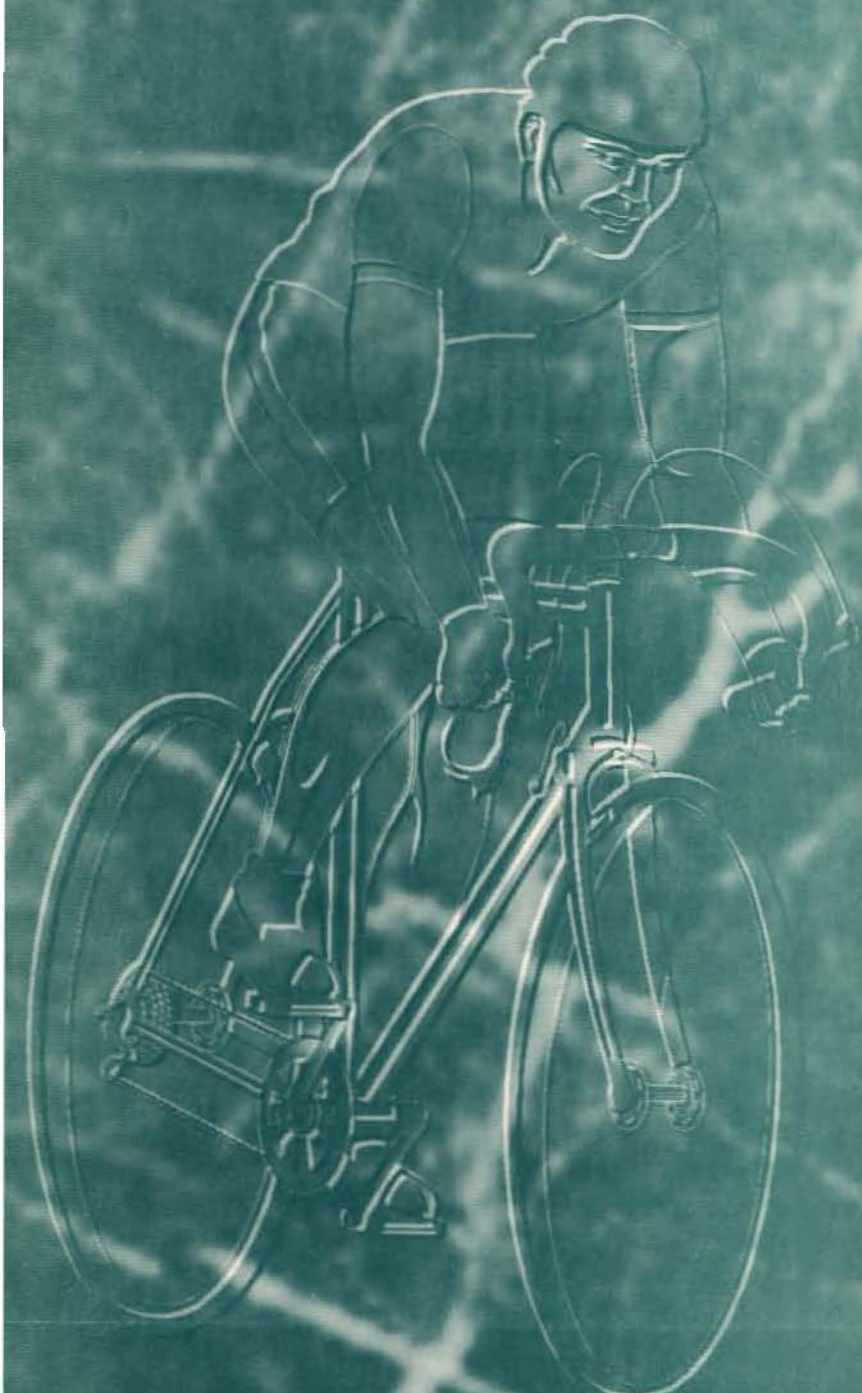
Bicycle Facilities Network Identification Handbook



Iowa Department of Transportation

Bicycle Facilities
Network Identification Handbook

January 1995

Prepared by
The Iowa Department of Transportation
in cooperation with the U.S. Department of Transportation
Federal Highway Administration

PREFACE

The enclosed bicycle facilities network identification process should identify whether a bicycle facility is needed; and if a certain classification is the answer, it will suggest what to consider when locating such a facility. Planned and constructed off-the-road bicycle facilities are not always the solution to bicyclists' needs or desires. Sometimes an off-the-road bicycle facility could have an adverse impact on bicycle usage; it may be possible to resolve the problem through a roadway improvement or law enforcement.

Existing streets and highways are the most economical and efficient way to accommodate bicycle traffic. However, these roadways are not always convenient and safe for bicyclists. There is a wide range of roadway improvements which can enhance and encourage bicyclists' safety. Improvements can be simple and involve minimal design considerations (e.g., changing drainage grate inlets), or they can involve a detailed design (e.g., providing a bicycle path). Due to a broad range of roadway conditions within a planning area, bicycle and pedestrian facilities should be planned and accommodated on the best corridors that will provide the most direct access to traffic generators.

FOREWORD

The Bicycle Facilities Network Identification Handbook was developed to assist metropolitan planning organizations and regional planning affiliations identify a bicycle and pedestrian facilities network for their respective planning areas. The handbook was designed to be used by planners and decision-makers with varying amounts of experience in planning for bicycle facilities.

We hope you utilize this handbook to designate a network that will foster, enhance and provide safer bicycle and pedestrian travel for all users. We also welcome your comments regarding this handbook and its information, as well as any other comments you might have concerning bicycle and pedestrian facilities in Iowa. Please send all comments to:

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CHAPTER ONE
INTRODUCTION

The purpose of this Bicycle Facilities Network Identification Handbook is to provide a general set of guidelines that can be used by the metropolitan planning organizations (MPOs) and the regional planning affiliations (RPAs) to identify a recommended bicycle facilities network. This handbook is organized to assist planners, technicians and decision-makers, who may have varying amounts of exposure to bicycle and pedestrian facilities planning, with the network identification process.

This handbook has been divided into the following chapters: Chapter Two offers a brief description of bicycle users; Chapter Three presents the bicycle facilities classifications utilized throughout the handbook; Chapter Four discusses general locational criteria for bicycle facilities; Chapter Five presents general design considerations for each bicycle facility; and Chapter Six outlines the bicycle facilities network identification process.

Bicycle and Pedestrian Facilities System Plan

The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) requires the development of an intermodal long-range transportation plan at the state level. The framework and policies of this plan will help redefine the activities of the individual modes, the relationships between modes, and reflect a more broadly conceived vision for transportation in Iowa. The developmental focus of this plan will be on integrating and coordinating all of the past and current efforts, as well as incorporating the new requirements identified in the ISTEA.

The ISTEA also requires that states develop a long-range plan for bicycle transportation facilities and pedestrian walkways and its incorporation into the statewide intermodal long-range transportation plan. Another new requirement is the consideration of "strategies for incorporating bicycle transportation facilities and pedestrian walkways in projects where appropriate throughout the state." This is very important since these facilities often can be incorporated into major road projects through the construction of shared roadways for bicycles and sidewalks for pedestrians.

Bicycle facilities system planning is a relatively new area of transportation planning in Iowa. The Iowa Department of Transportation has commenced bicycle facilities system planning efforts at the state level in response to increasing bicycle and pedestrian facilities usage, and the enactment of the ISTEA.

The challenge that Iowa is currently facing is the integration of these existing fragmented bicycle and pedestrian facilities into a continuous statewide network. Over the past 10 years cities and counties within the state of Iowa have concentrated their efforts in developing recreational trails within their jurisdictions. However, most of the existing bicycle and pedestrian facilities in Iowa do not serve explicit transportation purposes because they do not link major traffic generators to each other, and they are primarily designed to serve recreational trips. A connected system of bicycle facilities is needed to guide bicyclists along reasonably direct routes that satisfy other travel desires and provide an alternative means of travel. These routes also need to connect and integrate with other modes of transportation.

The Bicycle and Pedestrian Facilities System Plan will outline the process of inventorying existing bicycle and pedestrian facilities throughout the state; identify issues, opportunities and constraints affecting and influencing these existing facilities; assist in developing a statewide network; and will lead to policies and criteria for developing and implementing bicycle and pedestrian facilities throughout Iowa.

Bicycle and Pedestrian Facilities System Planning Process

In order to develop the Bicycle and Pedestrian Facilities System Plan, the planning process has been divided into three phases. The objective of Phase I was the development of this Bicycle Facilities Network Identification Handbook. Included in this phase identified a set of goals and objectives for the bicycle and pedestrian facilities system plan.

In Phase II, the MPOs and RPAs will be asked to utilize this Bicycle Network Identification Handbook to develop their recommended networks. The MPOs and RPAs should develop a comprehensive bicycle network that should include all existing and proposed bicycle facilities and roadways improvements in their planning areas. It is recommended that planners involve bicycle organizations, clubs and advocates in the early stages of the planning process.

During Phase III the MPOs' and RPAs' recommended networks will be analyzed, and a statewide network will be developed. As part of this effort alternative scenarios will be developed. An implementation plan will be developed for each alternative to determine the feasibility of the network under each alternative, as well as to determine the phasing and prioritization of projects. Simultaneously, MPOs and RPAs will be developing their own implementation plans. During the development of their implementation plans, MPOs and RPAs will analyze bicycle facilities included in the recommended networks and determine their cost effectiveness. Through this implementation plan process, potential use of the facilities will be forecasted. Also, the need for bicycle and pedestrian support facilities (e.g., bicycle parking, bicycle racks on buses) will be determined. Finally, the entire planning process will be documented in the Bicycle and Pedestrian Facilities System Plan, which will become the bicycle and pedestrian element of the statewide intermodal long-range transportation plan.

