KENTUCKY TRANSPORTATION CABINET (KYTC)

EDITION 1
AUGUST 2022

COMPLETE STREETS, ROADS, AND HIGHWAYS MANUAL

A GUIDE TO IMPLEMENTING SAFE AND EQUITABLE TRANSPORTATION STRATEGIES FOR FACILITIES IN RURAL AND URBAN KENTUCKY.

KENTUCKY TRANSPORTATION CABINET

FOREWORD

On behalf of the Kentucky Transportation Cabinet (KYTC) and with profound appreciation to the staff, partners, stakeholders and agencies who participated, I am proud to present the 2022 Complete Streets, Roads, and Highways Manual. This document updates and replaces the KYTC 2002 Pedestrian and Bicycle Travel Demand Policy, which provided guidance for our bike and pedestrian infrastructure. The Manual update provides an opportunity to both reflect on past efforts and evaluate new and emerging needs and opportunities to enhance our Complete Streets Policy.

Streets and highways historically were designed around cars and trucks. Everything else, from buses to bicycles, not to mention pedestrians, had to find ways to fit in. It hasn't always been a good fit. Today, our transportation planners and designers approach their tasks holistically, taking the needs of all users into account and building accordingly.

Complete Streets are for every community, from rural Kentucky to small towns to the densest urban core. They provide safe transportation choices within the context of the surrounding area. They prioritize safe, connected, comfortable, equitable and accessible transportation networks that enable people to freely travel to places they want to go while allowing for the transport of goods and services. Beyond transportation, Complete Streets also provide opportunities and gathering spaces for art, commerce and community events.

The new KYTC *Complete Streets, Roads, and Highways Manual* is intended to support planners, engineers, transportation agencies and communities throughout Kentucky. It offers guidance, recommendations and resources. At the same time, it's flexible. Its guidance and recommendations can easily be modified and implemented in ways specific to a location. In the final analysis, it's about safety, equitability and accessibility for all users of Kentucky's transportation network.

Sincerely,

Jim Gray
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GLOSSARY OF TERMS

COMPLETE STREETS

Streets, roads, and highways that are safe for all expected users. Complete Streets design varies based on land use, corridor characteristics, and expected user types.

EQUESTRIAN

Includes horses and horse-drawn vehicles. For the purpose of this Manual, equestrians are considered in rural areas and for trail access and design for site-specific contexts.

MICROMOBILITY

Micromobility devices, for the purpose of Complete Streets in Kentucky, are defined as weighing 500 pounds or less and operating at speeds up to 30 mph.[1] For the purpose of this Manual, micromobility devices are considered to include bicycles, e-bicycles, and e-scooters as allowed by local ordinance.

MOTOR VEHICLE

All large motorized vehicles including, but not limited to, mopeds, motorcycles, cars, trucks, vans, SUVs, buses, and freight vehicles.

PEDESTRIAN

A pedestrian is anyone who is walking or traveling with the use of wheelchairs, other mobility devices, or navigational aids.

TRANSIT

Includes a variety of vehicle types and service models from large urban buses, light rail, small rural transit buses, and vans picking up at designated park-and-ride locations, transit stops, or individual homes.

1 FHWA *Public Roads – Spring 2021; Micromobility: A Travel Mode Innovation* (Price, Blackshear, Blount, Jr., and Sandt) https://highways.dot.gov/public-roads/spring-2021/micromobility-travel-mode-innovation

ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ABA	Architectural Barriers Act
ADA	Americans with Disabilities Act
ADD	Area Development District
ADT	Average Daily Traffic
BRT	Bus Rapid Transit
BCI	Bicycle Comfort Index
CDBG	Community Development Block Grant
CRFC	Critical Rural Freight Corridor
CUFC	Critical Urban Freight Corridor
DES	Design Executive Summary
DOJ	Department of Justice
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GIS	Geographic Information System
ITE	Institute of Transportation Engineers
KBBC	Kentucky Bicycle and Bikeway Commission
KIPDA	Kentuckiana Regional Planning & Development Agency
KYTC	Kentucky Transportation Cabinet
LOS	Level of Service
LOSS	Level of Service for Safety
LPA	Local Public Agency
LPI	Leading Pedestrian Interval
MASH	*Manual for Assessing Safety Hardware* (AASHTO)
MMA	Methyl-methacrylate
MOT	Maintenance of Traffic
MPO	Metropolitan Planning Organization
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
NACTO	National Association of City Transportation Officials
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NRSS	National Roadway Safety Strategy
PCI	Pedestrian Comfort Index
PHFS	Primary Highway Freight System
PROWAG	*(Proposed) Public Rights-of-Way Accessibility Guidelines*
RSA	Road Safety Audit
STEP	Safe Transportation for Every Pedestrian
TRB	Transportation Research Board
TRR	Transportation Research Record

STANDARD DRAWINGS

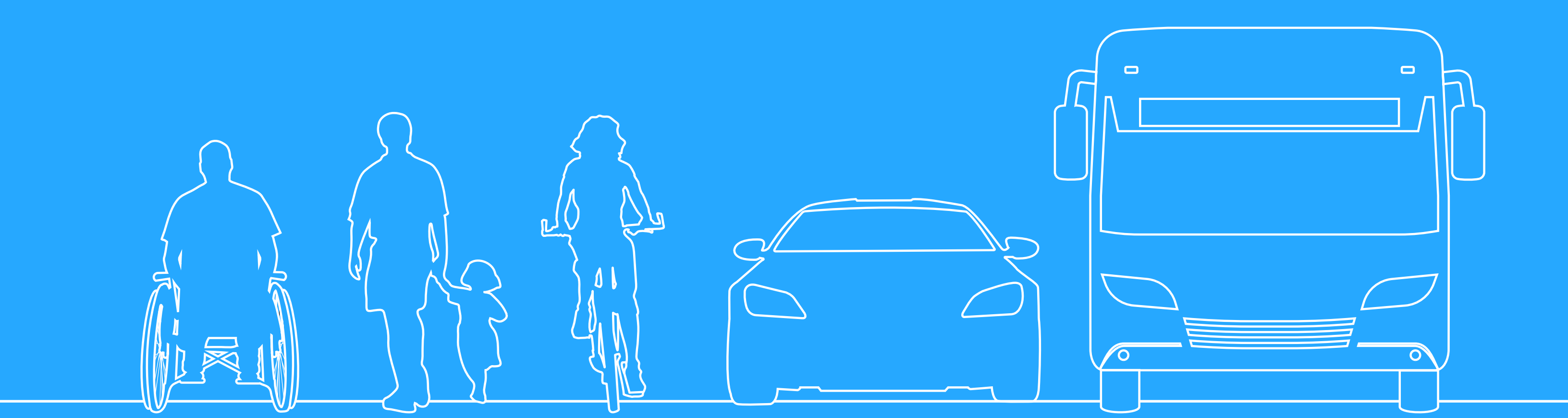
KYTC Standard Drawings online location:

transportation.ky.gov/Highway-Design/Pages/Standard-Drawings.aspx

STANDARD DRAWING NO.	DESCRIPTION
RGX-040	Detectable Warnings
RPM-170-09	Sidewalk Ramps
TPM-203	Typical Markings at Signalized Intersections
TPM-206	Typical Markings for Turn Lanes
TPM-207	Typical Markings for Turn Lanes

Note: At the time of the publication of this Manual, the KYTC Standard Drawings are under review. This table will be updated with the next release of the KYTC Standard Drawings.

CHAPTER 1
INTRODUCTION



Complete Streets are an evolution of the way streets, roads, and highways address the transportation needs of the communities they serve, shifting from a motor vehicle-centric transportation system to a new, holistic approach for building a network that supports the needs of all users.

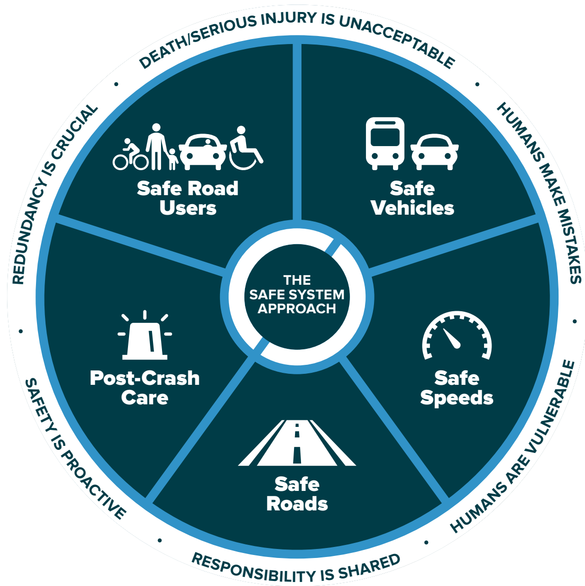
Figure 1.1 Complete Streets are safe and provide a variety of transportation choices and amenities. Shown are pedestrians in Louisville, KY walking on a sidewalk past a transit stop, comfortably separated from motor vehicle traffic with a furnishing zone. The furnishing zone may include landscape plantings, trash receptacles, wayfinding signage, seating, and other amenities.

Complete Streets are for every community, from the small towns and communities that are the fabric of rural Kentucky to the densest urban core. They provide safe transportation choices for pedestrians, bicyclists and other micromobility users (see Chapter 5 for definition), transit users, motor vehicle drivers, and others within the context of the surrounding area. Complete Streets in the Commonwealth of Kentucky prioritize safe, connected, comfortable, equitable, and accessible transportation networks that provide people with the freedom to travel to the places they want to go and allow for the transport of goods and services. Beyond transportation, Complete Streets also provide opportunities for art, commerce, community events, and other gathering spaces.

The vision for safe transportation through Complete Streets principles goes beyond the Commonwealth of Kentucky. The Federal Highway Administration (FHWA) identifies Complete Streets as a key opportunity to address roadway safety and implement strategies that encourage safe motor vehicle speeds in alignment with the National Roadway Safety Strategy's (NRSS) adopted Safe System[1] approach. The Safe System approach is focused on six principles:

1. Deaths and serious injuries are unacceptable.
2. Humans make mistakes.
3. Humans are vulnerable.
4. Responsibility is shared.
5. Safety is proactive.
6. Redundancy is crucial.

Figure 1.2 The six principles of the Safe System approach from the National Roadway Safety Strategy (NRSS).



The Kentucky Transportation Cabinet (KYTC) embraces the Safe System approach, and Complete Streets[2] are one tool that KYTC can use across the Commonwealth to address all six principles. The goal is to reduce deaths and serious injuries through a comprehensive, guided approach in partnership with local communities to implement design and programmatic strategies that reduce crashes, protect vulnerable roadway users, and increase freedom of movement on the transportation network.

In addition to the proven safety benefits, Complete Streets promote inclusive, accessible communities and revitalize economic development, increase tourism and improve health outcomes by encouraging walking, bicycling, utilizing transit, and using micro-mobility options like electric scooters. Complete Streets can also provide opportunities for children to walk or bike to school, the elderly to age in place, and people of all ages and abilities to enjoy their communities in an accessible, equitable, and secure manner.

SECTION 1.1

OVERVIEW AND PURPOSE

In the past, transportation design often favored single-occupancy motor vehicles, moving as many cars as quickly as possible through the network. However, some people choose or need to use alternatives to single-occupancy motor vehicles throughout the Commonwealth. Nearly one-third of Kentucky residents do not have a driver's license to operate single-occupancy motor vehicles. The KYTC Complete Streets Policy ("Policy") is the directive from KYTC at the administrative level to promote Complete Streets, creating safe transportation options for users of all ages and abilities through the planning, design, construction, operation, and maintenance of Complete Streets.

The intent of the Policy is to promote the inclusion of Complete Streets design and multimodal access in all transportation activities at the local, regional, and statewide levels, and to develop a comprehensive, integrated, and connected transportation network focused on the safety of all users. KYTC's Policy is supported throughout the transportation network and across the lifetime of a project by a variety of programs, departments, and offices.

The KYTC Complete Streets Manual ("Manual") supports and guides planning and engineering practitioners, transportation agencies, and local communities with the development of Complete Streets throughout the Kentucky transportation network. This Manual offers guidance, recommendations, and resources for the implementation of Complete Streets in all transportation projects as a tool to promote safety for all users as part of an equitable, accessible, and sustainable transportation network. It identifies and supports a variety of users on Kentucky streets and highways, including but not limited to: motorists, bicyclists, pedestrians, scooter-riders, transit-riders, and freight carriers.

Projects covered under this Manual include new construction, reconstruction, and modernization transportation projects. Specific guidance for urban curbside management and for rural and small communities with higher concentrations of farming, equestrians, and horse-powered vehicles operating on or near Kentucky's streets and highways is also discussed. This Manual recognizes that user types, multimodal guidance, and transportation best practices will continue to evolve. The Manual will continue to promote and incorporate the latest information related to Complete Streets as new methodologies, technologies, and guidance becomes available.

SECTION 1.2

AGENCY RESPONSIBILITY AND THE ROLE OF LOCAL PARTNERS

The Manual provides flexible Complete Streets guidance and recommendations, which may be modified and implemented based on location-specific context with prevailing planning and engineering judgment. For all Complete Streets, accessibility and maintenance for the longevity of the transportation network are critical components to the success of Complete Streets in supporting healthy, vibrant communities. All agencies, including both KYTC and local partners, associated with transportation planning, design, construction, and maintenance activities on state-maintained rights-of-way have a responsibility to consider Complete Streets as a tool to implement safe transportation choice to people of all ages, abilities, and socio-economic statuses holistically throughout the transportation network.

Local Public Agency (LPA) transportation activities on rights-of-way that are not state-maintained are also highly encouraged to consider Complete Streets as an important part of the transportation network. Complete Streets are not only about singular, state-maintained streets, roads, and highways; they are about a holistic transportation network throughout a community. A concerted effort from community partners with KYTC can create a transportation network that safely blends a variety of transportation mode choices, moves goods, and provides services throughout the Commonwealth. The Policy sets the standard for individual communities to also develop their own policies in support of Complete Streets principles.

SECTION 1.3

HOW TO USE THE MANUAL

The Manual is organized into 10 chapters, with progressively detailed guidance and recommendations. The Manual may be utilized in a variety of scenarios, including, but not limited to, site-specific applications as well as general guidance on Complete Streets best practices and standards.

Each chapter in the Manual answers questions about Complete Streets that benefit both transportation practitioners and community members. The following are some of the questions addressed in each chapter.

CHAPTER 1
Introduction

Why are Complete Streets important to Kentucky and the nation?

What is this Manual, and how should it be used?

Are Complete Streets for every community?

CHAPTER 2
Complete Streets, Roads, and Highways in the Commonwealth of Kentucky

Where are examples of successful Complete Streets in Kentucky?

What is the process for implementing Complete Streets in Kentucky?

How can a local agency, city, or community support Complete Streets?

How do national best practices and industry trends inform planning, design, and implementation of Complete Streets in Kentucky?

Do current guidance and policy allow for flexibility in design?

CHAPTER 3
Planning for Complete Streets, Roads, and Highways

What are Complete Streets?

Does land use affect travel patterns and inform Complete Streets planning?

How do Complete Streets prioritize safety for everyone in a transportation network?

Do Complete Streets align with community goals?

What makes a Complete Street, and how do decisions made affect the outcomes?

How are Complete Streets prioritized, and will they look the same everywhere?

CHAPTER 4
Getting Started in Complete Street Design

What must transportation engineers and related transportation practitioners consider during Complete Streets design?

How does street design inform speed, visibility, and safety outcomes?

CHAPTER 5
Design Elements of Complete Street Corridors

How are facilities selected for each type of potential user of a Complete Street corridor?

What are the design elements and specifications to consider for each of the facility types?

What Complete Streets design best practices protect the most vulnerable roadways users?

How can streetscape, greenspace, and other amenities create a sense of community, regulate motor vehicle speed, and provide comfortable transportation networks for all?

CHAPTER 6

Design Elements of Complete Street Intersections and Crossings

How are all transportation network users accommodated at intersections, interchanges, and other controlled or uncontrolled crossing locations while prioritizing safety for everyone?

Can access management principles reduce or manage conflicts with motor vehicles to protect vulnerable roadway users?

How can multimodal overpasses and underpasses be designed to cross active transportation barriers?

CHAPTER 7

Implementing Complete Streets on Existing Streets, Roads, and Highways

What considerations should be made for Complete Streets design in resurfacing and retrofit transportation projects?

How can roadway reconfigurations and road diets improve safety outcomes and provide space for Complete Streets opportunities?

CHAPTER 8

Tactical Urbanism, Pilot Projects, and Interim Design

How can demonstration projects build agency and community support?

What is the process to leverage pilot projects and interim design opportunities with limited funding and test improvements ahead of full-build transportation improvements?

What are the policies and guidance for maintaining and monitoring the outcomes of these improvements?

CHAPTER 9

Additional Considerations

When would additional barriers or safety railings improve safety outcomes for all users?

What are the lighting needs to address both real and perceived safety and comfort for all users?

Who is responsible for maintenance?

What are the recommendations and best practices for maintaining facilities?

How should surfaces be selected for different user facilities?

How can everyone be accommodated comfortably and safely through work zones?

CHAPTER 10

Resources

What resources are available for planning, design, and implementation of Complete Streets?

What references were used to develop the Manual?

The most recent version of the Manual is available on KYTC's Policy Manuals Library.[3]

ENDNOTES

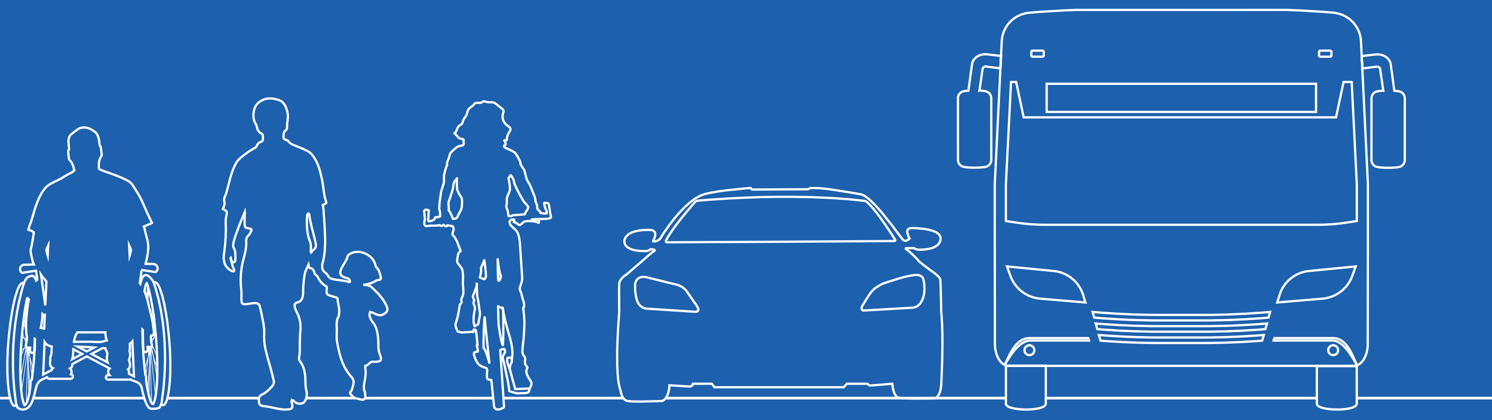
1 FHWA National Roadway Safety Strategy (NRSS) and the Safe System Approach https://www.transportation.gov/NRSS/SafeSystem

2 FHWA Complete Streets https://highways.dot.gov/complete-streets

3 KYTC Policy Manuals Library https://transportation.ky.gov/Organizational-Resources/Pages/Policy-Manuals-Library.aspx

EDITION 1
AUGUST 2022

CHAPTER 2
COMPLETE STREETS, ROADS, AND HIGHWAYS IN THE COMMONWEALTH OF KENTUCKY



SECTION 2.1

COMPLETE STREETS EXAMPLES

Complete Streets are part of healthy, vibrant, and thriving communities across the Commonwealth of Kentucky. Complete Streets are not only found in urban city centers. They are part of suburban communities, knitting together homes and small commercial clusters, driving economic revitalization of historic small town business districts, and connecting rural areas with schools and other communities. Complete Streets are everywhere, and they are successful when they meet the needs of the community they serve. More detailed information about land-use context and community size related to Complete Streets is provided in Chapter 3 – Planning for Complete Streets.

The following pages are examples of Complete Streets in various communities across Kentucky, reflecting the variety of facilities and implementation strategies that best suited the specific community needs.

URBAN

TOWN BRANCH COMMONS ALONG US 25 (VINE STREET)
Lexington, KY

US 25 (Vine Street) and Midland Avenue hosts the Town Branch Commons, a transformative public-private park and trail system that traces the historic Town Branch Creek through downtown Lexington. Town Branch Commons links two major trails, Town Branch Trail and the Legacy Trail, connecting downtown Lexington to the rural landscape surrounding the city. Modern stone walls provide seating and create a barrier to adjacent vehicular traffic. Frequent, high-volume pedestrians and bicyclists have separate facilities along the shared-use path and at intersection crossings to mitigate conflicts between the modes, clearly define throughways, and prevent encroachment on business frontage space using pavement markings and signage. Water is featured along the path in interactive fountains and planting areas to collect stormwater and improve water quality through green infrastructure adjacent to the roadway.

US 60A (EASTERN PARKWAY)
Louisville, KY

US 60A (Eastern Parkway) in Louisville, KY is a historic parkway designed by Frederick Law Olmsted, Sr. to connect Louisville's flagship parks in the 1890s. The original design of the parkway portrayed a tree-lined transportation network that provided safe, comfortable separation of transportation modes. The segment of US 60A between S. 3rd Street and Hahn Street aligns with the original design intent, providing landscaped median separation between motorists, dedicated bicycle lanes, sidewalks, and additional green space.

SUBURBAN

US 60 (E. MAIN STREET)
Frankfort, KY

A reconfigured US 60 serves residential and small commercial areas east of downtown Frankfort with two motor vehicle travel lanes and a two-way left-turn lane. Bicyclists are separated from motor vehicle traffic with dedicated lanes, and pedestrians are further separated with a curb and grass verge between the bicycle lanes and sidewalks.

W. BROADWAY
Louisville, KY

In the heart of historic west Louisville, W. Broadway is a residential gem. Buffered bicycle lanes provide separation from motor vehicles, along with sidewalks well-separated from motor vehicles with tree-lined verges. Trees provide shade for pedestrians to enjoy walking from residences to bus stops and the nearby historic Shawnee Park. This segment of W. Broadway is a city-maintained corridor, and an example of how communities can support Complete Streets as part of the larger transportation network.

SMALL TOWN

MAIN STREET
Morehead, KY

Beautiful downtown Morehead is anchored by Main Street with sidewalks and shared lanes for walking and bicycling. Near Morehead State University, Main Street is a frequent attraction for residents, students, and visitors to walk and bike. Signage and elements such as landscaping encourage slower speeds for motor vehicles and increase awareness of vulnerable roadway users.

S. 3RD STREET
Mayfield, KY

Shared lane markings and signage on the S. 3rd Street bikeway indicate to motor vehicle drivers to expect bicyclists on the road. The shared lane markings also indicate to bicyclists a low-speed, comfortable route for bicycling. The bikeway connects residents of the neighborhood east of KY 121 (Paris Road) to the Mayfield High School and Elementary School.

RURAL

KY 595
Berea, KY

For many rural areas, more vulnerable roadway users like bicyclists and pedestrians are accommodated on shared-use paths separated from the roadway. On the shared-use path along KY 595, bicyclists and pedestrians are separated from motor vehicle traffic by a wide grass verge.

KY 33/KY 2168
Danville, KY

Traffic calming and safety are critical components of rural Complete Streets. Along with a shared-use path for pedestrians and bicyclists, a roundabout at the intersection of KY 33 and KY 2168 just outside of Danville slows motor vehicle speeds and improves safety outcomes. Roundabouts are another tool in the FHWA Proven Safety Countermeasures to reduce crashes, lower vehicle speeds, and create inviting spaces to walk and bike.

SECTION 2.2

PLANNING AND DESIGN FLEXIBILITY

Designing roadways that effectively serve all modes across Kentucky can be a challenging undertaking, particularly along major, motor vehicle-centric thoroughfares and in areas with limited rights-of-way. The different land uses, community needs, and terrain across Kentucky's urban, suburban, small town, and rural areas require unique approaches. Flexibility in the Complete Streets design process requires knowledge of national and KYTC design standards, best practices and guidelines, a recognition of the range of options available, and an understanding of how deviating from these may impact safety and mobility for each mode being served. A flexible approach uses existing tools in creative and varied ways to solve design challenges. In 2013, FHWA released a guidance memorandum expressing support for flexibility in design and identified American Association of State Highway and Transportation Officials (AASHTO), National Association of City Transportation Officials (NACTO), and Institute of Transportation Engineers (ITE) design guidance as additional resources for the planning and design of safe pedestrian and bicyclist facilities.[1]

Figure 2.1 Examples of national guidance and policy guidance manuals.

FHWA, AASHTO, MUTCD, NACTO, & KYTC GUIDANCE AND POLICY

Flexibility in planning and design is inherent at both the national and state levels. FHWA provides resources and education for the planning and design of Complete Streets and related topics to specific facilities for transit, motorists, bicyclists, and pedestrians as well as Proven Safety Countermeasures to improve safety for all modes of transportation. The facility-specific design guidance in the Manual is heavily influenced by the AASHTO *A Policy on Geometric Design of Highways and Streets* ("the *Green Book*"), the *Manual on Uniform Traffic Control Devices* (MUTCD) and the supplemental AASHTO guides for pedestrian, bicycle, and transit facility design. The *Green Book* emphasizes the need for a holistic design approach and the use of engineering judgment while providing empirical models of best practices. It also highlights how effective street design involves balancing safety, mobility, and preservation of scenic, aesthetic, historic, cultural, and environmental resources using flexibility in the application of sound principles by the knowledgeable design professional.

Other national resources that shall be considered in the planning and design of Complete Streets include, but are not limited to, the NACTO design guidelines,[2] ITE design guidelines, and the FHWA Small Town and Rural Multimodal Networks.[3] These design guidelines provide context-specific design guidance for transportation networks for people walking, bicycling, using transit, and other design considerations that support Complete Streets principles. More detailed information on national design resources and design guidance is provided in Chapter 10.

Implementing Complete Streets is never a one-size-fits-all approach, and the Policy encourages flexibility in planning and design of Complete Streets. The Manual provides a variety of design options for use when implementing a Complete Street approach at any point in the lifecycle of the transportation network. Planning, design, and implementation flexibility are supported in related KYTC policy manuals housed in the KYTC Policy Manuals Library. In combination with national best practices and guidance, the approach outlined in the Manual allows planning and engineering practitioners the freedom to explore alternatives that will best support the needs of the people who will be using the network and apply sound engineering judgment in the development of safe transportation options.

KYTC DESIGN EXECUTIVE SUMMARY

The Manual supports flexible design and recognizes that this flexibility is often necessary to apply in planning, design and implementation of Complete Streets. Flexibility in planning and design requires an analysis of each specific site to determine the appropriate design that balances the needs of the various users. Using standard design elements, criteria, and dimensions may not always be possible in areas that are often in constrained rights-of-way or in challenging terrain such as the mountainous region of eastern Kentucky. Applying flexibility in the planning and design process to meet these challenges and others is often justified. For these instances, when it is determined by engineering judgment, KYTC allows the use of criteria other than the normally accepted values.

Flexibility in design is important, but it is equally important that any variation in design from either national or Kentucky-specific guidance is documented with the use of the KYTC Design Executive Summary (DES). The DES identifies the use of design elements, criteria or dimensions and must be reviewed for approval by KYTC. KYTC requires the identification of the resource when Complete Streets recommendations are developed from other sources. Other sources could include, but are not limited to, AASHTO, NACTO, FHWA, National Cooperative Highway Research Program (NCHRP), or design guidance from other states. The DES template can be downloaded from KYTC's *Highway Design Forms* website.[4]

SECTION 2.3

BEST PRACTICES, GUIDANCE, AND POLICIES

Building upon the Policy in support of Complete Streets in Kentucky's transportation network, this Manual incorporates best practices, guidance, and policy at the national and state levels to identify the standards of practice for transportation practitioners to implement Complete Streets. The Manual is also a guide for community leaders to help support Complete Streets for their residents and visitors alike, and provide safe and secure transportation networks for all modes of transportation.

Figure 2.2 Examples of national organizations providing Complete Streets guidance.

U.S. Department of Transportation
Federal Highway Administration

AASHTO

NACTO

NATIONAL BEST PRACTICES AND EMERGING INDUSTRY TRENDS

The elements of a Complete Street that promote safety for all users have evolved over time as the transportation focus continues to shift from a purely motor vehicle-centric, traffic capacity-driven network to a holistic approach that provides safe transportation choices for a variety of transportation modes. Planning and engineering best practices continue to evolve under the guidance of FHWA, AASHTO, and NACTO. These agencies house the resources that drive transportation planning, design, and implementation of best practices across all topics related to transportation. The guidance provided by these national agencies are the most current research-based best practices, proven design measures and other information related to safe transportation for all modes.

National advocacy groups such as the National Complete Streets Coalition through Smart Growth America work at the leading edge of emerging industry trends, leading the conversation about Complete Streets and what constitutes a safe and accessible street, road, or highway for all users. Emerging industry trends include advances in transportation technology such as electric scooters, innovations in transportation planning and design, and the evolution of Complete Streets policy to better serve more vulnerable roadway users such as bicyclists and pedestrians. In transportation planning and design, the transportation practitioners must balance cutting edge advances with proven practices, utilizing Kentucky-specific guidance and community-specific needs to implement safe transportation choices that are meaningful to the communities they serve.

COMMONWEALTH OF KENTUCKY GUIDANCE AND POLICIES

Complete Streets policies and manuals are not new to Kentucky. Numerous transportation policies across the Commonwealth support elements of Complete Streets to provide multimodal transportation networks for all users, including those who are walking and bicycling. In 2021, the National Complete Streets Coalition identified eight individual Kentucky communities and two counties with adopted Complete Streets policies, manuals, or related resolutions and ordinances that support Complete Streets initiatives. These include traffic calming and creating safer places to walk and bike. In 2002, KYTC created the *Pedestrian and Bicycle Travel Policy*,[5] which is the predecessor to the current statewide Policy.

In the past, Complete Streets initiatives have mostly been considered an urban application. However, safe transportation for people of all ages and abilities on all Kentucky streets, roads, and highways for all communities is important. Six of the eight Kentucky communities identified by the National Complete Streets Coalition in 2021 are considered rural (population less than 5,000), and the remaining two communities are considered a small town or small urban area (population between 5,000 and 49,999).[6] The two counties with Complete Streets policies are Grant County (rural) and Jefferson County (urban). At the time of publication of this Manual, Lexington-Fayette County Government, the Lexington Area MPO, and the Kentuckiana Regional Planning & Development Agency are in the process of adopting Complete Streets policies.

Complete Streets align with goals that transcend the size of the community, such as allowing elderly to age in place, providing equity in transportation for those who have limited access to a motor vehicles, and granting security for all who use the transportation network. Communities throughout Kentucky are encouraged to continue building support for Complete Streets in Kentucky by developing their own specific Complete Streets policy, supporting ordinances or resolutions in conjunction with the statewide Policy to address location-specific needs, and implementing Complete Streets principles in transportation networks across the Commonwealth.

Table 2.1 Kentucky's communities/counties/organizations with Complete Streets policies, ordinances, and related resolutions (including population) as identified by the National Complete Streets Coalition in 2021.*

**Note: Population data updated from available 2020 Census Population Estimates Base (April 1, 2020).*

LOCATION OF KENTUCKY POLICY, RESOLUTION OR ORDINANCE	POPULATION
Corinth	232
Crittenden	3,815
Dry Ridge	2,191
Grant County	24,941*
Independence	28,557*
KYTC (Statewide)	4,505,836*
Louisville/Jefferson County	782,969*
Raceland	2,424
South Shore	1,122
Taylor Mill	6,844*
Williamstown	3,925

Resources provided in this Manual by the FHWA and the National Complete Streets Coalition through Smart Growth America may be used along with previously developed policies, manuals, ordinances and resolutions.

In addition to the Policy, this Manual has been developed to assist KYTC, local agencies, consultants and communities throughout Kentucky in Complete Streets planning, design, and implementation. The Manual is an additional resource to be utilized in conjunction with national design guidance from FHWA, AASHTO, NACTO, and others along with KYTC's *Highway Design Guidance Manual*, the Planning Guidance Manual, the Traffic Operations Guidance Manual, and all other related policy manuals in Kentucky. These manuals are available on KYTC's *Policy Manuals Library*.[7] The library houses specific guidance for planning, design, implementation and maintenance of transportation elements common in Complete Streets.

Complete Streets in Kentucky are also supported by both statewide and community-specific advocacy groups. The focus of advocacy groups include bicycle, pedestrian, transit, community health, and transportation safety priorities, among others. For example, Bike Walk Kentucky and the Kentucky Bicycle and Bikeway Commission (KBBC) encourage Complete Streets planning and design that supports safe walking and bicycling throughout Kentucky. Complete Streets focus on providing safe transportation for all users. The communities they serve also benefit from access to healthy transportation and recreation along with increased economic activity spurred by getting people out of their cars to walk and shop. Partnerships with advocacy groups can help identify specific community needs and tailor the Complete Street to best serve the community.

SECTION 2.4

UNDERSTANDING THE PROCESS

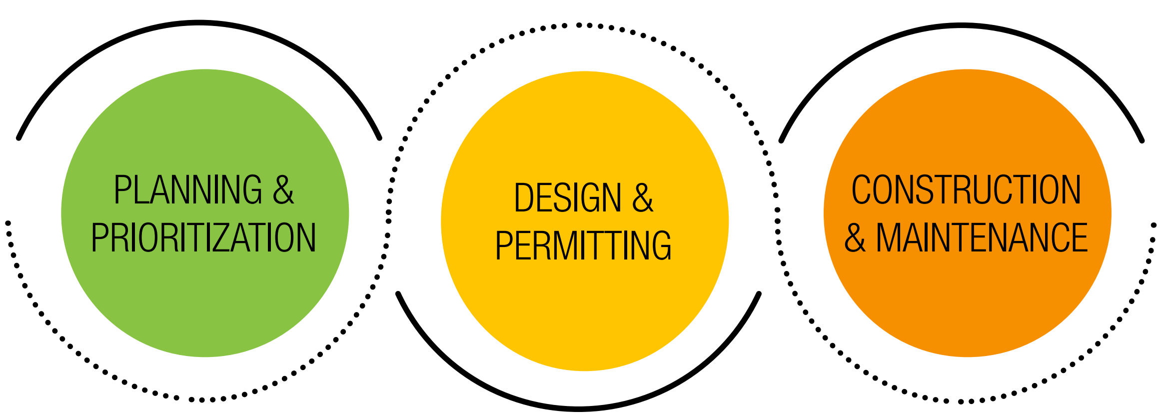
Developing a Complete Street in partnership with KYTC is an exercise in communication. Complete Streets address the needs of the communities they serve, with many agencies and stakeholders coming together throughout the life of their development. At the most basic level, most transportation projects cycle through three main phases throughout their lifetime: Planning and Prioritization, Design and Permitting, and Construction and Maintenance. A street, road, or highway may cycle through these phases many times, with the process repeating when transportation needs expand or change, land uses change or community goals evolve. A Complete Street may be considered at any point in the process, particularly for consideration on existing streets, roads and highways. Before modifying the infrastructure the transportation network is comprised of, first start with the planning and prioritization of what is important.

PLANNING AND PRIORITIZATION

Complete Streets often begin with a planning phase that identifies the purpose and need for a project. The accommodations for all applicable users should be considered in all projects when developing the purpose and need statements in consultation with Metropolitan Planning Organizations (MPO), Area Development Districts (ADD), transit agencies, local transportation agencies and others to ensure they reflect local needs and desires. The planning and prioritization process will occur with transportation planning, project management, and other personnel from the KYTC Planning and Project Development divisions in Central Office and the District in which the project is located. For LPA projects on or near state right-of-way, the local agency will lead the planning process with oversight from the KYTC. In all planning projects, input from the community is a critical component in identifying goals and establishing the criteria by which the project concepts will be evaluated.

Immediate, short-term, and long-term implementation strategies are identified and prioritized based on identified funding sources and anticipated construction timelines. Chapter 3 provides more detail on the relationship between land use, roadway context, and community goals in Complete Streets planning. Selection of Complete Streets elements is based on these relationships and prioritizing safety for all through Complete Streets planning.

Figure 2.3 The typical lifecycle of the transportation network.



DESIGN AND PERMITTING

Once the planning process is complete and funding is available, the design of the Complete Streets project may begin. Design often occurs in two phases: Phase 1 (Preliminary Design) and Phase 2 (Final Design). The KYTC *Highway Design Manual* provides a detailed overview of the project development process through these two phases. Both phases of design will identify the specific treatments to address Complete Streets transportation gaps, calm traffic, and improve safety for all modes. Additional phases of public engagement provide opportunities to further refine the design to meet the needs of the community. The following chapters contain more information on the design of Complete Streets and the specific elements of design included to accommodate all users:

- **Chapter 4** – Getting Started in Complete Street Design
- **Chapter 5** – Design Elements of Complete Street Corridors
- **Chapter 6** – Design Elements of Complete Street Intersections and Crossings

The oversight of the design phases is similar to the planning phase, and coordination will also include additional representatives from KYTC staff including, but not limited to the Divisions of Highway Design, Structural Design, Traffic Operations and Maintenance. KYTC Division of Permits will also review the final design plans and, upon approval, will issue an encroachment permit for state-maintained roads, streets, and highways for construction.

CONSTRUCTION AND MAINTENANCE

Construction of Complete Streets includes considerations for the flow of traffic and accommodation of all users through the work zone, also called the Maintenance of Traffic (MOT). More detailed information on the MOT and accommodation of all users in a work zone is provided in Section 9.5 Work Zone Accommodations. Construction may also require utility relocations and improvements, which may happen before, after, or concurrently with roadway construction. Once construction is complete, maintenance is a key component to the success of a Complete Street in accommodating all users. Additional information about long-term maintenance needs is discussed in more detail in Section 9.4 and the KYTC *Maintenance Guidance Manual.*

ENDNOTES

1 FHWA Guidance: *Bicycle and Pedestrian Facility Design Flexibility Memorandum* https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_flexibility.pdf

2 NACTO design guidelines https://nacto.org/publications/design-guides/

3 FHWA *Small Town and Rural Multimodal Networks* https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf

4 *KYTC Highway Design Forms* https://transportation.ky.gov/Highway-Design/Pages/HighwayDesignForms.aspx

5 Smart Growth America – National Complete Streets Coalition *Complete Streets Policy Adoption* Updated: 6/18/2021 web excel 20210618 (smartgrowthamerica.org).

6 Definitions from https://www.fhwa.dot.gov/publications/research/safety/15030/002.cfm

7 KYTC *Policy Manuals Library* https://transportation.ky.gov/Organizational-Resources/Pages/Policy-Manuals-Library.aspx

CHAPTER 3

PLANNING FOR COMPLETE STREETS, ROADS, AND HIGHWAYS

SECTION 3.1

WHAT IS A COMPLETE STREET?

