CHAPTER 5

CREATING A BICYCLE NETWORK VISION

OVERVIEW

Providing a bicycle network that is safety-focused, comfortable, connected, and convenient for people of all ages and abilities will help the City achieve the goals set forth in this plan. The planning team conducted a variety of assessments, as outlined in Chapter 1, in order to gather input from residents and visitors and gauge the existing and future bikeability of the city's streets and paths. The result of this input and analysis is the Bicycle Network Vision, a selection of streets and paths in the city which should be prioritized for high-quality bicycle infrastructure improvements. These improvements would take the form of off-street paths, streets with reduced vehicle speed and/or volume, or streets with increased separation for bicyclists from motor vehicle traffic.

In order for the City to achieve its bicycling goals and objectives, the Bicycle Network Vision was developed following three guiding principles:

1. **Safe: People will be able to bicycle in the city without the threat of real or perceived danger from motor vehicles or other people.**

2. **Comfortable: People of all ages and abilities will experience a well-designed, low stress, attractive street and path network.**

3. **Connected: People will be able to use the network to make convenient connections both locally and regionally to the places they need to go for work, school, shopping, and socializing.**

In addition to the network principles, the formulation of the Bicycle Network Vision was based on inputs from the public, the bicycle level of comfort analysis, bicycle count and crash data, and other factors as described throughout this chapter.

PUBLIC INPUT

Nearly 3,000 members of the general public provided comments through a combination of in-person and online forums. Further comments and refinements were received from representatives of the public, including the Cambridge Bicycle Committee, City Council, and City Staff.

Outreach media included flyers, written comment, an online user survey, street teams, two online WikiMaps, two public open houses hosted at the Main Library and Cambridge College, and numerous comments which were written or emailed to City staff. Results of the online user survey are discussed in Chapter 3.

WIKIMAPS

Two WikiMaps, a map-based online survey tool, were used to collect public input. The first WikiMap was aimed at identifying existing conditions: where bicycling improvements are needed and where bicycling conditions are exemplary and should be replicated in other locations, or where they provided an attractive connection. WikiMap users were able to log onto the WikiMap website and indicate where there are great streets or paths, where corridor or spot improvements are needed, and provide comments on existing bicycling infrastructure.

The first WikiMap was open for comments from May to June 2014. A second WikiMap was active from December 2014 to February 2015. This map collected public comment on the Draft Bicycle Network Vision. Users provided text comments and ranked the importance of streets in the Draft Network, and suggested additional streets or paths which were not included in the Draft. Approximately 1,113 users logged onto the WikiMaps and generated 995 comments. Figure 5.1 and Figure 5.2 show a summary of the first WikiMap results and were used during the development of the Bicycle Network Vision to identify locations deemed important by the public.

Figure 5.1: WikiMap 1 Comment Frequency by Location: Improvement Needed

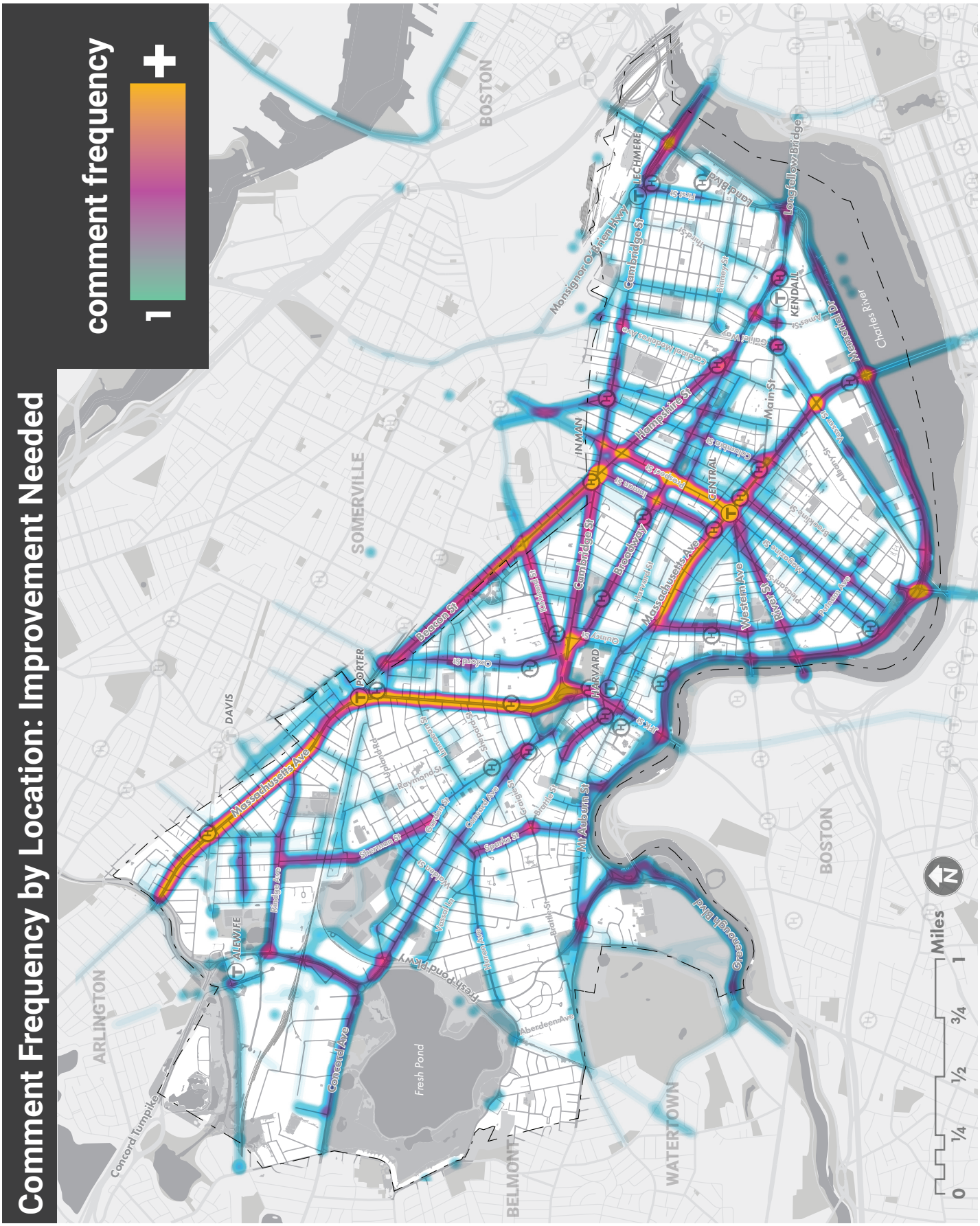
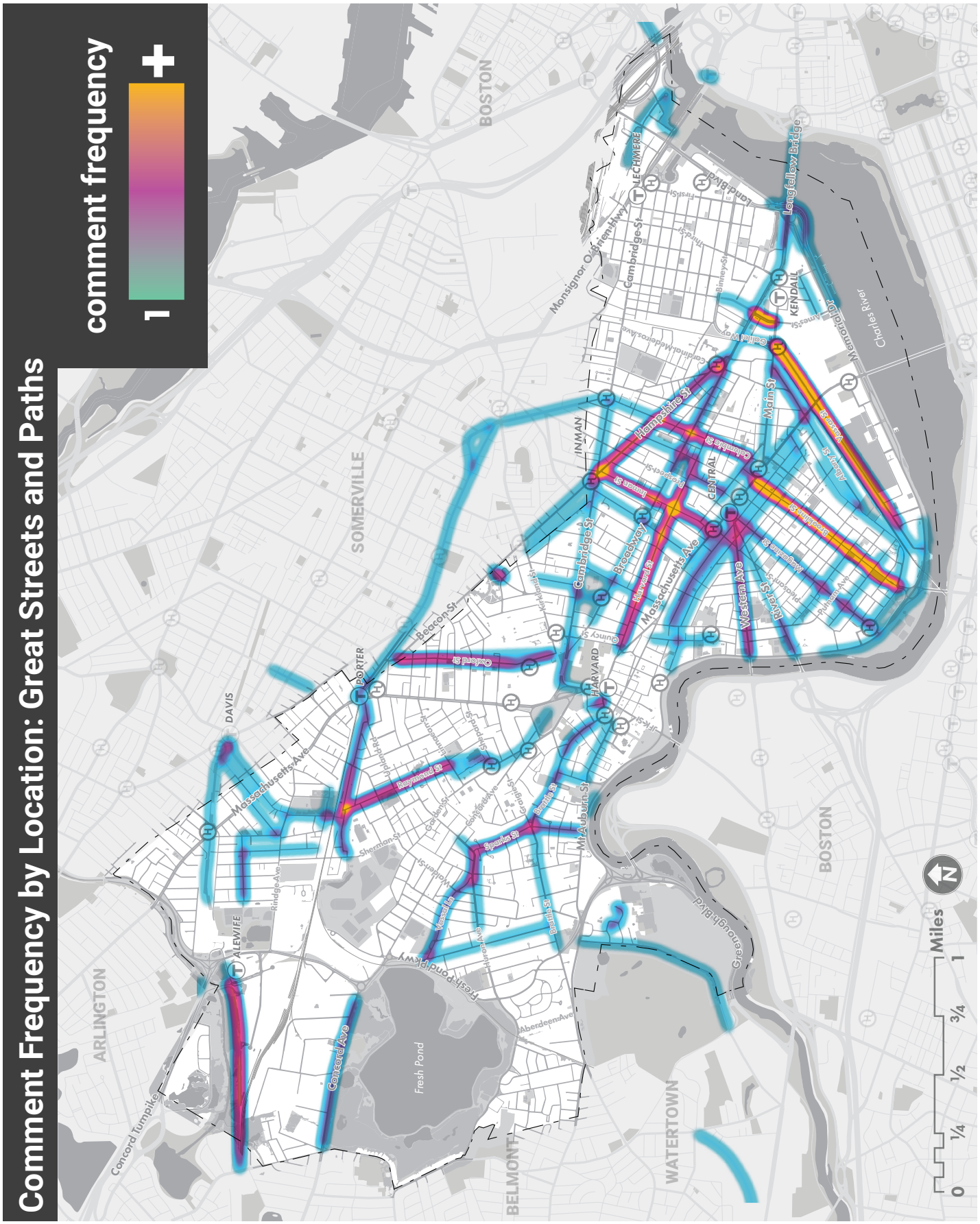


