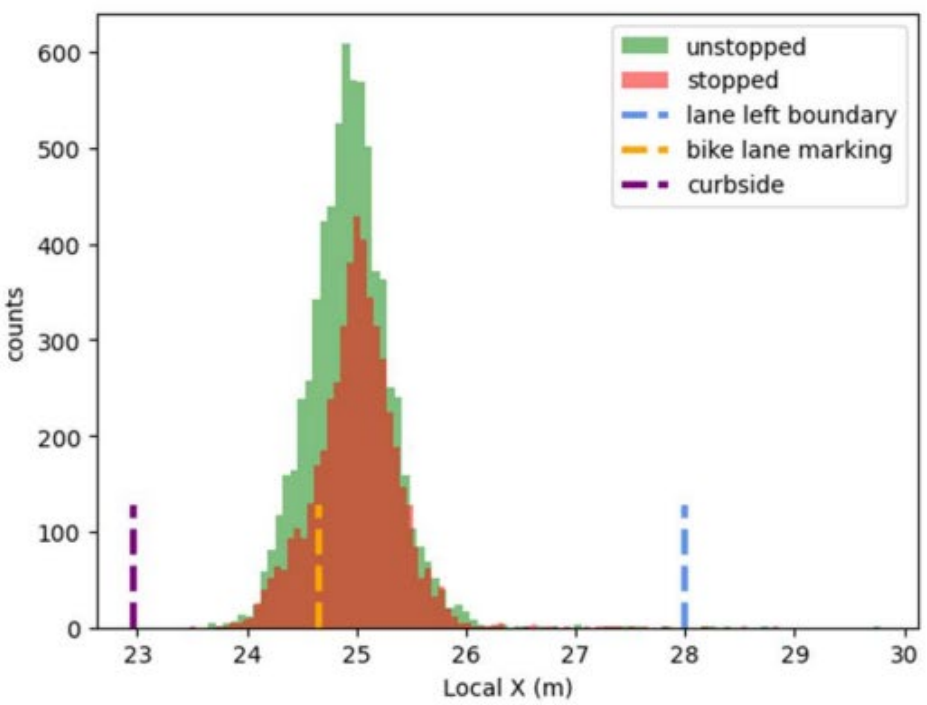
Entering crosswalk zone (left), 6m later fully into receiving approach (right)

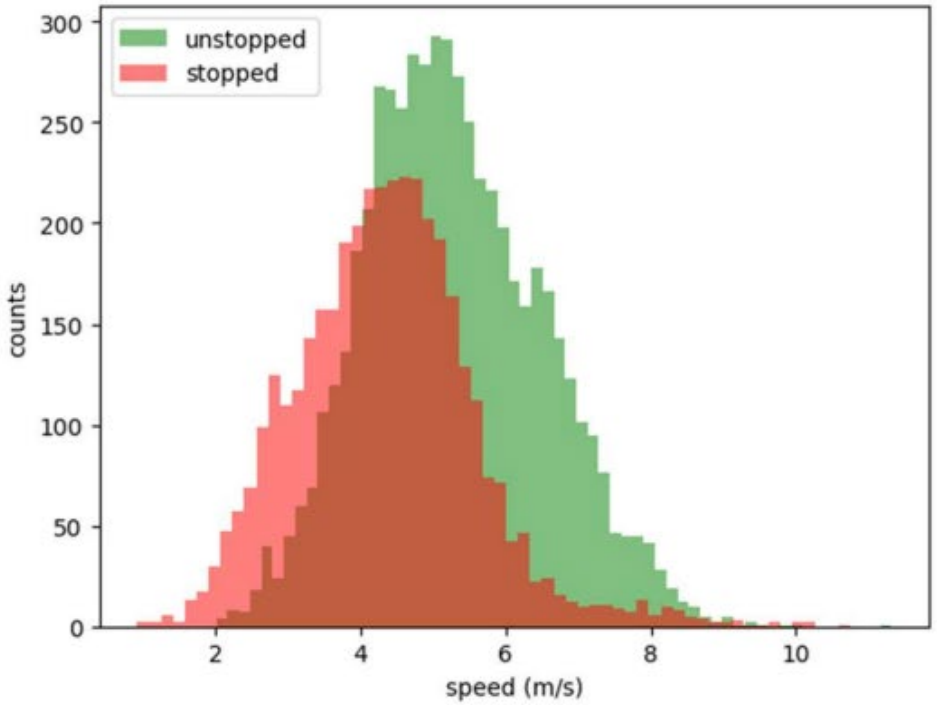
Source: NCHRP 17-100

Bellevue Pilot Results

Lane Departure Position and Speed





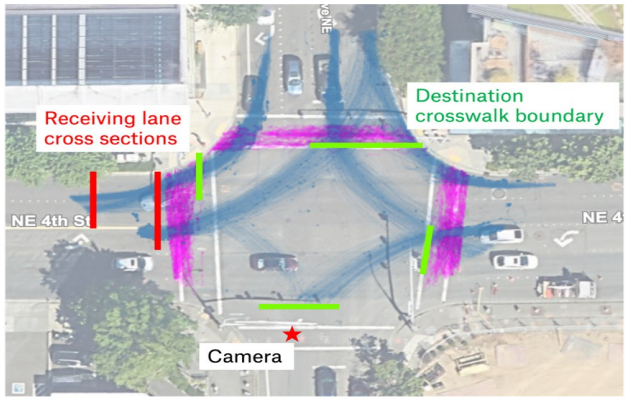


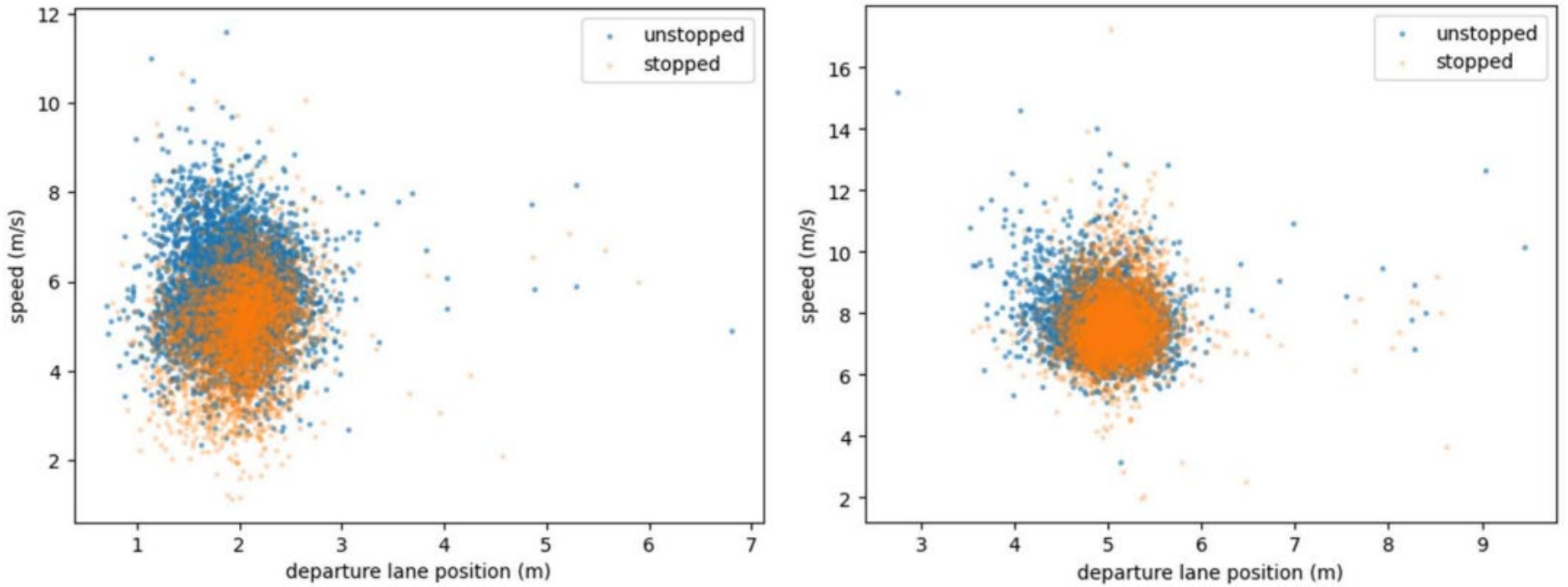
Vehicle departure lane position SBRT (left), 95th percentile speed (right)

Source: NCHRP 17-100

Bellevue Pilot Results

Lane Departure Position and Speed





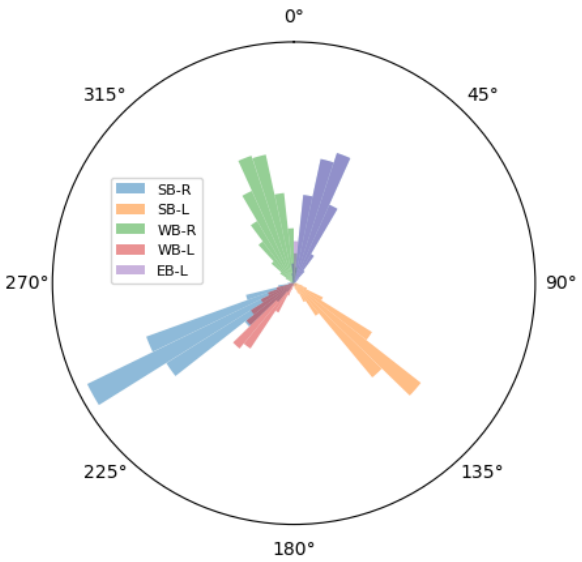
Vehicle departure lane position vs 95th percentile speed for SB-R (left) and WB-R(right)

Source: NCHRP 17-100

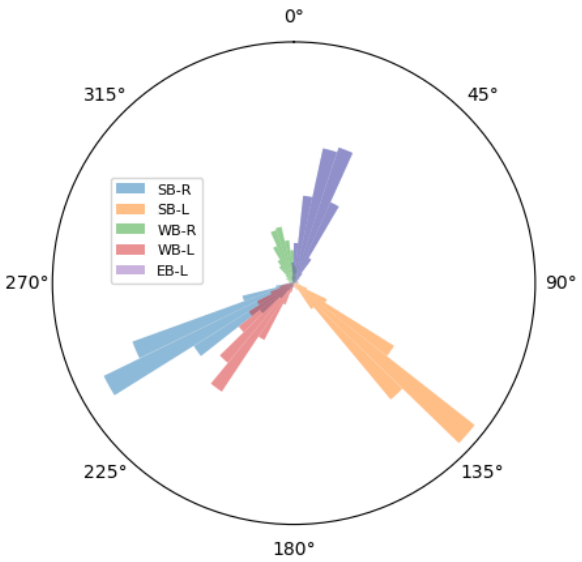
Bellevue Pilot Results

Vehicle exit angles

Passenger cars

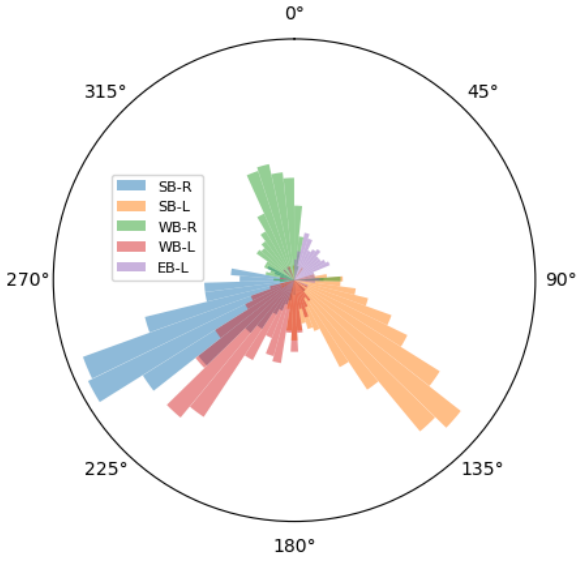


Unimpeded

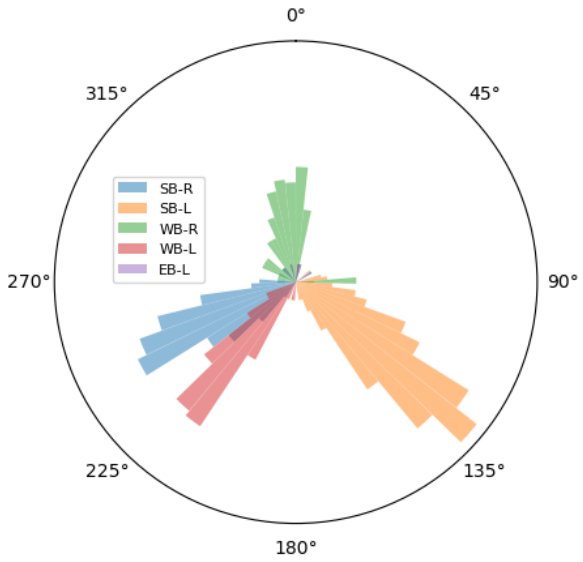


Impeded

Pickup truck, commercial vehicle, bus, van



Unimpeded



Impeded

Source: NCHRP 17-100

Summary & Take Aways

- ML and Big Data can enhance the ability of agencies and researchers to ask and answer new research questions about road users' activity at signalized intersections.
- With information known about the geometry of one intersection and the turning vehicles’ trajectories and speed within it, further studies can compare geometric design elements (such as curb radius, effective radius, number of receiving lanes, width of receiving lanes) to turning vehicle attributes (speed, heading at the crosswalk, turn radius).

