STEP: IMPROVING VISIBILITY AT TRAIL CROSSINGS

U.S. Department of Transportation
Federal Highway Administration

STEP
Safe Transportation for Every Pedestrian

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

Source: FHWA

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Acronyms

AADT	annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
DOT	Department of Transportation
FHWA	Federal Highway Administration
MUTCD	Manual on Uniform Traffic Control Devices
PHB	Pedestrian Hybrid Beacon
RRFB	Rectangular Rapid-Flashing Beacon
STEP	Safe Transportation for Every Pedestrian

Introduction

STEP: Improving Visibility at Trail Crossings is a resource for planning or improving at-grade trail crossings and trail access crossings. Trails, for the purposes of this summary document, include paved or well-defined unpaved shared use paths for pedestrians of all ages and abilities, and for multiple users such as bicyclists or equestrians. Informal worn paths or trails that do not include access for wheelchair users or blind pedestrians at the roadway crossing approach are not addressed by this guide.

Trails attract a wide range of users, including users of all ages and physical abilities such as young children, fast-paced bicyclists, and horse riders. The focus of this resource is on improving the driver's visibility of trail users at roadway crossings. The document presents a systemic approach to reviewing existing crossings or planning for improved at-grade trail crossings with engineering countermeasures, such as enhanced signs and traffic controls. A systemic approach uses data and local conditions to describe risk for crashes and can be applied before crashes occur. The systemic approach also provides a consistent approach to installing crossing countermeasures. Consistency increases the user experience and predictability.

This document does not describe the issues associated with or treatments for improving how the trail user approaches roadway crossings. These types of treatments - such as markings, signs, or bollards – are discussed in other guidance documents including AASHTO Guide to the Development of Bicycle Facilities (2012) (and subsequent guide under development), the Manual on Uniform Traffic Control Devices (MUTCD), and FHWA Small Town and Rural Multimodal Networks (2016). Additional information on equestrian trail crossings is available in the Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds, chapter 5. This document does not provide guidance on how to design a trail to meet accessibility standards or guidelines.

This resource should help practitioners make crossings more visible to drivers. The document describes safety issues and countermeasures for several most frequent types of trail crossings and introduces a process for reviewing trail crossing locations for issues and opportunities to reduce the chances of fatal or severe injury crashes. For guidance on shared use path or trail design, consult resources such as the AASHTO Guide to the Development of Bicycle Facilities, the Manual on Uniform Traffic Control Devices (MUTCD), State Department of Transportation (DOT) specific guidance, or Federal or State resource agency.

Figure 1: Signalized trail crossing with refuge. Source: FHWA

Steps for Improving Visibility of Trail Users at Roadway Crossings

The following steps can help the designer or planner collaborate with stakeholders, document current physical conditions, understand typical trail user characteristics, and describe the existing risk for crashes which could result in a fatality or a serious injury. Stakeholder coordination is needed throughout the project planning and design process.

1. Identify and Coordinate with Stakeholders

Designated trail crossings are marked, signed, and controlled by the agency who owns the roadway. Trail owners, such as a parks and recreation department or natural resource agency, determine trail approaches to roadway crossings. Local residents and stakeholders inform the needs of trail users. Each of these groups help inform trail crossing improvements. Trail crossing improvement projects require early and regular stakeholder engagement. Key stakeholders typically include, but are not limited to, the following agencies and groups:

- ➔ Land management or recreation agencies
- ➔ Individual members of the public
- ➔ Community groups
- ➔ Land developers
- ➔ Elected and appointed local officials
- ➔ Transportation agency representatives

2. Understand the Context and Trail Users

When reviewing trail crossings, consider the surrounding context and the types of people using the trail system. The types of land development (i.e. urban or rural setting) and ownership of the trail system may inform options for adding lighting or managing vegetation at trail crossings. For example, agencies owning trails in national or local parks may prefer to restrict overhead lighting. The types of nearby land uses (i.e. retail, housing, schools, parks) identify potential destinations for trail users. Nearby land uses and information about local demographics can also help identify likely types of trail users, such as older pedestrians or young bicyclists.

Trail users represent a range of ages, abilities, and modes of transportation. Driver speeds and trail user behaviors can impact the safety performance at trail crossings. For example, horses and horse riders can be easily startled by speeding bicyclists or inattentive drivers. Age of trail users inform pedestrian characteristics, such as walking speed, and bicyclists' experience with judging gaps and speed of traffic.

Figure 2: Children using scooters on a shared use path. Source: FHWA

3. Collect Data and Create an Inventory of Current Trail Crossing Conditions

A comprehensive data collection process and an inventory of current trail crossing conditions can help set priorities for crossing improvements. Practitioners should conduct site visits to collect additional data not available from digital sources, such as volume counts and field observations. Table 1 describes three categories of information to collect for trail crossing locations: crossing visibility, roadway and traffic characteristics, and trail context:

This inventory information can be combined into maps, updated per planned improvements, compared with local population data, and compared with pedestrian and bicycle crash history. Observations about drivers and trail users should also be added to the inventory, such as compliance with traffic controls or sudden stops.