PHASE I

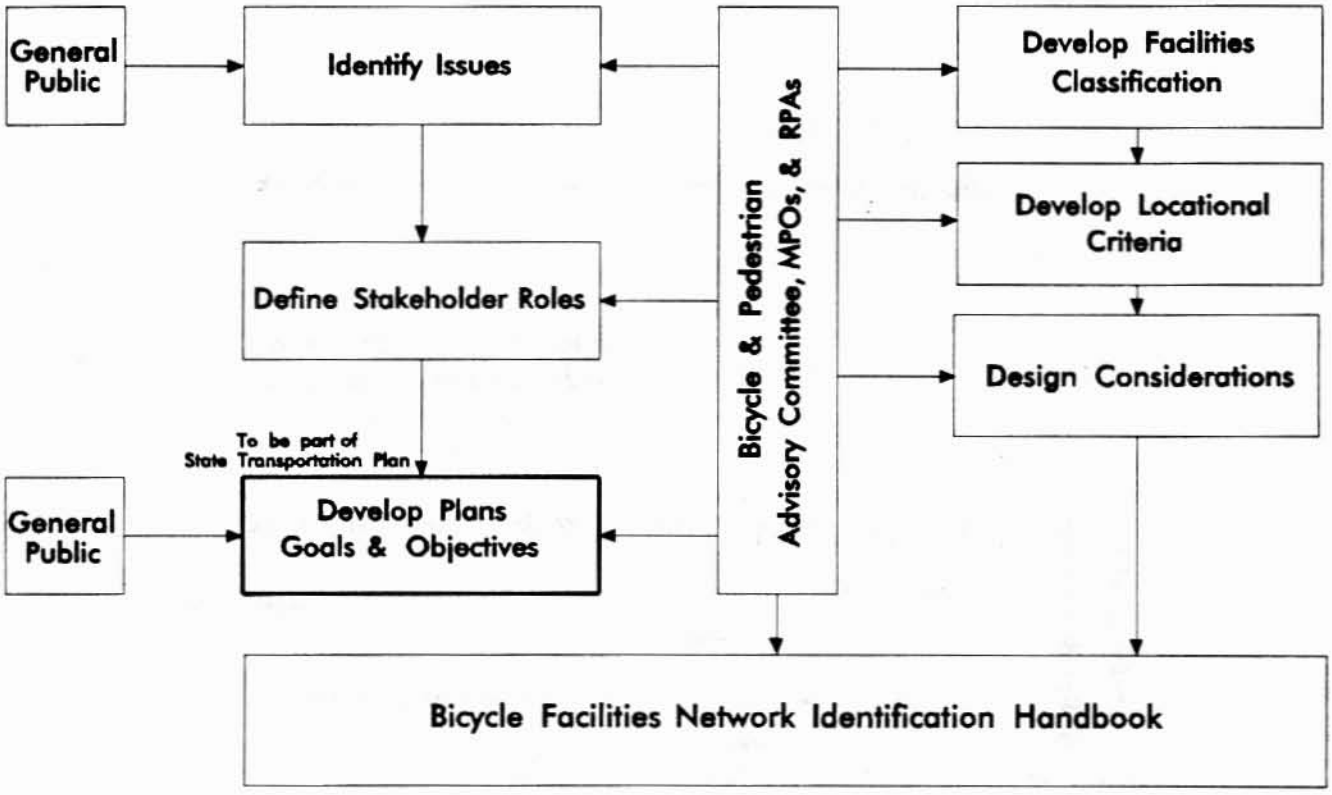


Figure 1.1 Bicycle and Pedestrian Facilities Planning Process

PHASE II

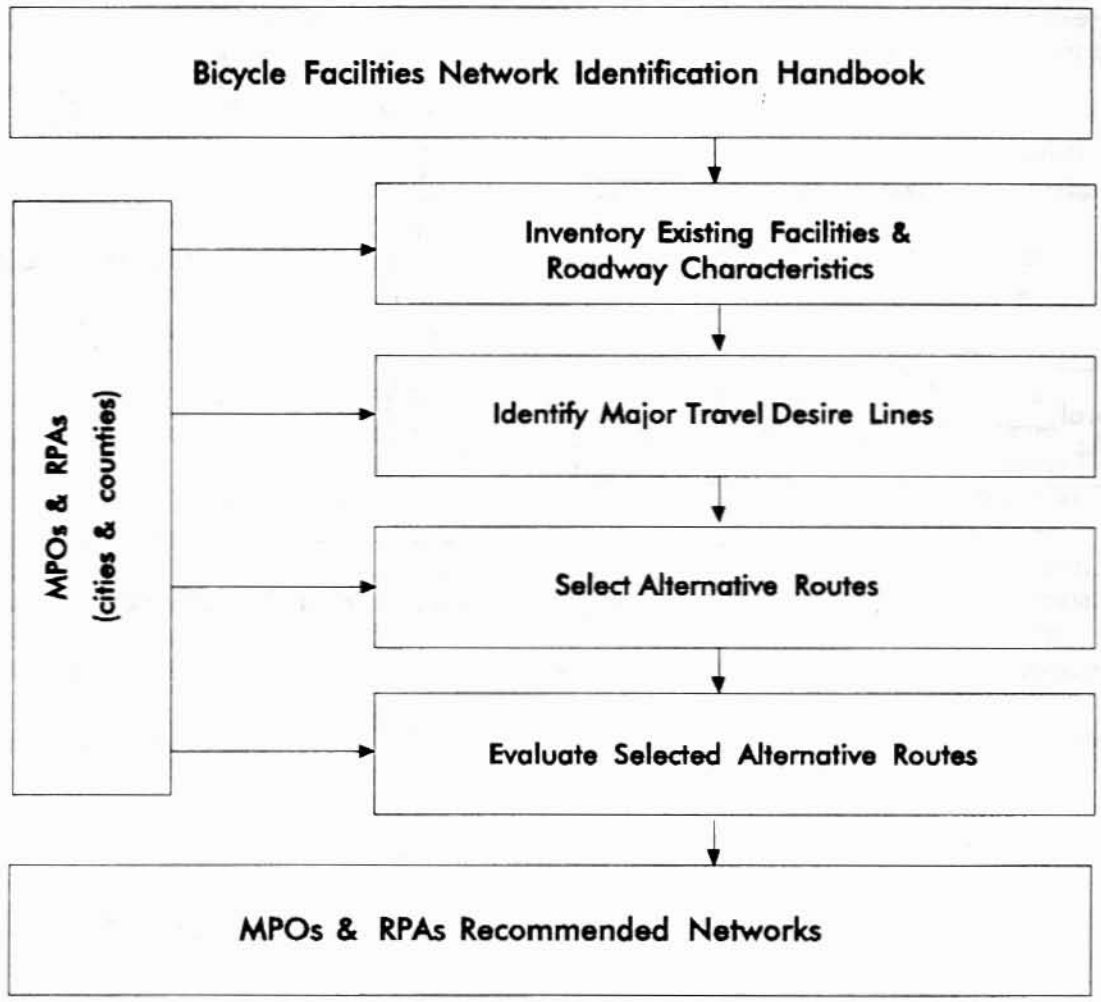


Figure 1.2 Bicycle & Pedestrian Planning Process

PHASE III

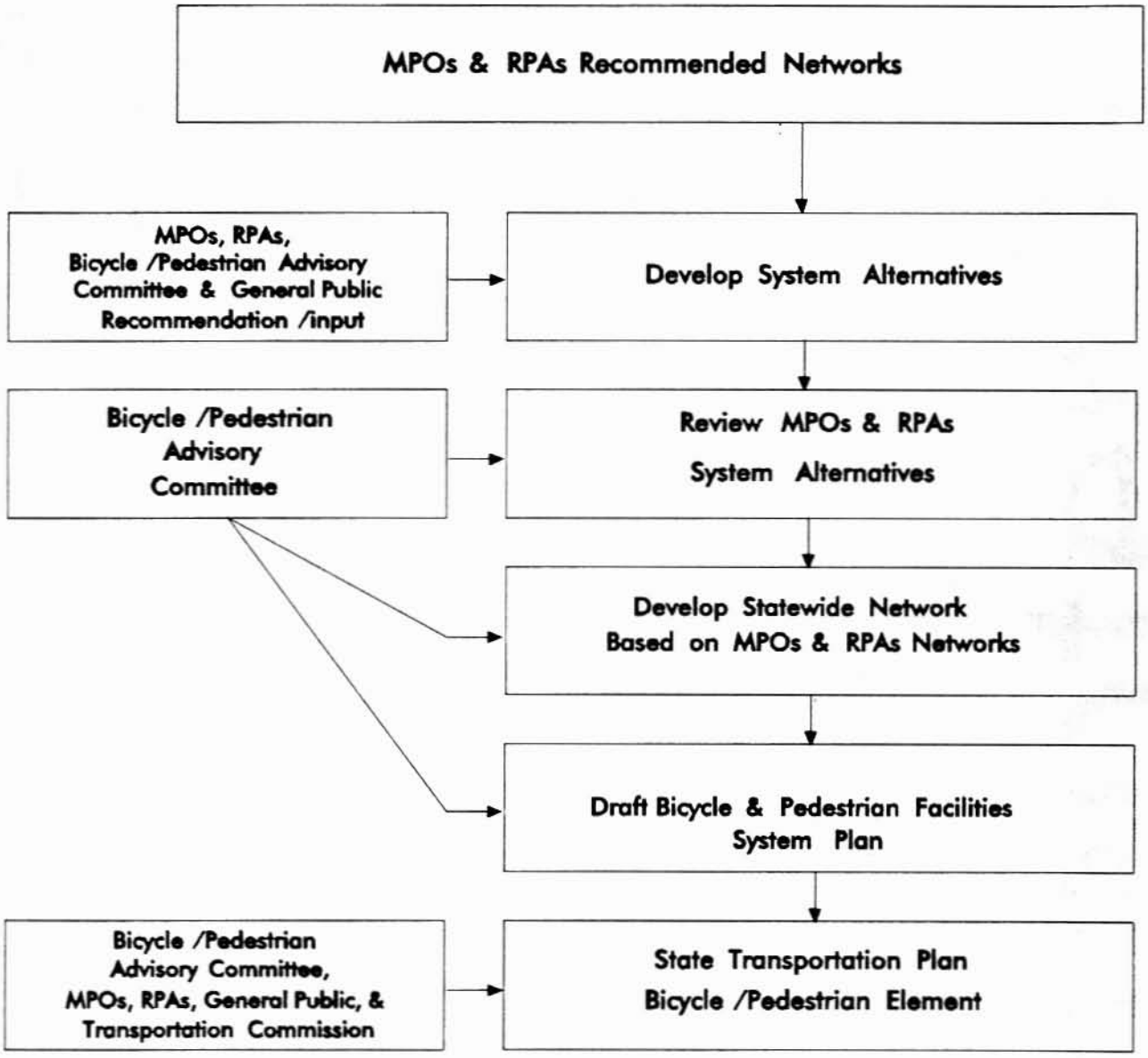
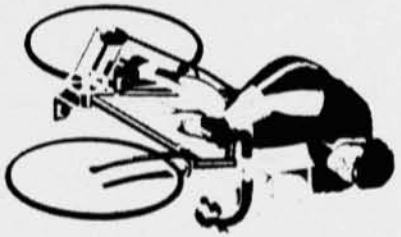


Figure 1.3 Bicycle & Pedestrian Planning Process



Chapter Two

CHAPTER TWO
BICYCLE USERS

Bicycle riders have been divided into two classes on the basis of travel purpose: transportation or recreation. Transportation includes going to work, shopping, school and other destinations. For the bicyclist using the bicycle as transportation, the objective is not the trip, but reaching the destination such as a commercial area, school or workplace. The bicycle is primarily a means of transportation for the trip, although secondary objectives such as exercise and pleasure influence the choice of vehicle. The transportation oriented bicyclists, while appreciating scenic bicycle facilities where they coincide with specific travel desires, places highest priority on the directness of the route, acceptable grade profiles, and minimum delay or inconvenience. On the other hand, for recreational bicyclists (i.e. tourists, off-the-road, physical fitness enthusiasts and racers), the trip itself is the objective. Scenic bicycle facilities which meander and have features such as points of interest and challenges are very desirable for this type of bicyclist.

There is a wide range of abilities and skills among bicyclists. No other vehicle is operated by such a disparate group of users. For the purpose of this handbook, the planner is asked to consider the range of bicyclists by examining the nature of three general bicycle groups. These three general groups of bicyclists represent the majority of all bicyclists, based on their bicycling skills and riding habits. The following classification of bicycle users has been adopted for this handbook[1].

2.1 Advanced Bicyclists

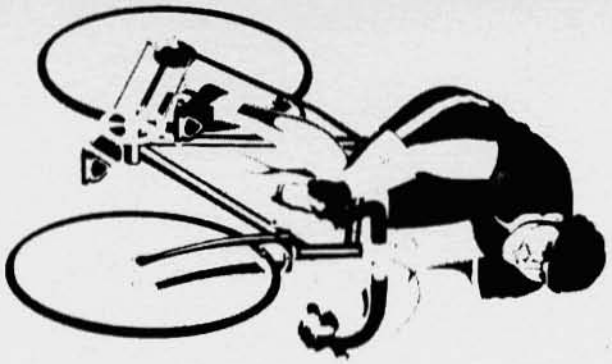
These are experience riders who can operate under most traffic conditions. They comprise the majority of the current users of collector and arterial streets and are best served by the following: (a) direct access to destinations, usually via the existing street and highway system; (b) the opportunity to operate at maximum speed with minimum delays; and (c) sufficient operating space on the roadway or shoulder to reduce the need for either the bicyclists or the motor vehicle operator to change position when passing.

2.2 Basic Bicyclists

These are casual or new adult and teenage riders who are less confident of their ability to operate in traffic without special provisions for bicycles. Some will develop greater skills and progress to the advanced level, but there will always be many basic bicyclists. They prefer: (a) comfortable access to destinations, preferably by a direct route using either low-speed, low traffic-volume streets or designated bicycle facilities; (b) well-defined separation of bicycles and motor

		vehicles on arterial and collector streets (urban or rural bicycle lanes) or separate rural bicycle paths.
2.3	Children Bicyclists	These are pre-teen riders whose roadway use is initially monitored by parents. They and their parents prefer the following: (a) access to key destinations surrounding residential areas, including schools, recreation facilities, shopping, etc.; (b) residential streets with low motor vehicle speed limits and volumes; (c) well-defined separation of bicycles and motor vehicles on arterial and collector streets or separate bicycle facilities.

[1] Selecting Roadway Design Treatments to Accommodate Bicycles. U.S. Department of Transportation, Federal Highway Administration. Publication No. FHWA-RD-92-073. January 1994.



Chapter Three

CHAPTER THREE
BICYCLE FACILITIES CLASSIFICATIONS

The following presents a brief description of the major types of bicycle facilities and the characteristics attributable to each:

3.1 Shared Roadways

Shared roadways are highway sections with a right lane of at least 12 feet (3.7 m). Wide curb lanes, that is a right lane wider than 12 feet (3.7 m), are also considered shared roadways. This type of facility can accommodate shared bicycle/motor vehicle use without reducing the motor vehicle capacity of the roadway. Because of the low volume of motor vehicle traffic, most of the county highways and neighborhood streets are currently suitable for bicycling with no additional improvements necessary. In order to be most effective, these types of facilities should be signed to instruct the motor vehicle driver and the bicyclist to share the road.

In rural settings, shared roadways are generally preferred by advanced bicyclists because they are better maintained than rural bicycle lanes.

Figure 3.1 Shared Roadway Facility in Milford, Iowa

3.2 Bicycle Lanes

Urban bicycle lanes are included as a portion of a roadway which has been designated by striping, signing and pavement markings for the exclusive use of bicyclists. Urban bicycle lane delineation is intended to promote the orderly flow of traffic by denoting specific areas reserved for bicycles and motor vehicles. This effect is supported by signs and pavement markings. Urban bicycle lanes should always be one-way facilities and carry traffic in the same direction as adjacent motor vehicle traffic. They work best on roadways without on-street parking.

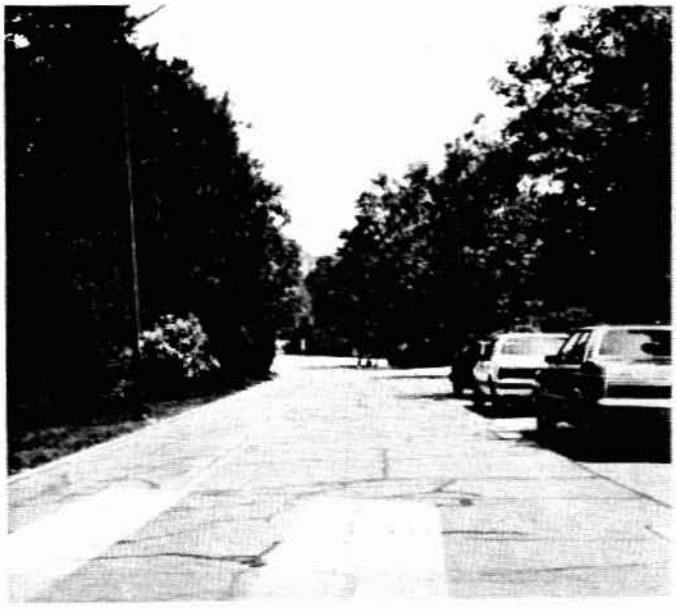


Figure 3.2 Urban Bicycle Lane Facility in Ames, Iowa

Rural bicycle lane facilities are paved shoulders placed on the portion of the roadway outside the edges of the motor vehicle travel way (or back of curb) and extending to the top of foreslopes. Rural bicycle lanes can be designated as bicycle facilities where the outside travel lane is narrow, where sight distance is restricted, and on highways with long, steep grades.

