Chapter 3 – Facility Opportunities and Guidelines

Chapter 3 seeks to build on the existing conditions outlined in **Chapter 2** by identifying options for the future bicycle system. This section discusses bicycle opportunities and focus areas, facility planning and design guidelines, and ancillary facilities and projects.

Bicycle Focus Areas

One objective of this plan is to fulfill the needs of special segments of the population that require bicycling for more than just recreational activity. Captive riders are those who have few transportation options and often turn to modes such as biking or walking for utilitarian purposes. Using U.S. Census 2000 data, the percentage of households owning one vehicle or no vehicle at all was examined within New Bern's extra-territorial jurisdiction. This information is shown in **Figure 3.1.** Many residents in Downtown New Bern, in the James City area, and between US 70 and Neuse Boulevard may be without easy access to a car. This portion of the population must turn to other modes of travel to complete errands and commute to work or school. As a result, an improved bicycle infrastructure would be beneficial to people with limited access to cars.

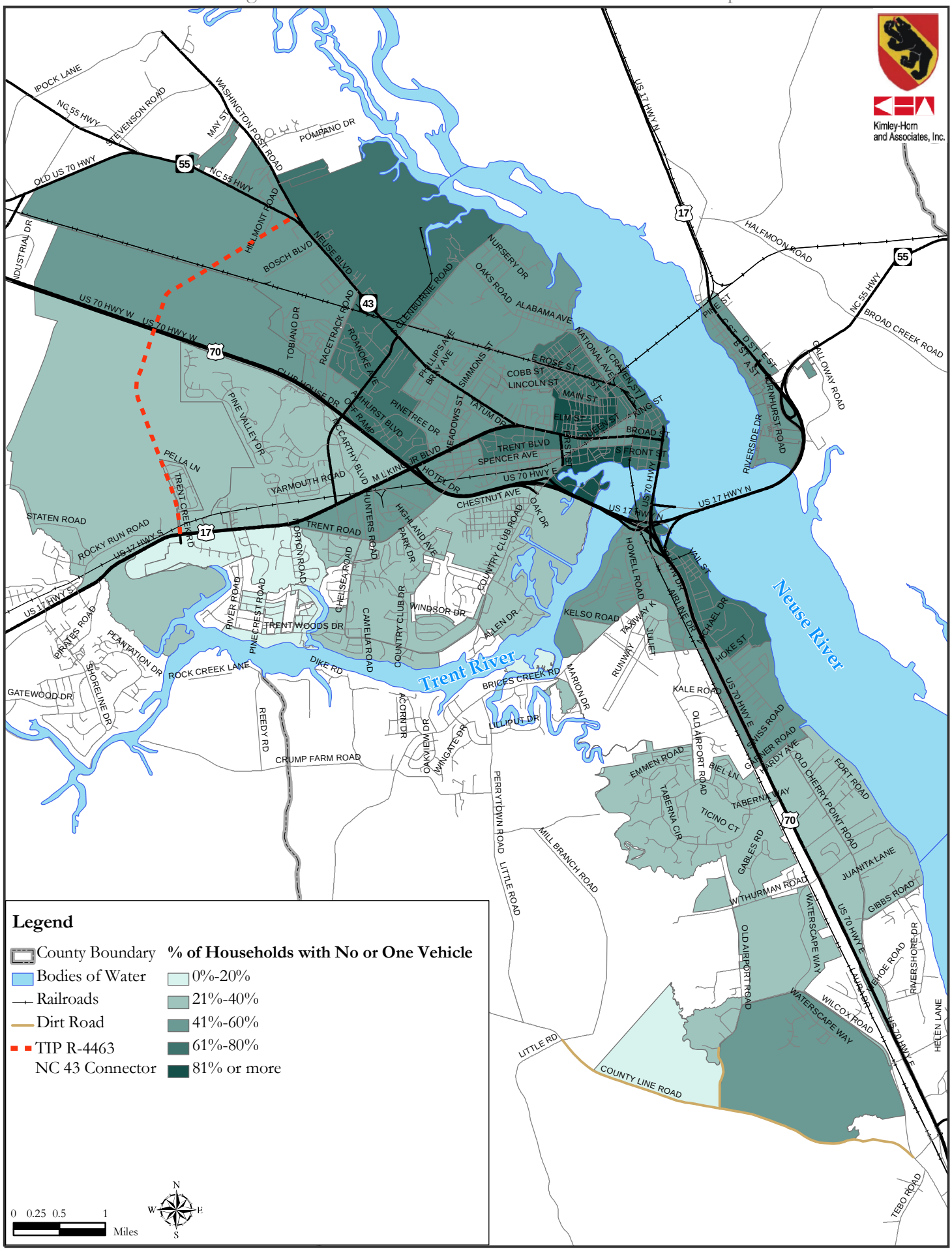
This plan considers connections with shopping areas, municipal buildings, libraries, parks, recreation areas and community centers, and the many schools and colleges in the area - in other words, some of the major destinations in New Bern. A map of these locations is shown in **Figure 3.2**. Connections with the waterfront and downtown areas are also considerations of this plan. The development of a bicycle route system heavily favors the connection of these facilities so that the bicycle routes link citizens with places they want to go.

Trip origins and destinations were investigated as a part of the *New Bern Bicycle Planning Survey*. Many of the connections that respondents desired included natural destination points such as those shown in **Figure 3.2**. Many people sought connections between these destination points and neighborhoods, while a smaller but significant number of respondents desired longer-distance connections between cities, counties, and state routes.

Bicycling Opportunities

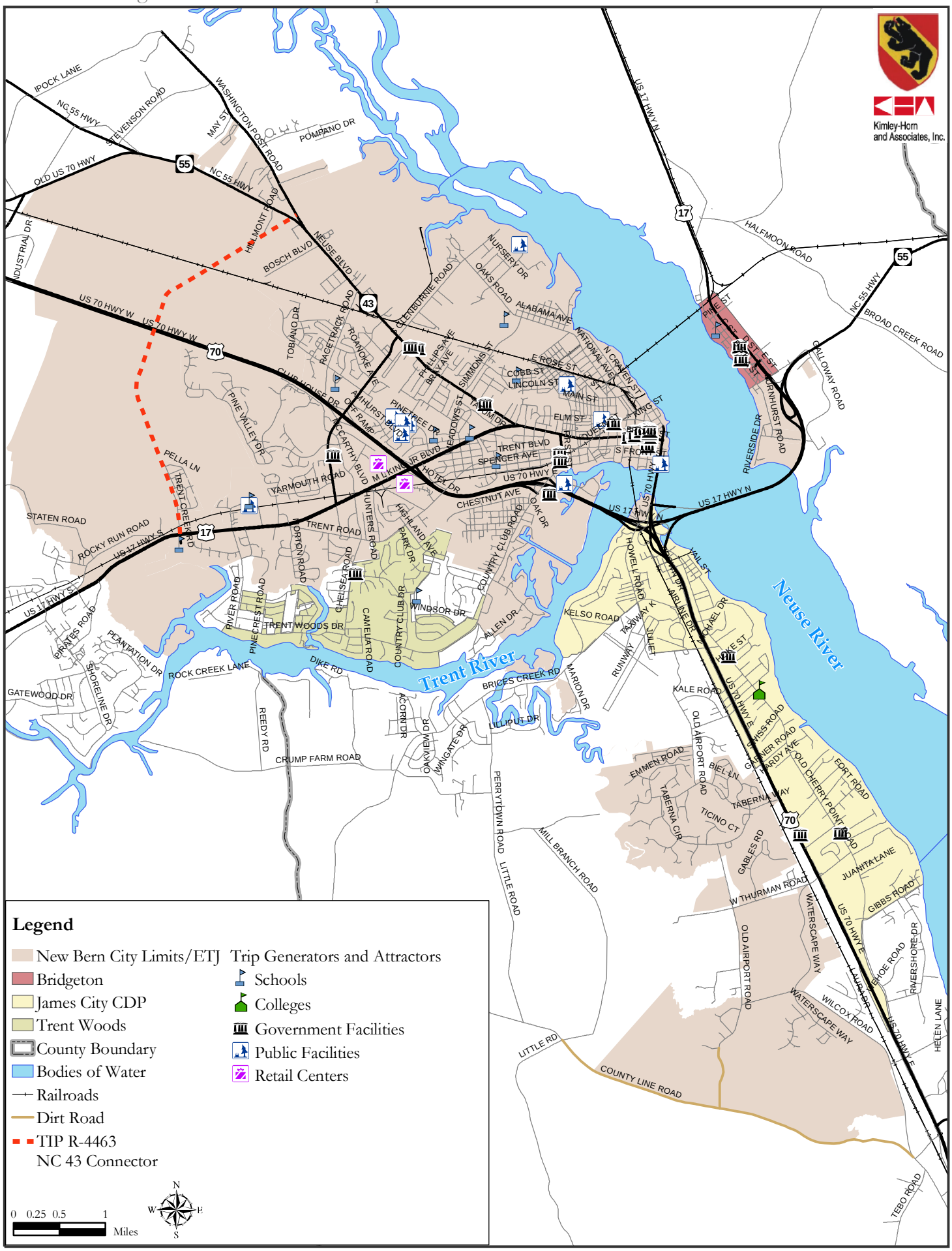
Currently, no bicycle projects are planned for the New Bern area. New Bern has one roadway project, however, in the 2006-2012 State Transportation Improvement Program, or TIP. This project, termed the NC 43 Connector and labeled R-4463, connects NC 43-55 to US 17 and will have an interchange at US 70. Because this facility is intended only to be limited access, there will be no opportunities for bicycling on the road itself. Connecting bicycle routes, however, is feasible as a result of the project providing connections with two major roads and as a result of establishing cross-access across the project. This project has partial funding allocated in the 2006-2012 TIP.

Figure 3.1 - Vehicle Ownership



New Bern Bicycle Plan

Figure 3.2 - Trip Generators and Attractors

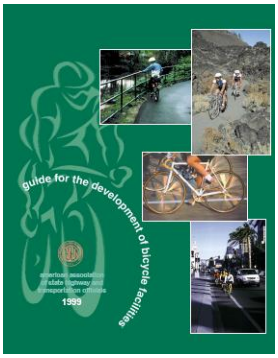


The New Bern Urban Design Plan 2000 outlines several recommendations for improvement. One of these recommendations is to perform a streetscape project on Broad Street. This project is slated to begin in 2007 and is locally funded. This project will consist of three parts. Broad Street from First Street to Queen Street is recommended to become four lanes with a median and enhanced sidewalks. The segment from Fleet Street to Hancock Street is recommended to undergo a "road diet", reducing it to two lanes with a median and on-street parking. From Hancock Street to Front Street, Broad Street is currently two lanes with a median. There may be an opportunity to consider the incorporation of bicycle lanes or other bicycle facilities as a part of this improvement.

