The Chapel Hill Bike Plan

Safe and Convenient

Plan Vision

Chapel Hill is a community where biking is a safe and convenient everyday choice.

Plan Adopted June 9, 2014

Division of Bicycle & Pedestrian Transportation

Toole Design Group

Special thanks to all who made this plan possible.

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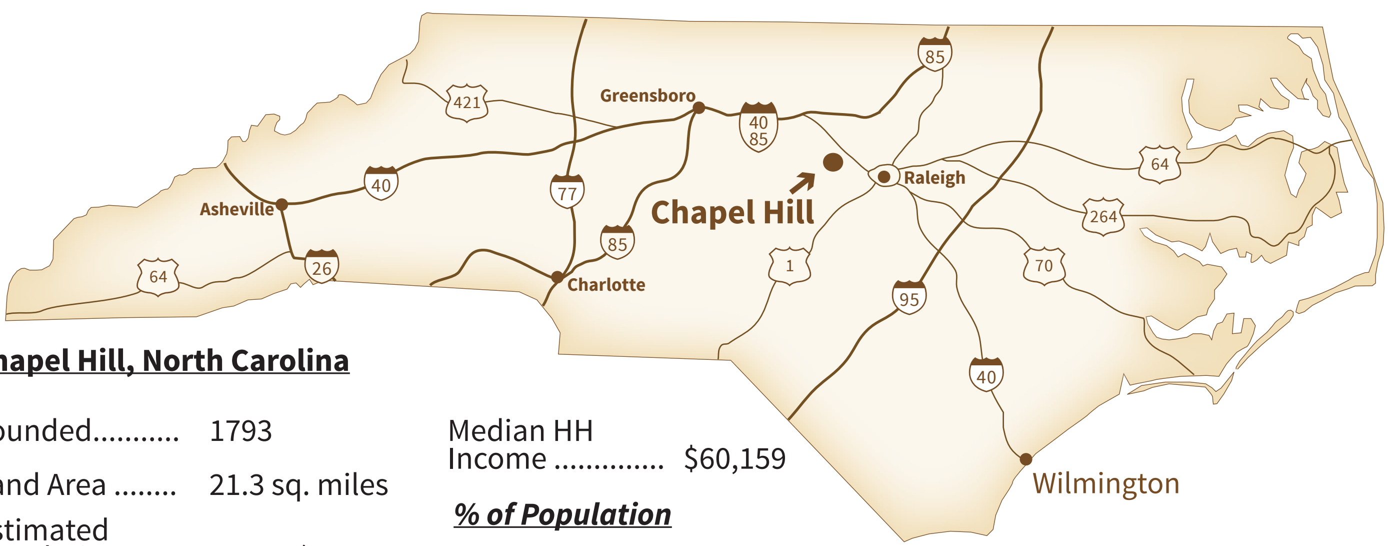


Chapel Hill, North Carolina

Founded........... 1793

Land Area .... 21.3 sq. miles

Estimated Population....... 58,424 (2012)

Estimated Number of Jobs................ 48,161

Housing Units 22,034

Median Age 25.6

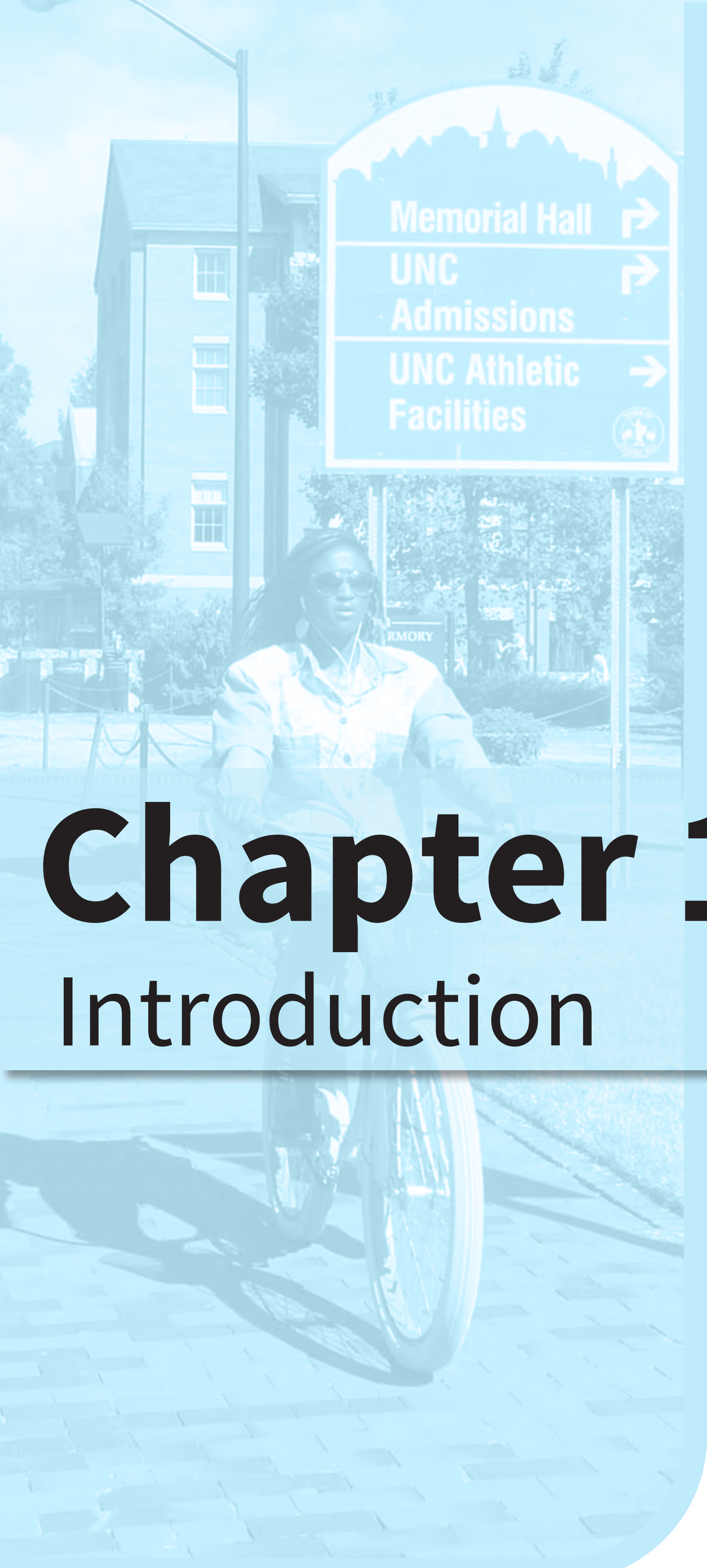
Median HH Income $60,159

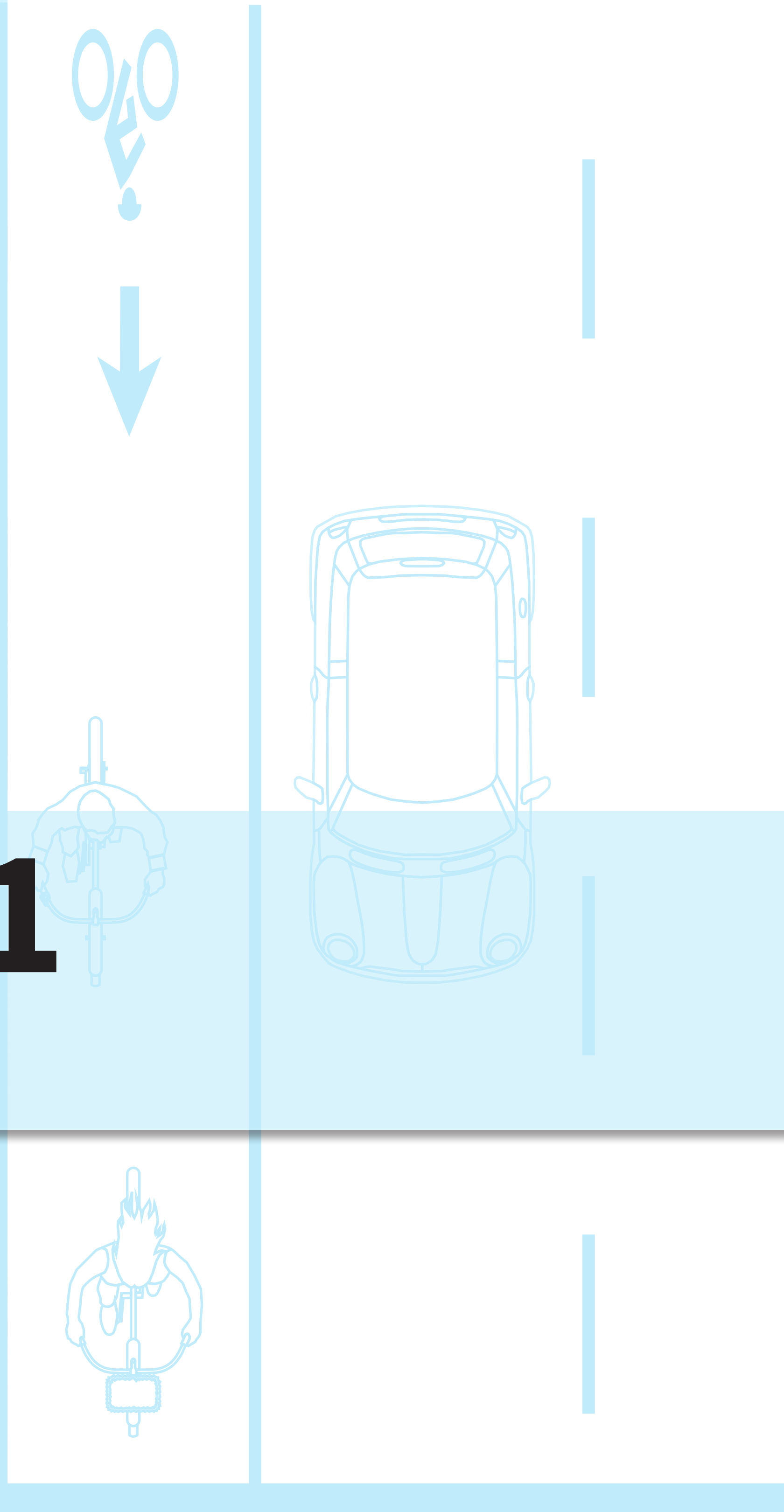
% of Population

Bachelors Degree or Higher 75%

Disability 6.3%

Moved to Chapel Hill in 2010 or later 33%





Chapter 1

Introduction

PLAN VISION

"Chapel Hill is a community where biking is a safe and convenient everyday choice."

This vision is where the Town would like to be in 15 years, and it embodies three key themes that were used to develop this plan. Those themes are...

safety **convenience** **choice**

The majority of people who participated in this planning process do not think Chapel Hill is a safe place to ride a bike. They want that to change and they believe that it can. They are not alone. This bike plan, the Town's 2020 Comprehensive Plan, and the recent results of the Town's biennial community survey indicate that the majority of residents desire a safer, more convenient, bikeable future.

PLAN PURPOSE

The purpose of this Plan is to provide the Town with a set of prioritized infrastructure improvements, policies and program recommendations that will guide Town decisions and investments for the future.

PLAN GOALS

1. Improve the safety of bicycling for all types of riders.
Safety was the number one concern raised during the development of this plan. Many suggested that safety concerns prevented people from bicycling in Town.

2. Foster the development of a culture where bicycling is an accepted and viable mode choice in Chapel Hill.
Though some people regularly bicycle in Town today, it is still not considered to be the most reasonable or attractive mode of transportation by many people. An awareness of the bicycle as an efficient and fun way good way to get around Town will help make it a more regular mode of community travel.

3. Develop a connected network of bicycle facilities in coordination with greenways throughout Chapel Hill.
Today, the low level of street connectivity in Chapel Hill is a major barrier to making bicycling a convenient choice, as bicyclists must travel on high stress arterials with inadequate bike accommodations for portions of a trip.

4. Increase bicycle use for all types of trips.
Everyday, people in Chapel Hill make different types of trips like commuting to work, running errands, or going shopping. Many of these trips are short enough to be made by bicycle. By achieving the first three

The 2020 Comprehensive Plan

Between 2011 and 2012, the Chapel Hill 2020 comprehensive planning process drew thousands of people together to build a vision for its future. One of the Big Ideas of the 2020 Plan, was for Chapel Hill to become a more connected and bikeable community. The goal of this effort is to provide safe connections between neighborhoods, schools, commercial areas, parks, rural bikeways and farms that promote exercise and environmentally friendly modes of transportation. This bike plan was developed as a Tool for the Town achieve the goals and realize the vision of the 2020 Comprehensive Plan in the years to come.

BICYCLING BENEFITS PEOPLE AND COMMUNITIES

Nationwide, interest in bicycling is growing because bicycling provides distinct economic, health, and environmental benefits to people and communities.

by attracting and retaining residents...

Increasingly, members of the Millennial generation (those born 1982-2003) are choosing not to drive. A 2013 survey found that this group prefers transportation choices that save money. Respondents also identified the flexibility of travel and convenience bicycling provides as important factors in their choice to travel by bike. Improved bicycle infrastructure can also attract families who want accessible, fun, family-friendly activities, like in the image below.

Families with young children often prefer to ride their bikes on "off-road" trail networks that are close to natural features.

by attracting and supporting business...

In addition to attracting and retaining residents, a robust bicycle network also attracts business. Employers are recognizing that the workforce of tomorrow wants to work in bikeable, walkable, amenity rich areas. So, in an effort to retain a competitive advantage, many major businesses who traditionally locate in suburban office parks are moving their offices into areas that offer more transportation choices. For example, Citirix, a technology company, is moving over 300 employees into a downtown Raleigh location.

Nationwide, there are also many commercial districts benefitting from increased on-bike traffic. A 2012 study from Portland, OR found that shoppers arriving by bicycle spend as much or more than shoppers arriving by car or by bus. Six other studies have also found increases in total retail sales along streets with newly-installed bicycle infrastructure.

realizing personal health benefits...

Biking can help adults prevent a number of diseases related to physical inactivity such as heart disease, obesity, and depression. Even short bike trips are a good form of aerobic exercise, and numerous studies have found exercise to be correlated with happiness.

For children, biking more frequently can be good for their health and educational performance. A 2012 Dutch study of 20,000 school age children found that those who traveled to school via bike performed much better on tasks demanding concentration, like solving puzzles and math problems. With regards to their health, studies show that childhood obesity is strongly correlated with physical inactivity. By providing a system of safe bicycle facilities, the Town can do their part to ensure that the youth of this community have a wide range of options for physical activity.

Bicycling can help reduce congestion and improve air quality

The bicycle has the potential to replace many "short" car tips and decrease the amount of emissions in urban areas. Even replacing a small percentage of short car tips could have a relatively larger environmental benefit as 60% of the air pollution from automobiles occurs in the first few minutes of operation. This is because the pollution control devices are less efficient when the vehicle is warming up. (League of American Bicyclists).

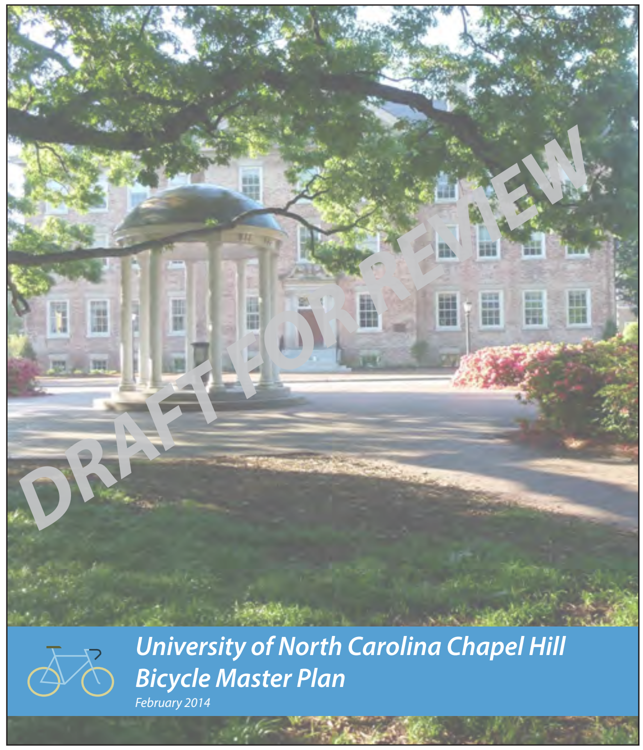
BIKEABLE UNIVERSITY COMMUNITIES ARE MORE COMPETITIVE AND ECONOMICALLY SUSTAINABLE.

UNC Chapel Hill has a major transportation impact and a number of strategies have been adopted to manage and accommodate the university's unique transportation needs. For example, the Fare-Free Chapel Hill Transit system is funded by its three major partners, UNC-Chapel Hill, the Town of Chapel Hill, and the Town of Carrboro. Transportation infrastructure improvements, such as greenways, are also built by the university for public use. These types of cooperative arrangements are vital to a high quality transportation system, one that balances safety and efficiency with other community goals.

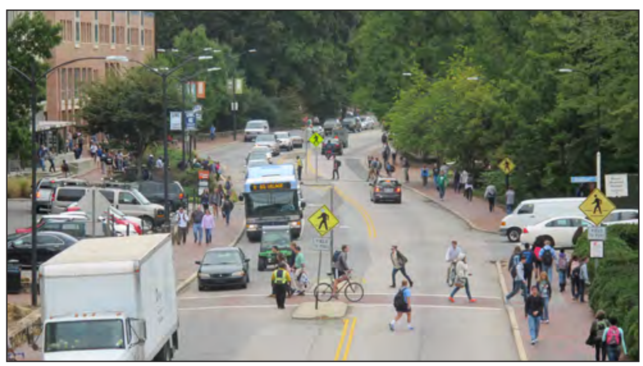
If Chapel Hill is to continue to propser, the availability of high-quality transportation choices cannot be overlooked as a predictor of the community's continued economic success. This is because multi-modal transportation systems , ones that offer "true choice", are a trademark of the high-quality of life communities that Chapel Hill "competes" with. For example, schools like the University of Virginia and Colorado at Boulder vie for the same caliber of students and faculty as does UNC. These peer communities also compete to retain newly educated residents after they graduate and attract innovative businesses. These new graduates and the new businesses they create are ideal economic engines for Chapel HIll.

Bicycle infrastructure can help Chapel Hill achieve a better economic position

The implication for local leaders is this; people and businesses are both willing to relocate to a community based on several factors, including the strength of the local economy and the availability of transportation choices. These two factors are interrelated and building one requires building and maintaining another.   By building and maintaining bicycle infrastructure, Chapel Hill can achieve a better economic position.



ABOVE: Cover of the new UNC Chapel Hill Bicycle Masterplan



ABOVE: South Rd. on UNC Chapel Hill Campus

LEFT: Cycle Track with separate pedestrian walkway on the University of Colorado at Boulder campus provides a safe, high quality transportation facility that attracts thousands of daily bicyclists.

THE AVAILABILITY OF BICYCLE INFRASTRUCTURE CAN CREATE A MORE EQUITABLE COMMUNITY

It is clear from some national demographic preference surveys that many people, notably the millennial generation, aspire to be less reliant on the car as their primary means of getting around. While many of these people may drive a car (i.e they can afford it and have a place to park it), it is also important to note that there are many residents who do not have the choice to drive a car. In particular, the U.S. Census American Survey Data indicates some segments of the Chapel Hill population that are dependent upon a combination of biking, walking, public transit, and carpooling to meet their transportation needs.

Chapel Hill Households by Vehicles Available

U.S. Census Bureau, 2010-2012 American Community Survey

Vehicles Available	0	1	2	3+
# of Households	2,113	7,886	7,404	2,353
% of Households	11%	40%	37%	12%

Bicycling is an efficient and cost-effective mode of transportation that expands mobility

While the bicycle is one of the most energy-efficient forms of transport, it is also one of the most economical as well (especially for shorter urban trips fewer than 3 miles in distance.) Utilizing a study which quantified the annual costs of owning and operating cars and bicycles on a per mile traveled basis, the following table was prepared to compare the annual cost of commuting via these modes. Based on these assumptions, it is possible that an individual could save approximately $1,500 per year by regularly riding a bike for a 3 mile trip to work. Please note that these costs are derived from a national study of the costs and benefits of various modes of travel. These figures do not include the environmental costs of vehicle emissions nor do they assign a monetary value to the health benefits one would experience by biking 6 miles per day or 120 hours per year in this example. Further, they do not assume any additional costs the bicycle commuter may experience as a result of their slower average speed of travel or any other potential inconveniences each mode may experience such as riding a bike in inclement weather or a driver's leisure time lost due to traffic congestion.

Car vs. Bike Cost and Travel Time Comparison for Commuting 6 Miles Per Day Over 10 Years

Cost Data from Victoria Transport Policy Institute http://www.vtpi.org/tca/

Variable	Used Car	Bike
Daily Commute Distance	6	6
Annual Commute Distance*	1,500	1,500
Purchase Cost	$5,000	$500
Ownership Cost (Per Mile)	$0.27	$0.07
Operating Cost (Per Mile)	$0.16	$0.03
Annual Cost (to Own and Operate)**	$1,654	$179
Avg Speed	25 MPH	12.5 MPH
Daily Time Spent Commuting	14.4 minutes	28.8 Minutes
Annual Time Spent Commuting	60 Hours	120 Hours

** 250 work days per year*
*** includes purchase cost amortized over 10 year period.*

The 2020 Comprehensive Plan

Plan Theme : A Place for Everyone

The six themes included in the 2020 Plan reflect major groups of community values. One theme group, *A Place for Everyone*, states Chapel Hill's commitment to continue to be a welcoming, supporting, diverse and creative place. This theme speaks to the need to create "enticing places to gather and play" and "to provide all people with access to opportunities.

The Bike Plan includes recommendations that would create new recreational spaces and improve transportation access to employment opportunities.

See more about the 2020 Plan @ www.townofchapelhill.org/2020

DESIGN CHAPEL HILL 2020 CONNECTIONS CHOICES COMMUNITY

BICYCLE INFRASTRUCTURE MAKES TRAVELING BY BIKE SAFER

One of the most dangerous situations for a cyclist is a collision with a motor vehicle. Even if a motorist is driving safely while obeying the speed limit, it is important to note that their typical speed of travel poses a relatively higher safety risk to cyclists in the event a collision occurs between them. Bicycle infrastructure can make the roads safer for cyclists by providing them with varying degrees of separation from the motor vehicle travel lanes. This separation reduces the chance of collision and thus improves safety.

The effects of motor vehicle speeds

From a safety perspective, it is important to note that the average automobile, when in motion, possesses significantly more kinetic energy than the average cyclist does. Kinetic energy, or the energy of motion, is represented by the formula below.

$$KE = \frac{1}{2} \cdot mass \cdot speed^2$$

One can see that speed has an exponential impact on the kinetic energy of moving objects. This simple fact is why speed and roadway safety are so interrelated. Figure 1 compares the kinetic energy produced by a 2014 Toyota Camry and a cyclist traveling at various speeds. In this example, even when the cyclist and motorist are traveling at the same speed (25 MPH), the average mid-sized sedan produces 70,000 foot/lbs of energy, roughly 19 times more kinetic force than the average cyclist produced. When the human body is subjected to these types of forces in a traffic accident, significant injury and death can result.

1 Pedestrian fatality risk as a function of car impact speed Erik Rosén*, Ulrich Sander Accident Analysis and Prevention 41 (2009) 536–542)

Figure 1: Relationship between travel speed and kinetic energy produced for cars and bikes*

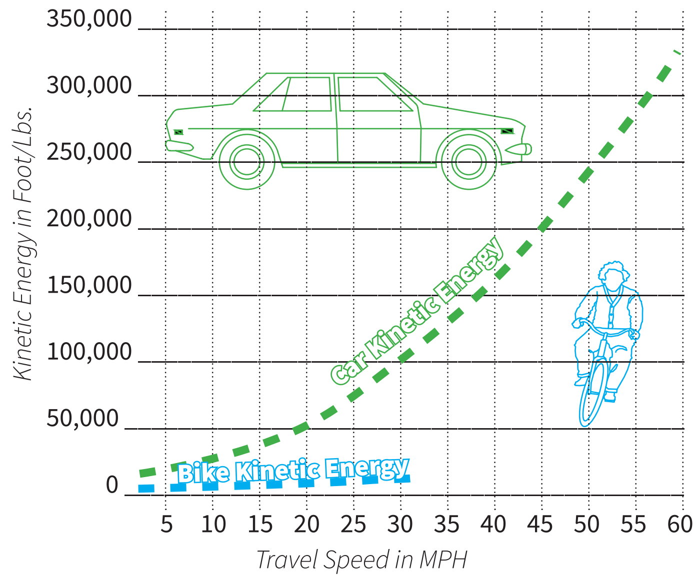
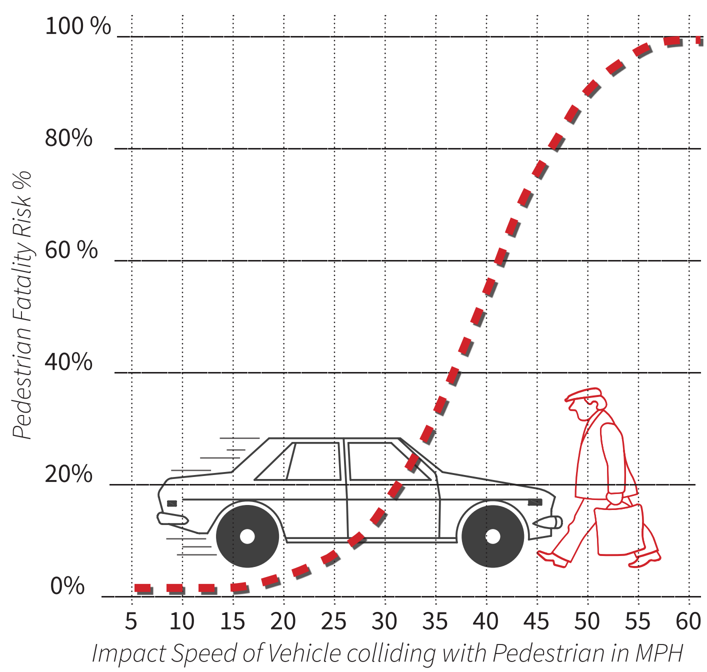


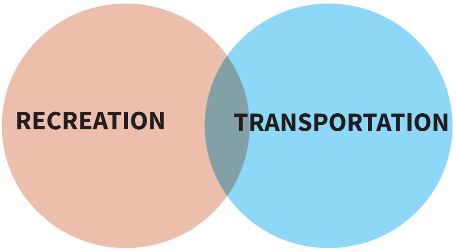
Figure 2: Relationship between collision speed and the risk of pedestrian fatality. [1]



European researchers have studied pedestrian/automobile crashes and the risk of pedestrian fatality. While this was a study of pedestrian risk, a similar trend would be expected for cyclists since they would also be unprotected and subjected to the high kinetic energy generated by a motor vehicle. Figure 2 of this page summarizes the European researchers findings.

BICYCLING IS FOR TRANSPORTATION AND RECREATION

The following page provides an overview of different forms of cycling most commonly found in American cities. Some people ride a bike purely for recreation. Others maintain that they ride a bike solely for transportation purposes alone (aka “Utilitarian”). Between these two ends of the spectrum are those who ride for both transportation and recreational purposes. The categories and descriptions below are meant to be general and serve primarily to illustrate that many people, of all ages, backgrounds, and physical ability levels ride bikes.



mountain bikers

Ride “fat-tire” bikes that provide traction and stability on natural surface trails which vary in width and may contain natural obstacles such as rocks, roots, and steep inclines.

fitness bikers

Prefer bikes that allow them to maintain an upright position and riding paved paths or smooth natural surfaces. They seek routes where there is good separation from vehicular traffic. Fitness, natural attractions, and family outings are the primary reasons these people ride bikes.

road bikers

Ride geared bikes at higher speeds for long distances alone or in groups. Experience and fitness levels range and these cyclists are comfortable riding mixed traffic. Urban areas with good greenway networks and safe access to rural secenic roads attract these cyclists.

youth cyclists

Youth cyclists straddle the two major categories as their daily bike usage may include multiple recreational and transportation related trips(school, practice, riding with friends, etc).

commuters

These cyclists are comfortable riding with mixed traffic and often make modifications to their clothing and bicycles to improve efficiency and safety while riding to work or for shopping trips.

lifestyle riders

These riders value the journey as much as the destination. Bikes ridden by this group vary widely in form and their designs are often a reflection of the rider’s individuality. Trips to the farmers market or other public spaces are common but these riders may also commute to work via bike.

primary means

For some people, the bike is their primary means of personal transportation. Many in this group can not afford or choose not to own automobiles . Others may be unable to obtain a driver’s license. Work trips to employment locations that are too far away to walk to, or are not served adequately by public transit are some of the primary trip motivations for these cyclists.

MONITORING AND COMMUNICATING PROGRESS: THE KEY TO A LIVING DOCUMENT

The Chapel Hill Bike Plan is intended to be a living document, and therefore should be updated every 5 years to assess progress, identify new opportunities, and re-evaluate priorities and goals. A progress status report should be developed and presented to the Town Council one and three years after this plan is adopted, and every two years that follow prior to an actual update of the plan. One component of evaluation relies on establishing benchmarks and reporting outcome based performance measures periodically. Additionally, evaluation must include review from appropriate Town Advisory boards, the Council, and the public. Also, the WikiMap that was used during the Bike Plan could be relaunched to maintain communcation between Town staff and the public (See Page 12).

This plan includes a short term facilities project list and that list should be maintained and updated annually as projects are undertaken and completed. The specific details, such as project cost, facility type, and the length of these projects should be catalogued in a spreadsheet that is linked to a Geographic Information Systems data layer. The status of a particular project (i.e project initiated, project under construction, or project completed) should also be tracked. These attributes will serve as the basis for one major component of future bike plan progress reporting.

Another major component of progress reporting will require collecting data and maintaining the three planning datasets listed below.

1. A Geographic Information Systems layer representing the existing bicycle and greenway facilities network.
2. Bicycle Traffic Count Data
3. Bicycle Crash Data

Each of these datasets are needed to assess and communicate the Town's progress toward becoming a safer, more convenient place to bicycle. These datasets are further described in Chapter 3, Existing Conditions, and their role in the reporting of key performance measures is discussed in Chapter 6, Plan Implementation.

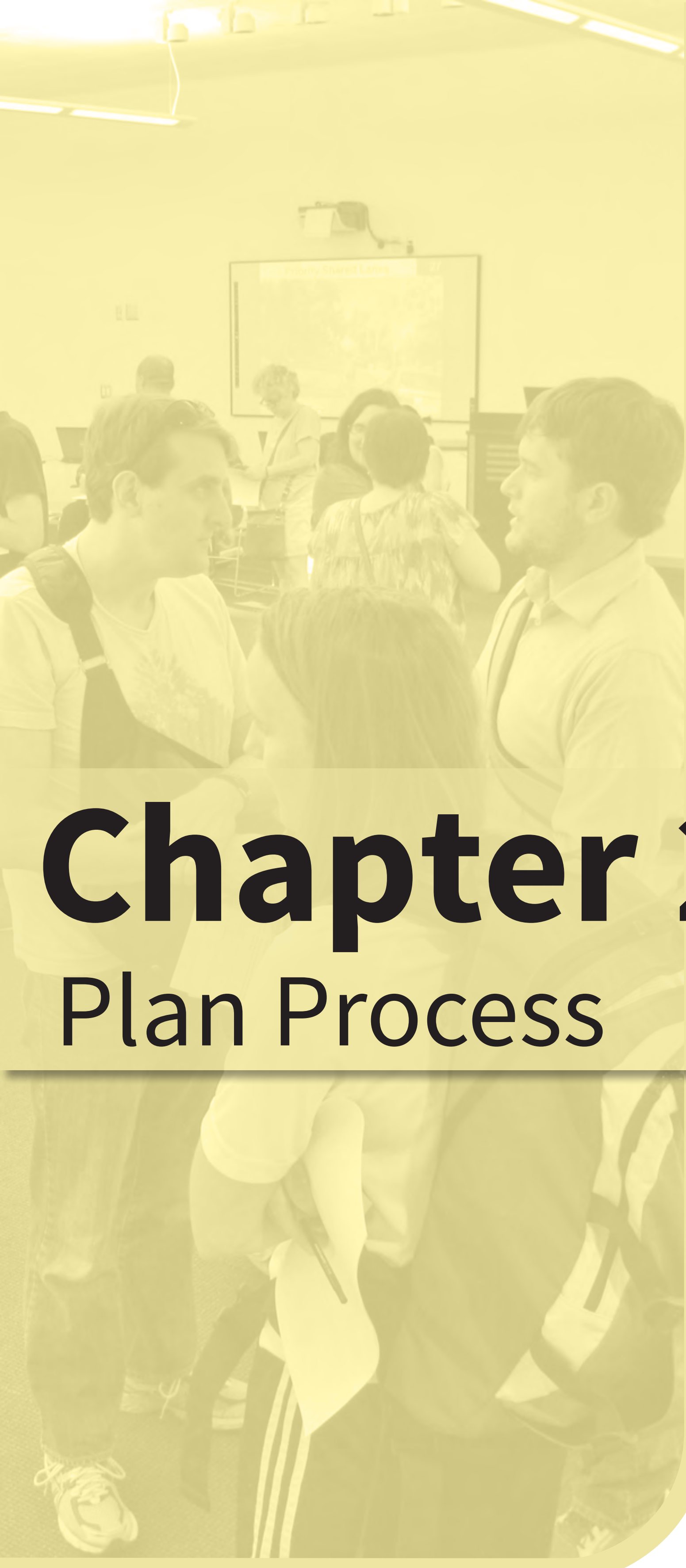
Lastly, this plan includes a set of Policy and Program Recommendations. Like the short term facilities project list, these policy and program recommendations should also be kept in a list and their status reported upon.

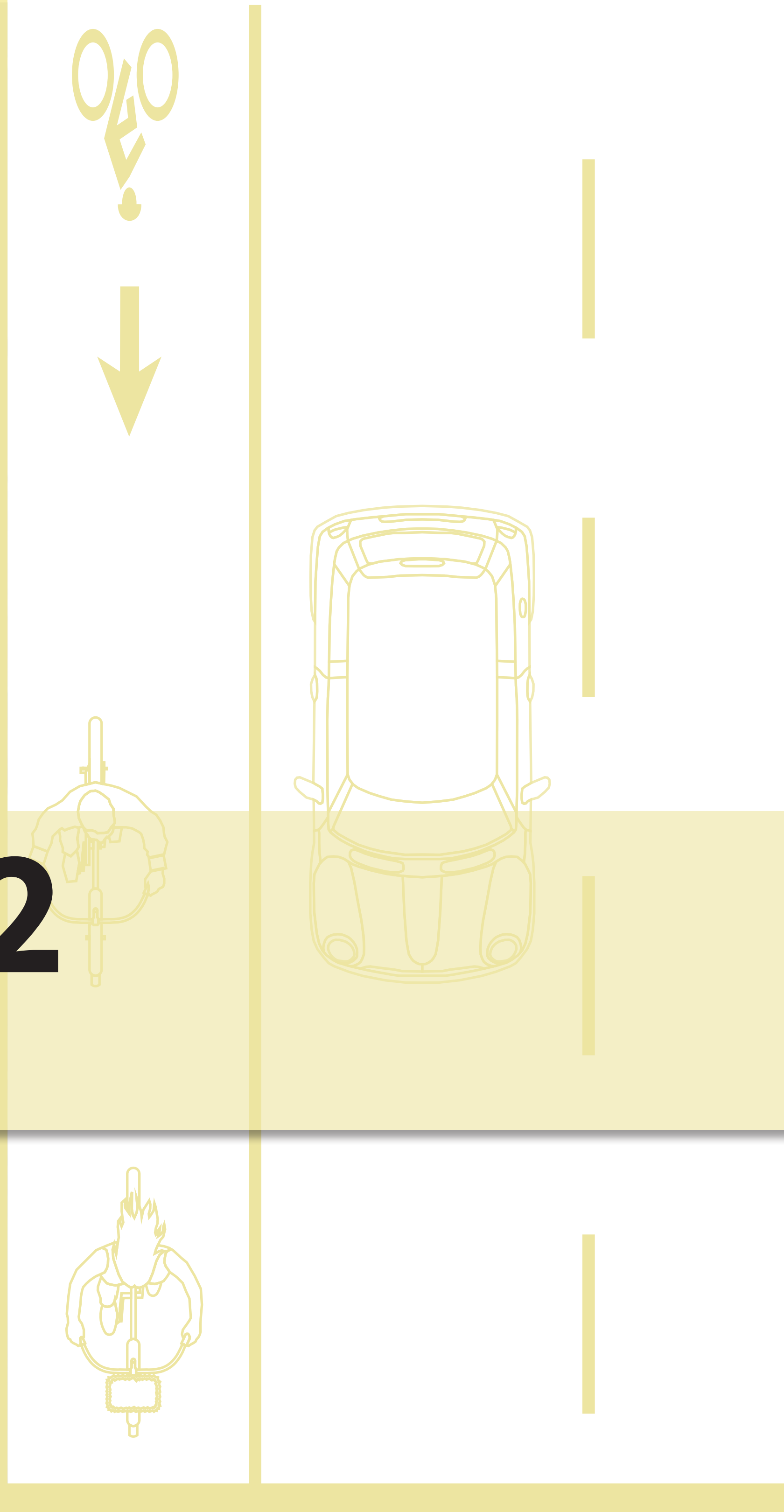
Imagery helps tell the story

Sidewalk Construction

Culbreth Rd. Greenway Underpass construciton in Southern Chapel Hill (Summer 2013)

As projects and activities related to this plan's recommendations are undertaken, photos should be taken at important phases of development. Not only will these photos serve as a visual record of the work that goes into building infrastructure, they can also be used on the Town's website and in presentations related to bike and pedestrian infrastructure.





Chapter 2
Plan Process

THE BIKE PLAN PROCESS

The Chapel Hill Bike Plan was a collaborative effort among Town staff, stakeholders, and the public. The outreach effort garnered a great amount of community feedback and attention by reaching over 600 residents through a number of citizen engagement methods.

	2013									2014					
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Project Start	COMMITTEE MEETING														
Public/ Stakeholder Outreach/		BIKE TO THE FUTURE 1 WIKI MAP RELEASE		ONLINE SURVEY			BIKE TO THE FUTURE 2								
Data Collection/ Fieldwork/ Research		COMMITTEE MEETING		COMMITTEE MEETING											
Draft Plan Review						COMMITTEE MEETING					ADVISORY BOARD REVIEW				
Final Plan Adoption													COUNCIL PUBLIC HEARING PLAN ADOPTION		

Steering Committee

A Steering Committee comprised of Town, business and citizen stakeholders was selected to guide the development of the Chapel Hill Bicycle Master Plan.

Public Events

Bike to the Future I and II were public forums held to get community input on the Chapel Hill Bike Plan. Over 100 people attended each of these events at the Chapel Hill Public Library.

Online Tools

The Bike Plan utilized two web-based tools to get feedback on cycling conditions and bicycle infrastructure preferences. Over 200 people contributed to the WikiMap, an interactive map where people could draw on the map and add comments. Over 300 people responded to an online survey questionnaire. Each of these tools provided valuable insights to the Steering Committee and Planning Team, and they are described in greater detail on page 11.

WHAT DID PEOPLE SAY ABOUT BIKING IN CHAPEL HILL?

A major goal of this planning process was to solicit public opinion on bicycling in Chapel Hill. Feedback gathered during this plan was similar to what was heard during the 2020 Comprehensive plan. People want more choices and greater connectivity in Town. Overall, most who provided feedback said that biking in Chapel Hill can be dangerous and stressful. Many also said that they wanted it to be more safe, convenient, and better connected in the future.

Compared to many other North Carolina communities, a greater proportion of people ride bikes in this community for transportation and recreational purposes. Despite the presence of a strong cycling culture, many who currently ride feel that it is unsafe and inconvenient in some places.

Some of those surveyed indicated that they would bike more in Chapel Hill if they felt safer riding a bike there. These same respondents indicated that streets with bicycle facilities, like Bike Lanes and Sidepaths, would be better places to ride than a street without such facility. Some said that these facilities would encourage them to bike more often.

People also indicated that Greenways were something that the Town should continue investing in, since they can provide off-road bike routes that avoid stressful high-speed-high-volume roads.

Many survey respondents thought Chapel Hill was a less safe place to bike than many other communities. When asked to rate Chapel Hill against another community they thought was safer for biking, people gave Chapel Hill a 4 and the other community an 8 (on average).

People agreed that the most important streets in Town to fix for biking were the major ones like Martin Luther King Jr. Blvd., Raleigh Rd., Fordham Blvd., and Estes Drive. Along with these streets, the three major downtown streets, Franklin St., Rosemary St., and Cameron Ave. would be vital to a convenient bicycle transportation network.

The “big map” gave attendees of Bike to the Future II an opportunity to prioritize transportation investments with “play” money.

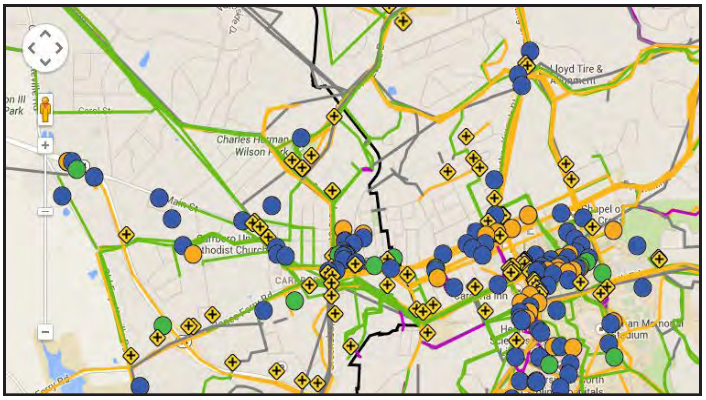
Citizens discuss bicycle related issues and provide written comments via the “Question Wall.” at Bike to the Future I.

THE WIKIMAP

The WikiMap, a web-based citizen engagement tool, was launched in May of 2013. This application gave bicyclists and non-bicyclists the ability to contribute to the plan in a way never done before in Chapel Hill. WikiMap users could draw points and lines on a web map related to different streets and areas of Town. After drawing those features, they could add a comment. Over 300 people made over 1,000 comments in two months. This provided the planning team and steering committee with valuable insight.

Selected WikiMap Comments

- "Manning drive from Fordham to campus is dangerous"
- "Riding on Estes is stressful"
- "The road is narrow. Cars pass by much too close."
- "the safest route without going too far out of the way"
- "the sidewalk is too narrow for bicyclists and pedestrians"
- "there are a lot of buses on MLK"
- "The Cloverleaf of Death...Cyclists not welcome"
- "the pavement is terrible"
- "Cyclists must ride in the *door zone*"
- "no dedicated bike lane"
- "I feel safer riding on populated streets at night than trails surrounded by woods"
- "Motor vehicles going way over the speed limit"
- "no wayfinding signs in this area"
- "there is often debris in the bike lane"
- "How does a child cross to get to soccer here?"
- "Chaos reigns during class changes"
- "Bike path is unseen by cars turning."
- "Cars not using turn signals; cyclists not obeying laws"



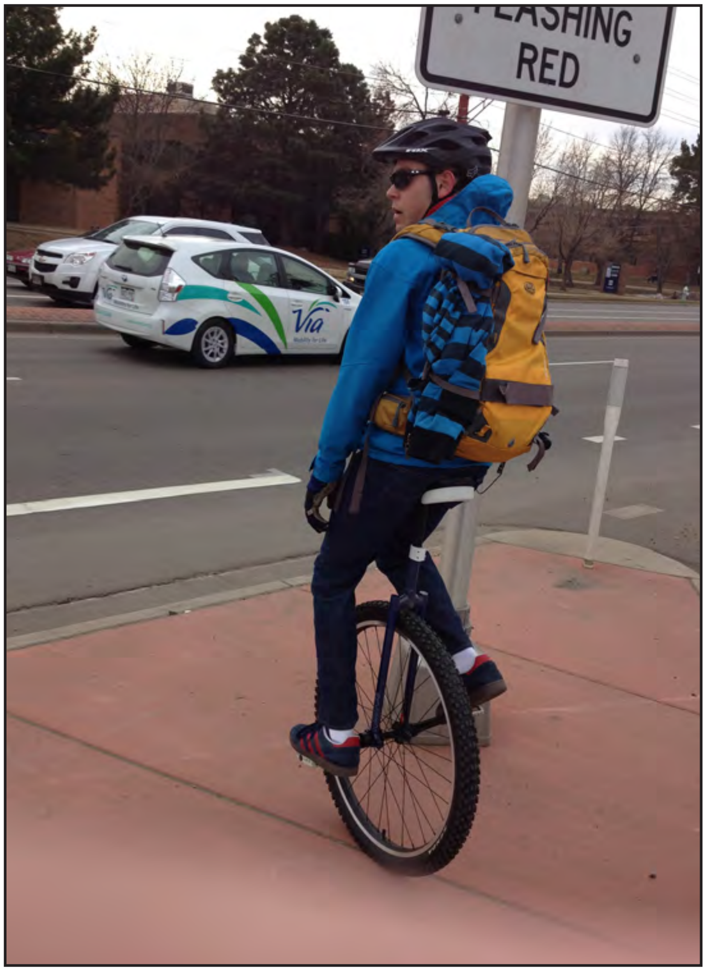
Screenshot of the WikiMap user interface.

THE ONLINE SURVEY

An online survey instrument was used to gauge opinions on current conditions and the future of bicycling in Chapel Hill. There were over 600 respondents. The section below contains some of the questions asked by the survey.

Selected Survey Questions

- What 3 words describe Biking in Chapel Hill today?
- Where would you let your kids ride a bike?
- Which factors have prevented you from biking?
- What are the good things about biking in Chapel Hill?
- What three streets are vital to biking in Chapel Hill ?
- What would make you bike more often?
- Where would rather bike? On Street A or B?
- What is the safest city you have ever biked in?



ABOVE: Boulder Colorado was a common response to the survey question "What is the safest city you have ever biked in?" In this image, a uni-cyclist is waiting to cross an 6 lane urban arterial on a pedestrian refuge island that connects with a 10 ft wide shared use path.

2013 COMMUNITY SURVEY

The Chapel Hill Community Survey is one of the ways the Town seeks feedback on the quality of service provided in the community. The third biennial survey was mailed to 2,000 randomly selected Chapel Hill households in November of 2013, a few months after the Bike Plan survey was available online. With respect to the Bike Plan, the Community Survey's results provide perspective on the need for bicycle infrastructure investment in Town.

Overall, The two areas that residents thought should receive the most increase in emphasis during the next two years were:

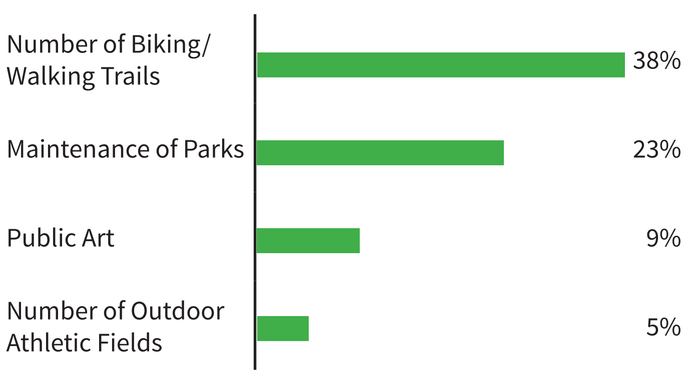
1. **Overall flow of traffic and congestion management**
2. **How well the Town is preparing for the future**

The Bike Plan can help the Town respond to these areas of needed emphasis . Further, the responses to some specific questions from this survey are directly applicable to bicycle infrastructure and perceptions of bicycle safety. Responses to these selected questions are summarized in the tables and graphics on this page. For full results for each question, visit the following link.

http://www.townofchapelhill.org/index.aspx?page=1390

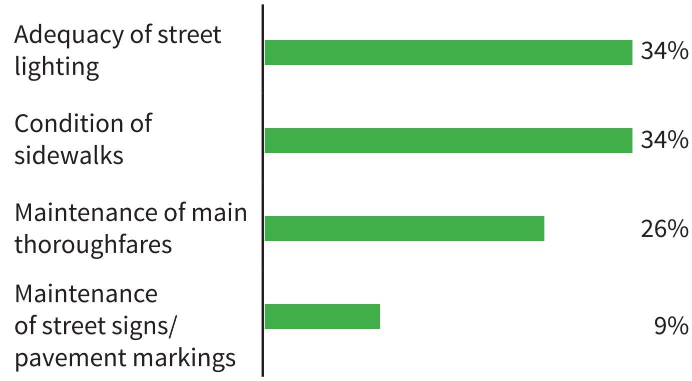
Community Survey Question

What Parks and Recreation services should receive the most emphasis from the Town over the next two years?



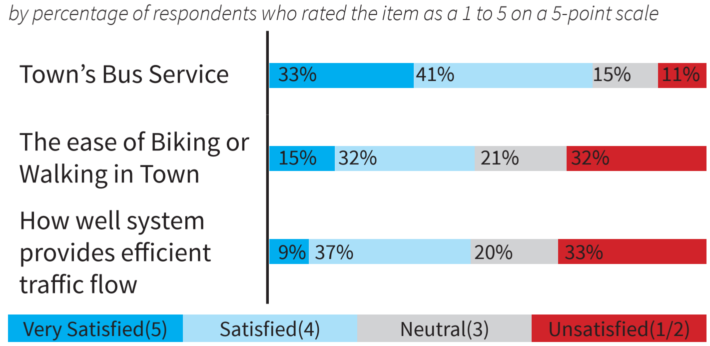
Community Survey Question

What Public Works services should receive the most emphasis from the Town over the next two years?

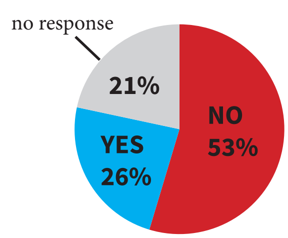


What is your level of satisfaction with transportation in Chapel Hill?

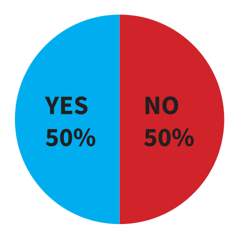
by percentage of respondents who rated the item as a 1 to 5 on a 5-point scale



Within the Town limits, do you feel safe cycling?



Does anyone in your household ride a bicycle?



For what purpose do they ride?

Recreation Only	65%
Commute to Work/School	9%
Recreation and Commuting	26%

Importance of various factors in your decision to live in Chapel Hill

by percentage of respondents who rated the item as "very important" or "somewhat important"

Safety and Security	96%
Quality of Public Schools	89%
Access to quality shopping	81%
Availability of Transportation Options	77%

Capital Improvements that are most important to residents

by percentage of respondents

Downtown Redevelopment	96%
Additional bicycle lanes/ off-road paths	89%
Sidewalk construction	81%
Public facilities	77%

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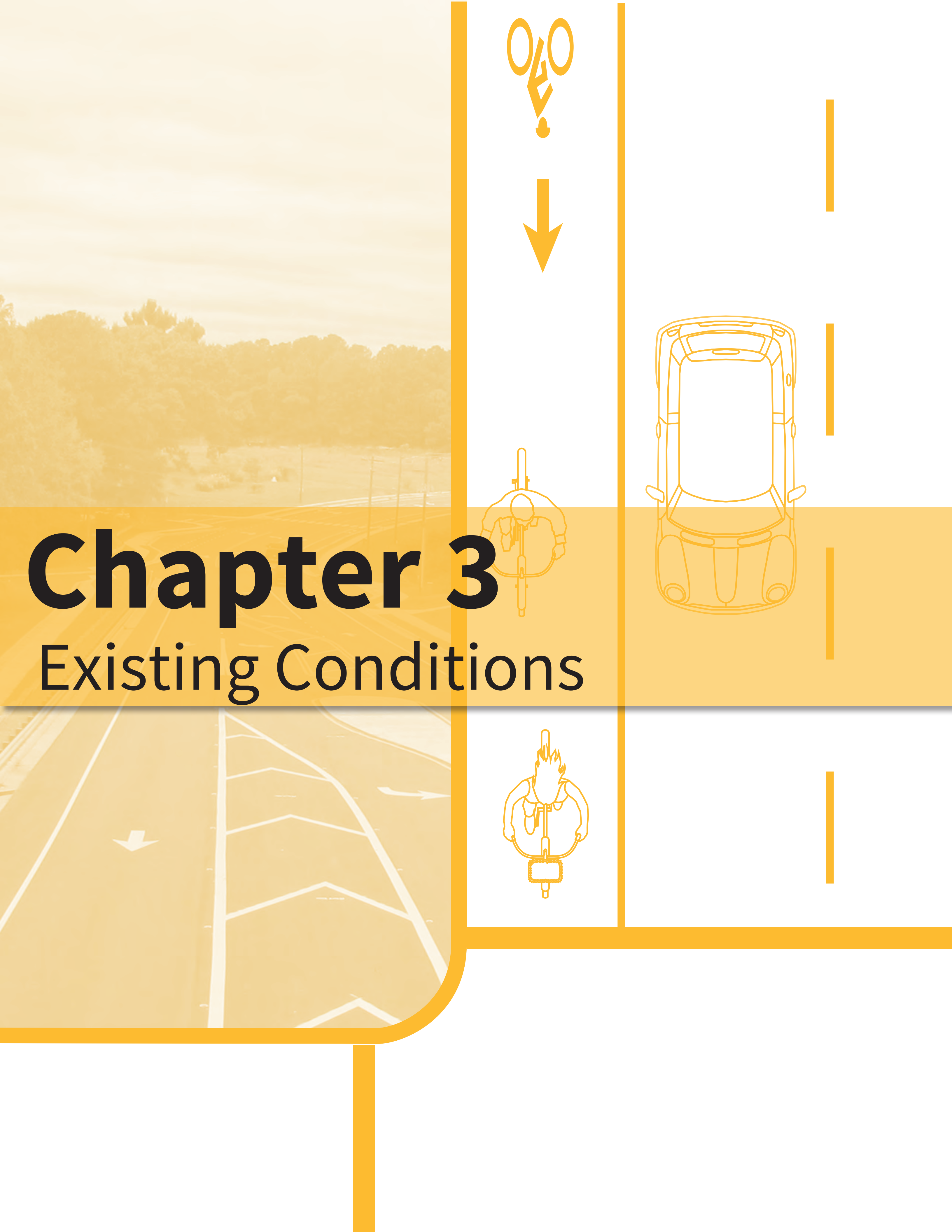


Chapter 3
Existing Conditions

ASSETS AND CHALLENGES

Assets

Similar to other University communities, Chapel Hill has the potential to be a great place for people to live, learn, and bicycle. Today, there is growing population of recreational and transportation cyclists and this community currently supports 10 bicycle shops in the area. Over 14% of the UNC student body reports to access the main campus via bike on a regular basis. This existing level of ridership and support, along with the Town's demographics, greenway system, and concentration of destinations in close proximity are assets that can be leveraged to make Chapel Hill a premier bicycling community. (

Despite these advantages however, the there are also challenges. This plan can aid the Town in addressing them.

Challenge : Terrain

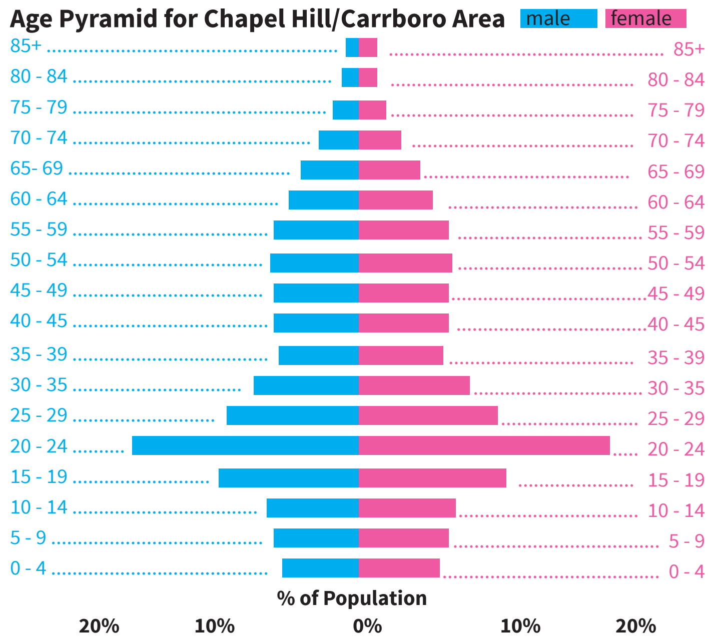
For some, the hilly terrain of Chapel Hill can be a mental and physical barrier to bicycling. See Figure 3 on the next page for an illustration of a typical roadway elevation profile in Town.

Challenge : Low Level of Street Connectivity

Between the 1950's and 1990's residential land development practices favored cul-de-sacs based street networks over a grid-based ones. Now, Chapel Hill, like many U.S towns and cities, has a street network with low-connectivity. In many places it often feels disconnected and inconvenient for those not driving an automobile.

Challenge : Lack of Bicycle Infrastructure on Major Roads

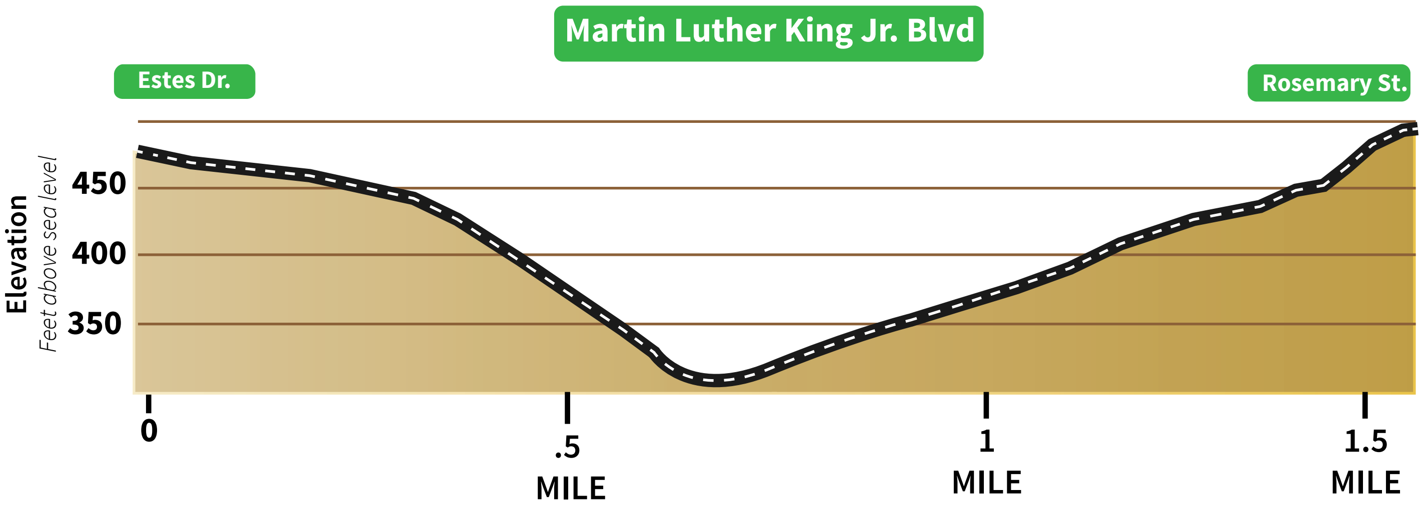
Much progress has been made in the past decade to include bicycle and pedestrian facilities on the Town's major street network. Weaver Dairy Rd. and S. Columbia St. provide good examples of getting bike lanes on a street owned by the NCDOT. The Shared Use Paths on NC 54 that were constructed in concert with Meadowmont are a good example of the Town working with land development applicants to build needed infrastructure. However, there is still much progress to be made as many major roads lack bicycle facilities. For the vast majority of people, biking on a major street without bicycle facilities, such as Estes Drive or Raleigh Road, is a stressful and less safe situation to bike in.

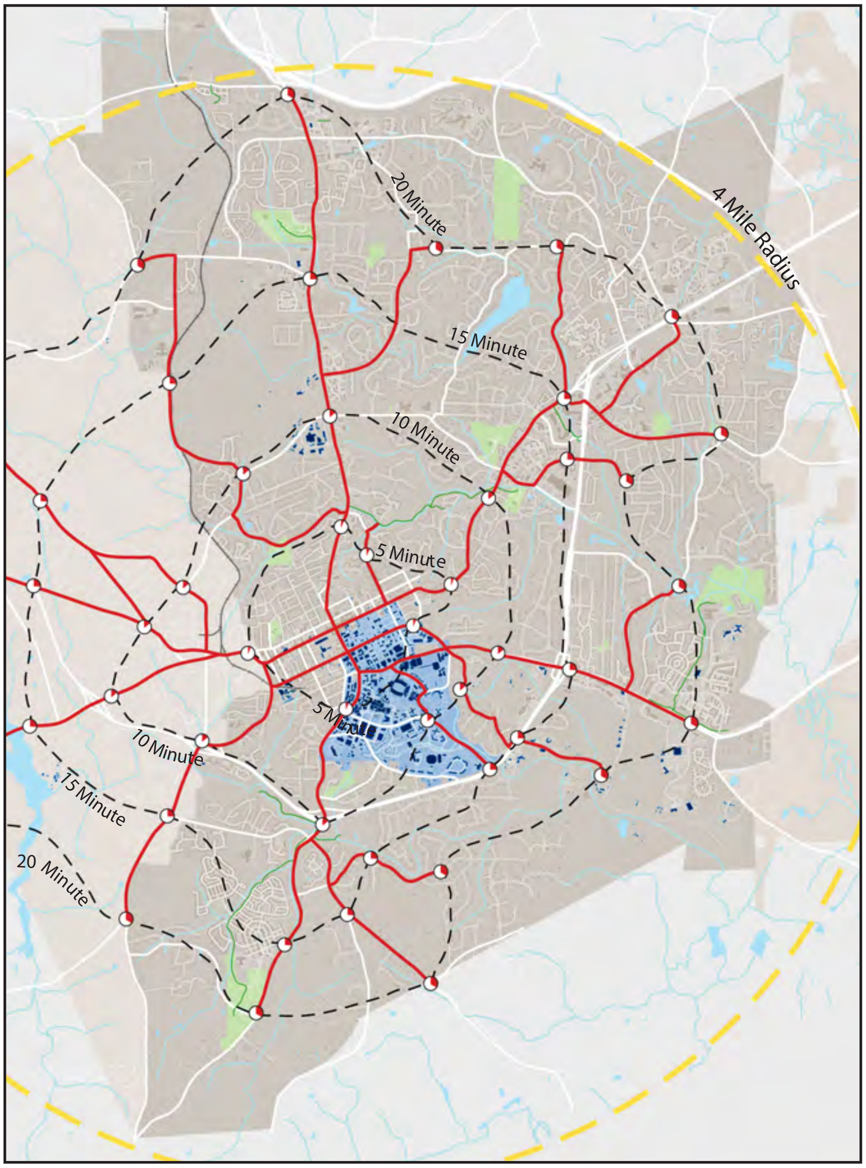


ABOVE: The presence of a major university influences the demographics of this community. In 2010, the largest population cohort in the Chapel Hill/Carrboro area was women between the ages of 20 and 24. (Data 2010 US Census)

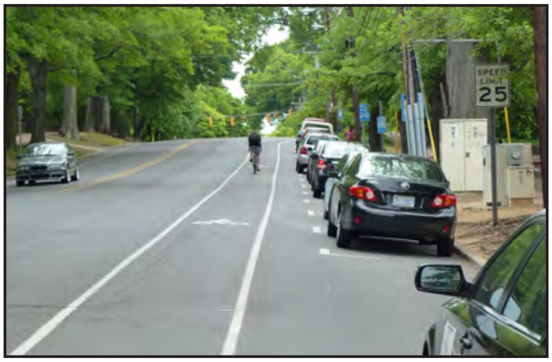
ABOVE: *Sections of the Orange Co. Bicycling Map.* Orange Co. has a system of signed road cycling routes totaling 158 miles in length. Route 1 goes through Chapel Hill and takes cyclists to popular routes of western Orange County.