Figure 5.2: WikiMap 1 Comment Frequency by Location: Great Streets and Paths



OPEN HOUSES

The first public open house was held on Thursday, June 12, 2014 at the Main Library. Approximately 60 people attended the open house. A number of stations were established for visitors to speak with Bicycle Program staff, respond to the online user survey, provide comments on a live WikiMap, discuss potential bicycle facility types, review the Bicycle Level of Comfort Analysis and bicycle crash trends, and discuss capital improvement projects with Public Works staff.

The second public open house was held on December 4, 2014 at Cambridge College. The event was attended by nearly 100 people. This event followed the same format as the first open house, but included the opportunity to review and comment on the Draft Bicycle Network Vision.

Additionally, large scale paper maps of the existing bicycle network were presented at 20 public events throughout 2014. Attendees were encouraged to identify and comment on locations in the city where bicycling issues need to be addressed. These paper-based comments were then compiled digitally with WikiMap comments to provide a database of needs to be addressed in this Plan.

BICYCLE LEVEL OF COMFORT

The Cambridge Bicycle Level of Comfort Analysis (BLC) is a planning tool used to quantify the level of comfort that a person bicycling is likely to perceive while riding on any street or path. The analysis correlates comfort with the physical and operational characteristics of roadways and crossings. It is based on the premise that a person's level of comfort on a bicycle increases as separation from vehicular traffic increases and as traffic volume and speed decrease. The result of the analysis is a numerical comfort ranking for every street and path in the city, from greatest comfort (BLC 1) to least comfort (BLC 5).

The BLC Analysis is the foundation of the Bicycle Network Vision. It allowed the planning team first to identify existing assets, by determining a network of comfortable streets on which people bicycle, and second to prioritize infrastructure improvements by closing critical gaps in the high-comfort network. This approach recognizes that the city's bicycle network is not just a handful of streets with bicycle-specific infrastructure, but rather every street is a potential route for bicyclists who have varying tolerances for the stress caused by biking near motor vehicles.

METHODOLOGY

The BLC Analysis is based on the Mineta Transportation Institute's pioneering research on Low-stress bicycling and network connectivity.[1] The Cambridge BLC used Mineta's ranking criteria for Level of Traffic Stress (analogous to BLC) as a baseline for the comfort ranking of each street or path. The analysis uses a weakest link principle to score road segments, recognizing that a bicycle route is only as appealing as its least comfortable or highest stress feature.

Following an initial stage of analysis, BLC rankings were vetted by City Staff, the City's Bicycle Committee, and the public to test the accuracy of the model. This ensured that the results matched with the actual experience of people most familiar with roadway conditions. Based on this feedback, the model was refined using additional criteria specific to Cambridge. This included ranking criteria such as narrow one-way, single-travel-lane streets with parking on two-sides, streets with high-frequency bus routes, and the addition of a fifth level of comfort to address state highways. For specific ranking criteria see Appendix D. Ultimately, each street or path in the city received a BLC ranking from 1-5, described below.

It should be noted that a large amount of data about each street was collected from a variety of sources, but certain values had to be assumed due to the unavailability of data. In particular, roadway volume and speed data were not available on many residential/local roadways. Values typical of local roadways were assumed for these streets, resulting in typically low stress rankings. Nevertheless, many of these streets may be less comfortable than the analysis suggests, due to actual volume and speed being higher than assumed.

The BLC analysis attempts to provide a general assessment of bicycling comfort, and as a result does not take into account factors that are of a seasonal or temporary nature. As a result pavement quality and accumulation of precipitation are not considered in the BLC. While surface quality can be a significant factor in bicycling comfort, it is typically not a permanent feature and often too dispersed along a roadway to affect the comfort of the entire corridor. Additionally, fluctuation in vehicle speed and volume at peak travel hours is not reflected in the analysis. A particular roadway may be comfortable for much of the day, but very uncomfortable during peak hours due to substantial increases in traffic.

BLC 1

Who: Your grandmother who enjoys riding to errands on Sunday afternoons; a young family of four, with the youngest child in a bicycle seat up front followed by his sister riding behind on her first bicycle; or you - enjoying a slow, quiet ride through your neighborhood.

What: Places where only people on bicycles or foot are allowed, like off-street paths or separated bicycle facilities; quiet neighborhood streets with only occasional vehicular traffic travelling at low speeds.

Where: Minuteman Commuter Bikeway; North Point Park path systems; Western Avenue cycle track, Spring Street.

BLC 2

Who: Your friends from out of town who have never ridden a bike on city streets; a Hubway rider who hasn't been on a bike in years but would like to give it a try; your son, a student at Cambridge Rindge & Latin, who rides to Danehy Park after school for soccer practice.

What: Neighborhood streets with some traffic, not travelling too fast; bike lanes against the curb; wide bike lanes on streets without much traffic that make travel predictable for people in cars and on bikes.

Where: Brookline Street, Richdale Avenue.

BLC 3

Who: Your neighbor, who diligently takes out her bike each morning to make the trip to work; MIT students riding for ice cream after class for a group study session; your friend from Somerville who rides to the supermarket every week for groceries.

What: Roads with frequent car traffic that may travel fast at times; bicycle lanes that are often blocked by vehicles – whether trucks making deliveries, cars pulling in an out of parking spaces, or car doors opening into the adjacent bicycle lane; narrow, often one-way, single-lane streets with frequent car traffic that can't pass bicyclists due to parking on either side.

Where: Cambridge Street, Magazine Street, Pearl Street.

BLC 4

Who: The bartender working in Central square whose bike messenger days are behind him; your cousin who rides to her job in Kendall Square from Arlington, rain or shine.

