Broadway Ave (US 441), Knoxville, Knox County, Tennessee

Pedestrian Road Safety Assessment Report

September 10-11, 2020

Table of Contents

Introduction

Background

The purpose of this study was to complete a road safety assessment (RSA), focusing on pedestrian safety, for North Broadway Ave (US 441) from Fairmont Blvd to Grainger Ave/Hall of Fame Drive (hereafter "study area"). The Federal Highway Administration (FHWA) supported the RSA through the Safe Transportation for Every Pedestrian (STEP) program. STEP is an innovation of the Every Day Counts (Rounds 4 and 5) initiative. Broadway Ave was selected per the request of the City of Knoxville and the Knoxville Regional Transportation Planning Organization (TPO) and in consultation with the FHWA Tennessee Division. The City of Knoxville is home to approximately 188,000 people, and the Tennessee Department of Transportation (TDOT), Knoxville Area Transit (KAT), and City provide operations and maintenance of facilities along the major arterial.

RSA Site Locations

The corridor is under the jurisdiction of TDOT. This major arterial is a two-way five-lane roadway with a continuous center two-way left turn lane, curb and gutter, and sidewalks on both sides . Posted speed limits are 40MPH along Broadway throughout the study area and 30-35MPH along residential cross streets. Annual average daily traffic (AADT) ranges from 15,000 at the Hall of Fame Dr/Grainger intersection, to 30,000 at Washington Pike, and 20,000 at the corridor's northern terminus. AADT overall has fallen approximately 25 percent since 2001, and the corridor exhibits strong directionality during AM and PM hours (indicating commuting southbound to the City's core).[1] Volumes are anticipated to show a continued drop in 2020 as a result of the COVID-19 pandemic.

Pedestrian and transit activity are highest near the study area's center. Land use patterns are similar across the corridor, with commercial and institutional fronting the corridor and residential one block beyond. The Knoxville Regional TPO provided the reported pedestrian and bicyclist-involved crash data set. **Major arterials like Broadway Ave represent 6 percent of Knoxville's road surface mileage but have 28 percent of reported bicycle and pedestrian injury crashes**.[2] This overrepresentation of reported crashes reinforced the need to address safety within the study area.

The RSA reviewed the following five segments of Broadway Ave (Figure 1). Each segment is approximately 1,000' long, or two city blocks.

- Segment 1 – Fairmont Blvd to Atlantic Ave
- Segment 2 – Claiborne Pl to Branson Ave
- Segment 3 – Branson Ave to Coker Ave
- Segment 4 – Coker Ave to Cecil Ave
- Segment 5 – Cecil Ave to Grainger Ave/Hall of Fame Dr

[1] Decreasing vehicle volumes are likely associated with the closing of the medical facility campus.
[2] Knoxville Crash Analysis Summary Report, Knoxville TPO, Oct. 2020, https://knoxtpo.org/wp-content/uploads/2020/10/Knoxville-Bike-Ped-Crash-Data.pdf

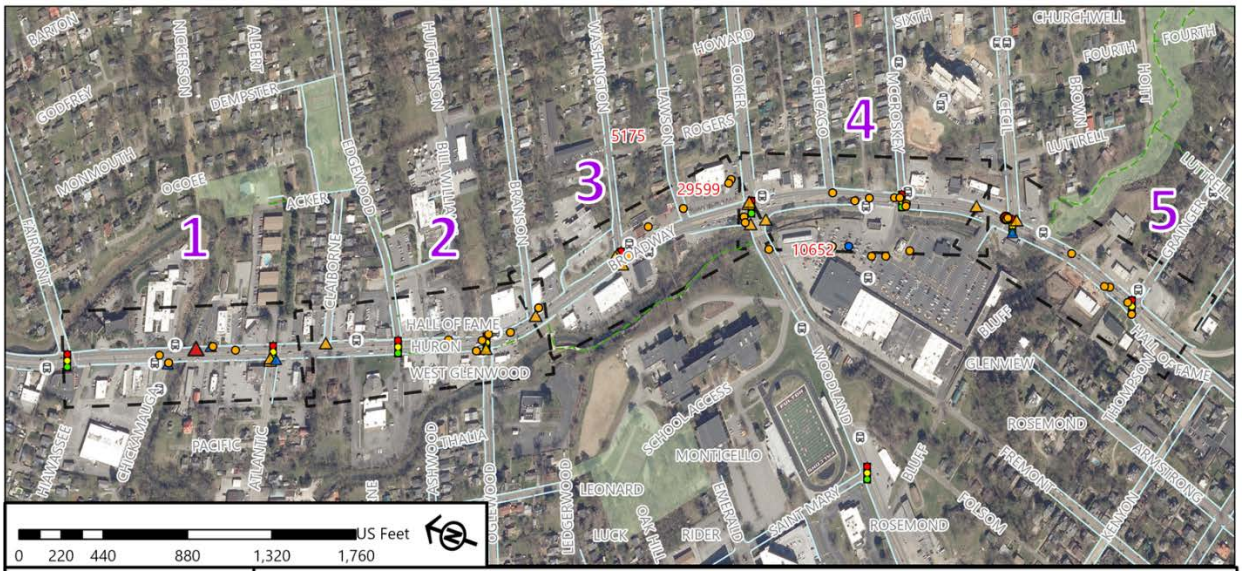


Figure 1 - Study Area Map Segments

RSA Process

RSA Team

The RSA team comprised the following people:

- Jessica Rich, FHWA Tennessee Division
- Ellen Zavisca, Knoxville Regional TPO
- Ken McMahon, City of Knoxville, Facade Improvement Program
- Jeffrey Branham, Chief Traffic Engineer, City of Knoxville
- Zach Roberts, Traffic Operations, City of Knoxville
- Chelsea Foster, Knoxville Regional TPO
- Jon Livengood, Alternative Transportation Engineer, City of Knoxville
- Dawn Michelle Foster, Engineering Staff, City of Knoxville
- Bryan Bartnik, Assistant Traffic Engineer, TDOT
- Bryan Hill, Consultant and Resident
- Andy Padgett, TDOT Region 1
- Rochelle Carpenter, Multimodal Coordinator, TDOT
- Nathan Vatter, State Traffic Engineer, TDOT
- Lauren Rider, City Council Representative for 4th District
- Lauren Blackburn, VHB on behalf of STEP
- Don Brown, VHB on behalf of STEP
- Joe Seymour, VHB on behalf of STEP

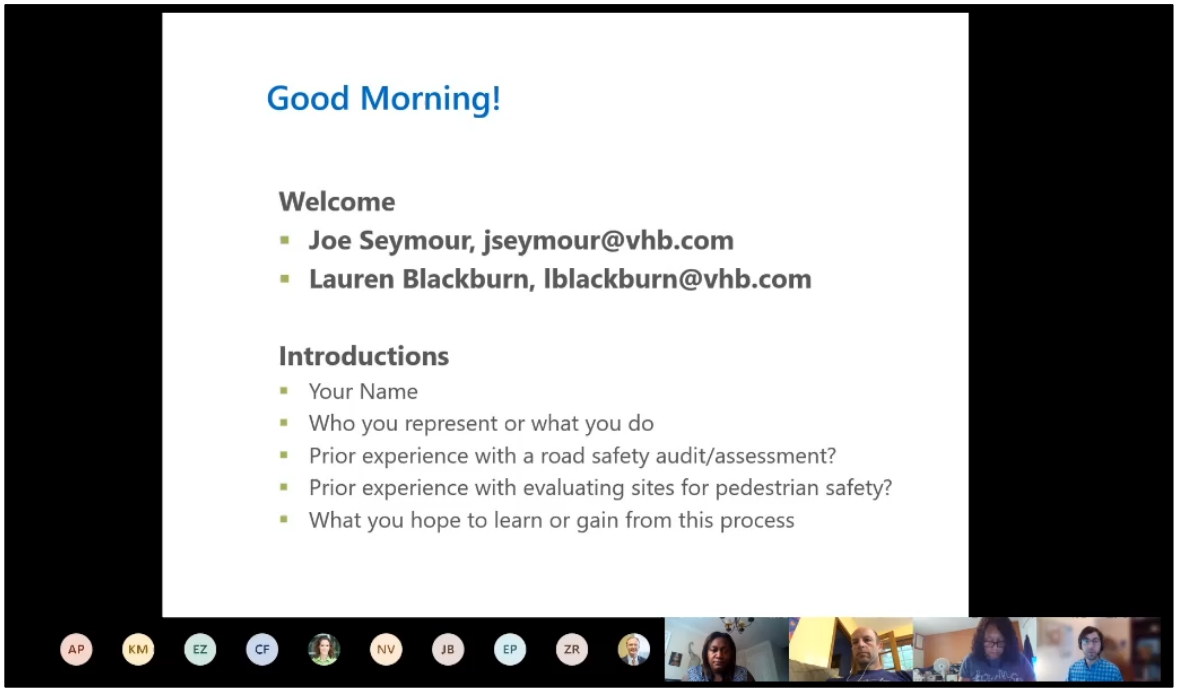
RSA Agenda

The RSA was conducted over a two-day period. Due to travel and group size restrictions from COVID-19, the traditional STEP RSA format was modified to two virtual meetings held on Microsoft Teams that were supplemented with field work from local RSA team members. The general activities conducted by the RSA are as follows:

Day 1: The RSA team conducted a kick-off meeting and discussed crashes for each of the study area segments and overall conditions. After the kick-off meeting, the RSA team began a review of the corridor's segments with the assistance of aerial imagery and photos and video captured during preparatory site visits. Following the conclusion of Day 1's virtual session, local RSA team members walked along the corridor and reviewed traffic conditions and then returned to the field to complete a nighttime corridor review.

Day 2: The RSA team reconvened over Microsoft Teams to continue discussing the corridor, including new findings and photos from the Day 1 field work and the nighttime field review. Discussion included a review of the STEP countermeasures, potential applications, and initial site-specific and corridor wide recommendations.

The Appendix includes the RSA's daily agendas, background briefing materials, and other supporting items.



Above: Day 1 Virtual Introductions During Broadway Ave Pedestrian RSA

Assessment Findings

Area-Wide Positive Features

The study area includes numerous features that promote pedestrian safety. These include marked crosswalks and pedestrian signal heads with countdown timers at most signalized intersections. Sidewalk is present along both sides of the corridor, and some intersection curb ramps were recently upgraded and include detectable warning strips. While the corridor is posted for 40MPH, the average speed is 35MPH, and the 85th Percentile is 40MPH; speeds are slightly higher in the off-peak period. Congestion and the traffic signal progression contribute to lower travel speeds. Knoxville Area Transit (KAT) operates transit service along the corridor, with transfers to other routes at the Broadway Shopping Center, and it is planning a Bus Rapid Transit service along Broadway. Overhead lighting is present throughout the corridor, though there are gaps and operational issues. The area also demonstrates high pedestrian

demand and activity through the combination of housing, transit, schools, parks, retail, grocers, and restaurants. These land uses present support the improvement and expansion the existing pedestrian facilities.

Area-Wide Reported Pedestrian Crashes

The corridor had 58 reported pedestrian and bicycle crashes from 2010 through 2019 (Figure 2). Bicycle and pedestrian travel behaviors along the corridor were similar (e.g. travel along the sidewalk and crossing at intersections). TPO provided the bicycle and pedestrian crash data in advance of the RSA to support analysis and preparation of the field materials and presentation. The City provided vehicular crash data to provide additional context on the corridor's safety issues. The FHWA facilitators prepared the crash summaries and segment crash maps.

Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- xxxx AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

Year	Type		Time of Day			Lighting		Severity			Crash Cause								Total
	Pedestrian	Bicycle	AM Peak (7AM-10AM)	PM Peak (4PM-7PM)	Off-Peak	Dark	Daylight	K Killed	Injury Crash	Other	Driver going straight	Driver turning left	Driver turning right	Driver turning (direction unclear)	Pedestrian crossing midblock	Bicyclist riding on sidewalk	Bicyclist riding wrong way	Reviewed	
2010		1			1		1			1						1			1
2011	4	1		2	3	1	4		5				1			1		3	5
2012	3			1	2		3		3		1	2							3
2013	5	4			9	4	5		8	1		2						7	9
2014	4	2		1	5	2	4		6				1		1	1		3	6
2015	6	1		4	3	1	6	1	6			1	2	1	2			1	7
2016	5	2		1	6	2	5		6	1		1			1			5	7
2017	3	1	1		3	1	3		4			1			2			1	4
2018	8	5		4	9	4	9		11	2	3		3			3		4	13
2019	1	2		1	2	1	2	1	1	1					1	1	1		3
Total	39	19	1	14	43	16	42	2	50	6	4	7	7	1	7	7	1	24	58

Figure 2 - Reported Pedestrian and Bicycle Crashes, 2010-2019

The majority of the reported pedestrian and bicycle crashes occurred near signalized intersections with marked crosswalks and pedestrian signal heads. Crash clusters (locations with three or more crashes) occurred in all the segments, which may be due to the corridor's consistent pedestrian-oriented land uses, transit access, and density of signalized intersections, as well as number of areas with elevated risk of conflict. Most crashes occurred outside of peak traffic hours and during daylight conditions (78 percent daytime vs 28 percent dark). However, it is still important to address the nonoperational lighting the nighttime field review revealed in several corridor segments. Non-fatal injury crashes were the most common at 86 percent with 10 percent other (non-injury) crashes, and 3 percent fatal crashes. The

reported crash category was Driver Failure to Yield (33 percent), followed by Lack of Safe Bicycling Facilities (12 percent), and Pedestrian Crossing Outside of Crosswalk (12 percent). Turning Vehicle Crashes (left and right) were for the most common reported crash factor (26 percent), followed by Midblock and Bicyclist-Sidewalk Riding crashes (12 percent each). This indicates issues with pedestrian visibility at intersections, lack of bicycle facilities, and insufficient opportunities to cross the roadway outside of signalized intersections.

Area-Wide Issues

The RSA observed the following issues affecting pedestrian safety along the study corridor.

- *Pedestrian Visibility at Intersections* – Marked crossing locations are only at signalized intersections, and while pedestrian signal heads are mostly present, failure to yield crashes represent a significant portion of all report pedestrian crashes. Pedestrians crashes were also reported crossing outside of marked crossings beyond the immediate intersection. This may indicate a preference for crossing during acceptable gaps in traffic instead of relying on a signal. Commonly reported motorist behaviors include low yielding to pedestrians rates, stopping over the stop bar on crosswalks, and turning right on red without first stopping.

- *Gaps in Network and Quality of Pedestrian Facilities* – While sidewalks are present to some extent throughout the corridor on both sides, there are some sidewalk and greenway gaps and likely non-ADA compliant curb ramps. There are also frequent curb cuts for driveway access to commercial properties; and most driveways do not delineate sidewalk from the driveway apron and likely do not meet ADA cross slope requirements. The lack of a furnishing strip throughout corridor segments makes walking uncomfortable, and obstructions from public and private property (e.g. vegetation) further reduce pedestrian comfort and safety at intersections.

- *Transit Infrastructure* – The majority of existing transit stop locations lack amenities such as shelters and benches. Where benches are present, they encroach into the sidewalk, narrowing the pedestrian path.

- *Pavement and Marking Quality* – Pavement markings, including crosswalks, appeared faded or worn, reducing their visibility and reflective properties. There are also locations where pavement markings are in need of replacement. Successive repavings have also increased the height of the roadway and created locations where there is limited or no vertical separation from the curb and sidewalk.

- *Frontage Conflicts* – There are many locations throughout the corridor where there is no separation between the sidewalk and the adjacent commercial properties' parking lot. The sidewalk functions as an extension of the parking lot and driveway without recognition of the pedestrian. As noted above, there are frequent curb cuts along the corridor, and businesses may have several access points along the same street, further reducing level sidewalk surfaces and creating additional potential driveway crossing conflicts. TDOT manages access points along this state route.

Left Image: A photo, looking south, showing pavement markings at the Coker/Woodland Ave intersection.
Right Image: A photo of Broadway Ave showing the five-lane cross section with the center two-way left turn late.

Area-Wide Suggestions

The following suggestions are recommended within three implementation timeframes to promote pedestrian safety throughout the corridor. These suggestions are dependent on funding availability, project feasibility, other local constraints, and coordination between local, state, regional, and private entities. Though these suggestions are recommended in a sequence, they should be revisited depending on funding availability and for compatibility with concurrent improvement opportunities (e.g. roadway resurfacing, new development, intersection upgrades, and expanded park facilities). TDOT plan sets for pedestrian improvements are included in the Appendix. Segment-based recommendations, implementation timeframes, and responsible parties are described later in this report and summarized in the Appendix.

Near-term (0-2 years)

- Refresh pavement markings and install crosswalks at new locations
- Landscape vegetation that is obscuring pedestrian visibility
- Review of intersection signal timing for consideration of protected left turn phasing, right turn on red prohibitions, and other improvements to reduce vehicle turning conflicts.
- Install pedestrian signal heads at signalized intersections and include a lead pedestrian interval (LPI) at those locations with frequent turning vehicle conflicts. Pedestrian signal heads with countdown timers can reduce pedestrian crashes by 25 percent, and LPIs can reduce pedestrian crashes by 13 percent.[3]

Intermediate (2-5 years)

- Incorporate coordinated signal phasing in the Advanced Traffic Management System (ATMS) plan

[3] For pedestrian countdown signals, consult the Toolbox of Pedestrian Countermeasures and their potential effectiveness, https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa18041/fhwasa18041.pdf. For LPIs, consult the FHWA Office of Safety STEP Program, https://safety.fhwa.dot.gov/ped_bike/step/resources/docs/fhwasa19040.pdf

- Pursue access management improvements to consolidate curb cuts and improve vehicular and pedestrian safety. Begin with temporary measures such as curb stops and flexible delineators.
- Modify intersection geometry to reduce the speed of turning vehicles. These could include reducing turning radii to slow the speed of right turns and hardening center lines to slow left turns. Begin with temporary measures such as flexible delineators, bollards, and pavement markings.
- Improve transit stop infrastructure for those locations with higher ridership to include benches and shelters

Long-term (5+ years)

- Continue access management and intersection geometric improvements by hardscaping temporary improvements and continuing sidewalks across driveway entrances.

Segment 1 – Fairmont Ave to Atlantic Ave

Reported Crashes

There were a total of 10 reported crashes within Segment 1, with four pedestrian and six bicycle crashes (Table 1). The majority of the crashes were injury crashes and occurred during daylight. Three of the 10 crashes were located at a signalized intersection (Atlantic Ave), while the remaining crashes occurred near driveways and at uncontrolled crossing locations. One of the corridor's two reported fatal crashes occurred near a driveway entrance. The noted crash categories indicate a lack of safe facilities and visibility for bicyclists and low visibility and few crossing opportunities for pedestrians.

Table 1 - Segment 1 Reported Pedestrian and Bicycle Crashes, 2010-2019

Type	Date	Time	Severity	Crash Factor	Crash Category	Daylight
Bike	8/5/2010	12:59 PM	No Injury	Bicyclist riding on sidewalk	Lack of safe facilities for bicycling	Light
Ped	6/14/2013	10:02 AM	Injury	Not enough information	Not enough information	Light
Bike	8/17/2013	9:58 PM	Injury	Driver turning left	Driver failure to yield	Dark
Ped	4/3/2015	6:06 PM	Injury	Driver turning right	Driver failure to yield	Light
Ped	11/5/2015	10:00 AM	Injury	Driver turning right	Driver failure to yield	Light
Bike	3/11/2018	4:44 PM	No Injury	Bicyclist riding on sidewalk	Lack of safe facilities for bicycling	Light
Bike	3/28/2018	12:46 PM	No Injury	Bicyclist riding on sidewalk	Lack of safe facilities for bicycling	Light
Bike	9/30/2018	2:08 AM	Injury	Not enough information	Not enough information	Dark
Ped	11/9/2018	11:00 PM	Injury	Driver going straight	Driver failure to yield	Dark
Bike	5/28/2019	2:10 PM	Fatal	Bicyclist riding against traffic	Bicyclist riding in unsafe manner	Light

Observations

- Land Use
    - There are frequent driveway curb cuts for businesses, and drivers were reported focusing on gaps in traffic before entering the roadway and not looking for pedestrians along the sidewalk or crossing midblock.
    - Parking is often located in the front of businesses fronting the roadway without buffers separating the parking lot, sidewalk, and roadway.
- Pedestrian Facilities
    - The crosswalks at Fairmont Blvd were faded, and there are pedestrian countdown heads at this location.
    - There are no marked crosswalks at Chickamauga Ave.
    - There are no pedestrian signal heads at the signalized Atlantic Ave intersection.
    - There are sidewalk gaps along Atlantic Ave, though sidewalks are to be installed as part of a TIP project between Broadway Ave and Pershing St.
- Transit Facilities
    - The bus stops in this segment are signed but lack infrastructure such as a bench or shelter.
    - There are no marked crossing opportunities to transfer from the stop on one side of Broadway at Chickamauga Ave to the other side.
- Visibility
    - Vegetation near the bridge obscured the visibility of pedestrians crossing Chickamauga Ave.
    - Vegetation at the southwest corner of Atlantic Ave obscured pedestrians from vehicles turning at the intersection.
- Traffic Control
    - Chickamauga Ave is stop controlled; the pavement on this street is rough and may need to be resurfaced. Rutting near the curb indicated wide and frequent turns.
- Lighting
    - This segment's lighting was described as low with gaps near Chickamauga Ave. This section of lighting is on a circuit and controlled by one sensor.

Above Image: A photo, looking south from Chickamauga Ave, showing an uncontrolled intersection and vegetation along the bridge that is reducing pedestrian visibility (red circle). This location was recommended for evaluation for installing a traffic signal.

Recommendations

Near-term (0-2 years)

- The City will initiate a work order to repair nonoperational lighting near Chickamauga Ave.
- The City and TDOT will treat the vegetation on the northwest corner of First Creek bridge and southwest corner of Atlantic Ave within their respective ROW, and the City will contact the affected property owners and request treatment.
- TDOT and the City will coordinate on refreshing faded crossing markings at Fairmont and Atlantic during scheduled roadway resurfacing projects.

Intermediate (2-5 years)

- TDOT will evaluate a traffic signal with pedestrian phase at the Chickamauga Ave intersection and consider restricting left turning movements and adding a median to support pedestrian crossings.

Segment 2 – Claiborne Pl NE to Branson Ave

Reported Crashes

There were a total of seven reported crashes within Segment 2, with five pedestrian and two bicycle crashes (Table 2). All were injury crashes, occurring mostly during daylight conditions. Notable crash categories include pedestrians crossing outside of the crosswalk and drivers failing to yield (during a left turn). The crashes are concentrated within the vicinity of the Oglewood Ave signalized intersection. The crashes may indicate low visibility of pedestrians crossing near the Oglewood Ave intersection and the

desire to cross outside of the Oglewood Ave intersection (or discomfort with turning vehicles near that location).

Table 2 - Segment 2 Reported Pedestrian and Bicycle Crashes, 2010-2019

Type	Date	Time	Severity	Crash Factor	Crash Category	Daylight
Ped	5/17/2012	2:34 PM	Injury	Driver going straight	Driver failure to yield	Light
Ped	4/11/2013	12:25 AM	Injury	Not enough information	Not enough information	Dark
Bike	5/9/2013	10:18 AM	Injury	Driver turning left	Driver failure to yield	Light
Ped	7/16/2015	5:04 PM	Injury	Driver turning left	Driver failure to yield	Light
Ped	6/21/2016	5:23 PM	Injury	Pedestrian crossing midblock	Pedestrian crossing outside of crosswalk	Light
Ped	1/1/2017	2:35 AM	Injury	Pedestrian crossing midblock	Pedestrian crossing outside of crosswalk	Dark
Bike	1/6/2019	5:56 PM	Injury	Bicyclist riding on sidewalk	Lack of safe facilities for bicycling	Dark

Observations

- Land Use
    - The gas station near Oglewood Ave has several access points onto Broadway, including next to the intersection.
- Pedestrian Facilities
    - The marked crosswalk at Edgewood Ave connects to a landscaped buffer.
    - There is no pedestrian signal head at the signalized Oglewood Ave intersection.
    - There are no crosswalks across the north and east legs of the Oglewood Ave and Broadway intersection. There is a utility pole in the northeast corner that reduces the width of the sidewalk and impedes the crossing.
- Transit Facilities
    - The transit stop on the west side of Broadway at Oglewood Ave has a bench, though the stop is on a Shared-Use Path (SUP) and is a conflict point for pedestrians and people waiting to ride KAT.

Left Image: A photo at the Oglewood Ave intersection, looking south, showing the existing transit stop and bench encroaching on the sidewalk and First Creek greenway connector, and immediately adjacent to a gas station driveway. Right Image: A photo at Edgewood Ave, looking west, showing the marked crosswalk on the northern leg of the intersection connecting to a curb and furnishing strip instead of a curb ramp.

Recommendations

Near-term (0-2 years)

- City to evaluate adding a pedestrian signal head on Oglewood Ave at Broadway.
- TDOT and City to coordinate on adding pavement markings and ramps on the south side of the Edgewood and Broadway intersection to connect with the First Creek greenway connector.

Intermediate (2-5 years)

- TDOT to evaluate the consolidation of access points for Krystal along Broadway and coordinate with KAT to improve the location of the transit bench and reduce obstructions on the sidewalk.
- TDOT to evaluate a location for a midblock crossing.

Segment 3 – Branson Ave to Coker Ave

Reported Crashes

There were a total of 11 reported crashes within Segment 3, with seven pedestrian and four bicycle crashes (Table 3). Nearly all the crashes were injury crashes and occurred during daylight conditions. Five of the crashes occurred in the vicinity of the signalized Washington Pike intersection, and five were located off Broadway (on side streets or in parking lots). The crashes at the Washington Pike intersection included turning vehicle crashes (failure to yield), which may indicate issues with pedestrian visibility when crossing during the WALK phase.

Table 3 - Segment 3 Reported Pedestrian and Bicycle Crashes, 2010-2019

Type	Date	Time	Severity	Crash Factor	Crash Category	Daylight
Ped	5/1/2011	4:10 PM	Injury	Not enough information	Not enough information	Light
Ped	8/18/2011	10:05 AM	Injury	Not enough information	Not enough information	Light
Bike	10/29/2014	10:10 AM	Injury	Not enough information	Not enough information	Light
Ped	11/8/2014	3:27 PM	Injury	Not enough information	Not enough information	Light
Ped	10/8/2015	6:49 PM	Injury	Pedestrian crossing midblock	Pedestrian crossing outside of crosswalk	Light
Bike	5/1/2016	8:21 PM	Injury	Not enough information	Not enough information	Dark
Ped	5/5/2016	1:23 PM	Injury	Driver turning left	Driver failure to yield	Light
Ped	4/20/2018	4:30 PM	Injury	Not enough information	Not enough information	Light
Bike	8/28/2018	3:58 PM	Injury	Bicyclist riding on sidewalk	Lack of safe facilities for bicycling	Light
Bike	12/19/2018	2:20 PM	Injury	Driver turning right	Driver failure to yield	Light
Ped	1/28/2019	12:49 PM	No Injury	Pedestrian crossing midblock	Pedestrian crossing outside of crosswalk	Light

Observations

- Land Use
    - There are multiple businesses on the both sides of Broadway that have several access points or continuous laydown ramps into each business. There are no parking stops, and vehicles were observed parked in the combined driveway/sidewalk area.
    - Fulton High School is to the west of Broadway, and approximately 30-40 percent of students are attending virtually due to COVID-19. Typically 1,000 students and 150 staff are present during normal operating conditions.
- Pedestrian Facilities
    - The ramps at Branson Ave have recently been improved.
    - The First Creek greenway is 10'-12' wide on the west side of Broadway; it connects to an overland sidewalk connector to the north and E Woodland Ave to the south.
    - The Washington Pike intersection has two legs with marked crosswalks, and the markings were faded. There are no pedestrian signal heads. The lack of a furnishing strip may complicate the placement of a pedestrian push button (automatic detection and recall were discussed as options).
    - There is open frontage without sidewalks—and delineation from the sidewalk—along the west side of Broadway near Washington Pike.

Left Image: A photo of the First Creek greenway, looking west towards Fulton High School.
Right Image: A photo the Washington Pike and Broadway intersection, looking east, showing the signalized intersection with crosswalk that does not have a pedestrian signal head.
Bottom Image: A photo north of Woodland Ave, looking north, showing the lack of separation of the sidewalk from commercial parking lots fronting the roadway. Parked vehicles were observed encroaching into the sidewalk.

Recommendations

Near-term (0-2 years)

- The City will draft and send a letter to the TDOT Strategic Transportation Investment Division (STID) requesting assistance with separating parking space from the sidewalk through short-term (e.g. curb stops or delineators) and long-term actions (e.g. sidewalk construction and access management plan).

Intermediate (2-5 years)

- TDOT to evaluate inclusion of LPI and pedestrian signal heads at the Washington Pike intersection as part of the ATMS Plan.

Segment 4 – Coker Ave to Cecil Ave

Reported Crashes

There were a total of 20 reported crashes within Segment 4, with 15 pedestrian and five bicycle crashes (Table 4). Nearly all were injury crashes and occurred during daylight conditions. Driver failure to yield was the most frequent crash category with the factor most often listed as turning vehicle crash. Signalized intersections were the site of the majority of crashes with the most at Coker/Woodland Ave, followed by McCroskey Ave. Five crashes were reported within the Broadway Shopping Center parking lot. The pedestrian crash patterns indicate visibility issues within marked crossings.

