






HANOVER BICYCLE AND PEDESTRIAN MASTER PLAN

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Introduction

Purpose of the Master Plan

This is the first master plan for pedestrian and bicycle circulation that has been developed for the Town of Hanover. The plan has been developed in order to:

- identify policies to make walking and bicycling in Hanover safer, easier and more attractive;
- to identify standards and guidelines for pedestrian and bicycle facility design;
- to provide an action plan for future improvements to the bicycle and pedestrian network;
- to outline steps to promote walking and bicycling in Hanover as an alternative to driving.

The Benefits of Walking and Bicycling

There are a number of reasons to promote walking and bicycling in Hanover:

Improved Mobility. Walking and bicycling provides an alternative means for travel beyond driving. Most trips begin and end as pedestrian trips. Encouraging trips by foot and bicycle helps to reduce demand for limited street and parking space capacity. Unlike driving, walking and bicycling as a means of transportation is more accessible to a broader range of individuals, particularly children and seniors who may otherwise not be able to drive. Given the broader range of ages of walkers and bike riders, safety in the design of these facilities is an important consideration.

Improved Public Health. There is a vast and growing body of evidence that physical activity is important for both physical and mental health. In the United States, higher levels of walking and bicycling are correlated with lower obesity levels; lower diabetes rates; and lower incidence of high blood pressure.[1] Walking is one form of exercise readily available to most individuals;

1 Alliance for Biking and Walking, *Bicycling and Walking in the United States, 2010, Benchmarking Report*. Washington, DC, 2010.

research increasingly notes that walking 30 minutes a day is an exercise regimen that holds many health benefits and is accessible across the spectrum of age, economic position and ability.

A Healthy Environment. Driving is a major contributor to air, water and land pollution and climate change. Walking and bicycling promote a more sustainable and healthy environment because they are both zero emission modes of transportation.

Enhanced Economy and Quality of Life. Numerous studies have found that communities that are pedestrian and bicycle friendly have economic advantages including higher property values, are attractive to 'creative economy' professionals and tourists, lower commuting costs and lower costs to taxpayers. Walking and bicycling also contributes to improved quality of life and a greater sense of community.

Factors that Influence Walking and Bicycling

Encouraging walking and bicycling is a fertile area of research of interest regarding transportation, environmental health and human health and wellness. Based on research to date a number of specific factors have been shown to affect demand for walking and bicycling (non-motorized transport) in a particular situation. These include (Victoria Transport Policy Institute)[2]:

- *Attractions.* Certain activity centers tend to be major attractors for walking and cycling, including commercial districts, school-college-university campuses, employment centers, recreation centers and parks.
- *Trip distance.* Most walking trips are less than a mile, and most bicycling trips less than 5 miles in length, although recreational trips are often much longer.
- *Demographics.* Young (10-20 years), elderly, and low-income people tend to rely more on walking for transport. Young and low-income people tend to rely on cycling for transport. Households with lower vehicle ownership rates tend to rely more on non-motorized modes than those with one vehicle per driver.
- *Land use patterns (density and mix).* Walking and bicycling for transportation tend to increase with density (i.e., number of residents and businesses in a given area) because higher density makes these modes more efficient.
- *Travel conditions*. Wide roads with heavy, high-speed vehicle traffic can form significant barriers to non-motorized travel. Special facilities for non-motorized travel (sidewalks, wide curb lanes, and paths), their condition and connectivity can have a significant impact on the amount of walking and bicycling that occurs.
- *Topography and climate.* These factors can affect walking and bicycling, but not as much as might be expected. For example, the cities of Seattle, Portland and Missoula report significantly higher levels of cycle transportation than many "Sunbelt" cities that are flat and have mild climates.
- *Community attitudes.* Local attitudes can have a major impact on the level of cycling in a community. For example, it may be unremarkable that cycling tends to be high among college students and staff, but many college towns find that cycling is also relatively common among people who have no formal affiliation with the college simply because it has become an acceptable form of transportation. This indicates that some people hesitate to cycle, but will if they perceive it to be more socially acceptable.
- *Time and geographic scope.* It may take several years for a community to fully achieve its full non-motorized travel potential. First year impacts are frequently modest, but tend to increase as individuals become more accustomed to non-motorized travel and as additional support facilities (pedestrian and bicycle network, bicycle parking, etc.) develop.

These factors form the foundation of understanding that this plan is built upon.

2 Victoria Transport Policy Institute, Online TDM Encyclopedia, www.vtpi.org.

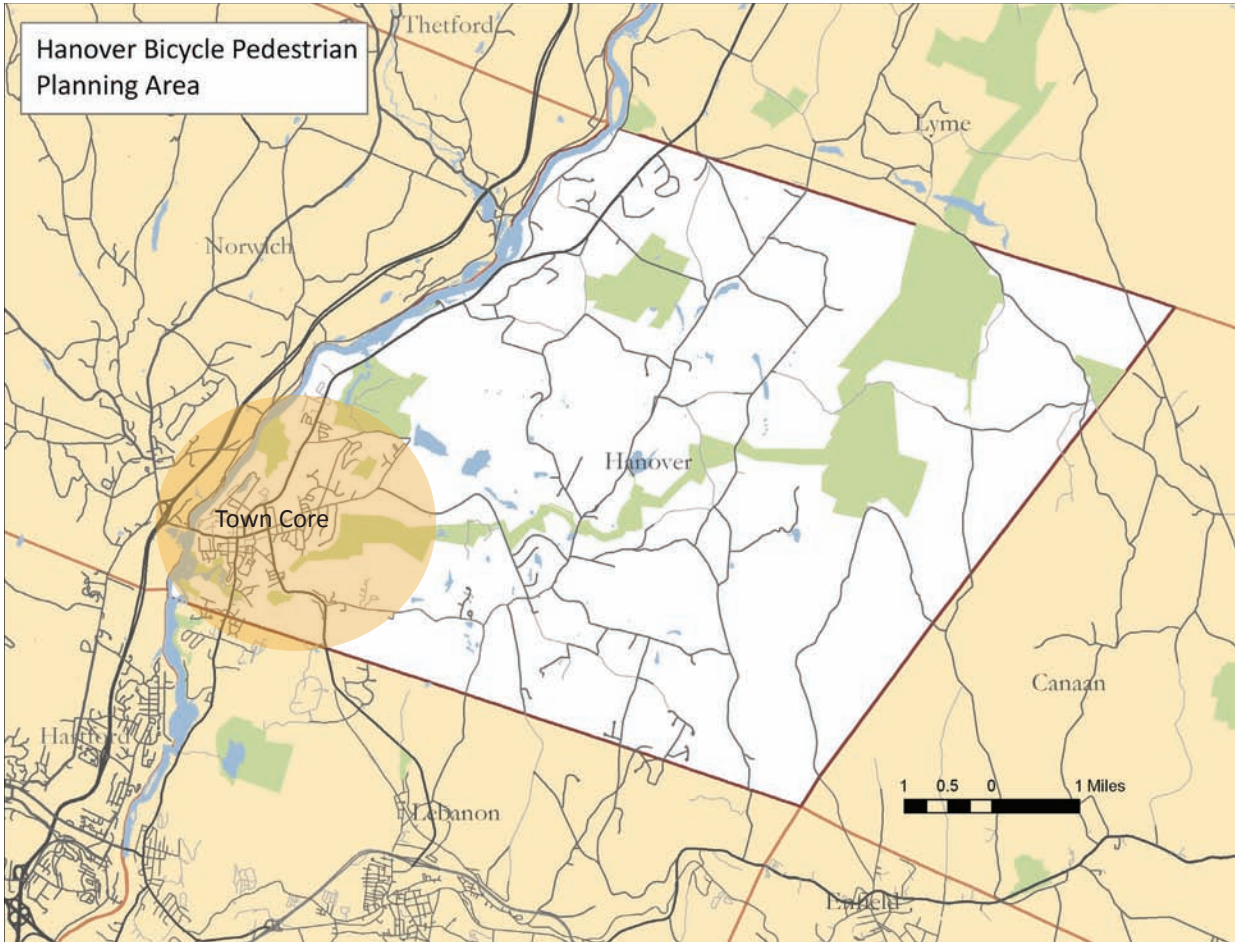


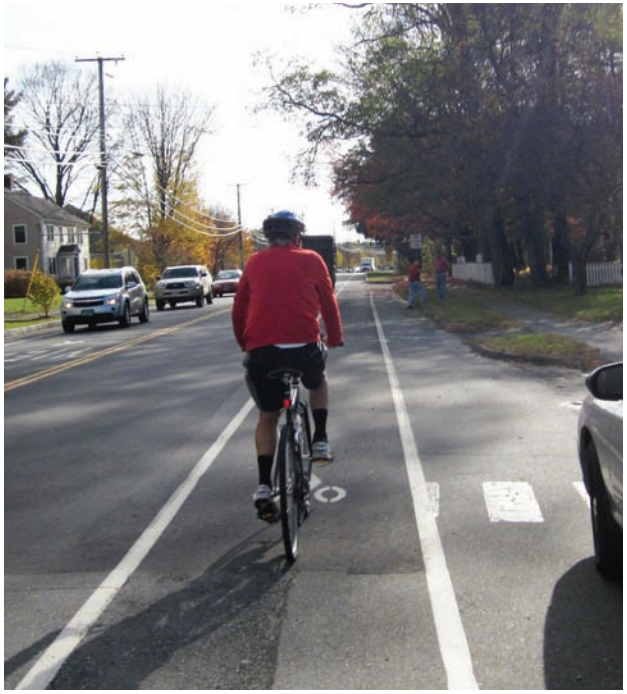
Figure 1: Plan Area

Plan Area

The focus of this plan is within the core of the town which includes the college, downtown, schools, and a majority of the residential neighborhoods of town. The plan does recognize that connecting routes to major destinations beyond the town line is important, particularly DHMC and Sachem Village, although both located in neighboring Lebanon. From a circulation perspective, both areas are closely connected with the College and Hanover.

Setting

The Town of Hanover had a 2000 population of 10,850. The Town is set along the Connecticut River which forms the western boundary of New Hampshire. Hanover is home to Dartmouth College, established in 1769, one of nine colleges established in the United States prior to the Revolutionary War. From a circulation point of view, the college campus and town center are very closely intertwined. The density of people and activities within the compact core of the college and Hanover's downtown provides an environment ideally suited to walking and bicycling. Dartmouth has an enrollment of over 6,000 undergraduate and graduate students and 4,000 employees. The College, as a major educational institution, employer and center of cultural offerings for the Upper Valley and beyond, has always had major influence on the Town's traffic patterns.



Walking and Bicycling in Hanover

Hanover enjoys very high levels of walking and bicycling: according to US Census *Journey to Work* data, the combined pedestrian and bicycle mode share in Hanover was 36.5% in 2000. By comparison, the statewide average is 3.7%. Significant levels of walking and bicycling in college and university towns is not uncommon, however. For example, 9 of the 13 Platinum and Gold level 'Bike Friendly Communities' as identified by the League of American Bicyclists are college towns.[3]

Despite these high levels of walking and bicycling, Hanover's pedestrian and bike mode share has declined significantly since 1990, when it accounted for 43.2% of work trips. The drop in the pedestrian and bicycling mode share between 1990 and 2000 is likely a reflection of the growth of both the town and the College, the move of Dartmouth Hitchcock Medical Center from the Dartmouth College campus in Hanover to Lebanon in 1991, and employees living in more remote, rural locations.

Dartmouth College

Dartmouth College has long promoted alternative modes of transportation, including transit, ridesharing, walking and bicycling for its students, faculty and staff. As of fall 2010, there were 4,248 undergraduates and 1,893 graduate students for a total enrollment of 6,141 students. [4] Over 90% of college undergraduates live on campus; this percentage has increased significantly over the last 10 years with the college's construction and improvement on housing on campus. Freshmen are not allowed to bring a car to campus; there-after, students must park in A-lot (East Wheelock near Burton Road at a cost of $42 per quarter). College supported graduate student housing is in place on campus, at Sachem Village and within the Town of Hanover.

Faculty and staff account for 4,060 employees. According to data from the Dartmouth College, eight percent (8%) of College employees walked or bicycled to work in 2009. Looking at all College employees, 38% arrive via the Ledyard Bridge; 24% via Route 120/Lebanon Street; 12% via South Main Street; 11% Route 120/Lyme Road; and 10% via East Wheelock Street.[5]

Green Commuting programs at Dartmouth College specifically related to pedestrian and bicycle circulation include the following (Source: *Dartmouth College Green Commuter Programs*, September 2008):

- The campus supports an extensive pedestrian network including pedestrian crossings and blue light security phones.
- Safe bicycle routes to and around campus and downtown.
- Bike racks are located throughout the campus; these are typically conveniently located near major buildings but not weather protected. Recently permitted projects include bike shelters or lockers.
- Bike and pedestrian commuters may sign up for free access to showers at Alumni Gym.
- Employee bike sharing program.

While pedestrian and bicycle counts are not sys-

3 The communities are: Boulder, CO; Davis, CA; Portland, OR (Platinum); Corvallis, OR; Eugene, OR; Fort Collins, CO; Jackson and Teton, WY; Madison, WI; Palo Alto, CA; San Francisco, CA; Seattle, WA; Stanford University, CA; Tuscon and East Pima, AZ; (Gold).

