
# Implementing Complete Streets Strategies

Course No: C03-075
Credit: 3 PDH

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*This course was adapted from the US Department of Transportation Federal Highway Administration, which is in the public domain.*

# Introduction

"Complete Streets" are standards and policies of transportation design that ensure the safe and adequate accommodation of all users of the transportation system, including pedestrians, bicyclists, public transportation users, children, older individuals, individuals with disabilities, motorists, and freight vehicles. Complete Streets consistently prioritize *safe designs* that address the concerns of *all* users of the transportation system.

The first half of this course is devoted to providing background in some tools that are useful in implementing Complete Streets strategies, such as road diets, speed cameras, and pedestrian refuge islands. The last half of the course provides six hypothetical scenarios of how arterial corridor configurations can be transformed to accommodate the needs of different users by implementing Complete Streets strategies. The scenarios are intended to represent common non-controlled access arterials. Arterials have been chosen because a disproportionate number of pedestrian crash fatalities take place on arterials (63% in 2019), which often lack sufficient sidewalks and pedestrian crossing opportunities as well as safe, convenient, and accessible facilities for all modes.

# Tools for Implementing Complete Streets Strategies:

# Appropriate Speed Limits

U.S. Department of Transportation
Federal Highway Administration




# Appropriate Speed Limits for All Road Users

There is broad consensus among global roadway safety experts that speed control is one of the most important methods for reducing fatalities and serious injuries. Speed is an especially important factor on non-limited access roadways where vehicles and vulnerable road users mix.

A driver may not see or be aware of the conditions within a corridor, and may drive at a speed that feels reasonable for themselves but may not be for all users of the system, especially vulnerable road users, including children and seniors. A driver traveling at 30 miles per hour who hits a pedestrian has a 45 percent chance of killing or seriously injuring them.[1] At 20 miles per hour, that percentage drops to 5 percent.[1] A number of cities across the United States, including New York, Washington, Seattle and Minneapolis, have reduced their local speed limits in recent years in an effort to reduce fatalities and serious injuries, with most having to secure State legislative authorization to do so.

States and local jurisdictions should set appropriate speed limits to reduce the significant risks drivers impose on others—especially vulnerable road users—and on themselves. Addressing speed is fundamental to the Safe System Approach to making streets safer, and a growing body of research shows that speed limit changes alone can lead to measurable declines in speeds and crashes.[2]

## Safety Benefits:

Traffic fatalities in the City of Seattle decreased 26 percent after the city implemented comprehensive, city-wide speed management strategies and countermeasures inspired by Vision Zero. This included setting speed limits on all non-arterial streets at 20 mph and 200 miles of arterial streets at 25 mph.[5]

One study found that on rural roads, when considering other relevant factors in the engineering study along with the speed distribution, setting a speed limit no more than 5 mph below the 85th-percentile speed may result in fewer total and fatal plus injury crashes, and lead to drivers complying closely with the posted speed limit.[6]

**For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/speedmgt/ref_mats/.**

## Applications

Posted speed limits are often the same as the legislative statutory speed limit. Agencies with designated authorities to set speed limits, which include States, and sometimes local jurisdictions, can establish non-statutory speed limits or designate reduced speed zones, and a growing number are doing so. While non-statutory speed limits must be based on an engineering study, conducted in accordance with the *Manual on Uniform Traffic Control Devices* (MUTCD) involving multiple factors and engineering judgment, FHWA is also encouraging agencies to use the following:[3]

- Expert Systems tools.
  - USLIMITS2.
  - NCHRP 966: Posted Speed Limit Setting Procedure and Tool.
- Safe System approach.

Based on international experience and implementation in the United States, the use of 20 mph speed zones or speed limits in urban core areas where vulnerable users share the road environment with motorists may result in further safety benefits.[4]

## Considerations

When setting a speed limit, agencies should consider a range of factors such as pedestrian and bicyclist activity, crash history, land use context, intersection spacing, driveway density, roadway geometry, roadside conditions, roadway functional classification, traffic volume, and observed speeds.

To achieve desired speeds, agencies often implement other speed management strategies concurrently with setting speed limits, such as self-enforcing roadways, traffic calming, and speed safety cameras. Additional information is in the following FHWA resources:

- FHWA Speed Management website.
- Self-Enforcing Roadways: A Guidance Report.
- Noteworthy Speed Management Practices.
- Jurisdiction Speed Management Action Plan Development Package.
- Traffic Calming ePrimer.

1 Reducing the speed limit to 20 mph in urban areas: Child deaths and injuries would be decreased.
2 Lowering the speed limit from 30 to 25 mph in Boston: effects on vehicle speeds.
3 FHWA's Methods and Practices for Setting Speed Limits: An Informational Report, (2012).
4 Recommendations of the Academic Expert Group for the 3rd Global Ministerial Conference on Road Safety.
5 https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa20047/sec8.cfm#foot813
6 Safety and Operational Impacts of Setting Speed Limits below Engineering Recommendations.

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FHWA-SA-21-034

# Tools for Implementing Complete Streets Strategies:

# Bike Lanes

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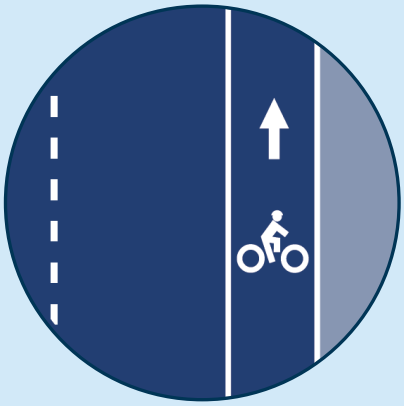


# Bicycle Lanes

Most fatal and serious injury bicyclist crashes occur at non-intersection locations. Nearly one-third of these crashes involve overtaking motorists[1]; the speed and size differential between vehicles and bicycles can lead to severe injury. To make bicycling safer and more comfortable for most types of bicyclists, State and local agencies should consider installing bicycle lanes. These dedicated facilities for the use of bicyclists along the roadway can take several forms. Providing bicycle facilities can mitigate or prevent interactions, conflicts, and crashes between bicyclists and motor vehicles, and create a network of safer roadways for bicycling. Bicycle Lanes align with the Safe System Approach principle of recognizing human vulnerability—where separating users in space can enhance safety for all road users.

## Safety Benefits:

**Bicycle Lane Additions can reduce crashes up to:**

**49%**
for total crashes on urban 4-lane undivided collectors and local roads.[6]

**30%**
for total crashes on urban 2-lane undivided collectors and local roads.[6]

Separated bicycle lane in Washington, DC. Source: Alex Baca, Washington Area Bicyclist Association

Separated bicycle lanes may provide further safety benefits. FHWA is anticipating completion of research in Fall 2022.

**For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf.**

FHWA-SA-21-051

## Applications

FHWA's *Bikeway Selection Guide* and *Incorporating On-Road Bicycle Networks into Resurfacing Projects* assist agencies in determining which facilities provide the most benefit in various contexts. Bicycle lanes can be included on new roadways or created on existing roads by reallocating space in the right-of-way.

In addition to the paint stripe used for a typical bicycle lane, a lateral offset with painted buffer can help to further separate bicyclists from vehicle traffic. State and local agencies may also consider physical separation of the bicycle lane from motorized traffic lanes through the use of vertical elements like posts, curbs, or vegetation.[2] Based on international experience and implementation in the United States, there is potential for further safety benefits associated with separated bicycle lanes. FHWA is conducting research on separated bicycle lanes, which includes the development of crash modification factors, to be completed in 2022 to address significant interest on this topic.

## Considerations

- City and State policies may require minimum bicycle lane widths, although these can differ by agency and functional classification of the road.
- Bicycle lane design should vary according to roadway characteristics (e.g., motor vehicle volumes and speed) in order to maximize the facility's suitability for riders of all ages and abilities and should consider the travel needs of low-income populations likely to use bicycles. The *Bikeway Selection Guide* is a useful resource.
- While some in the public may oppose travel lane narrowing if they believe it will slow traffic or increase congestion, studies have found that roadways did not experience an increase in injuries or congestion when travel lane widths were decreased to add a bicycle lane.[3]
- Studies and experience in US cities show that bicycle lanes increase ridership and may help jurisdictions better manage roadway capacity without increased risk.
- In rural areas, rumble strips can negatively impact bicyclists' ability to ride if not properly installed. Agencies should consider the dimensions, placement, and offset of rumble strips when adding a bicycle lane.[4]
- Strategies, practices, and processes can be used by agencies to enhance their ability to address equity in bicycle planning and design.[5]

1 Thomas et al. Bicyclist Crash Types on National, State, and Local Levels: A New Look. Transportation Research Record 673(6), 664-676, (2019).
2 Separated Bike Lane Planning and Design Guide. FHWA-HEP-15-025, (2015).
3 Park and Abdel-Aty. "Evaluation of safety effectiveness of multiple cross sectional features on urban arterials". Accident Analysis and Prevention, Vol. 92, pp. 245-255, (2016).
4 FHWA Tech Advisory Shoulder and Edge Line Rumble Strips, (2011).
5 Sandt et al. Pursuing Equity in Pedestrian and Bicycle Planning. FHWA, (2016).
6 Avelar et al. Development of Crash Modification Factors for Bicycle Lane Additions While Reducing Lane and Shoulder Widths. FHWA, (2021).

# Tools for Implementing Complete Streets Strategies:

# Lighting

U.S. Department of Transportation
Federal Highway Administration

OFFICE OF SAFETY

# Proven Safety Countermeasures

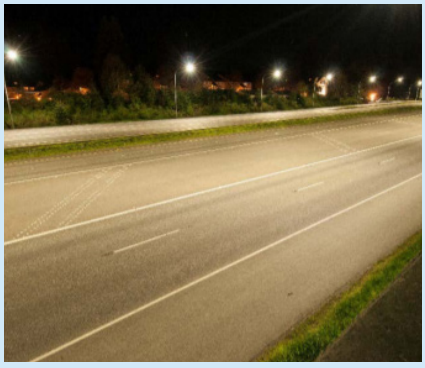
## Safety Benefits:

**Lighting can reduce crashes up to:**

**42%**
for nighttime injury pedestrian crashes at intersections.[1]

**33-38%**
for nighttime crashes at rural and urban intersections.[1]

**28%**
for nighttime injury crashes on rural and urban highways.[1]



Source: WSDOT

**For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/roadway_dept/night_visib/roadwayresources.cfm.**

FHWA-SA-21-050

## Lighting

The number of fatal crashes occurring in daylight is about the same as those that occur in darkness. However, the nighttime fatality rate is three times the daytime rate because only 25 percent of vehicle miles traveled (VMT) occur at night. At nighttime, vehicles traveling at higher speeds may not have the ability to stop once a hazard or change in the road ahead becomes visible by the headlights. Therefore, lighting can be applied continuously along segments and at spot locations such as intersections and pedestrian crossings in order to reduce the chances of a crash.

Adequate lighting (i.e., at or above minimum acceptable standards) is based on research recommending horizontal and vertical illuminance levels to provide safety benefits to all users of the roadway environment. Adequate lighting can also provide benefits in terms of personal security for pedestrians, wheelchair and other mobility device users, bicyclists, and transit users as they travel along and across roadways.

### Applications

#### Roadway Segments

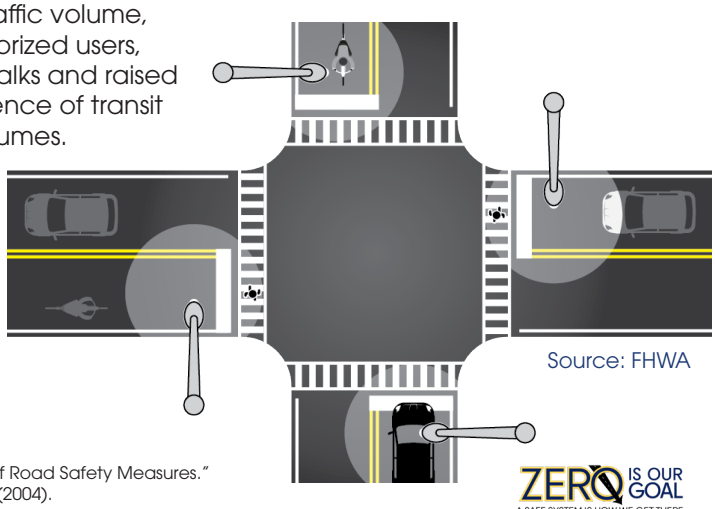
Research indicates that continuous lighting on both rural and urban highways (including freeways) has an established safety benefit for motorized vehicles.[1] Agencies can provide adequate visibility of the roadway and its users through the uniform application of lighting that provides full coverage along the roadway and the strategic placement of lighting where it is needed the most.

#### Intersections and Pedestrian Crossings

Increased visibility at intersections at nighttime is important since various modes of travel cross paths at these locations. Agencies should consider providing lighting to intersections based on factors such as a history of crashes at nighttime, traffic volume, the volume of non-motorized users, the presence of crosswalks and raised medians, and the presence of transit stops and boarding volumes.

### Considerations

Most new lighting installations are made with breakaway features, shielded, or placed far enough from the roadway to reduce the probability and/or severity of fixed-object crashes. Modern lighting technology gives precise control with minimal excessive light affecting the nighttime sky or spilling over to adjacent properties. Agencies can equitably engage with underserved communities to determine where and how new and improved lighting can most benefit the community by considering their priorities, including eliminating crash disparities, connecting to essential neighborhood services, improving active transportation routes, and promoting personal safety.



Source: FHWA

1 Elvik, R. and Vaa, T., "Handbook of Road Safety Measures." Oxford, United Kingdom, Elsevier, (2004).

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A SAFE SYSTEM IS HOW WE GET THERE

# Tools for Implementing Complete Streets Strategies:

# Pedestrian Medians

U.S. Department of Transportation
Federal Highway Administration



# Medians and Pedestrian Refuge Islands in Urban and Suburban Areas

A **median** is the area between opposing lanes of traffic, excluding turn lanes. Medians in urban and suburban areas can be defined by pavement markings, raised medians, or islands to separate motorized and non-motorized road users.