In rural settings, rural bicycle lanes will not be readily used by all bicyclists because of the accumulation of gravel and road debris. Advanced bicyclists may continue to use motor vehicle lanes where rural bicycle lanes are rough or not clean.

Figure 3.3 Rural Bicycle Lane Facility in Huxley, Iowa

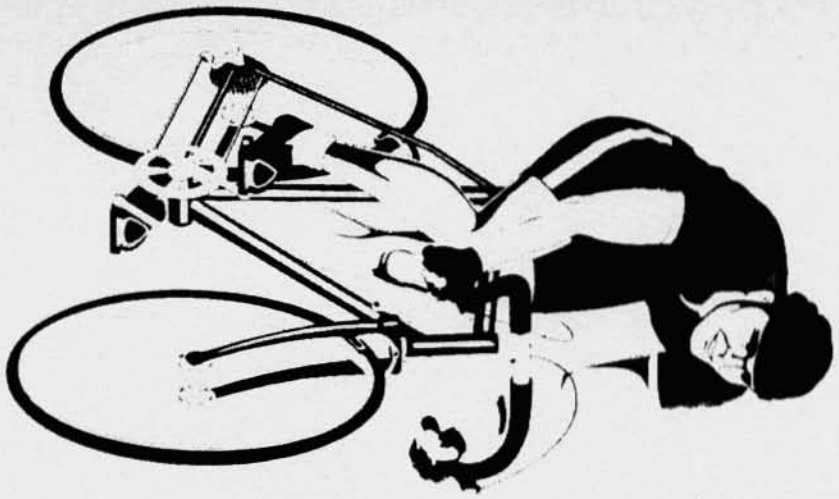
3.3 Bicycle Paths

Urban bicycle paths are adjacent to, and normally within, the roadway right of way but separate from motor vehicle traffic. Bicyclists are provided a separate path, with the exceptions of motor vehicles turning into or out of driveways, and it regularly crosses intersecting streets.

Figure 3.4 Urban Bicycle Path Facility in Des Moines, Iowa

Rural bicycle path facilities are designed for the shared use of bicycles and pedestrians and are completely separate from motor vehicle traffic. This type of bicycle facility can also occur in urban settings, where the right of way is available and the circumstances justify it. Street crossings are kept to a minimum or are avoided through the use of over- or underpasses. Rural bicycle path facilities will occur most often in open spaces, parks, abandoned railroad rights of ways, river and canal banks, and newly planned developments. Rural bicycle paths should be used to access corridors not served by streets and highways, or where right of way exists, permitting such facilities to be constructed away from the influence of parallel streets.

Figure 3.5 Rural Bicycle Path Facility in Waterloo, Iowa



Chapter Four

CHAPTER FOUR
BICYCLE FACILITIES LOCATIONAL CRITERIA

Over the years Iowa has built a network of streets and highways to carry motor vehicles throughout the state. Existing streets and highways are also the most economical and efficient way to accommodate bicycle traffic. However, these roadways are not always convenient and safe for bicyclists.

According to the Motor Vehicle Code of Iowa, a person operating a bicycle on the roadway is granted all rights and is subject to all requirements applicable to the driver of a motorized vehicle in that they are required to obey the rules of the road. Therefore, all roads and streets are available for bicycle usage unless specifically prohibited (i.e., Interstate).

The following locational criteria can be utilized to identify a subset of these streets and highways, plus off-the-road facilities, that will be given special status when considering bicycle and pedestrian needs. That is, these criteria can be used to designate a network which will foster, enhance and provide safe bicycle and pedestrian travel.

The factors to be considered in choosing the properly designated route for bicycle facilities vary, depending on the situation. These locational criteria are not absolutes; they vary in type and importance for each facility. Typically, the following criteria should be used to first identify a general bicycle corridor, then to locate the facility alignment within that corridor, and finally to choose the desired facility type. The following locational criteria should aid in determining the most applicable bicycle facility for the appropriate location.

4.1 Potential Use

The facility should be located along a route where bicycle and pedestrian usage can be maximized. Key trip origins and destinations from traffic generators are located where a significant number of bicycle and pedestrian trips start, or may potentially start (origin) and locations which may draw a significant number of bicyclists and pedestrians (destinations). The following factors should be examined to identify origins and destinations of trips.

- Areawide household distribution (single-family subdivisions and multi-family housing complexes).
- Location of major employment centers.
- Location of major commercial areas and shopping centers.
- Location of educational institutions.

- Location of intermodal transfer facilities (e.g., end points of transit system and major transfer points).
- Location of parks and recreational areas.
- Location of public facilities (e.g. libraries, museums, municipal buildings, airports, churches, and cementaries, among others).
- Potential shared usage of the facilities by rollerbladers, strollers, disabled, and joggers, among others.
- Access in and out of the communities to rural areas.
- Location of existing bicycle and pedestrian facilities end points.

4.2 Available Space

Minimum bicycle and pedestrian facilities width requirements, as well as horizontal and vertical clearance requirements, must be analyzed in selecting potential routes. Spatial needs vary in relation to the type of facility being developed and proximity of the route to motor vehicle traffic lanes.

4.3 Accessibility

Accessibility is measured by the distance a facility is from a specified trip origin or destination, and the extent to which all likely origins and destinations are served. Residential areas, parks and recreational areas should have access to bicycle and pedestrian facilities within 1/2 mile (0.81 km); where educational institutions, commercial areas, shopping centers, and employment concentrations should have bicycle and pedestrian facilities access originate or end at their property. The more frequent and convenient the access point, the more the facility will be used.

Figure 4.1 Accessibility to an urban bicycle path in Waterloo, Iowa

4.4 Directness

Delay and inconvenience can have a substantial impact on the facility utilization. Ideally, bicycle and pedestrian facilities should not increase the travel distance or trip time for the user. The facility should be designed to provide the most direct route possible from traffic generators within the community to residential neighborhoods.

4.5 Continuity

Whether a bicycle or pedestrian facility is part of an area-wide network or a set of single noncontinuous routes, the route should have as few missing links as possible. If gaps exist, they should avoid conflicting traffic environments such as high-volume or high-speed motor vehicle traffic routes with narrow outside lanes (for bicyclists) or no sidewalks (for pedestrians).

Figure 4.2 Example of bicycle facility continuity in Davenport, Iowa

4.6 Use Conflict

Different types of facilities introduce different types of conflicts. Shared roadway facilities can involve conflicts between bicyclists and motor vehicles. Urban and rural bicycle lanes, and urban and rural bicycle path facilities usually involve conflicts with other bicycles (e.g.,slower, older or younger users), with pedestrians on the facility, and with motor vehicles at street intersections, curb cuts and driveways. Conflict points exist whenever bicycles/ pedestrians cross motor vehicle traffic streams without the benefit of traffic signal control or motor vehicle/bicycle separation. The total number of such conflict points can be a useful measure in the evaluation of bicycle/pedestrian alternatives and the location of facilities through intersections.

In accordance with this criterion, the following is recommended:

- The location of two-way urban bicycle lane facilities immediately adjacent to a roadway should be discouraged.

- A strategy should be developed to reduce conflict between bicyclists and pedestrians within the same facility.

4.7 Intersections and Crossings

Each intersection should be examined as a specific case. The solution that provides the safest, most efficient movement of bicyclists, motorists and pedestrians should be selected.

Intersections are by nature places of more intense activity and conflict than other points on a street network. At intersections, potential conflicts increase since there is competition for the use of intersection space by the pedestrian, bicyclist, and motorist. Grade separated intersections can be justified where there is adequate bicycle, pedestrian and motor vehicle traffic.

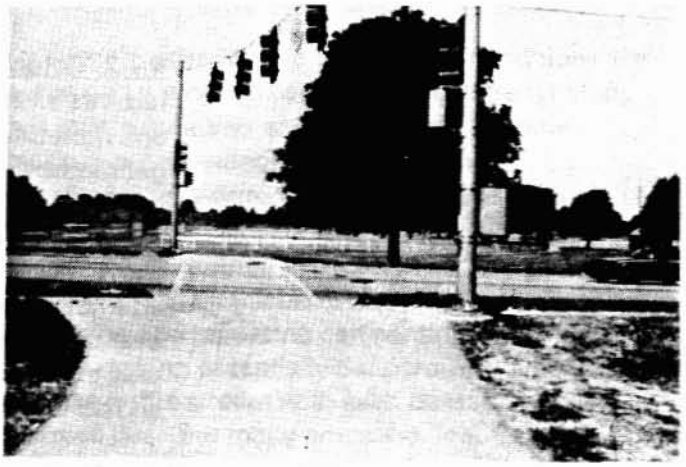


Figure 4.3 Example of an adequate intersection in Davenport, Iowa

Many suburban intersections are difficult or inconvenient to cross because of their configuration, signal phasing and timing problems. The difficulty of crossing wide, heavily traffic arterial and collector streets is perhaps the most common problem perceived for bicycle and pedestrian travel in suburban areas. Traffic signals are less frequent in suburban intersections than in downtown intersections, requiring bicycles and pedestrians to cross the street using their own judgement of adequate gaps in traffic. Additional signals are only rarely warranted because of the low pedestrian volumes in most places. Undivided highways, including those with two-way left-turn lanes pose particularly difficult crossing conflicts.

4.7.1 Motor Vehicle-Bicycle Left-Turn Conflicts: Left-turning vehicle conflicts often occur because a bicycle has low visibility and is often not observed after the motor vehicle starts making the left turning movement. This is particularly true at high-volume intersections where bicycle visibility is further shielded by qued motor vehicles. Left-turn conflicts are measured by the turning traffic volume, opposing through traffic volume, and the type of intersection control. Intersections with separate left-turn phase signalization present less hazard and should be highly rated. Signalized intersections without separate phasing should be rated on the basis of turning volume and opposing traffic volume, as should major unsignalized intersections and driveways on major arterials. Other locations present minimal left-turn conflicts.

4.7.2 Motor Vehicle-Bicycle Right-Turn Conflicts: The

4.7.2 Motor Vehicle-Bicycle Right-Turn Conflicts: The hazards inherent in the conflicts between bicyclists and right-turning traffic are primarily caused by the geometric design of the intersection or driveway involved. An unchannelized intersection presents relatively minor problems for bicyclists; a double-right turn lane presents more hazards. In rating alternatives for this condition, it is not necessary to evaluate all right turning possibilities along a route; only major volume locations and problem areas should be investigated.

4.7.3 Crossing Conflicts: Signalized intersections are the most positive means of dealing with crossing intersections and should therefore be highly rated for safety.

Any location which controls crossing motor vehicles by STOP signs is also relatively safe. However, locations where STOP or YIELD signs control the bicycle or pedestrian facility are more hazardous, since this situation implies a higher level of motor vehicle cross traffic. The hazard at these locations is caused both by the volume and the width of the cross street. They can best be evaluated by an on-site engineering traffic analysis of the gaps in crossing traffic at travel times when bicycling is expected.

4.8 On-Street Parking

The presence of on-street motor vehicle parking increases the width needed in the adjacent travel lane to accommodate bicycles. The density of on-street parking can affect the safety of bicyclists from opening motor vehicle doors and motor vehicles entering or leaving parking spaces. If possible, routes should be selected where on-street parking usage is light or where on-street parking can be prohibited.

4.9 Truck and Bus Traffic

The aerodynamic effect, height, length and width of high speed trucks, buses and trailers can cause safety problems for shared roadways, urban bicycle lanes, rural bicycle lanes and urban bicycle paths.

Therefore, total truck and bus volume characteristics of the traffic should be considered.

Buses in transit operations tend to alternate between periods of movement at higher speeds (than bicycles)

As a result, either of two undesirable conditions are apt to occur where bicycles travel on streets along bus routes (whether or not urban bicycle lane facilities are provided). One condition is "leapfrogging" where the bicycle moves to the left (out of the urban bicycle lane facility, if one is present) to pass a bus stopped at a load point only to be in turn overtaken by the bus at midblock. The sequence of passing and repassing can continue with the bicycle making potentially dangerous movements into the traffic stream with each passage of the stopped bus. But many times the "leapfrogging" condition degenerates to a "catchup-pullout" sequence. In this condition the bicycle catches up with the bus just as boarding or discharge of passengers is completed, repeating the situation block after block. More serious from a safety standpoint is the case in which the bicycle initiates a passing maneuver as the bus pulls out.

Because of this problem, it is inadvisable to locate urban bicycle lane facilities on roadways with low headway bus operations if suitable alternatives are available. On streets with moderate to long headway bus services (perhaps 20 minutes or more), this problem is lesser a concern and can be regarded as a low priority consideration.

4.10 Motor Vehicle Traffic Volume and Speed

Traffic volumes and speeds must be considered, along with the roadway width, frequency of intersection, number of driveways, and signals.

The following thresholds specify suggested treatments for urban and rural locations by bicycle facility classification and by type of bicyclists for various speed and traffic volumes.

