Part 900 Bikeway Design

Section 901 Introduction

The purpose of this part is to provide design standards for bicycle facilities on State Highways. Other parts address the design of pedestrian facilities, intersections, interchanges, urban design, and public transportation and provide additional and/or similar information on bicycle and pedestrian design considerations. A thorough guide for bicycle and pedestrian design is contained in Appendix L the Oregon Bicycle and Pedestrian Design Guide. Where there is a discrepancy between content in this part and the Bicycle and Pedestrian Design Guide, this part takes precedence. This chapter also stipulates where to refer to portions of Appendix L for additional content since Appendix L also contains design guidance that may only apply to city and county roads.

901.1 Documentation and Approval Font Key

Text within this part is presented in specific fonts that show the required documentation and/or approval if the design does not meet the requirements shown. Table 900-1 shows the four text fonts used, along with their descriptions. The text in figures, tables, exhibits, equations, footnotes, endnotes, and captions typically does not utilize the font key.

Table 900-1: Font Key

Font	Documentation	Approver
Bold text	Design Exceptions	State Roadway Engineer (SRE) and for some projects, FHWA
Bold Italics text	Design Decisions Document	Region with Tech Expert input or other approver as described
Italics Text	Document decisions	Engineer of Record (EOR)
General Text (Not bold or italics)	N/A	N/A

Bold Text - Some standards appear in a bold font style. A design exception is required to justify and document not meeting a standard that appears in bold. The State Roadway Engineer (SRE) gives formal approval, and FHWA approves as required. See 901.2 for a description of design standards. In the case of 3R clear zone approvals and local agency projects off the state highway system, design exceptions can be approved by someone other than the State Roadway Engineer (see sections 402 and 1003.5).

Bold Italics Text - Both standards and guidelines may appear in a bold italics font style. While a formal design exception is not required when not meeting a standard or guideline that appears in bold italics, document and justify the decisions made by the Engineer of Record in decision documents or other engineering reports. When not meeting a standard or guideline that appears in bold italics, region approval with input from Technical Experts, or other approval as described in the HDM, is required. For urban projects, formally record decisions via the Urban Design Concurrence Document in the Design Decision portion. The Urban Design Concurrence document is located on the Highway Design Manual website. See 901.2 and 901.3 for descriptions of design standards and guidelines.

Italics Text - Design decisions that require documentation appear in italic font style in design parameters sections. While a formal design exception is not required, document the design decisions made by the Engineer of Record in decision documents or other engineering reports. See 901.3 and 901.4.

General Text - Any informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. The remaining text in the manual is general text and may include supporting information, background discussion, commentary, explanations, information about design process or procedures, description of methods, or potential considerations and all other general discussion. General text statements do not include any special text formatting. General text may be used to inform and support design exception requests, particularly where narrative explanations show best practices or methods of design that support the requested design exception.

901.2 Standards

A standard is a statement of required, mandatory, or specifically prohibitive practice regarding a roadway geometric feature or appurtenance. The verb “provide” is typically used. The adjective “required” is typically used in figures to illustrate Standard statements. The verbs “should” and “may” are not used in Standard statements. The adjectives “recommended” and “optional” are only used in Standard statements to describe recommended or optional design features as they relate to required design features. Standard statements are sometimes modified by Best Practices (see 901.4).

901.3 Guidelines

A guideline is a statement of recommended practice in typical situations. The verb “should” is typically used. The adjective “recommended” is typically used in figures to illustrate Guideline statements. The verbs “provide” and “may” are not used in Guideline statements. The adjectives “required” and “optional” are only used in Guideline statements to describe required or optional design features as they relate to recommended design features. Guideline statements are sometimes modified by Best Practices (see 901.4).

901.4 Best Practices

A Best Practice is a statement of practice that is a permissive condition and carries no requirement or recommendation. Best Practice statements sometimes contain allowable ranges within a Standard or Guideline statement. The verb "may" is typically used. The adjective "optional" is typically used in figures to illustrate Best Practice statements. The verbs "shall" and "should" are not used in Best Practice statements. The adjectives "required" and "recommended" are only used in Best Practice statements to describe required or recommended design features as they relate to optional design features.

901.5 Definitions & Acronyms

A list of definitions and acronyms introduced in Part 900 is listed below. Acronyms that are defined in other Parts of the Highway Design Manual are not repeated in this part.

In addition to the terminology used in other parts of the HDM, the following terms are used primarily or exclusively in this chapter. Terms described in this chapter are listed below.

Bikeway Tier -	A three level distinction to characterize how much separation is between a bikeway and motor vehicle travel. The three levels are Tier 1 (separated bike lane or shared use path), Tier 2 (bike lane in a shoulder) and Tier 3 (shared lane), discussed in Section 940
Bike Bill -	Oregon Statute ORS 366.514, discussed in Section 912.1.
Bike Lane -	That part of the highway adjacent to the roadway that is designated for bicycle travel, delineated from the adjacent travel lane by a single stripe. Synonyms not used in the HDM: shoulder bikeway, shoulder bike lane.
Bike Ramp -	See Section 980.
Bikeway -	Any lane or way designated for use as a bicycle route. Synonyms not used in the HDM: Bicycle trail.
Bicycle Level of Traffic Stress -	(BLTS) See Chapter 14 in the ODOT Analysis Procedures Manual[1] and discussed in 922.1
Buffered Bike Lane -	That part of the highway adjacent to the roadway that is designated for bicycle travel, delineated from the adjacent travel lane by two stripes that delineate a buffer zone. See Section 945.1.
Essential Transportation Link -	See Section 930.

Floating Bus Stop -	See Section 984.
Highly Confident Bicyclist -	See Section 922.
Interested, but Concerned Bicyclist -	See Section 922.
Multiway Boulevard -	See Section 949.
Separated Bike Lane -	That part of the highway adjacent to the roadway that is designated for bicycle travel, separated by a street buffer that contains a vertical element (e.g., curb, parking). Synonyms not used in the HDM: cycle track, protected bike lane, separated bike path.
Shared Use Path -	See Section 801.2.
Shoulder -	That part of the highway adjacent to the roadway, delineated from the adjacent travel lane by a stripe, that may be used for bicycle travel as well as other functions such as parking.
Side Path -	See Section 948, Section 960 and Section 970 - A facility designated for shared use by bicyclists and pedestrians that is located within the highway right-of-way. Side paths may use striping to indicate preferred areas for bicycle and pedestrian travel, but do not provide vertical/detectable delineation between modes.
Sidewalk -	See Section 801.2.
Somewhat Confident Bicyclist -	See Section 922
Trail-	Defined in Section 801.2.

901.6 Comparison to Other Bikeway Guides

The organization of this chapter corresponds with the chapter outline in the proposed AASHTO Bike Guide, 5th edition. Where information is in conflict, the information in the Highway Design Manual takes precedence.

Table 900-2 Comparison between outline of HDM and AASHTO Bike Guide

HDM Section	HDM Appendix L Bike/Ped Design Guide	Proposed AASHTO Bike Guide
910's Design and Regulatory Considerations	Chapter i (introduction)	Chapter 1 - Intro & Regulatory Considerations
920's Design Users, Vehicles	Chapter i (introduction)	Chapter 2 - Design Users, Vehicles
930's Bikeway Networks	Chapter i (introduction)	Chapter 3 - Bikeway Networks
940's Transition Realm and Zones Bikeway Selection Process	Chapter 1 (Bikeway Types) Chapter 2 (Road Diets)	Chapter 4 - Selection Process Chapter 7 - Bike Lane Zones
950's Intersection Design Bikeway Crossing Design	Chapters 5 & 6	Chapter 5, 7, 9, 10, 11 - Intersection Design, Bikeway Crossings
960's Shared Use Paths	Chapter 7 (Separated Paths)	Chapter 6 - Shared Use Paths
970's Side Paths and Two-way Separated Bike Lanes	Chapter 7 (Separated Paths)	Chapter 7 - Side Paths and Separated Bike Lanes
980's Bicycle Ramp Design Bikes at Transit Stops	Chapter 1	Chapter 5 - Bike Ramps Chapter 7 - Transit Stops
990's Parking and Trip End Facilities	Chapter 3	Chapter 16 - Parking and Trip End Facilities

Section 910 Design and Regulatory Considerations

There are state and federal statutes, regulations, laws, rules or other high level requirements that must be considered, regardless of project type or funding. These include federal rules and policy, as well as Oregon statutes and planning policy. The federal requirements include code of federal regulations (CFRs) including civil rights laws, policy statements and memoranda from the USDOT, and the Manual on Uniform Traffic Control Devices (MUTCD). Oregon statutory requirements includes ORS 366.514, commonly known as “the Oregon Bicycle Bill”. Oregon Administrative Rules include the Oregon Transportation Planning Rule. Planning policy requirements include the Oregon Highway Plan, the Oregon Bicycle and Pedestrian Plan and the Oregon Transportation Safety Action Plan.

Improvements for walking and bicycling can be done under a variety of conditions or project scenarios. Most commonly, improvements are made as part of a construction project. Projects can be administered through ODOT, local public agencies or by private parties, such as a developer. Minor improvements to walking and biking facilities can also be made outside of project scenarios during routine maintenance operations. The requirements for a project are different, based on factors such as funding, which road authority is contracting the project and whether or not any part of the project is located on state owned right-of-way. For each of the different scenarios, ODOT's role may differ slightly, while state and federal requirements are the same. ODOT's process for ensuring ADA compliance is outlined in Chapter 800.

Section 911 Federal Requirements

911.1 Civil Rights Laws

The Americans with Disabilities Act (ADA), the Architectural Barriers Act and the Rehabilitation Act are federal Civil Rights laws. The combination of these laws mandates both the private and public sectors to make their programs, services and facilities accessible. For ODOT, that means that all provided services must be built so people with mobility, visual or cognitive limitations have access to use them. Facilities for bicycle travel that share the space with pedestrians (i.e., shared use paths) are required to meet pedestrian accessibility standards. Where pedestrian travel is provided apart from bicycle travel, these ADA requirements for pedestrian facilities (e.g., slopes) do not apply to the bicycle facility. However, the ADA still requires consideration to be provided for the needs of all people who use the bicycle facility. Many people with disabilities ride bicycles, adaptive bicycles and adult tricycles. General ADA requirements for pedestrian accessibility are described in Part 800. The ADA regulation (28 CFR 35-36) also requires that some projects include pedestrian accessibility improvements in addition to the baseline scope of work. See Part 800 for these requirements.

911.2 Federal Funding Regulation

Federal law regarding the administration of federal aid for highways is established in US Public Law 117-58 (the Infrastructure Investment and Jobs Act). It authorizes federal funds for pedestrian walkways, bicycle transportation and shared micro mobility transportation facilities via 23 USC, Section 217. Regarding planning and design, it says :

> "Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and State in accordance with sections 134 and 135, respectively. Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation facilities, except where bicycle and pedestrian use are not permitted.
>
> Transportation plans and projects shall provide due consideration for safety and contiguous routes for bicyclists and pedestrians. Safety considerations shall include the

> installation, where appropriate, and maintenance of audible traffic signals and audible signs at street crossings."

In 2010, the United States Department of Transportation issued a policy statement declaring support for going beyond minimum requirements to provide improved pedestrian and bicycle facilities. Their 2010 policy statement said that:

> "every transportation agency… has the responsibility to improve conditions and opportunities for…bicycling and to integrate…bicycling into their transportation systems. Because of the numerous individual and community benefits that…bicycling provide - including health, safety, environmental, transportation, and quality of life - transportation agencies are encouraged to go beyond minimum standards to provide safe and convenient facilities for these modes."

This memorandum encouraged road authorities to go beyond accommodation to improving the conditions for people walking and riding bicycles.

The FHWA issued a related memorandum in 2013 suggesting that current design references should be supplemented with various innovative guides and resources "…to help fulfill the aims… to go beyond the minimum requirements, and proactively provide convenient, safe, and context-sensitive facilities that foster increased use by bicyclists…of all ages and abilities." This memorandum affirmed support for design flexibility through the utilization of innovative designs that build upon the flexibility provided by current design standards in order to achieve improved conditions for bicycling.

In 2015, ODOT issued a letter of support that encourages engineers, planners and designers to reference the growing library of resources that help fulfill ODOT's mission "…to provide a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians…" and "…to be at the forefront of the integration of sustainable intermodal transportation…to help form sustainable solutions to today's ever-increasing intermodal transportation challenges…" A growing list of resources is available from AASHTO, FHWA, NACTO, and ITE.

911.3 Federal Standards

Federal law 23 CFR 655 Subpart F requires that all traffic control devices on public highways be in substantial conformance with the national standard established by the Manual on Uniform Traffic Control Devices (MUTCD). Oregon Administrative Rule OAR 734-020-0005 establishes an Oregon Supplement to the MUTCD that contains approved deviations from the federal manual in order to be in conformance with Oregon laws or other approved reasoning. Other deviations from MUTCD standards are permitted when following FHWA experimentation procedures or interim approvals. Some bikeway facility types are not likely to function effectively unless accompanied with appropriate traffic control measures.

The design standards in Part 900 reflect ODOT's adherence to national and statewide policy and applicable laws that require accommodating bicycle travel and supports going beyond minimum requirements to provide improved facilities.

Section 912 Oregon Statutory Requirements

912.1 "The Bike Bill"

ORS 366.514, known as "The Bike Bill" imposes requirements on projects that include any portion of modernization work. It requires that ODOT, cities and counties provide walkways and bikeways wherever a highway, road or street is being constructed, reconstructed, or relocated.

The terms: New Construction, Reconstruction and Relocation are defined in Section 102. "Being constructed, reconstructed or relocated" usually means that the project is categorized as 4R. However, as ODOT implements performance-based practical design, the purpose and need for a project may target specific modernization improvements without bringing the whole project into the 4R category. Isolated modernization improvements may include any work that constructs, reconstructs or relocates a portion of a highway. For example, a portion of a project can trigger the statutory requirement to provide walking and biking facilities if the improvements include adding a turn lane, through lane, widening a shoulder, or replacing a bridge deck. Significant intersection improvements and realignments such as a roundabout or construction of a new or replaced traffic signal also require pedestrian and biking facilities to be considered and evaluated.

Accommodating context-appropriate walkways and bikeways is required. The burden is on the governing jurisdiction to show the lack of need to provide facilities; the need is legislatively presumed but can be rebutted. The three statutory exemptions are listed below; improvements are not required if:

1. Scarcity of population or other factors indicate an absence of any need;
2. Costs are excessively disproportionate to need or probable use; or
3. Where public safety is compromised.

Providing walkways and bikeways means that the project's scope is required to ensure that people are able to walk and bike on that highway segment. First, determine whether the highway segments in the project currently have complete, context-appropriate pedestrian and bicycle facilities and curb ramps. If so, the statutory requirement is met. If not, provide improvements to the project scope unless one of the statutory exemptions applies. The level of improvement required to be included with a project is related to the project's scope. For example, a project that fully reconstructs a traffic signal might be located where the approach streets do not have walking and biking facilities. The project would be required to ensure that pedestrians and bicyclists are accommodated at the intersection and any approaches within the project limits. It would not be required to address the disconnected biking and walking network up to the intersection, that are outside the project limits.

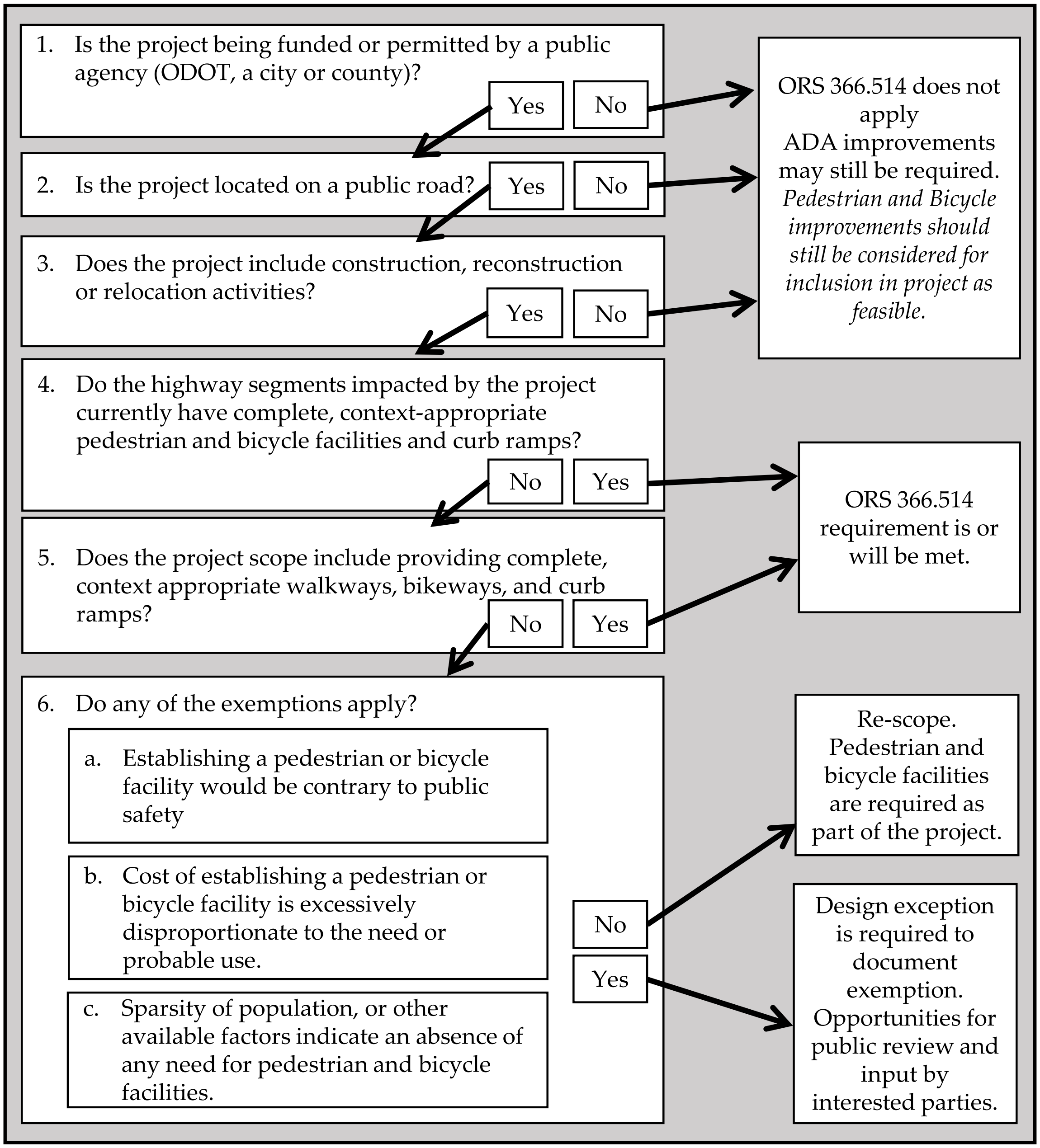
Appropriate walking facilities are generally considered to be present when sidewalk exists on both sides of a highway for urban areas, shoulders in rural areas, paths or a connected network of low-stress local streets parallel to freeways and expressways. Appropriate biking facilities is discussed in Section 901.

Seek an exemption only where it is obvious that one of the three statutory exceptions applies. Also reference planning documents to see if prior efforts have already established that walkways or bikeways are needed. The determination that one or more exemption is met requires documentation through a design exception. As support for the design exception, documentation[13] is required to ensure that the exemption allowed opportunities for public review and input by interested parties. The documentation provided by the project team consists of a summary of public involvement activities, input received and ODOT responses, including whether and/or how input was incorporated into the project. Where public involvement activities were not included in a project, documentation may include a letter from an organization that represents bicycle and pedestrian needs for the local agency or from the Oregon Bicycle and Pedestrian Advisory Committee (OBPAC) and ODOT responses to the letter. OBPAC is a governor appointed committee, which advises ODOT on the regulation of bicycle and pedestrian traffic, the establishment of bikeways and walkways and other statewide bicycle and pedestrian issues. Review time is needed in order for the bicycle and pedestrian organization to review any proposed exemption.

The statute addresses the source of funds for bicycle and pedestrian improvements. "Out of the funds received…reasonable amounts shall be expended as necessary to provide [walkways and bikeways] as part of the project." The lack of funding from a leveraged funding category does not negate the requirement to include improvements for walking and biking if the project triggers the requirement under the statute.

Figure 900-1 provides a flowchart to help determine when a project requires walking and biking improvements to be included. The ODOT Bicycle and Pedestrian Program Webpage includes additional resources including another, more thorough version of this flowchart[10] with guidance on each step of the process, including legal interpretations for the three exemptions and a section-by-section legal interpretation[2] of the statute.

Figure 900-1: ORS 366.514 Screening Flow Chart



912.2 Transportation Planning Rule

In Oregon, transportation planning is governed by Oregon Administrative Rule 660, Division 12. This is also known as the Transportation Planning Rule (TPR) as described in Section 109.7. See the local jurisdiction's Transportation System Plan for policies and requirements applicable to the bicycle system network. These may include requirements for:

- bicycle access to key destinations,
- mitigation or provision of street crossings,
- transitions between bicycle facilities,
- higher levels of separation or protection along streets that have higher volumes or speeds of traffic,
- separated or protected bikeways on streets in climate-friendly areas, Metro Region 2040 centers, and other places with a concentration of destinations, and
- bicycle facilities to result in a safe, low stress, and comfortable experience for people of all ages and abilities.

Section 913 Statewide Policy

913.1 ODOT Mission Statement

ODOT's mission statement[3] is that "We provide a safe and reliable multimodal transportation system that connects people and helps Oregon's communities and economy thrive". Many ODOT highways operate as the "Main Street" in a community. Business districts with the most comfortable and pleasurable pedestrian walking environments have shown to be the most successful. These include places where people work, shop and live in close proximity so they can walk to destinations. Therefore, comprehensive pedestrian design, rather than basic accommodation should be considered in these contexts. See urban context discussion in Part 200. Bicycle tourism is a significant industry in Oregon that also impacts Oregon's livability and economic prosperity. Rather than basic accommodation, comprehensive bicycle facility design should be considered along designated bicycle routes. Research has also shown that pedestrian and bicycle safety improvements result in improved safety outcomes for all highway users.

913.2 Performance Based Design

ODOT adopted a policy of context sensitive design to establish project scopes that meet specific needs that may omit unrelated improvements in order to systematically prioritize improvements that optimize the transportation system. Practical Design, Context Sensitive Design and Performance-Based Design have application where ideal conditions do not exist, thus permitting non-standard roadway sections that meet the intent of the design to the maximum extent feasible, often through a design exception.

In order to achieve a transportation system that functions for people to use bicycles for transportation, it is important to provide context-appropriate facilities. When the purpose and need for a project does not include an upgrade to the bicycle facility, an incremental improvement to the bikeway can be considered. The design standards in this chapter reflect ODOT's commitment to the US Department of Transportation policy statements, issued on March 11, 2010 and August 10, 2013. These statements recommended that states accommodate bicyclists and pedestrians while accommodating motorized vehicles and declared support for going beyond minimum requirements to provide improved pedestrian and bicycle facilities. The statements also affirmed support for design flexibility through utilization of innovative designs that build upon the flexibility provided by current design standards in order to achieve improved conditions for walking and bicycling. See discussion in Section 810 and Section 920 for Accommodation and Design for Pedestrians and Bicyclists.

Section 914 Statewide Planning

914.1 Oregon Bicycle & Pedestrian Plan

The Oregon Bicycle and Pedestrian Plan[1] has nine goals, a number of policies within those goals, and a number of planning strategies identified for achieving each of those policies. Many of those policies and strategies pertain to bicycle facility design. The role of strategies in the statewide Bicycle and Pedestrian Plan is intended to be comparable to a should-statement in the MUTCD. Designers should aim to achieve the strategies in the plan or document if it is not attained.

Within Goal 1 (safety), Policy 1.1 has 14 strategies to "provide safe and well-designed streets and highways". The first strategy (1.1A) contains directions for updating the Highway Design Manual: "Continue to update the ODOT Design Guidelines and Highway Design Manual to identify appropriate pedestrian and bicycle design features (e.g., type of separation, buffers, or crossing designs) suitable for different contexts, including consideration of: vehicle speed, roadway characteristics and constraints, planned land uses, users and uses, areas of pedestrian and cyclist priority, and latent demand." Additional strategies include: 1.1B (selecting the roadway cross-section and type of separation), 1.1C (improved illumination), 1.1F (intersection design considerations) and 1.1H (design treatments to control speed). Policy 1.4 is to improve bicycle users' perceived safety.

Within Goal 2 (connectivity), Policy 2.1, Strategy 2.1B says: "When local planning processes have, in consultation with ODOT, identified a local parallel bike route, and a bikeway on the state highway is determined to be contrary to public safety, is disproportionate in cost to the project cost or need, or is not needed as shown by relevant factors and therefore justified to be exempt from ORS 366.514 based on one of those statutory exemptions, ODOT will work with the jurisdictions to support the development of the parallel route and assure reasonable access to destinations along the state highway. ODOT and the local jurisdiction may enter into an agreement in which ODOT helps to fund, in negotiation and partnership with the local jurisdiction, construction of the bikeway in the vicinity of the state highway project that serves as an alternative or parallel route to the highway project." Policy 2.5 says: "Support off roadway…bikeways that help to connect communities, provide alternatives to motorized travel, or promote and support…biking tourism."

Within Goal 3 (mobility and efficiency), Policy 3.3, Strategy 3.3A says: "Research best practices and integrate into design guidelines innovative design treatments that both safely accommodate bicyclists and pedestrians and maintain appropriate freight carrying capacity. Promote opportunities for separation that does not constrain the mobility/accessibility of either mode." Strategy 3.2F says "When an existing roadway is realigned, restriped, or a cross-section modified, pedestrian and bicycle capacity should not be degraded; the width of bike lanes or sidewalks will not measure any smaller than the original width of such facility prior to roadway realigning, restriping, or cross-section modification. Develop an exception and appeal process."

Within Goal 8 (strategic investment), Policy 8.2, Strategy 8.2A gives priorities for identifying investments in bicycle projects. Among the priorities, it says: *"Elaborate the system through increased network connectivity, such as … more costly user comfort features." Strategy 8.2B says: "Be opportunistic in acquiring right-of-way for future potential…bicycle facilities…"* Part of the policy is to strategically improve the statewide bicycle network by addressing those locations where the existing bikeway type underserves the need or is not sufficiently comfortable for potential users to choose to ride under existing conditions. Elaborating the system would be to improve the bikeway type to something appropriate for its context. In many cases, the appropriate facility requires right-of-way and/or extra cost.

