



Technical Report for the
**Provo Bicycle
Master Plan**

Prepared for:



Prepared by:



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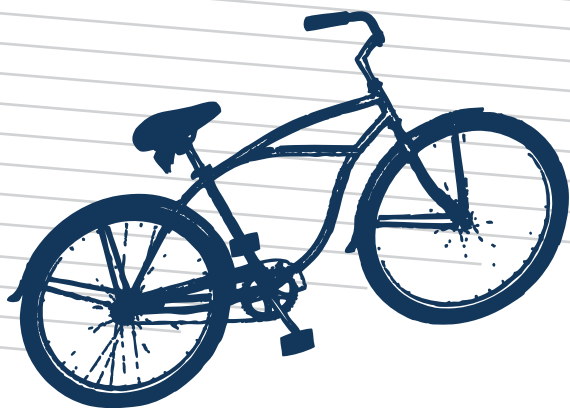


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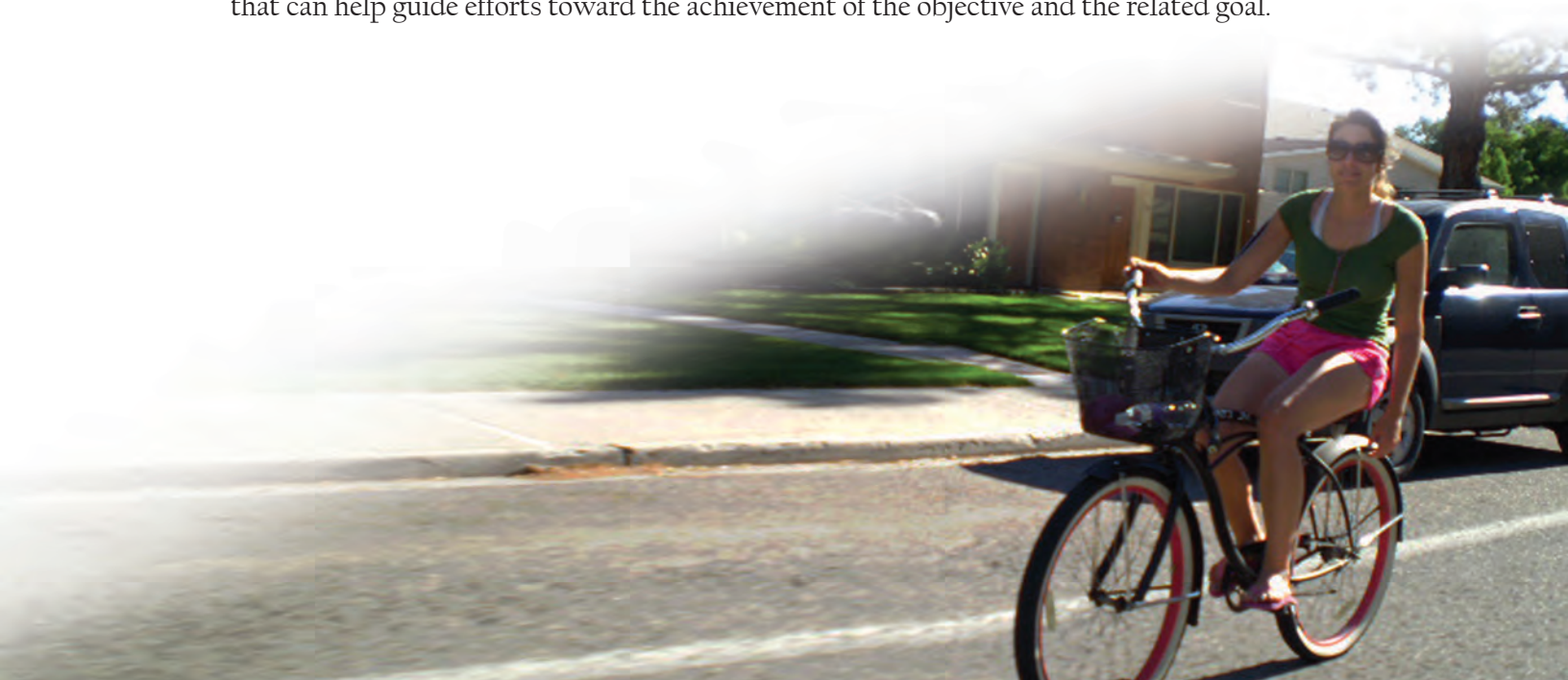


1 Vision, Goals, & Objectives

The Vision, Goals, and Objectives of the Provo City Bicycle Master Plan will guide the development and implementation of bicycle facilities in Provo for years to come. Goals and objectives direct the way public improvements are made, where resources are allocated, how programs are operated, and how city priorities are determined. This section lays out a framework for how to increase bicycling in Provo.

1.1 Vision Statement

A vision statement outlines what a city wants to be. It concentrates on the future and is a source of inspiration. Goals help guide the city towards fulfilling that vision and relate to both existing and newly launched efforts by Provo. Objectives are more specific statements within each goal that define how each goal will be achieved. They are measurable and allow tracking of progress toward achieving the goals and overall vision. Each objective has a number of implementation measures that can help guide efforts toward the achievement of the objective and the related goal.





« Connecting people who walk and bicycle to UTA's FrontRunner and bus services is part of Goal #8

The Steering Committee that helped guide this master plan established the following vision for bicycling in Provo:

“Provo City will create strong families, vibrant neighborhoods, and a healthy community through the promotion and accommodation of bicycling as a vital means of everyday transportation and recreation.”

1.2 Goals & Objectives

Based on input from the Steering Committee, the following eight categories of goals were established for bicycling in Provo:

1. Complete Streets
2. Implementation
3. Bikeway Network
4. Maintenance
5. Safety
6. Education and Encouragement
7. Evaluation
8. Bike-Transit Integration

This section describes each of these goal categories and supplies specific objectives to support each goal. These goals and objectives support the overall vision and describe the most important aspects of Provo's priorities and attitudes towards bicycling. Summaries of each goal, their purposes, and the objectives that support them are given in the following subsections.

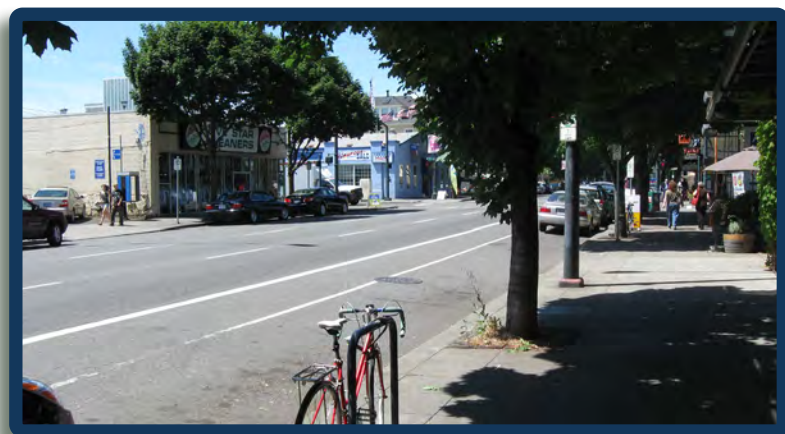


1.2.1 Complete Streets

Complete Streets is an ethos that encourages consideration of all road users when modifying or constructing roads. The genesis of Complete Streets can be traced back to the perception that pedestrians, bicyclists, and transit users should be more fully accommodated in the road design process. Complete Streets principles are typically incorporated at the municipal level through the adoption of policy and ordinance language. The following goal and objectives address how Provo can achieve the bicycle component of Complete Streets.

Purpose: Accommodate bicyclists within the public right-of-way.	
Objectives	
1A.	Consider every road in Provo where bicyclists are legally permitted as a road that bicyclists will use.
1B.	Coordinate Livable Streets traffic volume requirements with the development of residential bike routes/bike boulevards.
1C.	Require all Capital Improvement Projects to include relevant recommended facilities as contained in the bicycle master plan.
1D.	Provide a bicycle network that is safe and attractive for all users, particularly people who would like to ride more but do not feel comfortable with the infrastructure currently available.
1E.	Evaluate streets for recommended on-street bike facilities so that they may be implemented when street resurfacing and restriping projects are scheduled.
1F.	Incentivize or require private development projects to include bicycle facilities identified in this master plan.

» Complete streets welcome all types of users





« The Provo River Parkway is used for both transportation and recreation

1.2.2 Implementation

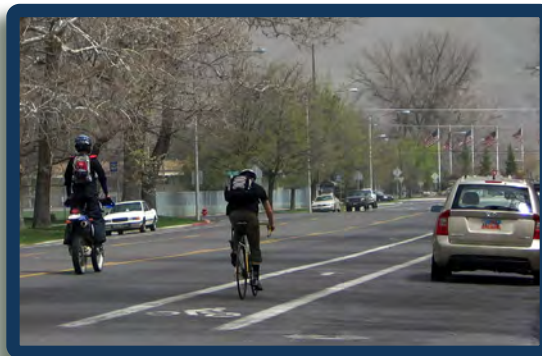
Implementing the recommendations outlined in the bicycle master plan will help Provo address the needs of its residents.

Purpose: Equip city staff/stakeholders with the necessary tools to implement the bicycle master plan.	
Objectives	
2A.	Thoroughly vet the recommendations in the bicycle master plan with the Project Steering Committee and relevant funding agencies so that the plan can be implemented as efficiently as possible.
2B.	Utilize the bicycle master plan Steering Committee throughout bikeway* implementation to ensure citywide support and harmony with other department plans, policies, and goals.
2C.	Maintain open dialog with Provo residents, advocacy groups, and other public groups at every stage of the bicycle master plan implementation.
2D.	Analyze previously-planned bikeways for feasibility and value in the overall network.
2E.	Prioritize proposed projects for construction and funding.
2F.	Engage with elected officials at major milestones of bicycle master plan implementation to remind them of the importance of bicycles in Provo’s transportation network.
2G.	Coordinate bikeway projects with the Utah Department of Transportation (UDOT) and the Utah Transit Authority (UTA) to help with planning and funding of bikeways.

* The term "bikeway" refers to any type of designated bicycle facility. Shared-use paths, bike lanes, and cycle tracks are just a few examples of bikeways. "Bikeway" and "bicycle facility" are synonymous.



» Goal #3 focuses on developing a complete bicycle network of facilities that serve multiple types of people, not just "serious" bicyclists

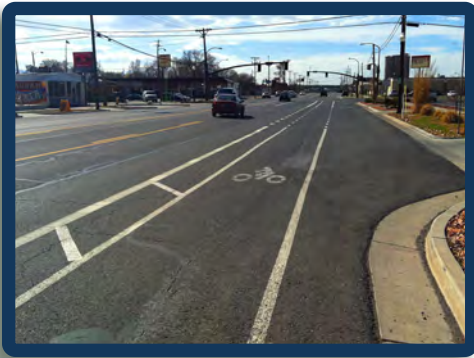


1.2.3 Bikeway Network

A complete bikeway network provides a variety of bikeway types, accommodating bicyclists of varying skills and abilities, and connects them with destinations throughout the city.

Purpose: Provide a complete bikeway network throughout the city of Provo.	
Objectives	
3A.	Implement a continuous network of bikeways that serves all bicycle user groups, including both recreational and utilitarian riders*.
3B.	Bridge network gaps between the adjacent communities of Orem and Springville.
3C.	Work with UDOT to coordinate desired bikeways on State roadways.
3D.	Prioritize future bikeway projects that connect to existing bicycle facilities.
3E.	Identify and construct a safe, attractive, and viable north-south bikeway.
3F.	Prioritize bikeway projects with connectivity to downtown, parks/recreation sites, BYU, and other major trip generators.
3G.	Adopt and adhere to existing and future design guidelines and standards established by the National Association of Cities and Towns (NACTO) Urban Bikeway Design Guide, American Association of State Highway Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities, and the Manual of Uniform Traffic Control Devices (MUTCD).

* A utilitarian bicycle rider is someone who uses a bicycle to accomplish a transportation-oriented purpose such as commuting to work, going to school, or shopping.



« Bike facilities must be kept clean of debris, weeds, and snow (pictured here is a buffered bike lane in Salt Lake City)

1.2.4 Maintenance

Well-maintained bikeways promote active use and enhance bicyclists’ safety and overall experience.

Purpose: Keep bicycle and trail facilities clean, safe, and accessible.	
Objectives	
4A.	Maintain existing and future bicycle facilities to a high standard in accordance with guidelines established in this plan.
4B.	Incorporate bicycle network repair and maintenance needs into the regular roadway maintenance schedule as appropriate, paying particular attention to sweeping and pothole repair on priority bicycle facilities.
4C.	Establish weed management program to target spread of Puncturevine (primarily on shared-use paths) for the purpose of reducing tire punctures.
4D.	Address bicyclist safety during construction and maintenance activities.
4E.	Identify safe, convenient, and accessible routes for bicyclists through construction zones.
4F.	Provide a simple way for citizens to report maintenance issues that impact bicyclist safety and for the city to respond appropriately.
4G.	Implement an on-going citywide bikeway maintenance strategy.
4H.	Develop and update actual maintenance costs for existing bikeways to help the City budget for its future bikeway network.
4I.	Consider future maintenance requirements when making choices for new facilities so that they are as easy as possible to maintain and minimize maintenance resource needs.



1.2.5 Safety

Bicyclists, motorists, and other road users should be considerate and operate their respective vehicles in a safe manner.

Purpose: Make Provo a safe and enjoyable place to ride a bicycle.	
Objectives	
5A.	Reduce the number of crashes involving bicyclists with pedestrians and with motor vehicles while increasing overall levels of bicycling and walking.
5B.	Design facilities that encourage bicyclists to travel at safe speeds when the facility is shared with other user types or intersects with pedestrians and other users.
5C.	Transition bicycle facilities through intersections according to current standards.
5D.	Provide well-marked, visible roadway crossings for shared-use path facilities and clarify expected behavior for motorists, bicyclists, and pedestrians.

» Education courses encourage more people to bicycle and to do so in a safe manner



1.2.6 Education & Encouragement

Many cities around the nation are finding that robust efforts in road user education and encouragement are just as effective at increasing bicycle use as construction of new facilities.

Purpose: Implement comprehensive education and encouragement programs targeted at all populations in the City.	
Objectives	
6A.	Educate the general public about bicycle safety issues and encourage non-motorized transportation with programs that target pedestrians, bicyclists, and motorists.
6B.	Install signage along local and regional bikeways to assist with wayfinding, increase motorists' awareness of bicyclists, and encourage more people to ride bicycles.
6C.	Support Safe Routes to School (SRTS) programs and other efforts, including educational and incentive programs to encourage more students to bicycle or walk to school, through a partnership with the school districts and other interested parties.
6D.	Promote bicycling through events sponsored by Provo City.
6E.	Encourage large employers, schools, UTA intermodal stations, and other activity centers to provide secure bicycle storage facilities and promote their efforts.
6F.	Encourage new commercial building projects to provide bicycle parking, showers, changing facilities, and lockers for employee use.
6G.	Partner with other interested groups across the State to update the driver's license exam to include the latest bicycle markings and signs, and to ensure that bicycle-related exam questions are used.
6H.	Create a downloadable and printable City bikeways map and make it available at logical locations throughout the City.
6J.	Make a link on the City website to the Provo Bicycle Committee's* website so that interested citizens can obtain current bicycling information.

* The Provo Bicycle Committee is a citizen group that promotes bicycle riding by working with the City government and holding events.



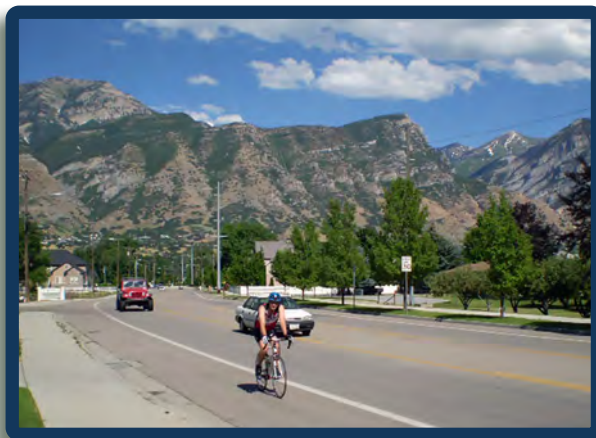
1.2.7 Evaluation

Tracking implementation of the bicycle master plan recommendations allows the City to be accountable to its stakeholders and identify strategies that are working or may need to be changed.

Purpose: Monitor implementation of the Provo City Bicycle Master Plan and conditions relating to bicycling in Provo.	
Objectives	
7A.	Track the success of the bicycle master plan as a percent completed of the total recommended bikeway system.
7B.	Create a regular bicycle count system in order to establish a baseline understanding of bicycle ridership for use in future evaluations.
7C.	Determine bicycle crash rates from available data.
7D.	Complete Bicycle Friendly Community application. Achieve Silver-level status by 2015 and Gold-level status by 2020.*

*For more information on these programs, visit www.bikeleague.org/programs

» Evaluation of bikeway implementation strategies and user habits is an important part of ongoing efforts in Provo



1.2.8 Bike-Transit Integration

Connecting bikeways with transit facilities helps to reduce traffic congestion and promote both bicycling and transit use.

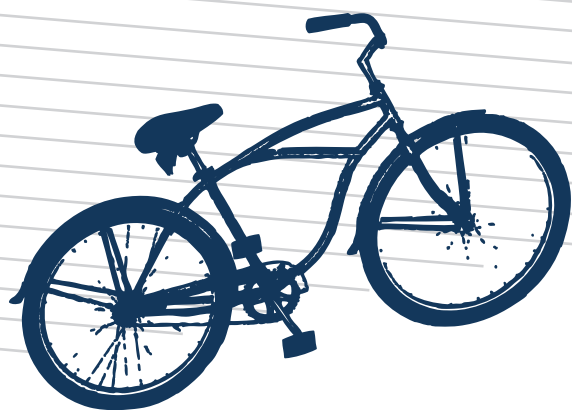
Purpose: Improve multi-modal transportation by coordinating bicycle projects with existing and future transit plans.

Objectives

- 8A. Provide access and bicycle support facilities to transit by connecting bikeways to transit stops and intermodal centers.
- 8B. Support UTA in accommodating bicycles on all transit vehicles including FrontRunner commuter rail and Bus Rapid Transit (BRT) buses.
- 8C. Provide secure end-of-trip facilities (bike parking, etc.) at intermodal centers.
- 8D. Partner with UTA and BYU when developing educational and outreach programs.
- 8E. Integrate bicycle parking into new bus shelters.



« Bike racks on transit vehicles are a key way to integrate bicycling with transit



2

2 Summary of Existing Plans

This section summarizes the major planning documents that shape the physical and policy environment for Provo City as it relates to bicycling. The following documents are reviewed in this section:

- » UDOT Guidelines for Bicycle and Pedestrian Accommodations
- » UDOT Roadway Design Manual of Instruction
- » UDOT Pedestrian and Bicycle Guide
- » UDOT Bicycle Priority Routes Project
- » Utah Traffic Controls for School Zones Manual
- » Mountainland Association of Governments (MAG) Bicycle and Pedestrian Planning
- » MAG Non-Motorized Trail Standards
- » Provo City General Plan
- » Provo Master Transportation Plan
- » Provo-Orem BRT Plans
- » Provo City Vision 2030
- » Proposed Improvements to City Bicycle Network





◀◀ UDOT's Guidelines
for Bicycle and
Pedestrian
Accommodations

2.1 UDOT Guidelines for Bike & Pedestrian Accommodations

UDOT has outlined bicycle and pedestrian accommodation guidelines to promote safety and mobility of bicyclists and pedestrians in roadway projects. The guidelines are as follows:

2.1.1 Freeways & Limited Access Highways

Bicycle and pedestrian accommodations are not required on urban area freeways where cycling and walking are prohibited. Where bicyclists are permitted on rural freeways, special attention should be given to rumble strip application and shoulders. For a listing of locations on state routes where bicyclists are prohibited, visit www.udot.utah.gov/walkingandbiking and select “Online Maps”.

2.1.2 Urban & Rural Arterials

Utah State Code defines bicycles as vehicles. Every effort should be made to include bicycle and pedestrian accommodations in all new construction and reconstruction projects on the state system. The specific level of accommodation will vary by project and should be determined by the Project Team in conjunction with the UDOT Bicycle and Pedestrian Coordinator. The guidelines were created in response to UDOT Policy 07-117: Routine Accommodations for Bicyclists and Pedestrians, which was adopted in May 2006. The text of this policy reads as follows:

“An accommodation is defined as any facility, design feature, operational change, or maintenance activity that improves the environment in which bicyclists and pedestrians travel. Examples of such accommodations include the provision of bike lanes, sidewalks, signs, and the addition of paved shoulders. Bicycling and walking are successfully accommodated when travel by these modes is efficient and safe for the public. The level of accommodation should be considered on a project-by-project basis.”

A checklist is included as part of the guideline document to facilitate a discussion between the project team members and to determine the level of accommodation for bicyclists and pedestrians in a roadway project.



2.2 UDOT Roadway Design Manual of Instruction

UDOT encourages multi-modal transportation options on roadway facilities. Bicycle and pedestrian planning and design guidelines outlined in Section 9 are based on AASHTO standards. Checklists are provided for bicycle and pedestrian facilities in general, as well as for the Concept, Environmental, and Scoping Phases of a project.

2.2.1 Bicycle Facilities

UDOT encourages the use of the Bicycle Compatibility Index (BCI) to evaluate roadways for bicycle compatibility. They also specify that urban state highways should have an 8-foot-wide minimum shoulder.

2.3 UDOT Pedestrian & Bicycle Guide

The Pedestrian and Bicycle Guide was created to provide UDOT staff and interested citizens resources for improving walking and bicycling conditions in Utah. The guide addresses design, maintenance, funding, education, and the UDOT project development process. It is a valuable resource and reference for any Utah city or county planning bicycle and/or pedestrian facilities.

2.4 UDOT Bicycle Priority Routes Project

In response to increased demand for bicycle facilities statewide, UDOT formed a planning team to prepare a statewide Bicycle Priority Routes analysis.

2.4.1 Public Involvement Element

The public involvement portion of this analysis began in September 2008 and included 13 open houses held throughout the state. The open houses offered general information about the project, sketches showing how bikes could be accommodated on state roads, a map showing existing conditions, and the selection criteria UDOT would use to prioritize bicycle route improvements. Public comments were received in a number of ways including comment sheet submissions, notes written on maps, and email comment submissions.

Of the 13 open houses, the closest one to Provo was held in Orem. 59 people attended the Orem open house September 2008. According to UDOT's geographic tracking of comments, attendees at Orem's open house represented several communities in Utah Valley.

2.4.2 Priority Routes

In Provo three Level 1 (highest) priority projects were identified. [Table 2-1](#) outlines these projects. UDOT makes mention in these project documents that funding has not been secured for the identified priority improvements and encourages public agencies to make the improvements as opportunities arise.



◀ UDOT's Bicycle and Pedestrian Guide

Table 2-1: Bicycle Priority Routes Projects

Street	Improvement
SR-114 (Geneva Road): 820 North to Orem boundary	Widen shoulders and/or restripe. Bike lanes are desired, but wide shoulders would be acceptable.
US-89 (State Street): 1100 South to Springville boundary	Widen shoulders (note: portions of this improvement have been completed since 2009).
Utah Lake Trail: end of current trail north to Orem boundary	New 10' wide shared use path.

2.5 Utah Traffic Controls for School Zones Manual

UDOT created this manual to ensure consistency and set specific standards for all Utah school crossing zones. All jurisdictions in Utah are required by code to use the manual.

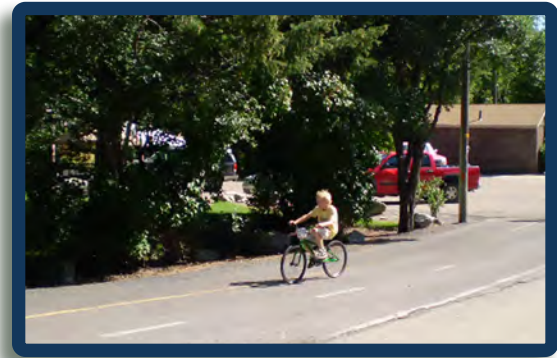
2.6 MAG Bicycle & Pedestrian Planning

MAG is responsible for preparing and approving a TIP for the Utah County region annually. The TIP is a compilation of projects sponsored by municipalities, the county, UDOT, UTA, and others utilizing various Federal, State, and local funding sources.

In May 2011, the MAG 2040 Metropolitan Transportation Plan (2040 MTP) was adopted, which includes a discussion on bicycle and pedestrian improvements regionally, including Provo. Generally, the 2040 MTP provides guidance on maintaining and enhancing the regional transportation system for urbanized Utah County. The 2040 MTP includes a section on bicycle and pedestrian improvements that indicates that funding is a major barrier to fully constructing a trail network that provides for connectivity between cities and destinations in the urbanized area of Utah County. Stated goals of the regional bicycle and pedestrian network are the reduction of vehicle trips and mitigation of traffic congestion. The 2040 MTP identifies a network that connects population and employment centers to each other based upon projected densities



»» The Provo River Parkway is a City and regional trail that has benefitted from MAG funding



through planning year 2040. A map is provided within the 2040 MTP that shows where the paved trails, bike routes (which includes bike lanes, wide shoulders, and signed routes), crushed stone trails, and priority planned trails are planned at the regional level, including existing trails to show connectivity. This map is shown in **Figure 2-1**.

The 2040 MTP further states that design considerations should cover connectivity, safe roadway crossings, traffic calming techniques, street, street furniture, and other pedestrian-scaled amenities. MAG’s staff utilizes the Bicycle Compatibility Index (BCI) model to analyze all roadway projects within the 2040 MTP. The output of the model indicates a Level-of-Service (LOS) ranging from “A” to “F”. A LOS of “C” indicates that a roadway is comfortable for the average adult bicyclist. Based on an LOS of “C”, MAG has identified that bike lanes or wide shoulders should be included in planned projects unless law or engineering judgment precludes such inclusion.

Regionally, approximately \$16M is needed annually to fund a bicycle and pedestrian network. While this level is not currently available at MAG, efforts are being made to combine bicycle and pedestrian efforts with roadway projects that will eventually create a network over time. Most of the bicycle and pedestrian projects at the regional level are made up of local city projects with the Utah Valley Trails Committee helping to identify gaps and determine which regional facilities will help provide the most connectivity.

2.7 MAG Non-motorized Trail Standards

The standards presented in this document are based on recommendations from the AASHTO Guide for the Development of Bicycle Facilities (1999), the MUTCD (2003), and other sources. Section B sets definitions of various facility types. Most notably, it discusses the nature of shared-use paths as follows:

“Proper design will accommodate two-way use, with infrequent interruptions by driveways or roadway crossings. Long sections of trail without road crossings or driveways are most desirable. At a bare minimum, 1320 feet (1/4 mile) between such interruptions should be planned and maintained throughout.

“Trails should not be located along roadsides where sidewalks are normally provided. Typically, sidewalks are not good candidates for use as trails, since they tend to be too narrow to accommodate multiple uses and are too

frequently interrupted. Where good trail design is not possible due to frequent interruptions or lack of suitable separation from roadways, a combination of bicycle lanes and sidewalks may be more appropriate.”

Section C governs design and construction standards and provides standards beyond what is available in the AASHTO Guide for the Development of Bicycle Facilities. Shared-use paths should be 10 feet wide (8 feet minimum) and conform to recommended surface thicknesses and subgrade requirements. Recommendations are also made for bridge structures, signage, grades, and corner radii. Finally, the standards require all new construction and alterations to comply with ADA laws.

2.8 Provo City General Plan

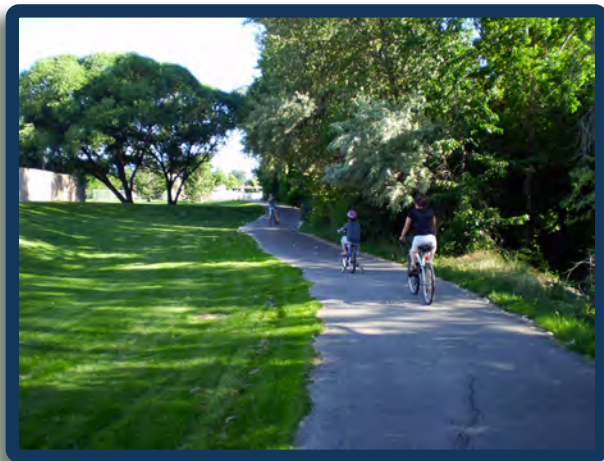
2.8.1 Chapter Eight – Transportation & Circulation

In the Bike Paths section, the General Plan identifies the importance of two bike paths to the Provo Bikeway System: the Provo River Parkway and The College Connector Trail. These off-street bikeways are the “backbone” of Provo’s bikeway network. The Plan also calls for the development of future on-street facilities to enhance safety and improve connectivity between on- and off-street bikeways.

The Intermodal Transit Station is identified as one of the premier destinations for future bikeway development. Chapter 8 also sets a goal for the City to be designated by the League of American Bicyclists as a Gold-level Bicycle Friendly Community.

2.9 Provo Master Transportation Plan

The Provo Master Transportation Plan (MTP) addresses bicycle transportation in several sections of the plan, which are described below.



◀ Provo River Parkway
south of Columbia
Lane

Bicycle & Pedestrian Projects - 2040 Metropolitan Transportation Plan

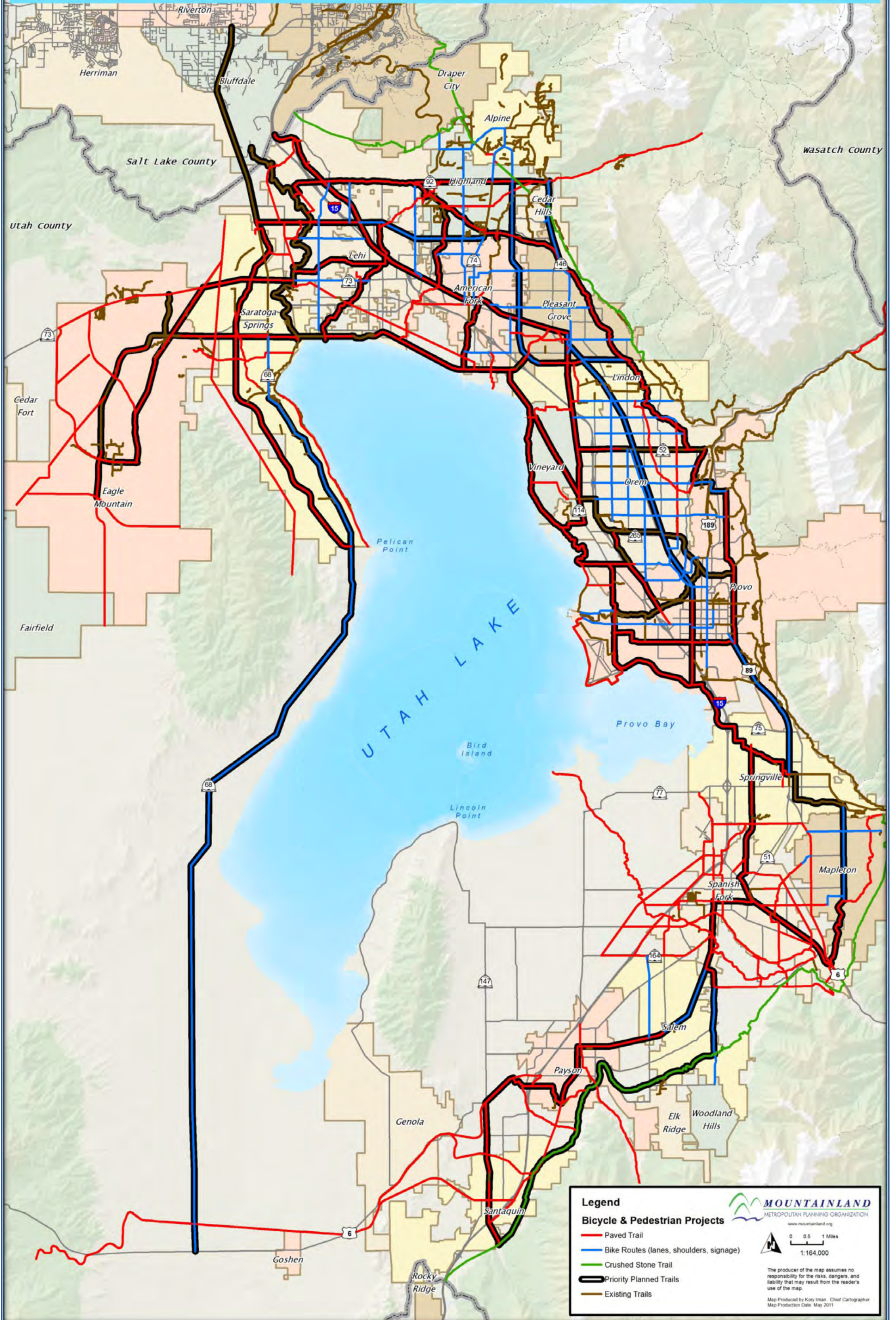


Figure 2-1: Bicycle & Pedestrian Projects – 2040 MAG Transportation Plan



2.9.1 Livable Streets

The first part that relates to bicyclists in Provo is the Livable Streets section. In this section, the desired maximum traffic volume for residential streets is defined as 1,800 vehicles a day. Under this designation, residential streets that meet the Livable Streets standards would also work well as residential bike routes, neighborhood greenways, or bicycle boulevards.

The Livable Streets Standards Policy Statements in the MTP mostly focus on livability as a measure of traffic volume or land use along a specific corridor with little mention of addressing the needs of alternate users of the road.

2.9.2 Traffic Mitigation Strategies

In the public involvement portion of the MTP a joint City Council and Planning Commission meeting was held wherein meeting participants ranked and scored various strategies for traffic mitigation. Strategies included instituting transit corridors, reducing land densities, instituting parking pricing, and building wider streets. Included in the ten strategies was the concept to “develop and improve bike and pedestrian paths”. Of the 10 choices, bike and pedestrian paths ranked the 4th highest, indicating a moderate level of support for bicycle facilities in Provo.

2.9.3 Transportation Demand Management (TDM) Strategies

The MTP outlines various TDM strategies to maximize transportation efficiency in Provo and decrease single occupant vehicle use. The Provo TDM policy strategies include:

- » Provo City will encourage TDM measures, such as a student shuttle system, van and car pools, alternative work hours, transit service improvements, and the construction of pedestrian and bicycle facilities and amenities.

The MTP identifies four different classes of bike facilities in Provo:

- » Class I routes – completely separate (from roads) rights-of-way designated for exclusive use of bicycles (often referred to as a bike path or bike trail).
- » Class II routes – paths that are part of the street right-of-way but are separated by a physical barrier such as a guardrail or landscaped median (commonly known as a cycle track or protected bike lane).
- » Class III routes – paths designated by a painted stripe or curb within the street right of way (commonly known as bicycle lanes).
- » Class IV routes – have no lane designation with bicyclists using the outside portion of the lane or shoulder (commonly known as bike routes).

The MTP includes a few examples of TDM measures that promote bicycling:

- » Bike lockers and changing facilities/showers
- » Secure bike parking near entrances to work

2.9.4 Traffic Calming

Provo City is committed to improving the quality of life in residential neighborhoods by calming traffic. The City will use measures such as bulb-outs and roundabouts to calm traffic and discourage cut-through traffic. When implemented with a bicycle network in mind, traffic calming measures can be critical building blocks of residential bicycle routes and can provide a more comfortable riding environment for less confident bicyclists. A grid pattern street system such as Provo’s is advantageous for bicyclists because it distributes traffic to a variety of streets rather than just a handful of collectors and arterials. Grid networks also provide multiple alternatives from which to choose when implementing bikeways.

The MTP promotes the adoption of a residential traffic calming goal that would:

- » Promote safe and pleasant conditions for residents, motorists, bicyclists, pedestrians, and transit riders on residential streets
- » Promote and support the use of transportation alternatives to the single occupant vehicle

These goals and others clearly support the development of a complete bikeway system, utilizing off-street and on-street facilities. In addition to existing streets and development the MTP also calls for traffic calming treatments to be included in new residential developments.

2.10 Provo-Orem BRT Plans

The Provo-Orem Bus Rapid Transit (BRT) System is a joint project of UDOT, UTA, and MAG. This project will link the two communities with a BRT line that aims to decrease single occupancy vehicle use and congestion, increase the convenience of travel between Provo and Orem, and improve overall traffic flow in the region. According to planning documents, the BRT system hopes to improve accessibility for bicyclists across I-15 and identifies several components to be developed as a part of the BRT implementation. These components are described in the subsections below.



« Provo's Master Transportation Plan contains various elements related to bicycling



2.10.1 800 South Interchange and Access to UVU

A bike lane is planned for the interchange at 800 South, which would provide improved access between eastern and western neighborhoods as well as improve cyclist safety by providing an alternative to crossing I-15 on University Parkway.

2.10.2 BRT Vehicles

All UTA buses currently include exterior bicycle racks on the front of the vehicles. As part of the proposed project, UTA plans to explore the feasibility of including bicycle storage areas within BRT vehicles, which would reduce boarding and alighting times. This would help improve mobility within the project study area by providing more convenient multi-modal transportation options.

2.10.3 Street Modification

Some of the existing bicycle facilities will be adjusted to accommodate the construction of the BRT project. Affected bicycle facilities will be relocated by the BRT Project onto adjacent streets. The Environmental Assessment for the BRT line lists two impacts to existing and planned bicycle facilities:

700 North Bike Lane

The existing 8-foot bike lane along 700 North would be reduced to 4 feet.

900 East Bike Route

If an exclusive BRT lane is constructed on 900 East in the future, the existing 2-foot shoulder will need to be removed. Therefore, no additional space would be available for a bike lane.

2.11 Provo City Vision 2030

In March 2010, Provo City formed a 10-member steering committee responsible for providing guidance on what the City should be like by the year 2030. The purpose of this process and document is to provide long-term direction to municipal decision-making. Section 12 of this document provides direction on Transportation and Mobility.

The Transportation and Mobility section contains the following goals that relate to the advancement of bicycling as a more substantial travel choice:

- » Goal 1: Promote the use of transit and alternative modes of transportation.
- » Goal 2: Augment the multi-modal transportation opportunities in Provo.
- » Goal 3: Modify current street standards to promote flexible street widths in residential areas.
- » Goal 5: Promote easier navigation with appropriate signage throughout the city.

2.12 Proposed Improvements to City Bicycle Network

BYU students in conjunction with a consulting firm analyzed several recommendations for new bikeway facilities that have been proposed in the past by the Provo Bicycle Committee. This analysis included the extents, benefits, and physical conditions of the proposed bicycle network. The findings of this report focus on rider experience and usefulness of the overall route as a potentially implementable bikeway in the overall Provo City bike network. To gauge and qualify rider experience, two performance criteria were developed for the routes – connectivity and travel time. “Connectivity” refers to how well a particular bikeway would connect to the rest of the bikeway network and important community destinations. Potential routes included multiple north-south corridors and one east-west corridor.

North-South Corridors

- » Freedom Blvd
- » 100 West
- » University Avenue
- » 700 East
- » 900 East

East-West Corridor

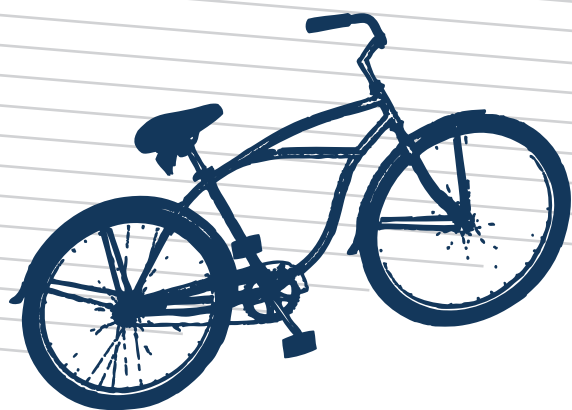
- » 500 North

The study examined proposed routes for travel time and connectivity in relation to major trip generating destinations within Provo. These destinations included:

- » University Parkway
- » Downtown portions of Center Street
- » Future Intermodal Transit Station
- » BYU Campus
- » Provo Recreation Center

Findings of this report conclude that there are three ideal bike routes in various parts of the city:

1. University Avenue
 - a. Add bike lanes north of 700 North as soon as possible
 - b. Add bike lanes south of 700 North in conjunction with BRT construction
 - i. Possibly develop Freedom Boulevard as an alternative to the southern section of University Avenue
2. 700 East
 - a. Add bike lanes in conjunction with road reconstruction
3. 500 North
 - a. Add bike lanes between 500 West and 700 East

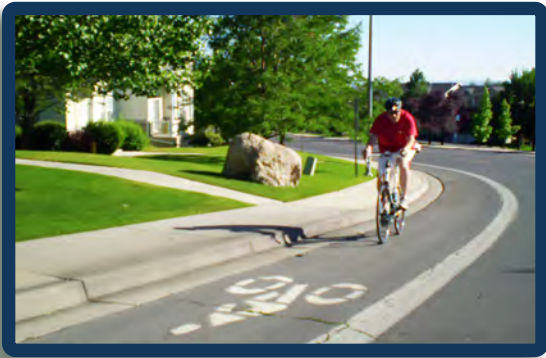


3 Summary of Existing Conditions

The backbones of Provo's off-street bicycle network are the Provo River Parkway and the College Connector Trail. Over the past decade, Provo has also been steadily growing its on-street bikeway network. This has been accomplished primarily by installing new bike lanes in conjunction with road surfacing projects and new construction. This chapter summarizes Provo's current bicycle infrastructure and is divided into the following sections:

- » Setting
- » Existing Bicycle Facilities
- » Bicycle Crash Analysis
- » Transit Connections
- » Opportunities
- » Constraints





◀ Bike lanes such as this one on Seven Peaks Blvd are an important part of Provo's existing bikeway network

3.1 Setting

Provo is the third largest city in Utah and is located approximately 40 miles south of Salt Lake City. It is located at the base of the Wasatch Mountains in Utah County, bordered by Orem to the north, Springville to the south, Utah Lake to the west, and Uinta-Wasatch-Cache National Forest to the east. Provo has a total area of 41.8 square miles with a mixed topography that supports bicycling.

According to the 2010 census, Provo's population is approximately 112,000 people. Provo is the seat of Utah County and the principal city of the Provo-Orem metropolitan area. Utah County has a population topping 519,000 people. The median age in Provo is 24.8 and 21.3% of the population is under the age of 18.

Provo's population is largely influenced by two major universities. Brigham Young University is one of the largest private universities in the United States with an active daytime student enrollment near 33,000 in 2011. Nearby Orem hosts Utah Valley University and its more than 28,000 students. BYU and UVU account for a significant percent of the area's population. They combine for at least 61,000 students and an additional 20,000 faculty and staff.

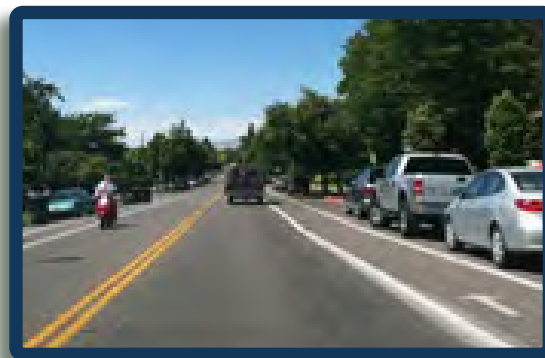
Several leading software and technology companies are located in the Provo/Orem area including Novell, Symantec, Adobe, Corel, Micron Technology, Ameritech Library Services, and Convergys. Significant employment in Provo is also provided by Nestle Frozen Foods, NuSkin Enterprises, and Intermountain Healthcare.

The Utah Valley Convention Center is a 21,000 sq. ft. exhibition hall and 18,000 sq. ft. ballroom that opened in 2012 in downtown Provo. The center hosts NuSkin's annual convention and other large-scale events that bring temporary population influx to downtown.

Provo contains a variety of land uses with several main streets serving as the major commercial/industrial corridors. Like many of Utah's communities, Provo's street system was built upon the common grid. As such, it provides various parallel routes for bicyclists and motorists. The majority of Provo's land is developed, with limited room for new development east of I-15. Much of the future development and growth will likely be urban in-fill and redevelopment. Because



»» The 800 North bike lanes connect western Provo with the BYU campus area



Provo is relatively built out and constrained by natural boundaries to the west and east, it does not face the ever-expanding boundaries and increased commuting distances between residential and commercial developments that other growing communities are grappling with. The challenge lies instead with providing a balanced transportation network that meets the needs of all residents and connects their homes to where they want to travel.

The topography and built environment in Provo generally support bicycling. Most of Provo is relatively flat with gentle increases in elevation approaching the BYU campus and more significant elevation increases in the foothill areas along the east edge of the city. The existing conditions in Provo provide a solid foundation on which to build future on-street bikeways.

3.2 Existing Bicycle Facilities

Provo’s existing bicycle network consists of shared-use paths, sidepaths, and bike lanes. Figures 3-1 through 3-3 graphically depict these bikeway types. Table 3-1 summarizes Provo’s existing bikeway mileage based on facility type. Figure 3-4 displays these facilities on a map. There are many miles of unpaved trails (primarily in the foothills) but those are not shown on the map because this master plan focuses on the urban area of Provo and its transportation-oriented bikeway system.

Table 3-1: Existing Bikeways

Facility Type	Mileage
Shared-Use Path	12.4
Sidepath	3.4
Bike Lane	21.5



◀◀ The Provo River Parkway Trail (pictured above along University Avenue) is the City's preeminent example of a shared-use path



Figure 3-1: Shared-Use Path



Figure 3-2: Sidepath



Figure 3-3: Bike Lane

3.2.1 Shared-Use Paths

Shared-use paths are paved facilities separated from motor vehicles. They provide space for bicyclists, pedestrians, and other non-motorized forms of transportation. Shared-use paths are typically located in rights-of-way (such as canals, streams, and utility corridors) that are independent of roads.

The Provo River Parkway is the main example of shared-use paths in Provo. It is a 15-mile paved facility between Vivian Park in Provo Canyon and Utah Lake. The trail varies in width from 8 to 16 feet wide. Most of the trail follows the Provo River with grade-separated crossings of major roads. However, a few sections – principally along University Avenue between 2230 North and 3700 North – are adjacent to surface streets and are classified as sidepaths (see Section 3.2.2). The Provo

»» The College Connector Trail provides a link between the BYU campus, shopping areas, and student housing





◀◀ The 700 North bike lanes connect the eastern bench of Provo to University Avenue

River Parkway is relatively flat. This topography makes the trail popular with families since small children can ride the trail. There are 10 trailheads along the Provo portion of the parkway.

3.2.2 Sidepaths

Sidepaths are similar to shared-use paths but have a few key traits that make them different. Sidepaths are located within or immediately adjacent to roadways. They typically cross more streets at-grade and have more driveway and intersection crossings than shared-use paths. Caution must be exercised when planning and building sidepaths because they may encourage people to ride bicycles at moderate-to-high speeds through driveways and intersections where drivers are not expecting to encounter them.

The College Connector is the longest and most visible sidepath in Provo. It was developed to link Brigham Young University to Utah Valley University in Orem. This path, in combination with other bike lanes and shared-use path segments, also connects Provo’s Rock Canyon to Orem’s Lake Park. Some long stretches of this path are free of driveway and intersection crossings, which allows it to function more like a shared-use path at times.

3.2.3 Bike Lanes

A bike lane is a portion of the roadway designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes create a visual separation between bicycle and automobile facilities, thereby increasing bicyclists’ comfort and confidence. Bike lanes are typically used on major through streets with average daily traffic (ADT) counts of 3,000 or higher and should be one-way facilities (on each side of the streets) that carry bicycle traffic in the same direction as motor vehicle traffic.

Provo City has many miles of marked bike lanes. Generally, they are placed adjacent to parking lanes. Where parking is not highly utilized many bicyclists may ride in the parking lane to achieve a greater separation from vehicle traffic. Provo has some bike lanes with rumble strips incorporated into the wide outside stripe. This practice is typically only found on higher speed rural highways in most of the nation and could be hazardous to urban bicyclists particularly where they are placed on curves.

