METROPOLITAN COUNCIL REGIONAL PEDESTRIAN SAFETY ACTION PLAN

SEPTEMBER 2022

Contents

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EXECUTIVE SUMMARY
INTRODUCTION

PROJECT BACKGROUND

The Metropolitan Council developed a Regional Pedestrian Safety Action Plan to improve safety for people walking and using mobility devices. By using a systemic approach, the Council identified roadway characteristics and locations that have a higher risk for serious pedestrian injuries and deaths regardless if a crash had occurred at those locations in recent years. By focusing improvements at these higher risk locations, the Council and regional partners can promote safety for all pedestrians in the region and work to eliminate pedestrian injuries and fatalities.

VISION

Reduce and ultimately eliminate pedestrian deaths and serious injuries from traffic crashes in the region.

THREE GUIDING PRINCIPLES

1. *Use a safe system approach*
2. *Make roadway and environment changes that encourage and support walking with safe and convenient crossings*
3. *Ensure equity is incorporated into the work*

PEDESTRIAN SAFETY

The study area includes the counties of Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington, and the urbanized portions of Sherburne and Wright counties within the metropolitan planning area boundary. Key findings from the analysis are shown on the following pages and a detailed report with all the findings and recommendations are available in the full Pedestrian Safety Action Plan report.

The following pages provide high level summaries and direction on how to use findings of three major components of this Plan:

- Key Takeaways
- Historic (2016-2019) Crash Analysis
- Systemic Safety Analysis (how to use safety analysis resources)
- Recommendations (countermeasure resources)

EXECUTIVE SUMMARY
KEY TAKEAWAYS

METROPOLITAN COUNCIL

Pedestrian count data is not widely available throughout the region, therefore the project team used proxies to understand where people would be most likely walking. In addition, the systemic safety analysis identified locations where there is a higher risk of a pedestrian crash by isolating relatively higher number of crashes associated with lower roadway network coverage.

PEDESTRIAN CRASH RISK IS CORRELATED WITH

- Travel lanes
- Traffic volumes
- Vehicle speeds

SPEED LIMIT 35

- Greater pedestrian activity (measured indirectly via transit stops, pedestrian destinations, Urban Center communities)

In general, roadways that have the following features are associated with a higher risk of a pedestrian crash*:

In rural areas: Lower Posted Speed Limits and 2-Lane Undivided roadways

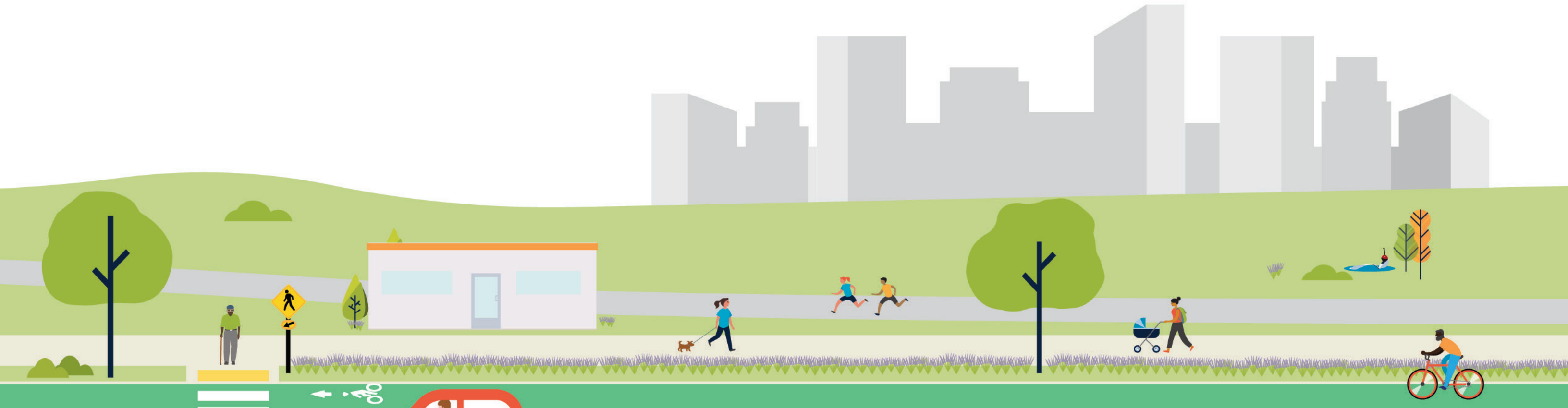
In suburban areas: Moderate Posted Speed Limits, Moderate Traffic Volumes, Transit Present on roadways

In urban areas: Lower Posted Speed Limits, Higher Traffic Volumes, Transit Present on roadways

* The Council's Thrive Community Types can be found in Appendix A: ThriveMSP 2040 Community Designations.

A greater percentage of **crashes in rural and agricultural areas** plus Wright and Sherburne Counties are **severe,** but the overall number is **smaller than urban areas** (28 compared to 357).

Most pedestrian crashes (70%), including most severe pedestrian crashes (57%), happen in **Urban Center communities.**



EXECUTIVE SUMMARY
HISTORIC CRASH ANALYSIS

HISTORIC CRASH ANALYSIS (2016-2019)

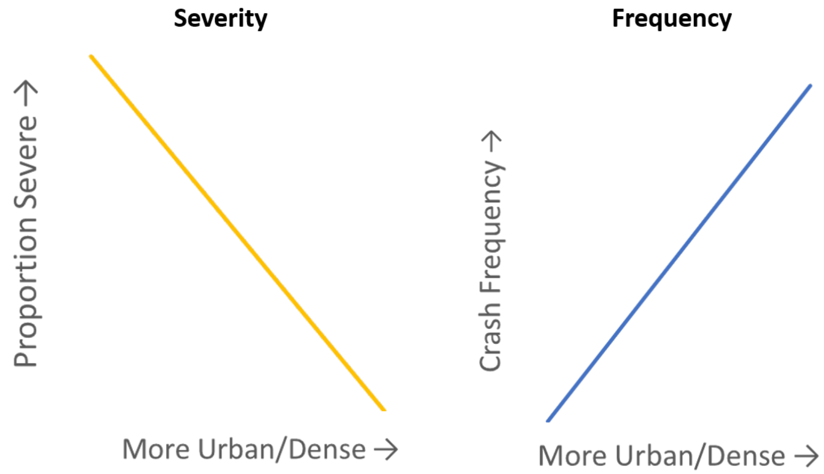
This page and the following provide background on the historic crash analysis. To learn more and review all the results see the Historic Crash Analysis section of the Metropolitan Council Pedestrian Safety Action Plan Final Report. To learn more about next steps, network screening and selecting countermeasures, see the Systemic Safety Analysis and Countermeasures summaries.

CRASH DATA

- 4-Year Period: 2016-2019
- Area: 7-County Metropolitan Region
- 3,261 Total Pedestrian Crashes
- 622 (19%) Severe or Fatal Crashes

GEOGRAPHIC DISTRIBUTION

- Most crashes and most severe crashes occurred in urbanized areas (2,287 total).
- A higher proportion of pedestrian crashes occurring in rural areas resulted in death or serious injury (47.8 percent) versus 18.5 percent in urban areas.



Representative trendline of crash severity and frequency

KEY TAKEAWAYS

- More crashes occur in urban areas, but a greater percentage are severe in rural areas.
- Nearly 80 percent of severe intersection crashes were within 500 feet of a transit stop.
- Nearly one third of crashes occurred on A Minor Reliever arterials and A Minor Augmentor arterials (991 crashes of which 44 were severe).
- Over 40 percent of crashes occurred at intersections with a signal (1,413 crashes).
- There is no discernible pattern of youth crashes happening near schools that is disproportionate in frequency or severity.
- Black and Native people are disproportionately killed while walking. Areas with higher concentrations of white populations and higher income indicators are associated with fewer crashes
- Pedestrian count data is not widely available throughout the region. Regular collection needs to be prioritized.

EXECUTIVE SUMMARY
HISTORIC CRASH ANALYSIS

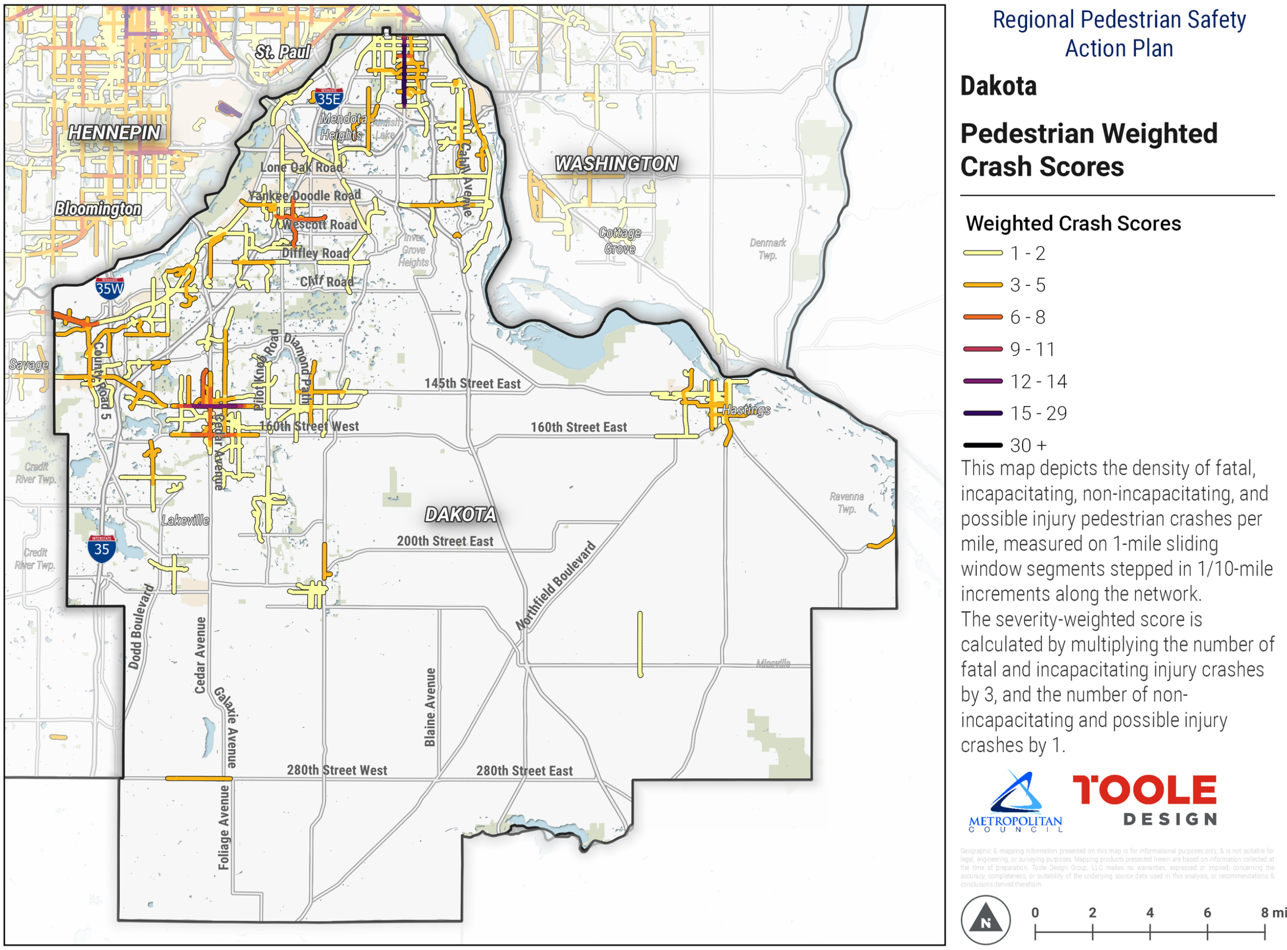
CORRIDOR PEDESTRIAN CRASHES (SLIDING WINDOW ANALYSIS)

A sliding windows analysis helps us understand crashes along a corridor and identify roadway segments with the highest crash density. This analysis was done by determining the number and severity of crashes along a one-mile “window” on a roadway and shifting that window along the roadway 1/10 mile at a time to examine each segment. Two sets of maps were developed based on this analysis to identify the following information:

» **Pedestrian Fatalities and Incapacitating Injuries:** These maps depict the density of fatal, incapacitating, non-incapacitating, and possible injury pedestrian crashes per mile.

» **Pedestrian Weighted Crash Scores:** These maps depict the density of fatal, incapacitating, non-incapacitating, and possible injury pedestrian crashes per mile and weigh the crashes by severity. Crashes were weighted by severity by multiplying the number of fatal and incapacitating injury crashes by three and non-incapacitating injury crashes by one (non-injury crashes are not reflected). Each segment is scored and the result visualizes the areas with the highest density of crashes for pedestrians.

Both sets of maps are available in the Appendix C of the Final Report and the Pedestrian Weighting Crash Score results are shown on the webmap. Below is an example of Dakota County data.



Example County Map: All county maps available in Appendix C.

EXECUTIVE SUMMARY
SYSTEMIC SAFETY ANALYSIS

WHAT IS A SYSTEMIC PEDESTRIAN SAFETY ANALYSIS?

A systemic pedestrian safety analysis is a proactive approach to evaluating a roadway network for pedestrian safety improvements. While more traditional safety analyses may only focus on specific sites with a high historic crash frequency (i.e. hot spots), a systemic pedestrian safety analysis focuses on sites throughout the roadway system with higher risk roadway features. By identifying and implementing countermeasures, all higher risk locations and jurisdictions can reduce or eliminate unsafe conditions before a serious pedestrian injury or death occurs.

It is important to note that this analysis identified areas of higher risk based on specific roadway features (outlined in the Crash Tree Diagram section). If a roadway is not identified as higher risk, it does not mean there is the absence of pedestrian crash risk.

NETWORK SCREEN

Results from the systemic safety analysis can assist professionals in screening their local network to identify higher risk roadway segments and intersections. These roadways can then be addressed with countermeasures to work toward eliminating serious and fatal pedestrian crashes. See the Recommendations Chapter in the Final Report on the types of countermeasures to implement once higher risk roadway and intersection locations are identified in your community. The results of the network screen are conveyed in the Crash Tree Diagrams and Webmap.

Crash Tree Diagrams

A crash tree diagram stratifies crash data into continually sub-divided categories by aggregating the crash data by stacked roadway, environmental, and behavioral variables. Crashes were aggregated by overall crash frequency, fatal and serious injury crashes, and crashes per mile or intersection for each stacked variable. Using this approach, safety analysts were able to estimate likely risk factors and identify higher risk locations for specific crash types. By doing this, crash trees illustrate the most potentially problematic location factors for pedestrian crashes, regardless if a pedestrian crash occurred in recent history. The crash trees developed for this analysis identify higher risk attributes by isolating relatively higher number of crashes associated with lower roadway network coverage. The crash trees included roadway segments and intersections organized by crash type and Thrive Community type and based on roadway features (see Table below). The crash tree diagrams are available in the Systemic Safety Analysis Chapter in the Final Report.

Pedestrian Crash Types	Thrive Community Type (simplified)
Intersection – Motor vehicle turning	Rural
Intersection – Motor vehicle going straight	Suburban
Midblock (segment)	Urban

Roadway Features (Intersection)	Roadway Features (Midblock)
Roadway configuration	Roadway Type
Speed limit	Number of lanes
Traffic volumes (AADT)	Speed limit
Intersection traffic control device	Traffic volumes (AADT)
Transit stop nearby	Transit stop nearby

Crash Tree Inputs

EXECUTIVE SUMMARY
SYSTEMIC SAFETY ANALYSIS

Webmap

The intent of the webmap is to visually display the results of the network screen and be used by the Council, municipal and county staff to look at roadways in their communities. The webmap components include:

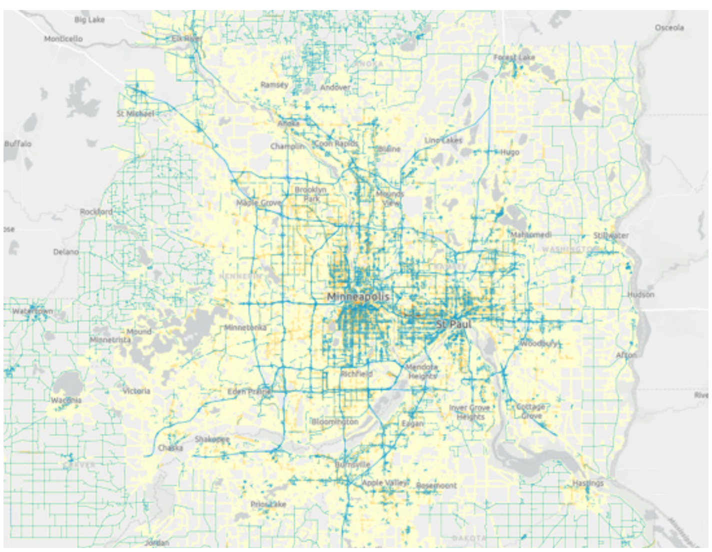
» **Sliding window analysis results** - density of weighted pedestrian crashes based on historical pedestrian crashes on a per-mile basis

» **Higher risk network** – roadway segments and intersections that have been identified as higher risk

» **Thrive community type** – rural, suburban, or urban

» **Environmental justice data** - % of People of Color (POC) and % of low-income households

Users can click on a roadway line segment or intersection point to view the roadway features that make the road segment or intersection higher risk.