In order to achieve the goals stated within the Oregon Bicycle and Pedestrian Plan, an Implementation Work Plan is in place that contains near-term actions in order to put the policies into action. One of the key initiatives identified is "Defining the network" which is summarized: *"Establish design and function expectations. Provide clarity on appropriate infrastructure, design, and treatments given unique contexts. Identify needs."*

914.2 Oregon Highway Plan

The provision of bicycle facilities is addressed in a statewide perspective in statewide planning documents, including the Oregon Highway Plan[6] and the Oregon Bicycle and Pedestrian Plan[4].

The Oregon Highway Plan has two actions related to bicycle facilities: Action 1B.10 "Continue to develop and implement design guidelines for highways that describe a range of automobile, pedestrian, bicycle or transit travel alternatives" and Action 2F.3 "In identifying solutions to traffic safety problems, consider solutions including, but not limited to: Constructing appropriate bicycle and pedestrian facilities including safe and convenient crossings."

914.3 Oregon Transportation Safety Action Plan

The Oregon Transportation Safety Action Plan (TSAP)[7] is a statewide strategic highway safety plan that provides a framework to accomplish a vision to eliminate fatalities and serious injuries by 2035. To achieve that vision, it has six goals and a number of policies and strategies within those goals. A couple of these policies can relate to the selection of bikeway facilities.

Within Goal 2 (infrastructure), Policy 2.3 says: "Plan, design, construct, operate, and maintain the transportation system to achieve healthy and livable communities and eliminate fatalities and serious injuries for all modes." Strategy 2.3.4 says: "Educate transportation planning and design professionals on how to incorporate safer context-sensitive designs into community projects." Since different bicycle facilities may be appropriate in different contexts, this strategy and policy direct the consideration of context-sensitivity in bikeway selection.

Within Goal 3 (Livable Communities), Policy 3.4 says: "Invest in transportation system enhancements that improve safety and perceptions of security for people while traveling in Oregon." Strategy 3.4.1 says: "Enhance perceptions of bicycling, walking, and transit safety and security by identifying and implementing appropriate facility design, lighting, and other changes to the built environment to improve personal security for pedestrians, bicyclists, and transit riders." Thus, the selection of bikeways influences users' perception of safety, and facilities that promote the perception of safety should be selected.

914.4 Transportation System Plan Guidelines

An interactive website[10] helps guide transportation system plans toward needs determination, including a specific application for bicycles. The application has descriptions for actions that shall, should and could be included.

Shall: At a minimum, the assessment of the bicycle infrastructure shall include:

- Identification of the local, regional, and state standards for adequacy
- Evaluation of deficiencies in the bicycle network, including gaps/missing bike lanes, narrow bike lanes, poor surface conditions, roadway hazards, etc.

Should: In addition to the items listed above, the assessment of the bicycle infrastructure should include the following elements when locally appropriate and when funding allows:

- Analysis of bicycle connectivity along key study corridors using one of two methodologies:
    - Conduct a Qualitative Multimodal Assessment of the bicycle network (see ODOT's Analysis and Procedures Manual[1] for technical guidance)

  - Conduct a bicycle level-of-traffic stress analysis of the bicycle network (see ODOT's Analysis and Procedures Manual[1] for technical guidance)
- Evaluation of gaps in bicycle access to destinations including transit stops, schools, shopping, medical, civic, recreational uses, and trails
- Analysis of bicycle crash data and risk-based safety issues (see ODOT's Bicycle Safety Implementation Plan for additional information)
- Evaluation of high bicycle fatality and serious injury crash locations

Could: Although not typically required or critical to the development of most TSPs, the assessment of the bicycle infrastructure could include the following elements when locally appropriate and when funding allows:

- Evaluation of bicycle design standards (e.g., Central Business District, residential standards, etc.)

The TSP Guidelines also have an application for developing solutions. The guidance also details shall, should, and could, and includes many specific bicycle solutions.

Section 920 Design Principles for Bikeways

Bicycle accommodation is required on all highways, except where riding is prohibited by administrative rule described in OAR 734-020-0045. Rules of the road govern how people may use bicycle facilities. See also the Oregon Bicyclist Manual[5]. The following principles discuss how the rules of the road are interrelated to the design of bikeways.

920.1 Right to the Road (ORS 814.400)

People have the right to bike on the road as a vehicle. By statute (ORS 814.400), bicycles are vehicles and can use the roadway. This includes electric-assisted bicycles. Bicycles are vehicles and should be accommodated as roadway users where possible. Safe on-street bicycle accommodation includes bicycle-safe drainage grates and adjusting manhole covers to street grade. People riding bicycles are subject to obeying traffic control devices (ORS 811.260, 811.265, 811.360).

Bike accommodation should normally be continuous on both sides of the roadway.

ORS 814.400 requires bicyclists to follow the rules of the road for vehicles. These statutes applicable to bicycling presume that bicycles operate in the same direction with motor vehicle traffic. The lateral position of bicyclists should normally be on the right side of a roadway.

There may be instances where a bicycle facility may be considered on the left side of the road or a two-way facility on one side. Transitions to the beginning and end of the left-side bike facility are critical to safe operation. If the transitions are not done properly, bicyclists are unlikely to cross to the other side of a road to use a path, bike lane or sidewalk, particularly if it the length of the left-side bike facility is short. Many users are likely to use a lane on the roadway a short distance rather than cross twice. Additionally, some users will continue to ride on the "wrong side" of the road for long distance beyond the end of the left-side bicycle facility.

920.2 Shared Lane – (ORS 814.430, 811.065)

Oregon Statute ORS 814.430 affects shared lane conditions. It requires people riding in a shared travel lane to ride as close as practicable to the curb or edge of roadway if they cannot ride at the normal speed of traffic. The statute provides reasonable exemptions for passing, turning, and avoiding hazards. Since the ability for a person on a bike to travel at the normal speed of traffic is affected by the road geometry – this should influence decision on the appropriateness of a shared lane condition.

Notwithstanding the legal right to operate in the road, bicycles cannot operate the same as motor vehicles. Bicyclists are affected by steep grades more than motorists are. Understanding how bicycle riding is affected by grades gives insight as to why people choose to ride how they do. Depending on the grade of a roadway, many bicycles can reach downhill speeds in excess of 30 mph, while uphill speeds can sometimes be comparable to walking speeds. A person riding a bicycle typically uses the momentum gained going downhill to help climb uphill. Thus, it is undesirable to create a stop condition at the bottom of a hill. Ensuring a bicycle's momentum is an important design principle particularly at street crossings. The center of gravity for a person riding a bicycle is often above the bicycle. When going fast, a sudden stop can cause a bicycle rider to lose control and fall over the handlebars. People are more vulnerable in a crash on a bicycle than in a motor vehicle.

Where motor vehicles and bicycles share a lane, there are two ways that road users can share the road. Some bicycle riders move into the center of the travel lane in line with motor vehicles and try to ride at a speed close to that of traffic. Others ride as far as practicable to the right, allowing motor vehicles to pass by keeping left. The way that bicyclists ride in the travel lane affects how motor vehicles pass. Motor vehicles either change lanes to pass or keep to the left side of the lane to slowly pass bicyclists while bicyclists ride as far as practicable to the right. ORS 811.065 requires drivers who pass bicyclists to drive to the left of the bicycle at a distance sufficient to prevent contact with the person operating the bicycle if the person were to fall into the driver's lane of traffic. The actual distance prescribed in the statute has not been identified. The statute applies when sharing the same travel lane at speeds above 35 mph. The distance is not applicable if the vehicle and bicycle are not in the same lane.

When allocating space in the cross section of a road to travel lanes, a wide outside travel lane may affect the way that motor vehicles pass bicyclists. In order for motorists to safely pass bicyclists in accordance with this statute, drivers must reduce speed to 35 mph or less or move to another lane. Wide outside lanes are discouraged on higher speed roads; providing a striped bike lane is generally preferable.

920.3 Other Users of Bike Lanes (ORS 814.500, 510)

Per ORS 814.500 and ORS 814.510, people with wheelchairs, scooters and other mobility devices may legally use bike lanes. Additionally, the bike lane can be used for a wide range of micro mobility users including segways, scooters, skateboards and roller blades.

Designs should also accommodate bicyclists of all ages and abilities. Many individuals prefer to ride away from motor vehicles. Individuals vary in how well they are able to handle their bicycle, their agility, their confidence and comfort with traffic, their decision-making ability in traffic situations, their physical attributes, their familiarity with laws, location, infrastructure and behavior of other road users.

Many individuals with disabilities use adaptive bicycles, tandem bicycles, or adult tricycles to meet their transportation needs and stay active. These types of bicycles have longer and/or wider wheel bases than typical diamond frame bicycles, resulting in different turning radius, cross slope, and queuing space needs. These needs should inform design of refuge island widths and queueing spaces at path crossings and island cut throughs where people on bicycles may need to make turns.

920.4 Use of Pedestrian Facilities (ORS 814.410)

People on bicycles are legally allowed to ride on sidewalks in Oregon, unless prohibited by local ordinance; however, only in rare cases should bicyclists be required to proceed through intersections as pedestrians. When bicycle users are directed to use a sidewalk – there are safety and operational disadvantages. Oregon law (ORS 814.410) requires bicyclists to yield to all pedestrians on the sidewalk and to ride at the speed of a pedestrian when approaching or entering crosswalks, driveways and curb ramps when a motor vehicle is approaching.

Another disadvantage of sidewalk riding is the traffic control at an intersection. For example, if through motor traffic can go straight on a green light, while bikes and pedestrians must push a button and wait for a walk indication – the delay may result in bicyclists crossing against the pedestrian don't-walk signal since they could proceed with vehicles if using the road.

Many individuals choose to ride on sidewalks, rather than the roadway in order to be further apart from motor vehicle traffic as a sense of safety and comfort. Separated bike lanes can provide the advantages of sidewalk separation, while allowing users to proceed through intersections as vehicles.

When designing bicycle facilities apart from the roadway that are not shared with pedestrians, designate the facility as a separated 'bicycle lane' rather than 'path' in order to ensure that bicyclists are not subject to the operational disadvantages described above.

920.5 Continuity of Bicycle Lanes (ORS 801.155)

Bicycle lanes are defined in ORS 801.155. In addition to the bicycle lane along a street, a bicycle lane also exists in an intersection if the bicycle lane is marked on the opposite sides of the intersection in the same direction of travel. This means that turning vehicles must still yield to people riding bicycles through an intersection even when no bike lane striping is present.

The path for bicyclists should be direct, logical and close to the path of motor vehicle traffic, making bicyclist movements visible and predictable to motorists.

Many bicyclists do not limit trips to places within a completed bicycle network. In an incomplete network, where a bicycle facility ends, bicyclists continue the trip in a variety of ways. Where a bicycle facility is not provided, it can be difficult for people driving to know where people on bikes will be. These include riding against traffic on a street, riding on a sidewalk, traveling through property lots and crossing streets at random locations to reach better riding conditions. Connecting gaps in a bikeway network improves the likelihood that people will ride where motorists can expect them and reduces the overall number of conflict points.

When designing for motor vehicles, it can be desirable to maintain a uniform roadway cross section by minimizing changes to the driving environment. Although maintaining a uniform cross section is generally desirable for bikeways, people riding bikes are able to transition between different types of bikeway facilities as long as the connections are direct and intuitive. For example, a bike lane may ramp up to a shared use path or separated bike lane then ramp back down to a shared lane as conditions change along a corridor.

920.6 Bike Lane, Bike Path or Bike Trail (ORS 801.160)

While Oregon law has statutory definitions for Bicycle Path (ORS 801.160), Bicycle Lane (ORS 801.155), Bicycle Trail (ORS 366.514(5)) and Sidewalk (ORS 801.485), these statutory definitions do not align with how these terms are commonly used. The Highway Design Manual does not use these terms in the same way as the statutory definitions. This section summarizes the differences in how these terms are used in order to discuss how laws affect people riding bicycles on these facilities.

The statutory definition of a Bicycle Trail is a general term synonymous with the term 'Bikeway' – that means any lane or way designated for use as a bicycle route. The statutory definitions for a Bicycle Path, Bicycle Lane and Sidewalk all define the facility by relating it to the location within or outside of a highway. According to the statutory definition of a Bicycle Path, it is a public way that is not part of a highway. The statute defines a Bicycle Lane as that part of the highway, adjacent to the roadway that is designated for bicycle travel, while a Sidewalk is that portion of a highway between the outside lateral line of the shoulder and the adjacent property line capable of being used by a pedestrian.

Shared Use Paths are not defined in statute. Multi-Use Path and Multi-Use Trail are common synonyms. It is common for shared use paths to exist outside of a highway as well as paths along a highway. A shared use path that is outside of a highway right-of-way is similar to a Bicycle Path, but a shared use path along a highway (Side Path) is similar to a Sidewalk. As noted in Section 920.4, there may be disadvantages to bicycle travel along a sidewalk.

While Separated Bike Lanes are also not specifically mentioned in statute, they meet the same definition as Bicycle Lanes even if they are adjacent to the roadway with a street buffer in between. The terms 'Cycle Track', 'Protected Bike Lane' and Separated Bike Path' are commonly used synonyms with Separated Bike Lanes. When referring to this type of facility, use the term Separated Bike Lane in order to minimize confusion about whether a bicyclist is required to follow statutes for riding in a Bike Lane versus riding on a Sidewalk.

920.7 Requiring Bike Lane or Path (ORS 814.420)

Oregon law (ORS 814.420) requires bicyclists to use a bike path or bike lane, rather than the roadway travel lanes, if a bike path or bike lane is provided. The statute allows a person to move out of the bike lane or path for a variety of reasons.

As noted in Section 920.4, there may be disadvantages to using a separated facility if traffic operations require users to proceed as pedestrians. When designing a separated facility, ensure that bicyclists have access to move into the road where needed to make turns, avoid debris, or pass other users as necessary.

920.8 Stop as Yield (ORS 814.414)

Per ORS 814.414, 814.416, 811.260 (11, 15) and 811.265, a person riding a bicycle is allowed to slow to a safe speed, check for cross traffic and proceed without stopping at stop signs and at flashing red lights. Thus, the traffic operation for a bicyclist is the same as would be for a yield sign. When evaluating intersection operations with stop signs or flashing red lights, use the design assumption that bicycle traffic operates with yield control.

Section 921 Design for Bicyclist Safety

Highways should be designed to reduce or eliminate the potential for crashes. Appropriate roadway design can reduce crashes that occur between motor vehicles and bicycles, bicycles and pedestrians, or bicycles and fixed objects.

[Placeholder for additional content – refer to Highway Safety Manual, ODOT process for ARTS projects, Safe System Approach etc.]

This section will also discuss using the Pedestrian & Bicycle Safety Implementation Plan.

921.1 Crashes with Motor Vehicles

[Placeholder for section]

This section will discuss design considerations

- Portion of bike crashes that involve motor vehicles
- The most prevalent types of bike crashes
- Design strategies to reduce crashes between bicyclists and motorists
- Risk factors

921.2 Non-Vehicle Crashes

According to the National Transportation Safety Board (NTSB) Safety Research Report[26], 80 percent of bicyclists who were treated at a hospital for injuries from bicycling from 2014 to 2017 were not involved in a crash with a motor vehicle. Among those incidents, 27 percent were head injuries and were typically the most severe. While the cause of each non vehicle-related injury can vary, each incident was likely to have involved falling off a bicycle or colliding into a fixed object. This means that ODOT crash data likely amounts to less than 1 in 5 serious injury crashes involving a bicyclist. Serious injury crashes may be occurring due to deficient infrastructure, human factors or other causes. As a result, bicycle safety and crash risk factors should be considered in project design, even if there is no documented crash history in a project area. The following are design factors to mitigate the probability of fixed object crashes and individuals falling off bicycles.

921.2.1 Restricting Motor Vehicles on a Bikeway (Bollards)

Bollards may be used to limit vehicle traffic on paths. However, bollards are often hard to see, cyclists may not expect them, and injuries result when cyclists hit them. Overuse of bollards is a serious hazard to bicyclists and may prevent path use by trailers, wheelchairs and other legitimate path users. In a group of riders, the riders in front block the visibility of those behind, setting up cyclists in the back of the pack for a crash.

Bollards should only be used when absolutely necessary. **When used, space bollards apart a minimum of 5 feet.** This provides for easy passage by cyclists, bicycle trailers and adult tricycles as well as wheelchair users. A single bollard is preferred, as two may channelize bicyclists to the middle opening, with a potential for collisions. They should not be placed right at the intersection, but set back 20 feet or more, so users can concentrate on motor vehicle traffic conflicts rather than on avoiding the bollard. Bollards should also not be placed near curves in pathways due to limited sight lines and tendency of bicyclists to travel in the middle of a path on curves. They should be painted with bright, light colors for visibility, illuminated and/or retro-reflectorized. A striped envelope around the bollard will direct path users away from the fixed object hazard. See ODOT Traffic Line Manual[11] Figure 440-B for object hazard striping detail. Bollard design should consider emergency services and maintenance access needs along a path. Flexible delineators, that collapse when struck by a bicyclist, should be considered.

Placing railing or other barrier part way across a trail makes it possible for intended users to accesses the trail; maintenance vehicle operators are provided with keys to unlock the fences when they need access. The fences, like bollards, can be hazards to bicyclists and can restrict certain trail users from gaining access to the trail. They should be coated with retroreflective material and well-lit.

921.2.2 Drainage Grates

Care must be taken to ensure that drainage grates are bicycle-safe, as required by ORS 810.150. If not, a bicycle wheel may fall into the slots of the grate causing the cyclist to fall. Replacing existing grates (A, B, preferred methods) or welding thin metal straps across the grate, perpendicular to the direction of travel (C, alternate method) is required. These should be checked periodically to ensure that the straps remain in place. Uneven grates may be marked as an obstacle until they can be repaired. See ODOT Traffic Line Manual[11] for marking details.

Grates with bars perpendicular to the roadway must not be placed at the bottom of curb ramps, as wheelchairs could get caught in the slot.

If a street-surface grate is required for drainage (ODOT types G-1, G-2, CG-1 and CG-2), care must be taken to ensure that the grate is flush with the road surface. Inlets should be raised after a pavement overlay to within 1/4 inch of the new surface. If this is not possible or practical, the pavement must taper into drainage inlets, so they do not cause an abrupt edge at the inlet.

The gap between the grate and the inlet should be kept tight, no more than ¾ inch, to prevent bicycle wheels from getting trapped. The most effective way to avoid drainage-grate problems is to eliminate them entirely with the use of inlets in the curb face (type CG-3). The cross-slope of the outer 3 feet or so of the bike lane should stay constant, with no exaggerated warping towards the opening. This may require more grates per mile to handle bypass flow; but this is the most bicycle-friendly design.

921.2.3 Bikeway-Railroad Crossings

Special care must be taken wherever a bikeway intersects railroad tracks. The most important concerns for bicyclists are smoothness, angle of crossing and flange opening.

The combination of smoothness, angle and flange opening create conditions that affect cyclists. By improving smoothness and flange opening, the angle becomes less critical. A common mistake is to overcorrect for the angle, as the resulting sharp reversing curves needed to create a right angle crossing can be more difficult for cyclists to negotiate than the crossing itself. Sometimes all that is needed is a slight widening of the shoulders to allow cyclists to align themselves better at the track crossing.

By statute, all public highway, bikeway, shared use paths, and sidewalk crossings of a railroad in Oregon are regulated by the Department of Transportation. The Commerce and Compliance Division must approve, by issuance of an Order, the construction of new crossings or alterations to existing crossings, to include the approaches to these crossings. Crossing Orders specify construction details, installation of traffic control devices, and assign maintenance responsibilities to the road authority and the railroad, who are parties to the application.

The four most commonly used crossing surface materials, in descending order of preference, are:

- Concrete: Concrete performs best under wet conditions and, when laid with precision, provides a smooth ride.
- Rubber: Rubber provides a ridable crossing when new, but they are slippery when wet and degrade over time.
- Asphalt: asphalt pavement must be maintained in order to prevent a ridge buildup next to the rails.
- Timber: Timbers wear down rapidly and are slippery when wet.

The risk of a fall is kept to a minimum where the roadway (or bikeway portion of the roadway) crosses the tracks at 90°. If the skew angle is less than 45°, special attention should be given to the bikeway alignment to improve the angle of approach, preferably to 60° or greater, so cyclists can avoid catching their wheels in the flange and losing their balance. OAR 741-115-0070 specifies regulations for bicycle lanes and multi-use paths that cross railroad tracks at the same grade. Under OAR 741-115-0070 (3), an engineering study is required whenever bicycle lanes or multi-use paths are proposed to cross railroad tracks at 59 degrees or less.

Efforts to create a right-angle crossing at a severe skew can have unintended consequences: the reversing curves required for a right-angle approach can create other problems for cyclists. It is often best to widen the roadway, shoulder or bike lane to allow cyclists to choose the path that suits their needs the best. On extremely skewed crossings (30° or less), it may be impracticable to widen the shoulders enough to allow for 90° crossing; widening to allow 60° crossing or better is often sufficient.

Creating a separated path to angle the bikeway at 90° degrees is feasible, but special care should be taken to maintain the path regularly.

The open flange area between the rail and the roadway surface can cause problems for cyclists, since it can catch a bicycle wheel, causing the rider to fall. Flange width must be kept to a minimum.

921.2.4 Pavement on Bikeways

Poor pavement quality and pavement seams can create a crash hazard for bicyclists because bicycle tires can easily become hung up in large potholes or uneven joints. Crash hazards are reduced when pavement cuts are located on or near the bike lane stripe and at least 4' of clear ridable width is provided without pavement seams. Longitudinal cuts parallel to the direction of bicycle travel (e.g., utility trenches) should be avoided in bike lanes and other areas used by bicycles to minimize crash risk from uneven seams that develop as patched pavements settle. If trenching is required in the bike lane, it is preferable to repave the entire bike lane width. See ODOT Pavement Design Guide[14] Section 6.1.4 for joint locations for paving.

921.3 Using Bicycle Crash Data

[Placeholder for section. This section will discuss how to use crash bicycle data for design exceptions and other project related scenarios to inform design decisions.]

Section 922 Design Users

There are three primary purposes in selecting a design user profile. The design user profile informs a project team whether the target comfort level of the bicycle facilities will suit those who are expected to ride in a project corridor. It also determines whether to design queuing areas for individuals or groups of bicyclists riding together. After a bikeway project is completed, the design of the facility affects how cohesive the highway segment fits into the bicycle network for users within that design user profile.

ODOT design standards are based on the most restrictive design control, which is not always the same design user profile. When deviating from a standard, the effects on the design user profile should be noted.

The following is a list of design user profiles for a bicycle facility.

- Individual highly confident adult bicyclist
- Individual somewhat confident adult bicyclist
- Individual interested but concerned adult bicyclist
- Individual school-age child bicyclist
- Adult group bicycling
- Family group bicycling

922.1 Bicyclist Typologies

The six design user categories are derived from four levels of bicycle user comfort and skill that are recognized in transportation research. Bicycle users are categorized in three categories as 'highly confident', 'somewhat confident', or 'interested but concerned'. A fourth category describes people who either cannot or choose not to use a bicycle as transportation, which is not a design user category. In addition to design user categories that are based on a bicyclist typology, three additional categories are based on conditions. The school-age child bicyclist is a more specific design user than the interested but concerned category in places where a route is intended for school children. Bicycle facilities that are often used for groups of bicyclists may be designed for the capacity of many users riding together. Bicycling can be a social mode of transportation, so side-by-side riding may be expected on any bicycle facility and accommodated when possible. Side-by-side riding should be designed for when the design user category is a group.

The FHWA Bikeway Selection Guide[20] elaborates on the four typologies and explains how the usability of each type of bikeway is influenced by users' riding skills, stress tolerance and trip purpose. Users' decisions also vary by the type of bicycle they use, its performance criteria and required operating space.

Accommodating bicycle transportation is required on all highways, while designing for the expected bicycle user typology is a context sensitive consideration. Chapter 14 in the ODOT Analysis Procedures Manual[1] describes the 'Bicycle Level of Traffic Stress' (BLTS) methodology, which is a qualitative assessment of how traffic conditions effect bicycle riders. BLTS levels can be used to assess the bicyclist typology provided for on an existing or planned bikeway. BLTS 1 is suitable for all ages and abilities. BLTS 2 is less suitable for young children but is suitable for teens and adults with adequate bicycle handling skills. BLTS 3 is suitable for most observant adult bicyclists. BLTS 4 is suitable for only experienced and skilled cyclists.

The type of bikeway accommodation and its BLTS affects people of different bicyclist typologies in their decision whether to ride. The potential for use by each of the three typologies of bicycle riders depends on individuals' perception of comfort and safety and the amount of land use attractions. 'Interested but concerned' bicycle riders are likely to choose a different mode of travel if they perceive a bikeway to be stressful or if the trip distance is long. A 'highly confident' bicyclist is less likely to be dissuaded from choosing to ride based on traffic and can ride longer distances. A facility designed for interested but concerned users (BLTS 1) will typically provide a transportation option for all potential bicycle riders, whereas a facility designed only for highly confident riders (BLTS 4) is unlikely to attract many new potential bicycle riders or provide a realistic alternative to driving for many users.

The six urban contexts generally correspond with land use patterns that result in shorter or longer distances between destinations. The level of demand for 'interested but concerned' bicycle riders is greatest in a Downtown and Urban Mix settings where close destinations result in shorter trips. Where land use density is lower, and the average trip length is longer – there are still some short trips that attract 'interested but concerned' bicycle riders. Each of the urban contexts has a different mix of user typology demand because of the land use and distance between destinations. Thus, the urban context is used as the indicator to decide the type of bikeway that is appropriate – rather than surveying the typology of users along that highway.

A greater portion of bicyclists who ride on rural highways tend to be highly confident riders. However, individuals without other transportation options also ride on rural highways. There may also be latent demand for bicycle trips that are not taken because of traffic conditions. Rural bikeways that are part of a designated bike route attract a wider variety of users.

