WISCONSIN BICYCLE PLANNING GUIDANCE

Guidelines for Metropolitan Planning Organizations & Communities in Planning Bicycle Facilities

Mobility for the 21st Century

Wisconsin Department of Transportation

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Guidelines for Metropolitan Planning Organizations & Communities in Planning & Developing Bicycle Facilities

Wisconsin Department of Transportation
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Introduction

According to TEA-21: "The plans and programs for each metropolitan area shall provide for the development and integrated management and operation of transportation systems and facilities (including pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system…"

PL102-240 Sec. 1203 (a)3

Bicycling is an important mode of transportation, used separately or with other modes of transportation. Beginning in 1991, the Federal government has recognized this role and its importance as part of a balanced transportation system. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) placed increased importance on the use of the bicycle from a transportation standpoint and called on each state Department of Transportation to encourage its use. With the passage of the Transportation Equity Act for the 21st Century (TEA-21), the Federal government reaffirmed its commitment to bicycling for transportation.

But even before the passage of the original ISTEA bill, the Wisconsin Legislature prescribed a "bicycling role" for the Wisconsin Department of Transportation (WisDOT). According to Wisconsin State Statute 85.023, WisDOT is to provide assistance in the development of bicycle facilities:

> *"The department (WisDOT) shall assist any regional or municipal agency or commission in the planning, promotion, and development of bikeways".*

The focus of these guidelines is on the utilitarian and transportation aspects of bicycling and less so on the recreational side, for purposes of planning. The purpose of this document is to provide assistance in the form of a general set of guidelines that can be used by Metropolitan Planning Organizations (MPOs) and Wisconsin's larger communities as they plan and develop bicycle facilities. A separate guide will be developed for counties and smaller communities that deals with their particular needs.

Although the emphasis of this guide is on planning rather than designing for bicycle transportation, general design information on the different types of bicycle facilities (bike lanes, wide curb lanes, multi-use paths, paved shoulders) has also been provided. Often consideration of the different types of bicycle facilities is necessary when alternative bicycle route options are being evaluated. Knowing, for example, that a preferred facility type is a poor match for a specific corridor may lead to a different corridor choice or facility type.

Utilitarian bicycle trips (e.g., commuting to school or work; shopping journeys; and personal business trips) are the primary focus of bicycle transportation planning processes.

Photo courtesy Arthur Ross

There are several bicycle planning models currently in use in the United States. The process described here was developed by Wisconsin Department of Transportation as a guide for communities and Metropolitan Planning Organizations. Models prepared by the American Association of State Highway and Transportation Officials (AASHTO), the Bicycle Federation of America, and the Florida DOT, as well as Wisconsin's *Planning Guide for Development of Pedestrian and Bicycle Facilities* (Governor's Office of Highway Safety, 1977) and the 1993 edition of this publication were consulted in developing these guidelines. Any organization preparing a bicycle plan or designing bicycle facilities should consult the *Guide for the Development of Bicycle Facilities* (AASHTO, 1999).

The planning process, as presented in these guidelines, incorporates a combined approach (route planning and design) to the development of a bicycle element of the MPO's or community's long range transportation plan. The route planning component involves the identification of potential bicycle travel corridors and the recommendation of bicycle facility types on selected routes through these corridors. The design component includes the routine consideration of bicycles in all relevant projects and the establishment of minimum standards for all streets and highways where bicyclists are permitted.

This two-pronged approach ensures that even the streets not designated as bicycle routes, would have minimum accommodation for bicyclists. Street segments not meeting appropriate standards and new transportation projects with potential bicycle impacts should be identified in the bicycle plan along with the proposed bicycle route system. Section 5 of these guidelines discusses this approach in detail.

Above left: The route planning component involves the identification of potential bicycle travel corridors, like a river bottom, and recommendation of bicycle facility types on selected routes through these corridors.

Above right: Basic system improvements, like eliminating roadway hazards, are critical to the design component of plan development.

Paving an independent shared-use asphalt path
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The Bicycling Public

Ultimately, most members of society ride a bicycle at some time for some purpose. As a result, defining the bicycling public is much like defining the public,

These guidelines recommend that plans consider the needs of the broad range of bicyclists found in a typical community. Bicyclists vary by age, of course, but they also vary by cycling experience and knowledge, by attitudes toward traffic, by where they live and what's nearby, by physical fitness levels, as well as by typical trip purposes and common destinations.

By looking at some of these factors, it is possible to gain a greater appreciation for the diversity of the bicycling public and the possible implications for the development of policies, plans and projects. To assume all bicyclists are alike or that they fit neatly into a small number of categories is to distort reality. Ultimately, most members of society ride a bicycle at some time for some purpose. As a result, defining the bicycling public is much like defining the public, in general.

Age differences: Unlike driving a car, riding a bicycle is something that people of all ages are capable of doing and are allowed to do. Very young children often ride their tricycles up and down the sidewalk or around the playground. Some kids learn the basics of balance and control with their first two-wheeler by the age of four. By elementary school age, many students ride to school or to the store or to visit friends.

By the time they are in junior high school, kids often have good handling skills, if not good traffic-safety skills; but it's important to remember that their bicycles are their primary means of independent mobility. Some learn bicycle safety in school or through recreational programs. Such programs are becoming increasingly popular and are encouraged by WisDOT (see Appendix D, p.47).

Many high school students stop riding as infatuation with the car takes hold. But by post-high school age, some young people come back to the bicycle—particularly if they attend college but unfortunately retain adolescent riding and traffic coping skills. Many Wisconsin college towns are known for high levels of bicycle use.

Some bicyclists ride on major streets because these streets are the most direct — or perhaps the only — routes from "A" to B."

Beyond school, many people limit their bicycling to family outings, errands, recreational trail riding, and as a means of low-impact exercise. The latter reason for bicycling is increasingly important in a society plagued by ailments that result from inactivity, including obesity and cardiovascular disease.

Some use the bicycle to commute or for touring or racing. Bicycle clubs, for example, tend to cater to people in the 25 to 50 age group. By retirement age, many people who haven't ridden for years take up the bicycle again as a way to keep limber and fit. And for some older Americans, the bike or adult tricycle may be their only means of independent travel.

Cycling experience and knowledge: Understanding of bicycling varies widely among the public, regardless of age. Many people know little about how to ride efficiently and safely, how to carry loads, what kinds of safety equipment are necessary, or even which side of the road to ride upon. Unlike motor vehicle operators, no mandatory education is required for people to begin bicycling. For the most part, bicycle skills are learned through "trial-and-error" experience gained on the bicycle. However, bicycle laws are mostly the same as those governing motor vehicle operation.

Those who live within an easy bike ride from shops can use the bicycle for personal business trips.

Attitudes toward traffic: Some bicyclists have learned to ride comfortably on busy streets. While few enjoy sharing a road with high volumes of car and truck traffic, many prefer riding on main roads for their directness, access to important destinations, and protection from cross traffic — reasons that appeal to motorists as well. Such bicyclists often have a relatively tolerant view of traffic and see themselves as simply part of the mix.

Others avoid traffic if possible and use quiet back streets that may be less direct. Some such bicyclists fear traffic, others find it unpleasant, and others see it as both fearsome and unpleasant. For some, however, riding on busy streets is a "necessary evil" and they will do it when the alternatives are too inconvenient. Unlike

Parks and picnic areas are common destinations for bicycle trips. Integrating such features into the community, rather than locating them in isolated places, is one way to encourage bicycling.

those who see themselves as part of traffic, these bicyclists tend to see busy streets as degraded bicycling environments.

Where they live and what's nearby: In some parts of a community, bicyclists may live near many services and destinations. They might live just around the corner from a grocery store, drug store, park, or library. They may live close to schools and workplaces. And in areas with well-developed street grids, they may have many choices of how to get from point A to point B. In such areas, residents may use the bicycle for a wide variety of trips but may be discouraged by high levels of through traffic coming from outlying areas.

In other parts of the community, there may be little mixing of land uses and, as a result, few destinations within easy reach of people's homes. This is typical of some suburbs. And in such areas, connectivity tends to be limited by such features as cul de sacs and curvilinear streets with few intersections. As a result, people living in such areas may be less inclined to use the bicycle for a variety of trip purposes. For example, if people must travel five miles for a quart of milk, chances are that few will use a bicycle for such trips.

"Obesity rose 6% nationally between 1998 and 1999…Since 1991, obesity among adults has increased by nearly 60 percent nationally..."

source: The Centers for Disease Control's website at www.cdc.gov/nccdphp/dnpa/press/archive/obesity_climbs.htm

Physical fitness levels: While bicycling requires relatively little energy use per mile, one's body is the engine. As a result, people who are physically fit will find bicycling much longer distances easier than those who get little exercise. This is particularly noticeable in hilly areas or traffic situations where one must keep up a fast pace.

According to the Nationwide Personal Transportation Survey, the average bicycle trip is approximately two miles in length, a distance that would take a fit rider eight to 10 minutes to cover. Some bicyclists would consider this too short a distance to bicycle and some planners agree, preferring to focus on longer distance trips. For others, however, a two-mile trip would be a challenge and may help improve their health and fitness.

BICYCLE TRIP DISTANCE AND TIME BY TRIP PURPOSE

1990 Nationwide Personal Transportation Survey

Trip purpose:	*Distance (mi.)*	*Time (min.)*
Earning a living	2.1	15.3
Family and personal business	1.6	11.5
Social and recreational	2.2	15.5

PERCENT OF ANNUAL BICYCLE TRIPS BY TRIP PURPOSE

1990 Nationwide Personal Transportation Survey

Trip purpose:	*Percentage*
Earning a living	9.9
Family and personal business	19.7
Civic, educational, and religious	14.1
Social and recreational	55.4

Source: NPTS Travel Mode Special Report, 1994, FHWA

Typical trip purposes and common destinations: Studies like the Nationwide Personal Transportation Survey have shown that people use the bicycle most often for social and recreational trips, trips to school, and short "personal business" trips (e.g., trips to the store or to visit friends). They use bicycle less often for work commute trips, partly because the commute trip tends to be longer than most other trip types and it is typically constrained to certain times of day and inflexible destinations.

Providing additional space on this arterial street can give bicyclists more "breathing space."

An approach to serve the broad range of bicyclists

More experienced bicyclists are generally well served by adopting roadway design standards that include wide curb lanes and paved shoulders on higher volume roadways. This design practice will be of benefit to both motor vehicle and bicycle users, allowing adequate space for street sharing with minimum need for changing lanes or lane position.

Less experienced bicyclists will be best served through the development of a bicycle route system that serves key travel corridors (typically arterial streets) and by providing designated bicycle facilities on these routes. Key travel corridors should be identified through the planning process described in these guidelines and should include treatments like bicycle lanes and unmarked bicycle lanes on arterial streets. In situations where the arterial streets are still intimidating, an option is to also create routes using side streets or a nearby shared-use paths. When side streets or paths are considered, directness and minimizing delays is still of major importance to bicyclists.

The Federal Highway Administration and WisDOT have made it clear that bicycle use should be encouraged and made a legitimate transportation choice. Surveys have indicated there is a large number of occasional bicycle riders who have indicated an interest in bicycle commuting if provided an improved bicycling environment. Planning of bicycle facilities to encourage more use among this group of adult casual users — for all trip purposes — appears to have the best opportunity for increasing overall bicycle usage.

The AASHTO Bicycle Facility Guidelines

The 1999 AASHTO *Guide for the Development of Bicycle Facilities* is the basic reference for bicycle facility designers. It has been adopted, in part or in its entirety, by many state and local governments. WisDOT is currently incorporating the *Guide* into its *Facilities Development Manual.* In conjunction with the *Manual on Uniform Traffic Control Devices* (2000), AASHTO's *Guide* is often the primary reference publication used to plan and design facilities.

For information on ordering the 1999 AASHTO *Guide for the Development of Bicycle Facilities*, contact the American Association of State Highway and Transportation Officials at 444 N. Capitol St, NW, Washington DC; by phone: (202) 624-5800 or via the web at www.aashto.org.

A planning and design approach will encourage the use of bicycling among occasional riders through a planned system of bicycle facilities while basic design considerations like safe drainage grates and wide curb lanes or bike lanes on arterial streets will improving accessibility for all bicyclists.

A busy arterial street may be the only through route through a major part of the community.

Bicycling on Arterials

Many planners and traffic engineers become uneasy when considering the possibility of accommodating bicyclists on urban arterials or highways. At the least, a basic level of accommodation on arterials is necessary for a variety of reasons. First, bicyclists have a need to get where they are going. They need access to important destinations and providing such access is an integral part of the transportation planning process. In addition, bicyclists, especially experienced bicyclists, have the same desire for directness as motorists.

And arterial streets are often the only ways to cross major barriers such as rivers, rail lines and freeways. These critical crossing points for cyclists are often at locations with higher motor vehicle volumes. Thus, minimum bicycle accommodations on these facilities is necessary to ensure safe mobility. Lastly, arterials provide direct access to major destinations. Access to places on such streets is essential for all bicyclists. Imagine, as a motorist, not being able to get to your place of work or a shopping mall because the streets serving these places do not accommodate motor vehicles.

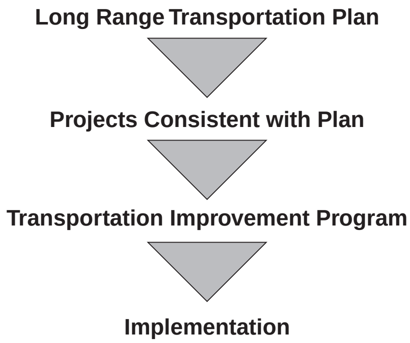
The use of wide curb lanes (14 to 15 feet lanes for through vehicle use where no parking is provided) is a means of providing a base level of accommodation on arterial streets. Other elements like bicycle-safe drainage grates and smooth pavement surfaces, and bicycle-sensitive traffic signals are also important. If the arterial street has been identified as the preferred bicycle route in a plan, then bicycle lanes should be considered.

Bicycling in the Planning Process

Since adoption of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and the subsequent Transportation Equity Act for the 21st Century (TEA-21), adopted in 1998, the concept of a seamless, multi-modal transportation system has become an integral part of urban transportation planning. Metropolitan planning organizations (MPOs) are required to develop and approve a multi-modal 20-year long range transportation plan.

These plans must address goals, issues, system deficiencies, financial constraint, etc. for all modes of transportation within each metropolitan planning boundary area. Modes include traditional highway systems, and expand to encompass bicycle, pedestrian, train, air, transit, and port. The idea is to ensure a transportation planning process that considers all transportation modes and supports community development and social goals.

According to ISTEA:
"The National Intermodal Transportation System shall consist of all forms of transportation in a unified, interconnected manner..."
PL102-240 Sec. 2



The linkage between long-range planning and implementation goes through the TIP.

Including a bicycle section in the long range transportation plan is critical to the implementation of bicycle-related projects. To assure that project implementation is connected to and consistent with the planning process, all projects proposed for federal or state transportation funding must first be clearly established in the MPO's adopted long range transportation plan. Smaller activities, such as striping lanes, may be grouped under such activities as "signing a network of bicycle lanes on highway systems." However, even these must be financially constrained within the plan if state or federal funds will be used.

According to TEA-21: "…the metropolitan planning organization and State shall cooperatively develop estimates of funds that will be available to support plan implementation."
Title 23 USC, Sec. 134(g)(2)(B)

The MPO's governing board, sometimes called its "policy committee," is responsible for adopting the plan. Once adopted, the plan becomes the basis for "dropping" projects into the MPO's 2 or 3-year transportation improvement program (TIP). At this point the funding has been secured, and the project is scheduled to start.

Plans can be amended at any time with the required public involvement and approval of the policy committee. The long range transportation plan and component sections must be updated every 3-5 years depending on non-attainment air quality status of the area.

Throughout this entire process, a broad spectrum of the local public needs to be engaged in the discussion and responsible for the recommendations of the proposed bicycle plan.

Developing the Bicycle Element

The bicycle element of the transportation plan should include an inventory and analysis of existing street and bikeway conditions, local transportation policies, and standard design practices; it should propose a vision, goals, and objectives for bicycling; it should suggest a bicycle route and facilities improvement strategy; it should propose any necessary modifications to existing policies and practices; and it should include a bicycle education and enforcement component.

The primary emphasis, however, of these guidelines is on developing a more "bicycle-friendly" transportation system by establishing a facilities network and bringing all streets up to a minimum level of compatibility. Often the focus of a bicycle element (or bicycle plan) is solely on the network but it is just as important to consider policies and practices.

The primary emphasis of these guidelines is on developing a more "bicycle-friendly" transportation system by establishing a facilities network and bringing all streets up to some minimum level of compatibility.

For example, if adequate space for bicycles is not included as standard procedure in new roadway designs, it will be difficult to retrofit bike lanes or other measures in the future. Similarly, if new traffic signal systems are not sensitive to bicycles from the beginning, then solving the problem can involve the added expense of painting extra pavement markings or installing new detector equipment.

In addition, when developing facility plans, communities and MPOs should consider how education and enforcement issues will be addressed, as well as what impact facility designs may have on these needs and vice versa. For example, developing two-way bicycle facilities on one side of the road will cause problems for educators and police trying to discourage wrong-way riding. The best solution is to work with educators and enforcement officials to develop a consistent approach on these issues.

A comprehensive bicycle element should contain goals and discussion relevant to the education of both bicyclists and motorists as to their respective rights and responsibilities, as well as to the enforcement of both bicyclists' and motorists' rules of the road. Additionally, since there is clearly an emphasis in TEA-21 on promoting bicycle use, an encouragement element is also recommended. These components are fairly straight forward and can probably be summarized in one section of the plan.

Public Involvement in Developing the Bicycle Element

For maximum impact, public involvement efforts should reach out to local residents through a variety of means.

Public participation is essential in all transportation planning — not just the development of the bicycle element — and should begin early in the process. TEA-21 encourages a "proactive" public involvement approach involving an early and continuing role for the public. It also encourages using a variety of means to reach affected groups, particularly the "traditionally underserved."

Community input can be obtained and citizen interest in the plan piqued in a variety of ways. And it is best to use more than one or two approaches in order to reach the greatest audience and provide means for all to get involved.

For instance, while it is common to hold public meetings on the bicycle plan, it can also be vital to attend meetings of existing groups (e.g., civic organizations, neighborhood associations, church groups, and others). In this way, one can reach out to those who don't have time or inclination to get directly involved, or who may not have heard what was happening.

In addition, extra attention can be focused on the project by conducting public meetings in different parts of the communities and publicizing them through various media (including neighborhood newsletters and bulletin boards). Including surveys in local newspapers is another means of gathering public opinion, as is the use of telephone surveys or mail-back surveys placed, for example, on bicycles parked at schools, parks, and work sites.

The creation of an advisory committee is an effective means of gaining organized and sustained input. It can also lead to the creation of a permanent committee that oversees the community's bicycle (and, often, pedestrian) program.

Who should participate in such a committee? The short answer is: those who have a real interest in getting — and staying — involved. Membership should be diverse and reflect the make-up of the community. Bicycling groups like the League of American Bicyclists and the Wisconsin Bicycle Federation have members in most metropolitan areas of the state and they can be very helpful in recruitment. Additionally, most metropolitan areas have bicycling groups. Besides members of bicycle organizations, however, it is important to reach out to other potentially interested parties. These may include teachers, students, casual bicyclists, safety advocates, parents' groups, and others. It is helpful to have people involved who are implementors and not just those who like to talk.

Advisory Committee membership should be diverse and reflect the make-up of the community.