A **pedestrian refuge island** (or crossing area) is a median with a refuge area that is intended to help protect pedestrians who are crossing a road.

## Safety Benefits:

**Median with Marked Crosswalk**

**46%**

reduction in pedestrian crashes.[2]

**Pedestrian Refuge Island**

**56%**

reduction in pedestrian crashes.[2]

Pedestrian crashes account for approximately 17 percent of all traffic fatalities annually, and 74 percent of these occur at non-intersection locations.[1] For pedestrians to safely cross a roadway, they must estimate vehicle speeds, determine acceptable gaps in traffic based on their walking speed, and predict vehicle paths. Installing a median or pedestrian refuge island can help improve safety by allowing pedestrians to cross one direction of traffic at a time.

Transportation agencies should consider medians or pedestrian refuge islands in curbed sections of urban and suburban multilane roadways, particularly in areas with a significant mix of pedestrian and vehicle traffic, traffic volumes over 9,000 vehicles per day, and travel speeds 35 mph or greater. Medians/refuge islands should be at least 4-ft wide, but preferably 8 ft for pedestrian comfort. Some example locations that may benefit from medians or pedestrian refuge islands include:

- Mid-block crossings.
- Approaches to multilane intersections.
- Areas near transit stops or other pedestrian-focused sites.

Example of a road with a median and pedestrian refuge islands. Source: City of Charlotte, NC


Median and pedestrian refuge island near a roundabout. Source: www.pedbikeimages.org / Dan Burden

**For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_PedRefugeIsland2018.pdf.**

1 National Center for Statistics and Analysis. (2020, March). Pedestrians: 2018 data (Traffic Safety Facts. Report No. DOT HS 812 850). National Highway Traffic Safety Administration
2 Desktop Reference for Crash Reduction Factors, FHWA-SA-08-011, September 2008, Table 11.

FHWA-SA-21-044

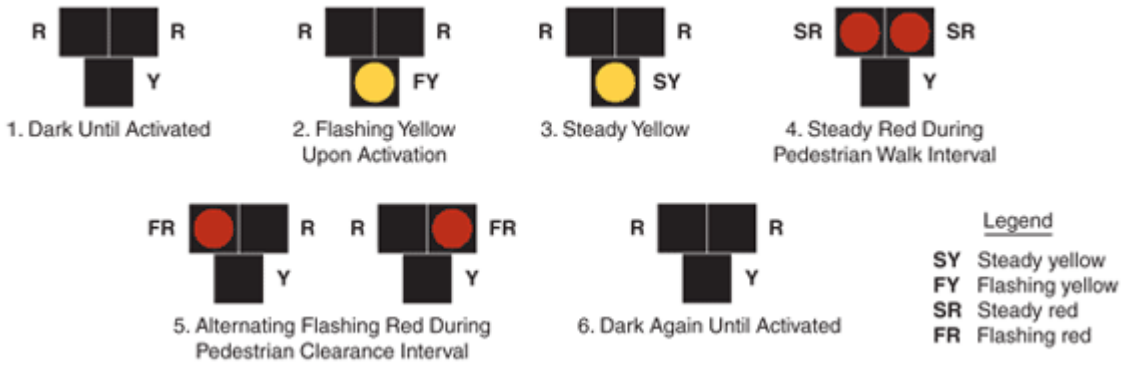
# Tools for Implementing Complete Streets Strategies:

# Pedestrian Hybrid Beacons

# Pedestrian Hybrid Beacons

**U.S. Department of Transportation**
**Federal Highway Administration**
**FHWA-SA-21-045**

The pedestrian hybrid beacon (PHB) is a traffic control device designed to help pedestrians safely cross higher-speed roadways at midblock crossings and uncontrolled intersections. The beacon head consists of two red lenses above a single yellow lens. The lenses remain ”dark“ until a pedestrian desiring to cross the street pushes the call button to activate the beacon, which then initiates a yellow to red lighting sequence consisting of flashing and steady lights that directs motorists to slow and come to a stop, and provides the right-of-way to the pedestrian to safely cross the roadway before going dark again.




**Sequence for a PHB.** Source: MUTCD 2009 Edition, Chapter 4F, FHWA

Nearly 74 percent of pedestrian fatalities occur at non-intersection locations, and vehicle speeds are often a major contributing factor.[1] As a safety strategy to address this pedestrian crash risk, the PHB is an intermediate option between a flashing beacon and a full pedestrian signal because it assigns right of way and provides positive stop control. It also allows motorists to proceed once the pedestrian has cleared their side of the travel lane(s), reducing vehicle delay.

Transportation agencies should refer to the *Manual on Uniform Traffic Control Devices* (MUTCD) for information on the application of PHBs.

In general, PHBs are used where it is difficult for pedestrians to cross a roadway, such as when gaps in traffic are not sufficient or speed limits exceed 35 miles per hour. They

are very effective at locations where three or more lanes will be crossed or traffic volumes are above 9,000 annual average daily traffic. Installation of a PHB must also include a marked crosswalk and pedestrian countdown signal. If PHBs are not already familiar to a community, agencies should conduct appropriate education and outreach as part of implementation.

## Sources

1. National Center for Statistics and Analysis. (2020, March). Pedestrians: 2018 data (Traffic Safety Facts. Report No. DOT HS 812 850). National Highway Traffic Safety Administration

2. Zegeer et al. NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. TRB, (2017).

3. Fitzpatrick, K. and Park, E.S. Safety Effectiveness of the HAWK Pedestrian Crossing Treatment, FHWA-HRT-10-042, (2010).

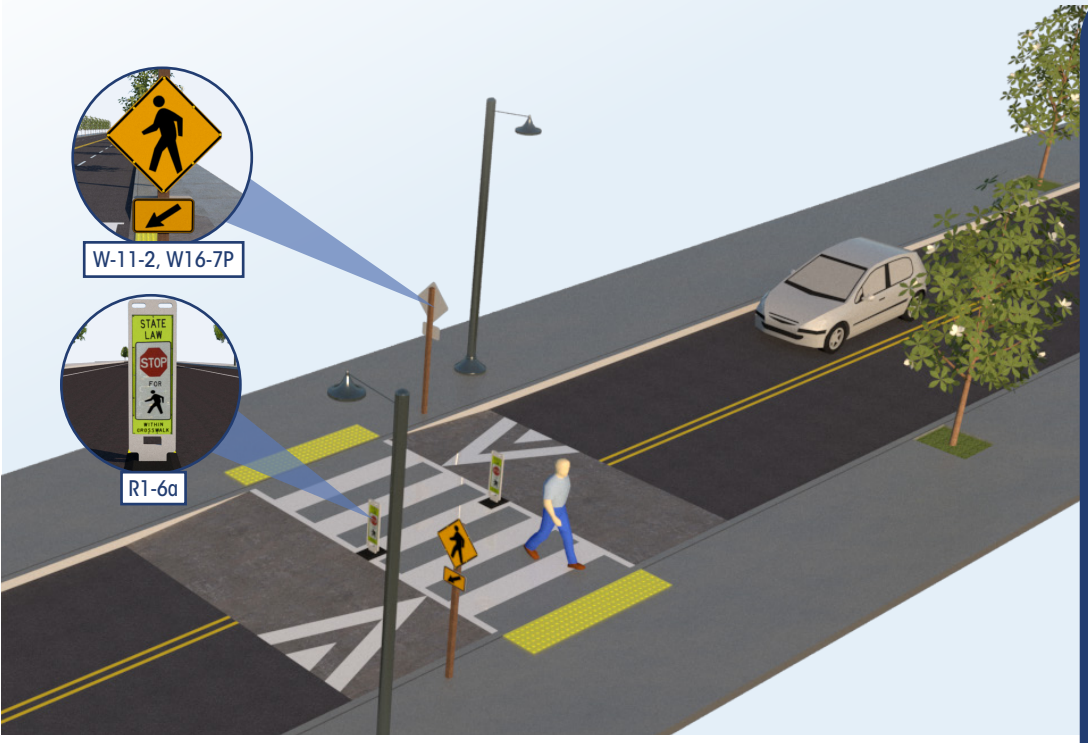
# Tools for Implementing Complete Streets Strategies:

# Raised Crosswalks

# Raised Crosswalk

**SAFE TRANSPORTATION FOR EVERY PEDESTRIAN**

***COUNTERMEASURE TECH SHEET***




Raised crosswalks are ramped speed tables spanning the entire width of the roadway, often placed at midblock crossing locations. The crosswalk is demarcated with paint and/or special paving materials. These crosswalks act as traffic-calming measures that allow the pedestrian to cross at grade with the sidewalk.

In addition to their use on local and collector streets, raised crosswalks can be installed in campus settings, shopping centers, and pick-up/drop-off zones (e.g., airports, schools, transit centers).

Raised crosswalks are flush with the height of the sidewalk. The crosswalk table is typically at least 10 feet wide and designed to allow the front and rear wheels of a passenger vehicle to be on top of the table at the same time. Detectable warnings (truncated domes) and curb ramps are installed at the street edge for pedestrians with impaired vision.

**Local and collector roads with high speeds pose a significant challenge for pedestrians crossing the roadway.**

**A raised crosswalk can reduce vehicle speeds and enhance the pedestrian crossing environment.**

**Raised crosswalks can reduce pedestrian crashes by**

**45%**

**FEATURES:**

- Elevated crossing makes the pedestrian more prominent in the driver's field of vision, and allows pedestrians to cross at grade with the sidewalk
- Approach ramps may reduce vehicle speeds and improve motorist yielding

**OFTEN USED WITH:**

- Crosswalk visibility enhancements

U.S. Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives

EDC

*June 2018, Updated*

# Raised Crosswalk

**EDC-4 STEP:** https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/step.cfm

Boston, MA. Photo: Peter Furth / nacto.org

## *CONSIDERATIONS*

Raised crosswalks are typically installed on 2-lane or 3-lane roads with speed limits of 30 mph or less and annual average daily traffic (AADT) below about 9,000. Raised crossings should generally be avoided on truck routes, emergency routes, and arterial streets.

Drainage can be an issue. Raised crosswalks may be installed with curb extensions where parking exists. They may also be used at intersections, particularly at the entrance of the minor street.

Since this countermeasure can cause discomfort and noise (especially with larger vehicles), it may be appropriate to get public buy-in. Raised crosswalks may not be appropriate for bus transit routes or primary emergency vehicle routes. For States that experience regular snowfall, snowplowing can be a concern.

## *COST*

The cost associated with a raised crosswalk ranges from $7,110 to $30,880 each, with the average cost estimated at $8,170.


References

Federal Highway Administration. (2013). "Raised Pedestrian Crossings" in PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System. Available: http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=7

Thomas, L., Thirsk, N. J., & Zegeer, C. (2016). NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways. Transportation Research Board, Washington D.C.

Bushell, M., Poole, B., Zegeer, C., & Rodriguez, D. (2013). Costs for Pedestrian and Bicyclist Infrastructure Improvements: A Resource for Researchers, Engineers, Planners, and the General Public. Pedestrian and Bicycle Information Center.

Elvik, R., Christensen, P., and Amundsen, A. (2004). "Speed and Road Accidents An Evaluation of the Power Model." Transportokonomisk Institutt, Oslo, Norway.

# Tools for Implementing Complete Streets Strategies:

# Rectangular Rapid Flashing Beacon

U.S. Department of Transportation
Federal Highway Administration



# Rectangular Rapid Flashing Beacons (RRFB)

A marked crosswalk or pedestrian warning sign can improve safety for pedestrians crossing the road, but at times may not be sufficient for drivers to visibly locate crossing locations and yield to pedestrians. To enhance pedestrian conspicuity and increase driver awareness at uncontrolled, marked crosswalks, transportation agencies can install a pedestrian actuated Rectangular Rapid Flashing Beacon (RRFB) to accompany a pedestrian warning sign. RRFBs consist of two, rectangular- shaped yellow indications, each with a light-emitting diode (LED)-array-based light source.[1] RRFBs flash with an alternating high frequency when activated to enhance conspicuity of pedestrians at the crossing to drivers.

For more information on using RRFBs, see the Interim Approval in the *Manual on Uniform Traffic Control Devices (MUTCD)*.[1]

## Safety Benefits:

**RRFBs can reduce crashes up to:**

**47%**

for pedestrian crashes.[4]

**RRFBs can increase motorist yielding rates up to:**

**98%**

(varies by speed limit, number of lanes, crossing distance, and time of day).[3]

RRFBs used at a trail crossing.
Source: LJB

## Applications

The RRFB is applicable to many types of pedestrian crossings but is particularly effective at multilane crossings with speed limits less than 40 miles per hour.[2] Research suggests RRFBs can result in motorist yielding rates as high at 98 percent at marked crosswalks, but varies depending on the location, posted speed limit, pedestrian crossing distance, one- versus two-way road, and the number of travel lanes.[3] RRFBs can also accompany school or trail crossing warning signs.

RRFBs are placed on both sides of a crosswalk below the pedestrian crossing sign and above the diagonal downward arrow plaque pointing at the crossing.[1] The flashing pattern can be activated with pushbuttons or passive (e.g., video or infrared) pedestrian detection, and should be unlit when not activated.

## Considerations

**Agencies should:[2]**

- Install RRFBs in the median rather than the far-side of the roadway if there is a pedestrian refuge or other type of median.
- Use solar-power panels to eliminate the need for a power source.
- Reserve the use of RRFBs for locations with significant pedestrian safety issues, as over-use of RRFB treatments may diminish their effectiveness.

**Agencies shall not:[2]**

- Use RRFBs without the presence of a pedestrian, school or trail crossing warning sign.
- Use RRFBs for crosswalks across approaches controlled by YIELD signs, STOP signs, traffic control signals, or pedestrian hybrid beacons, except for the approach or egress from a roundabout.

**For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RRFB_2018.pdf.**

1 *MUTCD* Interim Approval 21 - RRFBs at Crosswalks.
2 "Rectangular Rapid Flash Beacon" in PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System. FHWA, (2013).
3 Fitzpatrick et al. "Will You Stop for Me? Roadway Design and Traffic Control Device Influences on Drivers Yielding to Pedestrians in a Crosswalk with a Rectangular Rapid-Flashing Beacon." Report No. TTI-CTS-0010. Texas A&M Transportation Institute, (2016).
4 NCHRP Research Report 841 Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments, (2017).

