CONTENTS

GENERAL INFORMATION

1.1 CONCEPT

The principal considerations when designing recreational trails and sidewalks are to provide safe and adequate systems for bike and pedestrian traffic. In the case of counties, sidewalks may not be allowed, but if the owner(s) desire, sidewalks can be placed outside of the right of way. If sidewalks are justified in a rural area, they should be separate from the shoulder, unless they are part of a recreational trail system.

Recreational trails and sidewalks shall be designed to accommodate the physically handicapped. Sidewalk accommodations shall be in accordance with the standards set forth by the ADA, listed in Chapter 8, Section 1, 1.2. As explained in Chapter 8, Section 2, 2.1, there are currently no ADA standards for the design of recreational trails. In lieu of these standards, recreational trails should be designed to meet the recommendations of the "AASHTO Guide for the Development of Bicycle Facilities".

1.2 CONDITIONS

1. The design for sidewalk and recreational trail facilities shall be in conformance with the following:

   A. U.S. Architectural and Transportation Barriers Compliance Board (The Access Board) – ADA Accessibility Guidelines (ADAAG) – Most current version.

   B. U.S. Architectural and Transportation Barriers Compliance Board (The Access Board) – "Draft guidelines for Accessible Public Rights-of-Way" – June 17, 2002.

   C. U.S. Architectural and Transportation Barriers Compliance Board (The Access Board) – "Final Report of the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas" – September 30, 1999.

   D. The American Association of State Highway and Transportation Officials (AASHTO) - "Guide for the Development of Bicycle Facilities" –Most current version .

   E. The American Association of State Highways and Transportation Official (AASHTO) - "A Policy on Geometric Design of Highways and Streets. - AASHTO "Green Book" – Most current version.

   F. The Federal Highway Administration (FHWA) - "Manual on Uniform Traffic Control Devices" (MUTCD) – Most current version.

   G. Conflict - In case of a conflict between the above design standards, the Jurisdictional Engineer should be contacted for clarification.

2. Construction Standards shall be the most recent revision of the Urban Standard Specifications for Public Improvements together with the latest addenda.

1.2 CONDITIONS (Continued)

3. Project Submittals - All projects are to be submitted to the Jurisdictional Engineer for review, comment and approval. On new streets, the recreational trail and sidewalk location and grade shall be included on the paving plans.

4. This chapter provides details of recreational trails and sidewalks at intersections and general comments at entrances. For more details of recreational trails and sidewalks at entrances, see Chapter 5, Section 5.

1.3 DEFINITIONS

1. RECREATIONAL TRAIL (BIKEWAY) - A generic term for any road, path, or way which in some manner is specifically designated for bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

   A. CLASS 1 - SHARED USE PATH - A recreational trail (bikeway) physically separated from motorized vehicular traffic by an open space or barrier and either within the roadway right-of-way or within an independent right-of-way. Shared Use Paths may be used by pedestrians, skaters, wheelchair users, joggers and other non-motorized users.

   B. CLASS 2 - 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.

   C. SHARED ROADWAY - A roadway which is open to both bicycle and motor vehicle travel. This may be an existing roadway, street with wide curb lanes, or road with paved shoulders. This chapter does not address the considerations for Shared Roadways. The designer should refer to the AASHTO "Guide for the Development of Bicycle Facilities" for further information.

   D. CLASS 3 - SIGNED SHARED ROADWAYS - A shared roadway which has been designated by signing as a preferred route for bicycle use.

2. SIDEWALK - The portion of a public right-of-way between the curb line or lateral line of a roadway and the adjacent property that is improved for preferential or exclusive use by pedestrians.

   A. CLASS 'A' SIDEWALK - The back of the walk is to be located on the public right-of-way line and extends to the back of curb. The Class 'A' sidewalk is generally placed in the downtown business/commercial areas, through adjoining multiple-residential complexes, near schools and other pedestrian generators and where border width is restricted. The width of the walk varies. (See Chapter 8, Figure 2.8)

1.3 DEFINITIONS (Continued)

B. CLASS 'B' SIDEWALK - The back of the walk is typically located one foot or greater from the public right-of-way line. The walk is 4 feet wide and is generally located in residential areas. (See Chapter 8, Figure 2.8 for details and grades.)

C. CLASS 'C' SIDEWALK - The back of the walk is located on the public right-of-way line. The sidewalk is a minimum of 5' wide in commercial areas where buildings or other obstructions are located at the property line. The walk may be a minimum of 4' wide when no adjacent obstruction exists. A Class 'C' sidewalk can be located in residential areas, commercial areas, through adjoining multiple-residential complexes, near schools and other pedestrian generators where border areas are not restricted. (See Chapter 8, Figure 2.8)

3. ALTERNATIVE CIRCULATION PATH - An alternate circulation path provides access where pedestrian access routes are blocked by construction, alteration, maintenance, or other temporary conditions.

4. BICYCLE - Every vehicle propelled solely by human power, upon which any person or persons may ride, having two tandem wheels, except scooters and similar devices. Also includes three and four-wheeled human powered vehicles, but not tricycles for children.

5. BICYCLE FACILITIES - A general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling, including parking and storage facilities, and Shared Roadways not specifically designated for bicycle use.

6. BICYCLE ROUTE SYSTEM - A system of recreational trails designated by the jurisdiction having authority with appropriate directional and informational markers, with or without specific recreational trail route numbers. Bike routes should establish a continuous routing, but may be a combination of any and all types of recreational trails.

7. EASEMENT – A right of public access or use, created by an agreement with the owner of the land.

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

9. PEDESTRIAN ACCESS ROUTE - A general term denoting the portion of the public right-of-way that serves as an accessible route to elements required to be accessible. Pedestrian access routes shall consist of one or more of the following components: Walkway surfaces (sidewalks), ramps, curb ramps, blended transitions, crosswalks, pedestrian overpasses and underpasses, elevators, and platform lifts.

1.3 DEFINITIONS (Continued)

10. RIGHT-OF-WAY - A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation and public use purposes. Also, the right of one vehicle or pedestrian to proceed in a lawful manner in preference to another vehicle or pedestrian.

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

1.4 RECREATIONAL TRAIL PLANNING PROCESS

An understanding of the cyclist types, their behavior and needs is fundamental to the planning, location, design and operation of recreational trail facilities.

All cycling activity falls into two major categories: recreational and utilitarian. Persons engaged in either of these two types have different goals and objectives; as a result, many elements of recreational trail planning and design must respond to different needs within each category.

For recreational cyclists, i.e. tourists, physical fitness and pleasure riders, the trip itself is the objective. Scenic routes with meanders, overlooks, points of interest and even hills to add challenge are desirable features of the recreational facility. For the utilitarian cyclist, the objective is not the trip, but reaching a specific destination such as employment, school, home, store or community activity center. The recreational trail is merely a vehicle for making the trip although secondary objectives such as exercise and pleasure may influence the choice of vehicle. The utilitarian cyclist, while appreciating scenic routes where they coincide with specific travel lines, places highest priorities on directness of routes, acceptable grade profiles and minimized delay or inconvenience. The utilitarian cyclist is generally comfortable riding with motor vehicle traffic if appropriate facilities are provided.

Comprehensive systematic planning is necessary to insure that a useful recreational trail is provided for the public. To do this, the following items need to be addressed.

1. Identification of need of recreational trail system.

2. Determine objective of recreational trail(s).

3. Develop recreational trail potential use.

4. Route(s) evaluation, location and selection:

1.4 RECREATIONAL TRAIL PLANNING PROCESS (Continued)

- Adequate access
- Directness and convenience
- Continuity with recreational trail network
- Attractiveness of route
- Safety and security
- Delays along route
- Cost of improvements
- Shared use of recreational trail
- Maintenance
- Conflicts with other vehicles
- Adequacy of street use
  - . Grades and geometrics
  - . Surface obstructions and conditions
  - . Traffic volumes and speeds
  - . Truck and bus traffic
  - . Parking
  - . Intersection conditions
  - . Signing and pavement markings
  - . Sight distances
  - . Clearance (vertical and horizontal)
  - . Bridge and railroad crossings

1.5 RECREATIONAL TRAILS CLASSIFICATION

Recreational Trails are classified according to their location; i.e., separated from the roadway (Shared Use Path) or connected to the existing road system (Bicycle Lanes or Shared Roadway).

The classifications that will be used in this chapter are: Class 1 (separate from the roadway but may be part of the right-of-way), Class 2 (posted bicycle routes and separate marked Bicycle Lanes on the existing roadway surface with or without parking), and Class 3 (a Signed Shared Roadway surface between bicycles and motor vehicles that may be designated by signs as a marked bicycle route system but does not have marked Bicycle Lanes). These are explained in detail in the following subsections.

1. CLASS 1 - SHARED USE PATHS

Class 1 Recreational trails, also known as Shared Use Path, are a separate system from the roadway and are normally a two-way facility. Crossings with automobiles and pedestrian facilities are kept to a minimum. By nature, Shared Use Paths will occur most often in open spaces, parks, highway right-of-way, railroad right-of-way, river banks, and newly planned developments. Shared Use Paths offer opportunities not provided by the road system. They can either provide a recreational opportunity or can serve as a direct commute route if cross flow by motor vehicles can be minimized. When bikepaths are shared with other users, such as pedestrians, the widths may need to be increased to accommodate horizontal clearances. Figures 1.1 and 2.1 shows typical Shared Use Path cross sections.

1.5 RECREATIONAL TRAILS CLASSIFICATION (Continued)

2. CLASS 2 - BICYCLE LANES

Class 2 Recreational trails, also known as Bicycle Lanes or Bike Lanes, are an exclusive one-way lane for bicycle use only. Lanes parallel to motor vehicle travel lanes or parking lanes are designated through the use of signs and pavement markings.

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. Bike Lanes are intended to delineate the right-of-way assigned to bicyclists and motorists and to provide for more predictable movements by each. Bike Lane markings can increase a bicyclist′s confidence in motorists not straying into his/her path of travel. Likewise, passing motorists are less likely to swerve to the left out of their lane to avoid bicyclists on their right.

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

A more important reason for constructing Bike Lanes is to better accommodate bicyclists through corridors where insufficient room exists for bicycling on existing streets. This can be accomplished by reducing the number of lanes, or prohibiting parking on given streets in order to delineate Bike Lanes. In selecting appropriate streets for Bike Lanes, the criteria outlined in Chapter 8, Section 1.4 should be examined along with the MUTCD.

3. CLASS 3 - SIGNED SHARED ROADWAY

Class 3 Recreational trails, also known as Signed Shared Roadways, share the traveled portion of the roadway with motor vehicles and do not have striped Bike Lanes.

By law, bicyclists are permitted on all roadways, except prohibited freeways. When a particular roadway is identified as having characteristics that make it preferential for use by cyclists it may be beneficial to sign it as a designated bike route. There are several reasons for designating signed bike routes:

- The route provides continuity to other bicycle facilities such as Bike Lanes and Shared Use Path.
- The road is a common route for bicyclists through a high demand corridor.

1.5 RECREATIONAL TRAILS CLASSIFICATION (Continued)

- In rural areas, the route is preferred for bicycling due to low motor vehicle traffic volume or paved shoulder availability.

- The route extends along local neighborhood streets and collectors that lead to an internal neighborhood destination such as a park, school, or commercial district.

Signed Shared Roadways indicate to cyclists that there are particular advantages to using these routes compared to alternate routes. This means the responsible agencies have taken action to ensure these routes are suitable for bicycle use and will be maintained. Signing also serves to warn vehicle drivers that bicyclists are present.

Prior to signing a roadway as a designated bicycle route, the following criteria should be considered:

- The route provides through and direct travel in bicycle-demand corridors

- An effort has been made to adjust traffic control devices to give greater priority to bicyclists on the route, as opposed to alternative, non-designated routes. This could include placement of bicycle-sensitive detectors where bicyclists are expected to stop.

- Street parking has been removed or restricted in areas of critical width to provide improved safety.

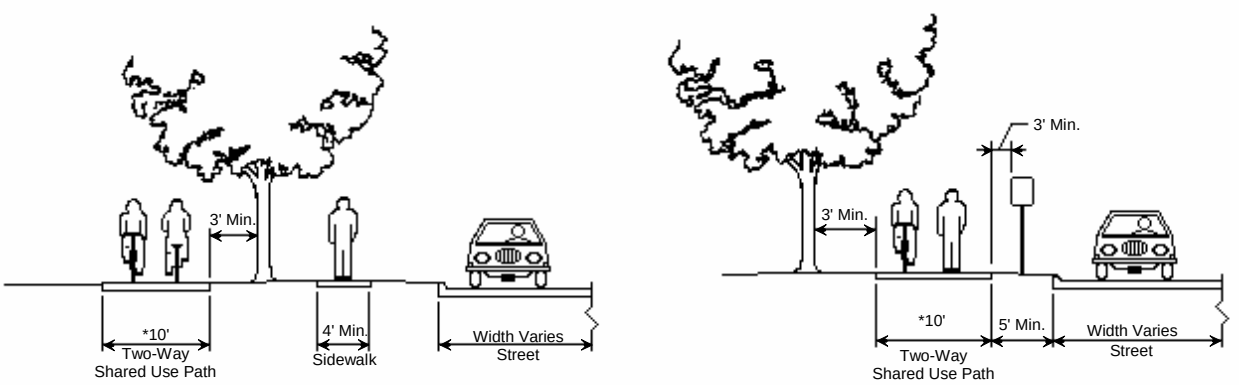
- A smooth surface has been provided (e.g. adjust utility covers to grade, install bicycle-safe drainage grates, fill potholes, etc.)

- Maintenance of the route will be sufficient to prevent accumulation of debris.

- Ensure that lane widths and roadway capacity are sufficient to accommodate both the vehicle and bicycle volumes expected (14' of usable outside lane is recommended).

CROSS SECTIONS - RECREATIONAL TRAIL CLASSIFICATIONS

FIGURE 1.1 - CLASS 1 - SHARED USE PATHS



* See Chapter 8, Section 2, 2.3, 1, A for guidance for narrower or wider width requirements.