LEFT: Image of recreational cyclists in western Orange County.





Chapel Hill is “compact” and the distances between many neighborhoods, commercial areas and the UNC Campus are all within a practical biking distance. This graphic illustrates the approximate time for a bicyclist to travel from downtown to other areas of the Town.



ABOVE: The bike lanes on West Cameron Avenue are the most utilized on-street bicycle facilities in town, with an estimated ridership exceeding 1,000 bicyclists per day. The high bicycle volumes on this street can be attributed to the link it provides between Carrboro’s Libba Cotten Greenway and the UNC campus.

ABOVE: The “Sharrows” on Martin Luther King Jr. Blvd. were added in 2008 as part of an experimental pilot project. Bicycle safe drainage grates are another design feature of this street intended to make cycling safer. This street is also heavily utilized by the Chapel Hill transit system.

THREE KEY DATASETS FOR A LIVING DOCUMENT

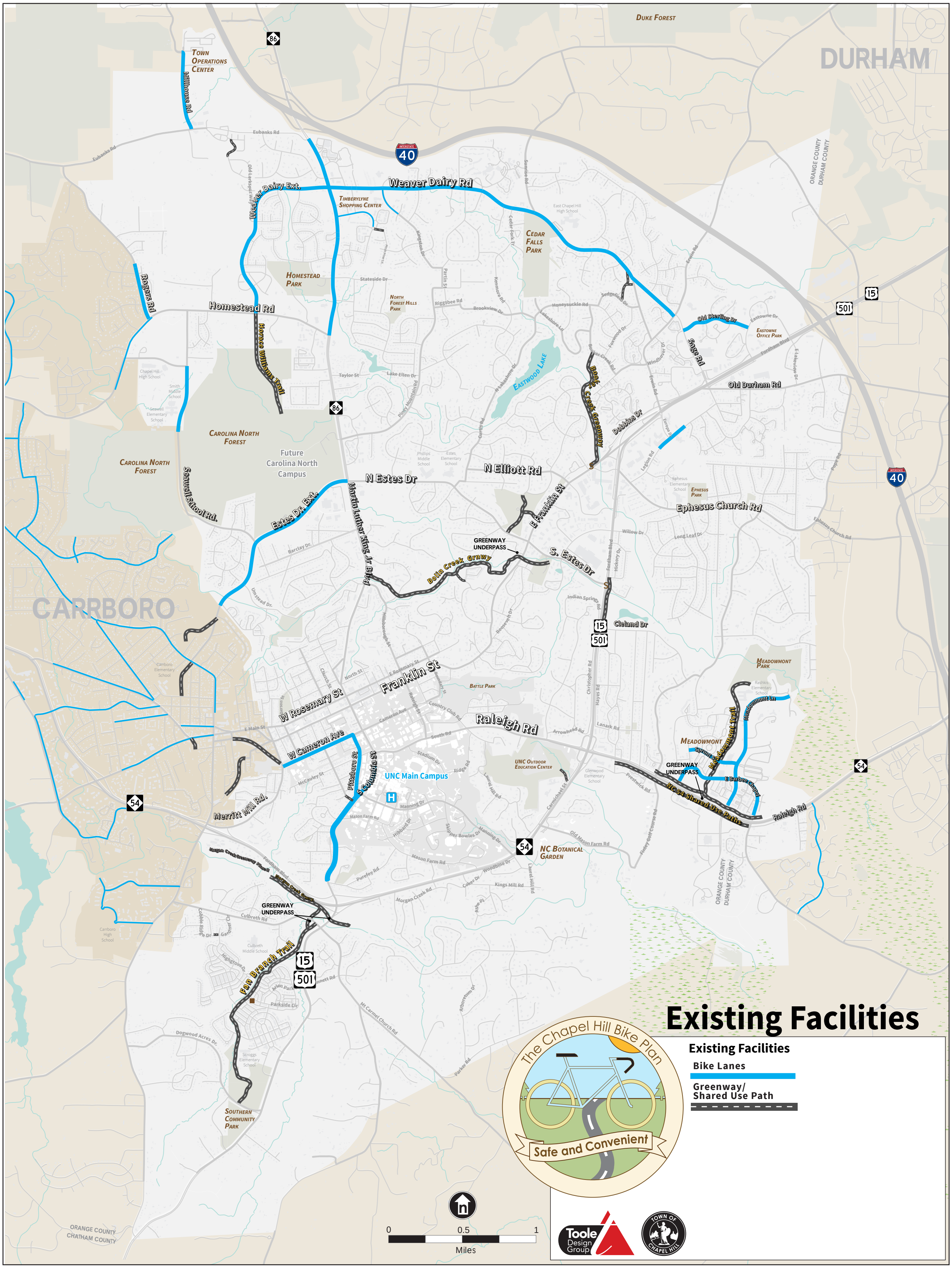
Geographic Information Systems (GIS) datasets are critical to planning for the Transportation Network and they were used extensively to develop this plan document. To keep this document a “living document” the Town must collect and maintain the following GIS datasets related to bicycle facilities, usage, and safety over time.

Existing bicycle facility dataset

A dataset which categorizes streets in Town based on the type of bicycle facility present and any other special characteristics such as that facilities length, width, or pavement condition. Paved Greenways should also be included in this layer as should paved “connectors” and bicycle and pedestrian underpasses and bridges. See map on next page.

On-Street Facilities	Length (Miles)	Off-Street Facilities	Length (Miles)
Cameron Ave Bike Lanes	.5	Northside of NC 54 Sidepath	.8
S. Columbia Bike Lanes	1.1	Southside of NC 54 Sidepath	1.25
Weaver Dairy Rd. Bike Lanes	2.5	Bolin Creek Greenway	1.5
Weaver Dairy Rd. Extension Bike Lanes	1.3	Lower Booker Creek Greenway	1.3
S. 15-501 Bike Lanes	.9	Upper Booker Creek Greenway	.33
Martin Luther King Jr. Blvd. Bike Lanes	1.37	Morgan Creek Greenway	.83
Old Sterling Dr. Bike Lanes	.46	Fan Branch Trail	1.6
Meadowmont Ln. Bike Lanes	1.0	Horace Williams Trail	1.0
E. Barbee Chapel Rd. Bike Lanes	.83	Meadowmont Trail	.75
Sprunt St. Bike Lanes	.35		
Westminister Dr. Bike Lanes	.31		
Kingston Dr. Bike Lanes	.21		

Bike and Pedestrian Underpasses and Bridges	Paved Connectors
NC 54 Sidepath/Meadowmont Trail Underpass	Weaver Dairy Rd.-Sedgefield Dr.
Fan Branch Trail @ Culbreth Rd. Underpass	S. Columbia St.-Briar Bridge Lane.
Bolin Creek Greenway Underpass @ Franklin St.	Caldwell St. - McMasters St.
	Frat Court Connector
	Fetzer Lane Connector
	Vineyard Sq. Acquatic Center


Existing Facilities
Existing Facilities
Bike Lanes
Greenway/
Shared Use Path
The Chapel Hill Bike Plan
Safe and Convenient
DURHAM
CARRBORO
Weaver Dairy Rd
Homestead Rd
N Estes Dr
N Elliott Rd
Franklin St
Raleigh Rd
Ephesus Church Rd
Old Durham Rd
W Rosemary St
W Cameron Ave
Estes Dr. Ext.
Martin Luther King Jr Blvd
S. Estes Dr
Merritt Mill Rd.
UNC Main Campus
Carolina North Forest
Future Carolina North Campus
Fan Branch Trail
Bolin Creek Grnwy
GREENWAY UNDERPASS
Miles
0
0.5
1
Toole Design Group
Town of Chapel Hill

Usage : Bicycle Traffic Count Data

A dataset which records number of bicyclists riding along a given street/or greenway during a specific period (1 hr, 12 hrs, etc.). To the extent possible, as new counts are conducted each year, they should be conducted at the same location and general timeframe as previous year's counts.

Fall 2012 Chapel HIll Bicycle Traffic Counts (7AM - 7PM)

Rank-Count Location	*Total*
1) Cameron Ave/Pittsboro St	853
2) McCauley St/Ransom St	521
3) Manning Dr @ Ridge Rd	447
4) Franklin St/Columbia St	446
5) Columbia St @ Fraternity Court	386
6) McCauley St/Pittsboro St	385
7) Columbia St/McCauley St	384
8) Raleigh St @ South Rd	335
9) South Rd @ Bell Tower	331
10) Franklin St @ Henderson St	288

ABOVE: Automatic counters like the one above for bicyle traffic display the number of cyclists counted in a given day. Devices such as this track facility usage and communicate a city's commitment to cycling.

Usage: US Census American Community Survey and UNC Commuter Survey

Based on Chapel Hill Bicycle commuting rates are 2.8%. This number reflects only the percentage of workers aged 16 and over living in Chapel Hill surveyed by the U.S Census that indicated they rode their bike to work. The actual percentage of bicycle trips in Chapel Hill for work, school, and recreation is likely higher than this figure.

Bicycle Commuting Rates
2010-12 American Community Survey

Chapel Hill NC	2.8%
Boulder CO	8%
Carrboro NC	4%
Davis CA	22%
Portland OR	6%
Charlottesville VA	3.3%
Madison WI	8%

UNC Chapel Hill Bicycle Commuting Rates

UNC CH Employees	5.2%
UNC CH Students	14.2%

ABOVE: Over 14% of UNC students reported to access the main campus via bicycle in 2012. Each year, approximately 4,000 freshmen must rely on a combination of biking and transit to access the campus and other parts of the community since no on-campus or satellite car parking is provided for these students.

Bicycle Crash Data

Analyzing the location of crashes can help prioritize infrastructure projects that fix the areas with the most pressing safety issues. There were 69 reported bicycle-automobile crashes in Chapel Hill from 2007 to 2011. In that time, only one crash resulted in a disabling injury, and there were no fatalities. The majority of these reported crashes were on Downtown or UNC main campus streets. 62% of crashes were officially reported to be caused by the motorist involved, and 28% were attributed to the bicyclist involved. The most prevalent crash types were a motorist turning right across a bicyclist's path of travel in the same direction, and a motorist turning left across a bicyclist's path of travel in the opposite direction. ***See Appendix B, Chapel Hill Bicycle Related Crash Maps.***

Using data provided by NCDOT, a sample crash report map was prepared to illustrate the types of details that NCDOT tracks for bicycle crashes. The Crash Type listed in table is shown in the adjacent illustration.

Bicycle Motor Vehicle crash @	Martin Luther King Blvd near Shadowood Apts.
Crash Day	Thursday
Crash Date	March 6 2008
Crash Location	Non-Intersection Location
Crash Type	Bicyclist Left Turn - Same Direction
Light Conditions	Daylight
Speed Limit	30-35
Crash Severity	Disabling Injury

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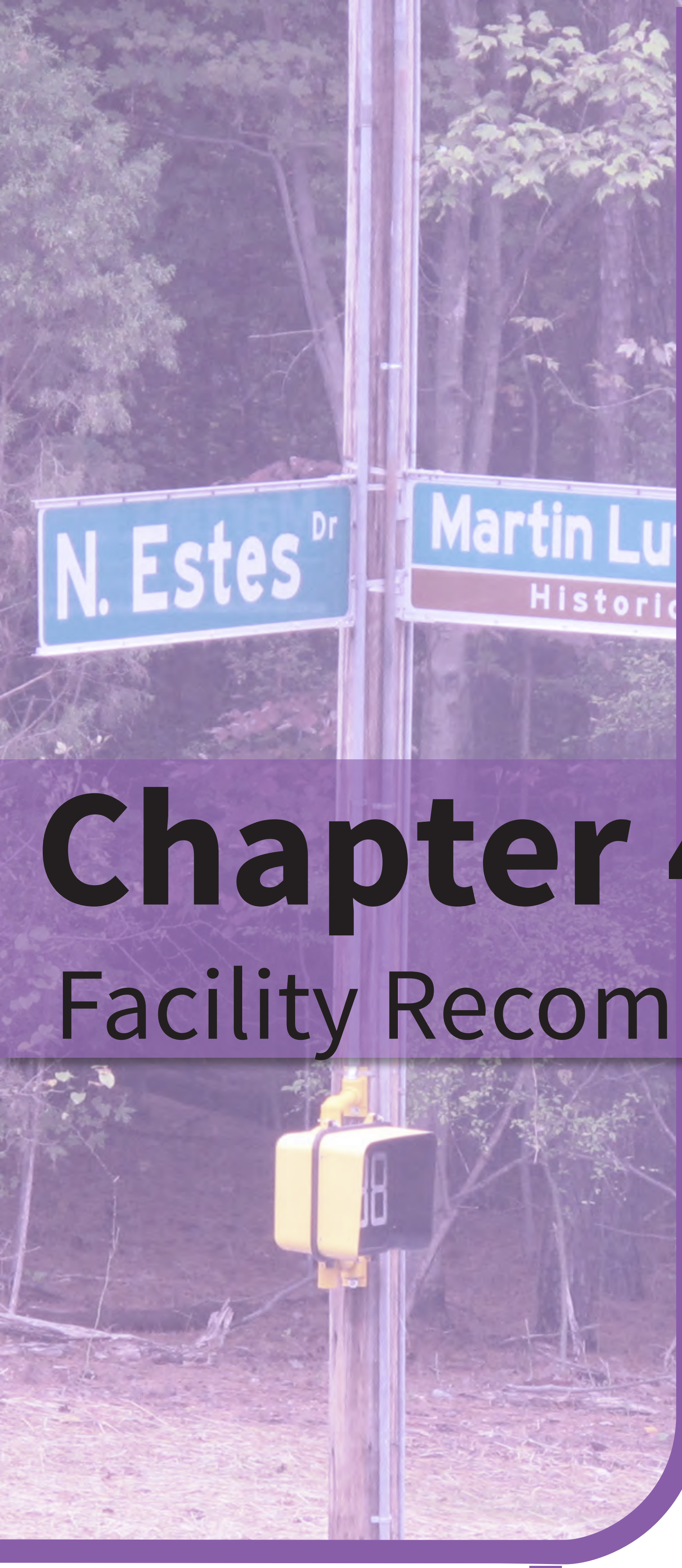
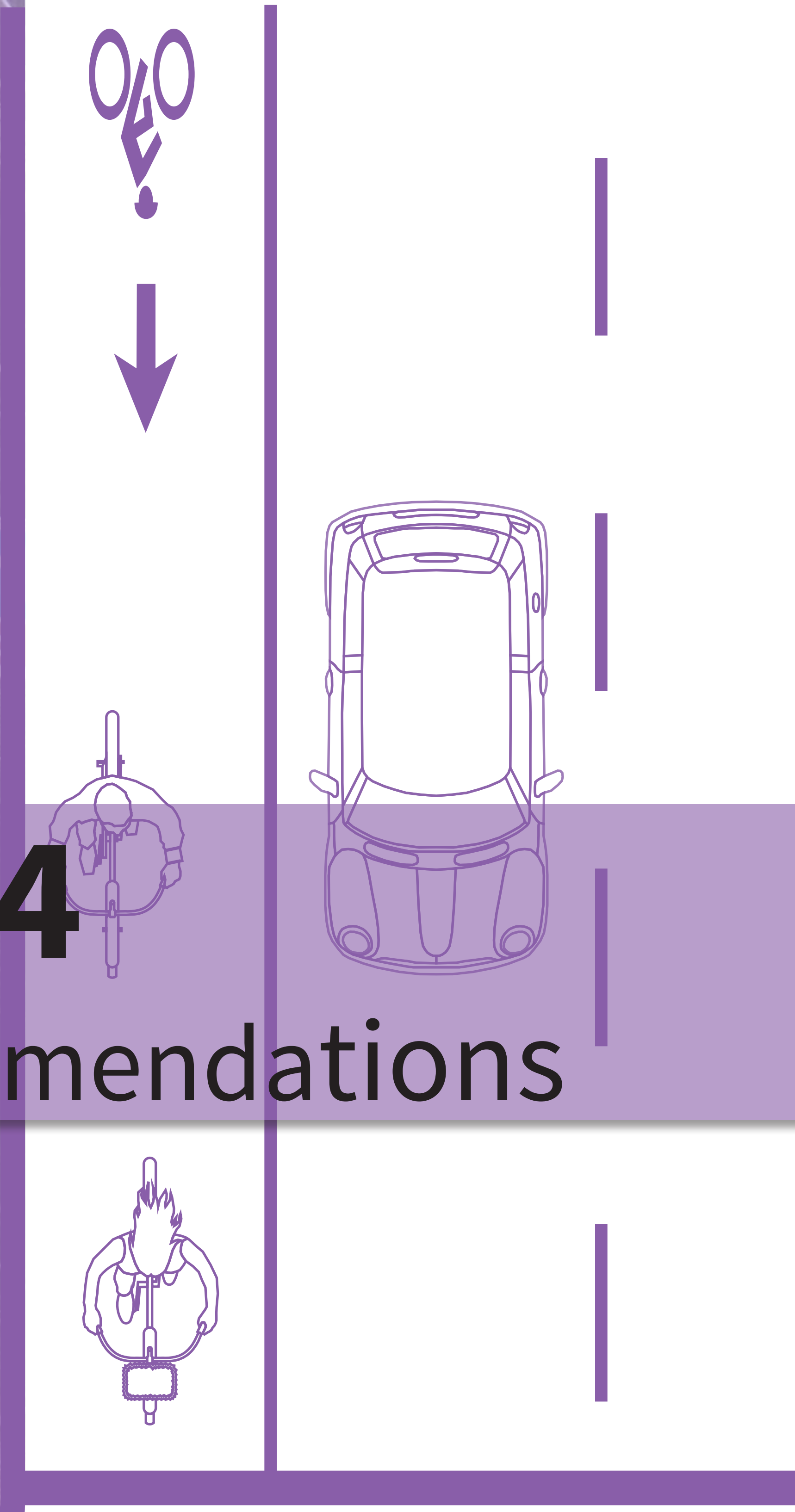




Chapter 4

Facility Recommendations

BICYCLE NETWORK

Physical Infrastructure

Physical infrastructure is the most essential component of the "Bicycle Network." The consultants for this planning process studied the Town's existing infrastructure in great detail. They planned for new infrastructure by considering the needs of different types of bicyclists and how these needs can best be met in the context of a multi-modal transportation system.

The Types of Cyclists

Cyclists can be categorized by their level of comfort biking in different situations. This categorization was based on seminal 2012 survey in Portland, OR that questioned residents about their level of comfort riding streets with bicycle facilities and riding on those without them. Based upon their answers respondents were then sorted into four categories described in the table below.

This plan reflects a major trend in bike planning in United States today. That trend is to focus on building a network of facilities that will encourage the ***Interested but Concerned*** group to ride their bikes more frequently.

Types of Cyclists

Category	Description
Strong and Fearless	Very comfortable riding with or without bike lanes on most streets.
Enthused and Confident	Very comfortable riding with bike lanes or on other facilities such as greenways or low-volume local streets. Less comfortable on high-volume high speed streets without bicycle facilities.
Interested but Concerned	Uncomfortable riding in most situations they encounter either because of safety concerns or lack of biking experience. Are interested in biking more if safer facilities are present so they can gain experience.
No Way No How	Physically unable to ride a bike or not interested in riding a bike for any number of reasons.

Level of Traffic Stress Assessment

The Mineta Transportation Institute developed an evaluation methodology in 2012 that rates streets and bike facilities by the amount of stress a cyclist would experience when riding on them. (See graphic on page 15.)This methodology was utilized to analyze Chapel Hill's existing network and plan for future improvements.

Street segments and intersections are classified into the following four levels of traffic stress (LTS), with "LTS 1" being the least stressful and "LTS 4" being the highest stress situation for a cyclist.

Level of Traffic Stress Scale

Traffic Stress Level	Description
LTS 1	Suitable for children (greenways, cycle tracks, low volume streets)
LTS 2	Interested but Concerned adults (bike lanes, sidepaths, moderate volume streets)
LTS 3	Enthused and Confident adults (climbing lanes, high volume streets & <30mph streets)
LTS 4	Strong and Fearless adults (high volume & >30mph streets, no separation)

Level of Traffic Stress Applied to Street Segment

This local example illustrates the Level of Traffic Stress methodology on a street segment in Town.

Martin Luther King Jr. Blvd.

From	*To*	*Facility*	*Stress Level*
Eubanks Rd.	Homestead Rd.	5' Bike Lanes	2
Homestead Rd.	Estes Dr.	Shared Travel Lane	4
Estes Dr.	Rosemary St.	Sharrows	4

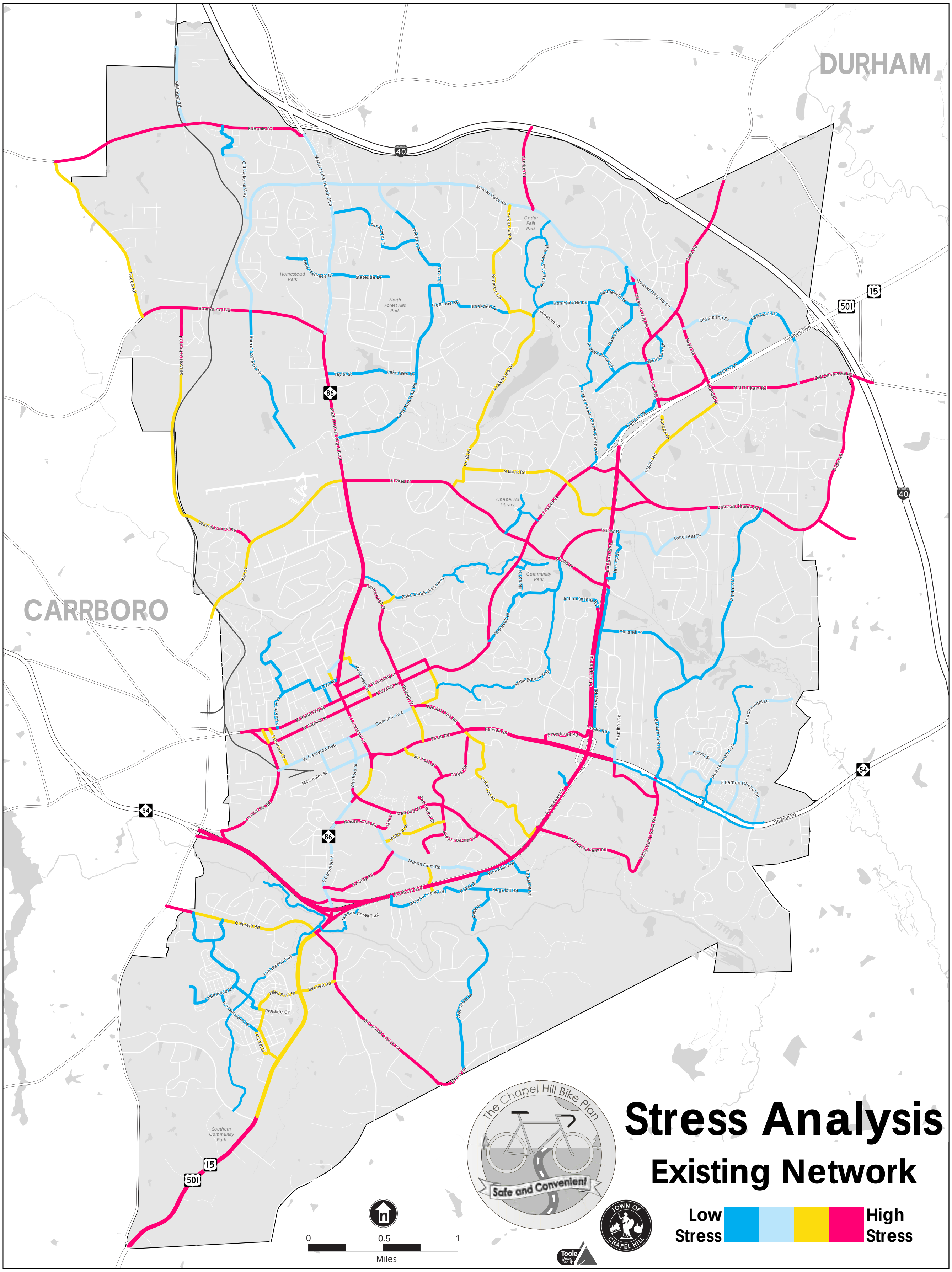
Consultants assessed the level of traffic stress on Chapel Hill's street network and identified low- and high-stress zones. They then determined where "gaps" exist between high and low-stress zones. Many improvements recommended in this network fill in these gaps in the bicycle network and will create a safer, connected transportation system.

Level of Traffic Stress Assessment for Intersections

Cyclists also experience stress when they to ride through larger, more complex street intersections. For a network to be complete, it must provide a seamless level of stress not only along the proposed route, but also at each street crossing, which themselves may be higher-stress due to conflicts with turning vehicles or the lack of a treatment to facilitate crossing of higher volume roadways. For example, while Oteys Road may be low-stress (LTS 2) to ride along due to low traffic volumes, the crossing of Fordham Boulevard is rated the highest-stress level (LTS 4) as there is no median access or traffic control to assist bicyclists with the crossing.

These green dashed lines indicate the proper place for cyclists to be on certain parts of streets.

BELOW: Graphic illustrates the Levels of Traffic Stress experienced by cyclists under different riding conditions


DURHAM
CARRBORO
The Chapel Hill Bike Plan
Safe and Convenient
Stress Analysis
Existing Network
Low Stress
High Stress
0
0.5
1
Miles

The Building Blocks of a Bicycle Transportation Network

Bicyclists should be expected on the streets except where they are prohibited. Safe, convenient, and well-maintained bicycle facilities and complementary design components like the ones described the following pages (24-31) are essential to accommodate and encourage bicycling in Chapel Hill.

Bicycle Facilities

The following descriptions of bicycle facilities include all of the facility types recommended in this plan.

Bicycle Facility - A general term denoting improvements and provisions to accommodate or encourage bicycling.

Buffered Bike Lane
Standard bicycle lane buffered from traffic with striping.
Typical Dimensions:
- 6-8 foot wide bicycle lane

Placement Considerations:
Desirable on roadways with more than 10,000 daily vehicular trips
Operational Benefits:
Additional separation from motor vehicles and pedestrians. Bicyclist can merge into travel lanes at intersections. Additional width allows bicyclists to ride side by side or pass slower moving bicyclists within lane.
Operational Drawbacks:
Motorists can encroach, park, or stop in bicycle lane. Can create confusion for motorists turning at intersections due to combined width of buffered lane.

Sidepath
Shared use path (greenway) with mixed bicycle and pedestrian traffic parallel to a roadway
Typical Dimensions:
- 8 to 12 feet in width
- 2 to 6-foot buffer to road

Placement Considerations:
Consider on high volume and/or speed roadways with minimal pedestrian activity and few intersections or driveways
Two-way on one side of street typical, both sides of street ideal
Operational Benefits:
Very comfortable most cyclists.
Operational Drawbacks:
Conflicts with turning motorists possible . In some cases, it may be desirable to eliminate conflicts with left turning motorists with a separate traffic signal phase.

Bicycle Lane
Travel lane for exclusive use of bicyclists.
Typical Dimensions:
- 4-6 feet in width

Placement Considerations:
Good for streets with more than 4,000 daily vehicular trips
Operational Benefits:
Bicyclists have separate space to ride in. Bicyclists can move into auto travel lanes.
Operational Drawbacks:
Minimal separation from motorists. Motorist encroachment.

Bicycle Facilities

Bicycle Climbing Lane
Standard bicycle lane marked on uphill portion of road with shared lane marking on downhill side.
Typical Dimensions:
- 4 to 6-foot bicycle lane uphill
- Sharrow placed in center of downhill lane

Placement Considerations:
Applicable on roadways with steep grades
Operational Benefits:
Bicyclists have separate space to ride while moving very slow (5-12 mph) relative to motorists
Bicyclist have full width of downhill lane to operate at higher speeds (15-35mph)
Operational Drawbacks:
No separation from motorists on downhill direction

Priority Shared Lane
Placement of bicycle symbol within travel lane shared highlighted with green
Typical Dimensions:
4 to 6-foot continuous marked bicycle "lane" within shared travel lanes (10'-13')
75 to 100-foot marking spacing
Placement Considerations:
Desirable on roadways with no space for separate bicycle facilities, high volumes of bicyclists and/or frequent sidewalk bicycling
Operational Benefits:
Continuous green lane guides bicyclists and motorists
Operational Drawbacks:
May be confusing to some motorists

The approval status for this type of facility by Federal Highway Administration is currently under review

Pavement Markings and Signs

Pavement markings on highways and on private roads have important functions in providing guidance and information for the road user. Major marking types include pavement and curb markings, delineators, and colored pavements. In some cases, markings are used to supplement other traffic control devices such as signs and traffic signals. In other instances, markings are used alone to effectively convey regulations, guidance, or warnings in ways not obtainable by the use of other devices.

SOURCE: MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES PART 3

Note: While the Shared lane marking has advantages in some situations, it is not considered to be bicycle facility on its own.

Shared Lane Marking AKA "Sharrow"
Placement of specific bicycle symbol within travel lane shared with motorists
Typical Dimensions:
- Placed in center of narrow (<13 feet) travel lanes
- Placed on right side of wide travel lanes (>13 feet)
- 150 to 250-foot marking spacing

Placement Considerations:
Can be placed on most roadways with speed limit < 35mph
Operational Benefits:
Reinforces bicyclists right to operate within a travel lane
Bicyclist can merge into travel lanes

Pavement Markings and Signs

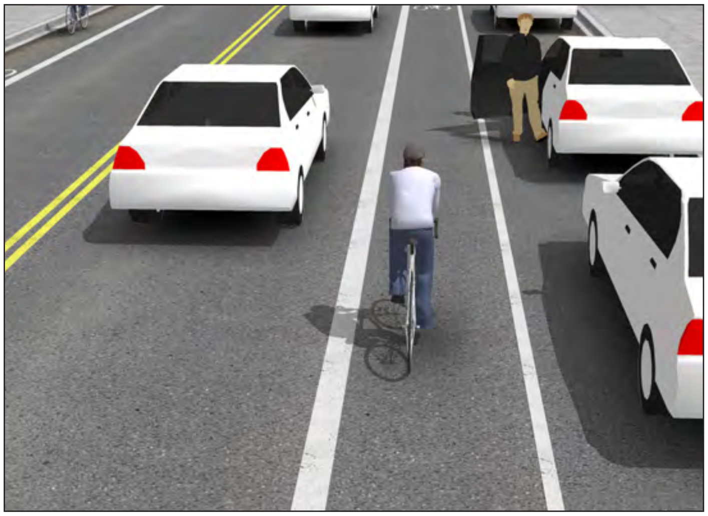
Longitudinal Pavement Markings
These are the white and yellow "dashed" and "solid" markings which delineate opposing directions of travel, travel lanes, and alert users of the location of the edge of the roadway. Their primary purpose is to provide users with guidance as to their lateral position in the roadway and this improves safety.

Typical Dimensions:

- Normal widths = 4 - 6 inches
- Wide widths = 8 - 12 inches

Placement Considerations:
Can be placed on most roadways

Operational Benefits:
Observational field studies have shown that drivers exhibit fewer centerline encroachments and less variability in vehicle positioning with 6-inch and 8-inch edge lines than with 4-inch edge lines. There can be several benefits in using wider markings, including improved detection under nighttime driving conditions (older drivers benefit the most).



ABOVE: Image from the NACTO Urban Bikeway Design Guide showing an 8 inch solid marking separating the bike lane from the motor vehicle travel lane.

"A bike lane should be delineated from the motor vehicle travel lanes with a 150-mm (6-inch) solid white line. Some jurisdictions have used a 200-mm (8-inch) line for added distinction."

SOURCE: AASHTO. (1999). GUIDE FOR THE DEVELOPMENT OF BICYCLE FACILITIES.

Retroreflective Pavement Markings and Signs
In the context of pavement markings, retroreflection (or retroreflectivity) occurs when the headlights of a car, motorcycle, or sufficiently powerful bicycle headlight illuminate a retroreflective surface (such as a white solid line delineating a bike lane or a stop sign. When the light hits the surface, that light is reflected directly back to its source (the driver) rather than being reflected diffusely in all directions. Pavement markings with adequate retroreflective properties are important to maintaining roadway safety during nighttime conditions. Because the retroreflective properties of pavement markings deteriorate over time, agencies need to actively manage the maintenance pavement markings in order to ensure that they are clearly visible at night to all users.

Operational Benefits:
About half of traffic fatalities occur at night, although only about one quarter of travel occurs after dark. Nighttime driving is inherently hazardous because of decreased driver visibility. Adequately maintained retroreflective signs and pavement markings improve highway safety. Requirements for maintaining the retroreflectivity of signs can be found at this link. *http://safety.fhwa.dot.gov/roadway_dept/night_visib/*

Signs For Bicycle Facilities

Regulatory Signs

Regulatory signs shall be used to inform road users of selected traffic laws or regulations and indicate the applicability of the legal requirements. Regulatory signs shall be installed at or near where the regulations apply. The signs shall clearly indicate the requirements imposed by the regulations and shall be.

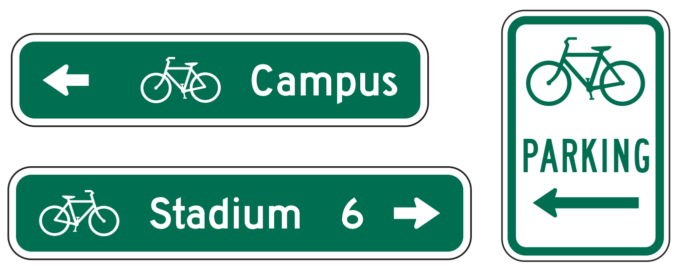
For example, **THE BICYCLES MAY USE FULL LANE** sign may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicyclists are present and where travel lanes are too narrow (14 feet or less) for bicyclists and motor vehicles to operate side by side. **THE BICYCLES MAY USE FULL** Lane sign may be used in locations where it is important to inform road users that bicyclists might occupy the travel lane and it may be used in conjunction with the Shared Lane Marking (Sharrow).

Warning Signs

Warning signs give notice of a situation that might not be readily apparent.

Guide Signs

Guide signs show route designations, destinations, directions, distances, services, points of interest, and other geographical, recreational, or cultural information.



Excessive Use of Signs

Regulatory and warning signs should be used conservatively because these signs, if used to excess, tend to lose their effectiveness. If used, route signs and directional guide signs should be used frequently because their use promotes efficient operations by keeping road users informed of their location.

SOURCE: THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD)

Traffic Signals

Signalized intersections allow bicyclists to cross arterial streets without needing to select a gap in moving traffic. Traffic signals make it easier to cross the street, though it is important to make improvements to reduce conflicts between bicyclists and turning vehicles. When evaluating warrants for the potential installation of new traffic signals, it is important to note that bicyclists may be counted as pedestrians or vehicles.

ABOVE: A bike signal face in red phase at a trail crossing in Madison Wisconsin

Bicycle Signal Faces

On December 24, 2013, the Federal Highway Adminstration issued an "Interim Approval" for the **OPTIONAL USE OF A BICYCLE SIGNAL FACE.** The bicycle signal face is a new traffic control device and has been used in approved experiments by cities such as Madision Wi and Alexandria Va. Bicycle signals faces can provide more clear direction to bicyclists crossing signalized intersections that they may enter an intersection, like at greenway crossing.

The new approval is limited to the use of bicycle signal faces at locations which do not allow conflicts between turning motorists and bicyclists. These are typically midblock greenway crossings or intersections which separate bicycle movements from motorist movements.

This Interim Approval does not create a new mandate compelling the use of bicycle signal faces, but will allow agencies to install bicycle signal faces in compliance with the conditions of the approval.

Pedestrian Hybrid Beacons (a.k.a: HAWK Signal - High Intensity Activated Crosswalk)

One of the nine "Proven Safety Countermeasures" endorsed by the Federal Highways Administration, this type of signal is intended to allow pedestrians and bicyclists to stop traffic to cross high volume arterial streets. The signal may be used in lieu of a full signal that meets any of the 9 warrants in the MUTCD as well as at locations which do not meet traffic signal warrants where it is necessary to provide assistance to cross a high volume arterial at a mid-block location.

The MUTCD provides suggested minimum volumes of 20 pedestrians or cyclists/hour for major arterial crossings (excess of 2,000 vehicles/hour).

Roadway Lighting

Biking, driving or walking on a dark roadway, as opposed to one that is well-lit, is less safe due to the reduced visibility (the night time traffic fatality rate in the United States is three times the daytime rate). In low-light conditions, a motorist may be unable to detect the presence of a cyclist in the roadway and this could lead to a collision. Also, low levels of roadway lighting make it difficult for cyclists to see approaching objects or obstructions in their path of travel and cause them to crash. For example, when riding at night on a poorly lit street, a cyclist may be unable to see a pothole or a fallen tree branch in the bike lane. Unlike a motor vehicle, whose mass and ground clearance provides their operator with the ability to run over such objects and maintain vehicular control, the cyclist can more easily lose control of their bike when striking small objects. One traditional technology, roadway lighting, can make a substantial impact on safety in these types of situations.

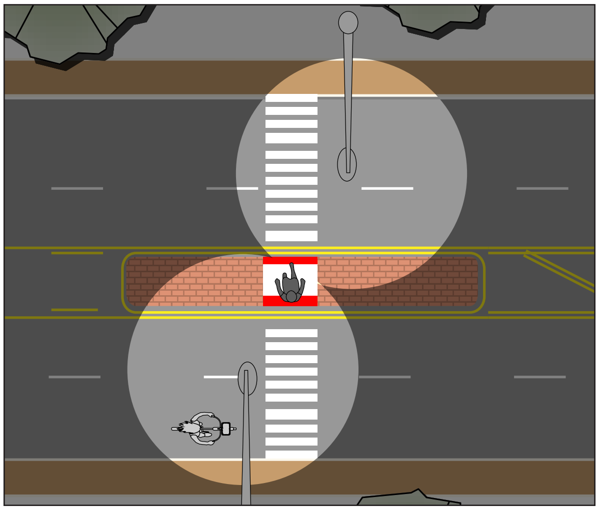
The general purpose of roadway lighting is to provide improved safety, security, and aesthetics for the various users of the roadways and associated facilities. There are three specific applications of roadway lighting that have implications for bicycling safety in Chapel Hill.

Streetscape Lighting

Streetscape lighting projects are designed to meet both the visibility requirements for drivers and the more subjective security and comfort considerations of cyclists and pedestrians.

Interchange and Intersection Lighting

The AASHTO Roadway Lighting Design Guide provides a number of "warrants" to assess whether or not a particular interchange would benefit from the installation of fixed lighting sources. The AASHTO guide recommends that urban and suburban interchanges with ramp volumes exceeding 10,000 vehicles per day be completely illuminated. See page 50 for relevant recommendation to this warrant.



Chapel Hill has 4 mid-block crossings on Martin Luther King Jr. Blvd and 2 on E. Franklin St.

Lighting at Crosswalks and Mid-Block Crossings

Many agencies have historically installed a single luminaire directly over the crosswalk below. While this provides high pavement luminance at the crosswalk, it does not adequately illuminate the pedestrian or cyclist using the crosswalk. At mid-block crossings, wo street lights should be located as shown in the image above.

SOURCE: INFORMATIONAL REPORT ON LIGHTING DESIGN FOR MIDBLOCK CROSSWALKS
SOURCES: ROADWAY LIGHTING REVISITED by Patrick Hasson and Paul Lutkevich
ASSHTO ROADWAY LIGHTING DESIGN GUIDE

Bicycle Stair Channels

A bicycle stairway channel is a pedestrian stairway with an included channel, which helps facilitate walking a bicycle up or down the stairs. The image to left shows the bicycle stair channel which connects the Culbreth Rd. sidewalks to the Morgan Creek and Fan Branch Greeways.

Integrating Bicycle Facilities with Transit

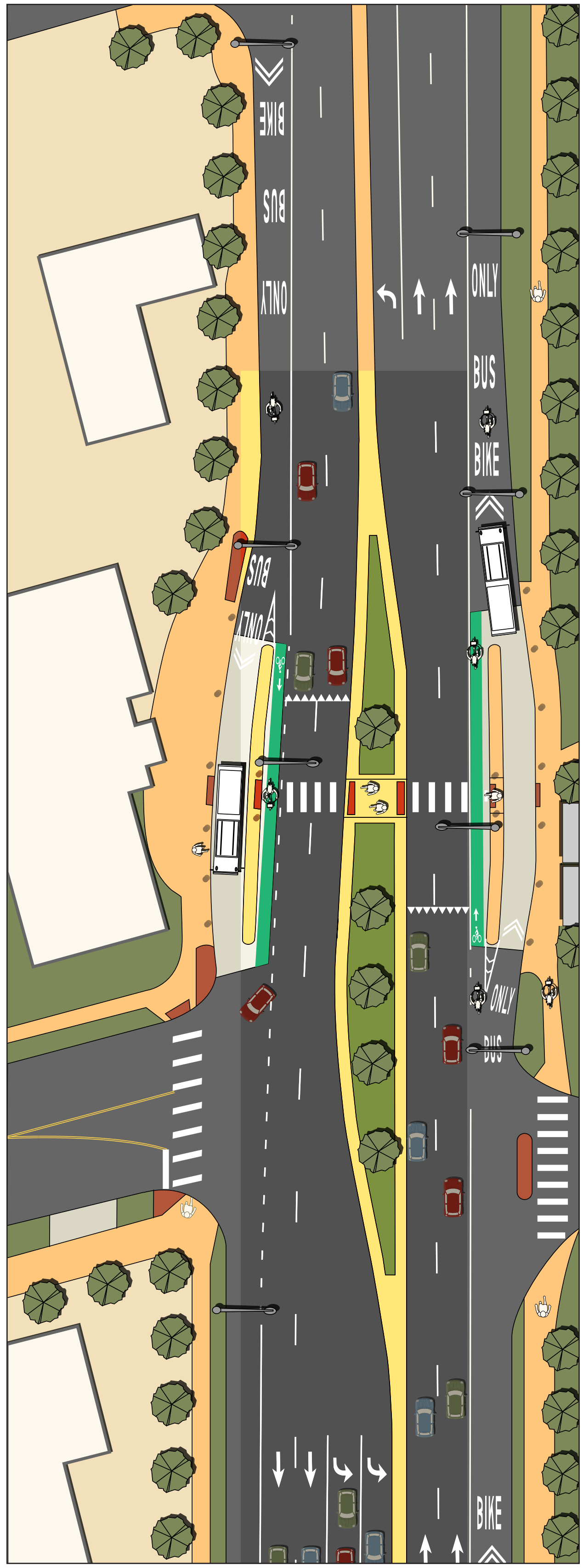
Bicycle and transit facilities can be integrated and should be when new facilities are designed and older ones are retrofitted. The AASHTO Guide to the Development of Bicycle Facilities states that "safe and convenient routes that serve bicyclists should be viewed as essential support strategies to increase transit ridership."

There are five main components of bicycle-transit integration.

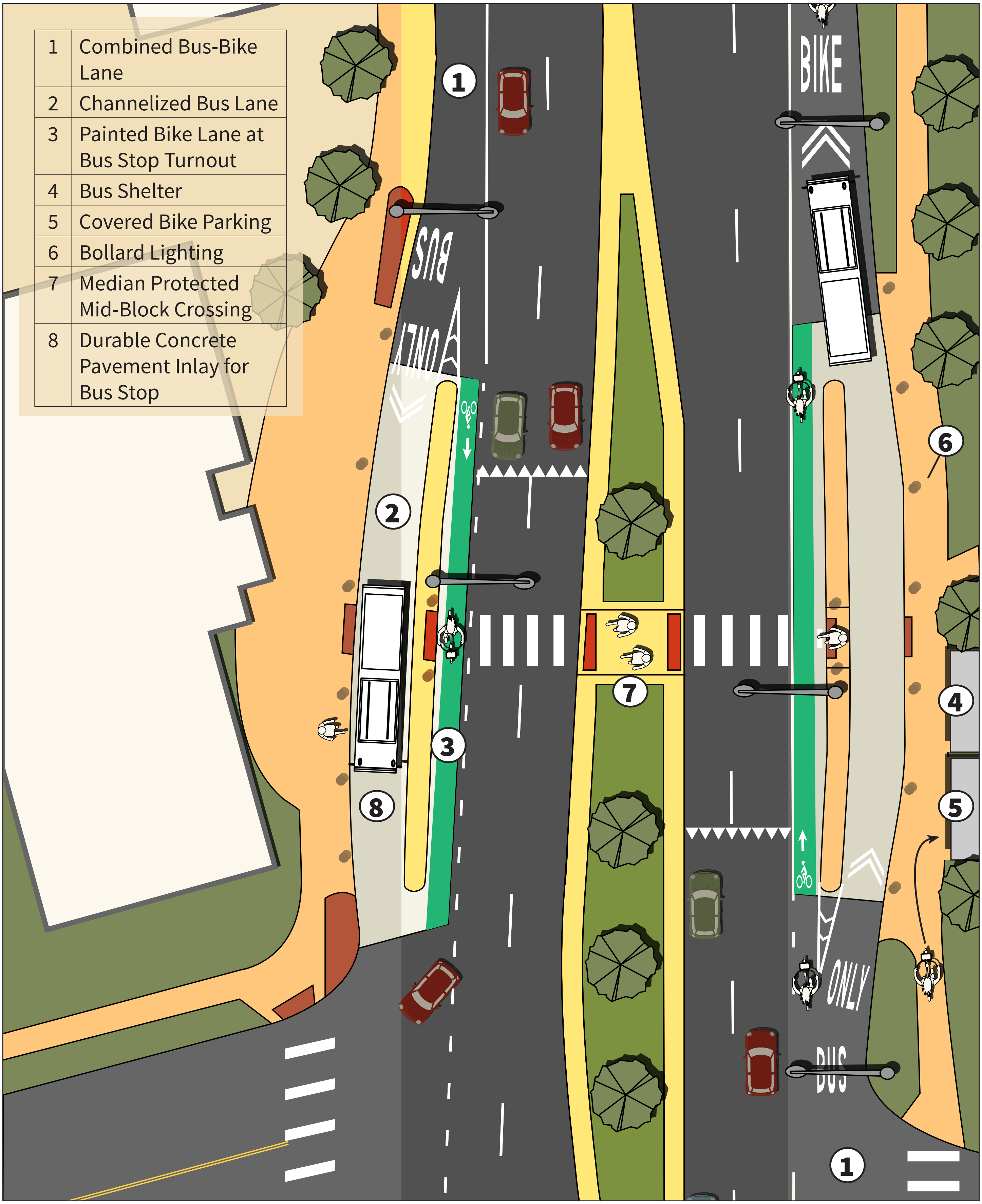
- Facilitating bicycle access on transit vehicles.
- Offering bicycle parking at Transit stop
- Improving bicycle facilities to access transit
- Using design strategies to manage conflicts between pedestrian users, transit vehicles, and bicyclists at transit stops
- Promoting the usage of the bicycle and transit modes

ABOVE: Coverered bike parking shelter near a transit stop

The illustration to the right and on the next page was drawn based off an existing street in Boulder Colorado. A recent street project improved this higher capacity transit corridor that runs north/south serving the University of Colorado. This street includes many "Super Stops" which allow for efficient transfer between transit and other modes. These stops include extensive amenities such as sheltered waiting areas, pedestrian scale lighting and secured/covered bike parking. The labels on the figure on page 31 provide some examples of transit-bicycle facility integration.



ABOVE: 28th Street combined "Bus-Bike Lanes" in Boulder CO.


1 Combined Bus-Bike Lane
2 Channelized Bus Lane
3 Painted Bike Lane at Bus Stop Turnout
4 Bus Shelter
5 Covered Bike Parking
6 Bollard Lighting
7 Median Protected Mid-Block Crossing
8 Durable Concrete Pavement Inlay for Bus Stop
BIKE
BUS ONLY
ONLY
BUS

BICYCLE FACILITY RECOMMENDATIONS

Build Short Term Priority Network

The short-term priority network is a system of bike lanes, sharrows/signed routes, climbing lanes, intersection improvements, and greenways vital to establishing connectivity near the center of Town. This network of bicycle facilities and general roadway safety improvements could be built within 10 years if....

- dedicated funding streams are put in to place, and
- the Town receives additional funding support for some major projects from state and federal sources.

The entire short term network could cost $16.5 million dollars. A list of the projects is included on the next page . Maps and detailed descriptions for the 10 projects are included in this chapter begining on page 35 with the Estes Dr. Connectivity project. The rest of the projects (11 & onward) are included in Appendix A.

Many of the improvements included in this network are relatively low in cost when compared to other types of transportation improvements that involve construction, road widening, and property acquisition. Please note that the costs estimated for these projects could vary from their final totals as the cost of materials fluctuates and additional implementation challenges may present themselves as specific projects are pursued for implementation. These costs do not include property acquisition or additional planning, design, or engineering costs.

The total amount of 14.3 million dollars was developed for planning this network based on the following assumptions of future revenues that could be dedicated to funding bicycle infrastructure.

Financial Assumptions

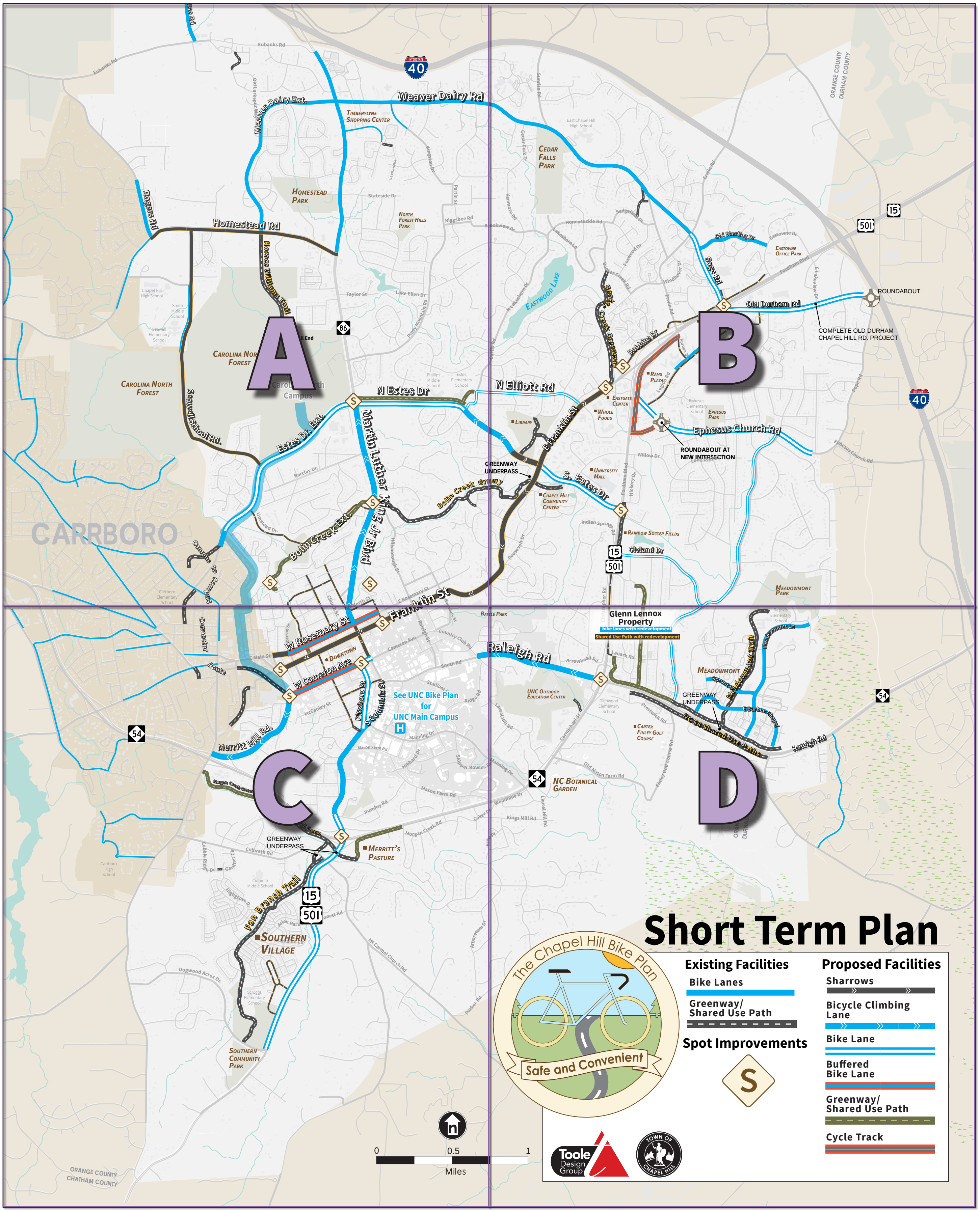
- **Planning Horizon**
  10 Years
- **Assumed budget for improvements**
  $16.5 million over 10 years
- **Annual MPO contribution**
  $500,000 ($5 million over 10 years)
- *Annual Town match to MPO funding*
  $100,000 ($1 million over 10 years)
- **Grants**
  $3,000,000 over 10 years
- **Local revenues (Bonds, property tax, vehicle tax, sales tax)**
  $7,000,000 over 10 years

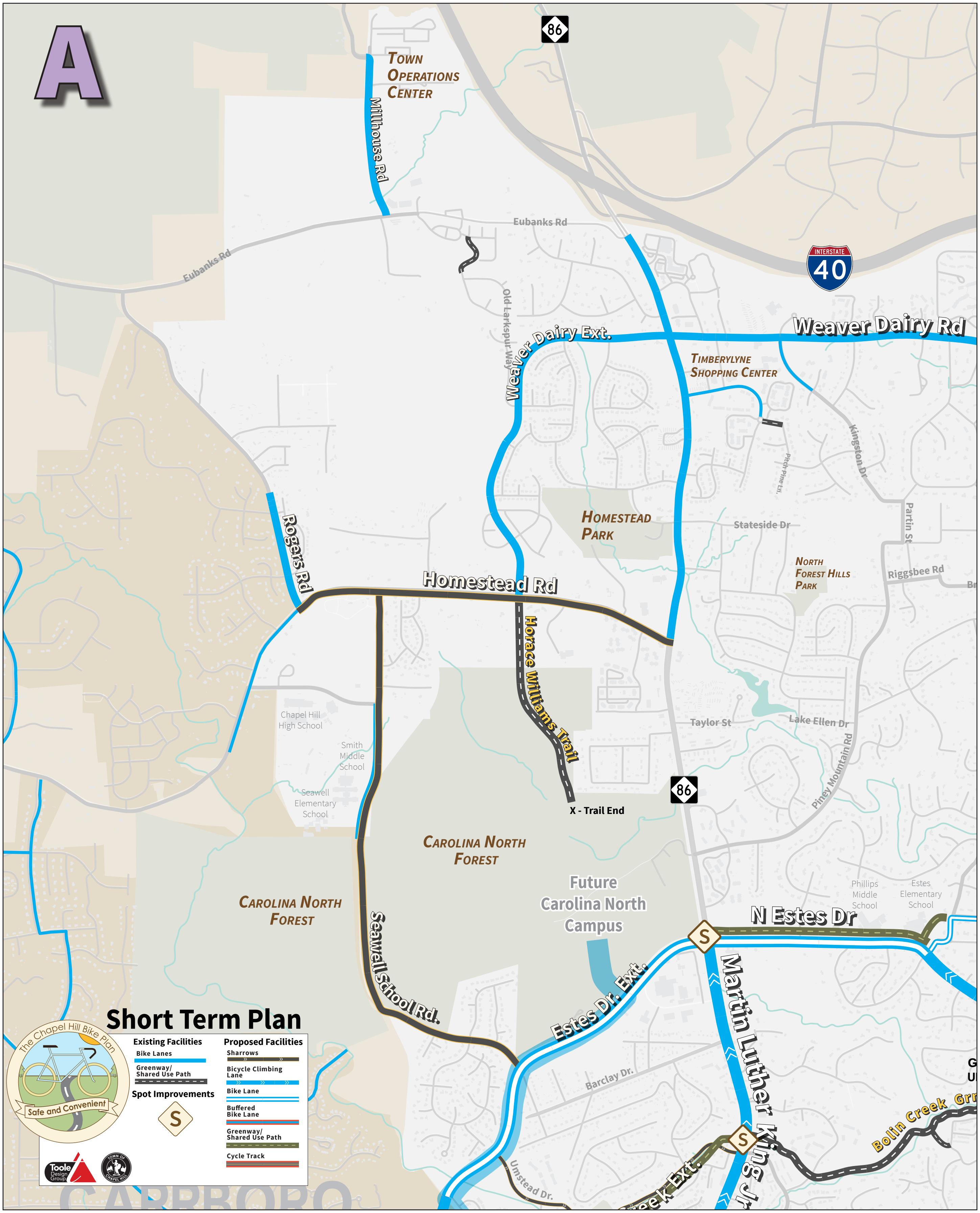
ABOVE: A NCDOT project that re-constructed over three miles of Weaver Dairy Rd. was completed in 2013. This project, which includes bike lanes and sidewalks for its entire length, cost approximately $18 million dollars to build. The majority of the project was funded via State and Federal sources.

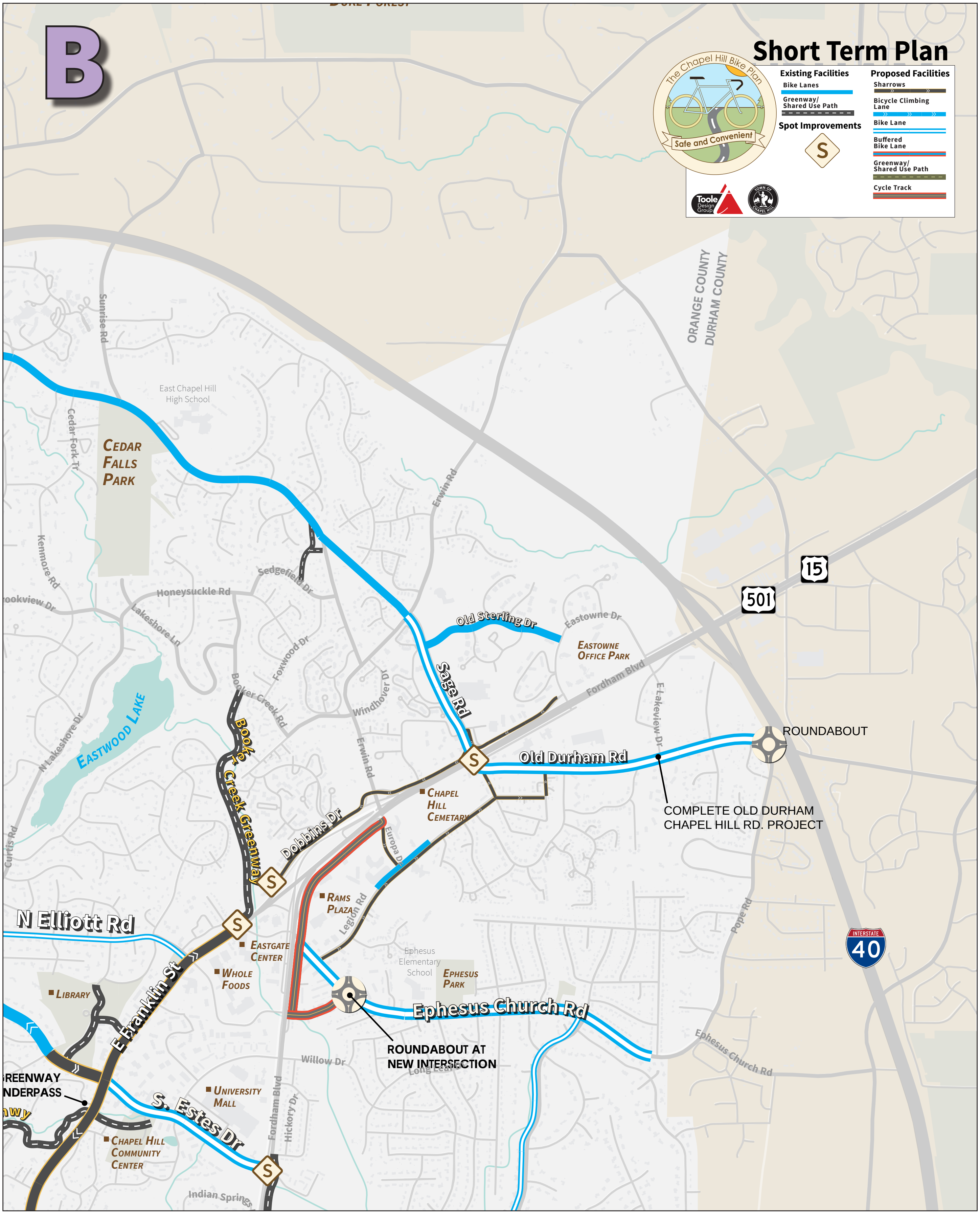
NOTE : The Short-term priority network <u>should not</u> be viewed as a prerequisite to implementing the plan's Long-term network(discussed on the next page) and vice versa. There may be cases where the long term facility recommendation becomes possible in the short term as a result of a new funding source or because of a major road project or redevelopment.