Bicycle Facility Design Guidelines

All new and reconstructed roadways in New Bern should be designed to accommodate bicycles[1]. While each roadway construction, paving, or striping project must be appropriate for the topography and land use of the corridor, the guidelines in this section should be utilized as a blueprint for incorporating bicycle facilities in roadway corridors.

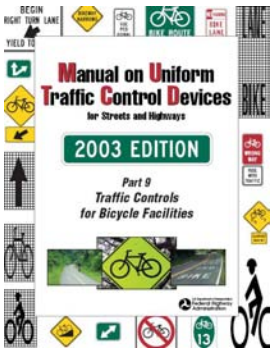
To develop recommended bicycle design standards for the City of New Bern, the Study Team reviewed several existing documents The review included the *AASHTO Guide for the Development of Bicycle Facilities*[2], the *Manual on Uniform Traffic Control Devices*[3], and the *North Carolina Bicycle Facilities Planning and Design Guidelines*[4].



Existing Design Guideline Documents

The section below summarizes the three main bicycle design guideline documents that were reviewed for this plan.

AASHTO *Guide for the Development of Bicycle Facilities.* Referred to as the *Bicycle Guide*, this is a federal document which sets forth the current design practices accepted by FHWA. This document discusses planning, design, operations, and maintenance issues associated with bicycle facilities. With respect to design, it addresses width dimensions, grades, cross slopes, radii, acceleration rates, deceleration rates and sight distances. The AASHTO *Bicycle Guide* is not intended to establish strict standards. It provides "sound guidelines that are valuable in attaining good design sensitive to the needs of both bicyclists and other highway users" (p. 2). It does, however, establish minimum guidelines for many treatments.



FHWA *Manual on Uniform Traffic Control Devices (MUTCD).* Unlike

[1] With the exception of freeways/expressways where bicycles are prohibited. In these situations, bicycles should be accommodated on a multi-use path or another parallel route nearby.

[2] *AASHTO Guide for the Development of Bicycle Facilities*, American Association of State Highway and Transportation Officials, Washington, DC, 1999.
[3] *Manual on Uniform Traffic Control Devices*, FHWA, Washington, DC, 2003.
[4] *North Carolina Bicycle Facilities Planning and Design Guidelines*, NCDOT, 1994.

the AASHTO *Bicycle Guide*¸ the *MUTCD* does constitute a standard. Failure to comply with the *MUTCD* can result in being denied federal funds and opens up non-compliant jurisdictions to additional liability in the event of a crash. The *MUTCD* addresses standards for signing, striping, markings, signals, islands, and traffic work zone devices (e.g., cones and barricades). It provides information on what symbols may be used on signs and when sign text can vary from the signs provided. The color, width, types, and applications of striping are defined in detail. It also provides dimensions and shapes of pavement markings and pavement lettering. All bicycle signage and lane markings should follow the guidelines and regulations outlined in the MUTCD. **Figure 3.3** contains some symbols from the MUTCD. See http://mutcd.fhwa.dot.gov/ for additional information.

North Carolina Bicycle Facility Planning and Design Guidelines. Design standards and guidelines for developing bicycle facility projects in North Carolina are provided in the *North Carolina Bicycle Facility Planning and Design Guidelines*. This document seeks to clarify specific aspects of standards that should be used when designing bicycle facilities. These standards apply to roads within the federal aid system and are consistent with the AASHTO guidelines. Demonstration projects outside the scope of the North Carolina guidelines can be undertaken on municipal streets.

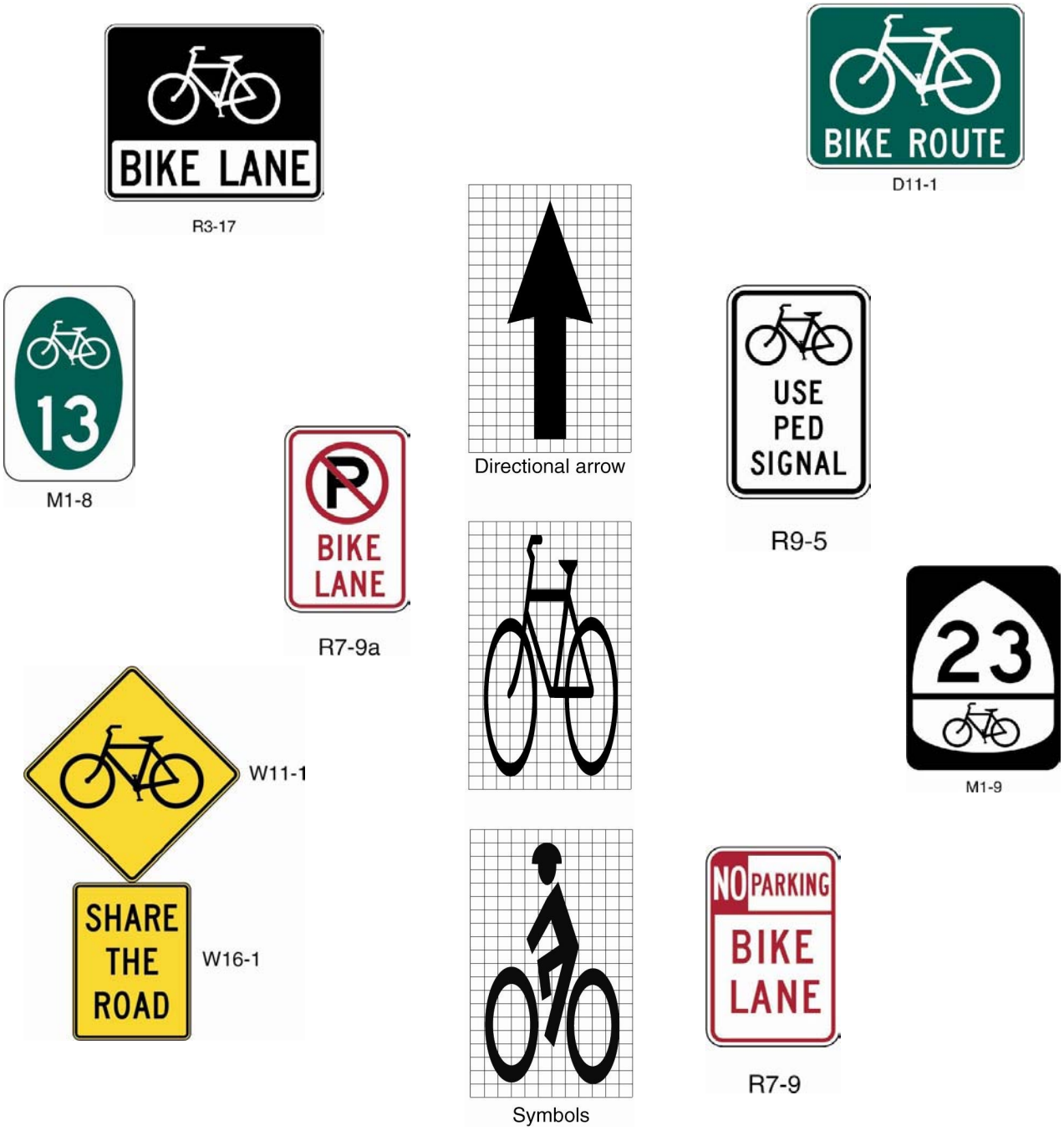
Designing Roadways for Bicyclists

It is important for roadway designers to understand how roadway and traffic characteristics affect bicyclists. Several research studies have suggested factors that influence bicyclist safety and comfort when riding on a roadway segment[5,6,7,8]. These factors include:

- Effective width of the roadway, which includes the width of the outside lane and paved shoulder/bike lane space
- Presence of a bike lane or paved shoulder
- Motor vehicle traffic volumes on the roadway
- Traffic from intersecting roadways/driveways
- Speed of the traffic on the roadway
- Percent heavy vehicles on the roadway
- On-street parking
- Pavement surface condition

[5] Landis, Bruce W., The Bicycle Interaction Hazard Score: A Theoretical Model. *Transportation Research Record 1438*, TRB, Washington, DC, 1994.
[6] Sorton, Alex. Bicycle Stress Level as a Tool to Evaluate Urban and Suburban Bicycle Compatibility. *Transportation Research Record 1438*, TRB, Washington, DC, 1994.
[7] Epperson, Bruce. Evaluating Suitability of Roadways for Bicycle Use: Toward a Cycling Level-of-Service Standard. *Transportation Research Record 1438*, TRB, National Research Council, Washington, D.C. 1994.
[8] Davis, Jeff. *Bicycle Safety Evaluation*. Auburn University, 1987.

Figure 3.3 MUTCD Signage Examples



In the late 1990s, groundbreaking research was performed to quantify the influence of each of these factors on the perceptions of bicyclists. One research study had bicyclists rate the characteristics of roadways in the field[9]; another had bicyclists rate roadway segments from video clips[10]. The former study resulted in the Bicycle Level of Service Model, and the latter resulted in the Bicycle Compatibility Index. All of the factors listed above were found to influence bicyclist comfort.

Both studies identified lateral separation between bicyclists and motor vehicles as one of the most significant factors influencing bicyclist comfort levels. The studies found that bicyclists preferred having wider pavement space to ride on. Further, both studies found that most bicyclists prefer having a shoulder or bike lane stripe provided on roadway segments when compared to the same pavement width without a stripe. In addition, a third study found that motorists give bicyclists more lateral space when bike lanes are striped[11]. These are particularly important findings because bicycle lanes and shoulders can be incorporated during roadway design.

These studies provide the background behind the recommendations to provide bicycle lanes and paved shoulders as preferred bicycle facilities in New Bern.

Guidelines for Specific Facilities

This section describes the types of bicycle facilities that should be incorporated into roadway projects in the City of New Bern.

Bicycle Lanes

A bike lane is a portion of the roadway that has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes are always located on both sides of the road (except one way streets), and carry bicyclists in the same direction as adjacent motor vehicle traffic. The minimum width for a bicycle lane is 4 feet; 5- and 6-foot wide bike lanes are typical for collector and arterial roads. Increasing the width of bike lanes provides greater comfort for bicyclists.