Motor Vehicle	Under 3,500 AADT	Over 3,500 AADT

(motor vehicle)	(motor vehicle)	(motor vehicle)
20 to 25 mph (32 to 40 km/h)	Shared roadway	Shared roadway
30 to 45 mph (48 to 72 km/h)	Shared roadway	Shared roadway
50 to 55 mph (81 to 86 km/h)	Urban bicycle lane	Urban bicycle path

Table 4.1 Urban Bicycle Facilities Treatments for Advanced Bicyclists by Traffic Volume and Speed

Motor Vehicle Posted Speed	Under 3,500 AADT (motor vehicle)	Over 3,500 AADT (motor vehicle)
20 to 25 mph (32 to 40 km/h)	Shared roadway	Urban bicycle lane
30 to 45 mph (48 to 72 km/h)	Urban bicycle lane	Urban bicycle lane
50 to 55 mph (81 to 86 km/h)	Urban bicycle lane	Urban bicycle path

Table 4.2 Urban Bicycle Facilities Treatments for Basic Bicyclists and Children by Traffic Volume and Speed

Motor Vehicle Posted Speed	Under 1,500 AADT (motor vehicle)	Over 1,500 AADT (motor vehicle)
20 to 25 mph (32 to 40 km/h)	Shared roadway	Shared roadway
30 to 45 mph (48 to 72 km/h)	Shared roadway	Shared roadway
50 to 55 mph (81 to 86 km/h)	Rural bicycle lane	Rural bicycle lane

Table 4.3 Rural Bicycle Facilities Treatments for Advanced Bicyclists by Traffic Volume and Speed

Motor Vehicle Posted Speed	Under 1,500 AADT (motor vehicle)	Over 1,500 AADT (motor vehicle)
20 to 25 mph (32 to 40 km/h)	Shared roadway	Rural bicycle lane
30 to 45 mph (48 to 72 km/h)	Rural bicycle lane	Rural bicycle lane
50 to 55 mph (81 to 86 km/h)	Rural bicycle lane	Rural bicycle path

Table 4.4 Rural Bicycle Facilities Treatments for Basic Bicyclists and Children by Traffic Volume and Speed

4.11 Barriers

A barrier blocks access to bicycle and pedestrian facilities. Examples include freeways, rivers, canals, railroads, parking lots, intersections, dead-end streets and bridges. A barrier may be continuous or it may be broken in a few places; for instance, overpasses across a freeway.

Certain natural and human-made features of the landscape form barriers that prohibit bicycle or pedestrian passage or make such passage unsafe and/or inconvenient. The absence of safe and convenient means for bicyclists to overcome these barriers will curtail bicycle travel and can encourage unsafe bicyclists' behavior.

During the network identification process, existing and potential barriers should be identified. In developed areas, barrier crossings should be provided no further that one mile apart. Proper planning can prevent development which creates barriers to future bicycle and pedestrian uses.

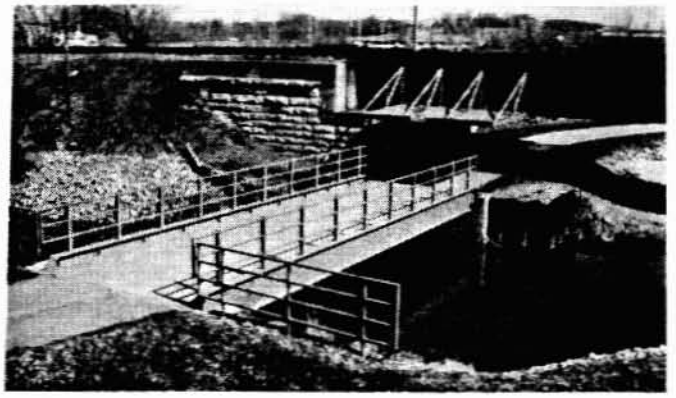
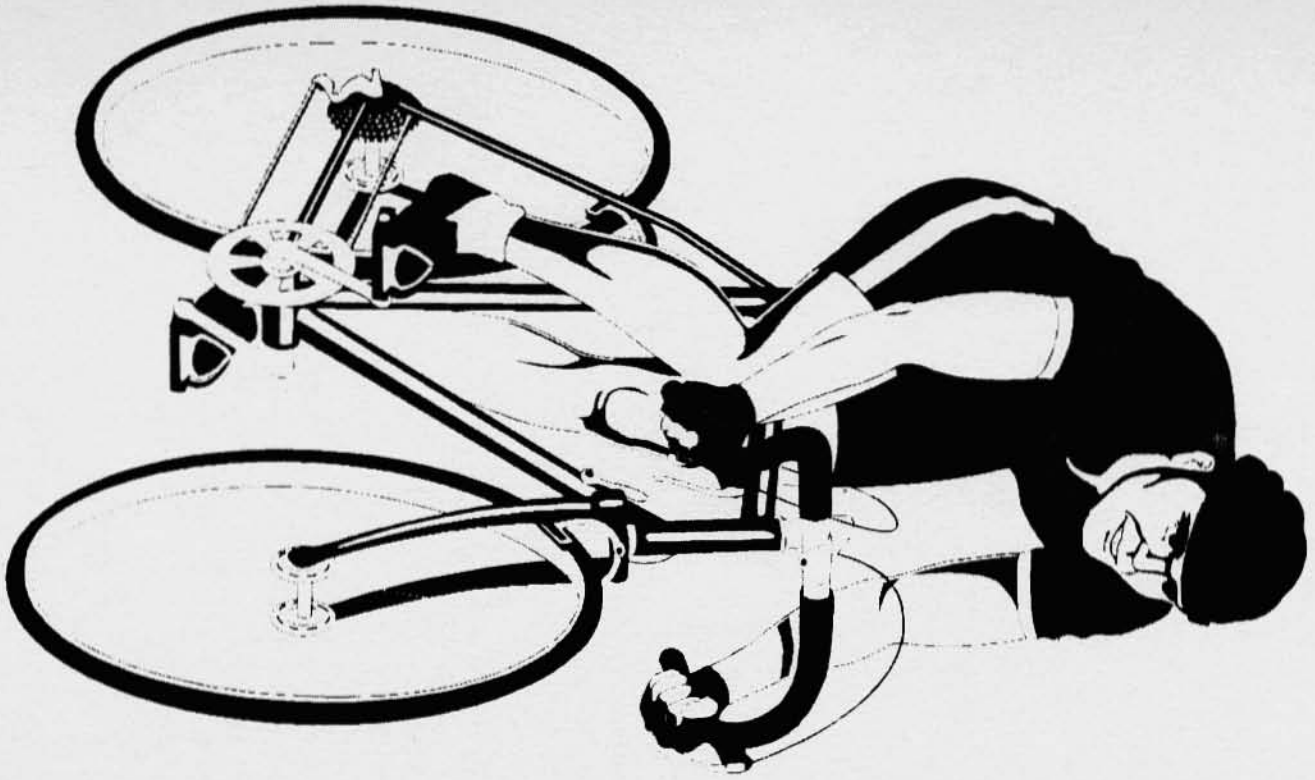


Figure 4.4 Example of a barrier crossing in Davenport, Iowa

4.12 Sight Distance

Adequate sight distances at intersections should be maintained by proper setback requirements. Motor vehicles must be given sufficient time to effectively respond to the presence of bicyclists and pedestrians approaching the intersection. At crossing locations not protected by signal control, pedestrians and bicyclists must be given adequate opportunity to perceive gaps in the motor vehicle traffic stream for safe passage. This mutual awareness is necessary to the safe operation of an intersection. Careful attention must be given to the restriction on sight distances caused by horizontal and vertical curvature and structural elements of the interchanges (e.g., bridge components, guardrail and landscaping).



Chapter Five

CHAPTER FIVE
BICYCLE FACILITIES DESIGN CONSIDERATIONS[1]

The purpose of this chapter is to assist MPOs and RPAs with the necessary design considerations that might affect the location of bicycle facilities. One of the most influential determinations of bicycle facility locations is feasibility of desirable design; consequently, the locational process presented in the previous chapter is interdependent with the design process. The ultimate design characteristics of bicycle facilities are generally determined by location recommendations. The Bicycle Facilities Network Identification Handbook utilizes a different bicycle facilities terminology; please refer to Figure 5.1 for a summary of the differences between the Handbook bicycle facilities terminology and the terminology utilized by AASHTO.

There is a wide range of roadway improvements which can enhance and encourage bicyclists' safety. *Improvements can be simple and involve minimal design consideration (e.g., changing drainage grate inlets) or they can involve a detailed design (e.g., providing a rural bicycle path). The controlling feature of the design of every bicycle facility is its location (i.e., whether it is on the roadway or on an independent alignment). Roadway improvements, such as* urban *bicycle lanes depend on the roadway's design. On the other hand,* rural *bicycle paths are located on independent alignments; consequently, their design depends on many factors, including the performance capabilities of the bicyclists and the bicycle.*

Design consideration are presented in this chapter to assist in the identification of roadway improvements and off-the-road bicycle facilities. *Modifications to facilities (e.g., widths, curve radii, super-elevations to facilities, etc.) that are necessary to accommodate adult tricycles, bicycle trailers and other special purpose human powered vehicles and accessories should be made in accordance with expected use, using sound engineering judgement.*

5.1 Roadway Improvements

To varying extents, bicycles will be ridden on all highways where they are permitted. 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. Bicycle-safe design practices should be followed to avoid the necessity for costly subsequent improvements. Because most highways have not been designed with bicycle travel in mind, there are often many ways in which roadways should be improved to more safely accommodate bicycle traffic. Roadway conditions should be examined and, where necessary, safe drainage grates and railroad crossings, smooth pavements, and signals responsive to bicycles should be provided. In addition, the desirability of adding facilities such as

Bicycle Facilities Classifications

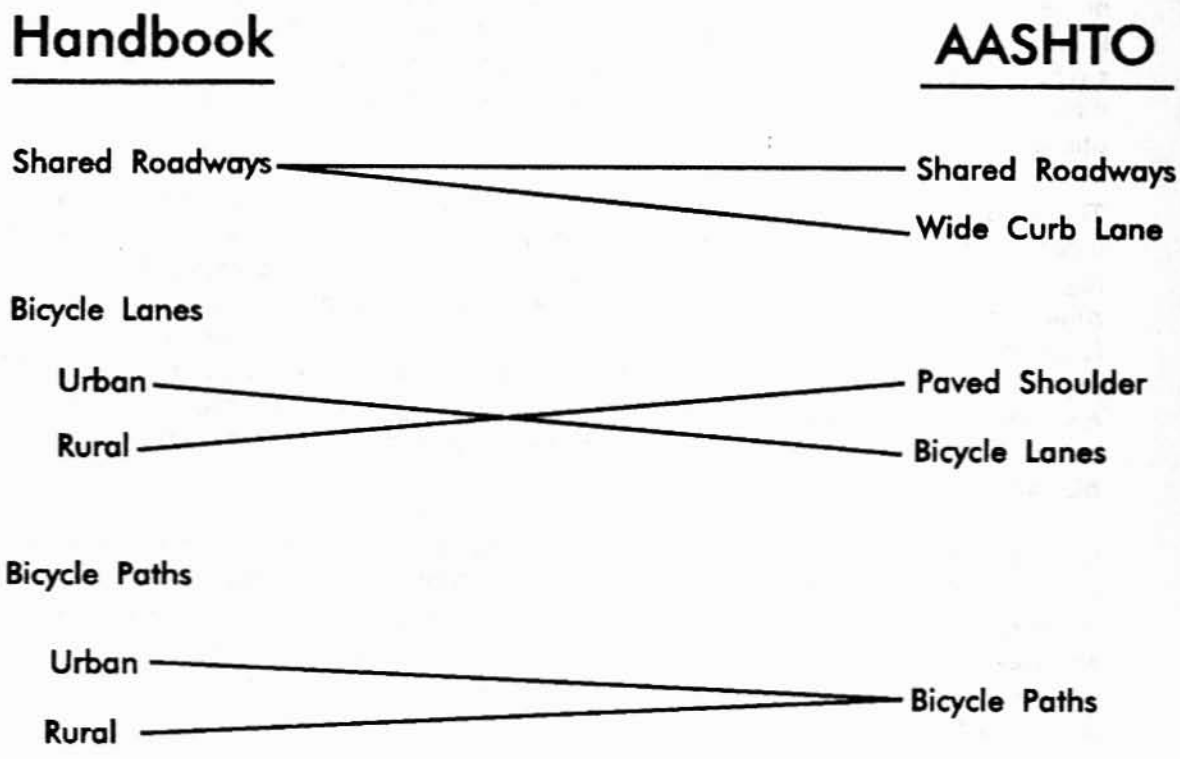


Figure 5.1 Bicycle Facilities Classifications

urban *bicycle lanes and* rural *bicycle lanes should be considered. Information on each of the different roadway improvements is contained in this section.*

5.1.1 Drainage Grates: *Street storm water drainage grate inlets and utility covers are potential problems to bicyclists.*

Parallel bar drainage grate inlets can trap the front wheel of a bicycle causing loss of steering control and, often, the bar spacing is such that they allow narrow bicycle wheels to drop into the grates, resulting in serious damage to the bicycle wheel and frame and/or injury to the bicyclists. These grates should be replaced with bicycle-safe and hydraulically efficient ones. When this is not immediately possible, consideration should be given to welding steel cross straps or bars perpendicular to the parallel bars to provide a maximum safe opening between straps. This should be considered a temporary correction.

While identifying a grate with a pavement marking would be acceptable in some situations[2], parallel bar grate inlets deserve special attention. Because of the serious consequences of a bicycle missing the pavement marking in the dark or being forced over such a grate by other traffic, these grates should be physically corrected as soon as practicable after they are identified.