4 Dartmouth College Department of Institutional Research, Dartmouth Facts and Figures, Fall 2010. http://www.dartmouth.edu/~oir/pdfs/studentlife_10.pdf

5 Joanna Whitcomb, Director of Campus Planning, personal communication, March 10, 2011.

temically collected, a recent traffic study conducted for the Hanover Inn (December 2010) collected pedestrian and bicycle volumes at the corner of Wheelock and Main Street. These counts, conducted between 7:00 am to 1:00 pm and 3:00 to 6:00 pm counted 2,745 pedestrian crossings of this intersection and 224 bicycle crossings of this intersection. No data was collected for the hours between 1:00 and 3:00 pm, which are often peak walking and bicycling hours, so daily volumes are likely to be much higher. Regardless, the point remains that the intersection of Main and Wheelock Streets is a key community crossroads where pedestrian and bicycle volumes are very high.

Hanover Schools

There are three public schools in Hanover. In a nutshell, the street location, enrollment and grades are summarized below:

Bernice A. Ray School

Reservoir Road

Grades K through 5

Enrollment: 500 students

Frances C. Richmond School

Lyme Road

Hanover Grades 6 through 8

Norwich Grades 7-8

Enrollment: 425 students

Hanover High School

Lebanon Street

Grades 9 through 12

Hanover, Norwich and Lyme

Enrollment: 749

In the Fall of 2008 a bus ridership study conducted for SAU 70 found that 54% of Ray School students and 57% of Richmond School Students ride the bus. In June 2009, both schools conducted Safe Routes to School parent and in-class surveys regarding travel to school. Preliminary analysis of the surveys revealed the following modal split by school:

Bernice A. Ray Elementary School

School Bus: 45%

Family Vehicle: 38%

Walk: 9%

Bike: 3%

Carpool: 4%

Transit: 0%

Other (scooter, etc.): 1%

Frances C. Richmond Middle School

School Bus: 57%

Family Vehicle: 31%

Walk: 6%

Bike: 2%

Carpool: 1%

Transit: 3%

Other: Scooter, etc.): 0%

The Ray School PTO Transportation Committee conducted an online parent survey in 2008 regarding transportation to the school. Among the findings of this survey, 75% of parents who drove their students to school reported that they would prefer that their students walk, bike or ride the bus. The top three changes that were identified to help achieve this desire include:

- Reduced travel time on the bus (34.8%)
- Sidewalks along the route (25.5%)
- Bike lanes along the route (19.5%)

Above, bus riders at the Ray School. Below, pedestrians negotiate the fence at the end of Dresden Road.

The SAU #70 District promotes awareness of walking and bicycling and sponsors 'walk and bike to school' days. The Town has received a grant to prepare a Safe Routes to School Travel Plan.

Pedestrian and Bicyclist Planning Goals

The Hanover Bike and Pedestrian Advisory Committee has adopted the following Vision Statement, Mission and Goals for Hanover:

Vision:

To develop an enlightened public policy and community support that encourages walking and cycling.

Mission:

The Hanover Bicycle and Pedestrian Committee is dedicated to educating and influencing public policy for the safe accommodation of cycling and walking for transportation, commuting, recreation, individual and environmental health. The Committee informs and advises the Town on matters of pedestrian and cyclist safety and road design consistent with the values and objectives expressed in the Town of Hanover Master Plan.

Hanover Pedestrian and Cyclist Goals:

1. Increase the level of walking and bicycling in Hanover:
    a. Infrastructure: Build infrastructure that encourages walking and bicycling, that ensures pedestrian and cyclist safety, convenience, and accessibility as well as enjoyable travel.
    b. Connectivity: Create links for pedestrians and cyclists, on streets and other places, which connect neighborhoods, schools, shopping, places of employment, transit, and public spaces.
    c. Access: Prioritize routes to school and transit that enable pedestrians and cyclists to travel safely and freely.
    d. Streetscapes and Land Use: Create an environment using landscaping, public spaces and amenities that encourages pedestrian and cyclists travel; buildings a sense of community; complements neighborhoods and commercial districts; and reduces impacts on air and water resources.
    e. Mobility Alternatives: Adopt programs to increase the use of transit, ridesharing and other forms of mobility to help promote pedestrian and cyclist activity.
2. Integrate pedestrian and cyclist considerations into all projects, policies and the planning processes.
3. Inform and educate residents of the benefits of walking and cycling.
4. Develop a comprehensive pedestrian and cyclist plan based on the 'Five E's' as follows: Education, Engineering, Encouragement, Enforcement, and Evaluation.
5. Meet the standards of the League of American Bicyclists to be designated a Bicycle Friendly Community and the standards of the Pedestrian and Bicycle Information Center's to be designated a Walk Friendly Community.

As discussed above, higher levels of walking and bicycling conserves energy, contributes to cleaner air, reduces the need for parking and improves personal health and fitness. The plan recognizes that

walking and bicycling serve both transportation and recreational needs. As a small town with mix of residential, employment, recreational and cultural attractions all within a compact area, walking and bicycling are, and have historically been a viable means of transportation. This plan sets forth a long term vision of a pedestrian and bicycle network for Hanover that is safe and convenient for a broad cross- section of walking and bicycling abilities.

Pedestrians

"The sum of the whole is this: walk and be happy; walk and be healthy. The best way to lengthen out our days is to walk steadily and with a purpose."
-Charles Dickens

New Hampshire State Statues

'Pedestrians Rights and Duties' under New Hampshire state statutes are described in RSA 265:34-40. The question often is raised regarding the 'rules of the road' so these key provisions of New Hampshire statues are listed below for reference. A quick review of these statues reveal that, from a standpoint of state law, cars rule to road in New Hampshire.

Pedestrian's Right of Way in Crosswalks.

- Every pedestrian crossing a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right of way to all vehicles upon the roadway.
- Any pedestrian crossing a roadway at a point where a pedestrian tunnel or overhead pedestrian crossing has been provided shall yield the right of way to all vehicles upon the roadway.
- Between adjacent intersections at which traffic control signals are in operation pedestrians shall not cross at any place except in a marked crosswalk.
- No pedestrian shall cross a roadway intersection diagonally unless authorized by traffic control devices; and, when authorized to cross diagonally, pedestrians shall cross only in accordance with the official traffic control devices pertaining to such crossing movements (265:35).

Drivers to Exercise Due Care. Notwithstanding the foregoing provisions of this chapter or the provisions of any local ordinance, every driver of a vehicle shall exercise due care to avoid colliding with any pedestrian or any person propelling

a human-powered vehicle and shall give an audible signal when necessary and shall exercise proper precaution upon observing any child or any obviously confused, incapacitated or intoxicated person (265:37).

Pedestrians on Roadway

- Where sidewalks are provided it shall be unlawful for any pedestrian to walk along and upon an adjacent roadway.
- Where a sidewalk is not available, any pedestrian walking along and upon a way shall walk only on a shoulder, as far as practicable from the edge of the roadway. Where neither a sidewalk nor a shoulder is available, any pedestrian walking along and upon a way shall walk as near as practicable to an outside edge of the roadway, and if on a two-way roadway, shall walk only on the left side of the roadway.
- Except as otherwise provided in this chapter, any pedestrian upon a roadway shall yield the right of way to all vehicles upon the roadway (RSA 265:39).

Characteristics of Pedestrian Friendly Streets

In many ways, Hanover is a walkers' haven: the small town setting, with a vibrant downtown ringed by attractive walkable neighborhoods; a college campus interconnected into the town fabric; a network of small-scale streets (all two lanes); trails through river and wooded open space areas; a link of the Appalachian Trail. Initially established 250 years ago, the core of Hanover was designed for people to walk from place to place. The goal of this Pedestrian and Bicycle Master Plan is to preserve and enhance Hanover's townscape for pedestrians and encourage walking.

As described in the introduction, there are a number of factors related to land use mix and urban design factors that significantly influence walking; these factors are beyond the scope of this report. The report focuses on factors related to the street right of way taking into consideration that we know people want to walk where there are many destinations and that the built environment is pleasant, human scaled and oriented to the street

The following summarizes essential design considerations for pedestrian friendly design. Design considerations related to the public right of way must take into consideration that as a Town that is now 250 years old many of Hanover's street rights of way are very constrained in terms of width and improvements must be considered on a case by case basis

Traffic Volume: Heavier traffic volumes and higher speeds on some streets diminish the environment for both bikes and pedestrians. Streets that carry the highest volumes in Hanover are as follows (2009 and 2010 data):

- Lebanon Street (so. of Summer Street): 16,000 ADT
- Lebanon Street / Route 120 (no. of Greensboro): 16,000 ADT
- West Wheelock St (NH 10A) at stateline: 16,000 ADT
- South Park Street (NH 120) south of E. Wheelock: 10,000 ADT
- Lyme Road (NH 10) north of Ivy Point Way: 8,800 ADT
- South Main Street (NH 10) at town line: 7,200 ADT
- North Park Street: 7,000 ADT
- College Street (west of No. Park Street): 6,700 ADT

Where these higher volume routes traverse the town fabric, sidewalks should be buffered from the road with tree lawns to mitigate the effect of traffic volumes on bikes and pedestrians (bike accommodation is discussed below). In appropriate locations street parking also provides a buffer. Fortunately, sidewalks with generous tree buffers are in place along West Wheelock Street, South Park Street, North Park Street, a portion of Lebanon Street, and College Street.

Traffic Speed: As shown in Figure 2, speed kills. A pedestrian's chance of surviving a collision with an automobile decreases drastically with the speed

A dense pedestrian walkway network serves the downtown and the core of the College campus.

of traffic. At 20 mph, cars can stop relatively easily for a pedestrian and the risk of a pedestrian fatality from the collision is 5%; that risk increases significantly to 45% as speed increases to 30 mph; and the risk of a pedestrian death is 85% if the speed is 40 mph.

The greatest factor influencing traffic speed is road design – street and block patterns; lane widths; street widths; the presence of on-street parking; vertical and horizontal curves; corner radii. Posted speed limits will have limited effect on traffic speed if the road is designed for higher speeds.

Block Sizes: In most communities block sizes and the street network set the overall template for a walkable community. Block sizes influence walkability for a number of reasons:

1. Shorter blocks and more intersections create multiple route options and the possibility for pedestrians to use the most direct route between origins and destinations. While a distance of 50 or 100 feet is so small as to be immaterial in a car or even on a bicycle, such a distance is significant to a pedestrian, particularly when walking in cold or inclement weather.

2. Frequent intersections mean more places where cars must stop and pedestrians can cross the street. This supports finding a direct walking route, and also increases safety.

3. A dense network of streets disperses traffic so that streets carry lower traffic volumes and are more pleasant places to walk.

What block length is optimal? "For a high degree of walkability, block lengths of 300 feet, more or less, are desirable. Blocks of 400 feet to 500 are typical of older urban areas and are workable…" (Ewing). In the core of Hanover, where pedestrian volumes are very high and the environment is pedestrian friendly, most pedestrians simply won't walk 100 or 150 feet out of their way to get to a marked crossing. Mid-block crossings and pedestrian lanes should be maintained and enhanced in the down-

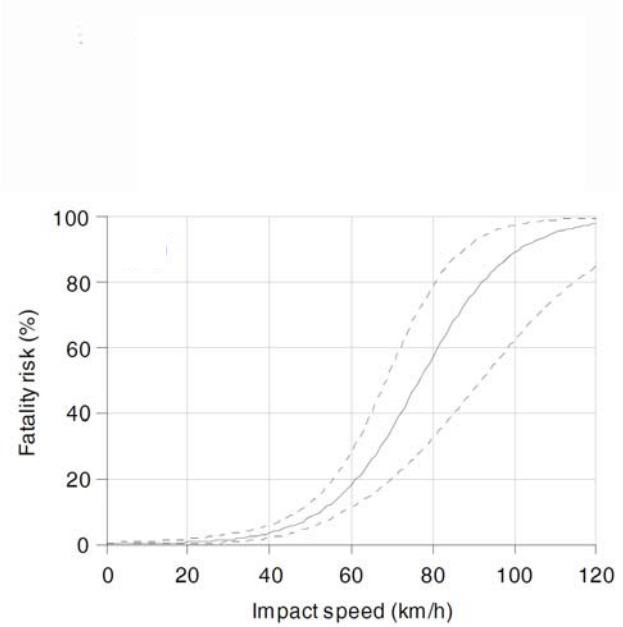


Figure 2. The relationship between speed and pedestrian fatalities.

Example Block Sizes in Downtown Hanover

Dartmouth Green:	400' by 600'
No. Main St: W. Wheelock to Allen St:	300'
No. Main St. W. Wheelock to Lebanon St:	500'
W. Wheelock St: College to Crosby:	500'
W. Wheelock St: Crosby to Park Street:	900'

Pedestrian connections and alleys provide convenience and access.

Tree lawns provide a buffer for pedestrians, improving their comfort and safety.

town and campus core to maintain a safe and effective pedestrian environment.

While these dimensions provide general guidance – considering context is crucial. The pedestrian network in downtown will be different than in lower density residential areas and common sense must be applied. It is clear that downtown Hanover and the core of the Dartmouth campus enjoy very high levels of pedestrian activity. Surrounding 'in-town' neighborhoods surrounding the downtown and the Dresden neighborhood also enjoy high levels of walking. Within these areas it is important to preserve and improve the rich and attractive network of streets, sidewalks, alleys, and pedestrian passages that provide a walkable network.

In downtown Hanover and the core of the college campus, the pedestrian network consisting of sidewalks, walkways and mid-block passages provides a robust walking environment with direct and efficient pedestrian routes between numerous commercial, institutional and residential destinations. The treatment of alleys connecting the main parking area behind Town Hall to Main Street add convenience for pedestrians and create a network that is excellent in terms of route directness.

The variety of the block patterns in Hanover adds to its pedestrian interest as well. A warped street grid that provides an interconnected network of streets calms traffic and provides visual interest for walkers in contrast to long straight streets that encourage higher speeds.