Table 4 - Segment 4 Reported Pedestrian and Bicycle Crashes, 2010-2019

Type	Date	Time	Severity	Crash Factor	Crash Category	Daylight
Bike	2/22/2011	5:26 PM	Injury	Bicyclist riding on sidewalk	Lack of safe facilities for bicycling	Light
Ped	7/20/2012	4:36 PM	Injury	Driver turning left	Driver failure to yield	Light
Ped	11/28/2012	2:52 PM	Injury	Driver turning left	Driver failure to yield	Light
Bike	1/3/2013	1:04 PM	Injury	Not enough information	Not enough information	Light
Ped	2/18/2013	2:49 PM	Injury	Not enough information	Not enough information	Light
Ped	6/3/2013	9:22 PM	Injury	Not enough information	Not enough information	Dark
Ped	7/1/2013	2:35 PM	Injury	Not enough information	Not enough information	Light
Ped	6/17/2014	9:36 PM	Injury	Not enough information	Not enough information	Dark
Ped	12/6/2014	3:33 PM	Injury	Driver turning right	Driver failure to yield	Light
Bike	8/9/2015	3:07 PM	Injury	Driver turning (direction unclear)	Driver failure to yield	Light
Ped	1/4/2016	2:58 PM	Injury	Not enough information	Not enough information	Light
Bike	3/11/2016	2:41 PM	Injury	Not enough information	Not enough information	Light
Ped	9/12/2016	2:11 PM	No Injury	Not enough information	Not enough information	Light
Ped	2/12/2017	3:54 PM	Injury	Driver turning left	Driver failure to yield	Light
Bike	4/20/2017	3:07 PM	Injury	Not enough information	Not enough information	Light
Ped	7/3/2017	9:13 AM	Injury	Pedestrian crossing midblock	Pedestrian crossing outside of crosswalk	Light
Ped	6/30/2018	5:06 PM	Injury	Driver turning right	Driver failure to yield	Light
Ped	7/10/2018	2:00 PM	Injury	Not enough information	Not enough information	Light
Ped	11/5/2018	7:26 PM	Injury	Driver going straight	Driver failure to yield	Dark
Ped	11/10/2018	4:11 PM	Injury	Not enough information	Not enough information	Light

Observations

- Land Use
    - The medical campus to the west of the study area is scheduled for redevelopment into a public safety facility.
    - The Broadway Shopping Center is a major draw for pedestrian and transit trips to the area. The shopping center includes a Kroger grocery store.
    - Fulton High School, while located in Segment 3, generates trips that pass through this area.
- Roadway
    - The Coker/Woodland Ave intersection's western legs are wide with a large turning radius.
- Transit Facilities
    - The study area's highest ridership KAT stop is the Broadway Shopping Center stop (toward downtown).[4] The stop has a waste bin but no other infrastructure. Riders were observed siting on a guard rail. There is no separation of the sidewalk from the adjacent commercial property's parking lot.
- Pedestrian Facilities
    - Both the signalized intersections of Woodland Ave/Coker and McCroskey Ave have three legs marked with crosswalks.
    - Pedestrian signal heads were present on the three legs of the Woodland Ave/Coker intersection, however signal heads at the McCroskey intersection were present only across Broadway. Crossing phases appeared adequate to complete the crossing in one stage.
    - The pedestrian push buttons at Woodland Ave/Coker did not appear to function during the RSA field review.
    - There is a planned greenway connection on the west side of Broadway, and the crossing would likely use the west leg crosswalk of the Woodland Ave/Coker intersection.
- Vegetation
    - Vegetation on the southwest corner of Woodland Ave/Coker appeared to obscure pedestrians.
- Lighting
    - The RSA team reported nonoperational light on the southbound approach to the Coker Ave Intersection on the east side (near Walgreens).

[4] KAT-supplied ridership data showed 1,626 riders at the Broadway Shopping Center stop from October 1-15, 2019, for an estimated daily average ridership of 108. The stop's ridership was nearly five times higher than the next highest stop within the study area.

Left Image: A photo of the Woodland Ave/Coker intersection, looking north, showing the wide crossing distances across Broadway. The crossing distance is approximately 100' curb to curb.
Right Image: A photo of the KAT Broadway Shopping Center transit stop, looking north, showing the lack of amenities for the corridor's highest use transit stop.

Recommendations

Near-term (0-2 years)

- City Council District 4 Member Lauren Rider to schedule a meeting with new KAT Director to review the results of the RSA.
- The City will mark a crosswalk across the entrance to the Broadway Shopping Center.
- The City will initiate a work order to repair nonoperational lighting near the Walgreens at the Woodland Ave/Coker and Broadway intersection.
- The City and TDOT will treat the vegetation within their respective ROW at the southwest corner of the Woodland Ave/Coker intersection, and the City will contact the affected property owners and request treatment.

Intermediate (2-5 years)

- The City, TPO, and TDOT will evaluate the Woodland Ave/Coker intersection after the opening of the public safety complex. The review could include reconfiguration of turn lanes for the inclusion of pedestrian refuge islands, realigned corners (potentially with mountable curbs), and allocation of a pedestrian queuing/storage area for the First Creek greenway connection.
- TDOT to evaluate adding a midblock crossing.

Segment 5 – Cecil Ave to Grainger Ave/Hall of Fame Dr

Reported Crashes

There were a total of 10 reported crashes within Segment 5, with eight pedestrian and two bicycle crashes (Table 5). The majority were injury crashes and occurred during dark conditions. Four of the crashes were in the proximity of the Cecil Ave intersection, including a fatality. Driver failure to yield was the most frequently reported crash category, followed by pedestrian crossing outside of crosswalk. The crash locations and descriptions indicate pedestrian visibility issues at the Cecil Ave intersection and lack of adequate crossing facilities at and near the Grainger/HoF intersection.

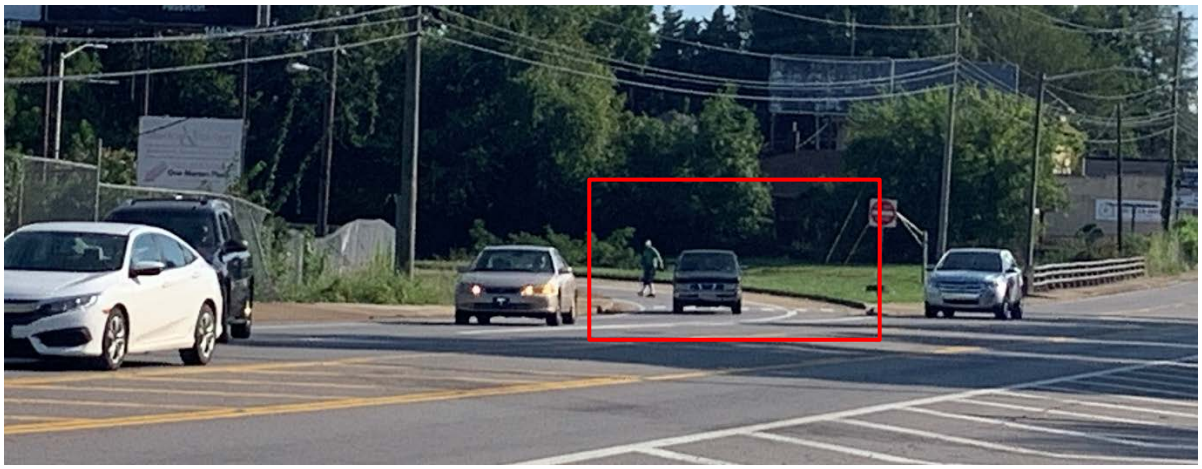
Table 5 - Segment 5 Re Reported Pedestrian and Bicycle Crashes, 2010-2019

Type	Date	Time	Severity	Crash Factor	Crash Category	Daylight
Ped	9/7/2011	2:12 PM	Injury	Driver turning right	Driver failure to yield	Light
Ped	9/14/2011	8:12 PM	Injury	Not enough information	Not enough information	Dark
Bike	9/20/2013	11:00 PM	No Injury	Not enough information	Not enough information	Dark
Bike	12/16/2014	4:45 PM	Injury	Bicyclist riding on sidewalk	Lack of safe facilities for bicycling	Light
Ped	12/27/2014	9:50 PM	Injury	Pedestrian crossing midblock	Pedestrian crossing outside of crosswalk	Dark
Ped	1/2/2015	6:09 AM	Injury	Pedestrian crossing midblock	Pedestrian crossing outside of crosswalk	Dark
Ped	7/15/2015	5:16 PM	Fatal	Not enough information	Not enough information	Light
Ped	2/19/2016	8:20 PM	Injury	Not enough information	Not enough information	Dark
Ped	4/16/2018	10:40 PM	Injury	Driver going straight	Driver failure to yield	Dark
Ped	11/14/2018	3:47 PM	Injury	Driver turning right	Driver failure to yield	Light

Observations

- Roadway
    - The Cecil Ave intersection is a three-legged, skewed, signalized intersection. The ongoing Broadway Corridor Improvement Study has produced a draft alternative for the intersection that would realign the intersection to square up with a new entrance to the Broadway Shopping Center.
    - The RSA team reported that the Cecil Ave intersection has poor vehicle yielding and visibility.
    - The Grainger/Hall of Fame (HoF) intersection is signalized but also has a free-flow southbound lane to the highway. The ATMS project is anticipated to include a protected phase for pedestrians (i.e. signal phase where there are no vehicle movements to conflict with a crossing pedestrian). The ongoing Broadway Corridor Improvement Study has also produced draft alternatives for this intersection, such as a roundabout and a T-intersection.

    - Northbound vehicles have been observed improperly using the center turn lane to make U-turns on the southbound HoF ramps.
- Pedestrian Facilities
    - Curb ramps at the Cecil Ave intersection are missing truncated domes or detectable warning surfaces. There are crosswalk markings across three legs, and the markings appeared faded.
    - There is a MioVision camera detection system at the Cecil Ave intersection that triggers the pedestrian phase. There is a pending equipment upgrade to extend the WALK phase.
    - The RSA team reported that the sidewalk on the east side of the roadway south of Cecil Ave is an uncomfortable place to walk given the lack of curb separating it from the northbound travel lane. Water pools on the sidewalk after rain. This sidewalk functions as the connection to the First Creek greenway.
    - The Grainger/HoF intersection is signalized and has one leg of the intersection marked across Broadway, but there is a continuous free-flow southbound lane. There are no pedestrian signal heads.
    - There is a faded marked crosswalk with pedestrian warning signage across the northbound off-ramp to Broadway.



Left Image: A photo at the Cecil Ave intersection, looking west, showing the lack of a pedestrian signal head at this high-pedestrian-crash intersection.
Right Image: A photo of the Grainger Ave intersection, looking south, showing the crosswalk spanning a free-flow southbound on-ramp.
Below image: A photo of the northbound off-ramp to Broadway, looking south, showing a pedestrian crossing at the marked crosswalk (red box).

Recommendations

Near-term (0-2 years)

- TDOT to consider inclusion of an LPI at the Cecil Ave intersection.
- The City will improve wayfinding along the overland connector portions of the First Creek greenway.
- TDOT and the City to assess vehicular crash patterns at the HoF/Grainger Ave intersection. If the analysis indicates turning vehicle crashes from U-turns, the City will to work with TDOT to explore adding quick curb or flexible delineators/bollards within the northbound turn lane on the Broadway approach to Grainger Ave (to prevent U-turns to the southbound on-ramps).

Intermediate (2-5 years)

- The City to improve the eastern sidewalk section south of Cecil Ave that provides access to the First Creek greenway.
- The City and TDOT to explore advance yield markings, additional warning signage with downward arrow, and Rectangular Rapid Flashing Beacon (RRFB) for the pedestrian crossing on the northbound off-ramp pedestrian crossing. RRFBs can reduce pedestrian crashes by 47 percent (for multilane roadways with up to 15,000 AADT).[5]
- TDOT to evaluate adding a midblock crossing.

Long-term (5+ years)

- The City and TDOT to design and construct the realignment of the Cecil Ave and HoF/Grainger Ave intersections with pedestrian crossing infrastructure, improved sidewalks, and First Creek greenway connection.

Next Steps

The findings of the RSA should be revisited on a recurring basis. The City, KAT, TPO, and TDOT may choose to review the RSA report with the original RSA team on an annual basis, for up to five years. The City may consider refreshing or revising the RSA process every 5 years. By developing performance measures for ongoing evaluation and review or utilizing those in place through the TPO's Mobility Plan, the City can track progress made at sites discussed by the RSA. Metrics can include the number of sites improved or the percent change in pedestrian crash rates over three or more years. The City, TDOT, and TPO may also consider short-term and pilot projects to demonstrate and further evaluate concepts noted within this report. These may include installing vertical delineators to separate vehicles and pedestrians in high-conflict areas.

Funding Opportunities

The City, TDOT, TPO, and other parties should also consider funding opportunities—like transit route and facility updates and spot safety improvements—and the long-range planning process to coordinate project development of safety measures.

Highway Safety Improvement Program (HSIP): The goal of the federally funded HSIP, as authorized in the FAST Act, is to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned public roads and roads on tribal lands. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads that focuses on performance. Approximately $62 million in HSIP funding was programmed in Tennessee in 2019.[6]

[5] FHWA, Safe Transportation for Every Pedestrian, Rectangular Rapid Flashing Beacons, 2018, https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RRFB_2018.pdf
[6] FHWA, "Tennessee Highway Safety Improvement Program 2019 Annual Report," https://safety.fhwa.dot.gov/hsip/reports/pdf/2019/tn.pdf

Congestion Mitigation and Air Quality Improvement (CMAQ) Non-Mandatory Program: CMAQ is a Federal reimbursement program authorized through the FAST Act and administered by TDOT. The CMAQ Program provides a flexible funding source to TDOT and local governments and tribes for transportation projects and programs that help meet the requirements of the Clean Air Act. Knoxville is eligible for CMAQ funds. Application information and the program guide are distributed by TDOT.

Transportation Alternatives Program (TAP): TAP is a Federal reimbursement program authorized through the FAST Act. TAP-Large Urban (for population areas >200,000) funds are administered and awarded through the TPO. Both the City of Knoxville and Knoxville TPO are eligible for TAP funds distributed by TDOT; the TPO receives approximately $760,000 per year. City of Knoxville and Knoxville TPO projects that have received TAP funds include portions of the First Creek greenway, sidewalk projects, and pedestrian intersection improvements.

Segment Implementation Recommendations

Location	Timeframe	Recommendation	Responsible Party
Segment 1 Fairmont Ave to Atlantic Ave	Near-Term	Initiate work order for nonoperational lighting near Chickamauga Ave	City of Knoxville
	Near-Term	Treat vegetation on the northwest corner of First Creek bridge and southwest corner of Atlantic Ave within respective ROW, and the City will contact the affected property owners and request treatment	City of Knoxville, TDOT
	Near-Term	Coordinate on working within the scheduled roadway resurfacing projects to refresh faded crossing markings at Fairmont Ave and Atlantic Ave	City of Knoxville, TDOT
	Intermediate	Evaluate a traffic signal with pedestrian phase at the Chickamauga Ave intersection and consider restricting left turning movements and adding a median to support pedestrian crossings	TDOT
Segment 2 Claiborne Pl NE to Branson Ave	Near-Term	Evaluate adding a pedestrian signal head on Oglewood Ave at Broadway	City of Knoxville
	Near-Term	Coordinate on adding pavement markings and ramps on the south side of the Edgewood and Broadway intersection to connect the First Creek Greenway connector	City of Knoxville, TDOT
	Intermediate	Evaluate consolidation of access points for Krystal along Broadway and coordinate with KAT to improve the location of the transit bench and reduce obstructions into the sidewalk	TDOT, KAT
	Intermediate	Evaluate location for a midblock crossing	TDOT
Segment 3 Branson Ave to Coker Ave	Near-Term	Draft and send a letter to the TDOT Strategic Transportation Investment Division (STID) requesting assistance with defining parking space from the sidewalk through short-term (e.g. curb stops or delineators) and long-term actions (e.g. sidewalk construction and access management plan)	City of Knoxville
	Intermediate	Evaluate inclusion of LPI and pedestrian signal heads at the Washington Pike intersection as part of the ATMS Plan	TDOT
Segment 4 Coker Ave to Cecil Ave	Near-Term	Schedule a meeting with KAT Director to review the results of the RSA	Knoxville City Council, KAT
	Near-Term	Mark a crosswalk across the entrance to the Broadway Shopping Center	City of Knoxville
	Near-Term	Initiate a work order to repair nonoperational lighting near the Walgreens at the Woodland Ave/Coker and Broadway intersection	City of Knoxville
	Near-Term	Treat the vegetation within respective ROW at the southwest corner of the Woodland Ave/Coker intersection, and the City will contact the affected property owners and request treatment	City of Knoxville, TDOT
	Intermediate	Evaluate the Woodland Ave/Coker intersection after the opening of the public safety complex. The review could include reconfiguration of turn lanes for the inclusion of pedestrian refuge islands, realigned corners (with potential mountable curbs), and allocation of a pedestrian queuing/storage area for the First Creek greenway connection	City of Knoxville, TDOT, Knoxville Regional TPO
	Intermediate	Evaluate adding a midblock crossing	TDOT, City of Knoxville
Segment 5 Cecil Ave to Grainger Ave/Hall of Fame Dr	Near-Term	Consider inclusion of an LPI at the Cecil Ave intersection	TDOT
	Near-Term	Increase wayfinding along the overland connector portions of the First Creek Greenway	City of Knoxville
	Near-Term	Assess vehicular crash patterns at the HoF/Grainger Ave intersection. If the analysis indicates turning vehicle crashes from U-turns, the City will to work with TDOT to explore quick curb or flexible delineators/bollards within the northbound turn lane on the Broadway approach to Grainger Ave (to prevent U-turns to the southbound onramps)	City of Knoxville, TDOT
	Intermediate	Improve the eastern sidewalk section south of Cecil Ave that provides access to the First Creek Greenway	City of Knoxville
	Intermediate	Explore advance yielding markings, additional warning signage with downward arrow, and Rectangular Rapid Flashing Beacon (RRFB) for the pedestrian crossing on the northbound HoF Dr off-ramp pedestrian crossing	City of Knoxville, TDOT
	Intermediate	Evaluate adding a midblock crossing	TDOT, City of Knoxville
	Long-term	Design and construct the realignment of the Cecil Ave and HoF/Grainger Ave intersections with pedestrian crossing infrastructure, improved sidewalks, and First Creek Greenway connection	City of Knoxville, TDOT

FHWA STEP Pedestrian Road Safety Assessment Agenda
September 10-11, 2020

N Broadway (US 441), Knoxville, TN

Day 1:

8:00-10:00 AM	RSA Kick-off Meeting • *Introduction of stakeholders and RSA team* • *Introduction to the RSA process* • *Pedestrian safety overview* • *Overview of study area*
10:00-10:15 AM	Break
10:15 AM-1:00 PM	Document Issues • *Segment by segment review* • *Assign homework and additional field investigation*
3:00 – 4:00 PM	Additional Field Investigation (optional) • *Meet at Sonic, 3307 N Broadway, Knoxville, TN 37917* • *Wear high visibility safety vest* • *Notify jseymour@vhb.com is going into the field*
7:30 – 9:00 PM	Nighttime Field Review (optional) • *Meet at Sonic, 3307 N Broadway, Knoxville, TN 37917* • *Wear high visibility safety vest* • *Notify jseymour@vhb.com is going into the field*

Day 2:

8:00-10:00 AM	Recap Previous Day's Findings • *Review field and nighttime field data gathering* • *Summarize issues* • *Discuss corridor-relevant countermeasures*
10:00-10:15 AM	Break
10:15 AM -1:00 PM	Team Discussion/Preliminary Findings • *Prioritize sites* • *Identify potential countermeasures* • *Discuss next steps*

TDOT Plan Sets

The following are links to recommended pedestrian and bicycle safety TDOT standard drawings or references in the TDOT Multimodal Design Guidelines:

Midblock crossings:
Section 7.5 of
https://www.tn.gov/content/dam/tn/tdot/multimodaltransportation/TDOT%20Multimodal%20Project%20Scoping%20Manual.pdf

Pedestrian Hybrid Beacon:
Section 7.5.2 of
https://www.tn.gov/content/dam/tn/tdot/multimodaltransportation/TDOT%20Multimodal%20Project%20Scoping%20Manual.pdf

Buffered bicycle lanes:
https://www.tn.gov/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/multimodal/mm-ts-1.html

https://www.tn.gov/content/tn/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/multimodal/mm-pm-4.html

Separated shared use paths:
https://www.tn.gov/content/tn/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/multimodal/mm-ts-3.html

Buffered sidewalks:
https://www.tn.gov/content/tn/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/multimodal/mm-ts-2.html

Pedestrian refuge island:
https://www.tn.gov/content/tn/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/roadway-and-pavement-appurtenances/rp-h-6.html

Leading pedestrian interval
Section 7.4.2 of https://www.tn.gov/content/dam/tn/tdot/traffic-engineering/tdm-2018/TDOT%20Traffic%20Design%20Manual_Complete%20Manual_Aug2018.pdf

Protected only left turn
Section 14.2.7 of https://www.tn.gov/content/dam/tn/tdot/traffic-engineering/tdm-2018/TDOT%20Traffic%20Design%20Manual_Complete%20Manual_Aug2018.pdf

MUTCD (or other) guidelines for STEP countermeasures for which TDOT does not have guidance:

Rectangular rapid flashing beacon
Road reconfiguration/lane repurposing

N Broadway (US 441) Pedestrian Road Safety Assessment

September 10-11, 2020

Good Morning!

Welcome

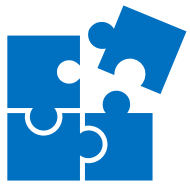
- **Joe Seymour, jseymour@vhb.com**
- **Lauren Blackburn, lblackburn@vhb.com**

Introductions

- Your Name
- Who you represent or what you do
- Prior experience with a road safety audit/assessment?
- Prior experience with evaluating sites for pedestrian safety?
- What you hope to learn or gain from this process

Overall Objectives for the RSA

- Enhance understanding about crash risk and unique vulnerabilities of pedestrians
- Engage with a variety of stakeholders to expand perspectives on pedestrian safety needs
- Identify and prioritize specific locations, along a set of select roadways in the area, where crash risk may be highest for pedestrians
- Discuss potential countermeasures and safety improvements for priority locations
- Increase staff confidence and skills for future road safety assessments, focused on pedestrian safety

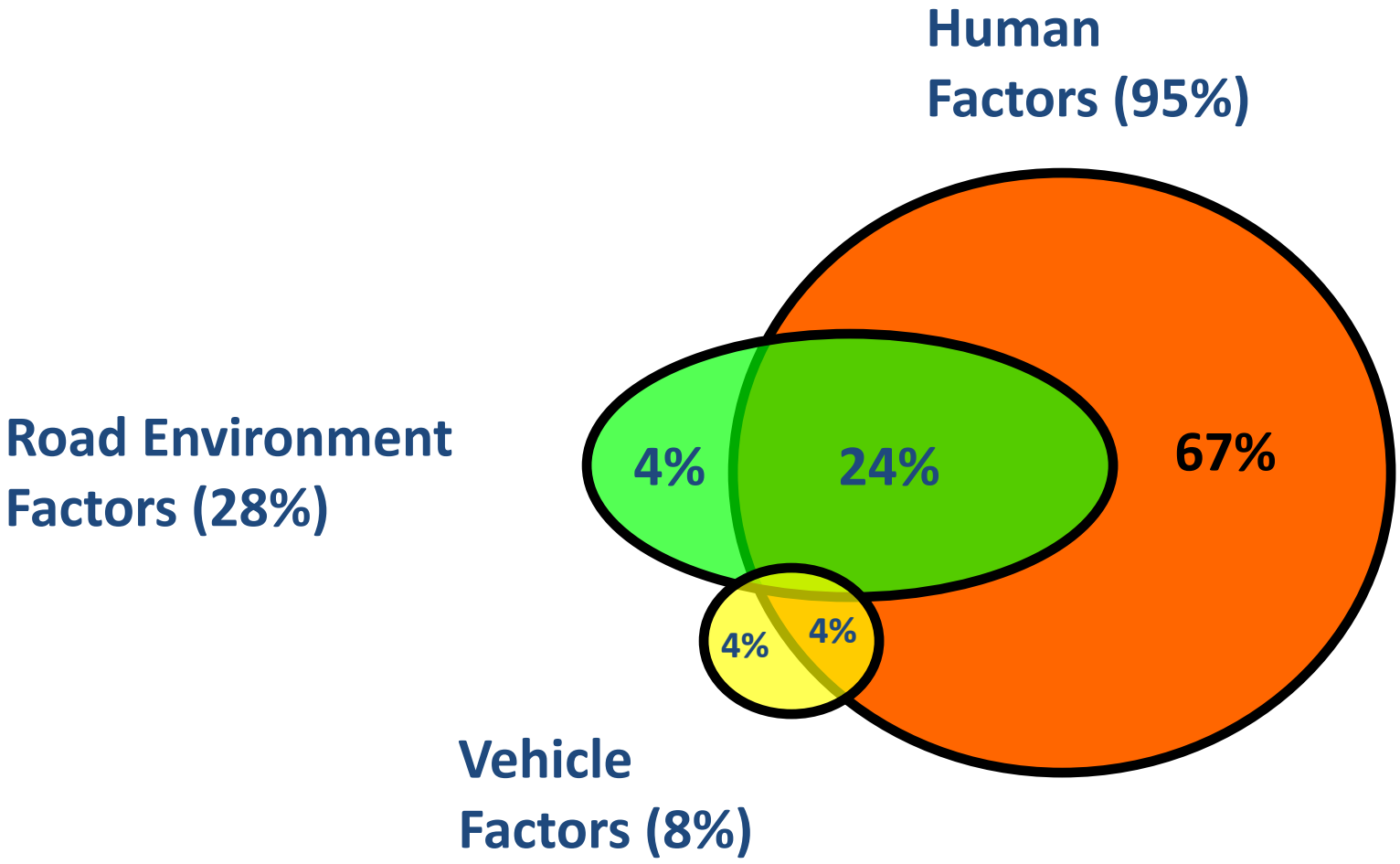


What is an RSA?

What is a Road Safety Audit / Assessment (RSA)?

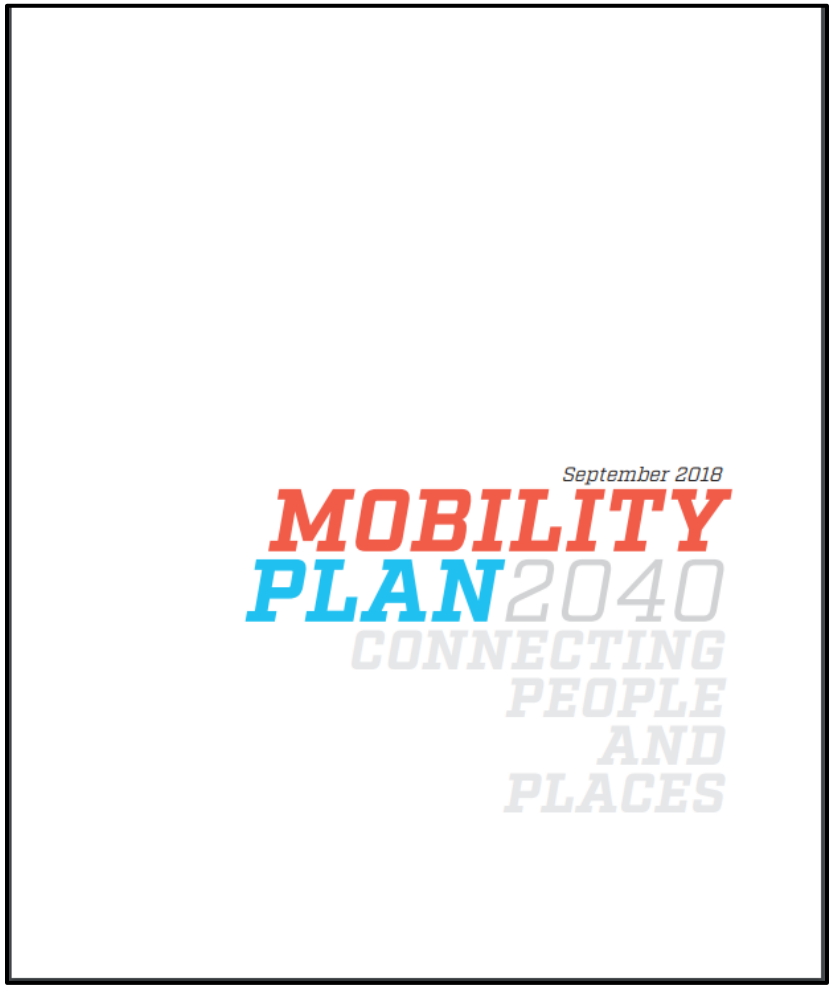
A formal safety performance evaluation of an existing or future road or intersection by an independent, multidisciplinary team.