FHWA-SA-21-053

# Tools for Implementing Complete Streets Strategies:

# Road Diets

U.S. Department of Transportation
Federal Highway Administration



**Safety Benefits:**

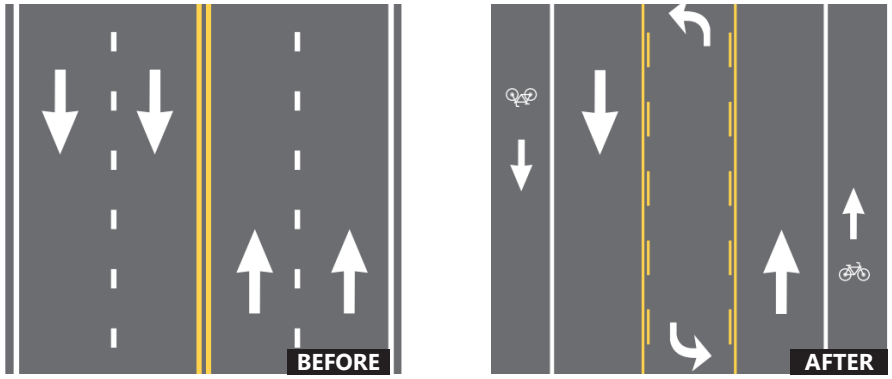
**4-Lane to 3-Lane Road Diet Conversions**

**19-47%**

reduction in total crashes.[1]

# Road Diets (Roadway Reconfiguration)

A Road Diet, or roadway reconfiguration, can improve safety, calm traffic, provide better mobility and access for all road users, and enhance overall quality of life. A Road Diet typically involves converting an existing four-lane undivided roadway to a three-lane roadway consisting of two through lanes and a center two-way left-turn lane (TWLTL).




Before and after example of a Road Diet. Source: FHWA

## Benefits of Road Diet installations may include:

- Reduction of rear-end and left-turn crashes due to the dedicated left-turn lane.
- Reduced right-angle crashes as side street motorists cross three versus four travel lanes.
- Fewer lanes for pedestrians to cross.
- Opportunity to install pedestrian refuge islands, bicycle lanes, on-street parking, or transit stops.
- Traffic calming and more consistent speeds.
- A more community-focused, Complete Streets environment that better accommodates the needs of all road users.

A Road Diet can be a low-cost safety solution when planned in conjunction with a simple pavement overlay, and the reconfiguration can be accomplished at no additional cost. Typically, a Road Diet is implemented on a roadway with a current and future average daily traffic of 25,000 or less.

Road Diet project in Honolulu, Hawaii. Source: Leidos

**For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/road_diets/.**

1 *Evaluation of Lane Reduction "Road Diet" Measures on Crashes*, FHWA-HRT-10-053, (2010).

FHWA-SA-21-046

# Tools for Implementing Complete Streets Strategies:

# Safe System Intersections

## What is a Roundabout?

A roundabout is a type of circular intersection, but is quite unlike a neighborhood traffic circle or large rotary. Roundabouts have been proven safer and more efficient than other types of circular intersections.

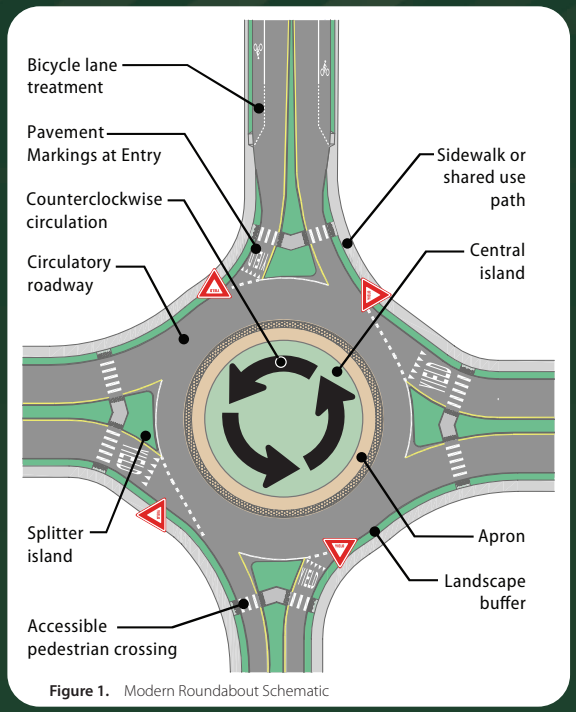



**Figure 1.** Modern Roundabout Schematic

Roundabouts have certain essential distinguishing features:

- **Counterclockwise Flow.** Traffic travels counterclockwise around a center island.
- **Entry Yield Control.** Vehicles entering the roundabout yield to traffic already circulating.
- **Low Speed.** Curvature that results in lower vehicle speeds (15-25 mph) throughout the roundabout.

FHWA identified roundabouts as a **Proven Safety Countermeasure** because of their ability to substantially reduce the types of crashes that result in injury or loss of life. Roundabouts are designed to improve safety for all users, including pedestrians and bicycles. They also provide significant operational benefits compared to conventional intersections.

***On average, roundabouts reduce severe crashes – those resulting in injury or loss of life – by 78-82%[1]***

[1] *Highway Safety Manual*, American Association of State Highway and Transportation Officials, Washington, DC, 2010.

## Educational Resources

Michigan "How to Use a Roundabout – Sharing the Road" Informational Brochure
*www.michigan.gov/documents/mdot/MDOT_RoundaboutPedBikeBrochure_465164_7.pdf*

New York Guidance for Roundabout Users
*www.dot.ny.gov/main/roundabouts/guide-users/pedestrians*

Washington State videos for Roundabouts and Pedestrians and Bicycles
*www.wsdot.wa.gov/Safety/roundabouts/PedestriansCyclists.htm*

## Leveraging Partnerships

PEDSAFE Pedestrian Safety Guide & Countermeasure Selection System - Roundabouts
*www.pedbikeinfo.org/data/faq_details.cfm?id=3454*

BIKESAFE Bicycle Safety Guide & Countermeasure Selection System – Roundabouts
*www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=25*

Choosing Roundabouts for Safe Routes to School
*www.saferoutesinfo.org/program-tools/case-study-bellingham-wa*

AARP Livable Communities Fact Sheet Series
*www.aarp.org/livable-communities/info-2014/livability-factsheet-modern-roundabouts.html*

## For More Information

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To learn more about roundabouts, please visit:
***safety.fhwa.dot.gov***

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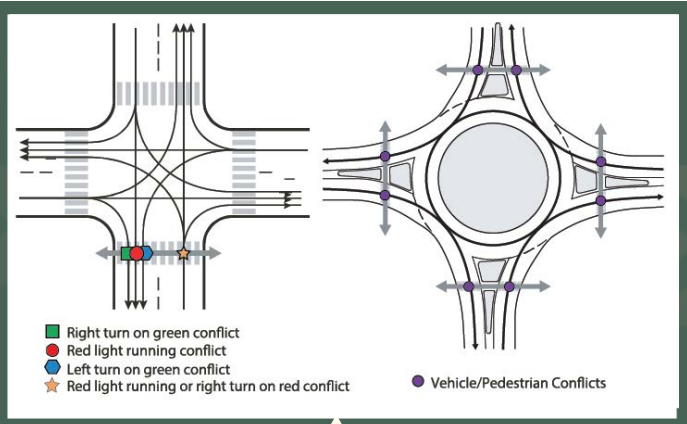
Safe Roads for a Safer Future
*Investment in roadway safety saves lives*

Cover photo source: Google Earth Pro

U.S. Department of Transportation
**Federal Highway Administration**

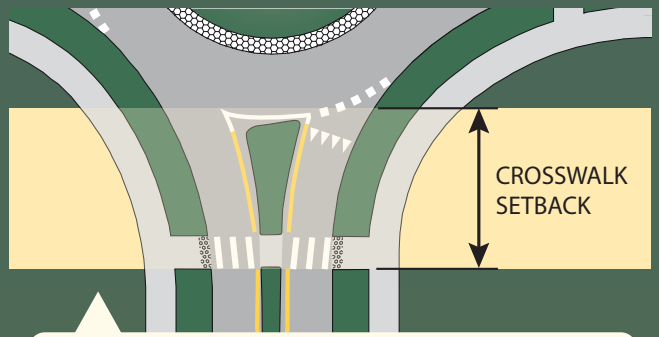
# ROUNDABOUTS
## *with Pedestrians & Bicycles*

## A Safe Choice for Everyone




**Less conflict.** Roundabouts have fewer conflict points. A single lane roundabout has 50% fewer pedestrian-vehicle conflict points than a comparable stop or signal controlled intersection. Conflicts between bicycles and vehicles are reduced as well.

Source: Hillary Isebrands, FHWA




**Shorter, setback crossings.**
Pedestrians cross a shorter distance of only one direction of traffic at a time since the entering and exiting flows are separated. Drivers focus on pedestrians apart from entering, circulating and exiting maneuvers.

**Lower speed.**
Traffic speed at any road or intersection is vitally important to the safety of everyone, and especially non-motorized users. Lower speed is associated with better yielding rates, reduced vehicle stopping distance, and lower risk of collision injury or fatality. Also, the speed of traffic through a roundabout is more consistent with comfortable bicycle riding speed.


Source: Jeffrey Shaw, FHWA

Source: City of Santa Cruz


Source: Janet M. Barlow, Accessible Design for the Blind

**Features for All Users.** Adding certain treatments at roundabouts can enhance the experience for both pedestrians and bicycles.

- At more complex roundabouts, such as those with multiple lanes, certain design elements and enhanced crossing treatments can improve accessibility for visually impaired pedestrians.
- Where bicycle facilities lead to a roundabout, providing an option to bicyclists to either ride in the travel lane or use a ramp to and from a separated shared use path.

Source: www.pedbikeimages.org / Dan Burden

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## Safety Benefits:

**RCUT**
**Two-Way Stop-Controlled to RCUT:**

**54%**
reduction in fatal and injury crashes.[2]

**Signalized Intersection to Signalized RCUT:**

**22%**
reduction in fatal and injury crashes.[3]

**Unsignalized Intersection to Unsignalized RCUT:**

**63%**
reduction in fatal and injury crashes. [4]

**MUT**

**30%**
reduction in intersection-related injury crash rate.[5]

**For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/intersection/rltci/index.cfm.**

FHWA-SA-21-030

# Reduced Left-Turn Conflict Intersections

Reduced left-turn conflict intersections are geometric designs that alter how left-turn movements occur. These intersections simplify decision-making for drivers and minimize the potential for higher severity crash types, such as head-on and angle. Two highly effective designs that rely on U-turns to complete certain left-turn movements are known as the Restricted Crossing U-turn (RCUT) and the Median U-turn (MUT).

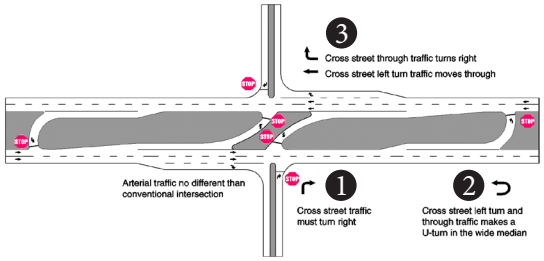
## Restricted Crossing U-turn

The RCUT intersection, also known as a J-Turn, Superstreet, or Reduced Conflict Intersection, modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location—either signalized or unsignalized—to continue in the desired direction. The RCUT is suitable for and adaptable to a wide variety of circumstances, ranging from isolated rural, high-speed locations to urban and suburban high-volume, multimodal corridors. It is a competitive and less costly alternative to constructing an interchange. RCUTs work well when consistently used along a corridor, but also can be used effectively at individual intersections. Studies have shown that installing an RCUT can result in a 30-percent increase in throughput and a 40-percent reduction in network intersection travel time.[1]

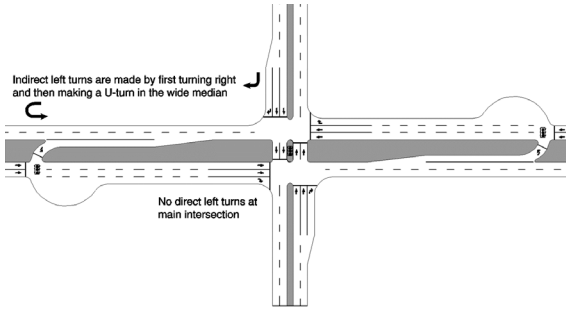
## Median U-turn

The MUT intersection modifies direct left turns from the major approaches. Vehicles proceed through the main intersection, make a U-turn a short distance downstream, followed by a right turn at the main intersection. The U-turns can also be used for modifying the cross-street left turns, similar to the RCUT.

The MUT is an excellent choice for intersections with heavy through traffic and moderate left-turn volumes. Studies have shown a 20- to 50-percent improvement in intersection throughput for various lane configurations as a result of implementing the MUT design. When implemented at multiple intersections along a corridor, the efficient two-phase signal operation of the MUT can reduce delay, improve travel times, and create more crossing opportunities for pedestrians and bicyclists.




Example of a unsignalized RCUT intersection. Source: FHWA




Example of a MUT intersection. Source: FHWA

1 Hugher and Jagannathan. Restricted Crossing U-Turn Intersection. FHWA-HRT-09-059, (2009).
2 Edara et al. Evaluation of J-turn Intersection Design Performance in Missouri. MoDOT, (2013).
3 Hummer and Rao. Safety Evaluation of a Signalized Restricted Crossing U-Turn. FHWA-HRT-17-082, (2017).
4 Hummer et al. Superstreet Benefits and Capacities. FHWA/NC/2009-06, NC State University, (2010).
5 Synthesis of the Median U-Turn Treatment, Safety, and Operational Benefits, FHWA-HRT-07-033, (2007).