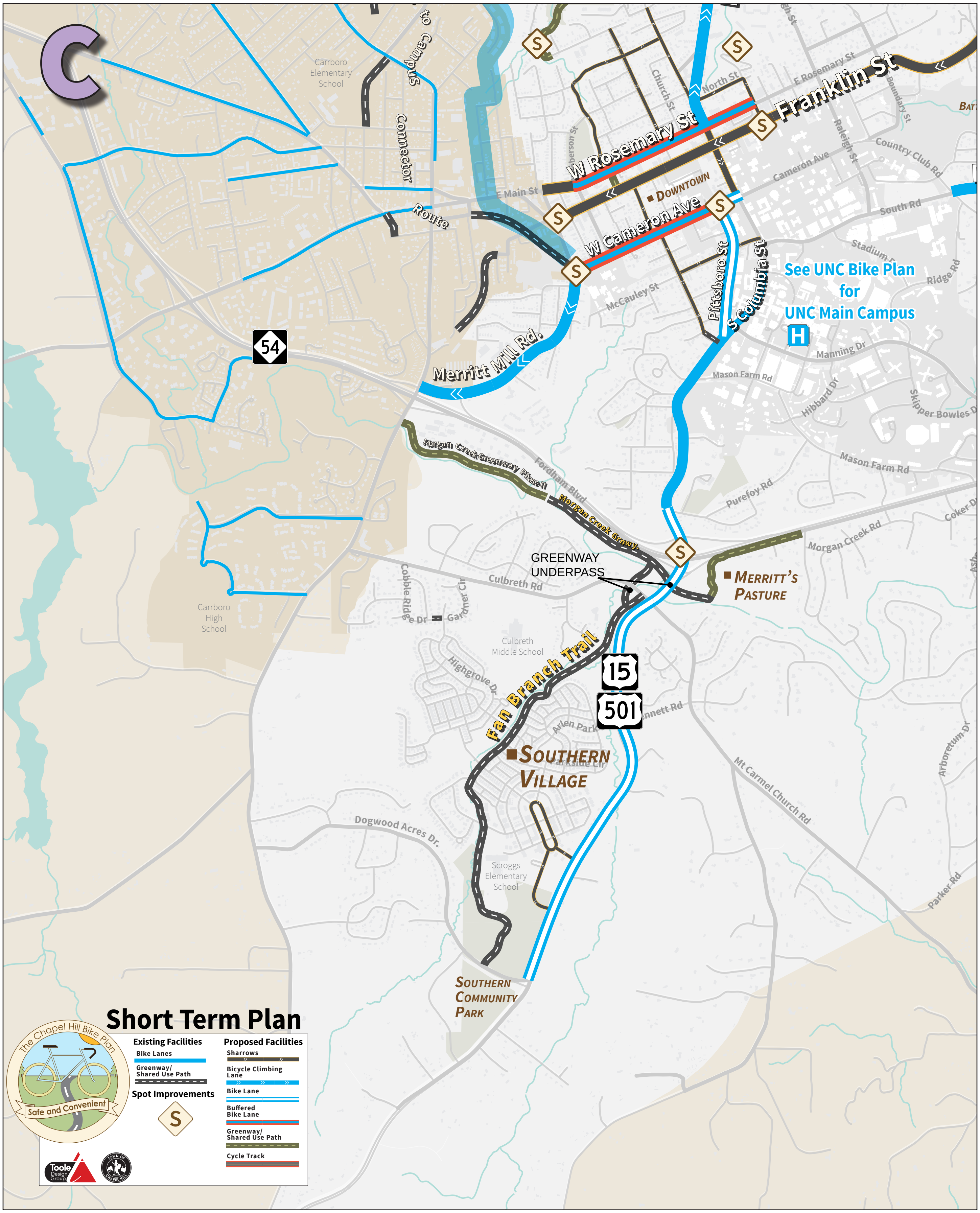
Short Term Network Priority List				
Priority	**Project Name**	**Cost**	**Timing**	**pg**
1	Estes Drive Connectivity	$2.3 Million	2014-2016	39
2	Rosemary St Buffered Bike Lanes	$70,000 - $115,000	2014-2015	43
3	Martin Luther King Jr. Blvd Bicycle Climbing Lanes	$275,000	2014-2016	46
4	Raleigh Rd. Safety Improvements	$900,000	2014-2016	50
5	S 15-501 Markings Update/James Taylor Bridge Lane Diet	$300,000	2014-2016	52
6	Tanyard Branch and Bolin Creek Greenway Extensions	$ 3.5 Million	2014-2020	54
7	Cameron Ave.Buffered Bike Lanes and Improvements	$725,000	2014-2020	57
8	Franklin St. Shared Lanes & Merritt Mill Rd Spot Improvement	$80,000	2014-2020	60
9	Morgan Creek Greenway Phase II	$3 Million	2014-2020	62
10	East Franklin St: Sharrows, Sidewalks, and Road Diet Study	$350,000	2014-2020	63
NR	Merritt Mill Rd Climbing Lanes	$100,000	2014-2020	65
NR	South Columbia Shared Lanes	$ 5,000	2014-2020	66
NR	Sage Rd. Road Diet	$140,000	2014-2020	67
NR	S 15-501 Bike Lane Extension (Market St to Dogwood)	$60,000	2014-2020	68-71
NR	Ephesus Church Rd Bike Lanes	$2 Million	2014-2020	68-71
NR	S Estes Dr. Road Diet	$250,000	2014-2020	68-71
NR	Shared Lane Markings on streets indicated on maps	$200,000	2014-2020	n/a
	Total Est. for these projects	**$14.3 Million**		

NR = Not Ranked


Short Term Plan
The Chapel Hill Bike Plan
Safe and Convenient
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Spot Improvements
S
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
Toole Design Group
Town of Chapel Hill
0
0.5
1
Miles
A
B
C
D
CARRBORO
Weaver Dairy Rd
Weaver Dairy Ext.
Homestead Rd
Rogers Rd
Homestead Park
Cedar Falls Park
Timberlyne Shopping Center
Old Sterling Dr
Sage Rd
Old Durham Rd
ROUNDABOUT
COMPLETE OLD DURHAM CHAPEL HILL RD. PROJECT
Eastowne Office Park
Dobbins Dr
N Estes Dr
N Elliott Rd
E Franklin St
Ephesus Church Rd
ROUNDABOUT AT NEW INTERSECTION
Rams Plaza
Eastgate Center
Whole Foods
Ephesus Park
Carolina North Forest
Seawell School Rd.
Estes Dr. Ext.
Martin Luther King Jr Blvd
Bolin Creek Ext.
Bolin Creek Grnwy
GREENWAY UNDERPASS
S. Estes Dr
University Mall
Chapel Hill Community Center
Rainbow Soccer Fields
Cleland Dr
Meadowmont Park
Glenn Lennox Property
bike lanes with redevelopment
Shared Use Path with redevelopment
Franklin St
W Rosemary St
W Cameron Ave
Downtown
Raleigh Rd
See UNC Bike Plan for UNC Main Campus
UNC Outdoor Education Center
Meadowmont
NC 54 Shared Use Path
Carter Finley Golf Course
Merritt Mill Rd.
NC Botanical Garden
Merritt's Pasture
Fan Branch Trail
Southern Village
Southern Community Park
Eastwood Lake
40
15
501
54
86
ORANGE COUNTY
DURHAM COUNTY
CHATHAM COUNTY


A
Town Operations Center
Millhouse Rd
86
Eubanks Rd
Eubanks Rd
Interstate 40
Old Larkspur Way
Weaver Dairy Ext.
Weaver Dairy Rd
Timberlyne Shopping Center
Kingston Dr
Pitch Pine Ln.
Homestead Park
Stateside Dr
Partin St
North Forest Hills Park
Riggsbee Rd
Rogers Rd
Homestead Rd
Horace Williams Trail
Chapel Hill High School
Smith Middle School
Seawell Elementary School
Taylor St
Lake Ellen Dr
Piney Mountain Rd
X - Trail End
Carolina North Forest
Carolina North Forest
Future Carolina North Campus
Phillips Middle School
Estes Elementary School
N Estes Dr
S
Seawell School Rd.
Estes Dr. Ext.
Martin Luther King Jr
Barclay Dr.
Bolin Creek Gr
Umstead Dr.
Short Term Plan
The Chapel Hill Bike Plan
Safe and Convenient
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Spot Improvements
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
Toole Design Group
CARRBORO


B
Short Term Plan
The Chapel Hill Bike Plan
Safe and Convenient
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Spot Improvements
S
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
Toole Design Group
ORANGE COUNTY
DURHAM COUNTY
East Chapel Hill High School
Cedar Falls Park
Eastwood Lake
Eastowne Office Park
Chapel Hill Cemetary
Rams Plaza
Eastgate Center
Whole Foods
Library
Ephesus Elementary School
Ephesus Park
University Mall
Chapel Hill Community Center
Sunrise Rd
Cedar Fork Tr
Kenmore Rd
Honeysuckle Rd
Lakeshore Ln
Sedgefield Dr
Foxwood Dr
Booker Creek Rd
Booker Creek Greenway
Windhover Dr
Erwin Rd
Old Sterling Dr
Eastowne Dr
Sage Rd
Fordham Blvd
E Lakeview Dr
Old Durham Rd
ROUNDABOUT
COMPLETE OLD DURHAM CHAPEL HILL RD. PROJECT
Dobbins Dr
Europa Dr
Legion Rd
N Elliott Rd
E Franklin St
Ephesus Church Rd
ROUNDABOUT AT NEW INTERSECTION
Willow Dr
Pope Rd
S. Estes Dr
Fordham Blvd
Hickory Dr
Indian Springs
GREENWAY UNDERPASS
N Lakeshore Dr
Curtis Rd
15
501
40
INTERSTATE


C
Franklin St
W Rosemary St
W Cameron Ave
E Main St
Downtown
Pittsboro St
S Columbia St
Merritt Mill Rd.
McCauley St
Church St
North St
E Rosemary St
Boundary St
Raleigh St
Cameron Ave
Country Club Rd
South Rd
Stadium Dr
Ridge Rd
See UNC Bike Plan for UNC Main Campus
Manning Dr
Mason Farm Rd
Hibbard Dr
Skipper Bowles Dr
Purefoy Rd
Coker Dr
Morgan Creek Rd
Merritt's Pasture
to Campus Connector Route
Carrboro Elementary School
54
Morgan Creek Greenway Phase II
Fordham Blvd
Morgan Creek Grnwy
GREENWAY UNDERPASS
Culbreth Rd
Cobble Ridge Dr
Gardner Cir
Carrboro High School
Culbreth Middle School
Highgrove Dr
Fan Branch Trail
15
501
Arlen Park
Southern Village
Mt Carmel Church Rd
Arboretum Dr
Dogwood Acres Dr.
Scroggs Elementary School
Parker Rd
Southern Community Park
Short Term Plan
The Chapel Hill Bike Plan
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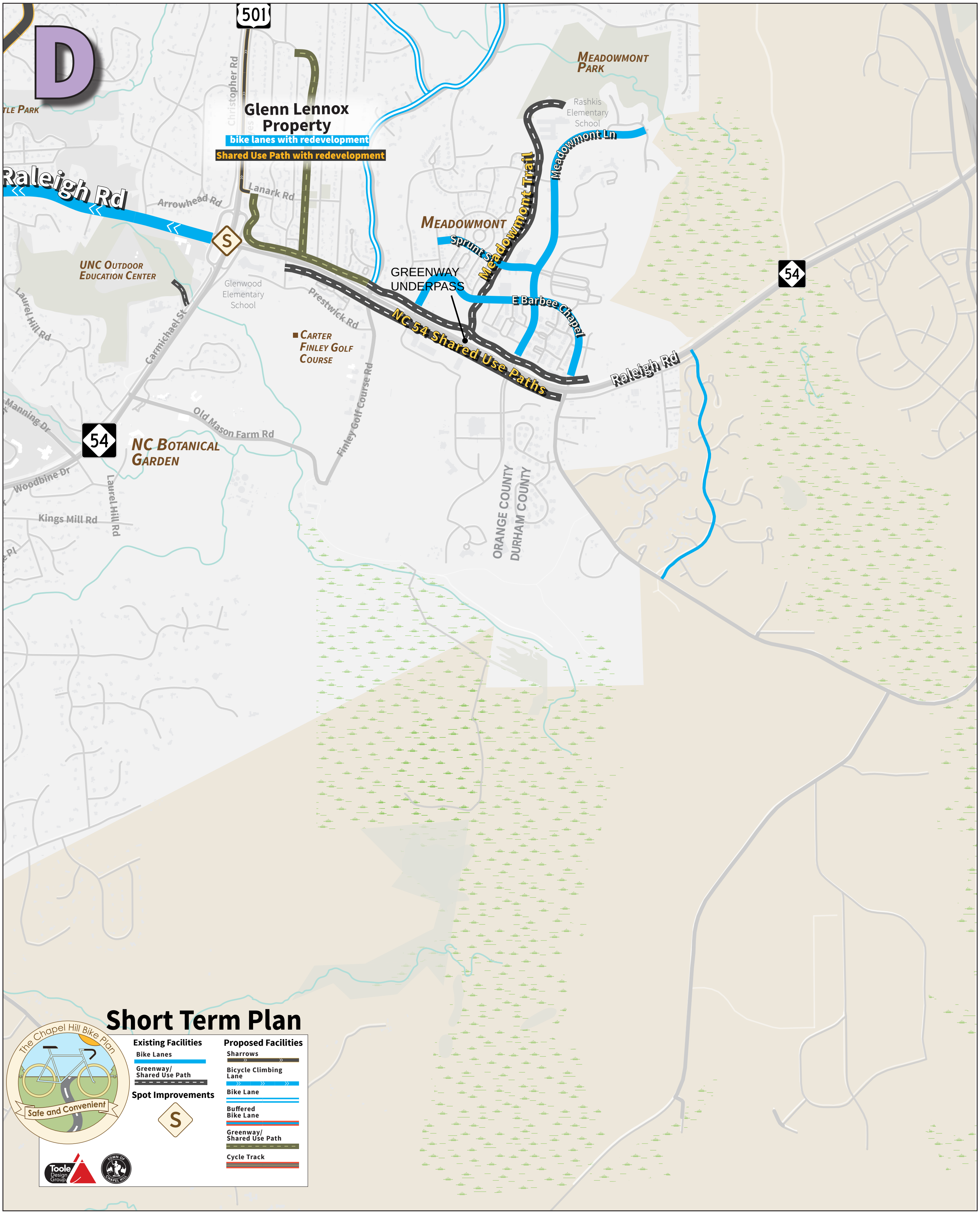
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
Toole Design Group


D
501
Glenn Lennox Property
bike lanes with redevelopment
Shared Use Path with redevelopment
Christopher Rd
Lanark Rd
Raleigh Rd
Arrowhead Rd
S
UNC Outdoor Education Center
Glenwood Elementary School
Prestwick Rd
Laurel Hill Rd
Carmichael St
Carter Finley Golf Course
Meadowmont Park
Rashkis Elementary School
Meadowmont Ln
Meadowmont Trail
Meadowmont
Sprunt St
GREENWAY UNDERPASS
E Barbee Chapel
NC 54 Shared Use Paths
Raleigh Rd
54
Manning Dr
Old Mason Farm Rd
Finley Golf Course Rd
NC Botanical Garden
Woodbine Dr
Kings Mill Rd
Laurel Hill Rd
Orange County
Durham County
Short Term Plan
The Chapel Hill Bike Plan
Safe and Convenient
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Spot Improvements
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
Toole Design Group

Considerations for Implementation

To implement the recommendations in this plan, it will be necessary to balance the competing spatial needs of various roadway users and modes. Simple pavement marking retrofits will be the easiest to implement since they do not require property acquisition or pavement reconstruction. Implementation will become more difficult as the project delivery method changes (new construction, reconstruction, resurfacing).

The configuration and width of automobile travel lanes and parking lanes has the largest impact on determining the space available for bike lanes and other bicycle facilities like Shared Use Paths. Therefore, during street reconstruction and resurfacing projects, the Town should consider reallocating street space to better accommodate pedestrians, bicyclists, and transit.

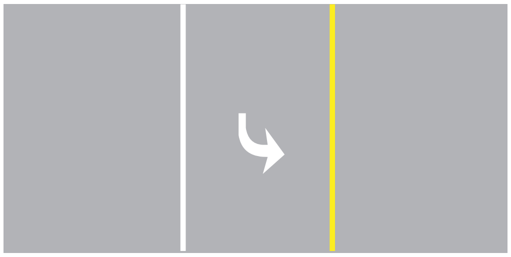
To implement the majority of the Short Term Priority Network projects described in this chapter, two main implementation strategies are recommended, “Lane Diets” and street reconstruction.

Lane Diets

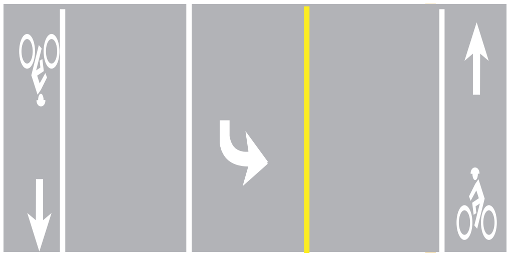
For bicycle lanes to be retrofitted onto some streets without reconstructing them, existing travel lanes will have to be narrowed. This process of lane narrowing is known as a Lane Diet and lane diets are the primary implementation strategy for the short term network. Road widening (or median narrowing) is reserved only for truly constrained situations where lane narrowing is not feasible or advisable.

The use of narrower travel lanes is consistent with the primary roadway design guidelines used by transportation engineerinng professionals, the AASHTO Policy on the Geometric Design of Highways and Streets. This book states that “lane widths may vary from 10-12 feet and that lane widths of 10 feet may be used in more constrained ares where truck and bus volumes are low and speeds are less than 35 MPH...and that 11 foot travel lanes are used quite extensively for urban arterial designs.” This is backed up by recent research focused on the safety of travel lane widths varying between 10 and 12 feet for motorists operating on arterial roadways with posted speeds of 45 mph or less. This research found lane width had no impact on safety or capacity under the majority of urban conditions.   It should also be noted that wider lane widths may encourage motorist speeding. Adding bike lanes to these streets where there is sufficient right-of-way can reduce speeding and increase safety in residential neighborhoods and near schools. (Appendix A).

before lane diet



after lane diet



Reconstruction of Streets

Streets that are too narrow already to add bicycle lanes through a lane diet would have to be reconstructed and widened to have in-road bicycle facilities. Street reconstruction projects will likely require property acquisition, utility relocation, drainage improvements, earth moving, inter-agency collaboration and public outreach.

GENERAL BICYCLE FACILITY RECOMMENDATIONS

These recommendations complement the specific facility recommendations and should be considered when implementing the short term priority network.

Develop pavement marking plans for the Short Term Priority Network Projects

Having these plans developed ahead of time for the priority network will allow the Town to take advantage of opportunities when they arise.

Add new bicycle facilities during street repaving when possible.

Ensure that funds are available for spot widening and intersection improvements that can be implemented when a street is being repaved.

Provide the maximum bicycle quality of service for bicycle facilities.

Maximize the space provided to bicyclists via wider shared travel lanes, shoulders, bicycle lanes, or greenways. (Appendix A)

Provide a minimum green signal clearance interval for bicyclists at all intersections

Revise signal timing to provide sufficient minimum green time for a bicyclist to safely enter and clear an intersection prior to the onset of the yellow phase. (Appendix A)

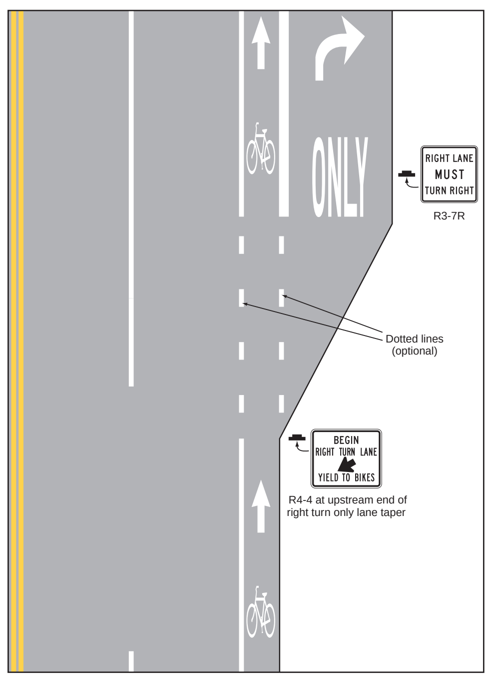
Assess and repair/replace existing facilities

ABOVE: The pavement markings used to delineate this bike lane on the James Taylor Bridge, which have deteriorated over time, need to be replaced

Alter maintenance schedules/ procedures to keep bike facilities functional

Retrofit streets with bicycle safe drainage grates

Continue bike lane markings through auxiliary right turn lanes and intersections.



LEFT: This pavement marking configuration is standard for delineating bicycle lanes from auxiliary right turn lanes.

Source : 2009 Manual on Uniform Traffic Control Devices

Provide pedestrian-scale lighting to improve roadway and greenway safety

GENERAL BICYCLE FACILITY RECOMMENDATIONS

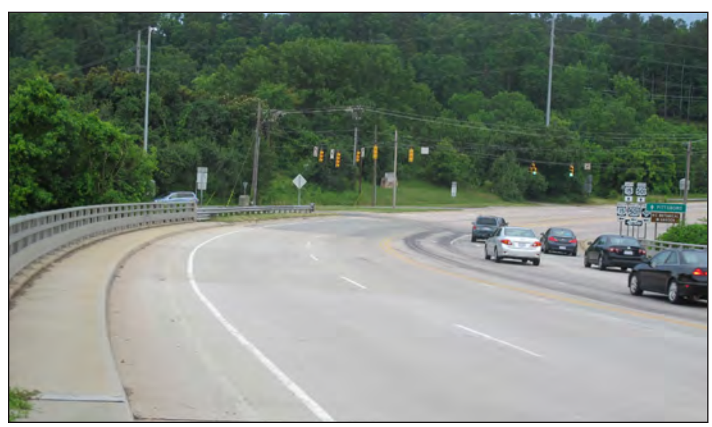
(CON'T)

Provide bicyclist accommodations on all bridges

All bridge crossings should be upgraded over time to provide a minimum of a 6-8 foot bicycle lane or shoulder on each side of the bridge. Further separation is desirable on bridges to provide a more comfortable facility which vertically separates motorized traffic from non-motorized traffic. At locations where pedestrian volumes are anticipated to be low or infrequent, a shared facility is sufficient. At locations where pedestrians will routinely be present, provision of separate cycle tracks is recommended. For some bridge locations, it may be more feasible or cost-effective to construct a parallel non-motorized crossing than to widen an existing bridge. The following crossings are shown in ranked preference for improvements to the network.

Town Bridges

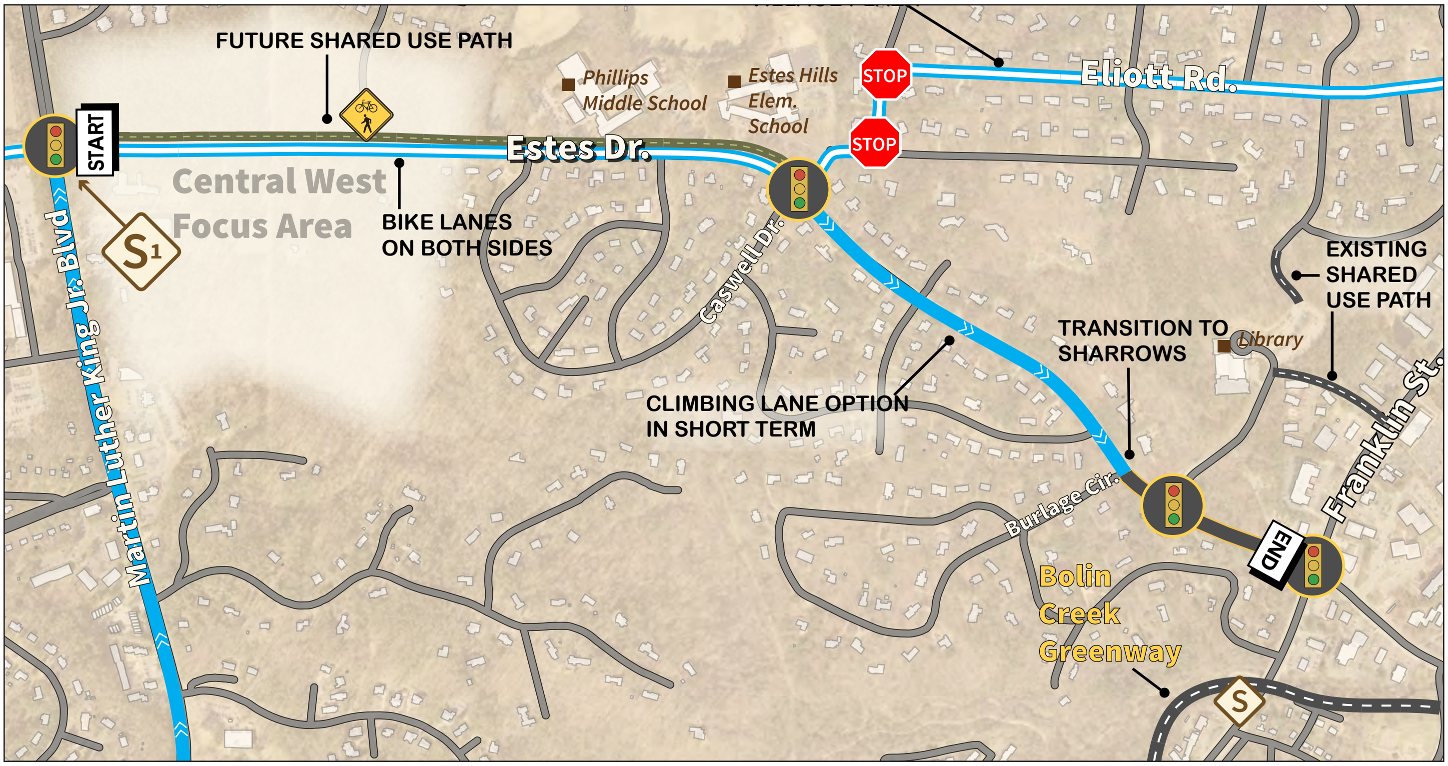
Priority	Bridge	ADT	Curb to Curb: Lanes	Bicycle Lane/ Shoulder	Sidewalk
Higher	Raleigh Road under Fordham	46,000	35 Feet: 3 Lanes	None	5 Feet
	15/501 over I-40	37,000	112 Feet: 10 Lanes	None	None
	Old Chapel Hill Road over I-40	9,900	26 Feet: 2 Lanes	None	None
	Farrington Road over I-40	9,900	30 Feet: 2 Lanes	None	None
	James Taylor Bridge (S. Columbia over NC54	32,000	64 Feet: 5 Lanes	4.5 Feet	4 Feet
	Fordham over Raleigh Road (southbound)	14,000*	28 Feet: 2 Lanes	None	None
	MLK over I-40	28,000	60 Feet: 2 Lanes	None	None
	Millhouse Road under I-40	4,999*	20 Feet: 2 Lanes	None	None
	Sunrise Road over I-40	4,999*	20 Feet: 2 Lanes	None	None
	Erwin Road over I-40	7,600	22 Feet: 2 Lanes	None	None
	Fordham over Raleigh Road (northbound)	14,000*	33 Feet: 2 Lanes	8 Feet	None
Lower	E. Franklin over Fordham	20,999*	27 Feet: 1 Lane	None	None



ABOVE: *Looking South* The James Taylor Bridge

LEFT: *Looking west* Fordham Blvd. bridge over Raleigh Rd.

Project Estes Dr. Connectivity
Priority 1
Est. Cost $ 2.3 Million



Project Description

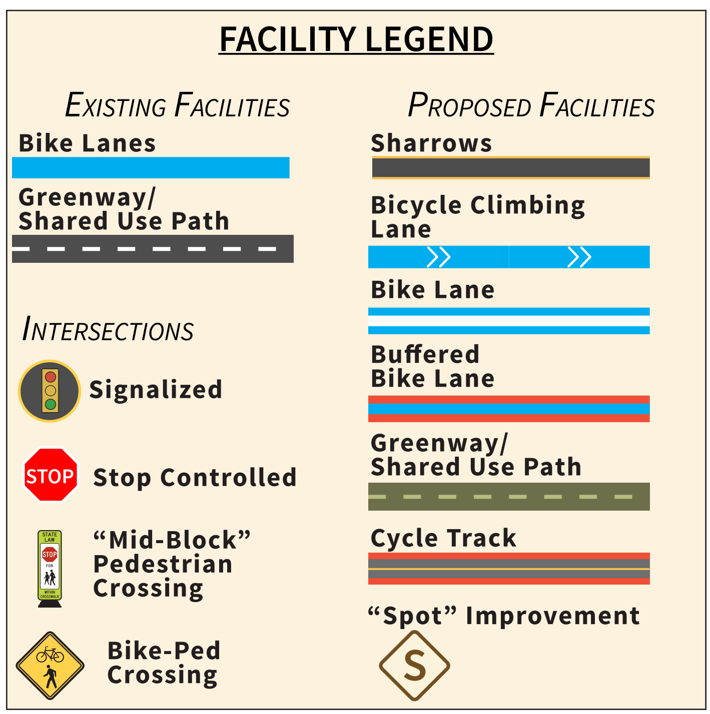
Construct a 10'-12' shared use path on the north side of Estes Dr. between Martin Luther King Jr. Blvd. and Caswell Rd.

In the near term, it is recommended that the 22-foot segment of Estes Drive between Martin Luther King Jr. Blvd and Caswell Rd. be widened to allow for the addition of six-foot bike lanes. Between Caswell Rd. and Library Dr., a bicycle climbing lane is recommended. Between Library Dr. and Franklin St, a shared lane marking is recommended.

S1 = Improve Estes Dr./Martin Luther King Jr. Blvd intersection

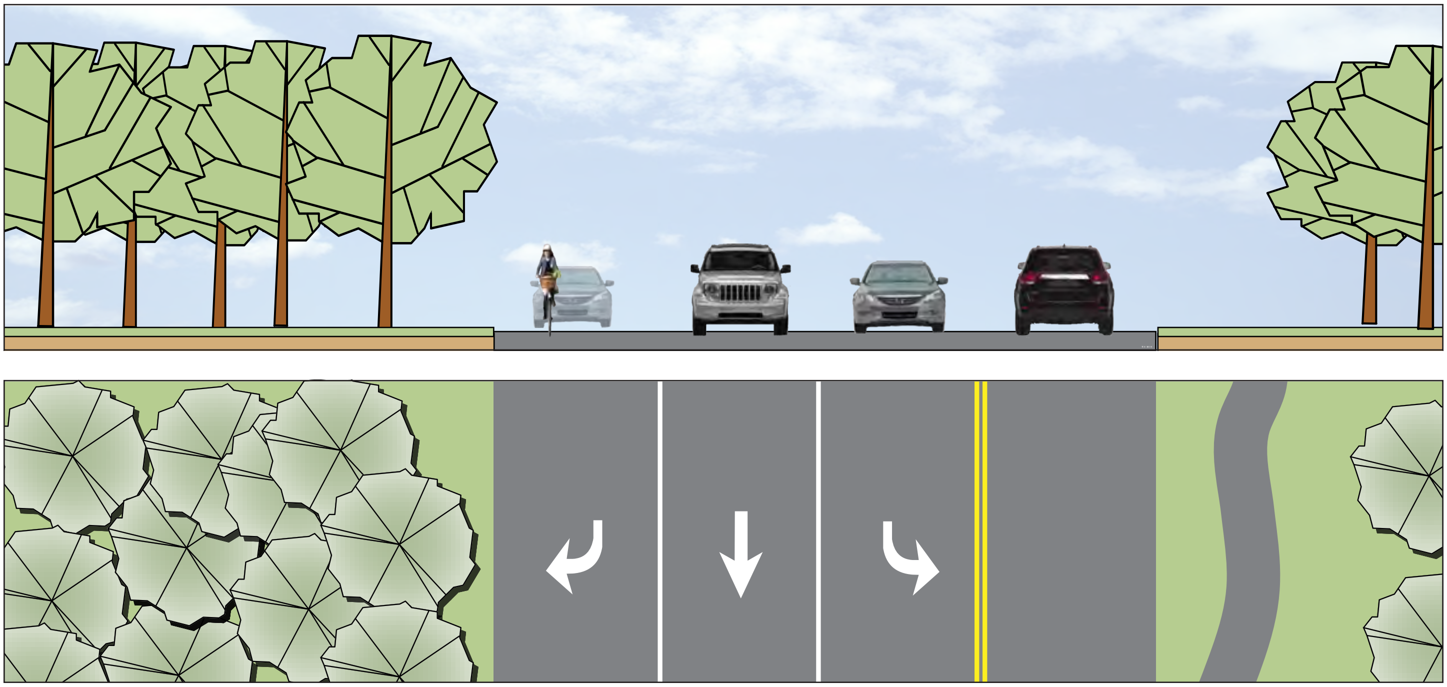
Implementation challenges

Widening the roadway may involve significant grading and filling, utility relocation and tree removal.

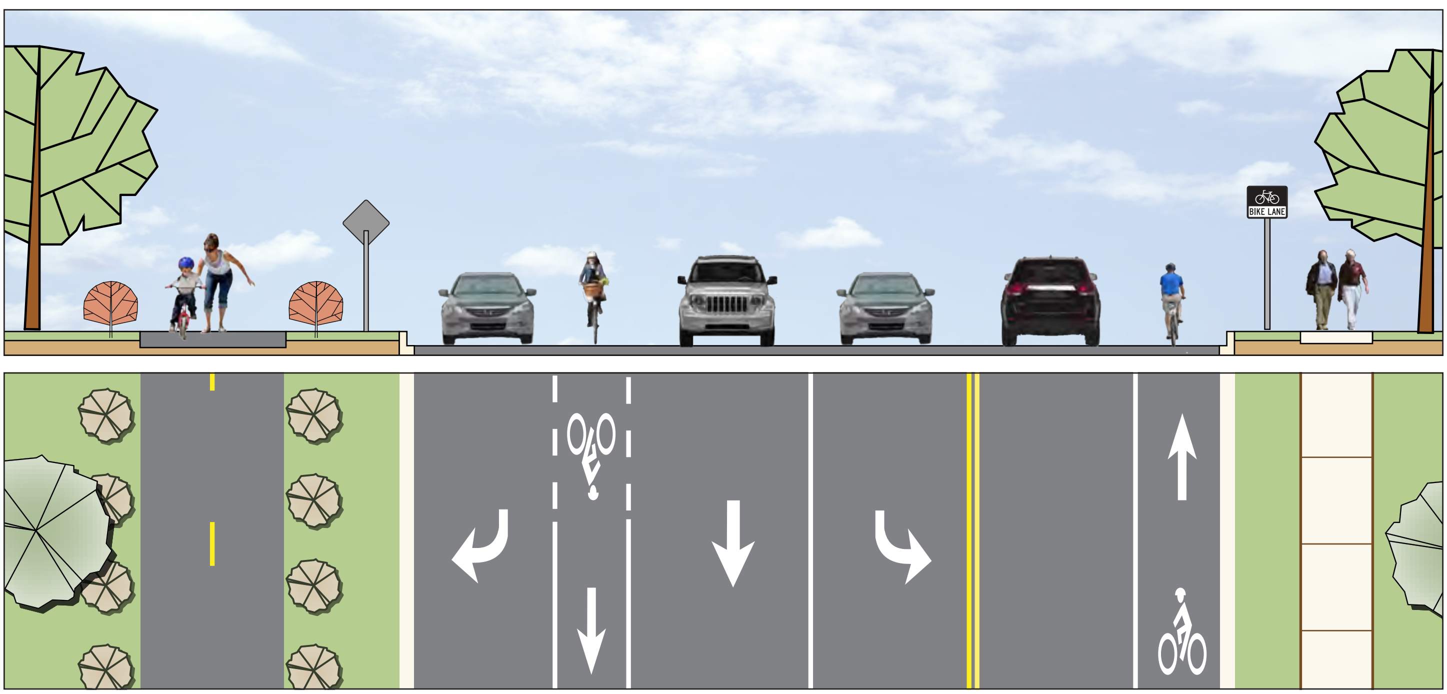


Estes Dr. Connectivity

Estes Dr. Existing Cross-Section
(From Martin Luther King Jr. Blvd to Caswell Rd.)
Looking East



Estes Dr. Short Term Cross-Section
(From Martin Luther King Jr. Blvd to Caswell Rd.)
Looking East



Project Estes Dr. Ext. -

Priority 1 (with Estes Dr. Connectivity Project)

Est. Cost

Project Description

- Add Bike Lane Markings

Bike Lane markings should be added in the existing striped shoulder along Estes Dr. Ext to make an official bike lane.

To connect the bike lane to the proposed Estes Dr. bike lanes east of Martin Luther King Jr. Blvd, some spot widening would be necessary at the intersection (See Map to right).

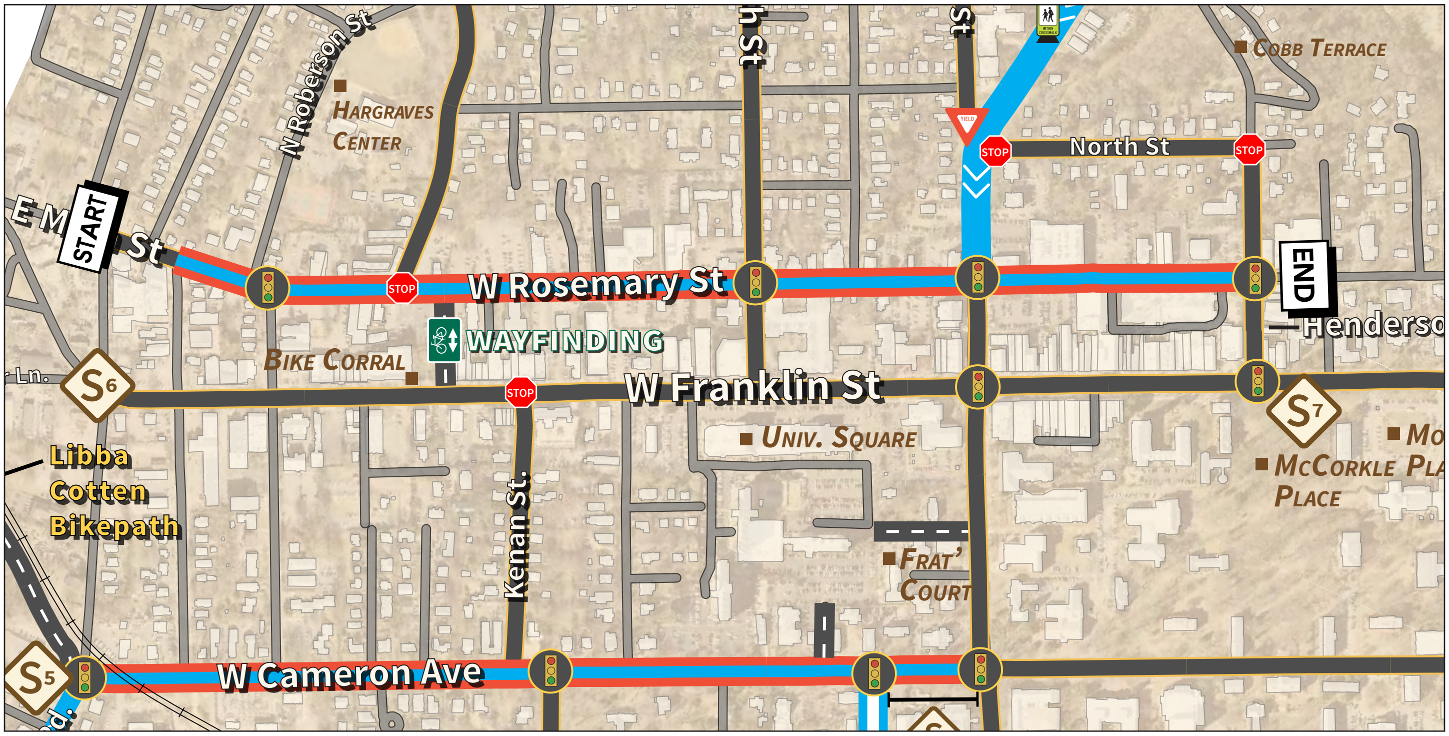
Estes Dr. at Martin Luther King Jr. Blvd. Looking East to Caswell Rd.


FACILITY LEGEND
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
"Spot" Improvement
Intersections
Signalized
Stop Controlled
"Mid-Block" Pedestrian Crossing
Bike-Ped Crossing
Downtown Overview Map for the Short Term Facilities Network
McMasters St.
Northside Elem. School
Martin Luther King Jr. Blvd
Townhouse Apts.
University Commons
Bicycle Apts
Cobb Terrace
Church St
Hargraves Center
E Main St
W Rosemary St
Henderson St.
Bike Corral
Brewer Ln.
W Franklin St
Univ. Square
Morehead Planetarium
McCorkle Place
Libba Cotten Bikepath
Kenan St.
Frat' Court
W Cameron Ave
Merritt Mill Rd.
UNC Cogeneration Facility
Carolina Inn
Polk Place
Davis Library
McCauley St
South Rd
Bell Tower
Pittsboro St
BriarBridge Rd Connector
S. Columbia St. Bike Lanes
Kenan Stadium
Stadium
Manning Dr.
Mason
Rams Head

Project Rosemary St. Buffered Bike Lanes

Priority 2

Est. Cost $70,000 - $115,000



Project Description

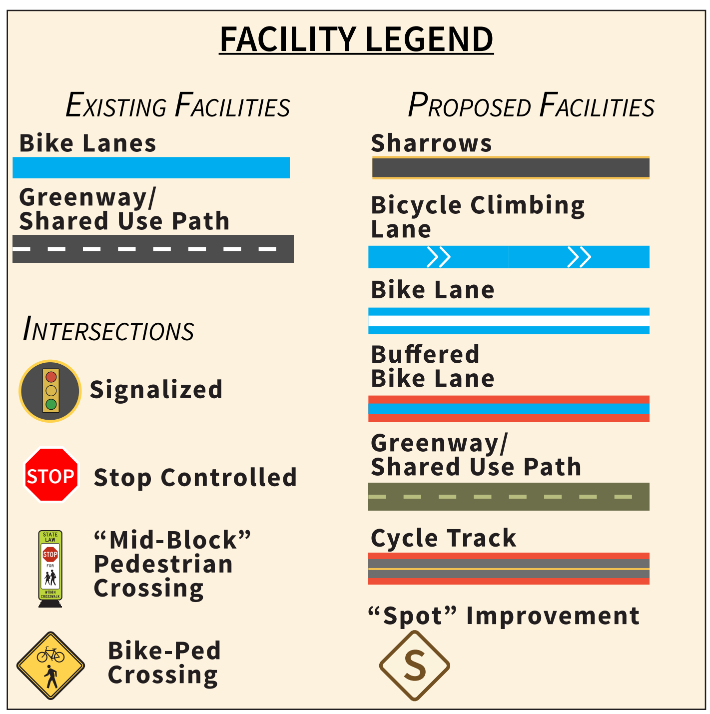
- Buffered Bicycle Lanes
- Shared Lanes

In the short term, buffered bicycle lanes are recommended to create more consistent traffic patterns for bicyclists and motor vehicles. The 40-foot roadway allows for buffered bike lanes in each direction which will provide a comfortably separated facility for bicyclists creating a high quality and comfortable alternative to Franklin Street. At intersections requiring left turn lanes, the bicycle lane can be narrowed to 5 feet.

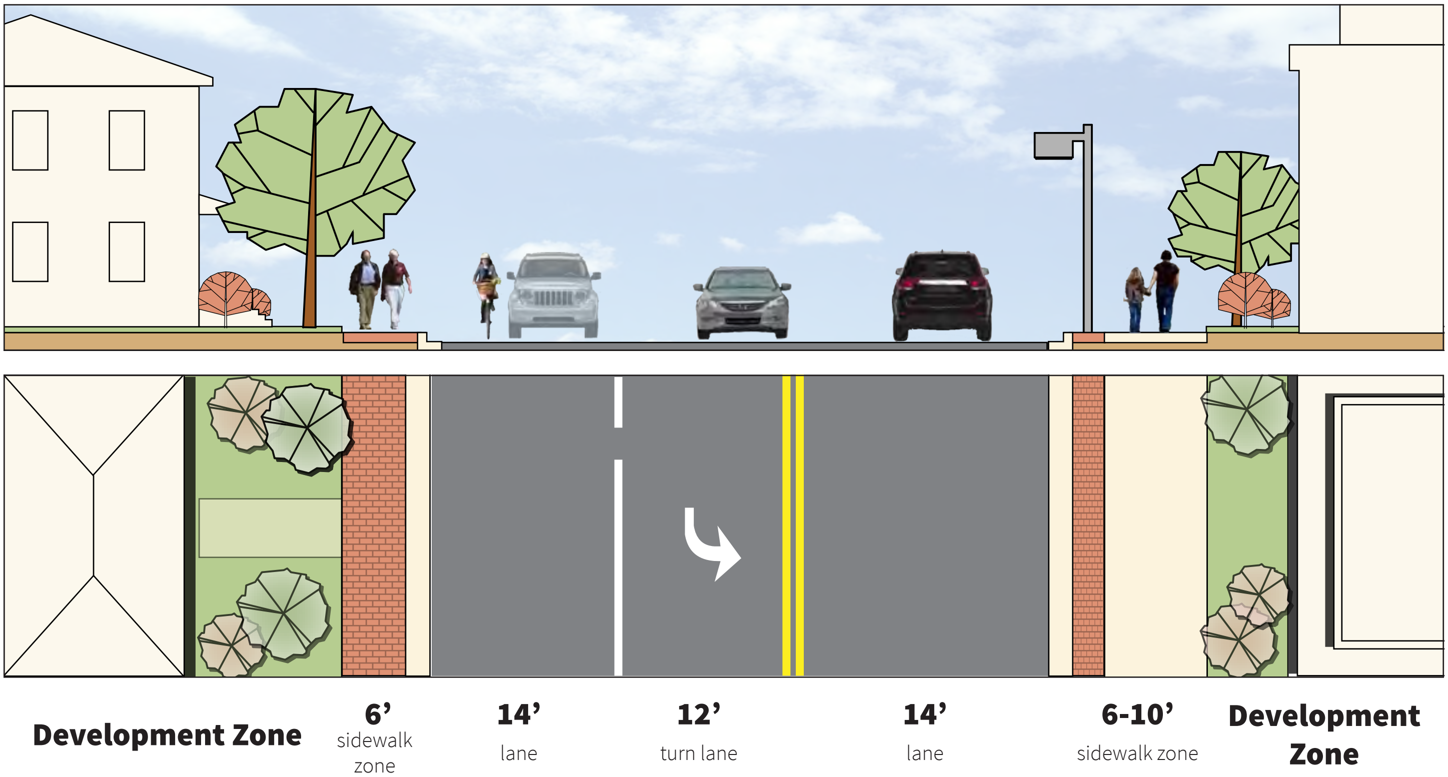
Implementation challenges

This design necessitates removal of 8-15 existing on-street parking spaces.

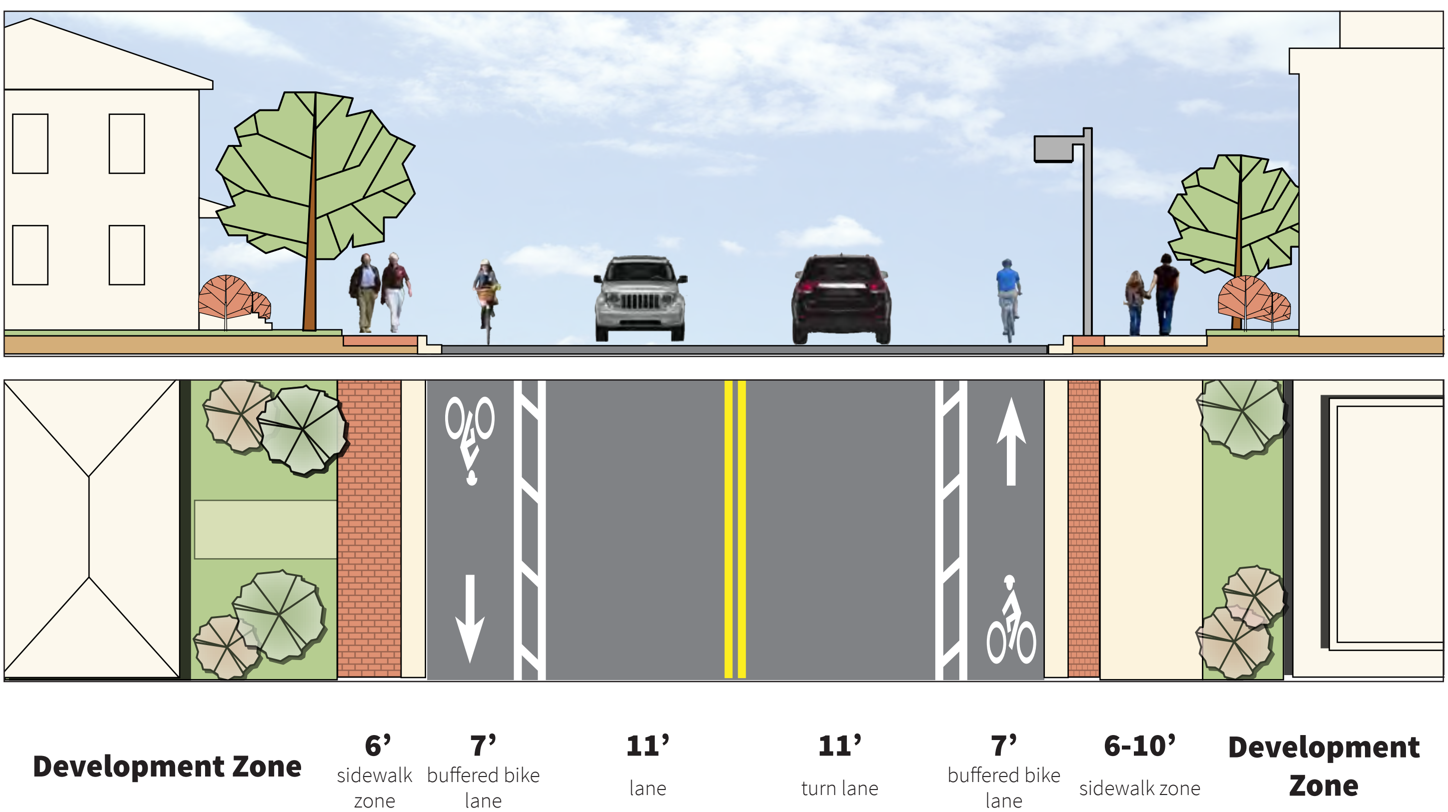
Provisions for large vehicle loading within the bicycle lane or on side streets may be required for some properties

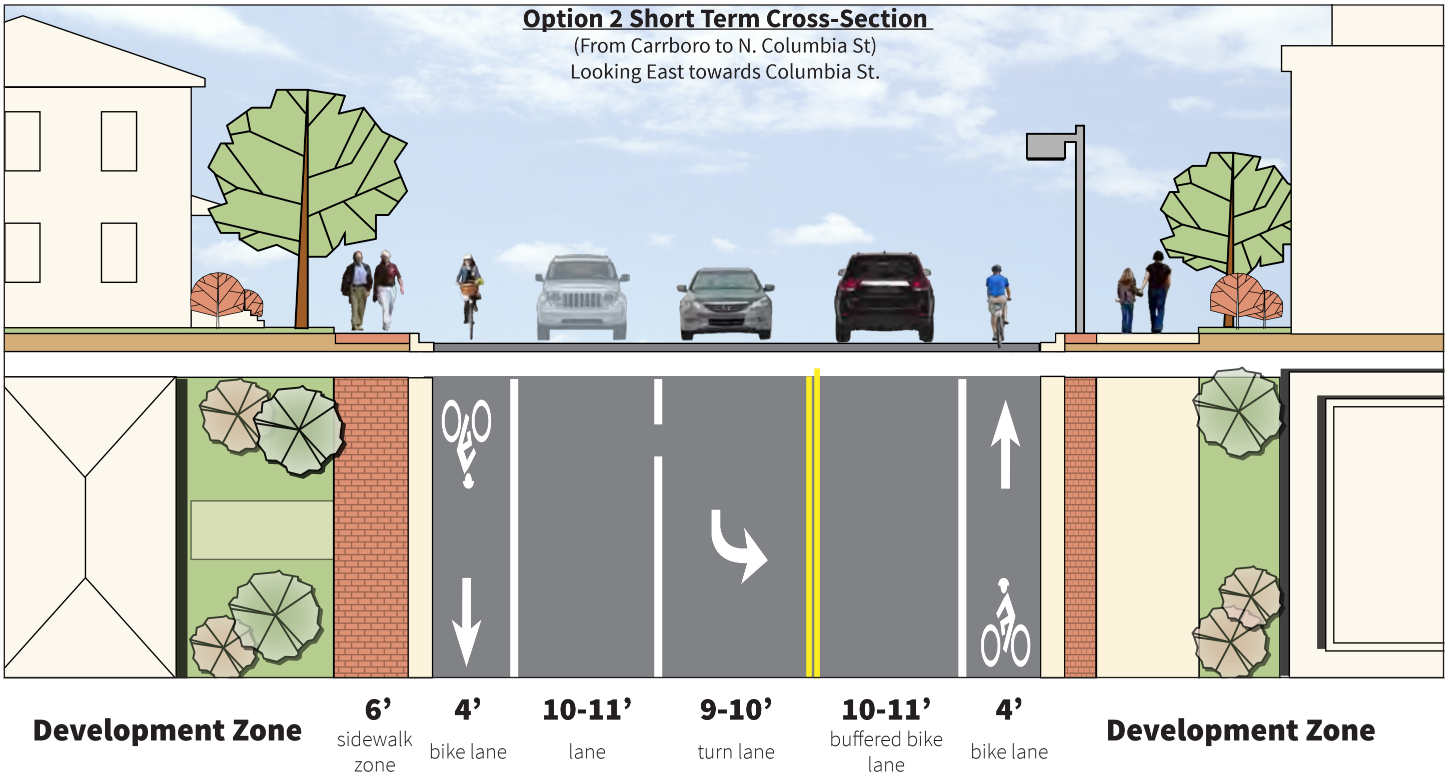


Rosemary St. Existing Cross-Section
(From Carrboro to N. Columbia St)
Looking East towards Columbia St.



Option 1 Short Term Cross-Section
(From Carrboro to N. Columbia St)
Looking East towards Columbia St.





About Option 2: If a future traffic analysis shows that the left turn lane at Church St. cannot be dropped without significantly reducing motor vehicle capacity at this intersection, then 4 foot bike lanes or sharrows could be used for the length of the left turn lane.

Rosemary St. at Church Street Looking East towards Columbia St.

Project Martin Luther King Jr. Blvd

Priority 3

Est. Cost $275,000

Project Description

- Bicycle Climbing Lanes
- Sidewalk Maintenance

S2 = Improved Stair Connection to Downtown/Campus

In the short term, it is recommended the roadway be reconfigured to provide a minimum 5 foot climbing bicycle lane in the uphill direction and shared lane markings in the downhill direction. This would be accomplished through a lane diet.

The shared lane marking should be located a minimum of six feet from face of curb to guide faster moving bicyclists away from drainage grates. The existing center turn lane and wide lanes create opportunities to reconfigure the space within the existing curb lines to add the climbing bicycle lanes. The continuous center turn lane provides additional buffering for the 10 foot inside lanes. The travel lanes should taper to 11 feet and the bicycle lanes to 6 feet on either side of the refuge island.

It is also recommended that the existing sidewalks be targeted for spot repair and maintenance to provide a facility for those bicyclists who do not feel comfortable sharing the roadway with motor vehicles. The full width of the sidewalk should be usable, and smooth and overhanding vegetation should be cleared.

Implementation challenges

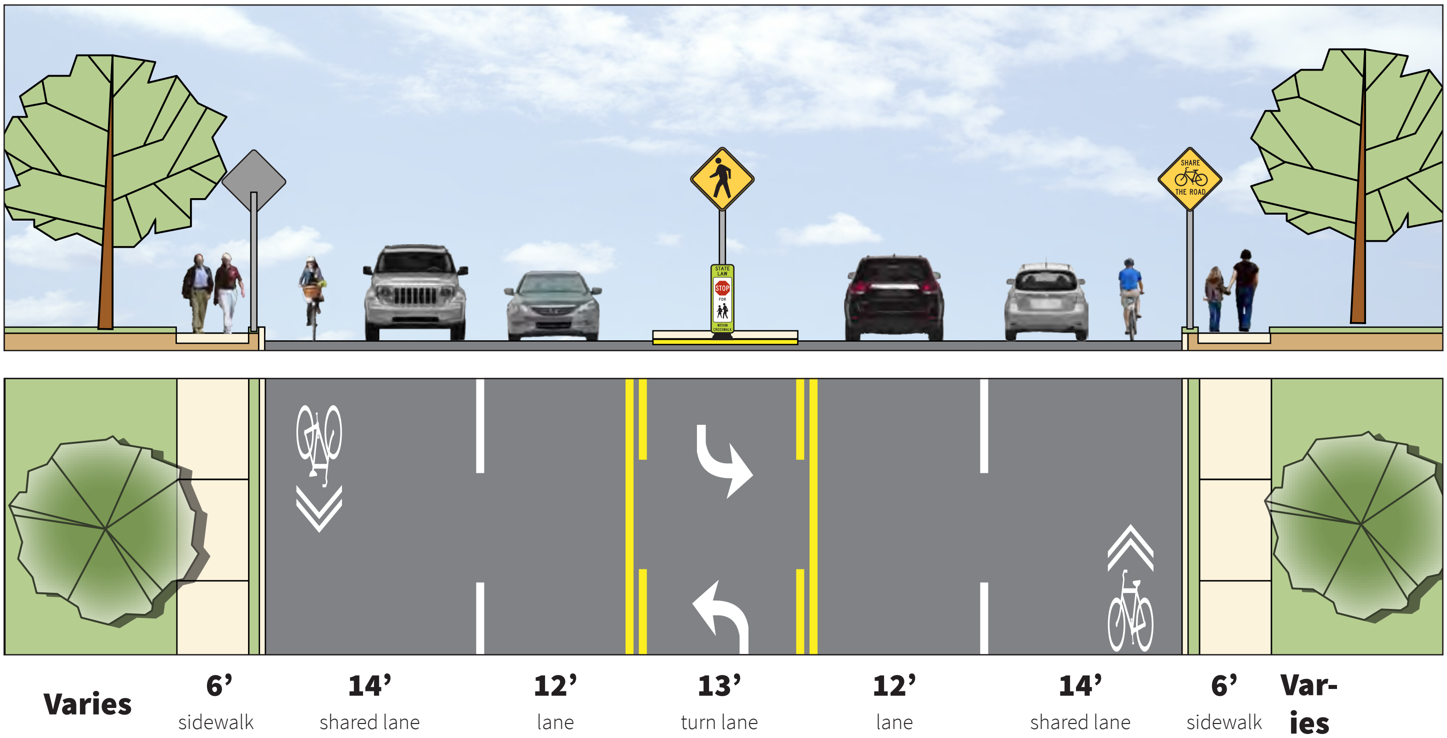
To achieve 6'foot bike lane and keep 11' motor vehicle travel lanes, it will be necessary to narrow the two mid-block pedestrian refuge islands to 8-9'.

ABOVE: Exisitng conditions and a conceptual rendering after a Lane Diet

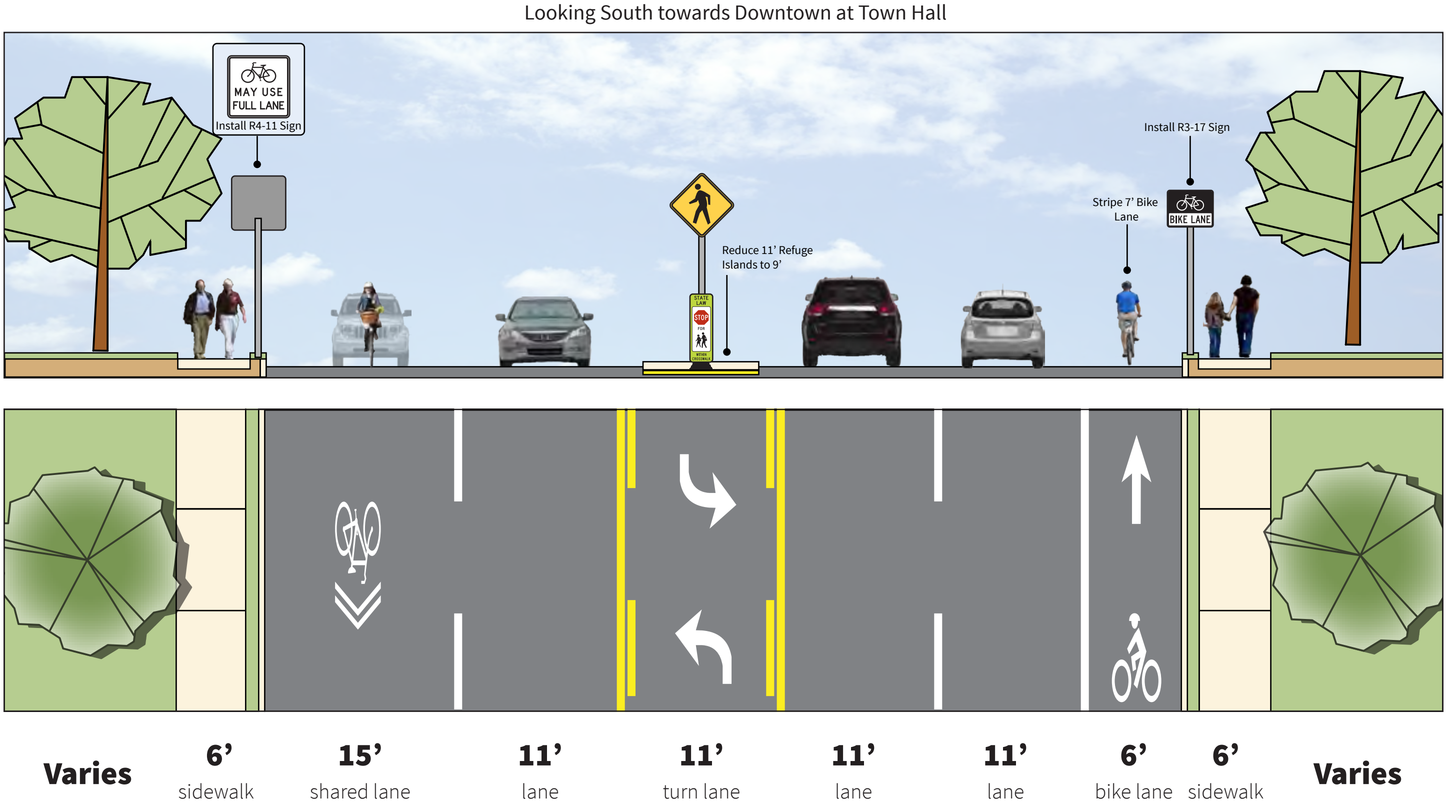
ABOVE: Sidewalk near University Terrace driveway.


FACILITY LEGEND
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Intersections
Signalized
Stop Controlled
"Mid-Block" Pedestrian Crossing
Bike-Ped Crossing
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
"Spot" Improvement
School
School
Estes Dr.
START
Martin Luther King Jr. Blvd
Chapel Hill Police Station
Bolinwood Dr.
Bolin Creek Greenway
Bolinwood Apts.
Umstead Park
Townhouse Apts.
Bicycle Apts
Hillsborough St
University Commons
REDUCE WIDTH OF CROSSING REFUGE ISLAND
Jay St.
McMasters St.
Northside Elem. School
Columbia St.
Town Hall
END
W Rosemary St
W Franklin St
SHARROWS
STOP
YIELD

Existing Cross-Section
(From Estes Dr. to Rosemary St.)
Looking South towards Downtown at Town Hall



Short Term Cross-Section
(From Estes Dr. to Rosemary St.)
Action: Lane Diet
Looking South towards Downtown at Town Hall



Connectivity provides convenience and value

Non-motorized transportation connections come in many forms, including greenways and shorter connections between neighborhoods and commercial areas. Even short connections, like a set of stairs, can provide significant benefits. To illustrate the value of non-motorized connectivity, a travel time-benefits analysis was prepared. This analysis considered two possible pedestrian routings that residents of the neighborhood south of Cobb Terrace would use to access the UNC Quad. Based on these routings, the travel time saved and the benefits accrued to pedestrians taking the blue route with the stairs (shown below) instead of the next shortest alternative route (orange) were calculated.

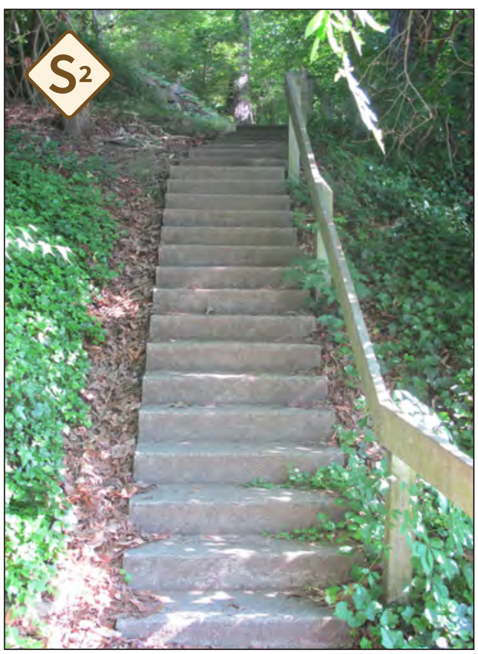
Providing convenience

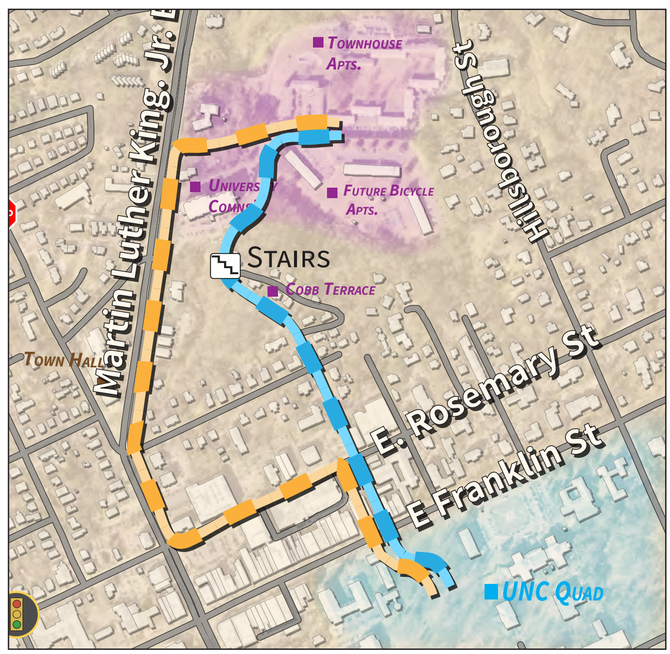
The results in the table below provide insight on how non-motorized connectivity makes walking more convenient. Based on an average walking speed of 2.8 MPH, a pedestrian who uses the blue route instead of the orange alternative would save 11 minutes of travel time daily, and 44 hours annually for a round trip to the Campus Quad (if they used it every weekday).

