Course Code: CE 455
Course Title: Traffic Engineering and Management

Lecture 7: Pedestrian and bicycle facilities

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Outline

- Pedestrian, pedestrian facilities, such as, side walk, Zebra crossing.
- Pedestrian refuge
- Guardrail, flexible barrier.
- Pedestrian signal foot over bridges,
- Pedestrian level of service
- Bicycle lane
- The bicycle network

Pedestrian

Definition

A pedestrian is a person travelling on foot, whether walking or running. In some communities, those traveling using tiny wheels such as roller skates, skateboards, and scooters, as well as wheelchair users are also included as pedestrians.

Pedestrian Facilities

- Sidewalks
- Walkways
- Crosswalks

Sidewalk

A pedestrian route, typically constructed of concrete and parallel to a street that provides a means for pedestrians to travel within the public right-of-way while physically-separated from vehicular traffic. Sidewalks are designed for pedestrian use only.

Sidewalks

PennDOT's Design Manual 2- Chapter 6: Pedestrian Facilities and the Americans with Disabilities Act (ADA) ▶ requires sidewalks to be a minimum of 5 feet in width. This is to comply with the ADA requirement for periodic passing spaces of 5 feet in width thus allowing the entire length of the sidewalk to provide for these spaces.

An active sidewalk/streetscape in West Chester Borough; A sidewalk located along a residential roadway.

Walkway

A designated single use facility with an improved surface, primarily for use by pedestrians, typically located outside of the road right-of-way and/or not directly adjacent to a street.

An internal walkway in the parking lot of the Government Services Center in West Goshen Township; A system of pedestrian walkways on the campus of West Chester University; Internal walkways within a parking lot, East Whiteland Twp., PA

Walkways (also known as internal walkways or pedestrian paths) are designed to ensure that pedestrians can avoid using parking aisles or travel lanes for access to building entrances. A walkway is generally used for pedestrian transportation between buildings and parking areas or sidewalks, within parking lots, between buildings on a parcel or within a development, or between adjacent uses, developments, or facilities as shown in the examples below.

Crosswalks

Crosswalks and pedestrian signals with countdown timers are designed to facilitate safe crossing of roadways. These types of facilities are intended to limit the potential conflict between pedestrians and motorists.

Crosswalks may be either marked or unmarked: a marked crosswalk is any portion of the road outlined by painted markings or a different texture of concrete or pavers to slow and alert drivers, as shown in the following examples.

Signage plays a key role in regard to safety at crosswalks. Drivers must be alert for possible pedestrian activity and stop for pedestrians who are crossing a roadway in a marked or unmarked crosswalk.

Crosswalk
A public right-of-way used for pedestrian travel across a roadway at an intersection or any portion of a block (mid-block crossing) to provide safe pedestrian access to adjacent roads, lots, or public use areas.

Crosswalks are usually marked at intersections where there is a substantial amount of vehicular and pedestrian traffic, such as along school routes and at signalized and four-way stop intersections.

A high-visibility crosswalk at the intersection of US Route 30 Business and PA Route 100 in West Whiteland Township; A high-visibility crosswalk in Downingtown Borough; A countdown timer in West Chester Borough.

High visibility crosswalks are pavement markings that are installed to raise the awareness of motorists to the potential of pedestrians crossing the roadway. There are many different types of pavement markings for high visibility crossings. Zebra crossings (as shown in the photos) are considered to be the most visible crosswalk treatment for both pedestrians and motorists.

Countdown timers are installed in conjunction with walk signals and pavement markings at crossings. Timers warn pedestrians of the time remaining to completely cross the roadway safely before motor vehicles begin to move through the intersection. Timers can be paired with audible cues to benefit sight impaired pedestrians.

Zebra crossing

When to use

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Check whether a zebra crossing is a suitable treatment for your site by referring to the following guidance:

PNG: Crossing selection process

Benefits

- Gives pedestrians priority resulting in minimal delays for pedestrians.
- Are obvious as a place for pedestrians to cross.

