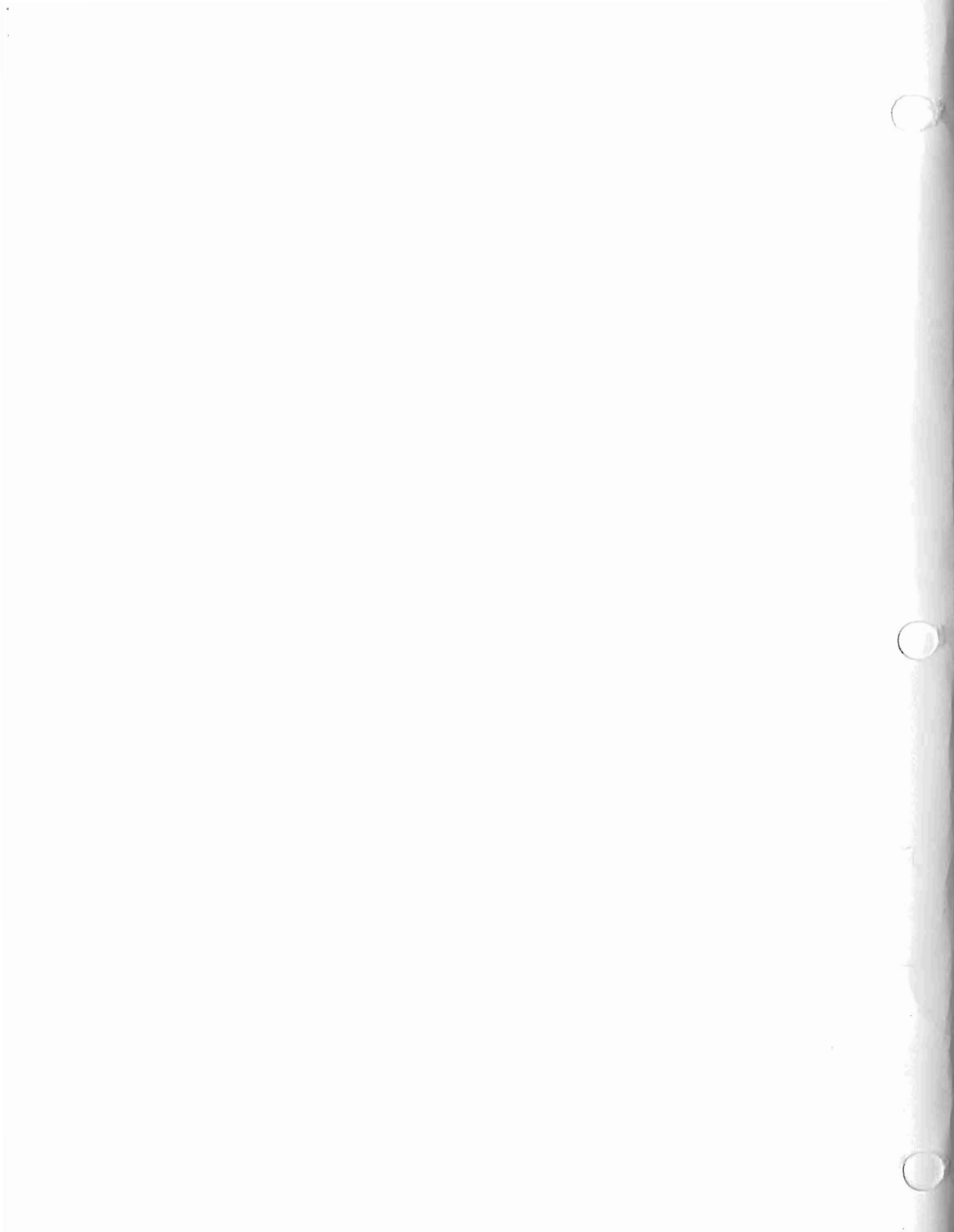


# **Arizona Bicycle Facilities Planning & Design Guidelines**

**Facilities Planning Committee  
Arizona Bicycle Task Force**

**November 1, 1988**

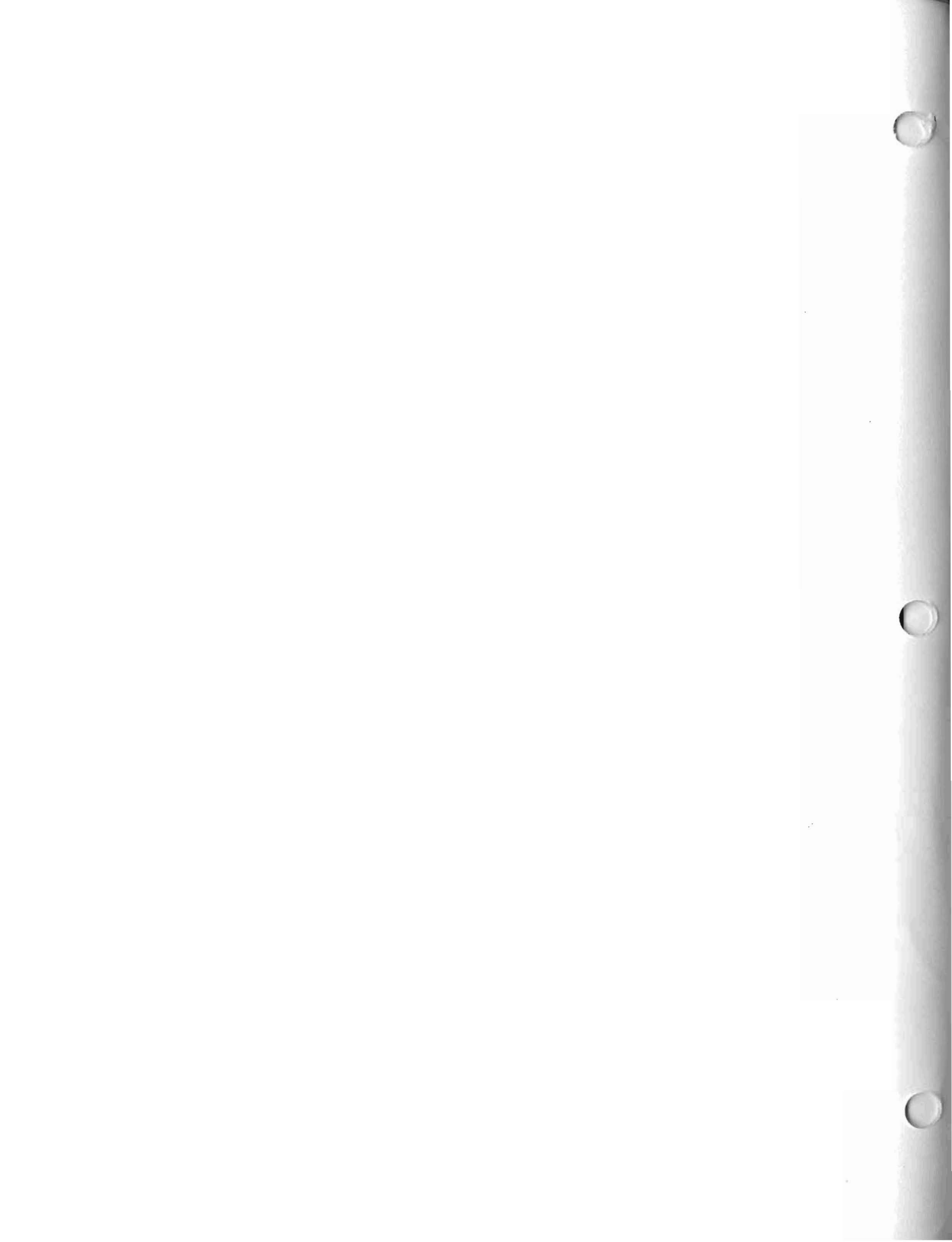


# preface

These Bicycle Facilities, Planning and Design Guidelines were developed by the Facilities Planning Committee of the Arizona Bicycle Task Force and approved by the Arizona Bicycle Task Force.

Copies of the Guidelines are being made available through the Engineering Records Section of the Arizona Department of Transportation as a service to cities, counties, associations, and other interested organizations.

The intent of the Guidelines is to provide for more uniformity in the planning, design and construction of bicycle facilities.



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## INTRODUCTION

### Purpose

This manual provides individuals and agencies in the State of Arizona with location, selection, and design information for bicycle facilities. The information presented in this manual reflects the state-of-the-art practice and is in agreement with proposed Federal guidelines.

The manual has been prepared by the Arizona Bicycle Task Force for the use in jurisdictions throughout the State of Arizona. The use of this manual will help to establish uniform bicycle facilities in conformance with Federal Highway Administration guidelines.

It is important to note that this manual reflects suggested planning and design guidelines. These guidelines are not to be construed as adopted design criteria.

### Philosophy

The underlying philosophy of this manual is summarized in the following four points:

#### 1. Official Recognition of the Bicycle as a Vehicle

The Arizona Revised Statutes (A.R.S. 28-812) recognize the bicycle as a vehicle and, therefore, the bicycle is entitled to share the roadway with other vehicles except where expressly prohibited.

#### 2. Selection of Appropriate Facilities

Bicycles Facilities (i.e., bicycle routes, bicycle lanes, wide curb-lanes, and separate paths) should not be viewed as a hierarchy of facilities, but rather as various alternatives, each of which may be most appropriate depending on the circumstances.

Sidewalk bikeway facilities are not a recommended alternative. The decision to use a sidewalk as a bicycle facility is at the discretion of the local municipality.

#### 3. Desirability of Shared Roadway Facilities

Shared roadway facilities (bike lanes, wide curb-lanes), if properly designed and located, can afford the bicyclist with facilities equally as safe as separate facilities. The most significant advantages result from increased visibility and maneuverability, greater system directness and continuity, and lower cost (as compared to a totally separate system).

#### 4. Bicycles as a Transportation Alternative

The Urban and rural bicycling population consists of people of all ages who use the bicycle for exercise, efficient transportation, recreation, and an alternative to motorized transportation. A very significant percentage of the bicycling population includes youngsters and adults who have no other means of transporting themselves. In urban areas, special attention should be given to providing safe bicycle facilities in school zones and residential areas.

## Organization of This Manual

The remaining portion of the manual is organized into three major chapters. Chapter 2 discusses general location and selection criteria for bicycle facilities. Chapter 3 presents specific design guidelines for bicycle facility design. The Appendices include information on bicycle storage facilities, bicycle loop detectors and bicycle facility signing. A glossary of bicycle related terms and a selected bibliography is also included.



## LOCATION AND SELECTION CRITERIA

The factors to be considered in choosing the proper location for bicycle facilities vary depending on the situation. The most important variables usually include those discussed in this chapter.

## LOCATION CRITERIA FOR INCREASING ACCESSIBILITY

### Potential Use

The facility should be located along a route where use can be maximized. The following factors should be examined to identify origins and destinations of trips:

1. Household distribution (single-family and multi-family)
2. Location of employment center
3. Location of major commercial areas and shopping centers
4. Enrollment and location of educational institutions
5. Location of multi-modal interface points (e.g., end points of the transit system; major transfer points)
6. Location of parks and recreational areas
7. Location of fast food and convenience stores

### Access

In locating a bikeway, consideration should be given to provision of adequate access points. The more frequent and convenient the access points, the more the facility will be used. This is important for bikeways serving utility trips as well as recreational trips. Adequate access for emergency and service vehicles should also be provided. [2]

### Directness

The bikeway should serve activity centers along a direct course. If a bikeway is not located between the trip origin and desired destination points (desire lines), it will be inconvenient and will not be used by most bicycle riders. Along recreational routes, this factor is not as important. [2]

The bicycle is considered to be a legitimate mode of transportation; accordingly, access is required from all major origins to all destinations. Ideally, all origin and destination pairs should be made accessible.

## Existing Barriers

In some areas, there are major physical barriers to bicycle travel, caused by topographical features, freeways, canals, railroad tracks, or other impediments. In such cases, development of a bicycle facility crossing a barrier can provide new opportunities for bicyclists. [2] This would better optimize the available land and facilities.

## Delays

Bicycle travel is inherently a slower mode of travel, particularly for longer trips. If bicyclists are required to make frequent stops, they will generally avoid the route. [2]

For this reason, when a bikeway is established on a minor street, consideration should be given to orienting stop signs to restrict cross traffic at most intersections, rather than on the bike route. This does not apply to major crossings, such as arterials and collectors, where stopping the traffic in favor of the bike route would disrupt the hierarchy of the street systems. However, it should be pointed out that this measure might also permit motorized vehicles traveling on these minor streets to increase their speed, thus attracting more traffic to this particular roadway.

Through streets for bicycles can be created without attracting more auto traffic if the implementing agency is willing to install "DO NOT ENTER - BICYCLES EXEMPTED" signs at strategic points such as mile and half-mile streets.

## LOCATION CRITERIA FOR PROMOTING BICYCLE SAFETY

### Use Conflicts

Different types of facilities introduce different types of conflicts. Facilities on the roadway can involve conflicts between bicyclists and motor vehicles. Bike paths usually involve conflicts with other bicyclists, with pedestrians on the path, and with motor vehicles at street intersections, curb cuts, and driveways. Sidewalk facilities can increase conflicts with pedestrians, with motor vehicles at highway and driveway intersections, and with fixed objects such as utility poles and guy wires. [2]

In accordance with this criterion, the following are recommended:

1. Roadway facilities should be provided only if the design criteria--intended to reduce bicycle/motor vehicle conflicts--are met.
2. Wherever possible, bike paths and pedestrian paths should be separate from each other.

3. The location of two-way bike paths immediately adjacent to a roadway should be discouraged.
4. Sidewalk facilities may be used by youthful bicyclists and only under very special conditions should they become part of the adult bikeway system.

## Accidents

Reducing the number of bicycle accidents (i.e., bicycle/motor vehicle, bicycle/bicycle, bicycle/pedestrian, and single bicycle accidents) along routes is obviously important. The potential for alleviating accident problems through the improvement of a facility should be assessed, as should the potential for introducing new accident problems. [3]

When locating bicycle facilities, the following guidelines should be followed in order to reduce the potential for accidents:

1. In general, the location of bike facilities should be governed by the principle that the facility should not encourage or require bicyclists or motorists to operate in a manner inconsistent with the normal rules of the road.
2. Bicycle lanes should always be one-way facilities and carry traffic in same direction as adjacent motor vehicle traffic.
3. Sidewalk bikeway facilities are not a recommended alternative. The decision to use a sidewalk as a bicycle facility is at the discretion of the local municipality.

## Traffic Volumes and Speeds

For facilities on the roadway, traffic volumes and speeds must be considered along with the roadway width, frequency of intersections, number of driveways, and signs. Commuting bicyclists frequently use arterial streets because they minimize delay and offer continuity for trips of several miles. If adequate width for all vehicles is available on more heavily traveled streets, improving heavily traveled streets can be more desirable than improving adjacent streets. When this is not possible, a nearby parallel street may be improved for bicyclists, provided that stops are minimal and the route conditions are adequate. [3]

## Truck and Bus Traffic

Because of their aerodynamic effect and width, high-speed trucks, buses, motor homes, and trailers can cause special safety problems for bicyclists. [3]

Thus, if there is a choice between comparable routes, the route with the lower traffic volume would be preferable. As a general guide, shared roadway bikeways may be placed on roadways that carry truck/bus volumes of less than five percent of average daily traffic (ADT), and bike lanes may be accommodated on roadways with a combined truck/bus volume greater than five percent.

## Pavement Surface Quality

Facilities located on roadways must have smooth pavement. The need for a bikeway surface as smooth if not smoother than the normal road surface is predicated on the fact that most bicycles have high-pressure tires that transmit every bump and do not have a suspension system to absorb these bumps. (However, care should be taken so that pavement surfaces used by other vehicles are not so smooth as to be slick and, thus, hazardous.) Utility covers and drainage grates should be flush with the pavement surface, and drainage grates should be designed to allow the crossing of bicycles without causing a fall. Grates should have a checkerboard pattern, or have slats oriented perpendicular to the flow of traffic. Approaches to railroad crossings should be improved as necessary to provide for safe bicycle crossings. [3]

The criteria for pavement surface quality are discussed in subsequent sections.

## Maintenance

Ease of maintenance is important when locating facilities. Inadequately maintained facilities may prove to be poor investments. [3]

Proper maintenance can correct some unsafe conditions for bicycling; however, the cost of additional maintenance should also be considered.

## On-Street Parking

The turnover and density of on-street parking can affect the safety of bicyclists (e.g., opening car doors and cars entering or leaving angle parking spaces.) [3]

## LOCATION CRITERIA FOR IMPROVING SECURITY

Providing bicycle parking facilities is an essential element in an overall effort to promote bicycling and improve security. People are discouraged from bicycling unless sufficient and secure parking is available. Bicycle parking devices should be provided at both the trip origin and the destination and should offer protection from theft and damage.

The wide variety of bicycle parking devices fall into two categories of user needs: commuter or long-term parking, and convenience or short-term parking. The minimum needs for each differ with respect to placement and protection.

Long-term parking is needed at locations such as employment centers, schools, transit stations, and multi-family dwellings. Facilities should be provided which support the bicycle by the frame, secure both wheels and accessories, and offer protection from the weather. Bike lockers and attendant-operated storage areas are good examples of long-term parking facilities.

Short-term parking is needed at locations such as shopping centers, convenience and fast-food stores, libraries, recreation areas, and post offices. Facilities should be very convenient and should be near building entrances or other highly visible areas which are largely self-policing, and should support the bicycle by the frame. Where bicycle parking is not properly designed and located, bicyclists often use trees, railings, parking meters, and other fixed objects which can both cause damage to the object and create a hazard for pedestrians.

Several factors should be considered when planning and providing bicycle parking facilities. The facilities should protect bicycles from damage by automobiles and should not interfere with the normal pedestrian flow. Also, facilities should be adequately spaced so that persons parking their bicycles will not disturb other parked bicycles. Facilities should be able to accommodate a wide range of bicycle shapes and sizes. Finally, facilities should be simple to operate. If possible, signs depicting how to operate the facility should be posted. [3]

A wide variety of bicycle parking facilities are on the market today, ranging from simple racks, to racks complete with cable or locking devices, to lockers. Racks that rely on either of the wheels to support the bicycle can cause problems resulting in bent wheels, toppled over bicycles, and insufficient protection against theft. The best facilities do not rely on either wheel for support, yet provide secure locking. Parts theft can best be controlled by locating parking facilities in highly visible areas, or by providing for lockers or attendant-operated storage. Good design of bicycle parking facilities can help to make them attractive as well as convenient and secure.

## **LOCATION CRITERIA FOR IMPROVING RIDING ENVIRONMENT**

### **Air Quality**

The proximity to concentrations of air pollution should be considered for its possible effect on the health of bicyclists. [3]

Roadways with heavy, slow traffic are potential offenders, although a recent study by the U.S. DOT has shown that bicyclists do not develop higher bloodstream levels of carbon monoxide than do motorists traveling in the same corridor. Known air quality problem areas, or "hot spots," whether related to stationary or mobile pollutant sources, should be avoided if possible.

### **Attractiveness**

The scenic value is particularly important along a bikeway intended to serve a recreational purpose. [3]

## **Grades**

Steep grades on bikeways should be avoided if possible. Most bicyclists cannot negotiate steep uphill grades greater than 6 percent; these can be a severe deterrent to use of the facility. Also, riding downhill can be risky, particularly for unskilled bicyclists or for bicyclists with faulty equipment.

## **INTRODUCTION TO SELECTION CRITERIA**

The selection process should be governed by the principle that facilities should not encourage bicycle or motor vehicle use in a manner contrary to the normal rules of the road. Adherence to this principle enhances both user safety and convenience.

One important consideration in selecting the type of facility is continuity. Alternating segments of bike paths and bike lanes (or bike routes) along a route are generally incompatible, as street crossings by bicyclists are required when the route changes character. Also, wrong way bicycle travel will occur on the street beyond the ends of bike paths because of the inconvenience of having to cross the street.

## **BICYCLE FACILITY TYPE AND ROADWAY FUNCTION**

Once the bikeway options have been identified, each bicycle facility/roadway function combination must be further evaluated in terms of a number of location and design criteria such as traffic volumes and speeds, truck and bus traffic, street widths, on-street parking, etc.

Selection of the appropriate facility type to meet the bicycle need is dependent on many factors. The following paragraphs describe the most common uses for each facility type.

### **Bicycle Paths**

Generally, bike paths should be used to serve corridors not served by streets and highways or where wide rights-of-way exist permitting such facilities to be constructed away from the influence of parallel streets. Bike paths should offer opportunities not provided by the road system. They can either provide a recreational opportunity or, in some instances, can serve as direct high-speed commuter routes if crossflow by motor vehicles can be minimized. The most common uses are along rivers, lake shores, canals, utility rights-of-way, abandoned railroad rights-of-way, within college campuses, or within and between parks. There may also be situations where such facilities can be provided as part of planned developments. Another common application is to eliminate impediments to bicycle travel caused by construction of freeways, or because of the existence of natural barriers. [2]

In some cases, bike paths could also be accommodated within the interstate rights-of-way, assuming that applicable laws permit and the criteria for bicycle and motorized traffic separation and compliance with the normal rules of the road are met. Right-of-way widths would have to be such that adequate room exists for the separated facilities.

## **Bicycle Lanes**

Bicycle lanes are a portion of the roadway which has been designated for the preferential or exclusive use of bicyclists. This designation includes striped bike lanes, paved shoulders, and lanes for joint use by bicycles and disabled motor vehicles and bus-only diamond lanes. Tucson, for instance, uses a lane designated as BUS/RIGHT TURN ONLY (BICYCLES EXEMPTED).

Bike lanes are established along streets in corridors where there is significant bicycle demand, and where there are distinct needs that can be served by them. The purpose should be to improve conditions for bicyclists in the corridors and to better accommodate bicyclists through corridors with insufficient room for safe bicycling on existing streets. Other corridors that may warrant bike lanes include:

1. Corridors with heavy bicycle traffic, where bicyclists must frequently pass each other traveling in the same direction.
2. Insufficiently lighted corridors on which frequent nighttime usage is expected, e.g., those with a nighttime entertainment/shopping/education/recreational center as a common destination.
3. Corridors on which lane designation is not complicated by frequent residential or commercial driveways or roadway intersections.

Additional measures that might not be possible on all streets must be implemented on bike lane streets to improve the situation for bicyclists, (e.g., pavement surface improvements, stronger sweeping programs, special signal facilities, etc.). Special efforts should be made to ensure that high levels of service are provided with these lanes (i.e., bicycle-sensitive signal actuators, pavement markings, etc.), if bicycle travel is to be regulated by delineation. Additional night lighting of extensively traveled bicycle corridors also increases safety and comfort.

Bicycle lanes can be provided by widening existing roadways, paving shoulder areas, eliminating parking, or using emergency lanes for disabled vehicles.

## **Wide Curb-Lanes**

Like bike lanes, wide curb-lanes are placed along streets in corridors where there is significant bicycle demand. Unlike bicycle lanes, however, wide curb-lanes are for shared use by bicycle and motorized traffic. The added lane width provides greater room for maneuvering and increases the lateral distance between bicyclists and vehicles.

Wide curb-lanes are appropriate bicycle facilities where traffic speeds and volumes are tolerable for shared roadway facilities.

Wide curb-lane facilities are selected when there is insufficient room for a separate bike lane, yet significant demand exists for providing a facility of some kind. To many experienced riders, wide curb-lanes are a preferred facility type because it integrates bicycle and vehicular traffic, and forces recognition and awareness on the part of the motorist. Some studies have indicated that on-road facilities have a higher safety index than off-road (side-walk) facilities (Deleuw, Cather and Co.) [5]

Wide curb-lane facilities can be created by widening roadways, by narrowing traffic lanes, or a combination of both. It should be noted that both the AASHTO (American Association of State Highway Transportation Officials) and the National Advisory Committee on Uniform Traffic Control Devices have commented in favor of reducing vehicle lanes from 12 feet to 11 feet for the purpose of widening the right-most curb-lane for bicycle use.

## **Bicycle Routes**

Bike routes are shared facilities which serve either to: (1) provide continuity to other bicycle facilities (usually bike lanes); or (2) designate preferred routes through high-demand corridors. As with bike lanes, designation of bike routes should indicate to bicyclists that there are particular advantages to using these routes as compared with alternative routes. This means that responsible agencies have taken actions to ensure that these routes are suitable as shared routes and will be maintained in a manner consistent with the needs of bicyclists. Normally, bike routes are shared with motor vehicles. [2]

Bike route planning should be undertaken in conjunction with the local area's transportation planning so that the special needs for bicycle routes are integrated with the area's circulation needs.

## **Shared Roadway (No Bikeway Designation)**

Most bicycle travel now occurs on streets and highways without bikeway designations. This will probably be true in the future as well. In some instances, entire street systems may be fully adequate for safe and efficient bicycle travel, and signing and striping for bicycle use may be necessary. In other cases, a street may be inherently unsafe for bicycle travel and it would be inappropriate to encourage additional bicycle travel by designating the street as a bikeway.

Many rural highways are used by touring and recreational bicyclists for intercity travel. In most cases, it would be inappropriate to designate the highways as bikeways because of the limited use and the lack of continuity with other bike routes. [2]

## DESIGN CRITERIA

## DEFINITIONS

### AASHTO

American Association of State Highway and Transportation Officials.

### A.R.S.

Arizona Revised Statutes

### Bicycle

Every device propelled by human power upon which any person may ride, 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. (A.R.S. 28-101)

### Bicycle Facilities

A general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling, including parking facilities, maps, all bikeways, and shared roadways not specifically designated for bicycle use.

### 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.

### 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 a specific bicycle route number.

### Bikeway

Any road, path, or way which in some manner is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

### Highway

A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

### MUTCD

Manual of Uniform Traffic Control Devices. State law (A.R.S. 28-641) requires the adoption of a uniform system of traffic control devices which . . . shall correlate with and so far as possible conform to the system set forth in the most recent edition of the manual of uniform traffic control devices for streets and highways prepared by the National Joint Committee on Uniform Traffic Control Devices.

### Right-of-Way

A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation purposes, but with other associated uses such as utilities, water and sewage lines, bus benches and buffer zones.

### Right-of-Way

The right of one vehicle or pedestrian to proceed in a lawful manner in preference to another vehicle or pedestrian.

### Roadway

The portion of the highway, including shoulders, for vehicle use.

### 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.

### Sidewalk

The portion of a highway designed for preferential or exclusive use by pedestrians.

## INTRODUCTION

There is a wide range of facility improvements which can enhance transportation. 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 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 bicycle lanes depend on the roadway's design. On the other hand, bicycle paths are located on independent alignments; consequently, their design depends on many factors, including the performance capabilities of the bicyclist and the bicycle.

Improvements for motor vehicles through appropriate planning and design can enhance bicycle travel and in any event should avoid adverse impacts on bicycling. A community's overall goals for transportation improvements should, whenever possible, include the enhancement of bicycling. Public involvement in the form of public meetings or hearings or bicycle advisory groups is desirable during the planning and design process.

Guidelines are presented in this chapter to help design and construct both roadway improvements and separate paths that accommodate the operation characteristics of "bicycles" as defined in the guide. Modifications to facilities (e.g., widths, curve radii, superelevations, 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 judgment. Minimum standards should be strictly adhered to.

## **ROADWAY IMPROVEMENTS**

Bicycle-safe design practices, as described in this guide, 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 lanes, bicycle routes, shoulder improvements, and wide curb-lanes should be considered. Information on each of the different roadway improvements is contained in this section.

### **Drainage Grates**

Drainage grate inlets and utility covers are potential problems to bicyclists. When a new roadway is designed, all such grates and covers should be kept out of bicyclists' expected path. On new construction where bicyclists will be permitted, curb inlets should be used wherever possible to completely eliminate exposure of bicyclists to grate inlets. It is important that grates and utility covers be adjusted flush with the surface, including after a roadway is resurfaced.

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 bicyclist. These grates should be replaced with bicycle-safe and hydraulically efficient ones. When this is not immediately possible, weld steel cross straps of 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 pavement markings, the treatment indicated in the MUTCD (Appendix A), would be acceptable. In most situations, parallel bar grate inlets deserve special attention. Because of the serious consequences of a bicyclist missing the pavement marking in the dark or being forced over such a grate inlet by other traffic, these grates should be physically corrected as described above, as soon as practicable after they are identified.

### **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 bicyclist's front wheel to be trapped in the flangeway, 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 than approximately 45 degrees, consideration should be given to widening the outside lane, shoulder, or bicycle lane to allow bicyclists adequate room to cross the tracks at a right angle (see Figure 1). Where this is not possible, commercially available compressible flangeway fillers can enhance bicyclist safety. In some cases, abandoned tracks can be removed. Warning signs and pavement markings should be installed in accordance with the MUTCD.

### **Pavements**

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. Thus, to the extent practicable, pavement surfaces should be free of irregularities and the edge of the pavement should be uniform in width. On older pavements it may be necessary to fill joints, adjust utility covers or, in extreme cases, overlay the pavement to make it suitable for bicycling.

### **Traffic Control Devices**

At intersections where bicycle facilities are in place, 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 arrangement as motor vehicles; however, on multi-lane streets special consideration should be given to ensure that short clearance intervals are not used. If necessary, an all-red clearance interval may be used.



To check the clearance interval, a bicyclist's speed of 10 m.p.h. (16km/h) and a perception/-reaction/braking time of 2.5 seconds should be used. Detectors for traffic-actuated signals should be sensitive to bicycles and should be located in the bicyclists' expected path, including left-turn lanes. Where programmed visibility signal heads are used, they should be checked to insure that they are visible to bicyclists who are properly positioned on the road.

The MUTCD should be consulted for requirements 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. For additional information refer to Appendix A.

## Shoulders

Wide-curb lanes and bicycle lanes are usually preferred over shoulders for use by bicyclists. Shoulders are typically rough and contain much debris such as glass and obstacles. Therefore, they are usually a safety hazard.

However, if it is intended that bicyclists ride on shoulders, smooth paved shoulder surfaces should be provided and maintained in a clean and safe condition. Pavement edge lines supplement surface texture in delineating the shoulder from the motor vehicle lanes. Rumble strips 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.

Shoulder width should be a minimum of 4 feet (1.2m) when intended to accommodate bicycle travel. Roads with shoulders less than 4 feet (1.2m) wide normally should not be signed as bikeways. If motor vehicle speeds exceed 35 mph (55km/h), if the percentage of trucks, buses, and recreational vehicles is high, or if static obstructions exist at the right side, then additional width is recommended.

Adding or improving shoulders can often be the best way to accommodate bicyclists in rural areas, and they are also a benefit to motor vehicle traffic. Where 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.

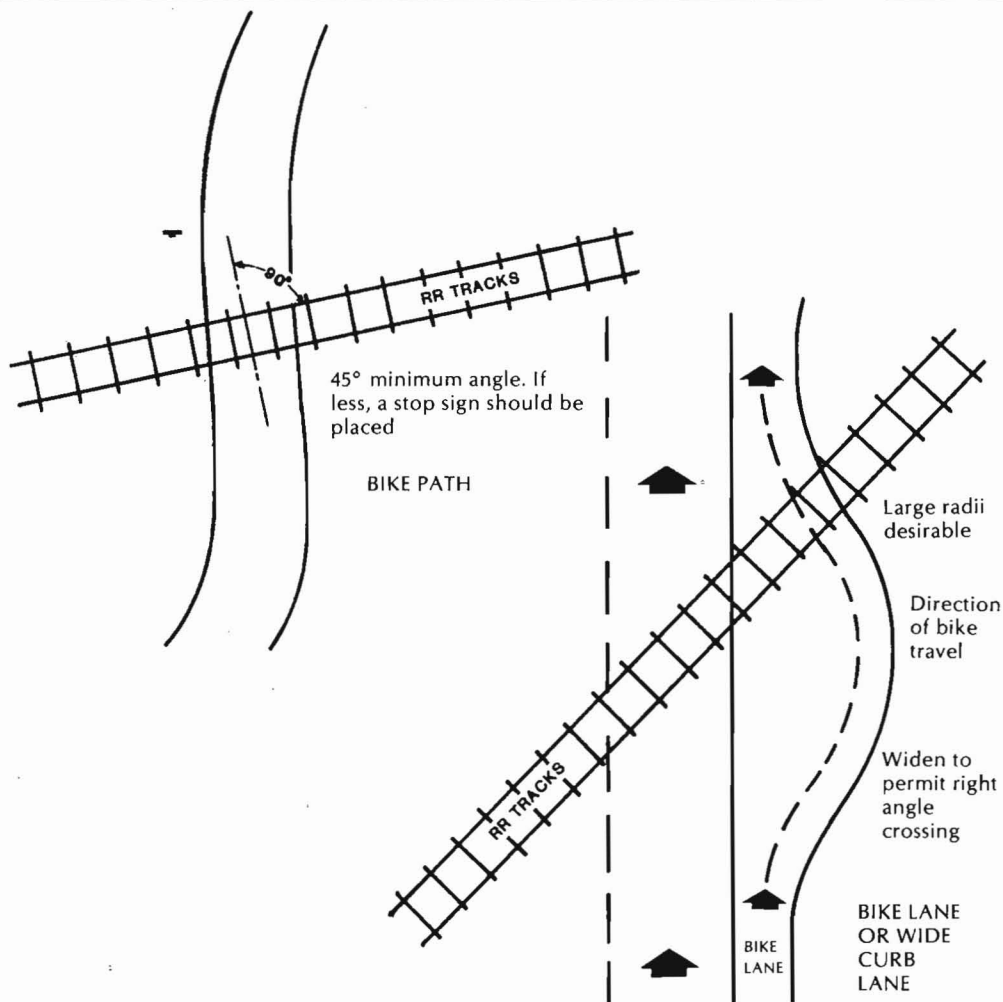


Figure 1

## Wide Curb-Lanes

On highway sections without bicycle lanes, a right lane wider than 12 feet (3.7m) can better accommodate both bicycles and motor vehicles in the same lane and thus is beneficial to both bicyclists and motorists. In many cases where there is a wide curb-lane, motorist will not need to change lanes to pass a bicyclist.

Also, more maneuvering room is provided when drivers are exiting from driveways or in areas with limited sight distance. In general, a lane width of 15 feet (4.3m) of usable pavement width is desired. Drainage grates, parking, and longitudinal ridges between pavement and gutter sections are not considered usable pavement.

Widths greater than these can encourage the undesirable operation of two motor vehicles in one lane, especially in urban areas. When widths exceed 14 feet of usable pavement surface, a pavement edge line should be striped to discourage the undesirable operation of two motor vehicles in one lane. For example, if 15 feet of usable pavement surface exists, 11 feet could be striped for the motor vehicle lane, whereby, the minimum desirable 4 feet of remaining width adjacent to the motor vehicle lane would be provided for the cyclist. [3]

Figure 2(a) shows a typical urban roadway with wide curb-lane.

When a right-turn only lane exists at an intersection the additional width should be placed in the right-most through lane (see Figure 3).

Restriping to provide wide curb-lanes can be accomplished on most existing multi-lane facilities by making the remaining travel lanes and left-turn lanes narrower. This should be performed after careful review of traffic characteristics along the corridor.

## BICYCLE ROUTES

It may be advantageous to sign some urban and rural roadways as bicycle routes. When providing continuity to other bicycle facilities, such as commuting facilities, a bicycle route can be relatively short. However, a bicycle touring route can be quite long. For long bicycle routes, a standard bicycle route marker with a numerical designation can be used in place of a bicycle route sign. Refer to Appendix A, (MUTCD Page 9B-10, Figure M1-8).

It is often desirable to use supplemental plaques with bicycle route signs or markers to furnish additional information, such as direction changes in the route, and intermediate range distance and destination information. [3]

Overall, the decision whether to provide a bicycle route should be based on the advisability of encouraging bicycle use on a particular road, instead of on parallel and adjacent highways. The roadway width, along with factors such as the volume, speed, type of traffic, parking conditions, grade, and sight distance, should be considered when determining the feasibility of a bicycle route.

Generally, bicycle traffic cannot be diverted to a less direct alternate route unless the favorable factors outweigh the inconvenience to the bicyclist. Roadway improvements, such as safe drainage grates, railroad crossings, smooth pavements, maintenance schedules, and signals responsive to bicycles, should always be considered before a roadway is identified as a bicycle route.

Further guidance on signing bicycle routes is provided in the MUTCD.

## BICYCLE LANES

Bicycle lanes can be considered when it is desirable to delineate the rights-of-way assigned to bicyclists and motorists and to provide for more predictable movements by each. Bicycle lanes may include striped lanes on the roadway, use of emergency parking lanes, or use of paved shoulders. Passing motorists are less likely to swerve into the bicycle lane, since the two have separate lanes. Bicycle lane markings can increase bicyclists' confidence in motorists not straying into their path of travel. Likewise, passing motorists do not move to the left to avoid bicyclists on their right. Raised pavement markings and raised barriers present a hazard to bicyclists and should not be used to delineate bicycle lanes. The use of paint or thermoplastic markings to delineate bike lanes are generally preferred. [3] Thermoplastic markings may be slick when wet.

Presently, State design directives require use of thermoplastic markings for most State contracted roadway improvements. One potential compromise may be to permit painted markings along shoulders or to delineate bicycle lanes, stop bars, crosswalks in a bicycle lane, or other areas where encounters with bicycles are likely.

Bicycle lanes should always be one-way facilities and flow in the same direction as adjacent motor vehicle traffic. Two-way bicycle lanes on each side of the roadway are undesirable because they promote riding against the flow of traffic. Wrong way riding is a major cause of bicycle accidents and violates the Rules of the Road stated in the Arizona Statutes.

In addition, the maintenance of a bike lane may require more sweeping than normal to clear surface debris from the lane.

## Bicycle Lane Widths

Under ideal conditions, the minimum desirable bicycle lane width is 4 feet (1.2m). However, certain edge conditions dictate additional desirable bicycle lane width. To examine the width requirements for bicycle lanes, Figure 2 shows three usual locations for such facilities in relation to the roadway. Figure 2b depicts bicycle lanes on an urban curbed street where a parking lane is provided. The recommended bicycle lane width for this location is 5 feet (1.5m). Bicycle lanes should always be placed between the parking lane and the motor vehicle lanes. Bicycle lanes between curb and the

parking lane create hazards for bicyclists from opening doors and poor visibility at intersections and driveways, and they prohibit bicyclists from making left turns; therefore, this placement shall never 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 (3.7m) 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 bicycle lanes as shown in Figure 2b. In both instances, if parking volume is substantial or turnover is high, an additional 1 or 2 feet (0.3 or 0.6m) of width is desirable for safe bicycle operation.

Figure 2c depicts 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, of hitting a pedal on the curb, of an uneven longitudinal joint, or of a steep cross slope.

Bicycle lanes in this location should have a minimum width of 5 feet (1.5m) from the curb face. If the longitudinal joint between the

gutter pan and the roadway surface is uneven and falls within 5 feet (1.5m) of the curb face, a minimum of 4 feet (1.2m) should be provided between the joint and the motor vehicle lanes.

Figure 2d depicts bicycle lanes on a highway without curb or gutter. Bicycle lanes shall be located between the motor vehicle lanes and the roadway shoulders. Bicycle lanes may have a minimum width of 4 feet (1.2m) where the shoulder can provide additional maneuvering width if paved. A width of 5 feet (1.5m) or greater is preferable; additional widths are desirable where substantial truck traffic is present, where prevailing winds are a factor, where motor vehicle speeds exceed 35 mph (55km/h), or if the shoulder is not paved.

The typical width for a motor vehicle lane adjacent to a bike lane is 12 feet (3.6m). There are situations where it may be necessary to reduce the width of motor vehicle lanes in order to stripe bike lanes. In determining the appropriateness of narrower motor vehicle lanes, consideration should be given to factors such as motor vehicle speeds, truck volumes, alignment, and sight distance. Where favorable conditions exist, narrow motor vehicle lanes may be feasible.