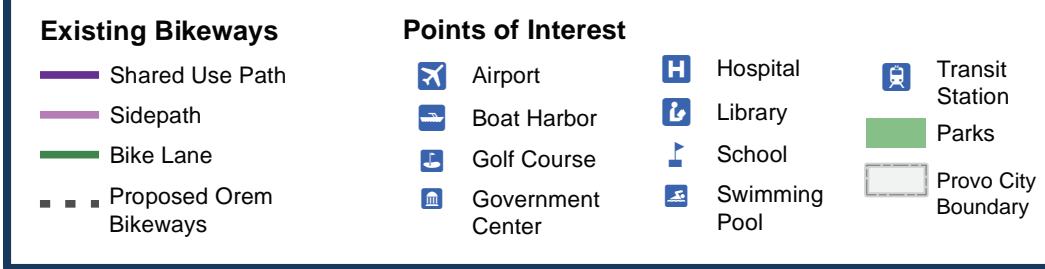
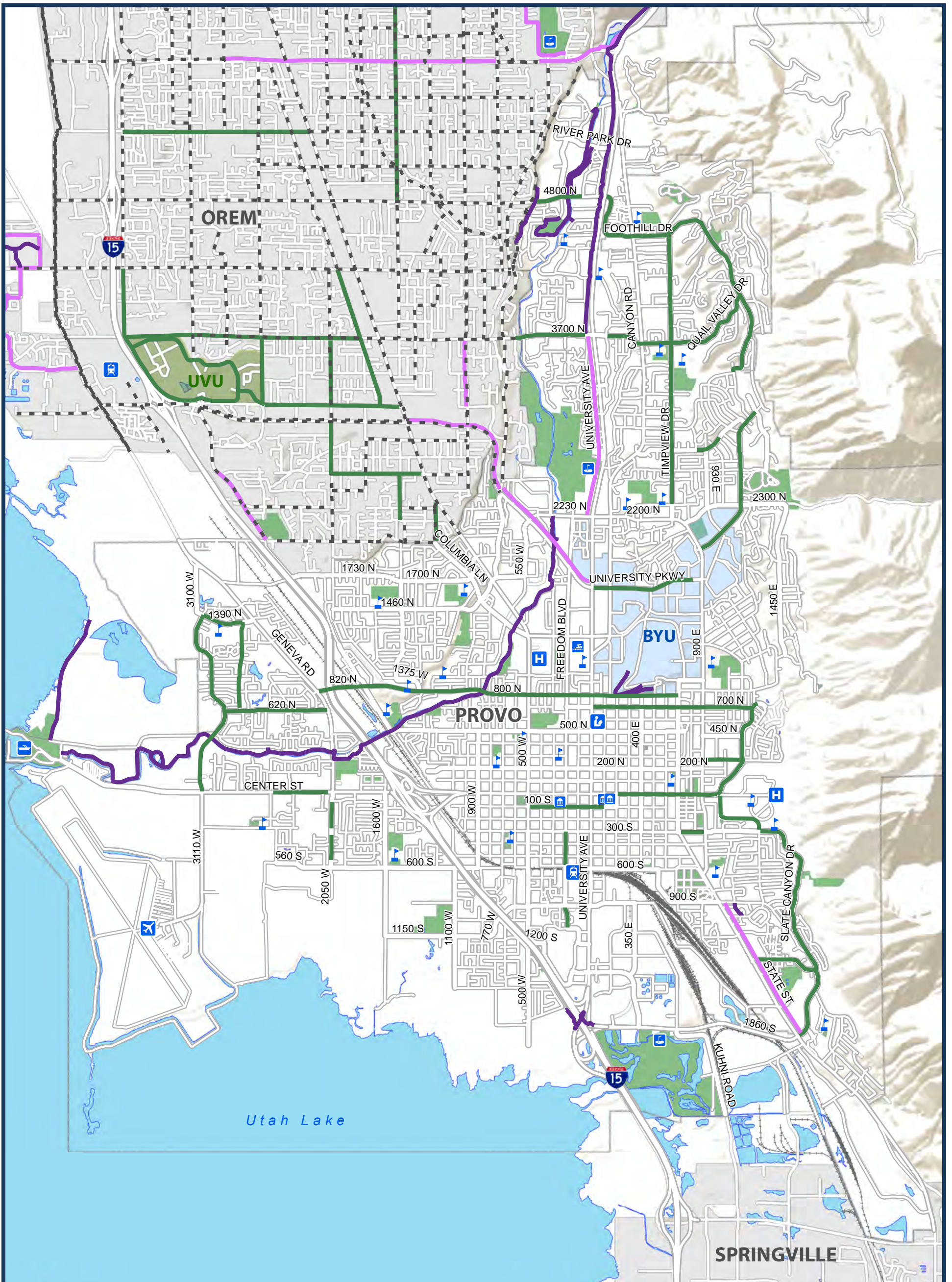
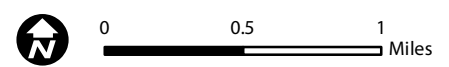


Figure 3-4: Existing Bikeways





3.3 Bicycle Crash Analysis

Bicycle crash statistics for the 2008-2011 period were obtained from the Provo Police Department to analyze trends and highlight areas that exhibit high numbers of bicycle-related crashes. Figure 3-5 shows the results for the central part of the City where most crashes occur. The size of the circles and the numbers inside them correspond to numbers of crashes at specific locations.

The following trends are evident from looking at the crash map:

- » A large majority of crashes occur at or near intersections.
- » Areas around the perimeter of BYU (particularly on the west side of campus) experience the most crashes.
- » The University Avenue and Bulldog Boulevard corridors are particularly noticeable hotspots for bicycle crashes.
- » Aside from the BYU campus perimeter, the other noticeable hotspot is 2230 North between Freedom Boulevard and University Avenue.

Care should be taken with drawing definitive conclusions about crash causation based on this cursory analysis. However, the data do highlight locations in the City that merit a closer look for possible improvements. The following traits are common among the hotspot corridors:

- » They are locations where significant bicycle demand exists.
 - » In the case of University Avenue and Bulldog Boulevard, they are funnels for students traveling to and from BYU and Provo High School.
 - » The 2230 North hotspot is a short missing link in the Provo River Parkway system where trail users must ride on a narrow sidewalk right next to traffic in order to transition from the northern part of the parkway to the southern part.
- » They are locations without designated bikeway accommodations, which may lead to situations where people on bicycles behave in unpredictable ways.

It should be noted that bicycle-related crashes are routinely underreported, particularly those that did not require police or emergency personnel to respond to the scene of the crash. Nevertheless, there are enough data points from documented crashes to paint a broad picture of locations in Provo where bicyclist safety is a concern.

3.4 Transit Connections

Provo City's transit service is provided by UTA. Existing services include standard bus routes and FrontRunner commuter rail. BRT is being planned for the future. Route maps and timetables for all UTA services can be found at www.rideuta.com.

3.4.1 Bus Service

Provo City's transit service is provided by UTA. UTA has 12 bus routes that serve Provo, connecting to various parts of the Provo-Salt Lake region. Most bus service intervals range between 30-

60 minutes, but the local Utah Valley-TRAX Connector (Route 811) and Provo-Orem Shuttle (Route 830) run every 15 minutes for large parts of the day. Many of the routes connect to Provo’s FrontRunner station. Bicycle racks that accommodate two bicycles are available on all UTA routes aside from Ski Service and Paratransit service routes.

3.4.2 Bus Rapid Transit

UTA will also be implementing a BRT line between Provo and Orem serving the Provo and Orem FrontRunner stations, downtown Provo, BYU, and UVU. The BRT line has the potential to change the way the overall transportation network functions between Provo and Orem. **Figure 3-6** shows the proposed BRT route and station locations. There are 13 planned BRT stations within Provo City’s limits. Once the BRT line is operational, buses will likely run every 5 minutes.

3.4.3 FrontRunner Commuter Rail

FrontRunner is a commuter (heavy rail) train operated by UTA. This service presently operates between Pleasant View (north of Ogden) and Provo with future extensions south of Provo possible. Travel time between Provo and Salt Lake City is approximately one hour. Initial ridership projections for the Provo-Salt Lake City portion of FrontRunner (which opened in December 2012) were estimated at 7,500 people per day.

The Provo FrontRunner station is located at approximately 650 South between Freedom Boulevard and University Avenue. This station will likely be an epicenter of new bicycle traffic in Provo. Commuter rail facilities are complemented by bicycle facilities because they allow people to extend the reach of their non-motorized trips over longer distances. FrontRunner trains have room for 12 bicycles in a designated bicycle car as well as additional space in the normal passenger cars. Convenient bicycle access to the Provo FrontRunner station will be an important component of Provo’s bicycling future.



« FrontRunner began service from Provo to Pleasant View (north of Ogden) in December 2012

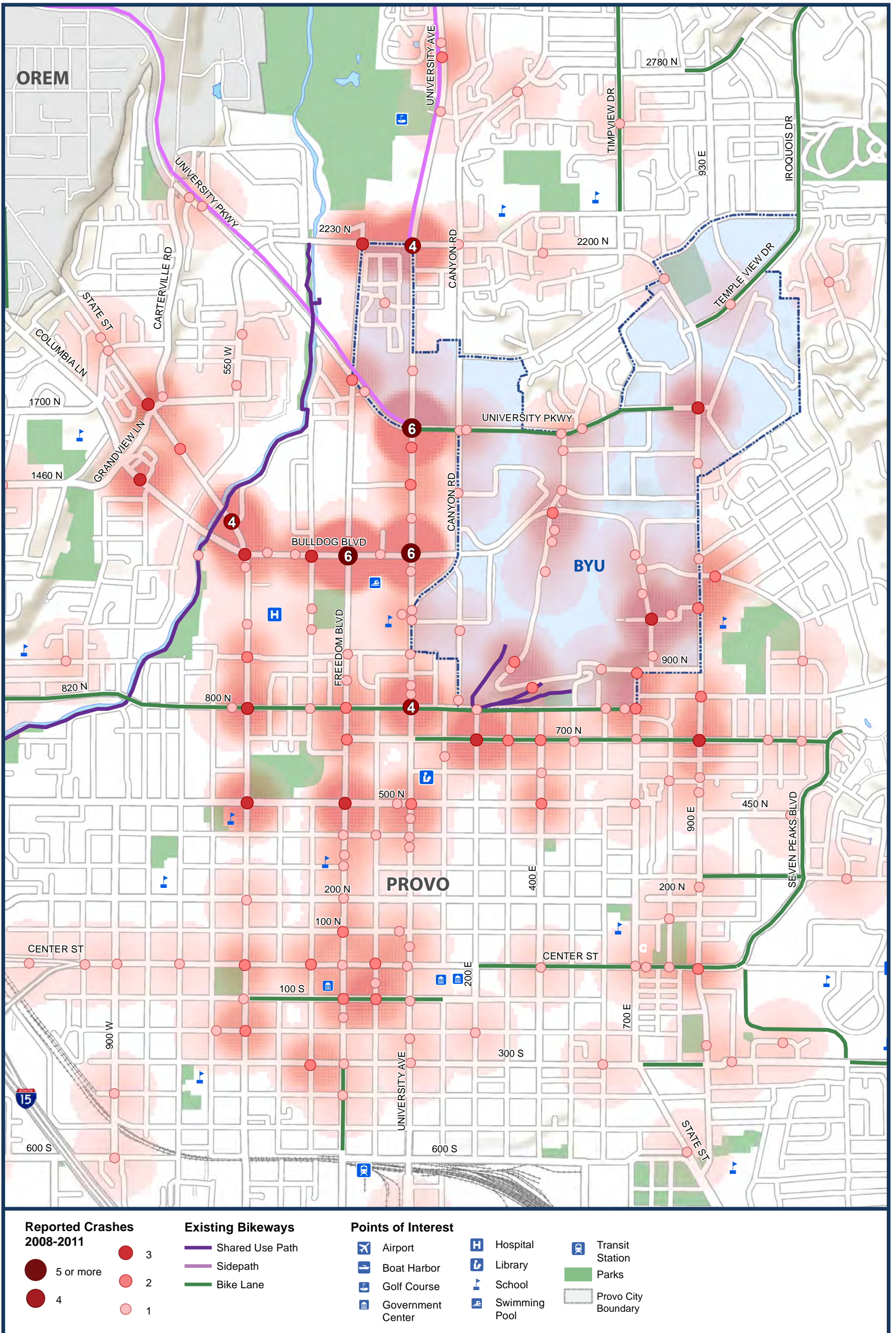


Figure 3-5: Bicycle Crash Analysis

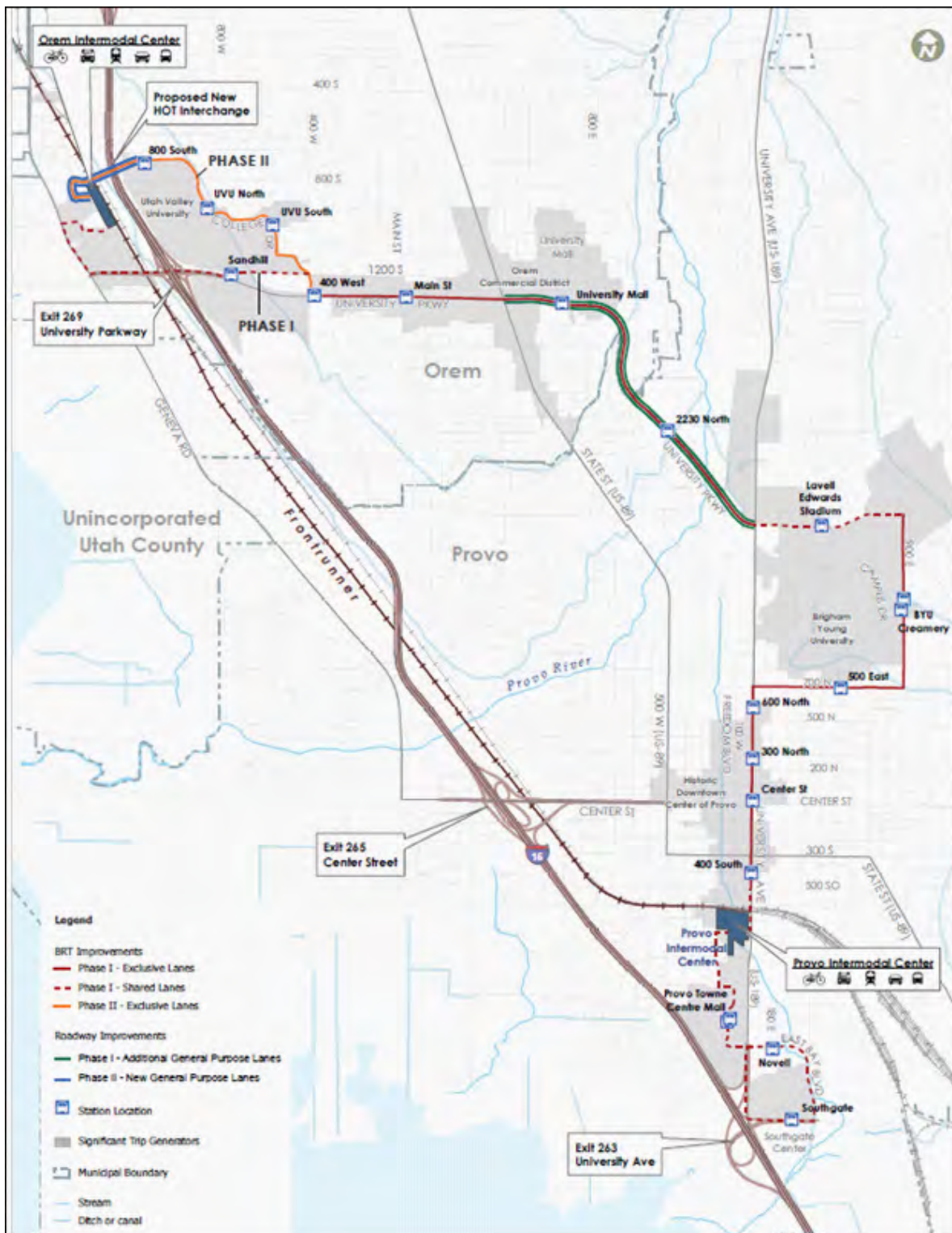


Figure 3-6: Proposed BRT Route Map

3.5 Opportunities

3.5.1 2010 General Plan Proposed Network

In 2010 the Provo Bicycle Committee helped move forward a new bicycle facilities plan that is now included in Provo’s General Plan. The plan aims for the City to reach gold-level Bicycle Friendly Community status and to quadruple the inventory of on-street bike lanes from approximately 21 to nearly 80 miles. Facility recommendations include shared-use paths, sidepaths, and bike lanes. Table 3-2 lists the mileage of the proposed bikeways in these three categories.

Table 3-2: General Plan Proposed Bicycle Network Mileage

Bikeway Type	Mileage
Shared-Use Paths & Sidepaths	73
Bike Lanes	59

These proposed facilities were carefully considered during the master plan process to determine their feasibility, quality, and whether or not they should remain as recommended facilities in the Provo City Bicycle Master Plan.

3.5.2 Roads

Roadways in Provo City are classified by street sections as outlined in the Master Transportation Plan. Street sections provide basic parameters on street layout, including direction on width for lanes, medians, sidewalks, planters, curb, and gutter. The current street sections for Provo City include layouts for the following types of streets:

- » 120’ section
- » 84’ section
- » 72’ section (4-lane with median)
- » 72’ section (4-lane, wide outside lane, no median)
- » 3-lane collector street
- » Local Street (38’ ROW)
- » Local Street (32’ ROW)

These street designations correspond with target ADTs. At present the street sections do not have standard designations for streets with bike lanes, shared lane markings, or shared roadways although bike lanes are currently found on many streets. Under current design standards some of the existing street sections could include on-street bicycle facilities with slight reallocations of road space. Examining on-street bikeway feasibility was an integral part of the Provo Bicycle Master Plan.



3.5.3 On-Street Parking

The allocation of vehicle parking on the public right-of-way can play a significant role in the provision and condition of on-street bikeways. In some instances, on-street parking may be hazardous to bicyclists depending on the design and parking turnover rate. In other instances, it may be determined that on-street parking is under-utilized and could be removed in order to provide bicycle facilities. Sometimes parking can actually be beneficial to bicyclists by helping to slow vehicles speeds.

Provo has varying types and designs of on-street parking. In residential areas, on-street parking is often parallel to the curb and unmarked. On higher volume local streets and collectors, on-street parking can be designated by a white stripe. On some streets on-street parallel parking may present a hazard to bicyclists who ride too close to doors of parked cars. “Dooring” occurs when a driver opens a parked car door into the path of a bicyclist, resulting in a crash.

Bicyclists can avoid being doored by riding outside of the door zone. This can sometimes be difficult on roads with narrow lanes that do not provide adequate room for a car to pass a bicyclist safely. It can also be daunting for less-confident or experienced bicyclists to ride a safe distance from parked cars.

Another form of on-street parking found in Provo City is diagonal parking. Diagonal parking is common in commercial areas (e.g. Center Street) due to its ease of use when entering and exiting. While dooring is not a potential hazard with diagonal parking, this type of parking does present other hazards to bicyclists. Traditional “front-in” angled parking results in difficulty for drivers to see oncoming bicyclists while reversing. The limited rear-view perspective can result in collisions when bicyclists and motorists are not cautious in these areas. Many cities are now using “back-in” angled parking, which provides improved visibility for drivers, curb-side loading of the vehicle’s trunk, and easier maneuvering relative to parallel parking.

3.5.4 Expansion of Shared-Use Path Network

Provo’s shared-use paths are a significant amenity to bicyclists. These paths are highly desired because they provide separation from motor vehicle traffic, making them a more comfortable place to ride for many bicyclists. Shared-use paths also provide a superior riding experience for longer trips because they frequently have grade-separated crossings that allow bicyclists and other path users to travel with minimal delays or influence by vehicular traffic on the surrounding road network.

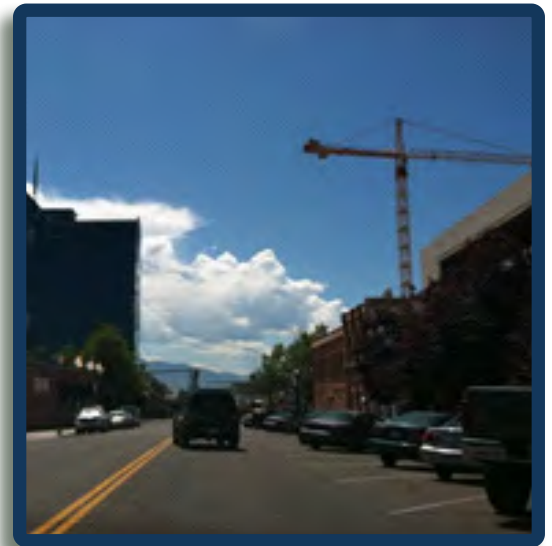
Opportunities to expand existing trails or develop new trails can be limited, especially for cities like Provo where there is limited land available for new development. Despite these limitations, there are opportunities for the expansion of shared-use paths in Provo and the improvement of existing pathways. Potential opportunities include shared-use paths along the Union Pacific rail line that runs parallel with I-15.

Adding bicycle facilities to active rail corridors is often referred to as “Rails with Trails” (RWT). RWT describes any shared-use path or trail located in or directly adjacent to an active railroad corridor. There are over 60 RWTs presently active in the United States totaling more than 240 miles in 30 states. RWTs are located adjacent to active rail lines ranging from a few slow-moving short-haul freight trains weekly to high-frequency passenger trains traveling as fast as 140 mph. In addition to the existing paths, dozens of additional RWTs are proposed or planned. While most are located on public lands leased to private railroads, many are on privately-owned railroad property. A local example of a trail that was developed within a historic rail right-of-way is the Provo River Parkway in Provo Canyon. In cases where a rail corridor is no longer active, these corridors can be converted into a shared-use path.

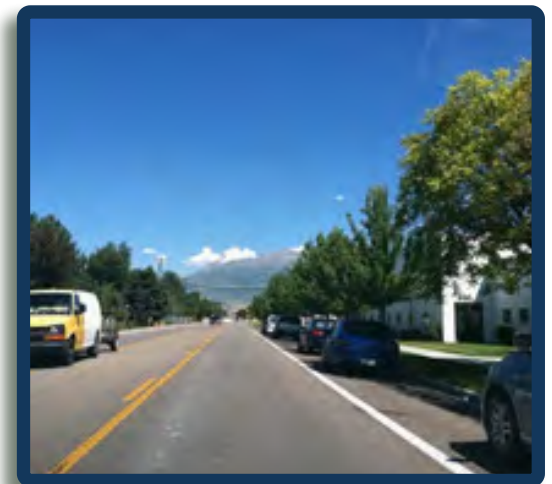
Another opportunity for expanding the shared-use path network is the shoreline area of Utah Lake. Lakes, rivers, and other bodies of water often make for natural places to travel by bike. These paths receive heavy use due to their scenic qualities as well as uninterrupted rights-of-way. At present, there is a paved shared-use path going north from Utah Lake State Park along the shore area for nearly a mile. Shared-use paths are also planned along the lake wetland areas as part of the Westside Connector and Northwest Connector projects, which would essentially trace the outside perimeter of the Utah Lake wetlands between the I-15/University Avenue interchange and Geneva Road in west Provo.

3.5.5 Canal Corridors

Canal corridors often make for good shared-use paths because they provide cut-through opportunities not offered by the roadway network and are almost always constructed along gentle grades. The canals in Provo offer north-south connection opportunities, which could provide



On-street diagonal parking on 100 West



On-street parallel parking on Freedom Boulevard (200 West) at approximately 800 South



» Bike racks are available on FrontRunner for passengers that want to bring a bicycle on board but do not want to stand with it during the ride



valuable additions to the city’s off-street path network. Several of the canals run between Orem and Provo. If bikeways were developed along these canals, they could provide good bikeway connections between the communities. In many cases, however, there is little right-of-way next to the canals and pathway development would require piping of the canal with the path placed on top, which can be very expensive.

3.5.6 Transit

Bus Rapid Transit

The Provo-Orem BRT line will likely be operational within a few years. This project will provide residents of Provo-Orem with a frequent and fast transit option between and within the two communities. It has the potential to significantly improve traffic flow between Provo and Orem by providing a convenient alternative to cars. The BRT system will have multiple stations within Provo City, terminating at the Provo FrontRunner station. BRT buses will be equipped with front racks and BRT stations may also include bike racks for individuals who prefer to leave their bike at the station. The BRT will greatly increase the convenience of multi-modal commuting, making bicycling a more viable transportation option.

Frontrunner Station/Intermodal Hub

The recently-opened FrontRunner commuter rail line is a large benefit for bicyclists because it allows them to bring bikes on board and lengthen the effective distance that they are able to travel comfortably. Integrating bicycle storage accommodations (particularly long-term secure storage) into the Provo FrontRunner station would further enhance Provo’s transit system utility for bicyclists.

Creating high-quality bikeways to connect the station with the rest of Provo is also important. This was a major focus of the route recommendations presented in Chapter 5.

3.5.7 Development

Provo has limited developable land. However, the City has an opportunity to ensure that bicycle facilities are included in the design of future roadways and reconstruction of existing streets. Land

redevelopment provides opportunities for implementing recommendations in this master plan. Building approvals provide an opportunity to incorporate the bike parking recommendations found in Chapter 6.

3.6 Constraints

This section discusses the types of barriers that Provo faces in its attempt to become more bicycle friendly.

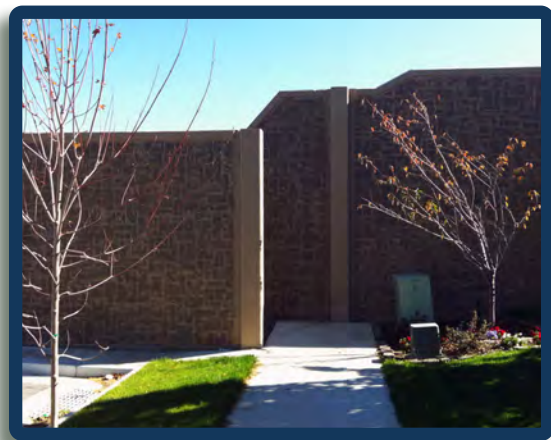
3.6.1 Physical Barriers

This type of barrier is identified as a physical impediment to travel, such as a freeway where crossings can only occur at interchanges and limited grade-separated locations. I-15 is the most obvious example of a physical barrier in Provo because there are only a few bike-friendly ways to cross it. The Provo River is also somewhat of a physical barrier, but crossing are much more plentiful compared to I-15.

3.6.2 Facility Barriers

Facility barriers are those that (through their design or physical constraints) restrict, prohibit, or discourage active use. Facility barriers can take many forms. Barriers can be gaps in a facility (where a bikeway ends suddenly), or actual facilities that do not provide optimal riding conditions. Bike lanes that provide little to no buffer between on-street parking place bicyclists in danger of being doored when a motorists opens a door into a bike lane. This situation could be classified as a facility barrier.

Lack of maintenance can also lead to unusable facilities or undesirable conditions. Shared-use paths and bike lanes frequently collect snow or road debris, making them hazardous to use.



◀ Limited-access highways such as this one are common physical barriers for people who walk and bicycle



3.6.3 Situational Barriers

This type of roadway occurs where roadway widths, travel speeds, or other roadway characteristics make bicycle travel difficult, uncomfortable, or unsafe regardless of the provision of bike lanes or wide shoulders. 900 East is a good example of a situational barrier in Provo.

3.6.4 Gaps

Gaps typically exist where physical or other constraints impede bikeway network development. Typical gap constraints include narrow bridges on existing roadways (such as the University Avenue viaduct) and large intersections where bike lanes are dropped on the approaches in order to accommodate turn lanes. Traffic mobility standards, economic development strategies, and other policy decisions may also lead to gaps in a bikeway network. For instance, a community's strong desire for on-street parking or increased vehicle capacity may hinder efforts to install continuous bike lanes along a major street. **Figure 3-7** presents a theoretical diagram illustrating different kinds of bikeway gaps.

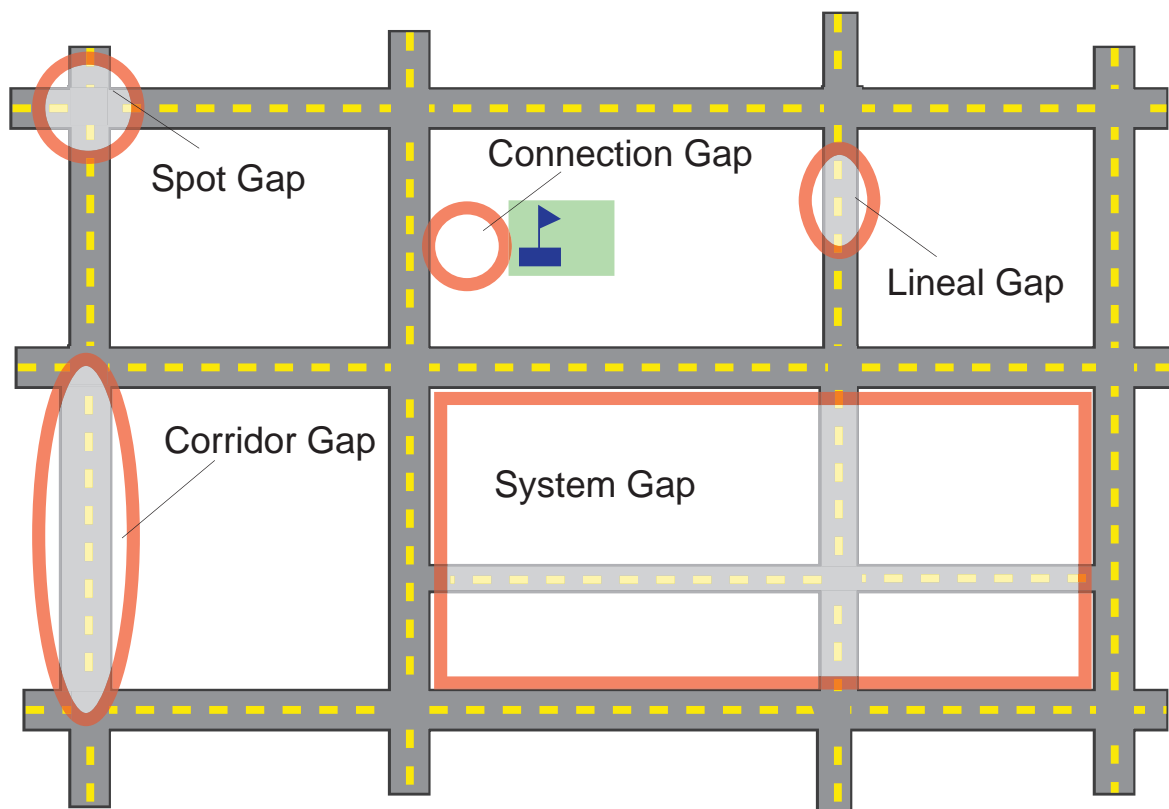


Figure 3-7: Bikeway Gap Types

Bikeway gaps are significant constraints in Provo. However, this also means that there is a tremendous opportunity to fix the gaps. Gaps exist in various forms ranging from short missing links on specific street or path corridors to larger geographic areas with few or no bicycle facilities at all. Gaps can then be organized based on length and other characteristics as described in the subsections that follow.

Spot gaps

Spot gaps refer to point-specific locations lacking dedicated bicycle facilities or other treatments to accommodate safe and comfortable bicycle travel. They primarily include intersections and other conflict areas posing challenges for people riding bicycles. Examples include bike lanes on a major street “dropping” to make way for right turn lanes at an intersection or a lack of intersection crossing treatments for bicyclists on a route or path as they approach a major street. **Figure 3-8** shows an example of a spot gap. Another example is 4800 North between Edgewood Drive and University Avenue.



Figure 3-8: Spot Gap Example

Connection gaps

Connection gaps are missing segments (1/4 mile long or less) on a clearly defined and otherwise well-connected bikeway. Major barriers standing between bicycle destinations and clearly defined routes also represent connection gaps. Examples include:

- » Bike lanes on a major street “dropping” for several blocks to make way for on-street parking
- » A discontinuous off-street path
- » A freeway standing between a major bicycle route and a school.

Figure 3-9 shows an example of a connection gap.



Figure 3-9: Connection Gap Example

Lineal gaps

Lineal gaps are similar to connection gaps but are longer – typically half-mile to one-mile long. Figure 3-10 shows an example of a lineal gap.



Figure 3-10: Lineal Gap Example

Corridor gaps

Corridor gaps are missing links longer than one mile. These gaps will sometimes encompass an entire street corridor where bicycle facilities are desired but do not currently exist. Figure 3-11 shows an examples of a corridor gap.

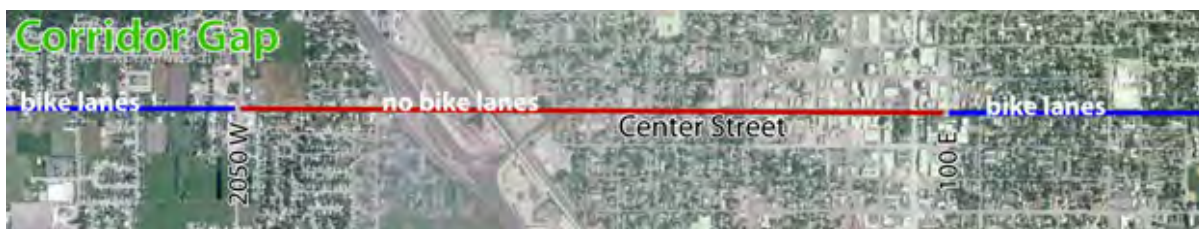


Figure 3-11: Corridor Gap Example

System gaps

Larger geographic areas (e.g. a neighborhood or business district) where few or no bikeways exist would be identified as system gaps. Figure 3-12 identifies one of the system gaps in the Provo City bikeway network.



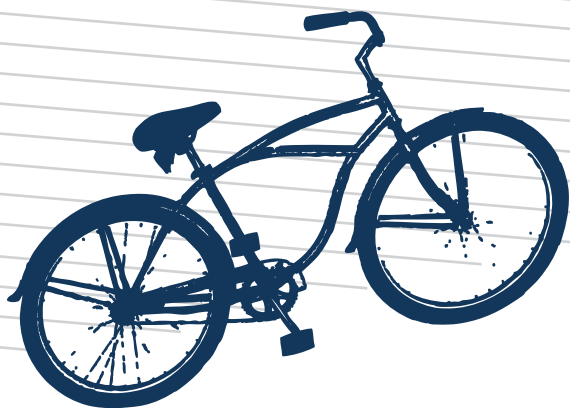
Figure 3-12: System Gap Example

3.6.5 Insufficient Road Widths

Along some Provo roads the existing width may not be sufficient to accommodate a bikeway in addition to the other desired uses of road space. This occurs in two distinct scenarios. The first is where the existing width is narrow, such as Carterville Road. The second situation occurs where roadways are wide but are currently striped to the curb with vehicle lanes or parking and the political willpower does not exist to remove either of those uses. In both cases, property acquisition either through sale or easement dedication may be needed to provide the necessary width for establishing a bikeway.

3.6.6 Snow Removal Practices

Winter brings colder temperatures and ice accumulation. Both of these factors can affect the decision to bicycle for transportation or recreation in the winter. While ice accumulation will always remain a barrier to bicycling, improved maintenance and enforcement practices can minimize the impact to those wishing to bicycle year-round in Provo.



4

4 Needs Analysis

The information in this chapter summarizes the process used to solicit input from the public, work with a steering committee to guide development of the master plan, and develop a model to estimate the demand and benefits of bicycling in Provo. The chapter is organized into the following sections:

- » Needs and Types of Bicyclists
- » Steering Committee
- » Public Workshops
- » Project Website and Online Survey
- » Boulder (CO) Bicycle Tour
- » Demand and Benefits Analysis





◀◀ Different types of bicyclists have varying needs, expectations, and abilities

4.1 Needs & Types of Bicyclists

Similar to motor vehicles, bicyclists and their bicycles come in a variety of sizes and configurations. This variation ranges from the type of bicycle a bicyclist chooses to ride (e.g. a conventional bicycle, a recumbent bicycle, or a tricycle) to the behavioral characteristics and comfort level of the bicyclist. Bicyclists by nature are much more sensitive to poor facility design, construction, and maintenance than motor vehicle drivers. Bicyclists are more exposed to the elements and prone to physical injury due to the lack of protection of the bicycle compared to the automobile.

Bicyclist skill level also leads to a dramatic variance in expected speeds and behavior. Several systems of bicyclist classification are currently in use within the bicycle planning and engineering professions. These classifications can be helpful in understanding the characteristics and infrastructure preferences of different bicyclists. However, it should be noted that these classifications may change in type or proportion over time as infrastructure and culture evolve. Sometimes an instructional course can instantly change a less confident bicyclist to one that can comfortably and safely share the roadway with vehicular traffic. Bicycle infrastructure should be planned and designed to accommodate as many user types as possible with separate or parallel facilities considered to provide a comfortable experience for the greatest number of bicyclists.

The 1999 AASHTO Guide for the Development of Bicycle Facilities identifies bicyclists as being “Advanced or Experienced”, “Basic or Less Confident” or “Children”. These AASHTO classifications have been the standard for at least 15 years and have been found to be helpful when assessing people who currently bicycle. However, these classifications do not accurately describe all types of bicyclists, nor do they account for the population as a whole, especially potential bicyclists who are interested in riding but may not feel existing facilities are safe enough. Beginning in the Pacific Northwest in 2004, and then supported by data collected nationally after 2006, alternative categories have been developed to address the attitudes of Americans towards bicycling. **Figure 4-1** illustrates the different viewpoints and their respective proportions.



» Different types of bicyclists have varying needs, expectations, and abilities



Figure 4-1: Bicyclist Types by Overall Population

Less than 2% of Americans comprise a group of bicyclists who are “**Strong & Fearless**”. These bicyclists typically ride anywhere on any roadway regardless of roadway conditions or weather. They can ride faster than other user groups, prefer direct routes and will typically choose roadway connections – even if shared with vehicles – over separate bicycle facilities such as bicycle paths.

“**Enthusied & Confident**” bicyclists encompass 10-13% of people. They are mostly comfortable riding on all types of bicycle facilities, usually prefer low traffic streets or shared-use pathways when available, and may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of bicyclists including commuters, recreationalists, racers, and utilitarian bicyclists.

The third group can be categorized as “**Interested, but Concerned**”. They do not ride a bicycle regularly. 50-60% percent of the population falls into this category, which represents bicyclists who typically only ride on low traffic streets or bicycle paths under favorable conditions and weather. This group perceives traffic and safety as significant barriers that prevent them from bicycling more often. They may become more regular riders with encouragement, education, and experience.

The remainder of the American population – 20-30% – do not ride bicycles at all and perceive severe safety issues with riding in traffic. This group is classified as “**Not Interested**”. Some people in this group may eventually give bicycling a second look and may progress to the user types above. However, a significant portion of them will never ride a bicycle under any circumstances.

University cities such as Provo offer a special environment that varies significantly in transportation modal trends from the rest of the nation and even the general population within the same city. Students, faculty, and staff on university campuses typically walk and bicycle in much higher numbers than their counterparts elsewhere. Individuals commuting to campuses choose alternative means of transportation for varying reasons – to save money, to avoid the hassle of parking, for convenience, and because it’s more environmentally-friendly than driving alone.

4.2 Steering Committee

A steering committee with representation from a variety of city departments, other agencies, and citizens was formed to meet regularly, review draft documents, and generally guide development of the Provo Bicycle Master Plan. The committee met monthly during the course of the project. **Table 4-1** lists the members of the steering committee along with the interests that they represented.

Table 4-1: Provo Bicycle Master Plan Steering Committee

Name	Agency/Department
Casey Serr	Provo City Engineering
David Graves	Provo City Engineering
Brian Torgersen	Provo City Engineering
Mark Crosby	Provo City Police Department
Dixon Holmes	Provo City Economic Development
Nathan Murray	Provo City Economic Development
Rob Nesbit	Provo City Streets
Doug Robins	Provo City Parks & Recreation
Phil Uhl	Provo City Information Systems
Brent Wilde	Provo City Community Development
Bill Peperone	Provo City Community Development
Sterling Beck	Provo City Council
Sam Ray	Provo School District
Ken Anson	Utah Transit Authority
Craig Hancock	UDOT Region 3
Evelyn Tuddenham	UDOT Central Bicycle & Pedestrian Office
Jim Price	Mountainland Association of Governments
Bob Ross	Brigham Young University
Zac Whitmore	Provo Bicycle Committee (citizen advocate)



4.3 Public Workshops

Two public workshops were held during the planning process. Comments from these public workshops served as the foundation for the plan and for revisions to the draft recommendations.

4.3.1 Workshop #1 – November 2011

An initial workshop was held on November 29, 2011 at the Provo City Library. There were 36 people in attendance. The open house provided opportunity for the public to ask questions, familiarize themselves with this master plan effort, review information pertaining to Provo and its existing bicycle facilities, and give input about the types of bicycling improvements they would like to see.

Interactive Presentation & Survey

A presentation and visual preference survey was conducted to gauge the bicycling behaviors and characteristics of those in attendance and also give live feedback about the types of bikeways attendees preferred. Participants were first asked a series of questions about what type of bicyclist they are, how often they ride, and factors that keep them from riding more. Results showed that those in attendance were generally more experienced cyclists, with 70% of participants rating themselves as “Enthusied and Confident” or “Strong and Fearless” riders and almost half of them riding daily.

The visual preference survey aimed to educate participants about the different types of bicycle facilities and give them the opportunity to give live feedback about the bikeway types that they would most like to see implemented in Provo. People were shown images depicting various bikeway types and were then able to vote on how much they liked or disliked them. Results of the survey were displayed live on the screen immediately after each question was complete so that

» Open house participants took a visual preference survey and discussed city bicycling concerns with the project team



participants could see the overall preference of the group. People generally responded favorably to all types of the facilities described in the presentation, but liked bike lanes the most. **Figure 4-2** summarizes some of the results obtained through the preference survey exercise.

Map Exercise

Several large maps were spread out on tables to show current designated bikeways. Participants were given markers and sticky notes to critique existing bicycle facilities, identify areas where improvements are needed, and make suggestions for new bikeways. This mapping exercise was very popular. Attendees contributed a wealth of information about preferred routes, barriers, and concerns.

Comment Cards

Open house participants were also invited to provide specific feedback regarding issues and suggest needed improvements on comment cards.

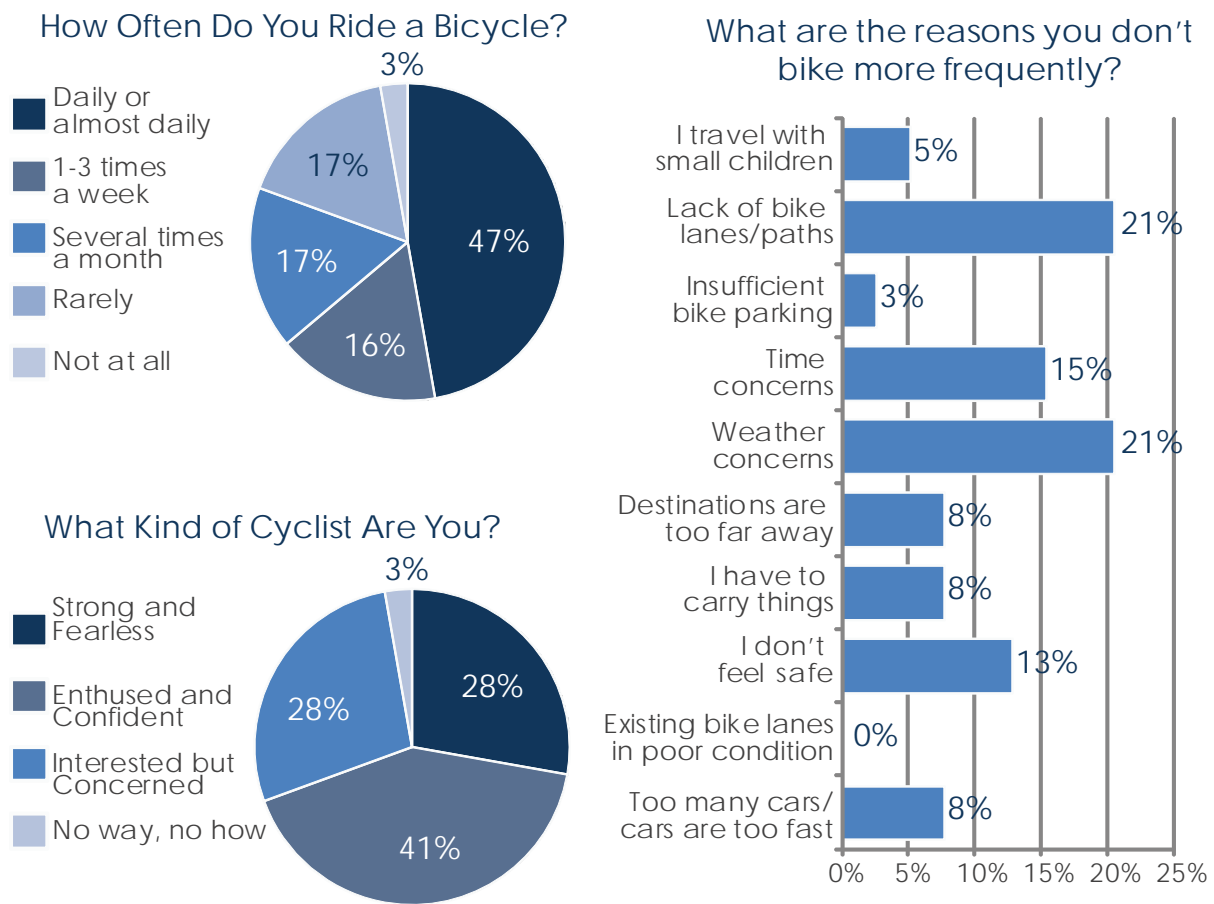
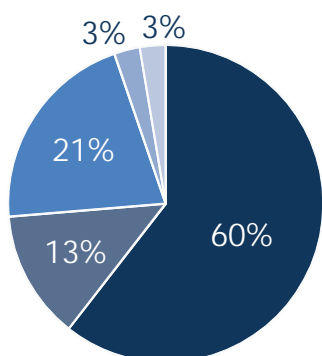


Figure 4-2: Visual Preference Survey Results

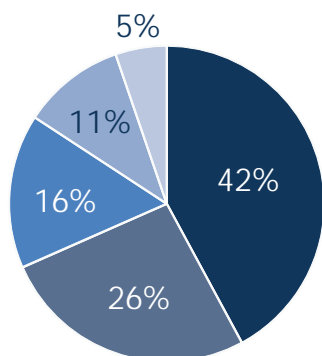


How do you feel about?:

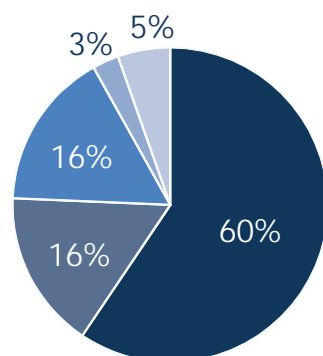
Shared-Use Paths



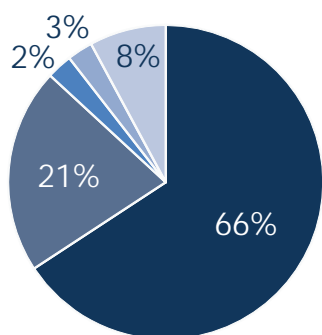
Sidepaths



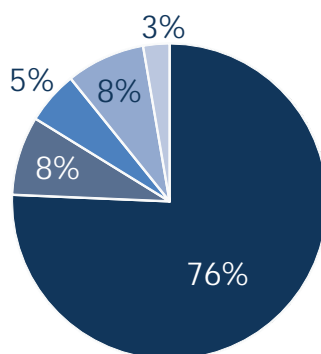
Cycle Tracks



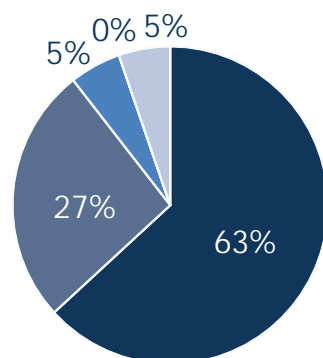
Buffered Bike Lanes



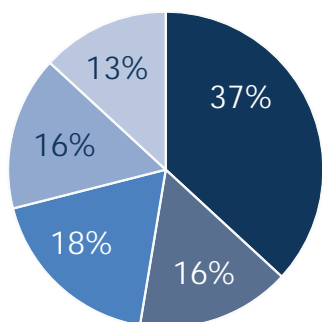
On-Street Bike Lanes



Bike Boulevards



Shared Roadways



Unpaved Trails

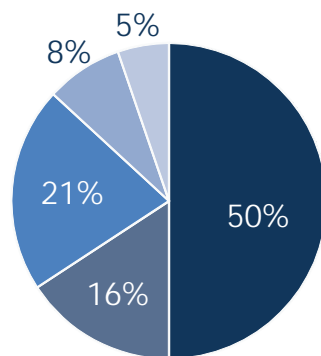


Figure 4-2: Visual Preference Survey Results (cont'd)

4.3.2 Workshop #2 – April 2012

A second workshop was held on April 10, 2012 at the Provo City Library. The purpose of this meeting was to give the public the opportunity to comment on maps showing the draft bikeway network and draft non-infrastructure program recommendations. A total of 39 people attended and provided their input via written comments on the maps and comment cards.

Map Exercise

As in the first workshop, a mapping exercise was conducted. Whereas the first workshop only displayed existing bikeways and invited attendees to make open-ended comments about what they'd like to see, the maps for this second workshop contained detailed recommendations for specific bikeway types on specific streets.

Participants gathered in groups to talk about their thoughts and provide comments about what they liked on the maps or would like to see altered. Sticky notes and pens were used to draw attention to specific areas on the maps where people liked a recommendation or wanted to express a desire for a modification.

Non-Infrastructure Programs

Boards were displayed describing possible non-infrastructure programs that could support bicycling in Provo. Attendees were given five dots each and asked to place them on the non-infrastructure program recommendations that they felt were most important.



Open house attendees wrote comments on large maps



Figure 4-3 shows the non-infrastructure program preferences demonstrated by those who voted. Staffing a bicycle coordinator position, creating a City bicycle map, and implementing a Complete Streets Policy ranked as the three top preferences.