CAMPO Regional Safety Action Plan

Automating and visualizing safety needs analysis with the Texas Highway Safety Improvement Plan

Regional Safety Action Plan (RSAP)

- CAMPO received funding from USDOT to conduct a roadway safety plan through the Safe Streets and Roads for All (SS4A) grant program.
- The plan includes a CAMPO-wide regional plan and individual chapters for each member county.
- This plan will allow CAMPO and local jurisdictions to apply for implementation funding through SS4A.

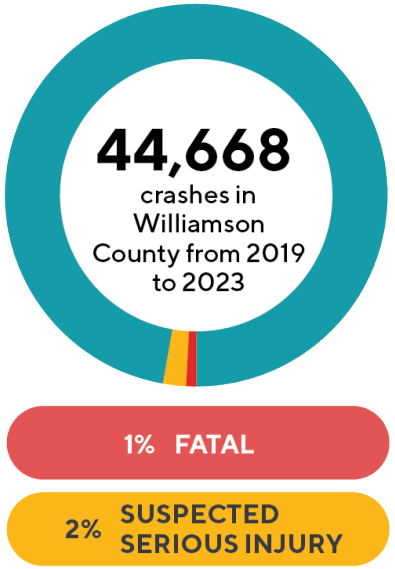
Project Scope

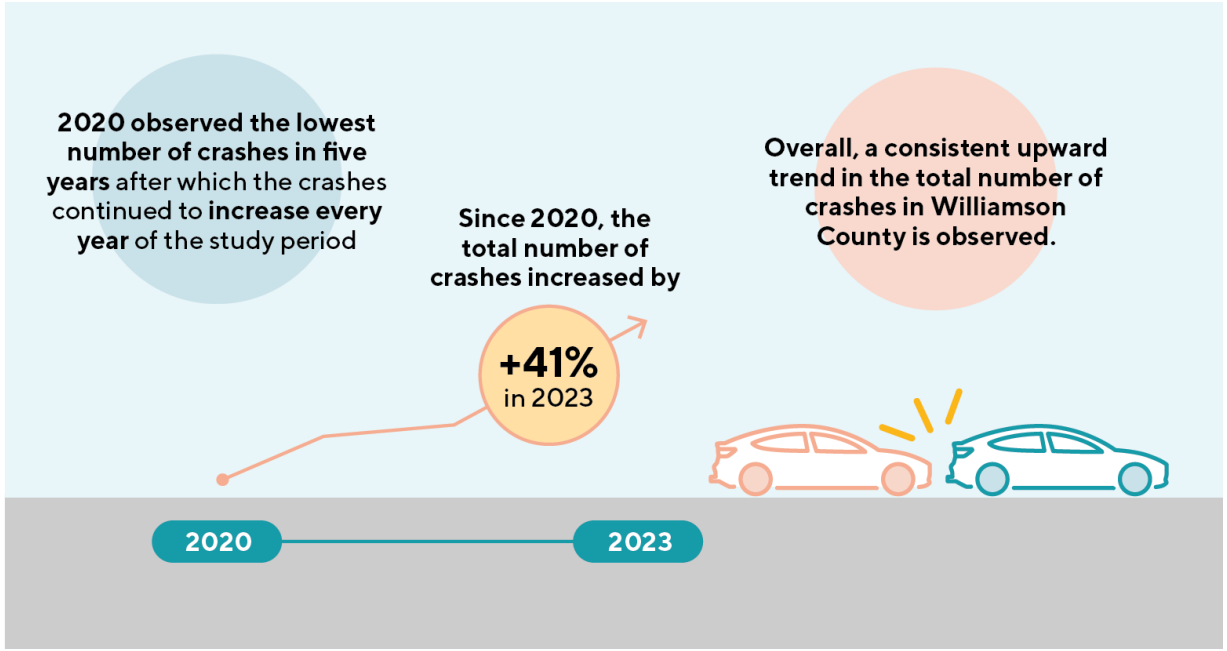
- EXISTING PLANS AND POLICIES REVIEW
- SAFETY GOALS AND OBJECTIVES DEVELOPMENT
- ROADWAY SAFETY ANALYSIS USING AVAILABLE DATA
  - » HIGH-INJURY NETWORKS (HIN)
- POLICY RECOMMENDATIONS
- PROJECT AND STRATEGY IDENTIFICATION AND PRIORITIZATION
- EQUITY ANALYSIS
- PUBLIC OUTREACH

REGIONAL SAFETY ACTION PLAN WITH COUNTY CHAPTERS

Williamson County

Historic Crash Analysis





Williamson County

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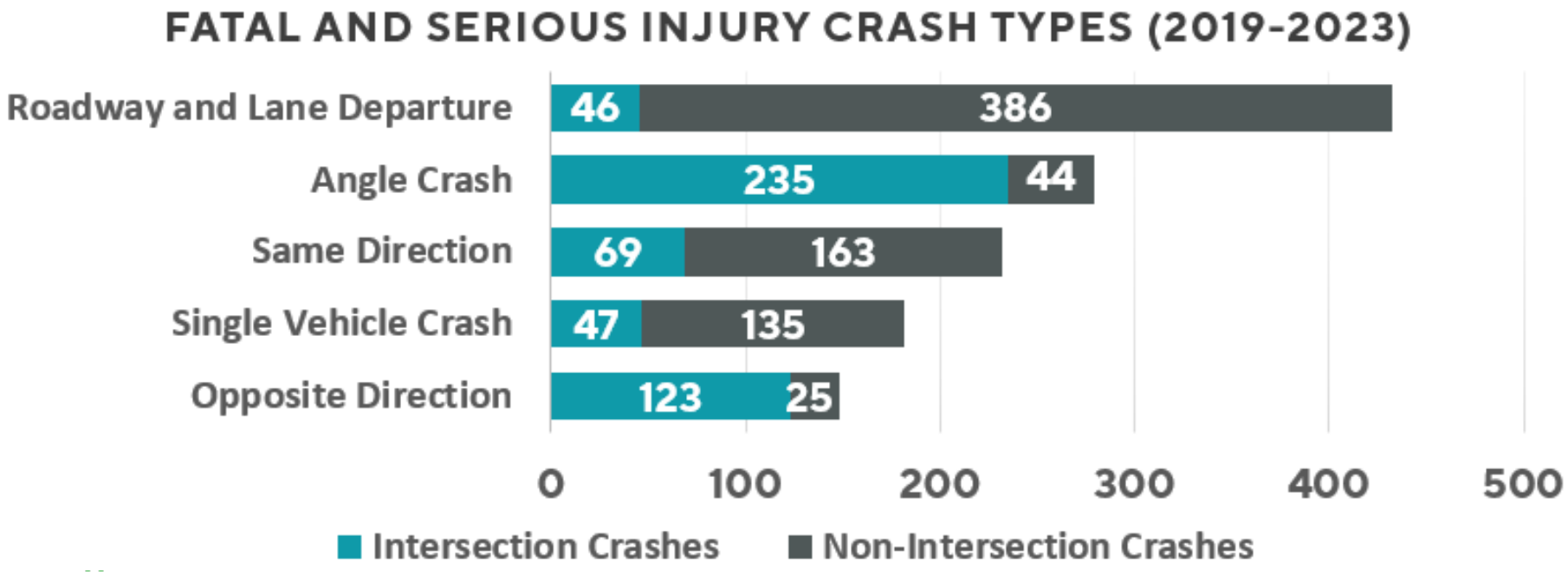


Notes:

- Crash types are mutually exclusive, meaning each crash is counted only once.
- A ‘Roadway and Lane Departure’ crash occurs when a single vehicle's first harmful event happens off the roadway or when two vehicles collide head-on due to one traveling the wrong way without attempting to pass.
- ‘Single Vehicle’ and ‘Opposite Direction’ crash types are counted only if they do not meet the Roadway and Lane Departure criteria.
- Intersection crashes include those where the crash data is labeled as ‘At Intersection’ or ‘Intersection Related’. Non-intersection crashes include ‘Driveway Related’ or ‘ Non Intersection’.

	DARK CONDITIONS	INTERSECTION	ROADWAY DEPARTURE	YOUNGER AND OLDER DRIVERS	SPEED RELATED
Total Crashes	28%	44%	16%	37%	29%
Fatal and Serious Injury Crashes	42%	41%	34%	34%	28%

	MOTORCYCLE	OCCUPANT PROTECTION	IMPAIRED DRIVING	VRU	DISTRACTED DRIVING
Total Crashes	2%	2%	4%	1%	16%
Fatal and Serious Injury Crashes	16%	15%	14%	12%	11%

Williamson County

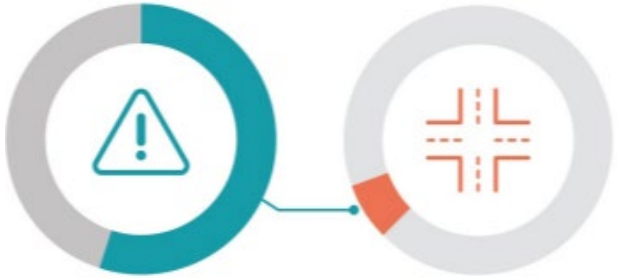
HIN – Intersection Methodology

1. **Obtain Williamson County 2019 – 2023 crash data**
2. **Conduct spatial analysis in GIS**
    1. Inventory and identify the roadway network
    2. Identify intersections and capture them
    3. Geolocate intersection information
    4. Summarize crashes by severity type for each intersection
3. **Weigh crashes** based on severity type:
    - Fatal (K) and suspected serious injury (A) crashes = 12 points
    - Suspected minor injury (B) and possible injury crashes (C) = 1 point
    - Non-injured or unknown crash types = 0 points

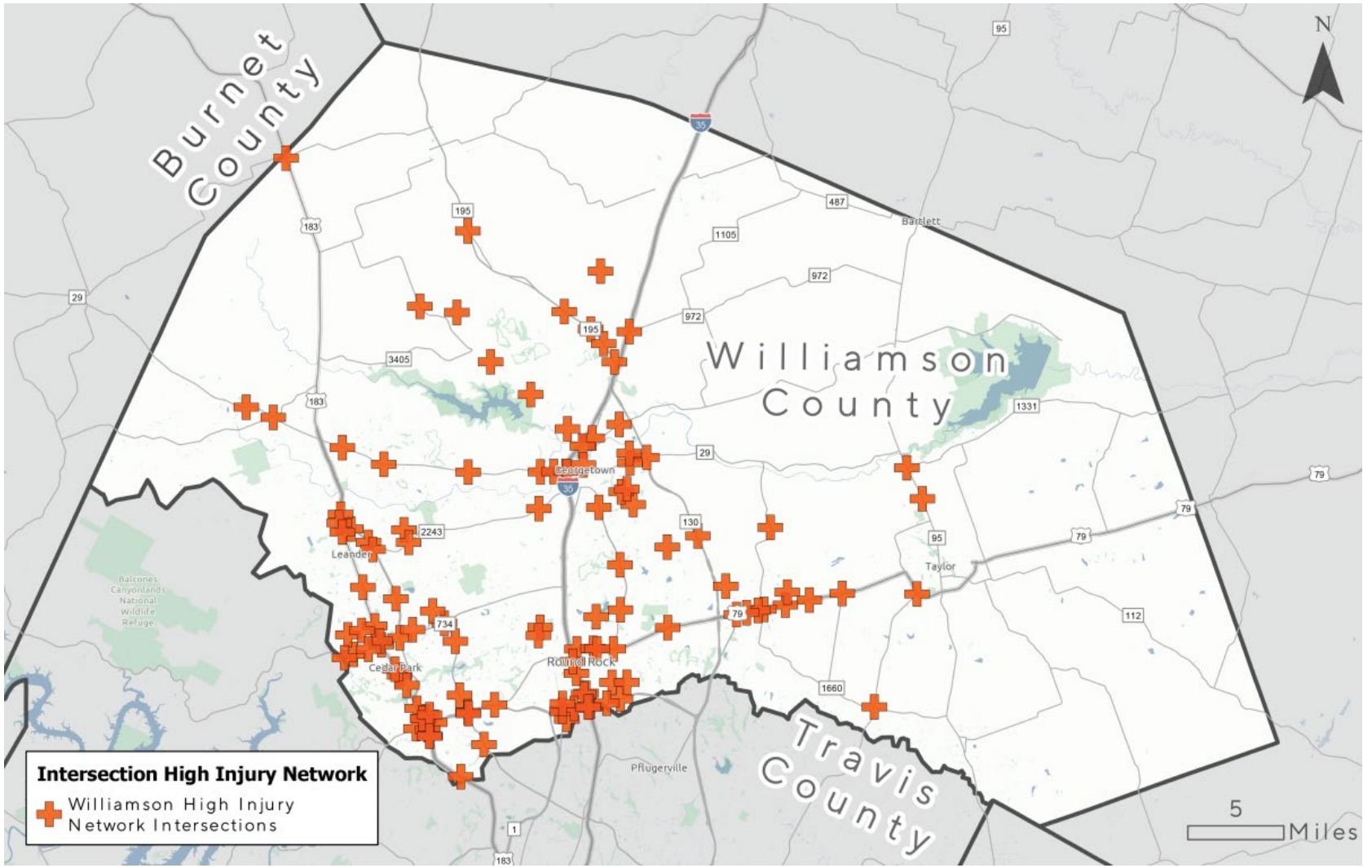
Intersections with high severity type crashes will have high weighted points.