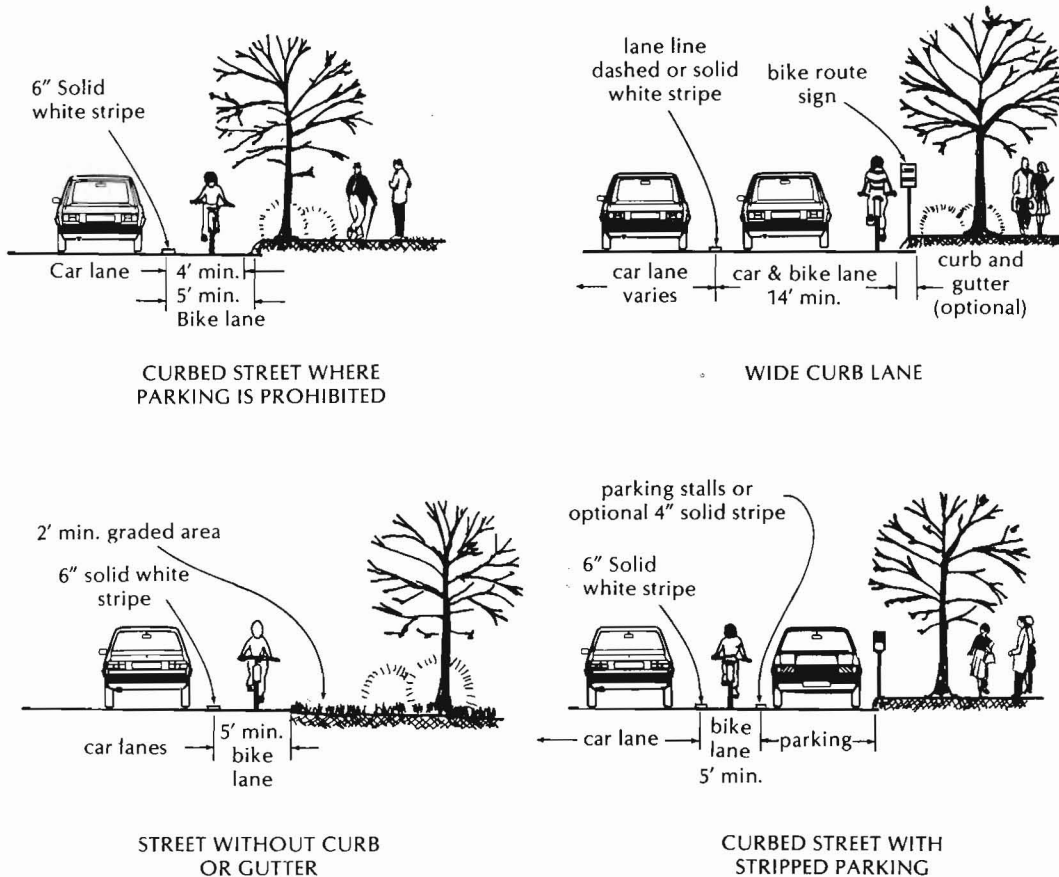
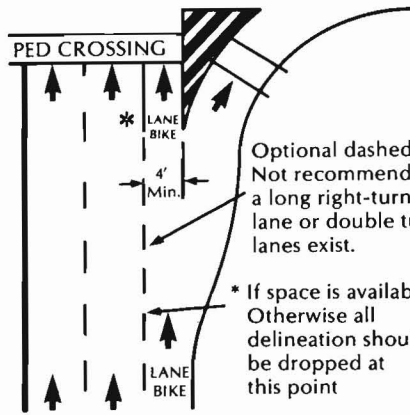
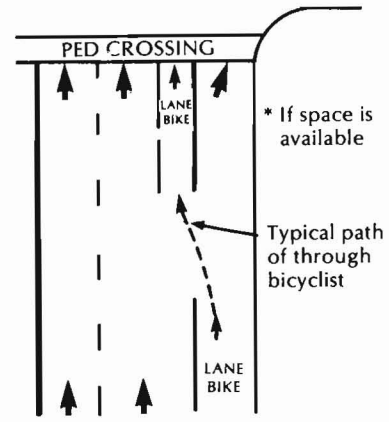


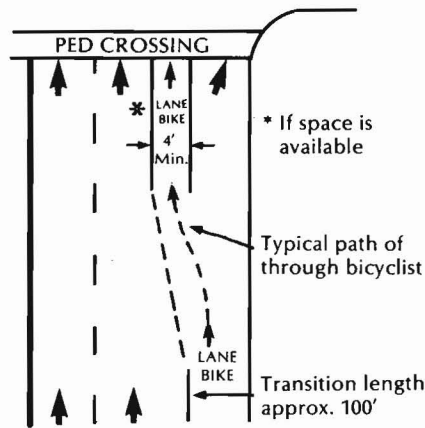
Figure 2



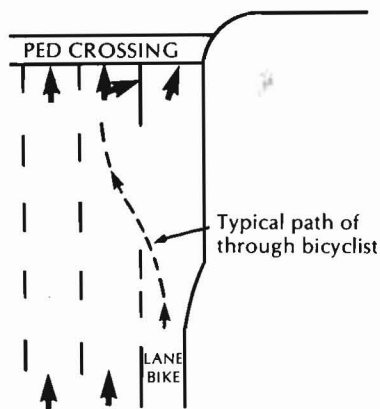
RIGHT TURN ONLY LANE



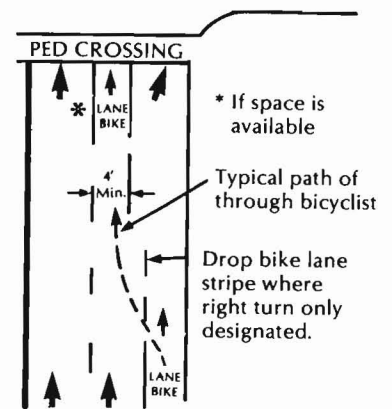
PARKING LANE BECOMES RIGHT TURN ONLY LANE



PARKING LANE BECOMES RIGHT TURN ONLY LANE WITH BIKE LANE STRIPING



OPTIONAL DOUBLE RIGHT TURN ONLY LANE



RIGHT LANE BECOMES RIGHT TURN ONLY LANE

Source: AASHTO Guide for Development of New Bicycle Facilities

BIKE LANES APPROACHING MOTORIST RIGHT-TURN ONLY LANES

## Bike Lanes on One-Way Streets

If the bike lanes are to be located on one-way streets, the following guidelines should be kept in mind:

1. It is preferable to have lanes on the right side of the one-way street.
2. Bicycle lanes on the left side may be desirable if they reduce conflicts that may occur with heavy bus traffic.

## Intersections With Bike Lanes

Bicycle lanes tend to complicate both 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 turn. Thus, some bicyclists will begin left turns from the right-side bicycle lane and some motorists will begin right turns from the left of the bicycle lane. Both maneuvers are contrary to established Rules of the Road and result in conflicts. Common movements of motorists and bicyclists are shown in Figure 4.

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

When confronted with such intersections, bicyclists have to merge with right-turning motorists. Since bicyclists are typically traveling at lower speeds than motorists, they should signal and merge where there is a sufficient gap in right-turning traffic, rather than at a predetermined location. For this reason, it is recommended that either all delineation be dropped at the approach of the right-turn lane (or off ramp) or that a single, dashed bike lane line be used to aid smooth transition across the right-turn lane (see Figure 3). A pair of parallel lines (delineating a bike lane crossing) to channel the bike merge is not recommended, as bicyclists will be encouraged to cross at a predetermined location, rather than when there is a safe gap in right-turning traffic. Also, some bicyclists are apt to assume they have the right-of-way, and may not check for right-turning motor vehicle traffic.

A dashed line across the right-turn-only lane (or off-ramp) is not recommended on extremely long lanes, or where there are double right-turn-only lanes. For these types of intersections, all striping should be dropped to allow the bicyclist’s judgment to prevail. Bike lanes crossing on-ramps do not present the same problems, as bicyclist normally have a good view of traffic entering the roadway, and will adjust their path as necessary to cross ramp traffic. A “Bike Xing” sign may be used to warn motorists of the potential for bicyclists crossing their path. [2]

Figures 3 and 5 present examples of details on pavement markings for bicycle lanes, approaching motorists right-turn-only lanes and for on and off ramps. Where there are numerous left-turning bicyclists, a separate turning lane, as indicated in Part IX of the MUTCD (see Appendix A) should be considered. The design of bicycle lanes should also include appropriate signing at intersections to reduce the number of conflicts. General guidance for pavement markings for bicycle lanes is contained in the MUTCD.

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

A wide separation between a bicycle path and canals, ditches or other significant depressions is essential for safety. A minimum 5 foot separation from the edge of the bike path pavement to the top of the slope is desirable. If this is not possible, a positive barrier such as dense shrubbery or a chain link fence should be provided (see Figure 7).

A wide separation between a bicycle path and an adjacent highway is desirable to confirm to both the bicyclist and the motorist that the bicycle path functions as an independent highway for bicycles. When this is not possible and the distance between the edge of the roadway and the bicycle path is less than 5 feet (1.5m), a suitable physical divider, such as a fence, dense shrubs, or other barrier should be included in the design. Such dividers serve both to prevent bicyclists from making unwanted movements between the path and the highway shoulder and to reinforce the concept that the bicycle path is an independent facility. Where used, the divider should be a minimum of 4.5 feet (1.4m) high to prevent bicyclist from toppling over it, and it should be designed so that it does not become a hazard in itself.

The vertical clearance to obstructions should be a minimum of 8 feet (2.4m). However, vertical clearance may need to be greater to permit passage of maintenance vehicles and, in undercrossings and tunnels, a clearance of 10 feet (3m) is desirable for adequate vertical shy distance.

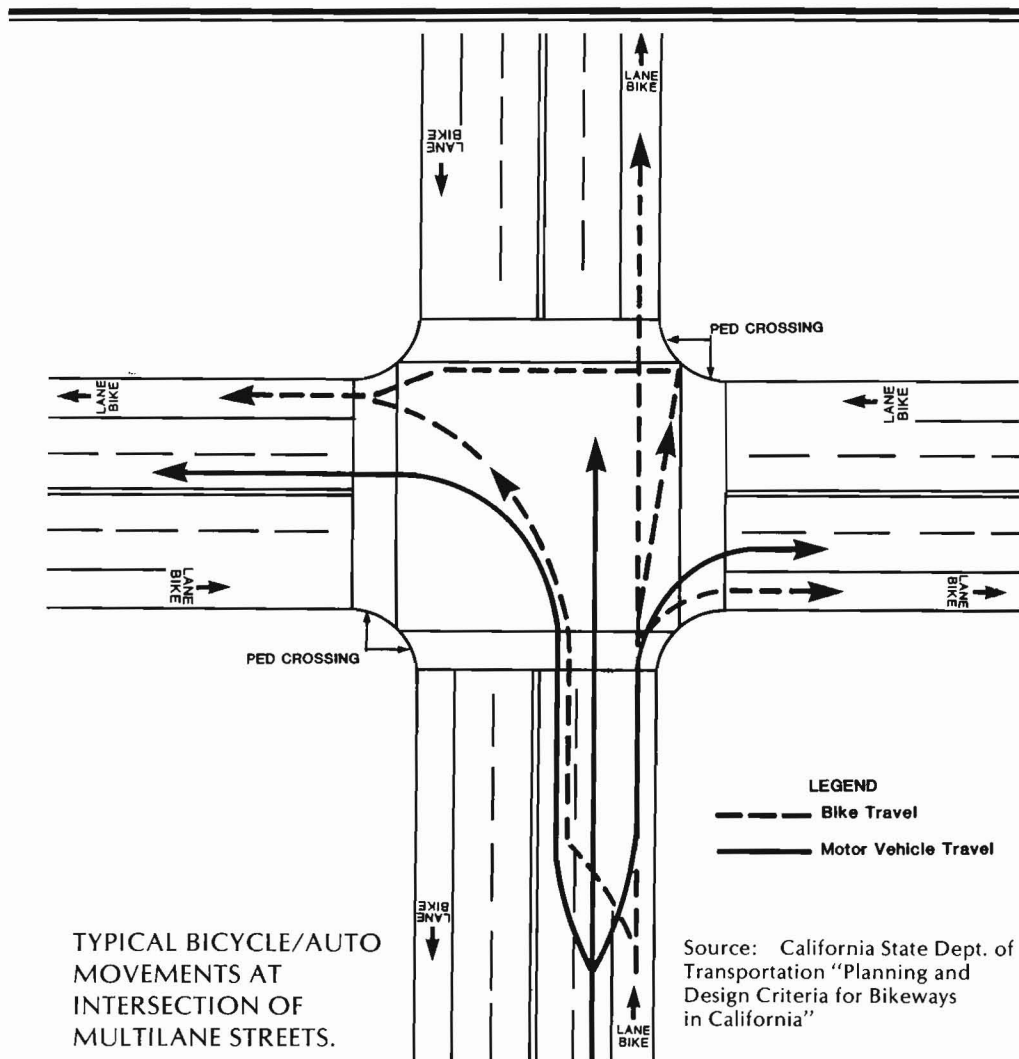


Figure 4

### Signal Design for Bicycle Lanes

At intersections where there are bike lanes and traffic signals, installation of bicycle-sensitive loop detectors within the bike lane is desirable. This is particularly important where signals are traffic-actuated, and will not change for a bicyclist unless a motor vehicle is present, or unless the bicyclist leaves the bike lane to trip the signal within the traffic lane. Generally, push button actuators are unsatisfactory at intersections; if the actuator is not properly located near the curb, bicyclists may have to dismount to reach it on the sidewalk. Often button activators are located 4 feet from the face of the curb.

It is also important that loop detectors in left-turn lanes be sensitive enough to detect bicycles. Where significant bicycle use is anticipated on any street with traffic-actuated signals it is recommended to install loop detectors that are sensitive enough to detect bicycles. [2] An example of such a loop detector is included in Appendix C.

### Striping and Signing Bicycle Lanes

General requirements for striping and signing of bike lanes are contained in the MUTCD (see Appendix A and Figures 3 and 5). These guidelines are appropriate for Arizona and should always be consulted and followed.

Raised barriers (e.g., raised traffic bars and asphalt concrete dikes) or raised pavement markers should not be used to delineate bike lanes. Raised barriers and pavement markers prevent motorists from merging into bike lanes before making right turns, as required by the UVC (Uniform Vehicle Code), and restrict the movement of bicyclists desiring to enter or exit bike lanes. In addition, they can impede routine maintenance activities.

Adequate pavement surface, bicycle-safe grate inlets, and safe railroad crossings should always be provided on roadways where bicycle lanes are being designated. [2]

Where funding is limited, adding or improving bike lanes on uphill sections first will give slower moving bicyclists needed maneuvering space and decrease conflicts with faster moving motor vehicle traffic.

## BICYCLE PATHS

Bicycle paths are facilities on exclusive rights-of-way and with minimal cross flow by motor vehicles. Bicycle paths can serve a variety of purposes. They can provide a commuting bicyclist with a shortcut through a residential neighborhood (e.g., a connection between two cul-de-sac streets).

Located in a park, they can provide an enjoyable recreational opportunity. Bicycle paths can be located along abandoned railroad rights-of-way, the banks of rivers and canals, and other similar areas. Bicycle paths can also provide bicycle access to areas that are otherwise served only by limited access highways closed to bicycles. Appropriate locations can be identified during the planning process.

Bicycle paths should be thought of as extensions of the highway system that are intended for the exclusive or 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 design criteria for bicycle paths and those for highways (e.g., in determining horizontal alignment, sight distance requirements, signing, and markings). On the other hand, some criteria (e.g., horizontal and vertical clearance requirement, grades, and pavement structure) are dictated by operating characteristics of bicycles that are substantially different from those of motor vehicles. The designer should always be conscious of the similarities and the differences between bicycles and motor vehicles and of how these similarities and differences influence the design of bicycle paths. The following sections provide guidance for designing a safe and functional bicycle path.

### Separation Between Bike Paths and Highways

Bike paths should not be considered a substitute for the street because many bicyclists will find it less convenient to ride on these types of facilities as compared with the streets, particularly for utility trips. Some problems with bike paths located immediately adjacent to roadways are as follows:

1. Unless paired, they require one direction of bicycle traffic to ride against automobile traffic, contrary to normal rules of the road.
2. When the bike path ends, bicyclists going against traffic will tend to continue to travel on the wrong side of the street. Likewise, bicyclists approaching a bike path often travel on the wrong side of the street in getting to the path. Wrong way travel by bicyclists is a major cause of bicycle/automobile accidents and should be discouraged at every opportunity.

3. At intersections, motorists entering or crossing the highway often will not notice bicyclists coming from their right, as they are not expecting contra-flow vehicles. Even bicyclists coming from the left often go unnoticed, especially when sight distances are often poor.
4. When constructed in narrow roadway right-of-way, the shoulder is often sacrificed, thereby decreasing safety for motorists and bicyclists using the roadway.
5. Many bicyclists will use the highway instead of the bike path because they have found the highway to be safer, more convenient, or better maintained. Bicyclists using the highway are often subjected to harassment by motorists, who feel that in all cases bicyclists should be on the path instead.
6. Bicyclists using the bike path generally are required to stop or yield at all cross streets and driveways, while bicyclists using the highway usually have priority over cross traffic, because they have the same right-of-way as motorists.
7. Stopped cross street motor vehicle traffic or vehicles exiting side streets or driveways may block the path crossing.
8. Because of the closeness of motor vehicle traffic to opposing bicycle traffic, barriers are often necessary to keep motor vehicles out of bike paths and bicyclists out of traffic lanes. These barriers can be a hazard to bicyclists and motorists, can complicate maintenance of the facility, and can cause other problems as well.

For the above reasons, bike lanes, wide curb-lanes or bike routes (shared use) may be the best way to accommodate bicycle traffic along highway corridors depending upon traffic conditions. [2]

### Width and Clearance for Bicycle Paths

The paved width and the operating width required for a bicycle path are primary design considerations. Figure 6 depicts a bicycle path on a separated right-of-way. Under most conditions, a desirable minimum all-paved width for a two-directional bicycle path is 10 feet (3m). In some instances, however, a minimum of 8 feet (2.4m) 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) pedestrian use of the facility is not expected to be more than occasional, (3) there will be good horizontal and vertical alignment, providing safe and frequent passing opportunities, and (4) the path 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 a bicycle path to 12 feet (3.7m); i.e., a substantial bicycle volume, possible shared use with joggers and other pedestrians, use by large maintenance vehicles, steep grades, and where bicyclists will likely to ride two abreast.

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

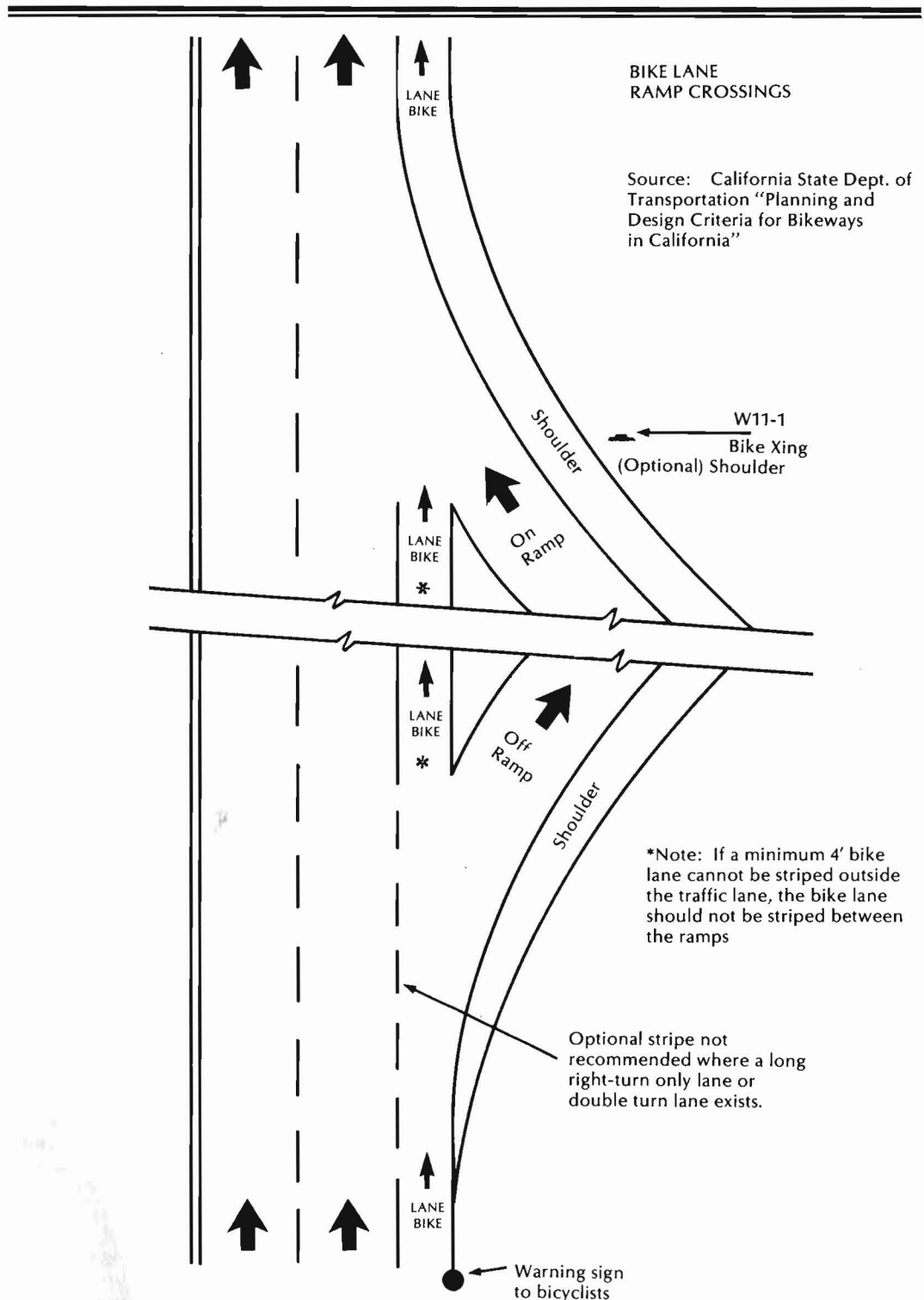
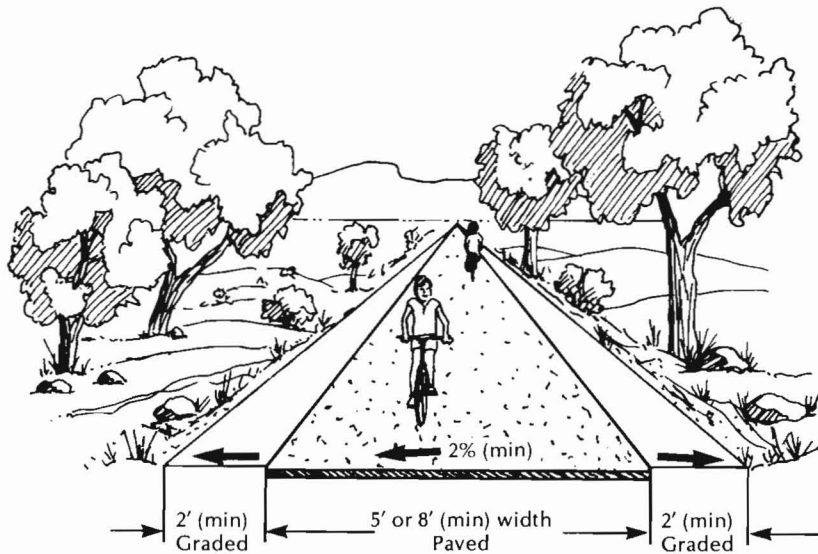


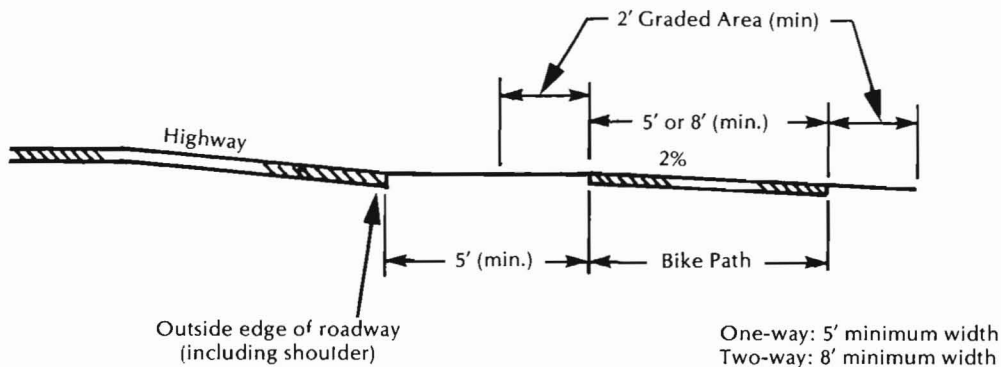
Figure 5





One-way: 5' minimum width  
 Two-way: 8' minimum width  
 Metric Conversion: 1 ft. = 0.3 m.

(not to scale)



TWO-WAY BIKE PATH ON SEPARATED RIGHT-OF-WAY

Figure 6

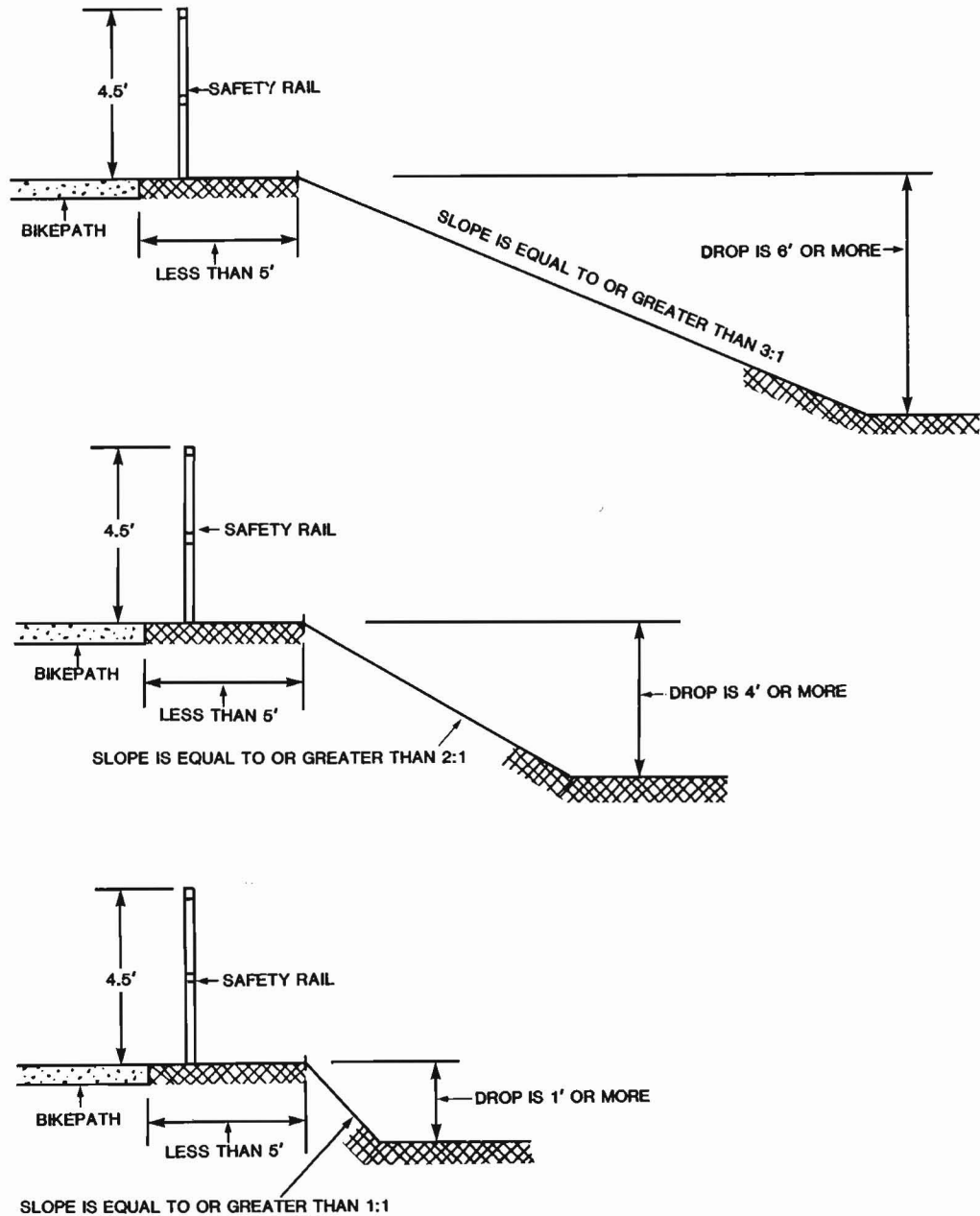
### Bicycle Path Design Speed

The speed that a bicyclist travels is dependent on several factors, including the type and condition of the bicycle, the purpose of the trip, the condition and location of the bicycle path, the speed and direction of the wind, and the physical condition of the bicyclist. Bicycle paths should be designed for selected speed that is at least as high as the preferred speed of the faster bicyclists. In general, a minimum design speed of 20 mph (32km/h) should be used; however, when the grade exceeds 4 percent, or where strong prevailing tailwinds exist, a design speed of 30 mph (48km/h) is advisable.

On unpaved paths, where bicyclists tend to ride slower, a lower design speed of 15 mph (24km/h) can be used. Similarly, where the grades and the prevailing winds dictate, a higher design speed of 25 mph (40km/h) can be used. Since bicycles have a higher tendency to skid on unpaved surfaces, horizontal curvature design should take into account lower coefficients of friction.

“Speed bumps” or similar surface obstructions, intended to slow down bicyclists in advance of intersections, should not be used.

## BIKEPATH SAFETY RAILS ALONG SIDE SLOPES



SAFETY RAIL IS NEEDED WHERE THE CONDITIONS  
WILL EXCEED THE ABOVE DEPICTED LIMITS

## Bicycle Path Horizontal Alignment and Superelevation

The minimum radius of curvature negotiable by a bicycle is a function of the superelevation rate at a bicycle path surface, the coefficient of friction between the bicycle tires and the bicycle path surface, and the speed of the bicycle. The minimum design radius of curvature can be derived from the following formula.

$$R = \frac{V^2}{15(e + f)}$$

Where R = Minimum radius of curvature (ft.)  
 V = Design speed (mph)  
 e = Rate of superelevation  
 f = Coefficient of friction

For most bicycle path applications, the superelevation rate will vary from a minimum of 2 percent (the minimum necessary to encourage adequate drainage) to a maximum of approximately 5 percent (beyond which maneuvering difficulties by slow bicyclists and adult tricyclists might be expected). The minimum superelevation rate of 2 percent will be adequate for most conditions and will simplify construction.

The coefficient of friction depends upon speed; surface type, roughness, and condition; tire type and condition; and whether the surface is wet or dry. Friction factors used for design should be selected based upon the point at which centrifugal force causes the bicyclist to recognize a feeling of discomfort and instinctively act to avoid higher speed. Extrapolating from values used in highway design, design friction factors for paved bicycle paths can be assumed to vary from 0.30 at 15 mph (24km/h), to 0.22 at 30 mph (48km/h). Although there are no data available for unpaved surfaces, it is suggested that friction factors be reduced by 50 percent to allow a sufficient margin of safety.

Based upon a superelevation rate (e) of 2 percent, minimum radii of curvature can be selected from Table 1.

When substandard radius curves must be used on bicycles paths because of right-of-way, topographical, or other considerations, standard curve warning signs and supplemental pavement markings shall be installed in accordance with the MUTCD. The negative effects of substandard curves can also be partially offset by widening the pavement through the curves.

**TABLE 1**  
**DESIGN RADII FOR PAVED BICYCLE PATHS**

Design Speed - V (mph) (1 mph = 1/6km/hr)	(e = 2 percent) Friction Factor - f	Design Radius (feet) (1 ft. = 0.3m)
20	0.27	95
25	0.25	155
30	0.22	250
35	0.19	390
40	0.17	565

## Grades on Bicycle Paths

Grades on bicycle paths should be kept to a minimum, especially on long inclines. Grades greater than 5 percent are undesirable because the ascents are difficult for many bicyclists to climb and the descents cause some bicyclists to exceed the speeds at which they are competent. Where terrain dictates, grades over 5 percent and less than 500 feet (150m) long are acceptable when a higher design speed is used and additional width is provided.

## Bicycle Path Sight Distance

To provide bicyclists with an opportunity to see and react to the unexpected, a bicycle path should be designed with adequate stopping distances. The distance required to bring a bicycle to a full controlled stop is a function of the bicyclist's perception and brake reaction time, the initial speed of the bicycle, the coefficient of friction between the tires and the pavement, and the braking ability of the bicycle. [3]

Figure 8 indicates the minimum stopping sight distance for various design speeds and grades based on a total perception and brake reaction time of 2.5 seconds and a coefficient of friction of 0.25 to account for the poor wet weather braking characteristics of many bicycles. For two-way bicycle paths, the sight distance in the descending direction, that is, where "G" is negative, will control the design.

Figure 9 is used to select the minimum length of vertical curve necessary to provide minimum stopping sight distance at various speeds on crests. The eye height of the bicyclist is assumed to be 4.5 feet (1.4m) and the object height is assumed to be zero to recognize that hazards to bicycle travel exist at pavement level.

Figure 10 indicates the minimum clearance that should be used to line-of-sight obstructions for horizontal curves. The desired lateral clearance is obtained by entering Figure 10 with the stopping sight distance from Figure 8 and the proposed horizontal radius of curvature.

Bicyclists frequently ride abreast of each other on bicycle paths and, on narrow bicycle paths, have a tendency to ride near the middle of the path. For these reasons, and because of the serious consequences of a head-on bicycle accident, lateral clearances on horizontal curves should be calculated based on the sum of the stopping sight distances for bicyclists traveling in opposite directions around the curve. Where this is not possible or feasible, consideration should be given to widening the path through the curve, installing a yellow center stripe, installing a "curve ahead" warning sign in accordance with the MUTCD, or some combination of these alternatives.

## Intersections with Bicycle Paths

Intersections are an important consideration in bicycle path design. If alternate locations for a bike path are available, the one with the most favorable intersection conditions should be selected. The ideal intersection design is a grade separation, but in many cases its cost is prohibitive. Some recommended intersection treatments are shown in Figures 11 through 15.

When intersections occur at a grade, a major consideration is the establishment of right-of-way. The type of traffic control to be used (signal, stop or yield sign, etc.) and location should be in accordance with the MUTCD. Care should be taken to ensure that bike path signs are located so that motorists are not confused by them, and that highway signs are placed so that cyclists are not confused by them. At crossings with infrequent automobile traffic, such as residential or commercial driveways, bicycles should be given priority. In any event, adequate sight distance and proper signing must be provided.

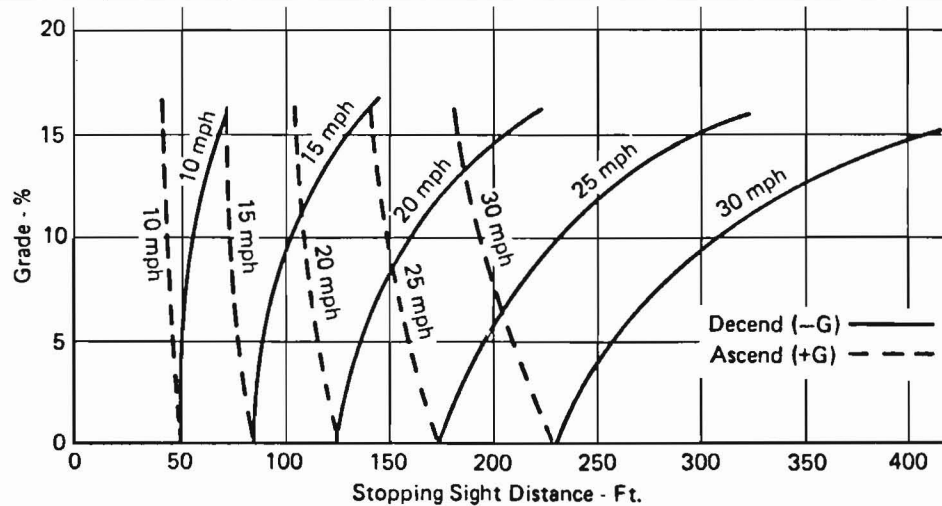
It is preferable that the crossing of a bicycle path and a highway be at a location away from the influence of intersections with other highways. Controlling vehicle movements at such intersections is more easily and safely accomplished through the application of standard traffic control devices and normal Rules of the Road. Where physical constraints prohibit such independent intersections, the crossings may be at or adjacent to the pedestrian crossing. Rights-of-way should be assigned, and sight distance should be provided so as 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 crossing bicyclists.

Bicycle path intersections and approaches should be on flat grades (to allow for starting and stopping and adequate line-of-sight requirements). Stopping sight distances at intersections must be checked and adequate warning be provided to permit bicyclists to stop before reaching the intersection, especially on downgrades.

The maximum grade of the approaches should be 5 percent. Consideration should be given to a flat approach preceded by a short, steep, vertical section in areas where slopes are unavoidable.