Implications

- Unless on a platform, or without other measures like kerb extensions and median refuge, zebra crossings do not improve pedestrian safety or may even decrease it.
- High pedestrian flows can dominate and cause traffic delays.
- Can increase rear end crashes between vehicles, however these tend to be low severity.

Table: Location considerations for zebra crossings

Factor	Potential difficulties	Solution / mitigation
Posted speed > 50km/h	Drivers are less likely to give way to pedestrians. Specific approval is required from Waka Kotahi NZ Transport Agency where the speed limit exceeds 50km/h.	Reduce speeds. Consider alternative crossing types.
Multi-lane or divided roads	Stationary vehicles can obscure pedestrians. Some drivers will overtake a car stopped in another lane.	Reduce to single lane in each direction. Consider alternative crossing types.
Close to intersections	Drivers focus can be on the intersection rather than the crossing. Forward visibility of the crossing may be less than desirable.	Ensure vehicle speeds are low (this can be reinforced through a platform at the zebra crossing). Set back the zebra crossing to provide space for a turning vehicle to yield to pedestrians out of the stream of through traffic. Consider alternative crossing types.

Design considerations

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Flush medians must not be used to interrupt zebra crossings, but should be terminated either side of the crossing, with a pedestrian island installed in the centre, to divide the crossing into two stages.

Kerb ramps on the adjacent footpaths (installed to the standards in kerb ramps) provide access to zebra crossings.

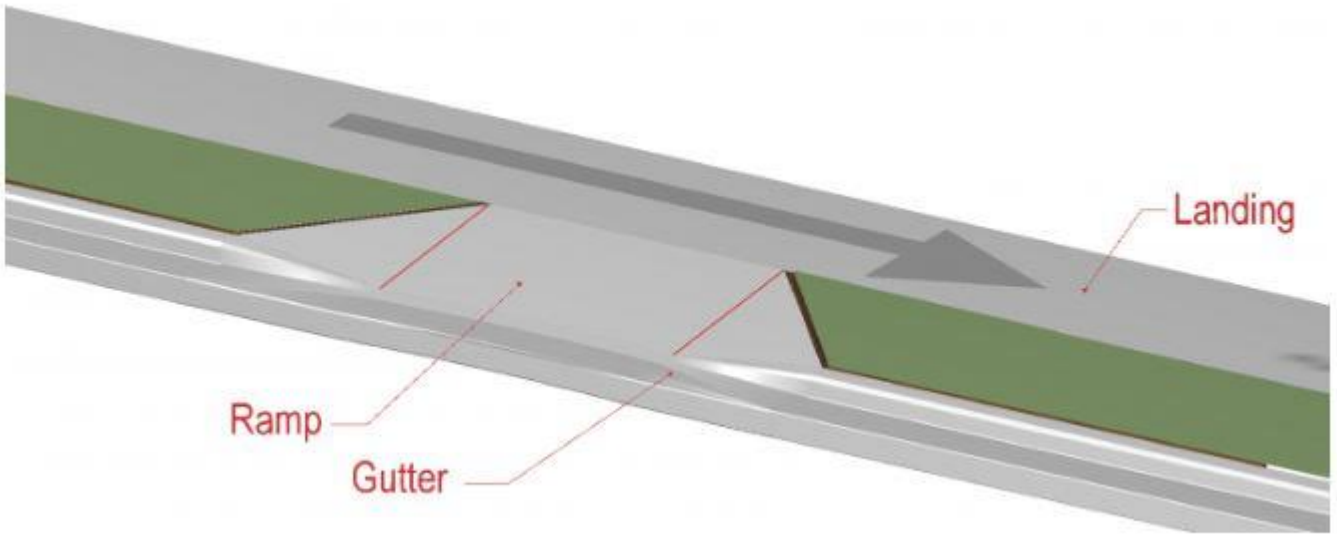
PNG: Kerb ramp design

Although zebra crossings may be legally up to 15m long, none should be longer than 10m. Where a longer distance is likely, kerb extensions should be used to reduce the distance travelled in one crossing movement. If kerb extensions cannot be used, pedestrian refuges may be installed instead, noting this legally divides the crossing into two stages which can be problematic in terms of vehicles giving way.