The AASHTO *Guide for the Development of Bicycle Facilities* states, "[Bike lanes may be provided] by reducing the width of vehicular lanes or prohibiting parking… " (p. 8). **Figure 3.4**, taken from the North Carolina Bicycle Planning and Design Guidelines (adapted from the AASHTO *Bicycle Guide)*, specifies widths for bike lanes.

NCDOT recommends that bicycle lanes be considered for a roadway based on the demand, connectivity of origin and destination points, surrounding land uses, traffic and geometric conditions, and presence of other route alternatives.

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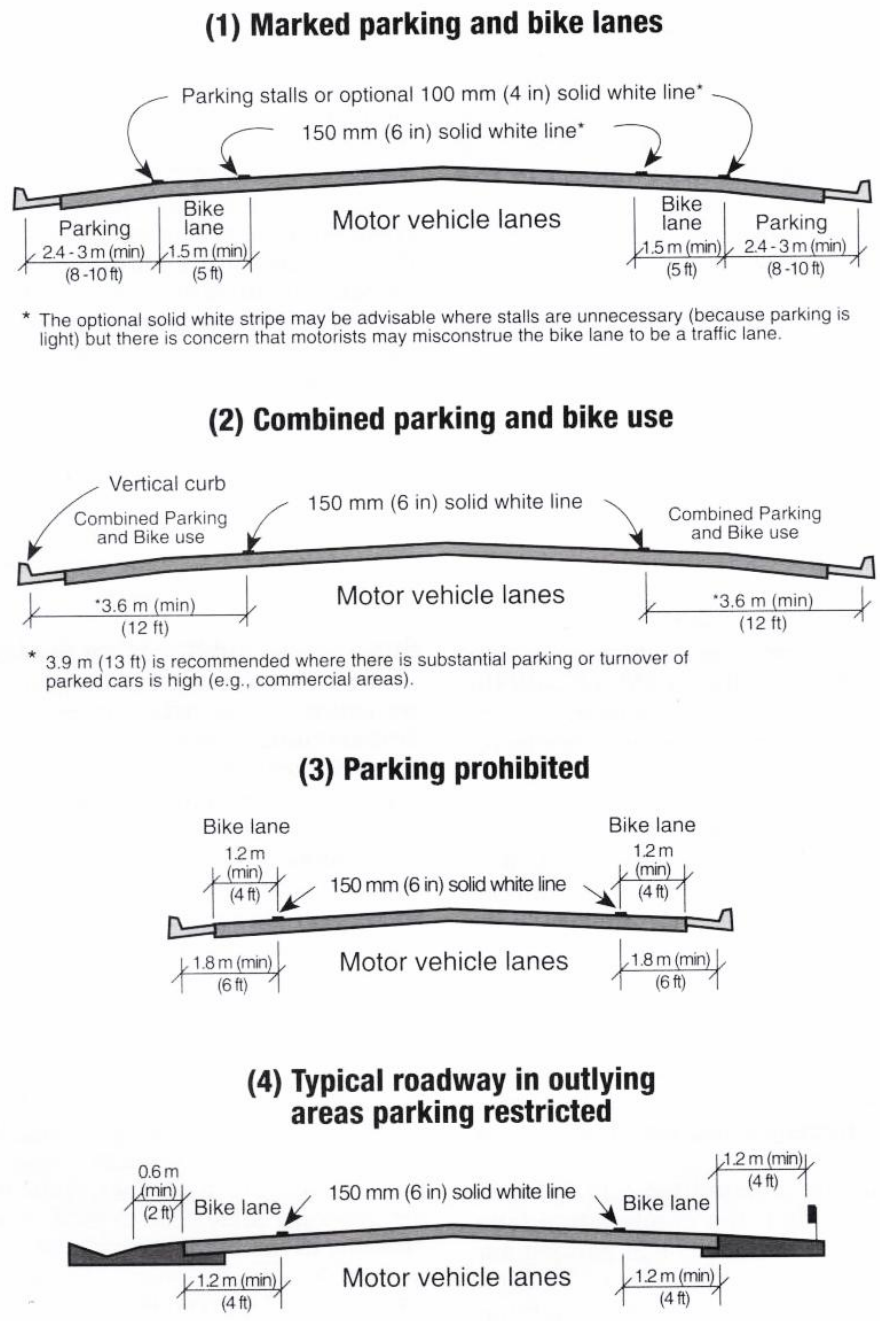
[9] Landis, Bruce W., et al. Real-Time Human Perceptions: Towards a Bicycle Level of Service, *Transportation Research Record 1578*, TRB, Washington, DC, 1996.
[10] Harkey, D.L., et al. Development of the Bicycle Compatibility Index: A Level of Service Concept: Final Report, Report No. FHWA-RD-98-072, Federal Highway Administration, Washington, DC, August 1998.
[11] Hunter, William W., et al. A Comparative Analysis of Bicycle Lanes Versus Wide Curb Lanes: Final Report, Federal Highway Administration, FHWA-RD-99-034, December 1999.

Figure 3.4 Typical Bike Lane Cross-Sections



Typical bike lane cross sections on two-lane or multi-lane highways.

Source: AASHTO Guide for the Development of Bicycle Facilities, 1991.

Paved Shoulders

Paved shoulder space improves the safety and comfort of bicyclists. There is no minimum width for paved shoulders; however, a width of 4 feet is preferred. Even wider shoulders provide greater levels of bicyclist safety and comfort. On many roadways, motor vehicle travel lanes can be narrowed to provide more shoulder space. According to the AASHTO *Bicycle Guide*, "where 4-foot widths cannot be achieved, any additional shoulder width is better than none at all." Facilities striped and signed specifically as paved shoulder bicycle facilities must have a width of at least 4 feet. Paved shoulders improve safety for motor vehicles, prevent pavement damage to the travel lanes, and provide space for pedestrians[12].

While unmarked paved shoulders are generally acceptable for roadway sections without frequent intersections, on those where intersections are frequent, appropriate bike lane marking should be applied.

Wide Curb Lanes

Wide curb lanes (typically 14-feet wide) are used to provide extra space for bicyclists. While wide curb lanes are an effective way to encourage motorists to give cyclists adequate clearance when passing, they are largely unrecognized by casual cyclists as bike facilities. As noted in the research studies above, having a striped bike lane greatly improves cyclists' feelings of safety and comfort. In communities like New Bern that want to significantly increase the number of people riding bicycles, it is strongly recommended that a program to create striped bike lanes be adopted, rather than wide outside lanes. In other words, whenever feasible, striped bike lanes are preferred over wide outside lanes. Wide outside lanes are acceptable when striped lanes are not feasible. These lanes may be the preferable alternative in areas with heavy strip development or with numerous driveway cuts in order to provide bicyclists with an additional comfort level without the untwanted interactions between striped bicycle lanes and driveway and turning movements.

Shared Roadways

Shared roadways are streets and roads where bicyclists can be served by sharing the travel lanes with motor vehicles. Usually, these are streets with low traffic volumes and/or low speeds, which do not need special bicycle accommodations in order to be bicycle-friendly.

Multi-Use Paths on Independent Alignments

Multi-use paths (or shared use trails) are becoming quite popular, not only with bicyclists, but with many non-motorized transportation device users across the country. They can provide a high-quality bicycling experience in an environment that is protected from motor vehicle traffic because they are constructed in their own corridor, often within open-space area. Multi-use paths can be paved and should be a minimum of 10-feet wide. Twelve feet is preferred where heavy usage is anticipated. Multi-use paths may be reduced to eight feet if there are physical or right-of-way constraints.

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[12] In addition, AASHTO's *Guide for Achieving Flexibility in Highway Design* (2004) states, "Paving part or all of the shoulder... helps reduce crash rates... and helps to facilitate use of the road by bicyclists. Shoulder paving also reduces maintenance requirements... .Where a 'full width' shoulder cannot be achieved, the designer should strive to provide as wide a shoulder as possible that meets functional requirements" (p. 66).

Multi-use paths are, in effect, little roads and should be designed as such. This means there are clearance requirements, minimum radii, stopping sight distance requirements and other criteria just as there are for roadways. Additionally, designers must comply with the *MUTCD* and AASHTO *Bicycle Guide* when designing these facilities.

Though paths should be thought of as roadways for geometric and operational design purposes, they require much more consideration of amenities than do roadways. Shade and rest areas with benches and water sources should be designed along multi-use paths. Where possible, vistas should be preserved. Way finding signs (how far to the library or the next rest area or directions to restrooms) are important for non-motorized users. These types of design considerations can help make a multi-use path more attractive to potential users.

Sidepaths/Wide Sidewalks

A sidepath is essentially a multi-use path that is oriented alongside a road but is separate from the road. The *AASHTO Guide to the Development of Bicycle Facilities* and *North Carolina Bicycle Facilities Planning and Design Guidelines* strongly caution those contemplating a sidepath (or wide sidewalk) facility to investigate various elements of the roadway corridor environment and right-of-way before making a decision. AASHTO provides nine cautions/criteria (pp. 34-35) for designing sidepaths.

In addition to AASHTO's cautions, research from the US and abroad confirm that bicycle/motor vehicle crash rates are higher for bicyclists riding on a sidepath than on a roadway.[13,14,15,16,17] Consequently, designers are advised to be very careful when choosing to design sidepaths.

There are some high-volume, high-speed roadways where sidepaths are the only bicycle facility that can be provided without very costly changes to the roadway corridor. In these cases, it may be preferable to provide a sidepath. This decision must consider the magnitude of intersecting driveway and roadway conflicts. In addition, sidepaths should be provided on both sides of the roadway if possible to encourage bicyclists to ride in the same direction as adjacent traffic. Finally, the long-term strategy on these roadways should be to widen the road or narrow the lanes to provide additional space for bicyclists in on-road bike lanes or shoulders.

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[13] Kaplan, J. *Characteristics of the Regular Adult Bicycle User*. FHWA, U.S. Department of Transportation, 1975.

[14] Moritz, W. Adult Bicyclists in the United States - Characteristics and Riding Experience in 1996. *Transportation Research Record: Journal of the Transportation Research Board, 1636,* TRB, National Research Council, Washington, DC, 1998

[15] Wachtel, A. and D. Lewiston. Risk Factors for Bicycle-Motor Vehicle Collisions at Intersections. *ITE Journal*, September, 1994.

