GREATER MERCER TRAILS PLAN

PATTERN BOOK

GREATER MERCER TMA
Discover Greener Paths

September 2019

Purpose

This ***Pattern Book*** provides design guidance on trail facilities to advance the implementation of the *Greater Mercer Trail Network Plan* consistent with the Plan's Vision Statement.

Lawrence-Hopewell Trail at Mercer Meadows

Greater Mercer Trail Network Plan **Vision Statement:**

"The *Greater Mercer Trail Network Plan* will help create an integrated network of multi-use trails and paths to serve a variety of transportation needs and connect users of all ages and abilities to the many opportunities, services, and destinations in the region."

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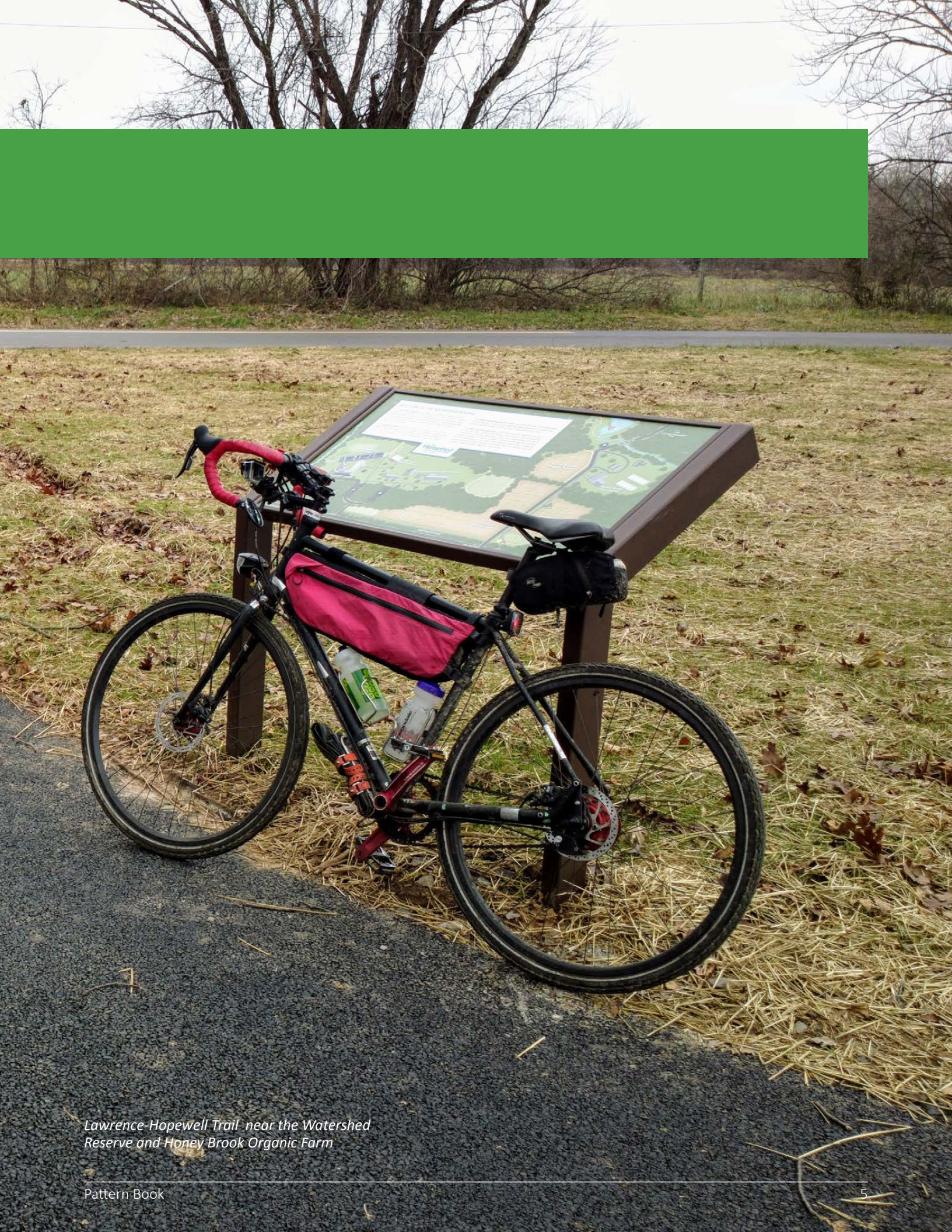
GREATER MERCER TRAILS PLAN



Lawrence-Hopewell Trail near the Watershed Reserve and Honey Brook Organic Farm

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TRAIL NETWORK FACILITIES

Trail facilities enhance mobility and access to community destinations, recreation, and natural settings. A robust network of trail facilities will enable people to move throughout their communities without depending on motor vehicles and create connections among a wide variety of people and destinations.

This section provides general design guidance on shared use path and trail facilities that are envisioned as principal components of the *Greater Mercer Trail Network Plan* with a focus on the following:

- Shared Use Path
- Sidepath
- Recreation Trail
- Bridges & Boardwalks
- Road Crossings
- Surface Materials
- Green Infrastructure
- Aesthetics & Livability
- Smart Technology
- Permitting Guidance
- Maintenance & Operations
- Cost Estimating

Trolley Line Trail in West Windsor

SHARED USE PATH

A shared use path is a facility for non-motorized mobility that is designed to accommodate pedestrians, bicyclists, and other non-motorized users, such as in-line skaters, skateboarders, and kick scooter users. A shared use path generally consists of a paved travel area that is 10 to 14 feet wide (minimum 8 feet wide in constrained areas) in a right-of-way that is independent of the existing roadway network.

Typical Application

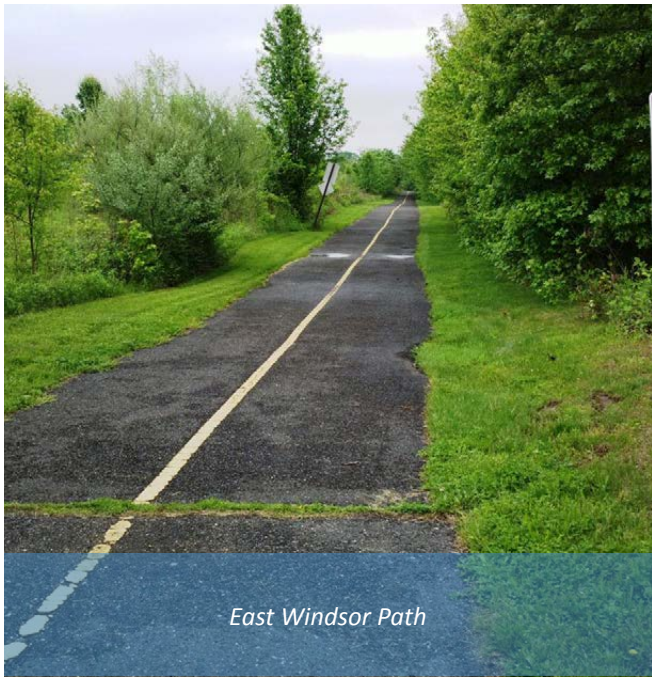
A shared use path can be considered for locations where there is a long, continuous right-of-way that is independent of the road. Shared use paths can provide both transportation/mobility benefits and recreational use. The Lawrence Hopewell Trail is an example of an extensive shared use path facility that forms a ±20 mile loop between Lawrence Township and Hopewell Borough. Other applications for shared use paths can include rail-to-trail conversions and utility corridors.

Benefits

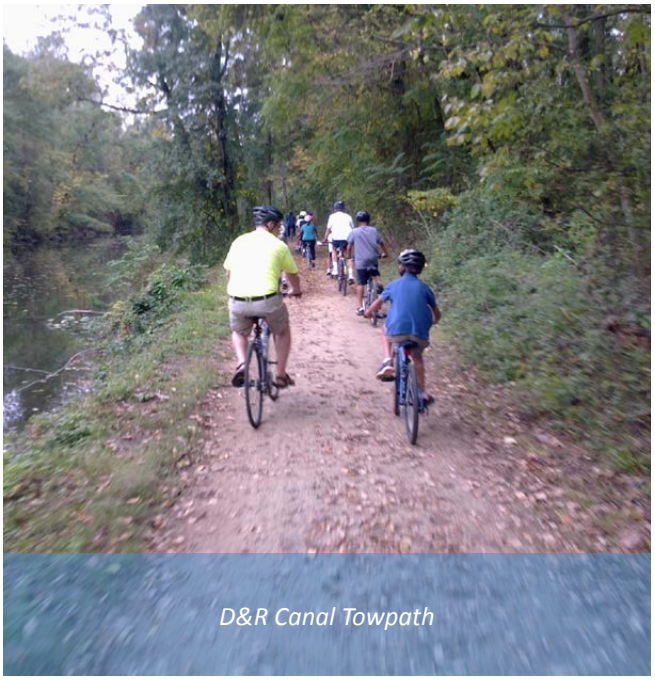
- Provide low-stress mobility for non-motorized users through full separation from the motor vehicle right-of-way
- Separation from motor vehicles can increase safety
- Attractive to users of all ages and abilities
- Typically designed for and accommodate two-way travel
- Complement and enhance on-road bicycle and pedestrian circulation networks
- Often provide recreational and/or scenic benefits by connecting to or through parks and open space

Considerations

- Can be challenging to connect independent rights-of-way to achieve a substantial, network-level length of shared use path
- Can be difficult to estimate peak user volumes
- The running slope of a shared use path should not exceed 5%, according to Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way; Shared Use Paths, Architectural and Transportation Barriers Compliance Board, Federal Register, Vol. 78, No. 30, Wednesday, February 13, 2013



East Windsor Path



D&R Canal Towpath

Recommended Features for Shared Use Paths

1. Shared use paths are appropriate for rights-of-way that are independent of the roadway, such as through park land or open space.
2. The paved width for a shared use path is 10 to 14 feet, depending on anticipated user volume. In constrained areas, a paved width of 8 feet is acceptable. Where high user volumes are anticipated, a shared use path can exceed 14 feet.
3. A clear shoulder area should be maintained along both edges. The shoulder should provide a minimum of 2 feet of horizontal clearance from the edge of the path. No signs, posts, furnishings, or other obstacles should be placed within the minimum 2-foot clearance.
4. The cross slope of the shared use path should not exceed 2%.
5. The running slope of the shared use path should not exceed 5%.

SIDEPATH

A sidepath is a multi-use path that is constructed adjacent to a roadway, within the public right-of-way. This is in contrast to a standard shared use path that is constructed in an independent right-of-way.

As a shared use path facility, a sidepath is designed to accommodate travel by pedestrians, bicyclists, and other non-motorized users. A sidepath generally consists of a paved travel area that is 10 to 14 feet wide (minimum 8 feet wide in constrained areas), separated from the adjacent roadway by a buffer space or barrier.

Typical Application

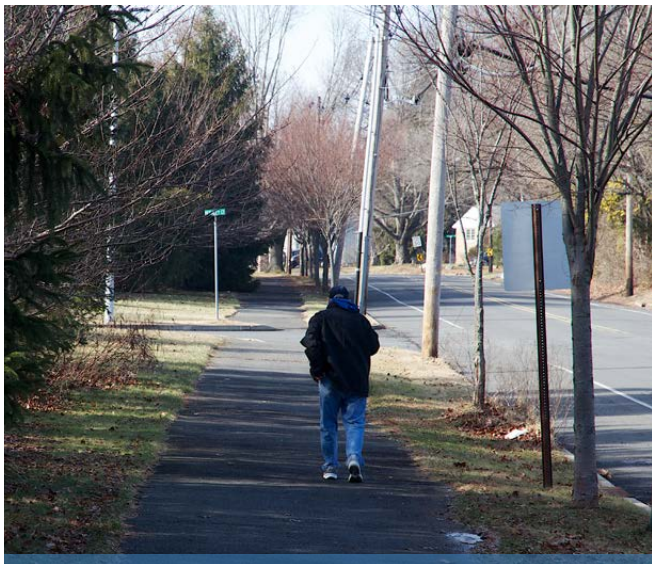
Sidepath facilities are generally advised along roadways where traffic speed and volume create a high level of traffic stress for bicyclists and there is insufficient operating width for on-road bike lane facilities.