Webmap displaying sliding window analysis results

EXCEL DASHBOARD

A related resource that will help practitioners track progress toward eliminating pedestrian deaths and serious injuries is the excel dashboard. The dashboard is intended to provide planning level stats for individual counties and at the regional level. This information can be used to convey safety needs and track progress. The dashboard includes:

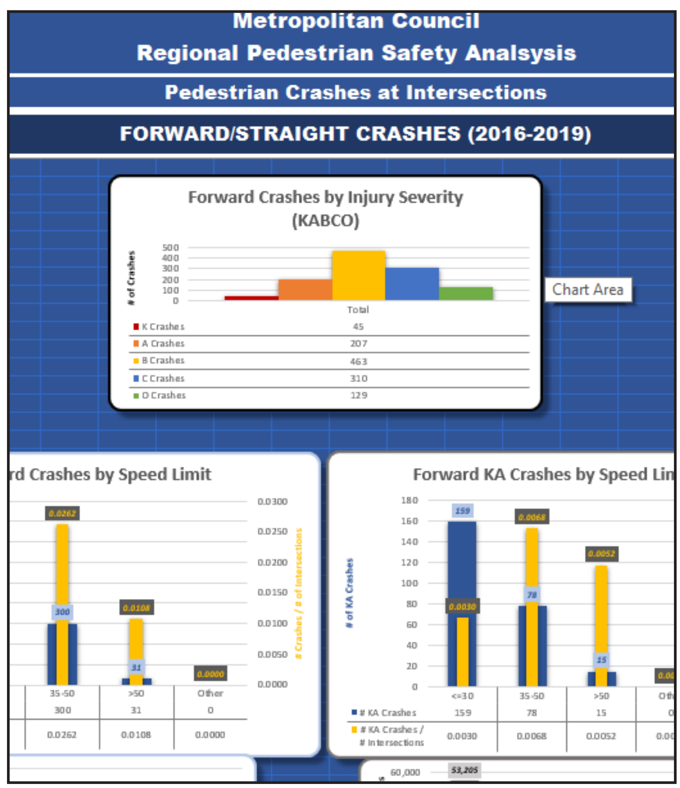
A slicer tool to filter by:

» County

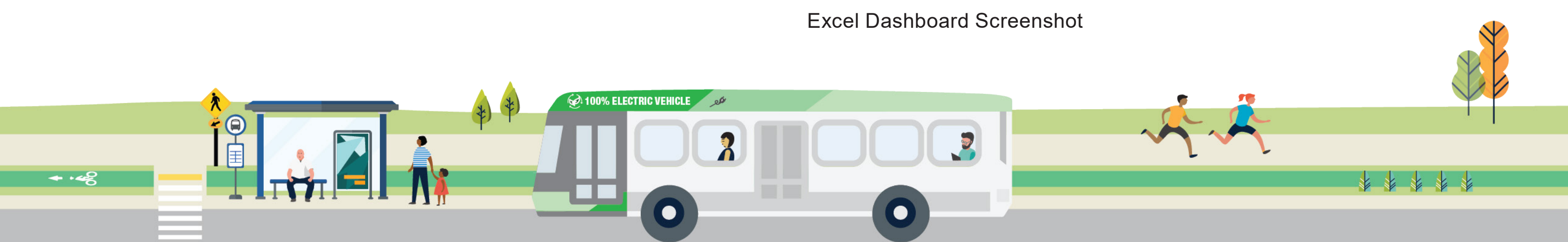
» Low-income areas

» High % of POC areas

Charts will dynamically change and display roadway feature information by crash type. For example a user can filter by county and display a bar chart split by the number of lanes and showing number and percent of all pedestrian crashes and severe pedestrian crashes.



Excel Dashboard Screenshot



EXECUTIVE SUMMARY

RECOMMENDATIONS

Recommendations to address pedestrian safety include both infrastructure countermeasures and programmatic recommendations.

COUNTERMEASURES

Countermeasures are infrastructure changes to the roadway that can help reduce or eliminate serious and fatal pedestrian crashes. Resources on best practices and examples of countermeasures to implement in the region include the following (see Table 3 of the final report for the resource descriptions):

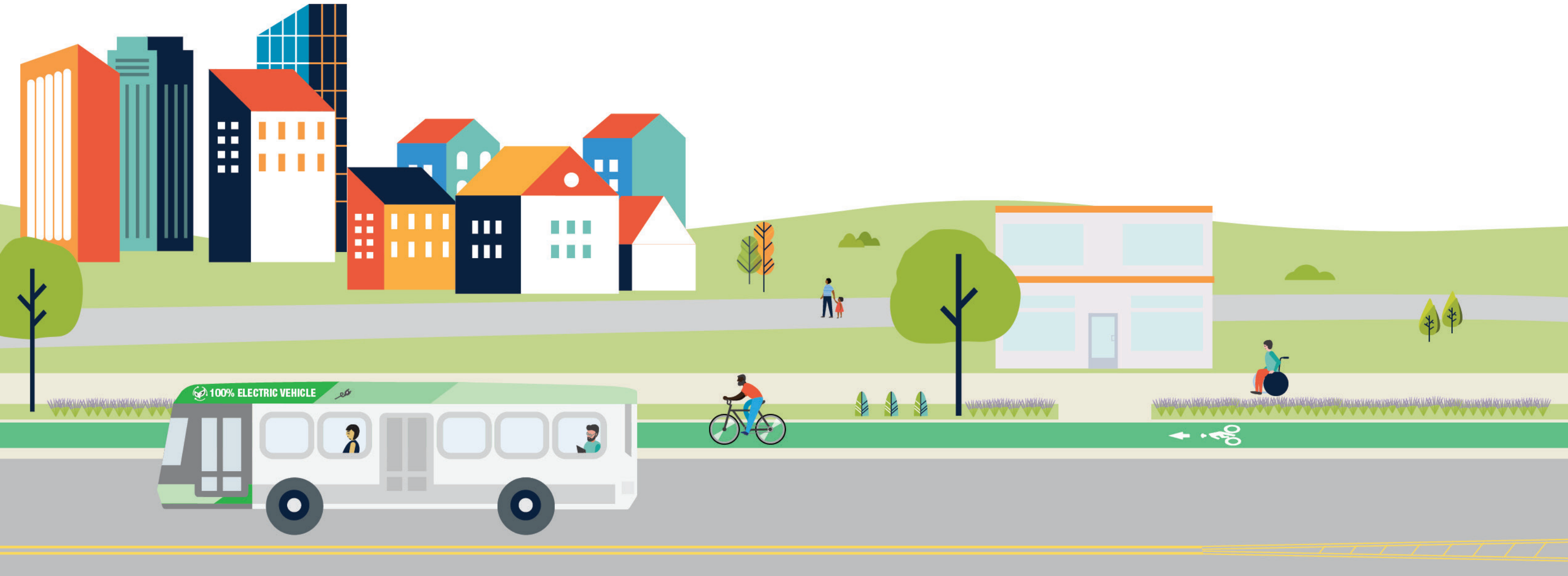
- MnDOT: Best Practices for Pedestrian and Bicycle Safety
- MnDOT: Design and Engineering - Pedestrians Webpage
- MnDOT: Facility Design Guide - Chapter 8 Non-Motorized Facilities
- MnDOT: Traffic Engineering Manual - Chapter 13 Non-Motorized Facilities
- MnDOT: Pedestrian Safety Analysis Final Report
- FHWA Proven Countermeasures
- FHWA: Proven Countermeasures - Filter Tools
- FHWA STEP Studio

Below and on the following page are recent examples of countermeasures applied within the region to address pedestrian safety.

66th Street in Richfield (Hennepin County)

Description: Along 66th Street between Nicollet and Richfield Parkway roundabouts and Rectangular Rapid Flashing Beacons (RRFBs) were constructed. As a result, pedestrian fatality and crashes were reduced. Prior to installation, there were three pedestrian crashes along the corridor. Three years after construction there were zero pedestrian crashes.

66th Street and Nicollet Avenue; Source: Google Maps

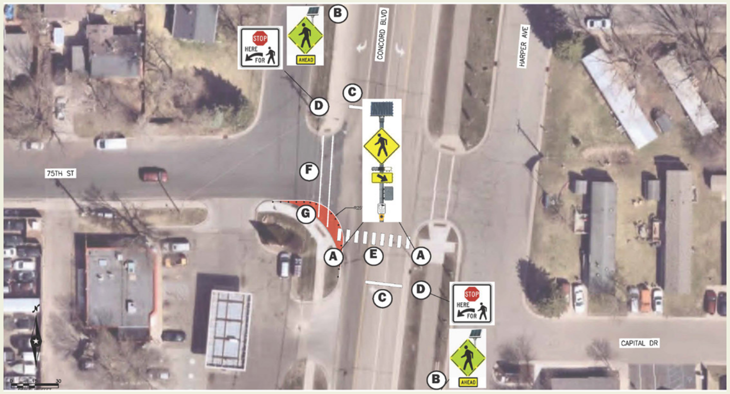


EXECUTIVE SUMMARY

RECOMMENDATIONS

Concord Boulevard and 75th Street (Dakota County)

Description: Multiple temporary improvements were added to the crossing of Concord Boulevard at 75th Street in Inver Grove Heights. Concord Boulevard is a higher speed roadway with multiple lanes and a history of safety issues for pedestrians. Temporary installations included Rectangular Rapid Flashing Beacons, advanced pedestrian crossing signage (LEDs), advanced stop bar and signage, and a tightened curb radius for SW intersection corner.



Countermeasures map; Source Concord Boulevard and 75th Street Infosheet: https://www.co.dakota.mn.us/Transportation/TransportationStudies/Current/Documents/PedestrianCrossingConcordInfoSheet.pdf

PROGRAMMATIC

Programmatic recommendations include ways for the Council in collaboration with local agencies to promote and encourage pedestrian safety efforts through the Council programs. Programs are categorized in high, medium, and low priority. Descriptions of each can be found in the Recommendations Chapter.

High Priority

- Regional Solicitation Changes
- Integrate the Regional Pedestrian Safety Action Plan into other Metropolitan Council Programs
  - Shared Pedestrian Safety Regional Vision
  - Complete Streets Policy
- Relationship between Transit and Pedestrian Safety
- Additional Modes Research

Medium Priority

- Trainings and Workshops
- Integrate Safe System Approach into Policy and Support Local Partners

Low Priority

- Crash Analysis Assistance

INTRODUCTION

As the Metropolitan Planning Organization (MPO) for the Twin Cities area, the Metropolitan Council (Council) is in a unique position to promote pedestrian safety through its position leading regional visioning and planning processes, monitoring reviewing comprehensive plans, long-range planning goals funding projects and ability to providing technical assistance to communities in the region. The Council developed this Pedestrian Safety Action Plan to ground existing pedestrian safety initiatives in a data- and evidence-driven systemic process.

This Plan's vision is to help reduce and ultimately eliminate pedestrian deaths and serious injuries from traffic crashes in the region.

Three guiding principles framed this work:

1. Use a safe system approach
2. Make roadway and environment changes that encourage and support walking with safe and convenient crossings
3. Ensure equity is incorporated into the work

The project consultant, Toole Design, analyzed pedestrian-involved crashes to uncover factors contributing to pedestrian deaths and serious injuries on roadways within the region. This report provides a summary of the historic (2016-2019) and predictive crash analyses. This was a data-based approach that the project team used to identify risk factors throughout the region's road network that may contribute to pedestrian fatalities and serious injuries, including some that may be addressed through systemic application of pedestrian safety engineering countermeasures.

The following sections of this report describe the analysis methodology, key findings, and associated recommendations in greater detail. An executive summary with infosheets provides high-level takeaways of the project outcomes, findings, and recommendations for technical and non-technical audiences. These outcomes will aid the Council in pursuing appropriate and effective agency actions to help achieve its goal of zero deaths or serious injuries on roads within the region.

Summary of Recommendations

- The historic crash and crash tree analyses results identified:
  - General crash trends and key takeaways, and
  - Roadway segments and intersections with a higher risk of pedestrian crashes.
- Changes to the regional solicitation process were made based on key takeaways to prioritize funding projects that address pedestrian safety.
- Infrastructure countermeasures can be implemented at higher risk roadway segments and intersections to work toward a goal of zero pedestrian deaths.
- Programmatic recommendations include aligning the region to have one shared vision for pedestrian safety, educating agency staff and the general public, and identifying additional research and analyses that would help the region improve roadway safety.

The Safe System Approach

One of the three guiding principles for the Pedestrian Safety Action Plan is following the Safe System approach. This approach has a goal to eliminate all fatal and serious injuries for all roadway users. A key component to the Safe System approach, that differs from traditional road safety practices is the understanding that humans make mistakes, but that those mistakes should not result in death or serious injuries. The traditional approach would be to alter human behavior rather than alter the transportation system design.

Safe System Principles

The Safe System approach contains six principles (Figure 1). The first principle is death/serious injury is unacceptable, meaning while crashes may happen, crashes should not result in death or serious injuries. The second principle is humans make mistakes. We can design systems so that when mistakes are made, they are not fatal or cause serious injuries. The third principle is humans are vulnerable; designs should take into consideration human vulnerabilities. The fourth principle is responsibility is shared. All designers within the transportation network need to be involved and design systems that will not result in fatality or serious injury. The fifth principle is safety is proactive; aiming to design or redesign systems before a crash occurs. The last principle is redundancy is crucial. Strengthening all parts of the transportation system helps ensure that if one part of the system fails another part can still prevent a serious or fatal injury.

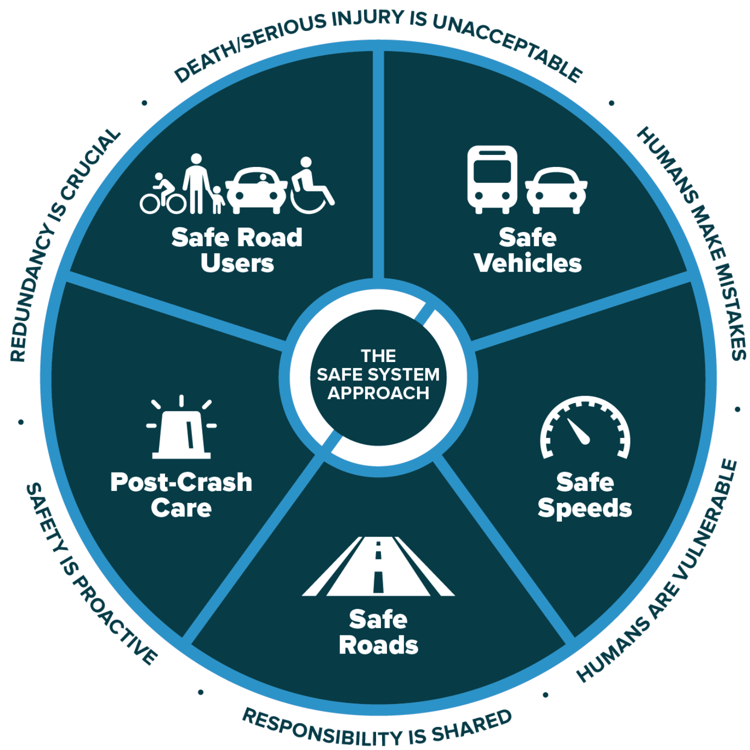


Figure 1: Safe System approach principles and elements, Source: https://safety.fhwa.dot.gov/zerodeaths/zero_deaths_vision.cfm

Safe System Elements

Crash risks are addressed through the following five elements of the Safe System approach:

- **Safe road users:** addressing the safety of all roadway users.
- **Safe vehicles:** designing and regulating vehicles to minimize severity of a crash.
- **Safe speeds:** reducing speeds which leads to reduced impact forces, increased time for drivers to stop, and improved visibility (Figure 2).
- **Safe roads:** designing roadways to accommodate human mistakes.
- **Post-crash care:** providing reliable and fast emergency care when a collision occurs[1].