Williamson County

High Injury Intersections



Over half of all fatal intersection crashes in Williamson County occurred on **only 7%** of the county's intersections



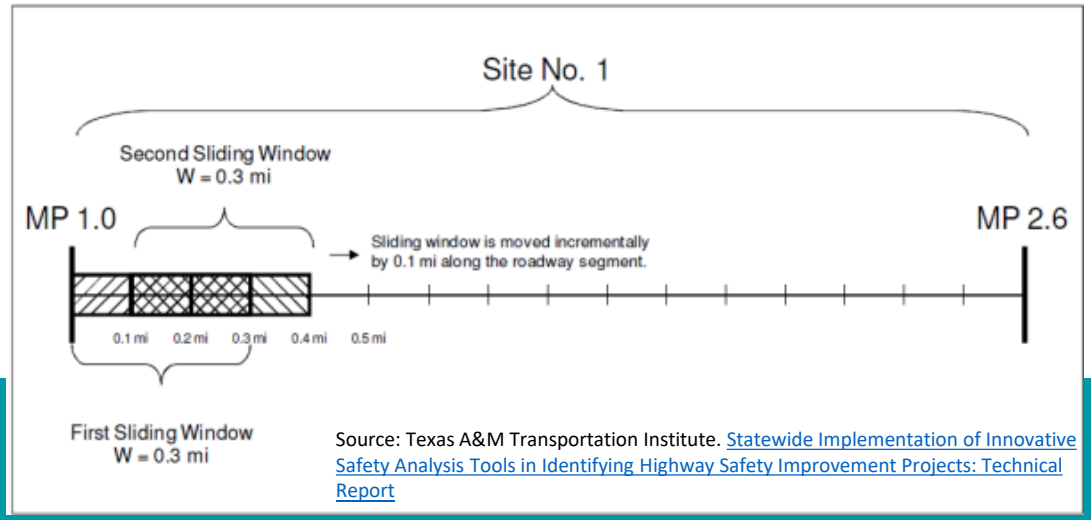
Williamson County

HIN - Non-Intersection Methodology

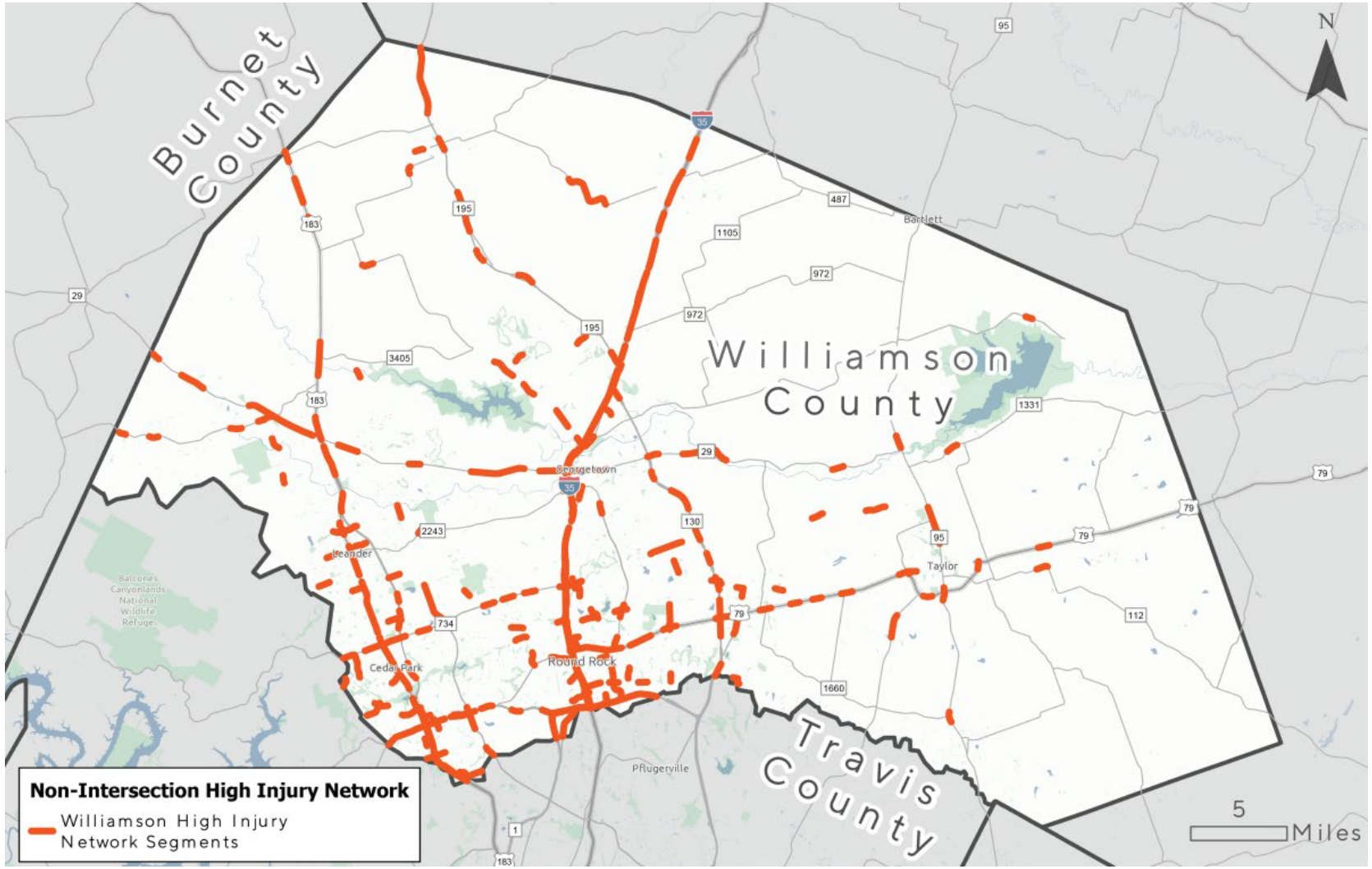
1. **Split each corridor** into 0.1-mile-long segments
2. **Join crashes** to the 0.1-mile segment layer using street name
3. **Spatially join any remaining crashes** using a search distance of up to 200 feet
4. **Summarize the 0.1-mile segment layer**'s unique ID and crash statistics and emphasis area (Python Script)
5. **Identify a cutoff** for identifying High Injury Network (based on weighted crash score)**.**
6. **Merge contiguous segments** within the High Injury Network and rank them using the weight crash score**.**

A sliding 0.5-mile window with a 0.1-mile increment was used

Illustration of a Sliding Window Method



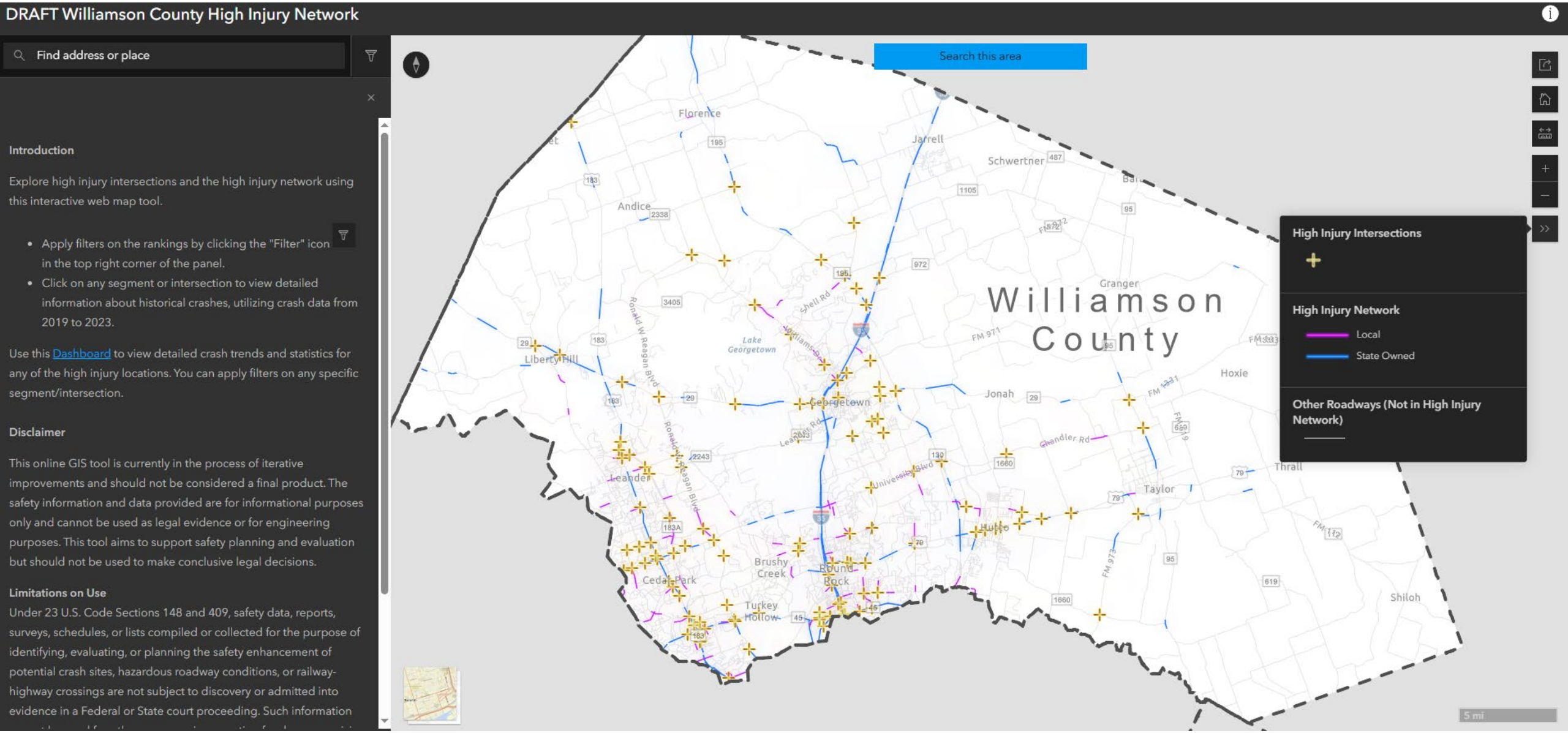
Source: Texas A&M Transportation Institute. Statewide Implementation of Innovative Safety Analysis Tools in Identifying Highway Safety Improvement Projects: Technical Report



Williamson County

High-Injury Segments

Over **70% of all fatal and serious injury** non-intersection crashes in Williamson County occurred on only **8% of the county's roadways**.


DRAFT Williamson County High Injury Network
Find address or place
Introduction
Explore high injury intersections and the high injury network using this interactive web map tool.
Apply filters on the rankings by clicking the "Filter" icon in the top right corner of the panel.
Click on any segment or intersection to view detailed information about historical crashes, utilizing crash data from 2019 to 2023.
Use this Dashboard to view detailed crash trends and statistics for any of the high injury locations. You can apply filters on any specific segment/intersection.
Disclaimer
This online GIS tool is currently in the process of iterative improvements and should not be considered a final product. The safety information and data provided are for informational purposes only and cannot be used as legal evidence or for engineering purposes. This tool aims to support safety planning and evaluation but should not be used to make conclusive legal decisions.
Limitations on Use
Under 23 U.S. Code Sections 148 and 409, safety data, reports, surveys, schedules, or lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding. Such information
Search this area
Williamson County
High Injury Intersections
High Injury Network
Local
State Owned
Other Roadways (Not in High Injury Network)
Florence
Jarrell
Schwertner
Andice
Granger
Liberty Hill
Lake Georgetown
Georgetown
Jonah
Hoxie
Leander
Cedar Park
Brushy Creek
Round Rock
Taylor
Thrall
Hutto
Turkey Hollow
Shiloh
5 mi