Curb-cuts at intersections should be the same width as the bicycle paths. Curb-cuts and ramps should provide a smooth transition between the bicycle paths along the roadway. [3]



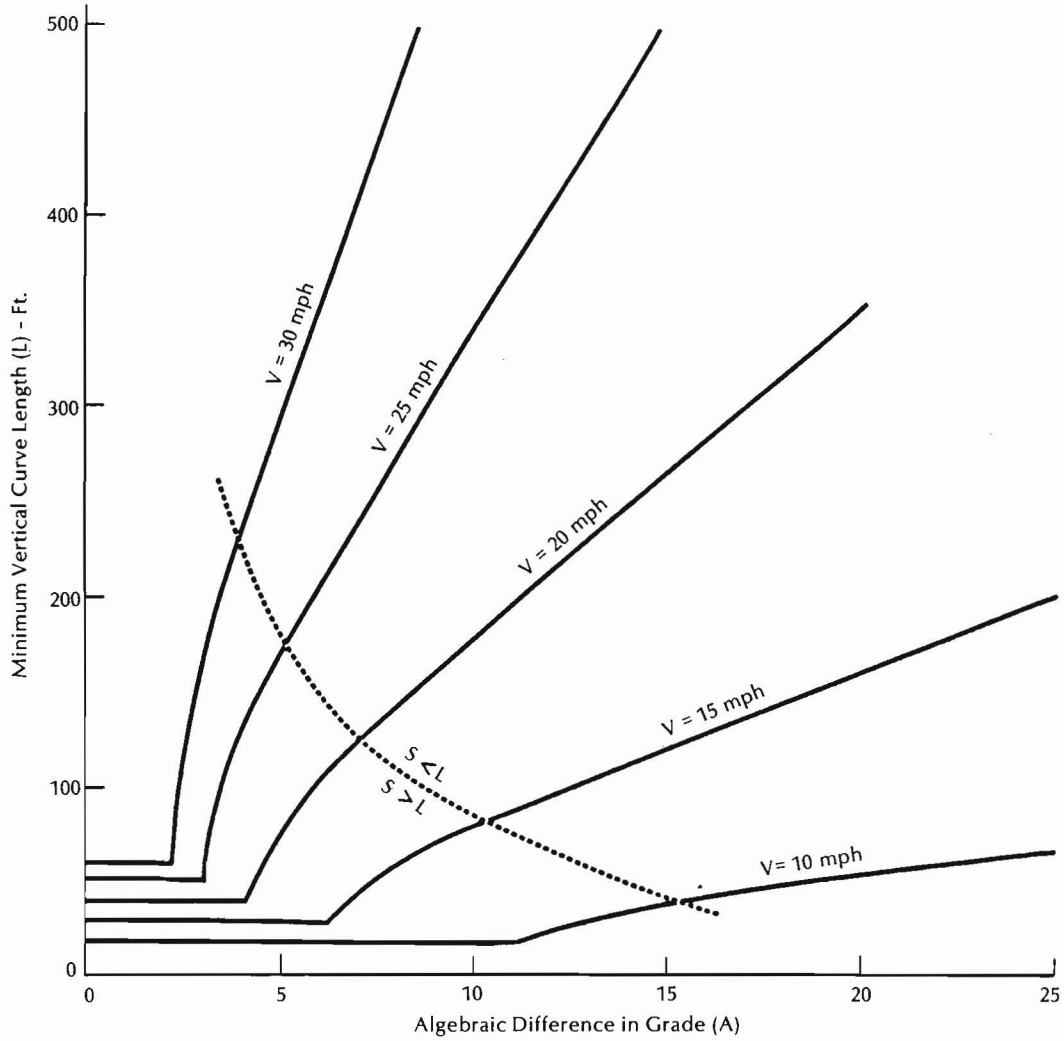
$$S = \frac{V^2}{30(f \pm G)} + 3.67 V$$

(Metric conversion: 1 ft. = 0.3m, 1 mph = 1.6 km/h)

Where: S = Stopping Sight Distance, Ft.  
V = Velocity, mph  
f = Coefficient of Friction (use 0.25)  
G = Grade Ft./Ft. (rise/run)

Figure 8

Source: AASHTO Guide for Development of New Bicycle Facilities



$$L = 2S - \frac{200 (\sqrt{h_1} + \sqrt{h_2})^2}{A} \quad \text{When } S > L$$

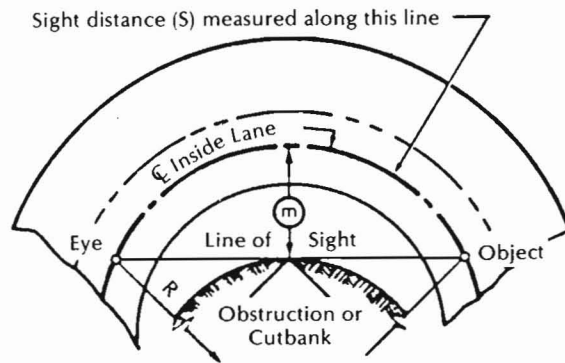
$$L = \frac{AS^2}{100 (\sqrt{2h_1} + \sqrt{2h_2})^2} \quad \text{When } S < L$$

$$L_{MIN} = 2V$$

S = Stopping Site Distance (Ft.)  
 A = Algebraic Difference in Grade  
 $h_1$  = Eye Height of Bicyclist (4.5 Feet)  
 $h_2$  = Height of Object (0 Feet)  
 L = Minimum Vertical Curve Length (Ft.)

SIGHT DISTANCES FOR CREST VERTICAL CURVES

Figure 9



Line of sight is 2.0' above C inside lane at point of obstruction

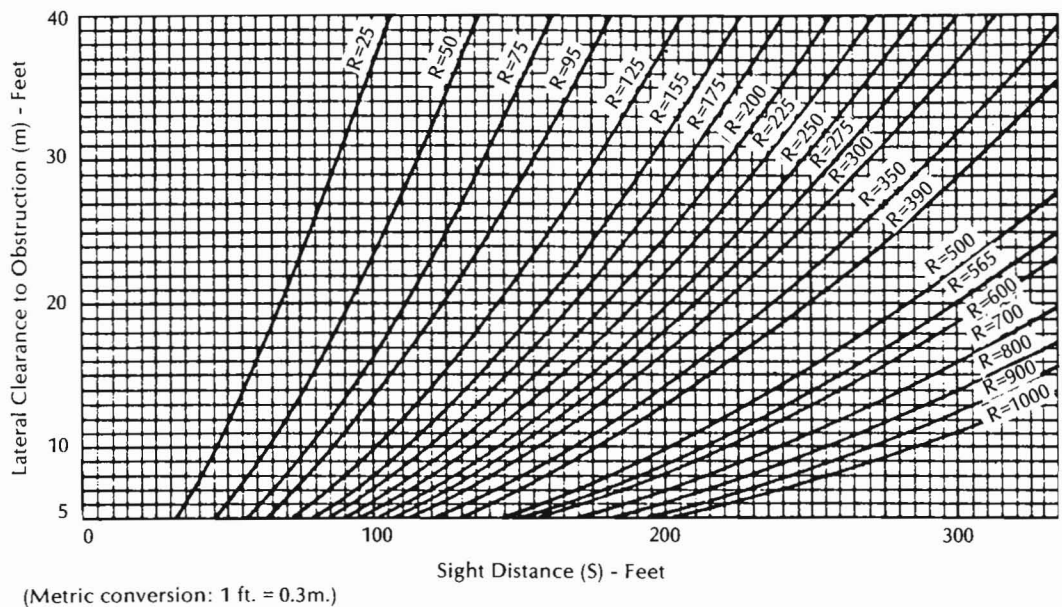
- S = Sight distance in feet.
- R = Radius of C inside lane in feet.
- M = Distance from C inside lane in feet.
- V = Design speed for S in mph.

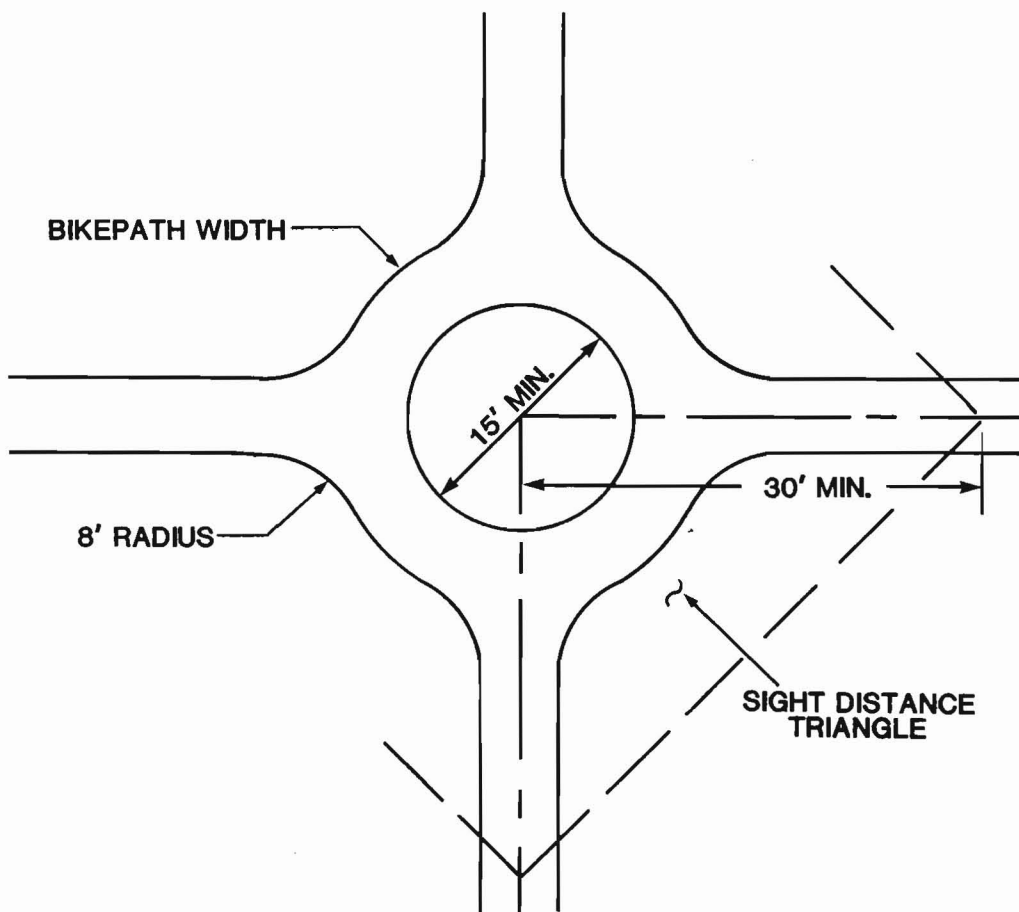
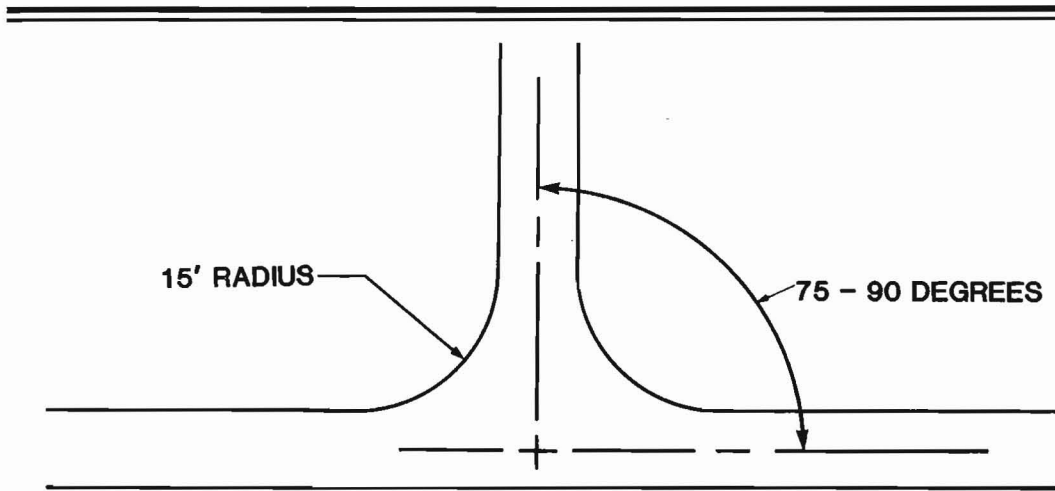
Angle is expressed in degrees

$$m = R \left[ \text{vers} \left( \frac{28.655}{R} \right) \right]$$

$$S = \frac{R}{28.65} \left[ \cos^{-1} \left( \frac{R-m}{R} \right) \right]$$

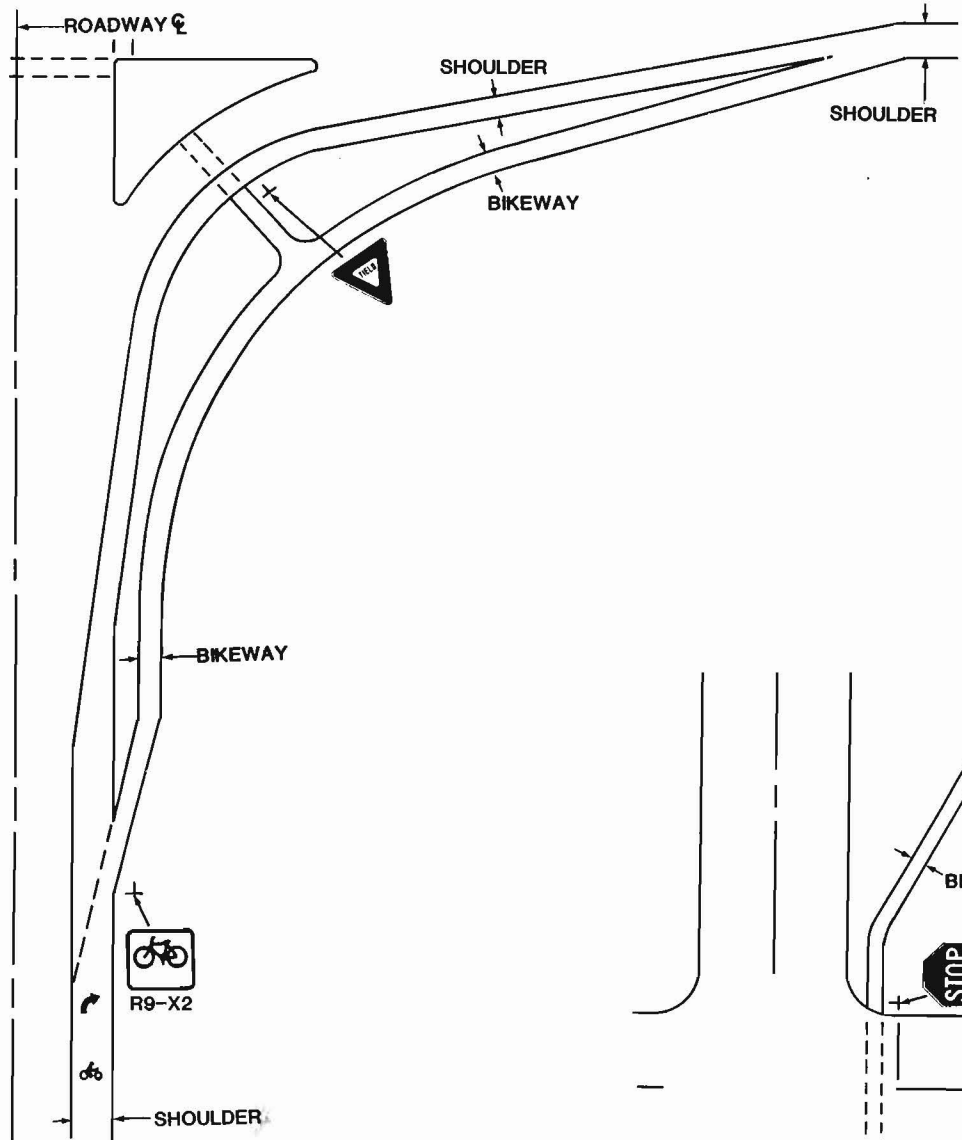
Formula applies only when S is equal to or less than length of curve.





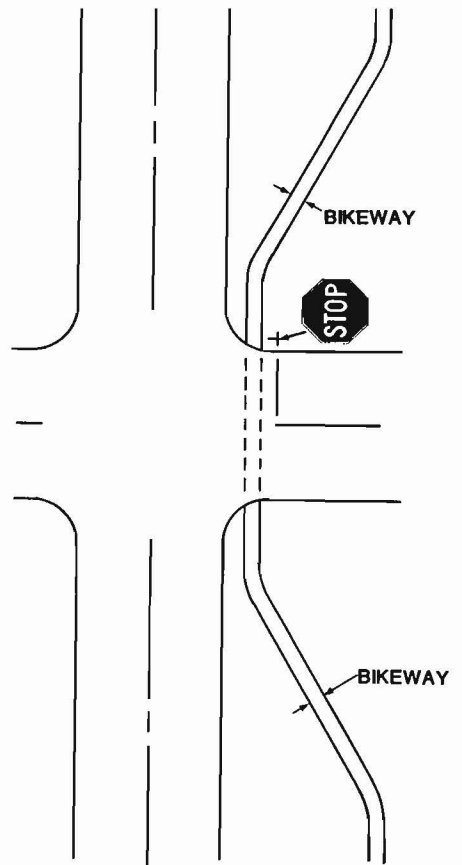
## BIKEPATH INTERSECTIONS

Figure 11



HIGH SPEED - HIGH VOLUME  
ON ROAD TO OFF ROAD TREATMENT

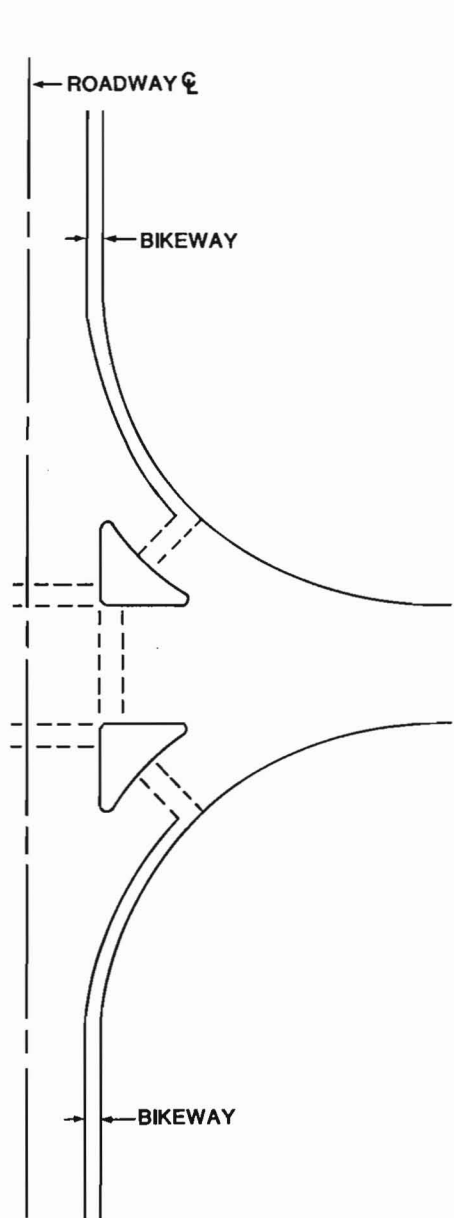
Figure 12



OFFSET BIKEWAYS  
INTERSECTION TREATMENT

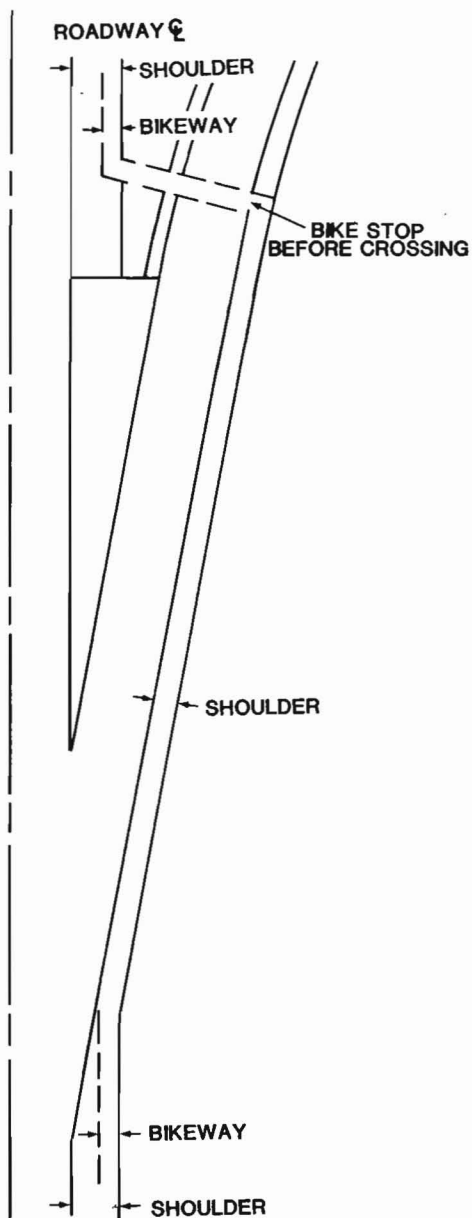
Figure 13





LOW SPEED - LOW VOLUME  
TREATMENT

Figure 14



HIGH SPEED - LOW VOLUME  
BIKEWAY TREATMENT

Figure 15

### Signing and Marking Bicycle Paths

Adequate signing and marking are essential on bicycle paths, especially to alert bicyclists to potential hazards and to convey regulatory messages to both bicyclists and motorists at highway intersections. In addition, guide signing, such as to indicate directions, destinations, distances, route numbers, and names of crossing streets, should be used in the same manner as they are used on highways. In general, uniform application of traffic control devices, as described in the MUTCD, will tend to encourage proper bicyclist behavior.

Care should be exercised in the choice of pavement marking materials. Some marking materials, for example, are slippery when wet and should be avoided in favor of more skid resistant materials. Paint is preferred.

General guidance on signing and marking is provided in the MUTCD. Part IX of the MUTCD refers specifically to traffic controls for bicycle facilities (see Appendix A). Also see Figures 2 and 3.

## Pavement Structure For Bicycle Paths

Designing and selecting pavement sections for bicycle paths is in many ways similar to designing and selecting highway pavement sections. A soils investigation should be conducted to determine the load carrying capabilities of the native soil and the need for any special provisions. The investigation need not be elaborate, but should be done by, or under the supervision of, a qualified engineer.

In addition, there are several basic principles that should be followed to recognize some basic differences between the operating characteristics of bicycles and those of motor vehicles. While loads in bicycle paths will be substantially less than highway loads, paths should be designed to sustain without damage wheel loads of occasional emergency, patrol, maintenance, and other motor vehicles that are expected to use or cross the path.

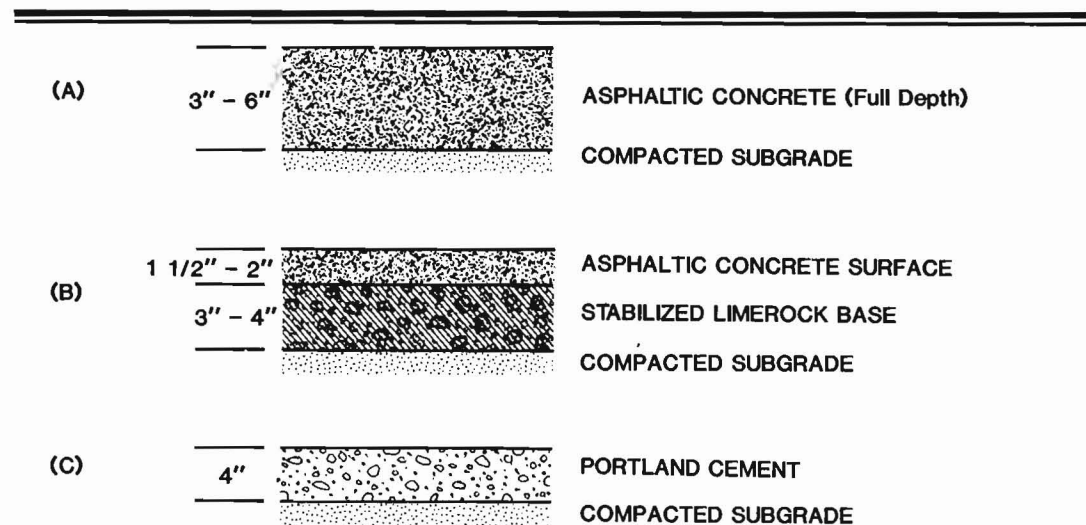
Special consideration should be given to the location of motor vehicle wheel loads on the path. When motor vehicles are driven on bicycle paths, their wheels will usually be at or very near the edges of the path. Since this can cause edge damage that, in turn, will result in the lowering of the effective operating width of the path, adequate edge support should be provided. Edge support can be either in the form of stabilized shoulders or in constructing additional pavement width. Constructing a typical pavement width of twelve feet, where right-of-way and other conditions permit, eliminates the edge raveling problem and offers two other additional advantages over shoulder construction. First, it allows additional maneuvering space for bicyclists and second, the additional construction cost can be less than for constructing shoulders because the separate construction operation is eliminated.

It is important to construct and maintain a smooth riding surface on bicycle paths. Bicycle path pavements should be machine laid; soil sterilants should be used where necessary to prevent vegetation from erupting through the pavement; and, on portland cement concrete pavements, transverse joints, necessary to control cracking, should be saw cut to provide a smooth ride. On the other hand, however, skid resistance qualities should not be sacrificed for the sake of smoothness. Broom finish or burlap drag concrete surfaces are preferred over trowel finishes, for example.

At unpaved highway or driveway crossings of bicycle paths, the highway or driveway should be paved a minimum of 10 feet on either side of the crossing to reduce the amount of gravel being scattered along the path by motor vehicles. The pavement structure at the crossing should be adequate to sustain the expected loading at that location.

Hard, all-weather pavement surfaces are usually preferred over those of crushed aggregate, sand, clay, or stabilized earth, since these materials provide a much lower level of service.

Good quality pavement structures can be constructed with asphaltic or portland cement concrete. Because of wide variations in soils, loads, materials, and construction practices, it is not practical to present specific or recommended typical structural sections that will be applicable statewide. Attention to the local governing conditions and to the principles outlined above is needed. Experience in highway pavement, together with sound engineering judgment, can assist in the selection and design of a proper bicycle path pavement structure and may identify energy conserving practices, such as the use of sulfur-extended asphalt, asphalt emulsions, and fused waste.



TYPICAL PAVEMENT STRUCTURAL SECTIONS FOR BIKEPATHS

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

Where it is necessary to continue a bicycle path onto a highway bridge, several alternatives should be considered in light of what the geometrics of the bridge will allow. (See Figure 19 for both new and retrofit conditions.)

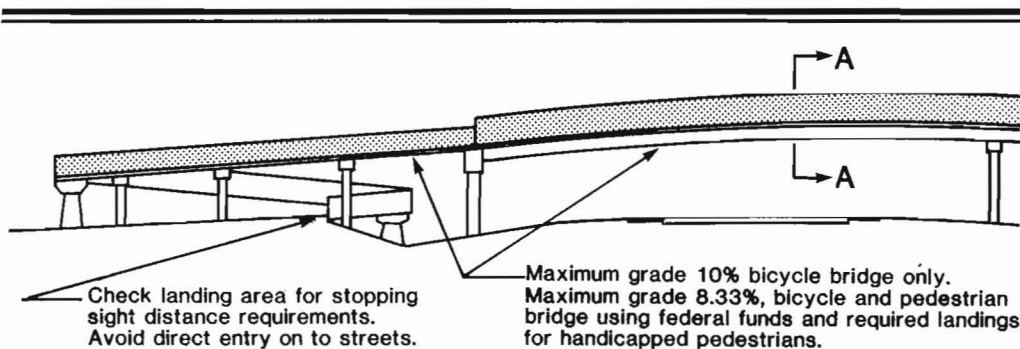
One option is to carry the bicycle path across the bridge on one side. This should be done where: (1) the bridge facility will connect to a bicycle path at both ends, (2) sufficient width exists on the side of the bridge or can be obtained by widening or restriping lanes, and (3) provisions are made to physically separate bicycle traffic from motor vehicle traffic as discussed above.

A second option is to provide either wide curb-lanes or bicycle lanes over the bridge. This may be advisable where: (1) a one-way bicycle path becomes bicycle lanes at one end of the bridge which will allow the cyclist to cross in the same direction as motor vehicle flow, and (2) sufficient width exists or can be obtained by widening or restriping.

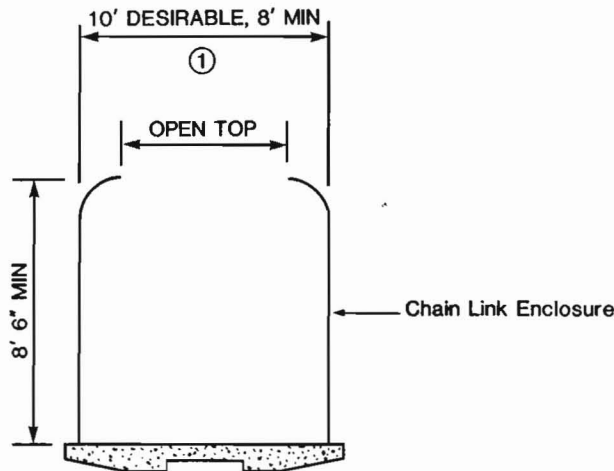
Figures 20 and 21 illustrate ways to continue a bicycle path under a new or existing bridge.

Because of the large number of parameters involved in retrofitting bicycle facilities onto existing bridges, compromises in desirable design criteria are often inevitable. Therefore, the width to be provided is best determined by the designer, on a case by case basis, after thoroughly considering all the parameters.

In some cases, an underpass will be the best way to carry a bicycle path under a highway. Figure 22 shows alternate underpass cross-sections for bicycle paths.



**HALF ELEVATION**



**SECTION A-A**

① In areas where it is not economically feasible to separate the pedestrian and bicyclists on the bridge, it is recommended that an 8 foot minimum clear zone be utilized for a width. In areas where more than occasional encounters between groups of pedestrians and cyclists can be anticipated, provision of facilities wider than the above minimum is desirable.

**SEPARATE BIKEWAY BRIDGE**

Figure 17

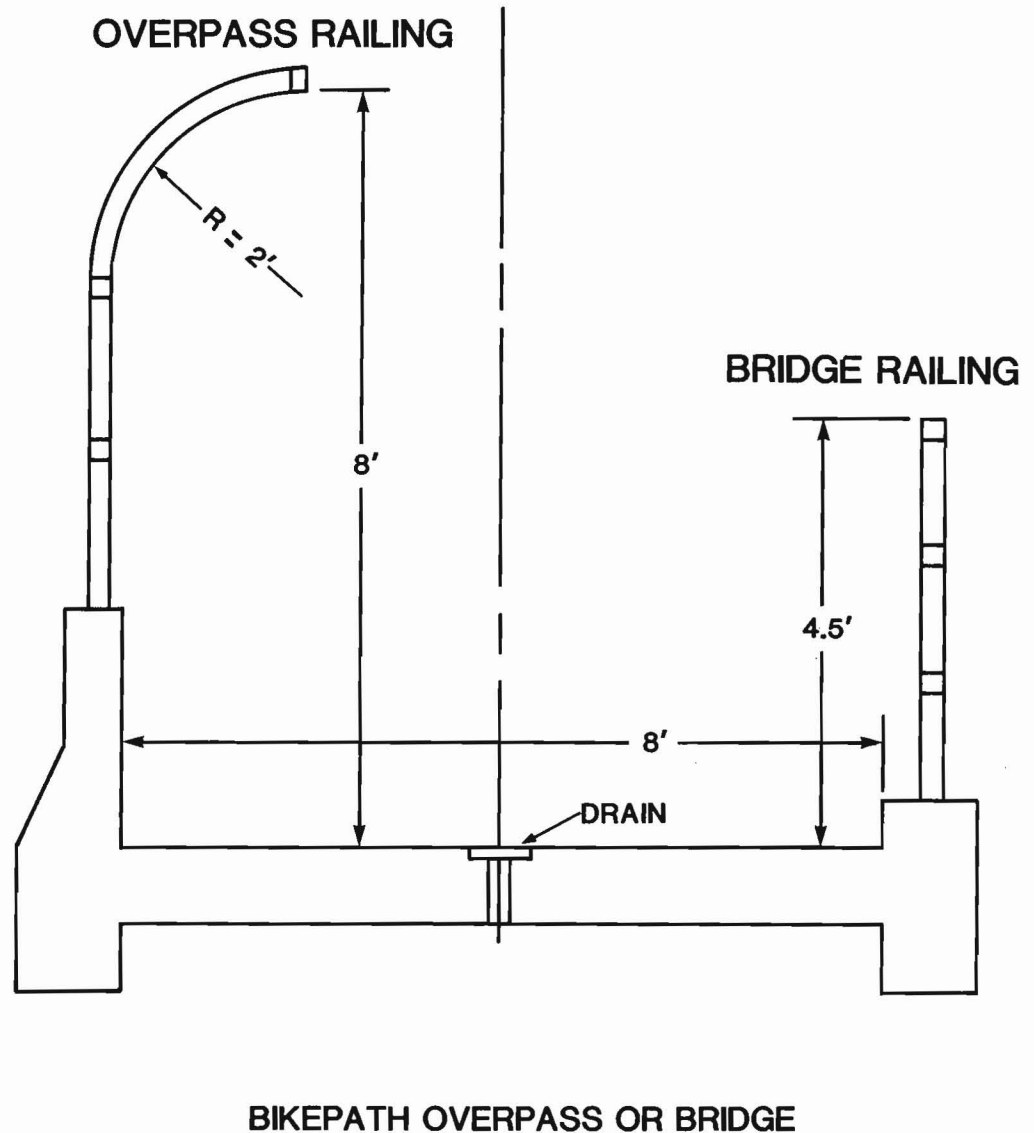


Figure 18

### Drainage for Bicycle Paths

The recommended minimum pavement cross slope of 2 percent adequately provides for drainage. Sloping in one of the directions instead of crowning is preferred and usually simplifies the drainage and surface construction. A smooth surface is essential to prevent water ponding and potential ice formation in certain areas. Where a bicycle path is constructed on the side of the hill, a ditch of suitable dimensions should be placed on the uphill side to intercept

the hillside drainage. Such ditches should not create hazards for bicyclists. Where necessary, catch basins with drains should be provided to carry the intercepted water under the path. Drainage grates and manhole covers should be located outside of the travel path of bicyclists. To assist in draining the area adjacent to the bicycle path, the design should include considerations for preserving the natural ground cover. Seeding, mulching, and sodding of adjacent slopes, swales, and other erodible areas should be included in the design plans.

**URBAN DESIGNS**

**RURAL DESIGNS**

**ON ROAD BIKEWAYS**



**BRIDGE DECK SECTIONS**

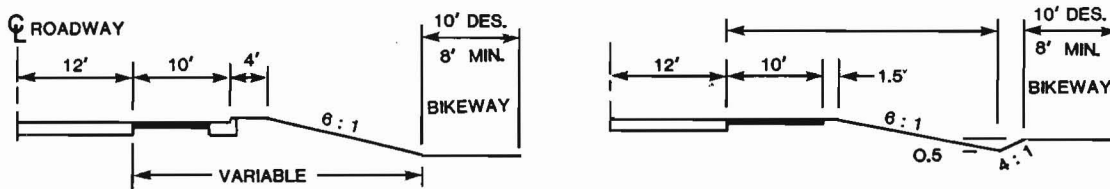


**APPROACHING ROADWAY SECTIONS**

**OFF ROAD BIKEWAYS**



**BRIDGE DECK SECTIONS**

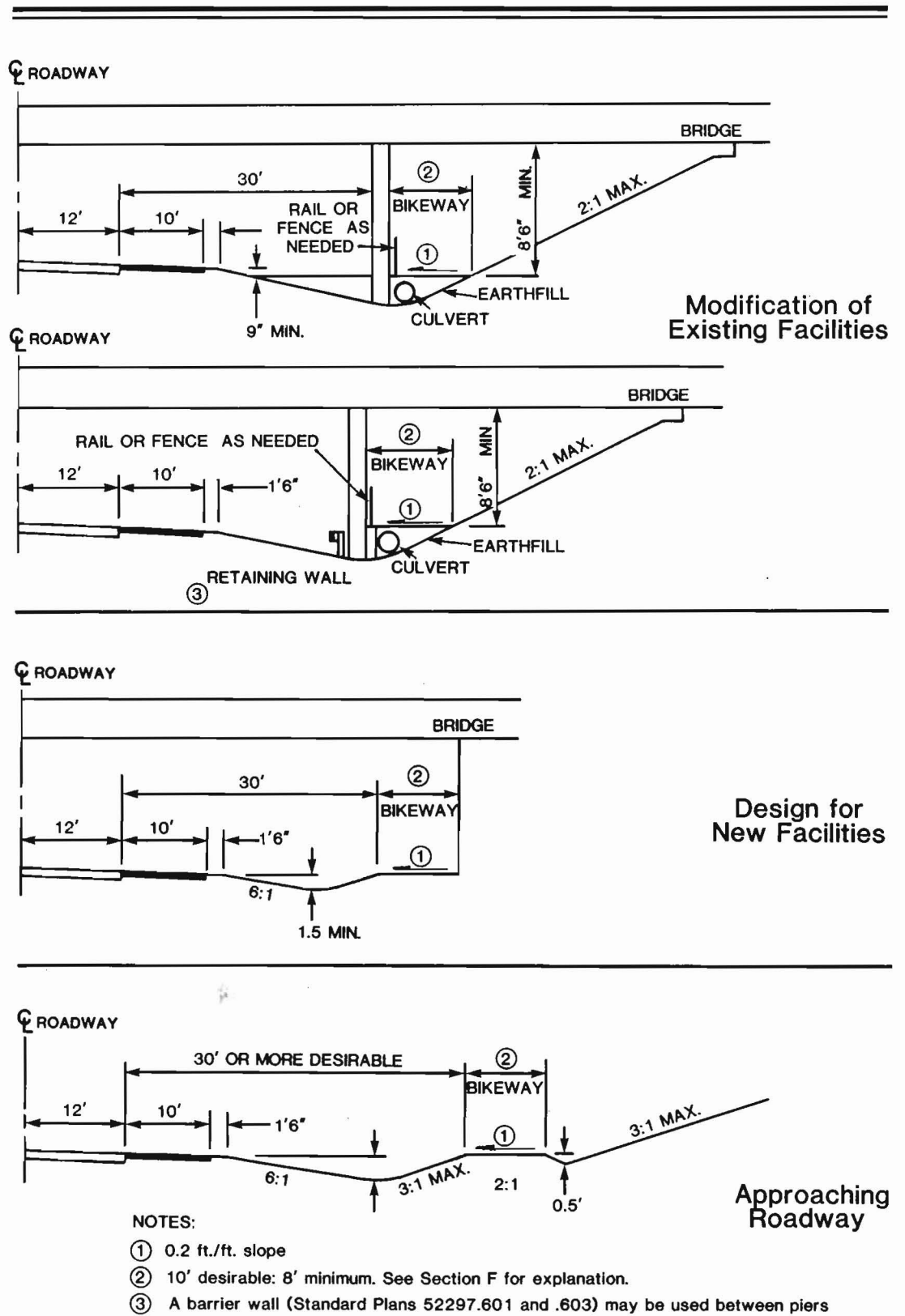


**APPROACHING ROADWAY SECTIONS**

**NOTES:**

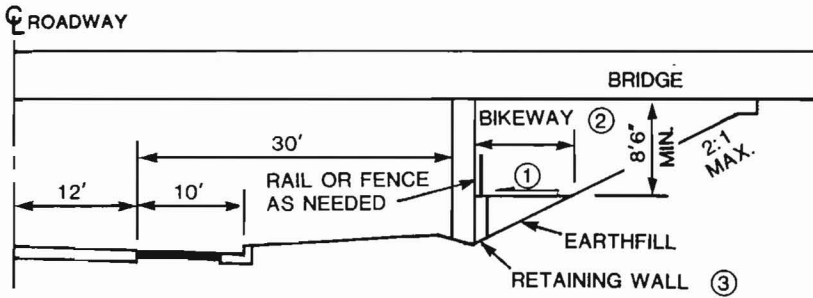
- ① .02 ft./ft. slope
- ② Minimum width. Includes provisions for pedestrians.
- ③ If shoulder width is 6' no fence is required on top of barrier.

**DESIGNS FOR BRIDGE DECKS WITH BIKEWAYS**

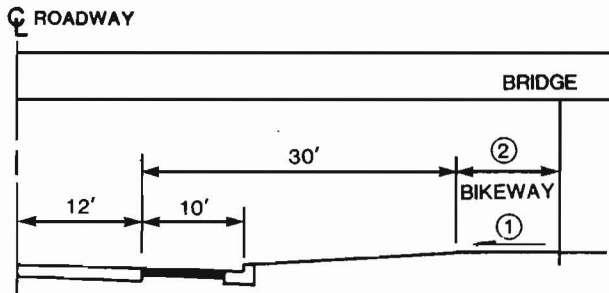
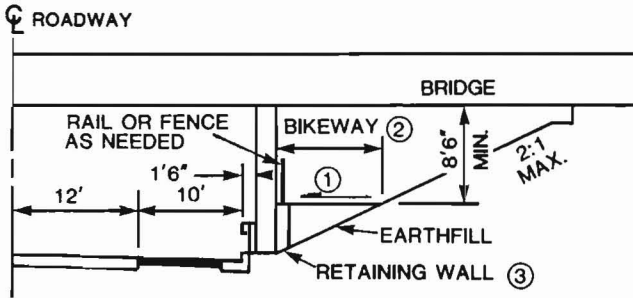


**OFF ROAD BIKEWAYS UNDER BRIDGE STRUCTURES - RURAL**

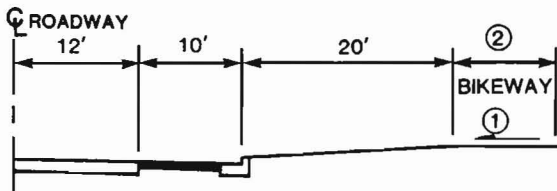
**Figure 20**



Modification of Existing Facilities



Design for New Facilities



Approaching Roadway

NOTES:

- ① 0.2 ft./ft. slope
- ② 10' desirable: 8' minimum. See Section F for explanation.
- ③ A barrier wall (Standard Plans 52297.601 and .603) may be used between piers

OFF ROAD BIKEWAYS UNDER BRIDGE STRUCTURES – URBAN

Figure 21

## MULTI-USE BICYCLE PATHS

In general, multi-use paths are undesirable; bicycles and pedestrians do not mix well. Whenever possible, separate bicycle and pedestrian paths should be provided. If this is not feasible, additional width, signing, and striping should be used to minimize conflicts.