Benefits:

- Potential to link origins and destinations along established routes
- Traffic separation and low level of traffic stress are attractive to users of all ages and abilities
- Separation from motor vehicles can increase safety
- Can be incorporated into existing crossing locations, avoiding the need to create midblock crossings
- Can accommodate two-way or one-way travel, depending on configuration
- Potential to tie into existing stormwater management systems associated with roadways
- The running slope of the sidepath facility is permitted to follow the general terrain profile of the roadway

Considerations:

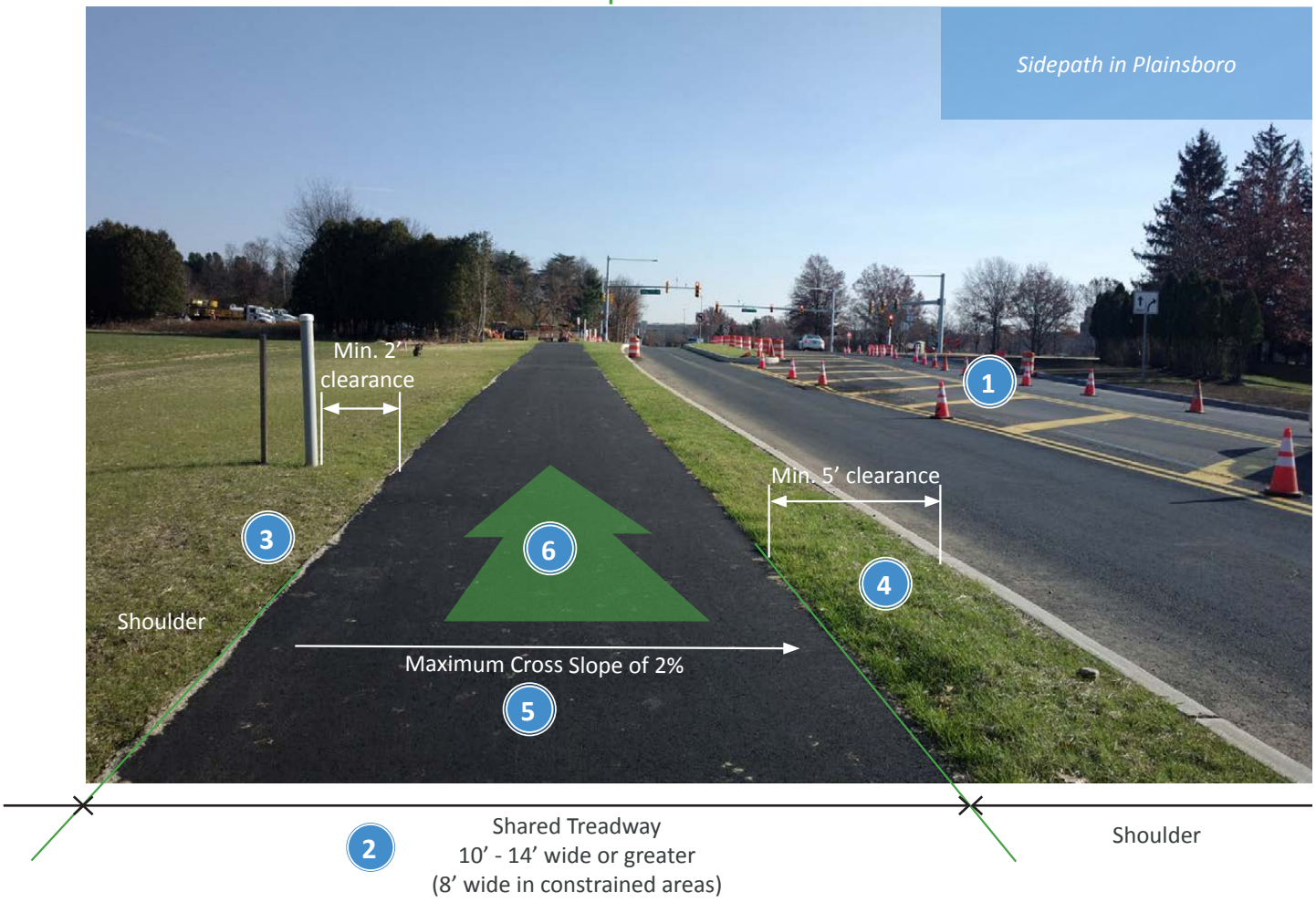
- Right-of-way acquisition
- Frequency of driveways and land use access can create conflict points and increase user stress
- Structural modifications at bridges, culverts, or underpasses may be required
- Constraint can be imposed by fixed objects such as utilities, traffic control boxes, or vegetation
- Two-stage left turns may be considered for bicyclists at intersections
- ADA accessibility at driveway crossings



Sidepath along Dutch Neck Road in East Windsor

Sidepath along Gordon Road connecting to Sharon Elementary School in Robbinsville

Recommended Features for Sidepaths



1. Sidepaths are applicable for roadways that have a high level of traffic stress due to traffic speed or volume, lack ample space for an on-road bicycle facility, and have a relatively low number of driveways and intersections.

2. The paved width for a bidirectional sidepath is 10 to 14 feet, depending on anticipated usage volume. In constrained areas, a paved width of 8 feet is acceptable.

3. A shoulder area should be maintained along both edges. The shoulder should provide a minimum of 2 feet of horizontal clearance from the edge of the path. No signs, posts, furnishings, or other obstacles should be placed within the minimum 2-foot clearance.

4. The minimum recommended width between the sidepath and adjacent roadway is 5 feet. This may include an unpaved shoulder, but not a paved shoulder. Where separation is less than 5 feet, a physical barrier or railing (that does not limit sight distances at intersections) should be installed between the sidepath and the roadway. When constructed along a high-speed highway, a separation of greater than 5 feet is recommended; or, if this cannot be achieved, use of a crashworthy barrier should be considered, in consultation with the *AASHTO Roadside Design Guide*.

5. The cross slope of the sidepath should not exceed 2%.

6. The running slope of the sidepath is permitted to follow the profile of the roadway.

RECREATION TRAIL

Recreation trails are pedestrian routes that are designed primarily for recreational purposes. When bicycle use is anticipated, the design parameters for a shared use path should be followed. When recreation trails are planned in the highway right-of-way, they serve the same purpose as a sidewalk and should be designed to sidewalk standards.

Typical Application

Recreation trails are typically designed, constructed, and maintained outside of the highway right-of-way in parks or open space where there is an opportunity and desire for such as facility. Recreation trails are destinations unto themselves and are distinct from the sidewalk network and access routes for parking lots, picnic areas, playgrounds, viewing areas, and other programmed spaces.

Benefits

- Attract users for pleasure, recreation, and exercise
- Can be planned, designed, and tailored to suit a wide range of experiences
- Can be composed in a network within a park destination, so that repeat visitors have the opportunity for different experiences of the site

Considerations

- The United States Access Board's *Accessibility Standards for Federal Outdoor Developed Areas* presents the most current technical guidance for trail accessibility and can be applied to construction of trails developed at the state, county, or local levels
- The *Accessibility Standards* apply to national parks and other outdoor areas developed by the federal government and identify conditions for exceptions where full compliance may not be practicable
- The United States Access Board intends to develop guidelines for non-federal outdoor sites covered by the Americans with Disabilities Act and areas developed with federal grants in the future (see https://www.access-board.gov/guidelines-and-standards/recreation-facilities/outdoor-developed-areas)

St. Michaels Farm Preserve in Hopewell include grass surface recreation trails.

Recommended Features for Recreation Trails

Recreation trail in East Windsor through a detention basin that would otherwise be unused

1. Provide a treadway that is 5 to 6 feet wide, or 3 feet wide at a minimum.

2. The running slope of a trail can exceed 5%, but should be designed to meet the guidelines of the *U.S. Access Board's Accessibility Standards for Federal Outdoor Developed Areas*, as summarized in the table to the right. (These guidelines include exception criteria which would exempt a facility from compliance for reasons such as the nature/intention of the trail or constructibility).

3. Where furnishings, amenities, or other appurtenances are provided, ensure that there is a minimum 2-foot clear space between the edge of the path and the object.

4. Provide wayfinding and/or informational signage to advise users of the facility name and route, permissible travel modes, and rules and regulations.

Maximum Slope and Segment Length:

Running Slope of Trail Segment		Max. Length
Steeper than	But Not Steeper Than	
1:20 (5%)	1:12 (8.33%)	200 feet
1:12 (8.33%)	1:10 (10%)	30 feet
1:10 (10%)	1:8 (12%)	10 feet

Preferred Cross Slope should be 2%, however a maximum cross slope can be up to 5% where necessary for drainage.

5. This type of facility is not designed to meet AASHTO guidelines for shared use by pedestrians and bicyclists. Signage should be provided to indicate that bicyclists are to yield to pedestrians or dismount.

BRIDGES & BOARDWALKS

Shared use path bridges are structures that enable pedestrians and bicyclists to move across significant obstacles or areas that are difficult or dangerous to cross, such as watercourses, steep grades/ravines, or highways. Shared use path boardwalks enable pedestrians and bicyclists to move across environmentally sensitive areas, such as wetlands or floodplains, in a manner that minimizes disturbance and protects natural resources.

Typical Application

Prefabricated bridges are widely available for shared use path applications, and should be designed and sited in coordination with a licensed engineer. Existing bridges or bridge components can often be retrofitted in place for shared use path applications, which is a common approach in rail-to-trail conversion projects.

Boardwalks are generally available as modular systems that are designed in coordination with a licensed engineer to minimize disturbance and ensure that sound foundations can be achieved in sensitive areas where the bearing capacity of the soil may differ from adjacent areas.

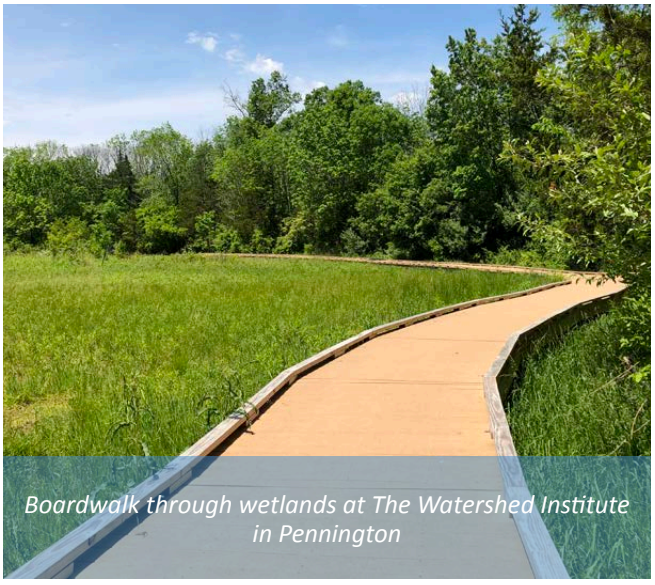
Benefits

- Enable trail facilities to traverse obstacles or environmentally sensitive areas with minimized impacts
- Enhance the trail experience by providing access to elevated vantage points or ecologically interesting areas
- Create possibilities for reuse of existing bridge structures, especially applicable to rail-trail facilities

Considerations

- Structural loading requirements can vary based on anticipated users and volumes; coordination should take place to determine needs for vehicular access ranging from emergency vehicles to small maintenance vehicles
- Concrete is recommended as the preferred decking material because it can provide an accessible, slip-resistant, low-maintenance surface
- Horizontal clearance should meet the AASHTO shared use path minimum guideline of an 8-foot-wide operating width with 2 feet of clearance (shy distance) on each side
- Where the AASHTO minimum width guideline cannot be achieved, signage directing bicyclists to dismount should be installed

Steel truss shared use path bridge, part of D&R Canal State Park, over U.S. Route 1 in Lawrenceville



Boardwalk through wetlands at The Watershed Institute in Pennington

Recommended Features for Bridges & Boardwalks

1. To accommodate pedestrian and bicyclist shared use, a 10- to 14-foot-wide operating area (or 8 feet in constrained areas), exclusive of clear zones, is recommended.

2. Clear zones that are 2 feet wide are recommended on both sides of the operating area.

3. Concrete decking is recommended for slip resistance, low maintenance, and accessibility. Alternative decking materials include wood or composites, aluminum, or grate decking.

4. Railings should be provided when the height of the deck exceeds 30 inches over the adjacent grade. Railings should be a minimum 42 to 48 inches high, or higher depending on local codes, engineering judgement, or context (such crossings of excessive height). Where the deck is less than 30 inches above surrounding grades, railings or bumper curbs are optional.

5. A grab rail or rub rail is recommended as a component of the railing structure. A grab rail can be helpful to people with mobility impairments or during icy weather. A rub rail can reduce the likelihood that a bicycle handlebar would contact a vertical members of the railing structure.

ROAD CROSSINGS

Well-designed crossings make shared use paths, sidepaths, and trails safer, more connected, and more comfortable for pedestrians and bicyclists. Where possible, path or trail facilities should be routed to crossing locations at existing roadway intersections, in order to provide crossing at a location with existing crosswalks and/or traffic controls.

In certain locations, typically where there is demand that cannot be met by routing to an existing intersection, shared use paths or trails may require a midblock crossing. Midblock crossings should be designed in consideration of traffic speed, traffic volume, roadway width, path user volume, and general context. They should be highly visible to road users and path users, maintain clear site lines for all, have relatively flat grades, and intersect at as close to a right angle as possible. Visibility of midblock crossings can be enhanced through the application of marked crosswalks and signs or beacons.

The AASHTO *Guide for the Development of Bicycle Facilities* (2012) includes engineering guidance for the design of sidepath and midblock crossings for shared use paths. Example schematics of general design considerations are provided on the next page.

Crossing Signs and Beacons

1. A **Pedestrian Crossing Warning sign** assembly (MUTCD sign # W11-2 and W16-7P) can be installed at crossings. Advance warning signs can be installed ahead of the crossing to notify drivers and indicate the distance to the upcoming crossing.

2. An **In-Street Pedestrian Crossing sign** (MUTCD sign # R1-6a) can be installed on the roadway centerline or median at a marked crosswalk.

3. A **Stop Here for Pedestrians sign** (MUTCD sign #R1-5b or R1-5c) can be installed in advance of a marked crosswalk to indicate where motorists should stop.

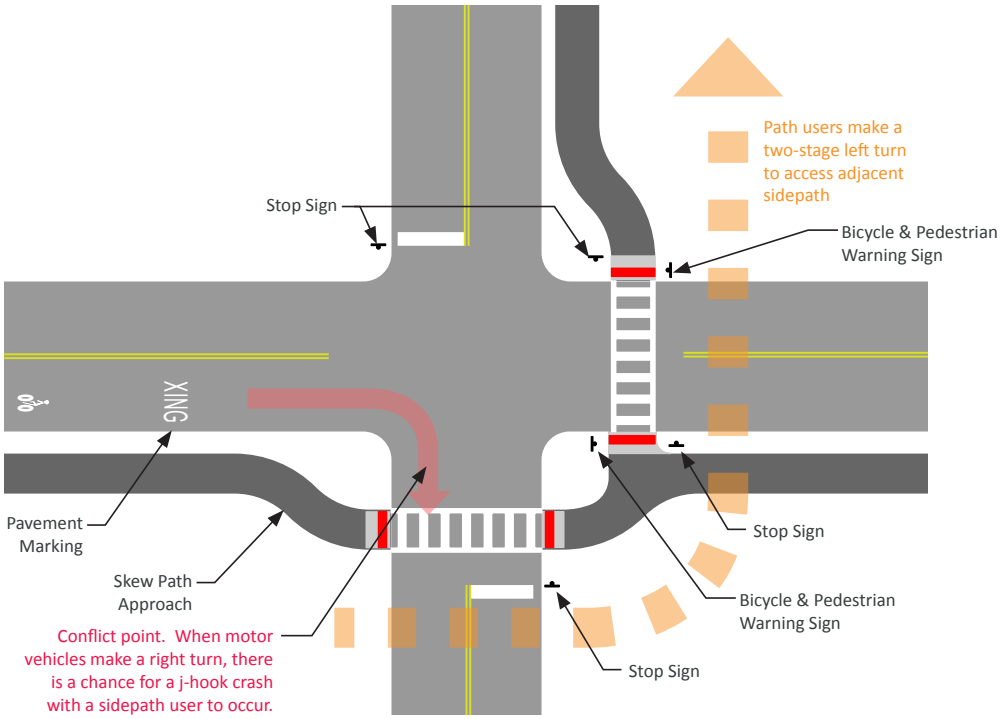
4. A **Rectangular Rapid-Flashing Beacon (RRFB)** is an actuated flashing device to supplement Pedestrian Crossing Warning signs at midblock crossings. This treatment has Interim Approval status (IA-21) from the Federal Highway Administration (FHWA). NJDOT has obtained an Approved Request for Interim Approval (IA-21.34) from FHWA that also applies to local agencies.