FIGURE 1.2 - CLASS 2 - BICYCLE LANES

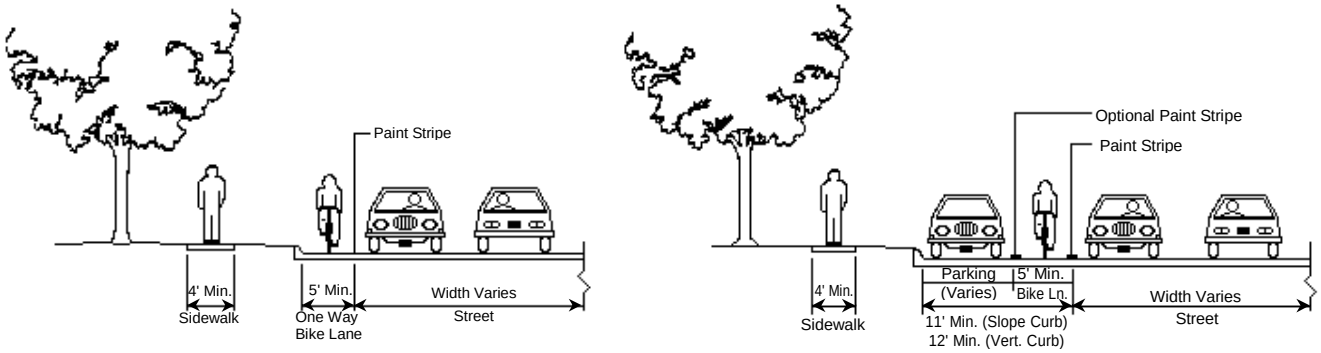
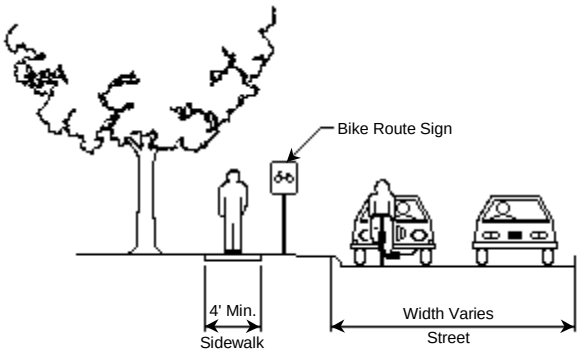


FIGURE 1.3 - CLASS 3 SIGNED SHARED ROADWAY



RECREATIONAL TRAIL DESIGN

2.1 ACCESSIBLE RECREATIONAL TRAIL DESIGN

All recreational trail design should be approached with the intention of providing an accessible facility for all users, including those users with disabilities. The Americans with Disabilities Act (ADA) has established accessibility standards for buildings and their sites, but not for outdoor developed areas. Currently there are no federal ADA regulations that provide standards for recreational trails. However, the process to adopt such standards has begun. The Architectural and Transportation Barriers Compliance Board (Access Board) has released the "Final Report of the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas". Based upon this report (dated September 30, 1999) actual standards will eventually be developed through a rule making process which provides for public input and negotiation. This process may take several years before the final standards are adopted.

Until such standards are developed by the ADA, recreational trails should be designed according to the recommendations of the AASHTO Guide for the Development of Bicycle Facilities which are summarized herein (see Chapter 8, Table 2.5 for grade requirements). In many aspects, designing a trail to accommodate bicyclists inherently creates a facility which is accessible to the disabled.

The designer may also wish to refer to the Access Board's Final Report for additional recommendations on accessible design.

The designer should do as much as possible to make a trail accessible. However, for situations where a trail is not considered accessible, signing should be placed at the trail access points to warn the user of the situations that are present (i.e. steep grade or cross slope, narrow width, uneven surface, etc.).

2.2 GENERAL

The values contained in Table 2.1 and corresponding reference discussions for each item, as described in Chapter 8, Section 2, 2.3 were developed from the AASHTO, "Guide for the Development of Bicycle Facilities".

TABLE 2.1 - RECREATIONAL TRAIL DESIGN CRITERIA
(Refer to Chapter 8, Section 2, 2.3 on the following pages for additional information on the following items)

REF. NO.	ITEM	CLASS 1 (Shared Use Paths)	CLASS 2 (Bike Lane) no parking	CLASS 2 (Bike Lane) with parking
1.	Cross Sections (ft) (Chapter 8, Section 2, 2.3, 1)	See Chapter 8, Section 2, 2.3, 1		
2.	Design Speed (mph) (Chapter 8, Section 2, 2.3, 2)			
	A. unpaved surfaced (min. grades)	15	---	---
	B. paved surfaced (min. grades)	20	20	20
	C. paved surfaced (grades greater than 4% and longer than 500 ft.)	30	30	30
3.	Shoulder Width (ft) (Chapter 8, Section 2, 2.3, 3) (each side)	2 (min) 3 (desirable)	---	---
4.	Right-of-way (ft) (Additional width along each side of trail) (Chapter 8, Section 2, 2.3, 4)	2 (min.) 3 (desirable)	---	---
5.	Clearances (Chapter 8, Section 2, 2.3, 5)			
	A. Lateral Clearance (ft.)			
	• Utilities, trees	3	---	---
	• Slope drop-off (3:1 or steeper)	5	---	---
	B. Vertical Clearance (ft.)			
	• Overhead	8 (min.)	8 (min.)	8 (min.)
	• Under crossings & tunnels	10 (desir.)	10 (desir.)	10 (desir.)
6.	Stopping Sight Distance	See Chapter 8, Section 2, 2.3, 6 for details		
7.	Horizontal Alignment	See Chapter 8, Section 2, 2.3, 7 for details		
8.	Vertical Alignment	See Chapter 8, Section 2, 2.3, 8 for details		
9.	Minimum surface depth on natural subgrade (in)	(Chapter 8, Section 2, 2.3, 9)		
	A. PCC surface	4	---	---
	B. Hot Mix Asphalt surface	5	---	---
	C. Crushed rock surface	6	---	---

2.3 REFERENCE INFORMATION FOR TABLE 2.1

The following considerations shall be used as a guide when designing recreational trails. See Table 2.1 for summary.

1. Recreational Trail Widths

A bicyclist requires a minimum of 40 inches of essential operating space based upon their profile. A width of 4 feet is assumed as the minimum width required for the cyclist to effectively operate the bicycle and is assumed as the minimum width for any facility designed for exclusive or preferential use by bicyclists. Where motor vehicle traffic volumes, motor vehicle or bicyclist speed, and the mix of truck and bus traffic increase, a more comfortable operating space of 5 feet or more is desirable.

In addition to the minimum operating space of 4', a maneuvering allowance should also be provided. This additional width allows the rider freedom to maneuver around debris, travel around curves more confidently, meet and pass other cyclists and pedestrians more safely, and ride at a higher level of comfort. An additional 1 foot maneuvering allowance is recommended on the outside of all trails. This additional 1 foot of width is the basis for a 5' Bike Lane and a 10', two-way Shared Use Path described below.

A. Class 1 - Shared Use Paths

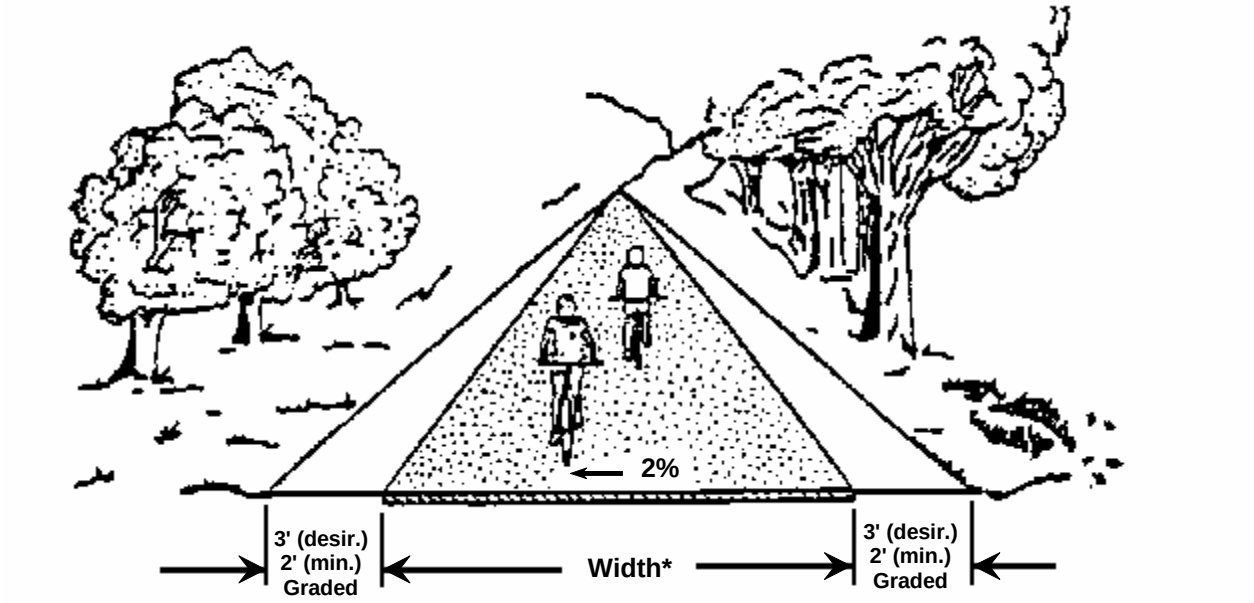
The paved width and the operating width required for a Shared Use Path are primary design considerations. Figure 1.1 depicts a Shared Use Path separated from the roadway. Under most conditions, a recommended paved width for a two-directional Shared Use Path is 10 feet. In some instances, however, a minimum of 8 feet can be adequate. This minimum should be used only where the following conditions prevail: (1) trail 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, (4) the path will not be subjected 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 Shared Use Path to 12 feet because of substantial user volume, probable shared use with joggers, wheelchair users, other pedestrians, use by large maintenance vehicles, steep grades and where bicyclists will be likely to ride two abreast.

The minimum width of a one-directional Shared Use Path is 6 feet. It should be recognized, however, that one-way trails 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 a Shared Use Path will be used as a two-way facility and designed accordingly.

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

A wide separation between a Shared Use Path and an adjacent roadway is desirable to confirm to both the bicyclist and motorist that the Shared Use Path functions as an independent facility for cyclists and other users. When this wide separation is not possible and the distance between the edge of the shoulder and the Shared Use Path is less than 5 feet, a suitable physical divider may be considered. Such dividers serve both to prevent bicyclists from making unwanted movements between the path and the roadway or roadway shoulder and to reinforce the concept that the Shared Use Path is an independent facility. Where used, the divider should be a minimum of 42 inches high, to prevent bicyclists from toppling over it, and it should be designed so that it does not become an obstruction to motorists or Shared Use Path users in itself.

FIGURE 2.1 – CLASS 1 – SHARED USE PATH – SEPARATED FROM THE ROADWAY



***One Way: 6' minimum (See Chapter 8, Section 2, 2.3, 1, A)**
Two Way: 10' (See Chapter 8, Section 2, 2.3, 1, A for guidance for narrower or wider width requirements).

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

B. Class 2 Bicycle Lanes

Before a decision is made to provide Bicycle Lanes on an existing or proposed roadway, the roadway geometrics must be checked to determine if they meet the Bicycle Lane criteria contained herein. If certain roadway elements are not satisfactory for Bicycle Lanes, other routes need to be examined.

Figure 2.2 shows the typical Class 2 Bicycle Lane cross sections.

1) Bike Lanes with On-Street Parking Permitted

As shown in Figure 2.2, Bicycle Lanes should always be placed between the parking lane and the motor vehicle lanes. Bicycle Lanes between the curb and the parking lane can create obstacles for bicyclists from opening car doors and poor visibility at intersections and driveways, and they prohibit bicyclists from making left turns; therefore, this placement should not be considered.

Where parking is permitted, but a parking stripe or stalls are not provided (refer to Chapter 8, Section 2, 2.7-2), the combination lane, intended for both motor vehicle parking and bicycle use, should be a minimum of 12 feet wide. This width is based upon an average vehicle parking requirement of 8 feet and a minimum 4 foot operating space for the bicyclist.

If parking volume is substantial, or turnover is high, it may be desirable to add an additional 1 or 2 feet of width to the Bicycle Lane to ensure safe operation.

2) Bicycle Lanes with Parking Prohibited

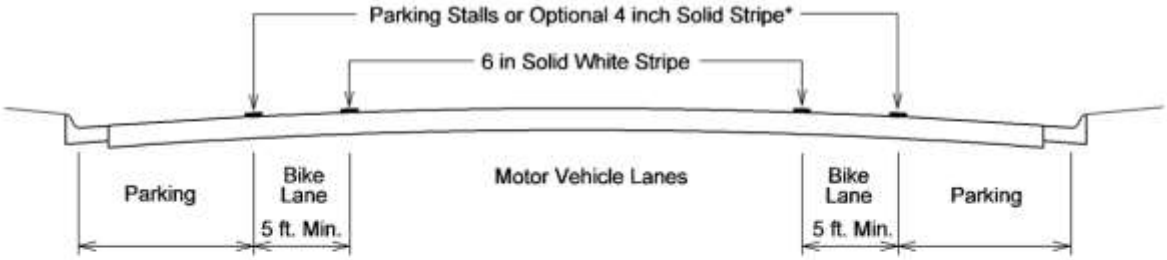
When parking is prohibited, the recommended width of a Bike Lane is 5 feet from the face of curb to the Bike Lane stripe (5.5 feet from back of curb). This 5 foot width is based upon providing a minimum of 3 feet of ridable surface (refer to Chapter 8, Section 2, 2.3-5.A.2) between a longitudinal curb and gutter joint and the Bike Lane stripe (given that the longitudinal joint is smooth). Therefore, if a curb and gutter unit wider than 2.5 feet is used, the Bike Lane width should be increased accordingly (i.e. 5.5 foot lane for 3 foot curb and gutter). If the longitudinal curb and gutter joint is not smooth, such as between a concrete curb and gutter and an asphalt roadway, 4 feet of ridable surface should be provided. See Chapter 8, Section 2, 2.3-5.A.2 for proper clearances beyond the curb.

