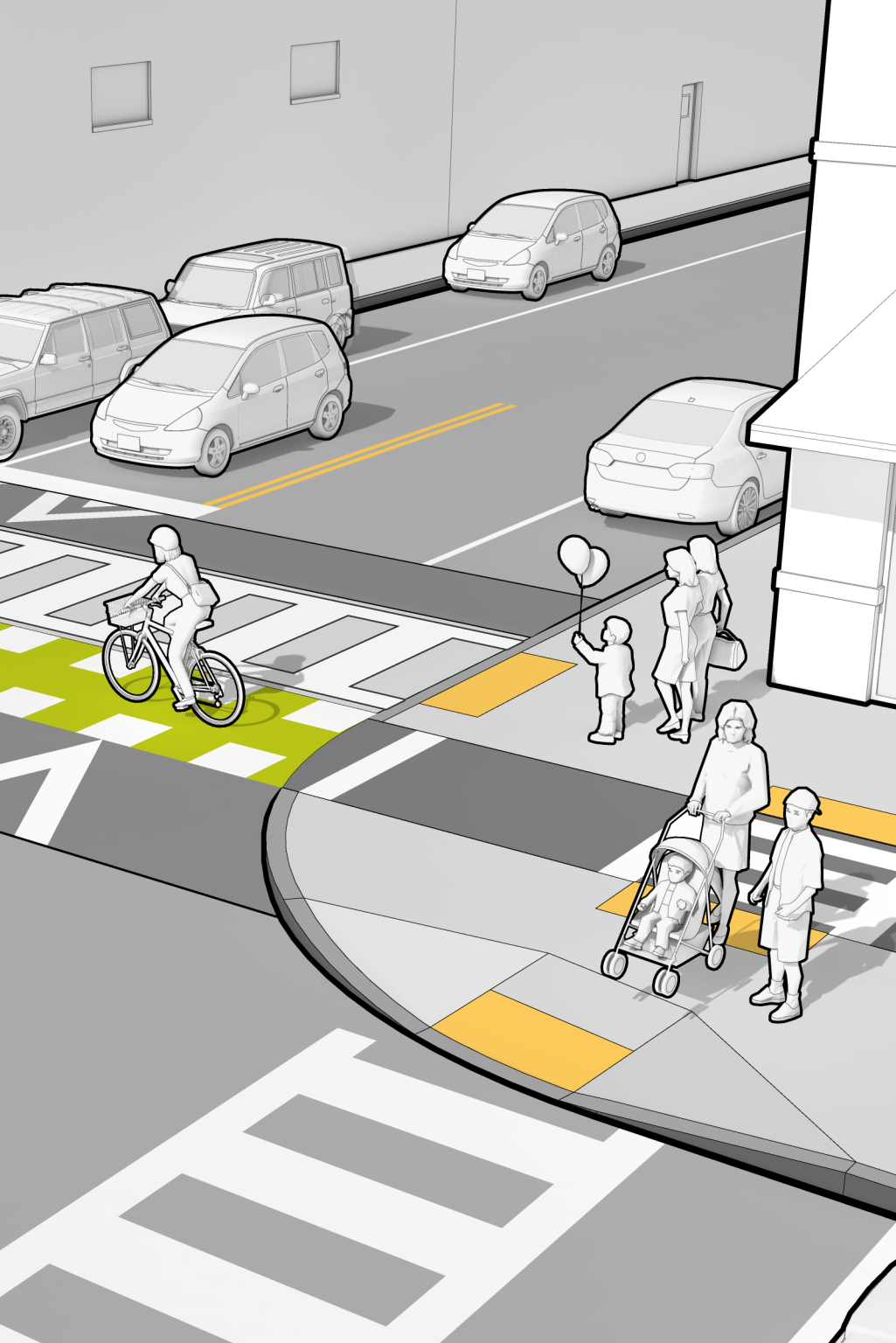


2

PLANNING

The process of building a separated bike lane, like any transportation facility, should begin with planning before advancing through design, environmental review and construction. As outlined in the PD&DG, the planning process is important to ensure public engagement regarding design alternatives, and ultimately to build consensus prior to proceeding with the design. This chapter focuses on this planning process and provides an overview of low-stress bicycle networks, the role of separated bike lanes and determining the appropriate configuration.