Figure 2: Impact Speed and a Pedestrian's Risk of Severe Injury or Death, Source: ***https://aaafoundation.org/impact-speed-pedestrians-risk-severe-injury-death/***

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[1] FHWA, Zero Deaths – Saving Lives through a Safety Culture and a Safe System. https://safety.fhwa.dot.gov/zerodeaths/zero_deaths_vision.cfm

STAKEHOLDER ENGAGEMENT

Technical Advisory Group (TAG)

A Project Management Team (PMT) consisting of representatives of the Council, MnDOT and local agencies, was formed to help provide overall project direction on all tasks, review draft deliverables, and ensure stakeholder engagement. All PMT members were also part of the TAG consisting of staff from the Council, MnDOT, counties, cities and other agencies that met six times during the project. TAG members provided insights and advice on analysis methodologies, analysis results, countermeasures, programmatic recommendations, and recommended process updates. Below is a list of the TAG members (Table 1) and timeline of TAG meetings (Figure 3).

Table 1: Technical Advisory Group members

Name	Organization
Ashley Asmus*	Metropolitan Council
Mackenzie Turner-Bargen*	MnDOT Metro District
Mike Samuelson	MnDOT Metro District
Derek Leuer*	MnDOT
Eric DeVoe*	MnDOT
Sonja Piper*	MnDOT
Jake Rueter	MnDOT
Jane Rose	Anoka County
Angie Stenson	Carver County
Gina Mitteco	Dakota County
Jordan Kocak	Hennepin County
Brad Estochen*	Ramsey County
Craig Jenson	Scott County
Joe Gustafson	Washington County
Sara Buermann	Wright County
Ethan Fawley	Minneapolis
Reuben Collins	Saint Paul
Jack Broz	Richfield
Steve Mahowald	Metro Transit
Ellen Pillsbury	MDH
Emily Smoak	MDH
David Fenley	Minnesota Council on Disability
Will Stein	FHWA

**PMT members*

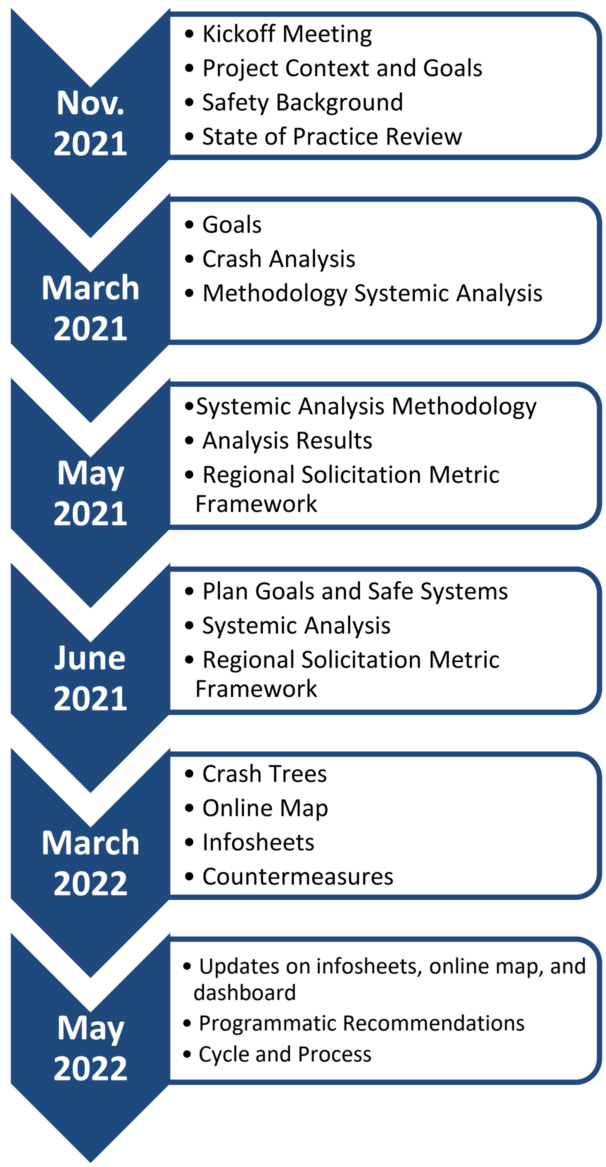
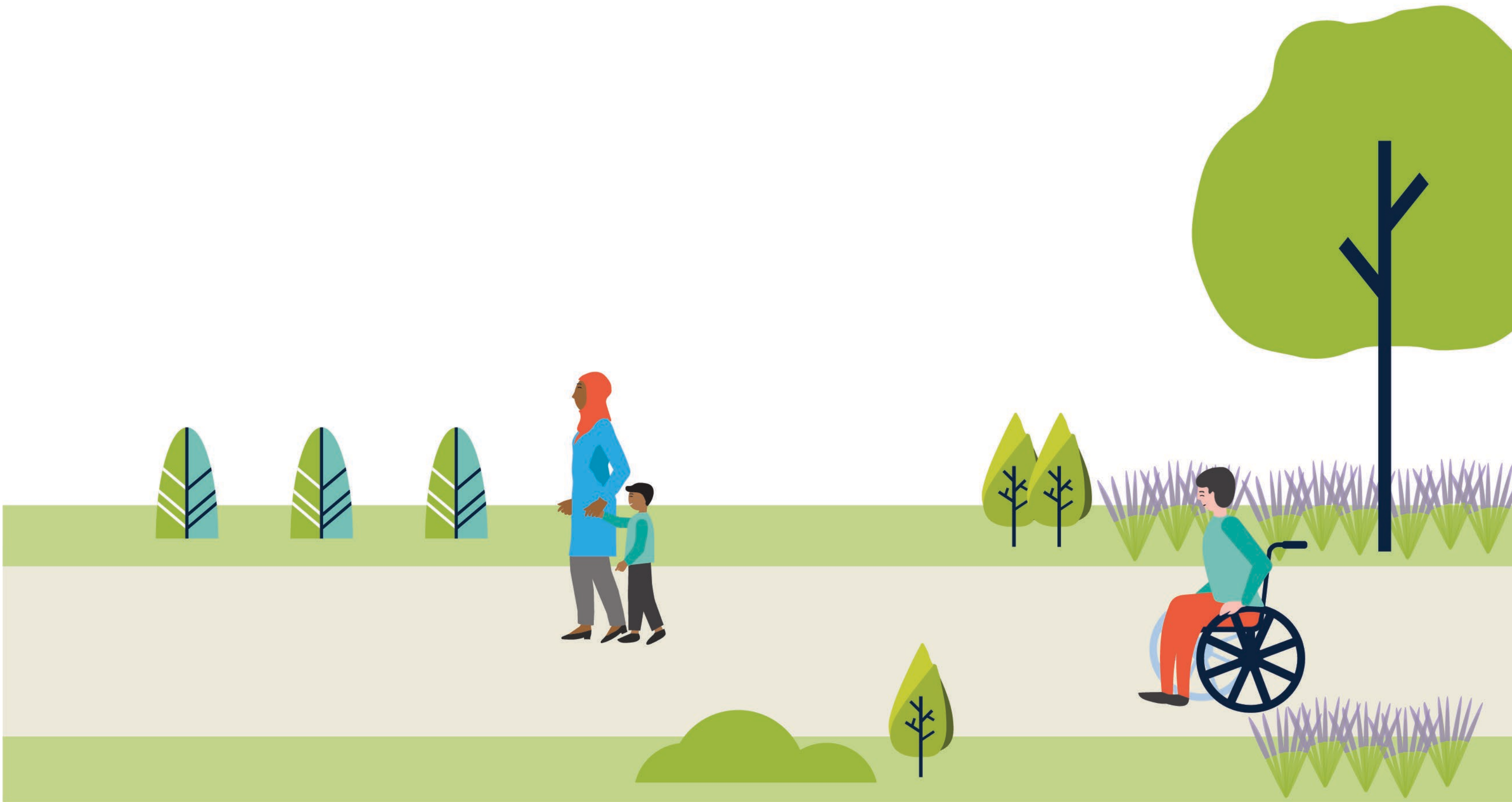


Figure 3: Technical Advisory Group meeting timeline

STATE OF PRACTICE REVIEW



Introduction

This section reviews current practices by other MPOs; other entities in the State of Minnesota, including the Minnesota Department of Transportation, cities, and counties; and domestic and international best practices. The project team also reviewed more than ten key guidance and resource documents for planning and designing safe infrastructure for people walking. A table with brief summaries of each document can be found in Appendix B.

What are MPOs doing?

Pedestrian Safety Action Plans

MPO pedestrian safety action plans identify strategic institutional changes and safety projects or programs necessary to achieve the MPO pedestrian safety vision and necessary implementation actions.

The Atlanta Regional Commission, as an extension of its 2016 *Walk. Bike. Thrive!* strategy document, produced *Safe Streets for Walking and Bicycling*, a road safety action plan focused on eliminating pedestrian and bicyclist fatalities in the Atlanta region by 2030. This data-driven plan took a systemic, Vision Zero approach and identified risks, policy priorities, and evidence-based countermeasures for systemic implementation along high-risk corridors and at high-risk intersections.

Broward MPO’s *Bicycle and Pedestrian Safety Action Plan* used a data analysis throughout the MPO’s service region (a single-county in Florida) to identify crash hot spots and locations with high daily transit use or propensity for walking and bicycling. It also considered land use context and mismatch between existing highway-oriented street design and surrounding pedestrian-oriented land use context. The plan identifies pedestrian priority areas, quick-build safety projects, necessary design standard changes to align with pedestrian safety goals, and non-infrastructure approaches intended to improve safety. The *Bicycle and Pedestrian Safety Action Plan Actions (Appendix)* identifies specific actions to be taken, lead agencies and partners, and timelines for implementation.

The Pinellas County *Pedestrian Safety Action Plan* was prepared for the Florida Department of Transportation, with Pinellas County MPO, a single-county metropolitan planning organization, as an integral partner in the plan’s creation. The plan does not adopt a vision zero goal, but rather a reduction from over 13 to "fewer than 10" severe pedestrian injuries per 100,000 people per year by 2020. It used crash data analysis to identify strategic countermeasures to "optimize the safety of all users." Many of its approaches are more traditional, including encouraging compliance with existing laws through education programs focused on mutual respect and courtesy (as was more common in the state of practice when the plan was produced in 2009). It also considers land use context and strategies. For example, it acknowledges that much of the built environment in Pinellas County was developed in the second half of the 20th century oriented toward automobile mobility, often at the expense of safe and efficient pedestrian mobility. The plan acknowledges the need to retrofit the suburbs to provide practical and safe alternatives to automobile travel via pedestrian-oriented development and redevelopment of existing commercial and residential land.

Other MPO Safety or Pedestrian Plans

Other related MPO efforts besides pedestrian safety action plans have been made that may improve pedestrian safety, but these may have a different focus, scope, or immediate goals than a pedestrian safety action plan.

The Delaware Valley Regional Planning Commission (DVRPC) regularly produces a *Transportation Safety Analysis and Plan*, but its approach is more traditional, focusing on geographic hot-spots, year-over-year trends, and it does not advance a Vision Zero goal. DVRPC also produced a *Crashes and Communities of Concern in the Greater Philadelphia Region* report, which focuses specifically on safety outcomes in areas within the MPO's service region that have higher percentages of low-income, racial or ethnic minority, or disabled people. The report identified a high degree of overlap between the City of Philadelphia's High Injury Network and communities of concern and advances systemic safety strategies to help reduce these existing disparities.

The Metropolitan Washington Council of Governments (MWCOG) recently produced a *Transportation Planning Board Safety Study Resources and Safety Policy.* A new effort for MWCOG, the study was designed to better understand the factors that lead to fatalities and serious injuries on the region's roads. It also identified multiple design and funding interventions to improve pedestrian safety and support regional partners in achieving their established Vision Zero goals (e.g., District of Columbia, Montgomery County, City of Alexandria, Virginia).

The MWCOG also produced a *Bicycle and Pedestrian Plan for the National Capital Region*, which is a comprehensive strategy to identify over 650 long-term project needs to improve bicycle and pedestrian safety and comfort, with total planned investments of approximately $3 billion. At its July 2020 board meeting, the Transportation Planning Board approved the *National Capital Trail Network*, a 1,400 mile, continuous network of long-distance off-road trails serving the region. The Network will be used to prioritize funding in the MWCOG's programs.

Finally, the Capital Area MPO (Austin) *2045 Regional Active Transportation Plan* is another leading example of a long-term MPO active transportation network planning in support of safety; it includes reducing pedestrian fatalities and serious injuries as its primary organizing goal for the network.

What are other agencies in Minnesota doing?

The City of Minneapolis has adopted a *Vision Zero Action Plan*, which supports the City's established target of zero pedestrian deaths or serious injuries by 2027. The plan identifies a high injury network of Minneapolis streets based on historic crash data and a set of safety-first, equity-driven strategies to achieve the City's vision zero goal. Identified countermeasures include 4 to 3 lane conversions, turn calming, refuge islands, leading pedestrian intervals, daylighting, curb extensions, and hardened centerlines, among other recommended design interventions. Leading strategies include speed limit reductions and rapid implementation of cost-effective safety improvements on high injury streets.

The Minneapolis Vision Zero Action Plan builds on the *Vision Zero Crash Study* of which bicycle and motor vehicle safety was the primary focus, and its *Pedestrian Crash Study*. These efforts focused more on safety data analysis and less on policy and countermeasure implementation strategies.

The City of Saint Paul adopted a pedestrian master plan, *Walking Saint Paul*, as an addendum to its comprehensive master plan. It uses equity as its foundation and commits to making walking safe for everyone while connecting vibrant communities in all parts of Saint Paul. The Plan identifies goals, strategies, and actions to equitably make walking investments by prioritizing areas with the highest need over five to ten years.

Minnesota Department of Transportation is currently undertaking a *Minnesota Statewide Pedestrian Safety Analysis* to better understand statewide dynamics in pedestrian safety and support the future identification of pedestrian-oriented countermeasures and strategies through a pedestrian safety action plan. MnDOT has also produced *Minnesota Walks*, a framework for making walking and rolling safe, convenient, and desirable in Minnesota. MnDOT also created the *Statewide Pedestrian System Plan*, completed in March 2021, to support improved pedestrian infrastructure and investment prioritization on

MnDOT roads. MnDOT also has an ongoing Toward Zero Deaths initiative, which has been mostly focused on enforcement.

The Minnesota Department of Transportation has also partnered with counties throughout the state to produce County Roadway Safety Plans, which are intended to improve roadway safety in counties across the State. The county roadway safety plans helped identify projects that may be eligible for federal funding through the state's Highway Safety Improvement Plan (HSIP). One county's plan noted that it was not intended to be a complete safety plan because other higher-cost safety strategies that may also be effective are not addressed. See Appendix B: State of Practice Review Table for safety planning work being completed on the local level.

What are other national and international best practices?

Some jurisdictions have had stand-out success in achieving significant reductions in pedestrian crashes, which are summarized below.

US Cities

New York City provides leading-edge pedestrian safety action plans for each borough of the city in its *Boroughs Pedestrian Safety Action Plans Update*. This update of previous pedestrian safety plans in New York, extends a longstanding history of prioritizing pedestrian safety through analysis and effective intervention. New York is one of few US jurisdictions making significant progress toward its Vision Zero goal. New York officials were also invited to speak about the City's pedestrian safety efforts at the recent US Department of Transportation Summit on Pedestrian Safety, summarized in the presentation *Identifying Risk and Safe Systems Approach: US DOT Summit on Pedestrian Safety, 2020*.

In San Francisco, which is one of few US jurisdictions to see significant success in making progress toward its Vison Zero commitment, the Municipal Transportation Agency's *New Steps for Pedestrian Safety: Quick and Effective Pedestrian Safety Improvements* builds on years of strategic planning and civic leadership, including new streetscape design standards in 2010, data analysis in 2012, strategic pedestrian safety goals in 2013, a capital plan to fund pedestrian safety projects in 2014, and a new Vision Zero commitment in 2015. The *New Steps* document summarizes quick and effective street design interventions, such as intersection daylighting, curb extensions, high-visibility crosswalks, leading pedestrian intervals, and advanced yield lines that were implemented at hundreds of locations across the city at high-injury corridors and intersections. The City, County, and MPO's collaborative two-year *Vision Zero Action Strategy* also identified key challenges to achieving pedestrian safety and strategies to overcome them, including communities of concern for severe and fatal collisions, project opposition, a culture of speed over safety, high demand for all modes of transportation, and designs that protect people driving but not pedestrians.