DRAFT Williamson County High Injury Network

Find address or place

Search this area

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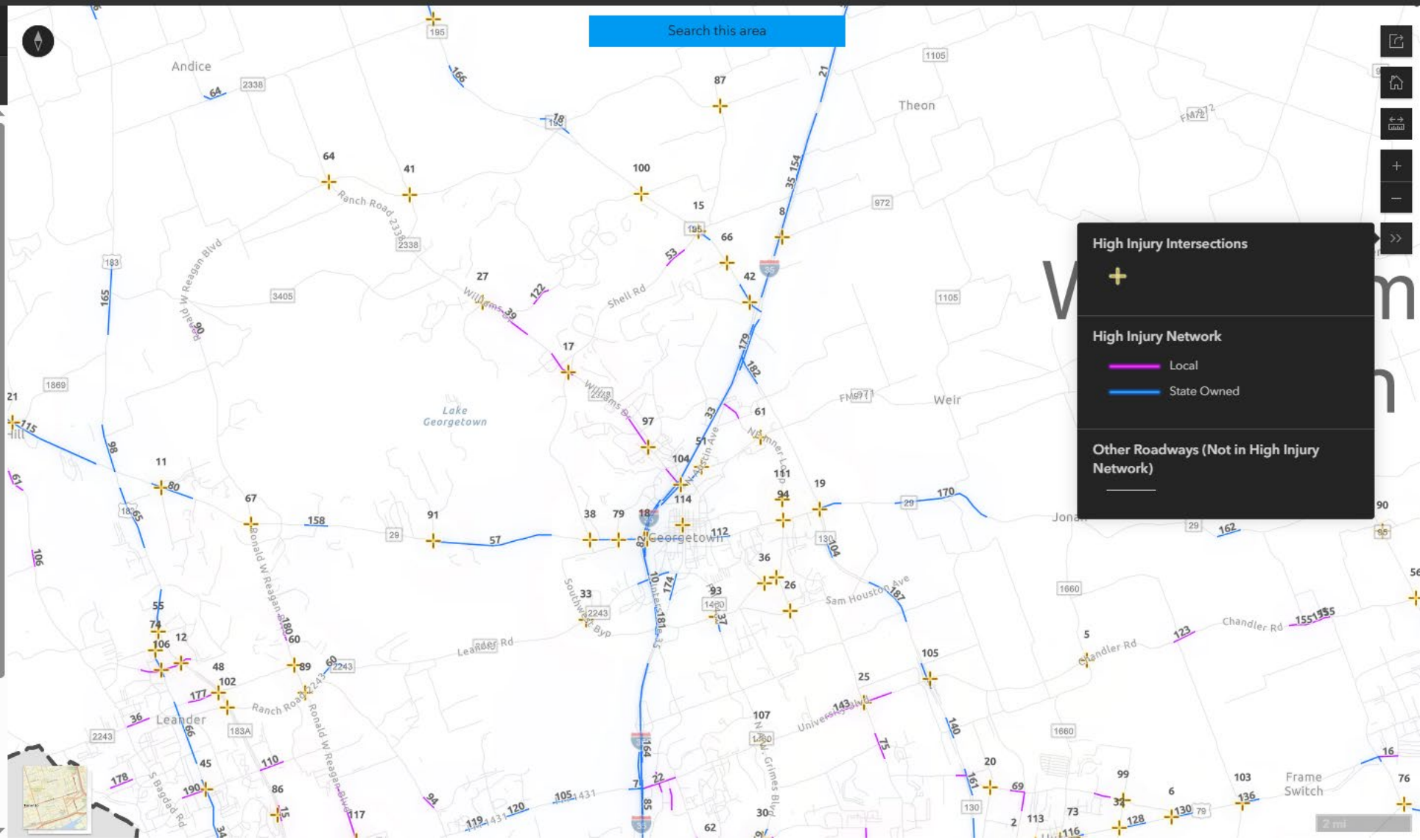
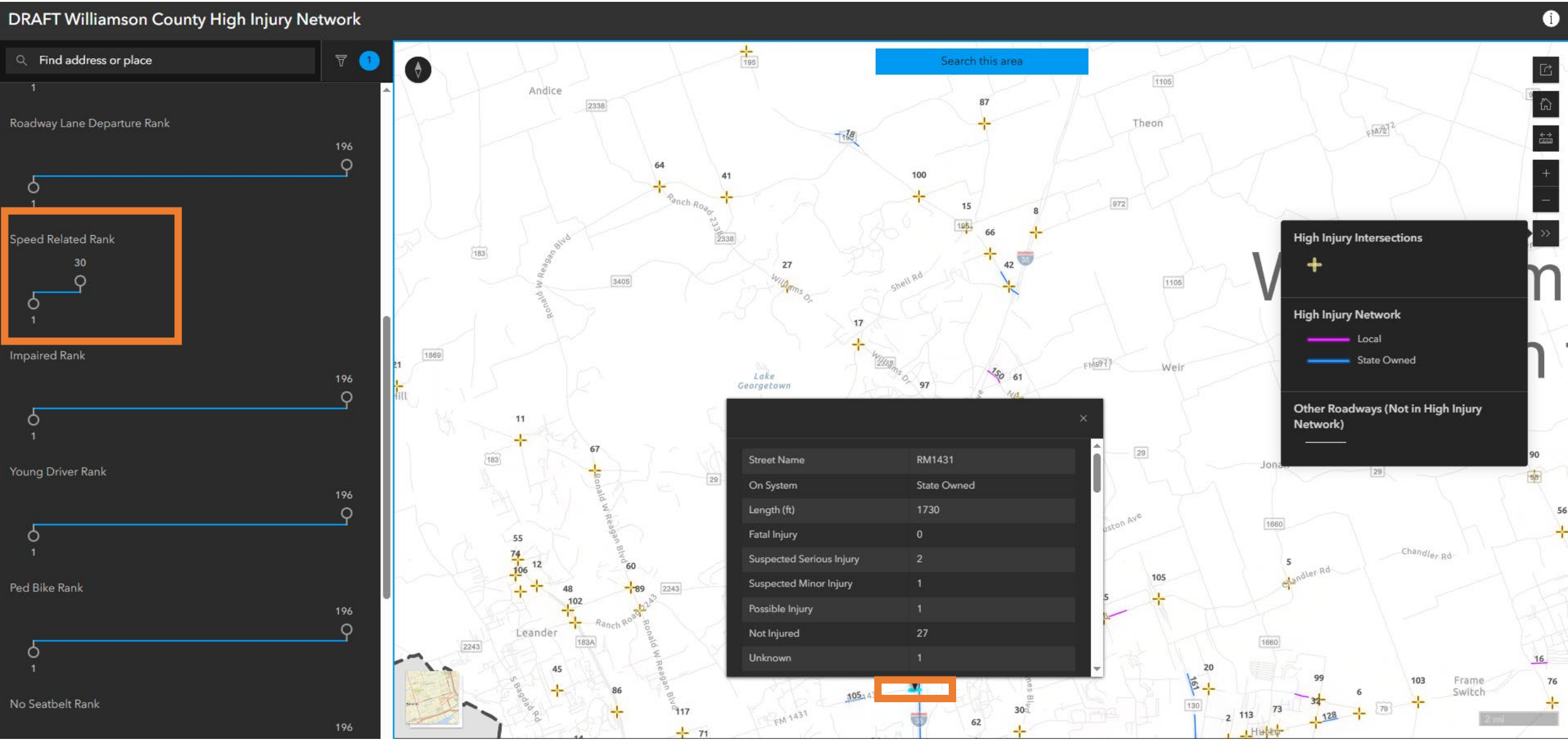
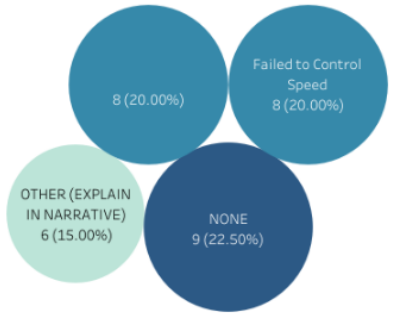



DRAFT Williamson County High Injury Network
Find address or place
1
Roadway Lane Departure Rank
196
1
Speed Related Rank
30
1
Impaired Rank
196
1
Young Driver Rank
196
1
Ped Bike Rank
196
1
No Seatbelt Rank
196
Search this area
Andice
Theon
Weir
Leander
Lake Georgetown
Ranch Road 2338
Ronald W Reagan Blvd
Williams Dr
Shell Rd
Chandler Rd
Frame Switch
FM 1431
High Injury Intersections
High Injury Network
Local
State Owned
Other Roadways (Not in High Injury Network)
Street Name RM1431
On System State Owned
Length (ft) 1730
Fatal Injury 0
Suspected Serious Injury 2
Suspected Minor Injury 1
Possible Injury 1
Not Injured 27
Unknown 1

Crash Collision Type

Crash Type	Collision Type	Direction	Fatal Injury	Suspected Major Injury	Suspected Minor Injury	Possible Injury
Angle C..	Angle - on..	North-East				1
Roadway and Lane Departure	One motor vehicle - going straight	East	1		1	4
		East-East				1
		Northeast			1	4
		Northeast-Northe..	1		1	
		Northwest				1
		Southwest			1	1
		West		1	3	3
		West-West		1	3	
Same Direction	Same direction - both going..	East-East			1	
		East-Not applicable				1
		Northeast-Northe..			2	1
	Same dire..	West-West				3
	Same dire..	East-East				1
Single Vehicle..	One motor vehicle - g..	East			1	
		East-Not applicable	1			

Contributing Factors



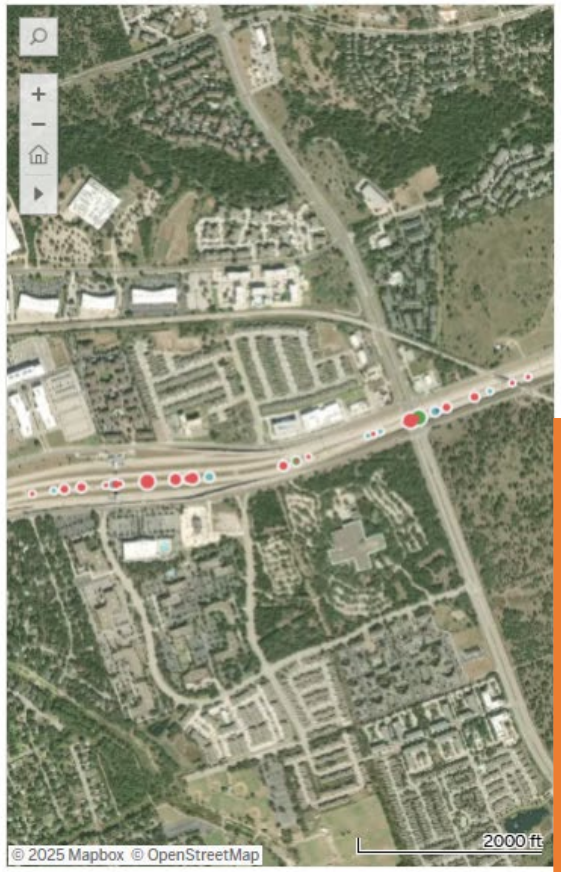
First Harmful Event

Harmful Event	Fatal Injury	Suspected Major Injury	Suspected Minor Injury	Possible Injury
Fixed Object	2	2	9	14
Motor Vehicle In Tr..			3	7
Overturned			2	
Pedestrian	1			

Heat Map

Segment Rank: 5
Intersection Rank: (All)
% Contributing Factors: 0.1500 — 1.0000
On-System: (All)
Crash Severity: (All)
Crash Type: (All)
Location: (All)
Harmful Event: (All)
Light Condition: (All)
Contributing Factor: (All)

Map



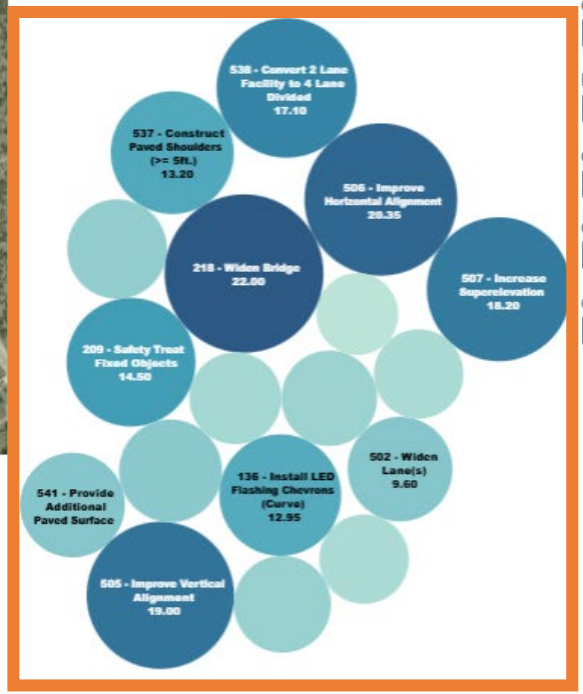
Crash Severity
- Fatal Injury
- Suspected Major Injury
- Suspected Minor Injury
- Possible Injury

Crash Type
- Angle Crash
- Roadway and Lane Departure
- Same Direction
- Single Vehicle Crash

Crash Types by Severity

Crash Type	Fatal Injury	Suspected Major Injury	Suspected Minor Injury	Possible Injury
Angle Crash				1
Roadway and Lane D..	2	2	10	14
Same Direction			3	6
Single Vehicle Cra..	1		1	

Top Work Codes (Expected Crashes Reduced)



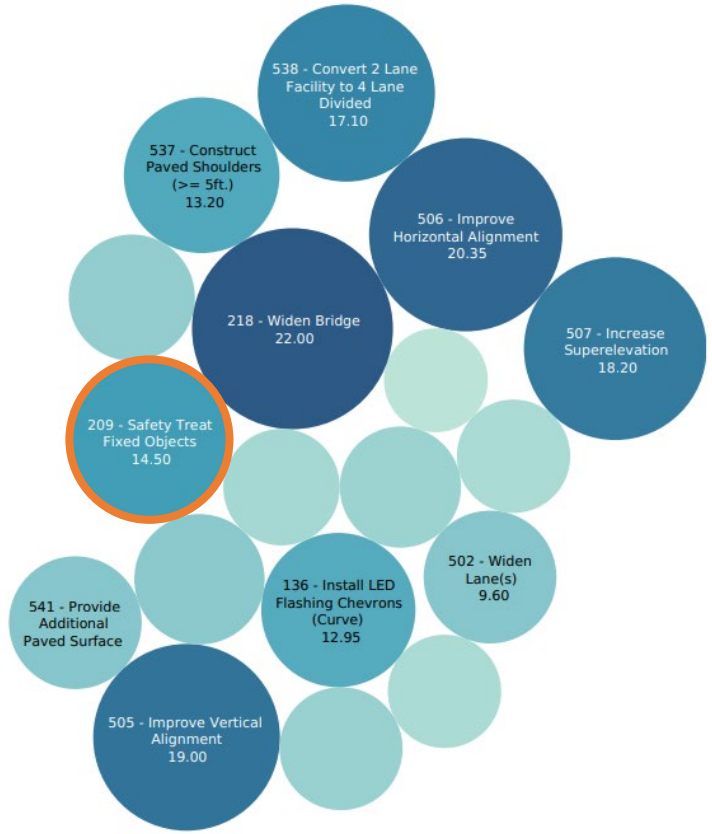
On-System: (All)
Segment Rank: 5
Intersection Rank: (All)
Crashes Reduced: 0 — 7,000
Crashes Reduced: 2.0% — 10.0%
Crash Type: (All)
Harmful Event: (All)
Object Struck: (All)
Contributing Factor: (All)
Countermeasure: (All)