What: Roads that have fast and/or constant motor vehicle traffic and no bicycle lane; streets with steady bus traffic making frequent stops; bicycle lanes that are often blocked by illegal parking.

Where: Massachusetts Avenue, Prospect Street.

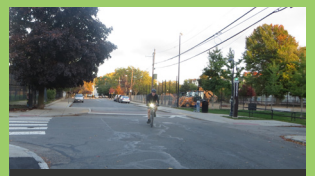
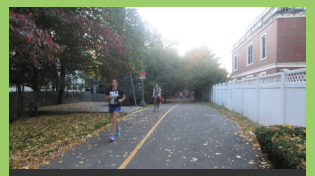
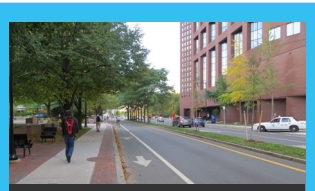
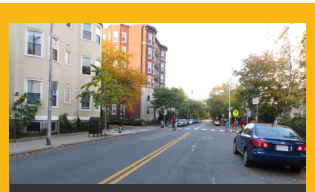
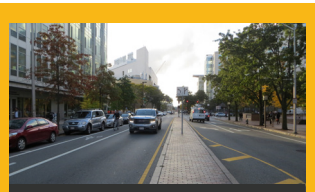
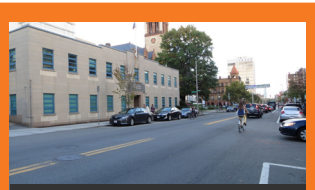
BLC 5

Who: Your coworker who rides his top-of-the line road bike out to Lexington every weekend for a half-century.

What: Roads designed as highways, meant to carry extremely high volumes of very fast moving motor vehicle traffic travelling between cities.

Where: Memorial Drive, Fresh Pond Parkway.

Figure 5.3: Bicycle Level of Comfort Criteria and Examples

BICYCLE LEVEL OF COMFORT	TYPICAL CRITERIA	EXAMPLES		
1	Protected/Separated or Shared with ADT <2K or Shared with Speed <30 mph	 Pemberton Street	 Community Path	 Vassar Street
2	Wide/Buffered Bike Lane or Bike Lane w/out Parking adjacent or Shared with ADT 2-4K or Shared with Speed <30 mph	 Richdale Avenue	 Broadway	
3	Bike Lane adjacent to Parking or Shared with Speed 30 mph or Shared with ADT 4-6K or Narrow Operating Space	 Magazine Street	 Main Street	
4	Shared with Speed 30+ mph or Shared with ADT 6-15K or High Frequency Bus Route	 Massachusetts Avenue	 Broadway	
5	Shared with Speed 35+ mph or Shared with ADT 15+K and No Parking and 2+ Travel Lanes per direction	 Land Boulevard	 O'Brien Highway /Route 28	

FINDINGS

1. Shared use paths provide continuous high-quality regional connections, but often only at the edges of the city. Separated bike lanes on Vassar Street and Western Avenue connect bicyclists between paths and commercial, institutional, and employment centers on high-comfort routes. However, in general, routes connecting regional paths to destinations are not high-comfort.

2. BLC 1 and 2 streets/paths represent twice the mileage (appx. 140 miles) of BLC 3, 4, and 5 streets/paths combined (appx. 70 miles). BLC 1 and 2 streets, however, do not form a cohesive network of continuous high-comfort bicycle routes. They are fragmented by low comfort (BLC 3, 4, 5) streets, particularly around commercial and employment centers. Sometimes an otherwise good street has a barrier such as a difficult intersection. For example, Vassar Street's otherwise high comfort is not really continuous, as the major intersections are barriers. Fragmentation is also increased due to many local streets operating in a discontinuous one-way street pattern. High comfort streets that physically connect often do not provide a continuously bikeable route due to frequent changes in the direction of operation.

3. Most primary roads in Cambridge that provide access to commercial, institutional, and employment centers do not provide a comfortable biking experience (BLC 3, 4, or 5). These streets, such as Massachusetts Avenue, Broadway, Cambridge Street, and Concord Avenue, are in high demand by all modes of traffic, but may act as barriers for people who are not comfortable riding in such conditions. Often these streets are the only route to major activity centers aside from alternatives that require a significant detour. Finally, these streets and their intersection with other BLC 3-4 streets are also locations with the highest frequency of bicycle crashes. Such locations include Central and Inman Squares, the northern section of Massachusetts Avenue, and the major intersections of Cambridge Street and Broadway.