Providing value

To aid in the evaluation of transportation investments and the financial benefits they provide individuals, researchers quantified the monetary value of travel time. On average, the travel time of an individual in the United States is valued at $12.98 per hour. From the example above, saving 44 hours of travel time yeilds $580 in annual individual benefit.

To consider the annual benefit to the whole neighborhood, further assumptions and calculations were made. The area on the map in purple was estimated to have 1,570 residents in 2010. Assuming that only 50% of these residents use the Blue Route like in the example above, the total annual economic benefit of the Cobb Terrace stair connection exceeds $450,000 dollars annually.





Results of Pedestrian Travel Time-Benefits Analysis for University Commons Stairs

Route	Length Miles	Roundtrip Individual Time	Annual Individual Travel Time	Value 1 hr. Travel Time	Annual Individual Benefit	Potential Users	Annual Total Neighborhood Travel Time Savings	Annual Total Neighborhood Benefit
Blue	0.48	20 Min.	86 hrs.	$12.98	$580	785	35,124 hours	$455,913
Orange	0.74	31 Min.	131 hrs.	N/A	N/A	N/A	N/A	N/A

Project Raleigh Rd. Safety Improvements
Priority 4
Est. Cost $900,000

Project Description

- Bicycle Climbing Lanes
- Sidewalk Maintenance and Repair
- Enhanced Crossings at NC 54/US 15-501 On/Off Ramps
- Complete Interchange Lighting at Intersection of NC 54 and US 15-501

Bicycle Climbing Lanes

In the near term, it is recommended the roadway be reconfigured to provide a minimum 6 foot climbing bicycle lane with downhill shared lane marked with shared lane markings west of the UNC Spangler Center. The shared lane marking should be located a minimum of six feet from face of curb to guide faster moving bicyclists away from drainage grates.

Sidewalk Maintenance and Repair

It is also recommended that the existing sidewalks be targeted for spot repair and maintenance to provide a facility for those bicyclists who do not feel comfortable sharing the roadway with motor vehicles. The full width of the sidewalk should be usable, and the surface should be smooth.

S3 = Enhanced Crosswalks at 4 On/Off Ramps

S4 = Complete Interchange Lighting at Interchange at NC 54 and Fordham Blvd.

Implementation challenges

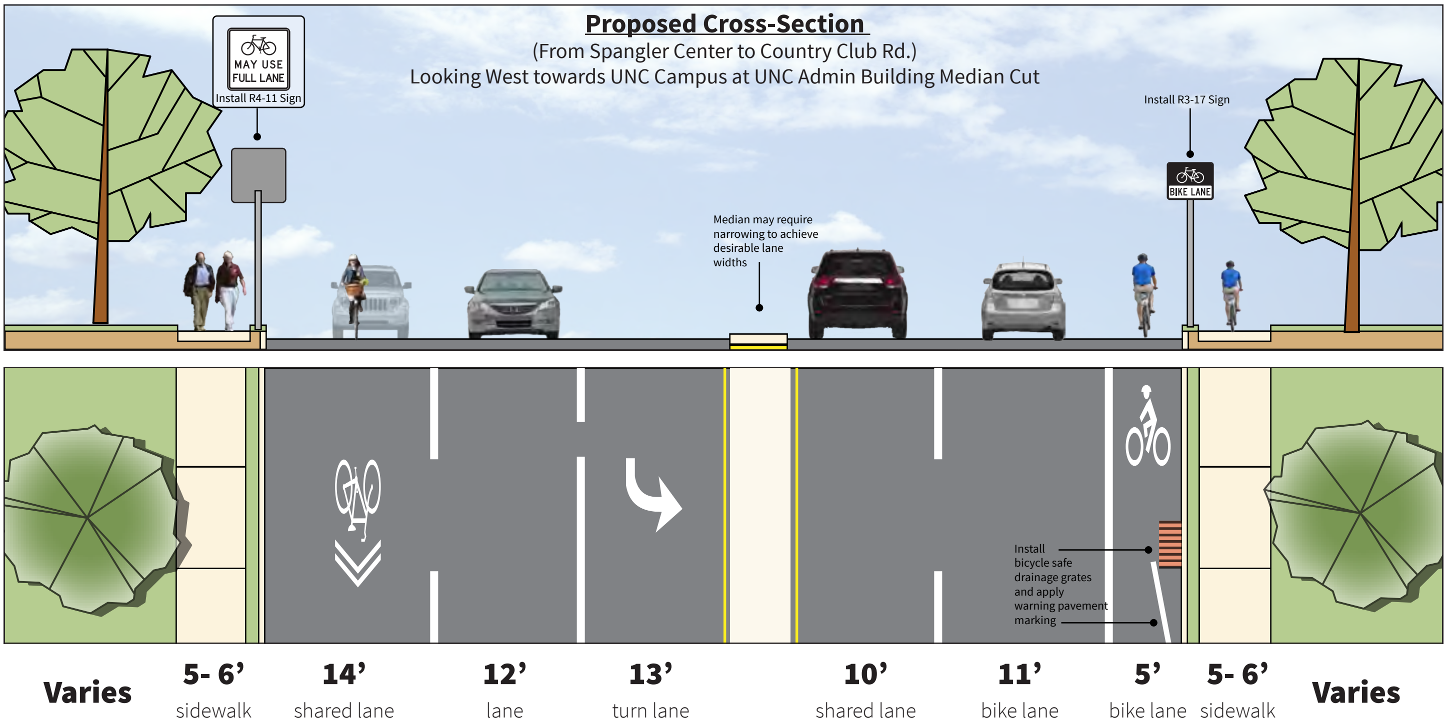
To maintain 11 foot travel lanes west of the interchange, the continuous median would require narrowing.

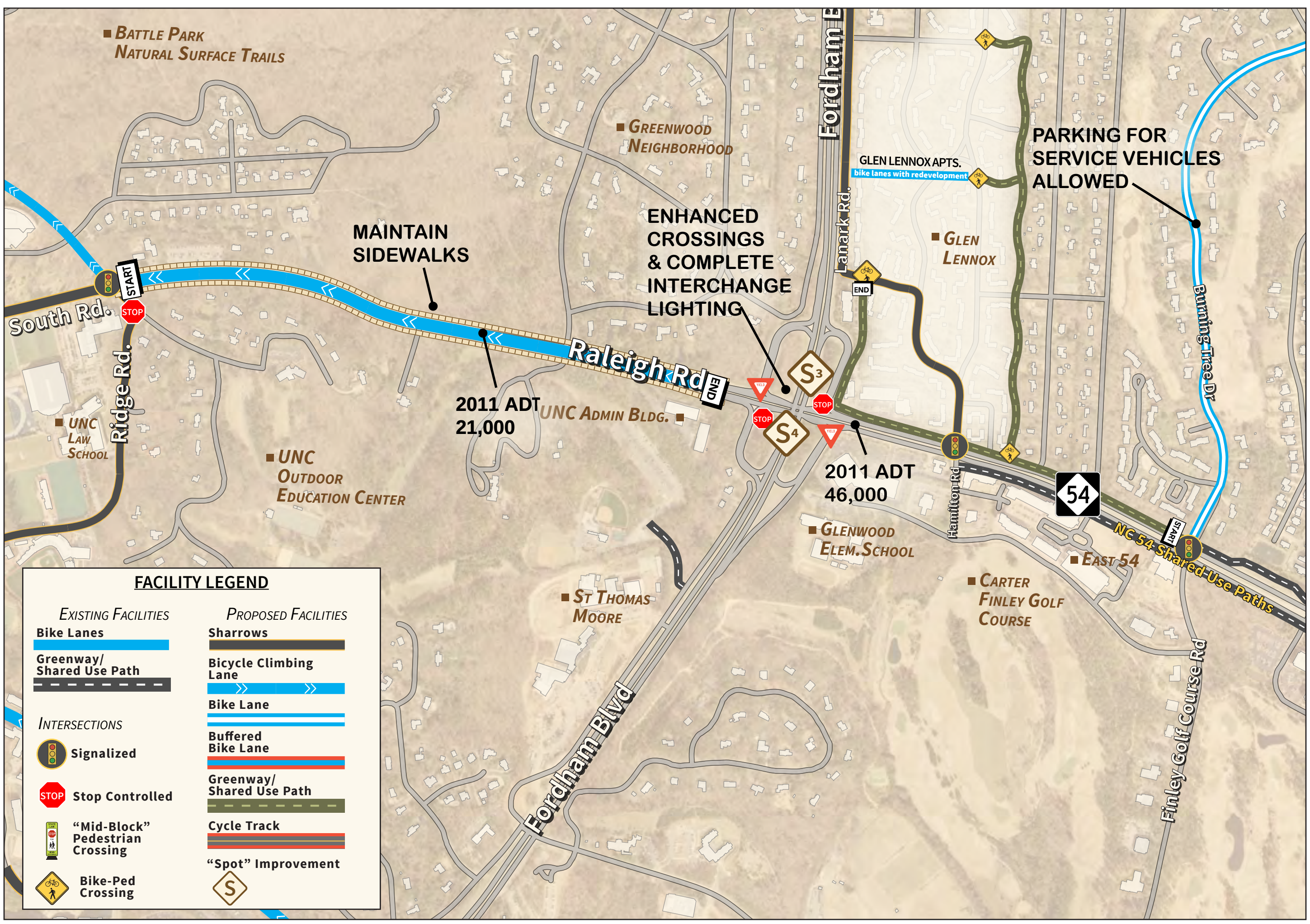
Looking east on NC 54 from Fordham Blvd bridge.

The AASHTO Guide to Roadway Lighting recommends complete interchange lighting for interchanges in urban and suburban areas where the daily traffic volume exceeds 10,000 vehicles per day for on/off ramps.

Along with cyclists, pedestrians and transit users would benefit from improved sidewalk conditions at this location along NC 54.

Low-cost improvements such as marked and colored crosswalks can make crossing the 4 ramps at this interchange safer for cyclists and pedestrians using this concrete pedestrian refuge island.


Proposed Cross-Section
(From Spangler Center to Country Club Rd.)
Looking West towards UNC Campus at UNC Admin Building Median Cut
MAY USE FULL LANE
Install R4-11 Sign
Install R3-17 Sign
BIKE LANE
Median may require narrowing to achieve desirable lane widths
Install bicycle safe drainage grates and apply warning pavement marking
Varies
5- 6' sidewalk
14' shared lane
12' lane
13' turn lane
10' shared lane
11' bike lane
5' bike lane
5- 6' sidewalk
Varies


Battle Park Natural Surface Trails
Greenwood Neighborhood
Fordham Blvd
Glen Lennox Apts.
bike lanes with redevelopment
Parking for service vehicles allowed
Maintain sidewalks
Enhanced crossings & complete interchange lighting
Lanark Rd.
Glen Lennox
South Rd.
START
STOP
Raleigh Rd
END
Ridge Rd.
UNC Law School
2011 ADT 21,000
UNC Admin Bldg.
S3
S4
UNC Outdoor Education Center
2011 ADT 46,000
Hamilton Rd
54
NC 54 Shared Use Paths
Burning Tree Dr
Glenwood Elem. School
East 54
Carter Finley Golf Course
St Thomas Moore
Fordham Blvd
Finley Golf Course Rd
FACILITY LEGEND
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Intersections
Signalized
Stop Controlled
"Mid-Block" Pedestrian Crossing
Bike-Ped Crossing
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
"Spot" Improvement

PROJECT S 15-501/JAMES TAYLOR BRIDGE LANE DIET
PRIORITY 5
EST. COST $ 300,000

Project Description

- **Bike Lanes; Green Bike Lanes**

Restripe existing 6’ bike lanes between Market St. and Mt. Caramel Church with new markings. From Mt. Caramel Church Rd to the S. Columbia St Bike Lanes, add 5’ Minimum bike lanes via a lane diet. Then, paint the bike lanes green on 15-501 from Mt. Caramel Church Road to Purefoy Rd. pursuant to the Federal Highway Administration’s Interim Approval for Optional Use of Green Colored Pavement for Bike Lanes (IA-14 April 15, 2011). Specific language regarding this approval of green bike lanes is included below. See Appendix A for additional guidance on the use of green colored bike lanes.

GREEN BIKE LANES

Background

A number of experiments have been conducted in the United States and in other countries around the world to determine the value of designating a particular pavement color to communicate to road users that a portion of the roadway has been set aside for exclusive or preferential use by bicyclists and to enhance the conspicuity of a bicycle lane or a bicycle lane extension. In these experiments, green colored pavement is being used as a traffic control device to designate locations where bicyclists are expected to operate, and areas where bicyclists and other roadway traffic might have potentially conflicting weaving or crossing movements. For example, at a location where a bicycle lane crosses an unsignalized freeway on-ramp.

Effects of Green Colored Bike Lanes

The Federal Highways Adminstration has reviewed the available data and considers the experimental green colored pavement to be satisfactorily successful for the bicycle applications that were tested. Positive operational effects have been noted in the experiments, such as bicyclists positioning themselves more accurately as they travel across intersections and through conflict areas, and no notable negative operational effects have been observed. The research has also shown that bicyclists and motorists both have a positive impression of the effect of the green colored pavement, with bicyclists saying that they feel safer when the green colored pavement is present, and motorists saying that the green colored pavement gives them an increased awareness that bicyclists might be present and where those bicyclists are likely to be positioned within the traveled way.

Conditions of Interim Approval

The FHWA will grant Interim Approval for the optional use of green colored pavement in marked bicycle lanes and in extensions of bicycle lanes through intersections and traffic conflict areas to any jurisdiction that submits a written request to the Office of Transportation Operations.

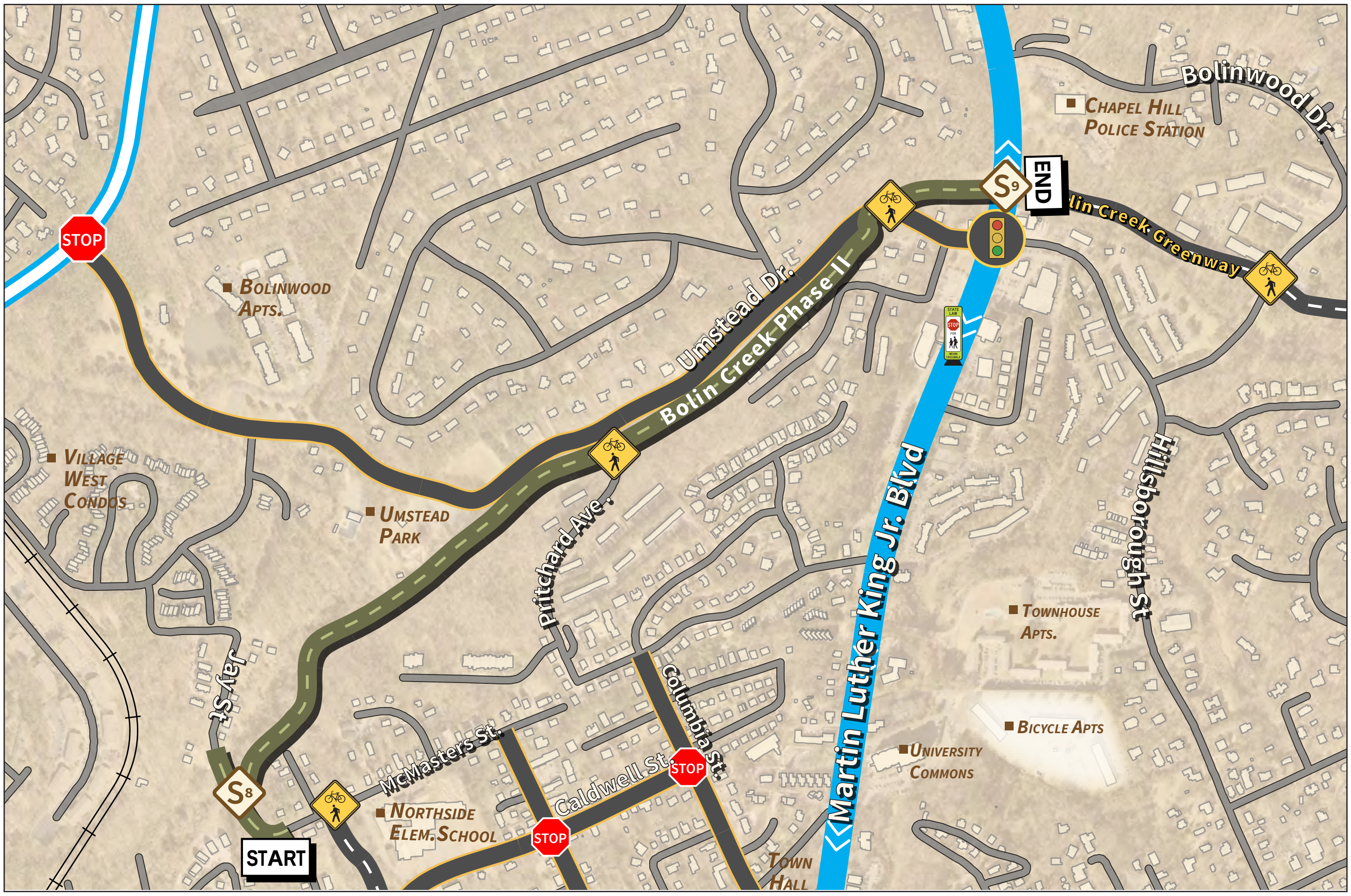

S. COLUMBIA ST BIKE LANES
54
END
LANE DIET JAMES TAYLOR BRIDGE
Morgan Creek Greenway
END
WORK WITH NCDOT TO CONNECT TO MORGAN CREEK RD.
STOP
Culbreth Rd.
Power Substation
Merritt's Pasture
GREENWAY UNDERPASS
START
EXISTING GREENWAY UNDERPASS
Fan Branch Greenway
Culbreth Middle School
Mt. Caramel Church Rd.
Bennet Rd.
Arlen Park Dr
15
501
Southern Village
Market St.
START
Scroggs Elem. School
Park and Ride Lot
FACILITY LEGEND
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Intersections
Signalized
Stop Controlled
"Mid-Block" Pedestrian Crossing
Bike-Ped Crossing
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
"Spot" Improvement

S 15-501/James Taylor Bridge Lane Diet

ABOVE: James Taylor Bridge on US 15-501 looking south

ABOVE: Conceptual rendering of green bike lane treatment through an on-ramp intersection

Project Tanyard Branch and Bolin Creek Extensions
Priority 6
Est. Cost $ 3.5 Million



Project Description

The Town controls much of the land from Martin Luther King Jr. Blvd. to Umstead Park, although one small gap in property ownership does exist. This project would likely be the single most difficult greenway section undertaken by the Town due to the significant physical constraints along this section of Bolin Creek. However, it is a vital link if the Town is to merge its trail system with the future trail systems of Carrboro and Orange County.

Implementation challenges

The physical constraints along Bolin Creek. The construction of two underpass tunnels and a bridge.

S8 = Small Bridge over Tanyard Branch Creek

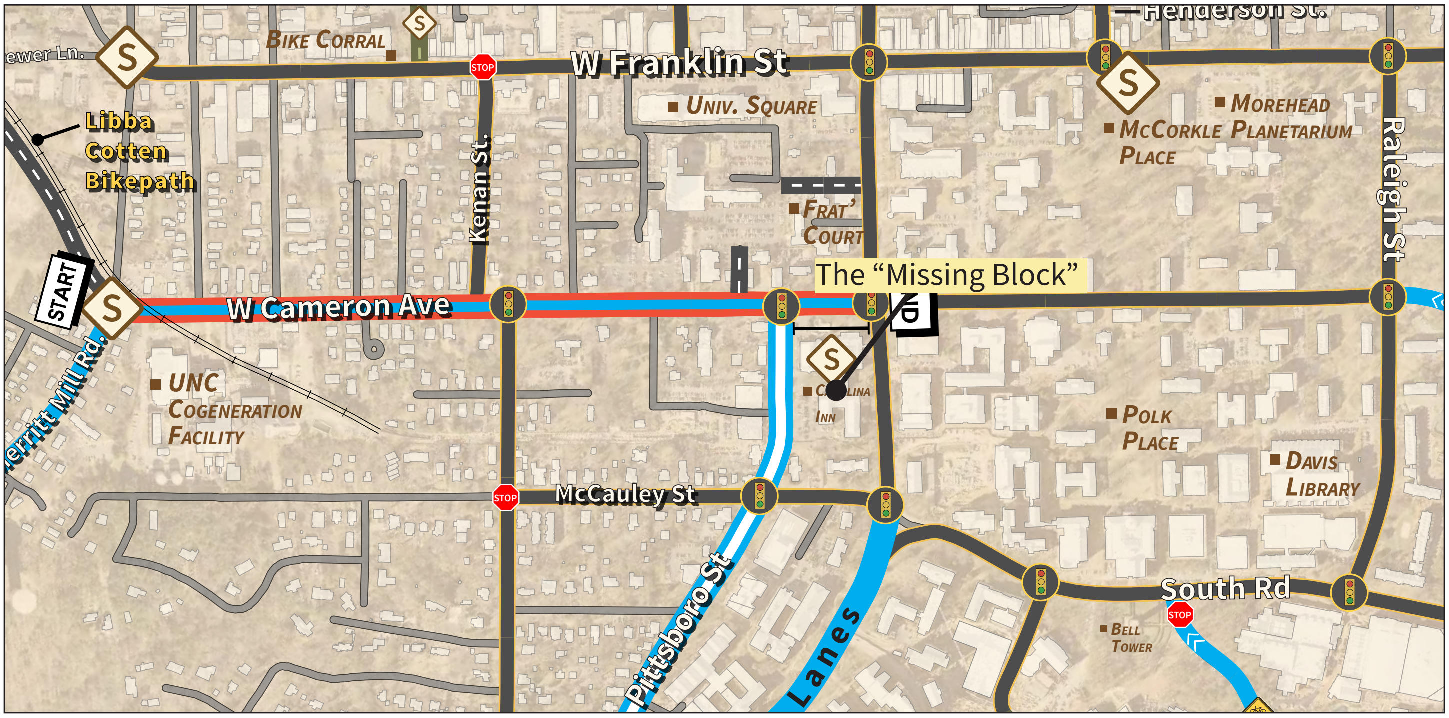
S9 = Using existing tunnel under Martin Luther King Jr. Blvd, connect Bolin Creek Phase II

A small bridge would need to be built over the Tanyard Branch Creek as part of this project.

Project — Cameron Ave. Improvements

Priority — 7

Est. Cost — $725,000



Project Description

- Buffered Bike Lanes
- Repaving
- Intersection improvements

S5 = Spot Improvement at Cameron/Merritt Mill Rd/Libba Cotton Bikeway at NC 54 and Fordham Blvd. Interchange

In the short term, repaving and a lane diet is recommended to allow for buffered bicycle lanes, a more comfortable facility that will better accommodate the high volume of bicycle traffic that travels this corridor daily. With this type of facility, groups of students will be able to ride together more safely two abreast. It is also recommended that the intersection at Merritt Mill Road be redesigned in the short term to facilitate a safe, predictable connection to the Libba Cotton Bikeway.

Implementation challenges

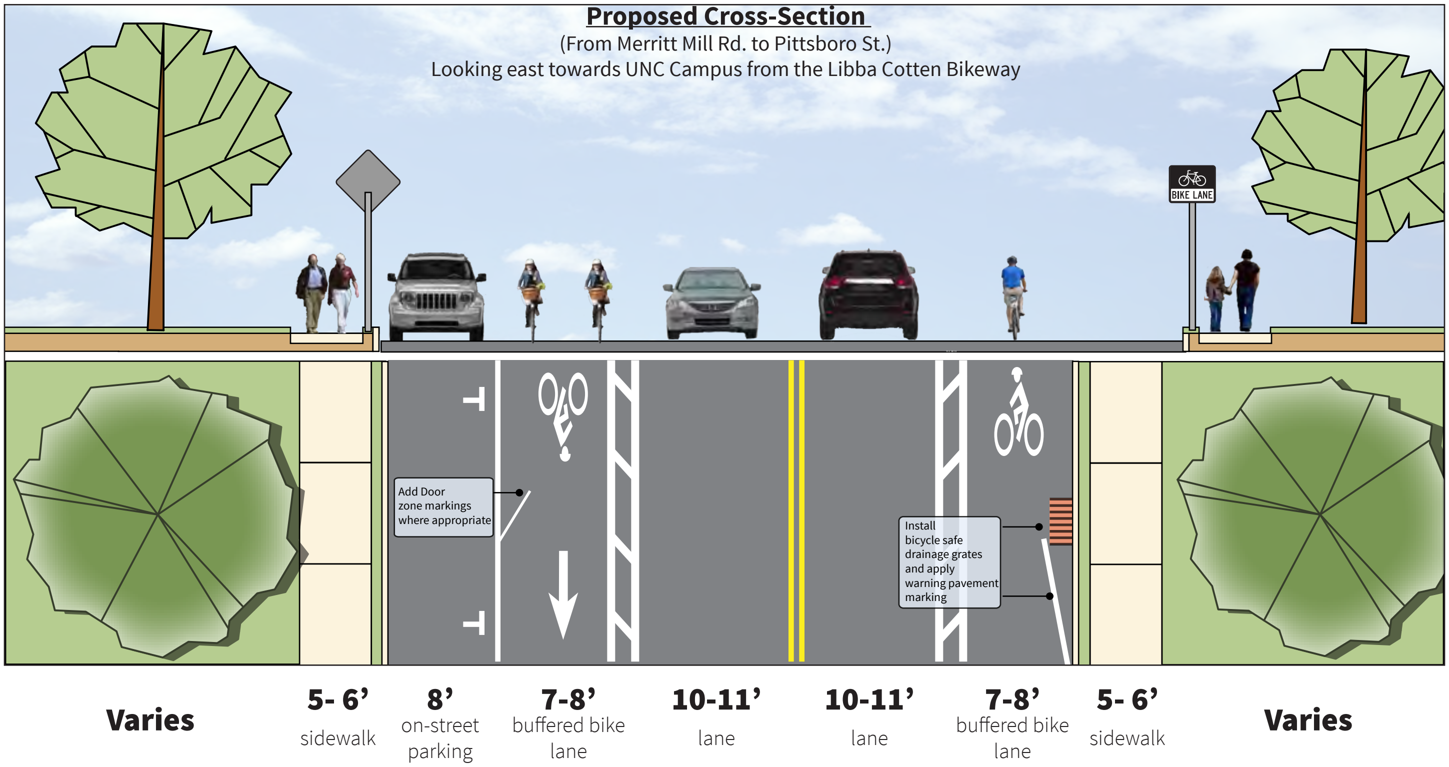
Completing the "missing block" between Pittsboro Street and South Columbia Street will require removal of a travel lane, which will require further study.

FACILITY LEGEND

Existing Facilities
- Bike Lanes
- Greenway/ Shared Use Path

Intersections
- Signalized
- Stop Controlled
- "Mid-Block" Pedestrian Crossing
- Bike-Ped Crossing

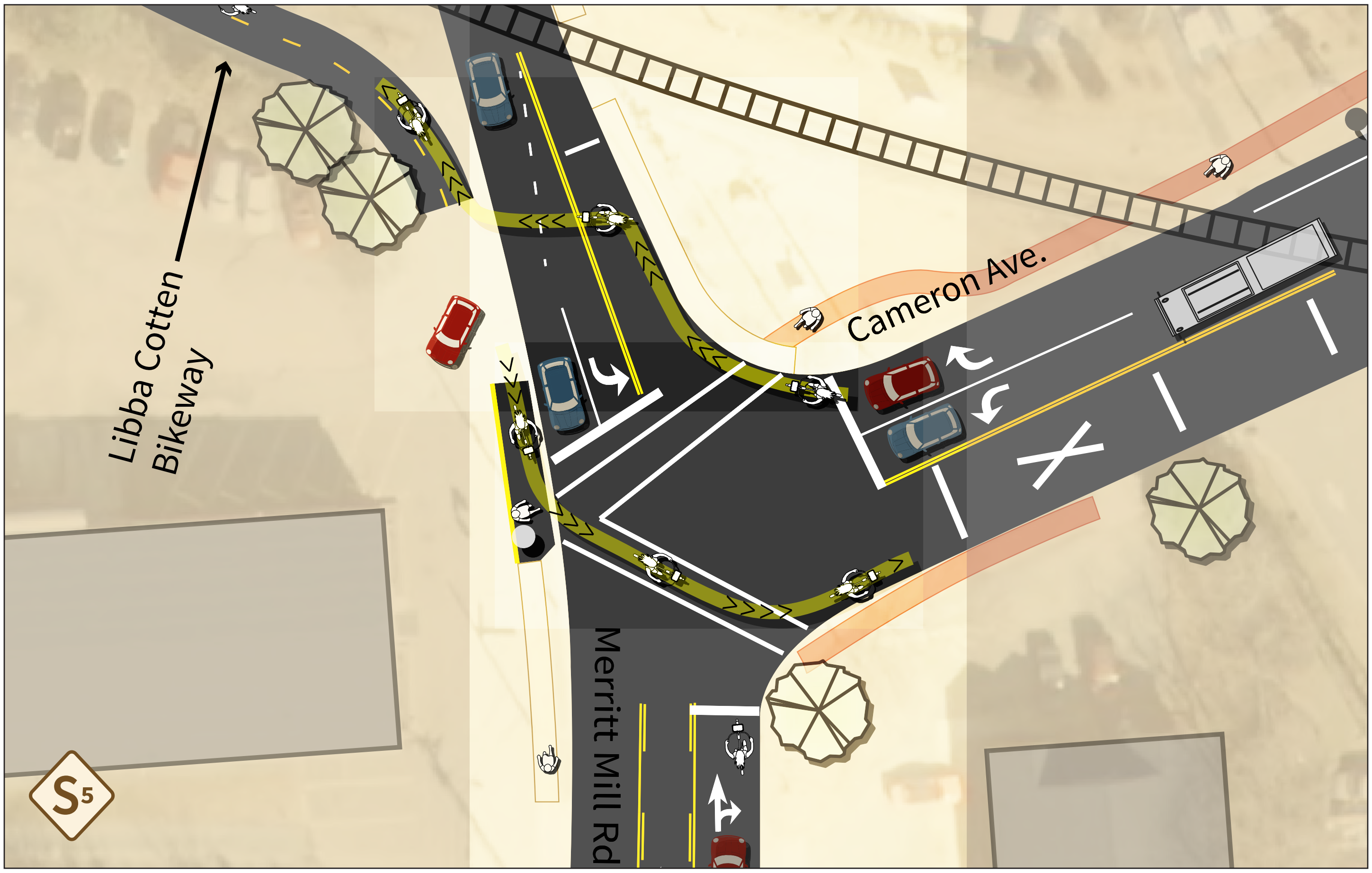
Proposed Facilities
- Sharrows
- Bicycle Climbing Lane
- Bike Lane
- Buffered Bike Lane
- Greenway/ Shared Use Path
- Cycle Track
- "Spot" Improvement



ABOVE: This image shows the beginning of the "missing block" at Cameron Ave. and Pittsboro St. This is where the Cameron Ave. bike lanes currently terminate. To get bike lanes to go all the way to the UNC Campus, a future study of this intersection and this segment of street would be required.

ABOVE: Currently, the on-street parking lane is 10' wide, the bike lanes are 5' wide, and the motor vehicle travel lanes are 13' wide.

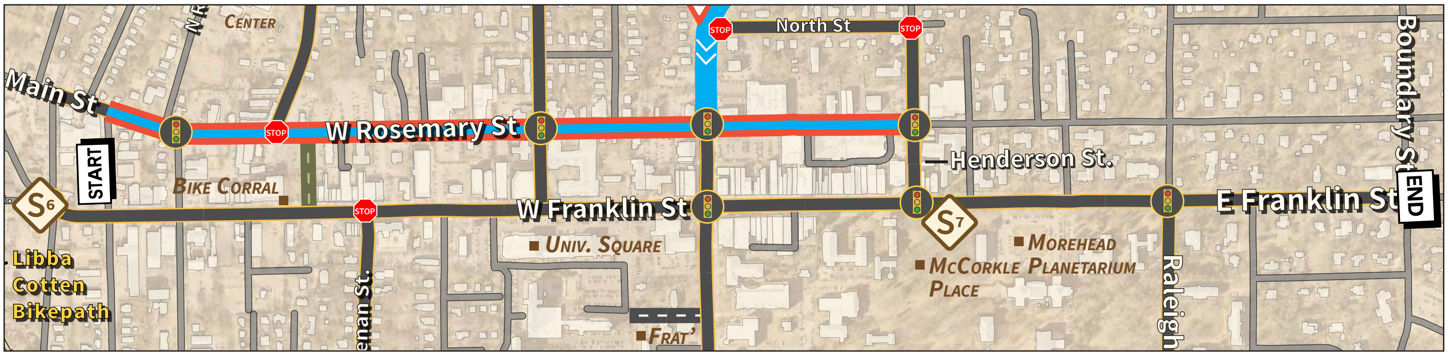
Two Common cyclist paths at the Cameron Ave. Libba Cotten Bikeway Intersection



Project — Franklin St. Shared Lanes

Priority 8

Est. Cost $ 80,000



Project Description

- Shared Lane

Add shared-lane markings (Sharrows) in center of curb lane between Merritt Mill Rd. and Boundary St.

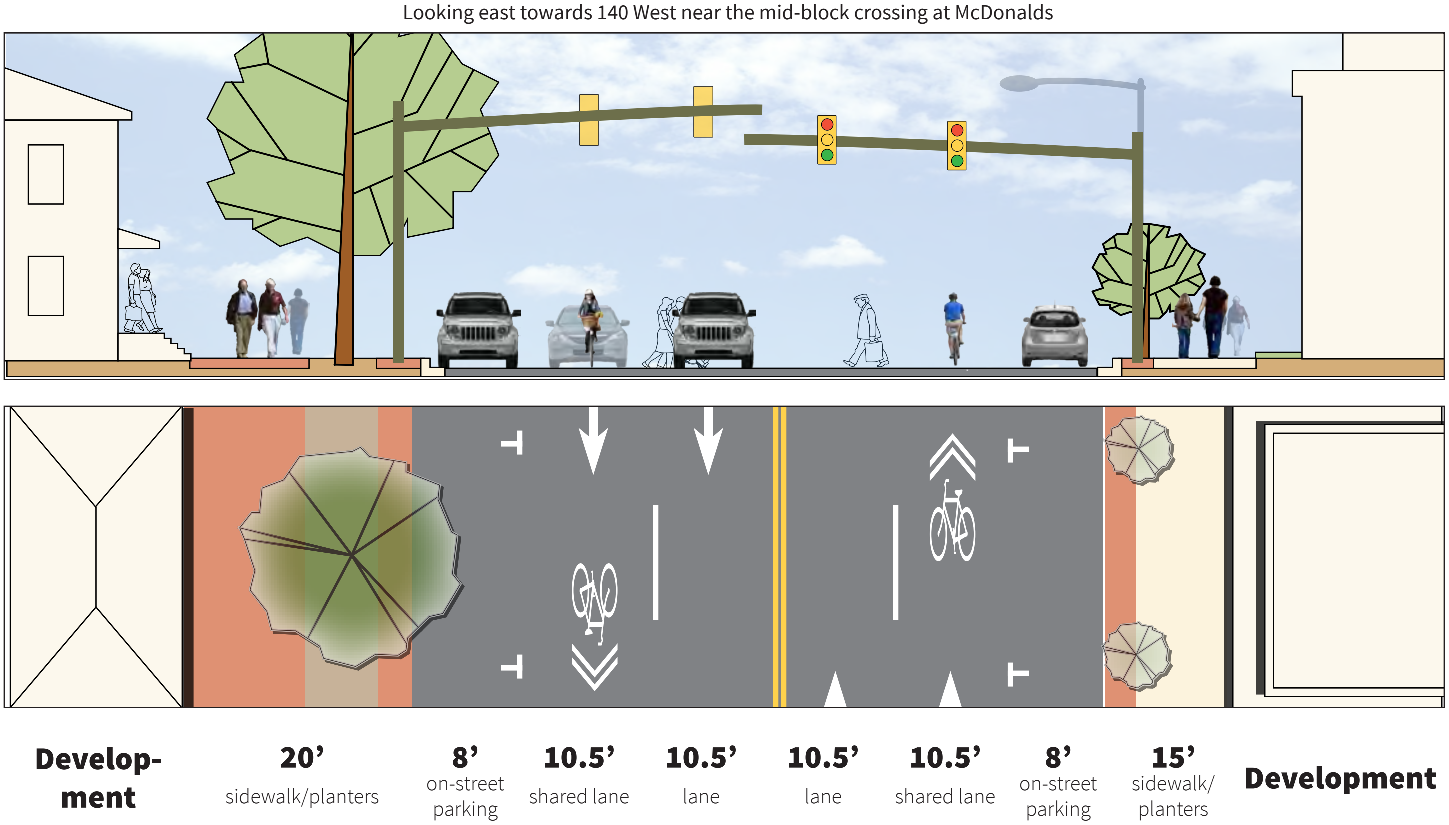
Install BICYCLES MAY USE FULL LANE signs where appropriate.

S6 = Spot Improvement at Franklin/Merritt Mill/Brewer Lane

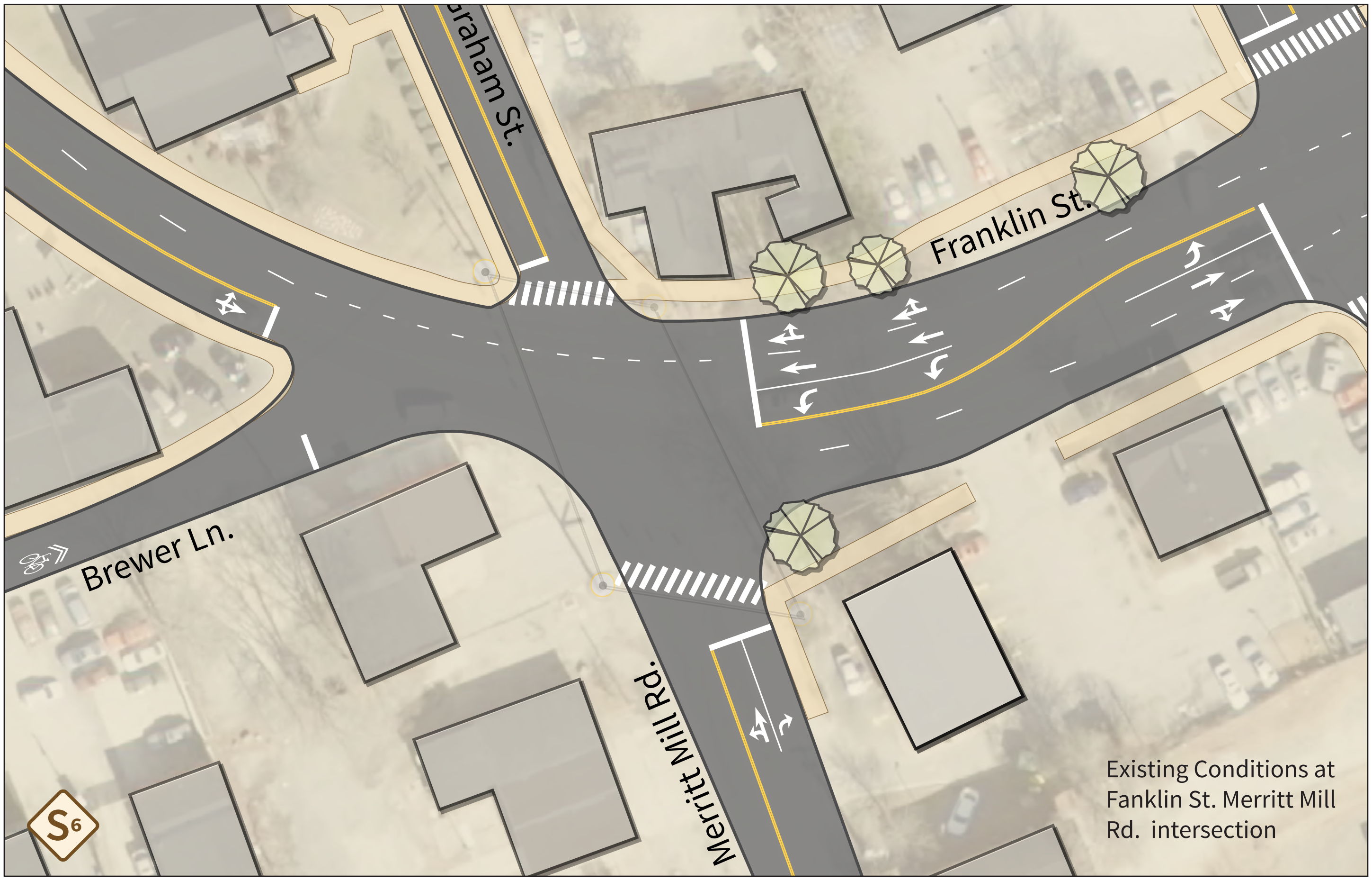
S7 = Convert steps to Ramp at UNC Campus/Franklin St/Henderson St. Intersection

Proposed Cross-Section

Looking east towards 140 West near the mid-block crossing at McDonalds



Looking west from 140 West Condos



Existing Conditions at Fanklin St. Merritt Mill Rd. intersection

PROJECT MORGAN CREEK GREENWAY PHASE II

PRIORITY 9

EST. COST $ 3.5 MILLION

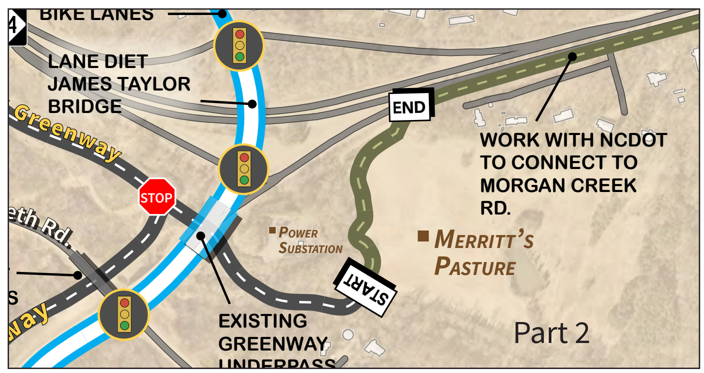
Project Description

- **Shared Use Path/Greenway/Bridges**

PART 1 : Design and construct the second phase of the Morgan Creek Greenway which will run from the Morgan Creek Greenway Parking Lot to Smith Level Road.

NOTE: Currently, the final alignment has not been selected and the project has yet to be designed. The total cost of the project could vary depending upon the final alignment and the number of bridges necessary.

PART II : Design and construct a paved path on the outer edge of Merritt's Pasture beginning at the current eastern terminus of the Morgan Creek Greenway to the gate at Fordham Blvd. Then work with NCDOT to develop a proper facility to connect this greenway to Morgan Creek Rd along the 54 Bypass.



Project — East Franklin St: Sharrows, Sidewalks, and Road Diet Study

Priority 10

Est. Cost $ 350,000

Project Description

- Maintain and Repair Sidewalks
- Shared Lane Markings
- Complete stairs to Bolin Creek Greenway
- Road diet feasibility study

In the short term, it is recommended that the existing sidewalks be targeted for spot repair and maintenance to provide a facility for those bicyclists who do not feel comfortable sharing the roadway with motor vehicles. The full width of the sidewalk should be usable, and the pavement should be smooth. Where feasible, the sidewalk should be widened to 8 feet to meet minimum AASHTO standards for sidepaths.

Implementation challenges

The roadway is not centered within the right-of-way resulting in some right-of-way lines aligning with the back edge of sidewalk which may limit sidewalk widening opportunities in some locations.

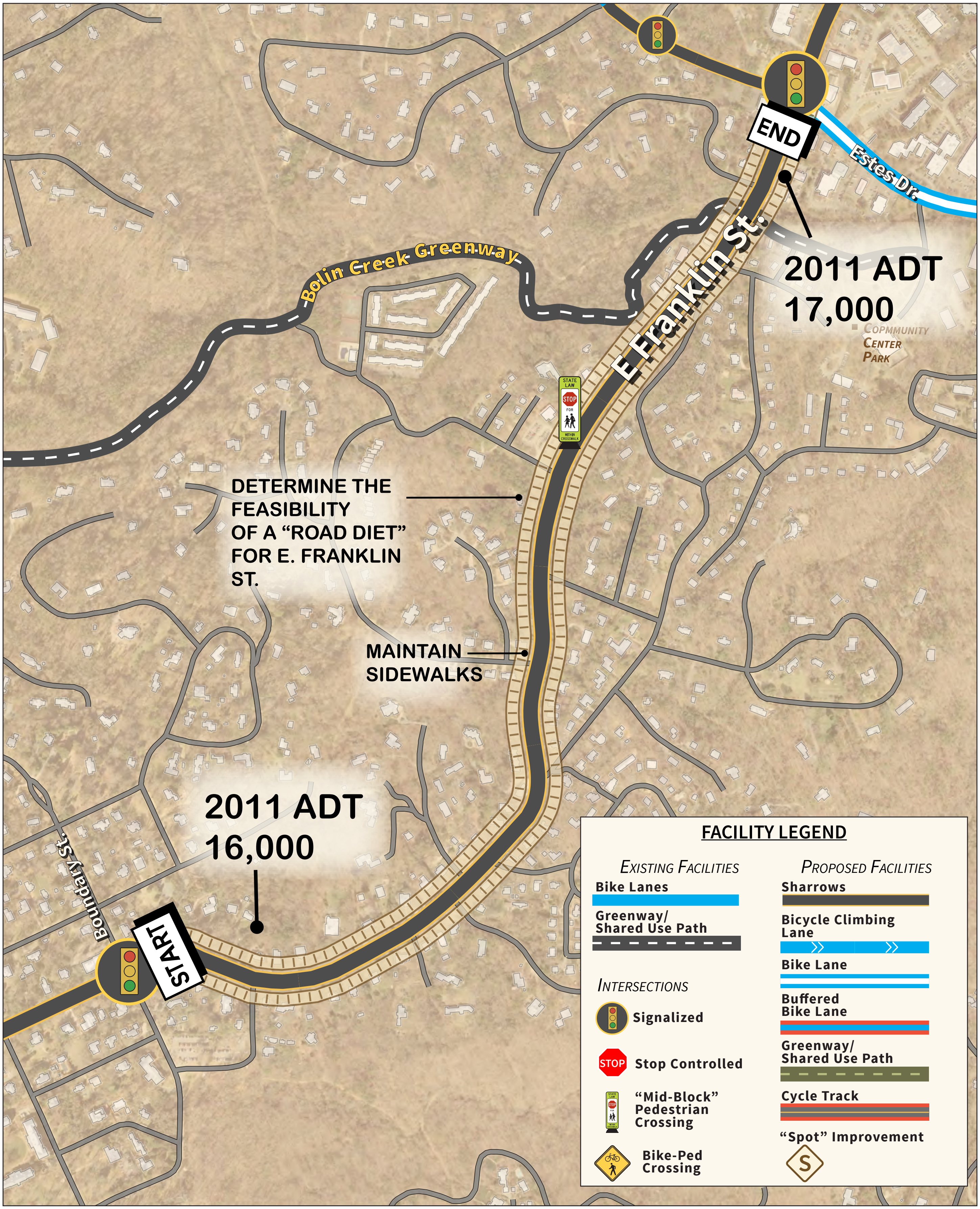
ABOVE: Along with deteriorating and broken sections of concrete, encroaching vegetation can limit the usable space of sidewalks significantly.

WHAT IS A ROAD DIET?

One of the Federal Highway Administration's "9 Proven Safety Countermeasures," the road diet normally involves converting an undivided four lane roadway into three lanes made up of two through lanes and a center two-way left turn lane. The reduction of lanes allows the roadway to be reallocated for other uses such as bike lanes, pedestrian crossing islands, and/or parking.

Guidance

Roadways with Average Daily Traffic (ADT) of 20,000 or less may be good candidates for a road diet and should be evaluated for feasibility. It has been shown that roads with 15,000 ADT or less had very good results in the areas of safety, operations, and livability. Driveway density, transit routes, the number and design of intersections along the corridor, as well as operational characteristics are some considerations to be evaluated before deciding to implement a road diet. See Appendix A.


END
Estes Dr.
E Franklin St.
2011 ADT
17,000
Copmmunity
Center
Park
Bolin Creek Greenway
DETERMINE THE FEASIBILITY OF A "ROAD DIET" FOR E. FRANKLIN ST.
MAINTAIN SIDEWALKS
2011 ADT
16,000
Boundary St.
START
FACILITY LEGEND
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Intersections
Signalized
Stop Controlled
"Mid-Block" Pedestrian Crossing
Bike-Ped Crossing
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
"Spot" Improvement

Project Name Merritt Mill Rd. Climbing Lanes

Priority 11

Estimated Cost $ 100,000

Project Description

- Bicycle Climbing Lanes

In the near term, it is recommended the roadway be reconfigured to provide a minimum 6 foot climbing bicycle lane with shared lane markings in the downhill direction. The shared lane marking should be located a minimum of six feet from face of curb to guide faster moving bicyclists away from drainage grates.

Merritt Mill Rd looking north towards Cameron Ave.

Project Name South Columbia Shared Lanes

Priority 12

Estimated Cost $ 5,000

This version of shared lane, the Priority Shared Lane, is currently under review by the Federal Highway Administration and would not be eligible for implementation in Chapel Hill until further rulings are issued.

Project Description

- Shared Lane

Add shared-lane markings (Sharrows) in center of curb lane between Cameron Ave. and Rosemary St.

Install BICYCLES MAY USE FULL LANE signs where appropriate.

Project Name Sage Rd. Road Diet

Priority

Estimated Cost $ 140,000

Project Description

- Bike Lanes

Bike Lanes on Sage Road would provide a connection for bicyclsts between the Weaver Dairy Rd. Bike Lanes and Old Durham Chapel Hill Rd. The exisitng ADT on Sage Rd. is 7400 vehicles per day.

S10 **Intersection Safety Improvement at Old Durham Rd./Sage/15-501 Intersection**

ABOVE: This section of Sage Rd. is over 60 feet wide.

Project Name S. Estes Dr. Road Diet

Priority

Estimated Cost $ 250,000

Project Description

- Bike Lanes from Franklin St. to Fordham Blvd.

Project Name S. 15-501 Bike Lane Extension to Dogwood

Priority

Estimated Cost $ 60,000

Project Description

- Bike Lanes from Market St. to Dogwood Acres Dr.

Project Name Ephesus Chruch Rd. Bike Lanes

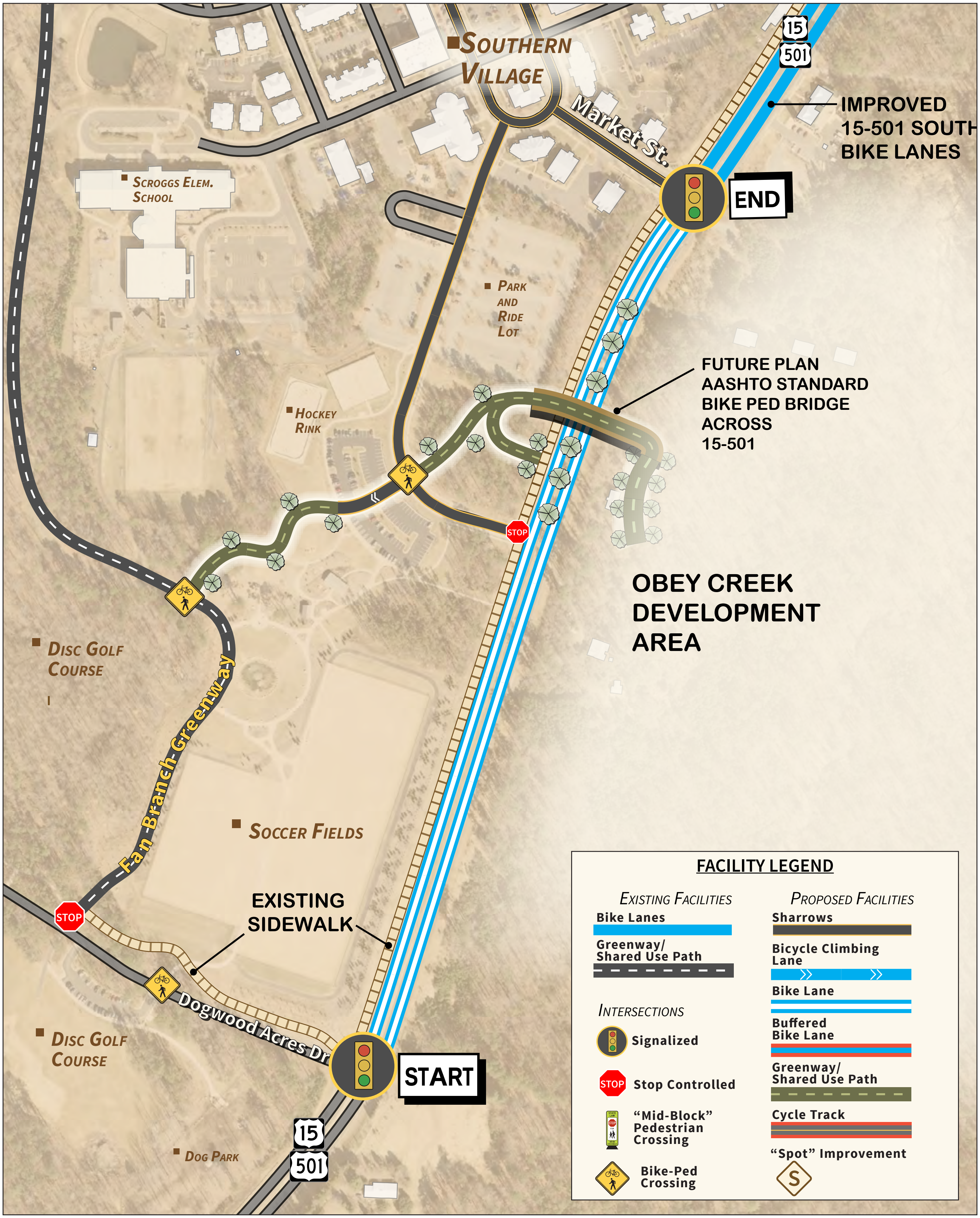
Priority

Estimated Cost $ 2 Million

Project Description

- Lane Diet from Colony Woods Dr. to Ephesus Elementary School to add Bike Lanes. A widening would be required in the section indicated the map on page #


Booker Creek Greenway
S14
S13
15
501
Trader Joes
Rams Plaz
Elliot Rd.
Michaux Rd
Connect Greenways with Redevelopment
Eastgate Center
Ephesus Fordham Focus Area
Ephesus Ch. Rd
Whole Foods
Booker Creek Greenway
Holiday Inn
Fordham Blvd
Franklin St.
Library
Elliot Rd.
See Greenway Masterplan
Existing Sidewalk
Willow Dr.
Willow Dr.
S12
Bolin Creek Greenway
University Mall
S. Estes Dr.
S11
S. Estes Apts.
S. Estes D
Facility Legend
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Intersections
Signalized
Stop Controlled
"Mid-Block" Pedestrian Crossing
Bike-Ped Crossing
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
"Spot" Improvement


15
501
Southern Village
Market St.
IMPROVED 15-501 SOUTH BIKE LANES
END
Scroggs Elem. School
Park and Ride Lot
FUTURE PLAN AASHTO STANDARD BIKE PED BRIDGE ACROSS 15-501
Hockey Rink
STOP
OBEY CREEK DEVELOPMENT AREA
Disc Golf Course
Fan Branch Greenway
Soccer Fields
EXISTING SIDEWALK
STOP
Dogwood Acres Dr
START
Disc Golf Course
Dog Park
15
501
FACILITY LEGEND
Existing Facilities
Bike Lanes
Greenway/ Shared Use Path
Intersections
Signalized
STOP
Stop Controlled
"Mid-Block" Pedestrian Crossing
Bike-Ped Crossing
Proposed Facilities
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
"Spot" Improvement
S

Old Durham Rd
Cosgrove Hill Apts.
Erwin Rd
15
501
Summerfield Crossing
Foxcroft Apts.
Dobbins Dr
Chapel Hill Cemetery
Scarlett Dr
COMPLETE OLD DURHAM CHAPEL HILL RD. PROJECT
15-501 SUPERSTREET CROSSING
Europa Center
Europa Dr.
INTEGRATE A CYCLE TRACK WITH REDEVELOPMENT
Ephesus Fordham Focus Area
Rams Plaza
Legion Rd
American Legion
START
Widening required in this section
Fordham Blvd
Holiday Inn
Ephesus Fordham Focus Area
Ephesus Elem. School
Ephesus Park
Ephesus Church Rd
Colony Woods Dr.
ELLIOT RD. EXTENSION CYCLE TRACK
ROUNDABOUT AT NEW INTERSECTION
PARKING FOR SERVICE VEHICLES ALLOWED
Pinehurst Dr.
END
DETERMINE FEASIBILITY OF CONNECTION TO WILLOW DR.
Willow Dr.
SEE GREENWAYS MASTERPLAN

Implement the Long Term Bicycle Facility Network

About the Long Term Network

The long-term network is a vision for a future system of low-stress facilities throughout the entire Town. Building major facilities, like Cycle Tracks and Sidepaths, would likely require roadway reconstruction, right-of-way acquisition, and/or additional citizen input separate from this plan. Many of these projects would not be viable as stand-alone Town projects. Rather, they would be implemented as part of other significant projects, such as adjacent redevelopment or major road reconstruction initiated by the North Carolina Department of Transportation. Unlike the Short Term Network, there is no timeline associated with this network and these recommendations should be implemented on an ongoing basis, as opportunities present themselves. The Long Term network map is located on page 73.

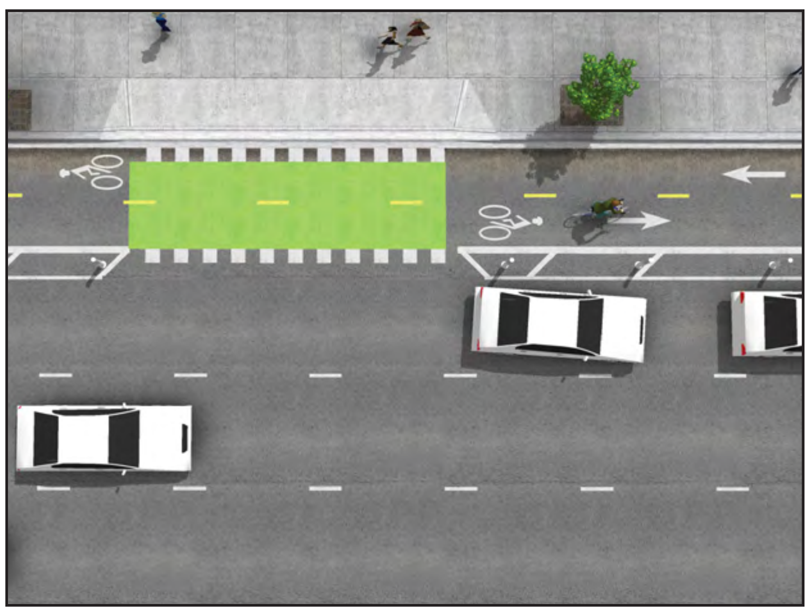
Cycle Track Alternative

The long-term network also includes a cycle track alternative for portions of Martin Luther King Boulevard, South Columbia Street, Cameron Avenue, South Road, McCauley Street, Pittsboro Street and Rosemary Street. These cycle tracks would complement the greenway system through the core of Chapel Hill and the University campus. Cycle tracks will provide the highest level of service to bicyclists through areas of Town that have the fewest greenway opportunities and the most intense traffic. The cycle tracks are intended to supersede the long-term network recommendations should an engineering feasibility study determine they meet construction feasibility, traffic operations, financial feasibility, and safety criteria. The Long Term Cycle Track Alternative Map is located on page 74

What is a Cycle Track?

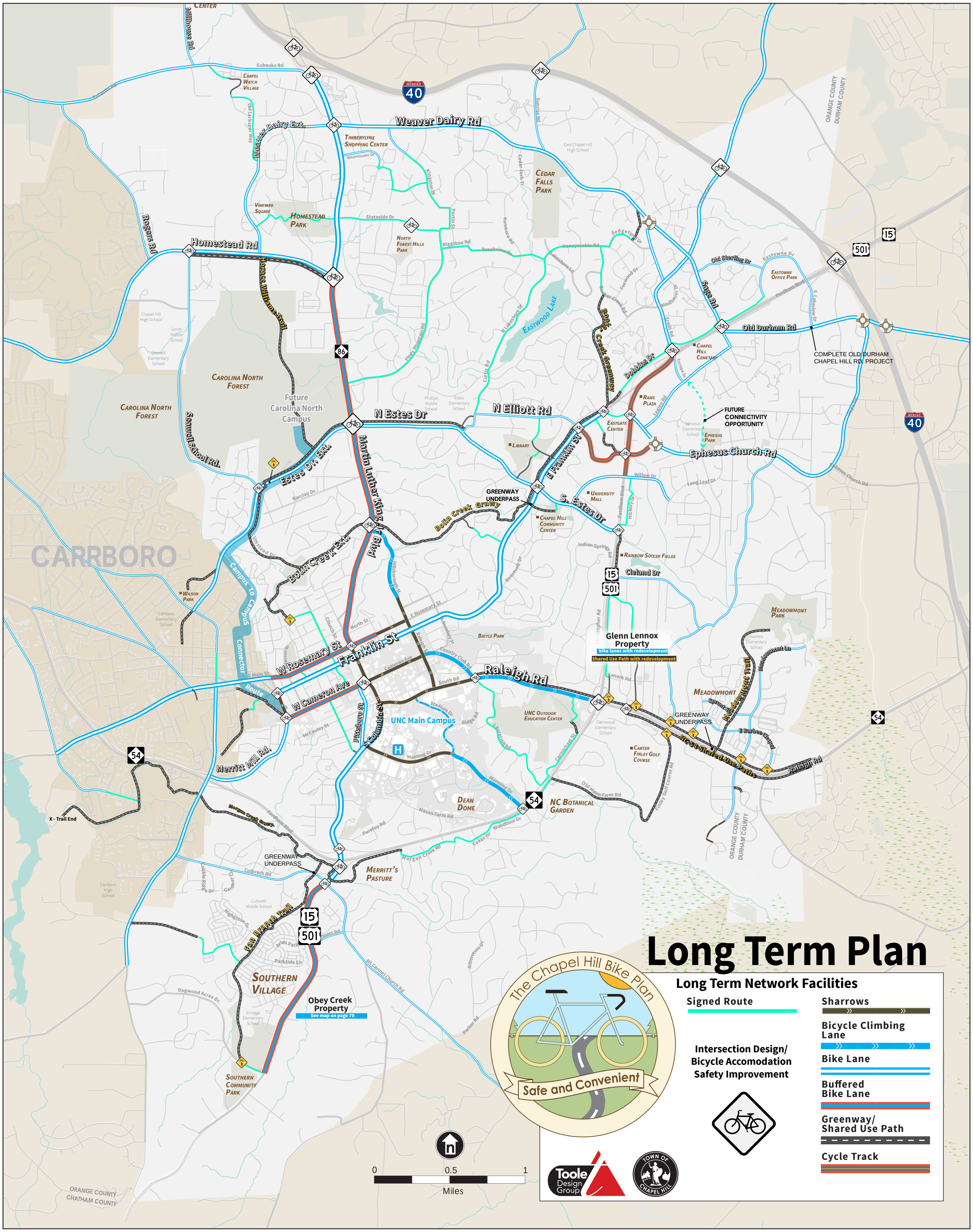
A cycle track is physically separated from both the roadway and the sidewalk intended for the exclusive use of bicyclists. It may be provided in one-way configurations on both sides of the roadway, or as a two-way facility on one side of a roadway.