# Tools for Implementing Complete Streets Strategies:

# Speed Safety Cameras

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# Speed Safety Cameras

Safe Speeds is a core principle of the Safe System Approach since humans are less likely to survive high-speed crashes. Enforcing safe speeds has been challenging; however, with more information and tools communities can make progress in reducing speeds. Agencies can use speed safety cameras (SSCs) as an effective and reliable technology to supplement more traditional methods of enforcement, engineering measures, and education to alter the social norms of speeding. SSCs use speed measurement devices to detect speeding and capture photographic or video evidence of vehicles that are violating a set speed threshold.

## Safety Benefits:

**Fixed units can reduce crashes on urban principal arterials up to:**

**54%** for all crashes.[4]

**47%** for injury crashes.[4]

**P2P units can reduce crashes on urban expressways, freeways, and principal arterials up to:**

**37%** for fatal and injury crashes.[2]

**Mobile units can reduce crashes on urban principal arterials up to:**

**20%** for fatal and injury crashes.[5]

**In New York City, fixed units reduced speeding in school zones up to 63% during school hours.[6]**

**For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/speedmgt/.**



FHWA-SA-21-070

## Applications

Agencies should conduct a network analysis of speeding-related crashes to identify locations to implement SSCs. The analysis can include scope (e.g., widespread, localized), location types (e.g., urban/suburban/rural, work zones, residential, school zones), roadway types (e.g., expressways, arterials, local streets), times of day, and road users most affected by speed-related crashes (e.g., pedestrians, bicyclists).

SSCs can be deployed as:

- **Fixed units**—a single, stationary camera targeting one location.
- **Point-to-Point (P2P) units**—multiple cameras to capture average speed over a certain distance.
- **Mobile units**—a portable camera, generally in a vehicle or trailer.

The table below describes suitable circumstances for SSC deployment.[1]

## Considerations

- SSCs can produce a crash reduction upstream and downstream, thus generating a spillover effect.[2]
- Public trust is essential for any type of enforcement. With proper controls in place, SSCs can offer fair and equitable enforcement of speeding, regardless of driver age, race, gender, or socio-economic status. SSCs should be planned with community input and equity impacts in mind.
- Using both overt (i.e., highly visible) and covert (i.e., hidden) enforcement may encourage drivers to comply with limits everywhere, not only at sites they are aware are enforced.
- Agencies should conduct evaluations regularly to determine if SSCs are accomplishing safety goals and whether changes in strategy, scheduling, communications, or public engagement are necessary.
- Agencies should conduct a legal and policy review to determine if SSCs are authorized within a jurisdiction and how the authorization and other traffic laws will affect a SSC program.
- Agencies should develop an SSC program plan with consideration of the USDOT SSC guidelines for planning, public involvement, stakeholder coordination, implementation, maintenance, evaluation, etc.[3]

| Considerations for Selection | Fixed | P2P | Mobile |
|---|---|---|---|
| Problems are long-term and site-specific. | X | X | — |
| Problems are network-wide, and shift based on enforcement efforts. | — | — | X |
| Speeds at enforcement site vary largely from downstream sites. | — | X | X |
| Overt enforcement is legally required. | X | X | X |
| Sight distance for the enforcement unit is limited. | X | X | — |
| Enforcement sites are multilane facilities. | X | X | — |

1 Thomas et al. Speed Safety Camera Program Planning and Operations Guide. FHWA, (2021).
2 Montella et al. "Effects on speed and safety of point-to-point speed enforcement systems". Accident Analysis and Prevention, Vol. 75, (2015). Note that this is an international study.
3 Speed Enforcement Camera Systems Operational Guidelines. NHTSA, (2008).
4 Shin et al. "Evaluation of the Scottsdale Loop 101 automated speed enforcement demonstration program." Accident Analysis and Prevention, Vol. 41, (2009).
5 Li et al. "A Before-and-After Empirical Bayes Evaluation of Automated Mobile Speed Enforcement on Urban Arterial Roads." Presented at the 94th Annual Meeting of the Transportation Research Board, Paper No. 15-1563, Washington, D.C., (2015). Note that this is an international study.
6 Automated Speed Enforcement Program Report 2014-2017. New York City DOT, (2018).

# Six Scenarios to Transform Arterials by Using Complete Streets Strategies

U.S. Department of Transportation
**Federal Highway Administration**

# COMPLETE STREETS TRANSFORMATIONS

*Six Scenarios to Transform Arterials using a Complete Streets Implementation Strategy*

# Complete Streets Transformations

*Six Scenarios to Transform Arterials using a Complete Streets Implementation Strategy*

A Complete Street is safe, and feels safe, for all users. The majority of States and hundreds of local jurisdictions have adopted Complete Streets policies, and FHWA is focused on supporting these transportation agencies to plan, develop and operate equitable streets and networks that prioritize safety, comfort, and connectivity to destinations for all people who use the street network. Complete Streets serve pedestrians, bicyclists, public transportation users, children, older individuals, individuals with disabilities, motorists, and freight vehicles. Complete Streets transformations are particularly important for arterials in urban and suburban areas and rural main streets where a disproportionately high number of fatal pedestrian crashes occur.

## What is a Complete Streets Implementation Strategy?

Complete Streets implementation starts with people, not transportation mode. The elements of a Complete Street vary based on community context and the role that a particular street needs to serve in the multimodal network. Not every street requires bicycle lanes or public transportation stops. Instead, creating a safe, connected, and equitable Complete Streets Network is an iterative strategy that involves:

1. Understanding the community and network **context**;
2. Identifying safety, connectivity, and equity **concerns**;
3. Implementing **improvements** over time; and
4. Evaluating **impacts** by monitoring and measuring success. [1]

## Focusing on Arterials

This document provides examples of how to apply a Complete Streets Implementation Strategy to transform arterials that pose significant safety, connectivity, and equity challenges. The scenarios discussed in this document are intended to represent common non-controlled access arterials.

A disproportionate number of pedestrian crash fatalities take place on arterials (63% in 2019), which often lack sufficient sidewalks and pedestrian crossing opportunities as well as safe, convenient, and accessible facilities for all modes.[2]

- In addition to a lack of facilities, high speeds and dark conditions contribute to fatalities and serious injuries among pedestrians. According to NHTSA, 76% of pedestrian deaths in 2019 occurred in the dark.[3]
- A recent study found that of the top 30 pedestrian crash hot-spot locations in the US, a majority have multiple lanes, high traffic volumes and speed limits above 30 mph, and 97% have adjacent commercial land uses. Seventy-five percent are also bordered by low-income communities.[4]

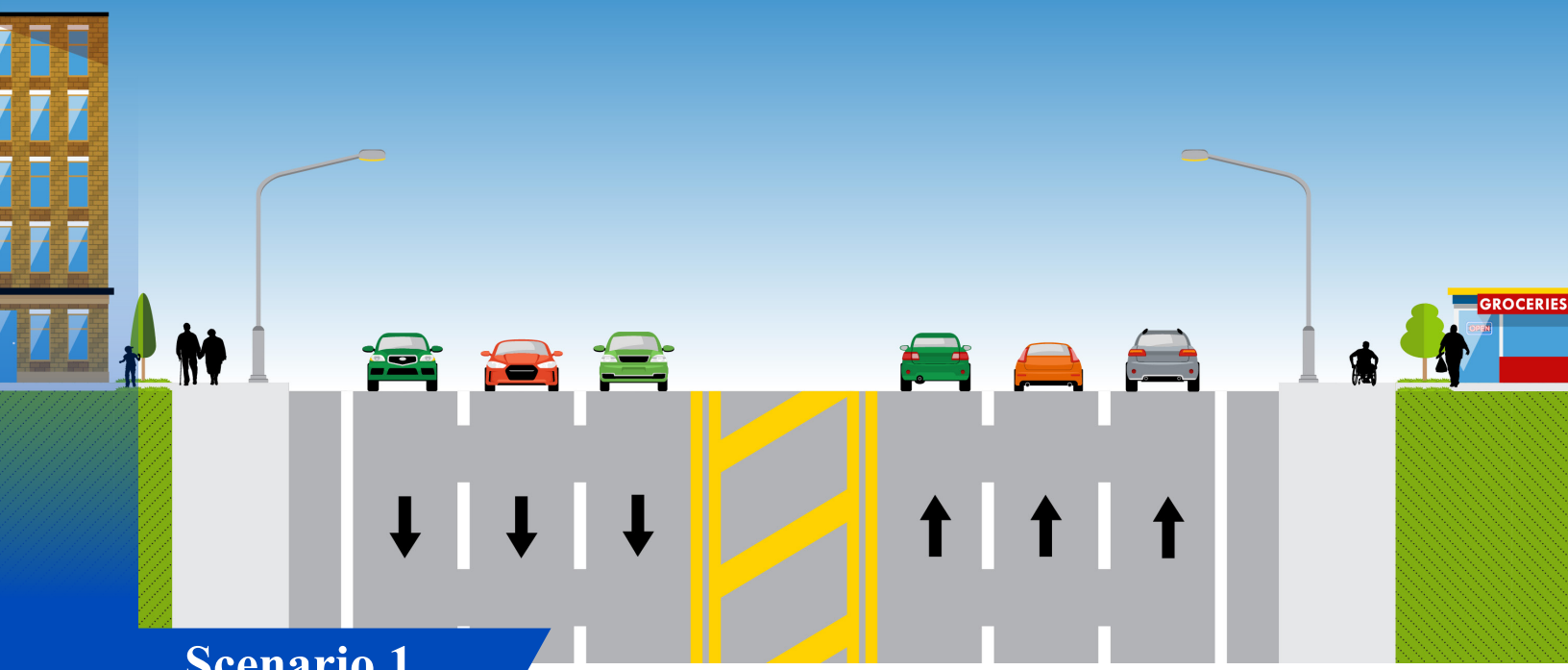
Making arterial roadways safe for all users is necessary to address the large portion of fatalities and serious injuries among vulnerable road users traveling outside of vehicles.

## Stimulating Ideas for Complete Streets Transformations

This document provides six hypothetical scenarios of how common arterial corridor configurations can be transformed to accommodate the needs of different users by implementing Complete Streets. The examples focus on (1) urban and suburban arterials with posted speed limits less than 55 mph, and (2) rural arterials that serve as main streets in smaller communities. The purpose of these scenarios is to stimulate ideas for improving existing streets as part of developing a Complete Streets network, with an emphasis on developing safe and complete bicycle and pedestrian networks and access to public transportation.

Complete Streets implementation aligns with the Safe System Approach, which anticipates human mistakes by designing and managing road infrastructure to keep the risk of a mistake low and to reduce injury severity if a crash does occur. The improvements elaborated in this document align with some of FHWA's Proven Safety Countermeasures and highlight three key strategies for improving safety on arterials: (1) managing speeds, (2) improving lighting, and (3) separating users in time and space. Additional resources on these countermeasures and strategies are included at the end of the document, and resources are linked throughout for more information on additional improvements. These transformations may take place in a single project, or over time.[5]

Many States and local agencies are installing innovative facilities and safety countermeasures to transform their streets to achieve safety for all users. To learn more, please browse FHWA's Complete Streets Website for trainings and case studies. To help quantify the potential safety effectiveness of Complete Streets improvements, visit the Crash Modification Factor Clearinghouse. [6]



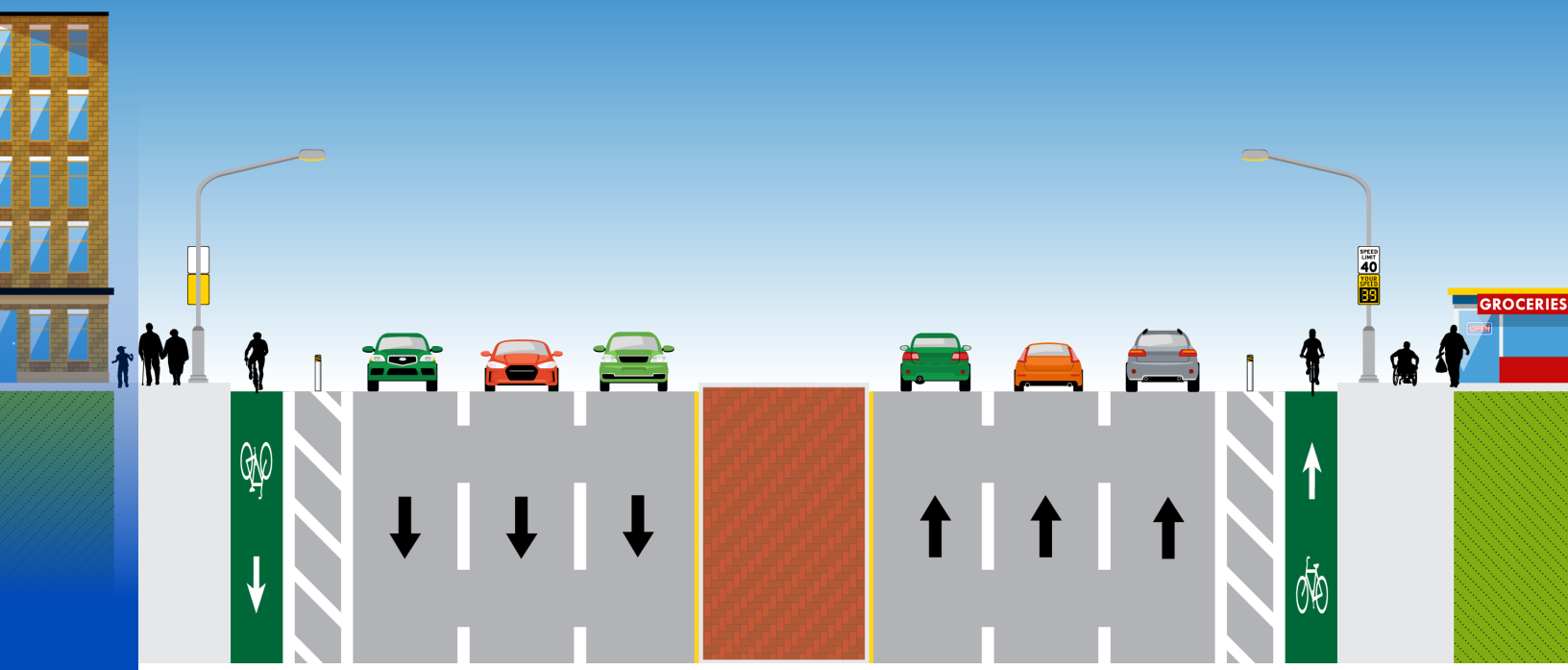

# Scenario 1

## Suburban 6-lane principal arterial

**Understand Context:** The cross-section below illustrates a typical arterial street in a suburban context. It has multiple through lanes, with an outside shoulder that is occasionally used by bicyclists. Sidewalks attach to the curb without trees or other separation from motor vehicles. They are frequently punctuated by driveways to allow traffic to enter retail establishment parking lots. Employers, restaurants, shopping centers and grocery stores are located along this corridor, and a university is located nearby, creating demand for short trips that could be made by bicycling or walking. Through public outreach, and a **road safety audit**, the transportation agency learns that the university population walks and bicycles at high rates, but they find it uncomfortable to access businesses in this corridor. In partnership with the local housing authority, the transportation agency engaged a targeted focus group of residents at an apartment complex. Discussions revealed that many residents rely primarily on walking and public transportation and have concerns about safely crossing the street to access the grocery store. This is due to high-volume, high-speed traffic and the lack of convenient crosswalks and adequate lighting. An analysis of safety data identified the arterial as the location of several of the jurisdiction's pedestrian and bicyclist crash hot spots.