2.1 PRINCIPLES OF LOW-STRESS NETWORKS

Separated bike lanes are an integral component of low-stress bicycling networks. Low-stress bicycle networks maximize safety and comfort for people bicycling by providing direct and convenient connections to destinations and other bike facilities in a manner that minimizes exposure to motorized traffic and conflicts with pedestrians. These three elements—**safety**, **comfort** and **connectivity**—are key principles of low-stress bicycle networks and the foundation of the planning and design guidance in this Guide.

2.1.1 SAFETY

People riding bicycles are vulnerable roadway users because they have less mass, less protection in the event of a crash, and travel more slowly than motor vehicles. Separated bike lane design should:

- Minimize and consolidate conflict points between modes where they must occur (e.g., at intersections).
- Encourage desirable yielding behavior by maximizing approach sight distance, reducing speeds and enhancing visibility at intersections and conflict points.
- Clearly delineate roadway space by travel mode.
- Provide consistent and uniform treatments to promote predictable behavior for all users.

2.1.2 COMFORT

Attention to user comfort is an important part of attracting more people to bicycling as a mode of travel. Separated bike lane design should:

- Provide horizontal separation from motor vehicle traffic.
- Ensure the amount of delay for bicyclists, particularly at intersections, is reasonable and balanced with other users.
- Minimize exertion and energy loss of bicyclists due to starting and stopping.
- Minimize exposure to traffic noise and pollution.
- Accommodate side by side bicycling and passing movements, where feasible.
- Provide smooth vertical transitions and pavement surfaces free from obstructions, irregularities and seams.



2.1.3 CONNECTIVITY

People who ride bicycles need a network of continuous low-stress routes. Separated bike lane design should:

- Provide recognizable facilities.
- Provide direct and convenient connections that minimize detours.
- Connect at a local scale for access, and a regional scale for mobility.
- Integrate into the larger multimodal transportation network.
- Provide seamless transitions between different facility types.



2.2 NETWORK CONNECTIVITY CONSIDERATIONS

MassDOT supports the goal of providing an interconnected network of bikeways serving all ages and abilities throughout the Commonwealth. Achieving a fully interconnected low-stress bicycle network takes a great deal of work and typically evolves over many years (and often decades) of time. The initial lack of connection to other bike facilities, therefore, should not preclude the consideration of separated bike lanes during project planning. A new separated bike lane that sees lower levels of use in its early years due to lack of connectivity may see considerably higher usage levels once connections have been made at a later date. The need for future projects to improve conditions on connecting corridors should be noted during the project development process and considered during future project programming.

Anticipated origins, destinations and route lengths should be considered when planning routes and configurations of bike facilities. When determining whether to provide separated bike lanes on a busy roadway, planners sometimes look for alternative routes on other parallel corridors. It is important to bear in mind that bicyclists operate under their own power and are sensitive to detours or out of direction travel. Most are willing to lengthen their trip only by **25 percent** to avoid difficult traffic conditions, in cases where they are able to access a low-stress bike

facility (such as a separated bike lane or off-road shared use path).¹ Consideration should therefore be given to providing a high quality bicycle facility along the busy corridor, rather than requiring a detour along a parallel route that may be too far away to attract bicyclists.

2.3 PLANNING PROCESS

Planning processes at the local, regional and statewide level should consider separated bike lanes and the implementation of low-stress bicycling networks. When consulting previously adopted plans, it is important to remember that separated bike lanes are a relatively new type of accommodation. While specific recommendations for separated bike lanes may not be included in existing plans, they should be considered along with other types of bicycle facilities such as paved shoulders and bike lanes. The following summarizes approaches for incorporating separated bike lanes into common planning processes.