### Sidewalks

Providing a sidewalk bicycle path is unsatisfactory for a variety of reasons. Sidewalks are typically designed for pedestrian speeds and are not safe for higher speed use. Conflicts are common between pedestrians traveling at low speeds (or exiting stores, parked cars, etc.) and bicyclists, as are conflicts with fixed objects (e.g., parking meters, utility poles, sign posts, bus benches, trees, fire hydrants, mailboxes, etc.). Walkers, joggers, and rollerskaters can, and often do, change their speed and direction almost instantaneously, leaving bicyclists insufficient time to react and 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 distance is often impaired by buildings, walls, property fences, and shrubs along sidewalks, especially at driveways. In addition, use of sidewalks can encourage wrong-way bicycling.

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. (2)

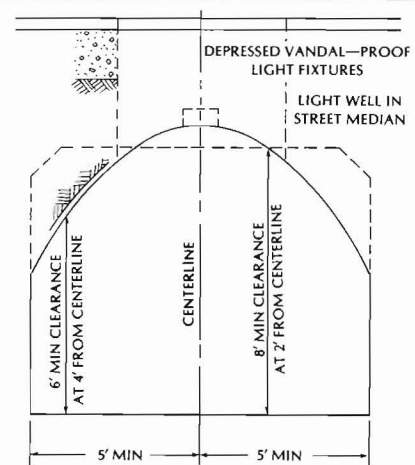
### Restriction of Motor Vehicle Traffic on Bicycle Paths

Bicycle paths often need some form of physical barrier at highway intersections to prevent unauthorized motor vehicles from using the facilities. Provisions can be made for a lockable, removable post to permit entrance by authorized vehicles. The post should be permanently reflectorized for nighttime visibility and painted a bright color for improved daytime visibility. When more than one post is used, a 5-foot (1.5m) space is desirable. Narrower spacing might prevent entry by adult tricycles and bicycles with trailers.

An alternative method of restricting entry of motor vehicles is to split the entrance into two 5-foot (1.5m) sections separated by low landscaping. Emergency vehicles can still enter if necessary by straddling the landscaping; the higher maintenance costs associated with landscaping should be acknowledged, however, before this alternative method is selected.

## Lighting for Bicycle Paths

Fixed-source lighting reduces conflicts along paths and at intersections. In addition, lighting allows the bicyclists to see the bicycle path direction, surface conditions, and obstacles. Lighting for bicycle paths is important and should be considered where cyclists riding at night are expected, such as bicycle paths serving college students or commuters, and at highway intersections. Lighting should also be considered through underpasses of tunnels, and when nighttime security could be a problem. Depending on the location, average maintained horizontal illumination levels of 0.5 foot-candle (5 lux) to 2-foot candles (22 lux) should be considered. Where special security problems exist, higher illumination levels may be considered. Light standards (poles) should meet the recommended horizontal and vertical clearances. Luminaires and standards should be at a scale appropriate for a pedestrian or bicycle path.



BIKEPATH UNDERPASS

Figure 22

### Mopeds

It is also undesirable to mix mopeds and bicycles on the same facility. Were it necessary to do so, the facility should be designed to account for the higher operating speeds of mopeds, the additional maneuvering requirements of mopeds, and the increased frequency of passing maneuvers. Many of the design guidelines prescribed within the "Bicycle Paths" section (e.g., widths, design speeds, horizontal alignments, grades, etc.) would be inadequate for facilities intended for moped use. Mopeds also contribute to a lessening of the quiet, relaxing experience most bicyclists desire on bicycle paths.

### Bicycle/Bridle Paths

Using a path for bicycles and horses creates an unsatisfactory and possibly dangerous mix. Horses startle easily and may kick out suddenly if they perceive bicyclists as danger. A bicycle path and a bridle path are also incompatible in their surface design requirements. Bicycles



function best on hard surfaces, horses function best on soft surfaces. A compromise to accommodate both would result in less than adequate surface for both.

## **SUPPLEMENTAL BICYCLE FACILITIES**

Providing bicycle parking facilities is an essential element in an overall effort to promote bicycling. People are discouraged from bicycling unless adequate parking is available. Bicycle parking facilities should be provided at both the trip origin and the trip destination and should offer protection from theft and damage. (See the Appendix for example bicycle parking facilities.)

The wide variety of bicycle parking devices fall into two categories of user needs; commuter or long-term parking, and convenience or short-term parking. The minimum needs for each differ in their placement and protection. Long-term parking is needed at locations such as employment centers, transit or subway stations, and multi-family dwellings. Facilities should be provided which secure the frame, both wheels, and accessories and which offer protection from the weather. Bicycle lockers and attended storage areas are good examples of long-term parking facilities. Short-term parking is needed at locations such as shopping centers, libraries, recreation areas, and post offices. Facilities should be very convenient and be near building entrances or other highly visible areas which are self-policing. The facility should be designed so that it will not damage bicycles (bent rims are common with racks that only support one wheel). If bicycle parking is not properly designed and located, bicyclists will use trees, railings, and other appurtenances. This practice can damage the appurtenances and create a hazard for pedestrians.

Several factors should be considered when planning and providing bicycle parking facilities. Care should be given in selecting the location to ensure that bicycles will not be damaged by motor vehicles. Parking facilities should not interfere with the normal pedestrian flow. Also, facilities should be designed so that persons parking their bicycles will not disturb other parked bicycles. The amount of security needed to prevent theft needs to be evaluated for each area.

Facilities should be able to accommodate a wide range of bicycle shapes and sizes including tricycles and trailers, if used locally. Finally, facilities should be simple to operate. If possible, signs depicting how to operate the facility should be posted.

In addition to bicycle parking facilities, there are several other improvements that complement bicycle paths and roadway improvements. Provisions should be considered for interfacing bicycle travel with public transit, such as racks on buses, buses converted to carry

bicycles aboard, or allowing bicycles on rapid rail facilities. Printing and distributing bicycle route maps is a high-benefit, low-cost project that is easily accomplished. Maps can help bicyclists locate bikeways, parking facilities, and identify the relative suitability of different segments of the road system. Also, maps can help bicyclists avoid narrow, high-speed, or high-volume roads, one-way streets, barriers and other problems to bicyclists. In addition, maps can provide information on Rules of the Road, bicycle safety tips, and interfacing with mass transit.

## **OPERATION/MAINTENANCE OF BICYCLE FACILITIES**

The agency responsible for the control, maintenance, and policing of bicycle facilities should be established prior to construction. The costs involved with the operation and maintenance should be considered and budgeted for when planning a facility. Neglected maintenance will render bicycle facilities unsafe, and the facilities will become a liability to the State or community. Bicyclists should be encouraged to report bicycle paths and roadways needing maintenance. A central contact person with authority to authorize maintenance work should be designated to receive such reports.

Bikeways, and roadways with bicycle traffic are often susceptible to having debris, such as glass or sand, accumulate in the area where bicyclists ride, therefore, regular sweeping is necessary. A smooth surface, free of potholes and debris, should be provided. The pavement edges should be uniform. Signs and pavement markings should be inspected regularly and kept in good condition. Highways with bicycle traffic may require a more frequent and higher level of maintenance than other highways.

For bicycle paths, attention should be given to maintaining the full paved width and not allowing the edges to ravel. Trees, shrubs and other vegetation should be controlled to provide adequate clearances and sight distances. Trash receptacles should be placed and maintained at convenient locations. Seeded and sodded areas in the vicinity of bicycle paths should have a regular schedule of mowing. Also, enforcement is usually necessary to prevent unauthorized motor vehicles from using the bicycle path. Routine maintenance patrolling of bicycle paths is desirable.

The routine maintenance of roadways provides an excellent opportunity to improve bicycle travel on those roads. Several bicycle facilities described in this manual can be implemented during routine maintenance activities. When lane markings for four or six lane streets are restriped, consideration can be given to adjusting the lane widths and providing a wide curb-lane for bicycles. Addition of edge lines can better delineate a shoulder, especially at night. When shoulders are resurfaced, a smooth surface suitable for bicycle riding should be considered. Additional roadway sweeping may be necessary for roadway facilities.



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# glossary of terms

## **ADT**

Average Daily Traffic volume.

## **Amenity Factor**

Any design feature of a bicycle system, over and above what is deemed a basically safe design, which promotes bicycle usage. Examples: weather-protected parking and scenic overlooks.

## **Attainment**

A level of service to be achieved for the purpose of evaluating the degree to which goals and objectives are met.

## **Bicycle Facilities**

A general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling, including parking facilities, maps, all bikeways, and shared use of roadways not specifically designed for bicycle use.

## **Bicycle Lane**

A portion of a roadway which has been designated for the preferential or exclusive use of bicycles, with through travel by motorists and pedestrians prohibited, but with crossflows by pedestrians and motorists permitted. This designation includes striped bike lanes, paved shoulders, and lanes for joint use by disabled vehicles and bicycles. [2]

## **Bicycle Path**

A bikeway which is physically separated from motorized vehicular traffic by an open space or barrier and which is either within the highway right-of-way or within an independent right-of-way. Crossflows with motorized traffic are minimized. [2]

## **Bicycle Route**

A segment of a system of bikeways designated by the jurisdiction having authority with appropriate directional and informational markers, with or without a specific bicycle route number.

## **Bicycle Wide Curb-Lane**

A portion of roadway which has been designated for shared use by bicycles and motorized traffic, characterized by a curb-lane which is of such width that bicycle and motorized traffic can be accommodated in the same lane. This lane should always be the through lane closest to the curb (when a curb is provided) or the shoulder edge of the road when a curb is not provided.

## **Bikeway**

Any road, path or way which in some manner is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

## **Capacity**

Maximum number of bicycles which have a reasonable expectation of passing through a given bikeway section during a given time period under existing facility conditions.

## **Clearance**

Lateral width required for safe passage of a bicycle as measured in a horizontal plane.

## **Climatological Elements**

Weather as it affects bicycling in either a positive or negative manner. This includes temperature, precipitation, wind, etc.

## **Design Speed**

A speed determined for design and correlation of the physical features of a bikeway that influence bicycle operation. It is the maximum safe speed that can be maintained over a specified section of bikeway when conditions allow the design features of the bikeway to govern usage.

## **Determinants**

Data and facts which govern the location and design of a bikeway.

## **Groove**

A narrow slot in the surface that could catch a bicycle wheel, such as a gap between two concrete slabs.

## **Highway**

A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

## **In-Street Bicycle Facility**

Any bicycle facility (bicycle route, lane, or wide curb-lane) on which bicycle traffic shares the roadway with motor vehicles.

## **Intermodal Transfer Point**

Any location at which a person or persons change from one transportation mode to another.

## **Legend**

Words, phrases, or numbers appearing on all or part of a traffic control device.

## **Location Criteria**

Relative predetermined standards used in selecting and weighing bikeway corridors.

## **Longitudinal Patterns**

Stripes or markings placed parallel to the flow of traffic.

## **Minimum Energy Path**

The route between two given points requiring the least amount of energy for a bicyclist to transverse.

## **MPO**

Metropolitan Planning Organization.

## **MTPO**

Metropolitan Transportation Planning Organization.

## **Origin--Destination Study (O & D Study)**

A survey of facility users designed to determine trip frequency and termini; used in determining bikeway needs.

## **Parameter**

A system component whose value determines the characteristics or behaviors of a system.

## **Pavement Marking**

Painting or applied line(s) or legend placed on any bikeway surface to regulate, guide, or warn traffic.

## **Pedestrian**

A person whose mode of transportation is on foot, including a person "walking a bicycle."

## **Planning Area**

A geographic district or region selected for planning objectives.

## **Planning Sub-Area**

The smallest geographic unit for which trip behavior is calculated and analyzed in transportation importance.

## **Representative Sampling**

A planning technique designed to record (to a specified level of accuracy) public opinions and attitudes regarding community issues, typically using interviews with or mailers to a segment of the population. Sampling which does not meet the specified level of accuracy is referred to as "non-representative sampling."

## **Right-of-Way**

A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation purposes.

## **Right-of-Way Corridor Width**

The width between the furthest edges of the right-of-way property on which the roadway is located; may include the roadway, shoulder area and lawn area, and sidewalk.

## **Roadway**

The portion of the highway, including shoulders, for vehicle use.

## **Secondary Bicycle Facility**

Bicycle facilities designed primarily for youthful and inexperienced adult bicyclists.

## **Service**

In bikeway operation, a qualitative measure for indicating the effect of factors such as speed, travel time, safety, travel interruptions, and maneuverability.

## **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.

## **Shoulder**

The portion of the roadway outside the edges of the traveled way (or back of curb) and extending to the top of the front slopes. The shoulders may be paved or unpaved.

## **Shy Distance**

The distance between the bikeway's edge and any fixed or moving object capable of injuring a bicyclist using the facility.

## **Sidewalk**

The portion of a highway designed for preferential or exclusive use by pedestrians.

## **Sidewalk with Ramps**

Sidewalk designed to provide smooth transition between grades by the use of slanted ramps; such facilities are typically wider than ordinary sidewalks, so that handicapped individuals can be accommodated.

## **Sight Distance**

A measurement of the bicyclist's visibility, unobstructed by traffic, along the normal travel path to the furthest point of the roadway surface.

## **Step**

A ridge in the pavement, such as that which might exist between the pavement and a concrete gutter or manhole cover; or that might exist between two pavement blankets where the top level does not extend to the edge of the roadway.

## **Stopping Sight Distance**

The total distance traveled from the instant a bicycle operator sights an object which requires him/her to stop to the point at which the vehicle stops. Perception plus reaction and braking distance equals stopping sight distance.

## **Superelevation**

Raised outside edge of a roadway curve designed to overcome the force causing a vehicle to skid when maintaining speed; often referred to as a "banked curve."

## **Termini**

The two ends of the travelway, i.e., the trip's beginning and its end location.

## **Traffic Control Devices**

Signs, signals, or other fixtures, whether permanent or temporary, placed on or adjacent to a travelway by authority of a public body having jurisdiction to regulate, warn, or guide traffic.

## **Traffic Flow Patterns**

Graphic presentation of vehicular or pedestrian movement at a given time on given streets.

## **Transportation Corridor**

A strip of land between two termini within which traffic, topography, environment, and other factors are evaluated for transportation purposes.

## **Transverse Patterns**

Pavement markings perpendicular to, or at an angle to, the flow of traffic, such as stop bars, crossover stripes and median delineations.

## **Travel Generators**

Particular areas or locations which represent trip destination points of the utilitarian bicyclist; for example, libraries, schools, recreation areas and work centers.

## **Travelway**

Any way, path, road, or other travel facility used for any and all forms of transportation.

## **Tributary Areas**

Geographic locations which act as feeders to major transportation corridors.

## **Trip Attractors**

Potential trip destinations, such as schools, recreation areas, shopping areas, and employment centers (essentially synonymous with "Travel Generators.")

## **Trip Producers**

Residential areas (trip origins).

## **Utilitarian Bicyclist**

An individual who uses a bicycle primarily to reach a particular destination.

## **Vehicle**

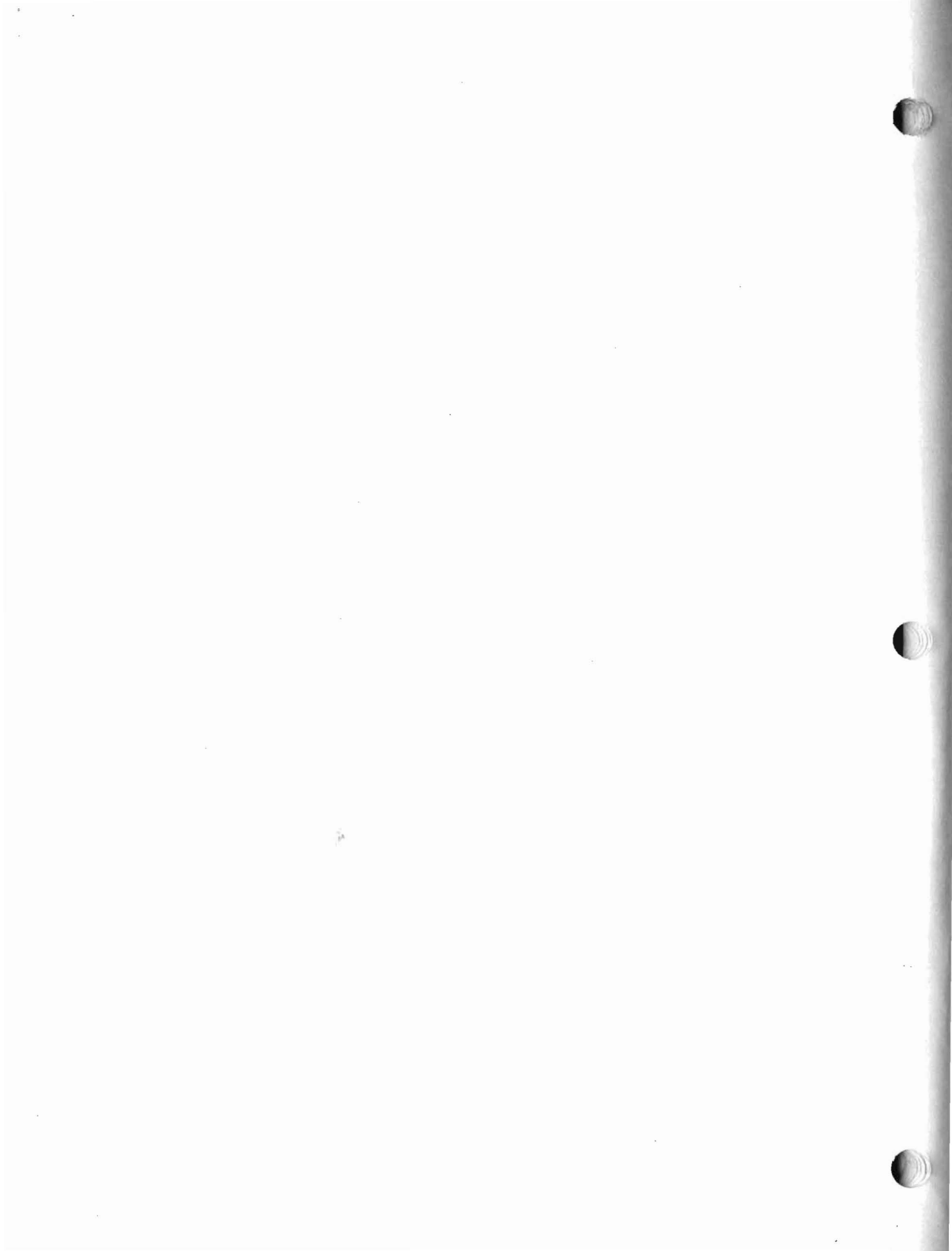
Every device in, upon, or by which any person or property is or may be transported or drawn upon a travelway, excepting devices used exclusively upon stationary rails or tracks.

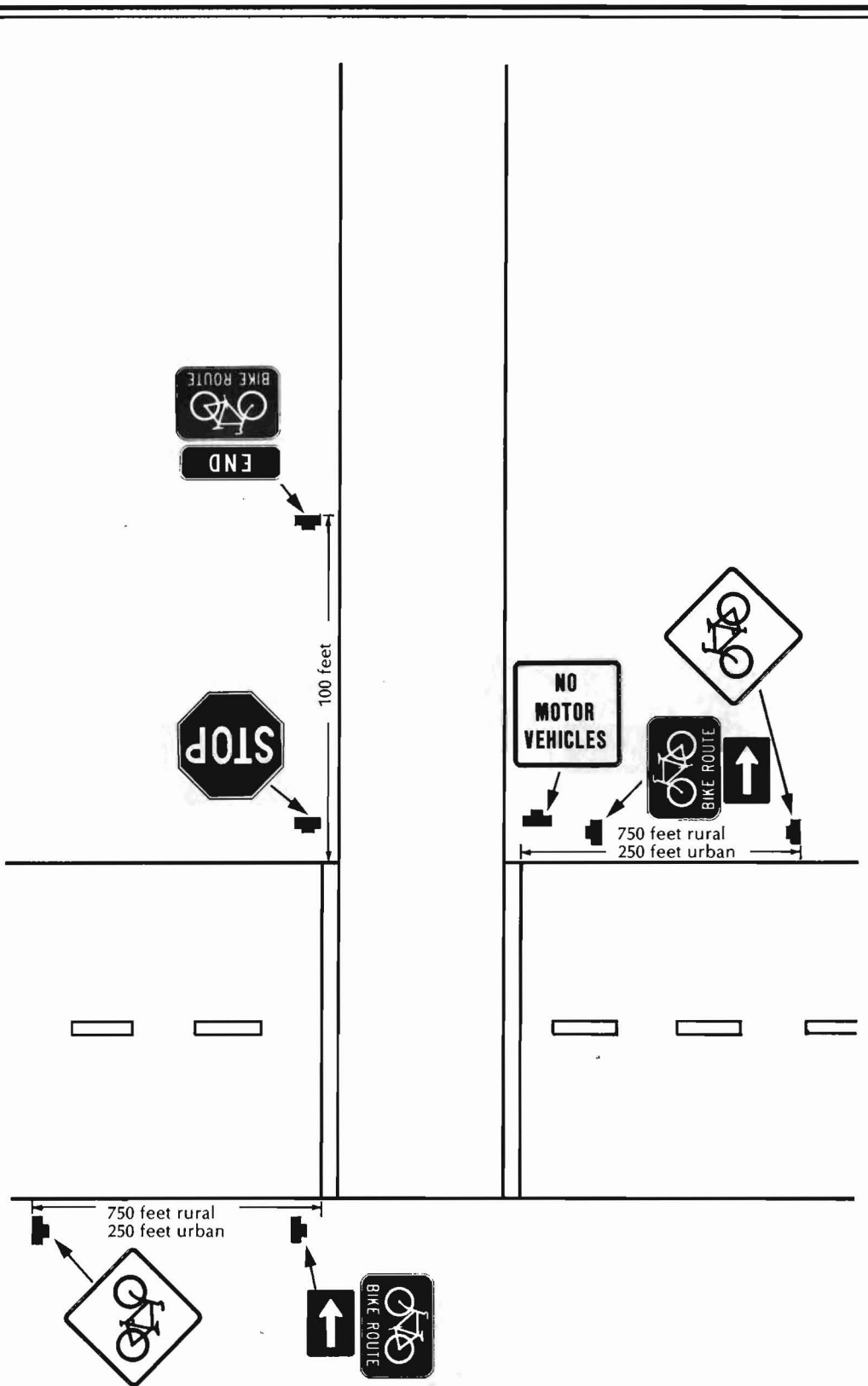
## **Volume**

The number of vehicles which pass a given point for a given amount of time (e.g., hour, day, year).

## **Warrant**

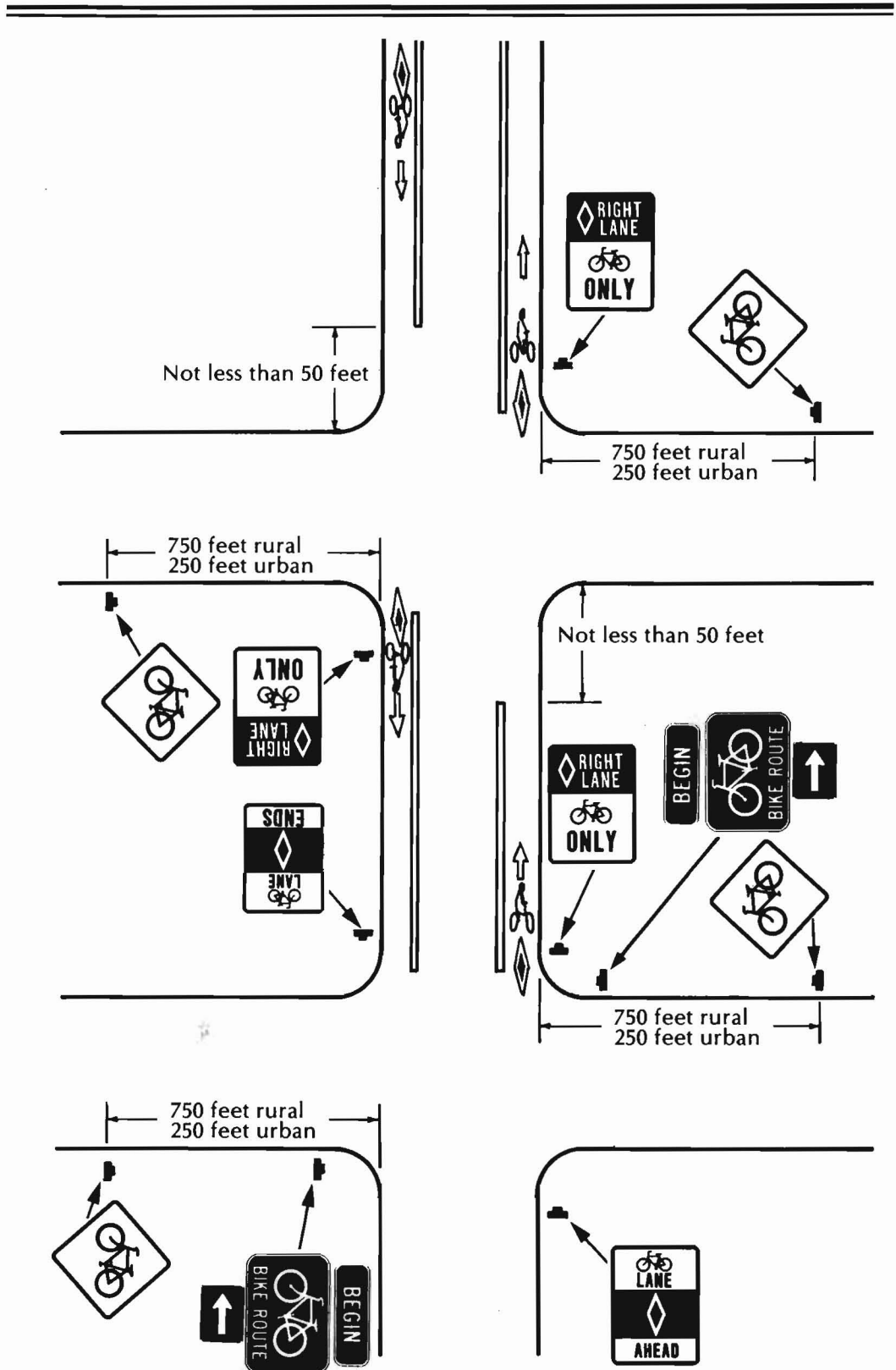
A minimum requirement for justifying the authorization of a traffic control device; for example, traffic volumes, accident statistics, and existing design.





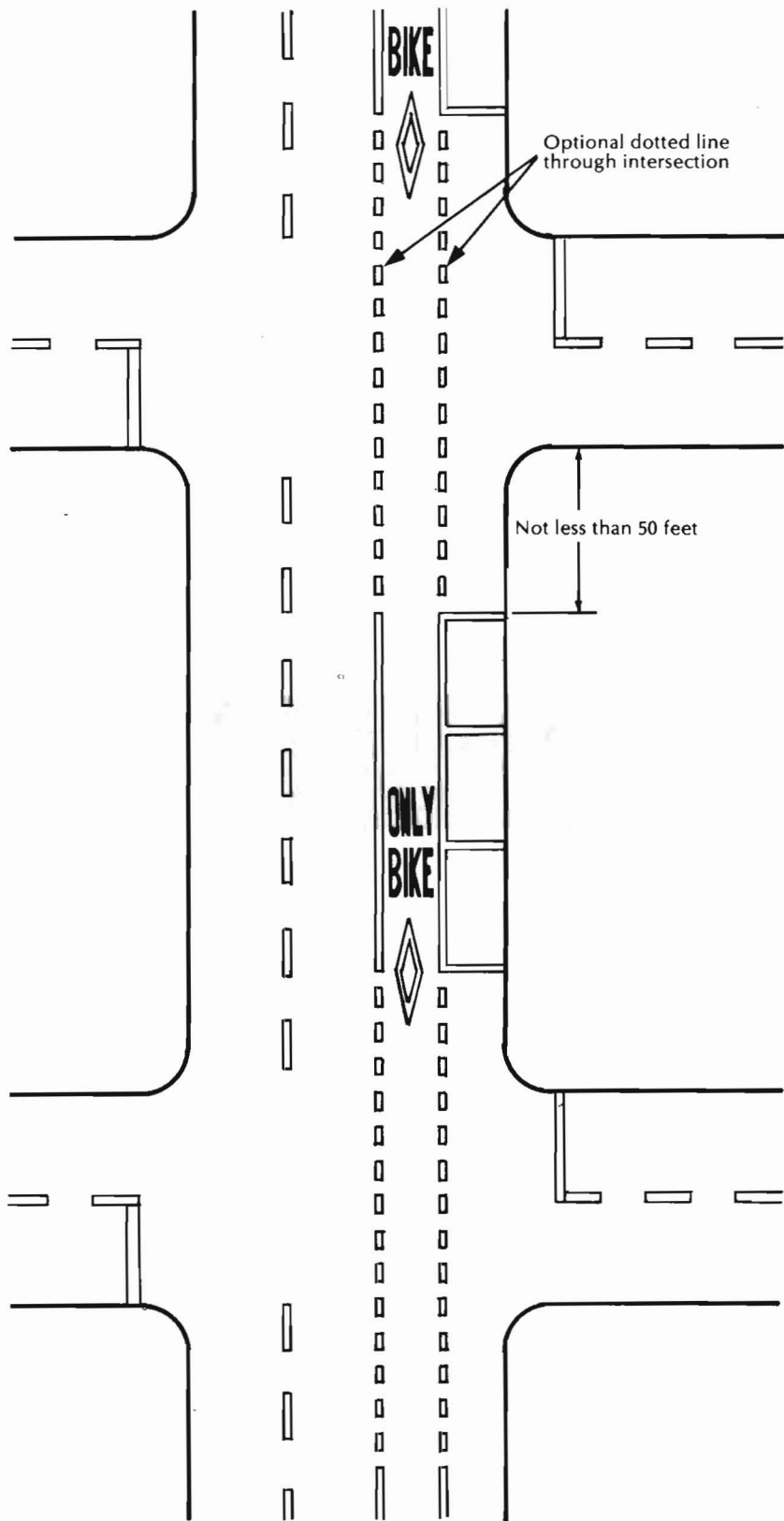
TYPICAL SIGNING FOR BEGINNING AND ENDING OF BICYCLE TRAIL

Figure 24



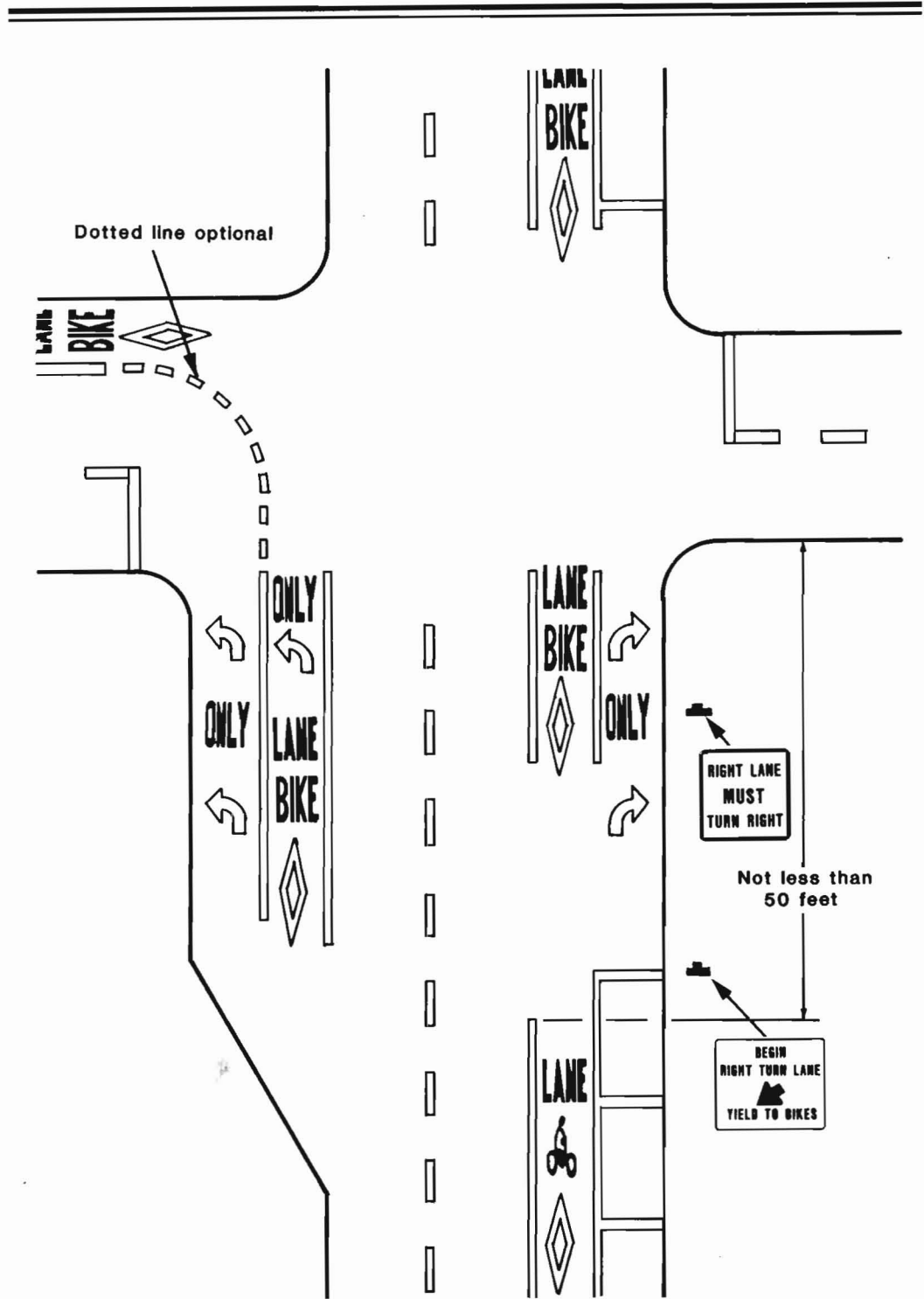
TYPICAL SIGNING FOR BEGINNING AND ENDING OF DESIGNATED BICYCLE LANE

Figure 25



TYPICAL PAVEMENT MARKINGS - DESIGNATED BICYCLE LANE, TWO-WAY TRAFFIC WITH PARKING AND LOW RIGHT-TURN VOLUME

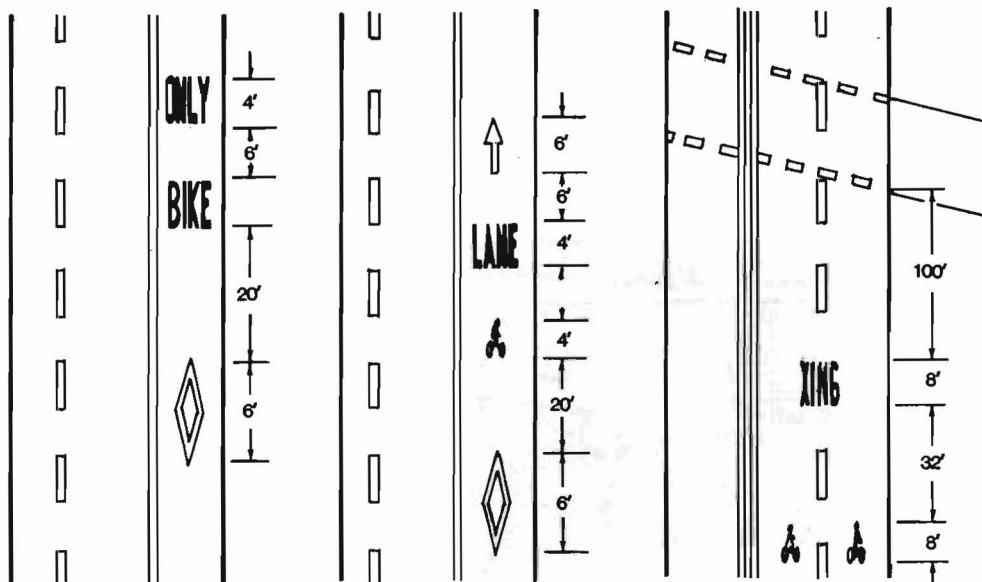
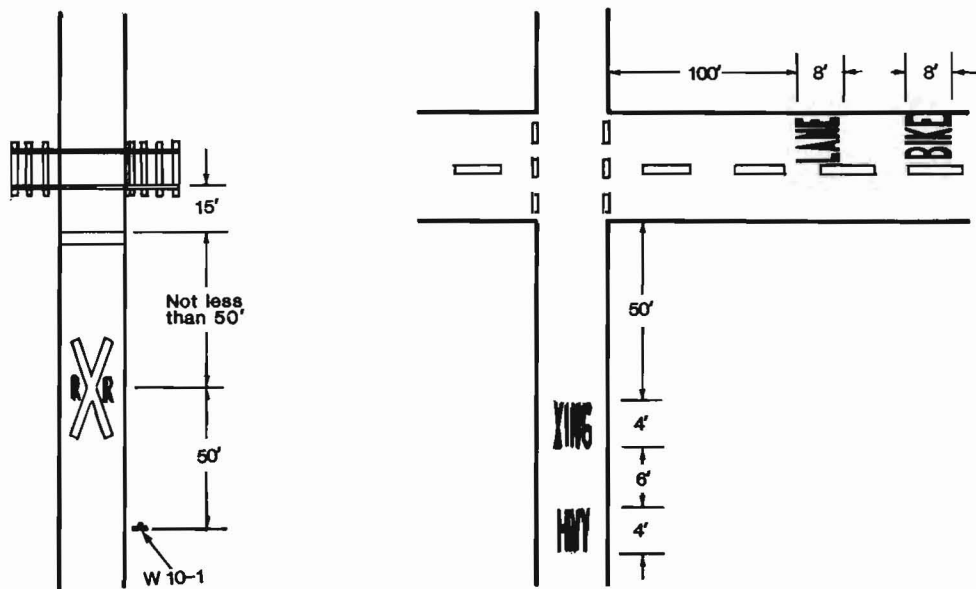
Figure 26



INTERSECTION PAVEMENT MARKINGS - DESIGNATED BICYCLE LANE WITH LEFT TURN AREA, HEAVY TURN VOLUMES, PARKING, ONE-WAY TRAFFIC OR DIVIDED ROADWAY

Figure 27





WORD AND SYMBOL PAVEMENT MARKINGS FOR BICYCLE FACILITIES

Figure 28

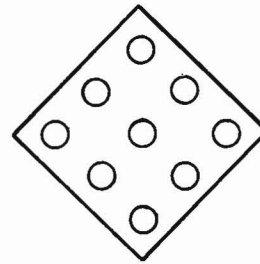
### 9C-5 Word Messages and Symbols Applied to the Pavement

Where messages are to be applied on the pavement, smaller size letters can be used on exclusive bike lanes than are used on regular highways. Where arrows are needed, half-size layouts of the arrows can be used (sec.3B-17). Optional word and symbol markings considered appropriate for use with the Preferential Lane Symbol marking are shown in figure 9-6. Standard pavement marking alphabets and symbols have been prepared.\*

### 9C-6 Object Markings on Bicycle Trails

There may be hazardous objects located adjacent to bicycle trails which, if visible to the rider, can be avoided with little difficulty. Such objects can be marked with highly visible markings to make their identification by approaching riders more certain. Care should be taken to avoid having object markers become hazardous objects. Corners of object markers as well as signs should be rounded to prevent their becoming a hazard.