According to FHWA, a Complete Street is a street, road, or highway that feels safe because it is safe for everyone. Successful Complete Streets are reflective of the community they serve, meaning no single set of criteria or template can be used to create a Complete Street. The ultimate goal of a Complete Street is to balance the needs of each transportation mode with flexible planning and design solutions that are context-sensitive, meet community transportation goals, provide an interconnected multimodal network, and prioritize safety for all users.

A Complete Street improves safety for all users, regardless of mode of travel. The appropriate design for each mode of travel is highly context-sensitive and dependent on a variety of factors that are unique to each community. A successful Complete Street that provides meaningful transportation choices in one location may look completely different than a Complete Street at a different location. The common denominator among all Complete Streets is that they provide a safe and comfortable travel experience for all expected users. An example rendering of a planned Complete Street retrofit in Danville, KY demonstrates how traffic calming and pedestrian-focused elements and amenities, including curb extensions, street trees, lighting, and marked crossings bring safety and character to this downtown street (Figure 3.1).

Figure 3.1 Planned retrofit of downtown Danville, KY street.

Figure 3.2 Land use context zones defining density of development. Image Source: FDOT *Florida's Complete Streets 360° Approach*

RELATIONSHIP TO LAND USE

The types of available transportation modes and how they are safely accommodated is largely driven by the surrounding land use. Beyond the simple designations of "urban" or "rural", land use provides contextual detail as to who is traveling on the transportation network, where they are going, and why. The appropriate design for and operation of a street must take into account the existing and future surrounding land use. Planning and design transportation professionals evaluate conditions beyond just urban and rural conditions. Where available, local agency land use, transportation plans, and community plans are used to understand potential future needs and projected demand for all modes.

Land use density is defined by a series of context zones (Figure 3.2) that designate an area as natural, rural, suburban, and increasingly dense urban contexts.[1] Trips to home, jobs, and other destinations also tend to shorten as distances between developments decrease. The specific use of each parcel in a context zone may also change with greater potential frequency as development density increases. For example, in a suburban area, residential neighborhoods may be interspersed with commercial developments. Increased density also encourages mixed-use development, with a variety of potential uses in one location.

As a result of increased land development density through each context zone, the frequency and density of trips increase and include more opportunities to use transportation modes other than single-occupancy motor vehicles (Table 3.1). Alternatives may include transit, walking, bicycling, or other micromobility transportation options for short trips (see Chapter 5 for micromobilty definition). A corridor may extend through different contexts, and the planning and design of transition zones between contexts are key to informing driver behavior and influencing safety outcomes for all users. In the planning and early design stages of a project, the transportation professional must understand the changing land use context, available right-of-way, and typical section, and overlay the existing and projected travel demand for all modes on the network. However, existing and projected demand should not be the sole indicator of need for Complete Streets facilities, including but not limited to, bicycle and pedestrian accommodations. The transportation professional may partner with land use planners to better coordinate the changing land development patterns with transportation projects.

Table 3.1 Transportation Expectations by Context

TRANSPORTATION EXPECTATIONS	CONTEXT				
	RURAL	**RURAL TOWN**	**SUBURBAN**	**URBAN**	**URBAN CORE**
USERS/ VEHICLES	• High frequency of motor vehicles/freight • Limited or no pedestrian activity • Potential for recreational cyclists • Potential for agricultural vehicles	• Regional vehicular/ freight traffic • Moderate pedestrian activity • Potential for some bicyclists	• Regional traffic on primary roadways mixed with local vehicular traffic and transit • Low-to-moderate pedestrian activity, which may be concentrated around commercial areas and/or transit • Increased potential for recreational walking/running in residential areas • Increased potential for recreational/ commuter bicyclists	• Moderate-to-high pedestrian activity • High potential for commuter bicyclists • High potential for transit interaction • Primarily local users	• High pedestrian activity with congregation and pedestrian activity zones • High potential for commuter bicyclists • High transit presence • High potential for micromobility • Primarily local traffic
MOVEMENT	• High desired movement (primarily for vehicles) with high quality of service • Minimal disruptions limited to peak times of day and/or seasons	• Moderate quality of service and slower traffic • Delays acceptable to local traffic • High quality of service for non-motorized users because of street-oriented development patterns	• Moderate-to-low vehicular quality of service during peak periods • Lower movement for non-motorized users because of higher vehicular speeds and longer travel distances	• Lower vehicular quality of service and slower travel speeds through majority of the day • Increased movement for non-motorized users because of increased activity densities and crossing opportunities	• Low vehicular quality of service and low travel speeds through most periods of the day • High mobility for non-motorized and micromobility users because of increased density, high crossing potential, and pedestrian-oriented development
PERMEABILITY	• Direct vehicular access to land uses • Lack of opportunities for pedestrian access • Minimal crossing opportunities for all users	• High vehicular, bicyclist, and pedestrian access opportunities • Direct pedestrian access to land uses • Vehicular and bicyclist access may be provided on adjacent roadways within the network	• Low-to-moderate access opportunities for all users • Primarily vehicle-oriented access with opportunities for localized pedestrian-oriented access	• High access opportunities for most users (vehicles, bicyclists, and pedestrians) • Access for freight movement may be restricted	• High access opportunities for non-motorized and micromobility users • Street-oriented businesses increase access for non-motorized users, while limited parking areas may decrease access for motorized users
NETWORK	• No redundant roadway network • May have cross streets/ intersections accessing dispersed locations	• Expanded street network within a limited area serving immediate land uses • May include cross streets accessing dispersed areas in surrounding rural area(s) • Through traffic concentrated on primary roadway	• Limited supporting roadway network • Parallel streets may be present but disjointed • Alternative routes between destinations may exist but likely on different roadway types • Large intersection spacing (~1/2 mi)	• High level of supporting roadway network with parallel and cross streets • Network supports localized area, but may be disjointed because of natural/built boundaries • Alternative routes between destinations exist • Regional traffic may have bypass alternatives	• Cohesive and dense surrounding street network with multiple parallel and cross streets • Multiple alternative routes exist on similar roadway types • Regional traffic may have bypass alternative
TARGET VEHICULAR SPEED (MPH)	**35 +**	**25–35**	**30–45**	**20–35**	**<25**

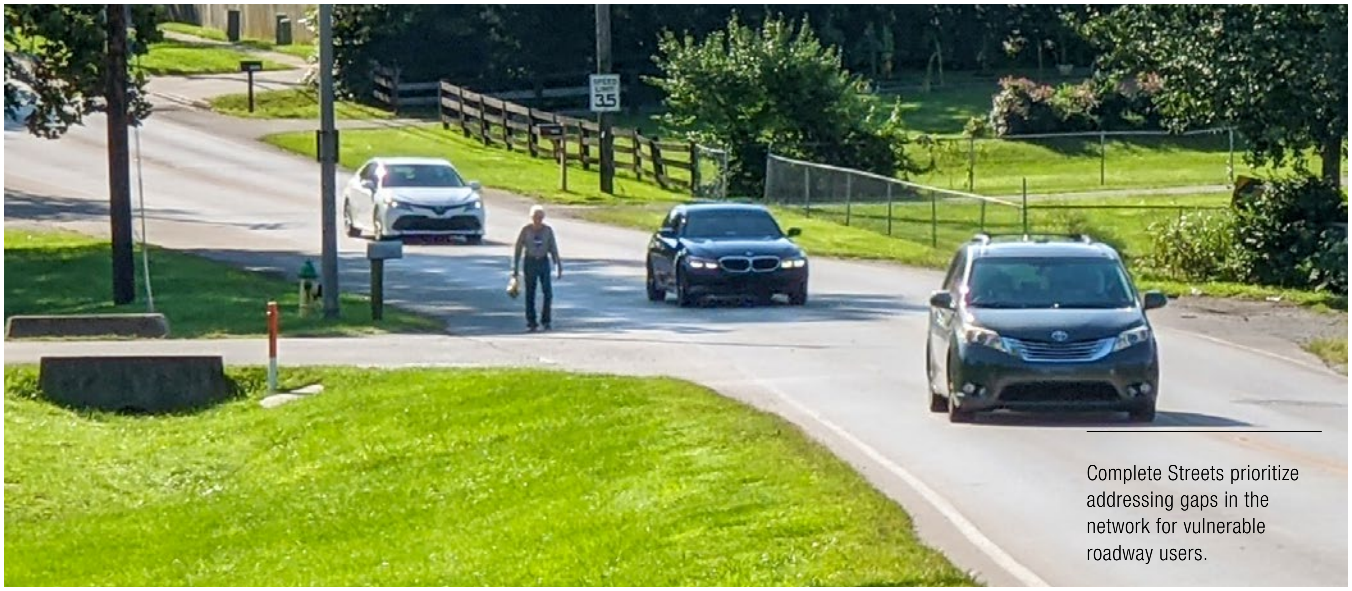
Transportation Research Record (TRR) Context Classification and Associated Transportation Expectations in Support of Contextual Roadway Design

RELATIONSHIP TO COMMUNITY GOALS

People desire safe, comfortable public spaces regardless of the size of the community, town, or city. Public spaces include many aspects of daily life. Arguably, one of the largest components of daily life is transportation. Kentucky's streets, roads, and highways are the threads that connect people and they are the conduits that fuel economic engines for communities across the Commonwealth. Investments in the character of a street have been shown to increase retail rents, residential property values, and livability of an area.

Regardless of the size of the community, people share common goals for a safe, accessible, and connected transportation network that provides secure, equitable transportation choices and supports positive health outcomes (Figure 3.3). Transportation networks planned with a Complete Streets approach address each of these shared goals. Advocacy agencies such as the Kentucky Bicycle and Bikeway Commission (KBBC)[2] and Bike Walk Kentucky[3] provide information and guidance on how communities can become involved in the project development process and support safe transportation infrastructure for all.

Figure 3.3 People share common goals of safety, comfort, access, connectivity, security, equity, and healthy environments in communities across Kentucky.



Complete Streets prioritize addressing gaps in the network for vulnerable roadway users.

COMFORT AND SAFETY

A person's level of comfort on the transportation network is often closely tied to their real and perceived safety. The difference in speed between different modes of transportation and the frequency of potential conflicts between them play a large role in comfort and overall safety of a network. Roadway users outside of motor vehicles are particularly vulnerable to interactions and conflicts with motor vehicles and people feel safer when separated facilities are provided for modes of travel with large speed differentials. People feel safer and more comfortable on roads, streets, and highways when they have clear sight lines to each other and the facilities are well lit. Streets, roads, and highways should safely accommodate the diversity of the community with comfortable facilities for users of all ages and abilities, from 8 to 80 years old. The 2022 KYTC *Statewide Bicycle and Pedestrian Master Plan* provides formulas for calculating comfort indices for both bicyclists and pedestrians for specific locations. The Bicycle Comfort Index (BCI) and Pedestrian Comfort Index (PCI) are methods that have been developed by KYTC to determine how compatible a roadway is for bicycles and pedestrians. The index tells the bicyclist or pedestrian what to expect on a specific roadway based on existing traffic operations and geometric conditions. The data that is collected and used to provide the BCI or PCI is based on factors such as Average Daily Traffic (ADT), posted speed limits, type of facility, percent of heavy vehicles, Level of Service for Safety (LOSS), and amount of buffer space. The BCI or PCI can be determined for each state maintained highway, and is just one way to determine comfort levels. For more information, reference the Master Plan or coordinate with the KYTC State Bicycle and Pedestrian Coordinator.

All users, regardless of mode of travel, experience stress when they feel unsafe or uncomfortable. Transportation planning and design can play a large role in reducing stress and risk on roadways and establishing space that feels comfortable for all users. Complete Streets principles are intended to reduce motor vehicle speeds and mitigate conflicts between different modes of travel, creating an environment where all modes are expected and supported with safe facilities appropriate to the surrounding context.

ACCESS AND CONNECTIVITY

An accessible and connected street, road, or highway is designed to provide access to all users regardless of age or ability, remove gaps in the network, and connect directly to destinations. The transportation network in Kentucky is motor vehicle-focused and does not always appropriately accommodate people who utilize transportation methods other than motor vehicles, by choice or necessity. Access and connectivity are also strongly related to comfort and safety for vulnerable roadway users like pedestrians, bicyclists, and others. Gaps in a transportation network cause discomfort, compromise user safety for alternate modes of travel, and reduce freedom of movement. Closing these gaps in connectivity is a priority of Complete Streets on streets, roads, and highways. Complete Streets principles stress an accessible, connected network for all ages and abilities in alignment with Americans with Disabilities Act (ADA), the KYTC ADA Transition Plan,[4] local community ADA Transition Plans, as well as local and regional bicycle and pedestrian master plans across the Commonwealth.

EQUITY AND SECURITY

An equitable transportation network provides all users with the facilities needed to move freely through the network and participate in their community equally in a safe manner. Complete Streets are a tool to help address disparities in transportation across a community by providing safe, adequate, and well-maintained facilities for all users, including pedestrians, bicyclists and other micromobility users, public transportation users, children, older individuals, disabled individuals, motorists, and freight vehicles. Addressing inequity in transportation facilities requires an understanding of socioeconomic status, transportation cost burden, car ownership, accessibility challenges for those with disabilities and age. Equity in transportation also requires planners and designers to have an understanding of the needs of the community and address those needs directly. Time and space for thoughtful discussion with the public may need to go beyond traditional public meetings that may conflict with work schedules, provide translated materials for non-English speaking communities, and meet people where they are with a variety of virtual or in-person communication channels.

HEALTH AND ENVIRONMENT

Healthy transportation options and easy access to recreation are essential to achieving healthy communities. Healthy corridors provide safe, intuitive, and navigable networks that encourage people to more easily choose active modes of travel and recreation. Modal shift away from single-occupancy motor vehicles, particularly for short trips, provides health benefits to individuals and communities through increased exercise and decreased congestion and emissions. Complete Streets may also help address urban heat island effects and provide opportunities to manage and filter stormwater with green infrastructure.

Complete Street on US 60 in Mt. Sterling, KY.

PRIORITIZING SAFETY FOR EVERYONE

Safety for everyone is the primary building block of Complete Streets. As more people bike and walk for leisure or out of necessity, the number of injury and fatal crashes involving bicyclists and pedestrians is on the rise. The goal of a successful Complete Street is to balance the needs of all modes along the roadway, while being good stewards of public resources and funding. Traditional measures of effectiveness, including motor vehicle speed, delay, and crash rate, will always be important when assessing the performance of a street. These metrics must also be utilized in concert with quantitative and qualitative assessments of the level of need, performance, and safety for all modes. One available assessment tool includes the most recent version of the *Highway Capacity Manual: A Guide for Multimodal Mobility Analysis* (Figure 3.4) which provides guidance for developing performance metrics for all modes and the AASHTO *Highway Safety Manual* for network screening for multimodal safety. Performance metrics developed must be balanced with an emphasis on prioritizing the safety of vulnerable roadway users such as bicyclists, pedestrians, and others outside motor vehicles.

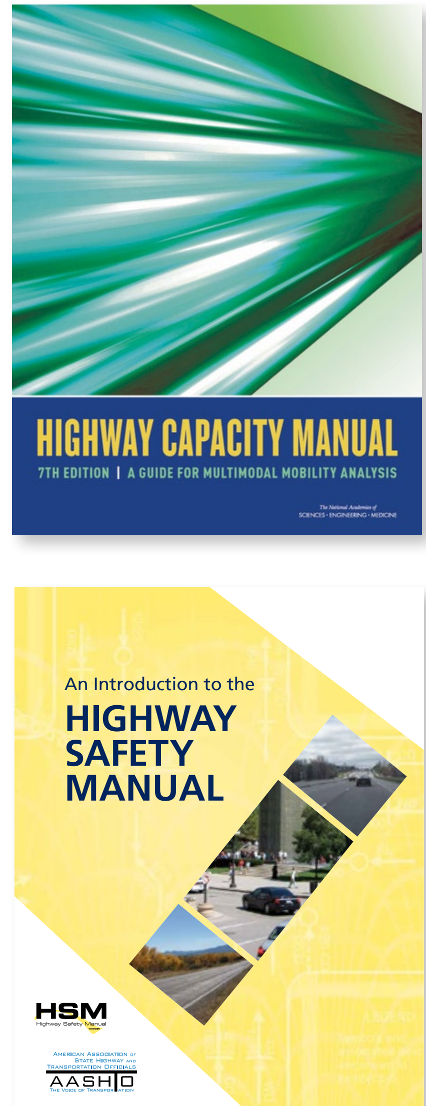


Figure 3.4 TRB Highway Capacity Manual assessment tool for multimodal performance metrics, and the AASHTO Highway Safety Manual network screening and predictive analysis for multimodal safety.

SECTION 3.2

ELEMENTS OF A COMPLETE STREET

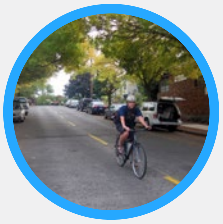
The cornerstones of Complete Streets are the elements that support safe travel, regardless of the mode of transportation. While not all streets, roads, and highways will provide dedicated, separate facilities for every mode of travel everywhere, a Complete Streets network holistically addresses transportation for all users with safe, direct, accessible routes to destinations. The process of implementing Complete Streets begins with an understanding of the individual elements and their considerations, tradeoffs, and benefits.

KIT OF PARTS

The building blocks of Complete Streets are the individual facilities that can be considered for each mode of transportation. The reason that different streets, roads, and highways may not look the same after implementing Complete Streets principles is that a wide variety of implementation options for each transportation mode can be considered. As shown in Figure 3.5, utilizing Complete Streets principles on an individual street, road, or highway and holistically across the network is a balancing act between different modal needs, priorities, and safety for all users. Transportation professionals, advocates, and non-practitioners may utilize free online tools, such as Streetmix[5] and Sketchup along with free data sources such as the Strava heat map[6] that allow users to understand who is using the roadway and work with the kit of parts to visualize potential options that might be available in the right-of-way. Consideration of potential options should always be paired with appropriate traffic analysis, evaluation of site-specific constraints, and engineering judgement. Additional facilities that are ancillary to the kit of parts include, but are not limited to crosswalks, mid-block crossings, and other crossings which are discussed in more detail in Chapter 6.

Vehicle Lane
Accommodates passenger motor vehicles, freight, and transit. May occasionally share space with micromobility users.

Dedicated Bicycle Lane
Accommodates bicycles, e-bicycles, and e-scooters separate from motor vehicles.



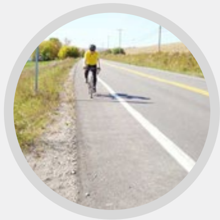
Shared Street
A variety of modes freely share space, with any combination of motor vehicles, pedestrians, and micromobility users.

Curbside Management
Allocates and manages space for curbside activities such as deliveries, rideshare, parking, and other activities.

Shared-Use Path
Accommodates micromobility users and pedestrians separate from motor vehicles.

Sidewalk
Accommodates pedestrians only, with potential local exceptions for children on bicycles or other micromobility devices.

Dedicated Bus Lane
Accommodates buses only, with potential exceptions for bus-bike shared lanes and right-turning motor vehicles.



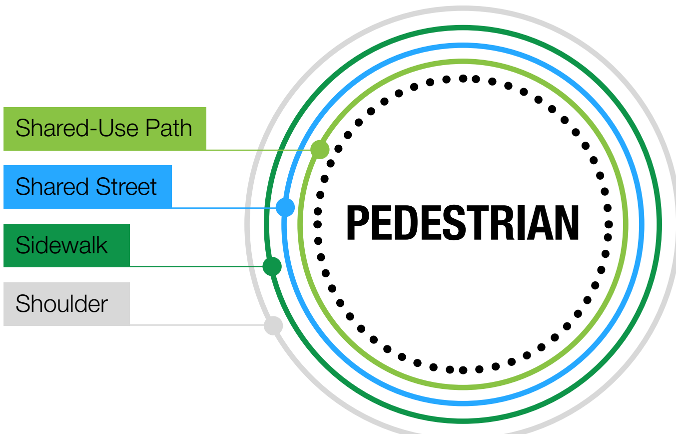
Shoulder
May accommodate a variety of transportation modes adjacent to the motor vehicle traffic lane, particularly in rural areas.

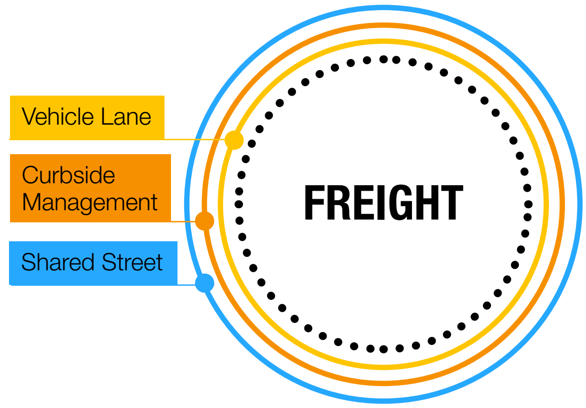
Figure 3.5 Kit of parts for a Complete Street.
continued on next page

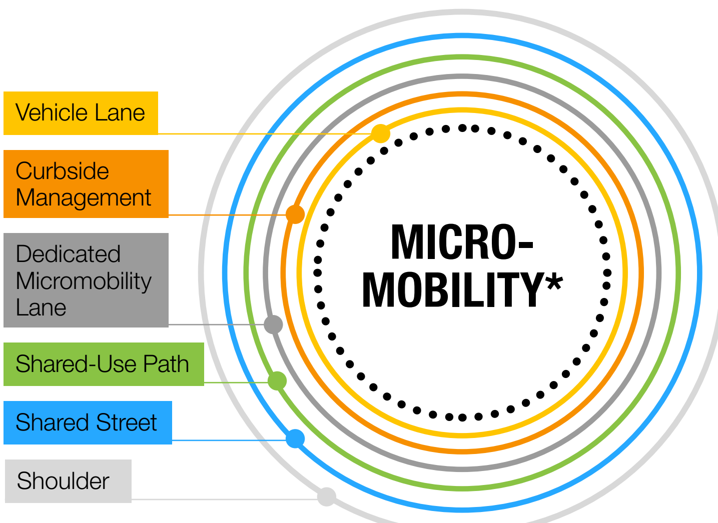
KIT OF PARTS FOR A COMPLETE STREET

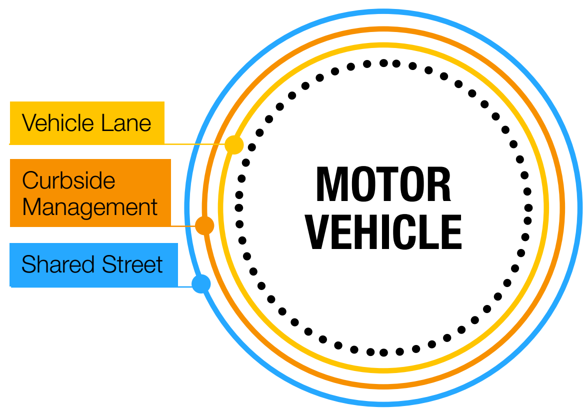
Complete Streets are a balance of a variety of transportation modes, safety needs, and priorities on a shared transportation network.

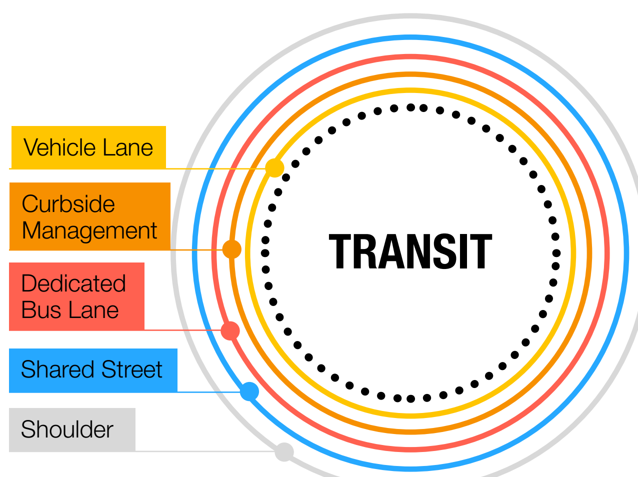
Each ring in the kit of parts represents a facility type that may be used to accommodate each mode of transportation. Some facilities may accommodate multiple Complete Streets users, as seen in the common rings between each user below. Engineering judgment should consider surrounding land use context, roadway geometry, access management, and demand when evaluating potential Complete Streets facilities.







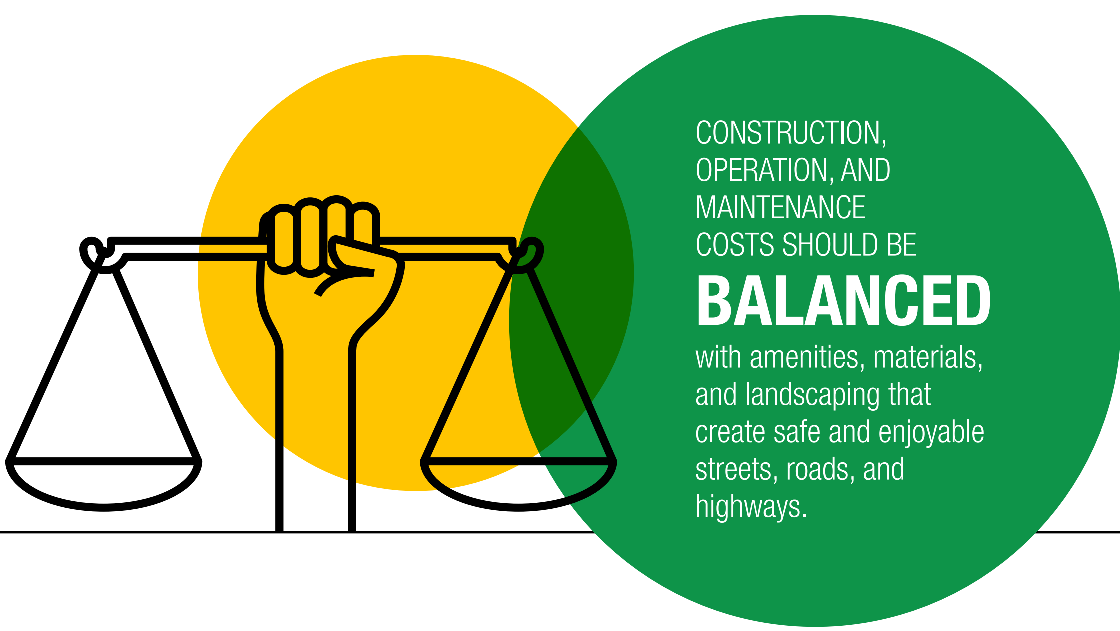




*Micromobility includes, but is not limited to, bicycles and e-bicycles. Other micromobility devices, such as e-scooters and other lightweight wheeled devices, may operate on specific facilities as allowed by local ordinance. More information on the definition of micromobility is located in Chapter 5.

UNDERSTANDING TRADEOFFS

Understanding, evaluating, and communicating to the public the tradeoffs associated with Complete Streets recommendations are critical to building public support (Figure 3.6). Right-of-way and design constraints often pose challenges when implementing Complete Streets principles on a new or an existing street, road, or highway. Planning and design considerations often determine how to best distribute limited right-of-way width to maximize safety for a wide variety of street users. For low-volume or low-speed streets, many of the design recommendations developed during the planning process can be easy to implement with fewer trade-offs. Complete Streets recommendations on higher-volume or higher-speed streets, roads, and highways are more challenging, requiring more separation between modes of transportation to allow safe passage for all users. In addition to performance and safety metrics, public perception of the impacts and tradeoffs are a powerful component of building streets, roads, and highways that benefit everyone.



CONSIDERATIONS AND TRADEOFFS

- Perceived travel time increase
- Right-of-way availability
- Modal balance/operations
- Consistent maintenance
- Freight operations
- Public perception
- Funding availability
- Interconnected multimodal network

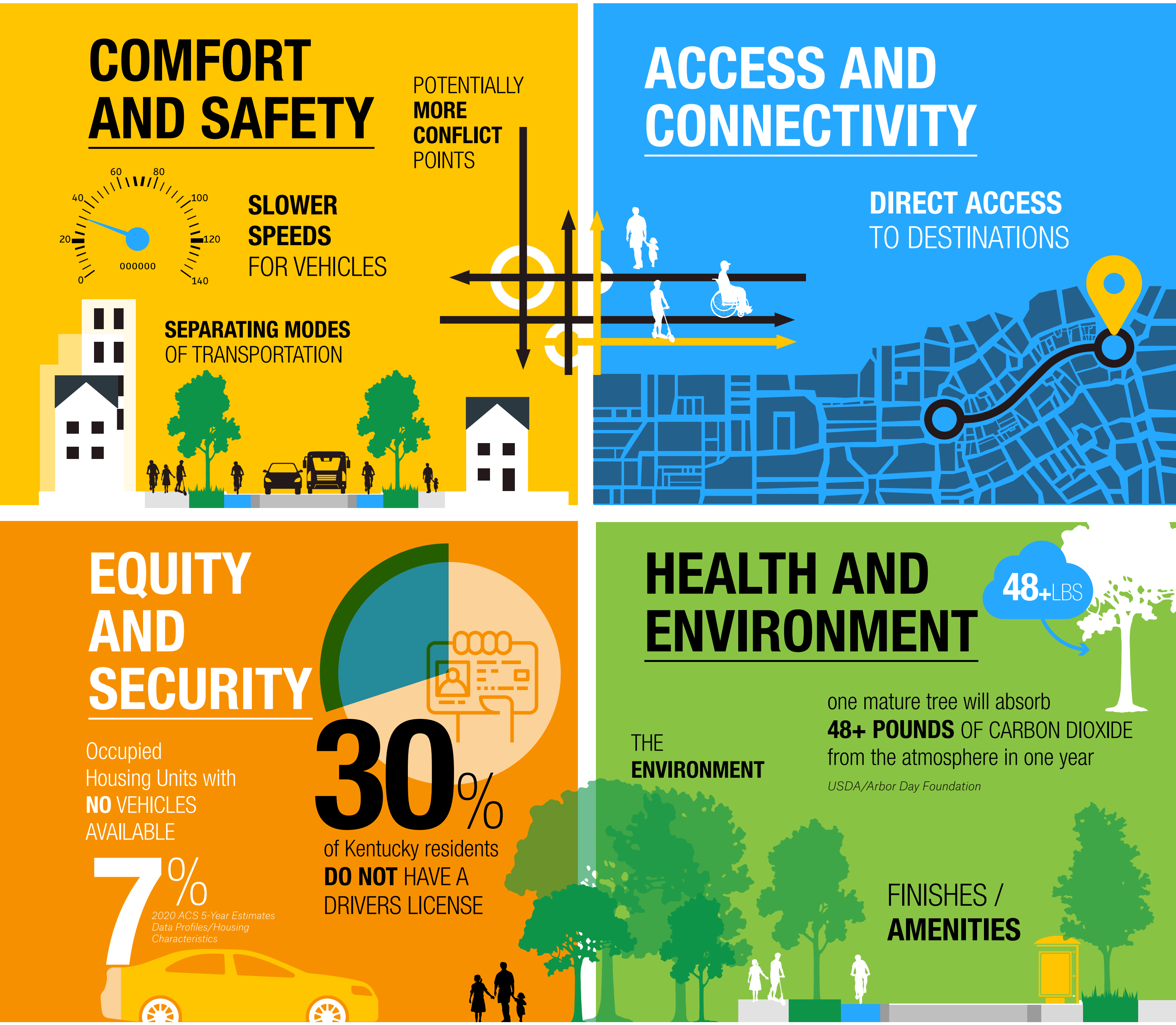


Figure 3.6 Potential considerations, needs, tradeoffs, and perceptions of Complete Streets planning.

SECTION 3.3

PROJECT PLANNING AND PRIORITIZATION

Planning and design of streets, roads, and highways that support safe transportation options across multiple modes involves identifying minimum and desired safety and service levels for all modes over the life of the project and performing an analysis of modal trade-offs for various design solutions. Context classifications of the roadway, the community context, balance of modal need and priority, and the purpose and goals of a project all play a role in the identification, funding, and implementation of Complete Streets principles on KYTC projects. Planning for Complete Streets requires an evaluation of the transportation network as a whole, and a practical application of Complete Streets principles on Kentucky roads, streets, and highways.

CONTEXT CLASSIFICATIONS AND COMPLETE STREETS IN RURAL, SMALL TOWN, SUBURBAN, AND URBAN COMMUNITIES

Roadway context classifications inform expectations on surrounding land use, expected motor vehicle traffic volumes, and types of trips taken on a network. Complete Streets principles should be considered on all streets, roads, and highways. However, the specific roadway context classification will determine the appropriate facilities. Following is a checklist of considerations to be used in conjunction with the most current edition of the AASHTO *Green Book* and specific AASHTO, NACTO, and other national design guides to identify appropriate facilities for each roadway context. Specific facility design guidance is located in Chapter 5 within this document.



PURPOSE AND NEED: PRIORITIZING SAFE STREETS FOR ALL

Prioritizing safe streets, roads, and highways for all users begins with identifying the purpose of a project and the needs it should address during the planning and preliminary design phases.

The Purpose and Need is the process by which the priorities of the corridor are identified and establishes the framework by which alternatives are evaluated and selected. Historically, the Purpose and Need has focused on motor vehicle-specific metrics of congestion, safety, and access. However, safe transportation for all users is a priority across the transportation network in Kentucky.

The Purpose and Need process should consider and prioritize safe, accessible, connected, and equitable transportation metrics alongside the traditional motor vehicle metrics. It should also include all modes of transportation holistically in the evaluation process. Beyond performance metrics, a Complete Streets-oriented Purpose and Need planning process can begin to identify potential funding opportunities related to healthy corridors, resiliency, sustainability, emissions reduction, air quality, and other initiatives. The Purpose and Need should be developed in coordination with local and regional partners including, but not limited to, MPOs, ADDs, transit agencies, and other trasnportation and planning agencies.

COMPLETE STREETS PLANNING CHECKLIST

KYTC requires the consideration of Complete Streets principles on all streets, roads, and highways throughout Kentucky. The planning, design, construction, and maintenance of Complete Streets may require additional coordination with local, state, and/or federal agencies or comply with state or federal regulations for operations, maintenance, historic preservation, and environmental protection. Examples include, but are not limited to, the appropriate KYTC District Office, the Kentucky Heritage Council, and the National Environmental Protection Act (NEPA).

Practitioners shall include appropriate bicycle, pedestrian, and other Complete Streets facilities on streets, roads, and highways when one or more of the following criteria are met:

- Pedestrian, bicycle, e-bicycle, and/or scooter usage exists along the roadway. This may be determined by the observation of pedestrian or other micromobility (bicycle, e-bicycle, e-scooter, or others as defined in Chapter 5) traffic, evidence of pedestrian activity (“goat paths” or roadside worn travel paths), data collection, Strava heat map data, or through the public involvement process. Public interest in and demand for bicycle accommodations should be determined at the planning and preliminary engineering stages through public involvement.
- A bicycle or pedestrian facility already exists on the roadway.
- Project limits are adjacent to planned or anticipated development of residential subdivisions, commercial, industrial, institutional, public or semi-public use areas, or other anticipated developments within the next 20 years with potential pedestrian or bicycle trips. Planned development may be determined by zoning designations from a local comprehensive land use plan, interviews with local political and economic leaders to gauge anticipated growth in the project area, or the public involvement process.
- The location is identified as an Area of Persistent Poverty or a Historically Disadvantaged Community.[7]
- A state, local, or regional adopted pedestrian and/or bicycle network or policy has designated pedestrian and/or bicycle improvements in the area of the specific roadway project or for that classification of roadway.
- Gaps in pedestrian, bicycle, and/or e-bicycle connectivity exist between two or more developed areas/community destinations currently separated by no more than 1.5 miles for pedestrians or 3 miles for bicyclists.
- The street, road, or highway is utilized for transit, particularly for stops and/or stations on set transit routes.
- The street, road, or highway is an identified freight corridor on Primary Highway Freight System (PHFS) or as a Critical Urban or Rural Freight Corridor (CUFC or CRFC) for additional freight considerations for lane and shoulder width or other facilities.
- Public interest in and demand for pedestrian and/or bicycle facilities are determined at the planning and preliminary engineering public involvement stages.
- Current and anticipated user demand for bicyclists and pedestrians should be used in combination with other criteria, and not used as a sole indicator of need for facilities.

Following is a discussion of context-specific guidance and multimodal accommodations for Complete Streets on rural, small town, suburban, and urban streets, roads, and highways. Context definitions and target speed for rural, small town, suburban, and urban areas are referenced from the TRR Context Classification and Associated Transportation Expectations in Support of Contextual Roadway Design.

Figure 3.7 Example of a rural shared lane on KY 1955 (Red Hill Road) near Livingston, KY.

RURAL STREETS, ROADWAYS, AND HIGHWAYS

Rural areas typically consist of natural areas and those with very light development of residential and commercial structures. Roadway corridors in rural areas typically consist of motor vehicle lanes. Shoulders (paved, gravel, or grass) may or may not be provided. Rural routes do not usually include curb and gutter (Figure 3.7). Typical multimodal users of these routes include people who choose not to or cannot use motor vehicles, including, but not limited to, recreational bicyclists, occasional equestrians or other rural trail users, horse-drawn vehicles, and farm implements. Rural transit operators may also utilize rural streets, roads, and highways for service. These routes are also frequently used, high-speed freight corridors.

Multimodal accommodations on rural streets, roads, and highways may include, but are not limited to, the following:

- Sidewalk and/or shared-use path
- Paved shoulder access for pedestrians, bicycles, equestrians, horse-drawn vehicles, and farm implements
- Bicycle lane in high-demand or particularly unsafe areas
- Bicycle and motor vehicle shared lane
- Shared street for all users on low-volume and/or low-speed streets
- Driveway pull-off or other accommodations for transit and/or mail delivery
- Wider travel lanes or shoulders to accommodate safe freight travel on identified freight corridors
- Associated signage, pavement markings, bicycle-friendly inlet grates, accessible crossings, appropriate barriers, and other considerations.
- Rural target speed ranges from 35 mph and above.

SMALL TOWN STREETS, ROADWAYS, AND HIGHWAYS

Small towns, sometimes referred to as rural towns, are small concentrations of development consisting of lower density residential and commercial properties and typically surrounded by rural areas. Roadway corridors in small town or small urban areas may closely resemble rural corridor cross-sections or may include curb and gutter (Figure 3.8). Moderate density locations may provide access to bike share or e-scooters for short trips, and residents may choose to access parks, sports, and other recreation by walking or bicycling. In addition to the considerations for rural contexts, KYTC also recommends consideration of multimodal facilities on small town streets, roadways, and highways when a KYTC-sponsored Small Urban Area Transportation Study recommends specific improvements.

