City of Phoenix

BICYCLE & PEDESTRIAN DESIGN GUIDANCE ELEMENT

APRIL 2023

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INTRODUCTION

CONTEXT

This toolbox presents high-level guidance for local planners, engineers, and advocates to improve the walkability and bikability of Phoenix and create more comfortable streets for pedestrians and bicyclists of all ages and abilities. Planners and project designers should refer to these guidelines in shaping future infrastructure projects; however, these guidelines are not intended to guide detailed design as they do not constitute standards.

Future roadway planning, engineering, design and construction will continue to strive for a balanced transportation system that includes a seamless, accessible bicycle and pedestrian network and encourages bicycle and pedestrian travel wherever possible.

The goal of a transportation system is to better meet the needs of people - whether in vehicles, bicyclists or pedestrians - and to provide access to goods, services, and activities.

Streets that include safe and inviting facilities for active modes provide users important transportation choices, whether it is to make trips entirely by walking or bicycling, or to access public transit. Often in urban or suburban areas, walking and bicycling are the fastest and most efficient ways to perform short trips.

Convenient, active travel provides many benefits, including reduced traffic congestion, financial savings for users, road and parking facility savings, improved economic development, and a more attractive and healthier environment through reduced greenhouse gases.

The design guidelines and recommendations in this document are intended for use on City of Phoenix roadways. Projects on Arizona Department of Transportation, county, or other roadways in other cities may require additional considerations.

Projects must not only be planned for their physical aspects as facilities serving specific transportation objectives; they must also consider effects on the aesthetic, social, economic and environmental values, needs, constraints and opportunities in a larger community setting.

Design guidance in this document meets or exceeds the minimums set by the Americans with Disabilities Act Accessible Design Guidelines (ADAAG) and the Public Right of Way Accessibility Guidelines (PROWAG).

All traffic control devices, signs, pavement markings included in street projects must conform to the Arizona Supplement to the “Manual on Uniform Traffic Control Devices” (MUTCD).


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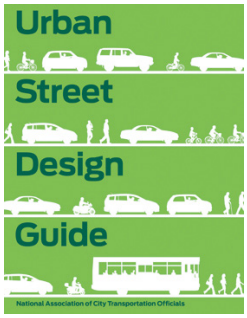
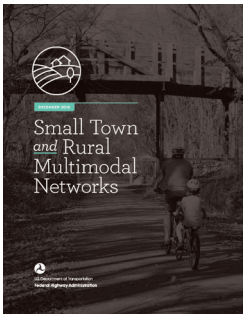
GUIDANCE BASIS

The sections that follow serve as an inventory of pedestrian and bicycle design treatments and provide guidelines for their development. These treatments and design guidelines are important because they represent the tools for creating a pedestrian- and bicycle-friendly, accessible community. The guidelines are not, however, a substitute for a more thorough evaluation by a professional engineer prior to implementation of facility improvements. The following guidelines are incorporated in this Design Guide.

Multi-modal Guidance

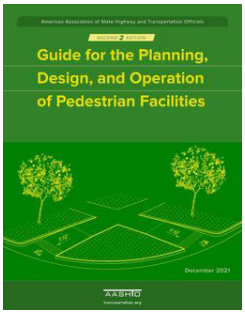


The National Association of City Transportation Officials' (NACTO) **Urban Street Design Guide (2013)** *is a collection of nationally recognized street design standards, and offers guidance on the current state of the practice designs.*

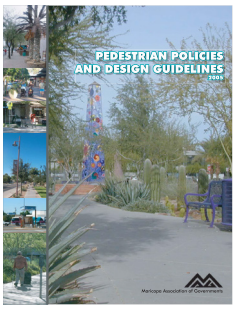


The Federal Highway Administration's **Small Town and Rural Multimodal Networks Report (2016)** *offers resources and ideas to help small towns and rural communities support safe, accessible, comfortable, and active travel for people of all ages and abilities. It connects existing guidance to rural practice and includes examples of peer communities.*

Pedestrian Guidance

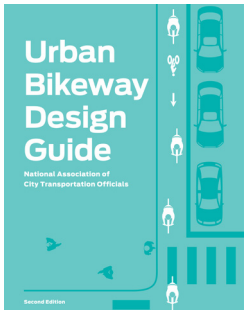


The American Association of State Highway Transportation Officials' (AASHTO) **Guide for the Planning, Design, and Operation of Pedestrian Facilities (2021)** *identifies effective measures for accommodating pedestrians on public rights-of-way, vary among roadway and facility types.*

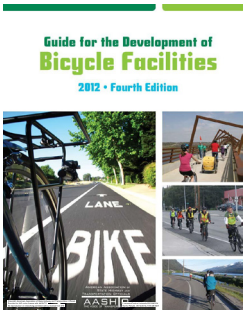


The Maricopa Association of Governments' (MAG) **Pedestrian Policies and Design Guidelines (2005)** *provides information and design assistance to better create and redevelop pedestrian areas throughout the region that integrate facilities for walking with other transportation modes.*

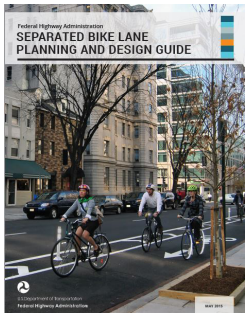
Bikeway Guidance



The National Association of City Transportation Officials' (NACTO) **Urban Bikeway Design Guide (2012)** *provides cities with state-of-the-practice solutions that can help create complete streets that are safe and enjoyable for bicyclists.*



The American Association of State Highway Transportation Officials' (AASHTO) **Guide for the Development of Bicycle Facilities (2012)** *provides information on how to accommodate bicycle travel and operations in most riding environments.*



Separated Bike Lane Planning and Design Guide (2015) *is the latest national guidance on the planning and design of separated bike lane facilities released by the Federal Highway Administration (FHWA). The resource documents best practices as demonstrated around the U.S., and offers ideas on future areas of research, evaluation and design flexibility.*

DESIGN NEEDS OF PEDESTRIANS

Types of Pedestrians

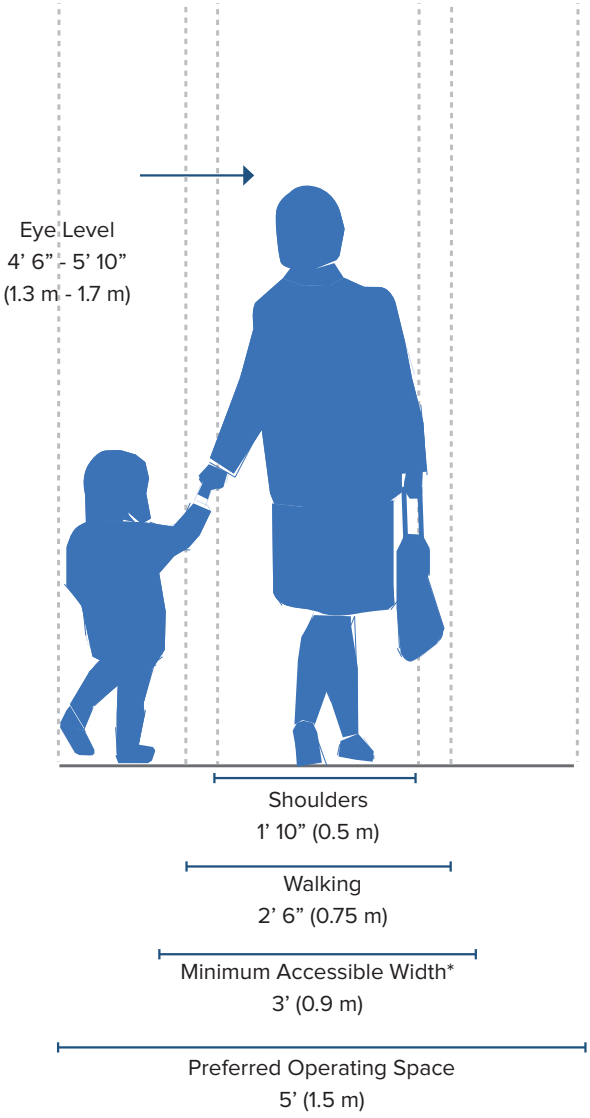
Pedestrians have a variety of characteristics and the transportation network should accommodate a variety of needs, abilities, and possible impairments. Age is one major factor that affects pedestrians' physical characteristics, walking speed, and environmental perception. Children have lower eye height and may walk slower than adults. They also perceive the environment differently at various stages of their cognitive development. Older adults walk more slowly and may require assistive devices for walking stability, sight, and hearing.

Disabled Pedestrian Design Considerations

The table below summarizes common physical and cognitive impairments, how they affect personal mobility, and recommendations for improved pedestrian-friendly design.

Disabled Pedestrian Design Considerations

Impairment	Effect on Mobility	Design Solution
Physical Impairment Necessitating Wheelchair and Scooter Use	Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
	Cross-slopes cause wheelchairs to veer downhill or tip sideways.	Cross-slopes of less than two percent.
	Require wider path of travel.	Sufficient width and maneuvering space.
Physical Impairment Necessitating Walking Aid Use	Difficulty negotiating steep grades and cross slopes; decreased stability and tripping hazard.	Cross-slopes of less than two percent. Smooth, non-slippery travel surface.
	Slower walking speed and reduced endurance; reduced ability to react.	Longer pedestrian signal cycles, shorter crossing distances, median refuges, and street furniture.
Hearing Impairment	Less able to detect oncoming hazards at locations with limited sight lines (e.g. driveways, angled intersections, channelized right turn lanes) and complex intersections.	Longer pedestrian signal cycles, clear sight distances, highly visible pedestrian signals and markings.
Vision Impairment	Limited perception of path ahead and obstacles; reliance on memory; reliance on non-visual indicators (e.g. sound and texture).	Accessible text (larger print and raised text), accessible pedestrian signals (APS), guide strips and detectable warning surfaces, safety barriers, and lighting.
Cognitive Impairment	Varies greatly. Can affect ability to perceive, recognize, understand, interpret, and respond to information.	Signs with pictures, universal symbols, and colors, rather than text.
Fatiguing Illnesses	Slower walking speed and reduced endurance; reduced ability to react. Increased chances of tripping or falling.	Longer pedestrian signal cycles, shorter crossing distances, median refuges, and street furniture. Smooth, non-slippery travel surface.



At point of contact

Pedestrian Characteristics by Age

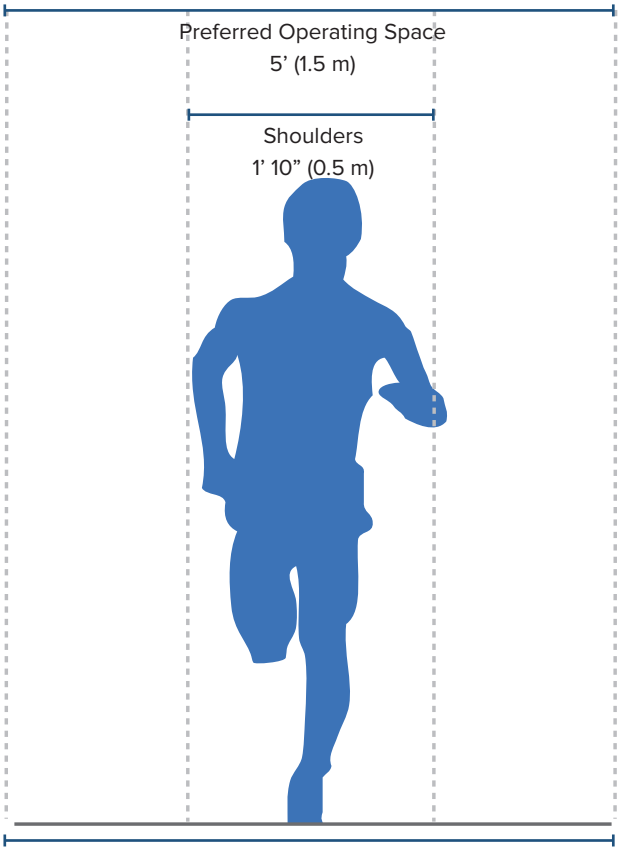
Age	Characteristics
0-4	Learning to walk
	Requires constant adult supervision
	Developing peripheral vision and depth perception
5-8	Increasing independence, but still requires supervision
	Poor depth perception
9-13	Susceptible to "darting out" in roadways
	Insufficient judgment
	Sense of invulnerability
14-18	Improved awareness of traffic environment
	Insufficient judgment
19-40	Active, aware of traffic environment
41-65	Slowing of reflexes
65+	Difficulty crossing street
	Vision loss
	Difficulty hearing vehicles approaching from behind

Source: AASHTO. Guide for the Planning, Design, and Operation of Pedestrian Facilities, Exhibit 2-1. 2021.

Design Needs of Runners

Running is an important recreation and fitness activity commonly performed on shared use paths. Many runners prefer softer surfaces (such as rubber, bare earth or crushed rock) to reduce impact. Runners can change their speed and direction frequently. If high volumes are expected, controlled interaction or separation of different types of users should be considered.

Runner Dimensions



Design Needs of Strollers

Strollers are wheeled devices pushed by pedestrians to transport babies or small children. Stroller models vary greatly in their design and capacity. Some strollers are designed to accommodate a single child, others can carry 3 or more. Design needs of strollers depend on the wheel size, geometry and ability of the adult who is pushing the stroller.

Strollers commonly have small pivoting front wheels for easy maneuverability, but these wheels may limit their use on unpaved surfaces or rough pavement. Curb ramps are valuable to these users. Lateral overturning is one main safety concern for stroller users.

Stroller Dimensions

Design Needs of Wheelchair Users

As the American population ages, the age demographics in Phoenix may also shift, and the number of people using mobility assistive devices (such as manual wheelchairs, powered wheelchairs) will increase.

Manual wheelchairs are self-propelled devices. Users propel themselves using push rims attached to the rear wheels. Braking is done through resisting wheel movement with the hands or arm. Alternatively, a second individual can control the wheelchair using handles attached to the back of the chair.

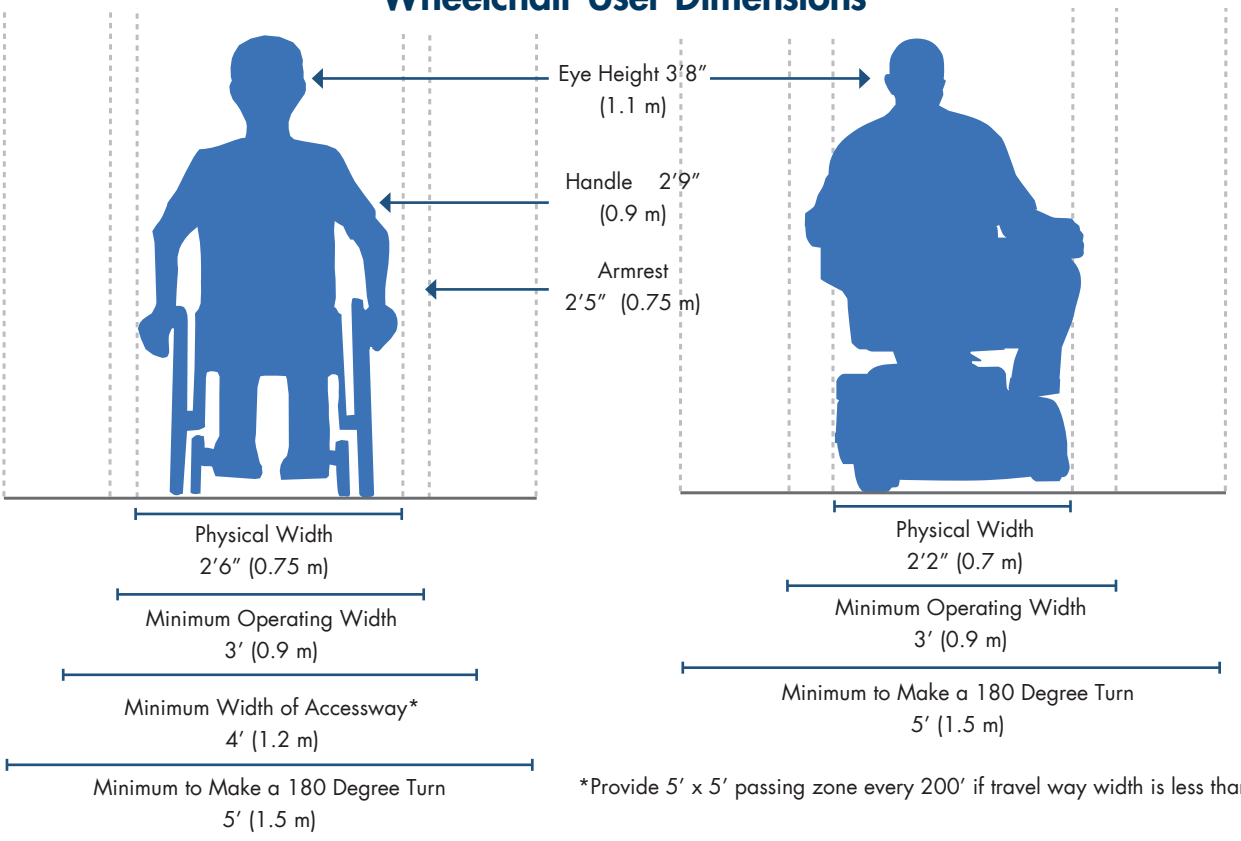
Power wheelchairs use battery power to move the wheelchair. The size and weight of power wheelchairs limit their ability to negotiate obstacles without a ramp. Various control units are available that enable users to control the wheelchair movement, based on their ability (e.g., joystick control, breath controlled, etc).

Maneuvering around a turn requires additional space for wheelchair devices. Providing adequate space for 180 degree turns at appropriate locations is an important element of accessible design.

Wheelchair User Design Considerations

Effect on Mobility	Design Solution
Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
Cross-slopes cause wheelchairs to veer downhill.	Cross-slopes of less than two percent.
Require wider path of travel.	Sufficient width and maneuvering space.

Wheelchair User Dimensions



*Provide 5′ x 5′ passing zone every 200′ if travel way width is less than 5 feet

DESIGN NEEDS OF BICYCLE & OTHER MICROMOBILITY DEVICE RIDERS

The facility designer must have an understanding of how bicycles and scooters operate and how the devices themselves influence that operation. People who ride bicycles and other micromobility devices, by nature, are much more affected by poor facility design, construction and maintenance practices than motor vehicle drivers. By understanding the unique characteristics and needs of bikes and micromobility devices, a facility designer can provide quality facilities that work for a wider spectrum of users and minimize user risk.

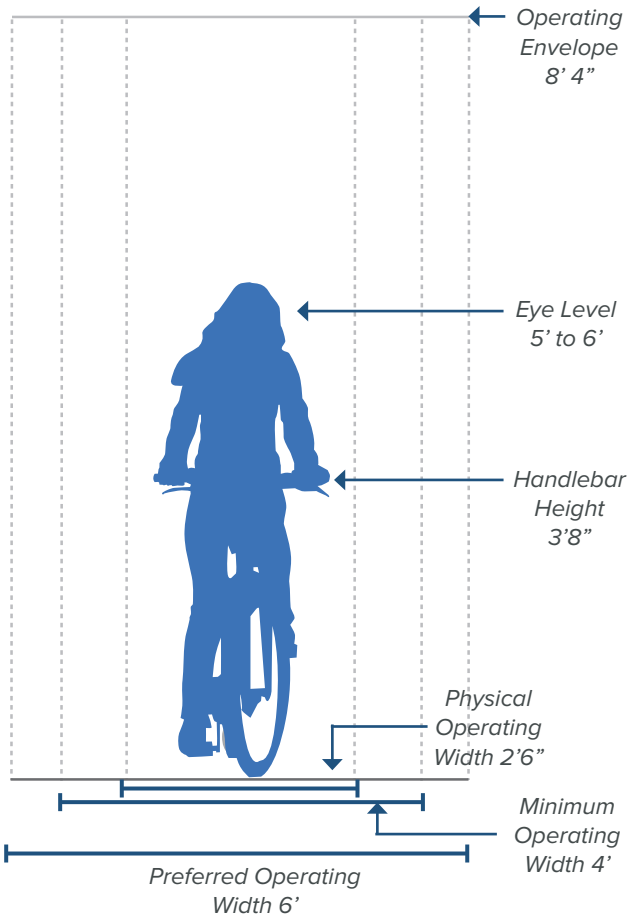
Bicycle as a Design Vehicle

Similar to motor vehicles, bicycles exist in a variety of sizes and configurations. These variations occur in the types of vehicle (such as a conventional bicycle, a recumbent bicycle or a tricycle), and behavioral characteristics (such as the comfort level of the bicyclist). The design of a bikeway should consider reasonably expected bicycle types on the facility and utilize the appropriate dimensions.

The figure illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear space to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer five feet or more operating width, although four feet may be minimally acceptable if the pavement is continuous and there is no curbing present..

In addition to the design dimensions of a typical bicycle, there are many other commonly used pedal-driven cycles and accessories to consider when planning and designing bicycle facilities. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories.