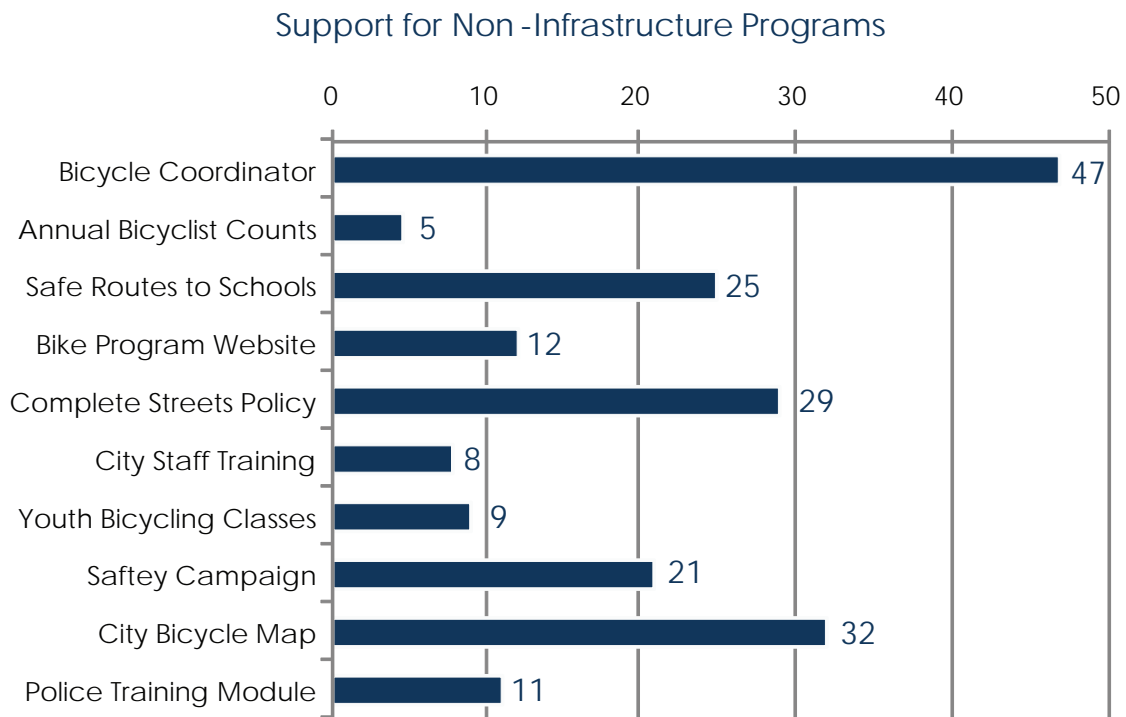


Figure 4-3: Support for Programs

» Participants ranked potential non-infrastructure programs using stickers to indicate the programs they feel would be most beneficial to Provo



4.4 Project Website & Online Survey

A project website (www.provobikeplan.com) was used throughout the master plan development process to announce open houses, display information, collect general comments, and conduct a detailed online survey. The online survey was offered between October 2011 and January 2012. The survey contained questions about personal characteristics and behaviors, bikeway type preferences, and demand for bikeways on specific roadways in Provo. In total, 558 responses were received. 18% of survey takers were under 25 years of age, 47% were between 26 and 44, and 32% were between 45 and 69. The gender split was 60% male and 40% female. Approximately 85% of survey takers were Provo residents.

Half of all respondents reported riding a bicycle once a week or more, while the other half's use was less frequent. When asked to specify reasons that they don't ride a bike (or don't ride more frequently), 56% of respondents specified that a lack of bikeways was a chief reason, while 46% indicated that too many cars and cars driving too fast were contributing factors. Other safety-related reasons were also frequently cited.

Survey respondents were then asked to rate the importance of bicycle facilities on specific roadways. University Avenue, 900 East, and 200 West (Freedom Boulevard) ranked as the top three most important roadways in Provo for bikeway facilities. Center Street, 500 West, State Street, Bulldog Boulevard, Canyon Road, 500 North, and Geneva Road also ranked high on the list.

The survey also asked respondents to pick their favorite bicycle destinations in and around Provo. The Provo River Parkway, BYU, and Utah Lake were the highest-rated destinations. Downtown Provo and the Provo City Library were also popular destination points.

A majority of survey respondents also said that the average distance of their bicycle trips is 5 miles or less, with recreation areas, workplaces, and neighborhood stores being the most popular destinations for riding a bicycle.



◀ The project website provided opportunities for public input, education, and master plan progress updates



The project website allowed visitors to submit open-ended comments to the project team about any topic that they wanted to convey. The comments covered a wide variety of topics and concerns. Table 4-2 groups the comments into general categories and shows how many comments were received for each one.

Table 4-2: Website Open-Ended Comment Summary

Accessibility	Number of Comments
lack of access/desire for additional access	51
desire for improved bicycle facilities	50
desire for improved crossing	8
Safety	
concern for safety of existing conditions	22
desire for more public education	2
Convenience	
desire for more/improved bicycle parking	10
desire for improved roadway/bikeway maintenance	9
general support for bicycle plan	4

» Steering committee members and key elected officials ride on a cycle track during their tour of Boulder, CO





◀ Steering committee members and key elected officials participate in a bicycle tour of Boulder, CO

4.5 Boulder (CO) Bicycle Tour

On May 21, 2012 the steering committee and other key stakeholders flew to Colorado to participate in a bicycling tour of Boulder. The purpose of the tour was to give stakeholders a first-hand look at a community that has been working for many years to implement the types of bikeways and programs recommended within the Provo Bicycle Master Plan. Many of the elected officials that would need to support adoption of this master plan and the City staff members who would ultimately be responsible for its implementation attended the tour. A representative from Boulder’s transportation planning division guided and narrated the three-hour bicycle tour. Table 4-3 lists the people who participated in this trip.

Table 4-3: Boulder Tour Participants

Name	Department/Agency
Greg Beckstrom	Public Works
Laura Cabanilla	City Council
John Curtis	Mayor
David Graves	Engineering
Craig Hancock	UDOT Region 3
Spencer Hawkes	Provo Bicycle Committee
Don Jarvis	Mayor's Sustainability Advisor
Gary McGinn	Community Development
Hal Miller	City Council
Nathan Murray	Economic Development
Doug Robins	Parks & Recreation
Casey Serr	Engineering
Matt Taylor	City Council (Admin Support)
Brian Torgerson	Engineering
Britney Ward	Engineering
Brent Wilde	Community Development
Gary Winterton	City Council



4.6 Demand & Benefits Model

4.6.1 Introduction

This section describes a model used to estimate the number of current transportation-oriented walking and bicycling trips in Provo and quantify how those trips benefit the community. The model also quantifies the future benefits of walking and bicycling given certain assumptions about the percentage of trips that will be taken using those two modes of transportation. The model uses a market segment approach to estimate the number of bicycling and walking trips taken by populations that traditionally have higher cycling and walking mode splits than work commuters (such as elementary and college students). National transportation surveys, in particular the *National Household Travel Survey* (NHTS, 2009) show that commute trips are only a fraction of the trips an individual takes on a given day. The model uses the NHTS findings to estimate the number of non-work, non-school trips so that they can be factored in with commute trips to estimate the total number of walking and bicycling trips that occur in a day.

4.6.2 Data Used in the Model

Journey-to-work information collected by the U.S. Census Bureau's American Communities Survey (ACS) is the foundation of this analysis. The most recent ACS data available for Provo City are the 2010 three-year estimates. Model variables from the ACS include:

- » Total population (111,780 people)
- » Employed population (52,393 people)
- » School enrollment (14,176 students grade K-12; 41,453 college students)
- » Travel-to-work mode split (see [Table 4-4](#)).

The 2009 NHTS provides a substantial national dataset of travel characteristics, particularly for bicycling and walking trips. Data used from this survey include:

- » Student mode split, grades K-12
- » Ratio of walking and bicycling work trips to non-work, non-social/recreational trips
- » Ratio of work trips to social and recreational trips
- » Average trip length by trip purpose and mode

Table 4-4: Provo Commute Mode Share*

	Bicycling	Walking	Source
Employed	2.38%	15.78%	2010 ACS
K-12	0.67%	10.57%	NHTS 2009
College	2.38%	15.78%	Assumed same as 2010 ACS "Employed"

* "Mode share" is the percent of trips made by a particular transportation mode.

Several of these variables provide an indirect method of estimating the number of walking and bicycling trips made for non-work reasons, such as shopping and running errands. NHTS data indicate that for every bicycle work trip there are slightly more than two utilitarian (i.e. transportation-oriented) bicycle trips made. Although these trips cannot be directly attached to a certain group of people (not all utilitarian bicycling trips are made by people who bicycle to work), these multipliers allow a high percentage of the community’s walking and bicycling activity to be captured in an annual estimate.

The SRTS Baseline Data Report (2010) was used to determine the average distances of school-related walking and bicycling trips.

Disclaimer

As with any modeling projection, the accuracy of the result is dependent on the accuracy of the input data and other assumptions. Effort was made to collect the best data possible for input to the model, but in many cases national data was used where local data were unavailable. Examples of information that could improve the accuracy of this exercise include detailed results of local SRTS parent and student surveys, a regional household travel survey, and a travel survey of college students.

4.6.3 Existing Walking & Bicycling Trips

Table 4-5 shows the results of the model, which estimates that 11,636 bicycle and 136,752 walking trips occur in Provo each day for transportation purposes. The majority are non-work utilitarian trips, which include medical/dental services, shopping/errands, family or personal business, obligations, meals, and other trips.



◀◀ The Provo Towne Centre Mall is a destination for people whether they drive, walk, or ride to get there



Trips made for social or recreational purposes are not included in this model since its underlying goal is estimating the transportation benefits of bicycling and walking. However, it is worth noting that NHTS data show that there are approximately 6.5 social and recreational bicycle trips made for every bicycle commute trip. This means that there are an estimated 16,000 bicycle trips being made in Provo every day for purely social and recreational purposes that are not accounted for in the model. NHTS data estimate that 5.9 social and recreational walking trips are made for every walking commute trip. However, it is likely that the factor for Provo is much less than that given the relatively high number of walking commute trips.

Table 4-5: Model Estimate of Current Bicycle & Walking Trips

	Bicycling	Walking	Source
Work Commute Trips			
Work commuters	1,245	8,269	Employed population multiplied by mode split
Weekday trips	2,490	16,538	Number of commuters multiplied by two for return trips
K-12 School Trips			
K-12 commuters	95	1,499	School children population multiplied by mode split
Weekday trips	191	2,998	Numbers multiplied by two for return trips
College Commute Trips			
College commuters	985	6,542	College population multiplied by mode split
Weekday trips	1,970	13,085	College bicyclists multiplied by two for return trips
Utilitarian Trips			
Daily trips (includes Sat/Sun)	6,986	104,132	Adult trips (sum of work and college) multiplied by ratio of utilitarian to work trips (NHTS).
Total Current Daily Trips	11,636	136,752	

Current Trip Replacement

To estimate the total distance that Provo residents travel to work or school by walking and bicycling, the model isolates different walking and bicycling user groups and applies trip distance information by mode based on the 2009 NHTS. The model values shown in Table 4-6 estimate that 49 million bicycling and walking trips each year replace 35 million vehicle trips and nearly 27 million vehicle-miles traveled. This equates to an estimated 7% reduction in non-freeway vehicle-miles traveled within Provo City.

Table 4-6: Current Bicycling & Walking Trip Replacement

	Bicycling	Walking	Source
Commute Trips			
Weekday trips reduced	1,561	12,019	Trips multiplied by the drive-alone trip percentage to determine auto trips replaced by bicycle trips
Weekday miles reduced	5,526	8,053	Number of vehicle trips reduced multiplied by average bicycle/walking work trip length (NHTS 2009)
School Trips			
Weekday trips reduced	114	1,991	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Weekday miles reduced	114	919	Number of vehicle trips reduced multiplied by average trip length to/from school (SRTS 2010)
College Trips			
Weekday trips reduced	1,235	8,008	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Weekday miles reduced	1,828	5,325	Number of vehicle trips reduced multiplied by average school/daycare/religious trip length (NHTS 2009) for bicycling/walking modes
Utilitarian Trips			
Daily trips reduced (includes Sat/Sun)	4,380	75,678	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Daily miles reduced (includes Sat/Sun)	8,292	50,452	Number of vehicle trips reduced multiplied by average utilitarian trip length (NHTS 2009) for bicycling/walking modes
Yearly Results	Bicycling	Walking	Total
Yearly trips by mode	3,623,891	45,495,674	49,119,566
Yearly vehicle trips replaced by mode	2,270,904	33,027,202	35,298,106
Yearly vehicle miles replaced by mode	4,850,371	21,750,242	26,600,613

Current Benefits

To the extent that bicycling and walking trips replace single-occupancy vehicle trips, they reduce emissions and have tangible economic impacts by reducing traffic congestion, crashes, and maintenance costs. In addition, the reduced need to own and operate a vehicle saves families money. These benefits are shown in **Table 4-7**. The current annual household transportation cost savings alone is estimated at \$130 per person or \$460 per household.



Table 4-7: Benefits of Current Bicycling & Walking Trips

	Bicycling	Walking	Source
Yearly vehicle miles reduced	4,850,371	21,750,242	
Air Quality Benefits			
Reduced Hydrocarbons (pounds/year)	14,543	65,213	EPA, 2005[*]
Reduced Particulate Matter (pounds/year)	108	484	EPA, 2005
Reduced Nitrous Oxides (pounds/year)	10,159	45,554	EPA, 2005
Reduced Carbon Monoxide (pounds/year)	132,596	594,593	EPA, 2005
Reduced Carbon Dioxide (pounds/year)	3,945,805	17,693,947	EPA, 2005
Economic Benefits of Air Quality			
Particulate Matter	\$9,072	\$40,682	NHTSA, 2011 [†]
Nitrous Oxides	\$20,317	\$91,107	NHTSA, 2011
Carbon Dioxide	\$67,652	\$303,368	U.S. Government
Reduced External Costs of Vehicle Travel			
Traffic Congestion	\$339,526	\$1,522,517	AAA, 2008[‡]
Vehicle Crashes	\$1,503,615	\$6,742,575	AAA, 2008
Roadway Maintenance Costs	\$679,052	\$3,045,034	Kitamura, R., Zhao, H., and Gubby, A. R., 1989[§]
Household Transportation Savings			
Reduction in HH transportation spending	\$2,667,704	\$11,962,633	IRS operational standard mileage rates for 2010 [**]
Total	\$5,286,938	\$23,707,915	

[*] From EPA report 420-F-05-022 "Emission Facts: Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks." 2005.

[†] NHTSA Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks, Table VIII-5 (<http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.d0b5a45b55bfbe582f57529cdba046a0/>).

[‡] "Crashes vs. Congestion – What's the Cost to Society?" http://newsroom.aaa.com/wp-content/uploads/2011/11/2011_AAA_CrashvCongUpd.pdf

[§] Kitamura, R., Zhao, H., and Gubby, A. R. (1989). Development of a Pavement Maintenance Cost Allocation Model. Institute of Transportation Studies – University of California, Davis (http://pubs.its.ucdavis.edu/publication_detail.php?id=19). \$0.08/mile (1989), adjusted to 2010 dollars using the Bureau of Labor Statistics Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm).

[**] <http://www.irs.gov/newsroom/article/0,,id=216048,00.html>

4.6.4 Future Walking & Bicycling Trips

Estimating future benefits requires additional assumptions regarding Provo’s future population and anticipated travel patterns in 2030. Future population predictions from the 2010 Provo General Plan were used in this model. **Table 4-8** shows the demographics used in the future analysis.

Table 4-9 shows projected 2030 bicycling and walking trips for two assumed bicycle mode share scenarios. The first scenario assumes a 5% bicycle mode share and the second assumes a 10% mode share. For simplicity, these mode shares were assumed to apply for all trip types (commuting, utilitarian, school, etc.). Walking mode share was assumed to remain equal to current levels.

The important factor to consider with these future assumptions is not the accuracy of the mode share percentages, but the benefits that would accrue to Provo if those numbers are reached. As more cities across the country track changes in bikeway mileage over time and participate in annual bicycle counts, more data will be available to better understand and refine future mode share predictive measures.

Table 4-8: Projected 2030 Demographics

	Number	Percent of 2030 Population	Source
Population	138,450	100.00%	2010 Provo General Plan: 2030 Population Estimate (based on 0.91% annual growth rate)
Employed population	62,800	45.40%	2010 General Plan - 0.91% annual growth rate
School population, K-12	17,558	12.70%	Assumes same percent as ACS 2009 estimate
College student population	51,343	37.10%	Assumes same as 2009 ACS estimate

Future Trip Replacement

The same trip replacement factors used for the existing analysis were applied to the numbers in **Table 4-10** in order to generate estimates of bicycling and walking trip replacement for the 2030 scenario. This table shows that a 5% bicycle mode share scenario would result in more than nearly 65 million annual walking and bicycling trips, which will reduce vehicle trips by more than 46 million and vehicle-miles traveled by more than 39 million. A 10% bicycle mode share would result in an estimated 74 million annual walking and bicycling trips, along with reductions of 53 million vehicle trips and nearly 54 million vehicle-miles traveled.

Future Benefits

Table 4-11 shows the air quality and economic benefits of the future projected walking and bicycling trips in Provo. For the 5% bicycle mode share assumption, annual transportation savings are estimated to accrue at a rate of \$156 per person or \$550 per household. A 10% bicycle mode share would result in an estimated \$213 per person cost savings or \$755 per household.



Table 4-9: 2030 Bicycling & Walking Trips

	Bicycling		Walking	Source
	5% Share	10% Share		
Commute Trips				
Work commuters	3,140	6,280	9,911	Employed population multiplied by mode split
Weekday trips	6,280	12,560	19,823	Number of commuters multiplied by two for return trips
School Trips				
K-12 commuters	878	1,756	1,856	School children population multiplied by mode split
Weekday trips	1,756	3,512	3,713	Numbers multiplied by two for return trips
College Trips				
College commuters	2,567	5,134	8,103	College population multiplied by mode split
Weekday trips	5,134	10,269	16,207	College bicyclists multiplied by two for return trips
Utilitarian Trips				
Daily trips	17,878	35,755	126,654	Adult trips (sum of work and college) multiplied by ratio of utilitarian to work trips (NHTS).
Total Future Weekday Trips	31,048	62,096	166,397	

» Good bicycle infrastructure can help to encourage investment and development in old and new neighborhoods

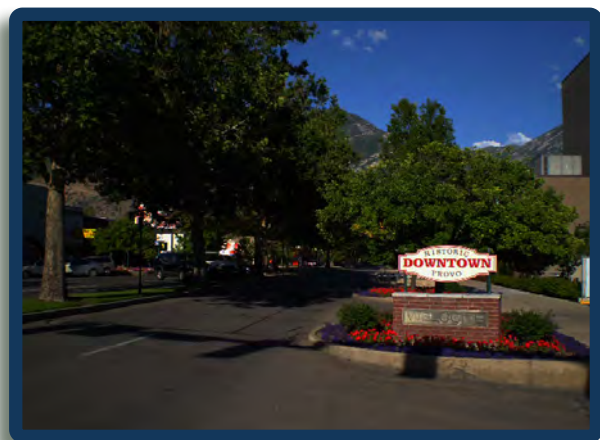


Table 4-10: 2030 Bicycling & Walking Trip Replacement

	Bicycling		Walking	Source
	5% Share	10% Share		
Commuter Trips				
Weekday trips reduced	4,046	8,541	14,406	Trips multiplied by the drive-alone trip percentage to determine auto trips replaced by bicycle trips
Weekday miles reduced	14,323	30,237	9,652	Number of vehicle trips reduced multiplied by average bicycle walking work trip length (NHTS 2009)
School Trips				
Weekday trips reduced	1,098	2,318	2,466	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Weekday miles reduced	1,096	2,314	1,139	Number of vehicle trips reduced multiplied by average trip length to/from school (SRTS 2010)
College Trips				
Weekday trips reduced	3,308	6,983	11,778	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Weekday miles reduced	4,896	10,335	6,596	Number of vehicle trips reduced multiplied by average school/daycare/religious trip length (NHTS 2009) for bicycling/walking modes
Utilitarian Trips				
Daily trips reduced (includes Sat/Sun)	11,518	24,316	92,046	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Daily miles reduced (includes Sat/Sun)	21,807	46,037	61,364	Number of vehicle trips reduced multiplied by average utilitarian trip length (NHTS 2009) for bicycling/walking modes
Yearly Results				Total
Yearly trips by mode	9,516,434	19,032,868	55,329,723	64,846,157 (74,362,591)
Yearly vehicle trips replaced by mode	6,124,542	12,929,588	40,165,325	46,289,866 (53,094,913)
Yearly vehicle miles replaced by mode	12,874,167	27,178,797	26,444,655	39,318,822 (53,623,452)



Table 4-11: Benefits of Future Bicycling & Walking Trips

	Bicycling		Walking	Source
	5% Share	10% Share		
Yearly vehicle miles reduced	12,874,167	27,178,797	26,444,655	
Air Quality Benefits				
Reduced Hydrocarbons (pounds/year)	38,600	81,490	79,289	EPA, 2005[*]
Reduced Particulate Matter (pounds/year)	287	605	589	EPA, 2005
Reduced Nitrous Oxides (pounds/year)	26,964	56,923	55,385	EPA, 2005
Reduced Carbon Monoxide (pounds/year)	351,945	742,995	722,926	EPA, 2005
Reduced Carbon Dioxide (pounds/year)	10,473,209	22,110,107	21,512,879	EPA, 2005
Economic Benefits of Air Quality				
Particulate Matter	\$24,080	\$50,835	\$49,462	NHTSA, 2011 [†]
Nitrous Oxides	\$53,927	\$113,846	\$110,771	NHTSA, 2011
Carbon Dioxide	\$179,566	\$379,084	\$368,844	U.S. Government
Reduced External Costs of Vehicle Travel				
Traffic Congestion	\$901,192	\$1,902,516	\$1,851,126	AAA, 2008[‡]
Vehicle Crashes	\$3,990,992	\$8,425,427	\$8,197,843	AAA, 2008
Roadway Maintenance Costs	\$1,802,383	\$3,805,032	\$3,702,252	Kitamura, R., Zhao, H., and Gubby, A. R., 1989[§]
Household Transportation Savings				
Reduction in HH transportation spending	\$7,080,792	\$14,948,338	\$14,544,560	IRS operational standard mileage rates for 2010 [**]
Total	\$14,032,932	\$29,625,078	\$28,824,858	

[*] From EPA report 420-F-05-022 "Emission Facts: Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks." 2005.

[†] NHTSA Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks, Table VIII-5 (<http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.d0b5a45b55bfbe582f57529cdba046a0/>).

[‡] "Crashes vs. Congestion – What's the Cost to Society?" http://newsroom.aaa.com/wp-content/uploads/2011/11/2011_AAA_CrashvCongUpd.pdf

[§] Kitamura, R., Zhao, H., and Gubby, A. R. (1989). Development of a Pavement Maintenance Cost Allocation Model. Institute of Transportation Studies – University of California, Davis (http://pubs.its.ucdavis.edu/publication_detail.php?id=19). \$0.08/mile (1989), adjusted to 2010 dollars using the Bureau of Labor Statistics Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm).

[**] <http://www.irs.gov/newsroom/article/0,,id=216048,00.html>

4.6.5 Comparison of Future Trip Replacement Against Baseline Conditions

A 5% bicycle mode share paired with the existing walking mode share would reduce vehicle-miles traveled by 12.7 million annually compared to existing conditions. A 10% bicycle mode share would reduce annual vehicle-miles traveled by approximately 27 million.

4.6.6 Comparison of Future Benefits Against Baseline Conditions

In order to provide some perspective about the impact of the vehicle-miles and emissions reductions described in the existing and future scenarios, the Utah Department of Air Quality (UDAQ) was contacted. UDAQ provided information about annual vehicle-miles traveled and air quality emissions attributable to on-road mobile sources. A comparison of these data showed that bicycling and walking currently reduce annual vehicle-miles traveled by an estimated 3.5%. These figures would rise to an estimated 4.2% or 5.7% in 2030 with 5% and 10% bicycle travel mode shares, respectively.

Comparison of projected air emission reductions showed that bicycling and walking reduce emissions between 0.01% and 0.80% depending upon the given emission category and time horizon selected. Bicycling and walking had the greatest reduction impact on carbon dioxide and the least effect on particulate emissions. It is likely that air emission reductions are smaller in scale than reductions in vehicle-miles traveled due to the fact that many air emissions (especially particulates) are primarily attributable to freight operations and transportation mode shifts from passenger vehicles to bicycling or walking do not reduce truck volumes.

The model predicts that a 5% bicycle mode share combined with existing walking mode share would save \$6.6 million of annual external costs (congestion, crashes, and road maintenance) in Provo compared to baseline conditions, whereas a 10% bike mode share would save \$14.1 million.

In terms of household transportation costs, a 5% bicycle mode share (assuming walking mode share remains the same) would save an additional \$26 annually per Provo resident (or \$90 per household) as compared to existing conditions. A 10% bicycle mode share would annually save \$83 more per resident and \$295 more per household relative to existing conditions.

4.6.7 Difficult-to-Quantify Benefits of Bicycling & Walking

Bicycling and walking are low-cost and effective means of transportation that are non-polluting, energy-efficient, versatile, healthy, and fun. Everyone is a pedestrian at some point, whether walking to a parked car, taking a lunch break, or accessing transit. In addition, bicycles offer low-cost mobility to the non-driving public. Bicycling and walking as a means of transportation has been growing in popularity as many communities work to create more balanced transportation systems and individuals seek to be healthier. In addition, more people are willing to bicycle more frequently if better bicycle facilities are provided.¹

1. Pucher, J., Dill, J. and Handy, S. (2010). *Infrastructure, programs, and policies to increase bicycling: An international review*. Preventative Medicine 50:S106-S125.



In addition to the tangible economic benefits estimated above, bicycling and walking have many other benefits that are challenging to quantify, but which have been studied by some communities and organizations. The League of American Bicyclists reported that bicycling makes up \$133 billion of the US economy, funding 1.1 million jobs.² The League also estimates that bicycle-related trips generate another \$47 billion in tourism activity. Many communities have enjoyed a high return on their investment in bicycling. For example, the Outer Banks of North Carolina spent \$6.7 million to improve local bicycle facilities, and reaped the benefit of \$60 million of annual economic activity associated with bicycling.³ Multiple studies show that walkable, bikeable neighborhoods are more livable and attractive, increasing home values⁴, and resulting in increased wealth for individuals and additional property tax revenue.

Bike lanes can improve retail business directly by drawing customers and indirectly by supporting the regional economy. Patrons who walk and bike to local stores have been found to spend more money to visit local businesses than patrons who drive.⁵ Other studies show that walkable, bikeable communities attract the young creative class,⁶ which can help cities gain a competitive edge and diversify economic base. By replacing short car trips, bicycling can help middle-class families defray rising transportation costs. Families that drive less spend 10 percent of their income on transportation, compared to 19 percent for households with heavy car use,⁷ freeing additional income for local goods and services.

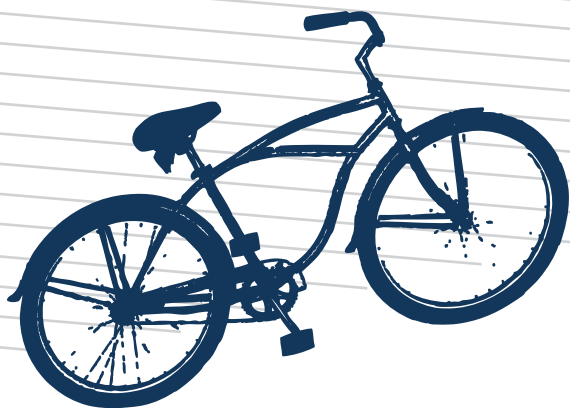
Bicycling can also improve quality of life. Since bicycling is among the most popular forms of recreational activity in the U.S.⁸, when bicycling is available as a daily mode of transportation, substantial health benefits result. The health benefit of bicycling for exercise can reduce the cost of spending on health care by as much as \$514 a year, which provides a financial incentive to businesses that provide health coverage to their employees.⁹

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2. Flusche, Darren for the League of American Bicyclists. (2009). *The Economic Benefits of Bicycle Infrastructure Investments*.
 3. N.C. Department of Transportation, Division of Bicycle and Pedestrian Transportation. (). *The Economic Impact of Investments in Bicycle Facilities*. atfiles.org/files/pdf/NCbikeinvest.pdf
 4. Cortright, Joe for CEOs for Cities. (2009). *Walking the Walk: How Walkability Raises Home Values in U.S. Cities*.
 5. The Clean Air Partnership. (2009). *Bike Lanes, On-Street Parking and Business: A Study of Bloor Street in Toronto's Annex Neighborhood*.
 6. Cortright, Joe for CEOs for Cities. (2007). *Portland's Green Dividend*.
 7. Center for Neighborhood Technology. (2005). *Driven to Spend: Pumping Dollars out of Our Households and Communities*.
 8. Almost 80 million people walk and 36 million people bicycle for recreation or exercise nationally. 27.3% of the population over 16 bicycles at least once over the summer. (National Sporting Goods Association survey, 2003)
 9. Feifei, W., McDonald, T., Champagne, L.J., and Edington, D.W. (2004). Relationship of Body Mass Index and Physical Activity to Health Care Costs Among Employees. *Journal of Occupational and Environmental Medicine*.46(5):428-436

Safety concerns are another reason to improve bicycling conditions. Although the incidence of crashes involving bicycles may be low, concerns about safety have historically been the single greatest reason people do not commute by bicycle, as captured in polls as early as 1991.¹⁰ An SRTS survey in 2004 similarly found that 30 percent of parents consider traffic-related danger to be a barrier to allowing their children to walk or bike to school. Addressing those concerns for bicyclists and pedestrians through physical and program improvements is another major objective of the Lehi Bicycle and Pedestrian Master Plan. Improving bicyclist safety can also be accomplished by increasing the number of people who walk and bike. Pedestrians in communities where twice as many people walk are 66% less likely to be injured by a motorist.¹¹

10. Lou Harris Poll (2001)

11. Jacobsen, P.L. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury Prevention* 9:205-209.



5 Bikeway Recommendations

A primary objective of the Provo Bicycle Master Plan is improving the connectivity and quality of the City's bicycling network. New facilities, safety improvements, and improved connections are needed to enable bicyclists to reach key destinations in a convenient and safe manner. This chapter presents the recommended facility improvements that will create a comprehensive bicycle network in Provo over time.

Draft recommendations were crafted in cooperation with the steering committee that helped to guide this master planning effort. The draft recommendations were then presented at a public workshop where attendees had the chance to comment on the recommendations. The public input and guidance from the steering committee were used to refine the recommendations into the final set presented in this chapter.

The following guiding principles were used to develop the recommendations:

- » Connect all areas of the City.
- » Fill critical gaps in the bicycling network.
- » Connect Provo's bicycle network to facilities in surrounding communities.





◀◀ Provo River Parkway

- » Where possible, recommend facility types that serve the widest range of users, particularly those who are less comfortable riding bicycles in close proximity to traffic.
- » Recommend facilities that can feasibly be constructed and maintained by the City.
- » Use a phased implementation approach that provides logical short- and medium-term recommendations, while retaining long-term visionary recommendations.
- » Avoid impacting on-street parking or traffic lanes along critical roadways where those impacts would be highly undesirable.

The following assumptions were used to develop the cost estimates that are presented in the tables later in this chapter:

- » Cost estimates were only provided for Phase 1 (1-5 year time horizon) recommendations. Phase 2 and Phase 3 estimates can be completed more accurately in future years after the City gains experience through Phase 1 implementation.
- » The cost estimates include contractor mobilization, design, contingency factors, and (where applicable) right-of-way acquisition.
- » Facilities will be constructed by contractors, not by City work crews (although many facilities will likely be constructed by City personnel in reality).
- » Facilities will be constructed with a high degree of quality in conformance with design best practices.
- » In relatively undeveloped parts of the City where road cross sections are not fully developed, on-street bikeway costs only include the incremental cost of adding striping, based on the assumption that the bikeway would not be installed until after the road builds out.
- » Projects would occur separately from one another.

Using City crews to perform some of the work may reduce the actual costs. Bundling several projects together into a single project or combining bikeway improvements with other transportation projects could also result in lower costs than are shown here in this master plan.



5.1 Bikeways

The bikeways recommended in this master plan consist of strategic routes that interact with the existing system to provide a high quality user experience and enable access to key destinations in and around the city. The bikeways are comprised of the following classifications:

- » Shared-use Paths
- » Sidepaths
- » Cycle Tracks
- » Bike Boulevards
- » Buffered Bike Lanes
- » Bike Lanes
- » Uphill Bike Lanes/Downhill Shared Lanes
- » Marked Shared Roadways
- » Signed Shared Roadways

Design guidelines and graphics for each of these bikeway types are included in Appendix A. Readers of this document who are unfamiliar with these terms will find Appendix A helpful for visualizing each bikeway type.

The following subsections describe each bikeway type. Each type is broken down into short-term (Phase 1), medium-term (Phase 2), and long-term (Phase 3) recommendations for specific routes. Short-term recommendations are those that could generally be completed within five years. They consist of facilities that can be constructed through re-striping of existing roads or can be combined with other projects that are already being planned for the near future.



»» Raised cycle track in Bend, OR

Medium-term recommendations consist of facilities that could be constructed within five to ten years. They require moderate changes to existing infrastructure, longer coordination times, environmental review, higher costs relative to short-term facilities, or could be constructed along with roadway projects being planned for the future.

Long-term recommendations are those that would require major changes to existing infrastructure, cultural or political shifts, right-of-way acquisitions, or significant funding. The anticipated time horizon for long-term recommendations is 10 years or longer.

Figures 5-1 and 5-2 show the Phase 1 and Phase 2 bikeway recommendations, respectively. Figure 5-3 shows what Provo’s bikeway network would look like with build-out of the first two phases. Figure 5-4 displays the Phase 3 bikeway recommendations, while Figure 5-5 shows all phases of bikeway recommendations combined. Figure 5-6 also shows all phases of the bikeway recommendations, but only for a zoomed-in portion of central Provo. All six of these figures include existing bikeways in order to demonstrate how the recommendations would help better connect what is already on the ground. They also include existing and proposed facilities in Orem so that readers can see how bikeways in Provo would tie into Orem’s network.

5.1.1 Bikeway Costs By Phase

Table 5-1 shows the total mileages of the proposed bikeways by phase. It also shows the total estimated cost of Phase 1 implementation. Costs include such items as signs, paint striping, hardscape improvements (e.g. asphalt or concrete construction for shared-use paths), and design fees necessary for implementation of the various bikeways. This table does not include the costs of spot improvements (point locations where improvements are recommended), which are discussed in Section 5.2. It is worth noting that the majority of the Phase 1 costs shown in Table 5-1 are attributable to two very expensive shared-use paths. The Phase 1 total drops to \$1.65 million when they are excluded.

Table 5-1: Total Bikeway Cost By Phase

Phase	Length (miles)	Cost
1	43.9	\$ 5,450,000
2	40.2	\$ TBD
3	19.1	\$ TBD
TOTAL	103.2	\$ TBD

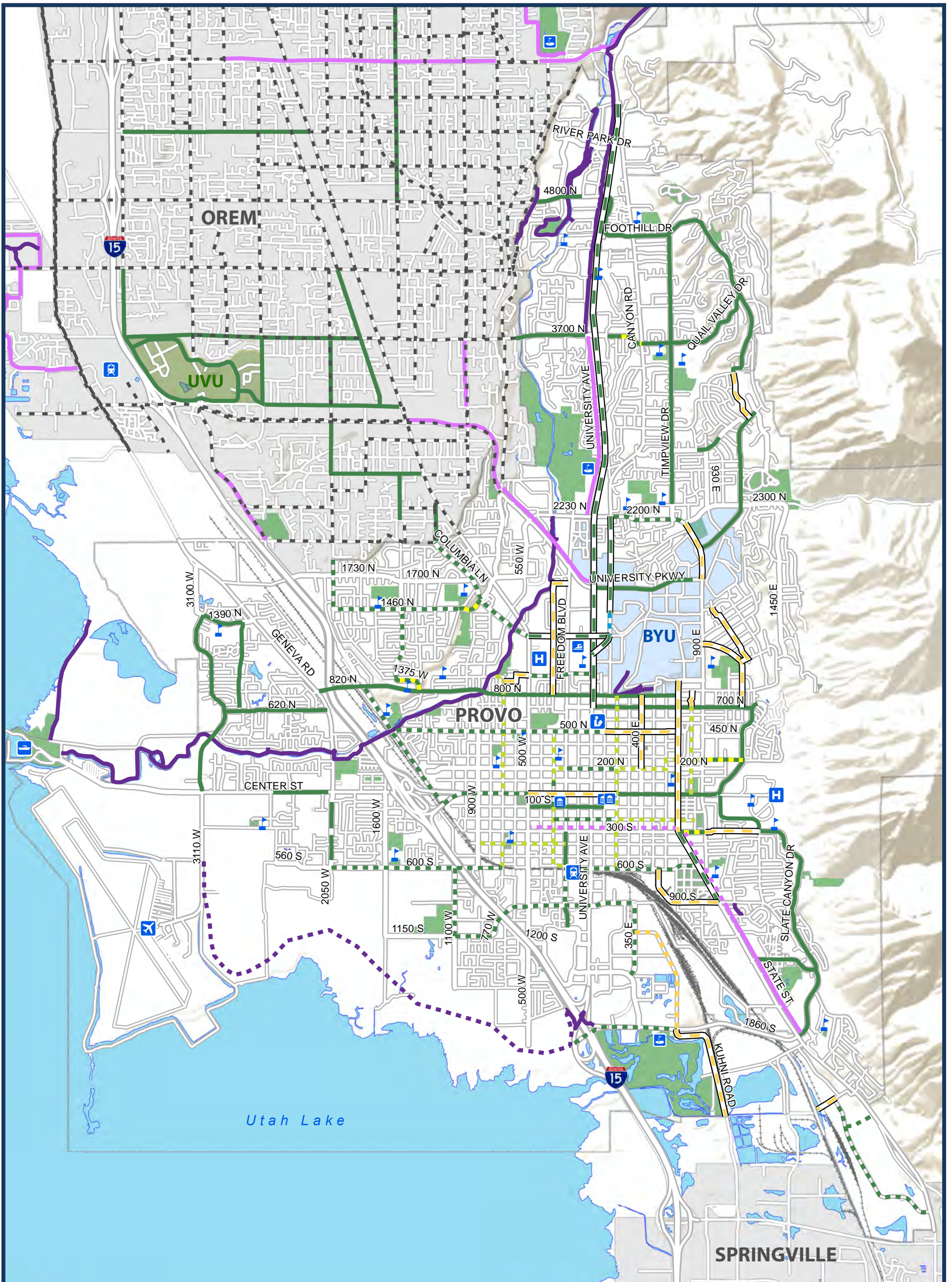
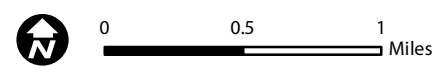


Figure 5-1: Recommended Bikeways - Phase 1



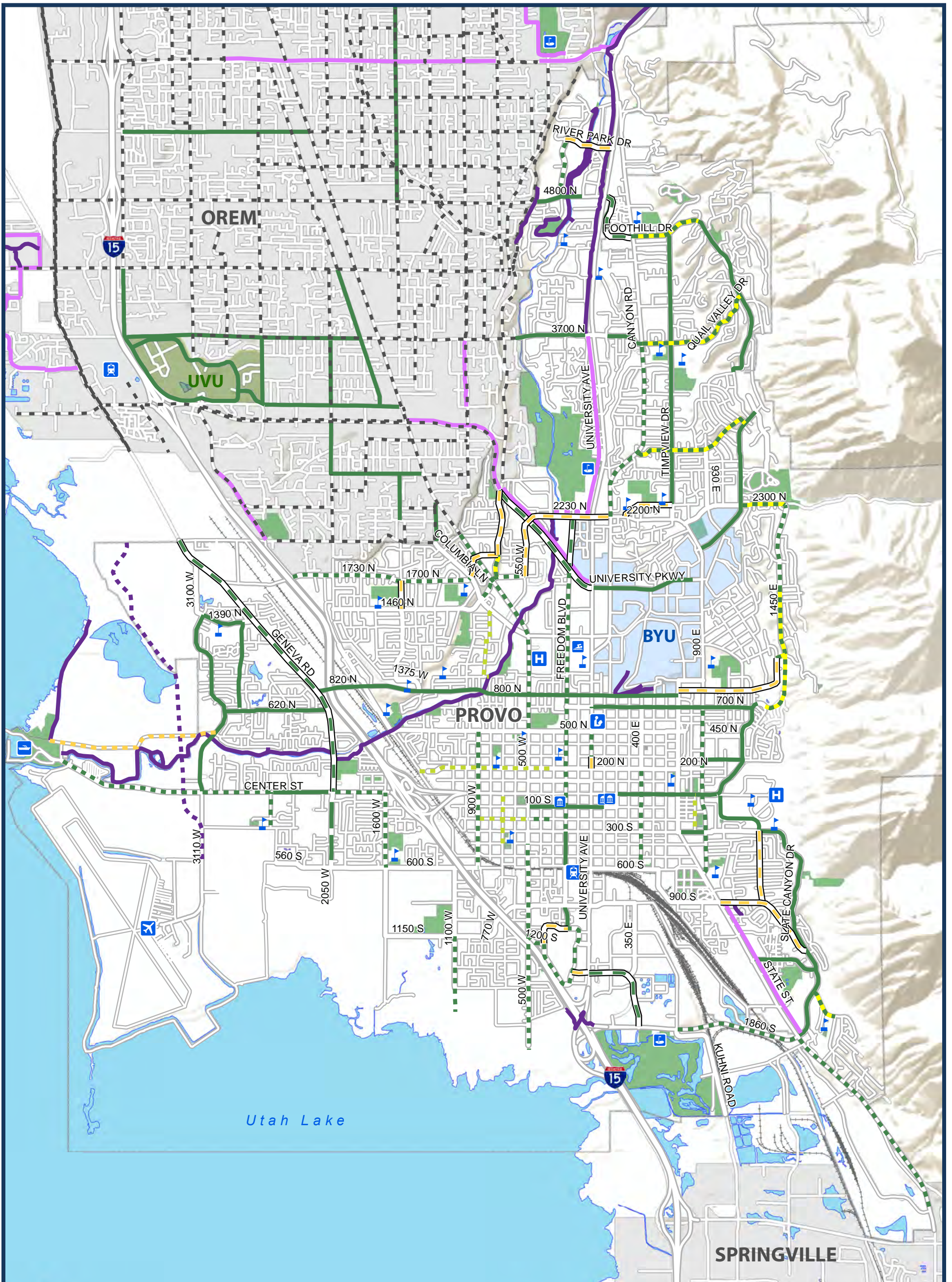
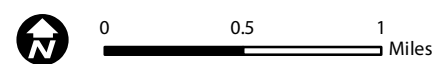


Figure 5-2: Recommended Bikeways - Phase 2



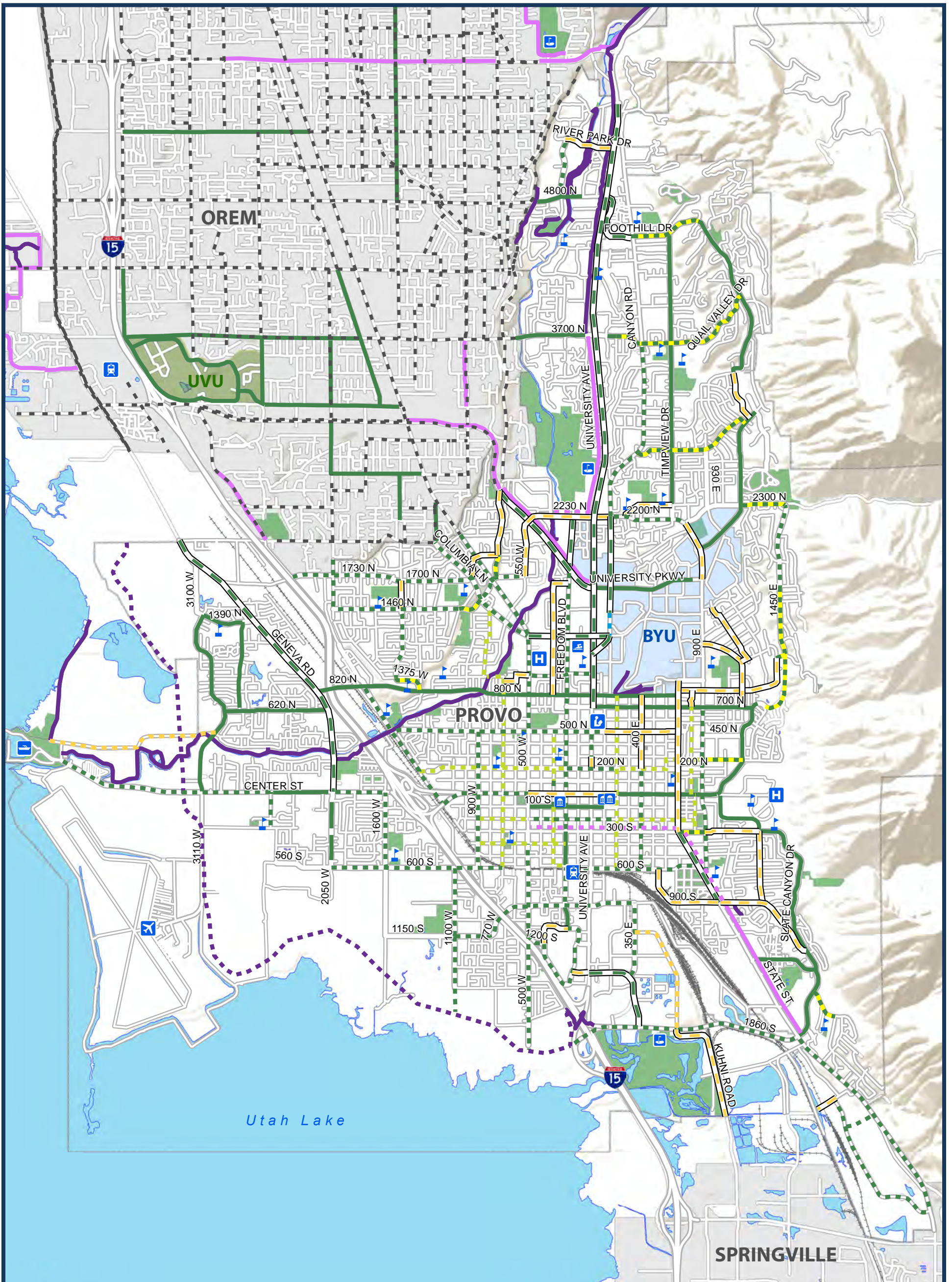
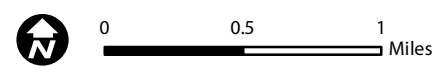


Figure 5-3: Recommended Bikeways - Phases 1 & 2



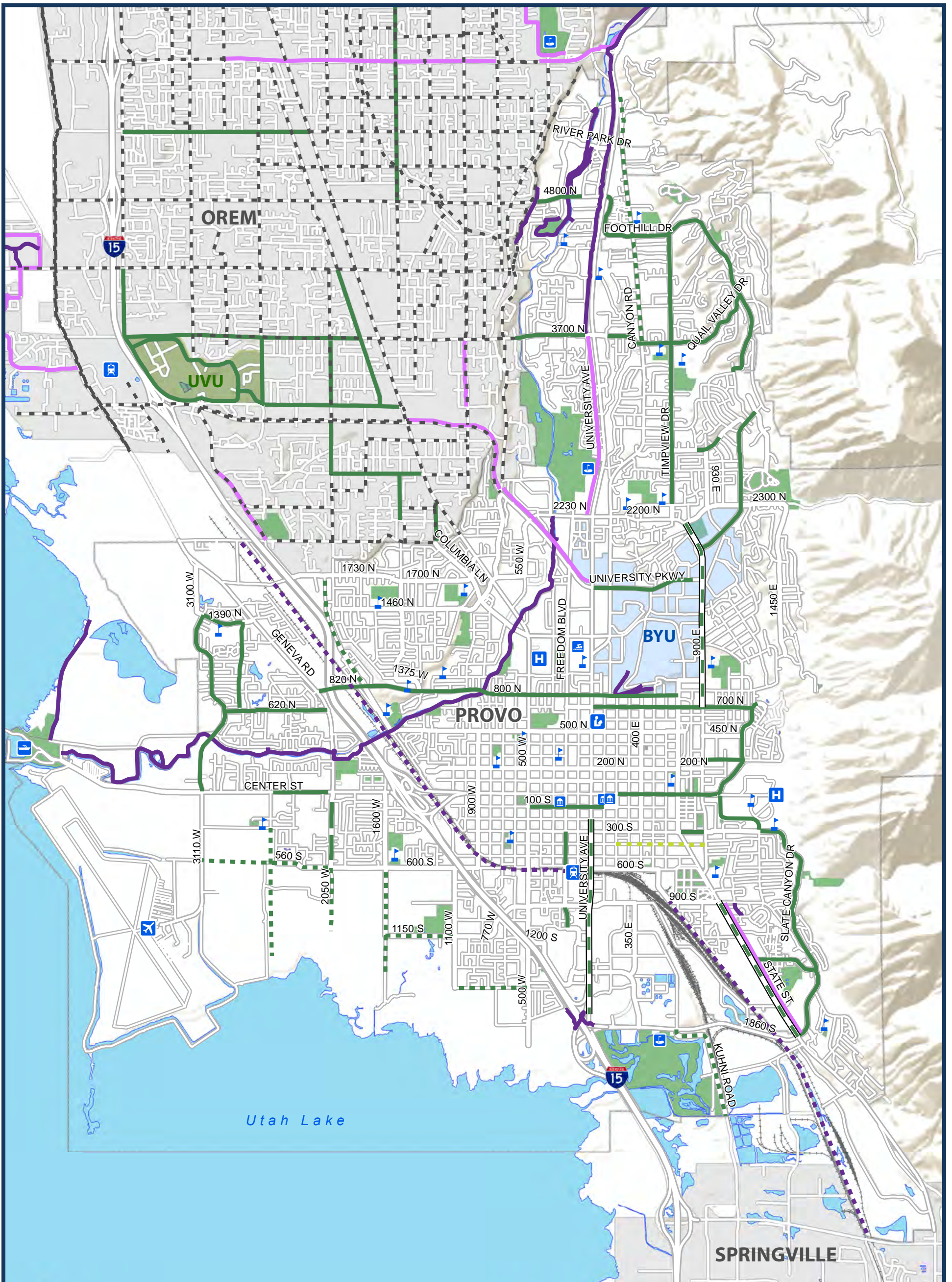
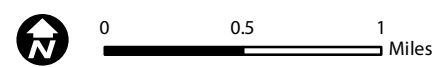