A "kick-off' meeting should be conducted to inform the public and/or the citizen advisory committee of the proposed process for the development of the plan. This will also provide an excellent opportunity to learn of the major concerns that bicyclists have. Additional meetings should be scheduled as part of the planning process. The entire citizen participation process should culminate with at least one final public hearing. (A more thorough discussion of public participation techniques is included in another WisDOT MPO guidance publication entitled *Public Participation Process.*)

The Planning Process

A complete planning process can be broken into seven steps and implementation:

1. *Develop vision, goals, objectives, and policies.*
2. *Establish/refine planning criteria for the bicycle transportation system.*
3. *Inventory bicycle usage, crashes, existing bikeway and roadway characteristics, and transportation policies and practices.*
4. *Identify bicycle travel corridors.*
5. *Evaluate and select specific route alternatives and design treatments.*
6. *Prepare a safety component.*
7. *Evaluate the finished plan against pre-established planning criteria and goals and objectives.*

1. Develop a Vision, Goals, Objectives, and Policies

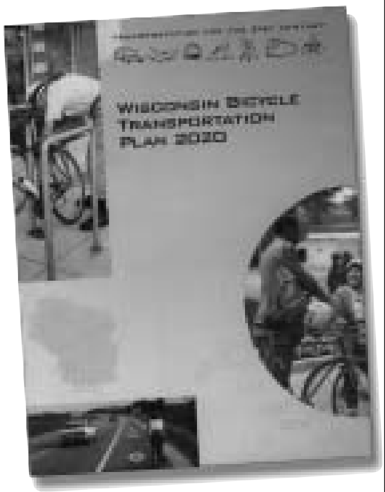
The establishment of planning criteria should be an interactive process with the development of goals and objectives and the consideration of alternatives.

The vision, goals, and objectives of a plan form the framework for action. The vision gives the mission of the organization in the context of the services they are to provide. The goals suggest measurable end points for the process. The objectives give the specific steps for reaching those goals. And the policies provide the decision-making context for taking those steps.

The Plan's vision gives the mission of the organization in the context of the services they are to provide.

Although the development of these elements can be guided by MPO or community planning staffs, representation of policy makers and users (bicyclists) is important. In general, goals should address the needs of the full range of bicyclists, integration of the bicycle with other modes, funding and prioritization of funding, facility development, public participation, education, encouragement, and enforcement.

This section should also include the MPO's or community's policies on minimum road width standards and options necessary to accommodate bicyclists on all streets (see examples in Appendix B, p.37). WisDOT has provided state goals and objectives as part of its statewide transportation plan (see sidebar), but local goals may be established in advance or as a complementary addition to the state goals.



The Wisconsin Bicycle Transportation Plan 2020 may be requested from:
Tom Huber
Bicycle and Pedestrian Coordinator
Wisconsin Department of Transportation
PO Box 7913
Madison WI 53707
It may also be downloaded from the Internet at:
http://www.dot.state.wi.us/dtim/bop/finalbike.html

Wisconsin Bicycle Transportation Plan 2020

The following vision, goals, and objectives are found in the Wisconsin Bicycle Transportation Plan and are offered as examples.

Vision statement:
To establish bicycling as a viable, convenient and safe transportation choice throughout Wisconsin.

Primary goals:

• Increase levels of bicycling throughout Wisconsin, doubling the number of trips made by bicycles by the year 2010.

• Reduce crashes involving bicyclists and motor vehicles by at least 10% by the year 2010.

Objectives:

Objective 1 - Plan and design new and improved transportation facilities to accommodate bicyclists and encourage their use.

Objective 2 - Expand and improve a statewide network of safe and convenient routes for bicycle transportation and touring, including safe and convenient access to and through the state's urban areas.

Objective 3 - Provide consistent safety messages and training to all roadway users by expanding the range of education activities through driver licensing and training, bicycle safety education, increasing understanding of traffic laws, and provision of public service information.

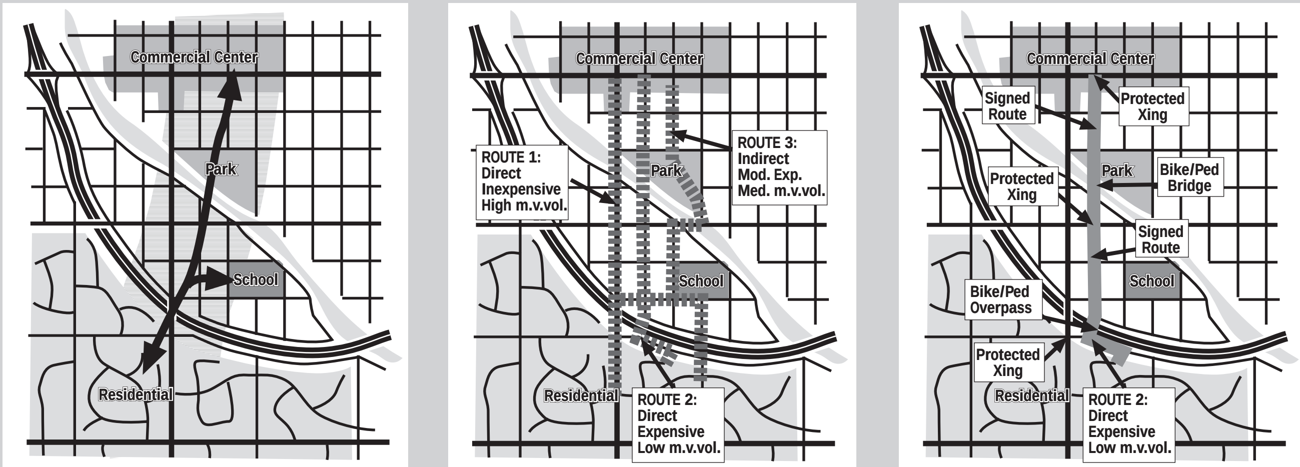
Objective 4 - Improve the enforcement of laws to prevent dangerous and illegal behavior by motorists and bicyclists.

Objective 5 - Encourage more trips by bicycles by promoting the acceptance and usefulness of this transportation mode.

2. Establish/Refine Bicycle Planning Criteria

Planning criteria should be used when evaluating and considering bicycle routes and facilities that will become part of an urban bicycle network. The consideration of these criteria in the planning process will help ensure the development of a desirable, effective, and safe bicycle network.

An example of the three steps in considering planning criteria



Potential Demand & General Corridors
Criteria: usage (including trip length), directness, accessibility/spacing, system continuity, barriers, security, and aesthetics

Bicycle Facility Siting
Criteria: directness, cost, funding, delays to bicyclists, safety (both real and perceived), and ease of implementation

Selecting Facility Type
Criteria: directness, cost, funding, delays to bicyclists, safety (both real and perceived), and ease of implementation

Consideration of the placement of bicycle routes should be done in accordance with three general sets of planning criteria in three distinct steps. The first set of planning criteria addresses bicycle user demand and the general corridor locations of proposed routes (see above). Included in this set are usage (including trip length), directness, accessibility/spacing, system continuity, barriers, security, and aesthetics.

The second set of criteria can be used in the siting of bicycle facilities within identified bicycle corridors, and include directness, cost, funding, delays to bicyclists, safety (both real and perceived), and ease of implementation. In the third step, these same factors are also used to select the appropriate facility type on a specific street segment.

Ultimately, these criteria will help determine and test a bicycle facility system's desirability and effectiveness. They also bear a strong similarity to what motorists expect in a highway system. A complete explanation of the criteria, organized into the three-step process, is included in Appendix A. MPOs and communities may wish to refine these criteria.

The establishment of planning criteria should be an interactive process with the establishment of goals and objectives and the consideration of project alternatives. For instance, if a goal is to improve route accessibility, then the standards for accessibility should be tightened to ensure that, if the standards were met when alternative projects are considered, there would be an improvement in accessibility.

3. Inventory Roadway Characteristics, Bikeway Conditions, Bicycle Use, and Crashes

The bicycle plan element's inventory section should include data and the appropriate analysis of the roadway conditions, existing bicycle facilities, and bicycle crashes. Additionally, an examination of the number and percent of people using the bicycle for transportation purposes will help establish a baseline for monitoring changes in usage.

Narrow outside lanes on arterial streets near major bicycle traffic generators should be noted and considered for improvements. Mixing with traffic on such streets can be a challenge for many bicyclists.

Roadway Inventory: An inventory of the roadway system should include all arterials and collectors. Some time may be saved, especially in larger communities and metropolitan areas, by considering just the streets/roads being considered as options for designated bicycle facilities. Data should be initially collected on the average daily traffic (ADT), pavement width, the adjacent land use (commercial, residential, mixed-use, etc), and the number of lanes. Traffic volumes are available on all classified roads under WisDOT's coverage count program and roadway geometries are available from various WisDOT data bases.

Land use information can be obtained from community land use plans and inventories. Land use along streets will often provide a good indication of the amount of potential conflict that could be expected from driveways and intersections, as well as the presence of likely trip destinations. More detailed data, such as pavement condition, speed limits, sight lines, grades, railroad crossings, etc., can be collected and examined for the alternatives at a later stage in the planning process.

One useful and relatively easy way to gain basic insight into bicycling conditions along major roadways is to use the "Bicycle Compatibility Index" (BCI), a tool developed for the Federal Highway Administration (following page). The BCI considers traffic volume, traffic speed, available space in the outside travel lane, presence or absence of a bicycle lane or paved shoulder, adjacent land use, parking, and several other factors to give a rating for a particular stretch of roadway (see Appendix C (p.43) for details). Used in conjunction with an agency's Geographic Information System, the BCI can quickly and easily produce an overview of the roadway network. Such roadway elements that do not show up in the analysis (e.g., problem intersections) can be overlayed on the basic BCI information.

In addition to looking at the "hardware" of the roadway system, it's also necessary to look at the policies that underlie that "hardware." This involves taking inventory of such things as existing typical roadway sections, standards for items like drainage grates, traffic signal detectors, and shared-use paths. Quite possibly some elements are based on non-bicycle-friendly approaches or outdated design manuals and should be updated to more current thinking. In addition, it is important to identify funding limitations that would hamper the development of bicycle facilities and programs.

The Bicycle Compatibility Index

A Way to Measure Bicycling Conditions

The Index: BCI = 3.67 - 0.966BL - 0.410BLW - 0.498CLW + 0.002CLV + 0.0004OLV + 0.022SPD + 0.506PKG - 0.264AREA + AF

Factors

BL	Bike lane or shoulder
BLW	Bike lane width
CLW	Curb lane width
CLV	Curb lane volume
SPD	Speed
PKG	Parking
AREA	Land use
AF	Adjustment factors • *trucks or buses* • *right turns* • *parking turnover*

BCI & Level of Service

LOS	*BCI*	*Compatibility*
A	≤1.50	Ext. high
B	1.51-2.30	Very high
C	2.31-3.40	Mod. high
D	3.41-4.40	Mod. low
E	4.41-5.30	Very low
F	>5.30	Ext. low

Typical Applications

Operational Evaluation: *Existing roadways can be evaluated..*

Design: *New roadways or roadways being re-designed can be assessed.*

Planning: *Forecasts can be used to assess bicycle compatibility of roadways in the future.*

The "Bicycle Compatibility Index" (BCI) is a tool developed for the Federal Highway Administration (see Appendix C, p.43, for details)

Bikeway Conditions: Since the 1970s, many changes have taken place in the bicycle facility field. Path widths that were considered appropriate in the 1974 *AASHTO Guide,* for example, are now seen as woefully inadequate. In some cases, two-way bicycle lanes were developed adjacent to roadways and "bicycle route" signage systems were created that included little information on destinations or distances. Some communities designated sidewalks as bikeways, with generally negative results. As a consequence, it is important to look at the community's existing bicycle facilities and compare them to current approaches to determine whether they need modification.

Designated sidewalk bikeways like this were typical of early approaches to bicycle facilities and should be noted during the inventory process.

Bicycle Use: Current bicycle use data is often unavailable, especially by bicycle trip purpose. Routinely this data has not been collected during transportation surveys or corridor counts. Unfortunately, when data on bicycling is missing, many officials assume there is little or no bicycling. And such assumptions often lead to a lack of investment in bicycling. When data is available, low numbers may also lead to a lack of investment. And lack of investment in a bicycle-friendly infrastructure is one reason often cited for low usage numbers. Few people will ride if they believe the environment is dangerous for bicycling. The appropriate use of bicycle use data is to determine current levels prior to implementing plans that further the community's bicycling vision, goals, and objectives.

As an example of the types of data that may be collected, WisDOT surveyed residents in the fall of 1998 and spring of 1999, and found that the bicycle was being used for 3.5% of all trips. Work commute information is also available. According to the Bureau of the Census, work trip commutes by bicycle are more common in MPO areas than in most non-MPO areas. Preliminary data from the 2000 Census indicates that work trips by bicycle are around 1% of all work trips, but data was collected for the last week of March for the predominant means of commute transportation for that week. As shown above, it is important to emphasize that other bicycle trip purposes are often more common than the journey to work. For example, the 1995 Nationwide Personal Transportation Survey showed that, for bicycling, going to school, shopping, or recreational facilities are more common than riding to work. For this reason, the full spectrum of trips must be considered when planning for bicycle use.

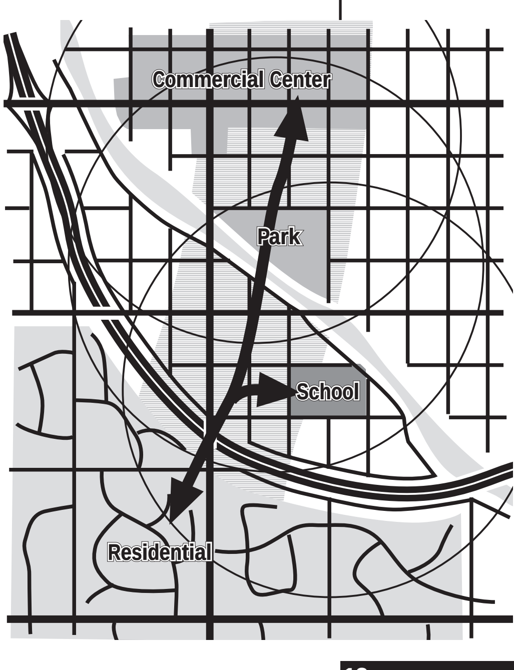
It is also important to understand typical bicycle trip lengths. Some bicyclists ride long distances to work or for recreation. However, given the nationwide average bicycle trip length of approximately 2 miles, planners should consider more of a “micro” view than they would for motor vehicle trips. For example, the short trip from a residential area to a nearby business district may be a better focus than a cross-town journey.

More recent comprehensive surveys of bicycle and pedestrian use need to be conducted of current and potential use as well as residents’ desires. While WisDOT may be conducting a statewide survey as part of the Personal Transportation Study, MPOs and communities are encouraged to conduct local surveys.

Bicycle Crashes: This is also the appropriate time in the planning process to review available bicycle crash data to determine common crash locations and to get a general idea of the types of crashes. Bicycle crash data are available from local police authorities or WisDOT. Crash data are reported universally for Wisconsin on Form MV4000. However, it is important to highlight two shortcomings of crash evaluations.

First, bicycle crashes reported through the MV4000 reporting process comprise a minority of all crashes. Some studies have indicated that as few as only 10% of all bicycle crashes are reported. One recent Federal study indicated that fewer than 50% of those bicycle crashes that sent someone to an emergency room showed up in police reports.

A typical bicyclist living in the neighborhood at bottom left is more likely to ride to the school than to the commercial area.



Secondly, it is important to consider the exposure rate of bicyclists when reviewing these data. Some of the streets and intersections with a higher frequency of bicycle crashes may have higher bicycle use. Ultimately, such data may help identify problem areas that need immediate remedial treatment.

4. Identify Bicycle Travel Corridors

Identifying bicycle travel corridors is not the same as simply plotting popular bicycling routes and/or assuming an increase in use. Estimating trip traffic is generally one of a transportation planner’s most complex and sophisticated tasks, but does not have to be so for estimating bicycle trip traffic.

To some extent, bicycle travel mirrors motor vehicle movements. When origin and destinations are paired (desire lines) the travel habits of bicyclists are much the same as motorists, while trip lengths are generally shorter. On week day mornings, travel is most common between residential areas and schools and places of employment. During the day, personal business trips tend to be more common. And in the afternoon, travel tends to focus on residential areas again.

Since many motor vehicle work trips are less than five miles and many are less than two miles, the potential for a shift to bicycling is considerable. By basing future bicycle travel on existing patterns alone, more direct linkages between origin and destination pairs will probably be underestimated, since current direct usage is often restricted by negative features of the cycling environment. For example, the only connection between a certain neighborhood and downtown may be a narrow and busy arterial route.

The question that should be posed is "Where would bicyclists be going if they could go exactly where they preferred?" and not "Where are they now?"

The important question that should be posed is "Where would bicyclists be going if they could go exactly where they preferred?" and not simply "Where are they now?" Certainly, if part of the goal of encouraging bicycle usage is to reduce single-occupant motor vehicle (SOV) traffic, then focusing on existing vehicle traffic patterns is essential.

Another means of identifying higher bicycle use corridors is to plot major trip generating centers such as schools, universities, commercial areas and major employers and then connect these generators with anticipated high use residential areas.

An appropriate way to identify desire lines for bicyclists is to plot trip-generating features such as schools, universities, commercial areas (downtowns, shopping centers, neighborhood shopping areas, malls, etc.), major employers, and industrial/business areas. Drawing connection lines between traffic-generating sites and residential areas should give planners a general idea of the desire lines of cyclists. Survey information, be it community or employer-based, can aid in determining desire lines.

Another method is to apply a projected bicycle mode split for the community to existing origin-destination data for specific corridors. For the first time, the 1990 U.S. Census provided bicycle commute mode splits for census tracts. However, this data was collected for the last week of March, 1990, not a high bicycle usage month in Wisconsin and it only considered the journey to work. The Census Bureau's "Look Up" tables on their Web site can be useful in this portion of the planning process. For instance, not only can they provide commute trip data (e.g., mode split and trip time) but they can identify parts of town with high numbers of school children, households without access to private autos, or other special characteristics. (See http://venus.census.gov/cdrom/lookup)

"Trips that are very short, that begin and end in a single zone (intrazonal trips) are usually not directly included in the forecasts.

This limits the analysis of pedestrian and bicycle trips in the typical travel demand modeling process since they tend to be short trips."

A Transportation Modeling Primer; *by Edward A. Beimborn, Ctr. for Urban Transportation Studies, Univ. of Wisconsin-Milwaukee*

Parks, playing fields, and other recreational sites that are accessible from neighborhoods may attract many bicycle trips. Adequate secure bicycle parking should be provided.

The resulting bicycle corridor map(s) will give a strong indication of where cyclists want to go but not necessarily where they are today. This information can be based, in part, on survey data identifying desired destinations and travel needs.

Whether the choice of bicycle forecasting methods involves plotting traffic generators and the resulting desire lines or by estimating bicycle volumes as a modal split, a few special situations may require adjustments. Some bicycle traffic generators, for instance, will attract an inordinately high number of bicyclists. First, educational institutions of all types generate an extraordinary number of bicycle trips. Elementary and middle schools generate child bicycle trips that may need special planning attention as foundation for a "Safe Routes to School" program. Simple travel surveys conducted in cooperation with the schools may show bicycling to account for as much as 15 to 30% of trips, depending on trip lengths and street characteristics. University campuses typically generate bicycle trips in excess of 10% of all trips and often remain high through the winter months. In addition, many university students use the bicycle as their primary means for transportation.

Second, parks, beaches, trails, parkways, scenic roads and other recreational facilities attract a higher percentage of bike trips than the community average. And, for parks with long trails, they typically attract many users who drive to the trailhead with their bikes on their cars.

TRANSPORTATION PURPOSE AND BICYCLE FACILITIES

Federal guidance requires that facilities have a "transportation purpose" in order to be funded. But what is a "transportation purpose"? Here is what the Federal Highway Administration says:

"Bicycle projects must be principally for transportation purposes. Any bicycle facility that provides access from one point to another can and will be used for transportation purposes and is therefore eligible for funding under TEA-21."

source: FHWA Guidance: Bicycle and Pedestrian Provisions of Federal Transportation Legislation

Finally, multi-mode connection points should also be considered. Bicycling to transit hubs, park-and- ride lots, and train stations represents one of the highest potential uses of the bicycle, especially in suburban locations. Combining transit with bicycle trip-making merges the best attributes of each mode — local penetration for bicycles and longer distance and speed for transit. Many communities across the country recognize the benefits of this linkage and provide bike racks on each of their transit system's buses, for example.