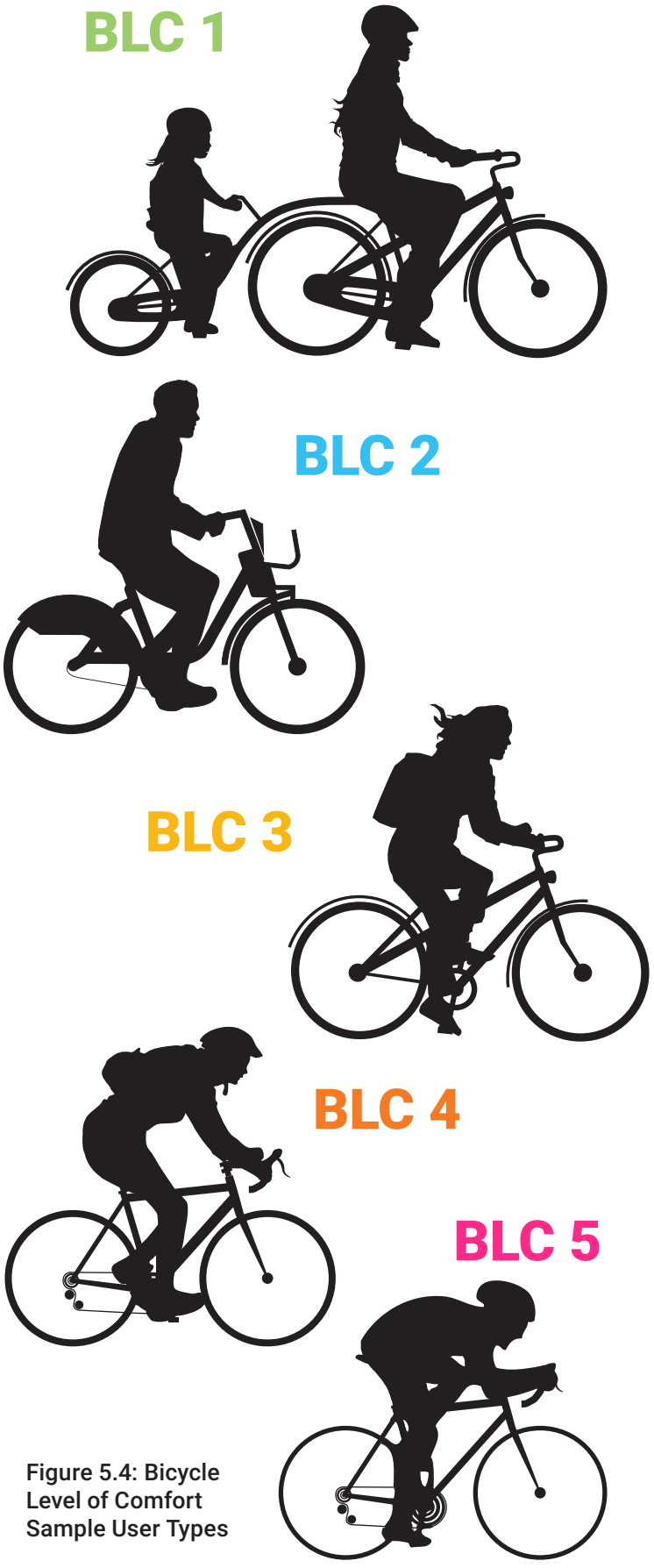


Figure 5.4: Bicycle Level of Comfort Sample User Types

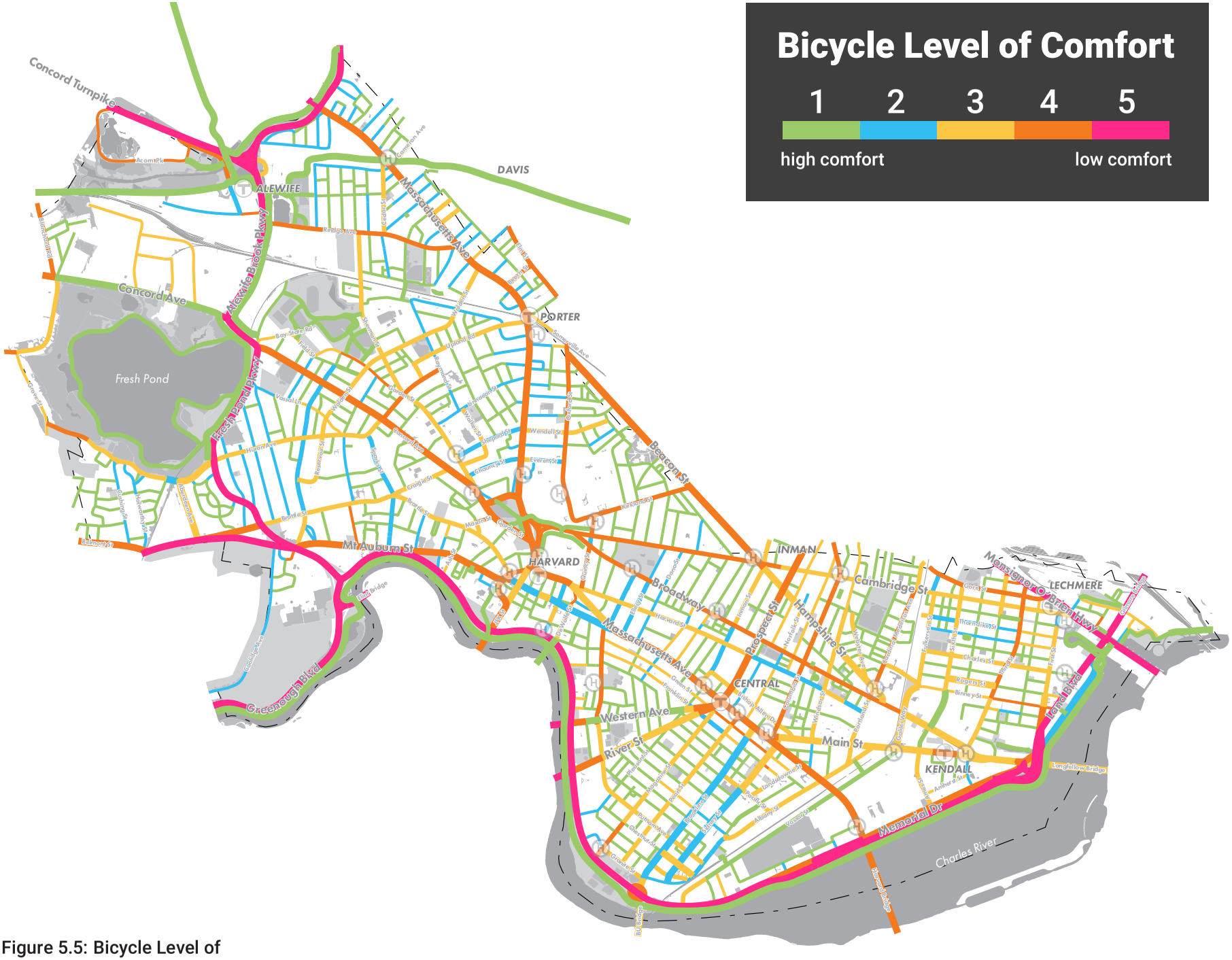


Figure 5.5: Bicycle Level of Comfort Analysis: BLC 1-5

Figure 5.6: Bicycle Level of Comfort Analysis: BLC 1 & BLC 2

BICYCLE COUNTS AND CRASH DATA

Cambridge conducts biennial bicycle counts and analyzes bicycle crash data collected from the Cambridge Police Department crash reports. Both data sources were used in the development of the Bicycle Network Vision. Details on bicycle counts and crashes are discussed in Chapter 3.

LEVEL OF ACCOMMODATION

Infrastructure recommendations in the Bicycle Network Vision take the form of a "level-of accommodation" for each street or path. These recommendations do not propose specific facility types, rather they provide infrastructure goals for each street or path which may be reached through a variety of design treatments. Specific bicycle facility types, as provided in Chapter 4, will be determined through a design process for each street/path which will include public outreach and will be informed by the latest best practices in bicycle infrastructure design at that time.

Since streets have different characteristics and functions, different street types need different levels of accommodation. Busy commercial streets like Massachusetts Avenue typically require separation from vehicular traffic and parking in order to provide comfort and safety for all users. Quieter residential streets like Harvard Street often benefit from lowering the speed and/or motor vehicle volume through traffic calming so that bicyclists are more safe and comfortable sharing the road.

The proposed levels of accommodations are:

1. **Off-street:** Paths, primarily through parks or open space and along linear corridors such as rail lines and rivers – motor vehicle traffic is prohibited.

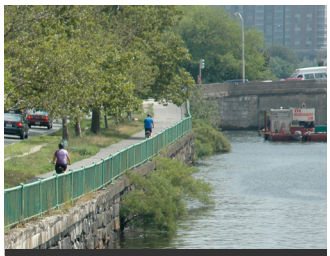
2. **Separated:** Physical separation from traffic with raised bicycle lanes, protected bicycle lanes, or other means which provide a vertical and horizontal barrier between bicyclists and motor vehicles. Separation is required primarily on major through-streets with higher traffic volumes and speeds. These streets often provide access to shopping, jobs, neighboring communities, and regional trails.

3. **Lower volume and/or speed:** Lower motor vehicle volume and/or speed with bicycle-friendly traffic calming, priority crossing treatments, or other traffic calming strategies, primarily on residential and less busy through-streets. These streets often provide access within and between neighborhoods, local parks, or schools.

Tools for Creating Off-Street Paths

Right-of-way


Rails-to-trails

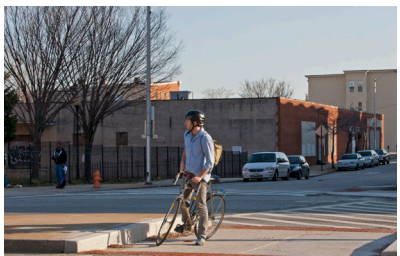

Waterways


Parks

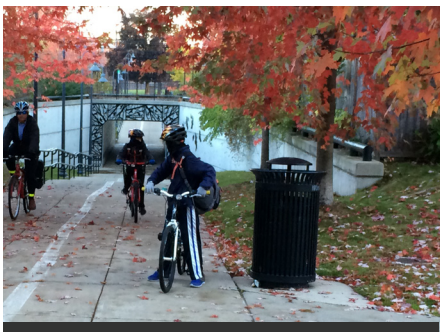

Parkways

Crossings

Stop Controlled


Crossing Islands

Signal Controlled


Grade Separation

Advisory Signage

Operation


Shared Use


Horizontal Bike/ped Separation


Vertical Bike/ped Separation

Amenities


Wayside Amenities

Wayfinding


Lighting

Figure 5.7: Level of Accommodation Example for Off-Street Paths

Tools for Creating Separation

Separation

Plastic Flexposts

Concrete Buffer

Landscaping

Planters

Level

Sidewalk Level

Roadway Level

Intersections

Protected Intersections

Signal Separation

Mixing Zones

Operation

One-Way

Two-Way

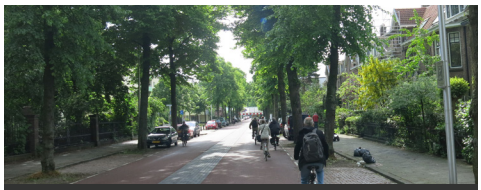
Figure 5.8: Level of Accommodation Example for Separated Bike Lanes