Figure 5-4: Recommended Bikeways - Phase 3



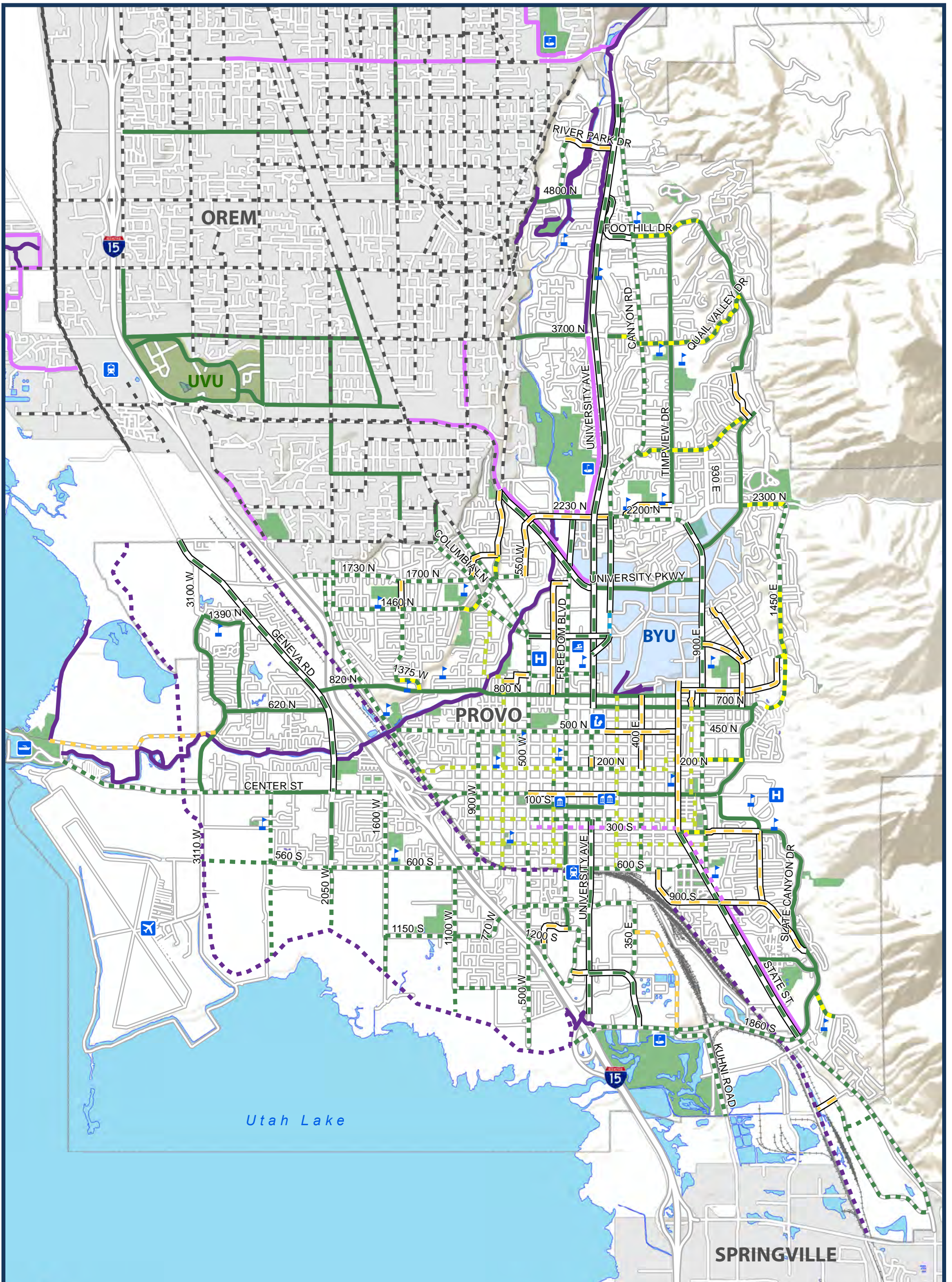
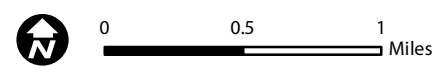


Figure 5-5: Recommended Bikeways - All Phases



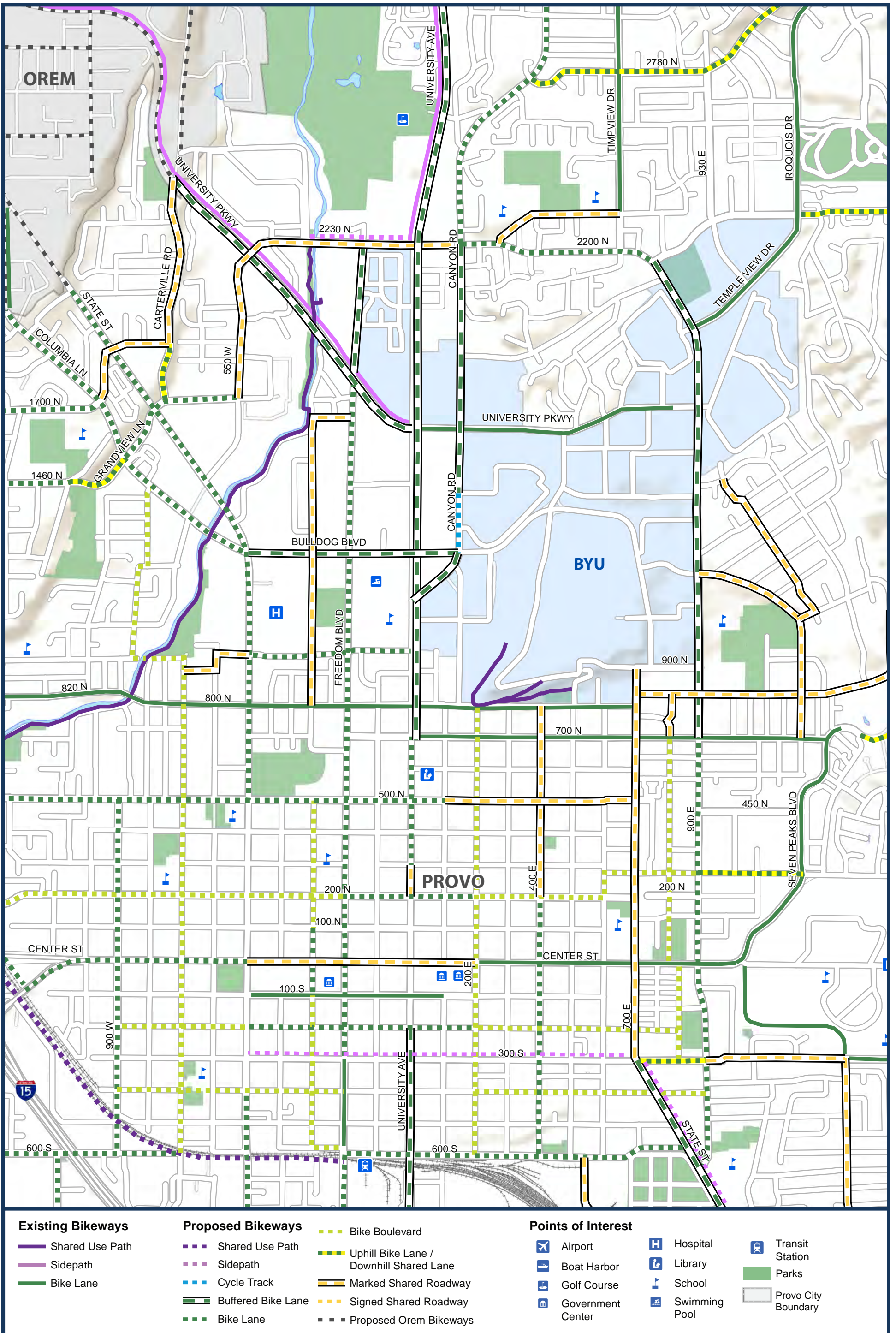

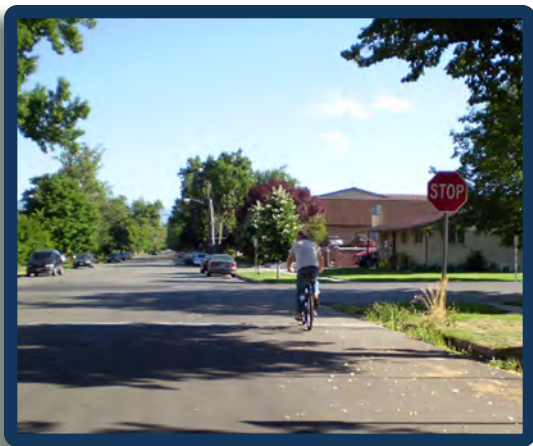



Figure 5-6: Recommended Bikeways (All Phases – Central Provo)



 This cycle track in Salt Lake City uses parallel parking to provide a physical barrier between cars and bicycles



 Bike boulevards can be implemented on some of Provo's local streets within the historic grid system

5.1.2 Shared-Use Paths

Shared-use paths are generally located within rights-of-way separated from roadways (such as streams, utility corridors, and railroads) and serve all types of non-motorized users. They are the facility of choice for many people who wish to avoid bicycling near traffic. However, they are also the most expensive bikeway type, may not serve transportation purposes as well as on-street facilities, and have limited opportunities for development due to the scarcity of non-roadway rights-of-way. Shared-use paths are typically 10' wide or greater and can be constructed of asphalt or concrete. **Table 5-2** lists each proposed shared-use path along with its respective phase, cost estimate, and notes about implementation considerations.

5.1.3 Sidepaths

Sidepaths are similar to shared-use paths. Their distinguishing characteristic is that they parallel roadways and frequently encounter intersections and driveways, whereas shared-use paths travel for long distances without encountering vehicle crossings and generally cross roads at right angles. Interactions between sidepath users and drivers may be complex, particularly when bicyclists ride in the direction opposite the traffic flow.

Sidepaths can be useful for pedestrians as well as children and adults who bicycle slowly. However, they are not a good alternative for faster or more experienced bicyclists because they place bicyclists in places where drivers may not expect them. In situations where a shared-use path is preferred but not feasible, short stretches of sidepath can be used to connect shared-use paths on both ends of the sidepath. **Table 5-3** lists the one proposed sidepath.

5.1.4 Cycle Tracks

Cycle tracks combine the off-street separation of shared-use paths with on-street elements of bike

Table 5-2: Recommended Shared-Use Paths

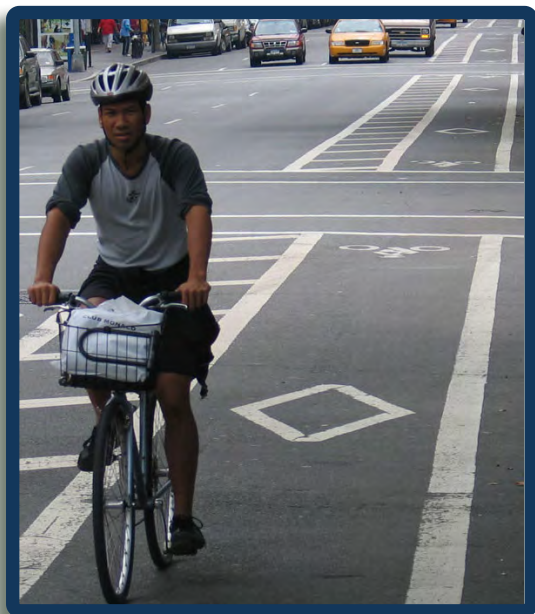
Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	1860 S Extension Path	1860 South Shared-Use Path	Proposed Westside Connector	0.13	\$ 150,000		Connects existing path through the interchange with the Westside Connector
	Westside Connector	Provo Airport	I-15 Interchange	3.82	\$ 2,000,000		Locate path on south side to minimize crossings; create safe and practical connection with proposed 1860 S bike lanes
P1 Subtotal				3.95	\$ 2,150,000		
2	Lakeview Pkwy	2000 N	Provo Airport	2.71			Locate path on west side to minimize crossings
P2 Subtotal				2.71	\$ TBD		
3	Railroad Shared-Use Path 1	2000 N	Freedom Blvd	3.64		UTA/UPRR	Will likely require ROW; a study is needed to determine feasibility
	Railroad Shared-Use Path 2	900 S	1860 S	2.88		UTA/UPRR	Will likely require ROW; a study is needed to determine feasibility
P3 Subtotal				6.52	\$ TBD		
TOTAL				13.2	\$ TBD		

Table 5-3: Recommended Sidepaths

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	State St	300 S	900 S	0.60	\$ 580,000	UDOT	Assumes path will be on east side of street
	300 S	500 W	700 E	1.10	\$ 1,070,000	UDOT	Assumes path will be on north side of street
P1 Subtotal				1.70	\$ 1,650,000		
2	2230 N	Provo River	University Ave	0.26			Part of the Provo River Parkway network; sidepath would be on north side of street
P2 Subtotal				0.26	\$ TBD		
TOTAL				1.96	\$ TBD		



▲ Bike boulevards are designed to make the routes more comfortable to bicyclists by slowing and reducing auto traffic



▲ Buffered bike lanes provide a measure of separation between bicyclists and cars

lanes. Between intersections, they provide the greatest amount of separation between cars and bicyclists of any on-street bikeway type. However, intersections must be treated at a very high level in order to safely transition cycle tracks through. The distinguishing characteristic of a cycle track is some form of barrier between moving cars and bicycles. Less-experienced bicyclists often prefer cycle tracks over other bikeway types because of the separation from car traffic.

In snowy climates such as Provo, care must be taken to design cycle tracks to facilitate snow removal. Smaller plows or the use of removable bollard posts are ways to construct cycle tracks that can be cleared of snow in the winter. Cycle tracks may also require frequent sweeping to keep the pavement clear and safe for bicycle travel. Proposed cycle tracks in Provo are listed in [Table 5-4](#).

5.1.5 Bike Boulevards

Bike boulevards are a relatively new bikeway type. They take advantage of low-speed, low-traffic streets where many people prefer to bicycle. Typically, these types of streets work well for bicyclists for a few blocks at a time, but pose a challenge as soon as the street intersects a larger or higher speed road. Key components of bike boulevards are intersection improvements such as median islands and signage that allow bicyclists to safely cross busy streets.

Bike boulevards are not typically installed on collector or arterial roads because dedicated space (such as a bike lane) is not provided on bike boulevards to separate bicycles from cars. Neighborhood traffic circles, curb extensions, and other traffic calming measures often accompany bike boulevards in order to keep traffic volumes and speeds low. Maintenance requirements for bike boulevards are generally limited to necessary upkeep of neighborhood traffic circles or intersection treatments. [Table 5-5](#) lists the proposed bike boulevards.

Table 5-4: Recommended Cycle Tracks

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	Canyon Rd	1430 N	Bulldog Blvd	0.17	\$ 25,000		Parking-buffered cycle track; will allow Provo to gain cycle track experience in a short, easily-implemented section
P1 Subtotal				0.17	\$ 25,000		
TOTAL				0.17	\$ 25,000		



Table 5-5: Recommended Bicycle Boulevards

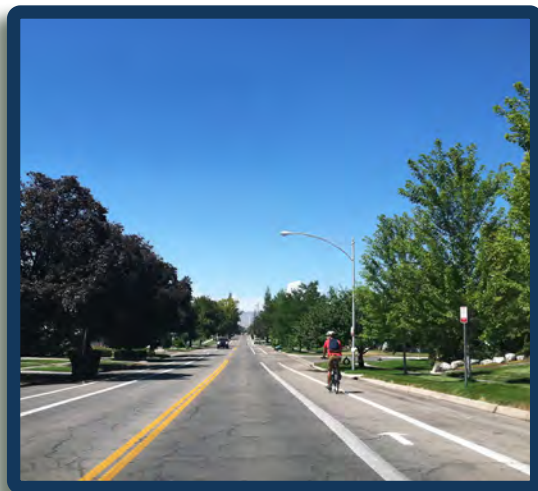
Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	200 E	800 N	600 S	1.28	\$ 200,000	UDOT coord. at 300 S	Consider closing 200 E at 800 N and creating raised intersection crossing leading to BYU; need median island for crossing at 300 S; may also need them at 500 N and 700 N, although small roundabouts may work
	200 N	300 W	Freedom Blvd	0.10	\$ 20,000		Short Phase 1 stretch to connect to 300 W BB; may need to convert this route to a bike lane if 200 N becomes a collector road
	200/300 N	200 E	900 E	0.70	\$ 100,000		Need median island for crossing 900 E; neighborhood traffic circles or other traffic calming may be considered at 200 E, 400 E, and 700 E; may need to convert this route to a bike lane if 200 N becomes a collector road; could use 200 N all the way to 900 E if the road is connected between 700 E and 800 E.
	200 S	200 E	800 E	0.58	\$ 80,000		Consider neighborhood traffic circle at 700 E
	300 W	500 N	100 N	0.36	\$ 50,000		Consider neighborhood traffic circle at 200 N
	300 W/600 S	100 S	Freedom Blvd	0.54	\$ 80,000		Important to link this to the FrontRunner station; need median island for crossing 300 S; consider neighborhood traffic circle at 400 S
	400 S	900 W	Freedom Blvd	0.65	\$ 110,000		May need crossing help (median island or traffic circle) at 500 W; consider access restrictions at Freedom to limit traffic
	700 W	400 S	600 S	0.18	\$ 20,000		

Table 5-5: Recommended Bicycle Boulevards (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	700 W	Provo River Pkwy	Center St	0.96	\$ 130,000	UDOT coord. at Center	Need median island crossing at Center St; may need crossing help (median island or traffic circle) at 800 N and 500 N
	800 E	700 N	Center St	0.64	\$ 100,000	UDOT coord. at Center	Need median island crossing at Center St; likely need another one (or a roundabout) at 700 N; consider traffic circle at 300 N; may need traffic diverters/access restrictions at 540 N
P1 Subtotal				5.99	\$ 890,000		
2	200 N	Independence Ave	300 W	0.99		UDOT coord. at 500 W	Need median island crossing at 500 W; consider neighborhood traffic circle at 700 W
	200 S	900 W	500 W	0.37		UDOT coord. at 500 W	Need median island crossing at 500 W
	700 W	Center St	400 S	0.36			
	850 E	Center St	300 S	0.27			May need a median island to help people make the jog from 850 E to 800 E
	800/850 W	Columbia Ln	Provo River Parkway	0.57			May need access restrictions or neighborhood traffic calming to keep traffic volumes low
P2 Subtotal				2.56	\$ TBD		
3	400 S	200 E	900 E	0.66			Need median island and possibly HAWK-type signal at State St
	P3 Subtotal				0.66	\$ TBD	
TOTAL				42.1	\$ TBD		



 Buffered bike lane in Salt Lake City



 Bike lane on 700 North in Provo

200 East is one of the most significant bike boulevards recommended in this plan. It would connect the area near the FrontRunner station with student housing areas and the southwest corner of the BYU campus. **Figure 5-7** shows a schematic drawing of a raised intersection at 800 North/200 East that would tie this bike boulevard to the campus and calm traffic.

5.1.6 Buffered Bike Lanes

Buffered bike lanes are similar to cycle tracks in that they provide a measure of separation from car traffic. The key characteristic that distinguishes a buffered bike lane from a cycle track is that the former uses a painted buffer to separate car traffic from the bike lane, whereas cycle tracks have some form of physical barrier between moving cars and bicyclists. People who do not like to bicycle near traffic usually prefer buffered bike lanes to “regular” bike lanes.

Like cycle tracks, buffered bike lanes may require more frequent sweeping than car travel lanes. Cars in adjacent traffic lanes tend to kick rocks into the buffered bike lanes. As a result, they accumulate debris without regular sweeping. Proposed buffered bike lanes are shown in **Table 5-6**.

One of the most significant buffered bike lane recommendations is Bulldog Boulevard between 500 West and Canyon Road. This stretch of road has exhibited the highest concentration of bicycle-related crashes of any location in Provo since 2007. **Figure 5-8** shows a schematic drawing of what buffered bike lanes on this road could look like. The green left turn queue boxes are explained in detail in Appendix A.

5.1.7 Bike Lanes

Bike lanes use a single white stripe to separate bicycle traffic from car traffic. Bike lanes will normally accommodate confident and experienced bicycle riders, but they may not provide enough



Figure 5-7: 800 North/200 East Raised Intersection Concept



Table 5-6: Recommended Buffered Bike Lanes

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	Bulldog Blvd	State St	Canyon Rd	0.60	\$ 25,000	Coord. w/UDOT at 500 W, University Ave	ADT is 28K from 500 W, 17K from 300 W to University, 18K from University to Canyon; would require 7-lane to 5-lane conversion; would help mitigate high bike crash locations; would benefit pedestrians by moving cars away from the curb; may need to work w/UDOT to modify 500 W intersection
	Canyon Rd	2230 N	1430 N	0.71	\$ 25,000		ADT is 13K; could consider keeping (or adding) on-street parking in some portions and creating a cycle track instead of BBL; addresses high-crash locations
	Canyon Rd	Bulldog Blvd	University Ave	0.18	\$ 10,000		ADT is 10K; addresses high-crash locations
	State St	300 S	900 S	0.59	\$ 25,000	UDOT	ADT is 15K; may need to remove some parking, but can probably keep parking on one side of the street in parts
	University Ave	5600 N	700 N	4.49	\$ 125,000	UDOT	Would utilize existing shoulder; parking already prohibited; left turn queue boxes recommended at large intersections
P1 Subtotal				6.57	\$ 210,000		
2	East Bay Blvd	University Ave	1860 S	0.69			ADT is 7K; would need to remove outside travel lane
	Geneva Rd	2000 N	Center St	2.29		UDOT	ADT is 11K; high speeds and moderate volumes lend themselves to BBL; dependent upon UDOT's timetable because it requires reconstruction and widening

Table 5-6: Recommended Buffered Bike Lanes (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
2	4800 N/ Foothill Dr	University Ave	Canyon Rd	0.51		UDOT	Has BLS on both sides with parking currently; parking would need to be removed; there appears to be no reason for cars to park along this stretch
	Freedom Blvd	University Pkwy	2230 N	0.38			Currently has 5 lanes for traffic; volumes are low enough to handle traffic with only 3 lanes
	University Pkwy	Carterville Rd	University Ave	0.99		UDOT	Would utilize 8' shoulder planned for BRT street cross-section
P2 Subtotal				4.86	\$ TBD		
3	State St	900 S	Slate Canyon Dr	1.16		UDOT	ADT is 20K; requires extensive widening, reconstruction, and utility relocation; dependent upon UDOT's timetable; BBL preferable because of high truck volumes, speed, and traffic
	University Ave	200 S	Approx. 1800 S	1.42		UDOT	Would require reconstruction of the railroad viaduct; some segments have wide enough shoulders to this right now; could also be a cycle track if desired and assumptions change in the future
	900 E	700 N	North Temple Dr	1.39			May only be feasible if travel patterns change in the future and traffic volumes drop; ADT is currently 25K south of University Pkwy
P3 Subtotal				3.97	\$ TBD		
TOTAL				15.4	\$ TBD		

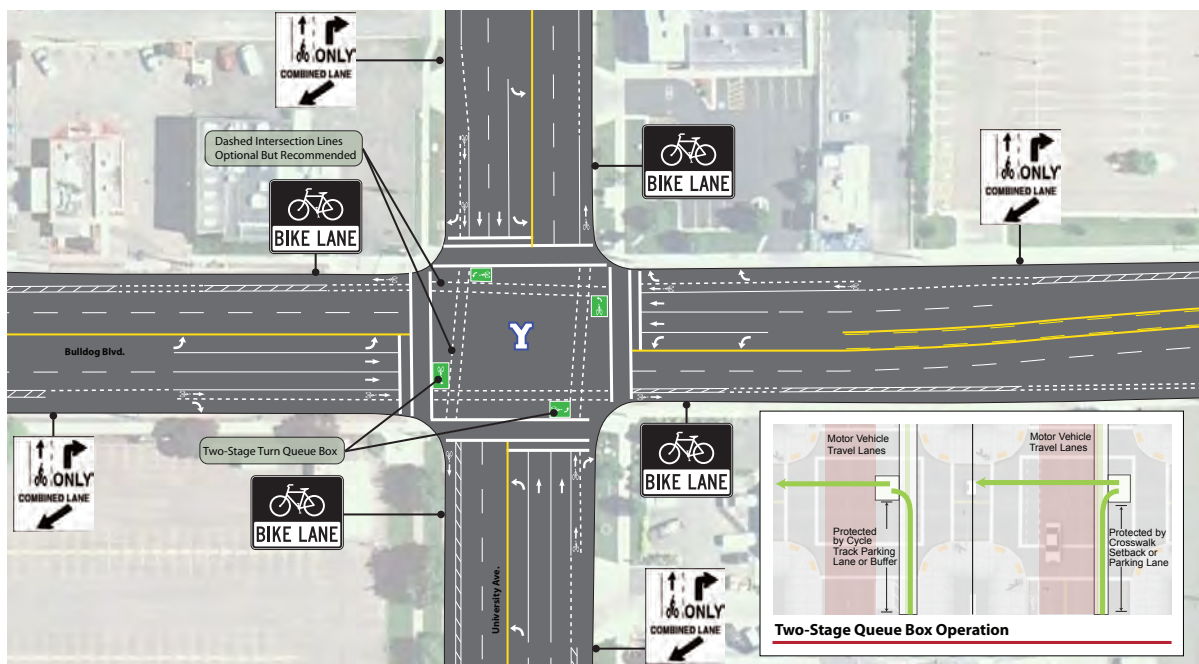


Figure 5-8: Bulldog Boulevard Buffered Bike Lane Concept

separation from high-speed cars to attract less-experienced riders. As with buffered bike lanes, regular sweeping may be needed to keep the lanes free from debris kicked into them by car tires.

Care must be taken to transition bike lanes through intersections in a safe manner and also protect the lanes from car doors in instances where the bike lanes are next to car parking. Table 5-7 shows the bike lanes recommended for Provo.

5.1.8 Uphill Bike Lanes/Downhill Shared Lanes

This facility consists of a dedicated, separated bike lane in the uphill direction and a marked shared roadway in the downhill direction. These are used in instances where steep hills yield downhill bicycle speeds close to the designated speed limit. The bike lane is provided in the uphill direction where car speeds are much higher than bicycle speeds so that cars can easily pass bicyclists without being impeded. Shared lane markings are provided in the downhill direction in order to encourage bicyclists to “take the lane” rather than riding too close to the curb or to parked cars, either of which could be very dangerous. Several roads in Provo are proposed for this treatment. They are shown in Table 5-8.

Table 5-7: Recommended Bike Lanes

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	1100 W	600 S	1150 S	0.51	\$ 15,000		Would need to remove parking from one side of the road (at least in some parts) but parking demand is low
	1460 N	2100 W	Jordan Ave	0.93	\$ 25,000		ADT is ~5K; may require parking removal on one side, but parking demand is low and there are frequent cross-streets with parking
	1500 W	1460 N	900 N	0.52	\$ 15,000		May require parking removal on side in some sections, but parking demand is low
	1860 S	Kuhni Rd	Proposed Westside Connector Shared-Use Path	0.81	\$ 20,000		Important connection with Westside Connector; would need careful consideration of area where westbound vehicles merge across to the I-15 on-ramp
	200 N	Freedom Blvd	200 E	0.37	\$ 10,000		May require parking removal on one side of street east of 100 W; consider making 100 E - 200 E a Bike Blvd instead (which is already proposed for 200 N east of 200 E)
	2100 W	2075 N	1460 N	0.35	\$ 10,000		ADT is ~5K; some parts lack developed frontage and the pavement needs to be widened to get BLS; may need to wait until street improvements are finished
	2230 N	Canyon Rd	N. Temple Dr	0.59	\$ 15,000		Would require removal of parking on both sides, but parking demand appears to be low
	300 W	100 N	100 S	0.19	\$ 10,000		Could be bicycle boulevard if the city would like it to be, but that would mean doing traffic calming along this stretch to reduce speed and volume.
	350 E	900 S	East Bay Blvd	0.54	\$ 15,000		May require parking removal on one side but demand is very low



Table 5-7: Recommended Bike Lanes (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	500 N	Independence Ave	100 E	1.57	\$ 35,000		ADT is 5-10K; west of 400 W, would need to remove parking on one side; east of 400 W, would need to remove left turn center lane or parking from both sides
	200 S	300 W	200 E	0.47	\$ 10,000		Would require parking removal on one side
	600 S	2050 W	700 W	1.25	\$ 30,000		Requires parking removal on at least one side; reconstruction/widening needed west of 1600 W to provide consistent cross-section
	600 S	Freedom Blvd	State St	0.98	\$ 25,000		Need to remove parking on at least one side but demand seems relatively low; good connection to FrontRunner station needed
	920/1150 S	1100 W	350 E	1.45	\$ 35,000		Would require parking removal on one side (or removal of left turn center lane), but parking demand appears to be fairly low; some widening needed west of 1100 W
	940 N/960 N	500 W	University Ave	0.46	\$ 10,000		Most of the parking has already been removed
	Center St	Independence Ave	500 W	0.65	\$ 15,000	UDOT	May require removal of parking on both sides (some sections have already been removed); parking demand seems relatively low and there is some off-street parking and numerous side streets that could accommodate parking

Table 5-7: Recommended Bike Lanes (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	Columbia Ln	2000 N	State St	0.99	\$ 25,000		ADT is 11-14K depending on location; may require parking removal on one side in some areas, but could possibly be done without that; could consider removal or narrowing of left turn center lane in some stretches; could consider shared lane markings instead of bike lane in downhill direction
	Freedom Blvd	600 S	920 S	0.28	\$ 10,000		ADT is 8K; requires parking removal on at least one side or removal of left turn center lane; good connection needed to FrontRunner station
	Independence Ave	820 N	Center St	1.04	\$ 25,000		Will need to remove some parking or eliminate left turn center lane; existing parking demand is very low except at the north end, but there is lots of off-street parking there
	Mountain Vista Pkwy	Ironton Blvd	State St	1.21	\$ 30,000		May not be needed until the area develops
	Valley Vista Wy	Mountain Vista Pkwy	State St	0.23	\$ 10,000		
	P1 Subtotal				15.39	\$ 395,000	
2	1100 W	1150 S	Proposed Westside Connector Shared-Use Path	0.57			Not necessary until Westside Connector is built; may require some widening
	1450 E	2320 N	1650 N	0.62			Relatively low traffic and low speeds; would require parking removal from one side, but on-street parking demand is low in this area



Table 5-7: Recommended Bike Lanes (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
2	1600 W	Center St	600 S.	0.51			Needs reconstruction/widening in areas to give consistent section – could do signed or marked shared roadway in interim
	1700 N	Orem Boundary	Columbia Ln.	1.32			Would require widening/development from Orem to 2100 W; may require parking removal on one side east of 1500 W
	200 S	500 W	300 W.	0.19			Would require parking removal on one side
	1860 S	State St	Kuhni Rd.	0.92			Would require substantial modification of the fill slopes to add width for BLs; would require expensive additions/modifications to the structures over the RR tracks; alternative could be to create a 10-12' path on the north side only.
	2530 W	Center St	280 S.	0.27			Requires parking removal on one side of street but demand appears to be low
	300 W	River Park Dr	4800 N	0.44			
	400 E	200 N	600 S	0.74			Would require removal of parking on one side in most areas; parking demand is usually low, but if parking cannot feasibly be removed, shared lane markings may be used
	500 W	400 S	Proposed Westside Connector Shared-Use Path	1.53			May require some parking removal (particularly south of 600 S) but existing parking seems to be low; provide good connection with Westside Connector SJJ

Table 5-7: Recommended Bike Lanes (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
2	1200 S	500 W	Towne Centre Blvd	0.14			
	900 W	500 N	600 S	1.00			May need to remove parking from one side in some stretches, but parking demand appears to be low currently; ADT is 3K
	Canyon Rd	3700 N	2230 N	1.38			Serves neighborhood commercial areas; may require removal of parking and/or shifting of lane striping in some areas, but demand appears to be fairly low (just a few small areas south of 2800 N)
	Center St	2100 W	1600 W	0.42		UDOT	Could do 5' BLs with keeping existing lanes and parking; may want to consider removing parking and installing a left turn center lane
	Center St	4200 W	2530 W	1.61			requires widening to provide enough space for BLs in both directions
	Grandview Ln	Columbia Ln.	550 W	0.41			Moderate traffic volumes; would need to remove parking from one side of the road – probably the north side between Columbia and State and the south side between State and 550 W
	State St/500 W	2000 N	500 N	1.61		UDOT	North of 940 N, would utilize existing shoulders where parking is already prohibited; would require parking removal on one or both sides south of 940 N; majority of parking demand is on east side of street, so could work with UDOT during a restripe to shift striping and keep parking on the east side if desirable



Table 5-7: Recommended Bike Lanes (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
2	Freedom Blvd	300 S	University Pkwy	1.95			Portions of this could be buffered bike lane or cycle track in future if traffic conditions allow for removal of lanes
	900 E	700 N	State St	1.24			Portions of this could be buffered bike lane or cycle track in future if traffic conditions allow for removal of lanes
	State St	Slate Canyon Dr.	Mountain Vista Pkwy	0.58		UDOT	Should be feasible within existing shoulder space
	Towne Centre Blvd	Freedom Blvd.	1200 S	0.88		Private	Would require removal of the second lane on the inside of the loop; if this is not possible, consider using shared lane markings in the outside; would need to work with mall owners
	University Ave	700 N.	300 N	0.43			Install at the same time as the BRT line
P2 Subtotal				18.76	\$ TBD		
3	1150 S	1600 W	1100 W	0.51			
	1560 S	1100 W	500 W	0.54			Dependent on reconstruction/widening, which may occur with development; would require parking removal on one side if it's 40' wide
	1600 W	600 S	Proposed Westside Connector Shared-Use Path	0.79			

Table 5-7: Recommended Bike Lanes (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
3	2050 W	600 S	Proposed Westside Connector Shared-Use Path	0.47			Would occur when Provo builds this road
	2530 W	280 S	Proposed Westside Connector Shared-Use Path	0.96			Would occur when Provo builds this road
	600 S	Proposed Westside Connector Shared-Use Path	2050 W	0.97			
	Canyon Rd	5800 N	3700 N	1.90			Can occur as development happens on the frontages
	Independence Ave	1700 N	820 N	0.90			Would occur when Provo extends this road north to 1700 N
	Kuhni Rd	1860 S	Provo City limit	0.86			Would require removal of left turn center lane from 1860 S to where the road bends to the south and widens out; would require removal of parking on the east side from there to 2260 S; requires widening/reconstruction from 2260 S to city limit
P3 Subtotal				7.90	\$ TBD		
TOTAL				42.1	\$ TBD		

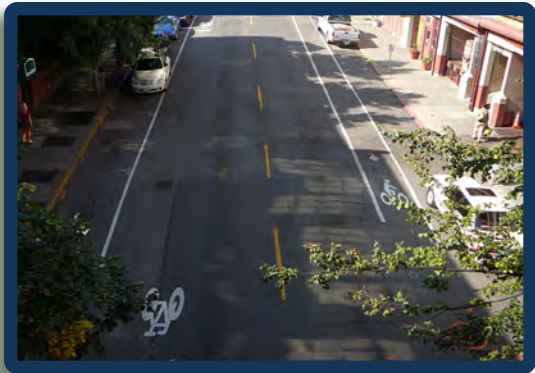


Table 5-8: Recommended Uphill Bike Lanes/Downhill Shared Lanes

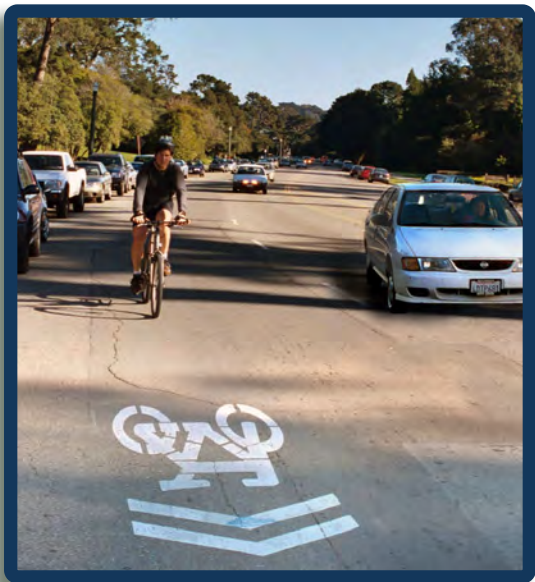
Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	1460 N	Columbia Ln	Jordan Ave	0.19	\$ 7,000		Would allow wider bike lane in uphill direction and encourage cyclists to ride away from the barrier and debris in the downhill direction
	3650 N/3700 N	180 E	Canyon Rd	0.21	\$ 7,000		
	300 N	900 E	Seven Peaks Blvd	0.26	\$ 8,000		Current configuration has substandard parking width and bike lane width; keep bike lane eastbound and use shared lane markings westbound; best option for bicyclists would be eliminating parking on one side of the road and keep bike lanes in both directions, but there is measurable parking demand here
	300 S	700 E/State St	900 E	0.18	\$ 7,000		Current configuration has substandard parking width and bike lane width; keep bike lane eastbound and use shared lane markings westbound; best option for bicyclists would be eliminating parking on one side of the road and keep bike lanes in both directions, but there is measurable parking demand here
	860 N	1500 W	800 N	0.23	\$ 8,000		Shift striping to the south to combine shoulder space into an uphill bike lane
	P1 Subtotal				1.07	\$ 37,000	
2	1450 E	1650 N	Arlington Dr	0.99			
	2300 N	Iroquois Dr/ Temple View Dr	1450 E	0.32			

Table 5-8: Recommended Uphill Bike Lanes/Downhill Shared Lanes (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
2	Foothill Dr	Canyon Rd	east of Brookshire Cir	0.54			Has BLs on both sides currently and would need to be restriped
	3650 N/Quail Valley Dr	Canyon Rd	Foothill Dr	0.92			Has BLs on both sides currently and would need to be restriped
	Carterville Rd	1720 N	1850 N	0.16			
	Indian Hills Dr/2780 N	Canyon Rd	Iroquois Dr	0.91			Section between 840 E and Arapahoe has BLs on both sides currently and would need to be restriped
	Nevada Ave	Slate Canyon Dr	Oregon Ave	0.25			
	Oak Cliff Dr	Oakmont Ln	1450 E	0.07			
P2 Subtotal				4.16	\$ TBD		
TOTAL				5.2	\$ TBD		



▲ This picture from Seattle shows an uphill bike lane/downhill shared lane configuration



▲ Marked shared roadway

5.1.9 Marked Shared Roadways

Marked shared roadways are typically implemented in corridors where dedicated space for higher-level treatments cannot be allocated, or where traffic speeds and volumes dictate that a higher-level facility is not warranted. This treatment should not be used on any roadways with a speed limit in excess of 35 mph. It is preferable to limit them to roads with speed limits of 30 mph or less. Unless speeds and volumes are low, many people will not feel comfortable riding on a road with this treatment. However, in instances where a higher-level facility is not technically or politically feasible, they can serve as valuable treatments to legitimize experienced riders who choose to bicycle there. The markings can be accompanied by optional signage that further notifies automobile drivers that bicyclists should be expected to ride in the lane where the markings are placed. Proposed marked shared roadways are listed in [Table 5-9](#).

5.1.10 Signed Shared Roadways

Signed shared roadways do not have any dedicated roadway space for bicycles. They simply provide signage designating the road as a bike route. Signed shared roadways can be created on roads with or without shoulders as well as with or without parking. It is a particularly effective treatment on roads with wide shoulders where parking is permitted, but is infrequently used. In these instances the shoulders behave like de-facto bike lanes for long stretches. Care should be taken when considering implementing this type of bikeway on roads with little or no shoulder, or on roads with heavy parking volumes. In those cases, a marked shared roadway may be a better option as long as the speed limit does not exceed 35 mph. Proposed signed shared roadways are listed in [Table 5-10](#).

Table 5-9: Recommended Marked Shared Roadways

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	1200 E/Birch Ln	900 E	700 N	0.66	\$ 7,000		Could do bike lanes, but parking removal would be required on one side of the street
	300 S	900 E	1450 E	0.40	\$ 5,000		
	300 W	Freedom Blvd (1625N)	800 N	0.89	\$ 8,000		Consider reconfiguring the Moon River/1625 N/300 W intersection to provide better connection to the Provo River Parkway
	400 E	800 N	200 N	0.54	\$ 5,000		Could be bike lanes if parking is removed, but there heavy parking demand; would feed into a main BYU bike parking location at 800 N; consider neighborhood traffic circles at 200 N, 500 N
	500 N	100 E	700 E	0.54	\$ 5,000		Could be bike lanes if parking is removed, but there heavy parking demand; consider neighborhood traffic circles at 200 E, 400 E
	550 E/900 S	600 S	State St	0.63	\$ 6,000		
	700 E	900 N	300 S	1.11	\$ 10,000		Consider neighborhood traffic circle at 300 N
	800 E	820 N	700 N	0.13	\$ 2,000		
	890 N/940 N	700 W	500 W	0.23	\$ 3,000		
	900 E	N. Temple Dr	University Pkwy	0.43	\$ 4,000		Would connect the bike lanes on University Pkwy with the ones on N. Temple
	Apple Ave-Cherry Ln	Fir Ave	Birch Ln	0.55	\$ 5,000		Would serve as a bypass to 900 E



Table 5-9: Recommended Marked Shared Roadways (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	Center St	500 W	200 E	0.65	\$ 6,000		Consider using a green shared lane treatment in addition to the shared lane markings, just as Salt Lake City has done on 200 S
	Ironton Blvd	Larsen Pkwy	Mountain Vista Pkwy	0.16	\$ 3,000		
	Kuhni Rd	1860 S	Provo City limit	0.86	\$ 8,000		
	Navajo Ln	Cherokee Ln	Iroquois Dr	0.38	\$ 4,000		
P1 Subtotal				8.16	\$ 81,000		
2	1350 E	300 S	Nevada Ave	0.53			
	1500 W	1700 N	1460 N	0.20			
	2320 N	2230 N	Timpview Dr	0.37			
	820 N/Oakmont Ln	700 E	Oak Cliff Dr	0.91			A bike/ped signaland/ or median treatment at 900 East to allow for safe bike/ped crossing would make this route much more useful
	900 S/Nevada Ave	State St	Slate Canyon Dr	0.81			A signal or median treatment at 900 South/ State to allow for safe bike/ped crossing would make this route much more useful
	950 W	Columbia Ln	Carterville Rd	0.32			
	Carterville Rd	University Pkwy	1850 N	0.51			
East Bay Blvd	Towne Centre Blvd	University Ave	0.12				

Table 5-9: Recommended Marked Shared Roadways (cont'd)

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
2	River Park Dr	300 W	University Ave	0.36			
	2230 N/Riverside Ave	Canyon Rd	1720 N	1.04			Could be bike lanes south of University Parkway, but parking removal would be needed and there is parking demand here
	Towne Centre Blvd (mail loop)	1200 S	Freedom Blvd	0.30		Private	Would need to work with mail owners
	University Ave	300 N	200 N	0.10		UDOT	This link connects the proposed bike lanes north of here to the proposed 200 N bike lanes
P2 Subtotal				5.57	\$ TBD		
TOTAL				13.7	\$ TBD		

Table 5-10: Recommended Signed Shared Roadways

Phase	Bikeway	Limit 1	Limit 2	Length (miles)	Cost	Jurisdiction	Notes
1	Industrial Pkwy	350 E	1860 S	0.89	\$ 12,000		
P1 Subtotal				0.89	\$ 12,000		
2	Boat Harbor Dr	Utah Lake Shoreline Trail	Lakeshore Dr	1.27			Could also be marked shared roadway
P2 Subtotal				1.27	\$ TBD		
TOTAL				2.2	\$ TBD		



5.2 Spot Improvements

Spot improvement recommendations were developed to enhance the linear bikeways. Examples of spot improvements are bridges, pathway connections, and intersection improvements. The master plan steering committee and the public (through comments given at the public workshops) were instrumental in identifying critical locations within the City where these improvements are needed. The recommended spot improvements are shown in Figure 5-9. Table 5-11 shows their estimated costs and implementation considerations. The numbers in the second column of this table correspond to the location numbers in Figure 5-9.

Table 5-11: Recommended Spot Improvements

Phase	Number	Location	Cost	Jurisdiction	Notes
1	1	1390 N from 2270 W to Geneva Rd	\$ 3,000		Extend existing bike lanes on 1390 N to Geneva Road
	4	800 N / Independence Ave Intersection	\$ 3,000		Restripe roundabout approaches and add shared lane markings
	6	820 N / 1375 W	\$ 3,000		Restripe roundabout approaches and add shared lane markings
	10	Provo River Parkway Trail near Moon River Dr	\$ 10,000		Construct convenient access ramp between the trail and Moon River Dr to allow bicyclists to more easily access the shopping areas east of Moon River Dr
	12	800 N / 500 W Intersection	\$ 3,000		Extend existing bike lanes to the intersection using Combined Bike Lane/Turn Lane method to bridge gap
	13	800 N / Freedom Blvd Intersection	\$ 3,000		Extend existing bike lanes to the intersection using Combined Bike Lane/Turn Lane method to bridge gap
	14	800 N / University Ave Intersection	\$ 3,000	UDOT	Extend existing bike lanes to the intersection using Combined Bike Lane/Turn Lane method to bridge gap
	15	800 N / 200 E Intersection	\$ 95,000	BYU	Raised intersection that would tie in with the 200 E bike boulevard concept; would need to coordinate with BYU since they own the property on the north side of 800 N
	16	700 N / 700 E Intersection	\$ 3,000		Extend existing bike lanes to the intersection using Combined Bike Lane/Turn Lane method to bridge gap
	17	700 N / 900 E Intersection	\$ 3,000		Extend existing bike lanes to the intersection using Combined Bike Lane/Turn Lane method to bridge gap
	18	University Pkwy / 900 E Intersection	\$ 3,000		Extend the existing bike lane to 900 E by using shared lane markings and/or Combined Bike Lane/Turn Lane method to bridge gap
	19	Timpview Dr from 2320 N to 2230 N	\$ 3,000		Extend existing bike lanes on Timpview Dr south to 2230 N; use the Combined Bike Lane/Turn Lane method at the 2230 N intersection, if needed

Table 5-11: Recommended Spot Improvements (cont'd)

Phase	Number	Location	Cost	Jurisdiction	Notes
1	20	3700 N from Edgewood Dr to 180 E	\$ 8,000	UDOT	extend existing bike lanes east to 180 E ; may require parking removal, but it doesn't appear that demand is very high here or that the impact of removal will be substantial
	21	4800 N from Orem Boundary to 420 W	\$ 4,000	Orem City	Convert to an uphill bike lane and downhill shared lane; do in tandem with the same improvement on Orem's part of the road to the west
	23	5500 N between the Provo River and University Ave	\$ 3,000		Add shared lane markings to connect the main Provo River Parkway Trail with another paved trail on the west side of the river
P1 Subtotal			\$ 150,000		
2	2	2050 W / Center St Intersection		UDOT	Extend bike lanes on the west and south approaches to the intersection by using the Combined Bike Lane/Turn Lane method
	3	2050 W from 270 S to 320 S			Closure of small gap in existing bike lane
	5	Provo River Parkway Trail underneath railroad tracks		UPRR	Widen undercrossing to make it safer and more comfortable for bicyclists; would likely need to be done in conjunction with railroad bridge replacement
	7	Provo River Parkway Trail underneath 820 N			Widen undercrossing to make it safer and more comfortable for bicyclists; would likely need to be done in conjunction with railroad bridge replacement; also widen bridge structure enough to have the 820 N bike lanes go over the bridge without dropping
	11	300 W / Moon River Dr / 1625 N Intersection			Reconfigure intersection to provide better connection to the Provo River Parkway
	22	4800 N from Edgewood Dr to University Ave		UDOT	Extend existing bike lanes to University Ave; may require purchase of a sliver of land on the south side of the street
3	8	Provo River Parkway Trail underneath Columbia Ln			Widen undercrossing to make it safer and more comfortable for bicyclists; would likely need to be done in conjunction with railroad bridge replacement
	9	Provo River Parkway Trail underneath State St		UDOT	Widen undercrossing to make it safer and more comfortable for bicyclists; would likely need to be done in conjunction with railroad bridge replacement
TOTAL			\$ TBD		

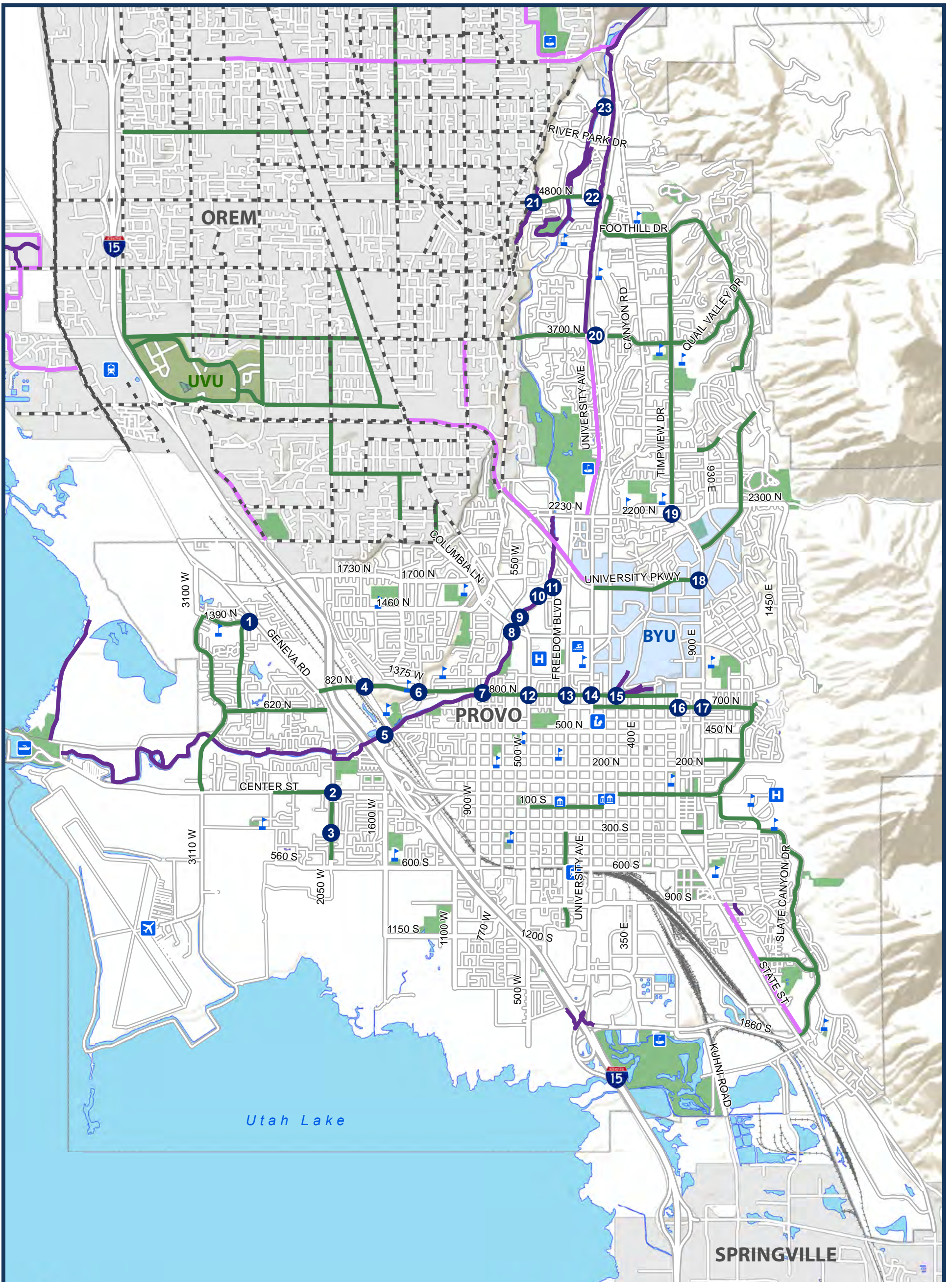
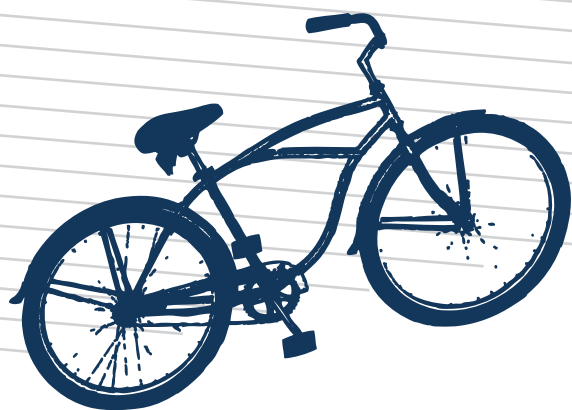


Figure 5-9: Recommended Spot Improvements

Figure 5-9: Recommended Spot Improvements



6 Wayfinding & Bike Parking

This chapter provides recommendations for wayfinding and bicycle parking. These elements enhance the linear bikeway improvements recommended in Chapter 5.