\* Available from the Federal Highway Administration (HTO20) Washington, D.C. 20590



Type I  
18" x 18"



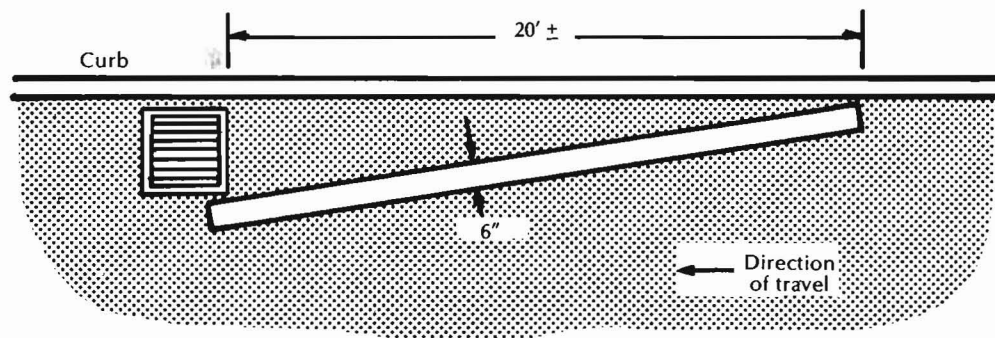
Type II  
6" x 12"



Type III  
12" x 36"

All object markers should be designed using reflective materials or coatings. Where practical, markers such as those described in section 3C-1 of this Manual should be used.

Where a storm drain hazard cannot be eliminated, it may be made more visible to bicyclists by defining with a white marking, applied as shown in figure 29.



TYPICAL MARKING IN ADVANCE OF DRAINAGE HAZARD

Figure 29

## BICYCLE PARKING

The following discussion on bicycle parking is reprinted from the Yuma County Comprehensive Bicycle Plan, September 1987, prepared by Drake & Associates in conjunction with Dan Burden.

### Introduction

The wide variety of bicycle parking devices falls into two categories of user needs; commuter or long-term parking and convenience or short-term parking. The minimum needs for each differ in their placement and protection. Facilities should be able to accommodate a wide range of bicycle shapes and sizes, including tricycles and trailers if used locally. Facilities should be simple to operate and directions should be posted, including whom to contact if maintenance is needed, or if other problems are encountered.

### Long-Term Parking

Long-term parking is needed at locations such as employment centers and multi-family dwellings. Facilities should be provided which secure the frame, both wheels, and accessories and which offer protection from the weather.

Unlike cars, bicycles are quite vulnerable to conditions such as rain and ultra-violet light, rendering them to a rusty, tire-rotted condition in as little as one season. Bicycle lockers and attended storage areas with a roofed area are examples of long-term parking facilities.

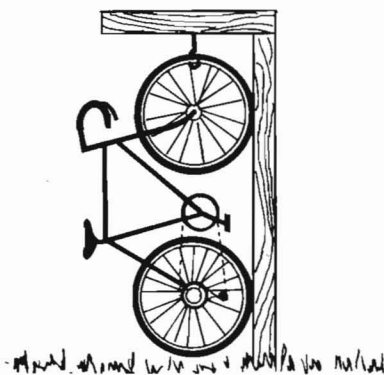
### Short-Term Parking

Short-term parking is needed at locations such as shopping centers, libraries, recreation areas, post offices, restaurants and other quick trip attractors. Facilities should be very convenient and should be near building entrances or other highly visible areas which are self-policing. A distance from a key attractor entrance greater than 25 to 50 feet could result in bicycles being secured to trees, posts, handicapped ramp rails, and other objects.

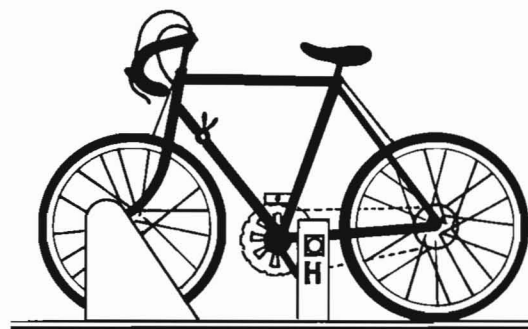
The facility should be designed so that it will not damage bicycles (bent rims are common with racks that only support one wheel). The device must allow for high-security locks (i.e., U-Lok (TM) and Kryptonite (TM)) and for combined security of both wheels and frame. The device must provide easy-in and easy-out locking and provide easily understood directions for use.



Long-Term Bicycle Parking



Short-Term Bicycle Parking



Combined Long and Short-Term Bicycle Parking

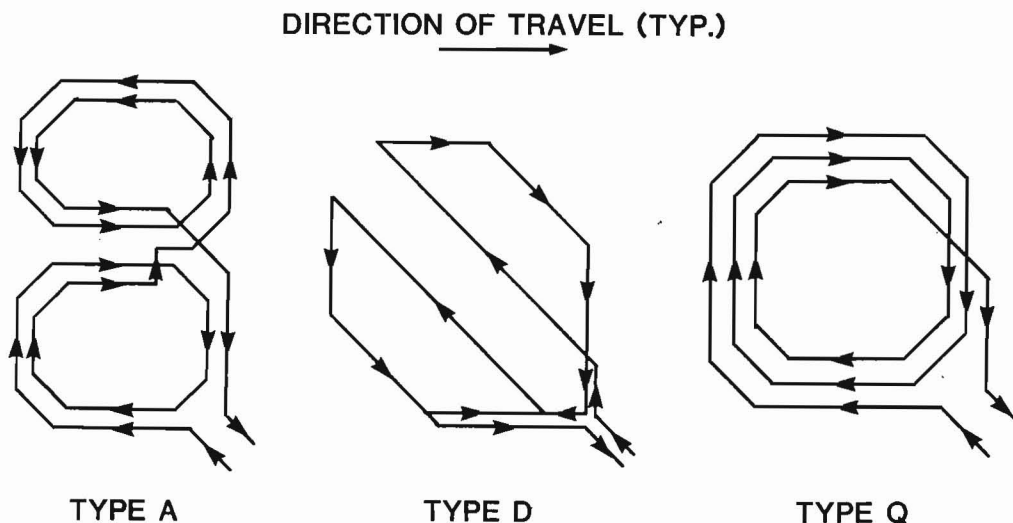
Figure 30



## BICYCLE LOOP DETECTORS

A recent study entitled the "City of San Diego Traffic Signal Bicycle Detection Study: Final Report, November 1985" examined various bicycle detection strategies. The report made several observations and recommendations with regard to bicycle detection:

1. The California Department of Transportation (CALTRANS) has three types of inductive loop detectors shown on the attached figure recommended for bicycle detection: (a) Type A square loop; (b) Type D (modified quadrupole) and Type W (quadrupole).
2. The Type D (modified quadrupole) and Type Q (quadrupole) detector loops should be the standard configurations to be used alone or in combination with Type A Loops.
3. Left-turn lanes and minor side street applications should use California State Type 5DA loop installations (type 5DA loop installation has five turns of conductors in the Type D loop).
4. Through traffic lanes that are shared by motor vehicles and bicycles should use Type D (modified quadrupole) loops. Detectors at the stop line that are used for presence of calling purposes are considered to be shared use detectors. Type D loops used alone or in combination with one, two, or three Type A loops should have five turns of conductors. These combination loop detectors should be spliced in series with each other at the pull box.
5. Advance detectors on arterials will not be expected to be shared by bicyclists; therefore, Type A loops are recommended.
6. Bike lanes that require narrow areas of detection and sharp cut-off properties should have Type Q (quadrupole) loops. These loops should cover as much of the lanes as possible. The edges of the loop should be installed one foot to the right of the bike lane line and six inches from the gutter lip. The width will vary but it is not critical to the operation.
7. Inductive loops should be marked at locations where the sensitivity is critical or where detection is not reliably achieved when the bicyclists ride in the approach lane in a position that is appropriate.



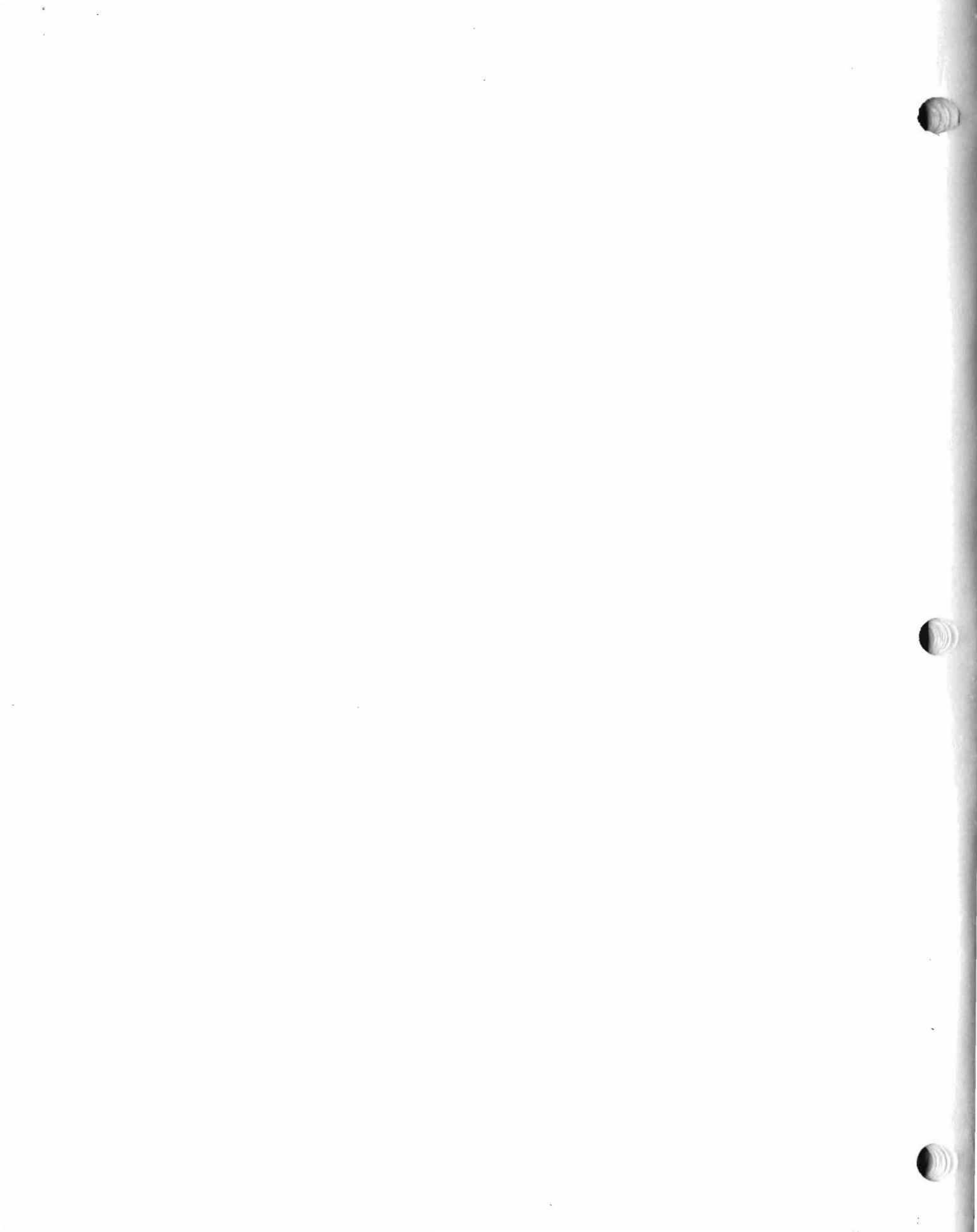
**RECOMMENDED CALTRANS LOOP TYPES FOR BICYCLE DETECTION**

Figure 31



# appendix d

This section contains engineering specifications for typical signs to be utilized in conjunction with development and construction of bicycle lanes and trails in Arizona.





CODE D11-1



ALL DIMENSIONS ARE IN INCHES

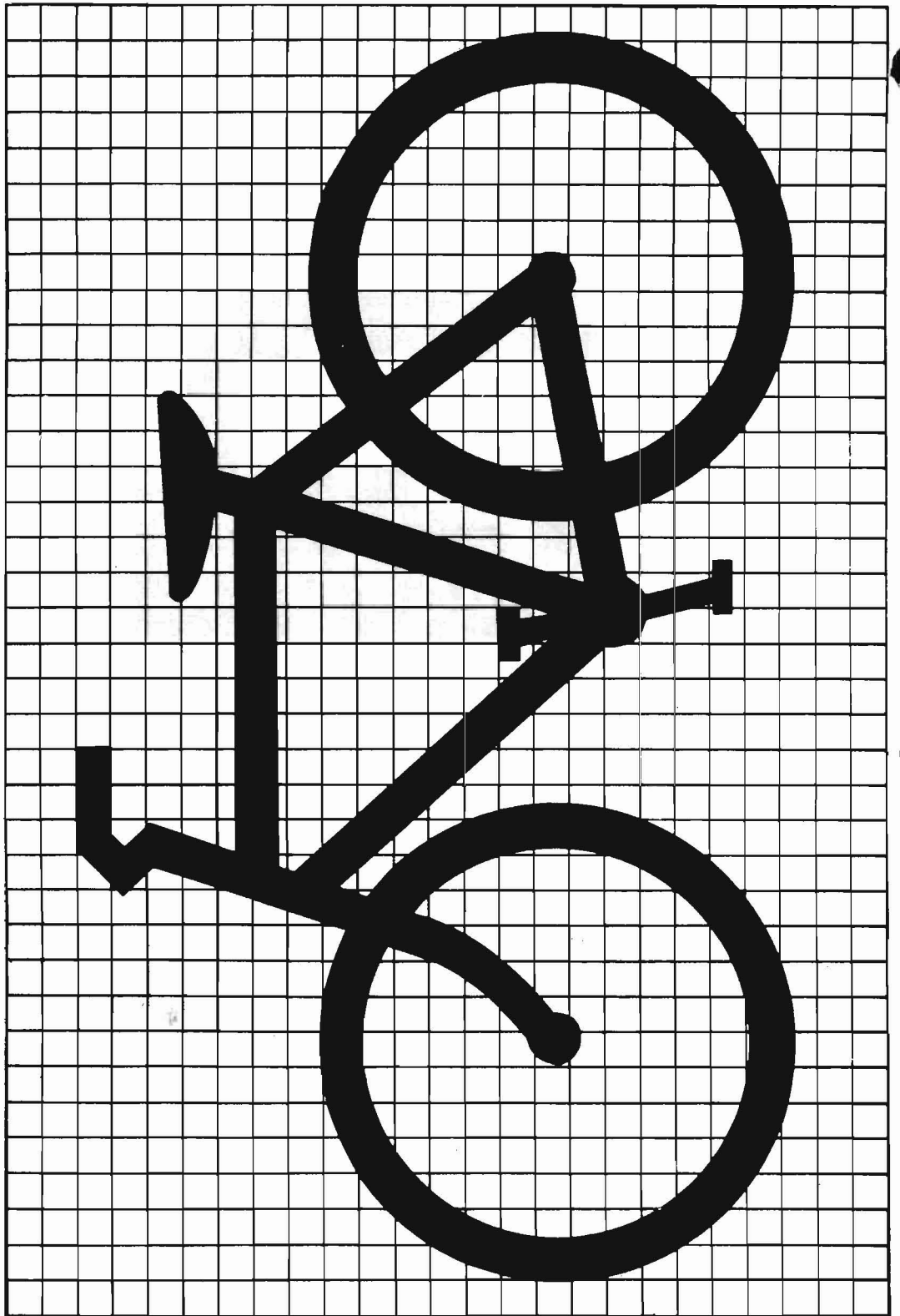
SIZE	BORDER WIDTH	MARGIN WIDTH	LETTER SIZE, SERIES & STROKE WIDTH					CORNER RADIUS
			LINE 1	LINE 2	LINE 3	LINE 4	LINE 5	
24x18		1/2		3C				1 1/2
30x24		1/2		4C				1 1/2

SIZE	DIMENSIONS															
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
24x18	5 1/2	9 1/2	1 1/2	7	3 1/2											
30x24	6 7/8	12 1/2	1 7/8	8 3/4	4 3/8											

Green BACKGROUND WITH White BORDER AND LEGEND

REMARKS: Opaque Background / Reflectorized Legend  
ALL DIMENSIONS ARE NOMINAL

REV	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN	C. A. B.	DATE Sept 1
APPROVED	<i>[Signature]</i>	



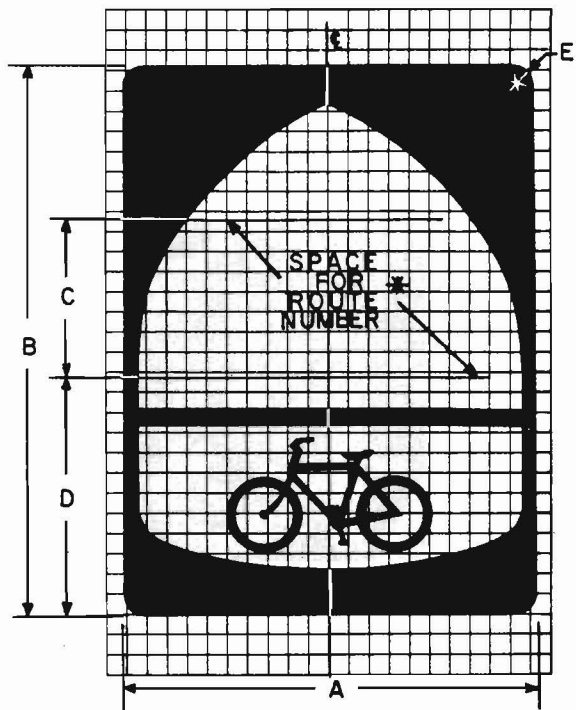


\* SEE W11-1 FOR  
SYMBOL DESIGN

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.																
STD.	12	18	1	5 1/4	4	5D	1 3/4	2 3/8	3	1 1/2						
EXPWY.																
FWY.																
SPECIAL																

<p align="center"><b>COLORS</b></p> <p>LEGEND 8 SYMBOL-WHITE (REFL)</p> <p>INNER BACKGROUND-GREEN (REFL)</p> <p>OUTER BACKGROUND-WHITE (REFL)</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	JDH	DATE
	APPROVED	<i>[Signature]</i>	



\* OPTICALLY CENTER NUMERALS

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.																
STD.	18	24	7D	10½	1½											
EXPWY.																
FWY.																
SPECIAL																

<p align="center"><b>COLORS</b></p> <p>LEGEND &amp; BIKE SYMBOL-BLACK(NON-REFL)</p> <p>INNER BACKGROUND- WHITE(REFL)</p> <p>OUTER BACKGROUND- BLACK(NON-REFL)</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	JDH	DATE JUN 86
	APPROVED	<i>[Signature]</i>	

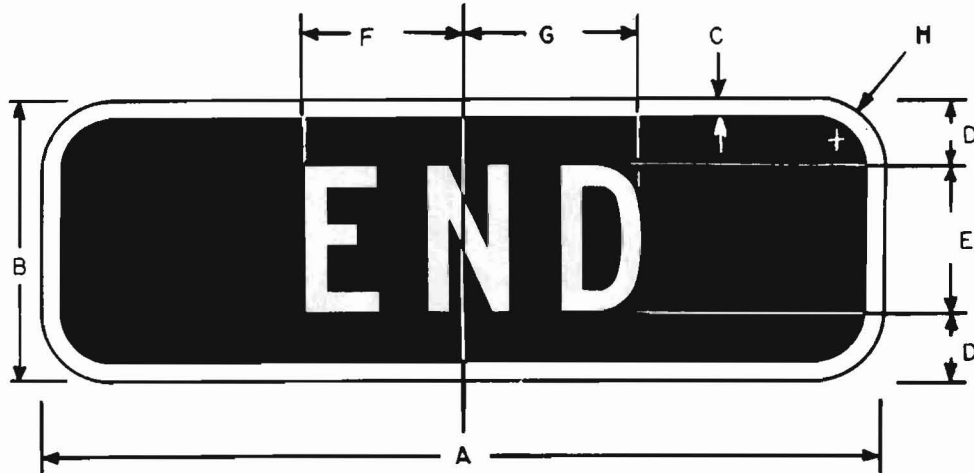


SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	12	4	3	1/4	1	2C	1									
STD.	24	6	6 1/4	1/2	1	4C	1 1/2									
EXPWY.																
FWY.																
SPECIAL																

<p align="center"><b>COLORS</b></p> <p>LEGEND - WHITE (REFL.)                  BACKGROUND - GREEN (REFL.)                  LEGEND - BLACK (NON-REFL.)                  BACKGROUND - ORANGE (REFL.)</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	J	DATE JUN 1988
	APPROVED	<i>[Signature]</i>	

CODE M4-12



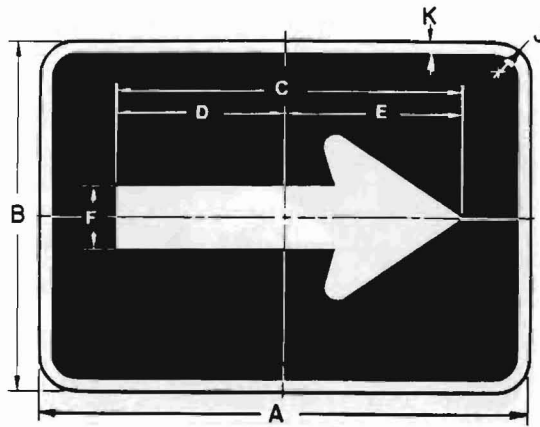
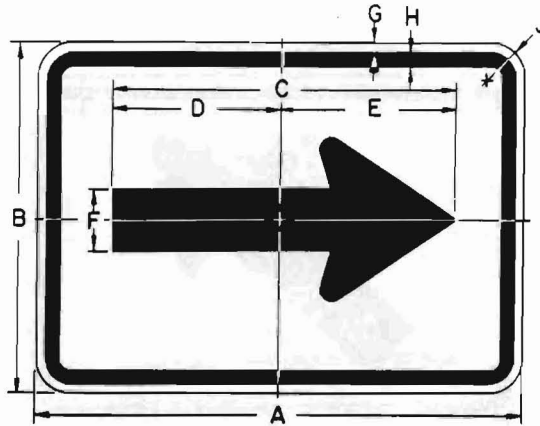
Increase Spacing 100%

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	12	4	1/4	1	2C	2 1/4	2 1/2	1								
STD.	24	6	1/2	1	4C	4 5/8	4 7/8	1 1/2								
EXPWY.																
FWY.																
SPECIAL																

<p style="text-align: center;">COLORS</p> <p>LEGEND - WHITE (REFL.)          BACKGROUND - GREEN (REFL.)          LEGEND - BLACK (NON-REFL.)          BACKGROUND - ORANGE (REFL.)</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	J	DATE JUN 86
	APPROVED	<i>[Signature]</i>	

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INTERSTATE

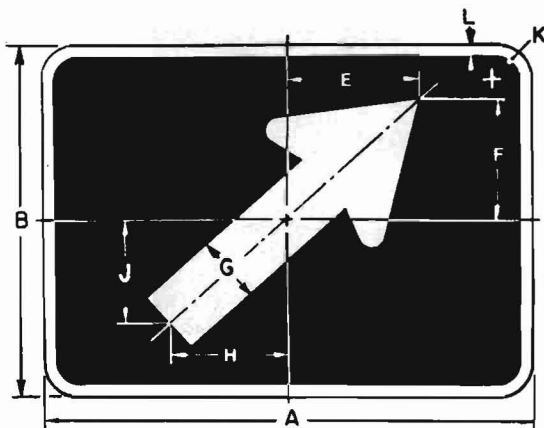
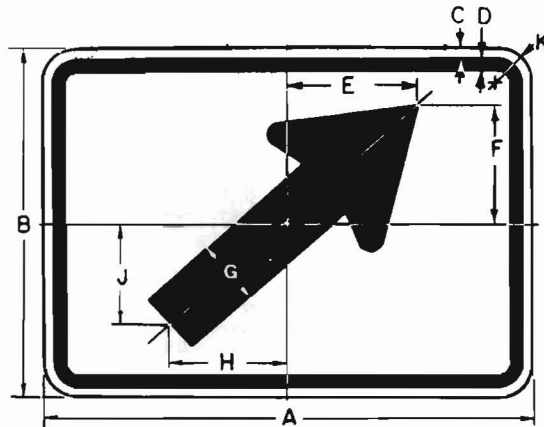
SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	21	15	14 <sup>5</sup> / <sub>8</sub>	7 <sup>1</sup> / <sub>8</sub>	7 <sup>1</sup> / <sub>2</sub>	2 <sup>5</sup> / <sub>8</sub>	3 <sup>3</sup> / <sub>8</sub>	5 <sup>5</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>						
STD.	24	18	16 <sup>3</sup> / <sub>8</sub>	8 <sup>1</sup> / <sub>8</sub>	8 <sup>1</sup> / <sub>2</sub>	2 <sup>3</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>8</sub>	5 <sup>5</sup> / <sub>8</sub>	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>						
EXPWY.																
FWY.																
SPECIAL																

COLORS  
 LEGEND- BLACK (NON-REFL)  
 WHITE (REFL)  
 BACKGROUND-WHITE (REFL)-ORANGE (REFL)  
 BLUE (REFL)-(INTERSTATE)  
 GREEN (REFL)-BROWN (REFL)

REV. ARIZONA DEPARTMENT OF TRANSPORTATION  
 TRAFFIC DESIGN SERVICES

DRAWN JDH DATE 11/11

APPROVED [Signature]

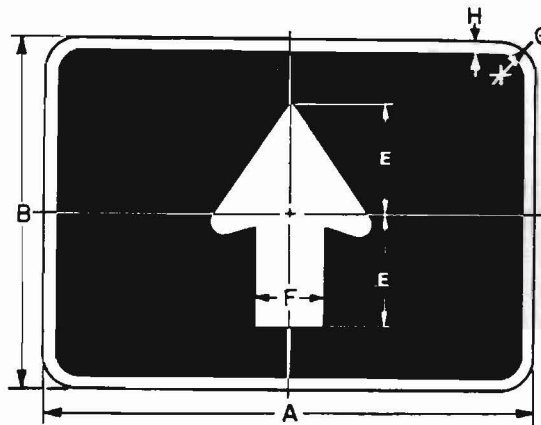
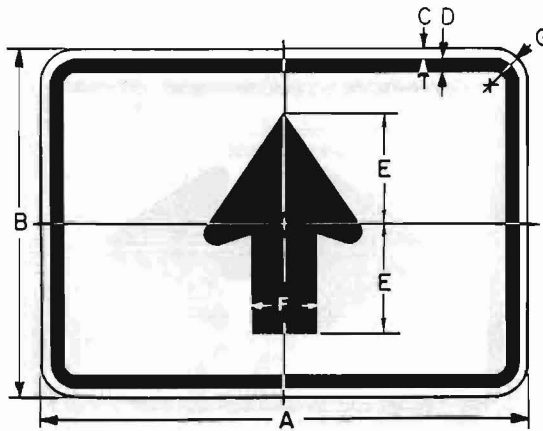


INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	21	15	3/8	5/8	55/8	51/16	25/8	51/16	45/16	1 1/2	1/2					
STD.	24	18	3/8	5/8	6 5/8	5 7/8	2 3/4	5 7/8	5 1/8	1 1/2	1/2					
EXPWY.																
FWY.																
SPECIAL																
<p style="text-align: center;"><b>COLORS</b></p> <p>LEGEND - BLACK (NON-REFL)                  - WHITE (REFL)                  BACKGROUND - WHITE (REFL) ORANGE (REFL)                  - BLUE (REFL) - (INTERSTATE)                  GREEN (REFL) BROWN (REFL)</p>										REV. ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES		DRAWN FR DATE		APPROVED		



CODE M6-3

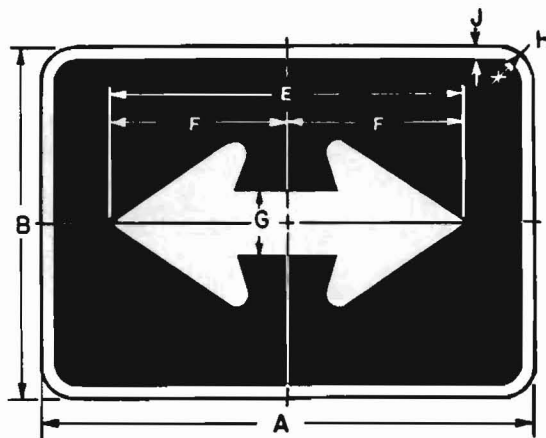
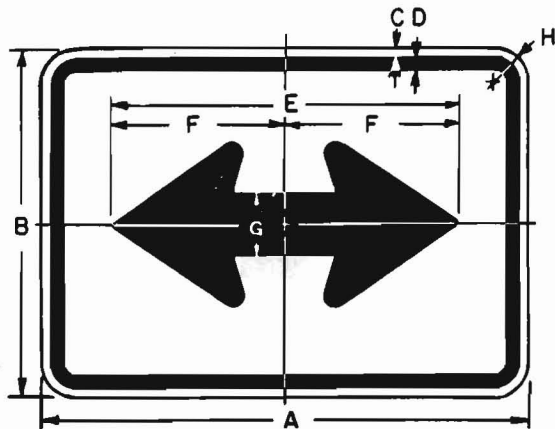


INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)																
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	
BIKE																	
MIN.	21	15	3/8	5/8	4 7/8	2 5/8	1 1/2	1/2									
STD.	24	18	3/8	5/8	6 3/4	2 3/4	1 1/2	1/2									
EXPWY.																	
FWY.																	
SPECIAL																	

<p style="text-align: center;"><b>COLORS</b></p> <p>LEGEND - BLACK (NON-REFL)                  WHITE (REFL)                  BACKGROUND - WHITE (REFL) - ORANGE (REFL)                  BLUE (REFL) - (INTERSTATE)                  GREEN (REFL) - BROWN (REFL)</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN		DATE
	JDH		
APPROVED			

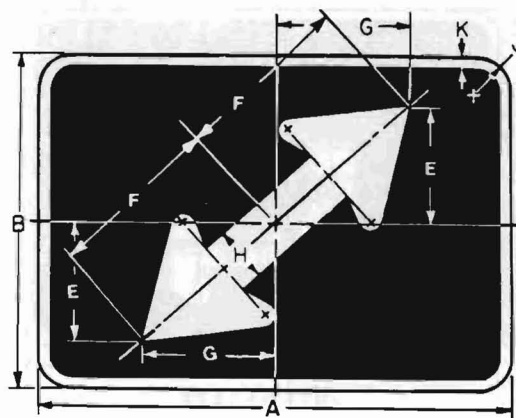
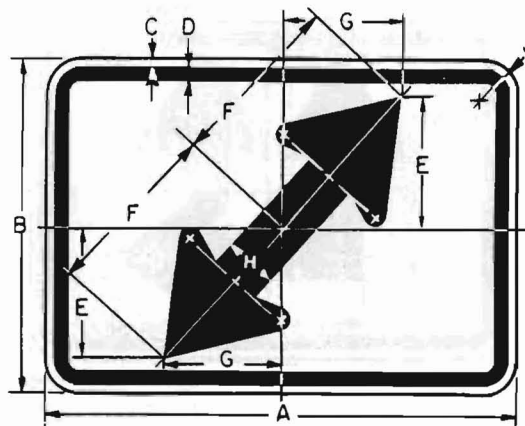


INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	21	15	3/8	5/8	15	7 1/2	2 5/8	1 1/2	1/2							
STD.	24	18	3/8	5/8	17	8 1/2	2 3/4	1 1/2	1/2							
EXPWY.																
FWY.																
SPECIAL																

<p align="center"><b>COLORS</b></p> <p>LEGEND - BLACK (NON-REFL)                  WHITE (REFL)                  BACKGROUND - WHITE (REFL)-ORANGE (REFL)                  BLUE (REFL)-(INTERSTATE)                  GREEN (REFL)-BROWN (REFL)</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	JDH	DATE
	APPROVED	<i>[Signature]</i>	



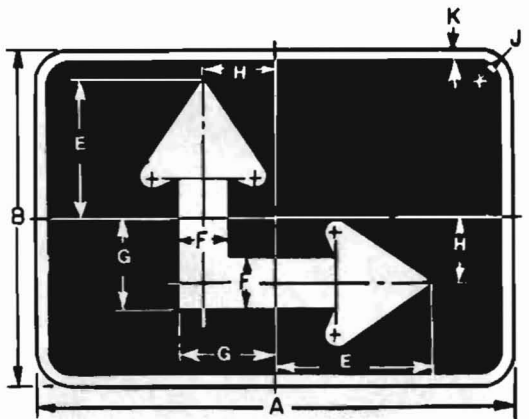
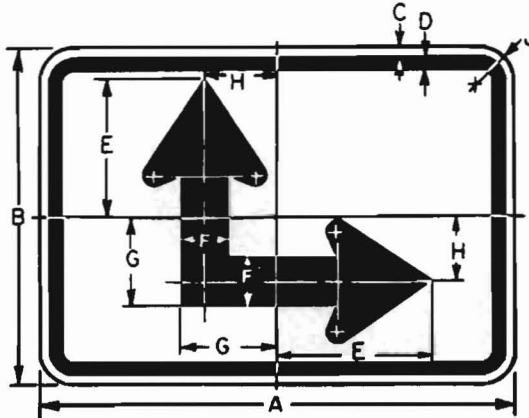
INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	21	15	3/8	5/8	5 1/4	7 7/8	5 7/8	2 1/4	1 1/2	1/2						
STD.	24	18	3/8	5/8	5 5/8	9	7	2 3/4	1 1/2	1/2						
EXPWY.																
FWY.																
SPECIAL																

**COLORS**

LEGEND - BLACK (NON-REFL.)  
 WHITE (REFL.)  
 BACKGROUND - WHITE (REFL.) - ORANGE (REFL.)  
 BLUE (REFL.) - (INTERSTATE)  
 GREEN (REFL.) - BROWN (REFL.)

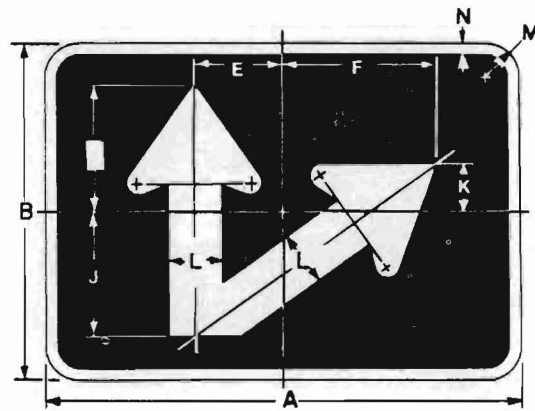
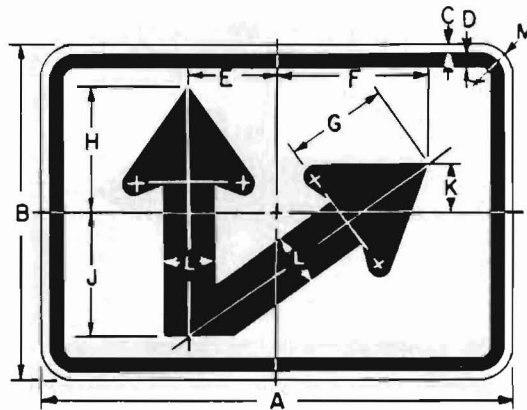
REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN	FR	DATE JUN 20
APPROVED		



INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	21	15	3/8	5/8	5 3/4	2 1/4	3 7/8	2 3/4	1 1/2	1/2						
STD.	24	18	3/8	5/8	7 1/2	2 3/4	5 1/8	3 1/8	1 1/2	1/2						
EXPWY.																
FWY.																
SPECIAL																

<p style="text-align: center;">COLORS</p> <p>LEGEND - BLACK (NON-REFL)                  - WHITE (REFL)                  BACKGROUND - WHITE (REFL) - ORANGE (REFL)                  - BLUE (REFL) - (INTERSTATE)                  GREEN (REFL) - BROWN (REFL)</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
		DRAWN FR	DATE 11/89
		APPROVED <i>[Signature]</i>	



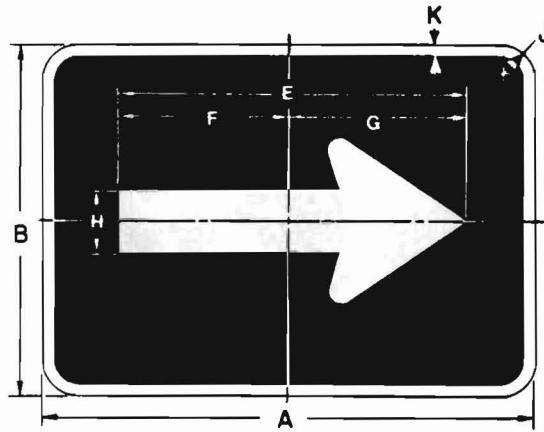
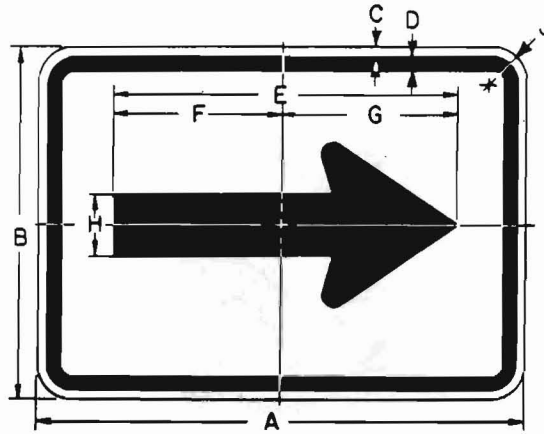
INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	21	15	3/8	5/8	3 7/8	6 3/4	4 1/2	5 3/4	5 1/2	2 1/8	2 1/4	1 1/2	1/2			
STD.	24	18	3/8	5/8	5 1/4	9 3/4	5 1/4	7 1/2	7 1/4	3 1/4	2 3/4	1 1/2	1/2			
EXPWY.																
FWY.																
SPECIAL																

**COLORS**  
**LEGEND - BLACK (NON-REFL.)**  
**WHITE (REFL.)**  
**BACKGROUND - WHITE (REFL.) - ORANGE (REFL.)**  
**BLUE (REFL.) - (INTERSTATE)**  
**GREEN (REFL.) - BROWN (REFL.)**

REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN	FR	DATE JUN 88
APPROVED	<i>[Signature]</i>	

CODE M7-1

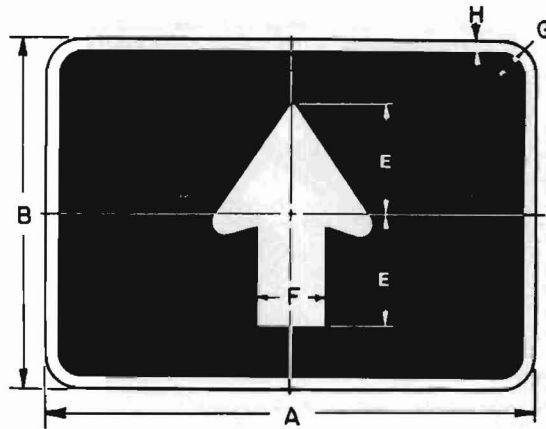
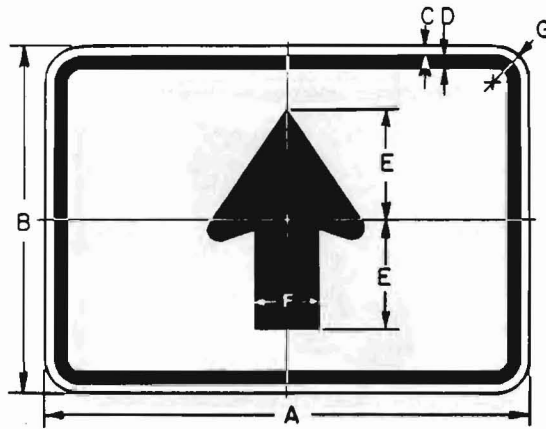


INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	12	9	3/8	3/8	8 3/4	4 1/4	4 1/2	1 5/8	1 1/2	1/2						
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

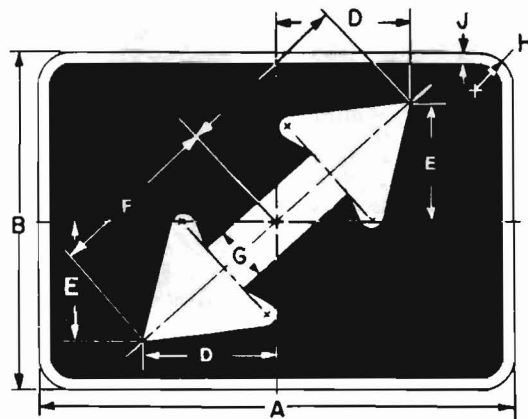
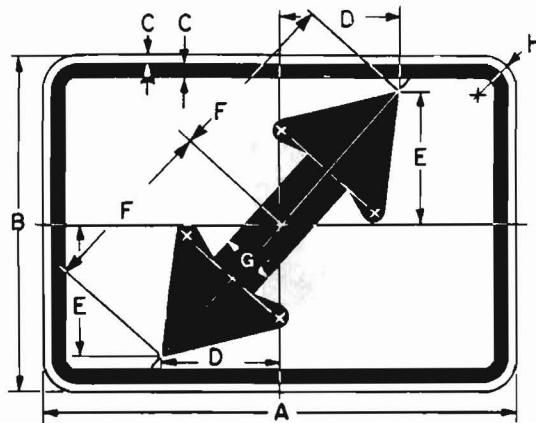
COLORS			REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	WHEN USED W/ SIGNS #DII-1 & MI-8	WHEN USED W/ SIGN # MI-9		DRAWN	DATE
LEGEND	WHITE (REFL.)	BLACK (NON-REFL.)		JDH	JUN 88
BACKGROUND	GREEN (REFL.)	WHITE (REFL.)		APPROVED	
				<i>[Signature]</i>	



INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	12	9	3/8	3/8	3	1 5/8	1 1/2	1/2								
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

COLORS			REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	WHEN USED W/ SIGNS #DII-1 & MI-8	WHEN USED W/ SIGN # MI-9		DRAWN JDH	DATE 11/17
LEGEND BACKGROUND	WHITE (REFL.) GREEN (REFL.)	BLACK (NON-REFL.) WHITE (REFL.)		APPROVED	



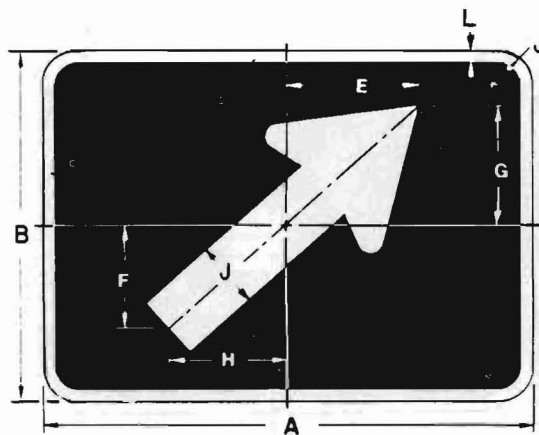
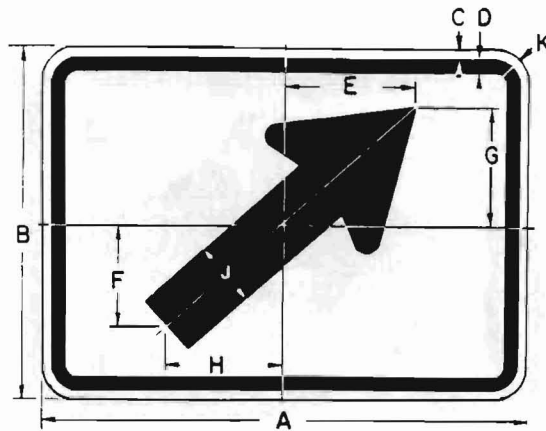
INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	12	9	3/8	3 5/8	3	4 1/2	1 3/8	1 1/2	1/2							
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

COLORS			REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	WHEN USED W/ SIGNS #DII-1 & MI-8	WHEN USED W/ SIGN #MI-9		DRAWN FR	DATE 3/1/77
LEGEND	WHITE (REFL.)	BLACK (NON-REFL.)		APPROVED	
BACKGROUND	GREEN (REFL.)	WHITE (REFL.)			