- **Area plans – Access and mobility** are important considerations for area plans. Neighborhood and sector plans should identify key corridors where separated bike lanes will improve bicycle access and mobility to key community destinations and regional routes.
- **Corridor plans – Corridor plans** are often initiated to address issues such as safety, accessibility and congestion along a corridor. An important objective for corridor plans is to evaluate different configurations of separated bike lanes. Where right-of-way is being acquired for roadway projects, obtaining or preserving sufficient right-of-way for separated bicycle lanes should be considered.
- **Development and redevelopment site plans – Locations where separation for bicycles is appropriate** should be identified early in the review process to ensure adequate right-of-way is preserved. Site plans should facilitate connections between separated bike lanes and other bicycle facilities within the development as well as nearby.
- **Traffic impact assessments – Analysis of traffic impacts for new or redeveloping properties** should consider the ability of separated bike lanes to attract higher levels of bicycling.
- **System-wide plans – Long-range and master transportation plans, bicycle network plans, and safety plans** should identify high priority corridors or locations for separated bike lanes. A cohesive regional network of separated bike lanes and shared use paths enables bicyclists to comfortably travel longer distances.

2.4 A FRAMEWORK FOR SELECTING SEPARATED BIKE LANES

Separated bike lanes are one of several facilities that can contribute to a safe, comfortable and connected low-stress bicycling network. This section provides a framework for selecting and configuring separated bike lanes.

2.4.1 DETERMINING WHEN TO PROVIDE PHYSICAL SEPARATION

As discussed in [Chapter 1](#), proximity to moving traffic is a significant source of stress and discomfort for bicyclists, and for good reason—the crash and fatality risks sharply rise for vulnerable users when motor vehicle speeds exceed **25 mph**.²

Separated bike lanes are generally preferable to conventional (not separated) bike lanes because they improve visibility between bicyclists and motorists at intersections. Separated bike lanes are typically set back from the road at a greater distance than conventional bike lanes. This encourages better yielding behavior on the part of turning motorists, who are better able to detect the presence of a bicyclist and to appropriately yield the right of way (see [EXHIBIT 2A](#)). As shown in [EXHIBIT 2B](#), conventional bike lanes subject bicyclists to a higher level of exposure at intersections, as discussed in more detail in [Section 4.2.1](#).

Separated bike lanes are not necessary on every type of street. There are many locations throughout Massachusetts where motor traffic speeds and volumes are low, and most bicyclists are comfortable sharing the road with motor vehicles or riding in conventional bike lanes. On streets where operating speeds are below **25 mph** and traffic volumes are below **6,000** vehicles per day, separated bike lanes are generally not necessary.

On streets with higher operating speeds and volumes, or where conflicts with motor vehicles are common, separated bike lanes or a shared use path is recommended. Other conditions that may warrant physical separation for bicyclists include the presence of:

- **Multi-lane roadways** – Multi-lane roadways enable motor vehicle passing and weaving maneuvers at higher speeds. This creates conflicts with bicyclists, particularly at intersections.
- **Curbside conflicts** – Conflicts with parked or temporarily stopped motor vehicles present a risk to bicyclists—high parking turnover and curbside loading may expose bicyclists to being struck by opening vehicle doors or people walking in their travel path. Stopped vehicles may require bicyclists to merge into an adjacent travel lane.³ This includes locations where transit vehicles load and unload passengers within a bicycle facility or shared curb lane.
- **Large vehicles** – Higher percentages of trucks and buses increase risks for bicyclists due vehicle size, weight and the fact that drivers of these vehicles have limited visibility. This is a particular concern for right turns where large vehicles may appear to be proceeding straight or even turning left prior to right-turn movements.
- **Vulnerable populations** – The presence of high concentrations of children and seniors should be considered during project planning. These groups may only feel comfortable bicycling on physically separated facilities even where motor vehicle speeds and volumes are relatively low. They are less confident in their bicycling abilities and, in the case of children, may be less visible to motorists, lack roadway experience, and may have reduced traffic awareness skills compared to adults.
- **Low-stress network connectivity gaps** – Separated bike lanes can help close gaps in a low-stress network. Examples include on-street connections to shared use paths, or where routes connect to parks or other recreational opportunities (see [Section 4.5](#)).
- **Unusual peak hour volumes** – On streets that experience an unusually high peak hour volume, separated bike lanes can be beneficial, particularly when the peak hour also coincides with peak volumes of bicyclists.