ABOVE: This image shows a one-way cycle track



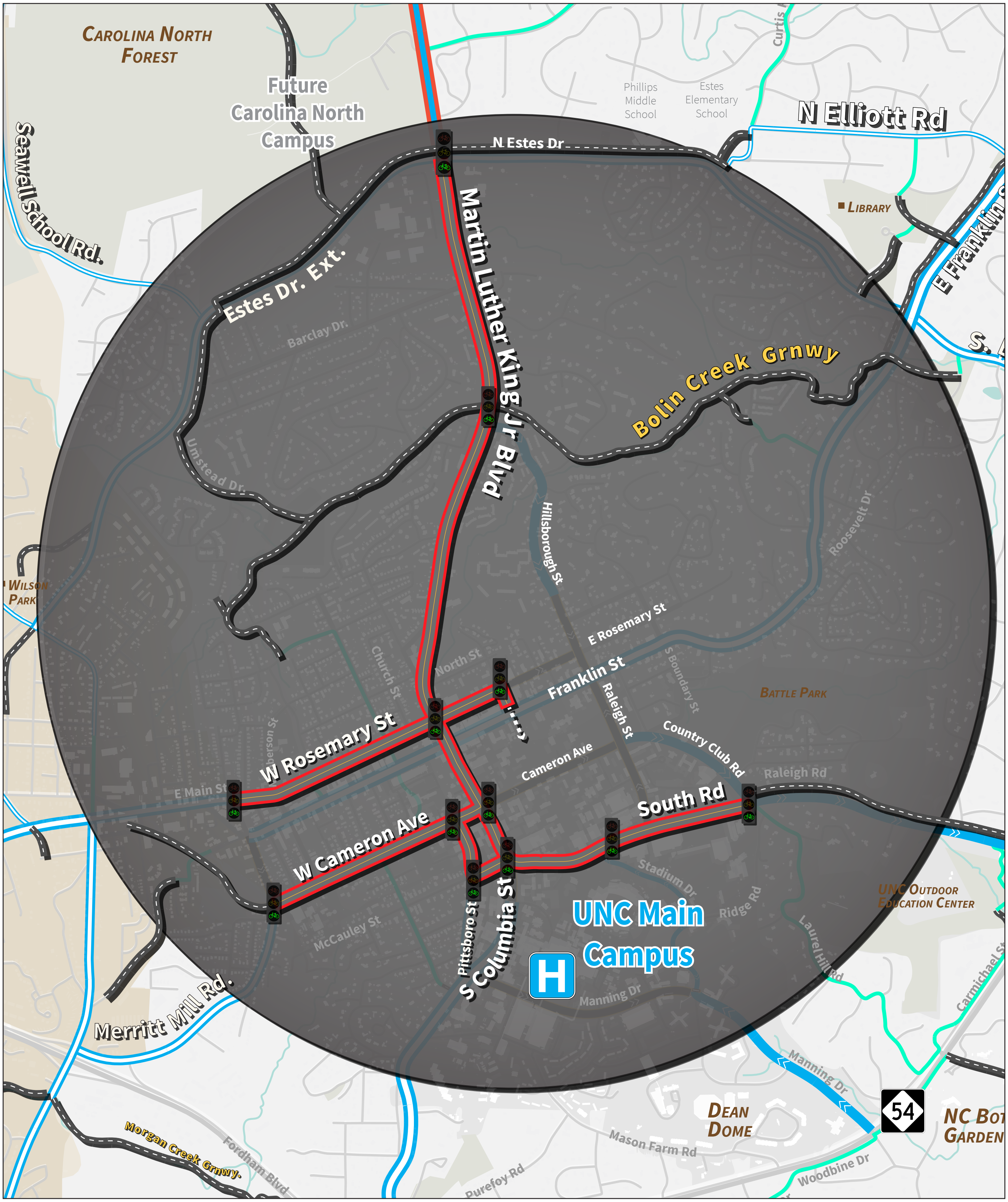
ABOVE: This rendering shows one possible configuration for a 2-way cycle track

SOURCE: NACTO URBAN BIKEWAY DESIGN GUIDE



Long Term Plan
Long Term Network Facilities
Signed Route
Sharrows
Bicycle Climbing Lane
Bike Lane
Buffered Bike Lane
Greenway/ Shared Use Path
Cycle Track
Intersection Design/ Bicycle Accomodation Safety Improvement
The Chapel Hill Bike Plan
Safe and Convenient
Toole Design Group
Miles
0
0.5
1
Weaver Dairy Rd
Weaver Dairy Ext.
Homestead Rd
Horace Williams Trail
Rogers Rd
N Estes Dr
N Elliott Rd
Martin Luther King Jr Blvd
Estes Dr. Ext.
Seawell School Rd.
Bolin Creek Ext.
Bolin Creek Grnwy
W Rosemary St
Franklin St
W Cameron Ave
Raleigh Rd
E Franklin St
S. Estes Dr
Ephesus Church Rd
Old Durham Rd
Sage Rd
Dobbins Dr
Booker Creek Greenway
Old Sterling Dr
Campus to Campus Connector Route
Merritt Mill Rd.
Fan Branch Trail
Meadowmont Trail
NC 54 Shared Use Paths
Cleland Dr
CARRBORO
Carolina North Forest
Future Carolina North Campus
Eastwood Lake
UNC Main Campus
Dean Dome
NC Botanical Garden
Southern Village
Glenn Lennox Property
bike lanes with redevelopment
Shared Use Path with redevelopment
Obey Creek Property
See map on page 70
GREENWAY UNDERPASS
FUTURE CONNECTIVITY OPPORTUNITY
COMPLETE OLD DURHAM CHAPEL HILL RD. PROJECT
X - Trail End
Cedar Falls Park
Homestead Park
Timberlyne Shopping Center
Meadowmont Park
Merritt's Pasture
Southern Community Park
ORANGE COUNTY
DURHAM COUNTY
CHATHAM COUNTY
40
15
501
54
86

Cycle Track Alternative



A Long-Term Vision for West Cameron Ave.

Purpose and need for improvements

This segment of Cameron Avenue is already the most highly traveled street by bicyclists in Town today. Users of the online interactive WikiMap noted West Cameron Avenue as a preferable cycling street, some said it was stressful to bike on and others said it was not.

Despite the presence of a bike lane on Cameron Ave., the two intersections at Pittsboro Street and at Merritt Mill Road were frequently cited as "dangerous intersections" on the WikiMap. Right-turning vehicles create conflicts for eastbound bicyclists at Pittsboro Street, where the eastbound bike lane ends. At the Merritt Mill intersection, there are no pavement markings present to guide bicyclists through the intersection to the Libba Cotten Bikeway. Field observations of this area revealed that there are many different ways cyclists ride through this intersection.

Existing conditions

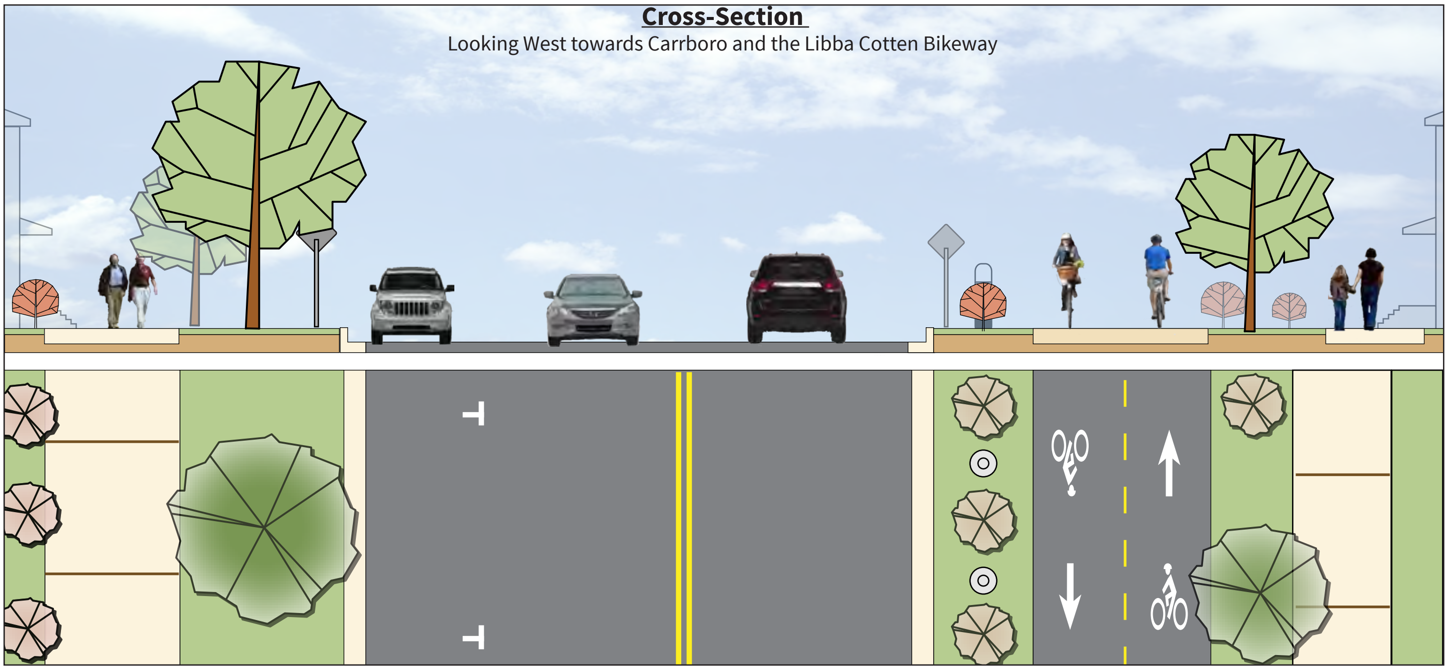
Currently, there are 5-foot bike lanes on both sides of the street from Pittsboro Street to Merritt Mill Road. There is a ten-foot wide on-street parking lane on the north side of the street. No bicycle facilities exist on the block from South Columbia Street to Pittsboro Street and pavement conditions in the south side bike lane are poor.

Long-term Option 1: Cycle Track

In the long term, Cameron Avenue could become part of a downtown cycle track network if this is preferred. By providing a fully separated, low-stress bike facility, a wider range of riders will be drawn to ride on Cameron Avenue. A properly designed cycle track will eliminate current intersection conflicts at Pittsboro Street. This design recommends a two-way cycle track on the north side of the street for the full length of the segment from South Columbia Street to Merritt Mill Road. See next page greater detail on the Cameron and Merritt Mill Intersection.

Cross-Section

Looking West towards Carrboro and the Libba Cotten Bikeway



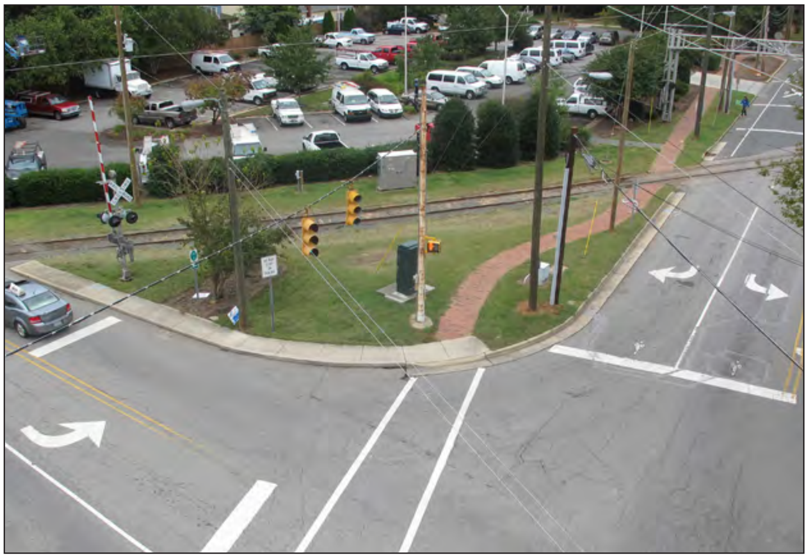
A Long-Term Vision for West Cameron Ave.

Implementation challenges

Reconstruction of the roadway edges between the curb and the right-of-way line will require:

- Utility pole relocations
- Street tree relocation
- Grading and possible retaining walls in the block from South Columbia Street to Pittsboro Street

This potential future design would also require that all of the on-street parking on the north side of the street be moved to the south side of the street.



ABOVE: The existing brick sidewalk at this intersection becomes the general area for a paved cycle track which would intersect more safely with the Libba Cotten Bikeway.

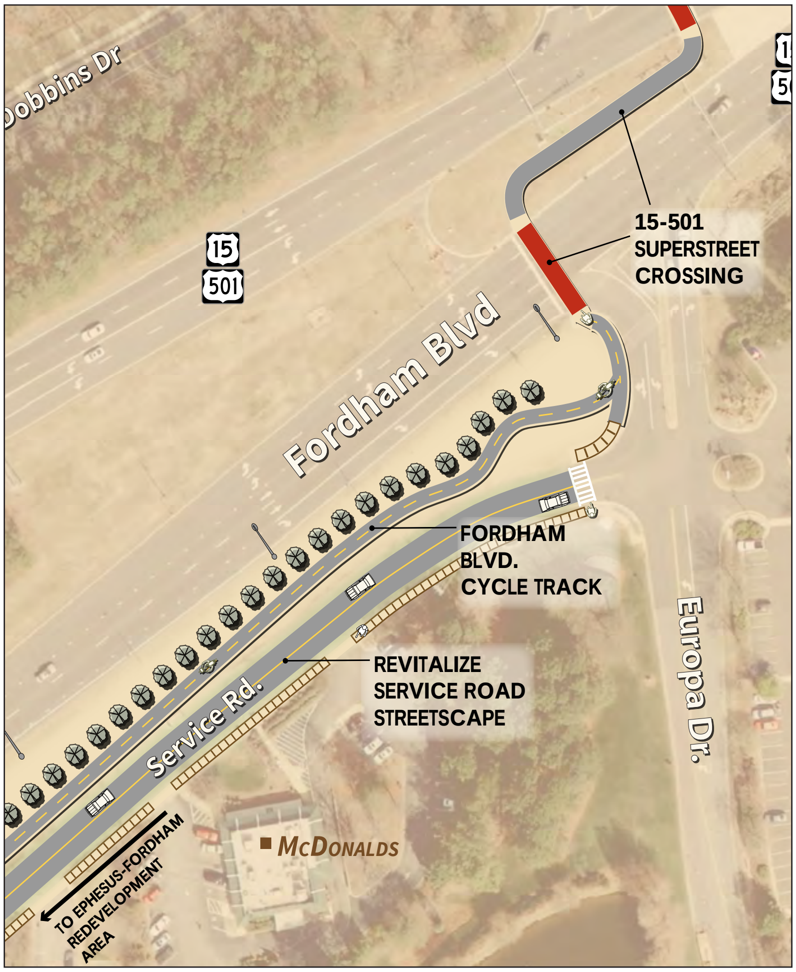
ABOVE: Potential long term reconfiguration of the intersection of Merritt Mill Road and West Cameron to connect Libba Cotten Greenway to West Cameron Ave. Cycle Track.

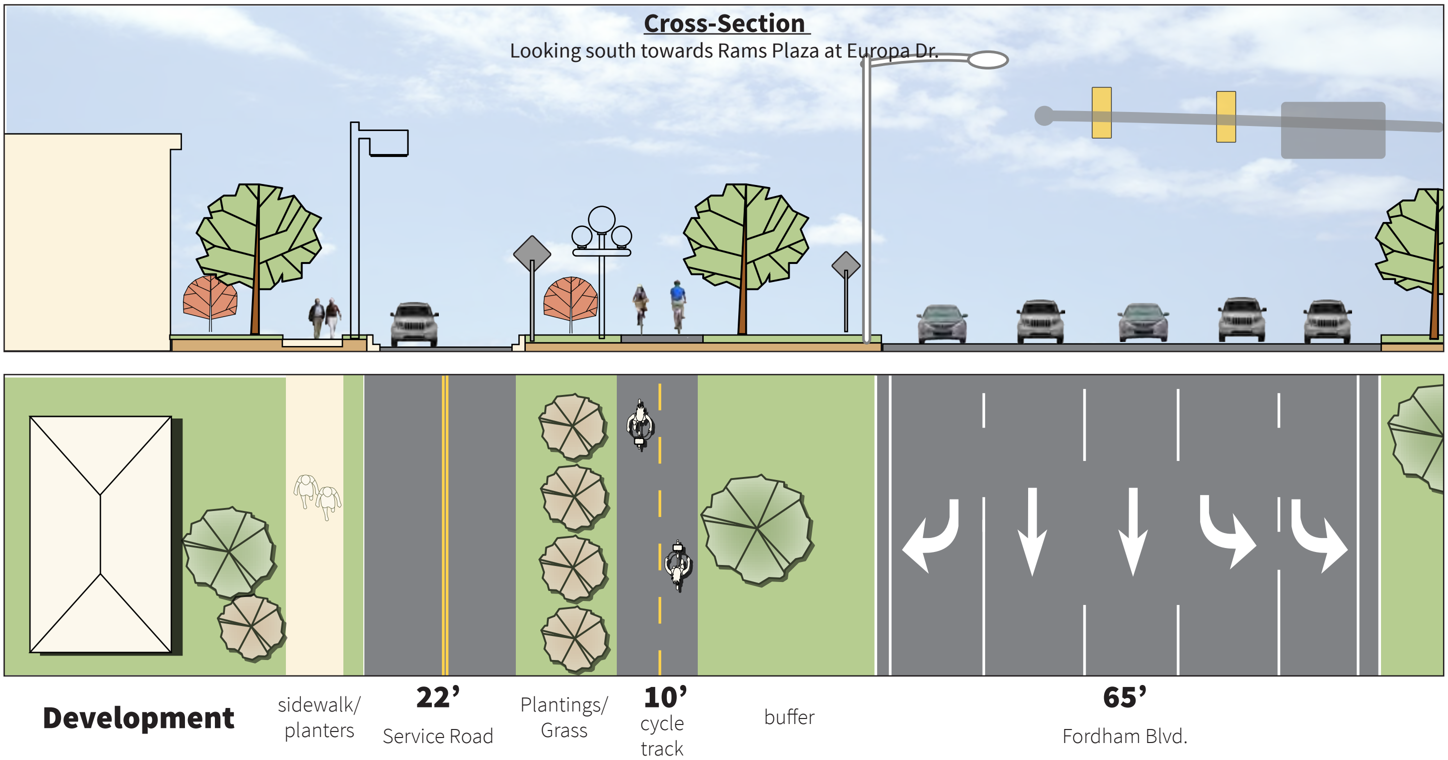
A Long-Term Vision for Fordham Blvd

Fordham Blvd Cycle Track

A Cycle Track would facilitate safe bicycle access along US15-501/Fordham Blvd. and connect people with a major residential and commercial node in Town. Sections of this proposed cycle track, would be built within the existing Fordham Blvd and Service Rd. right-of-way. The Cycle Track would extend along US 15-501, beginning at Elliot Rd and ending at Europa Drive. A facility like this would provide a high quality bike route between major residential and commercial districts, including the Ephesus Fordham Renewal Area.

If the Cycle Track were to be extended to the south (beyond Elliot Rd.), the Culvert underneath 15-501 at Elliot Rd. would likely have to be widened to provide the foundation for this facility. This additional segment would provide a addtional connectivity by linking the Glenn Lennox/NC 54 area to the Ephesus-Fordham district.





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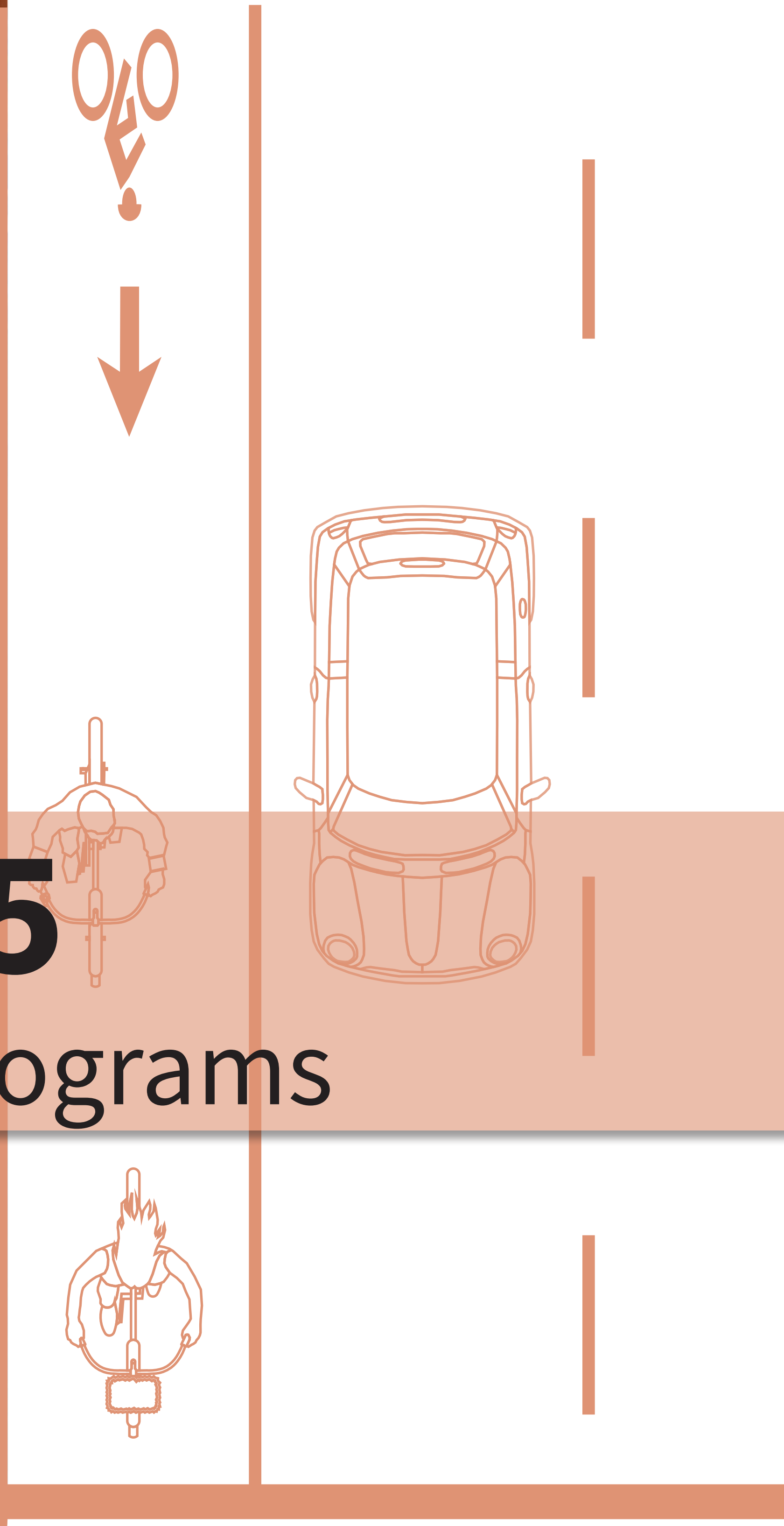

Chapter 5

Policies and Programs

POLICY RECOMMENDATIONS

These recommendations build on a number of existing policies already in place. For example, the Town's Complete Streets Policy below.

> *"The Town of Chapel Hill is committed to a Complete Streets policy that promotes healthy and active neighborhoods, which entails providing adequate access to pedestrians, bicyclists, transit riders, and motorists of differing abilities on roadways throughout the community."*

Revise Design Manual

Keeping the Town's design manual up-to-date with national bicycle facility design standards is needed to ensure new street designs are accommodating and safe for bicyclists.

Revise traffic code

Amending traffic code will put bicycle transportation on equal footing with driving as a mode choice.

Develop an online hazard reporting tool

An online tool, like the Bike Plan's WikiMap, can be used for all citizens to report roadway hazards such as debris and other obstructions in bike lanes and on greenways.

Include bike considerations in Focus Area Plans, Form-Based Codes and Land Use Management Ordinance Updates

Ensure that new and updated Town Land Use code(s) include provisions that create streets and developments favorable to bicycle travel.

Continue enforcement of traffic laws

The Town police department already conducts traffic enforcement actions to make the roads safer. Continuing these actions will increase the safety of all road users.

Ensure proper reporting of all bicycle related traffic accidents.

There are specialists in this area of law enforcement education who are provide this training

Consider alternative enforcement actions

The Town should consider an alternative system of enforcement for bicyclists who violate traffic laws. For example, some communities have instituted warnings in lieu of fines for first-time offenders. Instead of incurring a financial penalty, bicyclists are issued "citations" that provide educational information and discounts at local bicycle retailers.

ABOVE: Example citation given as part of "Alternative Enforcement" which reads as follows

"NOTICE TO BICYCLIST : You have a right to take a deep breath. You're not really in trouble. But, if you don't follow the rules of the road on the back of this ticket you might be (in trouble). So take a minute to review them, and then take this coupon to Landry's Bicycles to save on a new lock or helmet."

PROGRAM RECOMMENDATIONS

Educate public about bicycling and new bicycle facilities

As new facility types are added (buffered bike lane, etc), ensure that all roadway users understand how they should approach them. Use utility mailers to reach all Town residents. Partner with UNC to reach University community.

Partner with Carrboro for an annual "open streets" event.

By closing a street for a day, residents can see that the street is truly public space available for the use of everyone and celebrate that notion. The Carrboro event closed a small portion of East Main Street, and it would be a natural extension of this event to continue the closure along either Rosemary Street or West Franklin Street. These events have proven to be strong catalysts for bicycle and pedestrian improvements in cities and towns.

Create annual report on bicycle and vehicular crashes

Use local data to publish an annual analysis of crashed in Chapel Hill crashes. Benchmark to historical crash data from NCDOT to raise crash awareness.

Develop and Maintain a Town bicycling webpage

Create a clearinghouse for Chapel Hill bicycle resources to equip people with the information to make riding safe and convenient

Host a public bike ride series

Expand on the Spring Roll and winter community bike ride events to have a regular "cruiser rides' around Town.

Host more youth bike rodeos and events

Hold at least one rodeo per year at all CHCS K-8 schools. Hold rodeos at child-appropriate Town festivals. Events like this start kids off right and are fun for them, their parents and the community.

Update the Town's Bicycle Facilities/Greenways Map

As new facilities are built over time, a printed map suitable for community wide distribution should be made. Opportunities for funding partnerships with the business community should be explored for this effort.

Open Streets day in Carrboro 2013.

Kidical Mass ride in Chapel Hill, This youth bike event was staged by the ReCyclery, a local cycling non-profit

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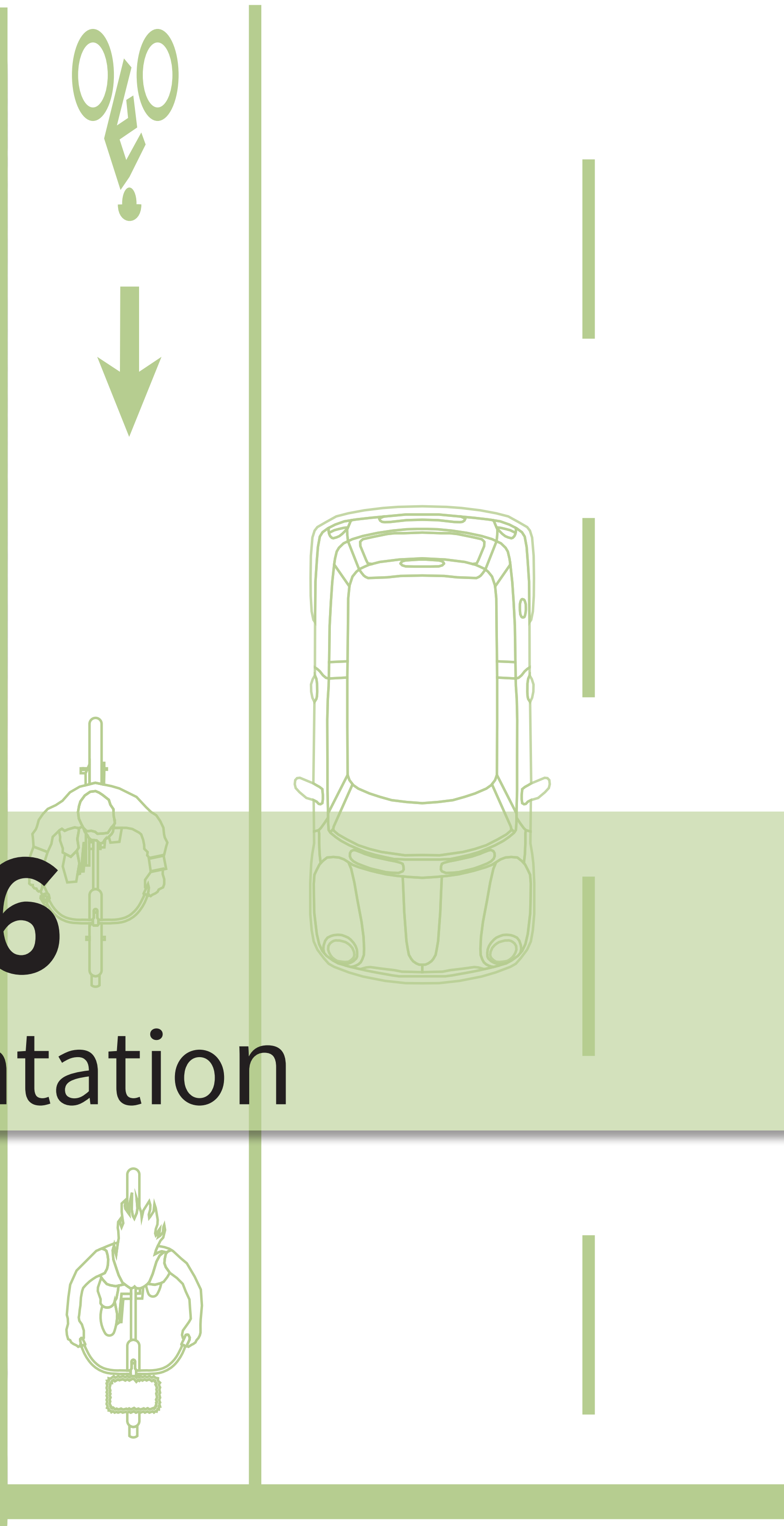


Chapter 6

Plan Implementation

Implementation Strategies

Organizational Strategies

Organizational strategies are actions the Town can take to ensure the plan is implemented in a coordinated and transparent manner with continued involvement from the community.

Establish Town Bike Ped Coordinator

The Town should designate a staff member(s) to be responsible for ensuring that bike plan implementation takes place in a coordinated and timely manner. See graphic on next page for more detail on the necessary roles and responsibilities of this effort.

Increase Inter-Departmental Coordination

The Town should utilize the Transportation Management Team, (a staff work group charged with developing and reviewing transportation polices and initiatives) , to oversee the implementation of this plan.

Support local advocacy groups and bicycle non-profit organizations

The vast majority of cities and towns that are great places for bicycling have strong bicycle advocacy groups. These groups routinely work with local governments to help get new bicycle infrastructure built. If Chapel Hill is going to be one of the best college towns in the country for bicycling, there will need to be strong involvement from citizens and groups like these to help it get there. By supporting and communicating with these groups, the Town can be sure that projects and local policies are consistent with the needs of end users and community values.

Use Transportation and Connectivity Advisory Board to help implement the plan.

This will help ensure that projects and policies are consistent with the needs of end users and community values .

Conduct annual bicycle counts

Tracking data on the changing number of bicyclists is vital for research, evaluation, and planning purposes. This dataset will be help the Town understand where, how, and why bicycle ridership has changed over time.

Publish a "Status Report on Bike Infrastructure and Roadway Safety"

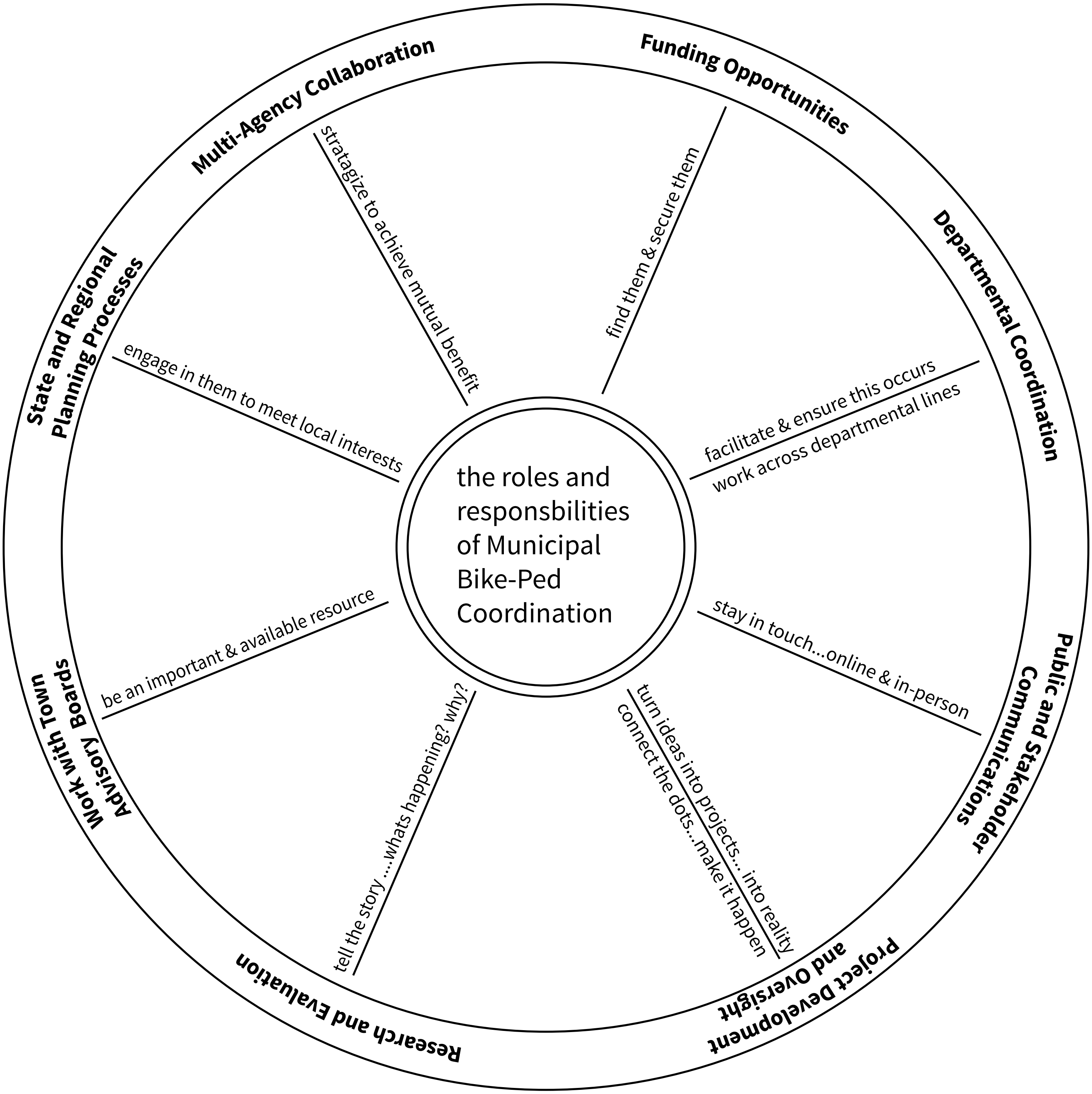
An annual status report that outlines the Town's goals and progress related bicycle facility construction progress made in the prior year will be critical to making this plan a living document. This report should also include the performance measures detailed starting on page 82

Host staff group bicycle rides

The plan implementation team should understand what it is like to ride a bike in Chapel Hill. A staff group ride can ensure this. By coordinating at least two bicycle rides or team field visits per year for members of the implementation team, they will gain a "shared" understanding of what it is like to ride a bike in Chapel Hill. This shared understanding will add perspective and inform decision making.

Establish Town Bike Ped Coordinator

The Town should designate a staff member(s) to be responsible for ensuring that bike plan implementation takes place in a coordinated and timely manner.



What does multi-agency collaboration look like?
The Franklin Street Bike Corral

When the Bike Plan was getting underway in the summer of 2013, a unique idea emerged from the downtown community related to improving bicycle infrastructure. This idea started conversations between multiple stakeholders and government agencies including the Downtown Partnership, the Town of Chapel Hill and the North Carolina Department of Transportation (NCDOT). This idea eventually turned into the first bicycle facility of its kind ever installed on a street owned by the NCDOT. This facility was the Franklin Street Bike Corral. *(Bike Corrals are multi-bike parking facilities that are installed in an on-street parking space.)*

In May of 2013, the planning team became aware of a shortage of bicycle parking in the West Franklin Business District. Bicycles locked to trash cans and other streetscape elements were frequently sighted. When bikes are locked to trash cans, the bikes can fall over on the sidewalk or impede access to the trash can, and this can be a pedestrian hazard or encourage littering. Throughout the country, Bike Corrals have been the solution to a common problem of many downtowns. That problem is a shortage of bike parking and shortage of space on which to install bike racks. Bike Corrals, like most good infrastructure, utilize space efficiently. Specifically, a well-designed Bike Corral can provide 12 bicycle parking spots in the same amount of space required to provide 1 motor vehicle parking spot. Since they provide an ample amount of bike parking, they also provide those who travel by bike with the assurance they will have a safe and secure place to lock their bike when patronizing downtown business establishments.

To make the Franklin Street Bike Corral happen, Town staff worked across departmental lines and engaged the NCDOT in a dialogue to develop a design that the NCDOT would approve. Since the NCDOT owns Franklin Street, any design modifications to it (such as bike corrals or bike lanes) must be approved by them. After Town Planning and Engineering Staff developed a design that gained approval, the Town's Public Works Department installed the Bike Corral in September of 2013. This project, while small in some ways, was also big because it is a great example of the type of working arrangements that will be vital to implementing this bike plan.

Implementation Strategies

Funding and Resource Strategies

Strategies like this are necessary to finance and build the infrastructure recommended by this plan.

Fund bicycle infrastructure projects via the Capital Improvement Program

A capital improvements program is a plan for major projects and purchases including; bicycle facilities, greenways, and sidewalks. The Town's Capital Improvement Program has typically included a list of capital projects with cost estimates, a potential schedule and priorities for 15 years. The facility recommendations of the Bike Plan were designed to be integrated into the Town's capital planning processes.

Incorporate bicycle projects into regular street maintenance

Bicycle infrastructure can be built during annual street restriping and resurfacing projects. These types of implementation actions utilize resources efficiently by leveraging dedicated funds already being used for street maintenance to build new bicycle facilities when feasible.

Include bicycle infrastructure in Downtown Improvements

Property and business owners may share in the cost of improvements located in the downtown area. Business Improvement Districts (BIDs) are responsible for bicycle infrastructure in many cities.

Study feasibility of payment-in-lieu ordinance for biking facilities

Pursue State and Federal Funding sources for plan projects

State and federal funding is important to the implementation of this Plan because state and federal agencies can finance large infrastructure projects that the Town could not afford otherwise. Major funding is available through the North Carolina Department of Transportation and the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization.

In order to use state and federal funding sources, the Town must maintain a stable supply of "matching funds" to be used as the required local contribution. State and Federal Funding sources normally require 20% of the project's total costs. For example, in order to use a federal funding allocation of 2 Million dollars for a specific project, the Town would likely have to contribute $400,000 dollars towards the projects total cost.

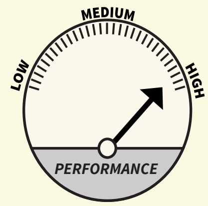
Include *bicycle infrastructure* as a specific category in the next local bond referendum

The adoption of this Bike Plan can lay a foundation for the inclusion of bicycle infrastructure in a major bond referendum in 2015. In 2003, a local bond referendum was passed that dedicated 5.3 million dollars to bicycle-pedestrian-and greenway infrastructure projects.

This plan estimates that at least 10 million dollars of local funds would need to be secured to implement the short term bicycle facilities network.

Performance Measures

Performance measures are used to track progress toward implementing the Plan and reaching the vision and goals. The most useful performance measures are quantitative ones that can be tracked over time. The performance measures for this plan are included in the following pages. These can be reported when the Bike Plan Status Reports are completed.

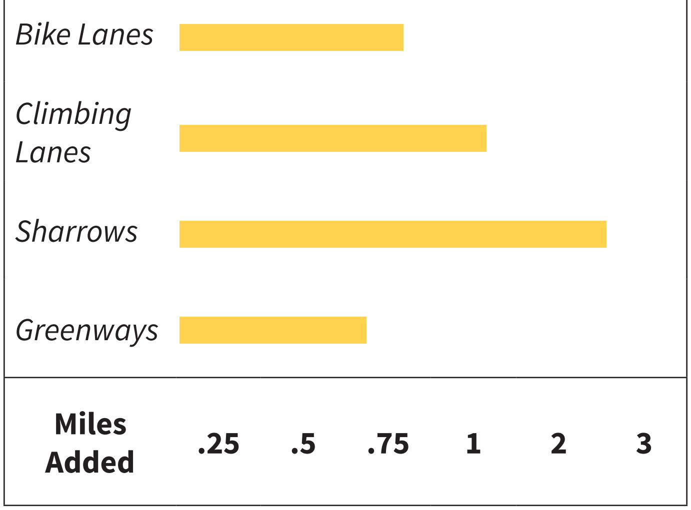


Category : Infrastructure Construction & Maintenance

This plan identifies many different infrastructure improvement projects and maintenance activities. When specific improvements or maintenance activities are completed, they should be tracked in a list and reported upon annually.

The mileage and other characteristics of the bicycle infrastructure the Town builds should also be included in the Bike Plan Status Reports. Examples of how to report these measures are included on this page.

Annual Bicycle Facility Construction Overview



PROJECT STATUS REPORT

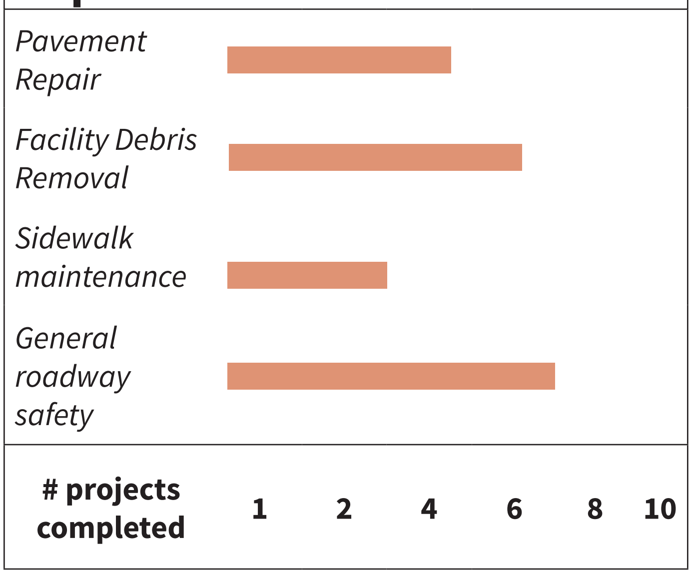
Project : Estes Dr. Connectivity

Unfunded		Funded
		X
Designed	Under Construction	Completed
X		

Notes

Project Construction expected to start in FY 2015-2016

Annual Maintenance and Improvement Overview



Category : Infrastructure Condition

The quality and condition of the Town's existing bicycle facilities should be kept in a GIS dataset and reported upon in the Bike Plan Status Report. In addition to a text description of the facility, current imagery that helps communicate any problems or special circumstances of the facility should also be included in these condition reports. Examples of how report infrastructure conditions are included on this page.

FACILITY CONDITION REPORT

S. 15-501 Bike Lanes

4'-6' Bicycle Lanes that extend from Market Street to the north side of the James Taylor Bridge.

Condition Assessment

The pavement markings for the bike lanes have deteriorated and their visibility during low light conditions is limited.

Recommendation

Work with NCDOT to restripe and remark these lanes based on the recommendations of the bike plan.

Image

Deteriorated bike lane markings on 15-501 S.

Category : Bicycle Usage

Bicycle usage over time can be tracked two ways.

1) Bicycle Traffic Counts at different locations in Town (including streets, greenways, and sidewalks)

2) Through survey data which ask respondents whether or not they ride a bike. The ones applicable to the Town currently are the U.S Census American Community Survey, the UNC Chapel Hill Commuter Survey, and the Town of Chapel Hill Community Survey.

To communicate increases/decreases in bicycle ridership over time, the Bike Plan Status Report should include sections that detail the most recent results of the traffic counts and surveys mentioned above, and compare those results with the results of previous years. Illustrative examples are provided below.

Bicycle Traffic Count Location	2012 Count	2015 Count	% Chg.
Cameron Ave/Pittsboro St	853	1,105	30%
McCauley St/Ransom St	521	635	22%
Manning Dr @ Ridge Rd	447	605	35%
Franklin St/Columbia St	446	500	13%
South Rd @ Bell Tower	331	340	3%
Rosemary St/Church St.	288	506	75%

Bicycle Commuting Rates
2010 and 2012 American Community Survey

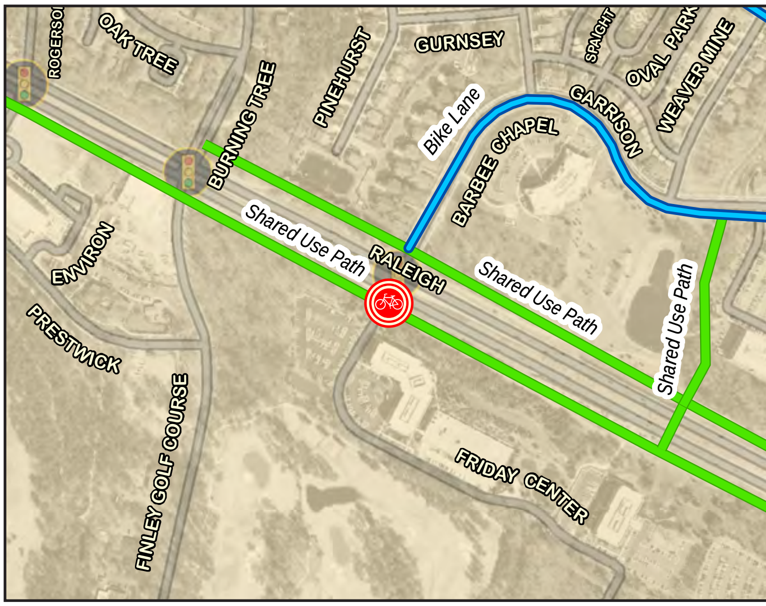
Subject	2010	2012	% Chg.
Bicycle Commuting Rate	2.3%	2.0%	-.3%
Male Bicycle Commuting Rate	2.8%	3.3%	+.5%
Female Bicycle Commuting Rate	1.9%	.7%	-1.2%

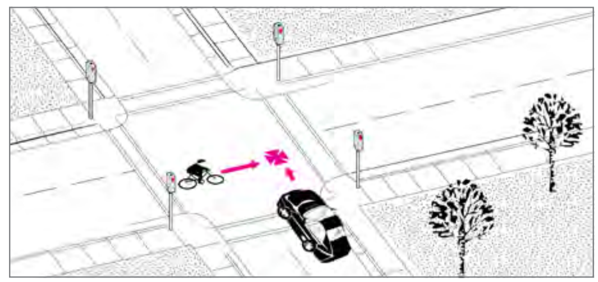
Category : Safety

Two of the Bike Plan's policy and program recommendations can help the Town report performance measures related to safety. The plan recommends that an Online Hazard Reporting Tool be developed where users can visit a website and click on map and report a possible safety hazard such as a downed tree limb on a greenway or debris in a bike lane. If this Hazard Reporting Tool is developed and utilized by the public, then the Town could report on the number of hazards that were addressed.

The plan also recommends that a report on vehicular and bicycle crashes be developed. This crash report could be incorporated in the Bike Plan Status Report. A crash report should include a map of all of the notable vehicle/bicycle crashes in the timeframe being analyzed. This report should also provide details based on the standard data attributes of NCDOT bicycle and vehicular crash data. The map should indicate areas in town where crashes occur most frequently.

An example of a bicycle crash map and report is included on this page. See Appendix B for more bicycle crash maps.





Crash Type
Motorist Drive Out - Signalized Intersection

Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

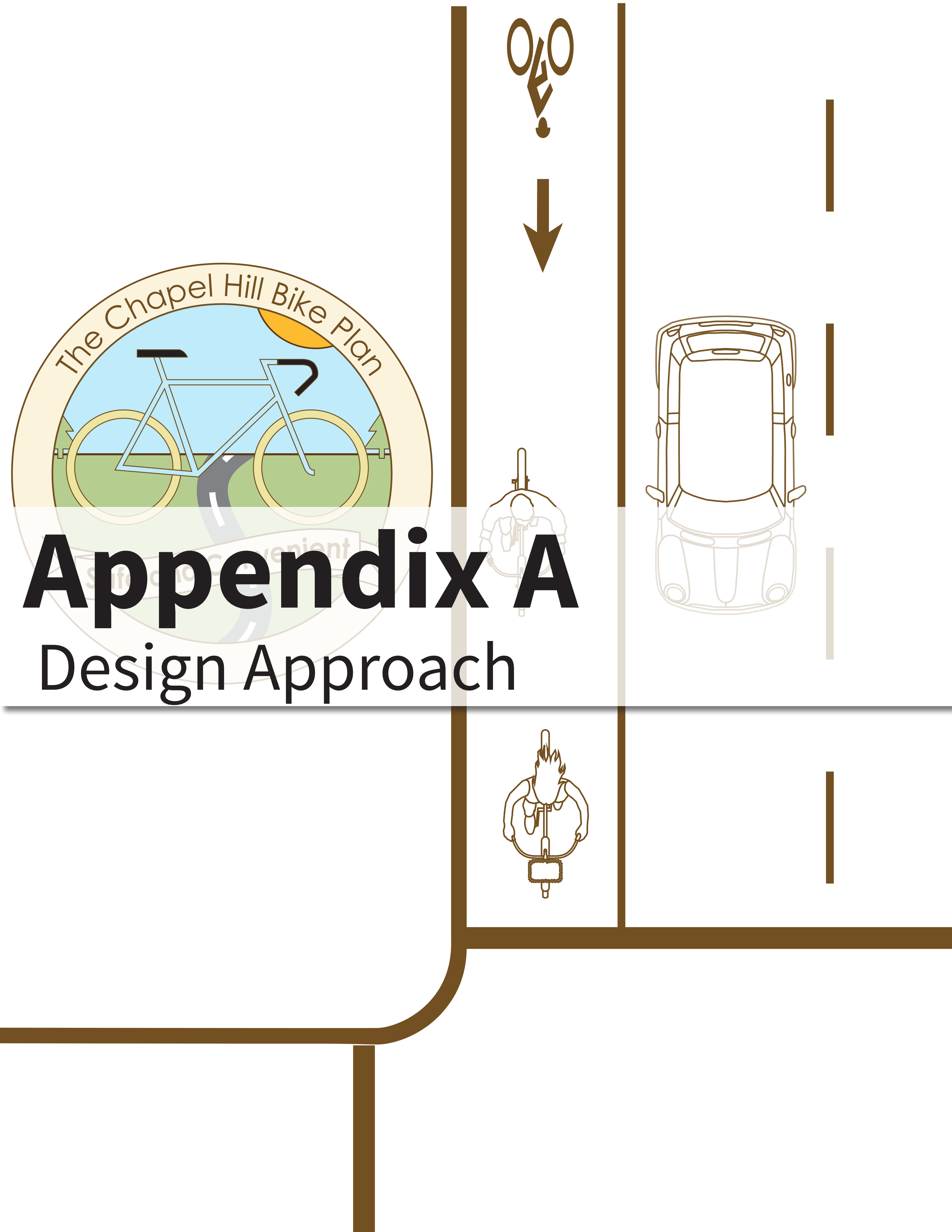
Date
30APR2010

Light Condition
Daylight

Category : Policy and Program Efforts

Like the construciton progress reports, thee policy and program recommendations should also be kept in a list and reported upon as progress is made. An example report is included below.

Bike Plan Policy Recommendation	Revise Traffic Code
Status Update	**COMPLETE**
Staff began revising the Town's traffic code in the summer of 2014 based on national best practices and guidance from the League of American Bicyclists. In the fall of 2014, the Transportation and Connectivity Board reviewed the proposed changes and in spring of 2015, the Town Council amended the Town's traffic code.	



Appendix A

Design Approach

Appendix A

Chapel Hill Bicycle Facility Design Approach

This appendix provides an overview of the guidelines and standards applicable to designing bicycle facilities in the Town of Chapel Hill. Following these standards and guidelines will enable Town Staff to be sure that their decisions are consistent with the best practices for safely accommodating bicycles.

B.1 NATIONAL GUIDELINES AND STANDARDS

The AASHTO Guide for the Development of Bicycle Facilities provides design and construction guidelines, and operation and maintenance recommendations for bicycle facilities. The 1999 Guide has been revised, and the new edition is undergoing final balloting by the AASHTO subcommittee on design, and has an expected release in summer 2012. The MUTCD 2009 edition provides standards for signs, signals, and pavement markings in the United States. These latest guidelines and standards provide clarity and additional guidance for on-street bicycle facilities, addressing many of the issues and questions on which the previous guidance was silent. Supplemental information on standard and experimental treatments can also be found in the National Association of Town Transportation Officials (NACTO) Urban Bikeway Design Guide. Following these standards and guidelines will allow local agencies to move forward with confidence that what they are doing is consistent with the latest thinking on safely accommodating bicycles. Furthermore, it is important for all departments and agencies involved in implementing this Plan to follow the latest standards and guidelines to ensure that facilities throughout the network are designed in a uniform manner.

Guide to the Development of Bicycle Facilities. AASHTO

AASHTO is a not-for-profit, nonpartisan association representing state highway and transportation departments. It publishes a variety of planning and design guides, including the 1999 AASHTO Guide for the Development of Bicycle Facilities, and the recent update to that guide, which is expected to be published in summer 2012. This guide provides planning and design guidance for on- and off-street bicycle facilities. It is not intended to set absolute standards, but rather to present sound guidelines that will be valuable in attaining good design sensitive to the needs of both bicyclists and other roadway users. The provisions in the Guide are consistent with and similar to normal roadway engineering practices. Signs, signals, and pavement markings for bicycle facilities should be used in conjunction with the MUTCD.

Key provisions in the AASHTO Bike Guide include:

- Bicycle planning, including types of planning processes, technical analysis tools, and integrating bicycle facilities with transit
- Bicycle operation and safety, including traffic principles for bicyclists and causes of bicycle crashes
- Design of on-road facilities
- Design of shared-use paths
- Bicycle parking facilities
- Maintenance and operations

Manual on Uniform Traffic Control Devices (MUTCD), 2009

The 2009 MUTCD is a document issued by the Federal Highway Administration (FHWA) of the U.S. Department of Transportation (USDOT) to specify the standards by which traffic signs, road surface markings, and signals are designed, installed, and used. These specifications include the shapes, colors, fonts, sizes, etc., used in road markings and signs. In the United States, all traffic control devices must generally conform to these standards. The manual is used by state and local agencies and private design and construction firms to ensure that the traffic control devices they use conform to the national standard. While some state agencies have developed their own sets of standards, including their own MUTCDs, they must substantially conform to the federal MUTCD, and must be approved by the FHWA. CDOT uses the national MUTCD in accordance with the Colorado Supplement to the Federal Manual on Uniform Traffic Control Devices 2009, Adopted December 15, 2011. The National Committee on Uniform Traffic Control Devices (NCUTCD) advises the FHWA on additions, revisions, and changes to the MUTCD.

Key provisions of the 2009 MUTCD related to bicycling include:

- Bicycle-related regulatory and warning signs
- Bicycle destination guide and route signs
- Pavement markings such as bike lane symbols and striping
- Trail signs

Significant changes in 2009 edition (from the 2003 Edition) include:

- New shared-lane pavement markings
- Bicycle lane regulatory signs no longer required
- Type 3 object markers for shared-use paths
- New bicycle destination guide and route signs
- New mode-specific guide signs for shared-use paths

The bicycle technical committee of the NCUTCD is currently developing and evaluating research and proposals for the following items:

- Bicycle signals Applications of the Rectangular Rapid Flashing Beacon to Trail Crossings
- Combined right turn lane/bike lanes
- Barrier separated lanes/cycle tracks

Additional information can be found here: http://www.ncutcdbtc.org/

National Association of City Transportation Officials (NACTO) Urban Street Design Guide and Urban Bikeway Guide

The National Association of City Transportation Officials (NACTO) has developed Urban Street and Bikeway design guidelines which are tailored to the unique constraints and needs of urban areas. The guidelines are compendium of state-of-the practice techniques designed to result in high quality, multi-modal communities. The guidelines are based on current research and applied experiential practice of urban design professionals from around North America. The guidelines are freely available and regularly updated through their respective websites:

Urban Street Design Guide: http://nacto.org/usdg/

Urban Bikeway Design Guide: http://nacto.org/cities-for-cycling/design-guide/

B.2 STATE GUIDELINES AND STANDARDS

NCDOT

Bicycle & Pedestrian Project Development & Design Guidance: https://connect.ncdot.gov/projects/BikePed/Pages/Guidance.aspx

Supplement to the MUTCD: https://connect.ncdot.gov/resources/safety/TrafficSafetyResources/2009%20NC%20Supplement%20to%20MUTCD.pdf

Complete Streets Policies and Guidelines: http://www.completestreetsnc.org/

B.3 LOCAL GUIDELINES AND STANDARDS

Town of Chapel Hill

Bicycle Parking Guidelines
The Town of Chapel Hill has adopted the APBP Bicycle Parking Guidelines as a standard reference for the planning, location, and design of bicycle parking.
http://www.townofchapelhill.org/Modules/ShowDocument.aspx?documentid=3361

Bicycle Facility Guidelines
The Town of Chapel Hill Bicycle Facility Guidelines were developed by Town staff and contain specifications and designs for on-street bike routes, on-street bike lanes, bicycle-related signs, and intersections of shared use paths with public and private streets. They are integrated into the Town Design Manual (2005) and standard details.

These Guidelines are fairly comprehensive, however, in some cases, they require updating. This Appendix focuses on the newest standards, guidelines, and best practices in bicycle facility design, which should be used to update the Town's existing Guidelines.

B.4 IMPLEMENTATION STRATEGIES

Design Strategy to Provide High Quality Facilities for Vulnerable Roadway Users

To effectively design for the bicyclist, it is important to understand key differences between traveling in a vehicle versus on the bicycle. While the operation of a bicycle is consistent with a vehicle, the operating characteristics and user experience are dramatically different. The motorist operates within a protected, crashworthy shell which is insulated and protected from the outdoor environment. The motor vehicle is capable of rapid acceleration and can maintain constant rates of speed, with suspension systems capable of moving the vehicle over surface irregularities relatively smoothly. The bicycle and the bicyclists function and experience traveling in relatively the opposite manner. In mixed traffic, the bicyclist is particularly sensitive to traffic noise and pollution (generated by the motorized vehicles), speed and acceleration differentials, and poor surface conditions which can create crash hazards and result in increased exposure to injury or death in the event of a crash. Compared to other roadway users, bicyclists (and pedestrians) are the most vulnerable users in the transportation system. Bicyclists also enjoy a number of significant advantages over the motorists in that they operate with greater freedom of movement, are less likely to be distracted while operating the bicycle and are more aware of their surroundings by being in the open environment.

Preference surveys and research studies have found widespread support and interest for bicycling with strong preferences given to the provision of high quality bikeways which provide the following elements:

- Separation from high volumes of fast-moving automobiles,
- Maneuverability within the bikeway to operate safely, and
- Space for cyclists to ride together in a social manner, side-by-side.

These qualities are routinely provided on trails, and are increasingly provided on streets through the provision of bicycle lanes, cycle tracks or the implementation of bicycle boulevards. The quality of provided bicycle facilities has a direct impact on the experience of the bicyclists and will therefore have a tremendous influence on the ability of the facility to sustain use, or to attract increased use. Well-maintained and high quality facilities have been demonstrated to attract higher levels of use than poorly maintained or low quality facilities. Likewise, interconnected systems with minimal gaps or interruptions are essential to a functioning bicycle system that supports and attracts high use as evidenced in cities such as Boulder, Charlottesville, Charlotte, Portland, Seattle, and Washington, DC.

Quality of Service Strategy

Research shows that bicyclists consider a wide variety of factors when assessing their quality of service, which focus on their comfort using a facility. For this reason, the 2010 release of the Highway Capacity Manual (HCM) include "Traveler Perception" methods in addition to the traditional performance measures (e.g. average delay, travel speed) to determine Level of Service for users. The 2010 HCM includes a methodology for bicycle level of service 1, which also considers basic descriptors of the urban street character to determine the overall quality of bicyclist experiences on the roadway. Factors that affect bicycle level of service include space provided (i.e. width of bicycle lane), separation or buffer from adjacent traffic, speed and volume of adjacent traffic and traffic composition (cars/trucks on roadways). While a motor vehicle level of service of "D" indicates the roadway is operating at an acceptable level (capacity relative to delay); a bicycle level of service of "D" indicates a bicyclist is experiencing poor comfort on the facility. As previously discussed, the motorist is relatively comfortable and secure in their vehicle as they are isolated from noise, weather, and are minimally physically engaged in the effort of driving. Their direct experiences with the bicyclists are typically limited to a perception of increased delay if they find themselves operating behind a bicyclist. This is the opposite for the bicyclist who is very sensitive to motor vehicle speed, volume, composition (trucks, buses, cars) and space due to their inherent exposure and vulnerability. This is a critical distinction which explains why the two levels of service are not directly comparable and why bicycle level of service is very sensitive to motorized traffic characteristics and separation/space.

The concept of level of service for bicyclists is relatively new compared to that of vehicle level of service concepts. As such, it is important to note that there are limitations to the existing models which the designer should become familiar. It is anticipated that extensive research will be forthcoming to improve the reliability of the measurements now that the concept has been validated and incorporated into the Highway Capacity Manual and AASHTO Guidelines.

An example of Bicycle Level of Service is provided in the table on page 49 comparing theoretical retrofit cross sections for a typical 5 lane arterial street (with a continuous center turn lane). This example illustrates the value of a combination of narrower vehicle lanes and wider bicycle lanes in creating a more comfortable bicycling environment; however the ability to provide a high quality level of comfort is limited by the higher traffic speeds and volumes in the adjacent lanes.

A similar quality of service exists 3 for trails where bicyclists with varying levels of skill are frequently operating in mixed use with pedestrians, joggers, rollerbladers, and dog walkers. Speed differentials and group behavior dynamics (pedestrians and bicyclists) affect the available operating space of the bicyclist potentially limiting their ability to move at normal desired operating speeds.

There are also numerous safety and comfort benefits which can be provided to bicyclists by providing wider bicycle lanes. Wider bicycle lanes create space for bicyclists to pass other bicyclists with more comfort, create additional buffer space to parked vehicles (and opening doors), create additional maneuvering space to avoid surface defects or hazards, and allow bicyclists to operate side by side if desired to engage in conversation. The graphic below illustrates the comparative operating differences.

[1] Bicycle Level of Service is an evaluation of bicyclist perceived safety and comfort with respect to motor vehicle traffic while traveling in a roadway corridor. It has been incorporated into the 2010 Highway Capacity Manual. The research is more highly developed for midblock segments than for intersection nodes.

Lane Width/Roadway Retrofitting Strategy for Street Segments

Travel lane widths were observed to vary from 10 feet to 15 feet throughout the Town on all classifications of roadways. For bicycle lanes or separated bikeways to be retrofitted onto some Chapel Hill streets, existing travel lanes will have to be narrowed or the roadway will have to be widened. It is recommended the Town consider providing wider bicycle lanes and narrower vehicle lanes in its cross sections that are only providing the AASHTO minimum, i.e. 5-feet, and when retrofitting existing roadways to create a more comfortable and safe experience for bicyclists. For example, on Cameron Avenue, the existing bicycle lanes are 5 feet in width while the adjacent travel lanes are 13 feet in width.