Table 1: Data Collection for Trail Crossing Inventory.

Type	Information to Record
Crossing Visibility	Vegetation near trail approach
	Warning signage and roadway markings in advance of trail crossing
	Stopping sight distance approaching trail crossing
	Overhead lighting in advance of and at trail crossing
	Crosswalk markings
Roadway and Traffic Characteristics	Motorist speed (posted and observed)
	AADT
	Crossing distance
	Number of travel lanes
	Vehicle turning movements
	Traffic controls or signal phasing at crossing
	Type of trail approach (surface, design, accessibility features)
	Existing bike infrastructure or parking on roadway
	Geometric features, such as raised islands or curb extensions, approaching trail crossing
Trail Context	Gradient of trail approach to roadway
	Trail destinations and land uses near crossing
	Parking near trailhead

4. Prioritize Locations Based on Risk and Select Countermeasures

Once the data has been collected and the trail crossing inventory is complete, practitioners can categorize risk for crashes and prioritize locations for developing safety improvements. Risk for severe injury or fatal crashes with pedestrians and bicyclists at trail crossings can increase with higher vehicle speeds, traffic volumes, and trail user activity. Countermeasures are selected based on risk and roadway characteristics. Constrained environments, such as minimum pavement width or physical features may limit options for crossing improvements, after considering options such as narrowing travel lanes or removing trees.

Table 2, referenced from the Michigan DOT Sidepath Intersection & Crossing Treatment Guide, is a summary of countermeasures considered for most types of trail crossings. The countermeasures are selected per roadway characteristics but may also correspond to other goals for the crossings identified in the inventory and site review. Goals for improving trail crossings may include improving traffic control, reducing speeds, and increasing trail user visibility.

Table 2: Trail Crossing Countermeasures.

Countermeasure or Crossing Treatment	Goals		
	Improved Traffic Control	*Speed Reduction*	*Trail User Visibility*
Motorist Stop/Yield signs and markings	x		x
Trail Crossing Warning signs			x
High-visibility crosswalk markings	x		x
Raised crosswalk		x	x
Pedestrian Refuge Island		x	x
RRFB or PHB	x		x
Pedestrian countdown signal head	x		
LPI	x		x
Overhead lighting			x
Curb extensions and tighter curb radii		x	x
Increase setback distance between adjacent trail crossing and roadway		x	x
Realign trail approach to roadway		x	x
Parking restrictions			x
Trim vegetation			x

Table 2 is informed by several key resources for selecting countermeasures for trail crossings. Trail crossings are primarily pedestrian crossings, so resources such as the *FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* are key references. The guide includes two tables that assist with potential countermeasure selection. Table 1 leverages current research to identify applicable countermeasures based on tiers of roadway configurations, speeds, and AADTs. The guide also includes Table 2, cross-referencing general safety issues to potential countermeasures, based on surrounding land development context, pedestrian travel patterns, and driver behaviors.

NCHRP Report 926: Guidance to Improve Pedestrian and Bicyclist Safety at Intersections discusses considerations for general types of intersection projects; data types and analysis methods; and criteria to selecting and refining potential countermeasures. The report includes a descriptive list of countermeasures for improving yielding and separation by intersection type, crash type, context, priority user and design trade-offs.

The FHWA Bicycle Safety Guide and Countermeasure Selection System (BIKESAFE) and the FHWA Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE) are online and interactive tools for selecting bicycle and pedestrian safety countermeasures. BIKESAFE addresses intersection features or countermeasures such as bicycle signal heads and on-road bicycle facilities. PEDSAFE addresses intersection features or countermeasures such as RRFBs, PHBs, countdown timers at pedestrian signals, and curb design.

Proven Safety Countermeasures for Trail Crossings

Rectangular Rapid Flashing Beacons (RRFB)

RRFBs are pedestrian-actuated conspicuity enhancements used in combination with a pedestrian, school, or trail crossing warning sign to improve safety at uncontrolled, marked crosswalks. The device includes two rectangular-shaped yellow indications, each with an LED-array-based light source, that flash with high frequency when activated. RRFBs are often activated by pushbuttons, however some RRFBs are equipped with motion sensors, which activate the RRFB and indicate a pedestrian is at the crosswalk.

Crosswalk Visibility Enhancements

Enhanced crosswalk lighting, signage, and markings can help drivers see pedestrians and help pedestrians decide where to cross. Features of this countermeasure include high visibility markings, parking restrictions around crosswalks, advance "stop" or "yield" markings, signs and curb extensions.

Raised crosswalks

Raised crosswalks are ramped speed tables spanning the entire width of the roadway, often placed at mid-block crossing locations.

Lighting

Overhead lighting is placed in advance of marked crosswalks, on both sides of the street, to illuminate the front of the pedestrian and the crosswalk. Design lighting to reduce "dark spots" between lit areas and shadows on the pedestrian.