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

3) Bicycle Lanes along Rural Roadways

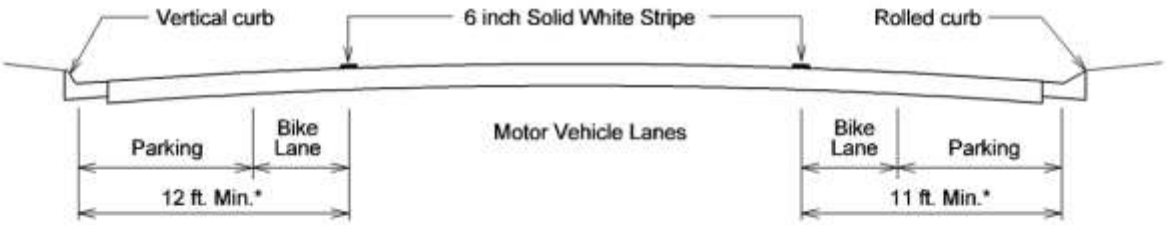
Bicycle Lanes should be located within the limits of the paved shoulder at the outside edge. Bicycle Lanes may have a minimum width of 4 feet where the area beyond the shoulder can provide additional maneuvering width. A width of 5 feet or greater is preferable and additional widths are desirable where substantial truck traffic is present, or where motor vehicle speeds exceed 50 mph.

FIGURE 2.2 TYPICAL CROSS SECTIONS FOR CLASS 2 - BICYCLE LANES



*The optional solid white stripe may be advisable where stalls are unnecessary (because parking is light) but there is concern that motorists may misconstrue the bike lane to be a traffic lane

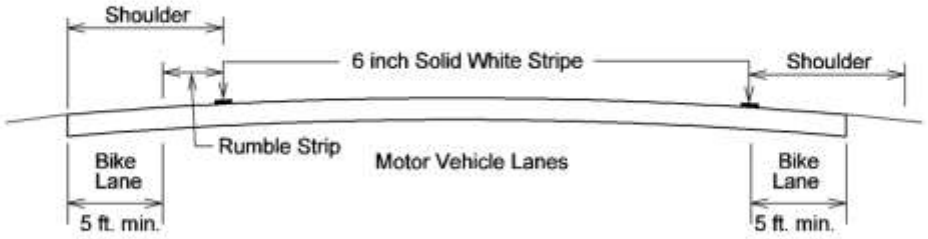
ON-STREET PARKING WITH PARKING STRIPE OR STALL



*13 feet is recommended where there is substantial parking or turnover of parked cars is high (e.g. commercial areas)

ON STREET PARKING PERMITTED WITHOUT PARKING STRIPE OR STALL

PARKING PROHIBITED



TYPICAL ROADWAY IN RURAL AREAS - PARKING PROHIBITED

SOURCE: AASHTO Guide for the Development of Bicycle Facilities, AASHTO, 1999

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

2. 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, location, and grade of the path, the speed and direction of the wind, the number of users on the path, and the physical condition of the bicyclist. Shared Use Paths should be designed for a 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 should be used, unless posted for slower speeds. However, when the grade exceeds 4 percent and the length is greater than 500 ft., or where stronger prevailing tailwinds exist, a design speed of 30 mph is advisable.

On unpaved Shared Use Paths, where bicyclists tend to ride slower, a lower design speed of 15 mph can be used unless posted for slower speeds. Similarly, where the grades or the prevailing winds dictate, a higher design speed of 25 mph 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 (See Chapter 8, Section 2, 2.3-7).

3. Shoulder Width and Slope

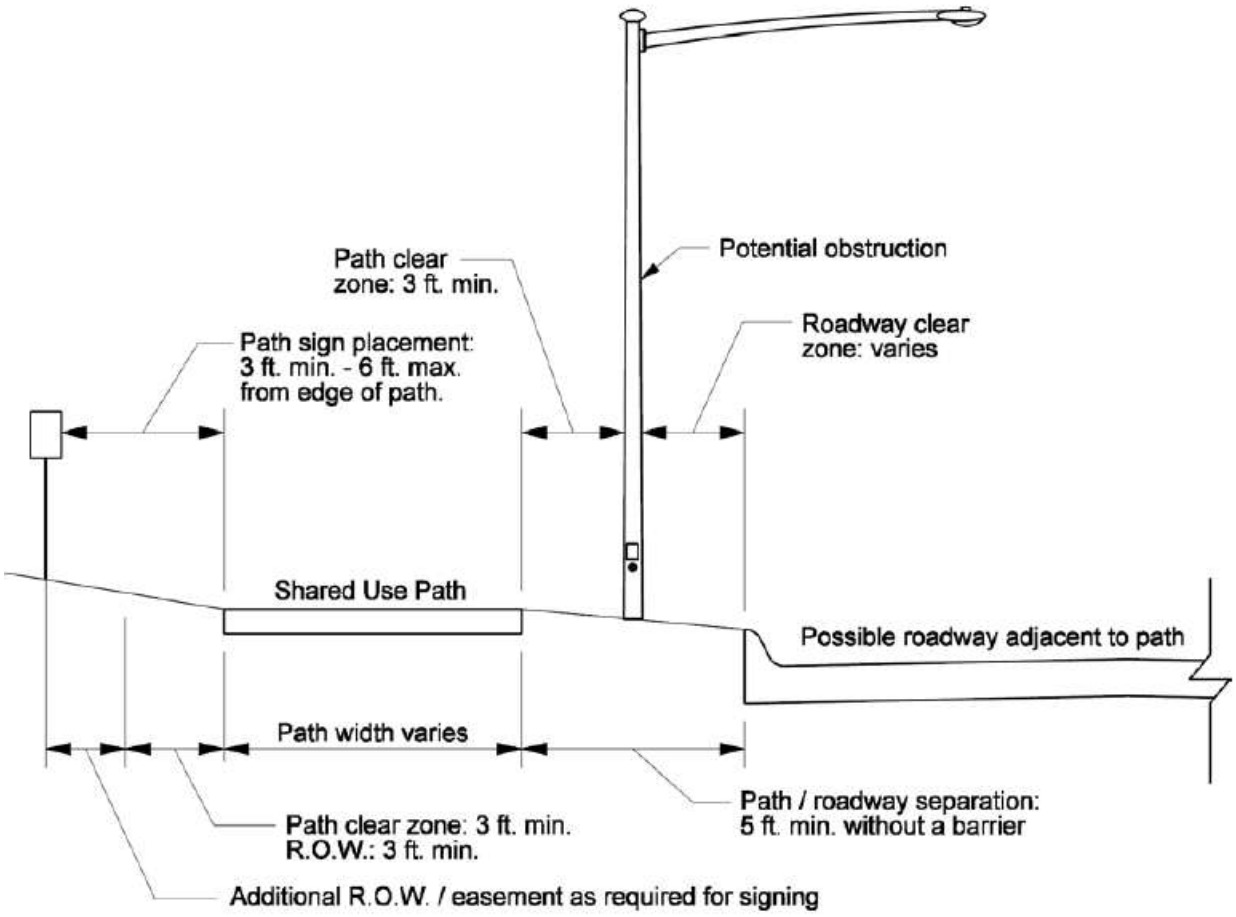
A minimum 2 feet (3 feet desirable) wide graded area with a maximum slope of 6:1 should be maintained adjacent to both sides of a Shared Use Path. A wider graded area on either side of the Shared Use Path can serve as a separate jogging path.

4. Right-of-Way / Easement

The right-of-way or easement area for Class 1 Shared Use Paths is the area required to allow the Shared Use Path to be maintained. The desirable right-of-way width should extend a minimum of 3 feet beyond either side of the trail. Additional right-of-way or easement may be required in the area of high embankments and/or drainage structures for features such as guardrails. For trails with signing, additional right-of-way or easements are required in order to properly place the signs outside of the 3 foot clear area. (refer to Chapter 8, Section 2, 2.3-5 and Figure 2.3)

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

FIGURE 2.3 TYPICAL CLEARANCE AND RIGHT-OF-WAY FOR SHARED USE PATH



5. Lateral and Vertical Clearances.

Perhaps the most critical factor in developing safe and comfortable recreational trail facilities is the provision of adequate clearance to a wide variety of potential obstructions that may be found along a prospective route. Guidelines for lateral and vertical clearance are particularly important in view of the wide range of riding proficiency that is found among riders. Clearance consideration must include:

A. Lateral clearances to fixed and movable obstructions.

1) For Shared Use Paths, a minimum lateral clearance of 3' should be provided between the edge of the Shared Use Path and any obstruction including trees, utility poles, signs, etc. Where ditches, canals, or slopes of 3:1 or greater are present, a wider clear width (5' or greater) should be considered. Refer to Figure 2.3.

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

2) Along Bicycle Lanes (without parking) that have a curb and gutter, bicyclists do not generally ride near the curb because of the possibility of debris in the gutter, hitting the pedal on the curb, an uneven longitudinal joint, or a steeper cross slope. Bicycle Lanes adjacent to curbs should have a minimum ridable surface of 3 feet (not including curb and gutter). This ridable area should be kept free of storm and utility grates that may cause the cyclist to swerve. The clear area provided behind the back of curb for motor vehicles is normally sufficient for cyclists as well.

B. Vertical clearances to overhead obstructions.

The vertical clearance to obstructions should be a minimum of 8 feet. However, vertical clearance may need to be greater to permit passage of maintenance and emergency vehicles. In underpasses and tunnels, 10 feet is desirable to account for vertical shy distance and vehicles.

Clearance guidelines for recreational trail operation are indicated in Table 2.1. It should be noted, however, that these guidelines are minimum recommendations. Where possible, additional space should be provided to permit passing within the recreational trail. Extra maintenance may be required to such things as trees trimmed to meet the clearances. Ice, snow and rain loads should also be considered when trimming.

6. Stopping Sight Distance

The degree of safety which a recreational trail offers relates in part to how easily conflicts are perceived. These conflicts may include pedestrians, other bicyclists, automobiles, animals or other obstructions. However, the ability of a bicyclist to react is dependent on the stopping sight distance that is provided. Safe stopping sight distances are a function of recreational trail speed, user ability and grade profile of the facility. The following equation and Figure 2.3 provide recommended stopping sight distances for various design speeds and gradients. These values are for concrete or bituminous surfaces.

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

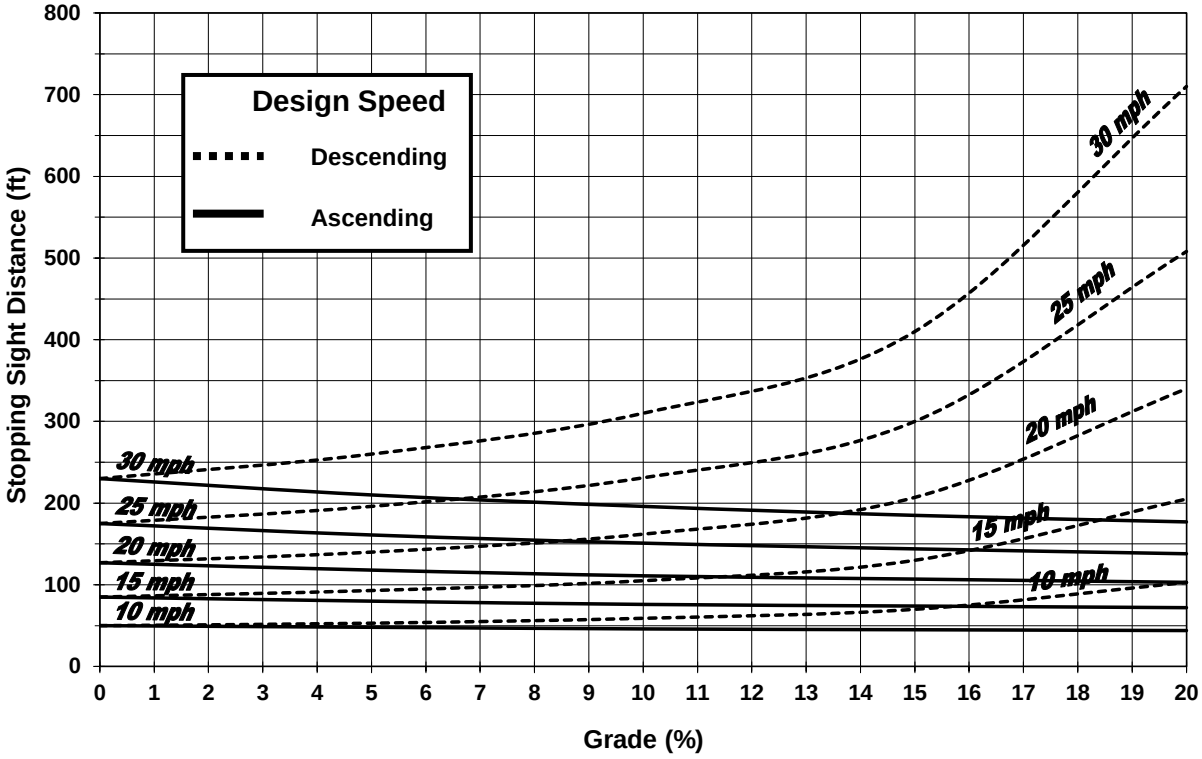
Where:

S = Stopping Sight Distance, ft
V = Design Velocity, mph
f = Coefficient of Friction (0.25 for paved, 0.125 for unpaved)
G = Grade (ft/ft) (Rise/Run)

SOURCE: AASHTO Guide for the Development of Bicycle Facilities, AASHTO, 1999

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

FIGURE 2.4 - MINIMUM STOPPING SIGHT DISTANCES



7. Horizontal Alignment

The minimum radius of curvature negotiable by a bicycle is a function of the superelevation rate of the recreational trail surface, the coefficient of friction between the bicycle tires and the recreational trail surface, and the speed of the bicyclist. 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). (see Table 2.1)

e = Rate of superelevation (0.02 ft./ft. min. to 0.05 ft./ft. max.)

f = Coefficient of friction. (use 0.25 for paved surfaces, 0.125 for non-paved surfaces)

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

For most Shared Use 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, makes travel and access easier for the disabled, and will simplify construction. Care should be exercised when designing Shared Use Paths when a constant super-elevation is used across the path to prevent water from being trapped on the high side. This is particularly true at the bottom of vertical curves and radii. Shallow ditch swales outside the shoulder area are commonly used to prevent this from occurring.

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 recreational trail can be assumed to vary from 0.31 at 12 mph to 0.21 at 30 mph. Although there is no data available for unpaved surfaces, it is suggested that the friction factors be reduced by 50% to allow a sufficient margin of safety.

Based upon a superelevation rate (e) of 2% or 5% , minimum radii of curvature can be selected from Table 2.2. As can be seen in Table 2.2, the increase in superelevation from 2% to 5% does not significantly reduce the radius where speeds are below 25 mph. Therefore, a superelevation rate of 2% is recommended for most designs.