Table 900-3: Level of Traffic Stress and Design User Profiles
Likelihood that Design User Profile Will Ride[28]

Level of Traffic Stress	Highly Confident Individual	Somewhat Confident Individual	Interested, but Concerned Individual	School-aged Individual Child	Adult Bicycle Group	Family Group
BLTS 1	Likely	Likely	Likely	Likely	Likely	Likely
BLTS 2	Likely	Likely	Sometimes	Sometimes	Likely	Sometimes
BLTS 3	Likely	Sometimes	No	No	Likely	No
BLTS 4	Likely	No	No	No	Sometimes	No

922.2 Selecting the Design Users

[Placeholder for future content]

922.3 Design Controls Based on Design User

[Placeholder for future content]

Section 923 Design Vehicles

[Placeholder for future content]

923.1 Design Vehicle Descriptions

[Placeholder for future content]

923.2 Selecting the Design Vehicle

[Placeholder for future content]

923.3 Design Controls Based on Design Vehicle

[Placeholder for future content]

Section 924 Design Speed

Several design requirements are based on a selected design speed. Normally, a design speed is only selected for shared use path projects. Aside from shared use paths, it is generally not necessary to designate a design speed for bicycle lanes. However, there are scenarios where a design speed is necessary. A bikeway should have a design speed designated separate from the roadway design speed in the following facilities:

- All shared use paths;
- Alignment of a separated bike lane if not parallel to the road;

- Passing areas within a bike lane;
- Sight distance calculations;
- Islands at protected intersections;
- Bicycle signals;

924.1 Selecting an Appropriate Design Speed

The ODOT Region Roadway Manager shall assign bikeway design speeds for a project. The AASHTO guide contains factors to consider but does not dictate design speed. More than one design speed may be selected as it is sometimes advisable to have different design speeds in different segments. Design speeds vary from 8 mph to 30 mph and are given in 2 mph increments.

- The typical recommended shared-use path design speed is 18 to 20 mph for rural paths where there are less pedestrians.
- The typical recommended shared-use path design speed is 14 to 16 mph for urban paths where there are more pedestrians.
- The typical recommended design speed at intersection approaches is 10 to 12 mph.
- The typical recommended design speed at street crossings is 8 mph.

Each of the above design speeds may be adjusted based on whether a path is on level terrain, rolling terrain or on a consistent grade or based on the expected mix of design users.

The typical average cruising speed of a human-powered bicycle on level terrain is 10 mph. Many individuals are capable of riding a road bicycle at a sustained average speed of 15 to 25 mph on level terrain. For every 1 percent increase in downhill grade, individual adult bicyclists on road bicycles increase speed by 0.53 mph on average. For every 1 percent increase in uphill grade, the same bicyclists decrease speed by 0.90 mph on average. Bicyclists can reach speeds of 30 mph on sustained downhill grades of 5 percent or greater. Electric-assist bicycles are capable of riding 20-28 mph and typically ride close to 20 mph. Segways and electric scooters can ride 15 mph.

The design speed need not vary with the grade of a path where the grade remains below 4 percent. Where rolling terrain frequently surpasses 4 percent uphill and downhill – the speed of bicyclists will frequently vary between fast and slow. As it becomes more difficult to maintain momentum uphill, bicyclists may increase downhill speeds to compensate for an uphill climb ahead. Design speeds in rolling terrain or on a consistent grade can either be increased based on the downhill grade – or design speeds can vary based on uphill versus downhill direction.

Regardless of the path design speed, approaches to street crossings should be designed at a slower speed than the rest of a path because bicyclists are preparing to come to a stop.

924.2 Design Controls Based on Design Speed

Shared use path design speed affects the following design elements along a shared use path:

- Intersection sight distance
- Stopping sight distance
- Sight triangles
- Horizontal curves
- Vertical curves
- Dashed centerline striping
- Length of a passing zone
- Signal timing

Section 930 Bikeway Networks

[Note that the ODOT Strategic Action Plan[9] has a goal to define a multimodal network. The content below is intended to help in the Bicycle Facility Selection Process to characterize the functional role of the highway in the bikeway network. This section is in development.][14, 15, 16, 18, 19, 20]

Different people can travel on a bicycle in a wide mix of environments. People can ride bicycles on all highways and streets, except where specifically prohibited by administrative rule OAR 734-020-0045 and indicated with traffic signs. People can also ride bicycles on sidewalks, except where prohibited by a city ordinance. People can also ride bicycles on a variety of facilities apart from highways including paved and unpaved shared use paths and trails, mountain biking trails, skate park facilities, as well as through unimproved land on uneven earth terrain.

Where riding a bicycle is not allowed, people can switch to another mode of transportation by walking the bicycle or taking the bicycle with them on a motor vehicle, train or other transit vehicle.

Notwithstanding the variety of facilities where some specific individuals can ride bicycles, most of these facilities are not usable options by all people who may ride a bicycle. The bicycle facilities that can be used by people of all ages and abilities include only those paved facilities that are specifically designed for bicycle travel and are located where they are perceived to be safe from traffic conflict.

The overall bikeway network within a city or other geographic boundary typically consists of all public streets and paved off-street paths. Each street or path may function as a link for a bicycle trip to destinations within that bikeway network. Wherever an ODOT highway is located within the geographic boundary, it may function to serve bicycle trips. The ODOT highway may function in any of the following roles in the overall bicycle network.

- Essential transportation link
- Destination Route
- Limited Access Route
- Destination Route Alternative
- Limited Access Route Alternative
- Designated Tourism Route
- Recreation Route
- School Route
- Off-chute

930.1 Essential Transportation Link

If a highway is the only route between two points, it is an essential transportation link.

930.2 Destination Route

Where the land use along a highway includes access to businesses, residences, or other services that are potential origin or destination points for a person riding a bicycle – this is a Destination Route.

930.3 Limited Access Route

Where a highway is access controlled and does not include access to businesses, residences or other services, it does not serve as an origin or destination point for bicycle trips. This is a Limited Access Route. Providing a low-stress parallel bicycle route may be an option for this type of facility.

930.4 Destination Route Alternative

This network role is any combination of bikeway facilities (typically detouring from the highway) that enables travel between two points along a destination route on the highway. Since the destination route includes origin and destination points, a parallel route must have frequent connections to a destination route and the destination route itself should include some bikeway accommodation.

930.5 Limited Access Route Alternative

This network role is any combination of bikeway facilities that enables travel between two points along a limited access route. Typically, this route may be in lieu of bikeway facilities on a freeway or expressway when following the procedure in Section 949.

930.6 Designated Tourism Route

This includes any route that is designated with a route name or number. Examples are all Scenic Bikeways, the Oregon Coast Bike Route, the Historic Columbia River Highway, National Bike Routes etc.

930.7 Recreation Route

Any other recreational path or route that is not designated with an official route name or number.

930.8 School Route

Any route that is used by school children is a School Route. This network role may overlap categories above.

930.9 Off-Chute

Any route that is a dead-end to a destination is an off-chute (e.g., route from a trail head, park and ride lot, transit station, etc.)

930.10 Selecting the Bikeway Network Role(s)

[Placeholder for future content]

930.11 Design Controls Based on Bikeway Network Role

[Placeholder for future content.

Consideration should include the following factors, which will be added as future content. Considerations include network development, trip length, connectivity, continuous versus interrupted flow.]

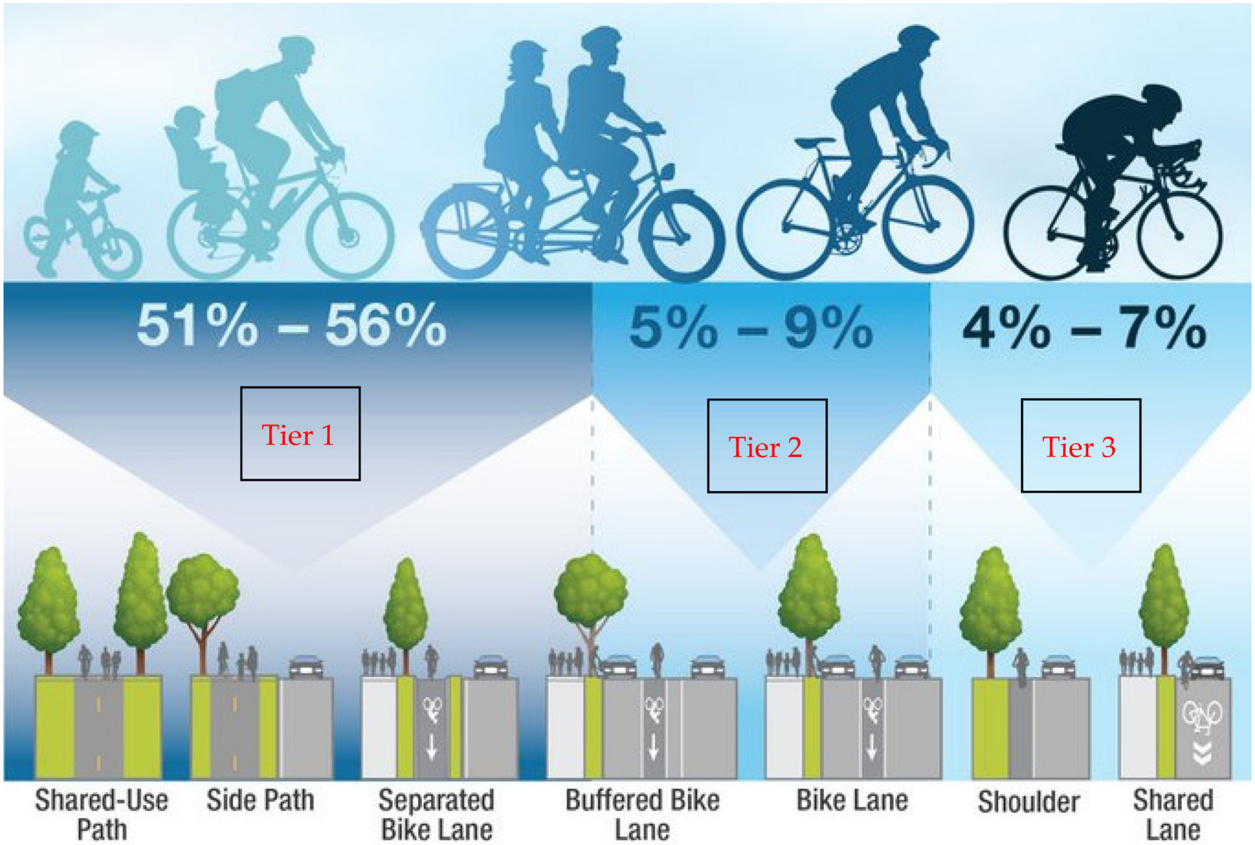
Section 940 Bikeway Tiers

Bicycle travel can be accommodated in three ways or tiers, varying by the level of separation with motor vehicles. It can be accommodated (Tier 1) in a space physically separated from motor vehicle traffic. This may be either a separated bicycle lane or a shared use side path. A separated bicycle lane is a designated lane that is apart from the roadway and has either curb or vertical objects between the bicycle lane and motor vehicle traffic. A shared use side path is separated from motor vehicle traffic in a similar way, but the space for bicycle travel is shared with pedestrians.

The second way bicycle travel can be accommodated (Tier 2) is where pavement markings delineate space on the road for bicycle travel apart from motor vehicle lanes. A paved shoulder delineated with a longitudinal stripe can serve bicycle travel but is not reserved exclusively for bicycle travel. A Bicycle Lane is reserved exclusively for bicycle travel. A buffered bicycle lane is a bicycle lane within a wider shoulder where an additional striped portion of the shoulder is marked to provide a horizontal space between bicycle travel and motor vehicles. This horizontal space functions as a safety buffer that may occasionally be used by oversized vehicles or by bicyclists to pass one another.

The third way (Tier 3) is by having bicycle traffic share the same travel lane on the roadway with motor vehicles. A narrow shoulder may also function as a Tier 3 facility if the shoulder width is insufficient for bicycle travel without encroaching into the travel lane.

Figure 900-2: Bikeway Tiers[20]

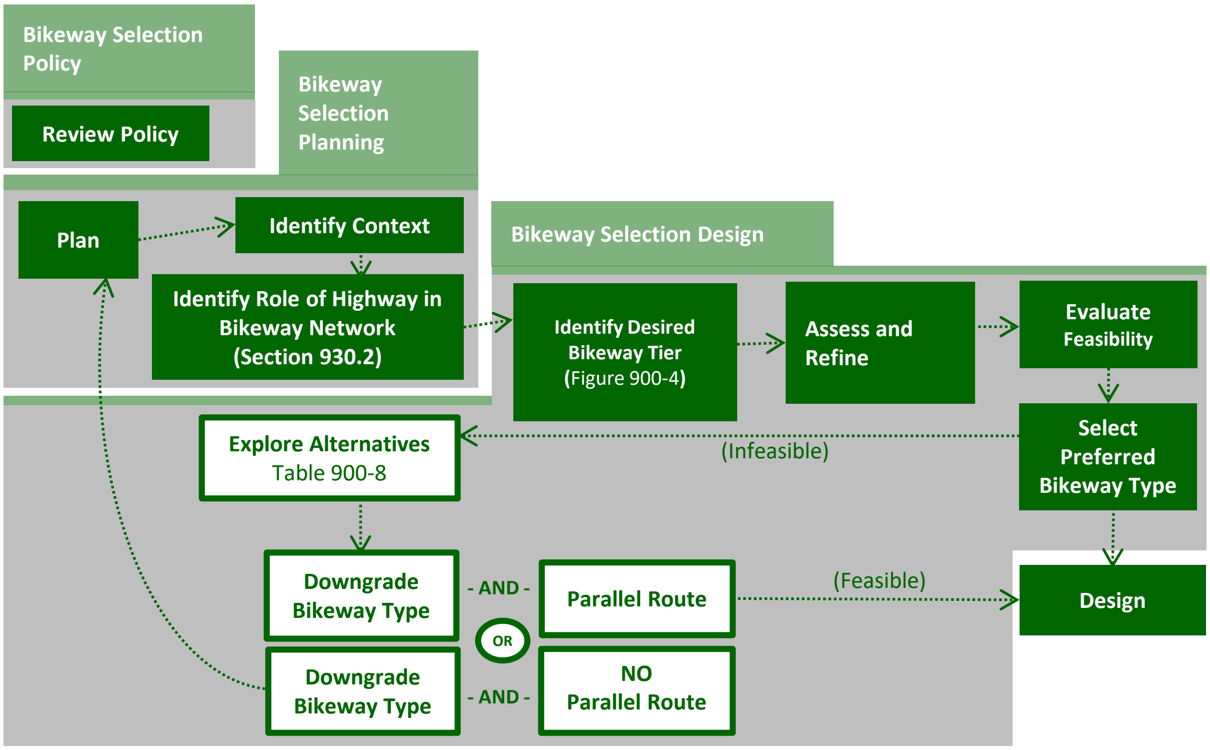


Section 941 Urban Bikeway Selection Process

The appropriate tier to accommodate bicycle travel varies by many factors including road context and traffic condition. Within each bikeway tier, there is a range of potential design cross sections. Determining the space to be allotted in the cross section of the bike lane zones is described in detail in Section 947.

Figure 900-3 is a flowchart that outlines the steps necessary to select the appropriate bicycle facility.

Figure 900-3: Bicycle Facility Selection Process [20]



The flowchart is divided into three parts: policy, planning and design.

941.1 Review Policy

The first part is to review the applicable policies in effect in the location where the bicycle facility will be. Some bikeway selection policy is already established in the Oregon Bicycle and Pedestrian Plan. Section 910 through Section 914 discuss those policies and plans which are applicable statewide. There may also be local policies for an individual road jurisdiction such as mode share targets, which should be considered in choosing the bicycle facility.

941.2 Bikeway Selection Planning

The second part of the flowchart is to review planning documents. Two goals in reviewing the planning documents are to determine the highway context and the role of the highway in the overall bikeway network. Bikeway selection planning includes efforts to identify and designate connected bicycle networks of “low-stress” bicycle facilities at the transportation system plan level. These networks represent the community’s vision for how to provide comfortable and safe access to key destinations for people riding bicycles. Planning efforts should identify

ODOT highway contexts as well as the role of the ODOT highway in the bikeway network. If the planning documents do not specify this information, these should be determined for an individual project.

When the highway context and role in the bikeway network are known, these are parameters for determining the cross section alternatives. More information on determining highway context is provided in Part 300. The highway context determines the design users, design vehicles, and required design controls as discussed in Section 922 and Section 923.

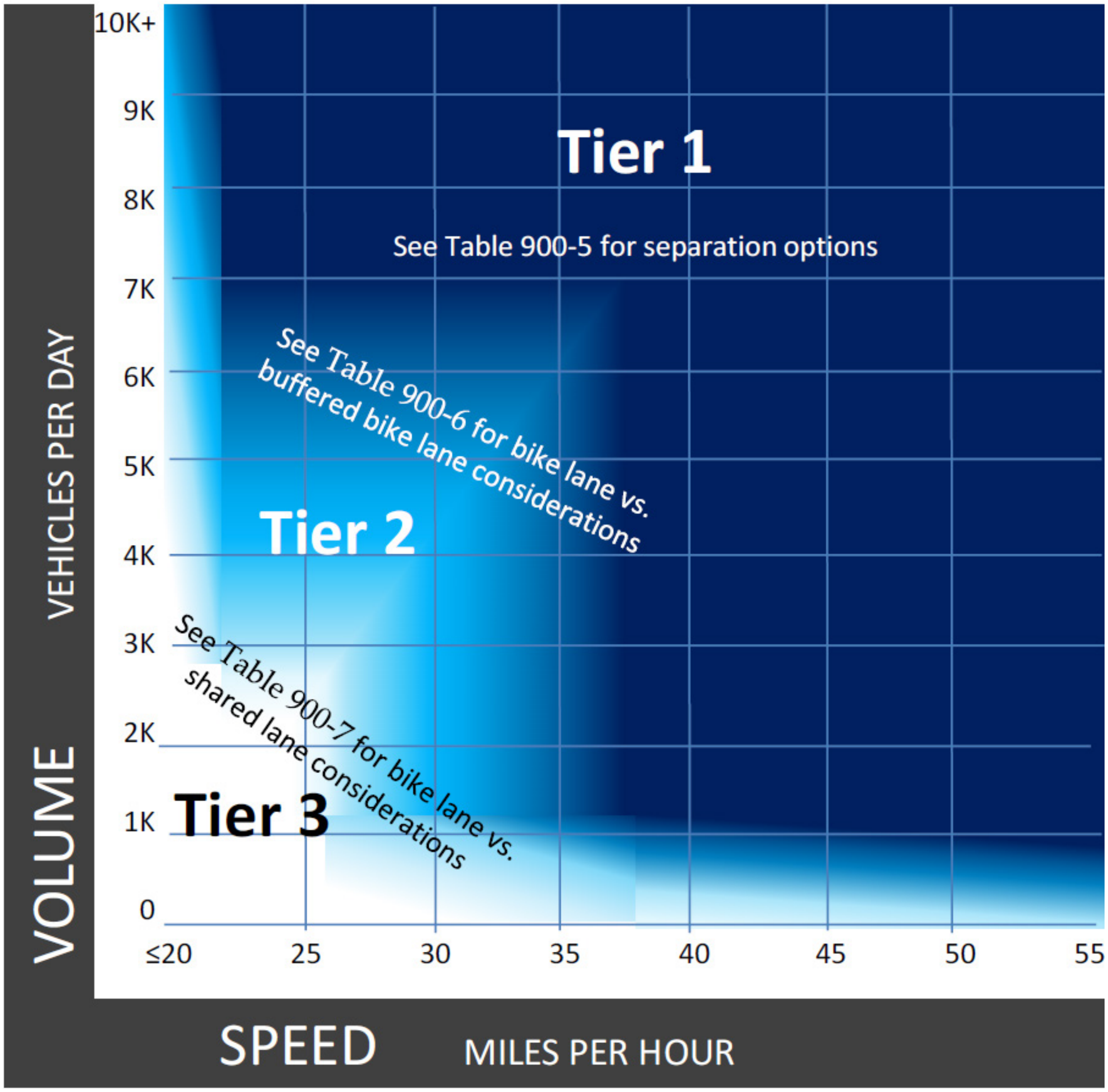
The role of the highway in the overall bikeway network affects how much an improvement to the bike facility might affect bicycle ridership. When the highway is the only route for bicyclists to a destination, it is more critical that the bikeway is context appropriate. When the highway is inside of a comprehensive bike network, such as a street grid, there may be alternative routes to a destination, aside from the bike accommodations on the highway.

The role of the highway segment in the bike network also determines whether the standard bikeway may be downgraded due to its relative importance within the larger network and the availability of alternative routes.

941.3 Identify Desired Bikeway Tier

The third part of the flowchart has several steps. The first step is to identify the target bikeway tier using Figure 900-4. This is a nomograph that uses posted speed and traffic volume to indicate which bikeway tier is appropriate for a given highway segment. The colors in the nomograph gradually blend, which reinforces the point that the determination of the appropriate bikeway type should consider more than speed and traffic volume. After the Tier is identified, each tier refers to a Table for key planning level information to refine the bicycle facility.

Figure 900-4: Bikeway Tier Identification Nomograph[20]



941.4 Assess and Refine Desired Bikeway

Within each bikeway tier, there is a range of potential bikeway types. After identifying the bikeway tier, the next step is to determine the options within that bikeway tier and then to refine the list by determining which of the recommended options is viable.

The standard range in widths for each zone in a bikeway is in Table 900-4. When reviewing the tables, the higher end of the dimension range should be the starting point, as shown first in the tables. Widths within the standard range should be refined to fit the conditions for the highway segment. Zones wider than the standard range do not require a design exception. Where the lower number in the standard width range is not attainable, see Section 941.6.

Table 900-4 Standard Width Range for Desired Bikeway

Urban Context	Tier 1				Tier 2			Tier 3
	Sidewalk Buffer Zone	Bike Lane Zone	Street Buffer Zone	Right Side Shoulder *	Sidewalk Buffer Zone	Bike Lane Zone	Street Buffer Zone	Bike Lane Zone
Downtown	6′-0′	8′-7′	3′-2′	2′-0′	6′-0′	6′-5′	3′-0′	Included in travel lane width
Urban Mix	6′-0′	8′-7′	4′-2′	2′-0′	6′-0′	6′-5′	4′-0′	
Commercial Corridor	5′-0′	8′-7′	5′-2′	4′-0′	5′-0′	6′-5′	5′-0′	
Residential Corridor	6′-0′	8′-7′	5′-2′	4′-0′	6′-0′	6′-5′	4′-0′	
Suburban Fringe	6′-0′	8′-7′	5′-2′	6′-0′	6′-0′	6′	5′-0′	
Rural Community	5′-0′	8′-7′	4′-2′	6′-0′	5′-0′	6′-5′	4′-0′	
Rural	See Section 946							

* The minimum right-side shoulder width may be reduced to zero where a street has a Tier 1, which is located outside of the shoulder. If the travel lane is directly adjacent to the curb, the overall shoulder width depends on other section elements. Elimination of shoulder width/lateral offset should only be considered in constrained locations and needs to be balanced with all cross-section and drainage needs. If the travel lane is next to a curb with a gutter (e.g., a 2-foot curb zone), the gutter typically serves as the right-side shoulder. A wider shoulder may be needed to accommodate drainage based on hydrological analysis or other specific needs. On Reduction Review Routes, comply with ODOT Freight Mobility Policies, ORS 366.215 and OAR 731-012. Element dimensions may need to be modified.

941.4.1 Tier 1 Separated Bike Lanes and Side Paths

When the traffic volume and speed result in a Tier 1 bicycle facility, a bikeway should be provided that includes a Street Buffer Zone. Table 900-5 identifies which options may be used within the Street Buffer Zone based on the context of a highway. 'X' indicates that the delineation option may be used in the urban context. Blank indicates that the delineation option is not allowed in the context. **A design exception is required to use a buffer option that does not have an X in the corresponding urban context.** A striping buffer is not included in this table because it results in a Tier 2 bicycle facility.

Table 900-5 Tier 1 Options in the Street Buffer Zone for Separated Bike Lanes and Side Paths

Delineation Options in the Street Buffer Zone	On-Street Parking*	Raised Island	Landscaping	Delineator Posts	Traffic Separator Curb	Planter Boxes	Concrete Barrier or Guardrail	Drainage Swale	Bio-swale
Downtown	X	X	X	X	X	X			X
Urban Mix	X	X	X	X	X	X			X
Commercial Corridor		X	X	X			X	X	X
Residential Corridor		X	X	X			X	X	X
Suburban Fringe		X	X	X			X	X	X
Rural Community	X	X	X	X		X	X	X	
Rural			X				X	X	

*On-street parking may be used as a street buffer only where on-street parking exists or is appropriate in the highway context.

Refer to the design requirements for each option considered to determine the required cross section width and any other design considerations. See Section 945 for the Street Buffer Zone standards of each delineation option. Additionally, refer to Bike Lane Zone and Sidewalk Buffer Zone requirements.

941.4.2 Tier 2 – Buffered Bike Lanes and Bike Lanes

When the traffic volume and speed result in a Tier 2 bicycle facility, a Bike Lane should be provided. A striped separation from traffic in the Street Buffer Zone is generally preferred. Refer to Table 900-6 for considerations whether to provide additional buffer width for a bicycle lane. Additional details are given on page 24 of the FHWA Bikeway Selection Guide[20].

Table 900-6 Tier 2 Considerations – Need for Separation (Buffered Bike Lane versus Bike Lane)

Consideration	Buffered Bike Lane	Bike Lane
Traffic Volume	Above 10% of ADT at peak hour	Evenly distributed
Vehicle Mix	High percentage of heavy vehicles	Low heavy vehicle percentage
Curbside activity	Conflicts with parked cars or other activity requires frequent merging	Low curbside activity
Driveway frequency	Driveways are spaced further apart	Frequent driveways
Schools	Used as a school route	Not used as a school route
Continuity	Connects to separated facility	Doesn't connect to separated facility
Transit Considerations	Frequent transit stops	Infrequent transit stops

941.4.3 Tier 3 - Shared Lanes

When the traffic volume and speed result in a Tier 3 bicycle facility, bike lanes are not always required. Bicyclists can ride in the travel lane with motor vehicles where speeds and traffic volumes are low (within the white zone in Figure 900-4). The painted stripe can be omitted from the required minimum shoulder width to result in a shared lane, wider than a typical travel lane. However, not all bicyclists are comfortable in traffic, especially children. Consider improved bicycle accommodation where riding is prohibited on sidewalks.

There are instances where a shared lane can be appropriate on a high-volume highway. Where a highway has dedicated lanes for transit or a combination of business access and transit (BAT lanes), and bicycle travel is shared with the dedicated lane, this type of bikeway is considered a shared lane condition. For the purpose of assessing the traffic volume for the Bikeway Tier Identification Nomograph in Figure 900-4, only the volume of transit vehicles and other allowed users is used to assess whether a Tier 3 facility is appropriate.

Where motor vehicles and bicycles share a lane, there are two ways that road users can share the road. Some bicycle riders move into the center of the travel lane in line with motor vehicles and try to ride at a speed close to that of traffic. Others ride as far as practicable to the right, allowing motor vehicles to pass by keeping left. Where approaches have shoulder or bike lane that drops, many riders may have difficulty transitioning from the shoulder into the travel lane.