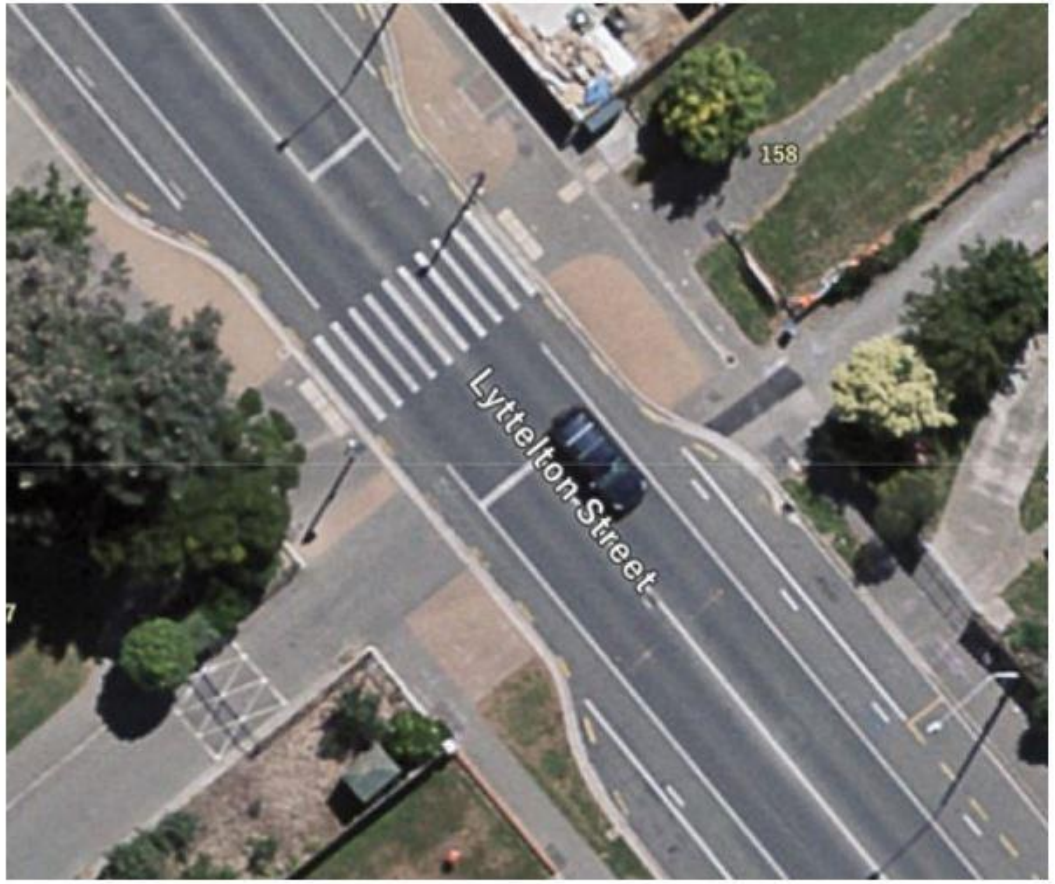
PNG: Kerb extensions

PNG: Pedestrian refuges

Vehicles parked close to a zebra crossing can impact on a drivers' sightlines making it difficult to see pedestrians waiting to cross[3]. Therefore, restricting parking through the use of kerb extensions and/or no stopping lines is important.



Typical perpendicular kerb ramp.



Kerb extensions to support a zebra crossing, Christchurch. (Source: Canterbury maps)

Pedestrian waiting in refuge to cross second traffic stream on Linwood Ave, Christchurch. (Photo: Ben Jassin)

Median refuge, Hereford Street, Christchurch. (Photo: Ann-Marie Head)

Pedestrian refuge

When to use

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Check whether a pedestrian or median refuge is a suitable treatment for your site by referring to:

PNG: Crossing selection process

Benefits

- Reduces crossing distance for pedestrians.
- Simplifies the crossing task as pedestrians only need to find gap in one stream of traffic at a time.
- Can considerably reduce delays to pedestrians.
- Can help to slow vehicle speeds by narrowing the traffic lanes.