Bicycle Rider - Typical Dimensions



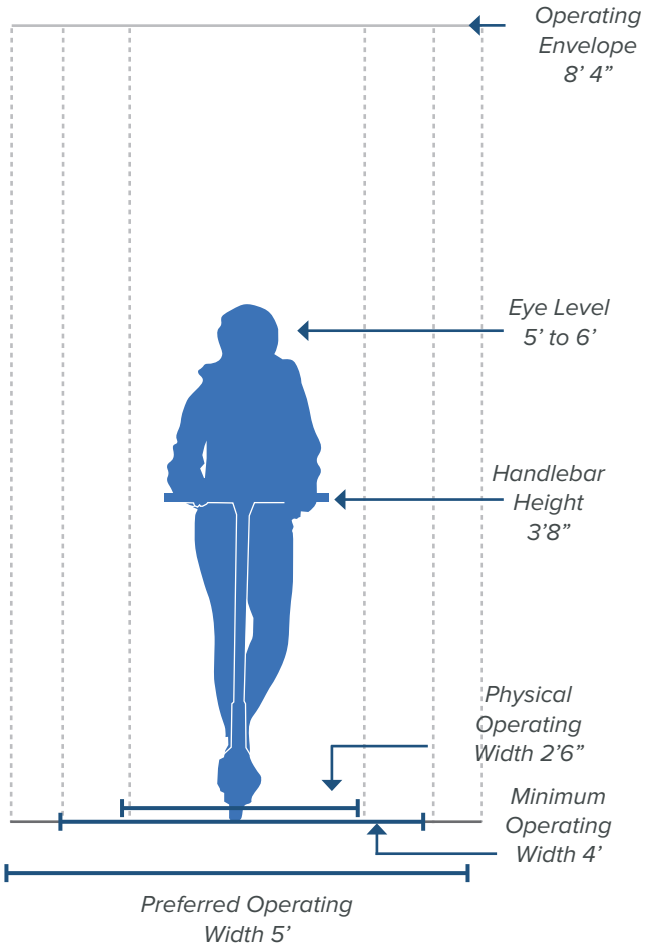
Other Micromobility Devices

Scooters, skateboards, and other similar micromobility devices, both human-powered and battery-powered are low-speed mobility devices that are typically operated in on-street bike facilities. These devices can be entirely human-powered, powered by an electric motor, or a combination of the two. They typically have an operating speed of 20 mph or less, but this can vary widely depending on whether manually-powered or motor driven, and other factors like hills.

In general, these devices have similar design operating envelopes of bicycles, (in some cases even narrower), and can be operated by a wide range of users, including those who may not be able to operate a traditional bicycle. As the wheels are smaller than bicycle wheels, potholes and large cracks are more disruptive to these vehicles

These devices have seen a dramatic increase in use, and will likely only continue to be the case as they become more affordable, available, and accessible, for both personal devices and shared micromobility systems.

Scooter Rider - Typical Dimensions



Design Speed Expectations

BICYCLE TYPE	FEATURE	TYPICAL SPEED
Upright Adult Bicyclist	Paved level surfacing	8-12 mph
	Crossing Intersections	10 mph
	Downhill	25-30 mph
	Uphill	5-12 mph
Recumbent Bicyclist	Paved level surfacing	18 mph
E-bikes and E-scooters	Paved level surfacing	10-20 mph
	Crossing Intersections	10-12 mph
	Downhill	30 mph
	Uphill	10-15mph

02

PEDESTRIAN TOOLBOX

INTRODUCTION

The Pedestrian Toolbox includes pedestrian-oriented infrastructure elements that create a more comfortable and safe pedestrian experience.

In Phoenix, in addition to all elements listed in the Toolbox, designing for heat mitigation is essential. To mitigate heat, trees, shade structures, and building heights and setbacks should be designed to provide the maximum shade on sidewalks and streets - preventing the ground materials from absorbing too much heat from the sun. Surface materials and their respective UV reflective properties can also assist in reducing the effects of heat form the sun.

This toolbox will be helpful to in addressing pedestrian needs.

SIDEWALKS

SIDEWALKS

Sidewalk Zones & Widths

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel separated from vehicle traffic. Providing adequate and accessible facilities can lead to increased numbers of people walking, improved accessibility, and the creation of social space.

Design Features

Enhancement Zone	Amenity Zone	Pedestrian Access Route (PAR)	Building Frontage Zone
The curbside lane can act as a flexible space to further buffer the sidewalk from moving traffic, and may be used for a bike facility. Curb extensions and bike corrals may occupy this space where appropriate.	The amenity zone, also called the furnishing or landscaping zone, buffers pedestrians from the adjacent roadway, and is also the area where elements such as street trees, signal poles, signs, and other street furniture are properly located.	The pedestrian access route is the area intended for pedestrian travel. This zone should be entirely free of permanent and temporary objects while fully meeting the requirements for pedestrian accessibility. Wide pedestrian zones are needed in areas or where pedestrian flows are high.	The building frontage zone allows pedestrians a comfortable "shy" distance from the building fronts, fencing, walls and vertical landscaping. It provides opportunities for window shopping, to place signs, planters, or chairs.

Street Classification	Parking Lane/ Enhancement Zone	Amenity Zone	Pedestrian Access Route (PAR)	Building Frontage Zone*
Local Streets	Varies	4 - 6 ft	6 - 8 ft	2 ft
Pedestrian Priority Areas	Varies	6 - 10 ft	8 ft	2 - 8 ft
Arterials and Collectors	Varies	4 - 6 ft	6 - 8 ft	4 - 6 ft

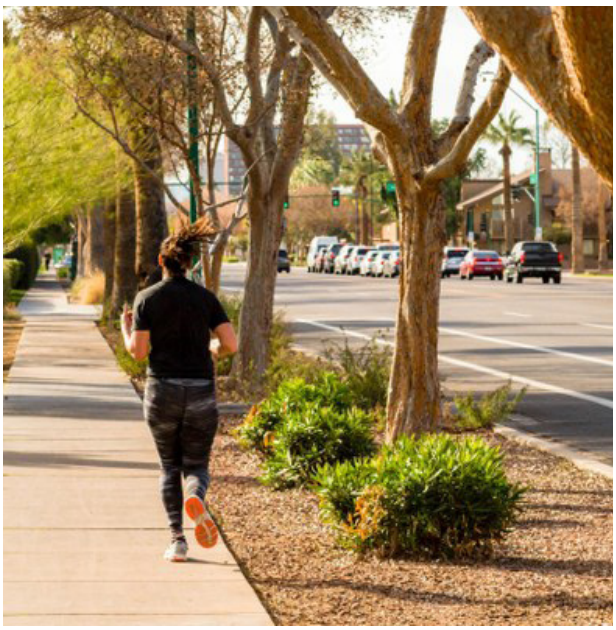
**Indicates ideal frontage zone space. Actual frontage zone is contingent upon the City's development code and required set backs*

Typical Application

- Wider sidewalks should be installed near schools, at transit stops, or anywhere high concentrations of pedestrians exist.
- At transit stops, an 8 ft by 5 ft clear space is required for accessible passenger boarding/ alighting at the front door location per ADA requirements.
- Sidewalks should be continuous on both sides of urban commercial streets, and should be required in areas of moderate residential density (1-4 dwelling units per acre).
- When retrofitting gaps in the sidewalk network, locations near transit stops, schools, parks, public buildings, and other areas with high concentrations of pedestrians should be the highest priority.

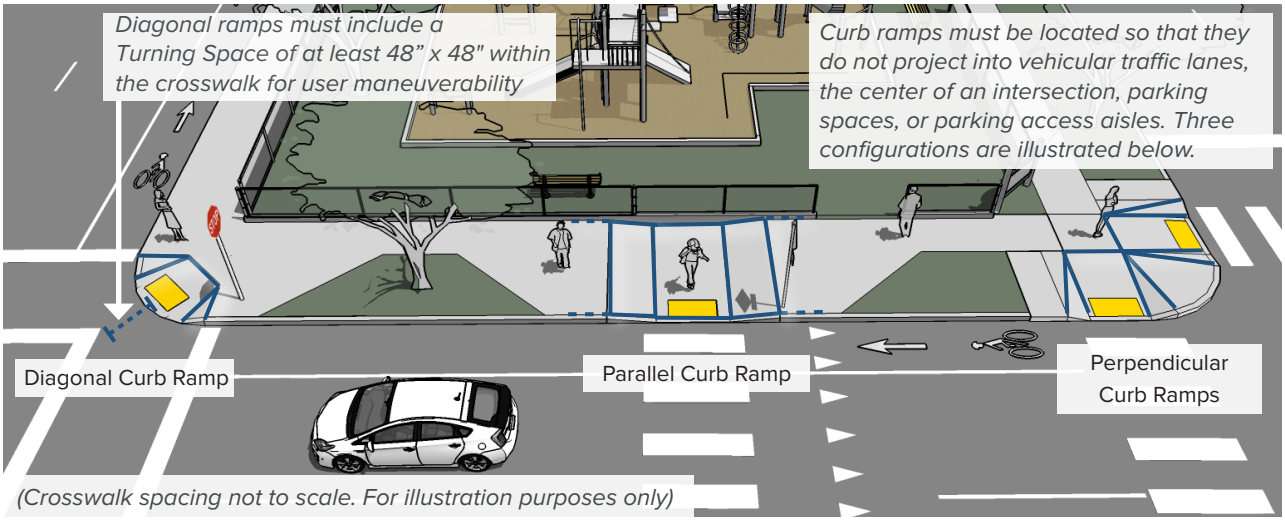
Materials and Maintenance

Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped boulevard. Less expensive walkways constructed of asphalt, crushed stone, or other stabilized surfaces may be appropriate. Ensure accessibility and properly maintain all surfaces regularly. Surfaces must be firm, stable, and slip resistant. Colored, patterned, or stamped concrete can add distinctive visual appeal. See 'Sidewalk Maintenance' for more information.



CURB RAMPS

Curb ramps are the design elements that allow all users to make the transition from the street to the sidewalk. A sidewalk without a curb ramp can be useless to someone in a wheelchair, forcing them back to a driveway and out into the street for access. There are a number of factors to be considered in the design and placement of curb ramps.



Typical Application

Curb ramps must be installed at all intersections and midblock locations where pedestrian crossings exist, as mandated by federal legislation (1973 Rehabilitation Act and ADA 1990). All newly constructed and altered roadway projects must include compliant curb ramps. In addition, existing facilities must be upgraded to current standards when appropriate.

The edge of the Pedestrian Access Route (PAR) at the ADA Ramp opening, transitioning from the sidewalk to the street, is equipped with detectable warning surfaces (also known as truncated domes) to alert people with visual impairments to changes in the pedestrian environment. Visual contrast between the raised tactile device and the surrounding infrastructure is important so that the change is readily evident to partially sighted pedestrians.

Design Features

- The level landing at the top of a ramp should be at least 4 feet long and at least the same width as the ramp itself. The slope of the ramp should be compliant to current standards.
- If the top landing is within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 4'-0" long (in the direction of the ramp run) and at least as wide as the ramp, although a width of 5'-0" is preferred.

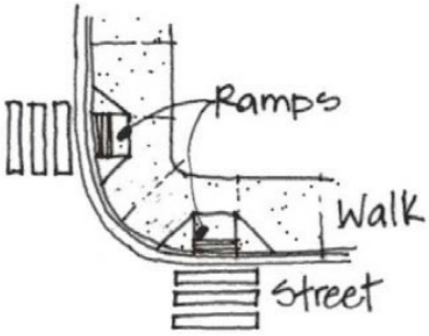
Not recommended: Diagonal curb ramp configuration.

Recommended: Directional curb ramps for crossing in both directions.

Further Considerations

Where feasible, separate directional curb ramps for each crosswalk at an intersection should be provided rather than having a single ramp at a corner for both crosswalks. Ramps dedicated to a single pedestrian travel direction orient pedestrians directly into the center of the intersection, which can be challenging for wheelchair users and pedestrians with visual impairments. Diagonal curb ramp configurations are not allowed during new construction and can only be installed as part of a maintenance activity or after a technical infeasibility study and approval by the city engineer.

Curb radii need to be considered when designing directional ramps. While curb ramps are needed for use on all types of streets, the highest priority locations are on streets near transit stops, schools, parks, medical facilities, shopping areas.

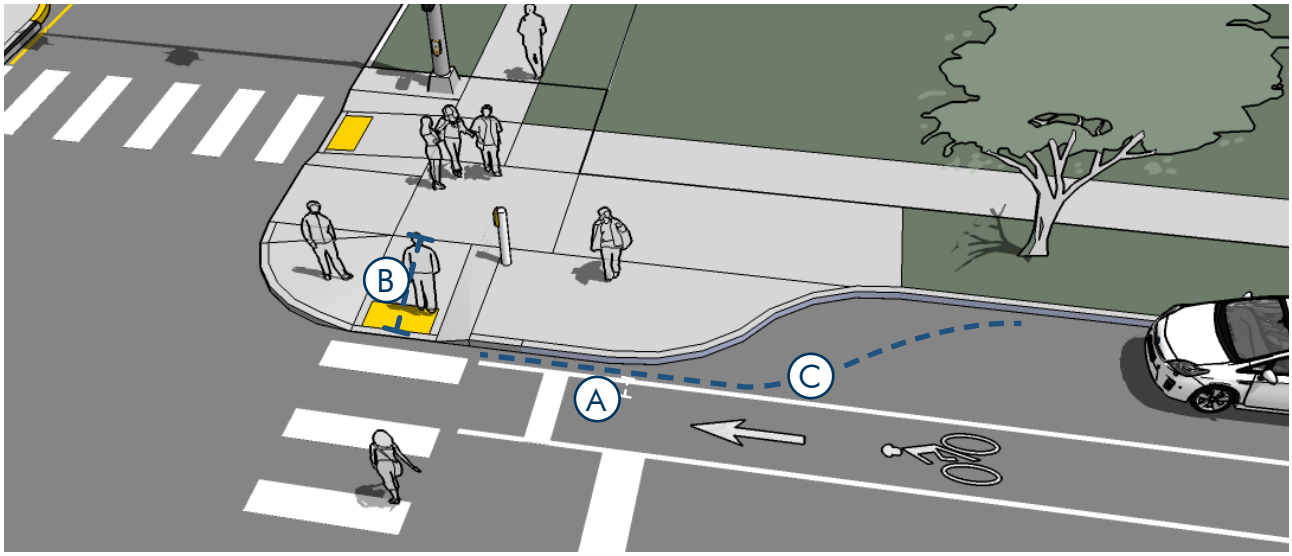


For new builds and comfortable level: Directional ramps with detectable warning.

Pedestrian Policies and Design Guidelines, pg 56. Maricopa Association of Governments, 2005

Materials and Maintenance

It is critical that the interface between a curb ramp and the street be maintained adequately. Asphalt street sections can develop vertical differentials where concrete meets asphalt at the foot of the ramp, which can catch the front wheels of a wheelchair.



CURB EXTENSIONS

Curb extensions, also called curb bulbouts and neckdowns, minimize pedestrian exposure during crossing by shortening the crossing distance and giving pedestrians a better chance to see and be seen before beginning to cross. Curb extensions are appropriate for any crosswalk where it is desirable to shorten the crossing distance and there is a parking lane adjacent to the curb.

Typical Application

- For purposes of efficient street sweeping, the minimum radius for the reverse curves of the transition is 10 ft and the two radii should be balanced to be nearly equal.
- The curb extension width should terminate one foot short of the parking lane to maximize bicyclist safety when bicycle lanes are not present. This buffer is also preferred when bicycle lanes are present.

Design Features

(A) Where a bike lane runs adjacent to the curb extension, design with a 1' buffer from edge of parking lane (preferred).

(B) Crossing distance is shortened by approximately 6-8 feet with a parallel parking lane or 15 feet or more with an angled parking lane.

(C) Curb extension length can be adjusted to accommodate bus stops or street furniture.

Further Considerations

If there is no parking lane, adding curb extensions across a roadway shoulder may be a problem for bicycle travel and truck or bus turning movements.

Materials and Maintenance

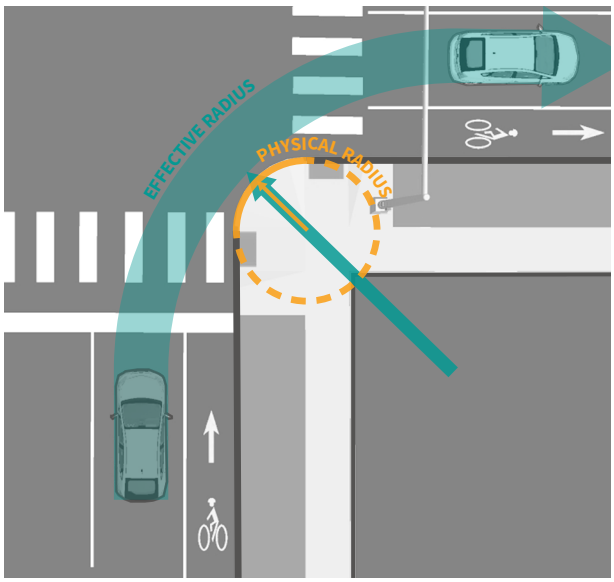
Planted curb extensions may be designed as a bioswale, a vegetated system for stormwater management. To maintain proper stormwater drainage, curb extensions can be constructed as refuge islands offset by a drainage channel or feature a covered trench drain.

CORNER RADII

The size of a curb's radius can have a significant impact on pedestrian comfort and safety. A smaller curb radius provides more pedestrian area at the corner, allows more flexibility in the placement of curb ramps, results in a shorter crossing distance and requires vehicles to slow more on the intersection approach. During the design phase, the chosen radius should be the smallest possible for the circumstances and consider the effective radius in any design vehicle turning calculations.

Typical Application

The curb radius may be as small as 3 ft where there are no turning movements, or 5 ft where there are turning movements and adequate street width. Wide outside travel lanes, on-street parking and bike lanes create a larger effective turning radius and can therefore allow a smaller physical curb radius.



Recommended: Bidirectional curb ramps for crossing in both directions.

Design Features

Corners have two critical dimensions which must be considered together.

- The physical radius controls the pedestrian experience.
- The effective radius is the widest turning arc that a vehicle can take through the corner and is larger than the physical radius.

Further Considerations

Several factors govern the choice of curb radius in any given location. These include the desired pedestrian area of the corner, traffic turning movements, street classifications, design vehicle turning radius, intersection geometry, presence of a bus or other large vehicle route, and whether there is on-street parking or a bike lane (or both) between the travel lane and the curb. Dual radius corners with mountable aprons or other corner hardening devices such as modular speed bumps can be used to accommodate larger design/control vehicles while still effectively managing ordinary vehicular traffic.

03

BICYCLE TOOLBOX

INTRODUCTION

Facility Selection: Bicycle User Type

The current AASHTO Guide to the Development of Bicycle Facilities encourages designers to identify their rider type based on the trip purpose (Recreational vs Transportation) and on the level of comfort and skill of the rider (Causal vs Experienced). An alternate, and commonly used, user-type framework for understanding a potential rider's willingness to bike is illustrated in the figure below. Developed by planners in Portland, OR* and supported by research**, this classification identifies four distinct types of bicyclists.

Strong and Fearless – This group is willing to ride a bicycle on any roadway regardless of traffic conditions. Comfortable taking the lane and riding in a vehicular manner on major streets without designated bicycle facilities.

Enthused and Confident - This group of people riding bicycles who are riding in most roadway situations but prefer to have a designated facility. Comfortable riding on major streets with a bike lane.

Interested but Concerned – This group is more cautious and has some inclination towards bicycling, but are held back by concern over sharing the road with cars. Not very comfortable on major streets, even with a striped bike lane, and prefer separated pathways or low traffic neighborhood streets.

No Way, No How – This group comprises residents who simply aren't interested at all in bicycling and may be physically unable or don't know how to ride a bicycle, and they are unlikely to adopt bicycling in any way.