The City of Seattle undertook a *Pedestrian and Bicycle Safety Analysis (recently expanded in Phase II)* to identify systemic pedestrian safety risks throughout the city and locations (corridors and intersections) that may benefit most from safety improvements to reach the City's Vision Zero goal. The City's proactive approach to pedestrian safety was highlighted by the FHWA in a *Safe Transportation for Every Pedestrian Case Study*.

The City of Austin also produced its *City of Austin Pedestrian Safety Action Plan*, which provides a comprehensive strategy for addressing pedestrian safety and creating a more comfortable walking environment in service of the city's vision of a sustainable, socially equitable, affordable, and economically prosperous city. The plan advances the City's Vision Zero goal through 21 key engineering, policy, land use, partnership, funding, and related actions.

International Cities

Other leading international efforts include the Copenhagen [Traffic Safety Plan](#) (2013-2020) and [Action plan for Green Mobility](#), Edmonton's Safe Mobility Strategy, Montreal's *Vison Zero Action.* Copenhagen and Edmonton's safety strategies (*Traffic Safety Plan, Safe Mobility Strategy*) consider a wider scope than most in the United States, including the fundamental influence of mode share on both sustainability and safety goals. Edmonton's Safe Mobility Strategy also addresses user perceptions of safety to ensure safe streets are accessible for everyone. Montreal's *Vision Zero Action Plan* emphasizes senior pedestrian safety and pedestrian priority at traffic signals.

Other US National Efforts

Smart Growth America regularly produces a *Dangerous by Design* report, which is a national analysis of pedestrian fatalities (sourced from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System). The most recent edition analyzes equity and pedestrian safety and finds disparate impacts for people of color, elderly pedestrians, and other groups in pedestrian safety trends.

U.S. DOT recently released its *Draft Current and Planned U.S. DOT Actions to Enhance Pedestrian Safety*, which is part of a recent initiative by the Secretary of Transportation to address rising pedestrian deaths throughout the United States. Draft actions include the completion of a U.S. DOT Action Plan on Pedestrian Safety, creating a lighting design guide and implementation policy to help improve pedestrian safety in urban areas, and creating a comprehensive five-year Pedestrian and Bicycle Safety Program Strategic Plan, among 69 diverse policy, research, and programmatic actions.

What are the best methodologies and approaches to use for pedestrian safety analysis?

Systemic Safety Approaches

Although FHWA has produced several resources for systemic safety analysis, they do not provide specific guidance on pedestrian analysis, which have specific issues of risks, countermeasures, and data. *National Cooperative Highway Research Program (NCHRP) Report 893: Systemic Pedestrian Safety Analysis* is a fundamental resource for systemic safety analysis for pedestrian transportation and presents detailed guidance for the seven steps of a systemic pedestrian safety analysis (Figure 4). The Pedestrian and Bicycle Information Center (PBIC) produced *Designing a Safer System for Pedestrians ,* a visual summary of the process.

Figure 4: Systemic Safety Analysis Process, NCHRP Report 893

A critical component of the systemic safety approach is high-quality data. The Collaborative Sciences Center for Road Safety produced *Completing the Picture of Traffic Injuries: Understanding Data Needs and Opportunities for Road Safety* for USDOT that organizes and reviews data sources relevant to safety analyses and provides guidance on linking data to expand the available and useful safety data past police crash data (the standard data source).

In addition to safety data, count data is necessary for systemic safety analysis. MnDOT's *Bicycle and Pedestrian Traffic Counting Program* is a source for information about counting procedures and a number of studies based on the data.

Design for Pedestrian Safety

A broad catalog of national resources has been developed to guide practitioners at the state and local level on practices to improve pedestrian safety. Complete lists of these resources are captured in *NCHRP Report 893 and NCHRP Report 926: Guidance to Improve Pedestrian Safety at Intersections*, as they were used to inform the guidance in these NCHRP research reports. Key national design resources include AASHTO's *A Guide for the Development of Pedestrian Facilities, the NACTO Urban Street Design Guide,* and FHWA's *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts.*

MnDOT has produced several resources for best practices in pedestrian safety design. *Minnesota's Best Practices for Pedestrian and Bicycle Safety* is a handbook that distills 19 best practices in safety planning from Federal resources and prepares them for application in Minnesota. The guide is currently being updated. Best practices in Minnesota are also synthesized, along with other national examples, in *Best Practices Synthesis and Guidance in At-Grade Trail-Crossing Treatments.*

As shown, there are numerous best practice design resources that summarize a variety of effective pedestrian safety treatments. Identifying an effective process for selecting countermeasure treatments is critical. Step five of the Systemic Pedestrian Safety Analysis Process focuses on selecting potential countermeasures. *NCHRP Report 926: Guidance to Improve Pedestrian and Bicyclist Safety at Intersections* is a practitioner guide to selecting countermeasures for the top pedestrian and bicycle crash types at intersections and includes a detailed glossary of countermeasures. MnDOT has also produced resources on countermeasure design and implementation with their *Pedestrian Safety Countermeasure Infosheets.*

Literature on Equity of Pedestrian Safety

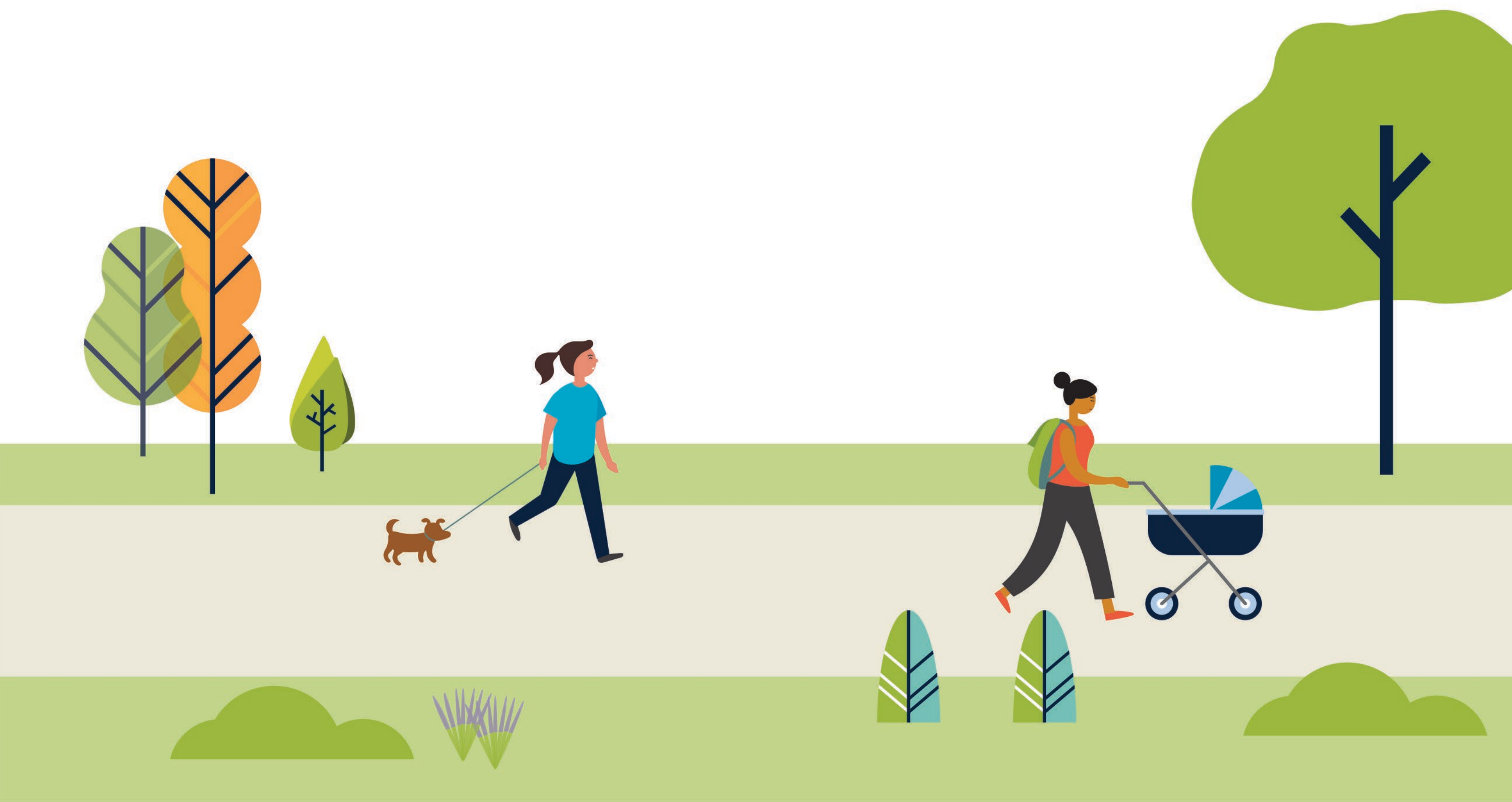
A list of academic literature on pedestrian safety and equity was identified, which includes information about how youth are impacted by pedestrian safety risk.

PBIC provides a high-level summary of pedestrian and bicycle equity issues in *Pursuing Equity in Pedestrian and Bicycle Planning.* In addition to a primer on concepts and active transportation needs of underserved populations, the paper also includes recommendations and resources for both process and outcome equity.

The report defines traditionally underserved populations that may have a greater need for safe facilities for walking and rolling compared to other groups, including: people living in poverty or without a vehicle, who tend to me more transit dependent; some recent immigrants, who may have language or cultural barriers to safer pedestrian travel; and children, older adults, and people with disabilities, who may have special physical or cognitive needs when interacting with the pedestrian environment, among others.

The report's recommended strategies and practices to address pedestrian inequities include proactive and varied community engagement techniques to ensure inclusivity; auditing and improving equity in organizational practices and policies such as hiring, training, and communications; and ensuring project prioritization approaches lead to equitable outcomes (for example, shifting from a complaint-based to goal-based prioritization system). The report also recommends centering equity goals as a high project priority to ensure there is a framework that comprehensively impacts outcomes, and performing racial equity impact assessments to understand potentially divergent impacts of projects on people from different racial groups, for example as detailed in NCHRP Report 710: Practical Approaches for Involving Traditionally Underserved Populations in Transportation Decisionmaking. Finally, it recommends leveraging data to identify concerns and opportunities—for example through scenario planning or environmental justice screening—and designing streets and facilities for everyone.

HISTORIC (2016-2019) CRASH ANALYSIS



Introduction

How the region's streets are planned and designed has a significant impact on safety for all road users. A safe system approach to transportation network and facility design is grounded in the understanding that crashes and deaths are not inevitable, and that safe road system design can mitigate human error and save lives. A historic or descriptive crash analysis plays an important role in supporting a safe systems framework. By examining patterns of crashes, including their risk factors and outcomes, the underlying nature of the safety deficiencies can be better identified. The following provides a summary of the analysis and key takeaways. For the full Crash Data Analysis and Trend Summary Memo see Appendix C.

The analysis is divided into six general categories which cover specific aspects of where pedestrian crashes occur: Basic Crash Report Variables, Geographic Distribution, Land Use, Roadway Characteristics, Demographics, and Economics. Any of these categories may result in different trends among pedestrian crashes.

The Basic Crash Report Variables category reviews factors such as crash severity in relation to type of vehicle involved and lighting conditions when the crash occurred. The factors analyzed in the Geographic Distribution category intend to identify crash occurrences with respect to broad regional boundaries. The Land Use attributes identify crash occurrences with respect to activities going on in the surrounding areas. Roadway Characteristics' attributes identify crash occurrences with respect to the physical and operational characteristics of the roadways. Finally, the attributes analyzed in the Demographic and Economic analyses explore the relationship between crash occurrences with respect to socio-economic factors.

Through this analysis, correlations were identified between fatal and serious injury pedestrian crashes and various factors including proximity to transit, functional classification, and areas where economically disadvantaged people, people with disabilities, and people of color live. These factors associated with higher pedestrian crash prevalence may be used by practitioners to identify the best locations for pedestrian countermeasure implementation, investment, and engagement in urbanized areas experiencing the majority of pedestrian crashes.

Crash Data

Although this analysis uses the presently available crash data from 2016 through 2019, national as well as regional traffic crash and travel patterns changed significantly in 2020 and 2021. If and when these new traffic patterns stabilize, the crash trends may substantively differ from those observed in this analysis. While 2020-2021 data was unavailable for this analysis, the short- and long-term trends associated with these patterns are important to consider alongside the historic crash analysis results.

Crash data was separated into the five FHWA injury categories: Killed (K), Incapacitating injury (A), Non-incapacitating injury (B), Possible injury (C), and No apparent injury (O).[2] From 2016 to 2019 a total of 3,261 crashes were observed. Of those crashes, 622 or 19 percent were severe or fatal crashes.

Geographic Distribution

The geographic distribution of crash data was analyzed to better understand where crashes were occurring. Most crashes and most severe crashes occurred in urbanized areas. Urbanized areas are

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[2] KABCO injury severity definitions: https://safety.fhwa.dot.gov/hsip/spm/conversion_tbl/pdfs/kabco_definitions.pdf

more likely to have higher percentages of crashes due to heavier traffic of all types. However, these crashes are less likely to be severe due to lower posted speed limits, streets that are designed so that motorists drive the posted speed limit, and more compact built environment with higher density of people using the transportation system. When analyzing pedestrian crashes, a higher proportion of pedestrian crashes occurring in rural areas results in death or serious injury. This is most likely due to the rural context where regional vehicular trips and road designs include higher travel speeds.

Proximity to transit, functional classifications, land use and roadway features may be used by practitioners to identify the best locations for pedestrian countermeasure implementation, as they significantly describe where pedestrian crashes occur. This approach can be used in both rural and urban areas. Additionally, engagement and investments should be prioritized in neighborhoods where people of color and people with disabilities live, work, travel, etc., as well as in neighborhoods where economically disadvantaged households are located, because these areas experience higher prevalence of pedestrian crashes, including fatal and serious injury pedestrian crashes.

Key Takeaways

- More crashes occurred in urban areas (2,287 crashes, of which 15.6 percent were severe or fatal), but a greater percentage are severe in rural areas (68 crashes, of which 47.8 percent were severe or fatal).
- Fewer than 25 percent of all intersections in the study area are within 500 feet of a transit stop, yet nearly 80 percent of severe intersection crashes were near a transit stop.
- Most crashes and most severe crashes occurred on A Minor Reliever arterials (500 crashes, of which 20 were severe or fatal) and A Minor Augmentor arterials (491 crashes, of which 24 were severe or fatal).
- More crashes and most severe crashes occurred at intersections with a signal (1,413 crashes, of which 16 percent were severe or fatal).
- There is no discernible pattern of youth crashes happening near schools that is disproportionate in frequency or severity.
- Black and Native people are disproportionately killed while walking (14 percent of pedestrians killed were Black, while only 9.6 percent of the population in the study area is Black. 2.3 percent of pedestrian killed were Native American, while only 0.48 percent of the population in the study area is Native American).
- Areas with higher concentrations of white populations and higher income indicators are associated with fewer crashes.
- Pedestrian count data is not widely available throughout the region. Regular collection needs to be prioritized.

SYSTEMIC SAFETY ANALYSIS

Introduction

By using a systemic approach, the Council can identify roadway characteristics and locations with a history, or future risk, of serious pedestrian injuries and deaths. By focusing improvements in these locations, the Council and regional partners can promote safety for all pedestrians in the region and strategically work to eliminate pedestrian injuries and fatalities.

This section outlines what a systemic safety analysis is, why one was conducted for the metropolitan region, and how it was applied as part of the Regional Pedestrian Safety Action Plan. The methodology is designed to identify places where conditions may be dangerous for people walking, even if pedestrian crashes have not been documented there. These systemic risk factors will be identified using both roadway data and available land use and transportation system information related to the approximate level of pedestrian activity (a proxy for the pedestrian volume or exposure to crash risk at a given location in absence of comprehensive pedestrian exposure data).

The team identified combinations of risk factors based on the historic (1) prevalence, (2) proportionality, and (3) severity of pedestrian crashes throughout the region. The methodology then screened the entire regional roadway network for locations where these risk factors create the types of conditions associated with pedestrian injuries or deaths. This approach to pedestrian safety will prepare local agencies to identify countermeasures that are linked to the most common or deadly combinations of conditions present in the region. Countermeasures are safety and design treatments to roadways that reduce or eliminate dangers to people walking, such as crossing visibility enhancements or changes to the roadway that reduce speeds to the desired target speed.