See ODOT Traffic Line Manual for standards regarding the use of shared lane markings. Where used, shared lane markings alert drivers that bicyclists may be in the travel lane and also indicate the position in the shared travel lane where bicyclists are likely to ride. This helps enable bicyclists to transition to the shared lane from a shoulder or bike lane that drops. The positioning of the shared lane marking also encourages bicyclists to position themselves toward the center of the travel lane where they are more visible to drivers and drivers are encouraged to pass by changing lanes as they would for another motor vehicle, rather than by passing closely in the same lane. Shared lane markings on wider outside travel lanes of 14’ to 15’ may also help increase driver awareness of bicyclists who choose to keep right and help facilitate vehicles safely passing bicycles at a low speed.

Table 900-7 Need for Separation (Bike Lane versus Shared Lane)

Consideration	Bike Lane	Shared Lane
Proximity to urban center	Further away, suburban areas	Urban center
Building set back	Parking lots front street	Buildings at back of walk
On-street parking	High turnover	Low turnover
Block length	Long block length	Short block length
Traffic signal coordination	Timed above posted speed	Timed below posted speed
Traffic Volume	Above 10% of ADT at peak hour	Evenly distributed
Number of Travel Lanes	More than two	Two or less
Grade	Uphill	Downhill
Schools	Used as a school route	Not used as a school route
Continuity	Connects to bike lanes	No bike lanes on approach
Other high-use indicators	Indications of high use	No indicators

Narrow bridges, tunnels, and other locations that reduce the width of a highway may require bicyclists to ride in the travel lane with motor vehicles. Often, these conditions occur on high-speed roads. Full width shoulders should be provided. However, when structural widening is beyond the scope of a project, high speed shared lanes can be treated with traffic control such as advance signing and active warning beacons. See Section 309.1 in the ODOT Traffic Manual[12].

941.5 Evaluate Feasibility

Reviewing various options using a decision-making framework can help prioritize trade-offs, refine decisions, and lead to a solution that supports the project needs.

When considering decisions about bicycle facility selection, keep in mind the maintenance needs with each facility type. Determine what maintenance issues there will be and how to mitigate them with the design. If a bicycle facility is being added to an existing cross-section by simply restriping the existing design elements, care must be taken to ensure removal of the existing striping does not leave "ghost" lines that may confuse both drivers and bicyclists. The final striping layout must be clear and understandable to roadway users. Discussion will be needed to determine the best method to remove or obliterate the striping (e.g., hydro blasting) to not leave behind ghosting of the original striping. Consider adjustments to lane configurations when scoping and designing pavement preservation projects.

When determining appropriate elements for the street buffer zone, the ability for maintaining the facility shall be considered. Consult ODOT maintenance staff for input when determining the following:

- Sweeping and maintaining constrained bicycle facilities.
- Restriping and maintaining markings for buffered bicycle lanes.
- Maintaining vertical elements like tubular markers used for delineation and separation of the bicycle facility and the travel lane.

Consider intergovernmental agreements with the local jurisdiction for maintenance of the transition zone and elements within it. This may include the pedestrian realm as well

In many cases, implementation of bicycle facilities on ODOT streets in urban areas is completed through a retrofit project, in which additional space for bicycle facilities require weighing trade-offs compared to other uses for the space.

941.6 Explore Alternative Bikeway Designs

In some cases, upon evaluating alternatives, it is possible that none of the preferred alternatives are viable. In that case, additional alternatives should be explored that are the next best option to the recommended bikeway type. When a bikeway is provided on a highway that is a lower tier than what is recommended, the potential usage is reduced because some of the users will not be comfortable using that bicycle facility.

Sometimes, the role of the highway in the overall bikeway network is such that the recommended bikeway tier is not necessary due to a parallel bicycle route that functions for most of the bicycle demand. Identify whether parallel bicycle routes serve the bicycle demand. If so, basic bicycle accommodation is still required; refer to Table 900-8.

***Design Concurrence Documentation is required to approve using an alternative bikeway design from Table 900-8 as the selected bikeway type.* A design exception is required to justify the width of a bikeway that is less than a design option in Table 900-8.**

In order for one of these designs to be approved by concurrence or a lesser design via design exception, the documentation must document how the preferred bikeway type was not viable – or that the bikeway network supports a parallel bike route.

Table 900-8: Alternative Bicycle Facility Design– With Identified Lower Stress Parallel Route

Highway Characteristics	Bikeway Type	Min. Width
Traditional Downtown	Bike Lanes with on-street parking	6′
	Bike Lanes with no on-street parking	5′
	Shared travel lane (20 - 25 mph)	Included in travel lane width
Urban Mix, Commercial Corridor, or Residential Corridor	Shoulder Bike Lanes	5′
	Shared travel lane (25 mph)	Included in travel lane width
Suburban Fringe: 35-45 mph	Shoulder	4′
	Bike Lanes	5′
Suburban Fringe: 50-55 mph or Expressway: 45 mph	Shoulder	8′
	Bike Lane or Buffered Bike Lane	8′
Expressway: 50-55 mph	Shoulder	8′
Freeway	Shoulder	10′

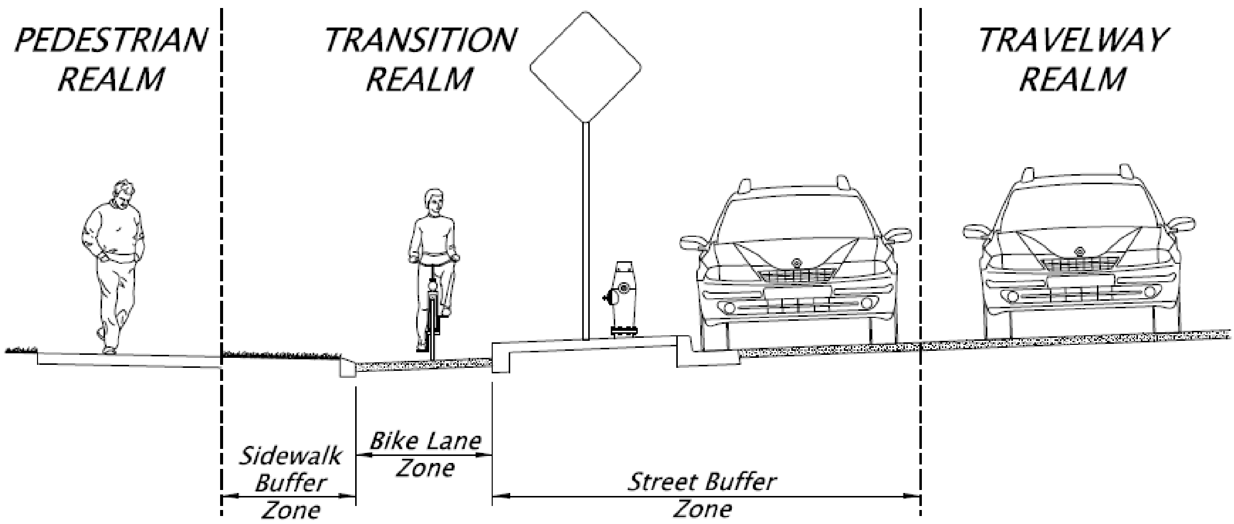
Section 942 Transition Realm and Zones

The cross section of a roadway has different functions as it serves bicyclists, pedestrians, motor vehicles, parking and land use access. Cross Section Realms are used to describe the parts of a highway's cross section. The portion of the highway between the Travelway Realm and the Pedestrian Realm is the Transition Realm. Not every highway includes a space between the Pedestrian Realm and the Travelway Realm. Assume that a Transition Realm always exists and can have a width of zero where the typical components of the Transition Realm are not included. The components that can make up a Transition Realm are a bike lane, on-street parking and a buffer strip.

As described in Section 940, bicycle traffic can be accommodated in three ways. Tier 3 bicycle facilities (shared lanes) exist where bicycle traffic is in the Travelway Realm. Tier 1 and Tier 2 bicycle facilities lie within the Transition Realm.

The Transition Realm is subdivided into three zones: The Bike Lane Zone, the Street Buffer Zone and the Sidewalk Buffer Zone. Every type of bikeway can be described in terms of these three zones.

Figure 900-5: Transition Realm and Bike Lane Zones



Section 943 The Bike Lane Zone

The portion of the road cross section designated exclusively for bicycle travel is the Bike Lane Zone. Where bicycle lanes are provided on the shoulder of a road, the entire bike lane is equivalent to the Bike Lane Zone. Where buffered bike lanes or separated bike lanes are provided, the Bike Lane Zone includes only the portion of the bike lane designated for bicycle travel. In a shared use path, the Bike Lane Zone overlaps the Pedestrian Zone within the Pedestrian Realm.

The Bike Lane Zone includes the operating width for a bicyclist and shy space on each side. The typical width of a person on a bicycle is 2.5 feet. The minimum operating width of a person riding a bicycle is 3.5 feet to account for a person leaning slightly and for side-to-side deviation from riding in a straight line. Leaning is increased around curves. Bicyclists shy away from curbs, signs, posts, fences, railings, and moving traffic.

The surface of the bike lane zone shall be paved. The standard width for the Bike Lane Zone varies by Bikeway Tier. Tier 1 and Tier 2 bikeways are described below. Since Tier 3 bicycle facilities are shared with motor vehicles, bike lane zone requirements do not apply. *A concrete gutter pan may be included as part of the bike lane zone if there is 4 feet of pavement beyond the longitudinal joint in the gutter pan.*

943.1 Bike Lane Zone for Tier 1

The bike lane zone is the portion of a separated bike lane intended for bicycle travel. Shared use paths combine the widths of the Bike Lane Zone and the Pedestrian Zone. Refer to Section 960 for Shared Use Path widths.

Typically, in a shoulder bike lane, a bicyclist who wishes to pass another bike will use part of the adjacent vehicle lane to do so. However, when bike lanes are constrained between curbs or other objects, passing may be restricted if the bike lane is not wide enough. Therefore, the bike lane zone must consider the ability for a bike to be passed or for two bikes to travel side-by-side. The ability for two bikes to travel alongside each other is also influenced by whether curbs are sloped or straight. The minimum dimension for a bike to pass another bike is 6.5-feet. The range in width for a bike lane zone depends on whether the street buffer is traversable.

The width of the bike lane zone is also affected by maintenance. If a separated bike lane will be swept using a maintenance vehicle, the width of that vehicle may control the width of the bike lane zone. Where the bike lane zone is adjacent to a pedestrian zone, a maintenance vehicle may be able to sweep both together when the boundary between zones is a bike lane curb or if they are at the same level.

The standard range in width for a separated bike lane zone between standard curbs shall be 8 to 7 feet wide, exclusive of curbs. Where a separated bike lane has a sloped bike lane curb on either or both sides, the bike lane zone width includes the width of the 0.5-foot sloped curb(s). Where a separated bike lane has softscape on either or both sides that is flush with the bike lane, the bike lane zone width shall be 8 to 6.5 feet wide. *Where the surface adjacent to the bike lane zone is flush pavement with intermittent objects in the street buffer, it is consistent with a Tier 2 bikeway (Buffered Bike Lane). Refer to the standard width for a shoulder bike lane rather than a separated bike lane when the surface adjacent to either side of the bike lane zone is flush pavement.* **Where available width is constrained, the bike lane zone may be narrower than the standard width range for short segments up to 200 feet.** Where the bike lane zone is adjacent to an accessible on-street parking access aisle (less than 200 feet in length), the bike lane zone may be reduced to 4-feet without a design exception. **Otherwise, a design exception is required if a segment of a bike lane zone is narrower than 5 feet.** In constrained areas, bicycles may not be able to pass each other. Ensure that passing opportunity is provided on each side of the constrained space.

A raised bike lane is a type of Tier 1 bikeway that generally does not include a horizontal street buffer from the motorized vehicle lanes. Raised bike lanes may be curbed on both sides. The curb adjacent to traffic is generally 2-6 inches in height. Since a bike lane edge stripe is typically placed on the road below the curb, the total width of a raised bike lane includes the curb together with the bike lane zone. Since 1-foot on each side of the curb functions as shy distance, the bike lane zone width is the same for a raised bike lane as for a separated bike lane. Separated and raised bike lanes have the potential to attract more riders than do shoulder bike lanes. Where the expected volume of bicyclists is 150 to 750 per hour, the bike lane zone width should be at least 8-feet. Where the expected volume of riders is less than 150 in the peak hour, the 6.5-foot width is acceptable. Where higher volumes are expected (over 750 bicyclists per hour) or to provide more comfortable side-by-side riding, a bike lane zone of 8 to 10 feet is preferred.

943.2 Bike Lane Zone for Tier 2

The bike lane zone is equivalent to the bike lane width for a shoulder or bike lane. The bike lane zone is the bike lane portion of a buffered bike lane.

Shoulders are usually striped as bike lanes in urban areas; this designates the shoulder as an area for preferential travel by bicyclists. Low potential bicycle use is not a reason to not provide a shoulder bikeway. The decision to designate shoulders as bike lanes is made by the Region Traffic Manager/Engineer and should be based on anticipated bike use, local transportation plans and/or bicycle plans, posted speed, inventory data of bikeway need and other factors. See Appendix F for instructions on how to access roadside inventory bikeway need data through the FACS-STIP tools.

When a bike lane is located immediately adjacent to a motor vehicle through travel lane, the standard width for the bike lane is 6 feet. ***In constrained areas, narrower lanes as narrow as 5-feet may be acceptable through a design concurrence documentation.*** **A design exception is required to justify a bike lane zone that is less than 5 feet.**

Bike lanes may also be wider than the standard 6 feet in areas of high use or on high-speed facilities. However, a wider lane could be mistaken for a motor vehicle lane or parking area. In areas with additional roadway width, a painted buffer stripe can be used to clarify that the space is intended for bicycle use.

Section 944 The Sidewalk Buffer Zone

The Sidewalk Buffer Zone is the space between the sidewalk and the Bike Lane Zone. It may be the same as the Buffer Zone or Curb Zone within the Pedestrian Realm. The intent of the Sidewalk Buffer Zone is to minimize encroachment of pedestrians in the bike lane and bicycles in the sidewalk. Separating modes improves each user’s sense of comfort and safety. The primary design objective is to address potential conflicts between pedestrians with vision disabilities and bicyclists.

If a bike lane is at the same elevation as a sidewalk, the sidewalk buffer zone is a critical consideration that affects usability between pedestrians and bicyclists. If the separation between modes is ineffective, pedestrians with vision disabilities can inadvertently walk from the sidewalk to the bike lane and continue into the street. This may occur where a separated bike lane continues as a shoulder bike lane.

A fundamental design decision needs to be made as to how bicycles and pedestrians travel on a corridor. The decision whether to separate or mix pedestrian and bicycle traffic should be consistent for as long on a corridor as feasible. ***At a minimum, the design separation method should extend from one intersection or major driveway crossing to another.*** The two separation methods between bicycle lanes and pedestrians are:

- Bikes and pedestrians are allowed to mix; or
- Bikes and pedestrians are not intended to mix.

944.1.1 Pedestrians and Bicycles Allowed to Mix

Where the width of the Sidewalk Buffer Zone is zero, pedestrians and bicycles should be expected to mix. There are three scenarios where bicycle traffic mixes with pedestrians.

- A shoulder or bike lane on a street that does not have a sidewalk.
- A shared use path that does not separate modes.
- A sidewalk-level separated bike lane or mode-separated shared use path.

Where sidewalks have not been provided on a street, pedestrians may use the shoulder or bike lane. No additional signing, marking or tactile indication is required to distinguish a bike lane or shoulder as a pedestrian facility.

Shared use paths shall be designed to serve pedestrians by meeting pedestrian accessibility requirements and including detectable warning surfaces at all street crossings. See Section 960 for more information. Most shared use paths do not separate pedestrians from bicyclists within the path. The expectation is that path users yield one to another within the path surface.

Some shared use paths may be designed with separate lanes for bicyclists from pedestrians. Sidewalk-level separated bike lanes can be equivalent to the mode-separated shared use path. Mode-separated paths can exist either where modes are allowed to mix, or where modes are not intended to mix. Where there is no physical separation between modes, the bike lane zone and adjacent pedestrian zone establish preferred places for users, while the expectation is that users may use the entire space and yield one to another, the same as the scenario of the shared use path without mode separation. These mode-separated paths are required to meet pedestrian accessibility requirements within the Pedestrian Zone. **Detectable warning surfaces are**

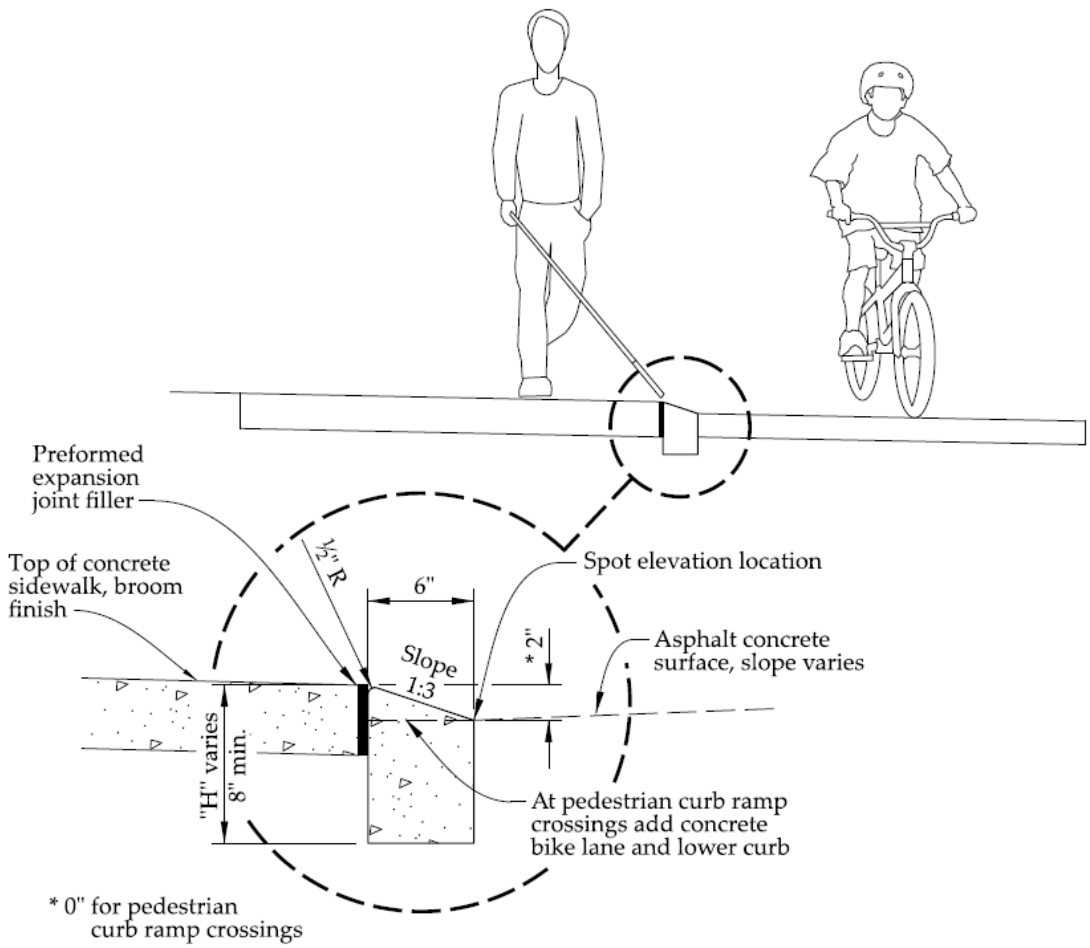
required at all street crossings for both the Pedestrian Zone and the Bike Lane Zone of Mode-Separated Paths where the Sidewalk Buffer Zone is zero.

944.1.2 Pedestrians and Bicycles Not Intended to Mix

Design the Sidewalk Buffer Zone so that the sidewalk and bike lane are distinct from one another. This is best accomplished when it is at a different elevation from the sidewalk. Normally, a curb separates the Pedestrian Zone from the Bike Lane Zone. In lieu of a curb, a horizontal buffer strip may be used to separate modes.

Where curb is used to separate modes, provide at least a 2-inch elevation difference between the pedestrian zone and the bike lane zone. See Standard Drawing RD702 for bike lane curbs.

Figure 900-6 Bike Lane Curb



Ideally, a buffer of softscaping should separate sidewalks from the bike lane. A buffer zone of street furniture can be effective if the treatment makes cross travel unlikely. Where a driveway crosses the sidewalk and sidewalk-level bike lane, there is a possibility for pedestrians to veer from the sidewalk to the bike lane if the separation between them is too narrow. **Where a buffer zone is used to separate modes (without curb), provided a minimum 2-foot landscape strip of softscaping or street furniture. At driveways, the width of the buffer zone should be at least 6-feet wide if no tactile edge is provided.**

Where the bike lane and sidewalk are side-by-side and there is no curb or buffer zone with physical separation between them, path users can be expected to intermix within that space. Since the design intent is to prevent inadvertent intermixing, a detectable edge treatment is necessary. **Work with ODOT's ADA staff to ensure that edge treatments are detectable for persons with vision disabilities.**

Section 945 The Street Buffer Zone

The street buffer is comprised of the space that separates the bike lane zone from the travelway. Tier 1 bicycle facilities and some Tier 2 bicycle facilities have a Street Buffer Zone. Other Tier 2 and all Tier 3 facilities do not. The role of the street buffer is to place a physical obstacle between moving traffic and bicycle riders. The obstacle is not to create a roadside hazard, but a visible barrier that separates bicycle and motor vehicle travel. The presence of an obstacle between traffic modes improves the sense of comfort and safety for bicycle riders while maintaining visibility and reducing traffic noise. The ideal width of the street buffer should be at least 6-feet in most urban settings regardless of the type used. ***The width of the Street Buffer Zone can be reduced to as little as 2-feet wide in constrained areas with Design Concurrence Documentation.*** If the street buffer is eliminated altogether, a Bikeway Tier is typically reduced from a Tier 1 facility to a Tier 2 facility.

Wider street buffers improve bicyclists' sense of comfort and safety, reduce noise and at night reduce headlight glare.

When determining appropriate elements within the street buffer zone, the ability for maintaining the facility shall be considered. Refer to Section 941.5 for maintenance considerations.

Since some objects in the street buffer zone may affect how oversized freight can use the roadway, this needs to be accounted for when considering which treatment is appropriate for the street buffer zone.

Table 900-9: Minimum Street Buffer Widths

Delineation Options in the Street Buffer Zone	Striping	On-Street Parking*	Raised Island	Landscaping	Other
Downtown	0′	8′	2′	3′	2'
Urban Mix	0′	8′	2′	4′	2'
Commercial Corridor	0′	NA	2′	5′	2'
Residential Corridor	0′	NA	2′	5′	2'
Suburban Fringe	0′	NA	5′	5′	2'
Rural Community	0′	8′	2′	4′	2'
Rural	0′	NA	5′	5′	2'

* On-street parking may be used as a street buffer only where on-street parking exists or is appropriate in the highway context.

Separated bike lanes include a buffer space with curb or vertical objects between the bicycle lane and motor vehicle traffic. Features that are typically located in a sidewalk buffer, such as mailboxes and hydrants, which are necessary to be accessed from the travel lanes, should be placed in the street buffer.

Figure 900-7: Separated bike lane with space for recycling cans in street buffer

Where pedestrian crosswalks cross a separated bike lane, the street buffer acts as a median island. In order to provide two sets of detectable warning surfaces, the minimum width of a street buffer island is 6-feet. If the street buffer is less than 6-feet wide, it cannot be used as a pedestrian refuge and street crossings should include the bike lane with the rest of the street crossing.

There are eleven types of separation that can be used in a street buffer. The width of the street buffer varies by the type of separation.

945.1 Striping Buffer

A Buffered Bike Lane is a facility where traffic striping alone is used to separate the Bike Lane Zone from the travelway to create a safety buffer. Bicyclists' use of the marked buffer area depends on how it is marked. ODOT's standard markings use a solid 8-inch white line on each side of the buffer zone. Accordingly, bicyclists are not intended to ride within the buffer zone. If the street buffer zone is marked so that bicycles are not precluded from operating within the street buffer zone, the increased width can enable side-by-side riding.

4 feet is the minimum width recommended for the street buffer zone in a buffered bike lane to provide a meaningful impact to bicyclist comfort when striping alone is used in the street buffer zone to separate bicyclists from moving traffic. However, buffer markings may be used where the street buffer zone is as narrow as 2-feet. Buffer markings are recommended where the sum total width for a Street Buffer Zone and Bike Lane Zone is 8 feet or greater. Where the width is 7-feet wide, configuring a bicycle lane to become a 5-foot bike lane with a 2-foot buffer zone reduces the bike lane such that side-by-side riding is not possible within the same lane. There is a tradeoff between the need to provide a visual separation from traffic and the need to provide sufficient width for bicycles to ride two abreast.

The painted buffer can separate bikes from high-speed vehicles to the left, or it can be used to separate bikes from parked cars on the right.

Figure 900-8: A striping buffer can be on the right or left of the bike lane.

Buffered bike lanes are Tier 2 bicycle facilities. When physical objects are added to the street buffer, they become Tier 1 bicycle facilities. See Section 945.5, Section 945.6 and Section 945.7.

945.2 Parking Lane

Typically, a bike lane is placed between motor vehicle lanes and a parking lane. Alternatively, the parking lane may be located between the bike lane and motor vehicle lane.

Figure 900-9: Parallel parking lane as street buffer

A parking lane street buffer is appropriate only in locations where high-use on-street parking exists or is appropriate in the street context. The context categories for an ODOT highway that may permit a parking lane street buffer are Downtowns/Central Business Districts and some areas in the Urban Mix context and Rural Community context. This configuration has the potential to provide a high level of bicyclist comfort.

A parking lane street buffer could be implemented with either diagonal street parking or parallel parking. Parallel parking is the most common.

Bike lanes that are located between a parallel parking lane and curb need to account for opening car doors and space for passengers to stand, unlock and open car doors and load or unload without encroaching into bicycle traffic. A buffer area should be marked adjacent to the parking stall. The recommended demarcated space is 4-feet, 2-feet minimum. Since the width varies for parking spaces (typically 7 feet to 9 feet), the sum of the parking space and demarcated door zone should be approximately 11 feet. If the buffer area is next to an ADA parking space, it shall meet requirements for an Access Aisle, minimum 5-feet in width.

Since it is not commonplace for drivers to park away from a curb, unfamiliar drivers might park in the bike lane zone, particularly if there are few other parked cars to align with. To remediate that risk, the following design considerations are best practices:

- Mark individual parking stalls;
- Place vertical elements (e.g., posts) in the buffer area between parking spaces;

Where parking occupancy is below a threshold, place vertical elements (e.g., raised island) to reduce the number of stalls.