Multimodal accommodations on small town streets, roads, and highways may include, but are not limited to those listed for rural streets, roadways, and highways as well as the following:

- Bicycle, e-bicycle, and/or e-scooter lane
- Bicycle, e-bicycle, and/or e-scooter and motor vehicle shared lane
- Shared streets
- Motor vehicle parking (parallel or back-in angle preferred)
- Freight loading and unloading zones
- E-scooter parking
- Bicycle parking
- Transit stops and wider curb lanes to accommodate larger transit vehicles on fixed routes
- Associated signage, pavement markings, bicycle-friendly inlet grates, accessible crossings, appropriate barriers, and other considerations.
- Small town target speed is 25 to 35 mph.

Figure 3.8 Example of a historic small town corridor on W. Main Street in Danville, KY.

SUBURBAN STREETS, ROADWAYS, AND HIGHWAYS

Suburban areas typically range from low density to medium density residential and commercial development with large building setbacks. Similar to small town accommodations, suburban roads, streets, and highways may be a mix of rural (no curb and gutter) and urban (curb and gutter) type cross sections (Figure 3.9). Moderate density areas with access to destinations provide opportunities to utilize walking, bicycling, transit, or potentially e-scooters for short trips. Target speed for suburban areas is 30 to 45 mph.

Multimodal accommodation on suburban streets, roads, and highways are similar to those recommended for small towns. Freight loading/unloading, e-scooter and bicycle parking, and high-turnover parking are typically concentrated around destinations and in concentrated commercial hubs along major corridors. Low-volume, low-speed residential corridors may not require separation for bicycles, scooters, and/or pedestrians.

Figure 3.9 Suburban street example with curb and gutter on Lexington Road in Louisville, KY.

Figure 3.10 Urban multimodal street example on Avenue of Champions in Lexington, KY.

URBAN STREETS, ROADWAYS, AND HIGHWAYS

Urban areas are typically high density, with a range of multi-story and high-rise developments and mixed uses with small building setbacks. Urban roads, streets, and highways typically utilize a curb and gutter cross section (Figure 3.10). Dense development in urban communities provides ample opportunity to utilize walking, bicycling, transit, and e-scooters for trips. High demand for curb space requires additional consideration for the safety of users and managing deliveries, rideshare, and parking. Target speed for urban areas is 20 to 35 mph.

Multimodal accommodation on urban streets, roads, and highways are similar to those recommended for small towns. Freight loading/unloading, e-scooter and bicycle parking, and high-turnover parking are common throughout urban contexts. Higher density of pedestrian and micromobility trips may require further separation between pedestrians, bicyclists, and other micromobility users than in suburban and small town contexts to mitigate conflicts and provide safety and comfort for all users.

RIGHT-SIZING FACILITIES

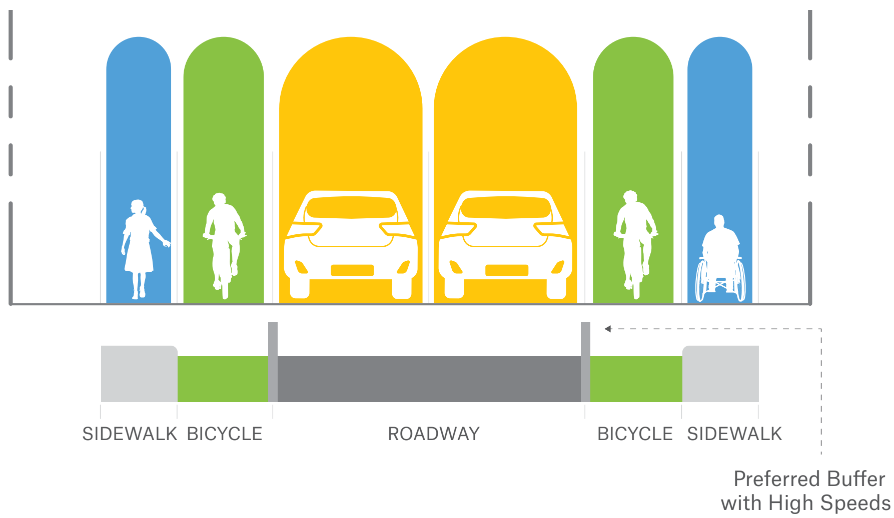
The “right size,” or level of modal separation for Complete Streets, is dependent on the context classification, safety needs for each mode, and available right-of-way. The transportation planning or design professional balances the priorities of expected users along a corridor including pedestrians, bicycles and other micromobility devices, transit, motor vehicles, freight, and other potential users, and allocates right-of-way based on these priorities.

This section includes five examples. The first three are examples of roadway sections most likely to be found in more densely developed areas such as small town centers, suburban, and urban context zones. The remaining two cases describe roadway sections without curb and gutter and sidewalk that are most likely to be found in less-developed or rural areas. Detailed information on the design of specific facilities is located in Chapter 5.

DEDICATED ACCOMMODATION

Separate accommodation for all users provides maximum safety, convenience, and comfort for everyone, as shown in Figure 3.11. Conflicts between modes are mitigated by providing individual facilities for each mode of transportation.

Figure 3.11 Dedicated accommodation for all users.



Separate accommodation for all users may be appropriate in any of the following scenarios:

- Areas with moderate-to-high levels of pedestrian, e-scooter, e-bicycle, bicycle, or transit demand
- Corridors identified that should accommodate all ages and abilities
- Streets, roads, or highways with moderate-to-high motor vehicle speeds
- Areas without substantial environmental or right-of-way constraints

Accommodations may include:

- Sidewalk, walking lane, or pedestrian shoulder separated from the roadway by a raised curb, landscaped verge, paint and post buffer, or appropriate barrier
- Bicycle lane, on- or off-street cycle track, or shoulder suitable for bicycle, e-bicycle, or e-scooter use
- Bus lanes for high-demand transit corridors

SHARED BICYCLE, E-BICYCLE, E-SCOOTER AND MOTOR VEHICLE ACCOMMODATION

The space necessary to provide separate accommodation for all users may not always be available. Some sharing and overlap between bicyclists and motor vehicle traffic may be acceptable to achieve environmental or design objectives. Shared facilities for bicycles and motor vehicles shown in Figure 3.12 and Figure 3.13 provide a separated space for pedestrians and partial- or fully-shared lanes for bicyclists. Fully-shared lanes should only be considered in significantly constrained rights-of-way with no direct alternate or parallel routes.

Scenarios where shared bicycle and motor vehicle accommodation may be appropriate include areas with low motor vehicle speeds and low-to-moderate motor vehicle volumes.

Accommodations may include:

- Sidewalk, shared-use path, or shoulder separated from the roadway by a raised curb, landscaped verge, paint and post buffer, or appropriate barrier
- Shared vehicle lane (fully-shared), advisory lanes (partial-shared), or shared bus lanes (partial-shared) for bicycles, e-bicycles, and e-scooters
- Signs and pavement markings indicating that the roadway is shared between bicycles, e-bicycles, e-scooter, and motor vehicles or transit vehicles

Figure 3.12 Partial-shared bicycle, e-bicycle, e-scooter, and motor vehicle accommodations.

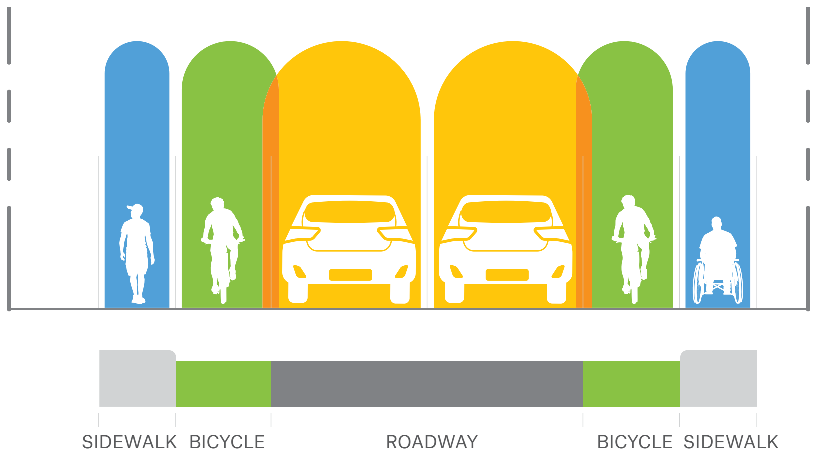
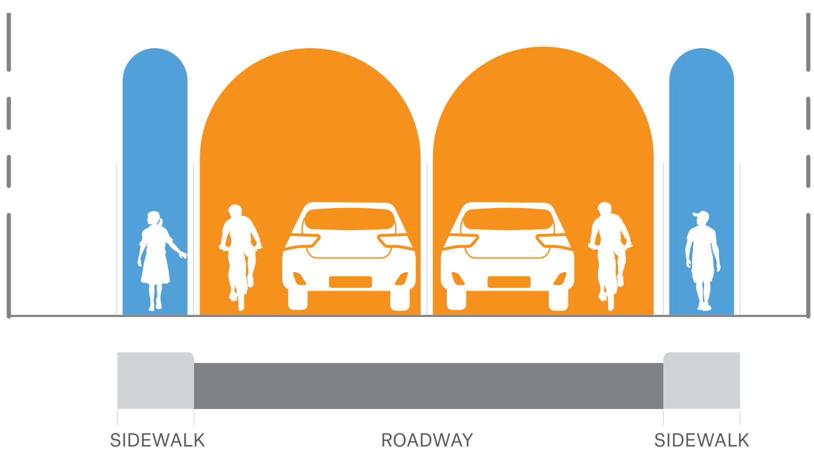


Figure 3.13 Fully-shared bicycle, e-bicycle, e-scooter, and motor vehicle accommodations.



SHARED BICYCLE, E-BICYCLE, E-SCOOTER, AND PEDESTRIAN ACCOMMODATION

On very high-volume, high-speed, and/or limited right-of-way streets, roads, or highways, a sidepath or shared-use path for pedestrians, bicycles, e-bicycles, and e-scooters may be used to provide space separating vulnerable roadway users from motor vehicles (Figure 3.14). Additionally, in sparsely developed rural and low-density suburban areas, pedestrians and cyclists often use the roadway shoulder as a shared resource adjacent to the motor vehicle lane (Figure 3.15). It should be noted that a shoulder with a cross slope greater than 2% is not considered an acceptable ADA-compliant pedestrian route, although pedestrians may use it to stay out of the travel lanes or unimproved roadside areas. In transitions from rural or low-density suburban to denser contexts, practitioners should consider transitioning to dedicated pedestrian and/or bicycle facilities or shared-use paths.

Scenarios where a shared facility between bicycles, e-bicycles, e-scooters, and pedestrians may be considered include:

- Areas with low-to-moderate micromobility use to mitigate conflicts between pedestrians and other micromobility modes, or in areas where high motor vehicle volume or speed requires separation for vulnerable roadway users and constrained right-of-way prevents further separation of modes
- Areas with high curbside turnover from motor vehicle parking, freight loading/unloading, or bus stops
- Corridors identified as needing to accommodate all ages and abilities

Figure 3.14 Shared-use path.

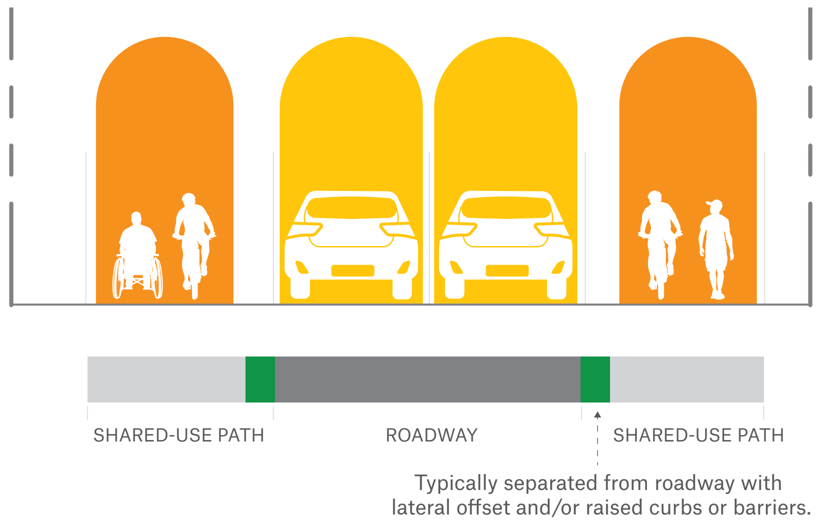
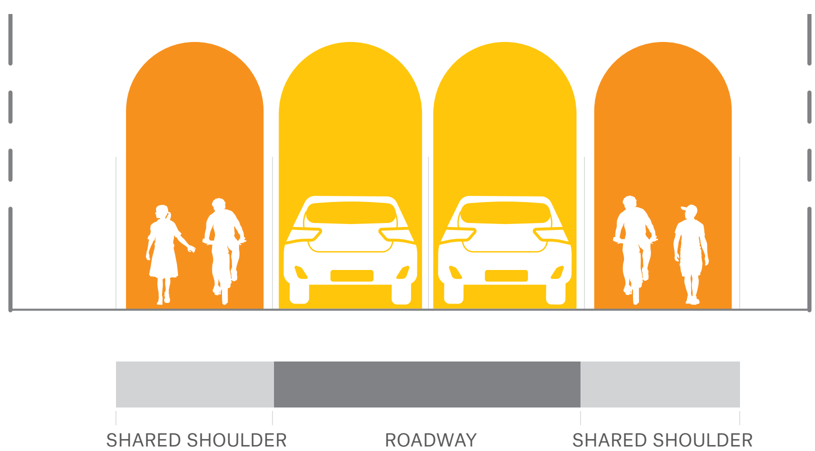


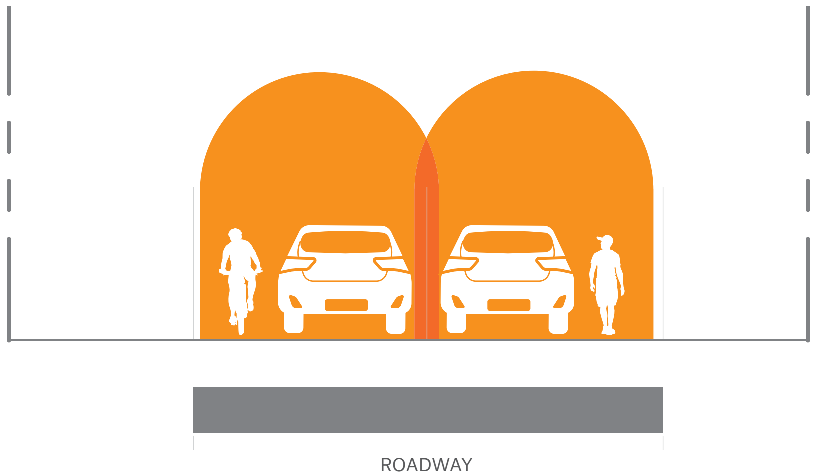
Figure 3.15 Shared shoulder.



SHARED STREETS

In highly context-specific conditions, all users may be accommodated in one shared street or travel lane as shown in Figure 3.16. This scenario is only appropriate where motor vehicle speed and volume is very low and is reinforced with a design that controls motor vehicle speed. Shared streets are typically successful in densely developed commercial areas where motor vehicle speed and volume are low and pedestrian, bicycle, and other micromobility demand is high, or in low-volume, low-speed residential neighborhoods with pedestrian demand to access parks, shopping, and other destinations.

Figure 3.16 Shared Street



ENDNOTES

1 FDOT *Florida's Complete Streets: A 360° Approach* http://www.flcompletestreets.com/

2 Kentucky Bicycle and Bikeway Commission https://transportation.ky.gov/BikeWalk/Pages/KY-Bicycle-and-Bikeways-Commission-(KBBC)-.aspx

3 Bike Walk Kentucky https://bikewalk.ky/

4 KYTC ADA Transition Plan https://transportation.ky.gov/Civil-Rights-and-Small-Business-Development/Documents/KYTC%20ADA%20Act%20Transition%20Plan.pdf

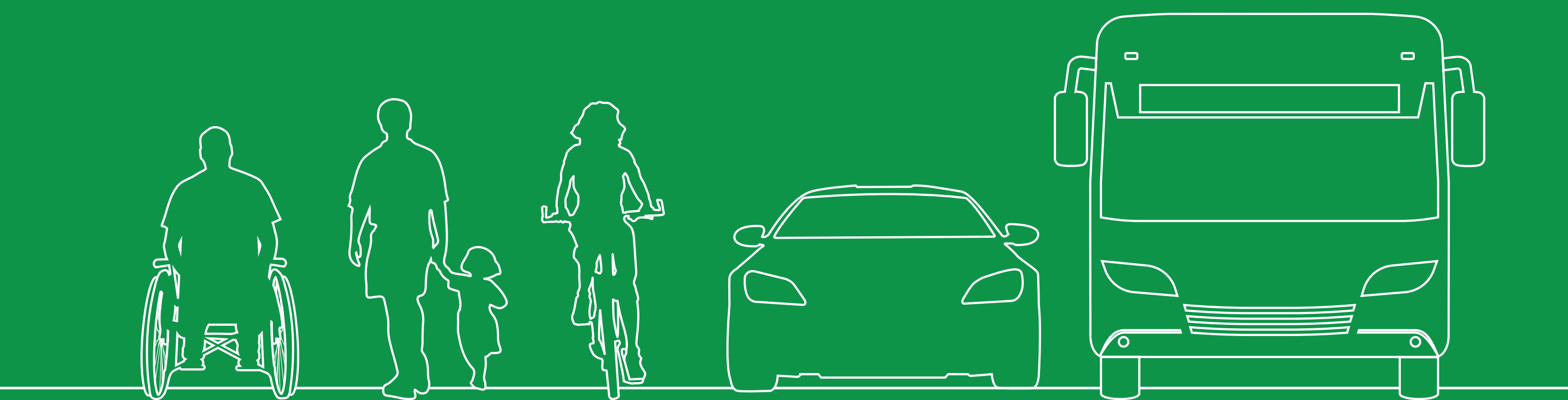
5 Streetmix https://streetmix.net/

6 Sketchup https://www.sketchup.com/

7 USDOT *Areas of Persistent Poverty & Historically Disadvantaged Communities* https://www.transportation.gov/RAISEgrants/raise-app-hdc

CHAPTER 4

GETTING STARTED IN COMPLETE STREET DESIGN



SECTION 4.1

ACCESSIBILITY AND CONFLICT MITIGATION

Design of streets, roads, and highways informs the choices, comfort, and safety of all users. When considering specific facilities for all modes, design choices related to motor vehicle size, speed, and management of conflicts between transportation modes directly impact safety outcomes and comfort for vulnerable roadway users. Accessible transportation networks provide safe freedom of movement for all vehicle types and people of all abilities, where all users can see and be seen by all modes. Speed management through design and control vehicle selection, traffic calming, visual cues, and other strategies support safety for everyone.

Complete Streets support comfortable and safe travel for all. This is accomplished by managing conflicts between modes and accommodating all users in a manner appropriate for the roadway context. The following is a discussion on the required accessibility design standards, user comfort, and conflict mitigation between different modes of transportation.

ACCESSIBILITY DESIGN STANDARDS

Accessible pedestrian pathways with clear navigation cues for people with disabilities is a critical component of Complete Streets design on streets, roads, and highways in Kentucky. All proposed Complete Streets projects and their associated planning, design, construction, and maintenance activities must address and comply with the ADA accessibility design standards within public rights-of-way. Wherever pedestrian facilities are intended to be a part of a transportation facility, federal regulations (28 CFR Part 35) require that those pedestrian facilities meet ADA guidelines. All new construction, retrofits, and reconstruction of existing transportation facilities must be designed and constructed to be accessible to and usable by persons with disabilities.

FHWA is one of the federal agencies designated by the Department of Justice (DOJ) to ensure compliance with the ADA for transportation projects. Pedestrian facilities shall be designed and built to accommodate persons with disabilities in accordance with the access standards required by the ADA to the maximum extent feasible. Sidewalks, shared-use paths, street crossings, and other infrastructure shall be constructed so that all pedestrians, including those with disabilities, can travel independently.

When accessibility is not properly addressed, unclear navigational cues, obstructions to the walking path, and inaccessible ramps can contribute to pedestrian discomfort and may negatively impact safety. For example, in Figure 4.1, the detectable warnings are placed at the end of the ramp as required by ADA accessibility standards. However, the alignment of the ramp and the detectable warnings would direct low-vision or blind pedestrians using a navigational aid into the middle of the intersection. It is important that the agency responsible ensures that ADA compliance is addressed correctly for each specific project.

On LPA projects, the public agency that is sponsoring the project is responsible for ensuring that ADA compliance is fully addressed. On all state routes outside of incorporated cities and on those with limited access (fully or partially controlled) within incorporated cities, KYTC is the responsible agency unless modified by a separate agreement with a local agency.

KYTC recommends exceeding the standard ADA compliance in transportation projects, incorporating other accessibility guidelines, recommendations, and standards for pedestrians, bicyclists, scooter users, and other non-motorized roadway users. Appropriate sources for supplemental guidance include, but are not limited to, the (Proposed) Public Rights-of-Way Accessibility Guidelines (PROWAG), the Architectural Barriers Act (ABA), the most current guidance by FHWA, Federal Transit Administration (FTA), and other national transportation resources. Accessibility is a critical component of healthy, vibrant, and thriving communities, and KYTC is committed to an accessible transportation network for people of all ages and abilities in new construction, reconstruction, and rehabilitation projects.

Figure 4.1 Incorrect ramp and detectable warning alignment, pointing the pedestrian toward the middle of the intersection.

NEW CONSTRUCTION PROJECTS

Construction of streets, roads, highways, interchanges, or any other transportation facility where none existed before are considered new construction projects. Pedestrian and micromobility needs (see Chapter 5 for definition) are assessed and included in all new construction projects where a need is identified and practical. All pedestrian facilities included in these projects shall fully meet the accessibility design standards when built to the extent that is feasible.

RECONSTRUCTION PROJECTS

Any project that potentially affects the usability of an existing pedestrian or micromobility facility is classified as a reconstruction project. Reconstruction projects include, but are not limited to, renovation, resurfacing, intersection enhancements or ADA accessibility projects, and modifications to the structural elements of a facility. Where existing elements or spaces are altered, each altered element or space within the limits of the project shall comply with the applicable accessibility requirements to the maximum extent feasible. Additional information on reconstruction projects on existing streets, roads, and highways is located in Chapter 7.

Whether a project is new construction or reconstruction of an existing roadway, the proposed project should provide the appropriate and feasible pedestrian and micromobility accommodations. These may include shared streets, pedestrian and/or micromobility shoulders or walking lanes, sidewalk and/or shared-use path, bicycle facilities, curb ramps, pedestrian push buttons at crosswalks, and truncated dome surfaces at intersections and commercial entrances with yield or stop traffic controls. Applicable KYTC Standard Drawings for some of these features or accommodations may be found online.[1]

Shared streets, or mixed-mode streets with pedestrians and micromobility sharing space with motor vehicles, introduce unique challenges to accessibility, particularly for pedestrians with limited vision and those using navigational aids. FHWA provides guidance on accommodating people with vision disabilities in Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities[2] in non-standard pedestrian facilities.

Additional detailed information on the design of safe and accessible facilities for all users along a corridor, including accessible pedestrian facilities and shared streets, is located in Chapter 5. Additional information on safe, accessible accommodation of all users through entrances, intersections, interchanges, and other similar locations is located in Chapter 6. Deviations from the accessibility standards and design best practices as outlined in this Manual shall be documented in the DES and approved by KYTC prior to construction.

CORRIDOR COMFORT AND SAFETY

Comfort and safety are the driving factors to support a choice in modal shift of transportation away from single-occupancy motor vehicles and are critical for equitable transportation options for those who do not or cannot use motor vehicles. As discussed in Chapter 3, user perception of comfort and safety are often closely tied to separation of the modes, managing conflicts between users, and mitigating potential negative impacts of speed on a corridor. The Safe System[3] approach recognizes that human errors will occur and separating users in both space and time with physical infrastructure and signal phasing can go a long way toward reducing the opportunity for errors that have an impact on users. In the following section, physical separation of users in space is discussed in more detail. Additional information on separating users in time by signal phasing and other intersection strategies is located in Chapter 6.

MITIGATING MULTIMODAL CONFLICTS

Avoidance of all conflicts between transportation modes is not realistic. At some point in the transportation network, a motor vehicle will need to access an entrance, pedestrians will need to cross the street, and transit operators will need to access a stop. Mitigating conflicts between the different modes must be considered and implemented to the extent feasible on every street, road, and highway. Conflict mitigation may include any combination of mode separation, buffers between modes, medians separating opposing directions of traffic or preventing left-turning traffic, barriers, or intersection treatments and signal phasing. Additional considerations related to comfort and safety through corridor and intersection design elements are located in Chapters 5 and 6, with further discussion on lighting, barriers, and other elements in Chapter 9.

MODE SEPARATION AND BUFFERS

Separation between modes may occur with buffers which may be implemented with any combination of striping, bollards, hardscape, landscape, or other raised separation (Figure 4.2). Buffer spaces help to reinforce space for different users, can increase intuitiveness of a transportation network, and offer more comfort for vulnerable road users. Buffer spaces may be utilized to improve the character and environmental health of the roadway by introducing landscape elements. Another benefit to additional separation is the potential for including passive speed management elements.

The first level of separation begins with dedicated facilities for vulnerable roadway users like bicyclists and pedestrians by removing them from the motor vehicle travel lanes. The next level of separation is provided by including dedicated space for each individual active transportation mode. In high-density contexts with high transit ridership, transit may also be separated from motor vehicle traffic to expedite service. Detailed information on the selection and design of specific facilities, including level of separation, is located in Chapter 5.

Figure 4.2 Different types of mode separation.

MEDIANS

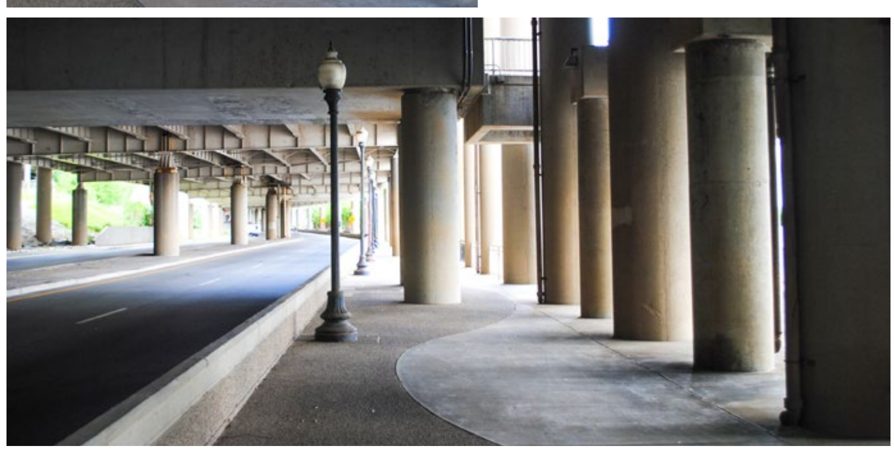
Medians are a highly encouraged component of Complete Streets. Medians play a role for all users and can be utilized to improve safety and prevent crashes throughout a corridor. Medians may separate opposing directions of traffic, eliminate left-turn conflicts, and provide a refuge for crossing pedestrians, bicyclists, e-bicyclists, and e-scooters. Medians should be raised and may be built with any combination of hardscape, grass, or landscaping (Figure 4.3). They also provide space to introduce traffic calming measures, as discussed in Chapter 4.

Figure 4.3 Examples of center median: hardscape, grass, and landscaped.

BARRIERS

In high-volume and/or high-speed roadways, barriers may be used to improve safety by providing separation for vulnerable roadway users or protecting drivers from roadside elements (Figure 4.4). Barrier selection, design, and context for implementation are site-specific. Detailed information on the process for including barriers and design selection is located in Chapter 9.

Figure 4.4 Example of roadside barrier preventing lane departures into the shared-use path and Ohio River.



SECTION 4.2

DESIGN AND CONTROL VEHICLES

The heaviest and most prevalent users of the transportation network include motor vehicles, buses, freight, and other large vehicles that often control the design elements for corridors and intersections. Although vehicles must be able to safely navigate the network, care must be taken to ensure that design elements do not negatively compromise the safety of other, more vulnerable roadway users.

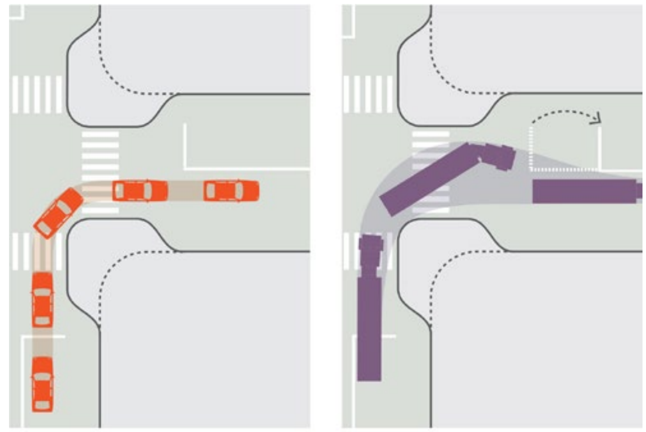


Figure 4.5 Design (left) and control vehicle (right) turning radii.

DEFINITION

The design vehicle is a motor vehicle that must be regularly accommodated without encroachment into the opposing traffic lanes. The design vehicle concept is most applicable when large vehicles such as buses, freight vehicles, or recreational vehicles regularly turn at an intersection with high volumes of opposing traffic. In contrast, the control vehicle is a relatively infrequent user of a facility that must be accommodated, but encroachment into the opposing traffic lanes, multiple-point turns, or minor encroachment into the street-side is acceptable. Acceptable encroachments will vary based on specific context of the street, road, or highway and the engineering judgment of the transportation practitioner in partnership with local stakeholder agencies.

SELECTION OF DESIGN AND CONTROL VEHICLES

The roadway should normally be designed for the largest design vehicle that will use the facility with considerable frequency (for example, a bus on fixed bus routes, a semi-tractor trailer on primary freight routes), but not the largest vehicle that might occasionally be present. The design vehicle influences the selection of design criteria related to turning radii such as curb-return radii and lane width. It is not always practical or desirable to choose the largest design vehicle that might occasionally use a roadway when beginning the design process. The larger turning radius negatively impacts safety of vulnerable roadway users through larger crossing distances, crosswalk design, and increased speed of turning vehicles, and may be inconsistent with the adjacent land use context and multimodal objectives for the street, road, or highway. In contrast, selection of a smaller design vehicle in the design of a facility regularly used by larger vehicles may create frequent operational problems. Detailed information on the selection of curb radii and curb extensions is located in the next section, and additional information on the design of specific intersection and crossing elements is located in Chapter 6.

SECTION 4.3

SIGHT DISTANCE, VISIBILITY, AND CONFLICT EXPOSURE

Visibility and acknowledgement of others sharing space is a vital component of both safety and comfort on a transportation network. Sight distance is the length of the corridor which is visible to a roadway user to view, acknowledge the presence of other users, and make decisions for safe navigation (Figure 4.6). Calculation of sight distance at potential conflict points, reduction of exposure to conflicts, and reduction or elimination of visual barriers at these locations are key to providing safe facilities to all users. Detailed information on designing intersections, crossings, entrances, and other conflict zones for the safety of all users is located in Chapter 6.

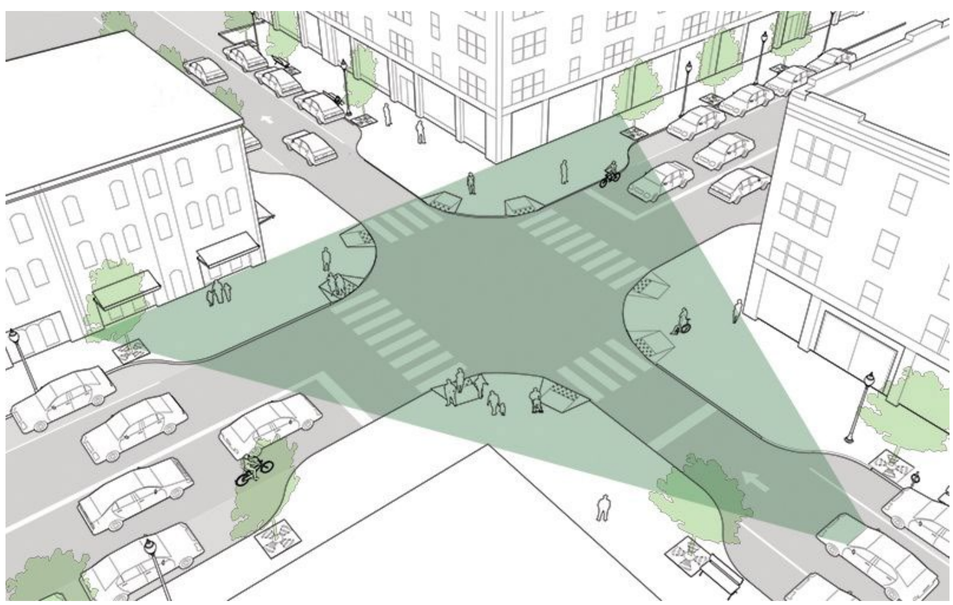


Figure 4.6 Example of visibility at an intersection from NACTO.

OVERVIEW OF SIGHT DISTANCE TRIANGLES

The visibility of all users is to be evaluated at intersections, crossings, entrances, and other potential conflict points. Vehicle operators, bicyclists, and scooters need to be able to see pedestrians crossing, and pedestrians need to be able to see every potential conflict that they may pose. Identifying sight triangles and mitigating or removing visual barriers within that space can help determine the optimal configuration of crossings for vulnerable roadway users. For example, in Figure 4.7, parking has been removed in the 20 feet of space approaching a protected intersection, improving sightlines from higher-speed motor vehicles to the parking protected bike lane. Visibility of vulnerable roadway users at intersections and crossings may also be improved with the selection of smaller curb radii and the use of curb extensions, as discussed in the following sections. KYTC Highway Design Guidance Manual Section HD-702.3, the AASHTO *Green Book*, and the NACTO *Don't Give Up at the Intersection: Designing All Ages and Abilities Bicycle Crossings*[4] provide more information on calculating sight distance and improving visibility for all users.

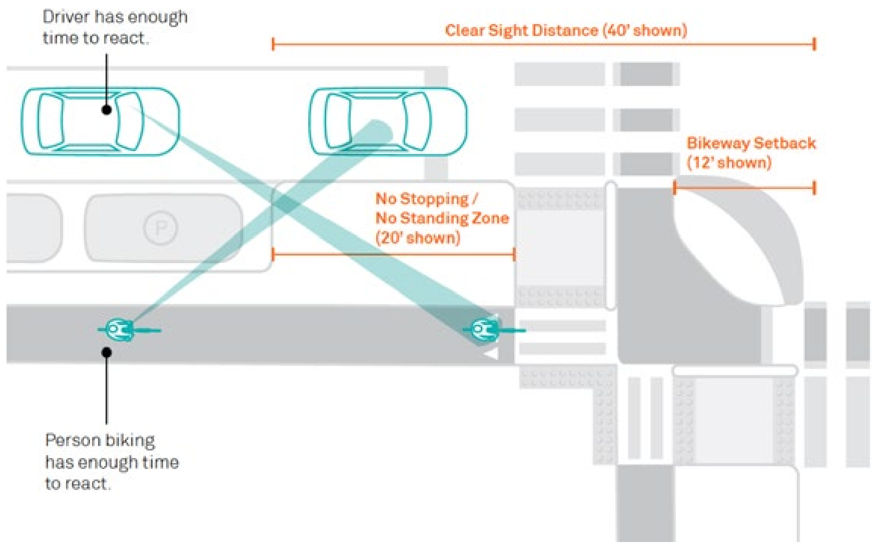


Figure 4.7 NACTO clear sight distance example at a protected intersection, with clear sight lines for all users shown in blue.

CURB RADII AND CURB EXTENSIONS

The primary objective at intersections and interchanges is to create a clear, distinct, and predictable travel path for all users through the intersection. The curb radii used at signalized and unsignalized intersections, interchanges, entrances, and other turning conflict locations with multiple users should be selected by the designer based on balancing safety, operations, and convenience for pedestrians, bicyclists, and motor vehicles. Visibility is impacted by both vehicle operating speed and the configuration of the intersection, crossing, entrance, or similar conflict point.

Curb radii should be appropriate for the largest design vehicle that regularly makes a specific turning movement. The use of the full curb radii necessary for the infrequent control vehicle can be impractical due to the constraints of available right-of-way along with the safety and comfort considerations for pedestrians at intersections, crossings, and other motor vehicle turning movement conflict locations. Large intersection turning radii, considered to be over 25 feet, allow motor vehicles to turn at higher speeds. On the other hand, large radii increase pedestrian crossing distance and move pedestrians out of the driver's line of sight, making it more difficult for pedestrians to see approaching vehicles, and vice versa. These factors along with longer crossing distances contribute a significant risk to pedestrians, bicyclists, and other vulnerable roadway users by creating longer exposure to motor vehicles operating at higher rates of speed. Smaller curb radii allow for shorter pedestrian and bicyclist crossing distances and reduce the speeds of turning vehicles, reducing exposure to moving vehicles, decreasing walk time, and increasing signal efficiency.