5. Evaluate and Select Specific Route & Facility Types

A plan should consider the development of a bicycle route system and the identification of arterial and collector streets that are currently unsuitable for bicycle travel — but that could be improved (e.g., upgraded when the street is reconstructed).

The previous section prescribed two ways of identifying bicycle corridors. Two planning criteria — use and directness — were the primary factors used in determining the general location of these corridors. This phase of the planning process involves two steps: the consideration and identification of a bicycle route system and minimum design treatments on all streets. The first step focuses on developing a skeletal network of bicycle facilities. The second entails identifying street segments that do not safely accommodate bicyclists.

Some unsuitable streets are arterials, many of which can be improved at the time of street reconstruction. These arterials might never become part of a bicycle route system, but some form of minimum accommodation for bicyclists should be provided where reasonably feasible (see sidebar on page 10 "Bicycling on Arterials"). Other streets to consider are low-volume links to important destinations. For instance, a residential street that crosses an arterial may connect a neighborhood to a school or park. Improving the safety of this crossing may foster many short bicycling trips.

This wide outside lane, while not attractive for most casual bicyclists, can provide extra space for motorists to pass cyclists.

Step one involves planning a bicycle route system through the interaction of two steps - identifying route alternatives and considering and selecting appropriate facility types. The practicality of adapting a particular route to accommodate bicyclists may vary depending upon the type of design treatment selected. Compromising or enhancing certain planning criteria must then be considered in the context of the different design treatment options. For instance, providing a bicycle lane on a busy arterial may be evaluated against a parallel side-street that is less expensive, but is less direct, has more delays, and requires parking removal on one side of the street. (Appendix G includes definitions of bicycle facility terms).

The most important factors are usage, directness, accessibility, connectivity, safety, and costs. (The planning criteria are included in Appendix A.) The first five factors represent the degree to which a specific route meets the needs of the anticipated users when compared to other routes. The cost factor considers the extent and timing of construction required to implement the proposed bicycle facility treatment. For example, one option may entail the often unpopular decision to alter or eliminate on-street parking while another does not.

There are essentially two options for serving the through travel needs of bicyclists in an identified corridor: direct integration on the arterial (or collector) or the use of a side-street parallel facility. Separated bicycle paths are options primarily along river grades, to connect subdivisions and cul-de-sacs, or along abandoned or shared rail corridors. However, separated paths are generally considered unsafe and of little merit placed directly along urban arterials (see sidebar), because of the numerous cross traffic conflict points and transition problems from on-road facilities to separated off-road facilities.

SHARED-USE PATHS AS SIDEPATHS

When two-way shared use paths are located immediately adjacent to a roadway, some operational problems are likely to occur. In some cases, paths along highways for short sections are permissible, given an appropriate level of separation between facilities, as in Figure 16. Some problems with paths located immediately adjacent to roadways are as follows:

1. Unless separated, they require one direction of bicycle traffic to ride against motor vehicle traffic, contrary to normal rules of the road.

2. When the path ends, bicyclists going against traffic will tend to continue to travel on the wrong side of the street. Likewise, bicyclists approaching a shared use path often travel on the wrong side of the street in getting to the path. Wrong-way travel by bi-cyclists is a major cause of bicycle/automobile crashes and should be discouraged at every opportunity.

3. At intersections, motorists entering or crossing the roadway often will not notice bicyclists approaching from their right, as they are not expecting contra-flow vehicles. Motorists turning to exit the roadway may likewise fail to notice the bicyclist. Even bicyclists coming from the left often go unnoticed, especially when sight distances are limited.

4. Signs posted for roadway users are backwards for contra-flow bike traffic; therefore these cyclists are unable to read the information without stopping and turning around.

5. When the available right-of-way is too narrow to accommodate all highway and shared use path features, it may be prudent to consider a reduction of the existing or proposed widths of the various highway (and bikeway) cross-sectional elements (i.e., lane and shoulder widths, etc.). However, any reduction to less than AASHTO Green Book 1 (or other applicable) design criteria must be supported by a documented engineering analysis.

6. Many bicyclists will use the roadway instead of the shared use path because they have found the roadway to be more convenient, better maintained, or safer. Bicyclists using the roadway may be harassed by some motorists who feel that in all cases bicyclists should be on the adjacent path.

7. Although the shared use path should be given the same priority through intersections as the parallel highway, motorists falsely expect bicyclists to stop or yield at all cross-streets and drive-ways. Efforts to require or encourage bicyclists to yield or stop at each cross-street and driveway are inappropriate and frequently ignored by bicyclists.

8. Stopped cross-street motor vehicle traffic or vehicles exiting side streets or driveways may block the path crossing.

9. Because of the proximity of motor vehicle traffic to opposing bicycle traffic, barriers are often necessary to keep motor vehicles out of shared use paths and bicyclists out of traffic lanes. These barriers can represent an obstruction to bicyclists and motorists, can complicate maintenance of the facility, and can cause other problems as well.

For the above reasons, other types of bikeways are likely to be better suited to accommodate bicycle traffic along highway corridors, depending upon traffic conditions. Shared use paths should not be considered a substitute for street improvements even when the path is located adjacent to the highway, because many bicyclists will find it less convenient to ride on these paths compared with the streets, particularly for utility trips.

When two-way shared use paths are located adjacent to a roadway, wide separation between a shared use path and the adjacent highway is desirable to demonstrate to both the bicyclist and the motorist that the path functions as an independent facility for bicyclists and others. When this is not possible and the distance between the edge of the shoulder and the shared use path is less than 1.5 m(5 feet), a suitable physical barrier is recommended. Such barriers serve both to prevent path users from making unwanted movements between the path and the highway shoulder and to reinforce the concept that the path is an independent facility. Where used, the barrier should be a minimum of 1.1 m (42 inches) high, to prevent bicyclists from toppling over it. A barrier between a shared use path and adjacent highway should not impair sight distance at intersections, and should be designed to not be a hazard to errant motorists.

source: ***Guide to the Development of Bicycle Facilities*** *(AASHTO, 1999)*

If the chosen corridor treatment involves integrating bicycle traffic into an arterial street environment, the likely recommended facility type is a bike lane. Depending, however, on the context, such a treatment may serve a broad range of bicyclists or it may primarily serve those with the most confidence and skill.

For example, some arterial streets in gridded areas are characterized by on-street parking, frequent signalized intersections, and relatively low motor vehicle speeds. In some suburban areas, arterial streets have no on-street parking, longer blocks with few signalized intersections, and relatively high traffic speeds.

Bicycle lanes would be appropriate measures in each of these contexts and are likely to result in improved ratings under the Bicycle Compatibility Index. However, in the latter situation, the result will still be a relatively high-stress bicycling environment. In such cases, it is important to also provide lower-stress options for the less-experienced bicyclists. “Bicycle boulevards” on adjacent residential streets with side street connections to commercial areas would be helpful.

On arterial streets, bicycle lanes are generally preferred over adjacent paths.

One other consideration may influence the design treatment type, at least in the short-term, and that is the scheduling of construction or reconstruction work on the selected route. The roadway may be scheduled for 3-R (resurfacing, reconditioning, reconstruction) work (including the bike facility improvements) or bike facility improvements may have to be retrofitted into the existing geometries or right-of-way widths. For this reason, transportation planners and engineers should always consider bicyclists’ needs while doing such routine improvement projects.

The next step in the process requires the planner to evaluate those arterial street segments (and some collectors) which are currently undesirable for most bicycle travel. Even though these segments may not be part of the recommended “route system”, their use by experienced bicyclists for through-travel and all bicyclists for accessibility will not diminish. Actually, it is quite probable once significant portions of the bike route system are improved, ridership on the arterial streets may even increase as bicycling on the rest of the system creates more bicycle trip making community-wide.

Thus, for improved bicycle access, better overall bicycle accommodation, and improved motor vehicle movement (when bicyclists and motor vehicles are sharing the same lane) all new arterials should be designed to provide appropriate bicycle accommodation, and all existing arterials should be evaluated for their bicycle suitability and accommodation using the Bicycle Compatibility Index approach mentioned earlier (see Appendix C (p.43)).

For existing arterials that need to be improved and can be practically improved (i.e., have sufficient right-of-way), the plan should reflect the costs of minimally bringing the arterial up to a basic level of accommodation (i.e. a 14 to 15 foot outside curb lane excluding the curb flag). In some cases, this may require roadway widening. However, using a "context-sensitive"approach, it may be possible to identify ways to create bicycling space without widening. In some cases, for instance, a two-way-left-turn-lane may be removed and replaced with turn bays only at specific locations where turning volumes warrant. In other cases, extra space may be shifted from interior through lanes to outside lanes. It is important to keep in mind that the plan is a long-range plan. As such, bringing existing arterials and bridges up to a basic level of accommodation may only be accomplished over a 20-30 year period.

Elementary school students learn some of the basics elements of safe bicycling.

6. Safety Programming Component

While the major focus of these guidelines centers on bicycle facility planning and improving bicycle accommodation, a major goal of most bicycle plans is to increase ridership while decreasing the number of crashes and fatalities. Building facilities or bicycle-friendly street improvements can enhance safety, but programmatic measures can and should be taken as well.

In preparing the safety component, planners should gain an understanding of key traffic laws. For instance, few planners realize that 346.075 of the Wisconsin State Statutes requires motor vehicles to pass bicycles with a minimum of three feet clearance. Appendix F includes Wisconsin statutes governing bicycle use and their equipment.

An evaluation of bicycle crashes may identify certain locations and problems that may be abated through planning and design. For instance, building a "short-cut" trail may allow kids to bicycle to a nearby store without crossing a major roadway. Other crashes, however, can be best dealt with through education and enforcement. For example, some in communities, wrong-way bicycling, riding at night without lights, and motorist failure to yield are common crash causes. These can be dealt with through a variety of media and educational efforts supported by enforcement.

A "3-E" approach (education, enforcement, engineering) has been used by bicycle practitioners for years as a comprehensive and integrated approach to safe bicycle usage. Such a comprehensive approach creates benefits and outcomes which are greater than the sum total of the elements. It does so partly by reducing the likelihood of different agencies working at cross-purposes to each other.

Recommendations on strategies, how they can be implemented, and who should implement them, should be made in the plan. Appendix C provides supplementary information on how to develop a safety component of a bicycle plan. WisDOT's Bicycle and Pedestrian Safety Program Manager can also provide specific program information and funding, as well as assistance in implementing this safety component.

7. Evaluate the Finished Plan Against the Planning Criteria and Goals/Objectives

The final step in the development of a bicycle system plan represents the reality check of the planning process. The planner must ask "Will the proposed approach meet the planning criteria established in step one and also the goals and objectives of the plan?"

If it appears that the criteria will be compromised or the goals unmet, then the proposed system will have to be refined or the criteria and goals modified. For example, if the plan specifies building a multi-use path between a neighborhood but the right-of-way is inadequate for a safe design, another approach should be considered. If the criteria or goals are modified, the planning process as a whole should be reviewed to determine if previously discarded routes should be reconsidered. There may be more preferred options in light of newly modified criteria and/or goals.

The final step in the development of a bicycle system plan represents the reality check of the planning process.

Implementation

The bicycle element of a transportation plan should include recommendations for implementation. This section should provide a guide for funding as well as a sequential picture of how the preferred plan should be completed. The implementation component should include a schedule, as well as a discussion of funding opportunities, signing, mapping, design, and land use/site plan considerations.

Funding: Almost every program of TEA-21 is a potential source of bicycle funds (see sidebar). However bicycle projects often have to compete with other modes for these funds. Several programs (e.g., "Transportation Enhancements") have made bicycle projects a priority funding category.

WisDOT, in partnership with MPOs, communities and counties, has a significant role in financing bicycle-related improvements and specific projects. WisDOT currently uses state and federal safety funds for a variety of education and safety promotion programs as well as to make grants to local communities for local safety programs.

More importantly, if a bicycle project, as part of a larger roadway improvement, has been included in a bicycle plan, then that bicycle project will be financed as an integral part of that roadway improvement, incidental to the entire project cost. WisDOT financing of all projects in MPOs requires the preparation of a bicycle element of the transportation plan and inclusion in a Transportation Improvement Program (TIP).

Bicycle Project funding sources under Tea-21

BICYCLE PLANNING	*STP, CMAQ, PLA, TCSP*
BIKE LANES	*NHS, STP, HEP, RHC, TEA, CMAQ, FTA, TE, BRI, FLH, BYW*
MULTI-USE TRAILS	*NHS, STP, TEA, CMAQ, RTP, BRI, FLH, BYW*
SPOT IMPROVEMENTS	*STP, HEP, TEA, CMAQ*
BUS BIKE RACKS	*STP, TEA, CMAQ, FTA, TE*
BICYCLE PARKING	*STP, TEA, CMAQ, FTA, TE, BYW*
TRAFFIC CALMING	*STP, HEP, RHC, TEA, CMAQ, TCSP*
SAFETY PROGRAMS	*CMAQ, 402, STP*

FUNDING CATEGORY KEY

402	State and Community Traffic Safety
BRI	Bridge
BYW	Scenic Byways
CMAQ	Congestion Mitigation and Air Quality
FLH	Federal Lands Highways Program
FTA	Transit Capital/Urban/Rural
HEP	Hazard Elimination Program
NHS	National Highway System
PLA	State and MPO Planning
RHC	Railroad-Highway Crossing Program
RTP	Recreation Trails Program
STP	Surface Transportation Program
TCSP	Transportation and Community and System Preservation
TE	Transit Enhancements
TEA	Transportation Enhancement Activities

source: FHWA Guidance: Bicycle and Pedestrian Provisions of Federal Transportation Legislation

WisDOT financing of all projects requires the preparation of a bicycle element of the transportation plan and inclusion in a "TIP," or Transportation Improvement Program.

WisDOT's funding of either enhancement-type or incidental-type projects is largely dependent on a community's and MPO's own commitment to funding bicycle projects as part of its implementation of the bicycle element of the transportation plan. Bicycle facility opportunities will present themselves on and off state highway routes. The design and funding of projects on the state highway system and within an urban area will be one of partnership with local agencies. Most bicycle projects within urban areas, as identified in the plan, will be located off the state highway system. Bicycle facilities should be integrated into street reconstruction projects if identified in the plan. Funding for these projects may not involve any federal or state funds.

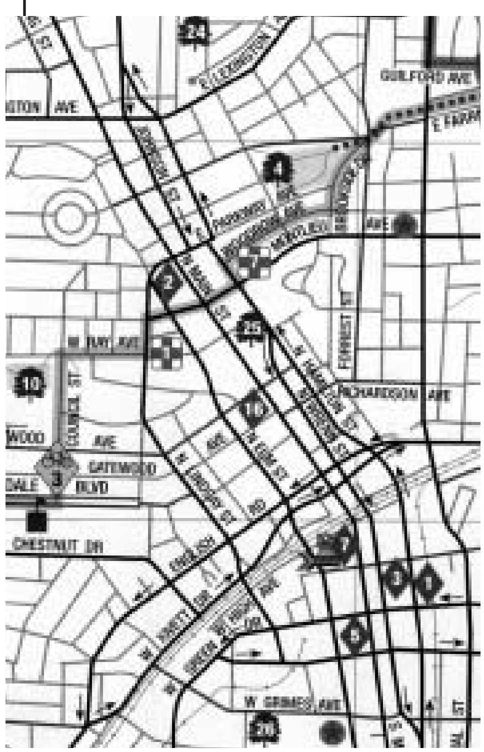
Communities and MPOs should identify those bicycle projects that should receive priority for funding. Generally, this involves prioritizing stand-alone bicycle projects (e.g., shared-use paths or bicycle/pedestrian overpasses/underpasses) and retrofit projects (those that cannot be held over until a specific street section is reconstructed). Because of the cost implications, funding bicycle projects that are incidental to a street reconstruction, such as a bike lane, will probably be delayed until the street is reconstructed. This does not preclude the possibility of implementing some interim accommodation measures, such as restriping to gain additional width in the curb lane to better accommodate bicyclists.

The following are situations where bicycle facility implementation opportunities may present themselves within a community: new construction, reconstruction, resurfacing, sewer and gas line reconstruction, communications cable installation, major planned unit developments, and industrial/commercial/business park developments. These opportunities should be used to implement bicycle-related recommendations of the plan.

Bicycle Mapping and Signing

Bicycle route signs are used as directional aids and to connect segments of a community's bicycle system. Mapping is an inexpensive way to let people know where they can bicycle and what facilities are available.

Bike map courtesy Bob Perrier



Some segments of a community's or MPO's bike route system will be suitable for bicycle transportation with little or no improvements. These segments can be mapped as "bicycle routes". Other segments of the proposed system may need to first be improved to make them suitable for bicycle transportation.

Mapping is a relatively inexpensive form of guidance for bicyclists. Providing maps of the community together with information on local routes, major destinations, points of interest, etc., allows the user to travel more comfortably within a community and between communities.

Another low-cost action is to install signs identifying bicycle routes, (again taking care that only suitable routes are signed). This technique involves little cost and, when properly used, will guide the bicyclist along a route. In many cases, bike route signing is used as a first or interim step toward providing a system of more advanced facilities. For example, a community may delay a bicycle project several years until the reconstruction of an arterial street provides an opportunity to also construct a bicycle lane.

Both signing and mapping are generally targeted to the average adult bicyclist. Mapping products should state this in the accompanying text.

Design and Construction

Final design and construction are major functions in the implementation of a bicycle plan. The details of bikeway design should be considered at this juncture. Appendix B includes some general information on bikeways, but the designing engineer would likely need to consult more detailed resources, including those mentioned in the sidebar.

Another round of bicycle considerations should be made by relating the plan to other roadway opportunities. One of the main objectives of a bicycle plan should be to help ensure that streets and highways can be safely "shared" by motorists and bicyclists. Bicyclists have many of the same destinations as motorists and are equally concerned about directness. As the AASHTO *Guide to the Development of Bicycle Facilities* states:

> *"All new highways, except those where bicyclists will be legally prohibited, should be designed and constructed under the assumption that they will be used by bicyclists".*

To ensure that streets and highways are built with the bicyclist in mind, a community should adopt a street/highway policy and related design standards for creating wider curb lanes and/or paved shoulders on collector and arterial streets. WisDOT's own warrants, included in the *Facilities Development Manual,* state that when WisDOT constructs, reconstructs, or finances any street/highway facilities, they will include suitable space for bicycling wherever ROW permits and bicycle use or anticipated use on a roadway exceeds 25 bicyclists per day (combined from both directions) or the street/highway has been included as part of a designated bikeway system (see Appendix A, p.33).

Bicycle Parking

As bicycling has grown through the years, so has bicycle theft. Some thieves steal entire bicycles while others steal parts of locked bikes. Lock-up facilities that were adequate 20 years ago are no longer meet the needs of today's bicyclists. Today, bike parking — particularly long-term parking — often means protecting the bicycle and its parts.

Yet, bicycle parking is often overlooked in the design of new buildings and parking facilities.

Old-style bicycle racks are known as "wheel-benders" for a good reason.

And most existing commercial or public facilities have poor bicycle storage facilities. Bicycle accessibility and use requires safe bicycle storage at even minor trip generators and mode transfer points. One way to ensure success is to change local zoning ordinances to require bicycle parking, as is done in Madison. Such ordinances require a certain number of bicycle parking spots based on the number of total motor vehicle spots and/or the type of land use.

Bicycle parking facilities vary in their utility and security. At one end of the spectrum, there are the old-style bicycle racks which are mostly good at only securing the front or rear wheel. These racks are not designed to work with today's popular "U"-shaped bicycle locks. Modem racks are designed to allow users to lock both wheels and the frame with a single U-lock.

The bicycle locker is one of the best forms of secure long-term bicycle parking. These are enclosed individual storage units large enough to hold a bicycle. Bicyclists are typically given keys to their lockers. In some cases, lockers are leased on a monthly or quarterly basis. Such an approach provides predictability for the user.

Inexpensive "hitching rail"-style bike racks work well for short-term parking for small numbers of bicycles.They should be installed in high-visibility locations.