Sidewalks. Sidewalks are the most basic element of pedestrian infrastructure providing a means to separate pedestrians from cars and provide them with a comfortable route for walking. Sidewalks are also important social spaces where neighbors can meet, engage in conversation, and watch passersby in an outdoor setting. The importance of the social dimension of sidewalks has been studied by many prominent researchers, and sidewalks must be appreciated for their significant contribution to a community's quality of life and social appeal.[1]

The basic design considerations for sidewalks are governed by the American with Disabilities Act (ADA) which sets basic requirements to eliminate barriers for persons with disabilities. Beyond basic ADA requirements however there are a number of considerations to make sidewalks as appealing and comfortable as possible to improve walkability.

Sidewalk Width: Typically, a minimum width of 5 feet is required. A five-foot wide sidewalk is adequate for two people to walk side by side and represents an adequate dimension for areas with light pedestrian traffic. To meet ADA requirements, sidewalks less than 5 feet in width must have passing space of five feet in width every 200 feet. Five feet is necessary for circulation, and this area must be kept clear of benches, utility poles, trees, bike racks, etc. In areas with higher pedestrian volumes, street furniture, buildings that run up to the sidewalk, additional width is required.

Tree Lawn / Buffer: Where possible, it is highly desirable to include a tree lawn or buffer area between the curb edge and the sidewalk to improve the environment and visual amenity of the

1 See for example, Jacobs, Jane, *The Death and Life of Great American Cities*, Random House, New York, 1961; Appleyard, Donald, Livable Streets, University of California Press, 1981; Jacobs, Allan B., Great Streets, Massachusetts Institute of Technology Press, Cambridge, MA, 1993; Whyte, William, The Social Life of Small Urban Spaces, The Conservation Foundation, Washington, DC, 1980.

street. The green strip between the street and the sidewalk provides numerous benefits: buffering pedestrians from nearby traffic, providing shade and reducing the urban heat island effect, providing a vertical element that enhances the sense of enclosure and reduces perceived width of the street, absorbing and filtering stormwater runoff, and storing snow in the winter months. In Hanover's very constrained rights of way, tree lawns are not always feasible. From a pedestrian point of view, streets that carry the highest volumes of traffic and pedestrians should be prioritized for street tree planting. In Hanover, these streets include Wheelock Street, Main Street, Park Street, Lebanon Street, Lyme Road, and College Street.

The width of the tree belt is an important consideration. For trees to thrive in this climate, a minimum width of five feet is required; while six or more feet will provide better growing environment for street trees. Buffer areas too narrow for tree planting can be planted with grasses, shrubs or ornamental plantings for visual interest. Due to their many visual and environmental benefits, tree planting should be the goal.

In areas where there is on-street parking, provision must be made for walking between the curb and the sidewalk. If a tree lawn is in place, paved walkways between the curb and the sidewalk (through the tree belt) are desirable. In very high volume pedestrian areas, such as downtown commercial streets, street trees planted in tree wells is the most appropriate treatment.

Street Trees: Street trees play an important role in creating a more pleasing walking (and bicycling) environment, acting as a buffer between pedestrians and motor vehicle traffic; creating a sense of enclosure and narrowing the perceived width of streets; providing shade in the summer; mitigating the urban heat island effect; and improving air quality. In general, street trees should be high crowned deciduous species that are tolerant of salt, pollution, soil compaction, and drought.

Green Street Planting: Tree lawn buffer areas also provide an opportunity to capture and manage surface stormwater from surrounding paved areas, thereby contributing to a more sustainable community. This approach to stormwater management can filter and remove excess sediments and other pollutants from runoff; reduce the velocity of runoff by detaining stormwater in an appropriately landscaped area; and allow retained stormwater to be absorbed into the ground and filtered through the landscape. Green street plantings can reduce the amount of polluted stormwater that enter into receiving creeks and waterways. This concept of a 'green street' can do double duty in creating a more attractive street for bike and pedestrians while also retaining stormwater and reducing water pollution.

The concept of green streets is a broad topic and there are numerous technical considerations and design approaches related to the context of the street. This broad topic cannot be covered entirely in this plan but should be considered as part of future street improvements. Opportunities for demonstration projects should be identified, implemented and observed in order to identify which strategies are most successful. As stormwater pollution is growing environmental concern which is going through a cycle of innovation, special opportunities for funding green street type projects may become available in the future.

Above, a 'green street' treatment in Seattle provides a narrower street and attractive planting buffer. Below, stormwater planting combined with a shared use path and mini-park in Vancouver, BC.

Table 1. Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT >9000 to 12,000			Vehicle ADT >12,000 - 15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multi-Lane (4 or More Lanes) With Raised Median***	C	C	P	C	P	N	P	P	N	N	N	N
Multi-Lane (4 or More Lanes) Without Raised Median	C	P	N	P	P	N	N	N	N	N	N	N

* These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone **will not** make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. **These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.**

** Where the speed limit exceeds 40 mi/h (64.4 km/h) marked crosswalks alone should not be used at unsignalized locations.

C = **Candidate sites for marked crosswalks**. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk alone.

P = **Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements.** These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = **Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.**

*** The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

Source: Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines, US Department of Transportation, Federal Highway Administration, February 2002.

Crosswalks. Crosswalks greatly assist pedestrian navigation, comfort and safety. Crosswalks assist pedestrian safety by alerting motorists and bicyclists to look for pedestrians and by guiding pedestrians to a safe crossing. Pedestrians must be able to cross streets at regular intervals and cannot be expected to go 300 to 400 feet out of their way to take advantage of a formal crosswalk. [2]

There has been some debate regarding the placement of marked crosswalks at uncontrolled intersections (intersections without signals or stop signs), and these situations pose a dilemma for traffic engineers. An extensive study by the FHWA conducted in 2002, as well as more recent studies by the Transportation Research Board, help shed light on the best practices for pedestrian crossings at uncontrolled intersections.

As ever, decisions about marked crosswalks in Hanover must take into consideration the unique setting and situation of the town. First and foremost the core of Hanover, including the College, the downtown retail district and surrounding neighborhoods are ***major*** pedestrian generators. As shown in our modal split data discussed above, as well as traffic studies conducted for various projects, Hanover enjoys very high levels of walking. As a small town, Hanover has a street network comprised of two-lane roads with ***many*** uncontrolled intersections and mid-block crossings. Guidance regarding the placement of marked crossings in Hanover must balance what we know about safety from research conducted and best practices from around the country with what makes sense for our unique town setting, bearing in mind that most studies have been conducted in areas with road conditions that are very different from Hanover.

2 Context Sensitive Solutions in Designing Major Urban thoroughfares for Walkable Communities, Institute of Transportation Engineers, 2010.

Table 1 on page 2-6 is an excerpt from the 2002 FHWA report and provides guidance regarding placement of marked crossings at uncontrolled intersections:

- when to consider a marked crossing and
- where they should be provided with additional pedestrian facility enhancements such as traffic calming, pedestrian refuges, curb extensions, signals, signage, etc.

Crosswalk Design Considerations: Crosswalks should be designed to be perpendicular to the street to the maximum extent feasible. This shortens the crossing distance and therefore the time a pedestrian is in the street, minimizing exposure to vehicles.

Hanover has three basic crosswalk designations:

Ladder Style. This highly visible crosswalk striping is successfully used for the majority of crossings in Hanover. The visibility of the white stripes on asphalt is a simple and effective crosswalk treatment for the majority of crossings.

Textured / Painted Crosswalk with Speed Hump. On College Street, crossings have been constructed with textured asphalt and painted to visually stand out. The slight speed hump calms traffic along the street where there are very high volumes of pedestrians and parked cars along both sides of the street.

Speed Table Crosswalk. On Maynard Street, a wide crosswalk combined with a speed table has been constructed to accommodate pedestrians. The speed table has been treated with a thermoplastic stencil that is brick red with white edges.

White ladder style crossings.

Colored textured pavement and a small speed bump slow traffic on College Street.

Speed table crossing on Maynard Street. This crossing could be augmented with white bars for greater visibility.

In every case, the white stop bar or ladder is the most visible part of the crosswalk. The visibility of the crosswalk on Maynard would be enhanced by traditional white stripes bordering the crosswalk.

Supplemental Signage or Stencils. Depending on street conditions, crosswalks are also supplemented with painted 'Ped Xing' stencils on the roadway. This additional markings help alert motorists to expect pedestrians. The use of these supplemental warnings should be carefully considered based on street conditions, so as to not cause visual clutter and / or be overused to the point where drivers do not notice the warning signage.

***Mid-Block Crossings*:** There are places along the street network where pedestrians will opt to cross mid-block rather than at the nearest controlled intersection. This may be due to a long distance between intersections, the desire to avoid back tracking, and/or high volumes of pedestrian-generating uses on opposing sides of the street. Formalized midblock crossings improve pedestrian safety and convenience by managing the crossings and channeling them to a safe location. Mid-block crossings can help nearby intersections with capacity problems by allowing pedestrian crossings without taking capacity from the intersection.

Because mid-block crossings can be unexpected, they should be made highly visible to drivers. The crosswalk should be visually dramatic: a visible 'ladder' stripe pattern or fully painted out striping, integral colored, textured pavement set off by white bars. Signage should be used to warn drivers of an upcoming midblock crossing. Mid-block crossings can be combined with speed tables or pedestrian refuges to add a measure of traffic calming to the crossing if warranted by street conditions. Traffic volumes and street use by emergency services are a consideration with respect to the use of speed tables.

As described in the beginning of this report, Dartmouth College and Hanover's downtown are major pedestrian generators and mid-block crossings are in place at several locations in the pedestrian core.

Pedestrian Signals. At most signalized locations, Hanover has installed pedestrian demand signals, and on Main Street (where pedestrian traffic is very high) there is a separate pedestrian phase and countdown signal that allows pedestrians to cross in every direction and be aware of the amount of time remaining to cross the street. At other intersections, pedestrians are to cross during the green phase for that intersection approach, and turning vehicles should yield to pedestrians in the crosswalk. Pedestrian signals assist movement at busy downtown intersections where there are significant volumes of both pedestrians and cars. The pedestrian phase is also often used by bicyclists. Currently, the Greensboro Road / Lebanon Street intersection lacks accommodation for pedestrians (and bikes). This is discussed below.

Driveway Curb Cuts: Vehicular curb cuts allow vehicles to cross a sidewalk into a driveway. As such they present the potential for conflicts between vehicles and sidewalk users as well as grade changes on the sidewalk which present tripping hazards a concern particularly in icy weather.

Curb cuts should be kept to an absolute minimum in number and width, particularly in the pedestrian core of town. The town's land use ordinances should reflect this goal by encouraging development to rely on alleys rather than curb cuts for access. Every attempt should be made to keep the pedestrian travel zone of the sidewalk free of grade

changes; a maximum 2% grade per ADA for 3 feet should be viewed as a minimum standard. Finally, the sidewalk material (i.e., concrete) should continue across the curb cut so that vehicles are visually reminded that they are crossing a sidewalk.

Curb Return Radii: The curb radii at intersections affect pedestrians in two ways: sharper turns (smaller radii) require cars to turn more slowly and also create shorter crossing distances. Curb radii should be as small as possible in pedestrian intensive zones, taking into consideration the largest vehicle type that will frequently turn the corner (the 'design' vehicle), and the turning path requirements. As a guideline for pedestrian zones, curb return radii should be 15' (ideal) to 30' (where required by larger vehicles for turning paths).

Benches: Street furniture, and benches in particular, provide an amenity that encourages walking. Benches should be placed along streets that have high pedestrian volumes and prioritized for locations such as the downtown, campus and Dresden neighborhoods, near major building entries, retail and restaurant destinations, sidewalks near senior housing and transit stops. For seniors, benches located along walkways between home and destinations such as the Coop or the library allow for taking a rest en route, and help to make the trip by foot more feasible.

Transit Shelters / Waiting Areas: Transit stops add to the vitality and life of the pedestrian environment. Stops with high boardings are greatly enhanced by attractively designed waiting areas which may include a bench, shelter (ideally with route and schedule information), trees, good lighting, nearby crosswalk, and identifying signage. Pedestrian safety, comfort and accessibility are paramount concerns at transit stops.

Lighting: Hanover has attractive, pedestrian scale (i.e., 10' to 14' in height) light fixtures in place along its core streets which carry high volumes of pedestrians, and the College has pedestrian scale lighting along campus pedestrian promenades. The town has recently retrofitted the downtown light fixtures with high energy efficiency LED fixtures.

Recommendations

Hanover has made significant improvements that have greatly improved its pedestrian environment. Most significantly in recent years, constructing roundabouts and narrowing the street section on Lyme Road from a rural highway design characterized by very wide traffic lanes and shoulders, to a 'Complete Street' profile that accommodates bike lanes, sidewalks and transit, is exemplary. This village center, which includes schools, employment destinations, a neighborhood market, recreational fields, a significant component of senior housing and single family housing, is a model of a walkable village center.

Similarly, changes to Hanover's downtown in the South Block area and the new sidewalk on Park Street at the baseball field have significantly improved the pedestrian network and quality of life in these districts.

Wide curb radii lengthen the crossing distance for pedestrians and discourage motorists from slowing down to turn the corner.