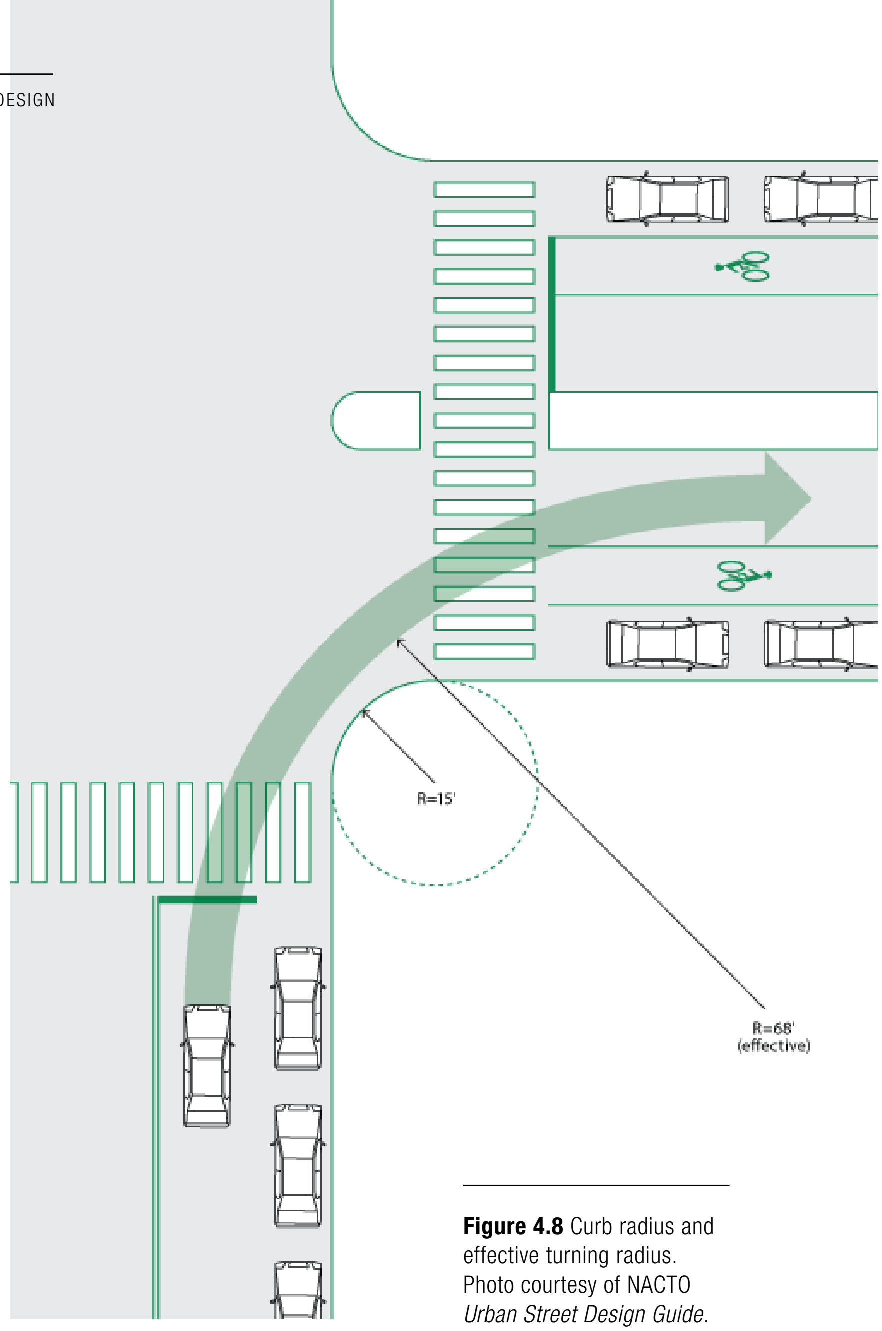


Figure 4.8 Curb radius and effective turning radius. Photo courtesy of NACTO *Urban Street Design Guide.*

To accommodate large design vehicles, or the infrequent control vehicle, allowing encroachment into opposing traffic lanes, adjacent shoulders, or the use of truck aprons and other mountable hardscape may be considered. The designer must ensure that infrastructure such as signal poles, signal cabinets, light poles, street furniture, or other amenities do not conflict with the control vehicle if areas outside the designated lane will be utilized. Additionally, on-street parking and bicycle lanes shall be considered when designing a curb radius, as they will increase a vehicle's effective turning radius, allowing the curb radius to be smaller than it would normally be, as shown in Figure 4.8.

At roadway intersections where trucks or other large vehicles make frequent right turns, a raised channelization island between the through lanes and the right-turn lane may be a better alternative than an overly large corner radius (Figure 4.9).

If designed correctly, raised islands can:

- Allow pedestrians to cross fewer lanes at a time (provides pedestrian refuge)
- Allow motorists and pedestrians to judge the right turn/ pedestrian conflict separately
- Reduce pedestrian crossing distance, which can improve signal timing for all users
- Balance vehicle capacity and truck turning needs with pedestrian safety
- Provide an opportunity for landscape and hardscape enhancement
- Align the pedestrian movement with better lines of sight of oncoming motor vehicular traffic

On streets, roads, or highways with curb and on-street parking or shoulders, curb extensions can be used to extend the sidewalk or curb line into the shoulder or parking lane, which reduces the effective street width at the intersection (Figure 4.10).

Curb extensions can:

- Reduce the crossing distance of pedestrians
- Improve the sight distance and sight lines for both pedestrians and motorists
- Create adequate space for curb ramps and landings where the existing sidewalk space is narrow
- Provide additional storage space for pedestrians waiting to cross
- Prevent parked cars from encroaching into the crosswalk area

In general, curb extensions should extend the width of the shoulder or parking lane, with the face of curb approximately one foot from the edge line of the through travel lane. Curb extensions may not be needed or desirable on every leg of an intersection if the street leg is narrow, parking is not permitted, or the curb extension would interfere with a bicycle lane or the ability of the design vehicle to negotiate a right turn. Storm drainage from the street must also be considered by the designer to ensure ponding does not occur. Low-level landscaping that does not conflict with sight distance or intersection sight triangle requirements is recommended on curb extensions to provide alignment cues for pedestrians with vision impairments and to increase the visibility of the extension to approaching motorists. Curb extensions are not typically appropriate at high-speed rural intersections or where channelized right turns are warranted.

Figure 4.9 Channelized right-turn island on US 60A (Eastern Parkway) in Louisville, KY.

Figure 4.10 Example of an intersection corner curb extension in Paducah, KY.

LANDSCAPE AND AMENITIES NEAR CONFLICT POINTS

Trees, landscaping, and amenities that support the comfort of roadway users, reflect the character of the surrounding land use, and provide health and environmental benefits are appropriate on streets, roads, and highways throughout Kentucky. However, the placement of landscaping and amenities must not block the view of other users along a roadway.

The height, width, diameter, and density of landscaping near intersections, interchanges, entrances, and other similar potential conflicts with turning vehicles must allow visibility for all users (Figure 4.11). Regardless of roadway context, landscape elements will follow the same guidance for sight distance as parking and amenities in urban, suburban, and small town areas and are prohibited from blocking pedestrian circulation areas. The AASHTO *Roadside Design Guide*[5] provides recommendations on the clear vision space above grade along urban streets and at intersections, and local jurisdictions may have further requirements and planting guidance. FHWA provides additional guidance on vegetation management to maintain clear sight lines and accessibility in rural areas and along bicycle and pedestrian paths in the *Vegetation Control for Safety, A Guide for Local Highway and Street Maintenance Personnel.*[6] Additional information on landscape and amenities in corridor design is located in Chapter 5.

Figure 4.11 Vegetation obstructing sight distance on KY 8 in Bracken County, KY.

SECTION 4.4

SPEED, TRAFFIC CALMING, AND TRANSITION ZONES

It is beneficial to proactively manage motor vehicle speeds along corridors and at intersection locations. Roadway users like pedestrians and bicyclists are particularly vulnerable to the negative impacts of high motor vehicle speed. Motor vehicle speed can be influenced through roadway design, the use of active speed management strategies, and passive measures that encourage slower speeds.

DESIGN SPEED, OPERATING SPEED, AND TARGET SPEED

Design speed controls roadway design criteria such as horizontal and vertical alignment, lane width, shoulder width, grade, and stopping sight distance. Operating speed references the speed at which motor vehicle drivers are observed operating their vehicles in a free-flow condition. The selected design speed should be a logical one with respect to the anticipated operating speed, topography, the adjacent land use, and the functional classification of the highway. On rural roadways above 45 mph, above-minimum design criteria for specific design elements should be used where practical. On facilities 45 mph design speed and below, use of above-minimum design criteria may encourage travel at speeds higher than the appropriate speed for the land use context.

Operating speeds are generally desired to be 25 to 35 mph on urban streets, and 40 mph or below for suburban streets. In both contexts, a concept called target speed should be utilized. The basis of target speed is that the current practice of creating a forgiving roadway for motor vehicles increases operating speed, creating a more dangerous street for all users including motorists, pedestrians, and bicyclists.Target speed applies to urban and suburban environments. It is not applicable to high-speed rural roadways where designing a “forgiving” road for vehicles is a primary consideration. The use of the concept of target speed is intended to limit operating speed through the design process. Instead of designing to current and sometimes undesirably high vehicle operating speeds by using the 85th percentile speed, it promotes constraining operating speeds through design.

On roadways with existing or planned high levels of multimodal activity, the target speed concept should be considered as an element of the design process. Target speed should be set at the highest speed at which vehicles should operate on a roadway in a specific context, consistent with the level of multimodal activity generated by adjacent land uses to provide both mobility for motor vehicles and a safer environment for pedestrians and bicyclists. The target speed should become the posted speed limit. Regardless of whether it is called “design speed” or “target speed,” urban roadways should have design elements that promote safer operating speeds consistent with the multimodal activity along the facility and the context of the project area.

SPEED DIFFERENTIAL

All roadway users, particularly pedestrians and bicyclists, are safer when motorists' operating speeds are lower. The design of a roadway should be consistent with the level of multimodal activity generated by adjacent land uses to provide both mobility and a safer environment for all users. Along corridors with large speed differentials between users, facilities separated by buffers or other physical elements for each user are recommended. Aside from increased safety, a direct correlation exists between speed differential and user comfort for all modes.

On higher-speed roads, the speed differential between vehicles and bicyclists or pedestrians should be a major factor in determining multimodal facility selection along a corridor. The likelihood of a fatality or serious injury increases exponentially with an increase in speed differential between motorized and non-motorized users. Increased speed differential also increases challenges for all users such as pedestrians judging gaps between vehicles when crossing a road, or a motorist judging the distance required to pass a cyclist.

TRANSITION ZONES

Transitioning from high-speed to low-speed roadway conditions requires managing driver expectation and using design cues to inform operational speed. Typical transition zones occur between less-developed land use, where drivers do not expect significant interactions with turning vehicles, bicyclists, or pedestrians, and developed areas where drivers should expect more traffic friction and more frequent interactions with other transportation modes. Driver behavior and speed should be managed with active roadway design and speed reduction countermeasures, as well as through passive context cues through roadside character, to inform the changes in driver expectations. Additional information on transition zone design and associated speed management strategies for Kentucky is available through the Kentucky Transportation Center (KTC) *Transition Zone Design Final Report.*[7]

ACTIVE AND PASSIVE SPEED MANAGEMENT

Managing speed along a street, road, or highway benefits all users by reducing crashes and mitigating the severity when they do occur. Speed management may be accomplished through active design measures or passive visual cues for motor vehicle drivers to slow down. Any number of active or passive speed management measures may be combined, and the transportation professional should consider speed management in all aspects of Complete Streets design. Collectively, these measures are often referred to as traffic calming. Although not an exhaustive list, when utilized in the appropriate conditions, the following speed management measures may be successful:

- Horizontal geometry with appropriate roadway curvature. Straight roadways may encourage higher operating speeds. Horizontal displacement measures, such as chicanes and other curb extensions, may be used in retrofit conditions to introduce curvature in urban, suburban, or small town contexts.
- Vertical displacement elements, including raised crossings, intersections, and speed tables that induce slower speeds.
- Intersection design, such as roundabouts, that slows speeds and reinforces yielding behavior.
- Pavement markings, optical lane narrowing, and physical lane narrowing and/or reduction through striping or pavement width reduction, median islands, or curb extensions.
- Pavement color or texture, or physical speed feedback such as transverse rumble strips.
- Signage, signage with speed feedback elements, and other speed-activated signage.
- Landscaping, street trees, medians, lighting, and other pedestrian, bicyclist, and transit amenities.

The use of specific traffic-calming measures is highly context-specific, and the consideration for each will vary with roadway context, speed, and other attributes. Additional information on the design and use of these and other traffic-calming measures are available through the KYTC *Standard Drawings*, ITE *Traffic Calming ePrimer*, FHWA *Proven Safety Countermeasures*, FHWA *Safe Transportation for Every Pedestrian* (STEP), and NACTO *Urban Street Design Guide*. Additional information on specific corridor elements is discussed in Chapter 5, with further detail on intersections and crossings located in Chapter 6.

ENDNOTES

1 KYTC *Standard Drawings* https://transportation.ky.gov/Highway-Design/Pages/Standard-Drawings.aspx?msclkid=a08e2c4bcef811eca966e544a6a758ae

2 FHWA *Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities* https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf

3 FHWA Safe System https://safety.fhwa.dot.gov/zerodeaths/resources.cfm and https://www.ite.org/technical-resources/topics/safe-systems/

4 NACTO *Don't Give Up at the Intersection: Designing All Ages and Abilities Bicycle Crossings* https://nacto.org/publication/dont-give-up-at-the-intersection/

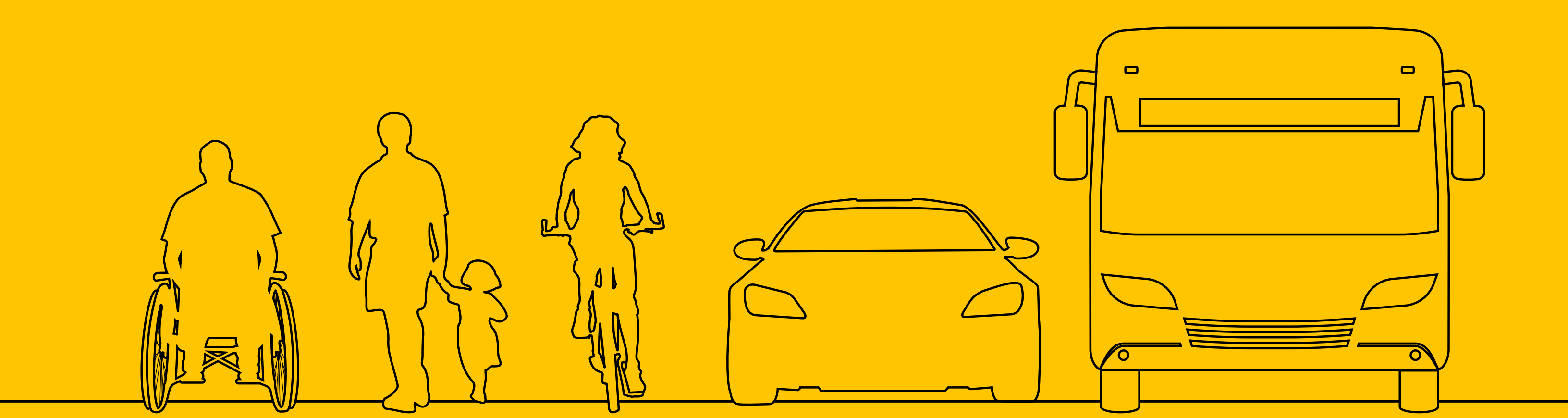
5 AASHTO *Roadside Design Guide*

6 FHWA *Vegetation Control for Safety, A Guide for Local Highway and Street Maintenance Personnel* https://safety.fhwa.dot.gov/local_rural/training/fhwasa07018/#:~:text=Trees%20near%20the%20road%20that,cut%20flush%20with%20the%20ground

7 KTC *Transition Zone Design Final Report* https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1598&context=ktc_researchreports

EDITION 1
AUGUST 2022

CHAPTER 5
DESIGN ELEMENTS OF COMPLETE STREET CORRIDORS



SECTION 5.1

INCORPORATING ALL USERS ON COMPLETE STREETS

Roadway design requires consideration of all existing and planned modes in the design process. The design process often needs a flexible approach to applying conventional roadway design criteria for the vehicle travel way to provide an appropriate level of accommodation for other users such as pedestrians and bicyclists. This chapter addresses some of the elements of travel way design that may require flexibility and creativity.

Designing a street, road, or highway with a Complete Streets approach is not one-size-fits-all. It requires an analysis of various site conditions to determine appropriate treatments and solutions.

FACTORS THAT SHOULD BE CONSIDERED

- Physical and operating characteristics of the street
- General land use type (urban, suburban, small town, rural)
- Adjacent and surrounding land use context (retail, office, residential, industrial, etc.)
- Community character, attributes, destinations, and transportation goals
- Motor vehicle crash history, current traffic volume, and future traffic demand
- Current and anticipated pedestrian volume, bicycle and/or other micromobility volume, and transit use
- Current and planned transit routes, freight corridors, and other large vehicle thoroughfare
- BCI and PCI comfort indices for bicyclists and pedestrians from the 2022 KYTC *Statewide Bicycle and Pedestrian Master Plan*

USER TYPE DEFINITIONS

Complete Streets may accommodate any combination of users. The wide variety of different user needs contributes to the complexity of Complete Streets design, and is one notable reason why every Complete Street is unique. The following are descriptions of the types of users that should be considered in the design process.

PEDESTRIAN

A pedestrian is anyone who is walking or traveling with the use of wheelchairs, other mobility devices, or navigational aids. Wheelchairs and other personal mobility devices may be motorized and operate at low speeds similar to walking. Any devices that can be legally classified as a moped, motorcycle, or gas-powered vehicle along with micromobility devices are not considered pedestrian mobility devices.

MICROMOBILITY

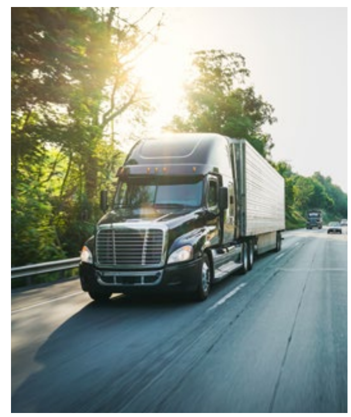
Micromobility encompasses a variety of human-powered and small electric vehicles. These vehicles are relatively lightweight when compared to mopeds, motorcycles, and large, motorized scooters and typically operate at much lower speeds. Micromobility devices, for the purpose of Complete Streets in Kentucky, are defined as weighing 500 pounds or less and operating at speeds up to 30 mph.[1] Local jurisdictions may develop additional micromobility definitions and restrictions based on weight, speed, or other characteristics. Non-motorized conveyances such as skates, skateboards, standing scooters, and other lightweight wheeled conveyances along with electric bicycles (e-bicycles) and electric scooters (e-scooters), are considered micromobility devices. Micromobility devices continue to expand in availability and evolve in design. This Manual focuses on bicycles and e-bicycles as the primary form of micromobility, and may be revised as new and emerging technology and micromobility-related regulations are developed.

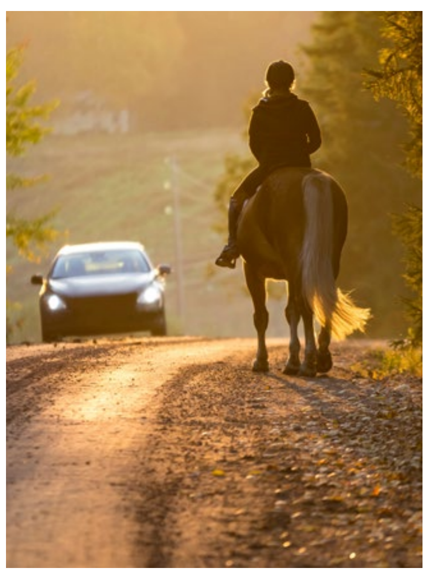
TRANSIT

Transit includes a variety of vehicle types and service models from large urban buses, light rail, small rural transit buses, and paratransit vans picking up at designated park-and-ride locations, transit stops, or individual homes. Where available, transit service is provided to people of all ages, abilities, and socioeconomic statuses across the Commonwealth.

MOTOR VEHICLE

Motor vehicles include more than just personal vehicles. They encompass freight, delivery services such as trash pick-up, and more. In some circumstances, transit vehicles may also be considered a motor vehicle.





OTHER USERS

Some location-specific Complete Streets will need to accommodate additional users. These may include equestrians, horse-drawn vehicles, and farm vehicles, among others. Although detailed information for these user types is not covered as part of this Manual, discussion on potential accommodations and surface selections are briefly covered for these relatively infrequent user types.

PRACTICAL APPLICATIONS OF COMPLETE STREETS

Although Complete Streets are about accommodating all users, it is not possible or practical to accommodate every user type on every road, street, or highway. Complete Streets are about more than just one individual street, road, or highway and are a holistic evaluation of the entire transportation network. In practical applications, Complete Streets include the evaluation of parallel and alternate routes as a universal approach for including all users, ages, and abilities.

SECTION 5.2

PEDESTRIAN FACILITIES

Pedestrian travel is a vital transportation mode. It is used at some point by nearly everyone and is a critical link to everyday life for many. Designers must be aware of the various physical needs and abilities of pedestrians to ensure facilities provide universal access. Pedestrians need safe spaces to navigate Complete Streets. The pedestrian facilities included in a project should be determined during the project planning or early design phases based on access control of the highway, local transportation plans, comprehensive plans and other plans (such as Safe Route to School Plans developed by schools and school districts), the roadside environment, existing and projected pedestrian volumes, user age group(s), and the continuity of local walkways along or across the roadway.

Pedestrian facilities typically include sidewalks, shared-use paths, and sidepaths. In some constrained, rural, or low-volume, low-speed contexts, a shared street, pedestrian shoulder, walking lane, or other alternative may be applied. Pedestrian facilities can either be immediately adjacent to streets, roads, and highways, or separated from them by a buffer. Pedestrian walkways are an FHWA Proven Safety Countermeasure (Figure 5.1).[2] Although sidewalks provide the highest safety improvement, paved shoulders also provide a significant benefit to safety for these vulnerable roadway users.

Pedestrian demand and accommodation are usually aligned with surrounding land uses and should be evaluated in the planning process to provide ample pedestrian space and roadside elements according to the checklist in Chapter 3. The AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities* includes information on establishing pedestrian demand and documenting pedestrian activity. In rural urbanized areas or small towns, retail and grocery stores are often located on the periphery or just outside the urbanized boundary. Although pedestrian demand may not be considered high, safe access to these destinations is still an important need for residents who may not have alternatives to walking. Discussion in this section includes the design of safe pedestrian facilities for users of all ages and abilities across a range of roadway contexts.

Figure 5.1 Pedestrian walkways are FHWA Proven Safety Countermeasures.

3. Gan et al. Update of Florida Crash Reduction Factors and Countermeasures to Improve the Development of District Safety Improvement Projects. Florida DOT, (2005).

Figure 5.2 Example of a sidewalk that does not provide a direct route.

ACCESSIBILITY

ADA requires pedestrian facilities to be designed and constructed so they are readily accessible to and usable by persons with disabilities. This chapter provides an overview of accessibility criteria for the design of pedestrian facilities that meet applicable state and federal standards. Designing pedestrian facilities extends much further than the ADA/PROWAG design criteria to address comfort and safety.

A pedestrian access route is defined as a continuous, smooth, accessible, and unobstructed path of travel provided for pedestrians with or without disabilities within, or coinciding with, a pedestrian circulation path. Access routes that provide direct connections to destinations, with few meanders, are typically preferred by those with visual impairments. Figure 5.2 shows an example of a pedestrian route that does not provide a direct connection. While the PROWAG has not yet been adopted nationally as standard, KYTC recommends considering PROWAG, and accessibility in public rights-of-way is required by the ADA. Additional guidance concerning the access route width, cross slope, grade, and pavement markings follows.

WIDTH

The width may vary by context and the pedestrian activity generated by the adjacent land use. Widths between 5 and 6 feet are typical, allowing pedestrians to walk side-by-side or pass another. Under physically constrained conditions, the width should be a minimum of 4 feet. The width is not inclusive of business frontage space or furnishing zones. The minimum width must be maintained around items commonly placed within or near the sidewalk area, including sign posts, luminaire supports, signal poles, seating, and other amenities (Figure 5.3). In areas with anticipated higher pedestrian volumes, or intermittently high pedestrian volumes such as commercial areas, campuses, event venues, and other high density attractors the width should be higher than the minimum.

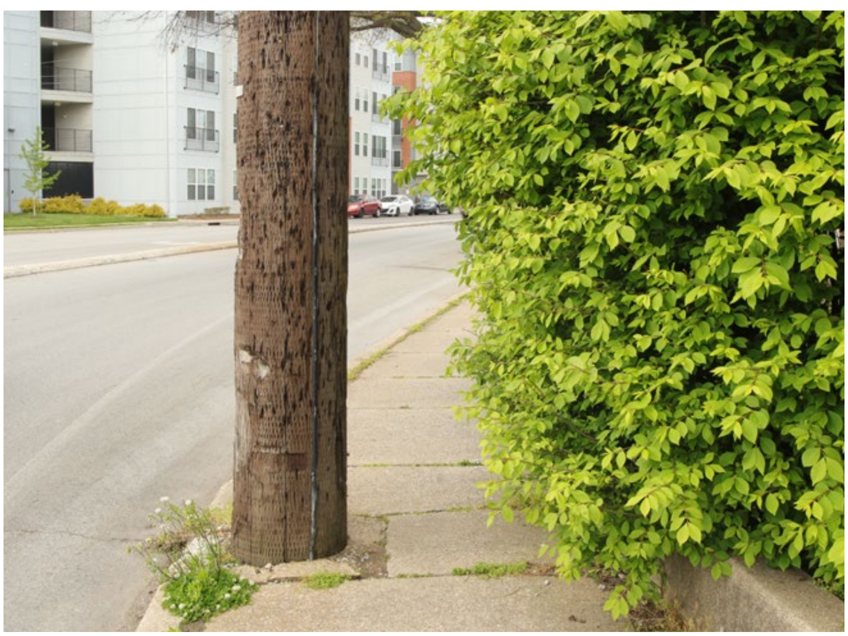


Figure 5.3 Sidewalk width obstructed by landscaping and utility pole.

CROSS SLOPE

A two percent maximum cross slope is a requirement of the ADA and PROWAG for pedestrian access routes and applies to all pedestrian facilities, including across entrances, drives, and other crossings. A cross slope of at least one percent is recommended to provide adequate drainage during and after a rain event, unless longitudinal grade will ensure adequate drainage. Ponded water on sidewalks, shared-use paths, or in crossings can create slipping hazards, obscure surface discontinuities, freeze in cold weather, and degrade the sidewalk or shared-use path.

GRADE

Longitudinal grades along the pedestrian path of travel can be challenging for pedestrians if they are too steep. PROWAG requires that longitudinal grades not exceed five percent for pedestrian access routes outside of a street or highway right-of-way and for pedestrian access routes within street crossings. Pedestrian access routes adjacent to roadways with grades steeper than five percent may match, but not exceed, the general grade of the roadway. The designer should consider level rest areas or other design approaches to mitigate excessive grades to meet accessibility standards and AASHTO guidance.

PAVEMENT MARKINGS

Pavement markings are typically utilized at crosswalk locations. Exceptions can be found in Section 5.3 for separation of active transportation modes on shared-use paths, sidepaths, and trails. Marked crosswalks are designed to keep pedestrians together where motorists can see them, and where they can cross more safely across the flow of vehicular traffic. They also aid visually impaired users to remain within the crosswalk area. The MUTCD and the KYTC *Highway Design Manual* provide guidance on the design of pavement markings. More information on crossing design is located in Chapter 6.

SIDEWALK DESIGN

Pedestrian accommodation can be provided by either dedicated pedestrian sidewalks, shared-use paths, or sidepaths. Shared-use paths and sidepaths are facilities that serve pedestrians, bicyclists, and occasionally other micromobility users. Sidewalks are typically provided on both sides of the street, whereas a shared-use path may be provided on only one side. A sidewalk should be considered on the opposite side of the street from the shared-use path to provide universal access to comfortable pedestrian facilities, transit stops, and destinations. During sidewalk design, the transportation professional should determine sidewalk width in consultation with the local agency, meet minimum ADA width requirements, and accommodate the expected volume of pedestrians according to existing and future land use along the project corridor. Locally adopted sidewalk standards may differ and should be coordinated with local agencies.

Figure 5.4 Urban sidewalk example on Frankfort Avenue in Louisville, KY.

Most sidewalks are located along streets with curb and gutter in urban, suburban, and small town center contexts (Figure 5.4). According to the AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities,* typical sidewalk width is 5 feet, with 6 feet recommended when the sidewalk is immediately adjacent to the back of curb. In dense urban settings, sidewalk width of 8 feet or more is recommended where pedestrian volumes are high.[3] In more densely developed small town, suburban, and urban areas, sidewalks may be closely integrated with other roadside elements and amenities such as street trees, landscaping, street furniture, bicycle racks, transit stops, and building frontages.

In suburban settings, the sidewalk is typically not adjacent to building frontages as it may be in more densely developed urban and small town settings. In rural and less-densely developed suburban areas, sidewalks can and do exist along

Most sidewalks are located along streets with curb and gutter in urban, suburban, and small town center contexts.

streets without a curb (Figure 5.5). As motor vehicle speeds increase, greater lateral offset is recommended from the edge of the travel lane. Crash-worthy barriers may be considered to protect the users of the sidewalk in site-specific contexts.

Sidewalks may be separated from the edge of the roadway to provide a pedestrian buffer, locate mailboxes, provide a planting strip or furnishing zone, serve as a place for transit stop amenities, and improve entrance slopes in areas with curb. Additional buffer space may be necessary for amenities or large landscape features such as street trees. Additionally, buffers, barriers, railings, hedges, or other design elements may be considered to encourage pedestrians to utilize the provided sidewalk and cross at designated crossings (Figure 5.6). Note that the buffer can be paved, but its width is not included as part of the minimum pedestrian facility width. Shoulders, bicycle lanes, or parking lanes on the road side of the curb can be included when determining the buffer width. However, some separation from the curb to the edge of the sidewalk is still recommended as a place to locate mailboxes and improve entrance slopes. The AASHTO *Roadside Design Guide* provides additional guidance and recommendations for separation between pedestrian facilities and motor vehicle travel lanes, including urban and restricted environments. If a buffer equal to the minimum recommended separation is not feasible on higher speed routes, the designer may consider the placement of a barrier in accordance with the design guidance in Section 9 of the AASHTO *Guide for the Planning, Design, and Operations of Pedestrian Facilities,* and the AASHTO *Roadside Design Guide.*

Figure 5.5 Rural sidewalk on KY 44 in Shepherdsville, KY.

Figure 5.6 Barrier preventing pedestrian crossings in undesignated locations on S. Limestone in Lexington, KY.

ALTERNATIVES TO SIDEWALKS

Dedicated sidewalk facilities for pedestrians on both sides of the road, street, or highway with separation from motor vehicles, bicyclists, and/or other micromobility users is recommended to improve safety for pedestrians and reduce multimodal conflicts. However, in areas where sidewalks are not feasible or desirable, limited space or other physical constraints prevent dedicated pedestrian facilities, limited funding prevents immediate construction of these facilities, or in other scenarios, alternative facilities may be considered to accommodate pedestrians. Additional guidance on the application and design of sidewalk alternatives in rural and small town areas is available through FHWA.[4]

Figure 5.7 Clair Street is an example of a shared commercial street in Frankfort, KY.

SHARED STREETS

Shared streets accommodate a variety of users mixing on the street, including any combination of pedestrians, motor vehicles, bicyclists, and other micromobility vehicles. Shared streets are applicable on low-volume, low-speed commercial (Figure 5.7) and residential streets or frontage roads. Managing motor vehicle speed and providing visual and tactile cues to visually impaired pedestrians to enable safe navigation of the shared space is a critical component of shared streets. Shared streets are composed of different zones to accommodate pedestrian comfort and access, furnishings, amenities, and shared space (Figure 5.8).[5] Vertical and horizontal deflection elements such as chicanes, mini-roundabouts, speed tables, raised intersections, and others may be used to control motor vehicle speed. Visual and tactile changes between zones alert pedestrians to changing conditions. Shared streets may also be temporarily or permanently closed to motor vehicle traffic, with pedestrians, bicyclists, and other micromobility users sharing the space.

Figure 5.8 Shared street zones.

Shared streets are composed of different zones to accommodate pedestrian comfort and access, furnishings, amenities, and shared space.

Streetscape elements within a shared street should be organized in a way that facilitates navigation by pedestrians with vision disabilities. The defining feature of a shared street is a shared zone where pedestrians, bicyclists, and motor vehicles can safely interact in the same space. If there is sufficient right-of-way, shared streets may also have a pedestrian-only comfort zone.

Frontage Zone varies	**Comfort Zone** 6' min, more preferred	**Furniture Zone**	**Shared Zone**
Landscaping, front stoops, door swings, awnings, café seating, retail signage and displays	Pedestrian access route NOTE: If there is insufficient right-of-way for a comfort zone of at least 6'-wide, consider the shared alley design	Lights, signs, utility poles and boxes, trees, bicycle racks, parking meters, transit stops, benches, stormwater facilities and snow storage	Shared circulation for pedestrians, bicycles, vehicles

Source FHWA Accessible Shared Streets: Notable Practices And Considerations For Accommodating Pedestrians With Vision Disabilities
https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf

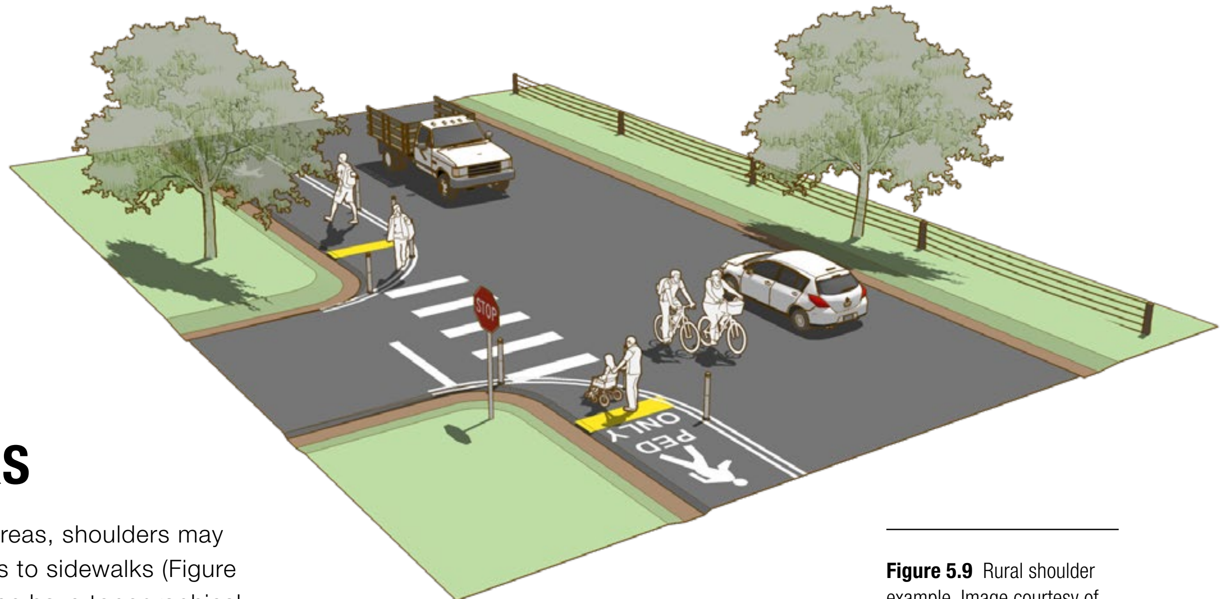


Figure 5.9 Rural shoulder example. Image courtesy of FWHA.

SHOULDERS

In rural, residential areas, shoulders may be viable alternatives to sidewalks (Figure 5.9). Rural areas often have topographical, geometric, or fiscal constraints that prevent the construction of sidewalks or shared-use paths. On very low-volume, low-speed residential corridors, sidewalks may not be desired or practical to construct. When shoulders are utilized, they must meet accessibility standards. Rural shoulders on high-volume and/or high-speed corridors with high pedestrian volumes may warrant buffers, vertical delineators, and/or roadside barriers for the comfort and safety of the vulnerable roadway users. Pedestrians do not experience the same level of comfort and separation on shoulders as on other dedicated, separated facilities. In transitions between rural and suburban or urbanized areas, the shoulder should also transition to a separated facility, such as a sidewalk or shared-use path.

SHARED-USE PATHS AND SIDEPATHS

Shared-use paths and sidepaths are facilities that serve pedestrians, bicyclists, and other micromobility users and are covered in more detail in Section 5.4. Shared-use paths, sidepaths, and trails may be considered appropriate with high volumes of pedestrians, high-speed motor vehicle traffic, and/or high-volume motor vehicle traffic. Pedestrians are considered the most vulnerable user, and additional separation from bicyclists and other micromobility modes on these facilities should be considered.

PEDESTRIAN FACILITIES ON BRIDGES

Bridge projects can be used to make critical new connections in pedestrian networks. A new bridge may provide a more direct route than previously available. For existing bridges, improving both the safety and comfort of non-motorized users may require that the bridge be retrofitted with more appropriate, separated facilities. Pedestrian accommodations should be provided on, or adjacent to, bridges whenever possible (Figure 5.10). Where appropriate, bridges should also accommodate pedestrian facilities extending under them so they do not create a barrier to access. Pedestrian facilities shall be included in bridge projects if the criteria in the Complete Streets Planning Checklist is met.

Figure 5.10 Pedestrian bridge adjacent to a motor vehicle access bridge on Eastern Parkway, Louisville, KY.

PEDESTRIAN ACCESS TO TRANSIT

In locations with transit, pedestrian throughways should be consistently connected to accessible transit stops. Transit stop accessibility shall follow the standards and guidance as discussed in Sections 4.1 and 5.2. Comfortable and convenient pedestrian access to and from transit stops and stations presents important opportunities to strengthen and expand the transportation system and provide more travel options for the public. Clear sidewalk width through transit stops shall be provided, with additional width considered for pedestrian waiting areas and encouraged for high volume stops. Individual transit authorities may develop additional standards and practices to be utilized in tandem with ADA and/or PROWAG and shall be consulted by the designer, when applicable.

SIGNING, STRIPING, AND PAVEMENT MARKINGS

Marked crosswalks are required at designated school crossings and at signalized intersections that have sidewalks with curb ramp access. Marked crosswalks should be considered at other unsignalized locations with high pedestrian activity. Additional design recommendations and details for intersections, interchanges, and crossings are located in Chapter 6.

SECTION 5.3

BICYCLE FACILITIES

Micromobility encompasses a wide range of small, lightweight electric and human-powered vehicles. Micromobility is an important mode of transportation, and often provides first and last-mile connectivity to transit and other modes of transportation. This section is a specific guide for the application and design of bicycle facilities, including electric bicycles (e-bicycles). Other micromobility users, including electric scooters (e-scooters), skaters, and others may be allowed to utilize bicycle facilities provided by local regulations and ordinances. Bicycle lanes are an FHWA Proven Safety Countermeasure,[6] and ongoing research at the time of this publication is identifying additional safety benefits associated with bicycle lanes and other improvements (Figure 5.11). Information on the design of shared-use paths and other shared facilities that accommodate all pedestrians and bicyclists, and may accommodate other micromobility users is located in the next section.

Unique design challenges may arise in the design of bicycle facilities. The KTYC Statewide Bicycle and Pedestrian Coordinator is a resource for expertise in the interpretation and implementation of local, state, and national design guidance. National guidance from the MUTCD, AASHTO *Guide for the Development of Bicycle Facilities,* and NACTO *Urban Bikeway Design* Guide, and others should be referenced for the application and design of bicycle facilities. In small towns and rural areas, the FHWA Small Town and Rural Multimodal Networks document provides further guidance on using bicycle facility alternatives and balancing bicycle and other micromobility needs with other users on streets, roads, and highways. Similar to pedestrian facilities, bicycle facilities are an important component of the transportation network for rural communities where shopping and other destinations are often located just outside of urbanized areas.