[16] Räsänen, M. *How to decrease the number of bicycle accidents? A research based on accidents studied by road accident investigation teams and planning guides of four cities.* Finnish Motor Insurer's Centre, Traffic Safety Committee of Insurance Companies. VALT. Finland, 1995.

[17] Summala, H., E. Pasanen, M. Räsänen, and J. Sievänen, J. Bicycle Accidents and Drivers' Visual Search at Left and Right Turns. *Accident Analysis and Prevention*. Elsevier Science Ltd., 1996/03, 28(2), pp.147-53, 1996.

One recently completed research study suggests that there may be ways to mitigate some of the safety risks associated with sidepaths.[18] To greatly simplify the results of this research, it finds that crashes occur less often when the speed of the trail user is reduced. This means some sort of "traffic calming" treatment for the trail may be appropriate at intersections. At signalized intersections, it is best to treat the path roadway crossings as crosswalks, bringing the pathway close to the adjacent roadway so its signals can be incorporated into the overall signalization plan. Additional treatments to the typical pedestrian heads may be desirable at these intersections. The most significant of these supplemental treatments is the blank out sign. NO RIGHT ON RED or YIELD TO PEDS IN CROSSWALK signage may increase motorist awareness of individuals riding (or walking) in the crosswalks.

At unsignalized intersections it is best to move the sidepath out of the area of the side street intersection with the adjacent roadway. This allows motorists to deal with one intersection at a time. Additionally, bicyclists are only required to scan in two directions.

[18] Petritsch, Landis, Huang, Challa. *Sidepath Safety Model - Bicycle Sidepath Design Factors Affecting Crash Rates*, submitted to TRB for publication, July 2005.

Signed Bicycle Routes

Signed routes will be an integral part of the bicycling network in New Bern. These facilities are an inexpensive way to guide riders to more bicycle-friendly roads. They can be used with any of the facilities listed above, including roads with bicycle lanes, shared roadways, and multi-use paths. The traffic and geometry of a road are important considerations when determining the location of a signed route. In addition, the functionality of the route for the purpose it was intended (e.g. scenic route or utilitarian connector) is a necessary component in the decision-making process.

BIKE ROUTE signing (M1-8, D11-1, or M1-9 signs with D1-1b or M7-1 through M7-7 subplates) is another treatment which can be implemented to improve conditions for bicyclists. BIKE ROUTE signs help guide bicyclists to preferred routes - roads with lower motor vehicle traffic speeds, fewer trucks, or lower volumes. Typically they are supplemented with destination and distance signing.

Special signs should be designed to guide bicyclists along the recommended Riverfront Route. These signs should incorporate their own colors and logo so that they can be recognized easily and help advertise the route to potential bicyclists. These signs can be used on municipal roads.

SHARE THE ROAD signs (W11-1 warning sign with W16-1 subplate) can be used along bicycle routes to alert drivers to the presence of bicyclists. These signs are not used to designate bicycle routes. They are typically considered when one or more of the following

criteria are met:

- Safety problems exist and the roadway cannot be improved with bicycle lanes
- Bicycling volumes are high
- A conflict or obvious courtesy problem exists between motor vehicle and bicycle traffic sharing the road

Other Bicycle Facilities and Amenities

The *North Carolina Bicycle Facility Planning and Design Guidelines* also provide design considerations and recommendations for other types of ancillary bicycle facilities and amenities. These items, such as bike racks, bikes on buses, and bike-friendly drainage grates and railroad crossings help to complete the bicycle system by eliminating barriers and providing security. In addition, the guidelines also discuss the maintenance of bicycle facilities, which is essential for the continued safe travel of bicyclists. Ancillary bicycle facilities and amenities are discussed in a subsequent section.

Recommendations for Incorporating Bicycle Facilities

When feasible, all new collector and arterial roadways in New Bern should include bicycle lanes when they are constructed. New construction is the easiest and most cost-effective opportunity to include bicycle facilities because they can be integrated as a part of a larger roadway project.

When collector and arterial roadways are resurfaced or reconstructed, the City of New Bern should evaluate the roadway cross-section to identify opportunities for bicycle facilities. This evaluation should consider how much motor vehicle travel lane width can be re-allocated and used for bike lane or shoulder space, given the lane configuration, traffic volumes, and traffic composition of the roadway. Two types of modifications should be considered to provide additional pavement width for bicycling: striping narrower lanes and/or removing travel lanes on roads with excess capacity. Reconfiguring a roadway during a reconstruction project is also more cost-effective than adding shoulders or restriping lanes as an independent retrofit project.

Neighborhood streets and rural roadways with low traffic volumes may be suitable for bicycling as shared roadways (e.g., special bicycle facilities are not needed).

Recommended Changes to New Bern Street and Sidewalk Standards

Land development and redevelopment projects are excellent opportunities to improve conditions for bicycling in New Bern. The City can ensure that bicycle facilities are provided as a part of development projects by updating its municipal code. For example, the current code states that shoulders (minimum 6-foot width) must be provided on all arterial and collector roadways constructed without curb and gutter.

This plan recommends several revisions to the New Bern municipal code.

Article XIV: Streets and Sidewalks

- Require bicycle lanes to be provided on all roadways classified as arterials
- Require bicycle lanes to be provided on all roadways classified as collectors
- Remove the statement that encourages cul-de-sacs (this development pattern increases the total distance that people need to bicycle, walk, and drive to reach destinations)

Article XVIII: Parking

- Add minimum bicycle parking space requirements for different types of land uses

Sample Cross-Sections

A set of sample cross-sections has been developed to reflect road treatments for specific bicycle recommendations. These cross-sections can be adapted to correspond to different road conditions and attributes as necessary. **Figure 3.5** corresponds to a cross-section with striped bike lanes. **Figure 3.6** corresponds to a cross-section with striped bike lanes and parking. **Figure 3.7** denotes a cross-section that has used differential striping to obtain wide outside lanes. **Figure 3.8** shows a cross-section containing a multi-use path on one side of the road.

Roadway Intersections

Intersections should be designed with a balanced level of accommodation for all modes, including pedestrians, bicyclists, motor vehicle traffic, and public transit. Narrow intersections decrease crossing distances for all users, including bicyclists. Narrower intersections can have a shorter traffic signal cycle length than wide intersections (when the intersection is signalized) and are safer for pedestrians and bicyclists, in general.

Special care must be given to bike lane design at intersections. Since intersections represent significant conflict points for bicyclists, appropriate striping, marking, and signing is critical to help ensure the proper behavior of cyclists and motorists.

When designing bike lanes at intersections, the City of New Bern should follow examples in the Pedestrian and Bicycle Information Center's *Bike Lane Design Guide*, which can be downloaded at www.bicyclinginfo.org/de/bikelaneguide.htm.

This document is a summary of the *Chicago Bike Lane Design Manual*. Four example intersection striping treatments are provided at the end of this section.

Signal Loops. Bicyclists frequently have trouble being detected at traffic signals. They often believe the signals are non-responsive and consequently run red lights. However, most traffic signal loops designed for motorists can detect bicyclists if the cyclists know where to place their bicycle. One effective way to address this problem is to mark the location on the pavement where a cyclist would have to stop the bike to be detected by a traffic signal. The sign pictured here and the symbol it shows have been tested for cyclist understanding and are being considered for future updates to *MUTCD*. To implement them before they are included in the *MUTCD* on federal or state-maintained roads would require a request to experiment be filed with FHWA. Another alternative would be to implement these loops as demonstration projects on municipal streets

Specific signal loops for bike lanes (or multi-use paths) can also serve to improve cycling conditions. A typical treatment is a quadrapole loop with overall dimensions of 2 feet by 20 feet.