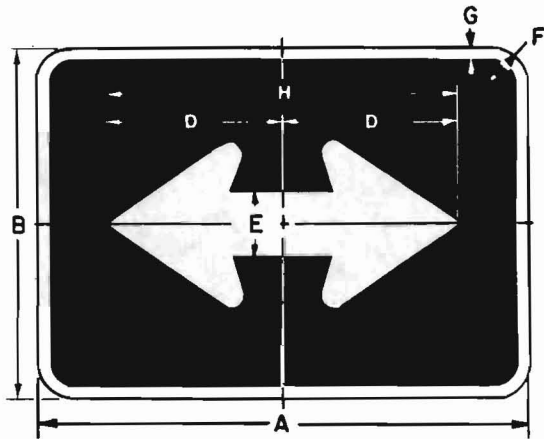
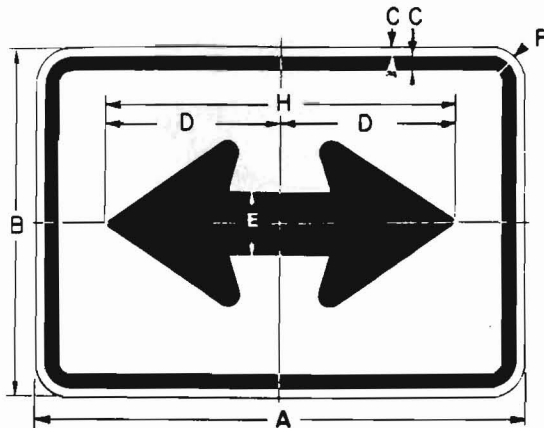


INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	12	9	3/8	3/8	3 3/8	2 5/8	3	3	1 1/8	1 1/2	1/2					
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

COLORS			REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	WHEN USED W/ SIGNS # D11-1 & MI-8	WHEN USED W/ SIGN # MI-9		DRAWN JDH	DATE
LEGEND	WHITE (REFL.)	BLACK (NON-REFL.)		APPROVED	
BACKGROUND	GREEN (REFL.)	WHITE (REFL.)			

CODE M7-5

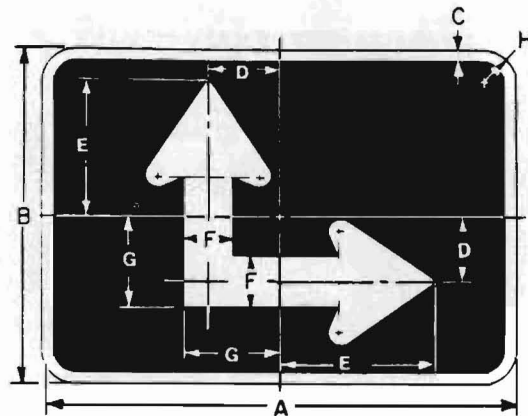
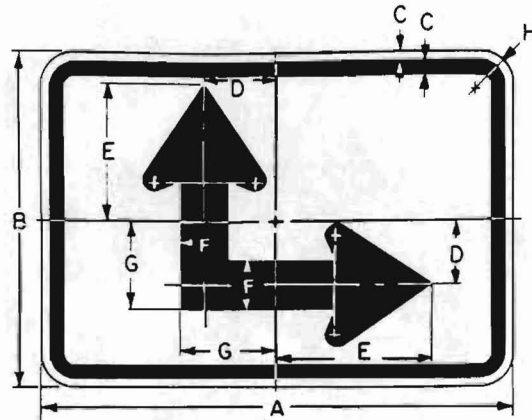


INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	12	9	3/8	4 3/8	1 5/8	1 1/2	1/2	8 3/4								
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

COLORS			REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	WHEN USED W/ SIGNS #DI-1 & MI-8	WHEN USED W/ SIGN #MI-9		DRAWN JDH	DATE 7/11/88
LEGEND	WHITE (REFL.)	BLACK (NON-REFL.)		APPROVED	
BACKGROUND	GREEN (REFL.)	WHITE (REFL.)			

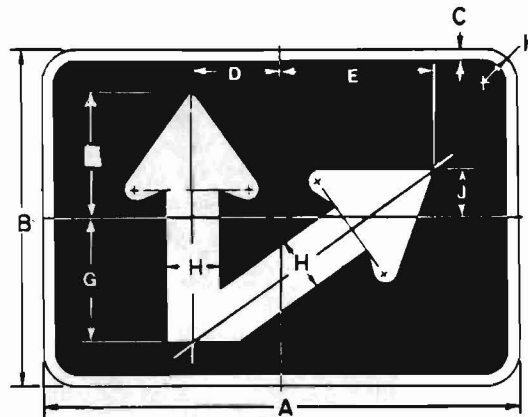
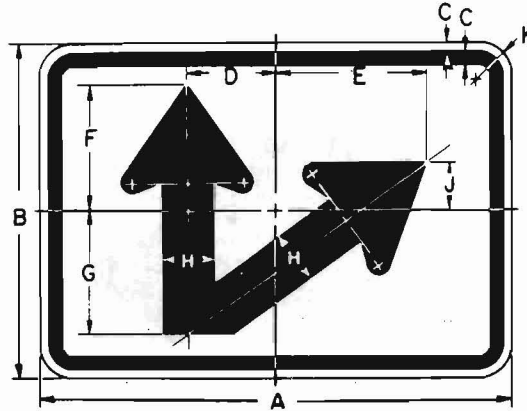


INTERSTATE

SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	12	9	3/8	1 5/8	3 3/8	1 3/8	2 1/4	1 1/2								
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

COLORS			REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	WHEN USED W/ SIGNS # D11-1&MI-8	WHEN USED W/ SIGN # MI-9		DRAWN FR	DATE
LEGEND	WHITE (REFL.)	BLACK (NON-REFL.)			
BACKGROUND	GREEN (REFL.)	WHITE (REFL.)	APPROVED		

CODE M 7-7

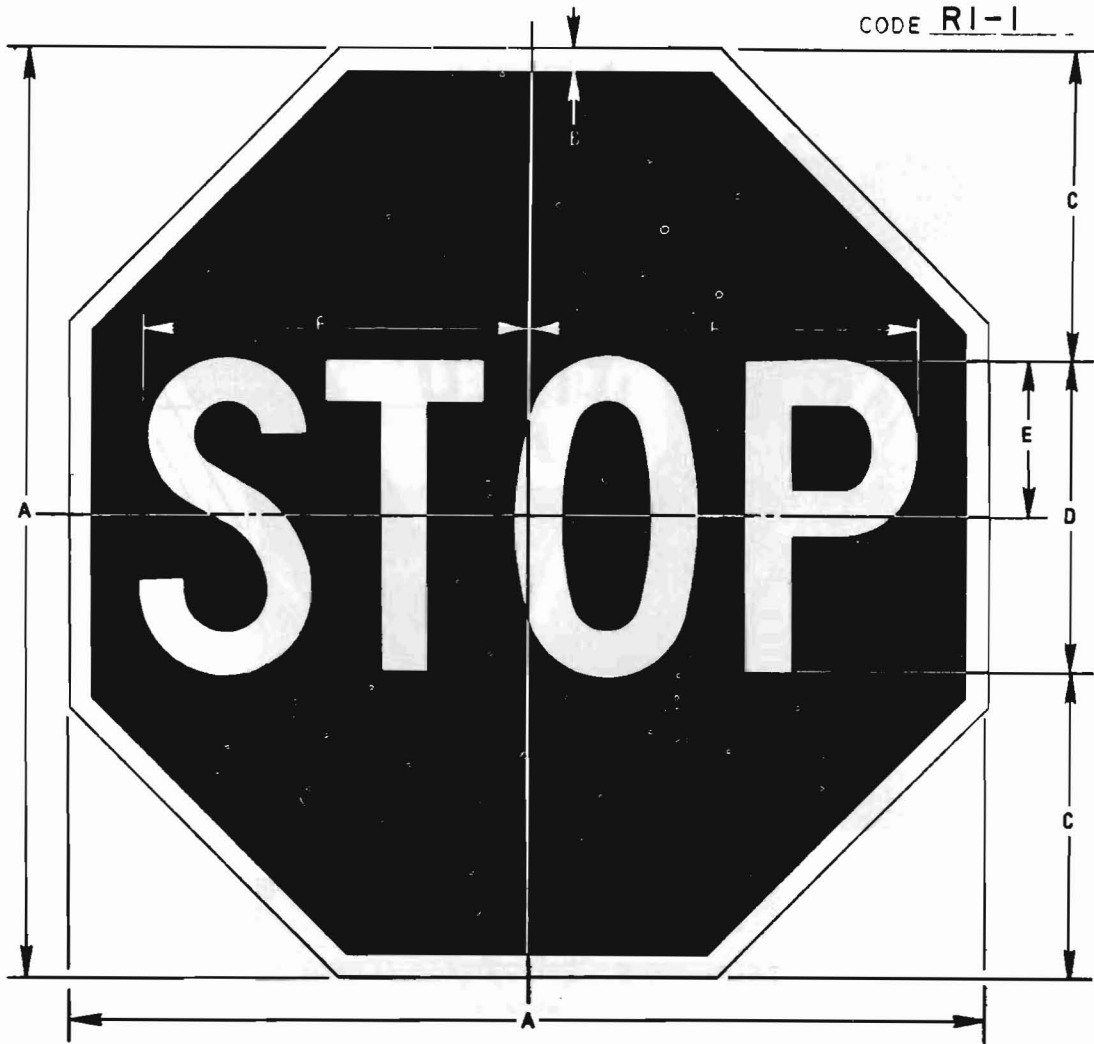


SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	12	9	3/8	3/8	4	3 3/8	3 1/8	1 3/8	1 1/4	1 1/2						
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

COLORS		REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	WHEN USED W/ SIGNS #DII-1 & MI-8	WHEN USED W/ SIGN #MI-9	DRAWN	DATE
LEGEND	WHITE (REFL.)	BLACK (NON-REFL.)	FR	11/13
BACKGROUND	GREEN (REFL.)	WHITE (REFL.)	APPROVED	

CODE RI-1



\* Reduce spacing 40%

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	6	6C	3	7 3/4										
MIN.	24	5/8	8	8C	4	10										
STD.	30	3/4	10	10C	5	12 1/2										
EXPWY.	36	7/8	12	12C	6	15										
SPECIAL	42	1	14	14C	7	17 1/2										
SPECIAL	48	1 1/4	16	16C	8	20										

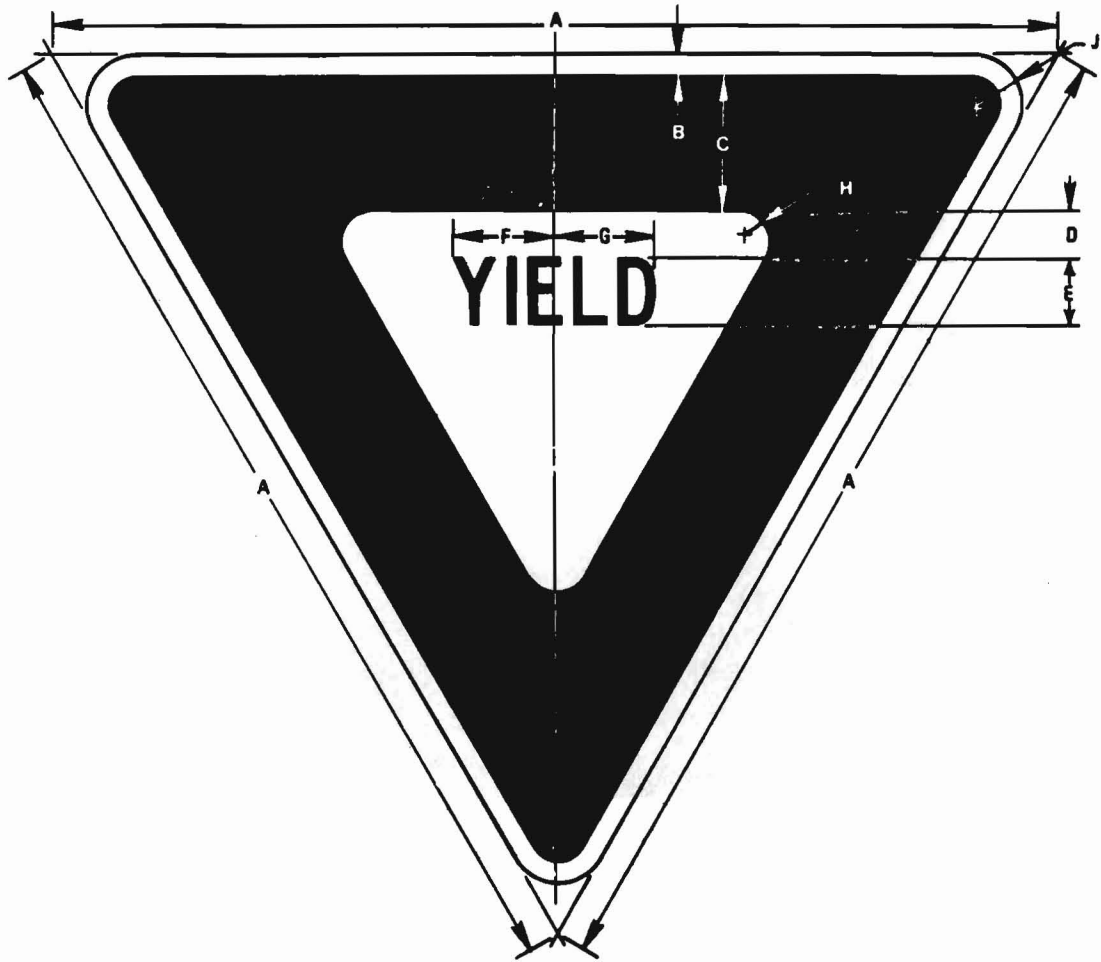
COLORS

LEGEND - WHITE (REFL)  
 BACKGROUND - RED (REFL)

ALL DIMENSIONS ARE NOMINAL

REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN	RGT	DATE AUG 1983
APPROVED	<i>[Signature]</i>	

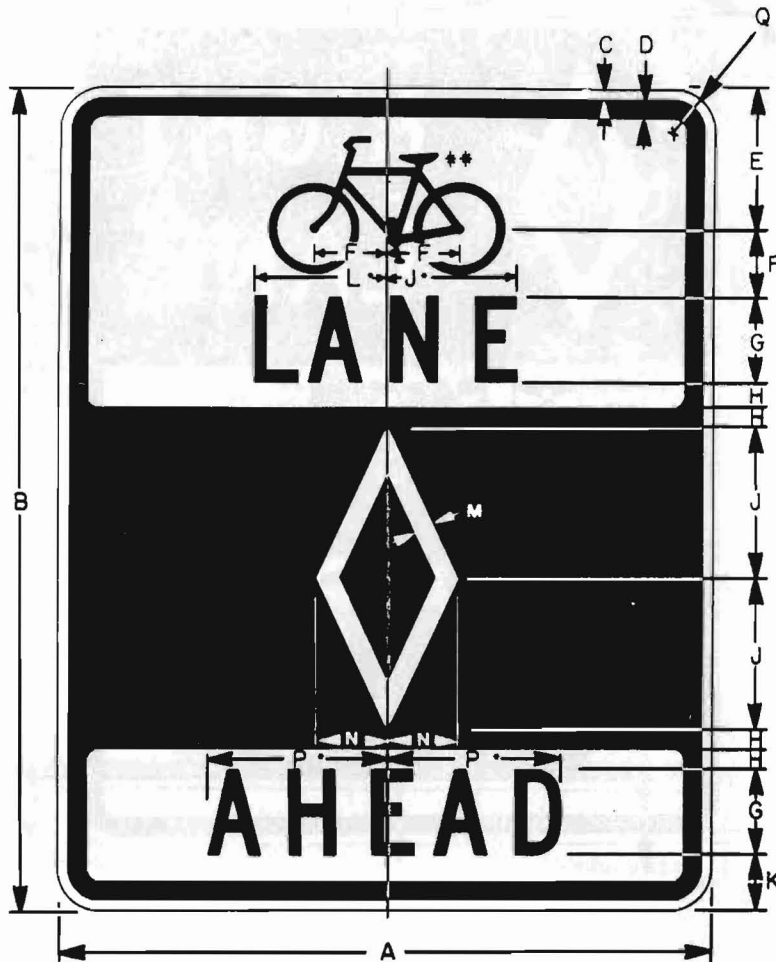
CODE RI-2



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	24	3/8	3	1 3/8	2C	3 1/4	3	7/8	1 1/2							
MIN.	30	5/8	4	1 3/4	2 1/2 C	3 15/16	3 5/8	7/8	1 1/2							
STD.	36	3/4	5	2	3C	4 11/16	4 3/8	1 1/4	2							
EXPWY.	48	1	6	2 3/4	4C	6 1/4	5 7/8	2	3							
FWY.	60	1 1/2	8	3 1/2	5C	7 7/8	7 1/4	2 1/2	4							
SPECIAL																

<p align="center"><b>COLORS</b></p> <p>LEGEND     -RED(REFL)</p> <p>BACKGROUND-WHITE(REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES
	DRAWN RGT	DATE AUG 1983
	APPROVED <i>Ernest L. Hutton</i>	

CODE R3-16



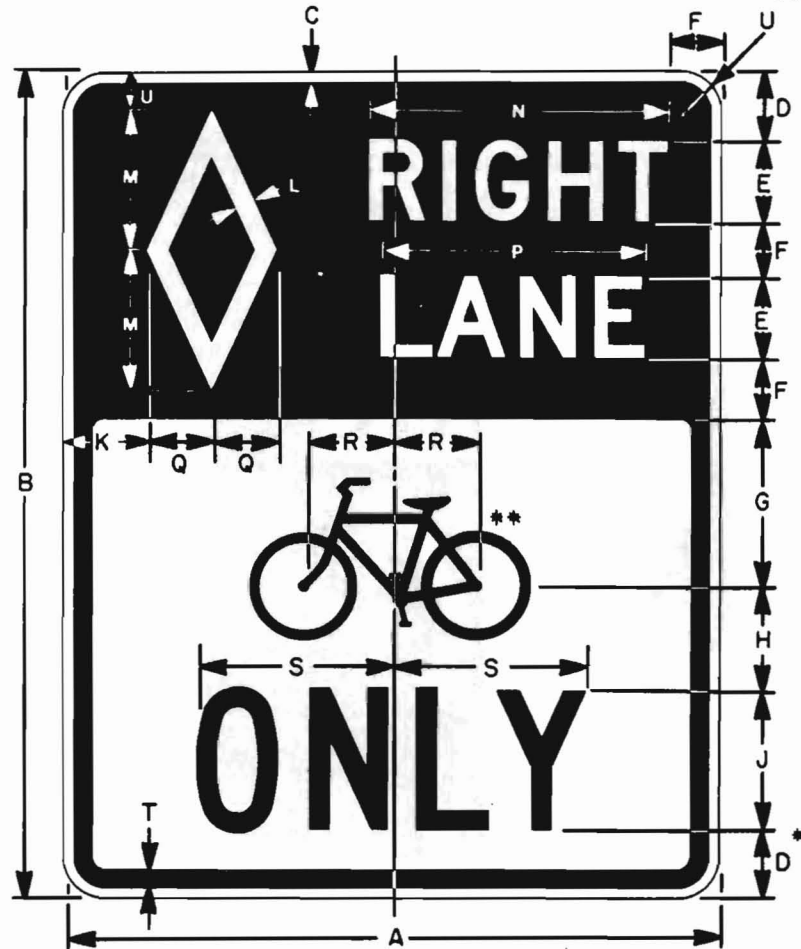
♦ ♦ See W11-1 for symbol design  
\* Increase spacing 100%

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.																
STD.	24	30	3/8	5/8	5 3/8	2 5/8	3C	1	5	2	4 5/8	3/4	2 3/8	6 3/8	1 1/2	
EXPWY.																
FWY.																
SPECIAL																

<p><b>COLORS</b></p> <p>LEGEND — BLACK (NON-REFL)</p> <p>BACKGROUND — WHITE (REFL)</p> <p>SYMBOL (MIDDLE) — REFL. WHITE ON BLACK</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE AUG 1983
	APPROVED	<i>[Signature]</i>	

CODE R3-17

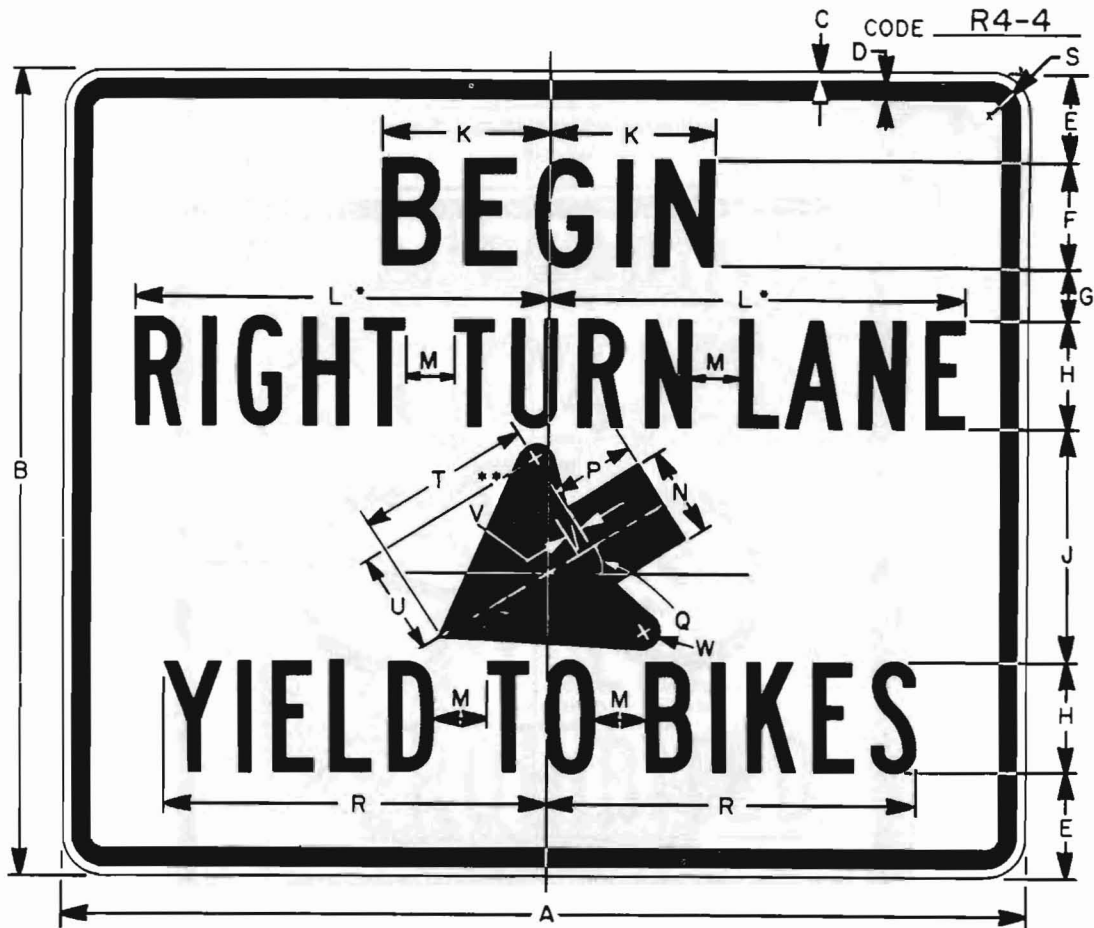


\*\*See W11-1 for symbol design.  
\*Optically locate symbol and top legend.

SIGN	DIMENSIONS (INCHES)																
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	
STD.	24	30	3/8	2 1/2	3D	2	6	4	5C	3	3/4	5	1 1/4	10	2 3/8	3 1/4	
	S	T	U	V	W	X	Y	Z									
STD.	7	5/8	1 1/2														

COLORS		REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
TOP	BOTTOM		DRAWN	DATE
SYMBOL & LEGEND-WHITE (REFL) / BACKGROUND-BLACK (NON-REFL)	LEGEND-BLACK (NON-REFL) / BACKGROUND-WHITE (REFL)			RGT
ALL DIMENSIONS ARE NOMINAL			APPROVED	<i>[Signature]</i>





- \* Reduce spacing 20%
- \*\* Optically locate arrow

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
STD.	36	30	1/2	3/4	3 1/2	4C	2	4B	9	6 1/4	15 1/2	2 3/8	3 1/4	3 1/2	30°	14 1/4

SIGN	S	T	U	V	W	X	Y	Z
	STD.	1 7/8	6 1/2	3 5/8	1/2	5/8		

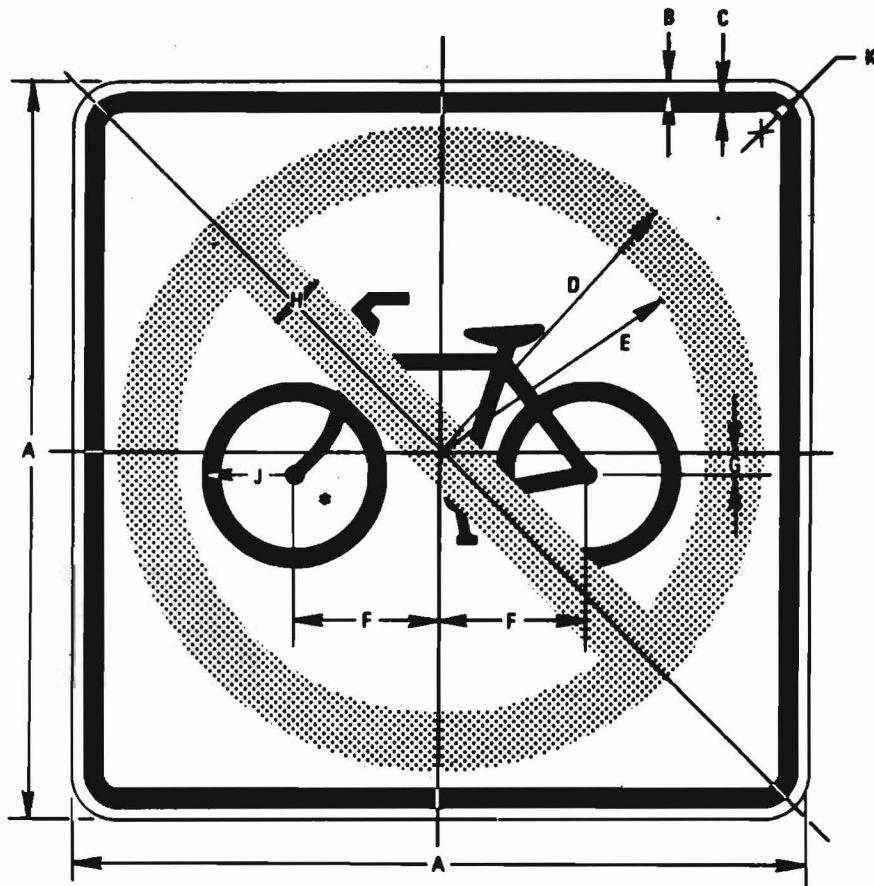
**COLORS**

LEGEND & ARROW - BLACK (NON-REFL)  
 BACKGROUND - WHITE (REFL)

ALL DIMENSIONS ARE NOMINAL

REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN	RGT	DATE AUG 1983
APPROVED		

CODE R5-6



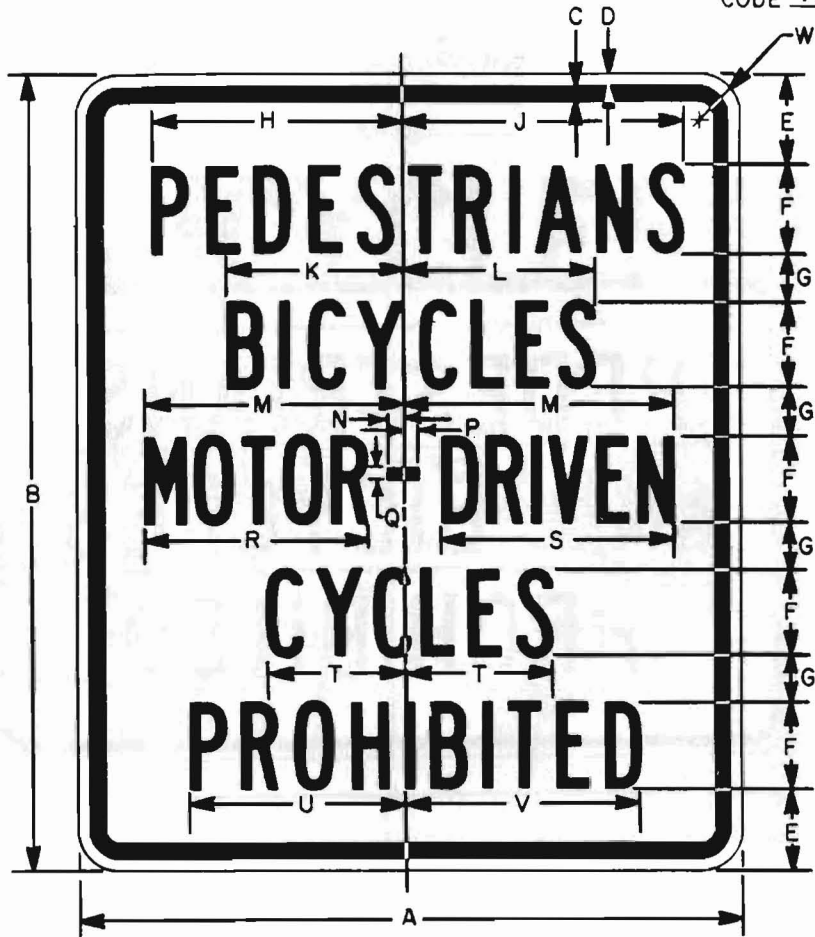
\*See W11-1 for symbol design

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	24	3/8	5/8	10 1/2	8 1/2	4 3/4	3/4	2	3	1 1/2						
STD.	24	3/8	5/8	10 1/2	8 1/2	4 3/4	3/4	2	3	1 1/2						
SPECIAL	30	1/2	3/4	13 1/8	10 5/8	5 7/8	7/8	2 1/2	3 3/4	1 7/8						
SPECIAL	36	5/8	7/8	15 3/4	12 3/4	7 1/8	1 1/8	3	4 1/2	2 1/4						
SPECIAL	48	3/4	1 1/4	21	17	9 1/2	1 1/2	4	6	3						

<p align="center"><b>COLORS</b></p> <p>CIRCLE &amp; DIAGONAL - RED (REFL)</p> <p>SYMBOL &amp; BORDER - BLACK (NON-REFL)</p> <p>BACKGROUND - WHITE (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES
	DRAWN RGT	DATE AUG 1993
	APPROVED <i>Charles H. ...</i>	

CODE R5-10a



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
STD.	30	36	3/4	1/2	4	48	2	11 5/8	12 1/4	8 1/4	8 7/16	12	1 1/16	7/16	1/2	10 1/8
	S	T	U	V	W	X	Y	Z								
STD.	10 9/16	6 1/2	10	10 7/16	1 7/8											

**COLORS**

LEGEND -BLACK (NON-REFL)

BACKGROUND-WHITE (REFL)

ALL DIMENSIONS ARE NOMINAL

REV.

ARIZONA DEPARTMENT OF TRANSPORTATION  
TRAFFIC DESIGN SERVICES

DRAWN  
RGT

DATE  
AUG 1983

APPROVED

CODE R5-10b



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.																
STD.	30	18	3/8	5/8	3	3C	1 1/2	11	11 3/16	12 1/2	12	3 1/2	9 1/4	9 3/4		
EXPWY.																
FWY.																
SPECIAL																

<p align="center"><b>COLORS</b></p> <p>LEGEND    - BLACK (NON-REFL)</p> <p>              BACKGROUND - WHITE (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>		<p>REV.    ARIZONA DEPARTMENT OF TRANSPORTATION           TRAFFIC DESIGN SERVICES</p> <p>DRAWN    RGT                      DATE    AUG 1983</p> <p>APPROVED <i>[Signature]</i></p>
--	--	--

CODE R5-11



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
STD.	30	1/2	3/4	5	4C	4	10 5/16	10 3/16	6 3/8	5 5/8	11 1/8	60°	3 3/8	3/8	1 3/8	16 1/2

**COLORS**

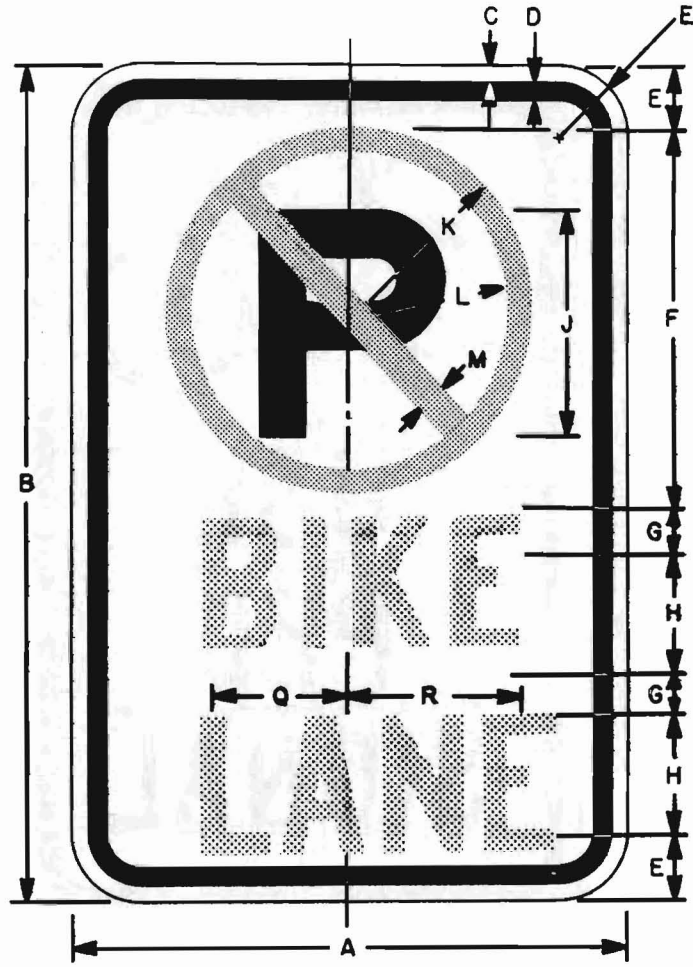
LEGEND      - BLACK (NON-REFL)

BACKGROUND - WHITE (REFL)

ALL DIMENSIONS ARE NOMINAL

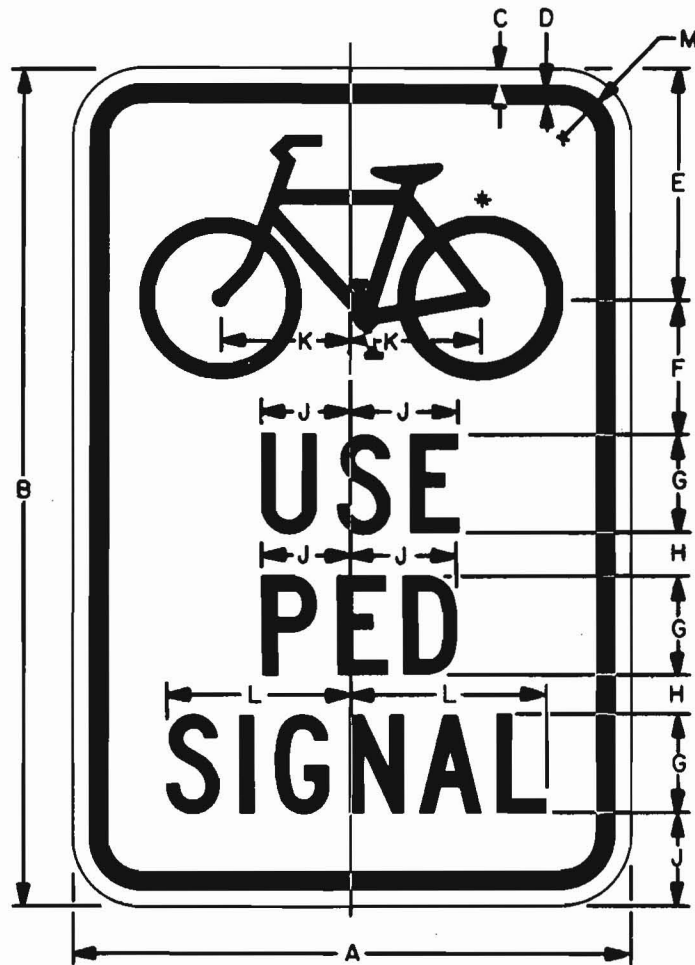
REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN	RGT	DATE AUG 1983
APPROVED	<i>[Signature]</i>	





SIGN	DIMENSIONS (INCHES)																
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	
BIKE																	
MIN.																	
STD.	12	18	3/8	3/8	1/2	8	1	2 1/2	5E(M)	4	3 3/8	5/8	2 3/4	3/4	3	3 5/8	
EXPWY.																	
FWY.																	
SPECIAL																	

<p align="center"><b>COLORS</b></p> <p>LEGEND, CIRCLE, DIAGONAL — RED</p> <p>BACKGROUND — WHITE</p> <p>LETTER P, BORDER — BLACK</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE
	APPROVED	<i>Carol P. Hutton</i>	AUG 1983

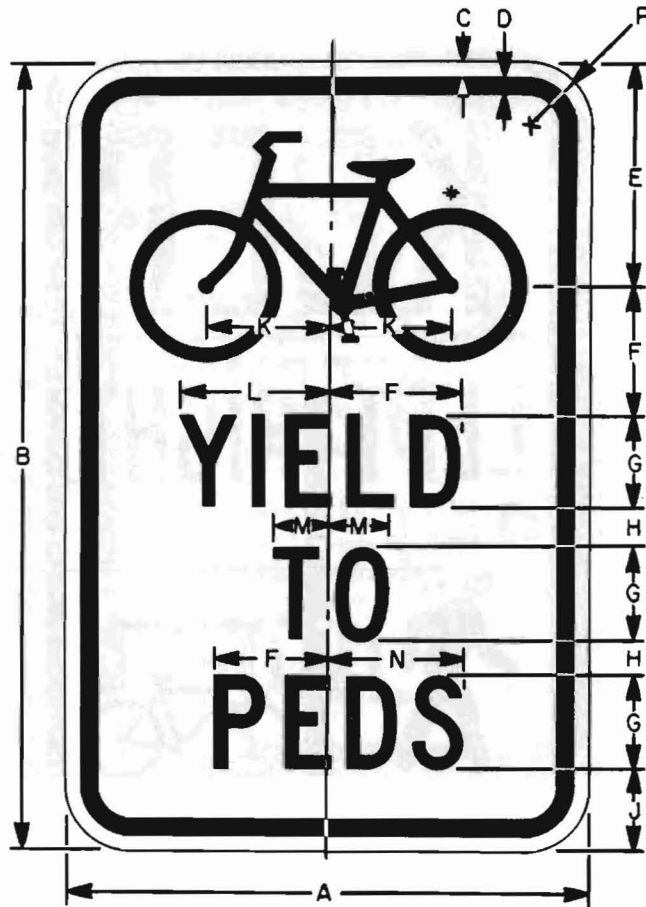


\*See W11-1 for symbol design.