6.1 Wayfinding

Navigation through a city is informed by landmarks, natural features, and other visual cues. Bicycle wayfinding signs can indicate travel direction, destination location, distance, and riding time. This information increases users' comfort and accessibility to the bicycle system. Wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution because bicyclists are likely present.

Bicycle wayfinding signage typically falls into three categories:

- » Confirmation Signs
- » Turn Signs
- » Decision Signs





«« Wayfinding signage helps bicyclists navigate easily to popular destinations

Based on MUTCD standards and guidance available in the NACTO Guide, **Table 6-1** outlines the three types of bikeway signs, guidance on their use, and an example of what that sign might look like as a part of the Provo bikeway network. These signs are recommended to be posted in a manner most visible to bicyclists and pedestrians rather than according to typical vehicle signage standards.

Signage can serve both wayfinding and safety purposes including:

- » Helping to familiarize users with the bikeway system.
- » Helping users identify the best routes to destinations.
- » Helping to address misperceptions about time and distance.
- » Helping overcome a barrier for people who do not currently bicycle often (e.g. people who are “interested but concerned” with regard to bicycling).

Recommendation

Develop and implement a Bicycle Wayfinding Signage Plan. Key components of the signage plan should include:

- » Sign locations along existing and planned bikeways.
- » Sign type – what information should be included along with desired design features.
- » Destinations to be highlighted on each sign.
- » Approximate distance and riding time to each destination (based on an assumed average riding speed of 10 mph).

At the time of this writing, Provo City was working towards creating a citywide wayfinding signage plan. The City also plans to hire a consultant to help critique the work and be available as an advisory resource. A further recommendation is to include bikeway signage in the overall City wayfinding effort.



Table 6-1: Sign Types & Sample Designs

Sign Type	Purpose	Example
Confirmation	Confirmation signs notify bicyclists that they are on a designated bikeway. Information on confirmation signs can include distance and/or time but do not include arrows.	
	Placed at regular intervals along a bike route, confirmation signs can also alert motorists of the bike route and advertise the convenience of bicycling to common destinations in the community.	
Turn	Turn signs alert bicyclists to a bikeway turning from one street to the next. Turn signs should be used at intersections when the bikeway terminates and connects to an adjacent bikeway.	
	Some municipalities use pavement markings in conjunction with turn signs to assist with wayfinding. Turn signs include destinations and arrows. Placement of these signs should be in close proximity to where the bikeway turns. Confirmation signs are often used soon after the turn so that bicyclists know that they have made the turn correctly and are on the bikeway that they intend to be on.	
Decision	Decision signs highlight the intersection of two or more bikeways and inform bicyclists of key destinations accessible from those bikeways.	
	Destinations and arrows should be included on Decision Signs. Travel time and distances are optional but recommended. Signs should be placed near intersections and in advance of other bikeways or popular destinations.	

6.2 Bicycle Detection & Actuation

Providing bicycle detection at intersections is a critical component of well-functioning bikeway networks. Standard intersections are configured to recognize vehicular traffic, but may not be sensitive enough to detect bicycles. Undetected bicyclists at intersections are forced to dismount their bicycle and use the pedestrian push button (if one exists) to activate the green light or illegally run the red light unless a car comes along to trigger the sensor. To better accommodate bicyclists at intersections, bicycle-specific detection devices can be installed. These devices recognize the presence of bicycles, limit wait times, and increase the convenience of bicycling.

According to the NACTO Guide proper bicycle detection includes two important criteria:

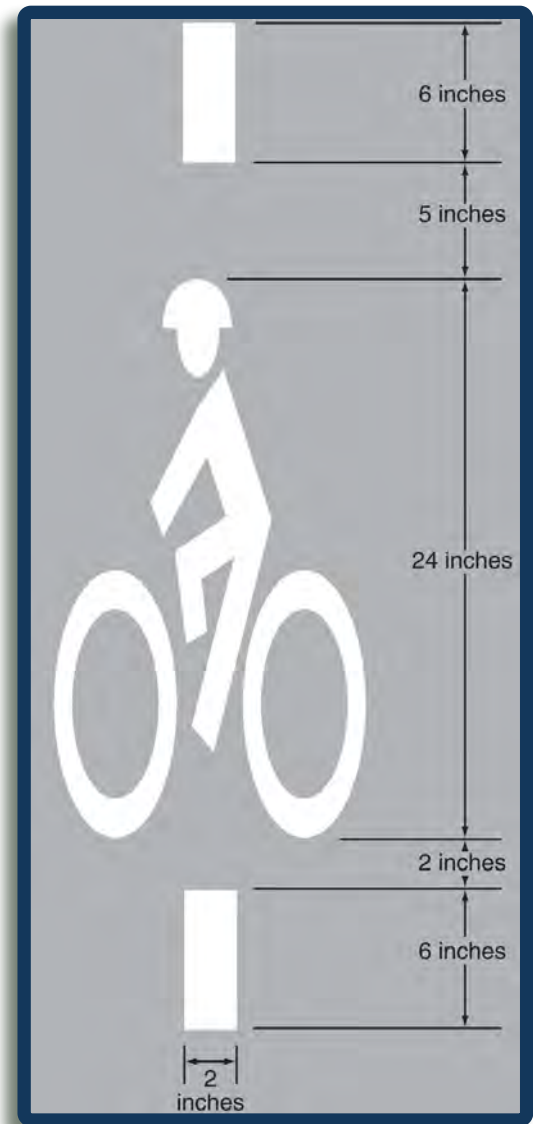
- » Accurately detects bicyclists.
- » Provides clear guidance to bicyclists on how to actuate the detection.

Four different types of bicycle detection are available at intersections. They are summarized in [Table 6-2](#) and then described in greater detail in the subsections that follow.

6.2.1 Loop

Bicycle-activated loop detectors are installed within the roadway so that bicycles will trigger a change in the traffic signal. This allows the bicyclist to stay within the lane of travel and avoid maneuvering to the side of the road to push a button.

Most demand-actuated signals use loop detectors, which can be calibrated to be sensitive enough to detect any type of metal including steel and aluminum. Some bicycles may lack enough detectable material by the loop, such as models that are mainly composed of carbon fiber or aluminum.



Recommended loop detector pavement marking design



Table 6-2: Bicycle Detection Types



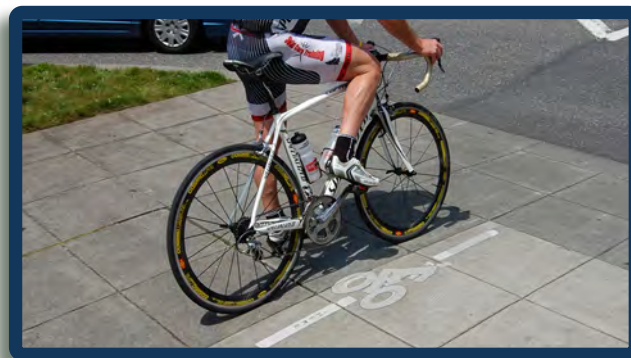
Type	Picture	Guidance	Cost
Loop		<p>From the NACTO Guide: Madison, WI utilizes bicycle signal detector loops to improve access and decrease wait times at signalized intersections for bicyclists. Two to four detector loops are installed along any approach where a local neighborhood road frequented by bicyclists meets a signalized intersection at an arterial road. Loops may also be installed on collector roads and bike lanes where they are deemed necessary. Detector loops are typically 6' by 6' and square or diamond shaped (as opposed to round). They are often installed during street resurfacings, and are placed between 3" and 9" below the surface. Shallow loops saw-cut into the pavement are most prone to damage. Approximately 80% of the City's 285 signalized intersections have bicycle signal detection loops in place. To help bicyclists identify the signal detectors, Madison is considering using pavement markings or striping to identify the most sensitive parts of the loops.</p>	<p>Approximately \$2,000-\$3,000 per loop, installed.</p>
Video		<p>From the NACTO Guide: As part of the N. 130th Street buffered bike lane project (Seattle, WA), video detection was installed for the westbound approach at Greenwood Ave. N. and N. 130 St. After shifting the existing lane markings to add the bike lanes, existing detection loops on this approach were no longer in the correct locations. Video detection was chosen because it was cost-effective and cheaper to install than cutting loops for three vehicle lanes and one bike lane. The pavement was also in subpar condition for cutting new loop detectors. The other three sections of the intersection continue to function using loop detection.</p>	<p>Video camera system costs range from \$20,000 to \$25,000 per intersection.</p>

Table 6-2: Bicycle Detection Types (cont'd)

Type	Picture	Guidance	Cost
Push-button		<p>Locate them such that bicyclists can actuate without dismounting bicycle. This option does not help with bicyclists wanting to make left turns, and may also be inappropriate at intersection approaches with a dedicated vehicle turn lane. Push buttons are most appropriate in areas where bicyclists do not have the option of turning left.</p>	<p>Push-button signals can cost between \$300-\$700 depending on function and design.</p>
Micro-wave		<p>From Florida State University: "RTMS is a true presence detector that can provide presence indication as well as volume, lane-occupancy, speed, headway, and classification information in up to eight discrete detection zones. The information is provided to existing controllers by contact closures and to other systems by serial communication. The detector can be mounted facing approaching traffic for single lane detection or sidefire for monitoring multiple detection zones. The mode of operation is configured with the setup program using a computer and serial communication." http://potentia.eng.fsu.edu/terl/detection/New2006/Non%20Intrusive%20Vehicle%20Detection%20Guidelines/Chapter5.pdf</p>	<p>Approximately \$3,000+ per unit. Installation costs vary and do not include annual maintenance.</p>



>> Loop detector at signal

Current and future loops that are sensitive enough to detect bicycles should have pavement markings and signage to instruct cyclists where to position themselves to effectively trigger the signal change.

6.2.2 Video

Video detection technology can detect a bicyclist's presence over a larger area by using pixel analysis of an image to detect the change from absence to presence of vehicles or bicycles. With video detection disturbance to the pavement can be avoided and the amount of metal in the bicycle is inconsequential. Changes to the detection can be made quickly with a few software modifications when lane configurations are changed or bike lanes are added. The detection zones can also be hand drawn to the appropriate size relatively easily if bicyclists are consistently positioning themselves outside of the expected vehicle detection zone. However, video detection cannot differentiate between a motor vehicle and a bicycle in a shared travel lane and therefore cannot be used to extend or create a signal phase unique for bicyclists. This may be possible when a bicycle lane is provided but would still require evaluation at each intersection.

Drawbacks to video can include poor detection in darkness (a lighted intersection and bicycles well equipped with lights solve this) and the shadows of adjacent vehicles triggering the bicycle area during certain times of day. It should also be noted that video detection is considerably more expensive than loop detection although the cost of video detection has fallen in recent years.

6.2.3 Push-button

Similar to pedestrian push button activation, a button positioned on the side of the roadway will allow a cyclist to trigger a signal change without dismounting from his or her bicycle or riding up on the sidewalk to push the button. This design takes advantage of existing infrastructure, diminishes the potential for conflicts between pedestrians and cyclists, and increases the convenience of the route for cyclists. Well-designed push button activation will be curbside and mounted at a height easily reached by cyclists. On-street parking near the push button area should be prohibited. The NACTO Guide provides the following guidance on push-button actuation devices:

“If provided, push-button activation shall be located so bicyclists can activate the signal without dismounting. If used, push buttons should have a supplemental sign facing the bicyclist’s approach to increase visibility.”

Though familiar to most pedestrians, push buttons are limited in their efficacy because they do not serve all of a bicyclist’s potential movements at an intersection. Push-button activation is not accessible for bicyclists wishing to turn left. For this purpose, push-button activation may only be appropriate at intersections where bicyclists do not have the option to turn left. Additionally, the 2004 Wisconsin Bicycle Facility Design Handbook states that push-button activation “should not be considered as a substitute for detectors, particularly where right turn only lanes exist.”

6.2.4 Remote Traffic Microwave Sensor Detection (RTMS)

RTMS is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method is marked with a time code which gives information on how far away the object is. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection cameras. In addition to its relatively low cost compared to video detection, other advantages of microwave detection include:

- » Elimination of the need for lane closures during installation (unlike loop detectors).
- » Ability to be used on any surface.
- » Ability to be used for pedestrian detection

A disadvantage of microwave detection technology is the complexity of maintaining the units. Maintenance will likely require the education and training of City staff or a contract with an outside vendor. Microwave detection for bicyclists is currently being used in Pleasanton, CA.

6.2.5 Recommendations

Provo City can improve intersections for – and detection of – bicyclists by implementing better bicycle detection at its intersections. The City presently uses video detection for cars at some of its intersections. Because of their familiarity with video detection, Provo may want to continue to use this technology and expand its use to include bicycle detection at prioritized intersections.



◀◀ Instructional sign for loop detector use



➤ Wave bike parking racks in Provo



With the right equipment, video systems can also be used to modify signal timing according to bicyclists' needs. The City should explore traffic signal timing for bicyclists when considering detection installation.

The City should evaluate the performance of video detection at high-priority intersections. A critical component to the evaluation of video detection will be field analysis and review. A review process that involves monitoring, counts, and successful or unsuccessful activation will help Provo determine which method works best for the community. In the event that video detection does not meet expectations, the City could explore implementing some of the other methods discussed in this section.

6.3 Bike Parking Ordinances & Design Guidance

This section describes current bike parking requirements as mandated by Provo City code, and how bike parking is discussed as a part of future growth in City planning documents. Expanding bicycle parking in municipal code is one way to increase the supply of bike parking in Provo. In addition to increasing bike parking, Provo should also adopt design standards for short- and long-term parking to ensure that quality amenities are available to bicyclists.

6.3.1 Provo City Code

A minimal amount of bike parking is required in downtown Provo based on adjacent land use and development size. Sections 14.21A.150(4), 14.21B.140(4), and 14.21C.130(3) of the City code give the same bicycle parking requirement for the DT1, DT2, and GW zones, respectively. The requirement is:

“Bicycle Parking. A minimum of one bicycle stall shall be required for every 2,000 square feet of gross floor area. Bicycle stalls must be provided in an enclosed area in the primary structure or within a parking structure on the property.”

At present, there is not any specific guidance on the design of bicycle parking facilities or a more nuanced discussion of parking capacity beyond the three land use zones discussed earlier. Both of these issues are addressed in Section 6.3.3.

6.3.2 City Planning Documents

Both the General Plan (2010) and the Center Focus downtown revitalization plan encourage the installation of bicycle parking facilities, particularly in locations useful to commuters and in close proximity to transit.

2010 General Plan, Chapter 8 – Transportation & Circulation

This section of the General Plan states the following:

“Provo City plans to significantly increase bike facilities within the City. Employers can promote greater use of bicycles for commuting by providing showers, lockers, and secure and convenient bicycle parking for employees and customers. Additional bike facilities would contribute to a network of safe and efficient transportation routes between residential areas, employment areas, recreational areas, and shopping areas.”

Center Focus – A Vision & Plan for Downtown Provo

Expanding bike parking is a common theme in the Center Focus plan. In part, it states:

“By installing bicycle racks at strategic locations Downtown, the City can help support the ever-growing bicycle culture.”

The following objectives and action items in the Center Focus plan pertain to bicycling.

Objective 3: Promote and expand transit service and ridership within and connecting to Downtown Provo.

Objective 3 Action Items:

2) Coordinate with intermodal hub and transit station planners to identify appropriate locations for bicycle storage facilities.

3) Work with transit facility planners to install bicycle storage facilities at stations.

Objective 5: Improve the bikeability of Downtown. Objective 5 Action Items :

3F – Identify strategic locations for the installation of new bicycle racks or lockers.

Both the General Plan and Center Focus plan encourage the installation of short- and long-term bicycle parking. Specific guidance on these types of facilities is discussed in the next section.

6.3.3 Bicycle Parking Guidelines

This section provides guidance on short- and long-term bicycle parking requirements for land uses within the City, both in terms of quantity and quality.

Off-street car parking requirements are outlined in Section 14.37.060 of Provo’s Municipal Code. At present, the only bike parking requirements (detailed in Section 6.3.1) are connected to areas of Provo zoned as General Downtown (DT1), Downtown Core (DT2), and Downtown Gateway (GW). To expand bike parking in Provo, the City can adopt general bicycle requirements that extend to all land uses. The expansion of bicycle parking outside of the aforementioned zones will enable more trips to be made by bicycle.



Just as car trips vary in purpose and duration, so too do bicycle trips. As a result, different types of bicycle parking are needed for different contexts. These needs can be met by providing both short- and long-term parking. The Association of Pedestrian and Bicycle Professionals (APBP) addresses the distinction between these two types of parking. A summary of this information is provided in Table 6-3.

Table 6-3: Criteria for Short- & Long-Term Bicycle Parking

[1]

Criteria	Short-term	Long-term
Parking Duration	Less than two hours	More than two hours
Fixture Type	Simple bicycle racks	Lockers, racks in secured area
Weather Protection	Unsheltered	Sheltered or enclosed
Security	Unsecured, passive surveillance	Secured, active surveillance
		Unsupervised
		"Individual-secure" such as bicycle lockers
		"Shared-secure" such as bicycle room or cage
		Supervised
Typical land uses	Commercial or retail, medical/healthcare, parks and recreation areas, community	Valet bicycle parking Paid area of transit station Residential, workplace, transit

[1] Association of Pedestrian and Bicycle Professionals (APBP) Bicycle Parking Guide, 2010. Page 10.

Unit of Measurement

Cities use different metrics for assigning appropriate levels of bicycle parking, including:

- » Unit count
- » Percentage of building square footage
- » Building occupancy
- » Percentage of car parking

Provo City uses a percent of a building’s square feet for bicycle parking, but for required car parking it also uses unit counts and building occupancy. The current standards for vehicle parking and recommendations for accompanying bicycle parking for the land uses outlined in section 14.37.060 of Provo’s zoning code are outlined in Table 6-4. The recommended bike parking rates were developed by blending APBP guidance¹ with other best practices from around the country.

Table 6-4: Recommended Bike Parking Requirements

Use	Current Car Parking Requirement	Recommended Short-Term Bicycle Parking	Recommended Long-Term Bicycle Parking
Church	1 sp./100 sq. ft.	5% of max daily attendance	1.5 sp./20 employees (2 min.)
Community center	1 sp./250 sq. ft.	1 sp./8K sq. ft. (2 min.)	1.5 sp./10 employees (2 min.)
Day care	1 sp./6 people at max occupancy	1 sp./20 students planned capacity (2 min.)	1.5 sp./20 employees (2 min.)
Government buildings	1 sp./200 sq. ft.	1 sp./8K sq. ft. (2 min.)	1.5 sp./10 employees (2 min.)
Health club	1 sp./4 people at max occupancy	1 sp./5K sq. ft. (2 min.)	1 sp./10K sq. ft. (2 min.)
Hospital	1 sp./450 sq. ft.	1.5 sp./20K sq. ft. (2 min.)	1.5 sp./20 employees or 1 sp./50K sq. ft., whichever is greater (2 min.)
Library	1 sp./300 sq. ft.	1 sp./20K sq. ft.	1 sp./10K sq. ft.
Movie theater	1 sp./4 seats	1 sp./20 seats	1 sp./40 seats
Professional offices	1 sp./250 sq. ft.	1 sp./20K sq. ft.	1 sp./10K sq. ft.
Restaurants	1 sp./4 seats	1 sp./5K sq. ft.	1 sp./12K sq. ft.
Retail (furniture, appliances, hardware, etc.)	1 sp./600 sq. ft.	1 sp./20K sq. ft.	1 sp./10K sq. ft.
Retail (grocery, convenience, personal)	1 sp./200 sq. ft. + 1 sp./400 sq. ft. on additional floors	1 sp./5K sq. ft. (2 min.)	1 sp./12K sq. ft. (2 min.)
Residential			
Elderly	1 sp./unit + .25 sp. for visitor	.10 sp./bdrm (2 min.)	.05 sp./bedroom (2 min.)
1 & 2 family	3 sp./unit	n/a	n/a
Multiple residential		1 sp./20 units (2 min.)	1.5/unit
Multi-family (1 bed)	1.75 sp./unit + .25 sp./unit for visitor	.05 sp./unit	1 sp./unit
Multi-family (2 bed)	3 sp./unit + .25 sp./unit for visitor	.10 sp./unit	1.25 sp./unit
Multi-family (3 bed)	3 sp./unit + .25 sp./unit for visitor	.15 sp./unit	1.5 sp./unit
Multi-family (4 bed)	4 sp./unit + .25 sp./visitor	.20 sp./unit	2 sp./unit
1-6 bedrooms (Batching singles)	2 sp./bdrm + .25 sp./unit for visitor	.25 sp./unit	1.5 sp./unit
Schools			
Elementary/Jr. High	3 sp./room used for administration	1 sp./20 students	1 sp./10 employees
High School/Trade	3 sp./room used for administration or classroom + 1 sp./4	1 sp./20 students	1 sp./10 employees



Provo's physical layout, large college-age population, and accessible downtown commercial core were all taken into consideration during the development of these recommendations. The APBP Bicycle Parking Guide provides two groups of recommendations – a standard set and a higher level for “Urbanized or High Mode Share Areas”. The higher rates were used because of Provo's unique characteristics that support higher levels of bicycling.

Short-term Bicycle Parking Guidance

Short-term bicycle parking serves short trips, errands, and quick activities. This section provides best practice guidance and dimensions for short-term bicycle parking. Short-term racks may be placed on sidewalks, in front of stores, or within parking structures in a manner that does not obstruct pedestrian movements or block doors. For security reasons, they should also be placed in well-lit, visible locations. **Table 6-5** shows recommended short-term bike rack dimensions and design considerations. **Table 6-6** gives information about a new type of short-term bike rack installation called a bicycle corral.

Long-term Bicycle Parking Guidance

Long-term bicycle parking is recommended when providing bicycle storage for long periods of time, overnight, or possibly all day for a work commute. Long-term facilities protect the entire bicycle, its components, and accessories against theft and inclement weather, including snow and wind-driven rain. Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Potential locations for long-term bicycle parking include transit stations, large employers, and institutions where people use their bikes for commuting rather than consistently throughout the day. **Tables 6-7, 6-8, and 6-9** illustrate three forms of long-term bicycle parking.

» Both short-term and long-term bicycle parking options are important amenities at transit stations



Table 6-5: Short-Term Bike Parking Rack Recommendations

Short-term Bicycle Parking Rack Recommendations	
Design Summary	Preferred Design
Rack Dimensions: 36" high by 24.5" wide.	<p>NOTES:</p> <p>1. MATERIAL: - PIPE: ASTM A53 2" SCHED 40 PIPE - PLATE: ASTM A36 3/8" PLATE</p> <p>2. FINISH: - SANDBLAST - EPOXY PRIME - TGIC POWDER COAT (COLOR PER SPEC)</p>
Construction: 2 3/8" x 2" x .188" wall single Schedule 40 ASTM A53 Steel pipe, constructed of two 90 degree bends.	
Base plate will be constructed of ASTM A36 with a thickness of 3/8" and will be welded onto the steel pipe. The base plate should be constructed to receive mounting hardware with three 0.50" diameter holes space at 120 degrees.	
Coating Material Finish: Long wearing, mildew and ultraviolet ray resistant coating made of TGIC powder coating. Coated in the factory prior to delivery. Any damaged surface area resulted from the Contractor's operation shall be repaired with approved materials in accordance to the manufacturer's specifications.	
Discussion	
These types of racks, commonly referred to as "Staple", "U", or "Inverted U" racks are used throughout the country due to their security, ease of use, and space-efficiency.	
Design Example	
Guidance	
APBP Bicycle Parking Guide, 2010	

Table 6-6: Bicycle Corrals


Short-Term Bicycle Parking Recommendations: Bicycle Corrals	
Design Summary	Design Example
<p>Close to destinations; 50' maximum distance from main building entrance.</p> <p>Bicyclists should have an entrance width of 5' – 6' from the roadway.</p> <p>Minimum clear distance of 6' should be provided between the bicycle rack and the property line.</p> <p>Should be highly visible from adjacent bicycle routes and pedestrian traffic.</p> <p>Locate corrals in areas that cyclists are most likely to travel.</p> <p>Can be used with parallel or angled parking.</p> <p>Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.</p>	 <p>Example of bicycle corral. Salt Lake City recently began installing a few such facilities.</p>
Discussion	
<p>Bicycle corrals (also known as “on-street” bicycle parking) consist of bicycle racks grouped together within the street area traditionally used for automobile parking. They are reserved exclusively for bicycles and provide a relatively inexpensive solution for providing high-volume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces. Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces. Bicycle corrals move bicycles off the sidewalks, leaving more space for pedestrians, sidewalk café tables, and other street furniture. Because bicycle parking does not block sightlines (as large motor vehicles would do), it may be possible to locate bicycle parking in no parking zones near intersections and crosswalks.</p>	

Table 6-7: Bike Rooms

Long-term Bicycle Parking Recommendations: Bike Rooms	
Design Summary	Design Example
<p>Improve surveillance through public lighting and closed circuit television cameras.</p> <p>Walls should be solid and opaque from floor to ceiling.</p> <p>Install a panic button so as to provide a direct line of security in the event of an emergency.</p> <p>Accommodate a maximum of 40 bicycles or 120 if the room is compartmentalized with expanded metal mesh with lockable industrial-grade doors into enclosures containing a maximum of 40 bicycles.</p>	 <p>Bike rooms can be provided in office or apartment buildings.</p>
Discussion	
<p>Bike Rooms are interior locked rooms or enclosures accessible only to people needing to park bikes. They are used where there is a moderate to high demand for bike parking, and where people are part of a defined group, such as a department of employees or a small to medium size apartment building where residents are familiar with one another. Depending on the number of users and size of facility, the room may or may not contain bicycle racks for people to lock their bike.</p>	
<p>Bike Rooms should be no further from elevators or entrances than the closest motor vehicle parking space. They should be no more than 150' from the nearest building elevator or entrance. Buildings with more than one entrance should consider providing interior bicycle parking close to each entrance, with an emphasis on entrances people are likely to approach by bike. Whenever possible, bike rooms should allow 24-hour secure access and ride-in/ride out convenience.</p>	
<p>Buildings should provide dedicated bicycle-only secure access points via secure key cards, non-duplicable keys, or numeric keypads. Unless there is a staffed attendant nearby, people must have a key or passcode prior to using these parking facilities. Therefore, Bike Rooms are best for long term, regular users rather than incidental, opportunistic users.</p>	



Table 6-8: Bicycle SPAs


Long-term Bicycle Parking Recommendations: Bicycle Secure Parking Areas (SPAs)	
Design Summary	Design Examples
<p>A Secure Parking Area (SPA) is a theft deterrent space accessible to an identifiable, limited group of people by key card or other controlled access locking device.</p>	 <p>This BikeSPA in Penn Station, New York City uses a passcard for access.</p>  <p>In the space formerly used for seven cars, a BikeSPA can comfortably park 80 bikes with room for future expansion. Double-height racks take advantage of the vertical space, maximizing parking capacity.</p>
<p>An 18' by 18' SPA can accommodate up to 20 bicycles and uses the space of approximately two automobile parking spots.</p>	
<p>Lighting and closed circuit television cameras should be used to provide an additional layer of security.</p>	
<p>Bicycle SPAs have a secure exterior skin consisting of welded or woven metal mesh with no opening larger than 2" from floor to ceiling.</p>	
<p>In an attended parking facility, locate the SPA within 100' of an attendant or security guard, or place it such that it is highly visible to other users of the parking facility or passersby.</p>	
<p>Entry doors must be steel and at least 3'-0" in width, with tamper proof hinges. The door should be constructed so as to provide permanent visual access in and out of the SPA. If the door is made from a solid material, a window may accomplish this</p>	
<p>Typical SPAs accommodate between 20 and 120 bikes.</p>	
Discussion	
<p>A Secure Parking Area for bicycles, also known as a BikeSPA or Bike & Ride, is a semi-enclosed space that offers a higher level of security and protection than ordinary exposed bike racks. Accessible via key card, BikeSPAs provide high capacity, secure parking for large volumes of bicycles. The increased security measures ease the minds of people uncomfortable leaving their bicycle in an outdoor area exposed to weather and threats of vandalism. BikeSPAs also include features such as benches, bicycle repair stands, bicycle tube and maintenance vending machines, as well as hitching posts that allow regular users to leave their personal bike lock at the SPA. These features make the Bike SPA especially attractive by eliminating some of the barriers that keep people from using the bicycle for transportation. Unless staffed by an attendant, people must have a key or passcode prior to using BikeSPAs. Therefore they are best for long-term, regular users rather than incidental, opportunistic users.</p>	

Table 6-9: Bicycle Lockers

Long-term Bicycle Parking Recommendations: Bicycle Lockers	
Design Summary	Design Example
Place in close proximity to building entrances or transit exchanges, or on the first level of a parking garage.	 <p>Example of bicycle lockers at a transit station</p>
Provide door locking mechanisms and systems.	
A flat, level site is needed; concrete surfaces preferred.	
Enclosure must be rigid.	
Transparent panels are available on some models to allow surveillance of locker contents.	
Integrated solar panels have been added to certain models for recharging electric bicycles.	
Minimum dimensions: width (opening) 2.5'; height 4'; depth 6'.	
Stackable models can double bicycle parking capacity.	
Discussion	
<p>Although bicycle lockers may be more expensive to install, they can make the difference for commuters who are deciding whether or not to cycle. Bicycle lockers are large metal or plastic stand-alone boxes and offer the highest level of bicycle parking security available.</p>	
<p>Security requirements may require that locker contents be visible, introducing a tradeoff between security and perceived safety. Though these measures are designed to increase station security, bicyclists may perceive the contents of their locker to be less safe if they are visible and will be more reluctant to use them. Providing visibility into the locker also reduces unintended uses, such as use as homeless shelters, trash receptacles, or storage areas. Requiring that users procure a key or code to use the locker also reduces these unintended uses.</p>	
<p>Lockers available for one-time use have the advantage of serving multiple users a week. Monthly rentals, by contrast, ensure renters that their own personal locker will always be available. Bicycle lockers are most appropriate:</p>	
<p>Where demand is generally oriented towards long-term parking.</p>	
<p>At transit exchanges and park-and-rides to help encourage multi-modal travel.</p>	
<p>Medium- or high-density employment areas, commercial districts, and universities.</p>	
<p>Where additional security is required and other forms of covered storage are not possible.</p>	



Both short-term and long-term bicycle parking options are important amenities at transit stations

6.3.4 In-Lieu of Parking

If the short- and long-term bicycle parking requirements outlined in Table 6-4 are adopted, Provo may also choose to offer an “In-Lieu of Parking” program. This program would allow property owners to pay fees to a fund established for the development of bicycle support facilities instead of installing bike parking on their own. The money collected in this fund can then be used for bicycle facility development anywhere in the City.

6.3.5 Bike Parking with Transit

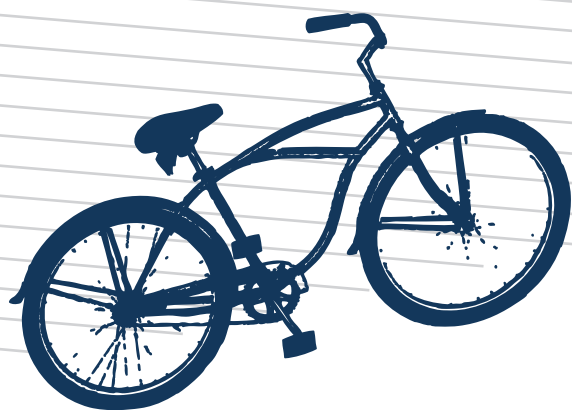
The FrontRunner and Provo-Orem Bus Rapid Transit (BRT) systems will bring new types of transit to the Utah Valley region. At present, all UTA buses include exterior bicycle racks on the front of the vehicles. UTA plans to explore the feasibility of including bicycle racks and storage areas within BRT vehicles.

FrontRunner trains include space for 12 bicycles in a dedicated bicycle car, plus space for four others in each passenger car.

Recommendation

In order to encourage multi-modal commuting and reduce single occupancy vehicle travel, Provo should work with UTA to encourage them to provide bicycle storage on BRT buses as well as short- and long-term bicycle parking at BRT stations and the Provo FrontRunner station. The FrontRunner station should include a bike cage or SPA within the parking lot or as a stand-alone facility outside of the parking lot, preferably as close to the station platform as possible.

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7 Program Recommendations

Bicycle programs enhance the biking experience and can be a cost-effective complement to infrastructure investments. They also can help Provo move toward its goal of becoming a Gold-Level Bicycle Friendly Community. This chapter recommends a tailored suite of new programs for the City to consider along with a few adjustments to existing programs. The goal of these programs is to:

- » Support and enhance the infrastructure recommendations shown in Chapter 5.
- » Increase the number of people riding bicycles in Provo.
- » Create a safer and more comfortable environment for bicycling.

7.1 New Programs

This section discusses new programs that Provo City and its partners can implement in order to increase bicycling. Each program is assigned a priority level of high, medium, or low. These rankings were decided upon by the steering committee after considering the input received at the second public workshop.





« A dedicated staff coordinator can focus on implementing the Bicycle and Pedestrian Plan most efficiently

7.1.1 Bicycle Coordinator

Purpose	Expand city capacity for implementing bicycle infrastructure and programs
Target Audience	n/a
Primary Agency	Provo City Engineering or Planning Departments
Partners	Provo City
Priority	High
Sample Programs	Salt Lake City Bicycle & Pedestrian Coordinators

The City should create a Bicycle Coordinator position to implement the projects and programs recommended in this plan. The job duties for this staff person could include the following types of activities:

- » Monitoring the design and construction of bikeways to ensure that they are built to standard and in a timely fashion.
- » Working with relevant City agencies (e.g. Public Works, Planning, Parks & Recreation) to implement the projects and programs recommended in this plan.
- » Identifying new projects and programs as opportunities arise.
- » Serving as the primary liaison for the Provo Bike Committee.
- » Writing an annual report card.
- » Applying for recognition through avenues such as the Bicycle Friendly Community program.

Experience has shown that agencies and organizations that have a staff person dedicated to bicycling concerns are much more successful at implementing their plans than those that don't. Salt Lake City currently has two full-time staff dedicated to implementing on- and off-street



>> Salt Lake City's bicycle program and information website



bikeways and a third full-time person focused on non-infrastructure programs. They also have a part-time intern that supports the activities of the three full-time staff. Implementation of bikeways and supporting programs has skyrocketed in Salt Lake City in the approximately three years since they began expanding their bicycle staff. During that time, cycling levels have seen a significant uptick. Comparison of standardized citywide bicycle counts showed a 27% increase in cycling levels from 2010 to 2011.

7.1.2 Bike Program Website

Purpose	Make it easier for residents to find information about bicycling
Target Audience	General public
Primary Agency	Provo City Engineering or Planning Departments
Partners	Community Development Department
Priority	High
Sample Programs	Vélo Québec: www.velo.qc.ca/english/index.php Salt Lake City: www.bikeslc.com

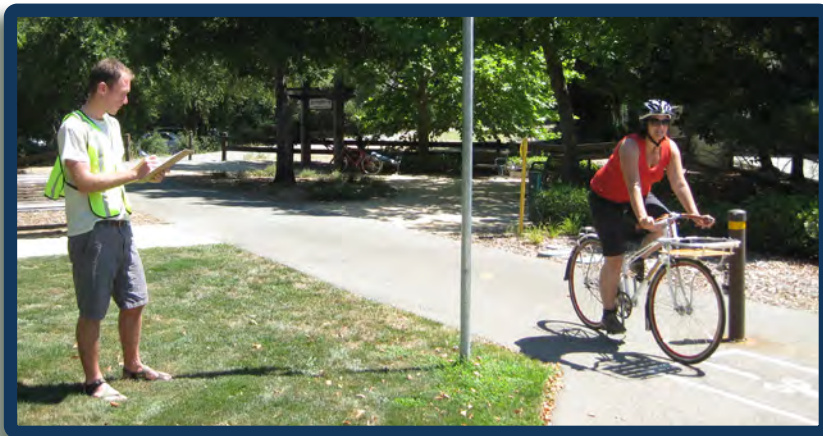
Residents and visitors will benefit from a “one stop shopping” location for bicycling information. The website should be hosted on the main City website and include:

- » A list of local bicycling groups and resources.
- » Information about current projects and how to get involved (e.g. public meetings, comment periods).
- » Maps and brochures (e.g. links to online maps and brochures, where to find hard copies).
- » Links to laws and statutes relating to bicycling.
- » Information about bicycling events (e.g. rides, classes, volunteer opportunities).
- » Names, phone numbers, and addresses of local bike shops.

7.1.3 Annual Bicyclist Counts

Purpose	Gather important benchmarking information about cycling rates
Target Audience	For use by agency staff
Primary Agency	Provo City Engineering and/or Planning Departments
Partners	Provo Bicycle Committee, BYU Engineering & Geography Departments.
Priority	High
Sample Programs	http://bikepeddocumentation.org/

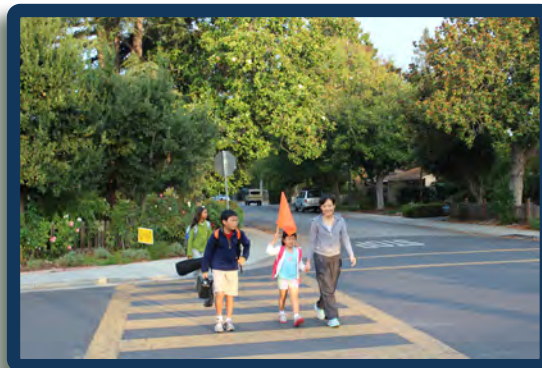
To better understand the needs and habits of Provo residents who bicycle, it is necessary to establish an annual data collection program. At a minimum, this program should tally the number of cyclists at key locations in the city. The same locations should be counted in the same manner annually. It is recommended that the data collection program use the methodology developed by the National Bicycle and Pedestrian Documentation Project (NBPD). Salt Lake City and the University of Utah are currently using this methodology for their annual bicycle counts.



« User counts help to evaluate demand and future needs



>> SRTS programs encourage children to walk and bike safely to school



7.1.4 Safe Routes to School

Purpose	Encourage and educate students and their parents about walking and biking to school; improve safety through physical improvements and programs
Target Audience	School-aged children and their parents; school administrators, faculty, and staff
Primary Agency	Provo School District, school staff, and city staff
Partners	Parents, neighbors, advocates, Provo Police Department, Provo Bicycle Committee, UDOT
Priority	High
Sample Programs	Marin County (CA) National Model Program: http://www.saferoutestoschools.org/index.shtml

SRTS is a program designed to increase the number and safety of children walking and bicycling to school. SRTS programs are often called “Five Es” programs because they include Engineering, Education, Encouragement, Enforcement, and Evaluation strategies. UDOT administers a federally-funded SRTS grant program. Several Provo schools have benefited from non-infrastructure programs funded by this program.

SRTS programs directly benefit schoolchildren, parents, and teachers by creating safer travel environments near schools and by reducing motor vehicle congestion at school drop-off and pick-up zones. Students that choose to bike or walk to school are rewarded with the health benefits of a more active lifestyle, the responsibility and independence that comes from being in charge of the way they travel, and knowledge at an early age that biking and walking can be safe, enjoyable, and good for the environment as well as their health. SRTS programs offer ancillary benefits to neighborhoods by slowing traffic and providing infrastructure improvements that improve biking and walking for everyone. Identifying and improving routes for children to safely walk and



« SRTS programs educate children about safe walking and bicycling practices

bicycle to school is also one of the most cost-effective means of reducing weekday morning traffic congestion and auto-related pollution.

The two most important actions that can be taken in Provo to further SRTS efforts are formation of an SRTS Task Force and creation of a Citywide SRTS Plan. The Task Force should include:

- » Representatives from the school district, school administrators, teachers, and families.
- » City staff from Engineering (and possibly Parks and Recreation if a significant role is anticipated from them).
- » Representative from the Provo Police Department.
- » Mountainland Association of Governments staff.
- » Neighbors, local volunteers (e.g. crossing guards), and advocates (e.g. Provo Bicycle Committee).

A Citywide SRTS Plan should be created based on walking audits for each elementary, middle, and junior high school, resulting in maps of needed engineering improvements. It is also strongly recommended that the national standard evaluation activities (parent survey and student travel mode tally) be implemented, along with plans to repeat the evaluation activities annually. Maps of recommended walking and bicycling routes to school should be created and distributed to parents. Finally, education and encouragement strategies should be created and prioritized.

Several of the program recommendations already listed in this chapter will directly help achieve SRTS goals, including:

- » Youth Bicycle Safety Education Program
- » Bike Light Campaign
- » Bicycle Map



Other recommended SRTS programs that can be implemented as stand-alone programs or as part of a larger SRTS Plan include:

“Boltage” Program

This program uses a solar-powered, WiFi-enabled RFID tracking device to track and reward students bicycling (and walking, if desired) to school. Because the tracking tags are mounted on childrens’ helmets, there is an added incentive for children to always wear a helmet. In prototype programs, walking and bicycling has increased by up to 500% in the first year of the program.

Integrate Walking and Bicycling Into the Classroom Curriculum

This program encourages children to keep track of their walking and bicycling miles. Teachers can use this data in different ways depending on the class subject. Mathematics classes can perform calculations using the numbers (e.g. average daily walking/biking miles, predicted mileage over the year). Physical education classes can use mileage to help students “run” a marathon. Social studies classes can use the data to “walk across Utah”.

Start a Walking School Bus or Park & Walk Program

Walking School Buses are organized groups of students accompanied by one or more adults along a regular route to school. Children join the bus at set times and stops. If a Walking School Bus cannot be formed, a first step or an alternative activity is to designate a Park and Walk location where parents park at a designated spot (such as a community park) and walk their children the rest of the way to school. Both Walking School Bus and Park and Walk programs can reduce traffic congestion near schools.

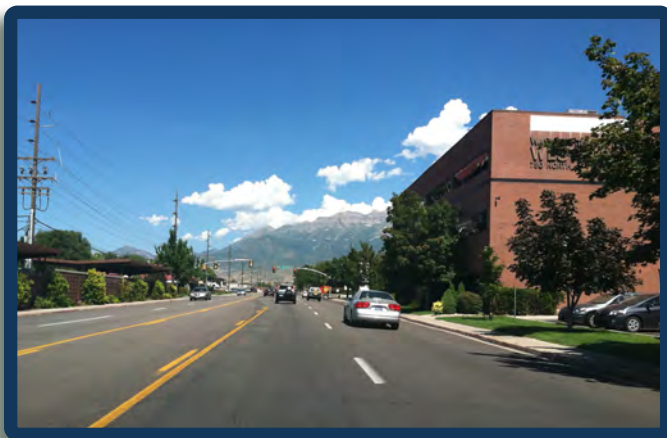
» SRTS programs help children be active and may save parents driving-related time and money



7.1.5 Complete Streets Policy/Resolution

Purpose	Ensure that City roadways are accessible and safe for all users
Target Audience	City Planners and Engineers
Primary Agency	Provo City Engineering or Planning Departments
Partners	Mountainland Association of Governments
Priority	Medium
Sample Programs	http://www.completestreets.org/

Complete streets policies direct transportation planners and engineers to consistently design streets with all users in mind (drivers, transit riders, pedestrians, bicyclists, the elderly, children, and people with disabilities). Many jurisdictions around the country have adopted Complete Streets policies and national model policies can be used as a starting point. A Complete Streets policy is one effective way to institutionalize the goals of this plan within the City.



« Complete Streets policies benefit communities by including different types of users in road designs



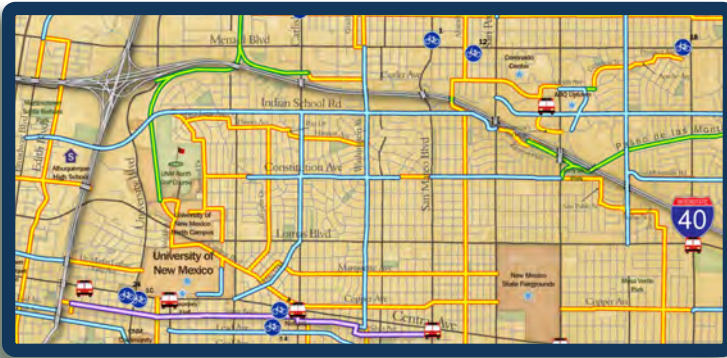
7.1.6 City Staff Training

Purpose	Educate and train planners and engineers on bicycle facility design and policy issues.
Target Audience	Planning, engineering, and maintenance staff
Primary Agency	Provo City Public Works and Planning Departments
Partners	Provo Bicycle Committee, Community Development
Priority	Medium
Sample Programs	Cheyenne, WY and Culver City, CA have recently used: http://www.michaelronkin.com/courses.htm

Professional development courses provide training to professionals who do not have extensive experience or training in bikeway design. This can be a successful way to institutionalize knowledge of bicycle facility design and create an agency culture that values bicycling.



» City staff training is a good way to institutionalize walking and bicycling into standard practices and processes



« Bicycle route maps help to promote cycling to visitors and residents

7.1.7 Bicycle Map

Purpose	Encourage cycling by providing route descriptions, support facility information, and locations of popular destinations
Target Audience	General public
Primary Agency	Provo City Engineering or Planning Departments
Partners	Mountainland Association of Governments, Provo Bike Committee
Priority	Medium
Sample Programs	<p>Portland (OR) maps: http://www.portlandonline.com/transportation/index.cfm?a=hacccb&c=deiaj</p> <p>Salt Lake City Bikeways Map: http://www.ci.sl.c.ut.us/transportation/bicycletraffic/map.htm</p>

One of the most effective ways to encourage people to bike is through the use of maps and guides to show that the infrastructure exists, to demonstrate how easy it is to access different parts of the city by bike, and to highlight unique areas, shopping districts, or recreational areas. Cycling maps can be used to promote tourism to specific areas, encourage residents to bike, or promote local business districts. Maps can be citywide or district-specific. They can be distributed as hard copies at locations throughout the city, posted online as a downloadable and printable map, posted online as an interactive map, or a combination of these options. Currently, the City bike map has been produced as part of the Provo City General Plan, which is managed by the Planning Division.