Tools for Creating
Lower Volumes and/or Speeds

Low Volume

Full Traffic Diverter

Half Traffic Diverter

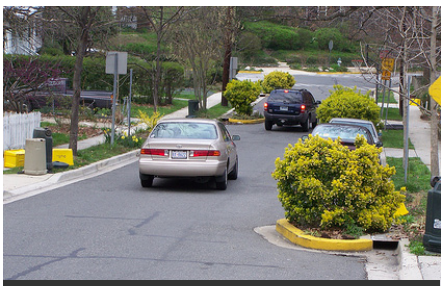


Bicycle Priority Street

Slow Speeds

Mini Traffic Circle

Green Street

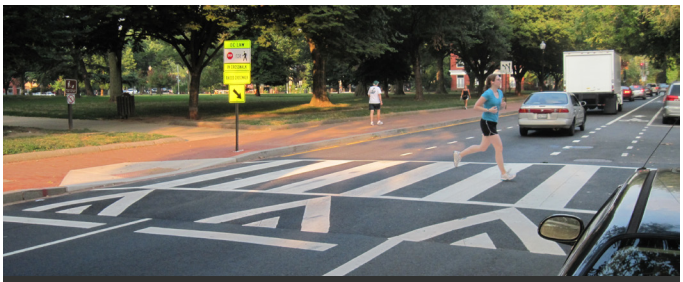


Landscaped Chicanes

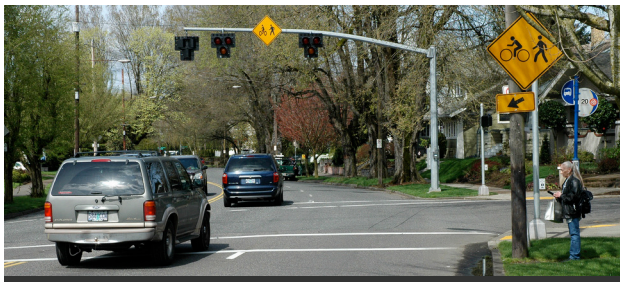
Curbside Community Gardening

Rain Garden Neckdown

Safe Crossings



Raised Crosswalk



Pedestrian- and Bicycle-only Signal

Branding

Wayfinding Signage

Street Art

Pavement Markings

Figure 5.9: Level of Accommodation Example for Volume and Speed Reduction

BICYCLE NETWORK VISION

The development of a comfortable, safe and connected bicycle network is an important step for Cambridge.

The 115-mile Bicycle Network Vision is best understood as a series of layers – starting with existing or high-comfort bicycle facilities (Figure A) and projects currently in-design or under-construction (Figure B). The existing network was assessed by its ability to connect people riding bicycles comfortably to key destinations including jobs, shopping, open space, and schools. In addition to land use, public comments, the BLC analysis, crash data, and other roadway conditions were utilized to determine where gaps exist in the current bicycle network and what major routes or desire lines for bicyclists need improved accommodation. Utilizing this assessment of existing conditions, the process of building the network focused on providing high-comfort routes between all major origins and destinations in the city.

Proposed off-street paths (Figure C) includes those paths which are envisioned to provide greater connectivity to the regional trail network. Streets proposed for increased separation (Figure D) represent mostly major streets and primary connections to destinations. Streets proposed for lower volume and/or speed (Figure E) mainly represent neighborhood and school connections. The resulting network is a long term vision for a safe, comfortable and connected network of streets and paths that seamlessly links key destinations throughout the city.

While all streets in Cambridge are used by bicyclists, the Bicycle Network Vision will prioritize the funding, redesign, reconstruction, and maintenance of projects to promote the completion of a connected high-comfort network (BLC 1 & 2) that provides a bicycling option for people of all ages and abilities. Improvements will continue to be made to other streets as opportunities arise. For example, adding shared lane markings to Broadway from Prospect Street to Portland Street improved the bicycling conditions but did not bring the street to a BLC 1 or 2. The Bicycle Network Vision will be a living document, updated regularly as new ideas and opportunities emerge.