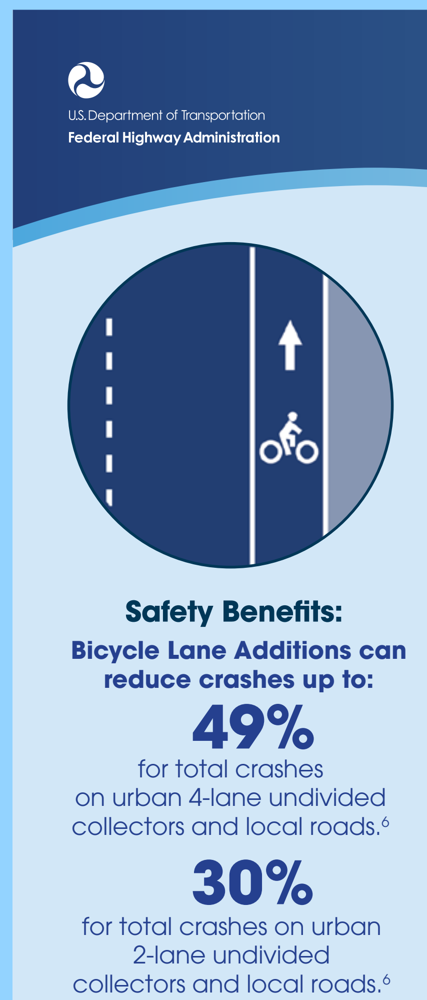


Figure 5.11 Bicycle lanes are FHWA Proven Safety Countermeasures.

6. Avelar et al. Development of Crash Modification Factors for Bicycle Lane Additions While Reducing Lane and Shoulder Widths. FHWA, (2021).

REGULATIONS AND RECOMMENDATIONS

Currently, bicycles are the most consistently regulated micromobility option in Kentucky. However, individual jurisdictions may impose additional regulations or ordinances related to micromobility within their community. Proposed multimodal facilities must allow sufficient width to allow all users to adhere to the Kentucky laws and regulations for bicycle travel, which covers expectations of bicyclists as well as motor vehicles in regard to occupying public space and safely passing cyclists in a motor vehicle. This Manual may be updated as new laws and policies are developed regarding bicycling and the operation of other micromobility devices in the Commonwealth. The laws, regulations, and policies related to bicycle and other micromobility travel in Kentucky may be found online.[7]

TYPES OF BICYCLE FACILITIES

Bicycle facilities come in a variety of designs that vary by separation from motorized vehicular travel and other users. Except for low-speed, low-volume residential streets where bicycle and micromobility vehicles can comfortably share the roadway with motor vehicles, separation between these modes is recommended to increase safety. Bicycle and other micromobility facilities continue to evolve in design and appropriate application. The designer should refer to the most recent FHWA, AASHTO, NACTO, and other references for design guidance and research on new and/or experimental facilities.

Bicyclists require a minimum of 4 feet of lateral operating space, with 5 feet or more preferred for the comfort of the users. For the purpose of this manual, 5 feet is considered the minimum bicycle and micromobility user design width, with 4 feet allowed in constrained spaces. Additional width may be recommended for specific facility types, such as parking-protected lanes, where the user cannot utilize a motor vehicle lane for additional space (Figure 5.12). Where bicycle facilities are located adjacent to curbs, inlets, vertical surfaces or elements, high-speed and/or high-volume motor vehicle traffic, or near steep slopes, additional width for user comfort and safety may be required. When appropriate, crash-worthy barriers or safety railings may be considered. Following is a detailed discussion of potential bicycle facility types, listed from least-protected to most-protected from vehicle conflicts.

SHARED STREETS

Shared streets accommodate a variety of users mixing on the street, including bicycles and other micromobility vehicles. On shared streets accommodating pedestrians, bicyclists, and/or other micromobility users, careful consideration must be given for managing potential multimodal conflicts. Shared streets closed to motor vehicle through-traffic may also be opportunities to incorporate public art and other amenities Figure 5.13.

Figure 5.12 Example of a parking-protected bicycle lane on 2nd Avenue in Portland, OR.

Figure 5.13 Pedestrian, bicycle, and campus-vehicle-only shared street on Rose Street on the University of Kentucky campus in Lexington, KY.

Figure 5.14 Example of an on-street shared lane on E. Washington Street, Louisville, KY.

ON-STREET SHARED LANES

A shared lane is a combined motor vehicle, bicycle, and/or other micromobility lane (Figure 5.14). Shared lanes are generally appropriate on local roads and streets, preferably with lower traffic volumes, and with posted speed limits of 35 mph and below. If a shared lane is proposed on a vertical grade that can impact bicycle speeds, a dedicated bicycle lane should be considered in the direction of increasing elevation, allowing for slower bicycles to climb outside the area of motor vehicular operation. Shared lanes employ pavement markings and signage to indicate the combined use. The design and position of shared lane markings and signage is detailed in the MUTCD.

SHOULDERS

Many rural state highways are used by bicyclists for commuting between cities or for recreational touring. Accommodating bicycle users on the shoulder is common on these routes. Providing and maintaining paved shoulders can significantly improve convenience and safety for both bicyclists and motorists.

Shoulder improvements to facilitate bicycle and other micromobility travel options include widening the shoulders, improving roadside maintenance (including periodic sweeping), and removing or replacing surface obstacles such as drainage inlet grates that are not compatible with bicycle tires. If shoulder rumble strips are present, the designer should follow the applicable AASHTO *Guide for the Development of Bicycle Facilities* guidance for placement of bicycle gaps.

Accommodating bicycle or other micromobility use on shoulders is appropriate at many locations. However, shoulder accommodations are not dedicated bicycle facilities, and users are not provided the same comfort and safety as with striped on-street lanes. In rural to suburban or urban transition areas, the designer should consider converting the shoulder to a protected buffered bicycle lane, both to encourage speed management of motor vehicle users through the transition and to establish a dedicated lane to accommodate users more comfortably on the network.

STRIPED BICYCLE LANES

Dedicated, striped, on-street bicycle lanes are located at-grade along a roadway and are adjacent to motor vehicle traffic lanes as shown in Figure 5.15. Where a gutter is present in the bicycle lane and does not span the full lane width, a minimum usable width of 3 feet and a preferred width of 4 feet measured from the longitudinal joint between the gutter and bicycle lane to the center of the lane pavement marking line is recommended (Figure 5.16 and Figure 5.17). On one-way streets, a contra-flow bicycle lane may be utilized in tandem with a bicycle lane or shared lane in the direction of motor vehicle traffic.

Figure 5.15 Striped bicycle lanes on University Drive, Lexington, KY.

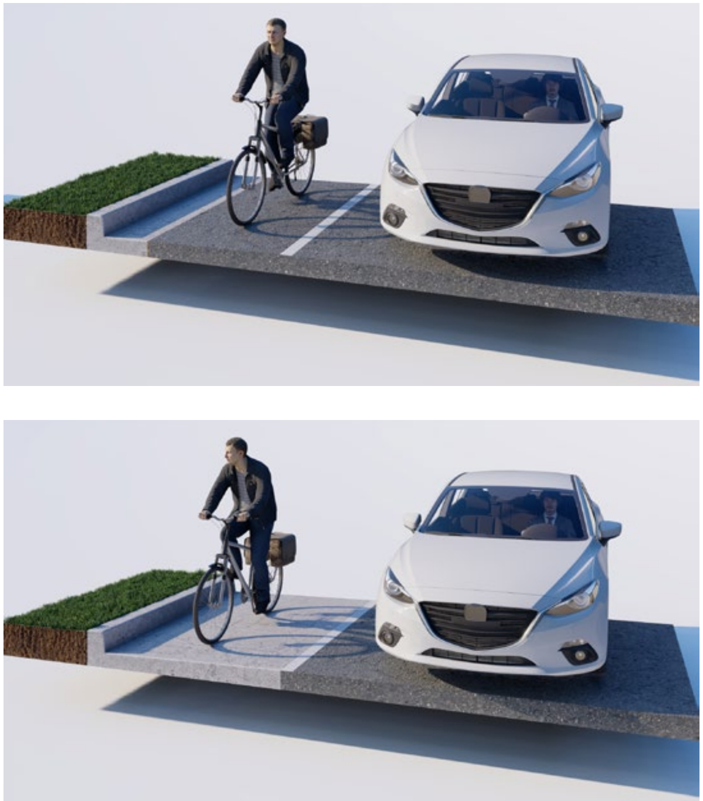


Figure 5.16 Bicycle gutter pan with adequate rideable surface between lane line and gutter seam (top) and bicycle lane-width gutter pan (bottom).

Where a gutter is present in the bicycle lane and does not span the full lane width, a minimum usable width of 3 feet and a preferred width of 4 feet measured from the longitudinal joint between the gutter and bicycle lane to the center of the lane pavement marking line is recommended.

Figure 5.17 Example of a full bicycle lane width gutter on Adams Street, Louisville, KY.

BUFFERED BICYCLE LANES

Buffered bicycle lanes utilize a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. The buffer space is created with pavement markings. When a buffer is placed between the travel way and a bicycle lane, it improves safety by separating bicyclists and/or other micromobility users users from moving motor vehicles. A buffer can also be placed between on-street parking lanes and bicycle lanes (Figure 5.18). When that configuration is selected, users have less risk of being hit by a door being opened from a parked car. Both treatments are acceptable, and the preferred placement of the buffer(s) depends upon site context.

Buffered bicycle lanes provide additional separation from motor vehicles, improving comfort and safety. They should be considered with the following guidance:

- Buffered or separated bicycle lanes are preferred to non-buffered or non-separated lanes and are required on facilities with speed limits above 45 mph.
- Bicycle lanes 6 feet or wider should be considered candidates for buffered bicycle lanes or separated bicycle lanes and should follow the recommended design guidance in this Manual to prevent motor vehicles from utilizing the bicycle lane.
- Bicycle lanes installed on the curb side of the parking lane are considered parking-protected separated lanes and should follow the related design guidance in this Manual.

Buffered bicycle lanes provide the following advantages when compared to conventional bicycle lanes:

- Greater separation between bicyclists and/or other micromobility users and motor vehicles, improving comfort and safety for the more vulnerable users
- Space for faster moving bicyclists and/or other micromobility users to pass slower moving users without having to encroach into the motor vehicle travel lane
- Additional space for bicyclists and/or other micromobility users without making the lane appear so wide that it might be mistaken for a travel lane or a parking lane
- Greater appeal to more users due to improved safety and comfort operating on the street, road, or highway

Figure 5.18 Buffered bicycle lanes on Avenue of Champions, Lexington, KY.

Figure 5.19 Separated two-way cycle track on Manchester Street, Lexington, KY.

Figure 5.20 Two-way cycle track (left) and pedestrian path (right) separated by a concrete band on Town Branch Commons in Lexington, KY.

SEPARATED BICYCLE LANES

To further improve comfort and safety, separated bicycle lanes should be considered in locations without parking, or where pavement width provides at least 8 feet for parking-protected lanes. Separated bicycle lanes, also referred to as cycle tracks or protected lanes, include bicycle lanes, a buffer area, and some type of vertical feature that reduces the likelihood of encroachment into the bicycle lane by motor vehicles, increasing user comfort and safety. The most common type of vertical separator used within the buffer area is a pavement-mounted flexible tubular marker or delineator. Use of temporary or permanent curbing, landscape, raised medians, and/or the parking lane adjoining the buffer area, can also accomplish the same goal of separation. The most common type of cycle track is a single separated bicycle lane, on each side of the roadway traveling in the same direction as motor-vehicle traffic. In some circumstances, two-way cycle tracks on one side of a corridor, as shown in Figure 5.19, are appropriate with additional considerations at driveways, entrances, and intersections.

For added separation between bicyclists, other potential micromobility users, and motorists, the lanes can be curb-separated and raised to the level of the sidewalk or to an intermediate level. When a raised and curb-separated bicycle lane is provided, separation from pedestrians with either striping, surface color or texture, curb, or buffer is required along with recommended signage and pavement markings indicating user type (Figure 5.20). On driveway and entrance crossings for raised bicycle lanes, the designer should strive to keep the facility elevated across entrances for increased user comfort and safety. In situations with parking-protected bicycle lanes, additional lane and buffer width should be provided to prevent conflicts with passenger side door swing from motor vehicles[8] and to provide adequate sight distance at intersections (Section 4.3).

SHARED-USE PATHS AND SIDEPATHS

Shared-use paths and sidepaths may be considered in lieu of separated lanes to provide shared two-way bicycle and/or other micromobility user operations and pedestrian access in constrained rights-of-way and/or along high-volume, high-speed motor vehicle corridors (Figure 5.21). Shared-use paths are addressed separately in Section 5.4 as they may serve multiple users such as pedestrians, bicyclists, and other micromobility users. The previous discussion regarding shared-use paths and sidepaths for pedestrians in Section 5.2 is applicable to the use of such facilities for bicyclists and/or other micromobility devices as well.

Figure 5.21 Sidepath (or shared-use path) adjacent to the road on Barret Avenue in Louisville, KY.

BICYCLE FACILITY SELECTION

FHWA provides guidance for the preferred bicycle accommodations based on ADT volumes and posted speed limits.[9] The selection guide in Figure 5.22 is appropriate for urban, suburban, and small town contexts, and Figure 5.23 is appropriate for use in rural contexts.

Figure 5.22 FHWA's preferred bicycle facility type for urban, suburban, and small town contexts.

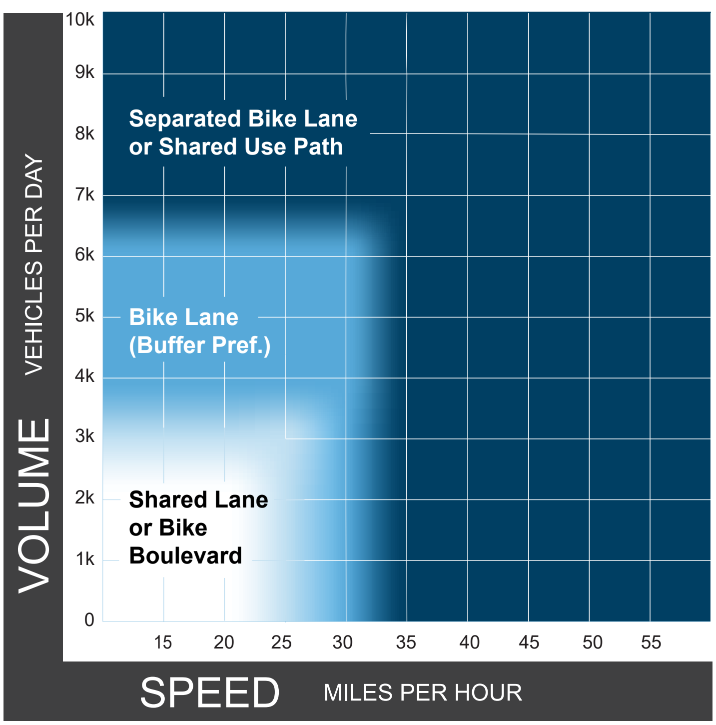
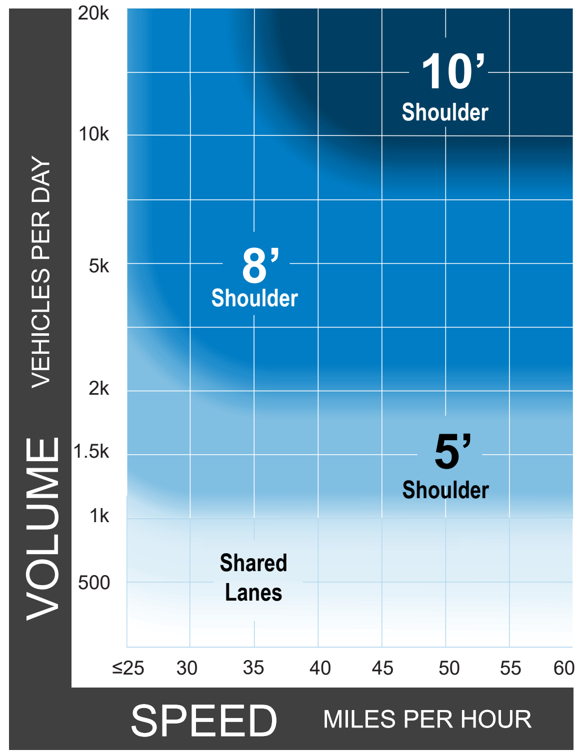


Figure 5.23 FHWA's preferred bicycle type selection for rural contexts.



DRAINAGE GRATES, INLETS, AND JUNCTIONS

Design considerations for bicycle lanes should take into consideration the ability of users to safely utilize the facilities during rain events. Drainage grates, gutter seams, and utility covers should be installed and maintained level with the surface of the bicycle lane. Drainage inlet grates on bicycle facilities should have openings narrow and short enough so that bicycle tires will not be caught by the grates and should be oriented perpendicular to the direction of travel. Existing grates that are not designed for bicycles should be replaced with a KYTC-approved grate.

BICYCLE AND OTHER MICROMOBILITY PARKING

Frequent and adequate parking should be provided for bicyclists and other micromobility users to prevent blocking pedestrian circulation routes. Parking may be implemented with racks or clearly marked parking zones on sidewalk pavement (Figure 5.24) while providing the clear pedestrian circulation access route outlined in Sections 4.1 and 5.2. Incentivization of proper parking by dockless bicycle and e-scooter riders is encouraged. In locations that support the use of geolocated boundaries through Geographic Information Systems (GIS), it is recommended to implement parking strategies and to use boundaries to delineate parking locations. NACTO provides additional guidance on best practices for managing shared micromobility, including infrastructure, parking, operations, and regulation.[10]

Figure 5.24 Dockless e-scooter parking on US 150 (Bardstown Road) in Louisville, KY.

Figure 5.25 Shared-use path on Beckley Creek Parkway bridge over Floyds Fork in Louisville, KY.

BICYCLE AND OTHER MICROMOBILITY FACILITIES ON BRIDGES

Similar to pedestrian facilities discussed in Section 5.2, bridge projects can be used to make critical new connections in bicycle networks (Figure 5.25). In constrained areas, bicyclists, and other micromobility users may need to dismount for safe access (Figure 5.26).

Figure 5.26 Bicycle dismount zone on the Louisville Loop under the KY-155 (Taylorsville Road) bridge over Pope Lick.

SIGNING, STRIPING, AND PAVEMENT MARKINGS

The MUTCD and FHWA allow the use of green pavement markings for bicycle facilities through an interim approval process. NACTO provides guidance on the use of green markings on lanes and in mixing zones to identify potential user conflict zones (Figure 5.27). The MUTCD and NACTO provide guidance for the use of standard lane striping and pavement markings, as well as associated warning, regulatory, and other signage. The designer should consider continuous green bicycle lanes at T-intersections and other similar intersection designs that allow continuous bicycle operation without conflicts with motor vehicles.

Figure 5.27 Example of green pavement markings for bicycle lanes on W. Broadway in Louisville, KY.

SECTION 5.4

SHARED-USE PATHS, SIDEPATHS, AND TRAILS

Shared-use paths may be designed for both transportation and recreational purposes and may be used by pedestrians, bicyclists, and other micromobility users as allowed by local ordinance. The design goal is to efficiently and safely accommodate all intended users and minimize conflict potential between modes. Where a shared-use path is designed to parallel a roadway, a separation and/or physical barrier should be considered between the path and the vehicular traveled way in accordance with AASHTO and the guidance in Section 9.1.

In alignment with the Architectural and Transportation Barriers Compliance Board (ATBCB),[11] KYTC defines shared-use paths, sidepaths, and trails as follows:

- **Shared-use paths** provide a universally accessible, separated off-street transportation and recreation corridor for pedestrians, bicyclists, and other micromobility users.
- **Sidepaths** are shared-use paths that are adjacent to the street, road, or highway. The term sidepath may be interchangeable with shared-use path, and this Manual will refer to sidepaths as shared-use paths.
- **Trails** are primarily recreational-focused paths, may or may not be universally accessible, and are not typically parallel to the roadway. The occasional equestrian, bicyclist, or pedestrian may utilize the roadway or shoulder to access trails.

DESIGN PARAMETERS

A shared-use path is typically physically separated from motor vehicle traffic by a buffer space or barrier and is designated for two-way travel. Shared-use path design is similar to roadway design, but on a smaller scale and with lower design speeds. Shared-use paths may also be used by pedestrians, skaters, and other non-motorized users and should be designed accordingly. When designing shared-use paths, the bicyclist may not be the critical design user for every element of design. For example, the crossing time of most intersections between roads and pathways should be designed for pedestrians, as they are the slowest users. Shared-use paths must also be carefully designed at all public street and private driveway intersections due to their two-way operation. Detailed information on intersections, interchanges, and other crossings is located in Chapter 6.

The AASHTO *Guide for the Development of Bicycle Facilities* provides guidance for the design of shared-use facilities for the higher-speed bicyclist. Non-transportation, recreational trail design of shared-use paths may vary. A summary of the geometric, transportation-focused design guidance from AASHTO is discussed as follows.

DESIGN SPEED

The design speed for a shared-use path is based on the bicyclist and is dependent on the terrain and the expected conditions of use. The average design speed for shared-use paths is 18 mph. However, design speed may vary to intentionally slow bicyclists and/or other micromobility users in high pedestrian volume locations or on approaches to crossings.

HORIZONTAL AND VERTICAL CURVES

The recommended minimum horizontal curve radius for a shared-use path is 60 feet. When minimum radius curvature cannot be obtained due to right-of-way, topographical, or other constraints and on intersection approaches and other scenarios where bicyclists and/or other micromobility users are intentionally slowed, the designer may use the following measures:

- Intermittent curves to slow or maintain desired speeds
- Standard curve warning signs and supplemental pavement markings in accordance with the MUTCD
- Optical speed bars, or perpendicular stripes painted on the pathway in decreasing intervals to slow user speed
- Varying pavement texture to encourage reduction in speed
- Widening the pavement through the curves

ACCESSIBILITY

Shared-use paths must meet all applicable ADA/PROWAG requirements to the maximum extent feasible for pedestrians. Where shared-use paths are within a roadway right-of-way, the grades shall not exceed the general grade of the adjacent roadway. Where shared-use paths are not within a roadway right-of-way, the grade shall be five percent maximum. For grades exceeding 5%, the designer should consider the ABA guidance on trail rest intervals for a range of grades up to 12%.[12] Shared-use path pavement may use either a single slope or crown to facilitate drainage. Shared-use paths in cut sections or adjacent to gravity/retaining walls require additional consideration of drainage design to minimize ponding after a rain event.

PATH WIDTH AND MITIGATING MULTIMODAL CONFLICTS

The recommended shared-use path width is 10 feet with a typical range of 10 to 14 feet. The width can be reduced to 8 feet when site-specific conditions prevent a full width path, but it should be recognized that narrower widths will yield lower levels of service during peak-hour use of the facility. On high-volume facilities, the designer should consider widths of 11 to 14 feet (or more), striping, buffers, and/or other separation between modes to safely and comfortably accommodate all users (Figure 5.28).

Figure 5.28 Visual and physical separation between pedestrians and bicyclists on Town Branch Commons in Lexington, KY.

HORIZONTAL AND VERTICAL PATH CLEARANCES

A 2-feet-wide lateral clearance, at a maximum of 6:1 slope on each side of the paved surface, is to be provided. Sections bound by a structure, such as a pedestrian/ bicycle rail, may reduce the lateral clearance (Section 9.1). The minimum operating vertical clearance for an adult bicyclist is 8.3 feet, and minimum preferred vertical clearance is 10 feet. For trails and other paths that accommodate equestrians, additional horizontal and vertical path clearance may be required.

ROADWAY OFFSETS

A lateral offset of 5 feet from the edge of the adjacent travel lane is recommended (Figure 5.29). When driveways are present, lateral offset allows the sloped driveway apron to be placed without interfering with the shared-use path cross slope. Additional separation beyond the minimum is preferred when feasible. If the appropriate buffer cannot be attained or the path is located in the clear zone, a physical barrier should be considered (Section 9.1).

Figure 5.29 Louisville Loop shared-use path lateral roadway offset on US 60 (Shelbyville Road) in Louisville, KY.

DRAINAGE GRATES, INLETS, AND JUNCTIONS

Similar to curbside bicycle lanes (Section 5.3), bicycle-friendly grates should be utilized on shared-use paths to prevent catching bicycle or other small wheels.

STRUCTURES

On bridges or in tunnels, it is common to pave the entire shared-use path, including the path clear zones. This usable width can be advantageous for emergency, patrol, and maintenance vehicles and allows for maneuvering around pedestrians and bicyclists who may have stopped. It also keeps the structure clear of loose shoulder material. The proposed structure width must follow the above paved path design guidelines with an additional 2-foot lateral clearance on both sides and proper safety railings on bridges (Section 9.1).

SIGNING, STRIPING, AND PAVEMENT MARKINGS

The public may confuse shared-use paths parallel to the roadway with sidewalks. Since bicycles are prohibited from use on sidewalks in many areas, pedestrian-scale signing should be considered to denote shared-use paths. Adequate signing is also required where shared-use paths intersect roadways and other paths. Pavement markings are considered optional on shared-use paths and may be utilized along with other elements to separate pedestrians from faster-moving bicyclists and/or other micromobility modes.

Special attention should be given to intersection and conflict warning signs (Figure 5.30). Additionally, curve and steep grade warning signs are recommended where applicable on shared-use paths. Grade warning signs shall be placed based on engineering judgment, and should be considered when the grade exceeds five percent. The MUTCD provides additional guidance on the selection, size, and placement of warning, guide, and other signage for the roadway and shared-use path. All path intersections with roadways shall have proper pavement marking and signage for both facilities as discussed in Chapter 6.

Figure 5.30 Example of shared-use path roadway crossing on the Louisville Loop in Louisville, KY.

SECTION 5.5

TRANSIT FACILITIES

This section provides general siting and design information for bus transit facilities. It is intended for KYTC engineering and planning staff, local transit providers, developers, and local agencies engaged on the collaborative development of transit facilities on or adjacent to state highways and state or federally-funded projects. Guidance for the design and operation of these facilities can be found in the AASHTO *Guide for Geometric Design of Transit Facilities on Highways and Streets,* FTA *Stops, Spacing, Location and Design,*[13] and the NACTO *Transit Street Design Guide*.[14]

OVERVIEW OF URBAN AND RURAL TRANSIT

In urban contexts, transit may consist of a variety of vehicles, including vans, buses, and light rail. Rural transit often provides service through smaller vans and buses. Both urban and rural transit operators may provide service for people with disabilities to their residences in addition to service to specific bus stops and/or park-and-ride locations. KYTC promotes public transportation services on state highways, including transit routes and stops. Transit serves a vital transportation function by providing people with freedom of movement and access to employment, schools, community and recreational facilities, medical care, and shopping centers. Transit directly benefits those who choose this form of travel as well as those who have no other choice or means of travel. Transit also benefits other users by helping to reduce congestion on roadway networks and reducing carbon emissions, thereby improving air quality.

ACCESSIBILITY

Waiting for, boarding, and alighting transit vehicles typically takes place in the sidewalk corridor. The bus boarding and alighting pad, the path to the shelter, and the area within the shelter must meet the requirements for universal ADA access (Sections 4.1 and 5.2). Transit stops should be located where boarding and alighting areas are accessible to the sidewalk or other pedestrian path. Each boarding and alighting area must accommodate the extension of assistive lifts from accessible buses and allow for wheelchairs to maneuver on and off the lift (Figure 5.31).[15] This space should be clear of all obstructions. In constrained corridors with infrequent bus service and low pedestrian volumes, the boarding and alighting area may overlap other clear spaces, such as the pedestrian access route.

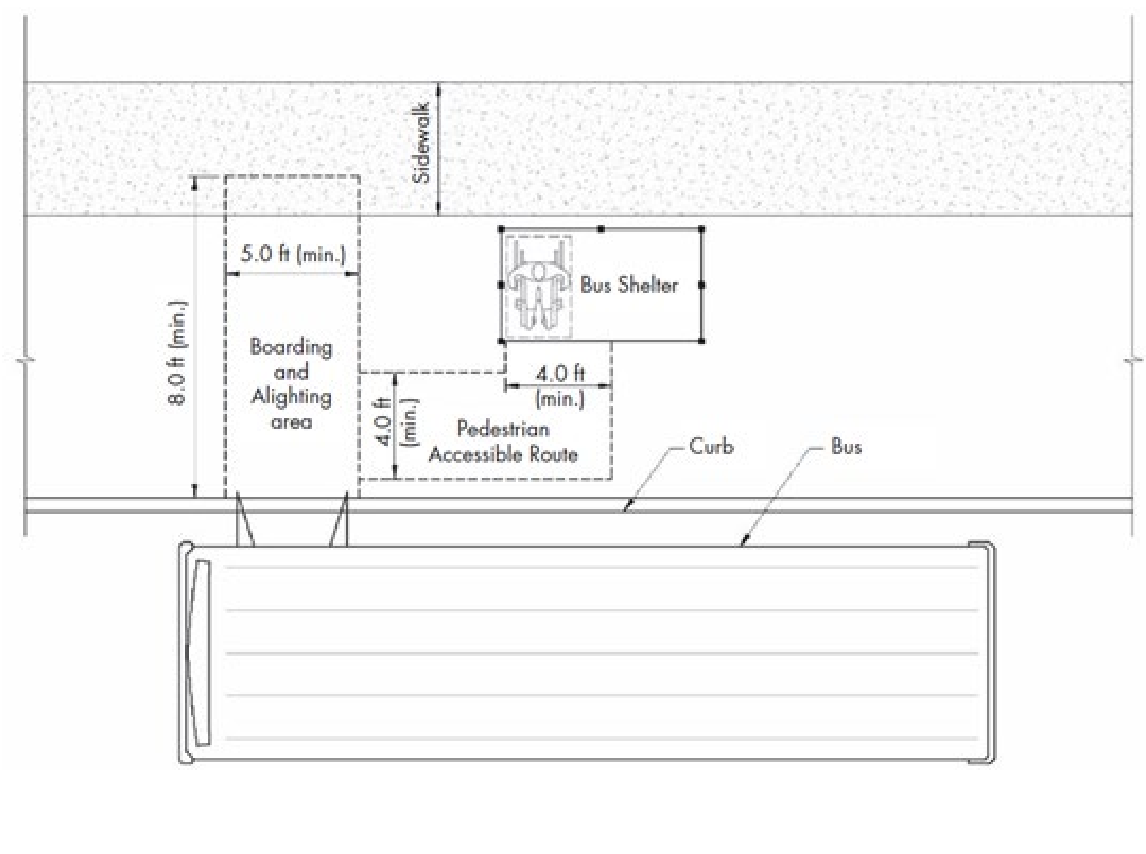


Figure 5.31 Accessible bus stop clear area. Photo courtesy of AASHTO.

BUS STOP PLACEMENT

The bus stop is the point of contact between the passenger and the transit services (Figure 5.32). Stops may be located such that a bus stops either within the travel lane or outside the travel lane in a turnout. The simplest bus stop is a location by the side of the road. The highest quality bus stop provides passenger amenities and protection from the weather.

The information in this section is offered as an example of best practices and is not intended to be binding by either the transit agency or KYTC. Transit agencies typically identify and maintain bus stop locations, including on state routes and/or state right-of-way. Transit agencies shall ensure bus stops are in locations with adequate sight distance and meet universal access requirements. Shelters and other passenger amenities should be considered as a component of Complete Streets to enhance rider comfort. KYTC strongly recommends that transit agencies coordinate with KYTC on new or updated bus stop locations, especially if passenger amenities and shelters are to be constructed within state right-of-way. The goal of this coordination and collaboration is to meet the needs of transit users and motorists while also improving pedestrian safety and connectivity. This collaborative development and planning of transit facilities is important for both KYTC and the public transit agencies to fulfill their ADA Transition Plans.

A vital part of the success of a transit system depends on the availability of convenient access to transit stations, stops, and park-and-ride facilities. Accordingly, transit user accommodations along and across roadways served by transit (and on streets that lead to transit corridors) should include pedestrian, bicycle, and/or other micromobility access to and from these facilities where appropriate. Users also commonly access transit by personal car and taxi, as well as other modes of transit.

Figure 5.32 Bus stop point of contact with passengers.

Transit user accommodations are typically applicable:

- Within a 0.75-mile pedestrian and bicycle catchment area of an existing fixed-route transit facility (i.e., stop, station, or park-and-ride lot). A catchment area is defined by a radial distance from a transit facility per Federal Transit Administration (FTA) guidelines and includes crossing and intersecting streets.
- Between transit stops/stations and local destinations. Mid-block crosswalks should be considered at transit stops located more than 0.25 miles from a signalized or stop-controlled intersection. Detailed information on mid-block crossings is located in Chapter 6.
- On limited access facilities, bus stops are only allowed at designated locations.

Placement of bus stops addresses the needs and convenience of transit providers, riders, and highway or street operations. Basic considerations include:

- Convenient service for patrons, including passenger transfers
- Presence and width of accessible sidewalks, crosswalks, curb ramps, and connection to pedestrian circulation systems
- Adequate curb space for the number of buses and dwell time (boarding, alighting, and loading/unloading of wheelchairs and bicycles) expected at the stop at one time, presence of parking, and truck delivery zones
- Traffic control devices near the bus stop, such as signals or stop signs
- Geometric design of the street, road, or highway and traffic characteristics such as motor vehicle volume, speed, crossing distance, crash history, sight distance, and traffic generator density
- Volumes and turning movements of pedestrians, bicyclists, and/or other micromobility users
- Proximity to rail crossings
- Transit queue bypass or priority equipment at signalized intersections, where appropriate
- Available space to pair stops on each side of a corridor where appropriate
- Proximity to intersections and other crossings

If any of these elements suggests an undesirable location for a pedestrian crossing, an alternate location for the transit stop should be considered.

Typically, the preferred locations for bus stops at the near or far side of an intersection. Stops near intersections provide the best pedestrian accessibility from both sides of the street and the cross streets. General considerations for locating stops near intersections include:

- A near-side stop on two-lane streets where vehicles cannot pass a stopped bus
- A far-side stop on streets with multiple lanes where vehicular traffic may pass uncontrolled around the bus
- On streets where vehicular traffic is controlled by a signal, the bus stop may be located either on the near side or on the far side, but the far side is preferred
- Where it is not desirable to stop the bus in a lane and a bus turnout is warranted, a far side or mid-block stop is generally preferred
- When locating a bus stop in the vicinity of a driveway, consider issues related to sight distance, blocking access to development, and potential conflicts between automobiles and buses

Bus stops may be placed at mid-block locations on long blocks or to serve a major transit generator. At mid-block bus stops, crosswalks should be considered based on pedestrian and bicycle access patterns. If a mid-block crosswalk is provided, it should be placed behind the bus stop so passengers do not cross in front of the bus, where they are hidden from passing traffic. The sections that follow discuss these three types of bus stop locations in more detail.

FAR-SIDE BUS STOPS

Far-side bus stops are located just past an intersection. Sight distance conditions generally favor far-side bus stops, especially at unsignalized intersections. A driver approaching a cross street on the through lanes can see any vehicles approaching from the right.

ADVANTAGES

- Right turns can be accommodated with less conflict.
- Minimum interference is caused at locations where traffic is heavier on the approach side of the intersection.
- Stopped buses do not obstruct sight distance for vehicles entering or crossing from a side street.
- At a signalized intersection, buses can often find a gap to enter the traffic stream, except where there are heavy turning movements onto the street with the bus route.
- Waiting passengers assemble at less-crowded sections of the sidewalk away from the intersection corners.
- Buses do not obscure traffic control devices or pedestrian movements at the intersection.

DISADVANTAGES

- Intersections may be blocked if other vehicles park illegally at the bus stop or if more buses than the stop can accommodate arrive at the same time.
- If signal priority is not used, the bus stops at the red light and again at the far-side stop, interfering with efficient traffic and bus operations.

NEAR-SIDE BUS STOPS

Near-side stops are located just prior to an intersection. A near-side stop may be desirable when physical street characteristics prevent a far-side stop or in high ridership or transfer demand locations. With near-side stops, the view to the right may be blocked by a stopped bus. Where the intersection is signalized, the bus may block the view of one of the signal heads.

ADVANTAGES

- Provides an alternative in cases where a far-side bus stop location does not provide a secure, convenient, or feasible boarding location for passengers.
- Minimum interference is caused where traffic is heavier on the departure side than on the approach side of the intersection.
- Less interference is caused where the cross street is a one-way street from right to left.
- Passengers generally exit the bus close to the crosswalk.
- Less interference results with traffic turning onto the bus route street from a side street.

DISADVANTAGES

- Buses can cause conflicts with right-turning traffic.
- Buses often obscure sight distance to stop signs, traffic signals, or other control devices, as well as to pedestrians crossing in front of the bus.

MID-BLOCK BUS STOPS

Mid-block stops are located away from an intersection. Mid-block stops may be desirable where traffic or physical street characteristics prohibit a near- or far-side stop adjacent to an intersection, or where large factories, commercial establishments, or other large bus passenger generators exist. A mid-block stop should be located at the far side of a pedestrian crosswalk (if one exists), so that parked buses do not block an approaching motorist's view of pedestrians in the crosswalk.

ADVANTAGES

- Buses cause minimal interference with the sight distance of both vehicles and pedestrians.
- Stops can be located adjacent to major bus passenger generators and attractors.

DISADVANTAGES

- Walking distances increase for passengers crossing at intersections.
- Buses may have difficulty reentering the flow of traffic.
- Driveway access may be negatively impacted in the vicinity of the stop.

CURB EXTENSIONS AND BUS BULBS

Bus bulbs are curb extensions utilized primarily for serving a bus stop (Figure 5.33). Bus bulbs are typically applicable along curbed streets with on-street parking or shoulders and are the width of the parking lane or shoulder with a 1-foot offset from the travel lane line. The bus bulb length should allow passengers to use the front and back doors of the transit vehicle utilizing the stop. In addition to reducing the pedestrian crossing distances, curb extensions can reduce the impact to parking compared to typical bus zones, mitigate traffic conflicts with other motor vehicles for buses merging back into the traffic stream, make crossing pedestrians more visible to drivers, and create additional space for passenger queuing and amenities on the sidewalk, such as a shelter and/or a bench.

Bus bulbs may also be utilized to protect bicycle lanes rather than requiring those users to mix with transit vehicles through bus stops. When the bicycle lane remains at pavement level, the separated bus bulb is sometimes referred to as a floating bus stop or a side boarding island stop. Regardless of the chosen bus bulb design, the accessibility of the stop for pedestrians and design for the mixing zone between pedestrians and bicyclists must be considered. The NACTO *Transit Street Design Guide and Urban Street Design Guide* provide more guidance on the design and application of bus bulbs.

Figure 5.33 Example of a bus bulb on US 31W (Main Street) in Louisville, KY.

Figure 5.34 Bus turnout on US 60A (Eastern Parkway) in Louisville, KY.

BUS TURNOUTS

A bus turnout is a recessed curb area located adjacent to the traffic lane (Figure 5.34). Bus turnouts are desirable only under certain conditions because of the delay created when the bus must reenter traffic. They should typically not be located on the near side of signalized intersections due to the difficulty for buses to reenter the traffic stream (queued vehicles block the turnout on the red cycle and moving traffic prevents reentry on the green cycle). The design of the turnout must accommodate the stopping area length for the number of buses expected simultaneously and sufficient entrance and exit tapers.