** Roger Geller, City of Portland Bureau of Transportation. Four Types of Cyclists. http://www.portlandonline.com/transportation/index.cfm?&a=237507. 2009.*
*** Dill, J., McNeil, N. Four Types of Cyclists? Testing a Typology to Better Understand Bicycling Behavior and Potential. 2012.*

Typical Distribution of Bicyclist Types

Facility Selection: Comfort

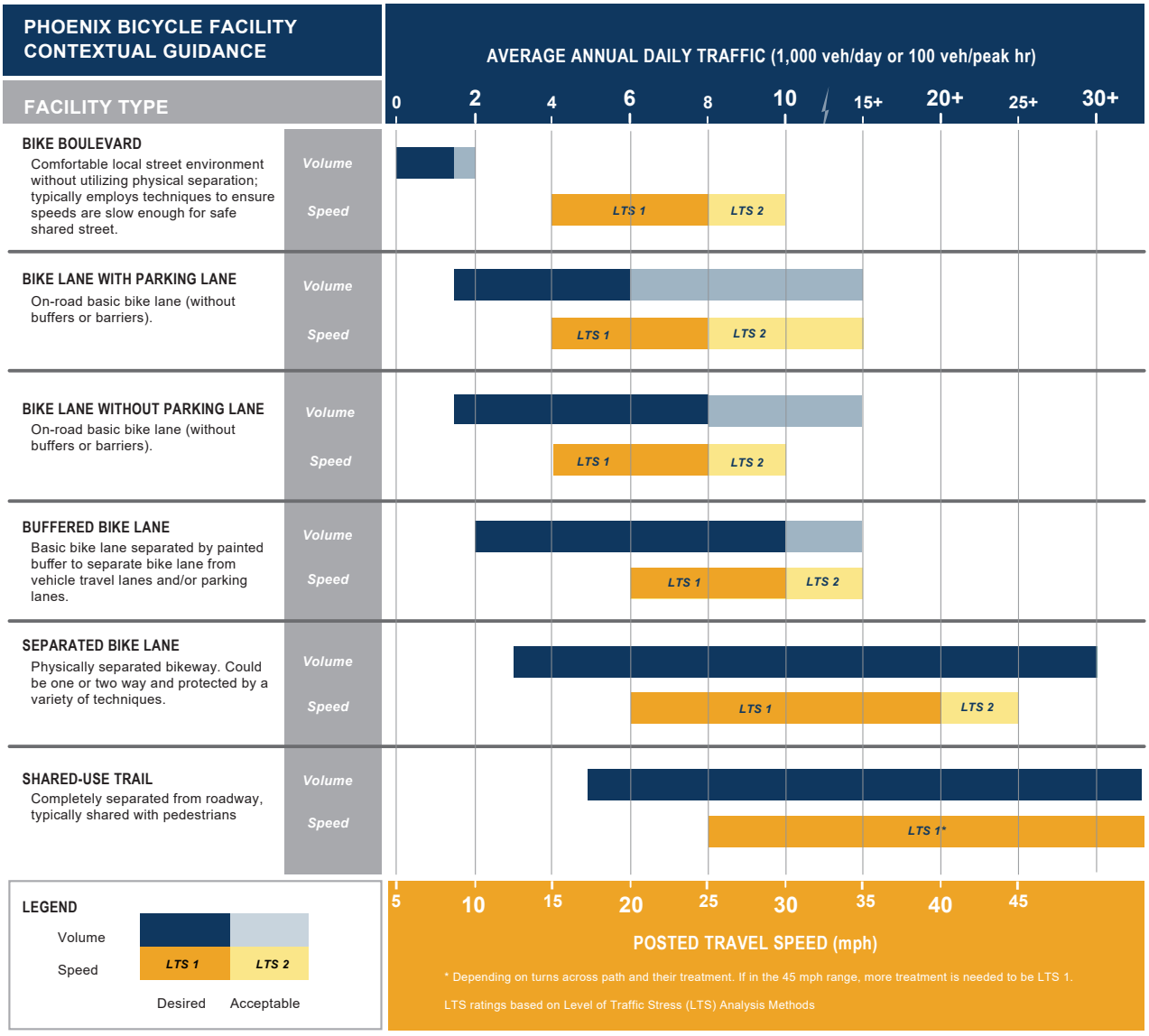
In order to provide a bikeway network that meets the needs of the Phoenix's "Interested but Concerned" residents (who comprise the majority of the population), bikeways must be low-stress and comfortable. By using a metric called Level of Traffic Stress (LTS), specific facility types can be matched to the needs of people who bicycle in Phoenix. Generally, "Interested but Concerned," users will only bicycle on LTS 1 or LTS 2 facilities.

Levels of Traffic Stress (LTS)

LTS LEVEL	DESCRIPTION	WHAT TYPE OF BICYCLISTS WILL RIDE ON THIS LTS FACILITY?		
		STRONG & FEARLESS	ENTHUSIASTIC & CONFIDENT	INTERESTED BUT CONCERNED
LTS 1	Presents the lowest level of traffic stress; demands less attention from people riding bicycles, and attractive enough for a relaxing bicycle ride. Suitable for almost all people riding bicycles, including children trained to ride in the street and to safety cross intersections.	YES	YES	YES
LTS2	Presents little traffic stress and therefore suitable to most adults riding bicycles, but demandsmore attention than might be expected from children.	YES	YES	SOMETIMES
LTS3	More traffic stress than LTS2, yet significantly less than the stress of integrating with multilane traffic.	YES	SOMETIMES	NO
LTS4	A level of stress beyond LTS 3. Includes roadways that have no dedicated bicycle facilities and moderate to higher vehicle speeds and volumes OR high speed and high volume roadways WITH an exclusive riding zone (lane) where there is a significant speed differential with vehicles.	YES	NO	NO

Facility Selection: Bikeways

As a starting point to identify a preferred facility, the chart below can be used to determine the recommended type of bikeway to be provided in particular roadway speed and volume situations. To use this chart, identify the appropriate daily traffic volume on the existing or proposed roadway, and locate the facility types indicated by those key variables. Other factors beyond volume which affect facility selection include traffic mix of including heavy vehicles, the presence of on-street parking, intersection density, surrounding land use, and roadway sight distance. These factors are not included in the facility selection chart below, but should always be considered in the facility selection and design process.

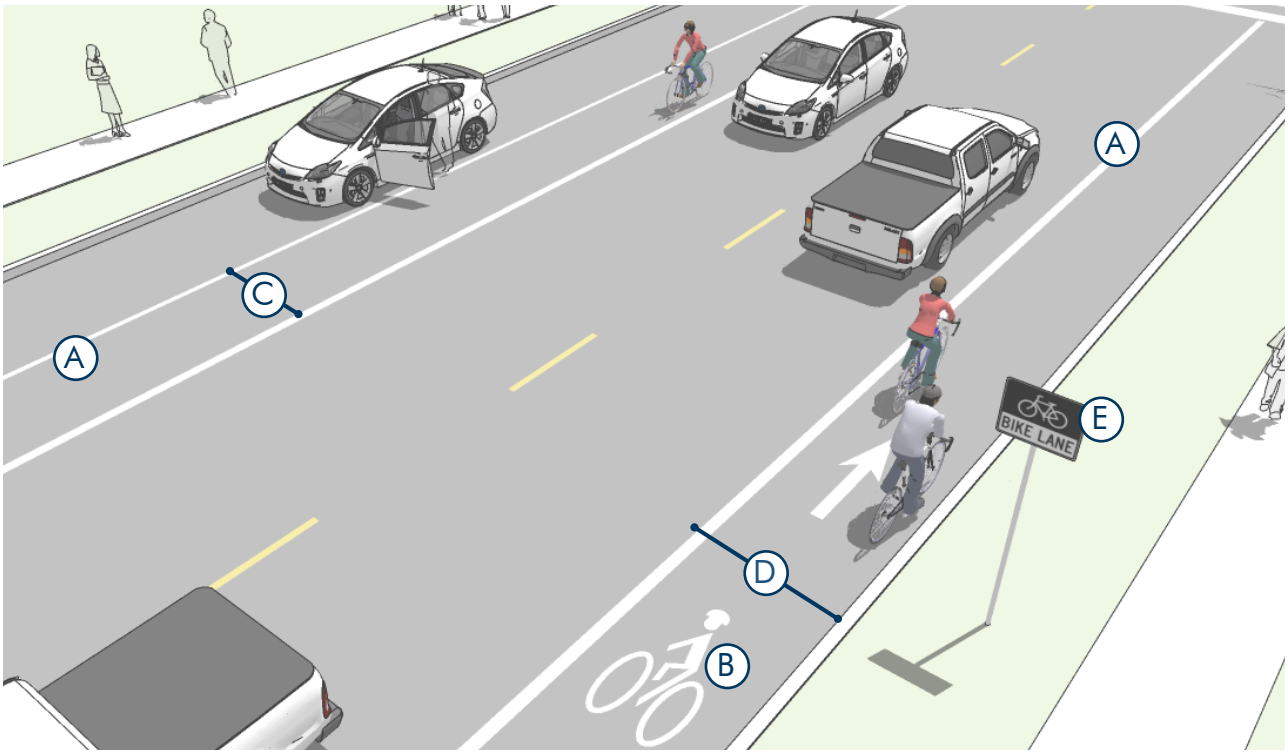


This chart can be used to identify a preferred bicycle facility, or facilities, that would provide an LTS 1 or 2 experience at a selected location. For street segments, desired and acceptable vehicular volumes for each facility are shown. These are the motor vehicle volume ranges that are appropriate for that facility. The correspondence between motor vehicle speed on the street and the LTS score for each facility are also shown. The speed entries determine the LTS scores for the facility. A facility should only be chosen when both the street volumes and LTS scores are appropriate. Since ranges overlap, it is important to allow more than one facility type to meet the desired LTS. Other factors should be considered when selecting a treatment, such as proximity to schools, parks, or trailheads.

BIKE LANES

STANDARD BIKE LANES

On-street bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signs. The bike lane is located directly adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge or parking lane.



Typical Application

- Bike lanes may be used on any street with adequate space, but are most effective on streets with moderate traffic volumes ≤ 6,000 ADT (≤ 4,000 preferred).
- Bike lanes are most appropriate on streets with lower to moderate speeds ≤ 30 mph.
- Appropriate for skilled adult riders on most streets.
- May be appropriate for children when configured as 6+ ft wide lanes on lower-speed, lower-volume streets with one lane in each direction.

Design Features

(A) Mark inside line with 8" stripe. Mark 4" parking lane line or "Ts".

(B) Include a bicycle lane marking at the beginning of the bike lane, beginning and end of bike lane pockets, approaches and farside of arterial crossings, and major changes in direction. MUTCD recommends every 80 ft - 1,000 ft depending on land use context.

(C) 6 foot width preferred adjacent to on-street parking, (5 foot min.). Buffer preferred when parking has high turnover, see Buffered Bike Lanes.

(D) 5.5–7 foot preferred adjacent to curb and gutter or 4 feet more than the gutter pan width.

(E) The R3-17 "Bike Lane" sign is optional, but recommended in most contexts.

Further Considerations

- On high speed streets (≥ 40 mph) the minimum bike lane should be 6 feet.
- It may be desirable to reduce the width of general purpose travel lanes in order to add or widen bicycle lanes.
- On multi-lane streets, the most appropriate bicycle facility to provide for user comfort may be buffered bicycle lanes or physically separated bicycle lanes.
- Contraflow bike lanes are a special type of bike lane that can be implemented in specific locations where a dedicated bike lane is needed for a particular direction of travel, but the roadway is oriented for one-way travel in the opposite direction, and/or when space constraints preclude a bike facility on nearby parallel routes that would otherwise serve this need. Contraflow bike lanes are effective in providing short, critical connections along bikeways, and special attention needs to be paid to facility transitions to other bikeway types.

Manhole Covers and Grates:

- Manhole surfaces should be manufactured with a shallow surface texture in the form of a tight, nonlinear pattern.
- If manholes or other utility access boxes are to be located in bike lanes within 50 ft. of intersections or within 20 ft. of driveways or other bicycle access points, special manufactured permanent nonstick surfaces ensure a controlled travel surface for bicyclists breaking or turning.
- Manholes, drainage grates, or other obstacles should be set flush with the paved roadway. Roadway surface inconsistencies pose a threat to safe riding conditions for bicyclists. Construction of manholes, access panels or other drainage elements should be constructed with no variation in the surface. The maximum allowable tolerance in vertical roadway surface will be 1/4 of an inch.

Bike lanes provided dedicated spaces for bicyclists to ride on the street.

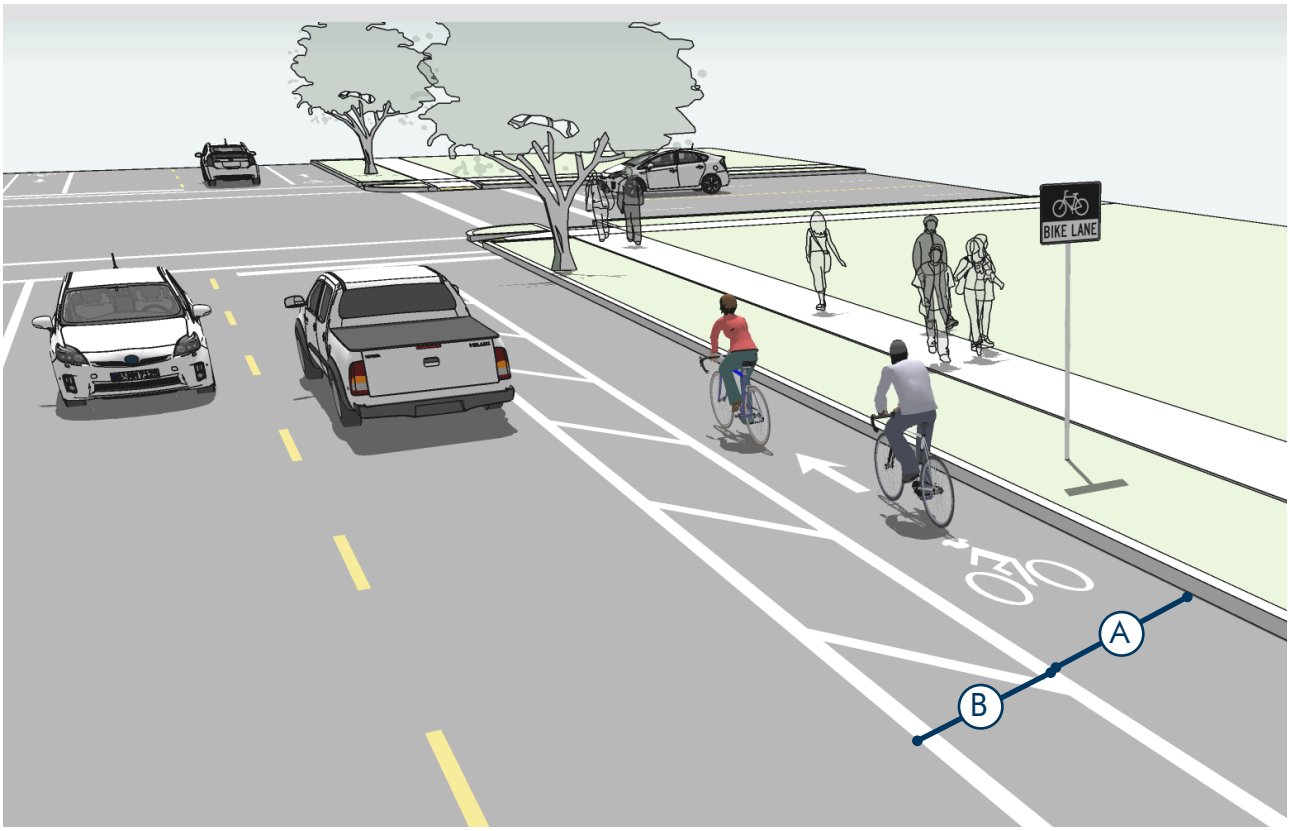
Materials and Maintenance

Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway.

Bike lanes should also be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

BUFFERED BIKE LANES

Buffered bike lanes are conventional bike lanes paired with a designated buffer space, separating the bike lane from the adjacent motor vehicle travel lane and/or parking lane.



Typical Application

- Anywhere a conventional bike lane is being considered.
- While conventional bike lanes are most appropriate on streets with lower to moderate speeds (≤ 30 mph), buffered bike lanes provide additional value on streets with higher speeds (+30 mph) and high volumes or high truck volumes (up to 6,000 ADT).
- On streets with extra lanes or lane width.
- Appropriate for skilled adult riders on most streets.

Design Features

(A) The minimum bicycle travel area (not including buffer) is 5 feet wide.

(B) Buffers should be at least 2.5 feet wide - but 3 feet or more in width is preferred. Diagonal markings are used in buffers that are 2.5 to 4 feet wide. Chevron markings are used in buffers over 4 feet wide.

- Buffers may be applied on the parking side, the travel side, both or alternating depending on the main source of concern.

Buffered bike lanes should include a striped buffer that is at least 2.5-3+ feet

The use of additional pavement markings delineates space between vehicles and bicyclists.

Further Considerations

- On multi-lane streets with high vehicles speeds, the most appropriate bicycle facility to provide for user comfort may be physically separated bike lanes.
- NCHRP Report #766 recommends, when space is limited, installing a buffer space between the parking lane and bicycle lane where on-street parking is permitted rather than between the bicycle lane and vehicle travel lane.1 This buffer is particularly useful in commercial areas where parking turnover is higher.

Materials and Maintenance

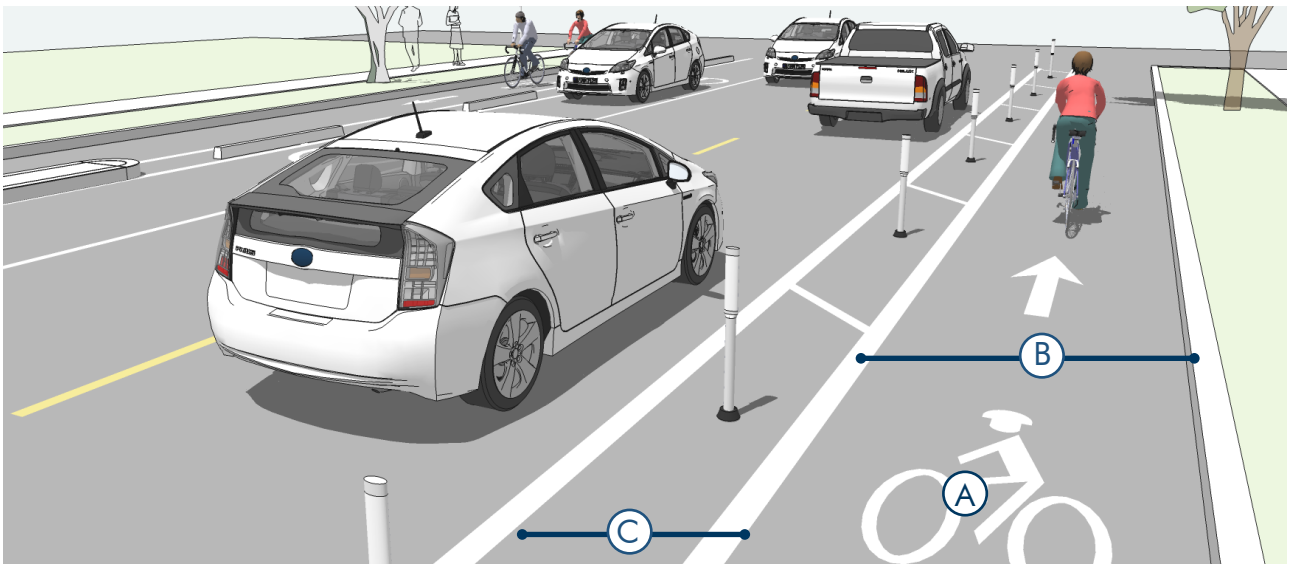
Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway.

Bike lanes should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

1 National Cooperative Highway Research Program. Report #766: Recommended Bicycle Lane Widths for Various Roadway Characteristics.

SEPARATED BIKE LANES: ONE-WAY

One-way separated bike lanes, also known as protected bikeways or cycle tracks, are on-street bikeway facilities that are separated from vehicle traffic. Physical separation is provided by a barrier between the bikeway and the vehicular travel lane. These barriers can include flexible posts, bollards, parking, planter strips, extruded curbs, or on-street parking. Separated bikeways using these barrier elements typically share the same elevation as adjacent travel lanes, but the bikeway could also be raised above street level, either below or equivalent to sidewalk level.



Typical Use

- Along streets on which conventional bicycle lanes would cause many bicyclists to feel stress because of factors such as multiple lanes, high bicycle volumes, high motor traffic volumes (9,000-30,000 ADT), higher traffic speeds (35+ mph), high incidence of double parking, higher truck traffic (10% of total ADT) and high parking turnover.
- Along streets for which conflicts at intersections can be effectively mitigated using parking lane setbacks, bicycle markings through the intersection, and other signalized intersection treatments.

Design Features

(A) Pavement markings, symbols and/or arrow markings must be placed at the beginning of the separated bikeway and at intervals along the facility based on engineering judgment to define the bike direction.

(B) 8 feet or more in width preferred in areas with high bicycle volumes or uphill sections to facilitate safe passing behavior. Minimum width, 6 feet (5.5 feet as an absolute minimum).

(C) When placed adjacent to parking, the parking buffer should be 4 ft wide to allow for passenger loading and to prevent door collisions.

- Buffers should be wide enough to support the type of separation provided without that separation creating a hazard for drivers or bicyclists using the roadway.
- When placed adjacent to a travel lane, one-way raised cycle tracks may be configured with a mountable curb to allow entry and exit from the bicycle lane for passing other bicyclists or to access vehicular turn lanes.
- Include green elephant crossings marks at conflict points like intersections or driveways.

Parked cars serve as a barrier between bicyclists and the vehicle lane. Barriers could also include flexible posts, bollards, planters, or other design elements.