When locating new bicycle parking, start with places where car parking is provided. Higher use destinations like schools, colleges campuses, and downtown areas may need large numbers of "bike spaces" while small individual shops may need only space for one or two bikes. Bicycle parking should be placed near building entrances to encourage use and in high visibility areas with high pedestrian traffic to discourage theft. All racks should be capable of accepting U-shaped locks to secure the frame of the bicycle.

Education regarding bicycle theft and prevention should be integrated into bicycle safety education programs. Information should be routinely disseminated on bicycle security and should be coordinated with bicycle registration programs. Mandatory bicycle registration programs can help enforcement agencies identify the rightful owners of recovered bicycles.

Interim Measures

Bicycle plans, as advocated in these guidelines, must be viewed as long-term in scope. Many of the larger and more expensive improvements will not be completed for years, but interim measures should be taken including drainage grate replacement, improving rail crossings, restriping, and alternative routing.

Many improvements to a bicycle route system (especially those recommended for arterial streets) will occur as opportunities arise for reconstruction. Some improvements will be accomplished as a matter of retrofitting existing facilities. For those improvements that must wait, interim measures may have to taken to complete portions of a bicycle route. There are several major measures that can improve the accommodation of bicyclists in an interim period restriping, alternative routing, drainage grate replacement, and railroad crossings. Appendix E includes a short guide, published in the National Center for Bicycling & Walking's *Bicycle Forum,* entitled *Improving Conditions for Bicycling*. This includes a brief description of many of the short-term and interim measures that can be taken.

AASHTO and the National Committee on Uniform Traffic Control Devices have commented in favor of reducing existing inside vehicle lanes from 12 feet to 11 feet for the purpose of widening the right-hand lane for bicycle use. The City of Madison has made these improvements on several of its arterial streets. This should be performed after careful review of present and projected traffic characteristics along a corridor.

The AASHTO *Guide* recommends a wide curb lane of 14 feet or wider, but there is some benefit when travel lanes are widened to 13 feet. On a four-lane arterial street with 12 foot travel lanes, simply narrowing the inside lanes to 11 feet and widening the outside to 13 feet is worth the effort, according to a study done by the Maryland DOT. And unless the speeds are very high, the loss of capacity for the narrowed inside lanes is negligible, according to the *Highway Capacity Manual.*

If a bicycle lane or wide curb lane has been recommended for an arterial, but the improvement is some time off, an alternative route should be designated and mapped and/or signed. Again, directness and the minimizing of delays will be necessary in order for it to be an attractive alternative to bicyclists.

Drainage grates can pose a serious problem for bicyclists. Many old designs can trap a bicyclist's front wheel, causing a crash. The best approach is to replace these grates with "bicycle-safe" grates. It should be noted that even "bicycle-safe" grates will still give a bicyclist a jolt if the wheel is caught the wrong-way by the grates. Grates should be installed level to the pavement and readjusted with future paving overlays.

A tapered approach allows bicyclists to cross the railroad tracks at a safe angle.

Another measure that can significantly affect the "ridability" of streets is the improvement of railroad crossings. Repair of road and track mismatches are ways to improve all crossings. Where railroad tracks intersect roadways at angles, two additional considerations should be considered. First, the paving of tapered approaches on either side of the crossing will allow bicyclists to cross the tracks closer to a right angle.

Second, in higher bicycle use areas, installing a concrete railroad crossing can reduce the problem significantly. Such crossings are used by some communities in the curb lanes of many track crossings, regardless of the tracks' angles.

Some land use patterns are more bicycle- and pedestrian-friendly than others (top) and the results are often seen in patterns of use.

Land Use and Site Planning

As an important means of promoting the bicycle as a suitable alternative to the auto, bicycle plans can call for local policies, plat reviews, site design review processes, and subdivision ordinances that require new developments to have proper street and neighborhood connection points and access to services provided by mixing land uses.

The manner in which land is developed can have a profound effect on the feasibility and accommodation of bicycling and on levels of use (see Census information below). Land use plans and zoning, developed with the attention to bicyclists, will likely include neighborhood commercial and mixed-used development districts that are in closer proximity to residential areas.

This will make bicycle and pedestrian trip making that much more attractive. On the other hand, the intensification of commercial land uses in malls or strip developments is normally not a bicycle- friendly development because of the high motor vehicle volumes generated by such places and the lack of bicycle accommodations leading there.

It is important that the needs of bicyclists are considered along with major developments, such as subdivisions, commercial developments, and planned unit developments. Some of the most relevant documents to the needs of bicyclists may be the local comprehensive community plans or land use plans. Therefore, just as a transportation plan must be consistent with area land use plans, the bicycle element of a transportation plan must also be compatible and integrated with local land use and comprehensive plans.

1990 Journey to Work Survey
Madison, Wisconsin

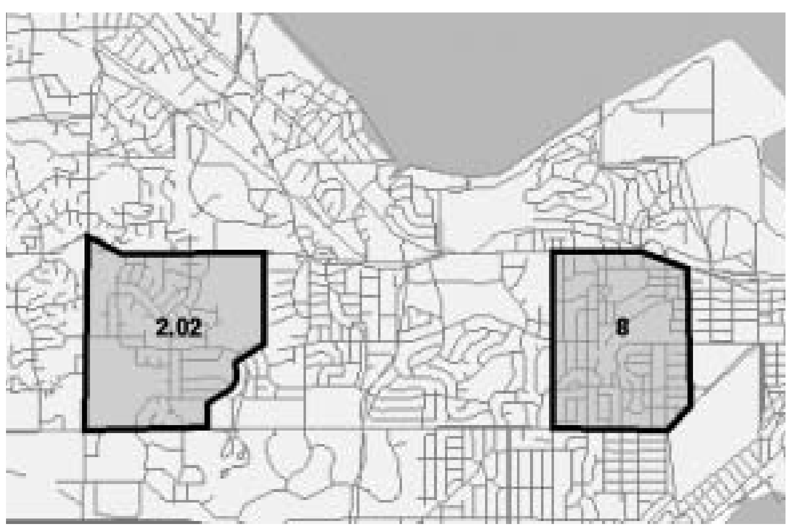
Tract 2.02

Bicycle...0.0%
Walk..2.4%
% within 14 min. of work:...........37.9%

Tract 8

Bicycle...4.2%
Walk..9.6%
% within 14 min. of work:...........45.5%

Source: U.S. Census Website Tract Level Look-Up Tables and Mapping Website



Bicycle plans can call for local policies, plat reviews, site design review processes, and subdivision ordinances that require new developments to have the proper connections to neighborhood and community circulation systems. Bicycle and pedestrian cross connections can be made between adjoining subdivisions and connect cul-de-sacs or commercial areas without the need for bicyclists and pedestrians to take a more circuitous route along arterials.

Zoning ordinances can be modified to require good bicycle and pedestrian connections (e.g., connector paths or interconnected street patterns) in project site plans.

On a larger scale, this can occur when major transportation projects are being designed. Bicycle facilities can be incorporated into the design of facilities or provisions can be made to allow for later accommodation. For example, a freeway may incorporate box culverts in urban and suburbanizing areas for future bicycle and pedestrian underpasses or highways may incorporate the needed right-of-way for any planned bike paths.

More specifically, bicycle plans should include recommendations on bicycle parking. Bicycle accessibility to places and buildings is rooted in accommodating bicycles with adequate and sufficient parking. One sure means of ensuring bicycle parking at new locations is through the incorporation of bicycle parking provisions into local ordinances, including zoning ordinances.

Other Beneficial Practices

There are a number of other beneficial practices that can be employed to encourage bicycle use. Some of these are outside the purview of the local and state government. One of the most important employer-provided improvements is the availability of showering facilities and workplace lockers. Secondly, businesses should provide bicycle racks, but if additional encouragement is desired, bicycle storage facilities should be provided as close to building entrances as possible.

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Appendix A: Bicycle Planning Criteria

The factors to be considered in choosing the location for bicycle facilities vary depending on the situation. The most important variables are described below. Typically, the following criteria will be used to first identify a general bicycle corridor, then to site the bicycle facility within that corridor, and finally to choose the desired facility type on a specific street segment. The same criteria will be used to choose the bicycle facility treatment type for a street segment as is used to select a street segment within a corridor.

Corridor Identification

Use - Bikeways (bike lanes, paths, routes) should be located in areas where use can be maximized. Generally, bikeways should be located within the same corridors as arterials and collectors since bicyclists have many of the the same origins and destinations as do motorists. The following factors may be considered in examining potential use of a bicycle facility and should provide some additional direction as to the destinations of bicycle trips:

- *Location of employment centers - Individual large employers or concentrations of employment.*
- *Location of commercial facilities - Including shopping centers, malls, large retailers, etc.*
- *Location of mode transfer - Major points of mode transfer such as transit hubs, railroad stations, connections of inter-city bike routes.*
- *Location of parks, stadiums, fairgrounds, and other recreational areas.*
- *Location of educational facilities.*
- *Area demographics - Population density and age, household size and type (single family, multifamily).*
- *Trip Length - Most utilitarian bike trips are less than five miles, as are most motor vehicle trips. In considering the scope and priority of a project, trip lengths between likely origins and destinations should be evaluated.*

In the consideration of bicycle facilities, WisDOT will use as a general warrant 25 bicyclists per day (combined from both directions) that are either currently using a particular roadway or likely to use it once a facility has been constructed. More specifically, when the state constructs, reconstructs, or finances any roadway, it will include suitable space for bicyclists wherever the existing ROW permits, as long as bicycle use or anticipated use on a roadway exceeds 25 bicyclists per day or the street or highway has been designated as part of a bikeway system.

Accessibility/Spacing - In locating a bicycle route, consideration should be given to the provision for frequent and convenient bicycle access. This criterion establishes a distance that a bicycle route is from a specified trip origin or destination. Most bike plans try to ensure that each urban home is no farther than a quarter to one-half mile from a designated bicycle route facility. Mobility and accessibility can be hampered by physical or traffic barriers and any required bicycle “detours” to gain access.

Bicycle facilities should be provided within all urban arterial and collector corridors. Generally, this includes the provision of a bike lane on the arterial itself or the provision of a side-street facility (in some cases, a bicycle path) in combination with a wide curb lane on the arterial itself. If side-street facilities or bicycle paths are favored, route directness and system continuity should not be compromised.

Many communities that have already developed bicycle plans require that the accessibility criterion be met by stating that every residence be within a certain distance to the designated bicycle route. Others just ensure that certain destinations such as schools, downtowns, shopping centers, major employment centers, major employers, community parks, industrial and business parks, etc., are served directly by bicycle facilities. Other communities (e.g., Eugene and Corvallis, Oregon) just require that all arterials be constructed with a bike lane.

Directness - For utilitarian bicycle trips, facilities should connect traffic generators and should be located along a direct line convenient for users. Cyclists, like motorists, prefer a direct route (if not in distance, in time). Bikeways should connect origin and destination pairs (desire lines) for destinational cycling. This is less of a factor for recreational cycling when often there is no specific destination.

A cyclist's willingness to use a designated route depends on the amount of indirectness involved, how superior the bikeway option is to the more direct route, how long the cyclist will use the designated bikeway, and how much of a hurry the cyclist is in. Over the course of two miles, most cyclists will not deviate more than two blocks off a direct route just to use a designated bike route.

Continuity - A planned bicycle route system should be free of missing links or gaps. If barriers exist that will impede system continuity, then improvements should be planned that will alleviate those system barriers.

Barriers - In most urban areas, there are physical barriers to bicycle travel, such as freeways, rail lines, rivers, and topographical features like steep grades. Bicycle facilities should be integrated into the design of street and bridge improvements to eliminate barriers.

Aesthetics - The scenic value of a bicycle route should not be of primary importance, but should be considered in evaluating alternatives when the other criteria are considered equal.

Security - The potential for criminal acts against bicyclists, especially along remote paths or through higher crime neighborhoods, and the possibility of theft or vandalism at parking locations should be considered in the selection of a corridor.

Siting a Bicycle Facility within a Corridor

Directness - Although this has been listed as a criterion in identifying the general location of a bicycle corridor, it also applies for locating a facility within a corridor. Utilitarian bicyclists have a destination will not detour more than several blocks within a bicycle corridor. Appendix E is an excerpt from the Oregon DOT Bicycle Plan which illustrates the problems of routing cyclists from street to street within a corridor.

Delays - Bicyclists have a strong inherent desire to maintain momentum. If bicyclists are required to make frequent stops, they may tend to avoid the route or disregard traffic controls. If the choice is to route cyclists on side-streets within a corridor instead of on an arterial, efforts should be made to reduce the number of delays by cutting the number of stop signs along the side-street facility. This should be done without increasing motor vehicle through-traffic. If motor vehicle traffic does increase, traffic calming techniques, such as bicycle boulevards, speed control devices, curb extensions, and traffic circles on lower volume neighborhood streets may be appropriate countermeasures.

Safety (Traffic Operational Factors) - Inherent in the consideration of bike route alternatives is the issue of safety. In a perfect and cash-limitless transportation network, there could be complete separation among bicyclists, motorists and pedestrians. Because separation is only practical and feasible in a limited number of situations, design criteria must be used to identify the appropriate bicycle facility treatment type and the design standards for that facility.

The most significant traffic operational factors for selecting a bicycle facility within a corridor are: traffic volumes, average motor vehicle speeds, traffic mix (auto, truck, bus), on-street parking (frequency of turnover, average number of parked vehicles), sight distance, and number of intersections and driveways.

Cost/Funding - Location selection will normally involve a cost analysis of alternatives. Every recommended bicycle route will have a set of necessary improvements. Funding con-

Bicycle Boulevards

A bicycle boulevard is created by turning streets into dead-ends or limiting access for motor vehicles, while providing continuous passageways for bicyclists. This provides a side-street bicycle route while reducing through car traffic.

Motor vehicle traffic may have been induced on the side-street by treatments made to the street designed to decrease delays for bicycles (i.e. reduction in the number of stop signs). All modes have access to any use along the boulevard, but only bicycles can use the street as a thoroughfare.

straints may limit the choice of alternatives. However, it is important that a lack of funds not result in a poorly designed or constructed facility. The cost of maintenance should also be considered in this analysis.

Ease of Implementation - Based on existing traffic operations/conditions, presence of parking, neighborhood politics, and the amount of space and right-of-way available (tied inextricably to costs), bicycle facilities will be considered by their ease of implementation. Trade-offs with the other criteria can make projects perceived as difficult to implement, actually easier to do, especially as interim measures. For instance, a project with a high cost but a source of funds, becomes that much more implementable.

Selection of Bicycle Facility Treatment

Most of the same criteria used to select a street segment within a corridor will be used to determine the appropriate treatment on a street segment. The appropriate treatment will again depend on the kinds of bicyclists a facility is most likely to attract. Generally, if an arterial is chosen as the preferred alternative, then the most likely treatment type will be a bicycle lane.

If a side- street route is chosen, then typically only the basic street improvements will be needed, but signage, sidewalks, delay reduction measures, and the possible parking removal may be necessary. If a side-street is chosen, the arterial will most often still need to be widened to better accommodate bicyclists. A bike lane will not generally be necessary, but a slightly wider curb lane will allow effective lane sharing between bicyclists and motorists.

Appendix B: Bicycle Facilities

The following is a brief description of the major types of bicycle facilities and the characteristics attributable to each. Graphics have been provided for each type of bicycle facility. Under Wisconsin statute 346.02 "every person riding a bicycle upon a roadway is granted all the rights and is subject to all the duties which this chapter grants or applies to the operator of a vehicle". Therefore, bicycle facilities must be designed to allow bicyclists to ride in a manner consistent with motor vehicle operation. (Please note that additional bikeway design information is provided in 11-45-10 of the *WisDOT Facilities Development Manual.)*

Shared Roadway
On a shared roadway, bicyclists and motorists are sometimes accommodated in the same travel lane or because of narrow widths or parked vehicles, motorists may find it necessary to overtake bicyclists by switching into the oncoming travel lane. Shared roadway facilities are common on city street systems and on narrow town roads and county trunk highways. This facility type will continue to provide a very common form of bicycle accommodation. Because of the low volume of traffic, most of these roadways are currently suitable for bicycling with no additional improvements necessary.

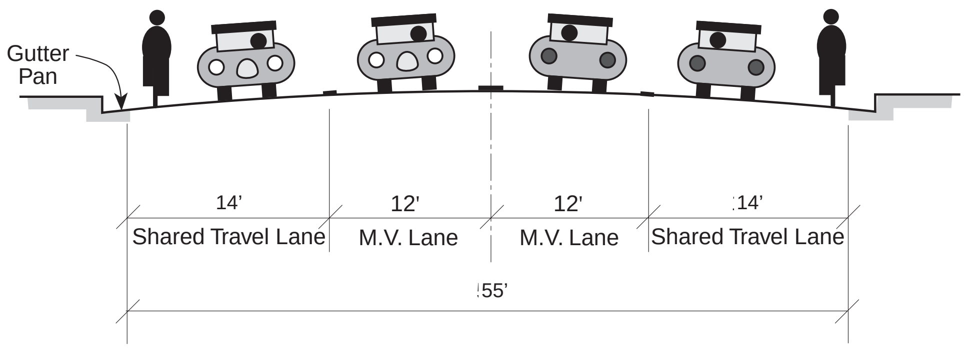
A quiet residential street works well as a shared roadway.

Wide Curb Lane
On multi-lane arterials and collectors with higher motor vehicle volumes and/or significant truck/bus traffic, a right (curb) lane wider than 12 feet is desirable to better accommodate both bicyclists and motor vehicles in the same travel lane. This should allow motorists to overtake bicyclists without changing lanes. The four generally accepted advantages of wide curb lanes are that they:

- *Accommodate shared bicycle/motor vehicle use without reducing the roadway capacity for motor vehicle traffic.*
- *Minimize both the real and perceived operating conflicts between bicyclists and motor vehicles.*
- *Increase the roadway capacity by at least the number of bicyclists capable of being accommodated.*
- *Assist turning vehicles in entering the roadway without encroaching into another lane and better accommodating buses and other wider vehicles.*

A collector street in a college town with a wide curb lane.

The AASHTO *Guide* considers a lane width of 14 feet of usable width as being desirable on road segments where parking is not permitted in the curb lane. Usable width generally cannot be measured from curb face to lane stripe, because adjustments must be made for drainage grates (even the “bicycle-safe” ones) and longitudinal joints between pavement and gutter sections.



A Typical Wide Curb Lane Treatment

For instance, on those road segments where no parking is allowed, the travel lane (from gutter pan joint line to lane stripe) should be 14 feet in width, reflecting the unsuitability of bicycle riding too close to the curb face or in the gutter pan, itself.

If parking is permitted in the curb lane, then the minimum width of the curb lane, from curb face to through travel lane is 14 feet, with 15 feet being the desirable width. In this design situation, the lane width can be measured from the curb face since parked motor vehicles can occupy the curb flag (gutter section). Conversely, when bicycles travel directly adjacent to a curb, they cannot safely operate in the gutter section.

Wide curb lanes are not striped or generally promoted as “bicycle routes”, but are often all that is needed to accommodate bicycle travel. Where a wide curb lane may be considered for future restriping as a bike lane, a 17 foot curb lane is recommended. Where bicycle travel is to be encouraged, the use of a bicycle lane is typically most effective.

Some bicycle friendly practices that can be used in building a wide curb lane are:

- *Inclusion of 18” or narrower storm sewer inlet drains that are “bicycle-safe” (all major manufacturers of drainage grates offer bicycle safe models).*
- *The curb and gutter section (curb pan or flag) of a street constructed as an integral section of the travel lane eliminating the longitudinal joint between the roadway and gutter, providing more usable space for bicyclists. This can only be done when concrete is the chosen paving material type for the driving lane. WisDOT District 3 is currently using integral construction on many or most of its urban state highway routes with no additional costs. Where the paving material for the travel lane is asphalt, the gutter section could be narrowed to less than the typical two feet to push the longitudinal joint closer to the curb face.*

Bike Lanes

Bicycle lanes can be considered when it is desirable to delineate available road space for preferential use by bicyclists and motorists and to provide for more predictable movements by each.