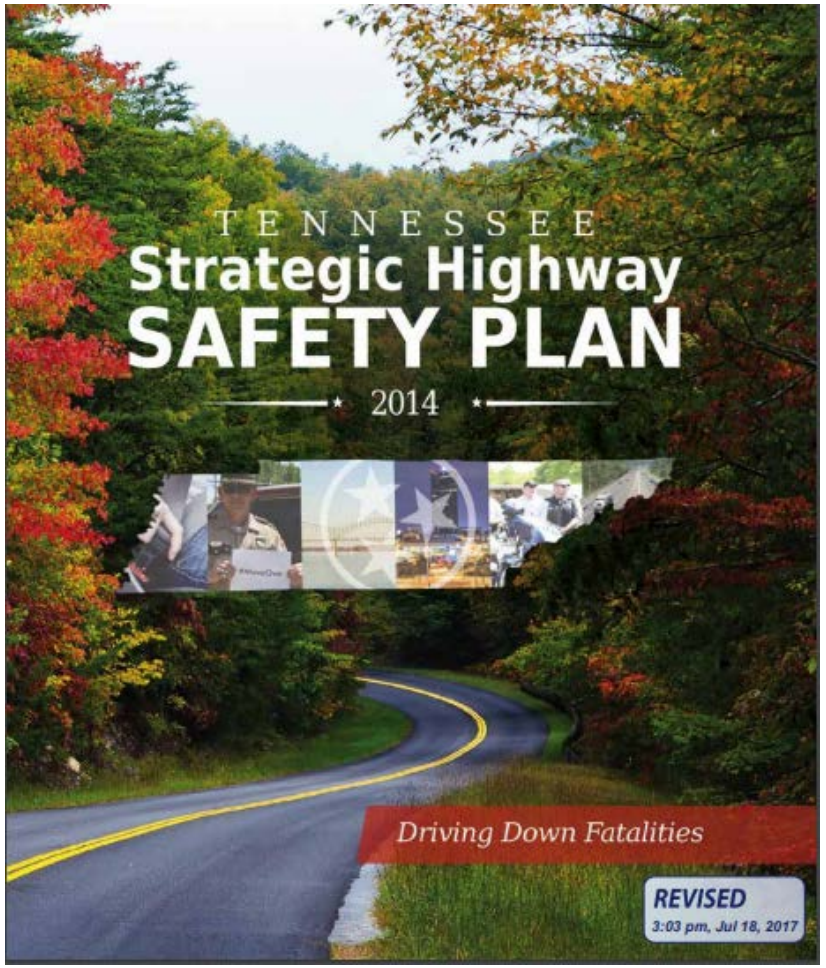
Why do we need RSAs?



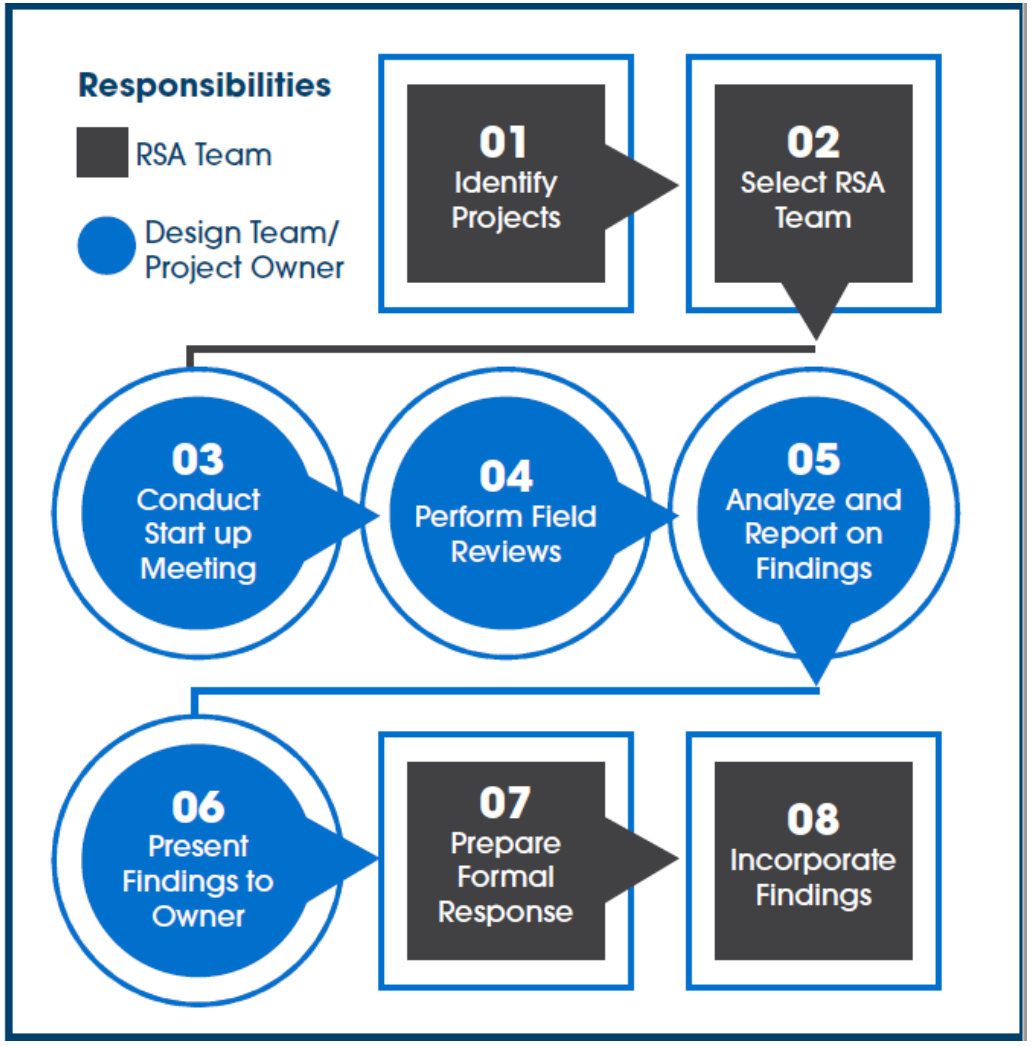
TYPICAL REPORTED CRASH CAUSES

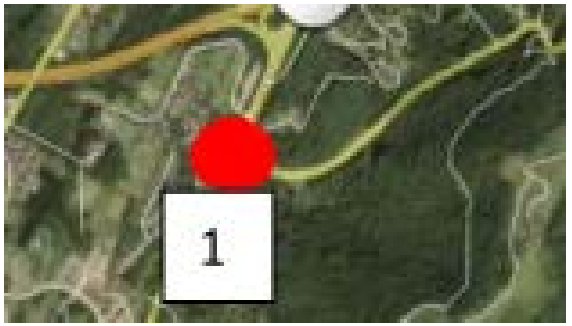
RSAs Support Other Goals





How are RSAs conducted?





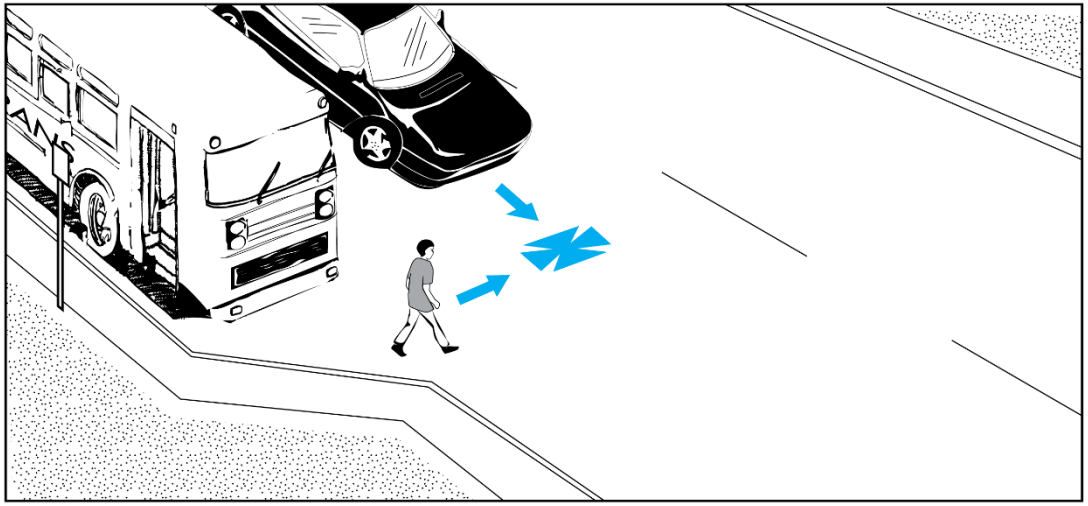
RSA Prompt Lists

- Presence of accommodations (bike, ped, and transit)
- Quality of facilities (bike, ped, and transit)
- Obstructions/continuity across network
- Overhead lighting
- Visibility of the crossing, pedestrians, and cyclists
- Driveways and conflicts
- Signs
- Pavement markings
- Signals (ped/bike accommodations)
- Destinations
- Traffic: speeds, gaps, turning movements