ADVANTAGES

- Allow vehicles to proceed around the bus, reducing delay
- Maximize vehicular capacity of high-volume vehicle priority streets
- Clearly define the bus stop
- Reduce potential for rear-end crashes
- At signalized intersections, provide a queue jump at a near-side stop

DISADVANTAGES

- Make it more difficult for buses to reenter traffic, increasing bus delay and average travel time for buses
- Can reduce accessibility due to difficulty of buses pulling parallel to curb
- Can create greater crash risk for buses pulling back into traffic
- Use additional space and might require right-of-way acquisition

BUS RAPID TRANSIT

Bus Rapid Transit (BRT) is a form of bus-based public transportation that mimics the speed and service of light commuter rail. BRT utilizes any combination of dedicated bus lanes, queue-jumps at signalized intersections, stop location, and stop spacing to streamline services and improve overall service. Dedicated bus lanes may be marked with permanent red pavement markings similar to the green markings for bicycle lanes, and use “BUS ONLY” pavement markings. BRT is most successful when paired with local routes that provide more frequent stop locations.

ADVANTAGES

- Faster bus service over longer routes
- Consistency in operation due to dedicated facilities and traffic queue jumps
- Flexibility to change routes (over light rail)

DISADVANTAGES

- Increased stop spacing over local routes
- Requires specialized signal and bus equipment for queue jumps
- Requires additional cost for dedicated lanes

Figure 5.35 BRT stop on US 31W (W. Market Street) in Louisville, KY.

SECTION 5.6

MOTOR VEHICLE FACILITIES

Motor vehicles are a critical component in the design of Complete Streets as they have the greatest impact to comfort and safety of all users. Following is a discussion of design considerations related to motor vehicles and the balance between their needs and the accommodation of other users.

VEHICLE TRAVEL LANES AND SHOULDERS

Complete Streets design is often controlled or impacted by the required widths of vehicle travel lanes. Lane width can affect the operation and safety of all modes along a roadway and should be carefully selected. Design of adjacent pedestrian and bicycle facilities is also often influenced or impacted by the width of roadway shoulders where they are used. Speed is a primary consideration when evaluating potential adverse impacts on safety.

On high-speed, rural, two-lane highways, an increased risk of cross-centerline head-on or cross-centerline sideswipe crashes is a concern because drivers may have more difficulty staying within the travel lane. On any high-speed roadway, the primary safety concerns with reductions in lane width are crash types related to roadway departure. FHWA provides a number of regularly updated Proven Safety Countermeasures (Figure 5.36) to manage speed and mitigate roadway and lane departures. In a low-speed, urban, suburban, or small town environment, the effects of reduced lane width are different. On these facilities, the risk of roadway departure crashes is less. Consideration for travel lane width in urban areas is typically dependent on corridors identified for large vehicle access, such as freight corridors and fixed transit routes. Typical travel lane widths range from 10 to 11 feet. However, a minimum of 9 feet is allowed in constrained conditions, and up to 12 feet is allowed for accommodation of heavy vehicles.

Figure 5.36 Example of FHWA Proven Safety Countermeasures for speed management and roadway departure.

Horses and occupants of horse-drawn vehicles are vulnerable roadway users found in rural contexts, shown here on US 31W in Simpson County, KY.

Reduced lane widths and number of motor vehicle travel lanes may be chosen with any roadway context to manage or reduce speed, shorten crossing distances for pedestrians, and provide additional space for facilities for other modes. These may include but are not limited to medians for access control, bicycle lanes, transit lanes, on-street parking, transit stops, and landscaping. The selection of lane and shoulder width by roadway context and design vehicle type is covered in more detail in the AASHTO *Green Book*. Local agencies may have adopted guidance on the selection of lane and shoulder width to be considered in addition to the *Green Book* guidance.

In areas with equestrians, horse-drawn vehicles, or farm implements, additional shoulder width and placement of rumble strips should be considered since horses and occupants of horse-drawn vehicles are particularly vulnerable to motor vehicle crashes. Horses do not like to step on the rumble strips and it is not comfortable to operate horse-drawn vehicles continuously on rumble strips. Additional shoulder width or frequent opportunities for these users and farm implement operators to pull out of the travel lane onto a wide shoulder should be considered in context-specific locations.

PARKING

When a proposed project is to include on-street parking, parallel parking is typically recommended. Parallel parking serves as a good traffic calming tool and can provide a buffer between the travel lane and the sidewalk. In lieu of parallel parking, reverse-in angle parking, also called back-in angle parking, (Figure 5.37) may be utilized to allow visibility to bicyclists and/or other micromobility users when the driver is leaving the parking space. The allowance for on-street parking should be based on the function and width of the street, the adjacent land use, and traffic volume, as well as existing and anticipated traffic operations.

Most vehicles will parallel park within 6 to 12 inches of the curb face and will occupy approximately 7 feet of actual street space. Therefore, the recommended minimum width of a parking lane is 8 feet, including the gutter pan. However, parking lanes that are 7 feet wide are acceptable when adjacent to a minimum 11-foot-wide travel lane. Parking should not restrict sight distance at intersections and other crossings, and curb extensions may be utilized to make pedestrians more visible to motor vehicles and reduce pedestrian exposure to conflicts. More information on visibility and curb extensions is located in Section 4.2.

Figure 5.37 Reverse-in angle parking on E. High Street in Lexington, KY.

FREIGHT CONSIDERATIONS

Freight vehicles are a critical component of Complete Streets design. They require wider travel lanes, larger turning radii, and other design considerations to successfully and safely navigate the transportation network to deliver goods and services throughout the Commonwealth. Additionally, freight vehicles may negatively impact the safety of bicyclists and/or other micromobility users in adjacent lanes or at crossings due to limited sight lines from the vehicle. Along heavy freight corridors and in instances with consistent high demand for freight curb access, consideration should be given for wider vehicle lanes and shoulders, increased turning radii, and separated bicycle facilities for the safety and comfort of all users. To balance the safety of pedestrians, bicyclists, and/or other micromobility users, turning speeds may be managed with truck aprons or other mountable speed control.

At the time of publication of this Manual, the Transportation Research Board (TRB) is collecting data and reviewing literature culminating in NCHRP Synthesis 53-17 *Integrating Freight and Active Transportation into Policies, Programs, Plans, and Project Development.*[16] The synthesis will include guidance and recommendations relating to the interactions between freight, pedestrians, bicyclists, and/or other micromobility users. Local agencies may also provide guidance for designing for freight and managing interactions with other users. An example in Kentucky is available through the Kentuckiana Regional Planning & Development Agency (KIPDA) *Freight Design Guide*.[17]

CURBSIDE MANAGEMENT

In urban areas, central business districts, and commercial areas where curbside space is in high demand, allocating and managing the curbside is critical to the circulation of people, goods, and services. Parking, deliveries, loading, rideshare, bicyclists, and/or other micromobility users may all be competing for limited space. In these situations, the priority is the safety of bicyclists and/or other micromobility users followed by safe curbside access for other important uses. Occasionally, these uses may share space as long as vehicles are not loitering in or otherwise blocking bicycle lanes. In situations with high turnover, particularly with large freight vehicles with limited sight lines, the safest solution is to provide dedicated, separated space for bicyclists and/or other micromobility users without interactions with vehicles, where feasible. The designer must consider the types of uses in demand in project-specific locations along with the anticipated volumes, and balance those needs with the safety of all users.

SIGNING, STRIPING, AND PAVEMENT MARKINGS

The MUTCD provides the guidance for signs, striping, and pavement markings on public streets, roads, and highways. The KYTC *Standard Drawings, Highway Design Manual, and Traffic Operations Manual* are additional resources for developing the signs, striping, and pavement markings for motor vehicle facilities. Additional information on signing, striping, and pavement markings related to intersections, interchanges, and other crossings is located in Chapter 6.

SECTION 5.7

FURNISHING ZONES

Landscaping, trees, shelters, benches, and other amenities in the furnishing zone between motor vehicles and other users on separated lanes, sidewalks, or shared-use paths are appropriate in Complete Streets design. ITE recognizes the importance of amenities, shade, and restful places in creating walkable, bikeable, and enjoyable communities.[18] This section contains general recommendations for plantings and green space, placement of amenities, and clearance requirements within different roadway contexts.

PLANTING AND GREEN SPACE RECOMMENDATIONS

Typical planting recommendations, including placement and species selection, will vary widely based on site-specific constraints, land use context, soil composition, and the presence of water. Green spaces, particularly shade trees, are important to the character of the corridor, improve comfort of pedestrians, bicyclists, and/or other micromobility users, and may also help reduce urban heat island effects (Figure 5.38). Street trees typically require a minimum of 6 feet of space to remain healthy with sufficient nutrients and water. Smaller plantings may require less space, but a minimum of 4 feet of space is recommended since plantings and green space require regular maintenance. When plantings and green spaces are part of a Complete Streets project, separate maintenance agreements should be developed for their care.

Figure 5.38 Street trees along US 150 (Broadway) in Louisville, KY.

In suburban to rural areas, less formal plantings and natural landscapes may be allowed to provide shade and enhance visual aesthetics (Figure 5.39). In any context, the plantings must not obstruct visibility at intersections or pedestrian circulation zones. Consultation with licensed landscape architects, arborists, KYTC staff, and local agencies on plant selection is recommended to ensure correct species selections for each site.

Figure 5.39 Suburban and natural park landscaping on Cherokee Parkway in Cherokee Park, Louisville, KY.

AMENITIES AND CLEARANCE REQUIREMENTS

Providing amenities and places to congregate, sit, and dispose of trash, in combination with landscaping and green space, contributes to vibrant, healthy communities. These types of amenities are often found in more developed small town, suburban, and urban contexts. Similar to landscaping, amenities should not obstruct visibility or pedestrian circulation.

Clearance is often a concern raised for roadside amenities and street trees in particular. The AASHTO *Roadside Design Guide* includes provisions for reduced clear zone opportunities in urban or small town urbanized areas to allow the inclusion of amenities on Kentucky streets, roads, and highways. However, amenities such as trees and natural landscapes should be encouraged even in suburban to rural areas. In areas where clearance to visual amenities is a concern in rural Complete Streets and scenic ways where bicycle or pedestrian recreation, tourism, and transportation occur more frequently, the potential use of roadside barriers should be considered in site-specific conditions in accordance with Section 9.1, AASHTO's *Roadside Design Guide* and the *Green Book*.

ENDNOTES

1 FHWA *Public Roads – Spring 2021; Micromobility: A Travel Mode Innovation* (Price, Blackshear, Blount, Jr., and Sandt) https://highways.dot.gov/public-roads/spring-2021/micromobility-travel-mode-innovation

2 FHWA *Proven Safety Countermeasures: Walkways* https://safety.fhwa.dot.gov/provencountermeasures/walkways.cfm

3 AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, Second Edition, 2021

4 FHWA *Small Town and Rural Multimodal Networks* https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf

5 FHWA *Accessible Shared Streets: Notable Practices And Considerations For Accommodating Pedestrians With Vision Disabilities* https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf

6 FHWA *Proven Safety Countermeasures: Bicycle Lanes* https://safety.fhwa.dot.gov/provencountermeasures/bike-lanes.cfm

7 KYTC *Laws and Policies* https://transportation.ky.gov/BikeWalk/Pages/Laws-and-Policy.aspx

8 NACTO *Urban Bikeway Design Guide* https://nacto.org/publication/urban-bikeway-design-guide/

9 FHWA *Bikeway Selection Guide* https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf

10 NACTO *Guidelines for Regulating Shared Micromobility* https://nacto.org/wp-content/uploads/2019/09/NACTO_Shared_Micromobility_Guidelines_Web.pdf

11 Architectural and Transportation Barriers Compliance Board Shared Use Path Accessibility Guidelines https://ne-ada.s3.amazonaws.com/s3fs-public/ANPRM%20on%20Shared%20Use%20Path%20Accessibility%20Guidelines.html

12 ABA Accessibility Standards Chapter 10: Outdoor Developed Areas https://www.access-board.gov/aba/guides/chapter-10-outdoor

13 FTA Stops, Spacing, Location and Design https://www.transit.dot.gov/research-innovation/stops-spacing-location-and-design

14 NACTO Transit Street Design Guide https://nacto.org/publication/transit-street-design-guide/

15 PROWAG R308.1.1 Boarding and Alighting Areas https://www.access-board.gov/prowag/chapter-r3-technical-requirements/

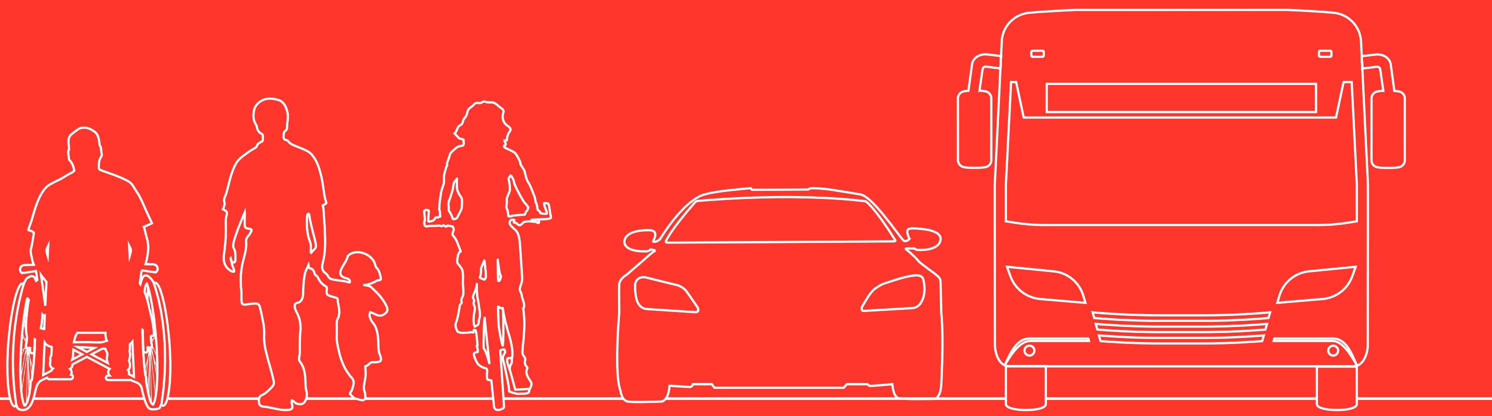
16 TRB NCHRP Synthesis 53-17 Integrating Freight and Active Transportation into Policies, Programs, Plans, and Project Development https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=5122

17 KIPDA Freight Design Guide https://www.kipda.org/wp-content/uploads/2019/12/final_kipda_freight_design_guide.pdf

18 ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach https://nacto.org/docs/usdg/designing_walkable_urban_thoroughfares.pdf

EDITION 1
AUGUST 2022

CHAPTER 6
DESIGN ELEMENTS OF COMPLETE STREET INTERSECTIONS AND CROSSINGS



SECTION 6.1

DESIGN FOR SAFETY IN AREAS OF CONFLICT

The primary objective when designing intersections and crossings for Complete Streets is to provide a visible, distinct, predictable, and clearly designated path leading to and through an intersection or crossing while managing potential conflicts between all users.

In any transportation network, users from different modes will eventually need to interact with each other. Complete Streets are safe streets for everyone. This includes intersections, crossings, and other locations where users interact with one another. As the number of different travel modes increases, so does the complexity and consideration for the safe accommodation of all users in areas of conflict. The KYTC Intersection Design Analysis Tool (IDAT),[1] the Capacity Analysis for Planning of Junctions (Cap-X) Tool,[2] and other multimodal safety and capacity analyses should be considered in the planning and design of intersections and interchanges.

Figure 6.1 Example of intersection, pedestrian, and bicycle FWHA Proven Safety Countermeasures.

SAFETY OF ALL USERS

On Kentucky's streets, roads, and highways, the safety of all users is paramount. Complete Streets provide safety for all users through the Safe System Approach, establishing the expectation that users other than motor vehicle drivers will be using the intersection or crossing, and designing for all ages and abilities.[3] FHWA provides Proven Safety Countermeasures related to intersections, conflict points, and safety for vulnerable roadway users like pedestrians and bicyclists (Figure 6.1).[4] Intersections and crossings should clearly define who has the right-of-way, provide sufficient sight distance for all users to see and react to each other, and provide physical separation in space and/or signalized separation in time wherever feasible and appropriate. Physical separation may include restricting turning movements through access management to reduce conflict points and protected intersections for vulnerable roadway users. On existing streets, roads, and highways, Road Safety Audits[5] are recommended in project planning and design phases to formally evaluate safety performance and identify areas needing safety improvements.

MIXING ZONES AND CONFLICT POINTS

Where different modes merge, diverge, or intersect is a point of potential conflict within the space of an intersection or crossing. Intersection, crossing, and entrance or driveway access design often dictates the number of potential conflict points between the users. Examples of conflict points and mixing zones include:

- Motor vehicles or bicyclists turning at an intersection
- Motor vehicles crossing over a bicycle lane or bus lane
- Accessing a driveway or entrance
- Transitioning from bicycle lanes to shared-use path
- Transit bus re-entering traffic from a turnout
- Interactions behind the curb between pedestrians, bicyclists, and/or other micromobility users (see Chapter 5 for definition) at crossings

Crossing design, speed management measures, pavement markings, signage, and other strategies may be used to clearly identify the right-of-way for each transportation mode.

SECTION 6.2

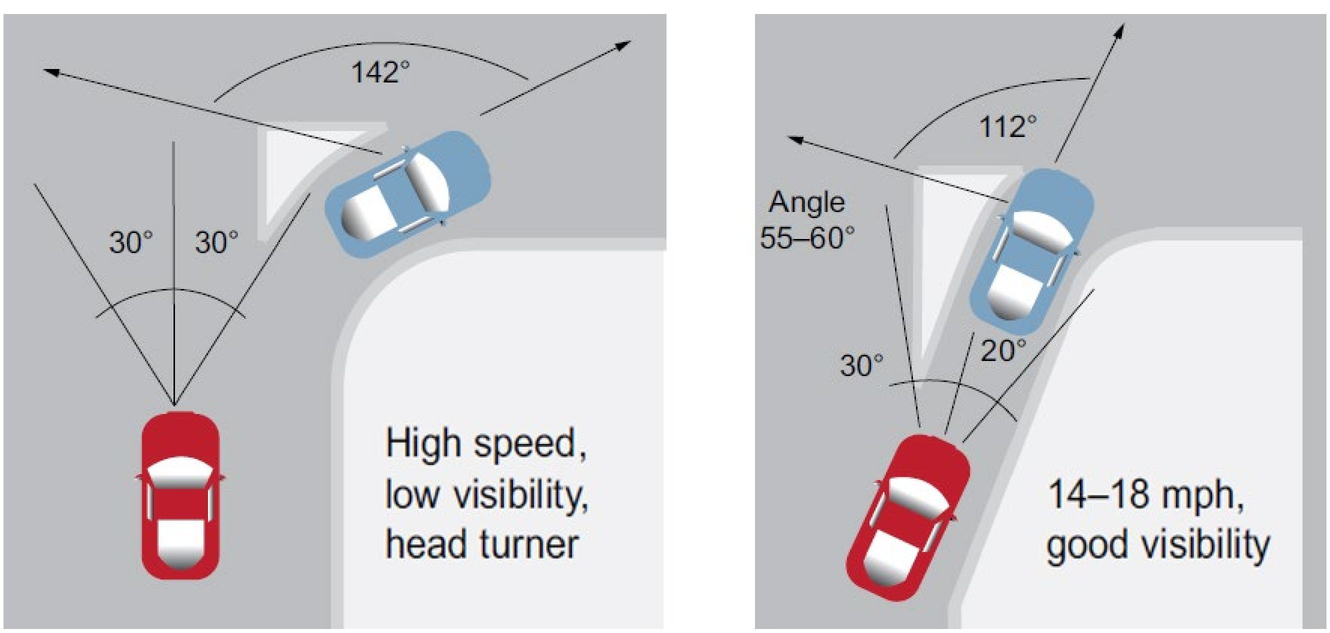
CROSSING DESIGN

Safe crossings have many design aspects in common, whether part of a controlled, mid-block, or uncontrolled intersection. Crossings must be universally accessible for the intended user. Crossings should ideally be located and designed to minimize the distance a vulnerable roadway user must cross at an intersection. Curb ramps, which may include concrete transitions between sidewalk and the ramp, are required to connect the facility at each street crossing. Curb ramp placement also has a large impact on crossing distances.

Speed management and safety countermeasures may also be utilized to slow motor vehicle speeds on the approach to crossings. On rural, higher-speed streets, roads, and highways, these countermeasures may include, but are not limited to, optical speed bars, transverse rumble strips, and speed feedback signs. On lower-speed rural residential streets as well as suburban, small town, and urban streets, additional vertical speed management countermeasures include but are not limited to protected intersections, raised crossings or speed tables, and raised intersections. Additional information on countermeasures specific to mid-block and uncontrolled crossings is located in Section 6.6.

In rural areas, additional design treatments to reduce crossing distances may be utilized, such as providing refuge islands or limiting the use of turn lanes. When channelized turn lanes are recommended, islands must accommodate all users through the intersection. Figure 6.2 shows the preferred channelized right-turn design[6] to slow motor vehicle speeds and improve safety for vulnerable roadway users. Suburban areas may utilize these treatments in addition to reduced turning radii and lane widths. Considerations for urban and urbanized small town areas with on-street parking, in addition to those previously listed, include the use of curb extensions to further minimize crossing distances. Refer to Section 4.3 for additional information on curb extensions.

Figure 6.2 High-speed (left) and preferred low-speed (right) channelized right-turn island design.



ACCESSIBILITY

Accessibility guidance applies to all crossings. When a project begins or ends at an intersection, all approaches to the intersection must be upgraded with similar multimodal features so that pedestrians of all abilities can traverse the intersection and bicyclists and/or other micromobility users have safe access through the intersection. More information on corridor accessibility and ADA standards is located in Sections 4.1 and 5.2. Where curb ramps are installed, they must be installed in all quadrants of an intersection that are connected by sidewalk and/or shared-use path facilities. Sidewalk design that provides ramps adjacent to the sidewalk and separate from the pedestrian circulation path with clear directional cues through curb and detectable warnings for pedestrians using mobility devices and navigational aids is preferred. Other ramp types may be utilized in areas with limited right-of-way, retrofits, or other constrained situations that prevent the use of the preferred ramp types. Refer to KYTC *Standard Drawings* for additional information on preferred ramp design, cross slope, ramp slope, and other details for sidewalks and shared-use paths.

Figure 6.3 Inaccessible detectable warning pavers on 2nd Street in Louisville, KY.

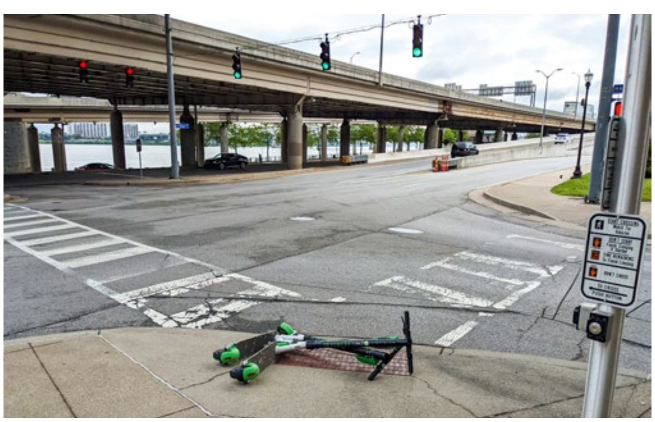


Figure 6.4 E-scooters blocking curb ramp on 2nd Street in Louisville, KY.

Detectable warning surfaces are required on all sidewalk and shared-use path ramps. Detectable warning surfaces are truncated domes installed at the transition from sidewalk to street that are large enough to be felt underfoot or with a mobility aid, but small enough not to create a tripping hazard. Refer to the KYTC *Standard Drawings* for additional design details. Detectable warning surfaces must be accessible and in good condition (Figure 6.3). For flush crossings in pedestrian walking lanes and shoulders, detectable warning surfaces are required to indicate the boundary between pedestrian and vehicular routes. Additionally, detectable warnings are required for ramps and cut-through pedestrian refuge islands at least six feet wide.

When bicyclists or other micromobility users utilize refuge islands and medians, the designer should allow for sufficient width and length of refuge space for staging various types of users. For example, bicyclists often require a longer queue space than pedestrians. Bicycles and/or e-bicycles pulling trailers, child carriers, and/or larger bicycles such as utility bicycles and tandem bicycles require additional space. Ramps shall not be blocked with signage or any other permanent or temporary obstructions. Frequent bicycle and/or other micromobility parking should be provided near intersections to encourage users to keep vehicles clear of ramps (Figure 6.4). Refer to Chapter 9 for information on accommodating pedestrians, bicyclists, and/or other micromobility users through an intersection or other crossing during construction phases that temporarily modify pedestrian and bicycle routes.

Crossing surfaces should be even and not slippery. Asphalt or concrete is the preferred walking and riding surface. Bricks, pavers, and cobblestones should not be used in crosswalks due to maintenance issues concerning "pop-outs" and their tendency to create an uneven walking and riding surface. However, they may be considered in sidewalk or shared-use path applications with appropriate maintenance agreements. When textured crossings or mixing zones are included in the intersection design, the preferred treatment is stamped concrete in lieu of pavers. Textured crosswalks must be marked with transverse reflective lines for visibility.

SIGNS, STRIPING, AND PAVEMENT MARKINGS

Clearly defining the right-of-way for each user type is important to mitigating the conflicts between modes. Pavement markings are the typical approach for designating preferential use lanes and identifying mixing zones. However, textured pavements are sometimes used for visually impaired users to discern between lanes of different modes.

Marked crosswalks are a place designated for pedestrians to cross a road. Marked crosswalks are designed to keep pedestrians together where motorists can see them, and where they can cross vehicular traffic more safely. Marked crosswalks can be either longitudinal or transverse pavement marking configurations. Longitudinal markings should be used where added emphasis is needed for the crosswalk, on shared-use path or trail crossings, or where local preference dictates. Additional information on the design requirements for crosswalks is located in the KYTC *Standard Drawings, Highway Design Guidance Manual*, and the MUTCD.

The approach to intersections needs to balance the safety needs of bicyclists and/or other micromobility users with the mobility needs of other users. The conflict between right-turning motor vehicles and through-moving bicyclists and/or other micromobility users is a serious crash risk at many intersections. At the time of this publication, transportation agencies in Kentucky are encouraged to use green pavement markings for bicycle facilities and red pavement markings for transit facilities with a FHWA-granted Interim Approval. At T-intersections or other similar crossings where bicycles can safely operate continuously, the designer should consider the use of continuous green pavement markings through the intersection. Mixing zones on the approach to intersections may be identified with transverse or “ladder” style crossing zones, signifying to motorists that they may utilize the space to cross the preferential lane to make a turn. These pavement markings may also be placed within the intersection, entrance, driveway crossing, or alongside marked crosswalks to improve motor vehicle operators’ awareness of these users in the crossing (Figure 6.5). Additional pavement markings, textured pavement, or the limited use of brick or pavers may also be used to slow the mixing of bicyclists and/or other micromobility users with pedestrians behind the curb on the approach to combined crossings. Additional considerations for the selection of surface treatments are located in Chapter 9.

Figure 6.5 Green pavement markings through the intersection of University Drive and Cooper Drive in Lexington, KY.

Bicycle facilities may also include queuing or staging areas for users to navigate a turn more easily at an intersection without requiring a merge with motor vehicle traffic. Left-turn queuing and staging areas are the most common turning movement facilities for bicyclists and/or other micromobility users to avoid a merge with motor vehicles. On some one-way streets or in contra-flow bicycle lanes, right-turn movements may warrant similar considerations. The treatments include bike boxes (Figure 6.6) for single through-lane motor vehicle traffic, and two-stage turn queue boxes (Figure 6.7) for multi-lane motor vehicle traffic. Bike boxes provide bicyclists and/or

Figure 6.6 Bike box on Spring Street in Louisville, KY.

Figure 6.7 Two-stage left turn queue box where bicyclists wait outside traffic to turn left on 6th Street in Louisville, KY.

other micromobility users a facility to maneuver to the front of the motor vehicle traffic queue during a red signal phase. Bike boxes are typically only recommended on single through-lane queue spaces to avoid the potential for multiple motor vehicle conflicts with the end of a red signal phase. Two-stage turn queue boxes should be considered on multi-lane corridors to safely facilitate bicycle and/or other micromobility turning movements. However, this treatment introduces additional delay for bicyclists. For particularly high-volume motor vehicle traffic, high bicycle demand, and/or identified bicycle priority corridors, bicycle signals may be considered in lieu of these turning treatments. When dedicated bicycle facilities are provided, the preferred treatment is to include receiving facilities on the far side of intersections, interchanges, or other crossings to facilitate safe travel through the crossing (Figure 6.8). Where receiving facilities are not feasible, the preferred treatment is to transition bicyclists to either a shared motor vehicle lane or to a shared-use path facility ahead of the intersection. When the facility transitions to a shared motor vehicle lane, sufficient space must be provided to indicate to all users that the preferential lane is ending. This indicates to motor vehicle operators to expect a merge and allows the bicyclist time and space to judge the gap and make the transition.

The NACTO *Urban Bikeway Design Guide and Transit Street Design Guide* along with the FHWA *Improving Intersections for Pedestrians and Bicyclists: Informational Guide*[7] provides additional guidance on the principles of safe design for bicyclists and pedestrians approaching and navigating intersections. The following sections include design considerations for vulnerable roadway users related to crossings at various intersection types, interchanges, and uncontrolled crossings.

Figure 6.8 Receiving bicycle lane on Goldsmith Lane in Louisville, KY.

SECTION 6.3

SIGNALIZED INTERSECTIONS

The MUTCD, ITE's *Traffic Engineering Handbook*, and the KYTC *Traffic Operations Guidance Manual* provide guidance for the warrants, design, and operation of traffic signals. Traffic signal design is complex, specific to site conditions, and dependent on the priority, safety, and comfort of each type of user of the intersection. Following are supplemental recommendations for the roadway designer and operator to consider for Complete Streets, including signal location and timing, and the reduction of crossing distances.

Figure 6.9 Pedestrian signals and push buttons at the corner of US 60A and US 150 in Louisville, KY.

MOTOR VEHICLE SIGNALS

When developing a signal timing plan, the designer should weigh its effects on all users, including the Level of Service (LOS) and comfort for motor vehicles, transit, pedestrians, and bicyclists. LOS represents the delay experienced by the user at an intersection, and comfort index formulas for both bicyclists and pedestrians are available through the 2022 KYTC *Statewide Bicycle and Pedestrian Master Plan*. Although signal cycle lengths of up to 120 seconds are typically acceptable to optimize vehicular traffic movements, expecting pedestrians or bicyclists to wait 120 seconds or more to cross may not be realistic. In urban areas with higher pedestrian, bicycle, and/or micromobility activity, short cycle lengths of 60–90 seconds may be appropriate. Additionally, long signal cycles in urban or suburban environments may negatively impact the speed of transit service.

PEDESTRIAN SIGNALS

When designing pedestrian signals, consideration must be given to the needs of all pedestrians, including those who might navigate the intersection at a significantly slower pace than the average pedestrian. The designer should determine whether pedestrian generators in the project vicinity might attract seniors and pedestrians with disabilities and adjust signal timing accordingly. In areas with visually impaired pedestrians, the designer should follow KYTC *Traffic Operations Guidance Manual* and the MUTCD for guidance on the consideration and approval of audible pedestrian signals.

Pedestrian pushbuttons, marked crosswalks, and pedestrian signals should be provided at all signalized locations with existing or planned sidewalks (Figure 6.9). Pedestrian pushbuttons and signals shall be used with existing or proposed marked crosswalks at signalized intersections. If there are no existing or planned sidewalks/pedestrian facilities, pedestrian signals of any kind are not required unless future pedestrian improvements that would warrant pedestrian signals are identified as part of the checklist outlined in Chapter 3. If marked crosswalks are not present, and will not be added, pedestrian signals are not required. When refuge islands are less than six feet wide, the intersection shall be timed for a complete pedestrian crossing. If pedestrian pushbuttons are used, they should be capable of easy activation and conveniently located near each end of the crosswalks, as outlined in the MUTCD.

All-pedestrian signal phases, sometimes called a pedestrian scramble, may be utilized in high-pedestrian volume locations to allow pedestrians to cross all legs of an intersection at once without conflicts from turning motor vehicles. Leading Pedestrian Interval (LPI) is an FHWA Proven Safety Countermeasure (Figure 6.10)[8] that may also be used to provide pedestrians, bicyclists, and/or micromobility users time to enter the intersection during the all-red motor vehicle phase to improve visibility of these users, mitigate conflicts with motor vehicles, and improve motor vehicle yielding behavior.

Figure 6.10 Safety benefits of a Leading Pedestrian Interval.

1. Goughnour, E., D. Carter, C. Lyon, B. Persaud, B. Lan, P. Chun, I. Hamilton, and K. Signor. "Safety Evaluation of Protected Left-Turn Phasing and Leading Pedestrian Intervals on Pedestrian Safety." Report No. FHWA-HRT-18-044. Federal Highway Administration. (October 2018)

BICYCLE SIGNALS

Bicycle signals may be utilized by bicycles, e-bicycles, e-scooters where allowed by local ordinance on dedicated bicycle facilities. Many situations occur where bicycle lanes, shared-use paths, and other bicycle facilities may utilize either the motor vehicle signals or the pedestrian signals to cross an intersection. In urban settings where turning motor vehicle volumes are high, bicycle volumes are high, and/or complex facilities exist such as physically separated bicycle lanes or two-way cycletracks on one side of the road, bicycle priority signals may be warranted. Figure 6.11 from the Massachusetts Department of Transportation (MassDOT)[9] provides guidance for motor vehicle turning movement thresholds that may be developed as part of the evaluation process for bicycle signals. Bicycle signal phasing may run independently or concurrently with pedestrian signals. At the time of this publication, bicycle priority signals may be used with an FHWA Interim Approval. In high bicycle volume corridors, either motor vehicle signals or bicycle signals may be timed for a “green wave” that favors bicyclists by facilitating their progression for a smooth and consistent flow along a corridor.

TRANSIT PRIORITY AND BUS SIGNALS

Similar to bicycle signals, transit priority and bus signals are most often applicable in urban areas and are found on fixed transit routes. Transit priority refers to the optimization of the signal timing to favor transit operation, either passively through coordinated signal timing or actively through vehicle detection. Transit priority may also be appropriate on some high-volume transit service corridors in suburban areas. Another level of priority includes the use of bus-specific traffic signals in tandem with dedicated bus lanes or a short segment of bus lane at the intersection. The bus signal allows the bus to jump the motor vehicle queue from a bus-only lane, in combination with a right-turn-only motor vehicle lane, or to make a left turn across stopped motor vehicle traffic from a bus stop.[10] These treatments are most often applicable in dense urban areas with high transit ridership, and may be combined with other transit priority design such as BRT. Additional information on the selection and implementation of bus priority and bus signal treatments and associated facility design are available through the NACTO *Transit Street Design Guide*,[11] FTA, and FHWA.

Figure 6.11 MassDOT bicycle signal motor vehicle turning volume thresholds.

Separated Bike Lane Operation	Motor Vehicles per Hour Turning across Separated Bike Lane			
	Two-way Street			One-way Street
	Right Turn	Left Turn across One Lane	Left Turn across Two Lanes	Right or Left Turn
One-way	150	100	50	150
Two-way	100	50	0	100

SECTION 6.4

GRADE-SEPARATED INTERSECTIONS AND INTERCHANGES

Crossing pedestrian and bicycle facilities through a grade-separated intersection or an interchange have a greater potential for conflict due to higher travel speeds, higher motor vehicle traffic volumes, and more complex lane configurations. Interchange crossings require similar considerations as intersection crossings, including crossing distance, the alignment of the crossing to motor vehicle traffic, and management of motor vehicle speeds. On new construction projects and reconstruction of existing grade-separated intersections and interchanges that will connect pedestrians and/or bicyclists, planners and engineers should consider a design that does not have free-flow turn lanes.

The preferred alignment of the crosswalk ramps intersects the motor vehicle travel path at a ninety degree angle, or perpendicular to the motor vehicle travel path. If this configuration is not feasible, the designer should consider aligning the pedestrian and/or bicycle facility to cross a ramp with a direct path of the shortest length possible. (Figure 6.12).

Figure 6.12 Direct pedestrian and micromobility crossing path on KY 237 and KY 18 interchange in Burlington, KY.

Refuge islands should be considered when multiple travel or turn lanes exist. The designer should also consider additional speed and safety countermeasures. More information on the application of these countermeasures for uncontrolled and yield-controlled crossings is located in Sections 6.5 and 6.6. Where appropriate, pedestrian and bicycle accommodations may be considered along the median and in the refuge islands. Although direct connections are preferred through interchanges and grade-separated crossings, parallel roads may also be considered as an alternative route for vulnerable roadway users around an interchange.

Pavement markings for pedestrians and bicyclists are unchanged from other intersection crossings. Clearly defining the mixing zone with a continuous bicycle lane and/or transitioning the bicyclists and/or other micromobility to a shared-use path facility are the preferred treatments across a motor vehicle ramp. Similar to other intersection crossing types, when a dedicated facility through the ramp diverge or merge is not feasible, the designer should provide sufficient space for all users to safely navigate the merge into a shared lane.

Shared-use path crossings share similar attributes to other at-grade intersection crossings. When bicycle lanes transition to shared-use paths, the designer should consider the use of active or passive speed management for bicyclists and/or other micromobility users and visual and tactile navigational cues for pedestrians with vision disabilities. Bicycle transition ramps should be designed to be accessible for bicycle wheels. Typically, an approach angle to the ramp seam between 60 and 90 degrees is preferred for bicycle accessibility. When angles less than 60 degrees are necessary due to site constraints, consideration for the construction method and joint placement may be required to reduce the risk of bicycle crashes. Pavement markings may be used on the path and through crossings to delineate dedicated space in high-volume pedestrian and bicycle locations. FHWA and the ITE *Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges: A Recommended Practice at the Institute of Transportation Engineers*[12] provide additional guidance for the selection and design of features that accommodate pedestrians, bicyclists, and/or other micromobility users through intersections and grade-separated interchanges.

SECTION 6.5

ROUNDABOUTS AND YIELD-CONTROLLED INTERSECTIONS

Roundabouts and other yield-controlled intersection crossings for pedestrians, bicyclists, and/or other micromobility users rely on the design of the roundabout or intersection approach to create low motor vehicle speeds. Roundabouts are an FHWA Proven Safety Countermeasure (Figure 6.13),[13] reducing conflicts for all modes of transportation in rural, small town, suburban, and urban contexts. In rural contexts where multiple transportation modes are uncommon, roundabouts provide valuable safety improvements for motor vehicles (Figure 6.14).

Vulnerable roadway users experience limited exposure to motor vehicle traffic at roundabouts using raised splitter islands that provide refuge, requiring users to cross only one direction of traffic at a time. Splitter islands must be designed to fully accommodate the expected pedestrian and bicycle volumes, with crossings placed at least one car length before the yield line at the roundabout entrance to allow motor vehicle visibility. Single-lane roundabout approaches and exits are preferred over multilane roundabouts due to their lower speeds and shorter crossing distances. The designer may consider the use of additional speed and crossing safety countermeasures as discussed in Section 6.6.