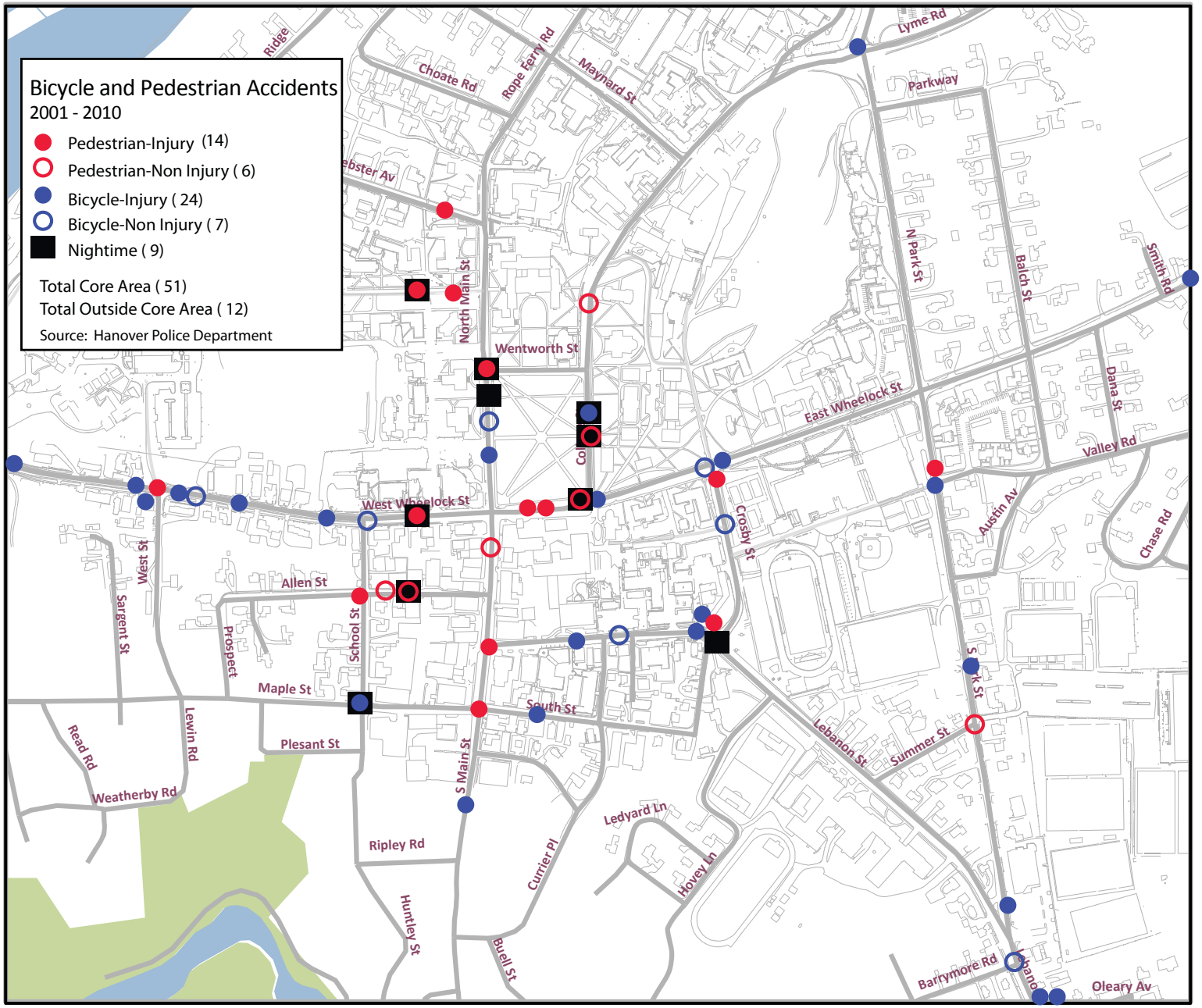


Figure 3: Pedestrian and Bicycle Accidents in the core of Hanover.

Accident Data

Bicycle and pedestrian accident data for the past 10 years is displayed in Figure 3. Overall, the number of accidents are low given the volumes of both pedestrians and traffic on core streets in Hanover. Using this data as a starting point, supplemented with field observations, a couple of areas emerge to be of concern for pedestrians, primarily crossings of Wheelock Street and streets around the Dartmouth Green.

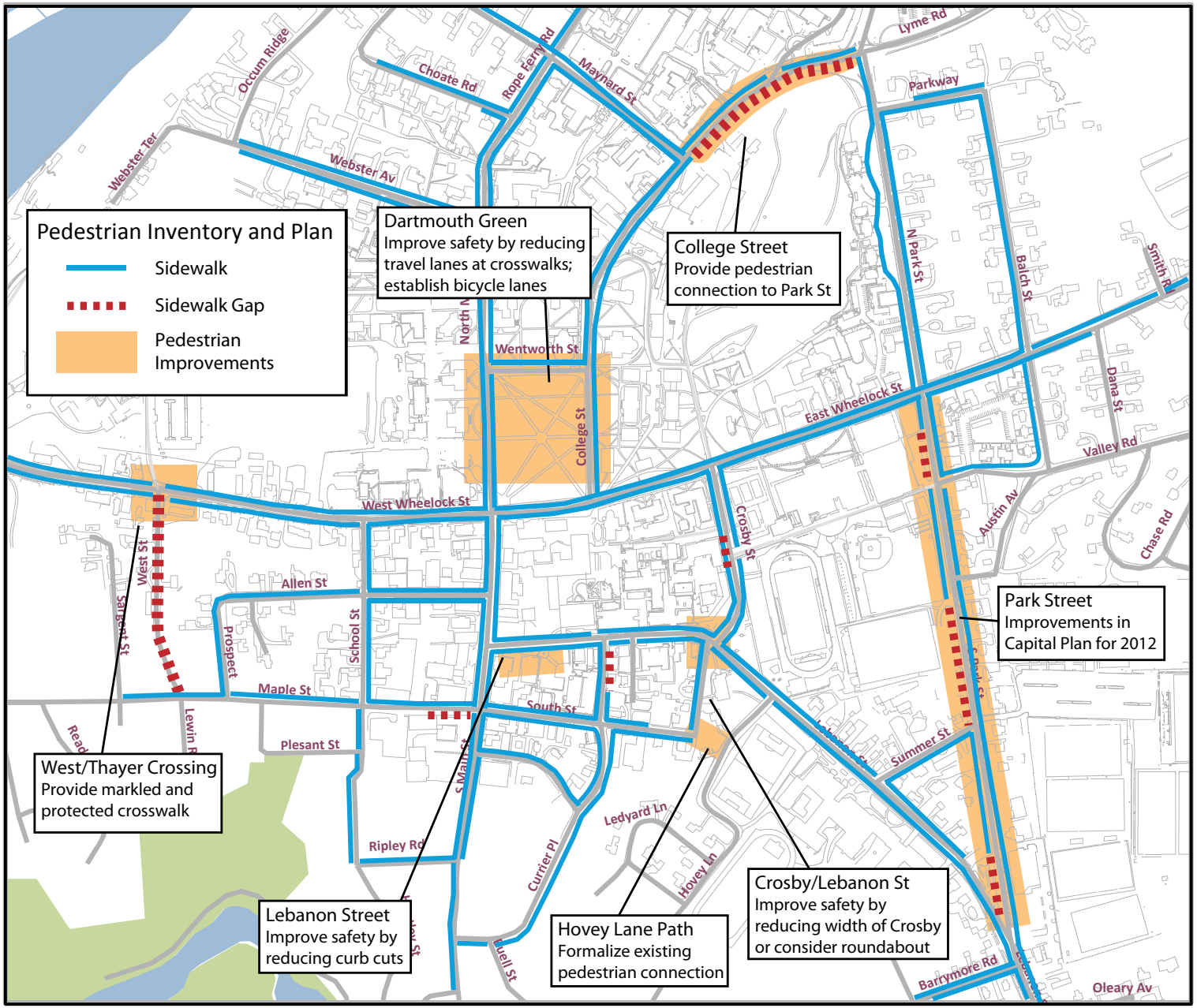


Figure 4: Recommended Pedestrian Improvements

Missing Sidewalks and Paths

Figure 4 shows the recommendations for pedestrian improvements to the core area of Hanover. It should be noted that in addition to the streets in the core area, the campus and the downtown include a number of pedestrian walkways and lanes that are important components of the pedestrian network that should be maintained and enhanced. However, there are several missing sidewalk links, described below, which should be constructed in conjunction with adjoining development or as opportunities arise.

Verona Road. This area is a focus of higher density housing, including Brook Hollow, The Courtyard, and Willow Spring senior apartments, with high pedestrian activity, vertical and horizontal street curves with poor sight distance at one location. This is also a busy family neighborhood with a school bus stop and a nearby nursery school. A sidewalk should be constructed along Verona Road from Wheelock Street to the Courtyard driveway or to the intersection of Willow Spring and Butternut.

West Street. West Street provides an important pedestrian connection between the 'west end' neighborhood and the Dartmouth campus via Thayer Drive, as well as to an Advance Transit stop. A sidewalk along this route should be considered.

College Street. There is a well-worn path indicating a strong desire-line along the south side of College Street to the graduate student housing on North Park Street. Due to grades, this is a challenging location for an ADA accessible walkway, which would likely require a retaining wall and railings, but it is clearly an important link in the pedestrian network.

South Street to Hovey Lane Path. This path is a very heavily used pedestrian and bike path that provides a very key link between Hanover High School and the Howe Library/ downtown and associated neighborhoods. This path is mulched. Due to heavy use, this path should be paved and maintained for winter travel. There are a number of technical issues that must be addressed here in order to make it useable for bikes as well as pedestrians, including; a contraflow bike lane (see Bicycle chapter) on the one –way section of South Street; and the interface / continuation of that path along Hovey Lane.

Lebanon Street from Greensboro Road to Buck Road. There are currently no pedestrian facilities provided to the numerous land uses along Buck Road. In addition, the Gile Hill housing complex has a direct pedestrian connection to Buck Road. The Town of Hanover's permit for Gile Hill requires the developer to provide a pedestrian facility prior to occupancy of the last unit. It is recommended that this connection be a sidewalk along Route 120, which can easily be constructed in the right-of-way be implementing a "road diet" on Route 120 through the Greensboro Road intersection. A preliminary traffic engineering analysis of this concept using current data from the Town of Hanover indicates it is feasible and would have little effect on traffic operations and congestion. The road diet would greatly increase pedestrian and bicycle safety, and would allow the construction of a high quality sidewalk to be much more cost effective.

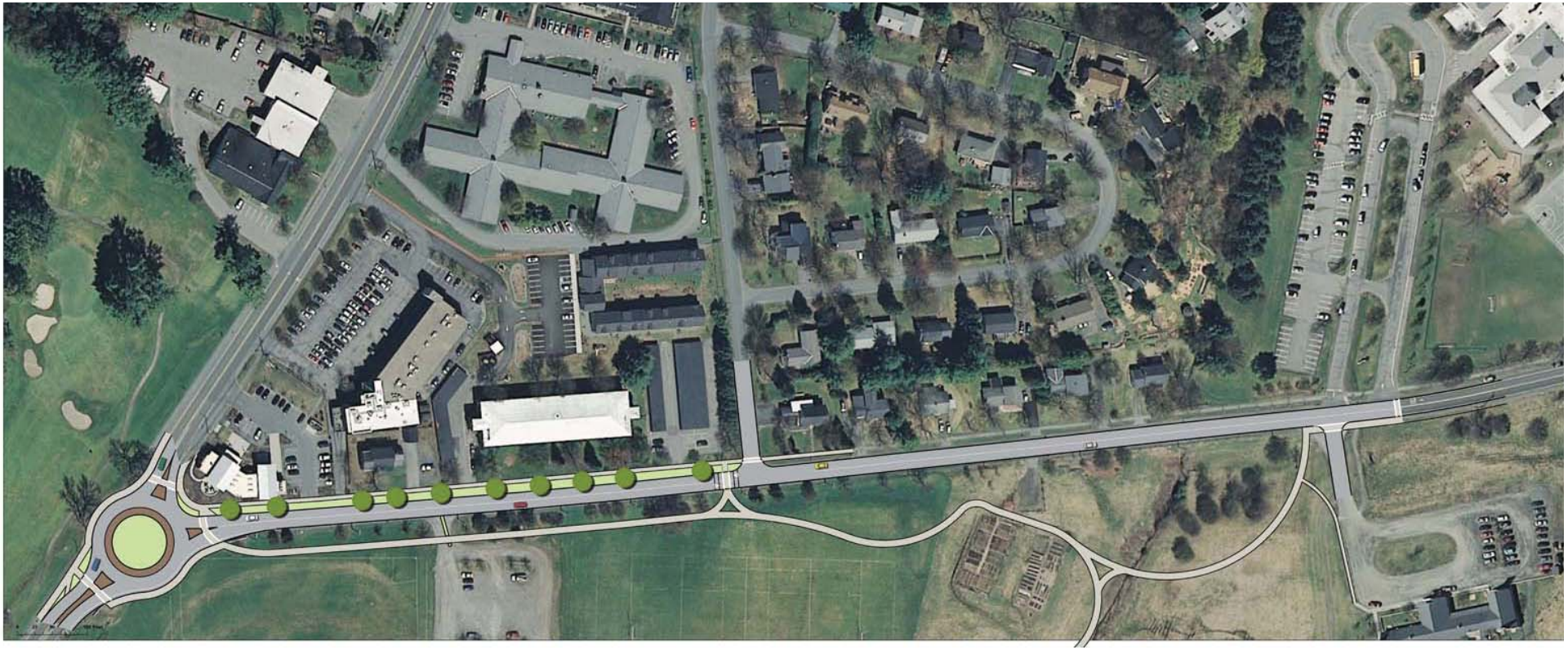


Figure 5: Recommended Improvements for Reservoir Road

Lyme Road Roundabout at Reservoir Road. The sidewalk here was intended for bicyclists to avoid riding in the roundabout, however, there is a clear pedestrian desire line to continue walking on the south side of Reservoir Road. As this is an important link to the Ray and Richmond schools, Dartmouth Child Care Center, Garipay Fields and Storrs Pond, a shared use path parallel to Reservoir Road is suggested.