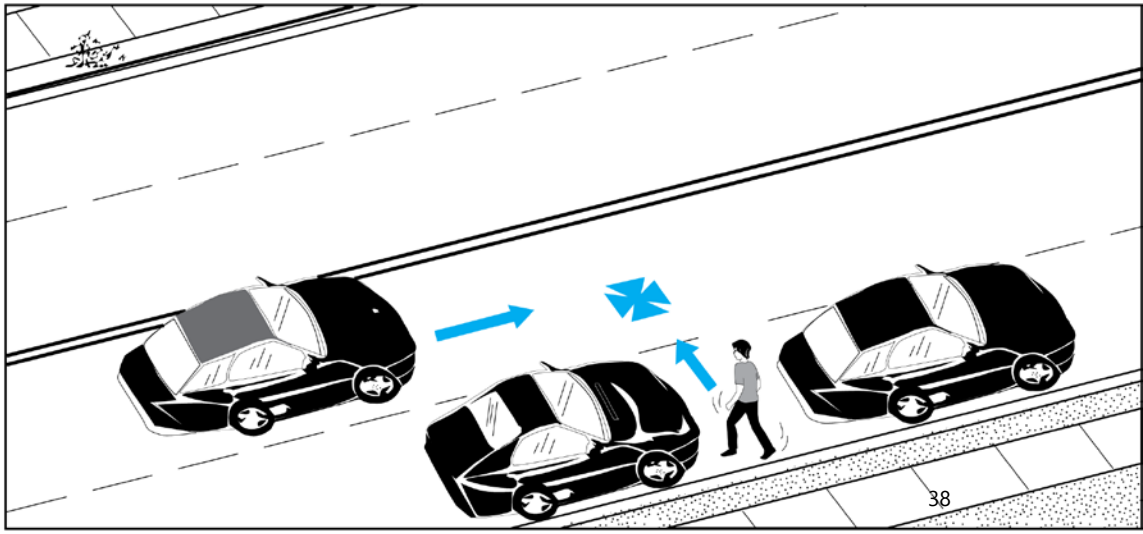
Crash Types

Multiple Threat Crash

Multiple Threat Crash



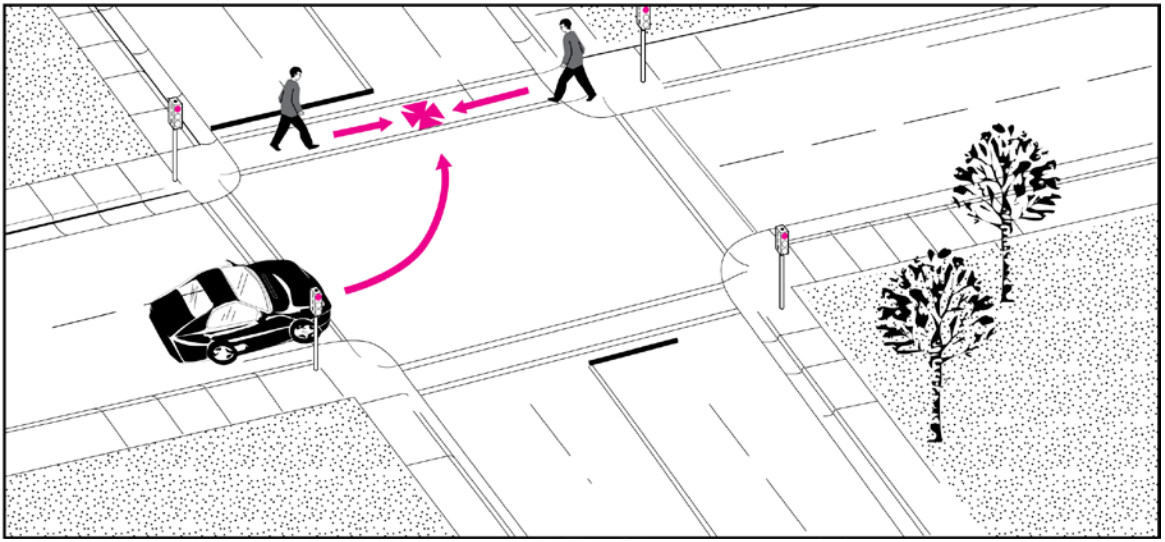
Multiple Threat- Commercial Bus



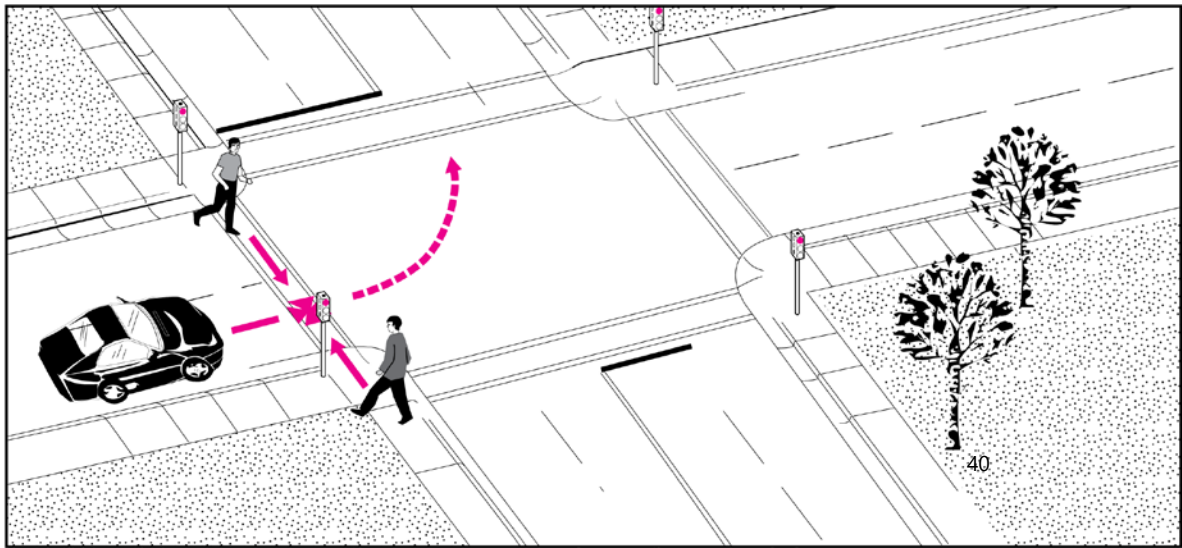
Multiple Threat- Trapped

Left Turn into Pedestrian Crossing Crash

Left Turn into Pedestrian Crossing Crash

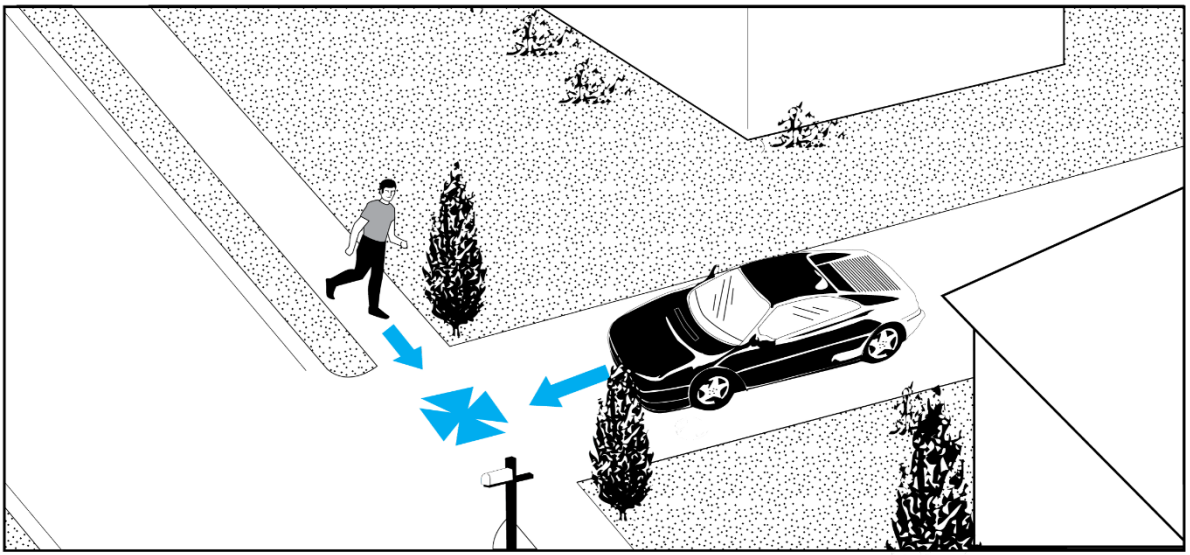


Motorist Left Turn-
Parallel Paths

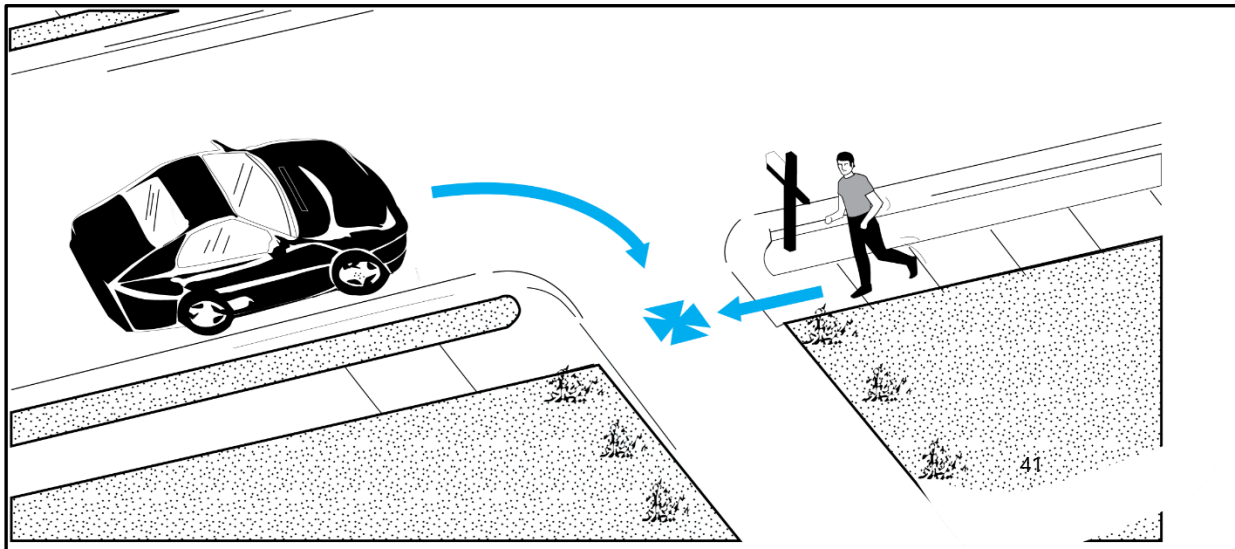


Motorist Left Turn-
Perpendicular Paths

Crossing Driveway

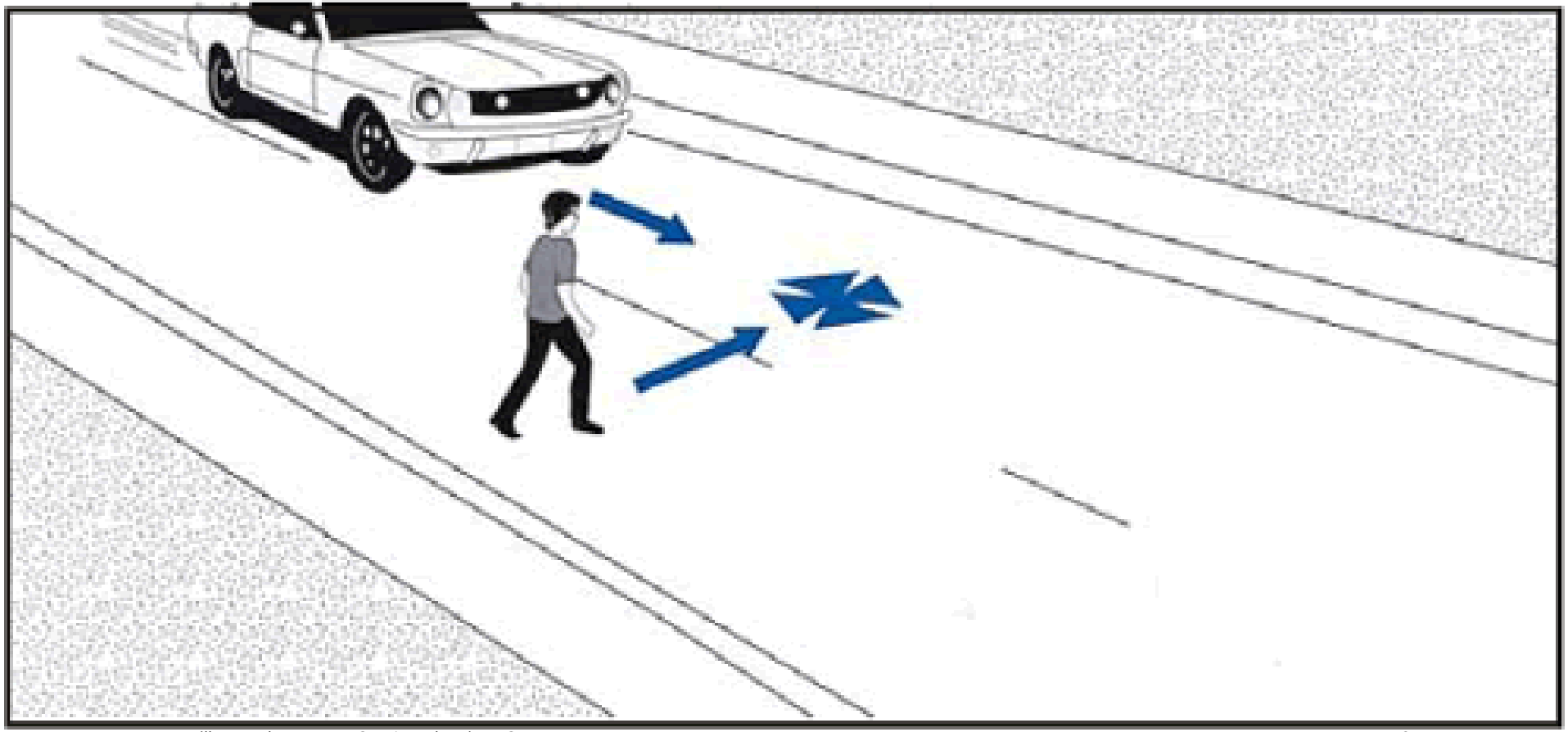


Motorist Exiting Driveway

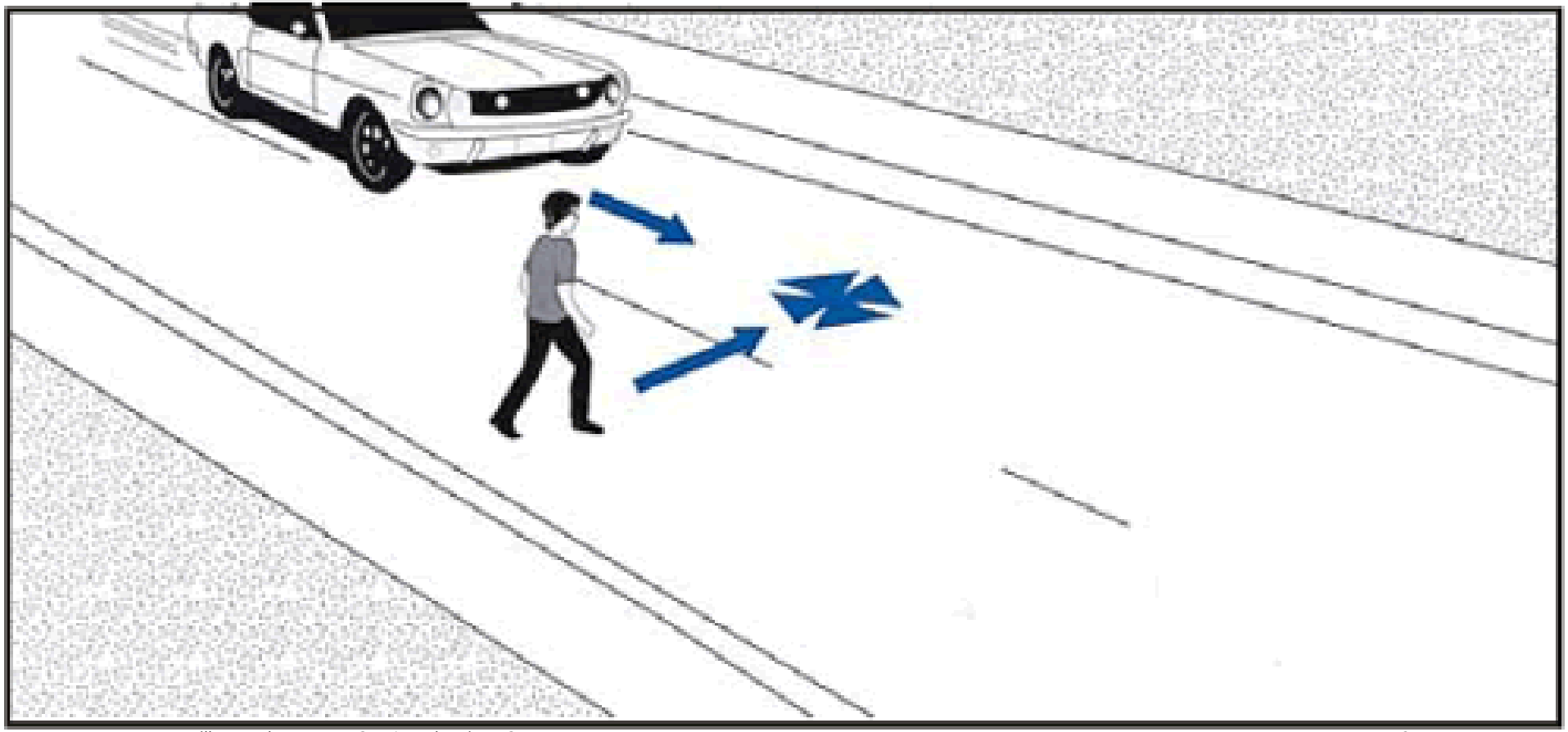


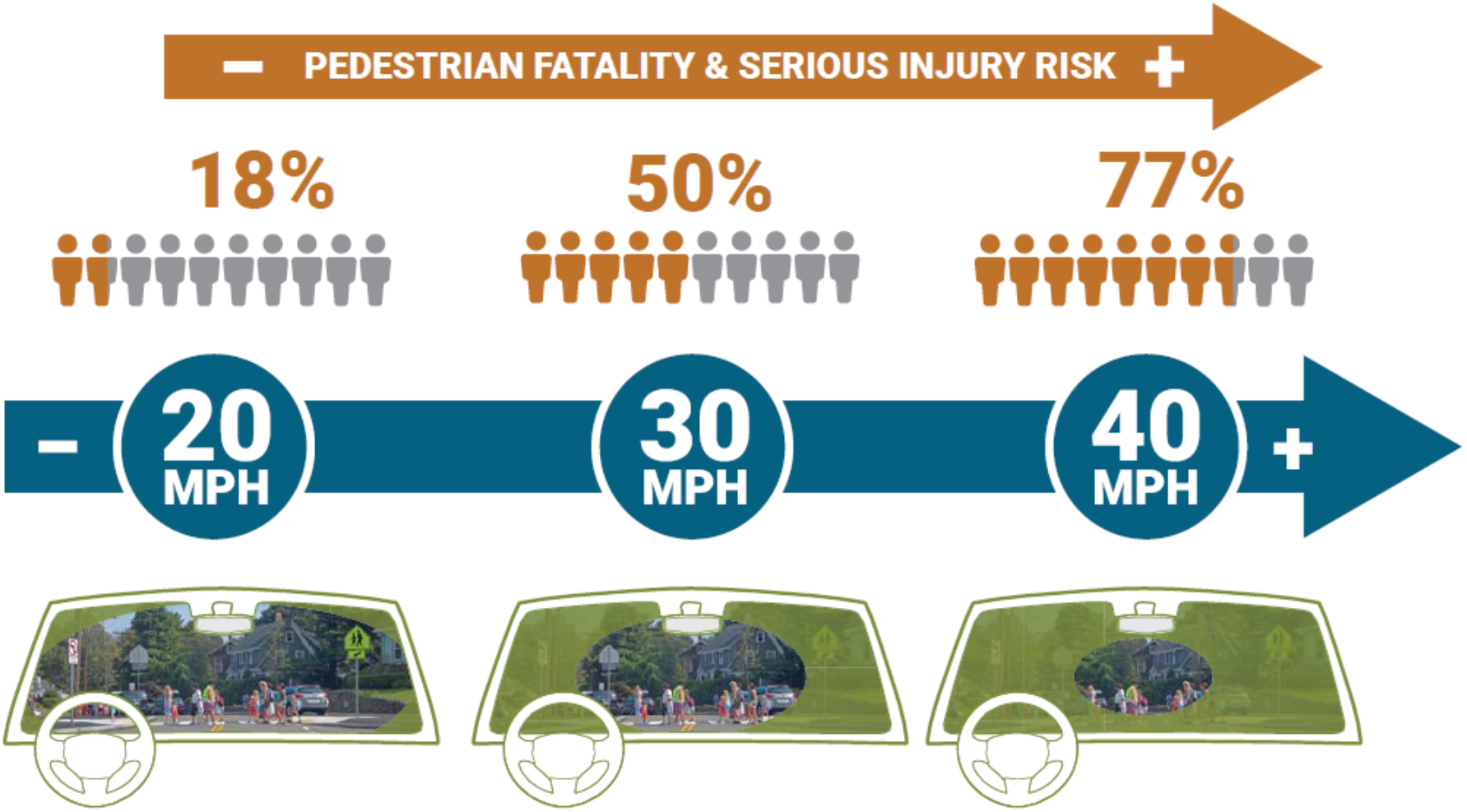
Motorist Entering Driveway

Crashes Due to Excessive Speed



Crashes Due to Excessive Speed

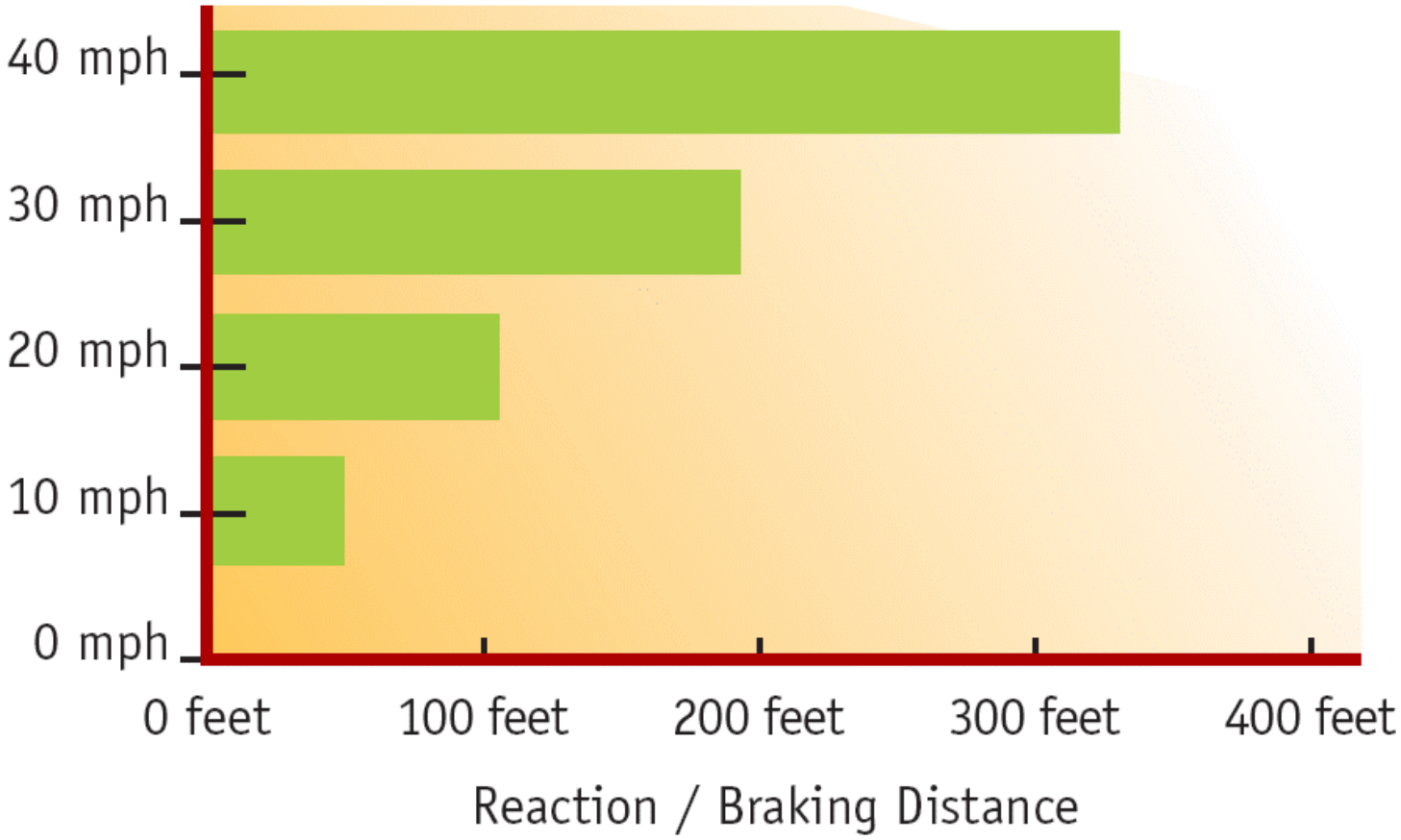




CONE OF VISION

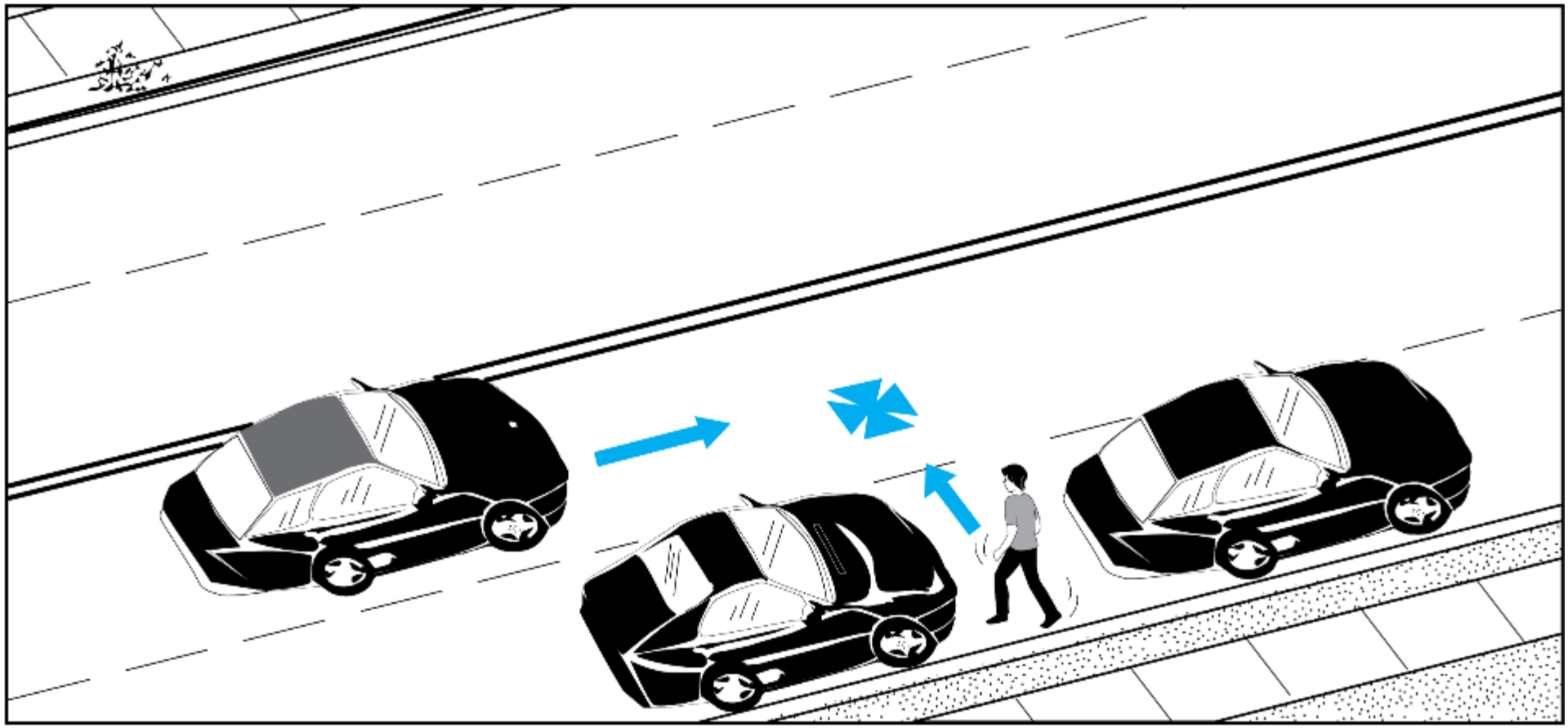
As motor vehicle speeds increase, the risk of serious injury or fatality for a pedestrian also increases (AARP Impact Speed and a Pedestrian's Risk of Severe Injury or Death 2011, p. 1). Also, motorist visual field and peripheral vision is reduced at higher speeds.

Speed Affects Crash Avoidance

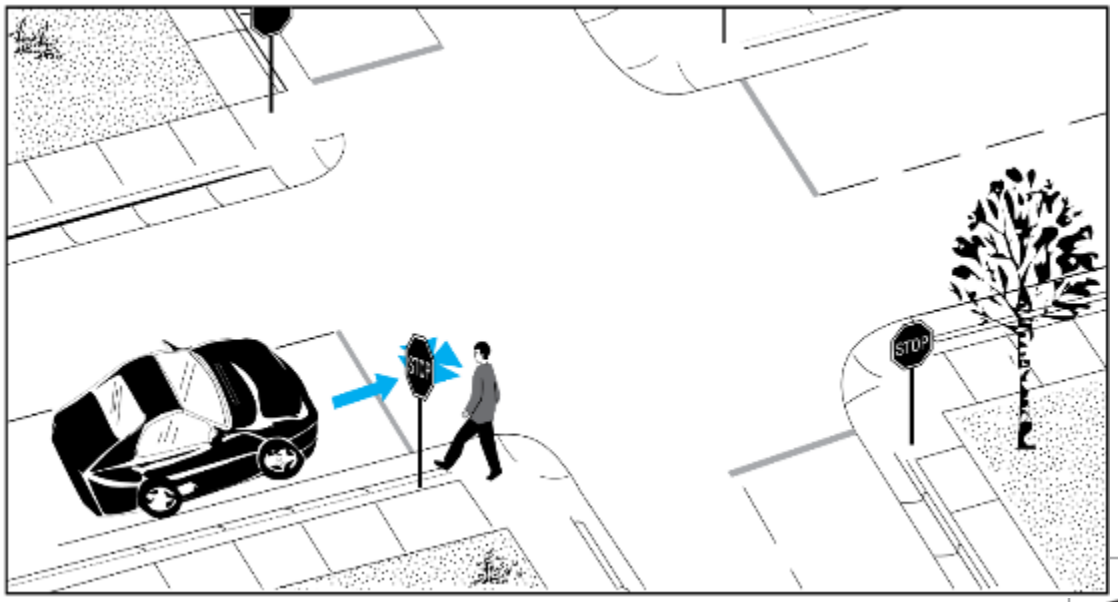


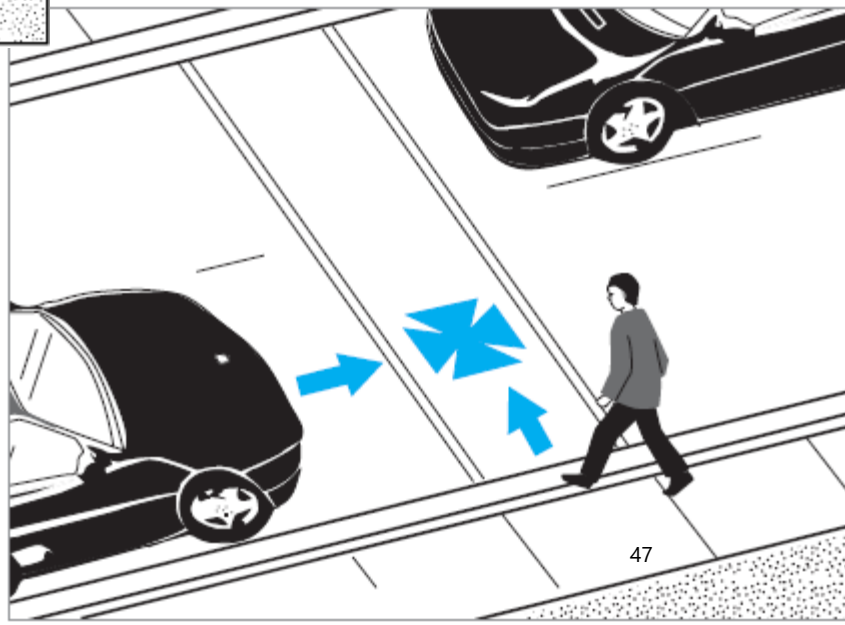
High speeds equate to greater reaction and stopping distance

Crashes due to Limited Visibility

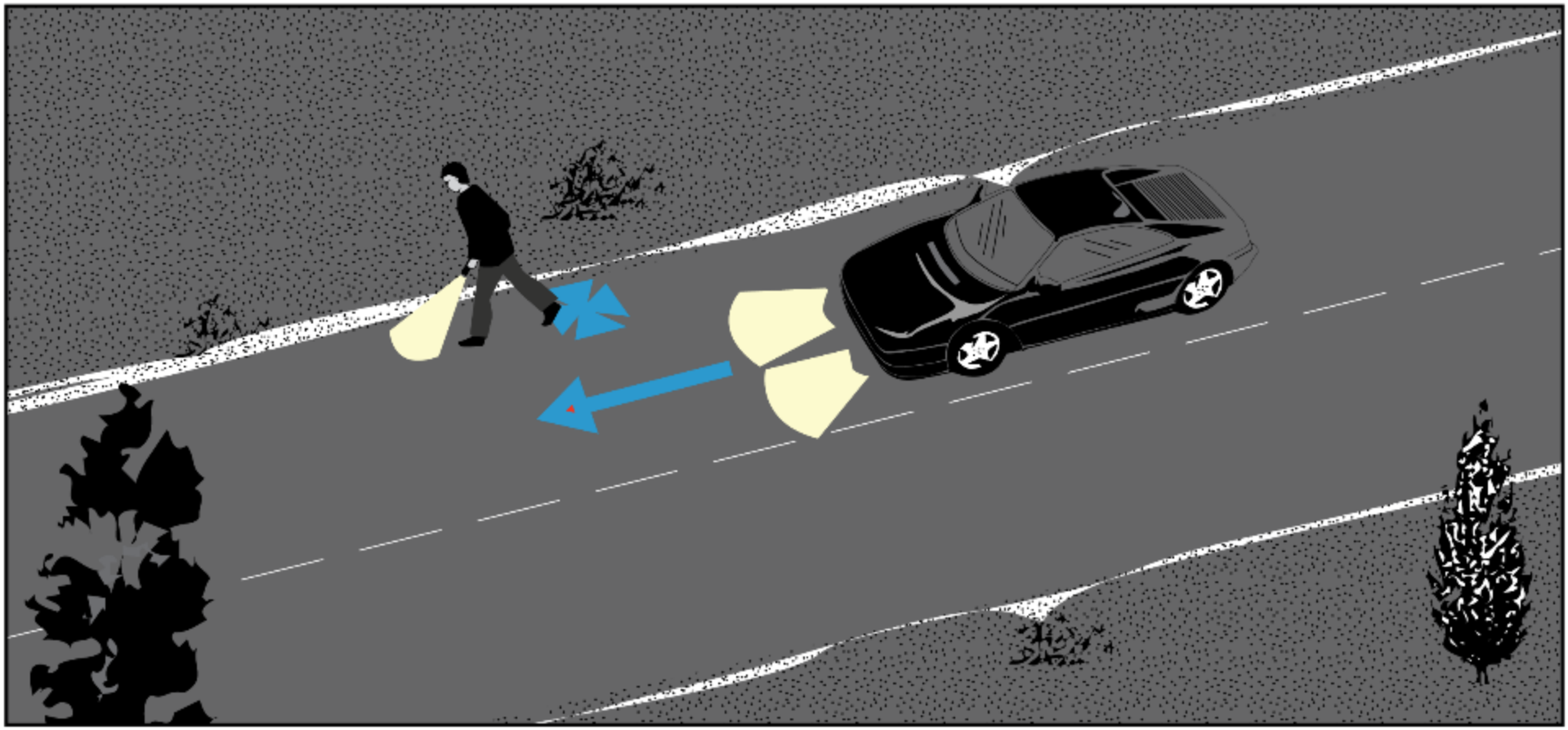


Crashes Resulting from Poor Yielding



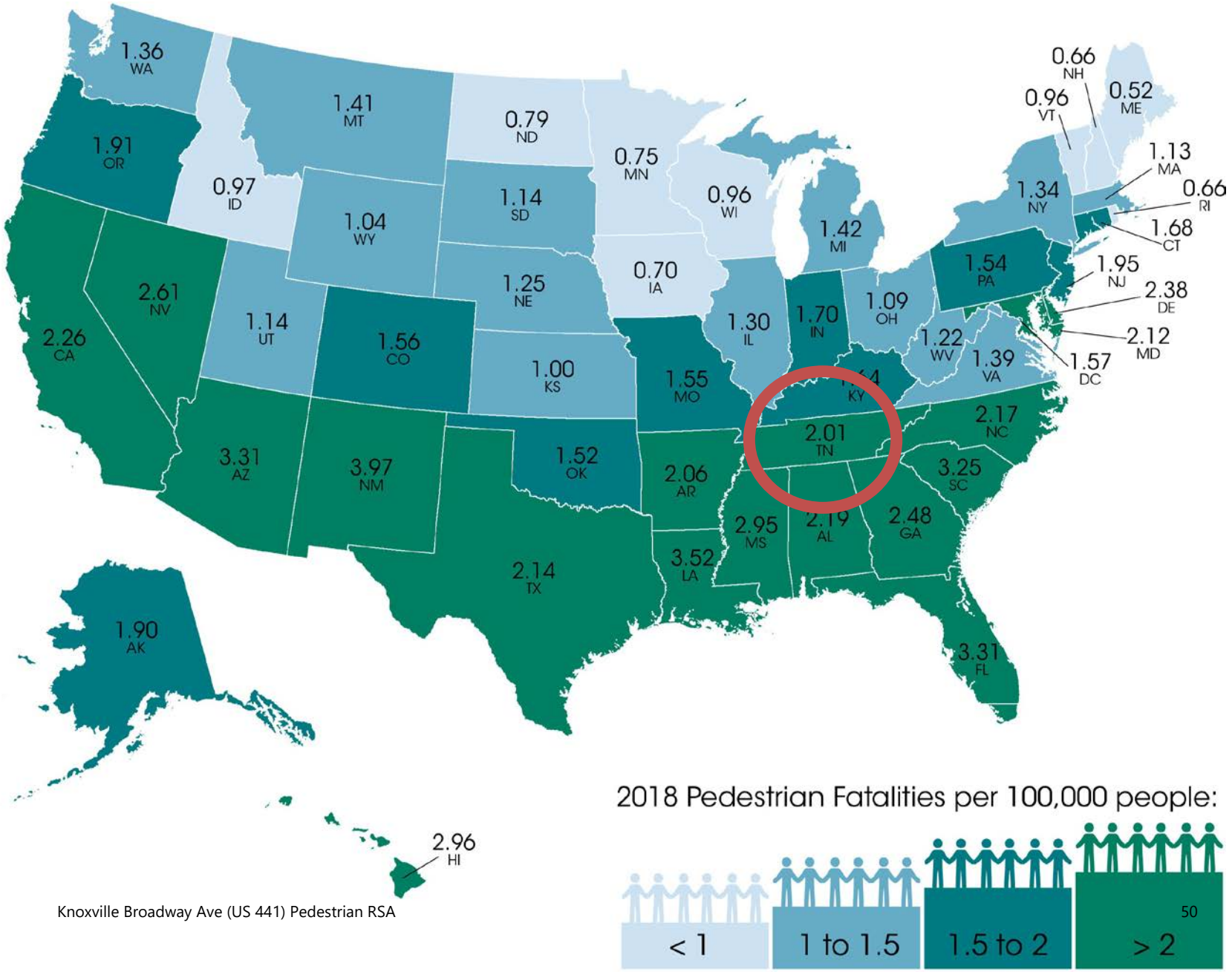


Crashes Due to Limited Separation

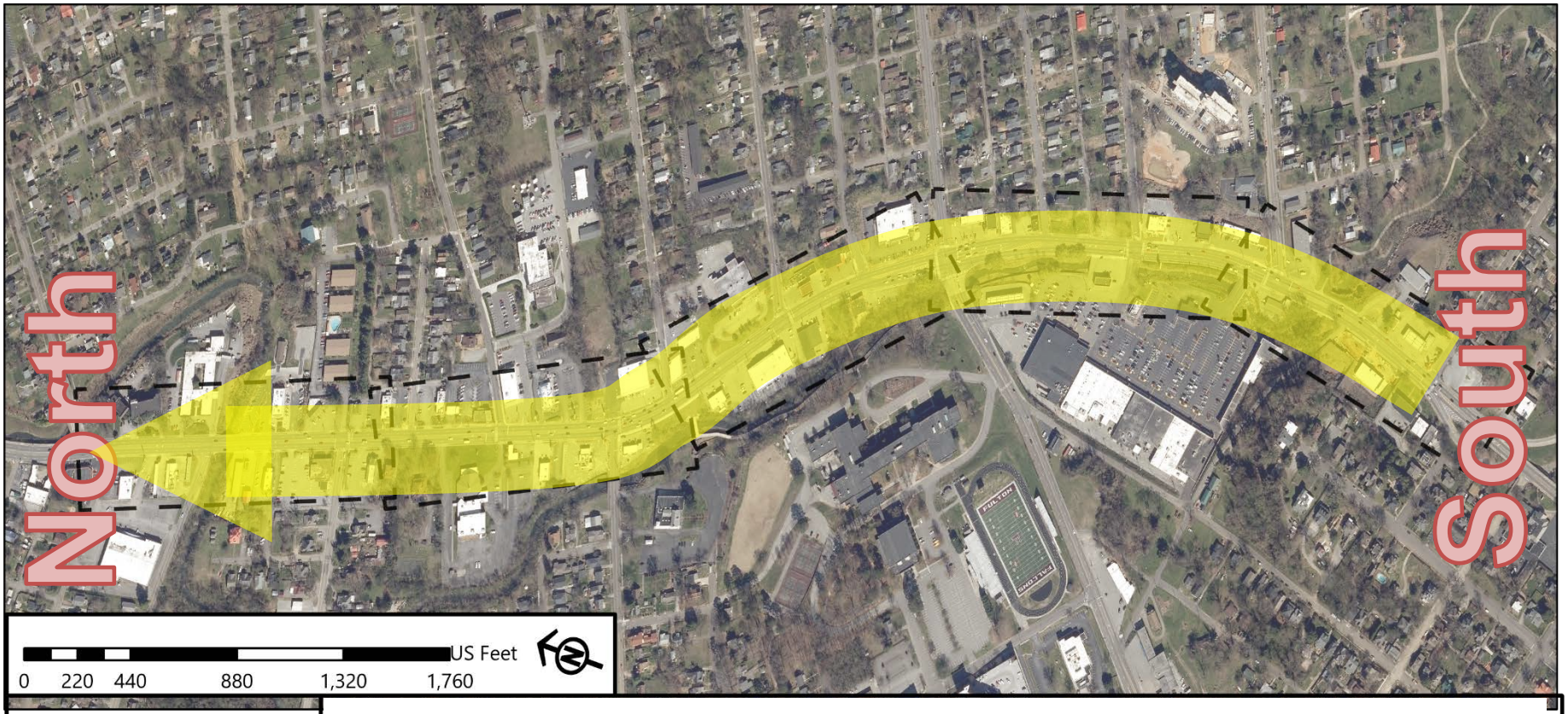


N Broadway RSA Site Overview

Which States? Pedestrian Fatalities per 100k: 2018

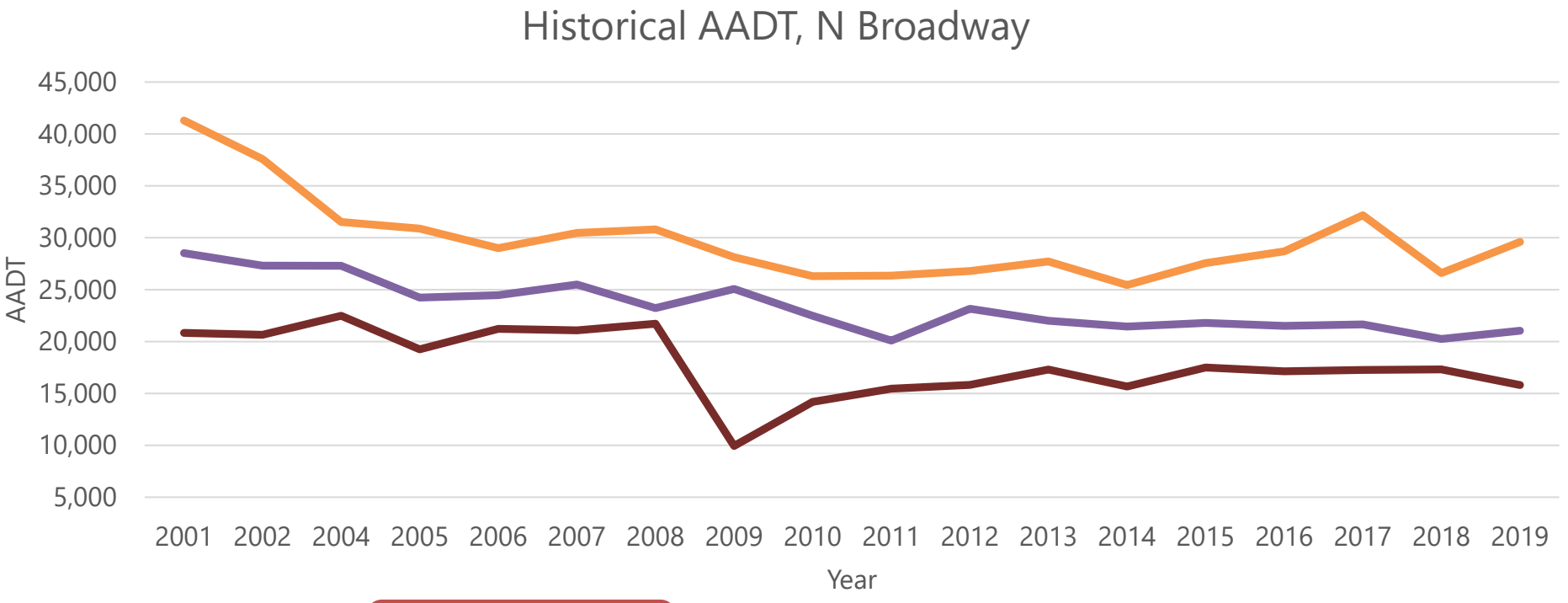


Getting to Know the Corridor



- N Broadway Ave (US 441)
  - From Grainger/HoF to Fairmont Blvd
  - ~1.1 mile long
  - Major Arterial
- Selected in consultation with Knoxville, TPO, and TDOT
- Major Arterials: 5.5% of surface mileage but 29% of Ped/Bike Injuries

Historical AADT (2001-2019)



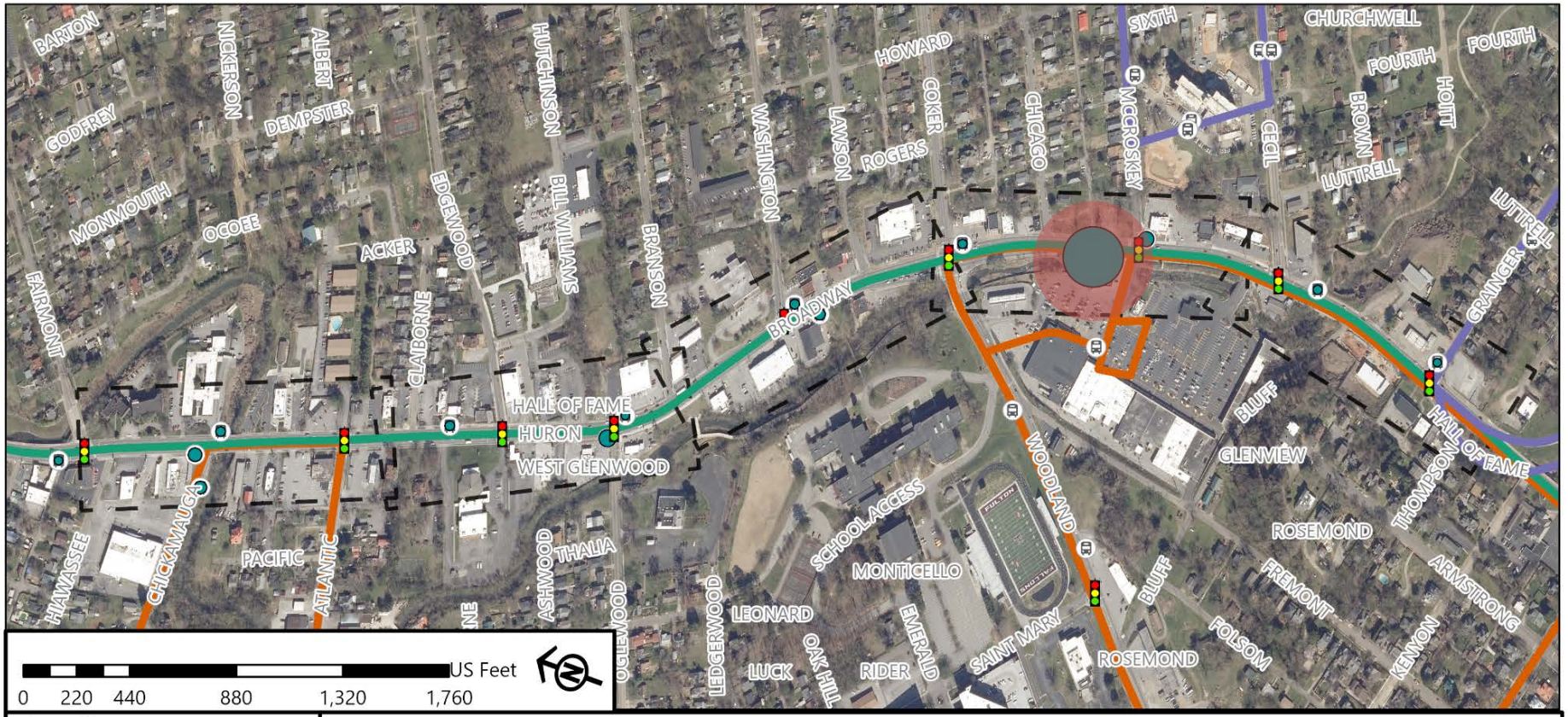
***North of RSA corridor**

Land Use

Land Use
- Single Family Residential
- Multifamily Residential
- Commercial
- Office
- Industrial (Manufacturing)
- Public/Quasi Public Land
- Agriculture/Forestry/Vacant Land
- Public Parks
- Private Recreation
- Under Construction/Other Uses
- Right of Way/Open Space
- Transportation/Communications/Utilities
- Signalized Intersections