**Identify Concerns:**

1. With wide lanes and a flush median, many drivers exceed the speed limit. Community members have expressed concerns about walking or bicycling on this route due to **high vehicular speeds and the lack of separation.**
2. Despite standard pedestrian crosswalks and signals at intersections, pedestrians find this street **difficult to cross** due to the many lanes, **distance between crossings**, **lack of median refuge** and **poor lighting** at the crosswalks. This includes residents of a low-income apartment complex who must cross the street to catch the bus and to access a grocery store.




### Implement Improvements:

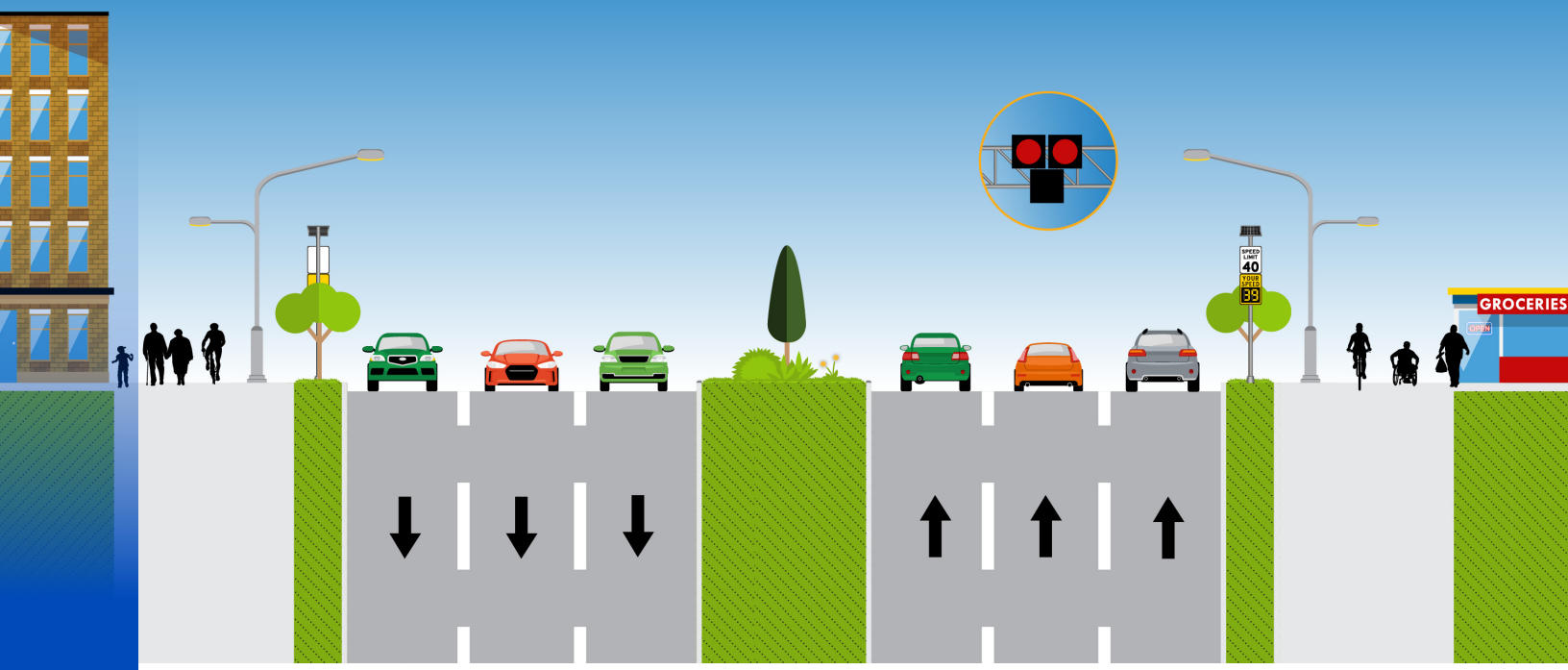
To provide improvements without moving the outside curb, the transportation agency can**:**

1. Set **appropriate speed limits**. When setting a speed limit, agencies should consider a range of factors that impact safety such as the presence of pedestrians and bicyclists, crash history, land use context, intersection spacing, driveway density, roadway geometry, roadside conditions, roadway functional classification, traffic volume, and observed speeds.
2. Add **speed feedback** signs to remind drivers to slow down and obey posted speed limits.
3. Provide space for a **separated bicycle lane** on each side by eliminating the shoulder and narrowing the travel lanes.
4. Install **green colored pavement** within the bike lanes with **Interim Approval from FHWA**,[7] to increase motorist awareness that bicyclists might be present.
5. Install a **wide raised median** so that sufficient space is available to provide median refuge for crossing pedestrians.
6. Ensure **accessible bus stop shelters** enhance visibility and provide protection from the elements.

### Evaluate Impacts:

After completing the interim project, the transportation agency evaluated the success of their Complete Streets implementation project and identified additional concerns:

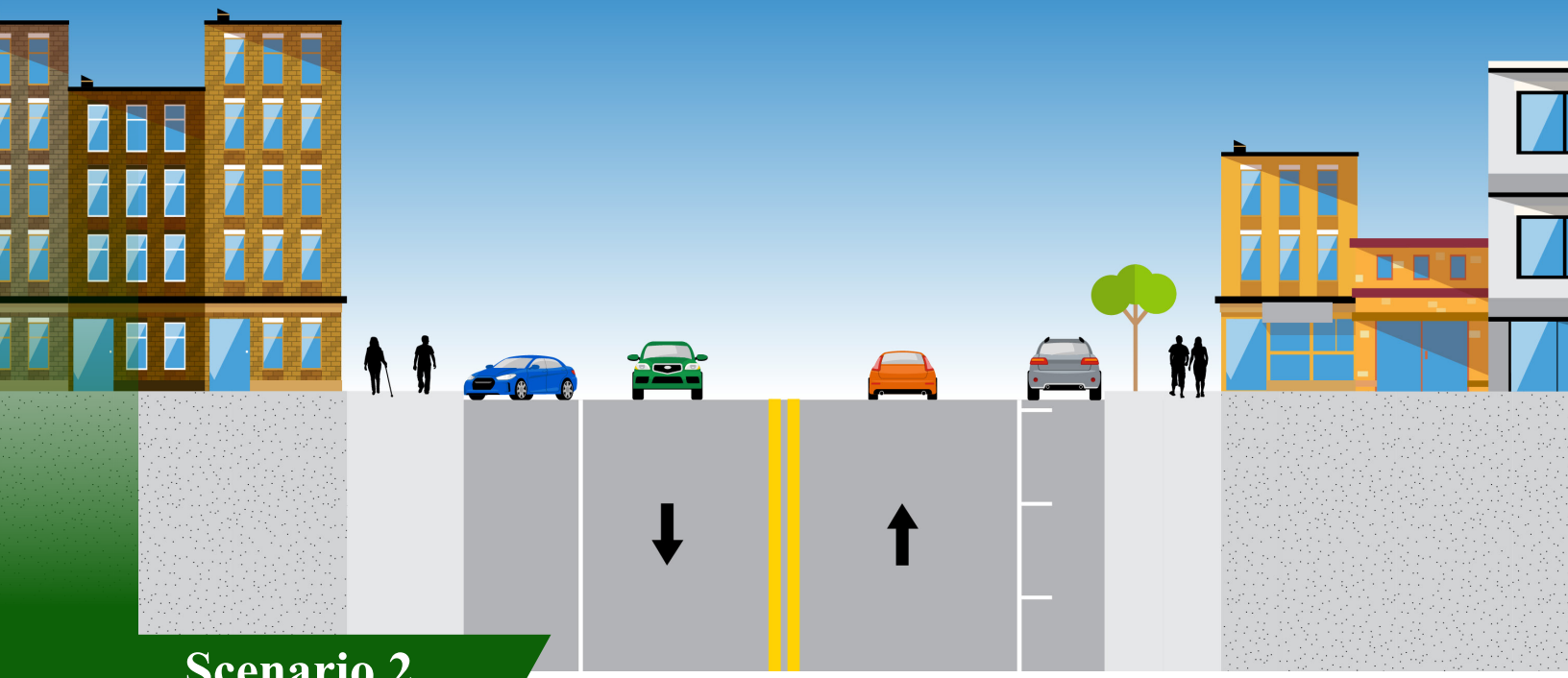
1. Pedestrian **lighting is inadequate** along the roadway and at crosswalks, and pedestrian crossings are still spaced far apart.
2. In-street separated bike lanes improved safety but did not provide a low-stress bicycling facility.
3. Many bicyclists were observed riding **contraflow** in the one-way bike lanes in order to access destinations without having to cross the arterial.




**Implement Improvements:**

Moving the outside curb, the transportation agency can**:**

1. Add a mid-block crossing using a **Pedestrian Hybrid Beacon (PHB)** to provide safe crossing opportunities between intersections where blocks are long and conduct public outreach to educate all users about PHBs.
2. Add visibility enhancements, including lighting, to crosswalks and shared use sidepath to increase the safety and comfort of pedestrians and bicyclists.
3. Narrow the roadway to provide **shared use sidepaths** for pedestrians and bicyclists behind the curb, allowing for safe and comfortable bidirectional travel on both sides of the road.
4. Add **trees** along the median and roadside to provide shade and possible traffic-calming effects.



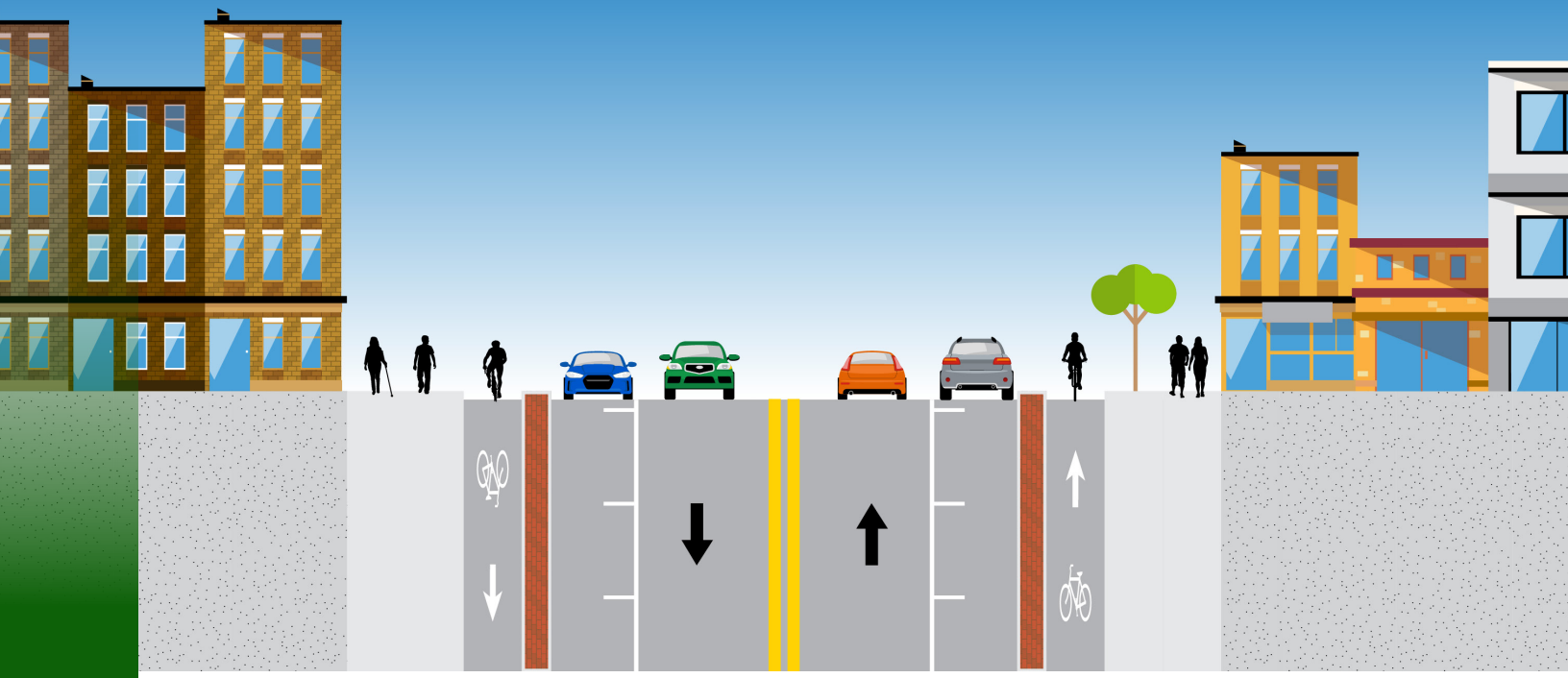
# Scenario 2

## Urban 2-lane minor arterial

**Understand Context:** This two-lane minor arterial features wide lanes, sidewalks without separation from the street, head-in angled parking on one side with parallel parking on the other side, and no bicycle facilities. The transportation agency is seeking to increase the number of short trips made by bicycling and walking to reduce congestion, as well as improve safety to meet their Vision Zero goals. During the engagement process, the agency learns that retail businesses want to retain street parking but note that the current parking does not work well for parcel delivery services. Additionally, customer feedback tells them that the street itself lacks any sort of unique character.