945.3 Raised Island Buffer

A bike lane may be separated from motor vehicle traffic with a raised concrete island.

Providing a raised island left of a bike lane can facilitate access to amenities that are normally accessible from a vehicle lane, such as mailboxes, fire hydrants, recycling containers, and transit boarding platforms. The width of a raised island can vary to match the space available. The minimum practical width is 2-feet. Where the street buffer island is at a street crossing, detectable warnings should be provided at each side of the island when the island is at least 6-feet wide. See Standard Drawing RD1140.

Figure 900-10: Island Buffer Cross Section with Drainage Gap

A raised concrete island may be cast in place or precast. The height of a raised island is typically the same as a median island which can have standard curb or a sloped curb, such as bike lane curb. A sloped or low height curb may be considered where emergency vehicle access is necessary.

Additional shoulder width may be necessary on the vehicle side of a raised concrete island to account for shy distance to a curb. On ODOT highways, at least 1’ of shy distance along the right side of travel lanes is required at 35 mph and above. The distance that bicyclists shy away from a vertical curb is 0.5 to 1-foot and negligible shy distance for a sloped curb.

There are two ways to establish a drainage flow line with an island street buffer. The flow line may be located either between the bike lane and sidewalk – or along the side of the island with motor vehicle traffic. In both conditions, periodic gaps in the island may be provided.

945.4 Landscape Buffer

A bike lane may be separated from motor vehicle traffic with a landscaping planter strip.

The elevation of the landscaping area may be flush with the elevation of the bike lane, or it may be separated with a retaining curb to keep sediment from spilling into the bike lane. If a curb is used to separate the bike lane from the planter strip, shy distance is needed to account for people riding away from the curb. If the landscape material is flush with the bike lane (such as bark dust or gravel), additional shy distance is not necessary.

The landscaping may have gaps to provide access to amenities in the buffer area that are normally accessible from a vehicle lane, such as mailboxes, fire hydrants and empty space to place recycling containers. The width of a landscape strip can vary to match the space available. The minimum practical width is 2-feet. At a street crossing, detectable warnings should be provided at each side of the landscape buffer zone if it is at least 6-feet wide. See Standard Drawing RD1140. For transit islands, see Section L104.5 in the Bicycle and Pedestrian Design Guide.

Figure 900-11: Landscape Buffer Cross Section at Street Crossing

Typically, the landscape strip is constructed similar to a sidewalk, where the curb to the left of the landscape buffer is the drainage flow line and bike lanes are raised to a level above the street. Where the landscape does not include a curb, it may function as a water quality swale.

945.5 Delineator Post Buffer

Bike lanes may be separated from motor vehicle traffic with raised posts.

Figure 900-12: Tubular markers as street buffer

The distance that most bicyclists shy away from a raised vertical post is 2′ to 3′. While shy distance is normally required within the bike lane zone, part or all of this shy distance is located within the street buffer zone. This is the preferred distance that a post should be offset from the edge of the bike lane line.

The types of posts range from tubular markers to bollards, flexible or rigid. Posts are a traffic control device and need to meet applicable requirements and approvals for the use of the traffic control device. Posts may be mounted directly on the pavement or may be installed on top of a base support.

The posts shall be crashworthy. Damaged posts need to be removed and replaced in order to avoid being a hazard in the bicycle lane. Consult with those who must maintain the features in the street buffer zone in the future to determine that there is a commitment to keep up with the maintenance needs for delineator posts. A commitment to maintain delineator posts is critical for this street buffer option to achieve the objective to provide a comfortable riding experience. The longitudinal spacing of posts along a roadway depends on the speed of traffic, maintenance considerations and traffic characteristics. Where traffic characteristics are generally favorable, a single post on each end of a short city block, supplemented with buffer striping may be enough to provide a relatively high level of bicyclist comfort. Where traffic characteristics call for greater separation, more frequent posts are preferred; the recommended spacing is 10 to 40 feet.

945.6 Traffic Separator Curb Buffer

There are various styles of curb that may be used in a street buffer for traffic separation. A standard 2-foot wide concrete traffic separator curb is similar to a raised concrete island street buffer.

However, extruded standard curbs, dowelled parking stops and other narrow plastic traffic curbs have additional operational considerations. These narrower curbs are characterized as 0.5 to 1.0 foot wide with a height of approximately 0.5 foot. As such, they are less conspicuous at night where illumination is not provided.

Two undesirable conditions may exist if the curb is placed immediately adjacent to the bike lane or immediately adjacent to a motor vehicle lane to separate motor vehicles from cyclists. First, cyclists may hit the curb, lose control and fall onto the roadway. At night, the curbs cast shadows on the lane, reducing the bicyclist's visibility of the surface. Second, when extruded curbs are hit by motor vehicles, it causes them to break and scatter loose pieces onto the surface. They make bikeways difficult to maintain as debris accumulates. Mitigations for these conditions are:

- Place curbs in the street buffer zone a safe distance from the bike lane edge stripe. (3-feet preferred, 1-foot minimum);
- Place curbs in the street buffer zone a safe distance from motor vehicles. (3-feet preferred, 1-foot minimum);
- Add delineator posts on top of curbs at the beginning of each block.
- Use plastic curbs with rounded edges.

945.7 Planter Box Buffer

A series of planter boxes may be placed intermittently in the street buffer zone.

Figure 900-13: Planter boxes in street buffer

The distance that most bicyclists shy away from a raised planter box is 2′ to 3′. This distance is measured from the edge of the bicyclist's operating space to the nearest vertical edge.

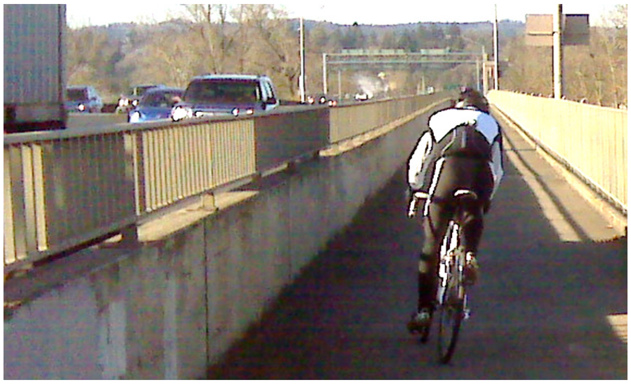
A planter box street buffer is appropriate only in locations where there is little to no history of fixed object crashes and other traffic calming measures are in place such that the presence of planter boxes is consistent with the surrounding environment. The risk for fixed object crashes is not solely dependent on low traffic speeds. Consider other low-speed crashes such as parking maneuvers, lane changes and turning maneuvers. Planter boxes should not be anchored to the pavement. In the event of a crash, planter boxes should be designed to slide rather than crumble.

The ODOT highway contexts that may permit a planter box street buffer are Downtowns/Central Business Districts and some areas in the Urban Mix context and Rural Community context. This configuration has the potential to provide a high level of bicyclist comfort.

945.8 Concrete Barrier Buffer

A concrete barrier may be used as a street buffer where it is necessary to separate high speed traffic from bicycles. The typical application of concrete barriers as a street buffer is for shared use paths alongside high-speed highways or on bridges.

Figure 900-14: Concrete barrier as street buffer



The distance that most bicyclists shy away from a concrete barrier is 2′ to 3′. This shy distance is measured from the edge of the bicyclist's operating space to the nearest vertical edge.

945.9 Guardrail Buffer

A guardrail may be used as a street buffer where it is necessary to separate high speed traffic from bicycles. The typical application of guardrail as a street buffer is for shared use paths alongside high-speed highways or on bridges.

The distance that most bicyclists shy away from a guardrail is 2′ to 3′. This distance is measured from the edge of the bicyclist's operating space to the nearest vertical edge.

Figure 900-15: Guardrail in street buffer

945.10 Drainage Swale Buffer

Where drainage is not provided with a piped storm system, roadside drainage is typically captured in a roadside ditch. This is a common street buffer for a rural location.

Figure 900-16: Roadside ditch as street buffer

See Section 963 for requirements for path shoulder requirements. A minimum 2-foot shoulder is needed alongside a path to function as a clear zone. The shy distance from a bicyclist to the side slope of a roadside ditch depends on the side slope and the depth of the ditch. If the side slope of the swale is 1:6 or less, there is little to no added impact to the shy distance within the bike lane zone. If the slope of the swale is steeper than 1:2, the distance that most bicyclists shy away from the beginning of the steep slope is 2′ to 3′. Providing 2-feet of shy space is needed from the edge of the bike lane or path away from the ditch.

945.11 Bio-swale Buffer

A water quality bio-swale may be used in the street buffer.

Figure 900-17: Bio-swale as street buffer

Bio swales tend to have a vertical drop off. The preferred shy distance from a bicyclist to a vertical drop off is 2 feet. This distance is measured from the edge of the bicyclist's operating space.

Section 946 Rural Bicycle Accommodation

In the majority of rural highway projects, the paved shoulder widths are sufficient to accommodate occasional bicycle travel. The occasional pedestrian using a rural highway is also served by paved shoulders.

Where bicycle use is higher, consideration should be given to increase the shoulder width to a minimum width of 4 feet on open shoulder and an additional foot when in-between lanes of traffic or for each side that is next to curb, guardrail or parking. When evaluating usable shoulder width, do not include the portion of shoulder occupied by rumble strips, if present.

946.1 Shoulders

Shoulders provide for safety, capacity and maintenance area along highways. Standard shoulder widths in 4R projects are listed in Table 900-10 and minimum shoulder widths in 3R projects are listed in Table 900-11.

Table 900-10: 4R Shoulder Widths

Highway Characteristics	Min. Width
Collector <400 ADT	2′
Arterial <400 ADT	4′
Collector 400 -1500 ADT	5′
Arterial 400-1500 ADT	6′
1500-2000 ADT	6′
>2000 ADT	8′
Mountainous 4-lane Expressway	8′
Other expressways	10′

Table 900-11: 3R Shoulder Widths (Based on AASHTO Minimums)

Average Running Speed	Design Year Volume (ADT)		
	<750	750 – 2000	>2000
50 mph or over	2′	3′	4′
Under 50 mph	2′	2′	4′

946.2 Designated Tourism Route Bikeways in Rural Areas

Rural (or urban) highways designated as Scenic Bikeways, National Bike Routes or other recognized bikeways should have greater attention to bicycle accommodation. Designated tourism route bikeways attract a wide range of users who vary in age, experience and ability. As noted in Section 922, three levels of bicycle user comfort and skill are recognized to affect users' decision whether to ride. It is important to provide bikeways that serve the 'interested but concerned' users along designated tourism route bikeways. Section 901 has a thorough discussion about bikeway types and a process to recommend the type of bikeway appropriate for the design user profile based on traffic conditions.

Usually, rumble strips should not be included on sections of highway that are designated tourism route bikeways but may be included where their impact on cyclists is sufficiently mitigated. See the ODOT Traffic Manual. Ongoing maintenance to keep shoulders clear should be a priority on these routes. Construction activity on shoulders of designated tourism route bikeways should make provisions to accommodate cyclists during construction or consider signed detours that may be different from motor vehicle detour routes.

Bicycle tourism is a significant industry in Oregon. Cyclists from across the nation and many other nations come to Oregon to ride on designated bikeways for recreation. Information and maps for promoted recreational bikeways are provided in Appendix E. A list of mile points, corresponding to currently designated bikeways can be found in Appendix E.

Section 947 Configuring Cross Section Space

The configuration of travel lanes on a highway may be modified to provide bike lanes within a highway cross-section that did not previously include them. This can be done by reducing the number of travel lanes, eliminating on-street parking or changing the median treatment. Reconfigured roadways from 4-lanes to 3-lanes with center turn lane and bike lanes show a significant crash reduction. Any reconfiguration of travel lanes requires Region Traffic Engineer/Manager approval and a freight mobility review as described in Appendix C. See Chapter 2 of Appendix L for specific examples of road lane reconfigurations.

[Placeholder for more content:
Evaluating Design Alternatives and Trade-offs to select a Bikeway & Hierarchy for Selecting the Next-Best Alternative]

947.1 Prioritizing Widths Between Zones

[Placeholder for future content]

947.1.1 Variability in Zone Widths

[Placeholder for future content.

This section will address:

- Passing spaces
- On-Street Parking
- Intersections]

Section 948 Two-way and Contra-Flow Bikeways

Bicycle traffic is typically accommodated in both directions of travel by providing a bike lane on each side of a road. Bike lanes on one-way streets are typically only in the direction of motor vehicle traffic. In areas of high bicycle demand, the left shoulder may be marked as a contra-flow bicycle lane when approved by the Region Traffic Manager/Engineer. Striping for contra-flow bicycle lanes are given in the ODOT Traffic Line Manual, Section 412.[11]

Three types of bikeways serve two-way bicycle travel. The first type is a shared use path that does not run parallel to a roadway. The second is a shared use path that does run along one side of a road and usually replaces the need for bike lanes on that road. This type of shared use path is referred to as a Side Path. The third type of facility is a two-way separated bike lane. A side path and a two-way separated bike lane operate similarly. The distinction is that side paths are designed to serve pedestrians, while two-way separated bike lanes are bikeways apart from pedestrian walkways.

In lieu of providing bike lanes on each side of a road, a two-way bicycle facility may be provided on one side of a road. To determine if a two-way bikeway is appropriate, evaluate if a bi-directional facility is appropriate for the location (see Section 948.1). Shared use paths that are not along a road do not need to be evaluated for one-way versus two-way operation.

Two-way shared use side paths are a preferred bicycle facility for limited access expressways or urban freeways and may be discouraged in other areas. Side paths are discussed in Section 970.

Although one-way separated paths may be intended for one direction of bicycle travel, they will often be used as two-way facilities. Caution must be used in selecting this type of facility. If needed, they should be designed and signed to promote one-way operation by bicyclists.

948.1 Evaluating One-way versus Two-Way Operation

Evaluate the following design considerations to determine whether bi-directional bicycle traffic is appropriate on one side of a roadway.

948.1.1 Driveways and Intersections Along Route

Two-way bicycle lanes and side paths are affected by each driveway and cross street approach along the route.

When bicycle traffic rides against the normal, predicted flow of motor vehicle traffic, conflicts can occur at driveways and cross streets. Crash risk is higher where cyclists ride facing traffic[26].

Bicyclists expect to proceed along a route without stopping at each driveway or minor side street. When bicyclists are required to stop or yield at cross-streets and driveways, stopping disrupts their momentum. Bicyclist's perception of safety on a protected facility may result in unexpected higher bicycle speeds when crossing intersections and driveways and in turn may increase the likelihood for crashes, especially where sight distance is limited.

Since the speed of bicyclists is faster than pedestrians, many drivers misjudge reaction time and proceed prematurely. Consequently, motor vehicles approaching side streets and driveways may proceed without noticing bicyclists.

Each vehicle approach may cause four potential conflict scenarios.

1. Approaching motor vehicles may stop on the cross-street or driveway and block the path.
2. A driver turning right from a side street or driveway may not expect to see a cyclist coming from the right.
3. A driver turning left onto a side street or driveway may not expect see a cyclist coming in the opposite direction.
4. A driver turning right onto a side street or driveway may not expect see a cyclist coming from the opposite direction.

Each conflict scenario is affected by the speed of bicycle travel along the route and whether motorists are able to notice and react.

Drivers often focus on oncoming traffic from the left without glancing to the right since motor vehicle traffic on the right is on the opposite side of the street. Thus, motorists crossing the path do not notice bicyclists coming from the direction opposite to prevailing traffic.

A bi-directional bikeway may therefore be discouraged in areas with frequent driveway or street access.

948.1.2 Transition at the Ends of Bi-directional Route

Transitions to the beginning and end of the left-side bike facility are critical to safe operation. Provide signs, markings and other traffic control as appropriate to clarify to the users that the two-way bikeway is shifting to become a one-way bikeway on each side of the street and to encourage users to cross at the designated place. If the transitions are not done properly, bicyclists are unlikely to cross to the other side of a road to use a path, bike lane or sidewalk, particularly if the length of the left-side bike facility is short. Many users are likely to use a lane on the roadway a short distance rather than cross twice. Additionally, when a two-way bicycle lane or side path begins or ends, some bicyclists riding against traffic could continue to travel on the wrong side of the street for a long distance beyond the end of the left-side bicycle facility. Wrong-way travel by bicyclists is a major cause of bicyclist-to-automobile crashes. A two-way bicycle lane or side path should not be implemented unless considerable care is taken to address safety issues posed by entering and exiting the two way facility.

To provide safe transitions to and from two-way bicycle lanes and side paths, entrances and exits from the path will require careful consideration and integration into the design. Depending on the context and origin/destinations to and from the two way facility on one side of the road, additional crossings may be needed, resulting in additional conflict zones to be mitigated. Paradoxically, the side path and its planned crossings could reduce the number of conflicts for a cyclist. Trip generation and conflict analysis is recommended.

Figure 900-18: Transition from bike lanes to side path across street uses corner to position bicycles at crosswalk.

948.1.3 Position and Sight distance

The term 'position' refers to the location of the bi-directional bike lane or side path and its user in relation to the driver on the roadway. Sight distance is critical at intersections and crossings with side paths. This is also discussed in the two previous sections. A cyclist on a two-way bicycle lane or side path, even when going in the same direction of traffic, are not within the normal scanning area of turning drivers. In addition, a cyclist riding contra to the flow does not see the signage and signals posted for roadway users that a driver and a cyclist going in the same direction see, missing valuable cues for safety. In some cases, the proximity of a side path to the roadway creates a condition where barriers or railings are needed to separate traffic. These barriers can obstruct sight distance and make it challenging for maintenance. Evaluating visual barriers at crossings is recommended.

948.1.4 Space Available

A side path should use the same design criteria as a shared use path. It is recommended to have at least a 5 foot buffer between the edge of asphalt of the roadway and the path. This may require additional right of way. Side paths can also be constrained by fixed objects, such as buildings, utilities, furniture and waterways. It is recommended to evaluate the available right of way to accommodate a side path.

948.1.5 User Compliance

Some bicyclists may choose to ride in the roadway rather than the side path because of some of the issues with conflicts discussed in this section. Bicyclists choosing to ride in the street instead of using the side path may be hassled by other road users.

948.1.6 Turns

Turning movements for cyclists on a side path are the same as for pedestrians. Generally, left turns involve yielding to cross traffic twice instead of only once and thus inducing unnecessary delay.

948.1.7 Continuity

[Placeholder for future content]

948.1.8 Conditions for a Successful Side Path

- Bicycle and pedestrian use is anticipated to be high;
- The traffic conditions (high-speed, high-volumes) on the adjacent roadway are such that on-road bikeways and sidewalks may be undesirable;
- The path can be kept separate from motor vehicle traffic, with few roadway or driveway crossings;
- There are no reasonable alternatives for bikeways and sidewalks on nearby parallel streets;
- There is a commitment to provide path continuity throughout the corridor;
- The path can be terminated at each end onto streets with good bicycle and pedestrian accommodation, or onto another safe, well designed path;
- There is adequate access to local cross-streets and other facilities along the route;
- Any needed grade-separation structures do not add substantial out-of-direction travel;
- The total cost of providing the path is proportionate to the need. This evaluation should consider the costs of grading, paving, drainage, fences, retaining walls, sound walls, crossings, signs and other necessary design features;
- Grade-separated structures needed to eliminate at-grade crossings;

At night, headlight glare is a concern.

As a result of discouraged use, few two-way separated bike lanes exist. However, in the last decade, there has been an increase in the installation of two-way separated bike lanes.

Some preliminary crash data suggests that while crash rates for two-way separated bike lanes are worse than one-way separated bike lanes, they are still lower than a shared travel lane condition.[33] Survey results indicate that separated bike lanes are preferred over shared lanes or on-street bike lanes by both cyclists and motorists[34]Another research report concludes that two-way separated bike lanes are preferable on one-way streets on the right side, rather than the left[35].

Section 949 Parallel Routes

As described in Section 912.1, by Oregon statute, bicycle facilities are required to be included wherever a public agency constructs, reconstructs or relocates a highway unless one of three exemptions is applicable. One of the exemptions is when other available factors indicate the absence of any need for bicycle facilities. **Where triggered by the scope of work, a design**

exception is required to omit a bicycle facility altogether from a highway segment cross section in favor of routing bicycle traffic onto a parallel route. If criteria in this section are met, the exception can be supported. Supporting information must include documentation of public acceptance affirming that bicycle travel is not needed along the highway corridor and that a parallel route is suitable to be used instead. When approved, ODOT can invest in improving the parallel route in lieu of improvements on the mainline highway.

If a parallel route is chosen as a solution, minimal pedestrian and bike facilities should still be provided along highways, if feasible, even when there are parallel routes. Such facilities provide access and refuge in the case of a vehicle breakdown or other emergency. It may also be needed for connections to destinations and transit stops along the highway, as well as trips by individuals who may not be familiar with the local network and the availability of the parallel route. Except in highly constrained areas, parallel routes should generally be an "alternative" additive element to the bicycle network rather than the only route option provided.

Normally, bicycle travel is accommodated with motor vehicle travel on the same highway roadbed. Where bicycle travel is accommodated on a parallel route apart from motor vehicles, this can be within the highway right-of-way or on a separate street's right-of-way. A design exception is not required where the parallel route is within the highway right-of-way.

One example is a Multiway Boulevard, which is a highway facility where medians are used to separate through travel lanes from local access lanes. The local access lane is a separate frontage road with a different speed that provides the pedestrian and bicycle facilities, and may include access to businesses, transit, or on-street parking. Bicycle lanes are not required to be duplicated on both the through facility as well as the access lane.

A Shared Use Path may function as a bicycling route that is generally parallel to a highway for transportation purposes even when it includes portions that are not in the highway right-of-way. Typical examples are paths that run along riparian corridors or parallel to an expressway. If portions of path within ODOT right-of-way are intermittent because the continuation of the path is outside of ODOT right-of-way, and the connected path as a whole functions to serve the transportation needs, a redundant bicycle facility within ODOT right-of-way is not required. See further information in Section 970.

There are two main conditions where parallel routes may be considered on another street right-of-way. First, where the role in the highway is that of a limited access route, typically, bicycle travel is better served on a route parallel to expressways and freeways than on the shoulder and the limited access route does not serve the mobility and access needs of bicyclists. Second, there are occasions when it is infeasible or impractical to provide bike lanes on a busy thoroughfare.

In both these cases, bicyclists should not be precluded from the state highway or signed onto other local routes because of constraints. However, in some locations bicyclists may prefer to travel on alternate routes. Tier 2 bikeways without buffers and Tier 3 bikeways are not ideal on roads with travel speeds greater than 45 mph. If a well-connected parallel on-street bike network is provided, the highway shoulder may be sufficient to accommodate the occasional cyclist, without requiring a separate bicycle facility. A shoulder is still required to facilitate bicyclists to access businesses. A well-connected parallel on-street bike network can serve the bicycle trips if access to the highway is provided.

The following are conditions to determine if it is appropriate to provide facilities on a parallel local street in lieu of the mainline:

- A bicycle facility on the state highway falls into one of three categories:
  1) Conditions exist such that it is not economically or environmentally feasible to provide adequate bike lanes on the mainline; OR
  2) Mainline does not provide adequate access to destinations; OR
  3) Bike travel on mainline would not be considered safe.
- Parallel route must provide continuity and convenient access to facilities served by the mainline;
- Costs to improve parallel route should be no greater than costs to improve the mainline; and
- Proposed facilities on parallel route must meet state standards for bike facilities.
- Adequate facilities on proposed parallel route must exist before a Bike Bill design exception based on 'other available ways' can be approved. Planned future improvements to bring a parallel route up to state standards are not acceptable.

The above criteria should be satisfied and considered along with other factors when considering parallel routes for the provision of bike access and mobility.

If a parallel route is determined to be the best alternative, determine whether a parallel route already exists or whether improvements would be necessary to meet the needs for bikeway access and bicycle network connectivity. Determine whether providing bike lanes on the parallel route requires acquiring right-of-way.

Strategy 2.1B in the statewide Oregon Bicycle and Pedestrian Plan allows ODOT to invest in infrastructure in lieu of improving bicycle facilities on a state highway under certain circumstances. It says:

When local planning processes have, in consultation with ODOT, identified a local parallel bike route, and a bikeway on the state highway is determined to be contrary to public safety, is disproportionate in cost to the project cost or need, or is not needed as shown by relevant factors and therefore justified to be exempt from ORS 366.514 based on one of those statutory exemptions, ODOT will work with the jurisdictions to support the development of the parallel route and assure reasonable access to destinations along the state highway. ODOT and the local jurisdiction may enter into an agreement in which ODOT helps to fund, in negotiation and partnership with the local jurisdiction, construction of the bikeway in the vicinity of the state highway project that serves as an alternative or parallel route to the highway project.

949.1 Parallel Route Design

[Placeholder for section]

This section will include design treatments to be provided onto parallel city streets (off-highway) to ensure that the bikeway meets the connectivity and access needs to replace the transportation function of the mainline.

The content may simply reference the Bike & Ped Design Guide for Bike Boulevard design.

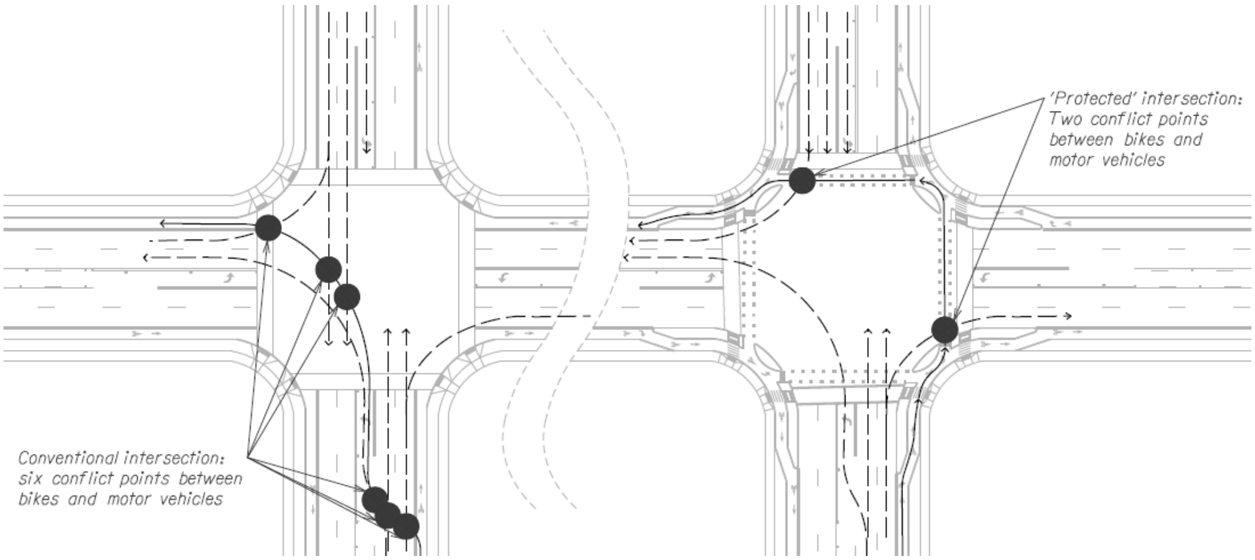
Section 950 Intersection Design

For a thorough and detailed discussion on intersection design, see Part 500. The following discussion will help the designer understand some of the key intersection design features that help enhance the safety and convenience of bicyclists. Other intersection design principles for pedestrians and bicyclists are discussed in detail in sections 224.1, 830.5 and Section 920 and in Appendix L, pages 6-1 and 6-5.