Figure 6: Recommended Improvements for the West/Wheelock/Thayer Intersection

Crossings

Wheelock / West Street / Thayer Drive. Wheelock is a major entry into town from the west. Thayer Drive is an important portal to the campus, and leads to both the Thayer Engineering School and the Tuck Business School. The immediate area around the intersection on Wheelock Street is dominated by student housing, leading to a natural desire for pedestrians to cross Wheelock Street at this location. Due to the steep grade of Wheelock Street, cars and bikes traveling downhill are often traveling fast. There is also a transit stop at this location. There is no marked crosswalk at this difficult location, yet the pedestrian crossings are fairly heavy.

Using the FHWA guidelines (see Table 1) a marked crosswalk alone at this location would be insufficient and may increase the risk of a pedestrian crash. Other treatments such as traffic calming treatments, pedestrian signals or a pedestrian refuge should supplement the crossing in order to improve safety for pedestrians.

In this area, there is sufficient right of way width to place a pedestrian refuge in the center of the street. When combined with signage, this would help to calm traffic and alert drivers to crossing pedestrians. This intersection should be observed to understand the numbers of pedestrian crossings as well as the location that pedestrians typically cross in order to understand if a crossing refuge would accommodate the desired route for most pedestrians and not negatively impact the bicycle environment.

College/Wentworth/North Main Street at Dartmouth Green

The streets around the green are overly wide and given the very high volumes and bicycle and pedestrian activity, consideration should be given to narrowing the roadway and tightening up the corner radii to shorten pedestrian distances and slow traffic turning the corner (recognizing that buses and large vehicles need to make turns). Consideration should be given to narrowing these streets, putting in bike lanes, tightening up corner radii. There are a number of options that could be accommodated on these streets. *This area is also an opportunity for 'green street' stormwater treatment approaches*.

Greensboro Road / Lebanon Street. There is no pedestrian accommodation at this signal which is the property of the New Hampshire DOT. This is one piece of a larger issue associated with this corridor, which is continually evolving with greater volumes of pedestrians, bicyclists and transit riders as new development is established in the area. Hanover should work with NHDOT to improve this intersection and roadway to better accommodate pedestrians and bicyclists (this area is discussed in the bicycle chapter as well).

Figure 7: Recommended Improvements for the Route 120/Lebanon St/ Greensboro Rd Intersection

Figure 8: Shared Use Path on Route 120 south of Greensboro Road will provide a needed connection for pedestrians and bicyclists from Hanover to to Buck Road and Gile Hill Housing

Etna Village. Etna's rural village center includes a focus community uses, including a store, public library, post office, that should be connected by safe walkways and crossings of Etna Road. Traffic calming would be an effective way to improve pedestrian safety by reducing traffic speeds.

Bicycles

"*Every time I see an adult on a bicycle, I do not despair for the future of the human race.*"

-H.G. Wells.

New Hampshire State Statues

According the New Hampshire state law bicycles are vehicles and have the same rights to the roadway and duties as motor vehicles. (RSA 265:143). This means that 'bicyclists may occupy any part of a traffic lane when their safety warrants it. If the lane is too narrow to share, it is safer for the bicyclists to communicate that information by riding in the center of the lane.' (NHDOT *Don't be a Road Hog/Don't be a Road Warrior*)

New Hampshire recently joined several other states in passing a 'three foot law' which requires motorists to allow a safe distance when passing bicycles:

Three- Foot Law. When passing a bicycle, leave a reasonable and prudent distance. That should be at least three feet when the vehicle is traveling at 30 miles per hour or less and one extra foot for every 10 miles per hour over 30. (RSA 265:143-a). Motorists may overtake bicycles only if it is safe to do so (RSA 265:18).

Other statutes that address frequently asked questions:

Where to Ride. Bicyclists must ride on the right side of the road , with the flow of traffic (RSA 265:16-II).

Riding Two-Abreast. Persons riding bicycles two or more abreast shall not impede the normal and reasonable movement of traffic and , on a laned roadway, shall ride within a single lane. (RSA 265:144-5).

Visibility. A bicyclist must wear at least one item of reflective apparel such as a reflective vest, jacket, or helmet from one-half hour after sunset to one-half hour before sunrise (RSA 265:144-12). When bicycling after dark a bicyclist must use a white front headlight and a red rear headlight or rear reflector visible for 300 feet. (RSA 266:86).

Helmets. Rider under the age of 16 must wear a helmet when operating a bicycle on a public way. (RSA 265:144-10).

Encouraging Bicycling as a Mode of Transportation

Many point to our cold, snowy winters and dismiss bicycling as a mode of transportation worth taking seriously. Interestingly, however, weather does not have a statistically significant influence on bicycling (Alliance for Bicycling and Walking, 2010.)[1] In the United States, Montana and Alaska are among the states with the coldest temperatures and are also among the states with the highest levels of bicycling. Minneapolis, Minnesota recently topped Portland, Oregon as the nation's most bike-friendly city (as designated by Bicycling magazine), and boasts the highest per capita number of bicyclists. Researchers point to investment in bicycling facilities (in particular separate cycling facilities), the availability of bike parking, integration of bicycles with public transit, traffic education and training for bicyclists and motorists, and promotional events as factors that have a clear influence on rates of bicycling (Pucher and Bueler).[2]

Recent studies point to the broader appeal of bicycling in countries with a developed network of separate facilities. In the United States male bicyclists outnumber women by a factor of 2:1. In The Netherlands women comprise 55% of cyclists. A recent study in New York City found that men are three times a likely to be cyclists as women; however a bicycle count on a path in Central Park found that 44% of the cyclists were women. Another study conducted in Portland, Oregon found that women riders would go out of their way to ride on traffic calmed 'Bike Boulevards.' (Baker) [3] In short, separate facilities that protect riders from traffic appeal to a broader population and hold the key to increasing bicycling as a mode of transportation.

A survey conducted in Portland, Oregon identified the following types of riders:

- '*Not interested*' approximately one-third of residents are not interested in riding a bike.
- '*Strong and fearless*' riders will ride anywhere with or without facilities and many times prefer no facilities at all. This group accounts for 1-2% of riders.
- '*Enthused and confident*' riders are comfortable with bike lanes on busy streets. They make up about 10% of riders.
- '*Interested but concerned*' riders make up about half the residents and are characterized as occasional riders that use bike trails and bike boulevards. These riders want to bicycle more but do not feel safe riding with traffic even when bike lanes exist. (City of Portland, Oregon, 2010).[4]

How is this relevant to Hanover? While the overall percentages of the population may vary somewhat, the rider profiles described above can be generalized to the overall population. Research in the United States and abroad indicates that separate cycling facilities, specifically a network of bike lanes and bike paths, are associated with greater levels of bicycling because they tap into the 'enthused and confident' and 'interested and concerned' rider categories.

Within a two-mile radius of downtown (a very

1 Alliance for Biking and Walking, op.cit. page 127-128.

2 Pucher, John and Ralph Bueler, *Making Cycling Irresistible: 'Lessons from the Netherlands, Denmark, and Germany*,' Transport Reviews, July 2008.

3 Baker, Linda. 'How to Get More Bicyclists on the Road: To Boost Urban Bicycling, Find out What Women Want.' Scientific American, October 2009.

4 City of Portland, Oregon. Portland Bicycle Plan for 2030. February 2010. www.portlandonline.com/transportation

easy bicycling distance with grades that are flat to moderate) there are a number of significant destinations including Dartmouth College, DHMC, Hypertherm, Creare and other employment destinations on Great Hollow Road, Sachem Village, the Ray and Richmond Schools, Hanover High School, two Coop grocery stores , downtown Hanover and numerous transit stops. In addition, 40% of all trips are less than 2 miles; 28% are less than one-mile. Using a bike for these short trips can be encouraged through a better bikeway network.

The approach to this master plan is to encourage greater levels of bicycling by expanding the bikeway network, increasing bike parking and integrating consideration of cycling into planning for new development.

Types of Bicycle Facilities

Separate (Class I) Facilities

Shared Use Path. A Shared Use Path is an off-street path used by both pedestrians and bicyclists. A shared use path is a bi-directional facility. AASHTO guidelines recommend a minimum width of 10-feet for a shared use facility, and greater width, 12- or 14-feet , recommended where there is substantial use by bicycles, skaters, joggers and pedestrians (AASHTO, 1999)[5]. A shared use path may be located within park and open space areas or within developed neighborhoods and communities. Off-street paths are particularly attractive for the 'concerned' riders (more-risk averse riders and children) and recreational users because they provide separation from motor-vehicle traffic. They are less than ideal for the 'confident and fearless' bicyclists when there is higher levels of foot traffic or slower riders that impede use. Bicyclists' Level of Service (LOS) on pathways is significantly impacted when the amount of foot traffic surpasses 15 percent of trail use.[6]

Cycle Track. A cycle track is a bike facility that is separate from both motor vehicle traffic and pedestrian traffic. A cycle track may be located in the street and buffered from adjacent traffic or may be raised like a sidewalk. A cycle track may be a one-way or two-way facility depending on the traffic and street context. Cycle tracks are typically applied in areas where there are few driveway and intersection conflicts and where traffic speed and volumes make it desirable to provide for separation between bikes and motor vehicle traffic. Street level cycle tracks are separated from traffic lanes by a parking lane (e.g., the cycle track is between the sidewalk and the parking lane) or a painted buffer space. Cycle tracks are attractive for a broad range of cycling abilities.

As a relatively new facility, design standards for cycle tracks are evolving and vary depending on street conditions. In general:

One way cycle track:	Street level - Minimum width of 5 to 7 feet, plus a minimum buffer to the street of 1-foot; 3-feet to a parking lane. Raised - Minimum width of 6.5 feet; plus a minimum buffer zone to the street of 1.5 feet.
Two-way cycle track:	Desirable width of 12-feet; minimum width in a constrained location is 8 feet.

Top: Shared Use Path next to a sidewalk; bike lane in street.
Bottom: Cycle Track (The Netherlands).

5 AASHTO (American Association of State Highway Transportation Officials), *Guide for the Development of Bicycle Facilities*, 1999.

6 US Department of Transportation , Federal Highway Administration, Shared-Use Path Level of Service Calculator, a User's Guide, July, 2006.

Top: Bike lane on Lyme Road
Bottom: Contra-Flow bike lane (Seattle).

Bike Lanes (Class II Facilities)

Bike Lane. A bike lane is a portion of a street set aside for exclusive or preferential use by bicyclists in urban areas. Bike lanes are one-way facilities that typically carry bicycles in the same direction as traffic (Exception: Contra-flow bike lanes (see below)). Bike lanes improve the comfort and confidence of riders. Striped and signed bicycle lanes make drivers aware that bicycles are to be expected along the roadway. While bikes are entitled to use travel lanes like motor vehicles, signed and striped bike lanes are a visual reminder to motorists that bikes are likely to be present. On streets where traffic volumes and/or speeds are low, such as many residential streets, or where there are no connections to the larger bicycle network, a designated bike lane is not needed. Bike lane recommendations (AASHTO and NACTO):

Traffic Volumes: 3,000 + ADT

Traffic Speed: 25 mph or higher

Width: The minimum bike lane width adjacent to a curbface is 5 feet; the desirable bike lane width is 6 feet. The desirable ridable surface adjacent to a street edge or longitudinal joint is 4 feet, with a minimum width of 3 feet.

Next to parallel parking spaces, bike lanes should be a minimum of 5-feet in width, with a 7- or 8- foot parking lane for a total of 12- to 13-feet.

Buffered Bike Lane. A buffered bike lane provides additional space between the bike lane and a vehicle travel lane or a parking lane. The purpose of the buffer is to provide greater space where traffic volumes and speed are higher or there is a higher volume of truck traffic.

Width: The buffer and the bike lane combined are considered the bike lane width. As a practical matter, the buffer must be a minimum of 2-feet, for a total minimum of 7 feet.

Contra Flow Bike Lane. As the name suggests, a contra flow bike lane allow bicycles to ride against the flow of traffic on a one-way street. These are used to provide a shorter, more efficient path for bicyclists to important destinations and often is applied where bicycles are already riding the wrong way.

Width: Same as for Bike Lane

Striping: A solid double yellow line separating the bike lane from traffic is recommended.

Class III Shared Routes

Bicycle Boulevard. A bicycle boulevard is a street that has been designed to facilitate convenient through movement of bicycles with traffic calming and restricted vehicle movements that will reduce traffic speeds and volumes on these streets. Diverters that allow bicycles to pass but diver cars, traffic circles that slow traffic, stop signs that give preference to the bicycle boulevard are all ways that a street is made to place a priority on safe and seamless bicycle movement. Bicycle Boulevards are particularly effective for children and 'concerned' riders. One study in Portland, Oregon found that more risk averse riders, women in particular, would go out of their way to ride on that City's traffic calmed Bicycle Boulevards. Signage and pavement markings oriented to the bicyclist are other features

that identify a street as a bicycle priority environment. Bicycle Boulevards are typically residential or local streets near major collector and arterial streets that provide connections to major locations and tie into the larger bicycle network.

The design elements of a Bicycle Boulevard depend on the unique setting of the street within a community.

Advisory Bike Lanes. Advisory bike lanes are an innovative technique that creates shared space on streets with no room for traditional bike lanes. Advisory bike lanes are used extensively in Europe, and are under study in the United States. An Advisory bike lane consists of dotted lanes on the sides of the roadway that designate bike lanes, removal of the center stripe and its conversion to a single center lane enough for a single car at a time. The dashed lines allow cars to enter the lane if a bicyclist is not present, but formalizes space for bicycles. Advisory bike lanes can be combined with traffic calming to reduce traffic speeds to create a slow street. This striping essentially formalizes how cars and bike operate on narrow roadways, but lends more support to the bicyclist.