Further Considerations

- Diagonal markings are used in buffers that are 2.5 to 4 feet wide. Chevron markings are used in buffers over 4 feet wide.
- Curbs may be used as a channeling device. Grade-separation provides an enhanced level of separation in addition to buffers and other barrier types.
- Where possible, physical barriers such as removable curbs should be oriented towards the inside edge of the buffer to provide as much extra width as possible for bicycle use.
- A retrofit separated bikeway has a relatively low implementation cost compared to road reconstruction by making use of existing pavement and drainage and using a parking lane as a barrier.
- Gutters, drainage outlets and utility covers should be designed and configured as not to impact bicycle travel.
- For clarity at major or minor street crossings, consider a dotted line for the buffer boundary where cars are expected to cross.
- Special consideration should be given at transit stops to manage bicycle and pedestrian interactions.
- Consideration should be given to ensuring that entrances to separated bike lanes do not look like car travel lanes by incorporating clear signage and pavement markings.

Materials and Maintenance

Bikeway striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway. Green conflict markings (if used) will also generally require higher maintenance due to vehicle wear.

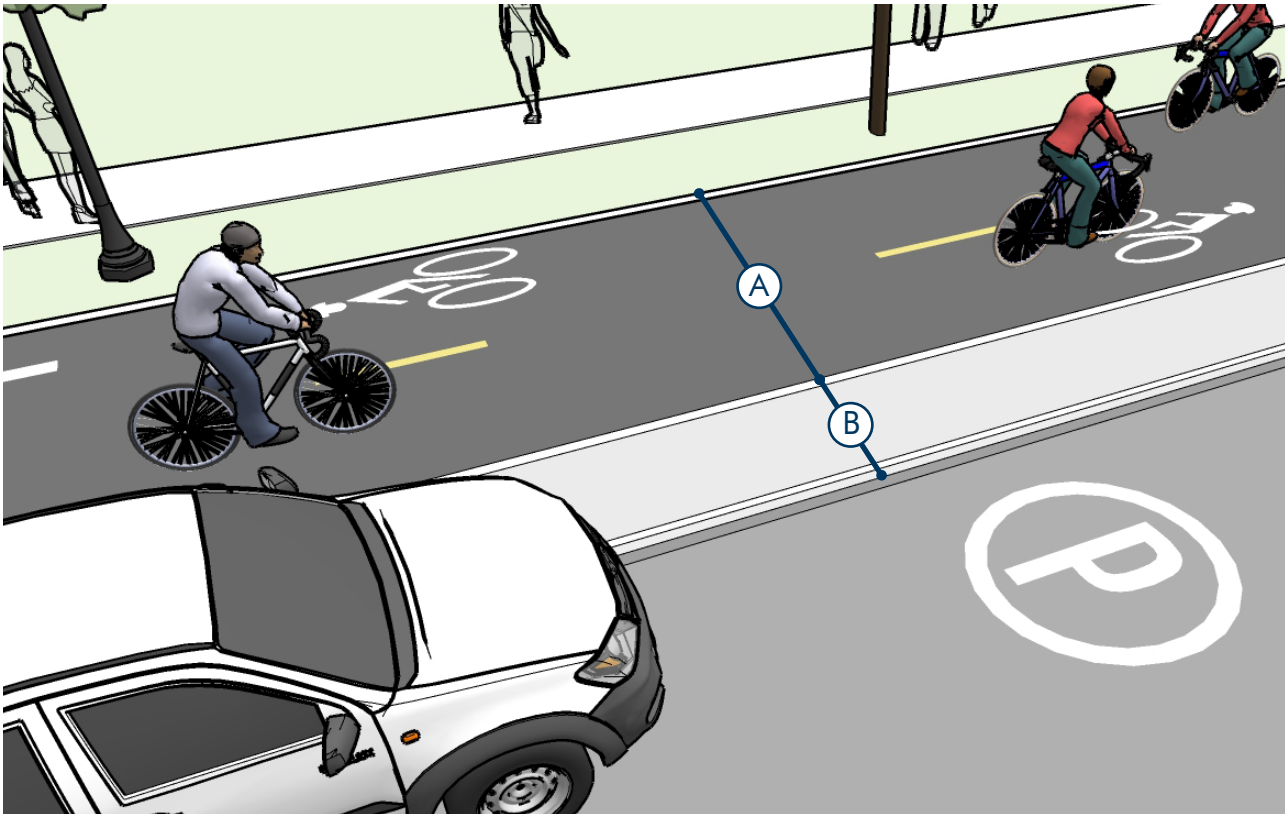
Bikeways should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

Install composite and reboundable delineator systems, which offer more durability.

SEPARATED BIKE LANES: TWO-WAY

Two-Way separated bike lanes are bicycle facilities that allow bicycle movement in both directions on one side of the road. Two-way separated bikeways share some of the same design characteristics as one-way separated bikeways, but often require additional considerations at driveway and side-street crossings, and intersections with other bikeways.



Typical Application

Works best on the left side of one-way streets.

- Streets with high motor vehicle volumes and/or speeds
- Streets with high bicycle volumes.
- Streets with a high incidence of wrong-way bicycle riding.
- Streets with few conflicts such as driveways or cross-streets on one side of the street.
- Streets that connect to shared use trails.

Design Features

(A) 12 foot operating width preferred (10 ft minimum) width for two-way facility.

- In constrained locations an 8 foot minimum operating width may be considered for short intervals.

(B) Adjacent to on-street parking a 4 foot minimum width channelized buffer or island should be provided to accommodate opening doors. (NACTO, 2012).

- Additional signalization and signs may be necessary to manage conflicts.

A two-way facility can accommodate bicyclists in two directions of travel.

Further Considerations

- A two-way separated bikeway on one way street should be located on the left side.
- A two-way separated bikeway may be configured at street level or as a raised separated bikeway with vertical separation from the adjacent travel lane.
- Two-way separated bikeways should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles.
- Two-way separated bikeways may have implications for signalized and unsignalized intersections that put contra-flow bicyclists in increased levels of risk. This should be strongly considered with any project. Bicycle exclusive signals and other control elements are often recommended with two-way separated bikeways.
- Consideration should be given to ensuring that entrances to separated bike lanes do not look like car travel lanes by incorporating clear signage and pavement markings.

Materials and Maintenance

Bikeway striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway. Green conflict markings (if used) will also generally require higher maintenance due to vehicle wear.

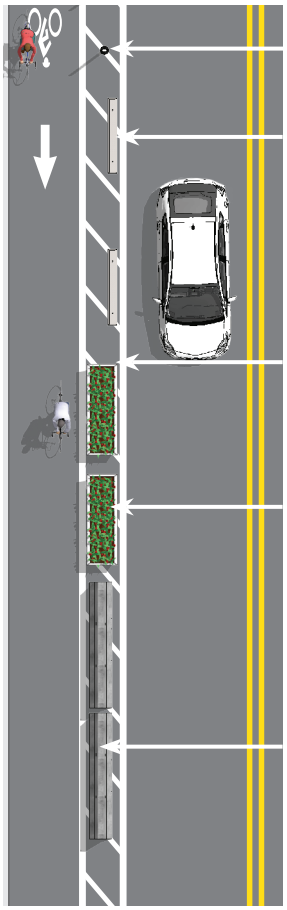
Bikeways should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

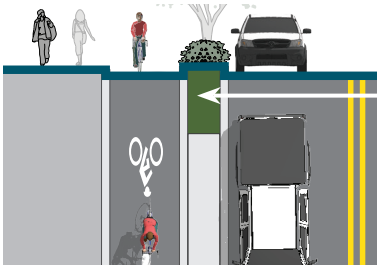
SEPARATED BIKE LANE BARRIERS

Separated bike lanes may use a variety of vertical elements to physically separate the bikeway from adjacent travel lanes. Barriers may be robust constructed elements such as curbs, or may be more interim in nature, such as flexible delineator posts.

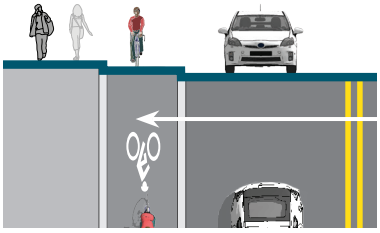
Barrier Separation



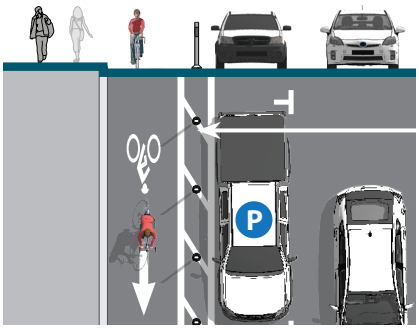
Median Separation



Elevation Separation



Parking Separation



Typical Application

Appropriate barriers for retrofit projects:

- Parked cars
- Flexible delineators
- Planters
- Modular curbing

Appropriate barriers for reconstruction projects:

- Curb separation
- Medians
- Landscaped medians
- Raised protected bike lane with vertical or mountable curb
- Pedestrian Refuge Islands

Raised separated bikeways are bicycle facilities that are vertically separated from motor vehicle traffic.

Design Features

- Maximize effective operating space by placing curbs or delineator posts as far from the through bikeway space as practicable.
- Allow for adequate shy distance of 1 to 5 feet from vertical elements to maximize useful space.
- When next to parking allow for 3 feet of space in the buffer space to allow for opening doors and passenger unloading.
- The presences of landscaping in medians, planters and safety islands increases comfort for users and enhances the streetscape environment.

Further Considerations

- With new roadway construction, a raised separated bikeway can be less expensive to construct than a wide or buffered bicycle lane because of shoulder trenching and sub base requirements.
- Parking should be prohibited within 30 feet of intersections and driveways to improve visibility. Clearly indicate the parking prohibition through the use of a red curb, signs, or other tools.

Materials and Maintenance

Separated bikeways protected by concrete islands or other permanent physical separation, can be swept and plowed by smaller street sweeper vehicles.

Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

BIKE BOULEVARDS

BIKE BOULEVARD OVERVIEW

A Bike Boulevard is a low-speed, low-volume roadway that is designed to enhance comfort and convenience for people bicycling. It provides better conditions for bicycling while improving the neighborhood character and maintaining emergency vehicle access. Bike Boulevards are intended to serve as a low-stress bikeway network, providing direct, and convenient routes across Phoenix. Key elements of Bike Boulevards are unique signage and pavement markings, traffic calming and diversion features to maintain low vehicle volumes, and convenient major street crossings.

Treatments depicted may vary per roadway segment or location.

Typical Use

- Parallel with and in close proximity to major thoroughfares (1/4 mile or less) on low-volume, low-speed streets.
- Follow a desire line for bicycle travel that is ideally long and relatively continuous (2-5 miles).
- Avoid alignments with excessive zigzag or circuitous routing. The bikeway should have less than 10% out of direction travel compared to shortest path of primary corridor.
- Local streets with traffic volumes of fewer than 1,500 vehicles per day (for the majority of their length) and with average operating speeds below 25 mph. Utilize traffic calming to maintain or establish low volumes and discourage vehicle cut through / speeding.

Design Features

- Signs and pavement markings are the minimum treatments necessary to designate a street as a bike boulevard.
- Implement volume control treatments based on the context of the bike boulevard, using engineering judgment. While motor vehicle volumes should not exceed 3,000 vehicles per day, ideal conditions are 1,500 vehicles per day or less.
- Intersection crossings should be designed to enhance comfort and minimize delay for bicyclists of diverse skills and abilities.

A traffic circle included in an intersection along a Bike Boulevard calms traffic since vehicles are forced to slow down. Photo credit: Alta

An example of an large pavement marking to reinforce that the street is a Bike Boulevard.

Further Considerations

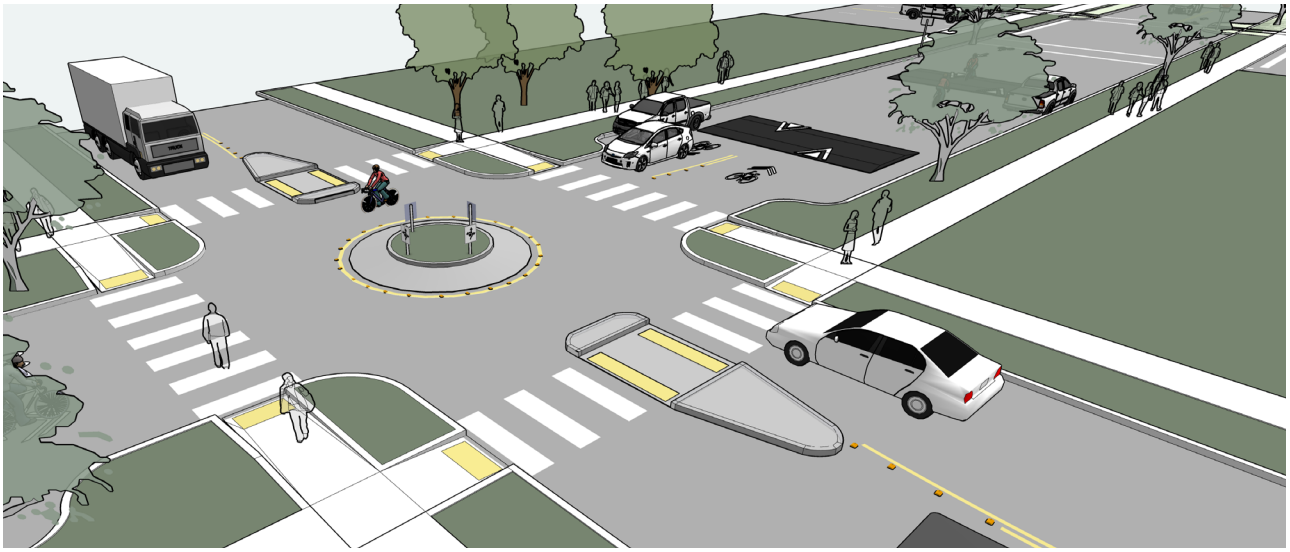
- Bike Boulevards are established on streets that improve connectivity to key destinations and provide a direct, low-stress route for bicyclists, with low motorized traffic volumes and speeds, designated and designed to give bicycle travel priority over other modes.
- Bike Boulevard retrofits to local streets are typically located on streets without existing signalized accommodation at crossings of collector and arterial roadways. Without treatments for bicyclists, these intersections can become major barriers along the Bike Boulevard.
- Traffic calming can deter motorists from driving on a street. Anticipate and monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

Materials and Maintenance

Bike Boulevards require few additional maintenance requirements to local roadways. Signage, signals, and other traffic calming elements should be inspected and maintained according to local standards.

TRAFFIC CALMING

Traffic calming devices can help mitigate speeding and cut-through traffic by changing driver behavior through a variety of visual or physical changes to the road environment. Such measures may reduce the design speed of a street and can be used in conjunction with reduced speed limits to reinforce the expectation of lowered speeds.



Typical Application

- Traffic calming measures should be limited to placement along local streets, typically with a maximum posted speed of 30 mph.
- Traffic calming measures should be implemented when the safety of all roadway users, especially pedestrians and bicyclists, is at risk due to high vehicular speeds. The risk can be determined by an engineering study.
- Traffic calming measures can be more applicable in areas with high potential for conflict between pedestrian/bicyclist and motor vehicles.
- Traffic calming measures may be most appropriate in areas with predominantly residential or mixed-use land use.
- If applicable, traffic calming measures should not infringe on bicycle space. Where possible, provide a bicycle route outside of the element so bicyclists can avoid having to merge into traffic at a narrow pinch point.
- Traffic calming measures should always consider emergency vehicle response times and turning abilities.

Design Features

- There are a variety of treatments and combinations of treatments that can be used for traffic calming.
- Priority traffic calming measures include strategies and devices that are primarily focus on safety. They are meant to regulate, warn, inform, enforce, and educate motorists, cyclists, and pedestrians on the road. Examples include, radar signs, pavement markings, turn restrictions, temporary speed bumps.
- Secondary traffic calming devices and roadway design features are used primarily to reduce traffic speeds within residential areas. These measures are used when primary calming devices have not been effective. Examples

include, speed tables, chicanes, traffic circles, and tree planting.

- Traffic diversion may be employed to discourage cut-through traffic from utilizing residential streets designated as Bike Boulevards. Traffic diverters are often employed when traffic volumes in a particular area have been found to be significantly higher compared to similar streets in other areas. Examples include, diverters, partial street closures, and median barrier/forced turn islands.

Further Consideration

Benefits of speed management include:

- Improves conditions for bicyclists, pedestrians, and residents on local streets.
- Reduced travel speeds decreases the exposure risks between bicyclists/pedestrians and motor vehicles.
- Reduced travel speeds result in reduced injury severity in the event of a collision.
- Helps achieve a safer and more livable neighborhood while balancing the transportation needs of the roadway.

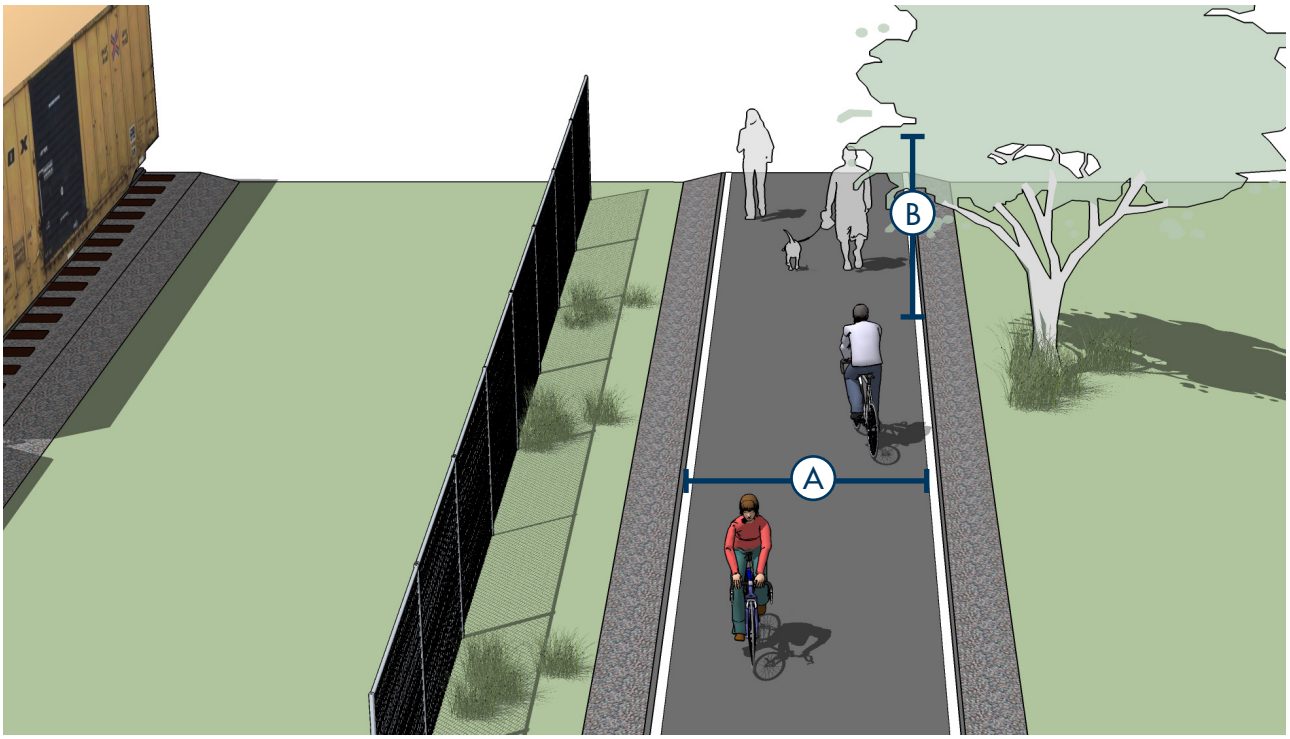
Bulb outs narrow the right-of way, creating visual friction and slowing cars.

04

SHARED USE PATHS

SHARED USE PATHS

A shared use path provides a travel area separate from motorized traffic for bicyclists, pedestrians, skaters, wheelchair users, joggers, and other users. Shared use paths are desirable for bicyclists of all skill levels preferring separation from traffic. These facilities should generally provide travel opportunities not provided by existing roadways.



Typical Use

- In waterway corridors, such as along canals, drainage ditches, rivers, and creeks.
- In abandoned rail corridors (commonly referred to as Rails-to-Trails or Rail-Trails.)
- In active rail corridors, trails can be built adjacent to active railroads (referred to as Rails-with-Trails.)
- In utility corridors, such as power line and sewer corridors.
- Along roadways.

Design Features

(A) 12-14 ft is recommended for heavy use situations with high concentrations of multiple users. A separate track (5' minimum) can be provided for pedestrian use.

- 10 ft is recommended in most situations and will be adequate for moderate to heavy use.

Lateral Clearance

- A 2 ft or greater shoulder on both sides of the path should be provided if the trail is constructed from asphalt. If the trail is constructed out of concrete these clearances should be maintained, but no gravel shoulder is required.
- 1-2 ft of clearance should be provided between the edge of path and barriers, such as walls or fences, or railing

Overhead Clearance

(B) Clearance to overhead obstructions should be 8 ft minimum, with 10 ft recommended.