TABLE 2.2 - MINIMUM RADII (ft.) FOR PAVED RECREATIONAL TRAILS

Design Speed - V (mph)	Friction Factor - f (paved surfaces)	Minimum Radius - R (feet) e=2%	e=5%
15	0.29	50	45
20	0.27	90	85
25	0.24	160	145
30	0.21	260	230

When tight radius curves must be used on Shared Use Paths because of right-of-way, topographical or other considerations, standard curve warning signs and supplemental pavement markings should be installed in accordance with the MUTCD. The effects of tight curves can also be partially offset by widening the pavement through the curves, and/or using a higher superelevation (up to 5%).

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

The widening of pavement widths on curves will provide increased safety and comfort. By doing so, the tendencies of the bicyclist to "lean into" turns and stray from the centerline can be accommodated without jeopardizing either his or her actual or psychological safety or comfort. Table 2.3 indicates the recommended means by which curve-widening designs should be developed. In extreme cases, where curve radii are less than 100 feet, widening is recommended up to a maximum of four feet depending on the radius of the curve and the design speed being used. Advanced warning signs should be placed prior to all curves which do not meet the recommended minimum radii.

TABLE 2.3 - SHARED USE PATH CURVE WIDENING GUIDELINES FOR VARIOUS RADII AND DESIGN SPEEDS
(e = 0.02 ft/ft)

Recommended Curve Widening (feet)

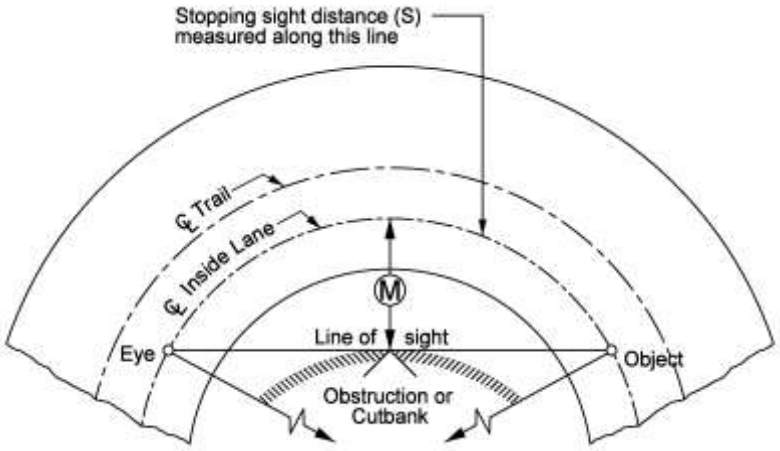
Design Speed	Minimum Radii (Feet) Of: 20	25	30	40	70	90
15 mph	4.0	3.6	2.4	2.0	---	---
20 mph		4.0	3.2	2.8	1.5	1.2
25 mph			4.0	3.4	1.9	1.5
30 mph				4.0	2.2	1.7

Figure 2.4 should also be checked when determining the horizontal curve requirements when sight obstructions or cutbanks are encountered.

Bicyclists frequently ride abreast of each other on Shared Use Paths and, on narrow paths, bicyclists have a tendency to ride near the middle of the path. For these reasons, 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.

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

FIGURE 2.5 - MINIMUM LATERAL CLEARANCES ON HORIZONTAL CURVES



S = Stopping Sight Distance (ft)
R = Radius of centerline of lane (ft)
M = Distance from centerline of lane to obstruction (ft.)

Angle is expressed in degrees

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

$$S = \frac{R}{28.655}\left[\cos^{-1}\left(\frac{R - M}{R}\right)\right]$$

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

Height of cyclist's eye = 4.5 ft.
Height of object = 0 ft.

TABLE 2.4 - MINIMUM LATERAL CLEARANCE, (M) ft. FOR HORIZONTAL CURVES

R (ft)	S = Stopping Sight Distance														
	20	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**
25	2.0	7.6	15.9												
50	1.0	3.9	8.7	15.0	23.0	31.9	41.5								
75	0.7	2.7	5.9	10.0	16.1	22.8	30.4	38.8	47.8	57.4	67.0				
95	0.5	2.1	4.7	8.3	12.9	18.3	24.7	31.8	39.5	48.0	56.0	66.3	75.9	85.8	
125	0.4	1.6	3.6	6.3	9.9	14.1	19.1	24.7	31.0	37.9	45.0	53.3	61.7	70.6	79.7
155	0.3	1.3	2.9	5.1	8.0	11.5	15.5	20.2	25.4	31.2	37.0	44.2	51.4	59.1	67.1
175	0.3	1.1	2.6	4.6	7.1	10.2	13.8	18.0	22.6	27.8	33.0	39.6	46.1	53.1	60.5
200	0.3	1.0	2.2	4.0	6.2	8.9	12.1	15.8	19.9	24.5	29.0	34.9	40.8	47.0	53.7
225	0.2	0.9	2.0	3.5	5.5	8.0	10.8	14.1	17.8	21.9	26.0	31.3	36.5	42.2	48.2
250	0.2	0.8	1.8	3.2	5.0	7.2	9.7	12.7	16.0	19.7	23.0	28.3	33.1	38.2	43.7
275	0.2	0.7	1.6	2.9	4.5	6.5	8.9	11.6	14.6	18.0	21.0	25.8	30.2	34.9	39.9
300	0.2	0.7	1.5	2.7	4.2	6.0	8.1	10.6	13.4	16.5	19.0	23.7	27.7	32.1	36.7
350	0.1	0.6	1.3	2.3	3.6	5.1	7.0	9.1	11.5	14.2	17.0	20.4	23.9	27.6	31.7
390	0.1	0.5	1.2	2.1	3.2	4.6	6.3	8.2	10.3	12.8	15.0	18.3	21.5	24.9	28.5
500	0.1	0.4	0.9	1.6	2.5	3.6	4.9	6.4	8.1	10.0	12.0	14.3	16.8	19.5	22.3
565		0.4	0.8	1.4	2.2	3.2	4.3	5.7	7.2	8.8	10.0	12.7	14.9	17.3	19.8
600		0.3	0.8	1.3	2.1	3.0	4.1	5.3	6.7	8.3	10.0	12.0	14.0	16.3	18.7
700		0.3	0.6	1.1	1.8	2.6	3.5	4.6	5.8	7.1	8.6	10.3	12.0	14.0	16.0
800		0.3	0.6	1.0	1.6	2.2	3.1	4.0	5.1	6.2	7.6	9.0	10.5	12.2	14.0
900		0.2	0.5	0.9	1.4	2.0	2.7	3.6	4.5	5.6	6.7	8.0	9.4	10.9	12.5
1000		0.2	0.5	0.8	1.3	1.8	2.4	3.2	4.0	5.0	6.0	7.2	8.4	9.8	11.2

SOURCE: AASHTO Guide for the Development of Bicycle Facilities, AASHTO, 1999

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

8. Vertical Alignment

A. Grades

Grades on Shared Use 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, the designer may use grades over 5 percent for short sections in accordance with Table 2.5 Grades steeper than 3 percent may not be practical for Shared Use Paths with crushed stone surfaces.

TABLE 2.5 - MAXIMUM ALLOWABLE GRADES FOR SHARED USE PATHS

Grade	Allowable Length of Grade, ft
0 - 5%	Unlimited
5% - 6%	800
7%	400
8%	300
9%	200
10%	100
11+%	50

SOURCE: AASHTO Guide for the Development of Bicycle Facilities, AASHTO, 1999

B. Crest Vertical Curves

Table 2.6 indicates the minimum lengths of vertical curves for varying sight distances. The eye height of the bicyclist is assumed to be 4.5 feet and the object height is assumed to be zero to recognize that impediments to bicycle travel exists at the pavement level. The stopping sight distance is that calculated from Figure 2.3. For two way Shared Use Paths, the design sight distance in the descending direction will control.

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

TABLE 2.6 - MINIMUM LENGTH OF CREST VERTICAL CURVES, L (ft.)

A	S = Stopping Sight Distance (ft)														
(%)	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
2												30	70	110	150
3								20	60	100	140	180	220	260	300
4						15	55	95	135	175	215	256	300	348	400
5					20	60	100	140	180	222	269	320	376	436	500
6				10	50	90	130	171	216	267	323	384	451	523	600
7				31	71	111	152	199	252	311	376	448	526	610	700
8			8	48	88	128	174	228	288	356	430	512	601	697	800
9			20	60	100	144	196	256	324	400	484	576	676	784	900
10			30	70	111	160	218	284	360	444	538	640	751	871	1000
11			38	78	122	176	240	313	396	489	592	704	826	958	1100
12		5	45	85	133	192	261	341	432	533	645	768	901	1045	1200
13		11	51	92	144	208	283	370	468	578	699	832	976	1132	1300
14		16	56	100	156	224	305	398	504	622	753	896	1052	1220	1400
15		20	60	107	167	240	327	427	540	667	807	960	1127	1307	1500
16		24	64	114	178	256	348	455	576	711	860	1024	1202	1394	1600
17		27	68	121	189	272	370	484	612	756	914	1088	1277	1481	1700
18		30	72	128	200	288	392	512	648	800	968	1152	1352	1568	1800
19		33	76	135	211	304	414	540	684	844	1022	1216	1427	1655	1900
20		35	80	142	222	320	436	569	720	889	1076	1280	1502	1742	2000
21		37	84	149	233	336	457	597	756	933	1129	1344	1577	1829	2100
22		39	88	156	244	352	479	626	792	978	1183	1408	1652	1916	2200
23		41	92	164	256	368	501	654	828	1022	1237	1472	1728	2004	2300
24	3	43	96	171	267	384	523	683	864	1067	1291	1536	1803	2091	2400
25	4	44	100	177	278	400	544	711	900	1111	1344	1600	1878	2178	2500

when S>L, $L = 2S - \frac{900}{A}$

when S<L, $L = \frac{AS^2}{900}$

Values below line represent S ≤ L.

L = Minimum Length of Vertical Curve (ft)
A = Algebraic Grade Difference (%)
S = Stopping Sight Distance (ft)

Height of cyclist's eye - 4 ½ ft.
Height of object - 0 ft

Minimum length of Vertical Curve = 3 ft.

SOURCE: AASHTO Guide for the Development of Bicycle Facilities, AASHTO, 1999

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

C. Sag Vertical Curves

Unlike crest vertical curves, sight distance is not a factor on recreational trails for sag vertical curves. However, in order to ensure rider comfort, it is recommended that sag vertical curves, with a minimum K value of 5, be provided for grade breaks in excess of 2%.

$$L = K \times (g_2 - g_1)$$

Where: L = curve length, ft
g_1 & g_2 = grades, %

9. Minimum Surface Depth

Designing and selecting pavement sections for Shared Use Paths is in many ways similar to designing and selecting highway pavement sections. As a minimum, a preliminary soils investigation should be conducted to determine the load carrying capabilities of the native soil and the need for any special provisions.

In addition, there are several basic principles that should be followed to recognize some basic differences between the operating characteristics of recreational trails and those of motor vehicles. While loads on Shared Use Paths due to bicycle and pedestrian use 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 Shared Use Path.

Special considerations should be given to the location of motor vehicle wheel loads on the Shared Use Path. When motor vehicles are driven on Shared Use 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, constructing additional pavement width at the edge, or a thickened pavement edge.

The thicknesses shown in the following paragraphs (and in Table 2.1) are the minimums required to create a stable surface which will withstand environmental conditions, is constructable, and will provide a reasonable service life. If the trail will be exposed to any significant traffic, other than the occasional emergency or maintenance vehicle (i.e. light truck), consideration should be given to increasing the thickness of the surface.

2.3 REFERENCE INFORMATION FOR TABLE 2.1 (Continued)

A. Portland cement concrete (PCC) Shared Use Paths on either natural subgrade or aggregate subbase should be no less than 4 inches thick and preferably 5 inches and shall be constructed with a minimum Class B concrete mix. For 8' (or narrower) paths, edge support (i.e. stabilized shoulders or thickened edges) should be provided if periodic maintenance trucks or patrol vehicles will use the Shared Use Path.

Transverse joints should be cut at a spacing equal to the width of the recreational trail. In addition, for 4 inch pavements, a longitudinal centerline joint is typically required in order to prevent the formation of a centerline crack. However, this longitudinal centerline joint is undesirable since it may open up and become uneven or may collect dirt and allow grass to grow up out of it. Both of these situations create the potential for cyclists to catch a tire and lose control; therefore, 5 inch or thicker PCC pavements should be constructed whenever possible.

B. Hot Mix Asphalt (HMA) surface depth for Shared Use Paths on natural subgrade or aggregate subbase should be a minimum of 5 inches thick (desirable thickness is 6 inches). For 8' (or narrower) Shared Use Paths, edge support (i.e. stabilized shoulders or thickened edges) should be provided if periodic maintenance trucks or patrol vehicles will use the Shared Use Path.

C. Normally a 4" thick aggregate subbase or flyash treated subgrade is necessary when the soils are poor quality (CBR of less than 3), or is non-uniform or has a high moisture content. See Division 2, Section 2010 of the Urban Standard Specifications for Public Improvements for subgrade treatment.

D. Crushed rock surface depth for Shared Use Paths on natural subgrade should be 6 inches thick. Typical construction may consist of 4" to 5" of a stable granular base material such as Iowa DOT Gradation 12 or 14 (Granular Subbase or Modified Subbase). The surface material should consist of smaller sized granular material to provide a smooth ride for cyclists. Crushed stone material such as Iowa DOT Gradation 21 (3/8" Cover Aggregate), or limestone screenings may be used.

2.4 SURFACE QUALITY

It is important to construct and maintain a smooth riding surface on recreational trails. Recreational trail pavements should be machine laid. Surface texture is needed but care must be exercised not to cause operational problems with too little or too much texture. Broom finish or burlap drag concrete surfaces are preferred over trowel finishes.

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

Future driveway construction should avoid construction of a vertical lip from the driveway to the gutter, as the lip may create a problem for bicyclists when entering from the edge of the roadway at a flat angle. If a lip is deemed necessary, the height should be limited to 1/2 inch.

Table 2.7 indicates the recommended Recreational Trail surface tolerances for Class 2, Bicycle Lanes and Class 3 Signed Shared Roadways, developed on existing streets to minimize the potential for causing bicyclists to lose control of their bicycle. (Note: Stricter tolerances should be achieved on new bikeway construction).