HSIP Countermeasures

Expected Crash Reduction

HSIP Countermeasure Overview

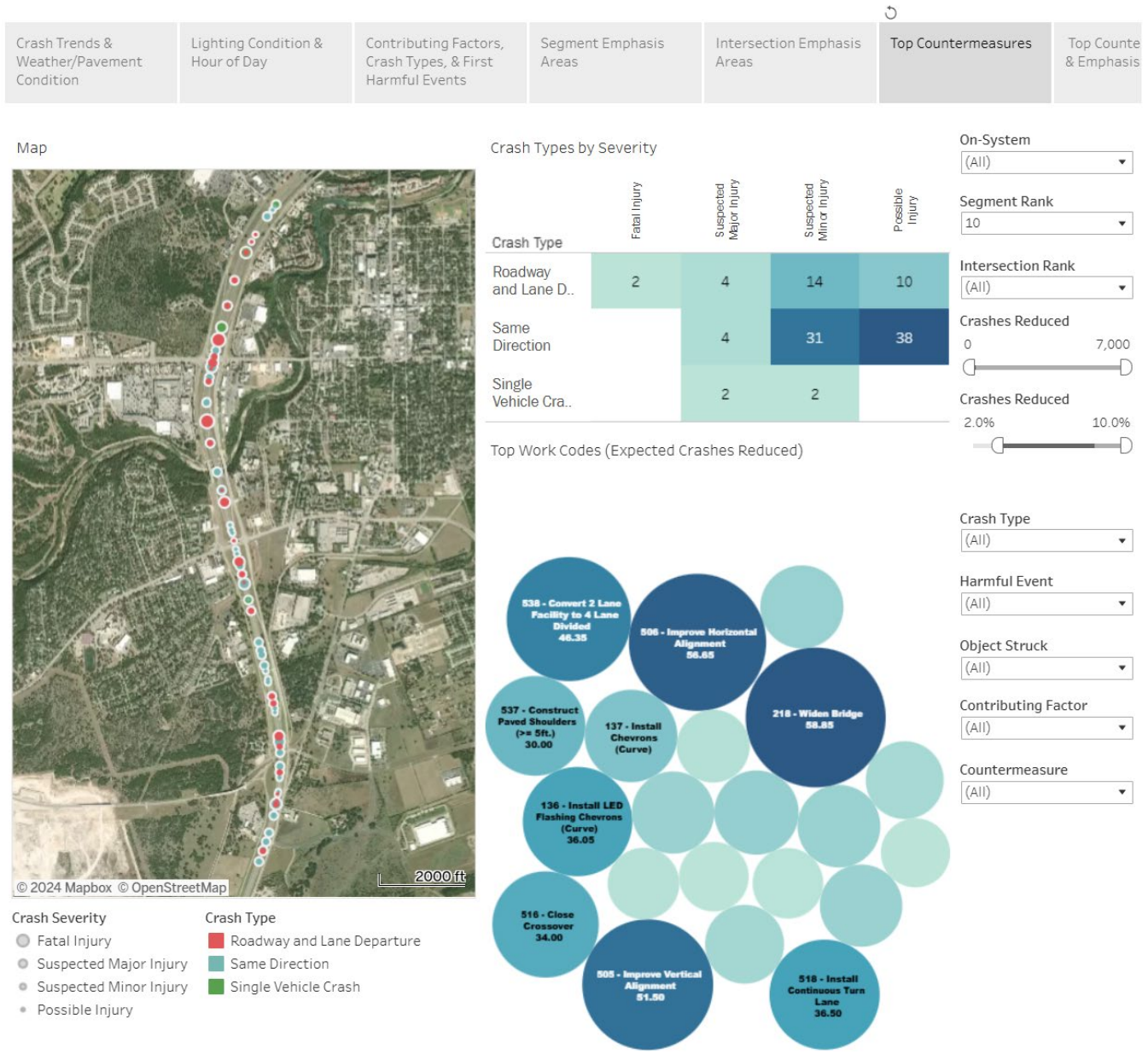
- Crash reduction estimates based on TxDOT-approved formulas
- Each work code linked to specific crash types and conditions
- Used to review High Injury Network segments for treatment options
- Includes 5-year projected crash reductions (e.g., 14.5 for safety treat fixed objects)
- Enables engineers and planners to assess and select appropriate countermeasures
- Aligned with Safe System and Vision Zero principles



209 Safety Treat Fixed Objects			
Definition:	Remove, relocate, or safety treat all fixed objects including the installation of guardrail for safety treatment of a fixed object or drainage structures within the project limits, to include both point and continuous objects.		
Reduction Factor (%):	50%	Maintenance Cost:	$0
Service Life (Years):	20	G-Match:	C
Preventable Crash:	(Roadway Related = 2, 3 or 4) OR (Object Struck = 20-26, 29-36, 40-42, 56-58, 60, 62, or 63)		
Required Documents:	None		

Project Development

Targeted Projects Approach



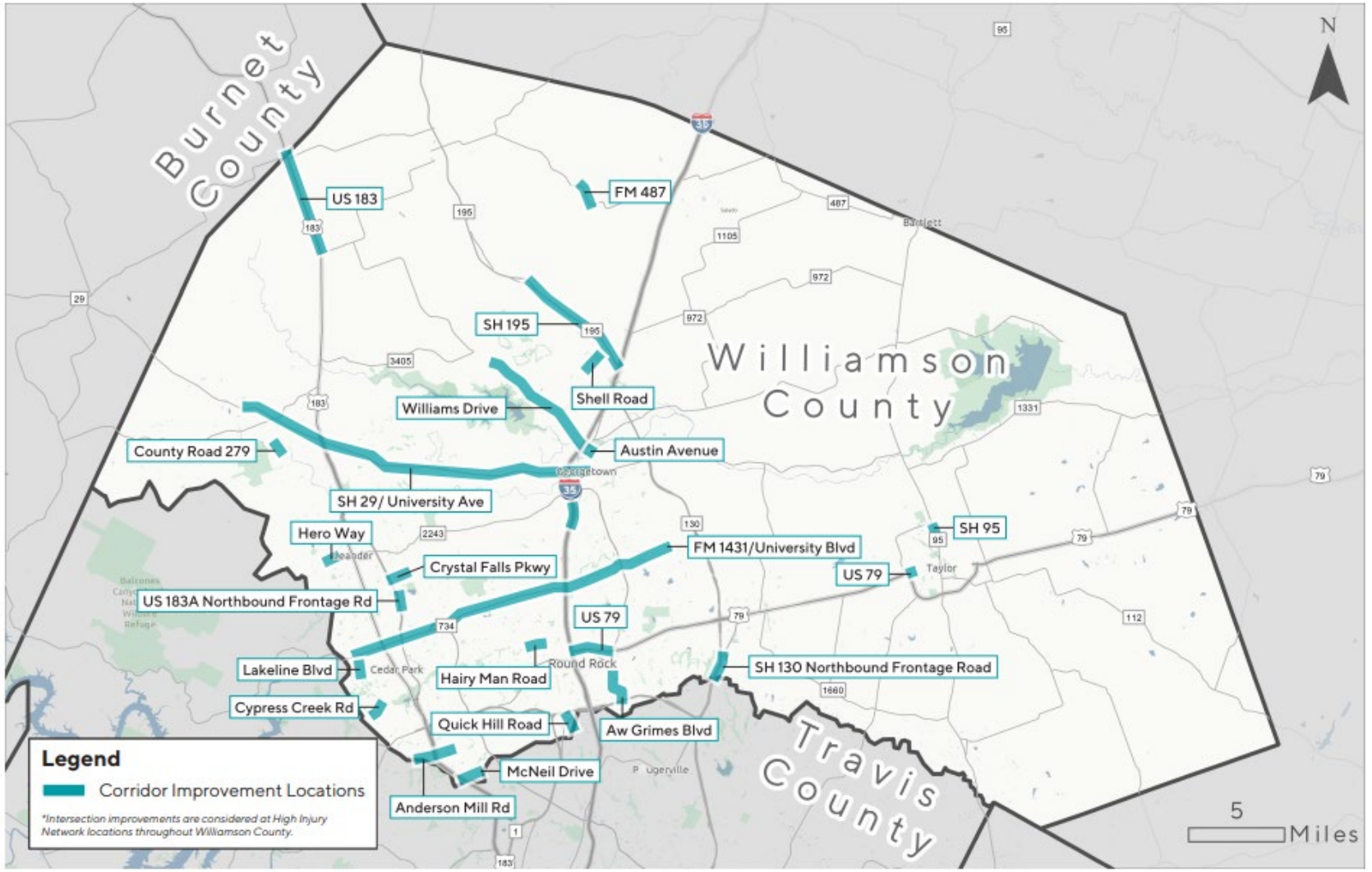
Project Development

Targeted Projects Map

Proposed Safety-Driven Infrastructure Improvements:

23 Corridor Improvements

36 Intersection Improvements



Project Development

Targeted Project Examples

Roadway Name	Limits From	Limits to	Project Description	Ownership	Safety Issues
Shell Road	Shell Spur	SH 195	Add edge line and center line rumble strips. Widen paved shoulder.	Williamson County	Roadway and Lane Departure
Crystal Falls Parkway	US 183A	Ridgmar Road	Close cross-overs where possible and align left-turns for a positive offset where possible. Add roadway lighting	Leander	Angle Crashes
US 79	Carlos G Parker Boulevard	Sloan Street	Add raised median with hooded lefts	Taylor	Angle Crashes
Williams Drive	Jim Hogg Road	Austin Avenue	Add raised median with strategically placed hooded lefts, add raised profile striping, add raised profile markers, safety treat fixed objects, add roadway lighting.	Georgetown	Angle Crashes Roadway and Lane Departure Dark Conditions
SH 195	Ronald Reagan Boulevard	IH 35	Add rumble strips and roadway lighting. Install wrong-way detection system. Replace "signal ahead" warning sign with roadside flashing beacon with "signal ahead" warning sign.	TxDOT	Roadway and Lane Departure Dark Conditions
Cypress Creek Road	Sun Chase Boulevard	Lakeline Boulevard	Add edgeline delineators, evaluate speed limit using USLIMITS2	Cedar Park	Speed Management Roadway and Lane Departure

Summary

Key Takeaways

Why This Matters Beyond CAMPO?

- **Replicable framework** for other MPOs and local agencies developing SS4A action plans
- **Integrates crash data, GIS, and TxDOT HSIP formulas** into one streamlined, visual analysis
- **Improves transparency** in how safety projects are selected and prioritized
- **Supports grant readiness** by aligning analysis with HSIP and SS4A funding criteria
- **Facilitates collaboration** between regional planners, local engineers, and TxDOT

TRB WEBINAR: ADVANCES IN ANALYSIS AND VISUALIZATION FOR SAFE STREETS AND ROADS FOR ALL

VALIDATION AND VISUALIZATION OF NEAR-MISS VIDEO ANALYSIS

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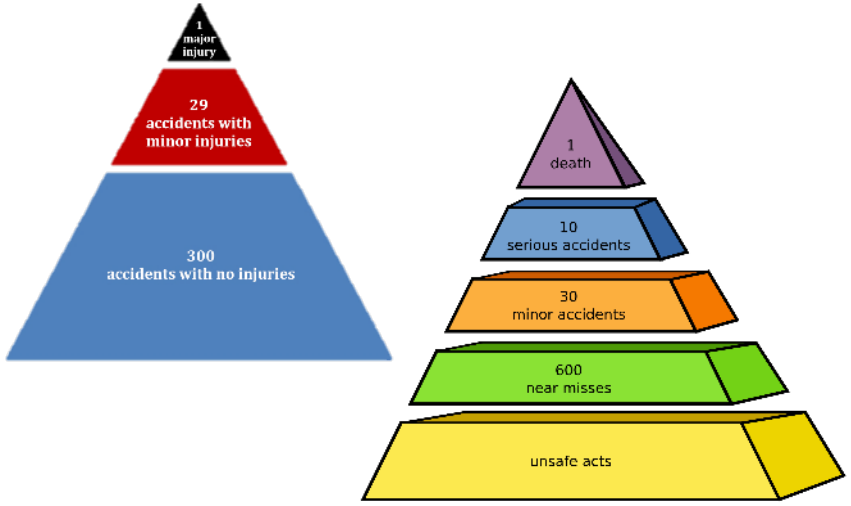
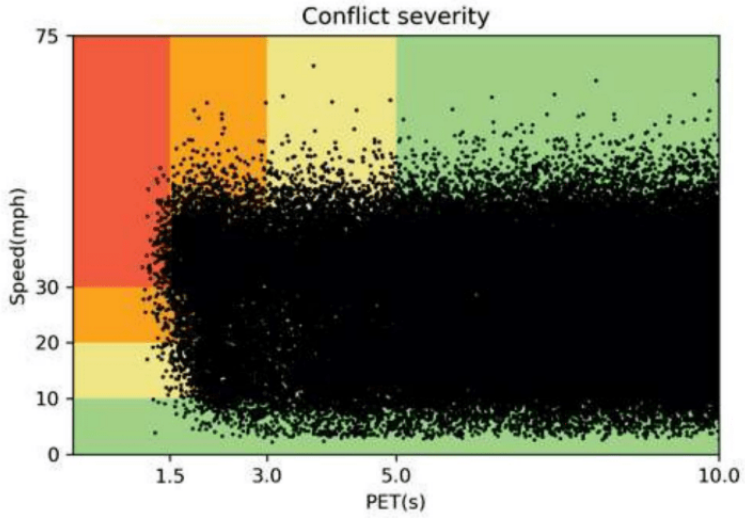
STUDY BACKGROUND

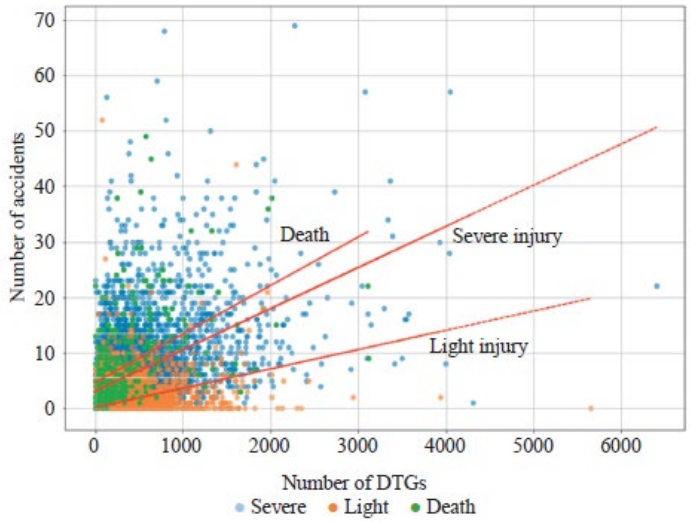
What is Near-Miss Data?