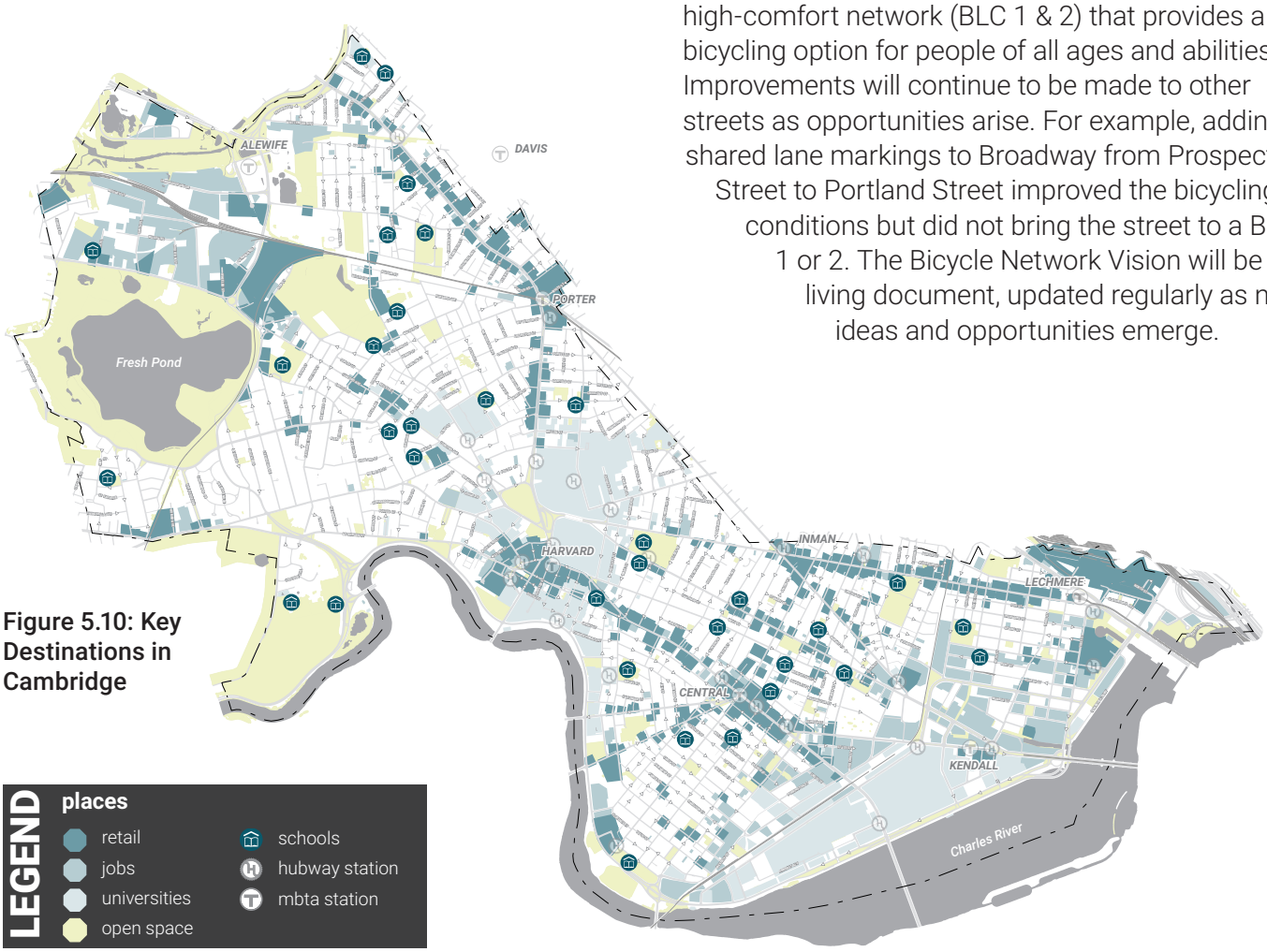


Figure 5.10: Key Destinations in Cambridge

Existing Bicycle Network

A

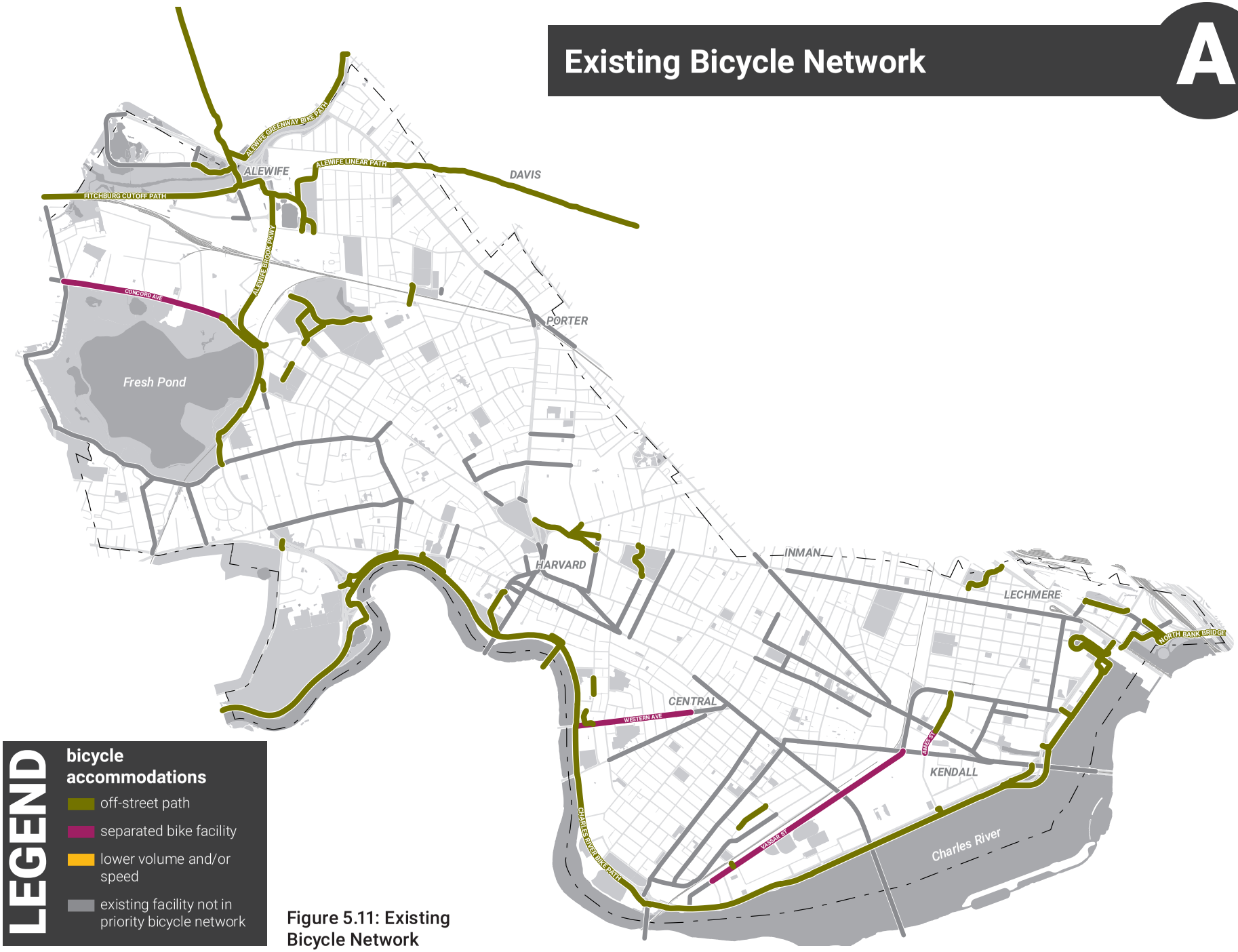
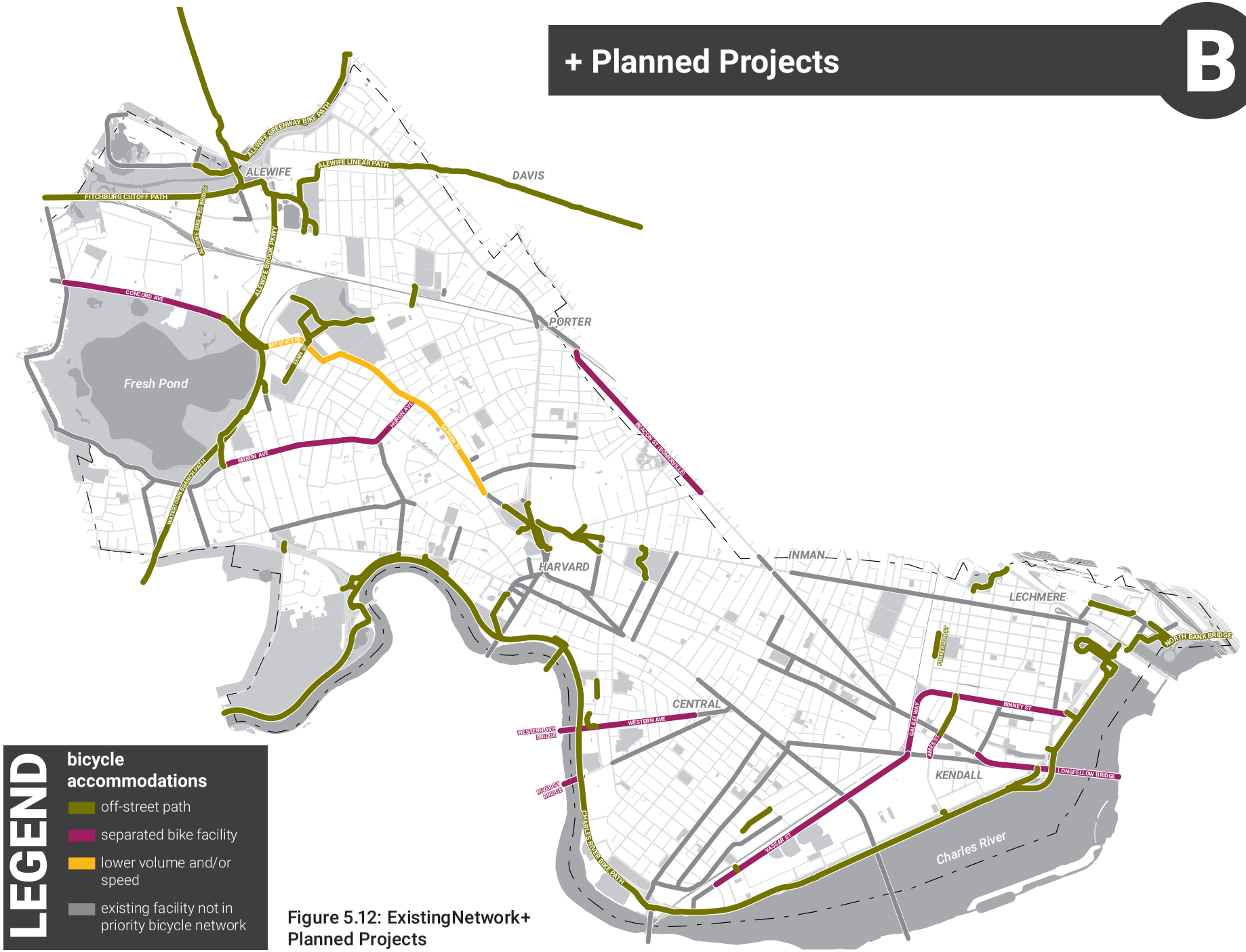