What is a systemic pedestrian safety analysis?

A systemic pedestrian safety analysis is a proactive approach to evaluating a roadway network for pedestrian safety improvements. While more traditional safety analyses may only focus on specific sites with a high historic crash frequency, a systemic pedestrian safety analysis focuses on sites throughout the roadway system with high-risk roadway features. The reason for this is that, although crashes at any one location are statistically rare events, and several years may pass between severe crash events there, the underlying crash risk due to roadway design features may be similar to or equivalent to a higher crash location. Relying on historic crash frequency alone for problem identification misses these locations, leading to an inadequate and reactive safety response. By identifying and treating *all* high-risk locations, safety planners and engineers can apply treatments designed to reduce or eliminate unsafe conditions before a serious pedestrian injury or death occurs.

Understanding these risk factors is a data-driven process. Systemic pedestrian safety analyses use roadway data to identify the safety of a given location for pedestrian use, such as:

- Number of lanes
- Intersection traffic control; and
- Vehicular traffic volumes

Systemic pedestrian safety analyses also use contextual data as proxies for potential pedestrian activity, such as:

- Land use
- Population or employment density; and
- Transit ridership

Incorporating these pedestrian crash exposure proxies helps to identify risk levels of where a pedestrian may be involved in a collision, given certain roadway conditions. Demographic and economic population characteristics, especially those linked to historic patterns of disinvestment and inequity – for example, race and racial segregation – are also useful in identifying and prioritizing areas of investment to maximize the safety benefit and ensure equity in investment decisions.

In this approach, target crash types are first identified by inspecting historical crash data involving pedestrians. Crash types defined in this project will include a combination of the motor vehicle movement and the pedestrian action that preceded a crash event: for example, crashes involving a pedestrian crossing the street mid-block and a motorist driving straight ahead. Crash types are used to identify groups of crashes that may be addressed with similar safety treatments. Once determined, these pedestrian crash types are connected with roadway and contextual variables to identify the risk factors that are most strongly linked with pedestrian fatalities and serious injuries. Risk factors may include pedestrian behaviors, vehicle speed, pedestrian crossing distance, transit stops, and other elements of the built environment. Combinations of risk factors are established using crash trees. The roadway network is then screened for a set of locations where these risk factors are present, whether or not these locations have a history of severe pedestrian crashes. Appropriate countermeasures can then be identified and implemented at multiple locations with higher risk and site characteristics, in addition to broader programmatic and evaluation recommendations targeted at key crash types and issues.

Why conduct a systemic pedestrian safety analysis for the metropolitan region?

Agencies often use systemic pedestrian safety analyses because they are cost-effective and can be proactive in addressing environments that are hazardous to pedestrian safety. Cost-effectiveness is maximized by focusing resources on prevalent crash risks or those risks associated with the most severe crashes. The systemic safety analysis provides evidence-based justification to recommend countermeasures for people walking and rolling, which are appropriate for application on a system-wide basis. In addition, safety benefits are optimized by addressing safety for the entire network, rather than focusing on specific locations with a crash history. A systemic approach allows for informed decision-making to maximize safety benefits for pedestrians while minimizing costs.

In the case of the metropolitan region, a systemic approach will account for the complex relationships between speed, volumes, roadway design, and diversity of land use characteristics present throughout the region. The analysis will determine high-risk roadway characteristics (e.g. wide or high-speed roads) and contextual variables (e.g. transit stops, pedestrian-trip-generating land uses) that are associated with pedestrian crashes.

Understanding these risk factors provides a basis for identifying and recommending appropriate roadway treatments to prevent pedestrian deaths and serious injuries. Therefore, the Council will be empowered with the information on the common causes of pedestrian crashes and a streamlined method to identify and apply solutions that reduce pedestrian deaths and serious injuries.

Methodology

The focus of this methodology is to determine engineering solutions that change the physical environment to make roadways safer for pedestrians across the metropolitan region, and to recommend both these engineering countermeasures as well as programmatic strategies for helping communities put them to good use.

This project used a two-part systemic safety analysis approach:

1. The project team analyzed the roadway and contextual factors that were frequently observed with pedestrian crashes to identify which factors were most closely linked to high crash frequencies or severe outcomes.
2. The project team screened the entire region's roadway network for locations that contain these high-risk elements.

This methodology addressed known data issues and challenges, such as known variables associated with pedestrian crash risk that are not available in the data, as well as any data issues that were discovered during the data cleaning and consolidation step during the historic crash analysis.

For example, careful consideration was given to sample size when stratifying data on multiple variables, and the project team made reasonable approximations or imputations, where possible, to address challenges with the consistency, completeness, and accuracy of roadway or crash attribute data. Data completeness may vary based on both jurisdiction location and road ownership. For example, more data are typically available about MnDOT trunk highways than intersecting county or local roads. Where data was missing from official sources, the project team made inferences when possible from functional class and land use context.

The crash types selected for the crash analysis and network screen were informed by the results of the historic crash analysis, past research, and data availability. These crash types include the following:

- Mid-block location, vehicle moving forward, with pedestrian crossing
- Intersection location, vehicle moving forward, any pedestrian action
- Intersection location, vehicle turning left, any pedestrian action
- Intersection location, vehicle turning right, any pedestrian action

Approach notes and caveats

Pedestrian volume data is not available for this crash analysis. Exposure data is often used in crash analyses to normalize crash data and measure the potential opportunities for a crash to occur. The lack of exposure data renders regression analyses (e.g., safety performance functions) impractical for this study. However, crash trees do not require exposure data and instead use proxy variables, such as land use, to identify high risk variables associated with previous crashes of each crash type, which can be used as indicators to screen for potential future crashes throughout the road system. In any case, if pedestrian exposure information (or exposure proxies) indicate an association between certain locations, or location types, and pedestrian deaths or serious injuries, this indicates that the existing road conditions are not safe for the level of pedestrian activity.

Analysis Steps

1. Create crash trees to identify combinations of risk factors

The project team used crash trees to identify risk factors to use for screening. Crash trees are a method of identifying high frequencies or severities of crashes based on the circumstance or characteristics associated with the crash event across a road network. Crash trees are a powerful tool both for discerning combinations of risk factors associated with severe outcomes as well as for communicating crash analysis results intuitively and efficiently. Crash tree diagrams are used to help identify potential combinations of area types, location types, traffic control types, or similar characteristics, which are associated with high crash histories.

The process of creating crash trees incorporates roadway, contextual, and crash data into diagrams with branches and nodes. Crash types were used as the initial branches of the crash tree to help identify similar crash circumstances that could be addressed using related safety countermeasures.

Further branches were then developed and explored by adding roadway and land use characteristics using Excel pivot tables. The project team tested different combinations of variables (for example, number of lanes, posted speed limit, nearby land uses, or presence of transit stops) that are known to be related to pedestrian crash frequency or severity for crash types of concern. Branches toward the top of the crash tree were broad categories that captured the highest percentage of crashes (e.g., by Thrive community type, or roadway characteristics), while those toward the "leaves" were more location-specific variables (e.g., presence of a transit stop, or specific land uses).

The crash trees were manipulated so that they produced a screened network small enough to be manageable and relevant to safety issues, yet large enough to target risk factors present throughout the road system, beyond individual crash locations. For the purposes of this study, the crash trees provided results that are suitable for each local agency to use for screening and prioritization in their own communities. The results are also useful for programmatic recommendations and funding prioritization or other evaluation criteria.

Crash trees were analyzed to find the combination of conditions under which focus crash types most frequently occur. The risk attributes and factors included, and thresholds for each, were based on (1) prevalence, (2) proportionality, and (3) severity. Each node (terminal branch) of the crash tree was measured by these three decision metrics. Prevalence, proportionality, and severity analyses were associated with roadway risk factors, contextual factors, or a combination of the two. For the prevalence and proportionality metrics, the project team first implemented the methodology focusing exclusively on crashes that resulted in fatal and serious injuries. However, if the sample size for some crash tree branches was too small, a broader segment of pedestrian crashes (e.g., fatal, severe injury, and moderate injury) were necessary for analysis. By definition, the severity metric required examining severe (fatal, serious injury) crashes relative to the number of crashes overall.

Prevalence

Prevalence, the first decision metric, explores the combinations of factors under which a large proportion of deadly or severe crashes are occurring. For example, a finding may be that 40 percent of severe or deadly pedestrian crashes are happening at intersections within 500 feet of a bus stop. Findings for the prevalence metric were indicated as a percentage of all fatal or serious injury (K or A on the KABCO scale[3]) crashes. These were analyzed as percentages across all crash types or as percentages of a specific subtype of pedestrian crashes (e.g., 40 percent of all severe pedestrian crashes versus 40 percent of severe pedestrian mid-block crossing crashes).

A high prevalence of severe and deadly crashes is likely to be associated with both roadway risk factors and contextual factors; pedestrian crashes can be influenced both by how dangerous the road is and the nearby pedestrian generators. Regardless of the roadway condition, if people who are walking are getting seriously injured or killed, the current road design may not be appropriate for the level of pedestrian activity.

It is important to note that prevalence of serious or deadly crashes does not always indicate where conditions are disproportionately dangerous. These crashes could be due to high rates of people walking and driving. In addition, any amount of deaths or serious injuries on the road network indicate a system failure, even if the rate per person is low. For this reason, safety improvements may be

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[3] KABCO injury severity definitions: *https://safety.fhwa.dot.gov/hsip/spm/conversion_tbl/pdfs/kabco_definitions.pdf*

necessary at locations that are relatively safer in terms of prevalence. Thus, additional decision metrics were used to analyze the risk factors for each crash type.

Proportionality

Proportionality, the second decision metric, identifies the conditions under which severe or fatal pedestrian crashes are most concentrated by examining crash rates (densities) for different crash types and conditions. Proportionality is measured by looking for the combination of factors where the proportion of serious pedestrian injury or fatal crashes happening exceeds the proportion of the network exhibiting this condition. This was done by analyzing a subset of crashes per mile or intersection and comparing it to the regional average.

For example, a finding may be that severe or fatal pedestrian crashes occur across the region at a rate of 0.1 severe or fatal crashes per mile. However, on minor arterials where the posted speed is greater than 25 mph, the rate is 1.5 severe or fatal crashes per mile. Crash and location types that are overrepresented on the network can be used to extrapolate where else on the network pedestrian safety should be addressed.

Thus, proportionality was indicated as a ratio of number of KA crashes per mile to the regional average number of KA crashes per mile (or per intersection, as appropriate, based on the crash type). This ratio can be obtained by dividing the subset density by the regional density. In the previous example, 1.5 crashes per mile / 0.1 crashes per mile would indicate that pedestrian crashes occur at a 15 times greater crash density per mile under those conditions than the network average.

Severity

Severity, the third decision metric, assesses the rate at which severe crashes occur. Severe or fatal pedestrian crashes, relative to an overall number of crashes, were analyzed for this metric. Given that a pedestrian crash occurs, the team investigated under what conditions pedestrian crashes are most likely to result in death or serious injury. For example, a finding could be that crashes at an intersection where the motor vehicle turns left are 20 percent severe across the network, but at signalized, high-speed, and high-volume intersections, these crashes are 50 percent severe. This higher severity rate is notable and suggests that these locations may be a higher priority for countermeasure implementation. It is important to note that severity results are difficult to interpret if the total number of pedestrian crashes under the combination of risk factors - of any severity - is fewer than 20-30 crashes.

Severity is measured by identifying combinations of factors where the percent of crashes that are severe is higher than average for that crash type. This decision metric will be represented as a ratio of severe crashes to the regional average. We can find the severity ratio by dividing the subset percentage of severe crashes by the regional average. For the previous example, this would be 50 percent severe / 20 percent severe, indicating that crashes under these conditions have 2.5 times greater severity than the regional average.

Severity may be more likely linked to roadway risk factors, particularly speed, and less likely linked to contextual factors. However, severity can also be linked to individual fragility, angle of impact, and other issues. Because this decision metric is the least likely of the three to be impacted by contextual factors, it was the most useful to identifying appropriate risk factors in places where people do not walk as often.

Input Variables

Crash trees were created separately for intersections and road segments. This analysis assumed that all pedestrians involved in intersection crashes were crossing the street. Intersection and segment variables listed in Table 2 were included in the crash trees.

Table 2: Crash Tree Inputs

Pedestrian Crash Types	Thrive Community Type (simplified)
Intersection – Motor vehicle turning	Rural
Intersection – Motor vehicle going straight	Suburban
Midblock (segment)	Urban
Roadway Features (Intersection)	**Roadway Features (Midblock)**
Roadway configuration	Roadway Type
Speed limit	Number of lanes
Traffic volumes (AADT)	Speed limit
Intersection traffic control device	Traffic volumes (AADT)
Transit stop nearby	Transit stop nearby

2. Network screen on risk factors

Based on the combinations of network risk factors identified from the crash trees, the project team conducted a screen of all streets and roads in the region where people were allowed to walk (i.e., non-access-controlled). This exercise identified parts of the network that are at a higher risk for pedestrian fatalities and serious injuries, whether or not they have a history of severe crashes. A network screen is important to identify roadway variables, contextual conditions, and crash types that are associated with relatively higher numbers of fatal or serious injury crashes, while representing few enough potential locations for systemic application of pedestrian safety countermeasures.

The results of the network screen were conveyed on a webmap identifying areas of higher risk of pedestrian crashes. The webmap components include:

- **Sliding window analysis results -** density of weighted pedestrian crashes based on historical pedestrian crashes on a per-mile basis
- **Higher risk network** – roadway segments and intersections that have been identified as higher risk and separated out by Higher Risk – higher volume and higher speed locations and Higher Risk – lower speed and lower volumes or freeways.
- **Thrive community type** – rural, suburban, or urban
- **Environmental justice data** - % of People of Color (POC) and % of low-income households compared to the regional average

Users can click on a roadway line segment or intersection point to view the roadway features that make the road segment or intersection higher risk. This map and its underlying data will facilitate the selection of countermeasures to be applied at higher risk locations throughout the metropolitan region to improve pedestrian safety.

Note about pedestrian "property damage only" crashes

A previous version of this methodology offered the option of dropping "property damage only" (PDO) crashes from the analysis before calculating the severity metric (percent of crashes that result in death or serious injury). In response to this recommendation, TAG members asked for clarification about what constitutes a pedestrian PDO crash. This section addresses that question.

For motor vehicle crashes, “property damage only” crashes are extremely common (e.g., “fender benders” in stop-and-go traffic). These crashes, if not considered carefully, can skew an analysis and result in misidentifying locations with frequent non-injury crashes and missing locations at risk of life-altering crashes. Indeed, certain safety countermeasures may occasionally result in *more* PDO crashes even while reducing the risk of severe crashes (e.g., roundabouts).

When motorists hit pedestrians, however, the result is unlikely to be a PDO crash due to differences in speed and mass. Those that do happen may be miscoded (i.e., may actually have caused some amount of injury to the pedestrian) or else likely happened at a very low speed (e.g., motorist backing slowly out of a parking space or driveway into the public right-of-way, or motorist creeping forward while attempting to turn on red). Our data show that PDO pedestrian crashes comprise a very small share of pedestrian crashes overall, consistent with expectations and patterns elsewhere.

Underreporting of pedestrian crashes tends to be more common among the lowest severity crashes. Underreporting also may spatially correlate with police department or precinct as well as local demographic characteristics. This is why the project team initially suggested excluding these crashes. However, the team ended up using the severity metric calculated for the overall region, rather than under specific combinations of attributes, due to the instability of the metric with smaller sample sizes. This eliminated the concern of property damage only crashes skewing the metric spatially, allowing us to retain PDO crashes in the dataset.

Crash Tree Diagrams

The following crash trees illustrate the most problematic location factors for pedestrian crashes, such as midblock crossings, intersections where a vehicle is turning into a crosswalk, or intersections where a vehicle might be going straight. For the entire Crash Tree Excel document see Appendix D. Additionally, crash trees support network screening for implementation of pedestrian oriented safety improvements. Based on the problematic location factors for pedestrian crashes, the crash trees allow decision-makers to better understand what types of pedestrian oriented safety improvements should be implemented. The trees identify and isolate relatively higher number of crashes associated with lower roadway network coverage.