The Mountainland Association of Governments is currently publishing a revised regional bicycling map. Provo City should create a map that complements the regional map and provides a finer grain of information specific to Provo, including transit routes and stops, bikeways, bike parking, locations of businesses likely to be frequented by bicyclists, and other information that will be useful to people riding bicycles in the City.



7.1.8 Youth Bicycling Classes

Purpose	Educate youth on traffic safety and bicycling skills
Target Audience	Children, families
Primary Agency	Provo City Public Works
Partners	Provo Bicycle Committee, Police Department, Fire Department
Priority	Medium
Sample Programs	http://bikeleague.org/programs/education/courses.php

Most people who bicycle have not received any training on safe bicycling practices, the rules of the road, or bicycle handling skills. Bicycling skills courses can address this education gap. The most common programs are the League of American Bicyclists courses (including Road I, Road II, and Commuting), taught by League Certified Instructors (LCI). Orem resident Brad Woods is the only LCI in Utah Valley, but several LCIs live in Salt Lake County. These courses cover bicycle safety checks, fixing a flat, on-bike skills, crash avoidance techniques, and traffic negotiation.

» Youth bicycling classes teach safety skills and help children feel more confident about traveling through their community



7.1.9 Police Training Module

Purpose	Educate law enforcement officers on bicycle laws and safety
Target Audience	Police Department
Primary Agency	Provo City Police Department
Partners	Provo Bicycle Committee
Priority	Medium
Sample Programs	http://webike.org/services/enforcement/continuum-of-training

Most law enforcement professionals do not receive training specific to bicycle laws, handling, or safety. Police education courses can help officers improve public safety and enforce existing laws more effectively by providing them with the training they need. These courses should include:

- » Comprehensive information about laws and statutes pertaining to bicycling.
- » Information about common crash types and causes, and how to prevent and enforce against the most serious offences.
- » Options for enforcement and education (e.g. guidance for when to issue a citation or warning, diversion class options, and safety materials that can be handed out during traffic stops or public events).



« A police force trained on bicycle laws and common crash types can improve safety through enforcement and education



» Safety and awareness campaigns educate pedestrians, cyclists, and motorists



7.1.10 Safety Campaign

Purpose	Promote safety by educating all road users through a high-profile campaign
Target Audience	College age population and students, general public
Primary Agency	Engineering and Planning Departments
Partners	Mayor's office, City Council, UDOT, BYU, UVU, MAG
Priority	Medium
Sample Programs	http://www.slobikelane.org/cm/programs/sharetheroad.html

A high-profile media campaign that highlights bicycle safety is an important part of helping all road users understand their roles and responsibilities on City streets. It is an effective way to raise the profile of bicycling and improve safety for everyone. A well-produced safety campaign will be memorable and include clean, clear graphics in a variety of media, such as print or audio/video advertisements, the distribution of free promotional items, and email or in-person outreach. This type of campaign is particularly effective when kicked off in conjunction with other bicycling events or at the beginning of the school year. It is recommended that Provo City coordinate with BYU and UVU to deliver these messages to the student community. Partnering with UDOT's annual Road Respect media campaign may also be beneficial.

Messages can focus on the following themes (and others that the City feels are relevant):

- » Safe bicycling skills and secure locking practices.
- » How to share the road (for both motorists and bicyclists).
- » Light and helmet use.
- » Bicyclist rights and responsibilities.



◀ Bicycle light campaigns educate people about the importance of being seen at night

7.1.11 Bicycle Light Campaign

Purpose	Encourage and enforce the use of bike lights
Target Audience	College age population and students, general public
Primary Agency	Police Department
Partners	Public Works, bicycle shops/retailers, Provo Bicycle Committee
Priority	Medium
Sample Programs	<p>Bicycle Transportation Alliance Bike Light Videos (Portland, OR): http://vimeo.com/19678357</p> <p>"See & Be Seen" Campaign (Portland, OR): http://www.portlandonline.com/transportation/index.cfm?&c=deibb&a=bebfjh</p>

Many bicyclists are unaware that a front headlight and rear light or reflectors are required by state law or they simply do not purchase lights. Research shows that bicyclists who do not use lights at night are at much greater risk of being involved in bike-car crashes.

The goal of a bike light campaign is to encourage light use through marketing, outreach, and on-the-spot installation of free or low-cost bike lights. This multi-pronged outreach effort should take place every fall as the days get shorter and students return to school. The police and volunteers could lead the outreach efforts and the Bicycle Coordinator could coordinate the campaign. The bike light campaign should include the following elements:

- » Well-designed graphic ads throughout the City, perhaps to be included as part of a broader safety campaign.
- » Continued enforcement of bike light laws.
- » Discounted or free lights and reflective gear distributed at key locations (e.g. libraries, recreation centers, bike shops) at the beginning of the school year.



7.1.12 Maintenance Alert/Hotline

Purpose	Allow bicyclists and others to report hazardous street conditions within the City
Target Audience	Residents who bicycle
Primary Agency	Provo City Public Works
Partners	Provo Bicycle Committee
Priority	Low
Sample Programs	http://www.co.pierce.wa.us/pc/abtus/ourorg/pwu/roadops/Contact_Info.htm

Currently, people who ride bicycles in Provo have a couple of avenues to report incidents or request maintenance repairs on the bikeway system. The Bike Provo website (www.bikeprovo.com) provides a webpage that allows people to report all manner of incidents. The website moderators can use this information to inform the city of recurring problems or take action on important items.

The Provo City website provides an email address and phone number where residents can request pothole repairs, street sweeping, snow removal, or other maintenance items. This webpage, however, is located six levels deep into the city website and is not easy to find. A better practice would be to develop a hotline and online forms (or a mobile smart phone application) for the following items, then provide links to them from a City bicycling website:

- » Bike rack installation request.
- » Bicycle information request.
- » General maintenance request (e.g. pothole repair, dangerous grates, tree pruning).
- » Parking enforcement request.
- » Sweeping request.
- » Snow plowing request.

City administration has already discussed the topic of a smart phone application to handle other reporting needs. Such an application could encompass the items listed above and give residents a one-stop-shop for reporting bicycle concerns in the same manner as other non-cycling issues.

7.1.13 Valet/Event Bike Parking

Purpose	Encourage bicycling by event attendees
Target Audience	General Public
Primary Agency	Bike Provo, Provo Bicycle Collective
Partners	Mayor, City Council, Downtown Provo, Inc
Priority	Low
Sample Programs	Salt Lake City Bicycle Collective: www.slcbikecollective.org

Events bring lots of people and traffic into the City. Whether it is religious devotionals, athletic events, or community events, Provo is a regional trip attractor. The Provo Bicycle Committee and other groups may be able to provide volunteer and administrative support for bicycle parking at such events. The City can encourage bicycle trips to many of the popular events by advertising and providing event bike parking. Valet parking has already been provided for the Rooftop Concert Series and the Provo Farmer’s Market each Saturday when it is in operation.



« Bike valets encourage people to bicycle to popular city events



7.2 Existing Programs

Provo City has a good foundation of bicycle programs available to the community. A few of these programs can be revised to complement the recommended programs and capitalize on the efforts of public agencies and private citizens.

7.2.1 Bicycle Licensing

Provo City currently has a bike licensing program. The Provo Bicycle Committee promotes this during its bike rodeos and other outreach efforts. Bicycle licensing municipal code and programs were common in the 1970s and 1980s, but since then most municipalities have found that the administrative costs are not offset by the revenue gained in licensing fees.

Recommendations:

- » Discontinue bicycle licensing and associated programs (e.g. fees, inspections, renewals, and transfer of ownership processes).
- » For security and tracking measures, the City could promote and encourage the use of private bicycle registration programs (e.g. Boomerangit) and educate the Police Department about where to find those programs so that they can reunite lost or stolen bicycles with their owners.

Rationale: Removing the bicycle licensing program is consistent with current best practices observed in other cities, is cost effective, and allows the City to focus attention on other programs and initiatives that have greater potential to expand bicycling in Provo.

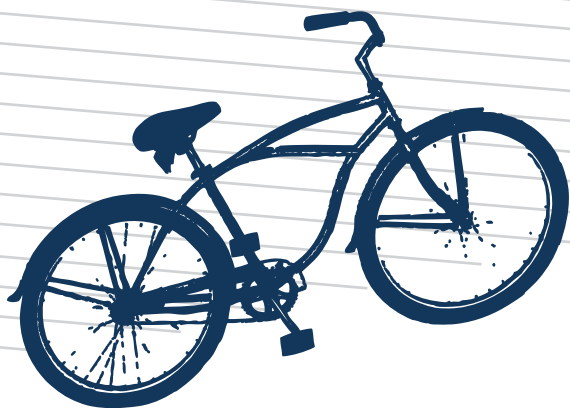
7.2.2 Bicycle Safety Rodeos

The Provo Bicycle Committee hosts a variety of activities throughout the year, including Bicycle Safety Rodeos. These rodeos focus on teaching participants the basics of traffic safety and rules of the road. The Provo Police Department is an active participant in these Bike Rodeos.

Recommendation:

- » Involve the Provo Fire Department in Bike Rodeos to improve curriculum as well as increase City presence and participation.

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8 Funding Sources

Funding for bicycle and pedestrian programs and infrastructure is administered at all levels of government. Summarized here are Federal, State, and local funds that can be used for bicycle and pedestrian infrastructure and programs. Each section provides information on the purpose and eligibility requirements along with direction to additional information where it is available.

This section discusses:

- » Federally Administered Funding
- » State Administered Funding
- » Local Funding
- » Other Sources





◀◀ Marked shared roadways help both drivers and bicyclists understand where bicyclists should ride within the shared lane space

8.1 Federally Administered Funding

In July 2012, the newest transportation authorization bill was signed into law. Moving Ahead for Progress in the 21st Century (MAP-21) came about after a series of extensions of the previous Federal transportation bill and took effect on October 1, 2012. While the legislation does make significant changes to how programs are packaged and funded and how funds are distributed, it is not expected that program eligibility and funding requirements at the local level will change substantially. Because the MAP-21 legislation is very new and many of the details and “rule making” have yet to be determined, it is likely that some of the individual components of these programs will change in the near future. It is in American Fork’s best interest to ensure that when applying for Federal, State, or regional grants, they are operating under the most recent information, regulations, and requirements.

State Departments of Transportation (UDOT in Utah) and Metropolitan Planning Organizations (MPOs) administer MAP-21 funding. In Utah County, the MPO is MAG. Most of these funding programs emphasize reliance on multiple transportation modes, reducing auto trips, and providing intermodal connections. Local match requirements are 6.77% or 20% depending on the given program. Many of the specific programs are discussed in the State Administered Funding section later in this chapter since funds are typically passed through to DOTs or MPOs.

8.1.1 Rivers, Trails, & Conservation Assistance Program

The Rivers, Trails, and Conservation Assistance Program (RTCA) of the US Department of the Interior National Park Service supports community-led natural resource conservation and outdoor recreation projects. The mission of the RTCA program is to implement the natural resource conservation and outdoor recreation mission of the National Park Service. RTCA works in urban, rural, and suburban communities with the goal of helping communities achieve on-the-ground conservation success for their projects.



The RTCA program provides technical assistance to its project partners by:

- » Building partner relationships.
- » Helping partners define goals through consensus.
- » Developing conceptual, strategic, and workable project plans.
- » Helping the public participate in defining community goals.
- » Identifying potential sources of funding for project implementation.
- » Teaching “hands-on” conservation and other technical skills necessary to successfully realize conservation and outdoor recreation projects.

RTCA works with nonprofit organizations, community groups, tribes or tribal governments, and local, State, or Federal government agencies. Assistance is provided for one year and may be renewed for a second year, if warranted. Project applications are due annually on August 1st. Prospective applicants should contact their local RTCA office at least two weeks prior to applying for assistance to start the dialogue about a potential project application. RTCA does not award monetary grants or loans. Instead, they supply a staff person with experience in community-based outdoor recreation and conservation to work with partners.

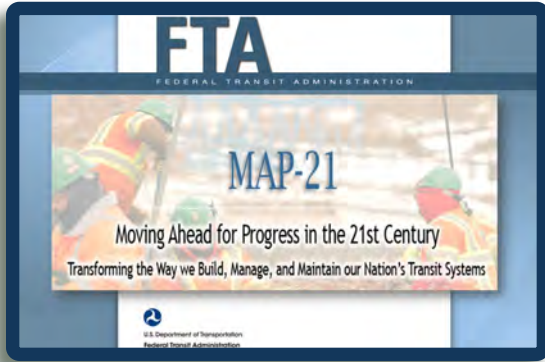
Online resources: www.nps.gov/rtca

Utah RTCA Contact:

Marcy DeMillion
801-741-1012, ext 125
324 South State Street, Suite 200
Salt Lake City, Utah 84111

»» The RTCA program can be a valuable planning resource for communities





◀◀ MAP-21 is the more recent Federal transportation bill and provides multiple avenues for funding of bicycle projects

8.1.2 Congestion Mitigation Air Quality Program

The Congestion Mitigation Air Quality (CMAQ) program is jointly administered by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA). This program supports surface transportation projects and other related efforts that contribute to air quality improvements and provide congestion relief. It was continued under MAP-21 and project sponsors can apply for funding for a variety of transportation projects that help attain or maintain the National Ambient Air Quality Standards (NAAQS) as set by the Environmental Protection Agency (EPA) as a requirement of the Clean Air Act. Eligible activities include projects that shift traffic demand to non-peak hours or other transportation modes, increase vehicle occupancy rates, or otherwise reduce demand.

Online resources: www.fhwa.dot.gov/map21/cmaq.cfm

8.2 State Administered Funding

8.2.1 Transportation Alternatives Program

The Transportation Alternatives Program (TAP) generally replaces in MAP-21 the Transportation Enhancement Program authorized under the previous Federal transportation bill. Funding amounts at the state level are equal to 2% of the total of all authorized Federal-aid highway and highway research funds. Each state must use a specific portion of these funds for recreational trails projects (as discussed later in this chapter). Among the eligible activities are:

- » Construction, planning, and design of on-road and off-road trail facilities for pedestrians, bicyclists, and other non-motorized forms of transportation, including sidewalks, bicycle infrastructure, and pedestrian and bicycle signals.
- » Construction, planning, and design of infrastructure-related projects and systems that will provide safe routes for non-drivers, including children, older adults, and individuals with disabilities to access daily needs.
- » Conversion and use of abandoned railroad corridors for trails for pedestrians, bicyclists, or other non-motorized transportation users.



8.2.2 Safe Routes to School

The SRTS program was also continued under MAP-21, although there is no longer a dedicated funding component solely devoted to SRTS (TAP funds are now used to fund SRTS efforts). UDOT provides Utah schools with walking and biking safety resources through the SRTS program. Federal SRTS funding can be used for two purposes: (1) educating children about how to walk and bike safely to school and (2) constructing infrastructure improvements such as sidewalks that increase the safety of children walking and biking to school. Prior to MAP-21, SRTS funds did not require a local match. A 6.77% match is now required.

Online resources: udot.utah.gov/srts

UDOT Contact:

Cherissa Wood
Utah Safe Routes to School Coordinator
cwood@utah.gov
801-965-4486

8.2.3 Federal Highway Administration Rec Trails Program

The Recreational Trails Program (RTP) was also continued under MAP-21 although it now contains an option for governors to opt out. If they do not, the RTP continues to function just like it did under the previous Federal transportation bill. It provides funds to states to develop and maintain recreational trails and trail-related facilities for both non-motorized and motorized recreational users. Federal transportation funds benefit recreation including hiking, bicycling, in-line skating, equestrian use, cross-country skiing, snowmobiling, off-road motorcycling, all-terrain vehicle riding, and four-wheel driving.

» The Division of State Parks and Recreation coordinates the RTP



The Combined Trails Advisory Council (a Utah-specific body) reviews the funding requests and provides funding recommendations. The Council generally meets in August to finalize the award list. The finalized list of projects to be funded under RTP is submitted to the Director of the Division of State Parks and Recreation for administrative approval and funding. Projects authorized for funding are placed on UDOT's Statewide Transportation Improvement Program (STIP).

Online resources: www.fhwa.dot.gov/environment/recreational_trails/

Utah's Recreational Trails Program contact:

Chris Haller
801-349-0487
chrishaller@utah.gov
Utah State Parks
1594 West North Temple, Suite 116
Salt Lake City, Utah 84116

8.2.4 Land & Water Conservation Fund

The National Park Service provides oversight for The Land and Water Conservation Fund (LWCF) Act which was established by Congress in 1965 to provide funds for the acquisition and/or development of public outdoor recreation areas. These facilities can include, but are not limited to ball fields, sports courts, spray parks, golf courses, public restrooms, swimming pools, skate parks, and walking trails. Land acquisitions for public outdoor recreation are also LWCF-eligible. The program is administered locally by Utah State Parks. Any site or facility that is purchased, developed, or improved with funding from the LWCF is protected in perpetuity as a public outdoor recreation area. LWCF funding requires a 50% match from the applicant. The grant recipient must be able to fund 100% of the project up front and is reimbursed periodically by LWCF up to 50% of the costs. Eligible recipients include local governments, tribal governments, and state agencies.

Online resources: stateparks.utah.gov/grants/land-water and www.nps.gov/lwcf/

Utah's Land & Water Conservancy Fund contact:

Susan Zarekarizi
801-538-7496
susanzarekarizi@utah.gov
Utah State Parks
1594 West North Temple, Suite 116
Salt Lake City, Utah 84116



8.2.5 Community Development Block Grants

Through the US Department of Housing and Urban Development (HUD), the Community Development Block Grant (CDBG) program provides annual grants on a formula basis to entitled cities, urban counties, and states to develop viable urban communities by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for low- and moderate-income persons. Eligible activities include, but are not limited to, acquisition of property for public purposes; construction or reconstruction of streets, water and sewer facilities, neighborhood centers, recreation facilities, and other public works; planning activities; and assistance to nonprofit entities for community development. HUD distributes funds to each State based on a statutory formula which takes into account population, poverty, incidence of overcrowded housing and age of housing. All funds (other than administrations and the technical assistance set-aside) are distributed by states to local government units.

Online resources: http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/stateadmin

CDBG Program contact:

Leroy P. Brown
Region 8
Denver Regional Office
1670 Broadway
Denver, Colorado 80202-4801
303-672-5076 ext 1326
Leroy.brown@hud.gov

8.2.6 Utah Department of Transportation – Long Range Plan

As part of the 2011-2040 Long Range Plan (LRP), which is a thirty-year plan for state transportation facilities in urban and rural areas, bicycle improvement projects are listed as part of capacity projects along State highways. American Fork and UDOT can continue to work together on an ongoing basis to identify opportunities for implementation of bicycle and pedestrian facilities as part of capacity improvements.

8.2.7 Utah Department of Transportation – Maintenance Program

UDOT carries out a number of annual road resurfacing projects that are geared at maintenance. There may be opportunities for road re-striping to be completed as part of regular road maintenance. This will require coordination between the City and UDOT to ensure that the pavement marking design is safe for cyclists and drivers.

8.3 Local Funding

Local funding sources are generally administered by MPOs and other regional agencies although counties or cities may administer some funding sources. Federal, state, and local revenue streams support these funding sources.

8.3.1 General Fund

General Fund expenditures are often used to pay for maintenance expenses and limited capital improvement projects. Projects identified for reconstruction or repaving as part of the Capital Facilities Plan list should also implement recommendations for bicycle and pedestrian improvements in order to reduce additional cost.

8.3.2 Special Improvement Districts

Special Improvement Districts (SIDs) are most often used by cities to construct localized projects such as streets, sidewalks, or bikeways. Through the SID process, the costs of local improvements are generally spread out among a group of property owners within a specified area. The cost can be allocated based on property frontage or other methods such as traffic trip generation.

8.3.3 Business Improvement Area

Pedestrian and bicycle improvements can often be included as part of larger efforts aimed at business improvement and retail district beautification. Business Improvement Areas (BIAs) collect levies on business in order to fund area-wide improvements that benefit business and improve access for customers. These districts may include provisions for pedestrian and bicycle improvements, such as wide sidewalks, landscaping, and ADA compliance.



Much of Provo's existing bicycle network has been funded by the City itself



8.3.4 Local Bond Measures

American Fork could issue bonds to fund bicycle and pedestrian improvements. This would spread the cost of the improvements over the life of the bonds. Certain types of bonds would require voter approval. The debt would have to be retired, so funding for repayment on the bond and the interest would be required.

8.3.5 Tax Increment Financing/Urban Renewal Funds

Tax Increment Financing (TIF) is a tool for using future tax revenue to finance the current improvements that will create those gains. When a public project such as a shared-use path is constructed, surrounding property values generally increase and encourage surrounding development or redevelopment. The increased tax revenues are then dedicated to finance the debt created by the original public improvement project. TIF typically occurs within designated Urban Renewal Areas (URA) that meet certain economic criteria and are approved by a local governing body. To be eligible for this financing, a project (or a portion of it) must be located within the URA.

8.3.6 Developer Impact Fees

American Fork could institute developer impact fees to fund bicycle and pedestrian improvements. Developer impact fees are typically tied to trip generation rates and traffic impacts produced by a proposed project. A developer may reduce the number of trips (and hence impacts and cost) by paying for on- and off-site bikeway improvements that will encourage residents to bicycle rather than drive. Establishing a clear nexus or connection between the impact fee and the project's impacts is critical.

8.4 Other Sources

8.4.1 Community Action for a Renewed Environment

The Community Action for a Renewed Environment (CARE) program helps communities address multiple sources of toxic pollutants in their environment. CARE supports communities by providing tools, technical support, and funding to enable them to use other voluntary programs of the community's choice to reduce emissions and exposures. The goals of the CARE Program are to reduce exposure to toxic pollutants through collaborative action at the local level; help communities understand all potential sources of exposure to toxic pollutants; work with communities to set priorities for risk-reduction activities; and create self-sustaining, community-based partnerships that will continue to improve the local environment. Eligible organizations include non-profit organizations, federally-recognized Indian tribal governments, Native American organizations, local governments, colleges, and universities.

CARE offers two different types of grants: Level 1 and Level 2. Level 1 grants help communities to join together to form a broad-based partnership dedicated to reducing toxic pollutants and environmental risks in their local environment. Level 2 grants help communities to identify problems and solutions. They are intended for communities that already have established broad-based collaborative partnerships and have completed environmental assessments.

Online resources: <http://www.epa.gov/care/>

8.4.2 Bikes Belong Coalition

The Bikes Belong Coalition accepts grant applications from organizations and agencies that are committed to putting more people on bicycles more often. Fundable projects include paved paths, lanes, and rail-trails as well as mountain bike trails, bike parks, BMX facilities, and large-scale bicycle advocacy initiatives. The Bikes Belong Grants Program has two application categories: facility and advocacy. For the facility category, Bikes Belong will accept applications from non-profit organizations whose missions are bicycle and/or trail specific. They also accept applications from public agencies and departments at the national, State, regional, and local levels. However, Bikes Belong encourages these municipalities to align with a local bicycle advocacy group that will help develop and advance the project or program. A key goal of the Bikes Belong grants program is to support bicycling in as many places as possible.

Online Resources: www.bikesbelong.org

8.4.3 Private Foundations

Various private foundations provide funds for bicycling and walking infrastructure. Through research at the national Foundation Center, individuals and organizations can find funders, instructions, and grant applications to help fund projects.

Online Resources: www.foundationcenter.org



◀ The Bikes Belong Coalition assists communities with funding bicycle projects

Provo Bicycle Facilities Master Plan

Appendix A: Bicycle Facilities Design Guide



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Design Needs of Bicyclists

The purpose of this section is to provide the facility designer with an understanding of how bicyclists operate and how their bicycle influences that operation. Bicyclists, by nature, are much more affected by poor facility design, construction and maintenance than motor vehicle drivers. Bicyclists lack the protection from the elements and roadway hazards provided by an automobile's structure and safety features. By understanding the unique characteristics and needs of bicyclists, the facility designer can provide the highest quality facilities and minimize risk to the bicyclists using them.

Bicycle as a Design Vehicle

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

Figure 2-1 illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. The bicyclist requires clear space to operate within a facility; this is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer five feet or more operating width, although four feet is minimally acceptable.

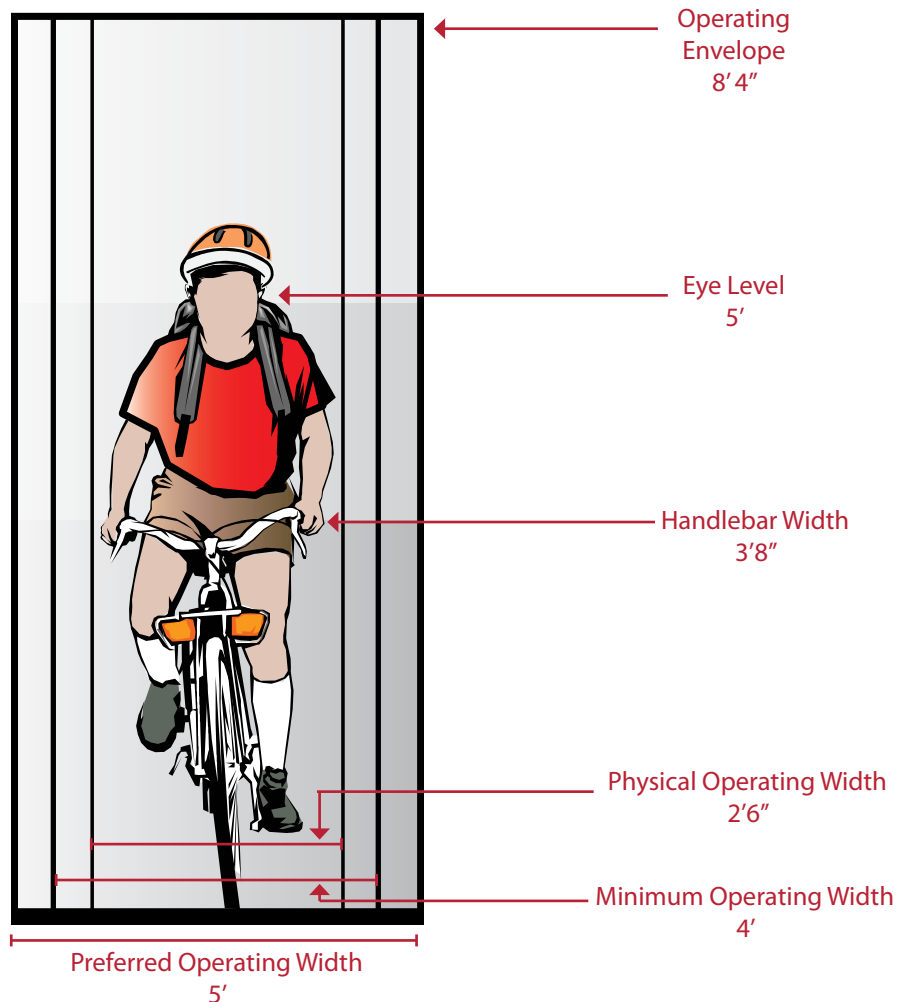


Figure 2-1 Standard Bicycle Rider Dimensions

Source: AASHTO Guide for the Development of Bicycle Facilities, 3rd Edition

In addition to the design dimensions of a typical bicycle, there are many other commonly used pedal-driven cycles and accessories to consider when planning and designing bicycle facilities. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories. Figure 2-2 and Table 2-1 summarize the typical dimensions for bicycle types.

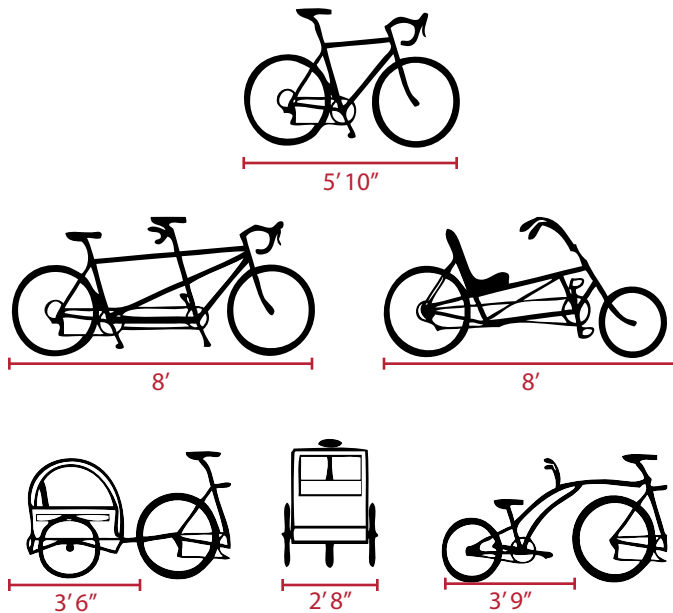


Figure 2-2 Bicycle as Design Vehicle - Typical Dimensions

Source: AASHTO Guide for the Development of Bicycle Facilities, 3rd Edition *AASHTO does not provide typical dimensions for tricycles.

Design Speed Expectations

The expected speed that different types of bicyclists can maintain under various conditions can also influence the design of facilities such as shared use paths. Table 2-2 provides typical bicyclist speeds for a variety of conditions.

The skill level of the bicyclist also provides dramatic variance on expected speeds and behavior. There are several systems of classification currently used within the bicycle planning and engineering professions. These classifications can be helpful in understanding the characteristics and infrastructure preferences of different bicyclists.

It should be noted that these classifications may change in type or proportion over time as infrastructure and culture evolve. Often times an instructional course can change a less confident bicyclist in to one that can comfortably and safely share the roadway with vehicular traffic. Bicycle infrastructure should be planned and designed to accommodate as many user types as possible with the consideration of separate or parallel facilities to provide a comfortable experience for the greatest number of bicyclists.

Table 2-1 Bicycle as Design Vehicle - Typical Dimensions

Bicycle Type	Feature	Typical Dimensions
Upright Adult Bicyclist	Physical width	2 ft 6 in
	Operating width (Minimum)	4 ft
	Operating width (Preferred)	5 ft
	Physical length	5 ft 10 in
	Physical height of handlebars	3 ft 8 in
	Operating height	8 ft 4 in
	Eye height	5 ft
	Vertical clearance to obstructions (tunnel height, lighting, etc)	10 ft
	Approximate center of gravity	2 ft 9 in - 3 ft 4 in
Recumbent Bicyclist	Physical length	8 ft
	Eye height	3 ft 10 in
Tandem Bicyclist	Physical length	8 ft
Bicyclist with child trailer	Physical length	10 ft
	Physical width	2 ft 6 in

Table 2-2 Bicycle as Design Vehicle - Design Speed Expectations

Bicycle Type	Feature	Typical Speed
Upright Adult Bicyclist	Paved level surfacing	15 mph
	Crossing Intersections	10 mph
	Downhill	30 mph
	Uphill	5-12 mph
Recumbent Bicyclist	Paved level surfacing	18 mph

*Tandem bicycles and bicyclists with trailers have typical speeds equal to or less than upright adult bicyclists.

Types of Bicyclists

It is important to consider bicyclists of all skill levels when creating a non-motorized plan or project. Bicyclist skill level greatly influences expected speeds and behavior, both in separated bikeways and on shared roadways. Bicycle infrastructure should accommodate as many user types as possible, with decisions for separate or parallel facilities based on providing a comfortable experience for the greatest number of bicyclists.

The bicycle planning and engineering professions currently use several systems to classify the population, which can assist in understanding the characteristics and infrastructure preferences of different bicyclists. The most conventional framework classifies the “design cyclist” as *Advanced, Basic, or Child*¹. A more detailed understanding of the US population as a whole is illustrated in Figure 2-3. Developed by planners in the City of Portland, OR² and supported by data collected nationally since 2005, this classification provides the following alternative categories to address ‘varying attitudes’ towards bicycling in the US:

- **Strong and Fearless** (Very low percentage of population) – Characterized by bicyclists that will typically ride anywhere regardless of roadway conditions or weather. These bicyclists can ride faster than other user types, prefer direct routes and will typically choose roadway connections -- even if shared with vehicles -- over separate bicycle facilities such as multi-use trails.
- **Enthusied and Confident** (5-10% of population) -This user group encompasses the ‘intermediate’ bicyclists who are fairly comfortable riding on all types of bicycle facilities but usually choose low traffic streets or multi-use trails when available. These bicyclists may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of bicyclists including commuters, recreationalists, racers, and utilitarian bicyclists.
- **Interested but Concerned** (approximately 60% of population) – This user type makes up the bulk of the cycling population and represents bicyclists who typically only ride a bicycle on low traffic streets or multi-use trails under favorable conditions and weather. These bicyclists perceive significant barriers towards increased use of cycling, specifically traffic and other safety issues. These bicyclists may become “Enthusied & Confident” with encouragement, education and experience.
- **No Way, No How** (approximately 30% of population) – Persons in this category are not bicyclists, and perceive severe safety issues with riding in traffic. Some people in this group may eventually give cycling a second look and may progress to the user types above. A significant portion of these people will not ride a bicycle under any circumstances.

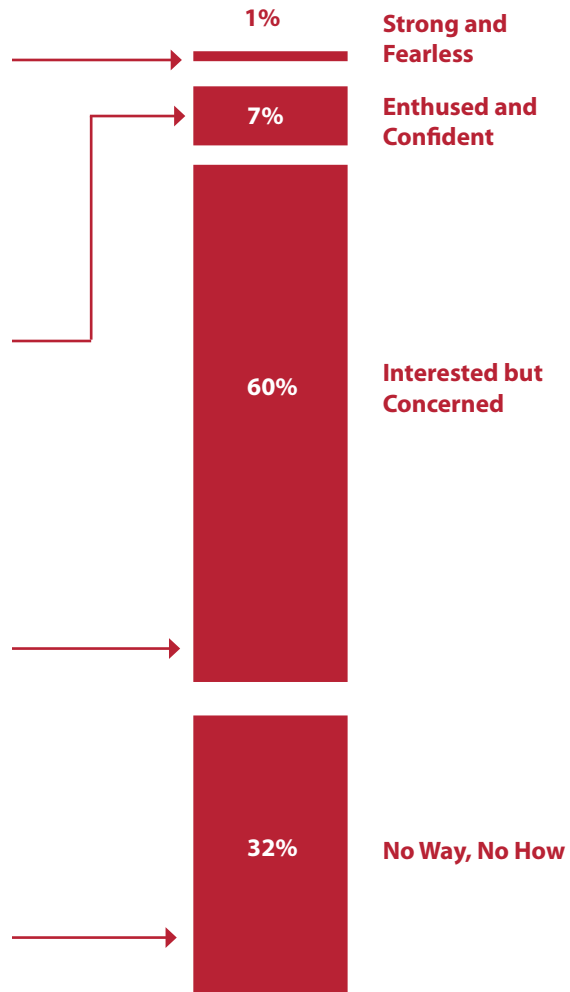


Figure 2-3 Typical distribution of bicyclist types

1 *Selecting Roadway Design Treatments to Accommodate Bicycles. (1994). Publication No. FHWA-RD-92-073*
 2 *Four Types of Cyclists. (2009). Roger Geller, City of Portland Bureau of Transportation. <http://www.portlandonline.com/transportation/index.cfm?&a=237507>*

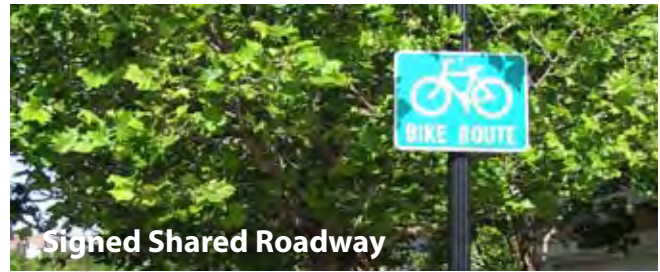
Shared Roadways

Shared roadways mix bicyclists with motor vehicles within the same roadway space. They are typically used on roads with low speeds and traffic volumes, however can be used on higher volume roads with wide outside lanes or with shoulders. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

Shared roadways can employ a large variety of treatments from simple signage and shared lane markings to complex treatments including directional signage, traffic diverters, chicanes, chokers, and /or other traffic calming devices to reduce vehicle speeds or volumes.

Bicycle Boulevards

A special class of shared roadways designed for a broad spectrum of bicyclists are called bicycle boulevards. Bicycle boulevards are low-volume local streets where motorists and bicyclists share the travel lane. Treatments for bicycle boulevards are selected as necessary to create appropriate automobile volumes and speeds, and to provide safe crossing opportunities of busy streets.



Signed Shared Roadway



Marked Shared Roadway



Shared Roadways with Diagonal Parking



Bicycle Boulevards

This Section Includes:

- Signed Shared Roadway
- Marked Shared Roadway
- Shared Roadways Adjacent to Diagonal Parking
- Bicycle Boulevards

Shared Roadways

Signed Shared Roadway

Signed Shared Roadway

Guidance

Lane width varies depending on roadway configuration.

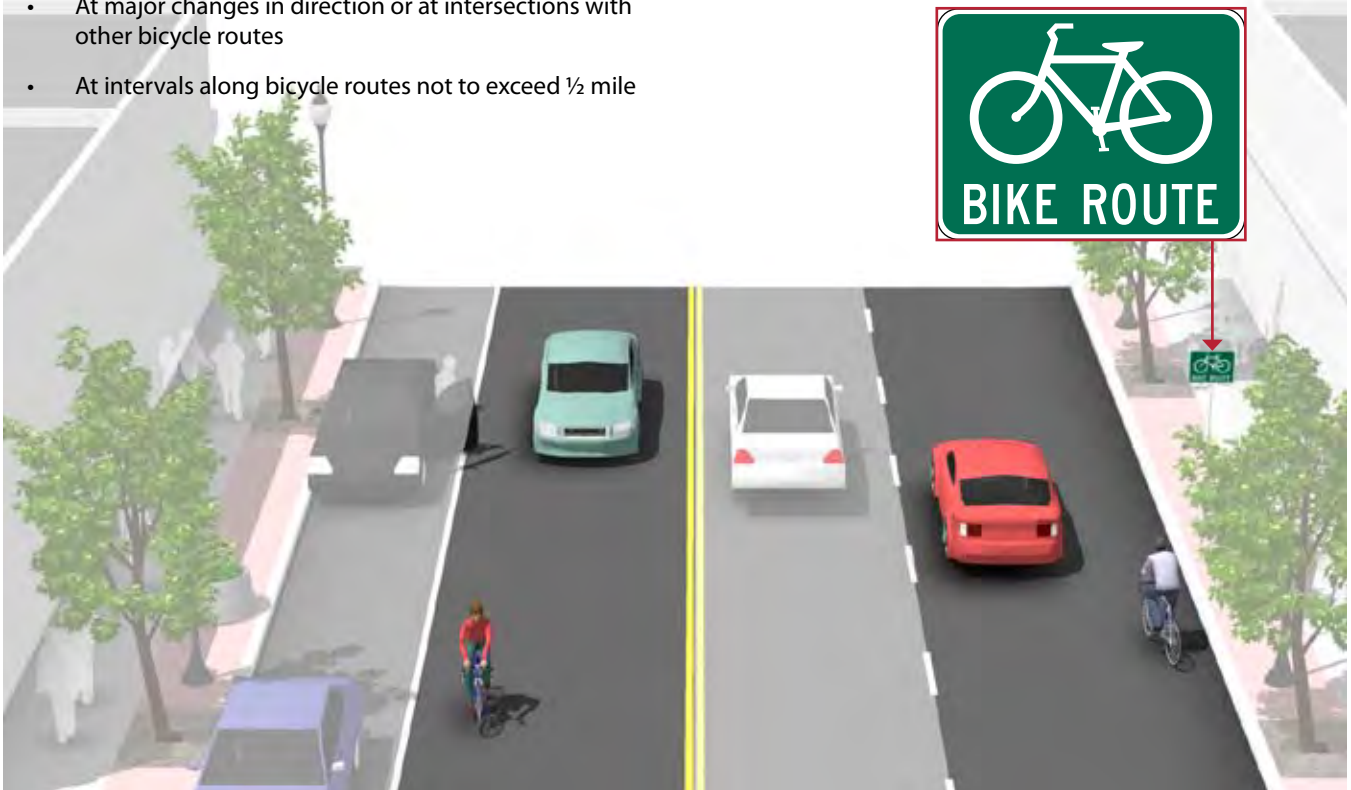
Bicycle Route signage (D11-1) should be applied at intervals frequent enough to keep bicyclists informed of changes in route direction and to remind motorists of the presence of bicyclists. Commonly, this includes placement at:

- Beginning or end of Bicycle Route
- At major changes in direction or at intersections with other bicycle routes
- At intervals along bicycle routes not to exceed ½ mile

Description

Signed Shared Roadways are facilities shared with motor vehicles. They are typically used on roads with low speeds and traffic volumes, however can be used on higher volume roads with wide outside lanes or with shoulders. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

MUTCD D11-1
(optional)



Discussion

Signed Shared Roadways serve either to provide continuity to other bicycle facilities (usually bike lanes) or designate preferred routes through high-demand corridors.

This configuration differs from a **bicycle boulevard** due to a lack of traffic calming, wayfinding, pavement markings and other enhancements designed to provide a high level of comfort for a broad spectrum of users.

Additional References and Guidelines

AASHTO. (1999). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual of Uniform Traffic Control Devices.

Materials and Maintenance

Maintenance needs for bicycle wayfinding signs are similar to other signs, and will need periodic replacement due to wear.

Marked Shared Roadway

Guidance

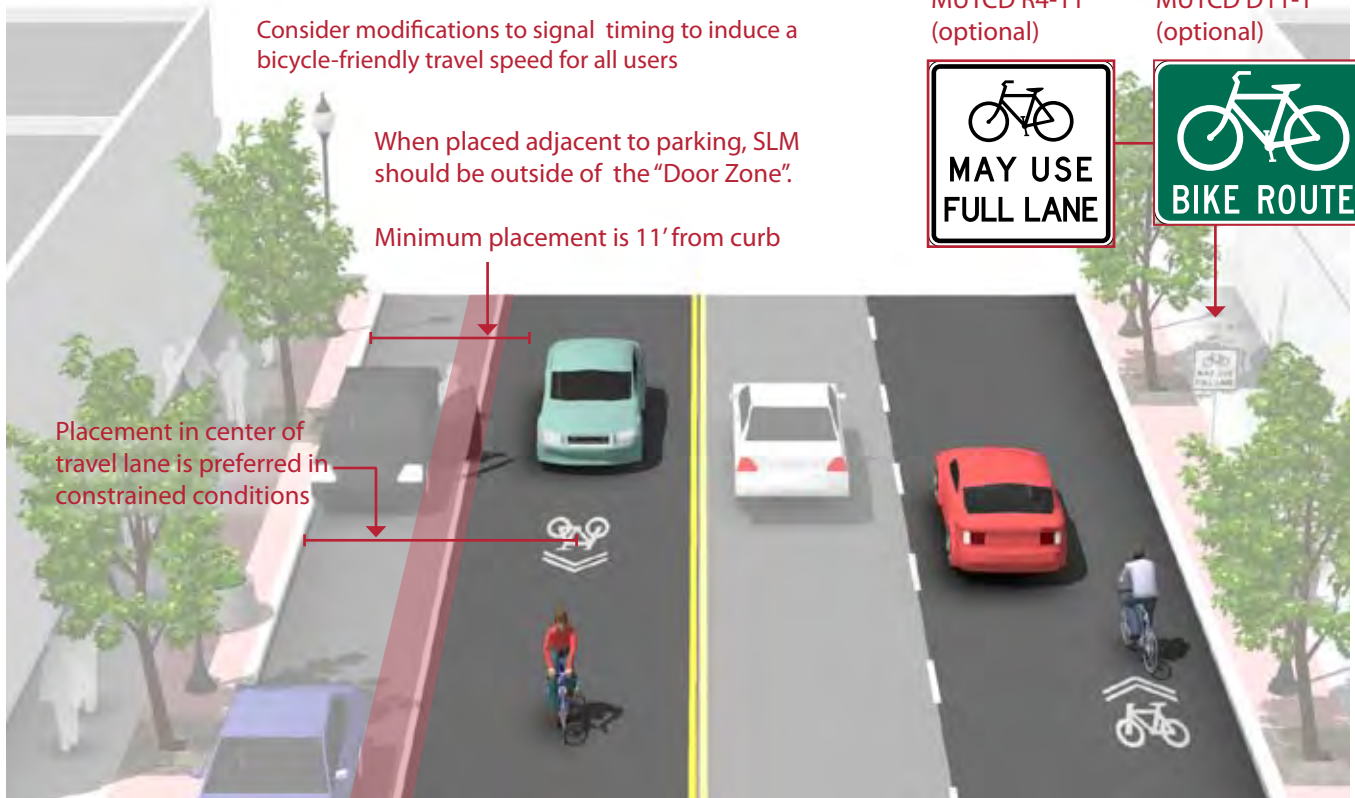
- Preferred placement in constrained conditions is in the center of the travel lane to minimize wear and promote single file travel.
- Minimum placement of SLM marking centerline is 11 feet from edge of curb where on-street parking is present, 4 feet from edge of curb with no parking. If parking lane is wider than 7.5 feet the SLM should be moved further out accordingly.

Description

A marked shared roadway is a general purpose travel lane marked with shared lane markings (SLM) used to encourage bicycle travel and proper positioning within the lane.

In constrained conditions, the SLMs are placed to discourage unsafe passing by motor vehicles. On a wide outside lane, the SLMs can be used to promote bicycle travel next to (to the right of) motor vehicles.

Under all conditions, SLMs should be placed outside of the door zone of parked cars.



Discussion

Bike lanes should be considered on roadways with outside travel lanes wider than 15 feet, or where other lane narrowing or removal strategies may provide adequate road space. Shared Lane Markings shall not be used on **shoulders**, in designated **bicycle lanes**, or to designate **bicycle detection** at signalized intersections. (MUTCD 9C.07 03)

This configuration differs from a **bicycle boulevard** due to a lack of traffic calming, wayfinding, and other enhancements designed to provide a high level of comfort for a broad spectrum of users.

Additional References and Guidelines

- AASHTO. (1999). Guide for the Development of Bicycle Facilities.
- FHWA. (2009). Manual of Uniform Traffic Control Devices.
- NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Placing the SLM markings between vehicle tire tracks will increase the life of the markings and minimize the long-term cost of the treatment.

Shared Roadways

Shared Lane Markings

Shared Roadway Adjacent to Diagonal Parking

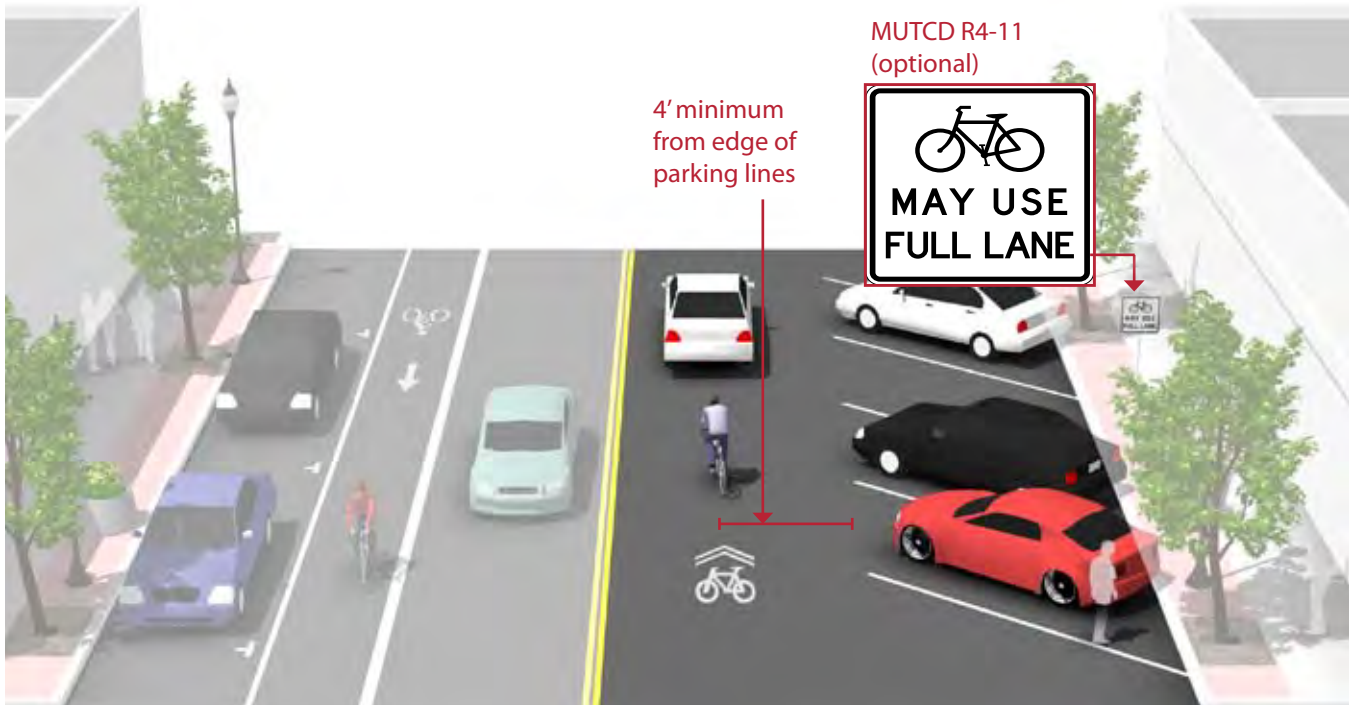
Guidance

- Preferred placement in constrained conditions is in the center of the travel lane to minimize wear and promote single file travel.
- Minimum placement of SLM marking centerline is 4 feet from the edge of parking lines.

Description

In certain areas with high parking demand such as urban commercial areas diagonal parking can be used to increase parking supply.