When a new roadway is designed, all such grates and covers should be kept out of bicyclists' expected path. On new construction, curb inlets should be used wherever possible to completely eliminate exposure of bicyclists to grate inlets. Grates and utility covers should be flush with the surface, including after a roadway is resurfaced.

5.1.2 Railroad Crossings: *Railroad-highway grade crossings should ideally be at a right angle to the rails. The greater the crossing deviates from this ideal crossing angle, the greater is the potential for a bicyclists's front wheel to be trapped in the flangeway or to slip on the rail, causing loss of steering control. It is also important that the roadway approach be at the same elevation as the rails.*

Consideration should be given to the materials of the crossing surface and to the flangeway depth and width. If the crossing angle is less that approximately

45 degrees, consideration should be given to widening the shared roadway, rural bicycle lane or urban bicycle lane to allow bicyclists adequate room to cross the tracks at a right angle. Where this is not possible, commercially available compressible flangeway fillers can enhance bicyclists safety. In some cases, abandoned tracks can be removed. Warning signs and pavement markings should be installed in accordance with the MUTCD.

5.1.3 Pavement Surface Conditions: *Pavement surface irregularities can do more than cause an unpleasant ride. Gaps between pavement slabs or drop-offs at overlays parallel to the direction of travel can trap a bicycle wheel and cause loss of control. Holes and bumps can cause bicyclists to swerve into the path of motor vehicle traffic. To the extent practicable, pavement surfaces should be free of irregularities and the edge of the pavement should be uniform in width. On older pavement it may be necessary to fill joints, adjust utility covers or, in extreme cases, overlay the pavement to make it suitable for bicycling.*

5.1.4 Traffic Control Devices: At intersections where bicycle traffic exists or is anticipated, bicycles should be considered in the timing of the traffic signal cycle, as well as the traffic detection device. Normally, a bicyclist can cross an intersection under the same signal phasing arrangements as motor vehicles; however, on multi-lane streets special considerations should be given to ensure that short clearance intervals are not used. If necessary, an all-red clearance interval may be used to allow bicyclists to clear the intersection before alternate direction traffic is given the green light.

To check the clearance interval, a bicyclist's speed of 10 mph (16 km/h) and a perception/ reaction/ braking time of 2.5 seconds is recommended. Detectors for traffic-actuated signals should be sensitive to bicycles and should be located in the bicyclist's expected path, including left turn lanes. When selecting traffic loop detectors, keep in mind that many bicycles have aluminum or non-metal frames and may be difficult to detect. In some situations, the use of pedestrian actuated buttons may be a preferred alternative to the use of detectors provided they do not require bicyclists to dismount or make unsafe leaning movements. Where

programmed visibility signal heads are used, they should be checked to ensure that they are visible to bicyclists who are properly positioned on the road.

The MUTCD should be consulted for guidance on signs and pavement markings. Where bicyclists are expected to use different routings than motorists, directional signing should be used to confirm to bicyclists that the special routing leads to their destination.

5.2 Shared Roadways

In general, a traffic lane width of 14 feet (4.3 m) of usable width is desirable. Usable width would normally be from curb face to lane stripe, or from edge line to lane stripe, but adjustments need to be made for drainage grates, motor vehicle parking, and longitudinal ridges between pavement and gutter sections. Widths greater than 14 feet (4.3 m) may encourage the undesirable operation of two motor vehicles in one lane, especially in urban areas, and consideration should be given to striping as a bicycle lane with when wider widths exist.

In rural settings, advanced bicyclists prefer shared roadways over rural bicycle lanes since the shared roadways tend to be clean of roadway debris and gravel.

Restriping to provide shared roadways may also be considered on some existing multi-lane facilities by marking the remaining travel lanes and left turn lanes narrower. This should only be performed after careful review of traffic characteristics along the corridor.

5.3 Urban Bicycle Lane

Urban *bicycle lanes should always be one-way facilities and carry traffic in the same direction as adjacent motor vehicle traffic. Two-way* urban *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*[3]. Urban *bicycle lanes on one-way streets should be on the right side of the street, except in areas where* urban *bicycle lane on the left side of the street will decrease the number of conflicts (e.g., those caused by heavy bus traffic).*

Adequate pavement surface, bicycle-safe grate inlets, safe railroad crossings and traffic signals responsive to bicycles should always be provided on roadways where bicycle lanes are being designated. Raised pavement markings and raised barriers can cause steering difficulties for bicyclists and should not be used to delineate urban bicycle lanes.

5.3.1 Urban Bicycle Lanes Width: *Under ideal conditions, the minimum* urban *bicycle lane width is 5 feet (1.5 m). However, certain conditions dictate additional desirable* urban *bicycle lane width. To examine the width requirements for* urban *bicycle lanes,* Figure 5.2 *shows three usual locations for such facilities in relation to the roadway.* Figure 5.2(a) *depicts* urban *bicycle lanes on an urban curbed street where a parking lane is provided. The desirable* urban *bicycle lane width for this location is* 6 feet (1.8 m). Urban *bicycle lanes should always be placed between the parking lane and the motor vehicle lanes.* Urban *bicycle lanes between the curb and the parking lane can create obstacles for bicyclists from opening motor vehicle doors and poor visibility at intersections and driveways, and they prohibit bicyclists from making left turns. Therefore this placement should not be considered.*

Where parking is permitted but a parking lane is not provided, the combination lane, intended for both motor vehicle parking and bicycle use, should be a minimum of 12 feet (3.7 m) wide. However, if it is likely the combination lane will be used as an additional motor vehicle lane, it is preferable to designate separate parking and urban *bicycle lanes as shown in* 5.2(a). *In both instances, if parking volume is substantial or turnover is high, an additional 1 or 2 feet (0.3 or 0.6 m) of width is desirable for safe bicycle operation.*

Figure 5.2(b) *depicts* urban *bicycle lanes along the outer portions of an urban curbed street where parking is prohibited.*

Bicyclists do not generally ride near a curb because of the possibility of debris, hitting a pedal on the curb, an uneven longitudinal joint, or a steeper cross slope. Urban *bicycle lanes in this location should have a minimum width of* 6 feet (1.8 m) *from the curb face. If the longitudinal joint between the gutter pan and the roadway surface is uneven and falls within* 6 feet

(1.8 m) *of the curb face, a minimum of* 5 feet (1.5 m) *should be provided between the joint and the motor vehicle lanes.*

Figure 5.2(c) *depicts* urban *bicycle lanes on a highway without curb or gutter.* Urban *bicycle lanes should be located between the motor vehicle lanes and the roadway shoulder.* Urban *bicycle lanes may have a minimum width of* 5 feet (1.5 m), *where the shoulder can provide additional maneuvering width. A width of* 6 feet (1.8 m) *is preferable; additional widths are desirable where substantial truck traffic is present, or where vehicle speeds exceed 35 mph (55 km/h).*

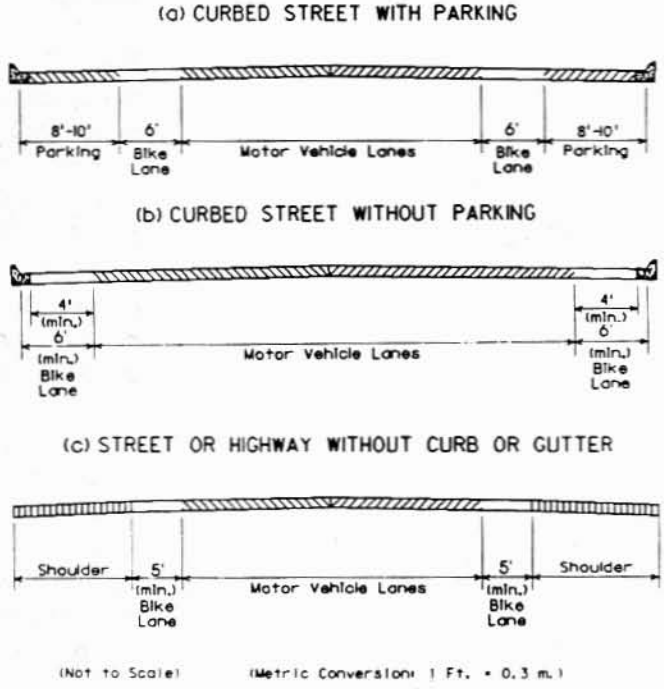


Figure 5.2 (a, b, c) Typical Urban Bicycle Lane Cross Section

5.3.2 Intersections with Urban Bicycle Lanes: Urban *bicycle lanes tend to complicate both the bicycle and motor vehicle turning movements at intersections. Because they encourage bicyclists to keep to the right and motorists to keep to the left, both operators are somewhat discouraged from merging in advance of turns. Thus, some bicyclists will begin left turns from the right side* urban *bicycle lane and some motorists will begin right turns from the left of the* urban *bicycle lane. Both maneuvers are contrary to established rules of the road and result in conflicts.*

At intersections, bicyclists proceeding straight through and motorists turning right must cross paths. Striping and signing configurations which encourage these crossings in advance of the intersection, in a merging fashion, are preferable to those that force the crossings in the immediate vicinity of the intersection. To a lesser extent, the same is true for left turning bicyclists; however, in this maneuver, most vehicle codes allow the bicyclists the option of making either a "vehicular style" left turn (where the bicyclists merge leftward to the same lane used for motor vehicle left turns) or a "pedestrian style" left turn (where the bicyclists proceed straight through the intersection, turn left at the far side, then proceed across the intersection again on the cross street).

Figure 5.3 *presents examples of details on pavement markings for* urban *bicycle lanes approaching motorists right-turn-only lanes. Where there are numerous left-turning bicyclists, a separate turning lane, as indicated in the MUTCD, should be considered. The design of* urban *bicycle lanes should also include appropriate signing at intersections to reduce the number of conflicts. General guidance for pavement marking of* urban *bicycle lanes is contained in the MUTCD.*

Adequate pavement surface, bicycle-safe grate inlets, safe railroad crossings, and traffic signals responsive to bicycles should always be provided on roadways where urban *bicycle lanes are being designated. Raised pavement markings and raised barriers can cause steering difficulties for bicyclists and should not be used to delineate* urban *bicycle lanes.*

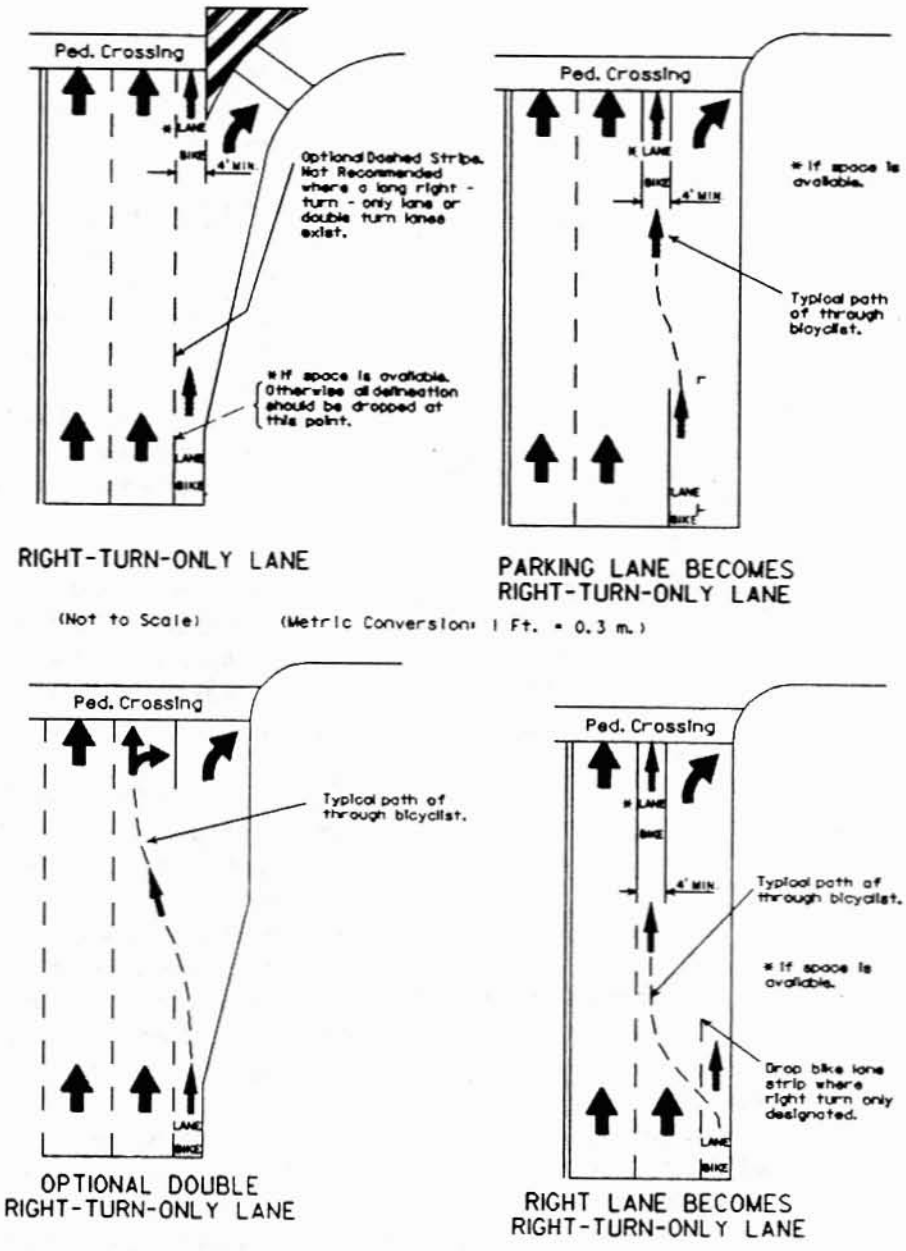


Figure 5.3 Urban Bicycle Lane Approaching Motor Vehicle Right-Turn- Lane

5.4 Rural Bicycle Lanes

Where it is intended that bicyclists ride on rural *bicycle lanes, a smooth paved facility should be provided and maintained. Pavement edge lines supplement surface texture in delineating the shoulder from the motor vehicle lanes. Rumble strips can be a deterrent on* rural *bicycle lanes.*

Adding or improving rural bicycle lanes can often be the best way to accommodate basic and children bicyclists in rural areas, and they are also a beneficial to motor vehicle traffic. When funding is limited,

adding or improving shoulders on uphill sections first will give slow-moving bicyclists needed maneuvering space and decrease conflicts with faster moving motor vehicle traffic.