Striping

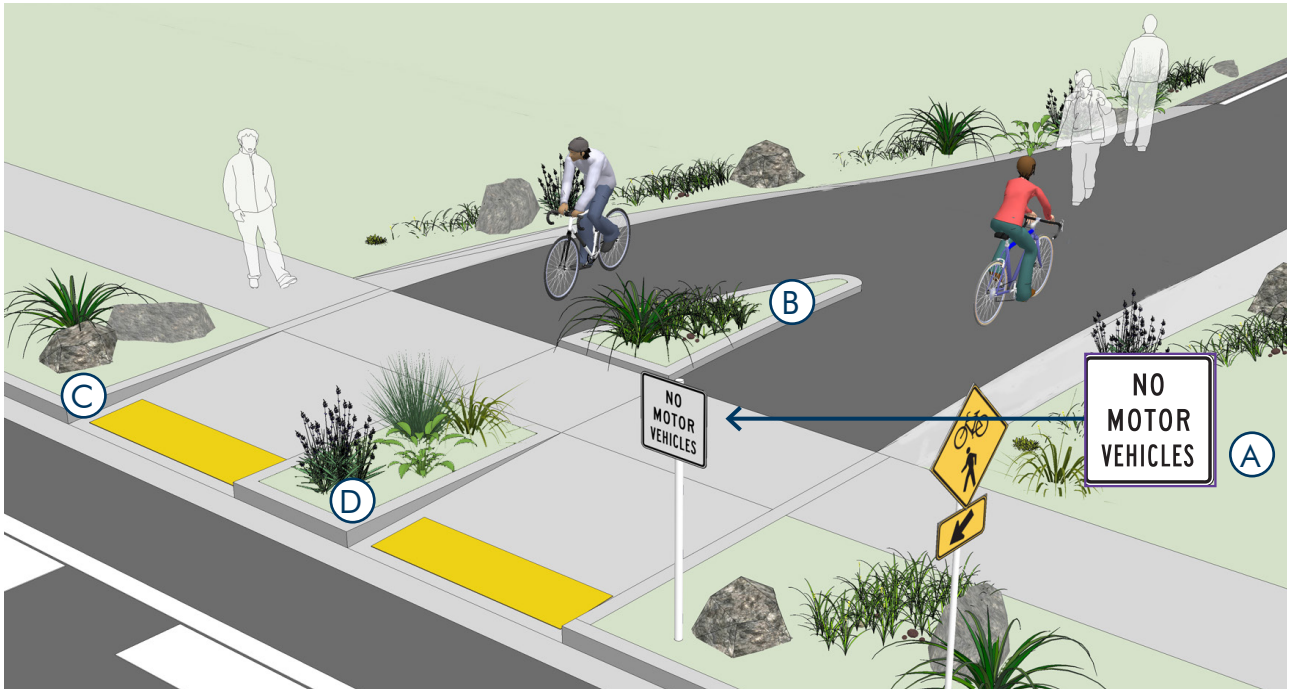
- When striping is desired, use a 4 inch dashed yellow centerline stripe with 4 inch solid white edge lines.
- Solid centerlines can be provided on tight or blind corners and transitions, and on the approaches to roadway crossings.

Further Considerations

- Under most conditions, centerline markings are not necessary. Centerline markings should only be used if necessary for clarifying user positioning or preferred operating procedure: Solid line = No Passing; Dashed line = Lane placement
- Paths with a high volume of bidirectional traffic should include a centerline. This can help communicate that users should expect traffic in both directions and encourage users to travel on the right and pass on the left. Wide trails will function better with higher levels of user traffic.
- Where there is a sharp blind curve, painting a solid yellow line with directional arrows reduces the risk of head-on collisions.
- Small scale signs should be used in trail environments.
- Terminate the path where it is easily accessible to and from the street system, preferably at a trailhead, controlled intersection, or at the beginning of a dead-end street.
- Use of bollards should be avoided when possible. If bollards are used at intersections and access points, they should be colored brightly and/or supplemented with reflective materials to be visible at night.

PATHWAY ENTRANCES

Bollards or other physical barriers are often used to restrict motor vehicle access to the shared use path. Unfortunately, physical barriers are often ineffective at preventing access, and create obstacles to legitimate path users. Alternative design strategies use signage, landscaping and curb cut design to reduce the likelihood of motor vehicle access.



Typical Application

- Bollards or other barriers should not be used unless there is a documented history of unauthorized intrusion by motor vehicles.
- If unauthorized use persists, assess whether the problems posed by unauthorized access exceed the risks and issues posed by bollards and other barriers.

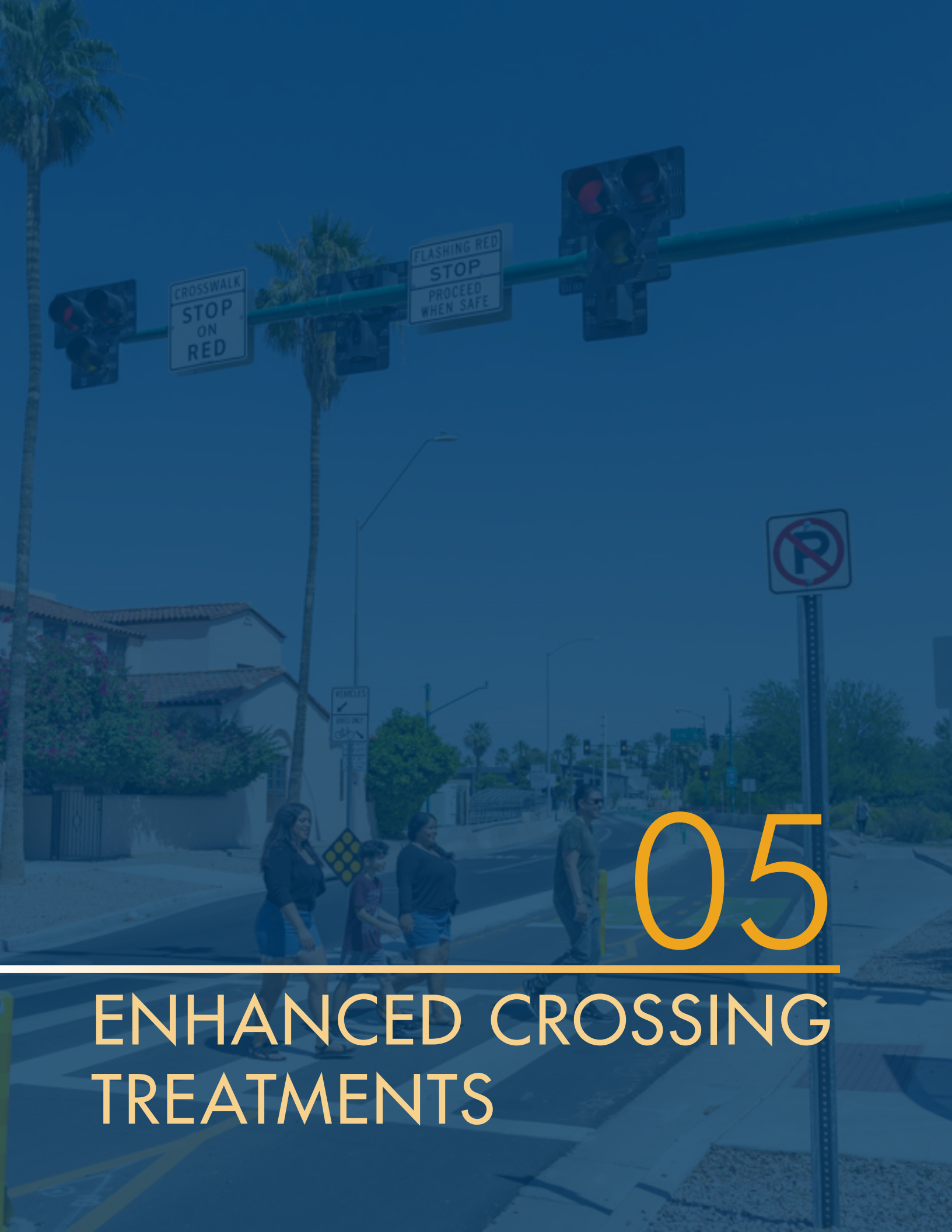
Design Features

(A) "No Motor Vehicles" signage (R5-3) may be used to reinforce access rules.

(B) At intersections, split the trail tread into two sections separated by low landscaping.

(C) Vertical curb cuts should be used to discourage motor vehicle access.

(D) Low landscaping preserves visibility and emergency access.



05

ENHANCED CROSSING TREATMENTS

INTERSECTION TREATMENTS

TWO-STAGE TURN BOXES

Two-stage turn boxes offer bicyclists a safe way to make turns at multi-lane signalized intersections from a physically separated or conventional bike lane. On separated bike lanes, bicyclists are often unable to merge into traffic to turn due to physical separation, making the two-stage turning critical. This treatment received Interim Approval from FHWA in 2017 (IA-20).

Typical Application

- Streets with high vehicle speeds and/or traffic volumes.
- At intersections of multi-lane roads with signalized intersections.
- At signalized intersections with a high number of bicyclists making a left turn from a right side facility.
- Preferred treatment to assist turning maneuvers on bike lanes, instead of requiring bicyclists to merge to make a vehicular left turn.
- Required for protected bikeways to assist left turns from a right side facility, or right turns from a left side facility.

Design Features

- The two-stage turn box should be placed in a protected area. Typically this is within the shadow of an on-street parking lane or protected bike lane buffer area and should be placed in front of the crosswalk to avoid conflict with pedestrians.
- 10 foot x 6.5 foot preferred dimensions of bicycle storage area (6 foot x 3 foot minimum).
- Bicycle stencil and turn arrow pavement markings should be used to indicate proper bicycle direction and positioning. (NACTO, 2012)

Further Considerations

- Consider providing a "No Turn on Red" on the cross street to prevent motor vehicles from entering the turn box.

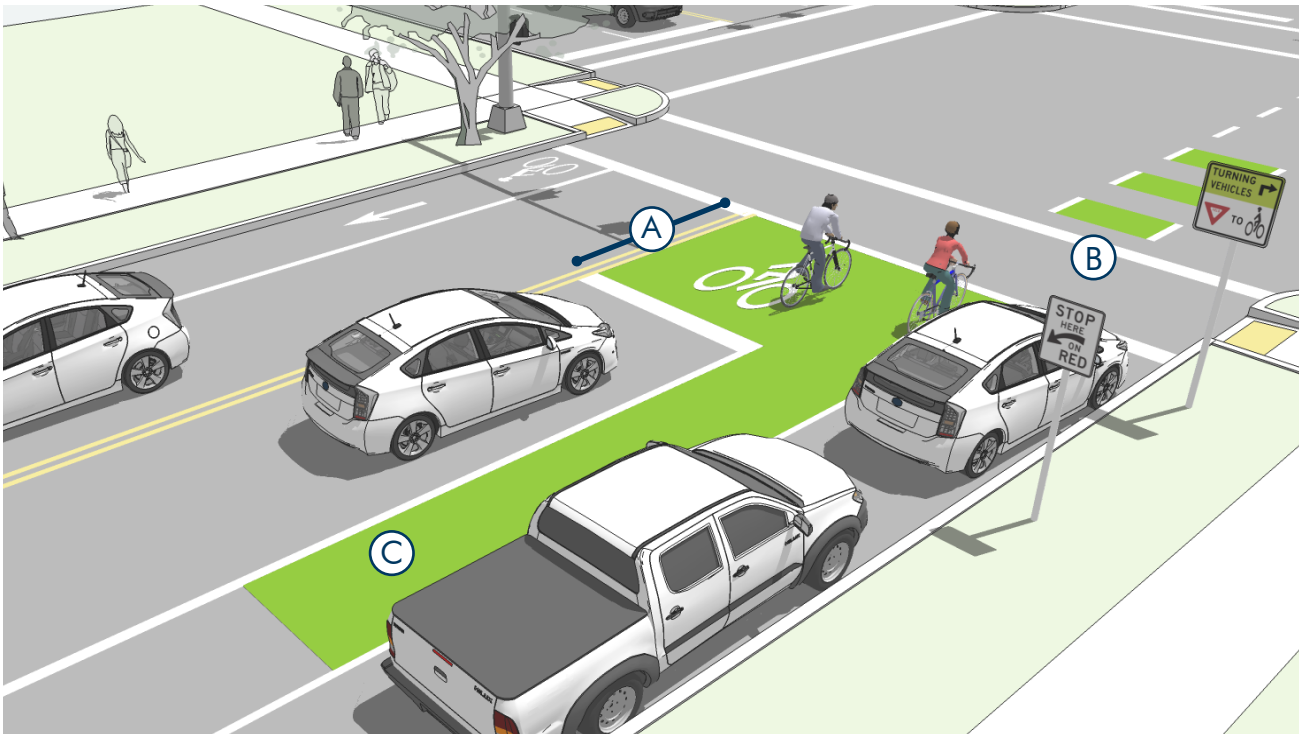
- This design formalizes a maneuver called a "box turn" or "pedestrian style turn."
- Design guidance for two-stage turns apply to both bike lanes and separated bike lanes.
- Two-stage turn boxes reduce conflicts in multiple ways; from keeping bicyclists from queuing in a bike lane or crosswalk and by separating turning bicyclists from through bicyclists.
- Bicyclist capacity of a two-stage turn box is influenced by physical dimension (how many bicyclists it can contain) and signal phasing (how frequently the box clears.)

Materials and Maintenance

Turn boxes may subject to high vehicle wear, especially turning passenger vehicles, buses, and heavy trucks. As a result, bike boxes with green coloring will require more frequent replacement over time. The life of the green coloring will depend on vehicle volumes and turning movements, but Thermoplastic or MMA are generally more durable material than paint.

BICYCLE BOX

A bicycle box is designed to provide bicyclists with a safe and visible space to get in front of queuing traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box. On a green signal, all bicyclists can quickly clear the intersection. This treatment received Interim Approval from the FHWA in 2016 (IA-18).



Typical Use

- At potential areas of conflict between bicyclists and turning vehicles, such as a right or left turn locations.
- At signalized intersections with high bicycle volumes.
- At signalized intersections with high vehicle volumes.
- Not to be used on downhill approaches to minimize the right hook threat potential during the extended green signal phase.

Design Features

(A) 14 foot minimum depth from back of crosswalk to motor vehicle stop bar. (NACTO, 2012)

(B) A "No Turn on Red" sign should be installed overhead to prevent vehicles from entering the Bike Box. A "Stop Here on Red" sign should be post mounted at the stop line to reinforce observance of the stop line.

(C) A 50 foot ingress lane should be used to provide access to the box.

- Use of green colored pavement is recommended.

A bike box allows for bicyclists to wait in front of queuing traffic, providing high visibility and a head start over motor vehicle traffic. Photo credit: Marin County.

Further Considerations

- This treatment positions bicycles together and on a green signal, all bicyclists can quickly clear the intersection, minimizing conflict and delay to transit or other traffic.
- Pedestrian also benefit from bike boxes, as they experience reduced vehicle encroachment into the crosswalk.
- Bike boxes require permission from the FHWA to implement, and jurisdictions must receive approval prior to implementation. A State may request Interim Approval for all jurisdictions in that State.[1]
- Bike boxes should not be used to accommodate bicyclist turns at intersections that have substantial parallel green time as bicyclists cannot safely occupy the box when arriving on green.

Materials and Maintenance

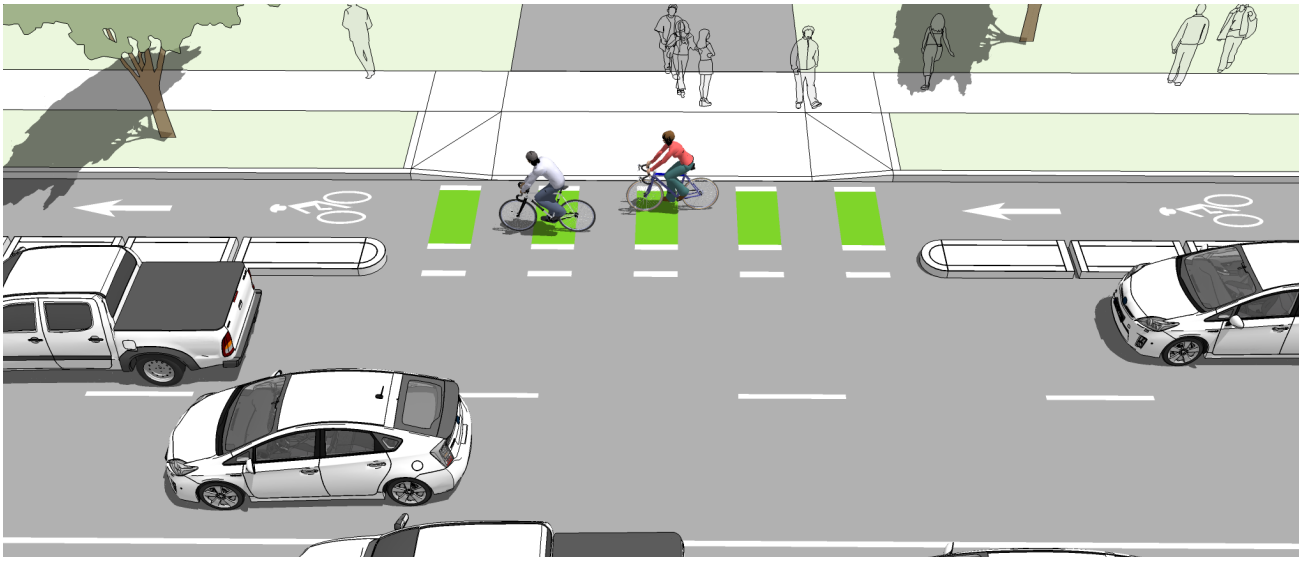
Bike boxes are subject to high vehicle wear, especially turning passenger vehicles, buses, and heavy trucks. As a result, bike boxes with green coloring will require more frequent replacement over time. The life of the green coloring will depend on vehicle volumes and turning movements, but thermoplastic is generally a more durable material than paint.

1 *FHWA. Interim Approval for Optional Use of an Intersection Bicycle Box (IA-18). 2016.*

DRIVEWAY & MINOR STREET CROSSINGS

The added separation provided by separated bikeways creates additional considerations at intersections and driveways when compared to conventional bicycle lanes. Special design guidelines are necessary to preserve sightlines and denote potential conflict areas between modes, especially in the case of a two-way bike lane when motorists turning into or out of driveways may not be expecting bicycle travel opposite to the main flow of traffic.

At driveways and crossings of minor streets, bicyclists should not be expected to stop if the major street traffic does not stop.



Typical Use

- Along streets with separated bikeway where there are intersections and driveways.
- Higher frequency driveways or crossings may require additional treatment such as conflict markings and signs.

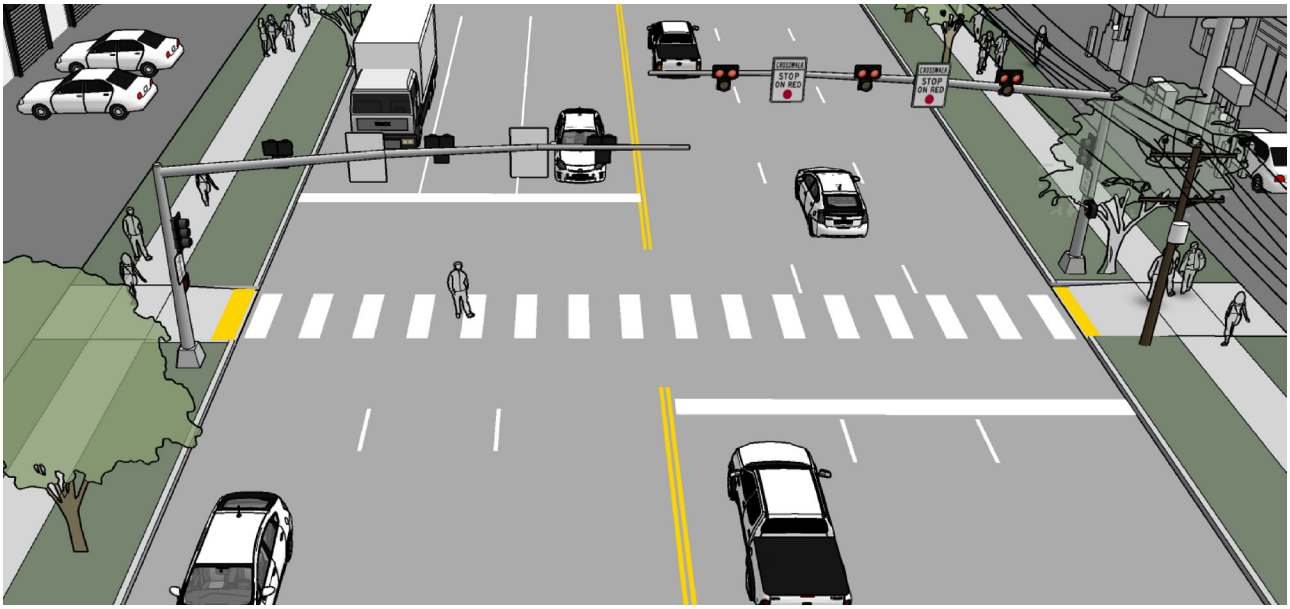
Design Features

- Remove parking to allow for the appropriate clear sight distance before driveways or intersections to improve visibility. The desirable no-parking area is at least 30 feet from each side of the crossing.
- Use colored pavement markings and/or shared line markings through conflict areas at intersections.
- If a raised bikeway is used, the height of the lane should be maintained through the crossing, requiring automobiles to cross over.
- Motor vehicle traffic crossing the bikeway should be constrained or channelized to make turns at sharp angles to reduce travel speed prior to the crossing.
- Driveway crossings may be configured as raised crossings to slow turning cars and assert physical priority of traveling bicyclists.
- Motor vehicle stop bar on cross-streets and major driveways is setback from the intersection to ensure that drivers slow down and scan for pedestrians and bicyclists before turning.