5. A **Pedestrian Hybrid Beacon** (also known as a HAWK signal) is an actuated signal to warn motorists to stop for pedestrians at midblock crossings. The device can be considered for locations where traffic signals are not warranted but there is a high volume of pedestrian crossings. A marked crosswalk must be provided in conjunction with a pedestrian hybrid beacon. Guidance is available in MUTCD Chapter 4F.

Sidepath Crossing Example

Where space is available, a common solution for sidepath design at intersections is to skew the sidepath alignment away from the intersection. This enables the crosswalk to be installed at a greater setback from the intersection, which can increase the visibility of sidepath users in the crosswalk and increase the reaction time of motorists. It also forces bicyclists to slow on approach to the crossing.

Additional guidance is available in the AASHTO *Guide for the Development of Bicycle Facilities* and FHWA *Small Town and Rural Design Guide*.

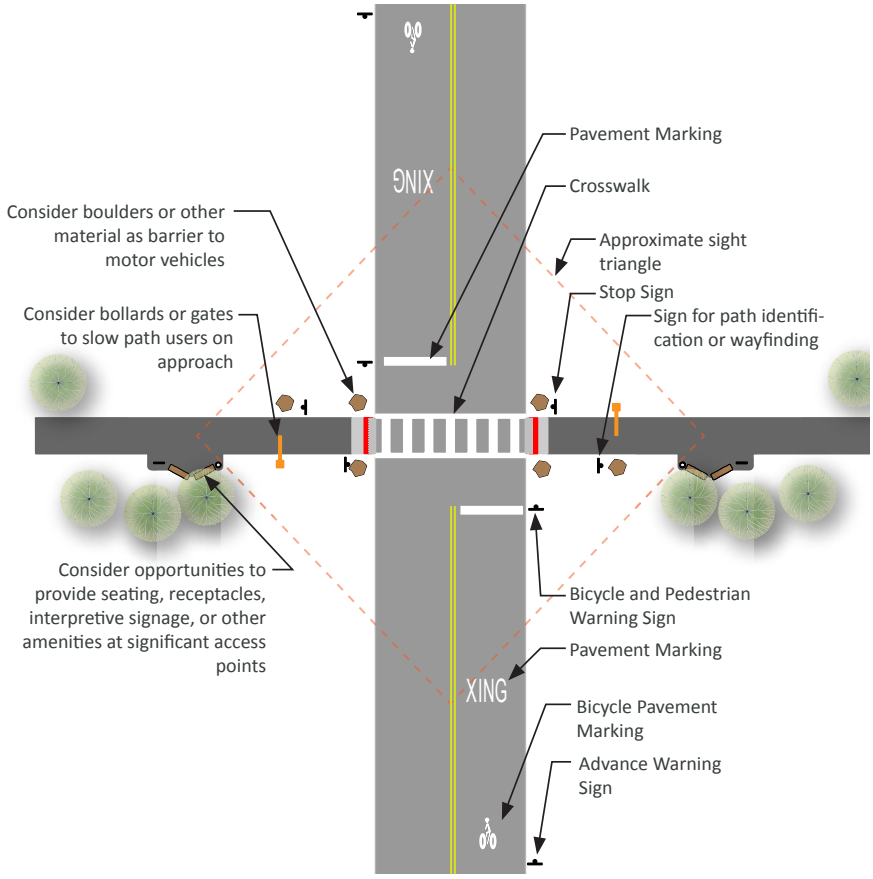


Shared Use Path Midblock Crossing Example

The motorist on approach can be alerted to the midblock crossing with warning signs and pavement markings in advance of the crossing. The distance in advance of the crossing varies based on speed limit (see MUTCD Table 2C.05). Visibility of the crossing can be enhanced with a marked crosswalk, signs, and/or beacons.

The pedestrian or bicyclists on approach to the roadway should also be alerted to the upcoming crossing. Shared use paths can be stop- or yield-controlled at crossings. Bollards or gates are often used as a physical measure to slow bicyclists on approach to crossings.

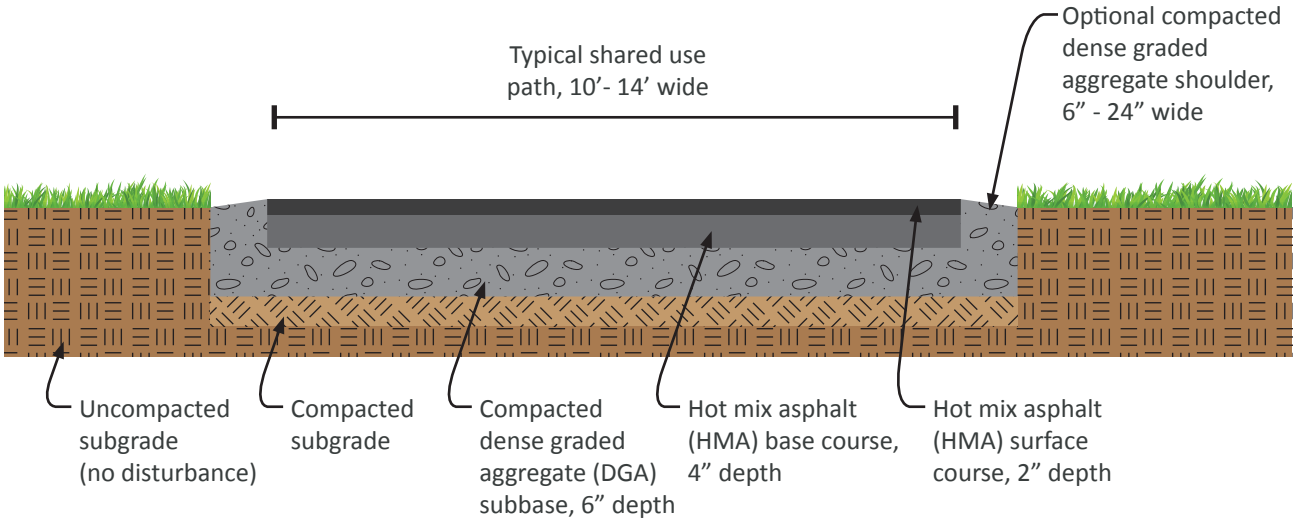
Crossings may also serve as entry points to shared use path facilities and can be enhanced with trailhead signage, benches, and receptacles.



SURFACE MATERIALS

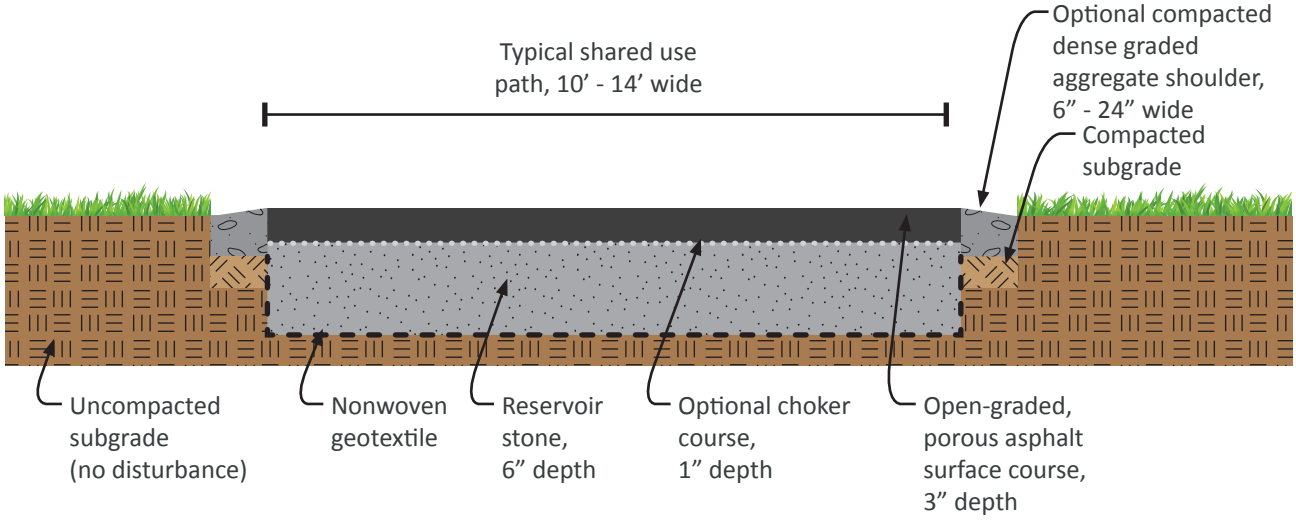
Shared use paths and trails are long-term investments and durability is a key design consideration. This section provides an overview of durable pavement profiles for asphalt, porous asphalt, and stone dust materials.

Cross Section: Asphalt Surface Shared Use Path



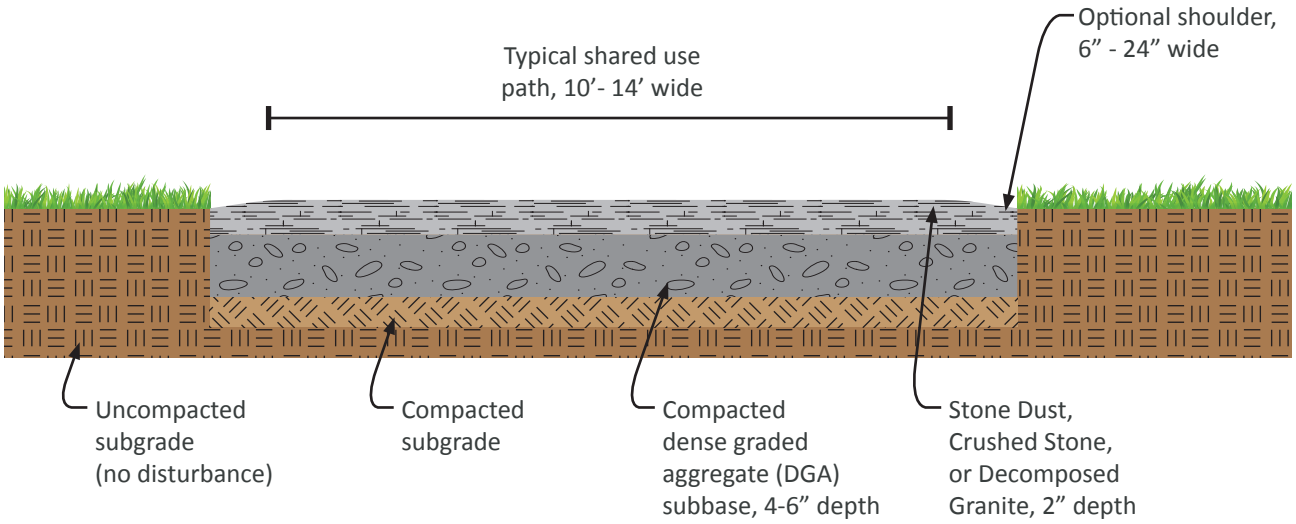
Note: Vehicular loading is a key consideration for the asphalt surface profile. The profile as shown anticipates access by maintenance and emergency vehicles. Where no vehicular access is necessary, the profile may be reduced to a 2-inch HMA surface course with a 6-inch DGA subbase. Depending on drainage patterns, an asphalt shared use path may have a crown or cross slope not to exceed 2%.

Cross Section: Porous Asphalt Surface Shared Use Path



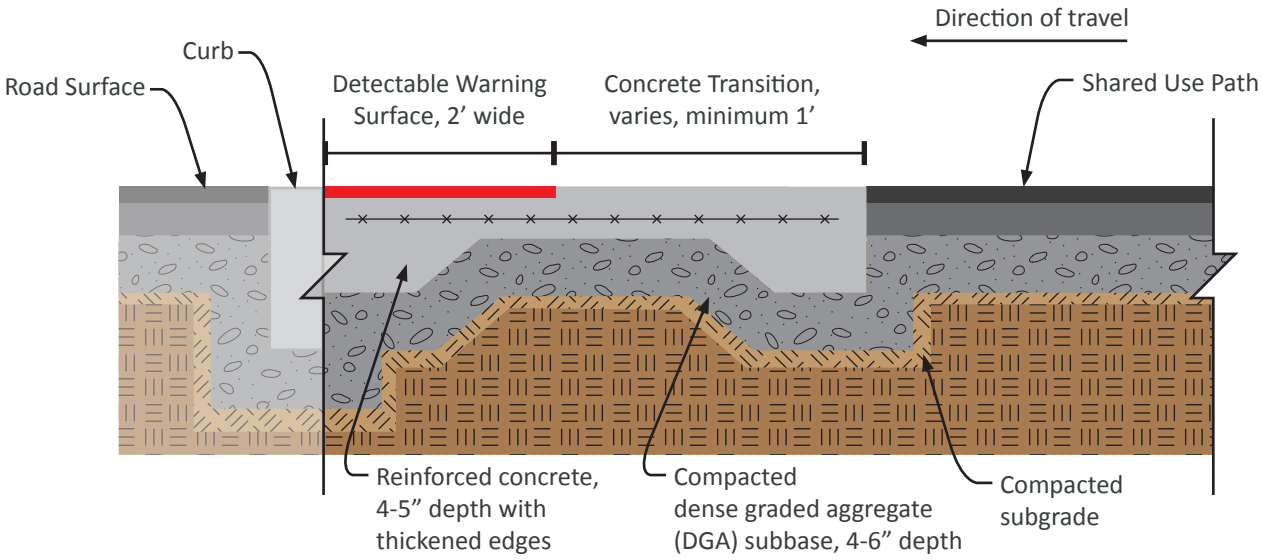
Note: Porous asphalt requires maintenance. The National Asphalt Pavement Association recommends that vacuum sweeping be performed twice per year to maintain porosity.