5.4.1 Rural Bicycle Lanes Width: *The width of a* rural *bicycle lane should be a minimum of 4 feet (1.2 m) when intended to accommodate bicycle travel. Roads with shoulders less than 4 feet (1.2 m) wide normally should not be signed as* rural *bicycle lanes. If motor vehicle speeds exceed 35 mph (55 km/h), if the percentage of trucks, buses and recreational vehicles is high, or if static obstructions exist at the right side, additional width is desirable.*

5.5 Urban Bicycle Paths

Urban *bicycle paths should be thought of as extensions of the highway systems that are intended for the preferential use of bicycles in much the same way as freeways are intended for the exclusive or preferential use of motor vehicles.*

There are many similarities between the design criteria for urban *bicycle paths and those for highways (e.g., in determining horizontal alignment, sight distance requirements, signing and pavement markings). On the other hand, some criteria (e.g., horizontal and vertical clearance requirements, grades and pavement structure) are dictated by operating characteristics of bicycles that are substantially different from those of motor vehicles.*

5.5.1 Width and Clearance: *The paved width and the operating width required for an* urban *bicycle path are primary design considerations.* Figure 5.4 *depicts an* urban bicycle path *on a separate right of way. Under most conditions, a recommended all paved width for a two-directional* urban *bicycle path is* 10 feet (3 m). *In some instances, however, a minimum of 8 feet (2.4 m) can be adequate. This minimum should be used only where the following conditions prevail: 1) bicycle traffic is expected to be low, even on peak days or during peak hours; 2) there will be good horizontal and vertical alignment providing safe and frequent passing opportunities; 3) there will be little use by pedestrians; 4) the facility will not be subject to maintenance vehicle loading conditions that would cause pavement edge damage. Under certain conditions it may be necessary or desirable to increase the width of an* urban *bicycle path to 12 feet*

(3.7 m); due to: 1) substantial bicycle volume; 2) shared use with joggers and other pedestrians; 3) use by large maintenance vehicles; 4) steep grades; and 5) where bicyclists will be likely to ride two abreast.

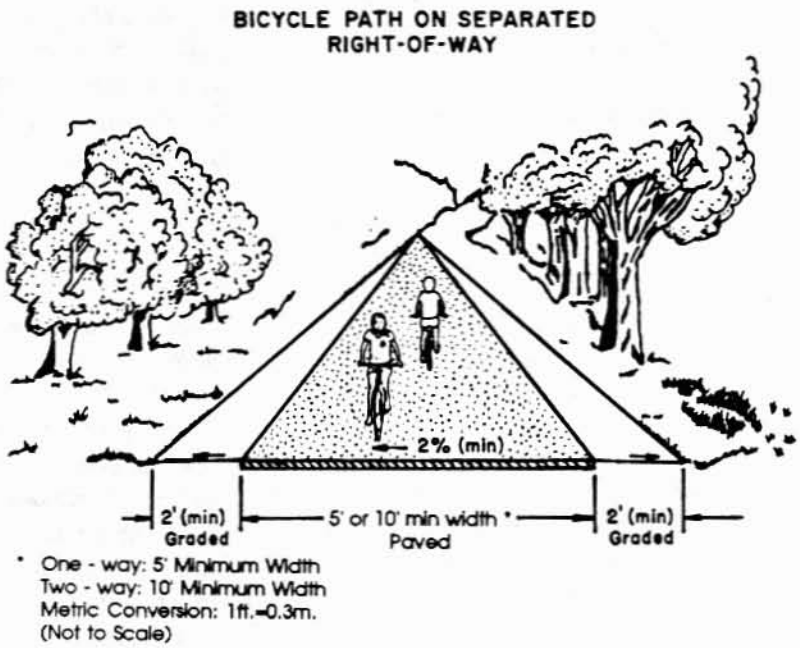


Figure 5.4 Urban Bicycle Path Cross Section

The minimum width of a one-directional urban bicycle path is 5 feet (1.5 m). *It should be recognized, however, that one-way* urban *bicycle paths often will be used as two-way facilities unless effective measures are taken to ensure one-way operation. Without such enforcement, it should be assumed that* urban *bicycle paths will be used as two-way facilities and designed accordingly.*

A minimum of a 2-foot (0.6 m) width graded area should be maintained adjacent to both sides of the pavement; however, 3 feet (0.9 m) or more is desirable to provide clearance from trees, poles, walls, fences, guardrail or their lateral obstructions. A wider graded area on either side of the urban *bicycle path can serve as a separate jogging path.*

A wide separation between an urban *bicycle path and adjacent highway is desirable to confirm to both the bicyclist and the motorist that the* urban *bicycle path functions as an independent highway for bicycles. When this is not possible and the distance*

between the edge of the roadway and urban *bicycle path is less than 5 feet (1.5 m), a suitable physical divider may be considered. Such dividers serve to prevent bicyclists from making unwanted movements between the bicycle facility and the highway shoulder and to reinforce the concept that the* urban *bicycle path is an independent facility. Where used, the divider should be a minimum of 4.5 feet (1.4 m) high, to prevent bicyclists from toppling over it, and it should be designed so it does not become an obstruction in itself.*

5.5.2 Intersections: *Intersections with roadways are important considerations in* urban *bicycle path design. If alternate locations for an* urban *bicycle path are available, the one with the most favorable intersection conditions should be selected. For crossing of freeways and other high-speed, high-volume arterials, a grade separation structure may be the only possible or practical treatment. Unless bicycles are prohibited from the crossing highway, providing for turning movements must be considered. In most cases, however, the cost of a grade separation will be prohibitive.*

When intersections occur at grade, a major consideration is the establishment of right of way. The type of traffic control to be used (signal, stop sign, yield sign, etc.), and location, should be provided in accordance with the MUTCD.

Sign type, size and location should also be in accordance with the MUTCD. Care should be taken to ensure that urban *bicycle path signs are located so that motorists are not confused by them and that roadway signs are placed so that bicyclists are not confused by them.*

It is preferable that the crossing of an urban *bicycle path and a highway be at a location away from the influence of intersections with other highways. Controlling vehicle movements at such intersections is more easily and safely accomplished through the application of standard traffic control devices and normal rules of the road. Where physical constraints prohibit such independent intersections, the crossings may be at or adjacent to the pedestrian crossing. Right of way should be assigned and sight distance should be provided to minimize the potential for conflict resulting from unconventional turning*

movements. At crossings of high volume, multi-lane arterial highways where signals are not warranted, consideration should be given to providing a median refuge area for bicyclists.

When urban *bicycle paths terminate at existing roads, it is important to integrate the path into the existing system of roadways. Care should be taken to properly design the terminals to transition the traffic into safe merging or diverging situation. Appropriate signing is necessary to warn and direct both bicyclists and motorists regarding these transition areas.*

When planning for urban *bicycle paths, be aware that if bicyclists are always required to yield, they may find alternative routes of disobey traffic signals.*

Urban *bicycle path intersections and approaches should be on relatively flat grades. Stopping sight distances at intersections should be checked and adequate warning should be given to permit bicyclists to stop before reaching the intersection, especially on downgrades.*

Ramps for curb cuts at intersections should be the same width as the urban *bicycle paths. Curb cuts and ramps should provide a smooth transition between the* urban *bicycle path and the roadway.*

5.5.3 Bridges and Structures: *An overpass, underpass, small bridge, drainage facility or facility on a highway bridge may be necessary to provide continuity to an* urban *bicycle path.*

On new structures, the minimum clear width should be the same as the approach paved urban *bicycle path; and the desirable clear width should include the minimum 2-foot (0.6 m) wide clear areas.*

Bridges designed exclusively for bicycle traffic may be also designed for pedestrians. On all bridge decks, special care should be taken to ensure that bicycle safe expansion joints are used.

Where it is necessary to retrofit an urban *bicycle path onto an existing highway bridge, several alternatives should be considered in light of what the geometrics of the bridge will allow.*

One option is to carry the urban *bicycle path across the bridge on one side. This should be done where: 1) the bridge facility will connect to an urban bicycle path at both ends; 2) sufficient width exists on that side of the bridge can be obtained by widening or re-striping lanes; and 3) provisions are made to physically separate bicycle traffic from motor vehicle traffic.*

A second option is to provide either wide curb lane or urban *bicycle lanes over the bridge. It may be advisable where: 1) the* urban *bicycle path transitions into* urban or rural *bicycle lanes at one end of the bridge; and 2) sufficient width exists or can be obtained by widening or re-striping.*

A third option is to use existing sidewalks as one-way or two-way facilities. This may be advisable where: 1) conflicts between bicyclists and pedestrians are minimal; and 2) the existing sidewalks are adequately wide. This option may be apply as a temporary solution, but require planning for future improvements.

Because of the large number of variables involved in retrofiting bicycle facilities onto existing bridges, the width to be provided is best determined by the designer, on a case-by-case basis, after thoroughly considering all the variables.

5.5.5 Multi-Use: *Providing an urban bicycle path in the sidewalk is unsatisfactory for a variety of reasons.* Municipal ordinances prohibit bicycles on sidewalks due to conflict with pedestrians.

Sidewalks are typically designed for pedestrian speeds and maneuverabilities and are not safe for higher-speed bicycle use. Conflicts are common between pedestrians traveling at low speeds and bicyclists, as are conflicts with fixed objects (e.g. parking meters, utility poles, sign posts, bus benches, trees, fire hydrants, mail boxes, etc.). Walkers, joggers, skateboarders, and roller skaters can, and often do, change their speed and direction almost instantaneously, leaving bicycles insufficient time to react to avoid collisions.

Similarly, pedestrians often have difficulty predicting the direction an oncoming bicyclist will take. At intersections, motorists are often not looking for

bicyclists (who are traveling at higher speeds than pedestrians) entering the crosswalk area, particularly when motorists are making a turn. Sight distances is often impaired by buildings, walls, fences and shrubs along sidewalks, especially at driveways.

Bicyclists riding on sidewalks can be expected in residential areas with young children. With lower bicycle speeds and lower motor vehicle speeds, potential conflicts are somewhat lessened, but still exist. It is inappropriate to sign a sidewalk as an urban *bicycle path if to do so would prohibit bicyclists from using an alternate facility that might better serve their needs.*

It is important to recognize that the development of extremely wide sidewalks does not necessarily add to the safety of sidewalk bicycle travel. Wide sidewalks encourage higher-speed bicycle use and can increase potential for conflicts with motor vehicles at intersections, as well as with pedestrians and fixed objects.

It is also undesirable and unsafe to mix mopeds and bicycles on the same facility.

5.6 Rural Bicycle Paths[4]

Rural bicycle paths are typically on exclusive rights of way and with minimal cross flow by motor vehicles.

5.6.1 Rural Bicycle Path Clearances: Perhaps the most critical factor in developing safe and comfortable bicycle facilities is the provision of adequate clearance to a wide variety of potential obstructions that may be found along a prospective route. Guidelines for lateral and vertical clearance are particularly important in view of the wide range of riding proficiency that is found among riders. Clearance consideration must include: (1) normal bicycle maneuvering allowances; (2) lateral clearances to static obstructions; (3) lateral clearances to dynamic obstructions; and (4) vertical clearances to overhead obstructions.

Minimum and desirable clearance guidelines for safe and comfortable bicycle operation are indicated in Table 5.1. Where possible, additional space should be provided to permit passing within the bikeway and to allow more adequate hazard avoidance.

BIKEWAY CLEARANCE GUIDELINES

Type of Clearance	Minimum Dimension (feet/inches)	Desirable Dimension (feet/inches)
Maneuvering Allowances [1]		
- each outside edge	9 inches	1 foot
- between bicycles, regardless of direction	1 foot - 6 inches	2 feet - 6 inches
Lateral Clearance to Static Obstructions [2]		
- utility poles, trees, hydrants, etc.	1 foot	2 feet
- raised curb	6 inches	1 foot
- curb drop-off	1 foot - 6 inches	2 feet
- sloped drop-off	1 foot	1 foot
- parked vehicles	3 feet - 6 inches	4 feet
Lateral Clearances to Dynamic Obstructions		
- moving vehicles	4 feet	6 feet
- pedestrian traffic	3 feet	4 feet
Vertical Clearances to Overhead Obstructions	8 feet - 6 inches	9 feet

[1] Maneuvering allowances should be provided for by additional bikeway pavement width, as specified.

[2] Lateral clearances can be provided for by either additional bikeway pavement width or separation. It is recommended that these clearances be provided for by simple distance separations, where possible, for poles, trees, rocks, hydrants and similar objects.