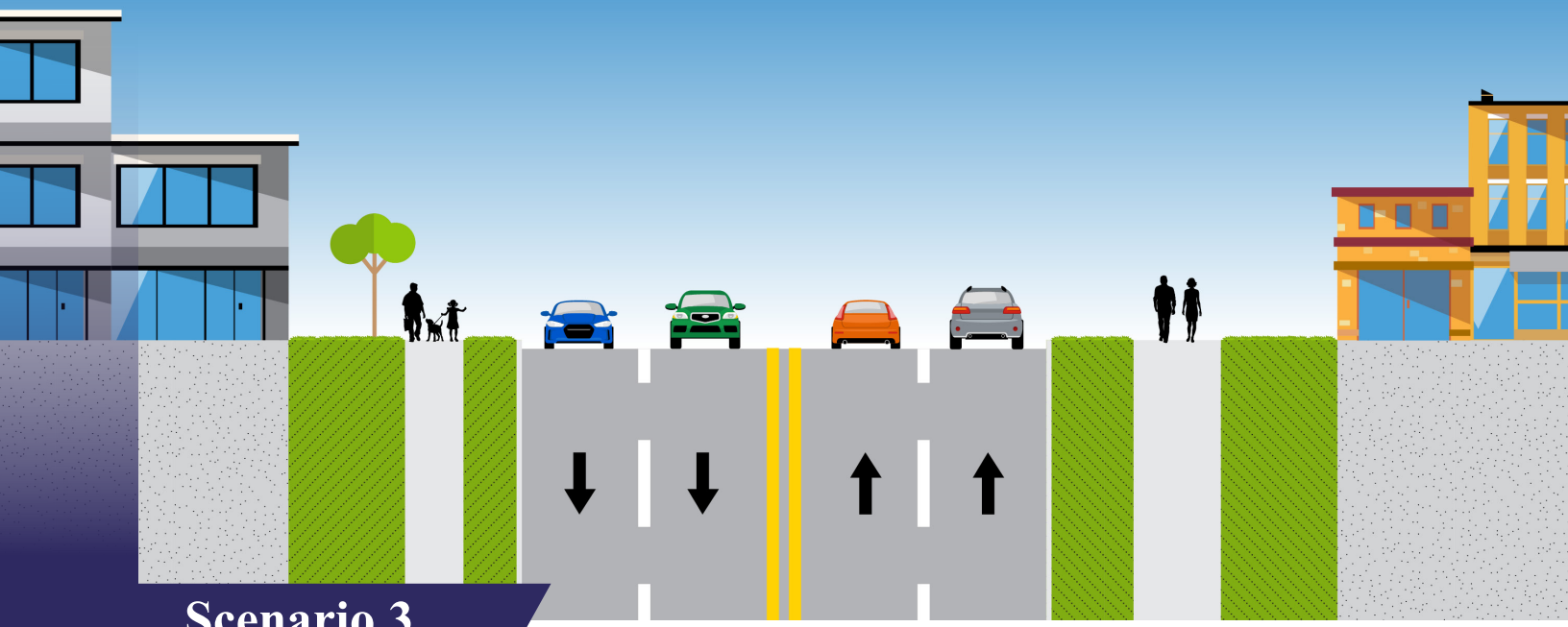
### Identify Concerns:

1. Wide lanes may encourage **high vehicular speeds**.
2. Pedestrians do not feel safe being so close to the roadway on the side without more **separation** from motor vehicles.
3. **Head-in angled parking** may pose a safety hazard and complicates freight delivery.
4. **Accessible parking spaces** are not available to individuals with disabilities.
5. Bicyclist safety is compromised by the l**ack of dedicated space for bicyclists** to travel.



**Implement Improvements:**

1. **Narrow driving lanes** to reduce vehicle speed.
2. Replace angled parking with **parallel parking** to allow for designation of freight delivery spaces while eliminating the need to back out of a space into traffic.
3. Add **accessible spaces** at the end of the block or on side streets to improve parking options for individuals with disabilities.
4. Add **dedicated bike lanes** in each direction with a **curb separation** from motor vehicles and parked cars to improve safety and comfort for bicyclists and pedestrians.



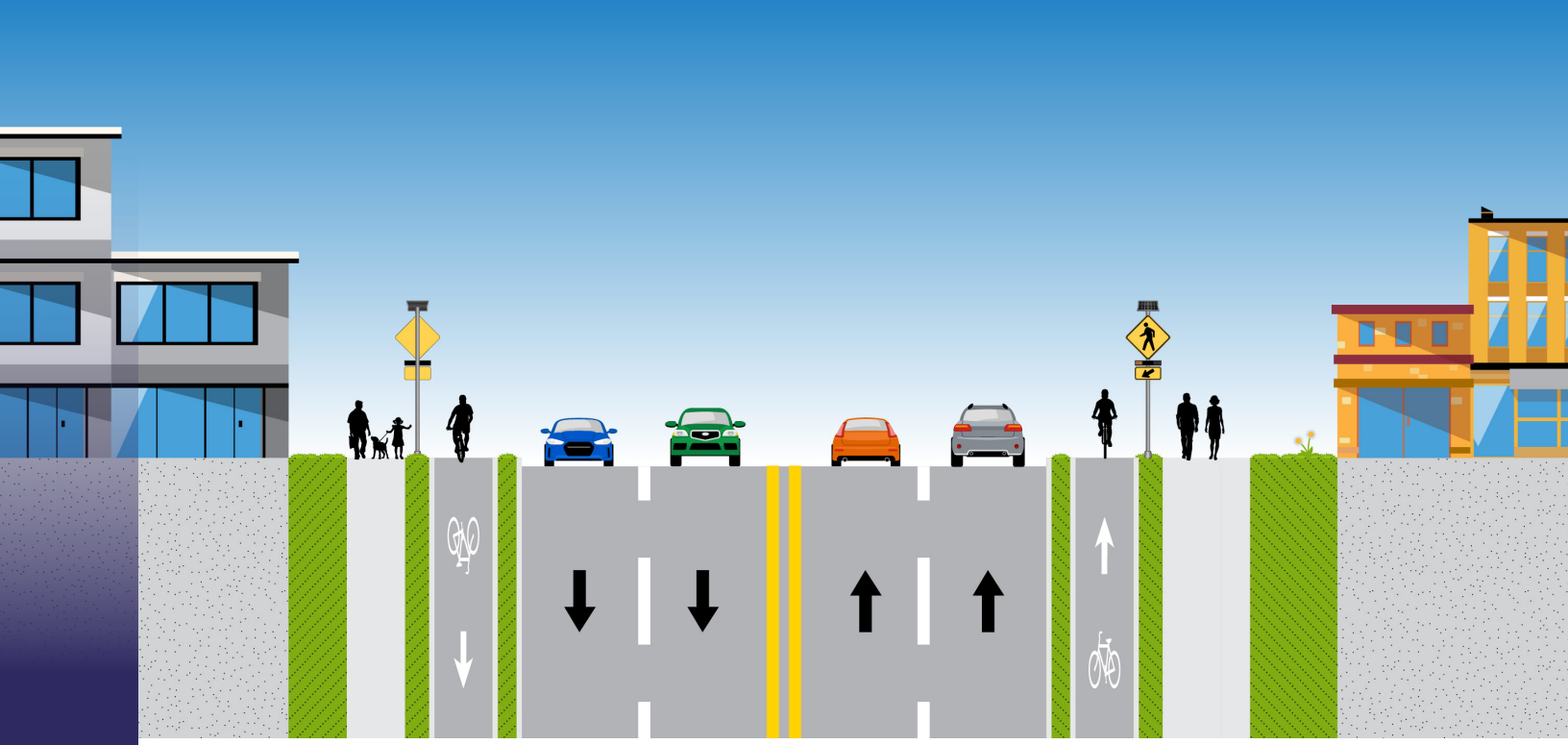
# Scenario 3

## Urban 4-lane minor arterial

**Understand Context:** This minor arterial includes four through-lanes that are relatively narrow. There is no dedicated space for bicyclists. Sidewalks in need of repair are present on each side. This minor arterial provides a critical link in the urban grid, connecting separate nodes of residential, shopping, dining, and medical facilities. Traffic volumes are too high to make a lane reduction feasible. However, analysis shows that this segment serves as a critical link in connecting the walking and bicycling networks of two adjacent neighborhoods. At one point along the roadway, an apartment complex for low-income older adults is located on one side of the street, with shops, medical facilities, and a park on the other side. Through targeted public engagement with residents at a community event, the agency learned that older adults cross the street daily to spend time outdoors or access the services, but they feel unsafe crossing. Several residents have been seriously injured in crashes. Many more have had near-misses. Indeed, analyzing crash data, the agency notes that several crashes involving bicyclists and seniors have occurred. Upgrading sidewalks and crosswalks, adjusting signal timing, and providing low-stress bicycling facilities and crossing opportunities could result in a significant increase in walking and bicycling trips and improve safety for all users, particularly the older adults who call this corridor home.

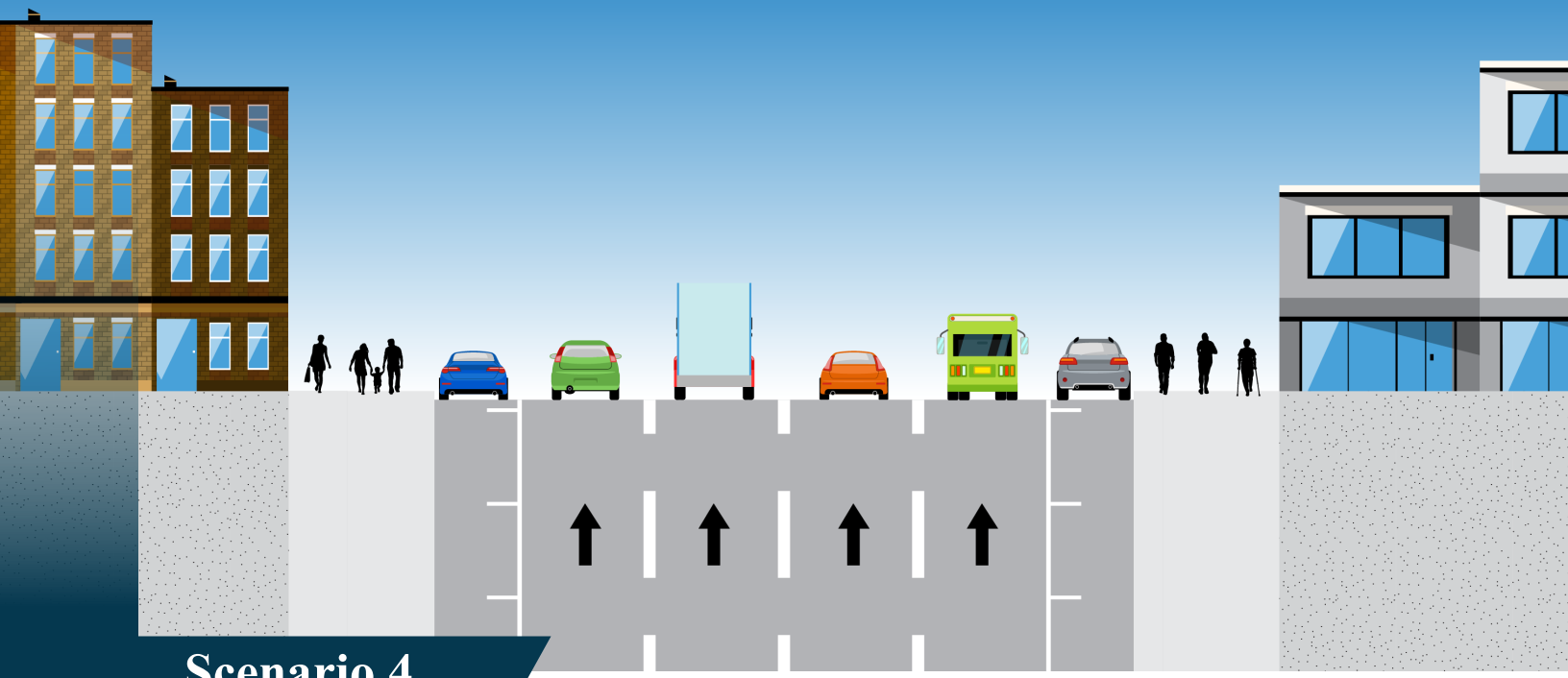
**Identify Concerns:**

1. **Pedestrians with disabilities** are unable to use the sidewalks because they have not been maintained in good condition.
2. The street is sometimes seen as a **barrier** rather than a connector for these neighborhoods. **Older adult residents** do not feel safe crossing the street.
3. Bicyclists do not feel safe using this road since there are **no dedicated bike facilities** and crashes involving bicyclists have occurred.



**Implement Improvements:**

1. Provide enhanced crossings through installation of a **Rectangular Rapid Flashing Beacon (RRFB)**.
2. **Reconstruct the sidewalk to eliminate barriers to accessibility**
3. Provide a vegetative strip between the sidewalk and the bike lanes to provide **separation** and **help pedestrians with vision disabilities** detect the edge of the sidewalk.
4. Add sidewalk-level **bike lanes** on each side to provide dedicated, separated space for bicyclists. By keeping the through-lanes the same width, the agency can avoid the expense of moving the curb and drainage.