Pedestrian Hybrid Beacons

A traffic control device with a face that consists of two red lenses above a single yellow lens. Unlike a traffic signal, the PHB rests in dark until a pedestrian activates it via pushbutton or other form of detection.

Pedestrian Refuge Islands

A median with a refuge area that is intended to help protect pedestrians who are crossing the road. This countermeasure is sometimes referred to as a crossing island or pedestrian island.

Leading Pedestrian Intervals

Leading Pedestrian Intervals (LPIs) are adjustments to signal timing to increase pedestrian safety at signalized intersections. An LPI gives pedestrians a typical 3- to 7-second head start before vehicles in the parallel direction are given the green signal indication.

Parking restriction

Parking restriction can include the removal of parking space markings, installation of new "parking prohibition" pavement markings or curb paint, and signs.

Types of Trail Crossings

Several features are common to all types of trail crossings:

- Trails attract people of all ages and abilities, including families and young pedestrians or bicyclists who may not have experience finding adequate gaps in traffic or may need additional time to cross roadways.
- Bicyclists approach roadway crossings at higher speeds than pedestrians, reducing decision sight distance to adequately judge the amount of time needed to clear the roadway from a "stop-go" decision point.
- Trail users travel in both directions, crossing the roadway with or against traffic flow. Trail users may not be able to see vehicles approaching from behind.
- Trails are often built in natural areas or pass through rural settings. Drivers may not expect or see trail users crossing in darker conditions unless overhead lighting is installed.
- People use trails for all purposes, such as for transportation or recreation, and can cross roads at all times of day or during all seasons. Drivers may not always expect to see trail users at roadway crossings.

However, as described earlier, trail crossings vary based on the configuration and type of the roadway and trail, environment and context, and the trail user needs. Additionally, infrastructure improvements should be considered based on the purpose and placement of the trail crossings. Trail crossings typically fall into one of four types: mid-block trail crossings, adjacent or parallel trail crossings, complex intersection crossings, and trailhead access crossing.

Mid-block trail crossings are crossings that occur outside of an intersection, regardless of distance from the closest intersection. When trails cross roads away from a controlled intersection, motorist speeds tend to increase, which can increase stopping sight distance. **Adjacent trail crossings** occur where the trail or sidepath runs parallel and close to a roadway, crossing another roadway (or driveway). Adjacent crossings have more conflict points with vehicles and trail users, than a mid-block crossing, because right and left turning movements as well as through traffic movements can all take place over the crossing. **Complex intersection trail crossings** include trail crossings that occur at signalized, skewed, or multi-lane uncontrolled intersections. These types of crossings often involve multistage phases for bicycle or pedestrian travel, indirect routes, or multilane crossings. A **trailhead access crossing** occurs where a trailhead or trail access point is across a roadway from a destination, such as a parking lot, school, store, transit stop, etc. These crossings can coincide with other types of crossings but may need additional infrastructure to enhance visibility. The following figures provide examples of each trail crossing type, common challenges to trail crossing safety, and countermeasures that may be considered for each type.

Figure 3. Family bicycling on a trail. Source: FHWA.

Mid-block Trail Crossings

Figure 4: Mid-block trail crossing with PHB.
Source: FHWA

Mid-block trail crossings are where a trail crosses a roadway away from an intersection. Perpendicular crossings are preferred over skewed mid-block crossings because they typically offer more sight distance for both the road and trail user of the upcoming crossing. When retrofitting a skewed mid-block crossing, curving the trail on either side of the crossing can achieve the desired perpendicular crossing.

Sight distance is a concern for many mid-block trail crossings. Stopping sight distance to mid-block trail crossings is limited as approaching driver speeds increase. Bicyclist decision sight distance is also restricted by faster cyclist travel speeds. Visual obstructions, such as trees and buildings,may limit the view of both the driver and trail users as they approach mid-block trail crossings. Pedestrians and bicyclists crossing roads carrying high volumes of traffic or with multiple travel lanes look for gaps in traffic to cross in one stage. Bicyclists carrying a trailer need more refuge space if crossing the roadway in multiple stages.

Figure 5: Mid-block trail crossing with RRFB.
Source: VHB

Mid-block Trail Crossings Issues

Higher traffic speeds ⑤ affect driver stopping sight distance when approaching mid-block trail crossings, and higher traffic volumes reduce the number of gaps that trail users have to cross the road in one stage ③. Curved roadways and skewed trail approaches ① limit visibility and sight distance of trail crossings, and vegetation or buildings near the crossing restrict driver and trail user view of the crossing ④. Wider or multilane roadways create longer crossing distances ②. These conditions are improved by removing visual obstructions such as tall vegetation and installing advance warning signs ahead of the trail crossing. Countermeasures such as refuge islands provide for a multistage crossing and may help reduce approaching speeds, and RRFBs improve driver visibility of the trail crossing.