Table 5.1 Rural Bicycle Path Clearance Guidelines

5.6.2 Rural Bicycle Path Width: Rural bicycle paths should be 10 feet (3.1 m) wide if they are located on an independent alignment. This preferred dimension is important because the rural bicycle path width will allow two bicycles to pass with safety, whether they be loaded with side pack panniers, pulling trailers or free from burden. The 10-foot (3.1 m) wide dimension will also allow bicycle traffic to comfortably pass pedestrian traffic using the rural bicycle path. Deviations from the 10-foot (3.1 m) width should take into consideration user volume, the frequency of peak events and the percentage of pedestrian users. Grass shoulders 1-foot 6-inches to 3-feet wide adjacent the rural bicycle path on either side are also recommended. The shoulders provide a recovery area, which is desirable if a user veers off the facility. At a minimum, a 2-foot wide clear zone free of obstructions should be maintained. Refer to

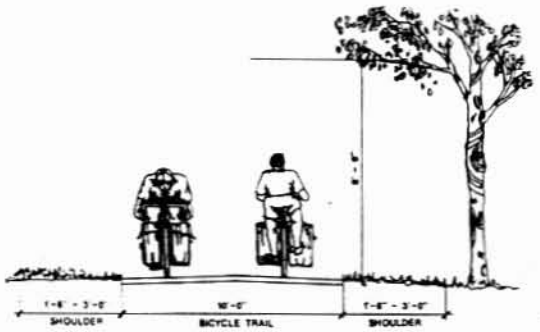


Figure 5.5 Recommended Rural Bicycle Path Widths

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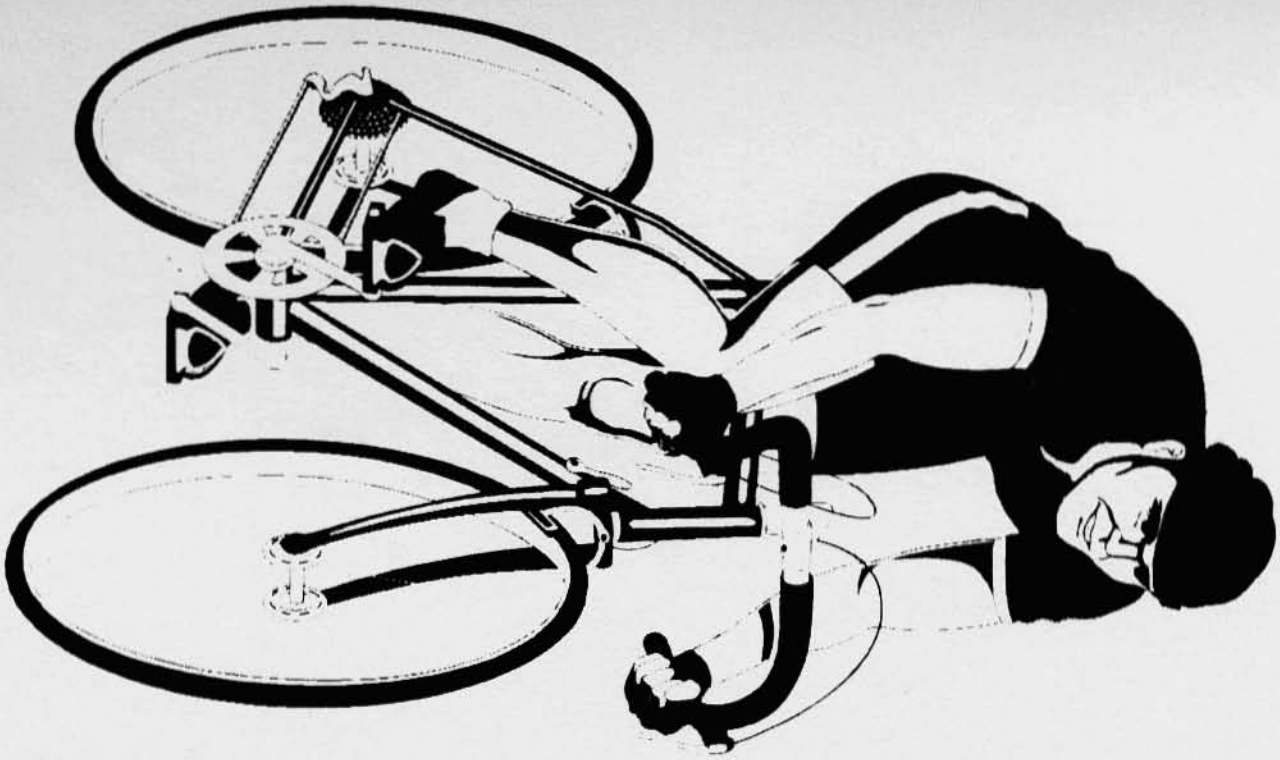
1 The text in italics has been used verbatim by permission from the Guide for the Development of Bicycle Facilities, Copyright 1991 by the American Association of State Highway and Transportation Officials.

2 The Manual of Uniform Traffic Control Devices (MUTCD) is the national standard for placement and selection of all traffic control devices on or adjacent to all highways open to public travel in accordance with Title 23, U.S. Code, Sections 109-b, 109-d and 402-a.

3 The Uniform Vehicle Code is a standard vehicle code which can be utilized by state governments in establishing a state vehicle code.

4 The following information has been abstracted from the Iowa Recreational Trails Plan design section.



Chapter Six

CHAPTER SIX
BICYCLE FACILITIES NETWORK IDENTIFICATION PROCESS

Following is an outline of the process that can be used to identify the bicycle facilities network for each MPO and RPA planning area. Although this process is based on the transportation planning process, it has been modified to address bicycle facilities characteristics.

It must be kept in mind that bicycle and pedestrian facilities planning must be conducted with the idea of incorporating it into transportation planning of other modes and activities. A bicycle and pedestrian facilities system plan needs to be compatible and able to function with other transportation systems. Often an improvement for bicycle or pedestrian travel can benefit other modes. Conversely, street and highway improvements, through appropriate planning and design, can enhance bicycle and pedestrian travel.

Most significant traffic generators lie on or near major arterial or collector streets. Therefore, bicycle and pedestrian travel should be accommodated on or near appropriate arterial or collector streets. Some improvements to accommodate bicycle and pedestrian facilities are necessary to ensure safe and efficient bicycle and pedestrian travel as some arterial and collector streets are not suitable for bicycle and pedestrian travel. Therefore, in those instances it is necessary to improve roadways parallel to major arterial and collectors to serve the identified traffic generators. Due to the broad range of conditions of roadways within a planning area, bicycle and pedestrian facilities should be planned and accommodated on the best facilities that will provide access to the identified traffic generators.

The bicycle facilities network identification process was developed as a cyclic and interactive process. The process will indicate when selecting an alternative route whether a candidate route will require major adjustment. If such adjustments are required for a route, it is advisable to consider repeating the sequence of steps with the new information gained in the initial evaluation and identify alternative routes. The routes which require major adjustments should be identified and signed to prohibit bicycle and pedestrian usage.

The bicycle and pedestrian facilities network identification process has been separated into the following seven steps:

- Seek public participation;
- Develop plan's goals and objectives;
- Inventory bicycle facilities and roadway system characteristic;
- Identify travel desire lines;
- Select alternative routes;
- Evaluate selected alternative routes; and
- Prepare a bicycle facilities network map.

6.1 Seek Public Participation

At the earliest phase of developing the bicycle facilities network, there must be a concerted effort made to identify, seek and involve groups and individuals who are concerned about current and future bicycle travel.

The ISTEA places significant emphasis on public outreach, and it is important to determine the valid sentiments and opinions of citizens, as opposed to only considering the opinions and judgement of planning and engineering staffs or professional advocacy organizations.

6.2 Develop Plan's Goals and Objectives

The goal and objectives of a plan form the framework for what actions are desired and what means are to be used to accomplish them. Thus, the goals and objectives may be viewed as bridging the gap between existing deficiencies and the desired ultimate circumstances. This is accomplished by considering the general needs derived from the conditions which exist today, and reflecting them in statements of more ideal conditions.

In general, goals and objectives should address a consensus of the planning area's general public and bicycle and pedestrian facilities users. Therefore, the success of preparing goals and objectives is heavily dependent on effective participation by citizens, public decision-makers and professional staff over the duration of the planning process.

6.3 Inventory Bicycle Facilities and Roadway System Characteristics

The inventory provides a description of a data base that can be used in the evaluation of any existing bicycle facilities and existing physical conditions of roadways. It should consist of a graphic and text listing of existing miles of each bicycle facility, its name, the location of the facility, the type of facility (classification), its width, surface type, nearby traffic generators, traffic volumes of adjacent, intercepting roadways, and any physical barriers near the facility. This inventory should also include analysis of the data as it relates to the physical conditions of roadways and existing bicycle facilities.

An inventory of existing roadway conditions is needed to help evaluate the suitability of a roadway for bicycle travel. The next step in the network identification process is to inventory those roadways that have been identified as prospective routes to accommodate bicycle facilities. Data should be initially collected on the average daily traffic, pavement width, the adjacent land use (commercial, residential, mixed-use, etc.), and the speed and number of traffic lanes. Land usage along the roadways will often provide a good indication of the amount of potential side friction that could be expected.

6.4 Identify Travel Desire Lines

By using a map of appropriate scale and detail[1], an overlay can be prepared which will facilitate the study of bicycle and pedestrian facility corridors, alternatives and traffic generator linkages as well as other opportunities for bicycle and pedestrian travel.

On the map provided, plot major traffic generators to identify corridors. Traffic generators are those origins and destinations such as educational institutions, commercial areas, shopping centers, work places, public facilities, recreational areas and parks. Then, traffic generators should be connected to major residential areas. Once trip originations and destinations are marked on the map, draw a straight line connecting them. In order to avoid a confusing and unrealistic "spider web" of routes, consideration must be given to the various routes. For example, connecting a residential area with a park is a reasonable route, whereas connecting a park with an industrial park is not likely to be reasonable. A bicycle and pedestrian facility network showing all possible combinations would simply not be practical.

In addition to the corridors marked, other opportunities for bicycle travel should be identified on the overlay. Some examples of these include: greenbelts, parks, utility rights of way, open space areas and abandoned railroad rights of way.

Bicycle facility barriers should also be included in the overlay as part of this exercise. Barriers can be separated into two general types. One type is the absolute obstacle to bicycle and pedestrian travel such as rivers, streams, freeways or bridges. The

other type is impediments such as busy unsignalized intersections, railroad crossings, extremely steep grades or incompatible land use. Whenever the corridor conflicts with bicycling obstacles, alternate corridors should be studied.

Bicycle accident locations should be investigated to identify any physical obstructions which may contribute to accidents.

Having plotted the traffic generators and the barriers, patterns of travel potential can be effectively screened over identified corridor opportunities. The resulting bicycle and pedestrian facilities corridor map(s) will give a strong indication of where bicyclists will want to go, which is not necessarily where they go presently.

6.5 Select Alternative Routes

Based on the lines you have drawn, identify corridors to facilitate identifying alternative routes. Final selection will come later. For corridors that are nearly parallel, overlapping or are in close proximity to other corridors, consideration should be given to combining them. This exercise will give a preliminary framework for a system of desired bicycle and pedestrian routes.

The underlying assumption is that bicyclists want to go to the same places as motorists and the existing system of streets and highways reflects the existing travel demands within the community.

After the locational criteria has been applied to one or several alternatives, then each corridor is evaluated for specific strengths and weakness. A route may require a minor adjustment, or perhaps a major revision of a candidate route may be warranted. When major changes are indicated, it is often advisable to consider the entire network identification process a cyclic one and repeat the sequence of steps with the new information gained in the initial evaluation. This aids in keeping the process logical and defensible.

6.6 Evaluate the Selected Alternative Routes

After each route is evaluated for specific strengths and weakness, then the gathered data can be evaluated for each selected alternative route. To

evaluate the selected routes the process involves: defining criteria to be used, and measuring the acceptability of each route against each criterion.

When comparing alternatives, each should be ranked against the others, then ranked against the criteria. Ranking should be as consistent and objective as possible and should reflect local needs and values; but it need not be complex. The major purpose of this evaluation process is an appeal to common sense and judgement. The goal is to identify the route that best meets the criteria and still serves the origins and destinations in question.

A rating procedure for the network should be developed and each route should receive a value for each factor. The factors to be rated should include:

- The degree to which a specific route meets the needs of the anticipated users as opposed to other route options.
- The possible cost and/or extent of construction required to implement the proposed bicycle or pedestrian facility treatment.
- The comparative ease of implementing the proposed design treatment. For example, one option may entail the often unpopular decision to alter or eliminate on-street parking while another does not.
- The opportunity to implement the proposed design treatment in conjunction with the planned highway project construction, reconstruction or improvement.

6.7 Prepare a Bicycle Facilities System Network Map

After a recommended network is developed, it should be illustrated on a map. Mapping bicycle and pedestrians facilities is typically a cost-efficient means of informing bicyclists and pedestrians where the most suitable facilities are located.

When available at appropriate locations, bicycle and pedestrian facilities maps not only inform users but can be designed to generate interest in the network.

This map will be submitted, in conjunction with the existing facilities inventory, to the Department for review and incorporation into the statewide network. Existing bicycle facilities should also be illustrated showing a complete network of proposed and existing routes within the network. This map should then be utilized as a planning and programming tool when implementing the metropolitan and regional long-range transportation plans.