Vulnerable Road Users (VRU)

Vulnerable Road Users (VRU) are defined in the ITS Directive as "non-motorised road users, such as pedestrians and cyclists as well as motor-cyclists and persons with disabilities or reduced mobility and orientation

Access and Linkages

A pedestrian-oriented neighborhood should include the following characteristics:

- Streets that are laid out in well-connected patterns on a pedestrian scale so that there are alternative automobile and pedestrian routes to every destination.
- A well-designed street environment that encourages intermodal transportation.
- Residential and internal commercial streets that are relatively narrow to discourage high speed automobile traffic.

Pedestrian Crash Types

The eight most common pedestrian crash types identified by Hunter, Stutts and Pein (1997) are outlined below:

Vehicle turn/merge

- Pedestrian and vehicle collided while the vehicle was preparing to turn, in the process of turning, or had just completed a turn or merge.

Mid-block dash

- At a mid-block location, the pedestrian was struck while running and the motorist's view of the pedestrian was not obstructed.

Pedestrian Crash Types

The eight most common pedestrian crash types identified by Hunter, Stutts and Pein (1997) are outlined below:

Not in roadway

- The pedestrian was struck when not in the roadway. Areas included parking lots, driveways, private roads, sidewalks, service stations, and yards.

Walking along roadway

- Pedestrian was struck while walking (or running) along a road without sidewalks. The pedestrian may have been hitchhiking, walking with traffic and struck from behind or from the front, walking against traffic and struck from behind or from the front, or walking along a road but the details are unknown.

Pedestrian Crash Types

The eight most common pedestrian crash types identified by Hunter, Stutts and Pein (1997) are outlined below:

Intersection dash

- Pedestrian was struck while running through an intersection and/or the motorist's view of the pedestrian was blocked until an instant before impact.

Intersection-other

- Crash occurred at an intersection but does not conform to any of the specified crash types.

Pedestrian Crash Types

The eight most common pedestrian crash types identified by Hunter, Stutts and Pein (1997) are outlined below:

Backing vehicle

- Pedestrian was struck by a vehicle that was backing.

Mid-block-other

- The crash occurred at mid-block but does not conform to any of the specified crash types.

Accessibility

Americans with Disabilities Act Accessibility Guidelines

Sidewalks

- have a minimum clearance width of 5 feet.
- should be surfaced with a smooth, durable, and slip-resistant material.
- maximum cross-slope is 2 percent (1:50)

Accessibility

Americans with Disabilities Act Accessibility Guidelines

Street Furniture (benches, newspaper boxes, etc.)

- No protruding object should reduce the clear width of a sidewalk or walkway path to less than 3 feet.
- No object mounted on a wall or post or freestanding should have a clear open area under it higher than 2.3 feet off the ground.
- No object higher than 2.3 feet attached to a wall should protrude from that wall more than 4 inches.

Pedestrian Signs and Pavement Markings

Regulatory Signs - provide information about the road rules and traffic laws

Pedestrian Signs and Pavement Markings

Warning Signs - type of sign which indicates a potential hazard, obstacle or condition requiring special attention.

Pedestrians and Work zones

Should a construction or maintenance activity arise on or near sidewalks or crossways, providing safe and continuous passage for pedestrians is a necessity. This is done by implementing temporary traffic control zone policies.

Facility Maintenance

Recommended maintenance practices include

1. Sweeping
2. Surface repairs
3. Vegetation
4. Traffic control devices
5. Drainage
6. Utility cuts
7. Snow removal

Pedestrian Level of Service (PLOS)

Table 2.1. Average Flow LOS Criteria for Walkways and Sidewalks

LOS	Space (ft^2/p)	Flow Rate (p/min/ft)	Speed (ft/s)	V/C Ratio
A	> 60	≤ 5	> 4.25	≤ 0.21
B	> 40-60	> 5-7	> 4.17-4.25	> 0.21-0.31
C	> 24-40	> 7-10	> 4.00-4.17	> 0.31-0.44
D	>15-24	> 10-15	> 3.75-4.00	> 0.44-0.65
E	> 8-15	> 15-23	> 2.50-3.75	> 0.65-1.00
F	≤ 8	variable	≤ 2.50	variable

LOS A

Pedestrian Space > 60 ft²/p, Flow Rate = 5 p/min/ft

At a walkway LOS A, pedestrians move in desired paths without altering their movements in response to other pedestrians. Walking speeds are freely selected, and conflicts between pedestrians are unlikely.