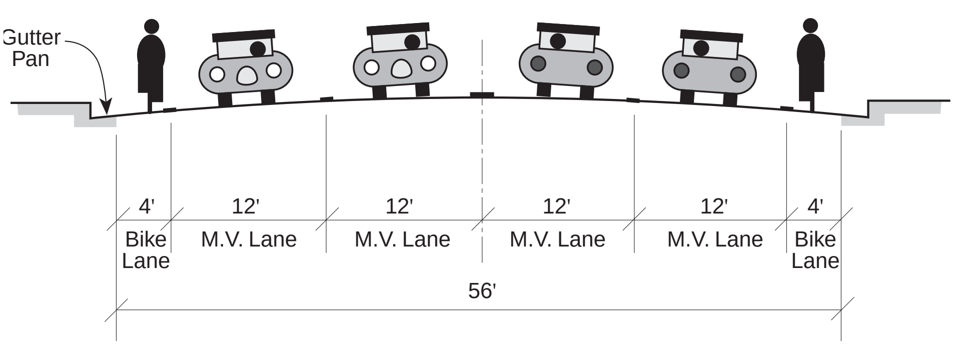
Bicycle lanes markings can increase a bicyclist's confidence in motorists not straying into his/her path of travel. Likewise, passing motorists are less likely to swerve to the left out of their lane to avoid bicyclists on their right. Bike lanes are generally established on urban arterials and sometimes on urban collector streets.

Bike lanes on an arterial street with a designated parking lane.

Bicycle lanes are delineated by painted lane markings and should always be one-way facilities and carry traffic in the same direction as adjacent motor vehicle traffic. Two-way bicycle lanes on one side of the roadway are unacceptable because they promote riding against the flow of motor vehicle traffic. Wrong-way riding is a major cause of bicycle accidents and violates the Rules of the Road stated in the Uniform Vehicle Code. Bicycle lanes on one-way streets should be on the right of the street except where a bicycle lane on the left will decrease the number of conflicts (e.g., those caused by heavy bus traffic).

The use of bike lanes does require an additional commitment to maintenance. Bike lanes must be kept free of debris and gravel - the sweeping motion of passing motor vehicles will not keep the bike lanes clean. Additionally, the bike lane stripes themselves must be maintained on a regular basis.

The minimum width for a bike lane is 4 feet to the left of parked motor vehicles, or 5 feet from the curb face. The recommended bike lane width is 5 feet. There must be a clear riding zone of 4 feet if there is a longitudinal joint between the travel lane and the curb and gutter section. Where parking is permitted, the bike lane must be placed between the parking area and the travel lane, the recommended bike lane width is 5 feet, and the combination lane (including parking and bike lane) should have a minimum width of 14 feet.



A Typical Bicycle Lane Design with no parking allowed

A Typical shoulder Treatment on a rural highway.

Paved Shoulders

Wide curb lanes and bike lanes are usually preferred in restrictive urban conditions and the widened shoulder will generally be more accommodating in rural circumstances. Where it is intended that bicyclists ride on shoulders, smooth paved shoulders should be provided and maintained.

Rumble strips and grooved travel lane indicators can be a deterrent to bicycling on shoulders and their benefits should be weighed against the probability that bicyclists will ride in the motor vehicle lanes to avoid them. Many states construct rumble strips with smooth short bypasses" in the strips themselves to allow bicyclist shock-free passage.

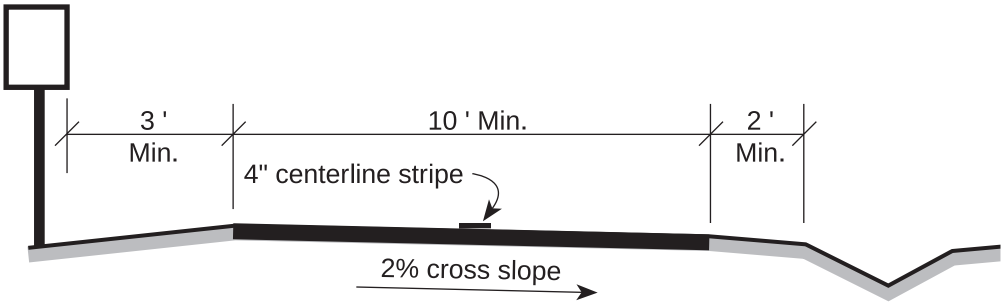
Paved shoulders are generally established on rural arterial and collector highways. Shoulder width should be a minimum of 4 feet when intended to accommodate bicycle travel. Arterial highways with shoulders less than 4 feet wide normally should not be signed as bikeways or bike routes.

Shared-use Path

A shared-use path is a facility that is physically separated from motor vehicle traffic by an open space or barrier, and may be within the roadway right-of-way or within an open space. Paths are normally two-way facilities. They may be appropriate in corridors not served by other facilities, if there are few intersecting roadways and driveways.

Shared-use paths can provide good bicycle mobility under certain circumstances, especially where the path is truly isolated from motor vehicles, such as along rivers grades, greenways, abandoned rail lines, and connections between subdivisions and cul- de-sacs. Special care must be taken to limit the number of at-grade crossings with streets and driveways. Two-way paths should not be placed on or adjacent to roadways. Otherwise, a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic, which is contrary to the rules of the road. The AASHTO *Guide* suggests nine problems associated with bike paths located immediately adjacent to roadways (see p. 22 of this document).

According to AASHTO, under most conditions a recommended all-paved width for two-directional shared-use path is 10 feet. Eight feet is considered the minimum width but this width should only be used when there is low bicycle use, little expected pedestrian use,



A typical 10-foot shared-use path cross-section; 8 feet may be used in extremely low volume situations.

and no anticipated maintenance vehicle loading conditions that could cause damage to the pavement edges. Many communities and states have gone to a 10 foot minimum width for shared-use paths and a 12-foot width in high-use areas.

Shared-use paths, especially those in urban areas, attract a multitude of different users including bicyclists, pedestrians, runners, skate-boarders, skaters (in-line and traditional), and people walking their pets. When path use is high, conflicts always arise between the different user groups. For this reason, it is impractical to expect that an urban path will be used solely by bicyclists. Under congested conditions, faster moving bicyclists (15 mph or greater) should not be using the facility without reducing their speed.

The very popular Burke-Gilman path in Seattle, Washington actually is signed to direct "fast bicyclists" to alternate street routes instead of encouraging them to speed along on the path. When designing shared-use paths in urban areas, the assumption should be that the paths will be used by almost all of the above user groups, thus making a 10-foot path width a minimum. A 12-foot or greater width should be considered desirable.

The minimum width of a one-directional path is 5 feet. One-directional paths, however, are seldom used in the United States, in part, because they are almost always used in a two-directional fashion by bicyclists. One-directional paths should be signed and designed to limit counter-flow riding.

Where a path must be parallel and near to a roadway, there must be a 5-foot minimum width separation, or a physical barrier of sufficient height must be installed.

A minimum of a 2-foot "shy" or clear zone should be maintained adjacent to both sides of a path. The recommended width of two-way path structures (overpasses, underpasses, long bridges) is 12 feet (10-foot minimum width and a 1-foot shy distance on each side). Greater widths will be necessary where there is significant bicycle and pedestrian use and/or there are long grades.

Widths less than 12 feet should apply under less demanding conditions (low pedestrian and bicycle use, a relatively flat or short bridge deck, or bicyclists are permitted to use the motor vehicle

Path bridges should be wider than the path, with a 1-ft. clear zone on each side.

section of the bridge deck in a shoulder area or bike lane). The vertical clearance to obstructions should be a minimum of 8 feet. However, vertical clearance may need to be greater to permit passage of maintenance vehicles.

As stated earlier, abandoned rail corridors are generally regarded as providing good opportunities for bike paths. A small number of trails in the United States have even been constructed along active urban spur or branch lines after a portion of the rail corridor had been sold to the local community by the rail line owner. For instance, the City of Madison purchased and constructed a bike trail along an active rail line in the eastern portion of the city.

Typically, rail line owners and operators have major concerns with joint uses within the corridor because of liability reasons and the fear that by so allowing the public closer proximity to the rail line, more people would trespass on the actual rail line putting the trespasser at risk and the company at increased exposure. These concerns are mollified if an actual land transaction takes place between the rail line owner and community (bike path sponsor). If local communities are unable or unwilling to purchase rail corridor property for shared corridor use, like Madison has done, co-use through an agreement with the rail line owner/operator is unlikely or would at least result in lengthy negotiations and agreements.

For more discussion on design criteria, such as grades, speeds, and alignment see the AASHTO *Guide for the Development of Bicycle Facilities,* referenced in this planning guide (copies may be ordered from AASHTO at www.aashto.org or 800-231-3475).

FHWA Pedestrian & Bicycle Safety Research Program Technical Brief

The Pedestrian & Bicycle Safety Research Program focuses on identifying problem areas for pedestrians and bicycles, developing analysis tools that allow planners and engineers to better understand and target these problem areas, and evaluating countermeasures to reduce the number of crashes involving pedestrians and bicycles.

U.S. Department of Transportation

Federal Highway Administration

Research and Development
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22201-2296

The Bicycle Compatibility Index: A Level of Service Concept

Currently, no methodology is widely accepted by engineers, planners, or bicycle coordinators that will allow them to determine how compatible a roadway is for allowing efficient operation of both bicycles and motor vehicles. Determining how existing traffic operations and geometric conditions impact a bicyclist's decision to use or not use a specific roadway is the first step in determining the bicycle compatibility of the roadway. The Bicycle Compatibility Index (BCI) can be used by bicycle coordinators, transportation planners, traffic engineers, and others to evaluate existing facilities in order to determine what improvements may be required as well as determine the geometric and operational requirements for new facilities to achieve the desired level of bicycle service.

Development of the BCI Model

The approach used in developing the BCI was to obtain the perspectives of bicyclists by having them view numerous roadway segments captured on videotape and rate these segments with respect to how comfortable they would be riding there under the geometric and operational conditions shown. Over 200 bicyclists participated and rated 80 unique roadway segments on a six-point scale. A rating of *one* indicated that the individual would be "extremely comfortable" riding there while a *six* indicated that the individual would be "extremely uncomfortable" riding in those conditions.

Using these perspectives, the BCI model was developed as shown in table 1. The model is applicable to urban and suburban roadway segments (i.e., midblock locations that are exclusive of major intersections) and incorporates those variables that bicyclists typically use to assess the "bicycle friendliness" of a roadway (e.g., curb lane width, traffic volume, and vehicle speeds).

The model predicts the overall comfort level rating of a bicyclist using the eight significant ($p \leq 0.01$) variables shown and an adjustment factor (**AF**) to account for three additional operational characteristics. The basic model (excluding the adjustment factor) has an R^2-value of 0.89, indicating that 89 percent of the variance in the index or comfort level of the bicyclist is explained by the eight variables included in the model. In other words, the model is a reliable predictor of the expected comfort level of bicyclists on the basis of these eight variables describing the geometric and operational conditions of the roadway.

The variable with the largest effect on the index is the presence or absence of a bicycle lane or paved shoulder that is at least 0.9 m wide (**BL**); the presence of a bicycle lane (paved shoulder) reduces the index by almost a full point, indicating an increased level of comfort for the

Table 1. Bicycle Compatibility Index (BCI) model, variable definitions, and adjustment factors.

$$\mathbf{BCI} = 3.67 - 0.966\mathbf{BL} - 0.410\mathbf{BLW} - 0.498\mathbf{CLW} + 0.002\mathbf{CLV} + 0.0004\mathbf{OLV} + 0.022\mathbf{SPD} + 0.506\mathbf{PKG} - 0.264\mathbf{AREA} + \mathbf{AF}$$

where:

BL = presence of a bicycle lane or paved shoulder ≥ 0.9 m
no = 0
yes = 1

BLW = bicycle lane (or paved shoulder) width
m (to the nearest tenth)

CLW = curb lane width
m (to the nearest tenth)

CLV = curb lane volume
vph in one direction

OLV = other lane(s) volume - same direction
vph

SPD = 85th percentile speed of traffic
km/h

PKG = presence of a parking lane with more than 30 percent occupancy
no = 0
yes = 1

AREA = type of roadside development
residential = 1
other type = 0

AF = $f_t + f_p + f_{rt}$

where:

f_t = adjustment factor for truck volumes (*see below*)

f_p = adjustment factor for parking turnover (*see below*)

f_{rt} = adjustment factor for right-turn volumes (*see below*)

Adjustment Factors

Hourly Curb Lane Large Truck Volume[1]	f_t
≥ 120	0.5
60 - 119	0.4
30-59	0.3
20-29	0.2
10-19	0.1
< 10	0.0

Parking Time Limit (min)	f_p
≤ 15	0.6
16 - 30	0.5
31 - 60	0.4
61 - 120	0.3
121 - 240	0.2
241- 480	0.1
> 480	0.0

Hourly Right-Turn Volume[2]	f_{rt}
≥ 270	0.1
< 270	0.0

[1] Large trucks are defined as all vehicles with six or more tires.
[2] Includes total number of right turns into driveways or minor intersections along a roadway segment.

bicyclist. Increasing the width of the bicycle lane or paved shoulder (**BLW**) or the curb lane (**CLW**) also reduces the index as does the presence of residential development along the roadside (**AREA**). On the other hand, an increase in traffic volume (**CLV** and **OLV**) or motor vehicle speeds (**SPD**) increases the index, indicating a lower level of comfort for the bicyclist. The presence of on-street parking (**PKG**) also increases the index. The adjustment factor (**AF**) accounts for three specific operating conditions shown to also negatively impact the comfort level of bicyclists, namely the presence of: 1) large trucks or buses, 2) vehicles turning right into driveways or minor intersections, or 3) vehicles pulling into or out of on-street parking spaces.

Table 2. Bicycle Compatibility Index (BCI) ranges associated with level of service (LOS) designations and compatibility level qualifiers.

LOS	BCI Range	Compatibility Level
A	≤ 1.50	Extremely High
B	1.51 - 2.30	Very High
C	2.31 - 3.40	Moderately High
D	3.41 - 4.40	Moderately Low
E	4.41 - 5.30	Very Low
F	> 5.30	Extremely Low

Level of Service for Bicycling

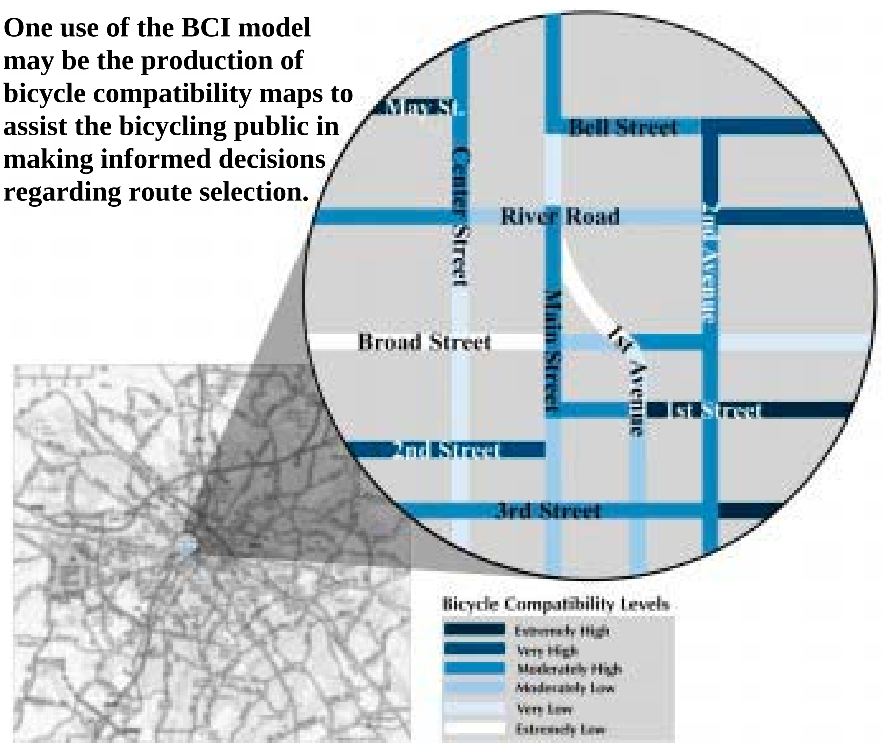
There are no level of service (LOS) criteria presently provided in the ***Highway Capacity Manual***. However, the definition of the LOS according to the manual is founded on the concept of users' perceptions of qualitative measures that characterize the operational conditions of the roadway. Two of the terms used in the manual to describe LOS are comfort/convenience and freedom to maneuver; both of these terms are applicable to bicyclists and are directly reflected in the BCI since the rating scale used by the study participants was an indication of comfort level. Thus, using the BCI values produced from the set of locations included in this study, LOS designations were established for LOS A through LOS F as shown in table 2.

BCI Applications

The BCI model and the subsequent LOS designations provide bicycle coordinators, transportation planners, traffic engineers, and others the capability to better plan for and design roadways that are bicycle compatible. Specifically, the BCI model can be used for the following applications:

➢ **Operational Evaluation -** Existing roadways can be evaluated using the BCI model to determine the bicycle LOS present on all segments. This type of evaluation may be useful in several ways. First, a bicycle compatibility map can be produced for the bicycling public to assist them in making informed decisions regarding route selection. Second, the

One use of the BCI model may be the production of bicycle compatibility maps to assist the bicycling public in making informed decisions regarding route selection.



most appropriate routes for inclusion in the community bicycle network can be identified. In addition, "weak links" in the network can be determined, and prioritization of sites needing improvements can be established based on the index values. Finally, alternative treatments (e.g., addition of a bicycle lane vs. removal of parking) for improving the bicycle compatibility of a roadway can be evaluated using the BCI model.

➢ **Design -** New roadways or roadways that are being re-designed or retrofitted can be assessed to determine if they are bicycle compatible. The planned geometric parameters and predicted or known operational parameters can be used as inputs to the model to produce the BCI value and to determine the bicycle LOS that can be expected on the roadway. If the roadway does not meet the desired LOS, the model can be used to evaluate changes in the design necessary to improve the bicycle LOS.

➢ **Planning -** Data from long-range planning forecasts can be used to assess the bicycle compatibility of roadways in the future using projected volumes and planned roadway improvements. The model provides the user with a mechanism to quantitatively define and assess long-range bicycle transportation plans.

BCI and LOS Workbook

The BCI and LOS criteria have been incorporated into a Microsoft Excel workbook to simplify using the model in real-world applications. The workbook includes three separate worksheets, which are linked together to produce the BCI and LOS results. The **Data Entry** worksheet allows the user to enter location information, geometric and roadside data, traffic operations data, and parking data. The **Intermediate Calculations** worksheet calculates the adjustment factors and makes several other key computations using the raw data. Finally, the **BCI and LOS Computations** worksheet calculates the BCI using the nine variables that make up the model and provides the bicycle LOS and compatibility level.

Availability of Reports & Workbook

The results of this research effort are documented in two reports published in December 1998. The first is the **final report** (FHWA-RD-98-072), which documents the research project including a comprehensive literature review, field data collection procedures, and results of the data analysis. The second is an **implementation manual** (FHWA-RD-98-095), which provides practitioners with a guide to using the BCI instrument along with several real-world examples. Both of these documents can be found on the web at the following address: www.hsrc.unc.edu/research/pedbike/bci/. The BCI workbook that can be used for entering data and producing BCI and LOS results can be downloaded from the same site.

For More Information

This research effort was conducted by David L. Harkey, Donald W. Reinfurt, and J. Richard Stewart of the University of North Carolina Highway Safety Research Center; Matthew Knuiman of the University of Western Australia; and Alex Sorton of Northwestern University Traffic Institute. For more information about this effort and the subsequent reports, please contact either of the individuals below.

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Appendix D: Developing the Safety Component of a Bicycle Plan

Introduction

Each year in Wisconsin approximately 1,700 bicyclists are injured or killed in traffic crashes[1] involving motor vehicles. It is estimated that an additional 17,000 bicyclists are injured in crashes not involving a motor vehicle.[2] Slightly more than half of the bicyclists injured or killed in Wisconsin (59%) are children aged 15 and younger.