This technique is currently experimental in the United States, but holds promise for small town and rural settings.

Sharrows. Shared Lane Markings or 'Sharrows' are road markings that indicate the path for a bicycle where there is inadequate room for a bike lane. Originally devised to guide bicyclists out to the 'door zone' of parked cars, the use of Sharrows has expanded greatly to designate positioning for bicyclists and a path through complex intersections, shared roadways, to designate bicycle boulevards, or bicyclist wayfinding. 'Sharrows should not be used as a substitute for bike lanes or cycle tracks, where these types of facilities are otherwise warranted or space permits' (NACTO, 2011). Sharrows are approved for use by the MUTCD.

As a practical matter, Sharrows should be limited to the following conditions:

- Next to parallel parked cars on bicycle network streets
- Along gaps on streets with bike lanes
- On lanes where bikes are encourage to take the lane for safety
- Through complex intersections

Intersections

Bike Boxes. Bike Boxes are designated 'boxes' at the head of a traffic lane (behind a crosswalk) at a signalized intersection that allow bicycles to get ahead of traffic queues during a red light phase. A bike box facilitates left turn movements for bicyclists and help prevent 'right hook' conflicts with motor vehicles at the beginning of a green light at intersections where there is a heavy right turn movement. A bike box must include a restriction on turning right on a red light unless there is a exclusive right turn lane.

Dimensions: Bike boxes are typically 10- to 16-feet deep. Bike boxes are used both with and without bike lanes.

Striping: Striping includes visible white lines to demarcate the bike box. Bike boxes can be painted green for greater visibility or just designated with a bike symbol. Additional signage per MUTCD standard is desirable.

Top: Traffic calmed Bike Boulevard (Berkeley)
Bottom: Advisory bike lanes (The Netherlands)

Top: Bike lanes with parking
Bottom: Through bike lane on Route 120 at Greensboro Rd.

Through Bike Lanes. As streets with bike lanes approach intersections with turning lanes, through lanes assist bicyclists navigate by positioning them left of right turn lanes or right of left turn lanes.

> ***Width***: Through bike lanes should be a minimum of 4 feet in width and ideally 5- to 6 feet wide. A dashed merge lane designated by dashed white lines should begin a minimum of 50-feet before the intersection and 100-feet if along a high speed/high volume roadway (NACTO).

Combined Bike Lane/Turn Lane. A combined bike lane / turn lane provides a dashed bike lane over a turn lane to clarify the shared use of the space by motorists and bicyclists. This is used in constrained right of way situations where there is not adequate space for a through bike lane.

> ***Width:*** Within the shared lane, a four-foot minimum width should be designated as the bicycle area.

Roundabouts. The modern roundabout is a circular intersection slows traffic at an intersection and by allowing traffic to remain slow and steady, often increases motor vehicle capacity. Numerous studies have shown that single-lane roundabouts have the potential to increase both motor vehicle capacity and motor vehicle and pedestrian safety. The conversion of an unsignalized intersection to a single-lane roundabout is frequently indicated as a pedestrian safety countermeasure.

One of the most important features of roundabouts that improves safety for all users is that their approaches are narrow and deflected, requiring all vehicles to reduce their speeds as they pass through. With the narrow approach widths, bike lanes cannot be carried through a roundabout, so bicyclists generally have two options for navigating a roundabout.

1. Join with the vehicular traffic and ride through the roundabout as a motor vehicle. Due to the very slow traffic speeds, experienced riders are generally comfortable with this option.

2. For less confident or young riders, most roundabouts are designed to allow a bicyclists approaching to join into the sidewalk, and basically navigate the roundabout as a pedestrian. IN this case, pedestrians should dismount and walk their bikes over the crosswalks.

Research suggests multilane roundabouts may not have the same safety benefits, and may actually increase bicyclist collisions. Chapter 5 of the US DOT FHWA publication, '*Roundabouts: an Informational Guide*,' states that adding an additional lane to a one-lane roundabout is likely to increase overall injury crashes by 25 percent. (CalTrans, 2010)[7] The following recommended treatment address accommodating pedestrians and bicyclists at multilane roundabouts:

- Design roundabouts to accommodate on-street bicyclists by reducing the speed differential between circulation motorists and bicyclists. The recommended maximum circulating design speed is 25 mph.

- Design approaches and exits to the lowest speed possible, in order to reduce the severity of potential collisions with pedestrians.

7 CalTrans (California Department of Transportation), 'Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians,' 2010.

- Design roundabout approaches, circulating lanes and exits to encourage bicyclists navigating the roundabout in the circulating roadway to control the lane. This approach reduces the chances of a bicyclists being cut off by a 'right hook.'

- Utilize the most effective tools possible to 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.

- Clearly indicate to motorists and bicyclists the correct way to circulate through the roundabout through appropriately designed signage, pavements markings, and geometric design elements.

- Clearly indicate to motorists, bicyclists, and pedestrians the right-of-way rules at multilane roundabouts through appropriately designed signage, pavement markings, and geometric design elements.

Other Treatments

Reverse Angle or Back-in/Head-out Diagonal Parking. As the name implies, reverse angle parking is angled parking designed for cars to back into the stall; when leaving the stall, the driver has a better view of the oncoming traffic, bicyclists and pedestrians. Reverse angle parking has the following advantages:

- ***Bicycle Safety***: This type of parking provides a safer environment for bicyclists using the roadways as the driver is able to see the cyclists when exiting the stall. Several cities which have implemented back-in angle parking have seen a reduction in the number of accidents over conventional parking arrangements.

- ***Loading at the Street***. Back-in parking also places the trunk of a car at the sidewalk allowing people to stand on the sidewalk to load or unload their car.

- ***Doors Open to the Sidewalk***. With cars oriented to the street, car doors block pedestrian access to the street and guide pedestrians to the sidewalk, another safety benefit, particularly for children (Nelson Nygaard Consulting Associates).[8],[9]

Although the use of reverse-angle parking has increased steadily in recent years, several cities have used this parking arrangement for decades including Wilmington, Delaware, which has had reverse angle parking for 50 years, and Seattle Washington, which has had reverse angle parking for more than 30 years (Nelson Nygaard, 2005).

Reverse angle parking in commercial district (Seattle).

8 Nelson/Nygaard Consulting Associates, "Back-in/Head-out Angle Parking, January 2005.

9 www.bicyclinginfo.org/bikesafe/case_studies, Back-in Diagonal Parking with Bike Lanes

The Bicycle Master Plan

The goal of the master plan is to identify a coherent and connected bikeway system that provides access to major destinations. The designated routes are shown in Figures 5 and 6. The Primary Bicycle Routes are routes that should be developed to the highest possible level (e.g. a separate route or bike lanes) to encourage bicycling for a range of trips including work, school, shopping, recreation, and medical appointments. The planned bike network ties into the network being developed in neighboring communities to support the development of a seamless bicycle transportation network.

Hanover's small town setting, limited street network, and constrained street rights of way provides a challenging setting for bicycle planning. The plan strives to be practical and implementable, while providing a coherent network. It is expected that the network will be developed over time as opportunities become available. Implementation of bike system improvements is expected to be made through a combination of implementation partners, primarily including the Town, property owners, and New Hampshire DOT.

Recommendations

Figures 5 and 6 presents the Bicycle Master Plan diagram for Hanover. The Plan outlines a coherent bicycle network that, if implemented, would significantly improve the bicycling environment of Hanover. The plan identifies the following classifications:

Primary Bicycle Corridor. Primary Bicycle Corridors identify the backbone routes that connect neighborhoods to major destinations in Hanover and its environs. ***The goal for the Primary Bicycle Corridors is to improve these routes to the highest possible level, ideally separate paths and/or bike lanes to provide a safer and more comfortable bicycling environment***. The Primary Bicycle Corridors connect to neighboring communities of Norwich, Lebanon and Lyme which contribute both bicyclists and destinations to Hanover's network. Due to our town's sparse street network, these corridors also tend to be the streets that also have high motor vehicle traffic volumes. Traffic calming to control vehicle speeds and developing improvements for bicycle traffic should be a priority on these routes.

Local Bicycle Corridors. Local Bicycle Corridors are other important bikeways that connect to the primary network and provide access to local destinations. The local bicycle corridors are proposed as a combination of bicycle treatments on lower volume streets and off-road paths.

The components of this network are described below:

Primary Bicycle Corridors

Lyme Road. Lyme Road provides the northern gateway into Hanover and includes the Ray and Richmond Schools, Garipay recreation fields, and the Dresden Village neighborhood, CRREL, a Coop grocery store and a significant complement of senior housing, apartments and single family housing. In the future, the College's Rivercrest property will add more college housing to the area. With the open space, the elementary and middle schools, senior housing, and future college housing in this area, the goal for the Lyme Road corridor is to provide both bicycle lanes (for confident commuter cyclists) as well as a shared use path for pedestri-