TABLE 2.7 - RECREATIONAL TRAIL SURFACE TOLERANCES FOR CLASS 2 AND 3

DIRECTION OF TRAVEL	GROOVES [1]	STEPS[2]
Parallel to travel	No more than 1/2" wide	No more than 3/8" high
Perpendicular to travel	---	No more than 3/4" high

[1] Groove - A narrow slot in the surface that could catch a bicycle wheel, such as a gap between two concrete slabs or drainage grates.

[2] 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 slabs when the top level does not extend to the edge of the roadway.

2.5 STRUCTURE DESIGN

An overpass, underpass, small bridge, drainage facility or facility on a roadway bridge may be necessary to provide continuity to a recreational trail.

On new structures, the minimum clear width should be the same as the approach paved bikepath. The desirable clear width should include a 2 foot wide clear area on both sides of the trail. Carrying the clear area across the structures has two advantages. First, it provides a minimum horizontal shy distance from the railing or barrier, and second, it provides needed maneuvering space to avoid conflicts with pedestrians and other bicyclists who are stopped on the bridge. Access by emergency, patrol, and maintenance vehicles should be considered in establishing the design clearances of structures on Shared Use Paths. Similarly, vertical clearance may be dictated by occasional motor vehicles using the path. Where practical, a vertical clearance of 10 feet is desirable for adequate vertical shy distance. Under certain conditions, 8.0 feet high may be adequate but the clearance needs to be clearly marked in advance of the structure.

Railings, fences, or barriers on both sides of a recreational trail structure should be a minimum of 42 inches high.

Bridges designed exclusively for recreational trail 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.

When it is necessary to retrofit a Shared Use Path onto an existing roadway bridge, several alternatives should be considered in light of what the geometrics of the bridge will allow.

One option is to carry the Shared Use Path across the bridge on one side. This should be done where (1) the bridge facility will connect to a Shared Use Path at both ends, (2) sufficient width exists on that side of the bridge or can be obtained by widening or restriping lanes and (3) provisions are made to physically separate bicyclists and motor vehicle traffic traveling in opposite directions.

A second option is to transition the Shared Use Path to either wide curb lanes or Bicycle Lanes prior to crossing over the bridge. This may be advisable where (1) the Shared Use Path transitions into, and continues as, Bicycle Lanes at one end of the bridge, and (2) sufficient width exists or can be obtained by widening or re-striping. This option should only be utilized if the Bike Lanes can be accessed without the potential for wrong way riding or inappropriate crossing maneuvers.

A third option is to use existing sidewalks as one-way or two-way facilities. This may be advisable where (1) conflicts between bicyclists and pedestrians will not exceed tolerable limits and (2) the existing sidewalks are adequately wide. As discussed above, a physical separation between bicyclists and motor vehicles traveling in opposing directions must be provided.

2.5 STRUCTURE DESIGN (Continued)

Under certain conditions, the bicyclist may be required to dismount and cross the structure as a pedestrian. This can be accomplished by stagger barriers perpendicular to the recreational trail that requires the bicyclist to stop and dismount. Adequate advance signing is necessary in this situation.

Because of the large number of variables involved in retrofitting recreational trail 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 variables.

2.6 DRAINAGE

The recommended pavement cross slope of 2 percent provides for drainage. Sloping in one direction instead of crowning is preferred and usually simplifies the drainage and surface construction. However, care must be exercised not to trap water on the high side of the recreational trail, particularly in curved areas. Also, a uniform surface is essential to prevent water ponding and ice formation.

Where a recreational trail is constructed on the side of a hill, a swale or ditch, outside of the shoulder edge and with suitable dimensions, should be placed on the uphill side to intercept the hillside drainage. Such ditches should be designed in such a way that no undue obstacle is presented to bicyclists. Where necessary, catch basins with drains should be provided to carry the intercepted water under the path. Depending on the use of the path and size of the drainage area a 5 year (minimum) or 10 year (desirable) storm event should be used in the trail drainage design.

Where a Shared Use Path is constructed next to a curbed roadway, storm runoff should typically run from the trail, across the parking area, and over the back of the curb. The parking grade (between the trail and street) should be sloped at a minimum of 2% for widths less than 10 feet, and 4% for widths greater than 10 feet unless other appropriate provisions are made to ensure proper drainage.

Drainage inlet grates on recreational trails shall have openings narrow enough and short enough to assure that bicycle tires will not drop into the grates regardless of the direction of travel. Where it is not immediately feasible to replace existing grates, 1 inch by 1/4 inch steel cross straps can be welded to the grates at a spacing of 4 inches on center to reduce the size of the opening. See Table 2.7 for opening requirements.

2.7 SIGNING AND MARKING

Adequate signing and marking are essential on Shared Use Paths, and Bike Lanes, especially to alert bicyclists to potential conflicts and to convey regulatory messages to both bicyclists and motorists at roadway 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 roadways. In general, uniform application of traffic control devices, as described in the MUTCD, shall be used and will tend to encourage proper bicyclist behavior.

1. Signing

A. Trail identification signs are to be located at access points, trailheads, and at regular intervals along the trail corridors. Signs are intended to be post-mounted four to five feet above grade to the bottom of the sign (see Figure 9B-1, MUTCD). Images may be silk-screened on a plastic or fiberglass panel. The symbols would augment trail identification signs informing which trail modes are allowed within specified corridors.

B. Directional signs are intended to be simple diagrams informing trail users as to corridor direction and changes in alignment. Directional signs are especially important in urban areas or where more than one trail exists.

C. Regulation signs and warning signs are to be used where hazards, cautions or other traffic control information is displayed and shall follow the MUTCD.

D. Several simple criteria should be exercised in locating signs.

1) Sign posts should be set back three to six feet from edge of recreational trail. Six feet is a preferred distance.

2) A hierarchy of letter size should occur, however, letter height of less than two inches is generally not recommended.

3) Regulatory signs normally shall be erected at the point where the regulations apply. Warning signs should normally be installed no less than 50 feet in advance of the hazard or caution.

4) Multiple messages may be mounted on the same post, however, the primary message as determined by the regulating agency should always be mounted at the top.

2.7 SIGNING AND MARKING (Continued)

2. Markings

For Class 1 Shared Use Paths, a 4 inch wide yellow centerline stripe to separate opposite directions of travel may be considered. The stripe should be broken in areas where adequate passing sight distance exists, and solid in other locations. This may be particularly beneficial for heavy volumes of users, on curves with restricted sight distance, and on unlighted paths where night time riding is expected. White edge lines can also be very beneficial where nighttime bicycle traffic is expected.

All Bicycle Lanes should be delineated from motor vehicle lanes with a 6 inch solid white line (wider lines may be used for added distinction). This marking increases the cyclists confidence that motor vehicles will not stray into their path of travel. Likewise, passing motorists are more confident that cyclists will stay in the Bicycle Lane and are therefore less likely to swerve to the left when passing a cyclist on the right.

For Bicycle Lanes where parking is permitted, a second 4 inch white line, or marked parking stalls are desirable between the Bicycle Lane and the parking lane. These markings encourages drivers to park closer to the curb without encroaching into the Bike Lane. They also discourage drivers from using the parking and Bicycle Lanes as an additional through travel lane. Refer to Figure 2.2.

General guidance on markings is provided in the MUTCD. Care should be exercised in the choice of pavement marking materials. Some marking materials are slippery when wet and should be avoided in favor of more skid resistant materials.

2.8 LIGHTING

Fixed-source lighting reduces conflicts along trails and at intersections. In addition, lighting allows the bicyclist to see the trail direction, surface conditions, and obstacles. Lighting for trails is important and may be considered where heavy night time riding is expected, such as paths serving college students or commuters, and at roadway intersections. Lighting should be considered through underpasses or tunnels, and when nighttime security could be a problem. See Chapter 11, Street Lighting, Table 2.1, for recommended illuminance and uniformity values. Where special security problems exist, higher illumination levels may be considered. Light standards (poles) should meet the recommended horizontal and vertical clearances.

2.9 INTERSECTIONS - CONSIDERATIONS

1. Class 1 Shared Use Paths

Intersections with roadways are important considerations in Shared Use Path design. If alternate locations for a Shared Use Path are available, the one with the most favorable intersection conditions should be selected. For crossings of freeways and other high-speed, high-volume arterials, a grade separation structure may be the only possible or practical treatment. Unless paths are prohibited from crossing the roadway, providing for turning movements must be considered. In most cases, however, the cost of a grade separation will be prohibitive.

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

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

It is preferred that the crossing of a Shared Use Path and a roadway be at a mid-block location away from the influence of intersections with other roadways. Controlling vehicle and bicycle movements at such intersections is more easily and safely accomplished through the application of standard traffic control devices and normal Rules of the Road. Where physical constraints prohibit such independent intersections, the crossings may be at or adjacent to the pedestrian crossing. Right of way should be assigned and sight distance should be provided so as to minimize the potential for conflict resulting from unconventional turning movements. At crossings of high volume multi-lane arterial roadways where signals are not warranted, consideration should be given to providing a median refuge area for bicyclists.

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

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

Ramps for curb cuts at intersections should be the same width as the Shared Use Path. Curb cuts and ramps should provide a smooth transition between the path and the roadway. Detectable warnings should be provided to warn visually impaired users that they are about to cross paths with motor vehicles.

2.9 INTERSECTIONS – CONSIDERATIONS (Continued)

2. Class 2 Bicycle 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 turns. Thus, some bicyclists will begin left turns from the right side Bike Lane and some motorists will begin right turns from the left of the Bike Lane. Both maneuvers are contrary to established Rules of the Road and result in conflicts.

A. Right Turn Lanes

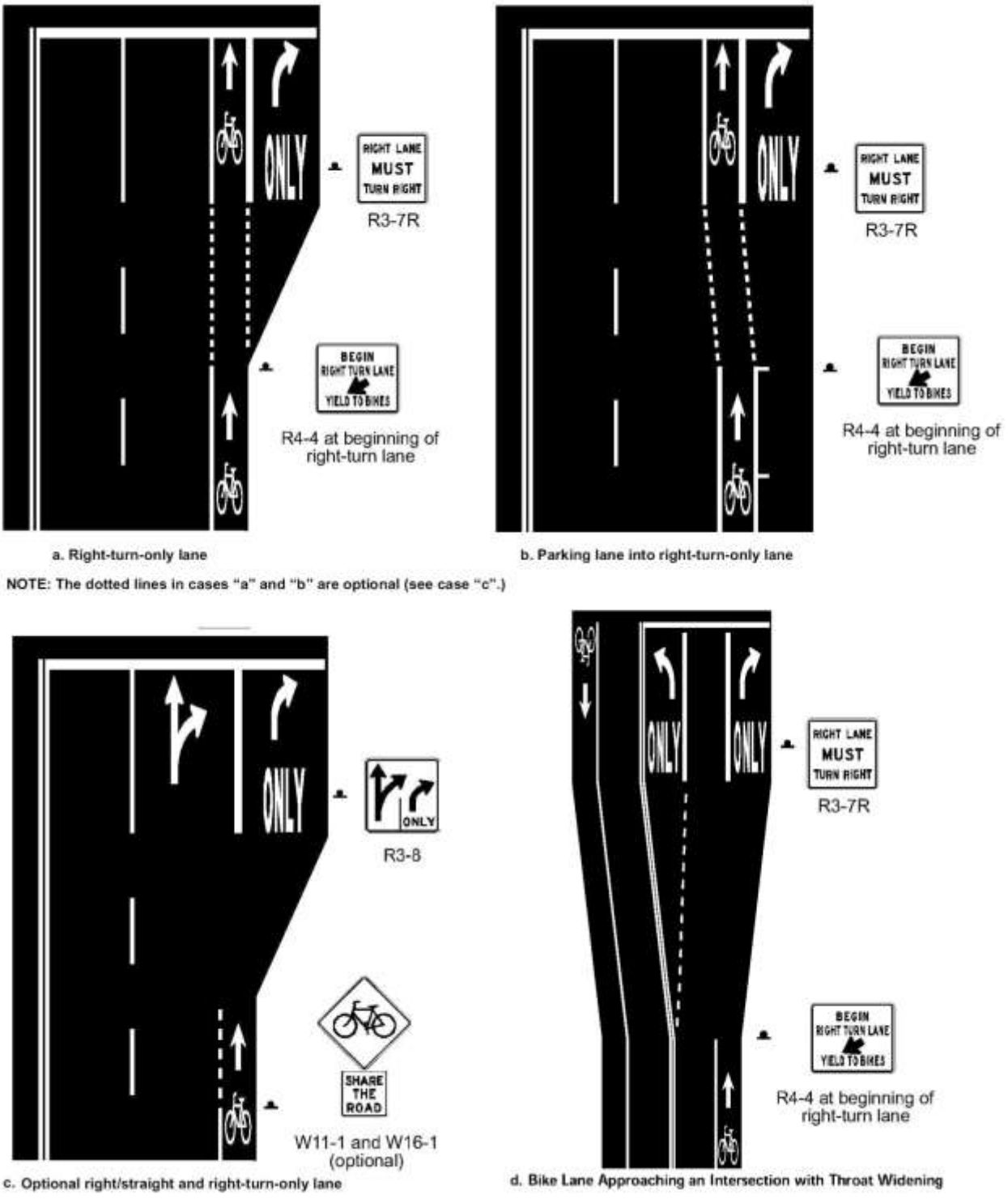
At intersections, bicyclists proceeding straight through and motorists turning right must cross paths. Striping and signing configurations which encourage these crossings in advance of the intersection, in a merging fashion, are preferable to those that force the crossing in the immediate vicinity of the intersection.

Figure 2.5 shows recommended pavement markings and signing for situations where a Bike Lane approaches a motorist right turn only lane.

At intersections where throat widening to add turn lanes has reduced the available width of the roadway for Bike Lanes below the minimum necessary, and roadway widening is not possible, the Bike Lane striping should be discontinued following a regulatory sign. Refer to Figure 2.5, detail d. Bicyclists proceeding straight through the intersection should be directed to merge with motor vehicle traffic to cross the intersection.