EXHIBIT 2A: MOTORIST'S VIEW AT SEPARATED BIKE LANE

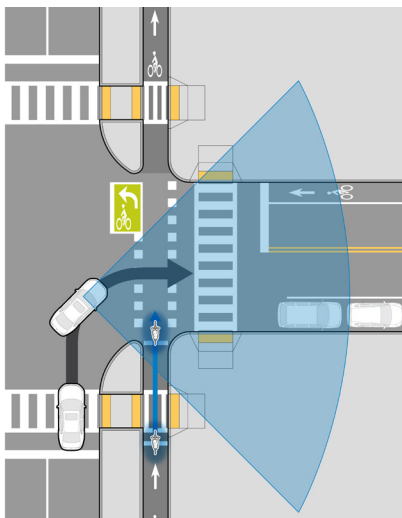
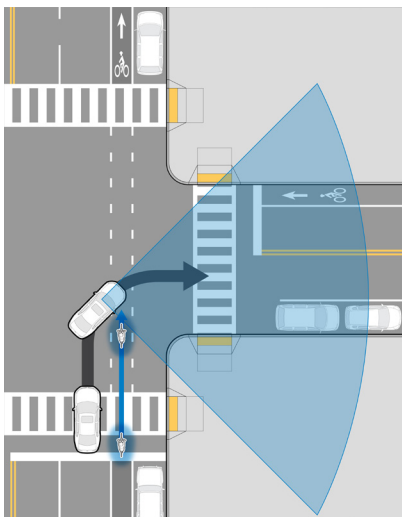


EXHIBIT 2B: MOTORIST'S VIEW AT CONVENTIONAL BIKE LANE



The Highway Capacity Manual's Bicycle Level of Service (BLOS) model is not calibrated to evaluate separated bike lanes, because this facility type did not exist in the U.S. when the model was developed. For this reason, conventional level of service tools are not well suited for determining the need for separated bike lanes. To fill this gap, the Mineta Transportation Institute developed a Level of Traffic Stress (LTS) analysis tool.⁴ This tool should be considered in lieu of BLOS when there is a need to evaluate separated bike lanes. It incorporates roadway criteria (e.g., on-street parking, speeds, number of travel lanes, heavy vehicle percentage and conditions at intersections) to determine the level of traffic stress for different facility types on individual segments in a network. When using this approach, LTS 1 and 2 will accommodate the 'interested but concerned' bicyclist.

2.4.2 CHOOSING SEPARATED BIKE LANES OR SHARED USE PATHS

The type of separated bike facility—separated bike lane or shared use path—and method of separation should be determined once it is decided that physical separation from motor vehicles should be provided.

Where both walking and bicycling demand are relatively low and are expected to remain low, a shared use path may be considered in lieu of a separated bike lane to satisfy demand for walking and bicycling in a single facility to reduce project costs. The shared use path may be located on one or both sides of the street depending

upon bicycle and pedestrian network connectivity needs. Shared use paths for this purpose should be designed with the same design principles as separated bike lanes while also accommodating pedestrian use. As volumes increase over time, the need for separation should be revisited.