Figure 5.11: Existing Bicycle Network

+ Planned Projects

B



LEGEND

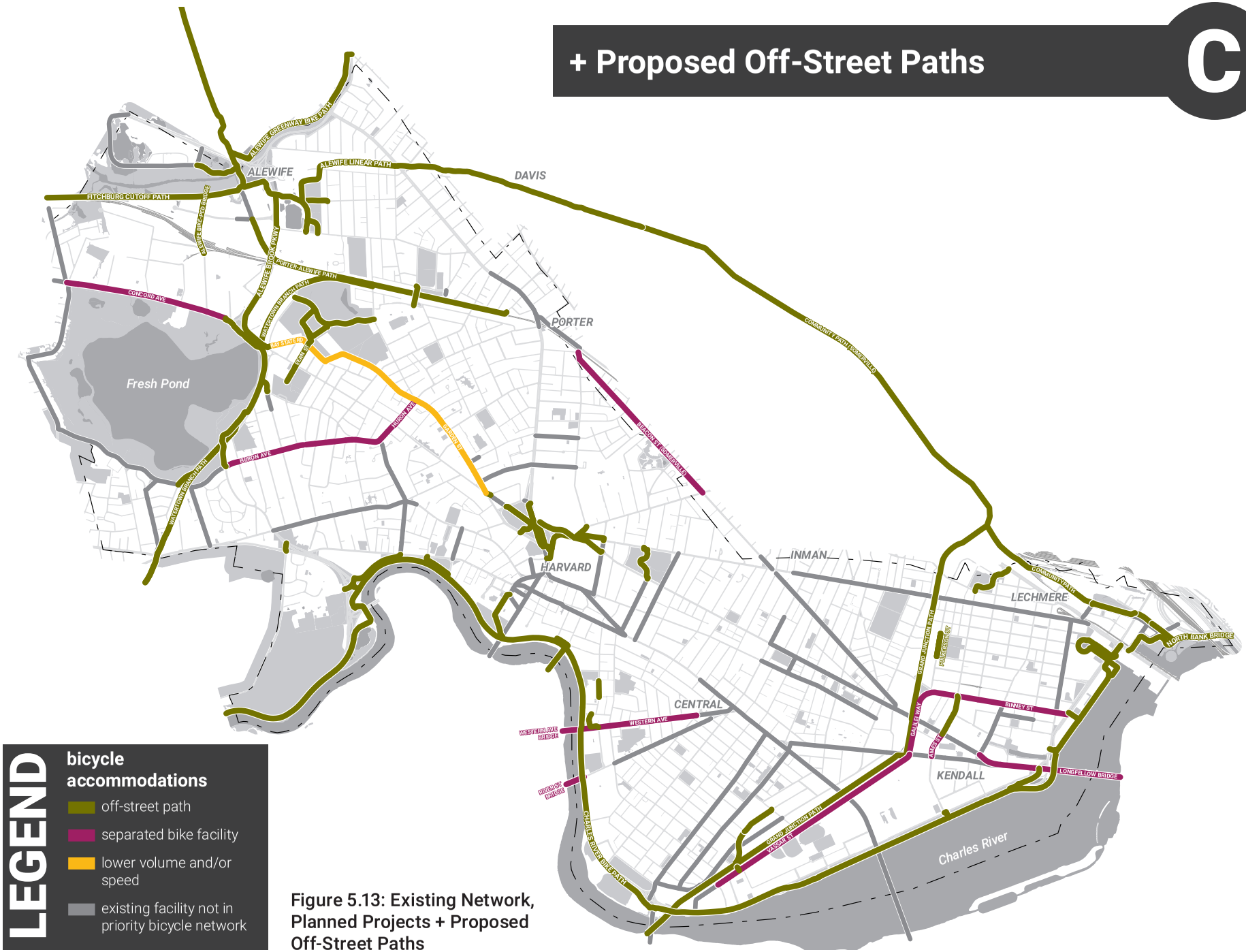
bicycle accommodations

- off-street path
- separated bike facility
- lower volume and/or speed
- existing facility not in priority bicycle network

Figure 5.12: ExistingNetwork+ Planned Projects

+ Proposed Off-Street Paths

C



LEGEND

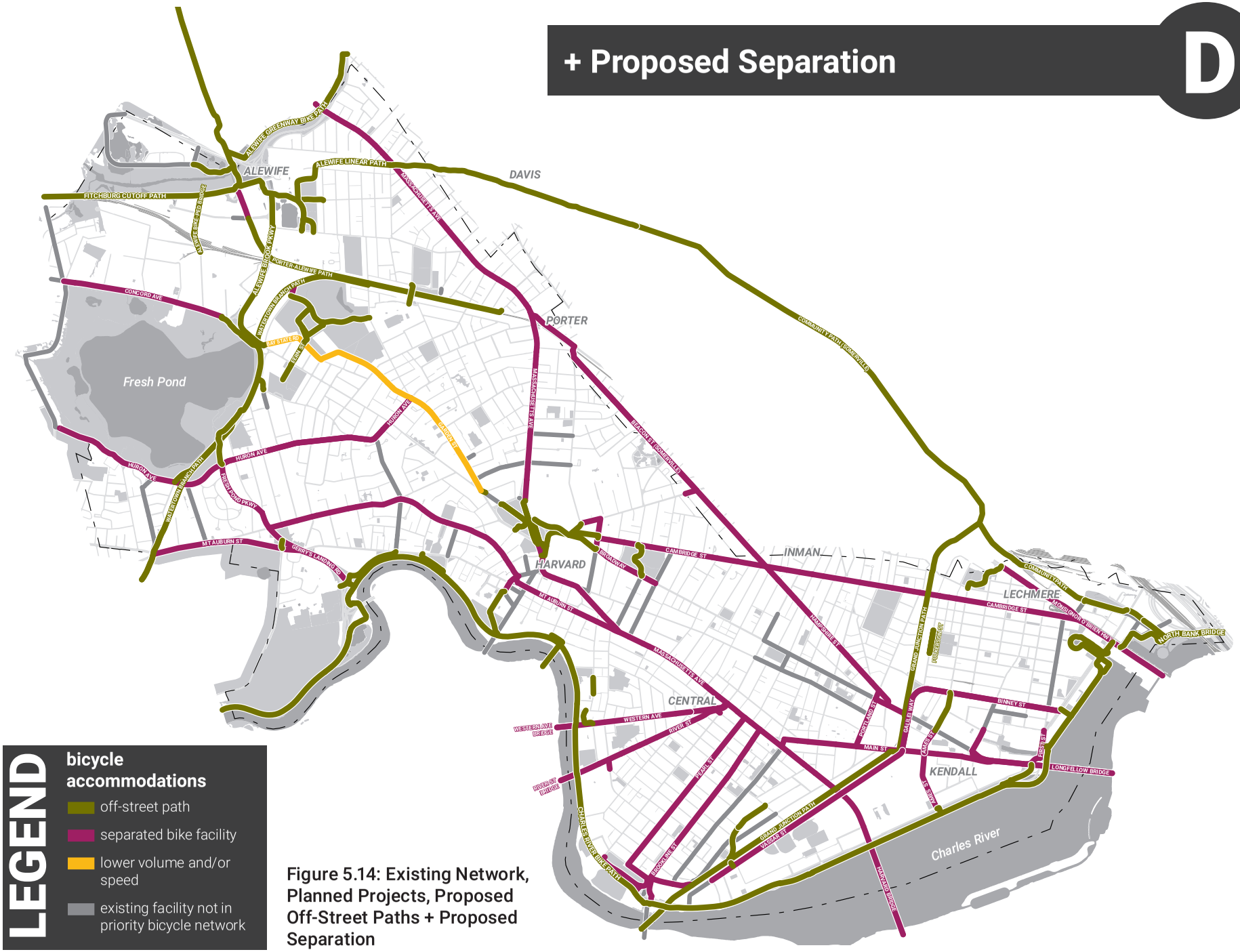
bicycle accommodations

- off-street path
- separated bike facility
- lower volume and/or speed
- existing facility not in priority bicycle network