2.9 INTERSECTIONS – CONSIDERATIONS (Continued)

FIGURE 2.6 - BICYCLE LANES APPROACHING RIGHT-TURN-ONLY LANES



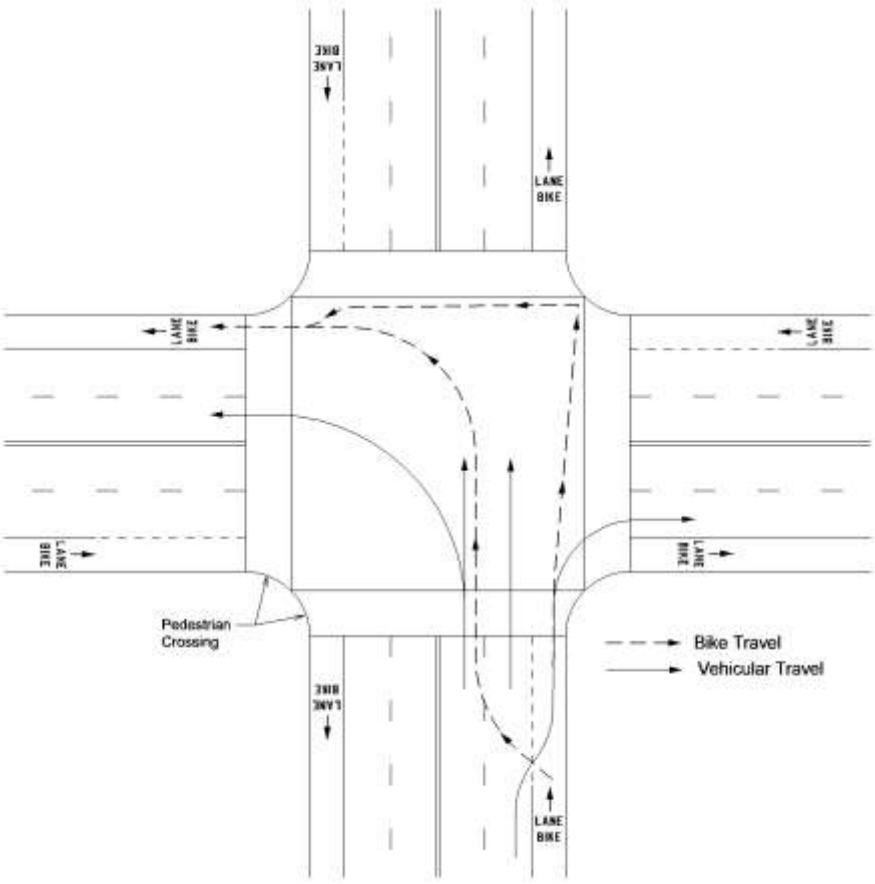
SOURCE: AASHTO Guide for the Development of Bicycle Facilities, AASHTO, 1999

2.9 INTERSECTIONS – CONSIDERATIONS (Continued)

B. Left Turn Lanes

Left turning bicyclists also encounter difficulties. Since the Bike Lane is on the right side of the street, bicyclists have to cross the path of cars traveling in both directions. Some bicyclists are proficient enough to merge across one or more lanes of traffic, to use the inside lane or left turn lane provided for motor vehicles. However, there are many who do not feel comfortable making this maneuver. They have the option of making a two-legged left turn by riding along a course similar to that followed by pedestrians (the bicyclist proceeds straight through the intersection, stops and turns left at the far side, then proceeds across the intersection again on the cross street), see Figure 2.6. Where there are numerous left turning bicyclists, a separate turning lane, as indicated in the MUTCD, 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 marking of Bicycle Lanes is contained in the MUTCD.

FIGURE 2.7 – BICYCLE LEFT TURN MOVEMENTS



SOURCE: AASHTO Guide for the Development of Bicycle Facilities, AASHTO, 1999

2.9 INTERSECTIONS – CONSIDERATIONS (Continued)

3. Traffic Control Devices at Intersections

At intersections where bicycle traffic exists or is anticipated, bicycles should be considered in the timing of the traffic signal cycle, as well as the traffic detection device. Normally, a bicyclist can cross an intersection under the same signal phasing arrangement as motor vehicles; however, on multi-lane streets special consideration should be given to ensure that short clearance intervals are not used.

To check the clearance interval, a bicyclist's speed of 10 mph and a perception/reaction/braking time of 2.5 seconds should be used. Detectors for traffic-actuated signals should have bicycle-sensitive detectors for Class 2 Bicycle Lanes and Class 3 Signed Shared Roadways. These detectors should be located in the bicyclist's expected path, including left turn lanes. In some situations, the use of pedestrian actuated buttons may be an acceptable alternative to the use of detectors provided they do not require bicyclists to dismount or make unsafe leaning movements. Where programmed visibility signal heads are used, they should be checked to ensure that they are visible to bicyclists who are properly positioned on the road.

2.10 AT-GRADE RAILROAD CROSSING

Whenever it is necessary to cross railroad tracks with a bicycle, special care must be taken. The crossing should be at least as wide as the approaches of the Bicycle Lane or Shared Use Path.

Whenever possible, the crossing should be straight, and at right angles to the rails. The greater the crossing angle deviates from being perpendicular, the greater the chance that a bicyclist's front wheel may be trapped in the flangeway, causing a loss of control. For Class 2 and 3 recreational trails (Bicycle Lanes and Signed Shared Roadways), where a skew angle of 45^{o} or less is unavoidable, the shoulder should be widened to permit bicyclists to cross at a safer angle (preferably perpendicularly) .

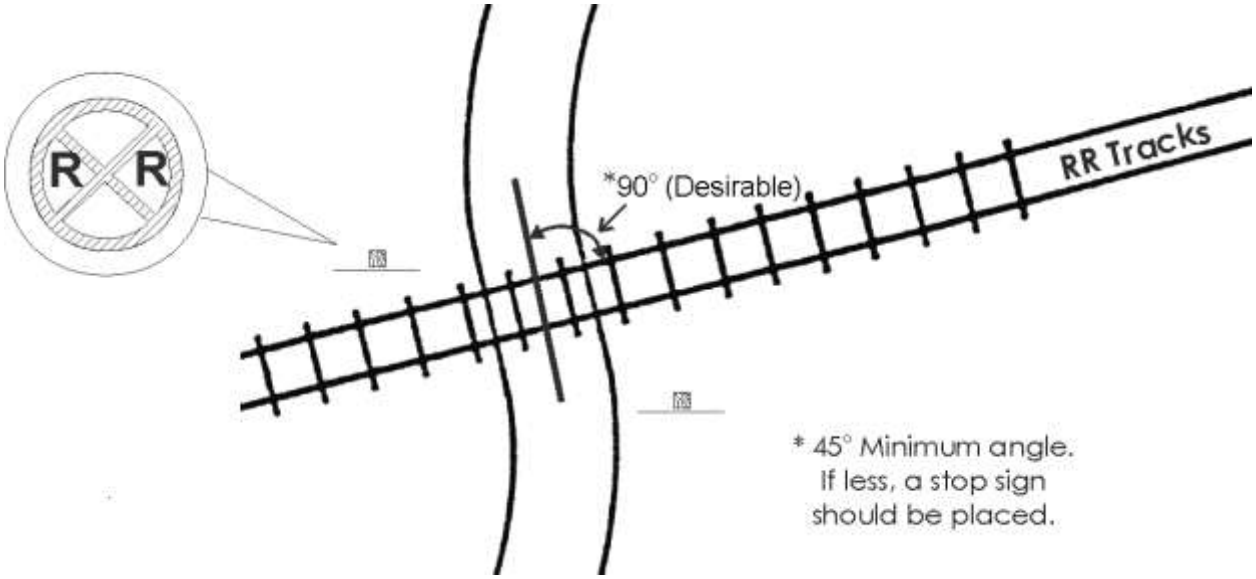
For Class 1 recreational trail facilities (Shared Use Path), the path should be realigned with a reverse curve configuration to allow crossing at a safer angle. Refer to Figure 2.8.

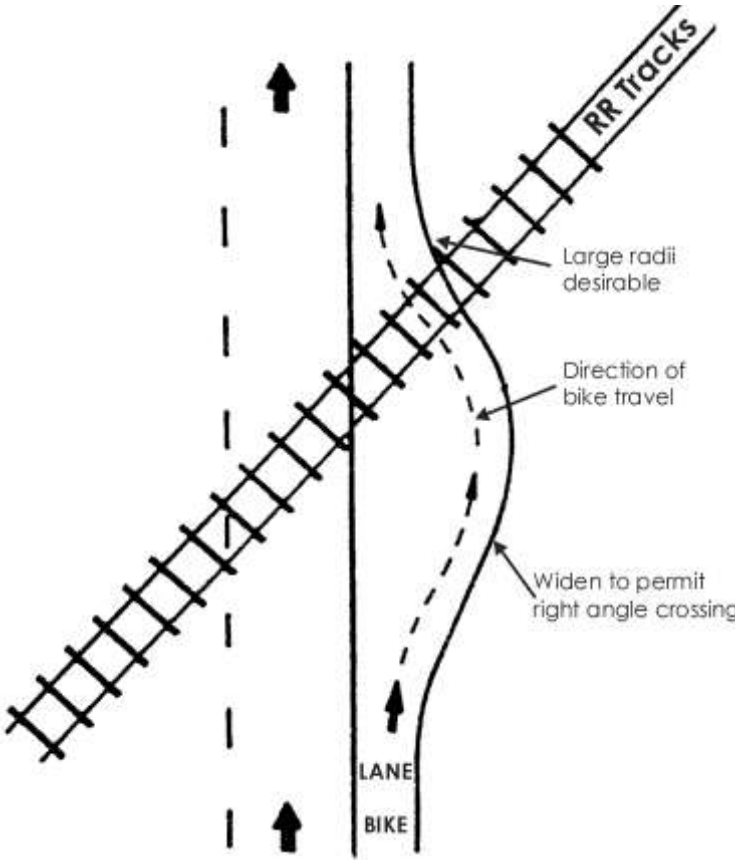
Special consideration should be given to the crossing surface and to the flangeway depth and width. Pavement should be maintained, so ridge build-up does not occur next to the rails. Rubber or concrete crossing materials are longer lasting and require less maintenance than wood or asphalt. Appropriate signs should be installed to warn bicyclists of the crossing and any dangers or hazards.

For off-road Shared Use Paths, it is also desirable to cross at 90 degrees. When it is not possible to cross at 90 degrees, the recreational trail should be widened to allow the cyclist to cross at as close to 90 degrees as possible or if an angle less than 45 degrees is encountered, a stop sign should be placed. (See Figure 2.8)

2.10 AT-GRADE RAILROAD CROSSING

FIGURE 2.8 - RAILROAD CROSSINGS





2.11 LAWS AND ORDINANCES

Recreational trail programs need to reflect applicable laws and ordinances. Recreational trail facilities should encourage or require bicyclists, pedestrians, or motorists to operate in a manner consistent with the adopted Rules of the Road as described in the *Uniform Vehicle Code*.

The National Committee on Uniform Traffic Laws and Ordinances, a group of more than 140 individuals involved in the complex problems of highway transportation, has developed and recommended the Uniform Vehicle Code (UVC) as a comprehensive guide or standard for state motor vehicle and traffic laws. In addition, the provisions of the Model Traffic Ordinance (MTO) have been designed as a guide for municipalities to follow in considering the development or revision of their traffic ordinances. Since bicycles are defined as vehicles, familiarity with the provisions in the UVC and MTO is important when developing bicycle facilities. The UVC and state and local laws and ordinances should be reviewed before decisions are made on the type of facilities desired. Sections 1-105, 1-158, 1-184, 11-201, 11-313, 11-1201, 11-1202, 11-1203, 11-1205, 11-1205.1, 11-1209, and 11-1210 of the UVC should be compared with corresponding state and municipal provisions.

The Motor Vehicle Code of Iowa under Chapter 321: Motor Vehicles and the Law of the Road, should also be reviewed and in particular sections 321.1(1), 321.1(3)(C), 321.1(47), 321.234(2-5).

SIDEWALK DESIGN

3.1 SIDEWALK GRADES

1. **Sidewalk Cross-Section Grade:** The maximum cross slope for sidewalks shall be 2%. For sidewalks located across an entrance, the driveway grade may need to be adjusted to meet this maximum. For commercial and other areas where a wide sidewalk creates grade problems for access drives, it should be noted that only the minimum sidewalk width (4') must be constructed at a maximum 2% cross slope across the entrance. The remaining width of the sidewalk may be constructed at a grade closer to that of the drive. For commercial entrances, the portion of the sidewalk that crosses the driveway should be delineated by joint lines so it is clear where the sidewalk crosses the entrance. (See Figure 2.14 and Chapter 5, Section 5, Figure 5.16A, Figure 5.16B, and Figure 5.17).

2. **Sidewalk Longitudinal Grade:** The grade of the pedestrian sidewalk shall not exceed the grade established for the adjacent roadway. However, along roadway grades which are less than 5%, the sidewalk longitudinal grade may be steeper than the roadway, provided the sidewalk longitudinal grade is less than 5%.

3. **Parking:** The parking grade (between the sidewalk and street) shall be a minimum of 2% for parking widths 10' wide or less and 4% for parking width greater than 10' unless the Jurisdiction approves a special grade.

3.2 SIDEWALK RAMPS

1. General

Federal and State laws requires that curb ramps be installed at all intersections and at certain mid-block locations on all new or reconstructed curb and sidewalk projects.

The predominant ramp conditions, perpendicular, parallel, and combination are shown in Chapter 8, Figure 3.2.

Perpendicular curb ramps are considered the most desirable since they do not require a pedestrian to travel across the ramp area if they do not intend to make use of it. However, if it is not possible to construct a perpendicular curb ramp because of right-of-way constraints, parallel or combination ramps may be used. Perpendicular curb ramps should be used for all new construction.

Diagonal ramps are perpendicular ramps located at the midpoint of a curb return or radius. Diagonal ramps require the pedestrian to enter the intersection at the corner (possibly outside of the crosswalk). Drivers may not anticipate this maneuver, therefore diagonal ramps are only permitted in alterations of existing sidewalks where other designs cannot be accommodated.

3.2 SIDEWALK RAMPS (Continued)

Blended transitions are achieved by depressing the entire curb radius to street level. This results in a flat platform throughout the entire area behind the radius. If blended transitions are used, special consideration needs to be given to potential problems with drainage (and ice) due to the large level area created at street elevation.

2. Perpendicular Curb Ramps

Perpendicular curb ramps shall have a running slope that cuts through the curb at right angles or meets the gutter grade break at right angles. Perpendicular curb ramps shall have:

A. Running Slope: The running slope shall be 5% minimum and 8.3% maximum.

B. Cross Slope: The cross slope shall be 2% maximum. Exception: This requirement shall not apply to mid-block crossings or when the street grade exceeds 2%.