Section 951 Interaction Between Modes

Most conflicts between roadway users occur at intersections, where one group of travelers crosses the path of others. Good intersection design minimizes and mitigates conflict points and clearly identifies right of way between motorists, pedestrians and bicyclists. The way that bicyclists execute a left turn affects the number of conflict points at an intersection. Intersections can be designed per Section 953 to accommodate bicycles in a distinctly separate track from motor vehicles to reduce conflicts and enable space for two-stage left turns.

Figure 900-19: Conflict Points at Conventional versus Protected Intersection



The complexity of an intersection also affects the ability for vision-impaired pedestrians to orient themselves using traffic sounds. Where possible, it is best for intersection legs to connect at as close to 90-degrees and with a radius as small as feasible. The radius should safely accommodate turning movements for a design vehicle that is expected regularly at the intersection. Truck aprons can be used where larger vehicles may be expected. Where channelized right turn lanes are used, it often creates an unprotected crossing, and the skew angle can reduce driver yielding to pedestrians that can be difficult for vision-impaired pedestrians.

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Section 952 Intersection Sight Distance

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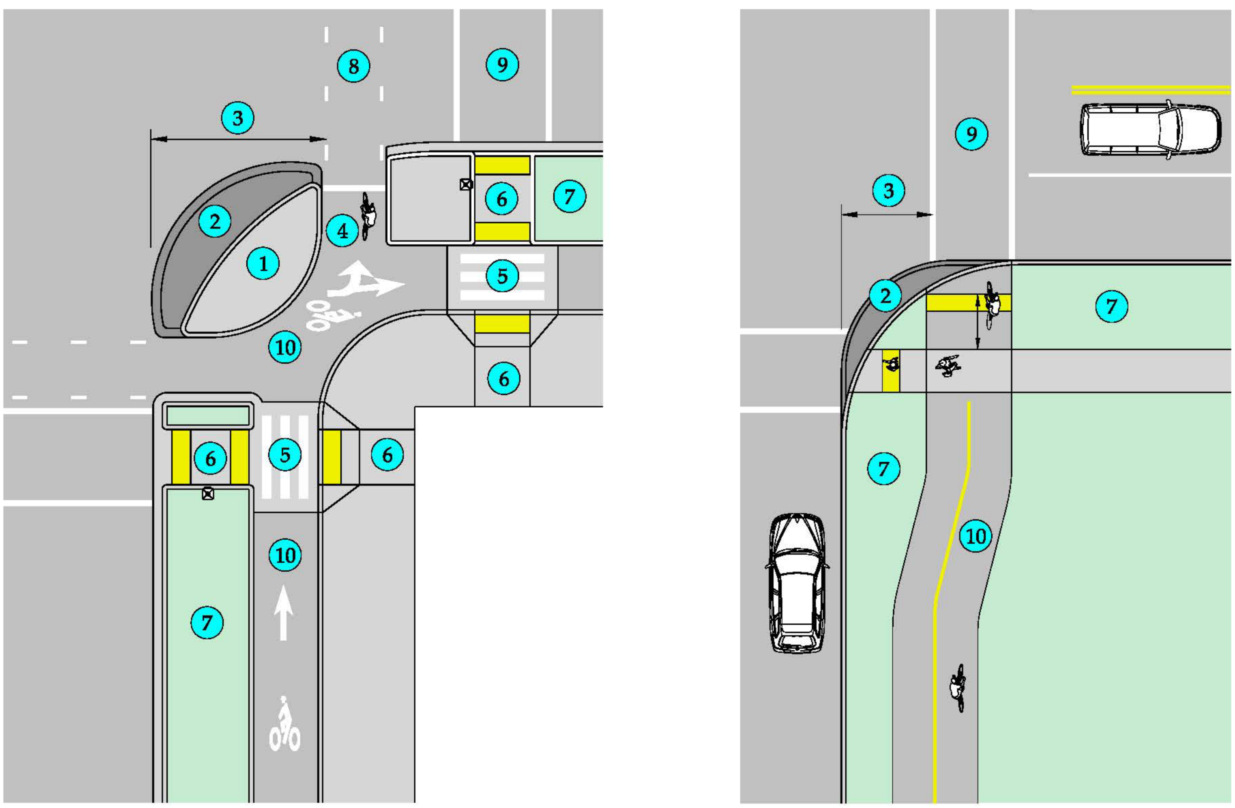
Section 953 Protected Intersections

A 'protected' intersection uses traffic islands between bicycle and motor vehicle lanes to reduce and segregate conflicts and facilitate two-stage left turns where bicyclists would not be comfortable entering the left turn lane. It clearly designates the right-of-way between modes and improves predictability. Bicyclists travel parallel to pedestrians in bicycle lanes that are separate from the pedestrian crosswalk and separate from the motor vehicle lane. 'Protected' intersections are the preferred intersection configuration where approaching bike lanes are separated or buffered from motor vehicle traffic. Where approaching bike lanes are not separated or buffered, a transition at the intersection can enable this configuration. When an intersection includes the elements that define a 'protected' intersection, the number of potential conflicts and the area of the potential conflict zone between bicycles and motor vehicles is reduced. These defining elements are shown in Figure 900-20. Where a street has a shared use paths rather than bike lanes, some of the design elements can be included in the intersection design.

There are two main purposes for a 'protected intersection'.

- Mitigating unprotected conflicts between through bikes and right or left turning vehicles;
- Facilitating two-stage left turns for bikes in a protected space.

Figure 900-20: Protected Intersection Design for Separated Bike Lanes and Side Paths



953.1 Design Elements of a Protected Intersection

Ten design elements are shown in Figure 900-20. These include:

1. Corner Island
2. Truck Apron

3. Motorist Yield Zone
4. Advance Bicycle Stop Line with Queuing Area
5. Crosswalk in Bike Lane
6. Detectable Warnings on each side of the Bike Lane
7. Refuge Across Street Buffer
8. Extension of Bike Lane in Street Crossing
9. Crosswalk
10. Bicycle Path Alignment Geometry

953.1.1 Corner Island, Truck Apron and Motorist Yield Zone

The corner island has three functions. First, it positions bicyclists to create an advance stop line. Second, it shifts the crossing away from the intersection corner to create a Motorist Yield Zone. Third, it establishes the curb line for vehicle turns in lieu of the corner radius. The radius of the corner island should allow the design vehicle to turn without encroaching onto the island. Since the curb radius can affect vehicle turning speed, a truck apron may supplement the corner island to control turning speeds for vehicles other than the design vehicle. When vehicles turn, the size of the corner island should enable a vehicle to stop and wait for bicycles without blocking traffic. The optimal motorist yield zone distance is 6-feet to 16.5 feet. The corner island should maintain sight lines between turning vehicles and bicyclists.

953.1.2 Advance Bicycle Stop Line with Queuing Area

The advance bicycle stop line has two functions. First, it positions bicycles to be clearly visible to drivers who are stopped at the stop bar and who are turning. The positioning also helps approaching bicyclists. Second, it functions similar to a left turn bike box for side-street traffic to wait with stopped mainline bicycle traffic, while being outside of the path of cross street bicycle through traffic. The minimum length of the queuing area is 6-feet, measured from the corner island to the bike lane. If the available space for a queuing area is less than 6-feet, bicycles may block through side street bicycle traffic.

953.1.3 Pedestrian-Bicycle Conflict Area Features

Several design elements are necessary to separate bicycles from pedestrians to ensure pedestrian accessibility and manage conflicts between pedestrians and bicyclists. As described in Section 944, pedestrian features depend on whether or not bicyclists and pedestrians are intended to mix. If the modes are intended to remain separated, provide a crosswalk in the bike lane with curb ramps on each side of the bike lane and increase the width of the street buffer to function as a refuge island with pedestrian signal pushbuttons in the island area. If bicyclists and pedestrians are intended to mix, as in a shared use path, the curb ramps shall be equal in width to the approaching shared use path and must comply with ODOT ADA criteria for curb ramps. In both cases, the street buffer should be of sufficient length and width to accommodate bicycles stopped without encroaching into the side street bike lane or sidewalk.

Where bicycles and pedestrians are kept separate, provide space for an extension of the bike lane in street crossing parallel to the crosswalk. Where the modes are mixed, a crosswalk is sufficient for both.

953.1.4 Bicycle Path Alignment Geometry

The design speed for the alignment of the bicycle path through the Protected Intersection area should be reduced since bicyclists must slow down to cross conflict areas. Where the width of the street buffer is increased to create a 7-foot wide refuge island, the alignment of the bike lane shall include horizontal curves. The widening of the street buffer zone, which thereby shifts bicycle traffic further from the travel lanes is called “bend-out deflection.” The beginning of the bend-out deflection is determined by the length necessary to create a 7-foot refuge island.

953.2 Retrofitting with Protected features

[Placeholder for section]

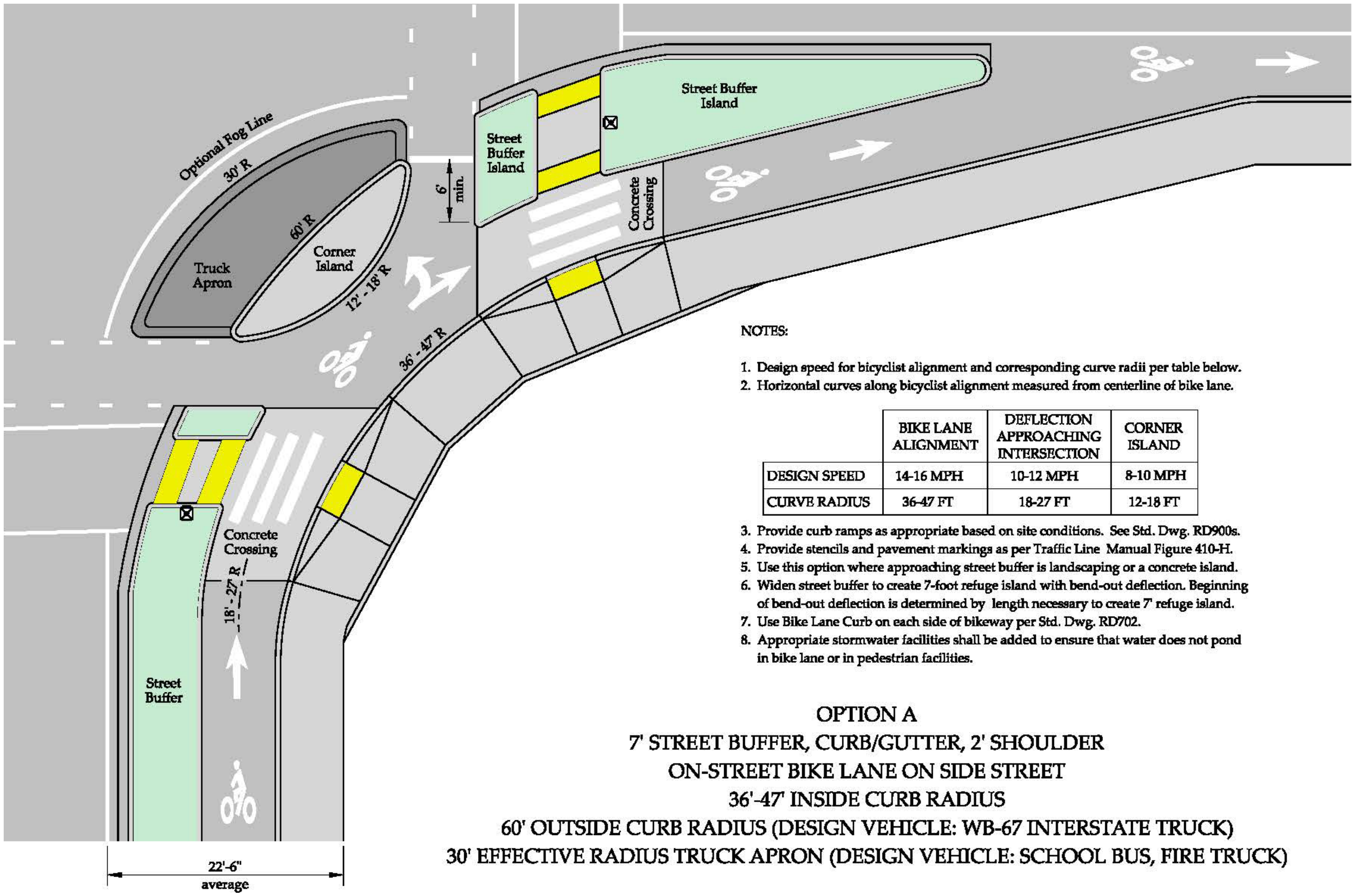
Protected intersections should be considered when upgrading intersections, even if the approaches don’t currently have separated or buffered bike lanes because the segments can be upgraded later in coordination with pavement preservation or other efforts.

953.3 Protected Intersection Layouts

The following example designs illustrate how the design features of a protected intersection may be applied at an intersection. These examples are not comprehensive.

953.3.1 Protected Intersection Layout with Wide Buffer

Figure 900-21 Protected Intersection with 7-foot Street Buffer



NOTES:

1. Design speed for bicyclist alignment and corresponding curve radii per table below.
2. Horizontal curves along bicyclist alignment measured from centerline of bike lane.

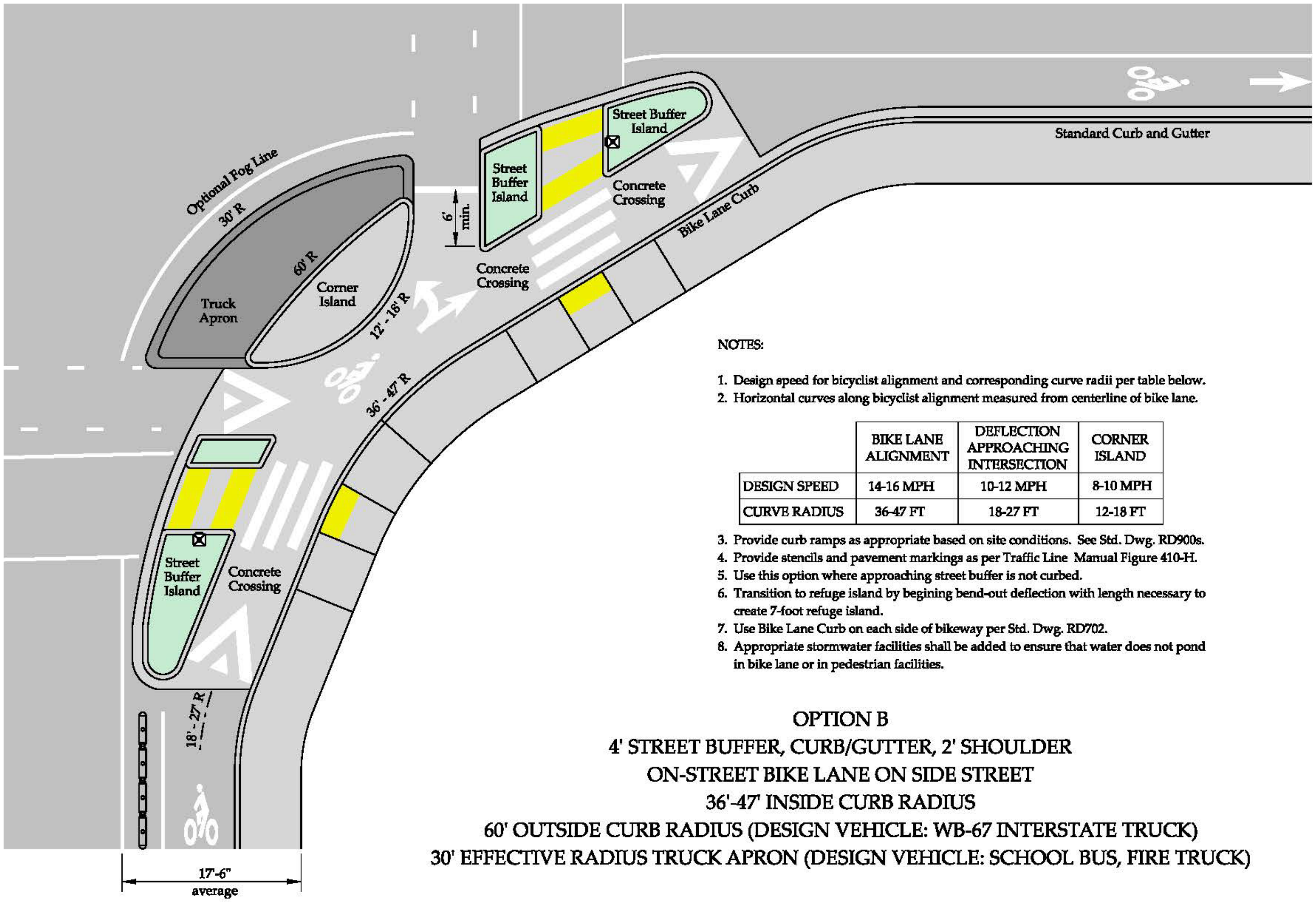
	BIKE LANE ALIGNMENT	DEFLECTION APPROACHING INTERSECTION	CORNER ISLAND
DESIGN SPEED	14-16 MPH	10-12 MPH	8-10 MPH
CURVE RADIUS	36-47 FT	18-27 FT	12-18 FT

3. Provide curb ramps as appropriate based on site conditions. See Std. Dwg. RD900s.
4. Provide stencils and pavement markings as per Traffic Line Manual Figure 410-H.
5. Use this option where approaching street buffer is landscaping or a concrete island.
6. Widen street buffer to create 7-foot refuge island with bend-out deflection. Beginning of bend-out deflection is determined by length necessary to create 7' refuge island.
7. Use Bike Lane Curb on each side of bikeway per Std. Dwg. RD702.
8. Appropriate stormwater facilities shall be added to ensure that water does not pond in bike lane or in pedestrian facilities.

OPTION A
7' STREET BUFFER, CURB/GUTTER, 2' SHOULDER
ON-STREET BIKE LANE ON SIDE STREET
36'-47' INSIDE CURB RADIUS
60' OUTSIDE CURB RADIUS (DESIGN VEHICLE: WB-67 INTERSTATE TRUCK)
30' EFFECTIVE RADIUS TRUCK APRON (DESIGN VEHICLE: SCHOOL BUS, FIRE TRUCK)

953.3.2 Protected Intersection Layout with Narrow Buffer

Figure 900-22 Protected Intersection with Narrow (2′) Street Buffer



NOTES:

1. Design speed for bicyclist alignment and corresponding curve radii per table below.
2. Horizontal curves along bicyclist alignment measured from centerline of bike lane.

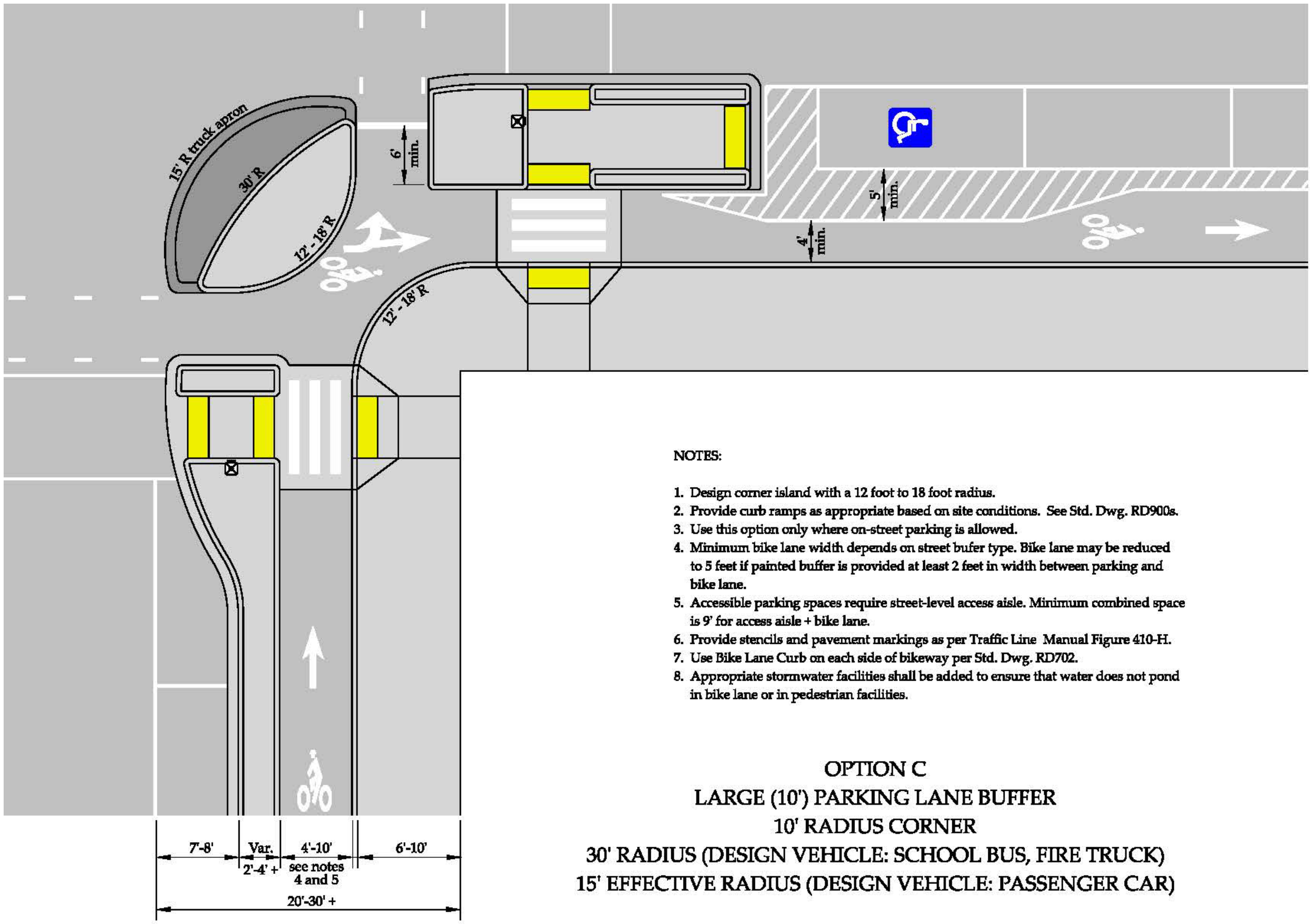
	BIKE LANE ALIGNMENT	DEFLECTION APPROACHING INTERSECTION	CORNER ISLAND
DESIGN SPEED	14-16 MPH	10-12 MPH	8-10 MPH
CURVE RADIUS	36-47 FT	18-27 FT	12-18 FT

3. Provide curb ramps as appropriate based on site conditions. See Std. Dwg. RD900s.
4. Provide stencils and pavement markings as per Traffic Line Manual Figure 410-H.
5. Use this option where approaching street buffer is not curbed.
6. Transition to refuge island by begining bend-out deflection with length necessary to create 7-foot refuge island.
7. Use Bike Lane Curb on each side of bikeway per Std. Dwg. RD702.
8. Appropriate stormwater facilities shall be added to ensure that water does not pond in bike lane or in pedestrian facilities.

OPTION B
4' STREET BUFFER, CURB/GUTTER, 2' SHOULDER
ON-STREET BIKE LANE ON SIDE STREET
36'-47' INSIDE CURB RADIUS
60' OUTSIDE CURB RADIUS (DESIGN VEHICLE: WB-67 INTERSTATE TRUCK)
30' EFFECTIVE RADIUS TRUCK APRON (DESIGN VEHICLE: SCHOOL BUS, FIRE TRUCK)

953.3.3 Protected Intersection Layout with On-Street Parking

Figure 900-23 Protected Intersection with Parking Buffer



Section 954 Conflicts at Turn Lanes

Bicycle lanes shall not be placed to the right of a right-turn only lane or to the left of a left-turn only lane, unless conflicting movements are mitigated. Mitigations include traffic signal control, geometric alignment, or grade-separation. Solutions with geometric alignment are discussed in Section 954.1.

954.1 Freeway-style Ramp Crossings

Conflicts between motor vehicles, pedestrians and bicyclists often occur at interchange areas due to the high volume of vehicle turns. To mitigate potential conflicts, the design of intersections serving freeway entrance and exit ramps should keep turning speeds slow and maximize visibility between bicyclists and motorists. Turning speeds are slowest at right-angle intersections and where the corner radius is minimized. The route of the bicyclist should be visible to the motorist. Skewed approaches also increase the crossing distance. Free-flow ramps should be avoided. Where they exist, physical features should be used to enhance sight lines and encourage slowing and yielding behaviors. Physical features may include minimized corner radius or truck aprons. Signs may be considered to further enforce the yield condition for unprotected pedestrian and bicycle crossings. Consider grade separation or signalization when there is either two-lane right or left turn lanes or where free flow ramps are utilized. Other interchange design principles for pedestrians and bicyclists are discussed in detail in Appendix L, pages 6-20 to 6-25.

Pedestrian and bicycle traffic must be accommodated through interchange areas to avoid freeways creating gaps and barriers in the local walking/biking network.