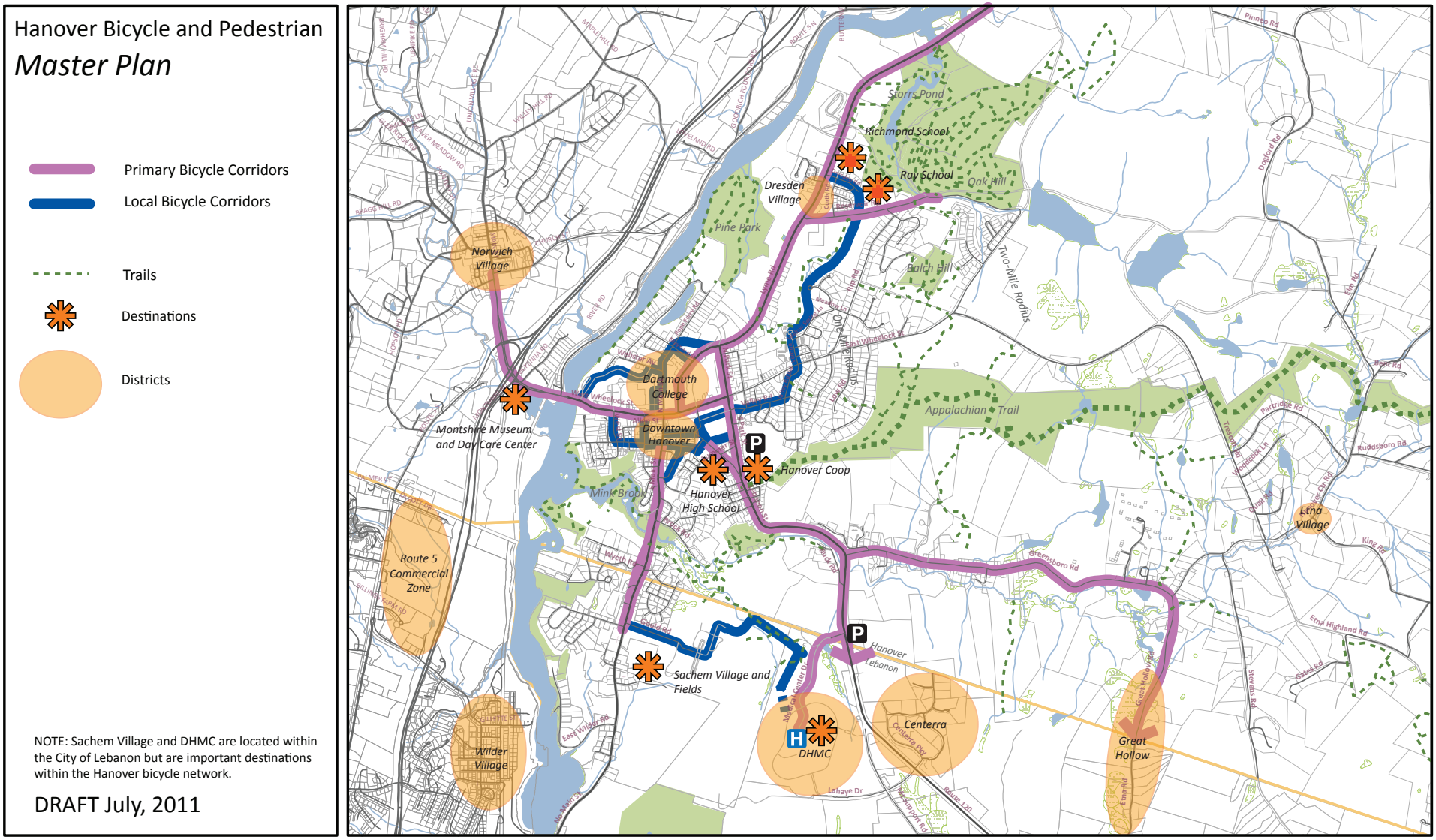


Figure 5: Bicycle Master Plan

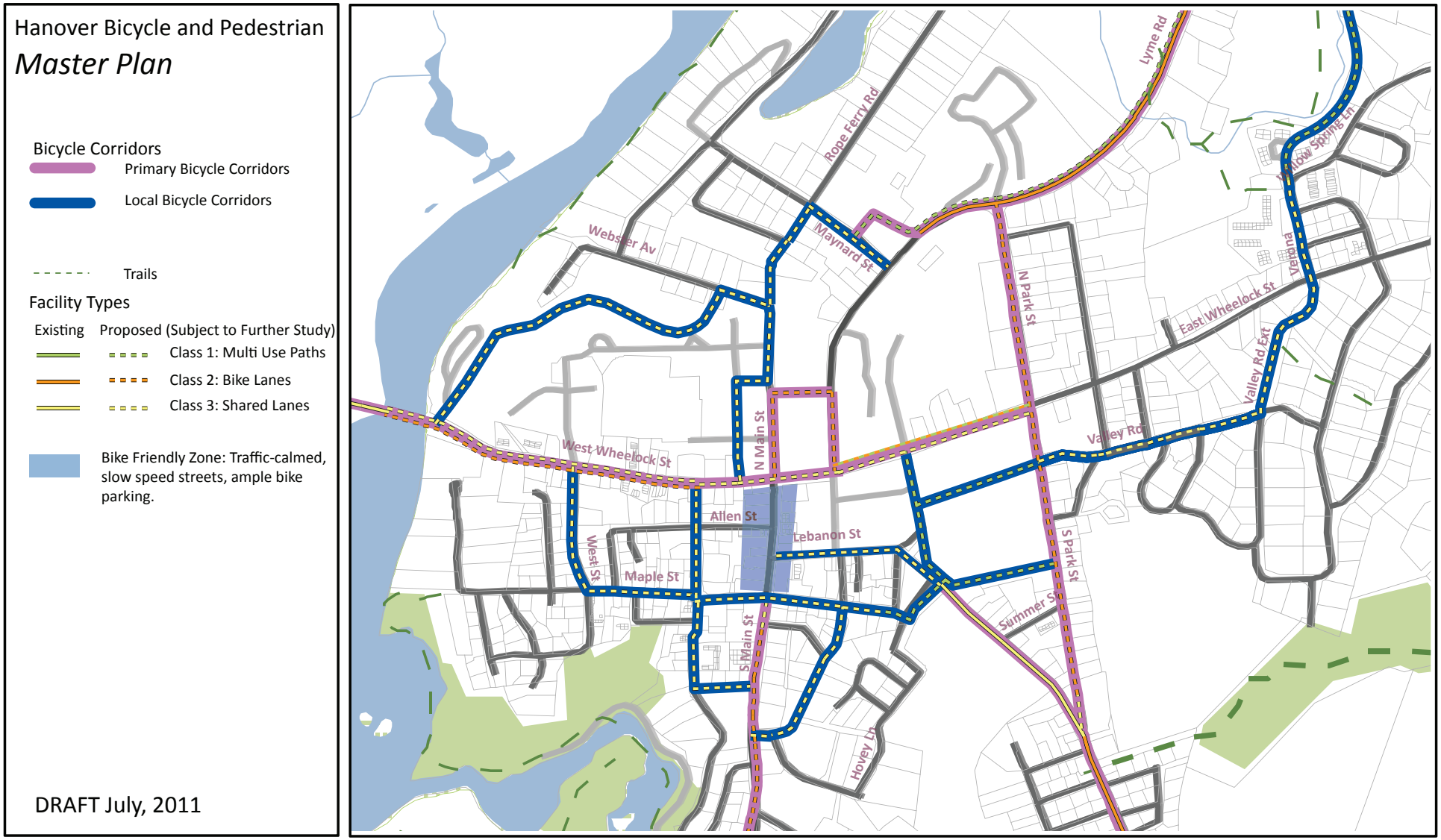


Figure 6: Bicycle Master Plan - Downtown Area

Left: Existing sidewalk on Lyme Road. Right: Parkway treatment with bike lanes, street trees and a shared use path.

ans, recreational users, children and seniors. Lyme Road between the roundabout and the Park/College Street intersection can become a 'green parkway' that includes an improved shared-use path with a street tree planting for pedestrians, joggers, less confident bicyclists, roller skiers, in addition to on-street bike lanes.

Constraint: Lyme Road at the Richmond Middle School has a tight cross section that precludes bicycle lanes. For a two-lane road with on-street parking and bike lanes, a minimum of 46 feet is needed; the current curb to curb distance is 40-feet. In the short-term, Sharrows should be used on this stretch of road to guide bicycles through the area, and low traffic speed should be established through traffic calming and speed limit enforcement. In the long term, as opportunities arise through road improvements and/or new development, space should be made for bike lanes with on street parking.

Left: College Street. Right: Shared use path along College Street.

Above: Bicyclist at College above Park and Dewey Field Road.

College Street from Park to Maynard. This key connection into the College campus is a very constrained two-lane right of way. The narrow right of way of the street with on-street parking lanes does a good job of calming through traffic entering from the north, but is unpleasant for bicyclists. The slight uphill grade after a signalized intersection often results in slow moving cyclists with cars passing them in a narrow street right of way. In this area an off-street option in the form of a continuation of the shared use path alongside College Street and swinging west into the campus and connecting to Maynard Street would provide a better, more pleasant route for non-motorized transportation. At Maynard Street this path connects into streets that are relatively quiet and pleasing for walking and bicycling, and provides a connection into the heart of the campus and downtown Hanover via North Main Street.

Dartmouth Green. College, Wentworth and North Main Street are wider than necessary for motor vehicle traffic. North Main and College Street have more frequent bike and pedestrian collisions. This is partially due to the sheer volume of pedestrians, bicycles and cars. In the short term, there is room for bike lanes in the direction of traffic. College and Wentworth Street are very wide one-way streets that can be narrowed considerably; College Street and North Main Street, with their numerous pe-

destrian crossings would be safer with a narrower street width, as often a car waiting for a pedestrian to cross blocks the view of the pedestrian for an oncoming car in the other lane. Based on observations of bicycle traffic at the intersection of Main and Wheelock, the possibility for a contra flow bike lane on North Main Street into the campus should be evaluated. North Main Street represents a very strong center of gravity for the campus and there is a strong desire line to enter the campus at North Main Street from South Main, and both directions on Wheelock Street.

West Wheelock Street. Wheelock Street from the Ledyard Bridge to Park Street is a major bicycle corridor and popular bike route for recreational and commuter bicyclists. Bike lanes were put in place from the Ledyard bridge west into the center of Norwich, Vermont, which has led to increased bicycle commuting on this corridor. Of the 8 collisions on this stretch of West Wheelock Street, six were the result of vehicles turning into driveways or streets and colliding with an oncoming bicycle; of these accidents five were in the westbound (downhill) direction where bicycles were traveling fast and to the right of cars. One accident was the result of a bike veering into traffic possibly to avoid obstacles at the edge of the road and one was the result of a bicyclist riding on a sidewalk and not seen by the motor vehicle. Making West Wheelock Street safer for bicycles involves improving the visibility and awareness of bikes along the roadway. The recommendations are different for the westbound and eastbound direction, due to the steep grade.

On the westbound, or downhill direction, bicyclists are traveling at speeds commensurate with cars, so it would be safer for bikes to 'take the lane' and ride with vehicles, rather than to the right of cars where they are not expected by turning vehicles. The westbound lanes should be marked with Sharrows in the center of the lane, and signage indicating that bikes share the lane with cars should be installed.

MUTCD R4-11

For the eastbound or uphill direction, marked bike lanes would extend from the Ledyard Bridge up to Main Street. While there is signed bike route that diverts bicyclists to West Street, many cyclists head straight up the hill, depending on their destination. Marked bike lanes would help to raise the awareness of drivers to expect bicycles on the street.

Constraint: West Wheelock Street from School Street to Main Street is a constrained right of way. At this location, on-street parking exists on the north side of the street and traffic is generally slow due to a signalized intersection and Main and Wheelock Street. Due to parked cars, a right turn lane, and slow moving traffic, bikes should ride in the traffic lane with cars on this block. While this approach is not attractive for 'interested but concerned' riders alternatives via Tuck Drive and West/Maple Street are available.

East Wheelock Street. East Wheelock Street is heavily used by bicyclists. The street connects the core of the Dartmouth campus to housing and the campus athletic complex. Along East Wheelock Street bicyclists use the street and sidewalks extensively and often ride without helmets. The East Wheelock street streetscape is very attractive and traffic along the street, while often heavy, is slow moving. There is parking on the south side of the street from College to Park Street. Given the volume of both cars and bikes on this roadway, the number of bike crashes is remarkably low, and are clustered at intersections with College and Crosby Streets. One incident was attributed to a bicyclist on the sidewalk at College Street, and two crashes at Crosby Street involved motorists not seeing bicyclists.

In the short term, there is adequate space for a striped bike lane in the west bound direction; and sharrows are appropriate in the east bound direction from College Street to Park Street to guide bicyclists out of the door zone.

In the long term, East Wheelock Street should be evaluated for a cycle track extending from Main Street to Balch Street. The high level of bicycling along this roadway, a large percentage of whom are college students riding short trips without a helmet, and a limited number of driveways and intersections would make it a good candidate for such a facility.

Top and bottom: Different approaches to negotiating the intersection of Park and Lebanon Street.

Park Street. Park Street is a significant link in the bike network, and with the bike lanes slated for summer 2011, it will be significantly improved for bicyclists.

Constraint. The block between Summer Street to Lebanon Street is very constrained. At this location the curb to curb dimension is about 28 at its narrowest point, at the Ledyard Bank. The roadway is so constricted along the frontage of the Ledyard Bank that bicyclists are stuck in the queue of cars stopped at the Lebanon / Park intersection.

To address this constraint, Sharrows should be utilized in the travel lanes to designate the shared roadway condition. The Town should evaluate the right of way constraints and work with property owners along this block to relieve the pinch point at the Ledyard Bank site and along this block.

Lebanon Street. Sharrows should be utilized along Lebanon Street from Main Street to Park Street. One 'dooring' occurred on Lebanon Street.

The intersection of Lebanon and Crosby Street is a focus of bicycle collisions with motor vehicles. Overall, this is a difficult intersection with an extremely long crossing distance created by very wide curb radii. All of these collisions occurred on the north side of Lebanon Street with bicycles riding on the sidewalk (2 crashes) and one riding against traffic, indicating a desire to stay on the north side of the street. As the north side of Lebanon Street is the campus and leads to a cluster of student housing on also on the north side of Lebanon Street, as well as Summer Street, the crashes may indicate a strong desire line to travel in both directions on the north side of Lebanon Street. If this is the case, it is doubtful that either sharrows or bike lanes would convince riders to ride in the street.

Under any condition, the poor geometry of this intersection should be evaluated as it does not work well for cars, pedestrians or bicyclists. A roundabout or tightened up corners to reduce the crossing distance would be a good start. More observation of bicycle and pedestrian activity is needed to best understand what would best accommodate bicyclists in this area.

Lebanon Street/NH Route 120. Bike lanes are in place from Park Street to the Hanover Town Line.

The intersection of Greensboro Road and Lebanon Street / Route 120 is controlled by a signal operated by NHDOT. The signal does not include any accommodation for pedestrians or bicyclists. Related issues at this intersection include the need for pedestrian access between Gile Hill and this intersection (a condition of approval for Gile Hill), reconfiguring bus stops to improve the waiting environment, and the possibility of a lane drop on Route 120 from Greensboro Road to Buck Road. Based on existing traffic volumes, Smart Mobility determined that a lane drop is feasible and will not result in traffic congestion. NHDOT will need to review a traffic study with future development projections to approve this change.

Options for bicycle accommodation on Route 120 to Medical Center Drive should be evaluated. Between Greensboro Road and Medical Center Drive, most destinations (specifically Buck Road development, Gile Hill and the DHMC entrance, are on the west side of the road; asking a bicyclist to cross Route 120 at Buck Road to access a bike lane does not make much sense in the current configuration of the roadway. For this area, three options should be evaluated including:

Top: Bicyclists on Greensboro Road. Clearly ('Strong and confident' riders. Bottom: Pinch point at South Main Street near Granger Circle.

- standard bike lanes and a sidewalk;
- a shared use path on the west side of Route 120; and
- a two-way cycle track and sidewalk on the west side of Route 120.

Greensboro Road. Greensboro is a two-lane semi-rural road that is popular for commuting and recreational biking and provides access from Hanover to Great Hollow Road/ Etna Road employers and from Etna to DHMC and greater Hanover. Greensboro Road is under the jurisdiction of the NHDOT. The road right of way is complicated as the road is very old. In addition to bicyclists, pedestrians are also forced to walk along a very narrow strip of land adjacent to the roadway. Ideally a shared use path would serve the area well, as there is no off-road pedestrian or bicycle accommodation for this neighborhood. This topic should be the focus of a separate planning effort developed in concert with neighborhood participation.

South Main Street / NH Route 10. Another very significant gateway to Hanover and Dartmouth College that is heavily used by bicyclists is South Main Street / Route 10. This route connects Sachem Village (College housing) and southern Hanover neighborhoods to town. The area around Granger Circle and Brook Road is particularly narrow, with essentially no shoulder room; however, right of way may exist. Hanover should work with NHDOT and the City of Lebanon to establish bike lanes along South Main Street from Sachem Village to Downtown Hanover.

Sachem Village to DHMC. Although outside the jurisdiction of Hanover, a bike/ped path between Sachem Village and DHMC is strongly encouraged.

Local Bicycle Corridors

Local bicycle corridors provide important neighborhood connections to the primary bicycle corridors, or in some cases provide an alternative to a primary bike route that maybe more appealing to the 'interested but concerned' bicyclists. These streets should be maintained as a combinations of traffic calmed routes and off-street paths that connect Hanover neighborhoods to the downtown and schools.

West/Maple/South Route. As an alternative to the steep hill of West Wheelock Street, the West/Maple Street alternative is a popular route for commuters and recreational cyclists. Due to right of way constraints, both streets should be traffic calmed shared routes.

South Street is similarly a shared route. The configuration of the end of South Street between the Howe Library and the path to Hovey Lane should be reconfigured to better accommodate bikes and pedestrians. It its current configuration, parking moved to the opposite side of the street and a contra flow bike lane adjacent to the sidewalk would provide a valuable bike and pedestrian connection.