C. Landing: A landing 4 feet minimum by 4 feet minimum shall be provided at the top of the curb ramp and shall be permitted to overlap other landings and clear floor or ground space. Running and cross slopes shall be 2% maximum. Exception: Running and cross slope requirements shall not apply to mid-block crossings.

D. Flares: Flared sides with a slope of 10:1 maximum, measured along the curb line, shall be provided where a circulation path crosses the curb ramp.

3. Parallel Curb Ramps

Parallel curb ramps shall have a running slope that is in-line with the direction of sidewalk travel.

A. Running Slope: The running slope shall be 2% minimum and 8.3% maximum. Exception: A parallel curb ramp shall not be required to exceed 15 feet in length.

B. Cross Slope: The cross slope shall be 2% maximum.

C. Landing: A landing 4 feet minimum by 4 feet minimum shall be permitted to overlap other landings and clear floor or ground space. Running and cross slopes shall be 2% maximum. Exception: Running and cross slope requirements shall not apply to mid-block crossings.

4. Blended Transitions

Blended transitions shall have slopes both parallel and perpendicular to the curb of 2% max.

3.2 SIDEWALK RAMPS (Continued)

5. Common Elements:

A. Width: The clear width of landings, blended transitions and curb ramps, excluding flares, shall be 4 feet minimum.

B. Detectable Warnings: Detectable warning surfaces shall be provided where a curb ramp, blended transition or landing connects to a crosswalk.

C. Surfaces: Storm sewer intakes, grates, access covers, or other appurtenances shall not be located on curb ramps, landings, blended transitions, and gutter areas within the pedestrian access routes.

D. Grade Breaks: Grade breaks shall not be permitted on curb ramps, blended transitions, landings and gutter areas within the pedestrian access route. Surface slopes that meet at grade breaks shall be flush.

E. Changes In Level: Vertical changes in level shall not be permitted on curb ramps, landings or gutter areas within the pedestrian access route.

F. Gutter Area: The grade break between the gutter area and street at the foot of a curb ramp shall not exceed 13%.

G. Surface Texture: Ramps shall have a textured, non-skid surface.

H. Clear Space: Beyond the curb line, a clear space of 4 feet minimum by 48 inches minimum shall be provided within the width of the crosswalk and wholly outside the parallel vehicle travel lane.

3.3. DETECTABLE WARNING SURFACES

Detectable warnings shall consist of a surface of truncated domes aligned in a square grid pattern.

1. **Dome Size:** Truncated domes in a detectable warning surface shall have a base diameter of 0.9 inches minimum to 1.4 inches maximum, a top diameter of 50% of the base diameter minimum to 65% of the base diameter maximum, and a height of 0.2 inches.

2. **Dome Spacing:** Truncated domes in a detectable warning surface shall have a center-to-center spacing of 1.6 inches minimum and 2.4 inches maximum and a base-to-base spacing of 0.65 inches minimum measured between the most adjacent domes on the square grid.

3. **Contrast:** Detectable warning surfaces shall contrast visually with adjacent walking surfaces whether light on dark or dark on light.

3.3. DETECTABLE WARNING SURFACES (Continued)

4. **Size:** Detectable warning surfaces shall extend 24 inches minimum in the direction of travel and the full width of the curb ramp, landing, or blended transition.

5. **Location:**

A. Curb ramps and blended transitions: The detectable warning surface shall be located at the back of curb line and perpendicular to the line of travel.

B. Railroad Crossings. Detectable warnings shall be located at the outside of each group of tracks that cross a pedestrian access route . The detectable warning surface shall be located so that the edge nearest the rail crossing is 6 feet minimum to 15 feet maximum from the centerline of the nearest rail.

C. Medians and Pedestrian Refuge Islands. Medians and refuge islands shall have detectable warnings. Detectable warnings at cut-through islands shall be located at the curb line, in line with the face of the curb, and shall be separated by 2 foot minimum length of walkway without detectable warnings.

3.4. SIDEWALK THICKNESS

The sidewalk thickness shall be 4" (minimum) of Portland cement concrete. Where the sidewalk crosses the driveway, the thickness shall be 6" (minimum) or the thickness of the driveway, whichever is greater. The 6" thickness also applies to curb ramps.

3.5. SUBGRADE

The subgrade shall be carefully brought to the elevation of the bottom of the proposed slab. The subgrade in embankments and fill shall be compacted in a maximum lift of six (6) inches or less. All soft spongy or yielding spots and all vegetation or other perishable matter shall be removed and refilled with suitable material approved by the Jurisdictional Engineer.

3.6 JOINTS

Isolation joints should be installed whenever sidewalk is placed against roadway pavement, parking lots, buildings, or structures. Isolation joints should be placed on the property side of the driveway and sidewalk intersection.

3.7 SPECIAL CONDITIONS

1. **Retaining Walls:** When the sidewalk construction requires the installation of retaining walls to maintain or support adjacent soils or adjacent improvements, the detailed plans shall include their design. Unless otherwise approved by the Jurisdiction, all retaining walls should be located on private property.

2. **Obstructions:** All obstructions are to be removed or relocated except for those that are impractical to move, i.e.: telephone/power poles needed for the integrity of the system and ornamental trees. In new subdivision areas, these items should never occur but in older, built up areas they will have to be addressed. In the case where the sidewalk must be shifted a 5:1 taper to and away from the obstruction with a straight section adjacent to the obstruction should be followed.

3. **Combination Sidewalk/Recreational Trail:** Where a combination sidewalk/recreational trail is required the minimum width shall be in accordance with Chapter 8, Section 2, 2.3-1.A. In the design of a combined facility, particular attention should be paid to maintenance of proper lateral clearances. The most common lateral clearance obstructions are trees, bushes, utility poles, parking meters, signs, drain grates, street furniture, fencing, driveways, landscaping materials, and intersections. Also, if combination is desired, signing and stripping should be used to minimize conflict and shall follow AASHTO criteria.

4. **Surface gaps at rail crossings:** Where the pedestrian access route crosses rail systems at grade, the horizontal gap at the inner edge of each rail shall be constructed to the minimum dimension necessary to allow passage of railroad car wheel flanges and shall not exceed 2.5 inches.

   EXCEPTION: On tracks that carry freight, a maximum horizontal gap of 3 inches shall be permitted.

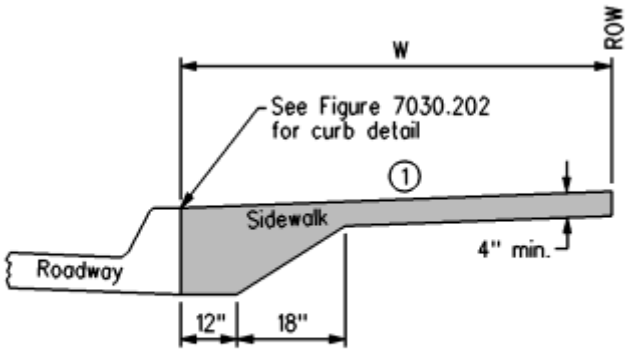
3.7 SPECIAL CONDITIONS (Continued)

5. **Medians and pedestrian refuge islands:** Medians and pedestrian refuge inland in cross walks shall be cut through level with the street or have curb ramps, which meet ADA accessibility requirements. Where the cut-through connects to the street, edges of the cut-through shall be aligned with the direction of the crosswalk for a length of 24 inches minimum. Where signal timing is inadequate for full crossing of all traffic lanes or where the crossing is not signalized, cut through medians and pedestrian refuge islands shall be 72 inches minimum length in the direction of pedestrian travel.

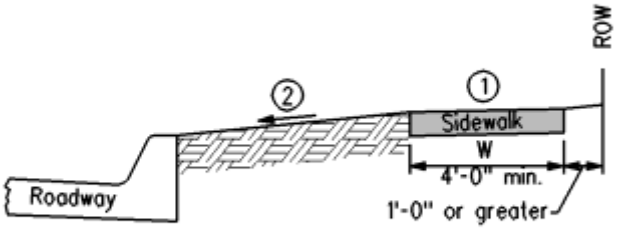
3.8. PERMITS

The builder shall obtain sidewalk permits from the Jurisdiction prior to construction of any sidewalk. The Jurisdiction shall be notified 24 hours before starting work for inspection and approval of the work.

FIGURE 3.1 - CLASSES OF SIDEWALKS AND RECREATIONAL TRAILS
(Corresponds to Figure 7030.201 in the SUDAS Standard Specifications)



CLASS A SIDEWALK
(Sidewalk extends from back of curb to ROW)



CLASS B SIDEWALK

CLASS C SIDEWALK

① Maximum cross slope of sidewalk (including sidewalk through driveway) is 2%.

② Parking slopes:
Less than 10 feet wide: 1/4 inch per foot
Over 10 feet wide: 1/2 inch per foot.

Special grade may be specified in the contract documents.

W = Sidewalk width as specified in the contract documents.

FIGURE 3.2 - CURB RAMPS OUTSIDE OF INTERSECTION RADIUS
(Corresponds to Figure 7030.205 in the SUDAS Standard Specifications)

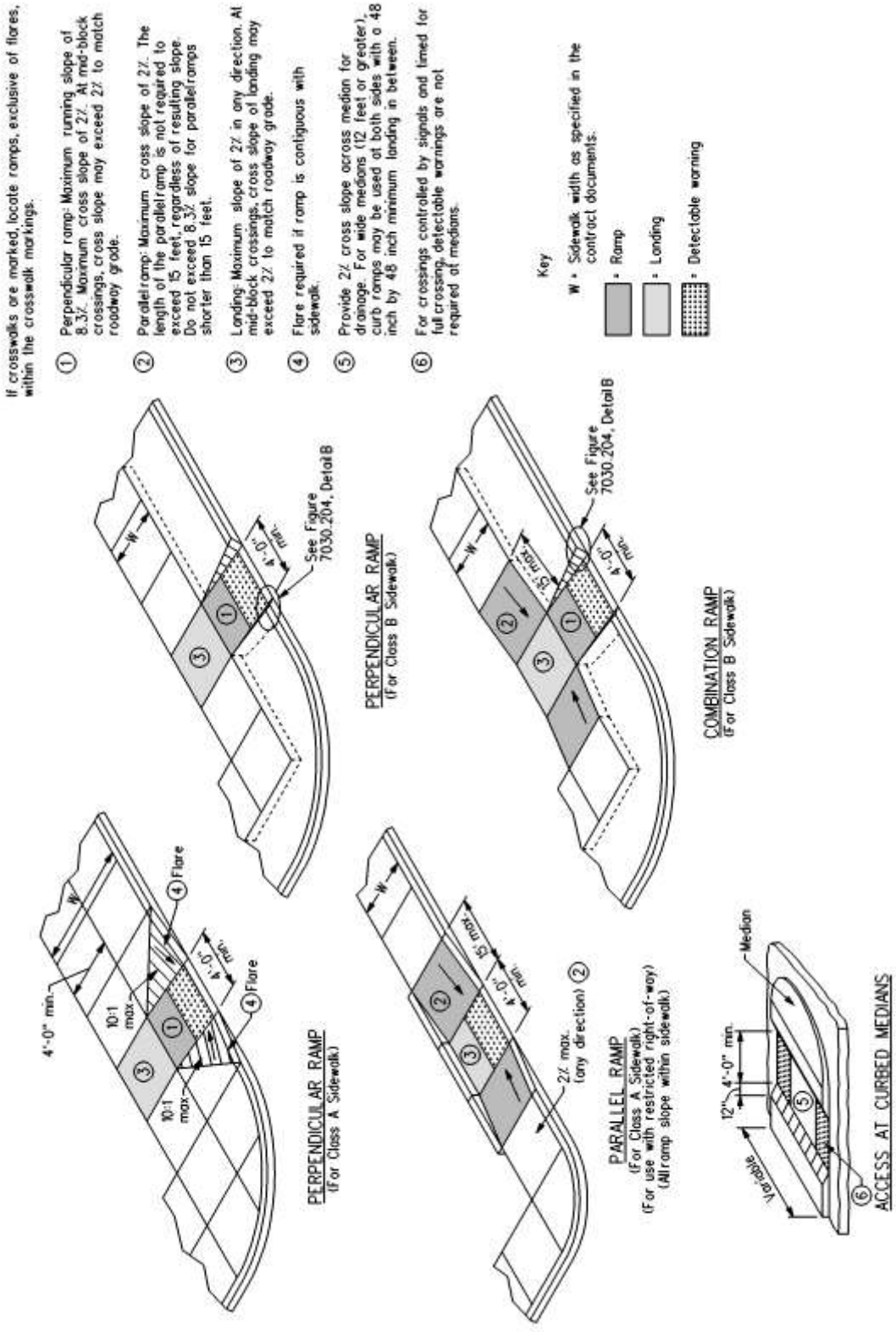


FIGURE 3.3 - CURB RAMPS WITHIN INTERSECTION RADIUS FOR CLASS A SIDEWALK
(Corresponds to Figure 7030.206 in the SUDAS Standard Specifications)