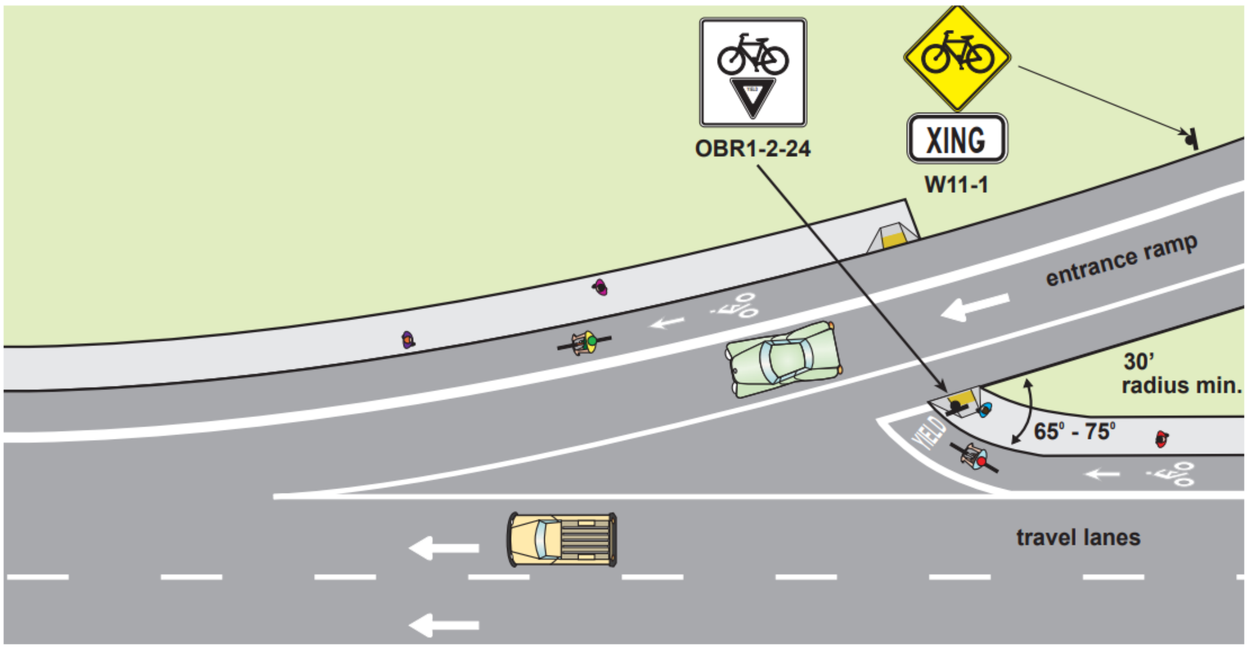
While bike lanes and sidewalks are not appropriate on limited access freeways, they are common on urban parkways, which often have freeway-style designs such as merging lanes and exit ramps rather than simple intersections. Traffic entering or exiting a roadway at high speeds creates difficulties for bicyclists and pedestrians. The following designs help alleviate these difficulties.

954.1.1 Right Lane Merge

It is difficult for cyclists and pedestrians to traverse the undefined area created by right-lane merge movements, because the acute angle of approach reduces visibility, motor vehicles are accelerating to merge into traffic and the speed differential between cyclists and motorists is high.

The design should guide cyclists and pedestrians in a manner that provides: a short distance across the ramp at close to a right angle; improved sight distance in an area where traffic speeds are slower than further downstream; and a crossing in an area where drivers' attention is not entirely focused on merging with traffic.

Figure 900-24: Bicycle Lane across Merge Area

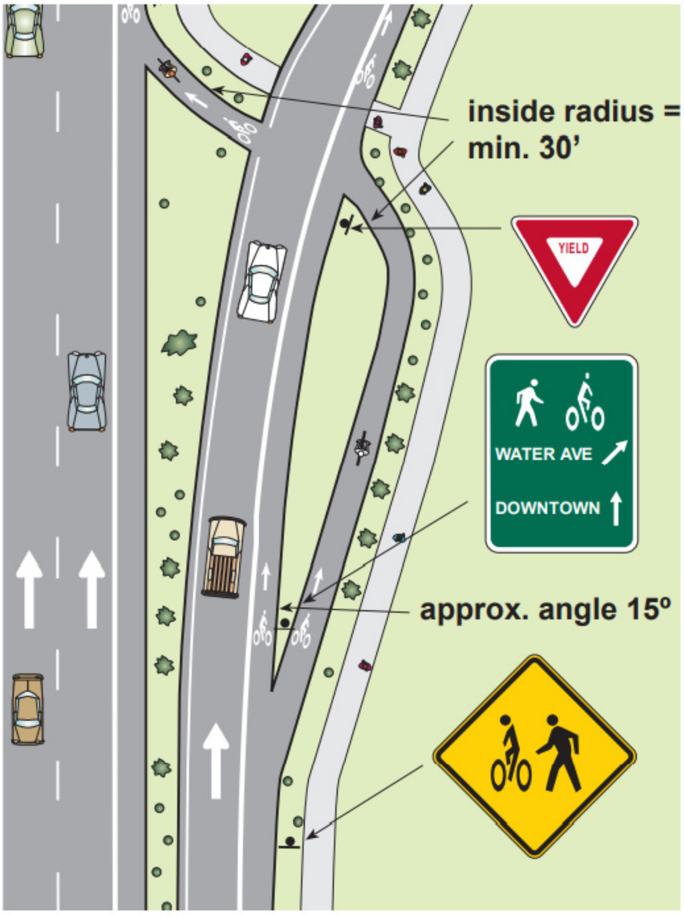


954.1.2 Exit Ramps

Exit ramps present difficulties for bicyclists and pedestrians because motor vehicles exit at fairly high speeds, the acute angle reduces visibility; and exiting drivers who don't use their turn signal confuse pedestrians and cyclists seeking a gap in traffic.

The design should guide cyclists and pedestrians in a manner that provides: a short distance across the ramp, at close to a right angle, improved sight distance in an area where traffic speeds are slower than further upstream; and a crossing in an area where the driver's attention is not distracted by other motor vehicles.

Figure 900-25: Bicycle Lane across Exiting Lane



Section 955 Bikeway Street Crossings

[Placeholder for future content]

955.1 Side-street Bike Route Crossings

[Placeholder for future content]

955.2 Off-Highway Trail Network Crossings

Many recreational shared use paths cross the state highway system as part of a trail network. Bicyclists often use these shared use paths as transportation links. Highways that cross these pathways should have access to the trail network. If a highway has a separate grade crossing with a pathway, provide a short path connection from the pedestrian and bicycle facilities along the highway to the pathway. See Appendix L, pages 7-13 through 7-16 for at-grade path crossings. See Appendix L, pages 7-13 through 7-16 for design guidance on under crossings and over crossings.

955.3 Grade-Separated Crossings

Though grade-separation appears to offer greater safety, the excessive added travel distance and grade change often discourages pedestrians who want to take a more direct route. A grade separated crossing must offer obvious advantages over an at-grade crossing to ensure that they will be used and justify the significant additional cost.

A structure that is unused because it is inconvenient or feels insecure creates a situation whereby pedestrians are at greater risk when they attempt to cross the road at-grade; drivers don’t expect pedestrians to be crossing the street if they see an overcrossing.

The additional distance is substantial: 17.5 feet of clearance is required over some highways; the added depth of the structure results in a 20-foot high bridge. ADA requires ramps to not exceed a 5 percent grade. Twenty feet of rise at 5 percent requires a 400-foot ramp in level terrain, for a total additional distance of 800 feet for both sides, approximately equal to two city blocks of out-of-direction travel. Higher clearance may be required over railroad tracks. This can be mitigated with stairs with a bike channel, or a series of ramps and landing with a level landing for every 2.5 feet in rise. Overcrossings are more successful where the roadway to be crossed is sunken.

Under crossings introduce two other issues that must be addressed: security and drainage. Security can be addressed by ensuring generous dimensions, good visibility and lighting. Drainage often requires a sump pump to ensure year-round operation. Under crossings are more successful where the roadway to be crossed is elevated. In both cases the pedestrian crossing is level. Undercrossing should be at least 10 feet high and 14 feet wide.

955.4 Crossbikes

[Placeholder for future content]

Section 960 Shared Use Path Design

Shared use paths are facilities for people to walk, jog, run, stroll, skate, bike, and use any of various mobility devices while being physically separated from a roadway. When a pathway is intended to serve bicycle travel together with pedestrian travel, it is a shared use path. The terms “shared-use” and “multi-use” are interchangeable. The terms “trail”, “path”, and “greenway” are often used interchangeably to refer to shared use paths, notwithstanding the term “trail” having other design connotations, which are different from shared use paths. See Section 850 for trail design. Shared use paths serve two purposes; one is providing a basic transportation need to get to destinations and the second is providing a place for recreational activity. Some shared use paths may include accommodation of additional users, such as equestrians. (See Section 855).

A shared use path is not a sidewalk. In some locations, a shared use path exists while a sidewalk or bike lane also exists. However, it is more common that the shared use path takes the place for both the pedestrian facility and the bicycle facility. When pedestrians and bicyclists share a sidewalk, appropriate multi-use or shared path guidelines are employed for the design. Shared use paths are designed to be fully accessible for all users for the entire width of the walkway.

Attributes of shared use paths:

- Are physically separated from motor vehicle traffic by an open space or barrier.
- Typically, do not physically separate the different user modes with a detectable edge.
- May include signs or markings to indicate which side of the path is for pedestrians versus bicyclists.
- Have the entire space equally available to all users.
- Are typically designed for two-way travel. Users can intermingle in opposing directions of movement.
- Have all-weather prepared surfaces to meet pedestrian accessibility route requirements.

960.1 Shared Use Path Configurations

Figure 900-26 illustrates various shared use path configurations as well as a similar configuration that is a separated bike lane, rather than a shared use path.

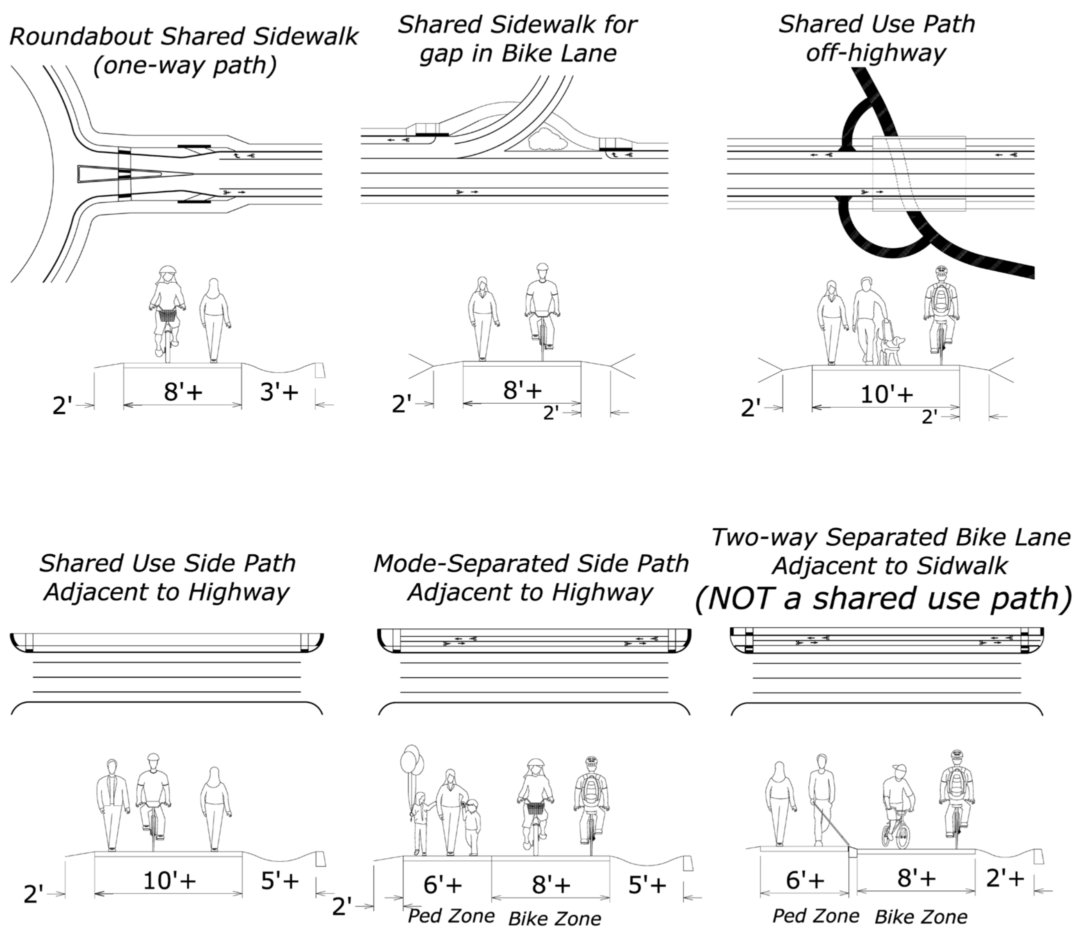
The top left and top middle illustrations are wide sidewalks that are shared with bicycle traffic. Where a bicycle lane joins a sidewalk, see Section 981.

The bottom row illustrates three scenarios with facilities within the highway right-of-way where pedestrians and bicyclists are physically separated from the travel way realm. Side paths are shared use paths that are parallel and adjacent to a road. Side path design is described in Section 970. Mode-separated side paths are described in Section 971. Two-way separated bike lanes adjacent to sidewalks are not shared use paths, though the operations are similar. They are also described in Section 971. Considerations for two-way bicycle facilities (side paths and separated bike lanes) are given in Section 948.

The top right illustration is a shared use path that is apart from a highway. It may include connections to a highway, or it may be entirely on an independent alignment. Where a shared use path is on an independent alignment that may or may not be on public right-of-way, well planned and designed shared use paths can provide access and mobility to pedestrians and bicyclists in areas where the roads don't serve their needs. They can have their own alignment along streams, canals, utility corridors, abandoned or active railroads, and greenways. Many serve as linear parks. Shared use paths can serve both utilitarian and recreational cyclists.

Sections 961 through 968 have design information that apply to shared use paths on independent alignments as well as side paths. Section 921.2 has design information for restricting motor vehicle encroachment on a path with bollards and design at rail crossings. See Chapter 7 of Appendix L for additional information. In addition to design requirements in this manual, consider guidance in the AASHTO Guide for the Development of Bicycle Facilities[15].

Figure 900-26: Types of Shared Use Path



Section 961 Path Width

Shared use paths outside a highway are not divided into zones as are sidewalks and bikeways. For paths along a highway, the path width substitutes for the sum of the pedestrian zone and the bike lane zone. The footprint of a path includes shoulder/shy distance as discussed in Section 963. The standard path width is the paved portion of the path, and typically does not include the shoulder/shy distance. **10 feet is the minimum standard width for a shared-use path**; *they should be at least 12 feet wide or more in areas with high use*. Table 900-12 gives recommended shared use path widths based on anticipated volume of users. The minimum width for a path, through a design exception, is 8 feet; only to be used at pinch points or where long-term usage is expected to be low.

Table 900-12 Recommended Shared Use Path Widths

Shared Use Path Peak Hour Volume	Recommended Width (feet)
Less than 50	8*
50 to 150	8 to 10*
150 to 300	10 to 12
300 to 500	12 to 15
500 to 600	16 to 20
Over 600	Over 20

*Design Exception required where width is less than 10 feet.

Design Exceptions are required for path widths less than 10-feet or shoulder/shy distance less than 2 feet. An ADA Exception is required where a path grade is steeper than 5 percent for paths that are not on the same alignments with an adjacent roadway.

The entire width of a shared use path shall be clear of obstructions. Additionally, sidewalks that include bicycle traffic mixed with pedestrian traffic should have the sidewalk **clear** width to allow for a minimum width multi-use pathway condition. Clear widths less than 6 feet require a design exception. In locations where bicycle riding on the sidewalk is prohibited by statute, appropriate signage is necessary to inform bicyclists.

Provide a clear width in the range between 10 feet – 12 feet on shared use paths. *10 feet is the standard width for a two-way shared-use path; they should be 12 feet wide or more in areas with high use.* **Provide 8 feet of clear width on shared sidewalk connection paths.** When pinch points occur or where long term usage is expected to be low, 8 feet is the minimum clear width for shared use paths and requires a design exception.

When mode separation is desired between pedestrians and bicyclists, additional width is required. **Provide a clear width between 14 feet and 20 feet for mode separated shared use paths.** *It is preferable to provide at least 16 feet of clear width comprising of two 5-foot bike lanes and a 6-*

foot walking area (pedestrian zone). Provide 18 or 20 feet in areas of very high use. While mode separation is provided typically with striping, low vision and blind pedestrians will need additional tactile cues to guide them to the intended area along the path. The entire width of the facility must still meet ADA cross slope and running slope (grade) requirements. Expect pedestrians to cross over and meander over the entire area, mode separation is best achieved with some grade separation via curb (refer to Section 944).

At roundabout approaches, bike lanes should ramp up to the sidewalk. The shared sidewalks operate as shared use paths, though bicycle travel is intended to be one-way while travel for pedestrians is intended to be two-way. Widen the sidewalk to 10 feet, minimum 8 feet. **Provide a bike ramp to allow bicyclists to merge from the bike lane onto the shared use path 165 feet in advance of the yield line to the circulatory roadway of a roundabout.** See Section 981 for bike ramp design.

Section 962 Path Users

Though shared-use paths are intended for many users, the bicycle is the appropriate design vehicle because of its higher travel speeds. The design speed for pathway segments shall be assigned by the ODOT Region Roadway Manager. See Section 924.1. Design speeds for shared use paths impact other design elements including sight distance and horizontal and vertical curves.

For trails that accommodate horses, consult the Equestrian Design Guidebook for Trails, Trailheads and Campgrounds[36].

Section 963 Path Clear Zone, Lateral Clearance, and Shy Space

The space on each side of a paved path surface affects how much of the path people use. Where steep side slopes, or objects are placed alongside the path, users tend to shy away from using the entire path width. Additionally, where obstructions such as signs or poles exist alongside a path, the shoulder functions similar to the clear zone that is necessary for a road to enable vehicles to recover without crashing into an object.

The purpose of a path's clear zone is to preserve the functionality of the entire path width and to minimize the likelihood of injury if users run off the path. The clear zone consists of the path shoulder and the side slope and regulates how close objects may be placed on the sides of the path. The space abutting the paved path should enable path users to ride or step on it without ankle twisting or losing balance and that does not result in loose gravel or other material being tracked onto the path. The space alongside a path that is clear of obstruction functions as shy distance. Where shy space alongside a path is not clear of obstruction, the useable width intended for path users and their level of comfort is reduced.

A 2 foot shy distance on both sides of a shared-use path should be assumed as the minimum physical space requirement to achieve the required lateral clearance when scoping a path project. *It is necessary to have 3 feet or more at locations where signs or other objects are planned alongside the path*.

The first 3-feet beyond the pavement on each side of a paved path function as shy distance for the path. However, it is not necessary that the entire 3-foot space be included within right-of-way so long as the space does not hinder the clear shy space with objects such as bushes, trees, or other vertical obstructions. The path should be abutted with graded and compacted material, such as gravel, flush to the path. At least the first 1-foot shall be graded at 1:6 or flatter. The entire shy space should be as level as practical to allow recovery by errant path users. **The maximum side slope in the first 3-feet of the path's shoulder shall be 1:2**. This applies to cut-sections, where falling debris can accumulate, stimulating weed growth, further restricting the available width. **Poles or sign posts shall be placed a minimum distance of 2-feet away from the paved path edge**. Objects, other than protective barrier, placed less than 2 feet from the path edge may be acceptable through a design exception. **Protective barriers, such as bicycle railings or fences shall be placed at least 1-foot from the path edge.** *In constrained conditions, in lieu of a gravel shoulder, the pavement may extend up to the constraint with a portion of the paved path marked with a white edge line to delineate some lateral clearance on that side.*

The standard clearance to overhead obstructions is 10 feet, **min. 8 feet** where fixed objects or natural terrain prohibit the full 10-ft clearance.

Where a path is parallel and adjacent to a roadway, there should be a 5-foot or greater width separating the path from the edge of roadway, or a physical barrier of sufficient height should be installed.

Section 964 Stopping Sight Distance

Stopping sight distance for bicyclists is the distance necessary for a bike to come to a full stop. Most objects along a shared use path segment do not encompass the entire width of the path and would not require complete stopping. The most common reason that stopping sight distance is necessary along a path is when groups of bicyclists ride together side-by-side. They can move into single file to avoid a hazard when they are able, but when the limited space is occupied by opposing path users, someone may have to come to a full stop to avoid collision.

Determination of stopping sight distance is based on a bike coming to a stop on wet pavement from the design riding speed and having taken 2.5 seconds to react prior to applying the brakes. The distance to stop is less when people travel at lower speeds, are on dry pavement, or react quicker than 2.5 seconds. Since the risk of injury is related to bicyclist speed, it should be noted that the need for a bicyclist to come to a full stop rather than travel around an obstruction is disparate from the likelihood that the bicyclist would be traveling at a faster design speed. An adult cyclist riding alone typically rides faster than an adult riding with children or a group of adults riding together, while the need for stopping is most common with group riding since an individual might weave around an object within the available width of the path.

Design exceptions are required to justify stopping sight distance around horizontal and vertical curves.

$$S = 3.67V + \frac{V^2}{30(f + G)}$$

Where,

S = stopping sight distance (ft)

V = design speed (mph)

f = friction factor (assume 0.16 for a typical bicycle)

G = grade in (ft/ft)

Section 965 Horizontal Alignment

Typically, simple horizontal curves shall be used on shared use paths. Curve radii are measured from the center of the shared use path. There are two ways to calculate the minimum radius of curvature along a shared use path. One way is to calculate based on the lean angle. The other way is to calculate based on superelevation rate.

Bicyclists lean to prevent falling outward due to forces associated with turning movements. Two-wheeled bicycles are typically the fastest users on a shared use path. Twenty degrees is the typical maximum lean angle for most riders of two-wheeled bicycles. The deflection angle (Δ) is another factor affecting the safe travel of bicycles on a horizontal curve. Deflection angles greater than 90 degrees require additional caution as inertial forces begin to act in the opposite direction from the beginning of the curve. Bicyclists entering these curves at higher speeds could risk running into opposing path traffic, riding off the outside edge of the path or falling over from turning forces.

Some bicycles (cargo bicycles, tricycles and bikes with trailers) have three or four wheels and are not able to lean. Users of these types of bicycles tend to be slower. In order to check that these users are accommodated, the superelevation method should be used at a speed 2 to 4 mph slower than the design speed.

Superelevation rate is equivalent to the cross slope of the path. Because a shared use path is also a pedestrian facility, paths must not exceed 2 percent cross slope in order to meet accessibility requirements. **The maximum superelevation rate (design cross slope) on a shared use path (shared with pedestrians) is 1.5 percent.** If a shared use path is physically separated with different tracts for pedestrians and bicyclists, the superelevation allowed for the bicycle-portion of the path may be increased up to 8 percent. **The maximum superelevation rate (design cross slope) for a bicycle-only path is 8.0 percent.**

Equation 900-1 - Radius of Curvature Based on Lean Angle

$$R = \frac{0.067V^2}{\tan\theta}$$

R = radius of curvature.

V = design speed. See Section 924 for selecting the appropriate design speed;

θ = the lean angle, typically 20 degrees.

Equation 900-2 –Radius of Curvature Based on Superelevation Rate

$$R = \frac{V^2}{15 \times (e + f)}$$

R = radius of curvature.

V = design speed. See Section 924 for selecting the appropriate design speed;

e = cross slope, expressed as decimal (e.g., 1.5% = 0.015)

f = coefficient of friction

Where the deflection angle of the horizontal curve is 90-degrees or less, the ODOT design standard for minimum radius of curvature is based on a lean angle. Where the deflection angle of the curve is greater than 90 degrees, the ODOT design standard for minimum radius of curvature is based on the superelevation rate using the design cross slope. The minimum radius recommended for shared use paths is provided in Table 900-13. A design exception is required to justify where the minimum radius of curvature is not achieved.

Table 900-13: Minimum Radius of Curvature for Horizontal Curves

Design Speed (mph)	8	10	12	14	16	18	20	22	24	26	28	30
Minimum Curve Radius (feet) at 20° Lean Angle	12	18	27	36	47	60	74	89	106	124	144	166
Minimum Curve Radius (feet) at 1.5% superelevation	12	20	30	42	57	74	96	122	151	184	222	267
Minimum Curve Radius (feet) at 5.0% superelevation*	11	18	27	37	50	65	86	108	132	161	194	231
Minimum Curve Radius (feet) at 8.0% superelevation*	10	17	25	34	46	60	78	98	120	145	174	207
Friction factor (f)	0.33	0.32	0.31	0.30	0.29	0.28	0.26	0.25	0.24	0.23	0.22	0.21

* Superelevation above 1.5% only to be used on paths not shared with pedestrians.

If design curve radius does not meet the design standard, based on the chosen design speed, consult the ODOT roadway unit in the Region tech center or the Technical Services Roadway Engineering Unit to discuss whether a design exception is needed.

If the minimum radius of curvature is not achieved using the standard method, the alternative method may be checked and used as support for a design exception. The lean angle method typically yields a smaller radius, except when the superelevation is above 5 percent. Back-calculating the speed for which bicyclists may safely traverse a curve is another way to support a design exception when the radius is not achievable. Another strategy to mitigate sharp horizontal curves is to straighten the horizontal alignment by adding tangent sections between curves so that deflection angles are under 90-degrees. Sharp horizontal curves can be mitigated by adequately informing path users to be cautious and slow around the curves. Typical mitigations include a centerline stripe and warning signs.

965.1 Horizontal Sightline Offset

People bicycling need a clear line of sight around obstructions that may reduce the sight line in a horizontal curve. **Evaluate stopping sight distance throughout the alignment of a horizontal**

curve. The lateral clearance to an object alongside a path is a Horizontal Sightline Offset (HSO). The equations below check whether an object impedes the sight distance of a horizontal curve and indicates the minimum clearance for horizontal curve line-of-sight obstructions based on curve radius and stopping sight distance. If keeping this line of sight clear is not practical, consider widening the path through the curve, installing a centerline stripe, installing warning signs or a combination of these alternatives.