SIGNALS AND BEACONS

HIGH-INTENSITY ACTIVATED CROSSWALKS (HAWK)

High-Intensity Activated Crosswalks (HAWK) are used to improve non-motorized crossings of major streets. A hybrid beacon consists of a signal head with two red lenses over a single yellow lens on the major street, and a pedestrian signal head for the crosswalk. HAWKS are only used at marked mid-block crossings or unsignalized intersections. They are activated with a pedestrian pushbutton at each end. If a median refuge island is used at the crossing, another pedestrian pushbutton can be located on the island to create a two-stage crossing.



Typical Application

- Suitable for multi-lane streets where speeds are above 30-45 mph
- Where off-street bicycle and pedestrian facilities intersect major streets without signalized intersections.
- At intersections or midblock crossings where there are high pedestrian volumes.

Design Features

- HAWKS may be installed without meeting traffic signal control warrants based on engineering judgment if roadway speed and volumes are excessive for comfortable pedestrian crossings.
- If installed within a signal system, signal engineers should evaluate the need for the HAWKs to be coordinated with other signals.
- Parking and other sight obstructions shall be prohibited in advance of, and beyond, the marked crosswalk to provide adequate sight distance.

Further Considerations

- HAWKs are normally activated by push buttons, but may also be triggered by infrared, microwave, or video detectors. If not on-demand, the maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street, but a much shorter delay is strongly preferred.
- Each crossing, regardless of traffic speed or volume, requires review to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.
- The installation of HAWKs should also include public education and enforcement campaigns to ensure proper use and compliance.

Materials and Maintenance

- HAWKs are subject to the same maintenance needs and requirements as standard traffic signals. Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

TOUCAN SIGNAL

"Toucan" signalized crossings of streets are a special signal configuration at minor street crossings of a major street, exclusively for people walking and biking, so that "two can" cross the major street concurrently. Vehicles on the minor street do not have a signal, and are instead forced to turn right at a stop sign. This does function as a half signal since vehicles are not allowed to turn left or proceed through. The placement of the Toucan can vary within a given intersection, depending on the overall roadway width, and whether one-way vs. two-way operations are contained fully within the median in the middle of the minor street.

A Toucan signal in Tucson, AZ. Motorists must turn right onto Stone Avenue, the major roadway (from either direction). Bicyclists can turn left, right, or go straight. Bicyclists turning left or going straight can push a button to activate a green bicycle signal indication. Photo credit: Steven Vance.

Typical Use

- Appropriate at carefully designed intersection locations
- Across higher traffic streets where people walking and biking both require safe and comfortable crossings, such as along Bike Boulevards.

Design Features

- A toucan signal assembly may be created by pairing a bicycle and pedestrian signal heads. The bicycle signal must comply with requirement from FHWA Interim Approval 16.
- The major street faces a standard traffic signal (red, amber, and green indications) for the major road. When located at an intersection, the minor cross street has Stop sign to control minor street motor vehicle traffic.

- The pedestrian/bike phase is typically activated actively by a pushbutton or passively using other detection devices.
- At street crossings, the design must be paired with access management or other measures to reduce potential conflicts. Such measures as turn restrictions with dynamic (blank-out) No Right turn/No Left Turn signs, or access management to limit conflicting motor vehicle movements into the and out of the intersection
- High visibility crosswalk markings and bicycle lane dotted lane line extensions (when connecting bike lanes) help to clarify pedestrian and bicyclist paths.

Further Considerations

- The FHWA has been discouraging "half signals" for several decades because of the potential conflict issues caused when minor-street drivers make a right turn onto the major street, in conflict with the crossing pedestrians (the center-running configuration shown in the photo to right eliminates this risk).
- The steady red signal indication provides a clear regulatory message that typically receives a more uniform control response than warning signs or flashing beacons. Red signal indications receive a high-degree of yielding with over 95% compliance (NCHRP 562).
- Because this is not a common signal configuration at intersections, it is important to operate all toucan signals consistently across the jurisdiction for maximum understanding, compliance, and safety.
- FHWA has approved bicycle signals for use, if they comply with requirements from Interim Approval 16.
- Pedestrians typically need more time to travel through an intersection than bicyclists. Signal timing and recall phases should be responsive to the detection and actuation by different users.
- Bicycle detection and actuation systems include user-activated buttons mounted on a pole, loop detectors that register a call to the bike signal when a bicycle is detected, microwave detectors, or video/thermal detection cameras that detect a change in the activity at the location.

Materials and Maintenance

Pedestrian and bicycle signal detection equipment should be inspected and maintained regularly, especially if detection relies on manual actuation. Pushbuttons and loop detectors will tend to have higher maintenance needs than other passive detection equipment.

BIKE DETECTION AND ACTUATION

Bicycle detection and actuation is used to alert the signal controller of bicycle crossing demand on a particular approach. Proper bicycle detection should meet two primary criteria: accurately detects bicyclists and provides clear guidance to bicyclists on how to actuate detection (e.g., what button to push, where to stand).

Typical Application

- At signalized intersections within bicycle lanes or general purpose travel lanes.
- At signalized intersections within left turn lanes used by bicyclists.
- At signalized intersections within separated bike lanes.
- In conjunction with active warning beacons and pedestrian hybrid beacons.

Design Features

Video Detection

- Video detection systems use digital image processing to detect a change in the image at a location. These systems can be calibrated to detect bicycle, although there may be detection issues during poor lighting and weather conditions.

Thermal Detection

- Infrared detection systems typically consist of one or more thermal cameras, a microprocessor to process the thermal imagery, and software to interpret the traffic flow data and communicate with the traffic signal controller. These systems are typically able to extract a significant amount of data from the thermal imagery.

Microwave Detection

- Microwave sensor detection is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method marks the detected object with a time code to determine its distance from the sensor.
- Microwave sensor detection is unaffected by temperature and lighting, which can affect standard video detection.

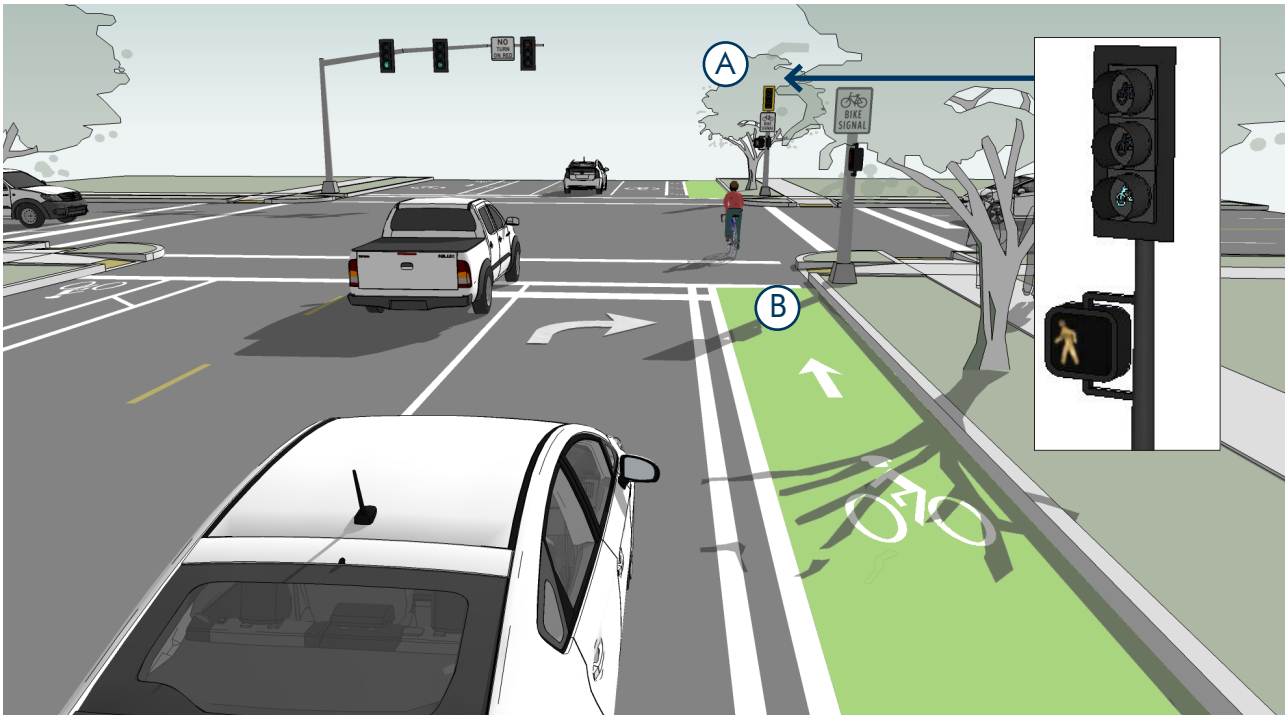
Materials and Maintenance

It is important to perform ongoing maintenance of traffic control equipment. Consider semi-annual inspections of controller and signal equipment, intersection hardware, and detectors.

Pavement markings are paired with a sign to teach riders how to activate the bicycle loop detection

BICYCLE SIGNAL PHASE

Separated bicycle lane crossings of signalized intersections can be accomplished through the use of a bicycle signal phase which reduces conflicts with motor vehicles by separating bicycle movements from any conflicting motor vehicle movements. Bicycle signals are traditional three lens signal heads with green, yellow and red bicycle stenciled lenses.



Typical Use

- Two-way protected bikeways where contraflow bicycle movement or increased conflict points warrant protected operation.
- Bicyclists moving on a green or yellow signal indication in a bicycle signal shall not be in conflict with any simultaneous motor vehicle movement at the signalized location
- Right (or left) turns on red should be prohibited in locations where such operation would conflict with a green bicycle signal indication.

Design Features

(A) An additional "Bicycle Signal" sign should be installed below the bicycle signal head.

(B) Designs for bicycles at signalized crossings should allow bicyclists to trigger signals via pushbutton, loop detectors, or other passive detection, to navigate the crossing.

- On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists.

A bicycle signal head at a signalized crossing creates a protected phase for cyclists to safely navigate an intersection. Photo credit: TREC

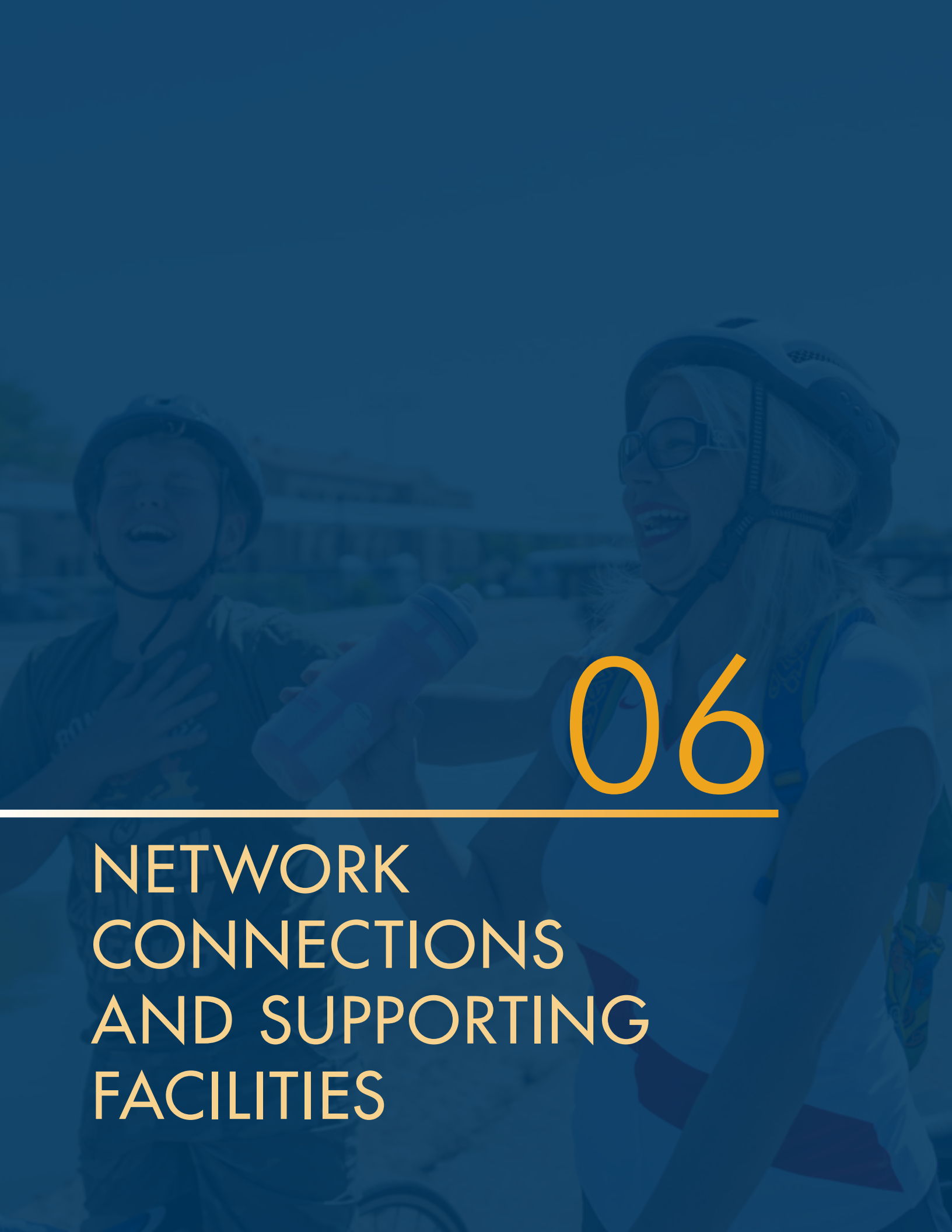
A bicycle detection system triggers a change in the traffic signal when a bicycle is detected.

Further Considerations

- A bicycle signal should be considered for use only when the volume/collision or volume/geometric warrants have been met.
- The Federal Highway Administration (FHWA) has approved bicycle signals for use, if they comply with requirements from Interim Approval 16 (I.A. 16). Bicycle Signals are not approved for use in conjunction with Pedestrian Hybrid Beacons.
- Bicyclists typically need more time to travel through an intersection than motor vehicles. Green light times should be determined using the bicycle crossing time for standing bicycles.
- Bicycle detection and actuation systems include user-activated buttons mounted on a pole, loop detectors that trigger a change in the traffic signal when a bicycle is detected and video detection cameras, that use digital image processing to detect a change in the image at a location.

Materials and Maintenance

Bicycle signal detection equipment should be inspected and maintained regularly, especially if detection relies on manual actuation. Pushbuttons and loop detectors will tend to have higher maintenance needs than other passive detection equipment.



06

NETWORK CONNECTIONS AND SUPPORTING FACILITIES

SHORT-TERM BICYCLE PARKING

People need a safe, convenient place to secure their bicycle when they reach their destination. This may be short-term parking of 2 hours or less, or long-term parking for employees, students, residents, and commuters.

Information on short- and long-term bike parking has been informed by the Association of Pedestrian and Bicycle Professionals (APBP) Bicycle Parking Guide, which is updated frequently and is available online at www.apbp.org.

Application

Bike Racks

- Bike racks provide short-term bicycle parking and are meant to accommodate visitors, customers, and others expected to depart within two hours. It should be an approved standard rack, appropriate location and placement.

Bike Corrals

- On-street bike corrals (also known as on-street bicycle parking) consist of bicycle racks grouped together in a common area within the street traditionally used for automobile parking.
- Bicycle corrals are reserved exclusively for bicycle parking and provide a relatively inexpensive solution to providing high-volume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces into on-street bicycle parking.
- Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces.

Design Features

Bike Racks

- When placed on sidewalks, 2 feet minimum from the curb face to avoid 'dooring.'
- 4 feet between racks to provide maneuvering room.
- Locate close to destinations; 50 feet maximum distance from main building entrance.
- Minimum clear distance of 6 feet should be provided between the bicycle rack and the property line.
- While bike racks could be installed perpendicular or parallel to the curb, it is important to ensure there is sufficient room for pedestrian traffic, even when a bike is locked to the rack.

Bike Corrals

- Bicyclists should have an entrance width from the roadway of 5-6 feet.
- Can be used with parallel or angled parking.
- Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.

Further Considerations

- Where the placement of racks on sidewalks is not possible (due to narrow sidewalk width, sidewalk obstructions, street trees, etc.), bicycle parking can be provided in the street where on-street vehicle parking is allowed in the form of on-street bicycle corrals.
- Some types of bicycle racks may meet design criteria, but are discouraged except in limited situations. This includes undulating "wave" racks, schoolyard racks, and spiral racks. These discouraged racks are illustrated on the following page.
- Bike racks should be made of thick stainless steel to reduce the chance of thieves cutting through the racks to take bicycles. Square tubing can provide further protection from cutting, as well.
- If a bike rack is installed as surface mount, countersink bolts or expansion bolts should be used to keep the rack in place. Covering the bolts with putty or epoxy can provide additional protection.

Inverted-U racks provide two points of contact.

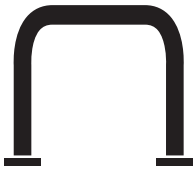
Racks with square tubing, good spacing, and a concrete base likewise offer two points of contact.

Types of Bike Racks to Use

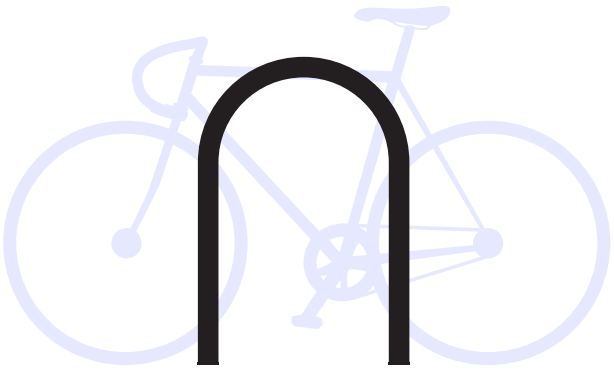
These racks provide two points of contact with the bicycle, accommodate varying styles of bike, allow for the frame of a bicycle and at least one wheel to be secured by most U-locks, and are intuitive to use.

POST & RING

WHEELWELL SECURE



INVERTED-U



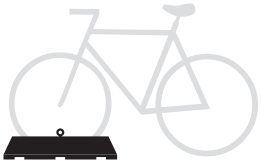
Communities may consider purchasing branded U-racks for installation on sidewalks.

Types of Bike Racks to Avoid

These racks do not provide support at two places on the bike, can damage the wheel, do not provide an opportunity for the user to lock the frame of their bicycle easily, and are not intuitive to use. Because of performance concerns, the APBP Essentials of Bike Parking Report recommends selecting other racks instead of these.