LOS B

Pedestrian Space > 40-60 ft²/p, Flow Rate > 5-7 p/min/ft

At LOS B, there is sufficient area for pedestrians to select walking speeds freely to bypass other pedestrians, and to avoid crossing conflicts. At this level, pedestrians begin to be aware of other pedestrians, and to response to their presence when electing a walking path.

LOS C

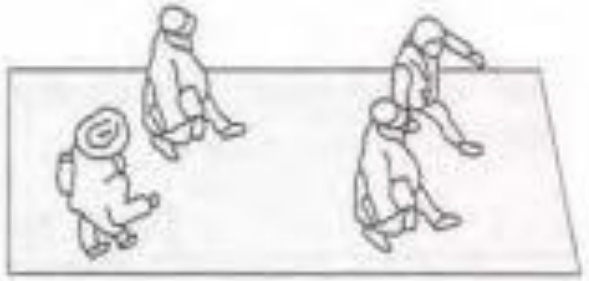
Pedestrian Space > 24-40 ft²/p, Flow Rate > 7-10 p/min/ft

At LOS C, space is sufficient for normal walking speeds, and for bypassing other pedestrians in primarily unidirectional streams. Reverse-direction or crossing movements can cause minor conflicts, and speeds and flow rate are somewhat lower.

LOS D

Pedestrian Space > 15-24 ft²/p, Flow Rate > 10-15 p/min/ft

At LOS D, freedom to select individual walking speed and to bypass other pedestrians is restricted. Crossing or reverse-flow movements face a high probability of conflict, requiring frequent changes in speed and position. The LOS provides reasonably fluid flow, but friction and interaction between pedestrians is likely.



LOS E

Pedestrian Space > 8-15 ft²/p, Flow Rate > 15-23 p/min/ft

At LOS E, virtually all pedestrians restrict their normal walking speed, frequently adjusting their gait. At the lower range, forward movement is possible only by shuffling. Space is not sufficient for passing slower pedestrians. Cross- or reverse-flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with stoppages and interruptions to flow.

LOS F

Pedestrian Space = 8 ft²/p, Flow Rate varies p/min/ft

At LOS F, all walking speeds are severely restricted, and forward progress is made only by shuffling. There is frequent unavoidable contact with other pedestrians. Cross-and reverse-flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrians than of moving pedestrian streams.

Guardrails

The purpose of guardrail is to reduce the potential for, and the severity of accidents involving vehicles that run off the road. The following parameters are useful in evaluating a location for the need of guardrail:

- Distance from the roadway to the hazard
- Embankment height and slope
- Speed and volume of traffic
- Horizontal and vertical alignment of the roadway
- Accident history

Source: FHWA (2009) [Location: I-70, Howard County, MD]

Flexible road safety barriers catch vehicles before they hit something harder – like a pole, tree or oncoming car.

Flexible road safety barriers are installed down the middle of a road to prevent head-on collisions or along the side of the road to help stop run-off-road crashes.

If you hit a flexible barrier, the steel cables flex, slowing down your vehicle and keeping it upright. The barriers absorb the impact of the crash so you and the people with you, don't.

They're a cost-effective infrastructure treatment that can reduce the number of people killed or seriously injured in crashes by 75 percent.


ROAD BARRIER
ABSORBS SHOCK

Introduction of F.O.B.

- A F.O.B. is a designed for pedestrians. F.O.B. can be used decoratively to visually link two distinct areas or to signal a transaction. Footbridges are often situated to allow pedestrians to cross water. They are also located across roads to let pedestrians cross safely without slowing down the traffic.
- Footbridges are small, but important, because they are usually presented in townscape. The appearance of footbridges, and indeed of any other bridges, in a town, is a major concern for designers.
- Footbridges can also be built in the same ways as road and rail bridges. Most footbridges are equipped with guard rails to reduce the risk of pedestrians falling.