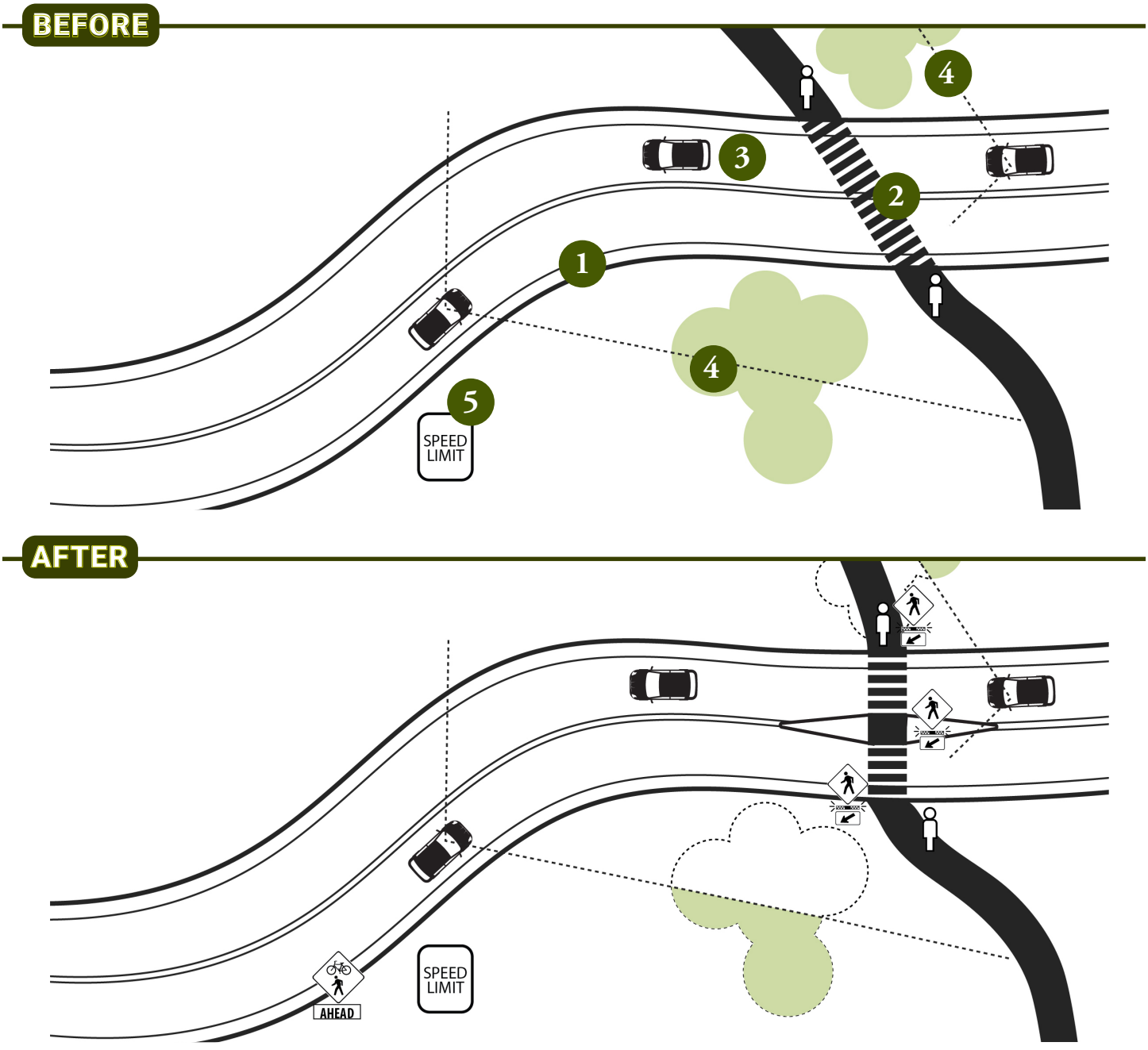

Figure 6: A before and after illustration of a mid-block trail crossing. Source: FHWA

Adjacent (Parallel) Trail Crossings

Figure 7: Adjacent trail crossing.
Source: FHWA

Adjacent trail crossings occur where a trail parallels a roadway and crosses another roadway (or driveway) near the intersection. Designing for enhanced sight distance is critical for increasing safety at adjacent trail crossings. The distance of the crossing from the intersection can impact sight distance, travel speeds of the approaching motor vehicles, and/or impact the necessary space for queuing between the crossing and the intersection.

Pedestrians and bicyclists traveling on sidepaths or adjacent trails travel in both directions and may not see traffic turning onto the side street from behind. Visual obstructions such as vegetation or buildings may also restrict view of drivers turning right or left turning from the parallel roadway across the trail. Trail user speeds on the approach to the roadway may reduce their ability to come to a stop at the crossing.