Cross Section: Stone Dust Shared Use Path



Note: Stone dust path surfaces can be subject to rutting and ponding through use and exposure over time and should be inspected and spot-repaired on at least an annual basis. Depending on drainage patterns, a stone dust shared use path may have a crown or cross slope not to exceed 2%. Stone dust path surfaces can be stabilized through structural or chemical-based solutions. Structural solutions include plastic or concrete cellular grids. Chemical-based solutions include binders, which can range from petroleum-based to plant-based products.

Longitudinal Section: Shared Use Path Transition



Note: Concrete transitions are applicable for all types of shared use paths and trails. Concrete transitions enable precise control of grades to meet Americans with Disabilities Act (ADA) requirements and provide a location for detectable warning surfaces. The material transition from asphalt or stone dust to concrete also alerts the path user to an upcoming crossing or obstacle.

ACCESSIBILITY

A trail network that is accessible to users of all ages and abilities will attract the greatest number of users and simultaneously enhance mobility, non-motorized transportation, and recreation. The following matrix, provides an overview of the accessibility guidelines that are associated with different types of pedestrian and/or bicyclist facilities. (The Information below is derived from *www.access-board.gov/guidelines-and-standards/streets-sidewalks/shared-use-paths/background/advance-notice).*

Facility	Definition	Primary Use	Intended Users	Right-of-Way
Shared Use Path	"...bikeways that are physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent right-of-way. Path users are generally non-motorized and may include but are not limited to: Typical upright adult or child bicyclists with or without trailers, recumbent bicyclists, tandem bicyclists, inline/roller skaters, skateboarders, kick scooter users, and pedestrians (including walkers, runners, people using wheelchairs (both non-motorized and motorized), people with baby strollers, people walking dogs, and others." -- AASHTO, 2012, page 5-1	Transportation/ Recreation	Pedestrians, bicyclists, other non-motorized wheeled users, low-speed electric bicycle operators[1], low-speed electric scooter operators[2]	Independent
Sidepath	"...a specific type of shared use path that run adjacent to the roadway, where right-of-way or other physical constraints dictate." -- AASHTO, 2012, page 5-8			Highway
Recreation Trail	"...pedestrian route developed primarily for outdoor recreational purposes. Pedestrian routes that are developed primarily to connect accessible elements, spaces, and buildings within a site are not a trail." -- U.S. Access Board, May 2014, [F106.5]	Recreation	Pedestrians, [bicyclists, other non-motorized wheeled users, low-speed electric bicycle operators[1], low-speed electric scooter operators[2]][3]	Independent
Sidewalk	"...that portion of a street between the curb line, or the lateral line of a roadway, and the adjacent property line or on easements of private property that is paved or improved and intended for use by pedestrians." -- MUTCD, 2009, 1A.13.192	Transportation	Pedestrians[4]	Highway
Bicycle Lane	"...a portion of a roadway that has been designated for preferential or exclusive use by bicyclists by pavement markings and, if used, signs." -- MUTCD, 2009, 1A.13.23	Transportation	Bicyclists	Highway (On-Road)

[1-2]Note that low-speed electric bicycle and low-speed electric scooter are defined by New Jersey Title 39:1-1 and operation of such is defined by 39:4-14.16.

[3]Signage should be provided to indicate right-of-way/yielding among different modes on recreation trails. Low-speed electric bicycles and low-speed electric scooters should not be operated on natural surface trails, unless permitted by the agency with jurisdiction.

[4]Note that use of sidewalks by bicyclists is subject to local ordinance.

Design/Accessibility Guidelines	Width	Grade	Cross Slope	Surface
Design: AASHTO *Guide for the Development of Bicycle Facilities*, 2010, Chapter 5 Accessibility: U.S. Access Board *Advance Notice of Proposed Rulemaking Shared Use Path Accessibility Guidelines,* March 2011, and supplements.	10' minimum (8' constrained)	5% maximum Not to exceed grade of established by adjacent roadway	2% maximum	Hard, durable surface such as asphalt recommended (compacted aggregate surface allowed)
Design: Various, context-based Accessibility: U.S. Access Board *Outdoor Developed Areas: A Summary of Accessibility Standards for Federal Outdoor Developed Areas*, May 2014, and supplements.	3' minimum with passing spaces every 1000', or 5' minimum	5% to 8.33%, for maximum 200'; 8.33% to 10% for maximum 30'; 10% to 12.5% for maximum 10'; and no more than 30% of the trail should exceed 8.33%	2% maximum for concrete, asphalt, board, or other solid surface; or 5% for aggregate or natural surface	Firm and stable
Design: AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, 2004 Accessibility: Proposed Guidelines for *Pedestrian Facilities in the Public Right-of-Way* (PROWAG), July 2011, and supplements.	4' minimum with passing spaces every 200', or 5' minimum	Not to exceed grade of established by adjacent roadway	2% maximum	Firm, stable, and slip resistant
Design: AASHTO *Guide for the Development of Bicycle Facilities*, 2010, Chapter 4; MUTCD Part 9 Accessibility: No ADA requirements	4' minimum with no curb, 5' minimum with curb	Equal to roadway	Equal to roadway	Equal to roadway

GREEN INFRASTRUCTURE

Materials

Strategies related to “green” construction can be an important consideration in the design of shared use path and trail facilities. These include strategies to reuse/repurpose materials or structures in place, use recycled materials or materials with recycled content, and specify materials that are locally-sourced, durable, and/or have low embodied energy from extraction or manufacturing processes.

D&R Canal Towpath is an excellent example of a facility being repurposed in place. The embodied energy that went into construction of the towpath in the 1800s is preserved to the benefit of users today and in the future.

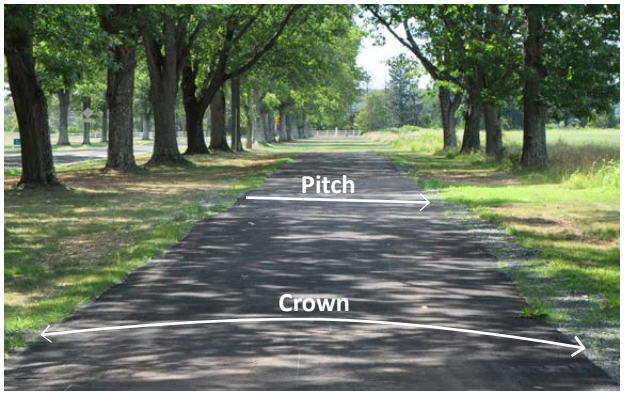
Boulders are placed at this trail access area to prevent vehicle access from the adjacent parking area. Boulders are a natural material that fit the trail aesthetic, have relatively low embodied energy (extraction, transportation), and can be recycled simply by moving them.

St. Michaels Farm Preserve in Hopewell includes grass surface recreation trails. This approach would not be appropriate for transportation-oriented trail facilities; however, it is a viable method to expand the overall trail network without the use of quarried or manufactured paving materials. Regular mowing is necessary to keep the tail passable, and trails can be re-aligned from season to season or year to year.

Steel is a building material that is necessary for structural components such as bridges. Although it has a significant embodied energy, steel is a durable material with a long service life. When use of steel is necessary, selection of a weathering steel with intentional surface oxidation can require less maintenance over time than alternative forms that are powder coated or painted.

Stormwater Management

Shared use path and trail facilities should incorporate responsible stormwater management practices. Such facilities have the potential to create stormwater runoff, yet are also susceptible to stormwater impacts from surrounding areas, such as erosion. To the extent possible, stormwater flows from shared use path or trail facilities should be directed to infiltrate and recharge the soils in the immediate surrounding areas (rather than be conveyed into structural stormwater management systems).



Shared use path facilities can have a crown or a pitch to shed stormwater and prevent ponding on the paved surface. Stormwater from adjacent areas that flows onto shared use paths can cause erosion and should be avoided.

Porous asphalt pavement has void spaces in the paving material that allows stormwater to pass through to underlying subsoils.

A swale can be designed in conjunction with a shared use path to capture, convey, and infiltrate stormwater along the shared use path.

A rain garden, or series of rain gardens, can be designed in conjunction with a shared use path to capture and infiltrate stormwater at key locations.

AESTHETICS & LIVABILITY

Wayfinding, Blazing, and Interpretive Signs

It is important for shared use path and trail facilities to feel secure, legitimate, and inspire confidence in trail users. Clear and informative signage provides the information, guidance, and cues that makes trails comfortable and easy to use, keeps trail users oriented, and explains the nuance of each individual trail. Trail facilities that do not have signage can feel uninviting, which may be a deterrent to new trail users and reduce the overall transportation and recreation benefits of the facility.

The Manual on Uniform Traffic Control Devices (MUTCD) Section 9B.20 provides guidance on Bicycle Guide Signs to communicate travel modes, route names, direction, destinations, and distance.

Trail facilities can include blazing signs that convey route identification, alternate routes, direction, and distance. The naming and branding of trail facilities, such as the Lawrence Hopewell Trail, can help attract new users.

Cultural interpretive signs along trail facilities convey information about the historic and cultural value of the trail, past uses, and points of interest within the landscape.

Geographical interpretive signs along trail facilities convey information about the land use, agriculture, industry, watershed, and ecology of the surrounding landscape.

Trailheads

A trailhead is a point where a trail user can enter a shared use path or trail facility. The components and design of a trailhead will vary based on the type of facility, its size, and user volumes. At a minimum, a trailhead should include a sign and a map that identifies the facility, destinations along the facility, travel distance, and approximate travel time by mode. Depending on demand and maintenance capacity, a trailhead may also include seating/rest areas, receptacles, bulletin boards, bicycle racks, drinking fountains, restrooms/comfort stations, and/or parking.

Seasonal Uses

A maintenance strategy for seasonal uses should be established during the planning and design of a shared use path or trail facility. For facilities where snow plowing will be necessary or desirable, coordination should take place with the entity that will be responsible for maintenance to ensure that the design of the facility is compatible with existing plow vehicle fleets and operations. Where a facility serves a recreation purpose, a snow event can create an opportunity for a new use or mode, such as cross country skiing.

SMART TECHNOLOGY

Trail map of The Watershed Institute in Pennington

Smart Maps

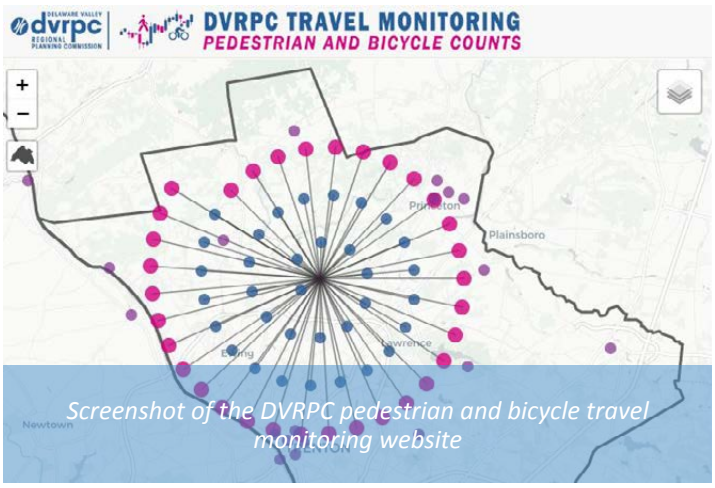
Trail maps are effective when they are portable, but printing and stocking paper maps is a continual maintenance expense. As a solution, this example from The Watershed Institute shows a trail map that includes a QR code that can be scanned with a smart phone so that the trail user can view the map on his or her phone.

It is also helpful to make GIS files of trail routes accessible to the public. While most trail data is maintained and updated as shapefiles, this format is not generally useful to the public. Instead, provide KML or KMZ files that can be download and opened in free apps like Google Earth.

Audio Tour example at The Watershed Institute in Pennington

Multimedia Trails

Multimedia trails use audio and video to bring new meaning to trails. The Audio Tour at The Watershed Institute provides an alternative trail experience where trail users listen to an audible description of key locations through their phones. This is a growing sector with application for cultural, historical, and ecological interpretation, as well as place-based fiction and poetry.



Screenshot of the DVRPC pedestrian and bicycle travel monitoring website

Trail User Counts

The Delaware Valley Regional Planning Commission (DVRPC) has a Permanent Bicycle and Pedestrian Counters program that tracks trail use in the DVRPC region, which includes Mercer County. Trail use counts help all levels of government and the public understand how trails are being used and inform decisions on capital expenditures, grants, and maintenance.

PERMITTING GUIDANCE

When advancing shared use path or trail projects, coordination with the New Jersey Department of Environmental Protection (NJDEP) is necessary to ensure that the project can obtain the necessary permits for construction. Coordination with NJDEP should begin early on, once a shared use path or trail project is identified for implementation and efforts are being made to advance planning, design, and/or grant applications.

Timely coordination with NJDEP may help to refine a given shared use path or trail project in order to:

- Meet qualifications for a general permit, rather than an individual permit (the latter being more costly and time-consuming);
- Develop a phased approach to implementation that identifies trail segments with independent utility and rational start/end points;
- Refine potential shared use path or trail alignments and design approaches to avoid or minimize impacts to regulated areas and identify appropriate mitigation practices, when necessary.