- Herbert Heinrich's triangle, 1931: 300:29:1 Ratio
  Frank Bird's amended triangle, 1966
- Theory of industrial accident prevention



- Bellevue, Washington Near Miss study
  Franz Loewenherz, 2020



- Heinrich's Law for Traffic Incidents, South Korea
  Sunghwan Cho et al., 2023

Concept and refinement (1931, 1966)

Video Analytics Big Data

Link to Severity (2020)

Link to Frequency (2023)

STUDY PURPOSE

How can Near-Miss Data be used?

Diagnosis and Evaluation

- Locations with low volumes but high-severity or high-profile crashes
- Before/After Analysis
- Systemic trends and challenge areas

Perceived Need and Proactive Improvements

- Minimal crash history:
  - Unreported Crashes
  - Perceived safety concerns
  - Low multimodal demand
- Systemic improvements still need some basis for implementation

But…the funding gap!

- Implementation requires funding →
- Funding often includes Benefit/Cost Analysis →
- Competitive applications benefit from severe crashes →
- Vision Zero goals are incompatible with many current funding mechanisms

Text, Level 2

STUDY GOALS

Short Term Goals

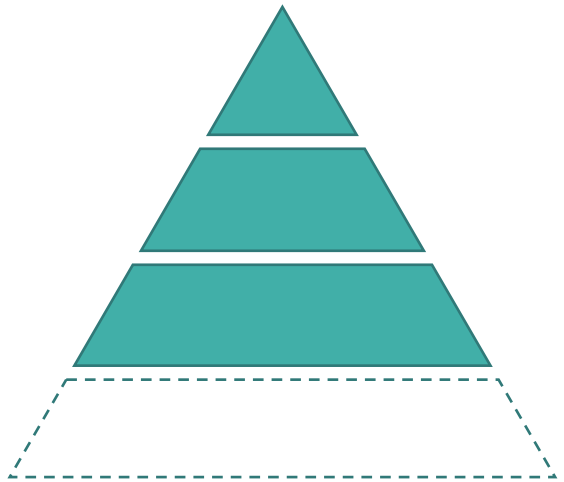
- Identify correlations between near-miss/risky behavior events and crash occurrence/probability
- Identify external effects on near-miss/risky behavior events
- Determine preliminary near-miss/crash factors (NMCF)

Long Term Goals

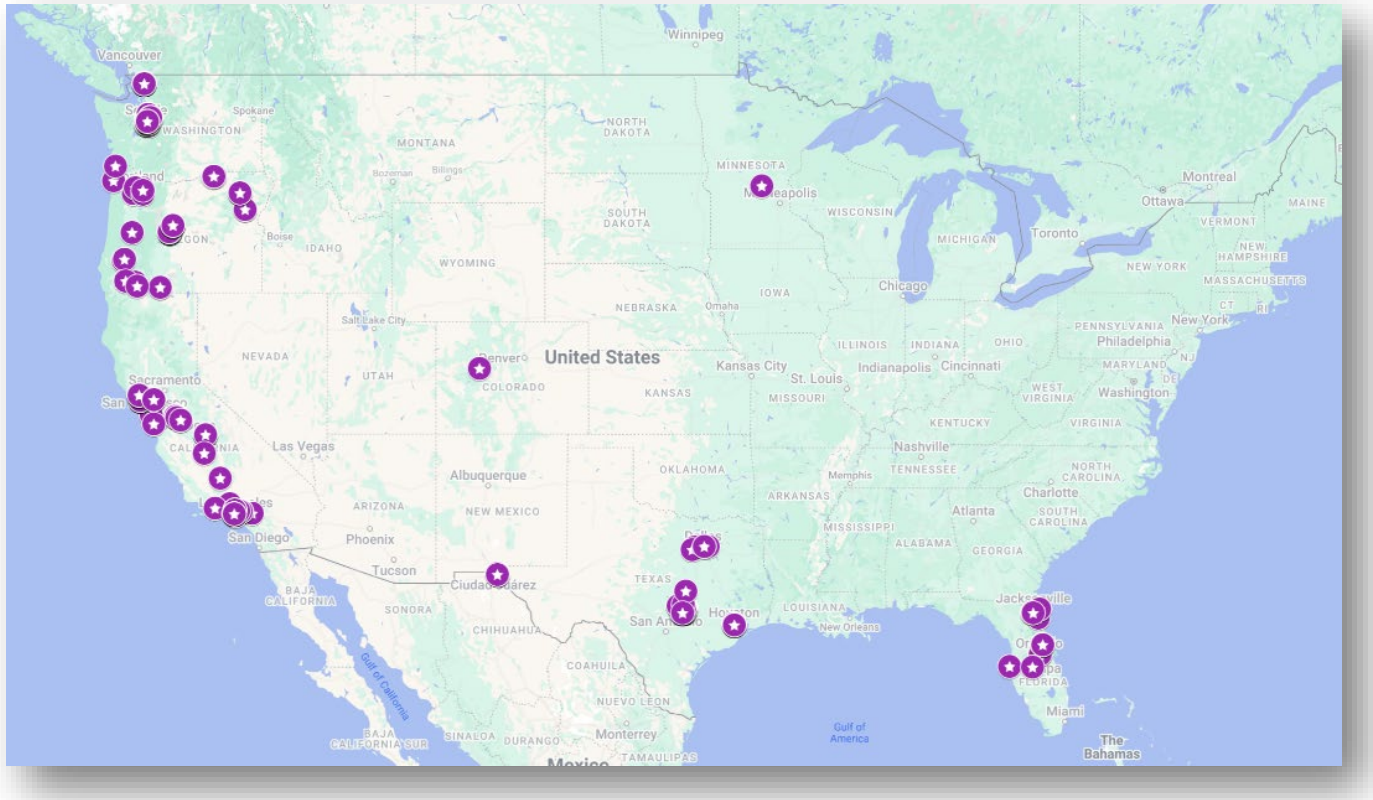
- Reduce time barrier to understanding crash reduction impacts
- Reduce reliance on crash history for safety improvement funding
- Recognize “Near Miss Analysis” as a proven safety countermeasures

Validate the relationship between near-miss events and crashes

(CA crash ratios are extremely consistent)



DATASET



Data Source

- **Street Simplified** – Near-Miss vendor
- Data from 426 studies across five states

Pilot Analysis of Locations in California

- Only signalized intersections
- No “After Improvement” data
- Early studies with different methodology removed

19 locations across 7 jurisdictions

DATASET

Data Source

- TIMS – Publicly available crash data
- Developed by UC Berkely SafeTREC as a tool to process California Highway Patrol crash data
- Includes only injury data (no PDO)

Crash Alignment Fields

Collision Severity

- Primary Collision Factor
- Type of Collision
- Ped/Bike Involved

DATA VISUALIZATIONS

SOURCE: STREET SIMPLIFIED, 2023

DATA VISUALIZATIONS
RISKY BEHAVIORS

Speeding

Red Light Running

Pedestrian Violation

SOURCE: STREET SIMPLIFIED, 2023

SPEEDING EVENTS *CORRELATION*

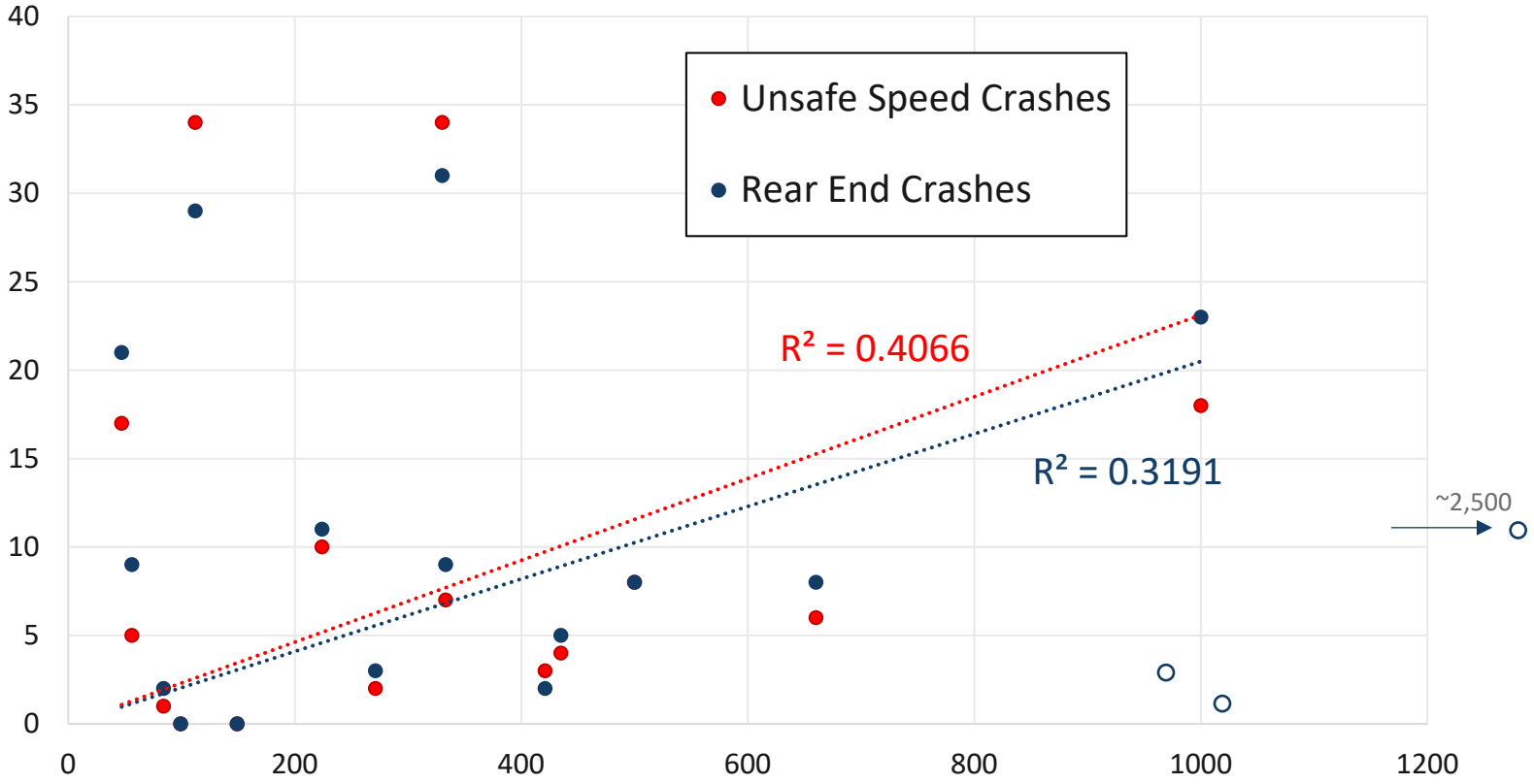
Speeding

SOURCE: STREET SIMPLIFIED, 2023

Potential Refinements:

- "Unsafe Speed" vs the posted speed limit
- Calibrate based on congestion periods

Speeding Events (1 day) vs Crashes (10 yr)