Figure 8: Adjacent trail crossing.
Source: FHWA

Adjacent (Parallel) Trail Crossings Issues

Trails adjacent or parallel to a roadway cross side streets, and vehicles may conflict with trail users when turning onto the side street from the parallel roadway ②. When the trail crossing is placed where drivers queue to turn from a side street, vehicles may encroach onto the crossing ③ or fail to yield to trail users in the crossing. Parked cars, street trees or other visual obstructions on the side street may reduce visibility of the crossing ①④. Crossings set further back from the parallel roadway increase driver sight distance of the trail crossing, and raising the crosswalk increases driver yielding while decreasing approach speeds. Restricting on street parking and removing vegetation increases visibility of the trail crossing for both drivers and trail users. Signs, markings, and devices such a narrowed trail or small island may be considered on the trail approach to the crossing to increase trail user compliance at the intersection.

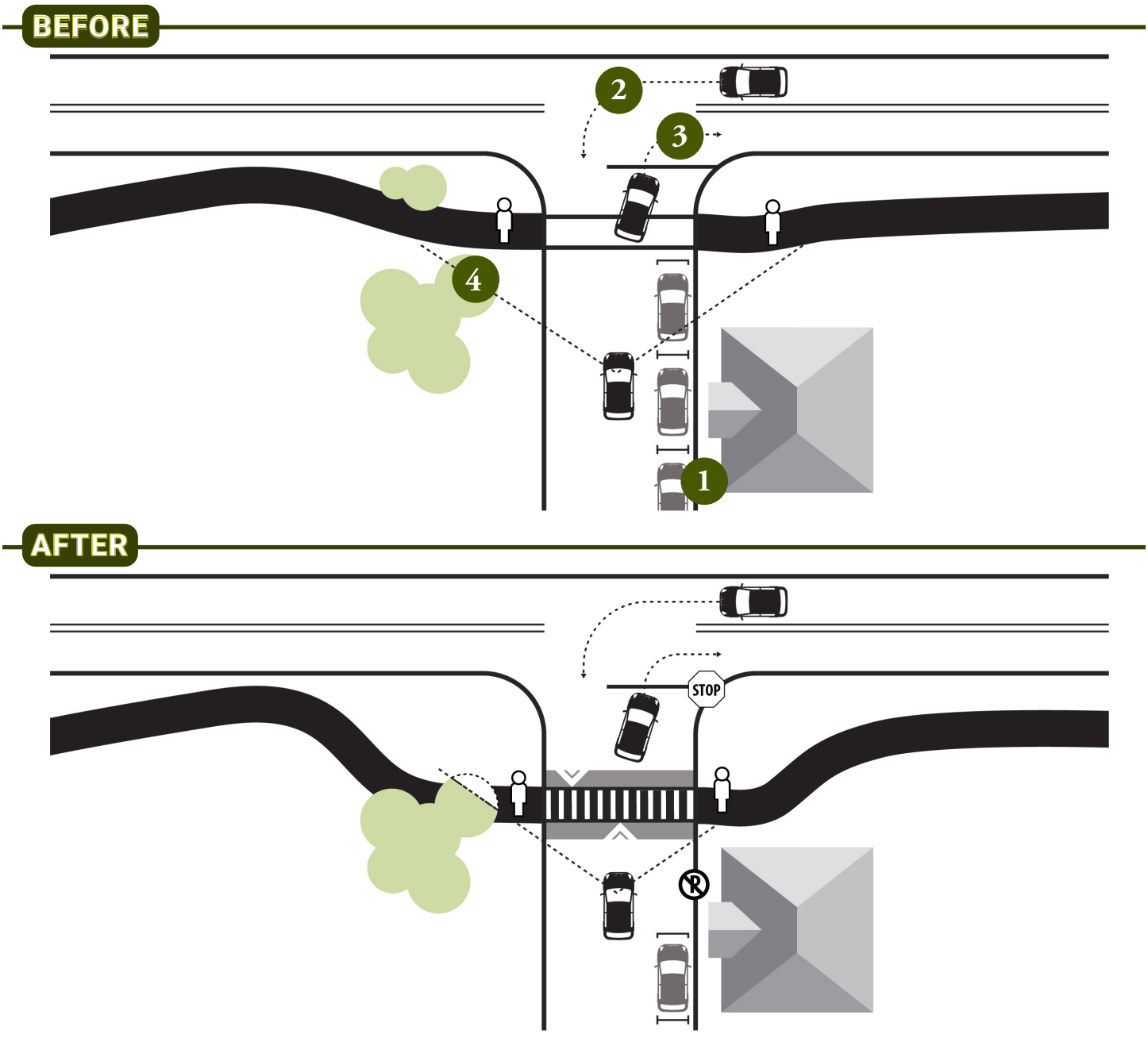

Figure 9: A before and after illustration of a adjacent trail crossing. Source: FHWA

Complex Intersection Trail Crossings

Figure 10: Trail crossing at a complex intersection with a wide refuge. Source: FHWA

Complex intersection trail crossings include intersections that have a nonstandard geometry, such as a "T" intersection or skewed approaches. Complex intersections can also include intersections with multiple through lanes and turn lanes, alternative designs such as Reduced Left-Turn Conflict intersections, permitted U-turns, or complex signal operations such as split phasing or flashing turn arrows.