- **Commercial** along corridor
- **Single family and multifamily** adjacent or one block back
- **Institutional and educational** throughout
- **Parks and recreation facilities**

Transit Routes & Stops

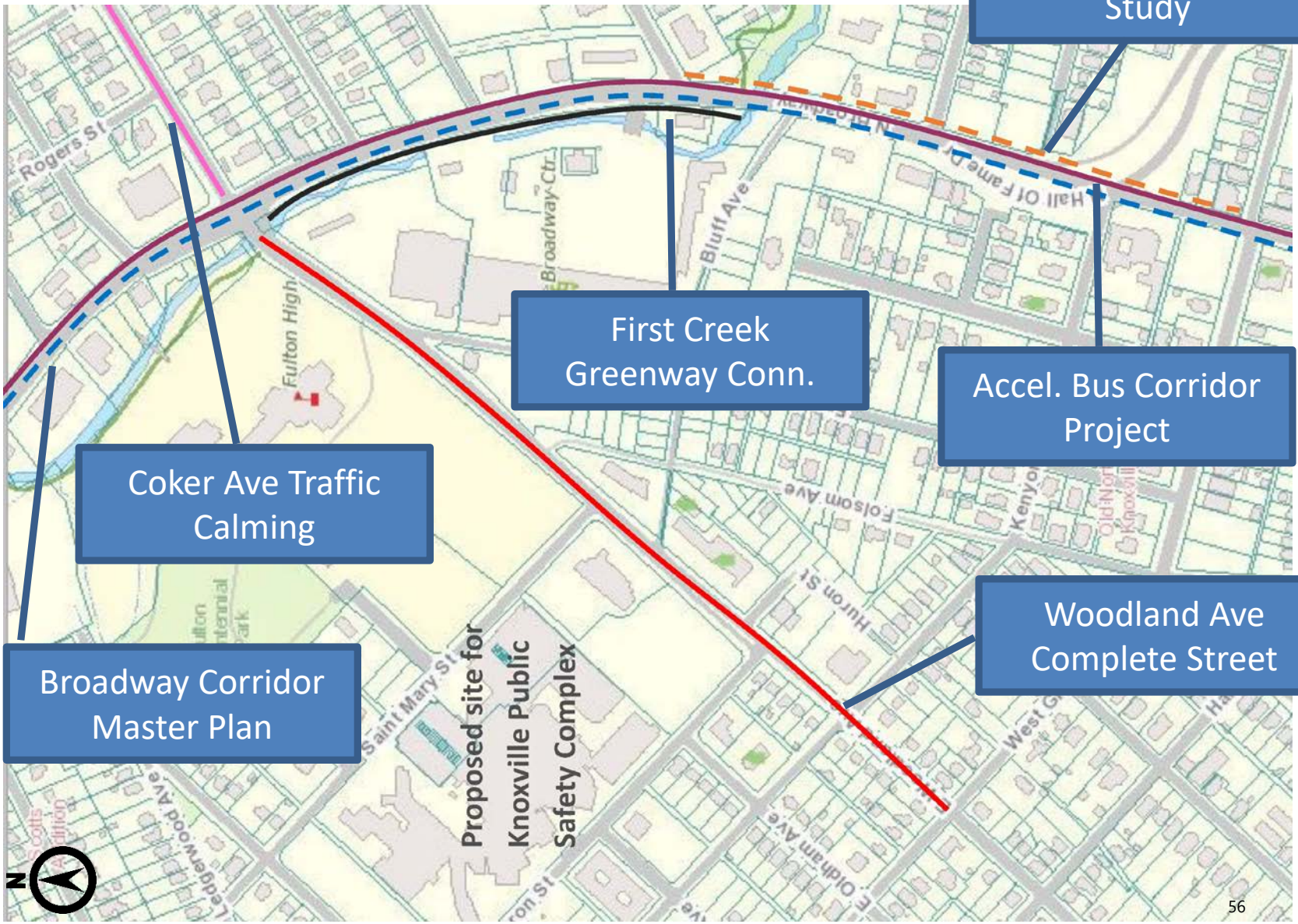


- Three routes along and intersect corridor
  - 60-minute headways -> Rts **21** & **23**, 15-30 min -> Rt **22**
  - Highest daily ridership at Broadway Shopping Center
  - Most stops without bench/shelter
  - Near side intersection stop placement

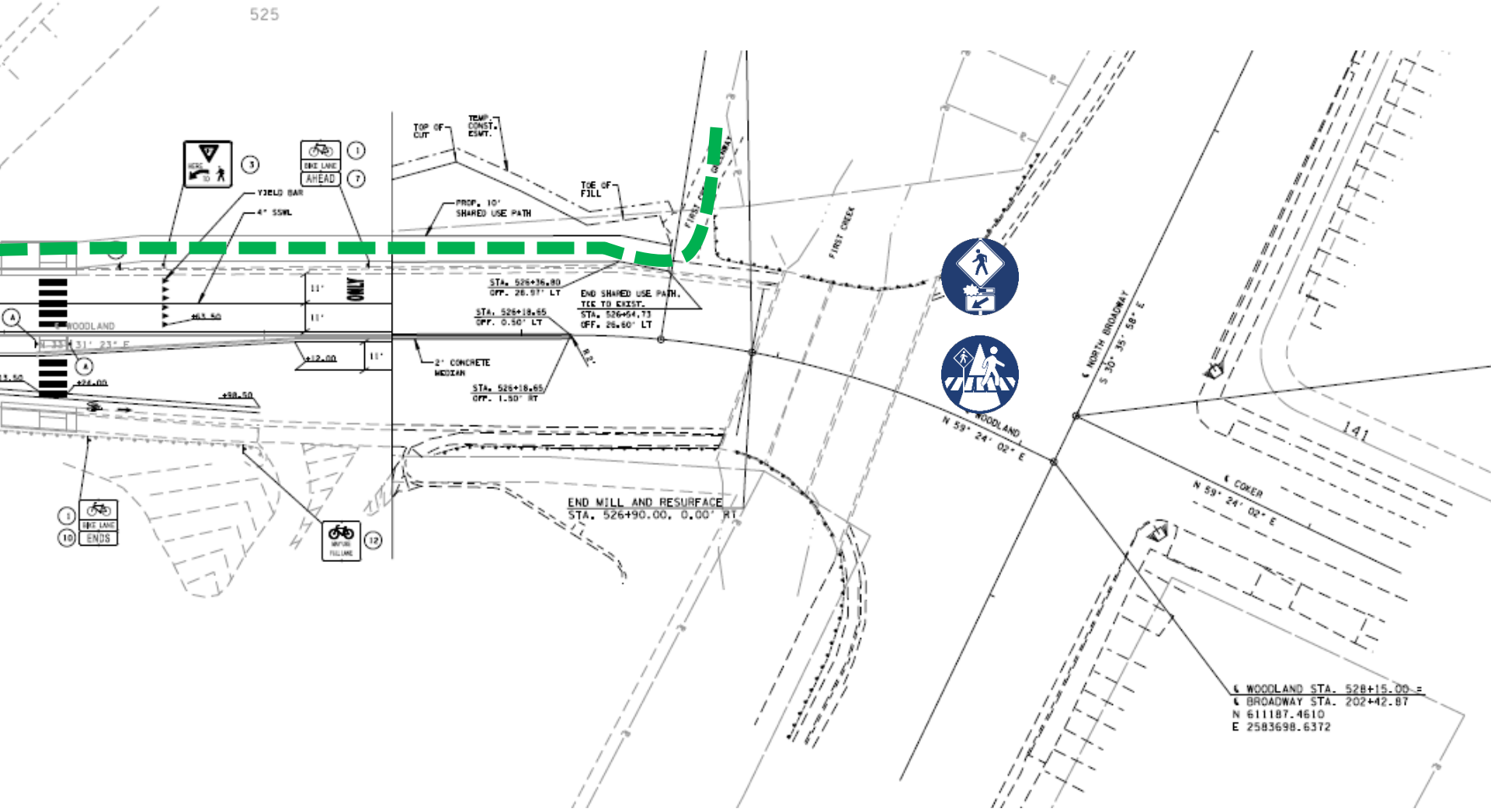
Other Corridor Attributes

- Signalized intersections every 600-1200’
  - Marked crossings with pedestrian signal heads; LPI?
  - No marked midblock or uncontrolled crossings
  - City policies related to treatments
- Sidewalks throughout, connect greenway
- Posted speed = 40MPH for most of corridor (35MPH avg, 40 MPH 85%)*.
- ~96% sedan, ~3% truck

Corridor Plan Summary



Woodland Ave Complete Street



Broadway Corridor Study

CECIL AND BROADWAY

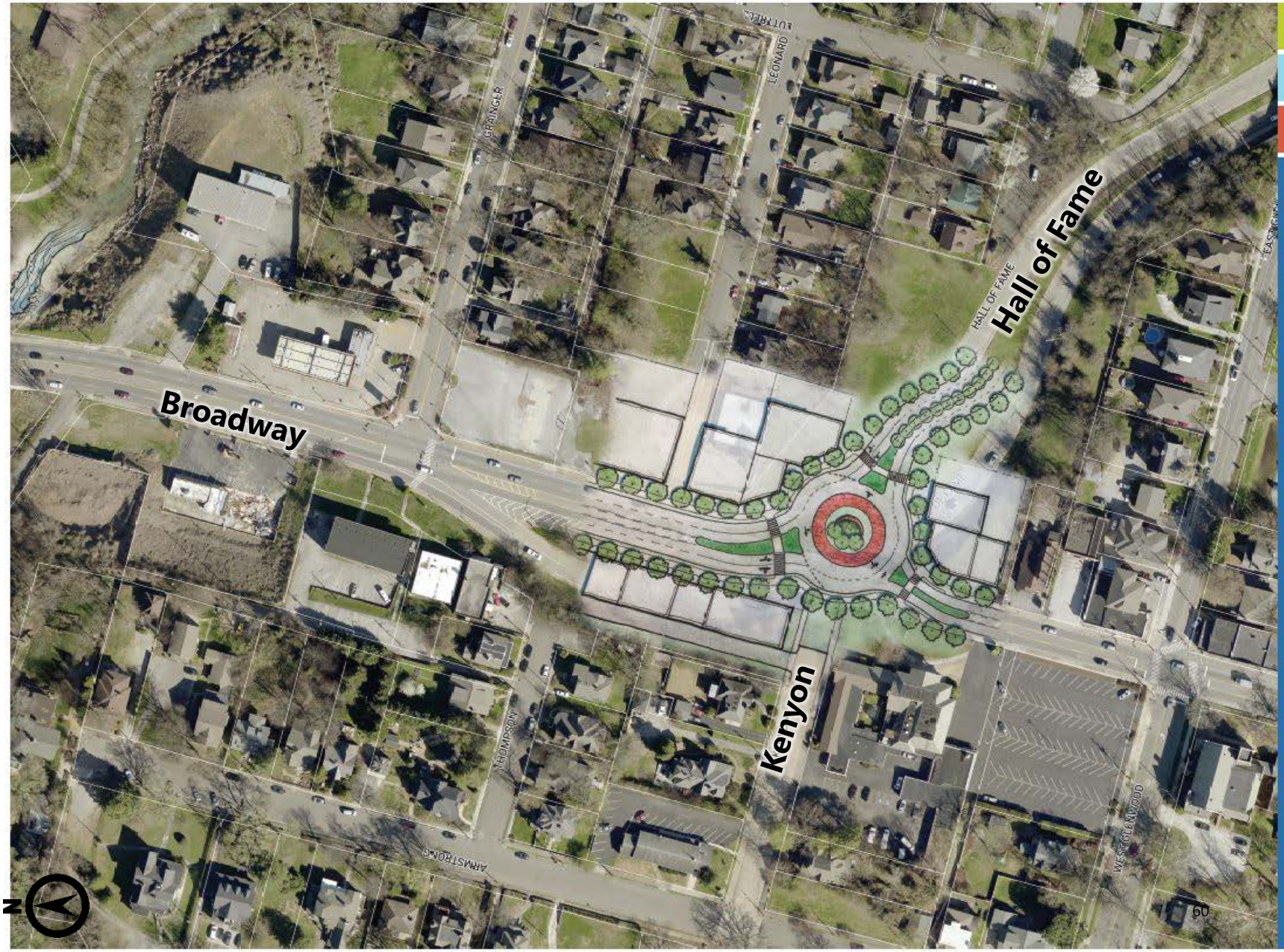
BROADWAY CORRIDOR IMPROVEMENT STUDY

Broadway Corridor Study

ROUNDABOUT 1

BROADWAY CORRIDOR IMPROVEMENT STUDY

Broadway Corridor Study



ROUNDABOUT 2

BROADWAY CORRIDOR IMPROVEMENT STUDY

Broadway Corridor Study

T-INTERSECTION

BROADWAY CORRIDOR IMPROVEMENT STUDY

Placeholder for Other Relevant Plans

Vehicular Crashes, 2014-2019

Manner of Collision	Coker/Woodland	Chicago Ave	McCroskey Ave	Cecil Ave	Bluff Ave	Grainger/Hall of Fame	Grand Total
Angle	7		18	17	3	15	60
Front to Rear	17	1	27	9		14	68
Head On			2	2			4
Not Collision with Motor Vehicle in Transport	4	2	7	6	1	6	26
Other			1	3			4
Rear to Rear		1	1	1			3
Rear to Side	1			1			2
Sideswipe, Opposite Direction	1		1	1			3
Sideswipe, Same Direction	9		9	10		9	37
Unknown	1	1	1	1			4
Grand Total	**40**	**5**	**67**	**51**	**4**	**44**	**211**

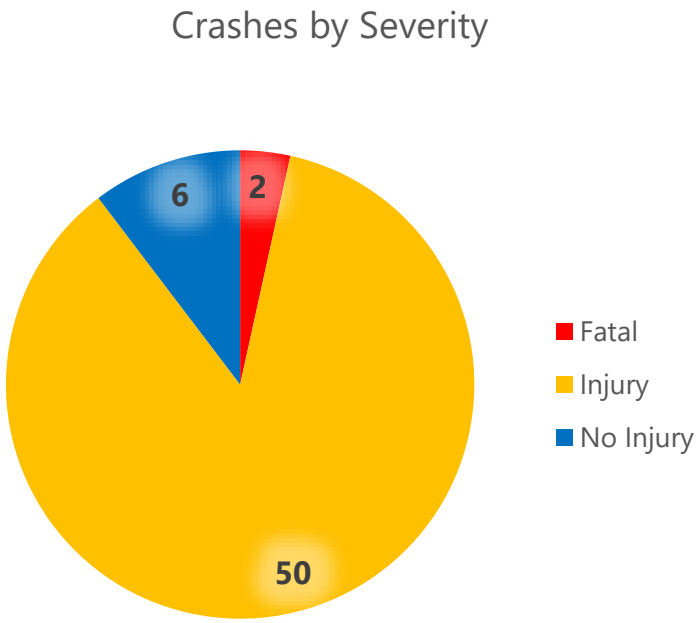
Ped/Bike Crash Summary – 2010-2019

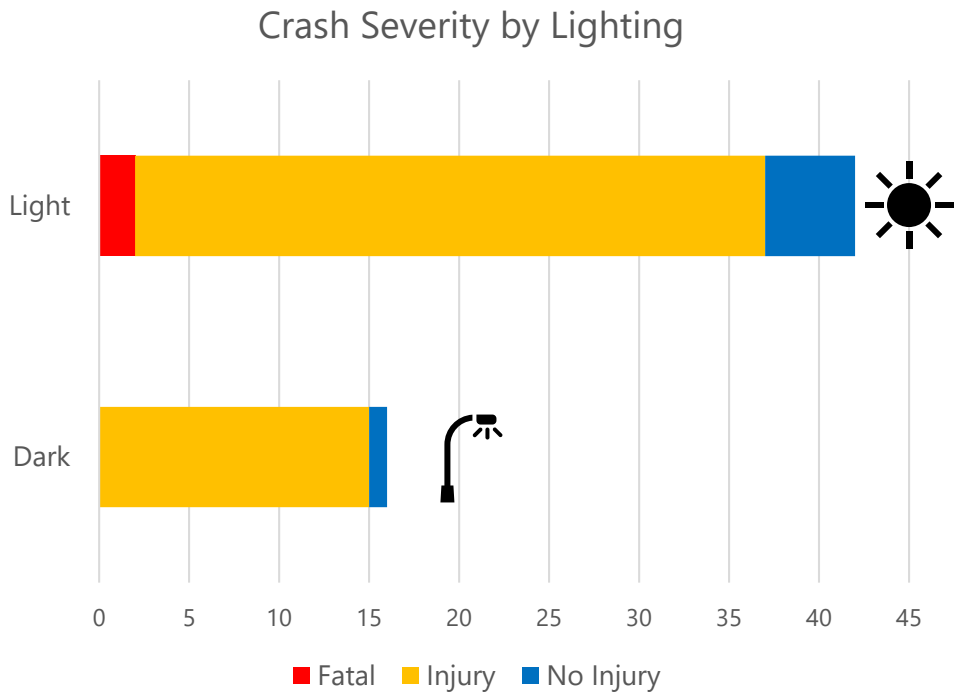
Year	Type		Time of Day			Lighting		Severity			Crash Cause								Total
	Pedestrian	Bicycle	AM Peak (7AM-10AM)	PM Peak (4PM-7PM)	Off-Peak	Dark	Daylight	K: Killed	Inujry Crash	Other	Driver going straight	Driver turning left	Driver turning right	Driver turning (direction unclear)	Pedestrian crossing midblock	Bicyclist riding on sidewalk	Bicyclist riding wrong way	Reviewed	
2010		1			1		1			1						1			1
2011	4	1		2	3	1	4		5				1			1		3	5
2012	3			1	2		3		3		1	2							3
2013	5	4			9	4	5		8	1		2						7	9
2014	4	2		1	5	2	4		6				1		1	1		3	6
2015	6	1		4	3	1	6	1	6			1	2	1	2			1	7
2016	5	2		1	6	2	5		6	1		1			1			5	7
2017	3	1	1		3	1	3		4			1			2			1	4
2018	8	5		4	9	4	9		11	2	3		3			3		4	13
2019	1	2		1	2	1	2	1	1	1					1	1	1		3
Total	39	19	1	14	43	6	42	2	50	6	4	7	7	1	7	7	1	24	58

Ped/Bike Crashes Along Corridor (2010-2019)

- 58 reported crashes: 2 fatalities
  - 9 appear in/near parking lots
- Highest frequency locations: Chickamauga, Oglewood, Washington, Woodland, McCroskey, Cecil
- Most crashes located at or near intersections

Pedestrian & Bicycle – Severity and Lighting (2010-2019)





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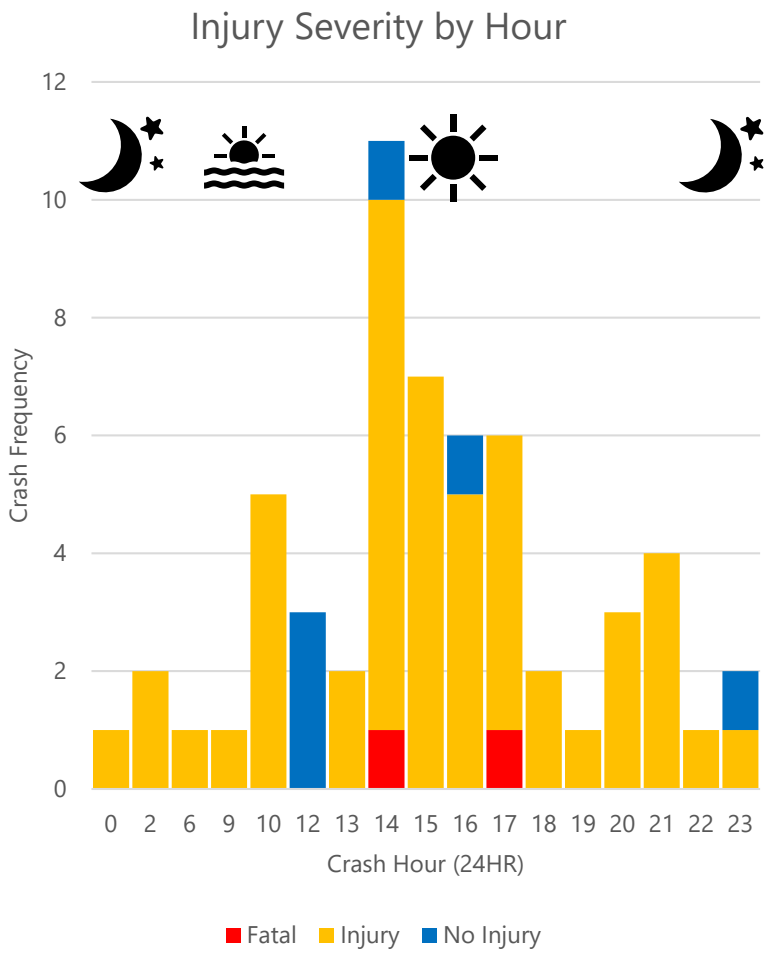
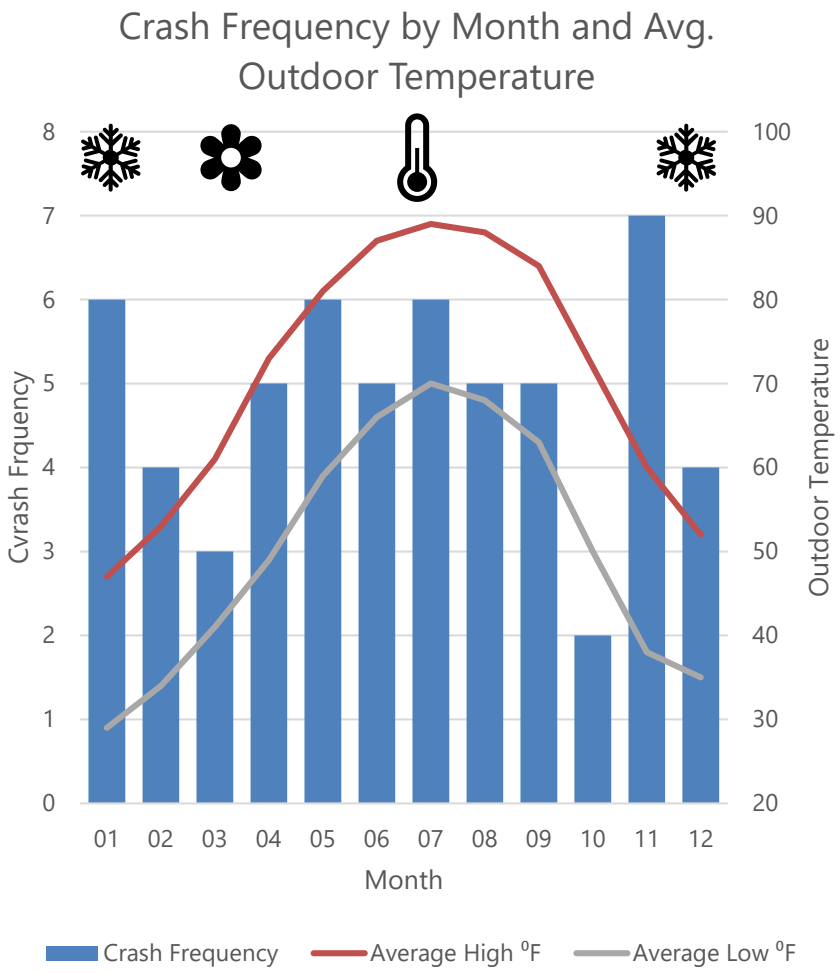
Pedestrian Crashes – Severity, Date, and Time (2010-2019)





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Injury Status by Factor

Crash Category	Injury Severity			
	Fatal	Injury	No Injury	Grand Total
Bicyclist riding in unsafe manner	1			1
Driver failure to yield		19		19
Lack of safe facilities for bicycling		4	3	7
Not enough information	1	21	2	24
Pedestrian crossing outside of crosswalk		6	1	7
Grand Total	2	50	6	58

Crash Factor by Crash Cause

Crash Category	Crash Factor								
	Vehicle Straight	Vehicle Turning Left	Vehicle Turning Right	Vehicle Turning (direction unclear)	Pedestrian - Midblock	Bicyclist - Sidewalk	Bicyclist - Wrong way	Reviewed	Grand Total
Bicyclist riding in unsafe manner							1		1
Driver failure to yield	4	7	7	1					19
Lack of safe facilities for bicycling						7			7
Not enough information								24	24
Pedestrian crossing outside of crosswalk					7				7
Grand Total	4	7	7	1	7	7	1	24	58

Break

Prompt Lists for “In the—Virtual—Field”

- What do you see?
- Who is travelling along or crossing the roadway(s)?
- Where are people going?
- What stands out to you as potential safety issues?

Location	Physical Environment / Infrastructure					
	Presence/Placement	Quality/Condition	Connectivity/ Consistency	Visibility	Lighting	Transit
Universal Considerations for Study Area	• Do facilities address ped and bike needs, including those with disabilities? • If future changes are proposed to the transportation system or surrounding land use, will those needs still be met?	• Are ped and bike facilities in good condition and accommodate users with disabilities?	• Are safe, continuous, and convenient ped and bike routes provided throughout the study area?	• Do obstructions block the view of roadway users? • What obstructions block the view of pedestrian and bicycle facilities (e.g., crosswalks, traffic control devices, signs)? • Does the sun create visibility issues at certain times of day?	• Are ped and bike facilities well-lit? • Can peds and bikes be seen by motorists during dark conditions?	• How does transit infrastructure interact with ped and bike facilities?
Along Street (including driveways)	• How are peds and bikes accommodated on both sides of the road? • Are facilities shared, separate, or buffered? • What is the comfort level for users? • Are ped and bike facilities appropriate for the adjacent land use? • Do parked vehicles obstruct ped paths? • Does parking adversely affect bike safety?	• Are the bike/ped facilities in good condition and well-maintained? • Are there obstacles (e.g. utility poles or signs) in the middle of the sidewalk? • Are the sidewalks wide enough for two people to walk together? • Does vegetation or debris infringe on pedestrian or bicyclists facilities? • Is the pavement free of obstacles (e.g., potholes, drainage grates, longitudinal joints)?	• How are peds accommodated at driveways/ access points? • Are ped walkways continuous? • Are bike routes continuous?	• Are there obstructions blocking the driver's view of peds and bikes? • Are driveways designed with peds and bikes in mind (e.g., less driveway density, access management, proper signage, pavement markings, etc.)?	• Are sidewalks and bicycle facilities adequately lit?	• Are there sufficient boarding areas (5 feet along curb, 8 feet perpendicular to curb line) and visibility at transit stops? • Do ped and bike facilities connect to transit stops?

Location	Physical Environment / Infrastructure					
	Presence/Placement	Quality/Condition	Connectivity/ Consistency	Visibility	Lighting	Transit
Mid-Block Crossing (marked)	• Are there crossing enhancements? • What are the distances between the mid-block crossing and other marked crosswalks?	• Are signs and pavement markings in good condition and visible/legible?	• Does this crossing lead to/from a ped/bike generator?	• Are there obstructions blocking the view of signs or pavement markings? • Do horizontal or vertical curves impede adequate sight distance between drivers and peds/bikes?	• Are pedestrian crossings adequately lit?	• Is there a transit stop located mid-block? • Are transit users crossing mid-block to get to/from the transit stop?
Observed Mid-Block Crossings (unmarked)	• Are crossings isolated or a frequent route used by pedestrians or bicyclists?	N/A	• How far is it to the nearest controlled crossing? • Why are peds/ bikes crossing mid-block and not at the closest marked crossing? • Are there generators that lead to pedestrians and bicyclists crossing mid-block?	• Are there obstructions blocking the view of pedestrians and bicyclists?	• Does this section of roadway have lights?	• Are mid-block crossings occurring near transit stops?

Location	Physical Environment / Infrastructure					
	Presence/Placement	Quality/Condition	Connectivity/ Consistency	Visibility	Lighting	Transit
Intersections	• How are peds and bikes accommodated (e.g., accessible ped signal, bike box, high-vis crosswalks, bike signal)? • What intersection characteristics increase/decrease ped and bike safety (e.g., channelized right turns, large cub radii, wide crossing distances, right-turn-on-red)?	• How many legs have a crosswalk and what is the condition? • Are ped push buttons accessible, with a locator tone, properly located and connected to the walkway, and functioning correctly? • Are curb ramps in good condition and ADA-compliant for each crosswalk or does a single curb ramp serve both crosswalks?	• Are intersection enhancements to signs, pavement markings, and signals consistent across intersections in the study area? • Do crosswalks line up with sidewalks?	• Can peds, bikes, and drivers see each other at all intersection legs? • Are there utility poles, signs or other objects blocking the view of traffic? • Do skewed intersections direct drivers' focus away from peds?	• Is the lighting adequate at all corners of the intersection?	• Do ped and bike facilities connect to transit stops? • Are transit stops on the near or far side of the intersection?
Shared Use Paths and Grade-Separated Crossings	• Do bicyclists have adequate space to ride comfortably (e.g., horizontal and vertical clearance at tunnels and bridges, construction zones, guardrails, fences)? • Do pedestrians have sufficient width to walk comfortably and is access to the facility accessible to individuals with disabilities?	• Does the condition of the facility promote personal safety? • What material is the structure (freeze/thaw)? • Are the grades and cross slopes accessible to individuals with disabilities? • Is there adequate drainage? • Does wildlife affect comfort levels? • Are sideslopes adequate for bicycles to return to the roadway in the event of a lane departure? • Are facilities properly maintained (free of vegetation, snow)?	• Are bike facility transition areas designed appropriately with logical termini or do they end abruptly, potentially contributing to sudden and difficult merges, uncontrolled crossings, or behaviors such as wrong-way riding? • How is access provided to destinations if grade-separated? • Is the facility connected to other ped facilities in the area?	• Does poor visibility compromise personal safety? • Does the speed of users affect their ability to see and react to shared use path connections?	• Is adequate lighting provided?	• Are connections to transit provided?