Why F.O.B. needed??

- The increasing pedestrian traffic on road crossings, junctions and inaccessible road terminals in the cities of our country. Unlike subways, steel pedestrian bridges are less economical, easy and fast to construct. The need of the study is to determine the combined strength and efficiency of the steel truss F.O.B.

Site Selection for F.O.B.

- The pedestrian bridge should be constructed in such a way that it can be extended to longer length in future either straight or perpendicular to 32.2m span bridge.
- The site should be chosen in such a way that the pedestrian bridges to be constructed in the site would facilitate the pedestrian to have easy access to the routes so that they can move to their destinations places with comfort.
- The safe bearing capacity of soil in the site should be checked accordingly, for the bridge to be constructed in the locality.

Escalator Foot Over Bridge - Projects - MAQ Engineering Ltd. Visit

Bike Lanes

A Bike Lane is defined as a portion of the roadway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions and facilitate predictable behavior and movements between bicyclists and motorists. A bike lane is distinguished from a cycle track in that it has no physical barrier (bollards, medians, raised curbs, etc.) that restricts the encroachment of motorized traffic. Conventional bike lanes run curbside when no parking is present, adjacent to parked cars on the right-hand side of the street or on the left-hand side of the street in specific situations. Bike lanes typically run in the same direction of traffic, though they may be configured in the contra-flow direction on low-traffic corridors necessary for the connectivity of a particular bicycle route.

The configuration of a bike lane requires a thorough consideration of existing traffic levels and behaviors, adequate safety buffers to protect bicyclists from parked and moving vehicles, and enforcement to prohibit motorized vehicle encroachment and double-parking. Bike Lanes may be distinguished using color, lane markings, signage, and intersection treatments.

6 benefits of bike lane

FEWER INJURIES

Bike lanes help to keep bikers safer. While some bike lanes are only delineated with a painted line, some areas are including actual barriers between bike lanes, sidewalks, and the road. In a comparison between Europe and North America, cyclists in the USA have a higher risk of injury. Researchers think it may have something to do with bike lanes.

ADDED SPACE TO ROADWAY

Bike lanes increase the amount of margin on roadways, which means that commuters have a larger visual space for maintaining safety in turning, avoiding fixed obstacles, and more. This space also means that bus stops have more room for picking up riders. Vehicle drivers will no longer need to move into oncoming traffic to go around bicyclists.

IMPROVED TRAFFIC FLOW

The addition of bike lanes helps to improve traffic flow because it gives bikers a place in the roadway. No longer do city bicyclists need to dodge cars or people and vice versa, but they can carry on at a steady speed. This improves traffic flow because everyone knows exactly where they belong.

SAFE SIDEWALKS

Once bicycles have a designated space for commuting through the city, the sidewalk becomes safer for pedestrians and individuals with disabilities. Police can then also require bikers to use bike lanes rather than sidewalks.

BETTER FOR THE ENVIRONMENT

Every person that feels safe enough to choose biking over driving helps to reduce air pollution and road congestion. Transportation is responsible for more than a quarter of greenhouse gasses. Just choosing to bike for short commutes can help decrease carbon output by 2,000 pounds every year.

HEALTH BENEFITS

The addition of bike lanes creates a feeling of safety for many people who would bike if they felt that it was a safe option. Not only does biking cut down on fuel use, but it also offers commuters the added benefit of exercise. For example, a two-mile bike ride can burn about 100 calories, and this type of cycling can decrease the chances of diabetes, depression, dementia, cardiovascular disease, cancer, and high blood pressure.

Bike lanes promise a number of benefits to city dwellers and commuters that orient the lanes as something of imperative importance for developing safer roadways and pathways. At StrongGo, we believe in creating a safe and accessible world, and we do that by committing to reliable and durable TekWay detectable warning dome tiles. Speak to an industry expert today by emailing csd@stronggo.com.