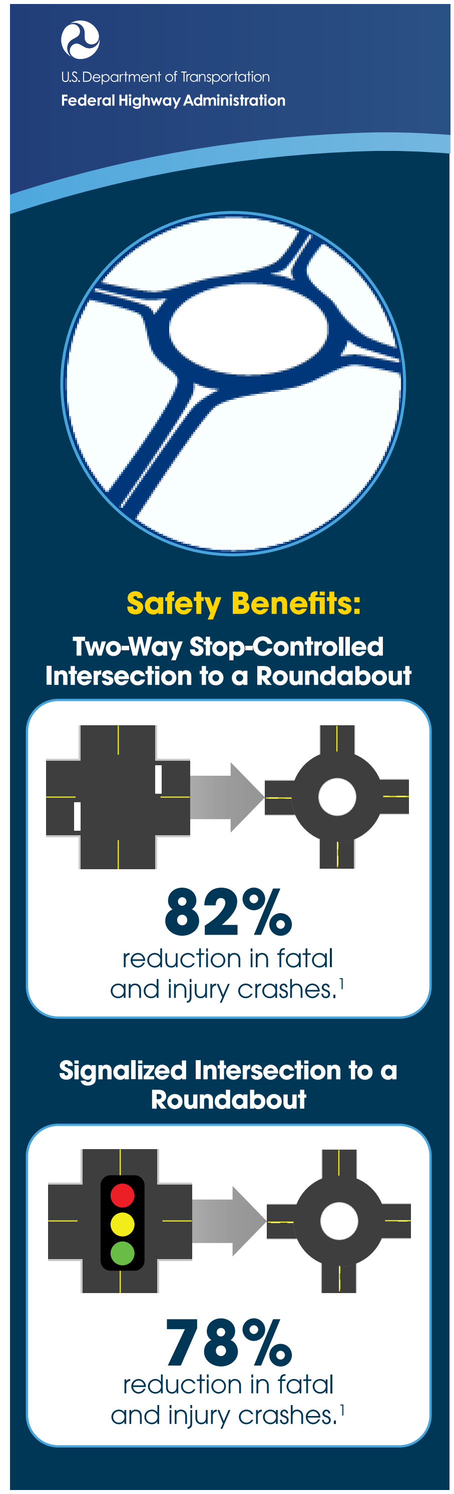


Figure 6.13 Roundabout Proven Safety Countermeasure.

1. AASHTO. The Highway Safety Manual, American Association of State Highway Transportation Professionals, Washington, D.C., (2010).

Figure 6.14 Rural roundabout example in Bath County, KY.

Safe crossings for visually impaired pedestrians at a roundabout is a challenge. At signalized intersections, visually impaired pedestrians often rely on accessible pedestrian signals to determine where and how to cross. Roundabouts do not directly interrupt flow and typically do not have signal control. Traversing roundabouts with multilane entries and/or exits creates additional difficulties for the visually impaired, and crosswalk enhancements may be needed. Additional guidance concerning accessible crossings at roundabouts can be found in NCHRP 674 *Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities*.[14]

The preferred treatment for pedestrians, bicyclists, and/or other micromobility users on the approach to a roundabout is to transition dedicated lanes to a shared-use path for navigating the intersection and combined crossings with pedestrians. This provides all ages and abilities access through the roundabout, with similar considerations for transition ramps, bicycle and/or other micromobility speed management, modal conflict management, and navigation cues as detailed in Section 6.4.

SECTION 6.6

MID-BLOCK AND OTHER UNCONTROLLED CROSSINGS

Mid-block crossings are located between roadway intersections, and other uncontrolled crossings may occur at a variety of intersections, interchanges, driveways, and entrances. Pedestrians, bicyclists, and/or other micromobility users at mid-block and other uncontrolled crossings can be accommodated safely and comfortably. Mid-block crossings are most typically found in urban contexts, urbanized small town areas, and suburban neighborhoods. Mid-block and other uncontrolled crossings should be sufficiently spaced between signalized crossings such that pedestrians, bicyclists, and/or other micromobility users have safe, convenient crossings to access residences, transit, and other destinations. The designer should consider the guidance in the NACTO *Urban Street Design Guide* for the implementation and spacing of mid-block and other uncontrolled crossings.

Similar to other crossing types, it is preferable that mid-block crossings intersect the roadway at an angle as close to perpendicular as possible to reduce crossing distance and exposure to conflicts. To the extent feasible, mid-block crossings should be placed far enough away from intersections to minimize conflicts between the users and turning motor vehicle traffic. Additional treatments at mid-block or other uncontrolled crossings may be considered to improve safety and visibility of vulnerable roadway users. These treatments may include, but are not limited to, medians, islands or other refuges, pavement markings, lighting, raised crosswalks or intersections, signage, roadway reconfigurations, pedestrian activated flashing beacons, and signals (Figure 6.15 and Figure 6.16). Additional guidance on the selection of safety countermeasures for mid-block and uncontrolled crossings is available through the FHWA *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations*.[15] Figure 6.17 shows the crash countermeasure matrix from the guide and demonstrates the selection of crash countermeasures to these crossing types based on roadway features. Many of the principles that improve pedestrian safety may also be applied to bicyclists and/or other micromobility users.

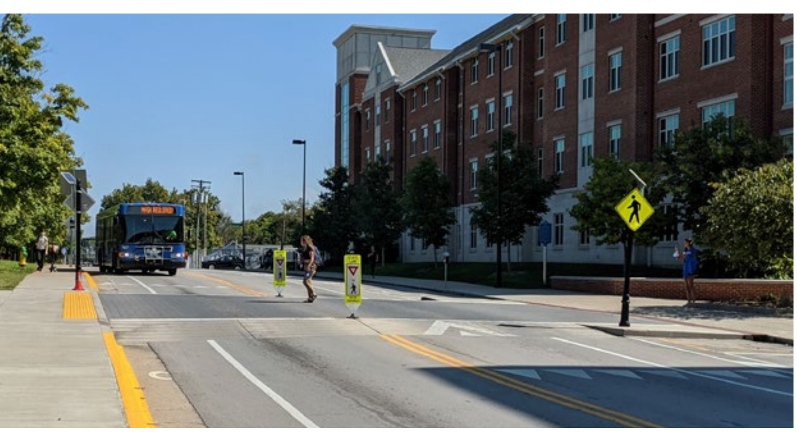


Figure 6.15 Raised pedestrian and bicycle crossing on Woodlawn Avenue n Lexington, KY.

Figure 6.16 Brighton Rail Trail mid-block crossing on Polo Club Boulevard in Lexington, KY.

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

Given the set of conditions in a cell,

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

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

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

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

***It should be noted that the PHB and RRFB are not both installed at the same crossing location.*

This table was developed using information from: Zegeer, C.V., J.R. Stewart, H.H. Huang, P.A. Lagerwey, J. Feaganes, and B.J. Campbell. (2005). Safety effects of marked versus unmarked crosswalks at uncontrolled locations: Final report and recommended guidelines. FHWA, No. FHWA-HRT-04-100, Washington, D.C.; FHWA. Manual on Uniform Traffic Control Devices, 2009 Edition. (revised 2012). Chapter 4F, Pedestrian Hybrid Beacons. FHWA, Washington, D.C.; FHWA. Crash Modification Factors (CMF) Clearinghouse. http://www.cmfclearinghouse.org/; FHWA. Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE). http://www.pedbikesafe.org/PEDSAFE/; Zegeer, C., R. Srinivasan, B. Lan, D. Carter, S. Smith, C. Sundstrom, N.J. Thirsk, J. Zegeer, C. Lyon, E. Ferguson, and R. Van Houten. (2017). NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. Transportation Research Board, Washington, D.C.; Thomas, Thirsk, and Zegeer. (2016). NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways. Transportation Research Board, Washington, D.C.; and personal interviews with selected pedestrian safety practitioners.

Figure 6.17 Crash countermeasure selection matrix.

SECTION 6.7

RAILROAD CROSSINGS

The design of pedestrian and bicycle facilities that cross railroad tracks often presents challenges due to the conflicting needs of pedestrians, bicyclists, and/or other micromobility users, and trains. However, these challenges should not allow railroad crossings to become a barrier to pedestrian and bicycle access (Figure 6.18). Depending on the control of the railroad crossing, detectable warnings may be used and placed according to the MUTCD guidance. The crossing width should match that of the dedicated bicycle lane, pedestrian facility, or shared-use path. Whenever practical, a crossing should be perpendicular to the tracks. Crossing angles between 60 and 90 degrees are particularly important for accessibility for both pedestrians and bicyclists over railroad tracks, as wheels can become caught in the spaces around the rails (Figure 6.19).[16] Concrete crossing surfaces are preferred to provide the smoothest and most durable accessible crossing surfaces for pedestrians and bicyclists. When a skewed railroad crossing is unavoidable, the lane, sidewalk, or shared-use path may be widened to allow users to cross as close to perpendicular as possible. The designer should coordinate with railroad owners, KYTC Division of Right of Way and Utilities, and any other applicable transportation agencies.

Figure 6.18 Railroad barrier to pedestrian crossing on KY 44 in Shepherdsville, KY.

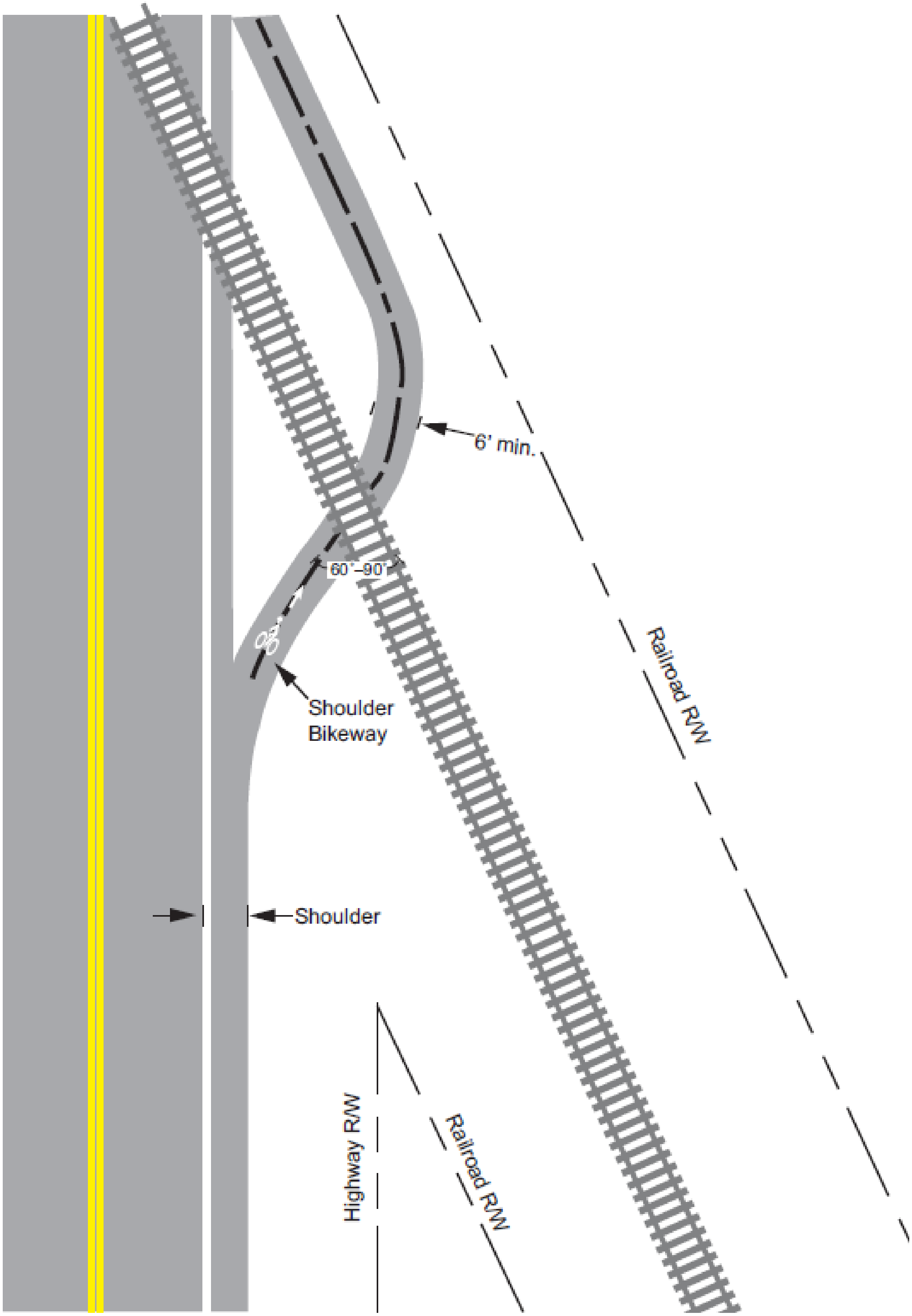


Figure 6.19 AASHTO's *Skewed Railroad Crossing for Bicyclists.*

SECTION 6.8

MULTIMODAL BRIDGES AND TUNNELS

Bridges and underpasses designed for pedestrians and bicyclists connect these users across major barriers that would otherwise prevent a direct connection (Figure 6.20 and Figure 6.21). Examples of major barriers may include, but are not limited to, bodies of water, highways or interstates, and railroad crossings. Accessibility for multimodal bridges and overpasses follow the same ADA Standards for pedestrian accessibility. ABA *Accessibility Standards*[17] may be utilized in addition to ADA standards, particularly those relating to trails. Multimodal bridges and tunnels that accommodate equestrians may require additional vertical and horizontal clearance.

Figure 6.20 Example of a shared-use path tunnel under Beckley Creek Parkway in Louisville, KY.

Similar to shared-use paths, bridge and tunnel widths should be sufficient to comfortably accommodate the anticipated user volumes. Additionally, given the constricted nature of both bridges and tunnels with walls and railings, additional width may be necessary to allow users to comfortably pass next to vertical surfaces. Potential multimodal conflicts may be mitigated with mode separation through pavement color or surface type, markings or striping, signage, and/or texture such as bicycle rumble strips.

Comfort and safety of a bridge or tunnel are important to pedestrians, bicyclists, and other micromobility users. Conditions in low lighting or at night and frequency of use may determine whether a person feels comfortable and safe utilizing the structure. Lighting for both bridges and tunnels is key to user comfort and safety, as well as the visibility of users approaching, navigating, and exiting the bridge or tunnel. Fall protection must also be included for the users of bridges, and protection from thrown objects overhead may also be considered when appropriate. Adequate drainage should be incorporated into tunnel design to prevent water ponding in structures.

The design of bridges, tunnels, and other structures is highly site-specific, should include consultation with structural engineers, and may also require additional review and approvals. For projects on or near state-maintained right-of-way, the applicable KYTC district office shall be consulted for guidance on the design and approval for structures and lighting.

Figure 6.21 Pedestrian bridge on Old Todds Road in Lexington, KY.

SECTION 6.9

ACCESS MANAGEMENT

The KYTC *Access Management*[18] website provides resources and guidance for all types of access management, including driveways, entrances, median openings, interchanges, and street connections. Motor vehicle access points are important components of the transportation network, connecting drivers to residences, businesses, and other roadways in the network. However, access points also create points of conflict between users. The frequency and design of access points for motor vehicles has an impact on the safety of all roadway users.

Practitioners should weigh the benefits of access points with the potential negative impacts to all users in a Complete Street corridor. Left-turning motor vehicle traffic has one of the highest potential conflicts with all users, particularly with dedicated two-way bicycle facilities on one side of the street, road, or highway. Right-turning traffic to the left of a bicycle lane may also be a point of conflict with vulnerable roadway users. Mitigation strategies include, but are not limited to, reducing the width and number of access points, restricting access to specific turning movements, delineating conflict zones with pavement markings, implementing vertical displacement like raised crossings, and others. *Reduced Left-Turn Conflict Intersections*[19] and *Corridor Access Management*[20] are two examples of FHWA Proven Safety Countermeasures that address access management and the associated safety benefits (Figure 6.22 and Figure 6.23).

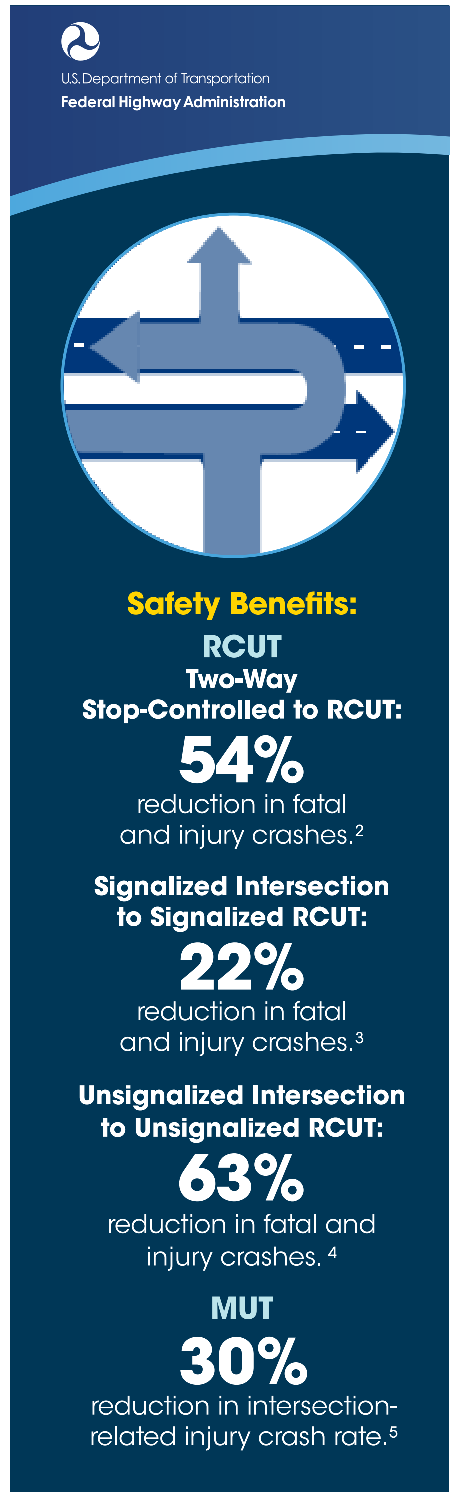


Figure 6.22 FHWA's reduced left-turn conflict intersections proven safety countermeasure.

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).
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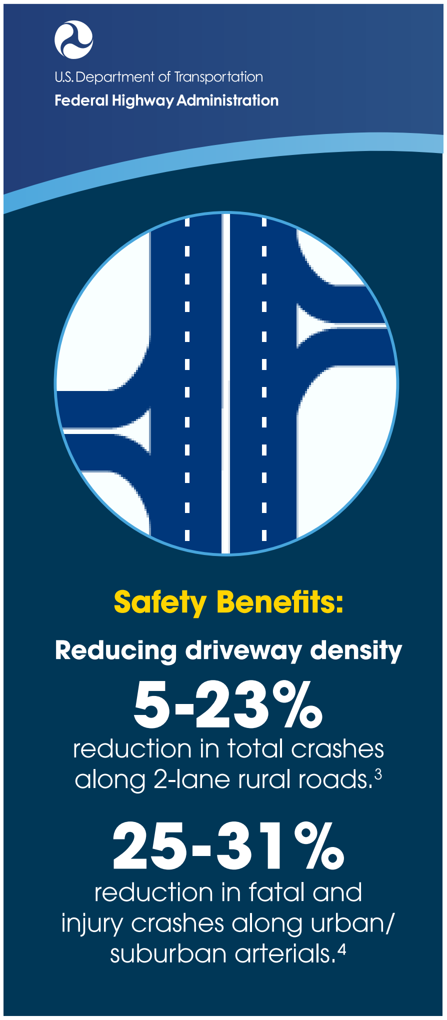

Figure 6.23 FHWA's Corridor Access Management Proven Safety Countermeasure.

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2. Le et al. Safety Evaluation of Corner Clearance at Signalized Intersections. FHWA-HRT-17-084, (2018).
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4. Elvik, R. and Vaa, T., Handbook of Road Safety Measures. Oxford, United Kingdom, Elsevier, (2004).

ENDNOTES

1 Kentucky Transportation Center Research Report KTC-12-04/SPR 380-09-1F *Improving Intersection Design Practices* https://uknowledge.uky.edu/ktc_researchreports/2/

2 FHWA *Capacity Analysis for Planning of Junctions (Cap-X) Tool* https://highways.dot.gov/research/resources/software/capacity-analysis-planning-junctions-cap-x-tool

3 FHWA *Improving Intersections for Pedestrians and Bicyclists: Informational Guide* (2022) https://safety.fhwa.dot.gov/intersection/about/fhwasa22017.pdf

4 FHWA *Proven Safety Countermeasures* https://safety.fhwa.dot.gov/provencountermeasures/

5 FHWA Road Safety Audits (RSA) https://safety.fhwa.dot.gov/rsa/

6 FHWA PEDSAFE http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=24

7 FHWA *Improving Intersections for Pedestrians and Bicyclists: Informational Guide* https://safety.fhwa.dot.gov/intersection/about/fhwasa22017.pdf

8 FHWA *Proven Safety Countermeasures: Leading Pedestrian Interval* https://safety.fhwa.dot.gov/provencountermeasures/lead_ped_int.cfm

9 Massachusetts Department of Transportation (MassDOT) *Separated Bike Lane Planning and Design Guide: Chapter 6, Bicycle Signals* https://www.mass.gov/doc/chapter-6-signals/download

10 FTA *Research & Innovation: Signal Priority* https://www.transit.dot.gov/research-innovation/signal-priority

11 NACTO *Transit Street Design Guide* https://nacto.org/publication/transit-street-design-guide/

12 ITE *Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges: A Recommended Practice at the Institute of Transportation Engineers* (2016)

13 FHWA *Proven Safety Countermeasures: Roundabouts* https://safety.fhwa.dot.gov/provencountermeasures/roundabouts.cfm

14 NCHRP 674 *Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities* https://www.trb.org/Publications/Blurbs/164715.aspx

15 FHWA *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf

16 AASHTO *Guide for the Development of Bicycle Facilities, 2012 Fourth Edition*

17 Architectural Barriers Act (ABA) *Accessibility Standards* https://www.access-board.gov/aba/#aba-1017

18 KYTC *Access Management* https://transportation.ky.gov/Congestion-Toolbox/Pages/Access-Management.aspx

19 FHWA *Proven Safety Countermeasures: Reduced Left-Turn Conflict Intersections* https://safety.fhwa.dot.gov/provencountermeasures/reduced_left.cfm

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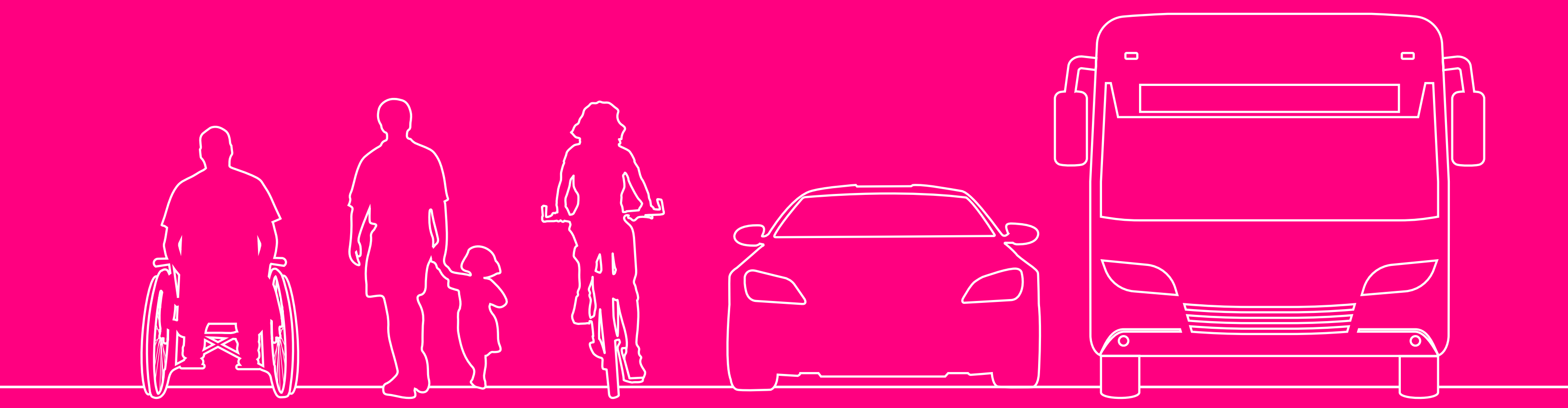
EDITION 1
AUGUST 2022

CHAPTER 7
IMPLEMENTING COMPLETE STREETS ON EXISTING STREETS, ROADS, AND HIGHWAYS



SECTION 7.1

RESURFACING AND RECONSTRUCTION PROJECTS

Many transportation planning and design projects take place on existing streets, roads, and highways throughout Kentucky. Complete Streets may be recommended and implemented in any phase of these projects. Complete Streets facilities may be paired with planned reconfiguration, resurfacing, and other reconstruction projects.

The planning and design considerations outlined in Chapters 3 through 6 apply in many cases to resurfacing and reconstruction projects. The decision for the specific facilities that may be incorporated into these projects will depend on the available right-of-way, type of project, and the modal priorities for the identified Complete Street corridor. Resurfacing and reconstruction projects may be considered when land use changes create destinations attracting pedestrians, bicyclists, and/or other micromobility users or to implement safety improvements for all users. Resurfacing and reconstruction projects may also allow for interim improvements toward a future full-build Complete Street with additional modal accommodations, dedicated or physically separated facilities, and other amenities. Resurfacing and reconstruction projects shall meet ADA policy and design guidelines for accessibility for all users.

The inclusion of pedestrian and bicycle facilities shall be considered for resurfacing and reconstruction projects in accordance with the Complete Streets Planning Checklist from Chapter 3 (Figure 7.1). On projects with existing catch basin grates that are parallel to traffic and may catch bicycle tires, the designer should replace the catch basin grates with appropriate perpendicular-type bicycle-friendly grates. More information on catch basin grates is located in the most current edition of the KYTC *Standard Drawings* on the Division of Highway Design website.[1]

When a project begins or ends at an intersection, all approaches to the intersection must be upgraded with similar multimodal features such that pedestrians of all abilities, bicyclists, and/or other micromobility users (see Chapter 5 for definition) can safely traverse the intersection to appropriate connecting facilities. Pedestrian and/or bicycle facilities, including curb ramps, shall be installed where they are missing or are not compliant with ADA guidance as discussed in Chapter 6. On signalized approaches without existing pedestrian and/or bicycle facilities, curb ramps shall be required only if pedestrian facilities are required based on the criteria from the Complete Streets Planning Checklist located in Chapter 3.

Figure 7.1 Conversion of Wilson Road in Radcliff, KY from two motor vehicle lanes with no pedestrian or bicycle facilities (top) to include center two-way left-turn lane, sidewalk on the left, and shared-use path on the right (bottom).

The following are some examples of project types that can potentially trigger implementation of a variety of ADA requirements on existing pedestrian facilities, or the consideration of bicycle and/or pedestrian facilities in accordance with the Complete Streets Planning Checklist:

- New alignment construction
- Existing roadway widening
- Realignment of a roadway (vertical or horizontal)
- Bridge replacement
- Raised channelization of the roadway
- Sidewalk improvements
- Traffic signal installation or reconstruction
- Intersection enhancements or ADA accessibility projects
- Resurfacing

The following pavement restoration and rehabilitation project types do not trigger implementation of ADA requirements:

- Spot pavement repair
- Liquid-asphalt sealing, chip seal (Bituminous Surface Treatment- BST), or crack sealing
- Lane restriping that does not alter the usability of the shoulder

If there is uncertainty as to whether a project requires consideration of pedestrian and bicycle facilities that meet ADA requirements, the designer should consult with the KYTC Statewide Bicycle and Pedestrian Coordinator and/or the KYTC ADA/504 Coordinator.

Figure 7.2 Sidewalk joint grinding to meet accessibility standards on Main Street in Louisville, KY.

The following accessibility provisions apply to reconstruction projects:

- All new pedestrian facilities constructed within existing right-of-way must meet applicable accessibility requirements from Chapters 4, 5, and 6.
- All existing pedestrian or bicycle facilities disturbed by construction must be replaced. The replacement facilities must meet applicable accessibility requirements.
- A reconstruction project shall not negatively affect the accessibility of a pedestrian or bicycle facility or an accessible connection to an adjacent building or site.
- Within the construction impact zone of a reconstruction project, any existing connection from a pedestrian access route to a crosswalk (marked or unmarked) that is missing a required curb ramp requires installation of a curb ramp that meets applicable accessibility requirements.
- A crosswalk served by a curb ramp must also have an existing curb ramp in place on the receiving end unless no curb or sidewalk exists on that end of the crosswalk. If a sidewalk is present and there is no existing curb ramp in place on the receiving end, an accessible curb ramp must be provided. This requirement must be met regardless of whether the receiving end of the crosswalk is located within the project limits.
- Within the construction impact zone of a reconstruction project, all existing curb ramps and pedestrian facilities should be evaluated to determine whether design elements meet the accessibility criteria. Existing curb ramps or pedestrian facilities that do not meet the accessibility criteria should be modified to meet applicable accessibility requirements (Figure 7.2). This may also trigger modification of other adjacent pedestrian facilities to incorporate transitional segments to ensure specific elements of a curb ramp will meet the accessibility criteria.
- Within the construction impact zone of a reconstruction project that includes realignment or widening of the roadway, all existing crosswalks (marked or unmarked) should be evaluated to determine whether crosswalk design elements meet the accessibility criteria. Crosswalks that do not meet the accessibility requirements should be modified to meet those requirements.

It may not always be possible to fully meet the applicable accessibility requirements during reconstruction of existing facilities. If such a situation is encountered, the designer should consult with the KYTC Statewide Bicycle and Pedestrian Coordinator to develop a workable solution to meet the accessibility requirements to the maximum extent feasible. Cost alone is not a justification for not meeting the accessibility criteria. Further information on accommodating pedestrians, bicyclists, and/or other micromobility users, and transit during construction on existing streets, roads, and highways is located in Chapter 9.

SECTION 7.2

ROADWAY RECONFIGURATIONS (ROAD DIETS)

Roadway reconfigurations, also known as road diets, are an FHWA Proven Safety Countermeasure[2] for multiple users on the roadway (Figure 7.3). A road diet reduces the number of motor vehicle lanes on an existing street, road, or highway and typically reallocates the additional pavement space to facilities for other users. Although the most common road diet occurs on four-lane undivided streets, roads, or highways, they may be successful on corridors with four or more lanes. The reduction of lanes results in safety improvements for all users on the street, road, or highway (Figure 7.4). The benefits and safety improvements may include calming traffic, reducing crossing and turning conflicts for motor vehicles, and providing dedicated space for bicyclists, pedestrians, and transit.

Figure 7.3 Roadway Reconfiguration Proven Safety Countermeasure

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

Figure 7.4 Road diet of Southern Parkway in Louisville, KY from four lanes (top) to two lanes, center two-way left-turn lane, and bicycle lanes (bottom).

Table 7.1 FHWA's road diet traffic volume guidance.

ADT THRESHOLD	GUIDANCE SUMMARY
Less than 10,000 ADT	A great candidate for road diets in most instances. Capacity will most likely not be affected.
10,000-15,000 ADT	A good candidate for road diets in many instances. Agencies should conduct intersection analyses and consider signal retiming in conjunction with implementation.
15,000-20,000 ADT	A good candidate for road diets in some instances; however, capacity may be affected depending on conditions. Agencies should conduct a corridor analysis.
Greater than 20,000 ADT*	Agencies should complete a feasibility study to determine whether the location is a good candidate. Some agencies have had success with road diets at higher traffic volumes.

**KYTC Research Report KTC-11-19/ SPR415-11-1F Guidelines for Road Diet Conversions finds road diets in Kentucky may be successful, and should be considered on, roads, streets, and highways up to a 23,000 ADT threshold.*

The conditions for successful road diets are context-sensitive and may vary from community to community. FHWA provides a summary of traffic volume threshold guidance[3] for consideration (Table 7.1). To allow greater flexibility, local agencies and practitioners may use different thresholds or supplemental guidance to accommodate local needs, preferred traffic capacity, or desired level of service.

Road diets are a powerful tool for creating a Complete Street on an existing street, road, or highway. The significant benefits to safety from implementing a roadway reconfiguration may also come with tradeoffs and potential impacts to consider. However, many of these tradeoffs or potential impacts may be mitigated through design. For example, transit vehicles, delivery trucks, and other similar users may temporarily block a travel lane when two through lanes are reduced to a single through lane. For higher traffic volume corridors with frequent bus service or deliveries, the designer could consider bus turnouts or similar curbside pull-off areas to accommodate these uses. In most applications, the safety benefits of road diets far outweigh any potential tradeoffs to capacity or operations. FHWA also provides additional guidance on the safety improvements, operational improvements, and potential tradeoffs of road diets.[4]

Typical road diets are a relatively low-cost improvement consisting primarily of pavement markings, striping, and signage. However, road diets may also be paired with resurfacing, reconstruction projects, or other construction projects. In some situations, due to the lane reductions, they may require additional intersection or corridor improvements for a successful Complete Street implementation. In many scenarios, these may include but are not limited to the relocation or replacement of signal heads, conversion of drainage grates to bicycle-friendly grates for bicycle lanes, and pedestrian accessibility improvements as outlined previously in Section 7.1.

ENDNOTES

1 KYTC *Division of Highway Design* https://transportation.ky.gov/Highway-Design/Pages/default.aspx

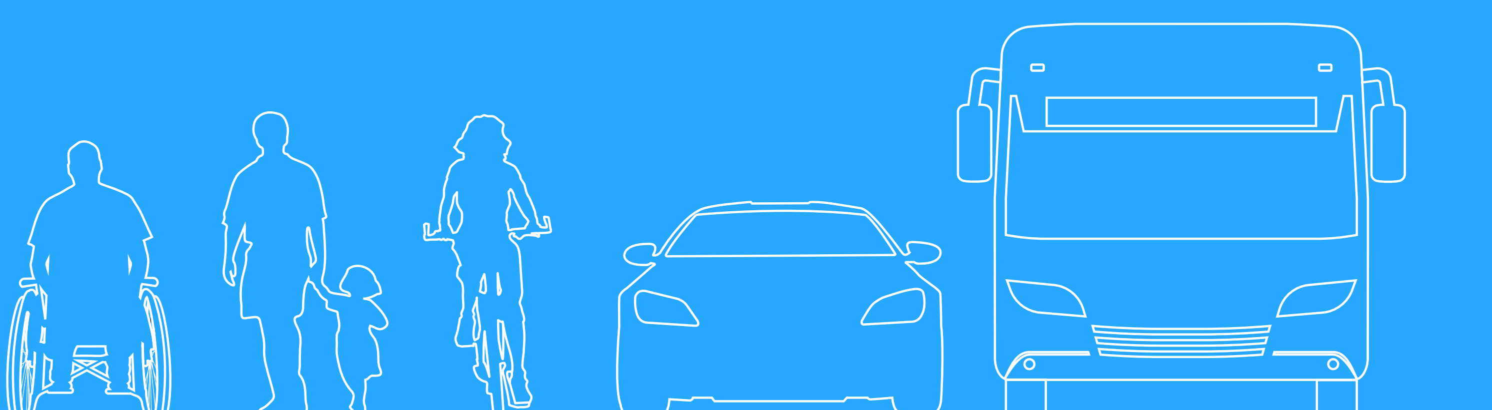
2 HWA *Road Diets (Roadway Reconfigurations)* https://safety.fhwa.dot.gov/provencountermeasures/road_diets.cfm

3 FHWA *Road Diet FAQ* https://safety.fhwa.dot.gov/road_diets/resources/pdf/fhwasa17021.pdf

4 FHWA *Road Diet Informational Guide* https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/ch2.cfm#s21

EDITION 1
AUGUST 2022

CHAPTER 8
TACTICAL URBANISM, PILOT PROJECTS, AND INTERIM DESIGN



SECTION 8.1

OVERVIEW

Flexibility in Complete Streets design and implementation includes opportunities for quick-build, low-cost, and phased construction strategies on existing streets, roads, and highways to advance long-term goals. The level of permanence for these projects varies. Opportunities to provide Complete Streets facilities and amenities on a lower budget and a faster timeline include tactical urbanism, pilot projects, and interim design strategies which may be identified and implemented in the planning or design phases. The *Urban Street Design Guide*[1] and the *Streets for Pandemic Response & Recovery*[2] from NACTO provide additional guidance on interim design strategies and the methods these strategies and related policies use to move projects from temporary to permanent installations for all users.

TACTICAL URBANISM

Tactical urbanism projects allow transportation agencies to implement relatively small, quick-build, targeted location projects that provide immediate safety benefits and amenities. As the name suggests, these projects are most often found in urban and small town urbanized areas but may also be appropriate in targeted suburban contexts.

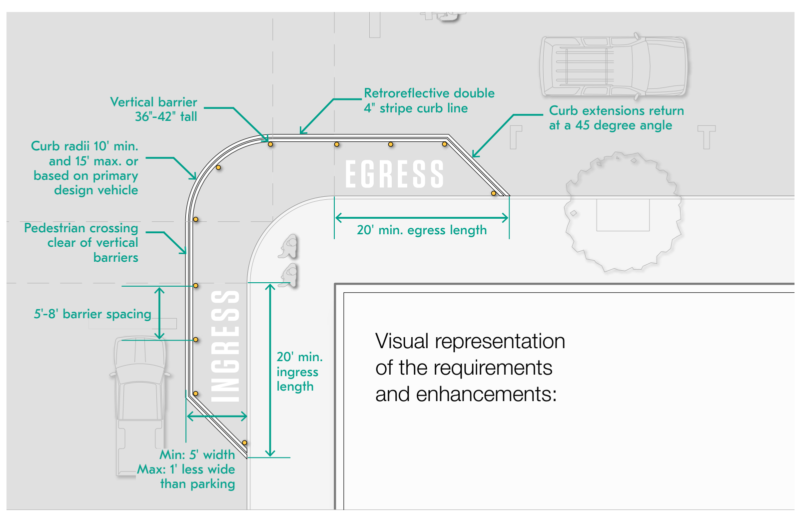
Examples of tactical urbanism projects include, but are not limited to, the following:

- Curb extensions to narrow lanes and shorten pedestrian exposure to motor vehicles
- Chicanes or other horizontal displacement to slow motor vehicle traffic
- Lane or channelized-turn lane closures
- Pedestrian, bicycle, and/or other micromobility facilities (see Chapter 5 for definition)
- Amenities such as micromobility parking including, but not limited to, bicycles, dockless e-bicycles, and e-scooters
- Parklets replacing parking spaces
- Public art spaces or pavement art

Although tactical urbanism projects are typically constructed with materials that will last several years and are intended to be replaced with permanent construction, projects may also be constructed with temporary materials for a very short-term implementation. Local agencies may create independent guidelines for design, materials selection, and maintenance of tactical urbanism projects. For example, the City of Atlanta in Georgia provides guidance on the implementation of tactical urbanism projects in the City of Atlanta Tactical Urbanism Guide (Figure 8.1).[3] Recommendations include criteria for permitted installations, acceptable colors, design guidelines, and allowable surface treatments, among others.