Location	Traffic Control Devices		
	Signs and pavement markings	Signals	Compliance?
Universal Considerations for Study Area	• Are signs and pavement markings for pedestrian and bicycle facilities present and effective?	• Are pedestrians and bicyclists accommodated at signals through adequate signal timing and phasing? • Are pedestrian push buttons accessible, with a locator tone, properly located and connected to the walkway, and functioning correctly?	• Do motorists, pedestrians, and bicyclists follow traffic laws?
Along Street (including driveways)	• Are bicycle pavement markings adequate?	N/A	N/A
Mid-Block Crossing (marked)	• Are crossing points for pedestrians properly signed and/or marked? Are curb ramps provided? • Are there signage enhancements for the crossing, such as RRFBs or flashing beacons?	• Are there any devices (i.e., PHB or signalization) to control the crossings? • If so, are pedestrian push buttons accessible, with a locator tone, properly located and connected to the walkway, and functioning correctly?	• Are drivers, pedestrians, and bicyclists compliant with traffic control devices? • Are drivers yielding to pedestrians? • Are bicyclists yielding to pedestrians?
Intersections	• Is paint on stop bars and crosswalks worn, or are signs worn, missing, or damaged? • Are there sign or pavement marking enhancements?	• How long is the pedestrian or bicycle signal? Is there enough time to cross? • Is there a pedestrian countdown and/or bicycle signal? • Do pedestrians and bicyclists use push buttons to actuate a crossing? • Is there a leading pedestrian interval (LPI)? Is it accessible to pedestrians with vision disabilities? Are bikes allowed to utilize the early start? • Are there restrictions on turning-movements, like no right-turn-on-red? • How long do pedestrians have to wait in between signals? • Do vehicles have protected or permitted left-turn control?	• Are drivers, pedestrians, and bicyclists compliant with traffic control devices? • Are drivers yielding to pedestrians (especially at right-turn)? • Are bicyclists yielding to pedestrians?
Shared Use Paths and Grade-Separated Crossings	• Do signs provide wayfinding or advance warning of at-grade intrsections?	N/A	N/A

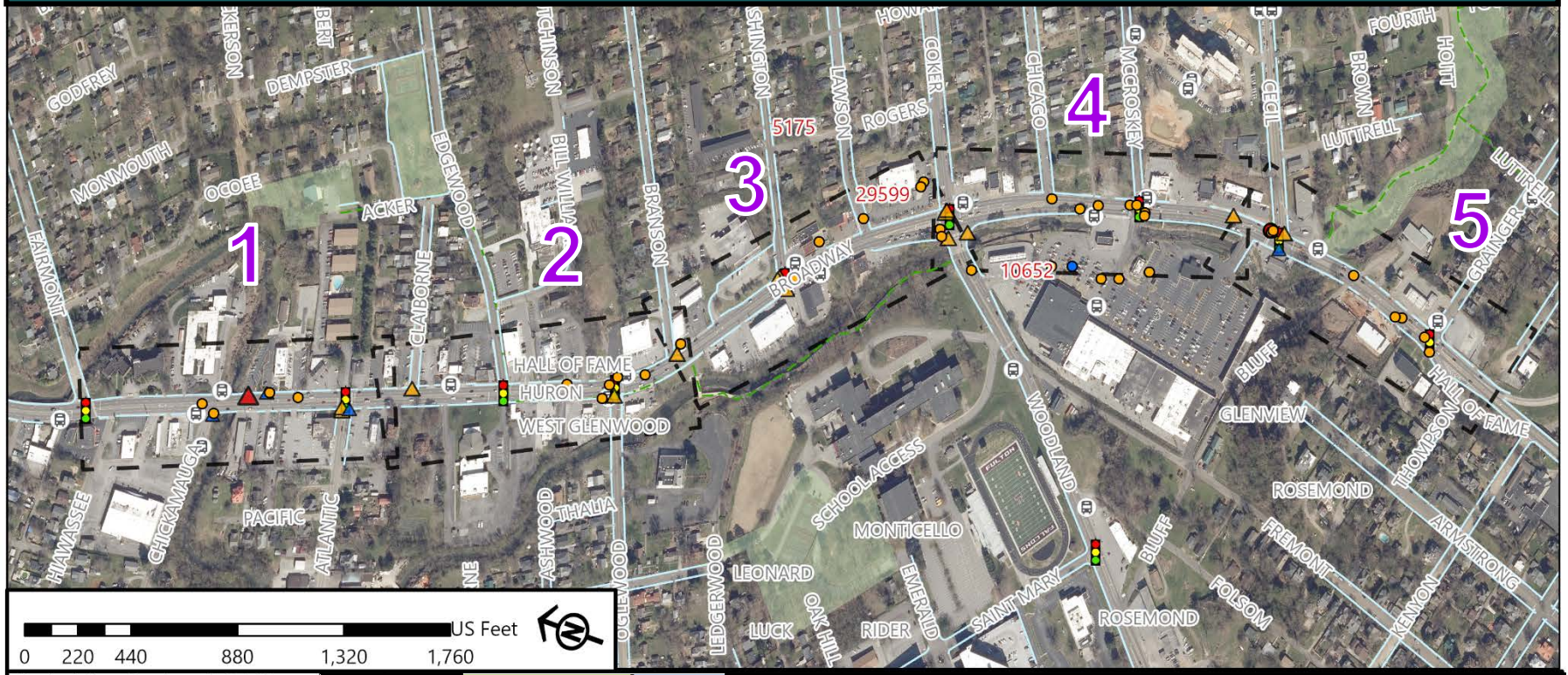
Location	Operations / Interactions / Behaviors		
	Characteristics	Mode Behavior	Interactions of Modes
Universal Considerations for Study Area	• Are design, posted, and operating traffic speeds compatible with pedestrian and bicyclist safety? • Is the safety of children in school zones adequately considered?	• Do pedestrians or motorists regularly misuse or ignore pedestrian facilities? • Are drivers, pedestrians, and bicyclists behaving in a safe, compliant manner? • Are behaviors systemic across the network or at isolated locations?	• Do roadway users look/scan for other travel modes? • Are drivers and bicyclists yielding to pedestrians at crossings? • Do drivers allow extra space or reduce speeds when overtaking or driving near bicyclists? • How do pedestrians and bicyclists interact with transit facilities?
Along Street (including driveways)	• Do scooters, bicycles, skateboards, or non-motorized vehicles create hazards for pedestrians (e.g., operating or parking on sidewalk)? • Are vehicles traveling at appropriate speeds?	• If available, are bicyclists using their dedicated facilities?	• Are drivers yielding to pedestrians at driveways? • Are there conflicts between bicycles and pedestrians on sidewalks?
Mid-Block Crossing (marked)	• What are vehicle speeds? • What are traffic volumes?	• Are people using the mid-block crossing? • Are drivers yielding to pedestrians or bicyclists in the crosswalk?	• Are the physical environment and traffic control devices adequate for a safe crossing?
Observed Mid-Block Crossings (uncontrolled)	• What are vehicle speeds?	• Are pedestrians and bicyclists waiting for gaps?	• Are drivers expecting crossing pedestrians or bicyclists?
Intersections	• What are vehicle speeds? • What are vehicle, pedestrian, and bicycle volumes at the intersection?	• Are drivers stopping in the crosswalk? • Are pedestrians crossing with or against the pedestrian signal, if present? • Do pedestrians and bicyclists use push buttons to actuate a crossing?	• Is it clear between roadway users who has the right-of-way and is there compliance? • Do drivers yield to pedestrians and bicyclists when turning right or left?
Shared Use Paths and Grade-Separated Crossings	• Is there a mix of grade-separated and at-grade crossings?	• Do pedestrians walk in a way that blocks the path for other users? • Are bicyclist speeds too fast for conditions? • Does a mix of grade-separated and at-grade intersections influence behavior (e.g., higher speeds, less expectancy of crossing conflicts)?	• Are there pavement markings that separate users? How are such separations communicated to pedestrians with vision disabilities? • What are the levels of comfort for users?

Field Visit Guidance

Observe and record what you see for physical elements and behaviors that may affect pedestrian safety along Louisiana Ave:

- ❑ Presence and continuity of facilities (ped and transit)
  - ❑ Sidewalks
  - ❑ Curb ramps
  - ❑ Bus stop
  - ❑ Bus stop shelter
  - ❑ Paved trail
  - ❑ Informal paths (e.g. "goat paths")
- ❑ Quality of facilities (ped and transit)
- ❑ Overhead lighting
- ❑ Visibility of expected pedestrians
- ❑ Driveways and other conflicts
- ❑ Signs
- ❑ Pavement markings
- ❑ Signals: pedestrian signals and phase timing
- ❑ Destinations (e.g. businesses, schools, recreation, homes)
- ❑ Observed traffic behaviors, including speeding, turning movements, and gaps in traffic
- ❑ Observed pedestrian behaviors (travel and crossings)

Map Segments – *N Broadway*



Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- XXXX AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

Year	Type		Time of Day			Lighting		Severity			Crash Cause								Total
	Pedestrian	Bicycle	AM Peak (7AM-10AM)	PM Peak (4PM-7PM)	Off-Peak	Dark	Daylight	K: Killed	Injury Crash	Other	Driver going straight	Driver turning left	Driver turning right	Driver turning (direction unclear)	Pedestrian crossing midblock	Bicyclist riding on sidewalk	Bicyclist riding wrong way	Reviewed	
2010		1			1		1			1						1			1
2011	4	1		2	3	1	4		5				1			1		3	5
2012	3			1	2		3		3		1	2							3
2013	5	4			9	4	5		8	1		2						7	9
2014	4	2		1	5	2	4		6				1		1	1		3	6
2015	6	1		4	3	1	6	1	6			1	2	1	2			1	7
2016	5	2		1	6	2	5		6	1		1			1			5	7
2017	3	1	1		3	1	3		4			1			2			1	4
2018	8	5		4	9	4	9		11	2	3		3			3		4	13
2019	1	2		1	2	1	2	1	1	1					1	1	1		3
Total	39	19	1	14	43	16	42	2	50	6	4	7	7	1	7	7	1	24	58

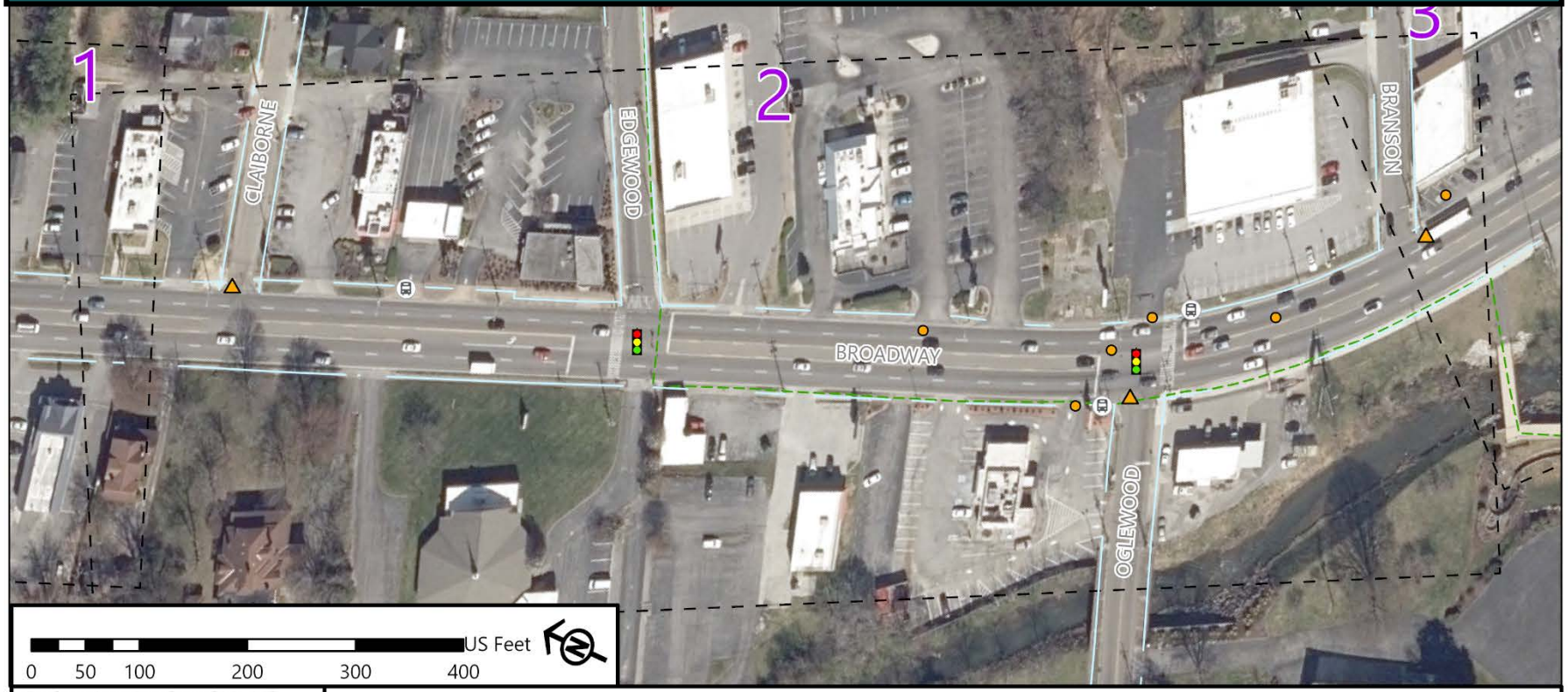
Segment 1 – *Fairmont to Atlantic*

Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- XXXX AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

Field Notes

Segment 2 – *Claiborne to Branson*

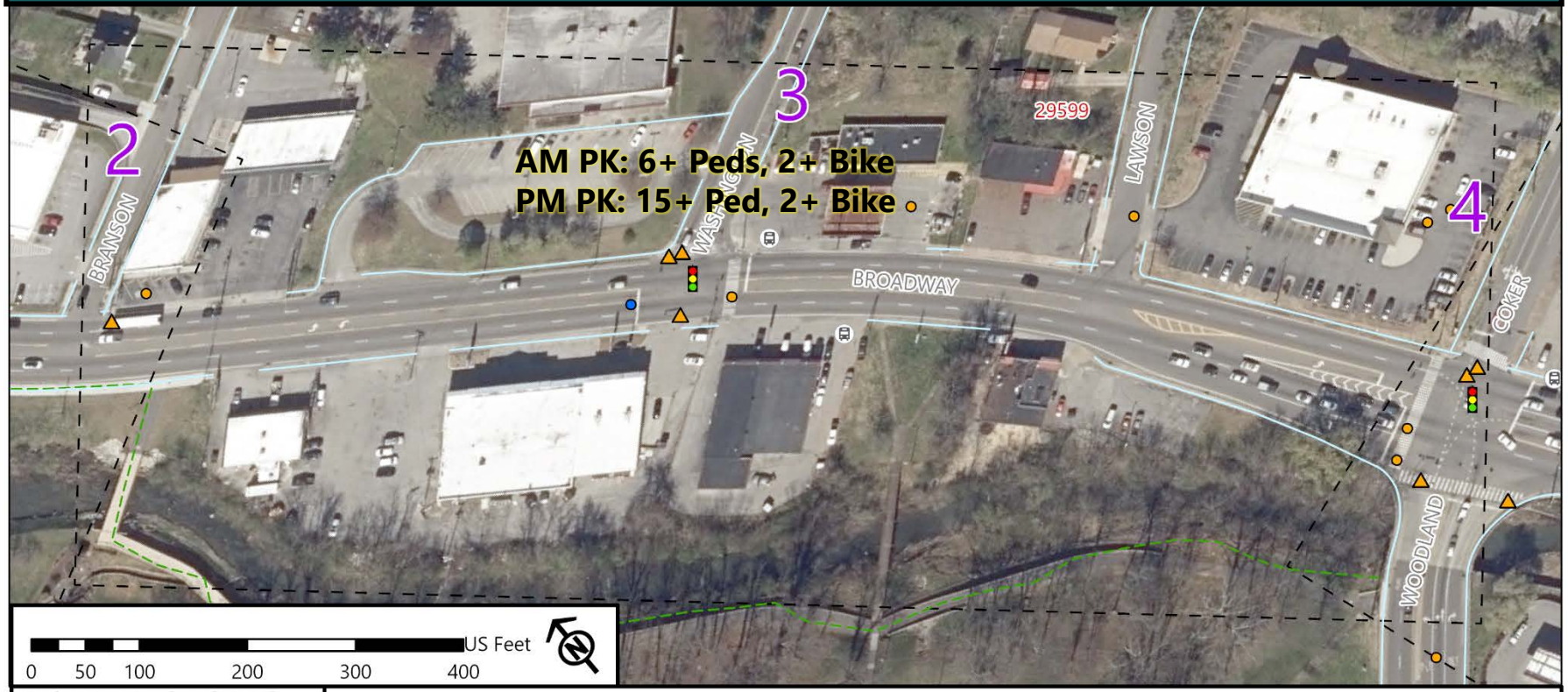


Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- XXXX AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

Field Notes

Segment 3 – *Branson to Coker*



Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- XXXX AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

Field Notes

Segment 3 – *Branson to Coker*

Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- XXXX AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

Field Notes

Segment 4 – *Coker to Cecil*

Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- XXXX AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

Field Notes

Segment 4 – *Coker to Cecil*

Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- XXXX AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

Field Notes

Segment 5 – *Cecil to Hall of Game/Grainger*

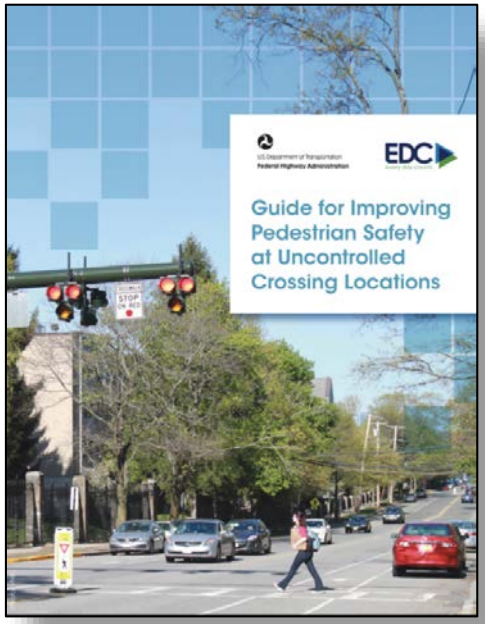
Pedestrian Crashes (10-19)
- Fatal
- Injury
- No Injury

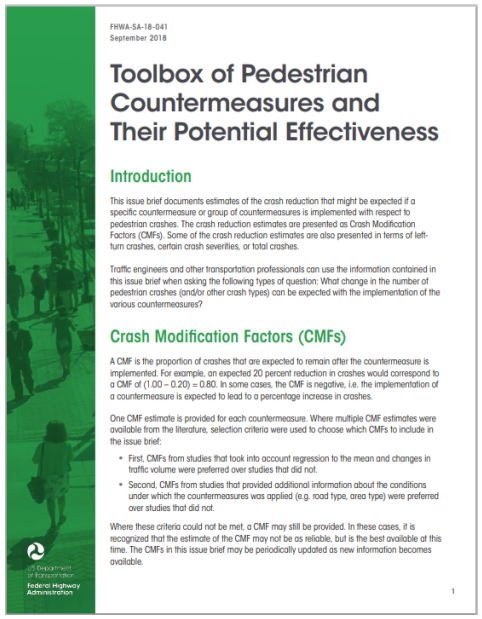
Bicycle Crashes (10-19)
- Fatal
- Injury
- No Injury
- Signalized Intersections
- XXXX AADT 2019
- Transit Stops
- Sidewalk
- Greenways
- Parks
- RSA Map Segments

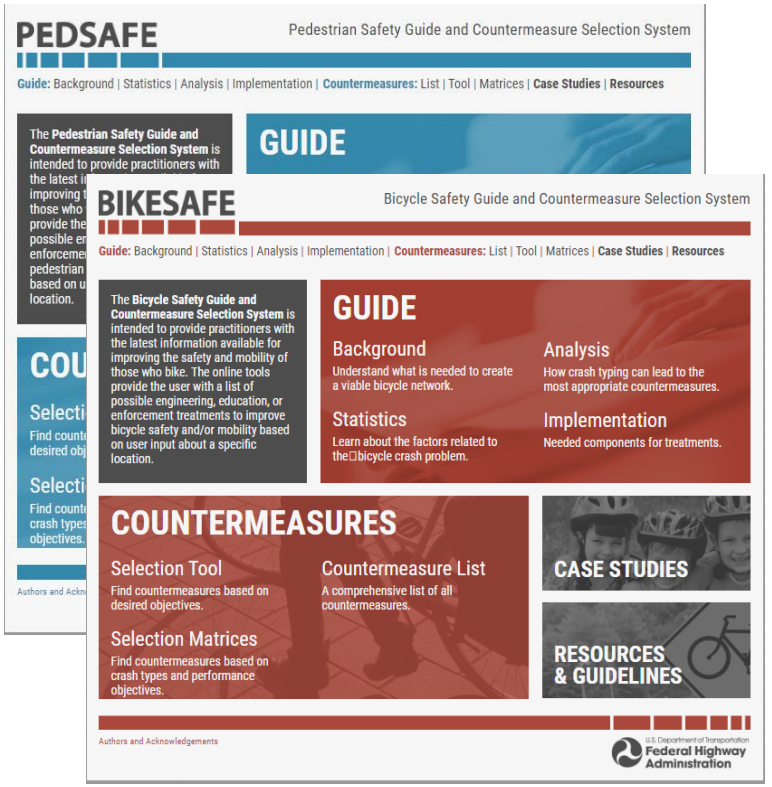
Field Notes

Countermeasures

Resources for Countermeasure Selection







Spectacular Seven

- Crosswalk Visibility Enhancements
- Raised Crosswalks
- Pedestrian Refuge Island
- RRFB
- PHB
- Road Diets
- LPI

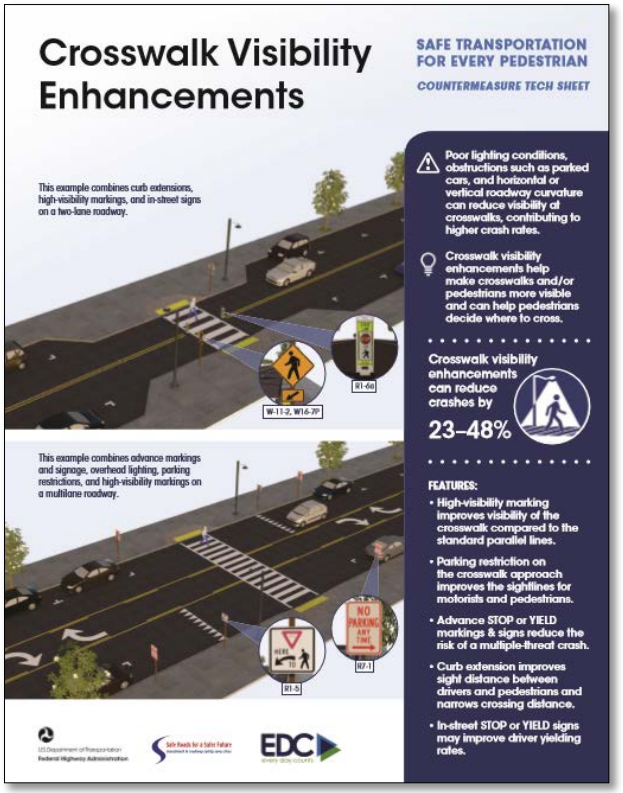


Table 1. Application of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	● 2 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6 7 9	○ 5 6 7 9	○ 5 6 ● 9
3 lanes with raised median (1 lane in each direction)	● 2 3 4 5 7 9	● ● 5 7 9	○ ● 5 ● 9	○ 3 4 5 7 9	○ ● 5 ● 9	○ ● 5 ● 9	○ 3 4 5 7 9	○ ● 5 ● 9	○ ● 5 ● 9
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	● 2 3 4 5 6 7 9	● ● 5 6 7 9	○ ● 5 6 ● 9	○ 3 4 5 6 7 9	○ ● 5 6 ● 9	○ ● 5 6 ● 9	○ 3 4 5 6 7 9	○ ● 5 6 ● 9	○ ● 5 6 ● 9
4+ lanes with raised median (2 or more lanes in each direction)	● ● 5 7 8 9	● ● 5 7 8 9	○ ● 5 8 ● 9	○ ● 5 7 8 9	○ ● 5 ● 8 9	○ ● 5 ● 8 ● 9	○ ● 5 ● 7 8 9	○ ● 5 ● 8 9	○ ● 5 ● 8 ● 9
4+ lanes w/o raised median (2 or more lanes in each direction)	● ● 5 6 7 8 9	○ ● 5 6 7 8 9	○ ● 5 6 8 ● 9	○ ● 5 6 7 8 9	○ ● 5 6 ● 8 9	○ ● 5 6 ● 8 ● 9	○ ● 5 6 ● 7 8 9	○ ● 5 6 ● 8 9	○ ● 5 6 ● 8 ● 9

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- ○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1. High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning sign
2. Raised crosswalk
3. Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4. In-Street Pedestrian Crossing sign
5. Curb extension
6. Pedestrian refuge island
7. Rectangular Rapid-Flashing Beacon (RRFB)**
8. Road Diet
9. Pedestrian Hybrid Beacon (PHB)**

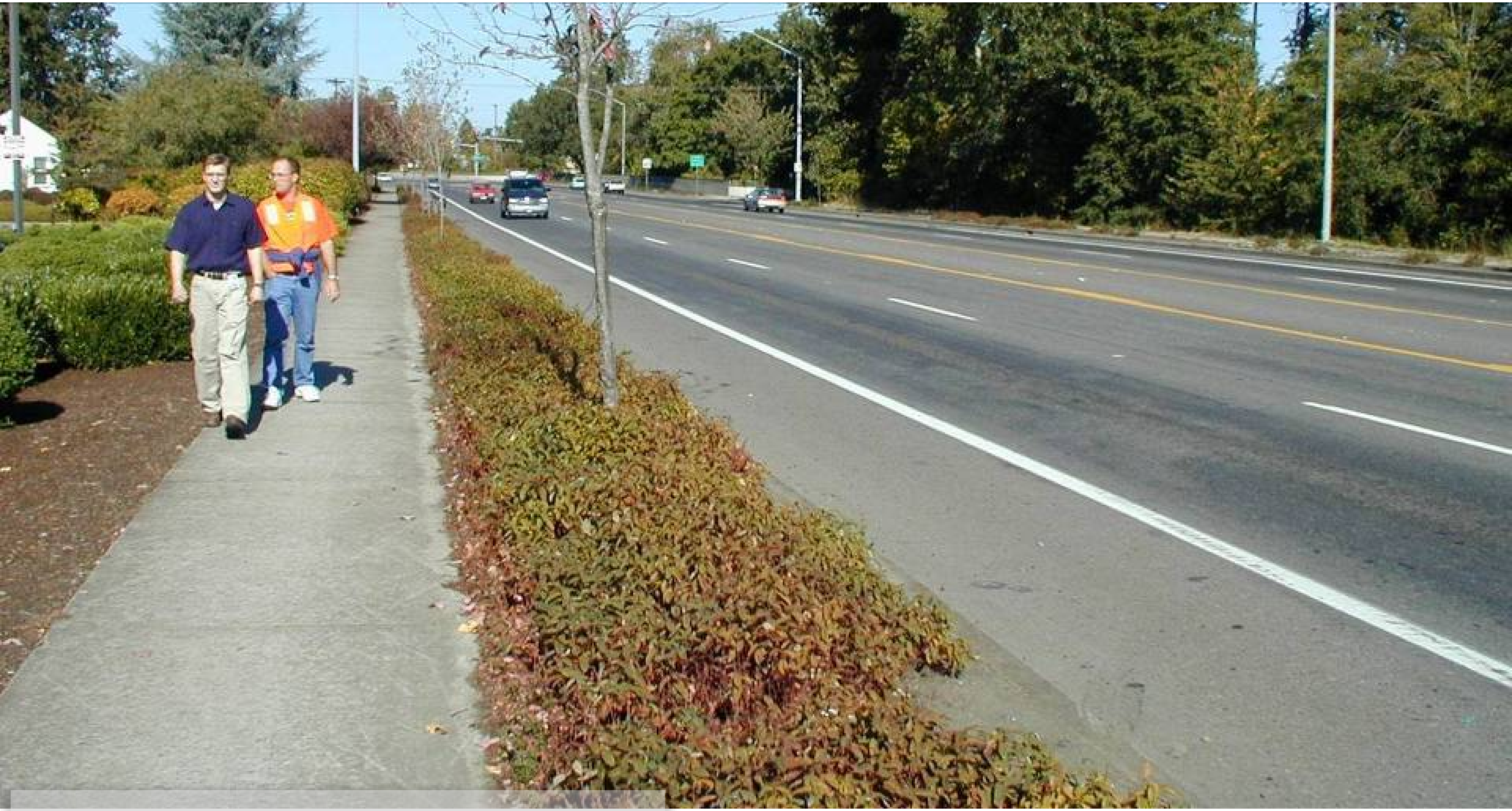
*Refer to Chapter 4, 'Using Table 1 and Table 2 to Select Countermeasures,' for more information about using multiple countermeasures.