Figure 3.5 Striped Bike Lanes Cross-Section

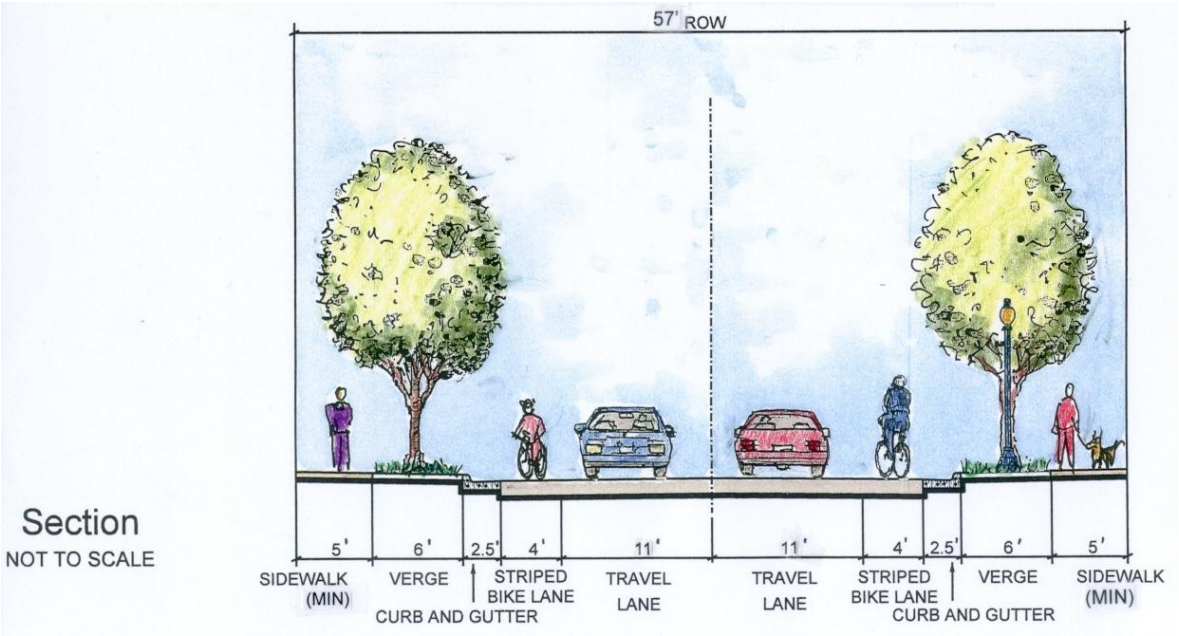


Figure 3.6 Striped Bike Lanes and Parking Cross-Section

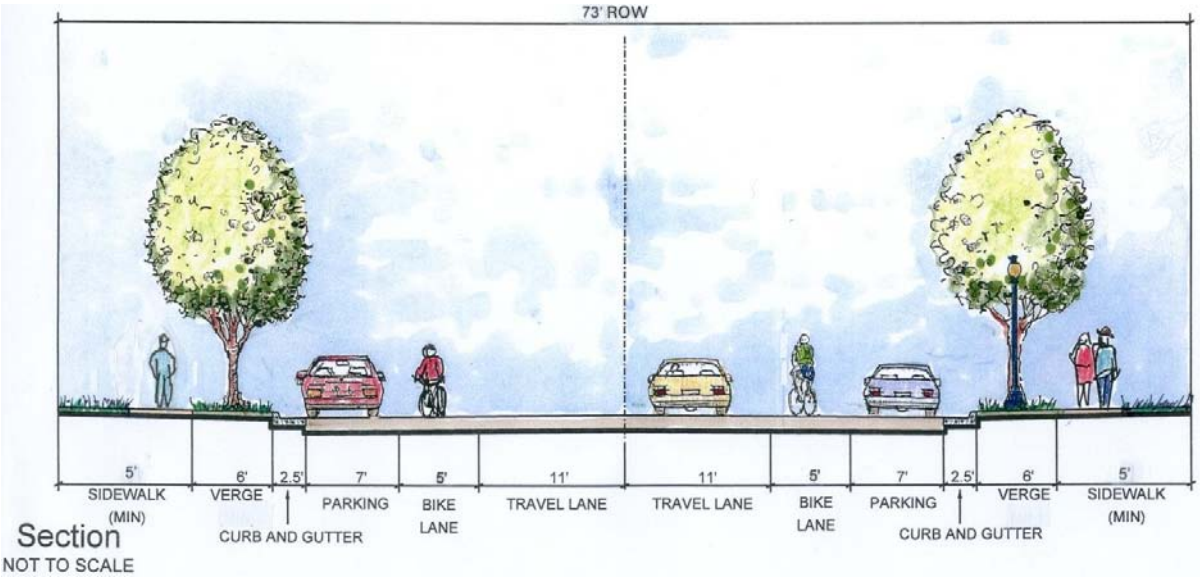


Figure 3.7 Wide Outside Lanes Cross-Section

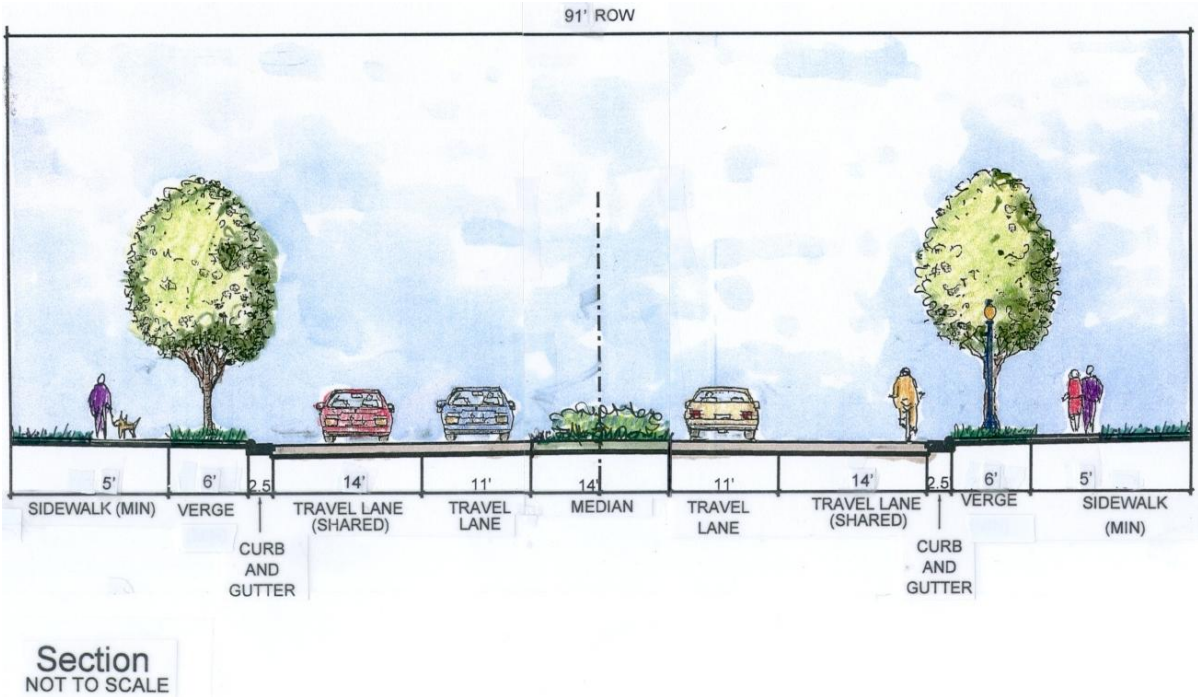
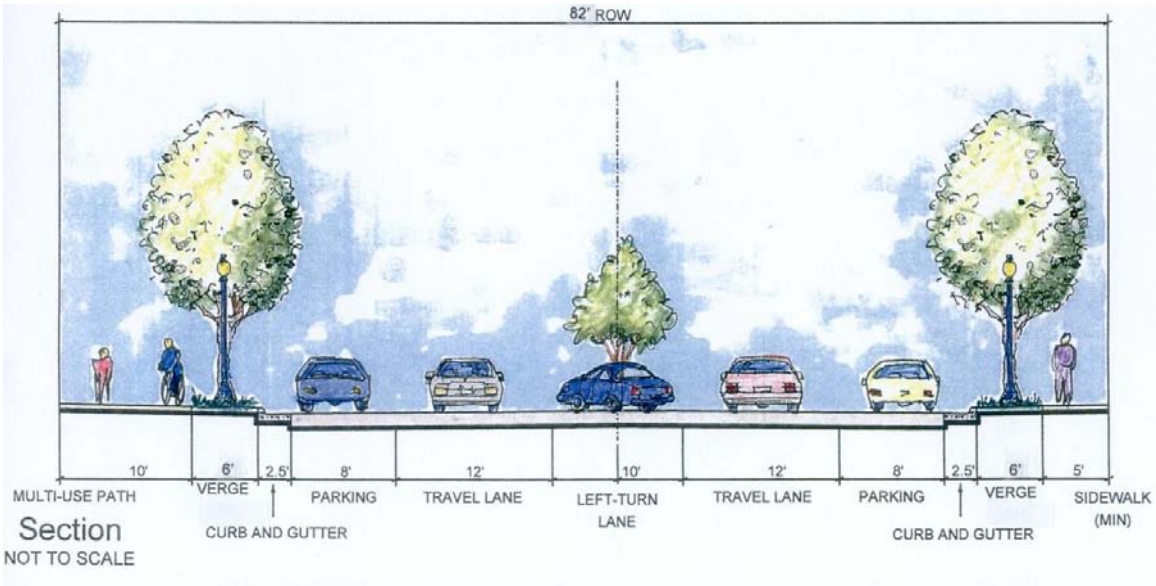
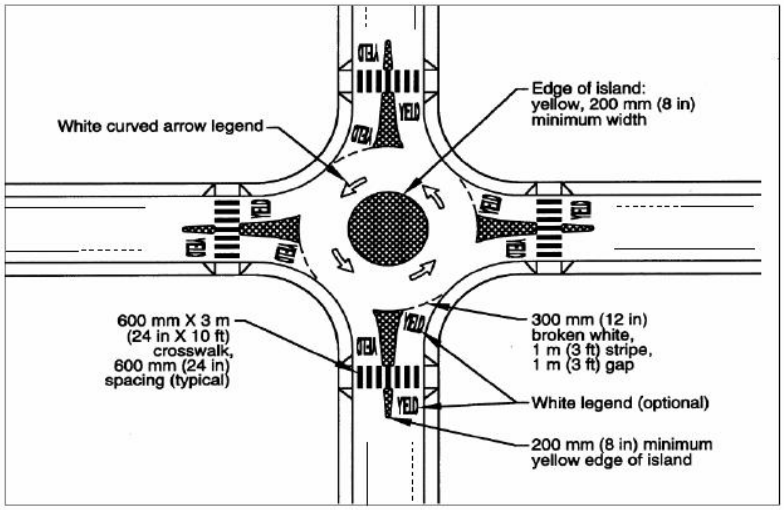


Figure 3.8 Sidepath Cross-Section



Roundabouts. Bicycles fare well at urban compact roundabouts. With low design speeds, minimized conflict areas, and yield upon entry traffic control, well-designed urban compact roundabouts are convenient and safe for bicyclists. The approaches to roundabouts should be treated just as any other unsignalized intersection: the bike lanes should be terminated prior to the roundabout, and cyclists should be allowed to claim the lane in the circulating roadway. An example drawing of this treatment, from the FHWA design guide[19] (with a modification to show approach bike lanes) is shown in **Figures 3.9** and **3.10**.

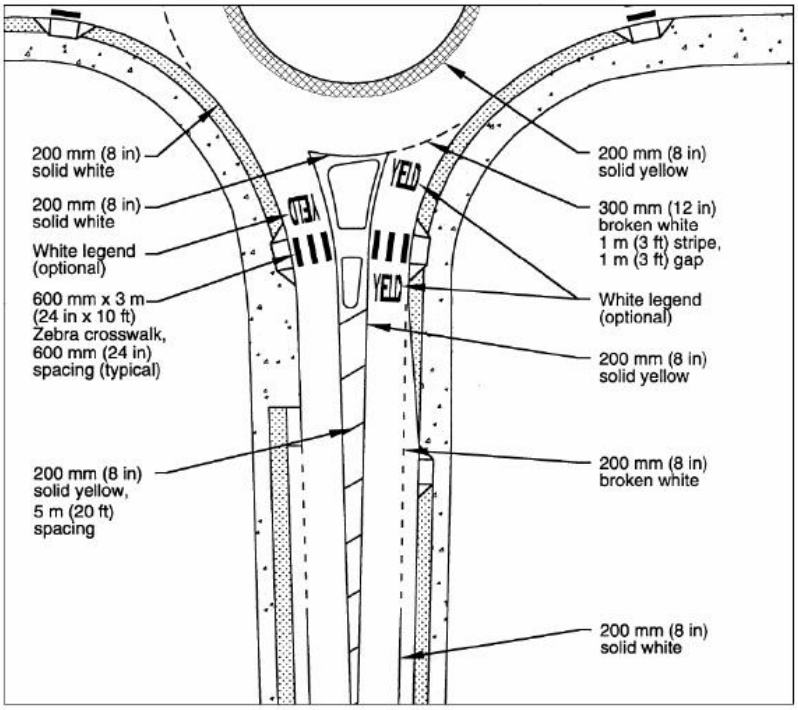
Figure 3.9 Roundabout with Bicycle Accommodations



Roundabouts: An Informational Guide FHWA-RD-00-67, June 2000 (modified)

It should be noted that the MUTCD states, "Bicycle lanes shall not be provided on the circular roadway of a roundabout intersection." This statement is made as a STANDARD and is thus not to be violated.
At roundabouts, such as the examples shown in **Figures 3.9** and **3.10**, bicyclists should be given a choice to either claim the lane and ride through the circulating roadway, or to move to a widened sidewalk and traverse the roundabout as pedestrians.