Research shows that bicyclist crashes are not random, unrelated events. They are situations that occur over and over—situations in which the motor vehicle operator, the bicyclist, or both make errors that threaten the bicyclist's life and safety. These are situations that could be avoided. A study of bicyclist/motor vehicle crashes conducted by Ken Cross and Gary Fisher in 1976 found that the following recurring events account for the majority of bicyclist crashes.[3]

- *Midblock or stop sign ride-out (by bicyclist).*
- *Bicyclist makes an unexpected left turn. *Motorist stops and goes.*
- *Motorist makes a left or right turn in front of bicyclist. *Wrong Way riding (by bicyclist).*

In the Cross-Fisher study two-thirds of the sample were children. In 1992 the WisDOT Office of Transportation Safety funded a bicycle crash analysis project designed to study three years of bicycle crash data in Madison, Wisconsin. Approximately 90% of the sample involved adults in crashes and the study revealed that different events account for adult bicyclist crashes. It is important to keep this in mind when one is developing countermeasure programs. In the Madison study the majority of crashes were caused by:

- *Motorist left turn/merge into a bicyclists' path.*
- *Motorist drive-out from a stop sign.*
- *Motorist drive-out from an alley.*
- *Bicyclist turn/merge into motor vehicle.*

Analyzing records of bicyclist crashes has allowed researchers to develop a number of programs designed to promote bicyclist safety. These programs are designed to teach bicyclists the skills necessary to avoid the "critical efforts" most commonly associated with bicycle/motor vehicle crashes.

While the development of bicycle facilities is one way to enhance bicyclists' safety, clearly there are some bicycle crashes that can only be dealt with through education and enforcement programs. Thus a comprehensive bicycle plan must include components covering bicyclists' education and enforcement of rules of the road for both bicyclists and motor vehicle operators.

Footnotes:

1. Throughout this narrative the term 'crash' is used instead of the term 'accident' to refer to bicyclist/motor vehicle collisions. A 'crash' is a counter measurable event whereas an accident sounds like an inevitable event.

2. Estimate based on research conducted by the North Carolina Highway Safety Research Center found that only 10% of bicycle injury crashes are reported on police accident report forms.

3. from Bicycle-Safety Education, Facts and Issues, by Kenneth Cross. Published by AAA Foundation for Traffic Safety, August 1978.

4. Effective Cycling is a program run by the League of American Bicyclists, a bicycling advocacy organization. It is a type of driver's education for bicyclists.

Target Audience

Bicycle safety programs may be developed for all three types of bicyclists previously identified, the child bicyclist, the average adult bicyclist and the experienced rider. The bulk of research completed to date has been focused on developing educational programs targeted for child bicyclists. However, there are some programs in existence designed to educate adult cyclists to become "effective cyclists."[4] General educational materials designed to promote safe bicycling for adults also exist.

Child Cyclists

The ideal program to educate children about bicyclist safety is one that is integrated through the school system and which is supported by children's parents. The Wisconsin Department of Transportation is working to promote a comprehensive bicycle safety curriculum targeted f&r children in fourth and fifth grade. Research shows that school-based curriculums often show results in terms of a positive change in children's knowledge, as measured on pre and post tests. However, when children's bicycling behavior is measured (i.e. wearing helmets, obeying traffic laws), there is often only a short-term improvement immediately following the safety program.[5]

However, if the school curriculum is supplemented with parents' follow-up messages to children, then studies show that children's behavior does change. It is extremely important that children be taught about bicycle safety while riding on a bicycle. In-class presentations can provide children with knowledge about traffic rules and regulations, but until they are given the opportunity to apply that knowledge, it is unlikely that their bicycle riding behavior will change.

Other child education programs include community bicycle safety events, bike rodeos, and bike safety fairs. A bike rodeo is a popular community event, often sponsored by local Kiwanis, Optimists, or other civic groups. Children are invited to bring their bikes to a park or large parking lot where they are run through a series of bike safety skills tests. These are excellent opportunities to teach children and their parents about bicycle safety and to introduce safe riding behaviors, such as helmet use and using bike lights, etc.

Experienced Bicyclists

For the most part, such bicyclists understand the rules of the road and are capable of functioning efficiently in traffic. However, experienced bicyclists, like many vehicle operators, may disobey traffic laws because they find them "inconvenient." Educational programs will probably have little effect on this type of rider because of their disinterest in going through this training. However, their behavior may be changed through enforcement programs. Many communities with large populations of adult bicyclists implement bicycle monitor programs or bicycle law enforcement programs—designating civilians or trained law enforcement officers as specifically responsible to make sure that bicyclists obey traffic laws.

In addition, this type of bicyclist could benefit from public information programs designed to educate motorists about their responsibilities in "sharing the road" with bicyclists. As noted from the Madison study, a majority of adult bicyclists crashes are "caused" by a critical error on the part of a motorist and not the bicyclist.

Footnotes:

4. Effective Cycling is a program run by the League of American Bicyclists, a bicycling advocacy organization. It is a type of driver's education for bicyclists.

5. Seattle Harborview Medical Center research.

Less Experienced Adult Bicyclists
These bicyclists, representing the majority of bicycling adults, will benefit from comprehensive public information and education programs. This includes promoting safe bicycling practices through the use of public service announcements (PSA's) on television and radio, brochures and articles in local newspapers and journals. Many good educational resources are produced by WisDOT (brochures, PSA'S, manuals), but unless these materials are promoted at the local level, their message will be lost. In addition, this type of bicyclist will benefit from general efforts to include information on bicyclist safety in all traffic safety materials, including driver's ed training, driver licensing exams, etc.

Some bicycle safety advocates believe that all individuals applying for a driver's license should be required to complete an "Effective Cycling" training course so that they will understand bicyclists rights to the roadway. Certainly, the Novice/Casual (average adult) bicyclist could benefit from this training program.

The Novice/Casual bicyclist may also benefit from selective enforcement programs promoted through the media. If these bicyclists, assumed to be law-abiding citizens, are educated about their responsibilities to obey the rules of the road, and if this education is reinforced through some high visibility law enforcement then, as these people begin to bicycle more and more, they will be more likely to bicycle in a safe manner.

The Motor Vehicle Operator
In any bicycle safety program it is very important to include both educational and enforcement programs targeted at motor vehicle operators. Research shows that one-third to two-thirds of all bicycle-motor vehicle crashes are caused by motorist errors. Drivers must be educated about bicyclists' rights to the road. A campaign promoting the idea of 'sharing the road with bicyclists' is recommended. Wisconsin law defines a bicycle as a vehicle, and a bicyclist has the rights and duties of vehicle operators[6]. Well-publicized selective enforcement programs that cite drivers for violating bicyclists' rights may be an effective way of communicating to your motoring public that they must "share the road" with bicyclists.

Summary

When a safety program involving education, enforcement, and engineering becomes part of an overall transportation plan, integrated with other programs (e.g. employee commute option programs) or within an overall traffic safety plan, supported by organizations and promoted through the media, bicyclist safety can become institutionalized in the community. This should, in turn, modify the behavior of drivers and bicyclists and lead to a reduction in the number of bicyclist-motorist collisions.

Historically, the most effective bicyclist crash countermeasures have been instituted at the local level rather than the State or Federal level. Bicycle safety programs can be introduced systematically involving all segments of the community in strategies designed to take into account the unique values and needs of the community. To have a long-term sustained effect, this comprehensive, integrated effort will require that bicyclist safety leadership involve city and county planners, law enforcement personnel, teachers, business people, parents, members of civic organizations, traffic safety professionals, and many others.

Footnotes:

6. Wisconsin Statute 346.02(4)

Appendix E - Rerouting Hazards

HAZARDS OF ROUTING CYCLISTS OFF THOROUGHFARES ONTO LESS-TRAVELLED STREETS

Planners and engineers unfamiliar with bicyclists' needs will often try to route them off from a busy thoroughfare, onto what are perceived as more desirable, less-travelled streets, rather than face the more challenging task of providing bike lanes on the thoroughfare. This diagram, and the discussion points, illustrate the problems with this approach.

WHY CYCLISTS PREFER A THROUGH ROUTE

1. It is the shortest distance from 'A" to "B" (The less-travelled street adds a distance of at least twice "n" feet, more if it meanders)

2. There may be destination points along the thoroughfare (e.g. at "C'), such as businesses, stores, schools or employment centers.

3. The less-travelled street will often have many stop signs; traffic on the thoroughfare will have the right of way, and signals-that favor through traffic over side streets.

4. Potential conflict points are increased with rerouting, especially for cyclists who are required to cross the thoroughfare twice (bicyclist #2).

CONSEQUENCES OF NOT PROVIDING BIKEWAY ON THOROUGHFARE

1. Because of the above reasons, many cyclists will choose to stay on the thoroughfare, even with no bike lanes, causing possible safety problems and reduced capacity (Bicyclists riding slowly in a narrow travel lane can cause traffic delays).

2. Circuitous bike route signing that is ignored breeds disrespect for other bicycle signing.

3. Some motorists will not respect bicyclists who are perceived to be "riding where they don't belong".

Source: 1992 Oregon Bicycle Plan. Printed with permission from the Oregon Department of Transportation

BASIC IMPROVEMENTS FOR BICYCLISTS

by John Williams

Here are some simple ways to improve bicycling in your community. These techniques are mostly inexpensive, requiring a minimum of specialized bicycle planning. But they can help ease conflicts for all modes of transportation—cars, bikes, and pedestrians.

Why encourage bicycling?

Bicycling is one of the most popular forms of recreation in America — in fact, it's number two over all. It's also excellent aerobic exercise. According to the National Center for Bicycling & Walking, more than 80 million Americans ride bicycles. Further, the bicycle is an economical non-polluting energy-efficient means of transportation. Some communities have worked hard to support bike use and, as a result, significant percentages of their work forces commute by bike.

For example, an estimated 9% of the commute trips in Madison, Wisconsin, are made by bike. Other bicycling cities include Davis, California, Eugene, Oregon, Boulder Colorado, and Gainesville, Florida. By encouraging bicycle use, these cities reap benefits like improved air quality, reduced traffic congestion, and a healthier citizenry. While some of their projects have been expensive, other have not. Let's look at those mostly inexpensive—but good—ideas.

Approaches for all streets

Studies show that bicycle users can be found in all parts of a city. They share destinations and trip purposes common to other road users and use all types of streets. For this reason, add basic bicycle improvements to all streets where bikes are allowed.

Different types of users, however, prefer different types of streets. Children and casual adult riders often ride on quiet neighborhood streets or paths. Serious commuting and recreational cyclists often ride on major streets and highways. At some point, however, everyone may need to use major streets to reach certain destination.

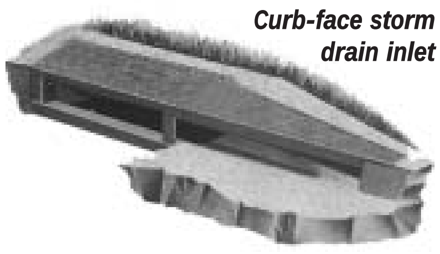
Fix or replace dangerous drain grates.

Drainage grates can be the bane of the bicyclist's existence. The worst ones are parallel-bar grates which can trap a bicyclist's wheel, causing a serious crash.

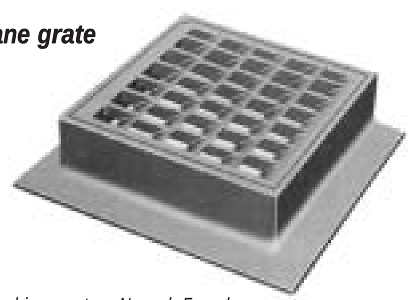
Replacing such grates with bicycle-safe models is the best approach. There are numerous designs that are both bicycle-safe and hydraulically-efficient. One good design is the curb-face inlet. These present no obstacle at all to the bicycle, as long as slopes to the inlets are not excessive.

Other safe designs include "vane" grates with short angled slots and honeycomb-style steel grates. Most grate manufacturers produce bike-safe models.

Curb-face storm drain inlet

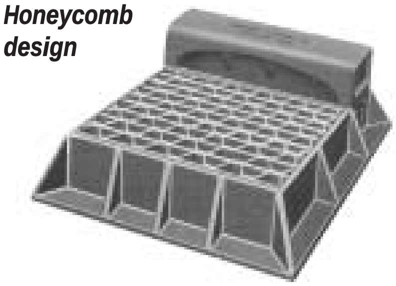


Vane grate



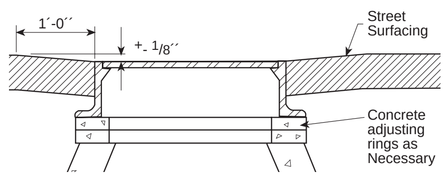
Graphics courtesy Neenah Foundry

Honeycomb design



In the short term, retrofitting may be a viable approach. Some agencies weld flat steel bars across the grate, perpendicular to the flow of traffic. In Wisconsin, however, these are often broken off by snow plows. Other agencies use covers over their grates. But if not cleaned frequently, these can collect debris, restricting the flow of water .

Retrofitting can solve the immediate problem and reduce an agency's potential exposure to liability. However, replacing dangerous grates is the best solution and has the lowest maintenance costs. Also, don't forget to change grate standards so that future installations will use bike-safe models.



Adjusting utility cover level with road.

Graphic courtesy Montana Public Works Assn.

Installation is also important. Make sure grates and utility covers are installed level with the pavement and are adjusted flush with future pavement overlays (see above).

References: Bicycle-Safe Grate Inlets Study, 1977, Report #FHWA-RD 77-24; Montana Public Works Standard Specifications, MPW, 1988; Neenah Foundry Construction Castings Catalog R, 1998

Patch and sweep carefully.

Many bicycles have relatively narrow tires and no shock absorbers. So, good surface conditions are essential. And paying attention to the roadway edge and patching practices can do a lot of good.

For example, a Palo Alto, California, poli-

Maintenance is an important concern for all bicyclists.

Careful patching can save bicyclists lots of grief.

Photo: Alex Sorton

cy requires utility companies to patch their roadway excavations to a high standard, with no big gaps or ridges. And if a patch fails within one year, the company must fix it.

Sweeping is also important for bicyclists. Passing motor traffic moves debris off to the

A sweeper keeps the bike lanes clean.

side of the roadway, where bicyclists often ride. Sweepers should pay special attention to the right edge and to places in intersections where debris builds up.

Fix railroad crossings.

There are two main railroad crossing problems. First, tracks that cross the roadway at less than 45º can divert a bicyclist's front wheel and cause a crash. Second, rough crossings can cause a bicyclist to lose control or damage a wheel.

Replacing rough crossings with smooth concrete or rubberized installations can eliminate the problem entirely. While these are expensive, they can also reduce maintenance costs. Cities like Seattle, Washington, install 4-foot sections of rubberized crossing near the right edge of popular bicycling streets. This can save money and benefit bicyclists.

One good way to solve the angle crossing problem is to flare the approaches on either side of the crossing. This allows bicyclists to cross the tracks at a right angle (see below).

On slow-speed rail lines with rubberized crossings, an alternative is to install flangeway fillers, which fill the wheel-grabbing gap next to the rail. However, this approach isn't recommended on high speed railroad lines; the filler does not compress quickly when a fast-moving train wheel hits it.

Flared rubberized crossing allows bicyclist to cross safely.

Photo: Alex Sorton

Reference: North Carolina Bicycle Facilities Planning and Design Guidelines, 1994

Use current bike facility guidelines.

Since the 1960s, bicycle facility designers have learned much about how bikes perform and what riders need. Some common mistakes still exist, however, and some are being re-created today; such mistakes can lead to multi-million dollar law suits. Here are a few tips from the *Guide for Development of Bicycle Facilities (AASHTO, 1999):*

Don't designate sidewalk bikeways. These cause car-bike conflicts at intersections and driveways, as well as conflicts with pedestrians. Madison, Wisconsin, and other cities have found that sidewalk bikeways have very high crash rates. Forty percent of all Madison bicycle crashes are related to sidewalk riding.

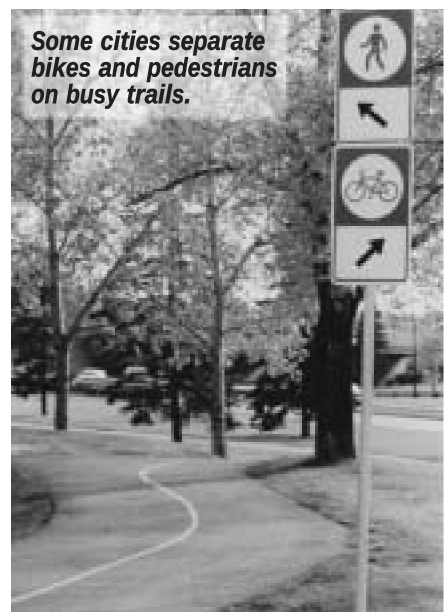
Two-way trail on one side of a road puts bicyclists in jeopardy.

Don't put two-way bikeways on one side of a street. These also cause serious conflicts at intersections and driveways. Two-way bike lane use has led to a number of fatal head-on collisions. And it encourages wrong-way riding.

Generous design speed on trail curves leads to safer conditions.

Use a realistic design speed on separate trails. Twenty miles per hour is a reasonable design speed on level ground. On hills, increase it to 30mph or more.

Be especially careful designing bike path curves and intersections. Unexpectedly tight curves can cause crashes, as can sight restrictions at intersections.



Some cities separate bikes and pedestrians on busy trails.

Shared trail use can cause problems. While it's seldom possible to avoid, mixing bikes and pedestrians on a trail can lead to serious conflicts if either bike volumes or pedestrian volumes are high. Some cities, like Calgary, Alberta, Denver, Colorado, and Madison, Wisconsin, separate bicyclists and pedestrians onto individual trail segments where use is particularly high. When shared use is unavoidable, add width and increase sight distance on curves and at intersections.

References: Guide for Development of Bicycle Facilities, 1999, American Assn. of State Hwy & Transportation Officials; "Bicyclist Crash Analysis in a City of Adult Bicyclists" Arthur Ross, City of Madison, 1992.

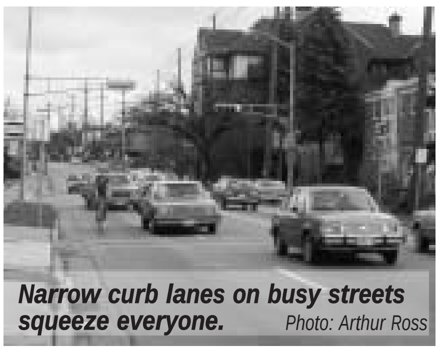
Improving Major Streets

For experienced bicyclists, cycling on major roads, while not always pleasant, has important benefits. These benefits are the same ones that motorists appreciate. Major roads tend to be more direct than quiet neighborhood streets. They are often protected by stop signs and signals at intersections. And those intersections often have good sight distance. Skilled bicyclists have little trouble riding safely on major roads.

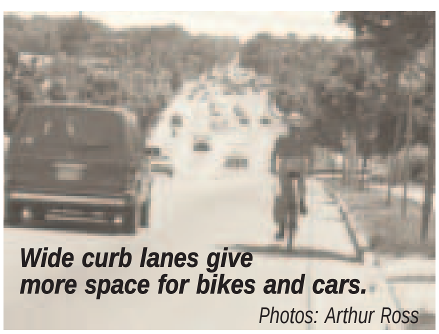
In some cases, it is possible to add bike lanes to arterial streets. Some cities have done this by removing a traffic lane with positive results. If this is not possible, it's still feasible to improve conditions for bicyclists. Here are some important options:

Create wide curb lanes.

One option for improving cycling conditions on major roads is to add width to the curb lanes. This approach gives motorists and bicyclists enough room to coexist in relative comfort.



Narrow curb lanes on busy streets squeeze everyone. *Photo: Arthur Ross*



Wide curb lanes give more space for bikes and cars. *Photos: Arthur Ross*

Further, wide curb lanes can reduce conflicts between cars on the roadway and cars waiting to exit from driveways.