Back-in diagonal parking improves sight distance between drivers and bicyclists when compared to conventional head-in diagonal parking. Back-in diagonal parking has other benefits to vehicles including: loading and unloading of the trunk occurs at the curb rather than in the street, passengers (including children) are directed by open doors towards the curb, there is also no door conflict with bicyclists. While there may be a learning curve for some drivers, using back-in diagonal parking is typically an easier maneuver than conventional parallel parking.



Discussion

Conventional front-in diagonal parking is not compatible or recommended in conjunction with high levels of bicycle traffic as drivers backing out of conventional diagonal parking have poor visibility of approaching bicyclists.

Additional References and Guidelines

There is no currently adopted Federal or State guidance for this treatment.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates.

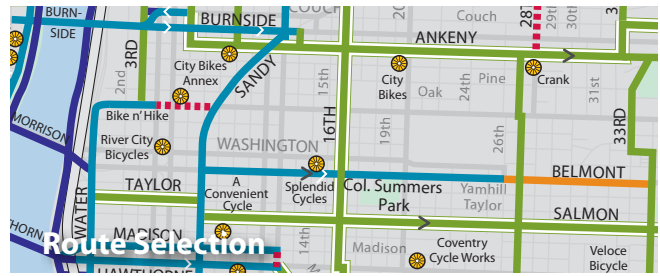
Bicycle Boulevards

Bicycle boulevards are a special class of shared roadways designed to accommodate a broad spectrum of bicyclists.

Also known as neighborhood greenways, bicycle boulevards are low-volume, low-speed streets that have been optimized for bicycle travel using treatments such as signage, pavement markings, traffic calming and/or traffic reduction, and intersection modifications. These treatments allow through-movements for bicyclists while discouraging similar through-trips by non-local motorized traffic.

Jurisdictions throughout the country use a wide variety of strategies to determine where specific treatments are applied. While no federal guidelines exist, several best practices have emerged for the development of bicycle boulevards. At a minimum, all bicycle boulevards should include distinctive pavement markings and wayfinding signs. They can also use combinations of traffic calming, traffic diversion, and intersection treatments to improve the bicycling environment. The appropriate level of treatment to apply is dependent on roadway conditions, particularly motor vehicle speeds and volumes.

Traffic conditions on bicycle boulevards should be monitored to provide guidance on when and where treatments should be implemented. When motor vehicle speeds and volumes or bicyclist delay exceed the preferred limits, additional treatments should be considered on the bicycle boulevard.



This Section Includes:

- Route Selection
- Basic Treatments
- Traffic Calming
- Traffic Diversion
- Intersection Treatments

Bicycle Boulevards

Route Selection

Guidance

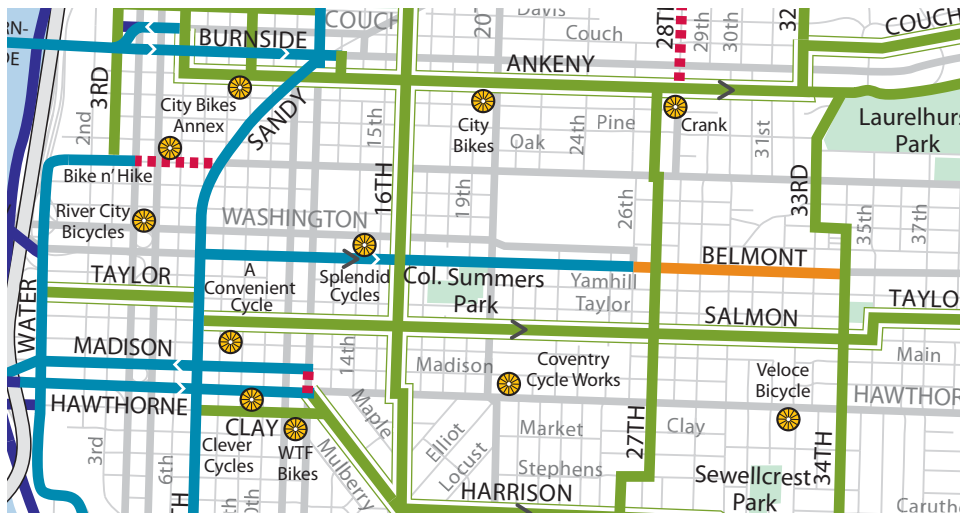
- Streets signed at 25 mph or less to improve the bicycling environment and decrease risk and severity of crashes
- Traffic volumes limited to 3,000 vehicles per day (ideally less than 1,500) to minimize passing events and potential conflicts with motor vehicles
- Streets that parallel major streets can discourage non-local motor vehicle traffic without significantly impacting motorists
- Streets where a relatively continuous route for bicyclists exists and/or where treatments can provide wayfinding and improve crossing opportunities at offset intersections
- Streets where bicyclists have right-of-way at intersections or where right-of-way is possible to assign to bicyclists

Description

Bicycle boulevards should be developed on streets that improve connectivity to key destinations and provide a direct route for bicyclists. Local streets with existing traffic calming, traffic diversions, or signalized crossings of major streets are good opportunities, as they tend to be existing bicycle routes and have low motor vehicle speeds and volumes. Other streets where residents have expressed a desire for traffic calming are also good candidates.

Bicycle boulevards parallel to commercial streets improve access for 'interested but concerned' bicyclists and complement bike lanes on major roadways.

In Portland, OR, the bicycle network includes a high density of neighborhood greenways parallel to streets with bike lanes.



LEGEND

- MULTI-USE PATH
Closed to motor vehicles
- - - MULTI-USE PATH (unpaved)
- BIKE BOULEVARDS / NEIGHBORHOOD GREEN STREETS
pavement markings & directional signs to guide cyclists
- - - SHARED ROADWAY
on lower traffic street
- BIKE LANE
or wide shoulder, usually on higher traffic streets
- SHARED ROADWAY WITH WIDER OUTSIDE LANE
on moderate and higher traffic street

Discussion

Bicycle boulevards should form a continuous network of streets or off-street facilities that accommodate bicyclists who are less willing to ride on streets with motorized traffic. Most bicycle boulevards are located on residential streets, though they can also be on commercial or industrial streets. Due to the presence of trucks and commercial vehicles, as well as the need to maintain good traffic flow and retain motor vehicle parking, bicycle boulevards on commercial or industrial streets can have higher automobile speeds and volumes than would be desired on neighborhood streets. Vertical traffic calming can minimize impacts to large vehicles and parking.

Additional References and Guidelines

- Alta Planning + Design and IBPI. (2009). Bicycle Boulevard Planning and Design Handbook.
- City of Berkeley. (2000). Bicycle Boulevard Design Tools and Guidelines.
- City of Emeryville. (2011). Bicycle Boulevard Treatments.

Materials and Maintenance

Repaving, street sweeping, and other maintenance should occur with higher frequency than on other local streets.

Bicycle Boulevards

Basic Treatments

Description

Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard. Together, they visibly designate a roadway to both bicyclists and motorists. Signs, and in some cases pavement markings, provide wayfinding to help bicyclists remain on the designated route.

Guidance

Pavement Markings

Place symbols every 250-800 feet along a linear corridor, as well as after every intersection.

On narrow streets where an automobile cannot pass a bicyclist within one lane of traffic, place stencils in the center of the travel lane.

See **marked shared roadway** guidance for additional information on the use of shared lane markings.

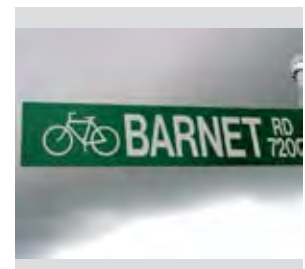
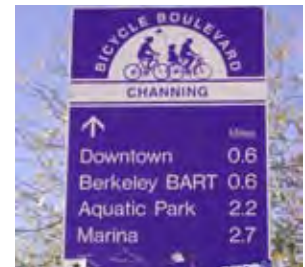
A bicycle symbol can be placed on a standard road sign, along with distinctive coloration.

Signs

See **wayfinding signage** for guidance on developing bicycle wayfinding signage. Some cities have developed unique logos or colors for wayfinding signs that help brand their bicycle boulevards.

Be consistent in content, design, and intent; colors reserved by the Manual on Uniform Traffic Devices (MUTCD) for regulatory and warning road signs are not recommended.

Signs can include information about intersecting bikeways and distance/time information to key destinations.



Discussion

Wayfinding signs displaying destinations, distances, and “riding time” can dispel common misperceptions about time and distance while increasing users’ comfort and accessibility to the bicycle boulevard network. Bicycle boulevards frequently include offset intersections or ‘jog’ onto another street. Signs and pavement markings can help bicyclists remain on the route. In addition, fewer businesses or services are located along local streets, and signs inform bicyclists of the direction to key destinations, including commercial districts, transit hubs, schools and universities, and other bikeways.

Additional References and Guidelines

- City of Milwaukie. (2009). Milwaukie Bicycle Wayfinding Signage Plan
- City of Oakland (2009). Design Guidelines for Bicycle Wayfinding Signage
- NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Pavement markings should be repainted and signs replaced as needed. Wayfinding signs should be regularly updated with new major destination and bicycle facilities.

Horizontal Traffic Calming

Description

Horizontal speed control measures are obstacles on the side of the travel lane, which cause motorists to slow down to navigate the travel feature or because the roadway narrows.

Horizontal speed control measures may reduce the design speed of a street, and they can be used with reduced speed limits to reinforce the expectation that motorists lower their speeds.

Guidance

- Maintain a minimum clear width of 20 feet or 28 feet with parking on both sides, with a constricted length of at least 20 feet in the direction of travel.
- Chicanes are a series of raised or delineated curb extensions, edge islands, or parking bays on alternating sides of a street forming an “S”-shaped curb, which reduce vehicle speeds by requiring motorists to shift laterally through narrowed travel lanes.
- Pinchpoints are curb extensions placed on both sides of the street, narrowing the travel lane and encouraging all road users to slow down. When placed at intersections, pinchpoints are known as chokers or neckdowns, and reduce curb radii, further reducing motor vehicle speeds.
- Traffic circles are raised or delineated islands placed at intersections that reduce vehicle speeds by narrowing turning radii and narrowing the travel lane. Traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles like fire trucks or school buses.



Temporary Curb Extension



Chicane



Choker or Neckdown



Pinchpoint with Bicycle Access

Discussion

Horizontal speed control measures should not infringe on bicycle space. Where possible, provide a bicycle route outside of the element to avoid bicyclists having to merge into traffic at a narrow pinch point. This technique can also improve drainage flow and reduce construction and maintenance costs.

Traffic calming can also deter motorists from driving on a street. Monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

Additional References and Guidelines

Alta Planning + Design and IBPI. (2009). Bicycle Boulevard Planning and Design Handbook.
 BikeSafe. (No Date). Bicycle countermeasure selection system.
 Ewing, Reid. (1999). Traffic Calming: State of the Practice.
 Ewing, Reid and Brown, Steven. (2009). U.S. Traffic Calming Manual.

Materials and Maintenance

Traffic calming should be designed to minimize impacts to snowplows. Vegetation should be regularly trimmed to maintain visibility and attractiveness.

Bicycle Boulevards

Traffic Diversion

Description

Motor vehicle traffic volumes also affect the operation of a bicycle boulevard. Higher vehicle volumes reduce bicyclists' comfort and result in more potential conflicts.

Implement volume control treatments based on the context of the bicycle boulevard, using engineering judgment. Target motor vehicle volumes range from 1,000 to 3,000 vehicles per day, above which the route should be striped as a **bike lane** or considered a **signed shared roadway**.

Guidance

- Traffic diversion treatments reduce motor vehicle volumes by completely or partially restricting through traffic on a bicycle boulevard.
- Partial closures allow full bicycle passage while restricting vehicle access to one way traffic at that point.
- Diagonal diverters require all motor vehicle traffic to turn.
- Median diverters (see **major intersections**) restrict through motor vehicle movements while providing refuge for bicyclists to cross in two stages.
- Street closures create a "T" that blocks motor vehicles from continuing on a bicycle boulevard, while bicycle travel can continue unimpeded. Full closures can be made permeable to emergency vehicles with the use of removable bollards or mountable curbs (maximum of six inches high).



Partial Closure



Diagonal Diverter



Median Diverter



Full Closure

Discussion

Bicycle boulevards with volumes higher than 3,000 vehicles per day are not recommended, although a segment of a bicycle boulevard may accommodate more traffic for a short distance if necessary to complete the corridor. Providing additional separation with a **bike lane**, **cycle track**, or other treatment is recommended where traffic calming or diversion cannot reduce volumes below this threshold.

Additional References and Guidelines

Alta Planning + Design and IBPI. (2009). Bicycle Boulevard Planning and Design Handbook.
 Ewing, Reid. (1999). Traffic Calming: State of the Practice.
 Ewing, Reid and Brown, Steven. (2009). U.S. Traffic Calming Manual.
 Oregon Department of Transportation. (1998). Right-In Right-Out Channelization.

Materials and Maintenance

Depending on the diverter type, these treatments can be challenging to keep clear of snow and debris. Vegetation should be regularly trimmed to maintain visibility and attractiveness.

Minor Intersection Treatments

Description

Treatments at minor roadway intersections are designed to improve the visibility of a bicycle boulevard, raise awareness of motorists on the cross-street that they are likely to encounter bicyclists, and enhance safety for all road users.

Guidance

- The majority of intersections with minor roadways along a bicycle boulevard should stop-control cross traffic to minimize bicyclist delay. This will maximize through-bicycle connectivity and preserve bicyclist momentum.
- Traffic circles are a type of **horizontal traffic calming** that can be used at minor street intersections. Traffic circles reduce conflict potential and severity while providing traffic calming to the corridor.
- If a stop sign is present along the bicycle boulevard, a second stop bar for bicyclists can be placed closer to the centerline of the cross street than the motorists' stop bar to increase the visibility of bicyclists waiting to cross a street.
- Curb extensions can be used to move bicyclists further into the street to improve visibility and encourage motorists to let them cross.



Stop Signs on Cross-Street



Traffic Circles



Bicycle Forward Stop Bar



Curb Extension

Discussion

Stop signs increase bicycling time and energy expenditure, frequently leading to non-compliance by bicyclists and motorists, and/or use of other routes. Bicycle boulevards should have fewer stops or delays than other local streets; a typical bicycle trip of 30 minutes can increase to 40 minutes if there is a STOP sign at every block (*Berkeley Bicycle Boulevard Design Tools and Guidelines*). If several stop signs are turned along a corridor, speeds should be monitored, and traffic-calming treatments used to reduce excessive vehicle speeds on the bicycle boulevard.

Additional References and Guidelines

City of Berkeley. (2000). Bicycle Boulevard Design Tools and Guidelines.
 City of London Transport for London. Advanced stop lines (ASLS) background and research studies.
 Transportation Research Board. (2006). Improving Pedestrian Safety at Unsignalized Crossings. NCHRP Report # 562.

Materials and Maintenance

Vegetation on traffic circles and curb extensions should be regularly trimmed to maintain visibility and attractiveness. Repaint bicycle stop bars as needed.

Bicycle Boulevards

Intersection Treatments

Major Intersection Treatments

Description

The quality of treatments at major street crossings can significantly affect a bicyclist’s choice to use a bicycle boulevard, as opposed to another road that provides a crossing treatment.

Guidance

- **Bike boxes** increase bicyclist visibility to motorists and reduce the danger of right “hooks” by providing a space for bicyclists to wait at signalized intersections.
- Median islands provided at uncontrolled intersections of bicycle boulevards and major streets allow bicyclists to cross one direction of traffic at a time as gaps in traffic occur.
- **Hybrid Beacons**, **active warning beacons**, and **bicycle signals** can facilitate bicyclists crossing a busy street where cross-traffic does not stop.
- Select treatments based on engineering judgment; see National Cooperative Highway Research Program (NCHRP) Report # 562 *Improving Pedestrian Safety at Unsignalized Crossings* (2006) for guidance on appropriate use of crossing treatments. Treatments are designed to improve visibility and encourage motorists to stop for pedestrians; with engineering judgement many of the same treatments are appropriate for use along bicycle boulevards.



Bike Box



Median Island



Hybrid Beacon (HAWK)



Rectangular Rapid Flash Beacon (RRFB)

Discussion

Bicycle boulevard retrofits to local streets are typically located on streets without existing signalized accommodation at crossings of collector and arterial roadways. Without increased treatment for bicyclists, these intersections can become major barriers along the bicycle boulevards and compromise safety.

Additional References and Guidelines

Transportation Research Board. (2006). *Improving Pedestrian Safety at Unsignalized Crossings*. NCHRP Report # 562.
 Federal Highway Administration. (2004). *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*. FHWA-RD-04-100

Materials and Maintenance

Maintain signs, markings, and other treatments and replace as needed. Monitor intersections for bicyclist delay to determine if additional treatments are warranted.

Offset Intersection Treatments

Description

Offset intersections can be challenging for bicyclists who are required to briefly travel along the busier cross street in order to continue along the bicycle boulevard.

Guidance

- Appropriate treatments depend on volume of traffic including turning volumes, the speed limit or 85th percentile speed of the main street, and the type of bicyclists using the crossing.
- **Contraflow bike lanes** allow bicyclists to travel against the flow of traffic on a one-way street and can improve bicycle boulevard connectivity.
- Bicycle left-turn lanes can be painted where a bicycle boulevard is offset to the right on a street that has sufficient traffic gaps. Bicyclists cross one direction of traffic, then they have a protected space to wait for a gap in the other direction. The bike turn pockets should be at least 4 feet wide, with a total of 11 feet for both turn pockets and center striping.
- Short **bike lanes** on the cross street assist with a bicycle boulevards jog to the left. Crossing treatments should be provided on both sides to minimize wrong-way riding.
- A **cycle track** can be provided on one side of a busy street. Bicyclists enter the cycle track from the bicycle Boulevard and ride along the busy street to reach the connecting segment of the bicycle boulevard. This maneuver may be signalized at one side.



Contraflow Bike Lane



Left Turn Bike Lanes



Short Bike Lanes on the Cross Street



Cycle Track Connection

Discussion

Because bicycle boulevards are located on local streets, the route is often discontinuous. Wayfinding and pavement markings assist bicyclists with remaining on the route.

Additional References and Guidelines

Hendrix, Michael. (2007). *Responding to the Challenges of Bicycle Crossings at Offset Intersections*. Third Urban Street Symposium.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Facilities should be cleared of snow through routine snow removal operations.

Separated Bikeways

Designated exclusively for bicycle travel, separated bikeways are segregated from vehicle travel lanes with striping, and can include pavement stencils and other amenities. Separated bikeways are most appropriate on arterial and collector streets where higher traffic volumes and speeds warrant greater separation.

Separated bikeways can increase safety and promote proper riding by:

- Defining road space for bicyclists and motorists, reducing the possibility that motorists will stray into the bicyclists' path.
- Discouraging bicyclists from riding on the sidewalk.
- Reducing the incidence of wrong way riding.
- Reminding motorists that bicyclists have a right to the road.



Conventional Bicycle Lanes



Left Side Bike Lane



Colored Bike Lanes



Buffered Bike Lanes

This Section Includes:

Conventional Bike Lanes

- Bike Lane With No On-Street Parking
- Bike Lane Next to Parallel Parking
- Bike Lane Next to Diagonal Parking

Additional Bike Lane Configurations

- Left Side Bike Lane
- Colored Bike Lane
- Buffered Bike Lane

Separated Bikeways

Conventional Bike Lane Configurations

Bike Lane with No On-Street Parking

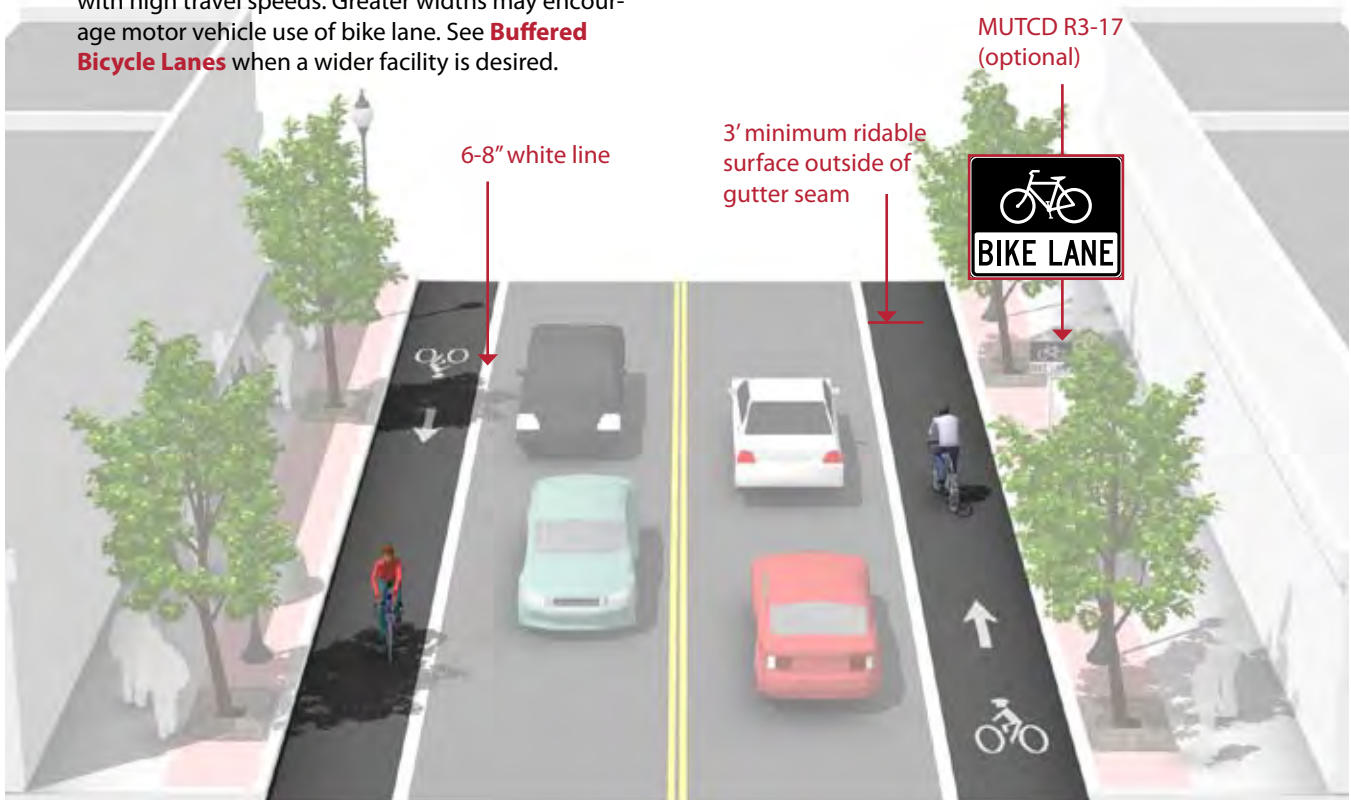
Guidance

- 4 foot minimum when no curb and gutter is present.
- 5 foot minimum when adjacent to curb and gutter or 3 feet more than the gutter pan width if the gutter pan is wider than 2 feet.
- 7 foot maximum width for use adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of bike lane. See **Buffered Bicycle Lanes** when a wider facility is desired.

Description

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is typically located on the right side of the street, between the adjacent travel lane and curb, and flows in the same direction as motor vehicle traffic.

A bike lane width of 7 feet makes it possible for bicyclists to ride side-by-side or pass each other without leaving the bike lane, thereby increasing the capacity of the lane.



Discussion

Wider bicycle lanes are desirable in certain situations such as on higher speed arterials (45 mph+) where use of a wider bicycle lane would increase separation between passing vehicles and bicyclists. Appropriate signing and stenciling is important with wide bicycle lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane. Consider **Buffered Bicycle Lanes** when further separation is desired.

Additional References and Guidelines

AASHTO. (1999). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual of Uniform Traffic Control Devices.
NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

Separated Bikeways

Conventional Bike Lane Configurations

Bike Lane Adjacent to On-Street Parallel Parking

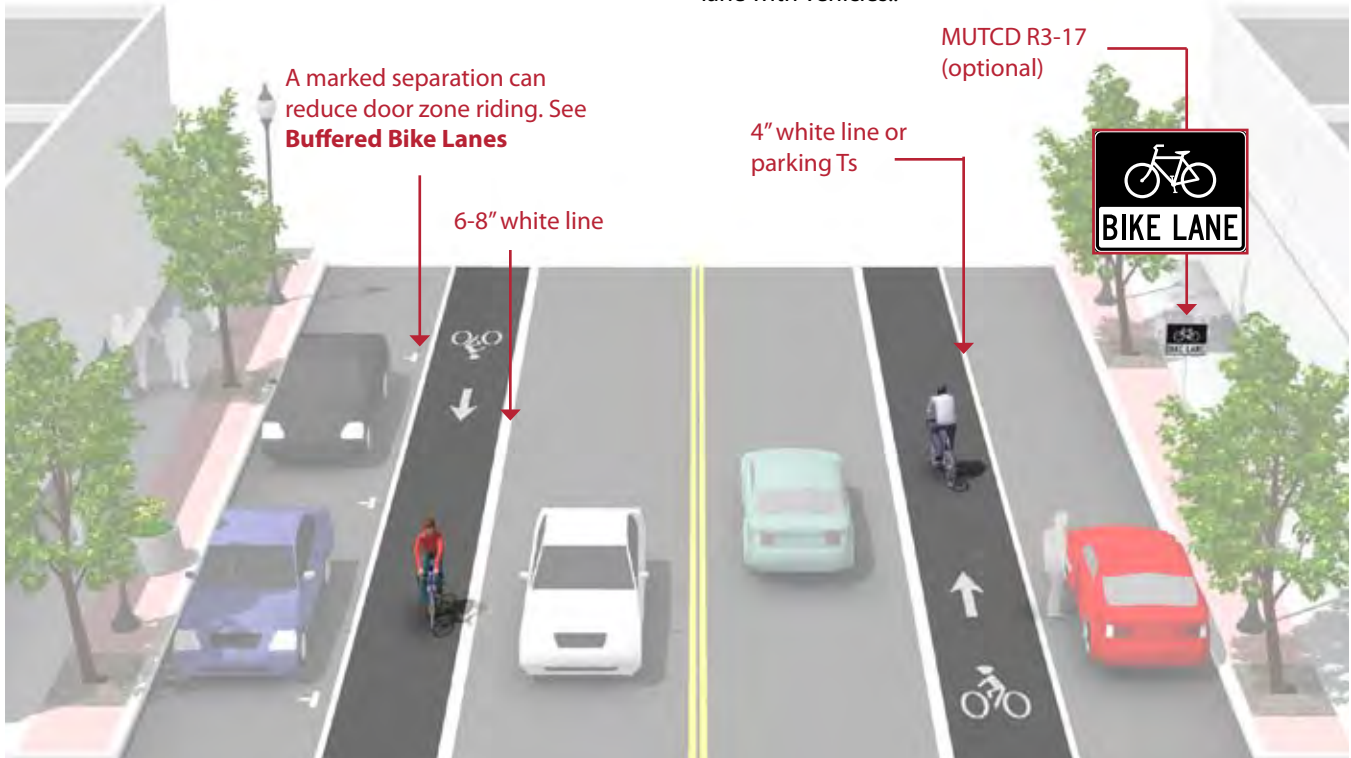
Guidance

- 12 foot minimum from curb face to edge of bike lane.
- 14.5 foot preferred from curb face to edge of bike lane.
- 7 foot maximum for marked width of bike lane. Greater widths may encourage vehicle loading in bike lane. See **Buffered Bicycle Lanes** when a wider facility is desired.

Description

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

Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped and signed bikeway than if they are expected to share a lane with vehicles..



Discussion

Bike lanes adjacent to on-street parallel parking require special treatment to avoid crashes caused by an open vehicle door. The bike lane should have sufficient width to allow bicyclists to stay out of the door zone, while not encroaching into the adjacent vehicular lane. Parking stall markings, such as parking “Ts” and double white lines create a type of parking side buffer to encourage bicyclists to ride farther away from the door zone.

Additional References and Guidelines

AASHTO. (1999). Guide for the Development of Bicycle Facilities.
 FHWA. (2009). Manual of Uniform Traffic Control Devices.
 NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

Separated Bikeways

Conventional Bike Lane Configurations

Bike Lane Adjacent to On-Street Back-in Diagonal Parking

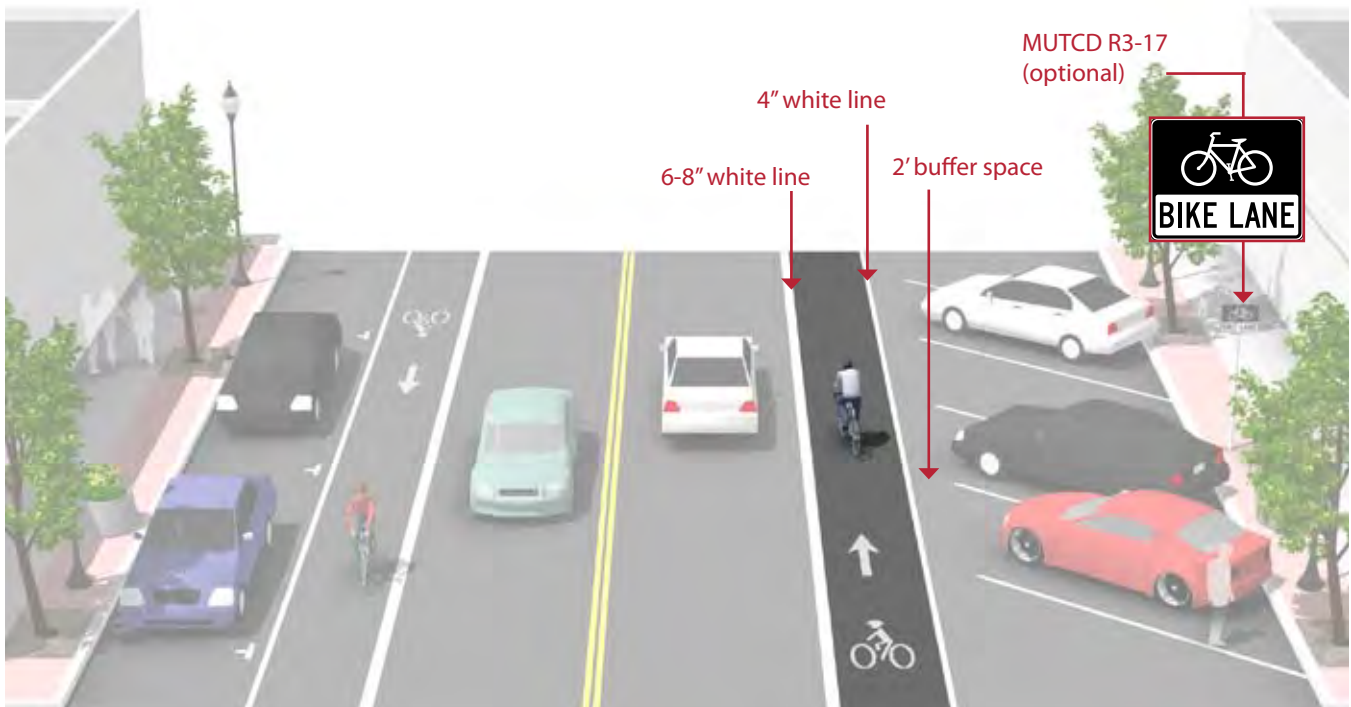
Guidance

- 5 foot minimum marked width of bike lane.
- Parking bays are sufficiently long to accommodate most vehicles (so vehicles do not block bike lane).

Description

In certain areas with high parking demand such as urban commercial areas, diagonal parking can be used to increase parking supply.

Back-in diagonal parking improves sight distances between drivers and bicyclists when compared to conventional head-in diagonal parking. Back-in diagonal parking provides other benefits to vehicles including: loading and unloading of the trunk at the curb rather than in the street, and passengers (including children) are directed by open doors towards the curb; there is also no door conflict with bicyclists. While there may be a learning curve for some drivers, using back-in diagonal parking is typically an easier maneuver than conventional parallel parking.



Discussion

Conventional front-in diagonal parking is not compatible or recommended in conjunction with high levels of bicycle traffic or with the provision of bike lanes, as drivers backing out of conventional diagonal parking have limited visibility of approaching bicyclists.

Additional References and Guidelines

There is no currently adopted Federal or State guidance for this treatment.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

Separated Bikeways

Enhanced Bikeways

Left Side Bike Lane

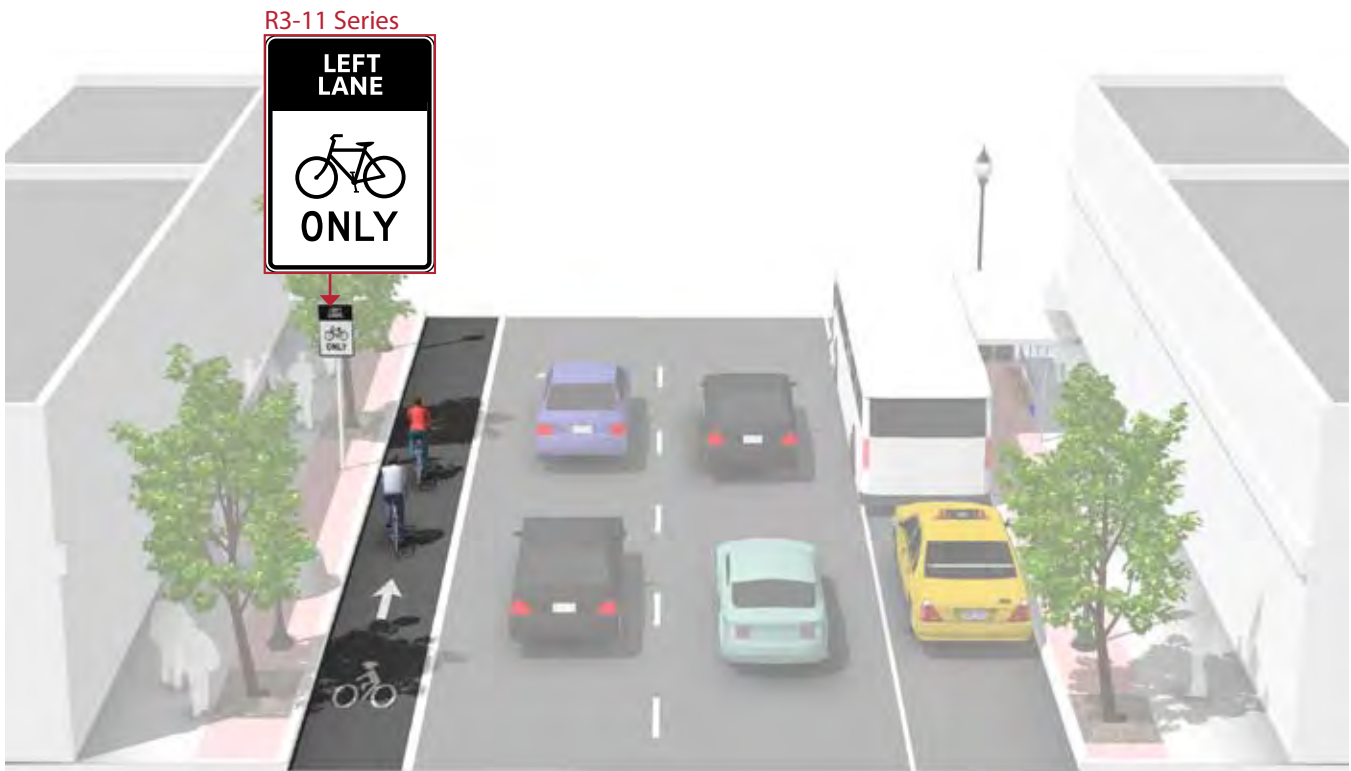
Guidance

- Follow guidance for conventional bike lanes.
- Signage should accompany left-side bicycle lanes to clarify proper use by bicyclists and may be effective in reducing wrong-way riding.
- Bicycle through lanes should be provided to the right of vehicle left turn pockets to reduce conflicts at intersections.

Description

Left-side bike lanes are conventional bike lanes placed on the left side of one-way streets or two-way median divided streets.

Left-side bike lanes offer advantages along streets with heavy delivery or transit use, frequent parking turnover on the right side, or other potential conflicts that could be associated with right-side bicycle lanes.



Discussion

Intersection treatments such as bike boxes and bike signals, should be considered to assist in the transition from left-side bike lanes to right-side bike lanes.

Additional References and Guidelines

AASHTO. (1999). Guide for the Development of Bicycle Facilities.
 FHWA. (2009). Manual of Uniform Traffic Control Devices.
 NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

Colored Bike Lanes

Guidance

The color green has been given interim approval by the Federal Highways Administration in March of 2011. See interim approval IA-14 for specific color standards.

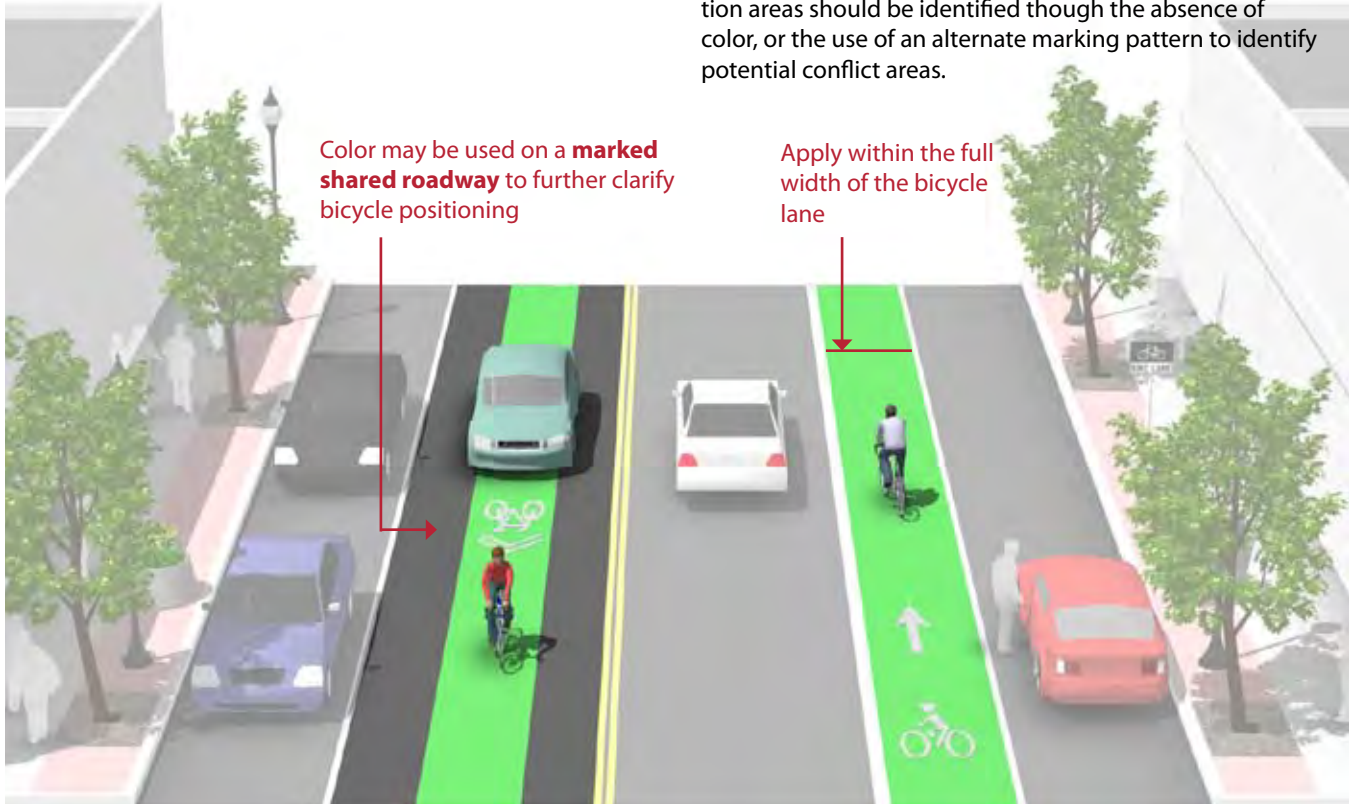
The colored surface should be skid resistant and retro-reflective.

Description

Colored pavement within a bicycle lane increases the visibility of the bicycle facility. Use of color is appropriate for use in areas with pressure for illegal parking, frequent encroachment of motor vehicles, clarify conflict areas, and along enhanced facilities such as **contra-flow bicycle lanes** and **cycle tracks**.

Color has also been used in conjunction with shared lane markings to create a “lane within a lane” to further clarify proper bicyclist positioning on shared roadway streets.

When applied along full corridors, driveway and intersection areas should be identified though the absence of color, or the use of an alternate marking pattern to identify potential conflict areas.



Discussion

Colored pavement is also used to identify potential areas of conflict, and reinforces priority to bicyclists in these conflict areas. See **Colored Bike Lanes in Conflict Areas** for more guidance.

Additional References and Guidelines

FHWA. (2011). Interim Approval (IA-14) has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10
 NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

Separated Bikeways

Enhanced Bikeways

Buffered Bike Lane

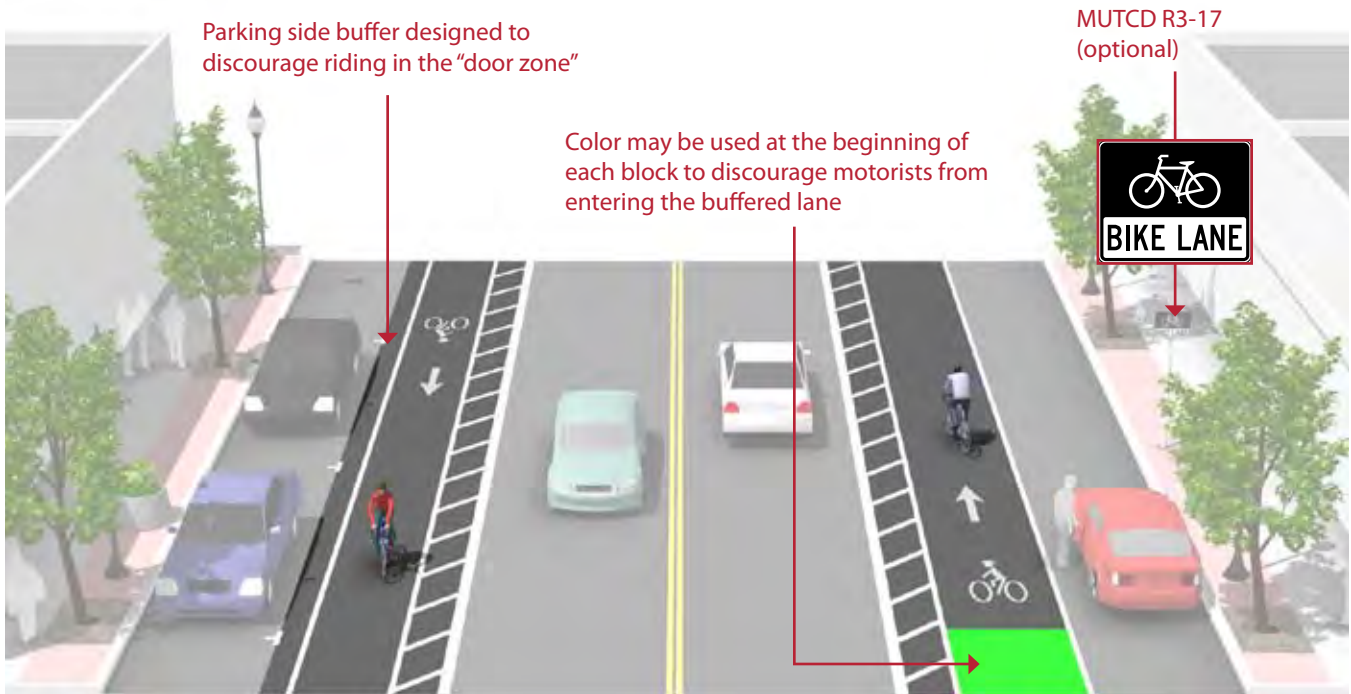
Guidance

- Where bicyclist volumes are high or where bicyclist speed differentials are significant, the desired bicycle travel area width is 7 feet.
- Buffers should be at least 2 feet wide. If 3 feet or wider, mark with diagonal or chevron hatching. At driveways or minor street crossings, consider dashing the inside buffer boundary where cars are expected to cross for clarity.

Description

Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. Buffered bike lanes are allowed as per MUTCD guidelines for buffered preferential lanes (section 3D-01).

Buffered bike lanes are designed to increase the space between the bike lanes and the travel lane or parked cars. This treatment is appropriate on bike lanes with high motor vehicle traffic volumes and speed, bike lanes adjacent to parked cars, and bike lanes with a high volume of truck or oversized vehicle traffic.



Discussion

Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection. Commonly configured as a buffer between the bicycle lane and motor vehicle travel lane, a parking side buffer may also be provided to help bicyclists avoid the 'door zone' of parked cars.

Additional References and Guidelines

FHWA. (2009). Manual of Uniform Traffic Control Devices. (3D-01)
 NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

Cycle Tracks

A cycle track is an exclusive bike facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. A cycle track is physically separated from motor traffic and distinct from the sidewalk. Cycle tracks have different forms but all share common elements—they provide space that is intended to be exclusively or primarily used for bicycles, and are separated from motor vehicle travel lanes, parking lanes, and sidewalks. In situations where on-street parking is allowed cycle tracks are located to the curb-side of the parking (in contrast to bike lanes).

Cycle tracks may be one-way or two-way, and may be at street level, at sidewalk level, or at an intermediate level. If at sidewalk level, a curb or median separates them from motor traffic, while different pavement color/texture separates the cycle track from the sidewalk. If at street level, they can be separated from motor traffic by raised medians, on-street parking, or bollards.

A two-way cycle track is desirable when more destinations are on one side of a street (therefore preventing additional crossings), if the facility connects to a path or other bicycle facility on one side of the street, or if there is not enough room for a cycle track on both sides of the road.

By separating bicyclists from motor traffic, cycle tracks can offer a higher level of security than bike lanes and are attractive to a wider spectrum of the public.

Intersections and approaches must be carefully designed to promote safety and facilitate left-turns from the right side of the street. See **separated bikeways at intersections** for more information.

This Section Includes:

Cycle Tracks

- Cycle Track Separation and Placement
- One-Way Cycle Tracks
- Two-Way Cycle Tracks
- Driveways and Minor Streets
- Major Street Crossings
- Shared Use Paths along Roadways



Cycle Tracks

Cycle Track Separation and Placement

Guidance

- Cycle tracks should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles. Cycle tracks located on one-way streets will have fewer potential conflicts than those on two-way streets.
- In situations where on-street parking is allowed, cycle tracks shall be located between the parking lane and the sidewalk (in contrast to bike lanes).

Description

Protection is provided through physical barriers and can include bollards, parking, a planter strip, an extruded curb, or on-street parking. Cycle tracks using these protection methods typically share the same elevation as adjacent travel lanes.

Raised cycle tracks may be at the level of the adjacent sidewalk, or set at an intermediate level between the roadway and sidewalk to separate the cycle track from the pedestrian area.



Discussion

Sidewalks or other pedestrian facilities should not be narrowed to accommodate the cycle track as pedestrians will likely walk on the cycle track if sidewalk capacity is reduced. Visual and physical cues (e.g., pavement markings & signage) should be present that make it easy to understand where bicyclists and pedestrians should be travelling. If possible, separate the cycle track and pedestrian zone by a furnishing zone.

Additional References and Guidelines

NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

In cities with winter climates barrier separated and raised cycle tracks may require special equipment for snow removal.

Cycle Tracks

One-Way Cycle Tracks

Guidance

- 7 foot recommended minimum to allow passing.
- 5 foot minimum width in constrained locations.
- When placed adjacent to parking, the parking buffer should be three feet wide to allow for passenger loading and to prevent door collisions.
- When placed adjacent to a travel lane, one-way raised cycle tracks may be configured with a mountable curb to allow entry and exit from the bicycle lane for passing other bicyclists or to access vehicular turn lanes.

Description

One-way cycle tracks are physically separated from motor traffic and distinct from the sidewalk. Cycle tracks are either raised or at street level and use a variety of methods for physical protection from passing traffic.



Discussion

Special consideration should be given at transit stops to manage bicycle and pedestrian interactions. Driveways and minor street crossings are unique challenges to cycle track design. Parking should be prohibited within 30 feet of the intersection to improve visibility. Color, yield markings, and “Yield to Bikes” signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic. If configured as a raised cycle track, the crossing should be raised, in which the sidewalk and cycle track maintain their elevation through the crossing.

Additional References and Guidelines

NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

In cities with winter climates barrier separated and raised cycle tracks may require special equipment for snow removal.