Figure 3.10 Roundabout Detail with Bicycle Accommodations

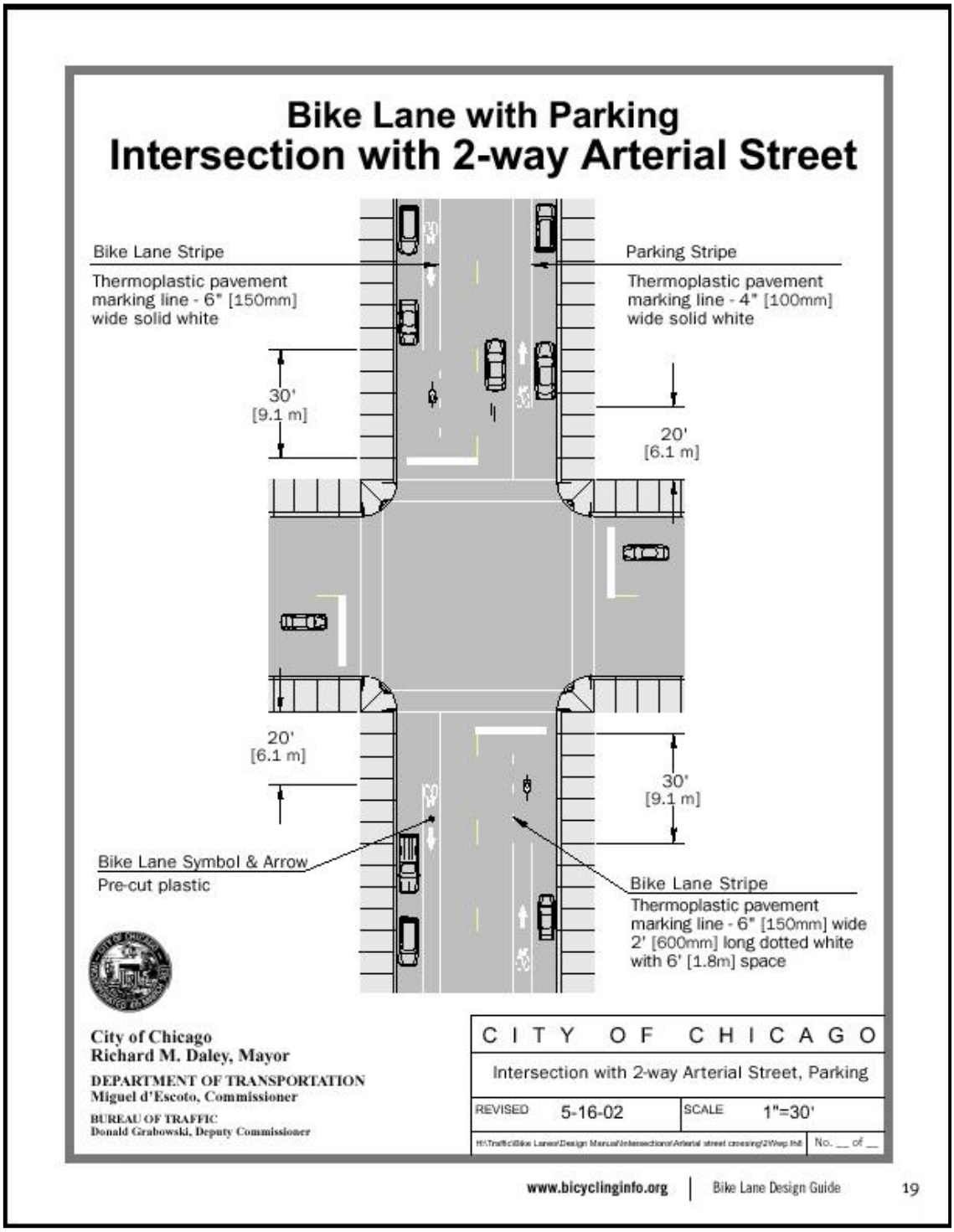


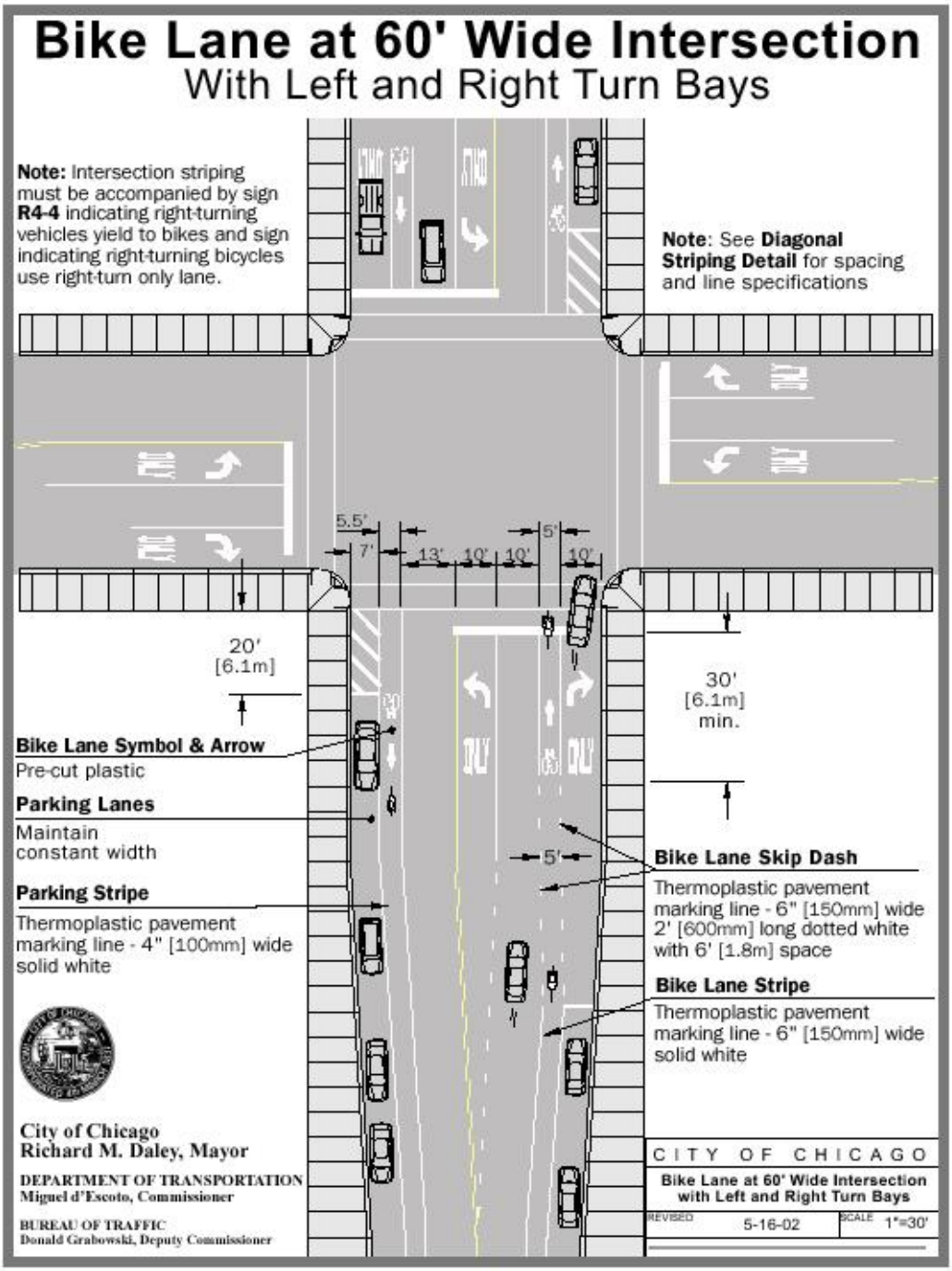
Roundabouts: An Informational Guide FHWA-RD-00-67, June 2000