Equation 900-3 Horizontal Sightline Offset (HSO) for Horizontal Curve

$$HSO = R\left[1 - \cos\left(\frac{28.65 \times S}{R_i}\right)\right]$$

Equation 900-4 Back-Calculation of Stopping Sight Distance from Horizontal Sightline Offset

$$S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R - HSO}{R_i}\right)\right]$$

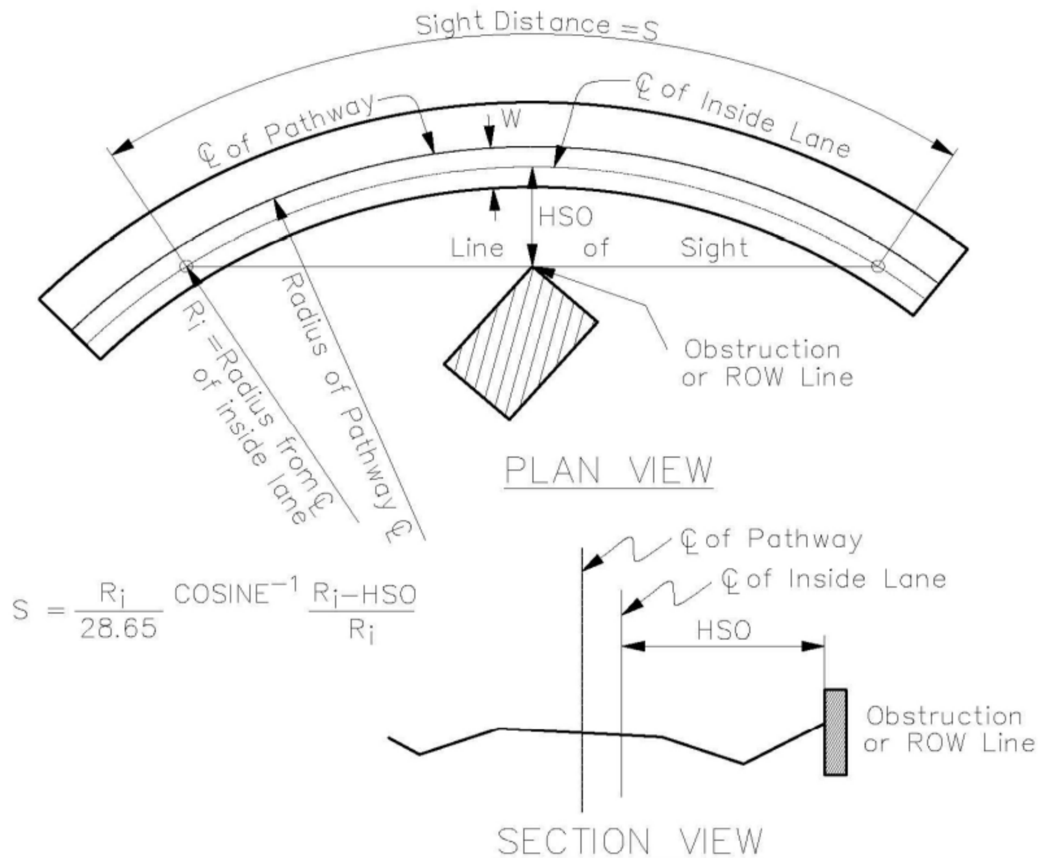
Where:

HSO = Horizontal sight line offset, distance from centerline of lane in path to obstruction (feet)

S = sight distance (feet)

R_i = Radius of curve, from centerline of inside lane in path (feet)

Figure 900-27: Horizontal Sightline Offset



(*Figure taken from Colorado Roadway Design Manual[16], Figure 14-32)

Section 966 Vertical Alignment

The minimum length of a crest vertical curve is based on the distance needed to provide minimum stopping sight distance. Below are the formulas to calculate the curve length needed based on stopping sight distance on crest vertical curves. This formula typically uses a person's eye height of 4.5 feet on a standard bicycle. A recumbent bicycle may be used as an alternative design vehicle for vertical curves because the 3.8-foot eye height of a person using a recumbent bicycle is lowest among bicycle types, which in turn limits the sight distance over crest vertical curves.

Equation 900-5 Length of Vertical Curve to Provide Stopping Sight Distance

$$L = \frac{A \times S^2}{100\left(\sqrt{2 \times h_1} + \sqrt{2 \times h_2}\right)^2} \; when\ S\ is\ less\ than\ L,$$

$$OR$$

$$L = 2 \times S - \frac{200\left(\sqrt{h_1} + \sqrt{h_2}\right)^2}{A} \; when\ S\ is\ greater\ than\ L.$$

Where:

S = stopping sight distance for flat grade (feet)

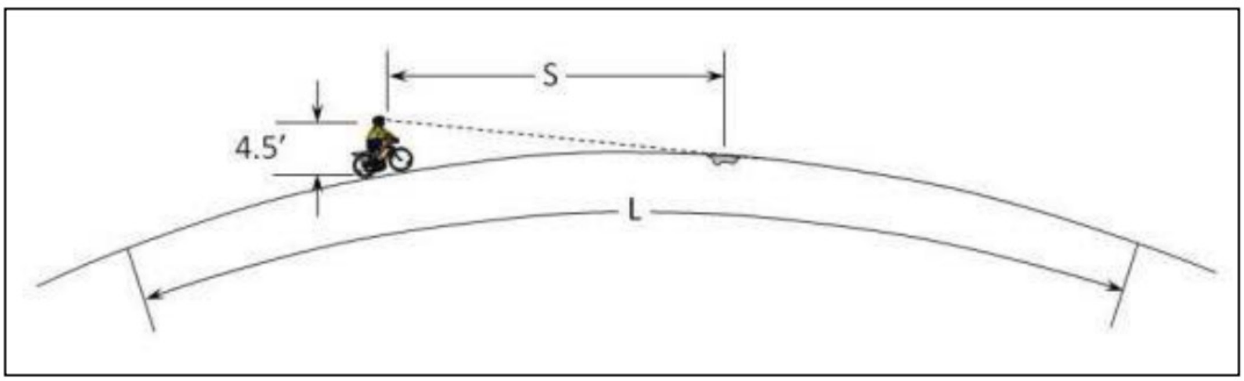
L = length of crest vertical curve (feet)

A = algebraic difference in grades (%)

h_1 = eye height of a bicyclist. 4.5 feet for standard bicycle

h_2 = height of object above roadway surface, 0 ft

Figure 900-28: Sight Distance on Crest Vertical Curve



(*Figure taken from Colorado Roadway Design Manual[16], Figure 14-33)

966.1 Path Grade

The grade of a shared use paths shall be 5.0 percent or less, except at ramps or along a road. The best practice is to design the alignment of a path lower than 5.0 percent in order to minimize the chance that it will exceed 5.0 percent when constructed. Concrete paths may be designed at 4.5 percent and asphalt paths may be designed at 4.0 percent in order to provide construction tolerance.

Shared use paths located along roadways above 5 percent grade may follow the grade of the road. **When the shared use path is parallel with the mainline highway alignment, the walkway shall not exceed the roadway grade.**

An ADA design exception is required where a vertical grade is designed to be steeper than 4.5 percent (5.0 percent finished surface) on shared use paths that are not on the same alignments with an adjacent roadway. To meet ADA requirements, the grade of separated shared use path shall not exceed 5.0 percent.

Where right-of-way and geometric constraints make the provision of a continuous grade less than 5 percent impractical, grades should be minimized and require a design exception for justification. Where potential grades exceed 5 percent, intermittent level resting intervals should be considered. Where provided, resting intervals shall be full width of the shared use path and 60 inches long. Alternatively, a 36-inch wide resting interval may be located adjacent to the shared use path. Recommended maximum distance between resting areas is 200 feet.

Where sustained grades exceeding 4 percent in excess of 300 feet in length are required, an increased design speed should be used. Additionally, consider providing mitigating measures including hill warning signs, wider clear recovery areas adjacent to the shared use path; and additional width to allow some users to dismount and walk their bicycles. Alternatively, consider installing a series of switchbacks to reduce the longitudinal grade. Transitions between grades with more than 2 percent algebraic difference can be made with vertical curves. The minimum length for a vertical curve on a shared use path is 3 feet.

Section 967 Path Surface

The surface material should be packed hard enough to be usable by wheelchairs, strollers, and children on bicycles (the roadway should be designed to accommodate more experienced bicyclists). Recycled pavement grindings provide a suitable material. The surface material must meet ADA surface requirements for the full width of the shared use path.

Refer to section 810.8 on Walkway Surfacing. Depth of asphalt construction of a walkway is shown in the RD600 series for shared use path pavement details. Shared use paths occasionally need to allow access for maintenance vehicles which will increase the asphalt pavement foundation and final surfacing depths.

Section 968 Path Cross Slope and Superelevation

Sharp curves should be banked with the high side on the outside of the curve to help bicyclists maintain their balance. The standard design cross-slope is **1.5 percent (2.0 percent finished surface)** to provide drainage, **in a crown section or shed section**.

Section 969 Path Transitions

Transitions to the beginning and end of the left-side bike facility are critical to safe operation. See discussion in Section 948.1.2.

Section 970 Side Path Design

When designing shared use paths that run alongside a highway, there are design and operational challenges. See Section 948.1 for a list of considerations for side paths and two-way separated bike lanes. The design of a side path must consider each conflict point along the path. Aside from conflict point mitigation, side paths shall meet most design requirements for shared use paths. Rather than shoulder/shy distance on both sides of the path, one side of the path is adjacent to the road. Section 945 discusses the Street Buffer Zone. The required width of a street buffer zone applies to separated bike lanes. However, if a shared use path is provided in lieu of a separated bike lane, there is a minimum street buffer width of 5-feet. **Where a path is parallel and adjacent to a roadway, there should be a 5-foot or greater width separating the path from the edge of roadway, or a physical barrier of sufficient height should be installed**.

[Placeholder for future content; specific side path design, incorporate Michigan side path guide[27]]

Section 971 Mode-Separated Side Paths and Two-way Separated Bike Lanes

The minimum total width required for a mode-separated path is described in Section 961. The typical 16-foot section is comprised of two 5-foot bike lanes and a 6-foot walking area. 18 or 20 feet are needed in areas of very high use.

A mode-separated side path is equivalent to a two-way separated bike lane alongside a sidewalk. This type of facility is sometimes referred to as a cycle track. They are used extensively in Europe on major arterials and are characterized by a physical separation from both motor vehicle traffic and pedestrian traffic. Both vertical and horizontal elements are used to separate modes. Sidewalk must be present in order for the separated bike lane to serve bicyclists only. Two-way separated bike lanes require special attention to traffic operations at intersections such as bicycle signals and two-stage left turn devices.

Section 944 discusses two alternatives, how to design a facility where bicycle and pedestrian traffic are side-by-side. The design is dependent on the fundamental decision whether pedestrians and bicycles are allowed to mix, or pedestrians and bicycles are not intended to mix. A two-way separated bicycle lane is a mode separated side path.

Section 901 discusses considerations for one-way versus two-way bicycle travel on one side of a road.

Section 961 through Section 968 include design standards for shared use paths.

Section 980 Bicycle Ramp Design

Sections 981, 982, 983 discuss where to use Bicycle Ramps, configurations.

[Placeholder for future section discussing slopes, etc.]

Section 981 Bike Lane to Shared Use Path

A bike lane may separate from motor vehicle lanes onto a separate alignment to bypass obstacles such as merging lanes, transit stops, a parking lane or the circulatory roadway of a roundabout but rejoin as an on-road bikeway. Bike lanes may also be separated from the roadway as speed, volume and heavy vehicle percentages increase, in order to partially mitigate the speed differential between modes. Means of path separation include horizontal and/or vertical elements. A bike lane may also diverge from the travel way beyond the edge of pavement and join the sidewalk. It serves bicyclists in one-direction, but it serves pedestrians in both directions. In each of these scenarios, a bicycle ramp is required to transition bikes into a pedestrian area.

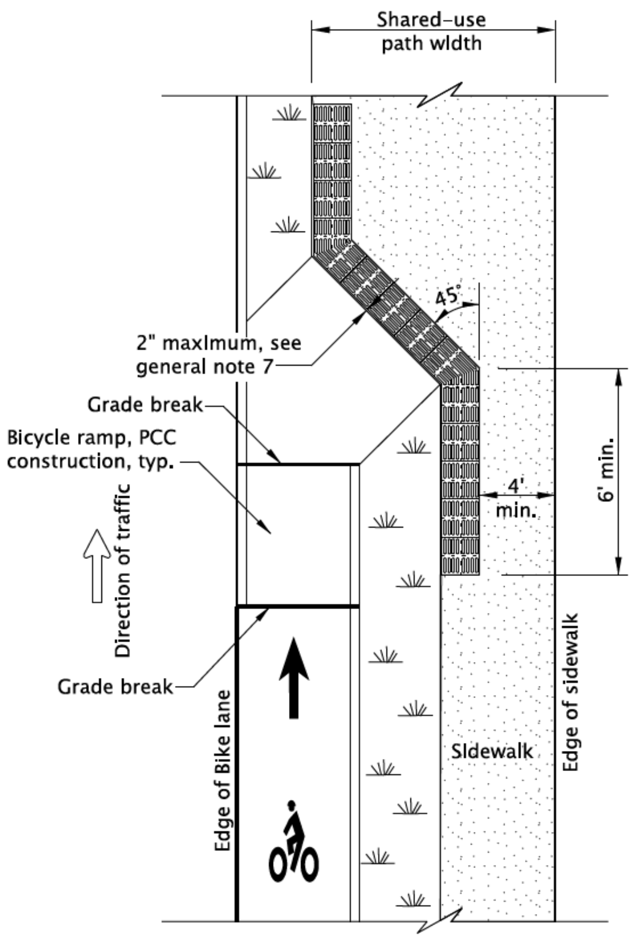
In general, bicyclists will be given a choice to enter a roundabout as a vehicle and occupy a lane until exiting the roundabout, or to use the sidewalks and crosswalks with pedestrians. For these bicyclists, a bike ramp is provided through the curb zone to exit the bike lane on approach to the roundabout and use the walkway and crosswalks in the manner of a pedestrian. This walkway results in a shared use path for a small segment along the central circle. The bike ramp is not required to be fully accessible however many of the geometrics are similar as power assisted mobility devices may travel in the shoulder under the ORS and could enter the shared use path with these sloped ramps. Bike ramps are not intended for pedestrians and requires additional treatments to communicate to the low vision and blind community it's intended use and function. Bike ramps can be confused with pedestrian curb ramps by vision impaired pedestrians. A tactile walking surface indicator shall be included adjacent to bicycle ramps. At roundabouts, add a bike ramp to merge from the bike lane onto the shared use path 165 feet in advance of the yield line to the circulatory roadway of a roundabout. See Part 500, Section 509 and Appendix L, Figure 1-40.

Bicycle ramps only serve bicycle traffic. If there is no sidewalk on the approach to a roundabout, the ramp to a path serving the roundabout functions for both bicyclists and pedestrians. Use a pedestrian curb ramp rather than a bicycle ramp in that case.

An important function of bicycle ramps that merge with shared use paths is the interface between people walking and biking. In order to mitigate the potential for sight-impaired pedestrians to inadvertently walk into a bike ramp, a tactile edge detection is needed along the border of the sidewalk or shared use path. One option for a detectable boundary is to use detectable guide strips. See Standard Drawing RD909. A tactile walking surface indicator shall be included adjacent to bicycle ramps (See section 825.2).

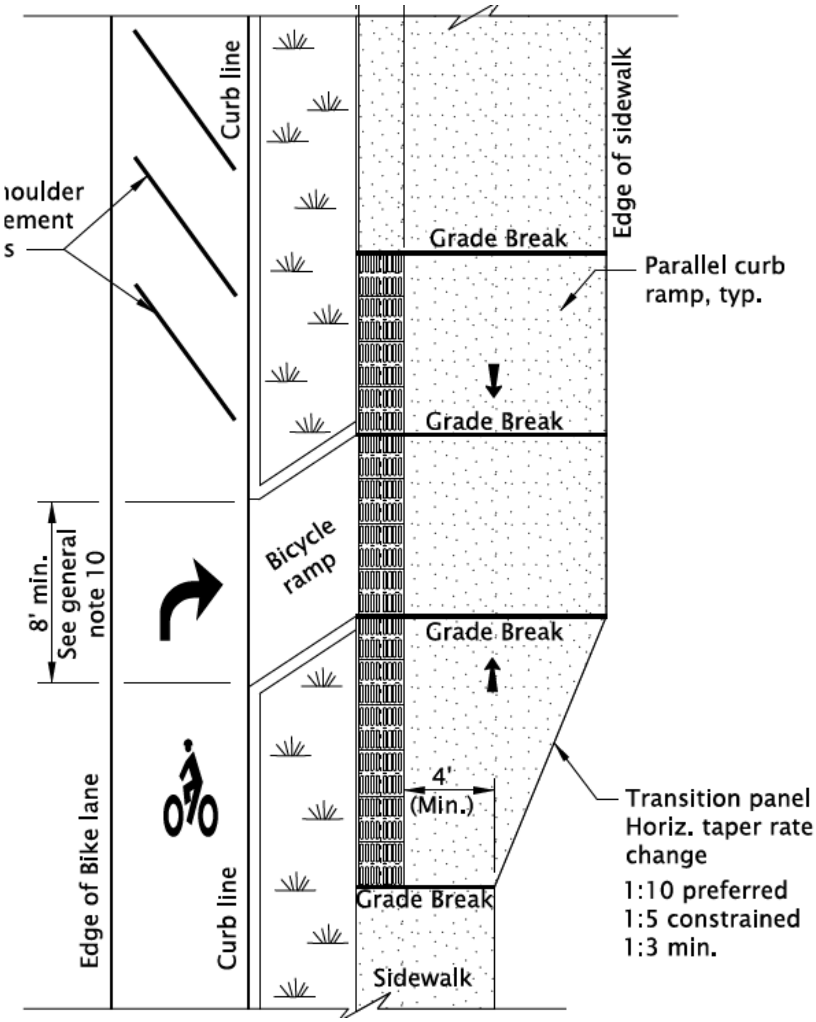
Where a bike ramp is in line with the approaching bike lane, the bike ramp may be equal in width to the approaching bike lane. See Figure 900-29.

Figure 900-29 Bicycle ramp to Shared Use Path (Bike Lane Drops)



Where a bike ramp requires bicycles to move parallel to the bike lane, **provide a minimum 8' wide ramp from the bike lane to the path.**

Figure 900-30 Bike Ramp Parallel to Path



Section 982 Bike Lane to Raised Bike Lane

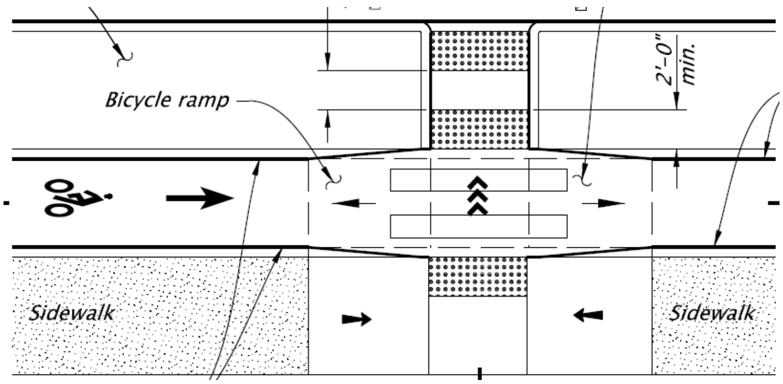
[Placeholder for future content] See Standard Drawing RD1140.

Section 983 Bike Lane at Raised Crossings

[Placeholder for future content]

See Standard Drawing RD1140 Raised crosswalks and raised intersections.

Figure 900-31 Bicycle Ramp to a Raised Crosswalk



Section 984 Bike Lanes at Transit Stops

Transit trips begin and end with a walk or bike ride. Pedestrian and bicycle facilities in transit corridors make transit systems more effective. Therefore, high priority should be given to providing sidewalks and bikeways on transit routes and on local streets feeding these routes. Bus stops should provide a pleasant environment for waiting passengers, with shelters, landscaping, adequate buffering from the road and lighting and may also include bike parking. Bus stop design should minimize conflicts with other non-motorized users, such as bicyclists on bike lanes or pedestrians walking past passengers waiting to board.

Where transit runs along streets with bike lanes, there are four ways that transit stops interact with a bike lane:

- Transit vehicle stops in bicycle lane;
- Transit vehicle crosses bicycle lane to enter a pull-out;
- Transit boarding area is a boarding island and pedestrians cross bicycle lane to enter boarding area;
- Bicycle lane exits onto sidewalk in a shared space.

Due to the dwell time at transit stops, the average running speed of a transit vehicle can be very similar to the average speed of a bicycle rider. As a result, people on bikes often experience a leapfrog effect, where they pass a transit vehicle while it is stopped, are passed by the transit vehicle shortly afterward, and then pass it again having caught up to its next stop. This cycle can continue as long as they continue along the same corridor. Even if a bicyclist stops and waits for the boarding and alighting, the bicyclist will typically catch up to the transit vehicle at the next stop to have the same dilemma repeat itself.

A typical conflict along such a transit corridor occurs when a bus stops in the bike lane. While the bike lane is blocked, bicyclists can either stop behind the bus and wait or attempt to pass on the left. On high speed or high traffic facilities, passing opportunities might be stressful and risky. When the bus re-enters traffic, a bike could be in the bus driver's blind spot. Since bicyclists are vulnerable users, there's more risk of personal injury at stake with a sideswipe crash than there is between two motor vehicles.

There are two transit stop configurations that minimize the leapfrog effect. Either a transit vehicle crosses the bike lane to enter a pull out or the transit boarding area is in a separate island such that pedestrians cross the bicycle lane to enter the boarding area. This is referred to as a 'floating bus stop'.

See Section L107 in Appendix L, the Bicycle and Pedestrian Design Guide for Floating Bus Stop Design.

Section 990 Parking

All modes of transportation, except walking, utilize a transportation vehicle that can be used insofar that the vehicle can continue traveling or be left alone at the user's destination. Once the vehicle is parked, the user becomes a pedestrian and requires accommodations to serve pedestrians.

Section 991 Vehicle Parking

On-street parking is part of the Transition Realm. Where on-street parking is permitted, the bike lane may be placed between parking and the travel lane or between the parking lane and sidewalk. Separated bike lanes with on-street parking as a buffer are described in Section 945.2.

Motorists are prohibited from using bike lanes for driving and parking but may use them for emergency avoidance maneuvers or breakdowns.

Diagonal parking can cause conflicts with bicyclists: drivers backing out have poor visibility of oncoming cyclists and parked cars obscure other vehicles backing out.

This is mitigated by the slower traffic speeds found on streets with diagonal parking, and cyclists ride close to the center of the adjacent travel lane. Bike lanes may be placed next to diagonal parking if the following recommendations are implemented:

- The parking bays are long enough to accommodate most vehicles, or long vehicles are prohibited;
- A 4 inches stripe separates the bike lane from parking; and
- Enforcement actively cites or removes vehicles encroaching into the bike lane.

Consider back-in diagonal parking: Back-in diagonal parking creates conditions advantageous to all traffic, including bicyclists: drivers can pull into the traffic stream with a good view of oncoming traffic, including bicyclists.

Note: approval from the State Roadway Engineer is required for diagonal parking.

Section 992 Bicycle Parking

Bicycle parking is necessary for people on bicycles to access destinations. Peoples' decision whether to bicycle can be greatly influenced by the presence of secure bicycle parking. While most bicycle parking may be outside of the highway right-of-way, bicycle parking within the public right-of-way is often desirable in areas with land use destinations. Bicycle parking should either be in clear sight from the bikeway or directional signage should be used so that people park in the designated bike parking rather than tied to appurtenances in the sidewalk buffer zone. Some bicycle racks may be placed with greater spacing to accommodate cargo and adaptive bicycles, which are larger. Many bicyclists use a series of transportation modes. Consider installation of bicycle parking at park and ride lots and transit stops.

Bicycle racks must be designed so that they:

- Don't bend wheels or damage other bicycle parts;
- Accommodate high security U-shaped bike locks;
- Allow users to secure the frame and both wheels;
- Support the frame at two locations;
- Don't obstruct pedestrians (especially when bikes are parked);
- Are covered where users will leave their bikes for a long time; and
- Are easily accessed from the street and protected from motor vehicles.

The simplest, easiest to install and most effective bike rack is the "inverted U" or "staple." Both fulfill all of the above design requirements. To establish a theme or motif, "art racks" are often created to add whimsical and artistic touches to otherwise perfunctory bike racks. In many cases they function well for bike parking, and don't interfere with pedestrian travel. But some racks have features that make it difficult to lock a bicycle securely or protrude too far into the pedestrian's path of travel. The best art racks are variations of the commonly accepted inverted U or staple designs.

When providing bicycle racks for Elementary School sites, use a child bicycle or BMX bicycle as a design vehicle. Ensure that the front and rear wheel of these smaller bicycles are close enough to the two bars of the bicycle rack to properly secure both wheels and frame to the rack. Ensure that some adult-sized bicycles can be secured as well.

Bicycle parking areas within a site may include signs that teach users best practices how to securely park their bicycle.

Curb extensions create good opportunities to provide bicycle parking out of the pedestrian zone, especially in areas where sidewalks are narrow. They also benefit from the proximity of a curb ramp at the corners. The parking should be placed where it will not obscure visibility of pedestrians crossing the street, or motorists waiting to enter a street.

Where there is insufficient room on the sidewalks to provide sufficient bicycle parking without cluttering the pedestrian zone, bicycle parking can be provided in the street. One parallel car parking spot can provide parking for up to 12 bicycles. It must be buffered by bollards, curb extensions or other forms of positive protection.

For additional bicycle parking design criteria, see Chapter 3 of Appendix L.

Section 993 Parking Other Micro Mobility Devices

People who travel using segways, skateboards, longboards, scooters and other small devices may bring them into their destinations. However, some businesses do not allow them inside and providing parking may enable people to use these other modes of transportation. Conventional bike parking may not function well for other devices. Where a known demand exists for another mode of transportation, parking may be considered in the right-of-way to serve that transportation mode.

[Placeholder for future details for design criteria to provide parking for each device]

Section 994 Bike and Scooter Share Stations

Bike share and scooter share services are characterized as systems where people generally rent a bicycle or a scooter from a docking station or hub and ride to another hub near their destination. Dockless systems allow users to stow the self-locking shared transportation device anywhere the user decides. This relies on the plentiful provision of adequate unused space on sidewalks to be used as potential bike share or scooter share parking. These systems can make trips on mass transit more viable when transit stops are not located as close to destinations as users prefer. A preferred location for bike share and scooter share stations is in proximity to transit stops where feasible.

Where docking share systems exist, a docking station or hub can be designed similar to bicycle parking. In addition to the siting criteria for bike parking, a docking station may also require electrical power and may include information kiosks and pay stations. Pay stations need to meet ADA requirements for operable parts: they require a clear space a minimum of 2.5′ x 4′ with a maximum 2 percent cross slope and controls within a 10-inch horizontal reach from a height between 15″ and 48″ above the ground. Docking stations may be located in an on-street parking space or within the sidewalk buffer zone. A minimum 6-foot clear space outside of traffic is needed for people to pull a bicycle out of a docking station.

Section 995 Trailhead Design

[Placeholder for future content]

Trailheads are locations where recreational bicycle trips begin but may have initiated with a motor vehicle. Design features include design for automobile parking, bicycle parking and amenities for bicycle travel such as restrooms, repair stands, water fountains, information kiosks, etc.

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