Cycle Tracks

Two-Way Cycle Tracks

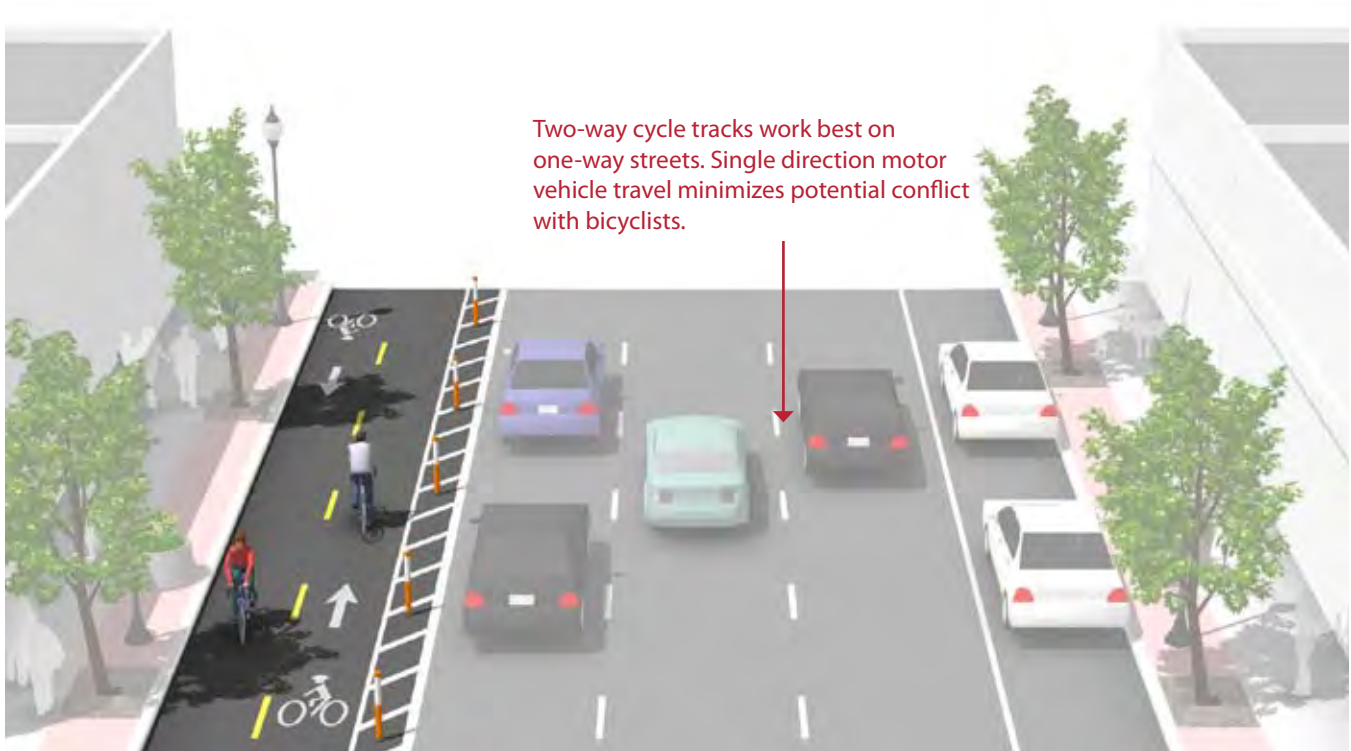
Guidance

- 12 foot recommended minimum for two-way facility
- 8 foot minimum in constrained locations
- When placed adjacent to parking, the parking buffer should be three feet wide to allow for passenger loading and to prevent door collisions.

Description

Two-way cycle tracks are physically separated cycle tracks that allow bicycle movement in both directions on one side of the road. Two-way cycle tracks share some of the same design characteristics as **one-way cycle tracks**, but may require additional considerations at driveway and side-street crossings.

A two-way cycle track may be configured as a protected cycle track at street level with a parking lane or other barrier between the cycle track and the motor vehicle travel lane and/or as a raised cycle track to provide vertical separation from the adjacent motor vehicle lane.



Discussion

Two-way cycle tracks require a higher level of control at intersections to allow for a variety of turning movements. These movements should be guided by separated signals for bicycles and for motor vehicles. Transitions into and out of two-way cycle tracks should be simple and easy to use and deter bicyclists from continuing to ride against the flow of traffic.

At driveways and minor intersections, bicyclists riding against roadway traffic in two-way cycle tracks may surprise pedestrians and drivers not expecting bidirectional travel.

Additional References and Guidelines

NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

In cities with winter climates barrier separated and raised cycle tracks may require special equipment for snow removal.

Cycle Tracks

Driveways and Minor Street Crossings

Guidance

- If raised, maintain the height of the cycle track requiring automobiles to cross over.
- Remove parking 30 feet prior to the intersection.
- Use colored pavement markings and/or shared lane markings through the conflict area.
- Place warning signage to identify the crossing.

Description

The added separation provided by cycle tracks creates additional considerations at intersections that should be addressed.

At driveways and crossings of minor streets a small fraction of automobiles will cross the cycle track. Bicyclists should not be expected to stop at these minor intersections if the major street does not stop.

Openings in the barrier or curb are needed at intersections and driveways or other access points to allow vehicle crossing.



Discussion

At these locations, bicyclist visibility is important, as a buffer of parked cars or vegetation can reduce the visibility of a bicyclist traveling in the cycle track. Marking and signage should be present that make it easy to understand where bicyclists and pedestrians should be travelling. Access management should be used to reduce the number of crossings of driveways on a cycle track. Driveway consolidations and restrictions on automobile movements reduce the potential for conflict.

Additional References and Guidelines

NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

In cities with winter climates barrier separated and raised cycle tracks may require special equipment for snow removal.

Cycle Tracks

Major Street Crossings

Description

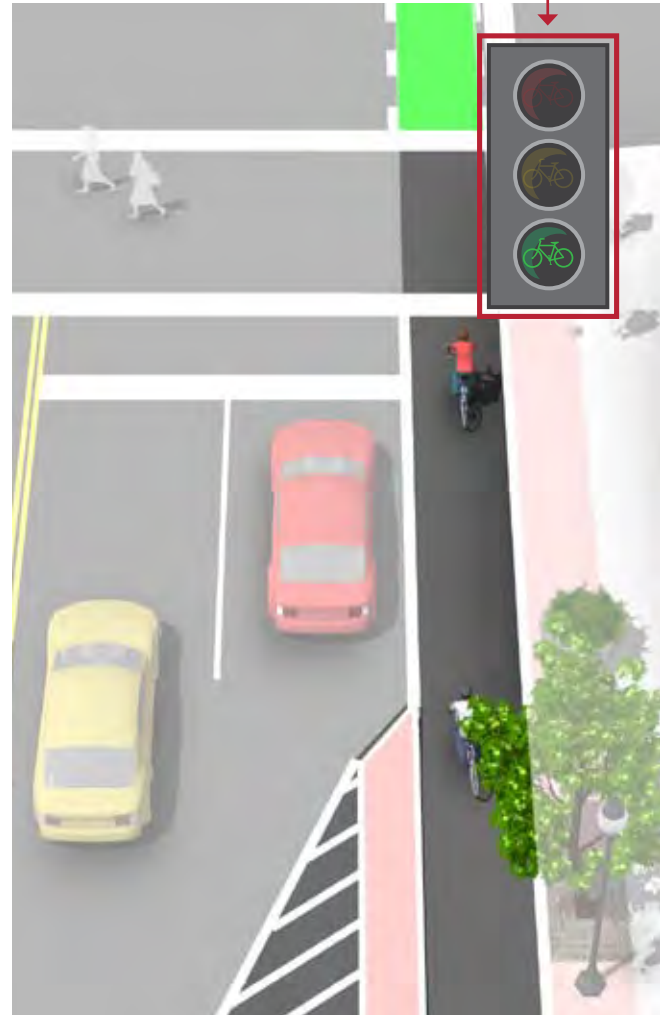
Cycle tracks approaching major intersections must minimize and mitigate potential conflicts and provide connections to intersecting facility types.

Cycle track crossings of signalized intersections can also be accomplished through the use of a bicycle signal phase which reduces conflicts with motor vehicles by separating bicycle movements from any conflicting motor vehicle movements.

Guidance

- Drop cycle track buffer and transition to bike lane 16' prior to intersection.
- Remove parking 16' -50' in advance of the buffer termination.
- Use a **bike box** or advanced stop line treatments to place bicyclists in front of traffic.
- Use **colored pavement** markings through the conflict area.
- Provide for left-turning movements with **two-stage turn** boxes
- Consider using a protected phase **bicycle signal** to isolate conflicts between bicyclists and motor vehicle traffic.
- In constrained conditions with right turn only lanes, consider transitioning to a **shared bike lane/turn lane**.

Demand-only bicycle signals can be implemented to reduce vehicle delay to prevent an empty signal phase from regularly occurring.



Discussion

Signalization utilizing a bicycle signal head can also be set to provide cycle track users a green phase in advance of vehicle phases. The length of the signal phase will depend on the width of the intersection.

The same conflicts exist at non-signalized intersections. Warning signs, special markings and the removal of on-street parking in advance of the intersection can all raise visibility and awareness for bicyclists.

Additional References and Guidelines

AASHTO. (1999). Guide for the Development of Bicycle Facilities.
 FHWA. (2009). Manual of Uniform Traffic Control Devices.
 NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

In cities with winter climates barrier separated and raised cycle tracks may require special equipment for snow removal.

Cycle Tracks

Shared Use Paths Along Roadways

Description

Similar to a two-way cycle track, a shared used path adjacent to a roadway provides two way travel separated from motor vehicle traffic.

A shared use path allows for two-way, off-street bicycle use and also may be used by pedestrians, skaters, wheelchair users, joggers and other non-motorized users. These facilities are frequently found in parks, along rivers, beaches, and in greenbelts or utility corridors where there are few conflicts with motorized vehicles.

Along roadways, these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in wrong-way riding where bicyclists enter or leave the path.

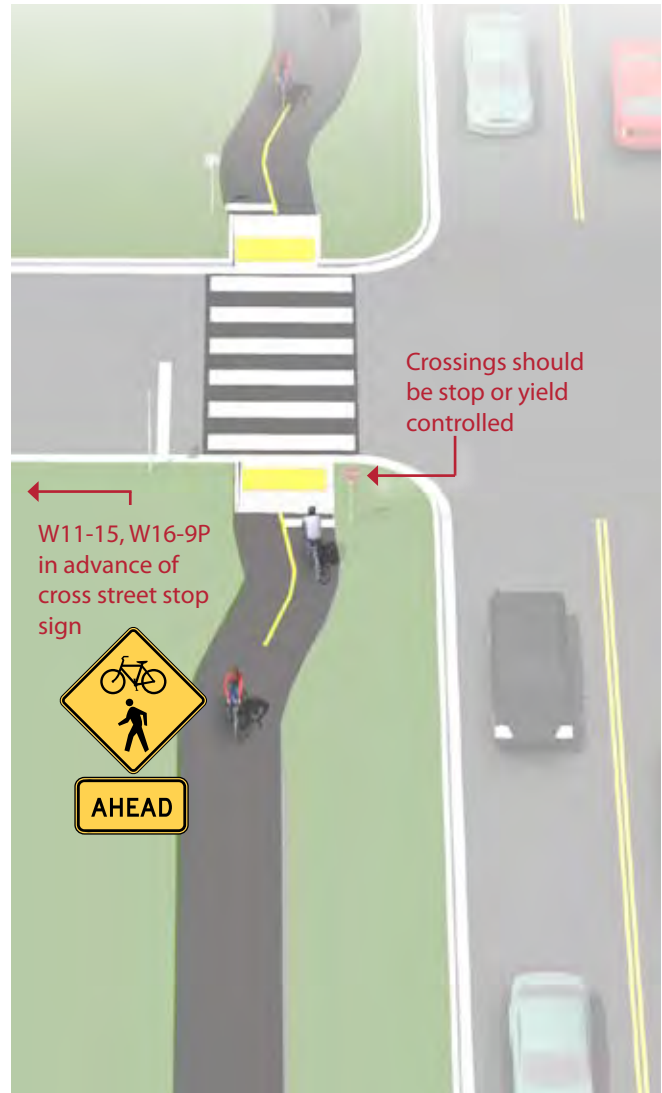
The AASHTO Guide for the Development of Bicycle Facilities generally recommends against the development of shared-use paths directly adjacent to roadways.

Guidance

- 8 feet is the minimum allowed for a two-way bicycle path and is only recommended for low traffic situations.
- 10 feet is recommended in most situations and will be adequate for moderate to heavy use.
- 12 feet is recommended for heavy use situations with high concentrations of multiple users such as joggers, bicyclists, rollerbladers and pedestrians. A separate track (5' minimum) can be provided for pedestrian use.

Bicycle lanes should be provided as an alternate (more transportation-oriented) facility whenever possible.

Pay special attention to the entrance/exit of the path as bicyclists may continue to travel on the wrong side of the street.



Discussion

When designing a bikeway network, the presence of a nearby or parallel path should not be used as a reason to not provide adequate shoulder or bicycle lane width on the roadway, as the on-street bicycle facility will generally be superior to the "sidepath" for experienced bicyclists and those who are cycling for transportation purposes.

Additional References and Guidelines

AASHTO. (1999). Guide for the Development of Bicycle Facilities.
NACTO. (2011). Urban Bikeway Design Guide. See entry on Raised Cycle Tracks.

Materials and Maintenance

Asphalt is the most common surface for bicycle paths. The use of concrete for paths has proven to be more durable over the long term. Saw cut concrete joints rather than troweled improve the experience of path users.

Separated Bikeways at Intersections

Intersections are junctions at which different modes of transportation meet and facilities overlap. An intersection facilitates the interchange between bicyclists, motorists, pedestrians, and other competing modes in order to advance traffic flow in a safe and efficient manner. Designs for intersections with bicycle facilities should reduce conflict between bicyclists (and other vulnerable road users) and vehicles by heightening the level of visibility, denoting clear right-of-way, and facilitating eye contact and awareness with competing modes. Intersection treatments can resolve both queuing and merging maneuvers for bicyclists, and are often coordinated with timed or specialized signals.

The configuration of a safe intersection for bicyclists may include elements such as color, signage, medians, signal detection, and pavement markings. Intersection design should take into consideration existing and anticipated bicyclist, pedestrian and motorist movements. In all cases, the degree of mixing or separation between bicyclists and other modes is intended to reduce the risk of crashes and increase bicyclist comfort. The level of treatment required for bicyclists at an intersection will depend on the bicycle facility type used, whether bicycle facilities are intersecting, and the adjacent street function and land use.

This Section Includes:

- Bike Box
- Bike Lanes at Right Turn Only Lanes
- Colored Bike Lanes in Conflict Areas
- Shared Bicycle/Right Turn Lanes
- Intersection Crossing Markings
- Two Stage Turn Boxes
- Bicycles at Single Lane Roundabouts



Bike Box



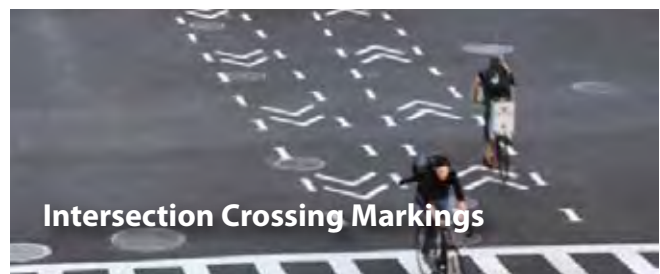
Colored Bike Lanes in Conflict Areas



Bike Lanes at Right Turn Only Lanes



Shared Bicycle/Right Turn Lane



Intersection Crossing Markings



Two Stage Turn Boxes

Separated Bikeways at Intersections

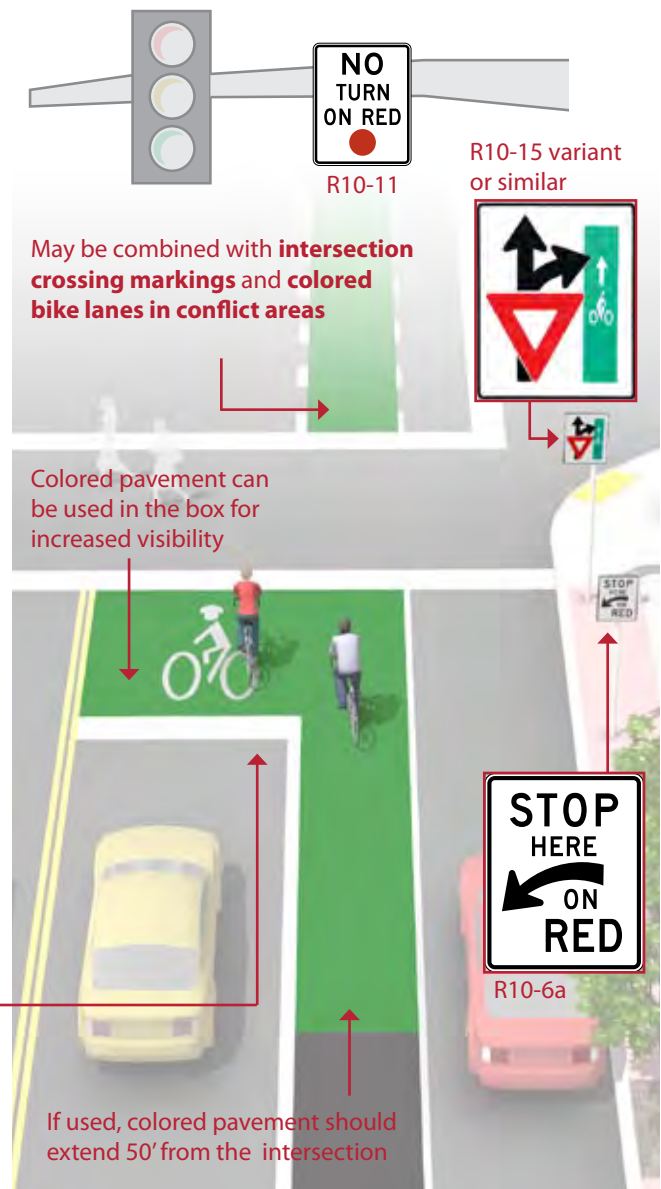
Bike Box

Description

A bike box is a designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible space to get in front of queuing traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box.

Guidance

- 14' minimum depth
- A "No Turn on Red" (MUTCD R10-11) sign shall be installed overhead to prevent vehicles from entering the Bike Box.
- A "Stop Here on Red" sign should be post-mounted at the stop line to reinforce observance of the stop line.
- A "Yield to Bikes" sign should be post-mounted in advance of and in conjunction with an egress lane to reinforce that bicyclists have the right-of-way going through the intersection.
- An ingress lane should be used to provide access to the box.
- A supplemental "Wait Here" legend can be provided in advance of the stop bar to increase clarity to motorists



Discussion

Bike boxes should be placed only at signalized intersections, and right turns on red shall be prohibited for motor vehicles. Bike boxes should be used in locations that have a large volume of bicyclists, and are best utilized in central areas where traffic is usually moving slowly. Prohibiting right turns on red improves safety for bicyclists yet does not significantly impede motor vehicle travel.

Additional References and Guidelines

NACTO. (2011). Urban Bikeway Design Guide.
 FHWA. (2011). Interim Approval (IA-14) has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10

Materials and Maintenance

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

Separated Bikeways at Intersections

Bike Lanes at Right Turn Only Lanes

Description

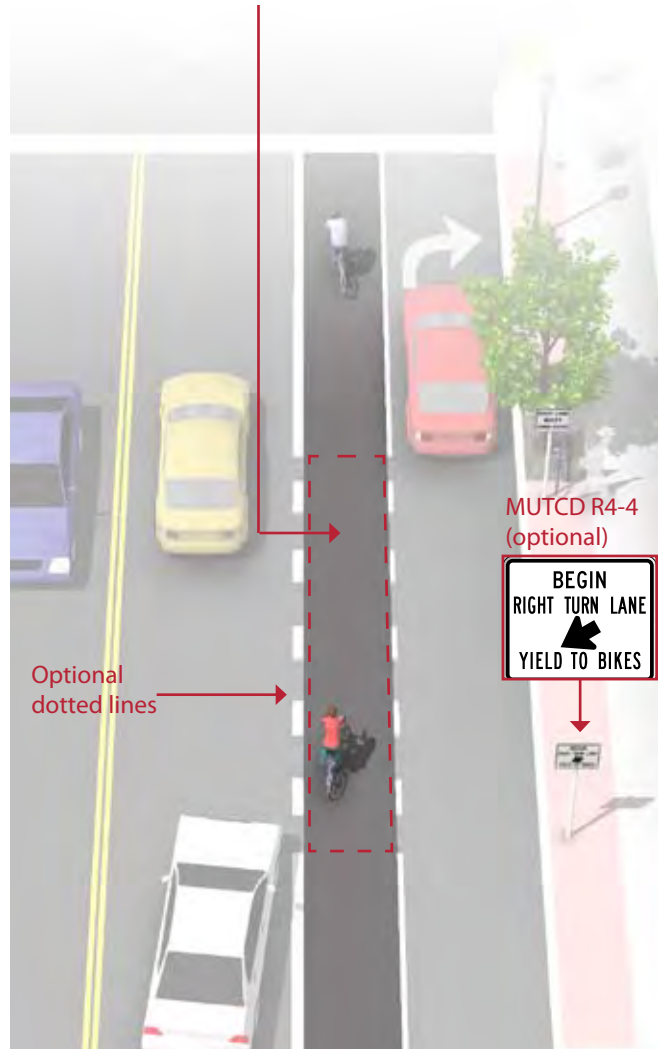
The appropriate treatment at right-turn lanes is to place the bike lane between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to use a **combined bike lane/turn lane**.

The design (right) illustrates a bike lane pocket, with signage indicating that motorists should yield to bicyclists through the conflict area.

Guidance

- Continue existing bike lane width; standard width of 5 to 6 feet or 4 feet in constrained locations.
- Use signage to indicate that motorists should yield to bicyclists through the conflict area.
- Consider using **colored conflict areas** to promote visibility of the mixing zone.

Colored pavement may be used in the weaving area to increase visibility and awareness of potential conflict



Discussion

For other potential approaches to provide accommodations for bicyclists at intersections with turn lanes, please see **combined bike lane/turn lane**, **bicycle signals**, and **colored bike facilities**.

Additional References and Guidelines

AASHTO. (1999). Guide for the Development of Bicycle Facilities.
 FHWA. (2009). Manual of Uniform Traffic Control Devices.
 NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

Separated Bikeways at Intersections

Colored Bike Lanes in Conflict Areas

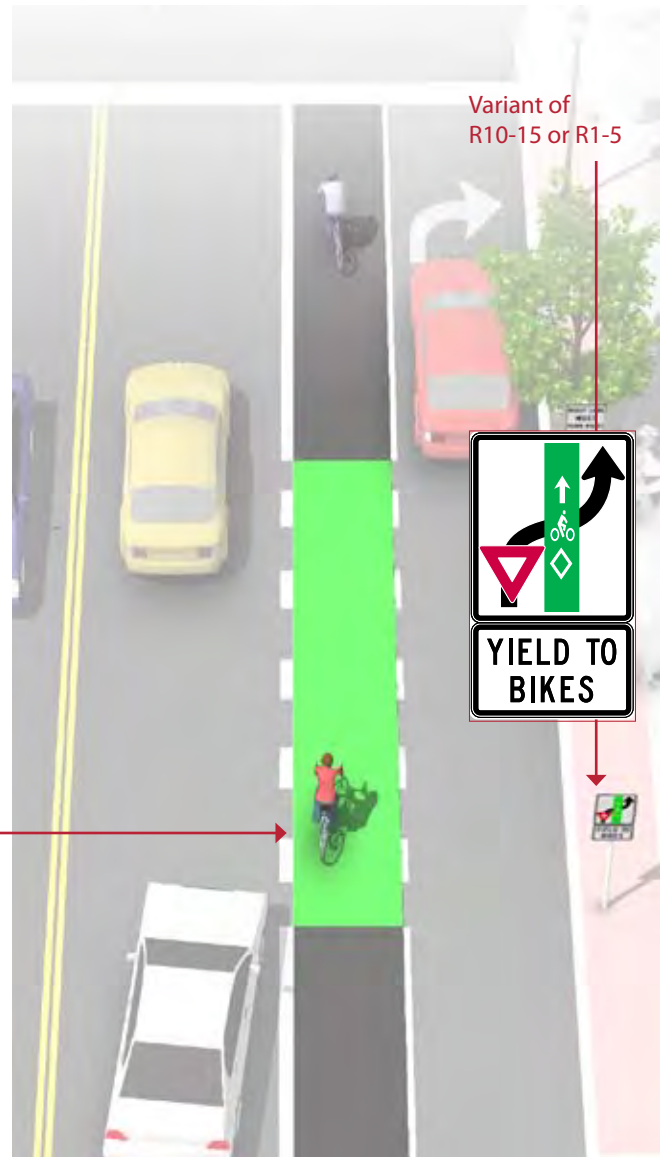
Description

Colored pavement within a bicycle lane increases the visibility of the facility thus identifying potential areas of conflict, and reinforces priority of bicyclists in conflict areas.

Guidance

- Green colored pavement was given interim approval by the Federal Highways Administration in March 2011. See interim approval for specific color standards.
- The colored surface should be skid resistant and retro-reflective.
- A “Yield to Bikes” sign should be used at intersections or driveway crossings to reinforce that bicyclists have the right-of-way in colored bike lane areas.

Normal white dotted edge lines should define colored space



Discussion

Evaluations performed in Portland, OR, St. Petersburg, FL and Austin, TX found that significantly more motorists yielded to bicyclists and slowed or stopped before entering the conflict area after the application of the colored pavement when compared to an uncolored treatment.

Additional References and Guidelines

FHWA. (2011). Interim Approval (IA-14) has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10
NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

Separated Bikeways at Intersections

Shared Bike Lane / Turn Lane

Description

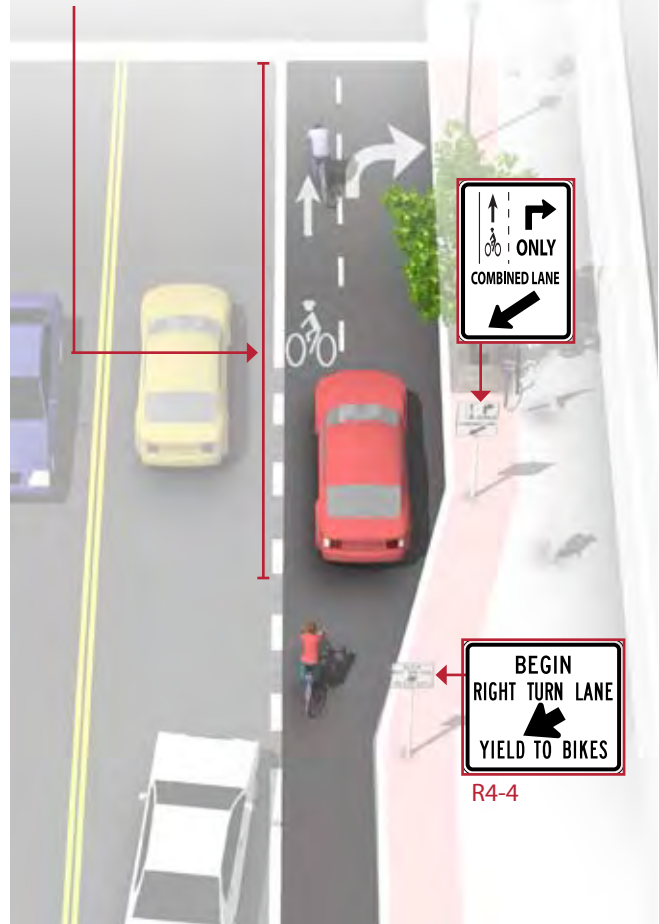
The shared bicycle/right turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. A dashed strip delineates the space for bicyclists and motorists within the shared lane. This treatment includes signage advising motorists and bicyclists of proper positioning within the lane.

This treatment is recommended at intersections lacking sufficient space to accommodate both a standard **through bike lane** and right turn lane.

Guidance

- Maximum shared turn lane width is 13 feet.
- Bike Lane pocket should have a minimum width of 4 feet with 5 feet preferred.
- A dotted 4 inch line and bicycle lane marking should be used to clarify bicyclist positioning within the combined lane, without excluding cars from the suggested bicycle area.
- A "Right Turn Only" sign with an "Except Bicycles" plaque may be needed to make it legal for through bicyclists to use a right turn lane.

Short length turn pockets encourage slower motor vehicle speeds



Discussion

Case studies cited by the Pedestrian and Bicycle Information Center indicate that this treatment works best on streets with lower posted speeds (30 MPH or less) and with lower traffic volumes (10,000 ADT or less). May not be appropriate for high-speed arterials or intersections with long right turn lanes. May not be appropriate for intersections with large percentages of right-turning heavy vehicles.

Additional References and Guidelines

NACTO. (2011). Urban Bikeway Design Guide. This treatment is currently slated for inclusion in the next edition of the AASHTO Guide for the Development of Bicycle Facilities

Materials and Maintenance

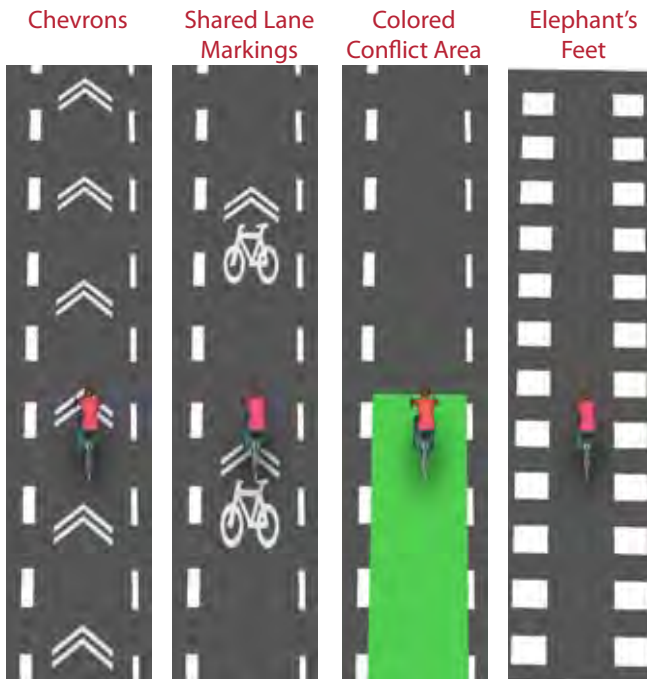
Locate markings out of tire tread to minimize wear. Because the effectiveness of markings depends on their visibility, maintaining markings should be a high priority.

Separated Bikeways at Intersections

Intersection Crossing Markings

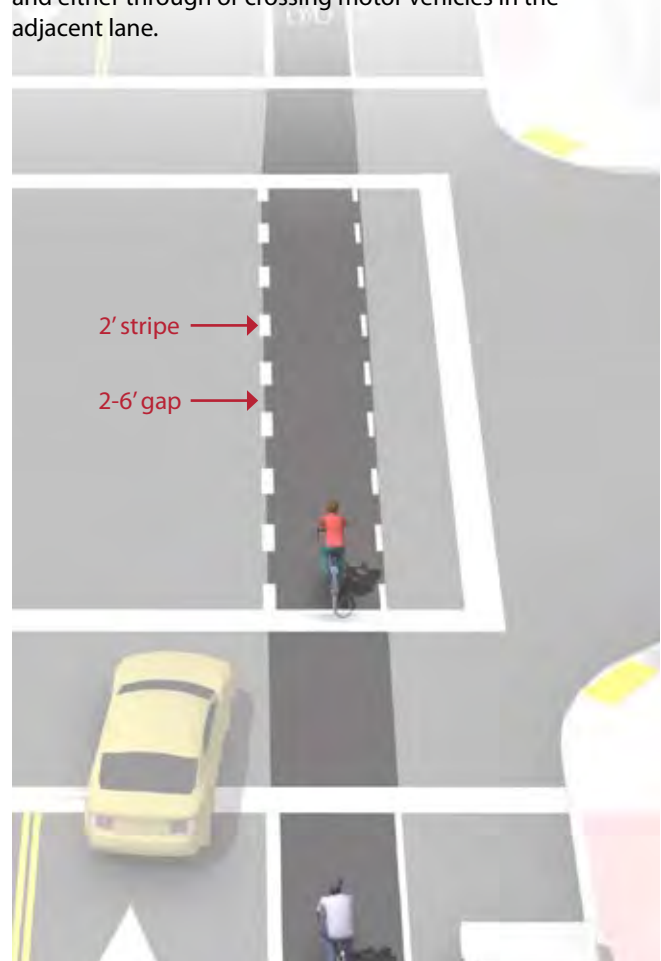
Guidance

- See MUTCD Section 3B.08: “dotted line extensions”
- Crossing striping shall be at least six inches wide when adjacent to motor vehicle travel lanes. Dashed lines should be two-foot lines spaced two to six feet apart.
- Chevrons, shared lane markings, or **colored bike lanes in conflict areas** may be used to increase visibility within conflict areas or across entire intersections. Elephant’s Feet markings are common in Europe and Canada.



Description

Bicycle pavement markings through intersections indicate the intended path of bicyclists through an intersection or across a driveway or ramp. They guide bicyclists on a safe and direct path through the intersection, and provide a clear boundary between the paths of through bicyclists and either through or crossing motor vehicles in the adjacent lane.



Discussion

Additional markings such as chevrons, shared lane markings, or **colored bike lanes in conflict areas** are strategies currently in use in the United States and Canada. Cities considering the implementation of markings through intersections should standardize future designs to avoid confusion.

Additional References and Guidelines

FHWA. (2009). Manual of Uniform Traffic Control Devices. (3A.06)
NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority.

Separated Bikeways at Intersections

Two-Stage Turn Boxes

Description

Two-stage turn queue boxes offer bicyclists a safe way make left turns at multi-lane signalized intersections from a right side cycle track or bike lane.

On right side cycle tracks, bicyclists are often unable to merge into traffic to turn left due to physical separation, making the provision of two-stage left turns critical in making these facilities functional. The same principles for two-stage turns apply to both bike lanes and cycle tracks.

Guidance

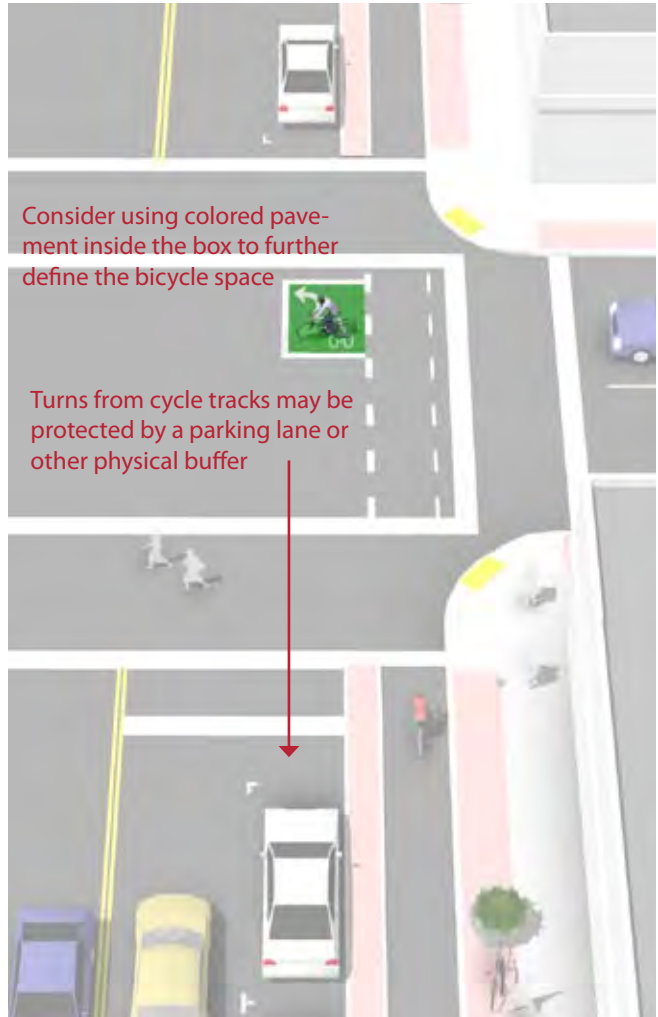
- The queue box shall be placed in a protected area. Typically this is within an on-street parking lane or cycle track buffer area.
- 6' minimum depth of bicycle storage area
- Bicycle stencil and turn arrow pavement markings shall be used to indicate proper bicycle direction and positioning.
- A "No Turn on Red" (MUTCD R10-11) sign shall be installed on the cross street to prevent vehicles from entering the turn box.

Cycle track turn box protected by physical buffer:



Bike lane turn box protected by parking lane:

Turns from a bicycle lane may be protected by an adjacent parking lane or crosswalk setback space



Consider using colored pavement inside the box to further define the bicycle space

Turns from cycle tracks may be protected by a parking lane or other physical buffer

Discussion

While two stage turns may increase bicyclist comfort in many locations, this configuration will typically result in higher average signal delay for bicyclists, due to the need to receive two separate green signal indications (one for the through street, followed by one for the cross street) before proceeding.

Additional References and Guidelines

NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates.

Separated Bikeways at Intersections

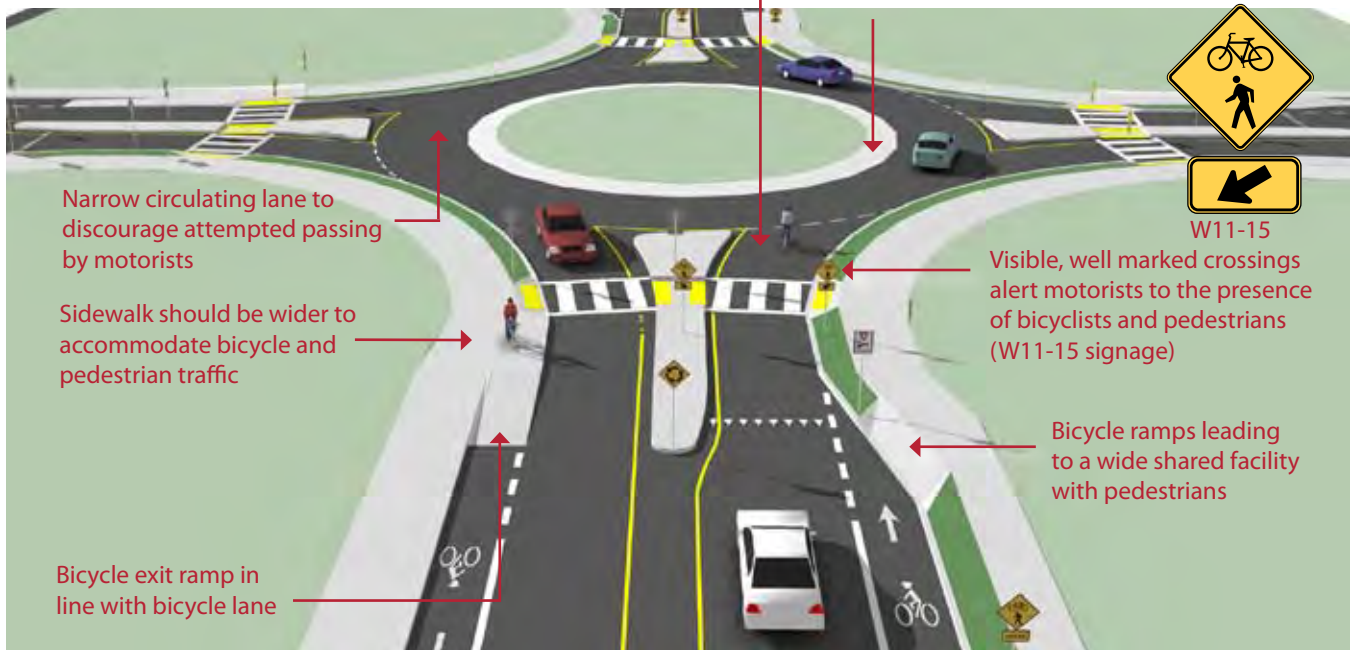
Bicyclists at Single Lane Roundabouts

Guidelines

- 25 mph maximum circulating design speed
- Design approaches/exits to the lowest speeds possible
- Encourage bicyclists navigating the roundabout like motor vehicles to “take the lane.”
- Maximize yielding rate of motorists to pedestrians and bicyclists at crosswalks.
- Provide separated facilities for bicyclists who prefer not to navigate the roundabout on the roadway.

Description

In single lane roundabouts it is important to indicate to motorists, bicyclists, and pedestrians the right-of-way rules and correct way for them to circulate, using appropriately designed signage, pavement markings, and geometric design elements.



Discussion

Research indicates that while single-lane roundabouts may benefit bicyclists and pedestrians by slowing traffic, multi-lane roundabouts may present greater challenges and significantly increase safety problems for these users.

Additional References and Guidelines

FHWA. (2000). Roundabouts: An Informational Guide
FHWA. (2010). Roundabouts: An Informational Guide, Second Edition. NCHRP 672

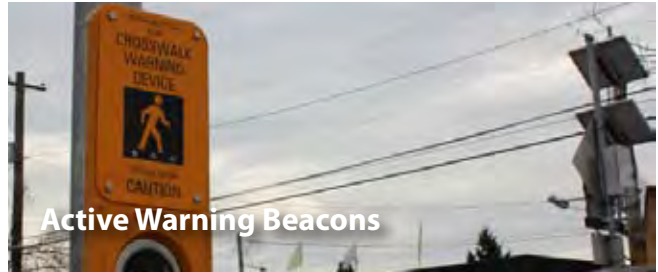
Materials and Maintenance

Signage and striping require routine maintenance.

Signalization

Bicycle signals and beacons facilitate bicyclist crossings of roadways. Bicycle signals make crossing intersections safer for bicyclists by clarifying when to enter an intersection and by restricting conflicting vehicle movements. Bicycle signals are traditional three lens signal heads with green, yellow and red bicycle stenciled lenses that can be employed at standard signalized intersections and hybrid beacon crossings. Flashing amber warning beacons can be utilized at unsignalized intersection crossings. Push buttons, signage, and pavement markings may be used to highlight these facilities for both bicyclists and motorists.

Determining which type of signal or beacon to use for a particular intersection depends on a variety of factors. These include speed limits, Average Daily Traffic (ADT), anticipated bicycle crossing traffic, and the configuration of planned or existing bicycle facilities. Signals may be necessary as part of the construction of a protected bicycle facility such as a cycle track with potential turning conflicts, or to decrease vehicle or pedestrian conflicts at major crossings. An intersection with bicycle signals may reduce stress and delays for a crossing bicyclist, and discourage illegal and unsafe crossing maneuvers.



This Section Includes:

- Bicycle Detection and Actuation
- Rectangular Rapid Flash Beacons (RRFB)
- Hybrid Beacon (HAWK)

Signalization

Bicycle Detection and Actuation

Description

Push Button Actuation

User-activated button mounted on a pole facing the street.

Loop Detectors

Bicycle-activated loop detectors are installed within the roadway to allow the presence of a bicycle to trigger a change in the traffic signal. This allows the bicyclist to stay within the lane of travel and avoid maneuvering to the side of the road to trigger a push button.

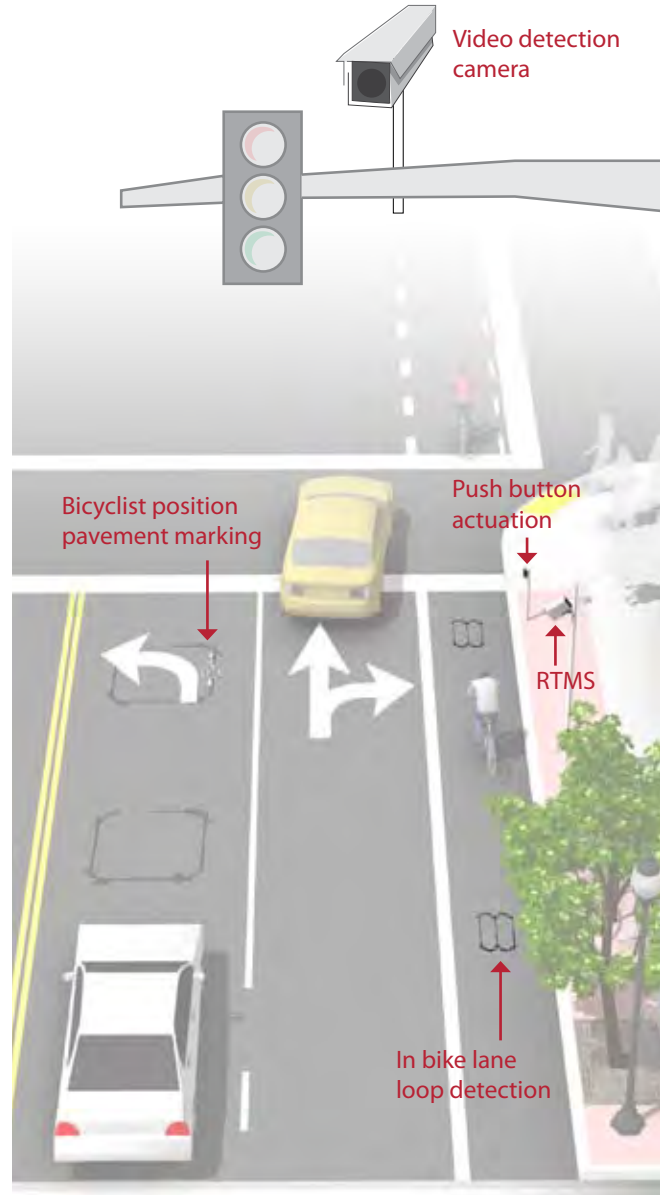
Current and future loops that are sensitive enough to detect bicycles should have pavement markings to instruct bicyclists how to trip them, as well as signage.

Video Detection Cameras

Video detection cameras can also be used to determine when a vehicle is waiting for a signal. These systems use digital image processing to detect a change in the image at the location. Video detection can be calibrated for bikes, bike lanes, and bike pockets. Video camera system costs range from \$20,000 to \$25,000 per intersection.

Remote Traffic Microwave Sensor Detection (RTMS)

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



Discussion

Proper bicycle detection should meet two primary criteria: 1) accurately detects bicyclists and 2) if necessary, provides clear guidance to bicyclists on how to actuate detection (e.g., what button to push, where to stand).

Bicycle loops and other detection mechanisms can also provide bicyclists extended green time before the light turns yellow, so that bicyclists of all abilities can reach the far side of the intersection.

Additional References and Guidelines

AASHTO. (1999). Guide for the Development of Bicycle Facilities.
 FHWA. (2009). Manual of Uniform Traffic Control Devices.
 NACTO. (2011). Urban Bikeway Design Guide.

Materials and Maintenance

Signal detection and actuation for bicyclists should be maintained with other traffic signal detection and roadway pavement markings.

Signalization

Active Warning Beacons

Guidance

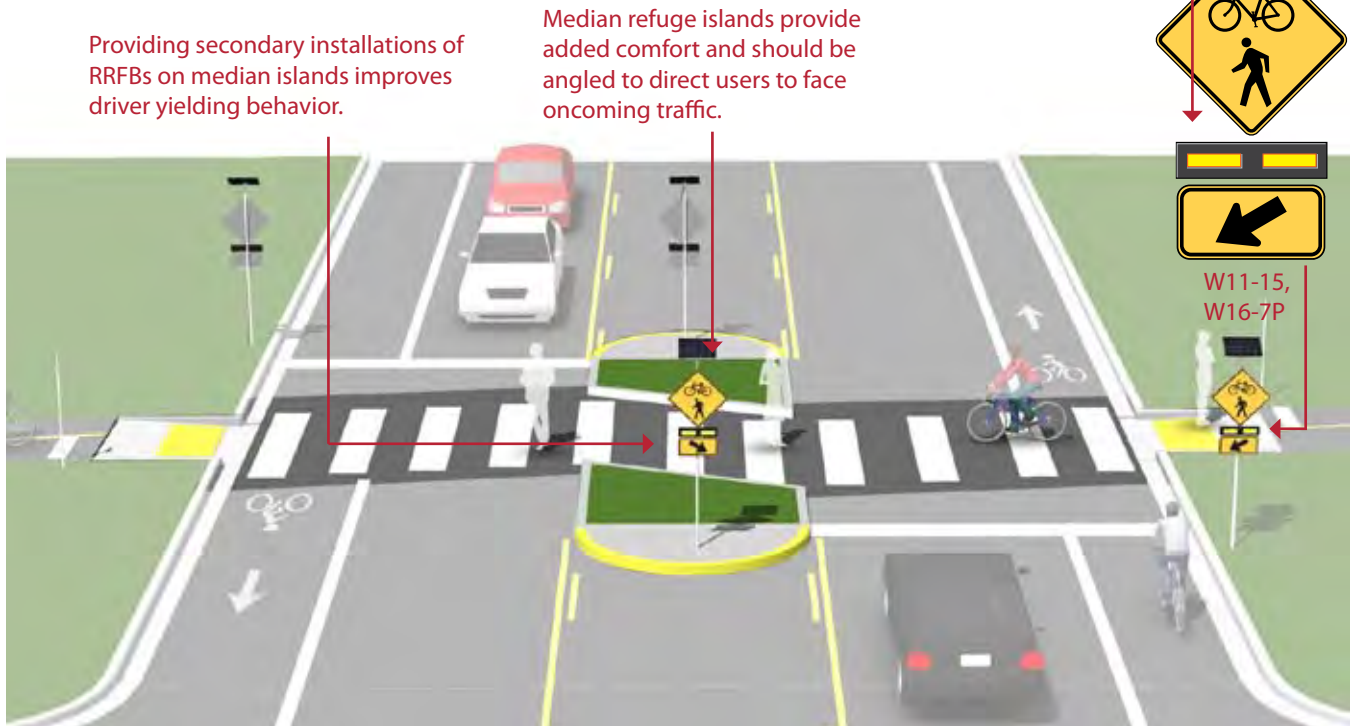
- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic signals.
- Warning beacons shall initiate operation based on pedestrian or bicyclist actuation and shall cease operation at a predetermined time after actuation or, with passive detection, after the pedestrian or bicyclist clears the crosswalk.

Description

Active warning beacons are user actuated illuminated devices designed to increase motor vehicle yielding compliance at crossings of multi lane or high volume roadways.

Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or rectangular rapid flash beacons (RRFB).

Rectangular Rapid Flash Beacons (RRFB) dramatically increase compliance over conventional warning beacons.



Discussion

Rectangular rapid flash beacons have the most increased compliance of all the warning beacon enhancement options.

A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88 percent. Additional studies over long term installations show little to no decrease in yielding behavior over time.

Additional References and Guidelines

NACTO. (2011). Urban Bikeway Design Guide.
 FHWA. (2009). Manual of Uniform Traffic Control Devices.
 FHWA. (2008). MUTCD - Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)

Materials and Maintenance

Depending on power supply, maintenance can be minimal. If solar power is used, RRFBs should run for years without issue.