Tom Walsh, Assistant Traffic Engineer for the City of Madison, Wisconsin, says "The wide curb lane is one of the most effective bicycle accommodation techniques available. It goes the furthest to integrate the bicycle into the normal traffic flow, allowing the bicyclist to use the existing street system as a vehicle without adversely interfering with other vehicles passing in the same lane."

How wide is wide enough? On a four-lane arterial street with 12-foot lanes, simply narrowing the inside lanes to 11 feet and widening the outside lanes to 13 feet is worth the effort, according to a study done by the Maryland DOT.

The consensus, however, seems to be that 14 to 15 feet of usable lane width (not counting curb and gutter) is the best.

References: Evaluation of Wide Curb Lanes as Shared Lane Bicycle Facilities, 1985, Maryland Department of Transportation; Highway Capacity Manual, 1985, Transportation Research Board. Road Diets: Fixing the Big Roads, Burden & Lagerwey, 1999; 1999 AASHTO Guide

Install bike-sensitive traffic signals.

Most demand-actuated signals are are tripped by the movement of a large mass of metal over a loop of wire buried in the pavement. However, such loops are widely known for being unresponsive to bicycles. Bikes generally don't have enough metal to turn the signal green. And, as a result, many bicyclists ignore signals.

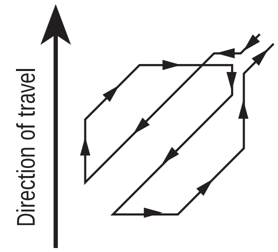
But modern detection systems can detect bicycles. The best standard design for general purpose lanes is a modified quadrupole loop (CalTrans Type D).

This loop (shown below and above right) is sensitive over its entire width but the sensitivity falls off rapidly outside. This feature helps avoid detection of vehicles in adjoining lanes. The diagonal quadrupole is an excellent design for new intersection loop installations.

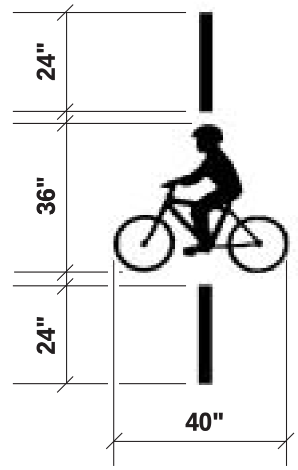
Recently-installed multiple diagonal quadrupole loop detectors.

However, many signals can detect bicycles if cyclists know where to position themselves. At intersections with the common square or rectangular loops, for example, the right edge of the loop is often sensitive enough to detect bikes and can be marked with a special pavement marking. A number of cities have experimented with various designs; the Madison design is shown above.

The CalTrans Type D Diagonal quadrupole loop detector.



Madison's bicycle pavement marking shows "hot spot" for detection.



References: Bicycle Forum Tech Note F-2, "Bicycles and Traffic Detectors;" Traffic Signal Bicycle Detection Study: Final Report, 1985, City of San Diego.

Improving Local Streets

Many bicyclists prefer riding on quiet neighborhood streets. These bicyclists may be less skilled than those who ride on major roads. Or they may simply prefer the slower pace of back streets. After all, quiet streets are often less stressful than busy streets. However, they may harbor hazards that can catch bicyclists unaware.

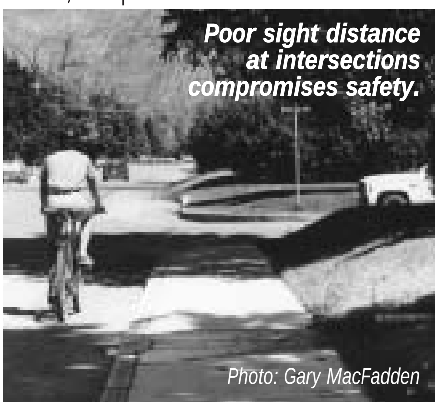
Several Federally-sponsored studies have shown that the majority of car-bike crashes happen on residential streets AND that residential streets may even have higher crash rates than do busier roadways.

The next sections discuss some of the improvements that will make local streets safer.

Here are a few local road tricks:

Improve sight distance at crossings.

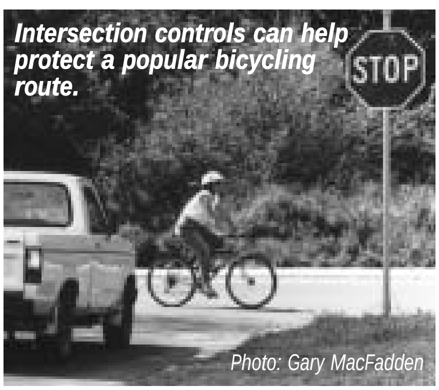
Visibility at intersections is crucial to everyone's safety. This is especially true for bicyclists, since they are so much smaller and often harder to see than the typical car. Many car-bike crashes result from motorists' and bicyclists' inability to see each other due to sight obstructions like large bushes, fences, and parked cars.



Poor sight distance at intersections compromises safety.

Photo: Gary MacFadden

Keeping sight lines clear at intersections can do much to improve bicycle safety. While such improvements aren't exotic, they can be very effective.



Intersection controls can help protect a popular bicycling route.

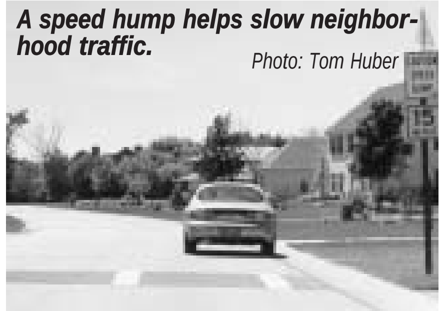
Photo: Gary MacFadden

Add effective intersection controls.

In the West, many residential street intersections are uncontrolled. Unfortunately, experience suggests that motorists (and bicyclists) often misunderstand the traffic laws governing such intersections.

Consider installing traffic controls on low-volume streets which meet popular bicycle routes. These can be stop or yield signs, depending on local preference.

Reference: Manual on Uniform Traffic Control Devices, FHWA, 1988



A speed hump helps slow neighborhood traffic.

Photo: Tom Huber

Use traffic calming measures.

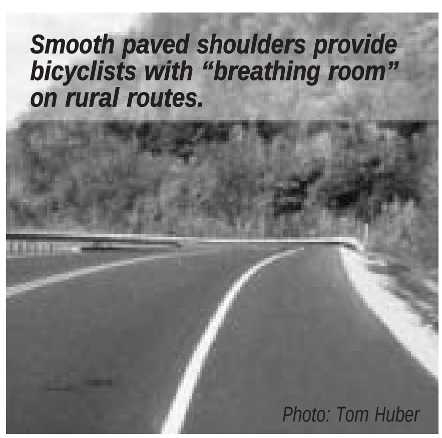
While not strictly bicycle improvements, carefully-designed traffic calming techniques can reduce dangers of riding on local streets. By reducing either traffic speeds or traffic volumes on residential streets, such provisions as mini-traffic circles, chicanes, diverters, and speed humps can help make quiet streets even quieter. Care must be taken, however, to avoid creating bicycling hazards in the process. FHWA's National Bicycling & Walking Study: Case Study 19 (see below) describes how to do this.

Seattle's mini-traffic circle program is one example of a program that has been both popular with residents and has reduced the number of crashes in residential street intersections significantly.

References: Traffic Calming, CART, 1989; Traffic Circles in Residential Areas, City of Seattle, 1993; Traffic Calming, Auto Restricted Zones and Other Traffic Management Techniques, Case Study 19, National Bicycling & Walking Study, USDOT/FHWA, 1994

Improving Rural Roads

Rural roads offer miles of quiet and enjoyable cycling. Many bicyclists consider this type of riding to be the very best recreation available. What can be done to improve rural roadways?



Smooth paved shoulders provide bicyclists with "breathing room" on rural routes.

Photo: Tom Huber

Pave shoulders on busy rural roads.

Some states, such as Wisconsin, add paved shoulders to rural highways when they reconstruct. They do this to encourage bicycling—they have a very active tourism program—and to improve conditions for motorists as well.

On narrow rural roads without paved shoulders, cars and trucks occasionally drop a wheel off the pavement edge. When the driver corrects, the wheels tend to tear up that edge. This damage can lead to continuing maintenance problems. Paved shoulders can cut down on maintenance costs by giving the motorists more room to correct steering errors. Further, paved shoulders can cut the incidence of run-off-the-road accidents.

How wide is wide enough? Consider paving at least three to four feet to a reasonable high standard with adequate sub-base. The Maryland Department of Transportation, for example, covers their previously-paved shoulders with a slurry seal for smoothness, They find that cyclists appreciate and use the smooth shoulders.

References: Guidelines for Wide Paved Shoulders on Low-Volume, Two-Lane Rural Highways; Rollins & Crane, TRB, 1989; Facilities Development Manual: "Shoulder Bikeways", WisDOT, 1993.

Use caution with rumble strips.

Rumble strips along the edge of rural highways have been shown to reduce the incidence of run-off-the-road crashes among motorists. However, unless carefully designed, they can cause serious problems for bicyclists. A rumble strip that covers the entire paved shoulder gives the bicyclist nowhere to ride except in the travel lane.

A number of states have worked hard to design rumble strips that cause fewer problems for bicyclists. For example, Wisconsin policies require the use of a narrow 12" rumble strip next to the shoulder stripe and discourage use on shoulders narrower than 6 feet.

References: Rumble Strips & Bicycle Wheels, Bicycle Forum, 1987; Survey of State Rumble Strip Policies, Adventure Cycling Assn., 1996

For more information…

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Appendix G:

Wisconsin Bicycling Laws

The statutes in this material have been generated from the 2001-2002 Wisconsin Statutes, but may not be an exact duplication. Please refer to the Wisconsin Statutes for the official text.

Some of the most commonly referenced state statutes related to bicycling are:

- Bicycle as a Vehicle – State Statute 340.01 (5) and 346.02 (4)(a)
- Lane Positioning - State Statute 346.80 (1 and 2)
- Riding Side-by-side - State Statute 346.80 (3)
- Hand Signals – State Statute 346.34 (1)(b) and 346.35
- Motorist Passing Bicyclist – State Statute 346.075
- Bicycling at Night – State Statute 347.489

Legal definitions:
340.01(5)
(5) "Bicycle" means every vehicle propelled by the feet acting upon pedals and having wheels any 2 of which are not less than 14 inches in diameter.
(5e) "Bicycle lane" means that portion of a roadway set aside by the governing body of any city, town, village, or county for the exclusive use of bicycles, electric personal assistive mobility devices, or other modes of travel where permitted under s. 349.23 (2) (a), and so designated by appropriate signs and markings.
(5m) "Bike route" means any bicycle lane, bicycle way or highway which has been duly designated by the governing body of any city, town, village or county and which is identified by appropriate signs and markings.
(5s) "Bicycle way" means any path or sidewalk or portion thereof designated for the use of bicycles and electric personal assistive mobility devices by the governing body of any city, town, village, or county.
(24m) "In-line skates" means skates with wheels arranged singly in a tandem line rather than in pairs.
(43m) "Play vehicle":
(a) Means a coaster, skate board, roller skates, sled, toboggan, unicycle or toy vehicle upon which a person may ride.
(b) Does not include in-line skates.
(74) "Vehicle" means every device in, upon, or by which any person or property is or may be transported or drawn upon a highway, except railroad trains. A snowmobile or electric personal assistive mobility device shall not be considered a vehicle except for purposes made specifically applicable by statute.

Applicable sections from Wisconsin statutes:

346.02(4): **Applicability to persons riding bicycles and motor bicycles.**
(a) Subject to the special provisions applicable to bicycles, every person riding a bicycle upon a roadway or shoulder of a highway is granted all the rights and is subject to all the duties which this chapter grants or applies to the operator of a vehicle, except those provisions which by their express terms apply only to motor vehicles or which by their very nature would have no application to bicycles. For purposes of this chapter, provisions which apply to bicycles also apply to motor bicycles, except as otherwise expressly provided.
(b) Provisions which apply to the operation of bicycles in crosswalks under ss. 346.23, 346.24, 346.37 (1) (a) 2., (c) 2 and (d) 2. and 346.38 do not apply to motor bicycles.

346.05(1m): **Vehicles to be driven on right side of roadway; exceptions.**
(1m) Notwithstanding sub. (1), any person operating a bicycle or electric personal assistive mobility device may ride on the shoulder of a highway unless such riding is prohibited by the authority in charge of the maintenance of the highway.

346.075(1): **Overtaking and passing bicycles, electric personal assistive mobility devices, and motor buses**
(1) The operator of a motor vehicle overtaking a bicycle or electric personal assistive mobility device proceeding in the same direction shall exercise due care, leaving a safe distance, but in no case less than 3 feet clearance when passing the bicycle or electric personal assistive mobility device, and shall maintain clearance until safely past the overtaken bicycle or electric personal assistive mobility device.

346.16: **Use of controlled-access highways, expressways and freeways.**
(1) No person shall drive a vehicle onto or from a controlled-access highway, expressway or freeway except through an opening provided for that purpose.
(2a) Except as provided in par. (b), no pedestrian or person riding a bicycle or other nonmotorized vehicle and no person operating a moped or motor bicycle may go upon any expressway or freeway when official signs have been erected prohibiting such person from using the expressway or freeway.
(2am) Except as provided in par. (b), no person riding an electric personal assistive mobility device may go upon any expressway or freeway when official signs have been erected prohibiting persons specified in par. (a) from using the expressway or freeway.
(2b) A pedestrian or other person under par. (a) or (am) may go upon a portion of a hiking trail, cross-country ski trail, bridle trail or bicycle trail incorporated into the highway right-of-way and crossing the highway if the portion of the trail is constructed under s. 84.06 (11).

346.17: **Penalty for violating section 346.04 to 346.16**
(2) Any person violating ss. 346.05, 346.07 (2) or (3), 346.072, 346.08, 346.09, 346.10 (2) to (4), 346.11, 346.13 (2) or 346.14 to 346.16 may be required to forfeit not less than $30 nor more than $300.
(4) Any person violating s. 346.075 may be required to forfeit not less than $25 nor more than $200 for the first offense and not less than $50 nor more than $500 for the 2nd or subsequent violation within 4 years.

346.23: **Crossing controlled intersection or crosswalk.**
(1) At an intersection or crosswalk where traffic is controlled by traffic control signals or by a traffic officer, the operator of a vehicle shall yield the right-of-way to a pedestrian, or to a person who is riding a bicycle or electric personal assistive mobility device in a manner which is consistent with the safe use of the crosswalk by pedestrians, who has started to cross the highway on a green or "Walk" signal and in all other cases pedestrians, bicyclists, and riders of electric personal assistive mobility devices shall yield the right-of-way to vehicles lawfully proceeding directly ahead on a green signal. No operator of a vehicle proceeding ahead on a green signal may begin a turn at a controlled intersection or crosswalk when a pedestrian, bicyclist, or rider of an electric personal assistive mobility device crossing in the crosswalk on a green or "Walk" signal would be endangered or interfered with in any way. The rules stated in this subsection are modified at intersections or crosswalks on divided highways or highways provided with safety zones in the manner and to the extent stated in sub. (2).
(2) At intersections or crosswalks on divided highways or highways provided with safety zones where traffic is controlled by traffic control signals or by a traffic officer, the operator of a vehicle shall yield the right-of-way to a pedestrian, bicyclist, or rider of an electric personal assistive mobility device who has started to cross the roadway either from the near curb or shoulder or from the center dividing strip or a safety zone with the green or "Walk" signal in the favor of the pedestrian, bicyclist, or rider of an electric personal assistive mobility device.

346.24: **Crossing at uncontrolled intersection or crosswalk.**
(1) At an intersection or crosswalk where traffic is not controlled by traffic control signals or by a traffic officer, the operator of a vehicle shall yield the right-of-way to a pedestrian, or to a person riding a bicycle or electric personal assistive mobility device in a manner which is consistent with the safe use of the crosswalk by pedestrians, who is crossing the highway within a marked or unmarked crosswalk.
(2) No pedestrian, bicyclist, or rider of an electric personal assistive mobility device shall suddenly leave a curb or other place of safety and walk, run, or ride into the path of a vehicle which is so close that it is difficult for the operator of the vehicle to yield.
(3) Whenever any vehicle is stopped at an intersection or crosswalk to permit a pedestrian, bicyclist, or rider of an electric personal assistive mobility device to cross the roadway, the operator of any other vehicle approaching from the rear shall not overtake and pass the stopped vehicle.

346.25: **Crossing at place other than crosswalk**
Every pedestrian, bicyclist, or rider of an electric personal assistive mobility device crossing a roadway at any point other than within a marked or unmarked crosswalk shall yield the right-of-way to all vehicles upon the roadway.

346.30(1)(b)2: **Penalty for violating sections 346.23 to 346.29.**
Any operator of a bicycle or electric personal assistive mobility device violating s. 346.23, 346.24 or 346.25 may be required to forfeit not more than $20.

346.34: **Turning movements and required signals on turning and stopping.**
*(1) Turning***.**
(a) No person may:
1. Turn a vehicle at an intersection unless the vehicle is in proper position upon the roadway as required in s. 346.31.
2. Turn a vehicle to enter a private road or driveway unless the vehicle is in proper position on the roadway as required in s. 346.32.
3. Turn a vehicle from a direct course or move right or left upon a roadway unless and until such movement can be made with reasonable safety.
(b) In the event any other traffic may be affected by such movement, no person may so turn any vehicle without giving an appropriate signal in the manner provided in s. 346.35. When given by the operator of a vehicle other than a bicycle or electric personal assistive mobility device, such signal shall be given continuously during not less than the last 100 feet traveled by the vehicle before turning. The operator of a bicycle or electric personal assistive mobility device shall give such signal continuously during not less than the last 50 feet traveled before turning. A signal by the hand and arm need not be given continuously if the hand is needed in the control or operation of the bicycle or electric personal assistive mobility device.
(2) Stopping. No person may stop or suddenly decrease the speed of a vehicle without first giving an appropriate signal in the manner provided in s. 346.35 to the operator of any vehicle immediately to the rear when there is opportunity to give such signal. This subsection does not apply to the operator of a bicycle approaching an official stop sign or traffic control signal.

346.35: **Method of giving signals on turning and stopping.**
Whenever a stop or turn signal is required by s. 346.34, such signal may in any event be given by a signal lamp or lamps of a type meeting the specifications set forth in s. 347.15. Except as provided in s. 347.15 (3m), such signals also may be given by the hand and arm in lieu of or in addition to signals by signal lamp. When given by hand and arm, such signals shall be given from the left side of the vehicle in the following manner and shall indicate as follows:
(1) Left turn—Hand and arm extended horizontally.
(2) Right turn—Hand and arm extended upward.
(3) Stop or decrease speed—Hand and arm extended downward.

346.36: **Penalty for violating sections 346.31 to 346.35.**
(1) Unless otherwise provided in sub. (2), any person violating ss. 346.31 to 346.35 may be required to forfeit not less than $20 nor more than $40 for the first offense and not less than $50 nor more than $100 for the 2nd or subsequent conviction within a year.
(2) Any operator of a bicycle or electric personal assistive mobility device violating ss. 346.31 to 346.35 may be required to forfeit not more than $20.