The Shared-Use Path Level of Service Calculator⁵ can help project proponents understand potential volume thresholds where conflicts between bicyclists and pedestrians will limit the effectiveness of a shared use path. When Level of Service is projected to be at or below level 'C,' separate facilities for pedestrians and bicycles should be provided, unless right-of-way constraints preclude separation.

As this calculator requires user volumes and other data that may not be available

An understanding of design principles and elements is required to determine the separated bike lane configuration:

- **Chapter 3 for general design considerations**
- **Chapter 4 for intersections**
- **Chapter 5 for curbside uses**
- **Chapter 6 for signalization**
- **Chapter 7 for maintenance**

during the planning process, project proponents can estimate activity by using existing volumes on similar streets and shared use paths in the vicinity, and making adjustments as necessary to account for existing and future land uses adjacent to the facility, as well as regional trends and mode shift goals.⁶

2.4.3 DETERMINING SEPARATED BIKE LANE CONFIGURATION

Early in the planning process for a separated bike lane, it is necessary to determine the most appropriate configuration for the facility. For example, the designer must determine if it would be more appropriate to place a one-way separated bike lane on each side of the street, or to place a two-way facility on one side of the street (and if so, which side). Selecting the appropriate configuration requires an assessment of many factors, including overall connectivity, ease of access, conflict points, curbside uses, intersection operations, maintenance and feasibility. The analysis should also consider benefits and trade-offs to people bicycling, walking, taking transit and driving. The primary objectives for determining the appropriate configuration are to:

- **Accommodate bicycle desire lines.**
- **Provide direct transitions to existing or planned links of a low-stress bicycle network.**
- **Provide convenient access to destinations.**
- **Connect to the roadway network in a direct and intuitive manner.**

The planning-level analysis should determine two basic components of the separated bike lane configuration:

- **Travel direction – one-way in the direction of motorized travel, one-way contra-flow or two-way**
- **Location – left and/or right side or in the median of the roadway**

TRAVEL DIRECTION

Determining travel direction is a function of network connectivity, roadway configuration and potential intersection conflicts. A primary consideration should be connecting to existing or planned links in a low-stress bicycle network.

One-way separated bike lanes in the direction of motorized travel are typically the easiest option to integrate into the existing operation of a roadway. This configuration provides intuitive and direct connections with the surrounding transportation network, including simpler transitions to existing bike lanes and shared travel lanes.

In some situations, however, one-way separated bike lanes are not practical or desirable, due to right-of-way constraints or a variety of other factors. In these locations, the challenges of accommodating a two-way facility on one side of the roadway must be weighed against the constraints posed by one-way facilities to determine the optimum solution.

Providing a two-way facility introduces contra-flow movements which can be

challenging to accommodate. Contra-flow movements require special attention at intersections, driveways and other conflict points as people walking and driving may not anticipate contra-flow bicycle movements. It is particularly important to consider options for managing potential conflicts between contra-flow bicyclists and left turning motorists. In this scenario motorists are primarily focused on identifying gaps in oncoming traffic and may be less cognizant of bicyclists approaching the intersection. Design solutions to mitigate these conflicts are addressed in [Chapter 4](#).

Contra-flow movements may also introduce challenges at their termini, as bicyclists must be accommodated back into the traffic mix in the correct direction of travel.

On signalized corridors, the contra-flow bicycle movement on a one-way street may be less efficient because signals are typically coordinated in the direction of motor vehicle travel. If there are substantial connectivity benefits to a contra-flow facility on a one-way street, it should be determined if these challenges can be overcome by applying traffic engineering principles and following the guidance established in [Chapters 3, 4 and 5](#) of this Guide.

LOCATION

Choosing where to locate separated bike lanes within the roadway is typically a balance between enhancing connectivity and avoiding conflicts. For example, it may

be beneficial to locate the separated bike lane on one side of the street to better connect to the bicycle network or provide access to destinations such as businesses, schools, transit centers, employment centers, parks and neighborhoods. Similarly, the prevalence of motor vehicle turning conflicts, high parking turnover, loading activities or transit service on one side of the street may influence the decision to locate the separated bike lane on the other side of the street. The provision of clear and intuitive transitions are key to the success and safety of the design.