Example: Existing 6-Lane Arterial Street Retrofit with No Parking [2]

Outside Travel Lane Width	Shoulder/Bicycle Lane Width to Left of Gutter Seam	Resulting Bicycle Level of Service (LOS Score)
15	0	D (3.52)
14	1	D (3.52)
13	2	D (3.52)
12	3	D (3.02)
11	4	C (2.84)
10	5	C (2.44)

Example with Minor Road Widening

Outside Travel Lane Width	Shoulder/Bicycle Lane Width to Left of Gutter Seam	Resulting Bicycle Level of Service (LOS Score)
10	6	B(2.44)
11	6	B(2.22)

Travel lane narrowing is recommended as the primary retrofit method to implement the planned network, with road widening (or median narrowing) reserved only for truly constrained situations where lane narrowing is not advisable or feasible. Nationally, narrowing lanes to add capacity to roadways is a relatively common practice for local and state transportation agencies. Lane narrowing to add vehicle capacity is widely accepted as a cost effective congestion mitigation strategy, but historically narrowing lanes to add bicycle facilities has not been as accepted. From a traffic safety standpoint, congestion creates a justification for adjusting lane widths to improve safety (by reducing crashes caused by congestion), which a majority of transportation officials feel comfortable pursuing as a mitigation strategy. However, when it comes to narrowing lanes to add bicycle lanes, agencies are typically concerned that narrowing lanes will reduce safety for motorists, reduce capacity, or in some instances it is believed there is no demand for the bicycle facility to justify adjusting lane widths.

Providing additional width for the motorist has not proven to provide any safety benefit on low speed urban roadways4, whereas extra space provided to the parked vehicle and the bike lane reduces the potential for a hazardous crash between a bicyclist and an opening vehicle door and creates enough space where a bicyclist could pass another bicyclist without having to encroach into the adjacent travel lane. The resulting bicycle lane is more comfortable and is more likely to attract use.

The use of narrower travel lanes as a strategy for improving capacity and safety on urban arterials where posted speeds are 35 mph or lower are consistent with the 2011 AASHTO Green Book which states "lane width of 10 feet may be used in more constrained areas where truck and bus volumes are relatively low and speeds are less than 35 mph 5 ". This is backed up by recent research 6 focused on the safety of travel lane widths varying between 10 and 12 feet for motorists operating on arterial roadways with posted speeds of 45 mph or less. This research found lane width had no impact on safety or capacity under the majority of urban conditions. The study resulted in a virtual elimination of the capacity reduction formula in the 2010 Highway Capacity Manual related to lane widths as it found little difference between 10, 11 and 12 foot lanes.

The AASHTO Green Book is vague with regard to defining what percentage of truck and bus volume is "low" however there is guidance in research and pavement design guidelines that suggest 10% as a decision point 7. It should also be noted that wider lane widths may encourage motorist speeding. Adding bike lanes to these streets where there is sufficient right-of-way can reduce speeding and increase safety in residential neighborhoods and near schools 8.

[2] The following assumptions apply to the roadway operating characteristics: 4 travel lanes, 21,000 ADT, 35 mph, no parking, no gutter pan, good pavement (score 4.0 out of 5.0), 50% directional split of traffic with 3% heavy vehicles.

[3] Chapter 23. Highway Capacity Manual. 2010.
[4] Potts, Ingrid, Harwood, Douglas and Richard Karen, "Relationship of Lane Width to Safety for Urban and Suburban Arterials, TRB 2007 Annual Meeting
[5] 2011 AASHTO Green Book, Urban Arterial Travel Lane Widths, page 7-29
[6] Potts, Ingrid, Harwood, Douglas and Richard Karen, "Relationship of Lane Width to Safety for Urban and Suburban Arterials, TRB 2007 Annual Meeting
[7] TRB Special Report 214 – Designing Safer Roads, 1987. It is important to note this report documented research proving wider travel lanes increased safety, but this research was only based on rural, 2 lane highways.
[8] Studies vary on the effectiveness of narrowing travel lanes as a speed reduction strategy. A majority of studies available for review generally find narrower lanes lower average speeds 3-5mph, but a small number of studies have also found no change or slight increases in speeds.
[9] AASHTO. A Policy on Geometric Design of Highways and Streets. Washington, D.C. : American Association of State Highway and Transportation Officials, 2004.

IMPLEMENTATION STRATEGIES

The following treatments describe the recommended short term and long term primary actions required to implement the network recommendations of the Town of Chapel Hill Bicycle Master Plan.

Lane diet

A lane diet reduces the width of existing motor vehicle travel lane(s) and redistributes that space for bike lanes or other roadway improvements. Assigning the appropriate width to travel lanes is the most critical decision point for lane diets.

Further, this assignment should reflect the effort to balance the safety needs of all street users while at the same time ensuring that public rights-of-way in the Town are used to the utmost efficiency. The AASHTO Policy on Geometric Design of Highways and Streets allows a flexible approach for selecting lane widths on major streets suggesting a range from 10-12 feet.9

Implementation of projects by lane diet will require grinding of existing pavement markings or a resurfacing with new markings applied.

Road diet

A road diet removes one or two travel lanes in order to provide a bicycle lane, or a buffered bicycle lane, within the existing width of the street. Typically, a center turn lane is provided for left-turn movements. Evaluation studies of resulting three-lane cross sections show they often function more efficiently for motor vehicle traffic (and with fewer crashes10) as well as allowing for bicycle lanes.

Implementation of projects by road diet will require grinding of existing pavement markings or a resurfacing with new markings applied.

Martin Luther King Jr. Blvd before and after a lane diet .

Erwin Rd. in Durham, NC before and after a road diet.

Parking removal

Parking removal is often done when bike lanes are desired but there is insufficient street width and other strategies such as lane diets or street diets are not an option. On-street parking is permitted on some arterial segments and along most collector and local streets in Chapel Hill. Demand for on-street parking was generally observed to be limited to locations adjacent to parks, schools, and commercial areas. Service vehicle parking (e.g. construction or landscaping vehicles) was sporadic but somewhat common in the residential neighborhoods. It is anticipated special events such as house parties and athletic events would result in additional parking demand for limited periods where driveways were insufficient to hold the volume of visitors.

Parking removal could be intermittent, e.g. at an intersection approach, or segment wide. The decision to remove on-street parking should be made only after a thorough analysis and stakeholder process. The stakeholder process should emphasize the benefits and trade-offs involved, and put neighborhood parking removal in the context of the whole bicycle network. In addition to understanding neighborhood concerns, an analysis of adjacent land uses and observed parking utilization is necessary for determining where parking may be removed without having negative impacts to businesses and residents.

Implementation of projects by parking removal may require grinding of existing pavement markings or a resurfacing with new markings applied. These projects will also require the posting of parking restriction signs.

Street reconstruction and/or widening

Street reconstruction projects reconsider all aspects of the street's design and function and can achieve a better balance between all users. These projects present an opportunity to meet desired standards for all modes through the relocation of curbs or acquisition of additional right-of-way and often incorporate green street elements.

Implementation of projects by reconstruction or widening will require development of plans, specifications, and estimate packages (PS&E). These projects are a significant financial and logistical undertaking often requiring public processes, permitting, and property acquisition. In some situations, these improvements may be accomplished through the development or redevelopment of adjacent private property where public right-of-way improvements are required.

Addition of pavement markings with supplemental signs

A large number of potential projects will only require the addition of pavement markings which may be supplemented with traffic control signs. The roadways on which these projects are proposed either have no markings, or they have markings which would not require grinding to relocate.

Implementation of projects by the addition of pavement markings would require a basic engineering plan detailing the locations of the proposed markings for installation by agency staff or a private contractor.

Further study

A smaller number of projects will require additional study and public consultation to determine the appropriate improvement. It is a baseline assumption that the cycle track projects and all road widening projects will require additional study due to the potential impacts on drainage, right-of-way and cost. Implementation of this action will require either Town staff or a private contractor to perform the study and to conduct the necessary public outreach and agency coordination.

Crossing improvements

The Plan has identified crossings where improvements will enhance bicyclist (and pedestrian) safety by providing space for bicyclists or enhancing their ability to safely navigate an intersection. Recommendations for intersections include adjustments to signal timing, addition of traffic signals, flashing beacons, warning signs, pavement markings and crossing islands. These improvements may require additional engineering study before implementation to verify the specific proposal.

[10] http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_013.htm

Redevelopment Opportunity

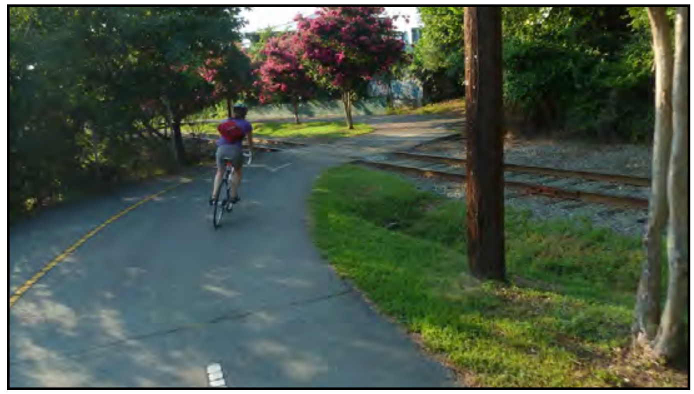
There are a number of planned or potential redevelopment opportunities throughout the Town which will present opportunities to implement the recommended long term bicycle facility. The extent of the improvement will be a result of a negotiation between the Town and the developer. Opportunities assumed to be implemented through redevelopment in this plan include:

- Ephesus-Fordham Future Focus Area
- University Square 123 Franklin Redevelopment
- Glenn Lennox/NC 54 Focus Area
- Carolina North
- Estes Drive/South MLK Boulevard Focus Area
- NC 54 Improvements by NCDOT
- North and South 15/501 Focus Areas

B.5 BICYCLE FACILITY TREATMENTS

The following treatments are referenced throughout the bicycle master plan. This section provides a definition specific to the context of this master plan with suggested minimum and/or typical dimensions where appropriate. It is assumed high volumes of pedestrians are present throughout the campus. Design guidance should be obtained from the references described in sections B.1, B.2, B.3, and B. 4 of this appendix.

ABOVE: A **campus sidewalk** is a two-way facility that is physically separated from motor vehicle traffic located within campus designed primarily for pedestrian traffic. These range in width from 6 feet to 10 feet on campus. Bicyclists routinely operate on all campus sidewalks and are not restricted from these sidewalks.



ABOVE: A **greenway or shared-use path** is a two-way facility that is physically separated from motor vehicle traffic located within campus designed to accommodate pedestrian and bicycle traffic. A greenway or shared-use path is located in an independent alignment from a roadway generally crossing roadways at right angles. A sidepath has the same characteristics as a shared-use path with the exception that it is located parallel to a roadway. Shared-use paths and sidepaths range in width from 8 to 16 feet on campus. The Shared Use Path Bicycle Level of Service model should be used to determine widths for new paths and projects where existing paths are surfaced, resurfaced or widened. However, shared use paths should be a minimum width of 10 feet with a preferable width of 12 to 16 feet on campus unless they are in an extremely constrained environment and the volume is anticipated to be low.

ABOVE: **Shared streets** are roadways designed to allow pedestrians, bicyclists and motor vehicles to share the roadway. They are typically designed with no curb and gutter and provide visual cues and traffic calming features to promote slow speed motorized traffic. They are appropriate in locations where pedestrian and bicyclist volumes equal or exceed motor vehicle volumes and the available space for separating pedestrians and bicyclists from motorized traffic is limited.

ABOVE: A **cycletrack** is physically separated from both the roadway and the sidewalk and is intended for the exclusive use of bicyclists. A cycletrack may be constructed at roadway level, sidewalk level, or at an intermediate height. Cycletracks can be provided in either one-way or two-way configurations. One-way cycle tracks typically vary between 5 and 10 feet in total width. Bi-directional cycle tracks typically vary between 8 and 11 feet in total width.

ABOVE: A **contra-flow bike lane** is a bike lane designed to allow bicyclists to ride in the opposite direction of one-way motor vehicle traffic. They convert a one-way street into a two-way street: one direction for motor vehicles and bikes, and the other for bikes only.

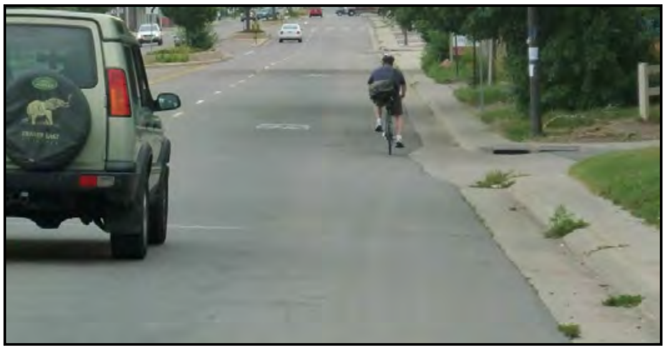
ABOVE: A **bike lane** designates a portion of a roadway with pavement markings and signs for the exclusive use of bicycles. Bike lanes may vary in width, but should never be less than 4 feet in total width, exclusive of a gutter on curbed roadways. Bike lanes may be wider on campus where volumes of bicyclists are higher.

ABOVE: **Buffered bike lanes** are created by striping a buffer zone between a bike lane and the adjacent travel lane and/or parking lane. The buffer creates a more comfortable operating environment for bicyclists by creating additional space between bicyclists and passing traffic or parked vehicles. It typically creates sufficient space for bicyclists to operate side by side if desired or to pass slower moving bicyclists without having to encroach on adjacent travel lanes. Buffered bike lanes are typically a minimum of 7 feet in total width inclusive of a 2 foot buffer. The bike lane or buffer may be wider.

ABOVE: A **climbing lane** is a bike lane provided only in the uphill direction of a steep street to accommodate slow moving bicyclists. To discourage wrong way riding in the climbing lane, a shared lane marking is provided in the downhill direction, where bicyclists can typically travel at speeds closer to motor vehicle speeds.

ABOVE: **Shared lane markings (sharrows)** are used on roadways where bicyclists and motor vehicles must share the same travel lane and it where there is a desire to provide visual cues to position bicyclists in the most appropriate location to ride for their safety. Shared lane markings also provide a visual cue to motorists to expect bicyclists to operate within the travel lane. Shared lane markings may be utilized within travel lanes of any width.

ABOVE: A **priority shared lane** is an application of shared lane markings supplemented with dashed longitudinal lines typically bracketing the shared lane marking within a travel lane. Colorized pavement may also be considered to supplement the sharrows. The treatment is currently experimental thus it is recommended to follow the official FHWA experimentation processes where this treatment is deployed.



ABOVE: **Wide outside lanes** are 14 feet or greater in width to allow motorists to pass bicyclists without encroaching into the adjacent lane. These lanes may have shared lane markings present. Bike lanes are the preferred treatments on major roadways when sufficient width is available to provide them (AASHTO). Wide outside travel lanes on arterial roadways are generally acceptable for experienced cyclists, but less-experienced bicyclists may not feel comfortable on this type of facility11.

RIGHT; **Signed bicycle routes** help bicyclists navigate street networks through the provision of wayfinding signs. Signed routes may be located on any type of roadway or path and are particular beneficial for use on routes which are not intuitive or would generally require a map to follow due to frequent changes of direction.

Additional Considerations for the Placement of Shared Lane Markings

In general, Shared Lane Markings are installed on streets where there is not enough space for bicycle lanes, or there is no desire for a bicycle lane. When bike lanes are desired but space limitations exist, a bike lane can be installed on one side of the street (the up-hill side of the street to provided dedicated space for slower, hill climbing bicyclists) and Shared Lane Markings on the downhill side. Shared Lane Markings may be the first choice (even if there is room for a bicycle lane) on some downhill sections.

Consideration for Shared Lane Marking Placement within a Travel Lane

The placement of shared lane markings will require engineering judgment as lane widths, quantity of lanes, operating speeds, and presence of parking will vary from street to street. In particular, the width of the shared travel lane and the number of available travel lanes impact typical operating behavior of motorists and bicyclists. Travel lanes with widths less than 13 feet will require motorists to partially or fully change lanes to pass bicyclists. Travel lanes of 13 feet or greater generally allow motorists to pass bicyclists with minimal or no encroachment into adjacent travel lanes (allowing 3 feet of horizontal separation between the motorist and bicyclist).

Generally, the center of shared lane markings should be located a minimum of 11 feet from the curb or edge of roadway at locations where parking is permitted adjacent to the travel lane. Generally, the center of shared lane markings should be located a minimum of 4 feet from the curb or edge of roadway at locations where parking is prohibited.

It may be appropriate to move the shared lane marking towards the center of the travel lane (exceeding the MUTCD minimums) if engineering judgment determine that this placement will enhance the safety of the bicyclist operating within the travel lane.

[11] Landis, Bruce W. et.al. "Real-Time Human Perceptions: Toward a Bicycle Level of Service" Transportation Research Record 1578, Transportation Research Board, Washington, DC 1997.

The shared lane marking may be moved towards the center of the lane regardless of whether it is adjacent to parking or not. In most cases, it will be a combination of two or more of the following factors which will indicate that consideration should be given to moving the Shared Lane Marking towards the center of the travel lane:

- Travel lane is less than 12 feet in width
- Speed of traffic
- Number of travel lanes (it may be desirable to place the shared lane marking towards the center of a narrower outside travel lane when a center turn lane is present or when there are multiple travel lanes in the same direction)
- Grade of roadway and expected bicyclist speed (center lane placement often works well when going downhill on streets with grade and higher bicycle speeds)
- Volume of traffic (may or may not be an issue – speed, grade, and number of lanes are more important)

Situations Where Travel Lanes Are Less than or Equal to 12 Feet in Width

Shared lane markings should be placed in the center of the travel lane where travel lanes are less than 12 feet to encourage bicyclists to occupy the full lane and not ride too close to parked vehicles or the edge of the roadway. A BIKES MAY USE FULL LANE (R4-11) sign may be used to supplement the marking. Travel lanes of this dimension are too narrow for sharing side by side with vehicles.

Situations Where Travel Lanes Are Between 12 Feet and 13 Feet in Width

Where travel lanes are 12-13 feet in width, the travel lane can appear shareable to roadway users if bicyclists operate on the right side of the lane resulting in unsafe passing maneuvers. It may be desirable to place the marking in the center, or close to the center of the lane to discourage these behaviors. A BIKES MAY USE FULL LANE (R4-11) sign may be used to supplement the marking.

Situations Where Travel Lanes Are Greater than or Equal to 13 Feet in Width

Where travel lanes are 13 feet or wider, motorists will generally be able to pass bicyclists within the same lane or will only need to slightly encroach on adjacent lanes to pass bicyclists. The Shared Lane Marking should generally be located in the right portion of the lane (per the MUTCD minimum requirements) with exceptions for locations adjacent to parking where it is desirable to encourage riding further from parked vehicles. A Share the Road sign (W11 1 AND W16-1P) may be used to supplement the marking. Shared lane markings should generally be used on arterial and non-arterial roadways with motor vehicle speeds 35 mph or less. Research has shown placing the marking in the center of travel lanes wider than 13 feet will likely result in poor compliance by bicyclists who will travel in the right portion of the lane which may undermine the effectiveness of shared lane markings in narrower lanes.

Signals

Signalized intersections allow bicyclists to cross arterial streets without needing to select a gap in moving traffic. Traffic signals make it easier to cross the street, though it is important to make improvements to reduce conflicts between bicyclists and turning vehicles. When evaluating warrants for the potential installation of new traffic signals, it is important to note that bicyclists may be counted as pedestrians or vehicles.

Bicycle Signal

Bicycle signals heads can provide more clear direction to bicyclists crossing signalized intersections that they may enter an intersection. This is particularly important at locations where bicyclists may be provided an advance or exclusive phase. At locations (typically trail crossings) where it is cyclists are expected to follow pedestrian signals, under present law and timing practices, bicyclists are may only “legally” enter the crosswalk during the solid WALK portion of the signal which is significantly shorter than the provided walk + clearance time. This often results in bicyclists disobeying the flashing don’t walk portion of the cycle which can lead to them being caught in the intersection during the change interval. Providing bicycle signals allows for a longer display of green as compared to the walk, which significantly improves the compliance with the traffic control. Further, the MUTCD states explicitly that pedestrian signals are for the “exclusive use of pedestrians”. Bicycle signals can be designed to call a green signal phase through the use of loop detectors (or other passive detection such as video or radar) or push button. Bicycle signal heads and a separate bicycle signal phase should be considered at intersections and trail crossings with very high volumes of cyclists or locations where it is desirable to provide separate phasing for the bicyclists.

Presently the MUTCD has no provision for bicycle signals; however bicycle signals are under experimentation in many jurisdictions and are being actively investigated by the National Committee for inclusion into the MUTCD. The use of bicycle signal heads would require permission to experiment from FHWA.

Rectangular Rapid Flashing Beacons

Rectangular rapid flashing beacons (RRFB) are installed at unsignalized street crossings or mid-block crossing to assist pedestrians and bicyclists in crossing the street. Rectangular rapid flashing beacons have proven to be effective devices at uncontrolled intersections for increasing motorist yielding rates and reducing pedestrian-vehicle crashes at crosswalk locations. The rapid flashing beacon device consists of a pair of rectangular, yellow LED beacons that employ a stutter-flash pattern similar to that used on emergency vehicles. The beacons are often mounted below a standard pedestrian crossing warning sign and above the arrow plaque. The beacons are pedestrian activated (pushbutton or passive detection) and placed on both sides of the street. If a median exists at the crossing location, a third and fourth beacon may be placed in the median, which, studies show, significantly increases motorist yield rates. Advanced pedestrian warning signs can also be used with the rapid flashing beacon. If traffic volumes are too high, or there are too many lanes (generally more than 4 travel lanes), a pedestrian hybrid beacon or full signal may be warranted. Research has shown higher motorist yielding rates for RRFBs versus standard flashing beacons; since these devices have been granted interim approval by FHWA, they are not included in the 2009 MUTCD due to late approval status, however, request to study is not required with interim approval to install these devices. A written request must be submitted to the FHWA to participate in the Interim Approval.

Pedestrian Hybrid Beacons (a.k.a: HAWK Signal - High Intensity Activated Crosswalk)

This signal is intended to allow pedestrians and bicyclists to stop traffic to cross high volume arterial streets. The signal may be used in lieu of a full signal that meets any of the 9 warrants in the MUTCD as well as at locations which do not meet traffic signal warrants where it is necessary to provide assistance to cross a high volume arterial.

The MUTCD provides suggested minimum volumes of 20 pedestrians or cyclists an hour for major arterial crossings (excess of 2,000 vehicles/hour). It is recommended that this signal be considered for all arterial crossings in the bicycle network and for trail crossings if other engineering measures prove inadequate to create safe crossings. Pushbuttons should be ”hot” (respond immediately), be placed in convenient locations for bicyclists, and abide by other ADA standards. Passive signal activation, such as video or infrared may also be considered. While this type of signal is intended for pedestrians, it would be beneficial to retrofit it as the Town of Portland, Oregon has with bicycle detection and bicycle signal heads on major cycling networks to provide adequate guidance. Depending upon the detection design, the Town may have the option to provide different clearance intervals for bicyclists and pedestrians. The provision of bicycle signal heads would require permission to experiment from FHWA.

Signal Timing and Bicycle Detection

It was observed that the majority of collector and local street crossings of arterials required actuation. The Town updated all signalized locations to detect bicyclists and marked the sweet spot for bicycle detection with the bike detection pavement marking. Based on email discussions with staff, the minimum green time provided for crossing arterials is typically 5-6 seconds with extension time provided as motor vehicles are detected. Yellow and red times totaling 4-6 seconds is provided at each location to allow a motor vehicle to clear the intersection. Should a bicyclist attempt to cross one of the Town's 7 lane arterials (approximately 90 feet), they may not clear the intersection within the time provided. Section 9D.02 of the 2009 MUTCD states: "On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists." Accommodating bicyclists at actuated intersections is one relatively cost-effective way in which a Town can make significant strides to improve the safety and level of service provided to bicyclists.

Bicycle Standing Time for various intersections widths

Intersection Width*	Bicycle Standing Time**
30	803
40	9
50	9.7
60	10.4
70	11.1
80	11.8
90	12.4
100	13.1
110	13.8
120	14.5

Timings at signalized intersections should be modified on a case-by-case basis to consider the specific needs of bicycles, which have slower acceleration and operating speeds than motor vehicles. A stationary, or "standing", cyclist entering the intersection at the beginning of the green indication and a moving, or "rolling", bicyclist approaching the intersection towards the end of the phase should be considered. The needs of standing cyclists can typically be accommodated by increasing the minimum green time on an approach, which is the current state of the practice. The needs of rolling cyclists require increases to the yellow and red times (change and clearance intervals), which may result in a slight loss of capacity at the intersection.

The minimum green time should be adjusted such that the total phase duration (minimum green time plus yellow and all red times) are long enough for a bicyclist leaving the stop bar at the beginning of the green indication to clear the far side of the intersection. This time is referred to as the Bicycle Standing Time and is sufficient for a bicyclist to react, accelerate and cross the roadway before the conflicting crossing traffic receives a green indication.

At intersections with arterial roads and a side street of lower classification, there may be concern about the impact to delay on the arterial when the side street minimum green time is increased (i.e. by 4 seconds as the worst case scenario) to accommodate the bicycle standing time. However, the changes to the minimum green time should have a small, if any, impact to the delay for motor vehicles on the arterial. During peak periods, the green time allocated for a minor approach typically increases over the minimum green time due to high demand on the minor street. During off peak periods, the loss of green time allocated to an arterial road will have little impact due to the lower traffic volumes on the arterial.

Equation for Bicycle Minimum Green and Crossing Time for a Standing Bicyclist12

$$BMG = BCT_{standing} - Y - R_{clear}$$

$$BMG = PRT + \frac{V}{2a} + \frac{(W+L)}{V} - Y - R_{clear}$$

where:

BMG	=	bicycle minimum green time (s)
$BCT_{standing}$	=	bicycle crossing time (s)
Y	=	yellow change interval (s)
R_{clear}	=	all-red (s)
W	=	intersection width (ft)
L	=	typical bicycle length = 6 ft (see chapter 3 for other design users)
V	=	bicycle speed crossing an intersection (ft/s)
PRT	=	perception reaction time = 1 s
a	=	bicycle acceleration (1.5 ft/s ^{2})

Signal Timing and Bicycle Detection (Con't)

Change and clearance intervals (i.e. yellow and red times) provided for motor vehicles may sometimes be sufficient for bicyclists. Generally, the yellow times used for motorists, typically between 3 and 6 seconds, are suitable for cyclists. However, it may be necessary to consider lengthening the red time depending upon posted speed limit, intersection width, bicyclist speed, roadway grade and red time used for motorists. The difference in clearance time between faster motorists and slower bicyclists is exaggerated by increased crossing distances and increased motorists speeds; therefore, it is more challenging to accommodate bicycles in the signal timing at wide, high-speed intersections. Additionally bicyclists traveling uphill may have even slower speeds than typical, further increasing their crossing times and requiring longer change and clearance intervals. As indicated above, increasing red times may be challenging due to potential decreases in motor vehicle capacity, increases in red-light running and increases in motor vehicle crashes. If it is determined that increasing the change and clearance interval are not feasible, it is recommended bicycle signal heads be evaluated to stop bicyclists from entering the intersection prior to the onset of the yellow indication which would be intended for motorists.

Crossing Islands

Crossing islands facilitate crossings of multiple lane and/or high-volume arterials by providing space in the center of the roadway, allowing the pedestrian or bicyclist to focus on one direction of traffic at a time (two-stage crossing). Median islands (or crossing islands) are constructed at the center of a road to physically separate the directional flow of traffic, and to provide pedestrians and bicyclists with a place of refuge while reducing the crossing distance between safety points.[13] Arterial roadway intersections that have low demand for left-turn movements can be potential candidates for adding median islands. Median islands can be constructed on these roadways by using the available center turn lane area, or by removing parking from one side of the street and shifting the travel lanes. Median islands are likely to be a medium- or long-term improvement on roadways where significant channelization changes are needed to provide enough space for the median island.

The newest AASHTO Bicycle Guidelines outline design considerations for median crossing islands:

- Median islands are beneficial to install on roadways that have high traffic volumes, roadways that are too wide for full roadway crossing, and roadways with more than three travel lanes.
- Minimum width for storage on the median is 6 feet. 10 feet accommodates a bike with trailer
- Island should be large enough for multiple people to be on the island at once e.g. strollers, bicyclists, pedestrians etc.
- Angling the refuge area at approximately 45 degrees is recommended to direct those crossing to face towards on-coming traffic.

Crossing Markings

The crossing markings used for bicyclists may differ depending on if the crossing is at a signalized or unsignalized location. For signalized locations bicycle pavement markings through intersections indicate the intended path of bicyclists through an intersection or across a driveway or ramp. They guide bicyclists on a safe and direct path through the intersection, and provide a clear boundary between the paths of through bicyclists and either through or crossing motor vehicles in the adjacent lane. MUTCD Section 3B.08 requires dotted lines the same width

and color to bind the bicycle crossing space. Other treatments include multiple shared lane markings, chevrons, or colored pavement (green). These treatments may not be applicable for crossings in which bicycles are expected to yield priority, such as when the street with the bicycle route has Stop or Yield control at an intersection. At these types of locations high visibility crosswalks may be used to create a visibly prominent crossing location for pedestrians, which also benefits bicyclists. High visibility crosswalks should be used in combination with advanced pedestrian/bike crossing warning signs. Other treatments that may be used in combination with high visibility crosswalks include curb extensions (to shorten crossing distances, crossing islands, and advanced yield markings. And at mid-block locations they may be used in combination with raised speed tables; however these are not recommended on higher speed and volume arterial streets.

Advanced Yield Markings

Advanced yield markings in conjunction with "Yield Here To Pedestrian" signs have proven to be effective at reducing multiple threat crashes at uncontrolled, marked crosswalk locations. A multiple threat crash results when a car in one lane stops to let the pedestrian cross, blocking the sight lines of the vehicle in the other lane of a multi-lane approach which advances through the crosswalk and hits the crossing pedestrian(s). The MUTCD (2009) requires the use of "Yield Here To Pedestrians" (R1-5, R1-5a) sign if yield lines (shark's teeth) are used in advance of a marked crosswalk that crosses an uncontrolled multi-lane approach. "Yield Here To Pedestrians" sign may also be used without the installation of advanced yield lines. If yield lines and "Yield Here To Pedestrians" signs are used in advance of a crosswalk, they should be placed together and 20 to 50 feet before the nearest crosswalk line; parking should be prohibited in the area between the yield line and the crosswalk. "Yield Here To Pedestrian" signs may be used in conjunction with the "Pedestrian Crossing" (W11-2) warning sign but must be on a preceding post and not block the road user's view of the W11-2 sign. This application should be considered at trail crossings, pedestrian hybrid beacon crossings, and bicycle boulevard crossings of arterials. It is recommended the bicycle symbol be incorporated onto the signs. If a pedestrian hybrid beacon is used at a crossing location, then a "Crosswalk Stop On Red" (R10-23) should be used per Section 2B.53 of the MUTCD.

High-visibility Pedestrian/Bicycle Crossing Warning Signs

High-visibility bicycle and pedestrian warning signs are recommended at trail crossings. These signs can increase driver awareness of bicyclists and pedestrians, especially at mid-block locations where bicyclists and pedestrians may not be expected. These signs will be most effective when combined with other treatments, such as marked crosswalks, curb extensions, median islands, etc. Signs should be used judiciously—too many signs can cause visual clutter and lead to non compliance. This sign is incorporated into the new MUTCD.

Crossings at Off-Set Intersections

Several designs have been developed to facilitate crossing of intersections with "legs" that do not line up directly across from one another. These include bicycle left-turn lanes that create a designated space for two-way left turns using pavement markings, left-turn with raised median that creates a single protected left turn using a raised curb median, and a sidepath. Left turn lanes should be a minimum six feet wide and 8 feet in length so that bicyclists can be completely separated from the travel lanes.

More Information

Greater detail on all of these design treatments can be found in the documents mentioned above, as well as other sources such as PedSafe and the National Association of Town Transportation Officials (NACTO) website.

[12] DRAFT AASHTO Guide for the Development of Bicycle Facilities (February 2010) http://design.transportation.org/Documents/DraftBikeGuideFeb2010.pdf

[13] AASHTO Guide for the Development of Bicycle Facilities 1999.

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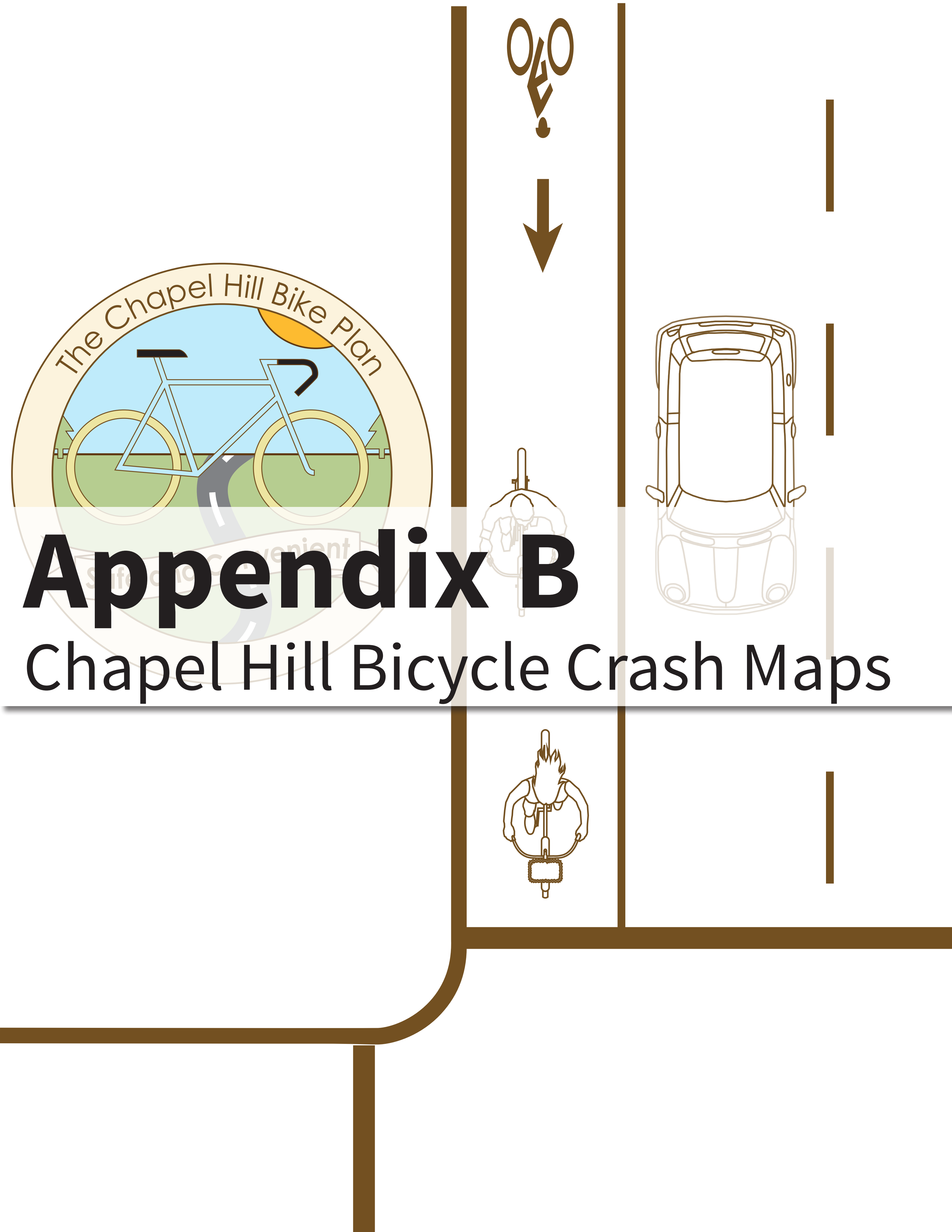


Appendix B

Chapel Hill Bicycle Crash Maps

ABOUT THE CRASH MAPS AND DATA

The following pages display the location and detail of reported bicycle related traffic crashes in Chapel Hill from 2007 to 2011. This data was provided by the North Carolina Department of Transportation Bicycle and Pedestrian Division. The next page is a map of Chapel Hill showing the location of all reported collisions. The pages that follow contain close up maps showing the exact location of each crash, an image of the “Bicycle Crash Type”, a standard descriptor used in bicycle crash reporting nationwide, and other data fields related to the crash. The bicycle crash image types were provided courtesy of the Pedestrian and Bicycle Information Center. (http://www.pedbikeinfo.org/pbcat_us/bike_images.cfm)

One field included in these reports, Crash Severity, has 6 different values and these explained below.

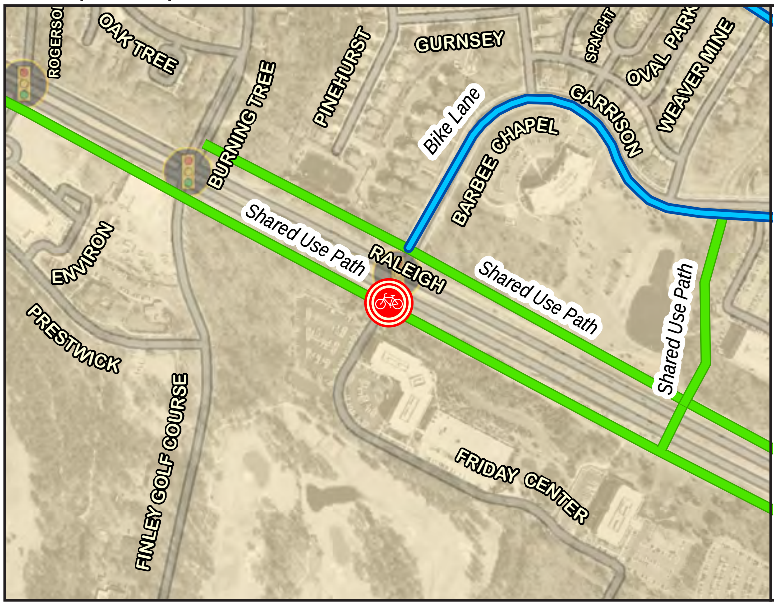
NCDOT Severity Index

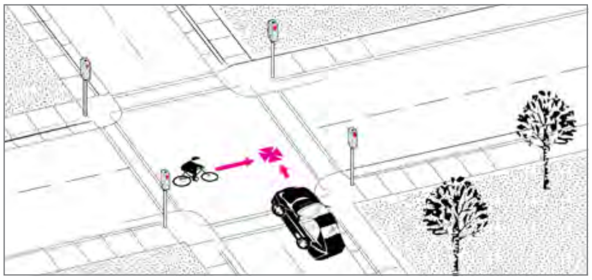
Crash Level Severity = worst level of injury sustained by an individual in the crash

6 Severity Levels

1. Fatal: Deaths that occur within 12 months of the crash
2. Disabling: Injuries that prevent normal activity for at least one day (massive loss of blood, broken bones, etc)
3. Evident: Injuries that are not fatal or disabling, but are evident at the scene (bruises, swelling, limping, etc.)
4. Possible: No visible injury, but there are complaints of pain or momentary unconsciousness
5. None
6. Unknown

Example Map





Crash Type
Motorist Drive Out - Signalized Intersection

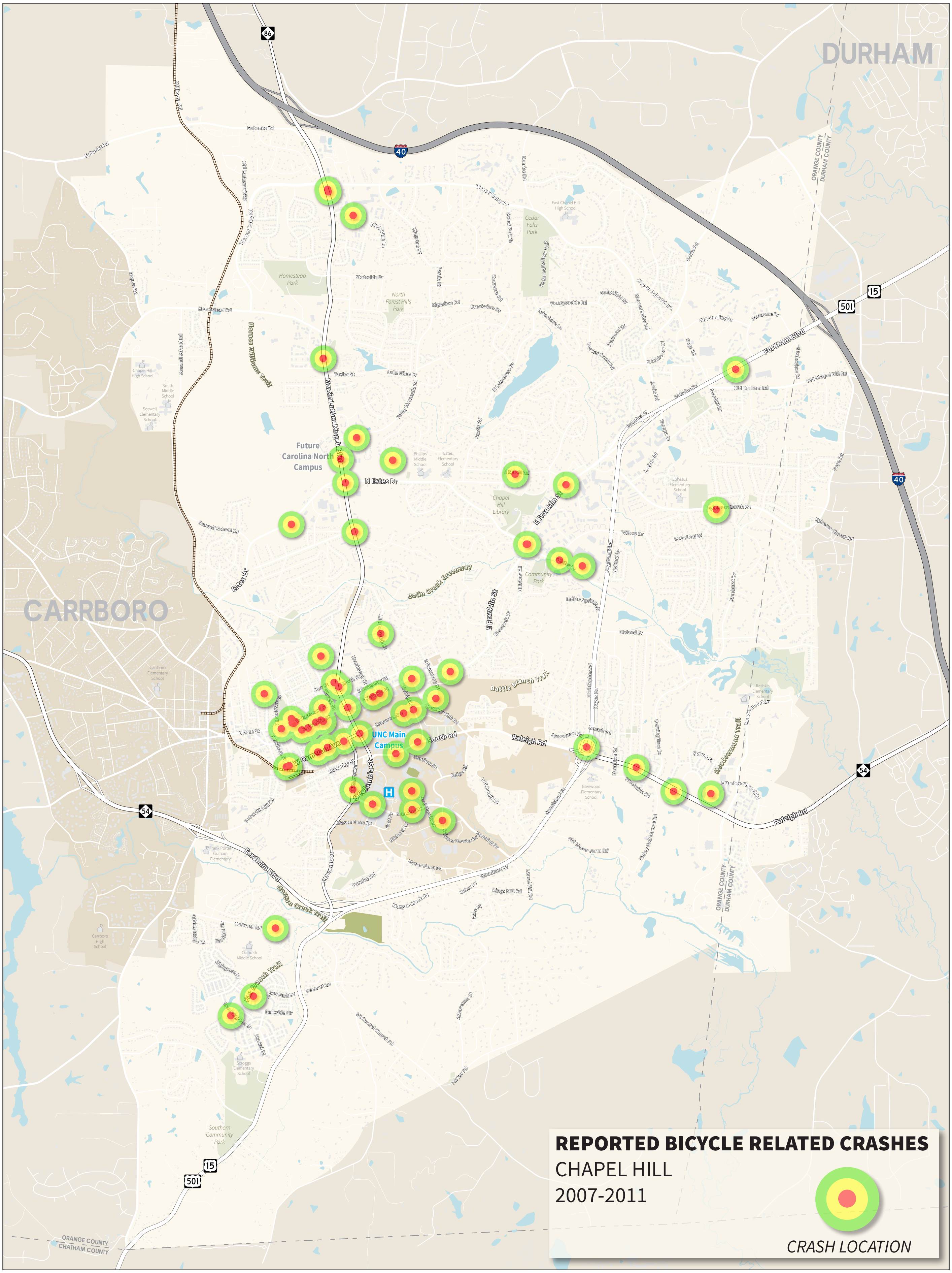
Injury Severity
B: Evident Injury

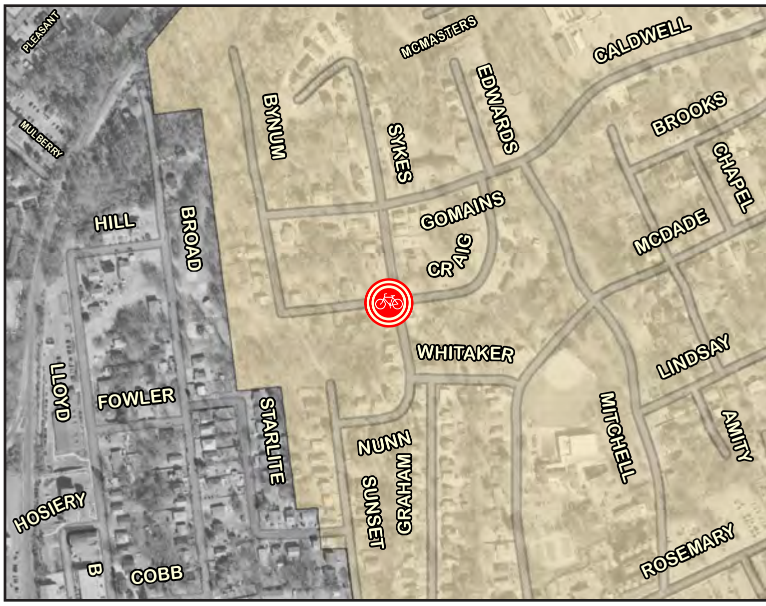
Speed Limit
20 - 25 MPH

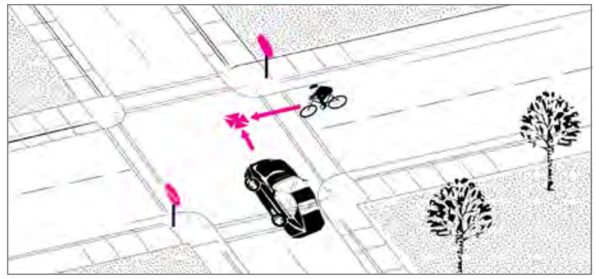
Date
30APR2010

Light Condition
Daylight

In total there were 68 reported bicycle crashes within the corporate limits of Chapel Hill between 2007 and 2011. The location of the crash is red bike icon. Bike lanes are shown as blue lines and Shared use paths are shown as green lines when they are present within the map extent.


DURHAM
CARRBORO
Future Carolina North Campus
UNC Main Campus
REPORTED BICYCLE RELATED CRASHES
CHAPEL HILL
2007-2011
CRASH LOCATION





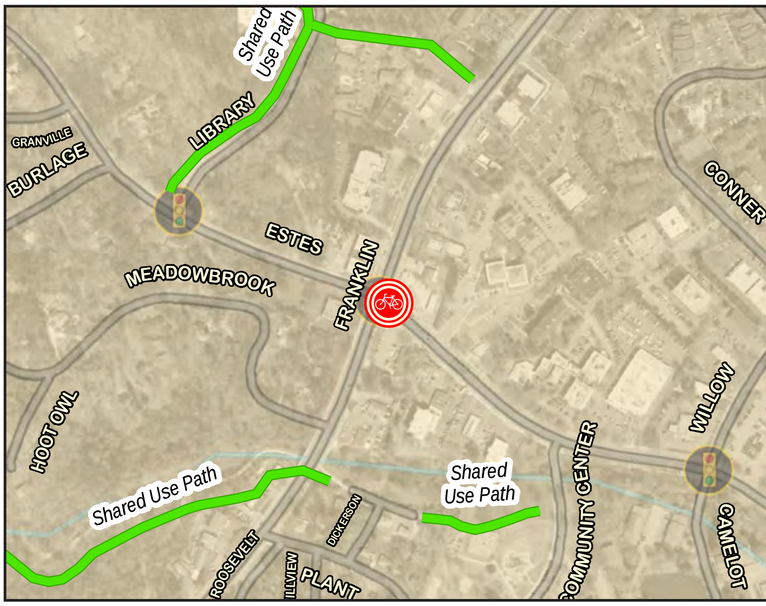
Crash Type
Bicyclist Ride Through - Sign-Controlled Intersection

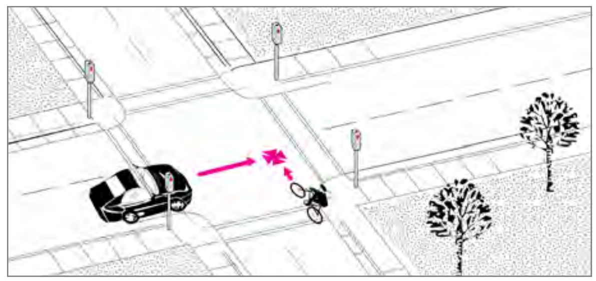
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
12NOV2011

Light Condition
Daylight





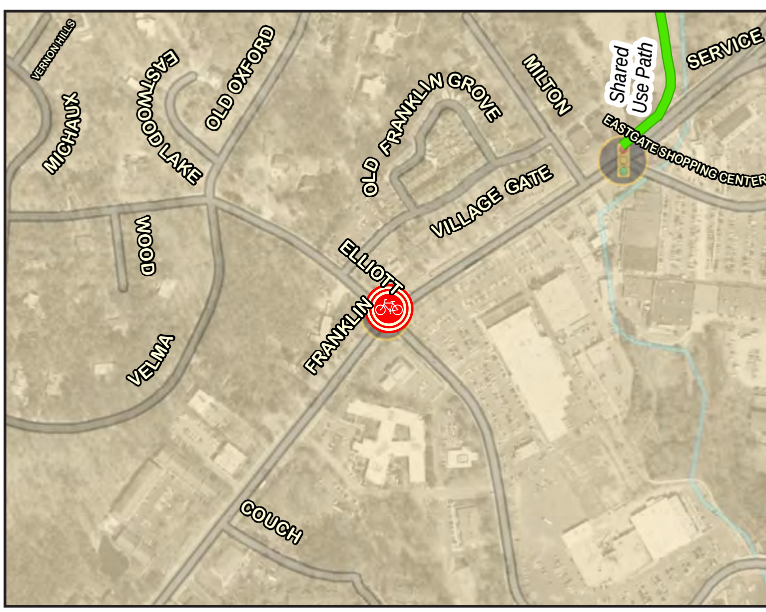
Crash Type
Bicyclist Ride Out - Signalized Intersection

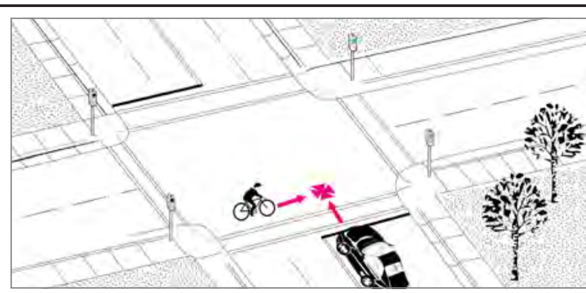
Injury Severity
B: Evident Injury

Speed Limit
30 - 35 MPH

Date
29SEP2007

Light Condition
Daylight





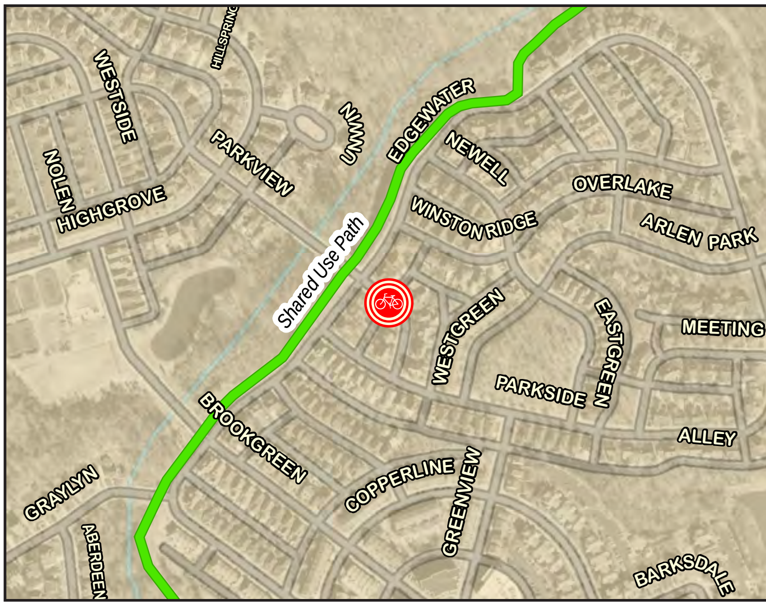
Crash Type
Bicyclist Failed to Clear - Trapped

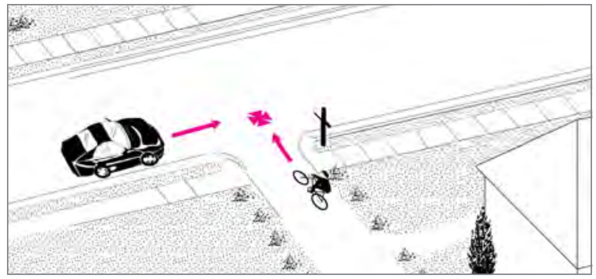
Injury Severity
C: Possible Injury

Speed Limit
30 - 35 MPH

Date
03SEP2008

Light Condition
Daylight





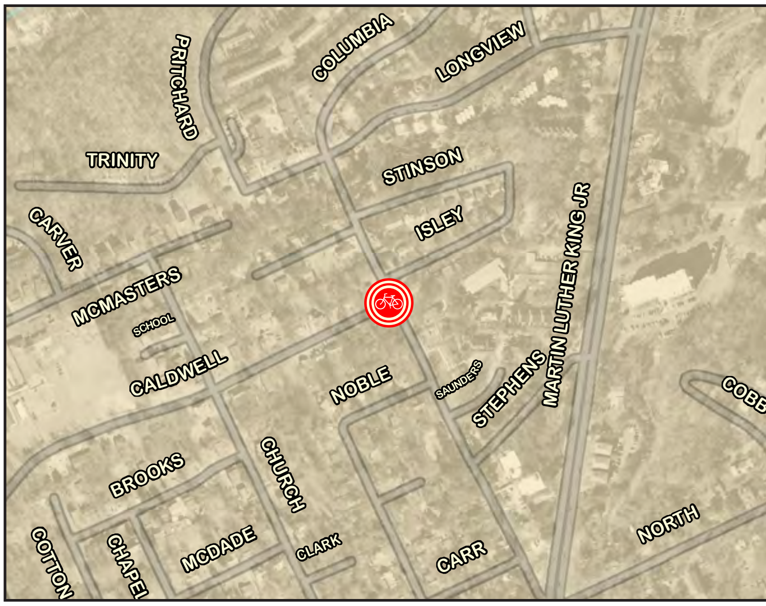
Crash Type
Bicyclist Ride Out - Residential Driveway

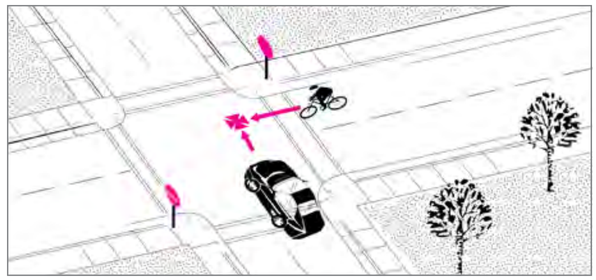
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
19DEC2008

Light Condition
Daylight





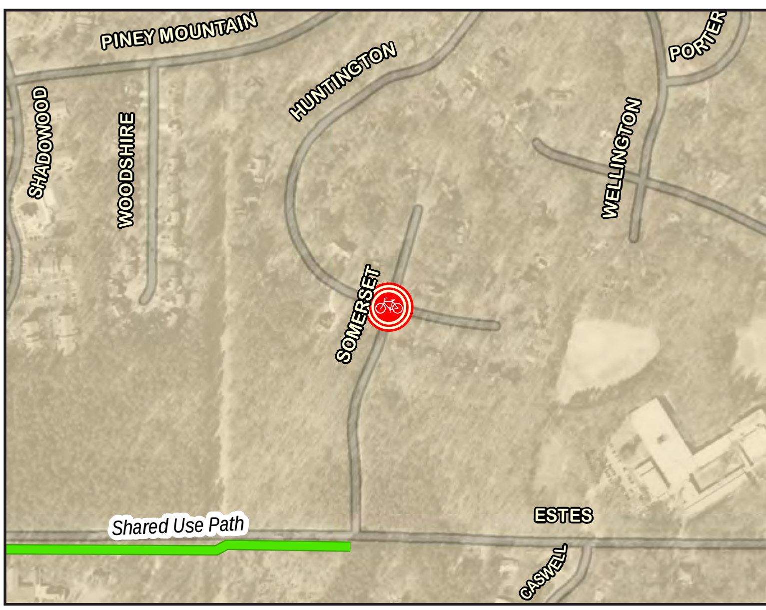
Crash Type
Bicyclist Ride Through - Sign-Controlled Intersection

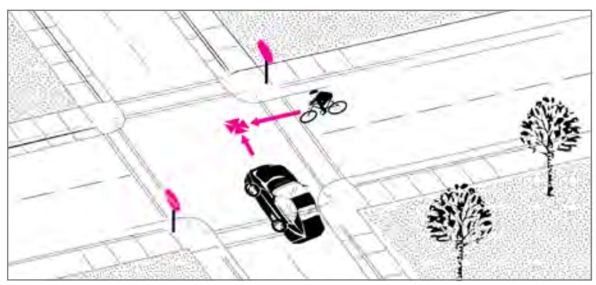
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
05MAY2007

Light Condition
Daylight





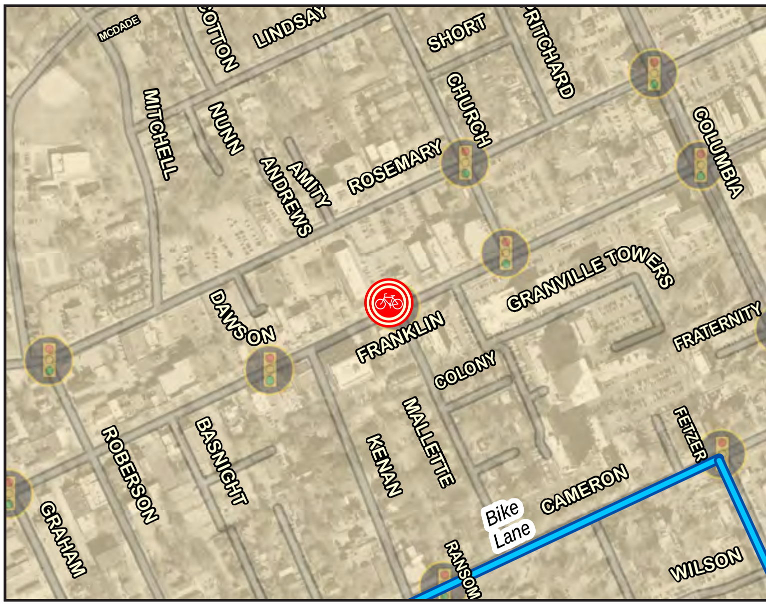
Crash Type
Bicyclist Ride Through - Sign-Controlled Intersection

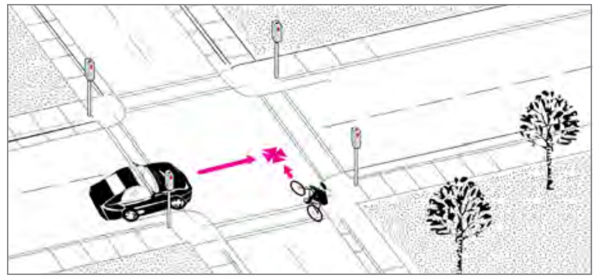
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
07OCT2010

Light Condition
Daylight





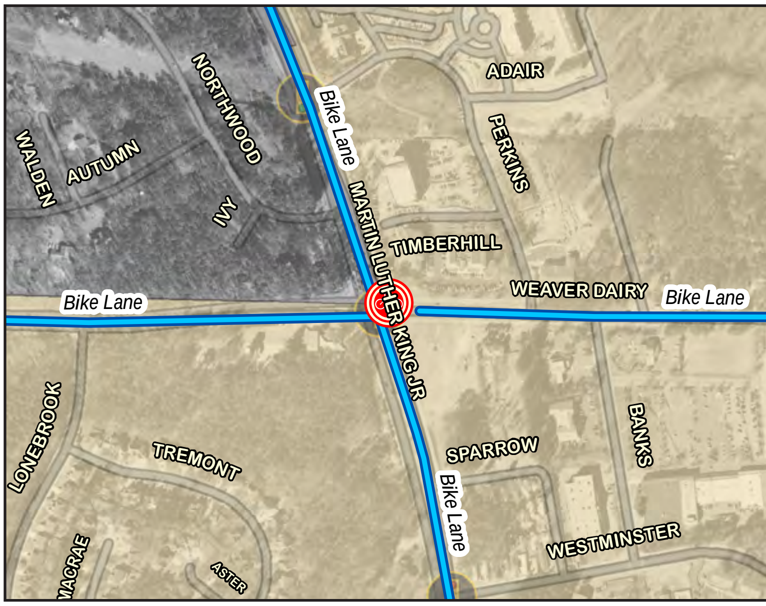
Crash Type
Bicyclist Ride Through - Signalized Intersection

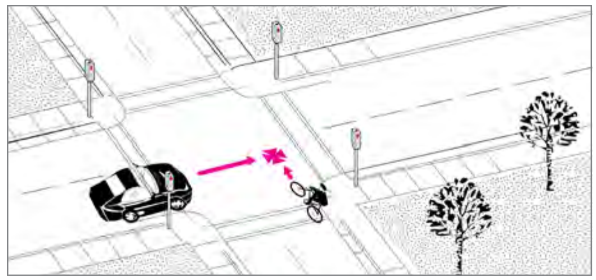
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
13NOV2008

Light Condition
Dark - Lighted Roadway





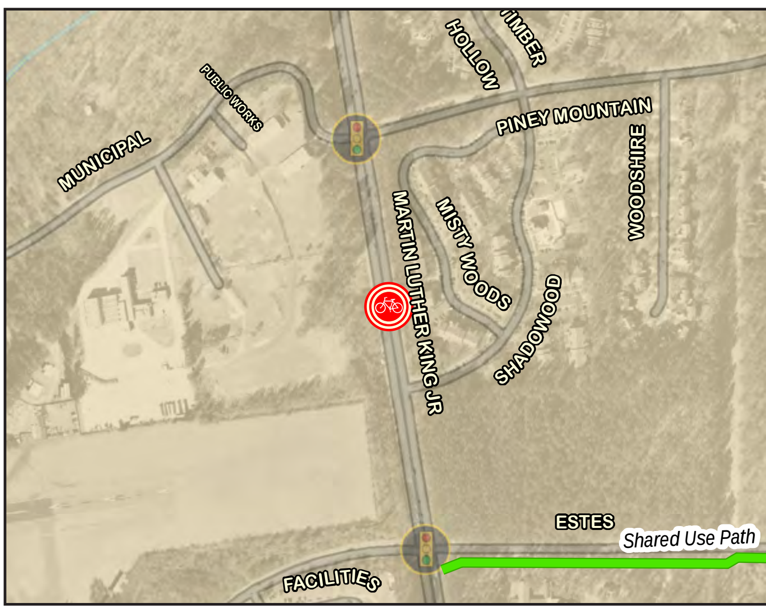
Crash Type
Bicyclist Ride Out - Signalized Intersection

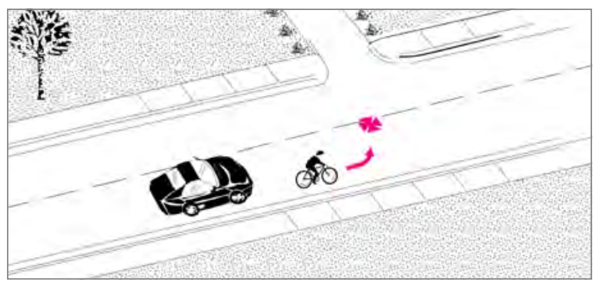
Injury Severity
C: Possible Injury

Speed Limit
30 - 35 MPH

Date
22APR2011

Light Condition
Daylight





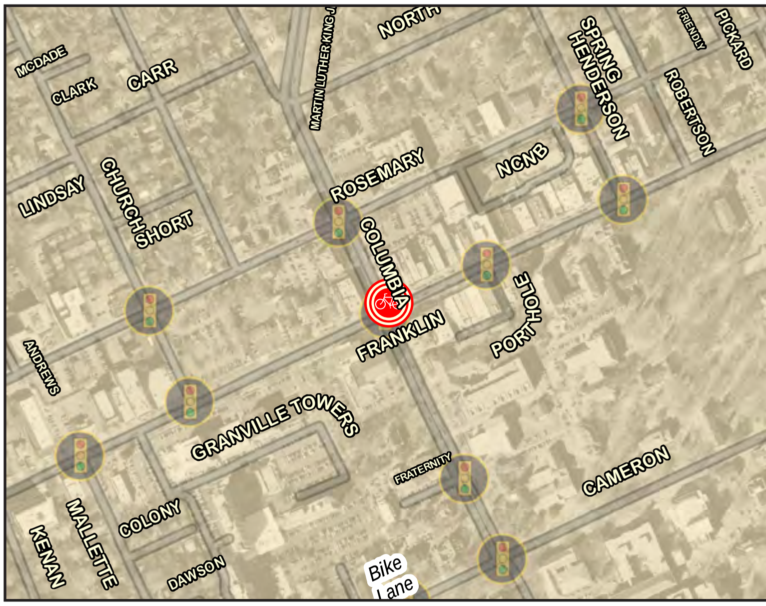
Crash Type
Bicyclist Left Turn - Same Direction