**The PHB and RRFB are not both installed at the same crossing location.

Table 2. Safety issues addressed per countermeasure.

Pedestrian Crash Countermeasure for Uncontrolled Crossings	Safety Issue Addressed				
	Conflicts at crossing locations	Excessive vehicle speed	Inadequate conspicuity/ visibility	Drivers not yielding to pedestrians in crosswalks	Insufficient separation from traffic
Crosswalk visibility enhancement	✓	✓	✓	✓	✓
High-visibility crosswalk markings*	✓		✓	✓	
Parking restriction on crosswalk approach*	✓		✓	✓	
Improved nighttime lighting*	✓		✓		
Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line*	✓		✓	✓	✓
In-Street Pedestrian Crossing sign*	✓	✓	✓	✓	
Curb extension*	✓	✓	✓		✓
Raised crosswalk	✓	✓	✓	✓	
Pedestrian refuge island	✓	✓	✓		✓
Pedestrian Hybrid Beacon	✓	✓	✓	✓	
Road Diet	✓	✓	✓		✓
Rectangular Rapid-Flashing Beacon	✓		✓	✓	✓

Urban/suburban Environments: Sidewalks



88% Reduction in Pedestrian Crashes

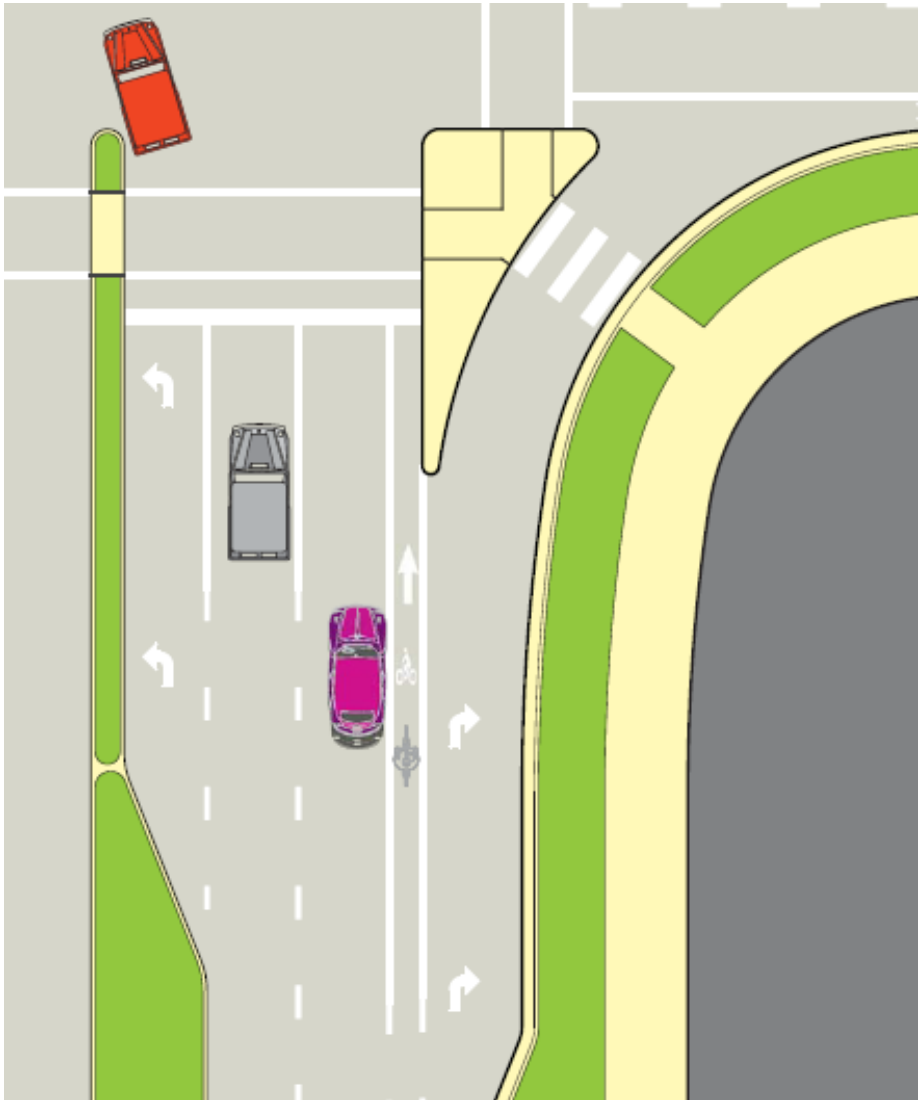
Reduce/Condense Access Points

Separated sidewalk keeps sidewalk level at driveways

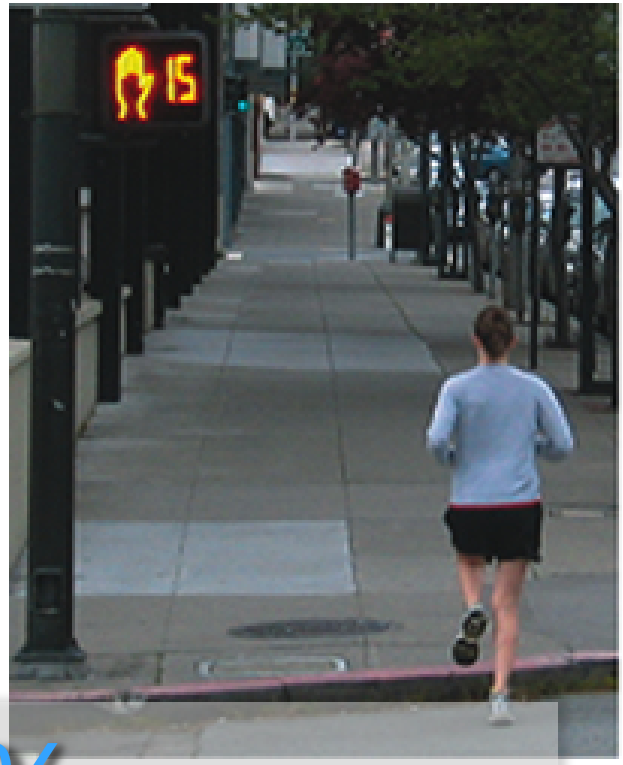
Islands at Intersections

Benefits:

- *Separate conflicts and decision points*
- *Reduce crossing distance*
- *Improve signal timing*
- *Reduce crashes*



Pedestrian Countdown Signal



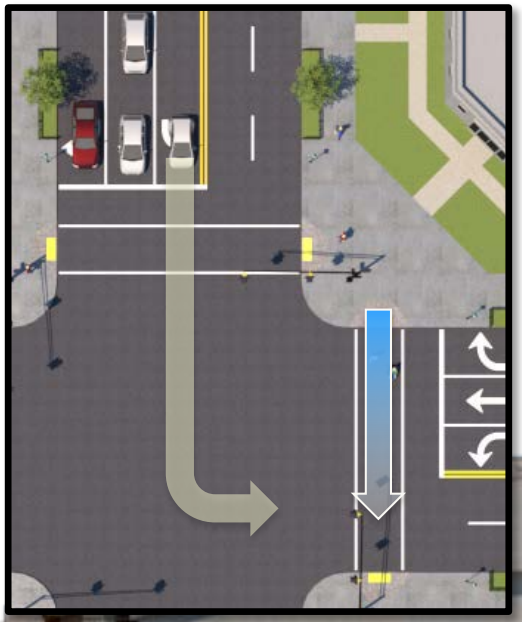
25% Reduction in Pedestrian Crashes

Use Short Signal Cycle Length

Long wait causes stacking: pedestrians wait in street, or don't wait and cross against the signal

Leading Pedestrian Interval

3+ Second
Advance Start



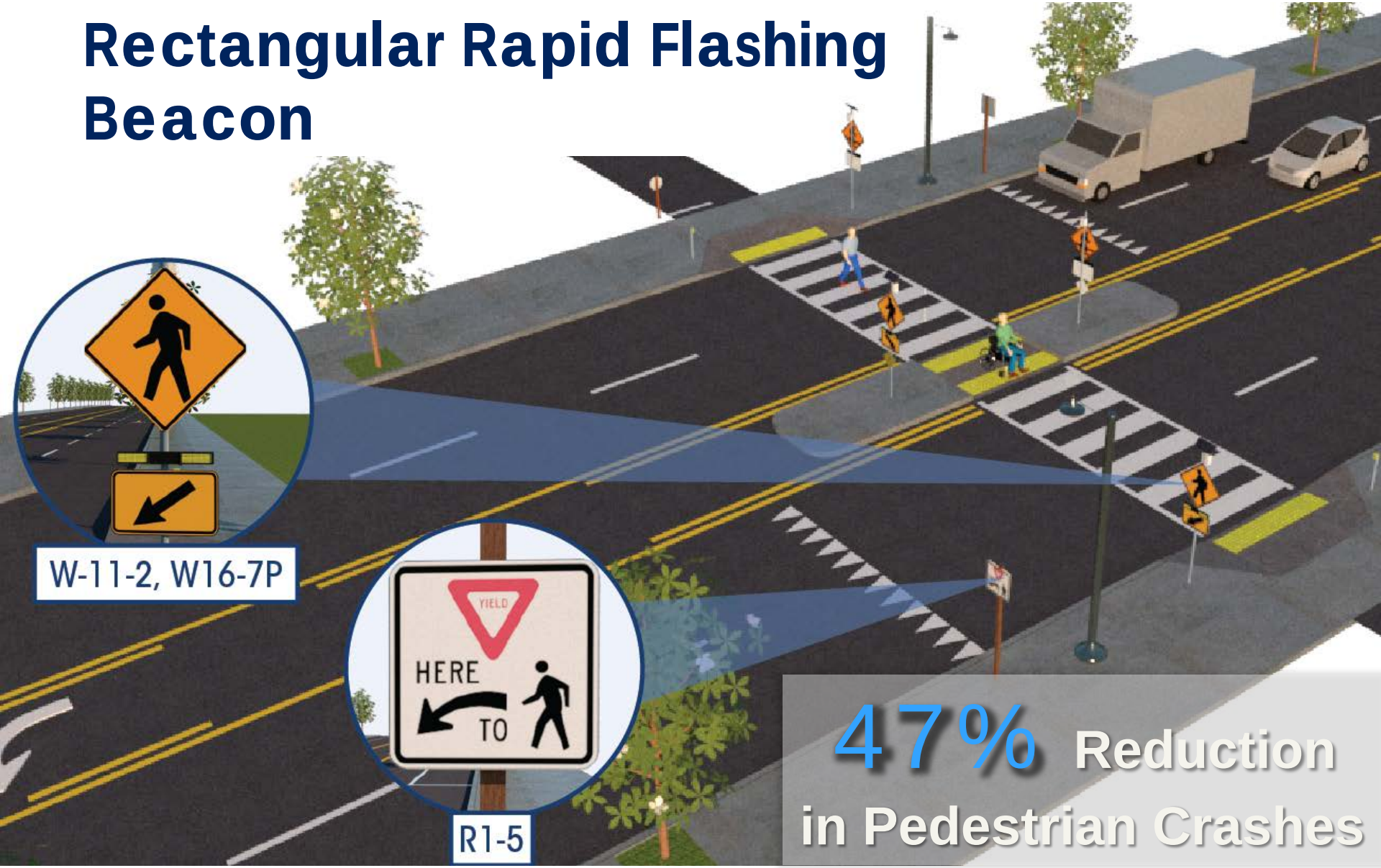
13% Reduction in Pedestrian Crashes

Leading Pedestrian Interval

WALK comes on 3 seconds prior to the vehicular green; pedestrians can enter crosswalk before turning vehicles arrive there.


Oberlin
Clark
Bank of America

Rectangular Rapid Flashing Beacon



Rectangular Rapid Flash LED Beacon

- Studies indicate motorist yield rates increased from about 20% to 80%
- Higher yielding rates sustained even after two years of operation and no identifiable negative effects
  - St. Petersburg FL research report 2008

Rectangular Rapid Flashing Beacon
New IA-21

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Correction issued 3/21/2018

Subject: **INFORMATION:** MUTCD – Interim Approval for Optional Use of Pedestrian-Actuated Rectangular Rapid-Flashing Beacons at Uncontrolled Marked Crosswalks (IA-21)

Date: MAR 20 2018

From: Martin C. Knopp
Associate Administrator for Operations

In Reply Refer To: HOTO-1

To: Federal Lands Highway Division Directors
Division Administrators

https://mutcd.fhwa.dot.gov/res-interim_approvals.htm#valid09

Figure 1. Example of an RRFB dark (left) and illuminated during the flash period (center and right) mounted with W11-2 sign and W16-7P plaque at an uncontrolled marked crosswalk.

- Must request and receive permission to use this new Interim Approval (1A-21) even if prior approval had been given for Interim Approval 1A-11
- A State may request Interim Approval for all jurisdictions in that State.

Interim Approval – Allowable Uses

- Function as **pedestrian-actuated conspicuity enhancement**
- Shall only be used to supplement post-mounted Pedestrian, School, Trail Crossing warning sign with diagonal downward arrow, plaque, or overhead-mounted warning sign located at or immediately adjacent to an uncontrolled marked crosswalk
- If deemed necessary by the engineer, in event of sight distance, additional RRFB may be installed in advance of crosswalk. Shall supplement not replace.

St. Petersburg FL

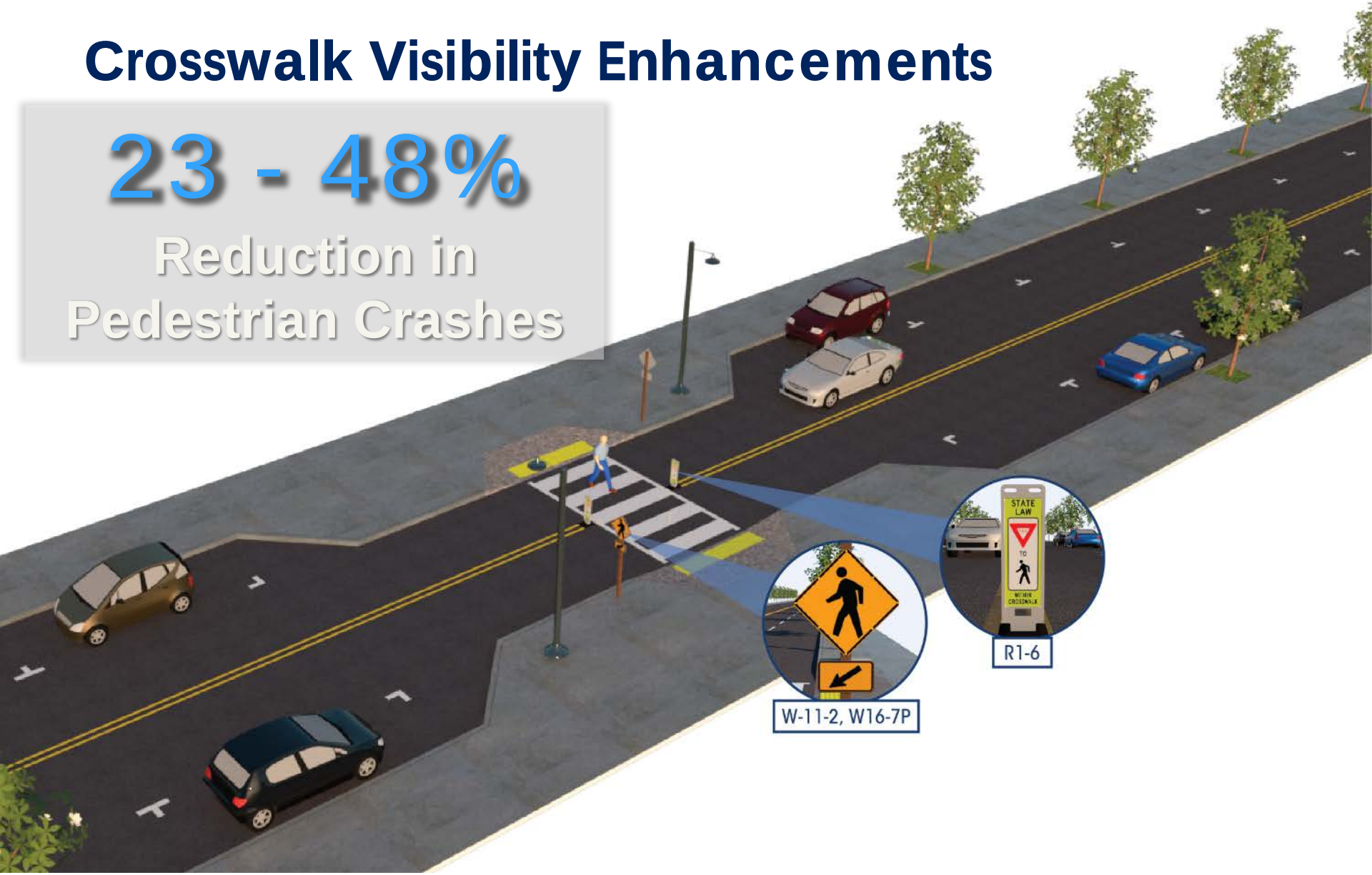
IA-21 3.a For any approach two RRFB required, One on right-hand and one on left-hand of roadway. If divided highway left-hand should be installed on median if practical rather than far left-hand.

RRFB Video IA-21Flash Pattern

Crosswalk Visibility Enhancements

23 - 48%

Reduction in Pedestrian Crashes



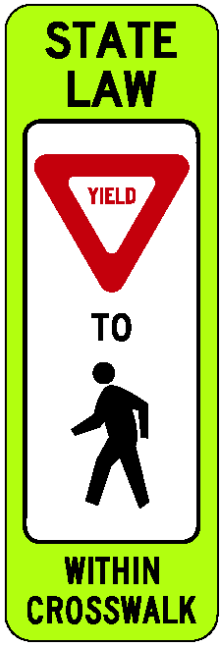
Crosswalk Visibility Enhancements
High Visibility Crosswalk

What Pedestrians See

Photo Source all 4: Michael Ronkin

What Drivers See

In-street pedestrian crossing signs



R1-6

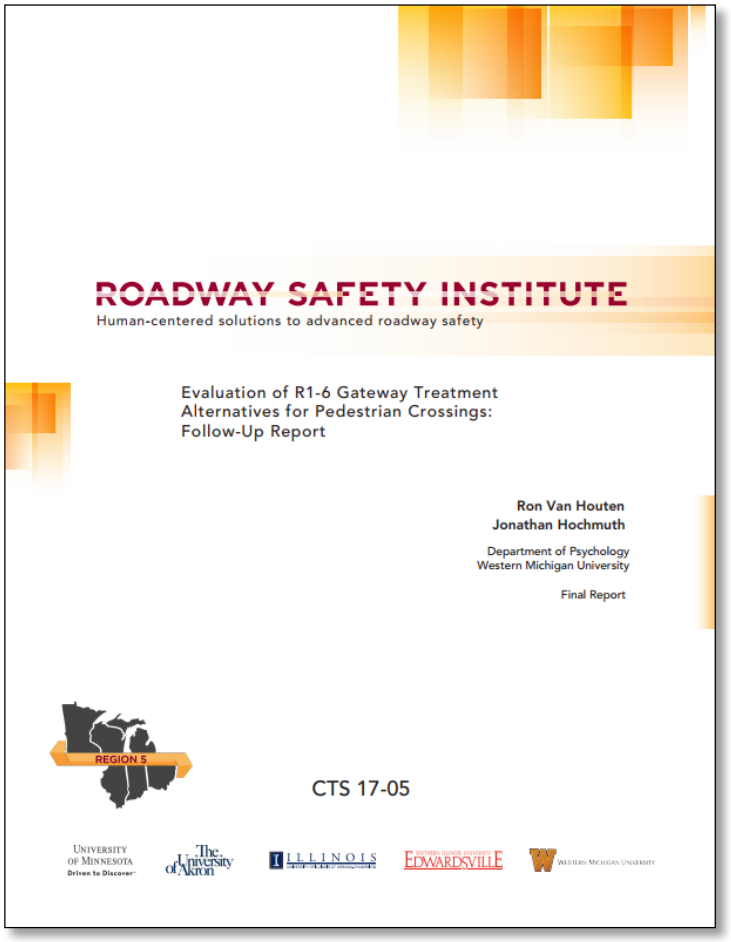
R1-6a

MUTCD signs

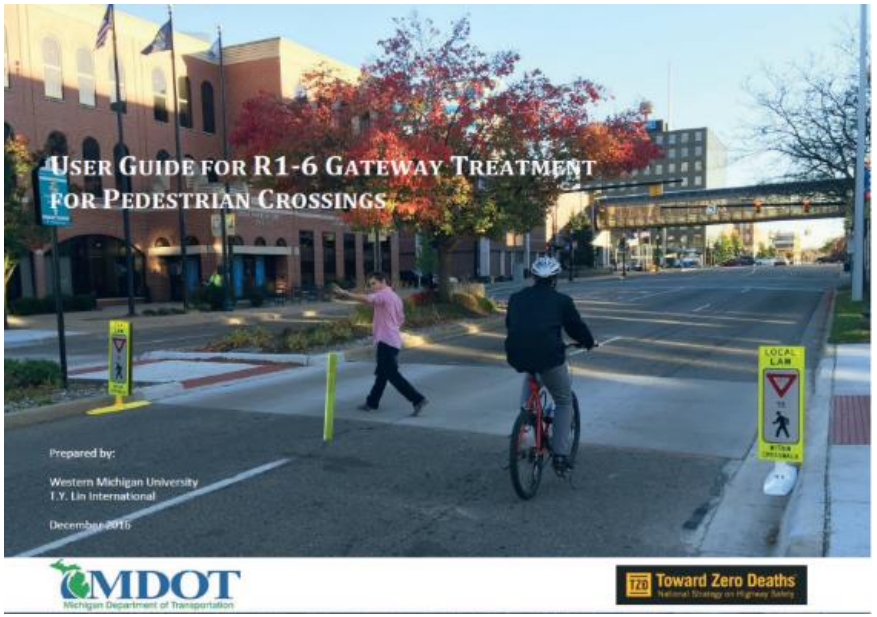
Yield or Stop depends on state law

2009 MUTCD Section 2B.12 and Figure 2B-2

In Street Gateway Treatment



https://conservancy.umn.edu/bitstream/handle/11299/189957/CTS%2017-05.pdf?sequence=1&isAllowed=y



https://mdotcf.state.mi.us/public/tands/Details_Web/mdot_user_guide_gateway_treatment.pdf

Gateway Treatment, Three–Lane Configuration Without Refuge Island	
Travel Lanes **Passing/Turn Lanes**	2 1
R1-6 Signs	4
Flexible Delineators	0
Yielding Compliance	Between 60% and 90% compliance rate if speed limit is 30mph or less for ADT up to 25,000. If the speed limit is 35 mph expect similar results if ADT is 12,000 or less. UNKNOWN above 12,000 ADT.
Approximate Cost	$1,200 for materials 20-minute installation 8 minutes to remove for winter 8 minutes to reinstall in spring

Figure 6a

General Description:

Note: By installing the gateway on the near side of the intersection, both crosswalks are covered with only four signs. Data show that a gateway at the near side crosswalk continues to be effective for the far side of the intersection, as the motorist on the far side has already passed through a gateway on the near side.

The signs on the curb side in the gutter pan would have a better chance of survival if they are moved placed between 3 and 50 feet in Advance of the crosswalk markings. This would reduce the chance of the sign being struck by a turning vehicle. Figure 6b shows a typical installation.

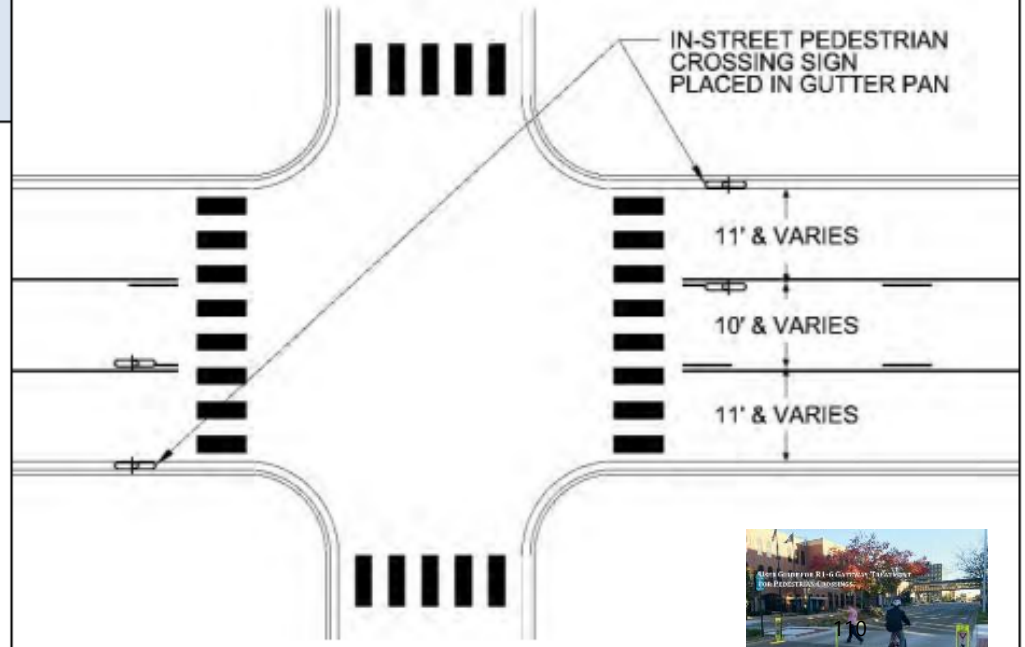
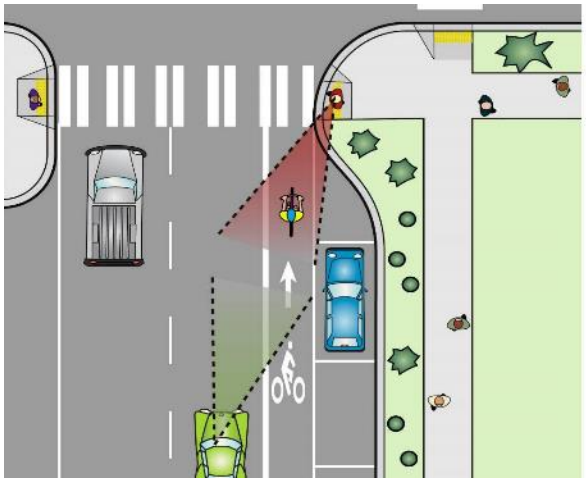


Figure 6b

Crosswalk Visibility Enhancements
Pedestrian Crossing signs

2009 MUTCD Sec. 2C.50 & Fig. 2C-11

Crosswalk Visibility Enhancements
Curb Extensions



Advance Signage and Markings

R1-5

R1-5a

(Use where local law says yield to pedestrians)

R1-5b

R1-5c

(Use where local law says stop for pedestrians)

MUTCD Sec. 2B.11 and Figure 2B-2

- Advance yield line & sign
- Consider double white lines for no passing

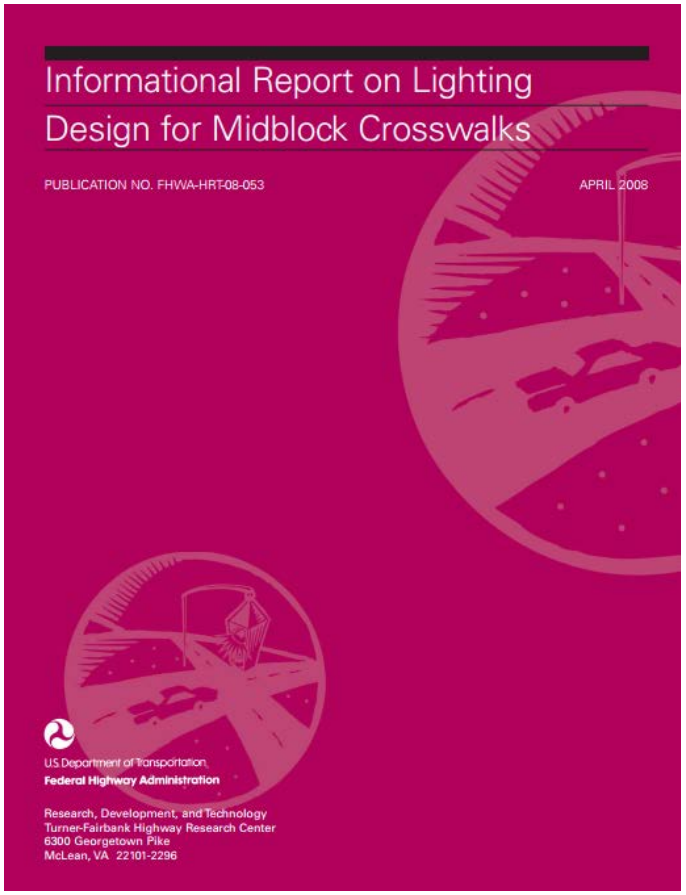
2009 MUTCD Section 3B.16 and Figure 3B-17

Crosswalk Visibility Enhancements
Crosswalk Lighting


Photo source: Youtube screen capture SWARCO

- CRF 42% to 59%
  - Lighting at intersections
  - 4 star rating
  - Vehicle/ped crashes

Informational Report on Lighting Design for Midblock Crosswalks



https://www.fhwa.dot.gov/publications/research/safety/08053/

- Vertical illuminance of 20 Lx in the crosswalk, measured at a height 5 ft from the road surface, provided adequate detection distances in most circumstances