[EXHIBIT 2C](#) and [EXHIBIT 2D](#) provide overviews of configurations for typical one-way and two-way roadways with a discussion of associated issues.



EXHIBIT 2C: EXAMPLE SEPARATED BIKE LANE CONFIGURATIONS ON A ONE-WAY STREET

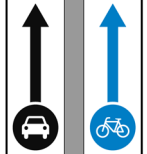
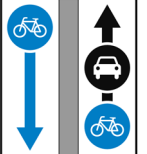
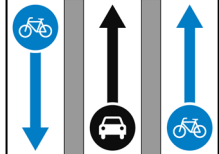
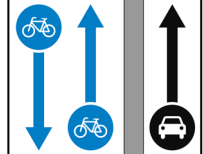
Corridor-level Planning Considerations	One-way SBL	Contra-flow SBL	One-way SBL Plus Contra-flow SBL	Two-way SBL
				
Access to Destinations	Limited access to other side of street	Limited access to other side of street	Full access to both sides of street	Limited access to other side of street
Network Connectivity	Does not address demand for contra-flow bicycling, may result in wrong way riding	Requires bicyclists traveling in the direction of traffic to share the lane (may result in wrong-way riding in the SBL); contra-flow progression through signals may be less efficient	Accommodates two-way bicycle travel, but contra-flow progression through signals may be less efficient	Accommodates two-way bicycle travel, but contra-flow progression through signals may be less efficient
Conflict Points (see Chapter 4)	Fewer because pedestrians and turning drivers expect concurrent bicycle traffic	Pedestrians and turning drivers may not expect contra-flow bicycle traffic	Pedestrians and turning drivers may not expect contra-flow bicycle traffic	Pedestrians and turning drivers may not expect contra-flow bicycle traffic
Intersection Operations (see Chapter 6)	May use existing signal phases; bike phase may be required depending on volumes	Typically requires additional signal equipment; bike phase may be required depending on volumes	Typically requires additional signal equipment; bike phase may be required depending on volumes	Typically requires additional signal equipment; bike phase may be required depending on volumes

EXHIBIT 2D: EXAMPLE SEPARATED BIKE LANE CONFIGURATIONS ON A TWO-WAY STREET

Corridor-level Planning Considerations	One-way SBL Pair	Two-way SBL	Median Two-way SBL
Access to Destinations	Full access to both sides of street	Limited access to other side of street	Limited access to both sides of street
Network Connectivity	Accommodates two-way bicycle travel	Accommodates two-way bicycle travel	Accommodates two-way bicycle travel
Conflict Points (see Chapter 4)	Fewer because pedestrians and turning drivers expect concurrent bicycle traffic	Pedestrians and turning drivers may not expect contra-flow bicycle traffic	Pedestrians and turning drivers may not expect contra-flow bicycle traffic, but median location may improve visibility and create opportunities to separate conflicts
Intersection Operations (see Chapter 6)	May use existing signal phases; bike phase may be required depending on volumes	Typically requires additional signal equipment; bike phase may be required depending on volumes	Typically requires additional signal equipment; bike phase may be required depending on volumes

2.5 FEASIBILITY

Space, funding and maintenance considerations should inform decisions made during the planning phase for separated bike lanes. When evaluating their feasibility, consideration should be given to various roadway reconfigurations, such as reducing the number of travel lanes, narrowing existing lanes or adjusting on-street parking.

Some configurations may only be feasible with reconstruction of the corridor. While more expensive than retrofit configurations within the existing curb lines, reconstruction provides greater opportunity to achieve recommended buffer widths and horizontal separation at intersections and conflict points (see [Chapter 4](#)). Reconstruction may have impacts on drainage and utility placement, among other considerations.