346.37: **Traffic-control signal legend.**
(1) Whenever traffic is controlled by traffic control signals exhibiting different colored lights successively, or with arrows, the following colors shall be used and shall indicate and apply to operators of vehicles and pedestrians as follows:
(a) *Green.* 1. Vehicular traffic facing a green signal may proceed straight through or turn right or left unless a sign at such place prohibits either such turn, but vehicular traffic shall yield the right-of-way to other vehicles and to pedestrians lawfully within the intersection or an adjacent crosswalk at the time such signal is exhibited.
2. Pedestrians, and persons who are riding bicycles or electric personal assistive mobility devices in a manner which is consistent with the safe use of the crosswalk by pedestrians, facing the signal may proceed across the roadway within any marked or unmarked crosswalk.
(b) *Yellow.* When shown with or following the green, traffic facing a yellow signal shall stop before entering the intersection unless so close to it that a stop may not be made in safety.
(c) *Red.* 1. Vehicular traffic facing a red signal shall stop before entering the crosswalk on the near side of an intersection, or if none, then before entering the intersection or at such other point as may be indicated by a clearly visible sign or marking and shall remain standing until green or other signal permitting movement is shown.
2. No pedestrian, bicyclist, or rider of an electric personal assistive mobility device facing such signal shall enter the roadway unless he or she can do so safely and without interfering with any vehicular traffic.
3. Vehicular traffic facing a red signal at an intersection may, after stopping as required under subd. 1., cautiously enter the intersection to make a right turn into the nearest lawfully available lane for traffic moving to the right or to turn left from a one-way highway into the nearest lawfully available lane of a one-way highway on which vehicular

traffic travels to the left. No turn may be made on a red signal if lanes of moving traffic are crossed or if a sign at the intersection prohibits a turn. In making a turn on a red signal vehicular traffic shall yield the right-of-way to pedestrians, bicyclists, and riders of electric personal assistive mobility devices lawfully within a crosswalk and to other traffic lawfully using the intersection.
(d) *Green arrow.* 1. Vehicular traffic facing a green arrow signal may enter the intersection only to make the movement indicated by the arrow but shall yield the right-of-way to pedestrians, bicyclists, and riders of electric personal assistive mobility devices lawfully within a crosswalk and to other traffic lawfully using the intersection. When the green arrow signal indicates a right or left turn traffic shall cautiously enter the intersection.
2. No pedestrian, bicyclist, or rider of electric personal assistive mobility device facing such signal shall enter the roadway unless he or she can do so safely and without interfering with any vehicular traffic.
(2) In the event an official traffic signal is erected and maintained at a place other than an intersection, the provisions of this section are applicable except as to those provisions which by their nature can have no application. Any stop required shall be made at a sign or marking on the pavement indicating where the stop shall be made, but in the absence of any such sign or marking the stop shall be made at the signal.

346.38: **Pedestrian control signals.**
Whenever special pedestrian control signals exhibiting the words "Walk" or "Don't Walk" are in place, such signals indicate as follows:
(1) Walk. A pedestrian, or a person riding a bicycle or electric personal assistive mobility device in a manner which is consistent with the safe use of the crossing by pedestrians, facing a "Walk" signal may proceed across the roadway or other vehicular crossing in the direction of the signal and the operators of all vehicles shall yield the right-of-way to the pedestrian, bicyclist, or electric personal assistive mobility device rider.
(2) Don't walk. No pedestrian, bicyclist, or rider of an electric personal assistive mobility device may start to cross the roadway or other vehicular crossing in the direction of a "Don't Walk" signal, but any pedestrian, bicyclist, or rider of an electric personal assistive mobility device who has partially completed crossing on the "Walk" signal may proceed to a sidewalk or safety zone while a "Don't Walk" signal is showing.

346.47: **When vehicles using alley or nonhighway access to stop.**
(1) The operator of a vehicle emerging from an alley or about to cross or enter a highway from any point of access other than another highway shall stop such vehicle immediately prior to moving on to the sidewalk or on to the sidewalk area extending across the path of such vehicle and shall yield the right-of-way to any pedestrian, bicyclist, or rider of an electric personal assistive mobility device, and upon crossing or entering the roadway shall yield the right-of-way to all vehicles approaching on such roadway.

346.54(1)(e): **How to park and stop on streets.**
(e) For the purpose of parking, mopeds and electric personal assistive mobility devices shall be considered bicycles. Where possible without impeding the flow of pedestrian traffic, a bicycle, moped, or electric personal assistive mobility device may be parked on a sidewalk. A bicycle, moped, or electric personal assistive mobility device may be parked in a bike rack or other similar area designated for bicycle parking.

346.59(2): **Minimum speed regulation**
(2) The operator of a vehicle moving at a speed so slow as to impede the normal and reasonable movement of traffic shall, if practicable, yield the roadway to an overtaking vehicle whenever the operator of the overtaking vehicle gives audible warning with a warning device and shall move at a reasonably increased speed or yield the roadway to overtaking vehicles when directed to do so by a traffic officer.

346.60(5)(b): **Penalty for violating section 346.59**
Any operator of a bicycle or electric personal assistive mobility device who violates s. 346.59 may be required to forfeit not more than $10.

346.77: **Responsibility of parent or guardian for violation of bicycle and play vehicle regulations.**
No parent or guardian of any child shall authorize or knowingly permit such child to violate any of the provisions of ss. 346.78 to 346.804 and 347.489.

346.78: **Play vehicles not to be used on roadway.** No person riding upon any play vehicle may attach the same or himself or herself to any vehicle upon a roadway or go upon any roadway except while crossing a roadway at a crosswalk.

346.79: **Special rules applicable to bicycles.** Whenever a bicycle is operated upon a highway, bicycle lane or bicycle way the following rules apply:
(1) A person propelling a bicycle shall not ride other than upon or astride a permanent and regular seat attached thereto.
(2) (a) Except as provided in par. (b), no bicycle may be used to carry or transport more persons at one time than the number for which it is designed.
(b) In addition to the operator, a bicycle otherwise designed to carry only the operator may be used to carry or transport a child seated in an auxiliary child's seat or trailer designed for attachment to a bicycle if the seat or trailer is securely attached to the bicycle according to the directions of the manufacturer of the seat or trailer.
(3) No person operating a bicycle shall carry any package, bundle or article which prevents the operator from keeping at least one hand upon the handle bars.
(4) No person riding a bicycle shall attach himself or herself or his or her bicycle to any vehicle upon a roadway.
(5) No person may ride a moped or motor bicycle with the power unit in operation upon a bicycle way.

346.80: **Riding bicycle or electric personal assistive mobility device on roadway.**
(1) In this section, "substandard width lane" means a lane that is too narrow for a bicycle or electric personal assistive mobility device and a motor vehicle to travel safely side by side within the lane.
(2) (a) Any person operating a bicycle or electric personal assistive mobility device upon a roadway at less than the normal speed of traffic at the time and place and under the conditions then existing shall ride as close as practicable to the right-hand edge or curb of the unobstructed traveled roadway, including operators who are riding 2 or more abreast where permitted under sub. (3), except:
1. When overtaking and passing another vehicle proceeding in the same direction.
2. When preparing for a left turn at an intersection or into a private road or driveway.
3. When reasonably necessary to avoid unsafe conditions, including fixed or moving objects, parked or moving vehicles, pedestrians, animals, surface hazards or substandard width lanes that make it unsafe to ride along the right-hand edge or curb.

(b) Notwithstanding par. (a), any person operating a bicycle or electric personal assistive mobility device upon a one-way highway having 2 or more lanes available for traffic may ride as near the left-hand edge or curb of the roadway as practicable.
(c) Any person operating a bicycle or electric personal assistive mobility device upon a roadway shall exercise due care when passing a standing or parked vehicle or a vehicle proceeding in the same direction, allowing a minimum of 3 feet between the bicycle or electric personal assistive mobility device and the vehicle, and shall give an audible signal when passing a bicycle or electric personal assistive mobility device rider proceeding in the same direction.
(3) (a) Persons riding bicycles or electric personal assistive mobility devices upon a roadway may ride 2 abreast if such operation does not impede the normal and reasonable movement of traffic. Bicycle or electric personal assistive mobility device operators riding 2 abreast on a 2-lane or more roadway shall ride within a single lane.
(b) Persons riding bicycles upon a roadway may not ride more than 2 abreast except upon any path, trail, lane or other way set aside for the exclusive use of bicycles and electric personal assistive mobility devices.
(4) No person may operate a bicycle, electric personal assistive mobility device, or moped upon a roadway where a sign is erected indicating that bicycle, electric personal assistive mobility device, or moped riding is prohibited.
(5) Except as provided in ss. 346.23, 346.24, 346.37, and 346.38, every rider of a bicycle or electric personal assistive mobility device shall, upon entering on a highway, yield the right-of-way to motor vehicles.

346.803: **Riding bicycle or electric personal assistive mobility device on bicycle way.**
(1) Every person operating a bicycle or electric personal assistive mobility device upon a bicycle way shall:
(a) Exercise due care and give an audible signal when passing a bicycle or electric personal assistive mobility device rider or a pedestrian proceeding in the same direction.
(b) Obey each traffic signal or sign facing a roadway which runs parallel and adjacent to a bicycle way.
(2) Every person operating a bicycle or electric personal assistive mobility device upon a bicycle way open to 2-way traffic shall ride on the right side of the bicycle way.
(3) Every operator of a bicycle or electric personal assistive mobility device entering a bicycle way shall yield the right-of-way to all bicycles and pedestrians in the bicycle way.

(4) Except as provided in s. 349.236 (1) (bm), a person may operate an electric personal assistive mobility device upon any bicycle path.

346.804: **Riding bicycle on sidewalk.** When local authorities under s. 346.94 (1) permit bicycles on the sidewalk, every person operating a bicycle upon a sidewalk shall yield the right-of-way to any pedestrian and shall exercise due care and give an audible signal when passing a bicycle or electric personal assistive mobility device rider or a pedestrian proceeding in the same direction.

346.82: **Penalty for violating sections 346.77 to 346.805.**
(1) Any person violating ss. 346.77, 346.79 (1) to (3), or 346.80 to 346.805 may be required to forfeit not more than $20. (1) Any person violating ss. 346.77, 346.79 (1) to (3) or 346.80 to 346.804 may be required to forfeit not more than $20.
(2) Any person violating s. 346.78 or 346.79 (4) may be required to forfeit not less than $10 nor more than $20 for the first offense and not less than $25 nor more than $50 for the 2nd or subsequent conviction within a year.

346.94: **Miscellaneous prohibited acts.**
(1) Driving on sidewalk. The operator of a vehicle shall not drive upon any sidewalk area except at a permanent or temporarily established driveway unless permitted to do so by the local authorities.
(11) Towing sleds, etc. No person shall operate any vehicle or combination of vehicles upon a highway when such vehicle or combination of vehicles is towing any toboggan, sled, skis, bicycle, skates or toy vehicle bearing any person.
(12) Driving on bicycle lane or bicycle way. No operator of a motor vehicle may drive upon a bicycle lane or bicycle way except to enter a driveway, to merge into a bicycle lane before turning at an intersection, or to enter or leave a parking space located adjacent to the bicycle lane or bicycle way. Persons operating a motor vehicle upon a bicycle lane or bicycle way shall yield the right-of-way to all bicycles and electric personal assistive mobility devices within the bicycle lane or bicycle way.
(17) In-line skates on roadway.
(a) A person riding upon in-line skates may go upon any roadway under the jurisdiction of a local authority, subject to any restrictions specified by municipal ordinance enacted under s. 349.235.
(b) Any person riding upon in-line skates upon any roadway shall ride in a careful and prudent manner and with due regard under the circumstances for the safety of all persons using the roadway.
(c) Notwithstanding any other provision of this subsection or s. 349.235, no person riding upon in-line skates may attach the in-line skates or himself or herself to any vehicle upon a roadway or, except while crossing a roadway at a crosswalk, go upon any roadway under the jurisdiction of the department.

346.95: **Penalty for violating sections 346.87 to 346.94.**
(1) Any person violating s. 346.87, 346.88, 346.89 (2), 346.90 to 346.92 or 346.94 (1), (9), (10), (11), (12) or (15) may be required to forfeit not less than $20 nor more than $40 for the first offense and not less than $50 nor more than $100 for the 2nd or subsequent conviction within a year.
(6) Any person violating s. 346.94 (17) or (18) may be required to forfeit not less than $10 nor more than $20 for the first offense and not less than $25 nor more than $50 for the 2nd or subsequent conviction within a year.

347.489: **Lamps and other equipment on bicycles, motor bicycles, and electric personal assistive mobility devices.**
(1) No person may operate a bicycle, motor bicycle, or electric personal assistive mobility device upon a highway, sidewalk, bicycle lane, or bicycle way during hours of darkness unless the bicycle, motor bicycle, or electric personal assistive mobility device is equipped with or, with respect to a bicycle or motor bicycle, the operator is wearing, a lamp emitting a white light visible from a distance of at least 500 feet to the front of the bicycle, motor bicycle, or electric personal assistive mobility device. A bicycle, motor bicycle, or electric personal assistive mobility device shall also be equipped with a red reflector that has a diameter of at least 2 inches of surface area or, with respect to an electric personal assistive mobility device, that is a strip of reflective tape that has at least 2 square inches of surface area, on the rear so mounted and maintained as to be visible from all distances from 50 to 500 feet to the rear when directly in front of lawful upper beams of headlamps on a motor vehicle. A lamp emitting a red or flashing amber light visible from a distance of 500 feet to the rear may be used in addition to but not in lieu of the red reflector.
(2) No person may operate a bicycle, motor bicycle, or electric personal assistive mobility device upon a highway, bicycle lane, or bicycle way unless it is equipped with a brake in good working condition, adequate to control the

movement of and to stop the bicycle, motor bicycle, or electric personal assistive mobility device whenever necessary.
(3) No bicycle, motor bicycle, or electric personal assistive mobility device may be equipped with nor may any person riding upon a bicycle, motor bicycle, or electric personal assistive mobility device use any siren or compression whistle.

349.06: **Authority to adopt traffic regulations in strict conformity with state law.**
(1) (a) Except for the suspension or revocation of motor vehicle operator's licenses or except as provided in par. (b), any local authority may enact and enforce any traffic regulation which is in strict conformity with one or more provisions of chs. 341 to 348 and 350 for which the penalty for violation thereof is a forfeiture.
(b) Any local authority shall enact and enforce parking regulations and penalties for violations of those regulations which are in conformity with the provisions of ss. 346.503, 346.505 and 346.56.
(c) Any local authority may enact and enforce any traffic regulation that is in strict conformity with any rule of the department promulgated under ch. 110, 347 or 348, except rules pertaining to federal motor carrier safety standards, for which the penalty for a violation thereof is a forfeiture.
(1m) Notwithstanding sub. (1), a municipal court may suspend a license for a violation of a local ordinance in conformity with s. 346.63 (1) or (2m).
(2) Traffic regulations adopted by local authorities which incorporate by reference existing or future amendments to chs. 340 to 348 or rules of the department shall be deemed to be in strict conformity and not contrary to or inconsistent with such chapters or rules. This subsection does not require local traffic regulations to incorporate state traffic laws or rules by reference in order to meet the requirements of s. 349.03 or sub. (1).
(3) If an operator of a vehicle violates a local ordinance in strict conformity with s. 346.04 (1) or (2), 346.18 (6), 346.27, 346.37, 346.39, 346.46 (1), 346.57 (2), (3), (4) (d) to (h) or (5) or 346.62 (2) where persons engaged in work in a highway maintenance or construction area or in a utility work area are at risk from traffic, any applicable minimum and maximum forfeiture for the violation shall be doubled.

349.105: **Authority to prohibit certain traffic on expressways and freeways.**
The authority in charge of maintenance of an expressway or freeway may, by order, ordinance or resolution, prohibit the use of such expressway or freeway by pedestrians, persons riding bicycles or other nonmotorized traffic or by persons operating mopeds or motor bicycles. The state or local authority adopting any such prohibitory regulation shall erect and maintain official signs giving notice thereof on the expressway or freeway to which such prohibition applies.

349.18: **Additional traffic-control authority of counties and municipalities.**
(1) Any city, village or town, by ordinance, may:
(a) Designate the number of persons that may ride on a motor bicycle at any one time and the highways upon which a motor bicycle or moped may or may not be operated.
(b) Establish a golf cart crossing point upon a highway within its limits. An ordinance enacted under this paragraph shall require that a golf cart stop and yield the right-of-way to all vehicles approaching on the highway before crossing the highway. The ordinance may require that a golf cart be equipped with reflective devices as specified in the ordinance. The city, village or town shall place a sign of a type approved by the department to mark the crossing point on both sides of the highway.
(c) Regulate the operation of a golf cart to and from a golf course for a distance not to exceed one mile upon a highway under its exclusive jurisdiction. The city, village or town shall place a sign of a type approved by the department to mark any golf cart travel route designated by the ordinance.
(2) Any city, town or village may by ordinance enacted pursuant to s. 349.06 regulate the operation of bicycles and motor bicycles and may by ordinance require registration of any bicycle or motor bicycle owned by a resident of the city, town or village, including the payment of a registration fee.
(3) Any county, by ordinance, may require the registration of any bicycle or motor bicycle owned by a resident of the county if the bicycle or motor bicycle is not subject to registration under sub. (2). Such ordinance does not apply to any bicycle or motor bicycle subject to registration under sub. (2), even if the effective date of the ordinance under sub. (2) is later than the effective date of the county ordinance. A county may charge a fee for the registration.

349.23: **Authority to designate bicycle lanes and bicycle ways.**
(1) The governing body of any city, town, village or county may by ordinance:
(a) Designate any roadway or portion thereof under its jurisdiction as a bicycle lane.
(b) Designate any sidewalk or portion thereof in its jurisdiction as a bicycle way.

(2) A governing body designating a sidewalk or portion thereof as a bicycle way or a highway or portion thereof as a bicycle lane under this section may:
(a) Designate the type and character of vehicles or other modes of travel which may be operated on a bicycle lane or bicycle way, provided that the operation of such vehicle or other mode of travel is not inconsistent with the safe use and enjoyment of the bicycle lane or bicycle way by bicycle traffic.
(b) Establish priority of right-of-way on the bicycle lane or bicycle way and otherwise regulate the use of the bicycle lane or bicycle way as it deems necessary. The designating governing body may, after public hearing, prohibit through traffic on any highway or portion thereof designated as a bicycle lane, except that through traffic may not be prohibited on any state highway. The designating governing body shall erect and maintain official signs giving notice of the regulations and priorities established under this paragraph, and shall mark all bicycle lanes and bicycle ways with appropriate signs.
(c) Paint lines or construct curbs or establish other physical separations to exclude the use of the bicycle lane or bicycle way by vehicles other than those specifically permitted to operate thereon.
(3) The governing body of any city, town, village or county may by ordinance prohibit the use of bicycles and motor bicycles on a roadway over which they have jurisdiction, after holding a public hearing on the proposal.

349.235: **Authority to restrict use of in-line skates on roadway.**
(1) The governing body of any city, town, village or county may by ordinance restrict the use of in-line skates on any roadway under its jurisdiction. No ordinance may restrict any person from riding upon in-line skates while crossing a roadway at a crosswalk.
(2) The department of natural resources may promulgate rules designating roadways under its jurisdiction upon which in-line skates may be used, except that no rule may permit a person using in-line skates to attach the skates or himself or herself to any vehicle upon a roadway.

Appendix H: Definitions

BICYCLE - A vehicle having two tandem wheels, either of which is more than 16" in diameter or having three wheels in contact with the ground any of which is more than 16" in diameter, propelled solely by human power, upon which any person or persons may ride Source: AASHTO Bicycle Guidelines.

BICYCLE FACILITIES - A general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling, including parking facilities, mapping all bikeways, and shared roadways not specifically designated for bicycle use. Source: AASHTO Bicycle Guidelines.

BICYCLE LANE - A portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists. Source: AASHTO Bicycle Guidelines.

BICYCLE PATH - A bikeway physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right of way or within an independent right of way.

BICYCLE ROUTE - A segment of a system of bikeways designated by the jurisdiction having authority with appropriate directional and informational markers, with or without specific bicycle route number. Source: AASHTO Bicycle Guidelines.

BIKEWAY - Any road, path, or way which in some manner is specifically designated for the exclusive use of bicycles or are to be shared with other transportation modes. Source: AASHTO Bicycle Guidelines.

HIGHWAY - A general term denoting a public way for purposes of travel, including the area within the right of way. Used primarily in reference to public ways in rural settings.

ROADWAY - The portion of the highway or street, including shoulders, typically used for vehicle use. Source: AASHTO Bicycle Guidelines.

SHARED ROADWAY - Any roadway upon which a bicycle lane is not designated and which may be legally used by bicycles regardless of whether such facility is specifically designated as a bikeway. Source: AASHTO Bicycle Guidelines.

SIDEWALK - The portion of a highway or street designed for preferential or exclusive use by pedestrians. Source: AASHTO Bicycle Guidelines.

STREET - A general term denoting a public way for purposes of travel in an urban setting.

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