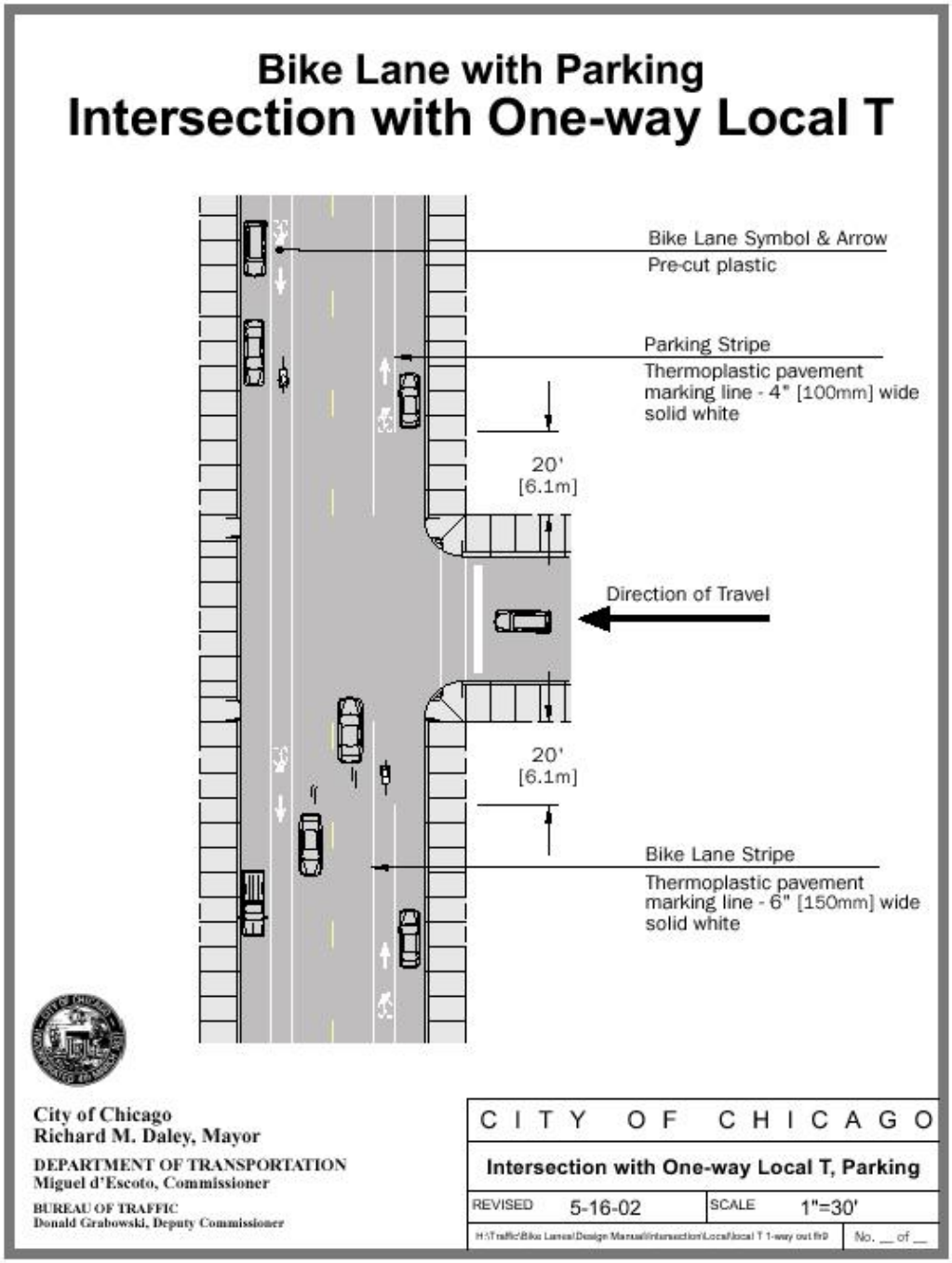
[19] FHWA, Roundabouts: An Informational Guide, FHWA-RD-00-67, McLean, VA, June 2000.

Example Intersection Striping Treatments

Figure 3.11 Example Intersection Striping Treatments




Bike Lane at 60' Wide Intersection
With Left and Right Turn Bays
Note: Intersection striping must be accompanied by sign R4-4 indicating right-turning vehicles yield to bikes and sign indicating right-turning bicycles use right-turn only lane.
Note: See Diagonal Striping Detail for spacing and line specifications
5.5'
7'
13'
10'
10'
5'
10'
20' [6.1m]
30' [6.1m] min.
Bike Lane Symbol & Arrow
Pre-cut plastic
Parking Lanes
Maintain constant width
Parking Stripe
Thermoplastic pavement marking line - 4" [100mm] wide solid white
5'
Bike Lane Skip Dash
Thermoplastic pavement marking line - 6" [150mm] wide 2' [600mm] long dotted white with 6' [1.8m] space
Bike Lane Stripe
Thermoplastic pavement marking line - 6" [150mm] wide solid white
City of Chicago
Richard M. Daley, Mayor
DEPARTMENT OF TRANSPORTATION
Miguel d'Escoto, Commissioner
BUREAU OF TRAFFIC
Donald Grabowski, Deputy Commissioner
CITY OF CHICAGO
Bike Lane at 60' Wide Intersection with Left and Right Turn Bays
REVISED 5-16-02
SCALE 1"=30'
18
Bike Lane Design Guide
www.bicyclinginfo.org



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Sample Cost Estimates

To accommodate the bicycle facilities being considered, a set of sample construction cost estimates were developed. These cost estimates were derived based on unit costs for similar facilities in other areas as well as by referencing the NCDOT cost estimation spreadsheet. Each unit cost is included below, along with a description of how it was obtained. The construction costs do not include right-of-way acquisition or mitigation. Relocation of utility poles is not considered due to the large variability associated with a specific scenario. Potential replacement of drainage grates is estimated between $150 to $500 depending on the necessity of replacing the frame. Railroad flangeway fillers are estimated at a cost of $500 per site, excluding additional crossing mitigation such as concrete pads and other surface treatments. All estimates are provided in 2006 dollars.

Multi-Use Path:
$300,000 to $500,000 per mile

This estimate assumes a 10 foot wide asphalt surface and does not include other potential mitigation such as building a structure over a wetland area.

Wide Paved Shoulder:
$300,000 to $400,000 per mile

This figure assumes a 4 foot wide paved shoulder on both sides of the road being built where there is currently a grass shoulder. Other factors such as extensive ditch work are not considered.

Signed Route:
$250 per sign or $1000 per mile

This estimate for bicycle route signage accounts for four signs to be placed in a mile section, with two signs in each direction. Many bicycle routes in urban and suburban areas require more than four signs per mile.

Striped Bike Lanes:
$15,000 per mile

The estimate for striped bike lanes accounts for striping lanes (thermoplastic) in each direction and signing the route. Also, painting the bike lane on municipal roads with a more visible color may be desired at a cost of $25,000 per mile. This will help to calm traffic by creating a sense of enclosure. These lanes are often created in conjunction with resurfacing projects; however, the cost of resurfacing is not included here.

Wide Outside Lanes:
$15,000 per mile

Wide outside lanes are used here when differential striping can be applied to a roadway. As a result, no additional widening is necessary. The estimate accounts for the cost of restriping and signing the route.

Signed Route with Striped Parking:
$15,000 per mile

These routes are again the result of working within the existing cross-section to create a new facility type. This estimate accounts for striping and signing costs.

Neighborhood Connector:
$50,000 to $85,000 for a prefabricated or removeable bridge.

This estimate assumes that the neighborhood connector would consist of a prefabricated bridge run for a short section over a stream or other barrier.

Ancillary Facilities and Programs

Mapping and Signing Projects

Comprehensive Route Systems

The recommendations shown in **Chapter 4** have been set forth in order to create a comprehensive route system for the City of New Bern linking commercial, recreational, and residential areas. Over the next twenty years, the implementation of these routes will ultimately result in an interconnected set of facilities. To accommodate these facilities, the proposed area-wide Bike Route System should be mapped and signed with bicycle route signs. Potential improvements are identified in this chapter. These recommendations encompass issues from maintenance to design and include but are not limited to:

- Provision of bike lanes on local streets where space is available and on-street parking is not an issue
- Exploration of the use of the shared lane symbol under restricted conditions
- Marking and signing traffic signal loops (and possibly recalibrating them) for bicyclists
- Replacing unsafe utility covers and catch basins within the bicyclists' line of travel
- Marking railroad crossings to improve safety
- Route signage

While the first five items listed above are important for the bicyclist who has decided to use a specific route, the last - route signage - is critical to helping cyclists determine which route to use. Route signage should provide useful information to the bicyclists. When creating a route system signing plan, the destinations being served and the best roadways (or facilities) to access those destinations must be considered. Signing should include information on the direction and distance to destination points, as well as intermittent confirmation that the bicyclist is still on the correct route.

Facilities that can be used to create a comprehensive route system include multi-use paths, bike lanes, shoulders, and wide outside curb lanes.

State/Regional Routes

Any route system implemented by New Bern should consider the existing state routes that run through the area. This plan incorporates the North Carolina Cross-State Bicycling Highways 3 and 7 into its facility recommendations. These routes should also be incorporated into the local comprehensive route system. State and regional routes benefit the local community with support from other jurisdictions, organized promotion, and occasional funding.

Share the Road Signing Initiative

North Carolina has been installing "Share the Road" signage since 1987. Although it was not part of the *Manual on Uniform Traffic Control Devices* (MUTCD) at that time, the sign has since been standardized and included in that manual. The sign, shown here, serves to make motorists more aware of the possibility of bicyclists on high-use roads with potentially hazardous conditions. When this sign is placed along a bicycle route, it

typically denotes a major roadway connecting with less frequently traveled roads. These signs serve as important and cost-effective safety and education tools. In fact, the visibility and impact of these signs has recently been acknowledged by the state by the issuing of a "Share the Road" license plate. The additional funds received through the sale of this license plate will be used to promote bicycle education and safety initiatives statewide.

Suitability Rating System

The bicycle level of service (LOS) methodology allows planners and designers to select a level of accommodation rather than a required specific design treatment to provide for bicyclists along a bike route. What the bicycle LOS methodology does not do is dictate what level of service is appropriate for a given community or user. This means that a community can decide that for one type of bike route system, such as a neighborhood route system, an LOS A or B may be required. Conversely, LOS C may be acceptable for the routes serving cross-town commuter cyclists. In addition to being widely accepted by state DOTs and local jurisdictions, the bicycle LOS method is also being considered as the basis for a national LOS model to be included in the Highway Capacity Manual.

A bicycle level of service analysis was not conducted as a part of this study. However, it is recommended that the city works with neighboring municipalities and Craven County to perform a level of service analysis with a corresponding map component. Ultimately this exercise also could serve as a benchmark for the road system in New Bern during future re-evaluations of the system.

Spot Improvement/Maintenance Programs

General Considerations

All non-Interstate roadways should be maintained so they are safe for bicyclists to use. The surface should be free of debris. Longitudinal cracks should be patched and drainage grates with longitudinal slots should be replaced. Utility covers should be flush with the roadway surface. Paved shoulders should be installed where rutting is occurring on the side of non-curb and gutter roadways. Potholes should be filled and maintained regularly. These items should be addressed through the normal roadway maintenance and Powell Bill program.

The alignment of drainage grates and gutter pans with existing pavement is also an area of concern in New Bern. Over repeated repavings, the pavement level on streets with curb and gutter can become significantly higher than the gutter pan. This poses a safety hazard for bicyclists and cars by creating a dangerous edge of pavement. This situation can be avoided by milling down the pavement so that a repaving will be flush with the

gutter pan or by raising the drainage grates and paving all the way to the curb.