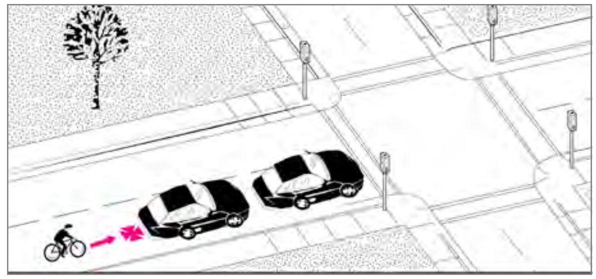
Injury Severity
A: Disabling Injury

Speed Limit
30 - 35 MPH

Date
06MAR2008

Light Condition
Daylight





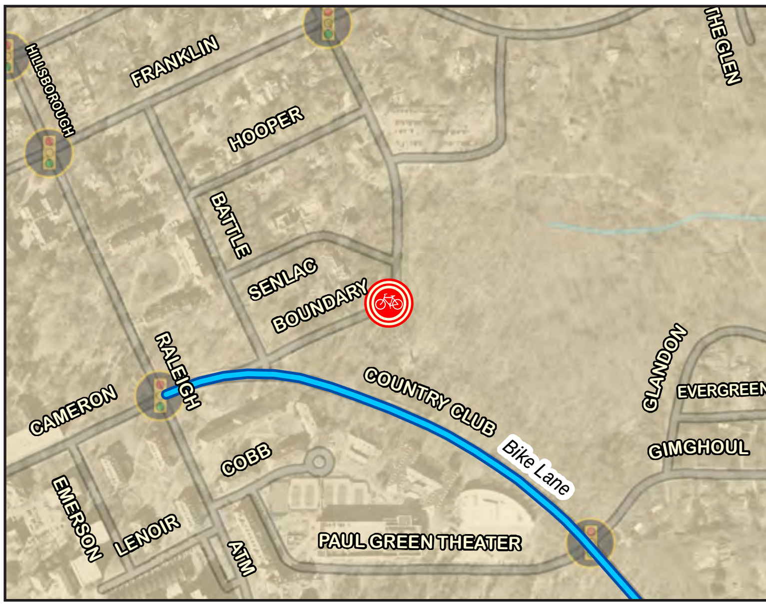
Crash Type
Bicyclist Overtaking - Passing on Right

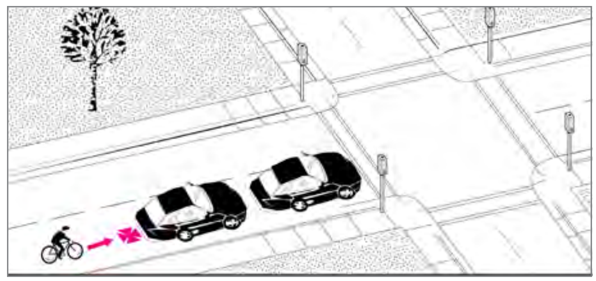
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
18AUG2008

Light Condition
Daylight





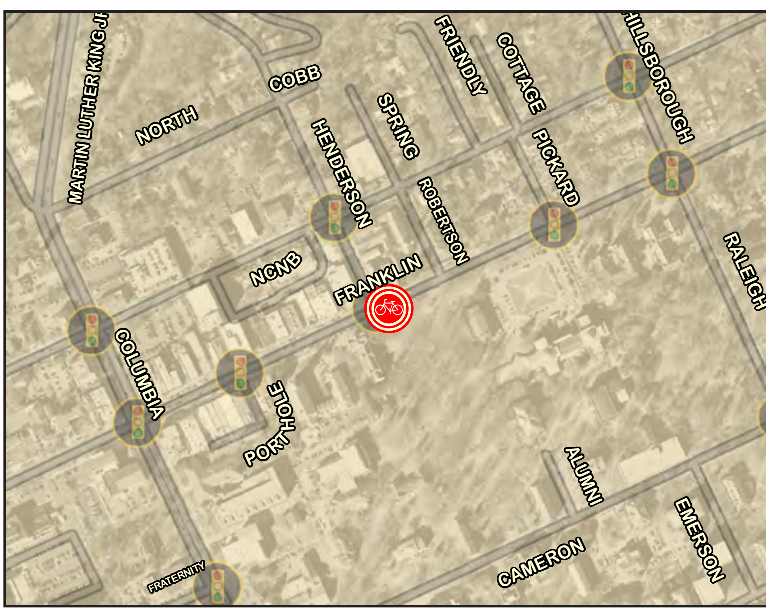
Crash Type
Bicyclist Overtaking - Passing on Right

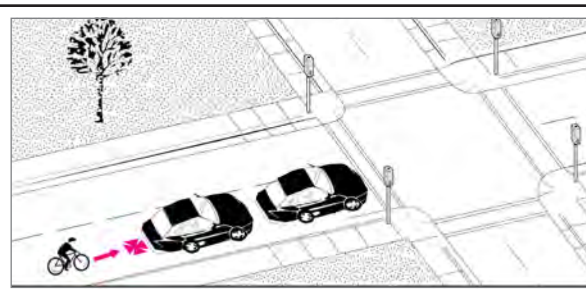
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
21FEB2009

Light Condition
Daylight





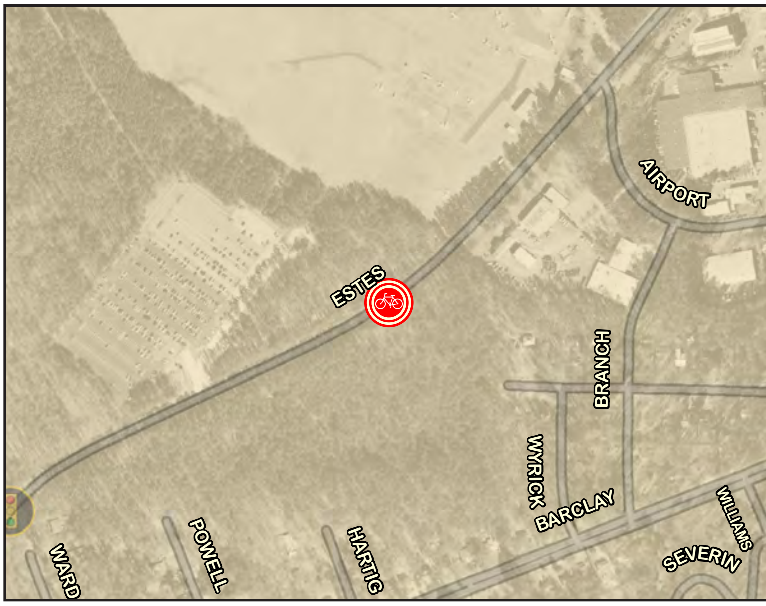
Crash Type
Bicyclist Overtaking - Passing on Right

Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
16MAY2009

Light Condition
Daylight



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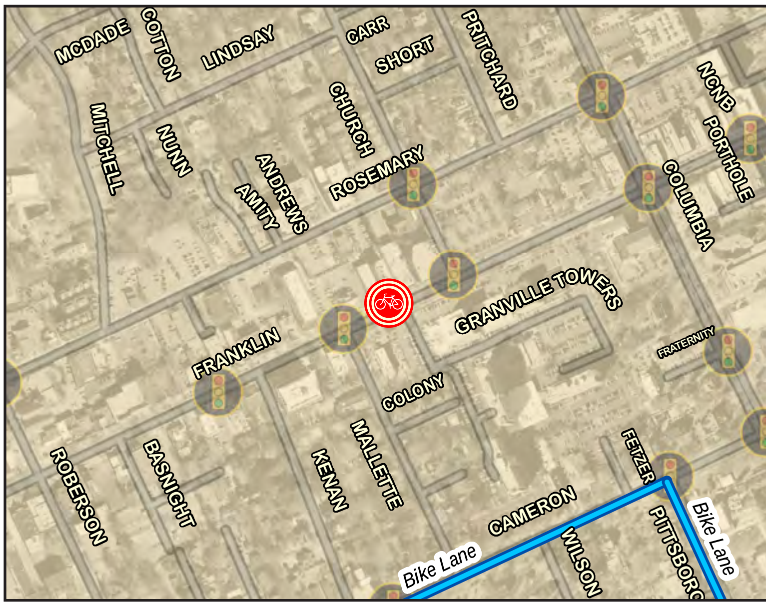
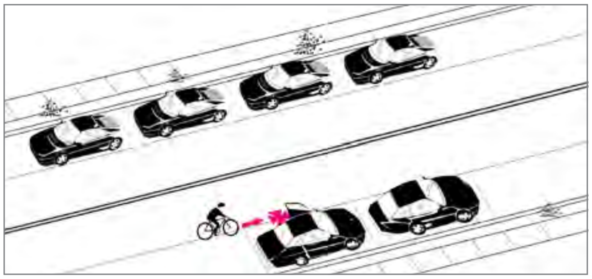
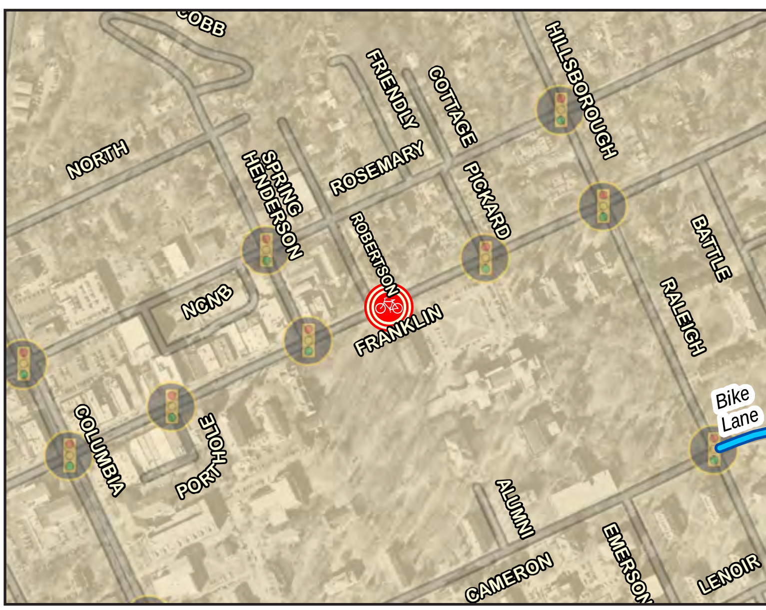
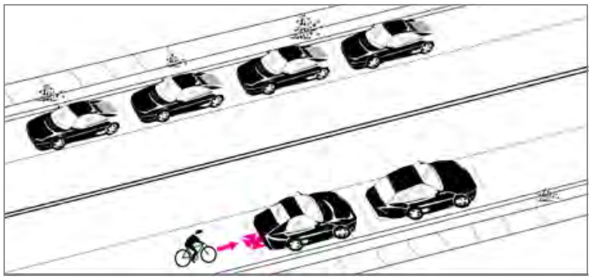
Crash Type	***Injury Severity***
Bicyclist Overtaking - Other / Unknown	C: Possible Injury
Speed Limit	***Date***
30 - 35 MPH	18JUN2009
Light Condition	
Daylight	



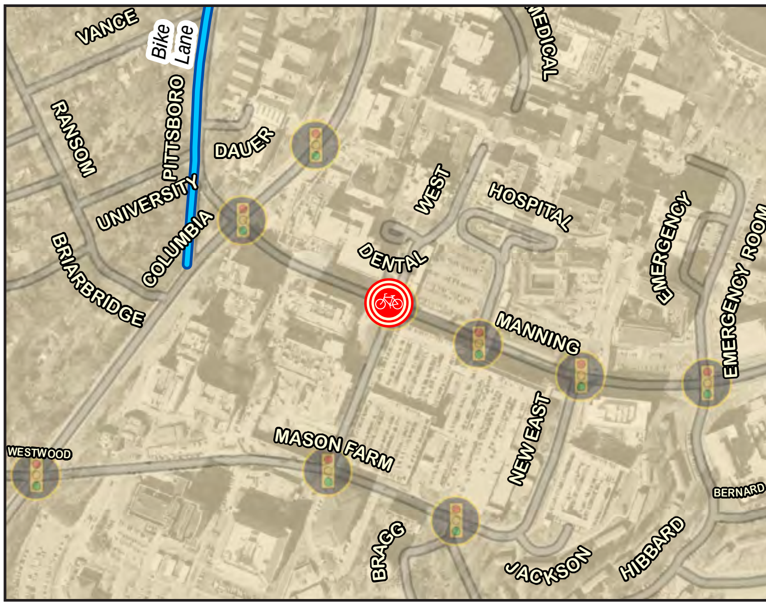


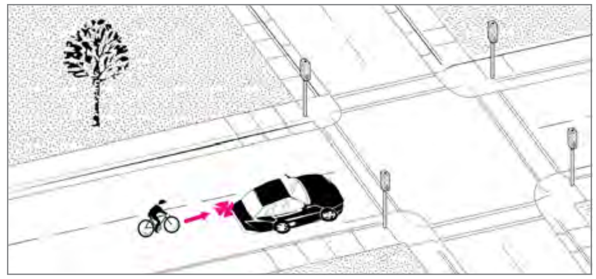
Crash Type	***Injury Severity***
Bicyclist Overtaking - Extended Door	C: Possible Injury
Speed Limit	***Date***
20 - 25 MPH	08SEP2010
Light Condition	
Daylight	





Crash Type	***Injury Severity***
Bicyclist Overtaking - Parked Vehicle	B: Evident Injury
Speed Limit	***Date***
20 - 25 MPH	17OCT2010
Light Condition	
Dark - Lighted Roadway	





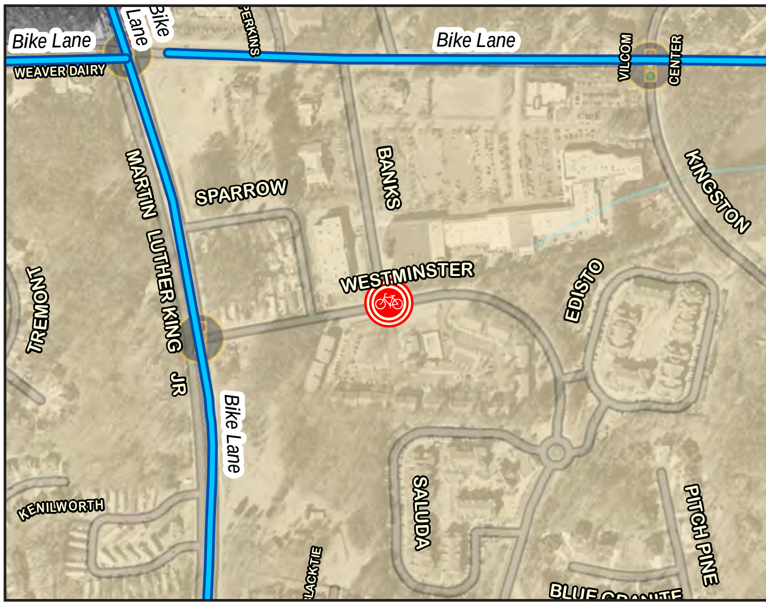
Crash Type
Bicyclist Overtaking - Passing on Left

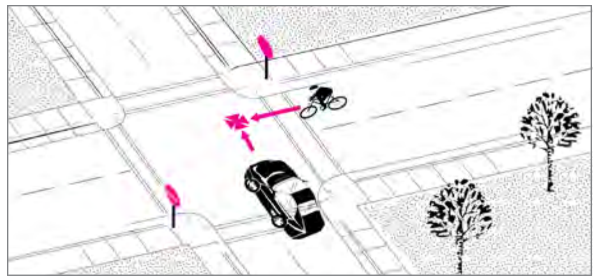
Injury Severity
O: No Injury

Speed Limit
20 - 25 MPH

Date
07SEP2011

Light Condition
Daylight





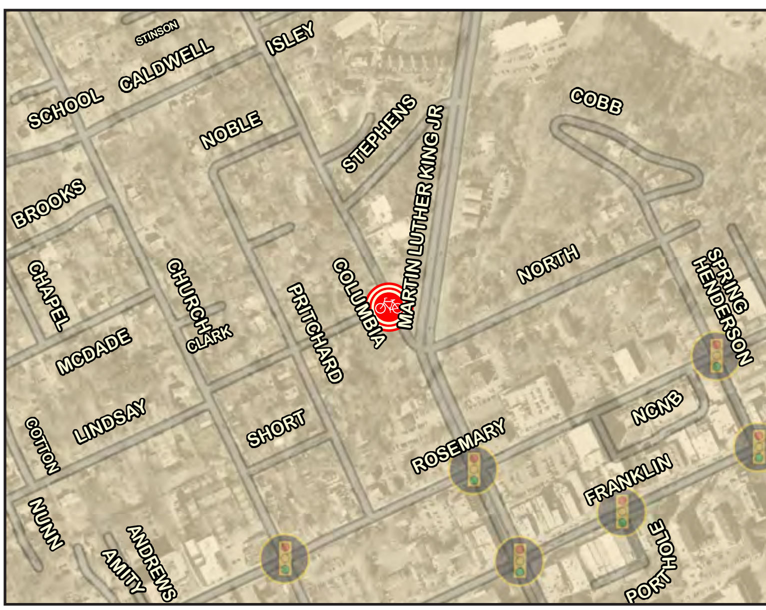
Crash Type
Sign-Controlled Intersection - Other / Unknown

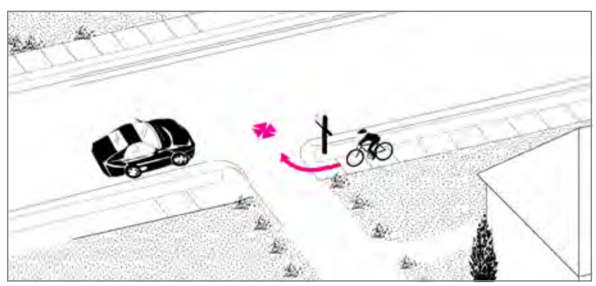
Injury Severity
B: Evident Injury

Speed Limit
Unknown

Date
12JUN2008

Light Condition
Daylight





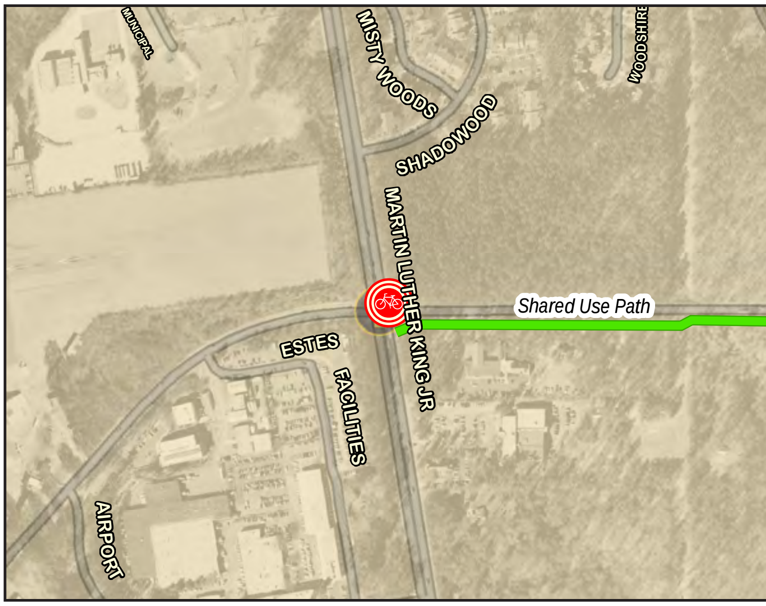
Crash Type
Crossing Paths - Uncontrolled Intersection

Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
29AUG2008

Light Condition
Dark - Lighted Roadway



?

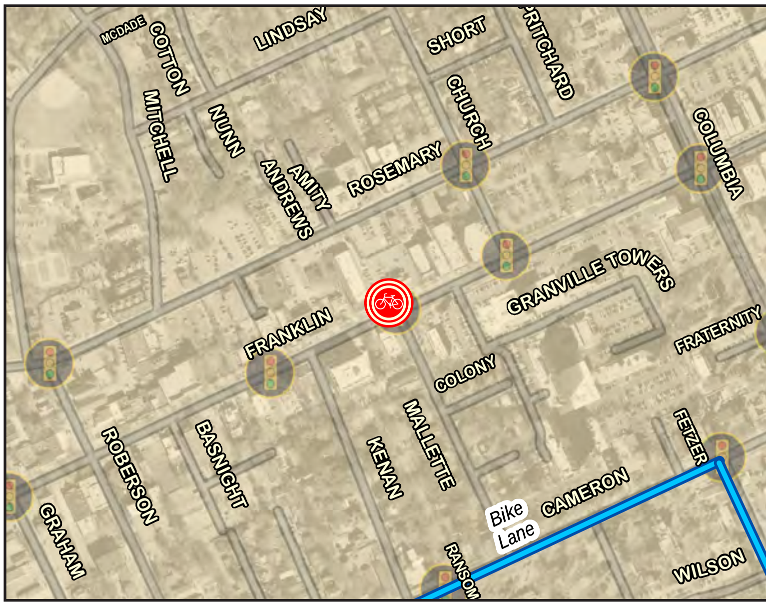
Crash Type
Signalized Intersection - Other / Unknown

Injury Severity
B: Evident Injury

Speed Limit
30 - 35 MPH

Date
12SEP2008

Light Condition
Dark - Roadway Not Lighted



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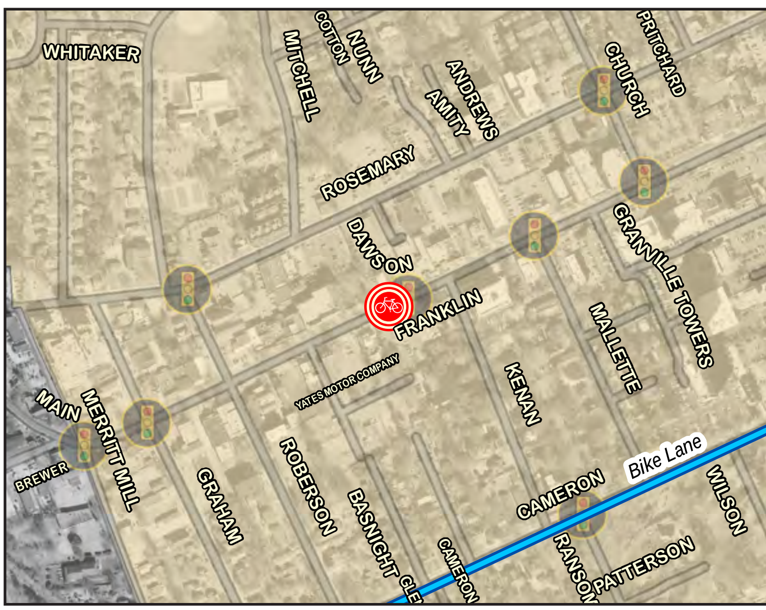
Crash Type
Signalized Intersection - Other / Unknown

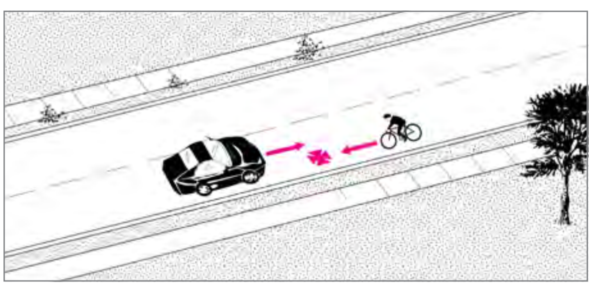
Injury Severity
C: Possible Injury

Speed Limit
5 - 15 MPH

Date
16DEC2008

Light Condition
Dark - Lighted Roadway





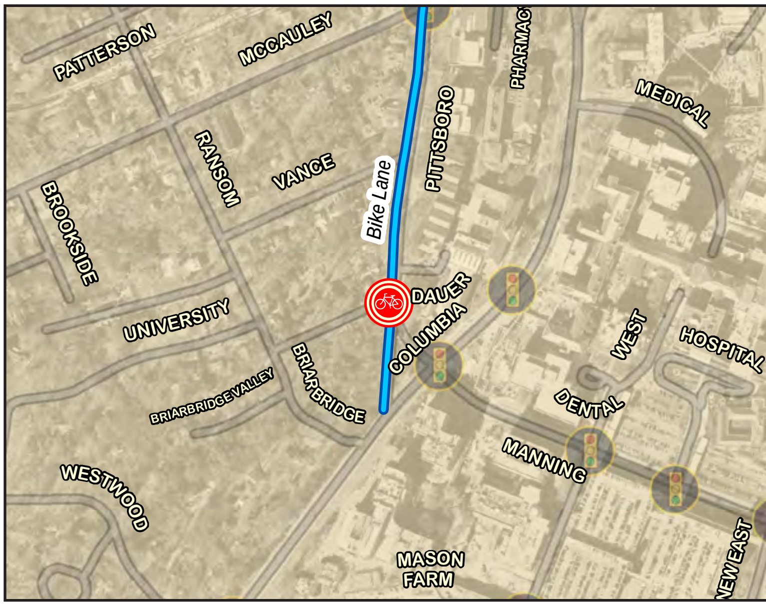
Crash Type
Head-On - Motorist

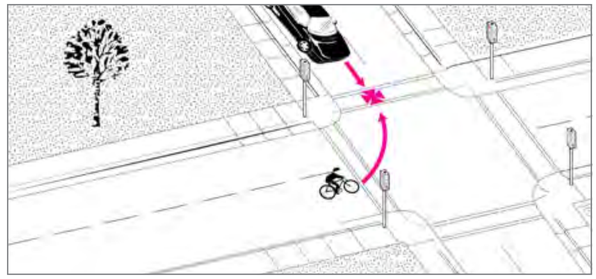
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
28MAY2008

Light Condition
Daylight





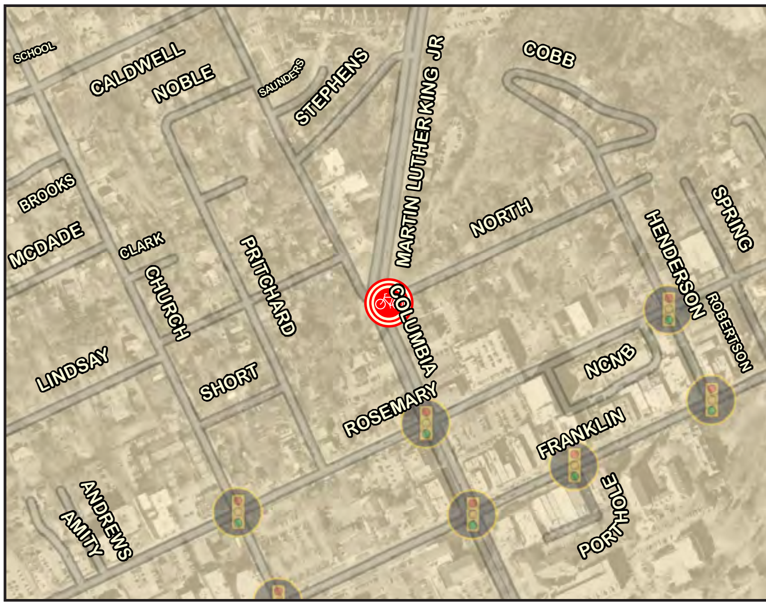
Crash Type
Bicyclist Turning Error - Left Turn

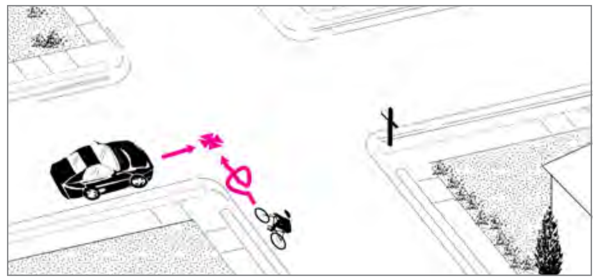
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
10JUL2007

Light Condition
Daylight





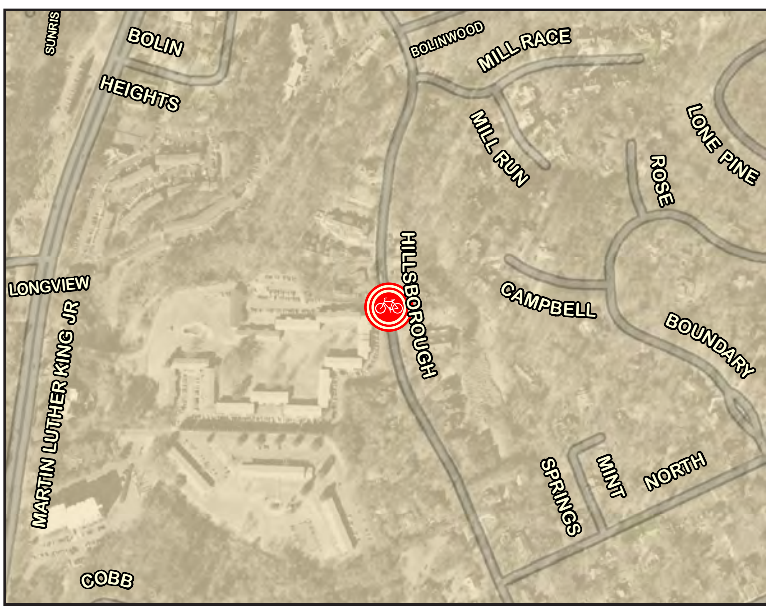
Crash Type
Bicyclist Lost Control - Other / Unknown

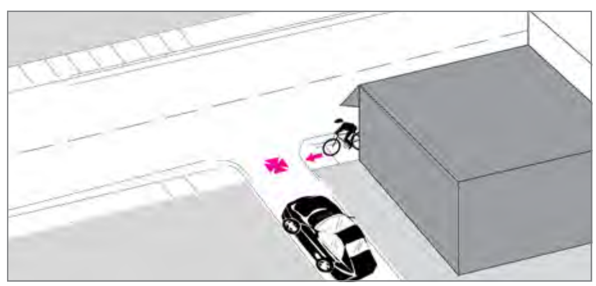
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
13OCT2011

Light Condition
Daylight





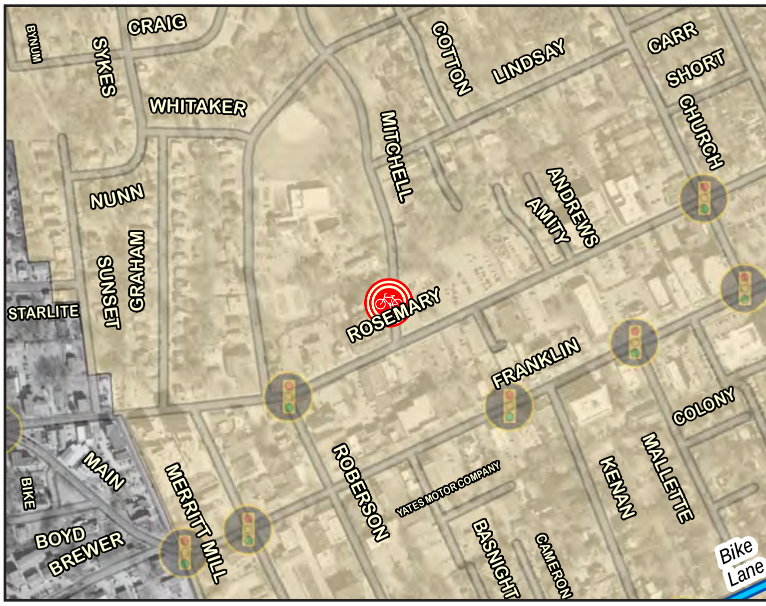
Crash Type
Motorist Drive Out - Residential Driveway

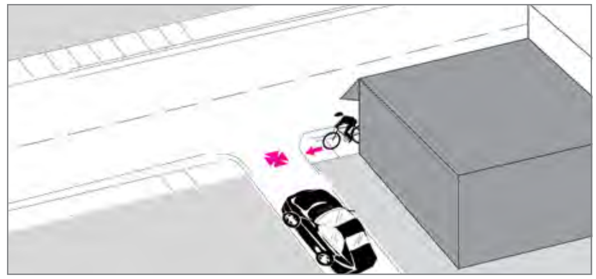
Injury Severity
O: No Injury

Speed Limit
20 - 25 MPH

Date
24MAY2008

Light Condition
Daylight





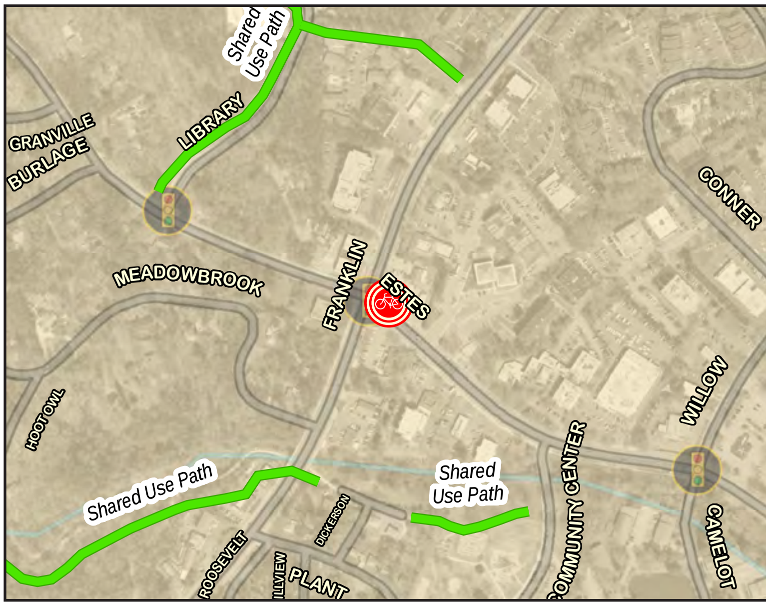
Crash Type
Motorist Drive Out - Commercial Driveway / Alley

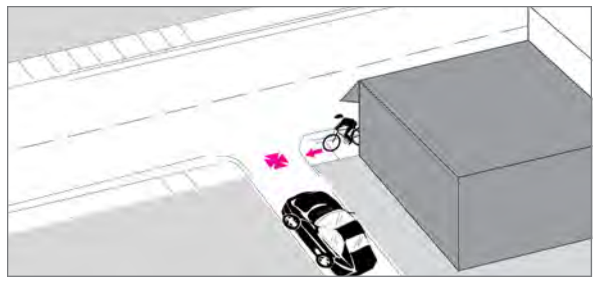
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
05OCT2008

Light Condition
Daylight





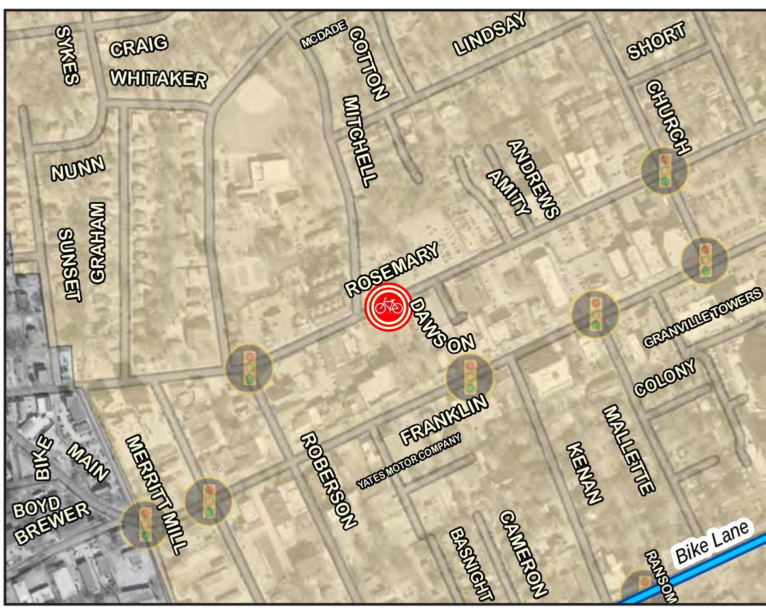
Crash Type
Motorist Drive Out - Residential Driveway

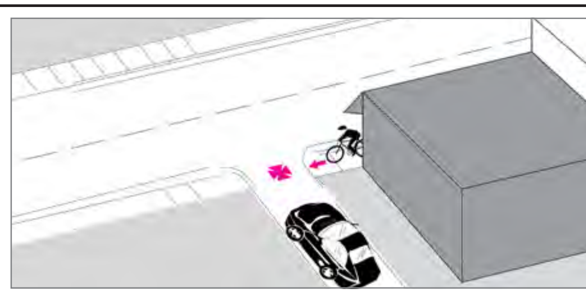
Injury Severity
B: Evident Injury

Speed Limit
30 - 35 MPH

Date
12JUN2009

Light Condition
Daylight





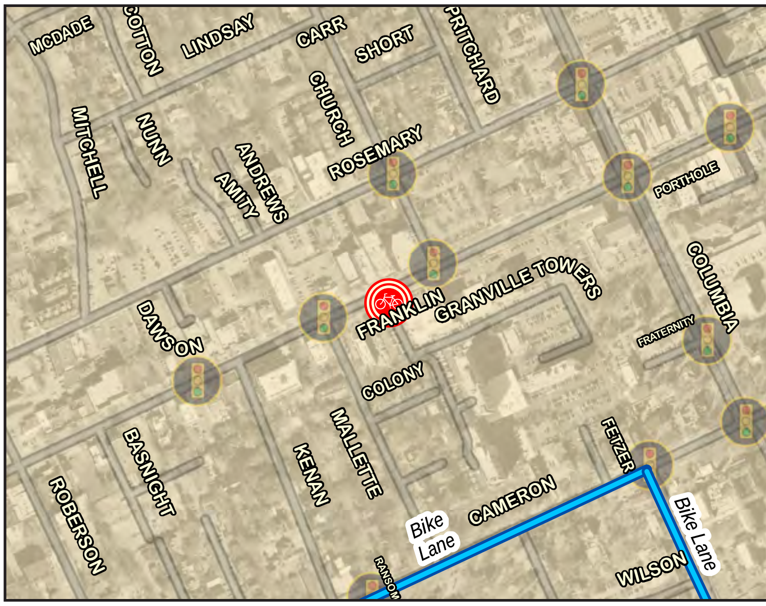
Crash Type
Motorist Drive Out - Commercial Driveway / Alley

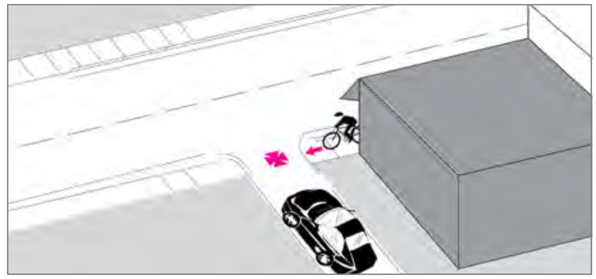
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
28OCT2010

Light Condition
Dark - Lighted Roadway





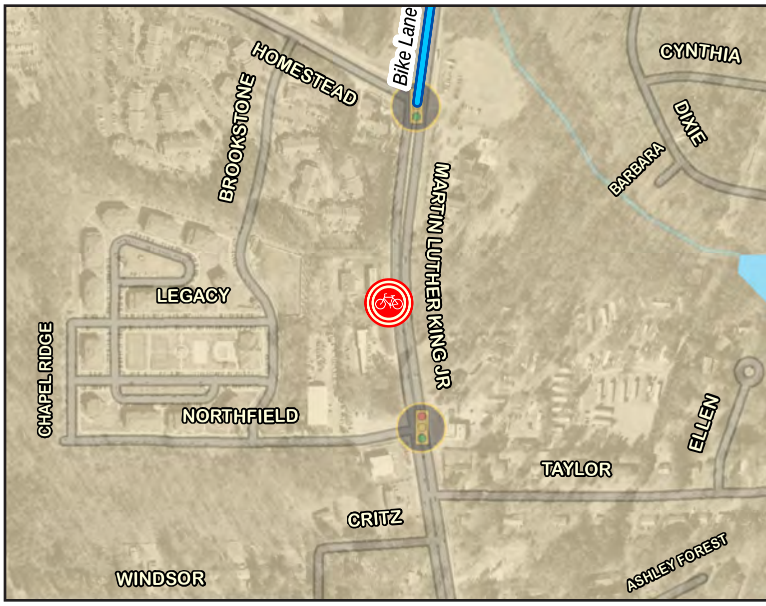
Crash Type
Motorist Drive Out - Commercial Driveway / Alley

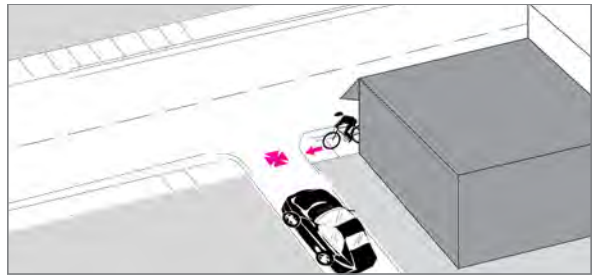
Injury Severity
C: Possible Injury

Speed Limit
5 - 15 MPH

Date
19JUL2011

Light Condition
Daylight





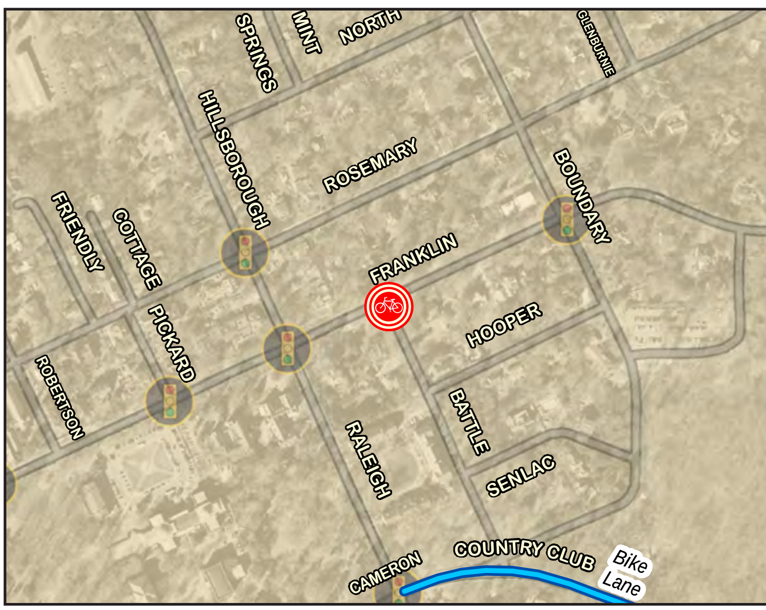
Crash Type
Motorist Drive Out - Commercial Driveway / Alley

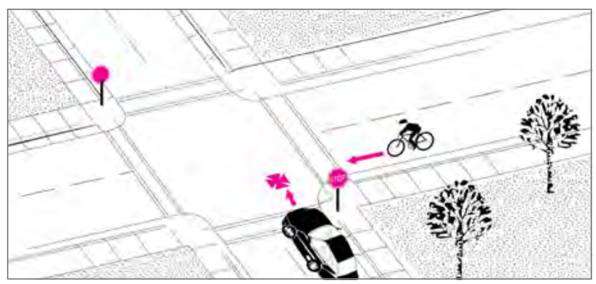
Injury Severity
C: Possible Injury

Speed Limit
30 - 35 MPH

Date
13AUG2011

Light Condition
Daylight





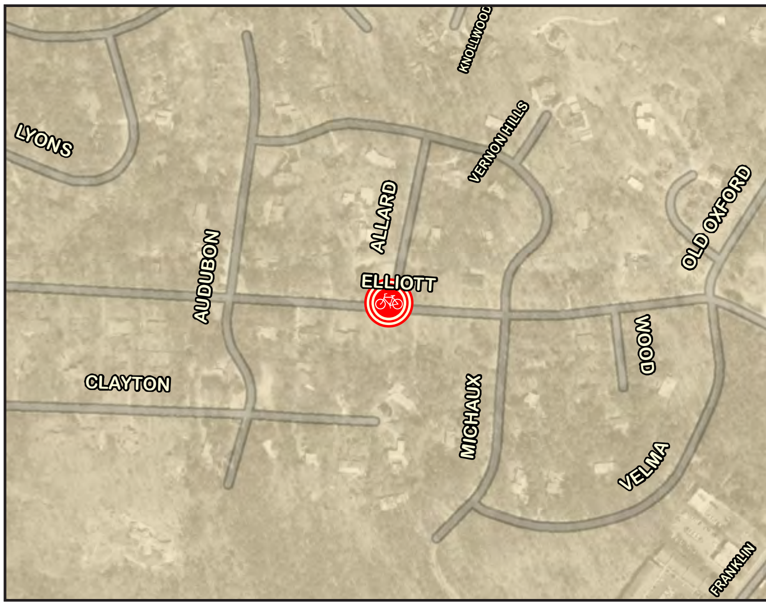
Crash Type
Motorist Drive Out - Sign-Controlled Intersection

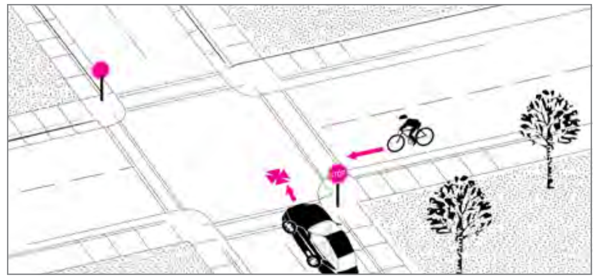
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
31MAY2007

Light Condition
Dark - Roadway Not Lighted





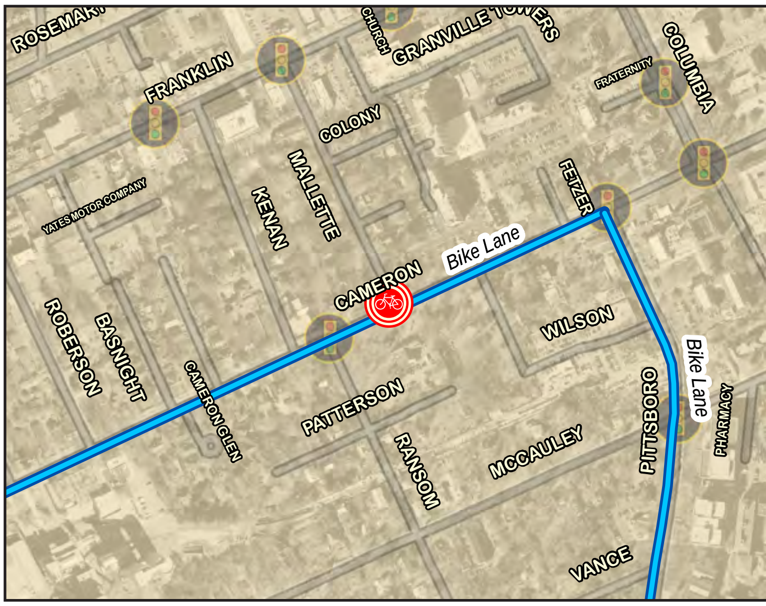
Crash Type
Motorist Drive Out - Sign-Controlled Intersection

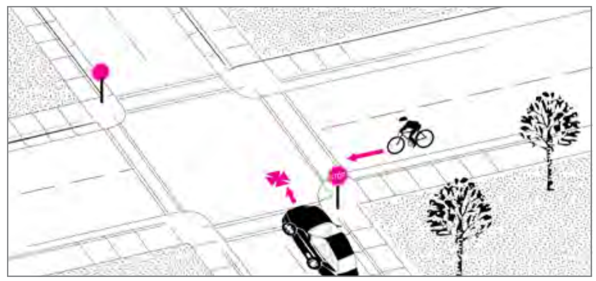
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
11MAR2008

Light Condition
Daylight





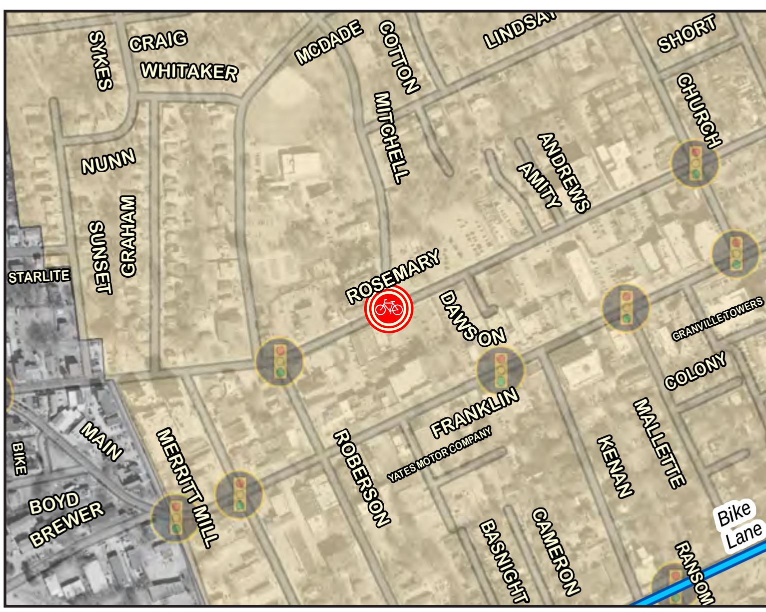
Crash Type
Motorist Drive Out - Sign-Controlled Intersection

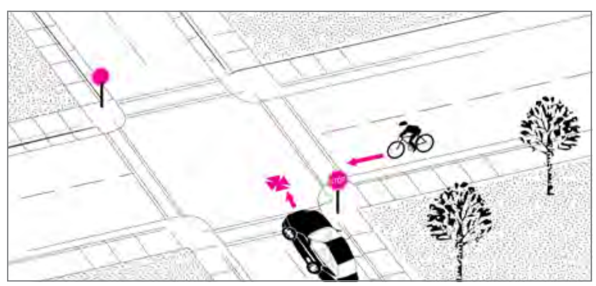
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
10JUN2008

Light Condition
Daylight





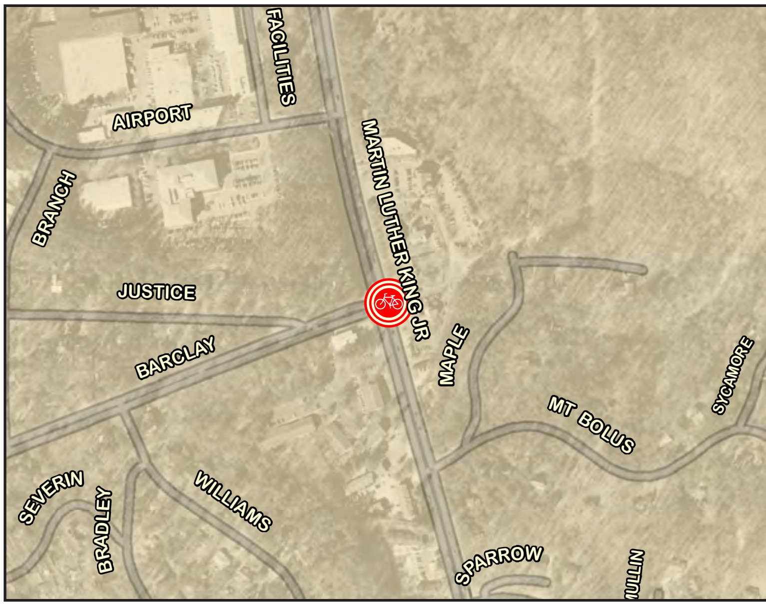
Crash Type
Motorist Drive Out - Sign-Controlled Intersection

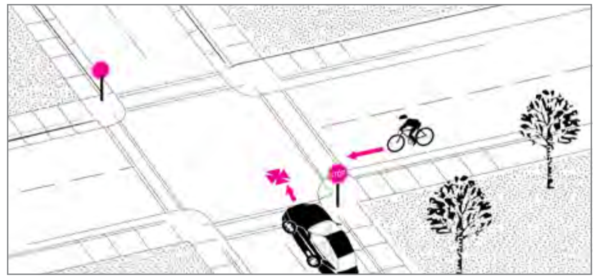
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
25JUL2009

Light Condition
Daylight





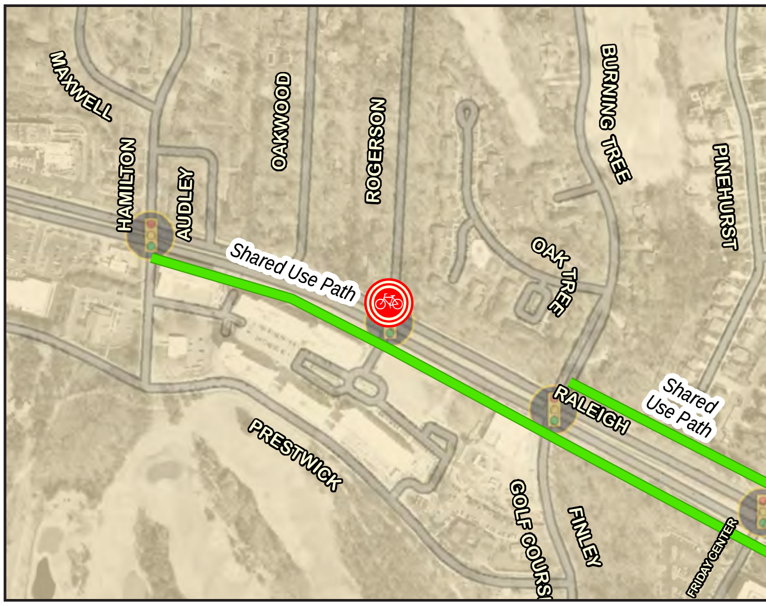
Crash Type
Motorist Drive Out - Sign-Controlled Intersection

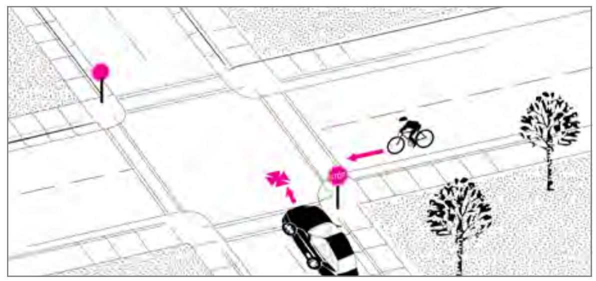
Injury Severity
C: Possible Injury

Speed Limit
5 - 15 MPH

Date
27MAY2011

Light Condition
Daylight





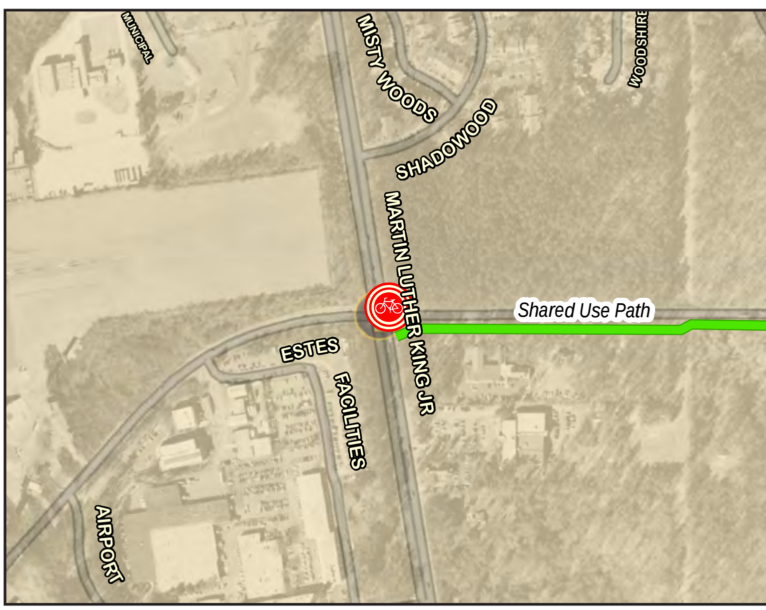
Crash Type
Motorist Drive Out - Sign-Controlled Intersection

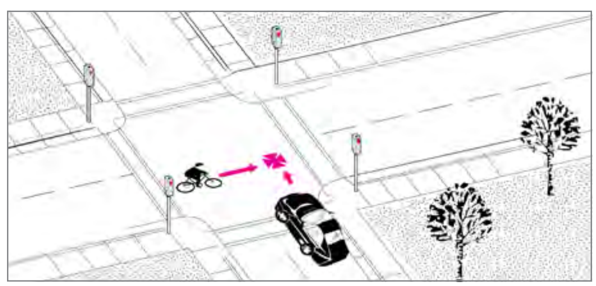
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
04AUG2011

Light Condition
Daylight





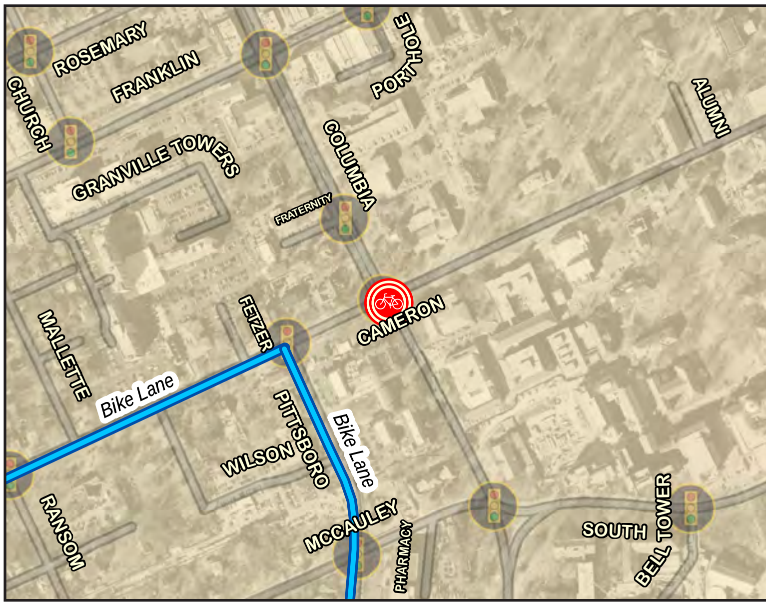
Crash Type
Motorist Drive Out - Right Turn on Red

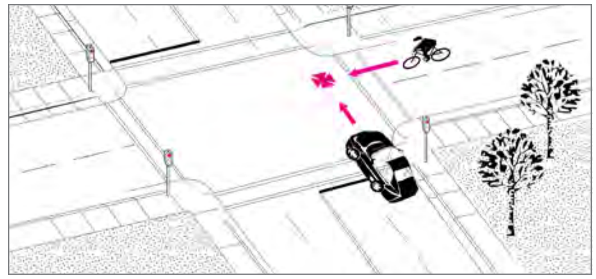
Injury Severity
C: Possible Injury

Speed Limit
30 - 35 MPH

Date
21JUL2008

Light Condition
Daylight





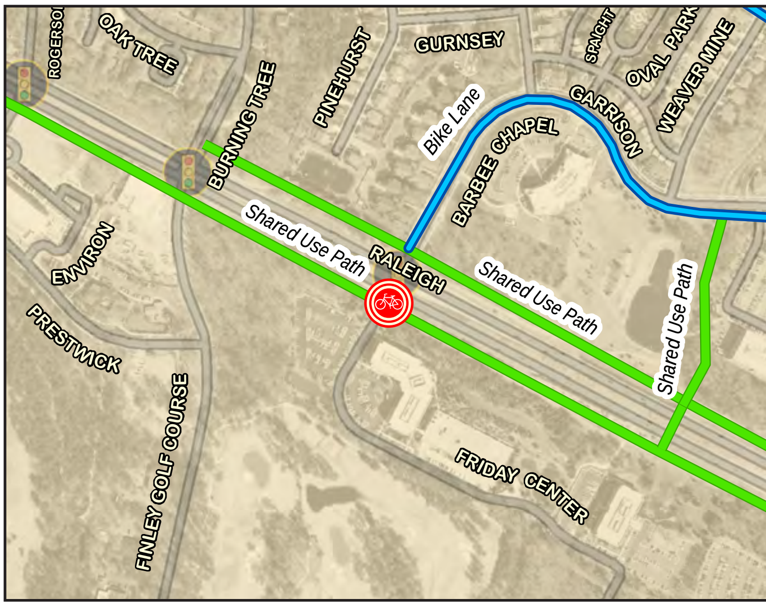
Crash Type
Motorist Drive Through - Signalized Intersection

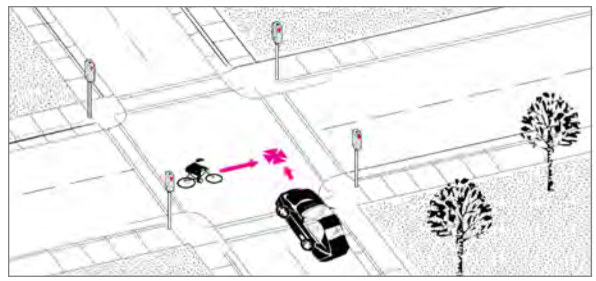
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
06AUG2009

Light Condition
Daylight





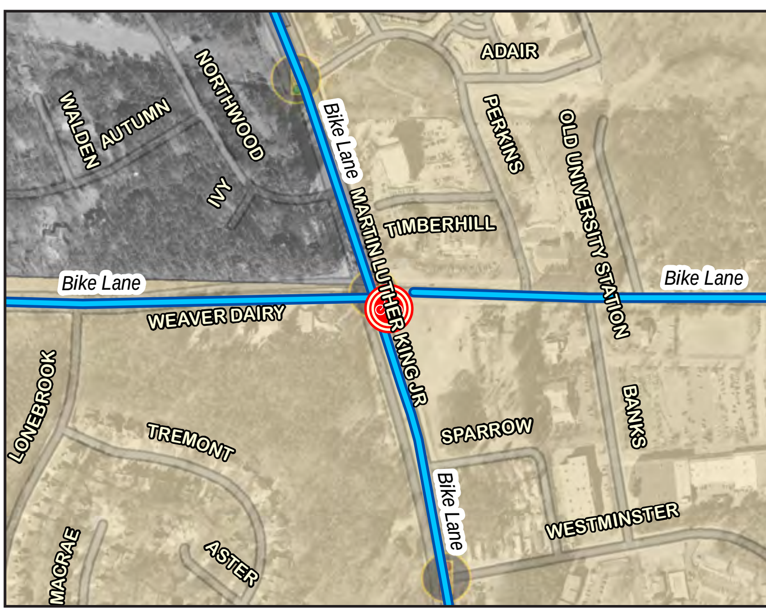
Crash Type
Motorist Drive Out - Signalized Intersection

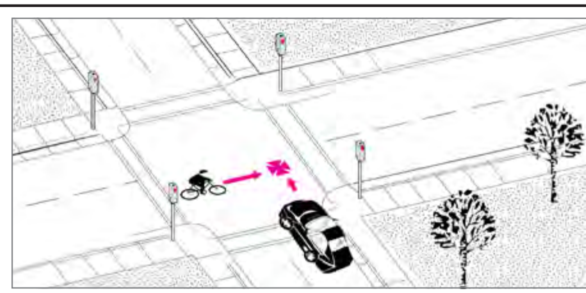
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
30APR2010