A lower-cost retrofit project (i.e., pavement markings and non-permanent separation methods such as flexible delineator posts, planters or temporary curbing) may be pursued to test a separated bike lane configuration in the near term while planning for permanent redesign of the roadway in the long term. Often these retrofit projects are implemented alongside planned roadway resurfacing to further reduce project costs.

Demonstration projects are a useful tool to introduce separated bike lanes to the public. Separated bike lanes can be piloted as demonstration projects using inexpensive, temporary materials for the buffers. Typically built as part of an ‘open



streets’ event or similar street festival, these projects are a great way for the public to experience and become familiar with the design of separated bike lanes. They are generally set up and taken down within the same day. Event staff and/or local traffic enforcement officials can be on site to supervise and provide information about the facility. Event planners should consider involving stakeholders, such as neighborhood groups or local advocacy organizations, in planning, promoting and staffing a pilot separated bike lane.

Project proponents should consider long-term maintenance costs of retrofit projects, including repairing and replacing treatments as well as compatibility with existing maintenance equipment and potential costs of increased labor (see [Chapter 7](#)).

Due to constraints within a corridor, separation may not be achievable for the entire length of the route, and it may be

necessary to install conventional bike lanes in these locations. Consideration should be given to development of project limits that create safe and seamless transitions as recommended in [Chapter 4](#).

The need for future projects to improve connections on adjacent corridors should also be noted during project development and considered in future programming.

If it is determined that separated bike lanes are an appropriate accommodation given the context, but not feasible given constraints of available space and/or funding, the highest quality feasible alternative should be provided on the corridor (e.g., a shared use path, buffered bike lanes, or standard bike lanes). In these circumstances, consideration should also be given to identifying a parallel route to accommodate the ‘interested but concerned’ users (per the discussion in [Section 2.2](#)).

2.6 PUBLIC PROCESS

As with any project, effective public engagement is a critical element for the success of a separated bike lane project. When conducting public engagement on projects that include separated bike lanes, the project team should give consideration to the fact that many people may not have experience with these types of facilities. Presentations should include precedent images, videos, and/or detailed illustrations that depict the designs. As separated bike lanes appeal to a larger percentage of the population, including many people who may not identify themselves as bicyclists, it is important to communicate the benefits of these designs for all users of the roadway. As alterations to the existing cross section occur with the implementation of separated bike lanes, additional outreach with stakeholders should be considered throughout the life of the project.



2.7 ENDNOTES

- 1 Monsere, C., McNeil, N., Dill, J. (2012). Multiuser perspectives on separated, on-street bicycle infrastructure. Transportation Research Record: Journal of the Transportation Research Board, 2314(1), 22-30.
- 2 Transportation Planning Council Committee 5P-8. (1999). Traditional Neighborhood Development: Street Design Guidelines. Institute of Transportation Engineers.
- 3 Meng D. (2012). Cyclist Behavior in Bicycle Priority Lanes, Bike Lanes in Commercial Areas and at Traffic Signals. Department of Civil and Environmental Engineering, Northeastern University. Retrieved from <http://www.northeastern.edu/peter.furth/wp-content/uploads/2014/08/Bicyclist-Behavior-in-Bicycle-Priority-Lanes-at-Red-Lights-and-in-Bike-Lanes-in-Commercial-Areas.-Masters-Report-Dun-Meng-Manny.pdf>.
- 4 Mekuria, M., Furth, P., Nixon, H. (2012) Low-Stress Bicycling and Network Connectivity. Mineta Transportation Institute, MTI Report 11-19
- 5 Hummer, J., et. al. (2006). Evaluation of Safety, Design, and Operation of Shared-Use Paths. Federal Highway Administration. FHWA-HRT-05-137.
- 6 Ewing, R., Cervero, R. (2010). Travel and the Built Environment - A Meta-Analysis. Journal of the American Planning Association, Vol. 6, No. 3.

This page left blank intentionally