The crash trees are based on the Thrive Community Type and Pedestrian Crash Type. The Pedestrian Crash Types consist of midblock (segment), intersection (motor vehicle turning), and intersection (motor vehicle going straight). Each of the following diagrams displays the branches by thrive type and pedestrian crash type that have been identified as part of the higher risk network. The higher risk network can be further broken down into two categories:

- *Higher Risk – higher volume and higher speed locations*
- *Higher Risk – lower speed and lower volume locations or freeways*

Higher Risk – lower speed and lower volume locations or freeways includes 1-2 lane suburban streets where crashes are occuring, but killed and severe injury crashes are relatively low. It also includes residential urban and suburban streets near transit stops. Freeways are also included in this category, because while pedestrians are not permitted on freeways, the project team wanted to acknowledge that pedestrian crashes have occurred along these corridors. All other are categorized as *Higher Risk – higher volume and higher speed locations.*

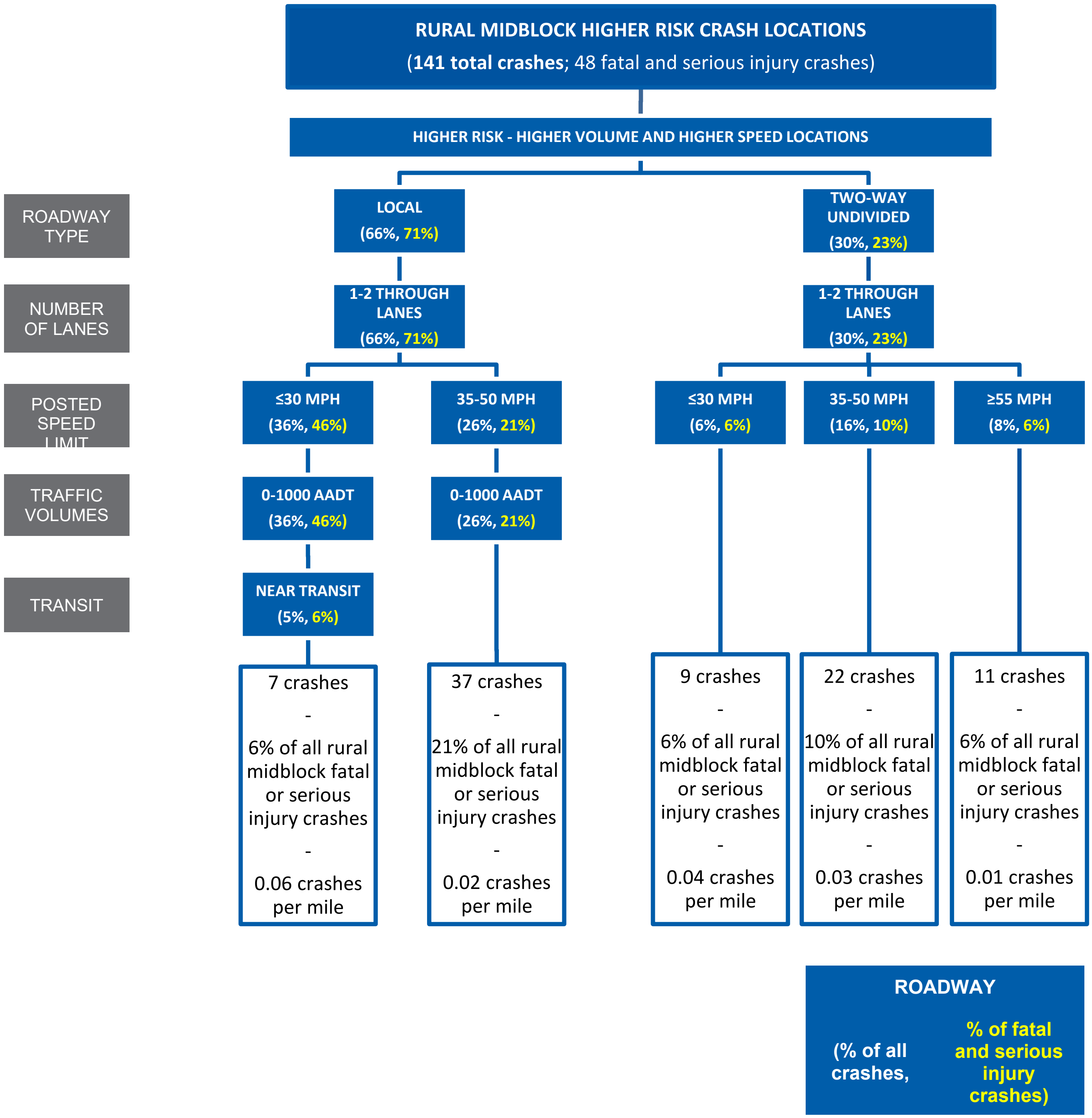


Figure 5: Rural Midblock Crash Tree Diagram

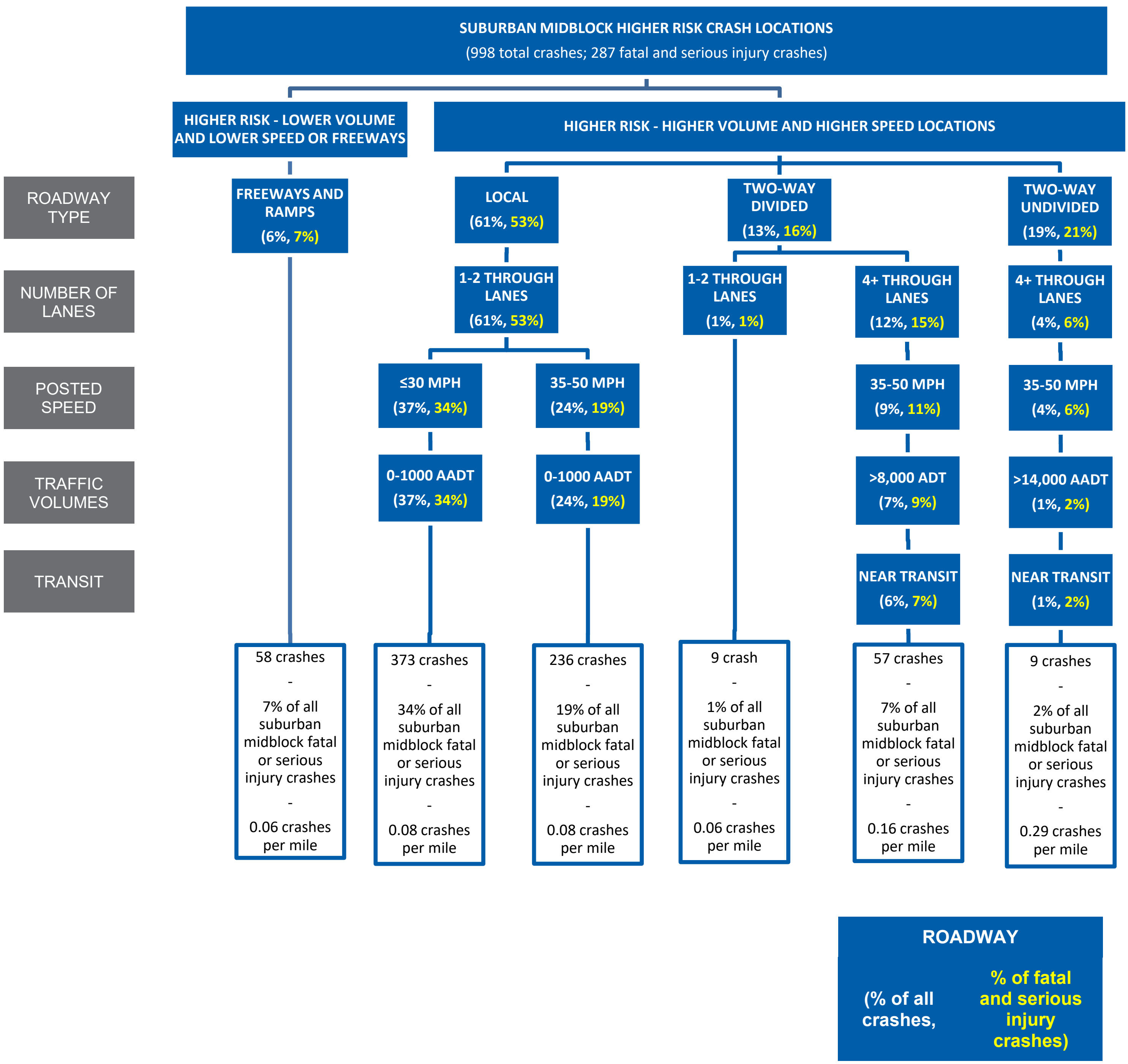


Figure 6: Suburban Midblock Crash Tree Diagram

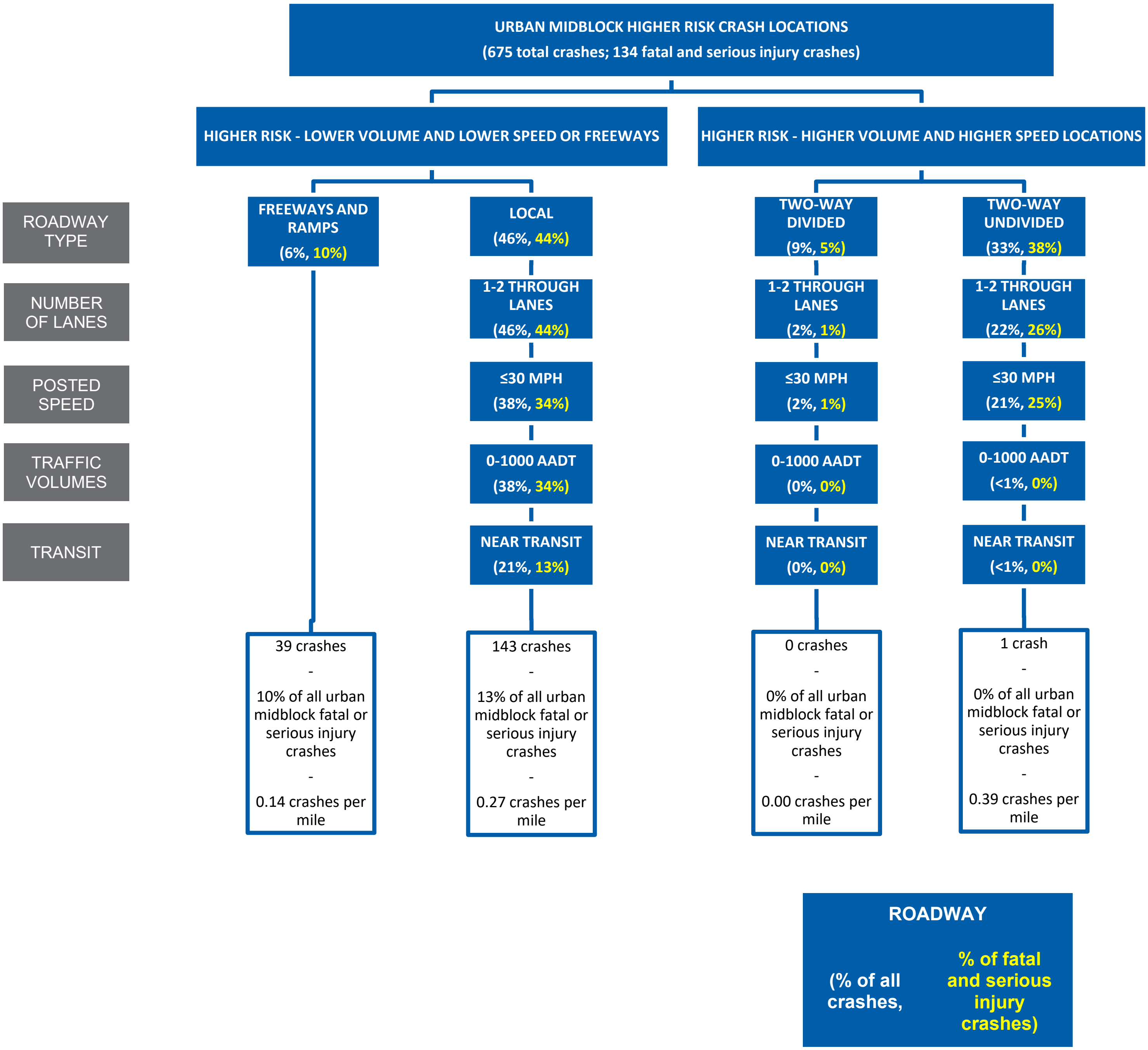


Figure 7: Urban Midblock Crash Tree Diagram

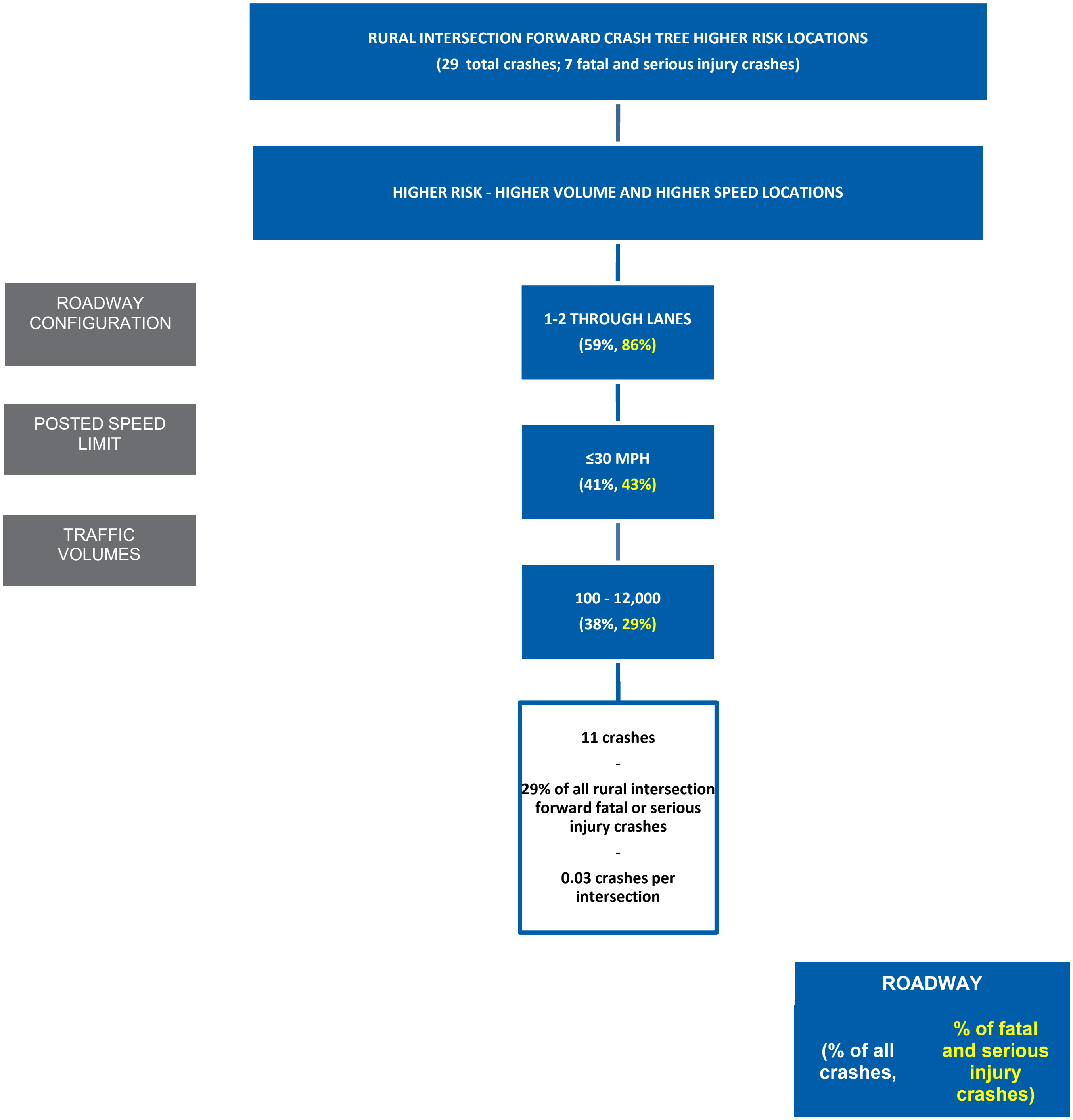


Figure 8: Rural Intersection Forward Crash Tree Diagram

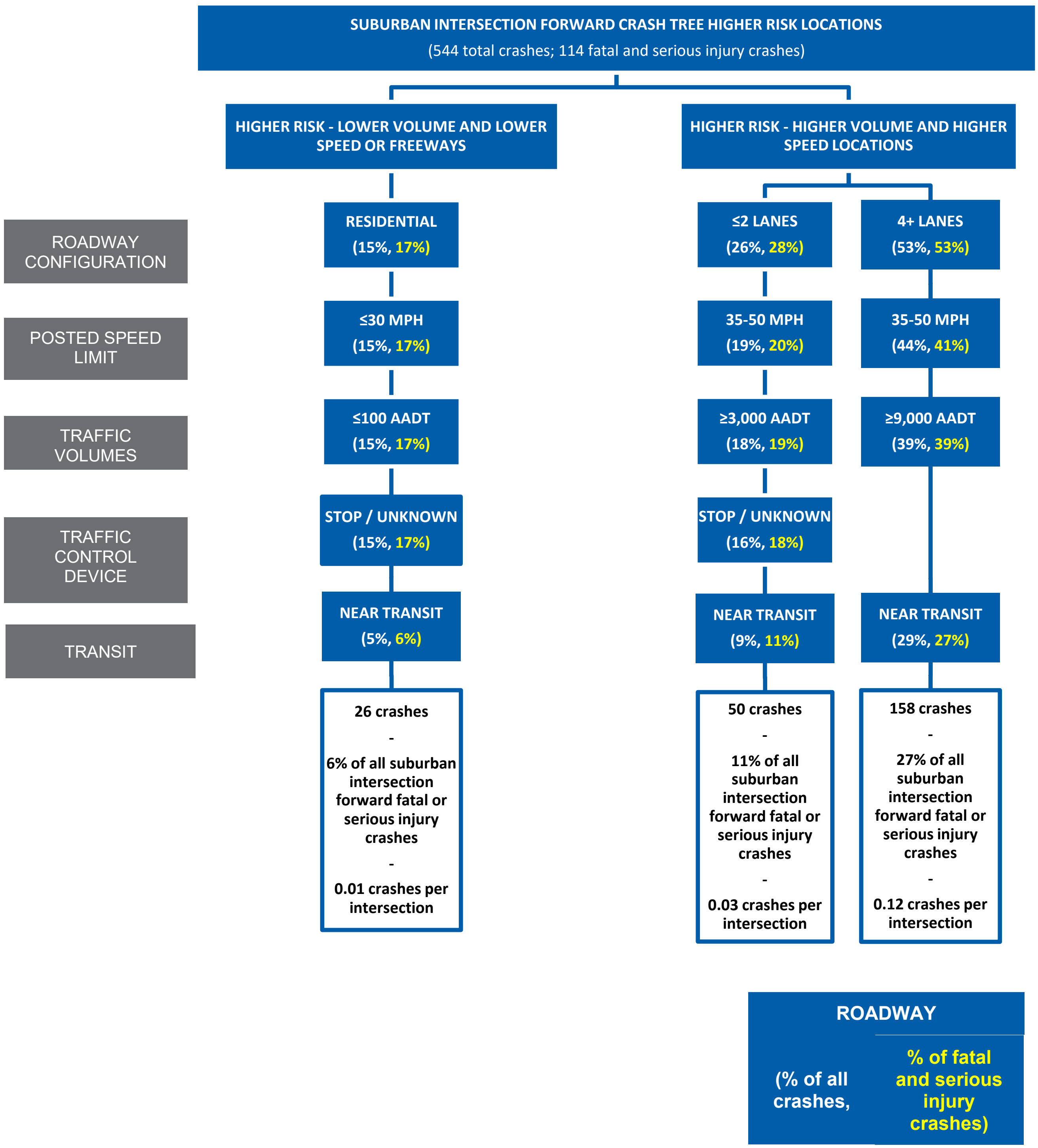


Figure 9: Suburban Intersection Forward Crash Tree Diagram

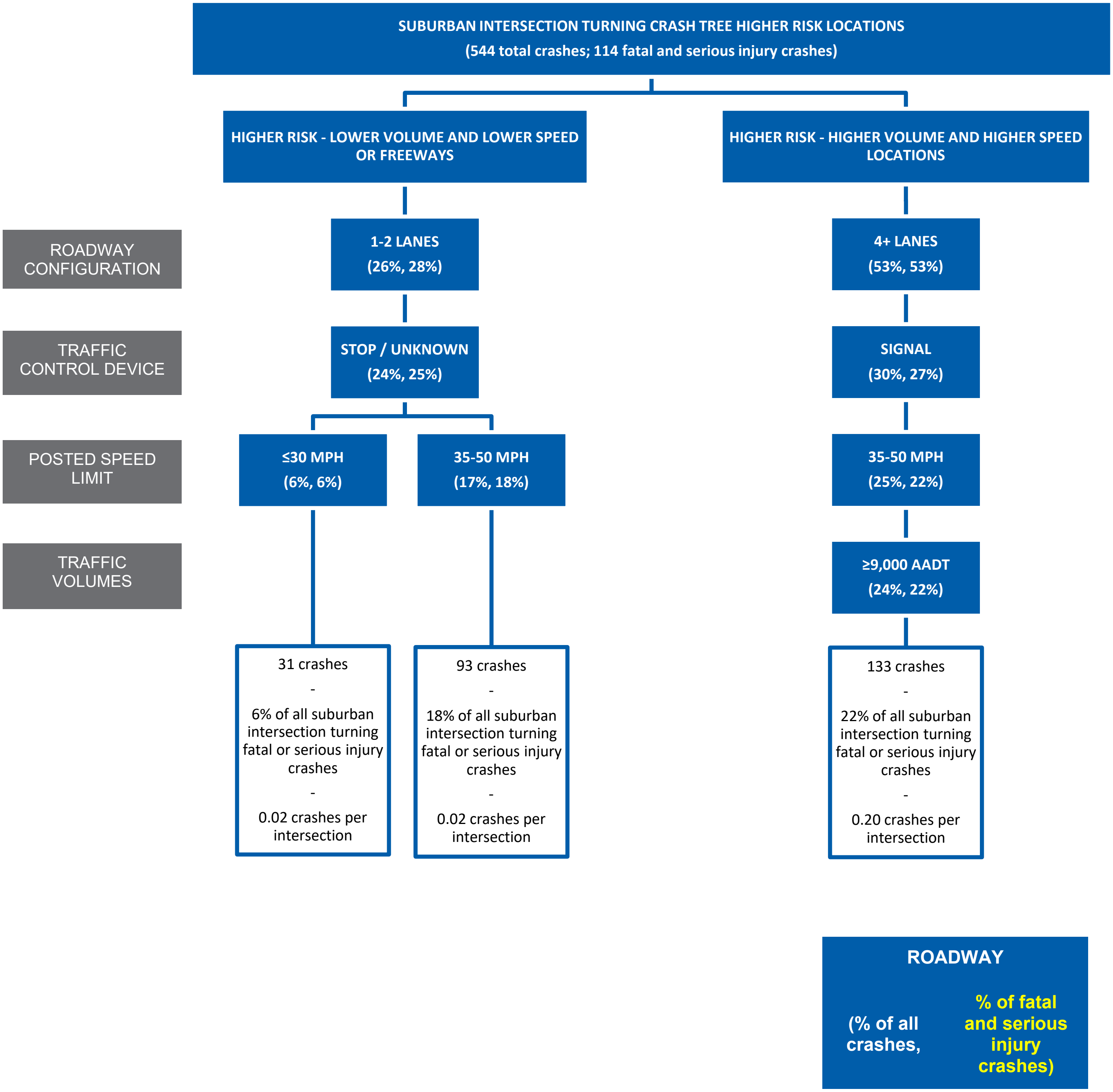


Figure 10: Suburban Intersection Turning Crash Tree Diagram

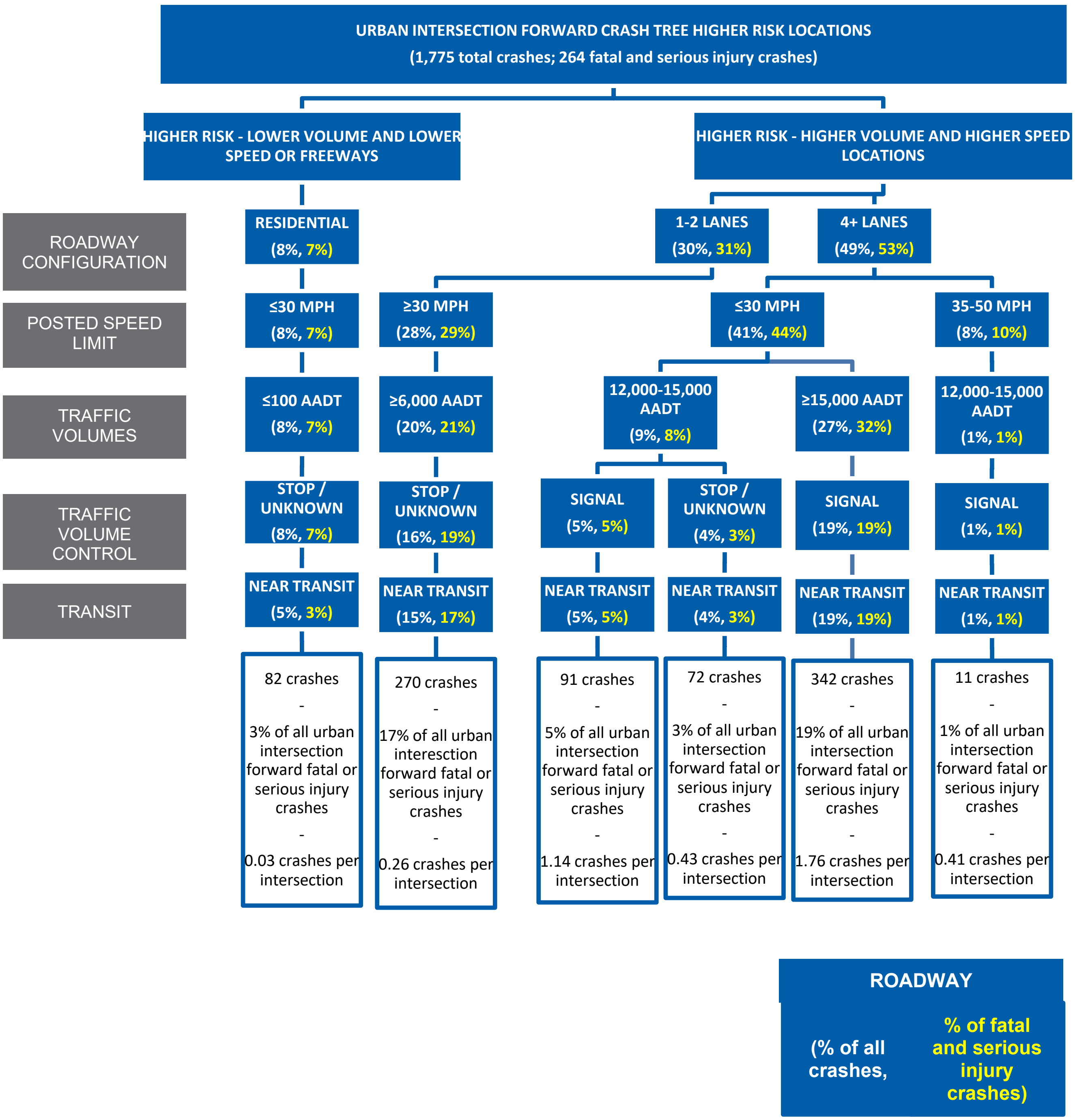


Figure 11: Urban Intersection Forward Crash Tree Diagram

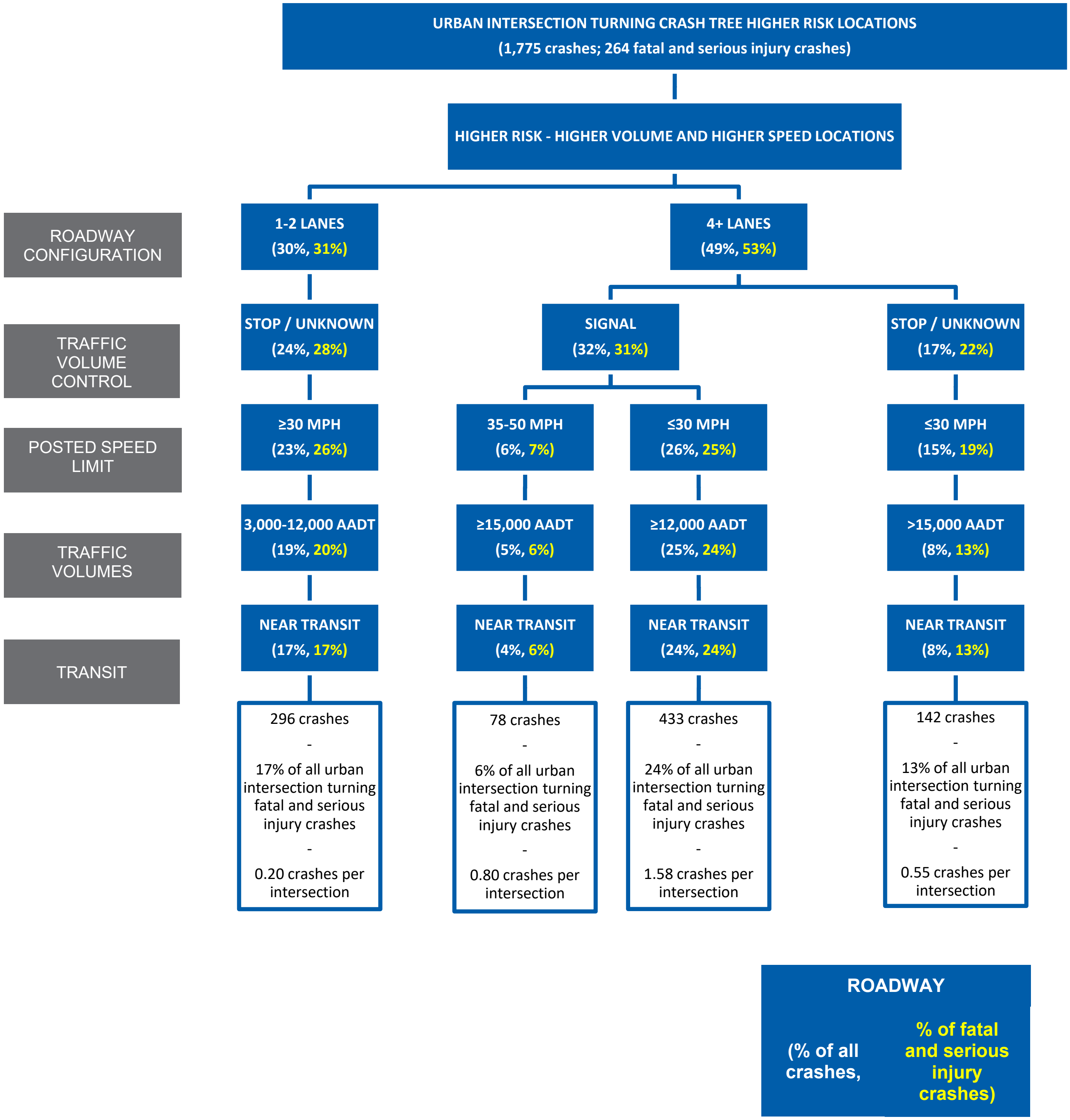


Figure 12: Urban Intersection Turning Crash Tree Diagram

Conclusion

Below are key findings from the systemic safety analysis. The following section provides recommendations in response to the findings in the historic crash analysis and systemic crash analysis. The biggest recommendation is to update the Regional Solicitation application to prioritize pedestrian safety.