Light Condition
Daylight





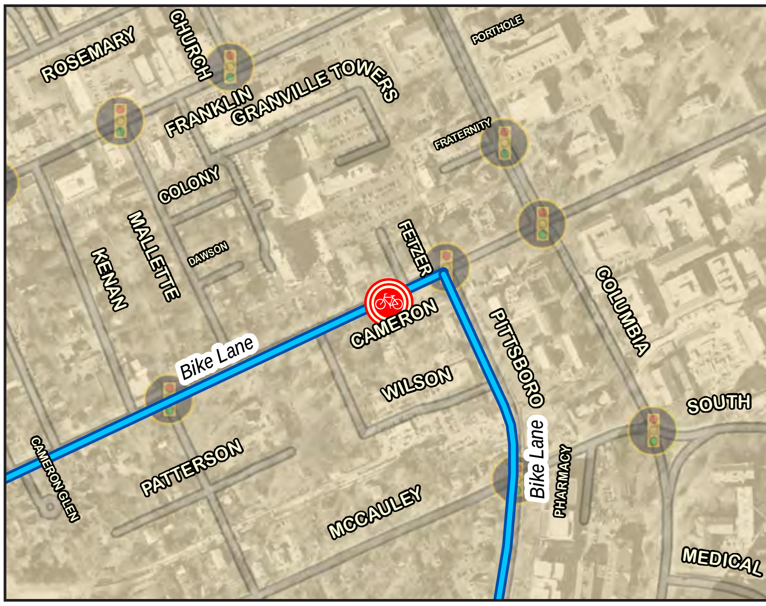
Crash Type
Motorist Drive Out - Signalized Intersection

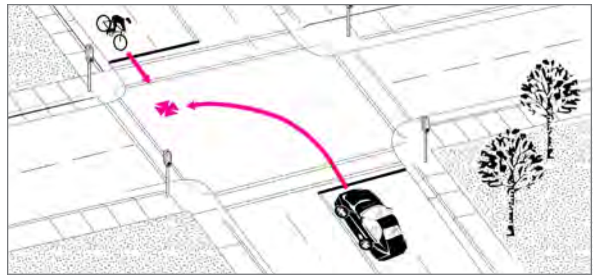
Injury Severity
B: Evident Injury

Speed Limit
30 - 35 MPH

Date
06MAY2010

Light Condition
Daylight





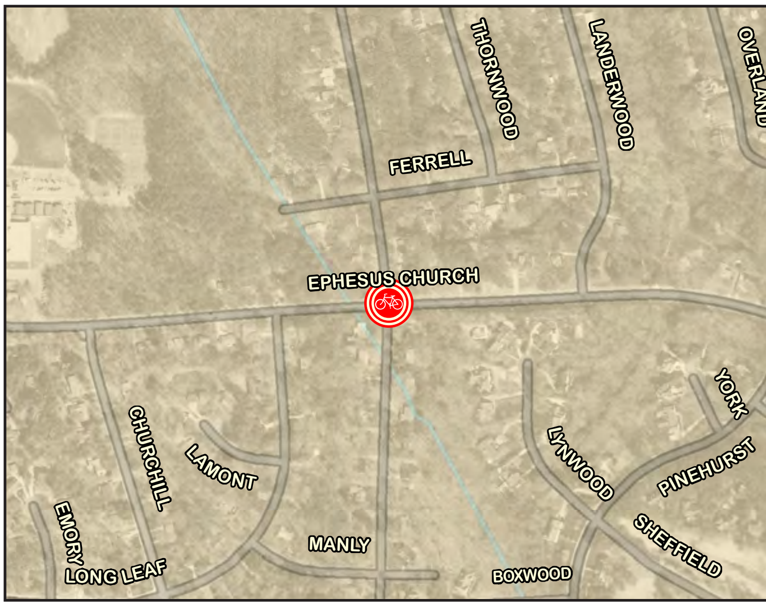
Crash Type
Motorist Left Turn - Opposite Direction

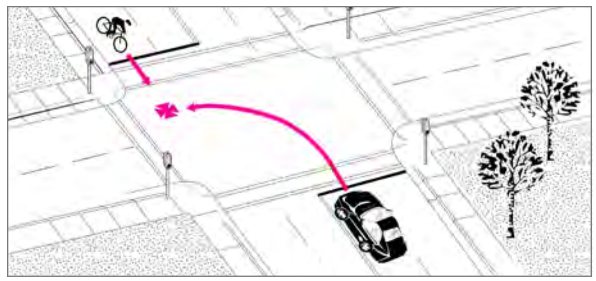
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
12SEP2007

Light Condition
Daylight





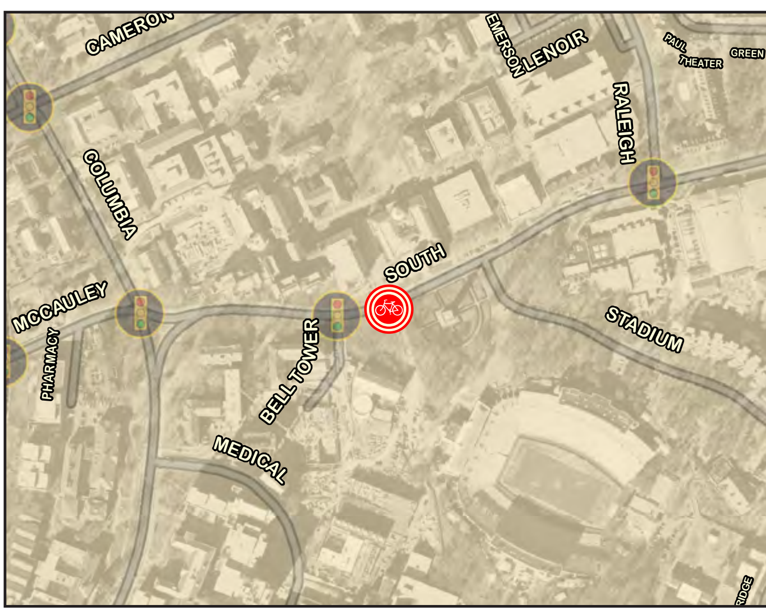
Crash Type
Motorist Left Turn - Opposite Direction

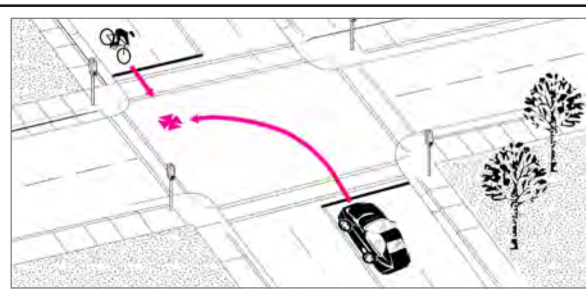
Injury Severity
C: Possible Injury

Speed Limit
30 - 35 MPH

Date
16MAR2008

Light Condition
Daylight





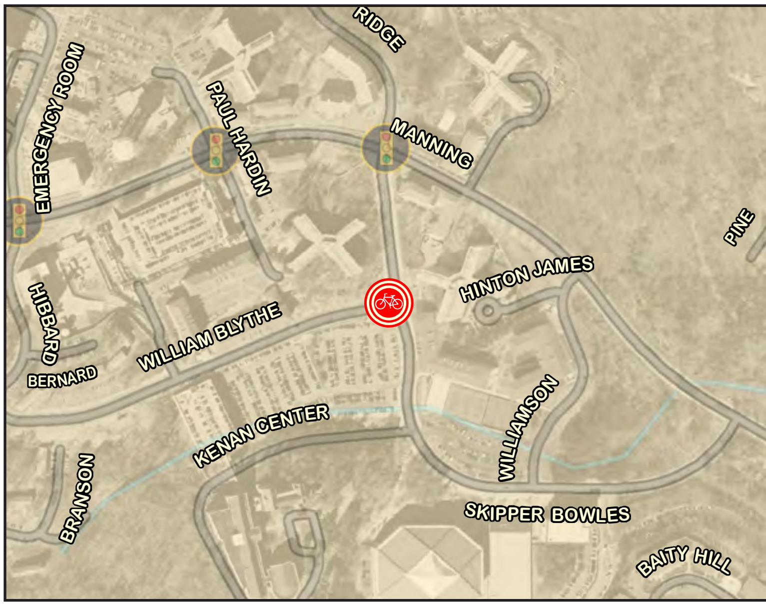
Crash Type
Motorist Left Turn - Opposite Direction

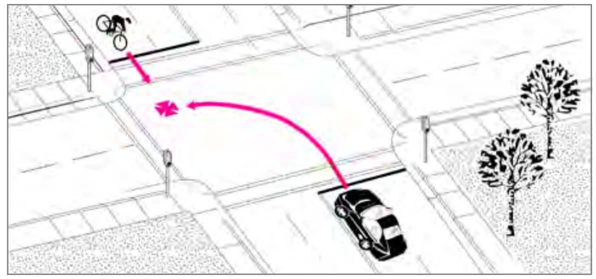
Injury Severity
C: Possible Injury

Speed Limit
Unknown

Date
16APR2008

Light Condition
Daylight





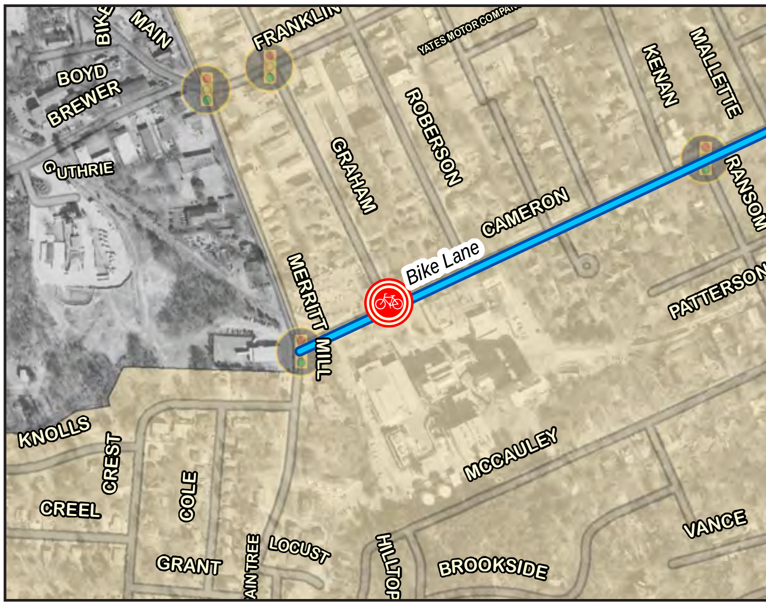
Crash Type
Motorist Left Turn - Opposite Direction

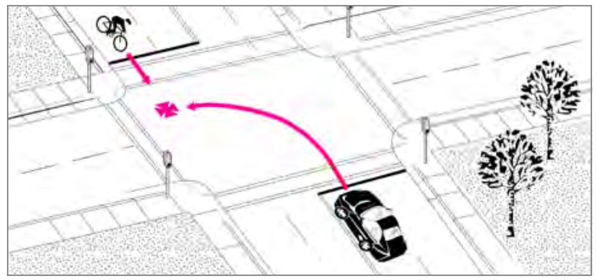
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
09SEP2009

Light Condition
Unknown





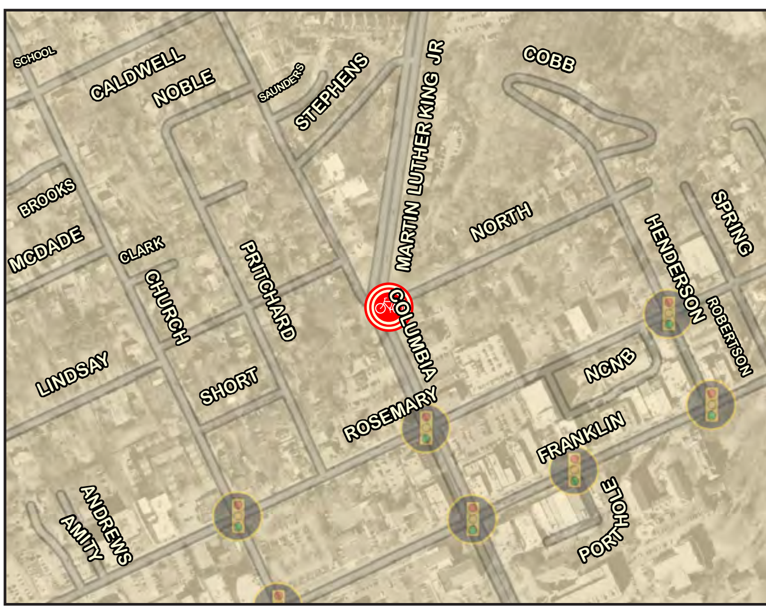
Crash Type
Motorist Left Turn - Opposite Direction

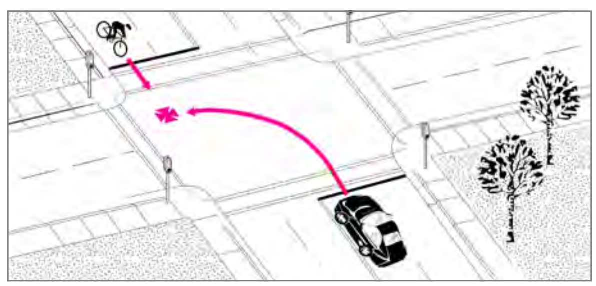
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
23NOV2009

Light Condition
Dark - Lighted Roadway





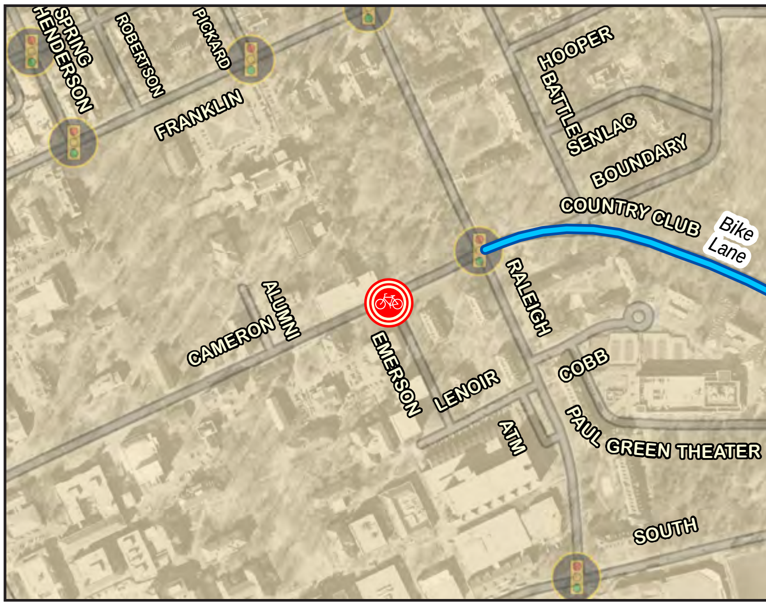
Crash Type
Motorist Left Turn - Opposite Direction

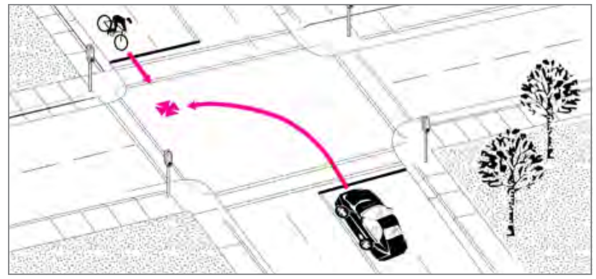
Injury Severity
B: Evident Injury

Speed Limit
30 - 35 MPH

Date
05MAR2010

Light Condition
Daylight





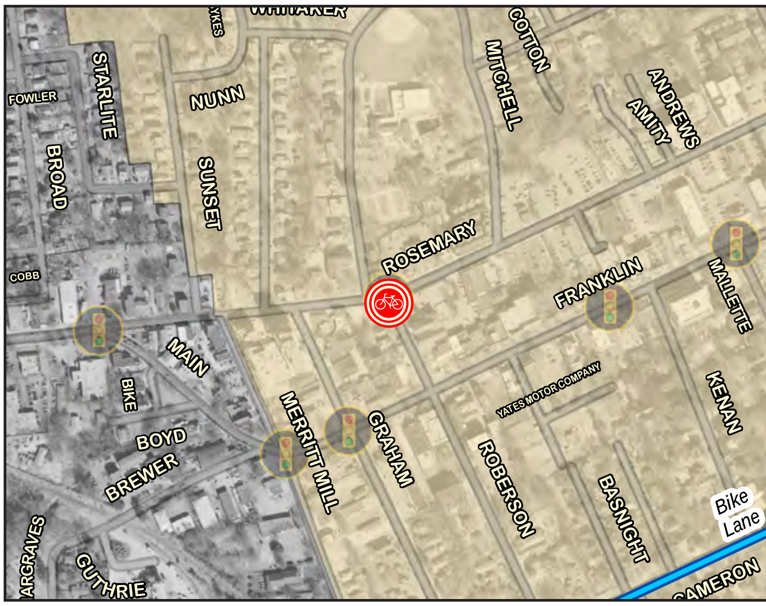
Crash Type
Motorist Left Turn - Opposite Direction

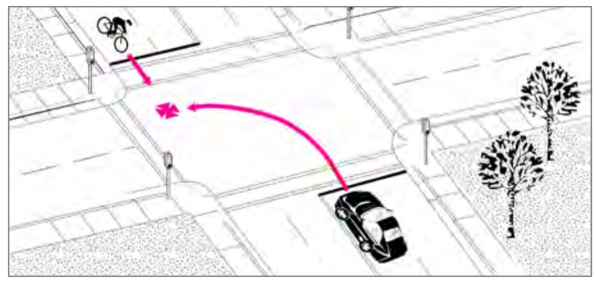
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
25AUG2010

Light Condition
Daylight





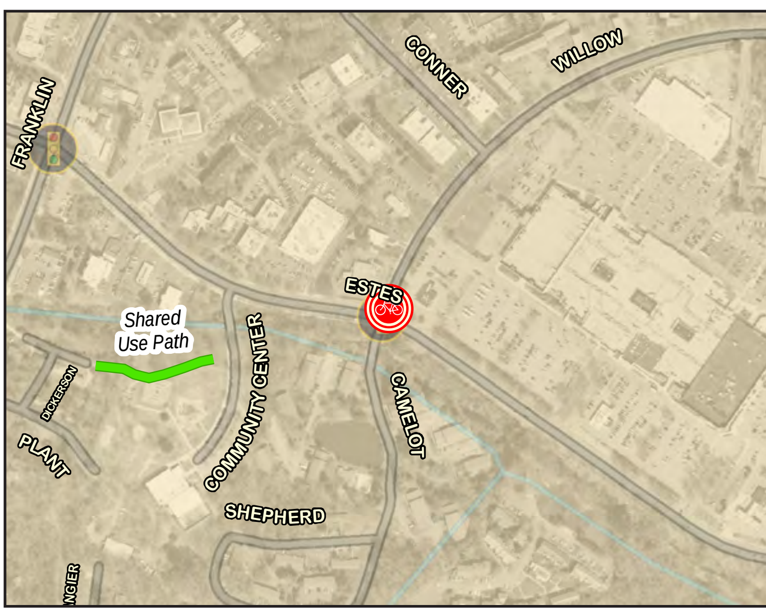
Crash Type
Motorist Left Turn - Opposite Direction

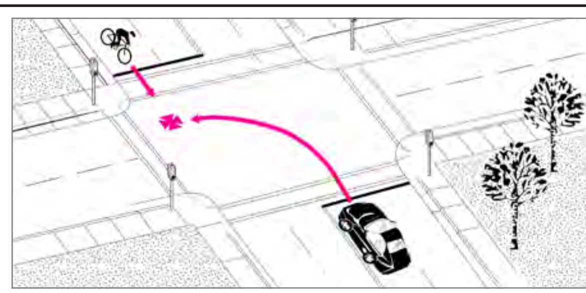
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
16OCT2010

Light Condition
Daylight





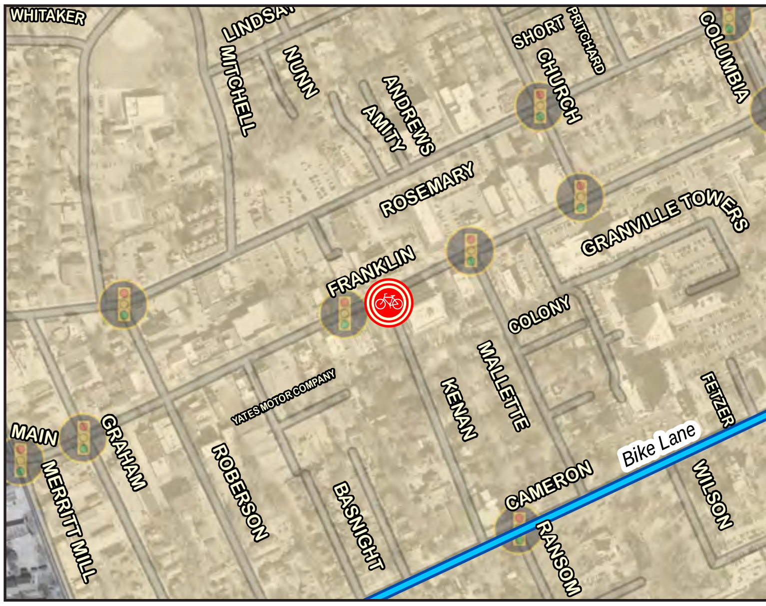
Crash Type
Motorist Left Turn - Opposite Direction

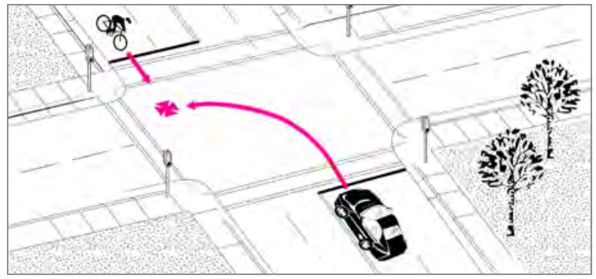
Injury Severity
C: Possible Injury

Speed Limit
30 - 35 MPH

Date
30NOV2010

Light Condition
Daylight





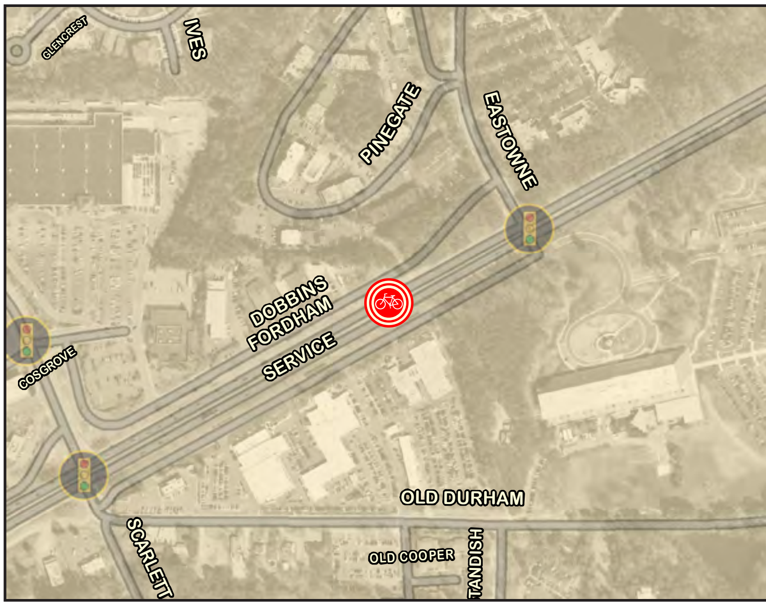
Crash Type
Motorist Left Turn - Opposite Direction

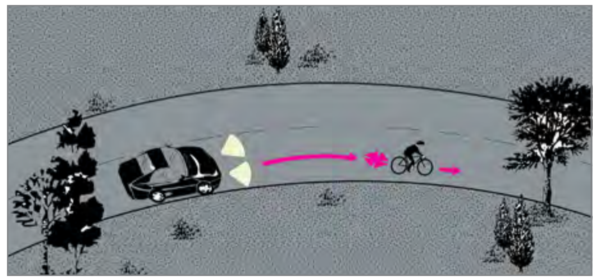
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
20SEP2011

Light Condition
Dark - Lighted Roadway





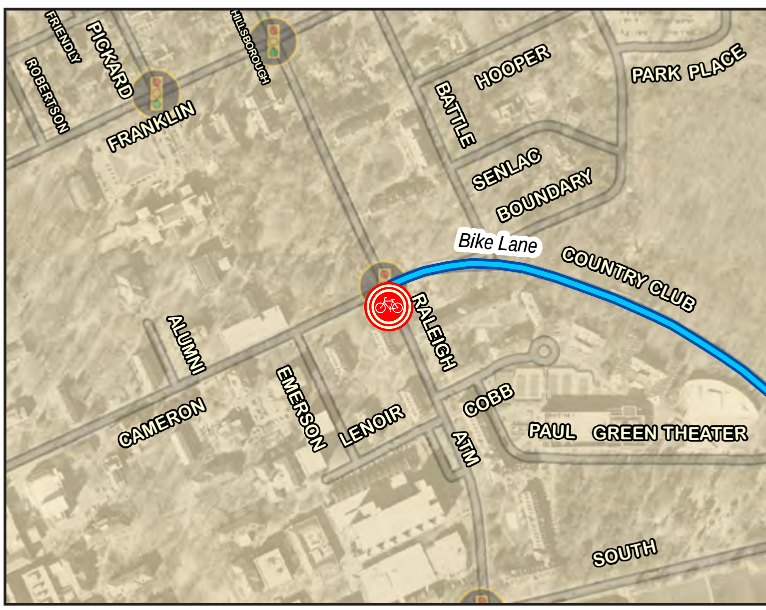
Crash Type
Motorist Overtaking - Undetected Bicyclist

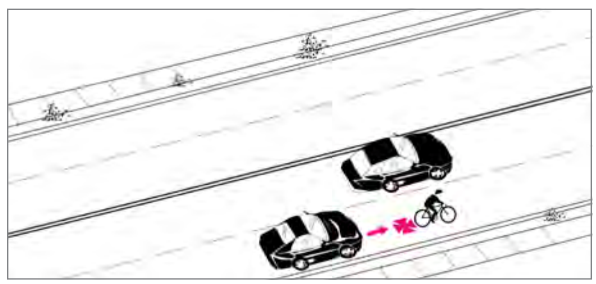
Injury Severity
C: Possible Injury

Speed Limit
40 - 45 MPH

Date
06APR2008

Light Condition
Dark - Roadway Not Lighted





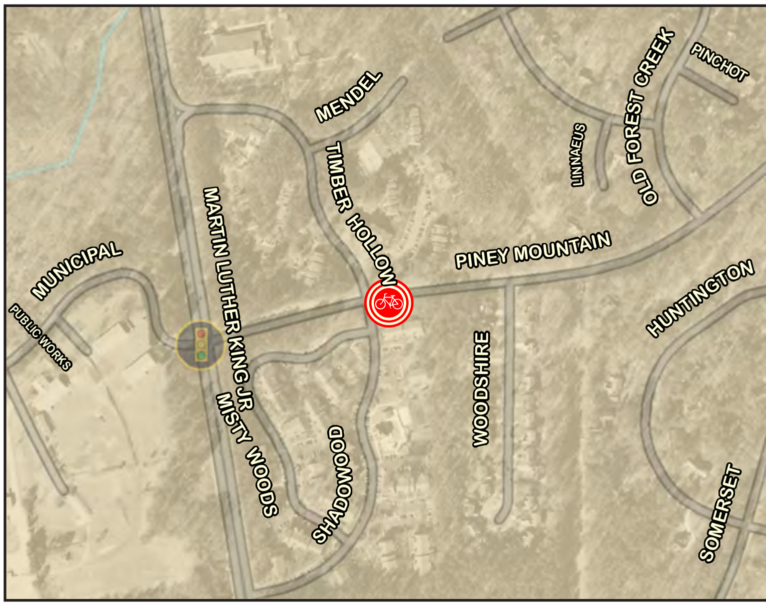
Crash Type
Motorist Overtaking - Misjudged Space

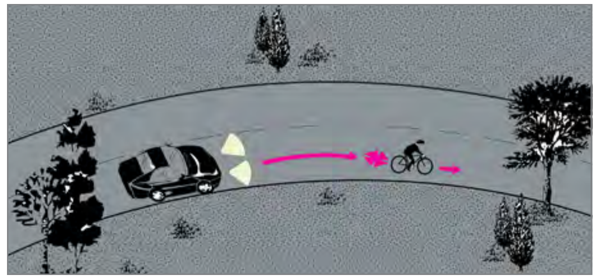
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
10SEP2009

Light Condition
Daylight





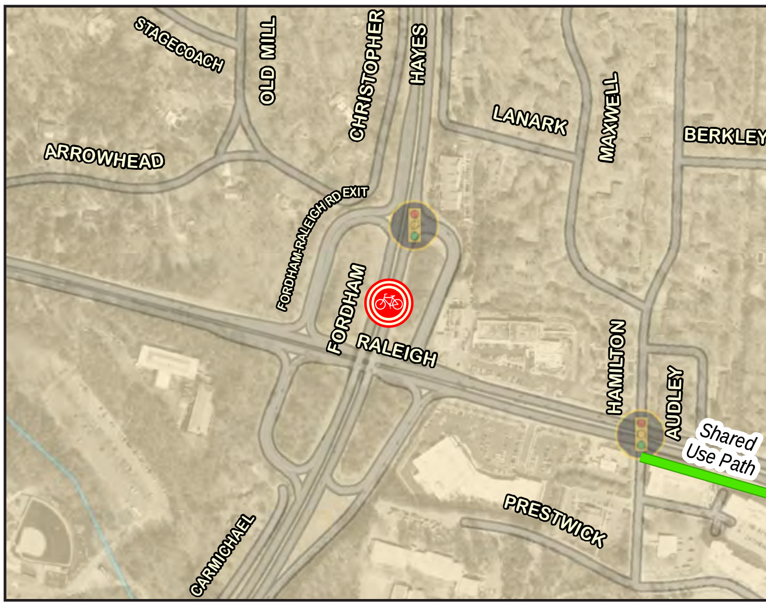
Crash Type
Motorist Overtaking - Undetected Bicyclist

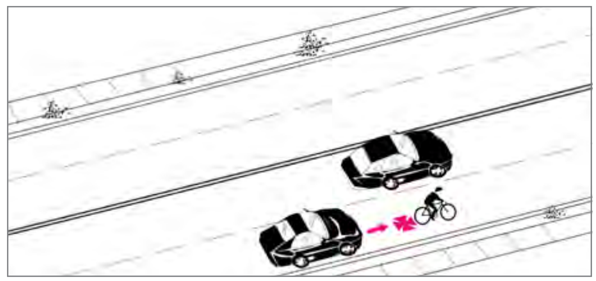
Injury Severity
C: Possible Injury

Speed Limit
30 - 35 MPH

Date
28SEP2010

Light Condition
Daylight





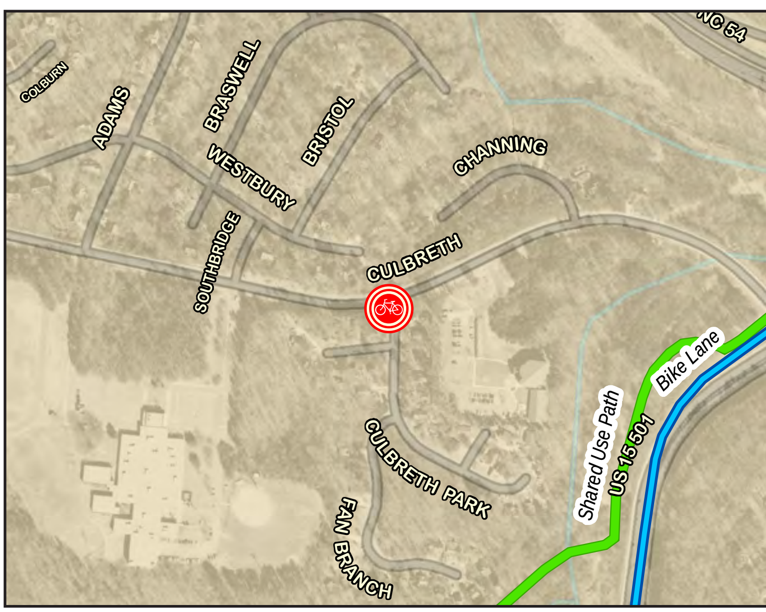
Crash Type
Motorist Overtaking - Misjudged Space

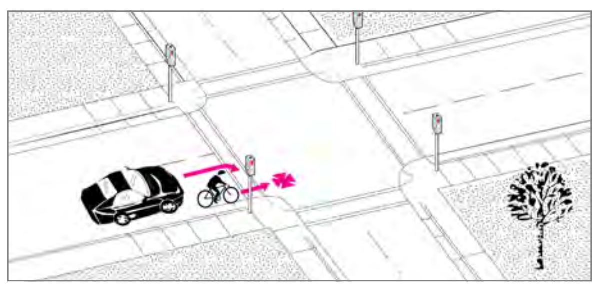
Injury Severity
C: Possible Injury

Speed Limit
40 - 45 MPH

Date
16MAY2011

Light Condition
Daylight





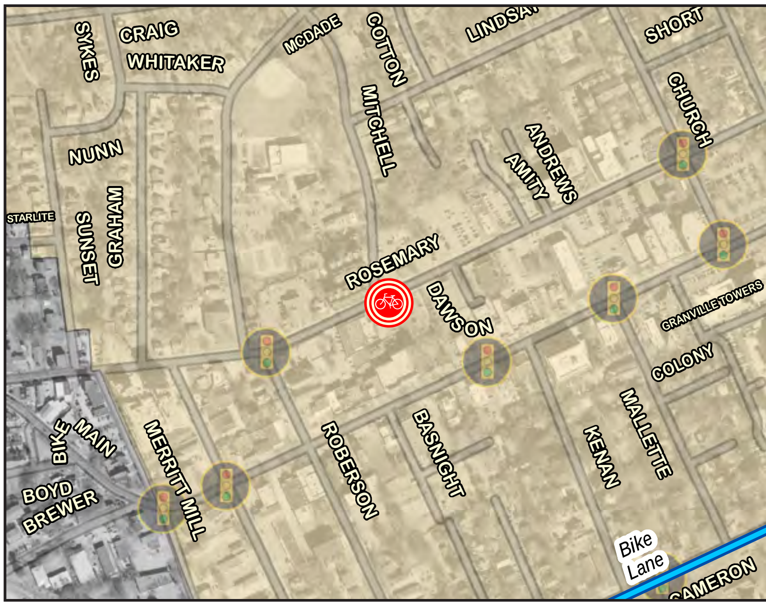
Crash Type
Motorist Right Turn - Same Direction

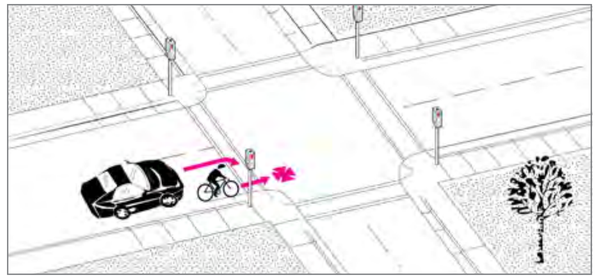
Injury Severity
B: Evident Injury

Speed Limit
30 - 35 MPH

Date
04FEB2008

Light Condition
Daylight





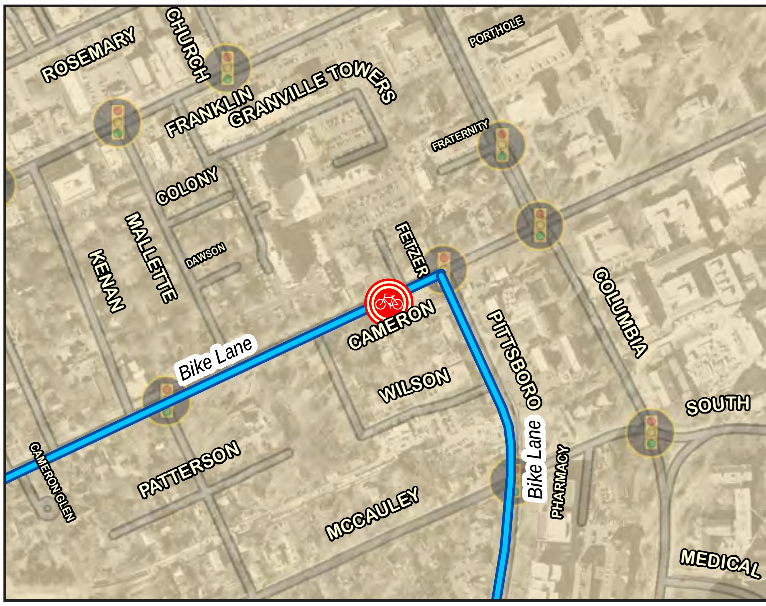
Crash Type
Motorist Right Turn - Same Direction

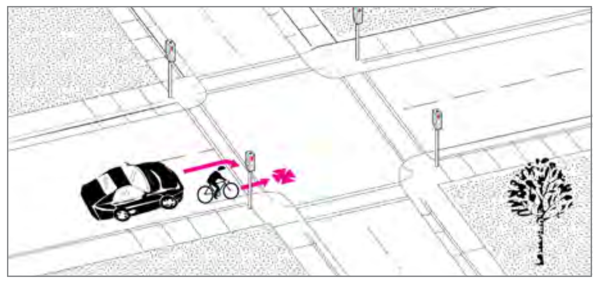
Injury Severity
B: Evident Injury

Speed Limit
5 - 15 MPH

Date
06MAY2008

Light Condition
Dusk





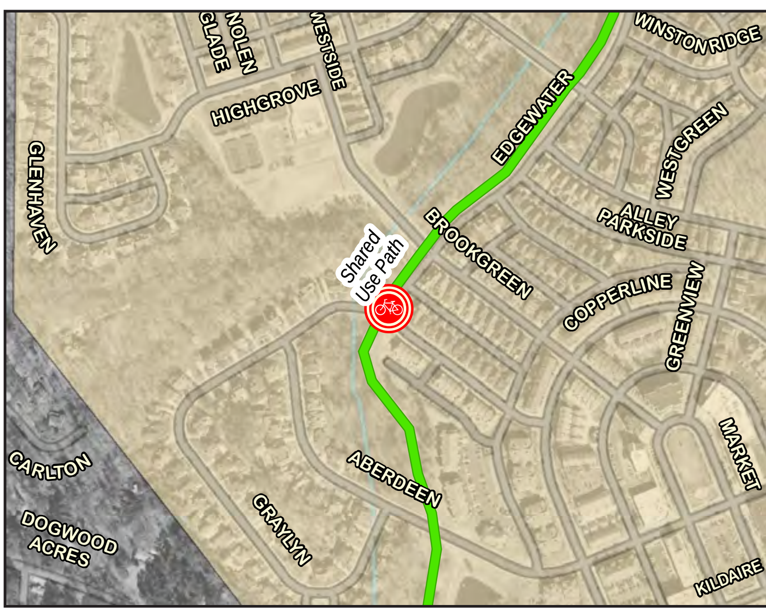
Crash Type
Motorist Right Turn - Same Direction

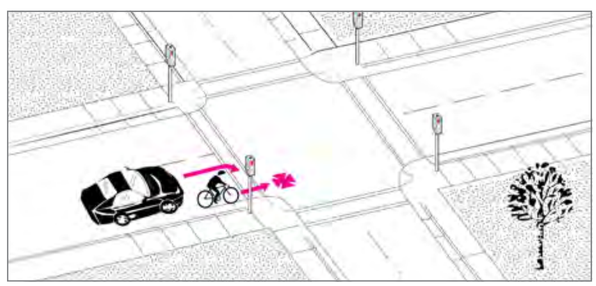
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
10FEB2009

Light Condition
Daylight





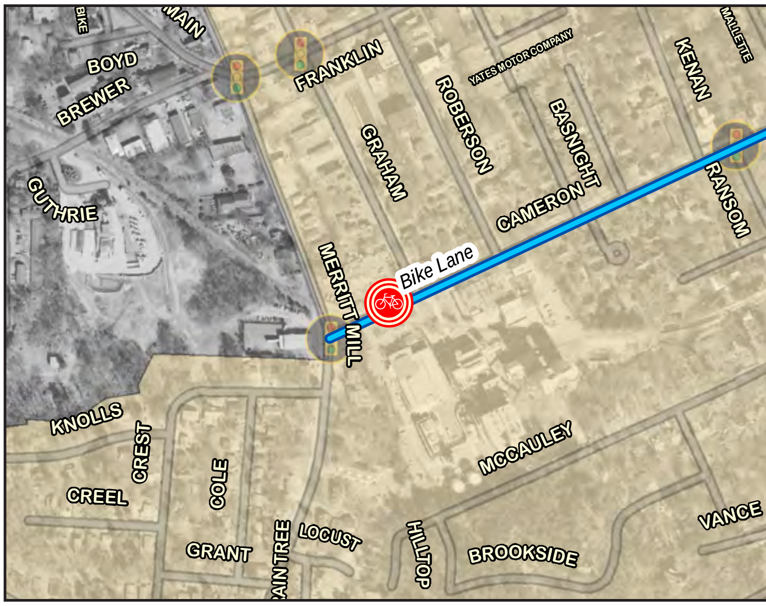
Crash Type
Motorist Right Turn - Same Direction

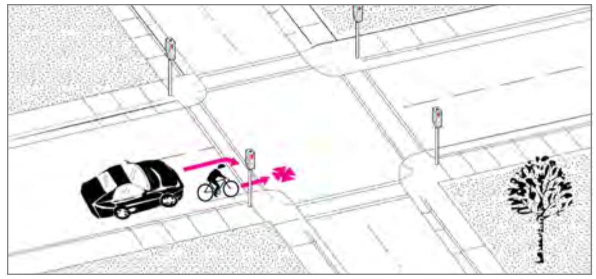
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
02SEP2009

Light Condition
Daylight





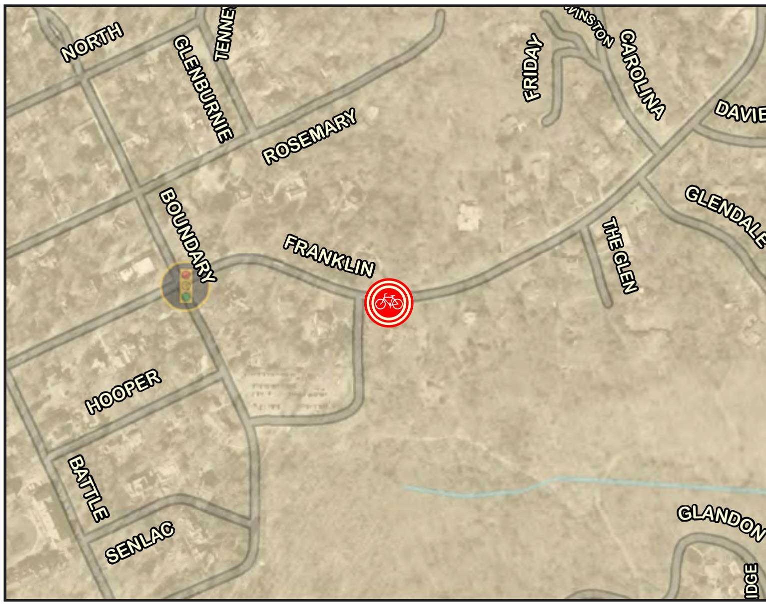
Crash Type
Motorist Right Turn - Same Direction

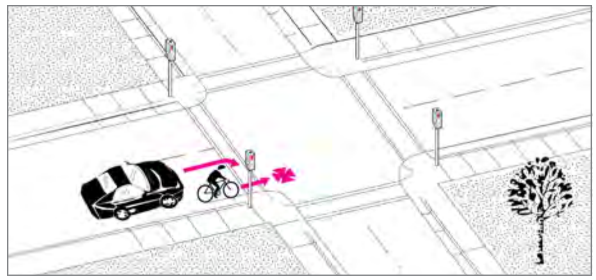
Injury Severity
C: Possible Injury

Speed Limit
20 - 25 MPH

Date
14JAN2010

Light Condition
Daylight





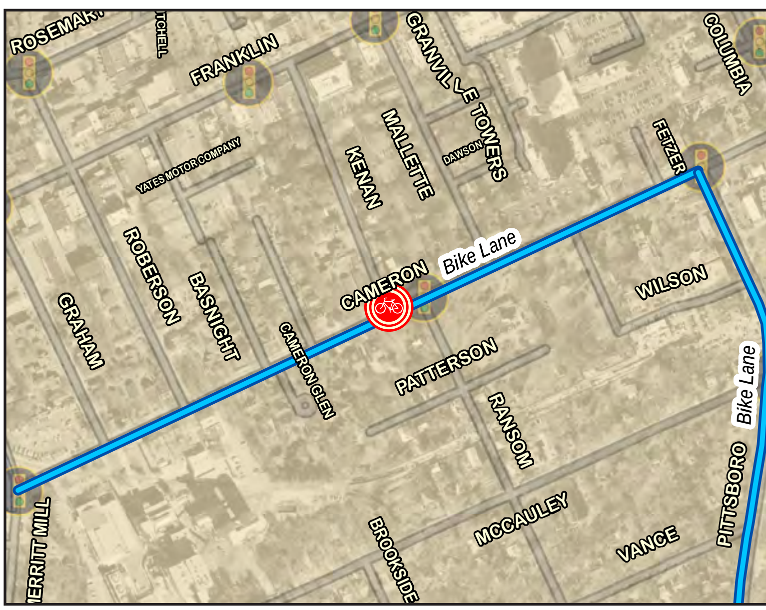
Crash Type
Motorist Right Turn - Same Direction

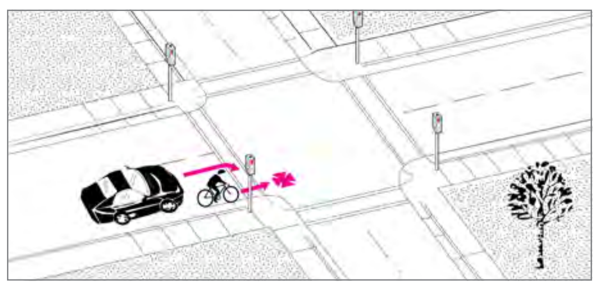
Injury Severity
C: Possible Injury

Speed Limit
30 - 35 MPH

Date
21JAN2010

Light Condition
Dark - Lighted Roadway





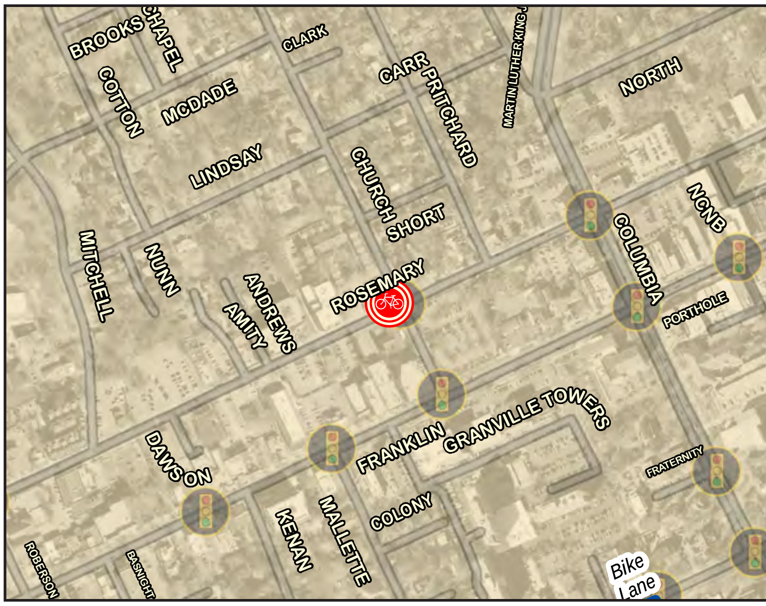
Crash Type
Motorist Right Turn - Same Direction

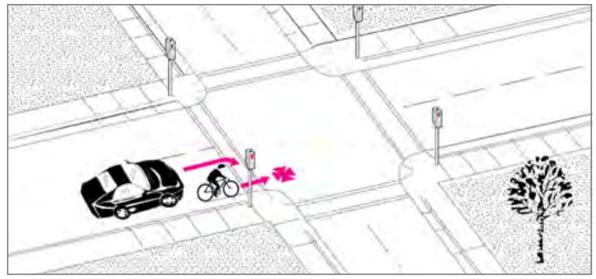
Injury Severity
B: Evident Injury

Speed Limit
Unknown

Date
18SEP2010

Light Condition
Dark - Lighted Roadway





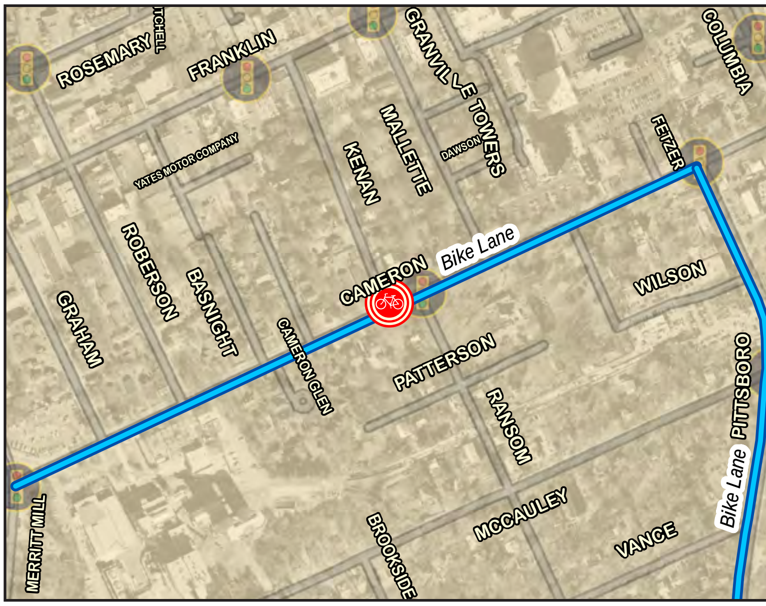
Crash Type
Motorist Right Turn - Same Direction

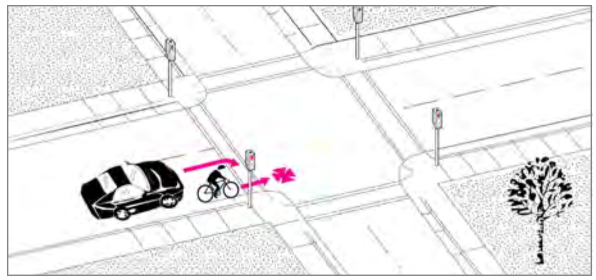
Injury Severity
O: No Injury

Speed Limit
20 - 25 MPH

Date
02FEB2011

Light Condition
Daylight





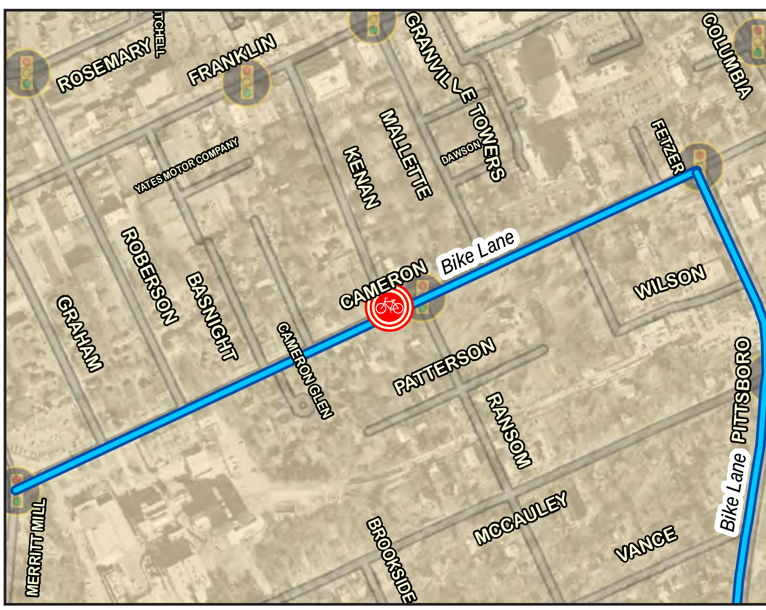
Crash Type
Motorist Right Turn - Same Direction

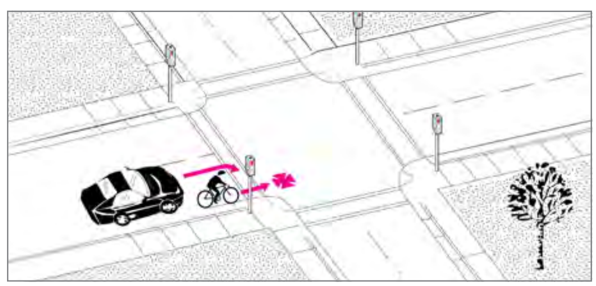
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
26AUG2011

Light Condition
Daylight





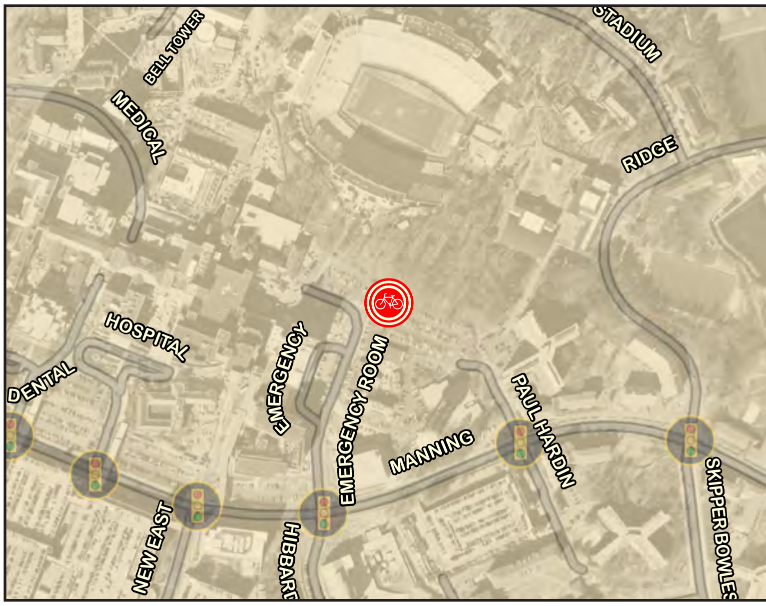
Crash Type
Motorist Right Turn - Same Direction

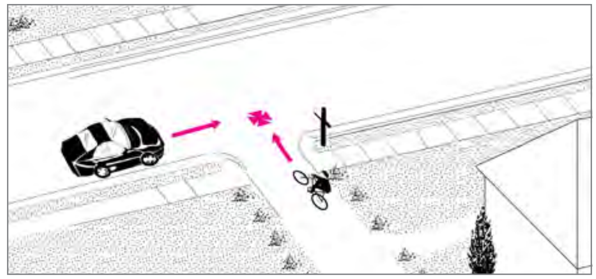
Injury Severity
B: Evident Injury

Speed Limit
30 - 35 MPH

Date
09OCT2011

Light Condition
Dark - Lighted Roadway





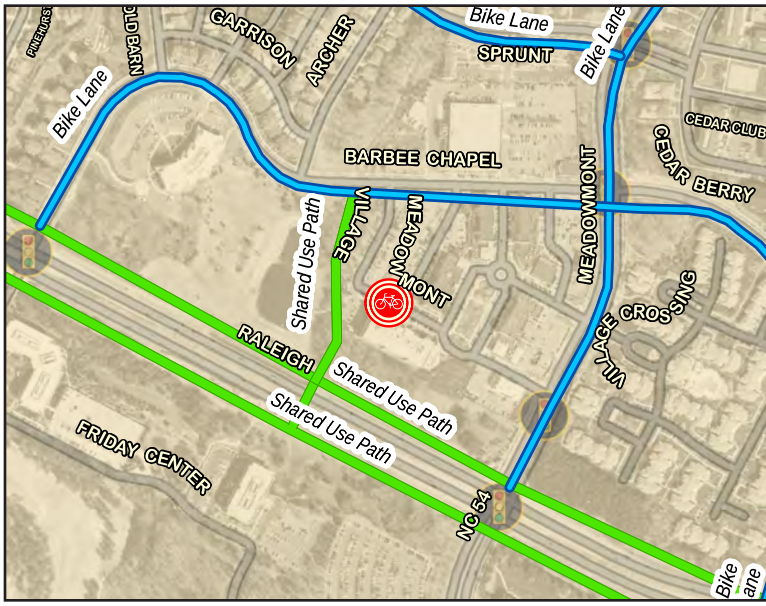
Crash Type
Non-Roadway

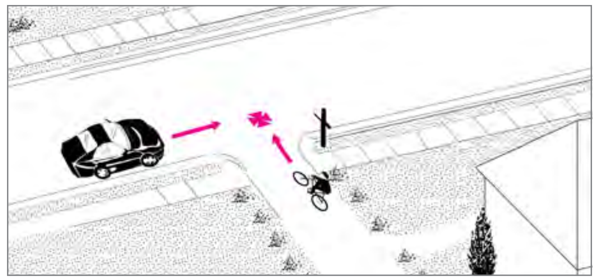
Injury Severity
B: Evident Injury

Speed Limit
5 - 15 MPH

Date
04DEC2007

Light Condition
Dark - Lighted Roadway





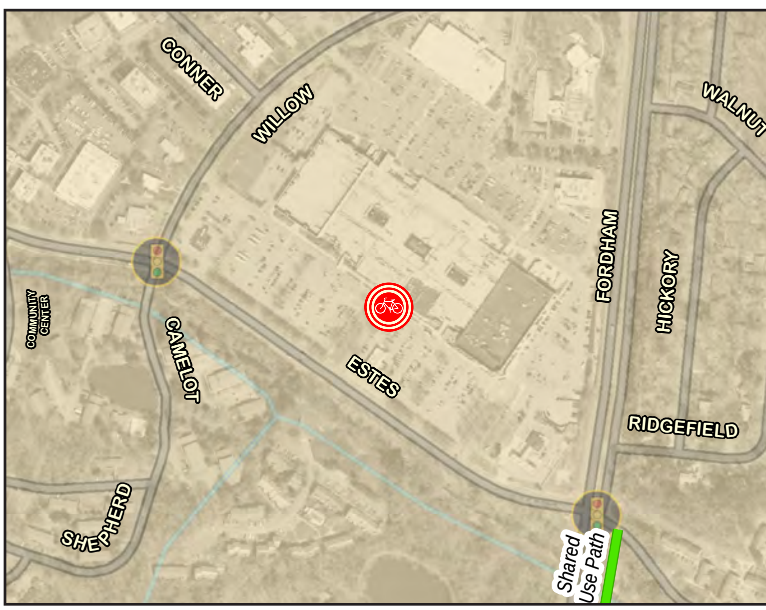
Crash Type
Non-Roadway

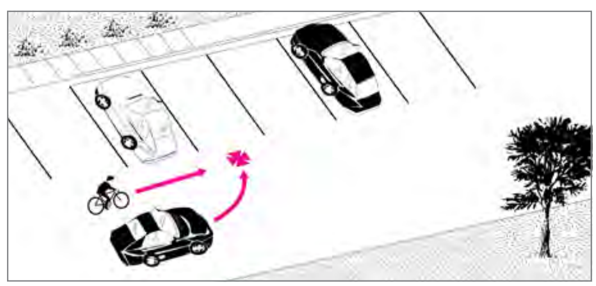
Injury Severity
C: Possible Injury

Speed Limit
Unknown

Date
02JUN2009

Light Condition
Daylight





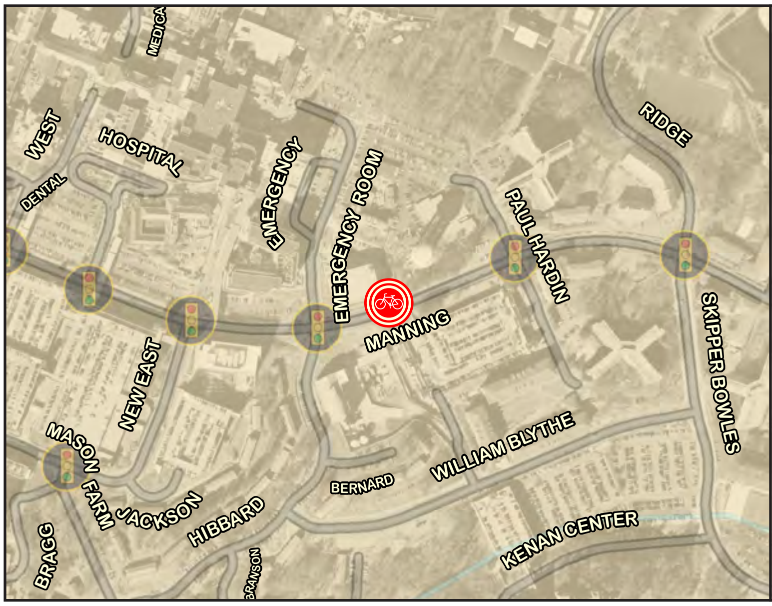
Crash Type
Non-Roadway

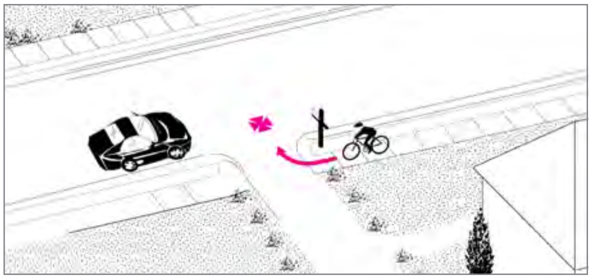
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
05JUN2010

Light Condition
Dark - Lighted Roadway





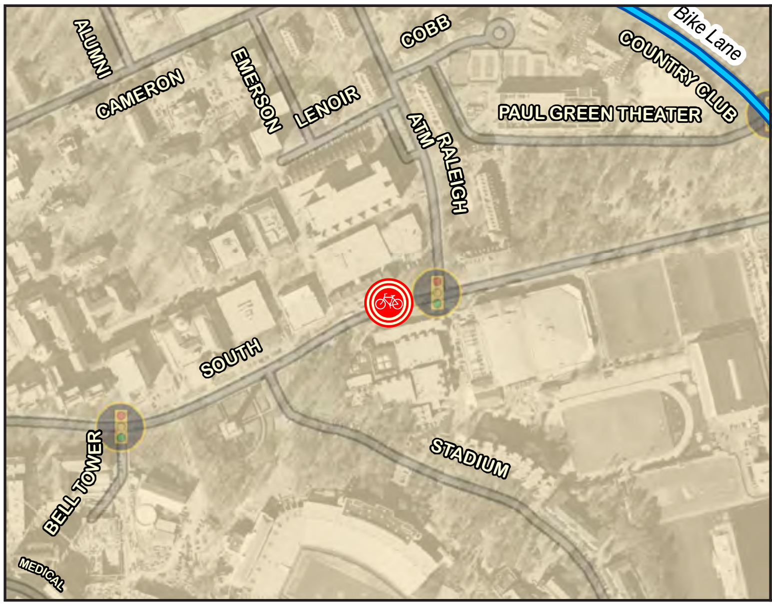
Crash Type
Bicyclist Ride Out - Parallel Path

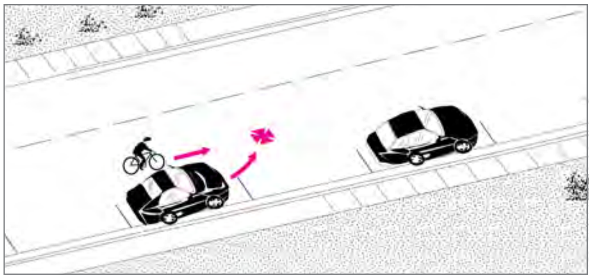
Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
21OCT2010

Light Condition
Daylight





Crash Type
Motorist Drive In / Out - Parking

Injury Severity
B: Evident Injury

Speed Limit
20 - 25 MPH

Date
08OCT2008

Light Condition
Daylight