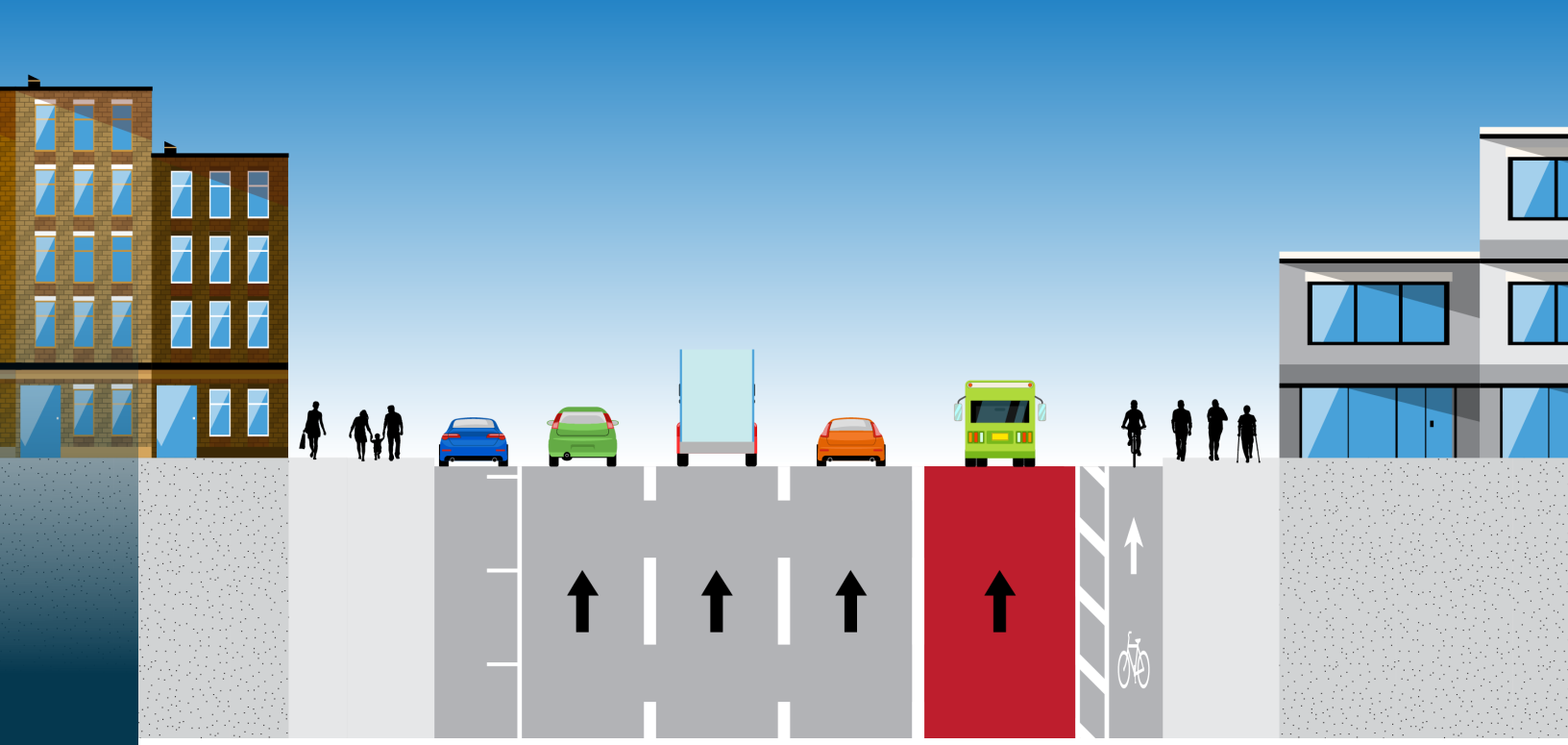
# Scenario 4

## Urban core one-way principal arterial

**Understand Context:** This one-way arterial in a downtown urban core has four travel lanes and parking on both sides of the road. The arterial is part of a one-way pair, with a similar arterial carrying parallel traffic in the other direction on the next block. When considered collectively, these paired roads occupy a substantial amount of space. The project's original justification was to prioritize high-speed vehicle throughput serving workers commuting between the suburbs to jobs in the city. Through targeted outreach with community members, the City learned that many downtown residents – particularly those who do not own vehicles – feel isolated from and unsafe finding access to jobs, healthcare, healthy foods, and recreation. The transit agency noted that while the bus route on this roadway is one of the busiest in the City, it has poor on-time performance. To address community needs, the City wants to improve bus service reliability, bus stop access and amenities, and increase transit frequency. The agency also wants to improve conditions for bicycling and walking to make it possible for residents to bicycle and walk more often for short trips and also reduce crowding on buses. The City determined that the community's overall goals for this downtown route are best met by improving bus service reliability and conditions for nonmotorized travel.

**Identify Concerns:**

1. Sidewalks on both sides are adjacent to the curb and **cluttered** with intermittent utilities that may impede travel for some users; no accessible parking spaces are available.
2. Several bus routes use this heavily congested corridor, and **bus service is unreliable** due to traffic delays, including trucks stopping for deliveries.
3. There are **no dedicated bicycle facilities** in this high-traffic corridor.
4. As with many multilane one-way streets, **speed** in the general-purpose travel lanes often exceed the posted speed limit.



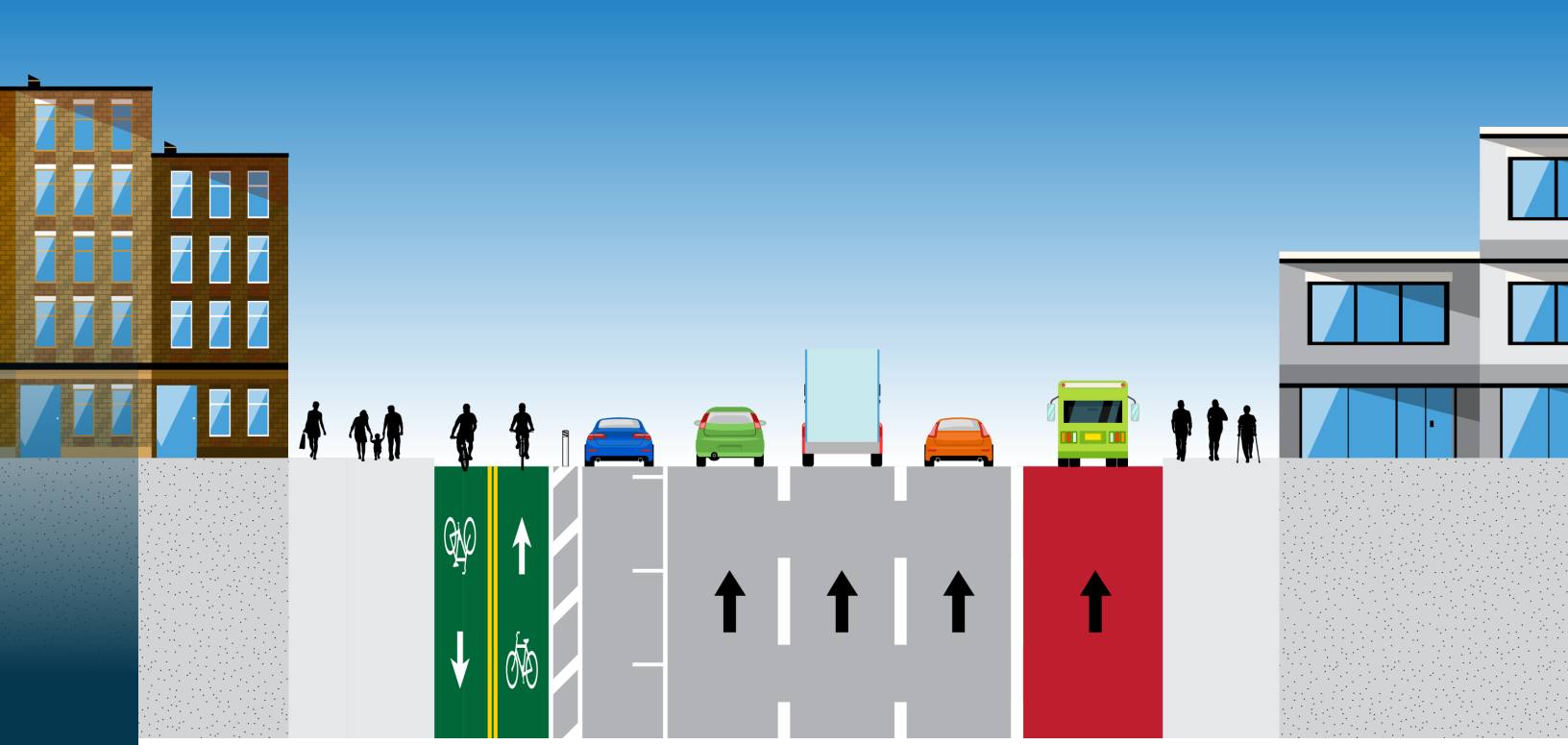
### Implement Short-Term Improvements:

Maintaining overall curb-to-curb width, the transportation agency can:

1. Relocate easily movable fixtures to provide a more predictable pedestrian space on both sidewalks, while maintaining utilities.
2. Add **accessible parking spaces** at either the end of the block or on side streets.
3. Re-allocate one travel lane for **exclusive use as a bus lane** to improve the on-time performance of bus routes and increase transit frequency. The transportation agency received **Interim Approval from FHWA** to install red colored pavement within the exclusive bus lanes.
4. Designate some **loading/unloading zones** to meet anticipated demand for freight deliveries in this busy corridor.
5. Repurpose parking on one side of the street as a **buffered bike lane** to encourage residents to bicycle more for short trips and to improve access to transit.

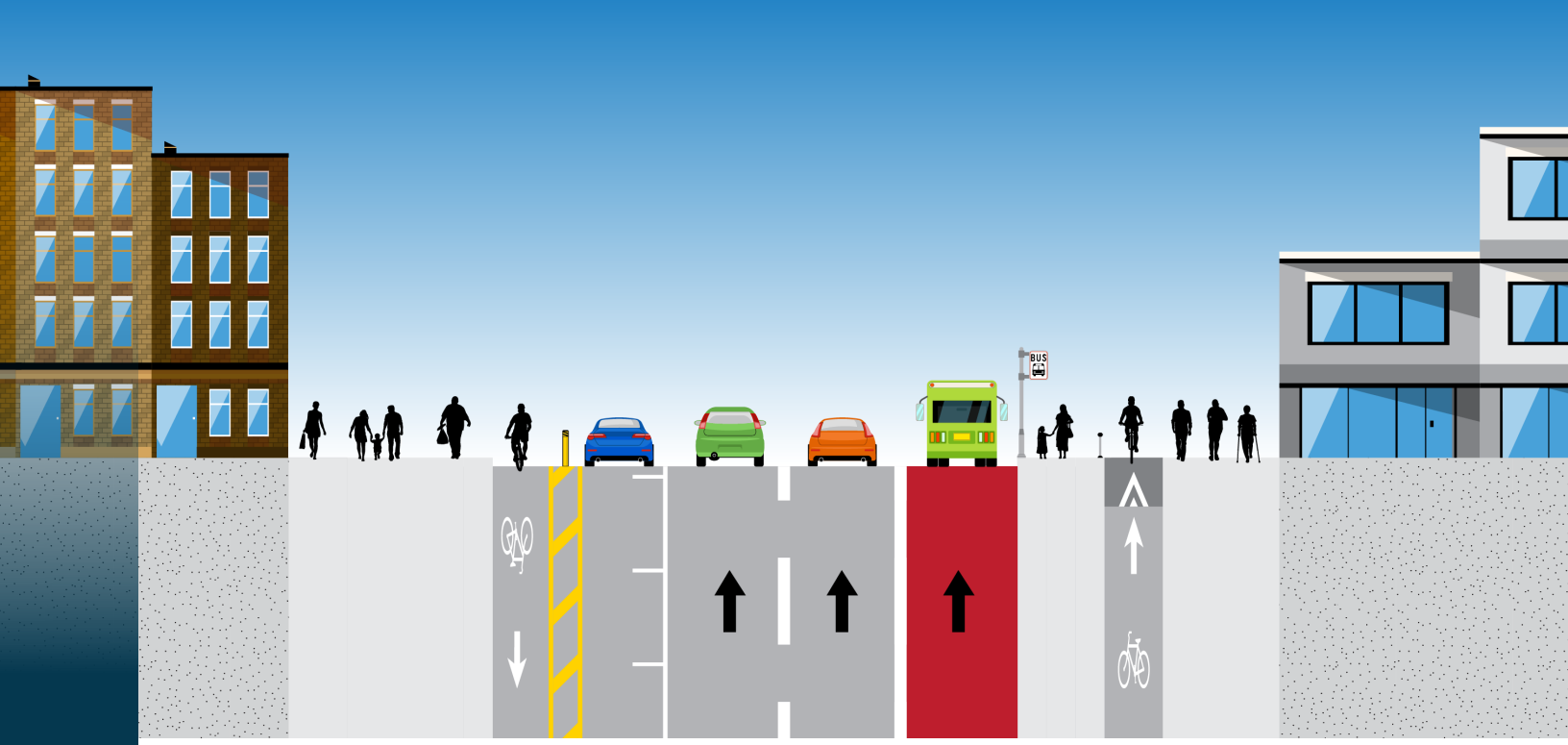
### Evaluate Impacts:

1. Vehicular **Speed** continues to exceed the posted speed limit.
2. **Contraflow bicyclists** use the one-way facility to shorten their overall trip length.
3. Buses must **pull into the bike lane** to reach the curb at stops.
4. Bicyclists have to pass the bus using the remainder of the bus lane.