Turning movement conflicts with trail crossings are the key concern at complex intersections. Long crossing distances or indirect routes across the intersection can increase crash risk for trail users at large or complex intersections. Passive detection and placement of push buttons to call the WALK phase for a wide range of trail users, including pedestrians with vision and hearing impairments and bicyclists, could be considered.

Figure 11: Trail crossing at complex intersection. Source: FHWA

Complex Intersection Trail Crossings Issues

Trails often cross intersections across two approaches, increasing trail user crossing activity on legs of the intersection ②. This increases exposure with specific turning movements at the intersection, such as left turns across one leg of the intersection trail crossing ①. Wide intersections with multiple through lanes and turn lanes create long crossing distances for trail users ③. Buildings and vegetation may limit sight distance and visibility of trails approaching intersections ④. Shorten overall crossing distance at complex intersections by including wide curb extensions, or install wide refuge islands for intersections with multiple through and turn lanes. Signal phasing and timing should accommodate a moderate walking speed and WALK phase for trail users of all ages and abilities and include features such as Leading Pedestrian Interval or right turn restrictions at trail crossings. Increase overall visibility of the trail crossings with wide, high-visibility crosswalk markings and cleared vegetation.

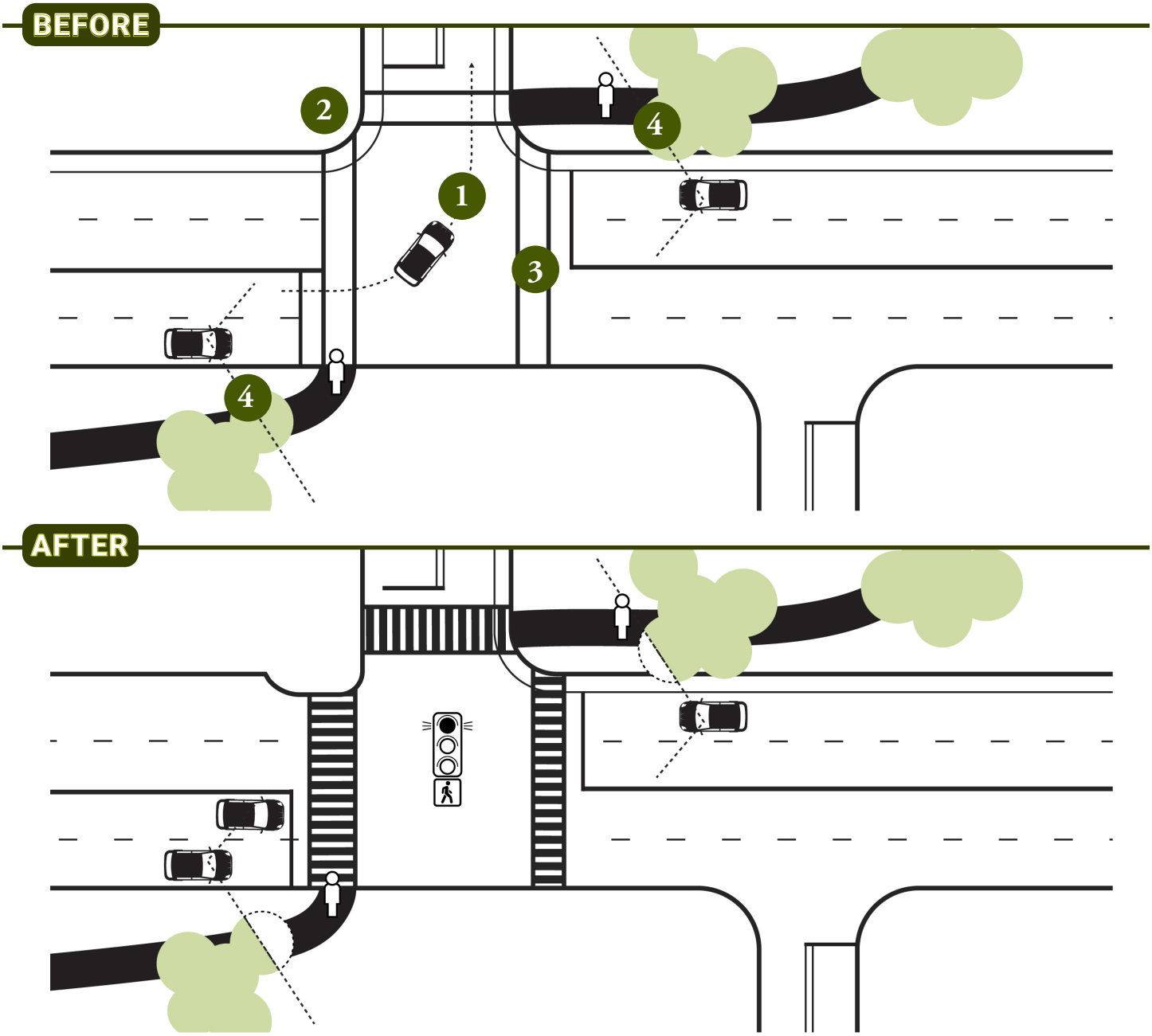

Figure 12: A before and after illustration of a complex intersection trail crossing. Source: FHWA