Key Findings

The systemic safety analysis identified locations where there is a higher risk of pedestrian crash by isolating relatively higher number of crashes associated with lower roadway network coverage. In general, roadways that have the following features are associated with a higher risk of pedestrian crash:

- **In rural areas:** Lower Posted Speed Limits and 2-Lane Undivided roadways
- **In suburban areas:** Moderate Posted Speed Limits, Moderate Traffic Volumes, Transit Present on roadways
- **In urban areas:** Lower Posted Speed Limits, Higher Traffic Volumes, Transit Present on roadways

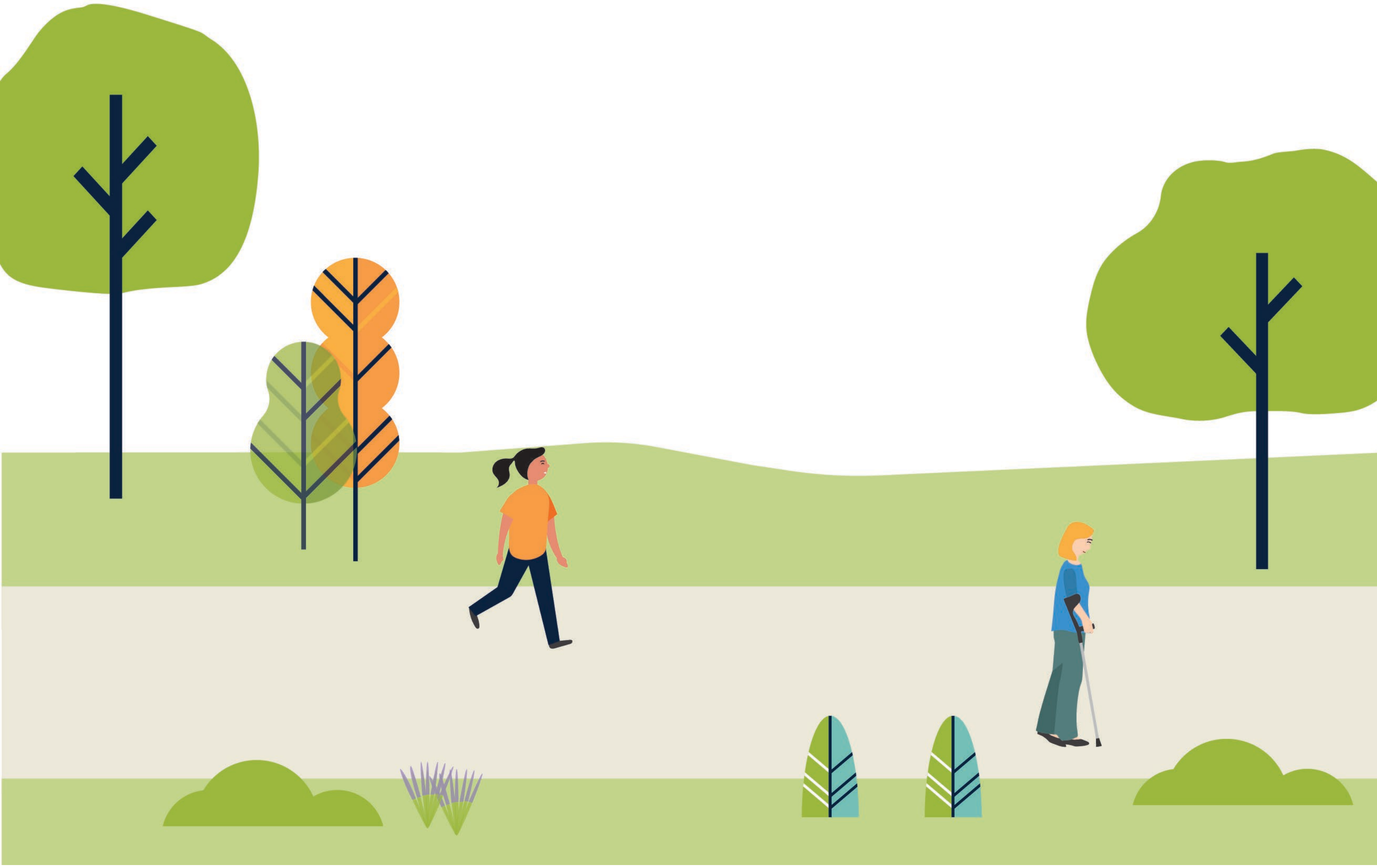
The crash trees show regional pedestrian crash risk is correlated with:

- Travel lanes
- Vehicle speeds
- Traffic volumes
- Greater pedestrian activity (measured indirectly via transit stops, pedestrian destinations, Urban Center communities)

Fewer pedestrians on the highest speed, highest volume roads mean we see fewer pedestrian crashes there, but this doesn't mean these locations are "safe".

Most pedestrian crashes (70 percent of all crashes), including most severe pedestrian crashes (57 percent of all severe crashes), happen in Urban Center communities.

RECOMMENDATIONS



Introduction

Recommendations are categorized into three topics:

- **Countermeasures:** Infrastructure changes to the roadway to address pedestrian crashes.
- **Programmatic recommendations:** Ways for the Council to Promoting and encouraging pedestrian safety efforts through the Council programs.
- **Update process:** Approach to updating the Pedestrian Safety Action Plan in the future.

Countermeasures

Implementing infrastructure changes (countermeasures) to the roadways and intersections that have been identified as higher risk can help reduce or eliminate serious and fatal pedestrian crashes. There are multiple existing guides published that provide best practices for appropriate pedestrian safety countermeasures. Implementing specific countermeasures is most likely to be by local agencies and/or road authorities. Table 3 below provides a list summary of and links to of relevant guides that can serve as resources to decision makers. It is recommended to begin with the *MnDOT Best Practices for Pedestrian and Bicycle Safety* document for countermeasure selection.

Table 3: Relevant State and National Countermeasure Guidance

Guide	Agency	Description
State Guidance		
MnDOT Best Practices for Pedestrian and Bicycle Safety	MnDOT	The *MnDOT Best Practices for Pedestrian and Bicycle Safety* document contains a matrix of strategies for different intersection elements and facilities. The document separates the facilities and elements into four categories: ▪ General Intersection Elements ▪ Controlled or Uncontrolled ▪ Intersection Elements ▪ Linear Facilities ▪ Within each category, the matrix of strategies contains a crash modification factor, evidence, candidate locations, and construction costs.
MnDOT Design and Engineering – Pedestrians Webpage	MnDOT	The *MnDOT Design and Engineering - Pedestrians* webpage contains guidance for designing and engineering pedestrian facilities based on federal legislation, MnDOT policies, and Minnesota State Statues. ▪ Safety and Education: provides information for drivers and pedestrians. ▪ Planning and Research: provides links to plans, programs, best practices, and data ▪ Design and Engineering: provides information and links to guidance, crossings and intersections, policies and practices, and Minnesota administrative rules ▪ Grants and funding: provides information and links to active transportation grants and safe routes to school grants ▪ Contacts: provides names, phone numbers, and emails for personnel who can answer questions relating to general questions, safety education and outreach, planning and research, design and engineering, data, maps, and safe routes to school.

Guide	Agency	Description
MnDOT Facility Design Guide: Chapter 8 Non-Motorized Facilities	MnDOT	The *MnDOT Facility Design Guide: Chapter 8 Non-Motorized Facilities* was published in early January 2022. Chapter 8 contains information on designing pedestrian facilities. Major sections included in this chapter that are helpful for pedestrian design guidance include: ▪ Pedestrian characteristics and travel behavior ▪ Pedestrian networks and corridors ▪ Planning and scoping for pedestrian facilities ▪ Americans with Disabilities Act (ADA) requirements ▪ Pedestrian facility types and design
MnDOT Statewide Pedestrian Safety Analysis Final Report	MnDOT	The *MnDOT Statewide Pedestrian Safety Analysis – Final Report* is a recent analysis report containing crash data and crash analyses with key findings based on criteria such as lighting conditions, functional classification, road ownership, location type, and equity.
Federal Highway Administration (FHWA)		
Proven Countermeasures	FHWA	The *FHWA Proven Safety Countermeasures* webpage contains links to safety countermeasures. There are five (5) categories with numerous strategies within each category. The five categories are speed management, roadway departure, intersections, pedestrian/bicyclist, and crosscutting. Additionally, the webpage includes recorded webinars, a comprehensive booklet on the 28 proven countermeasures, as well as guidance memos.
Proven Countermeasures - Filter Tool	FHWA	The *Proven Safety Countermeasures Filter Tool* allows users to filter, “by focus area, crash type, problem identified, and area type.” Users select their filters, click apply filters which then provides results to specific countermeasure links based off the selected filters.
STEP Studio	FHWA	The *Safe Transportation for Every Pedestrian (STEP) Studio* is a guide that provides information, recommendations, and resources to assist with selecting and implementing countermeasures for improved pedestrian safety.

Programmatic recommendations

Programmatic recommendations are grouped three priorities: high, medium, and low.

High Priority Recommendations

Regional Solicitation Changes

This project developed recommended changes to the Pedestrian Safety Measure in three roadway applications (strategic capacity, roadway reconstruction/modernization, and spot mobility and safety). Proposed changes were modified through the Council's technical committee review process and implemented in the 2022 regional solicitation cycle. At the end of each solicitation cycle, new criteria are evaluated for potential future changes, and the Council will consider further refinements to the pedestrian safety components for future funding rounds.

The measure contains four sub-measures, collectively described as a "Pedestrian Safety Worksheet" (see Appendix E). The first sub-measure is centered on how the project's proposed design will affect pedestrian safety, including specific pedestrian safety countermeasures, as well as any added risks. Sub-measures two and three evaluate existing safety risk and exposure factors, based on trends and patterns observed in both the historic crash analysis and the systemic crash analysis. The scoring guidance is weighting, which may be changed in the future if desired. The "Pedestrian Safety Worksheet" incorporates feedback received.

Through the engagement process with the TAG, there appeared to be support for additional changes to regional solicitation, including, shifting the weighting to increase the importance of safety measures, and reducing investment in roadway expansion and designs that worsen safety for all road users. Additional recommendations for future solicitation cycles that can be considered are in Appendix F.

Integrate the Regional Pedestrian Safety Action Plan into other Metropolitan Council Programs

It is recommended that this Plan be institutionalized by the Council and incorporated into other Council programs, to ensure an agencywide consensus on prioritizing pedestrian safety. This could include prioritizing pedestrian safety in the 2022 update of the Transportation Policy Plan and through local planning assistance offered for 2028 local comprehensive plan updates. This recommendation includes the following changes to related efforts:

Shared Pedestrian Safety Regional Vision

According to TAG feedback, having a shared pedestrian safety vision for the region is a top priority. The Council can take lead this effort by stating a goal of zero roadway deaths in planning and policy documents, such as the Regional Development Guide and Transportation Policy Plan (TPP).

Complete Streets Policy

To work toward a shared regional vision of pedestrian safety, the Council should update and strengthen their strategy toward using Complete Streets principles outlined in the Transportation Policy Plan. Strategy C2 states *"Local units of government should provide a network of interconnected roadways, bicycle facilities, and pedestrian facilities to meet local travel needs using Complete Streets principles".*[4] This could include adopting a regional Complete Streets Policy and requiring that projects funded through the Council meet the Complete Street Policy standards. This would help encourage the implementation of safe pedestrian facilities.

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[4] *https://metrocouncil.org/Transportation/Publications-And-Resources/Planning/2040-TRANSPORTATION-POLICY-PLAN-(2020-version)/Chapters/Chapter-2.aspx*

The Council should also point local agencies to national best practices for Complete Streets Policies. The National Complete Streets Coalition, a program of Smart Growth America, has multiple *resources* available to help agencies write and implement strong policies.[5]

Relationship Between Transit and Pedestrian Safety

Several findings from the historic crash analysis and the systemic safety analysis raised additional questions regarding the relationship between transit and pedestrian safety. 80% of intersection pedestrian crashes and 50% of midblock pedestrian crashes happen in close proximity to a transit stop or station, which is similar to the findings in MnDOT Statewide Pedestrian Safety Analysis Final Report published in December 2021.[6] A further study is needed to understand the relationship between transit and pedestrian safety. This includes what elements of transit system design and roadway design affect safety outcomes (e.g., stop spacing, crossing enhancements for mid-block stops, pedestrian countermeasures, etc.).

Additional Modes Research

This analysis focused on pedestrian safety. Similar analyses should be conducted to understand risk factors associated with bicycle and motor vehicle crashes and motor vehicle and motor vehicle crashes within the region. The Council is initiating a study around bicycle and motor vehicle crashes in the Fall of 2022.

Medium Priority Recommendations

Trainings and Workshops

Trainings and workshops are a method to educate the Council staff and build capacity within the Council and local agencies and could also be used to advance a shared regional pedestrian safety regional vision. Based on TAG feedback, trainings and workshops that are customized for a local agency would be the most beneficial.

Topics could include:

- Data collection
- Overview of the Regional Pedestrian Safety Action Plan outputs and proactive safety approach
- Details on best practice tools linked in the recommended countermeasures section (e.g., MnDOT Best Practices for Pedestrian and Bicycle Safety)
- Countermeasures for safe crossings on higher risk intersections
- How to engage community to understand safety issues beyond crash data
- Examples of model policies and plans for effective Vision Zero and Complete Streets implementation

Integrate Safe System Approach into Policy and Support Local Partners

Implement programs that encourage participation and unity amongst local partners around safety action. Encourage local participation by establishing standards, streamlining efforts, and providing useful resources. These programs should include:

- Automated enforcement at local agencies
- Encouraging local partners to adopt Complete Streets

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[5] https://smartgrowthamerica.org/program/national-complete-streets-coalition/

[6] http://www.dot.state.mn.us/trafficeng/safety/docs/mndot-statewide-pedestrian-safety-analysis-final-report.pdf

- Developing design guidance for best practices and standards
- Collaborating with local agencies for research, analysis, and outreach

Low Priority Recommendations

Crash Analysis Assistance

The Council could consider developing the capacity to provide crash analysis assistance to communities who may not have the resources to complete crash analyses on their own. This could go hand in hand with a training or workshop that focused on topics such as data collection and how to use findings from the crash analyses. Results could be integrated into work on Transportation Plans, Comprehensive Plan, Vision Zero Action Plans, and Capital Improvement Plans.

Plan update process

The Pedestrian Safety Action Plan should be updated on a regular basis to continue to understand and prioritize addressing pedestrian safety, respond to changes in the region, and understand what progress has been made toward pedestrian safety. Based on TAG feedback, it is recommended to update the Plan every five years to coincide with the preparation of the Transportation Plan Policy (TPP). Updating the entire Action Plan will include updating the historic crash analysis, the safety analysis, and the programmatic recommendations. A critical piece to ensure smooth update to the analyses is collecting consistent, and as complete as possible, data from local agencies.

Data Collection, integrations, and management

Data-driven processes require ongoing care and maintenance to ensure their continued validity and ability to guide decision-making. Different types of changes may occur with the underlying data over time, necessitating different types of data updates and a nuanced update process that addresses these types of changes on their own timelines. As noted in the Systemic Safety Analysis chapter, pedestrian volume data was not available for this crash analysis, but it is recommended to be collected in the future as pedestrian safety has been established as a regional priority.

Limited data availability and quality presented substantial limitations in this project. Regional-scale analysis is limited by the fragmented nature of data from many different agencies. To begin to address this it is recommended for the Council and MnDOT to collaborate on data collection and require consistent data contributions from all cities and counties in the region. For constancy it is recommended that agencies collect data using Model Inventory of Roadway Elements (*MIRE*). MIRE is the recommended listing of roadway characteristics and traffic inventory elements for transportation agencies by FHWA and is helpful outside of pedestrian safety. Additional specific data could be requested to be collected by local agencies that prioritizes attributes for pedestrian safety such as speed, lanes, lane widths, shoulders, crosswalk markings, signals, crossing enhancements, sidewalks, sidewalk widths and buffer space, curb bulb-outs, APS, curb ramps, etc. All data collected should be consistent with MnDOT guidance outline in their *2017 Bicycle and Pedestrian Data Collection Manual*.

To collect data local agencies, have several options including:

- Purchase third party vendor data for the region
- Collecting data in stages and prioritizing areas of greatest need (i.e., greatest concentration of severe pedestrian crashes are in urban center communities and near public transit stops and stations).
- Collect by facility type (ex: sidewalks)

Conclusion

Implementation of the recommendations in this study will improve the data available to the Council and its partners to work toward its goal of eliminating fatal and serious injury crashes, as well as make progress on implementing pedestrian safety countermeasures. Roadway segments and intersections that have been identified as higher risk, where pedestrian facilities or crossing safety measures are not yet present, can be prioritized for application of engineering treatments designed to improve pedestrian safety. By deploying these measures systemically, planners and engineers can work to reduce and eventually eliminate pedestrian fatalities and serious injuries.

Success of any safety effort requires accurate and reliable data to support system-wide analyses. This data-driven approach is necessary to identify roadway conditions throughout the region that make serious injuries and fatalities more likely and to inform the installation of safety treatments designed to prevent them.

Appendices

- Appendix A: ThriveMSP 2040 Community Designations
- Appendix B: Pedestrian Safety Action Plan State of Practice Resources
- Appendix C: Crash Data Analysis and Trend Summary Memo
- Appendix D: Crash Tree Excel Documents
- Appendix E: Pedestrian Safety Measure 2022 Regional Solicitation
- Appendix F: Proposed New Regional Solicitation Pedestrian Safety Criterion Memo