Regulated areas generally consist of:

- Wetlands and Wetland Transition Areas
- Regulated Waters, Flood Hazard Areas, and Riparian Zones
- Historic Structures, Historic Districts, Archaeological Sites
- Green Acres, Parkland, Open Space
- Brownfield Sites or Hazardous/Contaminated Material Sites

When evaluating a potential project in relation to regulated areas and environmental impacts, NJDEP generally requires the following approaches:

- Project sponsors should first try and avoid regulated areas;
- If impacts to regulated areas cannot be avoided, then they should be minimized to the greatest extent practicable;
- Any impacts to regulated areas will generally have to be mitigated for through standard mitigation practices.

NJDEP provides the NJ-GeoWeb website with interactive mapping as a means of screening for potentially regulated areas. (Note that the application is for preliminary planning only and regulated areas may require field delineation as shared use path or trail projects are advanced).

NJDEP General Permits 17 and 17A provide the basic requirements for potential trail or shared use path projects, respectively.

General Permit 17 applies to trail facilities that are 6 feet wide or less.

General Permit 17A applies to shared use path facilities to be designed in accordance with AASHTO guidelines.

NJDEP General Permit 17

"...authorizes activities in freshwater wetlands, transition areas, and/or State open waters necessary for construction of a trail and/or boardwalk for use by pedestrians, bicycles, and other non-motorized methods of transport."

"The total area of freshwater wetlands, transition areas, and/or State open waters disturbed under general permit 17 shall not exceed one quarter acre, except that this limit shall not apply to a site that is publicly owned."

NJDEP General Permit 17A

"... authorizes activities in freshwater wetlands, transition areas, and/or State open waters necessary for construction of a non-motorized, multiple use path for use by bicycles, skate boards, rollerblades and other non-motorized methods of transport."

"The total area of freshwater wetlands, transition areas, and/or State open waters disturbed under general permit 17A shall not exceed one-quarter acre." Otherwise, an Individual Permit will be required.

Source/Additional Information

NJDEP: Trails, Boardwalks, and Bike Paths (https://www.nj.gov/dep/landuse/activity/trail.html)

MAINTENANCE & OPERATIONS

For shared use paths or sidepaths, preventative maintenance begins with design and construction that provide good drainage, a high pavement standard, efficient access for maintenance vehicles and machinery, and a long-term plan for resurfacing. Equally important is to agree upon and document which parties will be responsible for maintenance. Facilities should be inspected on at least an annual basis to ensure continued safe operations, and the public should have a convenient way to provide notification of maintenance issues as they arise. Common maintenance issues and considerations include:

- **Crack sealing.** Cracks in asphalt paving can be hazardous to bicyclists and pedestrians. Unsealed cracks can lead to vegetation growing in cracks and exacerbate surface deterioration.
- **Mowing**. Grass shoulders can have significant mowing costs. Gravel shoulders can reduce mowing need.
- **Vegetation management.** If adjacent to vegetation, lateral clearance of the facility must be maintained to keep the full-width travel way clear of obstruction. Tree roots are also a major source of damage.
- **Snow removal.** For a mobility-oriented facility, snow removal should be anticipated. Pervious asphalt pavement requires significantly less salt/de-icer compared to conventional asphalt.
- **Sign and signal maintenance.** Signs and signals should be inspected on at least an annual basis to ensure they are legible and functional.
- **Debris removal/catch basin maintenance.** The facility should be swept clear of debris and stormwater facilities should be inspected on at least an annual basis to preserve functionality. Mud deposits in flood-prone areas should be cleared after flood events.

For recreation-oriented trails, the maintenance practices will depend upon the nature and operations of the facility.

- **Surface maintenance.** It is necessary to maintain the tread surface as firm and stable and to ensure that trail clearances are not hindered by encroaching vegetation, debris, or fallen trees. This should entail at least an annual inspection of the trail facility with repairs made as necessary.
- **Snow.** For trail facilities that are recreation-oriented, it is not necessary to remove snow. Instead, snow events can become an opportunity for other uses of the trail, such as cross county skiing.
- **Hiking and mountain bike trails.** For trails that are constructed to be rustic, durable, and recreation-oriented, trail maintenance should be minimal. An annual inspection should be made to ensure overall safety. Established trail user groups, such as the Jersey Off Road Bicycle Association (JORBA) often have the interest and capacity to maintain trails on an organized volunteer basis.
- **Trailheads, signs, and blaze markings.** Trail visitors orient themselves through use of trailheads, signs, and blaze markings. It is essential to maintain these to a high standard in order for people to safely and confidently navigate the trail.

COST ESTIMATING

To plan and implement shared use path and trail facilities, it is necessary to consider of costs and benefits. This section provides a range of order-of-magnitude, "rule of thumb" costs for the typical features that compose trail systems. This information is provided to support decision-making for feasibility, costs, and benefits of potential trail facilities.

In planning and implementing trail facilities, a range of costs must be considered. Trails are long-term investments in community infrastructure that provide significant benefits over time. Costs to consider include:

- **Design Costs.** Planning, conceptual design, and engineering-level design of trail facilities, traffic crossings and signals, stormwater management and green infrastructure, environmental analysis and permitting, lighting, signing, striping, bridge and culvert widening, bridges, development of specifications, and bidding.
- **Right-of-Way Costs.** Acquisition, easement, and appraisal services.
- **Construction Costs.** Construction of trails and supporting infrastructure, site preparation and clearing, grading, construction management, and inspection.
- **Maintenance Costs.** Annual inspections, crack sealing, vegetation management, snow clearing, sweeping, and miscellaneous repairs. Long-term resurfacing program. Facilities that experience flooding will need soil deposits and/or debris removed after flood events.

There are significant variables to be considered in the costs of design, right-of-way acquisition, and maintenance, such that an accurate rule of thumb for such costs cannot be calculated. Construction costs, however, are more discrete and are tracked over time through construction projects and bid tabulations.

The rule of thumb costs in this section can be used to create concept-level cost estimates to inform planning for shared use path and trail facilities. Users of this information should bear in mind that the actual costs for facilities will vary based on factors such as the existing conditions, facility size, drainage, fuel prices, utilities, materials, and level of finish.

Cost Estimating for Shared Use Paths, Trails, and Amenities

Asphalt Shared Use Path or Sidepath, 10' Wide

Rule of thumb:

$145-190 per linear foot (LF), installed (cost assumes subbase, and asphalt paving)

Example:

Shared use path for a half-mile:
$150/LF x 2640 LF (LF in a half mile) = $396,000, installed

Crushed Stone Path, 10' Wide

Rule of thumb:

$60 per linear foot (LF) installed

Example:

Crushed stone path for a half-mile:
$60/LF x 2640 LF (LF in a half mile) = $158,000, installed

Natural Surface Recreation Trail, 5' Wide

Rule of thumb:

$20 - $40 per linear foot (LF), where moderate clearing and surface preparation is necessary; otherwise, costs can be minimal

Example:

An natural surface trail is planned for a half-mile loop. 100 feet of the loop requires moderate clearing and surface preparation:
$20/LF x 100 LF = $2,000, installed

Trailhead Kiosk

Rule of thumb:

$4,000 each, installed

Example:

Three trailhead kiosks need to be replaced:
3 x $4,000 = $12,000, installed

Bench

Rule of thumb:

$1,200 each, installed (cost assumes bench is accessible to paved route)

Example:

Four new benches will be installed at a recreation trail:
4 x $1,200 = $4,800, installed

Cost Estimating for Shared Use Paths, Trails, and Amenities

Bicycle Rack

Rule of thumb:

$400 - 750 each, installed (cost assumes surface mount)

Example:

The sidewalk has space to accommodate 4 high quality, steel bicycle racks:
4 x $750 = $3,000 installed

Bollard

Rule of thumb:

$1,500 each, installed

Example:

A shared use path crossing is improved by adding 2 bollards:
2 x $1,500 = $3,000, installed

Wireless Call Box

Rule of thumb:

$3,000 each, installed

Example:

A call box is planned as part of a trailhead:
$3,000, installed

Drinking Fountain

Rule of thumb:

$3,500 each, installed (cost assumes easy access to water supply)

Example:

Two drinking fountains are planned as part of a trailhead:
2 x $3,500 = $7,000 installed

Signing/Blazing of Trail

Rule of thumb:

Low cost, $200 - $400 per mile for durable polyurethane markers, installed by staff or volunteers

Example:

A one-mile trail is signed with markers:
50 markers x $4.25 per marker = $212.50

Cost Estimating for Road Crossings

Roadway Crossing for Shared Use Path, Sidepath, or Recreation Trail

Rule of thumb:

$6,000 per crossing, installed (cost assumes curb ramps, 10’ wide continental crosswalk, and regulatory signs at 40’ crossing)

Example:

Three crossings are planned for a new shared use path:
$6,000 x 3 = $18,000, installed

Crosswalk, Continental Stripe, 6’ Wide

Rule of thumb:

$10 per linear foot(LF), installed (cost for thermoplastic stripes)

Example:

A 40’ crosswalk:
40’ x $10/LF = $400 installed

Regulatory Sign

Rule of thumb:

$300 each assembly, installed (cost includes post, sign, and supplemental plaque)

Example:

A crosswalk with 2 regulatory sign assemblies (W11-2 and W-16-7P)
2 x $300 = $600, installed

Rectangular Rapid-Flashing Beacon (RRFB)

Rule of thumb:

$20,000 per crossing, installed (cost includes 2 RRFB assemblies)

Example:

RRFBs are added to an existing crossing:
$20,000 installed

Pedestrian Hybrid Beacon (HAWK Signal)

Rule of thumb:

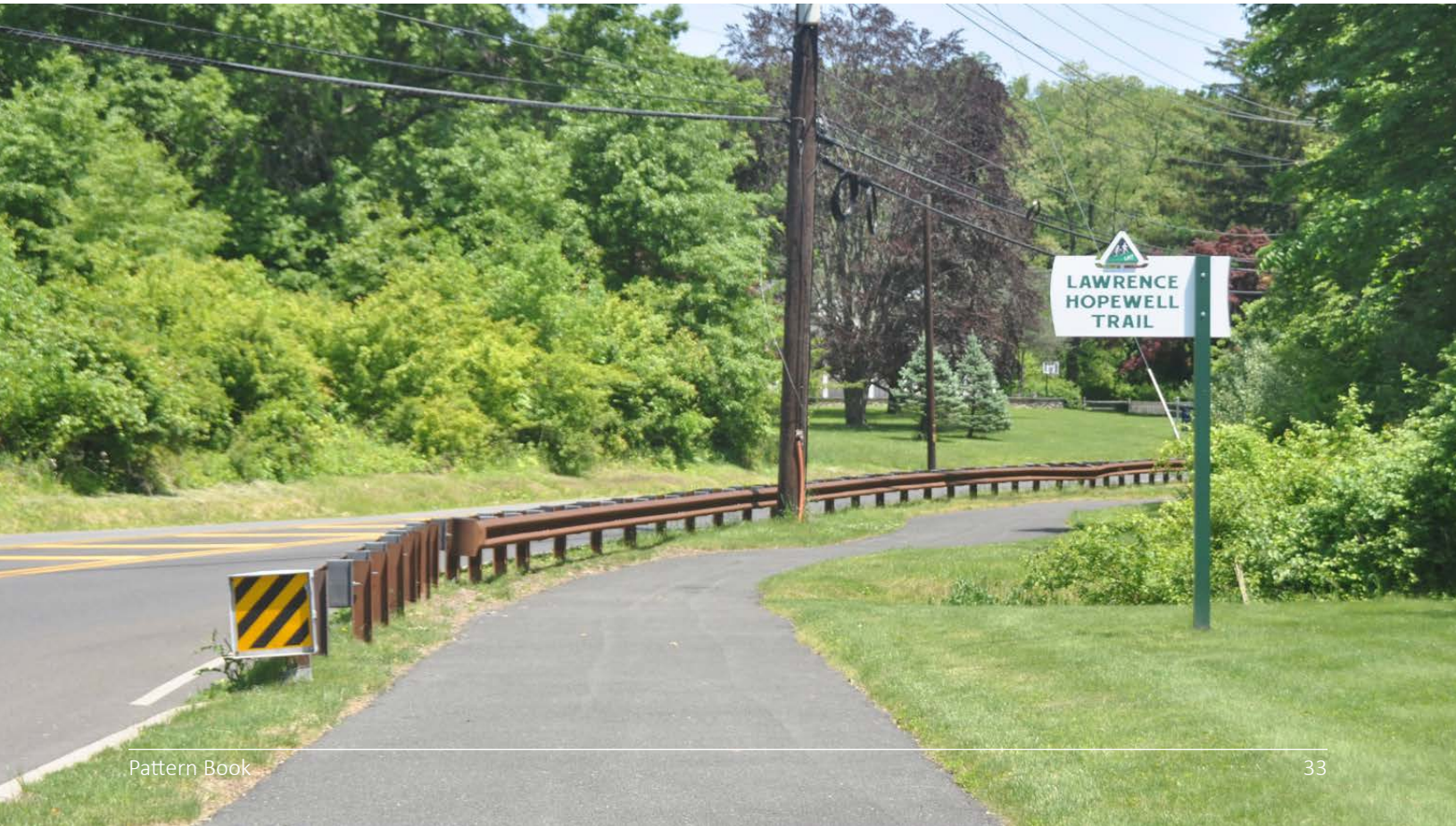
$150,000, installed (cost includes on HAWK signal assembly)

Example:

A HAWK signal is added to an existing crossing:
$150,000, installed

ADDITIONAL RESOURCES FOR DETAILED DESIGN GUIDANCE

- *2017 State of New Jersey Complete Streets Design Guide,* Chapter 3, NJ Department of Transportation, http://njbikeped.org/wp-content/uploads/2017/05/Complete-Streets-Design-Guide.pdf
- *Guide for the Development of Bicycle Facilities,* Fourth Edition, Chapter 5, American Association of State Highway and Transportation Officials (AASHTO), 2012, https://store.transportation.org/item/collectiondetail/116
- *Small Town and Rural Multimodal Networks*, U.S. Department of Transportation Federal Highway Administration, Chapters 4, December 2016, https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf
- *Manual on Uniform Traffic Control Devices,* (MUTCD) 2009 Edition with Revisions No. 1 and 2 Incorporated, dated May 2012, Part 9 Traffic Control for Bicycle Facilities, Federal Highway Administration, https://mutcd.fhwa.dot.gov/htm/2009r1r2/html_index.htm
- *Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG),* U.S. Access Board, July 26, 2012, https://www.access-board.gov/attachments/article/743/nprm.pdf
- *Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way*; Shared Use Paths, Architectural and Transportation Barriers Compliance Board, Federal Register, Vol. 78, No. 30, Wednesday, February 13, 2013, Proposed Rules, https://www.access-board.gov/attachments/article/1108/sup-snprm.pdf
- *Maintenance Practices and Costs of Rail-Trails,* Rails-to-Trails Conservancy, June 2015, https://www.railstotrails.org/resourcehandler.ashx?id=6336
- *A Summary of Accessibility Standards for Federal Outdoor Developed Areas,* U.S. Access Board, May 2014, https://www.access-board.gov/attachments/article/1637/outdoor-guide.pdf



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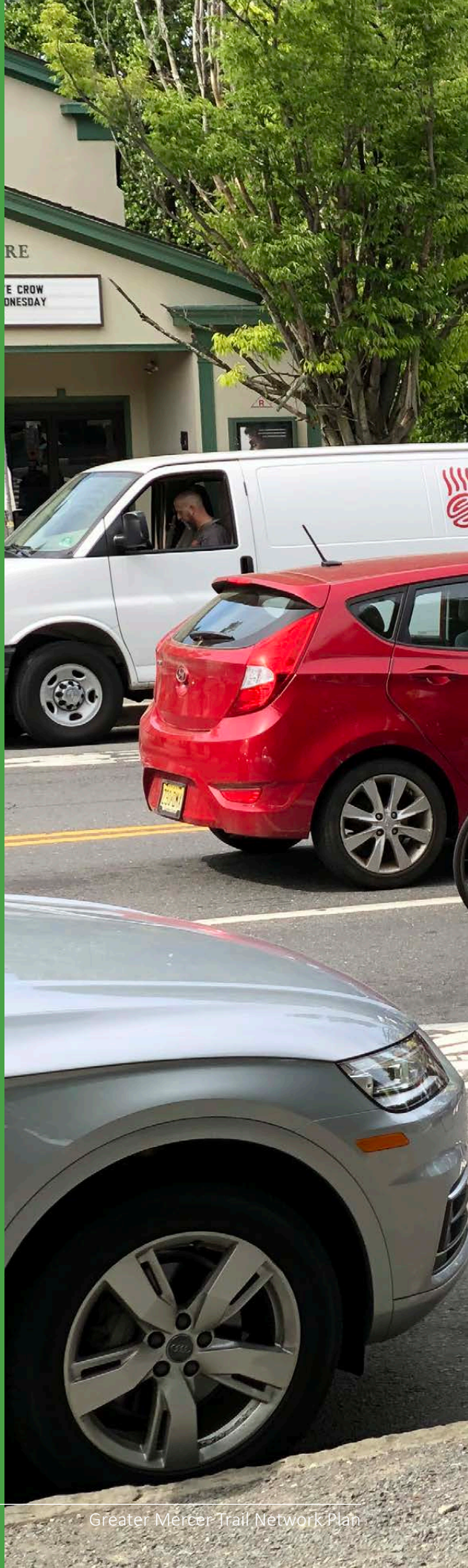
SUPPLEMENTING THE TRAIL NETWORK WITH ON-ROAD CONNECTIONS

Although an ideal trail network would provide a complete off-road experience, separate from motor vehicles, in practice there will inevitably be locations where on-road connections are necessary. Where there are opportunities to connect off-road trail facilities using on-road facilities safely and comfortably, the benefits of substantial connectivity can be realized. In some cases, an on-road connection may be a temporary solution, employed in the interim as more robust off-road connections are implemented over time. In other cases, an on-road connection may be a long-term solution due to limitations imposed by the built and natural environment.

This section provides guidance for on-road pedestrian or bicycle facilities that can be planned as connections between trail facilities. These include:

- Sidewalks
- Shared Lane Markings
- Bicycle Lanes
- Buffered Bicycle Lanes
- Protected Bicycle Lanes



Nassau Street in Princeton

SIDEWALKS

Sidewalks provide the fundamental infrastructure for pedestrian mobility as a component of the roadway network and the public right-of-way. As pedestrian access routes, sidewalks are the primary facility for pedestrians of all ages and abilities and should provide for a safe, usable, and continuous network connecting urban, suburban, and rural communities and destinations.

Typical Application

Sidewalks are paved pedestrian access routes that are provided parallel to roadways within the roadway right-of-way or within a sidewalk easement. Sidewalks vary in form, material, and width in relation to local context, density, destinations, and activities. Sidewalks should be constructed and maintained in areas with existing or anticipated pedestrian use and in areas of pedestrian activity where current pedestrian needs are not being met. Sidewalk connections are particularly important for conveying pedestrians to destinations such as schools, transit stations or bus stops, downtowns, shopping centers, and employment centers.

Benefits

- Separate from motor vehicle traffic and allow pedestrians to travel at their own speed with a sense of comfort and safety
- Designed, constructed, and maintained to be ADA-accessible and provide mobility and independence for people of all ages and abilities
- Are public space and provide important opportunities for neighborly interaction, socializing, and community-building
- In a downtown setting, sidewalks provide direct connections to local business and the frontage space along the sidewalk is often used as an outdoor extension of the business
- Sidewalks enhance the character of the locations where they are installed

Considerations

- The sidewalk network should be as complete as possible
- It is not recommended to have sidewalks on only one side of the road, but this condition may be acceptable where appropriate safety and mobility are provided to serve the population and context
- Along rural roads with sparse population and destinations, a sidepath may be considered in place of a sidewalk with the added benefit of serving both pedestrians and bicyclists

A bike corral on Witherspoon Street in Princeton uses the no-parking area ahead of a crosswalk as a transition for bicyclists to dismount and walk on the sidewalk

Hinds Plaza in Princeton is an expansion of the pedestrian realm between the sidewalk and the building

Downtown Sidewalk

Frontage Zone
Minimum 2’ Wide

Pedestrian Zone
Minimum 5’ Wide

Furnishing Zone
Minimum 2.5’ Wide

Maximum Cross Slope of 2%

1. The pedestrian zone is reserved for mobility: it is the space in the sidewalk that must remain open for pedestrian travel. The pedestrian zone should be a minimum of 5 feet wide, free of obstructions, and have a slip-resistant, level surface to accommodate pedestrians of all ages and abilities.

2. The frontage zone should be a minimum of 2 feet wide. This area provides access for pedestrians to enter and exit buildings without interrupting the flow in the pedestrian zone. The frontage zone is also the location where businesses can extend into the sidewalk. Where space and local regulations permit, the frontage zone is an opportunity for businesses to provide dining tables, furnishings, signs, exhibits, and items for sale.

3. The furnishing zone provides a buffer from the adjacent street and creates a linear space to locate elements such as:

   - Green Infrastructure
     - Street trees
     - Stormwater planters
   - Furnishings:
     - Benches
     - Receptacles
     - Bicycle racks
     - Planters
   - Transit Access/Bus Stops
   - Utilities:
     - Street lights
     - Hydrants
     - Signal/utility poles
     - Control boxes
     - Signs
     - Parking meters

Ribbon Sidewalk

1. The pedestrian zone must remain open and free of obstruction to provide for pedestrian mobility and travel. Sidewalks should be constructed at least 5 feet wide. Depending on the expected usage volume, a minimum width of 4 feet can be acceptable as long as a 5-foot passing area is provided at least every 200 feet. Where usage is expected to be high, a wider paved zone may be appropriate.

2. This style of sidewalk is common and appropriate for a range of contexts, including residential or commercial. As such, the adjacent property types and building setback are variable. Adjacent property owners are often responsible for maintenance of the sidewalk including removal of snow and ice and trimming of vegetation.

3. The street buffer can vary from 0 feet (when the sidewalk is against the curb) to 5 feet or more; it creates a linear space to locate elements such as:

   - Green Infrastructure
     - Street trees
     - Stormwater planters
   - Transit access/bus stops
   - Mailboxes
   - Signs
   - Furnishings:
     - Benches
     - Receptacles
     - Bicycle racks
     - Planters
   - Utilities:
     - Street lights
     - Hydrants
     - Signal/utility poles
     - Control boxes

4. The street buffer provides space for curb ramps to transition in grade from the level of the sidewalk to the level of the roadway. When there is no street buffer and a sidewalk is against the curb, a minimum 5-foot sidewalk is recommended.

Sidewalk Curb Ramp

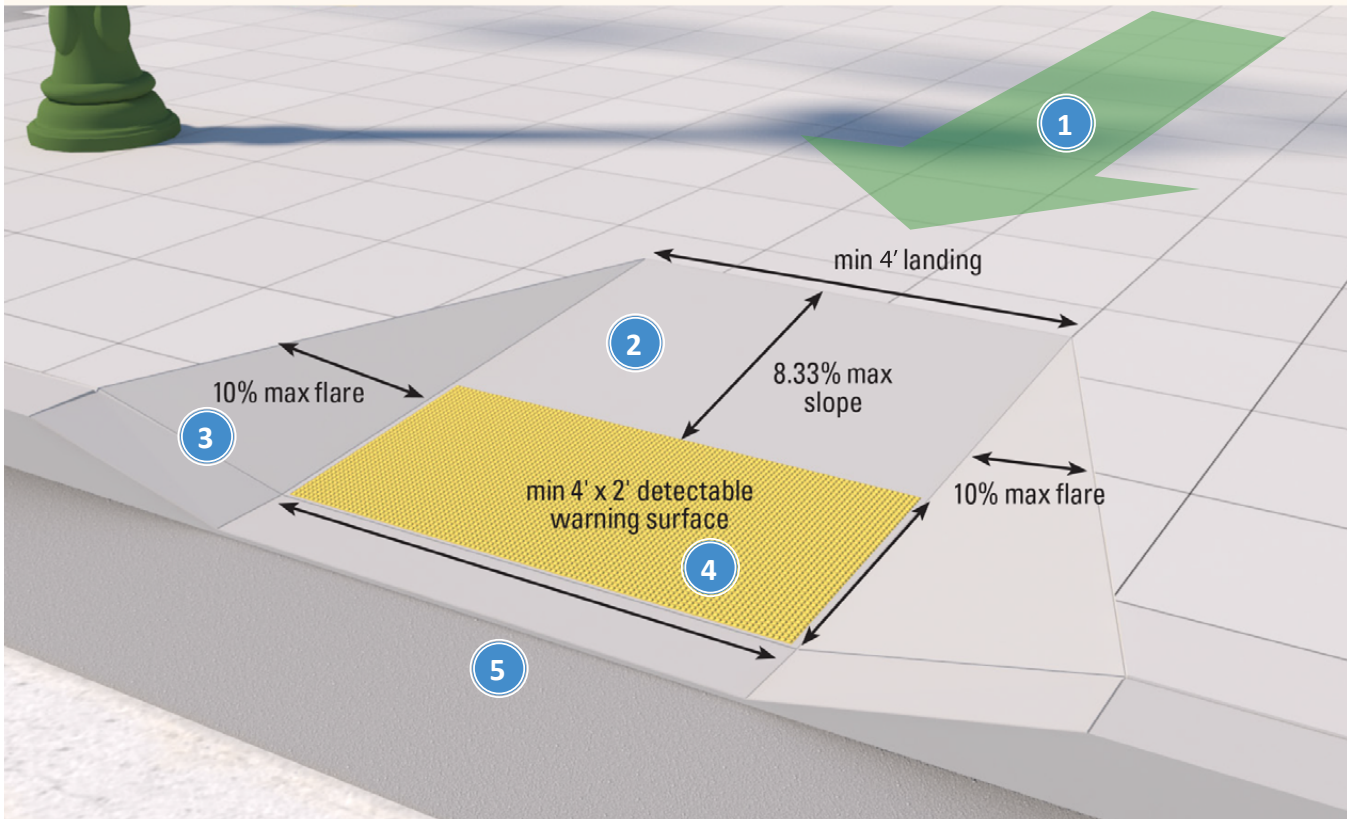


Image credit: NJDOT Complete Streets Design Guide, page 119.

1. Curb ramps should be located and oriented in line with pedestrian access routes and the general pedestrian path through a crosswalk. Curb ramps should be generally the same width as the pedestrian access route on the sidewalk (5-foot recommended landing, 4-foot minimum).
2. The maximum slope of a curb ramp should not exceed 8.33%. The cross slope of a curb ramp should not exceed 2%. The surface of a curb ramp should be smooth, firm, and slip-resistant.
3. When curb ramps have side flares in the walkable area, the slope of the flare should not exceed 10%. Side flares are not necessary when curb ramps are adjacent to grass or furnishings.
4. To alert people with vision impairments of the flush curb at a roadway crossing, a curb ramp should include a tactile detectable warning surface with truncated domes in a color that provides high contrast to the surrounding paving materials.
5. Design, construction, and maintenance of curb ramps should ensure that there is no accumulation of stormwater, snow and ice, or debris where the curb ramp meets the roadway surface. The pedestrian access route, which includes the sidewalk, curb ramp, and crosswalk, should be clear of drainage grates and utility covers.