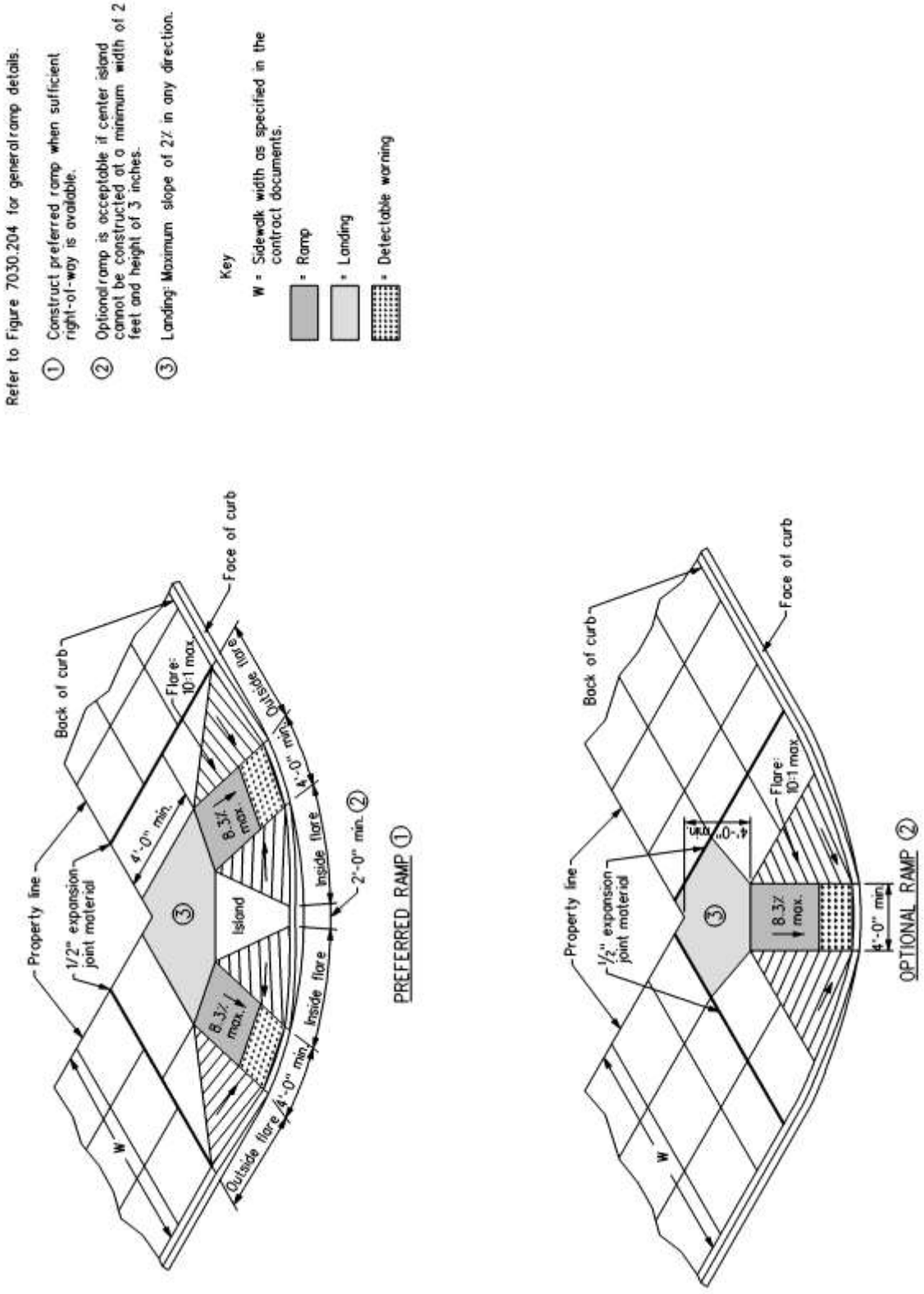


FIGURE 3.4 - CURB RAMP WITHIN INTERSECTION
RADIUS FOR CLASS B OR C SIDEWALK
(Corresponds to Figure 7030.207, Sheet 1 in the SUDAS Standard Specifications)

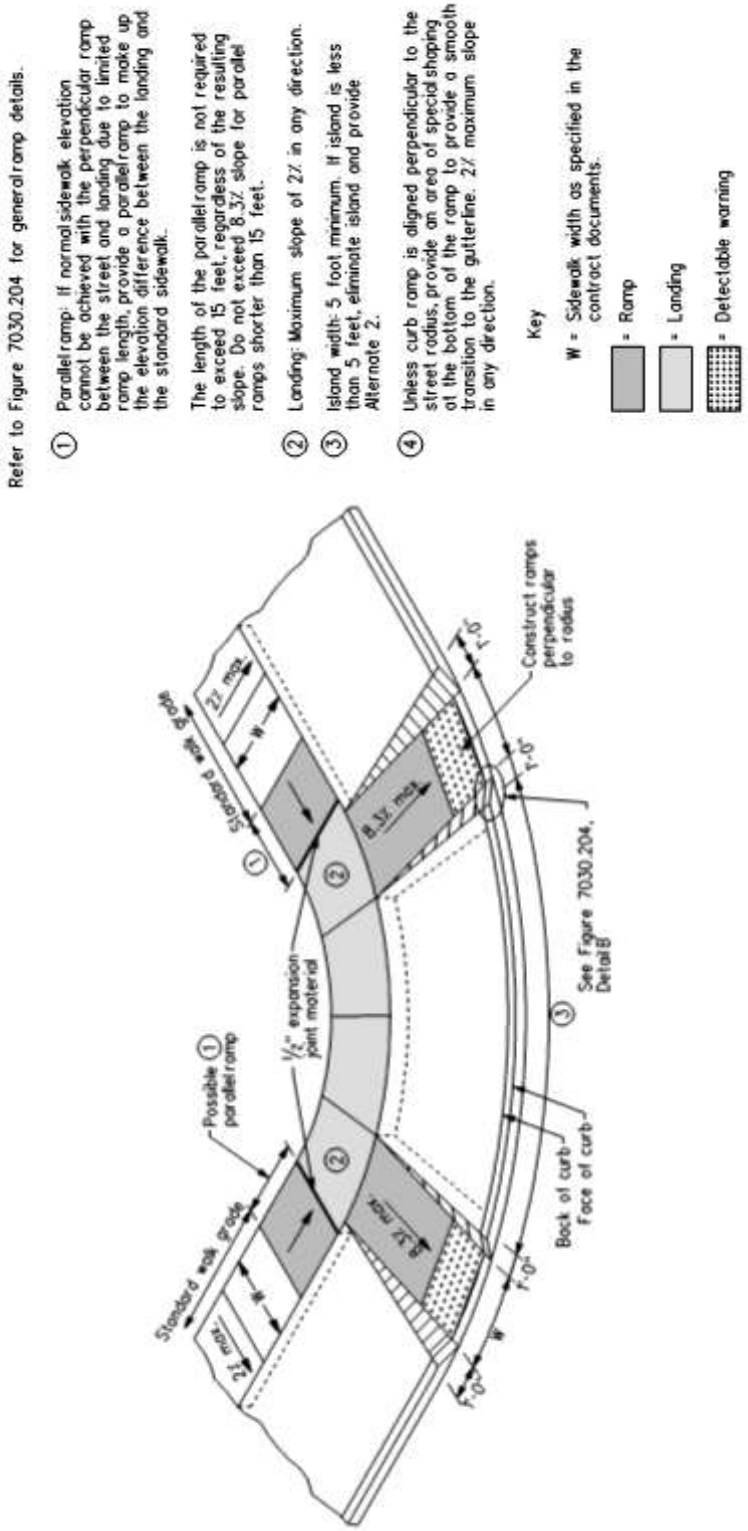


FIGURE 3.5 - ALTERNATE CURB RAMPS WITHIN
INTERSECTION RADIUS FOR CLASS B OR C SIDEWALK
(Corresponds to Figure 7030.207, Sheet 2 in the SUDAS Standard Specifications)

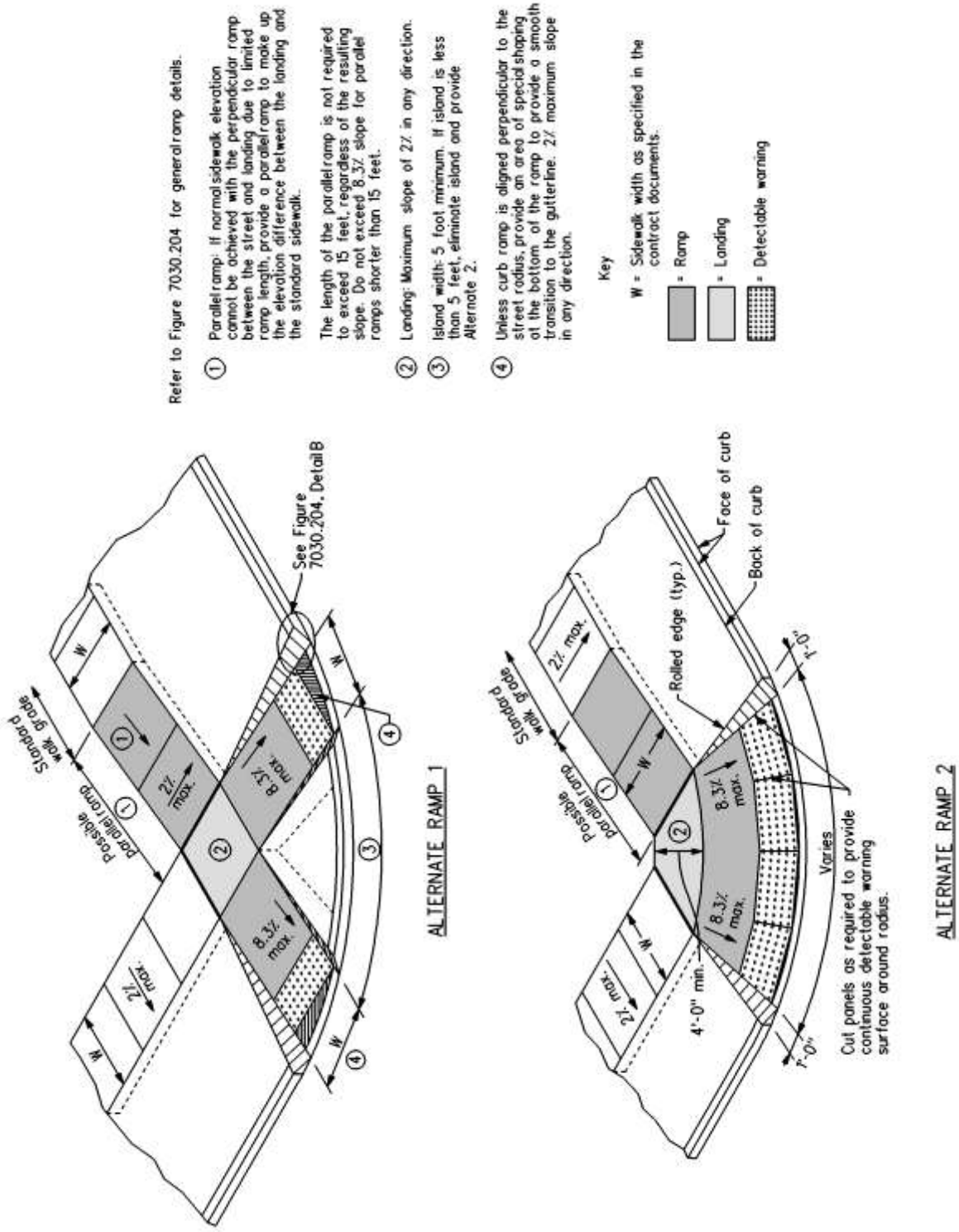
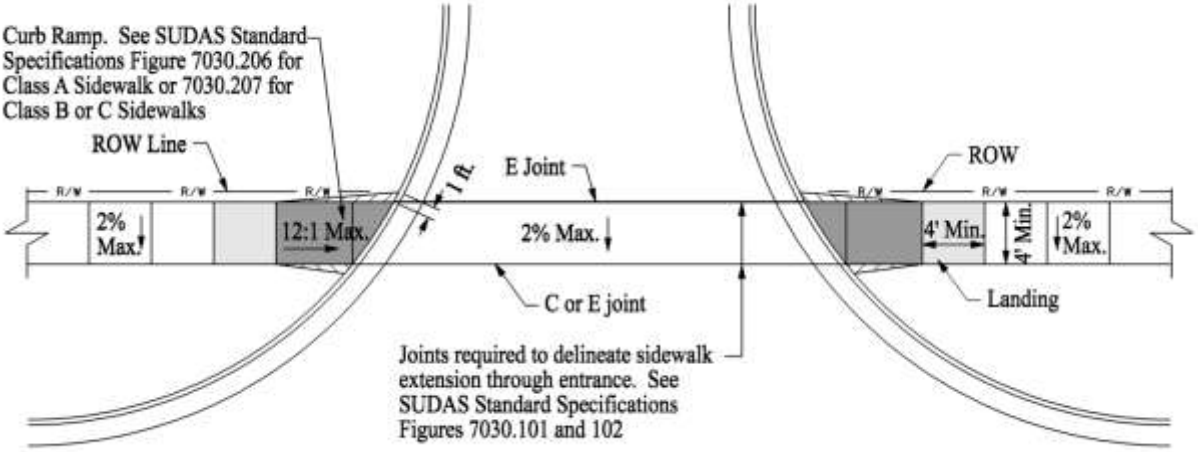


FIGURE 3.6 - TYPICAL COMMERCIAL ENTRANCE WITH CURB RAMP



PLAN VIEW - TYPICAL COMMERCIAL ENTRANCE WITH CURB RAMP

SIDEWALK LONGITUDINAL AND TRANSVERSE SLOPE TRANSITION DISTANCE

If the above grade restrictions required a depressed sidewalk through the driveway, a transition section shall be provided between the normal sidewalk grade and the depressed section. The transition section shall vary both longitudinally and transversely. As a general rule, use the following transition lengths:

Elevation Difference from normal sidewalk grade	Transition distance
1 to 2"	8'
2 to 4"	12'
4 to 6"	16'
Greater than 6"	Desirable max. slope is 16:1 Absolute max. slope is 12:1

THIS SECTION IS INTENTIONALLY LEFT BLANK!

PLEASE SEE WWW.IOWASUDAS.ORG FOR SAMPLE EASEMENT FORMS.

DESIGN REFERENCE MATERIAL

5.1 DESIGN REFERENCE MATERIAL

1. "Policy on Geometric Design of Highways and Streets, 2001", American Association of State Highway and Transportation Officials.

2. "Standard Road Plans", Iowa Department of Transportation.

3. "Guide for the Development of Bicycle Facilities", 1999. American Association of State Highway and Transportation Officials

4. Iowa Department of Transportation: "Standard Specification for Highway and Bridge Construction". – Most current version

5. Federal Highway Administration

   "Manual on Uniform Traffic Control Devices" and "The Traffic Control Devices Hand Book". – Most current versions.

   "A Recreational trail Criteria Digest", 1979.
   "National Bicycling and Walking Study", 1991.

6. National Committee on Uniform Traffic Laws and Ordinances.
   "Uniform Vehicle Code" (UVC).

7. Iowa State University

   "Design of Urban Streets".

8. Recreational trail Institute of America

   "Recreational trail Coordinators and Programs: Why, How, What, and Who", 1991.

9. California Department of Transportation.

   "Highway Design Manual".

10. McGraw-Hill

    "Time-Saver Standards for Landscape Architecture".