A curb extension is a traffic calming measure that widens pedestrian space on the street by narrowing the roadway. Tactical curb extensions are made of low cost, quick build materials such as striping, vertical delineators, and paint.

Curb extensions increase pedestrian safety by shortening crossing distances and making pedestrians more visible to drivers.



Visual representation of the requirements and enhancements:

Figure 8.1 Examples of tactical urbanism guidelines from the City of Atlanta.

EXAMPLE
6TH STREET TACTICAL URBANISM BUFFERED BICYCLE LANE AND CURB EXTENSIONS

On 6th Street in Louisville, Kentucky, tactical urbanism strategies were used to implement a buffered bicycle lane and curb extensions (Figure 8.2). Lane width reductions provided space for the installation of the buffered lane and encouraged slower driving speeds in the downtown core. Materials used to construct the lane and extensions included durable methyl-methacrylate (MMA) green lane markings, thermoplastic pavement markings and striping, permanent paint striping, and flexible delineator posts. The posts can be removed for snow removal and are easily replaced when damaged.

Figure 8.2 6th Street tactical urbanism project in Louisville, KY.

PILOT PROJECTS

Pilot projects test new ideas in transportation, allowing transportation agencies to analyze benefits and potential impacts before final, permanent construction. Pilot projects may also be implemented to build public support, with a range of permanence of days, months, or even years. Pilot projects are applicable across the range of roadway contexts, but may be found more commonly in urban, small town, and suburban areas.

Examples of pilot projects may include, but are not limited to, the following:

- Pop-up demonstration projects with temporary materials (tape, washable paint/chalk, cones, etc.) allowing public interaction ahead of more permanent, full-build implementation on an open or closed street
- Short-term corridor and/or intersection projects to test full-build construction impacts
- Temporary signal phasing with, or without, short-term striping to test traffic behaviors under new scenarios
- Targeted implementation of full-build construction

The designer should select materials that are easily removed for short-lived, pop-up, or demonstration projects to quickly return the area back to the original conditions upon completion of the approved trial period. Pilot projects that are intended to remain open to the public for an intermediate period of time should be constructed with durable materials intended to withstand expected wear and tear over the lifespan of the project.

EXAMPLE CycLOUvia TWO-WAY BICYCLE FACILITY DEMONSTRATION PROJECT

During CycLOUvia 2022 on US 31E (Main Street) in Louisville, Kentucky, two-way bicycle lanes were installed as a temporary demonstration between Campbell Street and Wenzel Street (Figure 8.3). During the street closure for CycLOUvia, temporary materials such as tape, removable spray chalk, and cones were used to construct the facility. This demonstration allowed the public to view and interact with the facility safely, without exposure to any conflicts with motor vehicles. At the end of CycLOUvia, the facility was removed and the street was returned to the original configuration.

Figure 8.3 Original Main Street configuration (top) and buffered bicycle lanes demonstration project during CycLOUvia (bottom).

INTERIM DESIGN

Lack of funding availability often limits the immediate design and/or implementation of large-scale capital projects. Interim designs may capitalize on smaller funding opportunities to implement Complete Streets facilities or safety improvements until additional funding for full-build projects is secured. Interim design strategies may utilize elements similar to those used for tactical urbanism and pilot projects, but they are typically phased improvements applied across the full-build project area and are typically constructed with longer-lasting materials. Interim design is applicable to all roadway contexts, including rural streets, roads, and highways.

EXAMPLE
WEST MARKET STREET CORRIDOR IMPROVEMENT

An example of a successful interim design with phased funding project is the West Market Street Corridor Improvement in Louisville, Kentucky. A study was initiated in late 2008 "to improve the quality of life for corridor residents, business owners, and users by outlining strategies to maximize the benefits from potential public and/or privately-financed improvements and development projects in the West Market study area." The study area was comprised of the historically underserved Shawnee, Portland, and Russell neighborhoods of West Louisville. Much of the study's recommendations centered on the application of Complete Streets concepts to the corridor, including safety improvements, amenities, living landscape, and green infrastructure. The majority of the corridor represented either commercial or residential districts with unique design recommendations tailored to usage and existing constraints (Figure 8.4).

Figure 8.4 Complete Streets concepts for commercial and residential districts on West Market Street in Louisville, KY.

Figure 8.5 Constructed West Market commercial interim design project safety improvements, green infrastructure, and amenities on West Market Street in Louisville, KY.

Implementation of the study recommendations occurred in several steps. An initial design contract was awarded utilizing local funds for all four of the commercial districts. As design progressed, funding for construction of the entire project had not yet been secured. However, limited local funds were available for construction. The project team determined that, rather than stretching the funding across all four districts to make minor improvements, a fully constructed stand-alone section would be more impactful and could be fully constructed with the available funds. This section was constructed in 2014 (Figure 8.5). It not only served as a proof of concept, but also generated enthusiasm among residents and business owners. While the initial study was supported by the public, the transformation of renderings into real infrastructure galvanized support to complete the remainder of the project.

Subsequently, with support from local leadership, Community Development Block Grant (CDBG) funds were allotted in order to complete construction of the remaining commercial nodes in 2017. The knowledge gained from the interim implementation led to some adjustments to material specifications and additional design details to clarify intent for the contractor.

While not initially intended to begin with an interim construction project, the phased implementation allowed the project team to take advantage of the initial funding that was available. This approach created renewed enthusiasm for the project among residents and local leaders, leading to a sustained effort to secure full construction funding.

SECTION 8.2

DESIGN AND PERMITTING

Similar to planning and design from previous chapters, tactical urbanism, pilot, and interim design projects still require planning and design guidance from engineers and other transportation practitioners. Accessibility is still a key consideration for all users on Complete Streets, even on temporary or intermediate design projects. These project types shall meet the accessibility guidance as discussed in Chapters 4, 5, and 6 for pedestrian, bicycle and/or other micromobility, transit facilities, and intersections. Permitting is required for construction, and the permitting process varies by agency.

SECTION 8.3

CONSTRUCTION, MAINTENANCE, AND MONITORING

Construction of tactical urbanism, pilot, and interim design projects may consist of relatively short-lived materials. The designer should balance the maintenance requirements of materials with the intended implementation lifespan, specifying durable materials recommended for longevity and lowered maintenance costs on intermediate to long-term projects. These projects may also require separate maintenance agreements with local partner agencies for the lifespan of the project. If a local agency is relying on volunteers to implement short-term or demonstration projects, a volunteer release may also be required.

Monitoring of projects, particularly for pilot projects, may be a key consideration for full-build implementation. Performance metrics monitored may include, but are not limited to, traffic operations, safety outcomes, and user volume. However, it is important to note that user volumes may be dictated by proximity to generators for the targeted user group along with connectivity to appropriate facilities beyond the project location. User volume should not be used solely as the deciding factor to implement full-build projects, particularly when the overall Complete Streets network is not fully built.

ENDNOTES

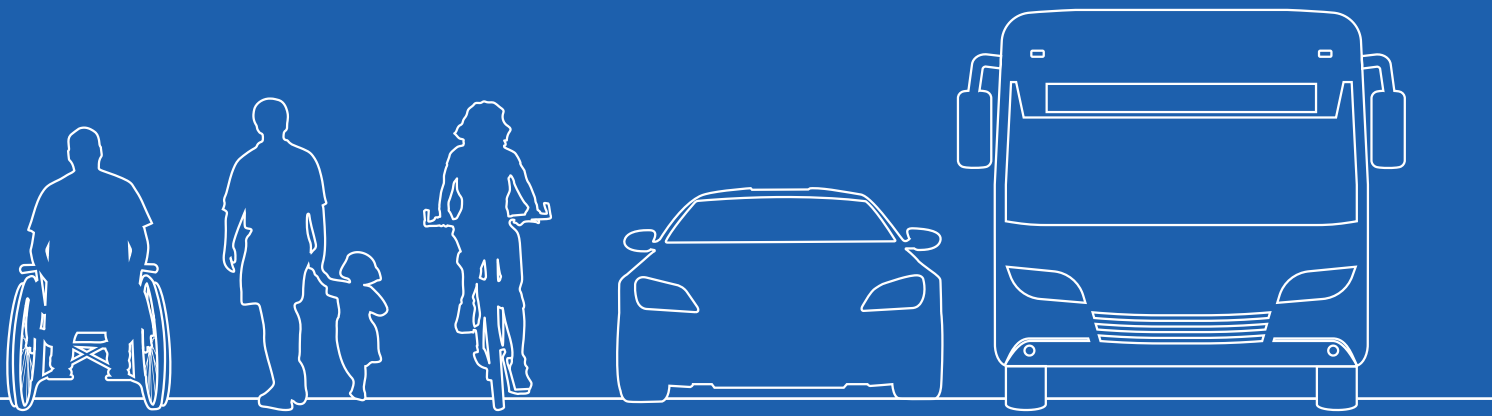
1 NACTO *Urban Street Design Guide Interim* Design Strategies | National Association of City Transportation Officials (nacto.org)

2 NACTO *Streets for Pandemic Response & Recovery* https://nacto.org/publication/streets-for-pandemic-response-recovery/

3 *City of Atlanta Tactical Urbanism Guide* (2022) https://www.atlantaga.gov/home/showdocument?id=54465&t=637818301937551959

EDITION 1
AUGUST 2022

CHAPTER 9
ADDITIONAL CONSIDERATIONS



Complete Streets require a variety of considerations beyond providing facilities. The designer should consider elements that further enhance user comfort and safety such as lighting, appropriate barriers and/or safety railings, surface types and/or treatments, stormwater management, maintenance, and work zone accommodations. This chapter addresses these additional considerations for the comfort and safety of all users on Complete Streets in Kentucky.

SECTION 9.1

ILLUMINATION

Illumination of Complete Streets is an important design consideration because it has a significant impact on both the actual safety of all roadway users, and the comfort and security perceived by pedestrians, bicyclists, and other micromobility users (see Chapter 5 for definition). Lighting for Complete Streets typically falls into two categories: roadway lighting (Figure 9.1), and multimodal lighting for facilities adjacent to the roadway. The designer should follow the FHWA *Lighting Handbook*[1] guidance for warrants, design, and placement of both roadway and multimodal lighting. Audits are recommended in project planning and design phases to formally evaluate safety performance and identify areas needing safety improvements.

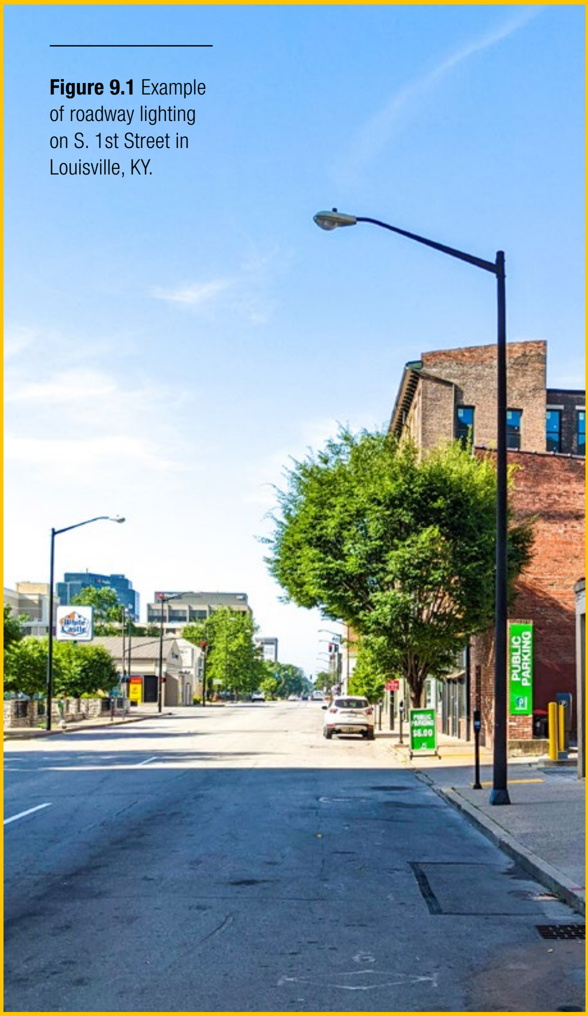


Figure 9.1 Example of roadway lighting on S. 1st Street in Louisville, KY.

ROADWAY LIGHTING

Roadway lighting provides illumination for facilities within the roadway, such as motor vehicle lanes, bus lanes, bicycle lanes, and crossings for all users. Roadway lighting is an FHWA Proven Safety Countermeasure and provides safety benefits for all users in both rural and urban contexts as shown in Figure 9.2.[2] The KYTC *Traffic Operations Guidance Manual* provides guidance regarding the responsible agency, design, approval, and maintenance of roadway lighting on or near state right-of-way. Specialty lighting may be utilized by local agencies if the required design criteria is met. The FHWA *Informational Report on Lighting Design for Midblock Crosswalks*[3] provides guidance on the placement of lighting near intersection and mid-block crossings (Figure 9.3).

Figure 9.2 FHWA's Lighting Proven Safety Countermeasure.

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

Figure 9.3 Example of intersection lighting on US 31W (E. Market Street) in Louisville, KY.

Figure 9.4 Example of multimodal lighting along the shared-use path on KY 1448 (Mapleleaf Road) in Maysville, KY.

MULTIMODAL LIGHTING

Illumination provided solely from roadway lighting is not always effective in lighting facilities outside of the roadway for pedestrians, bicyclists, other micromobility users, and transit users. The designer should consider multimodal lighting, sometimes referred to as pedestrian-scale lighting, mounted at a lower level for sidewalks, shared-use paths, separated bicycle lanes, and transit stops (Figure 9.4). Areas with high night-time pedestrian, bicycle, or other micromobility activity such as shopping districts, transit stops, schools, community centers, and other major generators, or areas with a history of crashes, should be prioritized for multimodal lighting.

Aesthetic or decorative lighting may be considered in Complete Streets projects with a separate maintenance agreement with local agencies. KYTC requires design coordination and approval through the Division of Traffic Operations for all lighting on or near state right-of-way, including aesthetic and decorative lighting.

SECTION 9.2

BARRIERS AND SAFETY RAILINGS

Barriers and safety railings may be used on Complete Streets in site-specific contexts. Safety rails protect pedestrians, and/or bicyclists and other micromobility users from steep slopes, drop-offs, and other non-vehicular hazards along a sidewalk or a shared-use path. Barriers provide crashworthy physical separation between motor vehicles and vulnerable roadway users and may be utilized to reduce the severity of roadway departure crashes. Figure 9.5 is an example of both a barrier between the shared-use path and motor vehicles, and a safety railing protecting path users from a steep slope.

Figure 9.5 Shared-use path along KY 1448 (Mapleleaf Road) in Maysville, KY with a barrier separation between the path and the motor vehicles and a safety railing protecting path users from steep slopes.

BARRIERS

Barrier height and design varies depending on the roadway and operational characteristics including vehicle type, vehicle weight, speed, and crash angle. Barriers are rated by test level through the AASHTO *Manual for Assessing Safety Hardware* (MASH). The designer should balance the safety of all users when determining whether a barrier is appropriate in site-specific contexts. For example, the prevalence of vulnerable roadway users should be used in comparison to the drawbacks of potential motor vehicle crashes with the barrier. Selection of crashworthy barriers shall follow MASH and other AASHTO guidance from the *Roadside Design Guide, Guide for the Development of Bicycle Facilities,* and/or the *Guide for the Planning, Design, and Operation of Pedestrian Facilities*. The aesthetic design of crashworthy barriers such as material selection and finishes may vary to match the nature of the site but shall not interfere with the crashworthiness of the barrier. When a bicycle facility is adjacent to a barrier, the designer should consider a barrier design that does not interfere with pedals and handlebars.

SAFETY RAILINGS

Typical safety railing height is 42 inches for pedestrians, bicyclists, and other micromobility users, with an increased height recommended for bicyclists and other micromobility users in site-specific contexts. When safety rails are needed, the AASHTO *Guide for the Development of Bicycle Facilities* and/or *Guide for the Planning, Design, and Operation of Pedestrian Facilities* shall be referenced for design, height, and lateral offset guidance. Safety rail design varies, and local agencies may use additional aesthetic design guidelines combined with required ADA accessibility and ABA design standards for pedestrian safety railings.

SECTION 9.3

PAVEMENT SURFACES

Surface materials, patterns, and textures are useful tools to establish dedicated facilities by user type and to identify mixing zones between different users. Surfaces may also be chosen to align with the context of a corridor.

Along with ADA accessibility requirements, the following should be considered:

- Surfaces should be smooth and free of rough textures, openings, and gaps.
- Pavement treatments should be non-slip for pedestrians, bicyclists, and other micromobility users.
- Expansion and contraction joints are allowed but must not create an elevation change of more than 0.25 inches.
- Pedestrian zone surfaces should be as uniform as possible for visually-impaired pedestrians.
- Pedestrian, bicycle, and/or micromobility edges should be clearly defined.
- Surface maintenance should be considered, particularly for high-maintenance surfaces such as pavers.
- Stamped concrete is the preferred treatment when pavement patterns are desired.
- Pavers and asphalt are allowed, but special considerations for maintenance should be included in any design to help ensure that the riding or walking surface continues to function smoothly and remain free from debris.
- Compacted gravel is allowed for shoulders, off-road trails, and other locations where universal ADA access is not necessary for off-road bicycles, equestrians, and other users.

SECTION 9.4

STORMWATER MANAGEMENT AND GREEN INFRASTRUCTURE

Stormwater management is important for safe and comfortable transportation for all users on streets, roads, and highways. Green infrastructure provides additional sustainability benefits by utilizing hardscape, landscape, and other strategies to collect and retain or infiltrate water through natural processes as shown in Figure 9.6.[4] Green infrastructure provides opportunities to incorporate landscape amenities on Complete Streets, improve transportation resiliency by reducing stormwater runoff, reduce urban heat island effect, provide urban wildlife habitats, improve air and water quality, and promote improved health outcomes.

DETENTION	RETENTION	(BIO)FILTRATION	INFILTRATION
Collect and hold runoff in temporary storage facilities or vegetated systems before slowly releasing the water into the downstream system.	Capture and hold stormwater on site to reduce runoff to sewer systems. Water is then evaporated, transpired, or infiltrated through the soil.	Remove particulate matter and other pollutants by filtering stormwater runoff through porous media such as sand, soil, or other filter.	Absorb stormwater through the ground surface and into the soil.

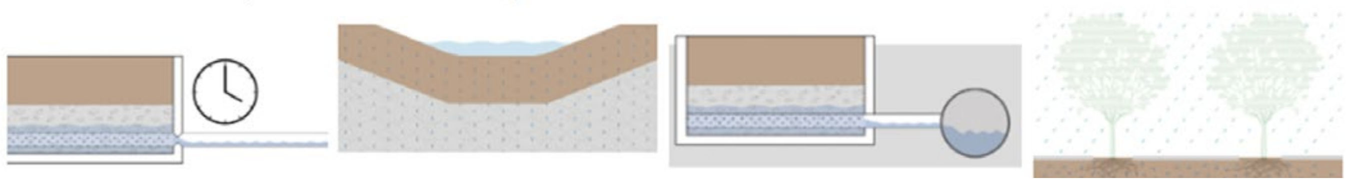


Figure 9.6 Sustainable stormwater management strategies from NACTO.

Figure 9.7 Bioswale green infrastructure on Town Branch Commons in Lexington, KY.

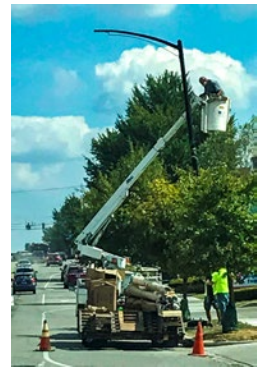
Sustainable stormwater management is applicable across all roadway contexts, with strategy and design elements varying by site-specific context and the presence or absence of curbs (Figure 9.7). Green infrastructure elements include, but are not limited to, permeable pavements or pavers, bioswales, and infiltration basins that may include landscape or street trees. The designer should consult with landscape architects or other living landscape experts to select appropriate species for each site-specific context. Green infrastructure may have different maintenance requirements than traditional stormwater management strategies and may require separate maintenance agreements with local agencies for implementation. Additional information on planning, design, permitting, and management of these types of facilities is available in the NACTO *Urban Street Stormwater Guide*, the NCHRP 20-68A, Scan 16-02 *Leading Landscape Design Practices for Cost-Effective Roadside Water Management*,[5] and the KYTC *Drainage Manual*.[6]

SECTION 9.5

MAINTENANCE

The longevity of Complete Streets relies on consistent maintenance of the facilities and amenities. All materials require maintenance, but time and cost to maintain Complete Streets may be mitigated by choosing longer-lasting construction materials that require less intensive maintenance. These materials may include, but are not limited to, pavement colorizers such as MMA or similar durable materials for bicycle and bus lanes (Figure 9.8), thermoplastic lane line striping, and concrete or asphalt surfaces.

Figure 9.8 Contractor placing MMA green pavement markings on 6th Street in Louisville, KY.



KYTC performing a variety of maintenance activities on streets, roads, and highways across Kentucky.

Maintenance-intensive materials such as paint may be more appropriate for short-term applications and interim projects or in locations that do not experience frequent exposure to motor vehicles. Additionally, pavers and pervious pavements should be used in a limited manner, and only with specific maintenance agreements for the lifetime of the application. Dedicated maintenance funding is recommended for pavers, permeable pavements, green infrastructure, and other maintenance-intensive materials and designs.

As an element of the design process, the designer should consult with all local agencies to determine partnering opportunities for facility maintenance beyond routine activities such as sweeping and debris removal. This consultation would establish which agency will be responsible for maintaining specific elements of the pedestrian, bicycle, other micromobility, motor vehicle, and transit facilities within the design project.

Bicyclists, other micromobility users, and pedestrians are especially vulnerable to poorly maintained facilities, and pedestrian facilities require focused maintenance to provide consistent, accessible routes. Beyond regular sweeping and clearing of pedestrian, bicycle, and other micromobility routes, FWHA provides detailed care, management, and repair strategies to maintain accessible pedestrian corridors.[7] Pedestrian, bicycle, and/or other micromobility facilities, including shared-use paths, are typically maintained by the state in unincorporated areas and by the local agency in incorporated areas. Transit access facilities, such as bus stops, are typically maintained by the local transit agency responsible for transit operations.

In incorporated areas, some local agencies may be better equipped to maintain facilities than others. It may be advantageous to discuss the maintenance capabilities of the local agency and develop a special maintenance agreement. It is important to set elements and expectations of the required maintenance activity for the multimodal facility type and discuss the anticipated methods for maintaining the facility.

Maintenance discussions should typically consider the following activities:

- Sweeping
- Pavement repair and rehabilitation
- Signing, striping, and pavement markings
- Stormwater management and/or green infrastructure
- Special signalization
- Snow removal
- Lighting

SECTION 9.6

WORK ZONE ACCOMMODATIONS

Figure 9.9 Work zone accommodations for pedestrians on Versailles Road in Lexington, KY.

Construction and maintenance activities may temporarily block or disrupt pedestrian, bicycle, other micromobility, and transit facilities. MOT plans shall address the access and mobility of these users through and around work zones (Figure 9.9). When existing pedestrian, bicycle, other micromobility, and transit facilities are disrupted, closed, or relocated in a temporary traffic control zone, the temporary facilities should be easily detectable and include accessibility features consistent with those of the existing facilities (Figure 9.10). Warning signs should be provided when an alternate circulation path is provided or a barricade is constructed. Temporary signage must be compliant with the current edition of the MUTCD for temporary traffic control. The designer should consider the use of flaggers or spotters if pedestrian generators such as schools are in the work zone vicinity to help pedestrians navigate the work zone.

Figure 9.10 Incorrect and unsafe MOT procedure for pedestrian access, with sidewalk blocked by signage and no clearly identified accessible alternate route around the work zone on US 31W (W. Main Street) in Louisville, KY.

Work zone considerations for all users include, but are not limited to, the following:

- Separate pedestrians, bicyclists, and other micromobility users from work zone equipment and operations.
- Separate pedestrians, bicyclists, and micromobility users from motor vehicle traffic moving through or around the work zone.
- Provide accessible paths, appropriate overhead clearance, and continuous paths clear of obstructions and hazards.
- Provide alternate routes that have accessible and convenient travel paths that duplicate, as closely as possible, the characteristics of the existing pedestrian facilities.
- Provide walkways that are clearly marked and pedestrian barriers that are continuous, rigid, and detectable to visually impaired pedestrians.
- Provide alternate routes for bicyclists and other micromobility users that duplicate, as closely as possible, the level of comfort and separation from motor vehicles as the existing facilities.
- Provide accessible routes to temporary transit stops where transit stops are affected or relocated because of work activity.
- Direct transit users to alternate stops with similar amenities within a reasonable distance to the existing stop.
- Where appropriate, provide audible or tactile notifications to guide visually impaired transit users to an alternate stop.

ENDNOTES

1 FHWA *Lighting Handbook* https://safety.fhwa.dot.gov/roadway_dept/night_visib/lighting_handbook/pdf/fhwa_handbook2012.pdf

2 FHWA *Proven Safety Countermeasures: Lighting* https://safety.fhwa.dot.gov/provencountermeasures/lighting.cfm

3 FHWA *Informational Report on Lighting Design for Midblock Crosswalks* https://www.fhwa.dot.gov/publications/research/safety/08053/08053.pdf

4 NACTO *Urban Street Stormwater Guide* https://nacto.org/publication/urban-street-stormwater-guide/planning-for-stormwater/regional-climate-ecology/

5 NCHRP 20-68A, Scan 16-02 *Leading Landscape Design Practices for Cost-Effective Roadside Water Management* https://www.domesticscan.org/download/4489/

6 KYTC *Drainage Manual* https://transportation.ky.gov/Highway-Design/Pages/Drainage.aspx

7 FHWA *A Guide for Maintaining Pedestrian Facilities for Enhanced Safety* (2013) https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa13037/fhwasa13037.pdf

CHAPTER 10
RESOURCES

KENTUCKY ADVOCACY GROUPS, ADVISORY GROUPS, AND RESOURCES

This chapter identifies resources for implementing Complete Streets projects in Kentucky that were available at the time of publishing this Manual. These resources include those referenced in this Manual, as well as additional materials that local agencies, transportation practitioners, community members, and others may find beneficial. The most current information available for each resource at the time of project implementation shall be utilized.

BIKE WALK KENTUCKY

Statewide advocacy, education, and outreach group for pedestrian, bicycle, and other micromobility safety, access, and connectivity.

https://bikewalk.ky/

KENTUCKY BICYCLE AND BIKEWAY COMMISSION

Advisory group to the Secretary of the Transportation Cabinet representing the interests of pedestrians, bicyclists, and other micromobility users in the Commonwealth.

https://transportation.ky.gov/BikeWalk/Pages/KY-Bicycle-and-Bikeways-Commission-(KBBC)-.aspx

KENTUCKY OFFICE OF HIGHWAY SAFETY

Safety awareness and education for all users in the Commonwealth, reducing crashes through data-driven, outcomes-based approaches.

https://transportation.ky.gov/HighwaySafety/Pages/default.aspx

KYTC ACCESS MANAGEMENT

Access management reports and recommendations to improve safety and efficiency for all users.

https://transportation.ky.gov/Congestion-Toolbox/Pages/Access-Management.aspx

KYTC *ADA TRANSITION PLAN* (2021)

Kentucky's plan to ensure accessible transportation for all users in the Commonwealth on new streets, roads, and highways and on the existing transportation network, where feasible.

https://transportation.ky.gov/Civil-Rights-and-Small-Business-Development/Documents/KYTC%20ADA%20Act%2Transition%20Plan.pdf

KYTC DIVISION OF HIGHWAY DESIGN

Procedures, policies, and design resources for all users on Kentucky streets, roads, and highways.

https://transportation.ky.gov/Highway-Design/Pages/default.aspx

KYTC DIVISION OF PLANNING

Procedures, policies, and planning resources for all users on Kentucky streets, roads, and highways.

https://transportation.ky.gov/Planning/Pages/default.aspx

KYTC LAWS AND POLICIES

Kentucky laws and policies related to pedestrians, bicyclists, and other micromobility users.

https://transportation.ky.gov/BikeWalk/Pages/Laws-and-Policy.aspx

KYTC OFFICE OF LOCAL PROGRAMS

Administering office for federally funded programs such as the Transportation Alternatives Program (TAP) and the Congestion and Mitigation and Air Quality (CMAQ) Program.

https://transportation.ky.gov/LocalPrograms/Pages/default.aspx

KYTC POLICY MANUALS LIBRARY

Collection of policy manuals governing planning, design, construction, permitting, and operations of streets, roads, and highways in Kentucky.

https://transportation.ky.gov/Organizational-Resources/Pages/Policy-Manuals-Library.aspx

NATIONAL RESOURCES

KENTUCKY TRANSPORTATION CENTER (KTC) *TRANSITION ZONE DESIGN FINAL REPORT* (2014)

Recommendations and guidance for transition zones between various roadway contexts and characteristics, such as land use and posted speed limit, to reduce operating speeds and inform driver behavior.

https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1598&context=ktc_researchreports

AMERICANS WITH DISABILITIES ACT (ADA) *ACCESSIBILITY STANDARDS*

Accessibility standards for public spaces, including transportation networks, to accommodate pedestrians with disabilities.

https://www.access-board.gov/ada/

ARCHITECTURAL BARRIERS ACT (ABA) *ACCESSIBILITY STANDARDS*

Accessibility standards applying to facilities designed, built, or otherwise modified with federal funds.

https://www.access-board.gov/aba/

AASHTO - *A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS*, SEVENTH EDITION, 2018*

Flexible, multimodal design recommendations for streets, roads, and highways to accommodate all users.

AASHTO - *GUIDE FOR THE DEVELOPMENT OF BICYCLE FACILITIES,* FOURTH EDITION, 2012*

Design recommendations for bicyclists on, or adjacent to, streets, roads, and highways. Includes shared-use path recommendations and accessibility requirements for both pedestrians and bicyclists. Recommendations may also apply to other micromobility users.

AASHTO - *GUIDE FOR THE PLANNING, DESIGN, AND OPERATION OF PEDESTRIAN FACILITIES*, SECOND EDITION, 2021*

Design recommendations and accessibility requirements for pedestrians on, or adjacent to, streets, roads, and highways.

AASHTO - *ROADSIDE DESIGN GUIDE*, FOURTH EDITION, 2011*

Guidance and standards for the design of the roadside for the safety of all users. Includes context-sensitive recommendations for various roadway characteristics and evaluation criteria for barriers.

FHWA - *COMPLETE STREETS*

The portal site for FHWA's support for Complete Streets and related safe streets initiatives, programs, and guidance.

https://highways.dot.gov/complete-streets

FHWA - *NATIONAL ROADWAY SAFETY STRATEGY* (NRSS)

The portal site for FHWA's safety strategies and call to action for safer streets for all.

https://www.transportation.gov/NRSS/SafeSystem

FHWA - *PROVEN SAFETY COUNTERMEASURES*

Proven Safety Countermeasures for a variety of users across the range of roadway contexts.

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

FHWA - *BICYCLE AND PEDESTRIAN FACILITY DESIGN FLEXIBILITY MEMORANDUM* (2013)

Memorandum encouraging flexibility and innovation in design for pedestrians and bicyclists. Recommendations may also apply to other micromobility users.

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_flexibility.pdf

FHWA - *SMALL TOWN AND RURAL MULTIMODAL NETWORKS* (2016)

Guidance for the implementation of pedestrian and bicycle facilities in small town and rural roadway contexts. Guidance may also apply to other micromobility users.

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf

FHWA - *ACCESSIBLE SHARED STREETS: NOTABLE PRACTICES AND CONSIDERATIONS FOR ACCOMMODATING PEDESTRIANS WITH VISION DISABILITIES* (2017)

Guidance and best practices for implementing accessible and safe shared streets for visually impaired pedestrians.

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf

FHWA - *SAFE TRANSPORTATION FOR EVERY PEDESTRIAN* (STEP)

Pedestrian-focused safety portal including guidance, tools, and case studies from across the United States.

https://safety.fhwa.dot.gov/ped_bike/step/resources/

FHWA - *GUIDE FOR IMPROVING PEDESTRIAN SAFETY AT UNCONTROLLED CROSSING LOCATIONS* (2018)

Pedestrian-focused safety improvements at uncontrolled crossings with selection criteria based on roadway characteristics. Safety improvements may also benefit bicyclists and other micromobility users.

https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf

FHWA - *BIKEWAY SELECTION GUIDE* (2019)

Bicycle facility selection by roadway context and characteristics. Guidance may also apply to other micromobility users.

https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf

FHWA - *IMPROVING INTERSECTIONS FOR PEDESTRIANS AND BICYCLISTS: INFORMATIONAL GUIDE* (2022)

Intersection and interchange design guidance to accommodate pedestrians and bicyclists. Guidance may also apply to other micromobility users.

https://safety.fhwa.dot.gov/intersection/about/fhwasa22017.pdf

**Note: Resource is available with purchase. Contact the Statewide Bicycle and Pedestrian Coordinator for more information from these guides.*

FHWA - *MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS* (MUTCD) (2012)

Sign, signal, and pavement marking standards for traffic control devices for all streets, roads, and highways open to public travel. Includes opportunities to apply for Requests to Experiment and Interim Approvals to test emerging design standards and technology.

https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm

FHWA ROAD DIET INFORMATIONAL GUIDES

Safety benefits, thresholds for selection, and design guidance for road diets, including accommodating pedestrians and bicyclists. Guidance may also apply to other micromobility users.

https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/ch2.cfm#s21

https://safety.fhwa.dot.gov/road_diets/resources/pdf/fhwasa17021.pdf

FHWA - *VEGETATION CONTROL FOR SAFETY: A GUIDE FOR LOCAL HIGHWAY AND STREET MAINTENANCE PERSONNEL* (2007)

Vegetation maintenance and other recommendations for managing living landscape on streets, roads, and highways.

https://safety.fhwa.dot.gov/local_rural/training/fhwasa07018/#:~:text=Trees%20near%20the%20road%20that,cut%20flush%20with%20the%20ground

FTA - *STOPS, SPACING, LOCATION AND DESIGN*

Transit recommendations for the siting, design, and amenities of bus stops.

https://www.transit.dot.gov/research-innovation/stops-spacing-location-and-design

FTA - *RESEARCH & INNOVATION: SIGNAL PRIORITY*

Research, technology, and recommendations for bus signal priority.

https://www.transit.dot.gov/research-innovation/signal-priority

ITE - *DESIGNING WALKABLE URBAN THOROUGHFARES: A CONTEXT SENSITIVE APPROACH* (2010)

Planning, design, and implementation guidance for accommodating pedestrians and bicyclists in urban contexts. Guidance may also apply to other micromobility users.

https://www.ite.org/pub/?id=E1CFF43C-2354-D714-51D9-D82B39D4DBAD

ITE - *TRAFFIC CALMING ePRIMER*

Portal site for traffic calming principles, application, and recommendations for implementation.

https://safety.fhwa.dot.gov/speedmgt/traffic_calm.cfm

ITE - *RECOMMENDED DESIGN GUIDELINES TO ACCOMMODATE PEDESTRIANS AND BICYCLES AT INTERCHANGES: A RECOMMENDED PRACTICE AT THE INSTITUTE OF TRANSPORTATION ENGINEERS* (2016)*

Design guidance and recommendations for pedestrian and bicycle access, connectivity, and safety through interchanges. Guidance and recommendations may also apply to other micromobility users.

NACTO - *URBAN STREET DESIGN GUIDE* (2013)

Planning, design, and other guidance related to urban street design. Design elements may also be used in other contexts.

https://nacto.org/publication/urban-street-design-guide/

NACTO - *URBAN BIKEWAY DESIGN GUIDE* (2014)

Bicycle planning, design, and implementation guidance related to urban street contexts. Design elements may be applicable in other contexts and to other micromobility users.

https://nacto.org/publication/urban-bikeway-design-guide/

NACTO - *TRANSIT STREET DESIGN GUIDE* (2016)

Street design elements relating to transit access, connectivity, and priority in urban contexts. Design elements may be applicable in other contexts.

https://nacto.org/publication/transit-street-design-guide/

NACTO - *URBAN STREET STORMWATER GUIDE* (2017)

Stormwater management and green infrastructure strategies in urban environments. Design elements and strategies may be applicable in other contexts.

https://nacto.org/publication/urban-street-stormwater-guide/

NACTO - *GUIDELINES FOR REGULATING SHARED MICROMOBILITY* (2019)

Shared micromobility (bicycles, e-bicycles, and e-scooters) management guidance for urban, small town, and dense suburban contexts.

https://nacto.org/wp-content/uploads/2019/09/NACTO_Shared_Micromobility_Guidelines_Web.pdf

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION (NHTSA)

Enforcing motor vehicle safety through vehicle performance standards and improving safety by reducing motor vehicle crashes in partnership with state and local governments.

https://www.nhtsa.gov/

TRB - *HIGHWAY CAPACITY MANUAL, SEVENTH EDITION*, 2022*

Multimodal mobility analysis tool for capacity and level of service for all users.

TRB - NCHRP 674 - *CROSSING SOLUTIONS AT ROUNDABOUTS AND CHANNELIZED TURN LANES FOR PEDESTRIANS WITH VISION DISABILITIES* (2011)

Design guidance for improving crossings at roundabouts and channelized turn lanes for visually impaired pedestrians.

https://www.trb.org/Publications/Blurbs/164715.aspx

TRB - NCHRP 926 - *GUIDANCE TO IMPROVE PEDESTRIAN AND BICYCLIST SAFETY AT INTERSECTIONS* (2020)

Design guidance related to pedestrian and bicyclists safety at intersections. Guidance may also apply to other micromobility users.

https://www.trb.org/Publications/Blurbs/180624.aspx

TRB - NCHRP 966 - *POSTED SPEED LIMIT SETTING PROCEDURE AND TOOL* (2021)

Procedure and tool to establish posted speed limits that promote safety of all users.

https://www.trb.org/Publications/Blurbs/182038.aspx

TRB - NCHRP 969 - *TRAFFIC SIGNAL CONTROL STRATEGIES FOR PEDESTRIANS AND BICYCLISTS* (2022)

Signal phasing and strategies to promote access, comfort, and safety for pedestrians and bicyclists through signalized intersections and interchanges. Strategies may also apply to other micromobility users.

https://www.trb.org/Publications/Blurbs/182635.aspx

**Note: Resource is available with purchase. Contact the Statewide Bicycle and Pedestrian Coordinator for more information from these guides.*

Division of Planning
200 Mero Street
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502.564.7183
transportation.ky.gov/Planning