LIMIT
20
POLICE

The Bicycle Network

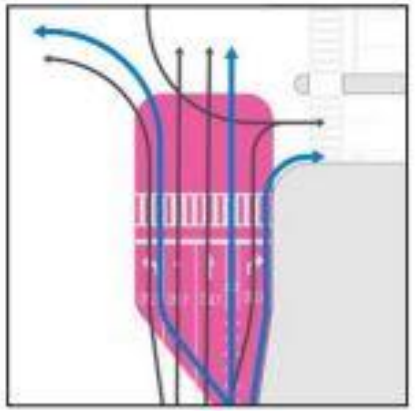
A bicycle network is a seamless interconnected system of bikeways. The purpose and quality of the network depends on the assumptions, goals, and decisions made during the

individual street or road does not serve the same role in the network and that some are more important than others. The network also helps to determine the extent to which a parallel route (described on page 34) is a feasible alternative.

Figure 3: Seven Principles of Bicycle Network Design

Figure 7: Comparison of Bicyclist Comfort and Safety at Intersections

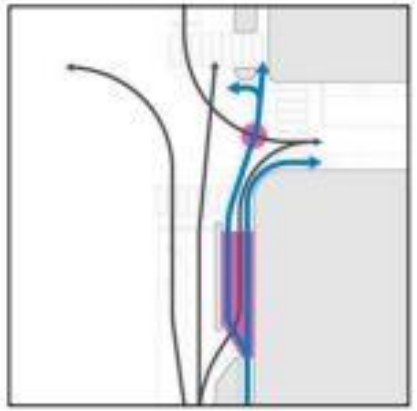
Exposure Level:
High



CONVENTIONAL BIKE LANES AND SHARED LANES

Bike lanes and shared lanes require bicyclists to share and negotiate space with motor vehicles as they move through intersections. Motorists have a large advantage in this negotiation as they are driving a vehicle with significantly more mass and are usually operating at a higher speed than bicyclists. This creates a stressful environment for bicyclists, particularly as the speed differential between bicyclists and motorists increases. For these reasons, it is preferable to provide separation through the intersection.

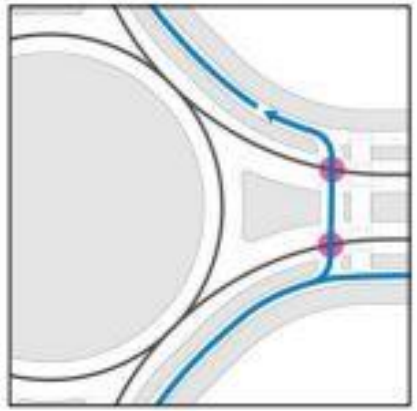
Exposure Level:
High to Medium



SEPARATED BIKE LANES WITH MIXING ZONES

One strategy that has been used in the U.S. at constrained intersections on streets with separated bike lanes is to reintroduce the bicyclist into motor vehicle travel lanes (and turn lanes) at intersections, removing the separation between the two modes of travel. This design is less preferable to providing a protected intersection for the same reasons as discussed under conventional bike lanes and shared lanes. Where provided, mixing zones should be designed to reduce motor vehicle speeds and minimize the area of exposure for bicyclists.

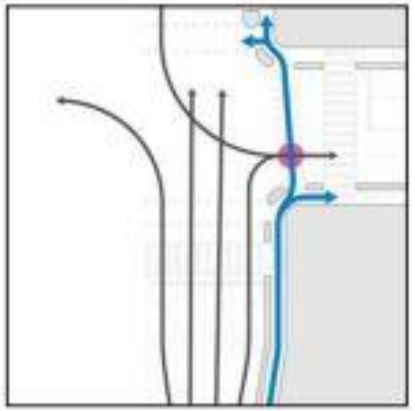
Exposure Level:
Medium to Low



SEPARATED BIKE LANES THROUGH ROUNDABOUTS

Separated bike lanes can be continued through roundabouts, with crossings that are similar to, and typically adjacent to, pedestrian crosswalks. Motorists approach the bicycle crossings at a perpendicular angle, maximizing visibility of approaching bicyclists. Bicyclists must travel a more circuitous route if turning left and must cross four separate motor vehicle path approaches. Yielding rates are higher at single-lane roundabouts.