Trailhead Access Crossings

Figure 13: Trailhead access crossing.
Source: FHWA

A trailhead access crossing occurs where a trailhead or trail access point is across a roadway from a destination, such as a parking lot, school, store, nearby neighborhoods, transit stop, etc. These crossings can coincide with the other type of crossings but may need additional infrastructure.

The type of destination across the road from the trail, who is using the trail and crossing, and the roadway characteristics should be considered. Trail crossings near a school should accommodate young children, who may tend to be smaller in stature and have less predictable behaviors at crossings. Parking lots at trailheads or other access points to the trail allow people to park and unload a bike or a horse. Turning vehicles entering and exiting the parking lot may conflict with trail crossings. Driveways, bus stops, and on-street parking restrict visibility of trail crossings placed nearby.

Figure 14: Trailhead access crossing with PHB.
Source: FHWA

Trailhead Access Crossings Issues

Trail access routes must be designed for trail users of all ages and abilities, regardless of gradient from the roadway to the trail ①. Multilane roads ② create long crossing distances, and roadways carrying high volumes or speeds of traffic provide few gaps for people to cross to access trails ③. Vegetation, buildings, and signage may restrict driver sight distance of trail crossings ④. Consider relocating trail access crossings, where visibility is poor, to controlled crossings or locations with improved sight distance. For uncontrolled crossings connecting to parking lots and popular destinations for trail users ⑤, consider Pedestrian Hybrid Beacons (PHBs), pedestrian signals, or crosswalk visibility enhancements. Install advance warning signs in advance of trail crossings in rural areas or other contexts where crossings are not expected.