Lighting Over Crosswalks

Fig 11. Traditional midblock crosswalk lighting layout

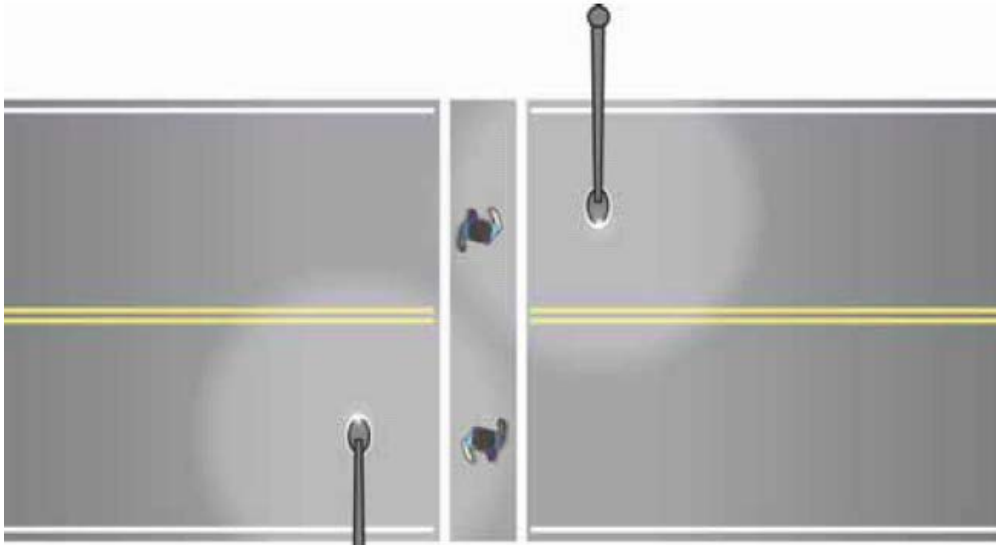
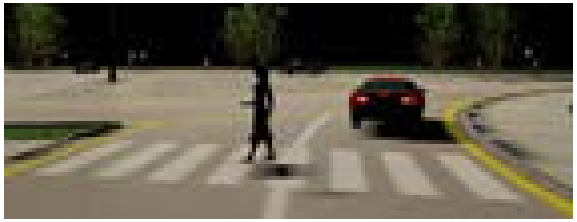
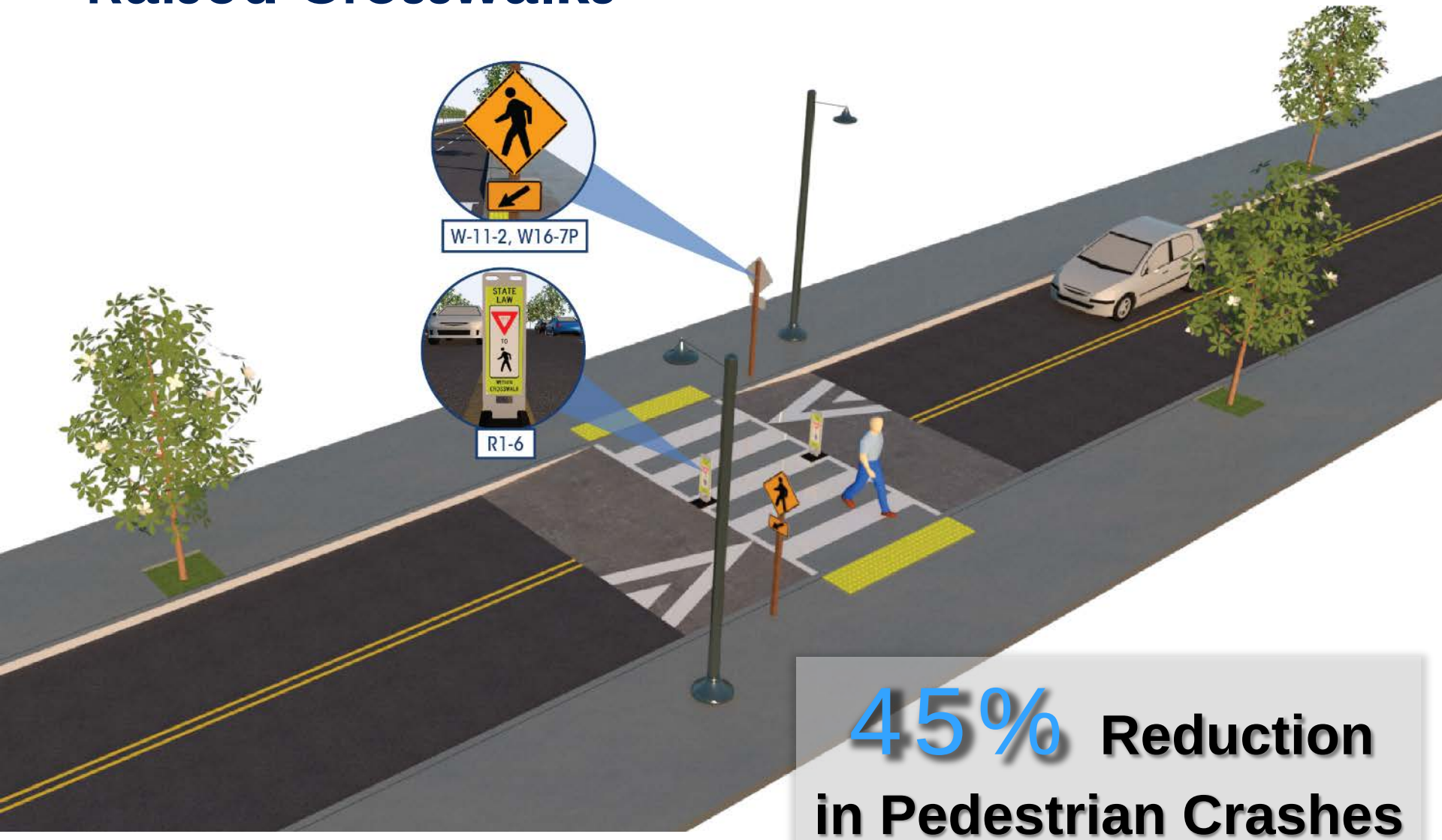


Fig 12. New design for midblock crosswalk lighting layout



Recommended lighting level: 20 lux at 5’ above pavement

Raised Crosswalks



45% Reduction in Pedestrian Crashes

Raised Crosswalks

- Typically installed on 2-lane or 3-lane roads
- Speed limits of 30 mph or less
- AADT below about 9,000
- May be candidate treatment for side streets

Photo Source: SRTS Guide


TRAIL X-ING
Burke-Gilman Trail
BUMP
BIKE SALE

Considerations

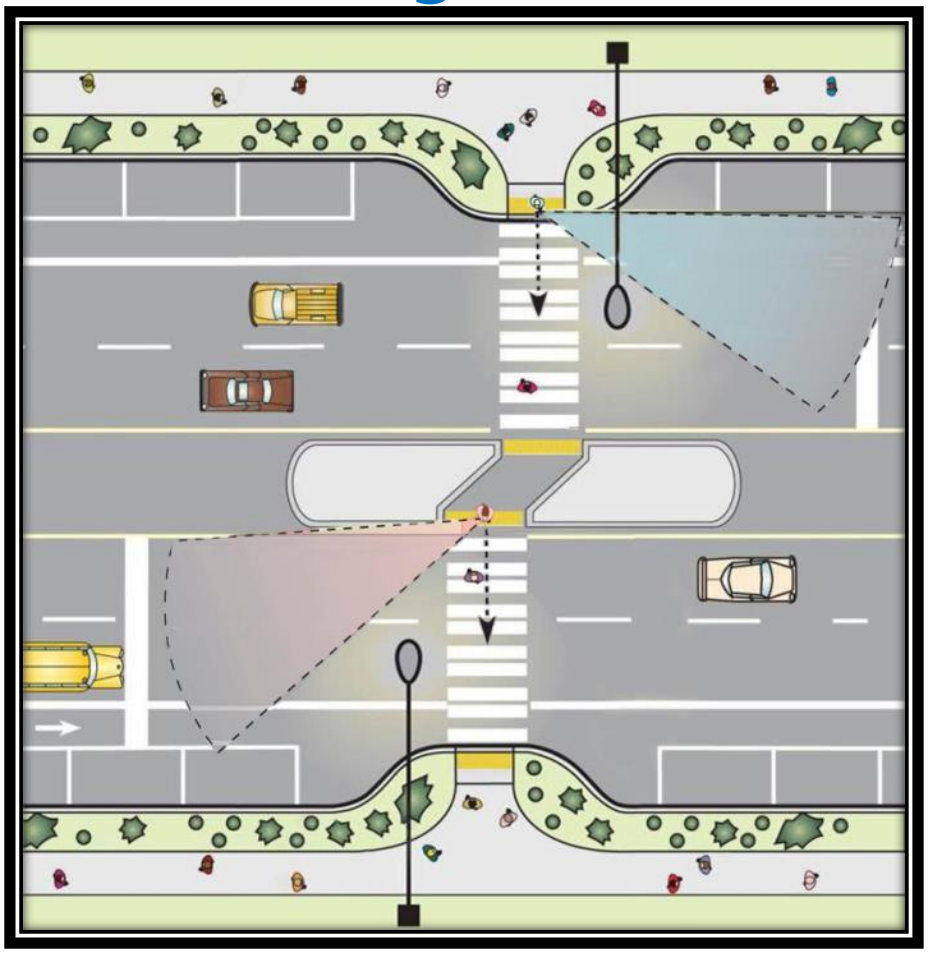
- Bus route
- EMS
- Snow Plowing
- Drainage
- ADA
- Curves or steep roadway grades

Figure 3.14.6. Raised Crosswalk with Bicycle Lane
(Source: Scott Batson)

Figure 3.14.4. Raised Crosswalk at Intersection
(Source: City of Cambridge, Massachusetts)

Pedestrian Refuge Islands

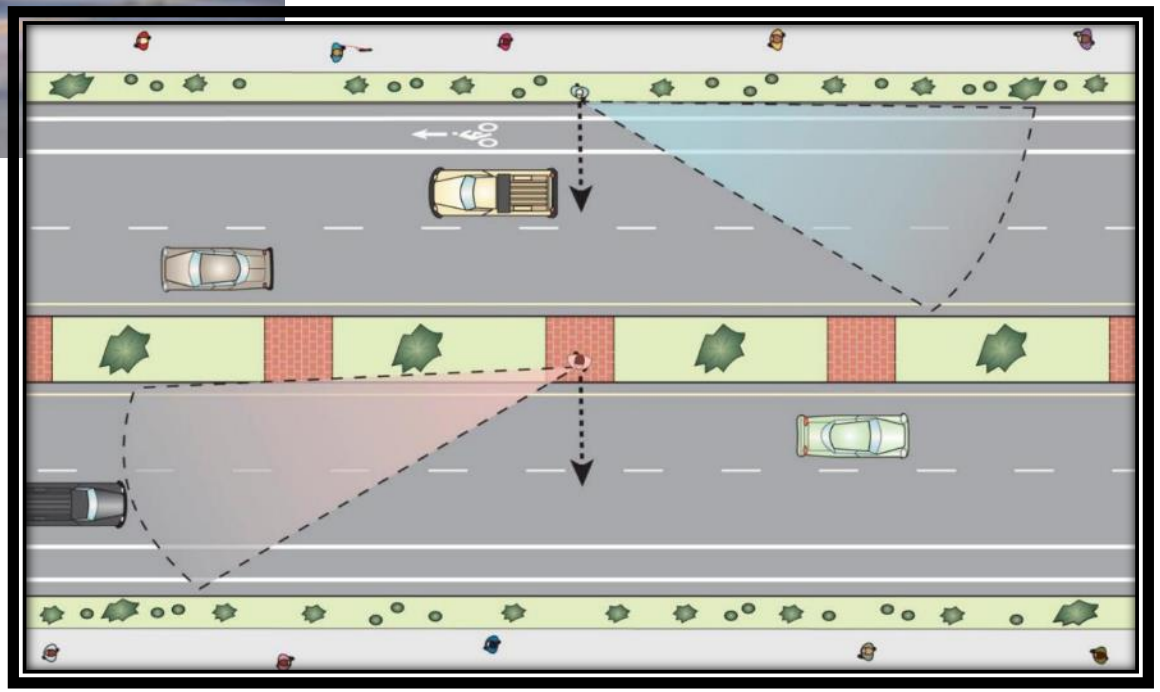
Raised median- Breaks complex crossing into two simpler crossings



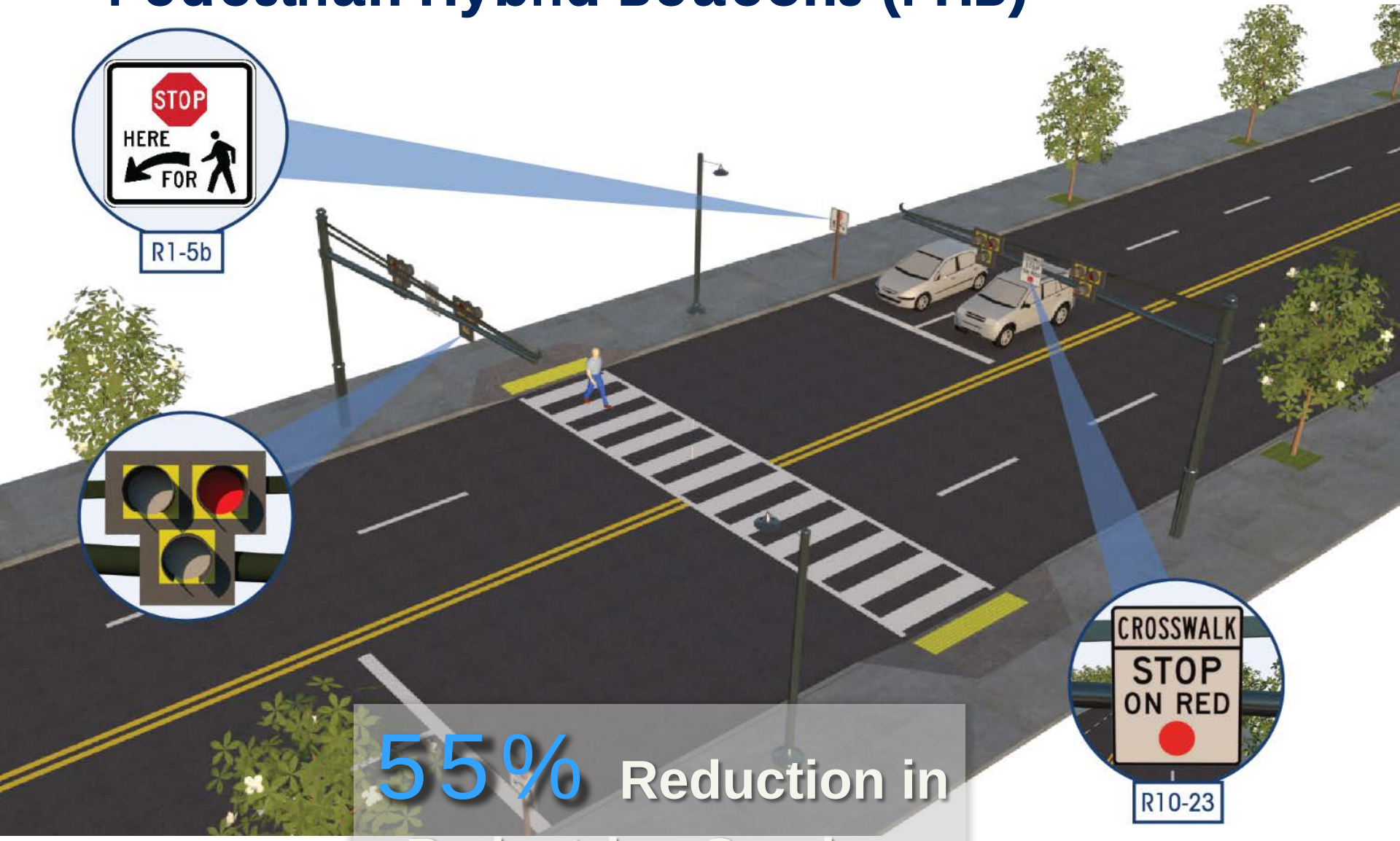
CRF: 39% unmarked crosswalks (uncontrolled)

CRF: 46% marked crosswalks (uncontrolled)

Continuous Raised Median



Pedestrian Hybrid Beacons (PHB)



55% Reduction in Pedestrian Crashes

Pedestrian Hybrid Beacons (PHB)

1

Blank for drivers

2

Flashing yellow

3

Steady yellow

4

Steady red

5

Wig-Wag

Return to 1

2009 MUTCD mandated sign

Standard:

A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign shall be mounted adjacent to a PHB face on each major street approach.

Option:

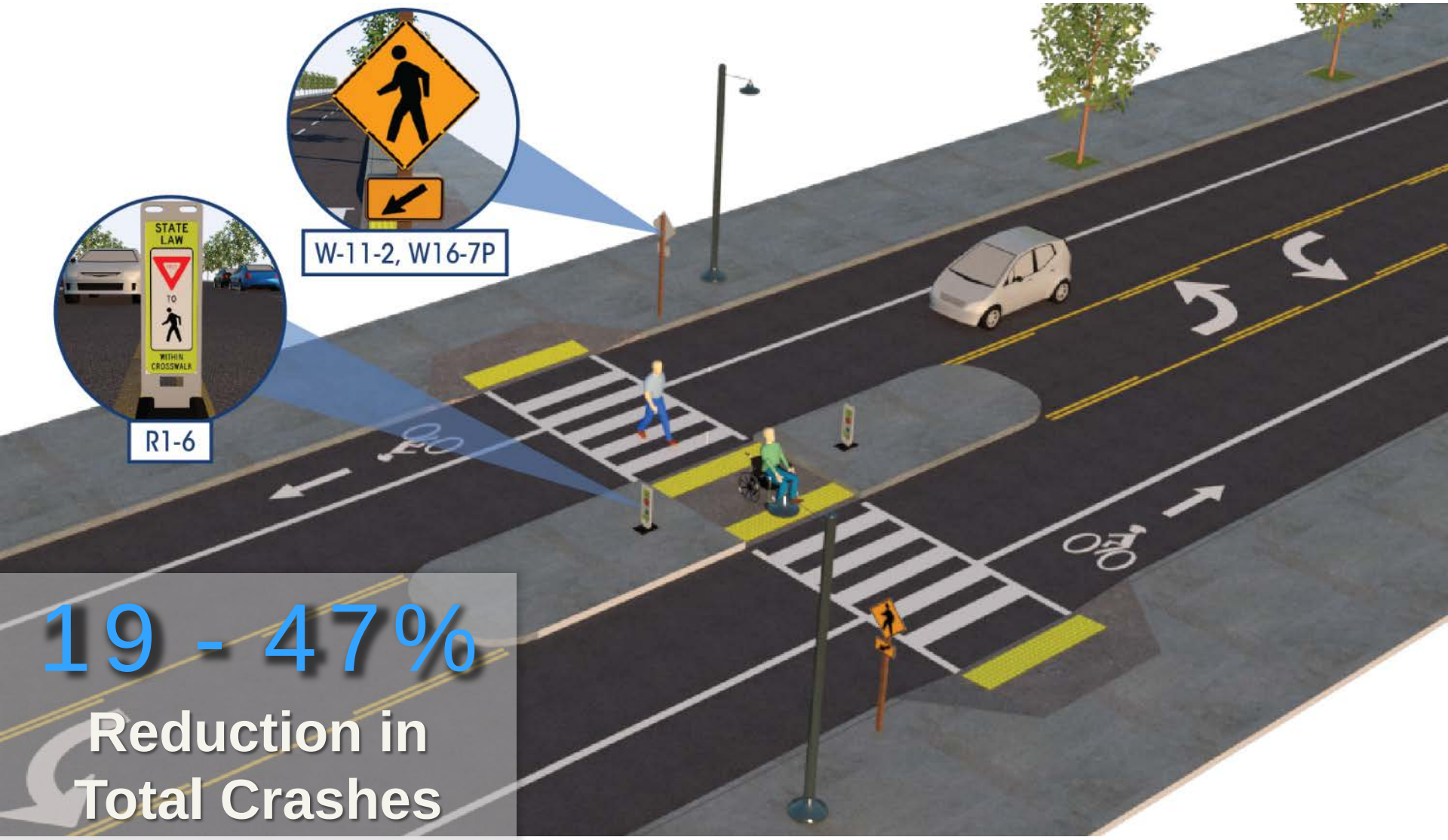
State MUTCD's may allow other appropriate MUTCD approved ped, bike or school crossing signs

Bike "Hawk" PHB

- First installation Tucson, AZ
- "BIKES WAIT"/"BIKES OK"

Road Diet: Before

Road Diet: After



19 - 47%

Reduction in Total Crashes

Road Diet / Roadway Reconfiguration

- Reduce crossing distance
- Eliminate /reduce “multiple threat” crash types
- Install crossing island to cross in 2 simple steps

Potential Space Reallocation

Road Diets

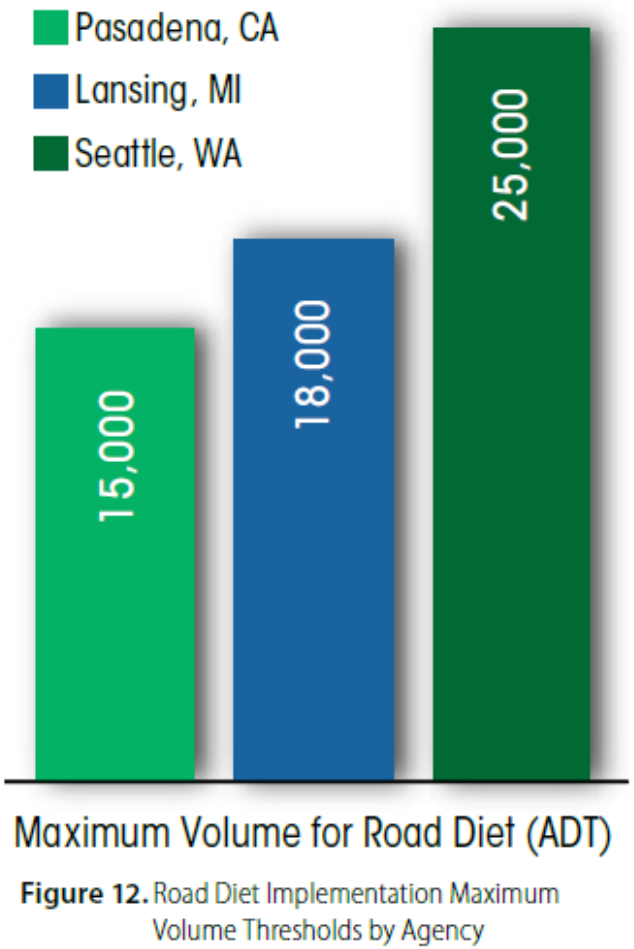


Figure 12. Road Diet Implementation Maximum Volume Thresholds by Agency

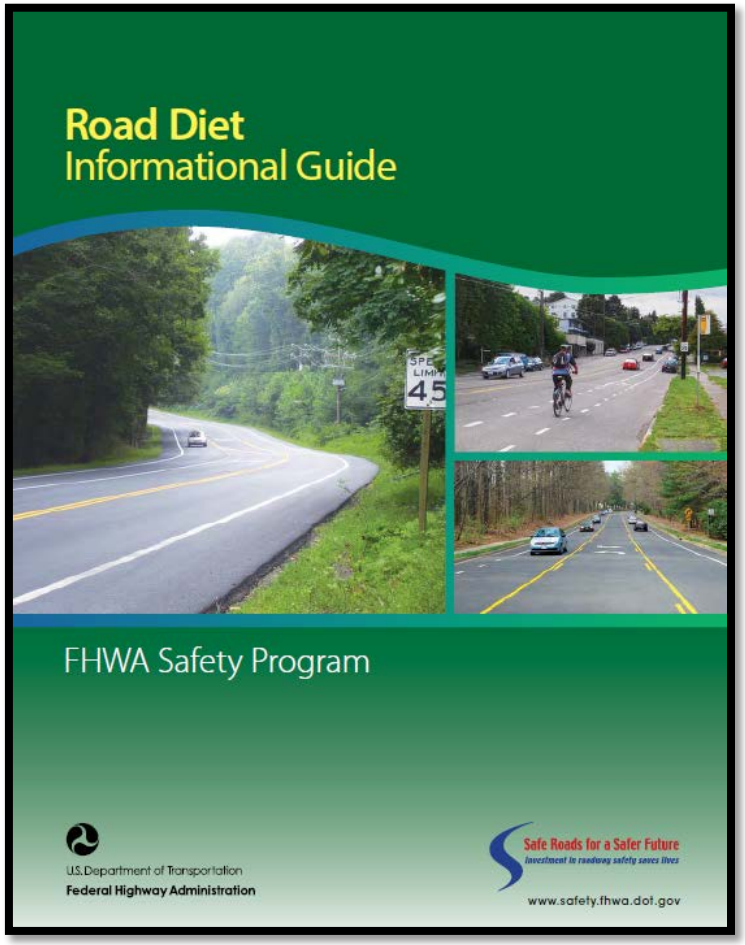
Considerations

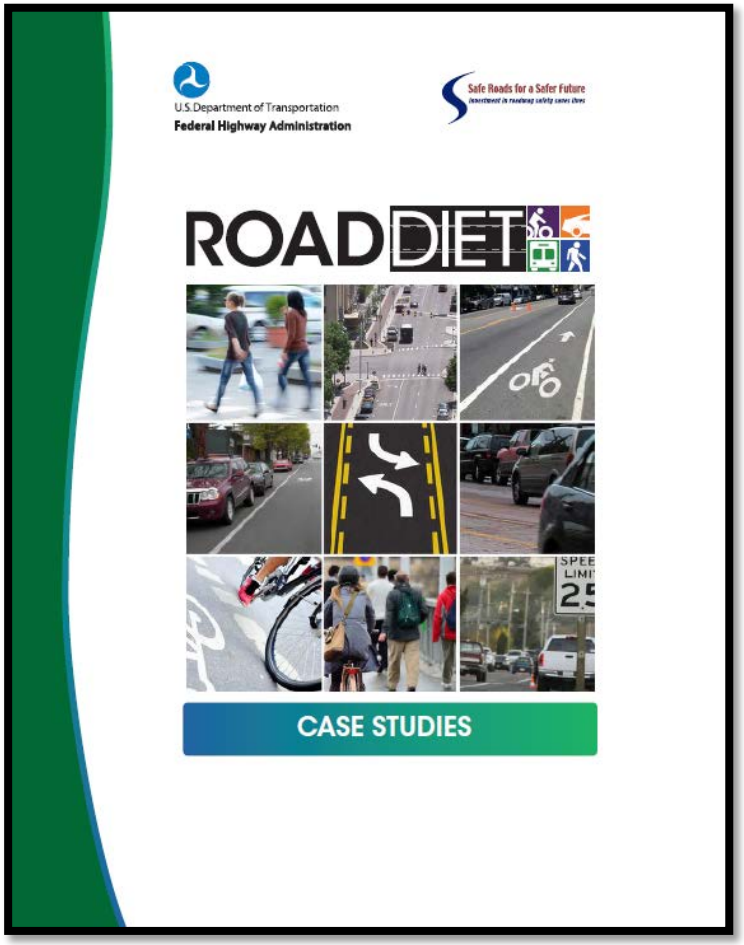
- Safety
- Operations
  - Peak Hour
- Design
  - Signalized Intersection Adjustments
- Resurfacing
- Context Sensitive Solutions/Complete Streets

Road Diet / Roadway Reconfiguration

- Reduce top end travel speeds
- Buffer sidewalk from travel lanes (parking or bike lane)
- Reclaim street space for “higher and better use” than moving peak hour traffic

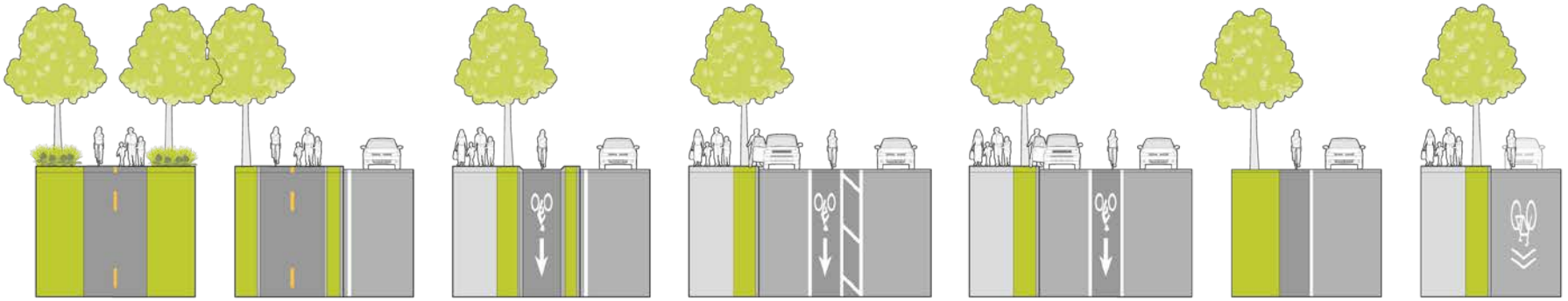
Road Diet Informational Guide & Road Diet Case Studies





https://www.fhwa.dot.gov/innovation/everydaycounts/edc-3/roaddiets.cfm

https://safety.fhwa.dot.gov/road_diets/



+ SEPARATION FROM TRAFFIC −