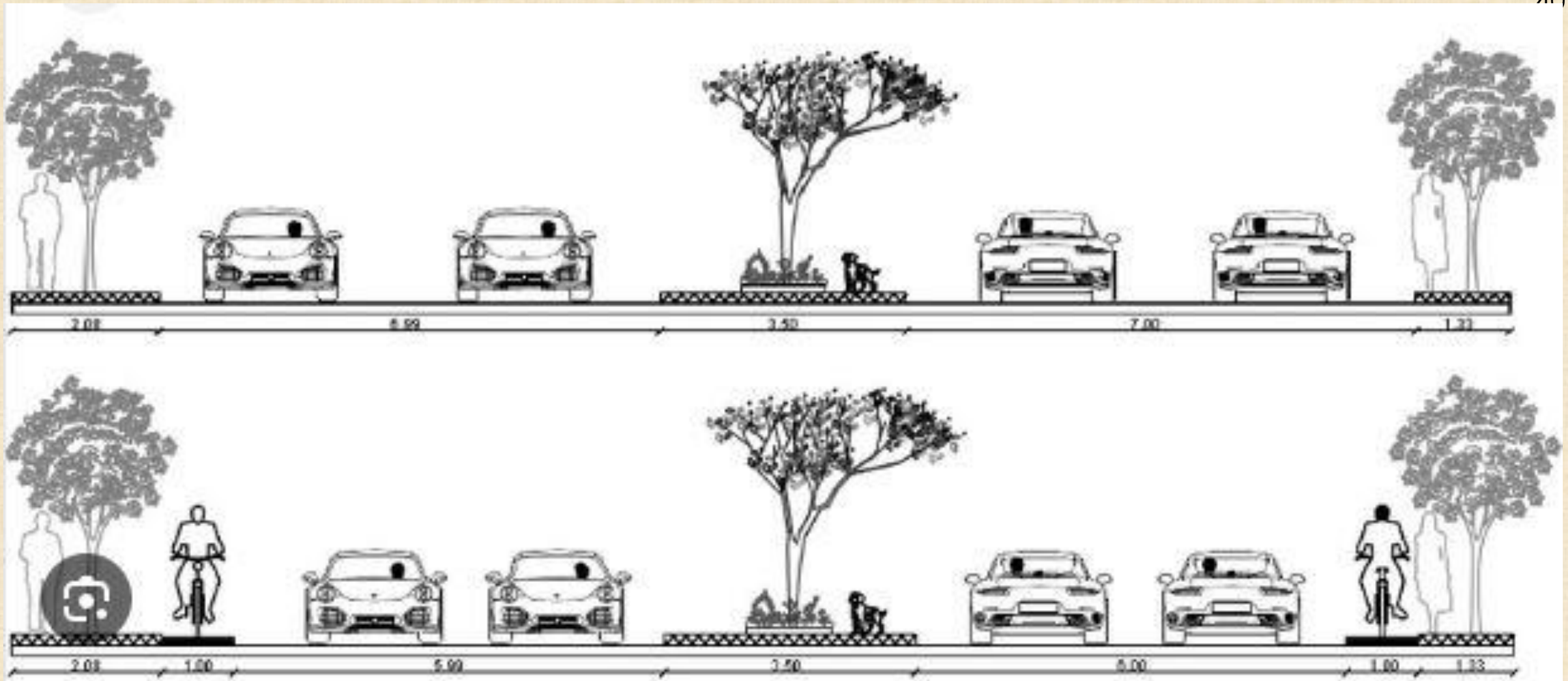
Exposure Level:
Low



PROTECTED INTERSECTIONS

A protected intersection maintains the physical separation through the intersection, thereby eliminating the merging and weaving movements inherent in conventional bike lane and shared lane designs. This reduces the conflicts to a single location where turning traffic crosses the bike lane. This single conflict point can be eliminated by providing a separate signal phase for turning traffic

bicycle
motor vehicle
conflict area



Cross section for a basic east-west road axis with a bicycle path... | Download Scientific Diagram

Visit

CITY OF SONOMA - BROADWAY - MODIFIED STANDARD BIKE LANE (4-LANES)

France Street to Napa Street