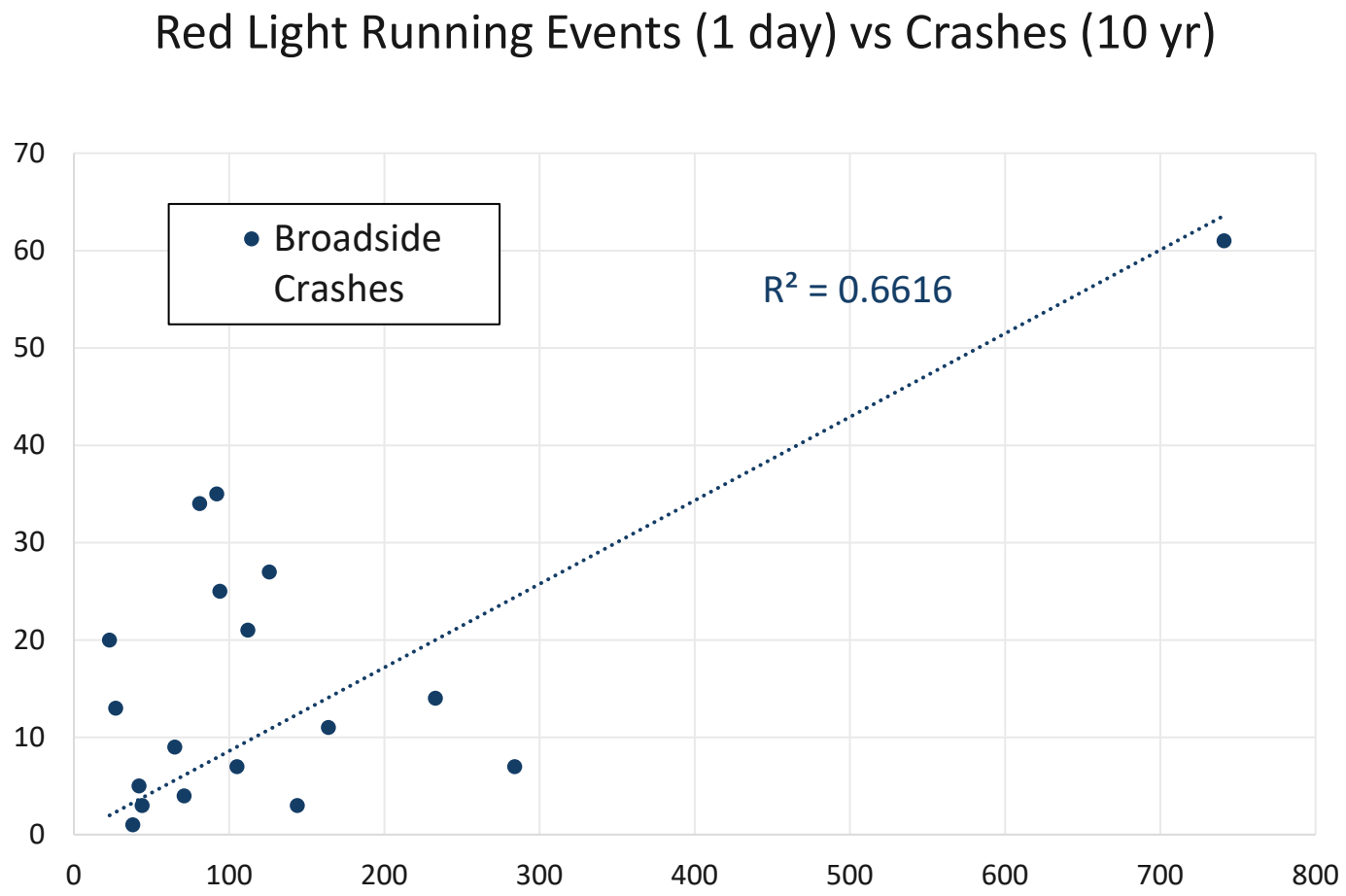


RED LIGHT RUNNING EVENTS *CORRELATION*

Red Light Running

SOURCE: STREET SIMPLIFIED, 2023

- Clear correlation between near miss events and crashes

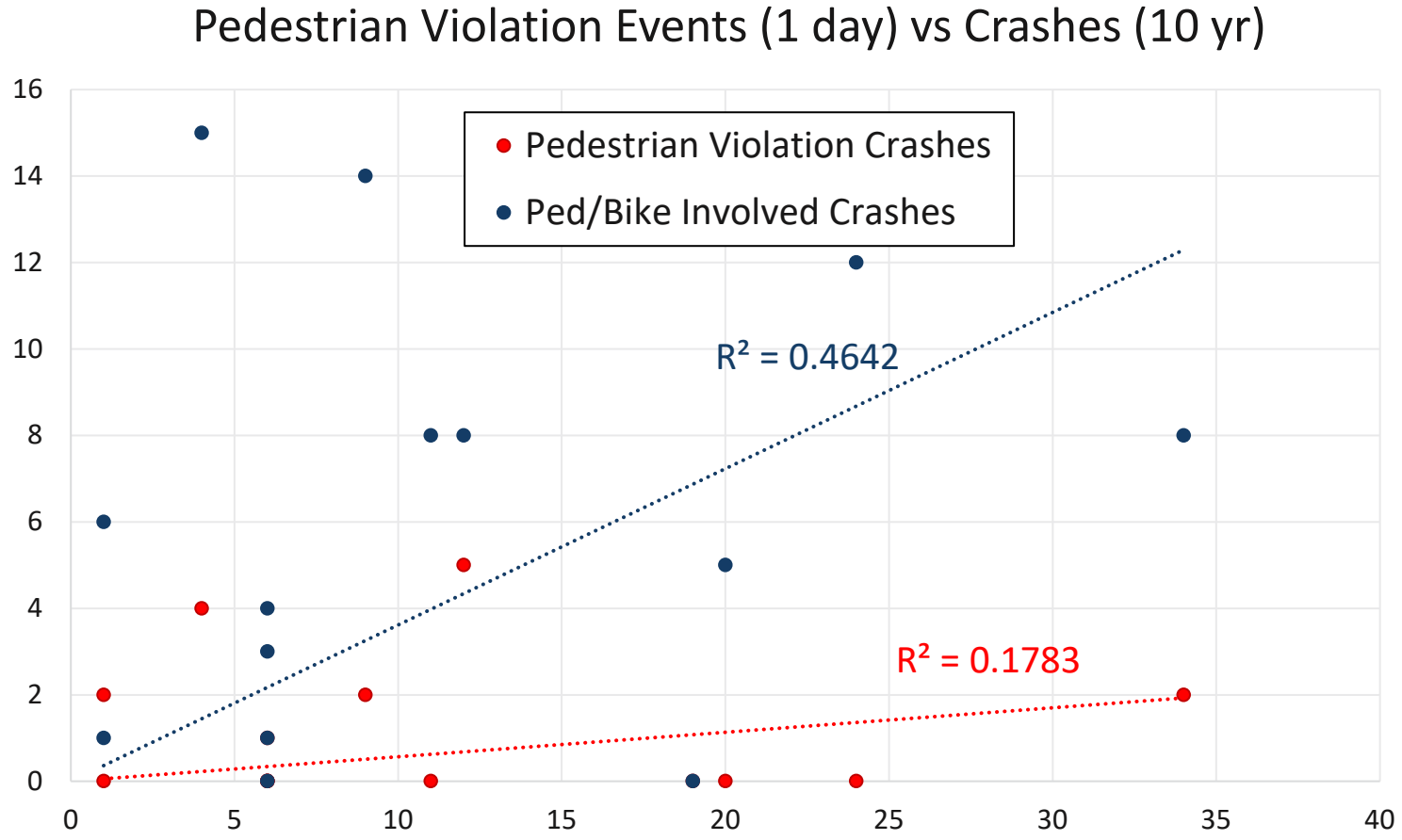


PEDESTRIAN VIOLATION EVENTS *CORRELATION*

Pedestrian Violation

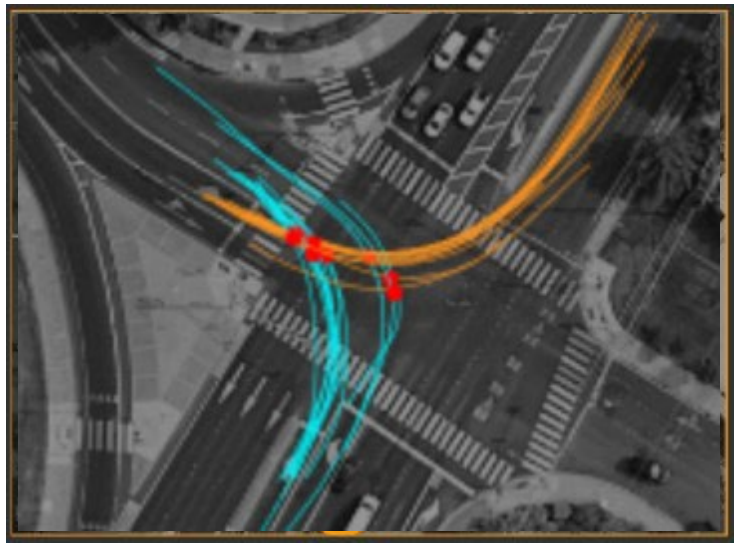
SOURCE: STREET SIMPLIFIED, 2023

- Much better match with total ped/bike crash events
- Further calibration with length of crossing