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[1] Metropolitan planning organization or regional planning affiliation planning area maps have been included for this purpose. However, some regional planning affiliations may have to supplement it with maps for cities within their planning areas.

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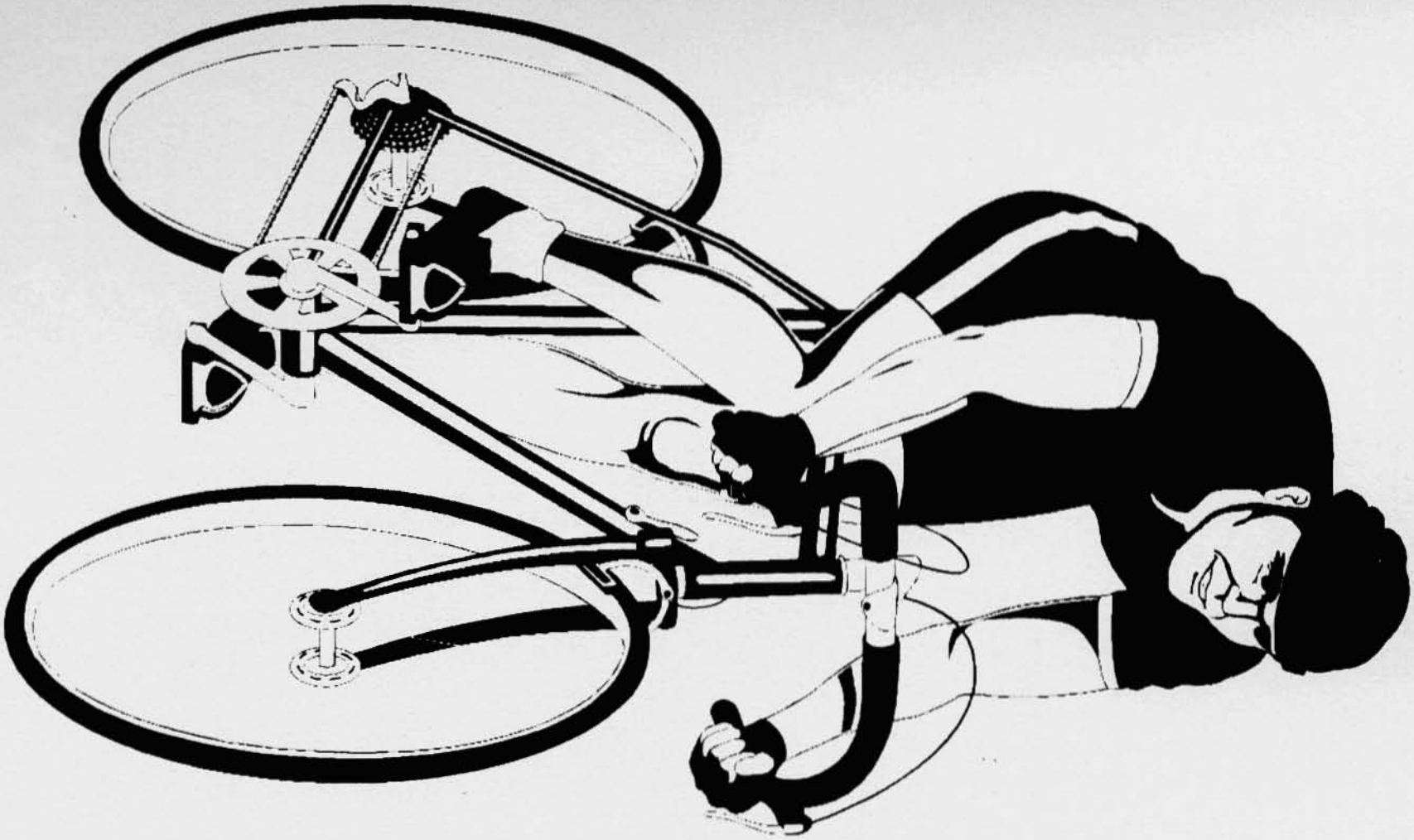

Glossary

GLOSSARY

To reduce repetitive explanation of frequently used words and terms while at the same time ensuring singular understanding of them, the following definitions are listed below.

Bicycle	A vehicle propelled solely by human power, upon which any person may ride.
Bicycle Transportation	Movement of people by a bicycle from one place to another.
Bicycle Transportation Facilities	Capital infrastructure, either linear or point specific, which fosters bicycle transportation by serving traffic generators along a direct course and aiding the safety of the transportation purpose.
Bikeway	Any road, path or way which in some manner is specifically designated as being open to bicycle travel, regardless of whether such facility is designated for the exclusive use of bicycles or are to be shared with other transportation modes.[1]
Clearance (lateral)	Width required for safe passage of a vehicle (or pedestrian) as measured in a horizontal plane.[2]
Clearance (vertical)	Height necessary for the safe passage of a vehicle (or pedestrian) as measured in a vertical plane.[3]
Design Speed	A speed determined for design and correlation of the physical features or geometrics of a facility that influence the safe vehicle operation.[4]
Grade	Rise or fall in elevation of a facility within a specified distance. As an example, a 1-percent grade is a 1 foot (0.31 m) rise or fall in elevation in 100 feet (31 m) of distance (measured horizontally).[5]
Headway	The time interval between the passing of the front ends of successive transit units moving along the same lane in the same direction usually expressed in minutes.[6]
Highway	A general term denoting a public roadway for purposes of vehicular travel, including the entire area within the right of way.[7]

Intermodal Transfer Point	Any location at which a person or persons change from one transportation mode to another.[8]
Metropolitan Planning Organization (MPO)	A policy making forum designated by the governor of each state in urbanized areas with populations of 50,000 or more. The responsibility for cooperatively carrying out transportation planning and programming will be clearly identified in an agreement of understanding between the state and MPO.[9]
Network	A configuration of bicycle and pedestrian facilities that constitutes the total system.[10]
Pedestrian	A person whose mode of transportation is on foot.[11]
Pedestrian Pathway	Temporary or permanent walkways which may or may not be placed near a roadway and are usually made of concrete, asphalt or gravel.[12]
Pavement Marking	Markings set into, applied on, or attached to the surface of the pavement for the purpose of regulating, warning or guiding traffic.[13]
Planning Area	A geographic region selected for planning objectives.[14]
Regional Planning Affiliation (RPA)	A multicounty organization used by member municipalities and counties to develop and review transportation plans and programs.[15]
Right of Way	A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to transportation purpose.[16]
Roadway	The portion of the highway, including shoulders, for vehicle use.[17]
Sight Distance	A measurement of bicyclists' visibility, unobstructed by traffic, along the normal travel path to the furthest point of the roadway surface.
Sidewalk	The portion of a highway designated for preferential or exclusive use by pedestrians.[18]
Super-elevation	Raised outside edge of a roadway curve for the purpose of overcoming the force causing a vehicle to skid when maintaining speed.[19]

Traffic Generators	Origins and destinations such as neighborhoods, schools, shopping centers, commercial areas, work places, recreational facilities, parks and public facilities.[20]
Transportation Trip	Transportation trips are destination oriented, such as school, work, shopping centers, public facilities, parks and recreational areas.
Walkways	A continuous way designated for pedestrians and separated from the through lanes for motor vehicles by space or barriers.[21]

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11 Ibid.

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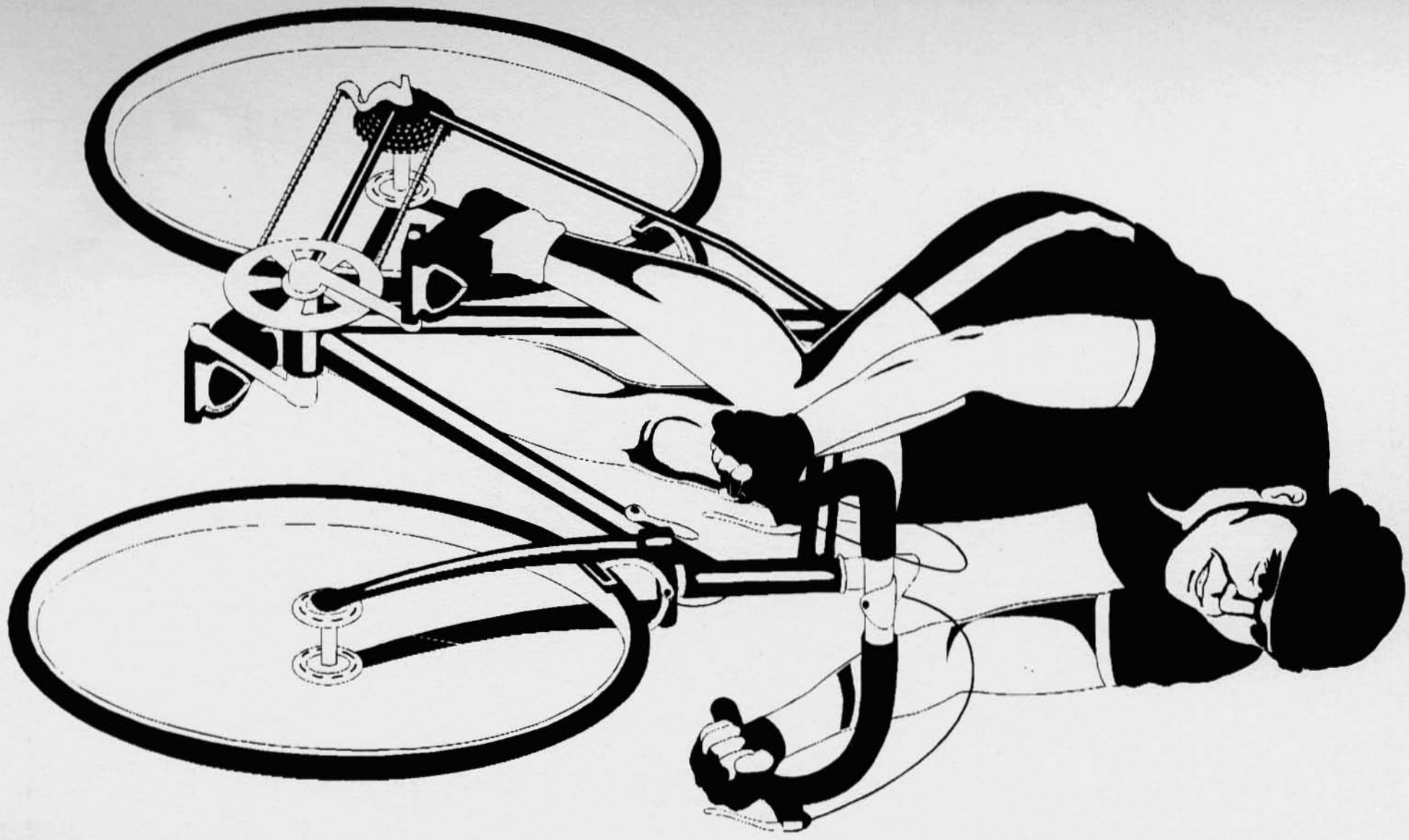
[17] Ibid.

[18] Guide for the Development of Bicycle Facilities. America Association of State Highway and Transportation Officials. Washington, D.C. August 1991.

[19] Urban Public Transportation Glossary. Transportation Research Board. National Research Council. Washington, D.C. 1977.

[20] Ibid.

[21] Guide for the Development of Bicycle Facilities. American Association of State Highway and Transportation Officials. Washington, D.C. August 1991.



Appendix

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APPENDIX E
STATEWIDE BICYCLE AND PEDESTRIAN FACILITIES SYSTEM PLAN'S GOAL AND OBJECTIVES

Goal

To integrate into the transportation system planning process the development of a bicycle and pedestrian network and accompanying facilities which improves the safety, access and linkages to urban, suburban and rural destinations.

Objectives

Identify an integrated system of bicycle and pedestrian facilities network.

- Develop and promote a bicycle and pedestrian facilities network of continuous routes between communities.
- Develop and promote a bicycle and pedestrian network within communities that is connected to the intercommunity bicycle and pedestrian facilities network.

Coordinate implementation of bicycle and pedestrian facilities network.

- Explore ways and means of ensuring continuous consideration of the bicycle and pedestrian facilities as a mode of transportation in all transportation planning efforts.
- Define the responsibilities of the State, MPOs, RPAs, and others for planning, programming, financing, constructing, and maintaining the statewide bicycle and pedestrian facilities network.
- Explore the use of bicycle and pedestrian facilities in conjunction with other modes of transportation (e.g. public transit, carpooling, etc.).
- Address concerns regarding tort liability associated with bicycle and pedestrian facilities.

- Establish criteria to provide adequate maintenance of facilities to ensure safe operation of bicycle and pedestrian facilities.
- Establish liaison with other agencies that deal with bicycle and pedestrian facilities related issues.
- Develop the Bicycle and Pedestrian Facilities Network Identification Handbook to assist MPOs and RPAs in the planning of bicycle and pedestrian facilities network.
- Identify improvements necessary for the safety of bicyclists, pedestrians and motorists.
- Determine the safety conditions of existing roadways and other facilities identified as part of network.
- Identify programs needed to increase safety. Develop systematic evaluations and revisions of the bicycle and pedestrian facilities system plans.
- Establish priorities for programming bicycle and pedestrian facilities on the statewide network.
- Identify programs needed to evaluate bicycle and pedestrian facilities (e.g., traffic monitoring, surveys).
- Determine funding priorities to develop and maintain a statewide bicycle and pedestrian facilities network.
- Analyze the utilization of current funding sources for bicycle and pedestrian facilities and figure out a cost-effective way to fund the statewide bicycle and pedestrian facilities network.