Vox Lane/ Field House Lane. Bicycle and pedestrian lanes through the College campus at Vox Lane (heavily used now by bike and pedestrians) and behind Leverone Field House/Football Field provide direct off street connections between Hanover neighborhoods and Hanover High School the Howe Library and downtown Hanover. The Town should work with the College to maintain Vox Lane and explore the option of a linkage behind Leverone Field House and the Football stadium.

Left: Dresden Road closure does not work for bicyclists, particularly in the winter. Right, Bike Boulevard treatment with bollards, stormwater planting allows bicyclists to use the street.

Valley /Verona / Girl Brook. Valley Road / Verona Road provides a relatively level neighborhood connection to Park Street. As described above, a sidewalk is recommended for Verona Road. Potential traffic calming along Valley and Verona Road and an improved crossing of Wheelock Street to raise awareness of bikes and pedestrian traffic should be considered. The Town should work with neighbors to develop a plan.

A shared use path along Girl Brook which would connect Hanover neighborhoods with the Ray and Richmond Schools and Storrs Pond is a key link in the local bike/ped network and will allow many students to arrive safely at school by bicycle. The corridor is a sewer easement that can be used for public access.

Reservoir Road/ Dresden Road. Special consideration should be given to Reservoir Road / Dresden Road area because of the schools. Dresden Road is a ready-made Bike Boulevard as a street with restricted traffic and a linkage between the schools. Modification of the fence between the Richmond Middle School and Dresden Road is needed to allow bicycle traffic, while still closing off car traffic. Dresden Road at this location seems like an opportunity for a demonstration green street stormwater planting that can perhaps be developed in conjunction with environmental science classes at the Richmond and/or Ray Schools.

Education

The importance of education for safe pedestrian and bicycle transportation cannot be overstated. Sharing the road safely requires all users to anticipate the actions of the others, so that conflicts and accidents can be avoided. Education must extend to all roadway users, including vehicle drivers, as many drivers are not aware of either the laws or how they can safely share the road with bicyclists and pedestrians.

The greatest opportunities for bicycle education can be realized through town recreation programs, which could ideally offer bicycle safety classes for riders of all ages and abilities. While the focus should be on safe bicycling, it should also include an understanding of the applicable laws, and ideally the Hanover Police should be involved in the discussion.

Finally, the Hanover Bicycle and Pedestrian Committee could provide information on their website that will allow visitors to understand safe bicycling, and laws, and the availability of classes. In addition, a blog or chat room on bicycling issues could be helpful for both riders and town officials, especially Police, to share concerns about safe bicycling.

Enforcement

Enforcement should be a component of a successful walkable and bikable community. It should clearly be tied with education, so that drivers and riders are aware of the laws that exist. The town should also review any local ordinances, and adjust as needed to reflect the town's goals. An example is riding on the sidewalk, which is often not clearly allowed or prohibited. One of the most important enforcement provisions that can improve safety for bicyclists and pedestrians is traffic speed enforcement.

Encouragement

For bicycling to be truly 'legitimized' as a mode of transportation, a number of actions can be taken to encourage bicycling by its incorporation into the community. There are a number of steps that can be taken to welcome bicyclists into a community, and make them feel at the center of things rather than a fringe group.

Events. The town should sponsor or support events such as Bike to School or Bike to Work days, that highlight the potential and enjoyment of bicycling for transportation. Group bike rides or tours will get more riders comfortable on their bikes, and therefore more likely to take up bicycling as a means of transportation, rather than a purely recreational activity.

Ancillary Facilities. Bicyclists needs are quite different from car drivers once they arrive safely on the bike network, the following additional resources will provide further encouragement for biking as transportation.

Bike Parking

Adequate bike parking is a critical element of the bike transportation system. The Association of Pedestrian and Bicycle Professionals publishes a comprehensive set of guidelines for bike parking which answers common questions about bike rack design and layout, as well as recommendations for bike parking standards by land use. These guidelines are extremely valuable and are included in the Appendix. The following discussion represents excerpts from that larger report (Association of Pedestrian and Bicycle Professionals, *Bike Parking Guidelines, 2nd Edition*, 2010):

'**Why is Bicycle Parking Important?**

One of the most common obstacles for bicyclists is the lack of bicycle parking at their destination. At the most basic level, bicycle parking encourages people to ride, but it also has some specific benefits, even for non-cyclists:

- *Bicycle parking is good for business*. Bicycle racks provide additional parking spaces which customers can use to patronize local businesses. Bicycle racks not only invite cyclists in, but they announce to potential cyclists and non-cyclists customers alike that the business supports sustainable values, an increasingly important factor for many consumers.

- *Designated, well-designed parking promotes a more orderly streetscape and preserves the pedestrian right of way*:

Top: Wave style rack at Howe Library
Bottom: Rack at Richmond School on a warm late spring day.

Cargo bike parked at the Hanover Coop.

- It presents a more orderly appearance for buildings.
- It prevents damage to trees and street furniture
- It keeps bicycles from falling over and blocking the sidewalk.

- *Bicycle parking helps legitimize cycling as a transportation mode by providing parking opportunities equal to motorized modes*.

Short Term versus Long Term Bike Parking

'Bike parking falls into two categories: short term and long term. Long term parking (defined as parking for more than two hours) includes sheltered or enclosed parking in a secured location. This may include sheltered bike rack, lockers, or a 'bike station.' The need for long-term parking is typically associated with residential complexes, workplaces and transit stations.

Bike Racks

The design of bike racks varies widely; some are functional, while others are not. The APBP recommends a bicycle rack that:

- Supports the bicycle in at least two places, preventing it from falling over.
- Allows locking of the frame and one or both wheels with a U lock.
- Is securely anchored to the ground.
- Resists cutting, rusting and bending or deformation.

There are a host of other considerations, but the bottom line is that the 'Inverted U' and 'Post and Ring' style racks meet all of the design criteria identified in the guide. 'Comb,' 'Wave' and 'Toast' style racks are not recommended primarily because they do not support the bicycle in two places which can cause the bike to tip over, bend the front wheel and do not or enable the frame to be properly secured.

Table 2 presents APBP's sample bicycle parking requirements for Urbanized or High Mode Share Areas. New bike parking should be required of new development, not unlike requirements for car parking.

There is a dearth of parking in some areas of Hanover, most notable to 'old' parts of the downtown in the vicinity of Main and Lebanon Streets. New bike racks in these areas should be installed in these areas. There should be some covered bike parking downtown as well. This is an area where the HPBAC can help by identifying existing racks and potential locations for new racks.

Showers: Bike commuting often requires wearing a different set of clothes while riding than while working. In addition, riding during warm or rainy weather makes access to a shower at or near the worksite important. While Dartmouth College employees may use the showers at the Alumni Gym if they bicycle to work, downtown Hanover employees generally do not have a similar option. The town might consider how it could provide a public shower for bicyclists that arrive to work in the downtown area.

Table 2: Sample Bike Parking Requirements (Source: Association of Pedestrian and Bike Professionals)

SAMPLE BICYCLE PARKING REQUIREMENTS – URBANIZED OR HIGH MODE SHARE AREAS

The following bicycle parking requirements have been scaled to reflect the increased bicycle parking requirements of communities which are densely developed, more urbanized, or which have higher levels of bicycle use.

Residential

Type of Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
Single family dwelling	No spaces required.	No spaces required.
Multifamily dwelling		
a) With private garage for each unit*	No spaces required.	0.10 spaces for each bedroom. Minimum is 2 spaces.
b) Without private garage for each unit	0.5 spaces for each bedroom. Minimum is 2 spaces.	0.10 spaces for each bedroom. Minimum is 2 spaces.
c) Senior Housing	0.5 spaces for each bedroom. Minimum is 2 spaces.	0.10 spaces for each bedroom. Minimum is 2 spaces.

*A private locked storage unit may be considered as a private garage if a bicycle can fit into it.

Civic: Cultural/Recreational

Type of Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
Non-assembly cultural (library, government buildings, etc.)	1.5 spaces for each 10 employees. Minimum requirement is 2 spaces.	1 space for each 8,000 s.f. of floor area. Minimum requirement is 2 spaces.
Assembly (church, theaters, stadiums, parks, beaches, etc.)	1.5 spaces for each 20 employees. Minimum requirement is 2 spaces.	Spaces for 5% of maximum expected daily attendance.
Health care/hospitals	1.5 spaces for each 20 employees or one space for each 50,000 s.f. of floor area, whichever is greater. Minimum is 2 spaces.	1 space for each 20,000 s.f. of floor area. Minimum is 2 spaces.
Education		
a) Public, parochial, and private day-care centers for 15 or more children	1.5 spaces for each 20 employees. Minimum is 2 spaces.	1 space for each 20 students of planned capacity. Minimum is 2 spaces.
b) Public parochial, and private nursery schools, kindergartens, and elementary schools (1-3)	1.5 spaces for each 10 employees. Minimum requirement is 2 spaces.	1.5 spaces for each 20 students of planned capacity. Minimum requirement is 2 spaces.
c) Public parochial, and elementary (4-6), junior high and high schools	1.5 spaces for each 10 employees plus 1.5 spaces for each 20 students of planned capacity. Minimum requirement is 2 spaces.	1.5 spaces for each 20 students of planned capacity. Minimum requirement is 2 spaces.
d) Colleges and universities	1.5 spaces for each 10 employees plus 1 space for each 10 students of planned capacity; or 1 space for each 20,000 s.f. of floor area, whichever is greater.	1 space for each 10 students of planned capacity. Minimum requirement is 2 spaces.
Rail/bus terminals and stations/ airports	Spaces for 7% of projected a.m. peak period daily ridership.	Spaces for 2% of a.m. peak period daily ridership.

Commercial

Commercial Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
Retail		
General food sales or groceries	1 space for each 10,000 s.f. of floor area. Minimum requirement is 2 spaces.	1 space for each 2,000 s.f. of floor area. Minimum requirement is 2 spaces.
General retail	1 space for each 10,000 s.f. of floor area. Minimum requirement is 2 spaces.	1 space for each 5,000 s.f. of floor area. Minimum requirement is 2 spaces.
Office	1.5 spaces for each 10,000 s.f. of floor area. Minimum requirement is 2 spaces.	1 space for each 20,000 s.f. of floor area. Minimum requirement is 2 spaces.
Auto Related		
Automotive sales, rental, and delivery Automotive servicing Automotive repair and cleaning	1 space for each 10,000 s.f. of floor area. Minimum requirement is 2 spaces.	1 space for each 20,000 s.f. of floor area. Minimum requirement is 2 spaces.
Off-street parking lots and garages available to the general public either without charge or on a fee basis	1 space for each 20 automobile spaces. Minimum requirement is 2 spaces. Unattended surface parking lots excepted.	Minimum of 6 spaces or 1 per 10 auto spaces. Unattended surface parking lots excepted.

Industrial/Manufacturing

Type of Activity	Long-Term Bicycle Parking Requirement	Short-Term Bicycle Parking Requirement
Manufacturing and production	1 space for each 12,000 s.f. of floor area. Minimum requirement is 2 spaces.	Number of spaces to be prescribed by the Director of City Planning. Consider minimum of 2 spaces at each public building entrance.

DEFINITIONS

Policy[1]: A specific statement of principle or of guiding actions that implies clear commitment but is not mandatory; a general direction that a governmental agency sets to follow in order to meet its goals and objectives before undertaking an action program [Source: *A Glossary of Zoning, Development, and Planning Terms*, American Planning Association, Planning Advisory Service Report Number 491/492]. Policies are the core principles which requirements, regulations and codes are designed to enforce.

Requirement: Something needed or necessary; a demand [Webster's Dictionary]. While some general requirements may be advisory in nature, they can be used more specifically by local agencies to enforce policy with regard to a particular project. In this case they would become mandatory.

Code[2]: Collection of laws [Webster's Dictionary]. As with other development requirements, codes governing bicycle parking are usually legislated by the local body of elected officials from a city, town or county. Codes contain regulations which are applied generally to enforce policy.

Regulation[3]: A rule or order prescribed for managing government [Source: *A Glossary of Zoning, Development, and Planning Terms*, American Planning Association, Planning Advisory Service Report Number 491/492]. Regulations are specific, legislated elements of a code, utilized to enforce policy.

[1] Advisory [2] Mandatory [3] Mandatory

Hanover Bike and Pedestrian Advisory Committee. The Committee play and important role in encouraging cycling and walking. The Committee should continue these efforts by:

- Collecting Pedestrian and Bicycle Counts
- Monitoring Accidents
- Increasing Awareness through Events
- Maintaining a Blog and Website for Public Input
- Plan Revisions and Updates

Land Use Policy

Hanover's land use policies are generally quite enlightened in terms of providing for pedestrian access and safety as new developments are designed and approved. However, there are some additional areas that should be improved upon in future updates of development ordinances.

- Provide an outstanding pedestrian environment, especially in downtown. All developments in the pedestrian cores of the Hanover (downtown/college, Dresden village, ?Etna?) should provide a friendly face to the street rather than blank walls (i.e. the South Street hotel initial proposal).
- Street design guidelines should be established for the major streets and roads that sets the framework for new development, and how it will address the street. The developers would essentially be required to implement these guidelines along their frontage.
- Multi-modal Transportation Considerations for New Development-While currently all major developments are analyzed in great detail for the traffic impacts, a similar focus should be placed on pedestrian and bicycle accessibility and safety. The ordinances should identify the appropriate balance between vehicle operations and bicycle and pedestrian safety, and this may alter among the different contexts within the town. For example, in downtown priority may be on improving the pedestrian environment rather than providing an extra traffic turning lane that would improve vehicle operations.