SHARED LANE MARKINGS

Shared lane markings, also called “sharrows,” are pavement markings that indicate a shared roadway environment for motor vehicles and bicycles, reinforce the legitimacy of bicyclists to use the roadway, and alert motorists to the potential presence of bicyclists. Shared lane markings are not exclusive bicycle facilities, but can be employed as a means to connect and provide a designated route between bicycle facilities.

Typical Application

Because shared lane markings do not constitute an exclusive bicycle facility, they should not be proactively applied as a means to conceptualize and build out a bicycle network. Rather, shared lane markings should be employed secondarily and strategically as a supporting element in a complete bicycle network.

According to the *New Jersey Complete Streets Design Guide*, shared lane markings should only be used on streets with a speed limit of 25 MPH or less and a low traffic volume, such that it is comfortable for bicyclists to operate in motor vehicle traffic. Shared lane markings are intended for single-lane, rather than multi-lane, roadways and can be paired with traffic calming measures.

Benefits

- Provide a visual connection and route guidance between bicycle facilities and through constrained areas that prevent the inclusion of bicycle facilities, while alerting motorists to the potential presence of bicyclists
- Assist bicyclists with lateral positioning in the traffic lane, which can reduce the incidents of dooring in the presence of on-street parallel parking
- Alert motorists to expect that bicyclists may share the roadway and encourage safe passing of bicyclists by motorists
- Provide a wayfinding element for gaps between bicycle facilities
- Require no additional roadway space
- Can reduce the incidence of sidewalk riding
- Can reduce the incidence of wrong-way bicycling

Considerations

- Not an exclusive bicycle facility and should not be considered a substitute for such
- Not effective to reduce level of traffic stress experienced by bicyclists
- Shared lane areas or streets may include traffic calming measures to reinforce the 25 MPH speed limits where applied

Bicyclists are aligned to the shared lane marking on Nassau Street in Princeton

Example of shared lane marking where there is no on-street parking on Washington Road in Princeton

Shared Lane Marking Recommended Features

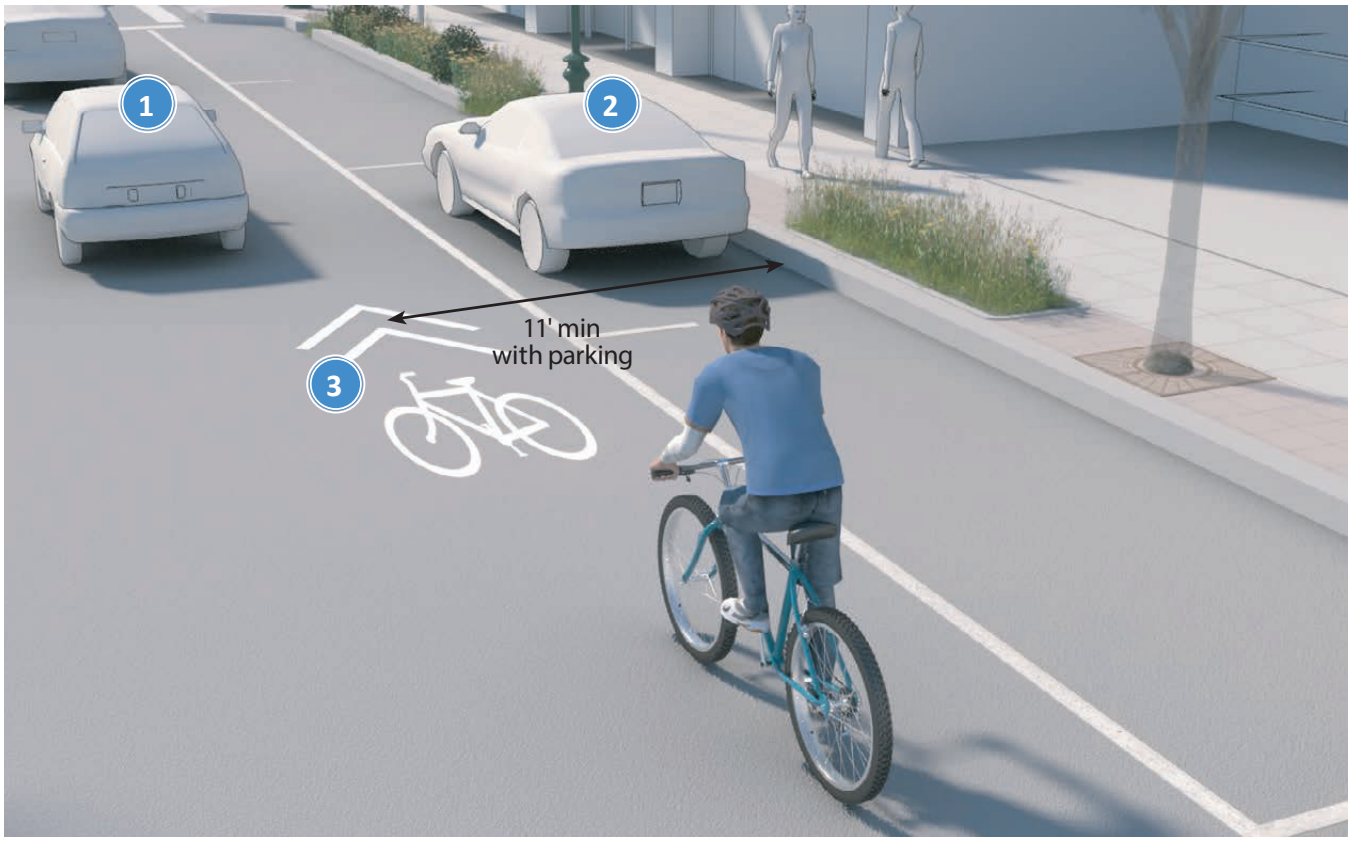
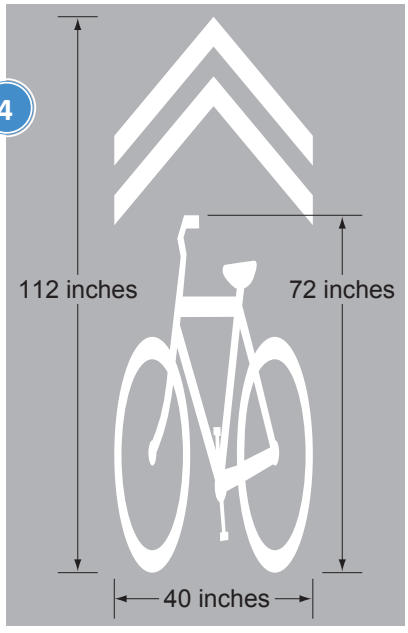


Image credit: NJDOT Complete Streets Design Guide, page 98.

1. Shared lane markings are applicable on roadways with a speed limit of 25 MPH or less, Average Daily Traffic (ADT) of 10,000 or less, and low truck volume.
2. Shared lane markings are applicable on roadways with or without on-street parallel parking.
3. On roadways with on-street parallel parking, the center of the shared lane marking symbol should be 11 feet from the edge of pavement or face of curb. On roadways without parallel parking, the center of the shared lane should be at least 4 feet from the edge of pavement or face of curb.
4. Shared lane marking symbols should be placed immediately after an intersection and at intervals of 250 feet or less thereafter.



BICYCLE LANES

Bicycle lanes designate an exclusive space for bicyclists to operate within a roadway through the application of pavement markings and signage. Bicycle lanes are on-road facilities that typically carry bicycle traffic in the same direction as motor vehicle traffic. Bicycle lanes dedicate a portion of available road space for bicyclists, allow bicyclists to travel at their preferred speeds independent of adjacent traffic, and help to facilitate predictable behavior among bicyclists and motorists.

Typical Application

Bicycle lanes are typically recommended on roadways with a posted speed limit of 25 to 35 MPH and average daily traffic of up to 10,000 vehicles, and may be recommended for roadways with a posted speed limit up to 40 MPH where the average daily traffic is relatively low at 2,500 vehicles.

Benefits

- Potential to link bicyclists to origins and destinations along established routes
- Can be applied to a range of roadway configurations and functional classifications, including:
  - One-way streets or two-way streets
  - Local, collector, or arterial roadways depending on speed and volume
  - Streets with or without lane or centerline markings
  - Streets that are residential, commercial, downtown, or rural in character
  - Streets with or without on-street parking
- Potential to retrofit existing roadways through application of pavement markings and signage

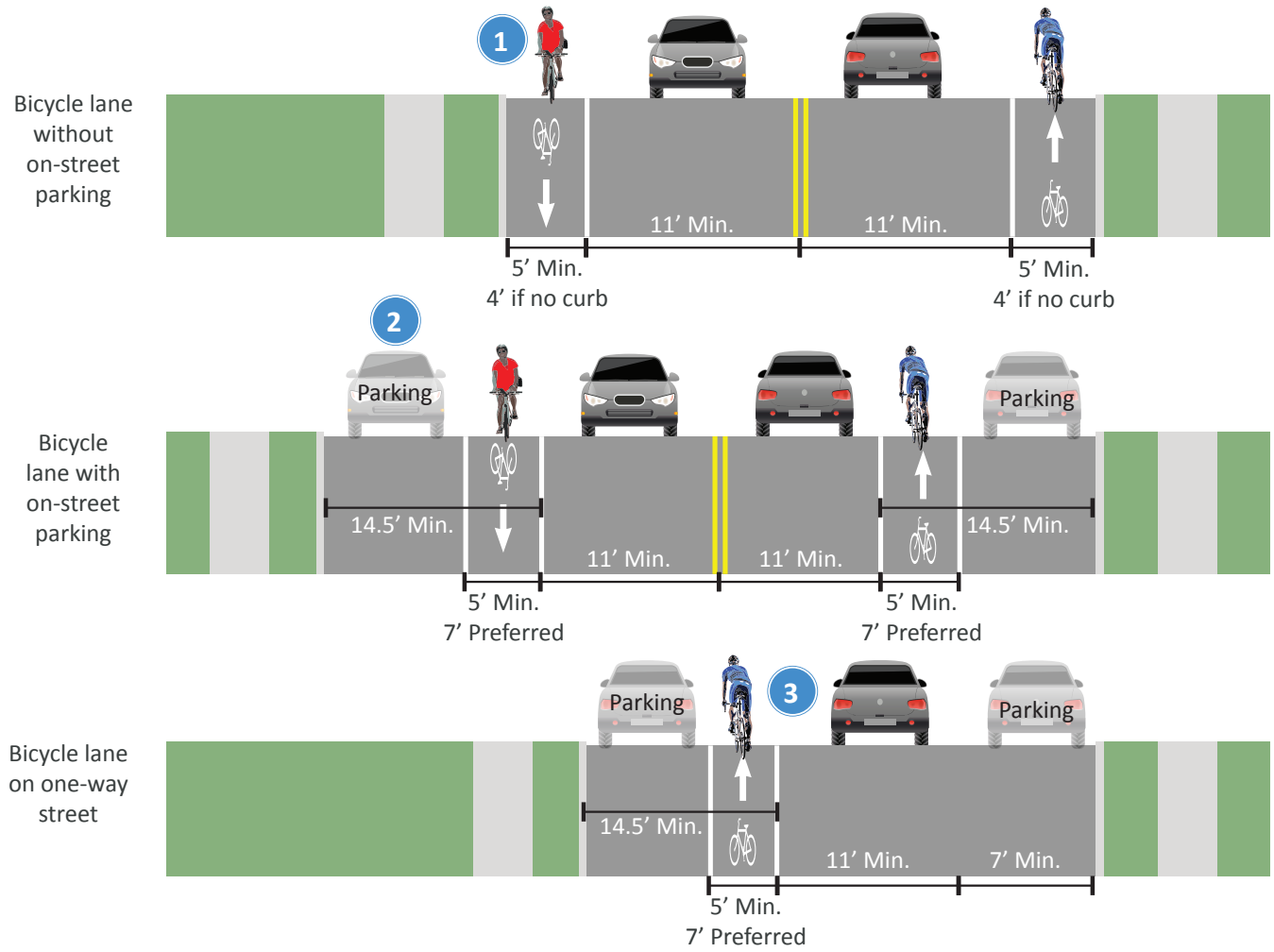
Considerations

- Many roadways with desirable connectivity may have speed limit or traffic volume in excess of recommended guidelines for application of bicycle lanes
- Many roadways with desirable connectivity may have paved roadbeds insufficiently wide to add bicycle lanes through striping alone
- Although roadway rights-of-way often extend beyond the edges of pavement, it may be expensive, physically challenging due to grades, utilities, or other features, or displeasing to adjacent property owners to widen the roadway
- Roadways with high conflict areas such as major driveways, high parking turnover, or pedestrian generators may not be desirable for bicycle lanes

Bicycle lanes as depicted in the New Jersey Complete Streets Design Guide, p. 91

Bicycle lane on Georgetown Franklin Turnpike in Blawenburg, Montgomery Township

Bicycle Lane Recommended Features & Typical Cross Sections



1. The recommended width for a bicycle lane is 5 feet. When no curb is present, it can be acceptable to provide a 4-foot wide bicycle lane.

2. The desirable width for a bicycle lane adjacent to on-street parallel parking is 7 feet, and the minimum width is 5 feet. When combined, the desirable distance from the edge of pavement to the edge of the bicycle lane is 14.5 feet.

3. When provided on a one-way street, the preferred location for a bicycle lane is the left side of the roadway. On streets with a high volume of turning vehicles, particularly right-turning vehicles, this configuration can result in fewer conflicts between bicyclists and motor vehicles.

BUFFERED BICYCLE LANES

Buffered bicycle lanes are conventional bicycle lanes with the addition of a striped buffer space to increase separation of the bicyclist from either adjacent traffic or parking. The facility designates an exclusive space for bicyclists to operate within a roadway through the application of pavement markings and signage.

Buffered bicycle lanes provide more separation from motor vehicle traffic and are more effective than conventional bicycle lanes at lowering traffic stress for bicyclists.

Buffered bicycle lanes typically carry bicycle traffic in the same direction as motor vehicle traffic, allow bicyclists to travel at their preferred speeds independent of adjacent traffic, and help to facilitate predictable behavior among bicyclists and motorists.