Figure 5.13: Existing Network, Planned Projects + Proposed Off-Street Paths

+ Proposed Separation

D



LEGEND

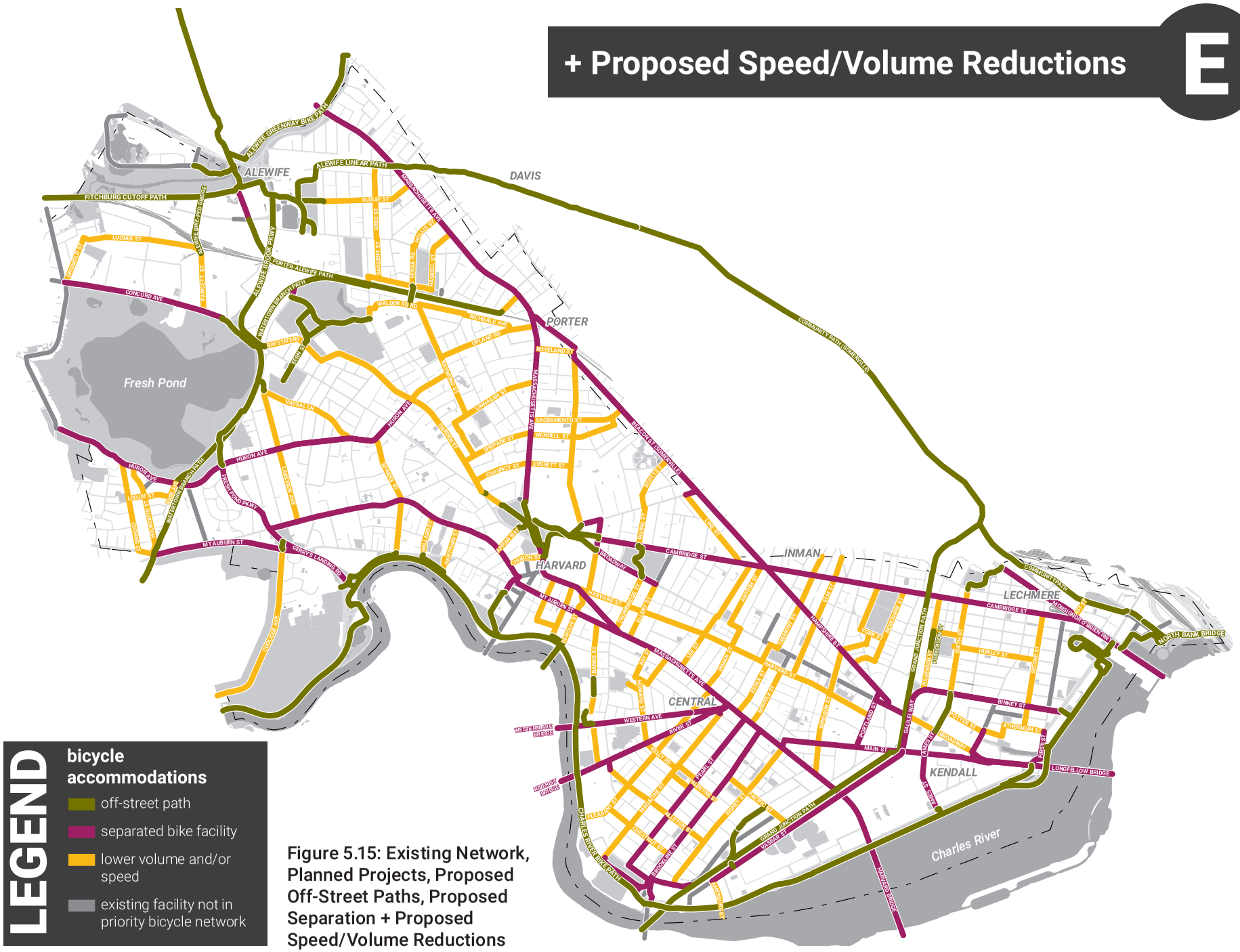
bicycle accommodations

- off-street path
- separated bike facility
- lower volume and/or speed
- existing facility not in priority bicycle network

Figure 5.14: Existing Network, Planned Projects, Proposed Off-Street Paths + Proposed Separation

+ Proposed Speed/Volume Reductions

E



LEGEND

bicycle accommodations

- off-street path
- separated bike facility
- lower volume and/or speed
- existing facility not in priority bicycle network

Figure 5.15: Existing Network, Planned Projects, Proposed Off-Street Paths, Proposed Separation + Proposed Speed/Volume Reductions

Bicycle Network Vision with Key Destinations

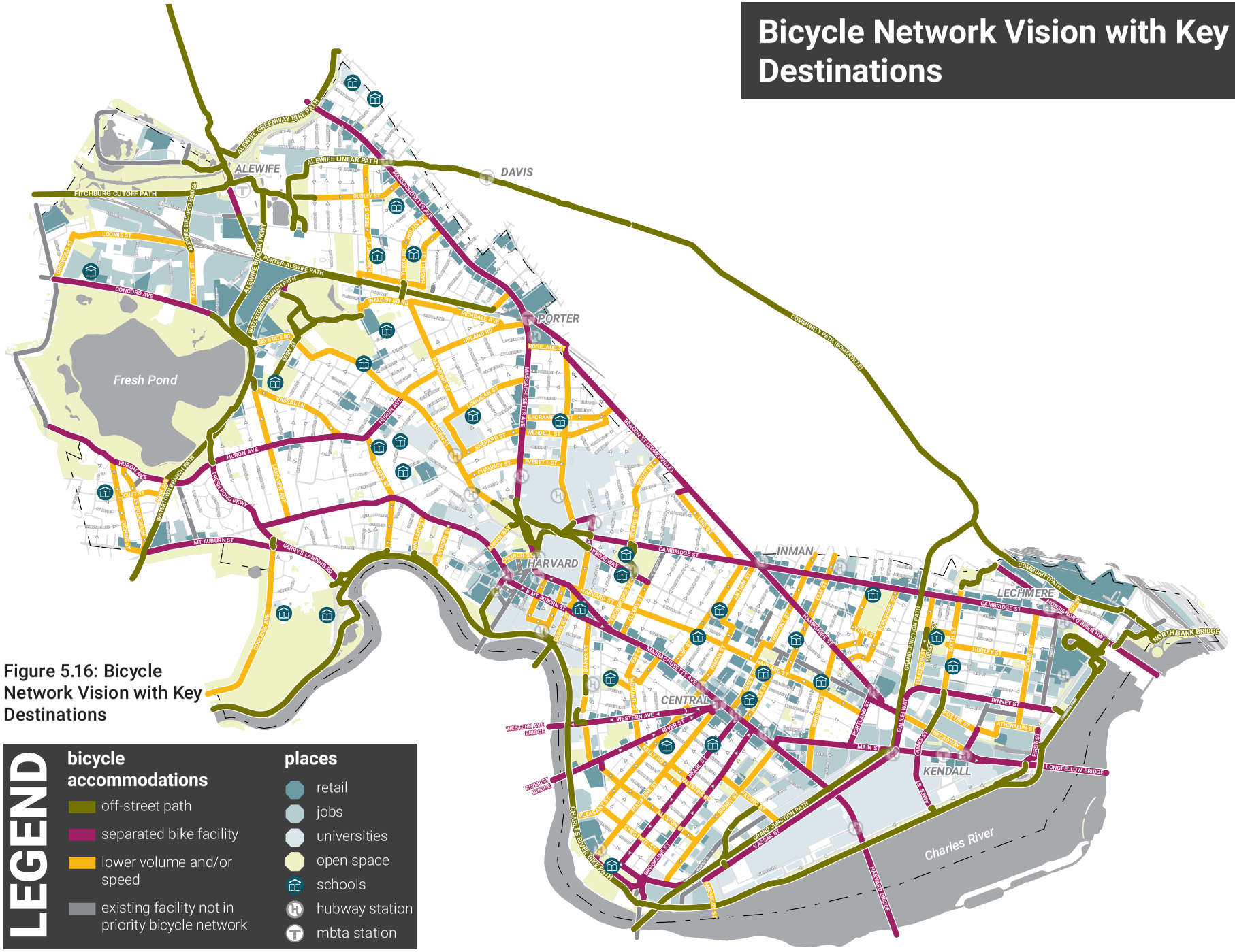


Figure 5.16: Bicycle Network Vision with Key Destinations

ENDNOTES

1 Mekuria, M., Furth, P., and Nixon, H., Low-stress bicycling and network connectivity, Mineta Transportation Institute (2012).