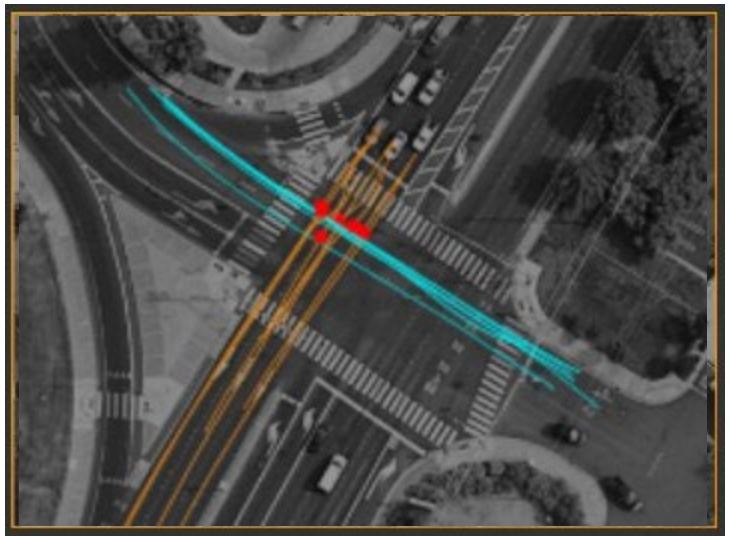


DATA VISUALIZATIONS
NEAR MISS EVENTS

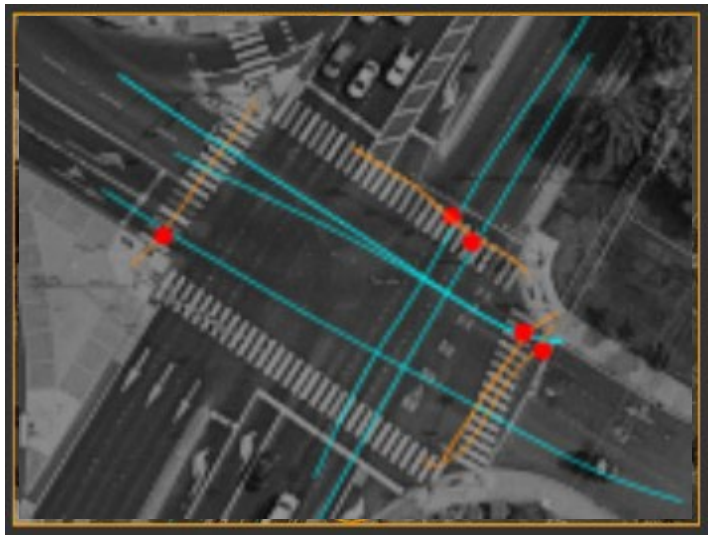
Left-Turn Conflicts



Thru-Thru Conflicts

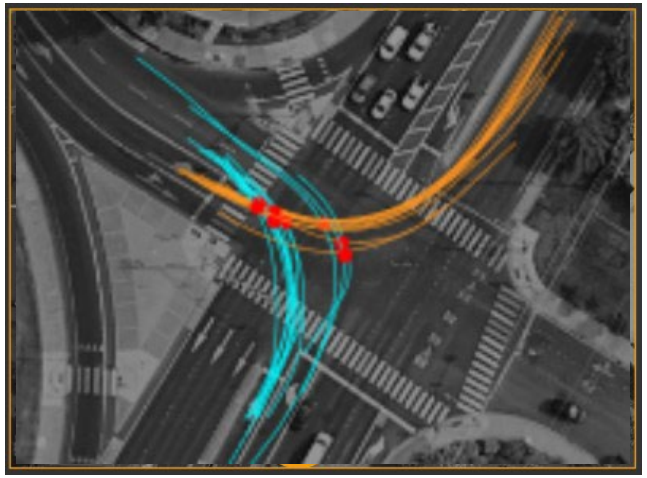


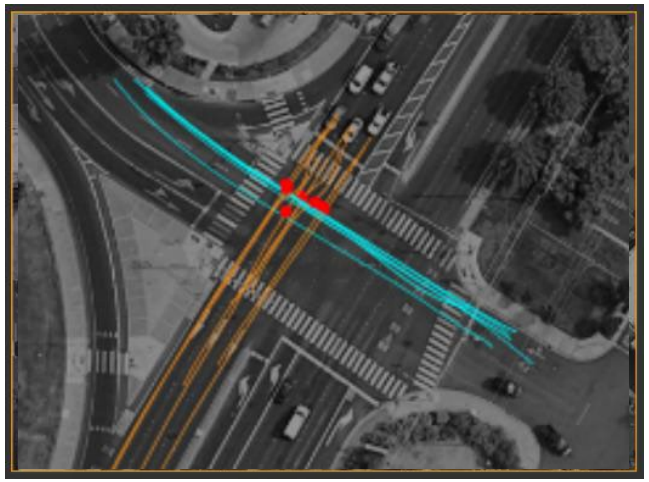
Ped/Bike Conflicts

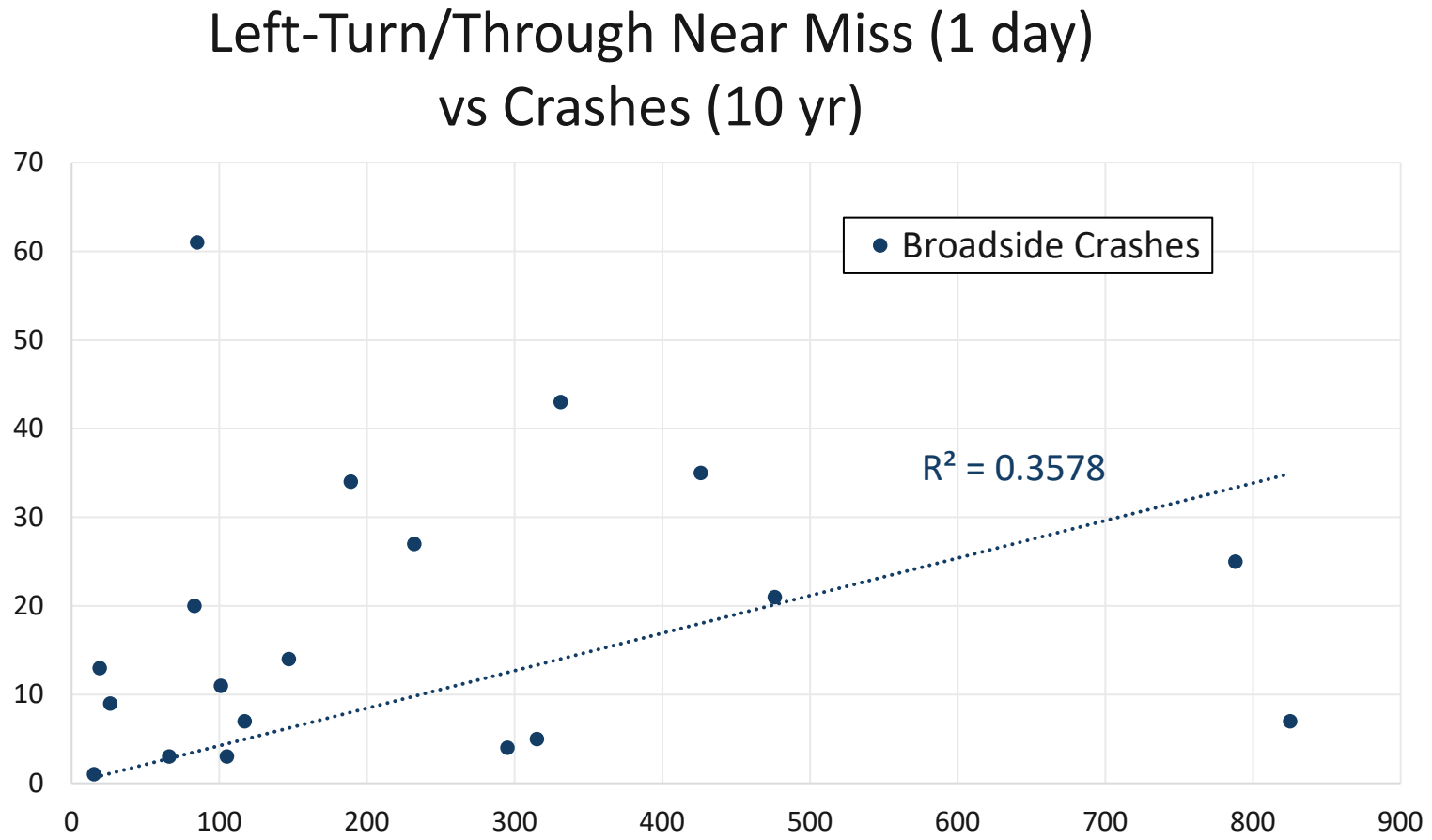


SOURCE: STREET SIMPLIFIED, 2023

LEFT-TURN/THROUGH NEAR MISS *CORRELATION*



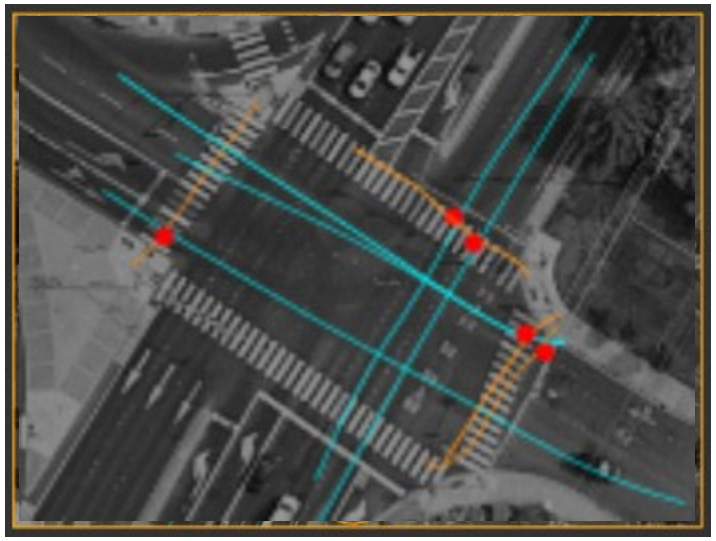




SOURCE: STREET SIMPLIFIED, 2023

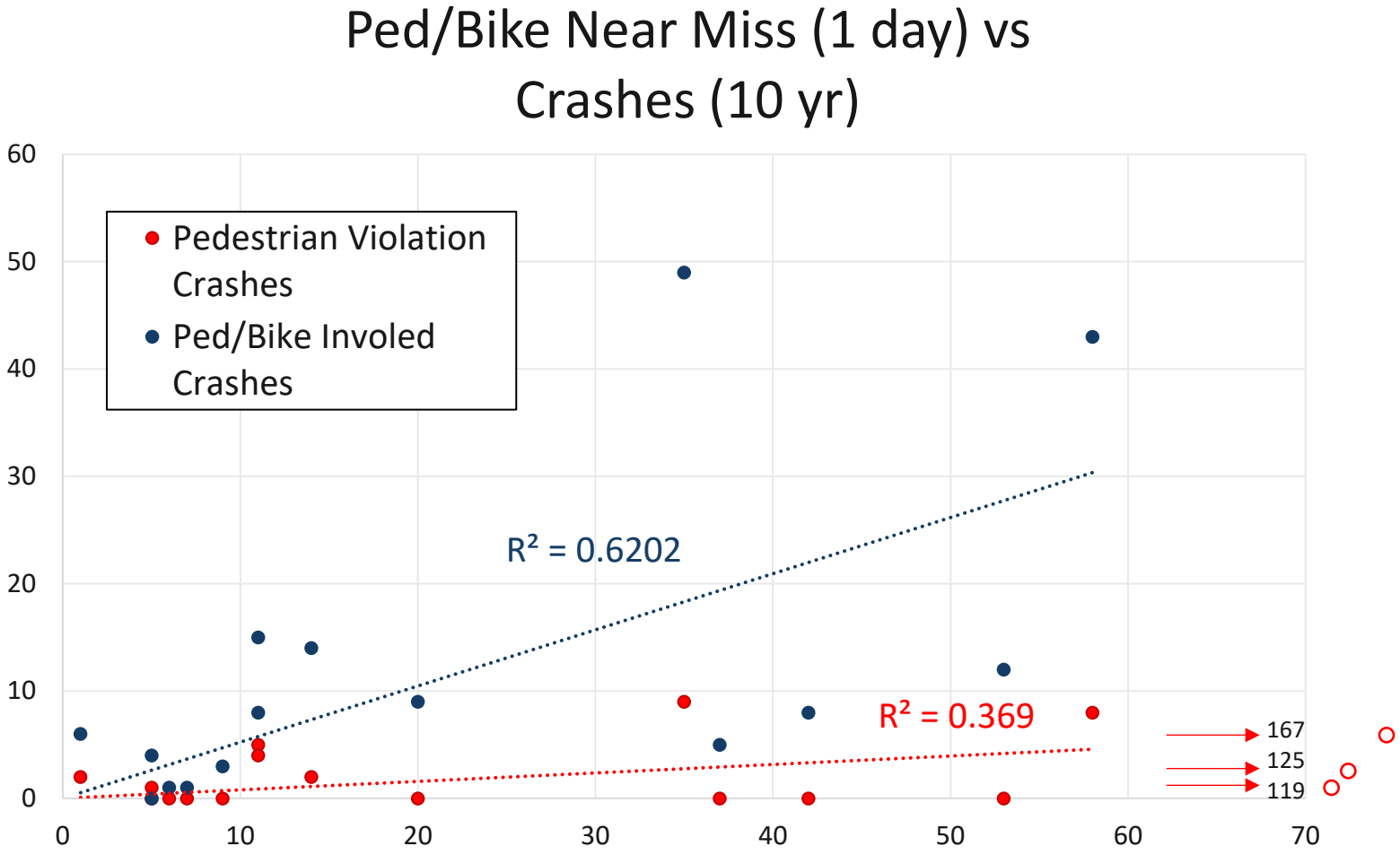
PEDESTRIAN/BICYCLE NEAR MISS *CORRELATION*

Ped/Bike Conflicts



SOURCE: STREET SIMPLIFIED, 2023

- High ratio between events and crashes
- Extreme values warrant further review



SUMMARY AND NEXT STEPS

- Clear correlation between risky behaviors/ near miss events and observed crashes
- Additional calibration may be necessary for built environment
- Some extreme values skew correlation – need further analysis
- Adding PDO data can offer better understanding of severity ratios
- Opportunity in expanding analysis to larger data sets (Texas, Washington, Oregon)

THANK YOU

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Washington, DC

https://trb-annual-meeting.nationalacademies.org/

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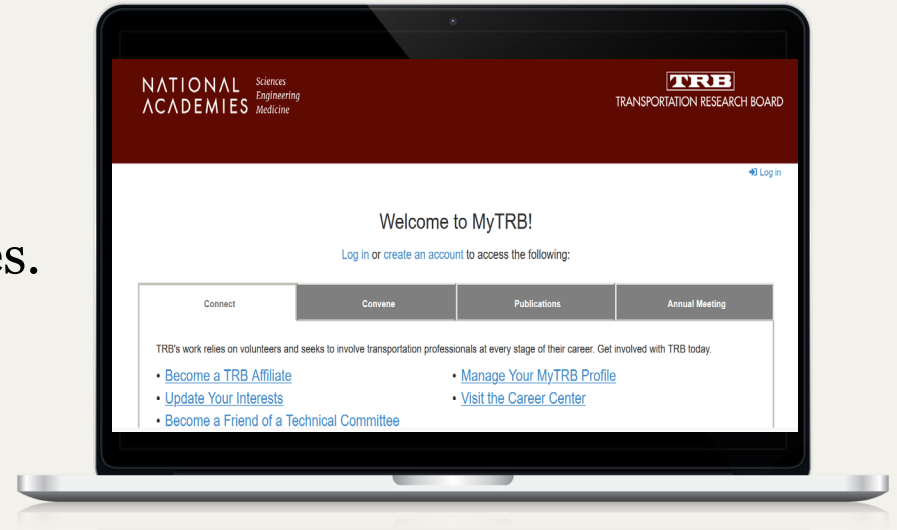

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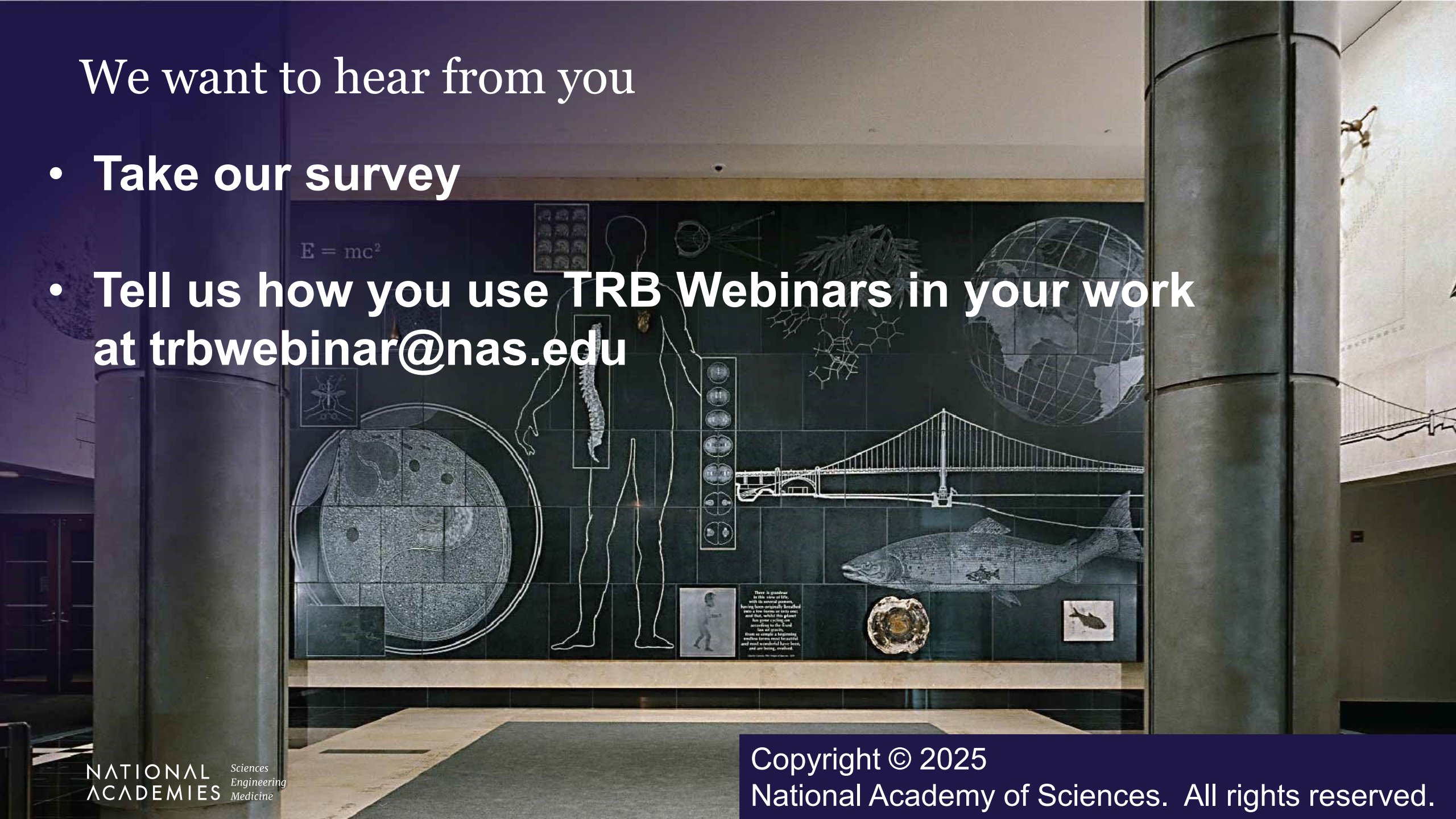

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