**Implement Option A for Long-Term Improvements:**

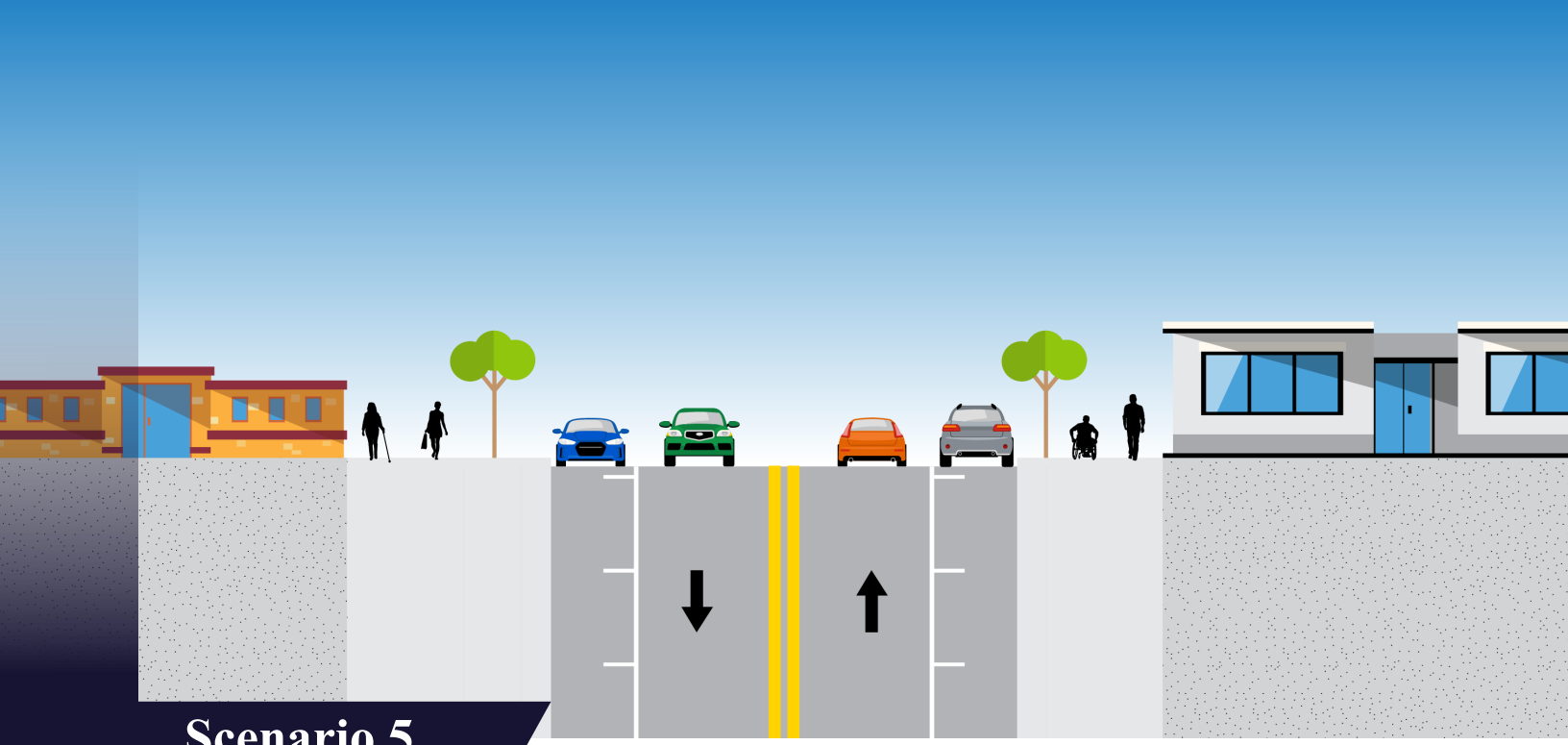
1. Install **Speed Safety Cameras** to decrease speeds and improve safety for all users.
2. Provide a **2-way separated bike lane** on the left side of the street to avoid conflicts with transit operations. Install green colored pavement within the bike lanes, with **Interim Approval from FHWA**.
3. Modify **traffic signals** to accommodate the 2-way separated bike lane.
4. Provide special attention to **operations and sight distance** at intersection, alley and driveway crossings for contraflow movements.
5. Install **bike signal faces and signs**, with **Interim Approval from FHWA**, and include street name signs to serve contraflow bicyclists.




**Implement Option B for Long-Term Improvements:**

1. Remove an additional through lane to further **prioritize bicycling** and gain space for improved transit facilities needed to support increased ridership.
2. Build a **floating bus island** in the vicinity of bus stops by narrowing the bike lane.
3. Raise the bike lane where pedestrians cross to access the bus stop to reinforce that bicyclists must **yield to pedestrians**.
4. **Provide a contraflow bike lane** on the left side of the roadway, so that bicyclists can easily access businesses, employers and transit stops located on this route.

Note: Some cities have returned one-way pairs to bi-directional travel, which can help reduce speeds and improve access.



# Scenario 5

## Rural 2-lane minor arterial Main Street

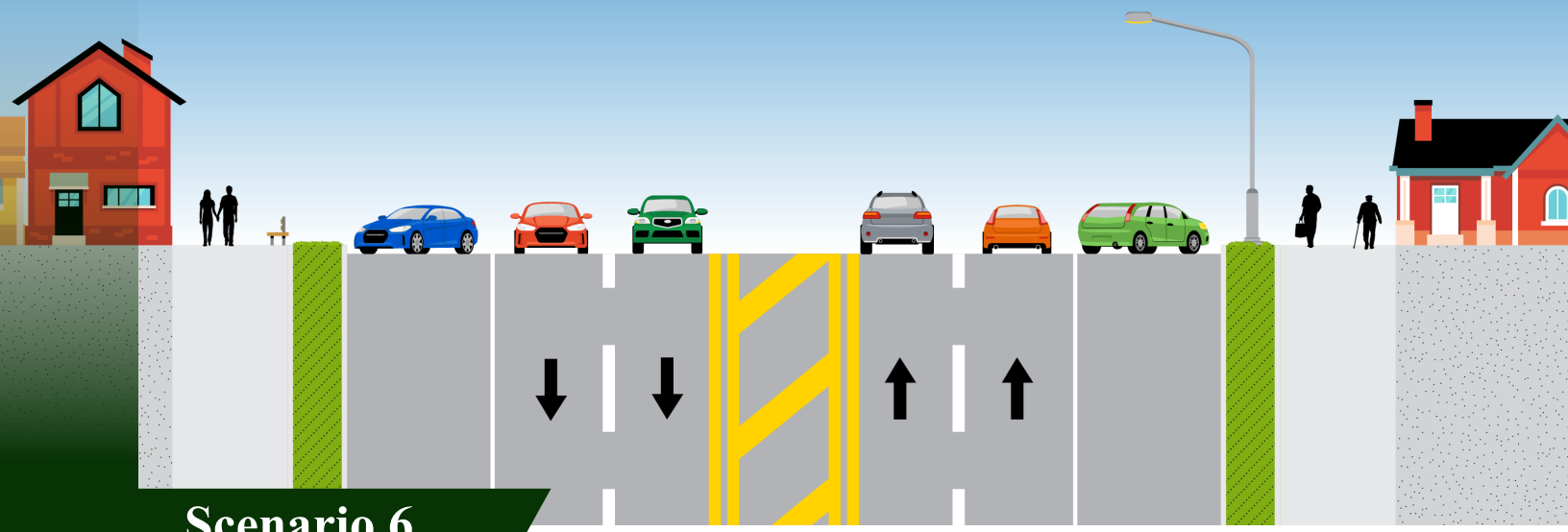
**Understand Context:** This two-lane arterial has one lane in each direction with parking on both sides of the street. It functions as the Main Street in a rural town. This highway is a numbered U.S. Route on the National Highway System that passes through several small rural towns located about 30 miles from a major metropolitan area. There are several local businesses along the route, and residential properties are located within a few blocks on either side of this Main Street. The business community wants changes that support their business district. And residents want traffic calming measures implemented to make the street easier to cross and to reduce travel speeds.

**Identify Concerns:**

1. Pedestrians find it difficult to cross the street because of **high speed** vehicular traffic.
2. Sidewalks exist but there are **no facilities for bicyclists**.
3. Lack of accessible spaces.

**Implement Improvements:**

1. Re-evaluate and set **appropriate speed limits**.
2. Add **curb extensions** at each intersection, and at some midblock crossing locations, to shorten pedestrian crossing distances to just two lanes. These measures also help reduce travel speeds in the corridor.
3. Add a mid-block **raised crosswalk** to calm traffic speeds and allow pedestrians to cross at-grade with the sidewalk.
4. Add **accessible spaces** at either the end of the block or on side streets.
5. Add signage to indicate entry to business district and to indicate bicycles will share the road.
6. Dedicated facilities for bicyclists are not added but riding in a shared lane with traffic is more comfortable due to the resulting **reduced travel speeds**.



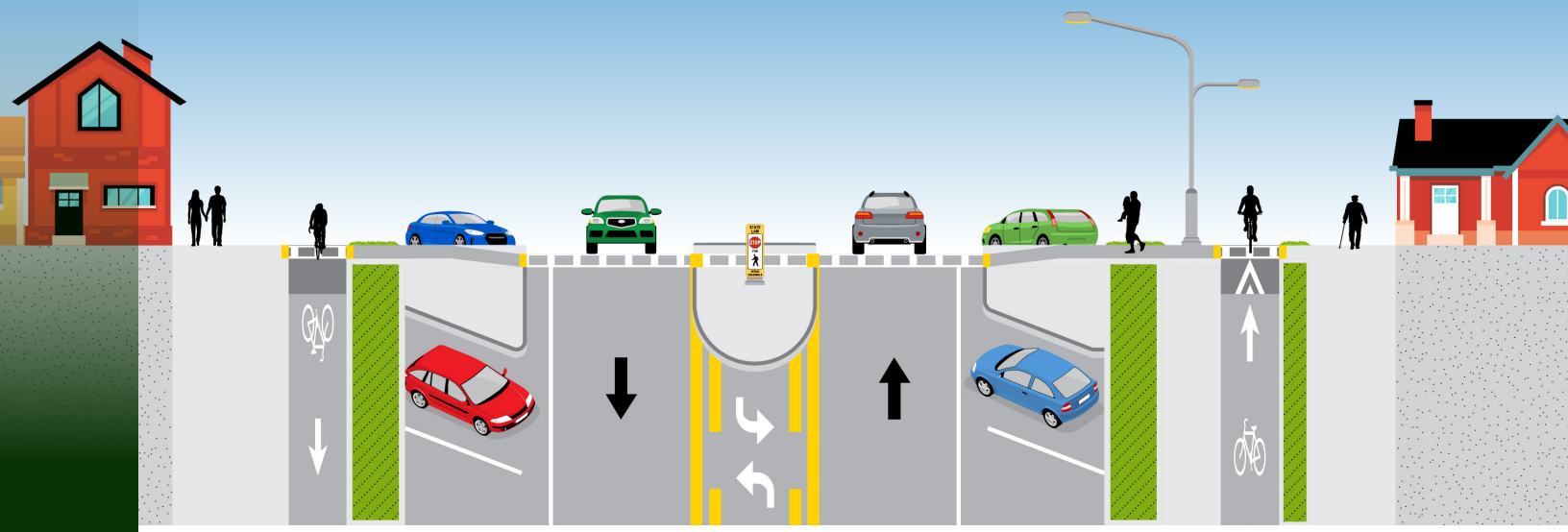
# Scenario 6

## Rural 4-lane principal arterial Main Street

**Understand Context:** This four-lane highway is the main street in a thriving rural town with a population of 11,000 people. A tourist location, the street is lined with restaurants, shops and other destinations. Community leaders have reached out to the State Department of Transportation (SDOT), who owns this highway, to request improvements that better support the needs of the community. After extensive outreach, the SDOT has agreed to reconstruct the highway to better serve the needs of local businesses and residents and implement a "road diet."

**Identify Concerns:**

1. The flush median is too narrow for a turn lane, and not marked for that purpose, so traffic waiting to make a **left turn** blocks the left through lane.
2. Bicyclists do not feel safe using this route due to the **lack of bike facilities**.
3. The wide lanes and flush median induce **high travel speeds** exceeding the 30-mph speed limit.
4. Pedestrians find it **difficult to cross** this wide roadway, even at intersections.
5. Drivers have difficulty **safely backing out** of head-in angled parking spaces due to the lack of visibility to the travel lanes.
6. People with disabilities have difficulty reaching the streets' attractions.



**Implement Improvements:**

1. Implement a **road diet**, repurposing two through lanes to:
   a. Add a **two-way center left turn lane** to facilitate turning traffic with **raised median refuge islands** at intersections and other crosswalks.
   **b. Add a bike lane** in each direction, with ample separation from the parking lane to allow shoppers to load their vehicles without interfering with bicyclist travel. Raise the bike lane at midblock crossings to improve yielding to pedestrians. These changes will help reduce crossing distance for pedestrians and reduce speeds.
2. Build **bulbouts** (or curb extensions) at intersections and mid-block crossings to shorten the crossing distance for pedestrians.
3. Retain angled parking but convert to **back-in parking** to improve safety and visibility.
4. Provide accessible parking spaces with wide access aisles to accommodate vans with wheelchair lifts.
5. Make accessibility improvements to sidewalks and crossings.
6. Improve **lighting** for pedestrians and drivers.
7. Provide loading/unloading zones to accommodate freight deliveries

## Additional Resources

### Managing Speed

Road Diets
Pedestrian Hybrid Beacon
Speed Safety Cameras
Raised Crosswalks
Appropriate Speed Limits[8]

### Separating Users in Time and Space

Road Diets
Bike Lanes
Pedestrian Medians
Rectangular Rapid Flashing Beacon

### Improving Lighting

Lighting

### Intersections

Safe System Intersections

*The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide information to the public regarding existing requirements under the law or agency policies. The U.S. Government does not endorse outside entities, products, or manufacturers. Links to content created by outside entities are provided for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one entity or product. External sites are not subject to Federal information quality, privacy, security, or accessibility guidelines.*

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1 See Measures of Success resources on the FHWA Complete Streets website for more information.
2 https://www.ghsa.org/resources/Pedestrians21
3 https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813079
4 Schneider, Sanders, and Proulx. 2020. United States Fatal Pedestrian Crash Hot Spot Locations and Characteristics. Transportation Research Board Annual Meeting, 2020. Manuscript Number: 20-02402
5 https://ops.fhwa.dot.gov/publications/fhwahop12004/index.htm
6 A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. A CMF reflects the safety effect of a countermeasure, whether it is a decrease in crashes (CMF below 1.0), increase in crashes (CMF over 1.0), or no change in crashes (CMF of 1.0). A CMF can also be expressed as a crash reduction factor or CRF. A CRF provides an estimate of the percentage reduction in crashes. For example, a CMF of 0.75 is equivalent to a 25% reduction in crashes (i.e. CRF = 25).
7 The transportation agency requested and received Interim Approval from FHWA in accordance with the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD).
8 Appropriate Speed Limits for All Road Users - Safety | Federal Highway Administration (dot.gov)