Typical Application

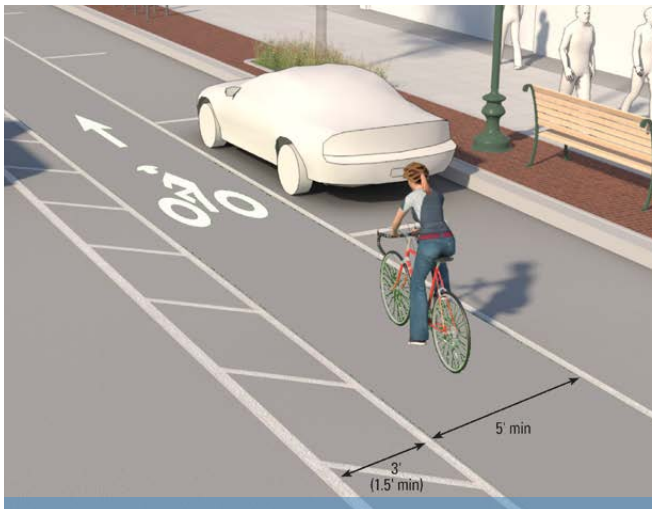
Buffered bicycle lanes are typically recommended on roadways with a posted speed limit of 25 to 35 MPH and average daily traffic of up to 15,000 vehicles, and may be recommended for roadways with a posted speed limit of 40 MPH where the average daily traffic is relatively lower at 5,000-10,000 vehicles . Buffered bicycle lanes can be recommended anywhere a conventional bicycle lane is recommended, assuming the additional space that is required is available.

Benefits

- When the buffer is installed adjacent to traffic, bicyclists feel a greater sense of separation from motor vehicles
- When the buffer is installed adjacent to parking, bicyclists are better protected from dooring accidents
- Buffer spaces allow for passing among bicyclists without entering the motor vehicle travel lane
- Buffered bicycle lanes are perceived by bicyclists as safer than conventional bicycle lanes and can encourage increased bicycle use

Considerations

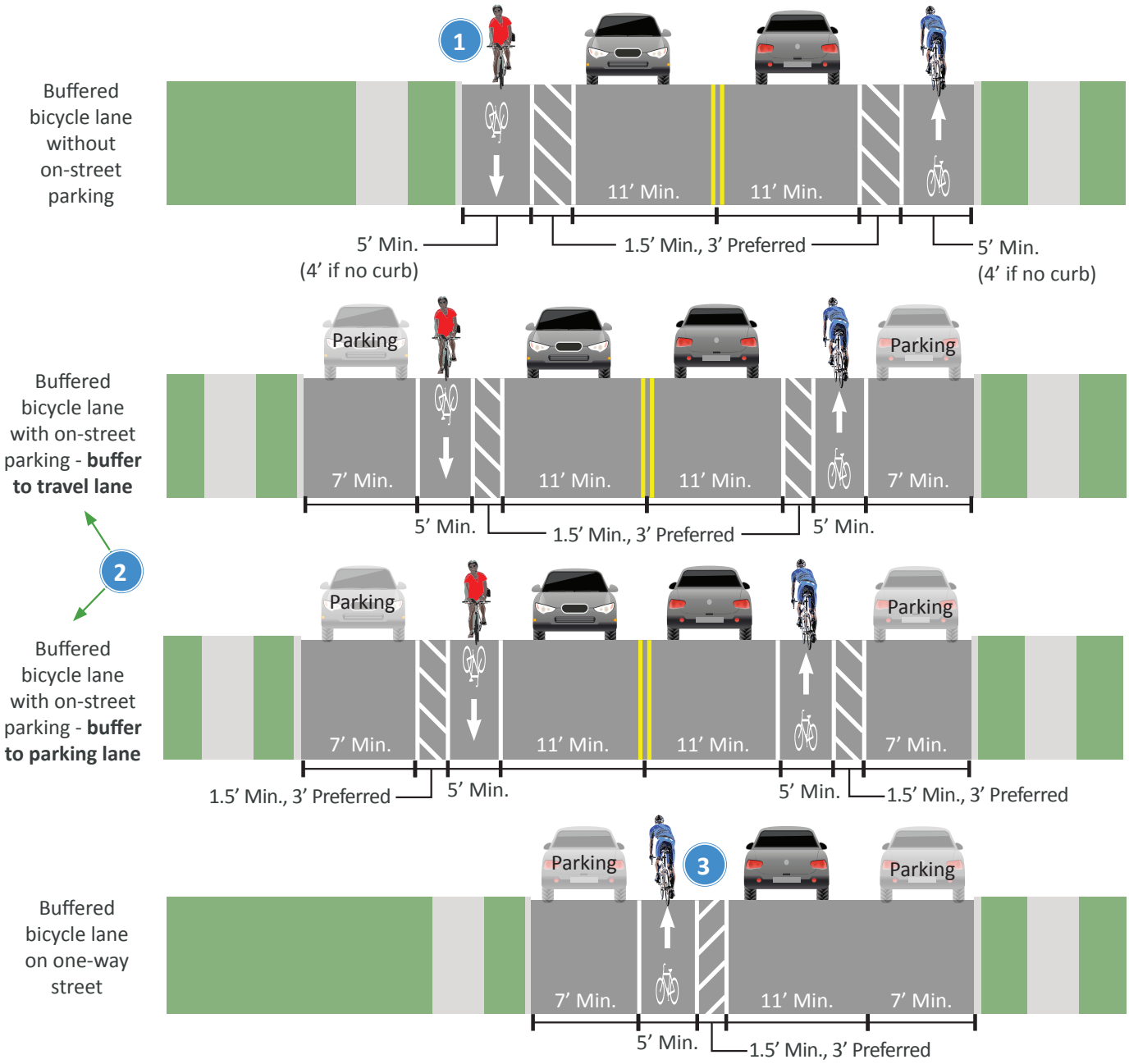
- Roadways with desirable connectivity may not be wide enough to add buffered bicycle lanes without widening the roadway
- Although roadway rights-of-way often extend beyond the edges of pavement, it may be expensive, physically challenging due to grades, utilities, or other features, or displeasing to adjacent property owners to widen the roadway



Buffered bicycle lane as depicted in the New Jersey Complete Streets Design Guide, p. 93

Buffered bicycle lane as a component of the Trenton Wellness Loop (Credit: Jay Watson, D&R Greenway Land Trust)

Buffered Bicycle Lane Recommended Features & Typical Cross Sections



1. The minimum recommended width for a buffered bicycle lane is 5 feet with a 3-foot buffer. When no curb is present, it can be acceptable to provide a 4-foot wide bicycle lane. The minimum width of a buffer is 1.5 feet.

2. On roadways with on-street parking, the buffer can be placed adjacent to the travel lane **or** the parking lane. The typical application is to buffer the travel lane to increase bicyclist comfort.

3. When provided on a one-way street, the preferred location for a buffered bicycle lane is the left side of the roadway. The preferred location of the buffer is adjacent to the travel lane.

PROTECTED BICYCLE LANES

Protected bicycle lanes are similar to buffered bicycle lanes, but introduce an element of vertical separation to delineate and/or protect bicycle operating space and deter or prevent vehicle encroachment. The form the vertical separation elements vary. Collapsible delineators, planters, concrete curbed islands, or on-street parking are elements that have been incorporated to provide vertical separation in different designs for protected bicycle lanes. The elevation of protected bicycle lanes matches that of the adjacent roadway.

Typical Application

Protected bicycle lanes are often recommended when adjacent motor vehicle traffic volume exceeds 45 MPH or 10,000 vehicles per day. Protected bicycle lanes can be installed anywhere a conventional or buffered bicycle lane is recommended, assuming the additional space for accessing the passenger side of parked motor vehicles is available.

Protected bicycle lanes are a preferred treatment along roadways with frequent on-street parking, high parking turnover, and high motor vehicle traffic volumes and speeds. Where on-street parking is present, the protected bicycle lane should be located between the curb and the parking lane, so that the parked cars provide vertical separation/protection. In this scenario, it is best to include a 3-foot striped area between the bicycle lane and the parking lane to prevent dooring crashes.

Benefits

- Bicyclists feel a greater sense of separation from motor vehicles with an element of vertical separation
- Protected bicycle lanes are perceived by bicyclists as safer than conventional bicycle lanes and can encourage increased bicycle use

Considerations

- Roadways with desirable connectivity may not be wide enough to add protected bicycle lanes without widening the roadway
- Although roadway rights-of-way often extend beyond the edges of pavement, it may be expensive, physically challenging due to grades, utilities, or other features, or displeasing to adjacent property owners to widen the roadway

Protected bicycle lane as depicted in the New Jersey Complete Streets Design Guide, p. 95

Protected bicycle lane with concrete curbed island as element of vertical separation (Photo credit: San Francisco Municipal Transportation Agency).

Buffered Bicycle Lane Recommended Features

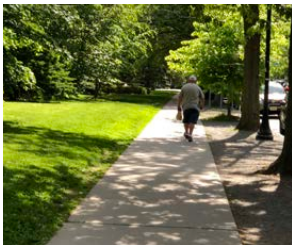
1. The preferred width for a protected bicycle lane is 6 feet. This can enable bicyclists to pass each other within the facility. The minimum width is 5 feet.

2. On roadways with on-street parking, the protected bicycle lane should be located between the parking lane and the curb. In this scenario, the buffer and vertical separators should be located adjacent to the parking lane. The minimum width of the buffer is 3 feet. Where there is no parking, the buffer can be reduced to a minimum of 1.5 feet.

3. The buffer area for a protected bicycle lane should include an element of vertical separation. These elements vary from plastic delineators to constructed, concrete curbed islands. The type of vertical separator can be a significant consideration in the overall cost of the facility.

Cost Estimating for On-Road Connections

Concrete Sidewalk 5' Wide



Rule of thumb:
$60 per linear foot(LF), installed

Example:
A 100' length of concrete sidewalk:
100' x $60/LF = $6,000 installed

Curb Ramp

Rule of thumb:
$2,000 each, installed (cost includes new concrete surface, new curb, and detectable warning surface)

Example:
An intersection needs 8 new curb ramps:
8 x $2,000 = $16,000, installed

Shared Lane Markings & Regulatory Signs

Rule of thumb:
$1.15 per linear foot (LF) in one direction, installed (cost includes shared lane marking symbols in thermoplastic, and regulatory signs)

Example:
Shared lane markings in both directions for a half-mile:
$1.15/LF x 2 (both directions) x 2640 LF (LF in a half mile) = $6,000, installed

Bicycle Lane

Rule of thumb:
$2.30 per linear foot (LF) in one direction, installed (cost includes striping, bicycle lane symbols in thermoplastic, and regulatory signs)

Example:
Bicycle lanes in both directions for a half-mile:
$2.30/LF x 2 (both directions) x 2640 LF (LF in a half mile) = $12,000, installed

Buffered Bicycle Lane

Rule of thumb:
$4.15 per linear foot (LF) in one direction, installed (cost includes striping, bicycle lane symbols in thermoplastic, and regulatory signs)

Example:
Bicycle lanes in both directions for a half-mile:
$4.15/LF x 2 (both directions) x 2640 LF (LF in a half mile) = $22,000, installed

Protected Bicycle Lane with Striping and Plastic Delineators

Rule of thumb:
$6.00 per linear foot (LF) in one direction, installed (cost includes striping, bicycle lane symbols in thermoplastic, regulatory signs, and plastic delineators)

Example:
Bicycle lanes in both directions for a half-mile:
$6.00/LF x 2 (both directions) x 2640 LF (LF in a half mile) = $31,680, installed

ADDITIONAL RESOURCES FOR DETAILED DESIGN GUIDANCE

- *2017 State of New Jersey Complete Streets Design Guide,* Chapter 3, NJ Department of Transportation, http://njbikeped.org/wp-content/uploads/2017/05/Complete-Streets-Design-Guide.pdf
- *Part 2 Designing Sidewalks and Trails for Access: Best Practices Design Guide*, U.S. Department of Transportation Federal Highway Administration, September 2001, https://nacto.org/wp-content/uploads/2015/04/designing_sidewalks_and_trails_access_kirschbaum.pdf
- *Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG),* U.S. Access Board, July 26, 2012, https://www.access-board.gov/attachments/article/743/nprm.pdf
- *Guide for the Planning, Design, and Operation of Pedestrian Facilities,* American Association of State Highway and Transportation Officials (AASHTO), July 2004
- *Urban Street Design Guide,* pp. 37-50, National Association of City Transportation Officials (NACTO), 2013, https://nacto.org/publication/urban-street-design-guide/street-design-elements/sidewalks/
- *Small Town and Rural Multimodal Networks*, U.S. Department of Transportation Federal Highway Administration, Chapter 4, December 2016, https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf
- *New Jersey Pedestrian Safety Action Plan,* NJ Department of Transportation, June 2014, https://www.state.nj.us/transportation/commuter/pedsafety/pdf/pedestriansafetyactionplan.pdf
- *Guide for the Development of Bicycle Facilities,* Fourth Edition, American Association of State Highway and Transportation Officials (AASHTO), 2012, https://store.transportation.org/item/collectiondetail/116
- *Urban Bikeway Design Guide*, National Association of City Transportation Officials (NACTO), 2011, https://nacto.org/publication/urban-bikeway-design-guide/
- *Manual on Uniform Traffic Control Devices,* (MUTCD) 2009 Edition with Revisions No. 1 and 2 Incorporated, dated May 2012, Federal Highway Administration, https://mutcd.fhwa.dot.gov/htm/2009r1r2/html_index.htm
- *Separated Bike Lane Planning and Design Guide*, U.S. Department of Transportation Federal Highway Administration, May 2015, https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page00.cfm
- *New Jersey Bicycle & Pedestrian Master Plan,* NJ Department of Transportation, November 2016, https://www.state.nj.us/transportation/commuter/bike/pdf/bikepedmasterplan2016.pdf

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