WAVE

COMB



WHEELWELL

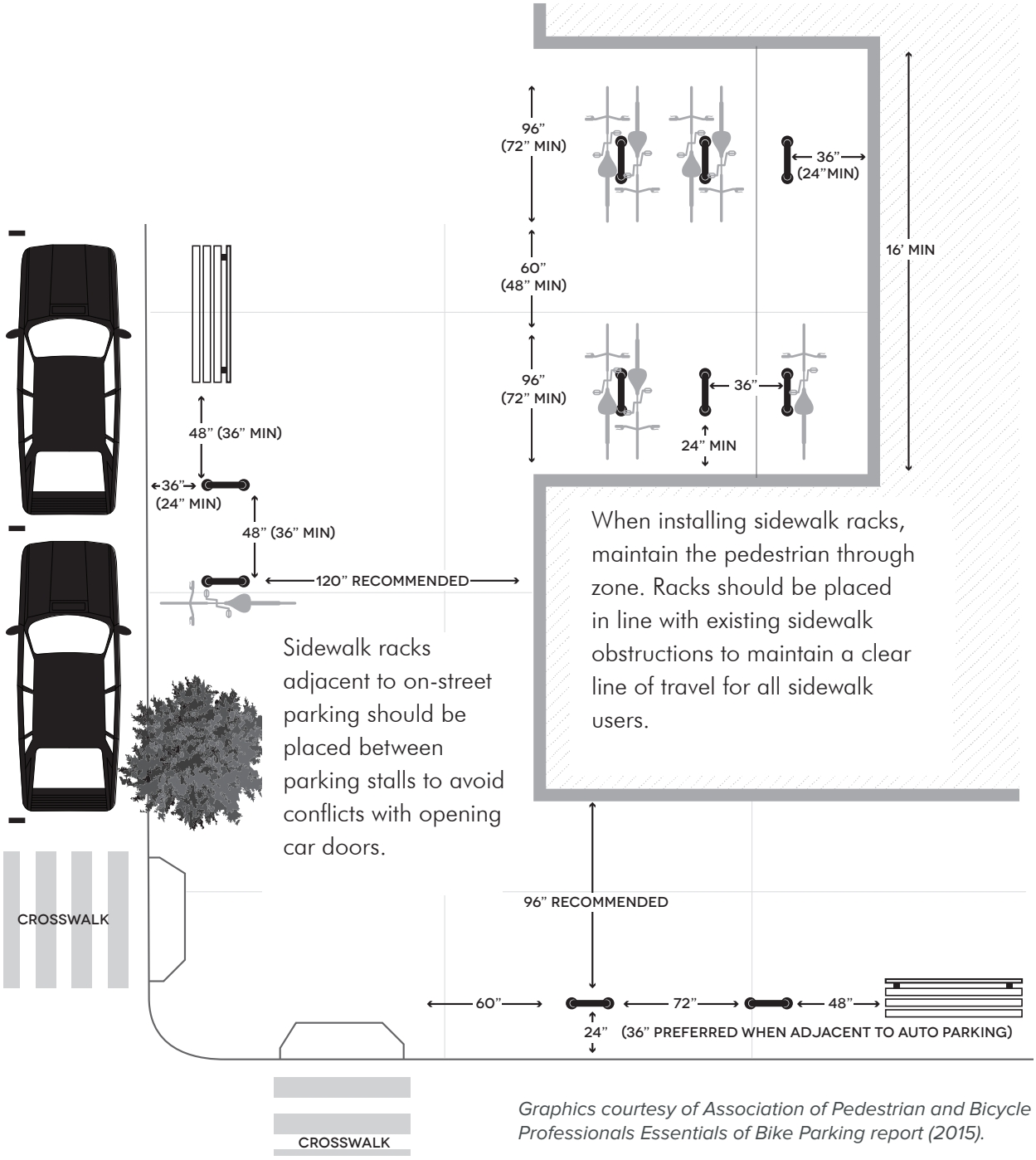
COATHANGER

BOLLARD

Graphics courtesy of Association of Pedestrian and Bicycle Professionals Essentials of Bike Parking report (2015).

Space Requirements

The following minimum spacing requirements apply to some common installations of fixtures like inverted U or post and ring racks that park one bicycle roughly centered on each side of the rack. Recommended clearances are given first, with minimums in parentheses where appropriate. In areas with tight clearances, consider wheelwell-secure racks, which can be placed closer to walls and constrain the bicycle footprint more reliably than inverted U and post and ring racks. The footprint of a typical bicycle is approximately 6' x2'. Cargo bikes and bikes with trailers can extend to 10' or longer.



Graphics courtesy of Association of Pedestrian and Bicycle Professionals Essentials of Bike Parking report (2015).

LONG-TERM BICYCLE PARKING

Users of long-term parking generally place high value on security and weather protection. Long-term parking is designed to meet the needs of employees, residents, public transit users, and others with similar needs.

Information on short and long term bike parking has been obtained from the APBP Bicycle Parking Guide, which is updated frequently and is available online at www.apbp.org.

Application

- At transit stops, bike lockers or a sheltered secure enclosure may be appropriate long term solutions.
- On public or private property where secure, long-term bike parking is desired.
- Near routine destinations, such as workplaces, universities, hospitals, etc.

Design Features

Bike Lockers

- Minimum dimensions: width (opening) 2.5 feet; height 4 feet; depth 6 feet.
- 4 foot side clearance and 6 foot end clearance. 7 foot minimum distance between facing lockers.

Secure Parking Area

- Closed-circuit television monitoring or on-site staff with secure access for users.
- Double high racks & cargo bike spaces.
- Bike repair station with bench and bike tube and maintenance item vending machine.
- Bike lock "hitching post" – allows people to leave bike locks.

Further Considerations

- As the APBP Bike Parking Guide notes, increasing density of bike racks in a long-term facility without careful attention to user needs can exclude users with less-common types of bicycles which may be essential due to age, ability, or bicycle type.
- To accommodate trailers and long bikes, a portion of the racks should be on the ground and should have an additional 36" of in-line clearance.

High Density Bike Racks

Racks may be used that increase bike parking density, like the ones below. While these types of racks provide more spaces, racks that require lifting should not be used exclusively. People with heavier bikes (i.e. cargo bikes) or people with disabilities or people who are simply small in stature may be unable to lift their bikes easily.

STAGGERED WHEELWELL-SECURE

VERTICAL

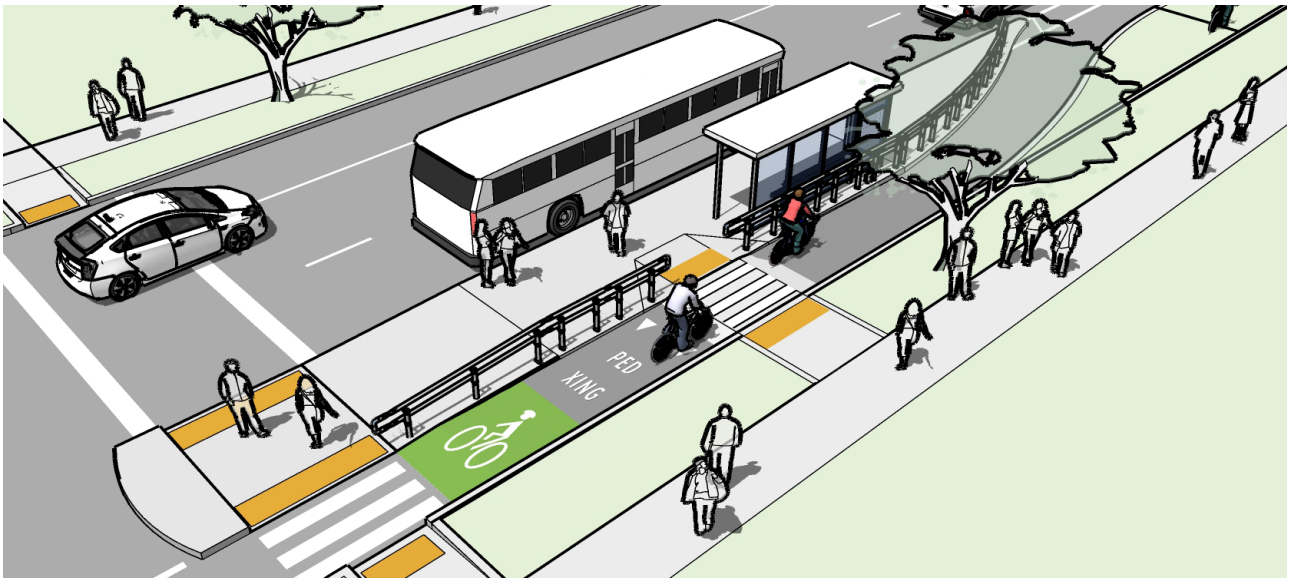
TWO-TIER

Bike Parking Rooms

Long term bike parking may be available in dedicated rooms in residential and commercial buildings. Bicycle parking can be accommodated in 15 square feet per space or less.

Bike lockers

Secured parking areas



TRANSIT STOP DESIGN

Bus platforms or waiting areas serve as the critical transition point for pedestrians as transit passengers. As such, bus platforms, shelters, and shelter amenities need to be designed to the benefit of people boarding, alighting, waiting, and passing through. Transit platforms and shelters should be designed to be comfortable and safe, accessible for people with disabilities, sized appropriately based on ridership and demand, use space efficiently, and to minimize delay and conflicts with other modes such as bicycles, and competing sidewalk uses.

Typical Application

- Bus stops can range from simple curbside stops with a pole and seating, to in-roadway platforms with shelters and other shelter amenities depending on demand, adjacent land use, and available right of way.
- Typically, bus stop shelters and amenities occupy an area of the sidewalk, either in the furnishing zone, or a reserved space in the frontage zone. They can also be located on transit islands which accommodates bicycle through traffic, or in medians for center running alignments.
- Shelters can face toward the roadway or away from the roadway. Shelters facing toward the roadway provide better sightlines, but may compete with other sidewalk uses and adjacent property access and circulation.

Design Features

- Bus shelters should be designed to minimize potential for conflicts between the bus, and people walking and bicycling through the area.
- Site visibility is a critical safety and security factor. The bus operator needs to be able to see waiting passengers, and waiting passengers need to be able to see approaching buses. The shelter, street trees, and other vertical elements must not obstruct visibility. The stop and shelter should be adequately illuminated at night for safety and security.
- The shelter should maximize use of materials that maximize visibility for waiting passengers, and minimize incentive for vandalism.
- The shelter canopy should be sized to provide sufficient coverage based on stop demand.

SHARED USE TRAILS AND ON-STREET TRANSITIONS

Transitions occur where the trail meets a roadway or railway, where one trail typology meets another, such as when an elevated trail transitions into an at-grade trail or where separated trail segments transition into shared environments. Transitions may also include horizontal shifts to avoid physical obstacles such as utility towers or other structures. Trail access means providing a formalized way for people to arrive and depart from the trail network by a variety of travel modes.

Typical Application

- Regional trail access points can take several different forms ranging from major trailheads, minor trailheads, and neighborhood entryways. These vary in the level of infrastructure and facility amenities.
- These access points are multimodal transition points; they serve as the transition between the on-street network and the off-street network for people walking, biking, riding transit, and driving.
- All trailheads should be open to the public.

Design Features

- Major trailheads feature convenient access to transit, parking for 10 or more vehicles, (including accessible spaces), short- and long-term bicycle parking, restrooms, trash/recycling facilities, wayfinding/interpretive kiosks, benches/picnic tables, and other day use amenities.
- Minor trailheads include similar facilities as major trailheads but a lower provision of vehicle and bike parking and day use amenities, and may be further from major transit and bike connection points.
- Neighborhood entry points are the most basic form of local accessways that do not provide many of the amenities of trailheads due to space constraints, neighborhood context, and/or proximity to other trailheads.

Typology Transitions

Design elements used to alert trail users include pavement markings such as optical speed bars or zebra stripe crosswalks with yield/stop markings. Other visual indications include bike and pedestrian directional markings, centerlane striping, and the use of colored pavement to visually narrow or indicate a change in environment.

Tactile indications include speed humps, tactile speed bars, and the use of multiple surface types, such as concrete, asphalt, and pavers.

Advisory, regulatory, and/or wayfinding signage are should be considered at transition points. Physical treatments to alert and guide trail users include traffic calming measures such as vertical and horizontal deflection.

Trail illumination is an important design element that must be considered along the trail, but is especially important in transition zones.

Mixing Zones

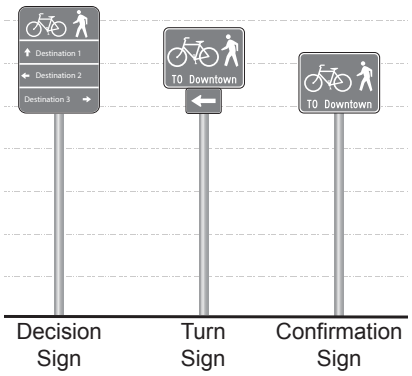
Mixing zones are necessary where physical space constraints do not allow for separated modes, or at locations along the trail where a high level of cross-traffic is expected. Mixing zones need to provide clear indication to all users that a transition is occurring in advance of the change, so that trail users can adjust their speeds and awareness appropriately to proceed carefully into the mixing zone.

Advanced warning can be accomplished with advisory signage, pavement markings, and the use of contrasting surface treatments (e.g. pavers/inlays with contrasting tones/textures, striping, or a combination of these treatments). These design elements help to guide trail users safely through the mixing zone by alerting users to the change in conditions and thus reducing the speed differential.

WAYFINDING

The ability to navigate across an urbanized area is informed by landmarks, natural features, and other visual cues. Signs throughout the city should indicate the direction of travel, the locations and travel time distances to those destinations. A pedestrian wayfinding system is similar to a transit, vehicular, or bike facility wayfinding system, in that it consists of comprehensive signing and/or pavement markings to guide pedestrians to their destination along routes that are safe, comfortable and attractive.

Sign types



Decision sign

Typical Application

Wayfinding signs will increase users' comfort and accessibility to the pedestrian system in denser urbanized areas and connections to other destinations across the larger region.

Signage can serve both wayfinding and safety purposes including:

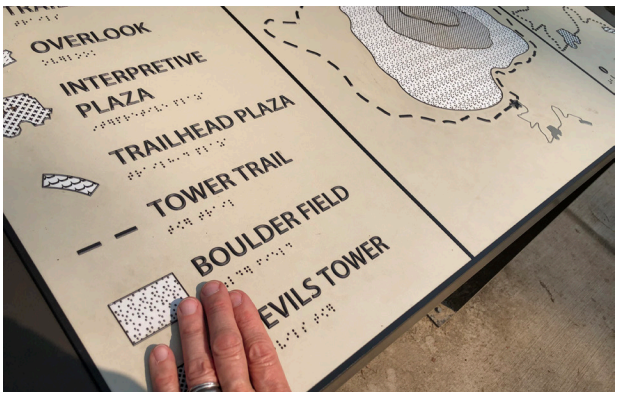
- Helping to familiarize users with the pedestrian network
- Helping users identify the best routes to destinations within walking distance or connections to other modes.
- Helping to address misperceptions about time and distance.
- Helping overcome a "barrier to entry" for people who are not frequent walkers.

Design Features

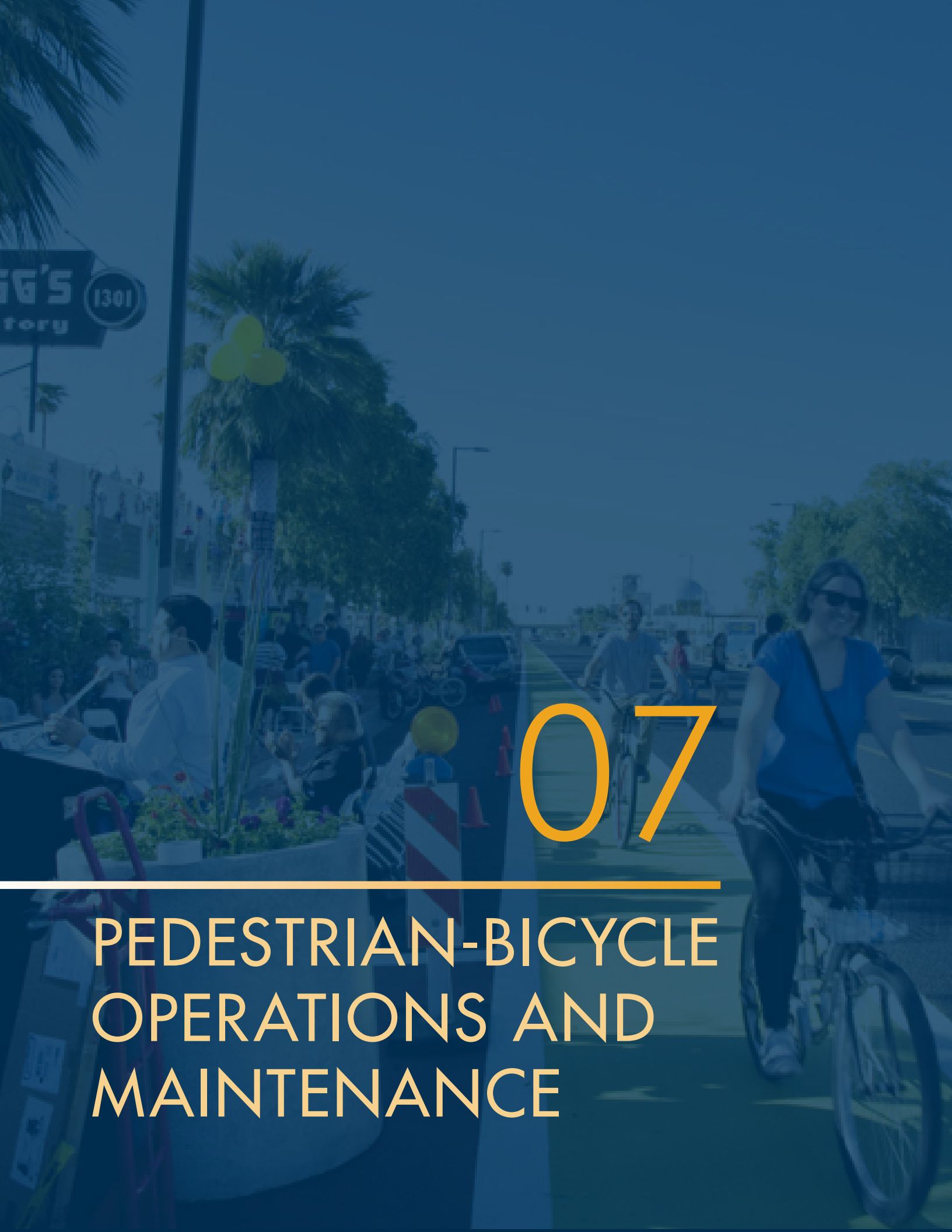
- Confirmation signs indicate to pedestrians that they are on the right trail to their destinations. They include destinations and distance/time, but not arrows
- Turn signs indicate where a route turns from one street onto another street.
- Decision signs indicate the junction of two or more pedestrian routes to access key destinations. These include destinations, arrows and distances. Travel times are optional but recommended.
- A regional wayfinding sign plan would identify sign locations, sign type, destinations, and approximate distance and travel time to destinations, and highlight connections between urban and non-urbanized areas.
- The Valley Path has existing branding and design guidance, see the *Valley Path Brand & Wayfinding Signage Guidelines*.

Further Considerations

- Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes.
- Too many road signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists rather than per vehicle signage standards.
- Green is the color used for directional guidance and is the most common color of bicycle wayfinding signage in the US.
- Check wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear and replace signage along the bikeway network as-needed.



Tactile navigation sign



07

PEDESTRIAN-BICYCLE OPERATIONS AND MAINTENANCE

SIDEWALK MAINTENANCE

The sidewalk is an essential space for people walking and using wheelchairs and other personal mobility devices, and it is also the location where many other important activities take place. Each of the zones described in 'Sidewalk Zones' needs to be maintained for the overall sidewalk space to function as intended.

Maintaining Sidewalk Zones

- The **Pedestrian Access Route** must remain free and clear of obstacles and impediments. This is the primary accessway for people traveling along streets and to and from adjacent properties, and must be maintained to ADA standards.
    - Property owners are responsible for maintaining all sidewalk zones abutting their property, not just the Building Frontage Zone.
    - Maintaining a firm, stable, and slip resistant surfaces is necessary for people walking or rolling to traverse the Pedestrian Access Route without risk of tripping, slipping or otherwise uneven footing.
    - Regular sweeping ensures the Pedestrian Access Route and other sidewalk zones are kept free of natural debris and litter.
    - Routine maintenance of sidewalk damage due to tree roots, freeze-thaw, etc. is the responsibility of abutting property owners.
- The **Amenity Zone** is where street furnishing are located, where people are often picked up and dropped off, where mail is delivered, and where other loading/unloading happens. It's the space where trees and landscaping are planted, and where street lighting and other utilities are located. The Amenity Zone must be maintained properly to ensure access to this area and all of these curbside uses are possible.
    - Vegetation in the Amenity zone should be regularly maintained by the City so as not to encroach on the pedestrian travel zone. Maintenance should be prioritized by plant species, high demand areas, and/or narrow sidewalk corridors. When they are not maintained on schedule, the space for pedestrian travel becomes constrained, creating bottlenecks, and/or forcing pedestrians into the street.
- The Building Frontage Zone is the area between the Pedestrian Access Route and the abutting property. Along commercial corridors this space may be utilized by businesses for outdoor cafe seating by permit, and in residential areas, this space may be occupied by landscaping or other natural screening.
    - Outdoor seating shall not occupy the Pedestrian Access Route or inhibit travel along the sidewalk.
    - Landscaping in the Building Frontage Zone should be maintained in a manner similar to landscaping in the Amenity Zone. Landscaping should be maintained by property owners so as not to encroach on the Pedestrian Access Route.
- The Enhancement Zone must be maintained for the following uses: bike facilities, vehicle parking, curb extensions, and bike parking.
    - Street sweeping should be conducted per maintenance schedule and following significant weather events to help to ensure intended use of this space.

PARKING, LOADING, AND GARBAGE ACCESS

Where separated bikeways are adjacent to on-street parking, drop-off locations, freight loading zones, or designated garbage pick-up areas, the design of the separation at those locations should provide an accessible aisle and adequate landing area to allow for travel from the vehicle to the curb ramp.