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.																
STD.	12	18	3/8	3/8	5	3	2C	1	2	2 3/4	4	1 1/2				
EXPWY.																
FWY.																
SPECIAL																

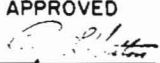
<p><b>COLORS</b></p> <p>LEGEND    - BLACK (NON-REFL)</p> <p>BACKGROUND - WHITE (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE AUG 1983
	APPROVED	<i>[Signature]</i>	





\*See W11-1 for symbol design

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.																
STD.	12	18	3/8	3/8	5	3	2C	1	2	2 3/4	3 1/4	1 1/4	3 1/2	1 1/2		
EXPWY.																
FWY.																
SPECIAL																

<p style="text-align: center;">COLORS</p> <p>LEGEND      - BLACK (NON-REFL)</p> <p>BACKGROUND - WHITE (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE AUG 1983
	APPROVED		

CODE R9-7



\*Reduce spacing 50%.  
 \*\*See W11-2 for symbol design  
 \*\*\*See W11-1 for symbol design.

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.																
STD.	12	18	3/8	3/8	2	4B	1 1/2	2B	4 1/2	4	4 3/8	4 5/8	3/8	3 1/4	2 3/4	1 1/2
EXPWY.																
FWY.																
SPECIAL																

<p><b>COLORS</b></p> <p>LEGEND - BLACK (NON-REFL)</p> <p>BACKGROUND - WHITE (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE AUG 1983
	APPROVED		

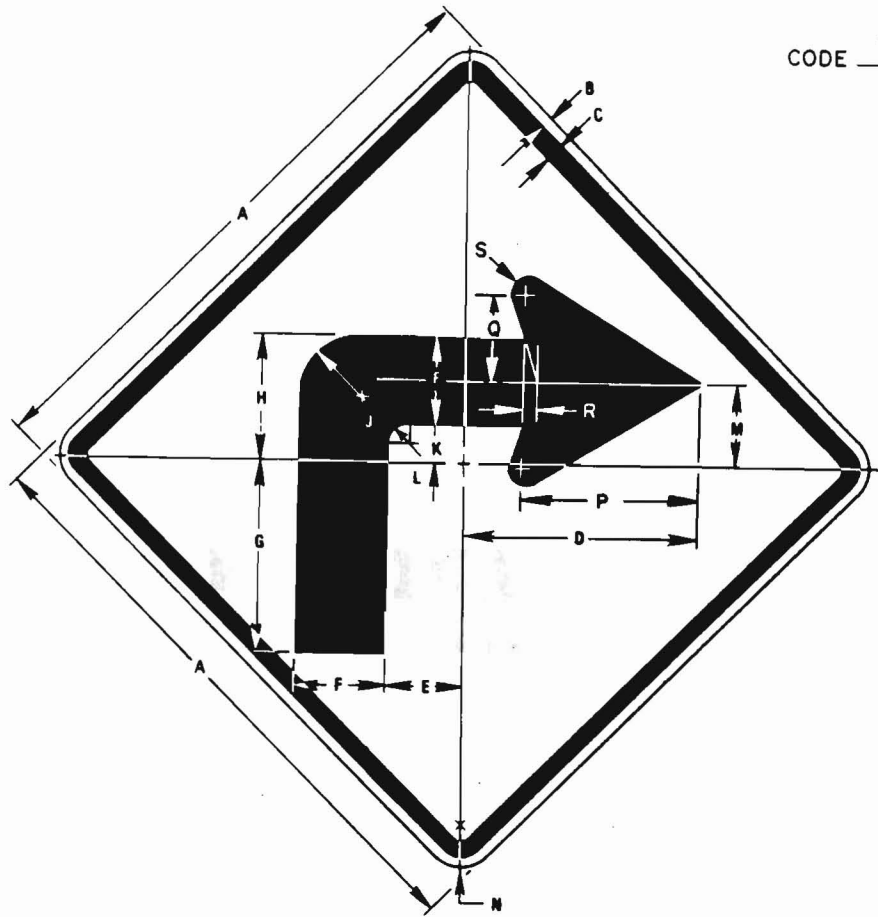


\*See W11-1 For Symbol Design  
 \*\*Reduce Spacing 75%

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.																
STD.																
EXPWY.																
FWY.	18	24	3/8	5/8	6 3/4	3 1/4	3C	1 1/4	2 1/2	3 1/2	3	7	3 15/16	4 1/4	1 1/2	
SPECIAL																

COLORS  LEGEND      - BLACK (NON-REFL) BACKGROUND - WHITE (REFL)  ALL DIMENSIONS ARE NOMINAL	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE 2/16/93
	APPROVED	<i>[Signature]</i>	

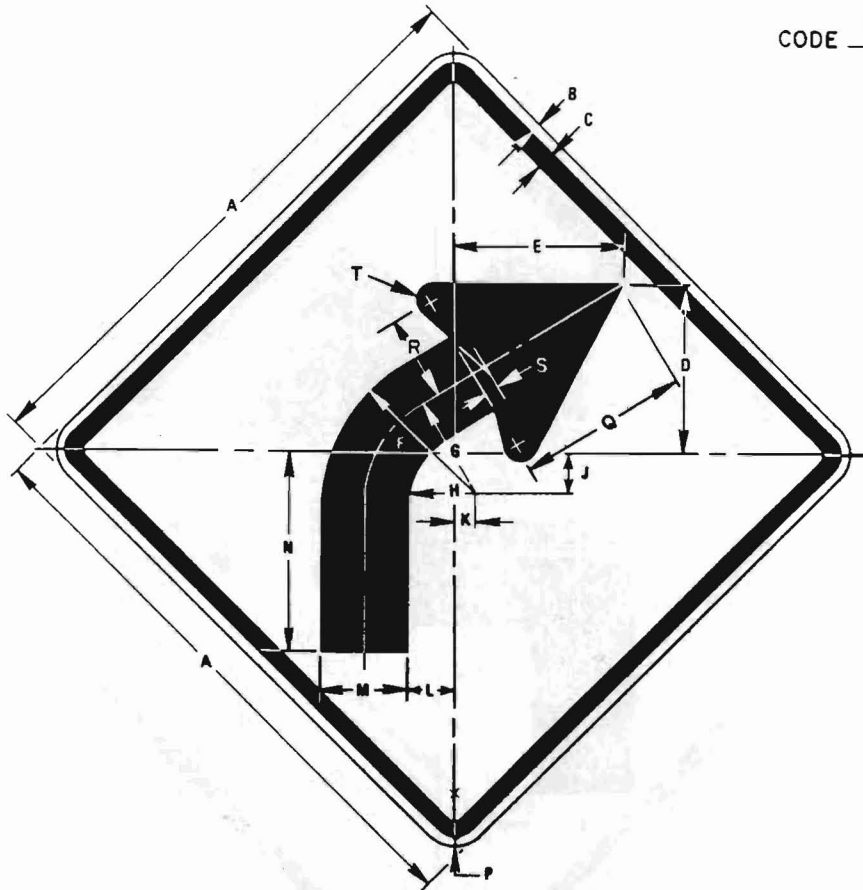
CODE WI-IR



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	7 1/4	2 1/4	2 5/8	5 7/8	3 3/4	1 7/8	1	5/8	2 1/2	1 1/2	5 5/16	3	7/16
MIN.	24	3/8	5/8	9 5/8	3	3 1/2	7 3/4	5	2 1/2	1 1/2	13/16	3 1/4	1 1/2	7 1/8	4	9/16
STD.	30	1/2	3/4	12	3 3/4	4 3/8	9 11/16	6 1/4	3	1 7/8	1	4 1/16	1 7/8	8 7/8	5	1 1/16
EXPWY.	36	5/8	7/8	14 3/8	4 1/2	5 1/4	11 5/8	7 1/2	3 5/8	2 1/4	1 1/4	4 7/8	2 1/4	10 5/8	6	13/16
SPECIAL	48	3/4	1 1/4	19 3/16	6	7	15 1/2	10	4 7/8	3	1 5/8	6 1/2	3	14 1/4	8	1 1/16
	S	T	U	V	W	X	Y	Z								
BIKE	1/2															
MIN.	1 1/16															
STD.	7/8															
EXPWY.	1															
SPECIAL	1 3/8															

<p style="text-align: center;">COLORS</p> <p>LEGEND      -BLACK(NON-REFL)</p> <p>                  BACKGROUND-YELLOW(REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	JG	DATE <b>MAR 1984</b>
	APPROVED	<i>[Signature]</i>	

CODE WI-2R



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	5 3/8	5 1/2	6	4 3/4	3 3/8	1 3/4	1 1/4	2	2 5/8	6 1/4	1 1/2	5 5/16	3
MIN.	24	3/8	5/8	7 1/8	7 1/4	8	6 1/4	4 1/2	2 11/32	1 3/4	2 3/4	3 1/2	8 1/4	1 1/2	7 1/8	4
STD.	30	1/2	3/4	8 7/8	9 1/16	10	7 13/16	5 5/8	2 5/16	2 3/16	3 7/16	4 3/8	10 5/16	1 7/8	8 7/8	5
EXPWY.	36	5/8	7/8	10 5/8	10 7/8	12	9 3/8	6 3/4	3 1/2	2 5/8	4 1/8	5 1/4	12 3/8	2 1/4	10 5/8	6
FWY.	48	3/4	1 1/4	14 3/16	14 1/2	16	12 1/2	9	4 1/16	3 1/2	5 1/2	7	16 1/2	3	14 1/4	8
	S	T	U	V	W	X	Y	Z								
BIKE	7/16	1/2														
MIN.	9/16	11/16														
STD.	11/16	7/8														
EXPWY.	13/16	1														
FWY.	1 1/16	1 3/8														

COLORS

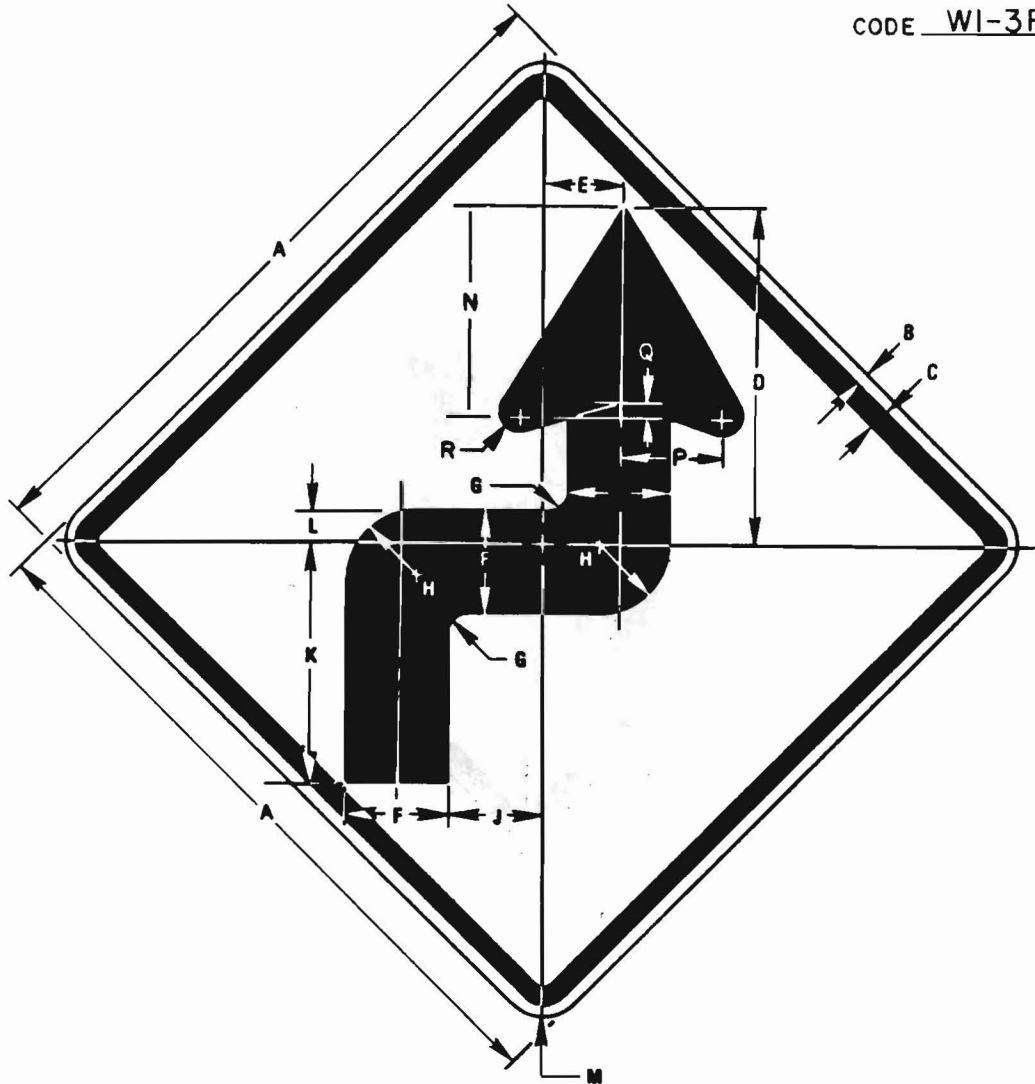
LEGEND      - BLACK (NON - REFL)

                  BACKGROUND - YELLOW (REFL)

ALL DIMENSIONS ARE NOMINAL

REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN	JG	DATE <b>MAR 1984</b>
APPROVED	<i>Edgar J. Hutton</i>	

CODE WI-3R

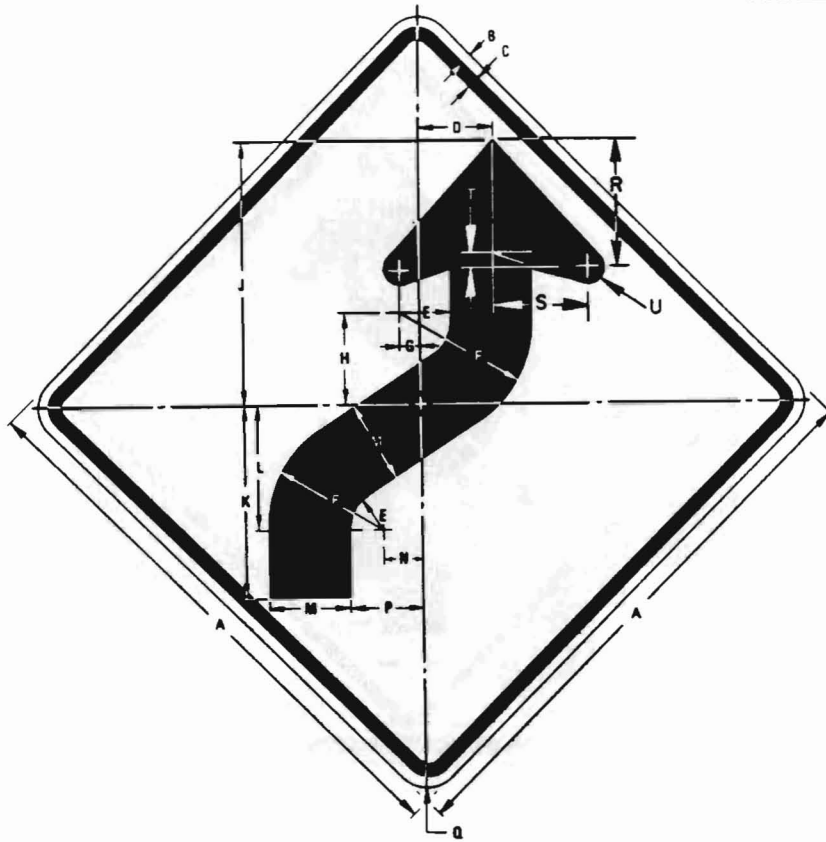


SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	8 <sup>23</sup> / <sub>32</sub>	2 1/8	2 5/8	5/8	13/16	2 1/4	6	27/32	1 1/2	55/16	3	7/16	1/2
MIN.	24	3/8	5/8	11 <sup>19</sup> / <sub>32</sub>	2 <sup>13</sup> / <sub>16</sub>	3 1/2	13/16	2 1/2	3	8 <sup>5</sup> / <sub>16</sub>	13/32	1 1/2	7 1/8	4	9/16	11/16
STD.	30	1/2	3/4	14 1/2	3 1/2	4 <sup>3</sup> / <sub>8</sub>	1	3	3 3/4	10 <sup>3</sup> / <sub>8</sub>	1 <sup>3</sup> / <sub>8</sub>	1 7/8	8 <sup>7</sup> / <sub>8</sub>	5	11/16	7/8
EXPWY.	36	5/8	7/8	17 <sup>7</sup> / <sub>16</sub>	4 <sup>7</sup> / <sub>32</sub>	5 1/4	1 1/4	3 5/8	4 1/2	12 <sup>15</sup> / <sub>32</sub>	12 <sup>1</sup> / <sub>32</sub>	2 1/4	10 <sup>5</sup> / <sub>8</sub>	6	13/16	1
FWY.																
SPECIAL	48	3/4	1 1/4	23 <sup>3</sup> / <sub>16</sub>	5 5/8	7	1 5/8	4 7/8	6	16 <sup>5</sup> / <sub>8</sub>	2 <sup>3</sup> / <sub>16</sub>	3	14 1/4	8	1 1/16	1 3/8

<p>LEGEND      - BLACK (NON-REFL)</p> <p>BACKGROUND - YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>		<p>REV.      ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES</p> <p>DRAWN      RGT      DATE      MAR      1984</p> <p>APPROVED      <i>[Signature]</i></p>
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CODE W1-4R

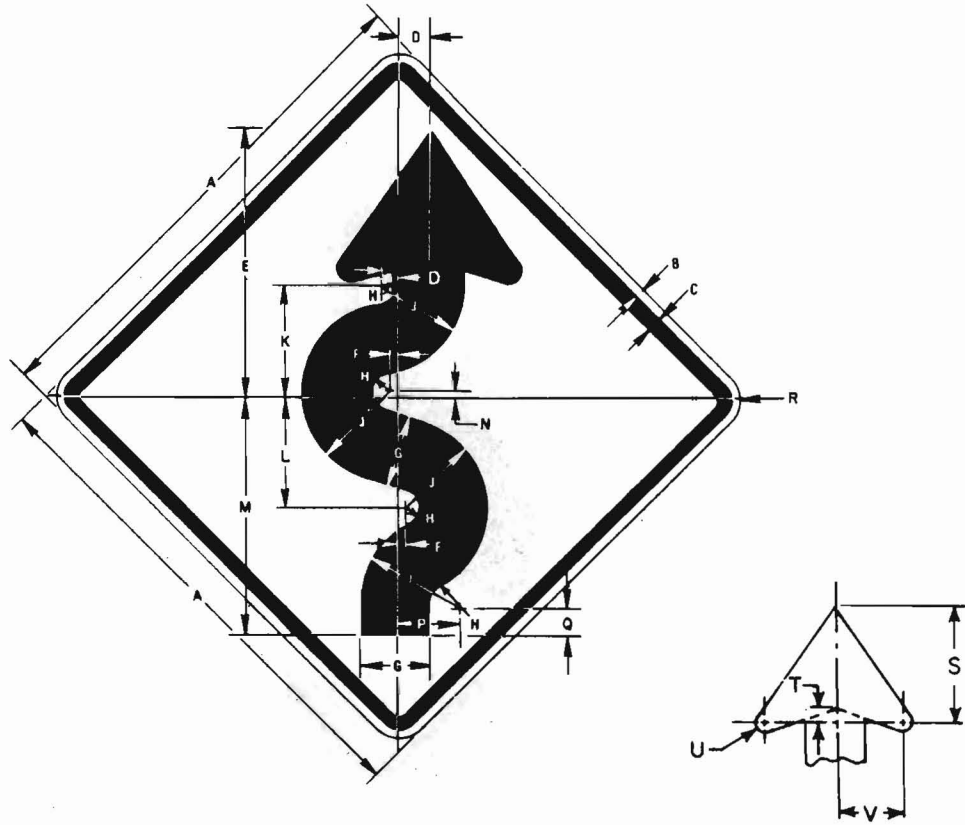


SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	2 3/8	1 1/8	3 3/4	1/16	2 5/8	8 5/8	6 1/4	4	2 5/8	7/8	2	1 1/2	4 1/8
MIN.	24	3/8	5/8	3 5/32	1 1/2	5	3/32	3 1/2	11 1/4	8 1/4	5 1/4	3 1/2	1 1/8	2 5/8	1 1/2	5 1/2
STD.	30	1/2	3/4	3 15/16	1 7/8	6 1/4	1/8	4 3/8	14 1/16	10 5/16	6 9/16	4 3/8	1 3/32	3 9/32	1 7/8	6 7/8
EXPWY.	36	5/8	7/8	4 23/32	2 1/4	7 1/2	5/32	5 1/4	16 7/8	12 3/8	7 7/8	5 1/4	1 11/16	3 15/16	2 1/4	8 1/4
SPECIAL	48	3/4	1 1/4	6 5/16	3	10	3/16	7	22 1/2	16 1/2	10 1/2	7	2 1/4	5 1/4	3	11

	S	T	U	V	W	X	Y	Z								
BIKE	3	7/16	1/2													
MIN.	4	5/8	11/16													
STD.	5	3/4	7/8													
EXPWY.	6	7/8	1 1/16													
SPECIAL	8	1 3/16	1 3/8													

<p style="text-align: center;">COLORS</p> <p>LEGEND      -BLACK(NON-REFL)</p> <p>BACKGROUND-YELLOW(REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	JG	DATE MAR 1994
	APPROVED	<i>[Signature]</i>	

CODE WI-5 R

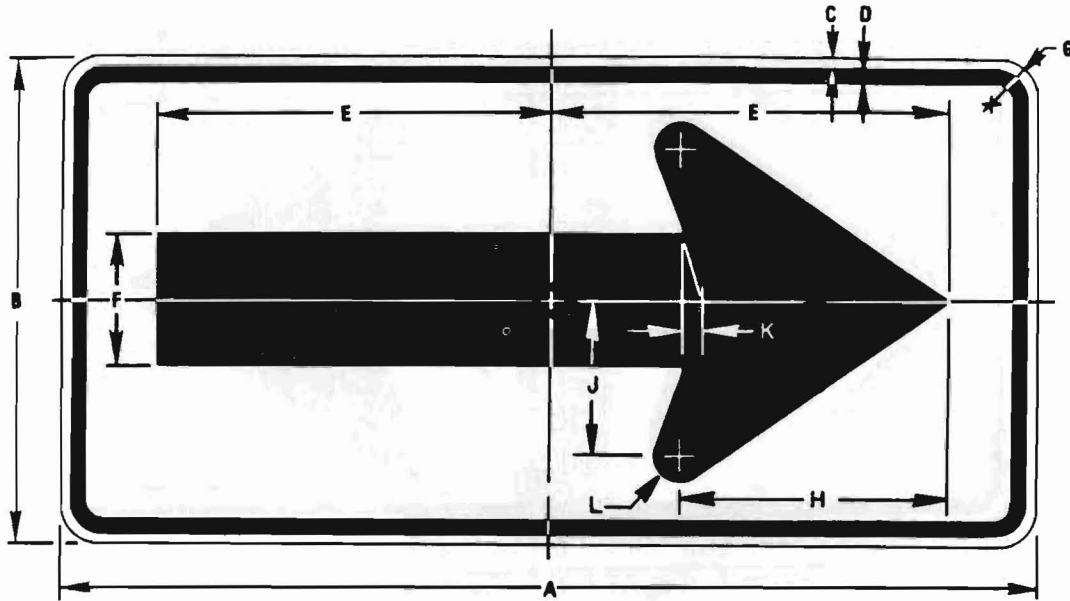


SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	1	9 5/8	3/8	2 1/2	1/2	3	4	4	8 5/8	1/4	2	1 1/4	1 1/2
MIN.	24	3/8	5/8	1 1/4	12 3/4	1/2	3 1/4	7/8	4 1/8	5 3/16	5 1/4	11 3/8	1/4	2 1/2	1 19/32	1 1/2
STD.	30	1/2	3/4	1 9/16	15 15/16	5/8	4 1/16	1 3/32	5 5/32	6 3/64	6 9/16	14 7/32	5/16	3 1/8	2	1 7/8
EXPWY.	36	5/8	7/8	1 7/8	19 1/8	3/4	4 7/8	1 5/16	6 3/16	7 25/32	7 7/8	17 1/16	3/8	3 3/4	2 13/32	2 1/4
SPECIAL	48	3/4	1 1/4	2 1/2	25 1/2	1	6 1/2	1 3/4	8 1/4	10 3/8	10 1/2	22 3/4	1/2	5	3 3/16	3
	S	T	U	V	W	X	Y	Z								
BIKE	5	3/8	1/2	2 13/16												
MIN.	6 5/8	1/2	5/8	3 11/16												
STD.	8 5/16	5/8	13/16	4 5/8												
EXPWY.	9 15/16	3/4	15/16	5 9/16												
SPECIAL	13 1/4	1	1 1/4	7 7/16												

<p style="text-align: center;"><b>COLORS</b></p> <p>LEGEND      - BLACK (NON-REFL)</p> <p>BACKGROUND - YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
		DRAWN RGT	DATE <b>MAR 1984</b>
		APPROVED <i>[Signature]</i>	



CODE WI-6



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	24	12	3/8	5/8	9 5/8	3 1/4	1 1/2	6 1/2	3 5/8	1 1/2	5/8					
MIN.	36	18	3/8	5/8	14 5/8	5	1 1/2	9 13/16	5 1/2	1 1/16	15 1/16					
STD.	48	24	1/2	3/4	19 1/2	6 1/2	1 7/8	13 1/16	7 5/16	15/16	1 1/4					
EXPWY.																
FWY.																
SPECIAL	60	30	5/8	7/8	24 3/8	8	2 1/4	16 5/16	9 1/8	1 3/16	19/16					

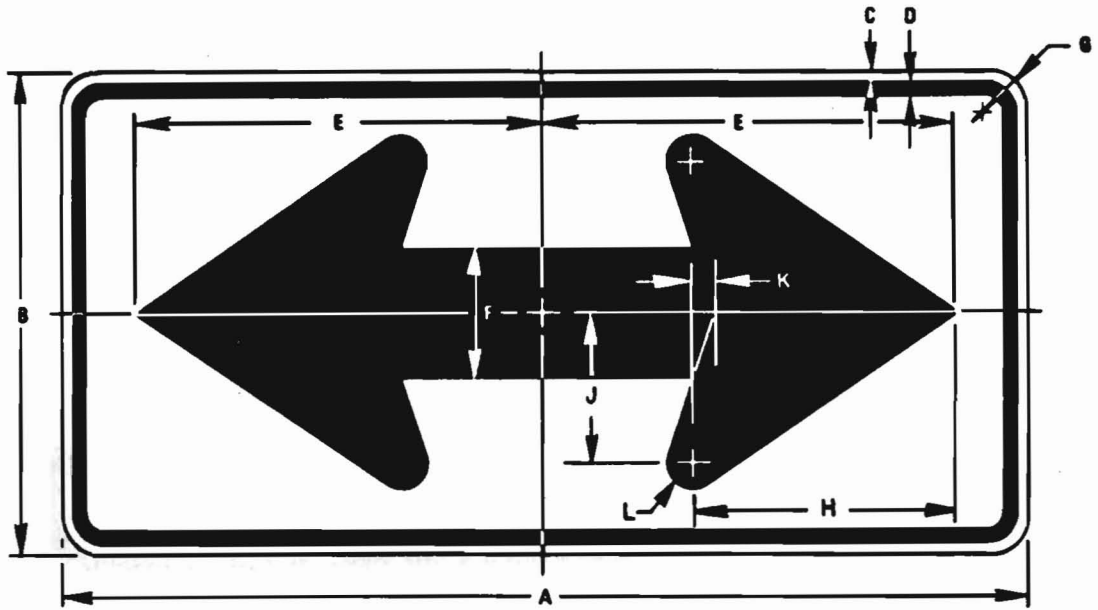
COLORS

LEGEND -BLACK(NON-REFL)  
BACKGROUND-YELLOW(REFL)

ALL DIMENSIONS ARE NOMINAL

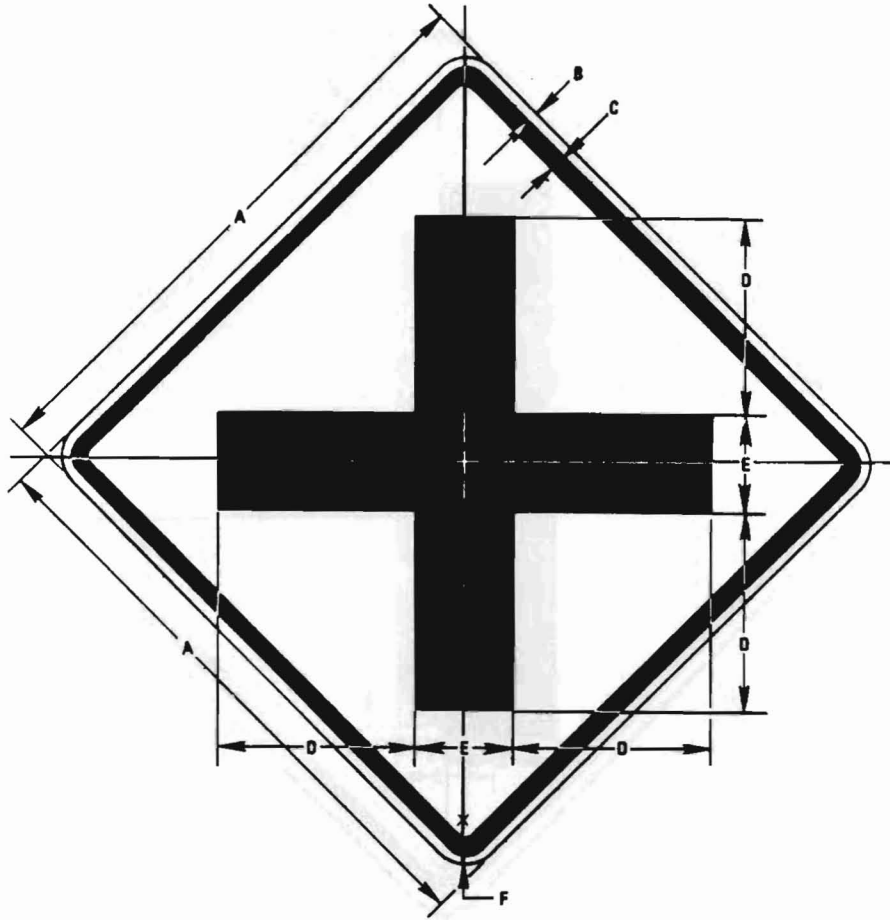
REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN RGT	DATE MAR 1984	
APPROVED <i>[Signature]</i>		

CODE W1-7



SIGN	NOMINAL DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	24	12	3/8	5/8	10 3/8	3 1/4	1 1/2	6 1/2	3 5/8	1/2	5/8					
MIN.	36	18	3/8	5/8	15 5/8	5	1 1/2	9 13/16	5 1/2	11/16	15/16					
STD.	48	24	1/2	3/4	20 1/2	6 1/2	1 7/8	13 1/16	7 5/16	15/16	1 1/4					
EXPWY.																
FWY.																
SPECIAL	60	30	5/8	7/8	25 3/8	8	2 1/4	16 5/16	9 1/8	13/16	19/16					
<p style="text-align: center;">COLORS</p> <p>LEGEND      -BLACK (NON-REFL)</p> <p>BACKGROUND -YELLOW (REFL)</p>										REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES					
										DRAWN	RGT	DATE <b>JUN 06</b>				
										APPROVED	<i>[Signature]</i>					

CODE W2-1



SIGN	DIMENSIONS (INCHES)																
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	
BIKE	18	3/8	5/8	6	3	1 1/2											
MIN.	24	3/8	5/8	8	4	1 1/2											
STD.	30	1/2	3/4	10	5	1 7/8											
EXPWY.	36	5/8	7/8	12	6	2 1/4											
FWY.																	
SPECIAL	48	3/4	1 1/4	16	8	3											

**COLORS**

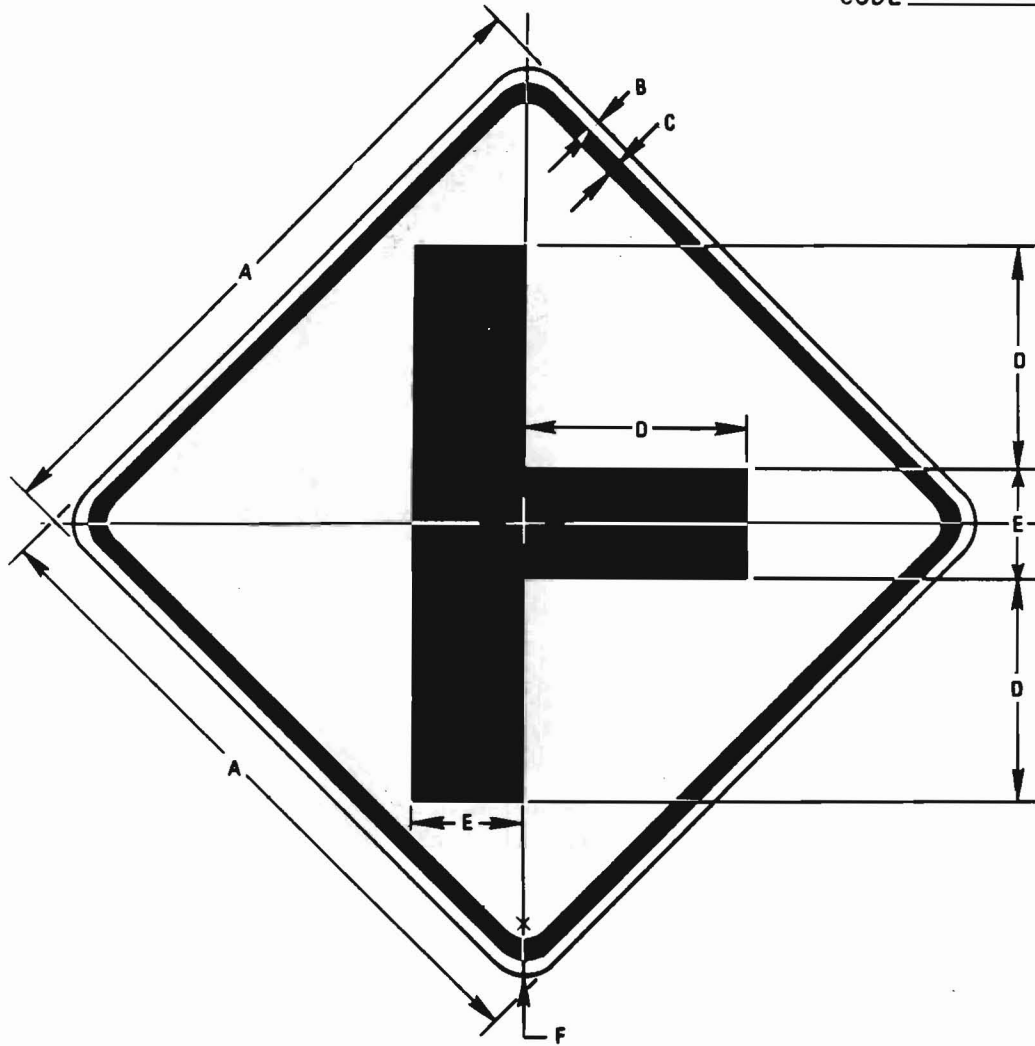
LEGEND      -BLACK (NON-REFL)

BACKGROUND -YELLOW (REFL)