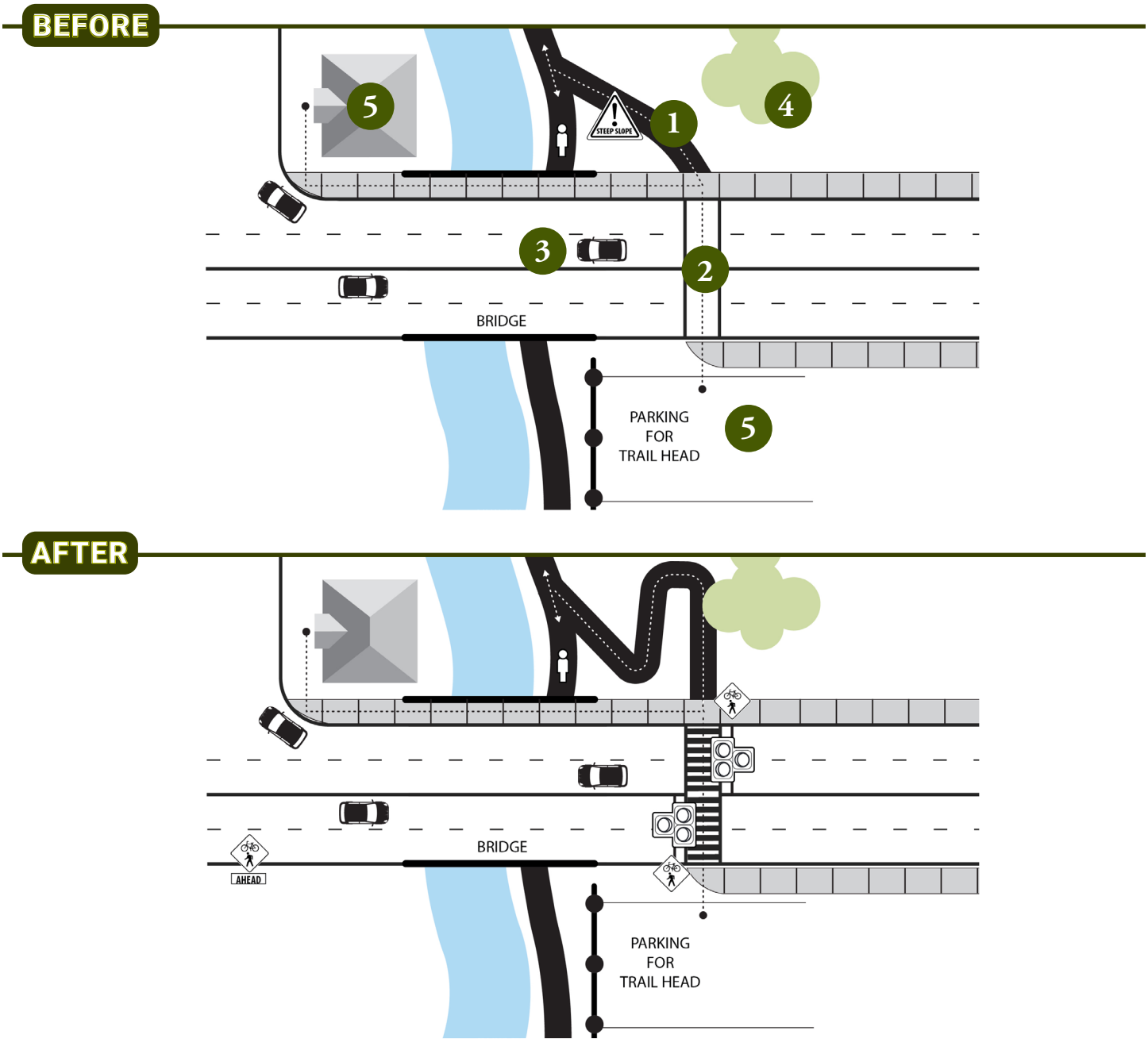

Figure 15: A before and after illustration of a trailhead access crossing.
Source: FHWA

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The following resources informed the guidance shared in this document.

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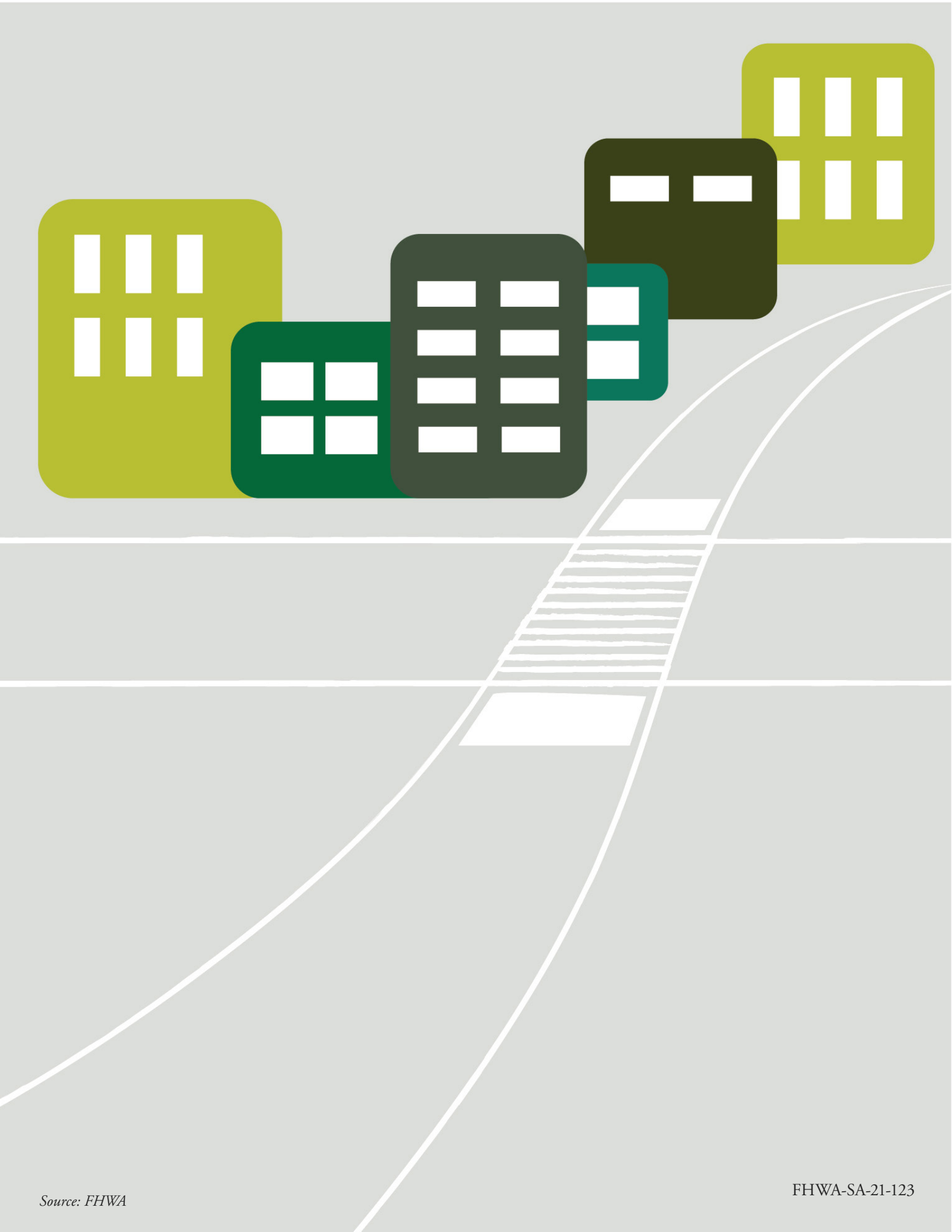

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