Colored pavement within a bicycle lane may be used to increase the visibility of the bicycle facility, raise awareness of the potential to encounter bicyclists, and reinforce priority of bicyclists in conflict areas.

Typical Application

- Streets with on-street parking and a separated bikeway along the same block face.
- Where ADA-accessible spaces are desired, either due to proximity to nearby building entrances, street grades, or other factors.
- Where loading and garbage pick-up zones are desired along the same side of the street as a separated bikeway due to adjacent commercial users such as retail or hotels, and cannot be relocated to adjacent block faces or alleys.

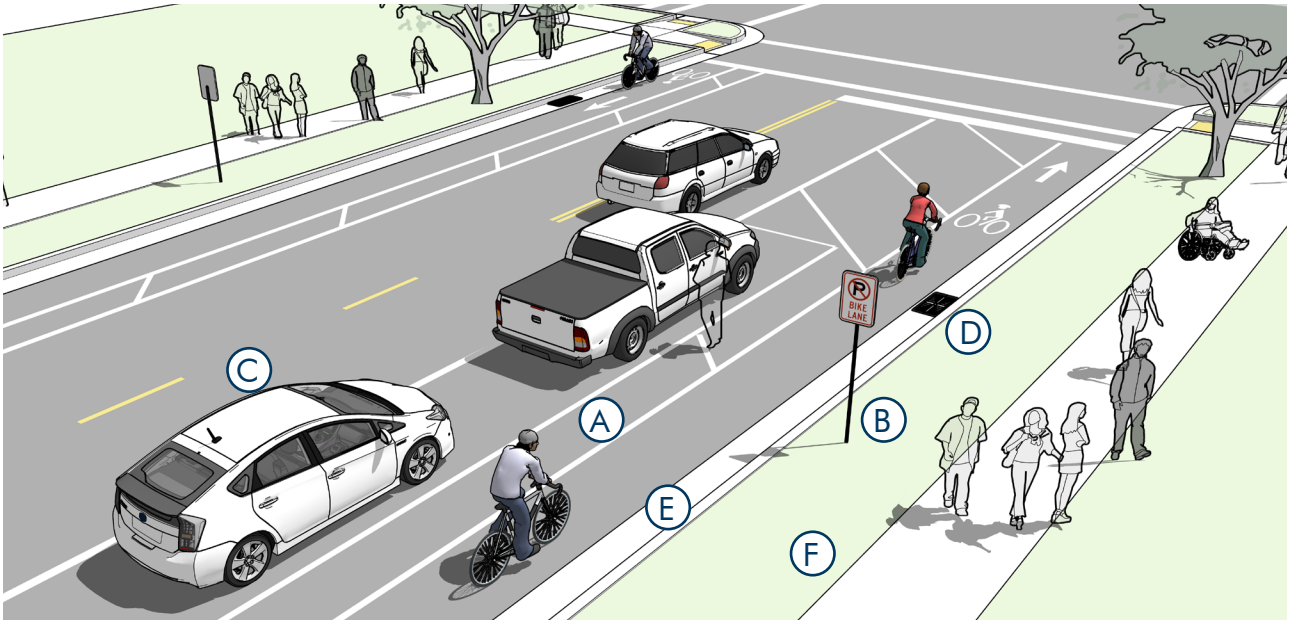
A passenger loading zone allows pedestrians to cross the separated bike lane to access the loading island. These designs should also incorporate truncated domes to alert people walking with vision disabilities of the crossing.

Design Features

- Accessible spaces should be located adjacent to intersections to simplify access to curb ramps.
- Accessible spaces must comply with all ADA requirements.
- To connect between the sidewalk and parking spaces, a crosswalk across the separated bikeway and curb ramp (6' minimum width) must be provided.
- Place a YIELD HERE TO PEDESTRIANS **(MUTCD R1-5)** sign where the separated bikeway crosses the parking access route to clearly establish a right-of-way. Yield line pavement marking may be placed prior to the crosswalk.

Further Considerations

- Garbage pick-up, freight loading, and drop-off hours should be restricted to hours of the day when less bicycle traffic is expected, to minimize potential interactions.
- The City can provide guidance to both waste management operators and customers on desirable recycling/trash can and bin placement with respect to both walkways and bikeways to improve safety and use of these facilities.



BIKE FACILITY MAINTENANCE

Regular bicycle facility maintenance includes sweeping, maintaining a smooth roadway, trimming encroaching vegetation, ensuring that the gutter-to-pavement transition remains relatively flush, and installing bicycle friendly grates. Pavement overlays are a good opportunity to improve bicycling facilities. The following recommendations provide a menu of options to consider to enhance a maintenance regimen.

Ⓐ Sweeping

Debris that is allowed to accumulate can become a hazard due to loss of control, inner tube blow outs, as well as service dog safety.

- Cover both on-road and off-road bikeways under the jurisdiction of the city. Can establish a seasonal sweeping schedule that allows for prioritization of routes. The schedule could prioritize facilities designated as major bikeways, before roadways designated as minor bikeways.
- Sweep bikeways periodically to minimize accumulation on the facility to maintain safe surface conditions.

Ⓑ Signage

- Include bikeway regulatory and wayfinding signing as part of the roadway sign maintenance program, regularly checking for vandalism, graffiti, and wear. Schedule replacement/repair as needed.

Ⓒ Roadway Surface

- Smooth pothole-free surfaces are especially critical for people on bikes.
- The finished surface on bikeways does not vary more than 1/4" for new roadway construction.
- Pavement should be maintained so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings.
- Ensure pavement inspections occur after trenching activities are completed and if excessive settlement has occurred to require mitigation prior to the expiration of the project's warranty period.
- To the extent possible, pavement markings and green-colored areas should be placed out of the vehicle path of travel to minimize wear. In general, striping, pavement markings, and green colored areas should be well maintained especially areas in the path of vehicle travel, and where high-turning movements occur.

Ⓓ Drainage Grates

- New drainage grates should be bicycle-friendly. Grates should have horizontal slats on them so that bicycle tires and assistive devices do not fall through any vertical slats.
- Create a program to inventory all existing drainage grates, and replace hazardous grates as necessary - temporary modifications such as installing rebar horizontally across the grate should not be an acceptable alternative to replacement.

Ⓔ Gutter-to-Pavement Transition

- Gutter-to-pavement transitions should have no more than a 1/4" vertical transition.
- Pavement transitions should be examined during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets.

Ⓕ Landscaping

- Vegetation on the edge of the roadway should not hang into or impede passage along bikeways.
- After storm events, remove fallen trees or other debris from bikeways as quickly as possible.

Coordination With Emergency Responders

- General roadway maintenance should be coordinated and prioritized on emergency response routes that overlap with major and minor bikeways.
- Provide fire, police, and EMS services with a map of major and minor bikeway routes.

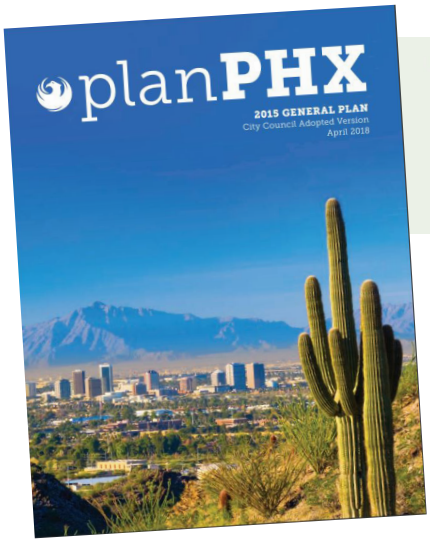
Recommended Bikeway Maintenance Activities

The City should ensure that each of these activities is addressed in City requirements, various operations plans, or emergency response plans. The frequency of each activity is at the discretion of the City Engineer. However, the activity should be done in a timely enough manner to ensure bikeways are operated in a safe manner for all users.

08

ADDITIONAL DESIGN PARAMETERS & CONSIDERATIONS

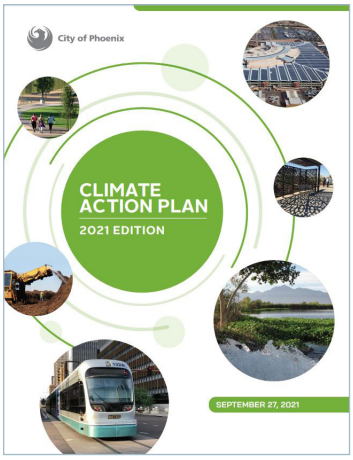
COMPLETE STREETS



THE GOAL

Create a system of streets which encourage and facilitate active transportation, support investment in transit, foster social engagement and community pride, **improves safety for all transportation** modes, supports the local economy and property values, and improve the **livability and long-term sustainability** of our region.

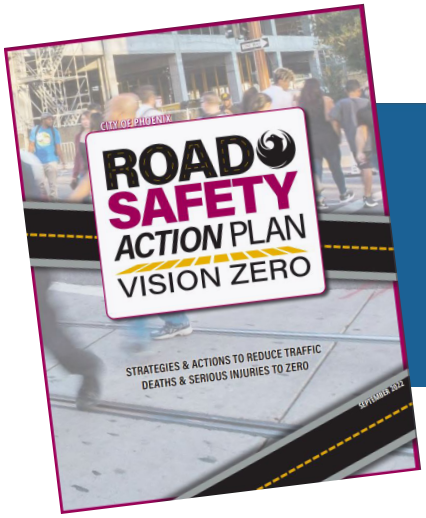
The Phoenix General Plan (2015) identifies Complete Streets as a key approach for enacting the core value of Connecting People and Places. The role of development is specified in the Land Use and Design Principle, "In order to balance a more sustainable transportation system, development should be designed to include increased amenities for transit, pedestrian and bicyclists such as shade, water, seating, bus shelters, wider sidewalks, bike racks, pedestrian scale lighting and way-finding."



2050 GOAL

All forms of transportation will be fueled with net-zero GHG sources of energy. Make walking, cycling, and transit commonly used, enjoyed, and accessible for every Phoenix neighborhood, including our disabled community. This goal will result in 90% of the population living within one-half mile of transit, and projects 40% of the population will choose to commute by walking, biking, transit or car share.

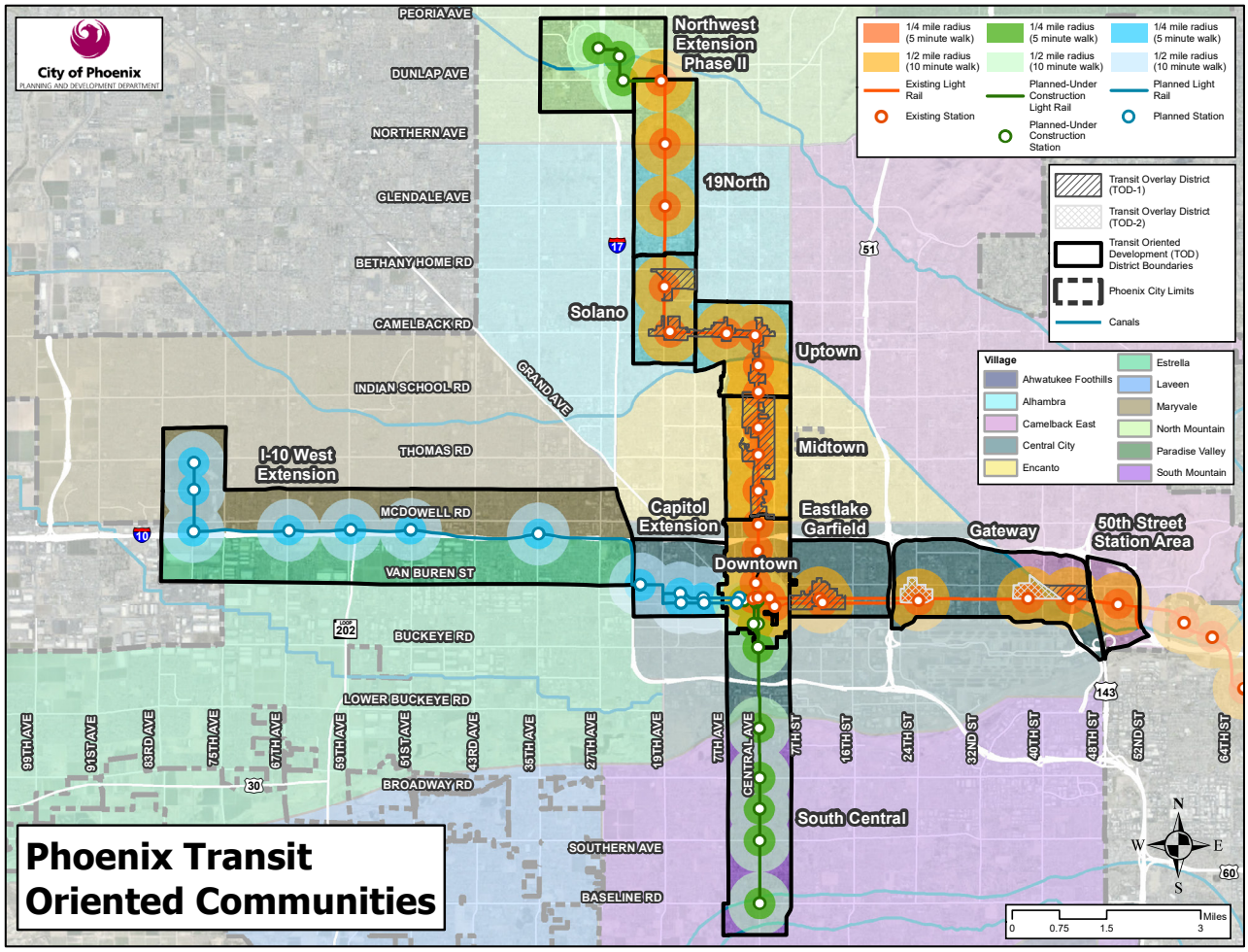
The Complete Streets Policy (2017) supports the implementation of the General Plan by directing staff to ensure City's rights-of-way serve a variety of transportation modes. Designing streets for safe and enjoyable walking, biking, and transit use helps Phoenix to achieve the goal of reducing single occupant vehicle trips set in the Climate Action Plan (2021). Additionally, streets that are designed with the safety of all users supports the goal of the Vision Zero Road Safety Action Plan to eliminate all serious injuries and fatalities on Phoenix streets.



VISION

Phoenix aspires to reduce the number of fatal and serious injury crashes on its streets to ZERO by 2050

HIGH ACTIVITY AREAS



In areas where active transportation is expected to be higher than typical, streets should be designed to ensure people using the street are comfortable and safe, whether they are walking, biking, using micromobility, driving, or taking transit. In Phoenix, planning processes have identified three types of areas where dense, mixed-use development should be concentrated and where walking, biking, and transit should be emphasized in street design.

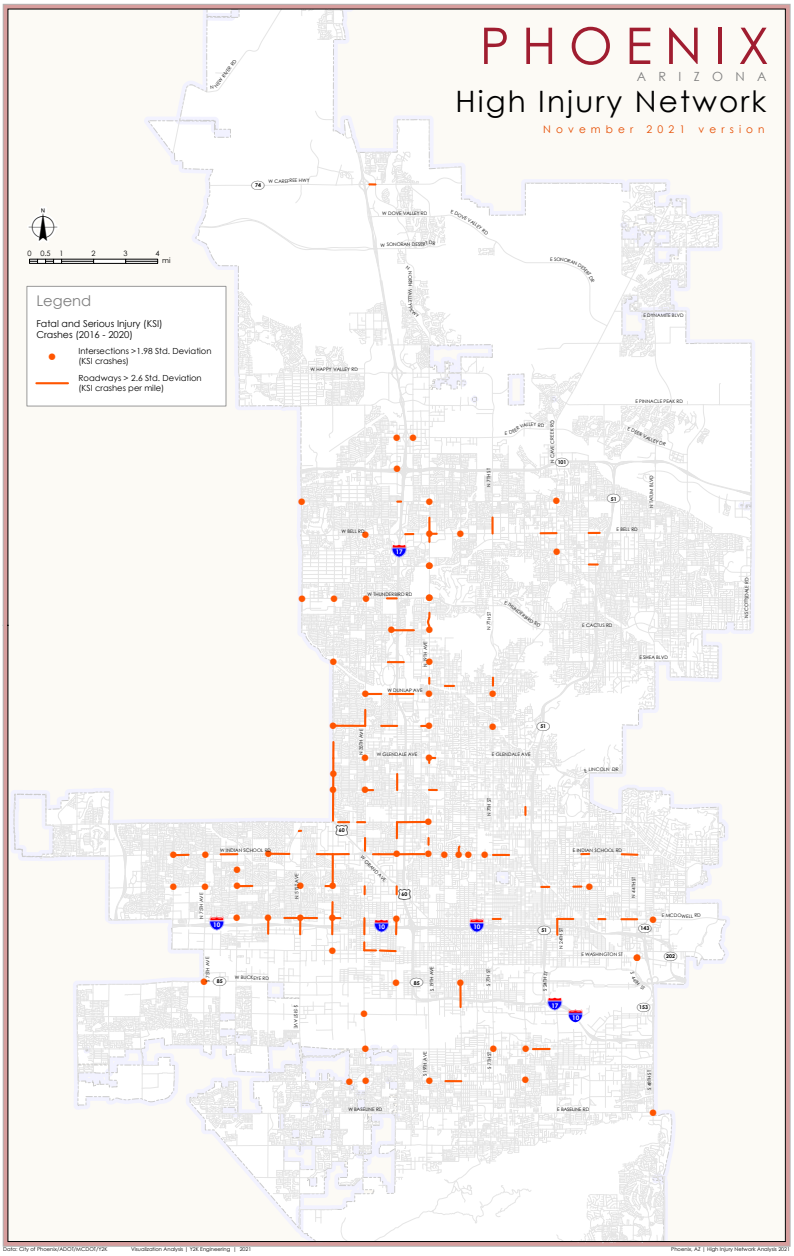
The downtown area was identified as a dense, multi-modal and mixed use area in the Downtown Strategic Plan (2004). One of the three planning principles was connectivity, with a specific emphasis on connecting walking, biking, and transit. In 2008, the Downtown Urban Form Project (2008) proposed a Form-Based Code for downtown that calls for walkable development. The Circulation and Parking Plan in the document further emphasized the need for streets that support walking, biking, and transit as key for downtown circulation. The Downtown Code was adopted by Council and added to the Zoning Ordinance in 2010. The Downtown Transportation Plan Update (2020) updated the strategies for increasing multimodal transportation in Downtown Phoenix.

Transit Oriented Development (TOD) areas have been specifically identified as areas for encouraging multimodal streets and denser development in order to foster access to transit. Currently every TOD area has adopted Walkable Urban Code. TOD areas will continue to be added as the high-capacity transit network in Phoenix develops. Policy plans for individual TOD areas have been developed through the Reinvent PHX planning effort and through individual TOD area plans. The City of Phoenix continues to develop plans for the most recently added TOD areas.

Urban Village Cores have also been identified as areas for a concentration of people and activities. The Phoenix Urban Village Model (1994) identifies multi-modal transportation as a feature of village cores, with a strong emphasis on providing pedestrian amenities in urban cores. While it describes suburban village cores as auto-oriented, it also notes that as villages build out over the next 30-50 years suburban cores may become more urban. The plan was approved 29 years ago and Phoenix has seen this shift happening throughout its suburban cores.

In addition to three types of areas defined in the planning processes above, there are further places where connectivity for people walking, biking, and using micromobility should be emphasized based on surrounding land use.

Large scale development, high-density multifamily/mixed-use Planned Unit Developments (PUDs), regional shopping centers and regional attractions (e.g. spring training facilities and event venues) are expected to increase active transportation. Street design and street crossings should be designed for safe and comfortable walking and biking.



Active transportation is expected to be high in recreation areas and near public facilities such as libraries, hospitals, schools. Streets near parks, preserves, trails, and public facilities should be designed with consideration for people accessing these amenities on foot or on bike. At entry points, appropriate street crossings are important for allowing people to access public facilities and recreation areas safely.

Finally, the High Injury Network defined in the Vision Zero Road Safety Action Plan has identified corridors and intersections with the highest levels of serious injury and fatality crashes in the City of Phoenix. In 2022, people walking were 43% of the fatal and serious injury crashes in Phoenix, despite walking trips being a small percentage of overall trips. As such, streets and intersections along the High Injury Network should be designed with special consideration for people walking, biking, and taking transit.

In the areas identified above, the following guidance should be considered when designing streets.

City of Phoenix Guidance

City of Phoenix Active Transportation Plan Design Guidance Element (2023)

City of Phoenix Crosswalk Guidance (2023)

City of Phoenix Street Planning and Design Guidelines (2023)

City of Phoenix Complete Streets Design Guidelines (2018)

National guidance

Institute for Transportation and Development Policy (ITDP) Transit Oriented Development Standard (2017)

National Association of City Transportation Officials (NACTO) Urban Street Design Guide (2013)

Federal Highways Administration (FHWA) Field Guide for Selecting Countermeasures at uncontrolled Pedestrian Crossing Locations (2018)

Federal Highways Administration (FHWA) Proven Safety Countermeasures (website)

City of Phoenix