ALL DIMENSIONS ARE NOMINAL

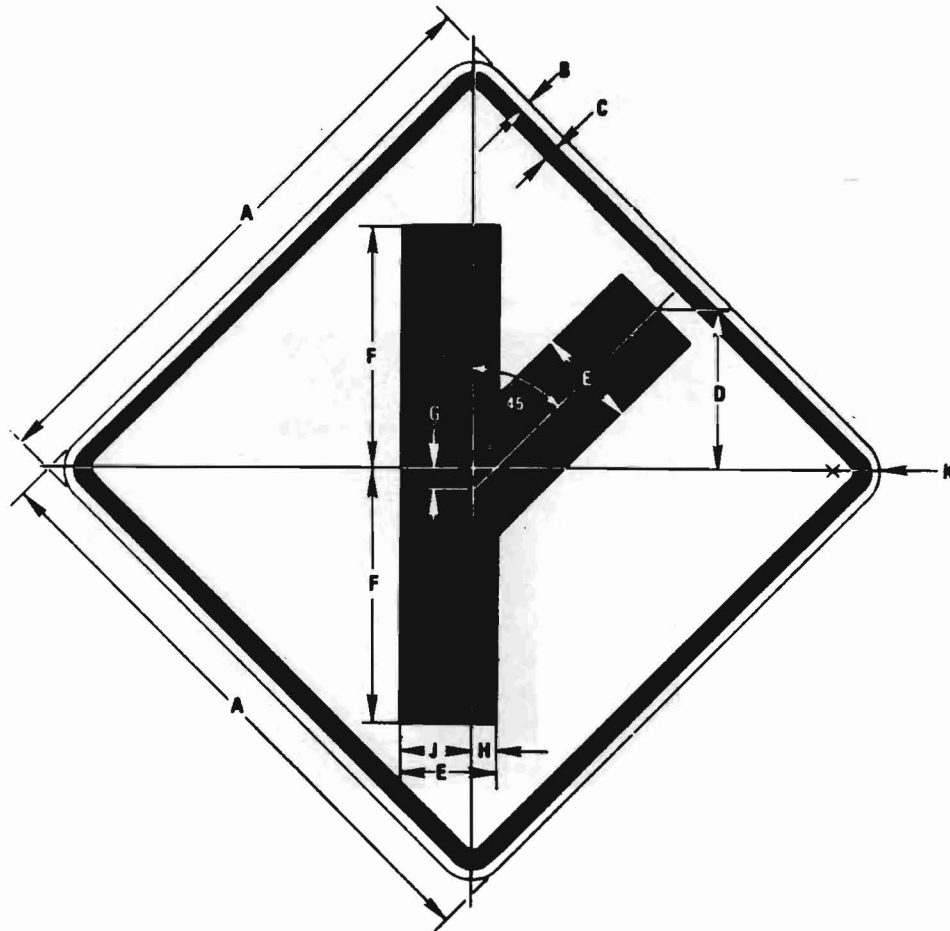
REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN RGT	DATE <b>MAR 1984</b>	
APPROVED <i>[Signature]</i>		

CODE W2-2



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	6	3	1 1/2										
MIN.	24	3/8	5/8	8	4	1 1/2										
STD.	30	1/2	3/4	10	5	1 7/8										
EXPWY.	36	5/8	7/8	12	6	2 1/4										
FWY.																
SPECIAL	48	3/4	1 1/4	16	8	3										

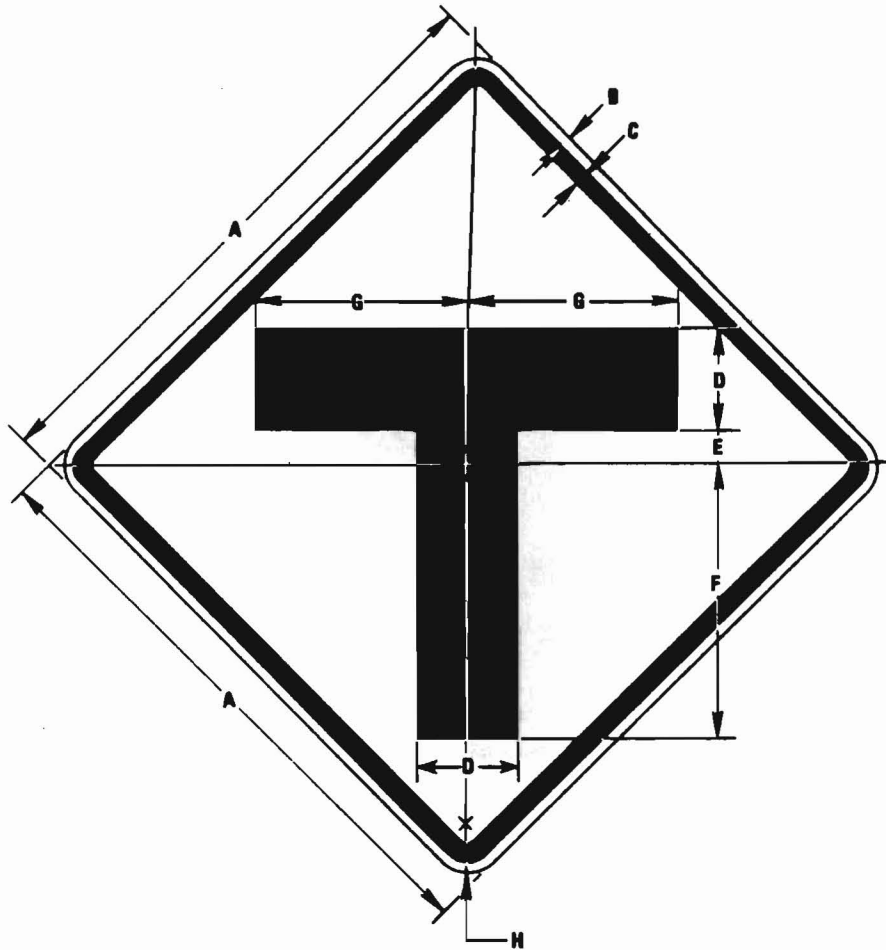
<p style="text-align: center;">COLORS</p> <p>LEGEND      - BLACK (NON-REFL)</p> <p>BACKGROUND - YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE <b>MAR 1984</b>
	APPROVED	<i>[Signature]</i>	




SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	5	3	7 3/4	3/8	3/4	2 1/4	1 1/2						
MIN.	24	3/8	5/8	6 2/32	4	10	9/16	1	3	1 1/2						
STD.	30	1/2	3/4	8 5/16	5	12 1/2	1 1/16	1 1/4	3 3/4	1 7/8						
EXPWY.	36	5/8	7/8	10	6	15	27/32	1 1/2	4 1/2	2 1/4						
FWY.																
SPECIAL	48	3/4	1 1/4	13 5/16	8	20	1 1/8	2	6	3						

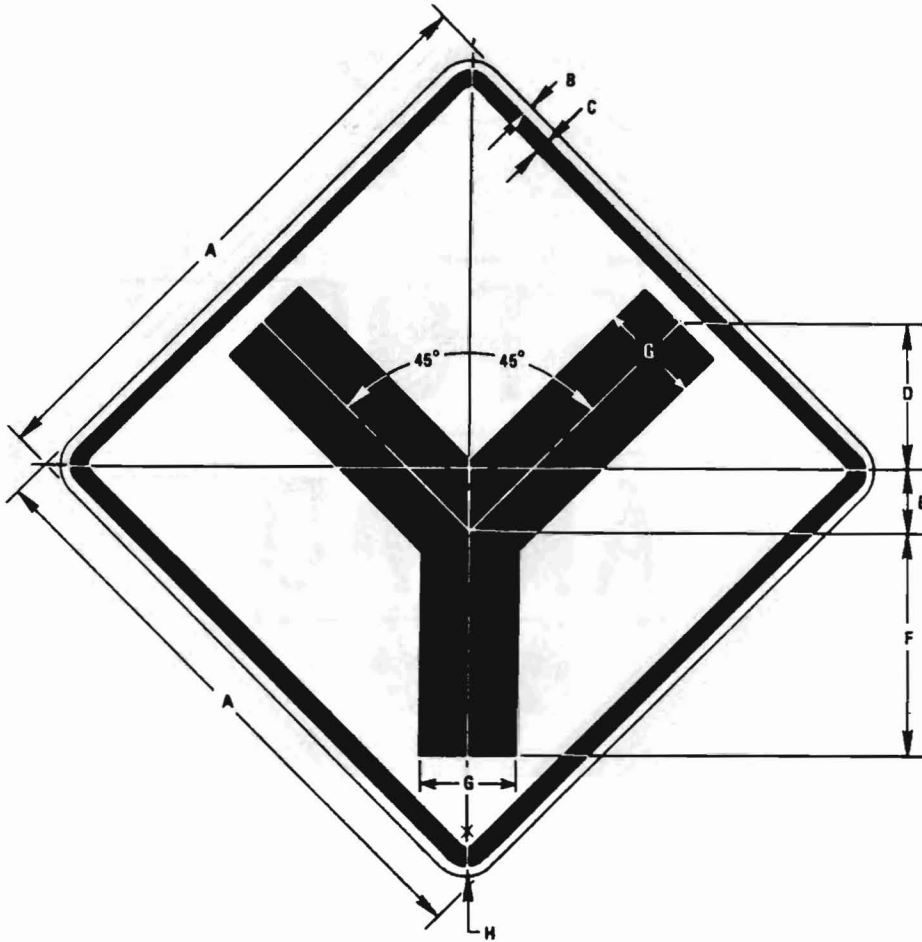
<p style="text-align: center;">COLORS</p> <p>LEGEND      - BLACK (NON-REFL)</p> <p>BACKGROUND - YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE MAR 1984
	APPROVED	<i>[Signature]</i>	

CODE W2-4



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	3	1 1/4	8 3/8	6 3/8	1 1/2								
MIN.	24	3/8	5/8	4	1 1/2	11	8 1/2	1 1/2								
STD.	30	1/2	3/4	5	1 7/8	13 3/4	10 5/8	1 7/8								
EXPWY.																
SPECIAL	36	5/8	7/8	6	2 1/4	16 1/2	12 3/4	2 1/4								
SPECIAL	48	3/4	1 1/4	8	3	22	17	3								

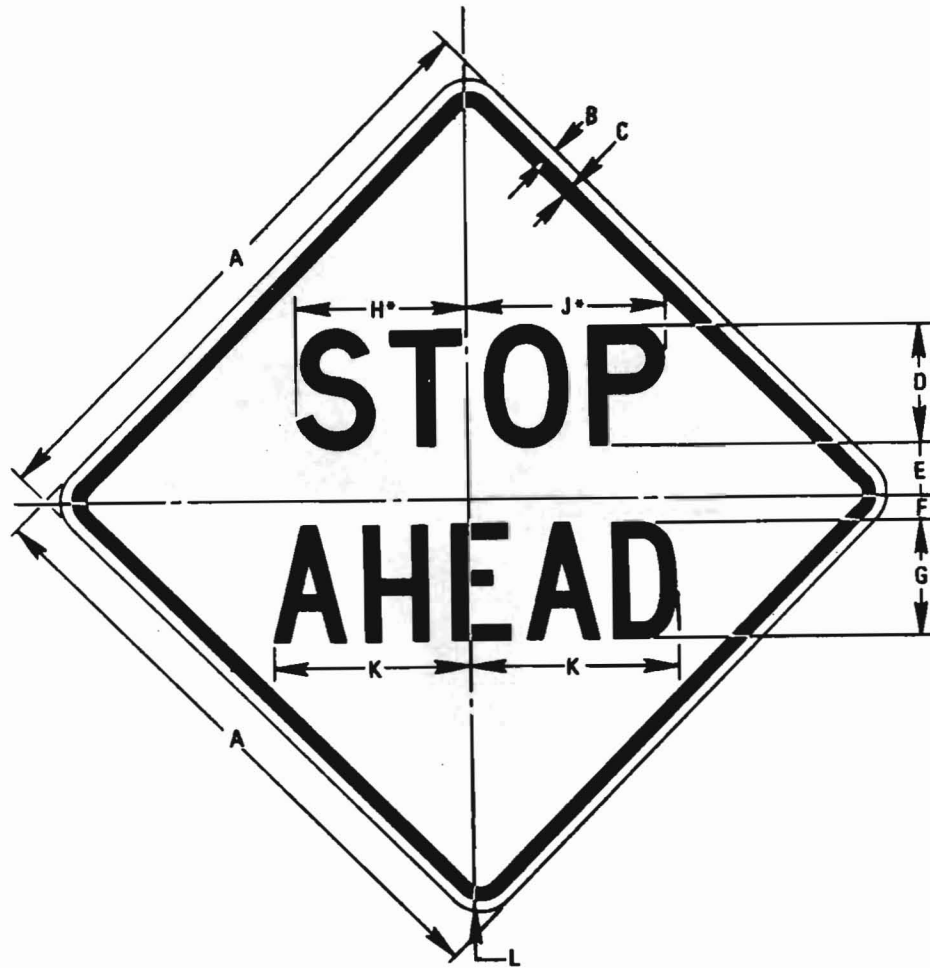
<p align="center"><b>COLORS</b></p> <p>LEGEND    -BLACK (NON-REFL)</p> <p>              BACKGROUND-YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RG T	DATE MAR 1984
	APPROVED		



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	4 1/2	1 3/4	6 3/4	3	1 1/2								
MIN.	24	3/8	5/8	5 29/32	2 3/32	9 3/32	4	1 1/2								
STD.	30	1/2	3/4	7 3/8	3	11 3/8	5	1 7/8								
EXPWY.																
SPECIAL	36	5/8	7/8	8 27/32	3 19/32	13 21/32	6	2 1/4								
SPECIAL	48	3/4	1 1/4	11 13/16	4 13/16	18 3/16	8	3								

<p style="text-align: center;">COLORS</p> <p>LEGEND      -BLACK(NON-REFL)</p> <p>BACKGROUND-YELLOW(REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
	DRAWN	RGT	DATE MAR 1984
	APPROVED	<i>Edward W. ...</i>	

CODE W3-1



\*Reduce spacing 20%; no reduction for Bike.

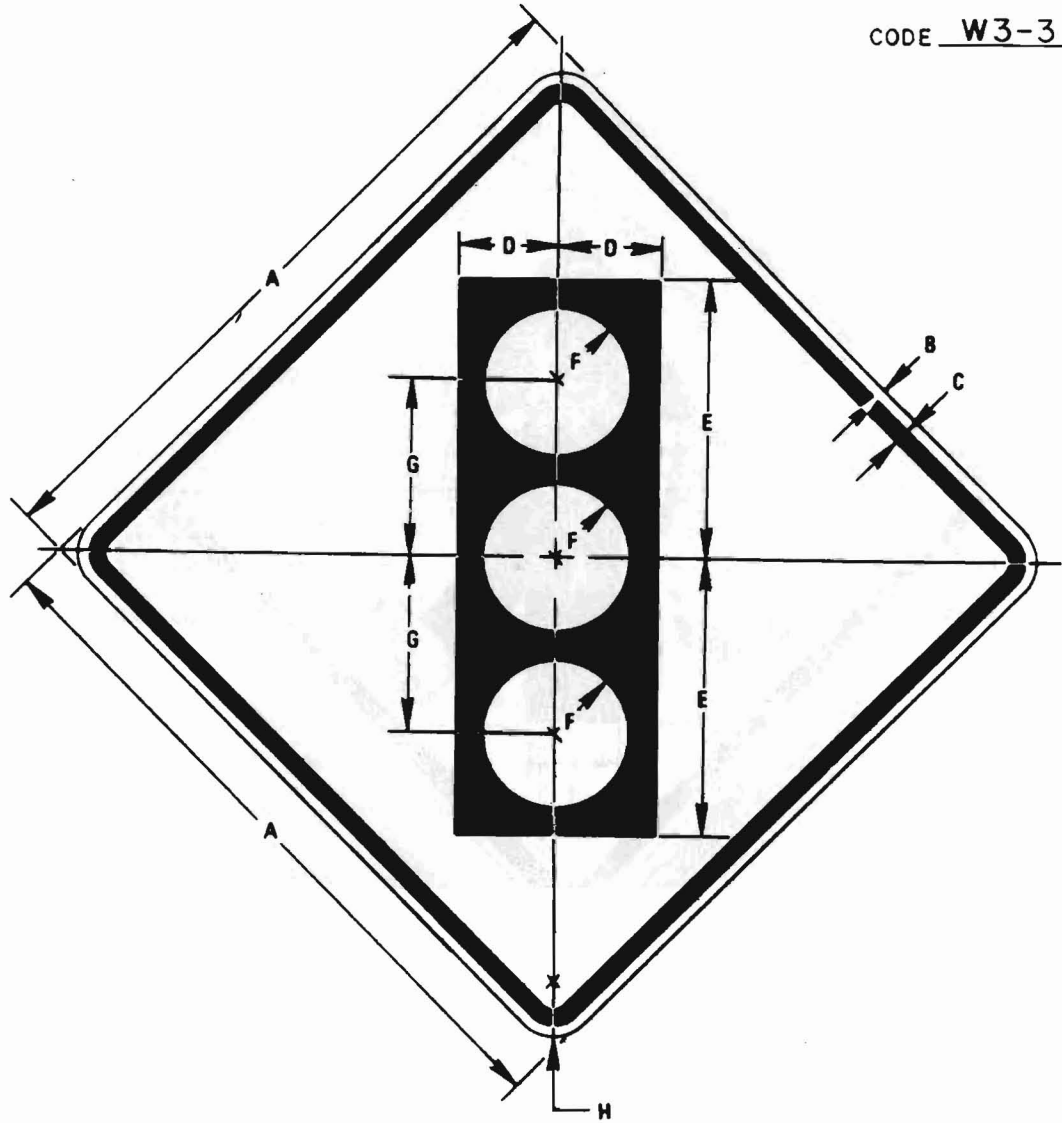
SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	3D	1 3/4	3/4	3C	4 3/4	5 1/4	5 3/8	1 1/2					
MIN.	30	1/2	3/4	6D	2 1/2	1 1/4	6C	9	9 7/8	10 1/2	1 7/8					
STD.	36	5/8	7/8	7D	3	1 1/2	7C	10 1/2	11 9/16	12 1/4	2 1/4					
EXPWY.																
FWY.																
SPECIAL	48	3/4	1 1/4	9D	4	2	9C	13 1/2	14 13/16	15 3/4	3					

<p style="text-align: center;">COLORS</p> <p>LEGEND      -BLACK (NON-REFL)</p> <p>                  BACKGROUND -YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>		<p>REV.      ARIZONA DEPARTMENT OF TRANSPORTATION                  TRAFFIC DESIGN SERVICES</p> <table border="1"> <tr> <td>DRAWN RGT</td> <td>DATE MAR 1981</td> </tr> <tr> <td>APPROVED <i>[Signature]</i></td> <td></td> </tr> </table>	DRAWN RGT	DATE MAR 1981	APPROVED <i>[Signature]</i>	
DRAWN RGT	DATE MAR 1981					
APPROVED <i>[Signature]</i>						



CODE W3-3

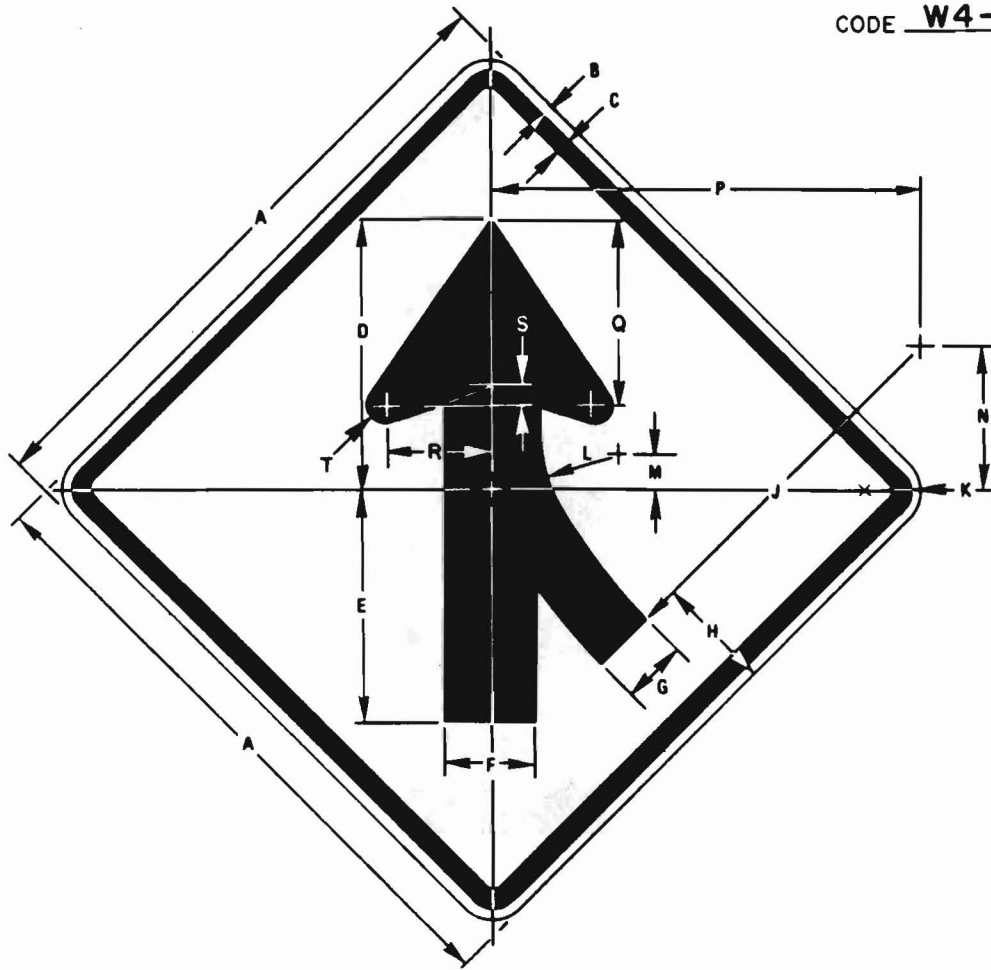


SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	3	8	2 1/4	5	1 1/2								
MIN.	30	1/2	3/4	5	13 3/4	3 3/4	8 3/4	1 7/8								
STD.	36	5/8	7/8	5 3/4	15 3/4	4 1/4	10	2 1/4								
EXPWY.																
FWY.																
SPECIAL	48	3/4	1 1/4	7 1/2	20	5	12 1/2	3								

**COLORS**  
 SYMBOL & LEGEND—BLACK (NON-REFL)  
 TOP CIRCLE—RED (REFL)  
 BOTTOM CIRCLE—GREEN (REFL)  
 BACKGROUND—YELLOW (REFL)  
 ALL DIMENSIONS ARE NOMINAL

REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
DRAWN	RG T	DATE MAR 1984
APPROVED	<i>[Signature]</i>	

CODE W4-1



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
MIN.	24	3/8	5/8	10 1/4	8 3/4	3 1/2	2 3/8	4 3/16	22 1/4	1 1/2	6 3/8	2 5/8	10 3/8	22 3/16	7 1/8	4
STD.	30	1/2	3/4	13	11	4 3/8	3	5 1/4	28	1 7/8	8	3	13	27 3/4	8 7/8	5
EXPWY.	36	5/8	7/8	15 3/4	13 1/4	5 1/4	3 5/8	6 5/16	33 5/8	2 1/4	9 5/8	4	15 5/8	33 5/16	10 5/8	6
FWY.	48	3/4	1 1/4	20 1/2	17 1/2	7	4 3/4	8 3/8	45	3	12 13/16	5 1/4	20 3/4	44 3/8	14 1/4	8
	S	T	U	V	W	X	Y	Z								
MIN.	9/16	11/16														
STD.	11/16	7/8														
EXPWY.	13/16	1														
FWY.	1 1/16	1 3/8														

<p>LEGEND</p> <p>—BLACK (NON-REFL)</p> <p>BACKGROUND —YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	<p>REV.</p> <p>ARIZONA DEPARTMENT OF TRANSPORTATION</p> <p>TRAFFIC DESIGN SERVICES</p>	
	<p>DRAWN</p> <p>JG</p>	<p>DATE</p> <p>MAR 1984</p>
	<p>APPROVED</p> <p><i>Edgar J. ...</i></p>	

CODE W5-4



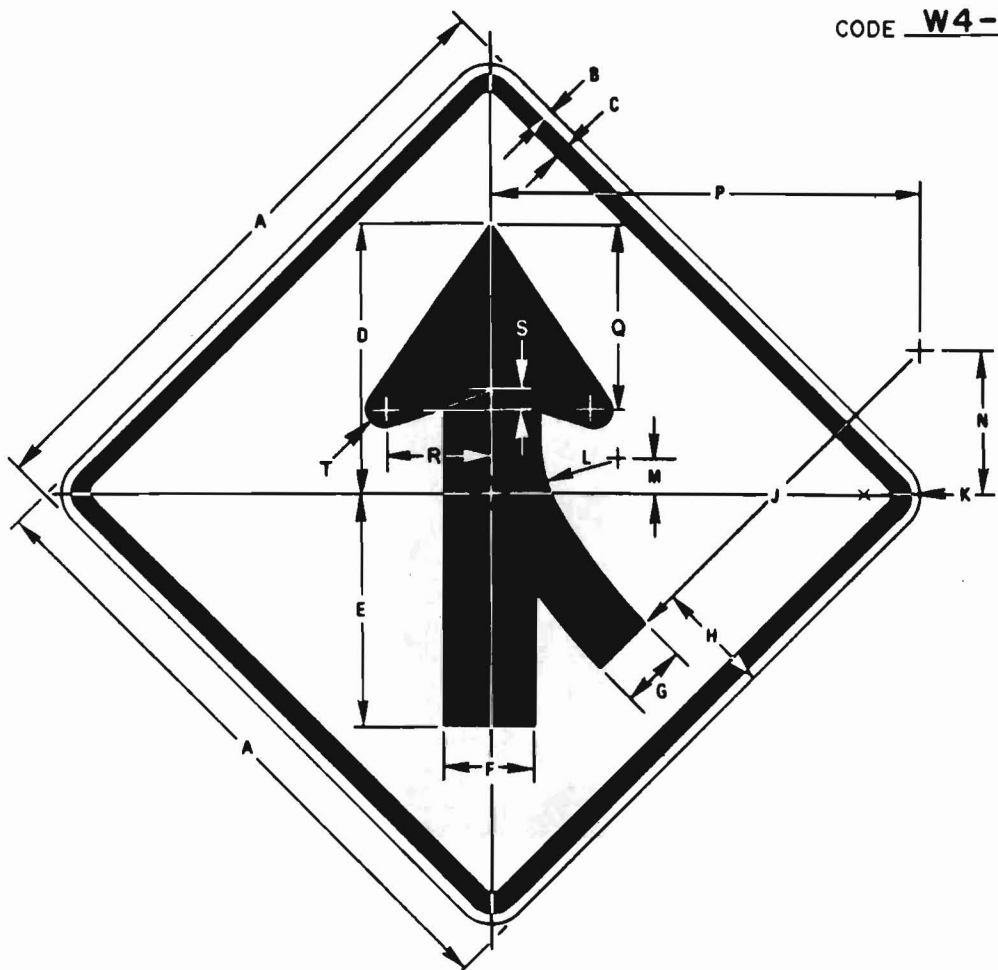
\* REDUCE SPACING 50%

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	1 1/2	3/8	5/8	3C	1	5/8	6 1/2	7 1/8	6 3/4	7 1/2					
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

<p>LEGEND</p> <p>BLACK (NON REFL)</p> <p>BACKGROUND YELLOW (REFL)</p>		<p>REV.</p> <p>ARIZONA DEPARTMENT OF TRANSPORTATION</p> <p>TRAFFIC DESIGN SERVICES</p>
<p>ALL DIMENSIONS ARE NOMINAL</p>		<p>DRAWN JJH</p> <p>DATE MAR 1984</p>
		<p>APPROVED</p> <p><i>[Signature]</i></p>

CODE W4-1



SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
MIN.	24	3/8	5/8	10 1/4	8 3/4	3 1/2	2 3/8	4 3/16	22 1/4	1 1/2	6 3/8	2 5/8	10 3/8	22 3/16	7 1/8	4
STD.	30	1/2	3/4	13	11	4 3/8	3	5 1/4	28	1 7/8	8	3	13	27 3/4	8 7/8	5
EXPWY.	36	5/8	7/8	15 3/4	13 1/4	5 1/4	3 5/8	6 5/16	33 5/8	2 1/4	9 5/8	4	15 5/8	33 5/16	10 5/8	6
FWY.	48	3/4	1 1/4	20 1/2	17 1/2	7	4 3/4	8 3/8	45	3	12 3/16	5 1/4	20 3/4	44 3/8	14 1/4	8
	S	T	U	V	W	X	Y	Z								
MIN.	9/16	11/16														
STD.	11/16	7/8														
EXPWY.	13/16	1														
FWY.	1 1/16	1 3/8														

<p>COLORS</p> <p>LEGEND - BLACK (NON-REFL)</p> <p>BACKGROUND - YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>	REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES
	DRAWN	DATE
	JG	MAR 1984
APPROVED		
<i>[Signature]</i>		

CODE W5-4



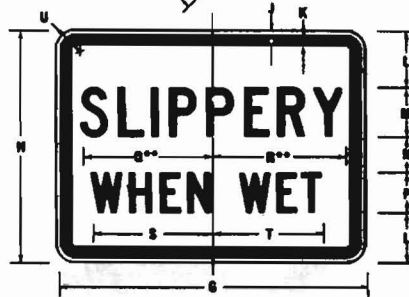
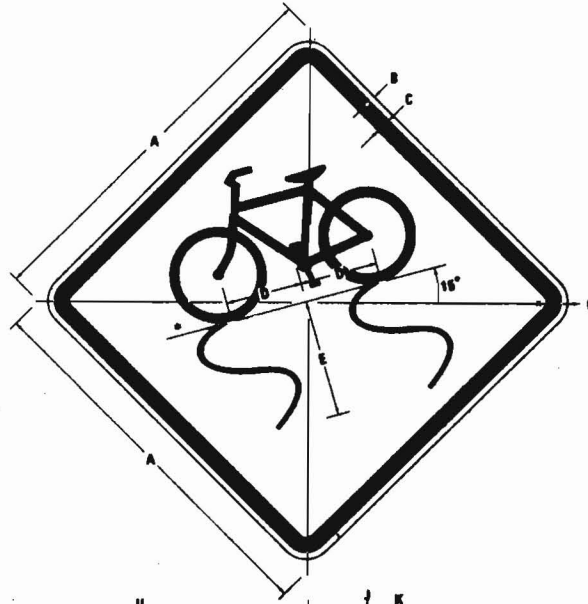
\* REDUCE SPACING 50%

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	1 1/2	3/8	5/8	3C	1	5/8	6 1/2	7 1/8	6 3/4	7 1/2					
MIN.																
STD.																
EXPWY.																
FWY.																
SPECIAL																

<p>ALL DIMENSIONS ARE NOMINAL</p>		<p>REV. ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES</p>
<p>COLORS LEGEND: BLACK (NON REFL) BACKGROUND YELLOW (REFL)</p>		<p>DRAWN JJH DATE MAR 1984</p>
		<p>APPROVED <i>[Signature]</i></p>

CODE W8-10



W8-10 S

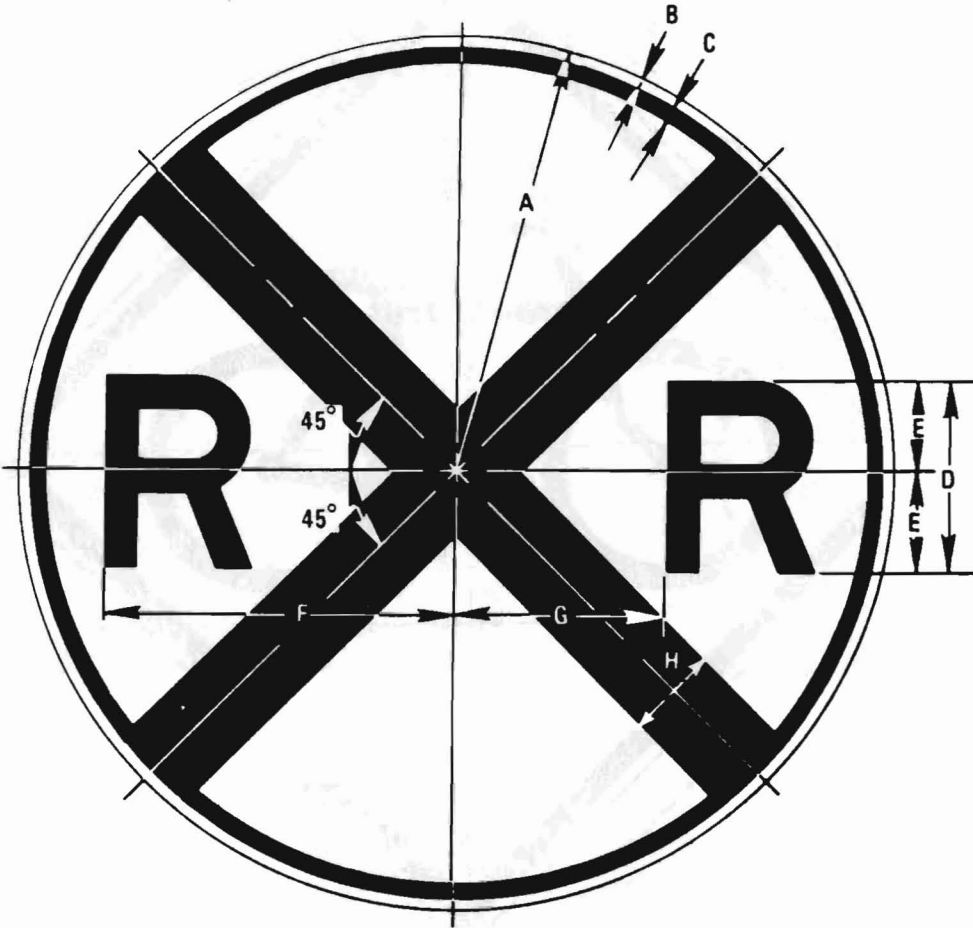
\* REDUCE SPACING 25%

\*See W8-5 & W11-1 for symbol design

SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE	18	3/8	5/8	35/8	53/4	1 1/2	12	9	3/8	3/8	2	2C	1 1/2	1 1/2C	5	5 1/4
MIN.	30	1/2	3/4	6	9 5/8	1 7/8	24	18	3/8	5/8	4	4C	3	3C	10	10 3/8

<b>COLORS</b> LEGEND, SYMBOL, BORDER—BLACK(NON-REFL) BACKGROUND—YELLOW(REFL) ALL DIMENSIONS ARE NOMINAL		REV.	ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES	
		DRAWN RGT	DATE MAR	1984
		APPROVED <i>[Signature]</i>		

CODE W10-1

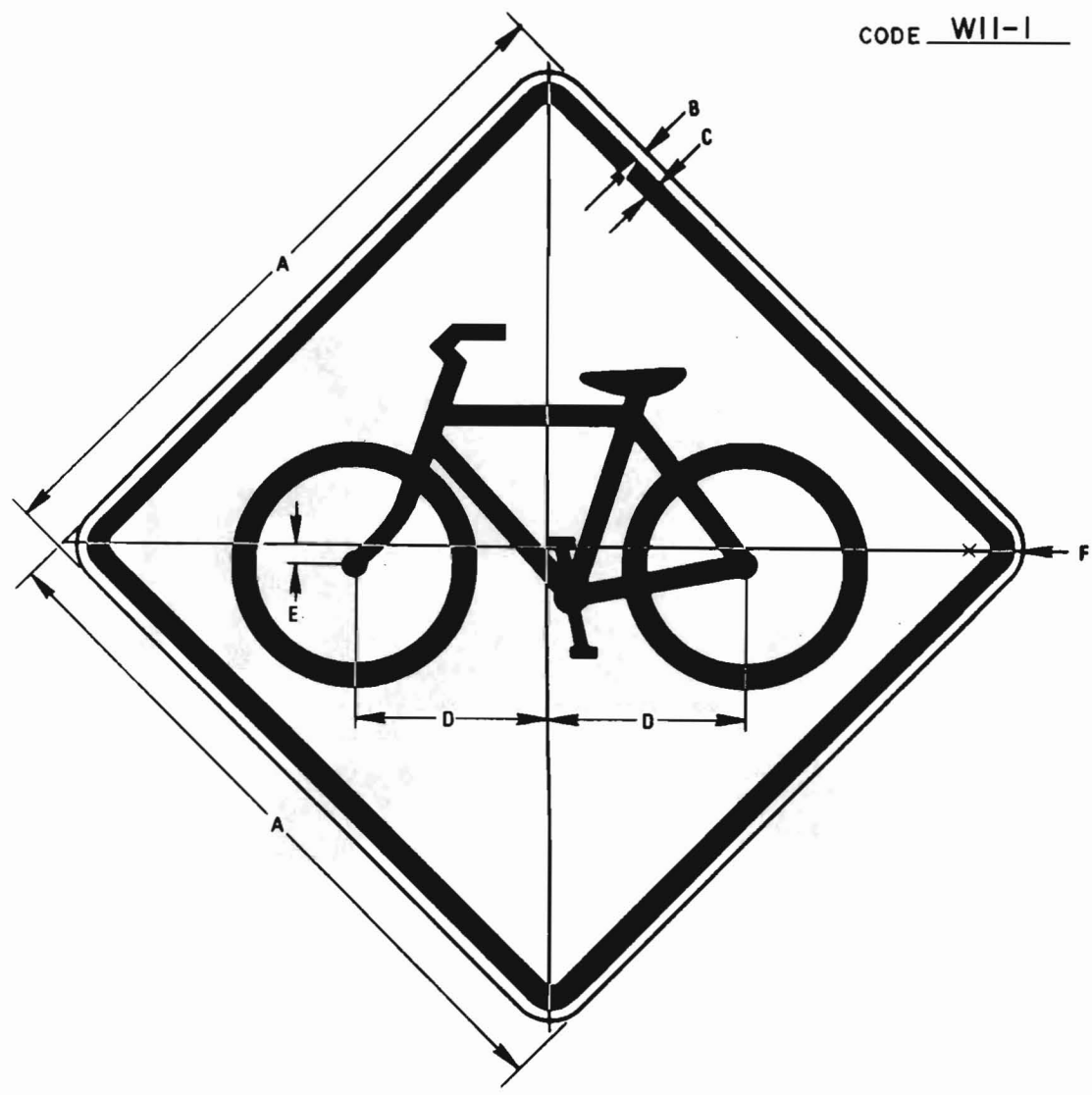


SIGN	DIMENSIONS (INCHES)															
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
BIKE																
MIN.	15	3/8	5/8	7E	3 1/2	12 3/8	7 1/8	3								
STD.	18	1/2	3/4	8E	4	14 3/8	8 5/8	4								
EXPWY.																
FWY.																
SPECIAL	24	3/4	1 1/4	10E	5	18 3/8	11 5/8	5								

<p><b>COLORS</b></p> <p>LEGEND      -BLACK (NON-REFL)</p> <p>BACKGROUND -YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>		<p>REV.      ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES</p> <p>DRAWN      RGT      DATE      MAR      1984</p> <p>APPROVED <i>Cheryl [Signature]</i></p>
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CODE W11-1



SIGN	DIMENSIONS (INCHES)																
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	
BIKE																	
MIN.	24	3/8	5/8	6 1/16	13/16	1 1/2											
STD.	30	1/2	3/4	8 1/2	1	1 7/8											
EXPWY.	36	5/8	7/8	10	1 3/16	2 1/4											
FWY.																	
SPECIAL	48	3/4	1 1/4	13 3/8	1 5/8	3											

<p style="text-align: center;">COLORS</p> <p>LEGEND      - BLACK (NON-REFL)</p> <p>BACKGROUND - YELLOW (REFL)</p> <p>ALL DIMENSIONS ARE NOMINAL</p>		<p>REV.</p> <p>ARIZONA DEPARTMENT OF TRANSPORTATION TRAFFIC DESIGN SERVICES</p> <p>DRAWN      RGT</p> <p>DATE <b>MAR 1984</b></p> <p>APPROVED <i>[Signature]</i></p>
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