Bicycle facilities, including trails, require an additional level of effort to provide acceptable maintenance. Maintenance issues occur most frequently on the right side of the pavement, where the cyclist is likely to be riding. Consequently, a more frequent maintenance cycle to address these defects should be provided for bicycle routes. Areas such as bridges where excessive debris tends to build up and bicyclists have limited refuge options should be maintained even more frequently. Examples of this include the US 17-Neuse River Bridge and the Trent River Bridge.

Signal Clearance

Traffic signal timing and loops along bicycle facilities require extra attention. According to the *MUTCD*[20],

> "At installations where visibility-limited signal faces are used, signal faces shall be adjusted so bicyclists for whom the indications are intended can see the signal indications. If the visibility-limited signal faces cannot be aimed to serve the bicyclist, then separate signal faces shall be provided for the bicyclist.
>
> On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists."

While the former can be easily evaluated, the latter concern (that of signal timing) is a little harder to address. The *AASHTO Guide for the Development of Bicycle Facilities* [21] provides information of clearance intervals and minimum green times for bicyclists. At wide intersections, the clearance interval equation can result in some excessively long yellow-plus-all red periods for signals. If the facility consists of a multi-use path or a bike lane, a signal loop can be placed in the bike lane or on the path in advance of the intersection. When a cyclist passes over the loop, the signal will extend the green time for the intersection approach to accommodate the crossing cyclists. This treatment is in common use for motorists and has been applied in various locations for bikes. The design of the loop is critical; an oversized loop in a bike lane will detect cars in the adjacent lane. An effective loop design for detecting bikes in bike lanes is a quadrapole 2 feet wide and 20 feet long (approximately half the size of a normal 40 foot roadway loop). Such a loop readily detects cyclists, but will not detect a car six inches to the side.

Roadway Symbol Buildup

Thermoplastic buildup is another concern of bicyclists. Bike lane symbols, lane use (directional) symbols, even crosswalks can all build up with repeated application and cause handling problems for bicyclists. More than two layers of thermoplastic (one marking) should not be allowed on bicycle facilities.

The slipperiness of thermoplastic and paints is another concern of bicyclists. One way to mitigate this concern is to add sharp silica sand to the glass spheres that make up the wet thermoplastic or paint. This increases the roughness of the markings' surface, reducing the potential for bicyclists to slip on the thermoplastic.

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[20] FHWA, *Manual on Uniform Traffic Control Devices*, pg. 9D-1, Washington, DC, 2003.
[21] *AASHTO Guide for the Development of Bicycle Facilities*, pg. 65, American Association of State Highway and Transportation Officials, Washington, DC, 1999.

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Safety Railings along Bicycle Facilities

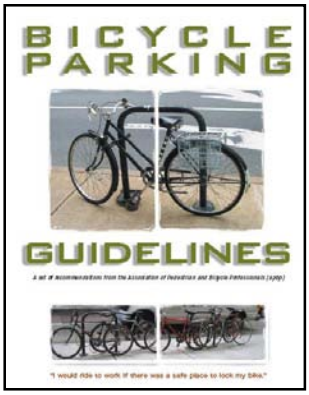
Bridge railing heights have been the subject of recent revisions to the *AASHTO Guide for the Development of Bicycle Facilities* and ongoing debates among bicycle facility design professionals. The current *AASHTO Guide for the Development of Bicycle Facilities* states that railing heights should be at least 42 inches to prevent bicyclists who hit the railing from tipping over the top. However, the current AASHTO Bridge Specifications require a 54-inch railing (this is also referenced in NCDOT's Bridge Policy as found at the following link: http://www.ncdot.org/doh/construction/altern/value/manuals/RDM2001/revpt1ch6-1yel.pdf). In practice, designers have been using the 54-inch railing when a structure is being built to the AASHTO specifications and a 42-inch railing along non-structural locations, such as when protecting bicyclists from embankments.

Bicycle Parking Facilities

Just as motorists need a place to park their cars when they arrive at destinations, bicyclists also need a place to park their bicycles. Consequently, when creating a transportation system to accommodate bicycling, parking must be included in that system. Bicycle parking is critical in areas where there are frequent bicycle riders such as the mall, schools, the YMCA, the marina, and other recreational areas. Bicycle parking should also be considered downtown and near businesses where bicyclists may frequent.

Typically, when parking is installed for bicyclists, the primary consideration is simply the accessibility or the convenience of the parking. While these are significant concerns for bicyclists, they are not the only issues. Bicyclists must also consider the security of the parking and the protection afforded to the bicycle.

The security concerns of bicycle parking can be addressed in several ways. High visibility of the parking rack can improve security. By locating parking near storefronts, or in high pedestrian use zones, the potential for theft or vandalism is reduced. However, placement needs to be carefully considered so as not to become a hazard to pedestrians or to diminish ADA accessibility. Well-lit areas can improve the security in areas where bicycles are parked after dark. Providing racks that support the frame instead of the wheel make it easier to lock a bike without damaging it. Bike lockers also provide good security for bicycles.



The protection required for a bicycle varies with respect to the purpose of the bicycle trip. For short duration trips, such as to the grocery store or the library, U-shaped bicycle racks on a concrete pad in front of the building may be acceptable. At a park and ride lot, or in front of an office building where the parking is for commuters, bike lockers or covered parking is more appropriate.

The Association of Pedestrian and Bicycle Professionals has produced a guidance document on good bicycle parking design.

This excellent document is available on line at the APBP website.[22] The website http://www.bicyclinginfo.org/de/park.cfm also provides information regarding bicycle parking costs and number of spaces recommended.

There are four basic elements to bicycle rack design. First, the bicycle should be supported upright by its frame in at least two places. Second, the rack should enable the frame and one wheel to be locked. Third, the rack should be anchored so that it cannot be stolen with bikes on it. Fourth, the rack should be placed as close to the building it serves as possible.

Bicycle racks can be tailored to reflect the culture or character of an area, or as a form of public art. Bike racks such as the one shown to the right make a statement about the area in which they serve as well as providing parking facilities for bicyclists.

Safety Initiatives to Reduce Bicycle Motor Vehicle Crashes in New Bern

Due to the low number of bicycle crashes reported for New Bern, these crashes were not analyzed in this study. However, the next step for further study could include an analysis of the bicycle crashes in the area with mitigation measures provided at each problem site.

Engineering/Traffic Calming Countermeasures

Intersection Signage

Static signs such as *NO TURN ON RED when Pedestrians Present* or the *Left Turning Vehicles Yield to Pedestrians* have been found to reduce the incidence of pedestrian conflicts at intersections. Consequently, it is reasonable to expect that these signs would also reduce the conflicts between motorists and bicyclists riding on a sidepath. However, they should be used sparingly and only where a problem has been documented and relatively constant pedestrian/bicycle use of the intersection exists. The overuse of signs or the use of the signs where pedestrians or bicyclists are not using the crosswalks dilute the ability of the signs to command the attention of motorists. Eventually this results in the signs being just background visual clutter.

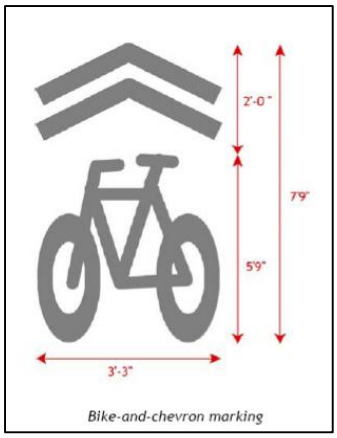
Because they are real time traffic control devices, blank out signs like the one pictured below can continue to be effective at intersections because they are only activated when there is a potential conflict. If motorists see a YIELD TO PEDS sign next to a permissive left turn signal, the motorists will know a pedestrian is crossing the conflicting crosswalk at that time. This "real-time" aspect of blank out signs allows for them to be placed at locations where conflicts are not

[22] APBP, Bicycle Parking, available at http://www.bicyclinginfo.org/pdf/bikepark.pdf.

frequent or constant enough to make a static sign appropriate.

Shared Lane Symbol

The Shared Lane Symbol, or "Sharrow", has the potential to reduce several different types of crashes and is being used in jurisdictions across the country. Because cyclists tend to center over the symbol, it may be useful for reducing door crashes (where a parked motorist opens a door into the path of a cyclist). Additionally, a similar treatment has been found to reduce wrong way riding and riding on the sidewalk, and to improve bicyclists' position in the travel lanes.



Bike-and-chevron marking

Consequently this treatment may actually reduce the incidence of "motorist failure to yield to the bicyclist crashes" and "overtaking crashes". Despite the potential for these collateral improvements, this treatment is recommended only in very selective areas, such as adjacent to on-street parking, or completing a link in a bicycle route.

This treatment is experimental and has not been approved by MUTCD, so its use would require one of two alternatives. This treatment can be used as a demonstration project on a non-state maintained roadway. If there is a desire to use Sharrows on a state or federal roadway, a Request to Experiment must be filed with FHWA prior to implementation. An evaluation plan must accompany this Request to Experiment and this must include measures of effectiveness. The following measures of effectiveness are suggested for New Bern:

- Separation between parked cars and bicyclists
- Percent of bicyclists riding on the sidewalk
- Percent of bicyclists riding against traffic
- Motorists' understanding of the symbol
- Bicyclists' understanding of the symbol

Transit Interface

At this time, no bicycle amenities are included on the vans, mini-buses, and sedans that make up the fleet of the Craven Area Rural Transit System (CARTS). CARTS, a service administered by Craven County, is geared toward elderly and handicapped riders with the service available to the general public on a space-available basis. Bike racks on these vehicles can eliminate a barrier presented to those individuals who need their bicycle for supplemental transportation after they deboard. Amenities for bikes on the CARTS service should be considered as a way to enhance the multimodal riding experience for users by extending the catchment area for the transit service, giving bicyclists more options, and potentially increasing transit ridership. Another amenity that should be considered to more fully integrate bicycle use and the transit system is the installation of bike racks near heavily used bus stops and destination points in town. With features such as bike racks, benches, and shelters, bus stops become more user-friendly environments and can attract additional riders.

Public Amenities

In addition to bicycle parking and provisions for bikes on buses, other amenities should be considered for implementation in order to create a more user-friendly bicycle system. Benches, water fountains, public restrooms, and changing areas provide riders with valuable services. These amenities are especially helpful in high traffic areas such as downtown and by major destination points such as shopping areas and schools. Bicycle rentals, especially within the downtown and near the marina, can also be a great amenity for tourists and residents alike. This service could be provided through a private entity or administered by the parks and recreation department.